The Distributed Oceanographic Match-up Service
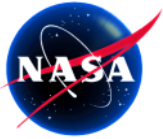
Shawn R. Smith (FSU), Thomas Huang (JPL), Steve Worley (NCAR),
Vardis Tsontos (JPL), Benjamin Holt (JPL), Mark A. Bourassa (FSU),
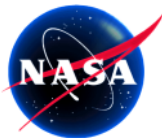Jocelyn Elya (FSU), Zaihua Ji (NCAR), Adam Stallard (FSU), and Nga
Quach (JPL)

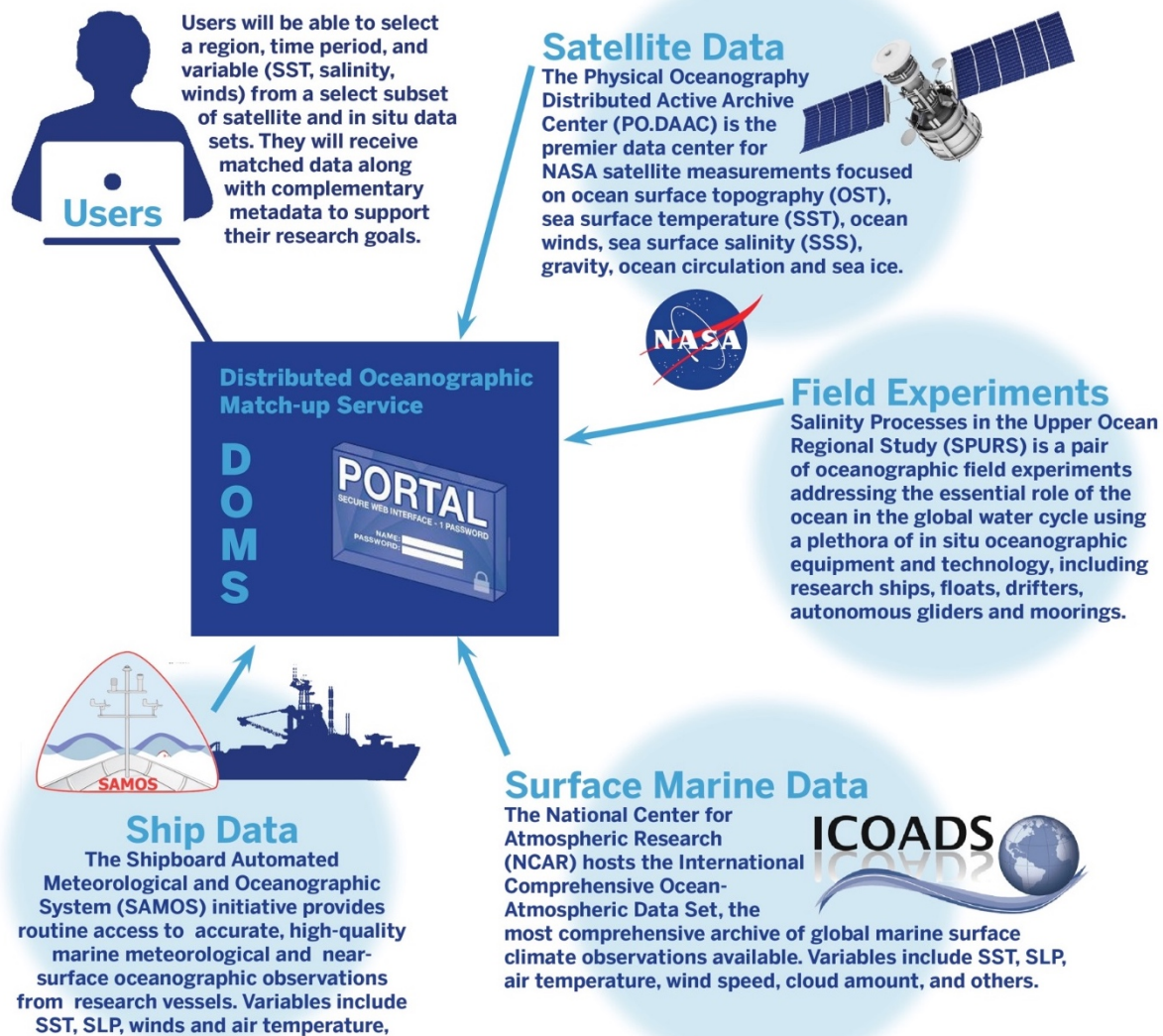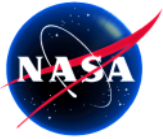MARCDAT-IV, 18-21 July 2016, Southampton, UK

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- Goal: To develop a distributed data service (a.k.a DOMS) to match satellite and in situ marine observations to support platform comparisons, cross-calibration, validation, and quality control

