ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

Bridging the gap between data and sensor information

Roland Koppe, Ana Macario

HELMHOLTZ
GEMEINSCHAFT


vessels
remote operated vehicles
towed systems
large stations
Neumayer-Station
lobor-atories
moorings
vehicles
weather stations
buoys
permafrost
obser-vatories
thermistor chains
and more
oberser-vations

Challenges

- Increasing **heterogeneity** of instruments, data formats, standards, methods, …
- Small over large to very large projects, but limited **resources**
- **Scalability** of technical solutions, and important of **curation** and help

A modular virtual research infrastructure designed to support scientific workflows, in particular in the flow from sensor observations to archives

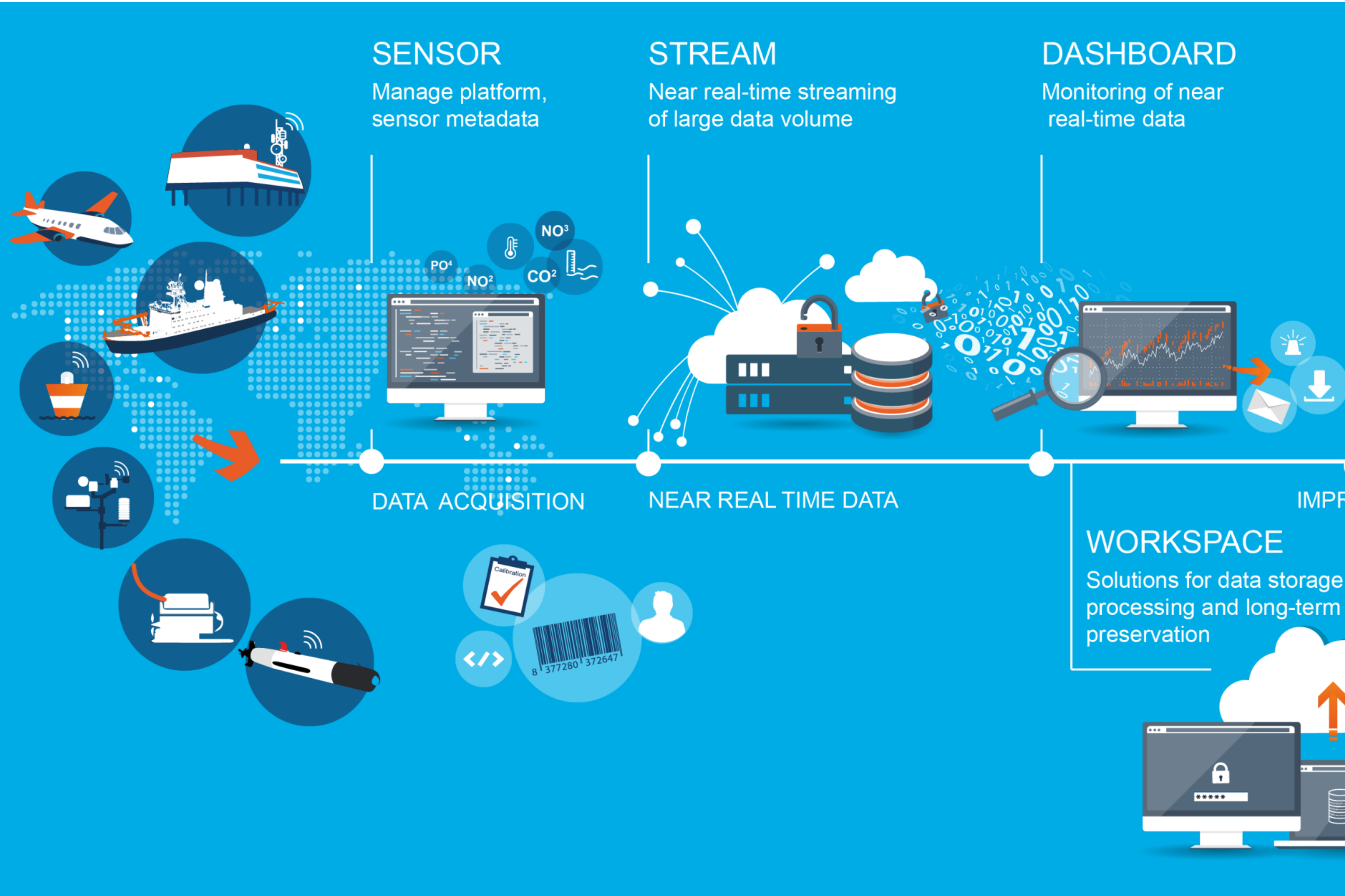
Mission

Objectives

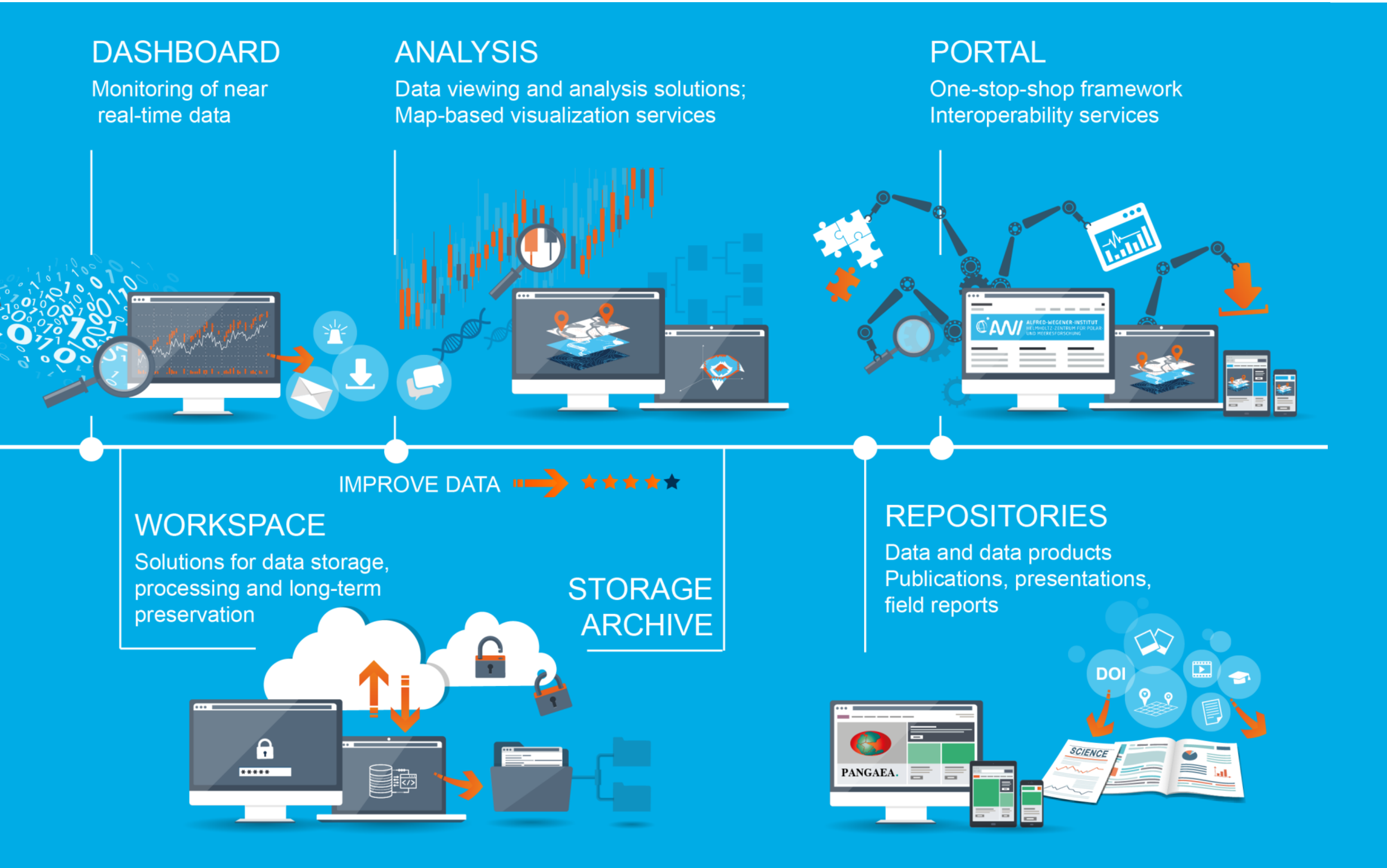
- **Generic** infrastructure for data flows
- **Sustainable** and up-to-date services
- **Interoperable** and support for standards
- Seamless **integration** of information systems
- **User-friendly** and simple services

