



(Near) real-time data publication for coastal and deep-sea observing system using OGC Sensor Web Enablement (SWE) standards

E. Partescano, A. Brosich, A. Giorgetti, M. Lipizer and V. Cardin



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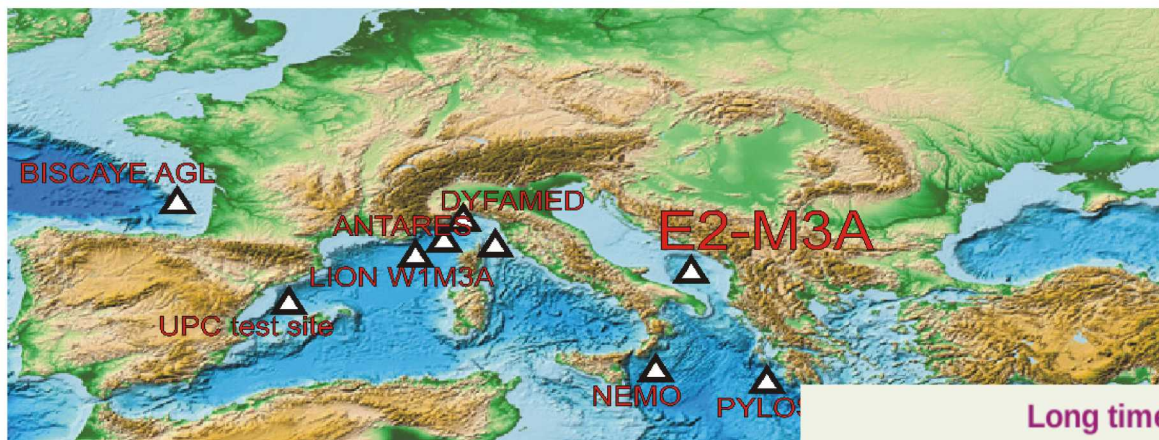


Purpose:

Describe a system developed at OGS to **share** in (near) real-time validated data from two meteo-oceanographic buoys using **OGC's Sensor Web Enablement (SWE)** standards aligned with several Oceanographic communities (EUROFLEETS2, FixO3 , Jerico-Next, ODIP II, RITMARE and SeaDataNet).

Device and Data

E2-M3A

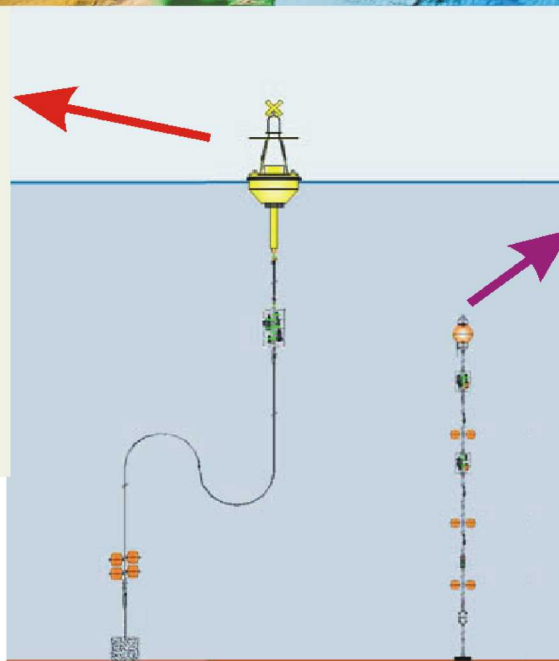


Real time (surface data)

Oceanographic parameters	Depth	Sampling interval
Temperature and Salinity	15 m	1 h
pH	15 m	12 h
pCO2	15 m	12 h
Meteorological parameters		
Atmosferic Pressure	3.5 m asl	30 min
Wind speed and direction	4.0 m asl	30 min
Air temperature	3.5 m asl	30 min
Relative humidity	3.5 m asl	30 min
Solar radiation	2.0 m asl	30 min

Long time series

Oceanographic parameters	Depth	Sampling interval
Temperature and Salinity	565, 1000, 1170 m	1 h
Temperature and Salinity	365, 765 m	3 h
Pressure	365, 565, 765, 1000 m	3 h
Turbidity	1204 m	1 h
Dissolved Oxygen	365, 765 m	3 h
Transmittance	365, 765 m	3 h
Currents (profiling)	150-300 m	1 h
Current	1180 m	1 h



<http://nettuno.ogs.trieste.it/e2-m3a>

Device and Data

E2-M3A

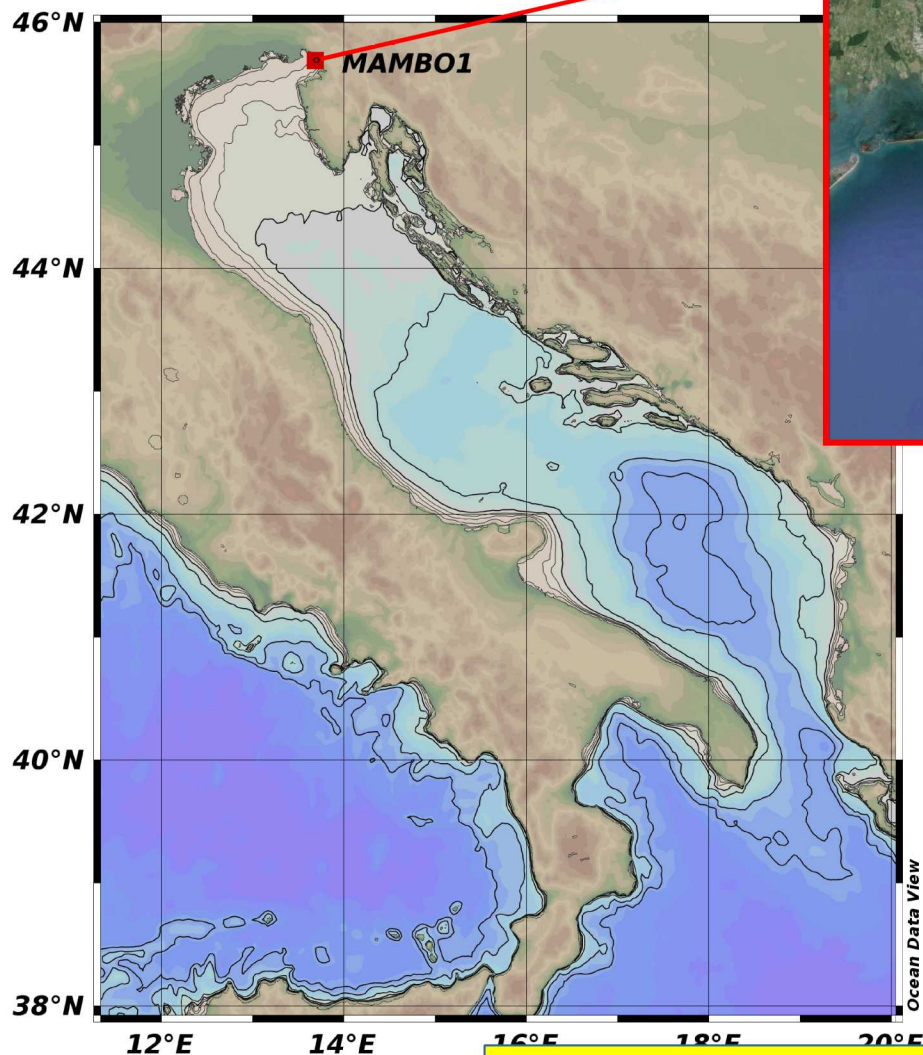


Oceanographic parameters	Depth	Sensor
Temperature and salinity	2 m	Seabird SBE37-SM
pHT	2 m	Sunburst SAMI pH
pCO2	2 m	Pro Oceanus CO2-Pro
pressure	2 m	Seabird SBE37-ODO
O2	2 m	Seabird SBE37-ODO
Temperature and salinity	15 m	Seabird SBE37-SM
Meteorological parameters	Depth	Sensor
Atmospheric pressure	3.5 m asl	Young 61202
Wind speed and direction	4 m asl	Young 04106
Air temperature	3.5 m asl	Young 41372
Relative humidity	3.5 m asl	Young 41372
Solar radiation	2 m asl	Eppley PSP
IR radiation	2 m asl	Eppley PSP

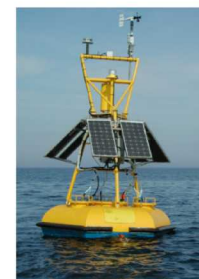


Device and Data

MAMBO1



Meteo-oceanographic coastal buoy named “MAMBO1” (Monitoraggio AMBIentale Operativo) is located in the Gulf of Trieste (northern Adriatic Sea)

