STOQS

The Spatial Temporal Oceanographic Query System

a geospatial database web application designed for providing efficient access to *in situ* oceanographic measurement data across any “dimension”

19 September 2013

Mike McCann
Monterey Bay Aquarium Research Institute

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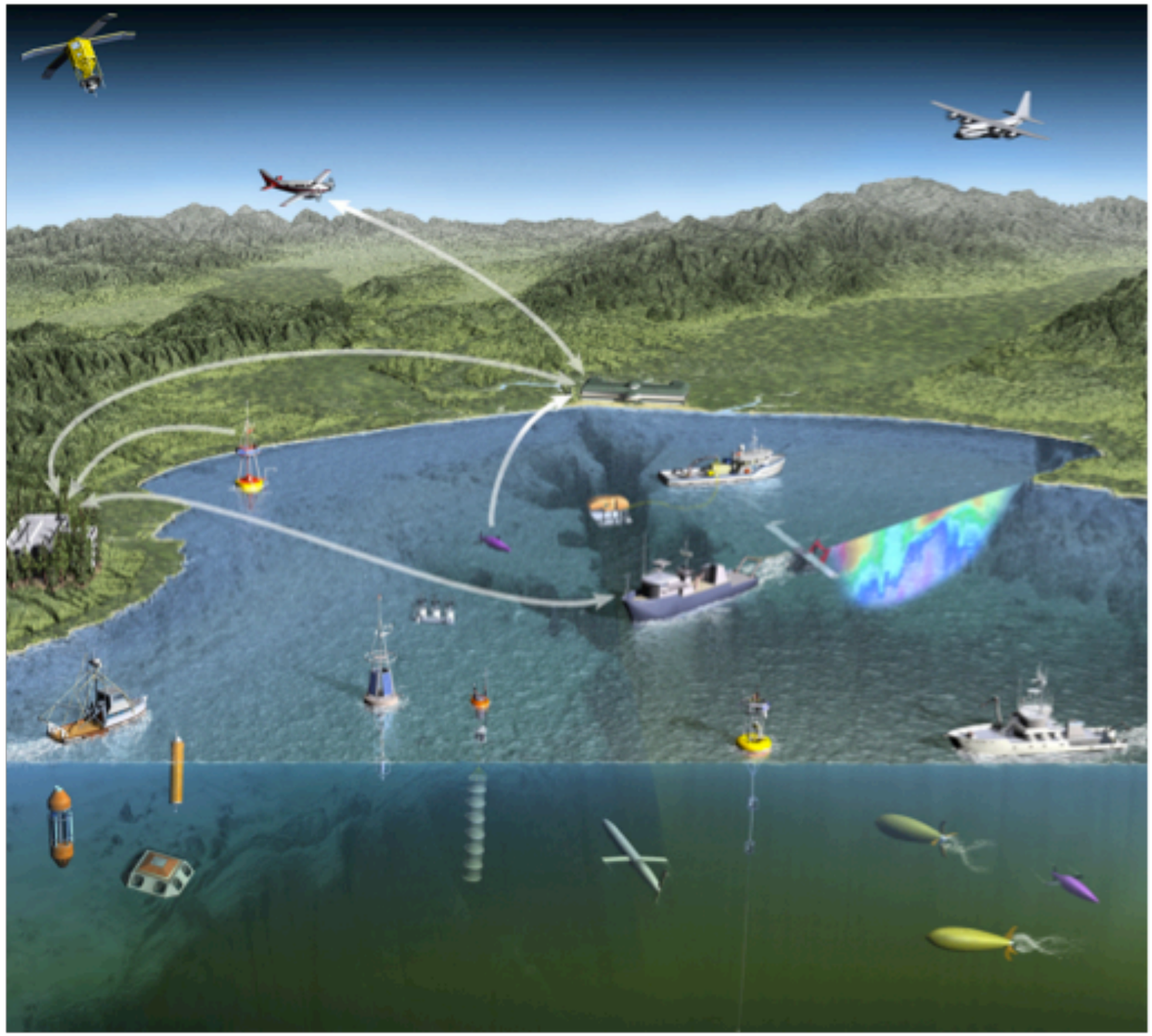
The Domain: Oceanographic Observation Campaigns



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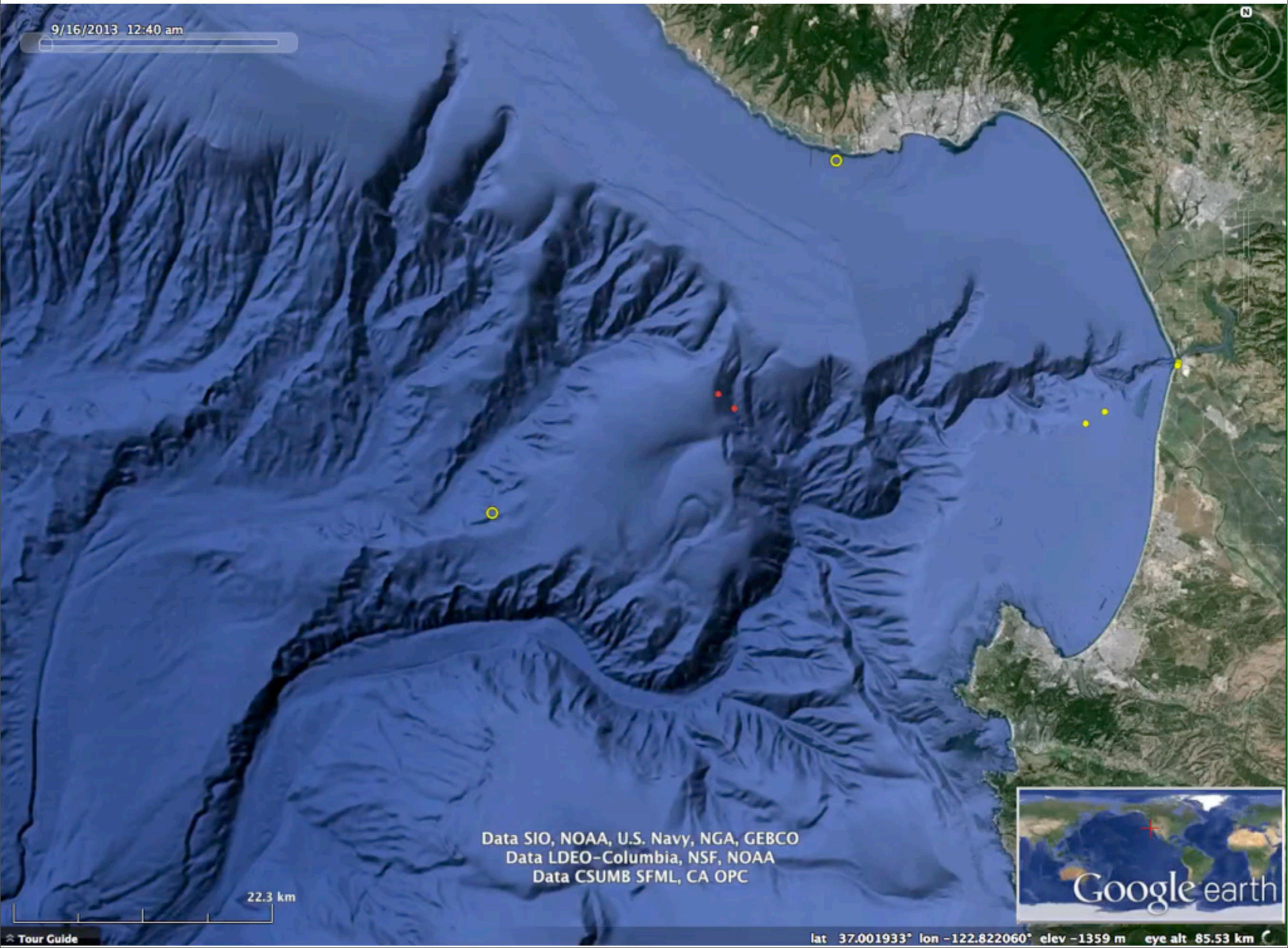

9/16/2013 12:40 am
N
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Data CSUMB SFML, CA OPC
22.3 km
Google earth
Tour Guide
lat 37.001933° lon -122.822060° elev -1359 m eye alt 85.53 km