- Prototype is in development
  - Target for completion early 2017
  - Will be hosted in JPL Labs environment
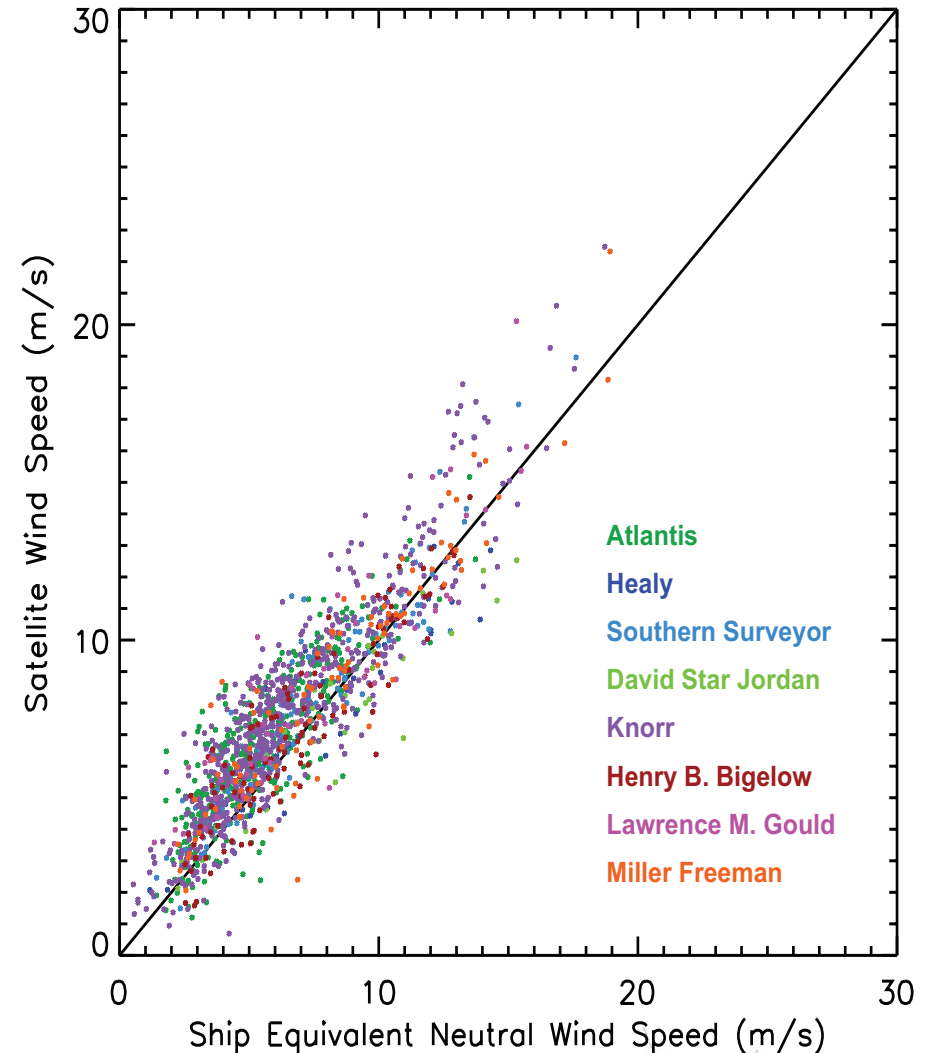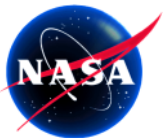 - JPL in process of clearing NASA security to make service accessible to the community.

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Users

Users will be able to select a region, time period, and variable (SST, salinity, winds) from a select subset of satellite and in situ data sets. They will receive matched data along with complementary metadata to support their research goals.

Satellite Data

The Physical Oceanography Distributed Active Archive Center (PO.DAAC) is the premier data center for NASA satellite measurements focused on ocean surface topography (OST), sea surface temperature (SST), ocean winds, sea surface salinity (SSS), gravity, ocean circulation and sea ice.

Distributed Oceanographic Match-up Service

DOMS

PORTAL
SECURE WEB INTERFACE - 1 PASSWORD
NAME:
PASSWORD:

Field Experiments

Salinity Processes in the Upper Ocean Regional Study (SPURS) is a pair of oceanographic field experiments addressing the essential role of the ocean in the global water cycle using a plethora of in situ oceanographic equipment and technology, including research ships, floats, drifters, autonomous gliders and moorings.

Ship Data

The Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative provides routine access to accurate, high-quality marine meteorological and near-surface oceanographic observations from research vessels. Variables include SST, SLP, winds and air temperature,

Surface Marine Data

The National Center for Atmospheric Research (NCAR) hosts the International Comprehensive Ocean-Atmospheric Data Set, the most comprehensive archive of global marine surface climate observations available. Variables include SST, SLP, air temperature, wind speed, cloud amount, and others.

ICOADS

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DOMS
Distributed Oceanographic Match-Up Service

ESTO
Earth Science Technology Office
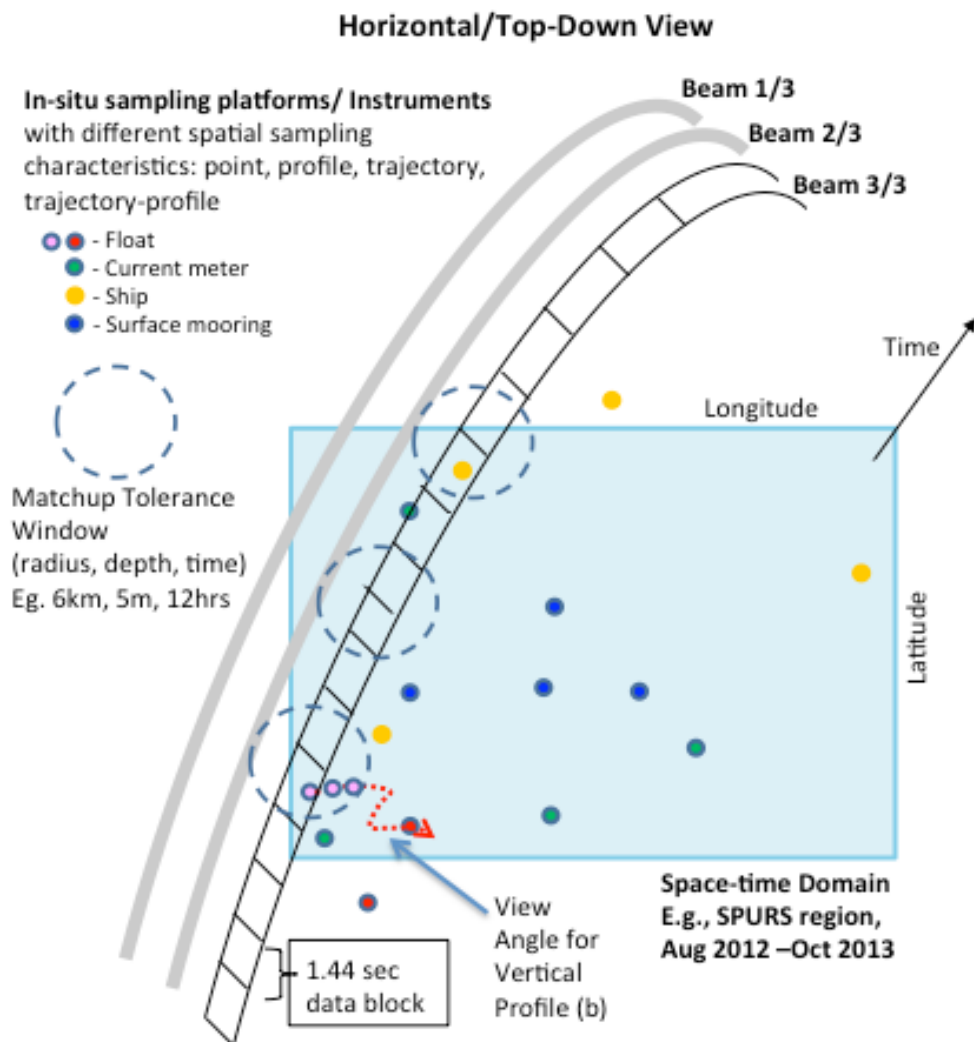
Use Cases for DOMS