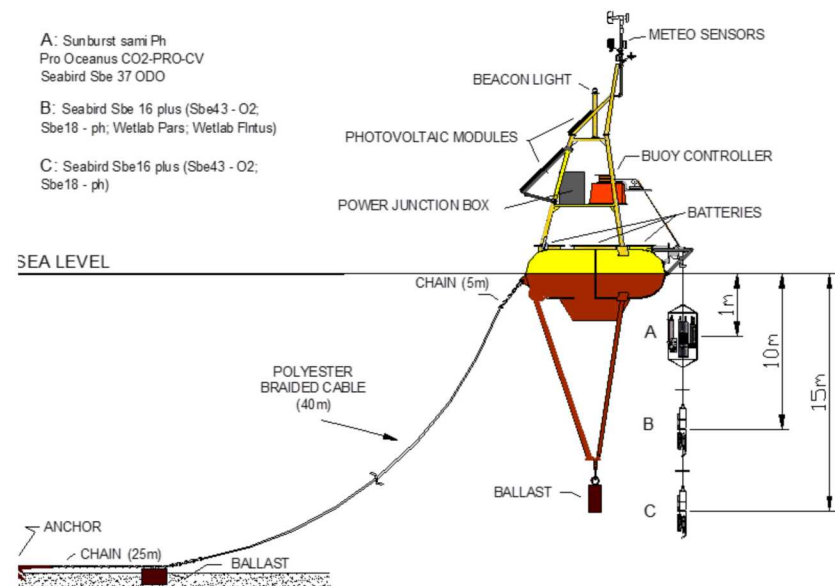


<http://nettuno.ogs.trieste.it/mambo>

Device and Data

MAMBO1

Meteorological parameters	Depth	Sensor
Atmospheric pressure	0 m	Young mod. 61201
Air temperature	0 m	Young mod. 41372VC
Wind speed and direction	0 m	Young Wind Monitor
Relative humidity	0 m	Young mod. 41372VC
Solar radiation	10 m	Wetlab Eco-PAR
Oceanographic parameters	Depth	Sensor
Temperature and salinity	1 m	Seabird SBE37-SM
pH	1 m	Sunburst SAMI pH Pro
pCO2	1 m	Pro Oceanus CO2 Pro
O2	1 m	Seabird SBE37-ODO
Temperature and salinity	10 m	Sea Bird16
O2	10 m	Sea Bird SBE43
pH	10 m	Sea Bird SBE18
Fluorescence	10 m	Wetlab Eco-AFL/FL
Turbidity	10 m	Wetlab Eco-NTU
Temperature and salinity	15 m	Sea Bird16
pH	15 m	ea Bird16
O2	15 m	Sea Bird16

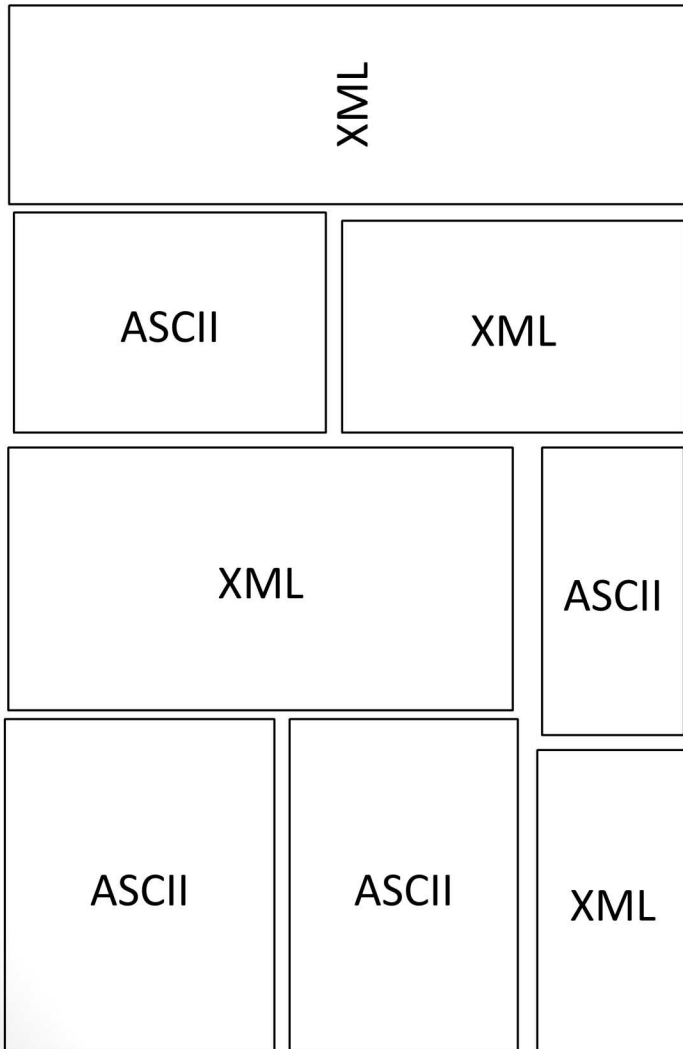


Complexity of information



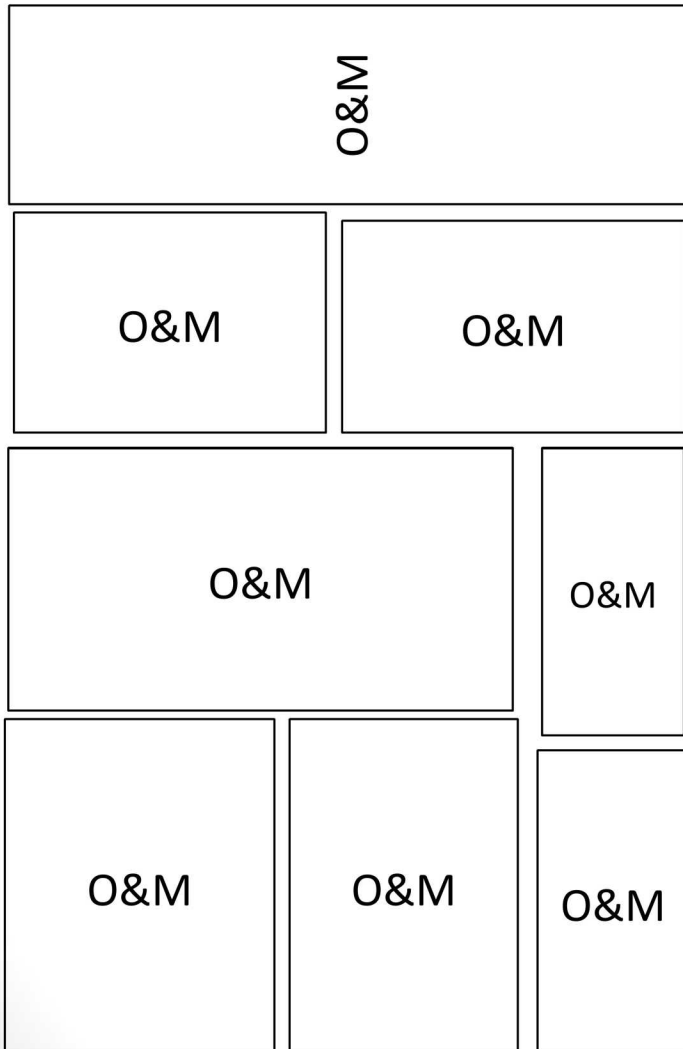
- data are acquired using different instruments
- different matrices
- acquired with different tools and methodologies
- at different spatial and temporal resolution
- specific procedures are developed to manage and distribute real-time data

Complexity of information



Transform heterogeneous data formats before to store them in the database, coming from different kind of instruments, with different formats (ASCII, XML, ...).

Type of data: the future (O&M XML Format)



Standardized format using standardized operations.

Sensor Web Enablement (SWE)

