新技術振興渡辺記念会殿 平成 30 年度下期 科学技術調査研究助成

「アジア地域における宇宙技術を用いた海洋観測実態と 非政府監視ツールの活用可能性調査」

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一般財団法人日本宇宙フォーラム

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1. 目的と調査方法

1.1. 背景と目的

海洋立国である我が国にとって海洋での活動は不可欠であり、世界が連携して海上安全を確保することが重要である。近年では、海洋開発、東シナ海での領有権問題、南シナ海中国人工島、サンゴ密漁、海上交通路(シーレーン)の安全確保、海賊対策など、非常に広範な課題を抱えており、科学技術も活用してこれらの問題に取り組んでいくことが求められている。これまで地上からのレーダや航空機等を用いて船舶の安全確保や位置把握等を行ってきたが、人工衛星は広域を把握できるため、宇宙を利用したグローバルな船舶の把握が急速に注目を集めている。

平成 26 年に新技術振興渡辺記念会殿の助成により、米国における海洋状況監視 (Maritime Domain Awareness: MDA)の調査を実施し、日本として初めて米沿岸警備隊 MIFC-LANT と米南方軍 JIATF-South を視察調査し、米国における MDA の日々の監視体制 と運用実態についてある程度明らかにすることができた。また、平成 29 年に新技術振興渡辺記念会殿の助成により、欧州における MDA の調査を実施し、船舶監視に限定せず海洋観測全般に係わる国際協力体制を目指そうとしている欧州の各機関による海洋観測の連携体制についての全容を整理した。

他方、アジア太平洋地域には、日本を含め、インドネシア、フィリピン、マレーシア、ベトナム、シンガポール等の海洋国家があり、漁船や輸送船の急激な増加に伴い、同地域における海洋観測の重要性はますます高くなってきている。各国では、それぞれ沿岸警備隊等の組織が他組織と連携して海洋状況の観測を行ってきているが、フィリピンやマレーシア等のいくつかの国に米国の海洋観測のWebGISプラットフォームである

「Seavision」が導入され、その活用が始められているという情報がある。また、Global Fishing Watch などの非政府の団体が民間の IT 企業 (グーグル社等) と連携して船舶 監視ツールなどを提供してきており、それらの活用も進んでいくことが想定される。なお、インドネシアでは既に活用されているという情報がある。本調査研究では、アジア太平洋地域の海洋国家における海洋監視の運用実態をヒアリングやワークショップにより把握する他、非政府・市民観測リソースによる海洋監視プラットフォームを整理し、それらの活用の可能性について考察した。

1.2. 調査研究方法

1.2.1. 各国における海洋関連技術専門家へのヒアリング

2018 年 11 月 27、28 日にシンガポールで開催された「15th Annual Global MDA: Maritime Security & Coastal Surveillance」に参加し、インドネシア、フィリピン、マレーシア、タイの海洋関係者からヒアリングを行った。また、2019 年 7 月にフィリピンを訪問し、フィリピン農業省 漁業・水産資源局(BFAR) からヒアリングを行った。

1.2.2. 日本における国際ワークショップの開催

2019 年 2 月 8 日に東京において、「宇宙を用いたグローバルな海洋監視の最新技術動向と将来に関するシンポジウム~本格的な宇宙利用と Society5.0 が切り開く海洋の未来~」を開催し、今後需要が高まるとみられる国内外の民間/NGO による海洋監視の取り組みについての情報収集を行った。特に、民間/NGO ベースの海洋監視プラットフォーム、例えば、米国の CSIS、Global Fishing Watch、Pew Charitable Trusts、Vulcan Inc. などが公開されてきており、高分解能の衛星データ、AIS データ、オープンな情報も含め、国のインテリジェンス機関よりもより広い情報を用いて付加価値を付け、即効的な提供を行ってきている。各国の行政機関も民間のプラットフォーム活用を検討する他、民間と協力してプラットフォームを開発する動きがあるなど、民間/NGO の活用が顕著になってきている。急速に能力を高めつつある、それらのプラットフォームの情報収集を行った他、将来の利活用の可能性について議論した。また、日本の民間による海洋監視への取り組み及び将来の可能性についても議論した。

また、2019 年 10 月 4 日に東京において、「第 2 回 宇宙を用いたグローバルな海洋監視に関するシンポジウムーアジア太平洋地域における海洋宇宙協力に向けて一」を開催し、アジアの海洋国家において、海洋で漁業等の監視オペレーションを行っている組織から講演者を招聘し、実際のオペレーションの観点から将来の宇宙技術適用への期待についての情報収集を行った。また、我が国の先進技術動向に関する講演に加えて、米国の宇宙技術を用いた海洋監視技術を有する組織からも講演者を招聘し、米国から見たアジア太平洋地域における海洋宇宙協力への期待についても情報を収集した。ユーザとなりえるアジア太平洋地域の漁業等監視オペレーション組織と日米の宇宙海洋技術プロバイダとの議論を通じて、将来オペレーションに適用可能な効率的・効果的な海洋宇宙協力の未来についての議論を行った。

① 「宇宙を用いたグローバルな海洋監視の最新技術動向と将来に関するシンポジウム ~本格的な宇宙利用と Society5.0 が切り開く海洋の未来~」

➤ 主催

(公財) 笹川平和財団海洋政策研究所、(一財) 日本宇宙フォーラムによる共催

➢ 開催日・開催場所

2019 年 2 月 8 日 (金) 於:笹川平和財団海洋政策研究所 国際会議場 (東京・ 虎ノ門)

▶ 講演者

内閣府総合海洋政策推進事務局、多摩大学大学院ルール形成戦略研究所、一般 社団法人日本宇宙安全保障研究所、宇宙航空研究開発機構(JAXA)、(株) 日本 海洋科学、海洋研究開発機構(JAMSTEC)、米 Naval Research Laboratory、Center for Advanced Defense System (C4ADS)、Vulcan Inc、OceanMind

- 講演資料添付1に示す。
- ② 「第2回 宇宙を用いたグローバルな海洋監視に関するシンポジウムーアジア太平 洋地域における海洋宇宙協力に向けてー」
 - ▶ 主催

(公財)笹川平和財団海洋政策研究所、(一財)日本宇宙フォーラムによる共催、 Secure World Foundation (協力)

▶ 開催日・開催場所 2019年10月4日(金) 於:笹川平和財団海洋政策研究所 国際会議場(東京・虎ノ門)

▶ 講演者

宇宙航空研究開発機構(JAXA)、株式会社 Synspective、東京大学 空間情報科学研究センター/株式会社スペースエッジラボ、公益財団法人笹川平和財団海洋政策研究所、国立研究開発法人 水産研究・教育機構、Institute for Marine Research and Observation/Ministry of Marine Affair and Fisheries (インドネシア)、Bureau of Fisheries and Aquatic Resources (BFAR)/Department of Agriculture (フィリピン)、Malaysian Maritime Enforcement Agency (MMEA) (マレーシア)、Observer Research Foundation (インド)、元 Pacific Islands Forum Fisheries Agency 関係者、Secure World Foundation、US Mission to ASEAN (USASEAN)

講演資料添付2に示す。

1.2.3. 我が国による技術協力可能性の検討

ヒアリング及び国際ワークショップで得られた情報を基に、我が国と各国でお互いに メリットとなる海洋観測・データ処理等技術の共同研究の可能性について整理した。ま た、各国の海洋観測のオペレーションに我が国の宇宙技術やデータを提供することによ り、オペレーションの改善につながる協力について検討を行った。また、非政府が提供 する海洋監視プラットフォームの各国による活用状況を把握し、我が国での活用の可能 性について考察した。

- 2. 非政府監視ツールの現状調査
- 2.1 Center for Advanced Defense System (C4ADS)
- ・ グローバルな国際セキュリティイシューにデータ分析やエビデンスベースの報告を基に 取り組むための NPO。
- ・ 商用データを含むオープンソースを用いて、環境問題や、不法取引、違法採掘など監視している。南シナ海や東シナ海の不審船、違法漁業、違法取引、武器取引などにも注力している。海洋監視をオンデマンド(24 時間レベル)で行っている。
- ・ WINDWARD が提供するプラットフォームを活用。北朝鮮の違法取引を監視する為のツールとして用いている。船の情報として、AIS などから方向や速度を得て、何処から何処に向かっているか、港の情報から、積荷は何かなどを得ている。港での船の発着、積み荷の移動、クレーンの動きなどを把握、活動状況を長期判断。
- ・ NPO として情報公開するだけで無く、米国務省などの要請に基づく解析も実施。国のインテリジェンス機関よりもより広い情報を用いて付加価値を付け、即効的な提供を行うことを強みとしている。また、最新の技術を取り入れる能力もある。顧客は国務省の他に、国連や世界銀行もある。
- ・ 主な活動:①北朝鮮の違法取引の監視、②違法・無報告・無規制(IUU)漁業の監視、③ 石油タンカーの正常運行の監視。
- ・ 分析手法:①船舶活動の分析(AIS、衛星画像、港湾データを組み合わせてハイリスク船舶を検知)、②ネットワーク分析:船舶のオーナーの変遷、不法活動を過去にした組織などのデータベースを分析。



WINDWARD と呼ばれるプラットフォームで「瀬取り」などを検知

- 将来の重点技術開発分野:
 - アルゴリズムによる SAR 衛星データを用いた積荷の動向検知、港湾での船舶特定
 - 船舶から漏れる無線電波の衛星で検知
 - 複数の小型衛星コンステレーションによるリアルタイム船舶活動監視

2.2 Vulcan Inc

- ・ マイクロソフト共同設立者の Paul G. Allen 氏が設立した会社。
- スマートでデータを活用したアプローチで、グローバルなチャレンジに取り組むプロジェクトを実施。
- ・ リアルタイムで意思決定ができる「SkyLight」と呼ばれる船舶監視プラットフォームの開発を行っている。船舶の動きの監視、船舶情報提供、船舶活動、分析情報を提供(海外政府に調達ベースで導入?)。また、「Sea Around Us」の活動にも協力。
- ・ 衛星データ(光学、SAR)を活用し、ディープラーニングでのパターン予測などを実施



SkyLight のウェブサイト(SkyLight には会員以外はアクセス不可)

・ AIS/VMSとSAR画像や赤外画像の組み合わせで dark vesselを検知。



· 「瀬取り」が疑われるポイントについてアラートを表示



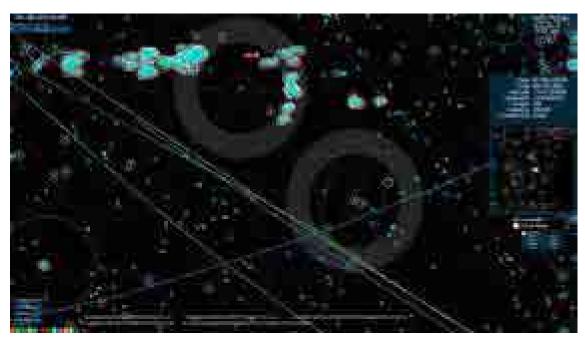
・ 将来的な技術開発:船舶航行パターンからのランデブー航行の検知



2.3 OceanMind

- ・ オーシャンマインドは NPO。最新技術により世界中の政府当局や水産バイヤーに漁業の状況を見える化し(システムで自動アラート送信)、世界の漁業をプロテクトすることが任務。
- ・ 海洋の活動をより網羅的かつ詳細に把握するためには AI の活用が不可欠。
- ・ 公式な統計によると世界の漁獲の33%が過度の消費(このままだと持続的な漁業ができなくなるレベル)だが、統計に反映されない IUU 漁業を考慮するとグローバルな危機。
- ・ 活用しているデータソース:
 - 船舶追跡データ
 - 衛星データ
 - 港湾データ
 - 漁獲資料
 - 船舶登録
 - 漁業ライセンス
 - 漁業規制・レギュレーションのデータベース。

・ AIS/VMSと SAR画像や赤外画像の組み合わせでdark vesselを検知。



黄色の〇の中が dark vessel

- ・ 船舶追跡データと光学衛星データの組み合わせで「瀬取り」を検知。
 - 船舶追跡データを用いて特定時間の複数の船舶の「瀬取り」が疑われるスピー ドパターンをディープラーニングで特定
 - その海域を高分解能光学衛星で撮像



赤と青が各船舶のスピードパターン

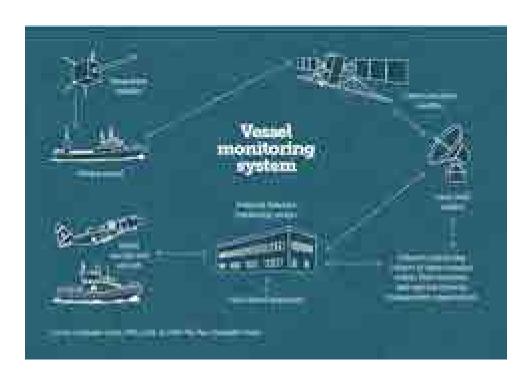


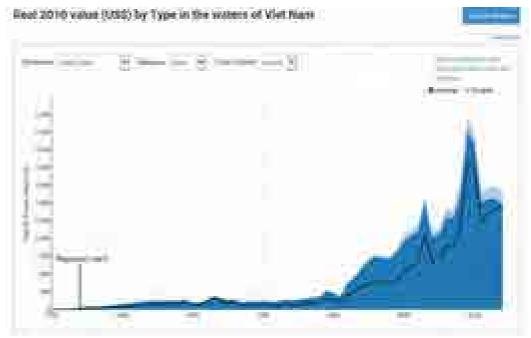
「瀬取り」を撮像した衛星画像

・ 将来的には船舶から漏れる無線電波(航行レーダ、VHF通信、衛星電話、電子レンジ)を衛星で検知できる可能性(英国近海で実証試験中)。

2.4 Pew Charitable Trusts

- ・ 研究、社会政策のための NPO で、世論研究、アート・文化、社会イニシアチブ、環境、健康、社会政策(政府、コンシューマ)の分野を重点的に活動。違法漁業の撲滅もプロジェクトテーマの一つ
- ・ 1999 年に「Sea Around Us」という漁業データベースを立ち上げ、現在も協力
- ・ 通信衛星や測位衛星を用いた Vessel Monitoring System (VMS)の普及活動を実施





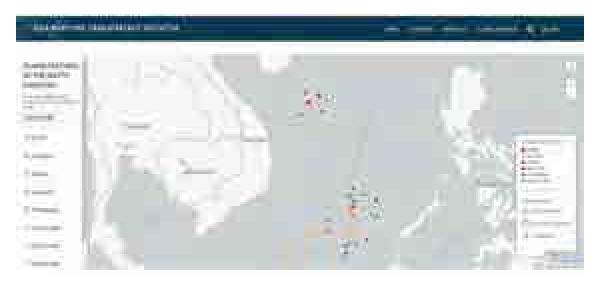
Sea Around Us の海域毎の漁獲統計データ

- 2.5 Center for Strategic and International Studies (CSIS)
- ・ 米国の民間シンクタンク。防衛、安全保障、外交政策、国際関係、政策提言などの活動 を実施
- ・ 「Asia Maritime Transparency Initiative」というプログラムを展開し、南シナ海、東シナ海

の中国の違法行為をウェブを通じて公開している。海洋のオイル/ガス開発、中国の軍事バランス、各国の海域、島の占拠状況などをマップ化

https://amti.csis.org/

- ・ 南シナ海の島の建設物等の衛星画像の最新情報を公開。建設物等は既に特定出来ているので、これからは AIS 信号を出していない(Dark Ship)中国の艦艇や、漁船を追跡することが課題。
- ・ 現状は Digital Globe 社の光学データを毎朝確認(分析者は 3 名。SAR データは利用していない)



Asia Maritime Transparency Initiative の島の占拠状況マップ



Asia Maritime Transparency Initiative のスプラトリ諸島の監視(高分解能光学衛星画像)

2.6 The Ted Waitt Foundation

- ・ 海洋保護や持続可能な漁業をミッションとするファウンデーション。元 Gateway 社の CEO である Ted Waitt 氏が設立
- ・ 様々な海洋関連プロジェクトへのファンディングを通じ、持続可能な漁業のための活動を 実施
- ・ National Maritime Intelligence-Integration Office (NMIO)と連携



Ted Waitt Foundation とパートナー組織の活動 (取組に関する)マップ http://waittfoundation.org/interactive-map/

3. アジア各国の海洋監視における宇宙技術の活用調査

3.1. インドネシア

インドネシアの 11 の漁業管理区域 (WPP) はそれぞれ固有の特徴を持っている。イン ドネシアにおける海洋資源のモニタリング、特に、インドネシアの海域における漁業活 動の漁船モニタリングは、衛星レーダデータを活用して実施されてきた。Bali Radar Ground Receiving Station (BARATA)はインドネシアの海域のモニタリングに多大な貢 献をしてきた。CosmoSkymed や Radarsat を含むレーダデータが活用されてきている。 両衛星データは相互に補完し合うもので、BARATA で直接受信を行うことができる。加 えて、Sentinel-2 といったフリーのデータの活用により、BARATAは IUU 漁業の管理や 監視で高いレベルでの解析ができるようになった。IUU漁業により、次のような大きな 影響が出てくる:①年間 2600 億インドネシアルピア相当の損失、②漁業従事者数の 50% の減少と 115 の海産物輸出者の廃業、③サンゴ礁の 30.45%に損害及び 25%の漁獲量に 相当する乱獲。インドネシアにおいて、IUU 漁業の監視に重要な役割をになる機関は、 海洋水産省 (MMAF)、警察、インドネシア沿岸警備隊、海軍、運輸省である。MMAF の下 で BARATA は運用され、インドネシアのユーザ(MMAF、インドネシア沿岸警備隊、海軍、 空間タスクフォース、海事調整府)に2時間以内に分析結果を提供するなど非常に効果 を上げている。海洋での活用における将来の宇宙技術のニーズは低コスト、高頻度観測、 高分解能、準リアルタイム入手性を含む衛星技術になる可能性がある。また、監視(違 法漁業、オイル流出)、積み替え/瀬取り、海運、プランニング・マネジメント (海洋 空間プランニング、養殖)を含む海洋での活用が期待される。

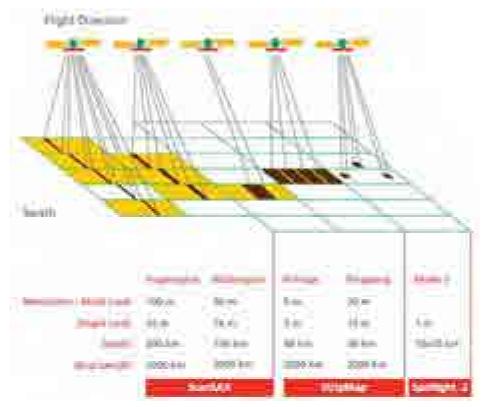
3.1.1. 活用されている衛星データ

インドネシアの Institute for Marine Research and Observation/Ministry of Marine Affair and Fisheries では、衛星データを活用した IUU 監視活動が行われている。具 体的には、イタリアの Cosmo-Skymed、カナダの Radarsat-2、欧州の Sentinel-2(無償 のフリーデータ)といったレーダ衛星のデータ活用が行われている。そのうち、

Cosmo-Skymed と Radarsat-2 は準リアルタイムでのデータ取得が行われており、特定の 海域をオンデマンドで撮像し、IUU 監視活動に役立てている。インドネシアに設置され ている BARATA と呼ばれる X バンドの衛星アンテナによってリアルタイムで受信が行わ れ、船舶監視システム(VMS)や自動船舶識別装置(AIS)情報と合せて、付加価値情報

として船舶の検知や分析が行われている。





Cosmo-Skymed の衛星データ

 $(http://www.\ e-geos.\ it/products/pdf/csk-product\%20handbook.\ pdf)$

Beam modes	Nominal swath width (km)	Maximal spallal resolution (m)
Spotlight	18	
Fine	-50	8
Wide Fine	150	8
Standard	100	25
Wide	150	25
ScanSAR Narrow	300	50
ScanSAR Wide	500	100
Ocean Surveillance	530	Variabie

Radar sat-Z の関星アータ

(http://www.asc-csa.gc.ca/eng/satellites/radarsat/technical-features/radarsat-comparison.asp)

3.1.2. IUU 監視オペレーションの実態

以下のように、Ministry of Marine Affair and Fisheries (MMAF) のみならず、インドネシア沿岸警備隊や海軍等、複数の政府系組織が協力して IUU 監視活動が行われている。



MMAFでは、前述の海外のレーダ衛星の撮像画像を活用する他、インドネシア宇宙航空研究所(LAPAN)の衛星 AIS 等も活用しつつ、船舶管理・監視活動を行っている。



3.1.3. 将来の期待される宇宙技術

① 衛星技術

- 低コスト、高頻度観測、高分解能データ

- 準リアルタイム監視
- シンプルなアクセス

② 海洋アプリケーション

- 監視活動アプリケーション: IUU 監視、オイル流出監視、瀬取り監視、海洋交通、人身売買監視
- 計画管理アプリケーション:海洋空間計画、環境保全エリア、海洋養殖
- 海洋/沿岸リソース:潜在的漁業エリア (PFG)

3.2. フィリピン

フィリピン農業省/漁業・水産資源局(BFAR)は、共和国法第10654号第14条で規定されたモニタリング、規制、監視(MCS)活動の一部として、船舶監視システム(VMS)の運用、パトロール船の展開、オンボード漁船監視システムの導入を行ってきている。MCS活動はすべてのフィリピン海域におけるすべてのフィリピン国籍の遠洋漁船に適用される。MCSシステムは、地方自治体、漁業海洋資源管理委員会、民間、その他関連機関と連携し、フィリピン海域の漁業及び海洋資源が持続的に管理され、フィリピン市民の利益のために保護されるよう農業省によって運用されている。

3.2.1. 活用されている宇宙技術

船舶監視システム (VMS)

フィリピンにおける VMS の導入は 2009 年に BFAR によって行われた。フィリピンの特定 の海域 (SMA-HSP1) を運航する主要なフィリピン漁船 (現在、313 隻) に 2012 年から 搭載が義務付けられ、通信衛星経由で漁船の管理等に用いられている。



② 自動船舶識別装置(AIS)

National Coast Watch Council (NCWC)から AIS を搭載した商船のモニタリング情報が BFAR に送られ、IUU の監視が行われている。NCWC からは SeaVision (BFAR が運用する 海洋プラットフォームとは別)と呼ばれる海洋監視プラットフォームを用いて、衛星データによる情報、AIS 情報、沿岸レーダによる情報が提供され、監視対象の漁船等の船舶は年々増加しつつある。現在、AIS と VMS による監視は Pilot-2 の段階にあり、将来的には 80 万隻といわれる船舶の統合的監視をめざしている。



③ Visible Infrared Imaging Radiometer Suits (VIIRS) 米国の Suomi National Polar-orbiting Partnership (Suomi-NPP) 衛星に搭載されて

米国の Subility National Potar-orbiting Partnership (Subility NPP) 衛星に搭載されているセンサ VIIRS のデータを用いて、特定の海域の漁船情報の検証が行われている。



3.2.2. IUU 監視オペレーションの実態

BFAR で運用している海洋監視プラットフォームは Integrated Marine Environment Monitoring System (IMEMS)と呼ばれ、VMS による船舶情報、港湾情報、電子レポーティング情報、気象情報、海洋情報などが統合化され、提供される。



3.3. マレーシア

マレーシアは海外の漁船による不法侵入の問題を抱えており、違法漁業、装置によるサンゴ礁への被害などで漁獲の減少、経済的収入の減少、サンゴ礁コミュニティにおける雇用確保の不安定を引き起こしている。また、ダイナマイト漁により、海洋環境に大きな影響を受けている。

3.3.1. 活用されている宇宙技術

マレーシアにおいては主に沿岸(陸上) AIS を用いた船舶の運航情報の管理を行っているが、衛星 AIS の活用も検討されつつある状況である。



3.3.2. 将来の期待される宇宙技術

将来的には光学衛星画像、レーダ衛星(SAR)画像、Visible Infrared Imaging Radiometer Suits (VIIRS) センサによる画像を用い、巡視船、パトロール機、沿岸レーダ、沿岸・衛星 AIS 等のデータを組み合わせ、統合的な船舶監視を目指している。また、今後、宇宙技術の活用が本格的に開始されることから、宇宙技術活用のキャパビルのニーズもある。



3.4. インド

違法・無報告・無規制(IUU)漁業は海洋国家にとって重要な社会経済をグローバルに脅かすものである。2つの大規模海洋生態系(large marine ecosystems)を含む広大な排他的経済水域(EEZ)を有するインドは伝統的に広範囲にわたる IUU 漁業による被害にあっている。インドは EEZ における IUU 漁業を取り締まる法やインフラの適切な監視やパトロールを行う能力を有しているものの、ガバナンスの綻び、不均衡な漁業管理(MCS)、時代遅れの法律などにより、インド EEZ の漁業の脆弱性にほとんど対応できていない。インドにおいて、特に漁船の検知、モニタリングで衛星 AIS、衛星光学・レーダ画像のような宇宙技術の活用について検討の余地がある他、同地域における弱い統治システム、MCS、海洋状況監視(MDA)を強固にするための将来の宇宙技術活用の可能性がある。

3.4.1. 活用されている宇宙技術

① 衛星データ

インド宇宙研究機構(ISRO)がこれまで多くの地球観測衛星を打ち上げてきており、それらの衛星からのデータを用いた船舶の監視等の海洋観測が行われている。ISRO は 1988 年以降、これまでに 24 機の Indian Remote Sensing (IRS)衛星を打ち上げ、そのうち 11 機が民生利用に供されている。また、ISRO は特に海洋観測に特化した OCEANSAT 衛星シリーズを 1999 年から運用しており、2009 年には OCENSAT-2 が打ち上げられ、海色や海上風の観測が行われている。



また、光学の衛星のみならず、雲がかかっている海域や夜間でも観測が可能なレーダを用いた衛星(SAR 衛星)も ISROによって運用されており、RISAT-1(Cバンド SAR)や RISAT-2(Xバンド SAR)といった衛星が運用中である。SAR 衛星は全天候型で船舶を検知することが可能だが、両衛星とも IUU 監視は主な観測対象にはなっていない。

② 船舶監視システム (VMS) 及び自動船舶識別装置 (AIS)

インドにおいては、2009 年に ISRO の Space Application Centre によって VMS システムが開発され、2017 年に VMS が義務付けられている。ISRO は VMS サービス向上のためにインドの地域航法衛星システムを活用し、船舶の監視を行っている。また、国際的に義務付けられている船舶には AIS が搭載されており、74 基の沿岸(陸上)AIS ステーションにより船舶の ID、位置、速度、転舵角などの情報の管理を行っている。沿岸 AIS では海岸から 40 海里程度の沿岸域でしか AIS 信号が受信できないため、それを補完する手段として衛星 AIS システムの活用が進められている。なお、2019 年 8 月にインドの ISRO とフランスの国立宇宙研究センター(CNES)が 10 機の AIS 衛星の共同開発・共同運用を行うことを発表している。

3 Long-Range Identification and Tracking System (LRIT)

国際海事機構 (IMO) は 2006 年から 300 グロストン以上の船舶に LRIT の導入を義務付けており、インドにおいても 2009 年に LRIT データセンターが設置され、データの共有が行われるようになった。LRIT は決まった政府機関のみが情報にアクセス可能な非常にセキュアなものである一方、運用コストが非常に高価なため、IUU 監視には基本的に用いられていない。

4. 考察

4.1. 海洋観測・データ処理等技術等の共同研究及び国際協力の可能性

今回、インドネシア、フィリピン、マレーシア、インドを中心に、各国の宇宙技術を 用いた海洋監視の運用状況について調査を行った。各国、それぞれで技術の活用に関し て能力の違いがあり、活用する衛星も自国で打ち上げ、運用している国と、他国の衛星 に依存している国とがある。以下に、それぞれの宇宙技術を用いた海洋監視の運用につ いて、比較した表を示す。

	衛星データ	衛星 AIS	海洋監視プラットフォーム
インドネシア	他国のSAR衛星	自国の AIS 衛星+	他国の技術により整備
	を活用	他国の AIS 衛星	
フィリピン	VIIRS を検証用	他国の AIS 衛星	他国の技術により整備
	に利用		
マレーシア	今後本格的に	他国の AIS 衛星	未整備?
	利用予定		
インド	自国の光学、	他国の AIS 衛星、	今回の調査では不明
	SAR 衛星を活用	自国の AIS 衛星も	
		整備中	

インドネシアにおいては、既に他国の衛星データや海洋監視プラットフォームを活用した IUU 監視活動が行われているが、その取り組みには効率化等の改善の余地がみられる。インドネシアが活用している SAR 衛星である Cosmo-Skymed や Radarsat-2 は商用衛星であり、データ購入費が非常に高価なことから、すべてのターゲット海域を網羅することはできず、特定の海域の計画的観測が行われている。我が国の将来的な貢献としては、日本が保有する SAR 衛星(ALOS シリーズや ASNARO)や今後運用されると思われる民間運用の SAR 衛星コンステレーション(Synspective や QPS 研究所の衛星)によるデータの活用が考えられる。また、AI/ビッグデータ解析を用いた効果的な特定の海域の計画的観測シーケンスの構築等も共同研究の題材になりえると思われる。

フィリピン、マレーシアは実際の IUU 監視の運用において、使われている宇宙技術はまだまだ少ない印象である。フィリピンにおいては、米国の海洋監視プラットフォーム SeaVision が導入されているものの、BFAR が保有する VMS の管理システムとは別のシステムとなっており、統合化の可能性やそれらを使いこなすための人材育成のニーズがあると考えられる。また、マレーシアにおいては、将来的に宇宙技術を用いた統合的な海洋監視活動「C4ISR」プロジェクトがあるものの、運用の実態としては、ほとんど宇宙技術は活用されてきていない。そのため、AIS と SAR 衛星画像を組み合わせた船舶検知

技術のキャパシティビルディング/研修など、主に人材育成に主眼を置いた国際協力により、宇宙技術の海洋監視への活用促進を図っていく必要がある。

インドは ISRO を中心に多くの地球観測衛星を運用しており、光学、SAR 衛星の両方を保有している。今回調査したインドの財団からの情報では、現状で IUU 監視にそれほど衛星データは活用されていないとのことだが、既述の通り、フランスとの共同で 10 機の AIS 衛星 (光学、SAR のペイロードも搭載) の開発・運用を目指すことになっており、今後、本格的に宇宙技術を活用した IUU 監視活動を行っていくと考えられる。なお、光学センサ、SAR ペイロード、AIS トランスポンダを同時に搭載した衛星のコンステレーションによる運用は、データ送信、データ処理のやり方によっては、ほぼリアルタイムに近い形で不審船(ダークベッセル)を検知できる可能性があり、今後の活用が注目される。我が国では、ALOS 衛星に AIS トランスポンダが搭載されており、混雑した海域での船舶の検知精度の向上(AIS 信号衝突問題の回避)に向けた技術向上が行われている。今後、インドとの共同研究により、それらの技術の向上なども一つの検討材料になる可能性がある。また、今回、インドの海洋監視プラットフォームについての調査が十分にできなかったが、機会があれば、プラットフォームの現状の調査についても実施する必要があると思われる。

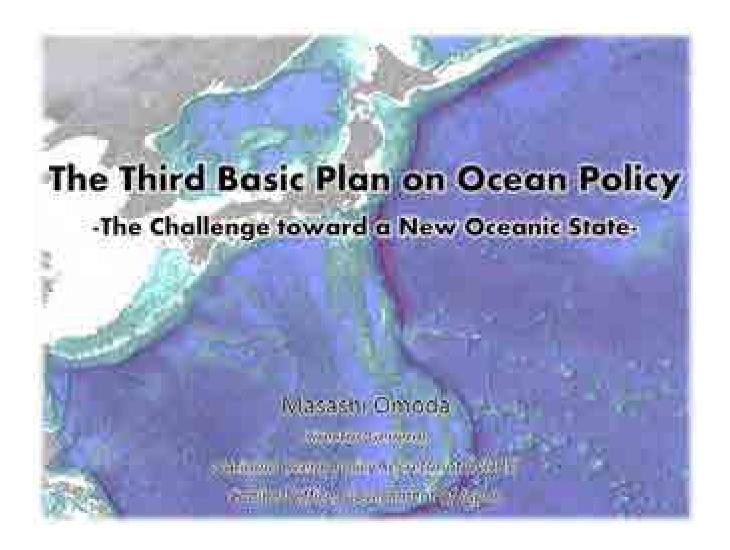
4.2. 非政府が提供する海洋監視プラットフォームの我が国での活用の可能性

既述の通り、欧米を中心に NGO や民間企業が様々な機能を有する海洋監視プラットフォームを開発し、サービスしてきている。これらの中には既に米国のセキュリティ向上 / 透明性の向上のために、米国政府に情報を提供してきているものもあり、我が国においても、それら民間の情報の活用促進が期待される。他方、国家セキュリティの観点から、我が国のプラットフォームによるデータ・情報の確保も重要であり、きちんと政府としてデータを確保すべき部分とオープン情報、フリー情報、民間情報を活用すべき部分の二重レイヤーによる運用と情報の統合化が必要になる。また、これらのシステムを活用して、いかに分析し、必要な情報を抽出するかのデータ分析官の育成もますます必要になると考えられる。

以上

添付1:第1回シンポジウム資料

※一部開示制限あり。一部開示不可。



The Basic Plan on Ocean Policy

- Japan's measures on the ocean are promoted in a comprehensive and systematic manner, based on the Basic Act on Ocean Policy (enacted in 2007) and the Basic Plan on Ocean Policy.
- The Third Basic Plan on Ocean Policy was formulated on May 15, 2018.
 (approval of the Headquarters for Ocean Policy and decision of the Cabinet)

<Structure for Implementation of Ocean Policy>

Basic Act on Ocean Policy

enacted on April 20, 2007

Basic Plan on Ocean Policy*

- ◆ First Basic Plan (March 2008)
- ◆ Second Basic Plan (April 2013)
- Third Basic Plan (May 2018)
 *revised almost every 5 years

Cabinet

Headquarters for Ocean Policy

Director-General: Prime Minister

Vice Director-General: Chief Cabinet Secretary

Minister for Ocean Policy

All ministers

Members: All minis

- ➤ Formulate and execute the Basic Plan
- ➤ Coordinate measures by rel. administrative bodies



Advisory Council/Councilors' Meeting for the Headquarters for Ocean Policy (experts appointed by the Prime Minister)

National Ocean Policy Secretariat

Outline of the Third Basic Plan on Ocean Policy (1)

Promote "Comprehensive Maritime Security"





(1) Maritime security

- Law enforcement Defense
 - ◆ Foreign policy
- ◆ Safety measures for marine traffic ◆ Responses to natural disasters

(2) Foundation for contributing to reinforcement of maritime security

- (a) Measures forming bases for maritime security
- ◆ Establish structures for MDA
- ◆ Preserve and manage remote islands
- ◆Ocean surveys & observations
- ◆ Develop HR and raise awareness ◆ Promote science and technology, R & D
- (b) Measures supporting maritime security
- Economic security
- Protect marine environment

etc.

