CEOS Ocean Variables Enabling Research and Applications for GEO (COVERAGE)

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- **International initiative** led by NASA under the Committee on Earth Observation Satellites (CEOS)

- **CEOS endorsed COVERAGE** at SIT-32 as a 3 year pilot project initiated in November 2017

- **Cross-cutting, collaborative effort** relevant to the 4 CEOS Ocean Virtual Constellations (SST, OST, OCR, OSVW) and GEO projects (MBON, Blue Planet) to:
  - enable more widespread use of ocean satellite products in support of applications
  - via implementation of an advanced technology platform providing value added data & services

- **Response to known needs of the ocean community** for improved, more integrated access to analysis ready data for societal benefit in support also of SDGs (14 in particular) relating to marine biodiversity & sustainable/ecosystem-based resource management

- **Stakeholder Beneficiaries**:
  Internal: Ocean VCs, WGISS
 *External*: GEO-Blue Planet, GEO-MBON, GOOS

COVERAGE aims to develop a data rich Tech. platform for more seamless delivery of analysis ready ocean data to demonstrate the value added of multivariate ocean data integration in support of science, applications, and public engagement:

- "Fusion environment" leveraging emerging cloud-based infrastructure, largely existing software capabilities available open source

- Curated aggregation of high quality, interagency multi-parameter observations (Sea Surface Temperature, Surface Winds, Sea Level Anomaly and Ocean Color)

- Global, Collocated to a common 0.25 deg. resolution grid, Near real-time, Gap-free

- Complemented by set of select in-situ datasets supporting target applications

- Access via value-added data services available via a COVERAGE Thematic Portal, interactive tools and associated Web service APIs

- Illustrated in the context of demonstration GEO-MBON applications
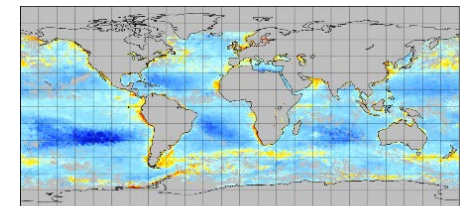
- User focused & Community driven
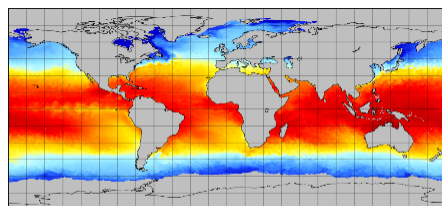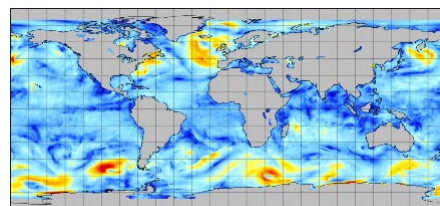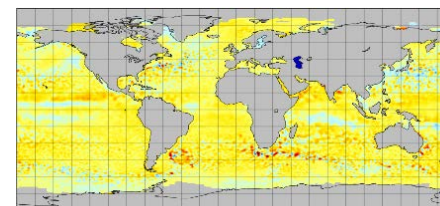
SST Surface Winds Sea Level Anomaly CHL-A

COVERAGE project has a 4-part development concept

A. Scoping	B. Prototype Development	C. Full Implementation	D. Evaluation

Phases:

A. Scoping/Planning (9 mo)
B. Prototype Development/Evaluation (1yr)
C. Full system development (1yr)
D. Testing/Evaluation & transition to operations (6mo)

Phase A work plan key elements (*completed*)

- Stakeholder engagement towards a collaborative project
- Identification of specific GEO-BP/MBON applications COVERAGE would support
- Inventory of target datasets, providers, interfaces
- Use case gathering & functional requirements
- COVERAGE technical system architecture, including CEOS data provider interoperability considerations

Phase B: COVERAGE Prototype & Demonstration (*in process*)

- Work plan developed

Advisory Board developed with cross-agency & stakeholder representation

Participants include:

NASA, NOAA, CNES, EUMETSAT, Copernicus-CMEMS, Australian Bureau Meteorology, Integrated Marine Ocean Observing System, **Sargasso Sea Commission**, CEOS Ocean VCs, & WGISS

