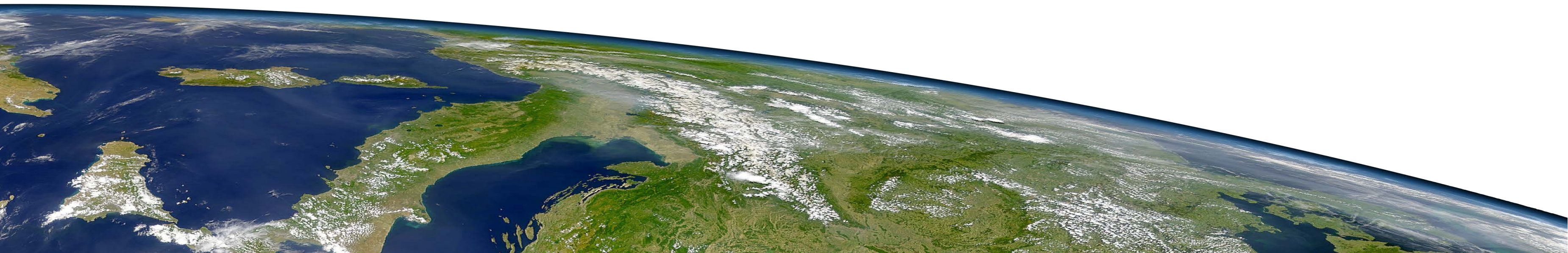




Operationelles Monitoring von Binnengewässern mit Copernicus und multiplen Satellitensensoren: Regionale und globale Anwendungen

Dr. Thomas Heege,
EOMAP GmbH & Co.KG, Germany



Questions

1) Acceptance of EO methodologies in Limnological applications

Key factor, barriers for operational use ?

2) Usage of EO in water agencies: e.g. for env. Evaluation or regulatory monitoring

Expectations, demand?

Requirements

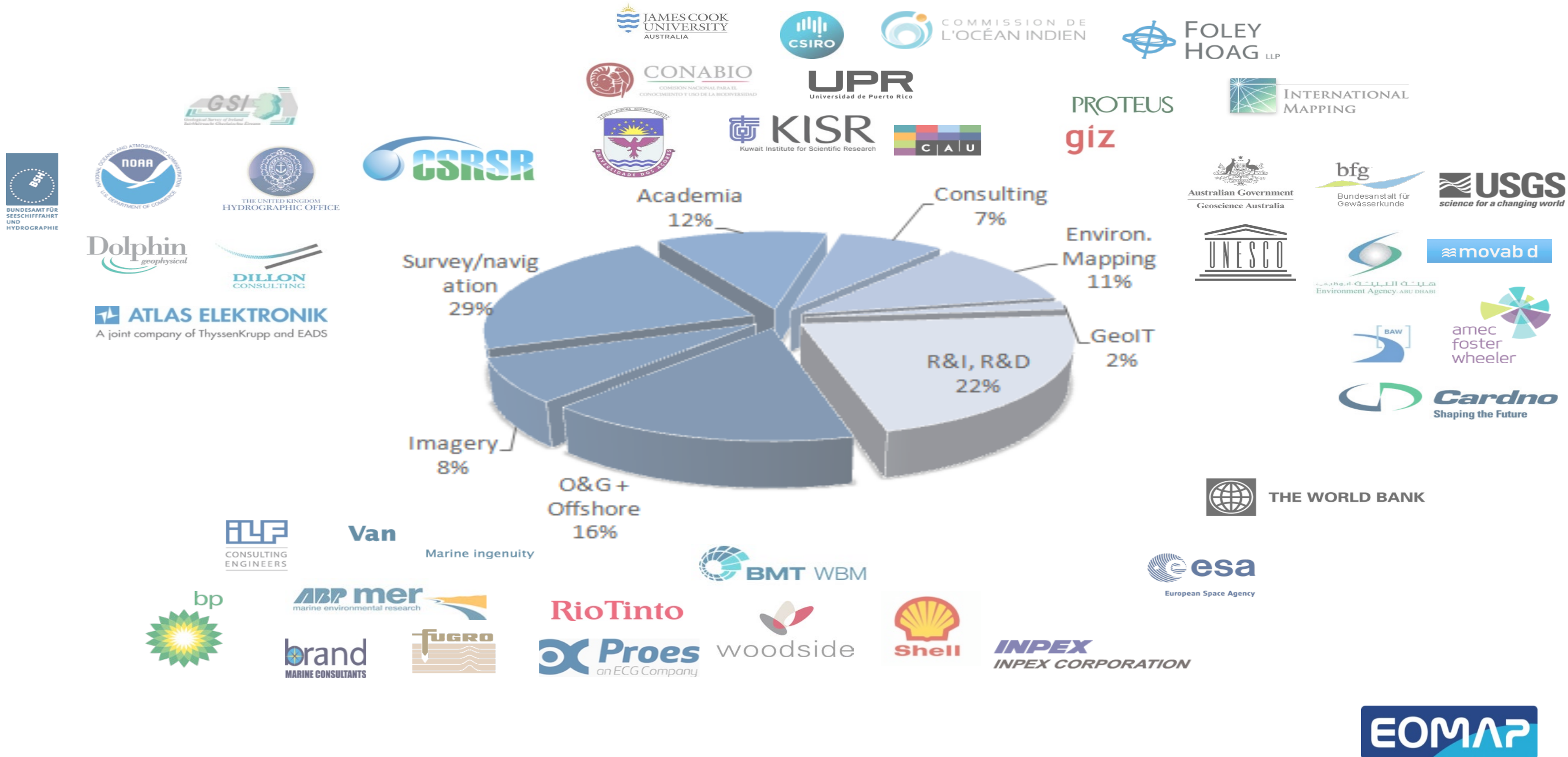
Use cases in operational applications

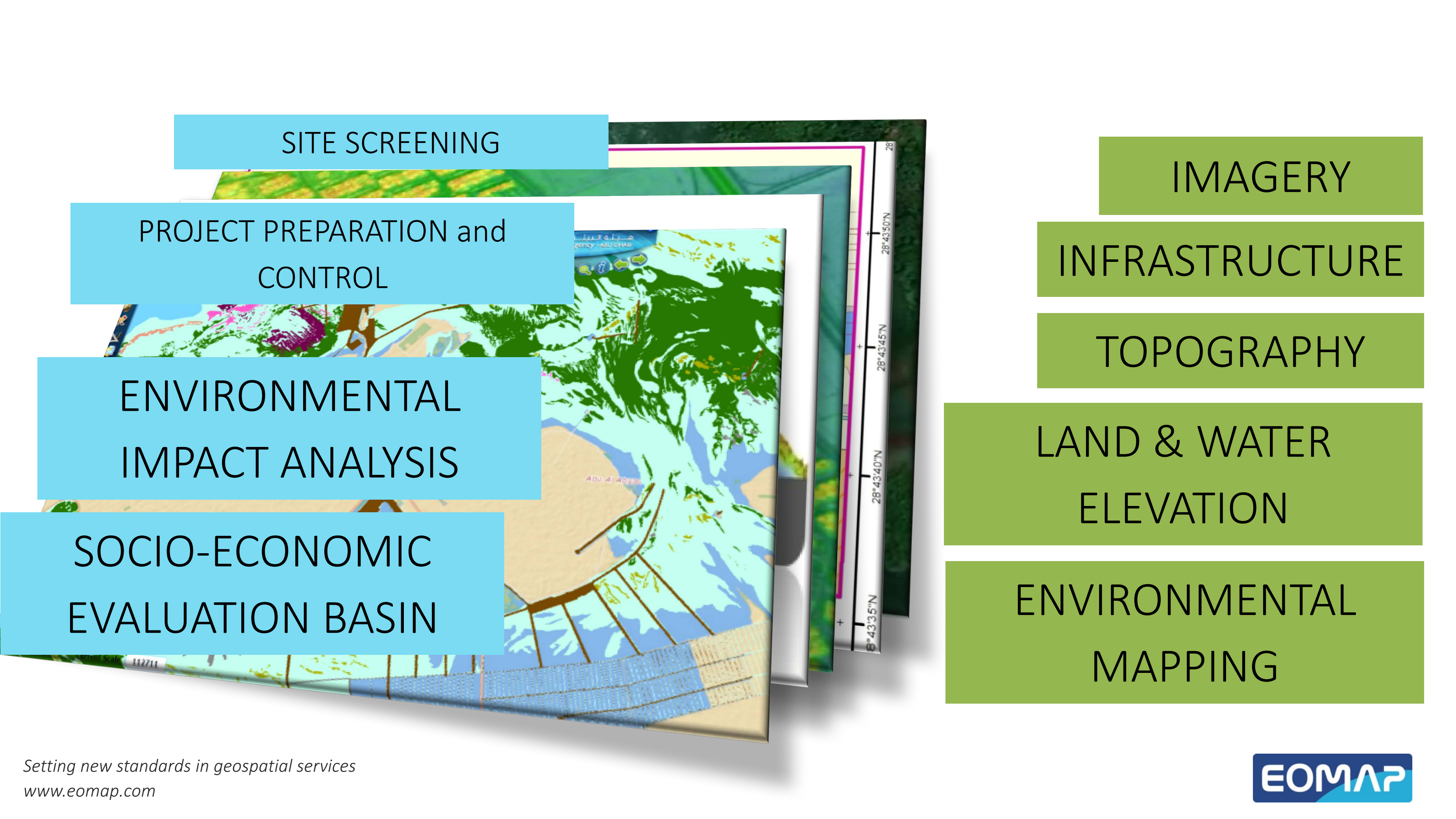
About EOMAP

- Global satellite service provider for offshore and water industries
- Core services: mapping & monitoring of inland, coastal and marine environments
- Headquarters: Seefeld near Munich/Germany