HELMHOLTZ
GEMEINSCHAFT

Data Flow Framework – O2A



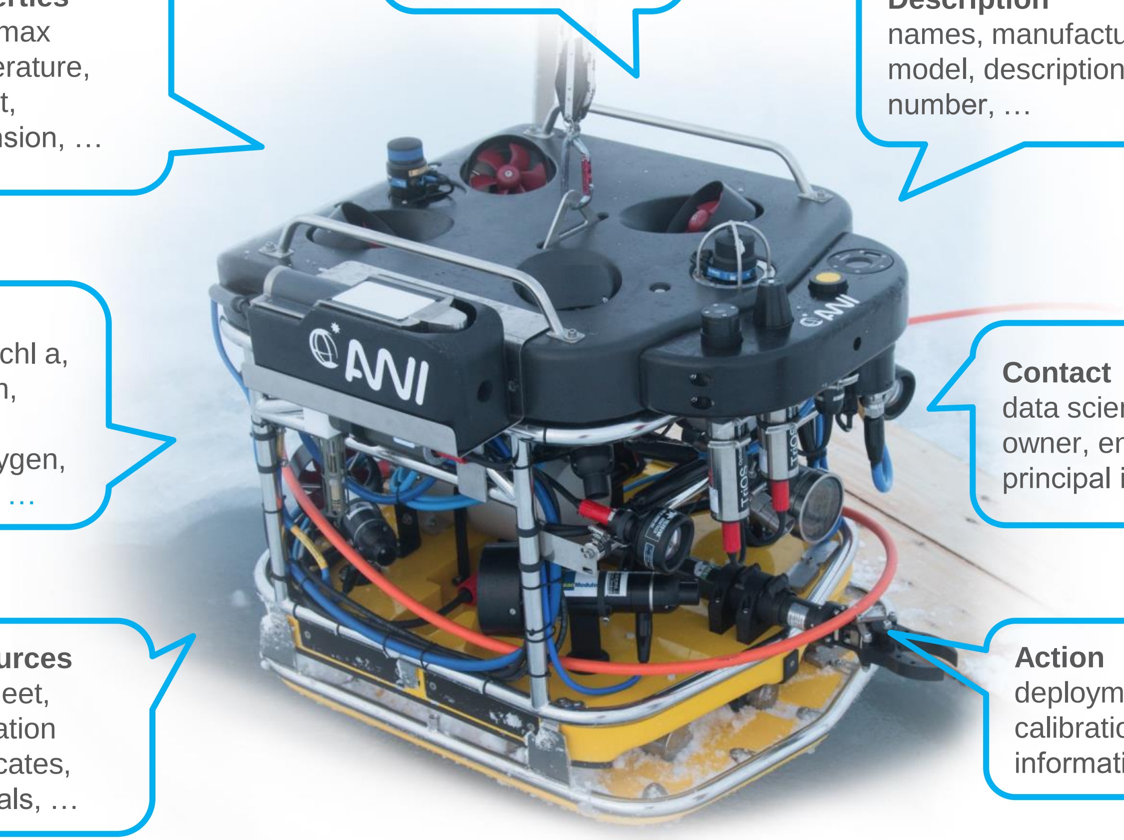
Data Flow Framework – O2A



Subdevices
multibeam sonar, fluorometer, camera, nitrate sensor,…

Properties
min / max temperature, weight, dimension, …

Description
names, manufacturer, model, description, asset number, …



Parameters
backscatter, chl a, FDOM, depth, conductivity, dissolved oxygen, temperature, …

Contact
data scientists, editors, owner, engineer in charge, principal investigator, …

Resources
factsheet, calibration certificates, manuals, …

Action
deployment, mount, calibration, failure, information, …

AWI | Browse | Search | Device Store | My Devices | User: rkoppe@awi.de

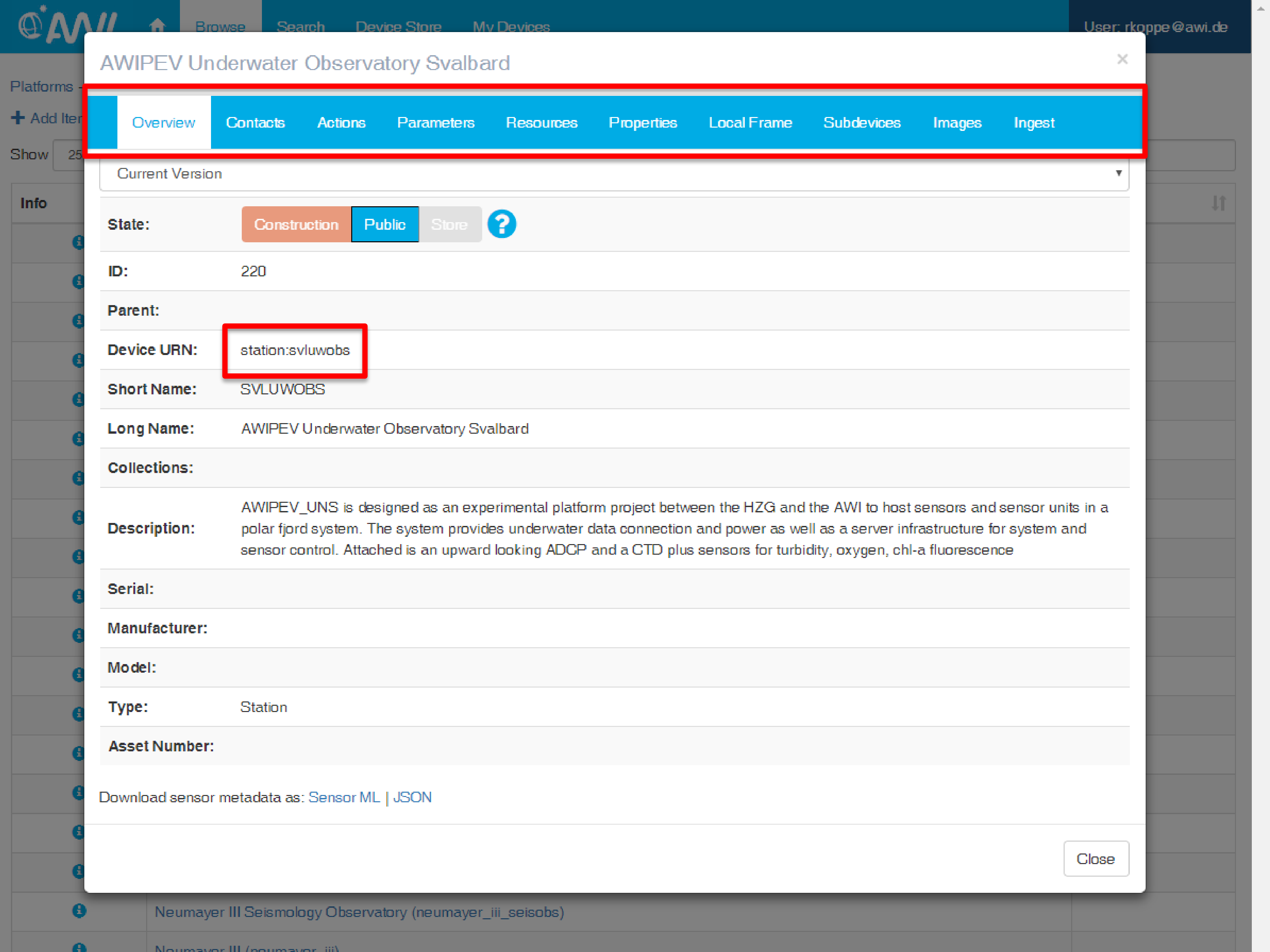
Platforms -> station

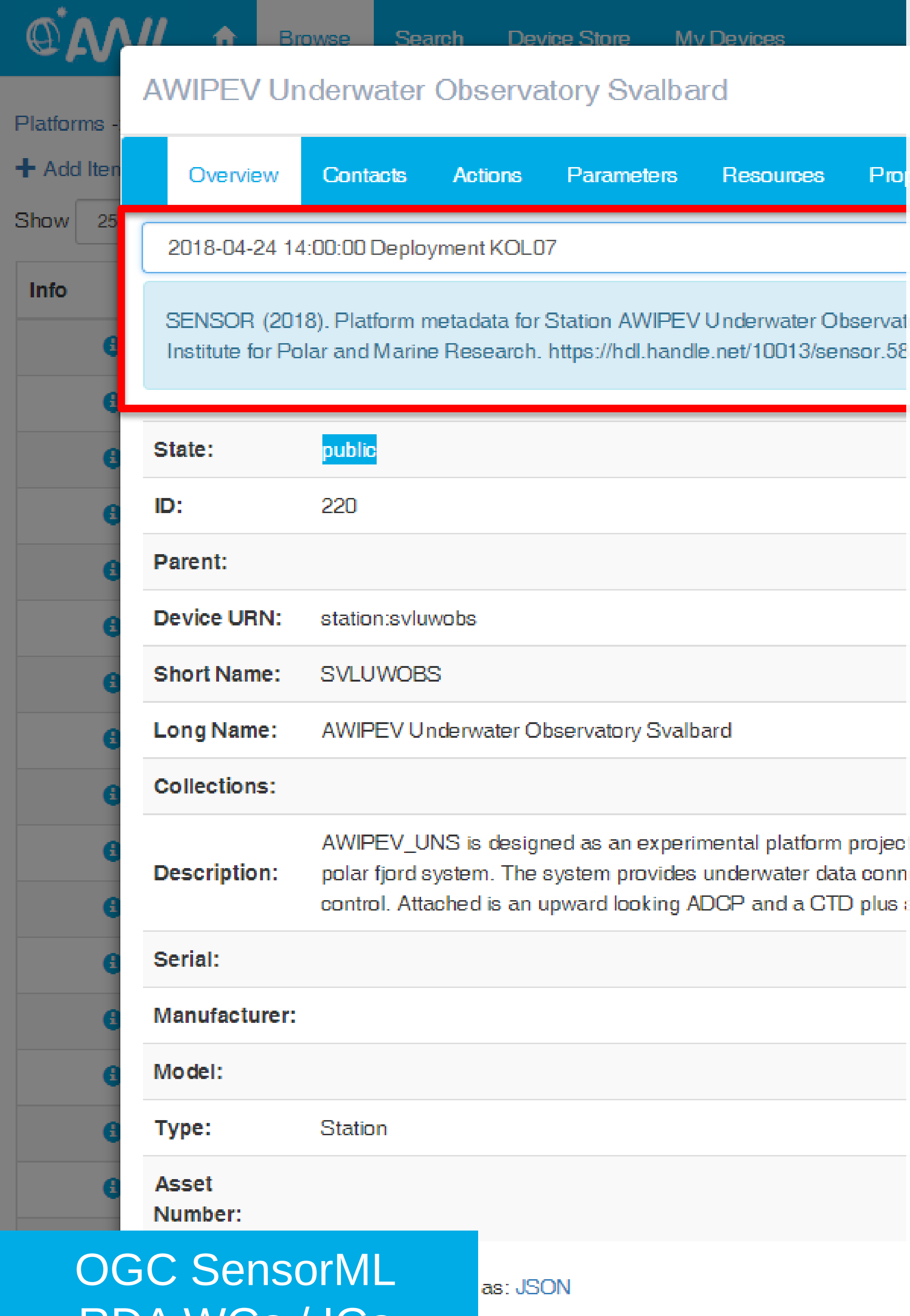
+ Add Item

Show 25 entries

Search:

Info	Device (Short Name)	Tools
	AWIPEV Underwater Observatory Svalbard (SVLUWOBS)	
	AWIPEV Atmosphere Observatory (awipev)	
	AWIPEV Permafrost Observatory Bayelva (Bayelva)	
	Base Belgrano II (Belgrano II)	
	Base San Martín (San Martin)	
	Beagal Channel Underwater Observatory (BEAUWOBS)	
	Cuxhaven intercalibration facility (cux_inter)	
	Dallmann (dallmann)	
	FINO (fino)	
	HAUSGARTEN observatory (HAUSGARTEN)	
	Helgoland Underwater Observatory (HELUWOBS)	
	Kohnen (kohnen)	
	LTO Samoylov station (samoylov)	
	Neumayer III Acoustic Observatory PALAOA (neumayer_iii_palaoa_obs)	
	Neumayer III Atmosphere Observatory (neumayer_iii_metobs)	
	Neumayer III Geomagnetic Observatory (neumayer_iii_magobs)	
	Neumayer III Infrasound Observatory (neumayer_iii_infraobs)	
	Neumayer III Seismology Observatory (neumayer_iii_seisobs)	
	Neumayer III (neumayer_iii)	


Browse
Search
Device Store
My Devices
User: rkoppe@awi.de
Platforms
Add Item
Show
Info
AWIPEV Underwater Observatory Svalbard
Overview
Contacts
Actions
Parameters
Resources
Properties
Local Frame
Subdevices
Images
Ingest
Current Version
State:
Construction
Public
Store
ID:
220
Parent:
Device URN:
station:svluwobs
Short Name:
SVLUWOBS
Long Name:
AWIPEV Underwater Observatory Svalbard
Collections:
Description:
AWIPEV_UNS is designed as an experimental platform project between the HZG and the AWI to host sensors and sensor units in a polar fjord system. The system provides underwater data connection and power as well as a server infrastructure for system and sensor control. Attached is an upward looking ADCP and a CTD plus sensors for turbidity, oxygen, chl-a fluorescence
Serial:
Manufacturer:
Model:
Type:
Station
Asset Number:
Download sensor metadata as: Sensor ML | JSON
Close
Neumayer III Seismology Observatory (neumayer_iii_seisobs)
Neumayer III (neumayer_iii)



- Sensor descriptions for provenance and reduced data integration effort
- Versioning and citability – use case in RDA PID WG
- Interoperability and standards
- ~1700 descriptions available and counting

OGC SensorML
RDA WGs / IGs

→ Demo

Available sensors

Filter sensors: neum

Sensor code		Sensor description	Last date	Age	Last value Unit	Platform ID	Sensor ID
station:neumayer iii:ashtec:latitude		Neumayer III:Ashtec:Latitude	2018-11-02 14:00:00	6 minutes	-70.66725	6	661
station:neumayer iii:ashtec:longitude		Neumayer III:Ashtec:Longitude	2018-11-02 14:00:00	6 minutes	-8.27988	6	662
station:neumayer iii:gps:latitude		Neumayer III:GPS:Latitude	2018-11-02 14:00:00	6 minutes	-70.66683	6	659
station:neumayer iii:gps:longitude		Neumayer III:GPS:Longitude	2018-11-02 14:00:00	6 minutes	-8.27967	6	660
station:neumayer iii:metobs:air_pressure	hPa	Neumayer III:metobs:air_pressure	2018-11-02 14:00:00	6 minutes	981.1 hPa	6	956
station:neumayer iii:metobs:air_temperature_10m	deg_C	Neumayer III:metobs:air_temperature_10m	2018-11-02 14:00:00	6 minutes	-15.8 deg_C	6	950
station:neumayer iii:metobs:air_temperature_2m	deg_C	Neumayer III:metobs:air_temperature_2m	2018-11-02 14:00:00	6 minutes	-15.8 deg_C	6	951
station:neumayer iii:metobs:visibility	m	Neumayer III:metobs:visibility	2018-11-02 14:00:00	6 minutes	75000.0 m	6	957
station:neumayer iii:metobs:wind_direction_10m	deg	Neumayer III:metobs:wind_direction_10m	2018-11-02 14:00:00	6 minutes	282.7 deg	6	952
station:neumayer iii:metobs:wind_direction_2m	deg	Neumayer III:metobs:wind_direction_2m	2018-11-02 14:00:00	6 minutes	283.9 deg	6	953
station:neumayer iii:metobs:wind_velocity_10m	m/s	Neumayer III:metobs:wind_velocity_10m	2018-11-02 14:00:00	6 minutes	2.8 m/s	6	954
station:neumayer iii:metobs:wind_velocity_2m	m/s	Neumayer III:metobs:wind_velocity_2m	2018-11-02 14:00:00	6 minutes	2.4 m/s	6	955
station:neumayer iii:weather:		Neumayer III:Weather:				6	874
station:neumayer iii:weather:air pressure (43m nn)	hPa	Neumayer III:Weather:Air pressure (43m NN)	2018-02-20 08:16:01	255 days	975.3 hPa	6	42
station:neumayer iii:weather:air temperature (2m)	C	Neumayer III:Weather:Air temperature (2m)	2018-02-20 08:16:01	255 days	-8.8 C	6	39
station:neumayer iii:weather:relative humidity (2m)	%	Neumayer III:Weather:Relative humidity (2m)	2018-02-20 08:16:01	255 days	89.0 %	6	43
station:neumayer iii:weather:wind direction (10m)	deg	Neumayer III:Weather:Wind direction (10m)	2018-02-20 08:16:01	255 days	96.0 deg	6	41
station:neumayer iii:weather:wind velocity (10m)	m/s	Neumayer III:Weather:Wind velocity (10m)	2018-02-20 08:16:01	255 days	7.5 m/s	6	40

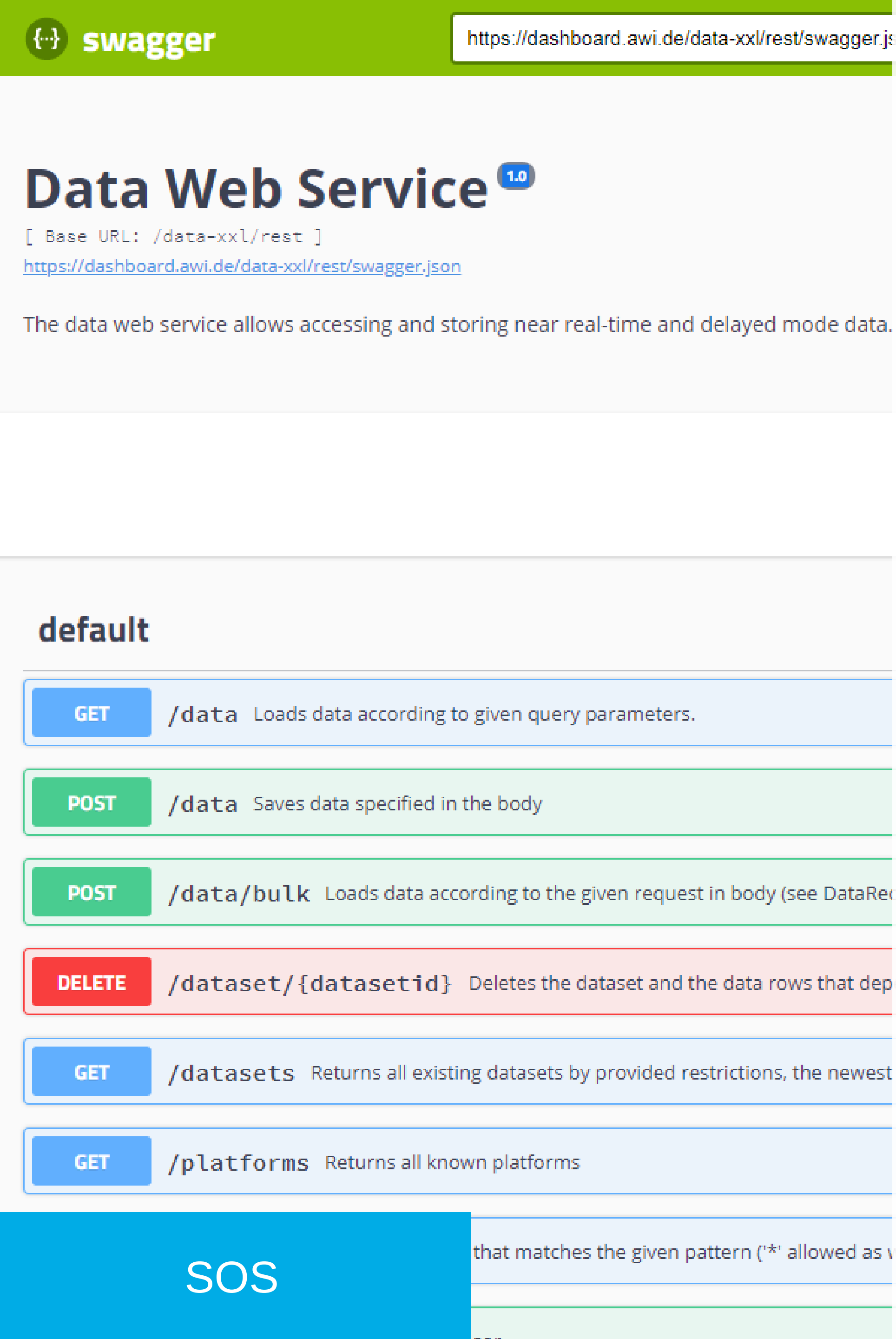
18 / 787 sensor(s) are registered for this data service.