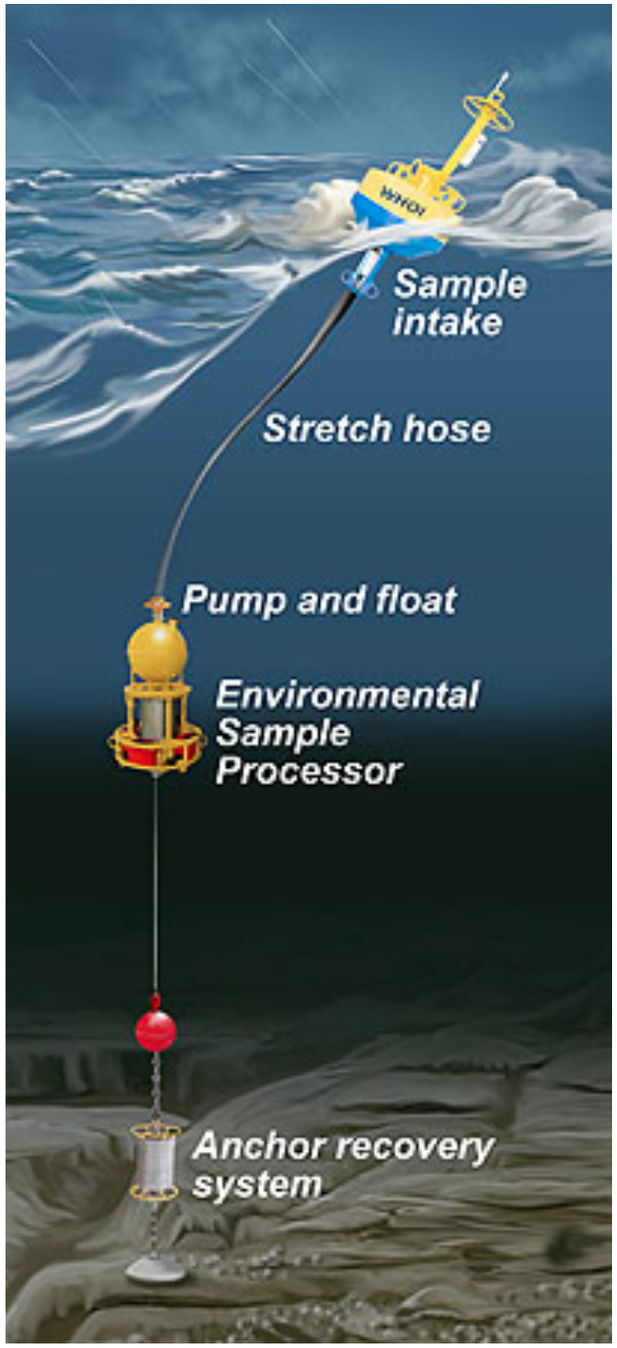
Talk Outline

- CF-NetCDF Discrete Sampling Geometries
- STOQS Data Model
- Application Architecture
- User Interface
- Data Flow

CF-NetCDF Discrete Sampling Geometries

- featureType
  timeSeries

- Stationary platform measures parameters from single depth over time



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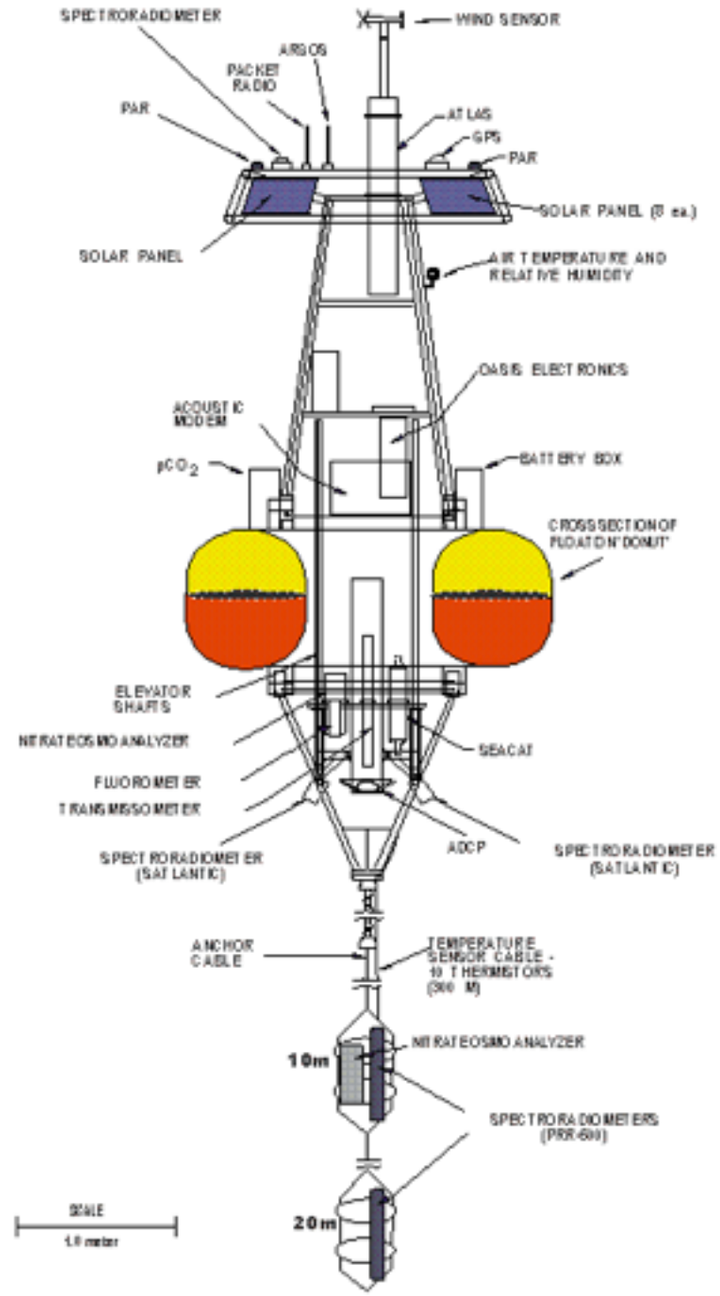
CF-NetCDF Discrete Sampling Geometries

- featureType
  timeSeriesProfile

- Stationary platform measures parameters from multiple depths over time



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CF-NetCDF Discrete Sampling Geometries

- featureType
  trajectory

- Mobile platform measures parameters while moving through the water

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CF-NetCDF Discrete Sampling Geometries

timeSeries

```
Dataset {
    Float64 LATITUDE[LATITUDE = 1];
    Float64 LONGITUDE[LONGITUDE = 1];
    Float64 DEPTH[DEPTH = 1];
    Float64 time[time = 1939];
    Grid {
     ARRAY:
        Float32 fWind_speed[time = 1939][DEPTH = 1][LATITUDE = 1][LONGITUDE = 1];
     MAPS:
        Float64 time[time = 1939];
        Float64 DEPTH[DEPTH = 1];
        Float64 LATITUDE[LATITUDE = 1];
        Float64 LONGITUDE[LONGITUDE = 1];
    } fWind_speed;
} CANON_september2013/Platforms/Moorings/OA_1/OA1_met_2013.nc;
```

CF-NetCDF Discrete Sampling Geometries

timeSeriesProfile

```
Dataset {
    Float64 LONGITUDE[LONGITUDE = 1];
    Float64 LATITUDE[LATITUDE = 1];
    Float64 DEPTH[DEPTH = 11];
    Float64 TIME[TIME = 13752];
    Grid {
     ARRAY:
        Float32 PSAL[TIME = 13752][DEPTH = 11][LATITUDE = 1][LONGITUDE = 1];
     MAPS:
        Float64 TIME[TIME = 13752];
        Float64 DEPTH[DEPTH = 11];
        Float64 LATITUDE[LATITUDE = 1];
        Float64 LONGITUDE[LONGITUDE = 1];
    } PSAL;
} all/OS_M1_R/OS_MBARI-M1_20120222_R_TS.nc;
```

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CF-NetCDF Discrete Sampling Geometries

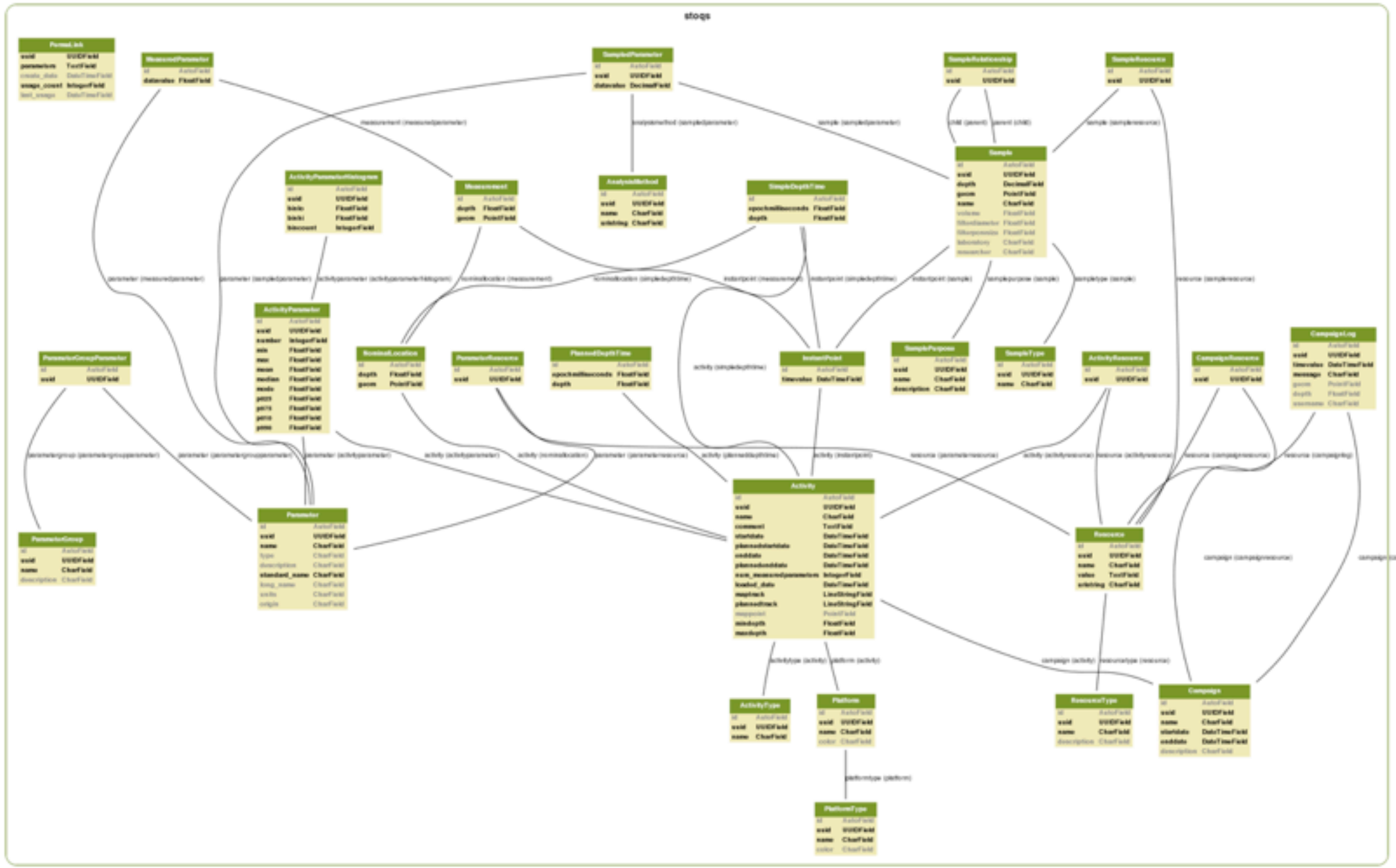
trajectory

```
Dataset {
    Float64 time[time = 50355];
    Float64 depth[time = 50355];
    Float64 temperature[time = 50355];
    Float64 oxygen[time = 50355];
    Float64 nitrate[time = 50355];
    Float64 bbp420[time = 50355];
    Float64 bbp700[time = 50355];
    Float64 fl700_uncorr[time = 50355];
    Float64 latitude[time = 50355];
    Float64 longitude[time = 50355];
    Float64 salinity[time = 50355];
    Float64 biolume[time = 50355];
} auv/dorado/2010/netcdf/Dorado389_2010_300_00_300_00_decim.nc;
```

