

COVERAGE

CEOS Ocean Variables Enabling
Research & Applications for GEO

An Platform to Simplify and Expand the Accessibility and Usage of
Inter-agency Satellite and in-situ Oceanographic Data

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ESA Living Planet Symposium

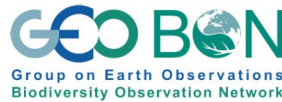
23-27 May, 2022

Drivers

- Imperative to better marshal available Earth observations of different types in support of interdisciplinary ocean science and marine applications for societal benefit.
- Better realize potential of EO data in supporting new & under-served user communities by addressing key technical constraints to access (product selection, usage mechanics)
- Need for value-added services augmenting existing EO data infrastructures providing enhanced access to diverse observations for the oceans to promote their more integrated and efficient usage.
- Open source, reusable, cloud-enabled software toolkit that can be easily spun up and scaled up to support different thematic applications quickly

Key Challenges

- Heterogeneity of data types and data access/delivery mechanisms
- Data interoperability considerations (particularly acute for in-situ & Biological data)



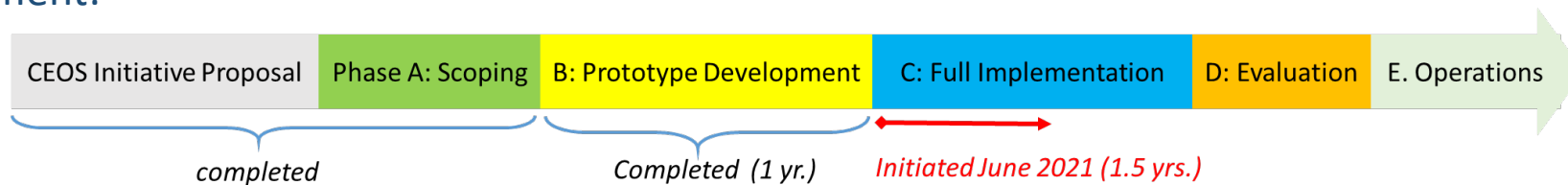
CEOS Initiative: Cross-cutting, collaborative effort involving CEOS Ocean Virtual Constellations, GEO-MBON & GEO-Blue Planet

Goals

- 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 0.25 deg. resolution as a baseline dataset, with a focus on supporting higher resolution dataset next.
- Demonstrates utility of the system in the context of a pilot thematic Ecosystem application: *“High-seas Fisheries & Biodiversity in relation to the Environment”*

Approach

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

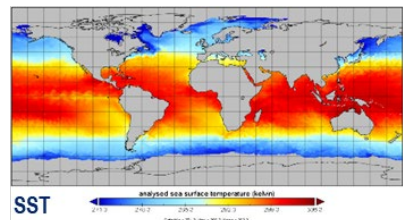




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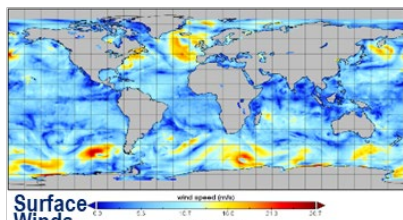
Constituent Data



High value, fit-for-purpose L4 NRT and Historical/Delayed mode Baseline Datasets included

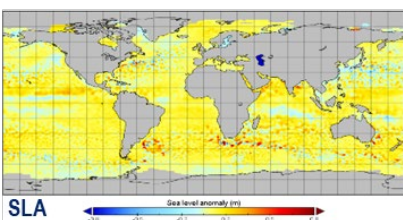
SST

- METOFFICE-GLO-SST-L4-NRT-OBS-GMPE-V3 (GHRSSST-CMEMS/UK Met.Office)
- MUR25-JPL-L4-GLOB-v4.2 (GHRSSST- NASA/Measures)



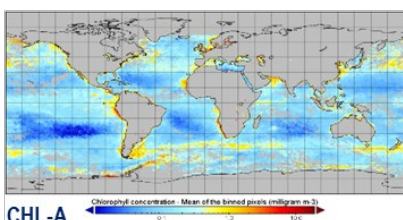
Ocean Surface Topography

- SEALEVEL_GLO_PHY_L4_NRT_OBSERVATIONS_008_046 (AVISO/CLS - CMEMS)
- SEALEVEL_GLO_PHY_L4_MY_008_047 (AVISO/CLS - CMEMS)
- SEA_SURFACE_HEIGHT_ALT_GRIDS_L4_2SATS_5DAY_6THDEG_V_JPL1812 (NASA/Measures - JPL)
- NOAA_LSA_SLA_GLOB_L4_NRT and DT (NOAA/LSA)



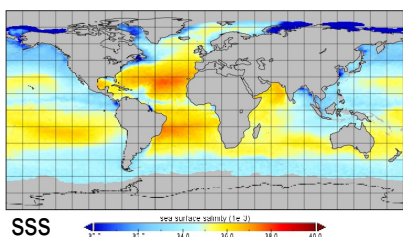
Ocean Color

- JPL-MRVA25-CHL-L4-GLOB-v3.0 (NASA/COVERAGE -JPL)
- OCEANCOLOUR_GLO_CHL_L4_REP_OBSERVATIONS_009_082 (Globcolour – CMEMS)
- OCEANCOLOUR_GLO_CHL_L4_NRT_OBSERVATIONS_009_033 (Globcolour – CMEMS)
- NOAA_MSL12-NRT-CHL-Daily-L4 and DT (NOAA/Coastwatch)