Request data

Begin 2018-11-01

End 2018-11-02

Format JSON



- Ingest bound to sensor descriptions
- Generic driver and QC/QA approach
- Monitoring / alarming functionality
- Access to data, quality flags, aggregation statistics, unit conversion, …

SOS

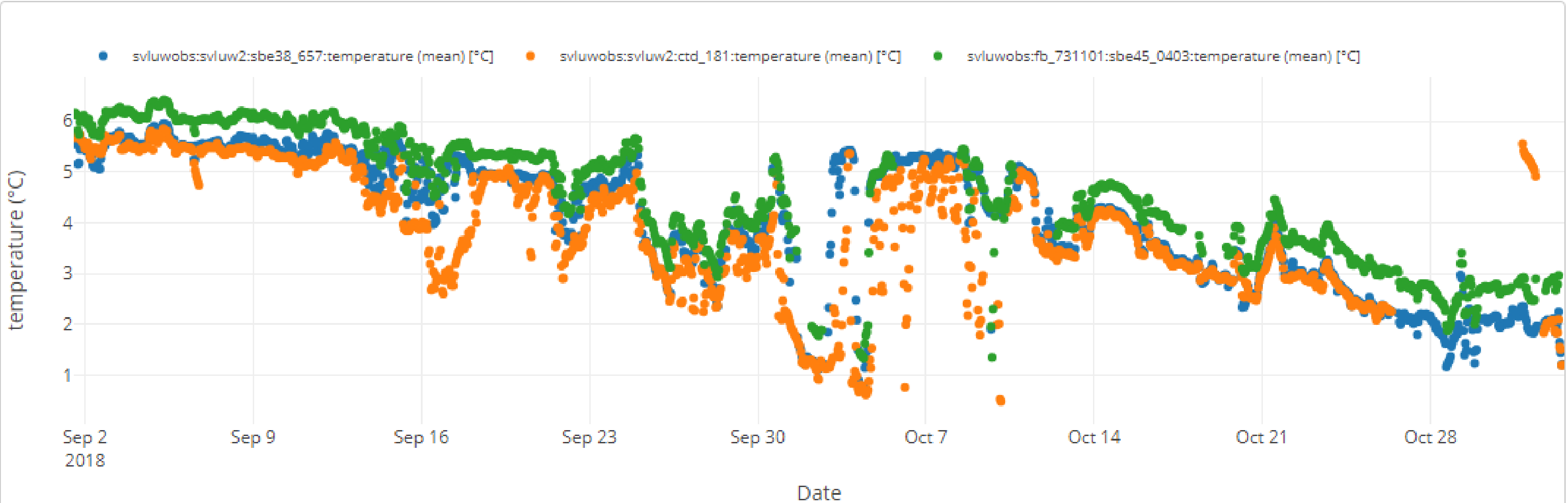
→ Demo

Dashboards   AWIPEV-COSYNA Underwater Observatory in NyAlesund/Svalbard - Temperature   Login

Water temperatures - NyÅlesund/Svalbard - N 78° 55.200 / E 11° 54.00

Focus on specific dates or values by horizontal or vertical left-click dragging a zoom window. Double-click for focus reset.

Click on sensor names in the plots to select/deselect data.



Value: sbe38_657:temperature

The variable "#sbe38_657:temperature" is measured by a temperature probe (SBE38, Company SeaBird) which is mounted at 12 m water depth (+/- tide).

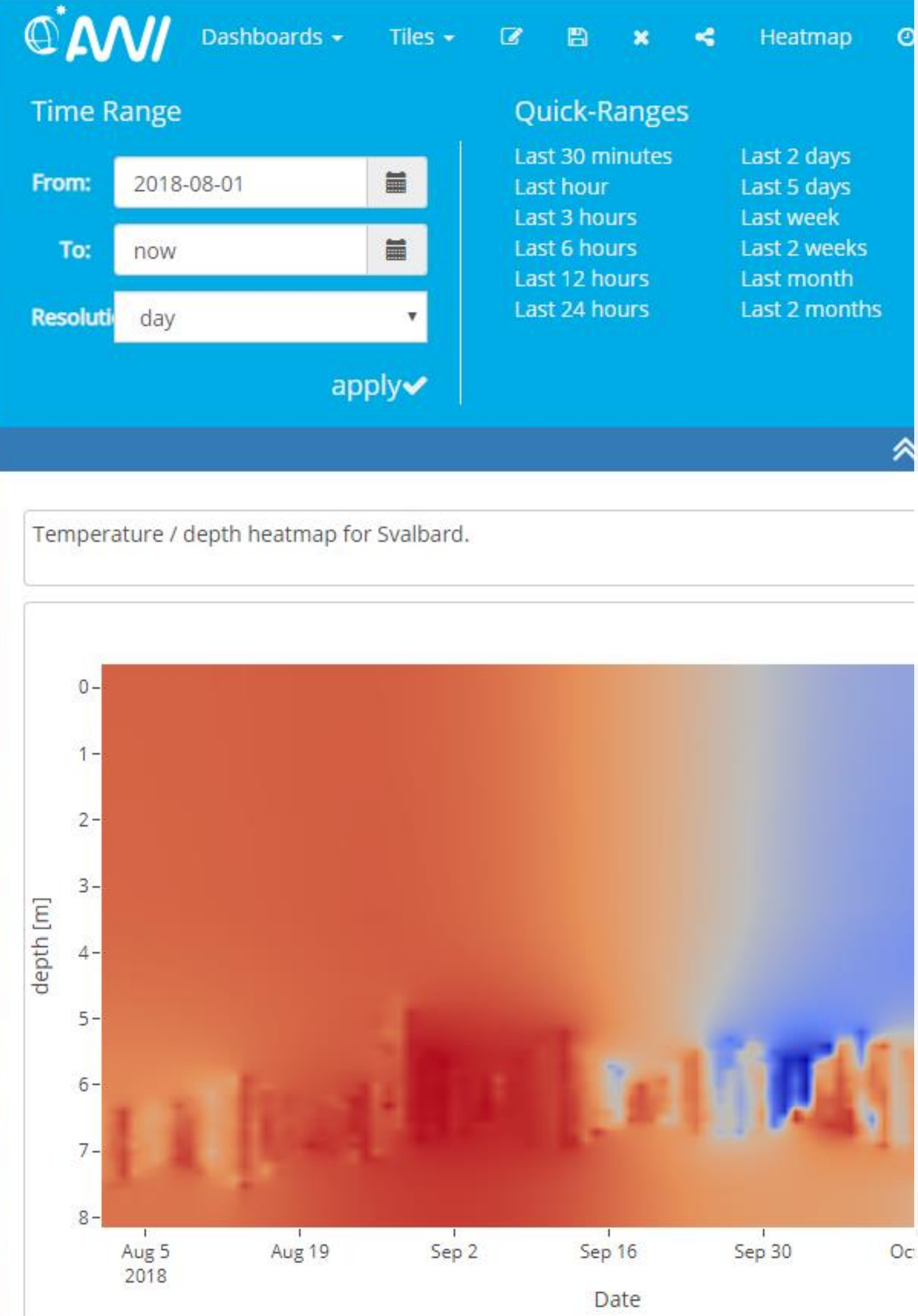
Value: ctd_181:temperature

The variable "#ctd_181:temperature" is measured by a combined conductivity - temperature - density probe (CTD90, Company Sea&Sun, Sensor Aanderaa optode) which is profiling every day at 12:25 hours between 11m (+/- tide) and the surface. After this cast, the probe is set to one of the five depth 9m, 7m, 5m, 3m or 1m for 24hours. By this procedure, each depth stratum is sampled for 24 hours once a week.

Value: fb_731101:sbe45_0403:temperatrure

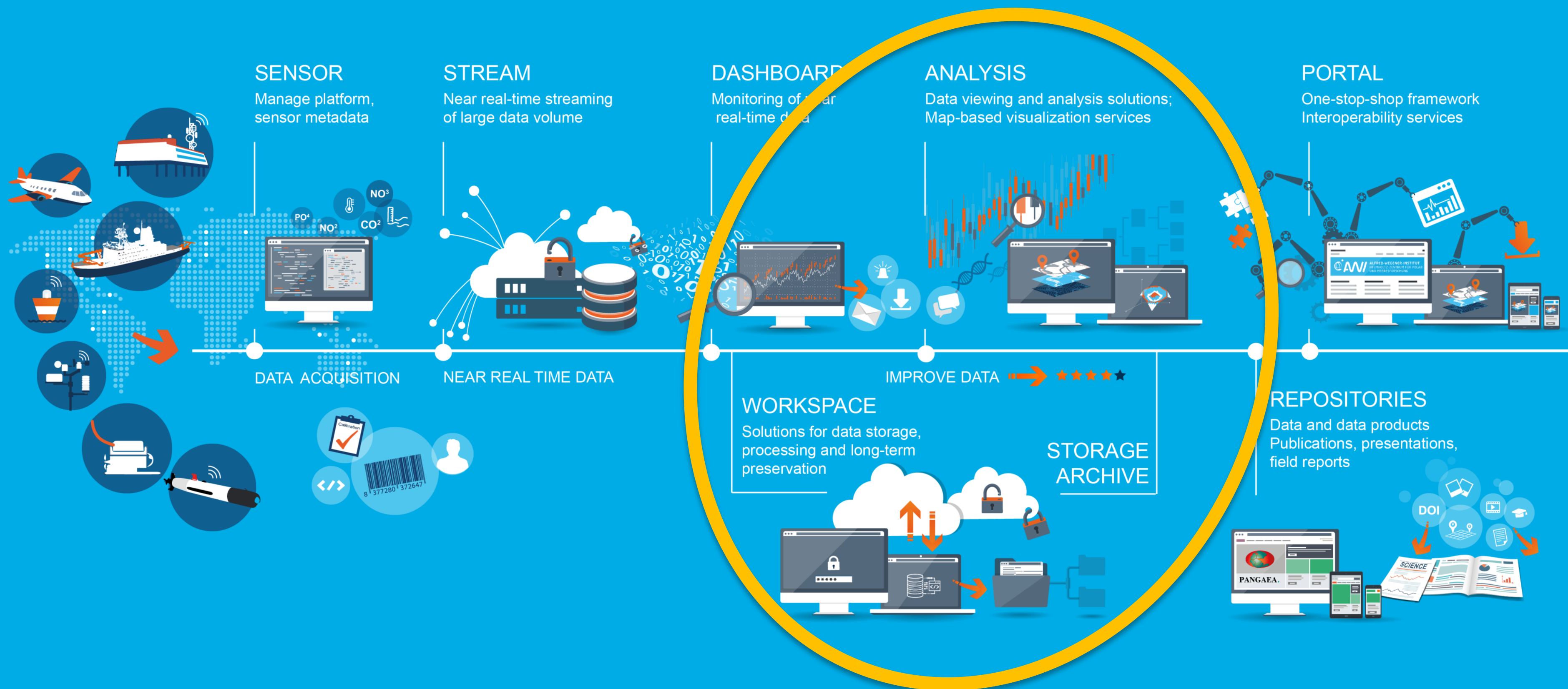
The variable "#fb_731101:sbe45_0403:temperatrure" is measured by a land based FerryBox system (Sensor SBE45, ADM) getting its water from a pumping station in a depth of 11m (+/- tide) close to the base of the underwater observatory.