Sensor Registry

Get Capabilities

GetFeatureOfInterse

Capabilities

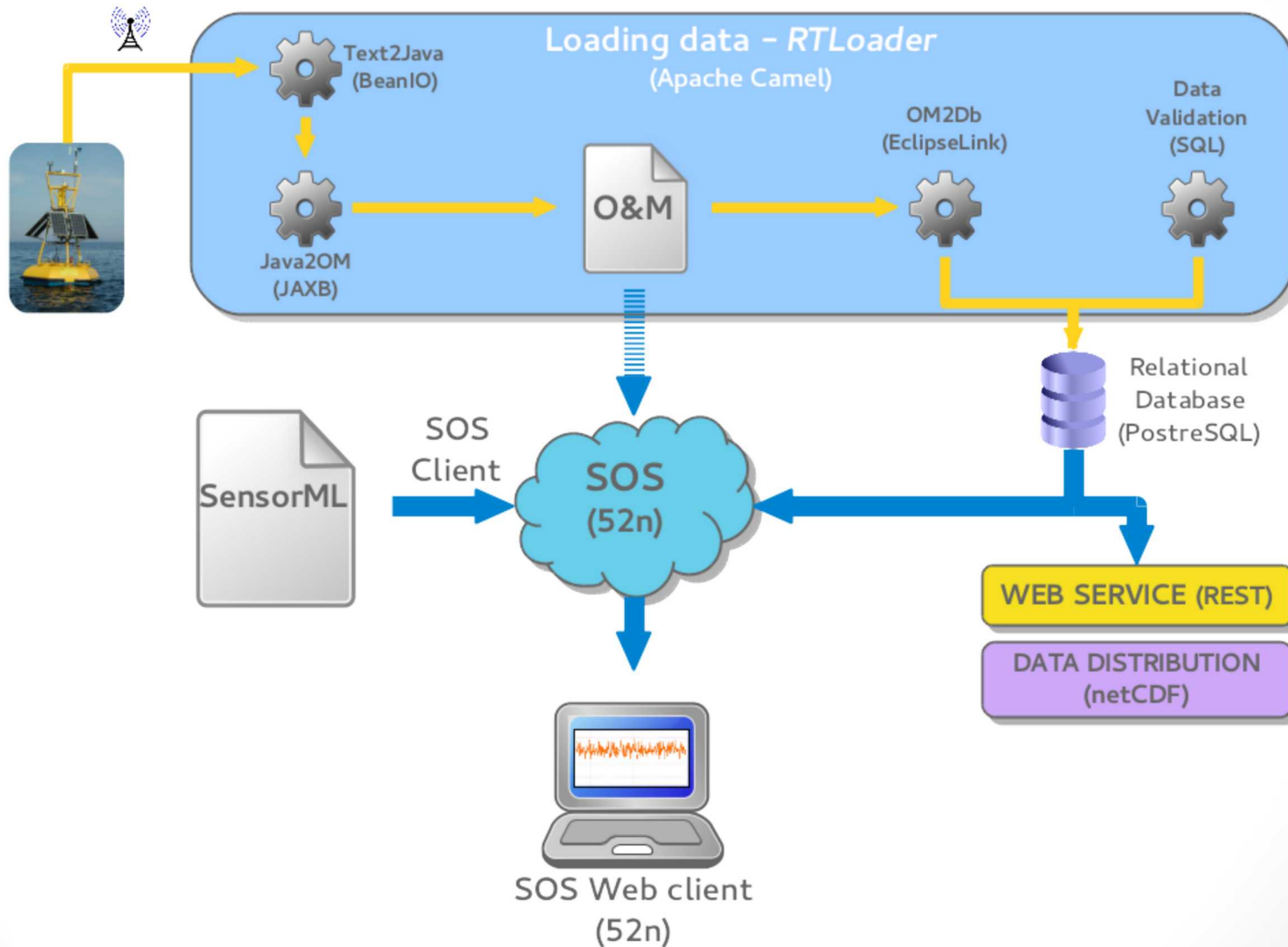
DescribeSensor

SensorML

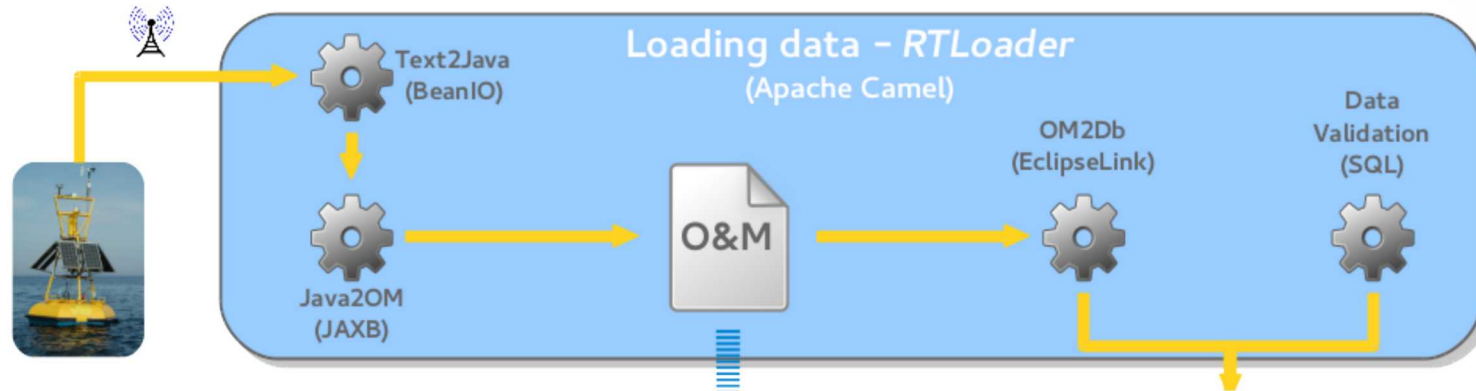
SOS

The OGC's Sensor Web Enablement (SWE) standards enable developers to make all types of sensors discoverable, accessible and useable via the Web.

Real – time Oceanographic Data Management System



Real – time Oceanographic Data Management System



- To store in the database real-time heterogeneous data, coming from different kind of instruments and with different formats (ASCII, XML, ...).
- The Java framework “Apache Camel” guarantees the possibility to manage the sequences, the queues and the end of the process

Data Validation

Check of the **date/time** and of the measuring position

Check of **duplicate** vertical profiles or measures

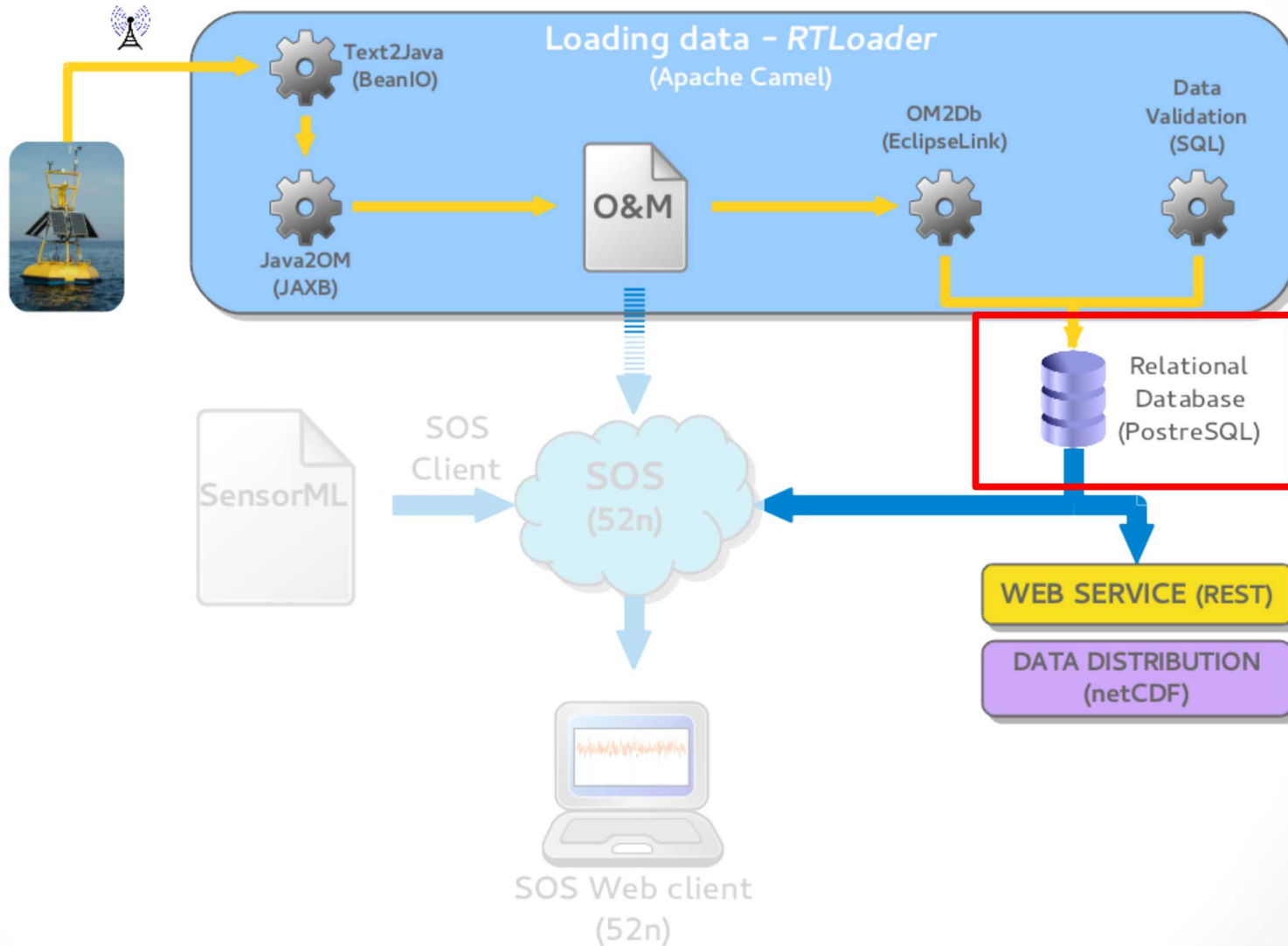
Checks for **missing data** and data format completeness

Check for **spikes** by testing data for large differences between adjacent values

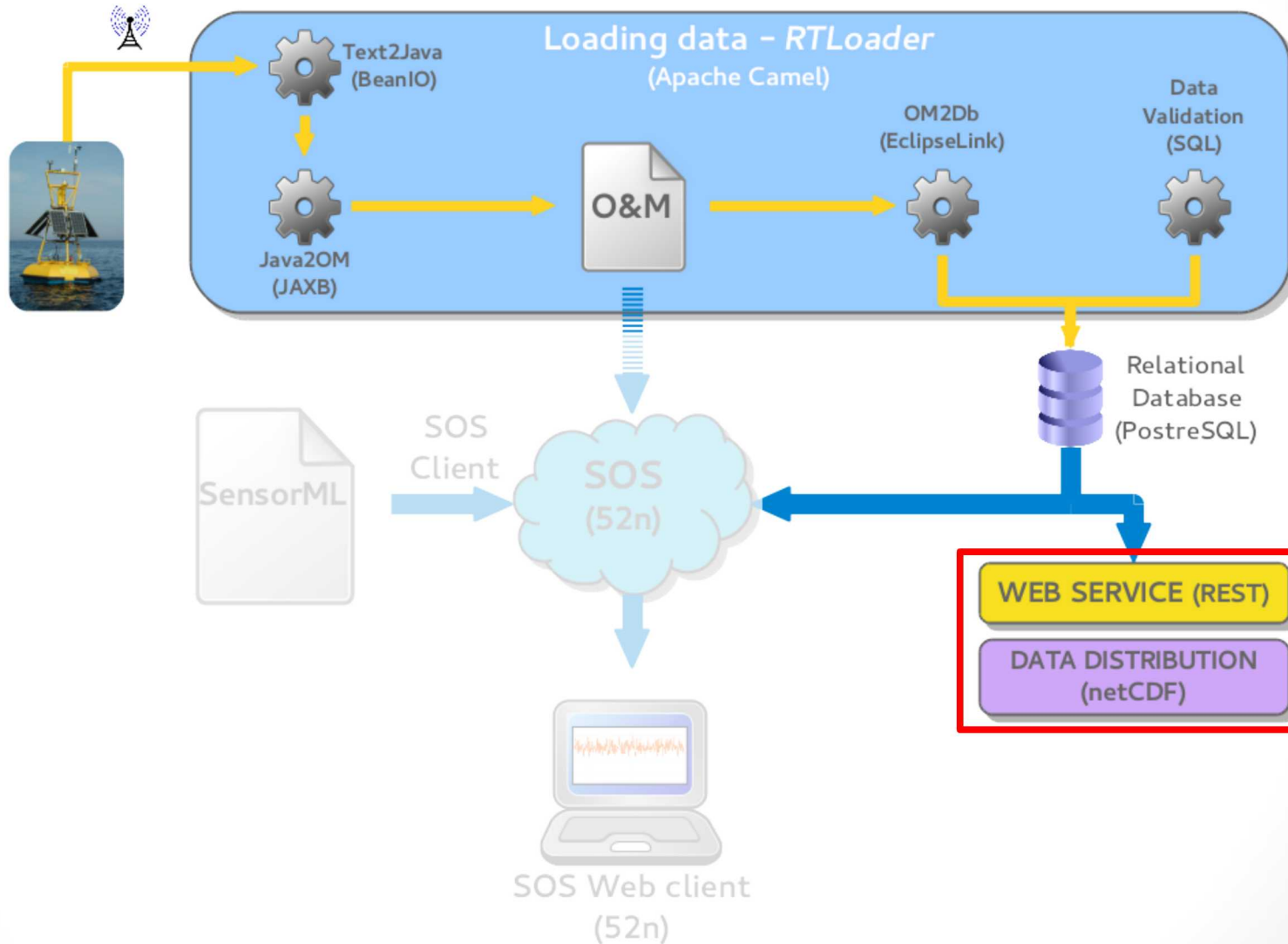
Check for **invalid values** by comparison with min & max values fixed for each parameter archived