Winds

- WIND_GLO_WIND_L4_REP_OBSERVATIONS_012_006 (CERSAT/IFREMER - CMEMS)
- WIND_GLO_WIND_L4_NRT_OBSERVATIONS_012_004 (CERSAT/IFREMER - CMEMS)
- RSS_CCMP_WINDS_V2.1 (NASA/Measures – RSS)



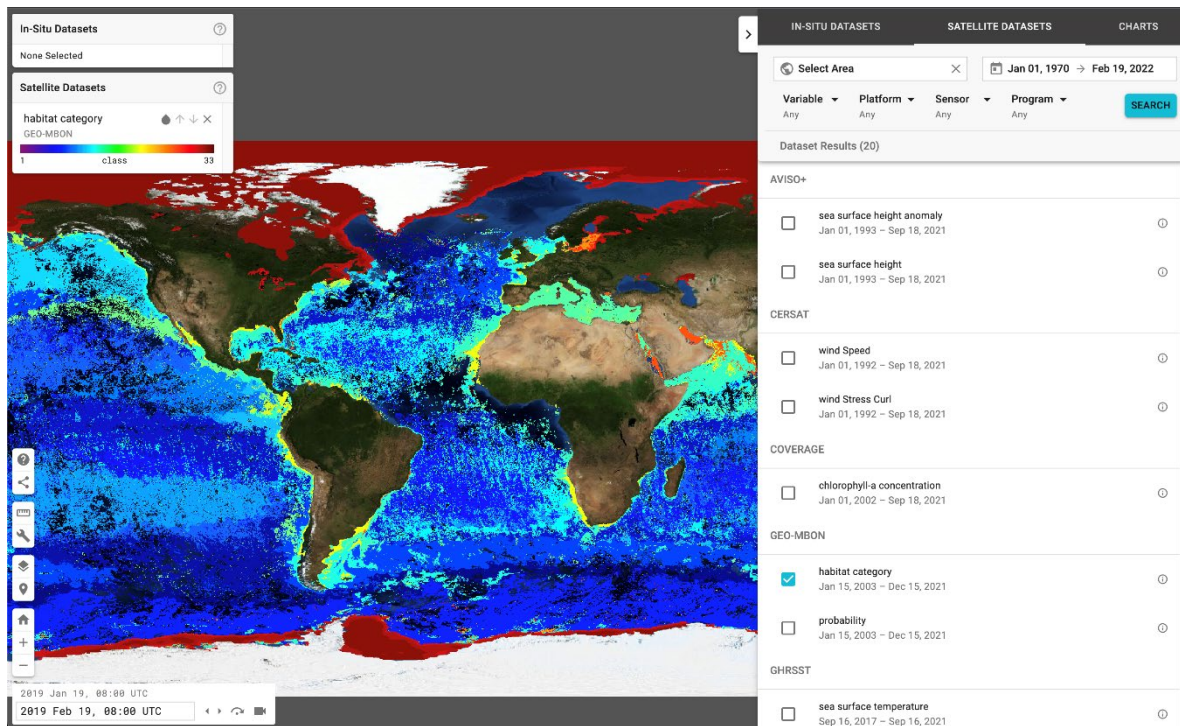
Sea Surface Salinity

- OISSS_L4_multimission_7day_v1 (NASA/SCP – IPRC-SOEST, RSS)
- OISSS_L4_multimission_Monthly_v1 (incl. SSS-anomaly field) (NASA/SCP – IPRC-SOEST, RSS)

In Phase-C, will target select high resolution products and certain value-added datasets relevant to regional spinoff applications

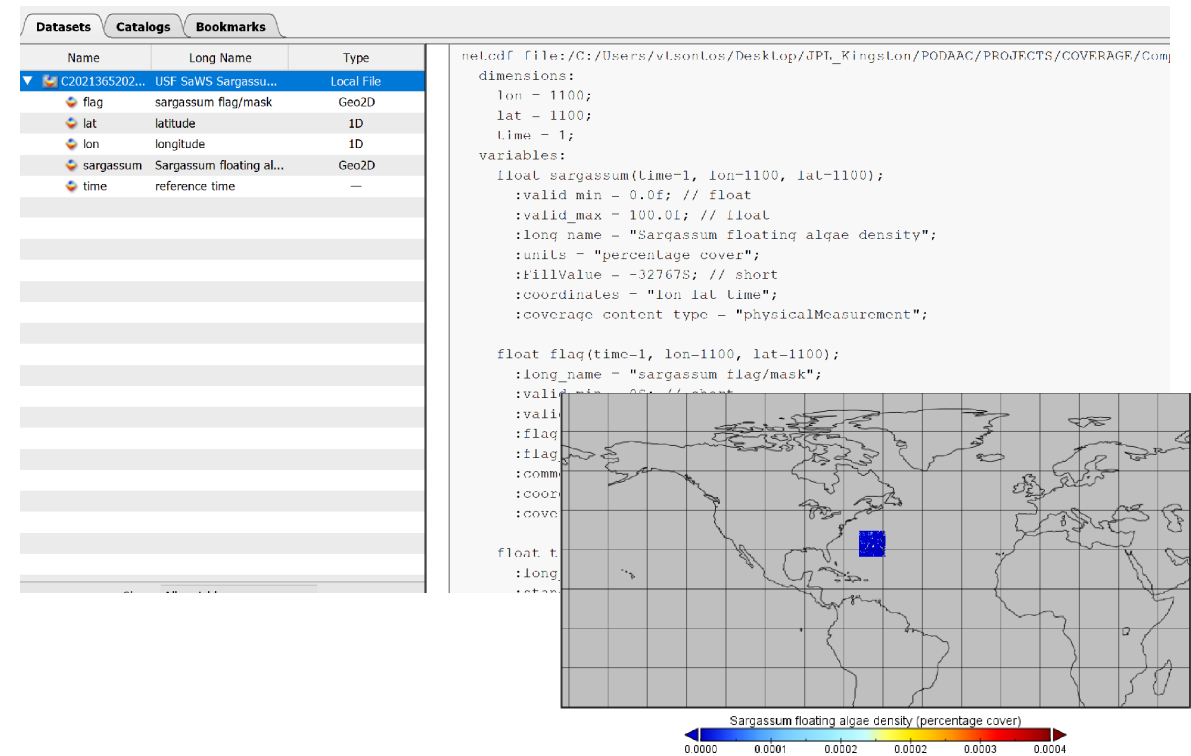
Inclusion of select Value-added dataset in support of Biodiversity & regional applications