Markets and client groups





SITE SCREENING

PROJECT PREPARATION and
CONTROL

ENVIRONMENTAL
IMPACT ANALYSIS

SOCIO-ECONOMIC
EVALUATION BASIN

IMAGERY

INFRASTRUCTURE

TOPOGRAPHY

LAND & WATER
ELEVATION

ENVIRONMENTAL
MAPPING

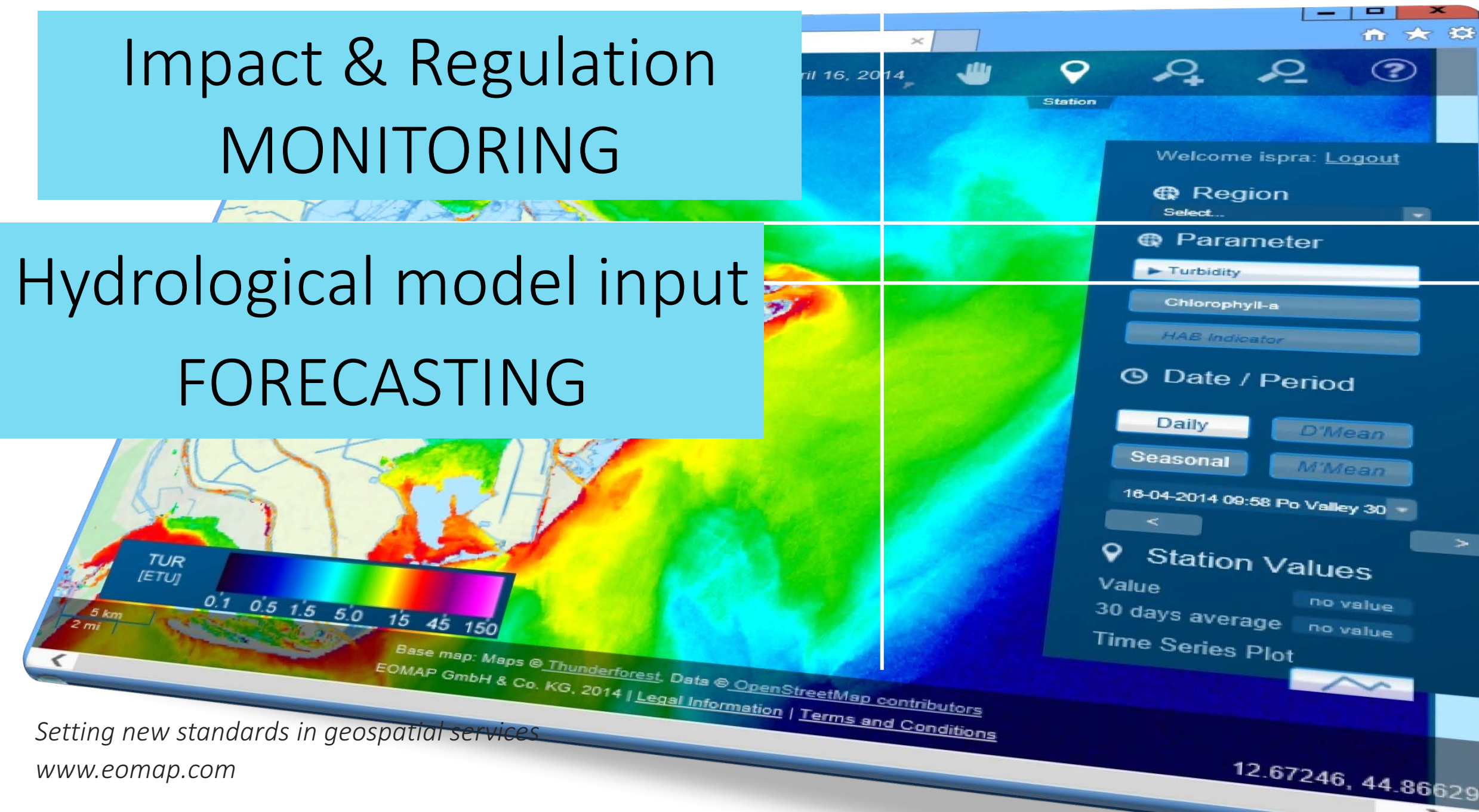
SEDIMENT TRAPPING

LIFETIME FORECASTS

Impact & Regulation
MONITORING

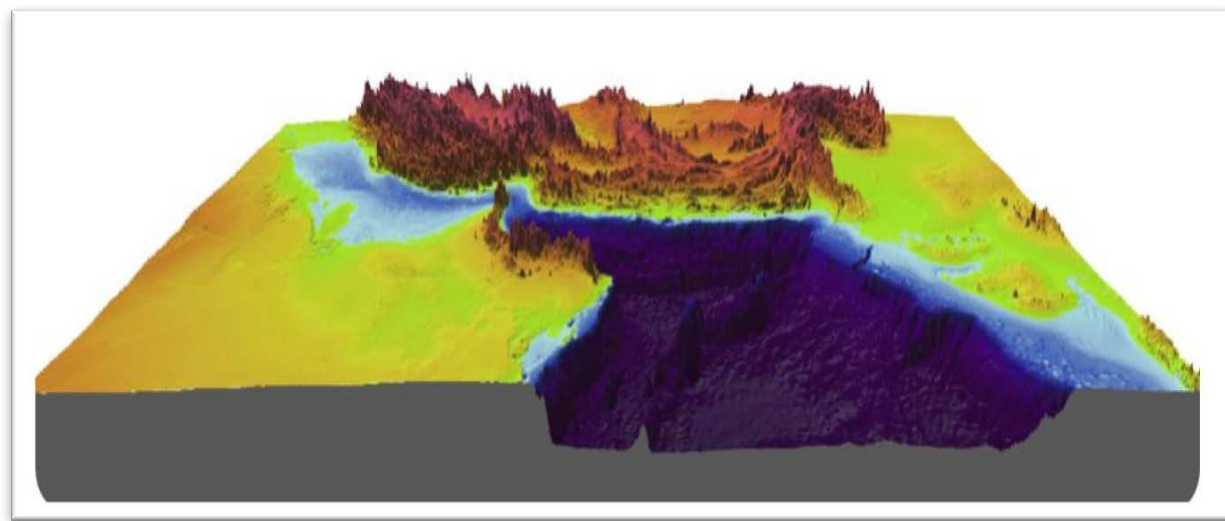
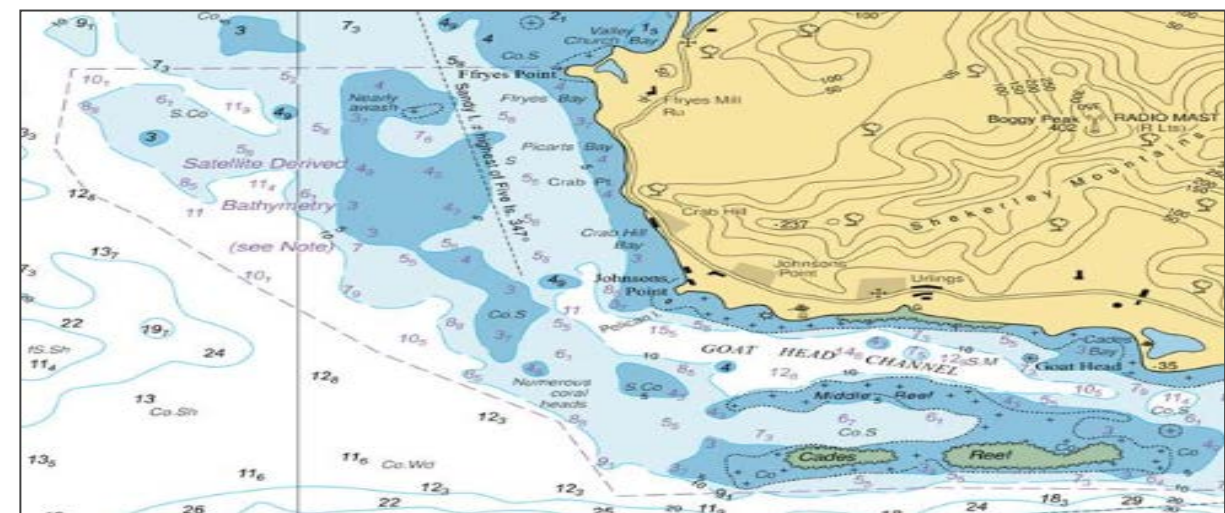
Hydrological model input
FORECASTING

WATER QUALITY



Use Cases: Multi-resolution coastal & bathymetry surveys

Recent Contracts: local, regional, national, global



Clients:

- Offshore construction companies
- Governmental organizations
- Hydrographical offices
- international courts & consultants
- ...

Challenge:

Fast and operational provision, multiple scales and independent measures

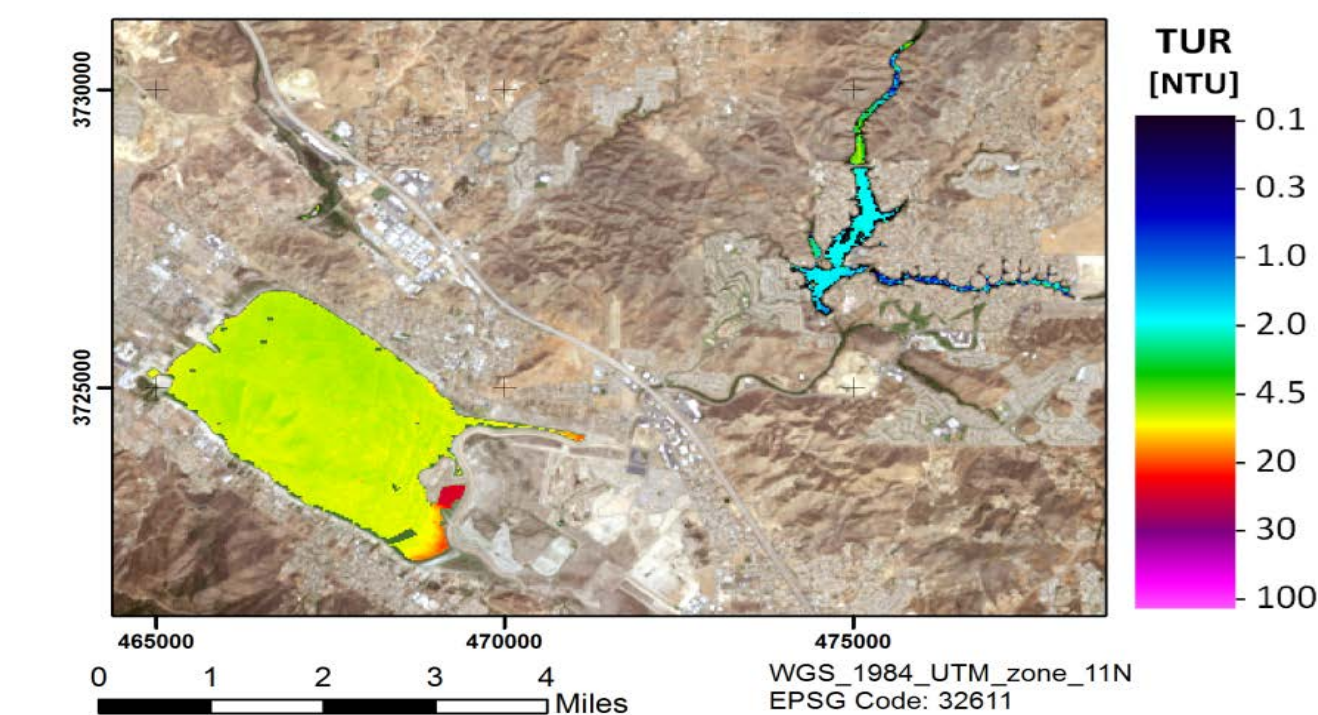
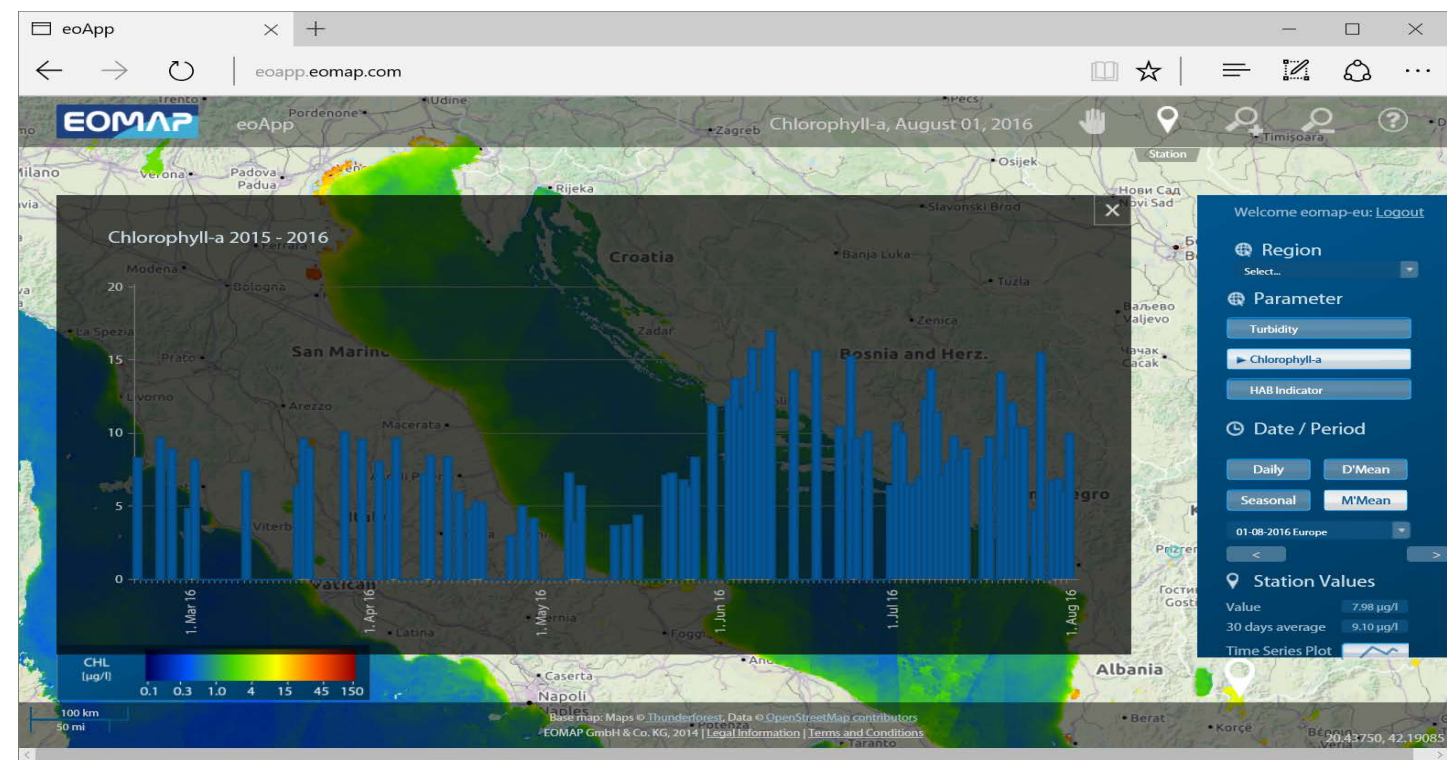
Solution and benefits:

- Proven and operational leading technology
- Multiple spatial resolutions (from 30cm – 30m)
- Fast turnaround, no permissions
- National licences



Use Cases: High-resolution water quality monitoring

Recent Contracts: local, regional, national, global



Clients:

- National Agencies (DE, US, IT, AU, ..)
- Intergovernmental Organizations
- Oil-Gas companies, consultancies
- ...

Challenge:

Environmental monitoring for regulators, powerplants, offshore construction companies, etc.

Solution and benefits:

- Robust and globally consistent measures
- Highest temporal and spatial resolution,
- Proven & liable technology
- National licences



Use Case: Environmental Impact Monitoring



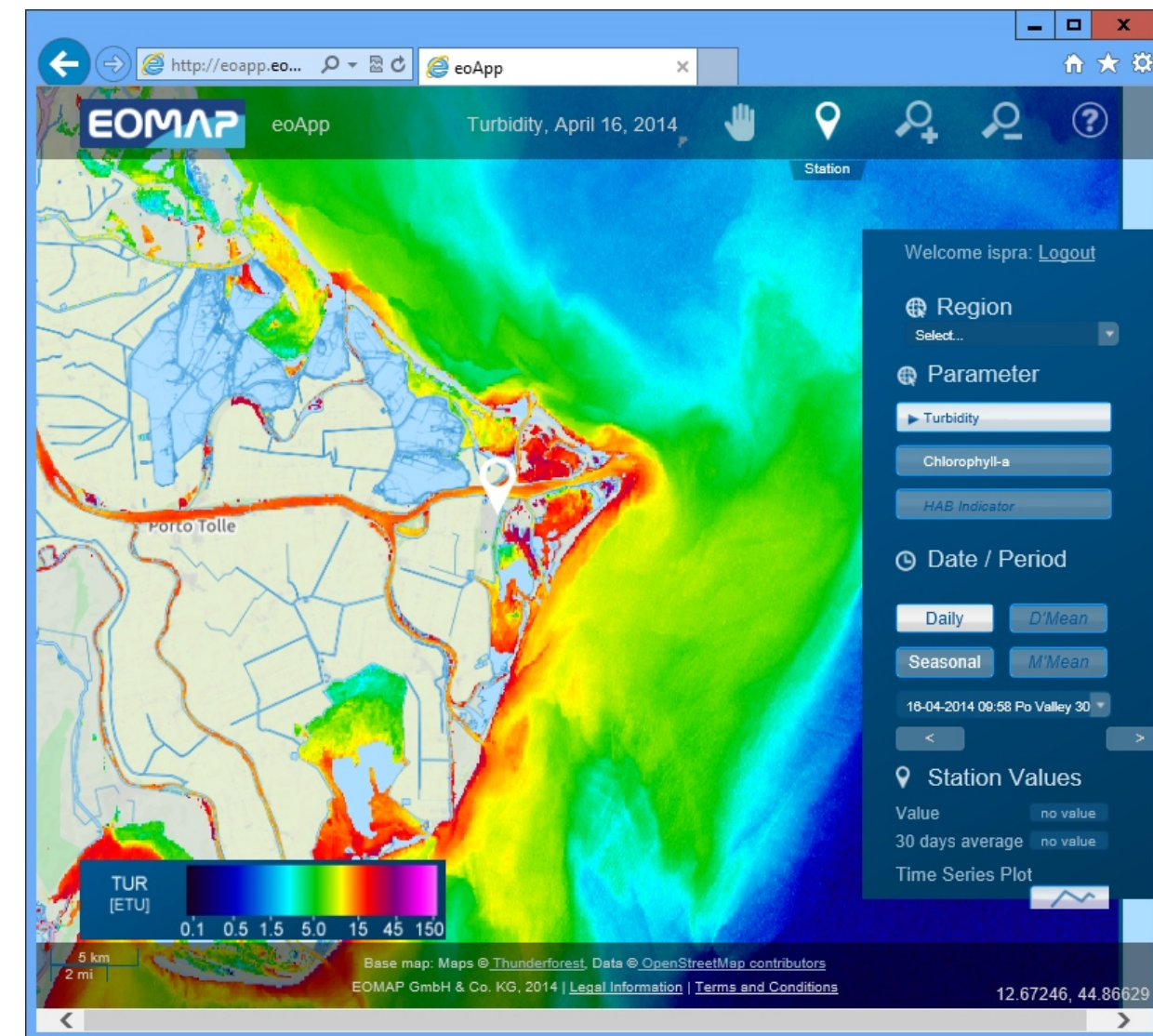
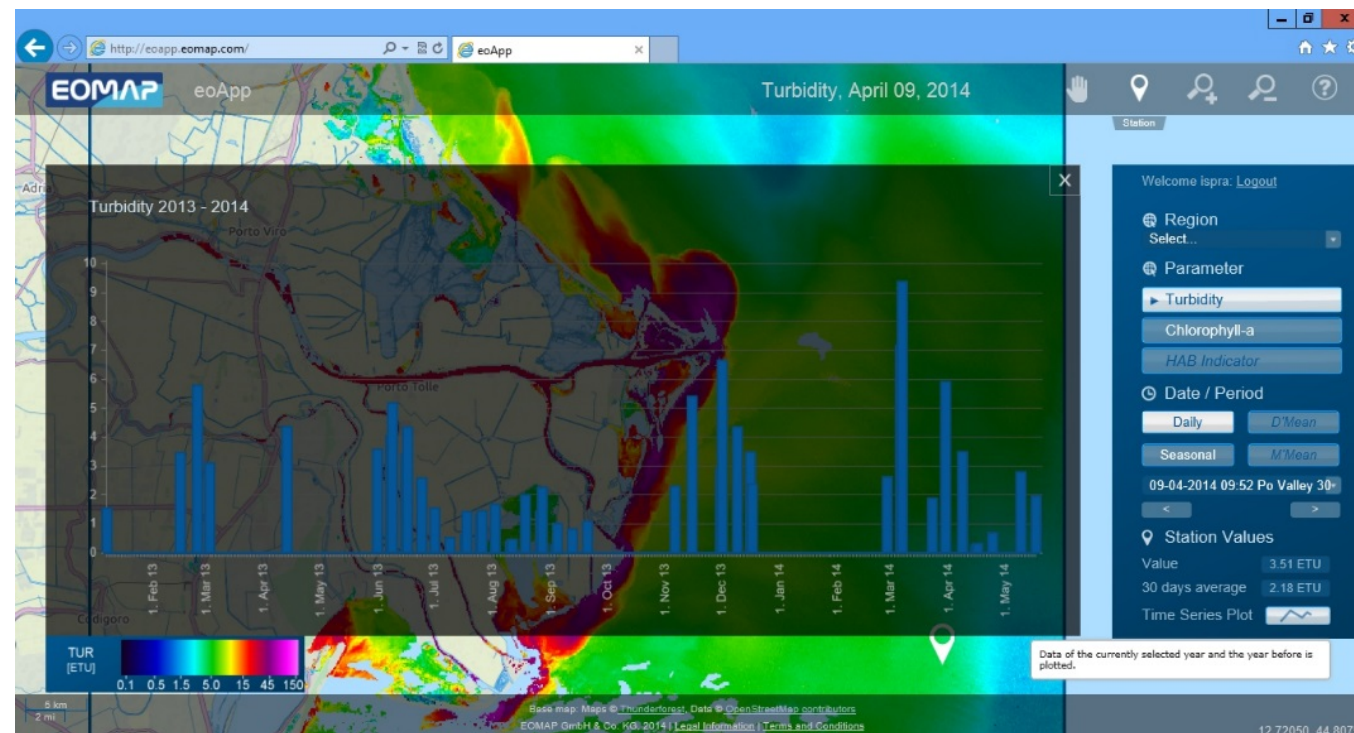
Client: National Italian Institute for Environmental Protection and Research – ISPRA