2

Outline of the Third Basic Plan on Ocean Policy (2)

Use ocean more for the purpose of industries



Methane hydrate



Use maritime zones for renewable energy



Improve accuracy of fishery resource evaluation

b. Maintain and protect the marine environment



Respond to marine litters



Establish MPAs

d. Improve scientific knowledge



Use satellitederived data



Ocean survey & observation

Outline of the Third Basic Plan on Ocean Policy (3)

e. Promote Arctic policy





Ny-Ålesund Research Station

f. International collaboration and cooperation



g. Develop <u>human resources with knowledge of ocean</u> and <u>enhance citizens' understanding</u>

4

MDA: application fields



Schematic image of information sharing for MDA*

Considering with appropriate classifications and access limitation of marine information, develop a new scheme for effective sharing and utilizing marine information Ministry of Defense Classified and limited access info. (Layer 3) **Application field** · Security MOD **JCG** · Law enforcement Japan Coast Guard MOD/JCG data sharing system (classified) Government-use info. (Layer 2) (unclassified) Application field Public open information (Layer 1) Japan Maritime safety Meteorological · Disaster preparedness MSIL · Promotion of marine industry Agency (MDA Situational Indication Linkages) · Environmental conservation Rel. ministries · R/D & agencies · International collaboration and cooperation Ocean research org Operated by JCG Space exploring org Effective integration between relevant systems Local governments Private sectors - Strengthen promotion of marine prediction technology and visualization Bi/Multi framework - Encourage and develop handling technology for large volumes data

*"Policy and measures to strengthen Japan's MDA capability"

6

Global Monitoring Activities: Today and Future

Dr. John Mittleman Maritime Domain Awareness

Symposium on Marine Monitoring and Future Activities Using Space Technologies
February 8, 2019

2/8/19

Japan Space Forum

The famous "Blue Marble" photograph



2/8/19

Japan Space Forum

Maritime Domain Awareness



2/8/19

Japan Space Forum

Global AIS



2/8/19

Japan Space Forum

Purse Seiner track

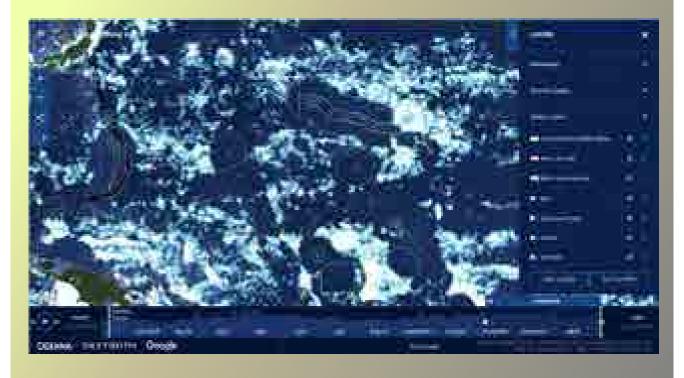




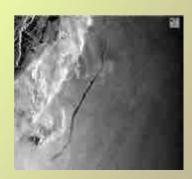
2/8/19

Japan Space Forum

Fishing Activity



Transparency



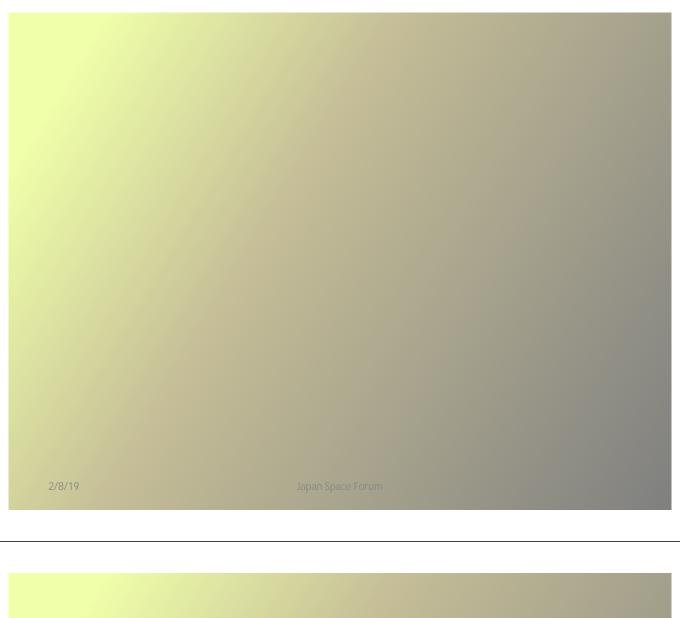


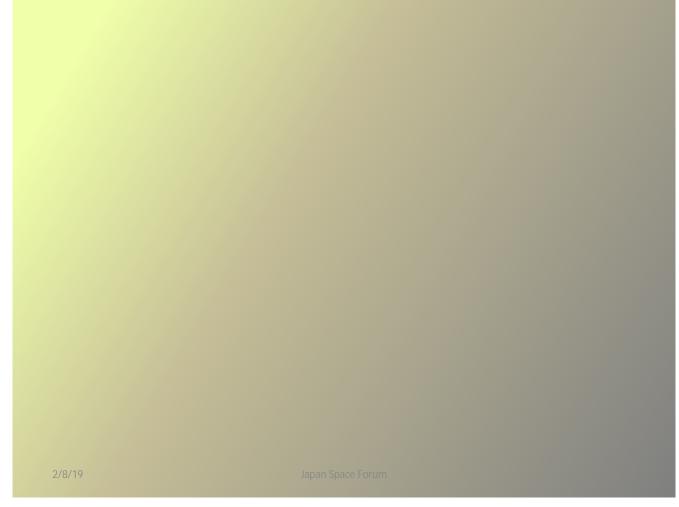




2/8/19

Japan Space Forum





Global Monitoring Activities: Today and Future – Keynote address

ABSTRACT

Small Satellites and Big Data are helping us understand the state of world, how it is changing, and how we can influence that trajectory. Quantity has become quality, as seen in the rise of artificial intelligence, which is enabled by computer technologies that make collecting huge amounts of data and intense computational analytics feasible. This leads to unprecedented global transparency, the ability to develop a penetrating understanding of activities and trends, the ability to disseminate it quickly and widely. The resulting democratization of intelligence appears to be nurturing a new "whole of society" response to global issues, and the emergence of new approaches to trans-national problems.

2/8/19

Japan Space Forum



WHO WE ARE

C4ADS is a 501(c)(3) non-profit using open data and cutting-edge emerging technologies to conduct innovative investigative research on conflict and transnational security issues.

PEOPLE

DATA

TECHNOLOGY

PARTNERS

Young, multilingual, widely traveled, and tech-savvy analysts

In-house fluencies in 15+ critical languages and field travel to 50+ countries including conflict zones and fragile states

Fuse disparate data across languages, regions, types for integrated capability

200+ business, tax, property, shipping, and judicial registries in 120 jurisdictions, alongside social media, satellite imagery, and geo-location

Adapt and build cutting-edge emerging technologies

- Philanthropic partnerships with technology companies (Palantir, AWS, Windward)
- Internal data science / engineering capabilities

Collaborate with public, private, media, and advocacy organizations

- Analysis is shared with the organizations best positioned to take action
- Work on joint investigations and provide open source training

We measure impact in actionable

36 designations

U.S. Treasury designations across seven sanctions programs (incl.

1.400 tons

of illicit contraband seized (including weapons, ivory, illicit timber)

2.7 billion dollars

In disruptions to illicit financial networks (including North Korean/Hezbollah TBML)



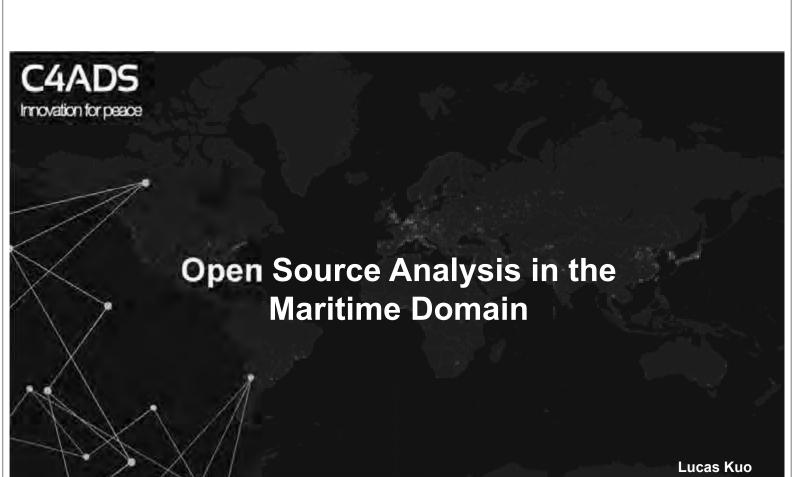
USING OPEN DATA

The reasons these networks are **observable** are also the reason that they are **vulnerable**

- 1. Illicit actors nest in and exploit **licit systems** of trade, finance and transportation.
- 2. This exploitation leaves a digital trail.
- 3. This use of the licit system makes illicit actors **vulnerable** their resources are **exposed** to forfeiture or freeze, and their access can be **restricted**.

C4ADS

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OVERVIEW OF PROBLEM SETS

Identifying typologies across problem sets and jurisdictions

- Tracking North Korean maritime sanctions evasion networks engaged in coal and fuel shipments and their connections to North Korea's broader portfolio of illicit activities
- Analyzing global illegal, unregulated, and unreported (IUU) fishing activity and mapping corporate ownership of fleets by vessel type up to the ultimate beneficial ownership level
- Monitoring illicit fuel shipments from Iran to Yemen that could be financing the Yemeni Civil War





Transshipment voyage patterns of DPRK- and foreign-flagged vessels unloading DPRK-origin coal in Russia for ultimate delivery in Japan and South Korea (Source: Windward and UN Report S/2018/171)





Beneficial ownership networks of global industrial large-scale purse seiner fleets

Illicit fuel shipments facilitating tradebased money laundering in Yemeni Civil War (Source: Windward)



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Rusiness Proprietary - Not for External Release

Risk-based screening measures should combine activity- and network-based analysis in order to build more comprehensive risk profiles.

ACTIVITY-BASED ANALYSIS

Augmenting AIS analysis with typologies and voyage-related context

- Use AIS transmissions to track individual voyages and develop alerts that are triggered whenever certain conditions are met
- Satellite imagery provide context on a vessel's activities at port and sea
- Port records can include vessel entry and exit dates, cargo details, and names of local port agents used



Alerts designed to capture high-risk vessels that exhibit specific vessel and voyage characteristics (Source: Windward)



Voyage patterns of foreign-flagged vessels that loaded coal in North Korea for delivery to Vietnam. Highlighted areas are where the vessels went dark prior to calling at a Vietnamese port. (Source: Windward and Carto)



Area of Interest layer of the hotspot for DPRK-linked ship-to-ship transfers (Source: Windward and OFAC)



Vietnamese port record showing the arrival time, draft, and agent of a vessel identified in the 2018 UN Panel of Experts report as having shipped coal from North Korea to Vietnam

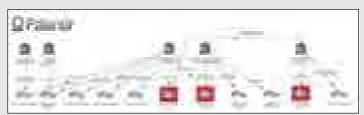


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NETWORK-BASED ANALYSIS

Going beyond sanctioned entities to identify high-risk networks

- Create a high-risk pool of vessels and corporate entities that have engaged in illicit activity
- The associated fleets of the owner and manager companies that operated illicit ships warrant increased scrutiny
- Historical ownership and management by known illicit entities should raise red flags
- Mapping the beneficial ownership of vessels and companies can uncover convergence across fleets



Overlapping current and historical corporate ownership/management between three vessels (in red) separately identified in the March 2018 UN Panel of Experts report as having shipped NK coal to foreign markets



C4ADS database of DPRK-linked maritime networks including high-risk ships, associated fleets, and corporate identifiers



DEMO: WINDWARD



DEMO: WINDWARD



DEMO: WINDWARD



ELECTRO-OPTICAL IMAGERY

EO imagery provides visual confirmation and ground-level context

Advantages

- Can be applied at any stage of an investigation
- Positive identification of vessels
- Analyze onshore activity

Disadvantages

- Resolution vs. Frequency
- Weather-dependent
- Lack of at-sea imagery



One-year AIS transmission histories of a US-sanctioned North Korea-flagged cargo ship (blue) and a Togo-flagged cargo ship (orange) with a US-sanctioned manager at Dalian Port, China. Satellite base map for reference only. (Source: Windward)



Satellite image (3-meter) of the North Korea- and Togo-flagged vessels servicing the same terminal in Dalian, suggesting risk of transshipment.
(Source: Planet Imagery)



VISIBLE INFRARED IMAGING RADIOMETER SUITE (VIIRS)

VIIRS can identify additional locations of interest and activity levels

Advantages

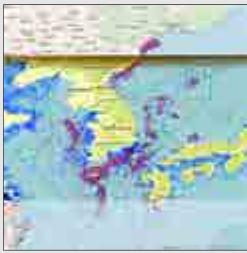
- Highlight potential hotspots of maritime activity that are not captured by AIS
- Clustering may suggest meetings at sea
- Updated daily and readily accessible

Disadvantages

 Difficult to apply to targeted investigations



VIIRS Boat Detection data (Korea region)
(Source: Earth Observation Group at NOAA)



AlS data (blue) overlaid with VIIRS Boat Detection data (purple) (Source: Windward and Earth Observation Group at NOAA)



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FUTURE DATA INTEGRATIONS: SAR

Synthetic Aperture Radar provides weather-independent and change detection capabilities

- Use synthetic aperture radar (SAR)
 imagery to obtain a target vessel's
 heading and speed during a dark voyage
 in the open sea
 - Apply change detection algorithms to SAR imagery of commodity piles at port (e.g. coal) to assess import/export flows
 - Apply vessel detection algorithms to SAR imagery of key port terminals to compare observable and AIS-reported activity
 - Fused with AIS data, SAR provides a powerful means to track where suspicious ships are actually going



Voyage path of foreign-flagged oil tanker traveling in direction of North Korea before going dark (Source: Windward)



Coal terminal at Wonsan Port, North Korea that can be analyzed for export activity (e.g. changes in pile height, terminal logistics activity) (Source: Google Maps)



FUTURE DATA INTEGRATIONS: RF DETECTION

Combine knowledge of physical presence of vessels with knowledge of communication patterns

- Use radiofrequency (RF) data to obtain information on signals emitted and received by vessels and affiliated port infrastructure
 - Track target vessels in high traffic areas (e.g. major sea lanes and ports) and during dark voyages
 - Pinpoint communications which could indicate suspicious activity
 - Identify instances of signals interference from shore-based assets



Distribution of detected Global Navigation Satellite System (GNSS) spoofing activity across key locations in target region between 2016 and 2018 based on AIS transmission patterns (Source: C4ADS and Windward)



Time-series analysis of above GNSS spoofing activity indicating possible coordination (Source: C4ADS and Windward)



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FUTURE DATA INTEGRATIONS: SMALL SATELLITES

Low-cost constellations allow civil society to engage actively in monitoring international legal regimes

- Cost-effective solutions such as small-sat constellations enable persistent and dynamic observation of key points to enforce international sanctions and law
 - DPRK shipping routes traverse a relatively limited geography which can be tracked
 - Yemeni ports can be observed to provide a picture of economic activity and sanctionsbusting in real time
 - High-risk areas for IUU fishing can be persistently monitored



Analysis of activities at North Korean satellite launch site (38 North)



Damage assessment of Russian airstrike on civilian hospital in Syria (Syrian Archive)



Identifying unseen fishing activity in the South China Sea (CSIS and Vulcan/Skylight)



Construction of Xinjiang internment camps (ABC Australia)



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Duns & Bradstreet Verified



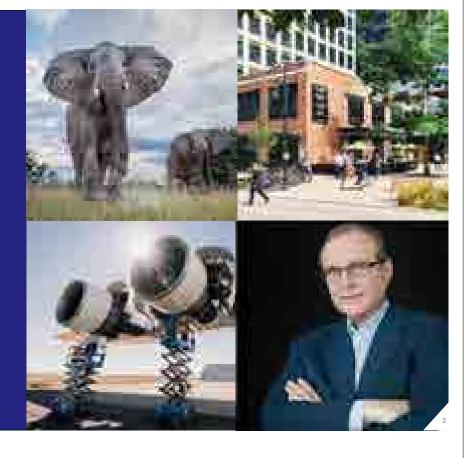


Who We Are

Launched by Microsoft co-founder Paul G. Allen and powered by the team at Vulcan, our system unapologetically aims to change the game for maritime enforcement.

What We Do

Skylight harnesses cutting edge satellite and machine learning technologies to address the devastating effects of illicit maritime activity and promote global stability.





Differentiated Technology



SATELLITE ANALYTICS



VESSEL DATABASE



MACHINE LEARNIN Investing in a robust technology stack enabling maritime transparency at scale

We partner with industry leaders and leverage our expertise for an unprecedented level of maritime imagery and dark-ship detection capabilities

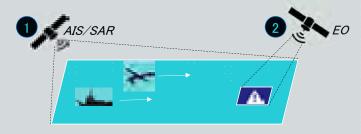
We leverage our best-in-class database of hundreds of thousands of vessels – while continuously building and expanding our depth of metadata.

Our proprietary algorithms synthesize billions of data points from millions of vessels to identify suspicious activity in real-time.



Next Generation Tasking

Short-Term: Automated alerts inform faster and more effective deployment of aerial/surface assets.



Long-Term: Enabled by improved responsiveness, Skylight alerts automatically trigger EO collections, dramatically improving results, latency, and costs.

Building toward a "tipping a queueing" system that unlocks satellite imagery over

Robust vesse data drives increasingly accurate alerts using machine learning

• Best in-class vessel database in place

Automated alerts, delivered in real-time, improve utilization of existing assets

• 1.000s of key activities detected daily

Streamlined imagery tasking and analytics enable operationally relevant insights using previously latent capacity

• Strategic partnership with industry leading satellite company in place



Our Solutions Built for Real-World Operations

Watchfloor Services

Tailored Solutions for the Toughest Problems

Alerting Platform

Direct User Access - Globally, in Real-Time





Watchfloor Services Redefining the Possible

Customized Area Reporting:

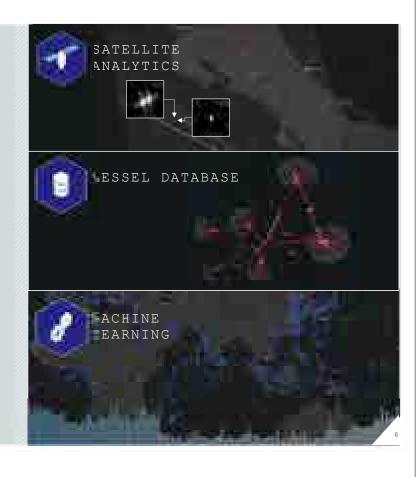
- Suspect Loitering
- Rendezvous Detection
- Situational Awareness

Satellite Monitoring:

- SAR: Wide-area monitoring for detection of non-transmitting "dark" vessels
- **EO**: Detailed identification and context for discrete area monitoring

Specialized Projects:

• Looking to try something new? Reach out to discuss your unique needs!

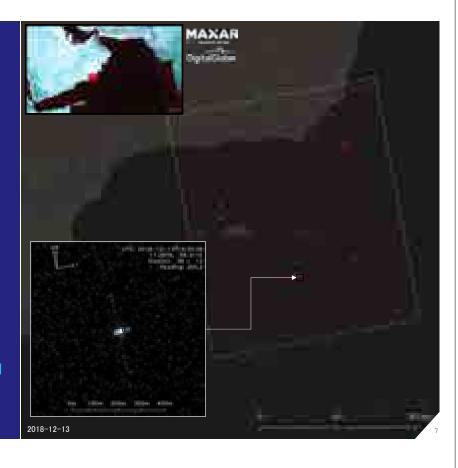


Sample Insight Synthetic Aperture Radar (SAR)

Wide Area Dark Vessel Detection

- This SAR collection captured 13 vessels, 5 of which were smaller than 15m
- The majority of vessels were "dark" and not transmitting an AIS signal
- The image chip shows two of these detections engaged in a potential transshipment

Key Takeaway: SAR imagery is most useful for pattern of life assessment over wide areas and focusing more precise assets





Wide Area Dark Vessel Detection

- Possible transshipment activity in known smuggling region.
- Collection based on pattern-of-life assessment with preliminary SAR collect.
- The vessels identified here are 10m-20m in length and would be very difficult to clearly identify using SAR.

Key Takeaway: EO is a powerful asset for identification of specific vessel or activities, but typically requires precise tasking



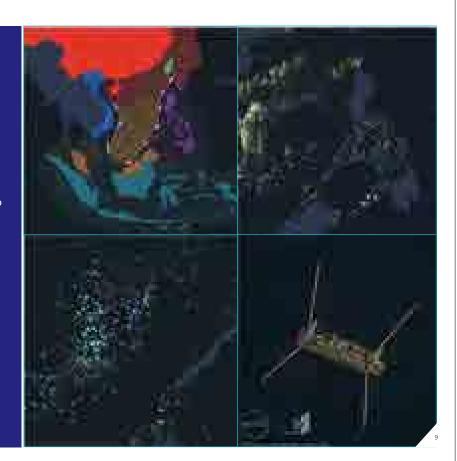
Sample Watchfloor Project

South China Sea

Dark Vessel Activity Analysis

- Systematic integration of SAR and VIIRS data to augment AIS activity
- Targeted EO monitoring to understand vessel activity and trends.
- Key findings:
 - 90%+ of vessel don't transmit with AIS
 - Far more fishing vessels present than than be supported by the local fisheries
 - Chinese fishing vessels are typically not fishing – and congregated by island outposts

Done in collaboration with CSIS
Effective research requires an integrated approach to leveraging collection modalities





Alerting Platform Next Generation

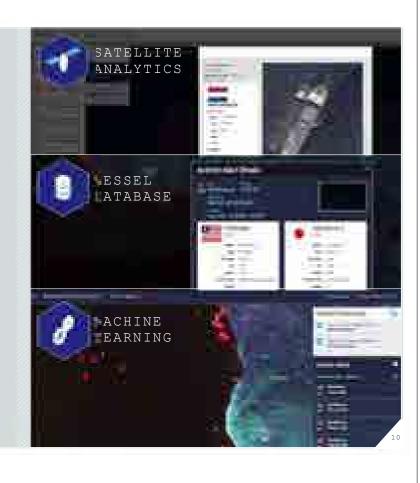
Aware ness: Available through a simple and secure web login. No specialized software updates or hardware installation required.

Global Coverage: Track hundreds of thousands of vessels and sift through oceans of data to detect suspect activity.

Quality Alerts: Leverage advanced machine learning to recognize patterns, detect anomalies, and classify events.

Real-Time Insights: Alerts are available immediately – enabling seamless direction to other aerial, surface, or space-based assets.

Interoperable: System is fully unclassified, allowing end users to push insights directly to operators and coordinate with partners.



The new Skylight

Alerting Platform



Skylight Alerting



- An alerting tool sifts through millions of data points daily to enable rapid, informed decisions
- Initial focus on rendezvous alerts (potential transshipments) due to broad utility



- An analysis tool requiring a skilled analyst
- 100,000s of active vessels at any time
- Overwhelming for manual analysis

Under Development

Single-Sided Rendezvous

1 Als inconsistencies

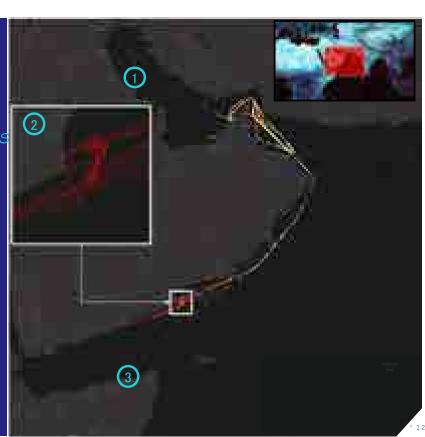
Vessel transmitted Als irregularly in
during deviation from standard route

2 Potential single-sided rendezvous

Track pattern consistent with
rendezvous behavior

Vessel then proceeded to Somalia
for the first time in over a year.

Availability expected in mid-2019 for users
of the Skylight Alerting Platform



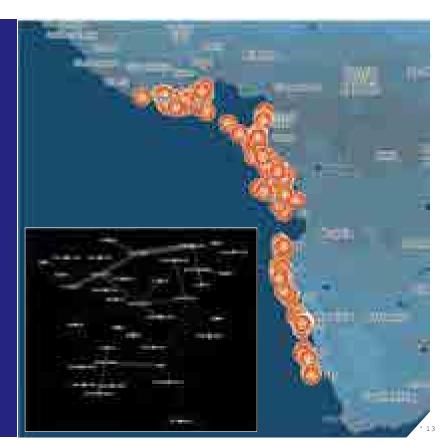


Under Development Contextual Database

West Africa Oil Transshipment Network

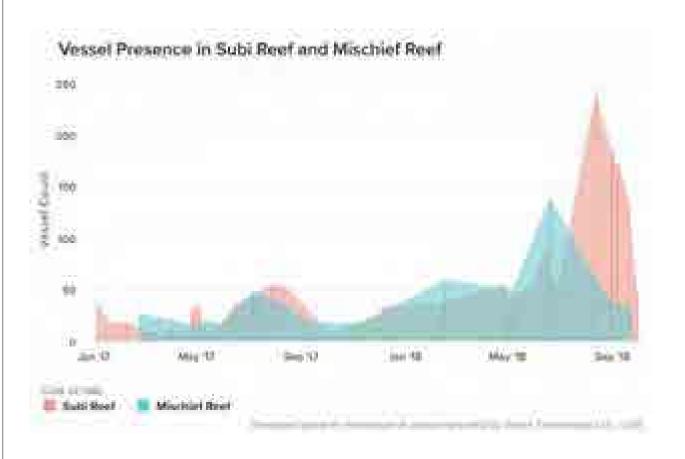
- 10 vessels initially identified in oil transshipment network in West Africa
- Over 1,000 related rendezvous identified in last
 2 years. Over 300 as likely transshipments
 - Significant fines per unauthorized ship-to-ship oil transfer in the region
 - Approximate value of hydrocarbon products potentially transferred per event: ~\$3.5M
- Ability to quickly identify affiliate vessels and potential common ownership.