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

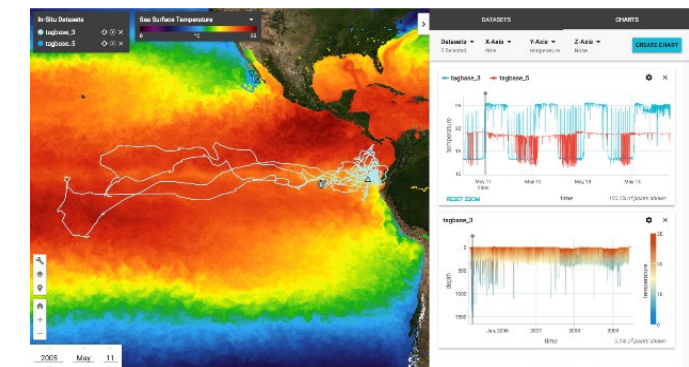
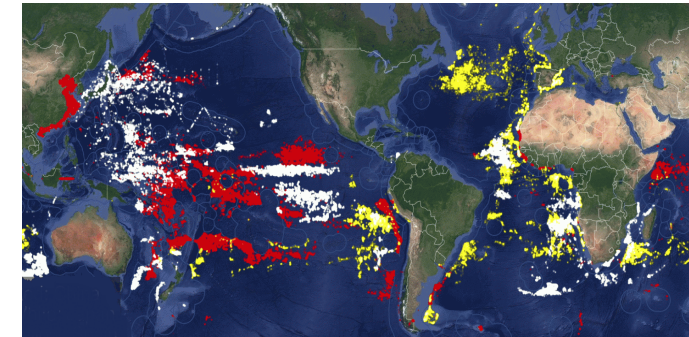
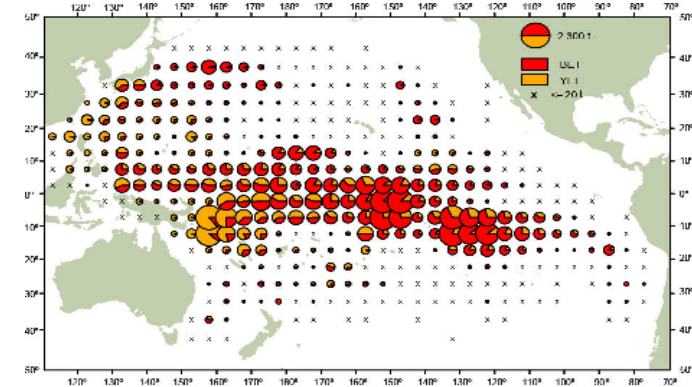
“Satellite Data in Support of Biodiversity & Fisheries Ecosystem Applications”

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 products by category (daily, since 2012 from *Global Fishing Watch*)

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 Saildrone, IOOS-glider, USGS estuarine station series, and range of NASA SPURS field campaign datasets