Challenge: Evaluation of the environmental impact of a gas power plant

build next to the river Po in Italy

Solution and benefits:

- ⚙ Long-term TSM, CHL, organic absorption, daily and weekly multi-satellite-sensor records (2012-2014)
- Robust and consistent measures and maps
- ✓ independent on in situ measures
- ✓ High temporal and spatial resolution



Use Case: Environmental Impact Monitoring

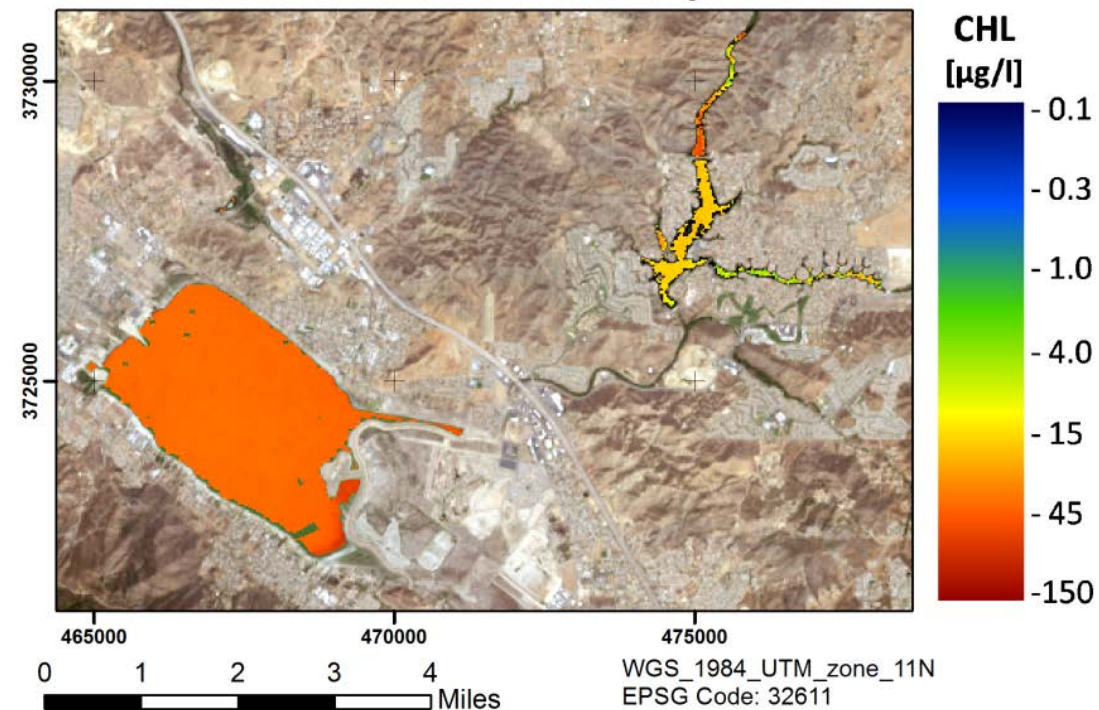
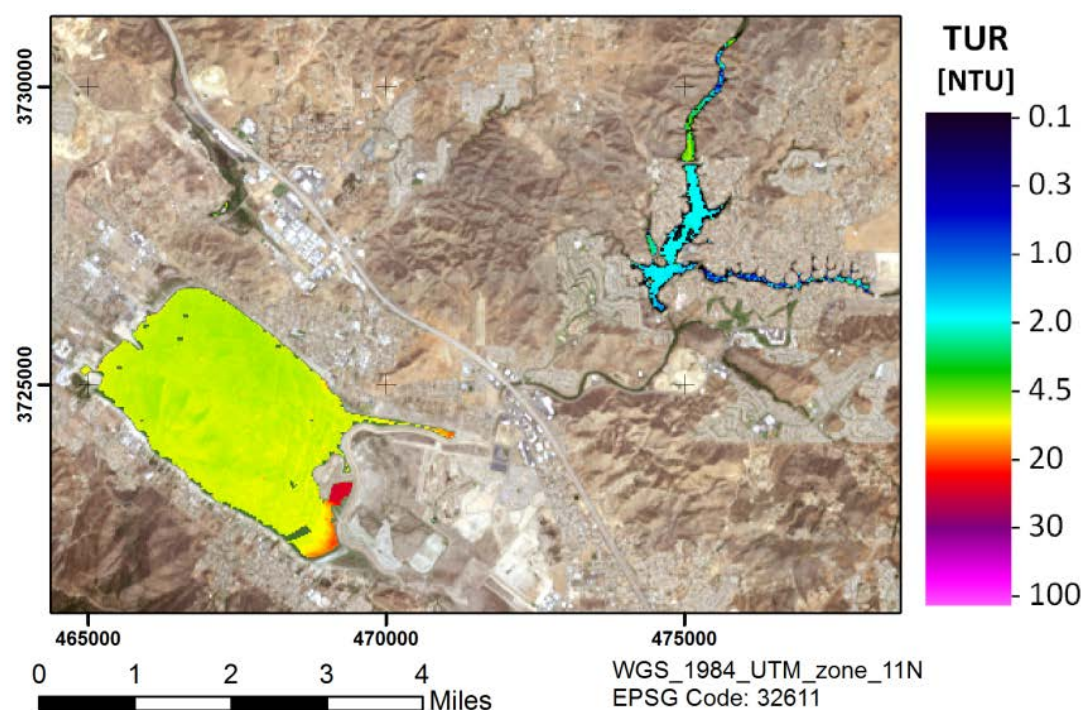


Client: Amec Foster Wheeler (engineering consultancy)

Challenge: Routine Lake Water Quality Monitoring for government

Solution and benefits:

- ⚙️ Multi-year water quality monitoring, satellite and in-situ integrated
- ✓ Fast delivery and reporting
- ✓ 10 - 30m spatial resolution
- ✓ Cost-effective solution



Use Case: Disaster monitoring Rio Doce, Brazil: Impact assessment 2016

<http://mundo.sputniknews.com/americalatina/20151112/1053575772/brasil-samarco-peces-intoxicados.html>

SPUTNIK

**Brasil obliga a Samarco a
recoger los peces
intoxicados por lodo tóxico**

© Foto: IBAMA

AMÉRICA LATINA

20:09 12.11.2015 (actualizada a las 20:10 12.11.2015)