Integrating activity characterization at scale will enable significantly enhanced insights





Thank You





PROTECTING THE WORLD'S OCEAN RESOURCES

WE FACE A GLOBAL CRISIS

OF FISH STOCKS ARE CURRENTLY **FULLY FISHED.**



ILLEGAL, UNREPORTED, AND UNREGULATED FISHING IS PUTTING

PRESSURE ON THE REMAINING STOCKS

COSTING THE GLOBAL ECONOMY

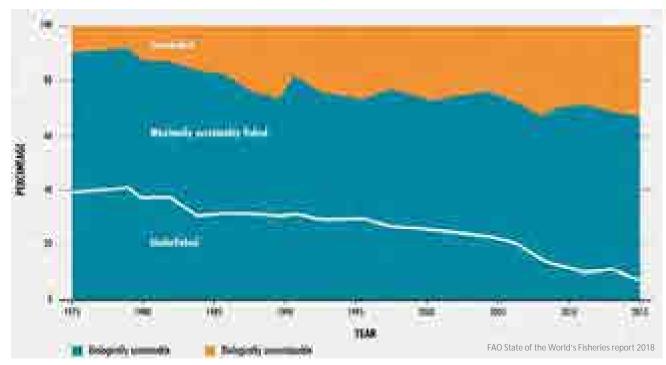


THREATENING THE FOOD SECURITY FOR

AND THE LIVELIHOOD OF



DECLINING TRENDS IN GLOBAL SEAFOOD STOCKS





OCEANMIND MISSION

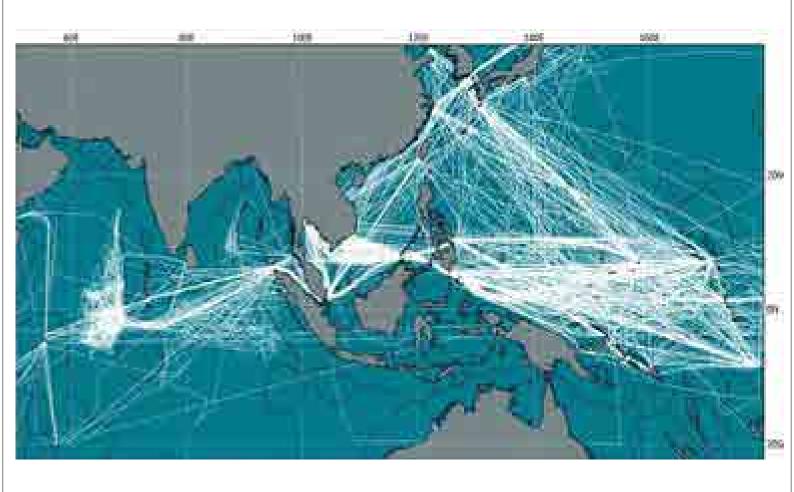


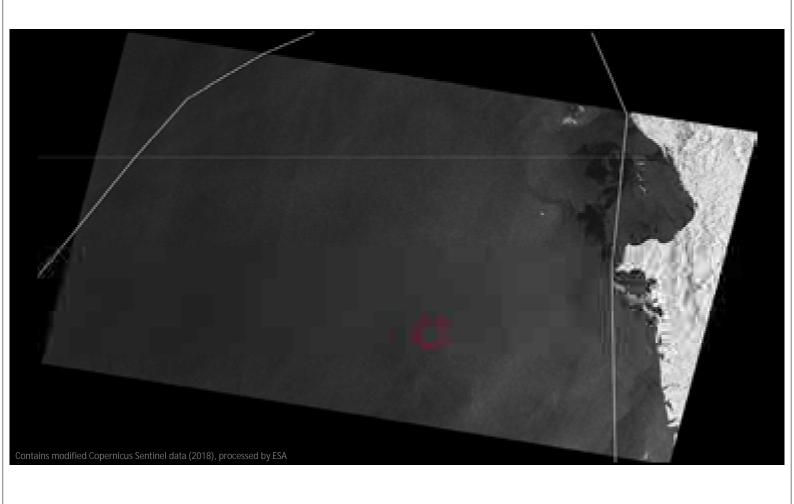
By empowering enforcement and compliance, OceanMind protects the world's fisheries

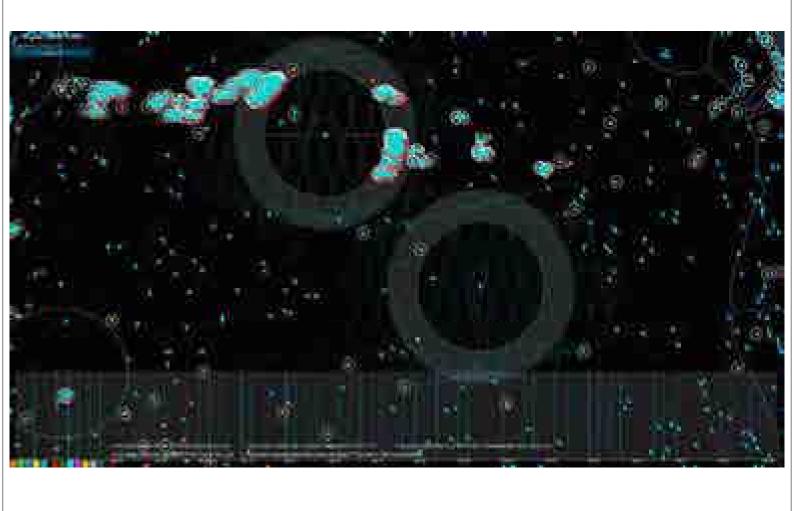
OCEANMIND IS AN IMPACT-ORIENTED, NOT-FOR-PROFIT ORGANISATION

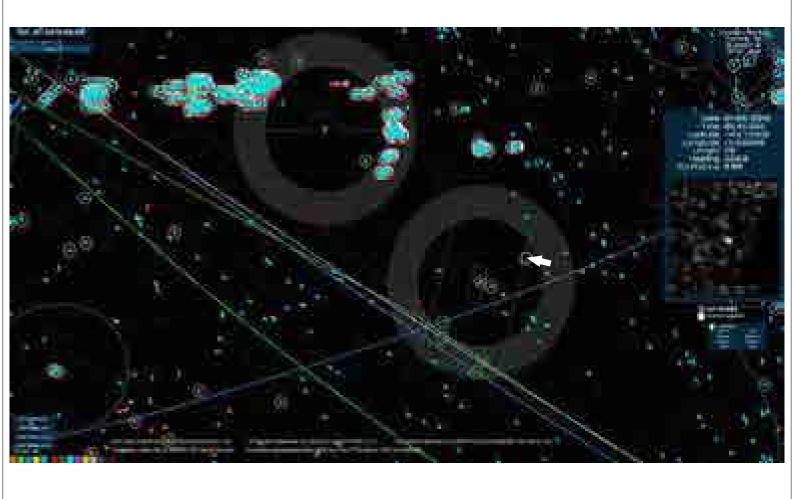
How OceanMind Works Satellite Observations Computational Analysis Analysis Actionable Insights Seafood Buyers



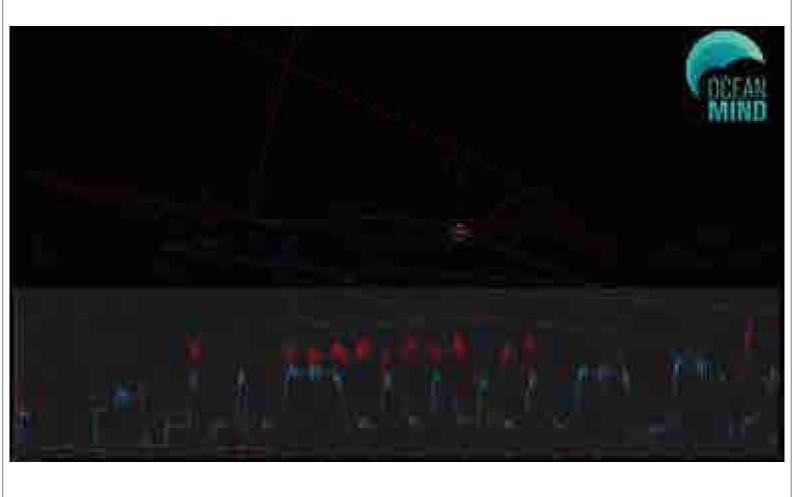








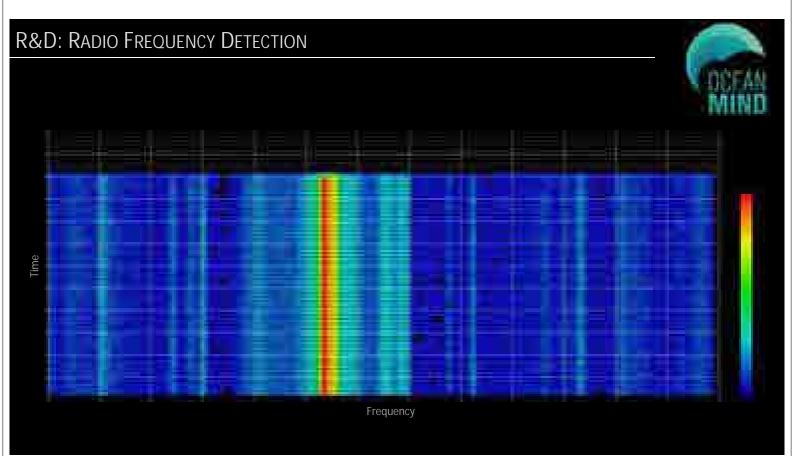










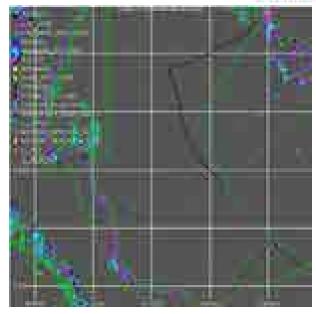


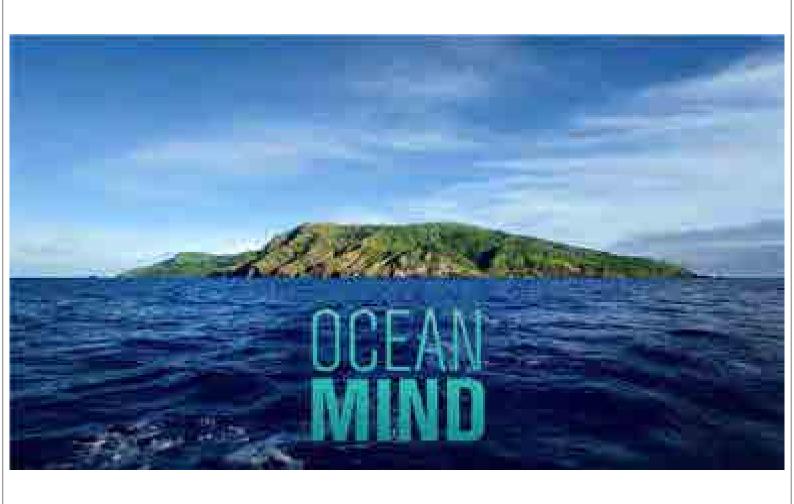
AI SUPPORTS HUMAN DECISION MAKING

OLEAN

Working with Microsoft's AI for Earth program, OceanMind is building global scale AI to change how we understand fishing behaviour on the oceans.









日本の宇宙技術をアジアの公共財化するルール形成

Rule-making Toward Public Use of Japan's Space Technologies for Asian Region

2019年2月8日

多摩大学大学院教授 ルール形成戦略研究所所長 國分俊史



國分 俊史(こくぶん としふみ)

多摩大学大学院教授、ルール形成戦略研究所 所長 パシフィックフォーラム シニアフェロー EYアドバイザリー・アンド・コンサルティング パートナー

■ 経歴

- ▶ IT企業の経営企画、シンクタンク、米国系戦略ファーム A.T. カーニー プリンシパル、米国系会計ファーム ヴァイスプレジデントパートナーを経てEYに参画。
- ▶ 社会課題および安全保障経済政策を起点としたルール形成戦略の第一人者として通商政策の立案や政・産・官・学によるイシューエコシステム作り、各国の安全保障経済政に翻弄されない企業戦略の立案を支援。また、安全保障経済政策に関する政府の委員や政務調査会、議員連盟のアドバイザーを多数歴任。ルール形成戦略研究所の創設者として世界各国の政府高官、インテリジェンス機関、シンクタンクとのネットワーク構築による日本のルール形成戦略力の多元化、減少傾向にある日本の安全保障政策の研究者の育成と就業機会の創出にまで取り組んでいる。
- ▶ 内閣サイバーセキュリティセンター「IoTのサイバー規格検討会」、経済産業省「電力インフラのデジタル化研究会」、「質の高い電力インフラWG」、総務省「デジタル変革時代のICTグローバル戦略懇談会」、防衛装備庁「サイバーセキュリティ検討会」の委員

■ 政策アドバイザー実績、経営コンサルティング実績(抜粋)

- > 自民党の「政務調査会 IT戦略特命委員会」のアドバイザーとしてサイバーセキュリティ政策、ブロックチェーン政策立案支援
- ▶ 自民党の「ルール形成戦略議員連盟」にて安全保障経済政策を起点としたルール形成のアドバイザーを担当
- > 自民党の「FCVを中心とした水素社会研究会」の政策アドバイザーと民間企業側の事務局責任者を担当
- ▶ 経済産業省通商政策局における社会課題起点での国際ルール形成戦略力の向上および「ルール形成戦略室」立ち上げ支援
- ▶ 日本のイノベーションカとサイバーセキュリティカ向上を意図した日本とイスラエル間での民間協カプログラム立ち上げ支援
- ▶ 自動車業界、総合エレクトロニクス業界、電力業界、重工業産業の主要大手企業に対するルール形成戦略プロジェクトや安全保障経済政策を梃にしたグローバル戦略プロジェクトを多数支援

■ 執筆(抜粋)

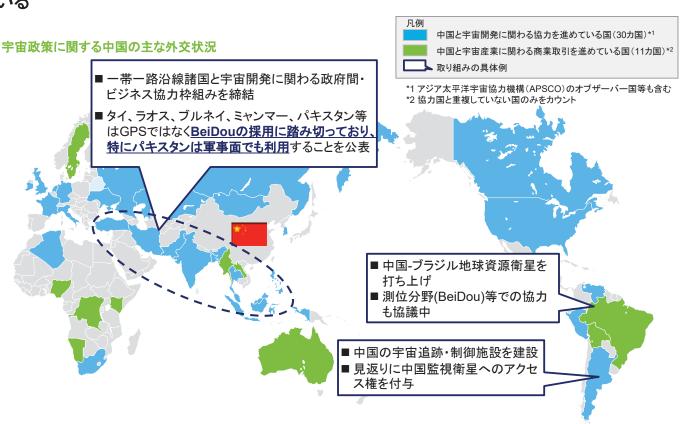
- » 編著:「世界市場で勝つルールメイキング戦略 技術で勝る日本企業がなぜ負けるのか」朝日新聞出版、
- ▶ 共著:A.T. カーニー最強の経営シリーズ 「最強の業務改革」、「最強のコスト削減」東洋経済新報社
- ▶ 寄稿: National Interest 2018年1月「Japan's New National Security Economy」、「米中サイバー規制が企業に強いる変革」Wedge OPINION 2月号、「インフラと測位システムの一体輸出 中国が狙う一対一路への軍事展開」Wedge Point of view6月号、DIAMONDハーバード・ビジネス・レビューオンライン「サステナビリティ戦略の最前線」など

中国による宇宙と海の依存戦略

China's Dependence Strategy in Space and Maritime Area

3

中国はBeiDouの利用を促す宇宙政策を梃に、各国と軍事政策の連携強化を進めている



中国の宇宙政策拡大に伴い、運航管理に関わるシステムも中国系によって抑えられる可能性がある

運航管理システムの現状

船舶自動識別装置(AIS)の概要

船舶関連情報の位置情報は現在の緯度と経度、 速度、針路をGPSで取得



中国による海洋公共サービスへの進出

BeiDouが海上衛星航空システムとして承認を獲得

■ 米GPS、露GLONASSに続く、第3の海上衛星航行システムとして国連が北斗衛星(BeiDou)を承認

政府がBeiDou関連産業の育成と海外進出を支援

- 政府はBeiDou関連業者を支援し、2020年までに 世界の衛星測位関連<u>市場シェアの80%獲得</u>を目 指す方針を発表
- 更に「一帯一路建設海上協力構想」にて、沿線国に対して、海洋観測監視インフラに関する技術・設備援助を増やし、衛星情報サービスを提供していく意向を示す

国連の承認獲得に加え、政府支援が進むことで 今後は運航管理関連システムも BeiDouを中心に構築されていく可能性が存在

5

無人監視船の開発も中国は着手し始めており、今後は港湾監視システムをコアに各国のインフラの要所を抑えたパッケージ輸出を展開していく可能性が高い

世界で進む無人監視船の開発

(イスラエル・G-NIUS)無人監視船開発を推進

- 無人兵器開発会社G-NIUSによって開発
- 港湾警備システムの一環として運用されており、 登録ルートの自動運航に加えて遠隔操作も可能



ロールスロイスが 参加を表明





中国が無人船舶開発に向けたアライアンスを発表

■ 中国船級協会と海航集団(HNAグループ)が中心となり、2017年7月に無人貨物船開発に向けたアライ

国営造船グループである中国船舶工業集団公司や 無人船開発を進めるロールスロイス等が参加

(英・ロールスロイス)無人貨物船/軍用船開発を推進

- 無人貨物船/軍用船開発を推進する方針を発表
- 海軍向け全自動運転船では巡視や監視、軍事用ドローンを発着ベースや有人船護衛を想定した開発を実施





一帯一路と連携した無人船輸出

中国が進める無人船開発

アンスを発表

『一帯一路』沿線国に対して海上監視技術を提供する方針

- 中国政府は「一帯一路建設海上協力構想」を発表
- 海洋調査、観測装置、<u>海上無人機、無人船</u>などの分野で各国と協力を進め、研究機関・企業による<u>海外普及を支援する方針</u>

中国では測位衛星システムと監視カメラを連動させ、犯罪者を追跡している

監視カメラと測位衛星システムの連動

中国は監視カメラにAIとGPSを活用して 犯罪者を追跡するシステムを構築

- 中国公安当局が2,000万台にもおよぶAI監視カメラをベースに構築した犯罪者追跡システム「天網」を開発
- 「天網」は通行人、バイク、自動車などを追跡し、 「男性・40歳・黒スーツ」、「白-SUV」などの概要を 認識
- ■「信号を無視した車」、「いきなり走り出す通行人」 など<u>異常な行動を捕捉した場合、姿を拡大して顔</u> 認証を開始
- 顔認証は犯罪容疑者データベースと連動しており、 リストに照合した場合は、即座に警報が作動
- **監視カメラにはGPS機能**が取り付けられており、 警察官に**位置情報を共有**

通行する車両や人物を認識、不審な行動をとった 場合は顔認証により犯罪DBと照合





不審人物の位置をカメラに備え付けられたGPSで特定し、 犯人の位置情報を警察官へ提供

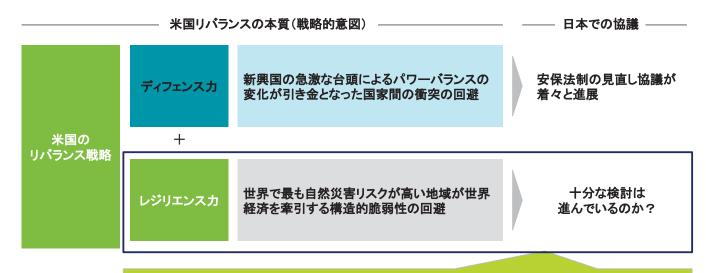
出所:ハーバー・ビジネス・オンライン2017年10月01日

7

米国が求める日本との連携

Collaboration with Japan which US Requires

米国の戦略目標にはアジア太平洋地域における自然災害を起点とした不安定要素の削減と災害インパクトを最小化させる政策のアジア各国へのインプリを行っていくことであり、そうした観点からの日本のリーダシップが求められている



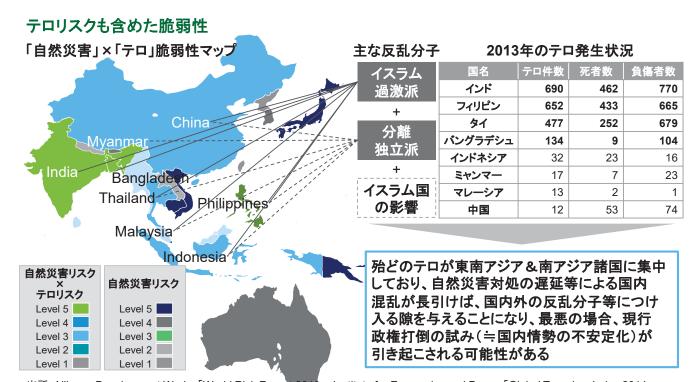
レジリエンスを高めるポイントは平時に

- ①不安定要因を極力排除および低減させておくこと
- ②災害時に迅速に復元できる準備・訓練をし続けておくこと

であり、アジア地域の安定を通じて日本の安全を確保していくという視点から経済政策を構想し、地域の安全保障を経済政策を通じて能動的にデザインしていく姿勢が必要

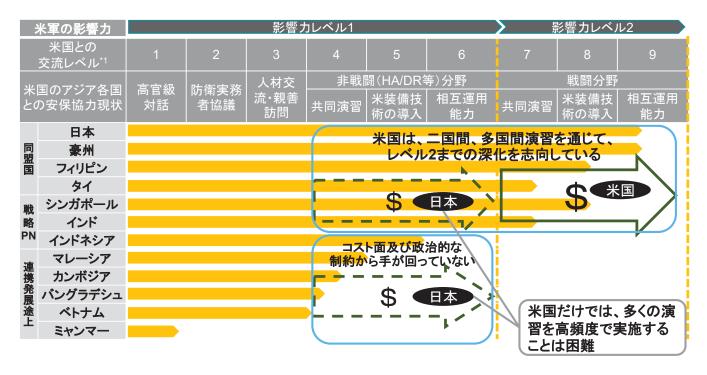
9

大規模自然災害は、国内秩序の混乱に繋がるリスクを増幅させる



出所: Alliance Development Works「World Risk Report 2013」、Institute for Economics and Peace「Global Terrorism Index 2014」、Global Terrorism Databaseより作成

日本には、米国を補完する形での積極的なHA/DR能力構築支援が求められている



11 *1:防衛協力に関する米国防省、国務省、シンクタンク等の発表資料を基に作成

米軍が期待している日本からの災害予測データ

2017年3月に米太平洋軍司令部を訪問してヒアリングを実施





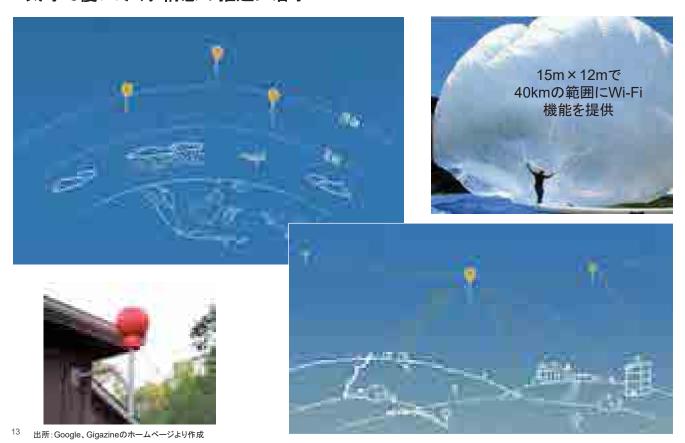


^そ太平洋軍 J5(政策部) 令部連絡官 日本デスク

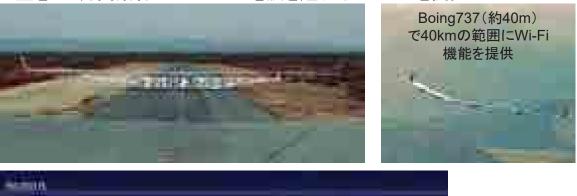
- 米太平洋指令本部はマウイにPacific Disaster Center(自然災害影響予測センター)を開設してアジア各国の自然 災害の発生状況とそれに伴う被害予測分析を現地のNGOから情報を得て行っているが情報の精度の低さが課題
- 日本が現地の社会インフラの運用から被害予測情報を米軍に共有してくれれば、米軍の救助効率を大幅に高められるためアジア太平洋地域の安全保障に大きく貢献する



Google XはProject Loonを立ち上げ成層圏(上空18km~27km)をWi-Fi機能を持つ気球で覆い尽くす構想の推進に着手



Facebookが設立したNPOは太陽光で気象の影響を受けない18km~27kmメートルの上空を3か月間飛行してWi-Fiの電波を送れるドローンを開発





宇宙の公共財化を実現するルールと拡張すべき機能

Rule and Function for Realization of Public Use of Space

15

鉄道インフラを情報収集という観点から捉えると、建設時には数百平方キロメートルに渡る 地質データ、運転開始後には日々の降雨量、地震、風速データの収集が可能であるという強み を持つ

鉄道建設・運用時に収集する情報

建設前・建設時に調査する情報 (例)

・ 中央新幹線(超電導リニアによる東海道新幹線 バイパス)の建設に向けて、線路を基準として幅 25kmもの範囲の調査を実施している



建設後に収集する情報(例)

- 降雨に起因した災害より列車運行の安全を 確保するために、雨量計の観測値に基づいて 運転中止等の列車運転規制を行っている
- 多くの鉄道において、雨量計の設置間隔は 10kmを標準としている



data

概要/イメージ

地質・地形データ(弾性波探査情報 等)

×

定常的な雨量データ 等

建設前後の調査データや管理時のデータを掛け合わせることにより、震災予防データとして活用できる

(参考)日本の電力会社は風力発電の建設時に生み出す騒音測定のための通行量調査や動植物の実態調査を周辺数キロメートルに渡って実施し、さらには雨量や落雷予測まで提供



出展:串間ウインドヒル株式会社「串間風力発電所(仮称)設置計画 環境影響評価方法書」、東京電力ホームページより作成

17

(参考)日本の電力会社は自治体主催の「水防協議会」に出席し、ダムの水位情報や雨量観測 データを提供して河川の氾濫予測に基づく地域の減災計画づくりを支援している

青森県の水防協議会出席者メンバー

<平成28年度水防協議会議事録>

日 時 平成28年4月27日(水) 13時30分より

場 所 青森県青森市中央1丁目11-18

ラ・ブラス青い森 2階 「メーブル」

出席者 (委員)

青森県県土整備部長

青森河川国道事務所 副所長

青森地方気象台 次長

東日本電信電話株式会社 青森災害対策室

東北電力株式会社 企画·総務部長

青森県警察本部警備第二課長

防災危機管理課 課長代理

農林水産部農村整備課 課長代理

警察との連携も 電力会社は実施

(事務局)

防災危機管理課 農村整備課 港湾空港課、河川砂防課

左記の議事録

第5章には、国土交通省、気象庁及び県等が設置している「雨量、水位及び瀬位」の観測所について記載してございます。

145ページから165ページにかけまして、国土交通省、青森地方気象台、県及び東北電力が 所管する両量観測所について、そして、166ページから181ページにかけては、国土交通省、 県が所管する水位観測所について、記載しております。

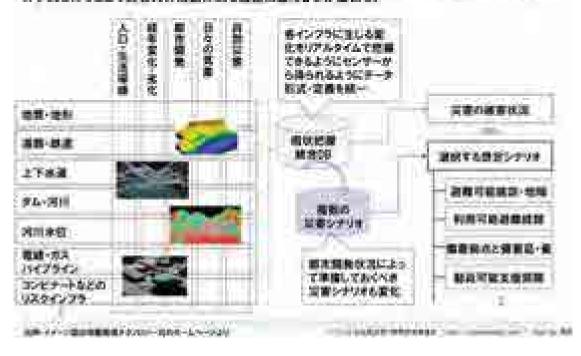
なお、これらの観測所の位置図は、第9章の資料編に記載してございます。

182ページから183ページにかけましては、国の測位観測所について、記載してございます。 184ページ、「雨量、水位の公表」には、現在、国や飛が一般に情報提供しております。 雨量 情報等を閲覧するためのパソコン及び携帯端末のアドレス等を記載しております。 青森県河川砂 防課では、雨量、水位情報に加え、ダム情報などを一括提供する「青森県河川砂防情報提供システム」を平成23年3月から、運用しております。|

自民党IT特命戦略委員会にてインフラから気象データ収集を可能にしていく方針が明示(1/2)

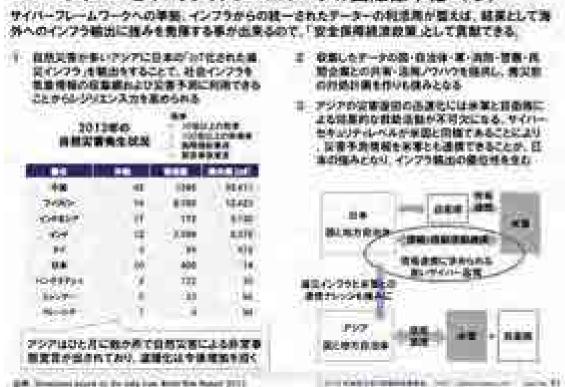
04 サイバーセキュリティフレームワークの国際標準化(2)

助賞・地形、道路、上下水温等の収存インフラ情報、センサー号から得られるリアル情報を有活用する 為に、データ形式や定義を統一する。得られた情報を解析し、実客インハクトや避難認知への影響をと の予測を行うことで実施的の結動体制を迅速に整える事が出来る。

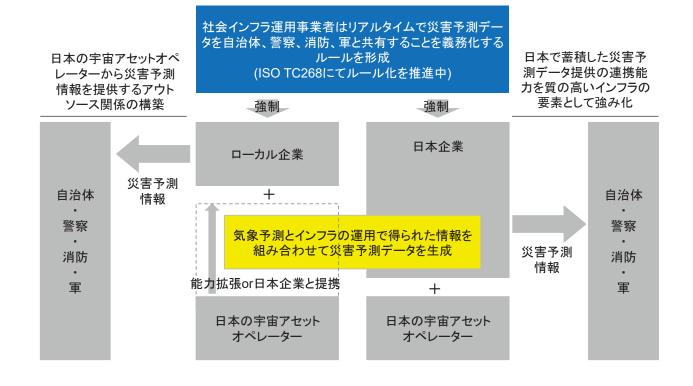


自民党IT特命戦略委員会にてインフラで収集した情報を米軍とシェアする方針を明示(2/2)

04 基本的な考え方: 04 サイバーセキュリティフレームワークの国際標準化(3)



社会インフラ事業者に災害予測情報をリアルタイムで提供するルールを課すことで日本の宇宙アセットオペレーターへの依存関係を戦略的に創造すべき





「宇宙を用いたグローバルな海洋監視の最新技術動向と将来」 Future Maritime and Japan's Role in International Collaboration

ーシンポジウム:(公財)笹川平和財団海洋政策研究所、(一財)日本宇宙フォーラム宇宙政策調査研究センター共催ー

海洋プロードバンドと地球ビッグデータが 新たな海洋立国への道を拓く

Broadband on the Ocean and Big Data of the Earth open a new avenue for a Maritime Nation

Feb.8, 2019

一般社団法人 日本宇宙安全保障研究所 主席研究員 木内英一

Eiichi Kiuchi, Research Fellow Japan Institute for Space and Security(JISS)



海洋、人類に残された最後の聖域 The Ocean, the Last Sanctuary

海洋は貿易の舞台、資源の宝庫、地球環境の母体 Stage of World Commerce, Reservoir of Resources and Environment Base





新たな海洋立国への挑戦 The Challenge toward a new Maritime Nation

海洋基本計画≪the third Basic Plan on Ocean Policy≫

1. 総合的な海洋の安全保障 - Comprehensive Maritime Security

2. 海洋の主要施策の基本方針 - Basic Policy for other main Measures

①海洋の産業利用の促進 - promote Industrial Use of the Ocean

②海洋環境の維持・保全 - maintain/conserve Marine Environment

③科学的知見の充実 - improve Scientific Knowledge

④北極政策の推進 - promote Arctic Policy

⑤国際連携·国際協力 - International Collaboration/Cooperation

⑥海洋人材の育成 - develop Human Resources



海洋に関わる現代の課題 Maritime Challenges today

代表的な課題: Typical Challenges are:

◆地球レベル(global level)

地球温暖化、生物多様性、地球環境保全、•••
Global Warming, Biodiversity, Global environmental Conservation

◆国家レベル(national level)

海洋安全保障、EEZ保全、海洋資源保全、•••

Maritime Security, Protection of EEZ and Marine Resources

◆社会レベル(society level)

災害対策、海難事故対策、安全航行管理、・・・

Countermeasures against Natural Calamities and Marine Accidents and Safety Traffic Management



人類共有地を紡ぐ物語(1) Innovation in Space and Cyber

同時に進行中のイノベーション Two Innovations proceed simultaneously

本格的な宇宙利用 《Full-Scale Space Utilization》

高精度測位

- High Precision Positioning

地球上いつでもどこでもブロードバンド通信

- Broadband Communication on the Ocean, anytime

高頻度地球観測

- Continual Earth Observation

ビッグデータ・イノベーション ≪ Big Data Innovation≫

ビッグデータ、AI、IoT、CPS の目覚ましい進化

- Big data, AI, IoT, Cyber Physical System are evolving dramatically



人類共有地を紡ぐ物語(2) Space-Cyber Interaction for the Ocean

ドラマを起こすシナリオが必要だ A Scenario is needed to make a Drama

- ◆本格的な宇宙利用 Full-Scale Space Utilization
 - •Broadband Communication on the Ocean
 - •Continual Earth Observation
- ◆ビッグデータ・イノベーション Big Data Innovation
 - ·Big Data of the Earth, AI, Cyber Physical System, · · ·

accelerate innovation

give solutions to

◆海洋の課題

Maritime Challenges

•Global, National and Social Levels

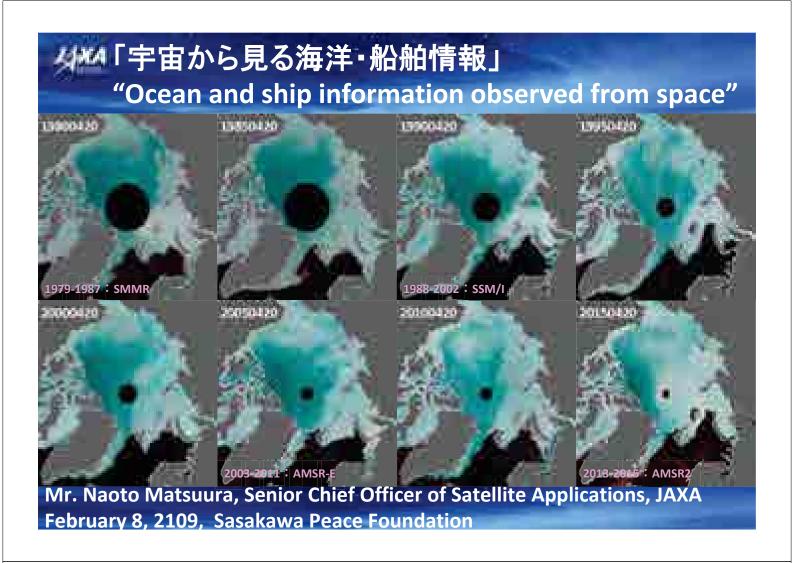
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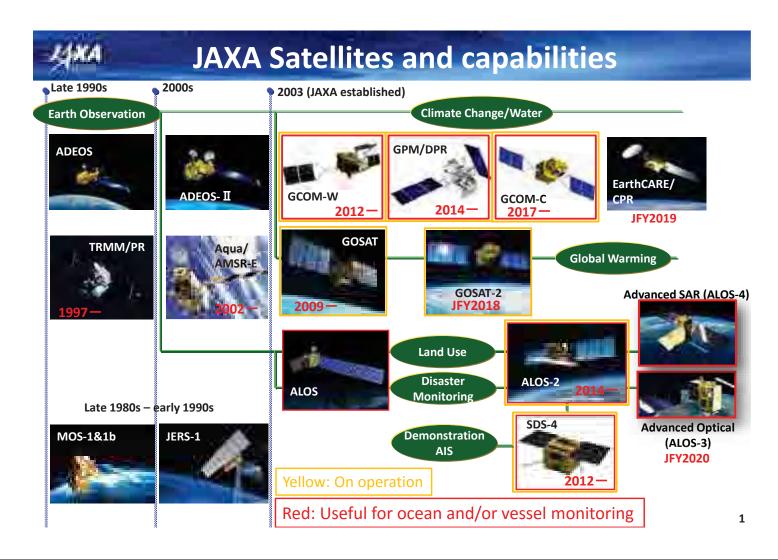
open a new avenue for

◆新たな海洋立国

A Maritime Nation

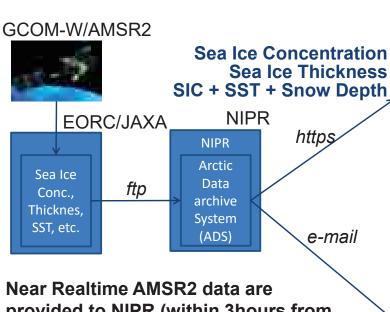
- •promote Industrial Use
- •conserve Maritime Environment
- •improve Science
- International Cooperation







AMSR2 Data Flow for Monitoring Sea Ice



Near Realtime AMSR2 data are provided to NIPR (within 3hours from satellite observations)

- Sea Ice Concentration (SIC)
- Sea Ice Thickness
- Sea Surface Temperature (SS
- Brightness Temperature
- Others (Soil Moisture etc.)