→ Demo



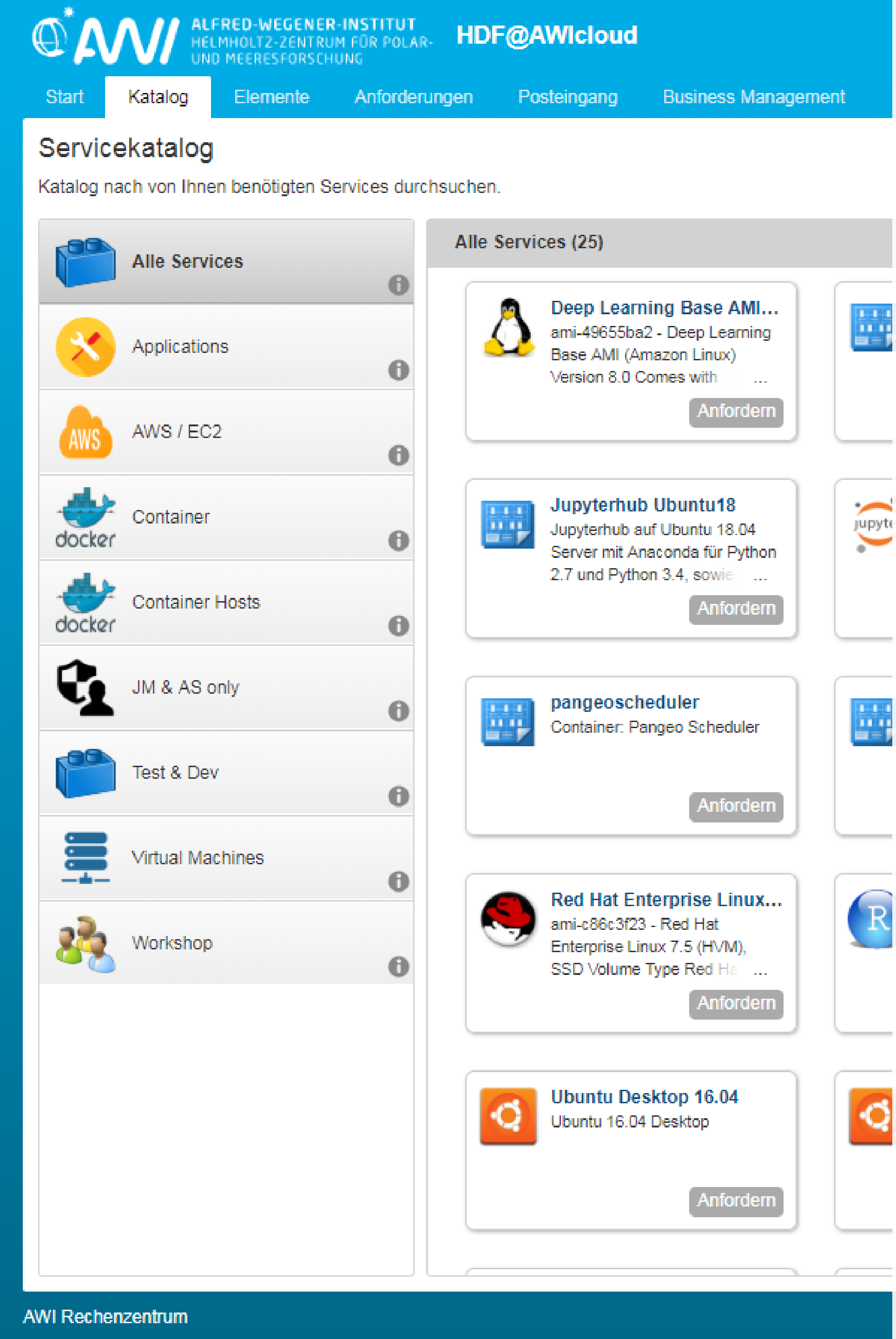
- User-customizable, flexible dashboards for data monitoring
- Analysis of near-real time and delayed-mode data
- Based on sensor descriptions and configurations

Data Flow Framework – O2A



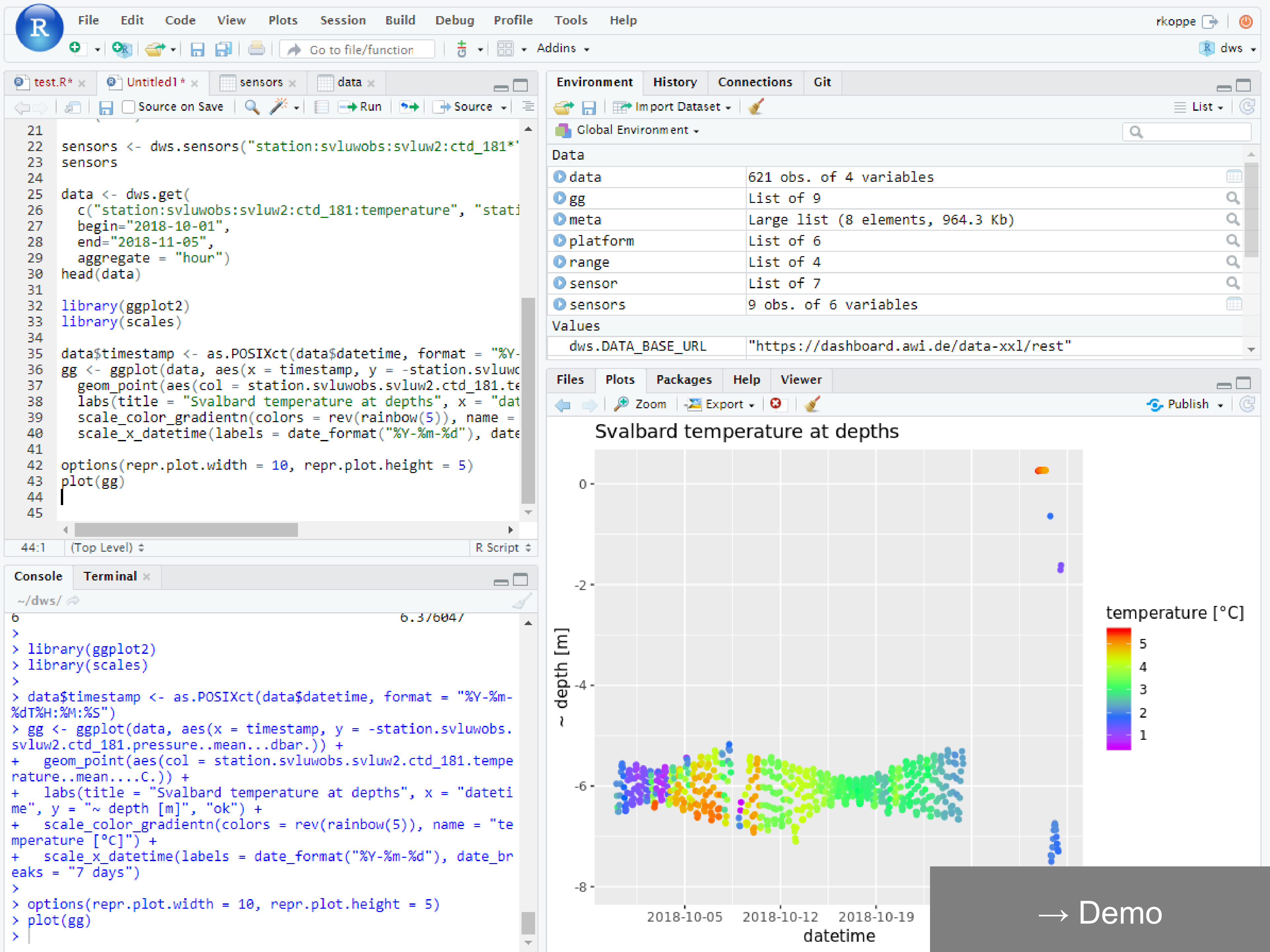
Workspace

- Science community workspace for data sharing and data analytics within the **Helmholtz Data Federation** (HDF)
- State-of-the-art storage, replicated between Bremerhaven and Potsdam
- User-friendly “one-click” compute solutions with virtual machines and containers
- Hadoop big data analysis based on Hortonworks data flow and data platform
- Raster data management and analysis with rasdaman, developments

