

COVERAGE

CEOS Ocean Variables Enabling
Research & Applications for GEO

A Reusable Platform Enabling Synergistic Use of Inter-agency Altimetry
and other Oceanographic Data in Support of Interdisciplinary
Marine Applications

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Venice, Italy



CEOS Initiative: Cross-cutting, collaborative effort involving CEOS Ocean Virtual Constellations, GEO-MBON & GEO-Blue Planet

Goals

- Implement Cloud-enabled Tech. platform providing access to complementary satellite & in-situ datasets from distributed sources via value-added data services
- Improved access to a coherent, curated set of global, interagency data products from the 4 Ocean VCs at common resolution as a baseline dataset, with flexibility to include select value-added and higher resolution products and support for in-situ
- Demonstrate utility of the system in the context of a pilot thematic Ecosystem application: *“High-seas Fisheries & Biodiversity in relation to the Environment”*



Copernicus
Marine Service



Approach

- Governance: Advisory Board from stakeholder organizations
- Community driven, Stakeholder focused, Open Source, data FAIR
- Phased Development:

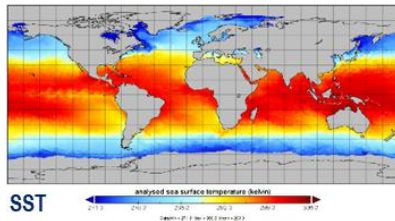




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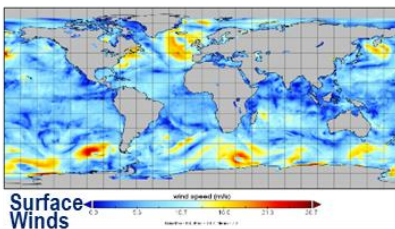
Constituent Data



Sea Surface Temperature

- METOFFICE-GLO-SST-L4-NRT-OBS-GMPE-V3
- MUR25-JPL-L4-GLOB-v4.2

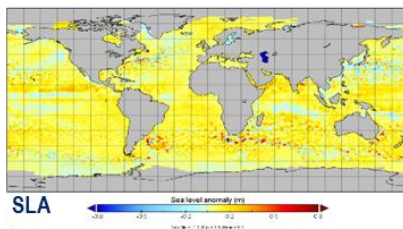
(GHRSSST-CMEMS/UK Met.Office)
(GHRSSST- NASA/Measures)



Ocean Surface Winds

- WIND_GLO_WIND_L4_REP_OBSERVATIONS_012_006
- WIND_GLO_WIND_L4_NRT_OBSERVATIONS_012_004
- RSS_CCMP_WINDS_V2.1

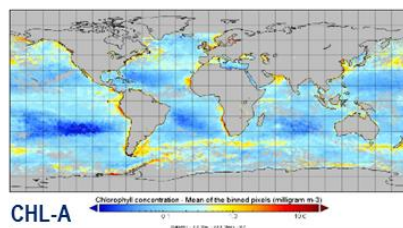
(CERSAT/IFREMER - CMEMS)
(CERSAT/IFREMER - CMEMS)
(NASA/Measures – RSS)



Ocean Surface Topography

- SEALEVEL_GLO_PHY_L4_NRT_OBSERVATIONS_008_046
- SEALEVEL_GLO_PHY_L4_MY_008_047
- SEA_SURFACE_HEIGHT_ALT_GRIDS_L4_2SATS_5DAY_6THDEG_V_JPL1812
- NOAA_LSA_SLA_GLOB_L4_NRT and DT

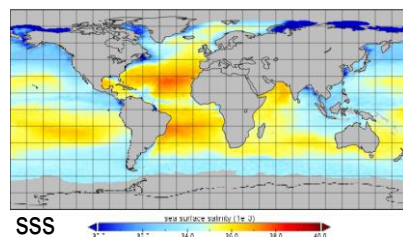
(AVISO/CLS - CMEMS)
(AVISO/CLS - CMEMS)
(NASA/Measures - JPL)
(NOAA/LSA)



Ocean Color

- JPL-MRVA25-CHL-L4-GLOB-v3.0
- OCEANCOLOUR_GLO_CHL_L4_REP_OBSERVATIONS_009_082
- OCEANCOLOUR_GLO_CHL_L4_NRT_OBSERVATIONS_009_033
- NOAA_MSL12-NRT-CHL-Daily-L4 and DT

(NASA/COVERAGE -JPL)
(Globcolour – CMEMS)
(Globcolour – CMEMS)
(NOAA/Coastwatch)



Sea Surface Salinity

- OISSS_L4_multimission_7day_v1
- OISSS_L4_multimission_Monthly_v1 (incl. SSS-anomaly field)
- CCI_OISSS_L4_multimission_Weekly_v3.21
- CCI_OISSS_L4_multimission_Monthly_v3.21

(NASA/SCP – IPRC-SOEST, RSS)
(NASA/SCP – IPRC-SOEST, RSS)
(ESA/CCI – ESA CCI, CEDA-NERC)
(NASA/SCP –ESA CCI, CEDA-NERC)



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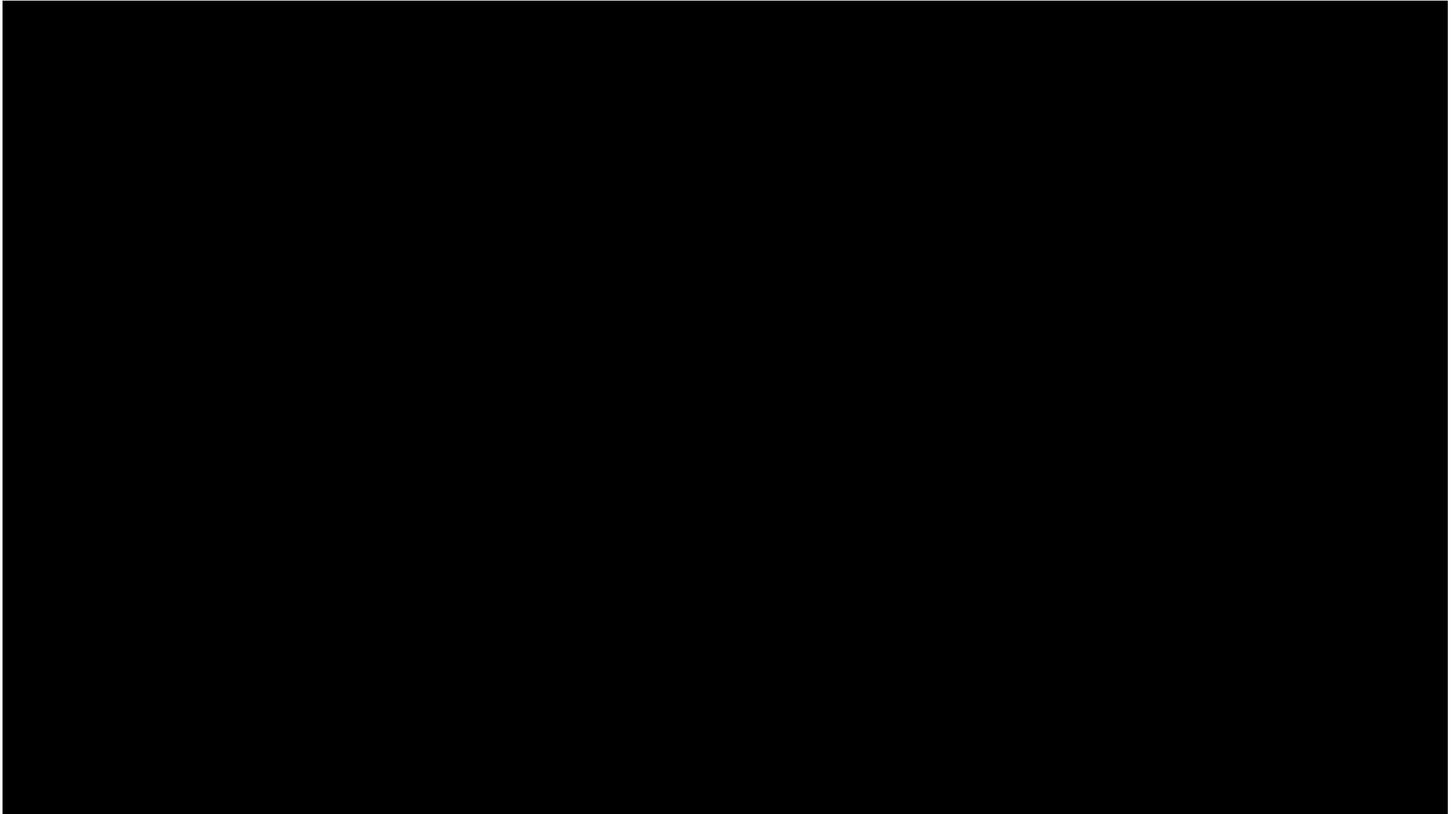
Level 4 multi-mission SSH/A Products in COVERAGE