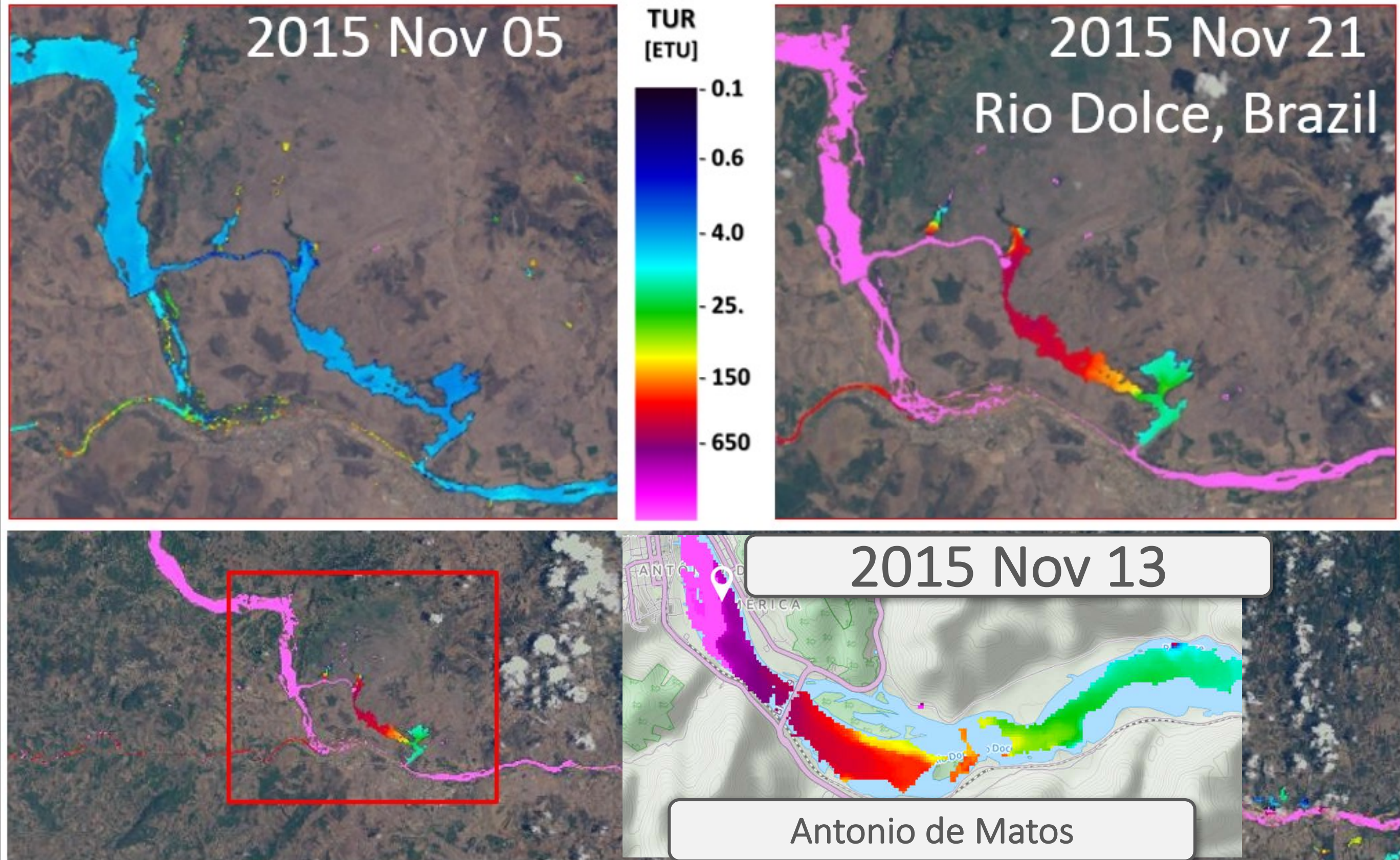
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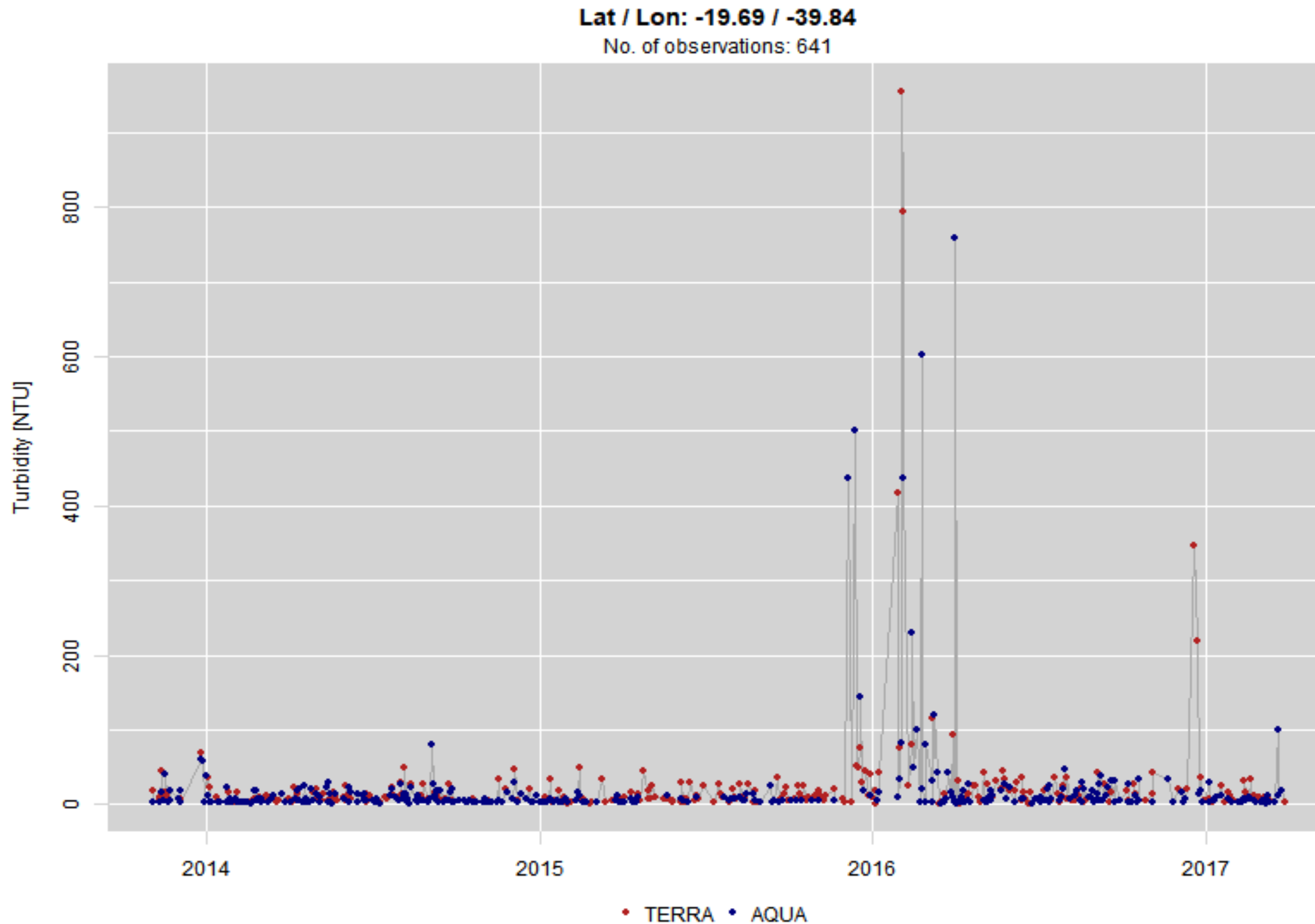
NOTICIAS

EOMAP

Use Case: Disaster monitoring Rio Doce, Brazil: Impact assessment 2016

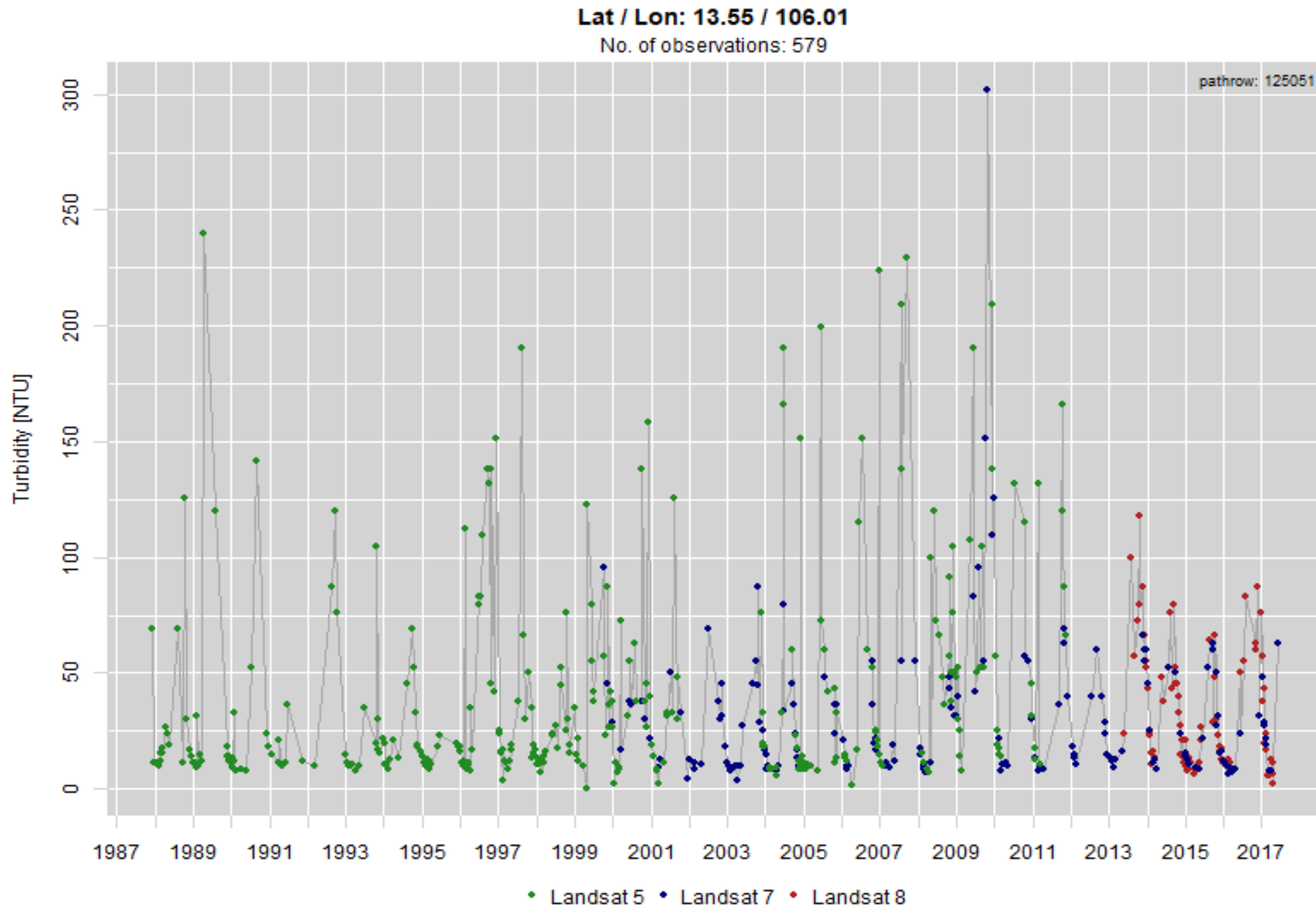


Rio Doce (Brasilien)