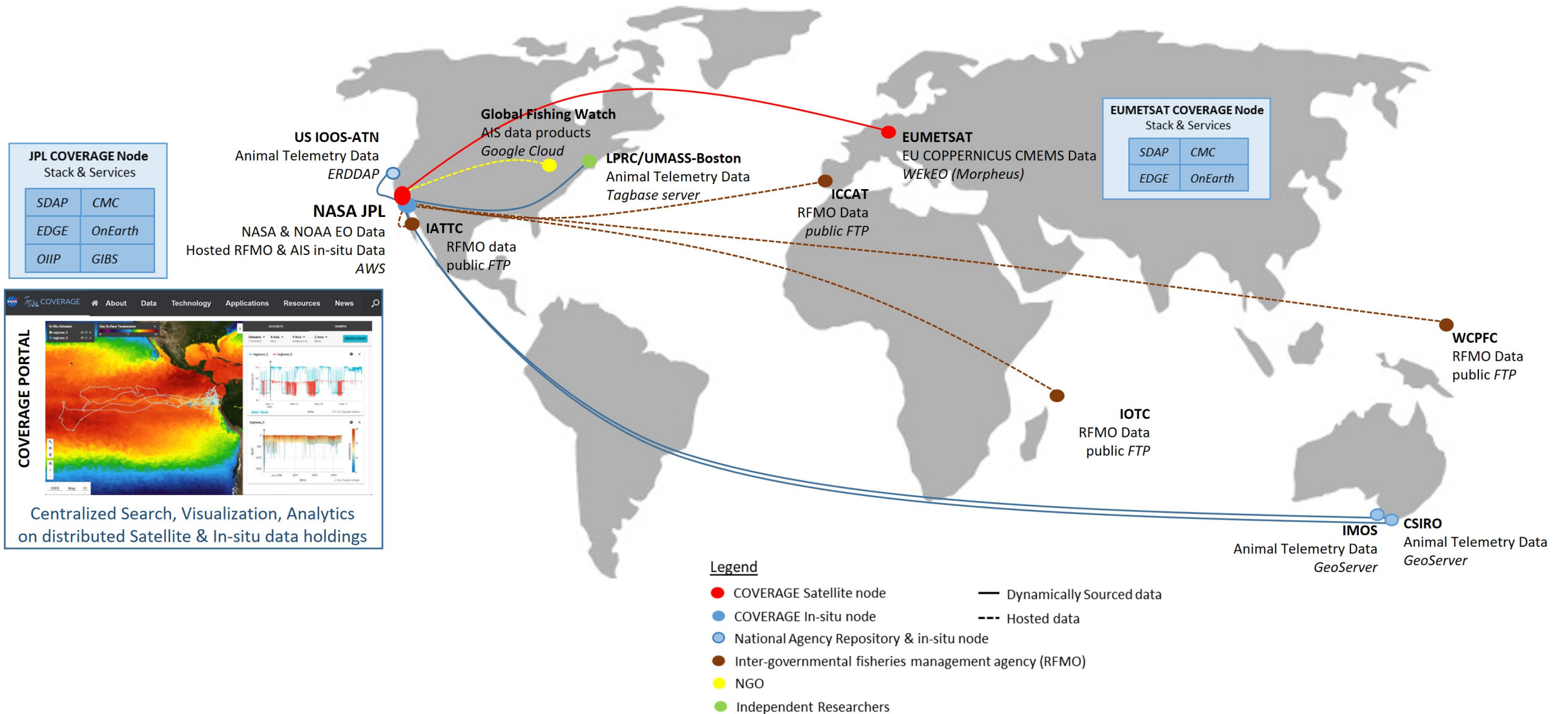


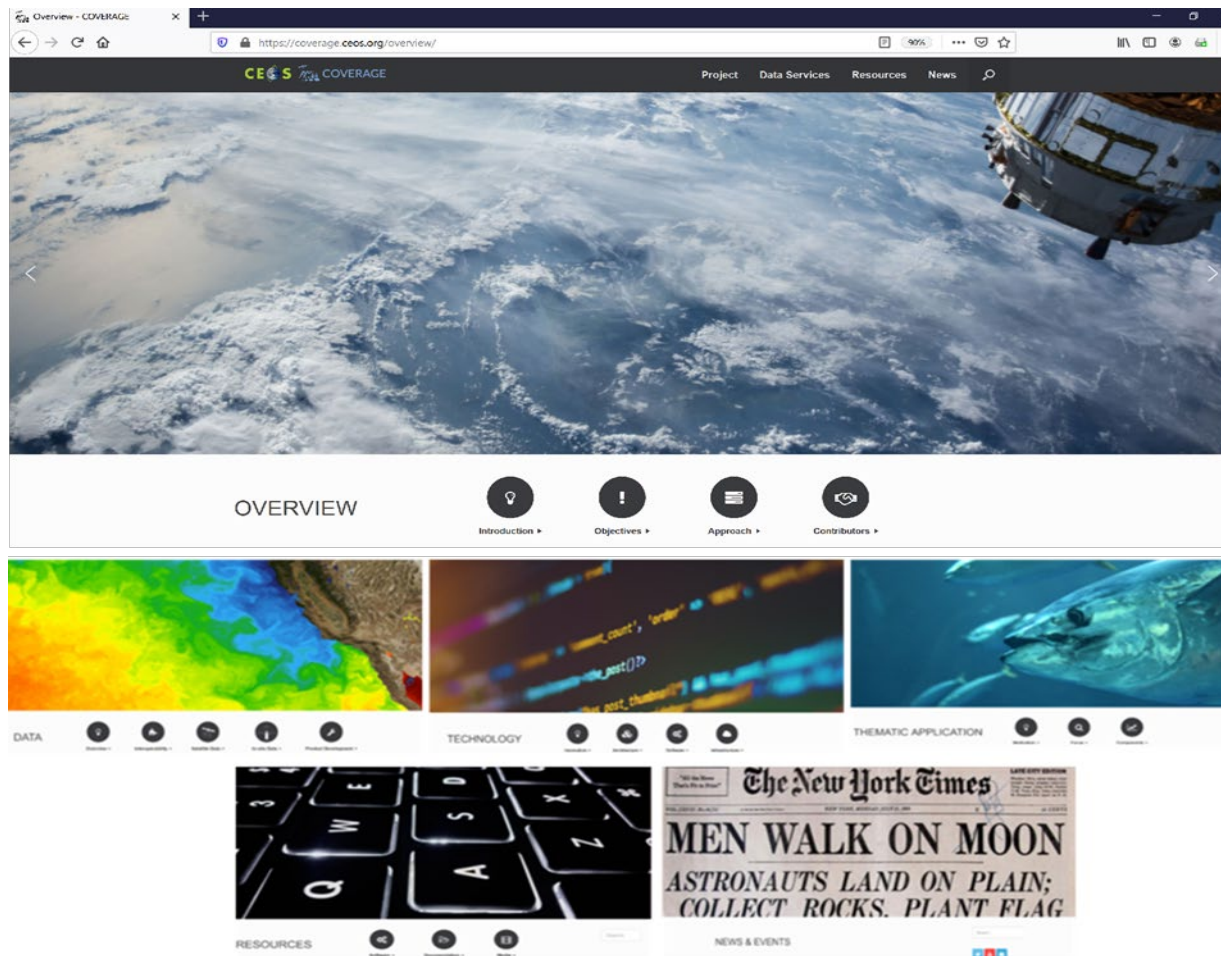


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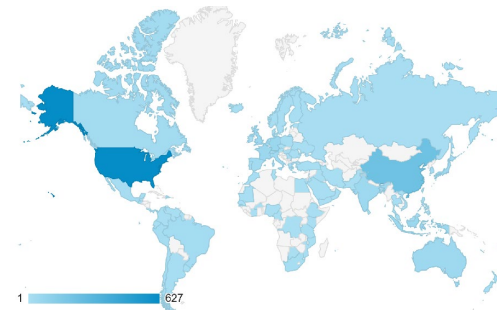
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System Architecture & Data Services