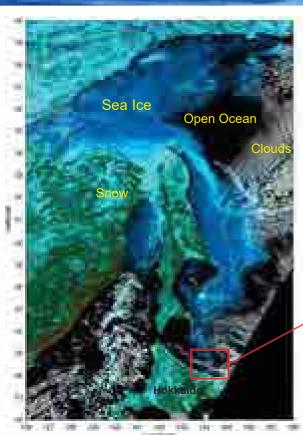
Sea Ice Monitor for SHIRASE Cruise

2

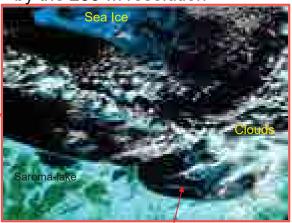
LAKA

GCOM-C "SHIKISAI" 250m resolution





- ✓ Okhotsk Sea Ice observed by "SHIKISAI" 250m image (RGB: 1.6μm, 0.87μm, 0.67μm) on 14 Jan 2019
- ✓ Fine structure and small pieces of the Sea Ice can be observed by the 250-m resolution



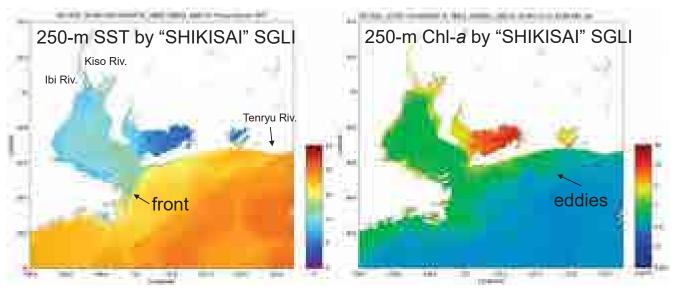
Sea Ice



GCOM-C "SHIKISAI" 250m resolution



- ✓ "SHIKISAI" has 250-m resolution channels in wavelengths of near-UV to near-infrared (11 channels), showtwave-infrared (1) and thermal infrared (2)
- ✓ Coastal area monitoring e.g., sea-surface temperature (SST) and Chlorophyll-a concentration (Chl-a) will be improved by the 250-m channels



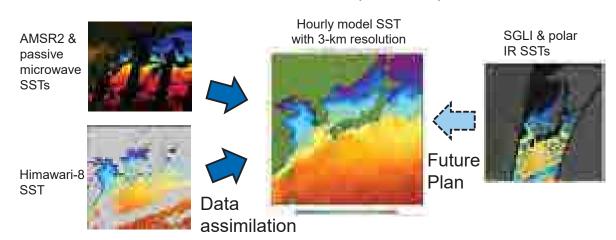
✓ Influence of rivers (e.g., Kiso, Ibi, and Tenryu Riv.), front of the Ise-Bay, and eddies near the coast are clearly captured by the 250-m image than 1-km one

4

MA

Ocean Weather Forecast by assimilating satellite observations

- JAXA and JAMSTEC have developed of the system assimilating satellite-based sea surface temperature (SST) into the 3-km resolution ocean model around Japan.
- JAXA has started routine distribution of SST analysis and 2-week forecasts by the model since Nov. 2019 through the JAXA P-Tree system (https://www.eorc.jaxa.jp/ptree/).
- Other data (temperature, salinity, currents under ocean) and their forecast are also available from JAMSTEC.
- Introduction of GCOM-C/SGLI SST is currently underway.

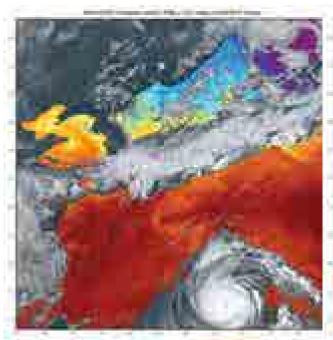


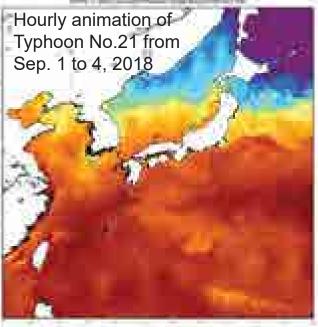
5

Decrease of sea surface temperature after Typhoon passing

Himawari SST & Visible RGB

Model SST with satellite assimilation





Previously, decrease of sea surface temperature (SST) corresponding to typhoon passing was partly observed by passive microwave imagers. This information is important for forecasting development/decay of typhoon.

6

SPace-based AIS Experiment (SPAISE)



SPAISE2 on ALOS-2

- 1. World's First satellite of simultaneous observation with SAR and AIS.
- 2. Channels for Satellite (Ch. 3 and 4)

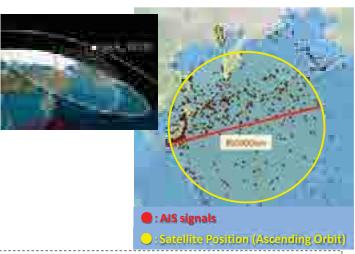


■ SPAISE1 on Small Demonstration Satellite-4 (SDS-4)

Launched on May 18, 2012

AIS (Automatic Identification System)

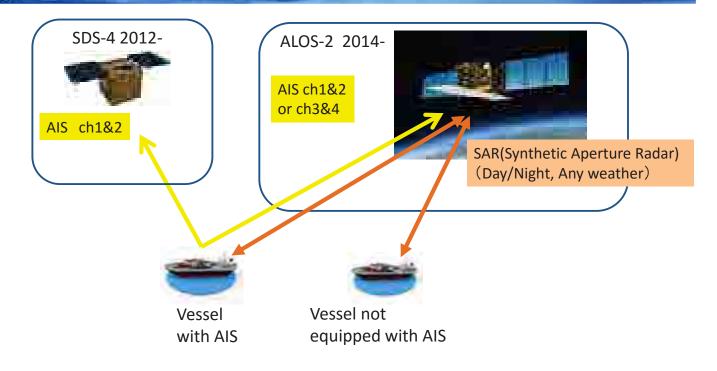
- Vessels over 300GT are obliged to be equipped with AIS under SOLAS Convention by IMO (Int. Maritime Organization).
- The satellite with AIS has the wide observation coverage of more than 5,000 km.



ALOS-2 is the only satellite in the world which is capable of simultaneous observation with SAR and AIS. (Several organizations are planning.)

7

JAXA's Mission: AIS Signal Reception on Satellite



ALOS-2 is the first satellite in the world which is capable of simultaneous observation with SAR and AIS.

8

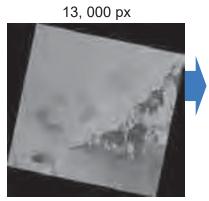
SPAISE+GCOM-W SST 2015/10/24 AMSR2 Sea Surface Temperature [°C] SPAISE → Ships with AIS signals (Small fishing ship near Japan): ○ Green ALOS-2/SAR → Ships with no AIS signals : ○ Red



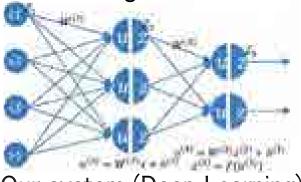
Deep Learning

Constructing a system that classifies the position, length, and type of ships from SAR images.

13, 000 px



SAR L 1.5 data



Our system (Deep Learning)

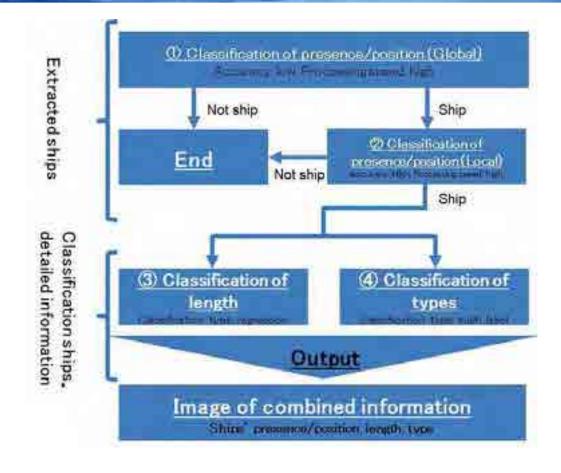




10

LAKA

Deep Learning





Deep Learning

Result of Proposal Methods

Ship Length



Pred.: 209m

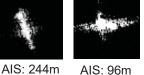
AIS: 263m

Pred.: 195m



Pred.: 59m





Pred.: 238m Pred.: 95m



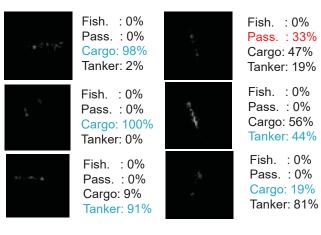






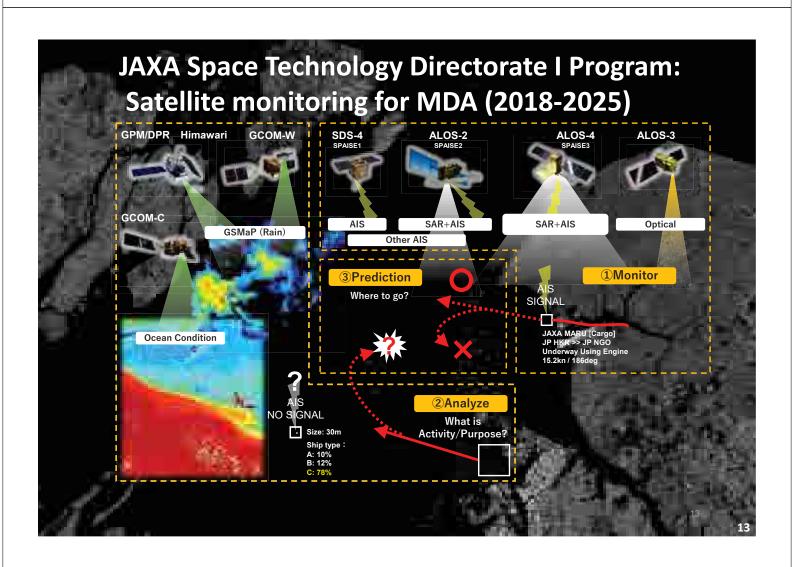
AIS: 74m Pred.: 352m Pred.: 103m Pred.: 103m

Ship Type (4 category)



Variance error: 13%

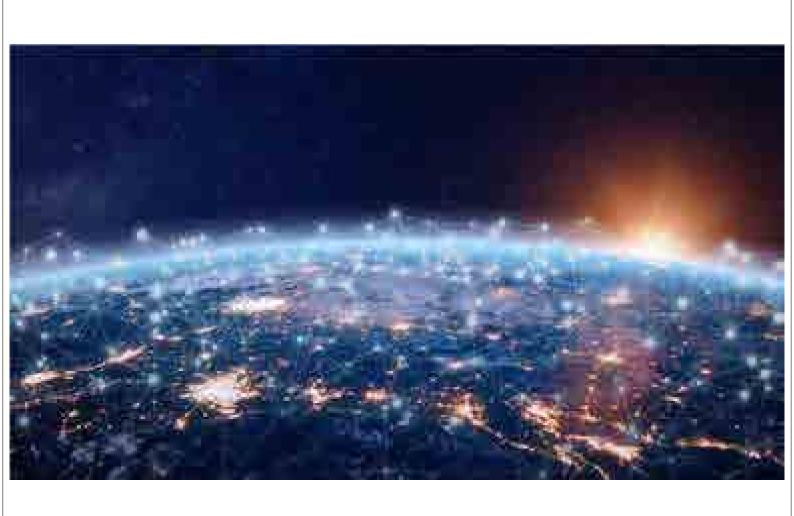
Accuracy: 66%



12

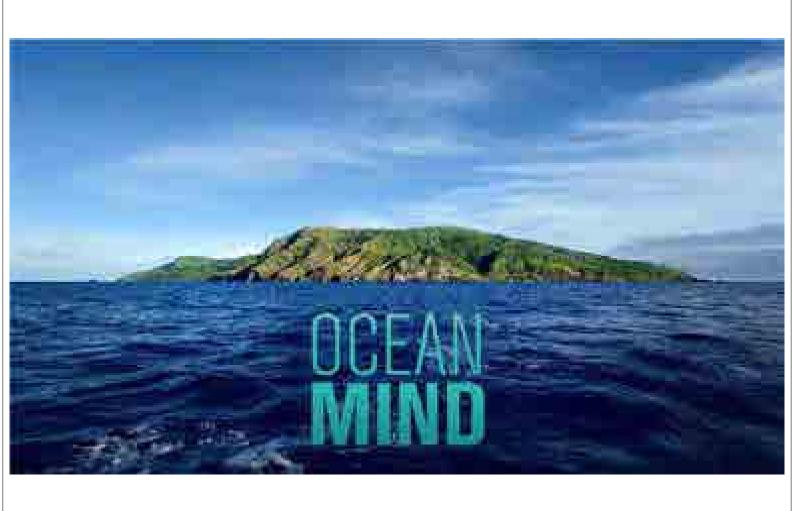


PROTECTING THE WORLD'S OCEAN RESOURCES









The possibility of MASS spreading by the universe

JAPAN MARINE SCIENCE INC.
General Manager of Marine Technical Group





Research and Development of Autonomous operation on NYK Group





What is our Goal?



- 1 Improve safety(Reduce the number of Accident)
- ② Reduce Work load(New approaches for future crew shortage)
- What do we need?



Advanced Support by system = Complement existing human factor

- How to approach our goal?
 - 1 The user perspective utilizing ship operation Know-How and Skill/Experiences which is acquired on scene
 - 2 Improve one by one toward our goal (Bottom-up way)
 - 3 Collaborate with best partners

Research and Development of Autonomous operation on NYK Group



Manned Autonomous Ship







- Advanced supporting system with realistic cost (Analysis and planning)
- Approval(decision making) by human, Operate by seafarer on board



Information Acquisition

Analysis

Planning

Approval

Manned **Autonomous**

Onboard Equipment Seafarer

Onboard Equipment Seafarer

Onboard Equipment Seafarer

Seafarer

Quote: Edward Fort, Global Head of Engineering, Lloyds Register, "Autonomous ships - LR approach" January 2018

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Concept of NYK Manned Autonomous ship

Remote <Monitoring> Concierge Nav. status Eng. status <Provide information> Value added Marine Weather Information Marine Traffic Long-term voyage planning

<Watch keeping Support>

Computer Vision (Visual processing & Identification) Display AR/VR

<Analysis / Planning Support>

Index for Collision risk judgement & Display risk area (*1)

Auto Collision Avoidance Program (*2)

<Maneuvering Support>

Remote operation at open sea Suggestion of Action for collision avoidance

Confirmation of action

- 1: Partial Findings in Study on Avoiding Collisions: The study was selected by MLIT for its "2016 Support Projects for R&D in Advanced Safety Technology of Vessels" in i-Shipping.
- A system development using artificial intelligence (AI) as core technology for navigation support system of domestic vessels: The study was selected by MLIT for its "2018 Transportation Research and Technology Promotion Program"

Sensor

SIMS

NeCST

APS

Participate in Demonstration Project to Remotely Operate a Ship: The study was selected by MLIT for its "participate in a demonstration project utilizing ship maneuvering support functions and remote control".

Anticipated effects for upgrade of satellite technology





High Precision Sensor on satellite



- **High accuracy on fixed position** [Auto Docking]
- Live viewing of traffic flow on the sea [Safe Navigation · Precaution of Piracy
- Actual weather status · sea condition (especially ocean current) [Economical Navigation]



Low cost/Stable/High speed/Full-time connection Satellite communication



- Grasping of Ship's data (Navigation · Engine condition etc.) with high precision [Safe & Economical Navigation · Quick accident response on shore
- **Remote system maintenance** [Safe Navigation]
- Dynamic remote operation from shore (Camera viewing · Control signal···) [Support Navigation]

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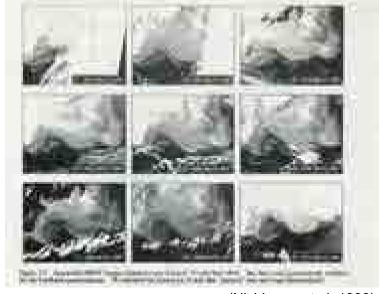


本資料は、電子的または機械的な方法を問わず、当社の書面による承諾を得ることなく複製又は頒布等を行わないようお願いします。

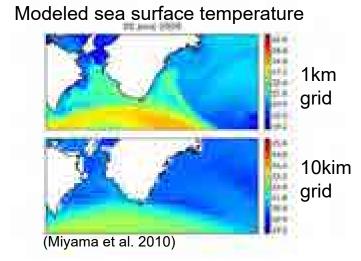
No part of this document shall be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of NYK Line

Big-data applications to observation and forecasting of oceanic conditions Yasumasa Miyazawa (Japan Agency for Marine-Earth Science and Technology)

Satellite sea surface temperature with 6-hour interval



(Nishimura et al. 1998)

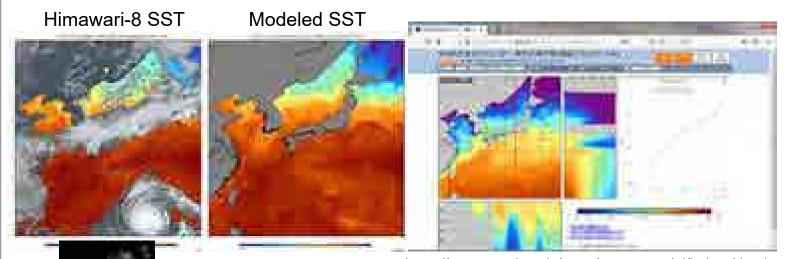


Higher resolution models are available ...

JAXA-JAMSTEC Cooperative Ocean Weather Forecast Operation since Nov. 2018

Observation + Model

Nowcast/Forecast



https://www.eorc.jaxa.jp/ptree/ocean model/index j.html

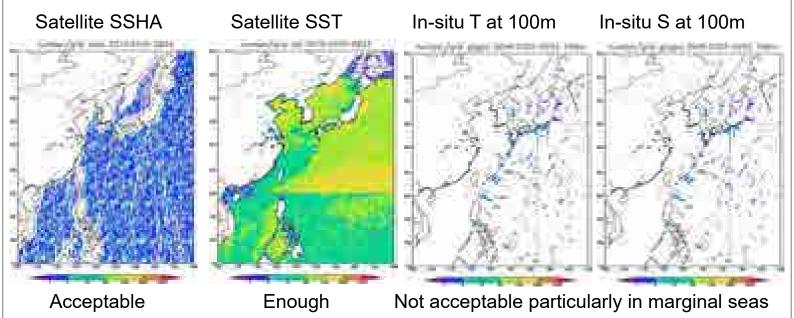
https://www.jma-net.go.jp/sat/himawari/enkaku.html

Ocean fore casting applications
Domestic cargo ship - -Tablet routes access On a bridge A cargo ship 499-ton http://www.forecastocean.com

Other on going applications: fishery, marine leisure, ocean drilling, defense, security

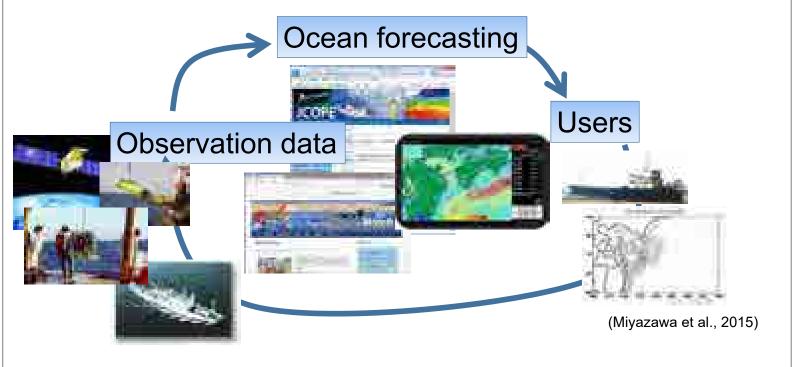
Observing Ocean: current status The skill of ocean prediction highly depends on available observation data.

<Numbers of available observation within one month>



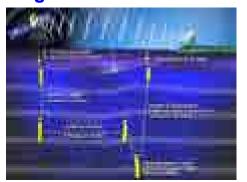
Possible feedback mechanism

A spiral for enhancing forecasting skills/ observation activity



Autonomous platforms in 21st century

Argo Float/Glider



http://www.argo.ucsd.edu/

Sail drone



https://www.saildrone.com/

Wave glider



https://www.liquid-robotics.com/

Animal telemetry Bio-logging



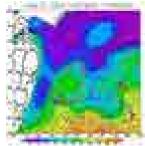
Miyazawa et al. 2015



Yusuke Goto



Tomoko Narazaki



Miyazawa et al. 2019

Toward more autonomous / deeper layers

Deep sea ocean currents (Nagano et al. 2013)

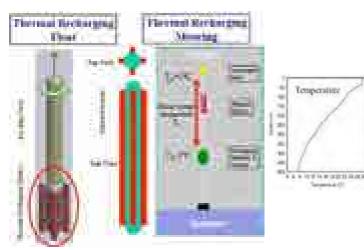
Current speed (cru/s)

Current Speed (cru/s)

Current Speed (cru/s)

http://ec-og.com

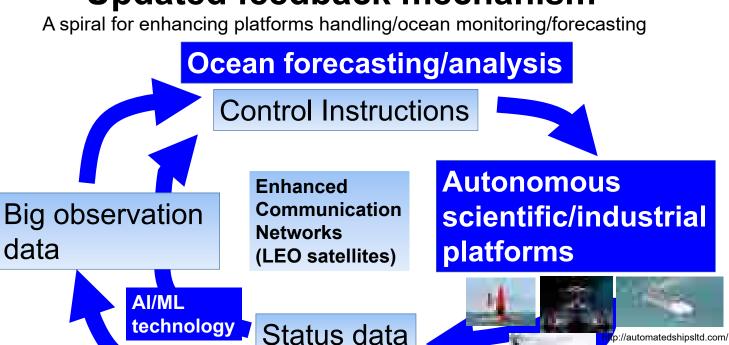
'SOLO-TREC'
Thermal energy converter



http://seatrec.com/

Harness the ocean renewal energy for marine activity (not for land activity)

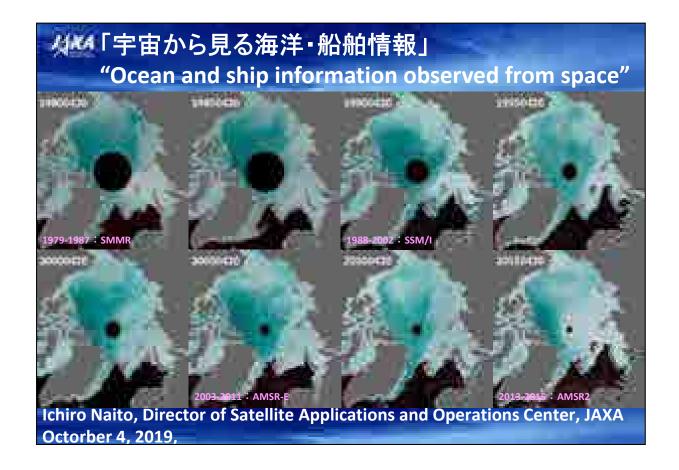
Updated feedback mechanism



Sensor data

添付2:第2回シンポジウム資料

※一部開示制限あり。一部開示不可。



これは1980年から2015年まで5年毎に北極海を観測した画像である。

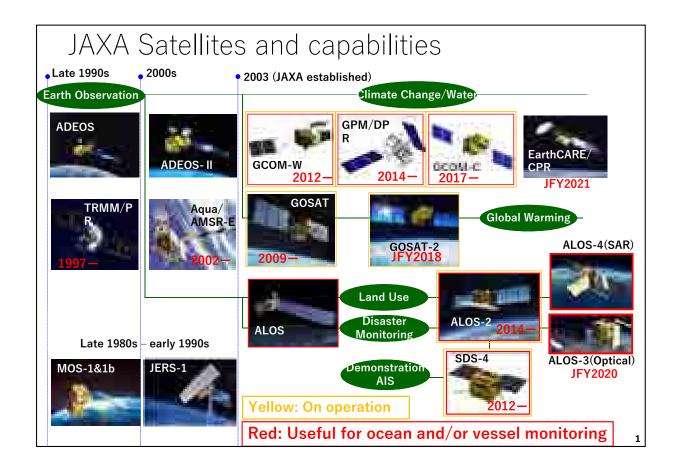
濃い青は厚い氷を、薄い青は薄い氷を示している。

これを見ると、年々、北極海の厚い氷が減少しているのがわかる。

これらのデータは一つの衛星が観測したものではなく、米国や日本の複数の衛星による継続的な観測から得られた情報である。

Brightness temperature (BT) of the Arctic sea-ice observed with satellite-borne passive microwave radiometers on April 20 (RGB composites of BTs at 18GHz and 36GHz. Deep blue indicates thick perennial ice, whereas bright blue indicate thin seasonal ice).

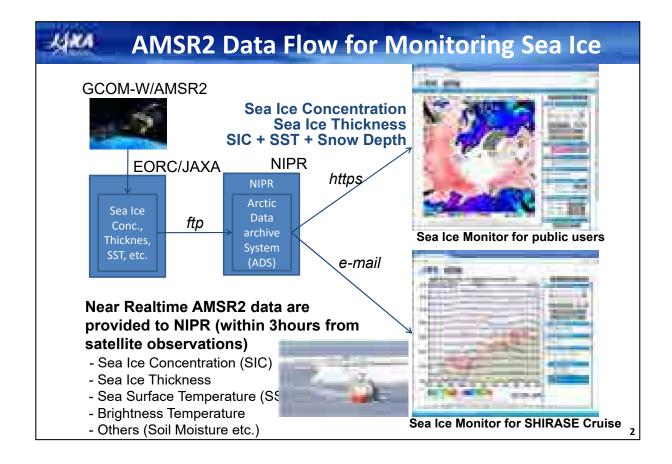
Recently perennial sea ice cover in the Arctic ocean is getting smaller year by year indicating the acceleration of the weakening of the Arctic sea ice.



日本は1980年代から地球観測衛星を打ち上げている。

JAXAは2003年の設立以来、気候変動や災害監視等を目的とする多くの衛星を開発・ 運用している。

Japan has been launching Earth observation satellites since 1990's JAXA was established in 2003 has been developing and operating many satellites

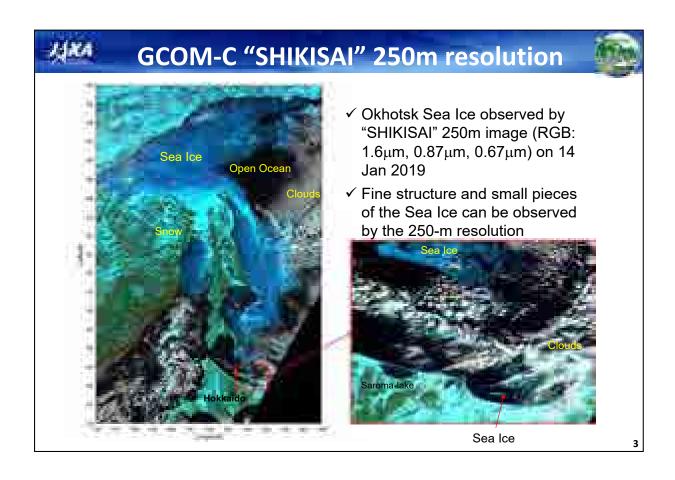


これは海氷モニタにおける衛星情報の流れを示したものである。

人工衛星で観測されたデータは、JAXAの地球観測解析センター(EORC)で処理され、海氷の厚さ、海面水温等の情報に変換され、国立極地研究所(NIPR)のシステムから配信されています。

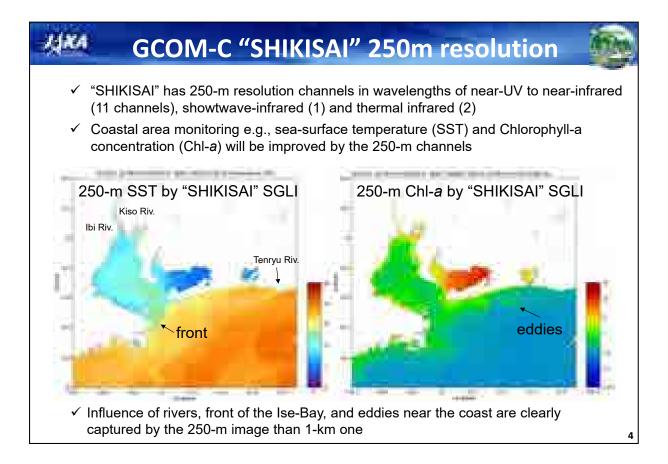
これらの情報は、一般ユーザによる海氷の監視に使われるほか、南極観測船しらせの航海でも利用されています。

Sea Ice Concentration (SIC) 海氷密接度
Sea Ice Thickness 海氷厚さ
Sea Surface Temperature (SST) 海面水温
Brightness Temperature 輝度温度
Soil Moisture 土壌水分



これは、「しきさい」が解像度250m解像度で観測した2019年1月に観測した画像です。 海氷、雪、雲等がきれいに識別されていることがわかります。

2019/01/14 01:50頃



これは「しきさい」の250m分解能の効果を説明する図となります。

「しきさい」は250m分解能を有する近紫外から近赤外、そして、短波長赤外、熱赤外を16チャンネルで観測します。

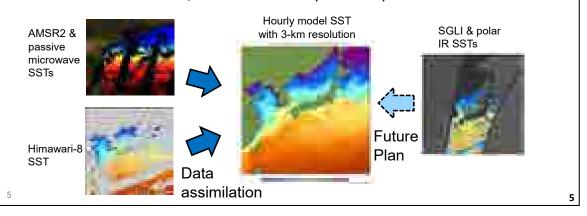
これらの情報から算出される海面水温(SST)や植物プランクトンに含まれるクロロフィル-Aの情報は、漁場の推定に役立つと考えられています。

この図では従来の1kmの分解能では細部が不明確であった河川の影響、伊勢湾の冷たい水と温かい水の境界(front)、沿岸近くの渦(eddies)がクリアに捉えられています。

2019/01/14 01:50頃

Ocean Weather Forecast by assimilating satellite observations

- JAXA and JAMSTEC have developed of the system assimilating satellite-based sea surface temperature (SST) into the 3-km resolution ocean model around Japan.
- JAXA has started routine distribution of SST analysis and 2-week forecasts by the model since Nov. 2019 through the JAXA P-Tree system (https://www.eorc.jaxa.jp/ptree/).
- Other data (temperature, salinity, currents under ocean) and their forecast are also available from JAMSTEC.
- Introduction of GCOM-C/SGLI SST is currently underway.



次に海中天気予報について紹介します。

JAXAと海洋研究開発機構(JAMSTEC)は衛星で得られた海面水温を、日本周辺の3kmの解像度の海洋モデルに同化するシステムを開発しました。

そしい、JAXAは2018年11月から、2週間先の海面水温の配信を始めました。

この図は、予報の概念を示しています。

左上は「しずく」衛星が観測した、分解能は荒いけど雲を通して観測できるマイクロ波から算出した海面水温(SST)です。

左下は、雲の下は見えないけど、高頻度に観測できる気象衛星「ひまわり**8**号」データから算出した海面水温データです。

これらのデータを、コンピュータの計算によって海中を模擬したモデルに観測したデータを入力、すなわち同化することで、分解能3kmの1時間毎の海面水温を推定しています。

雲の下の見えないところや、時間的にデータの抜けがあるところは計算して求める訳です。

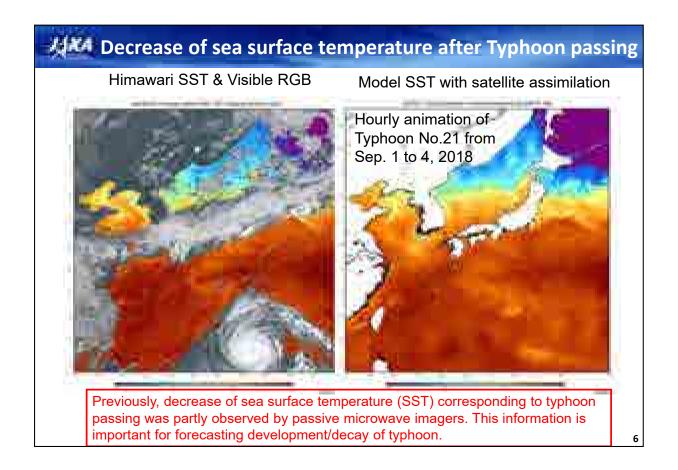
将来的には、「しきさい」の観測データを同化して、精度の向上を目指す予定です。

--参考データ---

「しずく」衛星が観測したマイクロ波から算出した海面水温 2日毎(?) 空間分解能

50km(?)

気象衛星「ひまわり8号」の海面水温 1時間毎、空間分解能 2km 「しきさい」の海面水温 2日毎(?) 空間分解能50km Polar IR SST(?)