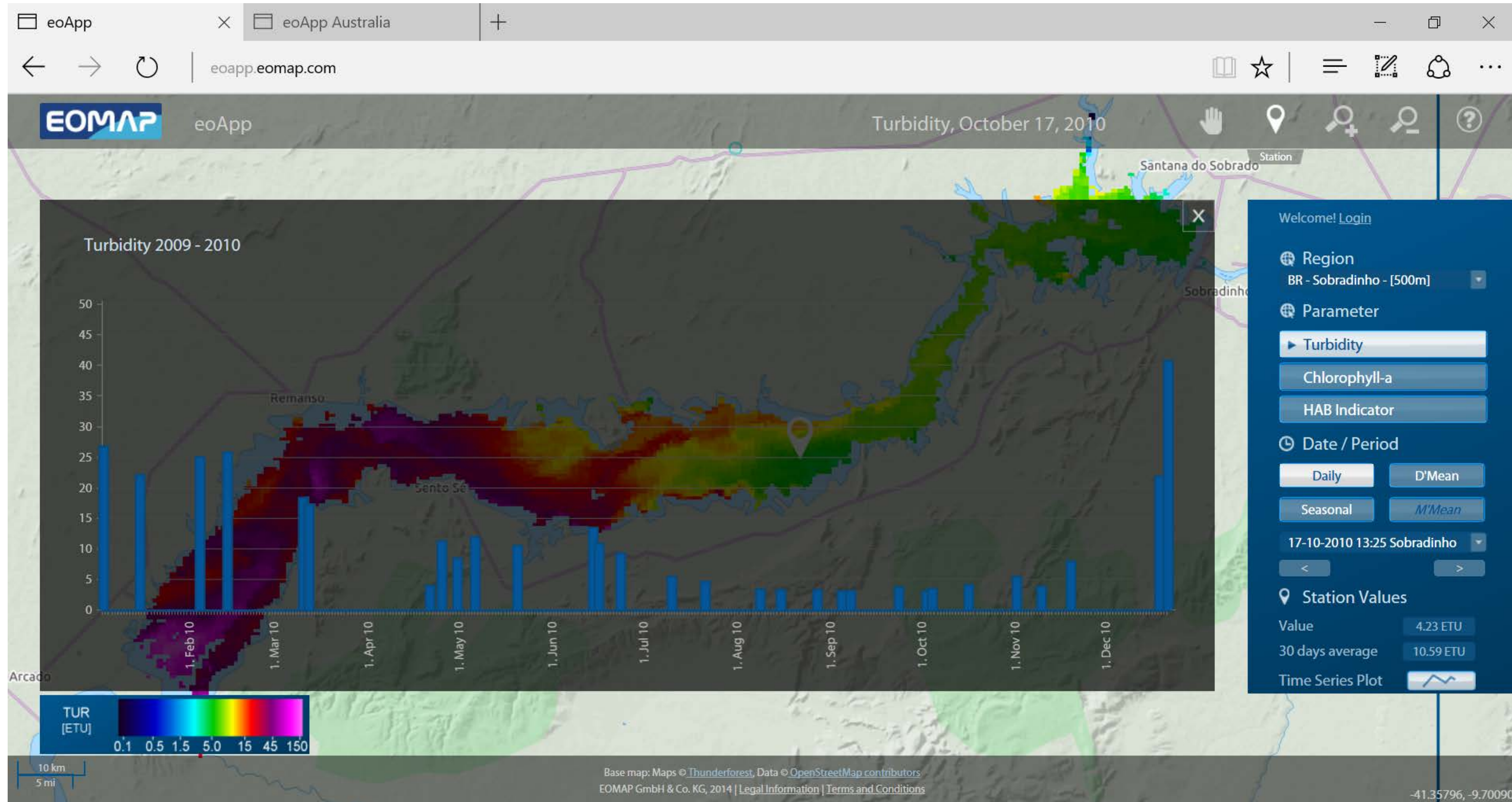


Mekong River

(Catch-Mekong
Project)