CF-NetCDF Discrete Sampling Geometries

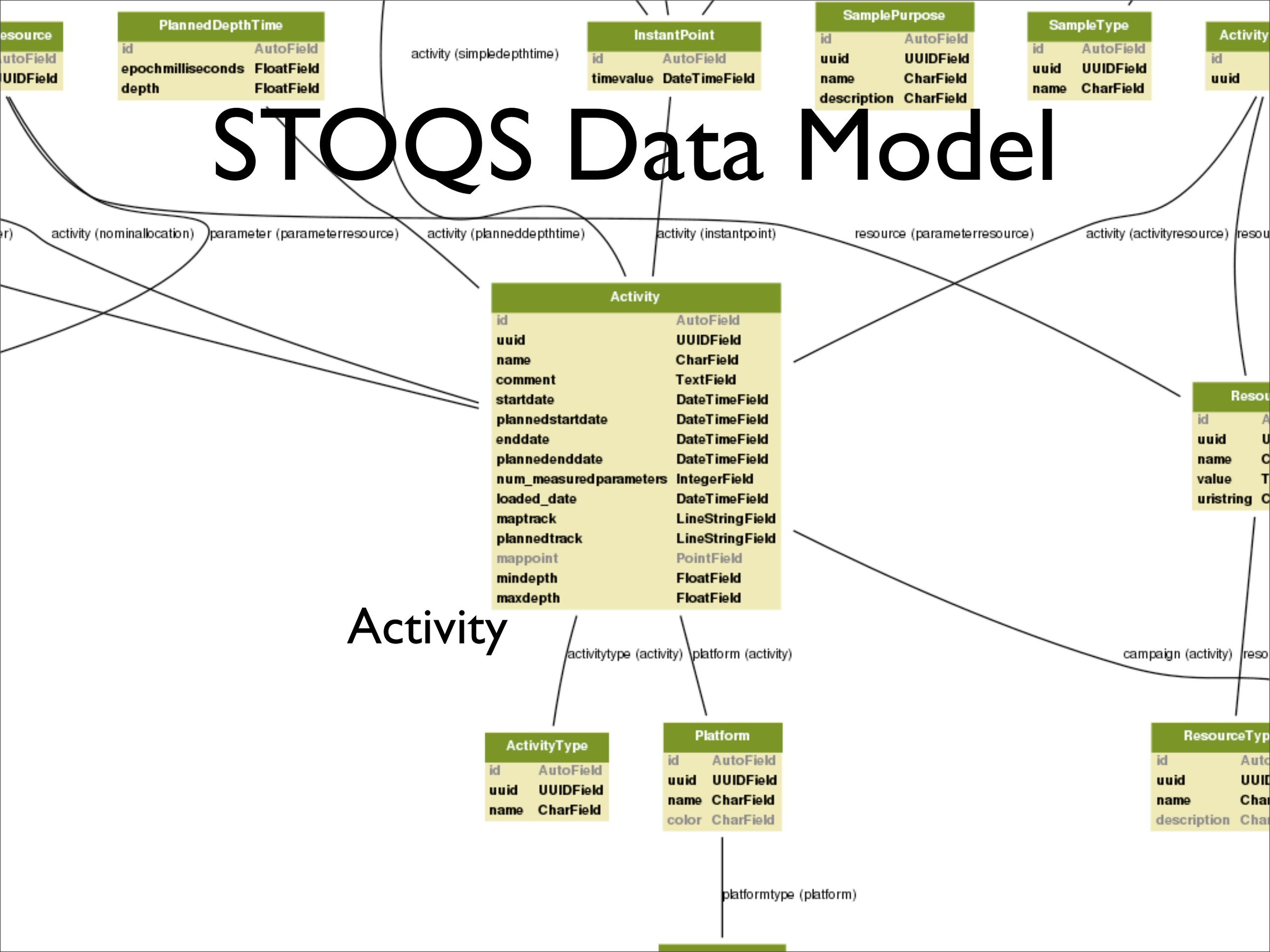
- Advantages
  - Interoperable: write and read in many languages and applications
  - Community adopted standard
- Disadvantages
  - Only coordinate dimensions are indexed for efficient access
  - Must read entire dataset for efficient sub-select on non-coordinate dimensions

