ITMD Annual Workshop 2022

Data management and visualization for large datasets at CMOP

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CMOP coordinator

- History
- Observations
- Data Management
- Data Visualization/Access

History: How did we get here?

1990-2000: LMER

- Science
- Designed to study Estuarine Turbidity Maxima (ETM)
- "Blind" cruises

1996-2006: CORIE

- Science & Translation
- Multi-purpose design (driver: circulation modeling)
- Physical sensors
- Endurance stations
- Real-time data
- Open-access data
- Model-informed cruises
- IOOS/NANOOS pilot project

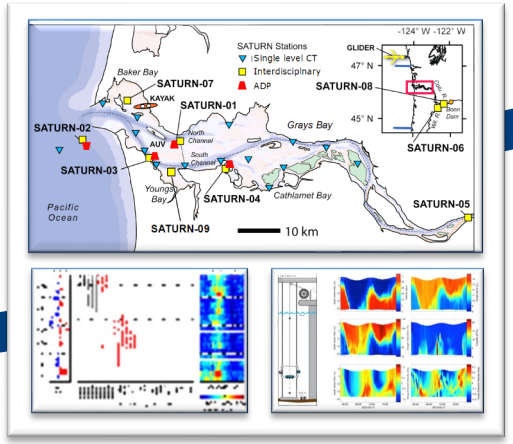
2006-2016: SATURN

- Science & Translation
- NSF-Science and Technology Center
- Multi-purpose design
- Interdisciplinary sensors
- Specialty endurance stations
- Pioneer array
- Coordinated campaigns
- Adaptive sampling
- IOOS/NANOOS sub-system

For historical context:

2007 – NOAA creates IOOS

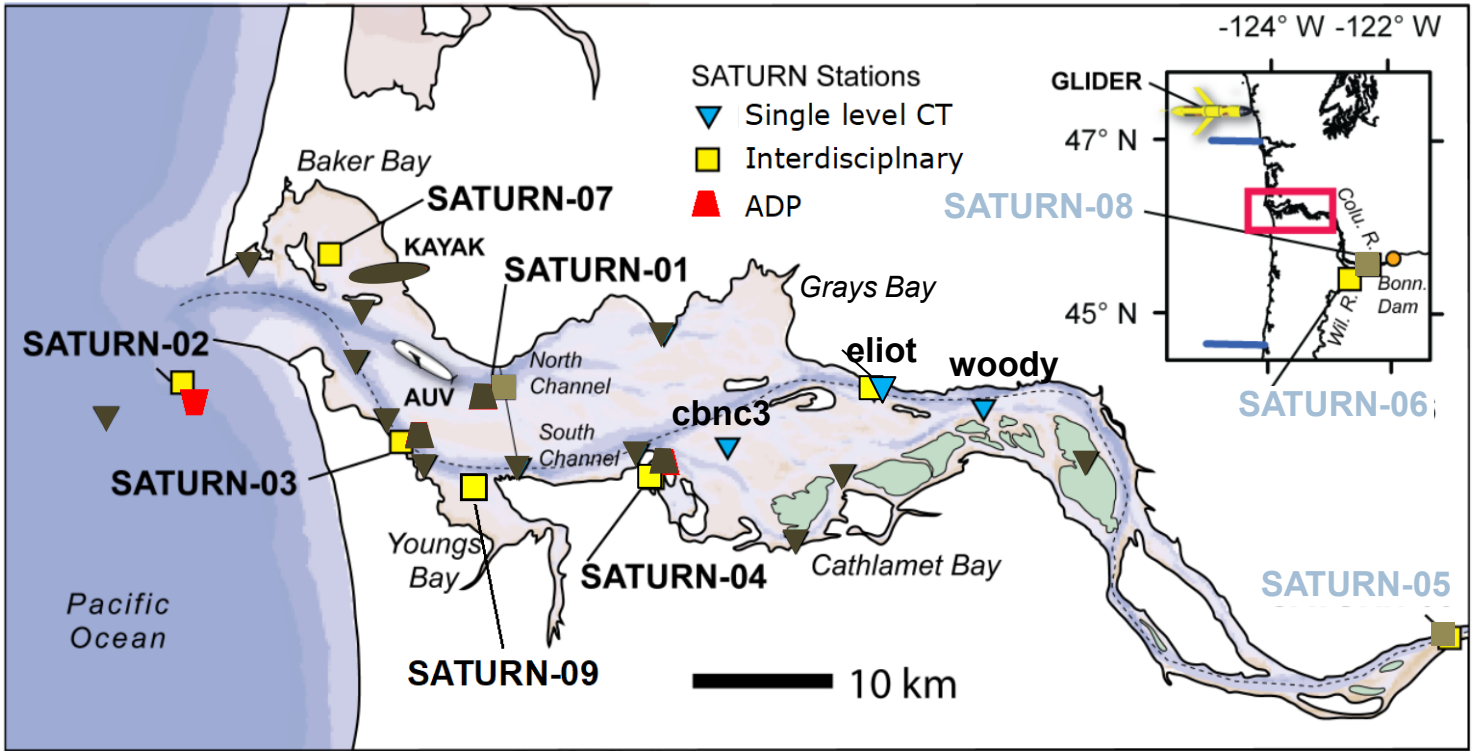
2007 – OOI IOs selected

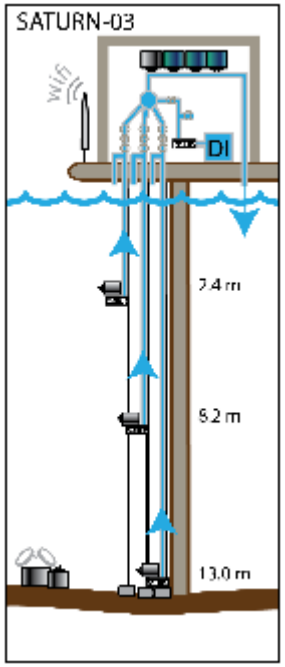


2020 onward: CMOP at CRITFC

- Interdisciplinary sensors
- Specialty endurance stations
- IOOS/NANOOS sub-system

Observations: Observation network (April 2022)