Defined Use Cases

- **Satellite Cal/Val and algorithm development**

- **Decision support**
  - Planning field campaigns
  - Real-time operational activities

- **Scientific investigation**
  - Process studies
  - Model assimilation services
  - User friendly interface to support student research

- **Alternate matching**
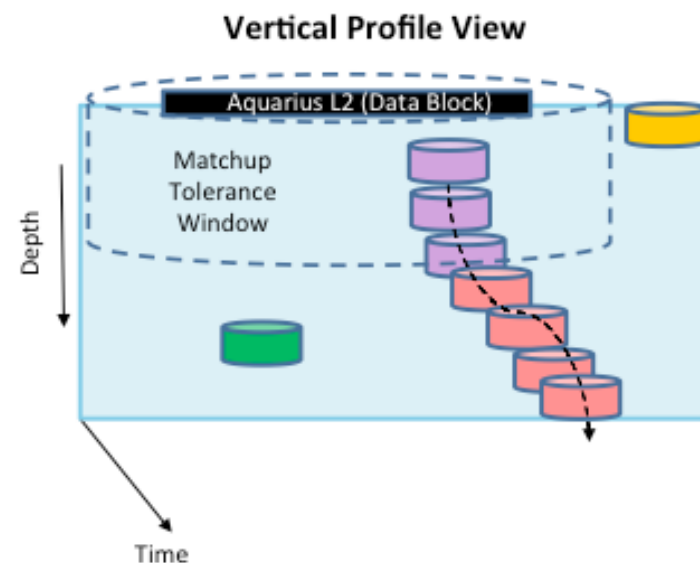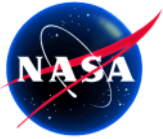 - Satellite to satellite
  - Satellite/in situ to model

Legend:
Atlantis
Healy
Southern Surveyor
David Star Jordan
Knorr
Henry B. Bigelow
Lawrence M. Gould
Miller Freeman

In situ to Satellite Data Matching

Horizontal/Top-Down View

In-situ sampling platforms/ Instruments with different spatial sampling characteristics: point, profile, trajectory, trajectory-profile

- Float
- Current meter
- Ship
- Surface mooring

Matchup Tolerance Window (radius, depth, time) Eg. 6km, 5m, 12hrs

Beam 1/3
Beam 2/3
Beam 3/3

Time
Longitude
Latitude

1.44 sec data block

View Angle for Vertical Profile (b)

Space-time Domain E.g., SPURS region, Aug 2012 – Oct 2013

- Example of data matching for Aquarius swath data
- Input space-time domain (including depth) and tolerance window
- Return only matches within criteria

Vertical Profile View

Aquarius L2 (Data Block)

Matchup Tolerance Window

Depth

Time

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DOMS
Distributed Oceanographic Match-Up Service

ESTO
Earth Science Technology Office

5

In situ data: SAMOS

- Shipboard Automated Meteorological and Oceanographic System (SAMOS) initiative provides high-quality underway data from research vessels.

- Hosted at FSU/COAPS.

- ~30 vessels participating in FY2014

  – Vessels operated by WHOI, SIO, UH, UW, BIOS, NOAA, USCG, USAP, IMOS, SO, LUMCON