STOQS Data Model



STOQS Data Model

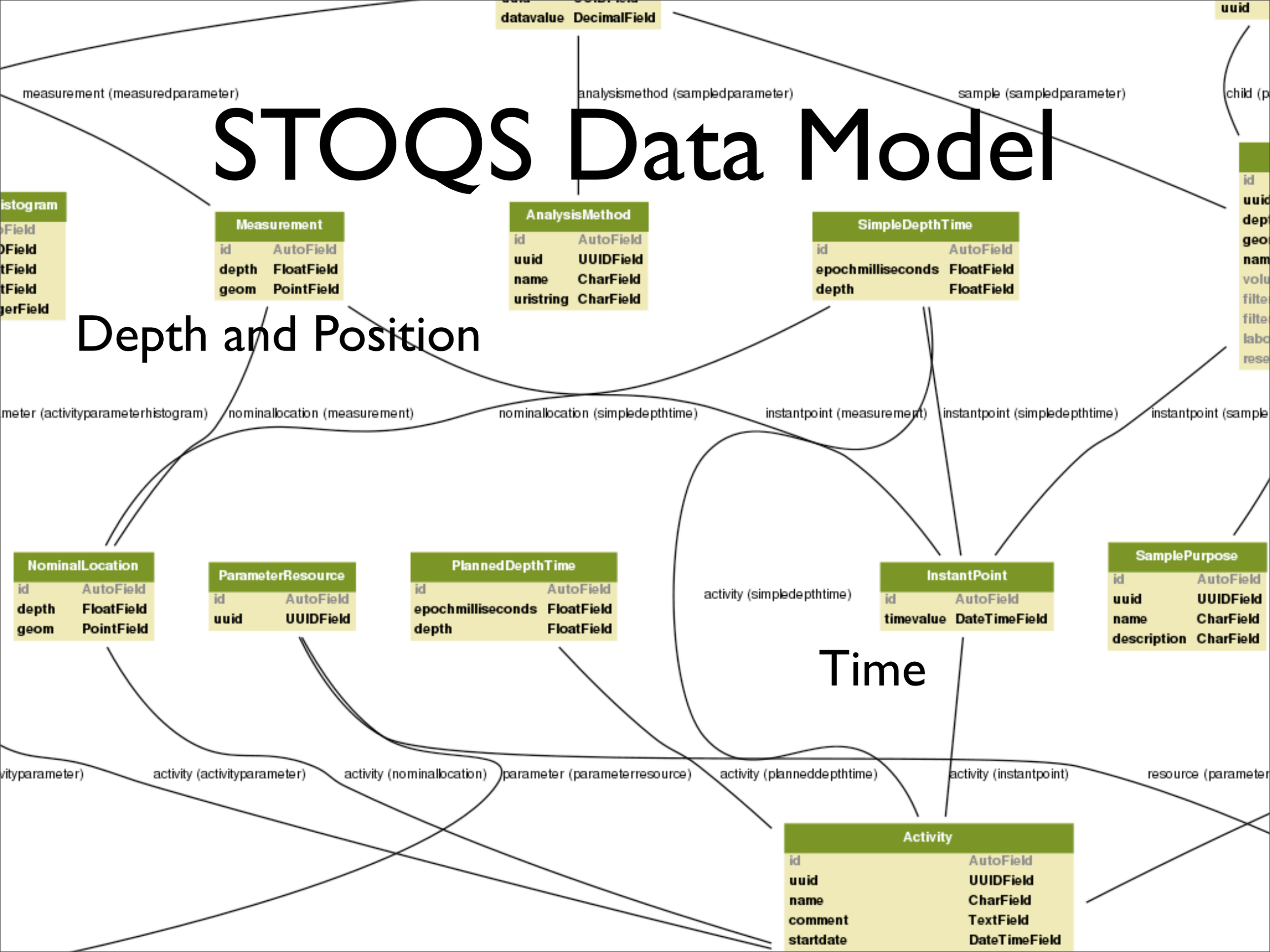
Activity



STOQS Data Model

Depth and Position

Time

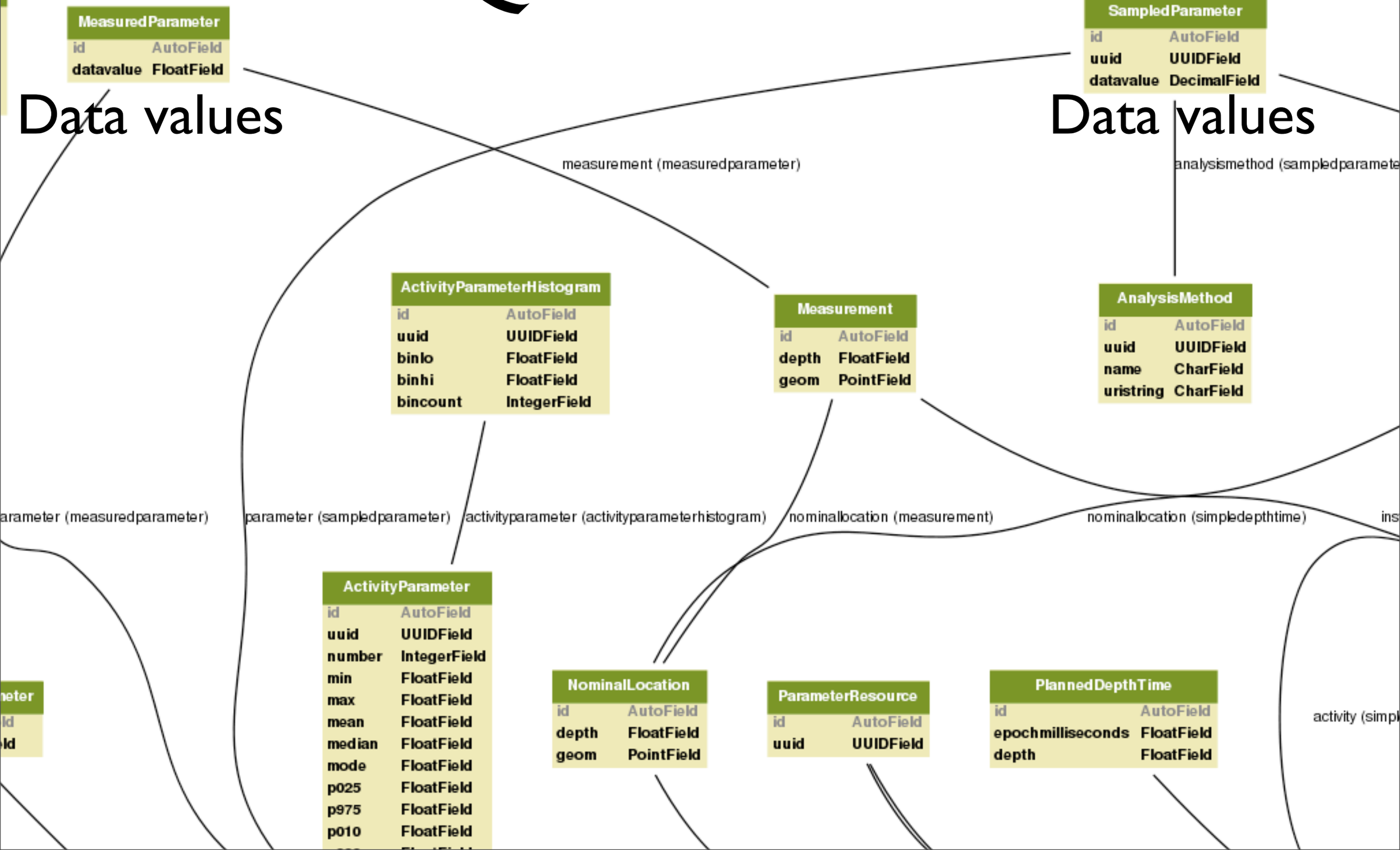


STOQS Data Model

stoqs

Data values

Data values



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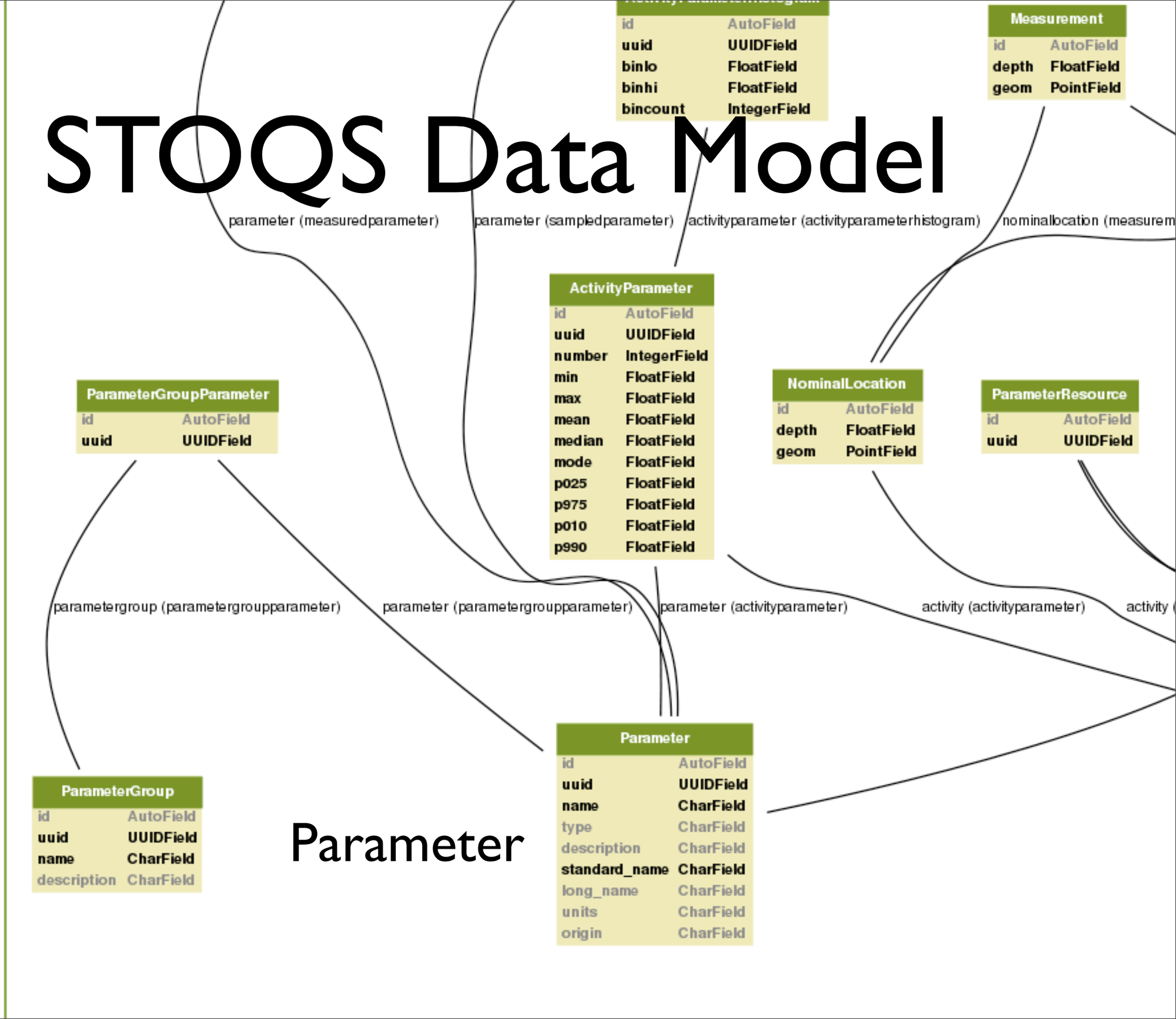
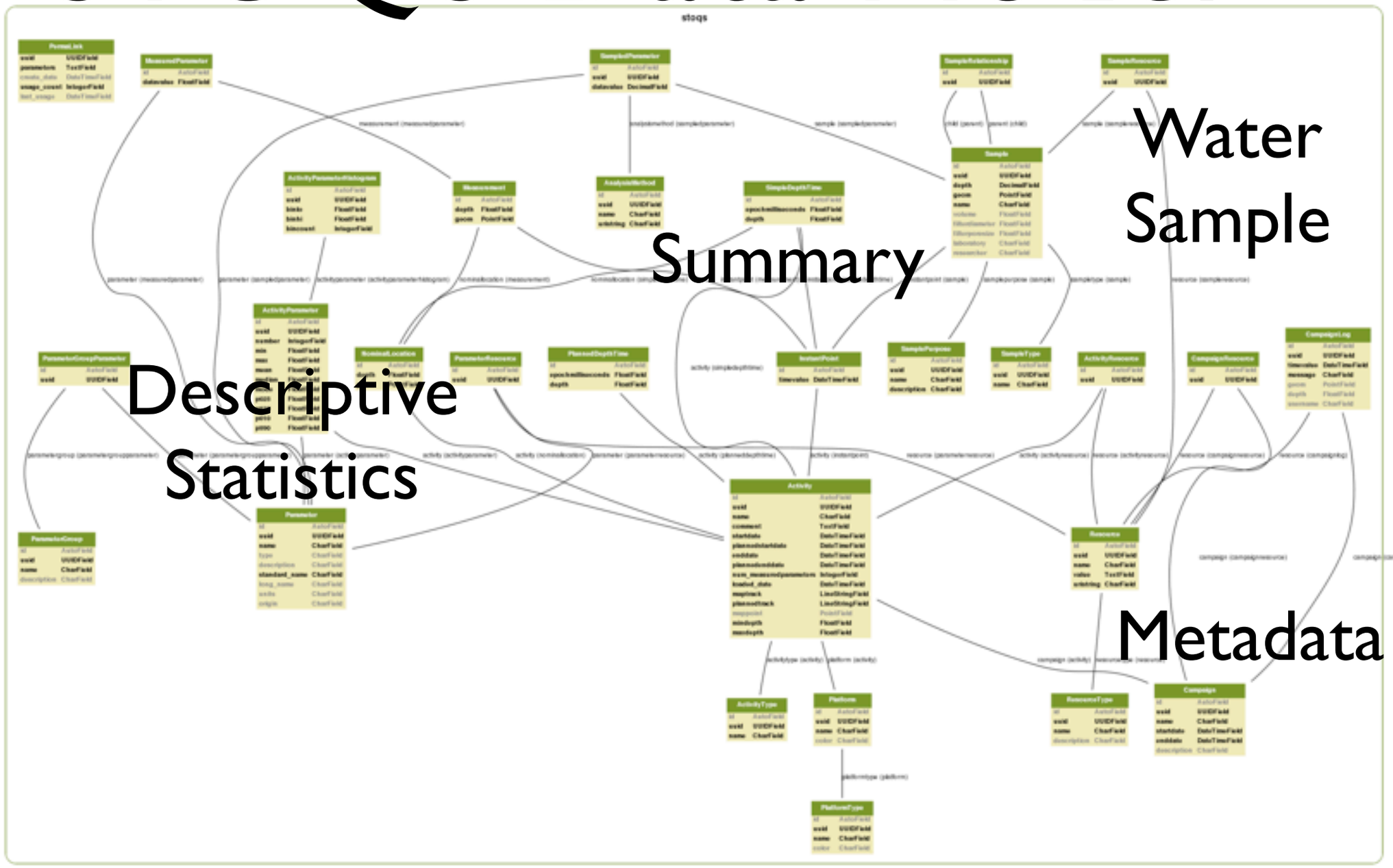