Station Design

Interdisciplinary stations

Offshore (SATURN-02): Jun-Oct

Pt Adams (SATURN-03): Year-round

Tongue Pt. (SATURN-04): Year-round

Baker Bay (SATURN-07): Year-round

Youngs Bay (SATURN-09): Year-round

North Channel (SATURN-01): -2017

Physical stations

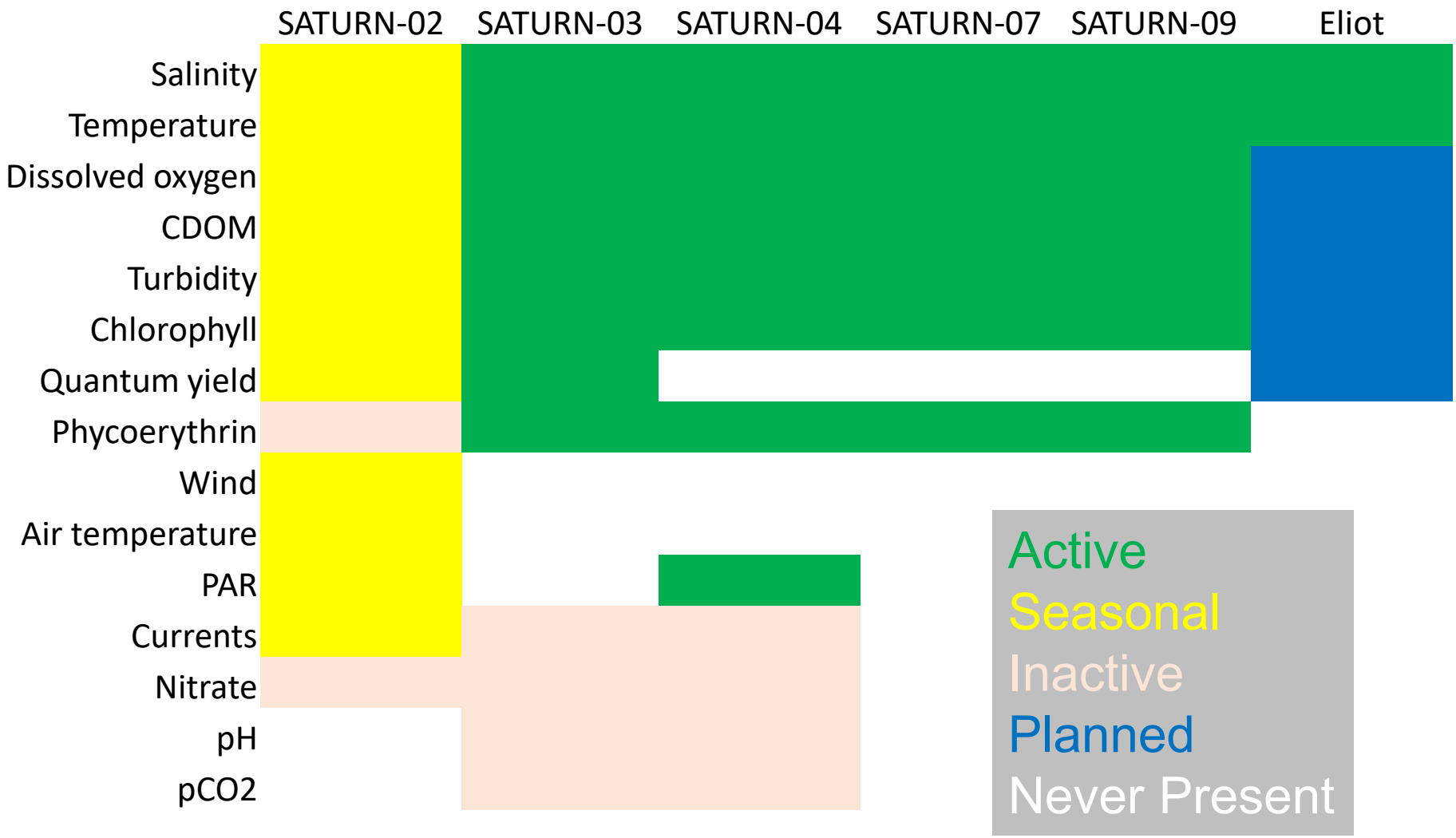
Elliott Pt. (eliot): Year-round, 2017-

Cathlamet Bay (cbnc3): Year-round
(no telemetry)

Woody Island (woody): Year-round

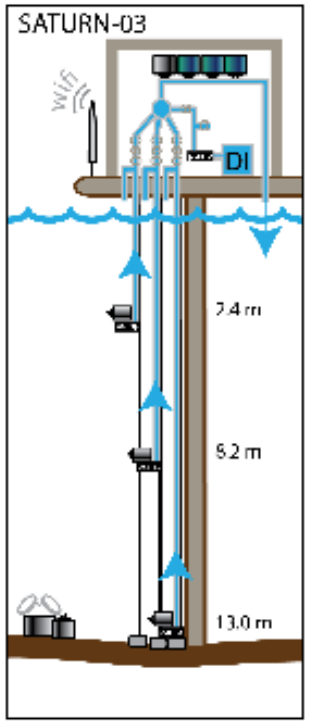
Upriver interdisciplinary stations:
SATURN-05 (Port Westward), SATURN-06 (Morrison Bridge), and SATURN-08 (Camas-Washougal) were developed by the Needoba-Peterson lab at OHSU as part of STC-CMOP in collaboration with USGS (-05, -06) and LCEP (-08). They did not transition to CRITFC-CMOP.