Includes complete series of key Near Real-time, Delayed mode/Reanalysis products from different agencies

[Video Link](#)

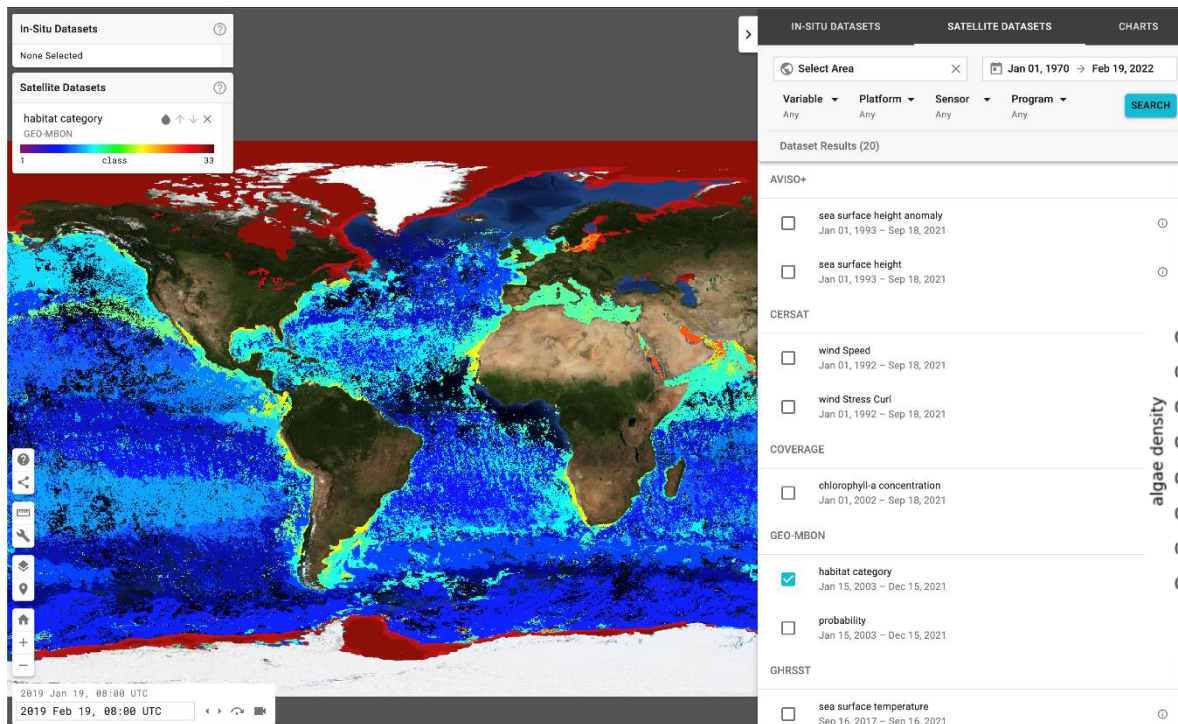


<https://coverage.ceos.org>



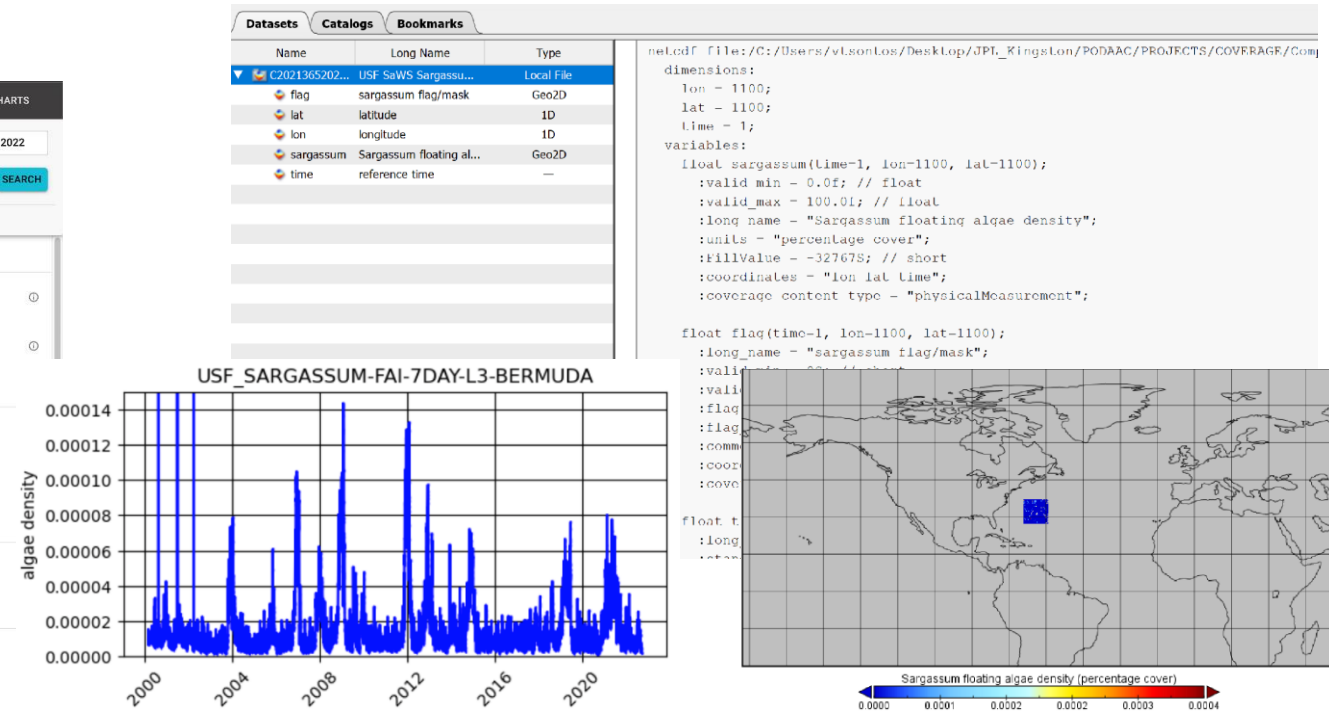
Inclusion of select Value-added dataset in support of Biodiversity & regional applications

GEO-MBON “SeaScapes” marine habitat classification monthly product integrated in COVERAGE Viewer



- Served via NOAA-Coastwatch THREDDS
- Developed by M. Kavanaugh (OSE)

USF Optical Oceanography Lab Sargassum Floating Algal Index Product



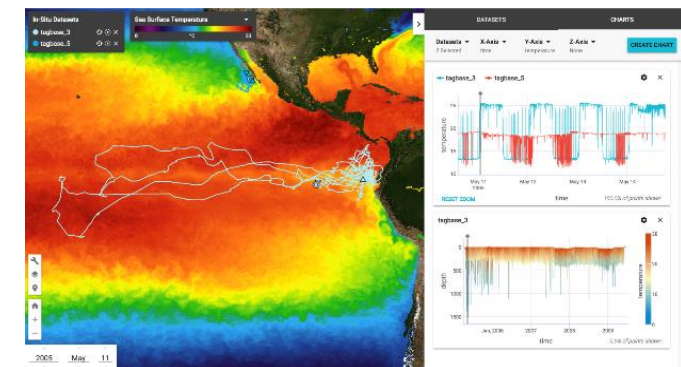
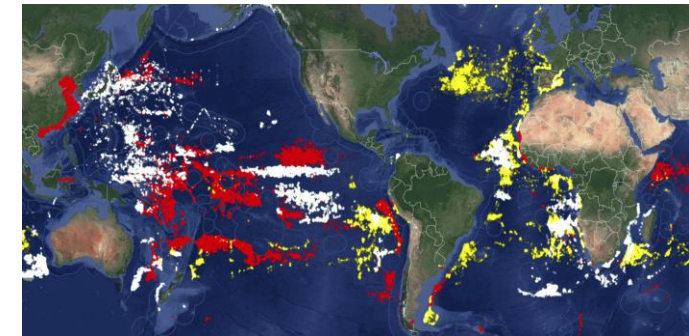
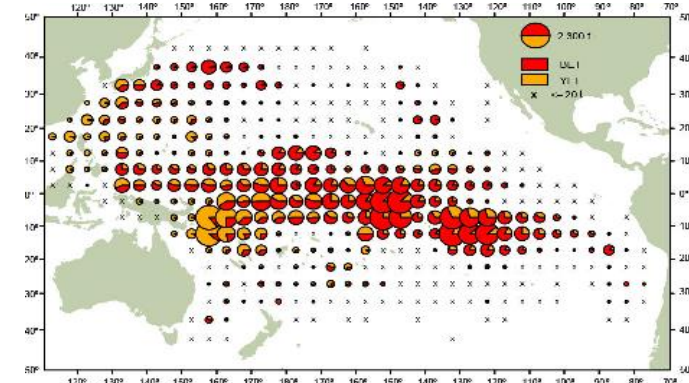
- Developed by Chuanmin Hu (USF)
- Available via USF Satellite-based Sargassum Watch System (SaWS) as PNG imagery for several regions, including Bermuda
- COVERAGE-USF collaborated to develop a netCDF-CF compliant dataset now integrated and served by COVERAGE
- Time-series analytics via SDAP