Quarterly Board meetings

Presentations & Outreach Efforts

Conference presentations:
3rd & 4th BP symposium, Copernicus Marine Week-2017, GHRSSTXVII & XVIII, AGU2018/19 & Ocean Sciences 2018

Meetings/Teleconferences

IMOS, CNES, NOAA-OceanWatch, IOOS, MBON, SSC, NASA/ESDIS, NASA/PODAAC, BP/UNDP-4M initiative

SIT-TW Meeting (*EUMETSAT*)
COVERAGE Workshop Side-Meeting
VC & Plenary session presentations

COVERAGE initial demonstration (2016) in collaboration with the Sargasso Sea Commission (SSC) as a proof of concept activity in preparation for CEOS initiative proposal

COVERAGE utility to SSC Efforts

- Provide access to data for data poor high seas area
- Illuminate the relationship between oceanographic conditions, biological resources & uses of the Sargasso Sea
- Tool potentially supporting future UN marine biodiversity treaty for areas beyond national jurisdiction (ABNJ)

COVERAGE & SSC

- NASA COVERAGE workshop hosted by SSC, Key West, March 20-22, 2016
- UN-HQ PrepCom ABNJ Meeting, NYC, August 31, 2016
- SSC 3rd Joint Meeting of Signatories, Horta, Azores, April 18-19, 2017
- SSC Workshop and 4th Joint Meeting of Signatories, Bermuda, March 13-14, 2019
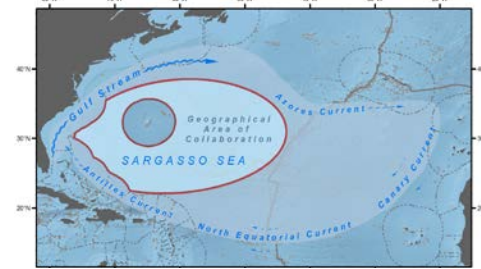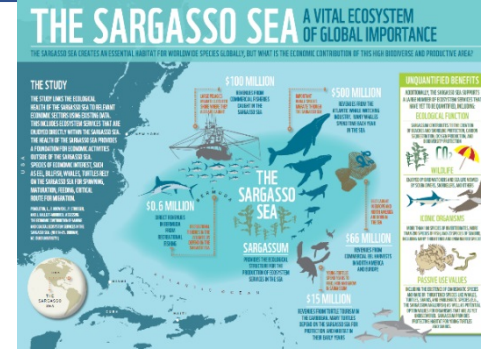
Completed a review of candidate interagency satellite data products across the 4 ocean VC parameters (SST, Winds, SSH, Ocean Color) for inclusion as a coherent set of 0.25 degree, global <u>baseline</u> products for COVERAGE

- Selection considerations: highest quality, add-value to each other
- COVERAGE satellite data profile: 0.25', global, NRT, multi-year, gap free/L4, interoperable formats
- Documentation of data search/access mechanisms, formats, volumes
- Shared for comment with Board, VCs, agency experts

<u>Conclusions</u>
- Manageable number of good options for all parameters
- Ocean Color: apparent paucity of L4 gap-free products
- Some heterogeneity in Data Search/Access mechanisms across agencies (NASA, Copernicus-CMEMS, NOAA)
- Importance of consideration of higher resolution products as well where applicable

SST

Surface Winds

SLA

CHL-A
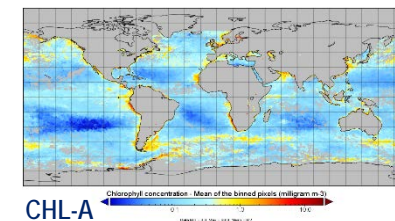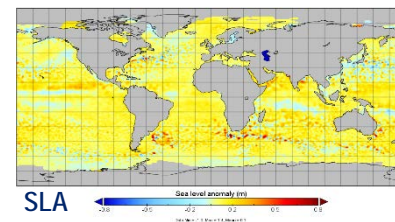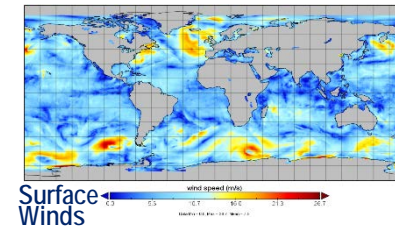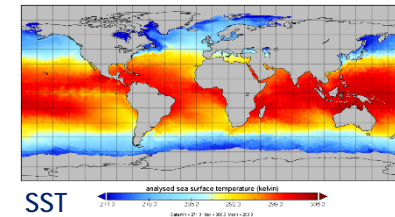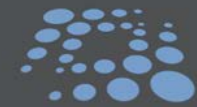
Product temporal coverage comparisons