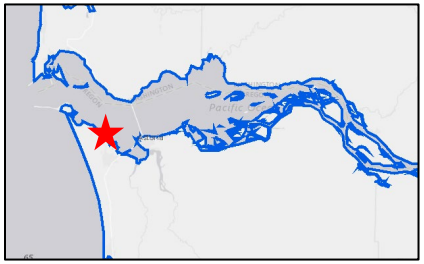
Observations: What we Measure



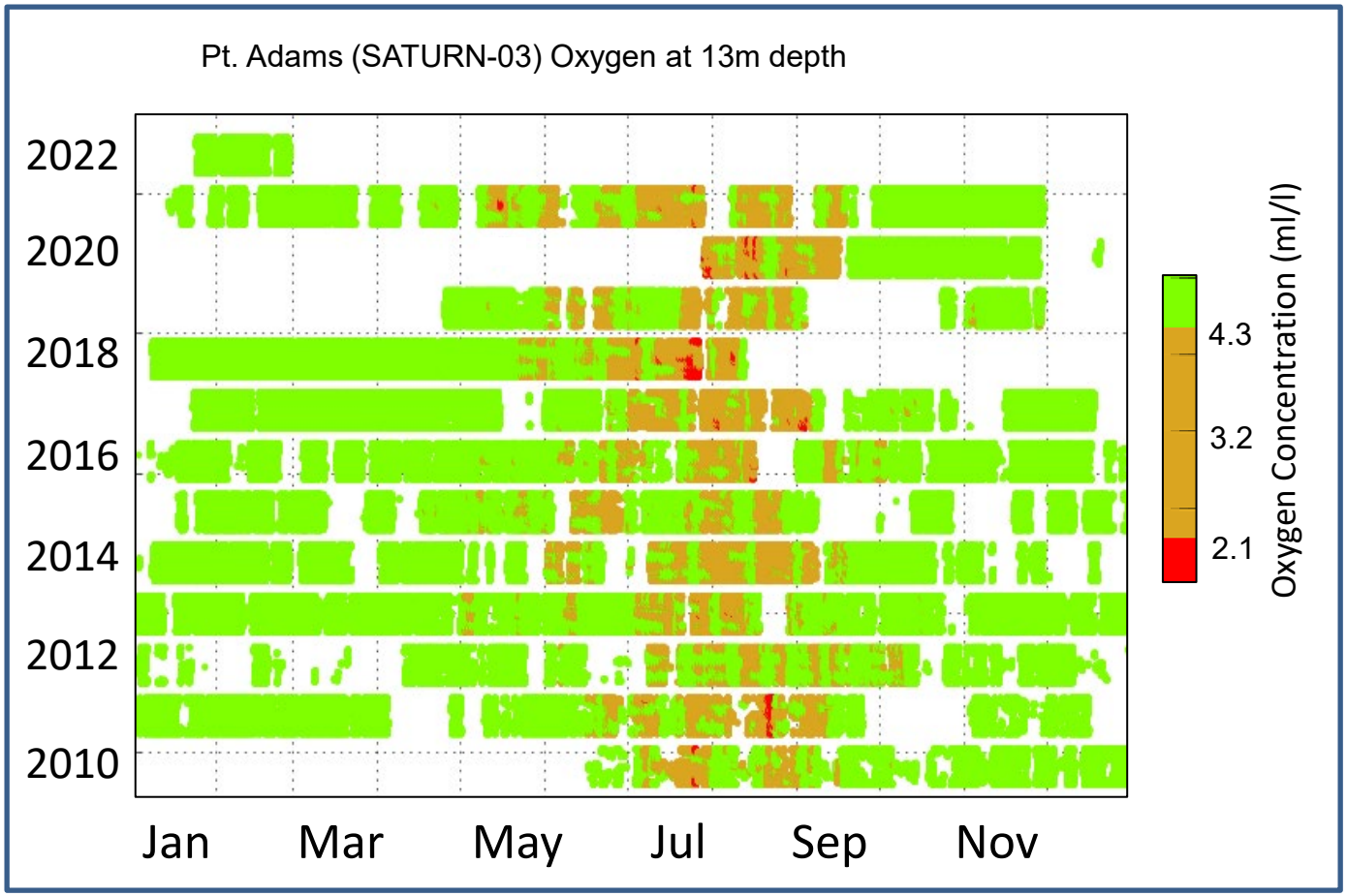
Cbnc3: salinity, temperature
Woody: temperature