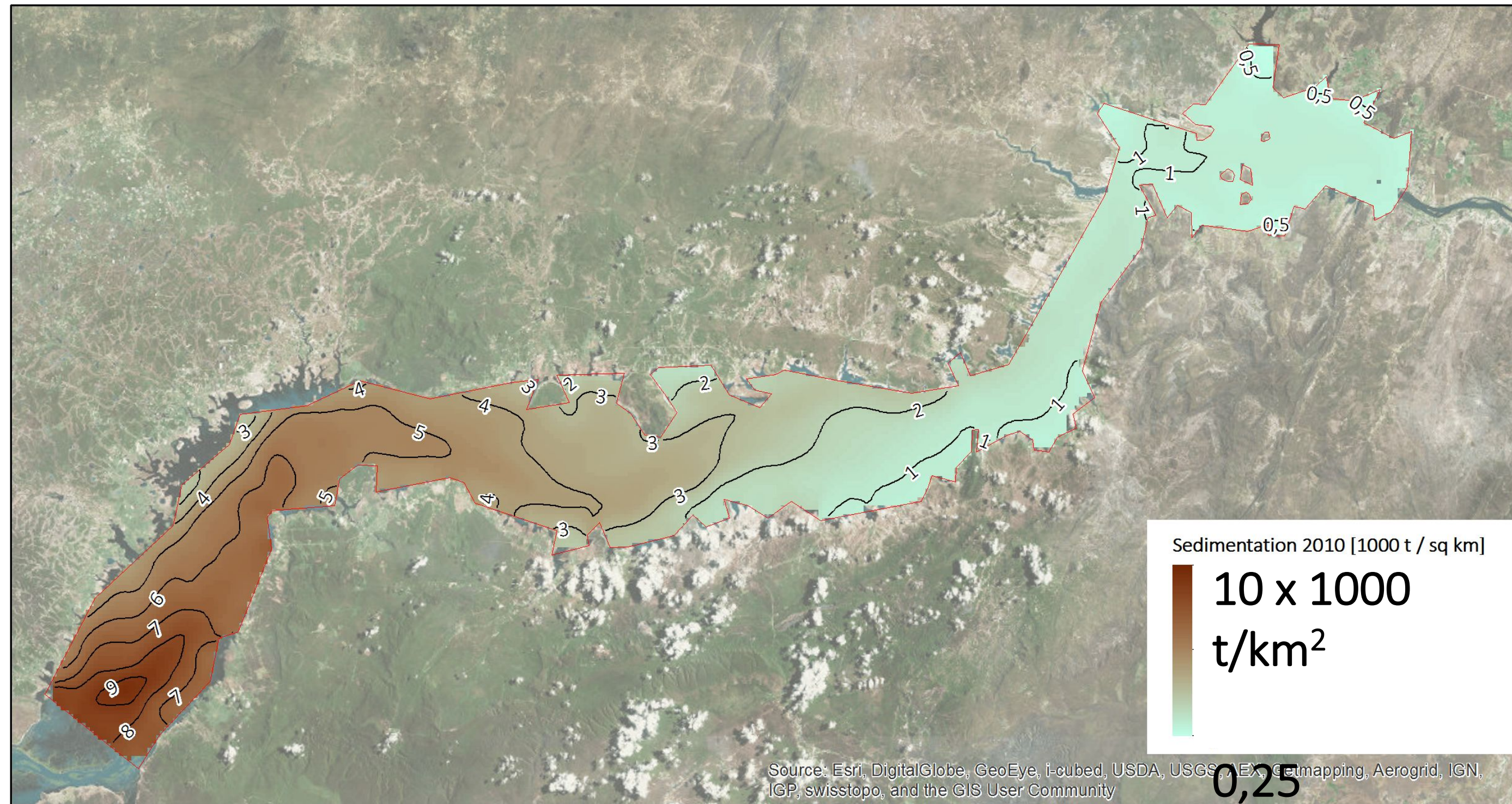


Turbidity in Sobradinho dam: actual and historic 30 years back in time



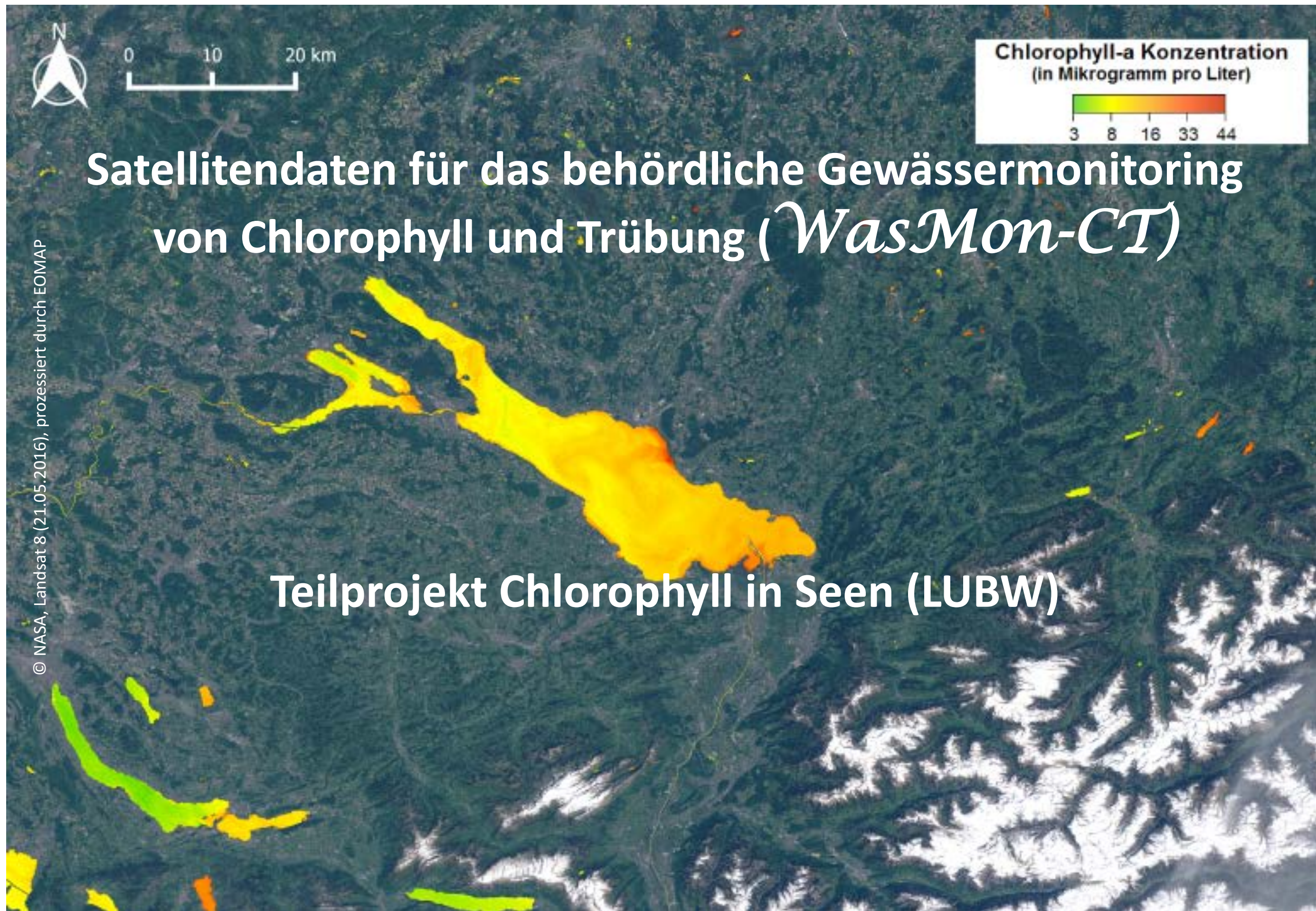
Distribution map of accumulated sediments 2010, Sobradinho reservoir

in tons per sqkm, accounting inflow/outflow discharge



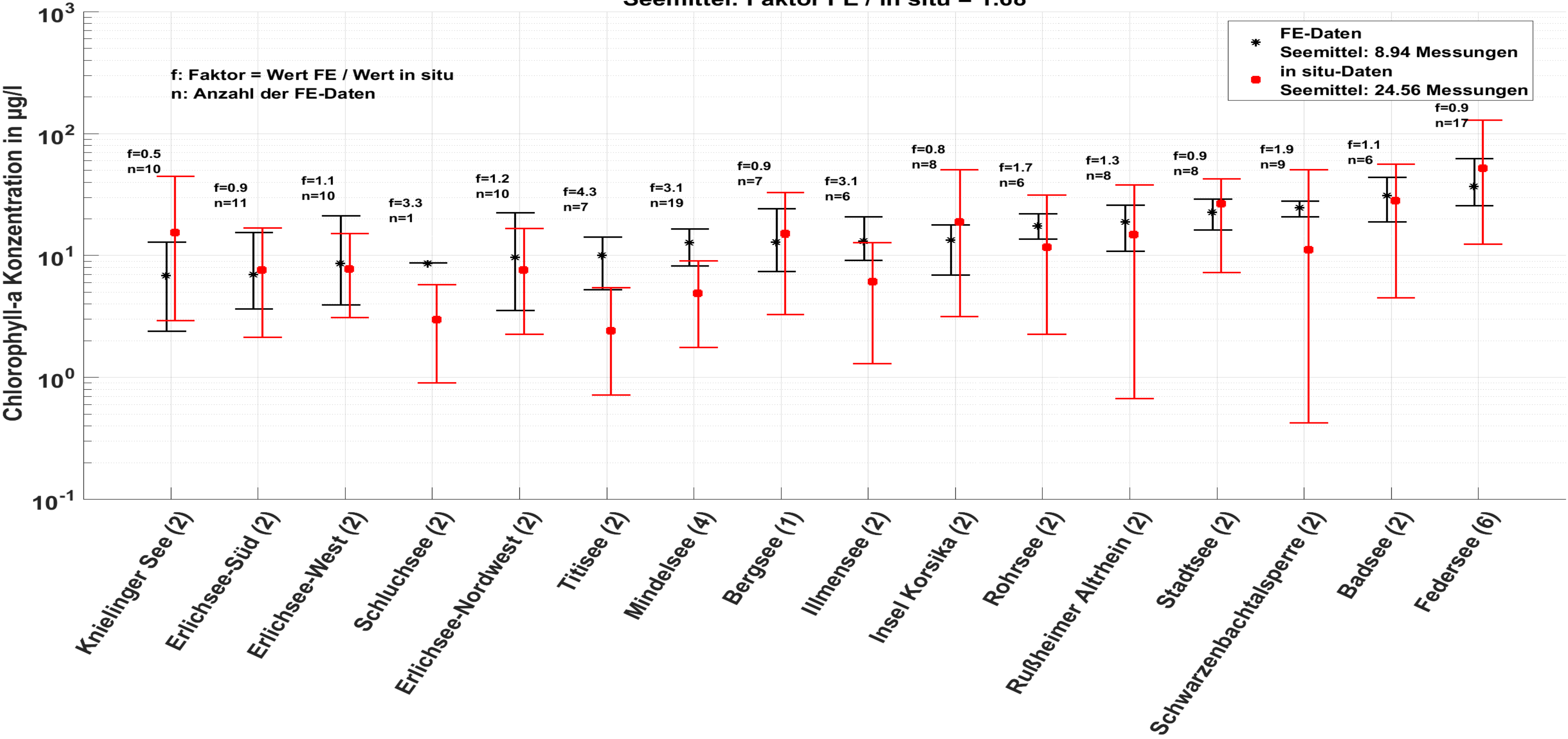
Total volume 2010:
8,2 million tons / y
by sedimentation

0 5 10 km



Erste Ergebnisse

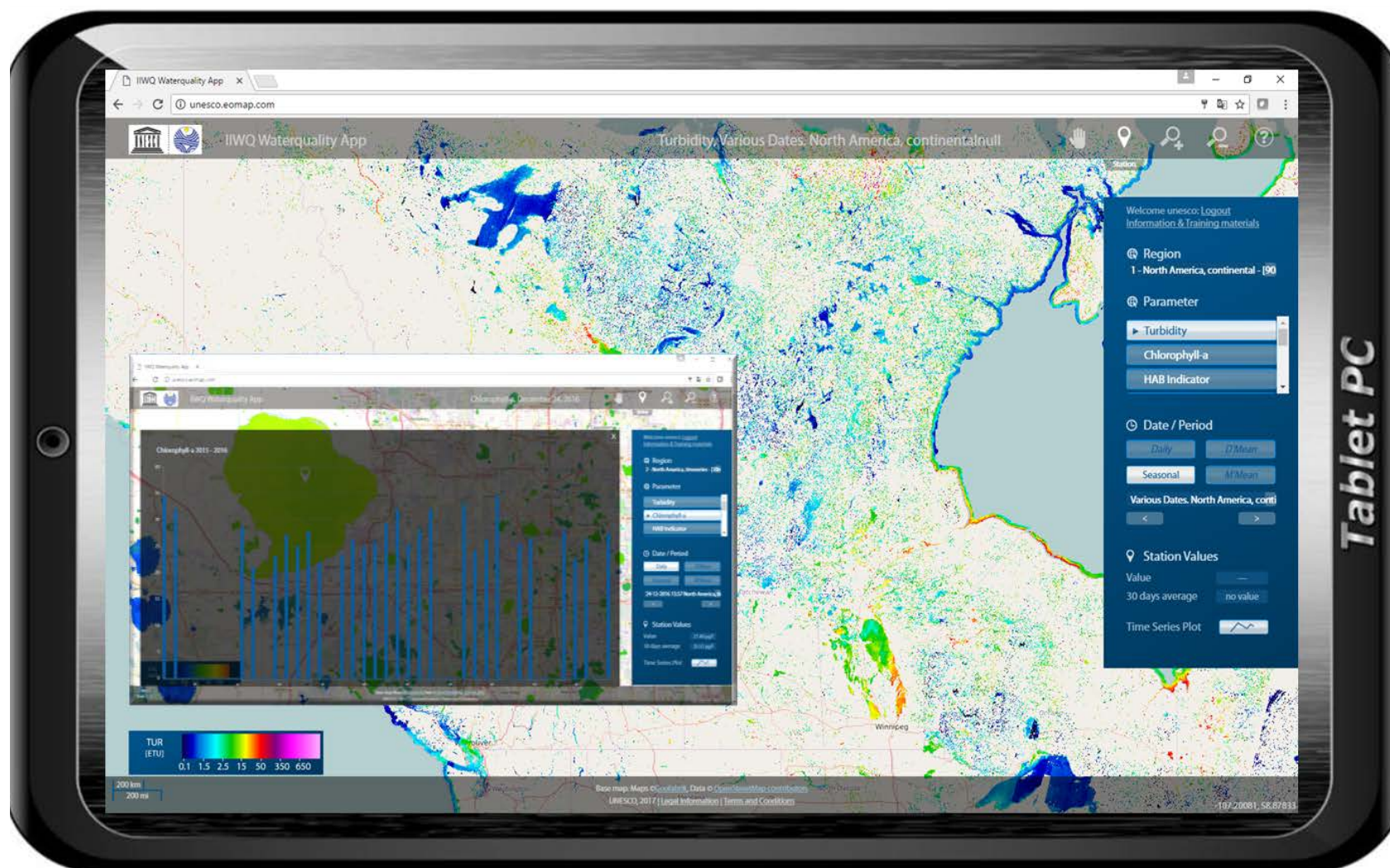
Vergleich der Mittelwerte aus mehreren Jahren (+MIN und MAX) für FE- und in situ-Daten: Chlorophyll-a
Seemittel: Faktor FE / in situ = 1.68