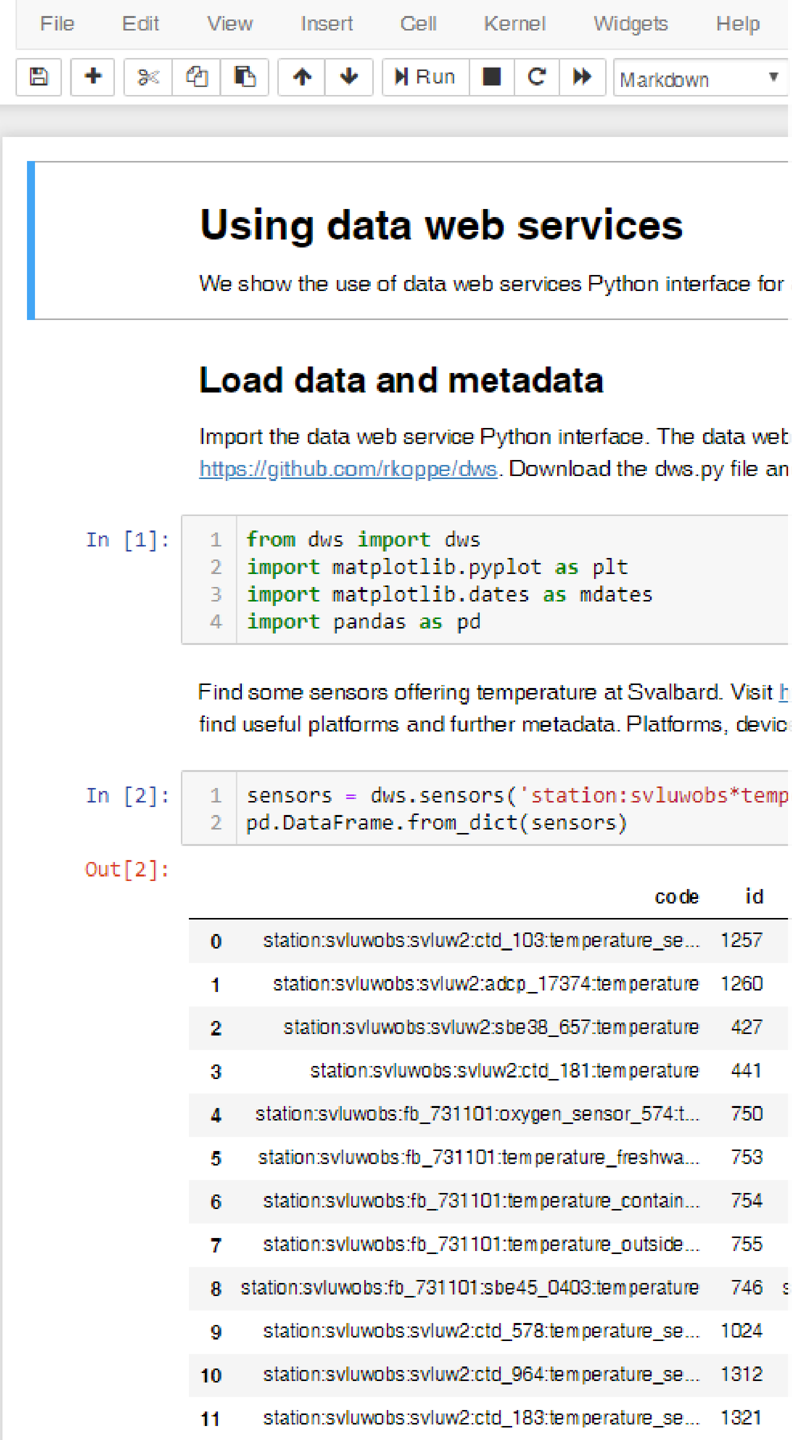


- Cloud management with VMware vRealize
- Providing tailored short-life containers and virtual machines for scientists
- Including support for hybrid clouds, e.g. Amazon WS
- Templates for e.g. RStudio and Jupyter

→ Demo



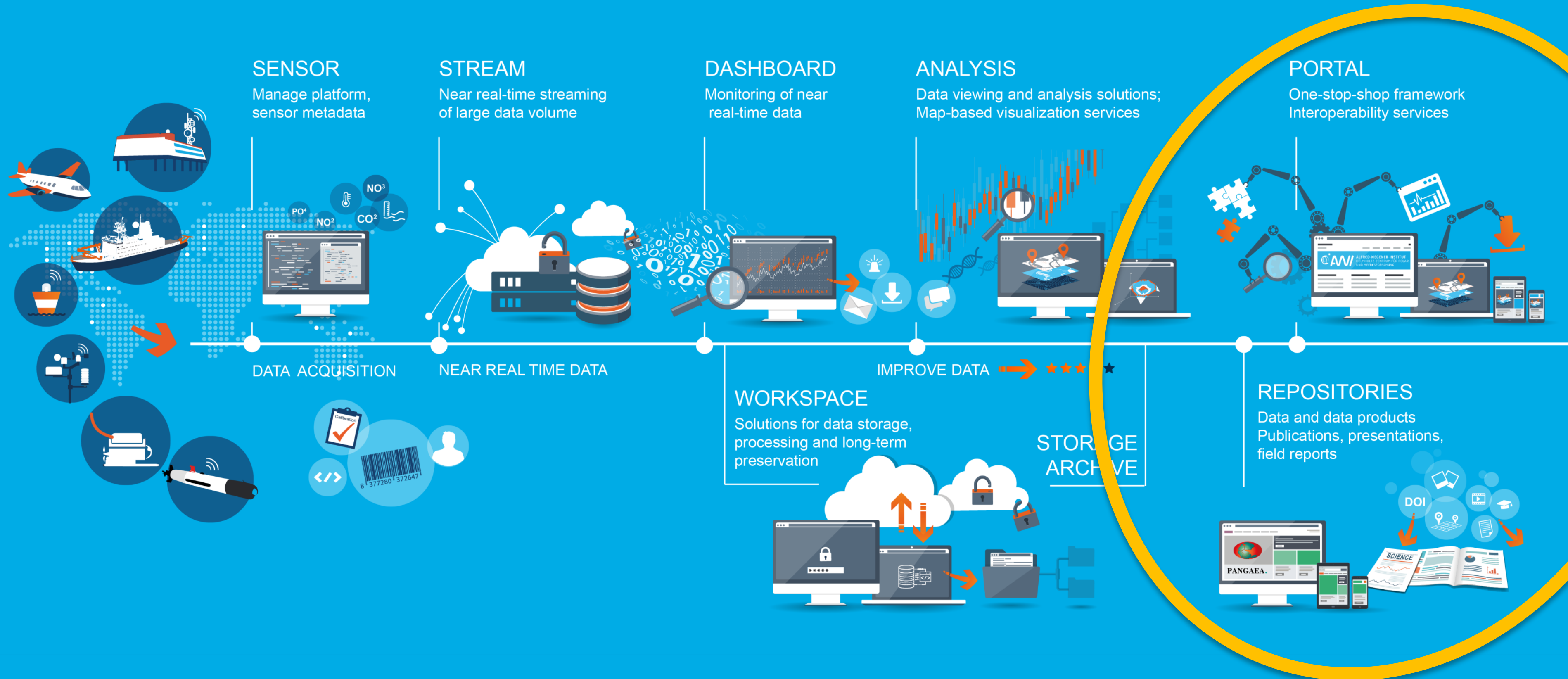
File Edit Code View Plots Session Build Debug Profile Tools Help
rkoppe
Go to file/function
Addins
dws
test.R*
Untitled1*
sensors
data
Source on Save
Run
Source
sensors <- dws.sensors("station:svluwobs:svluw2:ctd_181*"
sensors
data <- dws.get(
c("station:svluwobs:svluw2:ctd_181:temperature", "stati
begin="2018-10-01",
end="2018-11-05",
aggregate = "hour")
head(data)
library(ggplot2)
library(scales)
data$timestamp <- as.POSIXct(data$datetime, format = "%Y-
gg <- ggplot(data, aes(x = timestamp, y = -station.svluwo
geom_point(aes(col = station.svluwobs.svluw2.ctd_181.te
labs(title = "Svalbard temperature at depths", x = "dat
scale_color_gradientn(colors = rev(rainbow(5)), name =
scale_x_datetime(labels = date_format("%Y-%m-%d"), date
options(repr.plot.width = 10, repr.plot.height = 5)
plot(gg)
44:1
(Top Level)
R Script
Console
Terminal
~/dws/
> library(ggplot2)
> library(scales)
> data$timestamp <- as.POSIXct(data$datetime, format = "%Y-%m-%dT%H:%M:%S")
> gg <- ggplot(data, aes(x = timestamp, y = -station.svluwobs.svluw2.ctd_181.pressure..mean...dbar.)) +
+ geom_point(aes(col = station.svluwobs.svluw2.ctd_181.temperature..mean....C.)) +
+ labs(title = "Svalbard temperature at depths", x = "datetime", y = "~ depth [m]", "ok") +
+ scale_color_gradientn(colors = rev(rainbow(5)), name = "temperature [°C]") +
+ scale_x_datetime(labels = date_format("%Y-%m-%d"), date_breaks = "7 days")
> options(repr.plot.width = 10, repr.plot.height = 5)
> plot(gg)
Environment History Connections Git
Import Dataset
List
Global Environment
Data
data 621 obs. of 4 variables
gg List of 9
meta Large list (8 elements, 964.3 Kb)
platform List of 6
range List of 4
sensor List of 7
sensors 9 obs. of 6 variables
Values
dws.DATA_BASE_URL "https://dashboard.awi.de/data-xxl/rest"
Files Plots Packages Help Viewer
Zoom
Export
Publish
Svalbard temperature at depths
0
-2
-4
-6
-8
~ depth [m]
2018-10-05
2018-10-12
2018-10-19
datetime
temperature [°C]
5
4
3
2
1
→ Demo