Observations: Power of Long Timeseries

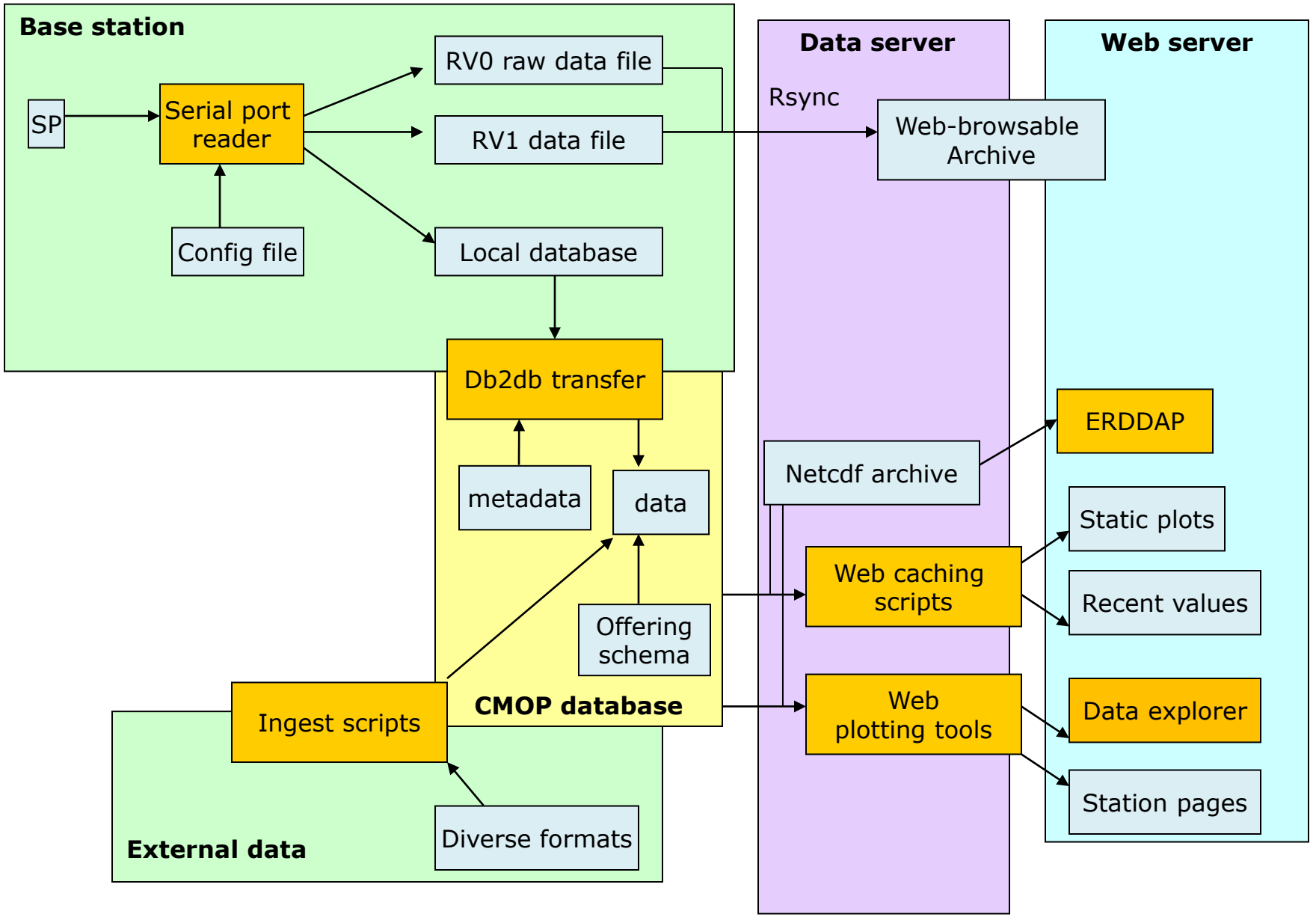




12-year history of hypoxia
in the lower estuary



Data Management: Data transfer system



Data tables and metadata: oxygen example

Deployment
Deploymentid
Station