COVERAGE generalized in-situ capability for oceanographic applications

- COVERAGE services can support full suite of in-situ spatial geometry data types (point, profile trajectory series)
- Demonstrated support for collection of NASA SPURS field campaign data

Fisheries Data Integrated into COVERAGE

- High seas monthly **spatial catch/effort time series by species**, aggregated spatially at 1 & 5 deg. spatial resolution, 1952-2018 from the 4 Tuna RFMOs
- **Electronic tagging datasets**: high resolution trajectory-profile series
- **AIS fishing vessel movement data** (daily, since 2012 from *Global Fishing Watch*)



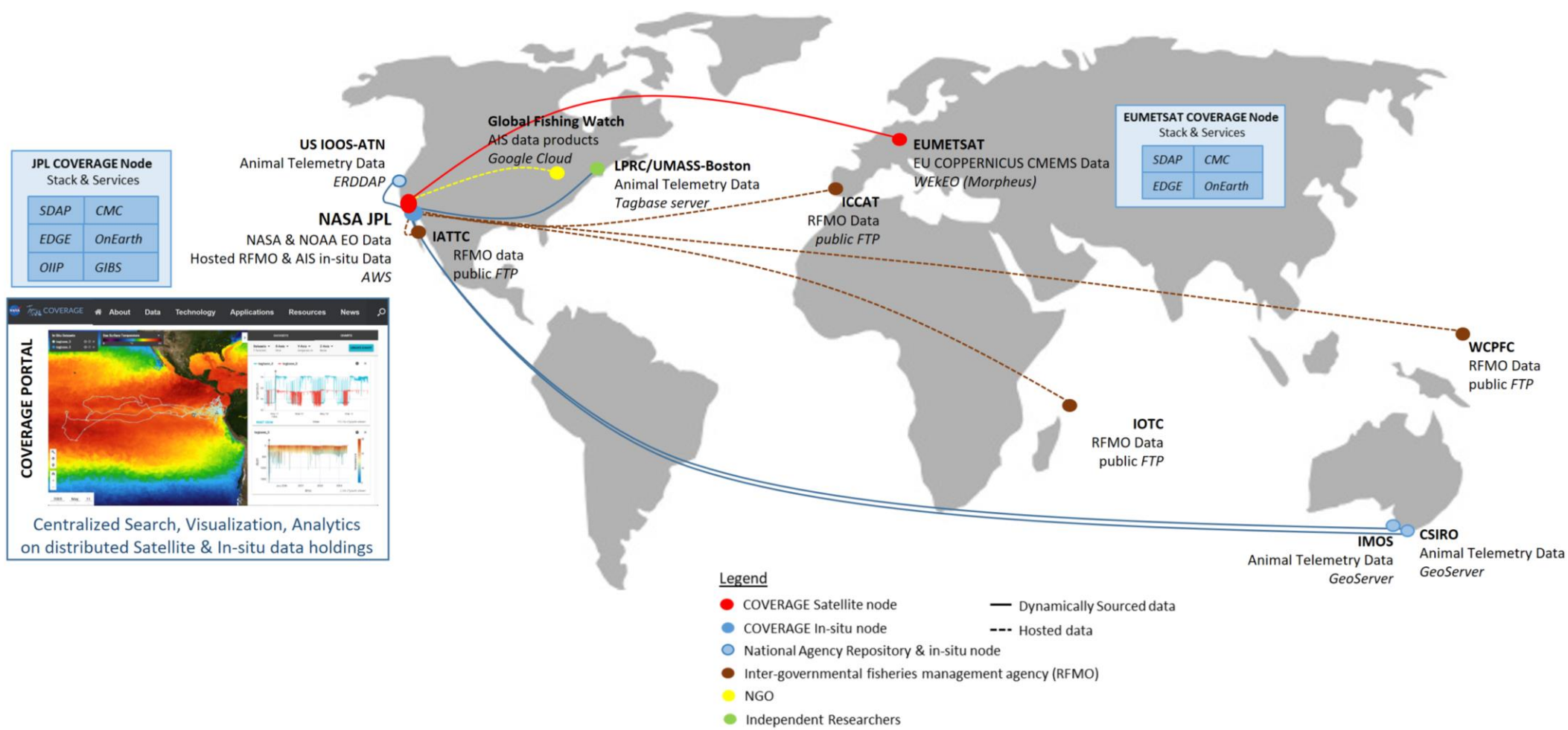


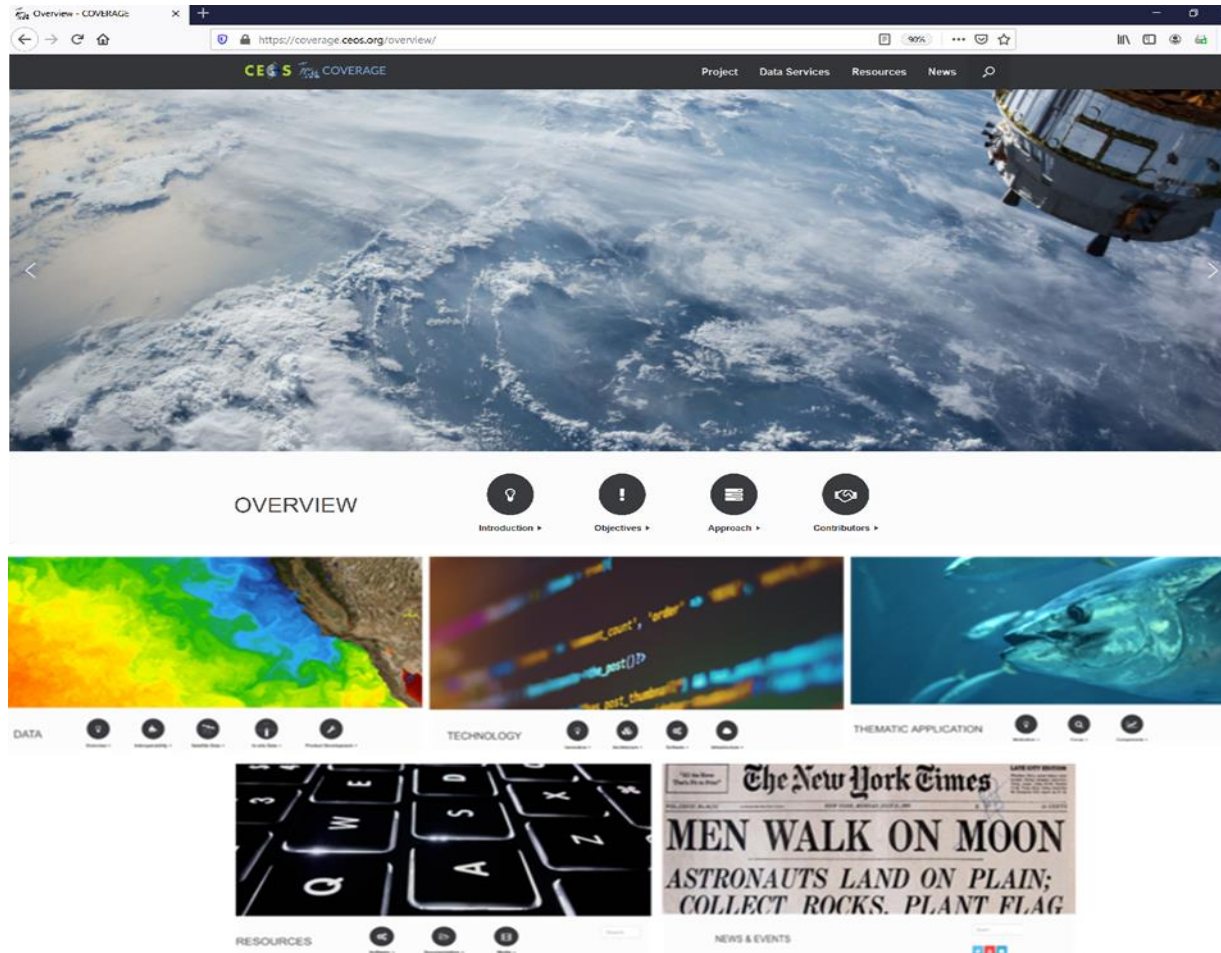
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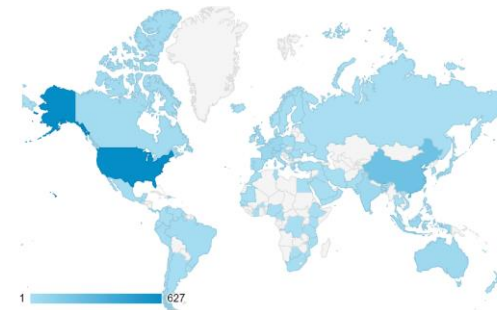
System Architecture & Data Services