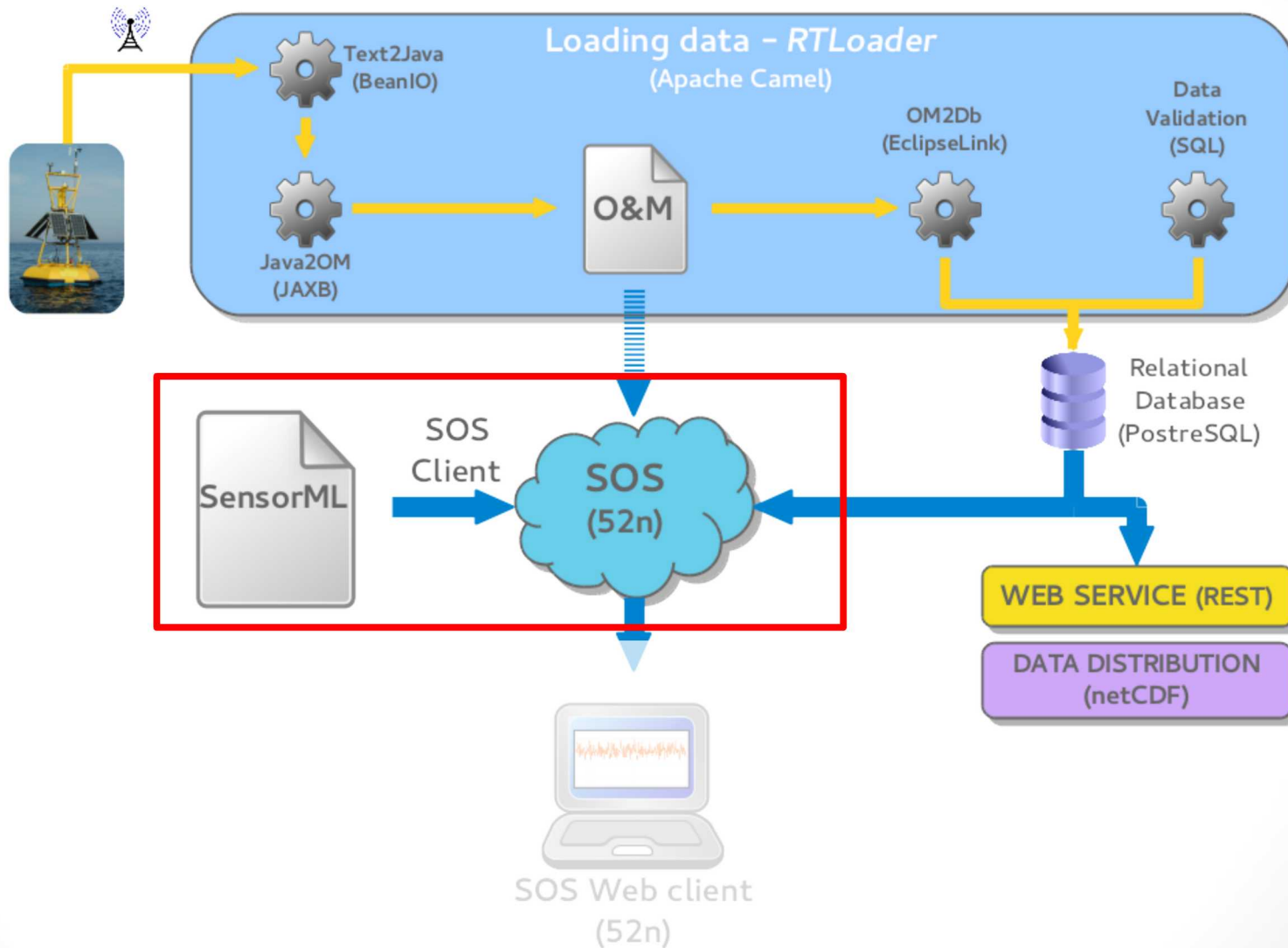
Real – time Oceanographic Data Management System



Real – time Oceanographic Data Management System



Real – time Oceanographic Data Management System



Sensor Web Enablement (SWE): **HOW**

SensorML

1. InsertSensor → SOS Client (52° North)

```
<!-- ===== -->
<!-- Created By: Elena Partescano NODC-OGS Trieste - 2015-03-25T18:00:00Z -->
<!-- ===== -->

<!-- ===== -->
<!-- System Search Keywords -->
<!-- ===== -->
<sml:keywords>
  <sml:KeywordList definition="http://vocab.nerc.ac.uk/collection/P03/current/D020">
    <sml:keyword>Other physical oceanographic measurements</sml:keyword>
  </sml:KeywordList>
</sml:keywords>
<!-- ===== -->
<!-- System Identifiers -->
<!-- ===== -->
<sml:identification>
  <sml:IdentifierList>
    <sml:identifier>
      <sml:Term definition="urn:ogc:def:identifier:OGS:uniqueID">
        <sml:label></sml:label>
        <sml:value>urn:ogc:object:feature:Sensor:OGS:CT_10597_E2M3A</sml:value>
      </sml:Term>
    </sml:identifier>
    <sml:identifier>
      <sml:Term definition="description">
        <sml:label>description</sml:label>
        <sml:value>The SBE 37-SMP-ODO MicroCAT is a high-accuracy conductivity and temperature (pressure optional) recorder with Serial interface, internal batteries, Memory, integral Pump, and Optical Dissolved Oxygen sensor. Constructed of titanium and other non-corroding materials for long life with minimal maintenance, the MicroCAT is designed for moorings or other long duration, fixed-site deployments. Calibration coefficients are stored in EEPROM, allowing output of C, T, P, DO, and time in ASCII engineering units (decimal or XML; raw output available); salinity, sound velocity, and specific conductivity can also be output.
      </sml:value>
      </sml:Term>
    </sml:identifier>
    <sml:identifier>
      <sml:Term definition="http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018">
        <sml:label>Short_Name</sml:label>
        <sml:value>SBE 37-SMP MicroCAT</sml:value>
      </sml:Term>
    </sml:identifier>
    <sml:identifier>
      <sml:Term definition="http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018">
        <sml:label>Long_Name</sml:label>
        <sml:value>Sea-Bird SBE 37-SMP MicroCAT C-T Sensor</sml:value>
      </sml:Term>
  </sml:IdentifierList>

```

Sensor Model Language (SensorML) is a OGC's XML standard models used to describe sensors and measurement processes.

SWE: metadata -> SensorML

```
<sml:Term definition="http://geossregistries.info/geosspub/resource_details_ns.jsp?compId=urn:geoss
  <sml:label>GEOSS_Resource_Details</sml:label>
  <sml:value>urn:geoss:csr:resource:urn:uuid:bc49af8b-573d-ea9a-ce8c-525be30a680a</sml:value>
</sml:Term>
</sml:identifier>
</sml:IdentifierList>
</sml:identification>
<!-- =====>
<!-- System Classifiers -->
<!-- =====>
<sml:classification>
<sml:ClassifierList>
<sml:classifier>
<sml:Term definition="http://vocab.nerc.ac.uk/collection/P02/current/TEMP">
  <sml:label>Intended Application1</sml:label>
  <sml:value>Temperature of the water column</sml:value>
</sml:Term>
</sml:classifier>
<sml:classifier>
<sml:Term definition="http://vocab.nerc.ac.uk/collection/P02/current/PSAL">
  <sml:label>Intended Application2</sml:label>
  <sml:value>Salinity of the water column</sml:value>
</sml:Term>
</sml:classifier>
<sml:classifier>
<sml:Term definition="http://vocab.nerc.ac.uk/collection/P02/current/AHGT">
  <sml:label>Intended Application3</sml:label>
  <sml:value>Vertical spatial coordinates</sml:value>
</sml:Term>
</sml:classifier>
<sml:classifier>
<sml:Term definition="http://vocab.nerc.ac.uk/collection/P02/current/DOXY">
  <sml:label>Intended Application4</sml:label>
  <sml:value>Dissolved oxygen parameters in the water column</sml:value>
</sml:Term>
</sml:classifier>
<sml:classifier>
<sml:Term definition="http://vocab.nerc.ac.uk/collection/L05/current/130">
  <sml:label>Sensor Type</sml:label>
  <sml:value>CTD</sml:value>
</sml:Term>
</sml:classifier>
<sml:classifier>
<sml:Term definition="http://vocab.nerc.ac.uk/collection/L19/current/SDNKG01">
  <sml:label>Deployment Role</sml:label>
  <sml:value>instrument</sml:value>
</sml:Term>
</sml:classifier>
```

SensorML

- WHAT
- WHERE
- WHEN
- HOW
- WHO

We developed a SensorML and O&M profiles using BODC vocabs: P01, P02, P03, P06, L05, L19, L22, L23 and connection to EDIOS catalog.