Depth
Bracket
Instrument
Instrumenttype
DeployedOn
RetrievedOn
Samplerate
Currentornull

OxygenVoltage
Deploymentid
Time
OxygenVoltage
RawRecord
Entered

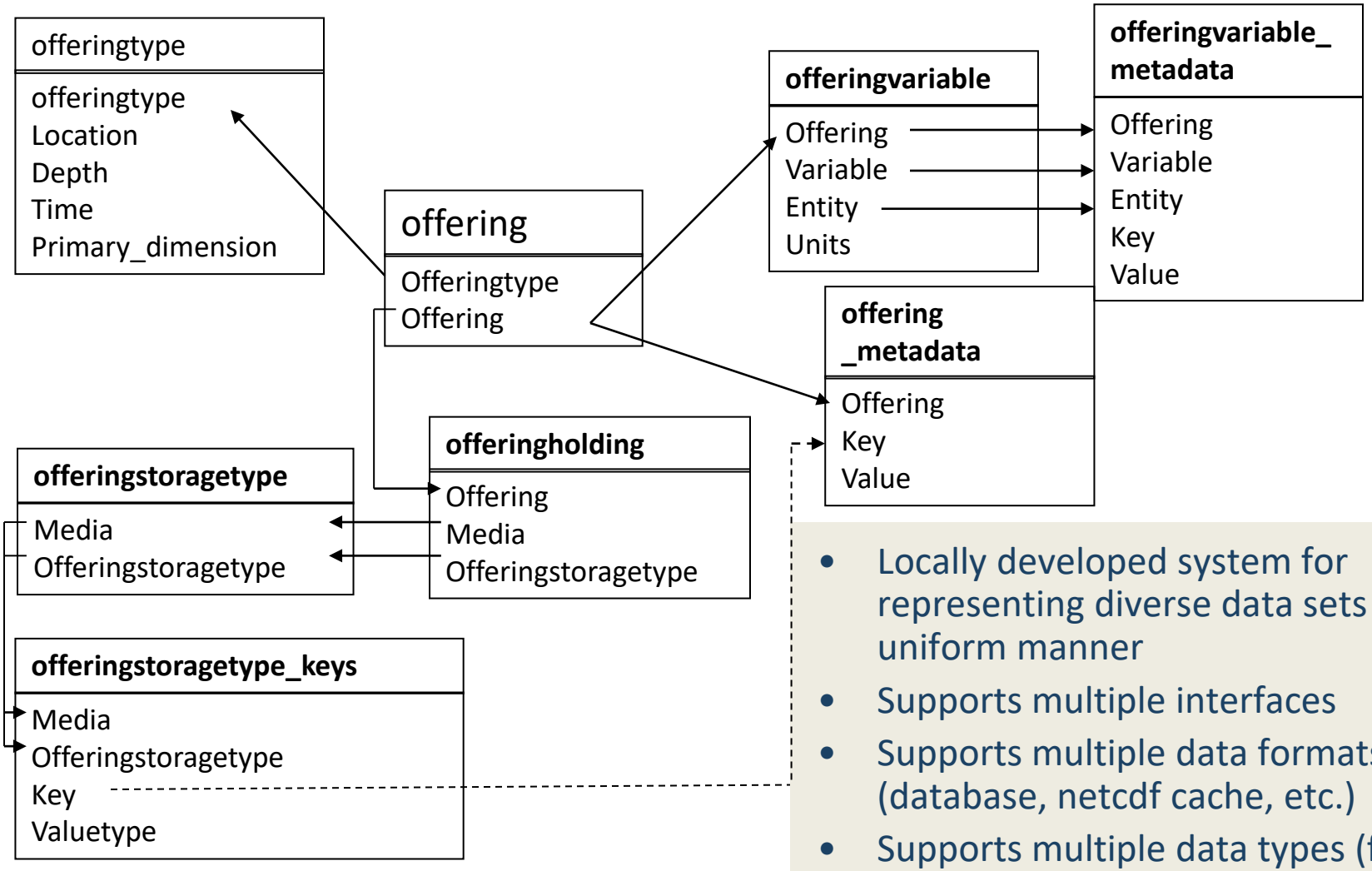
CTD
Deploymentid
Time
Temperature
Salinity
RawRecord
Entered