  – ~30-40K one-minute observations/month/vessel

SAMOS Data Density: 2005-2014

Hourly observations per bin
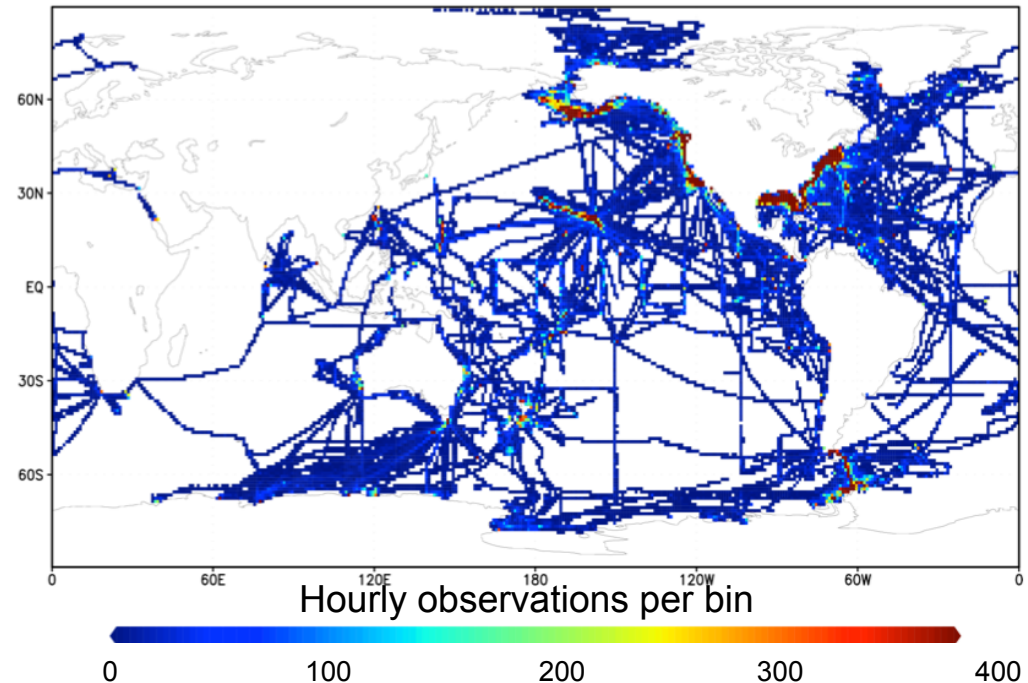
- Data include routine navigation (position, course, heading, speed), meteorology (wind, air temperature, humidity, pressure, rainfall, radiation), and oceanography (sea temperature and salinity).

- All data undergo scientific quality control.

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In situ data: ICOADS

ICOADS Release 3.0
- Global coverage from ocean observing systems
  - Approximately 3M records per month
  - VOS and R/V mainly from WOD and GOSUD
  - Moored buoys: GTMBA and national systems
  - Drifting buoys: surface and ARGO
- Percent of ocean coverage per year varies by parameter
- Updated monthly with NCEP + NCDC GTS data streams
- Each record has UID and observing system tracking metadata
- Salinity added as a new parameter

Note: Illustrative figures are produced from Release 2.5, the current operational archive

(b) map of platform mixture: Apr 2015

ICOADS website – hosted by NOAA/ESRL/PSD

ships — moored buoys — drifting buoys — C-MAN

sea surface temp.
sea level pressure
air temperature
wind speed
total cloudiness
relative humidity
evap. parameter

https://mdc.coaps.fsu.edu/doms
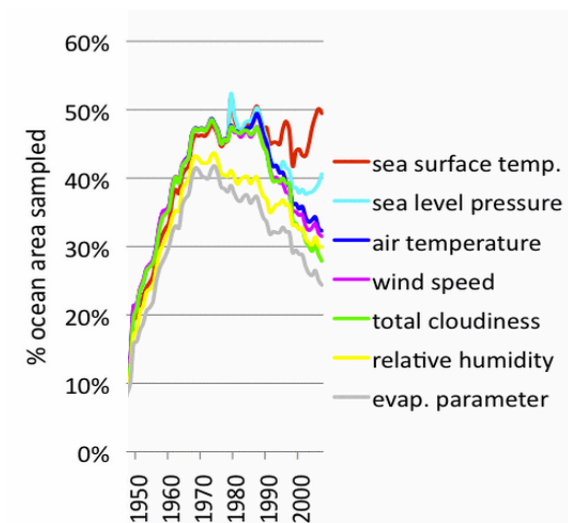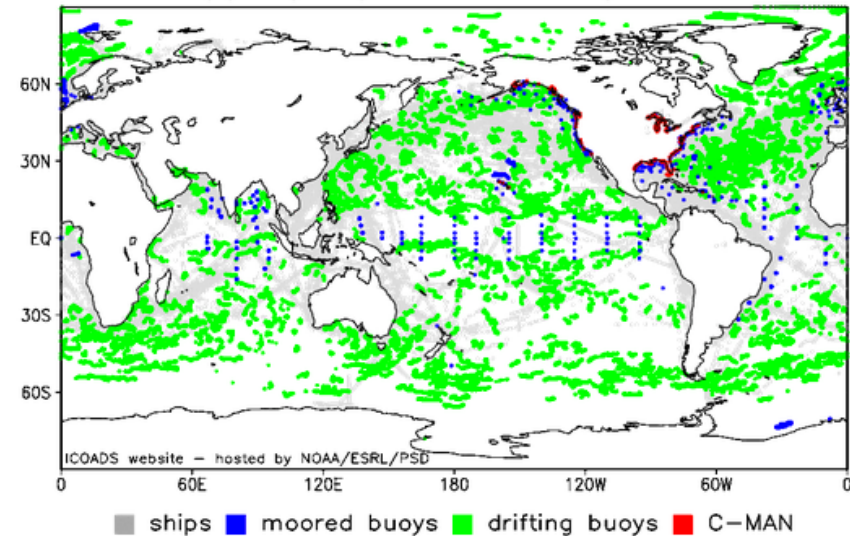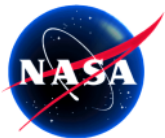
In situ data: SPURS-1

- NASA-funded oceanographic field campaign and science salinity process study in the North Atlantic maximum salinity region (2012-13).