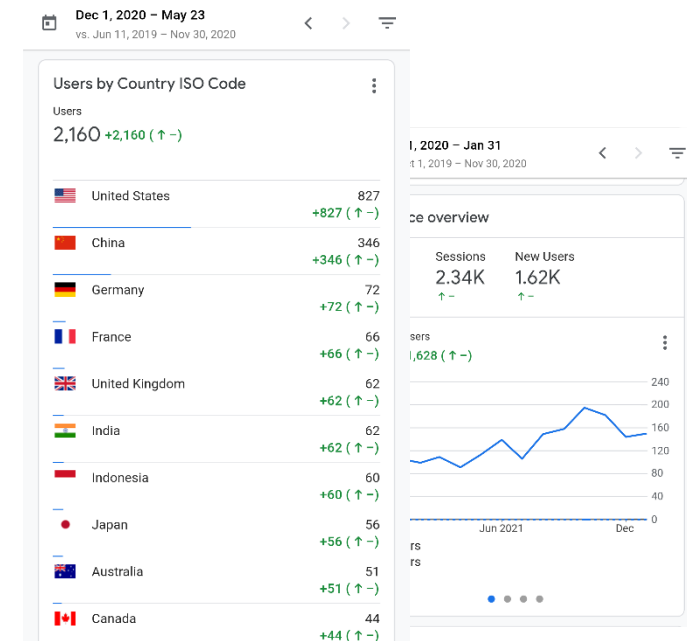




- Descriptive information on COVERAGE Initiative & Project
- Integrates Data services/tools
- Resources Area: project technical documentation, tutorial videos
- News Area: events & announcements
- Integrated COVERAGE You-Tube channel & Twitter feed
- Detailed site usage metrics via Google Analytics integration

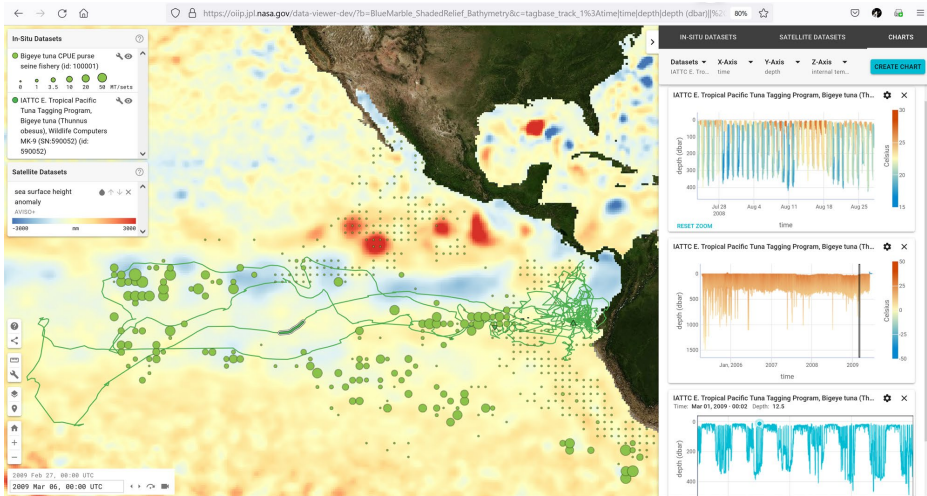


Visitors from 94
Countries



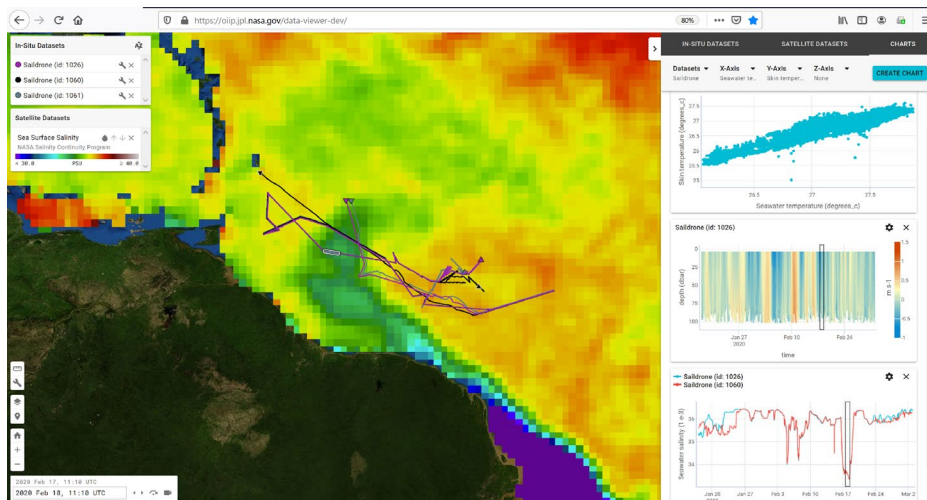
 https://twitter.com/coverage_ceos
Project announcements