Parameter

STOQS Data Model



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Application Architecture

Architecture

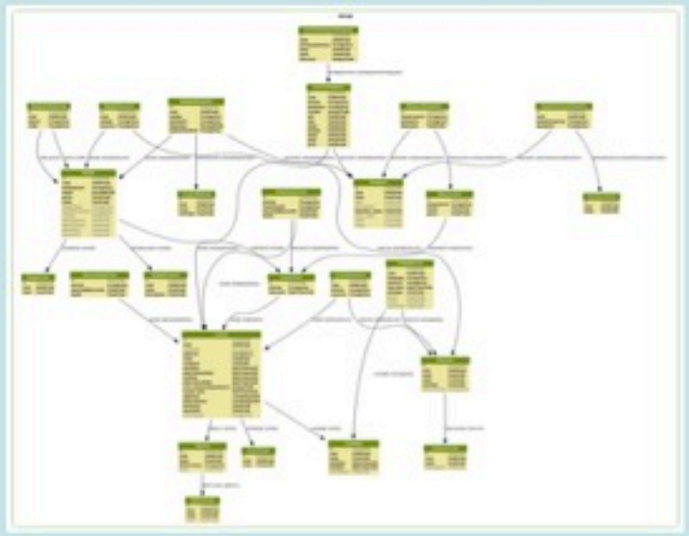
HTML5 | jQuery & AJAX | OpenLayers | Flot | Twitter Bootstrap

Client

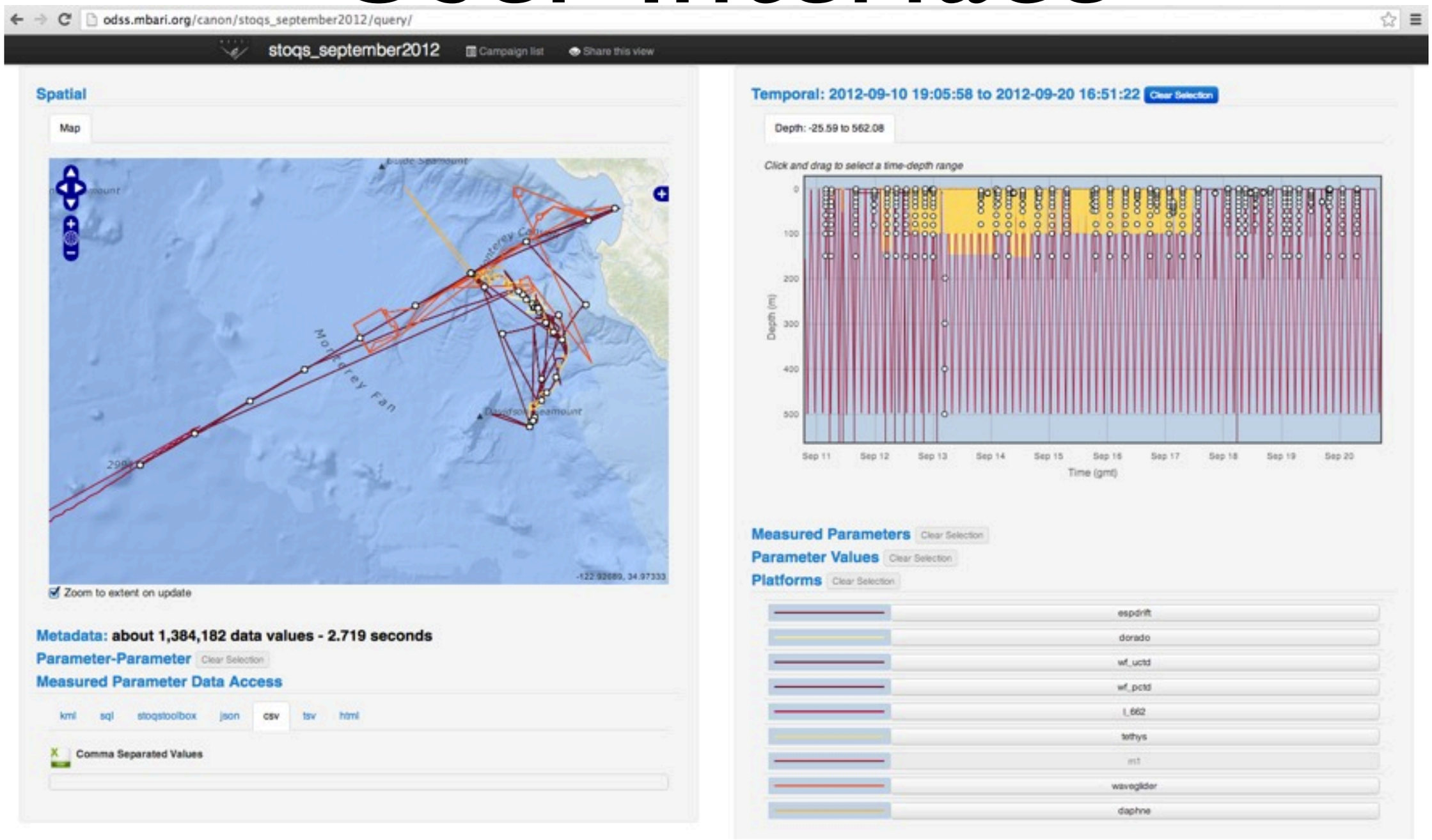
Server

Python with pydap, numpy, etc. | Minnesota Mapserver | GeoDjango ORM & web framework