- AIM:
  - Elucidate key mechanisms responsible for near-surface salinity variations
  - Quantify the relative significance of circulation, evaporation, precipitation over a range of scales over the open ocean.
  - Surface Salinity observations valuable for Aquarius/SAC-D Cal/Val

Ship (cruise #)	Dates	Country	Chief Scientist
Thalassa	16-Aug - 13-Sep-2012	France	Reverdin
Knorr (209)	6-Sep - 9-Oct-2012	US	Schmitt
Endeavor-1 (522)	15-Mar - 15-Apr-2013	US	Schmitt
Sarmiento	14-Mar - 10-Apr-2013	Spain	Font
Endeavor-2 (533)	19-Sep - 13-Oct-2013	US	Fratantoni

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

- Field campaign
  - Series of 5 cruises
  - Advanced sampling technologies deployed in a nested design
    - 900 x 800-mile square study area centered at 25°N, 38°W.
  - Natively heterogeneous formats for 15 datasets converted to NODC NetCDF standard by SPURS-DMT
  - Archived at the PO.DAAC, Discoverable & Distributed publicly as of 5/11/2015
    - PO.DAAC SPURS Mission Page: http://podaac.jpl.nasa.gov/spurs
    - SPURS-1 Dataset Catalog collection: http://podaac.jpl.nasa.gov/datasetlist?ids=Collections&values=SPURS-I&view=list
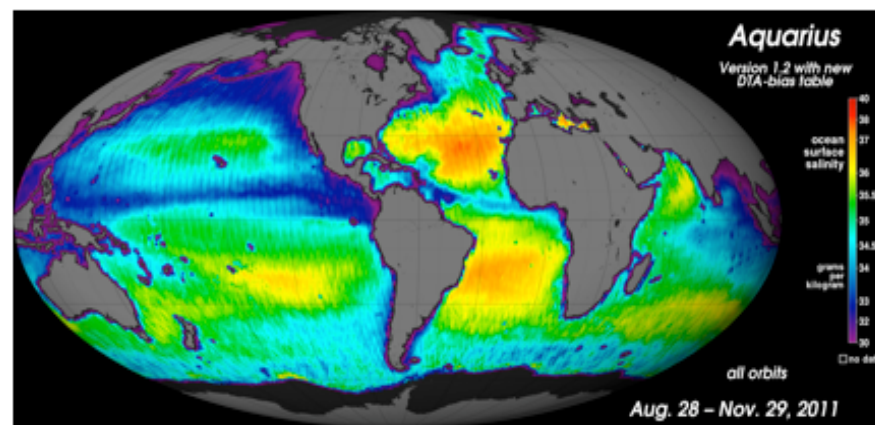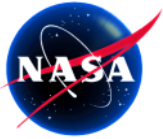
https://mdc.coaps.fsu.edu/doms
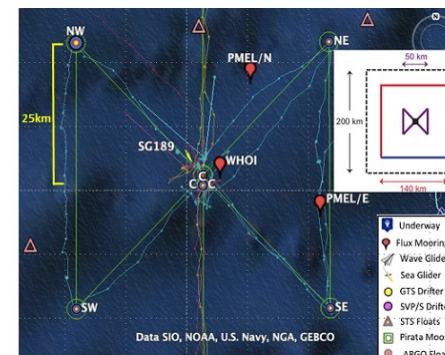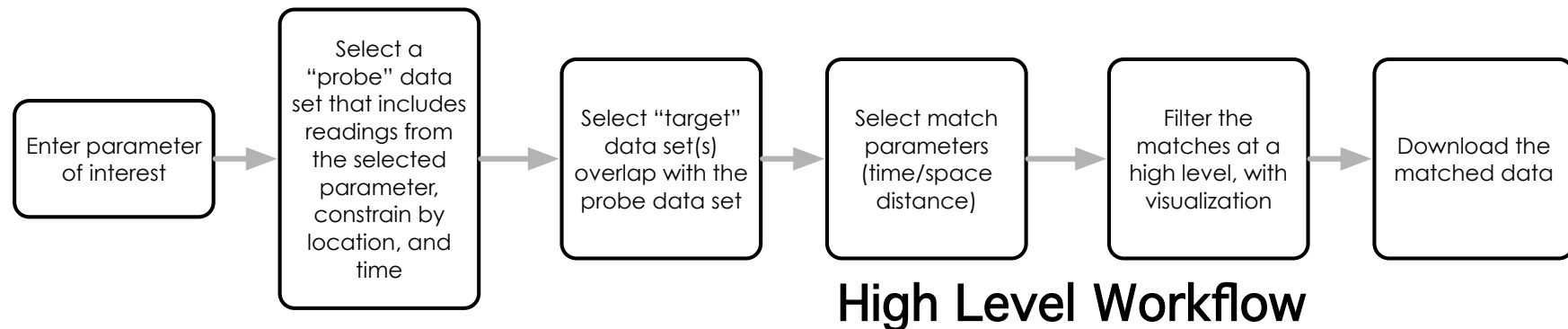
Satellite Data: PO.DAAC

- NASA DAACs with Oceanography focus
  - Supports archival/distribution of extensive collection of satellite data
  - Additionally supporting archival of select NASA-funded *in-situ* datasets
    SPURS-1, SPURS-2, Ocean Melting Greenland (OMG)
  - Datasets discoverable via:
    Web-portal (https://podaac.jpl.nasa.gov/) ,
    NASA ECHO/GCMD, P-WS
  - Data holdings accessible via a range of Tools & Services:
    ftp, OPeNDAP, W10n, CWS, THREDDS, LAS, HiTIDE, SOTO, etc.