SWE: metadata -> Observations and Measurements (O&M)

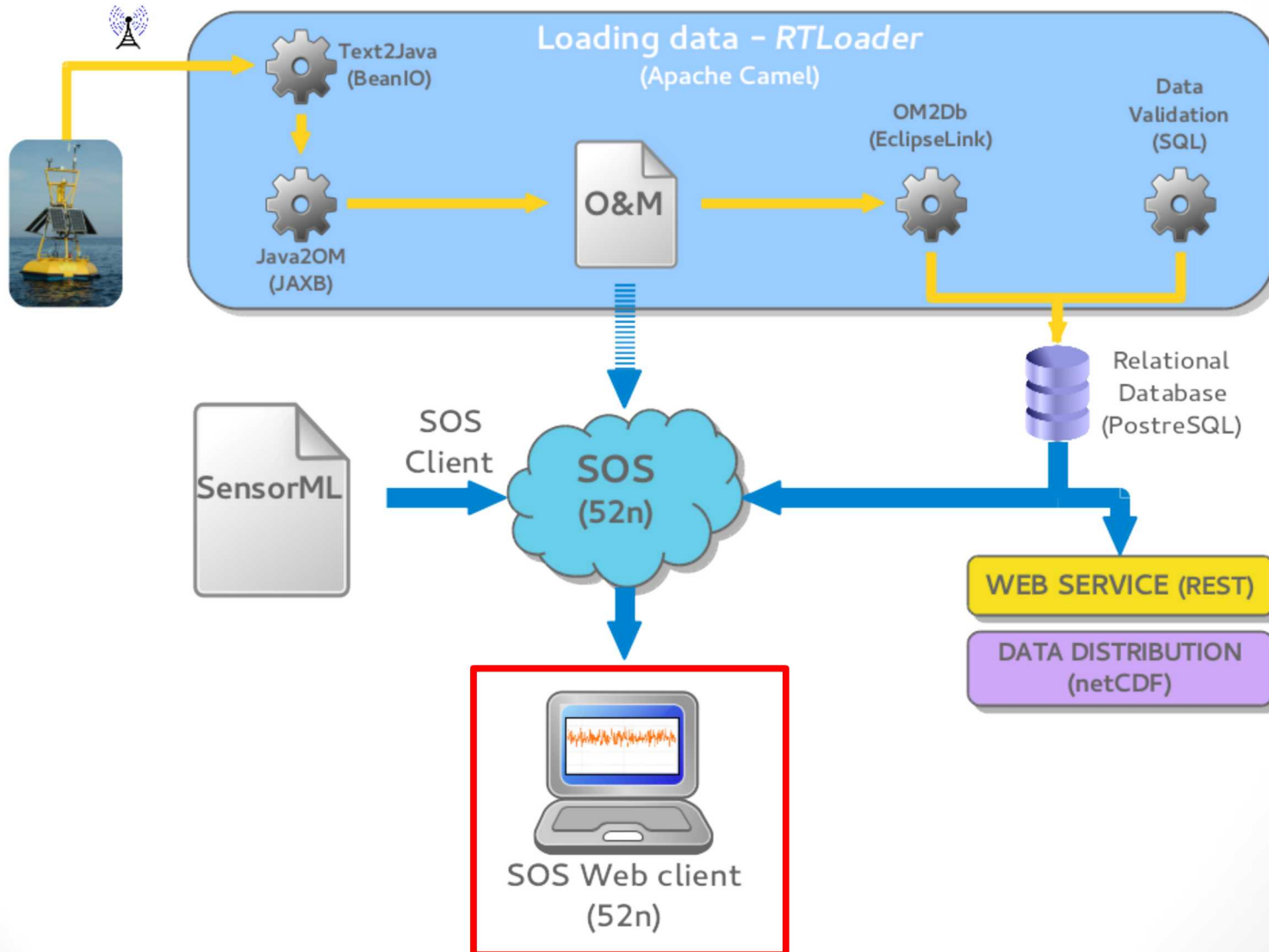
2. InsertObservations → REST – POST - request

```
</swe:Boolean>
</swes:extension>
<!-- multiple offerings are possible -->
<sos:offering>CT_E2M3A</sos:offering>
▼<sos:observation>
  ▼<om:OM_Observation gml:id="01">
    <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_SWEArrayObservation"/>
    ▼<om:phenomenonTime>
      ▼<gml:TimePeriod gml:id="phenomenonTime">
        <gml:beginPosition>2015-02-13T13:35:14Z</gml:beginPosition>
        <gml:endPosition>2015-07-29T07:58:08Z</gml:endPosition>
        </gml:TimePeriod>
      </om:phenomenonTime>
    ▼<om:resultTime>
      ▼<gml:TimeInstant gml:id="resultTime">
        <gml:timePosition>2015-08-06T14:40:13Z</gml:timePosition>
        </gml:TimeInstant>
      </om:resultTime>
    <om:procedure xlink:href="urn:ogc:object:feature:Sensor:OGS:CT_10597_E2M3A"/>
    <om:observedProperty xlink:href="http://vocab.nerc.ac.uk/collection/P01/current/DOXYZZXX"/>
    ▼<om:featureOfInterest>
      ▼<sams:SF_SpatialSamplingFeature gml:id="ssf_E2M3A">
        <gml:identifier codeSpace="">E2M3A</gml:identifier>
        <gml:name>E2M3A</gml:name>
        <sf:type xlink:href="http://www.opengis.net/def/samplingFeatureType/OGC-OM/2.0/SF_SamplingPoint"/>
        <sf:sampledFeature xlink:href="E2M3A_1"/>
        ▼<sams:shape>
          ▼<gml:Point gml:id="E2M3A">
            <gml:pos srsName="http://www.opengis.net/def/crs/EPSG/0/4326">41.5225 18.0895</gml:pos>
            </gml:Point>
          </sams:shape>
        </sams:SF_SpatialSamplingFeature>
      </om:featureOfInterest>
    ▼<om:result xsi:type="swe:DataArrayPropertyType">
      ▼<swe:DataArray>
        ▼<swe:elementCount>
          ▼<swe:Count>
            <swe:value>2828</swe:value>
          </swe:Count>
        </swe:elementCount>
        ▼<swe:elementType name="defs">
          ▼<swe:DataRecord>
            ▼<swe:field name="phenomenonTime">
              ▼<swe:Time definition="http://www.opengis.net/def/property/OGC/0/PhenomenonTime">
                <swe:uom xlink:href="http://www.opengis.net/def/uom/ISO-8601/0/Gregorian"/>
                </swe:Time>
              </swe:field>
            ▼<swe:field name="observable_property_oxy_E2M3A">
              ▼<swe:Quantity definition="http://vocab.nerc.ac.uk/collection/P01/current/DOXYZZXX">
                <swe:uom xlink:href="http://vocab.nerc.ac.uk/collection/P06/current/UMLL" code="mL/l"/>
                </swe:Quantity>
              </swe:field>
            </swe:DataRecord>
          </swe:elementType>
        </swe:encoding>
        <swe:TextEncoding tokenSeparator="#" blockSeparator="@"/>
      </swe:encoding>
    </om:result values>
    2015-02-13T13:35:14Z#5.26@2015-02-13T14:35:15Z#5.2@2015-02-13T15:35:14Z#5.15@2015-02-13T16:35:14Z#5.18@2015-02-13T17:35:
```

O&M

This standard defines XML schemas for observations. These provide document models for the exchange of information describing observation between different scientific and technical communities