- Cloud nodes on NASA/AWS & EUMETSAT/WEkEO hosting COVERAGE software stack and serving US and European/CMEMS EO datasets respectively
- Interfaces to GOOS regional Ocean Observing System elements serving in-situ data (e.g. IMOS-Australia, IOOS-US)
- Integration of fisheries-related data (AIS, Animal telemetry, RFMO Catch/Effort series)

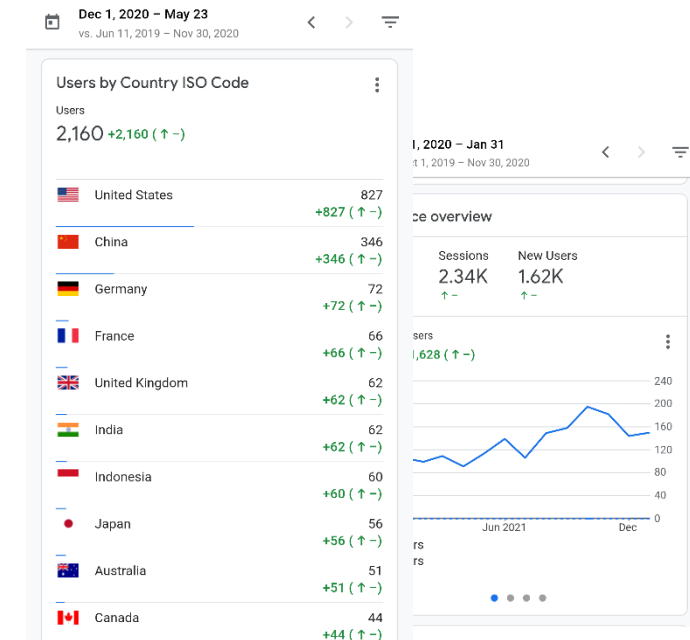


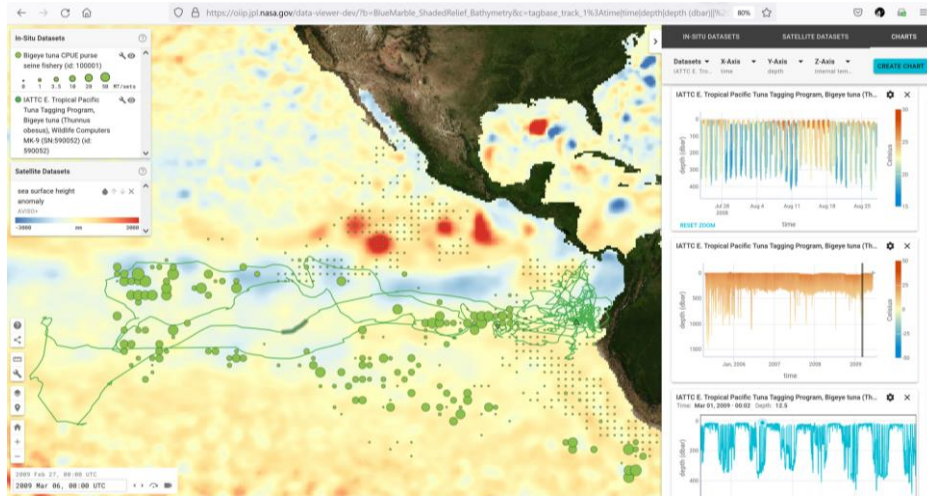


- Descriptive information on COVERAGE Initiative & Project
- Integrates Data services/tools
- Resources Area: project technical documentation, tutorial videos
- News Area: events & announcements
- Integrated COVERAGE You-Tube channel & Twitter feed
- Detailed site usage metrics via Google Analytics integration

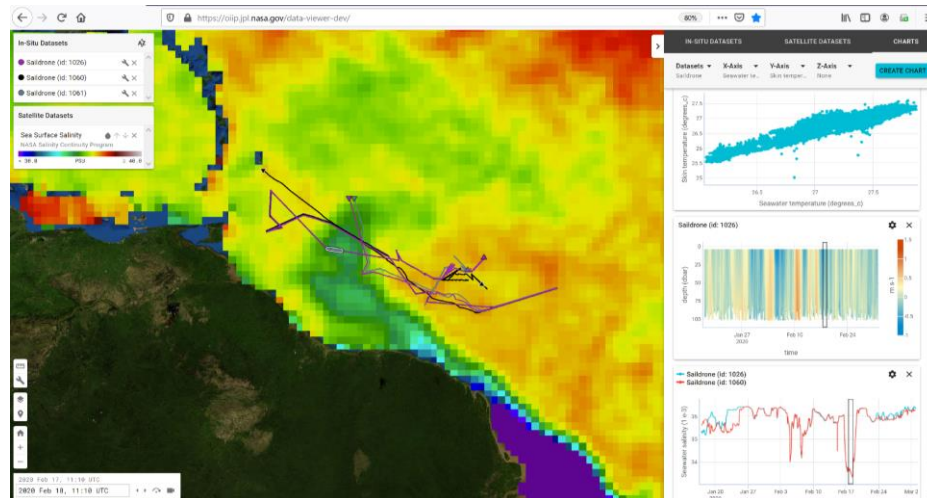


*Visitors from 94
Countries*



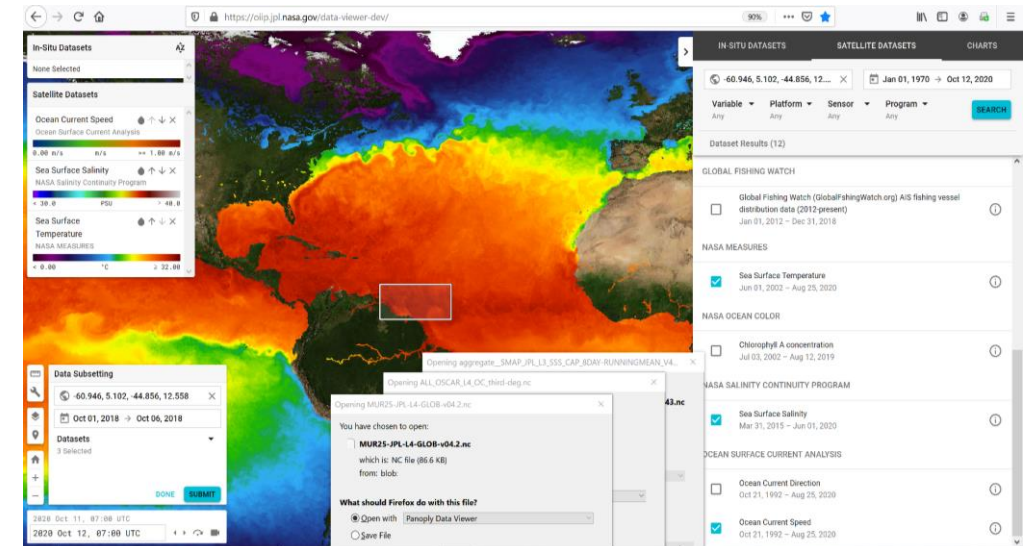


IATTC Bigeye Tuna archival tag & spatial catch distribution data relative to AVISO-SSHA and animal telemetry environmental measurements



Sairdron ATOMIC cruise ADCP and CTD data overlaid on Sea Surface Salinity data from SMAP

- Integrated visualization of satellite & in-situ data (generalized capability)
- Synchronized horizontal and vertical views of data and their evolution over time (custom time step intervals)
- Integrated dataset Search & Filtering
- “One-stop” Data Subsetting capability (satellite & in-situ)
- Online Help and [User Guide](#) documentation
- Sharable Links: captures all map & charting view settings
- Open Source: [JPL Common Mapping Client](#)
- Backend Imagery services: JPL OnEarth & NASA-GIBS WMTS, TDS-WMS
- What’s Next: Analytics API integration (eg. matchup operations)