- DOMS will leverage a range satellite products available from PO.DAAC
  - Prototype will use:
    - SST:
      - GHRSST-MODIS-A L2P
      - GHRSST-MODIS-T L2P
      - L4 MUR-SST
    - SSS: JPL SMAP L2B v2.0
    - Winds: ASCAT L2 25km

Aquarius
Version 1.2 with new DTA-bias table
ocean surface salinity
grams per kilogram
all orbits
Aug. 28 - Nov. 29, 2011
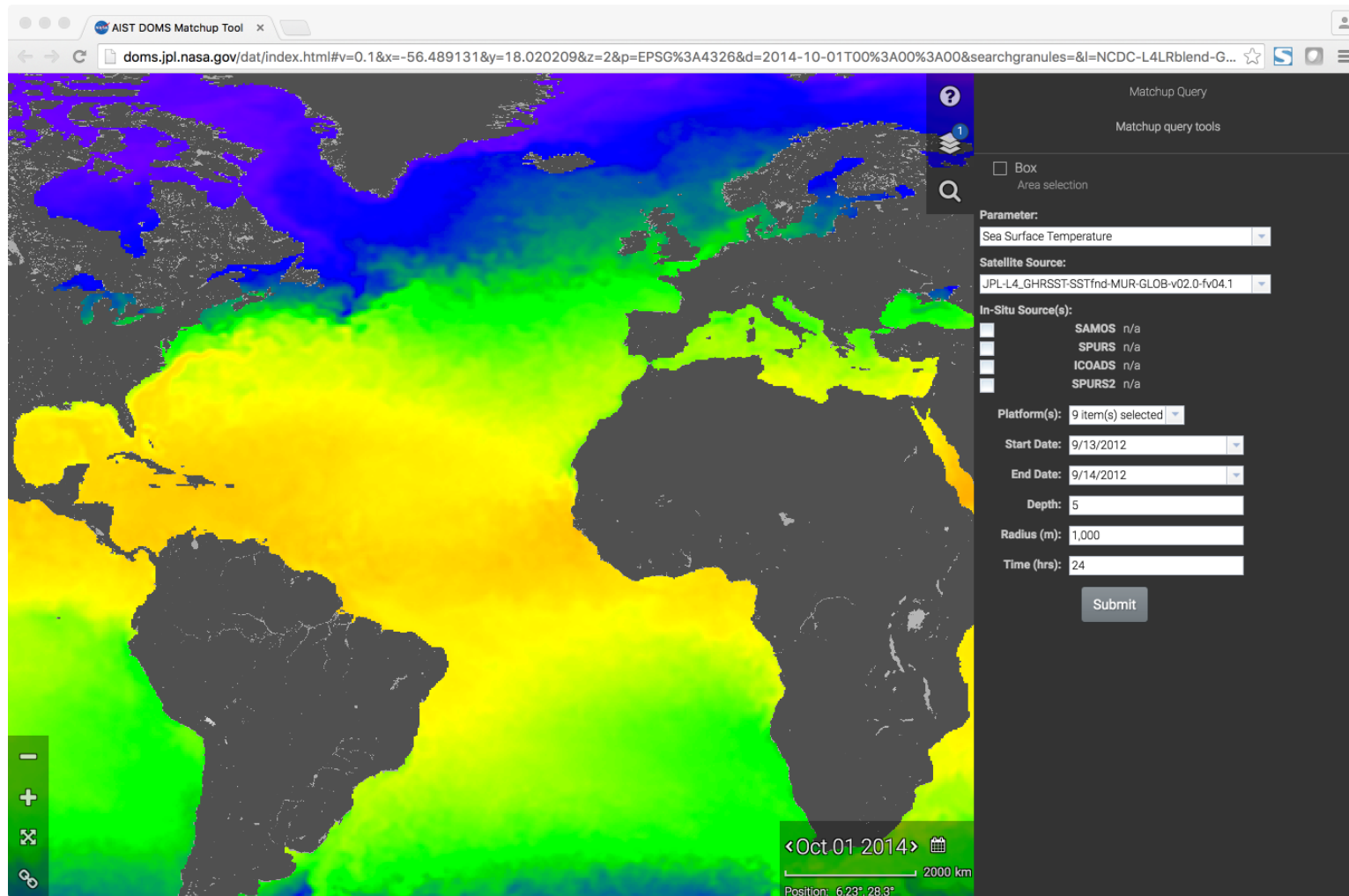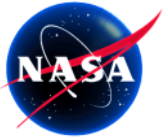
https://mdc.coaps.fsu.edu/doms

User Experience

- DOMS will provide a web portal and web services for users to browse and to submit match-up requests interactively.
  - Interface will allow users to "test" searches by returning metadata only, then follow with full matched dataset
  - Will support flexible filtering and query specification by:
    - Platform, device, parameter, provider
   - Matchup criteria: spatio-temporal domain (in x,y,z,t) and search radii/tolerances)

```
Enter parameter
of interest
      →
Select a
"probe" data
set that includes
readings from
the selected
parameter,
constrain by
location, and
time
      →
Select "target"
data set(s)
overlap with the
probe data set
      →
Select match
parameters
(time/space
distance)
      →
Filter the
matches at a
high level, with
visualization
      →
Download the
matched data
```