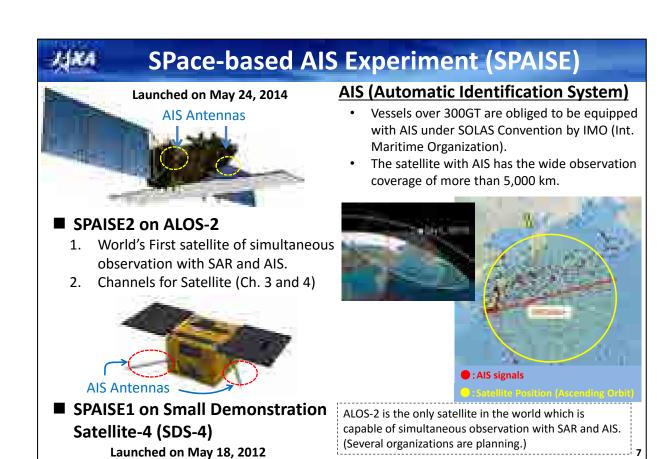
この図は台風通過後の海面温度の低下を表しています。

左図はひまわりの可視画像と、海面水温を示していますが、雲の下はわかりません。 右図はモデルに同化しているため、雲の下も推定しています。

海面水温の情報は、台風の発達や勢力低下の予測に重要であるため、この精度が改善されることは非常に有効である。

-----参考-----

従来より、台風通過後の海面水温の低下はマイクロ波画像による観測で部分的に推定されている。この情報は、台風の発達や減衰の予測に重要である。



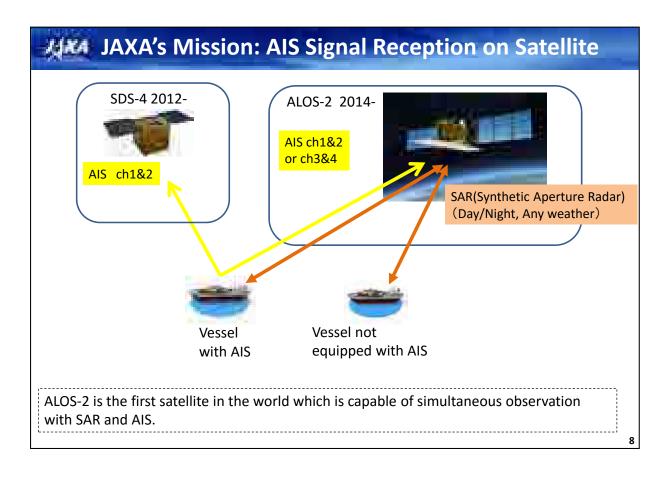
ここからは衛星ベースのAIS(自動船舶識別装置)の話になります

AISを装備した船は自分の周囲数十キロのデータを受信して相手の船の位置を把握します。

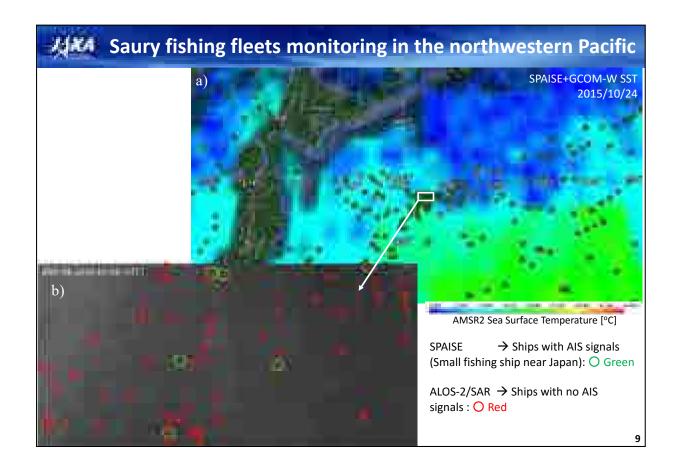
これに対して、衛星からは5000kmの範囲のデータを受信することができます。

JAXAは現在、ALOS-2とSDS-4という二つの衛星に搭載したAISのデータを取得しています。

そして、ALOS-2は船舶の位置を観測できるレーダも搭載されていて、レーダ画像とAIS情報を同時に取得することが可能です。



AISだけだと、AIS信号を発信していない船舶の情報はわかりません。 これに対して、ALOS-2は、AIS信号を発信していない船舶の位置を合成開口レーダで 把握することができます。



これは西太平洋のサンマ漁船の観測結果を示したものです。

背景には、衛星観測で得られた海面水温を重ねています。

この領域は、秋にはサンマの良い漁場として知られていますが、船が冷たい水と、温かい水の境界付近に船が集まっていることがわかります。

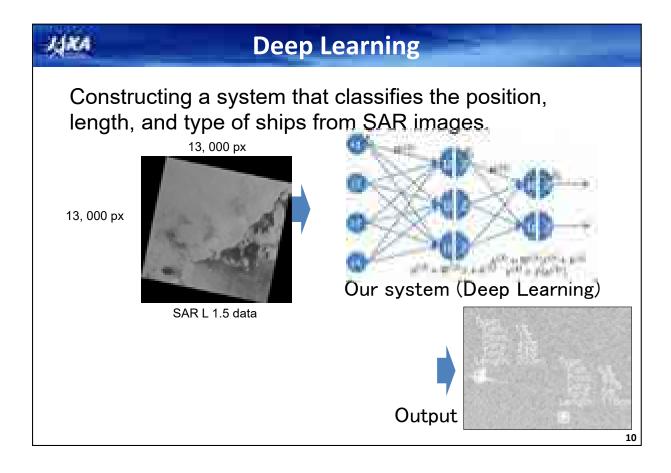
拡大した図では、緑はAIS信号が確認された船の位置、赤はSARで把握した船の位置を示していますが、AISで確認できないたくさんの船がいることがわかります。

(a) the distributions of SST derived from AMSR2 onboard the GCOM-W satellite and AIS signals derived from SPAISE1 and SPAISE 2 on 24 Oct. 2015 on Eastern of Japan Islands. (b) SAR I

mage at 1418 UTC 24 Oct. 2015, ship distribution from SPAISE2 (large circles) and detected by SAR image (small circles) in the rectangle of (a).

Figure (a) shows the distributions of SST derived from Advanced Microwave Scanning Radiometer 2 (AMSR2) onboard the GCOM-W satellite and AIS signals derived from SPAISE1 and SPAISE2 on 24 October 2015 on eastern maritime of Japan Islands. This field is famous for a good fishery ground of the Pacific saury in the autumn season. Ships concentrated at the front between cold SST area at

the north and warm SST area at the south around 40-41°N and 147-150°E. Figure (b) shows the ship detections from SPAISE2 and PALSAR2 in the rectangle area of Fig. (a). It indicates that much amounts of small fishing boats with no AIS worked in addition to ships with AIS signals in this area.



次は、ディープラーニング(深層学習)に関する取り組みについて紹介します。

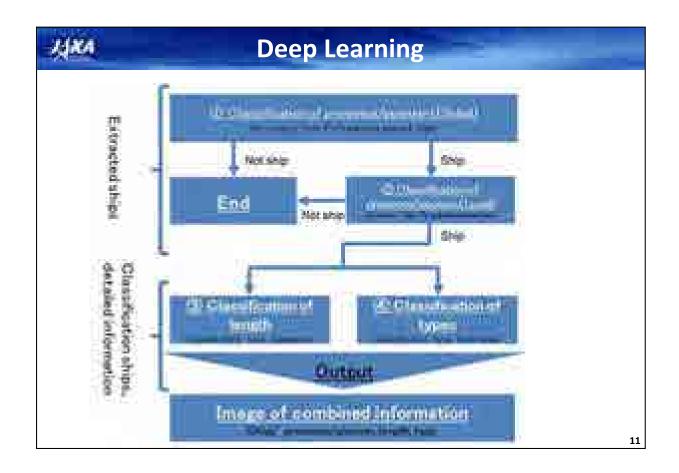
深層学習とは、人間の脳の働きをコンピュータで模擬する技術です。

従来のコンピュータの使い方は、人間が計算の仕方、すなわちアルゴリズムを考えてコンピュータにプログラミングし、データを入力して答えを得るといった使い方をしていました。

これに対して、ディープラーニングは、人間が失敗しながら正しいやり方を学習していくように、コンピュータに学習させて、正しい答えを出すようにする技術です。

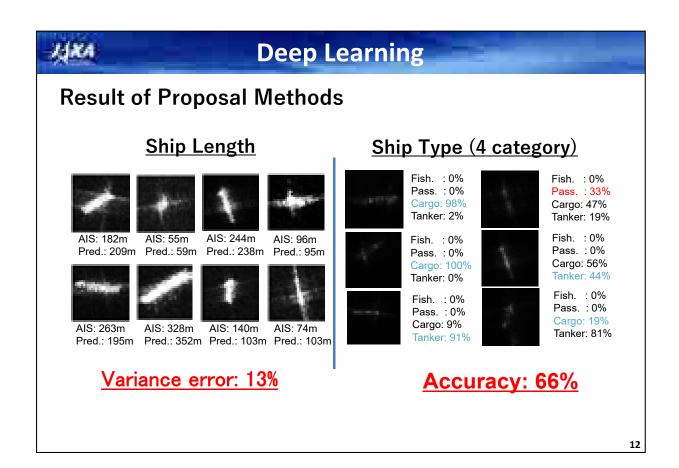
現在、JAXAでは、SAR画像から、船の情報を抽出するシステムの研究を進めています。

左上のようなSAR画像にディープラーニング技術を適用して、右下のように船の位置、 種類、長さを抽出するというものです。



これはディープラーニングの流れを簡単に示したものです。

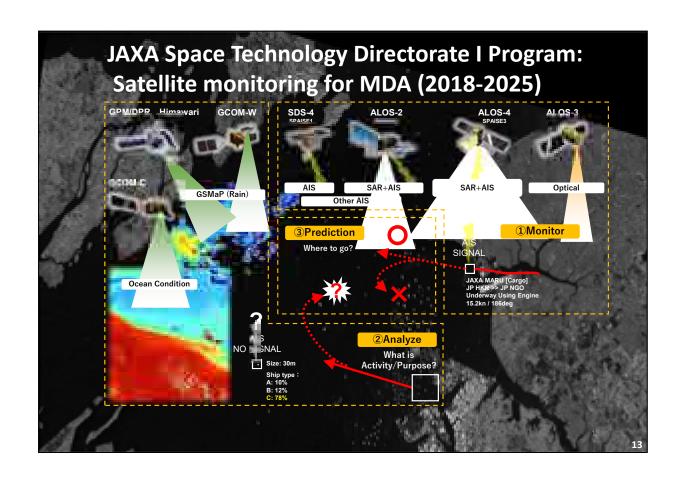
最初に船が映っている部分の画像を抽出します。 次に、船の画像から、船の長さ、種類を分類します。 最後に、元の画像に、抽出した情報を重ねて表示します。



こちらは解析結果です。

AIS情報を使って調べた船の大きさを正解とし、ディープラーニングで予測した値と比べると、誤差は13%となりました。

船の種類を4つに分類した結果、精度は66%でした。



JAXAでは、現在、海洋状況把握(MDA)プログラムに取り組んでいます。

これまで、船舶がどこにいるかといったモニタを行い、解析を加えることによって漁船がサンマ漁をしているといった情報がわかるようになってきました。今後は、将来の行動を予測するといった活動に取り組んでいく予定です。



小型衛星搭載合成開口レーダによる高頻度観測と海洋監視の実現

Revolution by frequent observation and ocean monitoring with small synthetic aperture radar satellites

October 04, 2019

Toshihiro Obata

Board Director and General Manager of Satellite System Development Department

Synspective Inc.

CONFIDENTIAL

判断を支える高頻度データ

01

Frequent Information for Decision Making

RIMPAC Demonstration to Identify the Ships

During the RIMPAC2018, 185 satellites are gathered and used for identifying ships

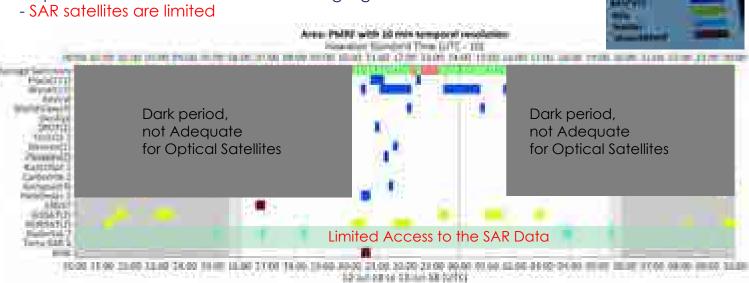


RIMPAC Demonstration to Identify the Ships

CONFIDENTIAL

Still there are period that satellites can not observe, even 185 satellite gathered.

- Optical satellite can not observe during night



Decision making in 50 years ago without Data

This may be something what we are doing Now in most business and personal decision making without data



https://note.mu/mkweather/n/nf20972a367ba

©-Synspective Inc.

Decision making with frequently updated data

5

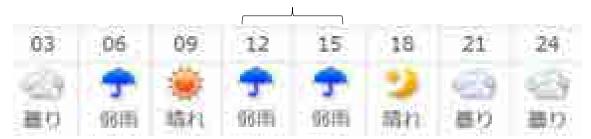
Now: Satellite data is valuable or expensive

Mostly for government strategic/long forecast

Future: Affordable data distribution for business and personal Daily decision making like weather forecast

- More variety and familiar usage (ex: Traffic jam monitoring)
- Timely and fresh (ex: construction progress abroad in 30min)

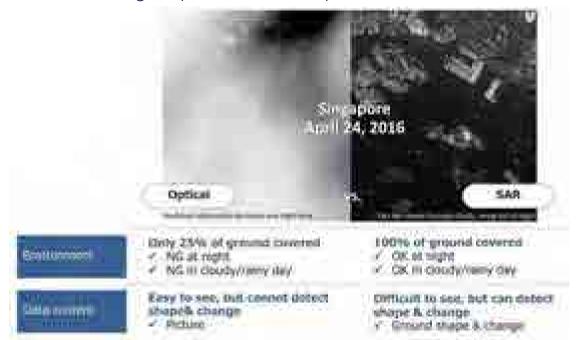
I need Umbrella!



©-Synspective Inc

Benefit of SAR (Synthetic Aperture Radar)

SAR can provide geospatial data even at night / in cloudy day, so it's good for area having rainy season, for example Asia and India.



©-Synspective Inc

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02

Synspectiveのビジョン

Who is Synspective?



Name Synspective Inc.

Date Founded 2018.2.22

CEO Motoyuki Arai

Address 3-10-3 Miyoshi, Koutou-ku, Tokyo, JAPAN

Business • Solution Services with Satellite Data • Development and Operation of Small SAR Satellites

Subsidery Synspective SG Pte. Ltd.
460 Alexandra Road #07-01 PSA Building Singapore 119963





Recent News (26th July 2019)

CONFIDENTIAL

SPACENEWS 39

Japanese SAR startop Synspective reaches \$100 million in funding



From SpaceNews Web Page on July 26th 2019

Synspective:

Founded in Feb 2018

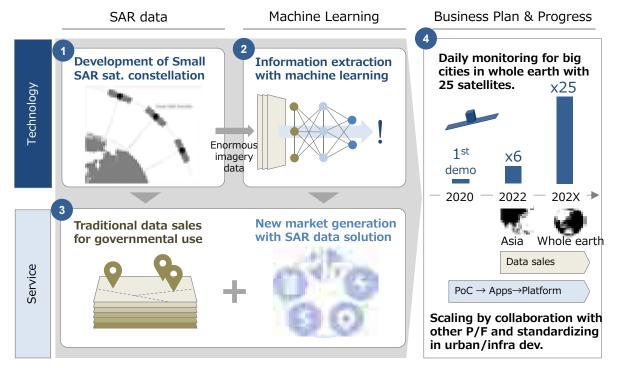
Raised \$100M in 17months from Japanese private companies for building and launching 6 satellites

Inheriting the outcome of Japanese Government Small SAR development project, called ImPACT

About 50 Members

Synspective Inc.

Main Business: SAR data solution



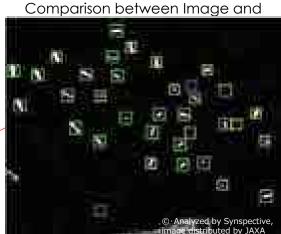
©-Synspective Inc

Ship Detection

CONFIDENTIAL

Detecting Ship for images and comparing with AIS (Automatic Identification System) data ⇒ Identifying Suspicious ship or pirate ship





Without AIS (Only Satellite detects)
With AIS (both Satellite and AIS detects)
With AIS (only AIS detects)

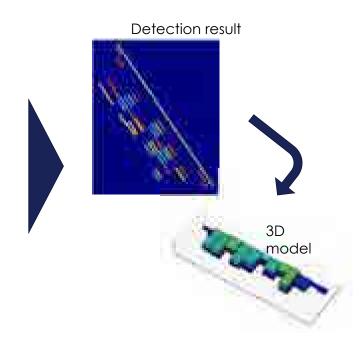
©-Synspective Inc

Counting Container at the harbor

Making 3D model of piled containers and estimating the number of the containers

Estimating amount of shipment and traffic





©-Synspective Inc.

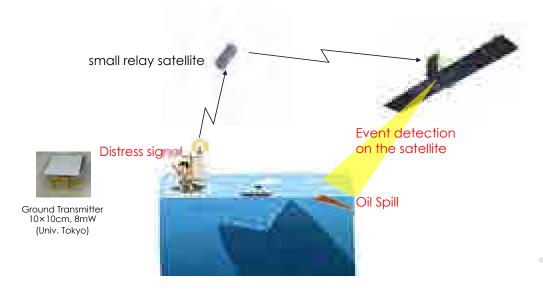
Autonomous quick data acquisition will be demonstrated in 2021

CONFIDENTIAL

Quick ordering of observation targets to the satellite without human processing and instructions via IoT and satellite network

by ground/sea sensors

by onboard(on-satellite) data processing (event detection)



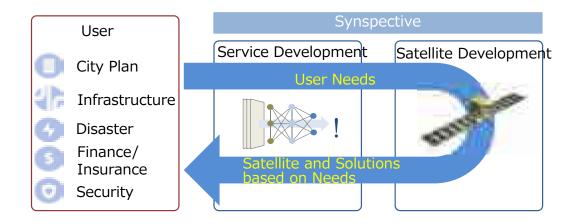
·Synspective Inc

Feature of Synspective

Synspective has both specialists:

data processing/service development and satellite development

who enable quick response to the user needs, by not only solutions, but also satellite



©-Synspective Inc

Sharing our Vision

Please check Synspective video on our Webpage or YouTube!



CONFIDENTIAL

1.

ive In

衛星開発状況

Development Status of our Satellite

Our Satellite

StriX-a from 'Strix uralensis', scientific name of 'Owl'

1st Demonstration X-band SAR Satellite

Deployable SAR Antenna Panel with Solar Cells

: 140kg Mass

: 5 x 0.7 x 0.7m (in Orbit) Size

0.7m Cubic(at Launch)

Resolution: $1\sim3$ m

: 2020 Launch



Position of Synspective Small Satellite

	Small SAR Satellites				Japanese SAR Satellites	
	Synspective	ICEYE	Capella Space	QPS	ASNARO-2	ALOS-2
		V			No.	
Cost	\$5M	\$3-5M	\$2-4M	\$4-8M	\$110M	\$190M
Mass	140kg	70kg	20-30kg	100kg	570kg	2000kg
Resolution	1-3m	0.5-10m	0.5-3m	1m	1m	3m
Band	X band	X band	X band	X/L band	X band	L band
Life	3 years	3 years	-	-	5 years	5 years
Daily Acquired Data - Observation Time - Swath	71,100km ² 20min./day 10-30km	21,600km² 1.1min./day 50km	1,600 -27,000km²	-	164,000km² 35min./day 10km	5,925,000km² 250min./day 50km

Antenna Mechanical Test











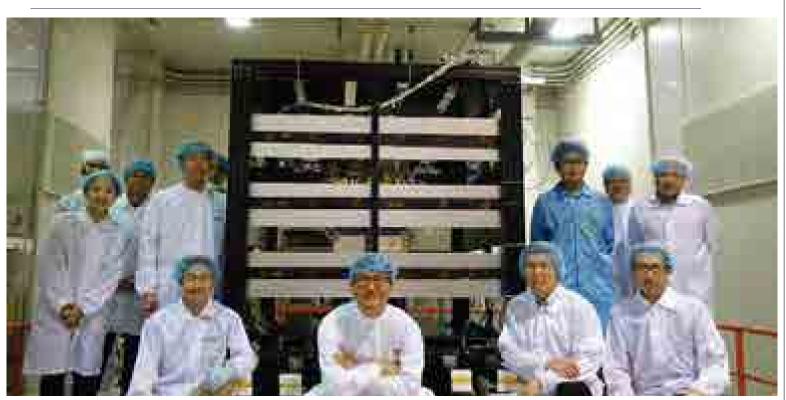
Assembled Flight Model Satellite Body



©-Synspective Inc

Satellite Development Team at Thermal Vacuum Test







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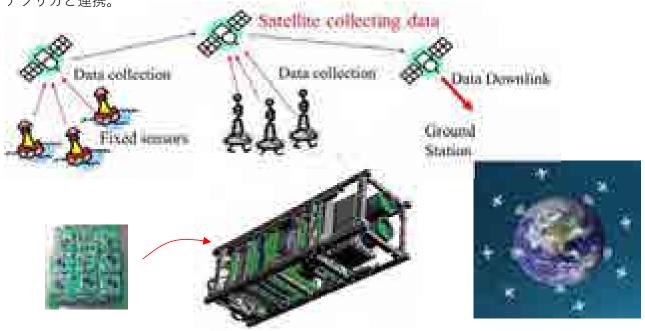
Toshihiro Obata

Board Director & General Manager of Satellite System Development Dept.

Synspective Inc. 3-10-3 Miyoshi, Koutou-ku Tokyo, JAPAN hello@synspective.com

超小型衛星によるIoT通信の実現

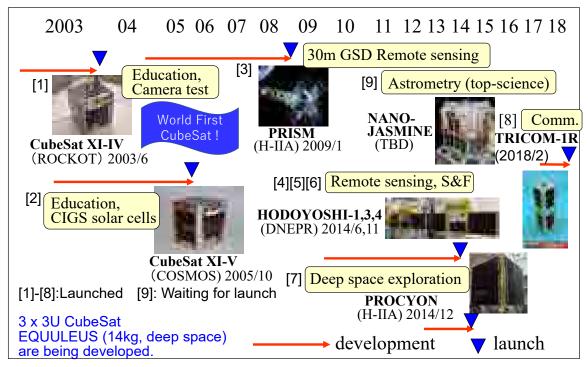
東京大学中須賀船瀬研究室のTRICOM1R衛星を活用し、宇宙IoTを標準化、量産コンステレーションを目指す。既に、海洋分野への展開にむけてインドネシア、フィリピン、アジア各国や中東アフリカと連携。





東京大学中須賀船瀬研究室





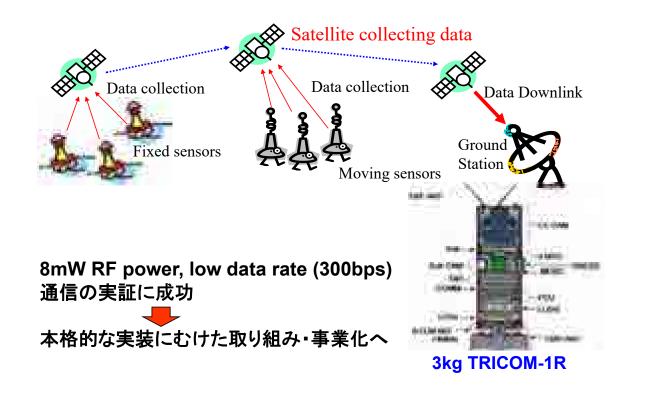
Launch of TRICOM-1R by SS-520-5

2018年2月3日 JAXA/ISASのSS-520によって打上げ

- S&F 通信およびカメラの実証成功
- <u>日本、ルワンダなどで、8mW 通信試験成功</u> transmission from Japan, RWANDA, etc
- これらの成果をさらに展開・サービス事業化を推進



<u> "Store & Forward" 通信による地上情報の収集</u>









MOU to develop 3U CubeSat to be launched in 2019

News from Africa (09/05/2018)

Smart Africa, Rwanda Sign Deal With

Tokyo University For Satellite Technology



Moreous States Washed: White Harmon States Washed: W



<u>TICAD7</u> 安倍総理オープニング スピーチー部抜粋

「目をずっと上げ、地球の外に上げてみたいと思います。もうじきそこに、ルワンダが東京大学と一緒に作った小型衛星が現れます。ルワンダの作付けや、水資源の様子を宇宙から見る衛星です。

-中略-

アフリカの未来に懸ける日本の事業者たちを、わが政府は、New TICADは、全力で支援します。」



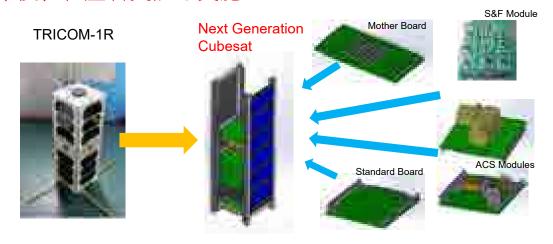
TICAD7横浜行動計画2019 AU フラッグシップ・イニシアティブ: アフリカ宇宙戦略

対応する重点分野:

- ・経済の多角化・産業化,競争力の 促進。持続可能な資金調達慣行の確保
- ・人的資本開発の支援及 び SDGs 達成のための STI の活用

Cubesatコンステレーションに向けた 量産・標準化の実現

- 2019年9月25日に2機打上げ。 (ルワンダ衛星、超小型推進器の実証)
- 今後、経産省実証も実施



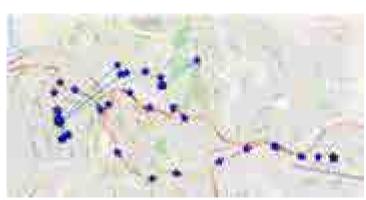
各国への提案

- Any Collaboration : Your Idea X Our Experience
- All options can include capability building programs



衛星LoRA通信の開発・実証

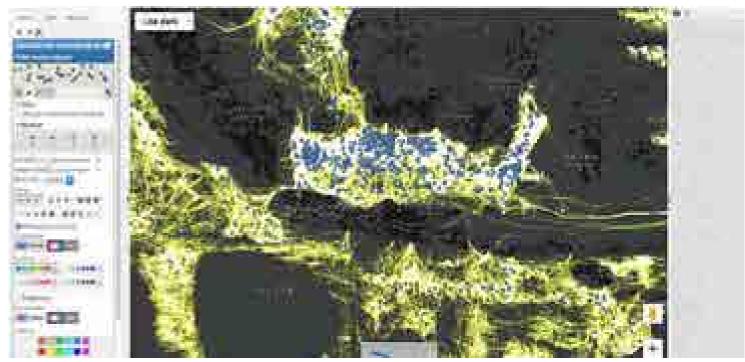
東京大学本郷キャンパス近郊におけるログ→



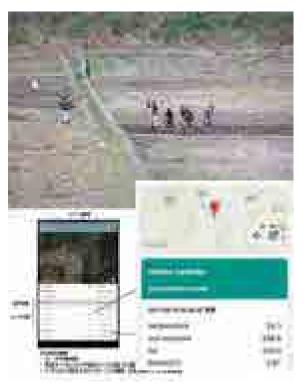
↑キガリ市内におけるLoRAによるGPSログ







キャプションを入力してください。





Japan Space Forum / The Sasakawa Peace Foundation
International Symposium on Maritime-Space Cooperation

How we utilize next generation
technology of AIS
Expectation for VDES

Self Introduction (Takeshi MIZUNARI)

- Japan Coast Guard Days (1999/12~2013/12)
 Navigating Officer (Resigned at Chief Officer)
 Info-Communication Division Officer at HQ (Concerning SPAISE(JAXA))
- The Japan Association of Marine Safety Days (2014/03~2018/12)
 Research on Prevention Maritime Polution from Ships
 Support Japanese Government (MLIT) on MEPC/PPR meeting at IMO
 Compiling ESI map for National Crude Oil Reserve Base
 Personally committed with Maritime-Space Collaboration Issue (went C-SIGMA)
- The Sasakawa Peace Foundation Days (2019/04~present)
 Fellowship Program for World Maritime University (WMU) MSc Course at Malmo, Sweden Join Maritime-Space Collaboration Issue Team
- Navigation Officer
 Diving Instructor (PADI Open Water Scuba Instructor)

Let Me Introduce My Present Occupation (1)

WMU (World Maritime University) Sasakawa Fellowship MSc Program
 Main target: Public servant in developing countries committed to maritime industries
 77 Countries, 669 Recipients since 1987 to now (2019/9) (approx. 30 per year)
 Support intermediate officers who commit to maritime or marine issues
 Also support networking after their graduation from WMU







3

Let Me Introduce My Present Occupation (2)

Maritime-Space Collaboration Issues
 Exchange opinions between various organization about VDES
 Study group on Maritime-Space collaboration issue





Disclaimer



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Agenda

- About AIS (review...)
- About VDES
- About Satellite VDES
- •What We Expect to Satellite VDES

- About AIS (review...)
- About VDES
- About Satellite VDES
- What We Expect to Satellite VDES

About AIS (review...) (1)

Simply saying...