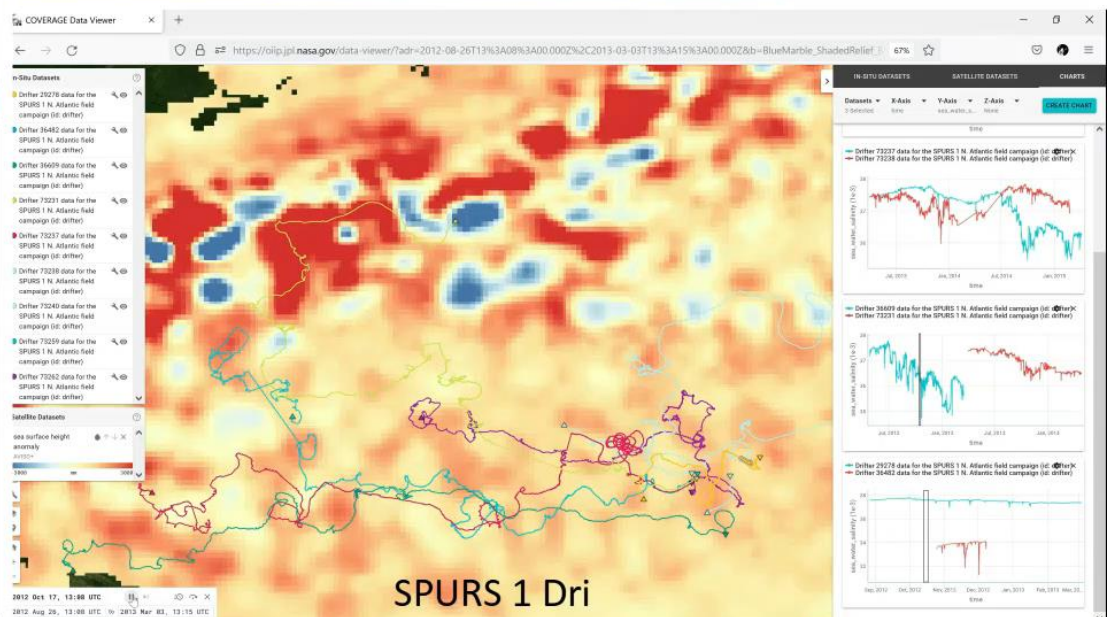
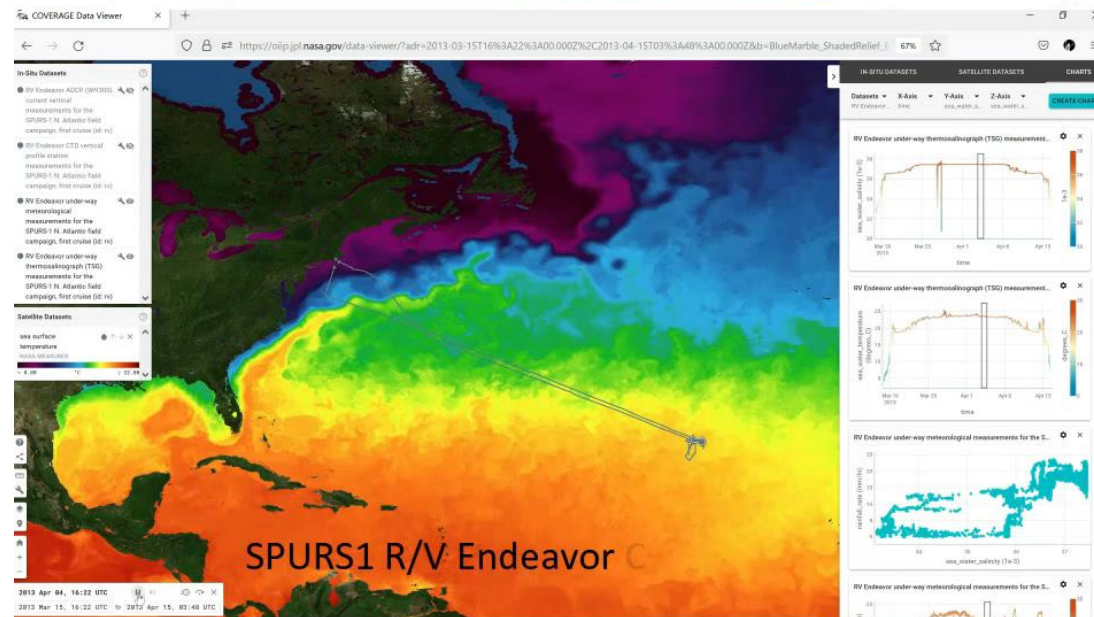
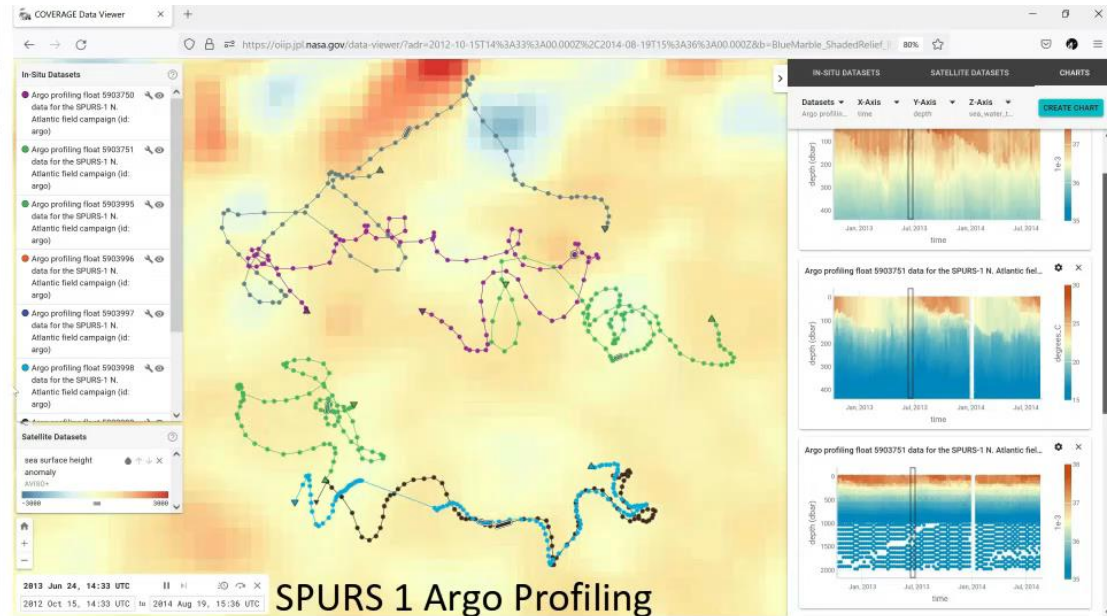
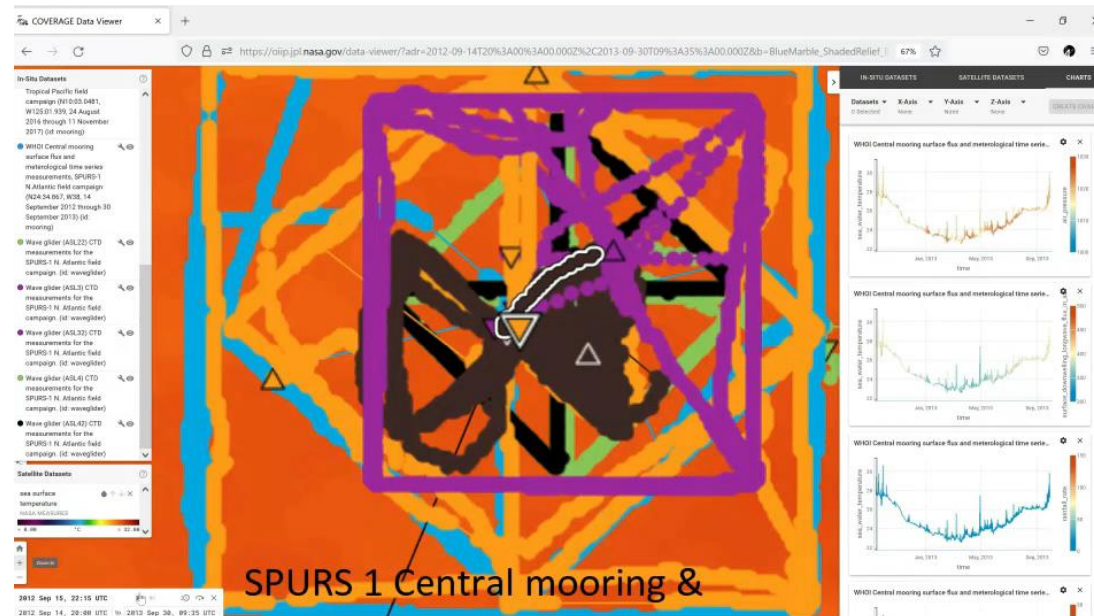
Integrated Data Search & Subsetting

Web-based Data Visualization Demonstration (1)

SPURS Oceanographic Field Campaign Data in relation to Satellite Fields

[Video Link](#)

SPURS Central Mooring, Glider & MUR-SST data (top left)
ARGO profiling float data on AVISO-SSHA, SPURS1 domain (top right)
R/V Endeavor thermosalinograph on SST data, SPURS1 cruise (bottom left)
Drifter surface data on AVISO-SSHA during SPURS1 campaign (bottom right)