- Leverage JPL's existing "Big Data" NEXUS/SDAP" open source Technology stack but adapt as necessary

- Distributed architecture, cloud enabled (reduce large data movements)

- Emphasis on Earth science data interoperability standards (CF, ACDD, ISO19115)

- Web-based Access via value-added data services

  o Search
  Visualization (raster & vector data)

  o Subsetting (space-time bounding box/polygon)

  o Colocation (satellite-insitu matchups)

  o Analytics (time-series, area average maps, Hovmoller, correlation)
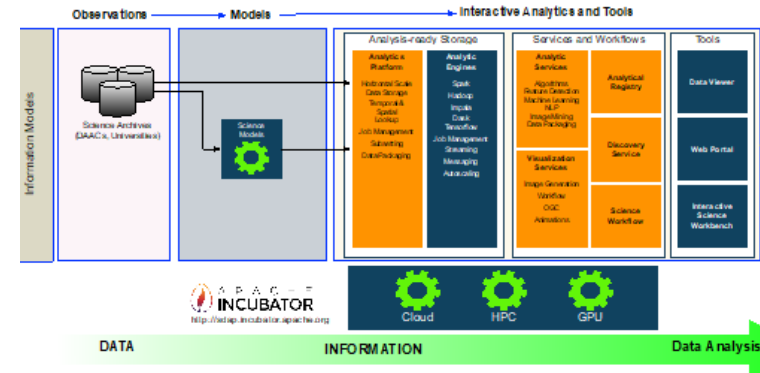
Interfaces

- COVERAGE project Portal

- Interactive GUI-based tools & services

- Jupyter notebooks (user coding support)

- Web service APIs to data services
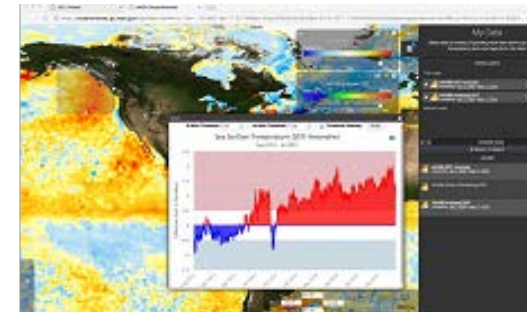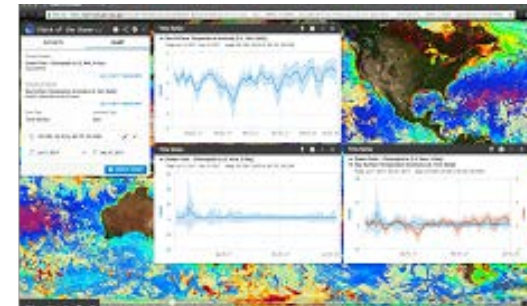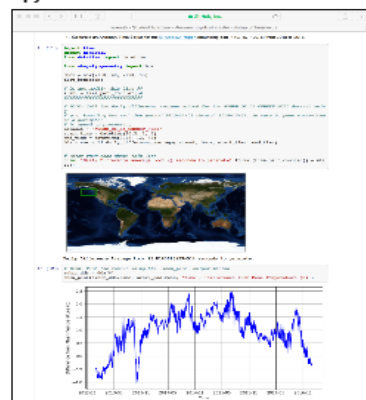
Summary of use cases highlighted by MBON in initial discussions:

- "Fisheries & the Environment"

- Dynamic SEASCAPES – access to ocean remote sensing data/services via COVERAGE

- OBIS – interfaces to Ocean Biogeographic Information System

- EMUs – Ecological Marine Units based also on remote sensing data time series

- Support derived products such as anomalies, climatologies, gradients, currents potentially important for marine biodiversity/ecology applications