Real – time Oceanographic Data Management System

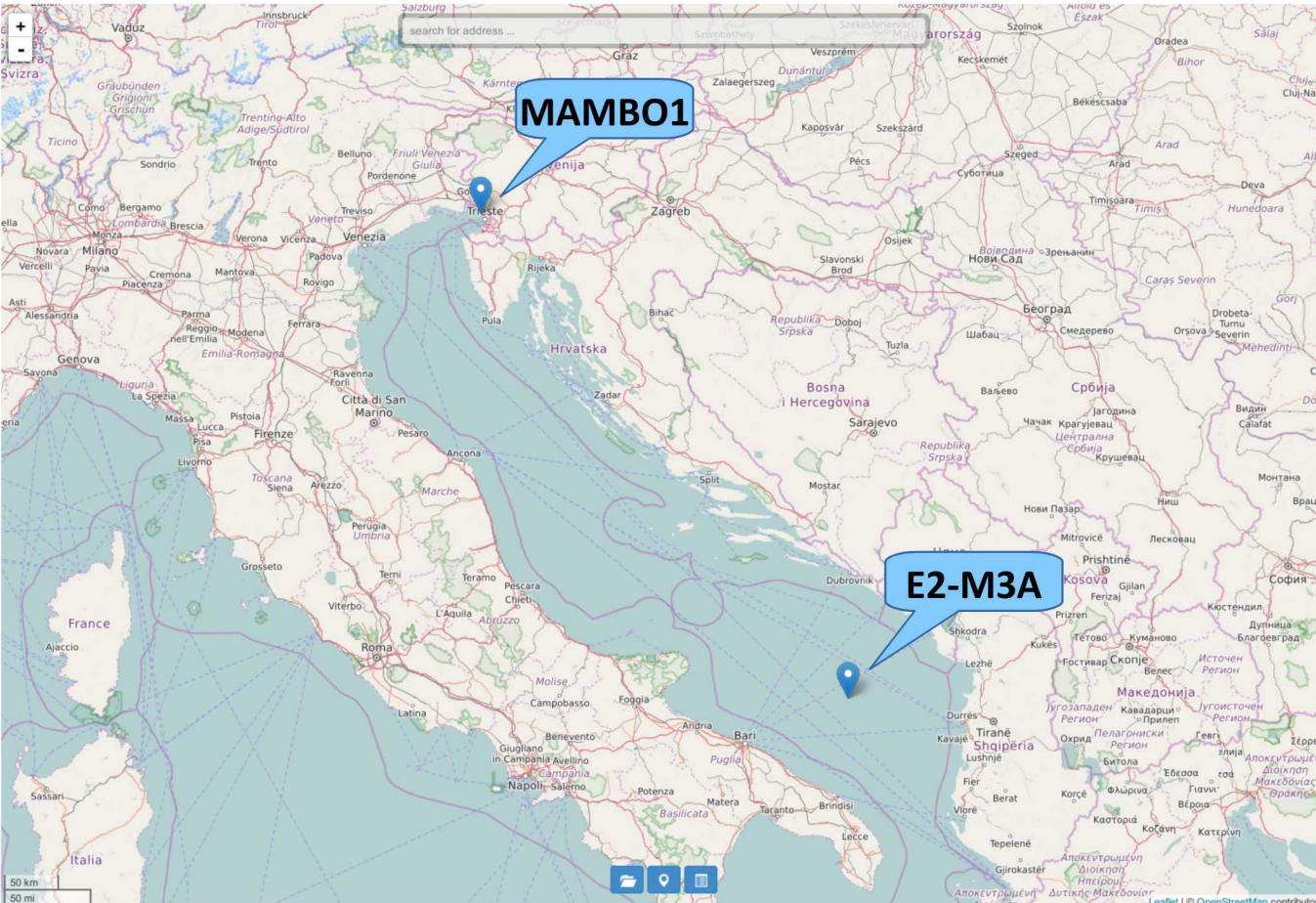


Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)

Select a station

★ Favorites  ⚙ Settings  Chart view



All Phenomena

- Concentration of oxygen (O₂) the water body
- Downwelling vector irradiance as energy (longwave)
- Downwelling vector irradiance as energy (solar wavelengths)
- Electrical conductivity of the water body
- Latitude
- Longitude
- Orientation (horizontal relative to magnetic north) of measurement platform
- Partial pressure of carbon dioxide (pCO₂) in the water body
- pH per unit volume of the water body
- Pressure exerted by the atmosphere
- Pressure exerted by the water body
- Relative humidity of the atmosphere
- Temperature (of measurement)
- Temperature of the atmosphere
- Temperature of the water body
- Wind from direction
- Wind from direction (gust)
- Wind speed (gust)
- Wind speed in the atmosphere

<http://nodc.ogs.trieste.it/sosWeb/>



Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)

The screenshot displays the web client interface for station MAMBO1. It is divided into three main sections:

- Map (Left):** A map showing the location of station MAMBO1 in Trieste, Italy. The map includes a search bar and a scale bar (50 km).
- Data List (Middle):** A list of sensor data for station MAMBO1. The data is organized into sections with checkboxes and star icons. The data points are:
 - pH per unit volume of the water body:** 7.189 pH_units (21.01.16 13:29 h)
 - Temperature of the atmosphere:** 19.37 degC (03.10.16 14:04 h)
 - Relative humidity of the atmosphere:** 41 % (03.10.16 14:04 h)
 - Pressure exerted by the atmosphere:** 1019.4 mBar (03.10.16 14:04 h)
 - Latitude:** 45.698 degree_north (03.10.16 14:02 h)
 - Longitude:** 13.709 degree_east (03.10.16 14:02 h)
 - Orientation (horizontal relative to magnetic north) of measurement platform:** 22.6 deg (03.10.16 15:04 h)
 - Wind from direction (gust):** 110.1 deg (03.10.16 14:04 h)
 - Wind speed (gust):** 13.4 ms (03.10.16 14:04 h)
 - Wind speed in the atmosphere:** 6.3 ms (03.10.16 14:04 h)
 - Wind from direction:** 114 deg (03.10.16 14:04 h)
- Phenomena List (Right):** A list of phenomena associated with the station. The list includes:
 - Concentration of oxygen (O2) the water body
 - Downwelling vector irradiance as energy (longwave)
 - Downwelling vector irradiance as energy (solar wavelengths)
 - Electrical conductivity of the water body
 - Latitude
 - Longitude
 - Orientation (horizontal relative to magnetic north) of measurement platform
 - Partial pressure of carbon dioxide (pCO2) in the water body
 - pH per unit volume of the water body
 - Pressure exerted by the atmosphere
 - Pressure exerted by the water body
 - Relative humidity of the atmosphere
 - Temperature (of measurement)
 - Temperature of the atmosphere
 - Temperature of the water body
 - Wind from direction
 - Wind from direction (gust)
 - Wind speed (gust)
 - Wind speed in the atmosphere

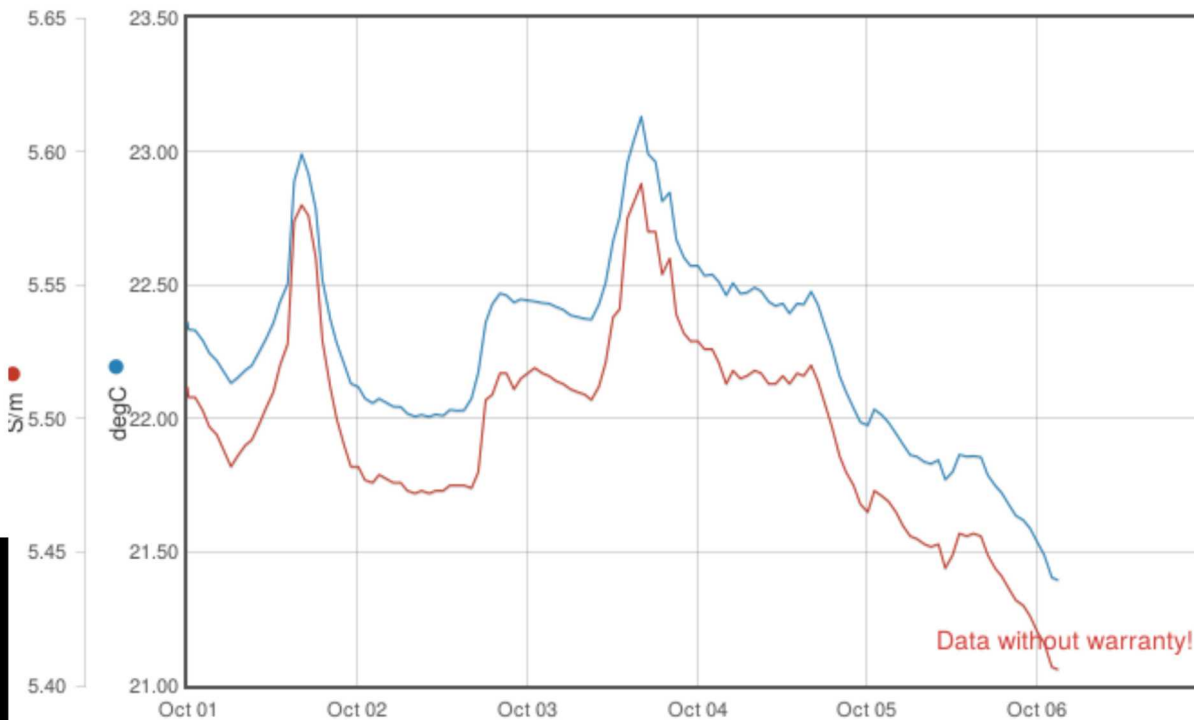
<http://nodc.ogs.trieste.it/sosWeb/>



Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)