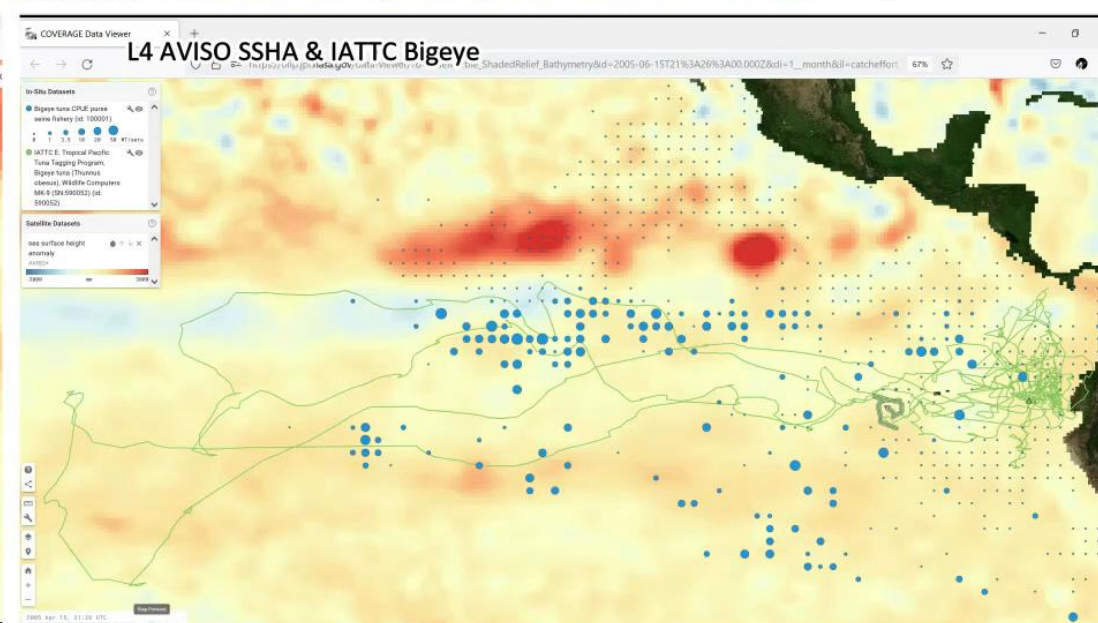
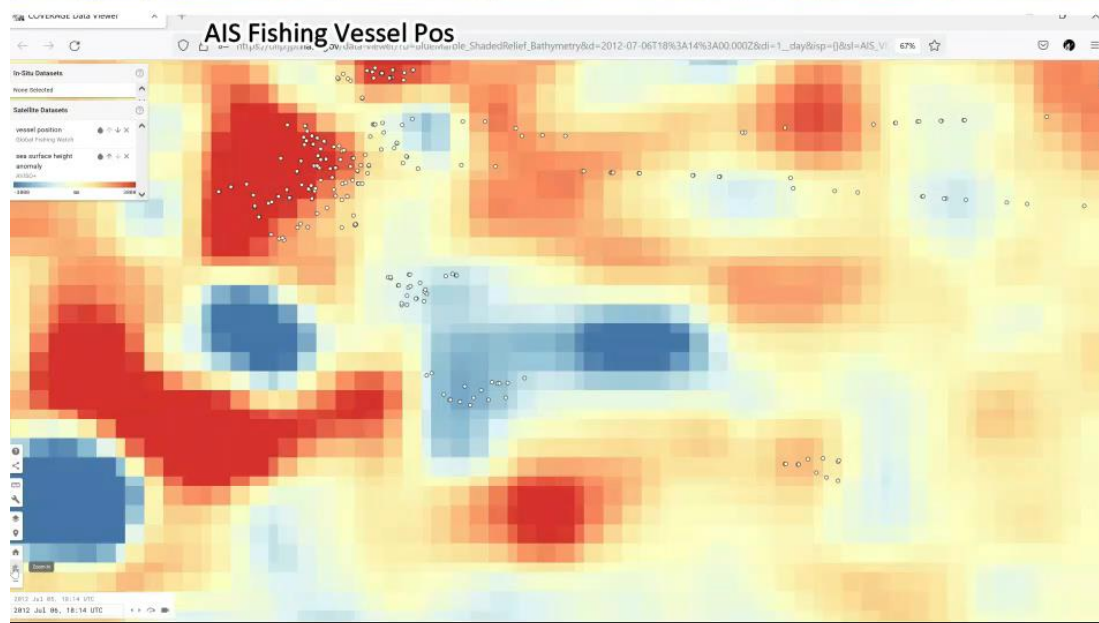
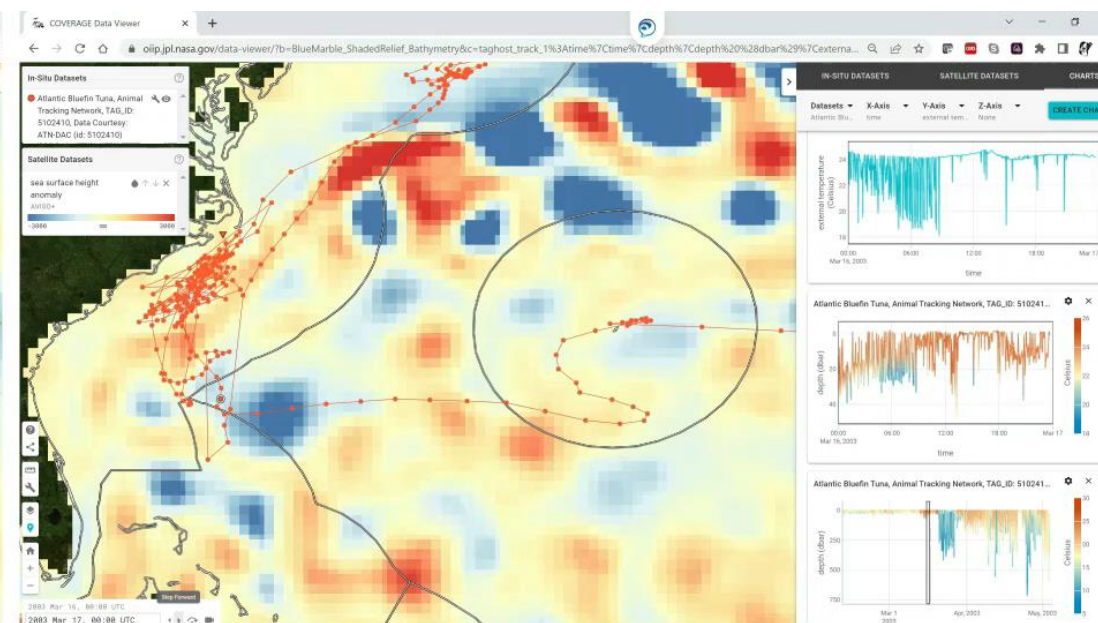
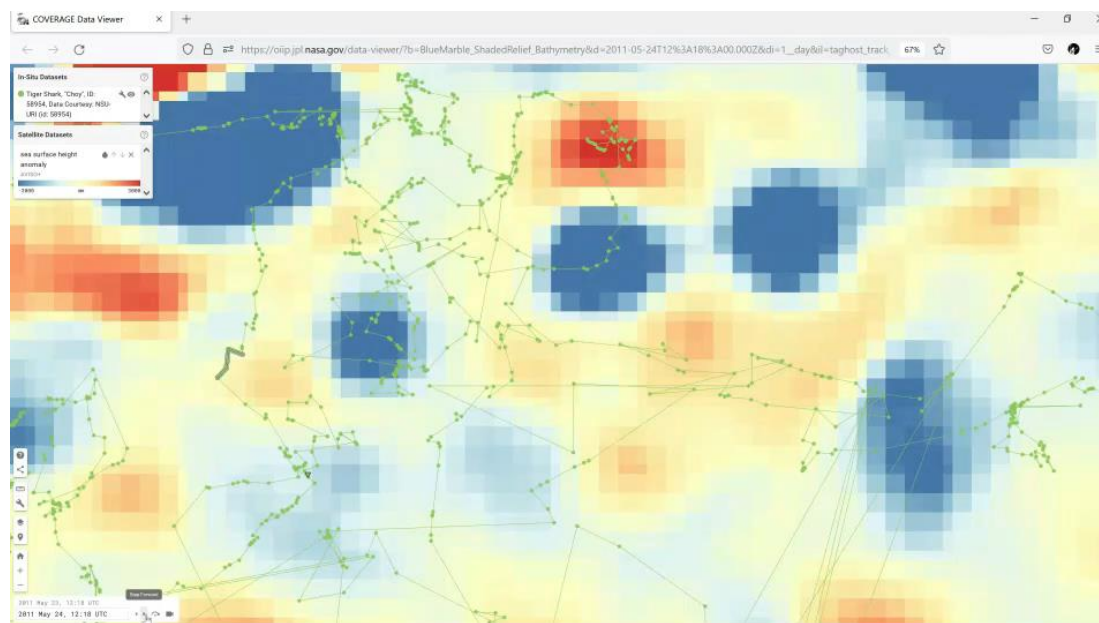