 <https://tinyurl.com/coverage-channel>
Demonstration/tutorial Materials

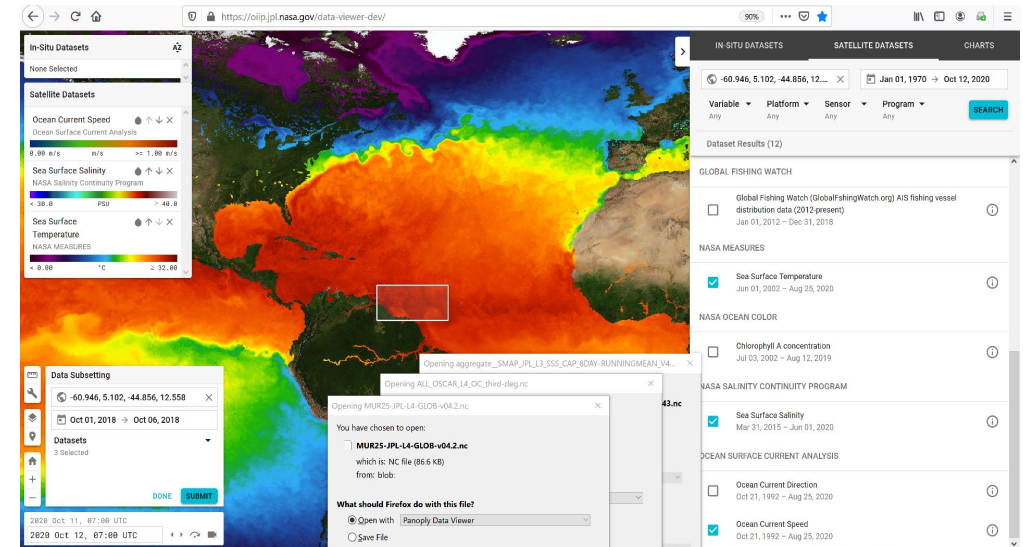


IATTC Bigeye Tuna archival tag & spatial catch distribution data relative to AVISO-SSHA and animal telemetry environmental measurements

- 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)

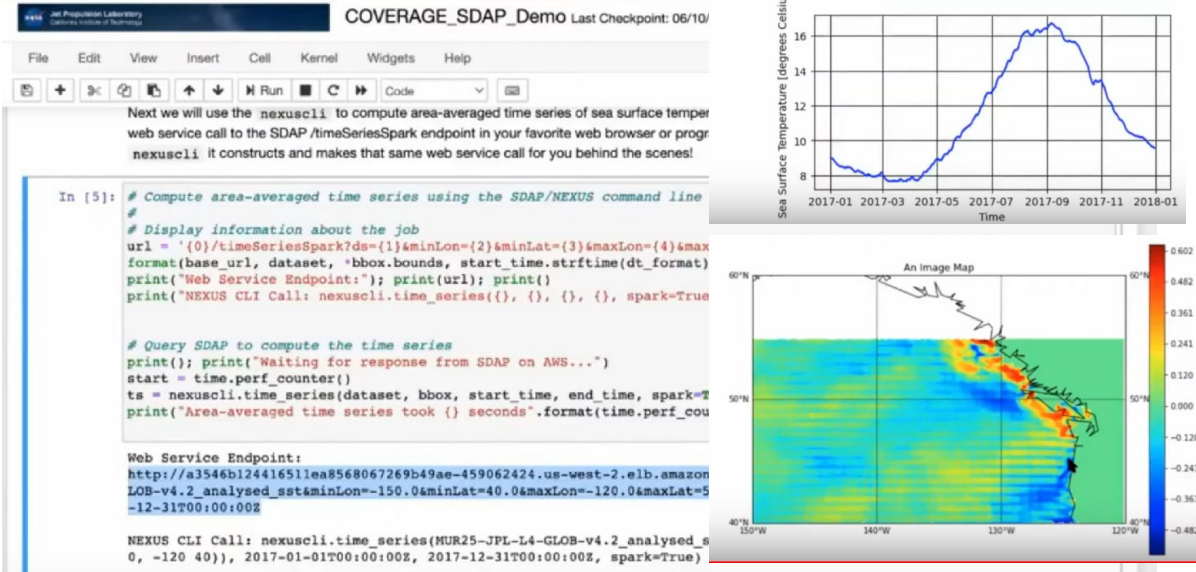


Sairdron ATOMIC cruise ADCP and CTD data overlaid on Sea Surface Salinity data from SMAP



Integrated Data Search & Subsetting

Jupyter Notebook Interface



The screenshot shows a Jupyter Notebook titled "COVERAGE_SDAP_Demo" with the following content:

Next we will use the `nexuscli` to compute area-averaged time series of sea surface temperature web service call to the SDAP /timeSeriesSpark endpoint in your favorite web browser or program `nexuscli` it constructs and makes that same web service call for you behind the scenes!

```
In [5]: # Compute area-averaged time series using the SDAP/NEXUS command line
# Display information about the job
url = '{}/timeSeriesSpark?ds={}&minLon={}&minLat={}&maxLon={}&maxLat={}&format={}&start={}&end={}&spark=True
format(base url, dataset, 'bbox.bounds, start time.strftime(dt_format)
print("Web Service Endpoint:"); print(url); print()
print("NEXUS CLI Call: nexuscli.time_series({}, {}, {}, {}, spark=True

# Query SDAP to compute the time series
print(); print("Waiting for response from SDAP on AWS...")
start = time.perf_counter()
ts = nexuscli.time_series(dataset, bbox, start_time, end_time, spark=True)
print("Area-averaged time series took {} seconds".format(time.perf_counter() - start))

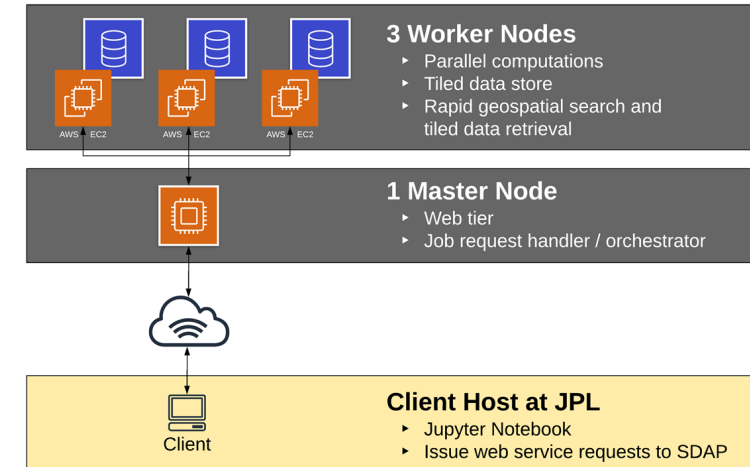
Web Service Endpoint:
http://a3546b124416511ea8568067269b49ae-459062424.us-west-2.elb.amazonaws.com/LOB-v4.2_analysed_sst&minLon=-150.0&minLat=40.0&maxLon=-120.0&maxLat=50.0&format=JSON&start=2017-01-01T00:00:00Z&end=2017-12-31T00:00:00Z&spark=True

NEXUS CLI Call: nexuscli.time_series(MUR25-JPL-L4-GLOB-v4.2_analysed_sst, -120 40), 2017-01-01T00:00:00Z, 2017-12-31T00:00:00Z, spark=True)
```

The notebook also displays two plots:

- A line plot titled "Plot the result" showing "Sea Surface Temperature (degrees Celsius)" over "Time" from 2017-01 to 2018-01. The temperature starts at approximately 8°C, rises to a peak of about 16°C in late 2017, and then gradually declines.
- An "An image Map" showing a spatial distribution of sea surface temperature over a region of the Pacific Ocean, with a color scale ranging from -0.482 to 0.602.

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 & APIs

Demo video:

<https://youtu.be/86I9F0vosuQ>



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Support for Key Stakeholders & Global Agendas

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) & FFEM funded projects
 - Ecosystem Diagnostic Analysis (EDA), identifying trends and impacts from available environmental, biological and socio-economic data
 - Development and adoption of ecosystem-based stewardship approach for the Sargasso Sea
 - COVERAGE providing integrative data system



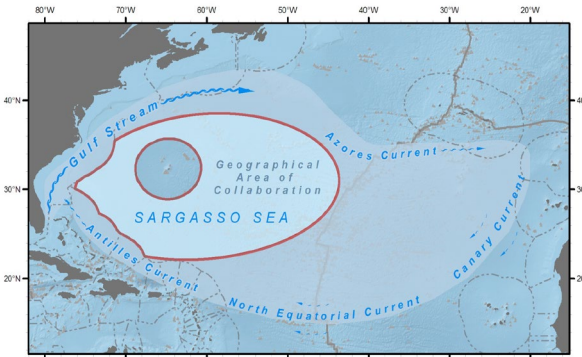
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Resilient nations.



United Nations
Educational, Scientific and
Cultural Organization

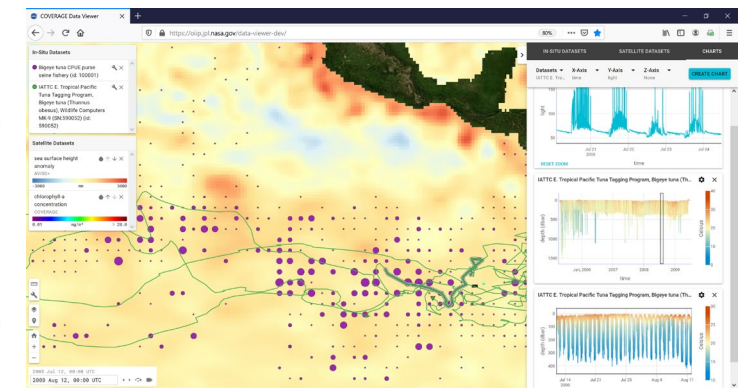
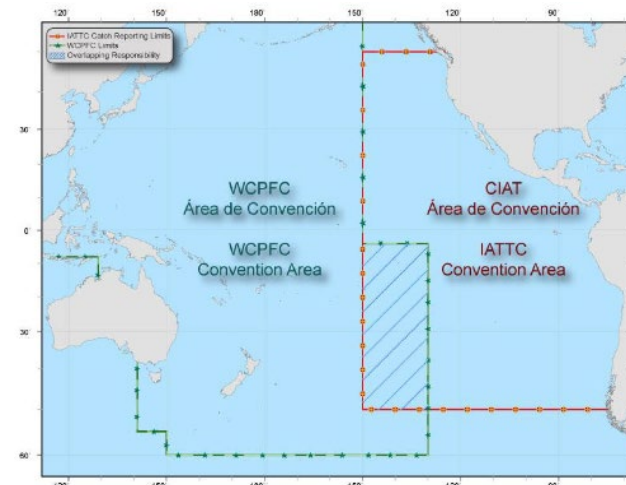