Diagram



★ Favorites



⚙ Settings

🗺 Map view

Legend

E2M3A ☆

Temperature of the water body (degC)

urn:ogc:object:feature:Sensor:OGS:CT_10597_E2

M3A



E2M3A ☆

Electrical conductivity of the water body (S/m)

urn:ogc:object:feature:Sensor:OGS:CT_10597_E2

M3A

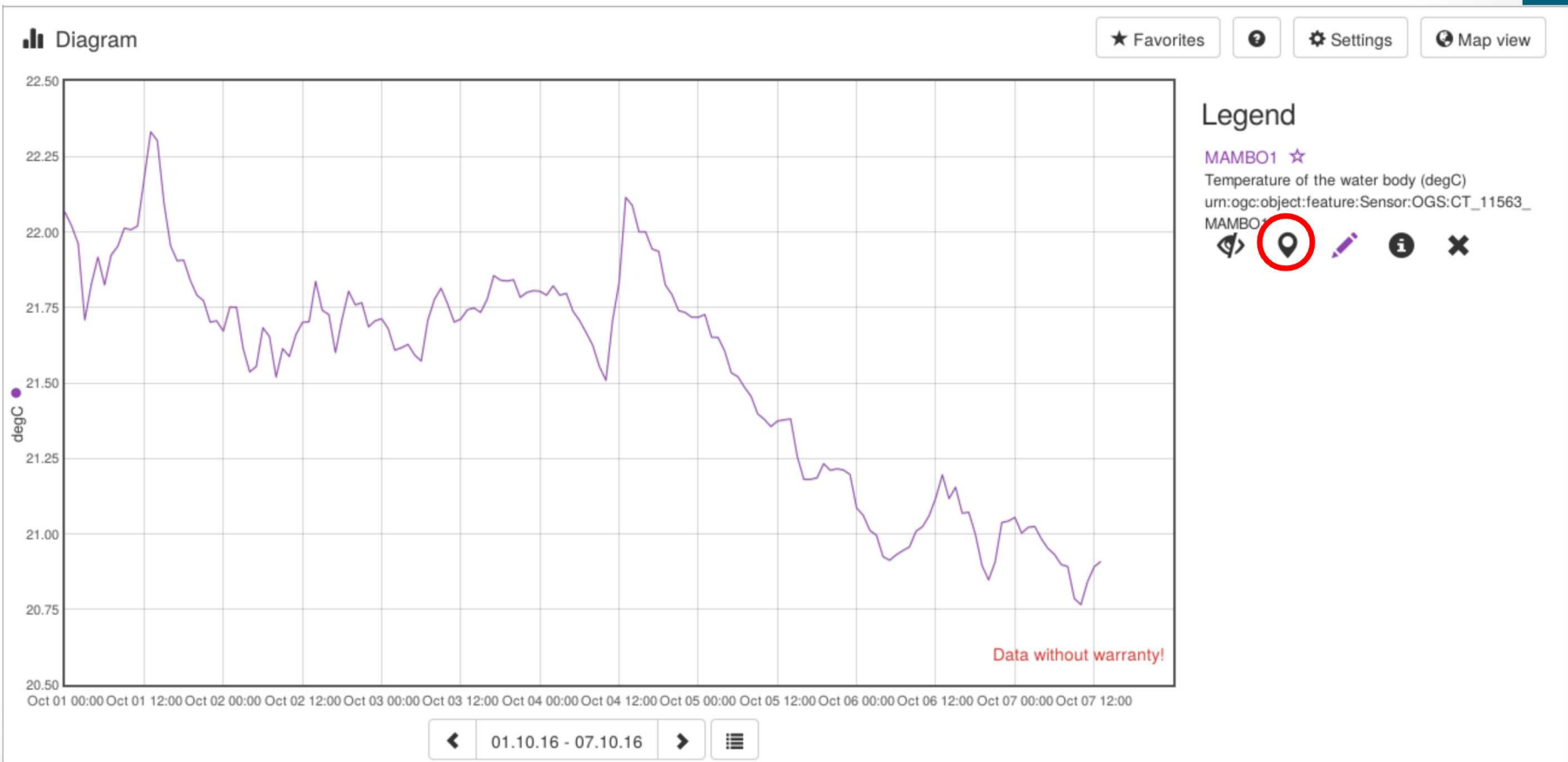


01.10.16 - 06.10.16



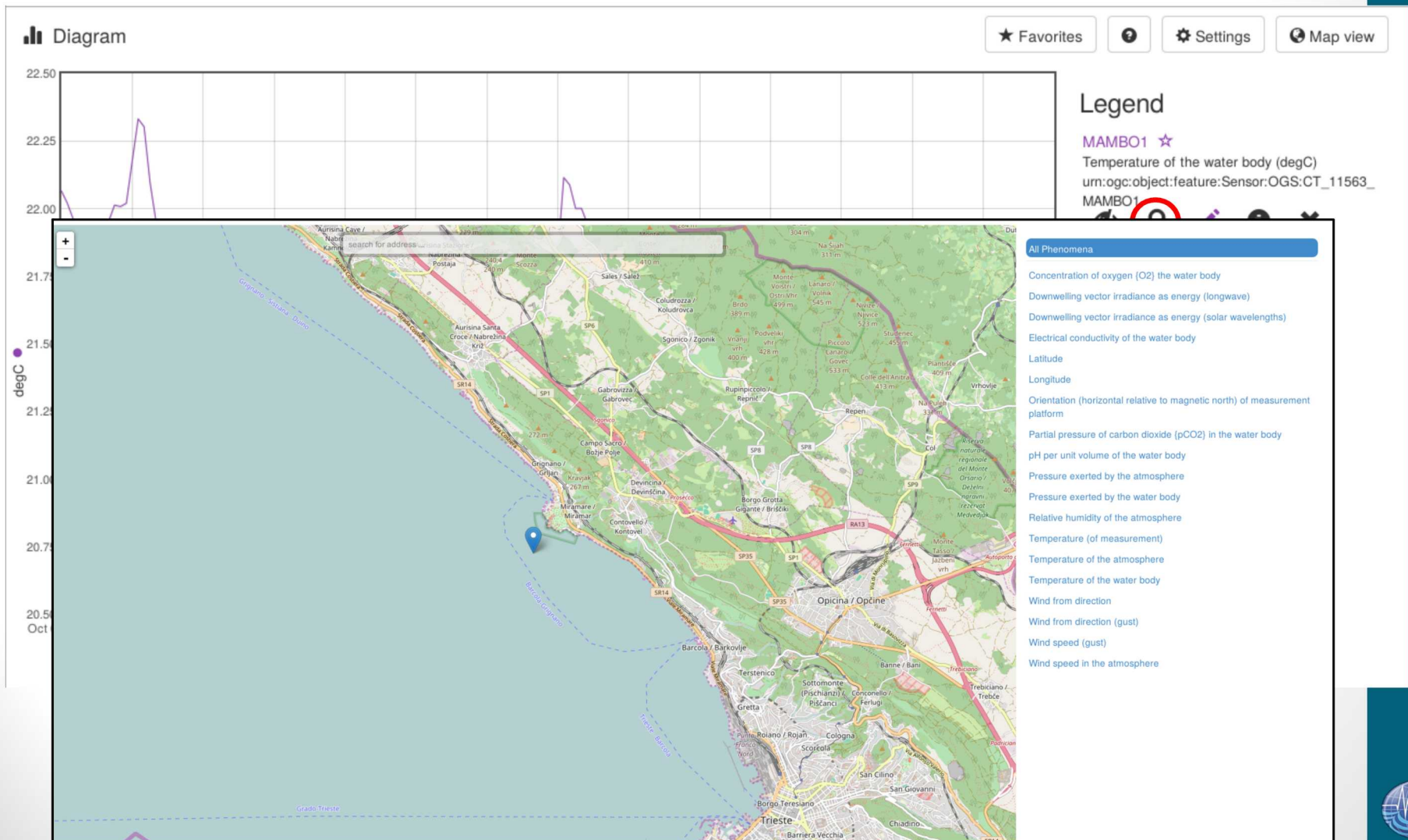
Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)



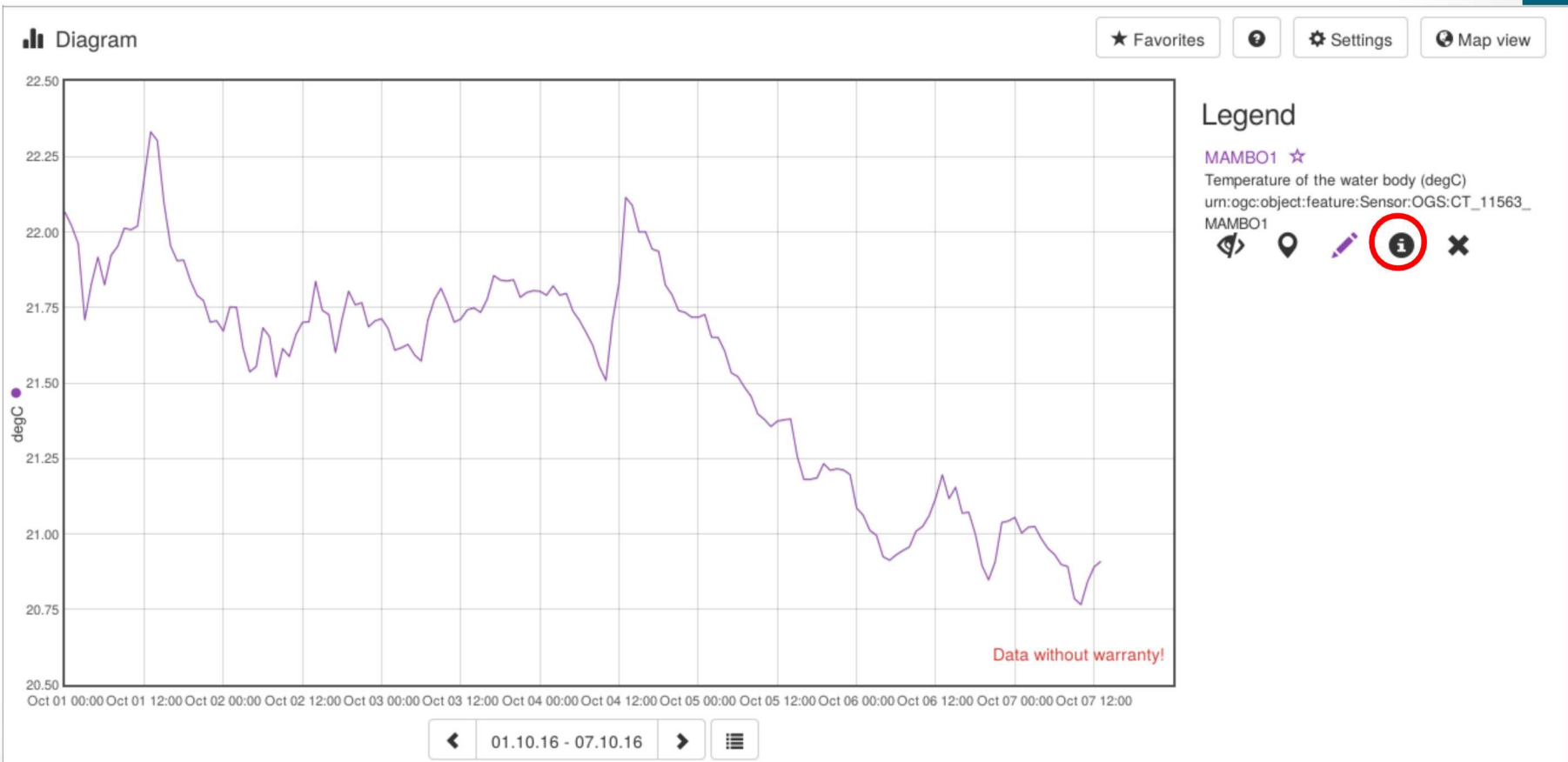
Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)



Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)



<http://nodc.ogs.trieste.it/sosWeb/>

Sensor Web Enablement (SWE): **HOW**

3. Data Visualization → Web Client (52° NORTH)



<http://nodc.ogs.trieste.it/sosWeb/>

Sensor Web Enablement (SWE): APPLICATION



FixO³ Diagram Map Favorites List selection Settings

search for address ...