Postgres + PostGIS



User Interface



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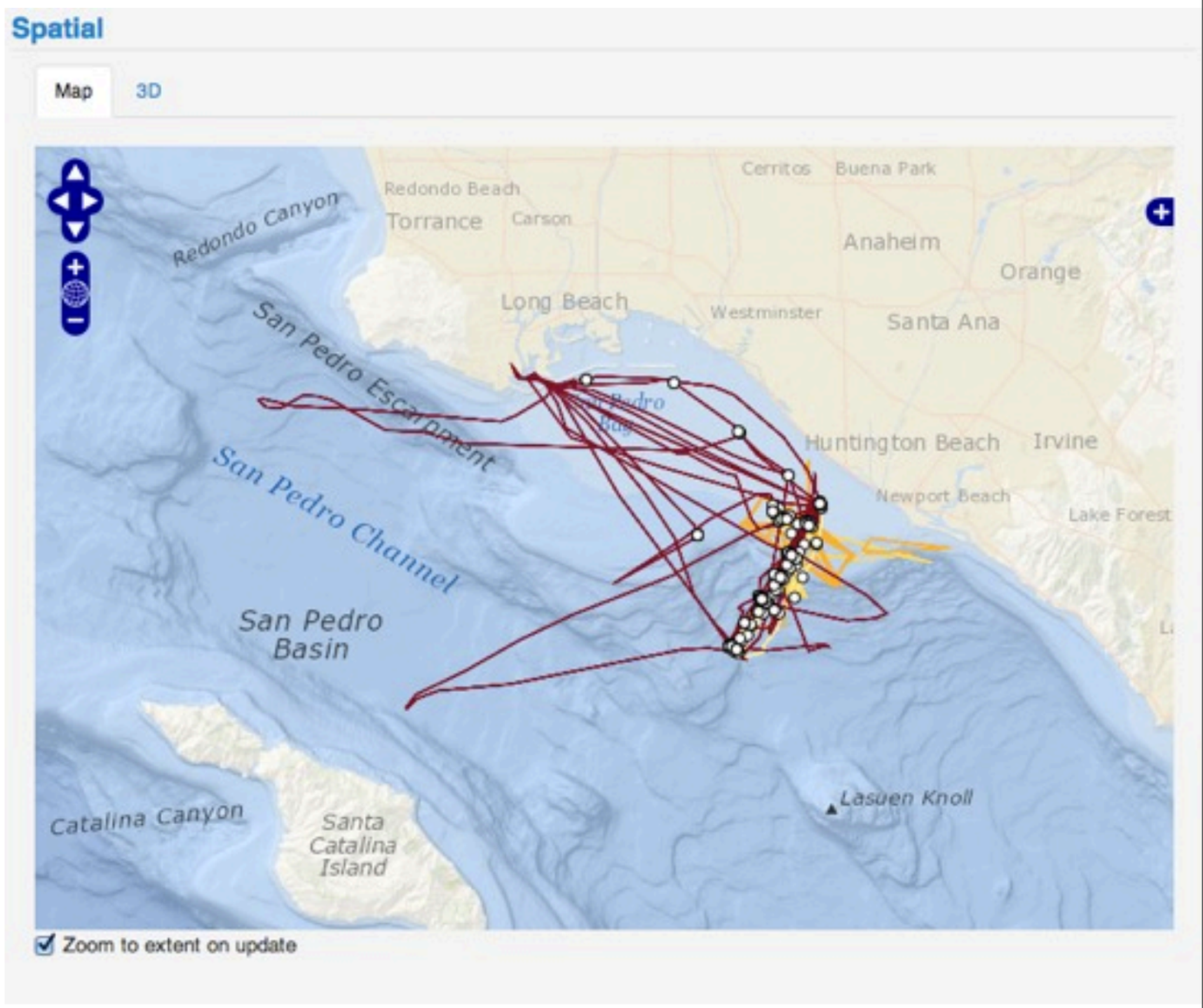
User Interface

- Spatial
  - Map: Mapserver generated tracklines rendered in OpenLayers
  - 3D: AJAX updates to X3DOM scenegraph
  - Sensor data display



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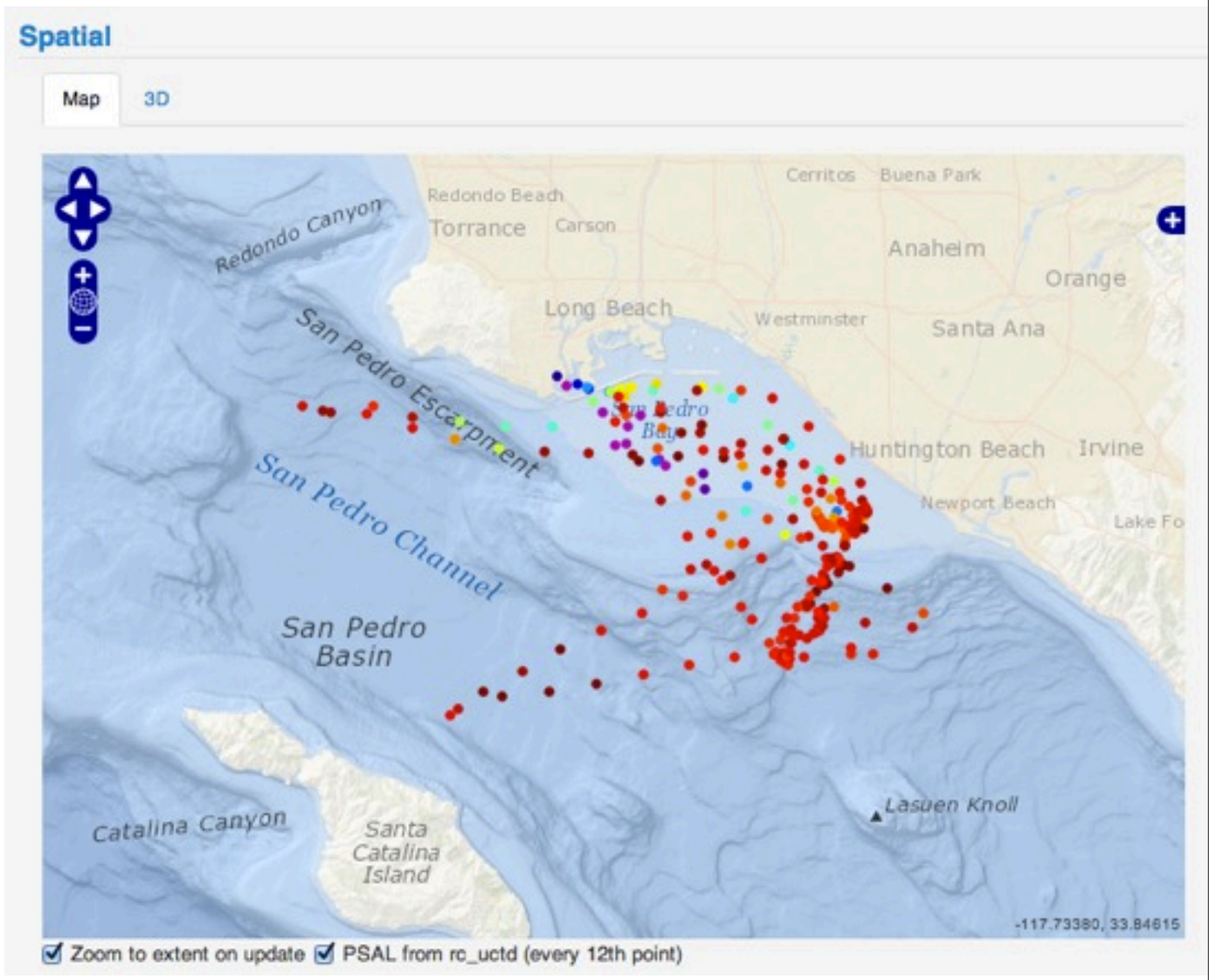

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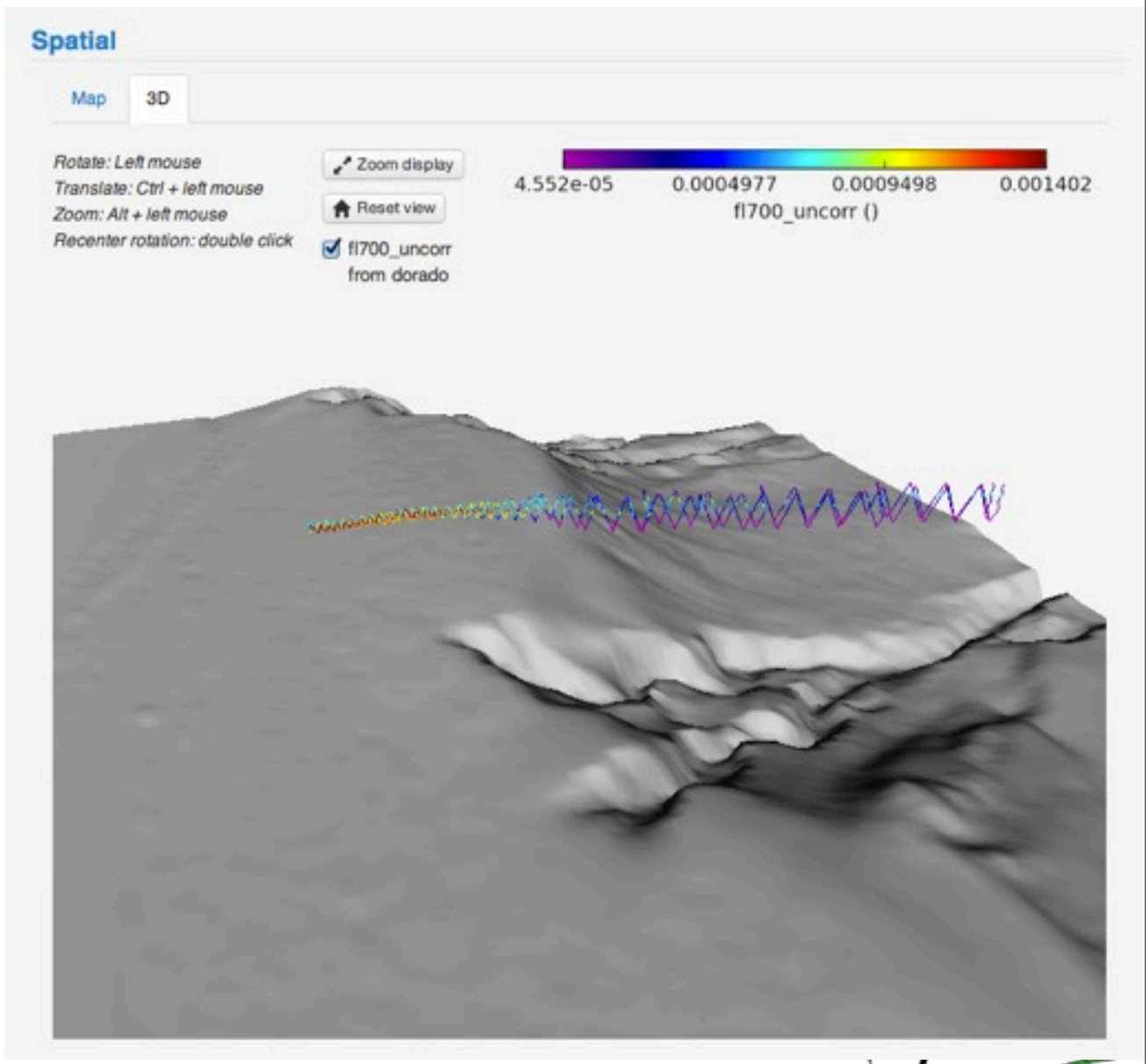