Functionality needed to support marine biodiversity-type applications:

- Connectivity to IOC-OBIS as a centralized repository of marine biogeographic data

- Ability to flexibly visualize, collocate, and extract time series of in-situ biological and satellite observations for regions of interest (user defined areas, EEZ/MPA polygons)

- GUI and APIs to both interactive and automated/script-based data access

- Higher/native resolution satellite data desired

High Seas & Regional Fisheries Applications involving integration of ocean remote sensing, physical model and in-situ datasets enabling decision support and research investigations

- Habitat analysis for Highly Migratory Species (HMS)

- Tuna Spatial catch forecasting

- By-catch mitigation

- Integration of environmental information in support of fisheries science & ecosystem-based assessment
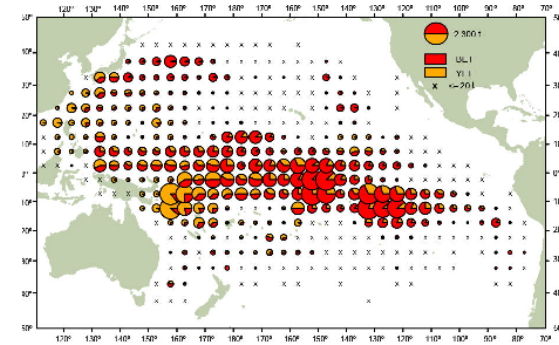
Questions:

extent & mechanism by which environmental variability over a range of scales affect stock structure, drive dynamics

Stakeholder agencies: eg. IATTC (RFMO), NOAA/NMFS

Supporting Data
- RFMO monthly spatial catch/effort time series by species, aggregated spatially at 1 & 5deg. resol., 1952-2018
- Electronic tagging datasets: high resol. trajectory-profile series
- AIS fishing vessel movement data products by category (daily, since 2012 from *Global Fishing Watch*)
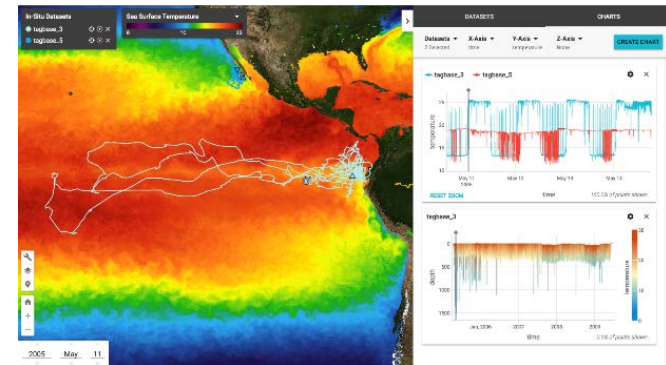
Web-based Visualization of 4-year, minute resol.
ETP Bigeye tuna eTag data (Schaffer & Fuller, IATTC)

A Nested/Multi-scale Application Concept

- Macro-scale open ocean application complemented potentially by select regional view(s)
- Facilitated by distributed system architecture of COVERAGE

Rationale:

- Richness of In-situ data in support of our target applications is limited for open ocean regions
- Regional approach will facilitate integration of select high-resolution satellite and potentially model data into our applications
- Facilitate broader agency participation in COVERAGE
- Provides an option for future COVERAGE expansion via regional spin-offs
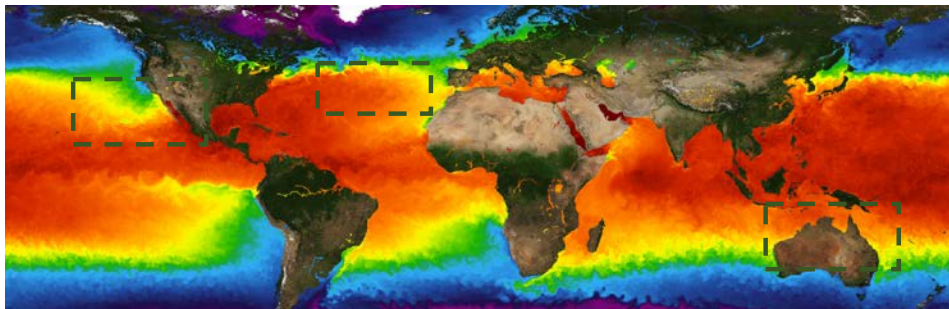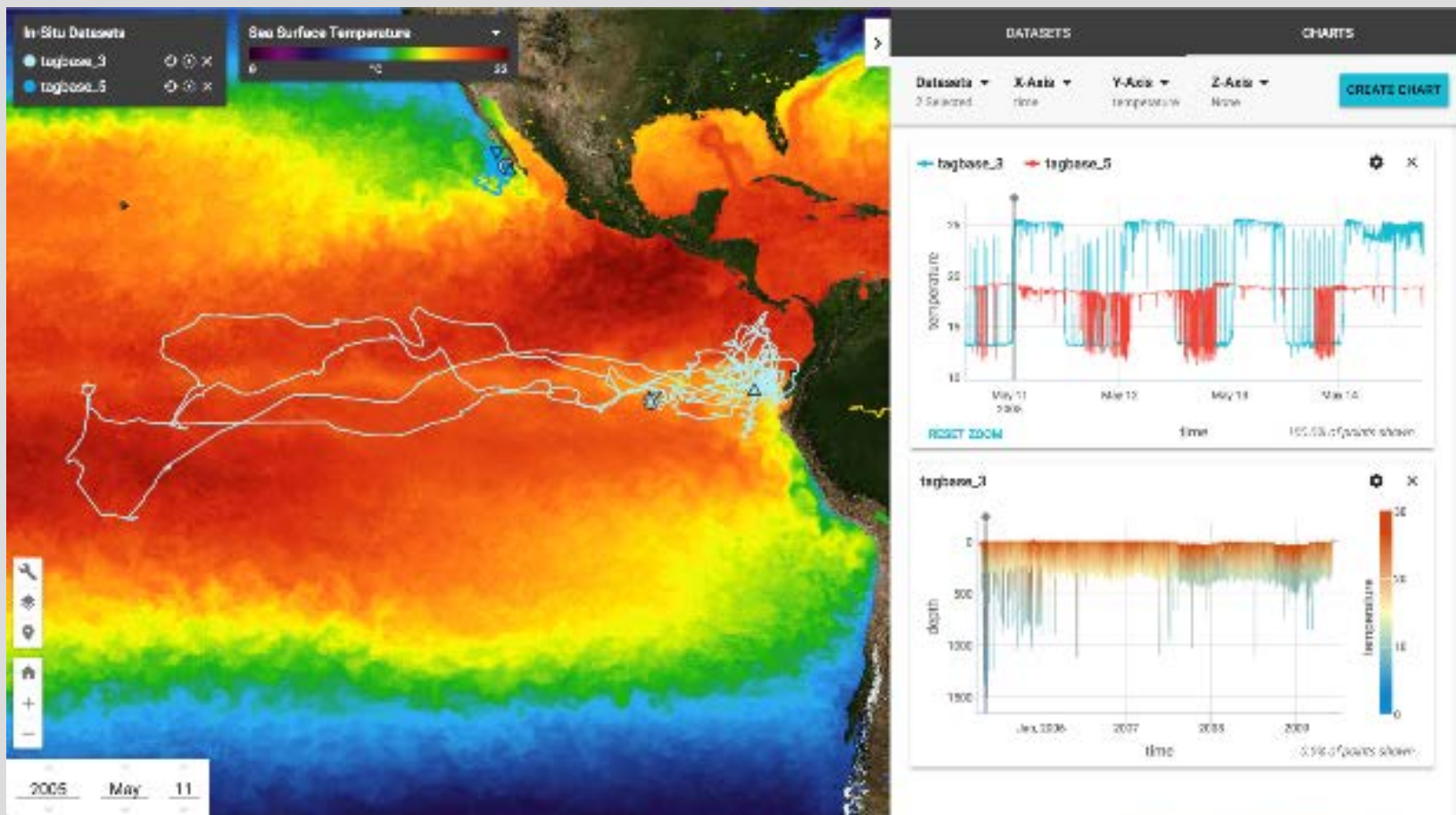
Possible Candidate Areas
- ETP
- Sargasso Sea
- AUS (IMOS)

Questions

DEMO Video