High Level Workflow

Dynamic Matchup – Alpha User Interface

High resolution data visualization

https://mdc.coaps.fsu.edu/doms

Dynamic Matchup – Alpha User Interface

Initial match according to user initial selection

https://mdc.coaps.fsu.edu/doms
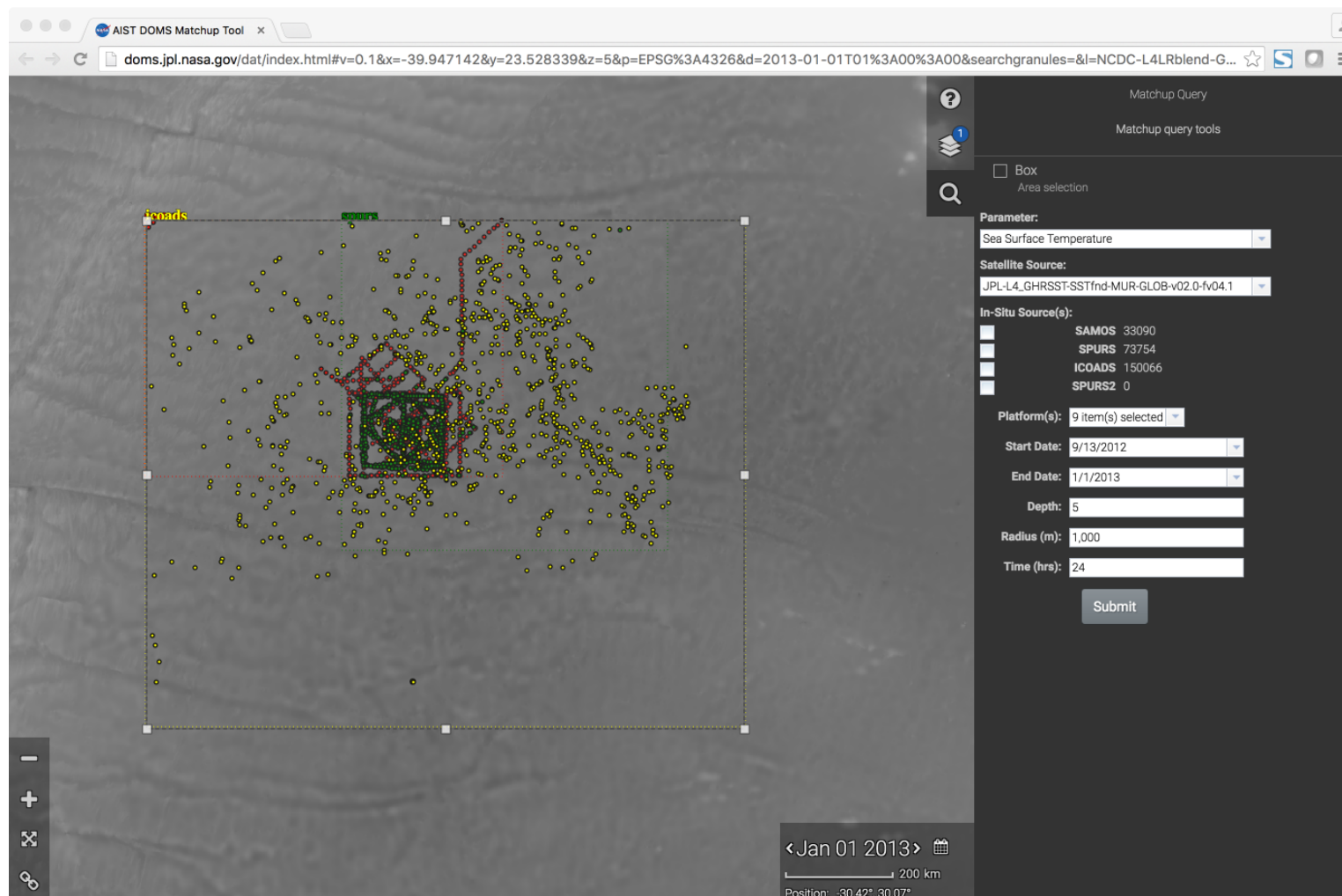
Dynamic Matchup – Alpha User Interface

SST matchup with SPURS

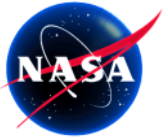https://mdc.coaps.fsu.edu/doms
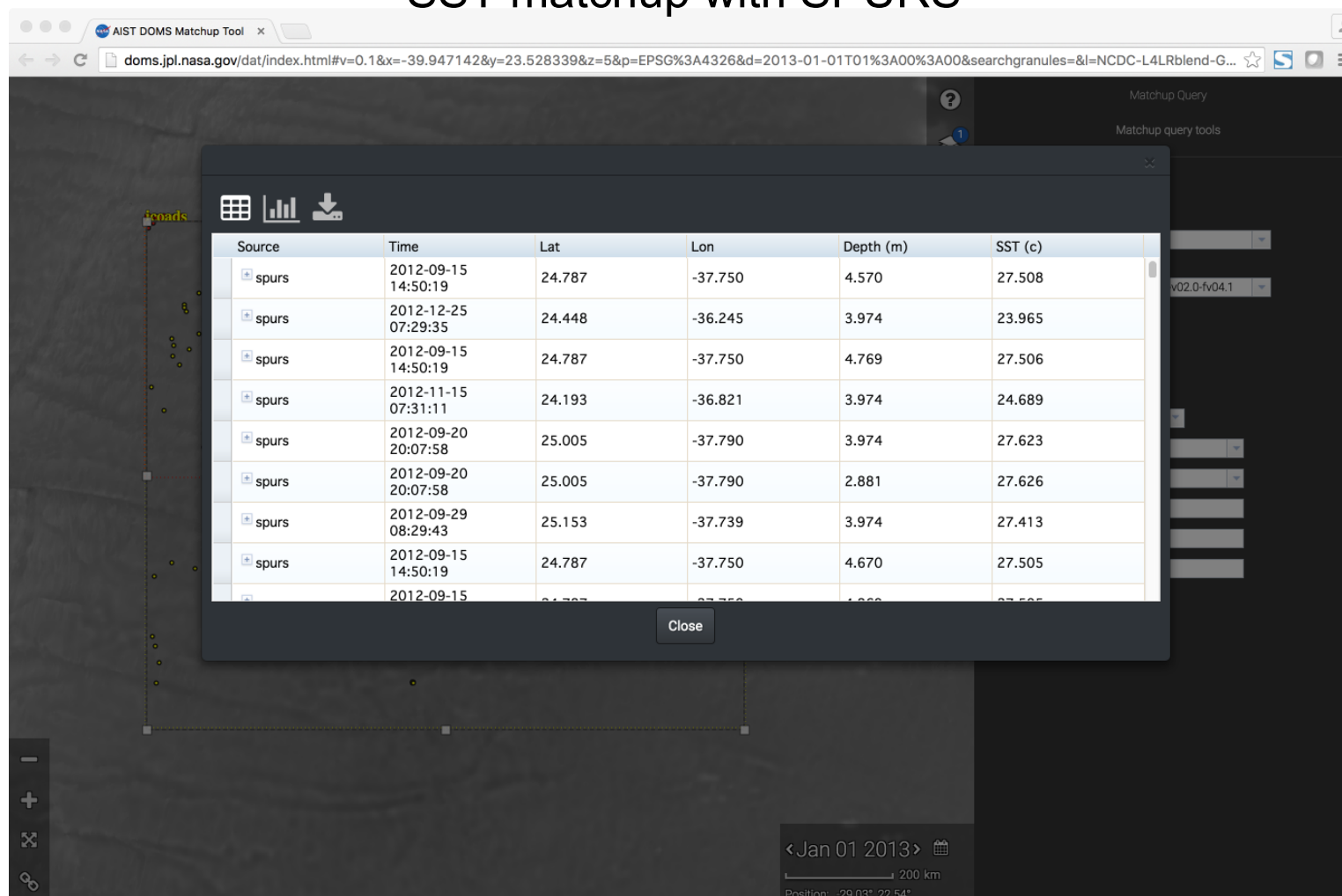
What's Under the Hood?