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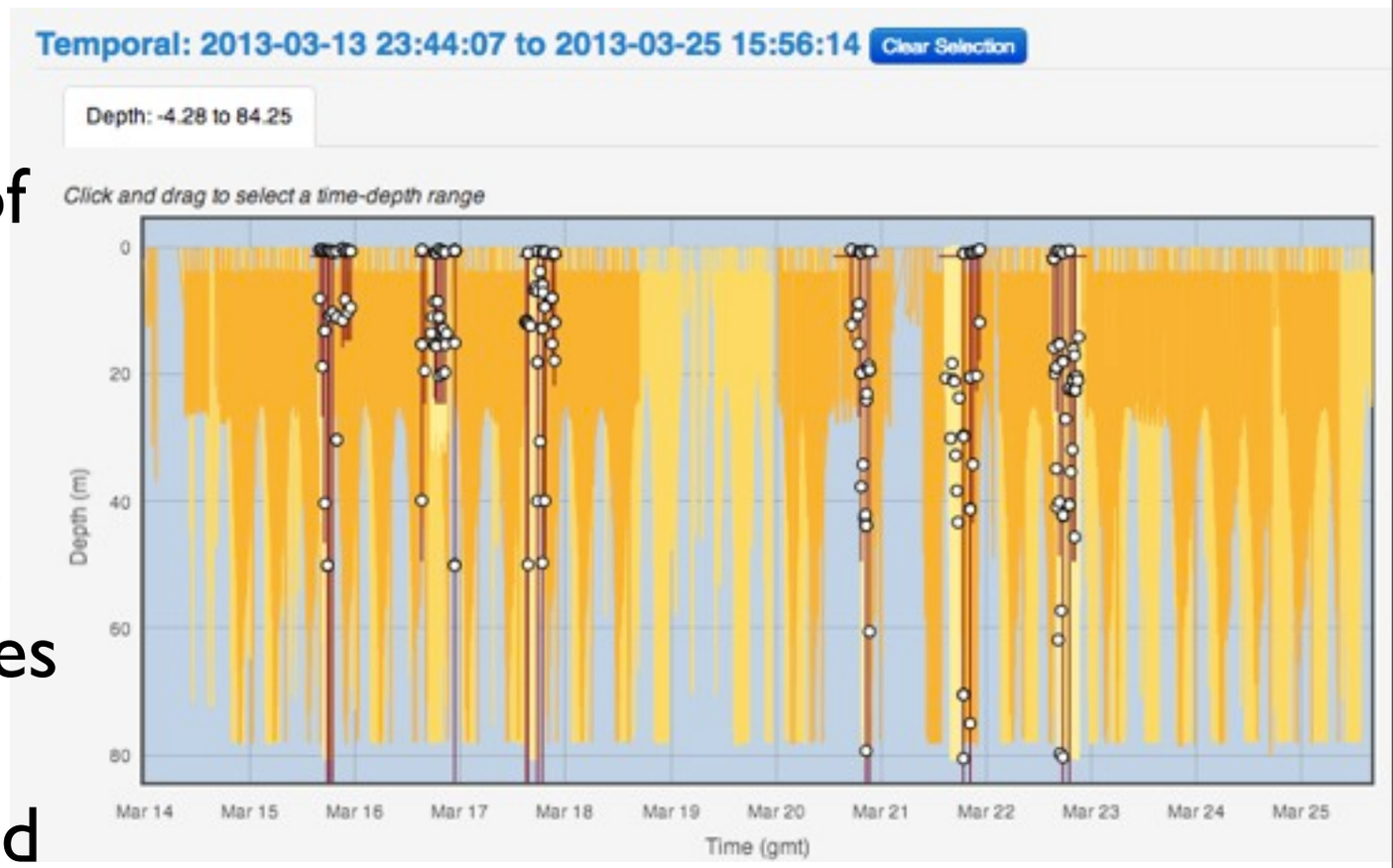
User Interface

- Temporal
  - Depth: Flot display of trajectories
  - Parameter: Flot display of timeSeries and timeSeriesProfiles
  - Sensor data rendered with Matplotlib on server



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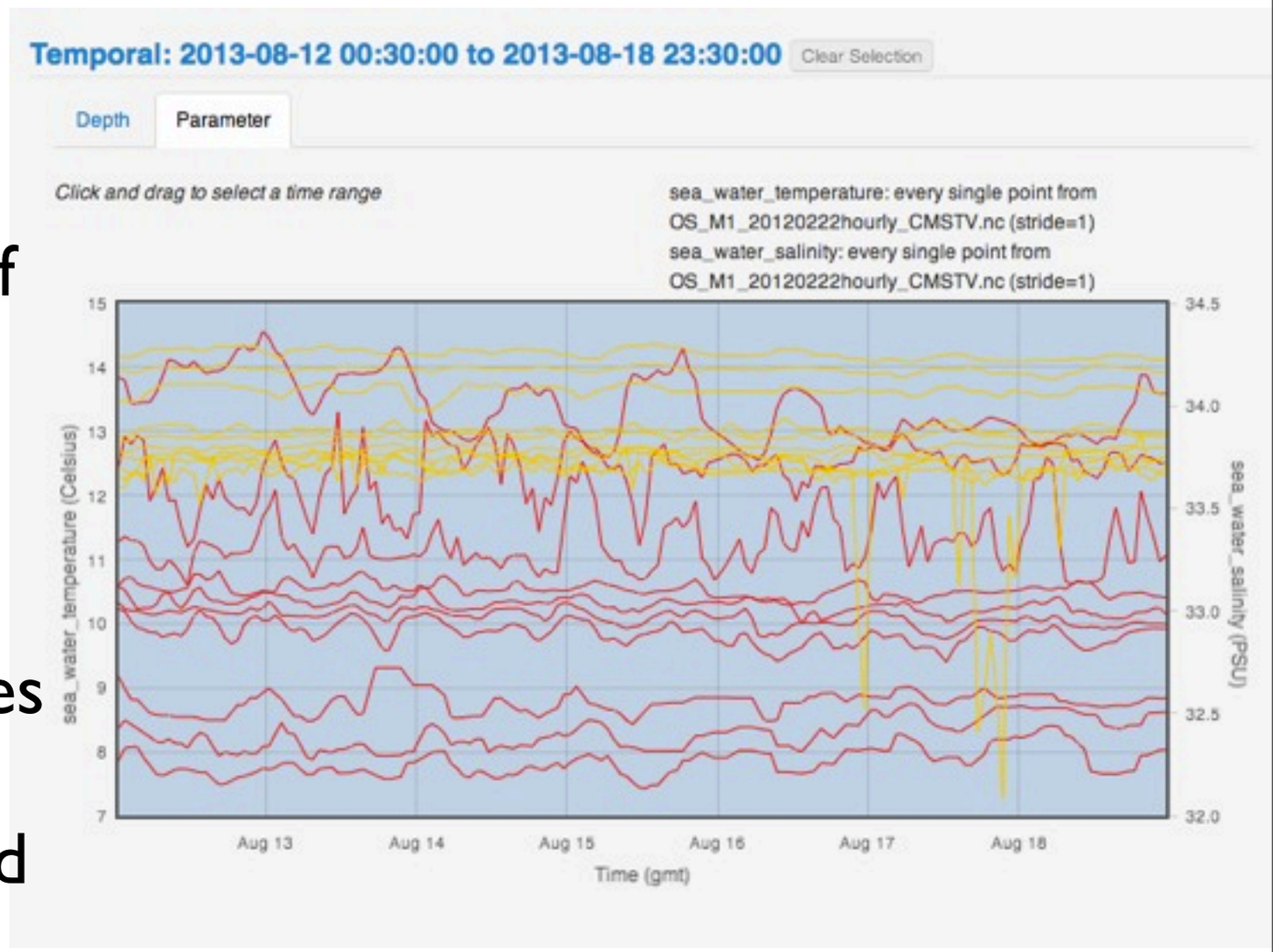