Web-based Data Visualization Demonstration (2)

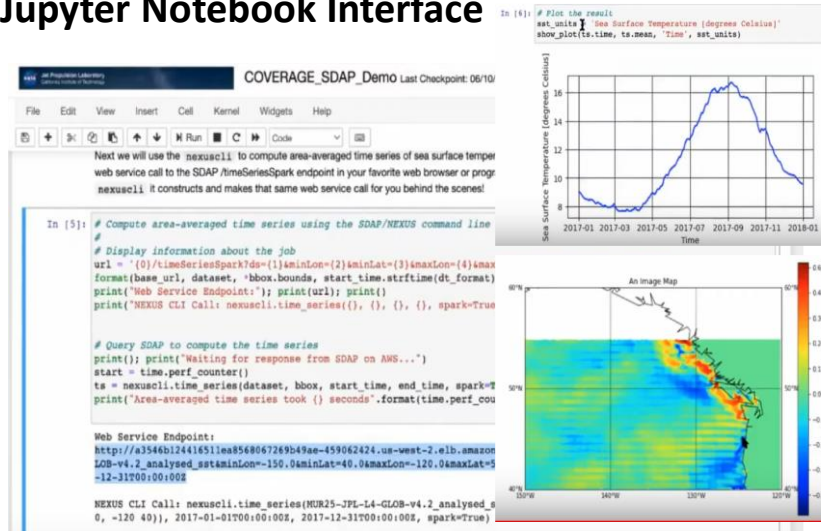
Eddy-field boundaries as Migratory Corridors & Biological/Fishery Hot spots

[Video Link](#)

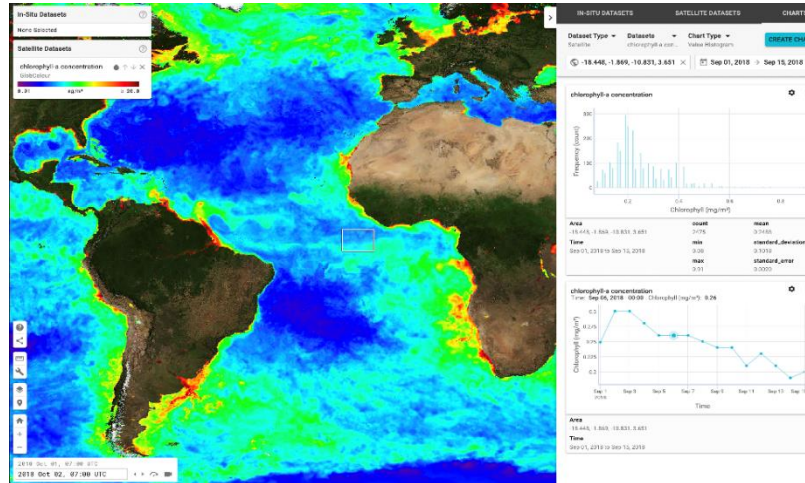
Tiger shark movements from SPOT tags on SSHA, Sargasso (top left)
Atlantic Bluefin Tuna archival tag data on SSHA, Sargasso (top right)
AIS fishing vessel movement data on SSHA, Sargasso (bottom left)
Bigeye tuna tag & monthly Catch/Effort on SSHA, E. Pacific (bottom right)



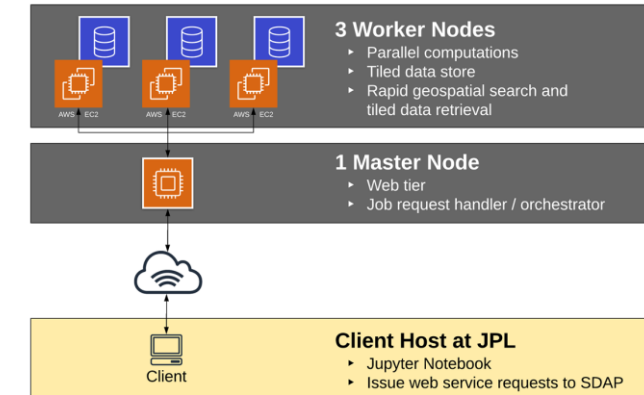
Jupyter Notebook Interface



Data Viewer Interface



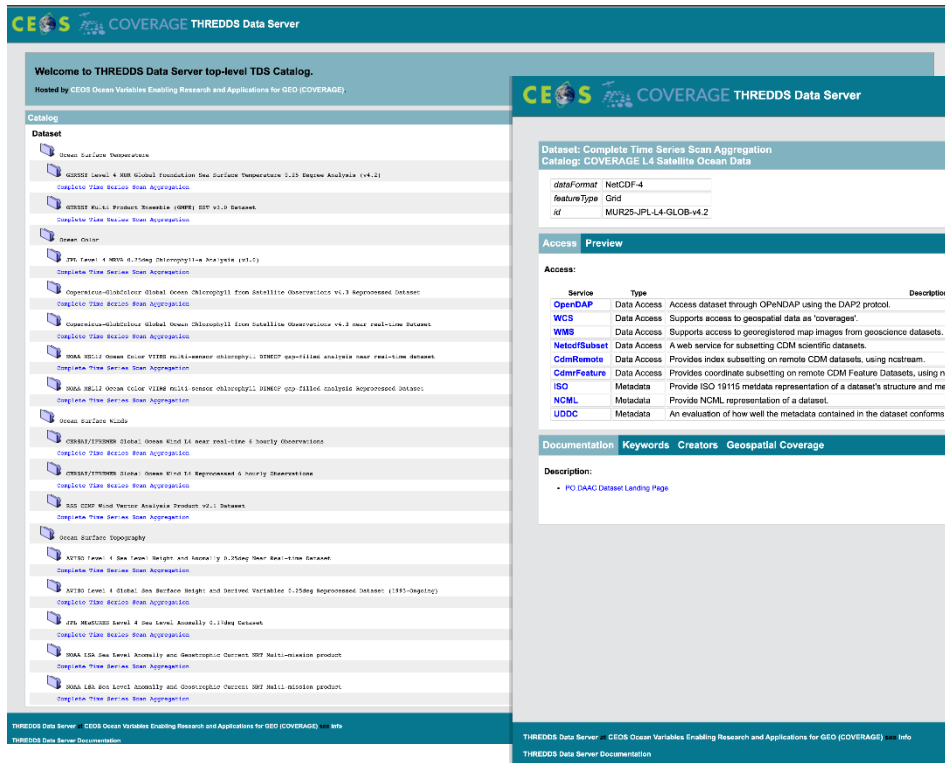
SDAP WEkEO Deployment Instance



- Science Data Analytics Platform (SDAP)
- Component of NASA/ESTO-AIST “Analytics Center Framework (ACF)
- Open Source : <http://sdap.apache.org>
- “Enabling Big Data Science Without Download”
- Range of built in parallel computing functions for satellite & model data
- Satellite-in situ collocation capability under development by NASA/ACCESS Cloud-based Data Matchup Service (CDMS) project

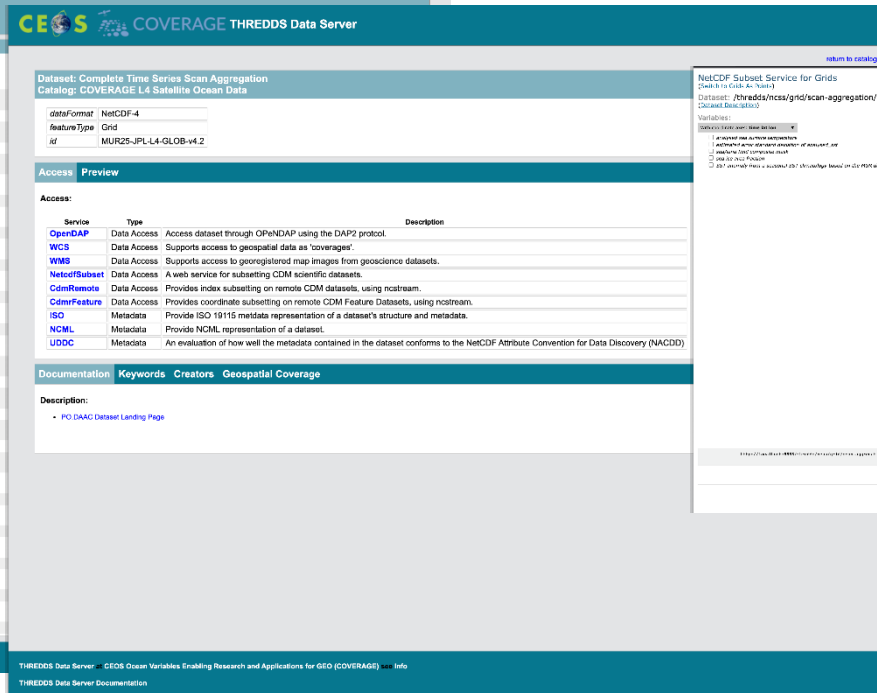
- Cloud Deployments:
AWS (JPL) & WEkEO (EUMETSAT)
- Interfaces:
Jupyter notebooks, Data Viewer & APIs

COVERAGE TDS Satellite Data Catalog



COVERAGE TDS Satellite Data Catalog interface showing a list of datasets under the heading "Dataset". The datasets include Ocean Surface Temperature, Sea Level, and Ocean Surface Height, each with a "Complete View" link. The interface also includes a "Catalog" section and a "Welcome to THREDDS Data Server" message.