The map shows Europe, the Mediterranean Sea, and parts of North Africa. Two green circular markers are placed on the map: one in the North Atlantic (labeled '2') and one in the North Sea (labeled '4'). Two blue circular markers are placed in the Mediterranean: one in the Adriatic (labeled '1') and one in the Ionian (labeled '3').

300 km
200 mi

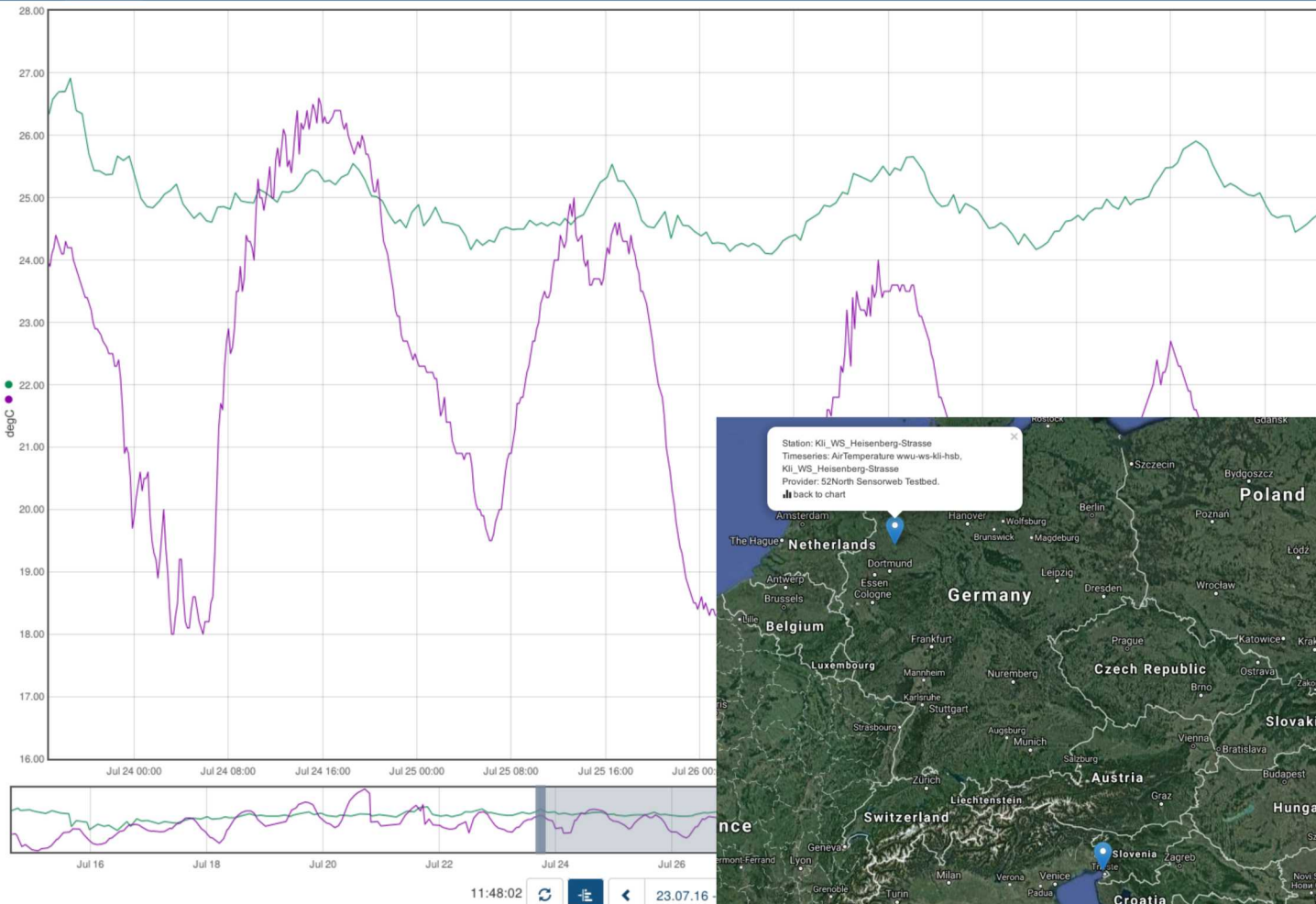
Leaflet

All Phenomena

- AirTemperature
- AtmosphericPressure
- chlorophyll
- Concentration of oxygen (O2) the water body
- conductivity
- Conductivity_Temperature_Depth_Ph
- Dewpoint
- Downwelling vector irradiance as energy (longwave)
- Downwelling vector irradiance as energy (solar wavelengths)
- Electrical conductivity of the water body
- fdom_chlorophyll_phycocyanin
- fluorescent_dissolved_organic_matter
- HailAccumulated
- HailDuration
- HailIntensity
- HailPeakIntensity
- Humidity
- index
- InSystemTemperature
- internal_temperature
- Latitude
- Longitude
- Luminance
- Orientation (horizontal relative to magnetic north) of measurement platform
- oxygen
- Partial pressure of carbon dioxide (pCO2) in the water body
- pH
- pH per unit volume of the water body
- phycocyanin:

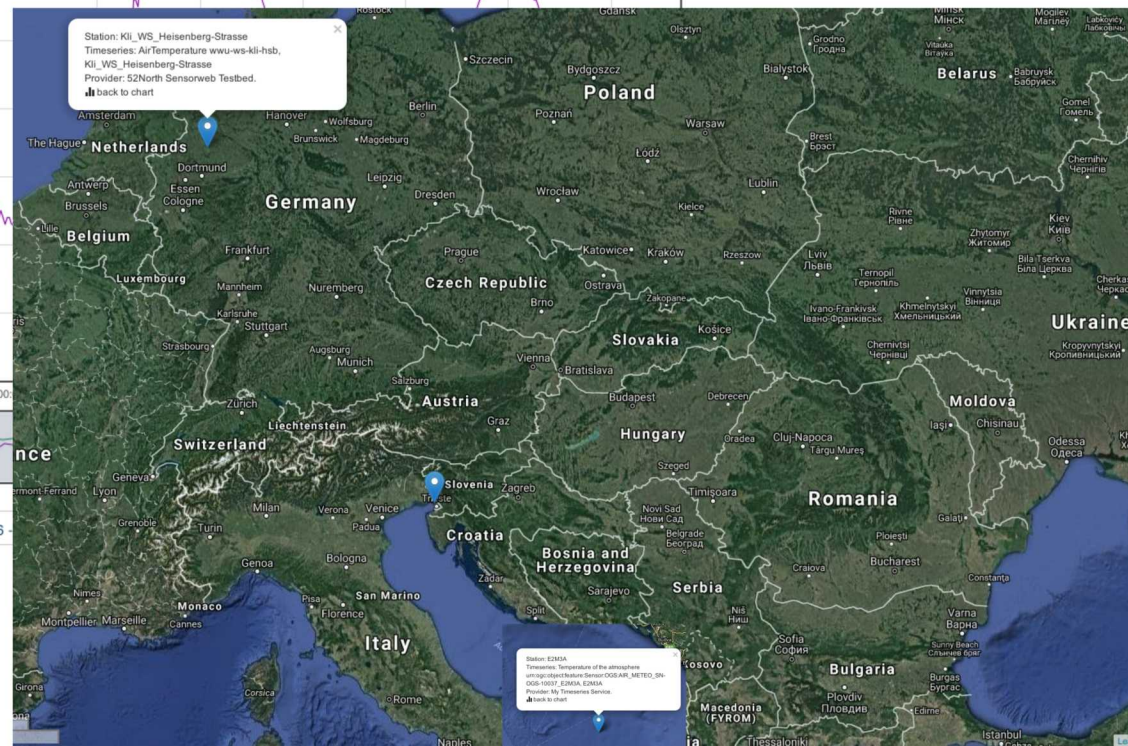
Sensor Web Enablement (SWE): APPLICATION

FixO³ Diagram Map Favorites List selection Settings



Legend

- Kli_WS_Heisenberg-Strasse ☆
AirTemperature (degC)
www-ws-kli-hsb
AirTemperature
[Map Icon] [Location Pin Icon] [Edit Icon] [Info Icon] [Close Icon]
- E2M3A ☆
Temperature of the atmosphere (degC)
urn:ogc:object:feature:Sensor:OGS:AIR_METEO_SN-OGS-10037_E2M3A
Temperature of the atmosphere
[Map Icon] [Location Pin Icon] [Edit Icon] [Info Icon] [Close Icon]



Thanks for the attention!