≥ 300G/T ships engaged on int'l voyage ≥ 500G/T cargo ships not engaged on int'l voyage All passenger ships

are

sharing ship's identity, type, position, course, speed, navigational status and other safety-related information

nowadays smaller ship voluntarily equip though they are manufacted (but not all the ships)

7

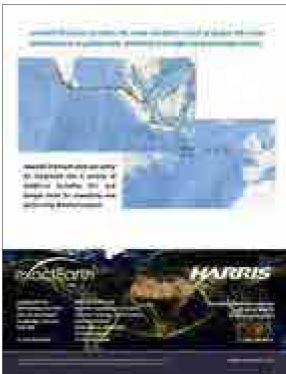
About AIS (review...) (2)

- Originally ship to ship communication (prevent collision)
 Not limited to ship's position (static information, application specific messages)
- Can also communicate with land base station
 e.g. "Virtual AIS navigational system)
 may be settled where hardly deploy buoys (deep place etc.)
- Broadcasting the data
 Only we need is to prepare receiver station to gather ship's information
- The capability of receiving AIS signal from satellite orbit had found
- Nowadays coastal vessel can be found by coastal station, ocean-going vessel can be found by S-AIS (not limited to fleet under control, they can purchase the data almost real time globally)

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About AIS (review...) (3)





About AIS (review...) (4)





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About AIS (review...) (5)



- About AIS (review...)
- About VDES
- About Satellite VDES
- What We Expect to Satellite VDES

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About VDES (1)

- VDES VHF Data Exchange System
- Expanded from AIS (frequency etc.), prepared as a infrastructure not limited to position report
- Simply speaking, "AIS and very low speed network"
 (not "internet" at this moment but has a capability)
 160MHz, max. 300kbps (not per ship, per area)
 Free of charge for vessels! (infrastructure and tax (in Japan) cost some)
- We are on the way of deploying Land frequency confirmed, Satellite frequency (uplink) confirmed Satellite frequency (downlink) will be discussed at WRC-19 (10/28 - 11/22)
- It is not confirmed what kind of data will be exchanged at this moment (will be standardized)

About VDES (2)

- What kind of data will be expected to exchange with VDES?
 IMO introduced e-Naviation strategy implementation plan (MSC.1/Circ.1595)
- It is introduced what kinds of data should be processed by computer

"Maritime Service Portfolio" concept

- MSP 1: VTS Information Service
- MSP 2: Navigational Assistance Service
- MSP 3: Traffic Organization Service
- MSP 4: Local Port Service
- MSP 5: Maritime Safety Information Service
- MSP 6: Pilotage Service
- MSP 7: Tug Service
- MSP 8: Vessel Shore Reporting
- MSP 9: Telemedical Assistance Service
- MSP 10: Maritime Assistance Service
- MSP 11: Nautical Chart Service
- MSP 12: Nautical Publications Service
- MSP 13: Ice Navigation Service
- MSP 14: Meteorological Information Service
- MSP 15: Real-time Hydrographic and Environmental Information Service
- MSP 16: Search and Rescue Service



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About VDES (3)

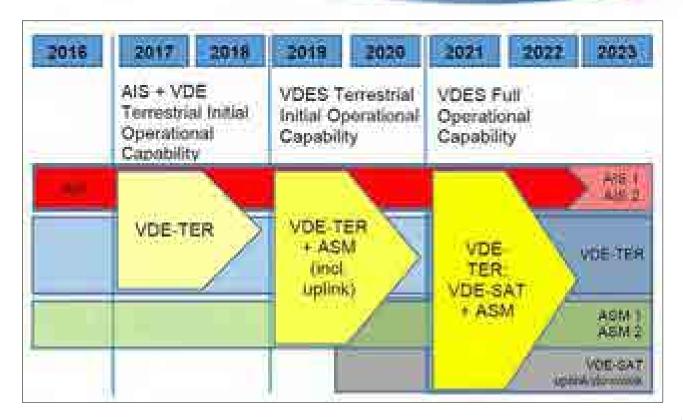
- IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities)
 They developed VDES (as well as e-Navigation concept)
- IALA issues VDES technical specification document
 IALA Guideline G1139 (The Technical Specification of VDES) Edition 2 (Jun./2019)





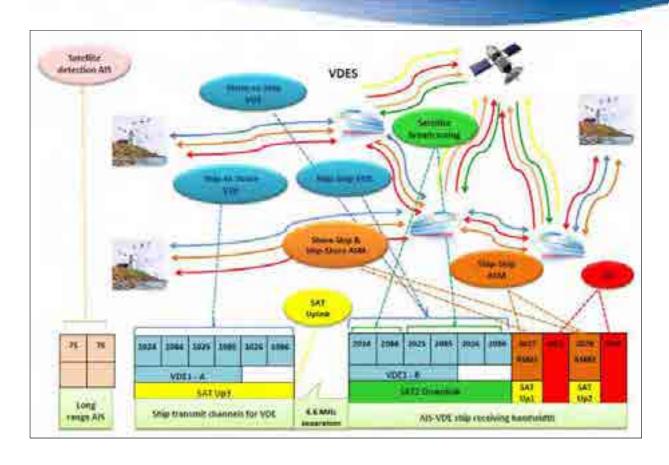


About VDES (3)



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About VDES (3)



About VDES (4)

Japan Coast Guard

- "Research on VDES maritime traffic use" (FY2017-2018)
 Research Committee conducted
 Trial manufacture of VDES Tx/Rx, then trial on 2018/12
- Terrestrial VDES will be deployed
 Satellite VDES was not considered at the moment
- To be determine what kind of data should be exchanged with VDES (waiting for IMO decision)

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- About AIS (review...)
- About VDES
- About Satellite VDES
- What We Expect to Satellite VDES

About Satellite VDES (1)

- Satellite VDES
 Satellite based VDES communication between base stations and vessels
- Uplink frequency has confirmed
- Downlink frequency Discussion had carried over from WRC-15 to WRC-19

To Be Determined at WRC-19 (2019/10 - 11)

Many proposal submitted to resolve, but not sure which one is likely been supported

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About Satellite VDES (2)

 MIC (Ministry of Internal Affairs and Communications) requested Public Comments for WRC-19



About Satellite VDES (3)

Norway did experiments
 Since their water is located on high latitude, we believe they are interested in Polar Orbit
 Satellite, in difficulty of being in good communication with Geostationary Satellite



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About Satellite VDES (4)

- We do need to wait until the result of WRC-19
- My perspective: Start immediately globally just after the result (R&D, Standardization, Deployment infrastructure, etc. etc.)
 But it is still needed to be determined by IMO, as they have reputation in shipping / maritime industries

- About AIS (review...)
- About VDES
- About Satellite VDES
- •What We Expect to Satellite VDES

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What We Expect to Satellite VDES (1)

- Very low speed (total approx. 300kbps)
 No rich contents
 Flow control will be needed by Administration (Organization or Coastal States?)
- No video transmission / communication
 (e.g. bridge camera, radar display, non-organized big data)
 Some method is needed to utilize (compression, coordination with other method)
- Should we review any maritime infrastructure?
 GMDSS, e-Navigation, etc. (more wider than they considered and discussed)

What We Expect to Satellite VDES (2)

- Sat/Ter VDES → Fit to Low Cost Data (few dozens of bytes)
- Do we have presently such data among maritime infrastructure...?
 - Position report for ordinary ship (submit periodically, some fail result SAR activities)
 - Position report for fisheries (observed by administration during fishing activity)
 - Distress alert (triggered by hand or water to transmit their position)
 - Weather observation report (report position and weather periodically)
 - LRIT (Long Range Identification and Tracking) (report position to next port of call)
 - SSAS (Ship Security Alert Systems) (report when attacked)
- Integrity, design, and safety issue may make transition difficult

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What We Expect to Satellite VDES (3)

- We had already experienced
 Telephone → Internet → IoT → Artificial Intelligence
- When infrastructure established, maritime communication will be expected to be simple
- We also can expect for other requirements / elements

What We Expect to Satellite VDES (4)

- Why should we make maritime communication simple?
- Answer: We should focus to carry simple communication device, not many
- Ship equipment is a quite pricy
 Agreeable by vessel (price of the vessel is pricy as well, so be covered)
 Disagreeable by small boat (quite quite pricy compare to the boat's price)
- If we can make mandatory requirement to equipment relax, more vessel/ship/boat can carry such ultimate device, which light more dark target
- Ultimate desire is unsterilized, like aerospace industries
 Discussion will be needed how we treat "row-a-boat"

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Closing Remark

Closing Remark (1)

Experiment "We Are 42"



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Closing Remark (2)

• Experiment "42" conducted by Port of Rotterdam

"The answer to the ultimate question of life, the universe and everything is 42."

「生命、宇宙、その他もろもろについての深遠なる疑問の答えは42。」 -銀河ヒッチハイク・ガイド(ダグラス・アダムス)

• Can we found our "42"?

References

- exactEarth
 - https://www.exactearth.com/
- バーチャルAIS航路標識の運用開始について(海上保安庁) https://www.kaiho.mlit.go.jp/info/kouhou/h27/k20151021/k151021-2.pdf
- 先進レーダ衛星(ALOS-4)(宇宙航空研究開発機構) http://www.jaxa.jp/projects/sat/alos4/index_j.html
- Global Fishing Watch https://globalfishingwatch.org/
- e-Navigation Strategy Implementation Plan(国際海事機関)
 http://www.imo.org/en/OurWork/Safety/Navigation/Pages/eNavigation.aspx
- IALA Guideline G1139 (The Technical Specification of VDES)
 https://www.iala-aism.org/product/g1139-technical-specification-vdes/
- 2019年世界無線通信会議(WRC-19)に向けた我が国の考え方(案)に係る意見募集の結果(総務省) https://search.e-gov.go.jp/servlet/Public?CLASSNAME=PCMMSTDETAIL&id=145209318&Mode=2
- NorSat-1 and NorSat-2 launched!(Norsk Romsenter)
 https://www.romsenter.no/eng/News/News/NorSat-1-and-NorSat-2-launched
- We are 42. https://weare42.io/about/
- ご清聴誠にありがとうございます。/ Thank you so much for your kind attention!! 水成 剛 / Takeshi MIZUNARI (Mr.)



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エグゼクティブサマリー(VDESの観点から)

- 超ざっくり言えば、VDES = AIS + 超低速回線(※インターネットや社内用イントラネットという意味ではなくVDES局保有者同士、但し接続余地あり)
- 「超低速イントラネット回線」に流す具体的なデータはまだ決まっていない
 - 海事業界側(IMO)は「どのようなデータを流通させたいか」のデータ分類を実施 e-Navigation Maritime Service Portfolios (MSC.1/Circ.1595)
 - 灯台業界側(IALA)はVDES技術基準について検討
 The Technical Specification of VDES (IALA Guideline G1139)
 - 無線業界側(ITU)は周波数割り当て等について検討
 Technical Characteristics for a VHF data exchange system in the VHF marine mobile band (M.2092-0)
 - 海図業界側(IHO)は海図データ等GISデータの統一化を実施 S-100 Universal Hydrographic Data Model
 - →でも、現段階でどのデータをどのように固めてどのように伝送するかが全て細かく決まっている訳ではない
- 地上系VDESの周波数は確定 2019年秋のWRC-19で衛星系VDESの周波数割当について国際的判断がなされる予定 各国は独自に実験を行いつつ判断を待っている状況 →Goの判断があれば一気に世界が動く可能性!

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AISの解説

- Automatic Identification System -> AIS
 300総トン以上の国際航海船舶・500総トン以上の非国際航海船舶・全ての国際航海を行う旅客船に 搭載義務が課せられているが、非搭載義務船でもAISを装備した船がいる
- 自船の位置を一定時間毎にVHF電波にて発信し続け、周囲(VHF帯電波が到達する見通し距離内) の船舶と衝突予防のために情報交換(実際には各船電波出しっぱなし)
- 船舶局にはClassA(搭載義務船用)とClassB(非搭載義務船用)の2種類がある
 位置情報:Message1~3(ClassBはMessage18~19)、速力等により位置情報の発信間隔が異なる

Ship's dynamic conditions	Nominal reporting interval
Ship at anchor or innored and not moving faster than 5 knots	3-mm ⁽¹⁾
Ship at anchor or moored and moving faster than 3 knots	10 40
Ship 0-14 kurns	1040
Ship 0-14 knots and changing course	3132"
Ship 14-23 knots	6 4(1)
Ship 14-23 knots and changing course	25
Slop -23 kmas	- 2+
Ship = 23 knots and changing course	25

Programme and the supplier of the first of	and the second second	N. Company
Motory's condition	Total Control	and the same of
Con B. W. Andrew and represent on severy less than Stock	-	7-86
Care & No. Asphane and represent serving 3 column	- 1	- 10
Co. S. W. Aglanta with appear across at 1988.	74	307
THE R P. LEWIS CO., LANSING, MICH.	-	107
Con-B TV Aghino while suppose on serving less like likes	-	
Face E. C.F. displaces while approximating from the China	16.	
Freedom and continue with appears	100	
Total in acceptant		
All No. and a	107	

- 船位以外にも様々なデータを送信している
 Message5(静的情報:IMO番号、呼出符号、船名、船種、サイズ、喫水、次港・到着予定時刻等)
 Message6(バイナリ、様々な情報をやり取りできるようになっている)
- バーチャル航路標識もある実際には浮標(ブイ)のない場所に、画面上にだけAIS航路標識シンボルを掲載

衛星AISの解説

- ある時、AISの電波が人工衛星の軌道から受信できる事に気づいた人がいた(→衛星AIS)米Orbcomm社、加ExactEarth社が競いながら発展(日本を含め他国も様々な実験を実施)
- ◆ 人工衛星軌道からAIS電波を受信することは非常に難しい 信号強度の問題(元々人工衛星までデータを送信することを想定していない) 信号分離の問題(半径2~30kmの海域でTDMAしている電波を広域受信すると信号衝突してしまう)
- 遠隔地の船舶動静情報を入手するには他にもLRIT(一般船)・VMS(漁船)といったものがあるが、ほぼ全ての国際航海を行う船舶が発信するAISデータは買うだけなので非常に利便性が高い
- 商用AISデータ販売に関しては現在ではExactEarth社の一人勝ち状態
 1分以内の遅延で全球データをリアルタイム配信
 後述するVDESデータも受信できるよう対応可能(ソフトウェア無線機技術)
- AIS電波未発射、MMSI(ID番号)の複数局共有・偽ID発信など、AISデータ単体だけでは判別できない 問題の解決が課題(e.g. SAR衛星情報との併用など)
- ちなみに、自社のフリートに関しては定時報告を打つのが通例であるため、ここで入手できる/したい情報とは支配下にない船舶の情報(e.g. 旗国/沿岸国/それ以外の国家による状況把握、他社情報の入手、研究、SIGINT/OSINT、etc.)

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VDESの解説

- VDES: VHF Data Exchange SystemAISの仕組み(周波数チャンネル等)を発展させ、位置情報だけではなく様々なデータを流すことのできるインフラとして今後用意される事が決定
- データを流す仕組みとしては現在のAISの仕組みの中でもASMがある VDEによって更に多くのデータを流せるようにする AIS(9.6kbps) + ASM(19.2kbps) + VDE(最大307.2kbps)
- VDEには地上系VDEと衛星系VDEがある

地上系VDE : 導入確定

衛星系VDE(地上→衛星) : 導入確定

衛星系VDE(衛星→地上): WRC-19で審議、各国動向を見守っている

- 地上系だけだと沿岸からVHF見通し距離しかカバレッジにならない
 全海洋をカバレッジにするためには衛星利用は不可避
 衛星系アップリンクのみだと片方向だけの伝送になってしまう、できればダウンリンクも欲しいしかしながら現状でもVSATがある……しかも早い……(でも高い……)
- VSAT等他の通信インフラとVDESとのプロ・コンを踏まえた活用?
- 現段階で利用方法は確定していない →様々な活用方法が発掘されるかも?

VDESを取り巻く環境(1:IMO e-Navigation)

- IMOではe-Naviation(次世代航海支援システム)のコンセプトを打ち出している(MSC.1/Circ.1595) 徐々に航海計器等の近代化を進めていきましょうという考え
- その中で、「Maritime Service Portfolio」という概念で電子処理するべきデータの種類を整理している
 - MSP 1: VTS Information Service
 - MSP 2: Navigational Assistance Service
 - MSP 3: Traffic Organization Service
 - MSP 4: Local Port Service
 - MSP 5: Maritime Safety Information Service
 - MSP 6: Pilotage Service
 - MSP 7: Tug Service
 - MSP 8: Vessel Shore Reporting
 - MSP 9: Telemedical Assistance Service
 - MSP 10: Maritime Assistance Service
 - MSP 11: Nautical Chart Service
 - MSP 12: Nautical Publications Service
 - MSP 13: Ice Navigation Service
 - MSP 14: Meteorological Information Service
 - MSP 15: Real-time Hydrographic and Environmental Information Service
 - MSP 16: Search and Rescue Service



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VDESを取り巻く環境(2:IALA VDES)

- IALA(国際航路標識協会)はVDESの仕掛人 航路標識 = 灯台・浮標等 + 電波航路標識 古くはデッカ・ロラン・オメガといった測位用電波航路標識も担当していた (これらはGNSS衛星の台頭により日本では廃止、一部ロランは海外でバックアップ運用)
- IALAはe-Navigationについても仕掛人
 ちなみに現在のIALA e-Navigation委員会議長は海上保安庁野口氏
- IALAはVDESの技術スペック文書を発行している IALA Guideline G1139 (The Technical Specification of VDES) Edition 2 (Dec/2018)







VDESを取り巻く環境(3:ITU 周波数割当)

- WRC(World Radiocommunication Conference): 世界無線通信会議 ITU(International Telecommunication Union)が4年に1度実施する会議
- VDESに関しては、地上系・衛星系(アップリンク)の周波数を策定
- 次回開催はWRC-19(2019/10/28~2019/11/22)、VDESに関しては議題1.9.2で審議 衛星系(ダウンリンク)の周波数について審議予定
 - Council RESOLUTION 1380 (Place, dates and agenda of WRC-19)
 1.9.2 modifications of the Radio Regulations, including new spectrum allocations to the maritime mobile—satellite service (Earth-to-space and space-to-Earth), preferably within the frequency bands 156.0125157.4375 MHz and 160.6125-162.0375 MHz of Appendix 18, to enable a new VHF data exchange system
 (VDES) satellite component, while ensuring that this component will not degrade the current terrestrial VDES components, applications specific messages (ASM) and AIS operations and not impose any additional constraints on existing services in these and adjacent frequency bands as stated in recognizing d) and e) of Resolution 360 (Rev.WRC-15)
- 規格文書として、ITU-R M.1371-5 (AIS) 及び M.2092-0 (VDES) がある。





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VDESを取り巻く環境(4:IHO S-100)

- IHO (International Hydrographic Organization)では電子海図向けの規格作業を行っている S57からS-100シリーズに移行中、電子海図のみならず航海に必要な様々な電子データの標準化を 実施
 - S-1XX (101-199) ではIHO関係の規格を制定 電子海図、海底面、潮流、海域境界、海洋保護水域、航行警報等
 - S-2XX (201-299) ではIALA関係の規格を制定 航行援助情報、寄港情報、ASM、DGNSS用アルマナック、eLoran関係等
 - S-3XX (301-399) ではIOC (Intergovernmental Oceanographic Commission)関係の規格を制定
 - S-40X (401-402) では内水電子海図調和グループ関係の規格を制定
 - S-41X (411-414) ではWMO/IOC合同技術委員会関係の規格を制定 海氷情報、気象情報、波浪情報等
 -



VDESを取り巻く環境(5:海上保安庁)

- ●「VDESの海上交通利用に関する調査研究」を2017-2018年度に実施 調査研究委員会実施 入力表示部を含むVDES送受信機試作、2018/12に実海域試験を実施
- 地上系VDESについては導入実施予定 衛星系VDESについては現時点で未想定 但し具体的なVDESでやりとりするデータについては未確定(IMOの要件待ち) (海上保安庁 野口氏 ヒアリングによる)

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VDESが担うべきアプリケーション案

- 東京海洋大学 庄司先生のご意見(2019/5/27 衛星VDES情報交換会(OPRI))
 - ASMやMSPにおける利用
 - 海上(含 浅水域)構造物、ブイ、漁網等の位置情報
 - 小型船等対応
 - AIS非搭載 → GPS + 陸上回線 or 無線(近距離時の対応)
 - 安定した通信インフラとしての利用
 - 海域を問わない通信 → 北極海航路
 - 高速大容量通信のバックアップ → 最小限の通信容量
 - 船舶からの情報提供
 - 船舶運航上の最小限(時間、船位 or GPS針路、GPS速力)
 - 航海性能解析用データ
 - 気象・海象関連データ
 - 船舶をセンサーとしたデータ(対水速力、針路、実航針路、GPS高度、動揺等)
 - 船上での気象・海象把握、津波予測
 - 船舶周囲情報(AIS、レーダー、映像等)
 - 船内での一次解析
 - 他の情報と比較(航空・衛星写真、Pathfinder衛星情報等)
 - 陸上からの情報提供
 - 個船に対応した気象・海象 → 商船、漁業
 - 陸上で統合解析した情報の提供
 - 陸上からの操船信号
 - 自動航行船対応



Satellite remote sensing technologies for estimating IUU fishing activities around Japan, in collaboration with GFW

衛星リモセン技術を用いたIUU漁業活動の解析 - GFWとの連集

Objectives

- ➤ Understanding fishing impact by foreign fishing boats
- ➤ Information services to fishing patrol or to fishermen for avoiding accidents
- ➤ Improvement of stock assessment accuracy

目的

- ▶外国漁船による漁獲圧の推定
- ▶漁業取締・漁船への情報提供
- ▶資源評価精度向上







Yoshioki Oozeki, Japan Fisheries Research & Education Agency (FRA) 水産研究・教育機構 大関芳沖

Foreign fisheries activities around Japanese EEZ 我が国EEZを取り巻く外国漁船の活動





Satellite remote sensing 衛星リモセンによる解析

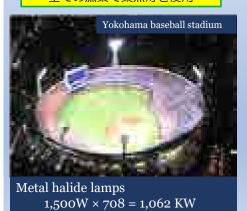
- ➤ S-NPP (VIIRS) S-NPPの夜間光画像
- ➤ Satellite AIS 衛星取得AISデータ
- ➤ Satellite synthetic aperture radar 人工衛星合成開口レーダー

Light points by satellite remote sensing images at the midnight 深夜の衛星リモセン画像による光点抽出



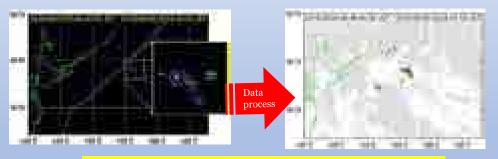


Most fishes and squid gather to the light at night (500kW) 全ての漁業で集魚灯を使用





- ➤ Light points extracted from the data of S-NPP satellite.
- > Effects of sun light, moon and clouds are eliminated.
- ▶S-NPP衛星データから光点を抽出
- ▶太陽・月・雲の影響を除去



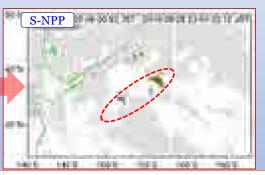
- Each light point corresponds to one fishing boat.
- Number of fishing boats in operation can be counted.
- ▶各光点が1隻の漁船に相当
- ▶ある時間における漁船の操業数推定が可能

Automatic Identification System (AIS) 船舶自動識別装置



- AIS is an automatic tracking system used for collision avoidance on ships.
- AIS information include MMSI code (ID), name, position, course, and speed.
- Satellite-AIS system provides the information of ships in high seas.
 - ▶ AISは船舶の衝突防止のために自動的に位置を追跡するシステム
 - ▶信号には、ID、船名、位置、針路、船速などが含まれる
 - ▶衛星AISシステムでは、公海域でも情報取得可能





- ➤ Monitoring only by AIS information is not reliable enough.
- ➤ Intentional suspension of signal transmission from the onboard AIS, low reliability of AIS signal including incorrect datum.
 - ▶AISデータだけからでは信頼できる情報は得られない
 - ▶故意の発信停止やID・船名などのデータ書換えもあり得る。

1) East China Sea 東シナ海



South China Sea 28'N Taiwan

Chub mackerel, Scomber japonicas マサバ Japan: 300,000 t per year (late 1970s)

 \Rightarrow 60,000 - 120,000 t per year (after 2000)

Foreign fishing vessels

- China: 500,000 t/year in the entire North Pacific
- ➤ Chinese purse seiners (lit covering net and tiger net) have been active
- ➤ The number of Taiwanese stick held dip net has been increasing

日本は1970年代に30万トン漁獲、近年は6-12万トンに低迷 中国は北西太平洋全体で50万トン漁獲、近年虎網による操業が活発化、台湾の 棒受け網船も増加傾向

Developing technique to detect the position of lit fishing gear types from satellite luminescence data (VIIRS)

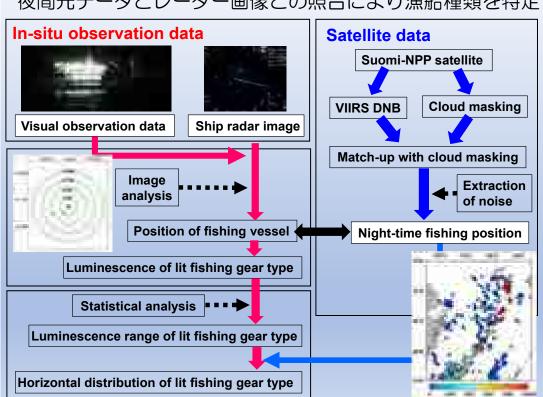
衛星リモセンによる光点データを、その海域のレーダー画像と併せて 解析することで、光の強さから漁法を特定





Lighting purse seiner (lit covering net)

Comparative analyses of VIIRS & radar image 夜間光データとレーダー画像との照合により漁船種類を特定 (R. Saito et al. in press)



現場観察 (左側上) 調査船や漁船による目視デー タとレーダー画像から、外国 漁船の位置と漁船種類を識別

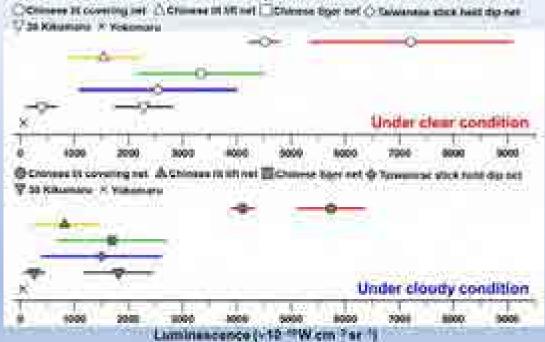
衛星データ (右側上) 人工衛星による夜間光解析

統計解析(左側下) 時間を合わせて、レーダー画 像と夜間光データを照合し、 光の強さから漁法を特定

Luminescence range of lit fishing gear types in ECS

光量範囲から漁法の推定が可能に (R. Saito et al. in press)

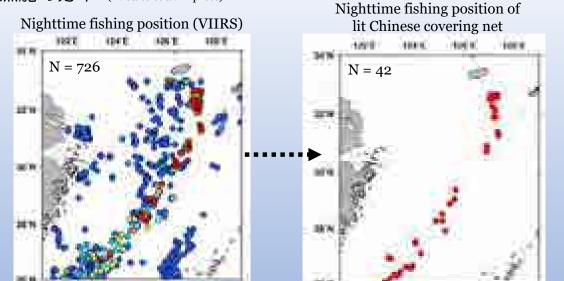




The luminescence range of Chinese lit covering net was separated from the other fishing gear types 光量範囲のデータから中国の敷網漁船のみを抽出 (上は晴天時、下は曇天時)

Horizontal distribution of Chinese lit covering net

中国の敷網漁船の分布 (R. Saito et al. in press)



Luminescence (×10⁻¹⁰ W cm⁻² sr⁻¹)
We can estimate the horizontal distribution position of lit Chinese covering net (right) form VIIRS data using its own luminescence range 全ての光点分布から、中国の敷網漁船のみを抽出することが可能になった

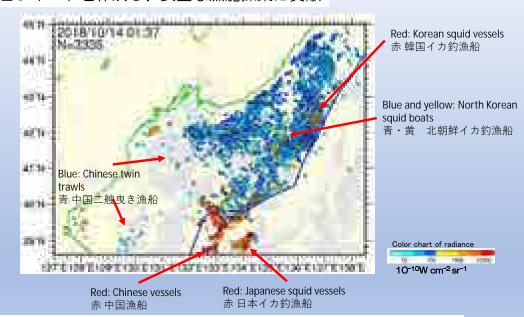
2) Japan Sea 日本海



Dailey report of fishing activities during nighttime (S-NPP, NOAA#20) 夜間の漁業活動について、毎日レポートを作成し、安全な漁船操業に貢献 (Courtesy of Dr. Inagake)



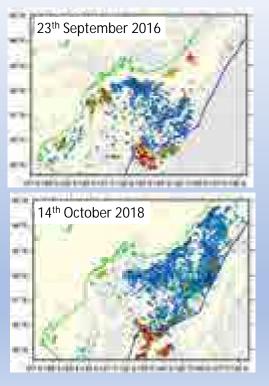


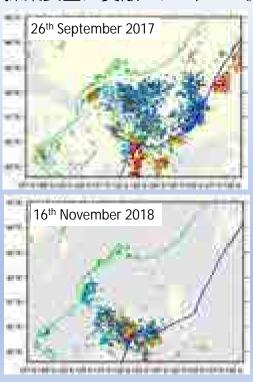


Chinese twin net trawls are difficult to distinguish from NK wooden boats by the light intensity. 中国の二艘曳きトロールは、灯火をつけないので夜間光の解析からは見つけにくい

Dailey report of fishing activities during nighttime 前夜の夜間光レポートを作成し、日本漁船の操業安全に貢献







Time-series of light points 操業数の日変化を追跡 (Courtesy of Dr. Inagake) 2016 Maximum: 845 2016 Maximum: 1032 Yellow: Moonlight Red: Chinese 黄色帯: 月明 vessels かりの存在 赤 中国漁船 Gray: with cloud 2017 Maximum: 730 2017 Blue: North Maximum: 2057 Blue & yellow: North Korean squid Korean squid boats boats or Chinese twin 青 北朝鮮イ カ釣漁船 trawls 青 中国二艘曳き漁船 黄 北朝鮮イカ釣漁船 Red: Korean Maximum: 347 Maximum: 2917 squid vessels 赤 韓国イカ釣 Maximum in 2018 2018 November: 1001 漁船

Technical trial on analyzing SAR data 合成開口レーダーによる解析技術開発

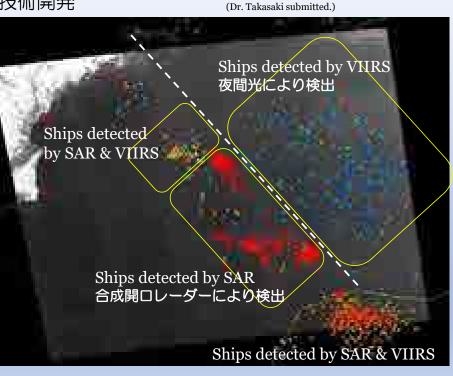
North Korean EEZ





ALOS-2 PALSAR (phased array L-band synthetic aperture radar)

JAXAのALOS-2衛星 Lバンド合成開ロレーダー

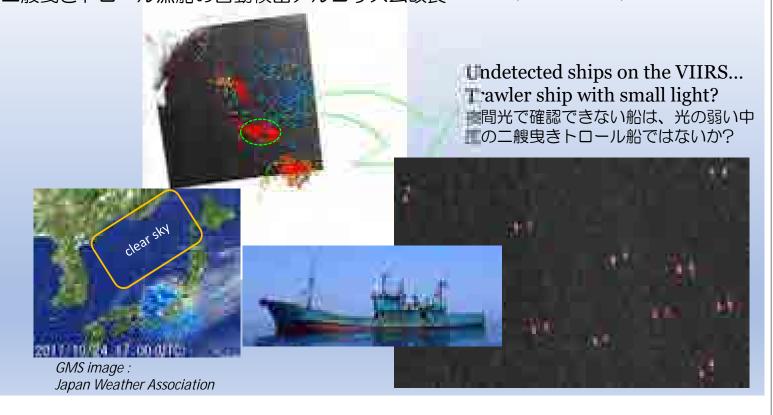


Russian EEZ

Improvement of auto detection algorism of twin net trawls 二艘曳きトロール漁船の自動検出アルゴリズム改良

(Dr. Takasaki submitted.)





3) North western Pacific 北西太平洋



AIS information downloaded from Shipfinder.com (2016 – Present)

2016年よりAIS情報を蓄積



Period	Group A	GroupB	Group C	Carrier Ship
Apr. 2016 - Mar. 2017	128	194	104	33
Apr. 2017 - Mar. 2018	145	259	128	54
Apri. 2018 - Dec. 2018	156	276	141	75

Group A: Chub mackerel fishing of China 中国のマサバ漁業

Group B: Pacif c saury fishing of China, Russia, S. Korea, and

Vanuatu 中国他によるサンマ漁業

Group C: Neon flying squid fishing of China

中国によるアカイカ漁業

Trans-shipment might be the key factor for estimating the fishing amounts. 漁船は長期間漁場に滞在するため、漁獲量推定には洋上転載活動の把握が重要









Future research activities of FRA, in collaboration with GFW GFWと連携した水研機構の将来の調査研究活動



- 1) East China Sea (China-Japan joint fisheries zone) 東シナ海
- ▶Distinguish of fishing boats by light intensity data 光点解析による漁業把握
- ▶Japanese common squid, small pelagics スルメイカ・マイワシ・マアジ等
- 2) Japan Sea (South Korea-Japan joint fisheries zone) 日本海
 - ➤ Comparative analyses of VIIRS and SAR data for vessel type identification 光点解析と合成開ロレーダーによる漁船識別
 - ▶Japanese common squid スルメイカ
 - 3) North western Pacific (NPFC area) 北西太平洋
 - ➤ Analyses of trans-shipments by the monitoring of AIS data (cargo ships, refrigerator factory ships) 輸送船の挙動把握に基づく洋上転載の解析
 - ▶ Pacific saury, small pelagics サンマ・サバ類・マイワシ
 - 4) Western Central Pacific (WCPFC area) 中西部太平洋
 - ➤ Analyses of trans-shipments by the monitoring of AIS AIS情報解析を主体とした洋上転載実態の把握
 - ▶Bluefin tuna, Skipjack マグロ類・カツオ

Thank you for your attention.







SPACE TECHNOLOGY APPLICATION TO MARITIME SURVAILLANCE IN INDONESIA:

Operational case of Bali Radar Ground **Receiving Station (BARATA)**

I Nyoman Radiarta

Institute for Marine Research and Observation Ministry of Marine Affair and Fisheries INDONESIA











"SATU KATA, SATU RASA, SATU KERJA





TABLE OF CONTENTS

- 1. Characteristic of Indonesian sea
- 2. Satellite data requirement
- 3. Existing operational for maritime applications
- 4. Future needs









CHARACTERISTIC OF INDONESIAN SEAS

GEOGRAPHY OF INDONESIA









The second longest coastline in the world

1. Canada: 202 thousand Km

2. Indonesia: 99 thousand Km

3. Greenland: 44 thousand Km

Indonesia as the largest archipelago in the world, where: North-South Indonesia exceeds the distance Berlin-Rome East-West Indonesia exceeds Dublin-Moscow distance

The area of Indonesia is not much different from the United States. However, Indonesian territory is dominated by the ocean

Source: Bappenas (2019)

(a) MARIEST PERANCAN (f) Specials (b) Respective (c) Specialists (deposed (d) Specials) (see

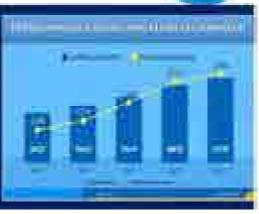
BRSDM KP

CHARACTERISTIC OF INDONESIAN SEAS

GEOECONOMY MARITIME INDONESIA







40 Offshore sedimentary basins have the potential to produce billions of barrels of oil and gas (Ministry of Energy and Mineral Resources).

Source: Bappenas (2019)

49% Transportation routes of world trade through the Malacca Strait, Lombok Strait, and other Indonesian seas (World Bank).

2-3% The contribution of the Fisheries sub-sector to GDP per year with a value of Rp317 trillion growth that is consistently increasing (BPS)

(C) SERIEST PERANCAN (F) Specially (G) (Imposing (C) Specialized Represent (M) Appointed paid







SATELLITE DATA REQUIREMENTS

RADAR DATA USED FOR OPERATIONAL IN INDONESIA

COSMO SKYMED

- Property to the Italian Space Agency and the Italian Ministry of Defense.
- Consists of 4 satellite constellations, each equipped with SAR (Synthetic Aperture Radar) instruments.
- It is a commercial satellite radar, so that users can determine the desired observation time and area
- CSK imagery can be acquired in nearreal time at BARATA.