TDS Services

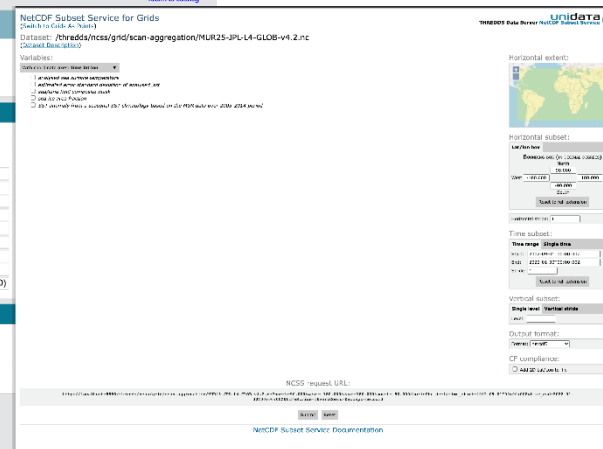


COVERAGE TDS Services interface showing a "Dataset: Complete Time Series Scan Aggregation" and a "Catalog: COVERAGE L4 Satellite Ocean Data". The interface includes a "dataFormat" dropdown set to "NetCDF-4", a "featureType" dropdown set to "Grid", and a "id" field set to "MUR25-JPL-L4-GLOB-v4.2". Below this is a table of access services:

Service	Type	Description
OpenDAP	Data Access	Access dataset through OpenDAP using the DAP2 protocol.
WCS	Data Access	Supports access to geospatial data as "coverages".
WMS	Data Access	Supports access to georegistered map images from geoscientific datasets.
NetcdfSubset	Data Access	A web service for subsetting CDM scientific datasets.
CdmRemote	Data Access	Provides index subsetting on remote CDM datasets, using ncstream.
CdmFeature	Data Access	Provides coordinate subsetting on remote CDM Feature Datasets, using ncstream.
ISO	Metadata	Provide ISO 19115 metadata representation of a dataset's structure and metadata.
NCML	Metadata	Provide NCML representation of a dataset.
UDDC	Metadata	An evaluation of how well the metadata contained in the dataset conforms to the NetCDF Attribute Convention for Data Discovery (NACDD).

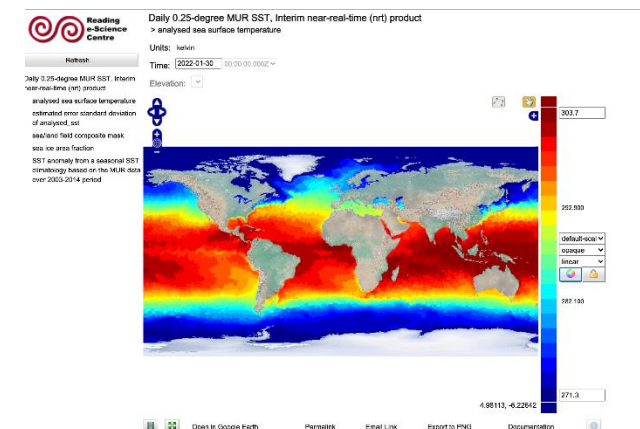
The interface also includes a "Documentation" section with links to "Keywords", "Creators", and "Geospatial Coverage".

nccs GUI



nccs GUI interface showing a "NetCDF Subset Service for Grids" and a "Dataset: /thredds/nccs/grid/scan-aggregation/MUR25-JPL-L4-GLOB-v4.2.nc". The interface includes a "Variables" section with a list of variables and a "Horizontal extent" section with a map showing the spatial extent of the dataset. The interface also includes a "Time range" section with a date range selector and a "Vertical extent" section with a depth range selector.

WMS GUI



WMS GUI interface showing a "Daily 0.25-degree MUR SST, Interim near-real-time (nrt) product" and a "analysed sea surface temperature" map. The interface includes a "Refresh" button, a "Time" selector set to "2022-01-01", and a "Elevation" dropdown set to "0". The map shows a global view of the sea surface temperature with a color scale ranging from 271.3 to 303.7.

- Powered by THREDDS v5 in the Cloud
- Deployed on both COVERAGE AWS and WEkEO nodes
- TDS catalogs accessing COVERAGE dataset granule repositories natively in S3 object stores
- Supported TDS services/APIs: nccs (subsetting/download), opendap, WMS, WCS, ISO metadata, and CDM remote (*new*)



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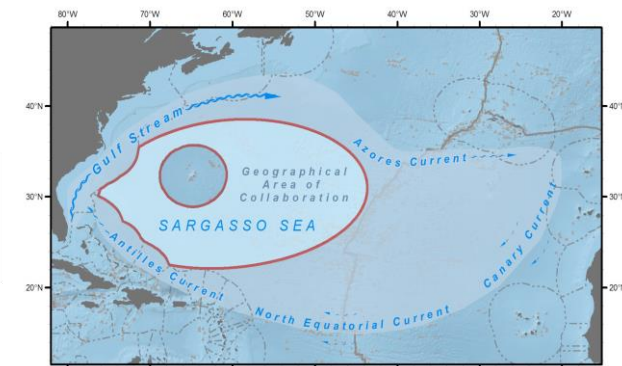
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Support for Key Stakeholders Applications



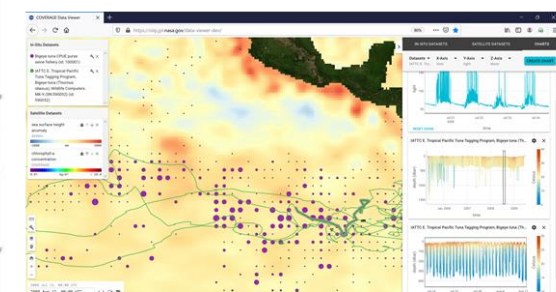
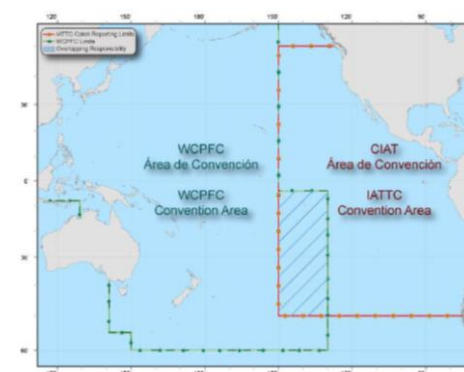
Sargasso Sea Commission (SSC)

- Promote stewardship of the Sargasso ecosystem via work program & action plan development for this high seas area
- Global Environmental Facility (GEF) funded project (UN IOC & UN FAO oversight)
- Ecosystem Diagnostic Analysis (EDA), identifying trends and impacts from available environmental, biological and socio-economic data
- Development of an ecosystem-based stewardship approach for the Sargasso Sea, including framework for MPA designation
- COVERAGE providing integrative data system



Inter-American Tropical Tuna Commission (IATTC)

- 21 Nation Intergovernmental Regional Fisheries Management Organization (RFMO)
- Responsible for the scientific assessment and management of Tuna and large pelagic fisheries in the E. Tropical Pacific (ETP)
- Potential applications of remote sensing data to support fisheries Dynamic Ocean Management, habitat analyses, Spatial catch forecast, By-catch mitigation, Fishery closed area designation
- IATTC-COVERAGE regional spin-off application



IATTC Bigeye Tuna archival tag & spatial catch distribution data relative to AVISO-SSHA and animal telemetry environmental measurements



- A reusable, Cloud-enabled software platform with core capabilities & data has been assembled, capable of supporting interdisciplinary marine applications. This can be extended/customized to support specific application use cases.
- COVERAGE leverages & showcases several key interagency satellite datasets spanning the CEOS Ocean VCs, including for Altimetry, and is well positioned to include SWOT gridded (L3/L4) products once available.
- The integration of complementary, higher resolution Altimetry data from SWOT, capable of resolving sub-mesoscale oceanographic features, would be highly desirable for marine Biodiversity/Fisheries applications.
- COVERAGE is partnering with 2 Intergovernmental agencies (SSC and IATTC) to advance emerging ecosystem-based management approaches that include remotely sensed environmental data in assessment frameworks.