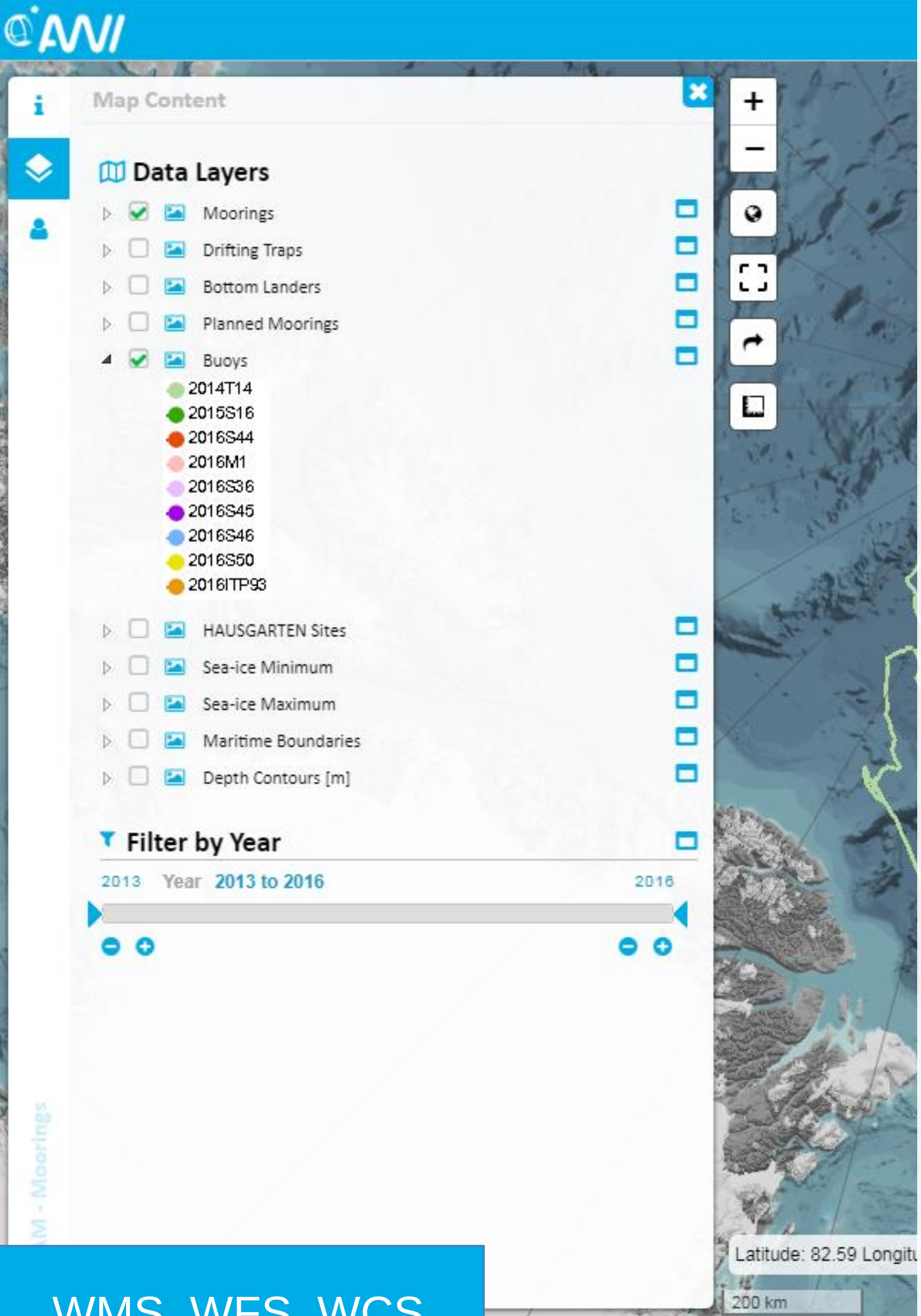


- Foster sharing of code incl. documentation
- Support native book-keeping of changes, versioning
- Promote methods for reproducible results
- Notebooks as supplement for publications

→ Demo

Data Flow Framework

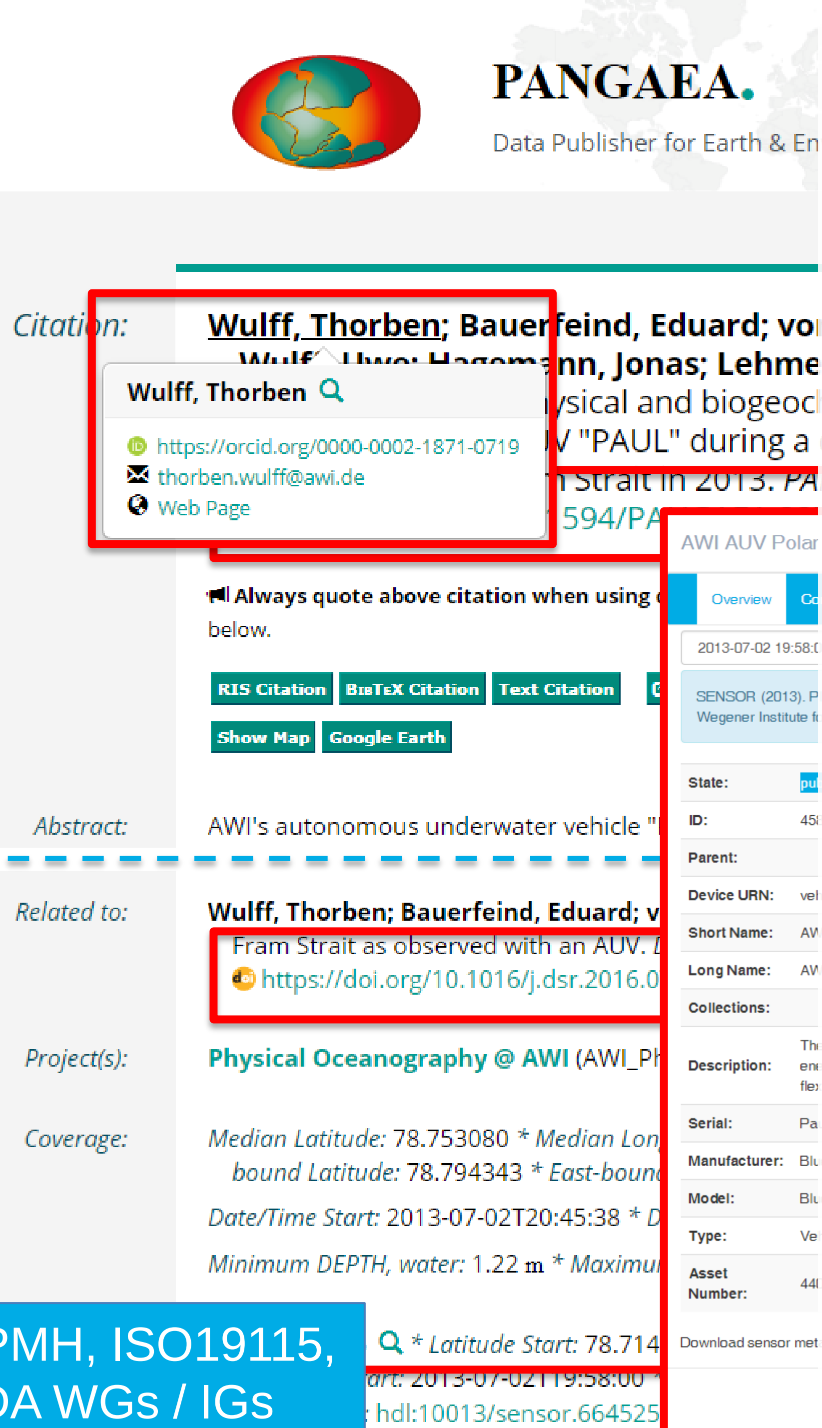




- Map visualization and composition of data products
- Maintaining world base maps in different projections based on RTOPO
- Providing standard products, e.g. satellite-based chlorophyll a and sea ice

WMS, WFS, WCS

→ Demo



- Data archiving and publication (DOI) including curation and harmonization
- Linking with articles, platforms, devices, sensors, expeditions, orcid
- Semi-automatic data flows when using O2A

OAI-PMH, ISO19115, RDA WGs / IGs

→ Demo

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

Search for author, expedition, project, ...