ConfigurationDetail
Deploymentid
Property
Type
Value

Oxygen
Deploymentid
Time
Oxygen
OxygenSaturation
Temperature
Salinity
RawRecord
Entered

- Each instrument has its own tables, with shared metadata tables for similar data types (e.g. fixed stations)
- For the example of oxygen, the oxygen sensor returns a voltage, which must be combined with instrument calibration coefficients and salinity and temperature from a co-deployed CTD to generate oxygen concentration and oxygen saturation
- Conversion from OxygenVoltage table to Oxygen table is handled by a dedicated script

Offering Schema



- Locally developed system for representing diverse data sets in a uniform manner
- Supports multiple interfaces
- Supports multiple data formats (database, netcdf cache, etc.)
- Supports multiple data types (fixed location timeseries, varying locations, sampling events, etc)
- Extensible to biological data

Example offering: Saturn03.1300.R.Oxygen

- Offering: Saturn03.1300.R.Oxygen, type: ‘fixed depth’
- Offering metadata:
  - Table Name: oxygen
  - Station: saturn03
  - Depth: 13m
  - Bracket: ‘R’
  - Pumped: true
- Offering variables:
  - Oxygen, units: ml/l, in water, offeringvariable_metadata:
    - Column: Oxygen
    - Sample rate: 3
    - Visibility: public
    - Dimensions: {‘time’:’time’}

Data access and visualization technologies

- Data access for long time series data from a database is not particularly fast, all fields of individual data records are contiguous rather multiple records of single field/variable
- NetCDF binary data format is designed for efficiently storing data with metadata in a format that allows rapid access along a primary data axis (e.g. time in a timeseries)
- CMOP-built interfaces use python to access and visualize from netcdf cache
- ERDDAP is an open-source tool developed by NOAA, which can be used to serve and visualize data (either raster/image data or tabular data) stored in a wide variety of formats, including databases, text files, netcdf files

Data access/visualization interfaces

- Data Explorer: used to generate the oxygen stripe plot (www.stccmop.org/datamart/observation_network/dataexplorer)
- Station pages (www.stccmop.org/datamart/observation_network)
- ERDDAP (coastwatch.pfeg.noaa.gov/erddap/index.html)
  - CMOP ERDDAP: data.stccmop.org:8080/erddap (in development)
- External sites:
  - NANOOS NVS (nvs.nanoos.org/Explorer)
  - NOAA NDBC (www.ndbc.noaa.gov/)
  - NCEI National archive (https://www.ncei.noaa.gov/access/search/index)
- Each external site uses its own data transfer protocol, although all are moving towards using ERDDAP

Data Management summary

- Data transfer from field to data center
- Raw data stored in text files and in database
- Processed data stored in instrument-specific database tables
- “Offering schema” used to connect instrument-specific tables to metadata
- Data converted from database tables into flat file cache in NetCDF format
- Data access and visualization uses NetCDF file cache for speedy access