More information at

http://www.e-geos.it/products/pdf/csk-product%20handbook.pdf



BRSDM KP

SATELLITE DATA REQUIREMENTS

RADAR DATA USED FOR OPERATIONAL IN INDONESIA

- Launched December 14, 2007, owned by the Canadian Space Agency (CSA) and MacDonald, Dettwille and Associates Ltd. (MDA); now MAXAR Company
- It is a commercial satellite radar, so that users can determine the desired observation time and area.
- RADARSAT-2 imagery can be acquired in near-real time at BARATA.



Beam modes	Nominal swath width (km)	Maximal spatial resolution (m)
Spotlight	18	1
Fine	50	8
Wide Fine	150	8
Standard	100	25
Wide	150	25
ScanSAR Narrow	300	50
ScanSAR Wide	500	100
Ocean Surveillance	530	Variable

http://www.asc-csa.gc.ca/eng/satellites/radarsat/technicalfeatures/radarsat-comparison.asp

RADARSAT

(a) MARIET FORANCIAN (f) Processo (a) Emporation (c) Specialization of Specialization (c) Specialization (c)

"SATUKATA SATURASA SATUKERIA SATUKARYA"

SATELLITE DATA REQUIREMENTS

RADAR DATA USED FOR OPERATIONAL IN INDONESIA

SENTINEL 2: Free available data

- Property to the European Space Agency (ESA)
- Consists of 2 satellite constellations: Sentinel 1A and 1B
- Data can be accessed free of charge via https://scihub.copernicus.eu/ with a delay of 8 hours.
- Has 4 scene modes: Interferometric Wide (IW), Wave (WV), Stripmap (SM), and Extra Wide (EW).
- Focus of Sentinel observation:
 - Continuous observation on land (IW mode)
 - Sea-ice monitoring (EW mode)
 - Open ocean monitoring (WV mode)
 - SM mode is used for emergency events
- As a result, not all Indonesian waters can be observed by Sentinel.



https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar











EXISTING OPERATIONAL IN INDONESIA

GLOBAL AND NATIONAL STRATEGIC ISSUES (IUU FISHING)



Source: KKP (2015)

IUU Fishing often occur in the Natuna Sea, Sulawesi Sea, Timor Sea, Malacca Sea, Arafura Sea

Source: Bappenas (2019)

Number of Crimes Related to IUU Fishing (case)



Source: KKP (2018)

Impact of Illegal / IUU Fishing Behavior



number of fishermen business (KKP, 2015)

() HINEST PERANCAN () PERMAP () PERMAP () PERMAP BRSDM KP

EXISTING OPERATIONAL IN INDONESIA

DIVISION OF MARINE LAW ENFORCEMENT OPERATIONAL AREAS AND LEGAL BASIS

MMAF · Indonesian Fisheries Management Area Conservation Areas in the Territorial Sea **Exclusive Economic Zone MTransportation** • Territorial Sea Islands Waters Inland Waters **POLICE** Inland Waters

Indonesian **Coast Guard**

- Waters and Jurisdictions (Inland Waters, Islands Waters and Territorial Sea)
- Additional Zones, Exclusive Economic Zones (EEZ), and Continental Shelf

NAVY

🕝 HARDET PERANCAN (f) Injulia p 📵 (Ingentary 🕞 Injulia Indonesia Kapasana 🔀 Apostok p galar

- Additional Zone
- Exclusive economic zone
- Continental Platform
- Territorial Sea
- Islands Waters

Source: Bappenas (2019)

 Islands Waters · Territorial Sea.



BRSDM KP



EXISTING OPERATIONAL IN INDONESIA

INTEGRATED SURVAILLANCE SYSTEMS OPERATED IN MMAF





BARATA BALI RADAR GROUND RECEIVING STATION



Source: PSDKP(2019)

BRSDM KP

EXISTING OPERATIONAL IN INDONESIA

BALI RADAR GROUND RECEIVING STATION-BARATA







- MMAF:
 - DJ of Marine and Fisheries Resources Surveillance
 - DJ of Spatial Planning
 - DJ of Capture Fisheries
- Indonesian Coast Guard
- Navy
- Spatial task Force: Satgas 115
- Ministry of Coordinating Maritime

EXISTING OPERATIONAL IN INDONESIA

DATA ANALYSING & INFORMATION DELIVERING





BARATA

- X-band satellite antenna to receive images in real time
- Image processors for 2 satellite missions (Radarsat-2 and Cosmo-Skymed)
- Value-adding systems to detect and analyze vessels

VMS

AIS

Purpose:

"Determining fishing vessels that do not have VMS and / or AIS reach are detected by satellite radar"

Source: PSDKP(2019)

Overlay Data VMS, AIS, and Radar Data



BRSDM KP

"SATU KATA, SATU RASA, SATU KERJA, SATU KARYA"



FUTURE NEEDS

SPACE TECHNOLOGY FOR MARITIME APPLICATION

Satellite technology:

- Low cost and high temporal/spatial data
- Near real time availability
- Easy accessible

Maritime Applications:

- Surveillance: Illegal fishing; Oil spill; Transhipment; Marine traffic, Human trafficking
- Planning and Management: Marine spatial planning; Conservation areas; Marine Aquaculture
- Marine/coastal resources: Potential fishing ground (PFG)







THANK YOU

I Nyoman Radiarta

Institute for Marine Research and Observation Ministry of Marine Affair and Fisheries INDONESIA











OUTLINE

Background – PH Marine Resources PH Performance in World Fisheries PH Losses in IUUF DA-BFAR MCS Definition

- Components
 - Sea Patrol Vessels
 - Land Vessel Monitoring System
 - IMEMS



BACKGROUND

Territorial Water & EEZ (2.2 million sq. km)

7X bigger than the total land area (29,817,000 has)

Andropologic Mater Essent

Foreign Mater Essent

Contropologic Time Essent

Estimate Essent Essent

Estimate Essential Esten



PH Performance in World Fisheries

3rd

AQUATIC PLANTS PRODUCTION

Produced a total of 1.75 million metric tons of aquatic plants (including seaweeds) or 7.36% of the total world production of 23.8 million metric tons (2012 data; SOFIA, 2014)

11th

FARMED FOOD-FISH PRODUCTION

Produced a total of 0.791 million metric tons of finfishes, crustaceans, and mollusks which constitutes 1.24% share to the total global production of 66.63 million metric tons (2012 data, SOFIA, 2014)

netric share 6.63 DFIA,

12th

MARINE CAPTURE FISHERIES PRODUCTION Produced a total of 2.13 million metric tons from marine capture fisheries or 2.67% of the total world marine capture production of 79.71 million metric tons (2012 data, SOFIA, 2014)





Impacts in IUU Fishing

- ☐ The estimated economic loss due to illegal fishing is USD894 million (Fisheries Resources in the Philippines, Alino)
- ☐ The World Resource Institutes suggests that the total net loss from blast fishing in the Philippines is USD 1.2 billion (L. Burke, E. Selig and M. Spalding, Reefs at Risks in Southeast Asia, 2002)
- Weaken competitiveness of National Fishing Industries
- Marine Ecosystem and fish stock degradation







Monitoring, Control & Surveillance

Section 14 of RA 10654 – Monitoring, Control and Surveillance of Fishing in all Philippine Waters and Philippine Flagged Distant Water Fishing Vessels – A MCS system shall be established by the Department in coordination with LGUs, FARMCs, the private sector and other agencies concerned to ensure that the fisheries and aquatic resources in Philippine waters are judiciously and wisely utilized and managed on sustainable basis and conserved for the benefit and enjoyment exclusively of Filipino citizens.



Monitoring, Control & Surveillance

- Monitoring data collection and analysis of fishing activity including, but not limited to, catches, species composition, fishing effort, discard, area of operation, etc. or the use by fisheries managers to arrive at management decisions.
- ☐ Control entails the enactment of appropriate legislation and ordinances under which the exploitation of the resources may be conducted
- Surveillance law enforcement. The checking and supervision of fishing activity to ensure that national legislation and terms, conditions of access, and management measures are observed.

Monitoring, Control & Surveillance

MCS Component:

- □ Land Component
 - Vessel Monitoring System (VMS)
 - Fisheries Observer Program
- Sea Component
 - MCS Patrol Vessels (Offshore MCS)
 - Deployment of Small Patrol Crafts (Coastal MCS)
 - Deployment of Fisheries Observers to Commercial Fishing Vessels
- ☐ Air Component At present BFAR is closely working with the Philippine Coast Guard (PCG)

Vessel Monitoring System (VMS)

- Vessel Monitoring system was established in 2009 for the Bureau of Fisheries and Aquatic Resources (BFAR) floating assets in an effort to combat illegal, unreported and unregulated (IUU) fishing activities.
- ▶ In 2012, VMS was introduced to fishing industry, as compliance to Western and Central Pacific Fisheries Commission (WCPFC) to authorize the Philippine-flagged fishing vessels to operate in Special Management Area -High Seas Pocket – 1 (SMA-HSP1).
- VMS uses communications and navigation systems to track the movements and activities of the vessels in the Philippine EEZ and high seas.

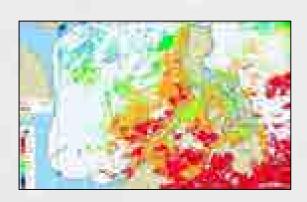


VMS Components



VMS Capabilities

Monitoring and tracking fishing vessels operating in HSP1 and other coastal states. The system can provide oceanographic, weather data, oil spill detection and radar satellite imaging.







VMS Coverage

- BFAR Floating assets 72
- Philippine-flagged fishing vessel 313
- Foreign fishing vessel passing through EEZ and 100 NM buffer zone – average 150 vessels



Automatic Identification System

National Coast Watch Council (NCWC) provided access to BFAR to monitor the commercial vessels equipped with AIS. The system is used to validate and to monitor any related IUU fishing activity.



Visible Imaging Infrared Radiometer Suite (VIIRS)

➤ The Visible Infrared Imaging Radiometer Suite (VIIRS) data is used to check and validate specific area or areas in Philippine waters most especially those areas with closed fishing.



Autonomous beacon for remote monitoring and communication(INO)

The INO Advanced beacon is connected to the Iridium communication satellite network to keep the user connected anywhere in the world and in complete safety. Adjustable tracking intervals allow you to track the route and communicate your GPS position, including heading and speed.

It is given to Fisheries Observer onboard fishing vessel to report any related IUU fishing activities and for their safety in case of emergency.





Integrated Marine Environment Monitoring System (IMEMS)

- KEY ELEMENTS
 - VMS Transceivers
 - Port and Coastal Monitoring System
 - Electronic Reporting System
 - Satellite Maritime Domain Awareness
 - Meteorological, Environmental and Productions System
 - · National Marine Data
 - · Fisheries Monitoring Centers
 - Ocean Resource Information System
 - Capacity Building



Information Systems

- Fishing Vessel E-Licensing System (FeLIS)
- Municipal Fisherfolk Registration System (FISHR)
- Boat Registration System (BOATR)
- Fisheries Law Enforcement Management Information System (FLEMIS)
- Electronic Catch Documentation and Traceability System (eCDTS)





SEA: Patrol Vessels

- ☐ The Bureau under its MCS Program maintains 10-units of 30-meter and 4 units of 11-meter patrol vessels deployed strategically around the country. The MCS patrol vessels provide greater capabilities for the bureau to efficiently address maritime incidents.
- ☐ The DA-BFAR has also awarded 30-footer MCS patrol vessels to various Regional Fisheries Offices around the country.
- ☐ These vessels aims to alleviate the continuosly deteriorating problems plaguing the Philippine fisheries sector

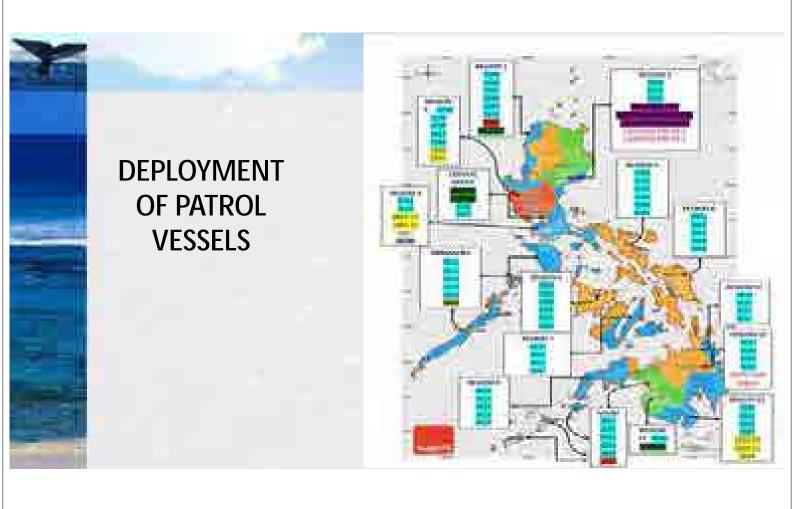


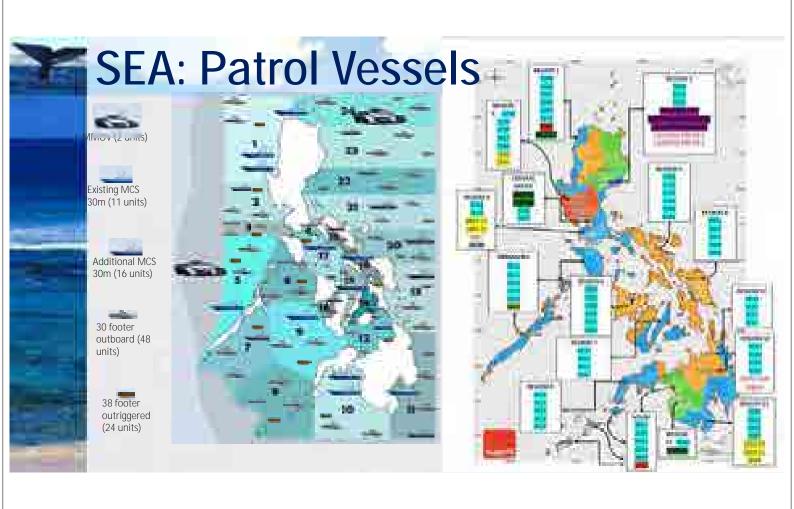


SEA: Patrol Vessels

- □ On-going constructions of 2 units of 50m multi-mission offshore vessels.
- ☐ MV DA-BFAR, is an research and management vessel that conducts oceanographic and fishing survey in Philippine waters to identify potential fishing grounds and collect fisheries information/data as basis for policy formulation.









IUU FISHING & MARITIME - SPACE TRACKING: MMEA PERSPECTIVE



4th Oct 2019 Tokyo, Japan

By:
Captain Maritime Abd Razak bin Mohamed
Senior Principal Assistant Director C4ISR
Maritime Security & Surveillance Division
MALAYSIAN MARITIME ENFORCEMENT AGENCY



INTRODUCTION



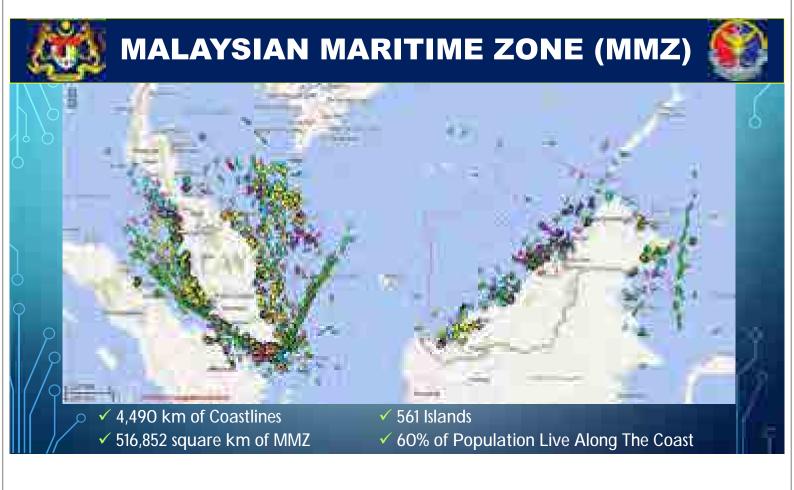
In striking a balance between achieving economic growth and maintaining ocean health, the Blue Economy warrants for proper planning and management of the maritime space. Major prioritised sectors like fisheries, aquacultures, ports and shipping, oil and mineral exploration and extraction, as well as ocean energy development should be properly planned and managed. Central issues like pollution control, marine ecosystem health and sustainable fisheries should always be the basis if we are to achieve the Sustainable Development Goals (SDG)

LIMA 2019 27 Mac 2019



Tun Dr Mahathir Mohamad Prime Minister MALAYSIA







mainly from offshore

* Petroleum & gas export value USD20 billion per year





ILLEGAL, UNREPORTED, UNREGULATED (IUU) FISHING





Organizations such as IOTC, WCPFC, etc.



RETAIL VALUE OF IUU FISHING



AND REAL PROPERTY OF THE PARTY	ARREST CONTRACTOR OF THE PARTY	with the control of the best of the control of	Mary St. Santana
	THE PERSON NAMED IN COLUMN 2	of Transmittional 6	
Committee of the second second second			

Transmittional Crime:	Estimated Annual Valley (1355)	
Drug Trefficking	\$426 billion to \$652 billion	
Small Arms & Light Weapons Trafficking	\$1.7 billion to \$3.5 million	
Human Trafficking	\$150.2 talled	
Dryse Totalisions	\$840 million to \$1.7 billion	
Trufficking in Cultural Property	\$1.2 oillion to \$1.6 billion	
Conterleiting	\$923 billion to \$1.13 tribon	
Biogal Westife Trade	\$5 briton to \$73 briton	
UU Febreg	\$15.5 tallion to \$36.4 billion	
Regal Lagged	\$22 tallion to \$157 balloon	
Megal Mining	\$12 billion to \$48 billion	
Onde Sie Theft:	\$5.2 fillion to \$11 9 hillion	
Total	\$1.6 trillion to \$2.2 trillion	



FORMS OF IUU FISHING



Illegal Fishing Activities within Country

- ✓ Vessel with a fishing license, but with vessel specifications
- outside the permitted or designated fishing areas
- Use prohibited & dectructive fishing gears and methods
- Landing of fish in unauthorized ports
- Transfer of catch at sea

SOURCE



FORMS OF IUU FISHING





Landing of Catch Across Borders

 $\begin{array}{ll} \mathsf{MALAYSIA} & \longleftrightarrow \mathsf{VIETNAM} \\ \mathsf{THAILAND} & \longleftrightarrow \mathsf{MALAYSIA} \end{array}$

MYANMAR → THAILAND INDONESIA → SINGAPOR

Concerned stakeholders:

- ✓ Small-scale fisheries
- ✓ Commercial fisheries

Another Issues:

✓ Double Flags





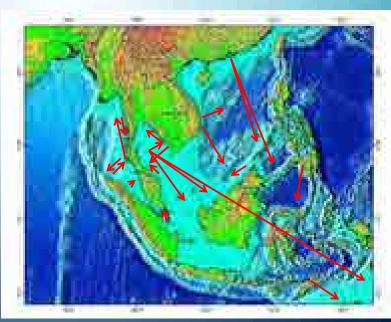
FORMS OF IUU FISHING



3 Poaching in Other Country's EEZ

ARREST STATISTICS FOR FISHERIES RELATED ACTIVITIES

✓ 2006 – 2019 : 1,321 boats and 11,243 crews from ASEAN countries and outside, were detained in Malaysia by MMEA





FORMS OF IUU FISHING



- Illegal Fishing and Trading Practices of Live Reef Food Fish (LRFF), Ornamentals and Endangered Aquatic Species
- ✓ Direct shipments of LRFF from producer to importers that bypass in−country exporters;





Source : SEAFDEC

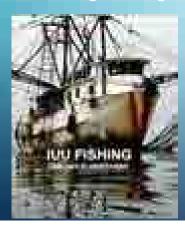


FORMS OF IUU FISHING

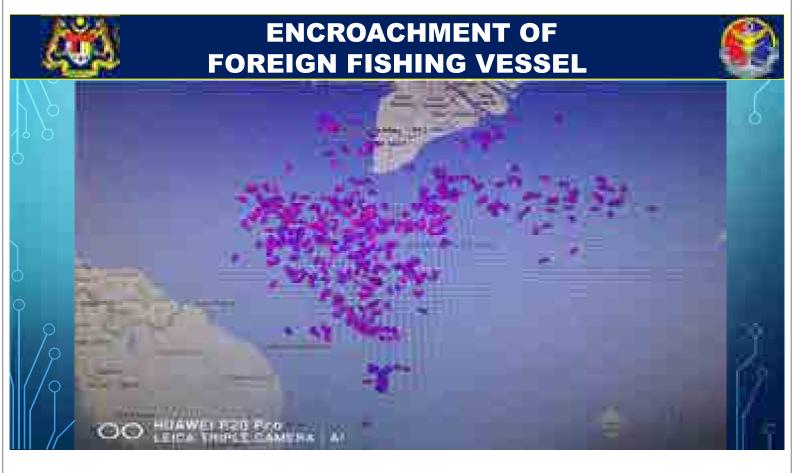


5 IUU Fishing in High Seas & RFMO Areas

- √ fishing without permission or during out-of-season;
- √ disregarding catch quotas;
- √ non-reporting and under reporting catch volumes & species
- ✓ IUU Fishing from Flag of Convenience, etc….













LEGISLATIONS FOR IUU



- Malaysian Maritime Enforcement Agency Act 2004
- Fisheries Act 1985
- Lembaga Kemajuan Ikan Act 1971
- International Trade In Endangered Species Act 2008
- Malaysian Quarantine and Inspection Services Act 2011
- Custom Act 1967
- Exclusive Economic Zone Act 1984
- Merchant Shipping Ordinance 1952
- Continental Shelf Act 1966
- Emergency (Essential Powers) Ordinance 1969



MONITORING, CONTROL & SURVEILLANCE



Monitoring – the collection, measurement & analysis of fishing activity including catch, species composition, fishing effort, by-catch, area of operations etc..

Control – involves the specification of the terms and conditions under which resources can be harvested

Surveillance – the regulation and supervision of fishing activity to ensure that national legislation and terms, conditions of access and management measures are observed



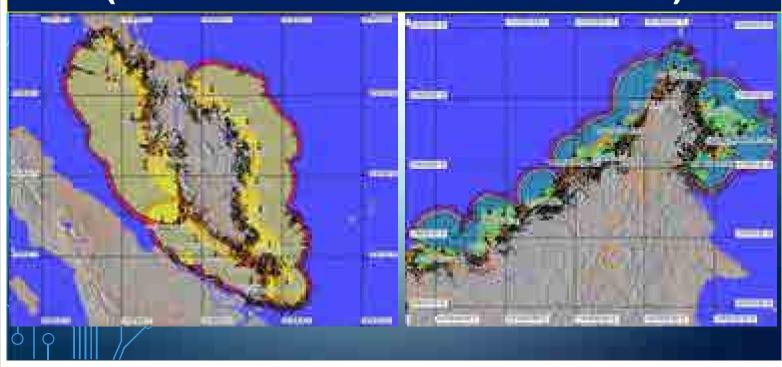
EFFORTS TO ADDRESS IUU FISHING

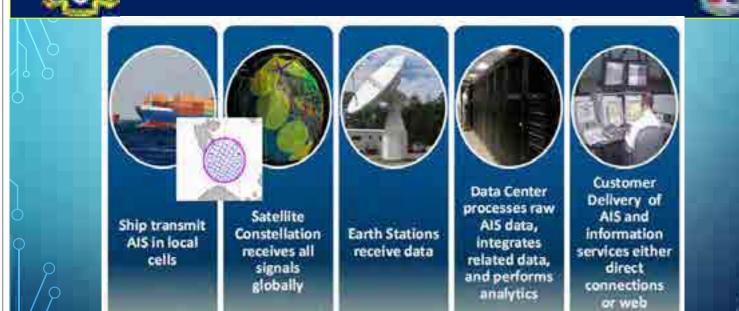


- Amendment of Fisheries Act 1985 in Parliament
- Procurement of OPVs and Patrol Crafts
- Upgrading C3I System to C4ISR System
- Installation of new surveillance radars
- Joint Enforcement on Land
- Monitoring, Control and Surveillance
- Special Task Force Operation Op Naga East/West
- Engagement with Regional Law Enforcement Agencies
- Continuous exercise and training with visiting ships
- Capacity building in Malaysia and abroad



AUTOMATIC IDENTIFICATION SYSTEM (TERRESTERIAL AIS COVERAGE)





Cost-to-Cost, Markey Senury and McKarles-Schitter Mollowking sweets class per Januarite

services

SATELLITE AIS





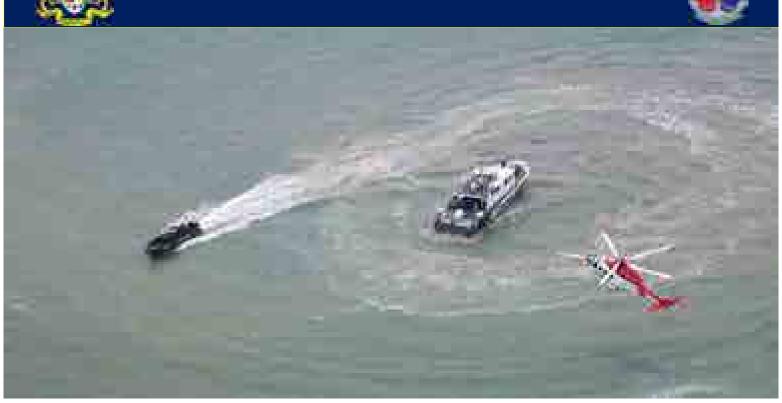






SUCCESS STORIES OF IUU FISHING







FV MING NO 5 (FV THUNDER)





Section 16(3) Fisheries Act 1985 (Act 317)

"The master of a foreign fishing vessel entering Malaysian fisheries waters for the purpose mentioned in subsection (1) shall notify by radio, telex or facsimile in the English or Malay Language an authorized officer of the name, the flag State, location, route and destination of the vessel, the types and amount of fish it is carrying and of the

- Owner World Maritime Navigation S.
- address: E Street, Urbanizacion Marbella, MMG Tower 16th Floor.
- D. Pegistered Managolian flag
- □ Ship Length: 53 meter, Breadth: 10 meter, draught: 4.85 meter, GRT: 1160
- 10 crows
- carry 18,000 kg of fish



- □ at anchor position when detained, 3 nm Southeast of Teluk Ramunia, Pengerang Kota Tinggi Johor
- ☐ Ming No 5 under IUU blacklist
- □ she was committed an offence under fisheries act
- □ charged under Section 16(3) Fisheries Act 1985 (Act 317)
- 18 June 2014, Ming No 5 master (Yury Gara) had been accused under section 16(3) Fisheries Act at Kota Tinggi court
- ☐ He pledged guilty and fined with RM200,000.00. The owner paid the fined as ordered by the Kota Tinggi court. Ship and cargo returned to the owner



FV VIKING





On the 7th April 2015, FV Viking master (Jimmi Kawilarang) had been accused under section 16(3)
 Fisheries Act 1985 at Kota Tinggi
 Session court

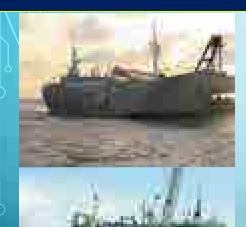
- Owner: BET
- Address:23 Oborale Street Tedi Ojo, Lagos. Nigeria
- Flag Nigeria
- ☐ Ship length: 62 meter, breadth: 10.7 meter, depth: 6.82 meter, GRT: 1322 tonnes
- 18 crews



- ☐ 15 March 2015, she was at anchored when detained
- No permission to anchor
- ☐ Failed to inform her arrival as foreign fishery vessel to Director General of Department of Fisheries(DOF)☐ EV Viking verified by DOF as a
- ☐ FV Viking verified by DOF as a fishing vessel.

☐ He pledged guilty and fined with RM200,000.00. He failed to pay and was send to Kluang prison for 3 months

FV PERLON



- Owner: Royal Marine & Spares Nigeria Limited
- Address: 7B Balarabe Musa Crescent,
 Victoria Island Lagos Nigeria
- 🕽 Flag: Nigeria
- Ship length: 60.3 m, breadth: 11m, moulded depth: 5.5m, GRT: 988 tons
- Cargo: 270 tons Patagonian and Antartic Toothfish

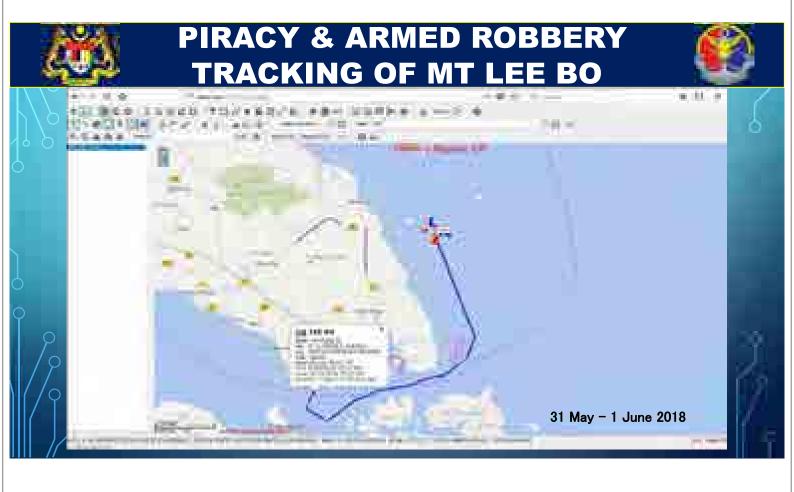


☐ //th July 2015, master and crew Asia Link pledged guilty and fined RM400,000.00
☐ 2 August, all crews FV Perlon pledged guilty for the charges. They was fined total of RM 5.595 million and cargo auctioned RM 5 million forfeited to Malaysia



- ☐ 9 May 2015, she was at anchored when detained.
 Approximately , 2.7 nm south of Tanjung Bulat, Pengerang Kota Tinggi Johor
- ☐ Involved in STS activity
- ☐ Other ship: Asia Link Barge☐ 60 tons already transfer to
- Asia Link Barge.
- □ FV PERLON charged under Section 16(3) Fisheries Act 1985 (Act 317) and Section 15(2) Fisheries Act 1985 (Act 317)
- ☐ Asia Link Barge charged under Section 20 Fisheries Act 1985 (Act 317)

30



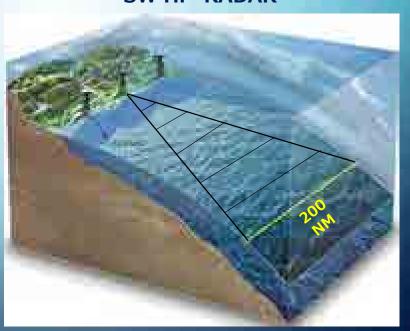
SUCCESFULL ARRESTS OF SEA ROBBERS FROM 2011 TO 2018







- Satellite Imagery, SAR & VIIRS SWATH Ship
- Maritime Surveillance Aircraft (MSA)
- \SW HF Radar
- Capacity Building on Space
- technology



CONCLUSION



- ✓ IUU Fishing threaten Food Security, Economy Security and Job Security
- Malaysia's National Plan Of Action (NPOA)-IUU closely follows the provisions of the FAO International POA-IUU
- IUU Fishing normally used Flag Of Convenience vessel. Eliminate FOC registration
- All fishing vessels must install AIS tracking device especially for SAR ops
- Need cooperation from Coastal State, Regional and International body to reduce/eliminate IUU Fishing



MONITORING IUU IN INDIA USING SPACE TECHNOLOGY: PROSPECTS AND CHALLENGES

International Symposium on Maritime-Space Cooperation in the Asia-Pacific Region

October 4, 2019

By Gayathri Iyer, Observer Research Foundation, India



STRUCTURE

Illegal, Unreported, Unregulated (IUU) Fishing Index - India Score India's Fishing and IUU Monitoring Control and Surveillance (MCS) Indian Use of Space Technologies for IUU MCS

- Satellite based Vessel Imaging systems
 - · Electro/optical imaging satellites
 - Ocean Colour Monitor (OCM) imaging satellites
 - Synthetic aperture radar imaging satellites (SARsats)
- · Satellite based monitoring and tracking data systems
 - Vessel monitoring systems (VMS)
 - Satellite Automatic Identification System (AIS)
 - · Long Range Identification and tracking
- Summary



INDIA IUU FISHING INDEX RANKING - 17 OF 152 COUNTRIES

The Indian Exclusive Economic Zone (EEZ) since 1997

Estimated EEZ Area available: 2.02 mn sq km

Coastal population: 560 mn

- Half of 1.3 Bn population on coasts
- 14 mn directly employed in fishing

Annual Fishing Industry Exports: \$6.4 bn

5.23 % of Agricultural GDP



India has adequate coastal surveillance infrastructure and patrolling capacity

- 5th Largest coast guard fleet in the world
- 60% of Indian Fishermen have Biometric IDs

Monitoring, Control and Surveillance (MCS) Issues

Fractured governance

 Unequal MCS asset distribution between Coast Guard and state Governments agencies

Legal complexities

 Coast Guard Act of 1978 and Maritime Zones of India (Regulation of Fishing foreign Vessels) Act 1981. No management plans to Monitor Indian Vessels or Indian Registered LOPs beyond the EEZ

IUU FISHING OF TOTAL REPORTED CATCH: 10.9% IN BAY OF BENGAL AND 2-3% IN ARABIAN SEA

More than 50% species in the Arabian Sea are at elevated risk of extinction

Sharks, rays, sawfish, hammerheads some of the most threatened fish in the word

f the last ations in

Seafloor ecosystem damage: Pink gold rush for prawns by mechanized trawlers

Bycatch use boom: Vulnerable and top of the food chain species particularly affected

Unintended consequences of 2004 Tsunami aid: sudden expansion and modernization of small-scale fisheries

India Sustains one of the last Healthy Tuna Populations in the World!