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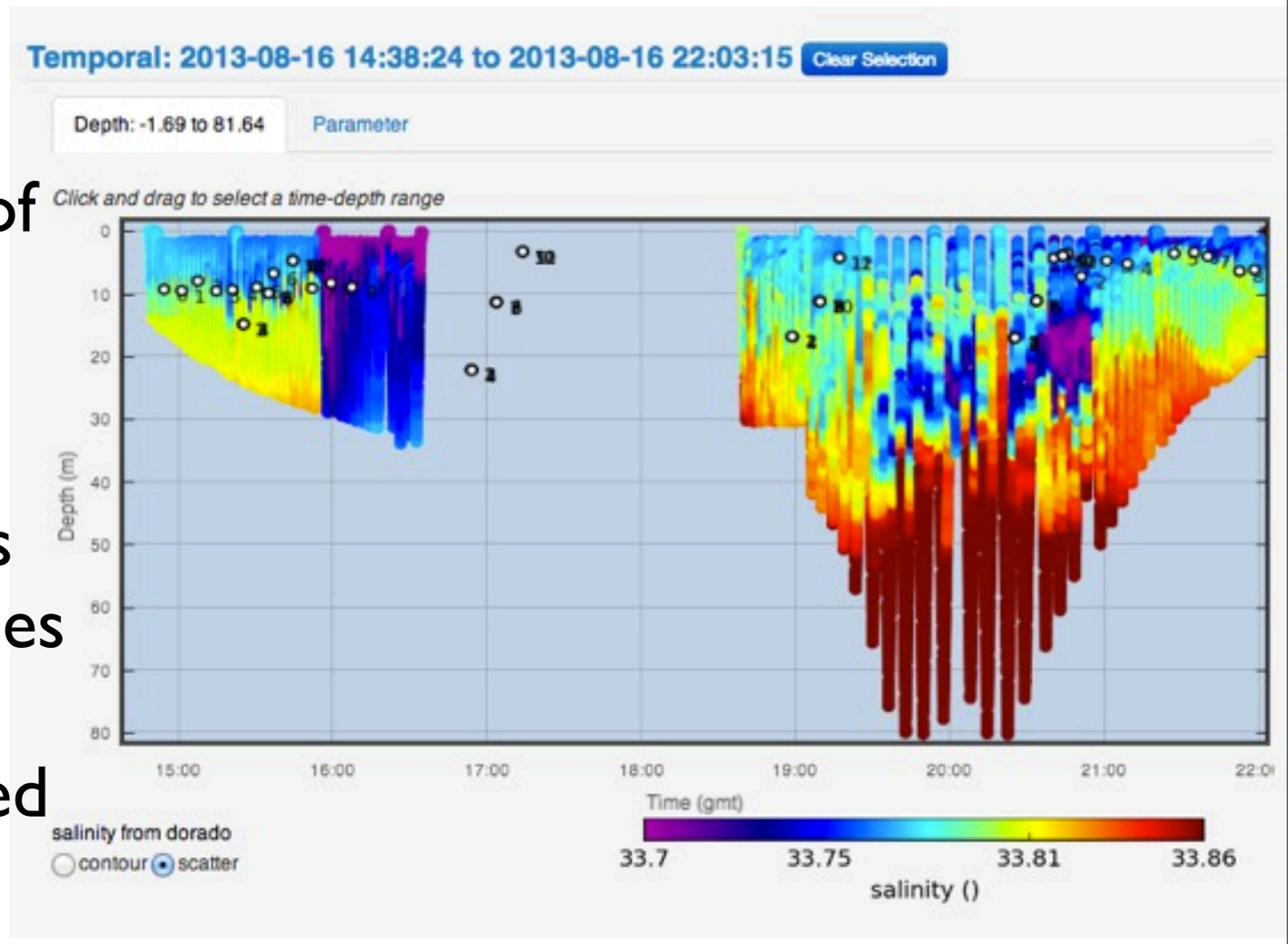

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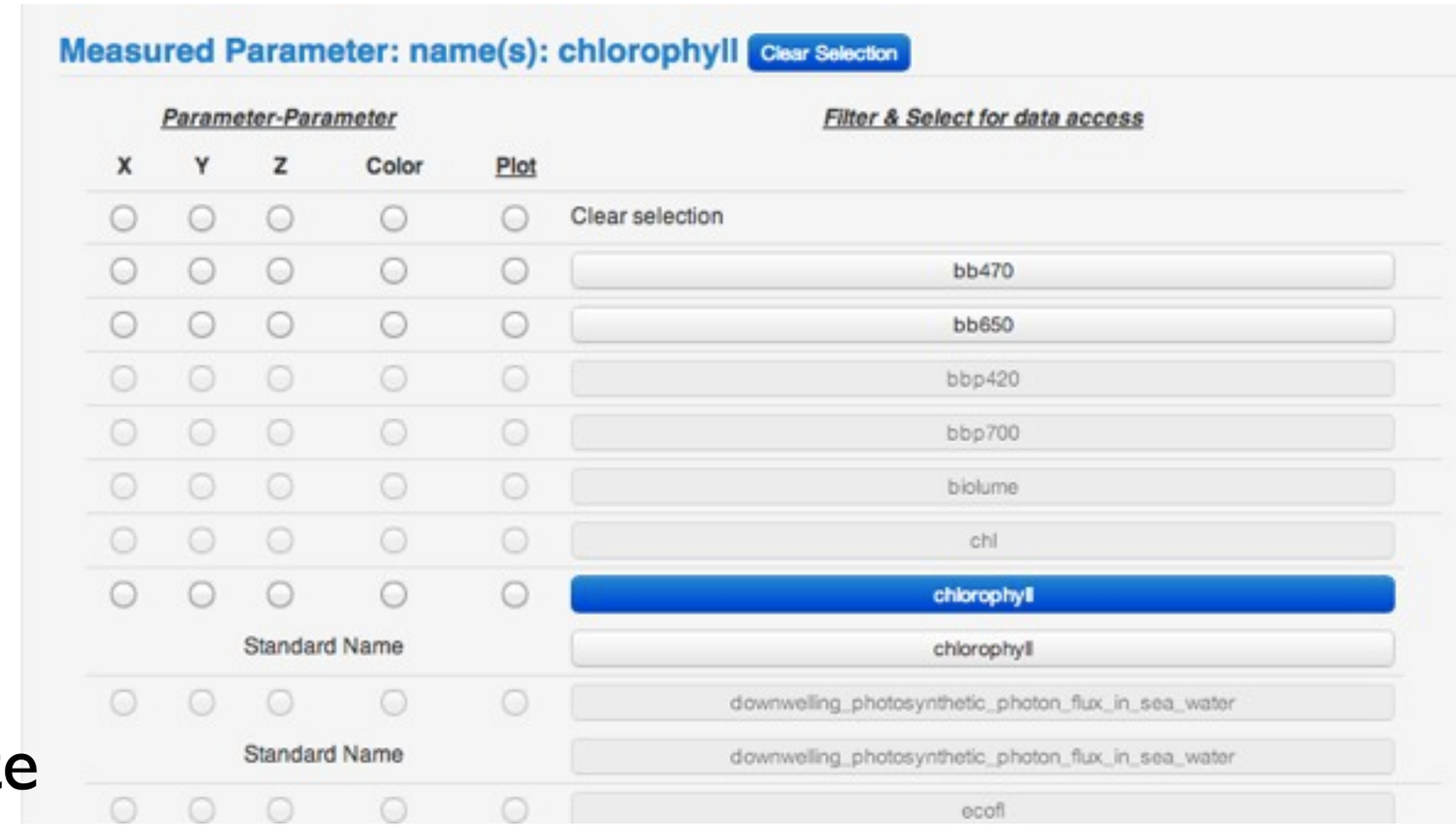
User Interface

- Faceted search
  - Parameters
  - Platforms
  - All displays update



User Interface

- Faceted search
- Parameters
- Platforms
- All displays update

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Data Flow

1. Install STOQS software on Linux server
2. Vehicles conduct missions collecting data
3. Create CF-NetCDF data files
4. Host files on OPeNDAP server(s)
5. Construct simple STOQS load script
6. Execute load

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20 March 2013

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The ECOHAB experiment—A first step toward predicting harmful algal blooms

Killing wildlife and occasionally sickening people, harmful algal blooms can be more than just a nuisance. But predicting these blooms is difficult—even more difficult than predicting the weather—because blooms result from a dynamic interaction between both physical and biological processes. Human activities, such as agricultural runoff and sewage discharges into the ocean, may also play a role.

The ECOHAB (Ecology and Oceanography of Harmful Algal Blooms) research program, sponsored by the National Oceanic and Atmospheric Administration (NOAA), is providing key information that may one day allow researchers to overcome these challenges and predict when and where blooms are likely to occur.

Since 2010, ECOHAB researchers have been conducting field experiments at two harmful algal bloom "hot spots"—Monterey Bay, in Central California, and San Pedro Bay, in Southern California. During March 2013, researchers will be conducting a month-long study of at the southern site in San Pedro Bay.

The ECOHAB research grant is overseen by Raphael Kudela of the University of California, Santa Cruz, but the field program involves a number of MBARI researchers, as well as MBARI's autonomous underwater vehicles (AUVs) and robotic DNA labs known as Environmental Sample Processors. Many of the tools and research strategies used in the ECOHAB experiment were developed as part of MBARI's Controlled, Agile, and Novel Observing Network (CANON) initiative.

These images show the study area for the March 2013 ECOHAB experiment. The left-hand image shows the tracks of a few ships, AUVs, and underwater gliders that were active during the second day of the experiment. The right-hand image shows this same area overlain by a satellite-derived map of chlorophyll, an indicator of marine algae near the sea surface (dark red areas have the highest amounts of chlorophyll). Real-time tracking of ships, robots, drifters, and ocean-conditions helps ECOHAB researchers monitor and plan their experiments from offices on shore. Base image: Google Maps

In pursuit of microscopic prey

During the March 2013 experiment, researchers are on the hunt for a microscopic alga (a diatom) called *Pseudo-nitzschia australis*. *Pseudo-nitzschia* diatoms sometimes produce a neurotoxin that can become concentrated in the bodies of small fish such as anchovies. When predators such as sea lions, pelicans, or other sea birds eat these fish, they may experience seizures and organ damage. The