- **Each data host (JPL, FSU, NCAR) implemented**
  - Apache Solr
    - Used to index data and metadata for common parameters to support search and discovery
    - Index content populated from different backend technology at each host (e.g., MySQL, THREDDS, NoSQL)
  - EDGE
    - Manages queries from central DOMS user interface at JPL to distributed data hosts

- **Matching algorithm**
  - Hosted by DOMS server at JPL
  - Applies user-specified tolerance criteria to identify "matched" data pairs
  - Returns all pairs for that fall within the space-time tolerance window around each satellite or in-situ value
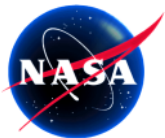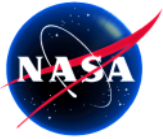
Looking Forward

- In 2016 we will continue development of prototype
  - Complete user interface
  - Complete output formats for matched datasets
  - Benchmark and stress testing

- Preparing to support SPURS-2 field experiment
  - Real-time data subsetting and matching of select in-situ data to SMAP salinity product

- DOMS will participate in Federation of Earth Science Information Partners (ESIP) technology readiness level testbed from July-Dec 2016
  - Goal to provide DOMS team with external review of user experience and assessment of potential for adoption/infusion of DOMS into other programs/agencies

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Summary

- A team from FSU, NCAR, and JPL is developing a distributed web portal/service to match in situ and satellite observations

- Prototype will be completed late 2016/early 2017

- Present focus is on
  - User interface (both GUI and web services)
  - Optimizing matching algorithm
  - Output data formats and delivery to user
  - Testing and reviewing system implementation and operation
  - Expanding application beyond initial cal/val focus
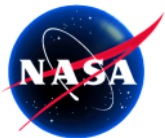
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Questions?

Development of DOMS is funded by NASA ESTO via the AIST program under grants to FSU (NNX15AE29G), NCAR (NNX15AG22G), and JPL.

Disclaimer: Any opinions, findings, and conclusions or recommendations provided are those of the contributors to the DOMS project and do not necessarily reflect the views of NASA.
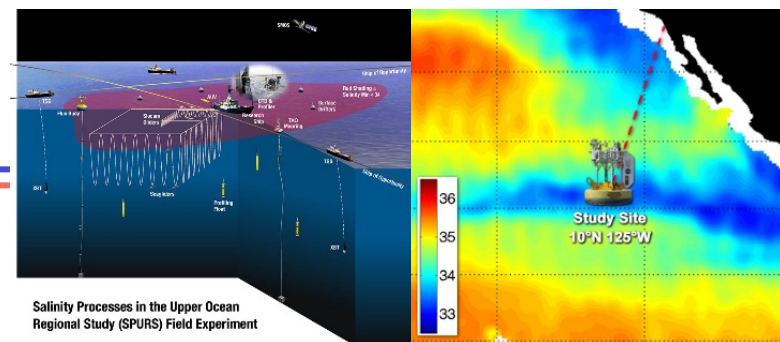
Looking forward

Salinity Processes in the Upper Ocean
Regional Study (SPURS) Field Experiment

Supporting SPURS-2 campaign
http://spurs2.jpl.nasa.gov/

- JPL group briefed the SPURS data management team (DMT) on DOMS capabilities and provided live demos of functionality
- Two uses for DOMS that can support the field campaign have been jointly identified:
  - Daily in situ and satellite data aggregation and subsetting to provide integrated data extractions for the SPURS2 domain
  - Create daily matchups of available SPURS2 in-situ streams and SST, SMAP-SSS, and/or surface wind satellite data
- SPURS2 data feeds have been identified (ARGO,TAO mooring, drifters) and sample data ingested into DOMS
- Next Steps for DOMS partners and DMT:
  - Establish a standard set of DOMS web-service queries to be executed during the field campaign
  - Ingest JPL SMAP-SSS L2 satellite data & in-situ sample Glider data into DOMS
  - DMT to test and provide further feedback on the DOMS system

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