HILSA COULD BE SOON EXTINCT in the BAY: an estimated 14,000 trawlers hover the migratory path of the fish as it approaches the river to spawn

SPACE TECHNOLOGIES CAN FILL GAPS IN MCS THROUGH SATELLITE IMAGING AND TRACKING OF VESSELS

MCS Challenges

- Vast EEZ
- Unequal MCS asset distribution between states and the Union - Aerial patrolling fragmented
- Industrial vessels do not take on-board observers
- Low prosecution rate due to lack of documented, time stamped proof of IUU fishing
- Low domain awareness: gaps in the availability, reliability, and quality of information on marine assets

Indian Space Research Organisation (ISRO) has developed a mix of imaging and data communication technologies: indigenous and in collaboration with other country space agencies

Satellite based Vessel Imaging systems

- · Ocean Colour Monitor (OCM) imaging satellites
- · Electro/optical imaging satellites
- Synthetic aperture radar imaging satellites (SARsats)

Satellite based monitoring and tracking data systems

- Vessel monitoring systems (VMS)
- Satellite Automatic Identification System (AIS)
- · Long Range Identification and tracking (LRIT)

IRS SATELLITE SYSTEM FOR OCEAN COLOUR MONITORING

24 Indian Remote Sensing (IRS) satellites launched by Indian Space Research Organization (ISRO) since 1988:

- Currently, world's largest operational constellation of 11 IRS for civilian use
- Data available through NRSC Data Centre purchase process and free through Bhuvan Geoportal of ISRO

India provides continuity of Ocean Colour Monitoring (OCM) data to the international ChloroGIN project

- OCEANSAT-1 in 1999: First OCM payload aboard IRS-P4 to assess clorophyll concentrations, algal blooms for ocean modelling, potential fishing zone (PFZ), productivity and harvesting potential
- OCEANSAT-2 in 2009: Second OCM payload
- OCEANSAT-3 to be launched in 2020



ISRO's ocean color program has evolved into ocean colour-based services: information on the state of the marine ecosystem of Indian EEZ at synoptic scales for policy makers and stake holders including law enforcement agencies

INDIAN REMOTE SENSING OPTICAL IMAGING SATELLITES FOR EARTH OBSERVATION

1980s: India started building and launching several Electro/Optical satellites for long-term spaceborne imaging capability under its National Natural Resources Management System program. Examples:

- 2 OCEANSAT IRSP4 and IRS OS2 in 1980s-90s
- 2 ResourcesSAT satellites (P6 and RS-2) satellites

Optical satellite imaging

- High resolution
- · Can detect and also identify vessels
- · However, strongly affected by:
 - Darkness
 - · Cloud Cover
- Very costly for identifying illegal fishing boats



SATELLITE-BORNE SYNTHETIC APERTURE RADAR (SAR) IMAGING SATELLITES OF INDIA

Globally, current methods for detecting, monitoring and acting on suspicious fishing activity are limited without radar satellite imaging technologies

- Satellite-borne Synthetic Aperture Radar (SAR) or optical sensor units till now were very large and expensive with limited availability. Ver few countries have launched them.
- India launched two SAR Satellites RISAT-1 and RISAT-2. Both are primarily focused on weather surveillance activities; IUU has not been their priority

January 2018

First Finnish commercial satellite ICEYE-X1 with world's first under 100kg SAR sensor payload launched by ISRO's PSLV-C40 rocket from Satish Dhawan Space Center in India

• Enables radar imaging of the Earth through clouds and even in total darkness

VMS USING ISRO'S INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM NAVIC

Vessel Monitoring Systems (VMS)

- Global navigation satellite systems and dual-mode communications (Global Position System)
- Use a variety of communication technologies: satellite AIS or Inmarsat, Iridium, Argos, etc.
- Advantages
 - Resource efficient one law enforcement employee can monitor nearly 500 boats
 - · No shore distance limitation
 - Cost effective, especially for monitoring mid-sea trans-shipments

Indian VSM was developed by ISRO's Space application Centre in 2009 for implementing in the EEZ but there was no mandate to use VMS till 2017

Large scale efforts begun by the Government of India to install VMS in all registered vessels (less than 20 m).



India uses its own Indian Regional Navigation Satellite System, a constellation of seven satellites operating under the name NavIC.

INTERNATIONAL COOPERATION BETWEEN ISRO AND CNES FOR SPACE AUTOMATIC IDENTIFICATION SYSTEM (S-AIS)

VHF and radar based Terrestrial Automatic Identification System (AIS): India set up a National AIS Network on 74 shore stations

Challenge: VHF range limitation of maximum of 25-40 nm from the coast. Currently India has AIS fitted on vessels larger than 20 m

Satellite detection of AIS: Private international companies like 'exactEarth' and 'ORBCOMM' providing commercial service

Current shortcomings in the Satellite AIS technology: ships' position data delayed by ~90 minutes depending upon the number of satellites available for covering a particular area



August 2019: India' ISRO and France's space agency CNES announced joint development and operations of 10 low-earth orbit satellites for world's first S-AIS series to track merchant ships on a real-time basis

LRIT BASED, REAL-TIME TRACKING AND REPORTING SYSTEM FOR ENHANCED MARITIME DOMAIN AWARENESS

Long-Range Identification and Tracking system (LRIT) - satellite based, real-time tracking and reporting system of ships

- IMO approved system since 2006 for ships of 300 gross tonnage plus
- Consists of Ship Satellite terminal, Inmarsat Satellite Communication, national data centres
- India installed LRIT data centre in 2009; it shares own data with the other Flag States
- Major advantage: very secure access only by authorized governmental agencies



However, in India the system is not being used by the member States regularly for monitoring the illegal fishing because it is costly to obtain positions of ships of another flag. S-AIS is cheaper

DIFFERENCES BETWEEN VMS, AIS AND LRIT SYSTEMS

VMS

Not mandated by IMO

Closed proprietary systems with high barriers to data access

Transmit every 30 min to 2 hr

AIS

Collision avoidance system mandated by the IMO; open and non-proprietary with international standards

Public broadcast system

Transmit continuously

LRIT

Reporting system mandated by the IMO, LRIT Protocol

Transmit every 6 hour, can be set for 15 minutes

Secure data only available to entitled institutions



SUMMARY

Conditions that affect India's space agency's efficacy in responding to maritime threats

- Priortized National Interest in protecting its fish for food security
- A mix of technologies including optical imaging and tracking
- International collaboration
- Domain awareness
- Enforcement



Tallengestoare.com

THANK YOU!

Gayathri lyer

Email: gayathri.iyer@orfonline.org

ww.orfonline.org



The use of satellite technology in combatting IUU fishing in the Pacific Islands region

Presentation to the 2019 International Symposium on Maritime-Space Cooperation in the Asia Pacific Region Tokyo, Japan

by

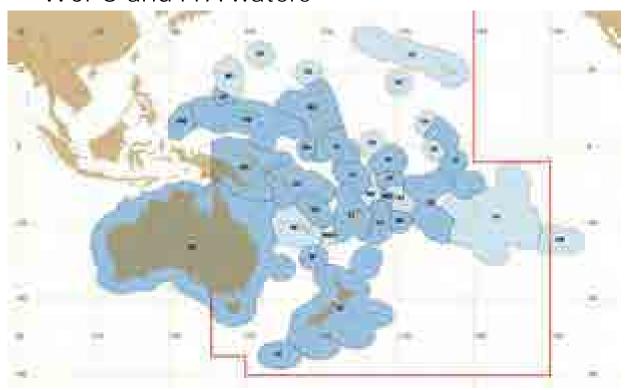
James T. Movick Consultant, Pohnpei, FSM.

The maritime management challenge facing PICs

The region is characterized by:

- Small Island Countries with very large EEZs (plus Australia & NZ)
 - PIC EEZs cover 30 million sq kms (not including ANZ)
 - · Adjacent High Seas & HS Pockets
 - Region spans 6 time zones & Intl Date Line
- o Highly valuable tuna resources
 - WCPO produces 55% of world tuna catch
 - Catch yields 2.25million tonnes per annum
 - 80% of catches are from FFA member EEZs
 - PNA EEZs alone produce 40% of world canning tuna supply
- Generally limited resources with which to undertake MCS
 - IUU fishing has the potential to significantly erode the benefits to Pacific Island people.

WCPO and FFA waters



Satellite tracking – a key part of the regional IUU fishing solution....BUT only when supported by an effective enforcement capability

The member countries of the Pacific Islands Forum Fisheries Agency (FFA)
were amongst the first multinational collective management arrangements
to require secure satellite tracking of registered vessels involved in fishing of
the tuna and other highly migratory fish species in their combined EEZs,
starting in 1998 and mandatory since 2002.

MY KEY TAKEAWAY POINT NUMBER 1.....

- The success of satellite tracking in reducing IUU fishing in FFA member EEZs has been noticeably significant but that success is also substantially due to the collective regulatory management framework shared by the PICs, which includes further surveillance and legal enforcement tools that support the integrity of the system and the apprehension and prosecution of vessels suspected of illegal fishing within the EEZs.TO BE EFFECTIVE TECHNOLOGY (SATELLITE SURVEILLANCE AND MONITORING) MUST BE SUPPORTED BY EFFECTIVE ENFORCEMENT INCLUDING LEGAL STANDING, LINKAGE TO DEPLOYABLE ASSETS AND LONG-ARM REACH CAPABILITY.
- The comparative importance of this supportive regulatory element is demonstrated by the less successful efforts of the WCPFC in combatting IUU fishing activity on the region's high seas areas.

The fundamental diplomatic/legal basis to PIC regional fisheries management efforts and success is Regional Cooperation supported by Zone Rights Based Management

- National sovereignty From the outset of UNCLOS3 PICs insisted on national (coastal state) sovereignty and sovereign rights over the management and development of tuna and other highly migratory stocks of fish (HMS) within their EEZs.
- As such, because HMS move across multiple zones, effective management requires cooperation amongst the coastal states sharing those stocks.
- The management framework adopted has been of Zone Rights Based Management - a multi-jurisdictional form of rights-based fisheries management that recognizes the right and responsibility of coastal states under UNCLOS to conserve and manage resources in their EEZs, giving coastal states a more equitable say in the management of highly migratory species.
- Noteworthy, that PICs were committed to the national sovereignty based approach even though in 1978 the extent of the fishery and its principal location within EEZs was not at all clear – a strong point of principle based on desire for greater equity.
- Understanding this basic conceptual framework is fundamental to understanding PIC regional fisheries management.

Implementing ZRBM

- 1. Establishing a regional body to coordinate their cooperation
 - In 1979 PIC leaders established the Pacific Islands Forum Fisheries Agency (FFA) to facilitate fisheries management cooperation amongst the PICs
 - With its secretariat in Honiara, Solomon Islands, FFA now includes the 15 independent PICs, Australia and New Zealand and the Territory of Tokelau.
- 2. From the early 1980's the FFA members adopted a number of cooperative uniform measures to enhance their limited individual capability to control foreign fishing activity in their EEZs (Detailed below).
- 3. Sharing and coordination of surveillance and enforcement efforts was formalized into more legally binding form in 1992 when FFA members adopted the 'Niue Treaty on Cooperation in Fisheries Surveillance and Law Enforcement in the South Pacific Region'.

Through FFA adopted key Common Programs

- HMTCs for licensing of foreign fishing vessels
- FFA Register of Fishing Vessels 1200 vessels
- FFA VMS
- FFA RSP
- FFA Observer Program
- Port controls & monitoring
- Legal / Prosecutions
- Data & information sharing / exchange
- Aerial & surface patrols







Monitoring, Control & Surveillance (MCS)

Primary MCS Monitoring tools are:

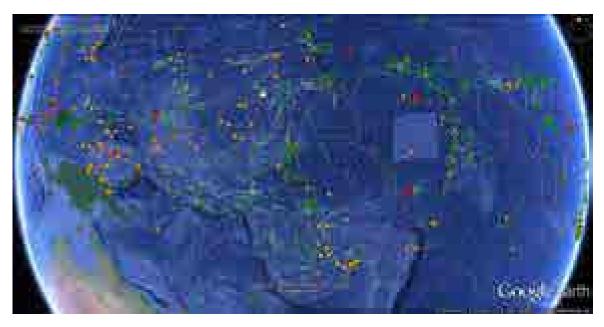
- FFA VMS
- WCPFC Vessel Monitoring System (VMS)
- Automatic Identification System (AIS)
- Electronic Op Room (E-Ops Room)
- Regional Surveillance Picture (RSP)
- Regional Information Management Facility (RIMF)
- Niue Treaty Information System (NTIS)



Vessel Monitoring System

- Agreed in 1997, became 'operational' in 1998 and mandatory by 2002.
- Type-approved Automatic Location Communicators (ALC)/Mobile Transmitting Units (MTU) required on all licensed fishing boats; mandatory reporting required from port to port; units directly interrogated by FFA; monitored in real-time by FFA RFSC (regionwide) and by PICs (own and authorized EEZs) in accordance with agreed data sharing rules – tracks 1200 boats.
- In 2007 WCPFC adopted same VMS platform as FFA to track vessels authorized to fish on the high seas, albeit HS data generally not accessible to FFA – tracks about 3000 boats.
- Advantage of the closed, type-approved, VMS units is that the location and details of the vessel cannot be easily altered without detection by the RFSC, unlike AIS units.
- In 2011 FFA members mandated that fishing vessels also install and utilize AIS units, which serves to further validate vessel position and can be a back-up in the event of VMS MTU failure.





FFA Regional Fisheries Surveillance Centre



Regional Fisheries Surveillance Centre

- the regional hub for cooperative fisheries monitoring
 - Established in 2009 located at FFA secretariat, Honiara.
 - Provides analysed Surveillance Picture to FFA Members and QUAD Surveillance Providers (Australia, NZ, France, USA) to support national MCS activities.
 - Analytical capacity complimenting Members' MCS efforts.
 - Coordinates QUAD surveillance with Members.
 - Assist Members through provision of case packages (incl. evidence to support prosecutions).
 - Capacity build Members on regional MCS tools.
 - Supports PMSP/FFA regional air surveillance operations.
 - Assists trials of new technology for FFA.

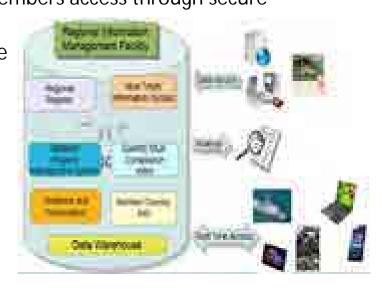
FFA Regional Information Management Facility – facilitating regional information sharing

Originally developed in 2009...operational by mid-2014

 RIMF is an integrated/central system to house/manage MCS data and info, that FFA Members access through secure

portals also allowing

them to populate/update their own information data-bases and regional information systems



Going forward: Proposed and interesting new technology for improved IUU fisheries detection

- Seeking to improve Real-Time data access Satellite communication systems
- Electronic monitoring video monitoring of on-board fishing activity and sensing of fishing equipment use, including FADs.
- Electronic reporting satellite communications to enable real-time catch data reporting by vessels and on-board Observers (also Observer safety).
- Independent/Verifiable AIS reporting validation.
- Using Satellite imagery platforms to cross-validate vessel position reporting data.
- Trials with night light vessel imagery, small boat detection using Satellite based SAR imagery, trials with high quality Satellite Optical imagery.
- Using Satellite remote sensing for intelligence assessment to more efficiently focus surveillance targeting
- Trials with Satellite remote sensing data to better focus surveillance efforts, such as plankton distribution, ocean currents and temperature.

Going forward: Broader law enforcement security cooperation – regional Maritime Domain Awareness

- The re-conceptualization of IUU fishing as a facet of trans-national crime will pose new opportunities and challenges for the use of satellite based technology in the PIC region in the years ahead.
- This will include engaging with Broader Law Enforcement stakeholders under the Boe Declaration on Cooperation in Broader Regional Security (which recognizes Climate change, People Security (food security and disaster response), Trans-National Crime, Economic resource security (including IUU fishing), and Cyber-security as regional security threats to be addressed collectively.
- Pacific Fusion Centre an Australia Government initiative with critical PIC governmental oversight and regional technical agency cooperation; to undertake cross-sectoral Intelligence analysis, Broader Information sharing, Intel capacity building and Maritime Domain Awareness in support of implementing 'Boe'.
- The PFC will develop a regional Maritime Domain Awarenes(MDA) system hopefully incorporating multiple Satellite communications, imagery and remote sensing input fused with other information to provide better security intelligence support to regional governments and appropriate technical agencies.

The PIC region – many needs and constraints

- For many PIC communities detection of IUU activity in near-shore coastal fisheries and protection of Marine Protected and Managed Areas is a pressing food, economic and environmental security issue.
- **❖BUT PIC's aspirations for more effective usage of satellite technologies, are significantly constrained by COST and LIMITED TECHNICAL EXPERTISE:**
- high cost of products and communications
- limited awareness of available technology, possible applications and meta-data
- limited technical know-how to develop algorithms to analyse the data to address the needs most important to PICs
- limited expertise to know and to properly frame the questions that can/should be asked
- apparent technical limitations to the expeditious use of international satellite systems in the region – available earth stations and orbits

So what can be done going forward? Key take-away point Number 2.....Let's DO something, don't just talk...SDG's ..PALM8..the mandate is there.....

- Help PICs address the cost issues through free or cheaper access including through creative indirect means eg development of algorithms to use free data feeds from existing satellites.
- Meet with PIC technical users to understand and address the technical constraints that they are experiencing.
- Help develop space technology/satellite expertise in the PIC region through appropriate academic scholarships, training programs and provide technical expertise to PICs.
- Undertake public information programs and events to inform PIC regional policy makers, technical officials and communities about the range and value of space technology/satellite observation and communication platforms and of products. e.g. support the Pacific Islands pre-event planned for the GEO conference in Canberra in November.
- Support the development of a Regional Earth Observation (including Satellite Oceans Observation) platform to promote greater access to and use of Earth Observation tools to address the needs of PICs more systematically.



Title: Considerations for global maritime-space cooperation in the Asia-Pacific

Presenter: Victoria Samson, Washington Office Director, Secure World Foundation

Bio: <u>Victoria Samson</u> is the Washington Office Director for <u>Secure World Foundation</u> and has over twenty years of experience in military space and security issues.

Before joining SWF, Ms. Samson served as a Senior Analyst for the Center for Defense Information (CDI), where she leveraged her expertise in missile defense, nuclear reductions, and space security issues to conduct in-depth analysis and media commentary. Prior to her time at CDI, Ms. Samson was the Senior Policy Associate at the <u>Coalition to Reduce Nuclear Dangers</u>, a consortium of arms control groups in the Washington, D.C. area, where she worked with Congressional staffers, members of the media, embassy officials, citizens, and think-tanks on issues surrounding dealing with national missile defense and nuclear weapons reductions. Before that, she was a researcher at <u>Riverside Research Institute</u>, where she worked on war-gaming scenarios for the <u>Missile Defense Agency</u>'s Directorate of Intelligence.

Ms. Samson holds a Bachelor of Arts (B.A.) degree in political science with a specialization in international relations from <u>UCLA</u> and a Master of Arts (M.A.) in international relations from the <u>Johns Hopkins School of Advanced International Studies</u>.

Brief description of the presentation: Space-derived data for MDA can be very beneficial, but there are considerations to keep in mind when sharing space-derived data it. As well, there are issues in space situational awareness data-sharing that may provide warning of possible complications that MDA data-sharing may face. Last, given the growing interest in space-derived MDA, there are broader space policy issues that this community should be aware of.

Remarks:

Hello. It is my honor to be speaking here at the "International Symposium on Maritime-Space Cooperation in Asia-Pacific Region." Thank you to the Ocean Policy Research Institute of the Sasakawa Peace Foundation and the Space Policy Research Center of the Japan Space Forum for inviting me to speak today. My organization is the Secure World Foundation (SWF), a private operating foundation that promotes the long-term sustainable use of outer space. SWF works with governments, industry, international organizations, and civil society to develop and promote ideas and actions for international collaboration that achieve the secure, sustainable, and peaceful uses of outer space. We use a cooperative, international approach to promote best practices and norms of behavior that will allow us to continue to have access to and use of space over the long-term.

I will focus my remarks today on three main issues. The first are considerations to keep in mind when sharing space-derived data for maritime domain awareness (MDA). Next, I will speak about issues in space situational awareness (SSA) data-sharing that may provide warning of possible complications that MDA data-sharing may face. Last, given the growing interest in space-derived MDA, I will speak about broader space policy issues that this community should be aware of.

MDA is can be defined as effective understanding of anything associated with the maritime domain that could impact security, safety, economy, and environment. MDA relies on a layered set of terrestrial, airborne, and space-borne systems. Satellites can play an important role in MDA, including optical and radar imaging satellites, as well as satellites that carry receivers for the Automatic Identification System (AIS) created by the International Maritime Organization (IMO) and even commercial satellites which

can collect radiofrequency signals. With the rise of commercial Earth observation constellations, we are seeing much higher revisit rates with less exquisite architecture, which is allowing for an explosion of usable MDA data points. As well, many of the satellites being launched as part of the smallsat revolution are providing Earth observation capabilities that could be used to improve MDA. Some of these systems carry synthetic aperture radar, which can see through bad weather and during day and night. Space-based solutions are helping to close the gap for knowledge of what is on the oceans.

Some complications to sharing space-derived MDA data are that sometimes there are a lack of training and/or a limited patrol response that is possible. As well, even with a multi-layered approach, there can be gaps in coverage. Furthermore, space-based MDA data suffers from the same problems that all data sources suffer: latency issues, the potential for deliberate spoofing or interference, validation of data, and concerns about bias of the data collector.

There also is the need to improve data analytics. Data that is collected is only useful if we know what to do with it, and even in our current space domain configuration, we run the risk of being inundated with too much data. Big data analytics are going to be crucial to being able to fully take advantage of the benefits that these space applications can bring to MDA. As well, while data is useful, it in and of itself is not going to provide decision-making support. It is the foundation for it, but you cannot stop just at sharing data. One option might be to get your data, apply machine learning to it in order to determine behavioral patterns, and overlay it on the regulatory context in order to produce real-time decision-making support at the operational level.

Now, I would like to discuss space situational awareness (SSA) and issues in international cooperation and data-sharing that may prove helpful in identifying potential complications for sharing space-derived MDA. SSA is the knowledge and characterization of space objects and their operational environment to support safe, stable, and sustainable space activities. This is done to operate safely and efficiently; avoid physical and electromagnetic interference; detect, characterize and protect against threats; understand the evolution of the space environment; and provide awareness and transparency of space operations. Most space actors do not have the resources or capacity to provide their own SSA, but instead rely on the U.S. military to send them notifications of potential close approaches, or conjunctions.

In the past several years, there have been two big changes in the SSA domain. The first is that the U.S. government is seeking to change which government entity is responsible for collecting and disseminating the data. We are potentially shifting to a system where instead of Strategic Command being in charge of sending out notices to operators, it may be a one-stop shop at the Department of Commerce. This is still being worked out, as Congress has not authorized this change yet. The second is the proliferation of SSA capabilities, both by other countries and also by commercial SSA providers.

The latter has prompted discussions about the essential nature of SSA. Is it necessary for spaceflight safety, and thus a public good that the government should provide at least a basic level of? How can the government encourage the commercial sector to invest in SSA if they will be competing with the public provision of free data? There is also the question of transparency of the data sources: how can you verify the data's authenticity? What is the liability of using commercially provided SSA? How do you combine multiple sources of data that use different formats? And finally, how do you share data without bumping into national security considerations, given that much of space information is almost reflexively classified?

Finally, I would like to use the few minutes I have remaining to discuss some of the broader space policy issues that the MDA community should be aware of as space becomes increasingly important to MDA. The space domain is undergoing a significant set of changes. A growing number of countries and commercial actors are getting involved in space, resulting in more innovation and benefits on Earth, but also more congestion and competition in space. From a security perspective, an increasing number of countries are looking to use space to enhance their military capabilities and national security. The growing use of, and reliance on, space for national security has also led more countries to look at developing their own counterspace capabilities that can be used to deceive, disrupt, deny, degrade, or destroy space systems.

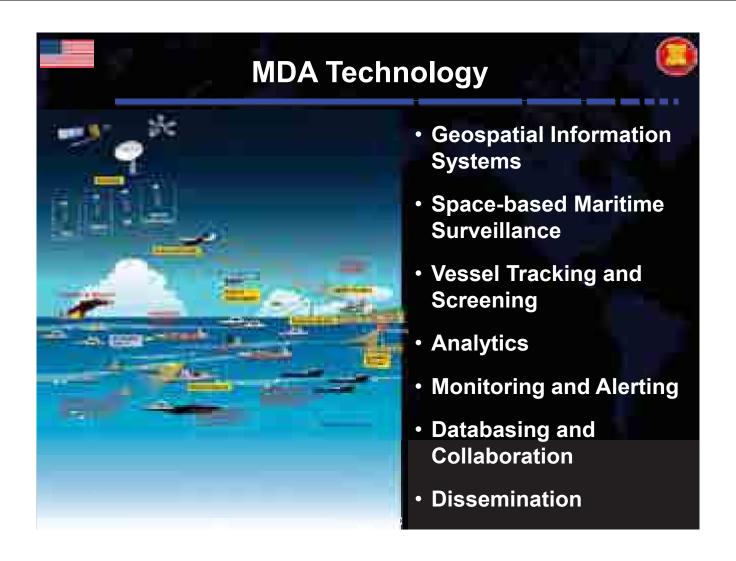
The existence of counterspace capabilities is not new, but the circumstances surrounding them are. Today there are increased incentives for development, and potential use, of offensive counterspace capabilities. There are also greater potential consequences from their widespread use that could have global repercussions well beyond the military, as huge parts of the global economy and society are increasing reliant on space applications.

Another disruption to the space domain is the emergence of new actors. During the Cold War, space was largely the province of only a few states. However, there are now over 80 countries that have access to satellites. Small satellites, or smallsats, have lowered the cost of entry to space. As of March 2019, there were 2062 active satellites. Earlier this year, we also saw the first launches of what have been called mega-constellations. We have the potential for the addition of 20,000 more satellites in Earth orbit in the near future, which will hugely change almost everything of how we operate in and from space. Another complication is that the mega-constellations are being launched by commercial companies, which means that space will be shifting from being dominated by nation-states to one where the commercial sector is preeminent. This will make global governance discussions challenging, as multilateral fora historically have only allowed the participation of nation-states.

We are at an inflection point for the use of space. Thoughtful, international, and cooperative considerations of these challenges now can help set the standards and norms to ensure that space is usable for and accessible to all in the long-term. Thank you for your time and attention.







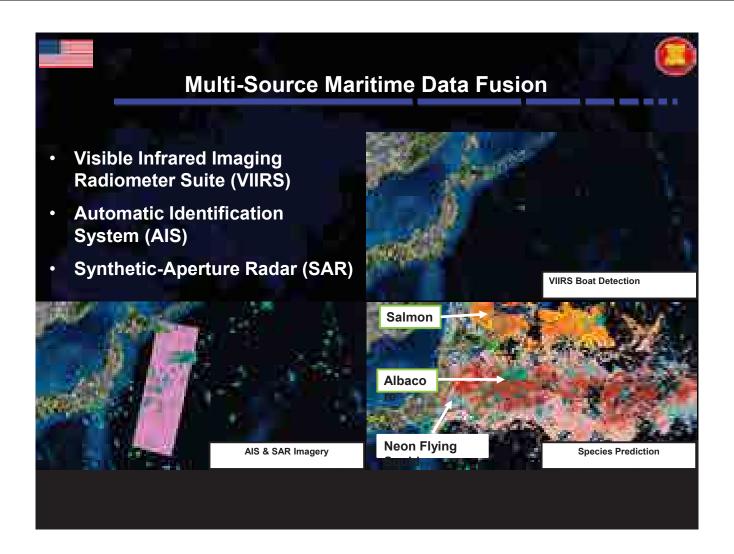


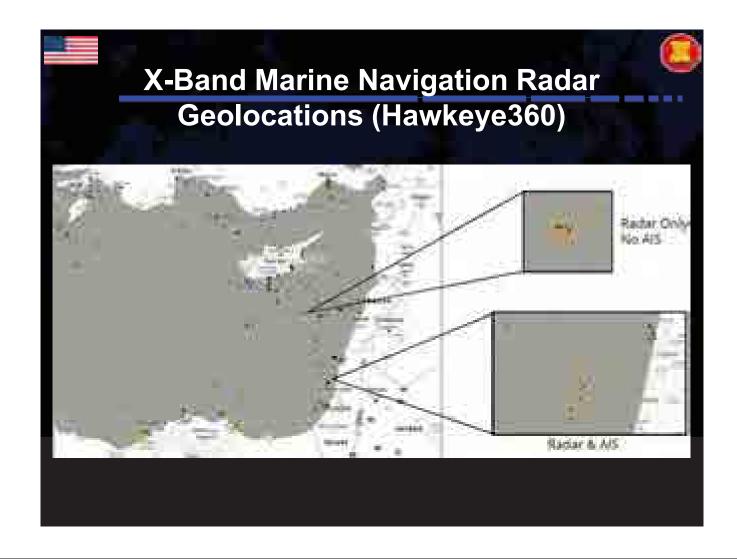
A comprehensive approach to maritime governance that is based on technology exploitation and information sharing among agencies, international partners, academia, and the private sector.

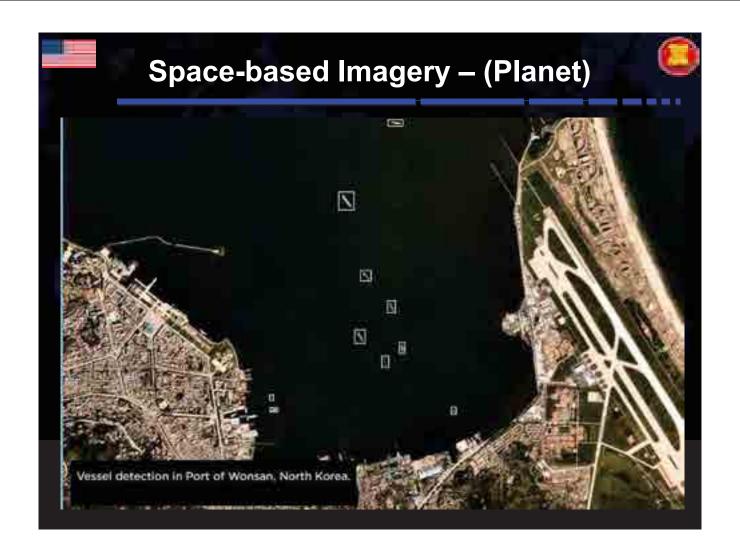


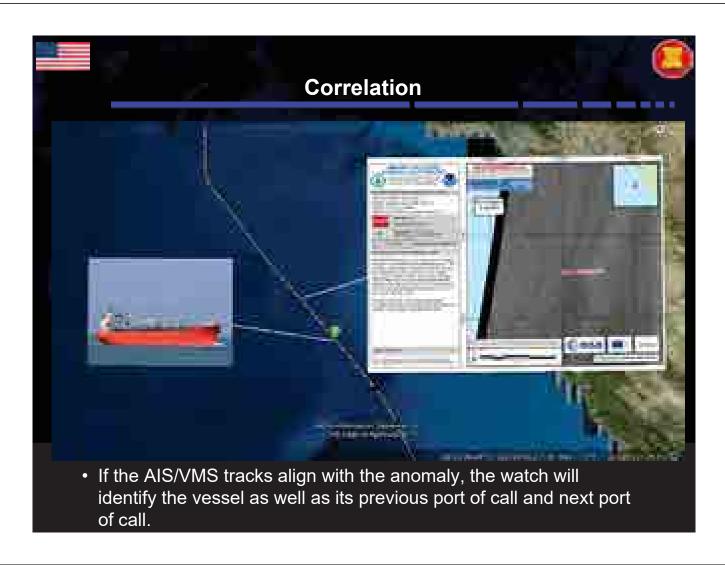


The National Maritime Intelligence Integration Office (NMIO) and the National MDA Executive Steering Committee work with the Global Maritime Community of Interest to identify opportunities for cooperation.









An Immediate Regional Need

- ASEAN Leaders express intent to establish greater maritime Cooperation in Southeast Asia.
 - Shared interest in building a common understanding of the regional security environment.
 - More information-sharing and greater maritime cooperation.





US Cooperation on MDA ASEAN Forums National Maritime Single Points of Contact

SeaVision