SERVICES

Manage your sensors and data

DATA

Find datasets and data products

EXPEDITION

Find expeditions, flights, dives

Latest expeditions:

PS115/2 with Polarstern	2018-09-05 - Longyearbyen 2018-10-16 - Bremerhaven	HE521 with Heincke	2018-10-30 - Bremerhaven 2018-11-03 - Bremerhaven

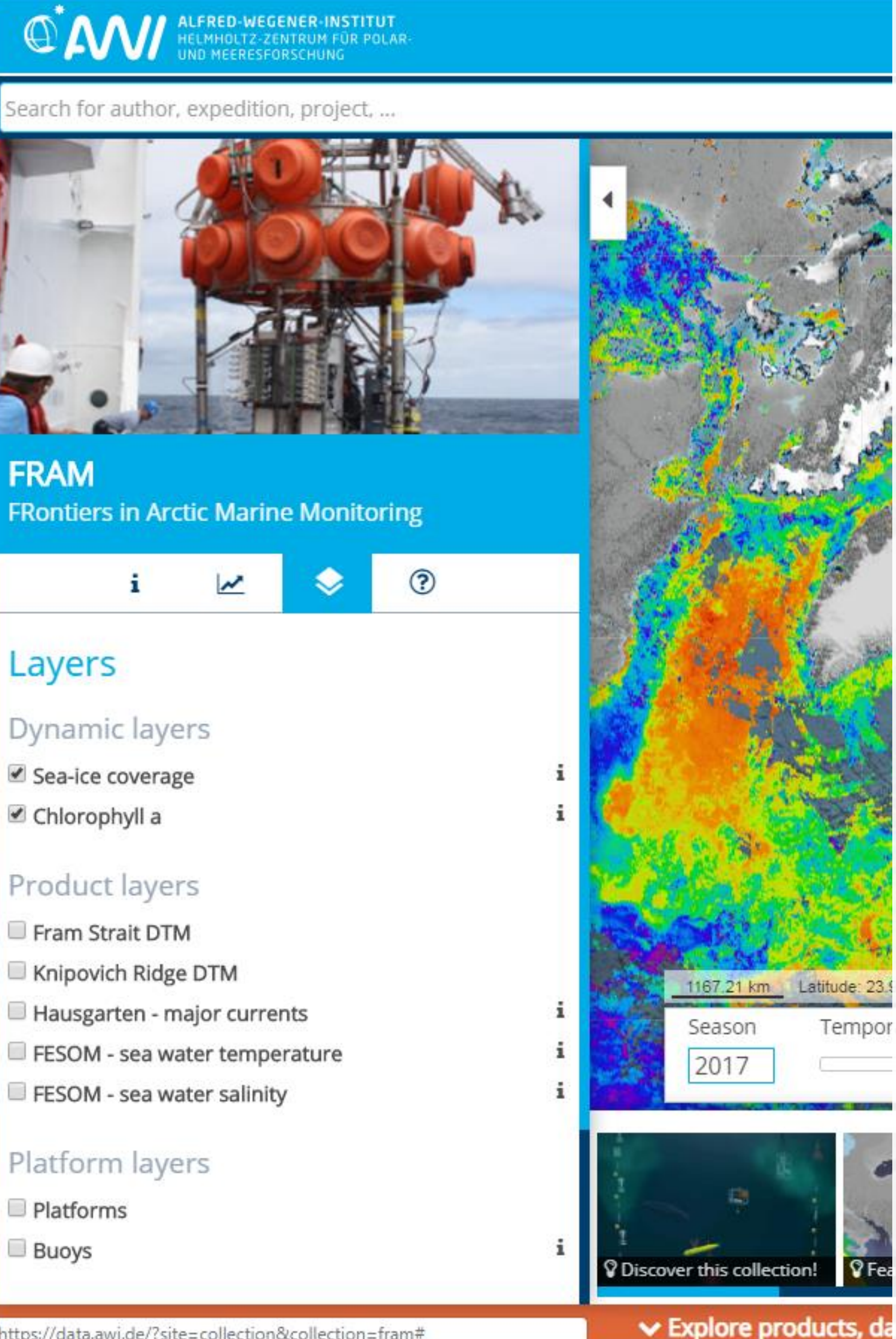
Latest news:
Measuring ice and snow thickness : Poke it with a stick | (Last blogpost from PS115.2 expedition to the Arctic after

COLLECTIONS

Explore data and products thematically grouped

NEAR REAL TIME DATA

Near real time data is presented in hourly averages and no quality control is applied.



- Portal as central access point to linked and combined data
- Platforms, devices and sensor overviews
- Expeditions
- Data, publications and reports
- Interactive data products
- Services

→ Demo

In Action

AWI

Frontiers in
Arctic Marine Monitoring

DIGITAL
EARTH

MOSAiC
International
Arctic Drift
Expedition

MOSES
Modular Observation Solutions for Earth Systems

HELMHOLTZ
Data Federation | HDF

HELMHOLTZ
GEMEINSCHAFT


AWI GRAPHIC
© Martin Künsting

The expedition's planned duration is 350 days in the ice.

The following 17 nations will participate in the expedition:

During the expedition, RV Polarstern will be resupplied by 4 icebreakers: Akademik Fedorov (RUS), Admiral Makarov (RUS), Oden (SWE), Xue Long (CHN).

The ice will drift at an average speed of roughly 7 km per day.

Around 300 people will work in the background for the expedition in order to realize it.

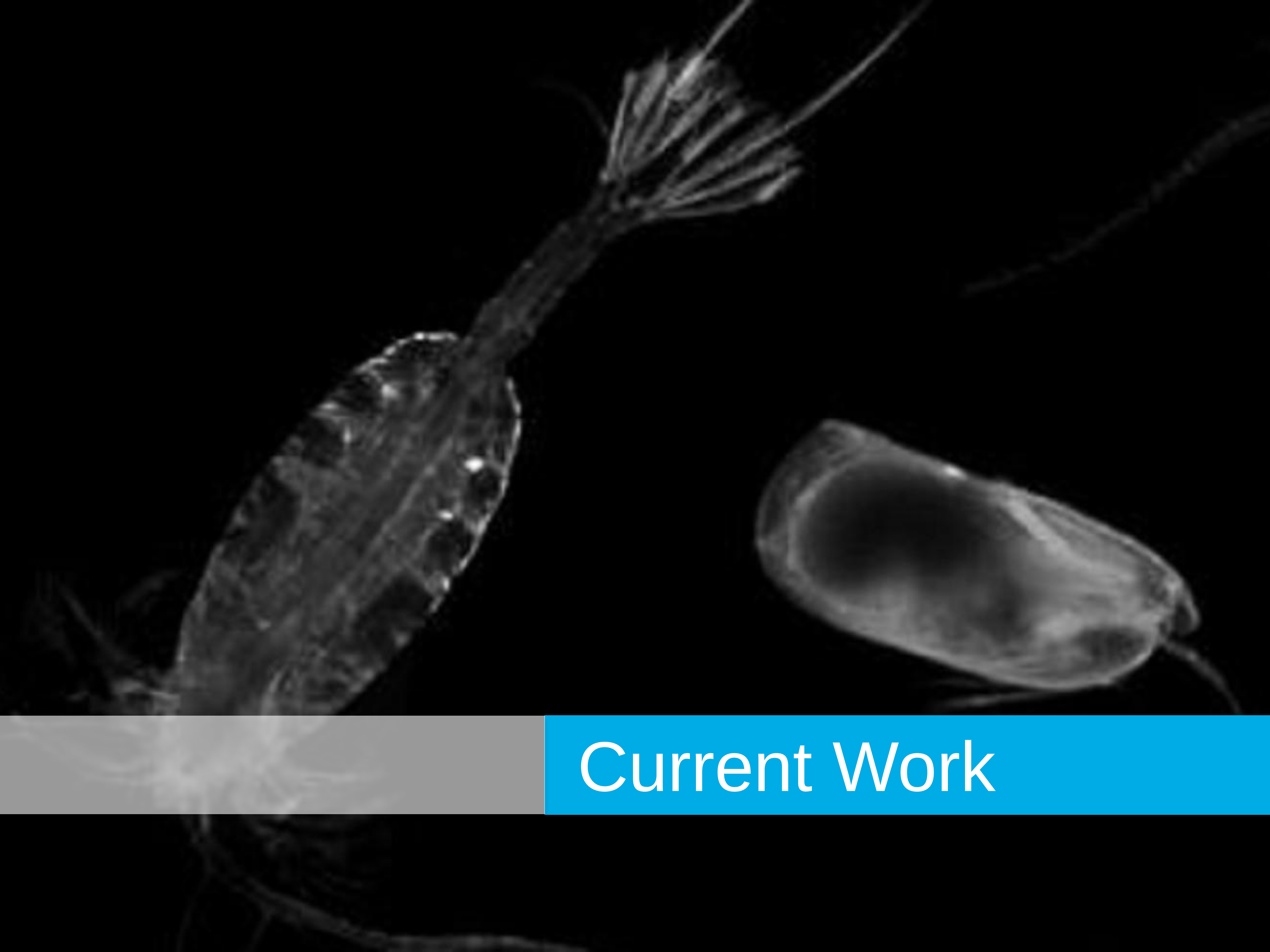
For 60-90 days the research icebreaker Polarstern will be less than 200 km away from the geographic North Pole.

Throughout the year, a total of 600 experts will be on board, and be exchanged in phases.

6.000 t of fuel will be required by the research icebreaker Polarstern alone.

RV Polarstern will cover a total of some 2,500 km.

Current Work



Current Work

- Setup virtual environments for applications like 3D modelling of the ocean floor
- Develop building blocks for e.g. machine learning methods for images and videos
- User-transparent scaling of computing resources, e.g. with Kubernetes
- Repository of drivers for data ingest and quality procedures incl. best practices
- Computing on GPUs between “standard” virtualization and HPC
- …

Learned and Outlook

Approach

- Illustrate **added value** for individuals, give incentives
- Make **hands on use** as easy as possible
- Provide **fast applicable** tools and best practices with examples
- Perform regular **user sessions** to foster community and user-network, beyond projects
- Collect and give **feedback**

Outlook and Preparations

- Data Management Plans as seamless starting point from project idea, over data ingest and science workspaces to publications
- Legacy systems: refactoring and further integration incl. harmonization of existing vocabularies, e.g. for devices, actions, …
- New data center on board of Polarstern, remote synchronization of services and data between Arctic and Antarctic over satellites
- Streamline sample management solutions for, e.g. cores and specimen and flow integration

Best Practices Needed

- Continuous measurements, time series
  - how to align tracked sensor information with data
- Combined datasets – PIDs for events of distinct instruments
  - how to combine it useful
- Agreements on formats and semantics – multi-partner and multi-discipline projects
- DMPs simple and actionable
- Integrating data products, prepare it for the community and beyond
- …

Thank you very much for your attention!

Ana Macario, Angela Schäfer, Antonia Haas,
Christian Schäfer-Neth, Hans Pfeiffenberger,
Peter Gerchow, Stefanie Schumacher, …

roland.koppe@awi.de