Intergovernmental
Oceanographic
Commission



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, MPA designation, Spatial catch forecast, By-catch mitigation
- IATTC-COVERAGE regional spin-off application



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



COVERAGE Involvement in the UN Decade of the Oceans on Behalf of CEOS

Serving as:

- Cumulative CEOS contribution to the UN Decade of the Ocean for Sustainable Development
- Joint CEOS liaison points with the IOC on the UN Decade Process

COVERAGE “Ocean Shot” Concept

- Concept proposal submitted to Ocean Decade U.S. (National Academy of Science committee) in December 2020
“Next Generation Data Service Infrastructure for a Digitally Integrated Ocean Observing System in Support of Marine Science and Ecosystem-Based Management”
- Published in special edition of Marine Technology Society Journal (June 2021) <https://doi.org/10.4031/MTSJ.55.3.45>
- Highlighted in the report released April 2022 by the National Academies of Sciences Ocean Decade committee on Cross-Cutting Themes for U.S. Contributions to the UN Ocean Decade. <https://doi.org/10.17226/26363>

Alignment & Coordination with relevant Decade U.S. and IOC efforts

- Digital Twins of the Oceans (DITTO)
- Marine Life 2030
- COAST





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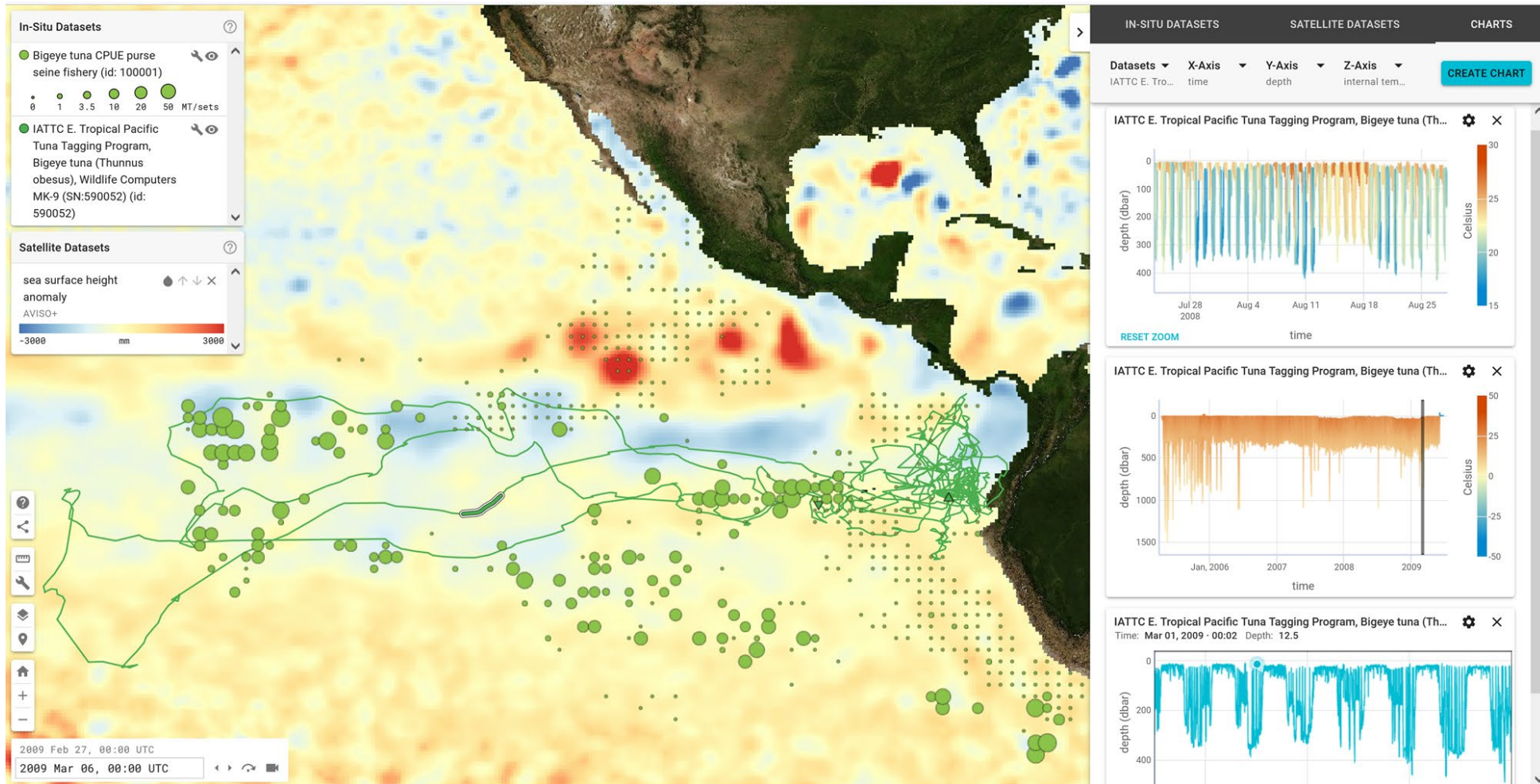
Questions/Comments? Contact Us

coverage@jpl.nasa.gov



<https://doi.org/10.1002/lob.10495>

Synopsis of a Consultative Workshop at the Ocean Sciences Meeting 2022 on the CEOS Ocean Variables Enabling Research and Applications for GEO (COVERAGE) Initiative



<https://coverage.ceos.org>



https://twitter.com/coverage_ceos



<https://tinyurl.com/coverage-channel>