Global use case: IIWQ World Water Quality Portal

Client: UNESCO, International Initiative on Water Quality IIWQ

Challenge: Easy access to global information for lakes and rivers
Capacity building for worldwide governments & SDG

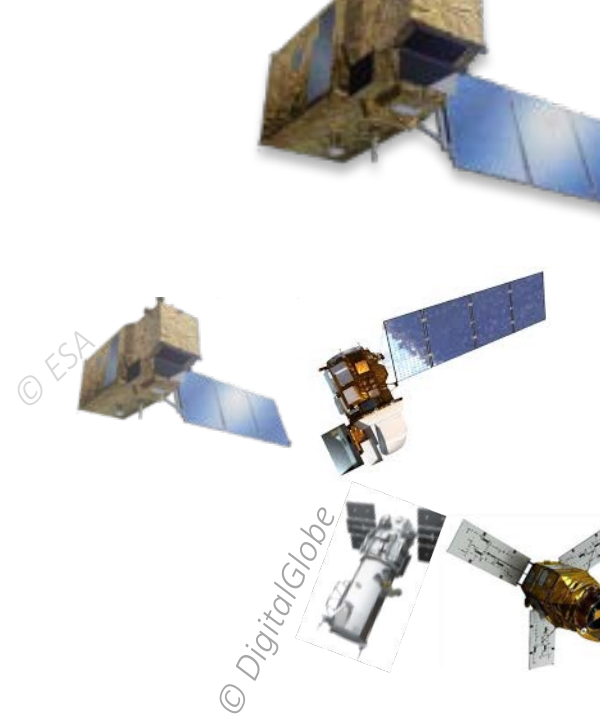
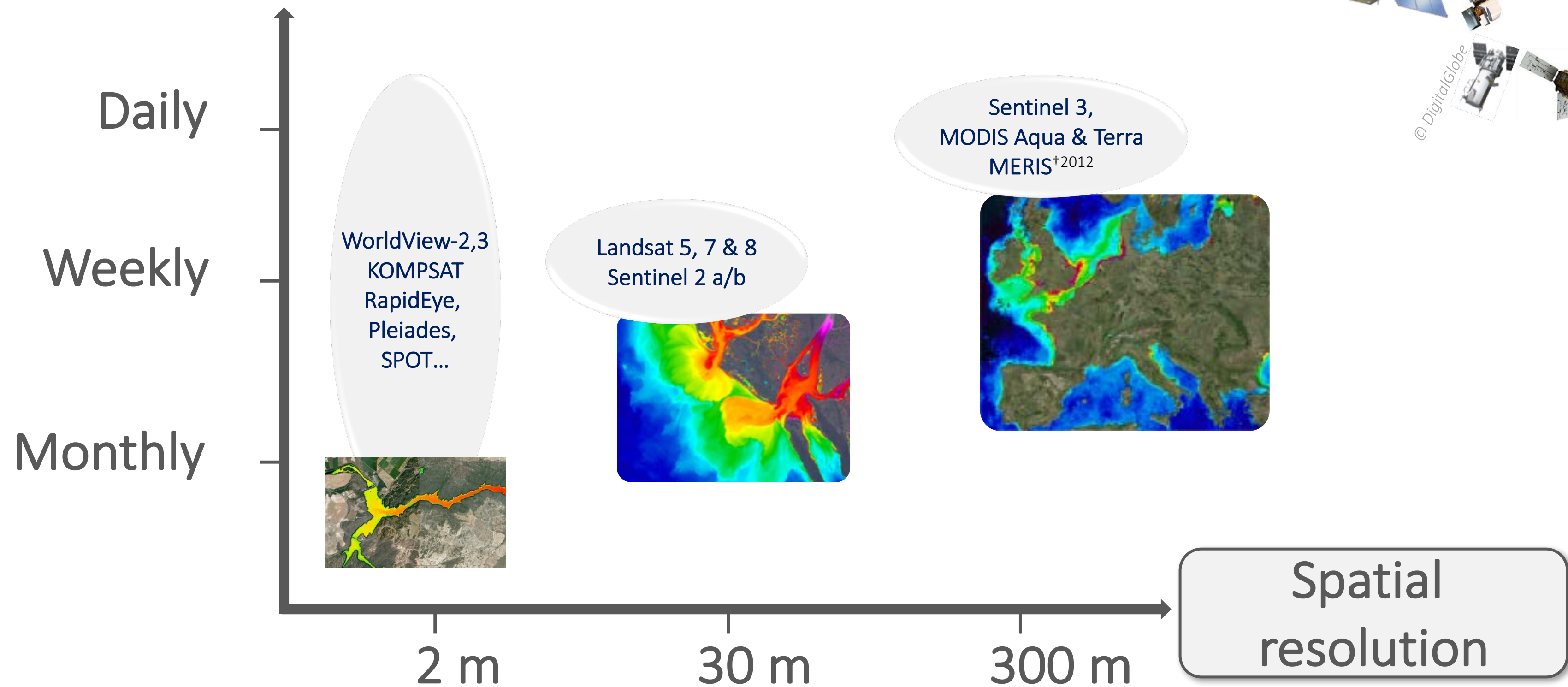


Solution and benefits

Global and Seasonal EOMAP Waterquality
Turbidity, Chlorophyll, Cyanobakt, Organic Absorption, SST

- Physics based: Independent & Consistent
- Multiple satellite sensors: L7 & L8 & S2a & S2b
- ✓ High temporal and spatial resolution
- ✓ Easy access through online web app
- ✓ Capacity building materials

Temporal resolution



EO derived water quality properties

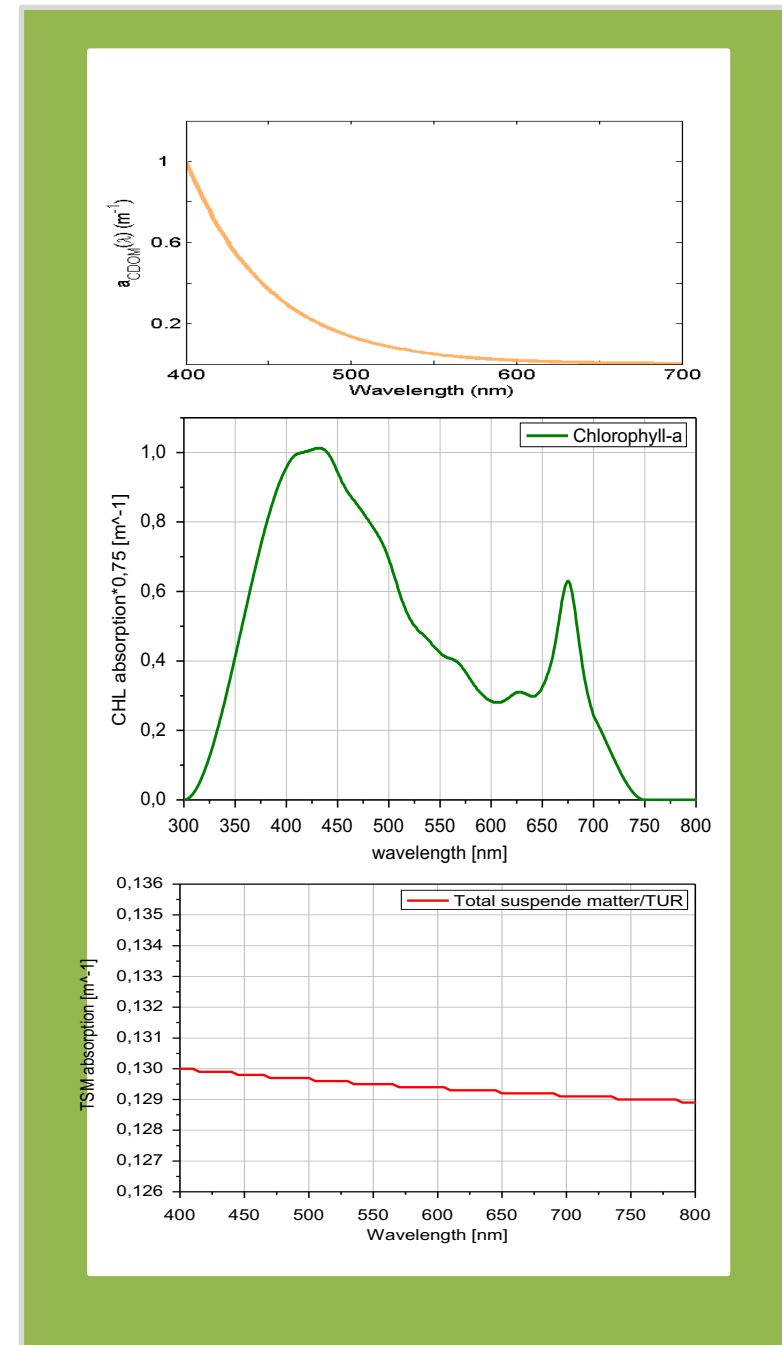
- *Reference properties: Spectral absorption and scattering coefficients*
- *Interface to established hydro-biological measurements*

water color



«

absorption and scattering



«

water constituents

turbidity

- TSM, Secchi depth, k ...

organic-/anorg. absorption

- CDOM , organic/anorganic

pigment absorption

- Chlorophyll a

specific pigment indicators

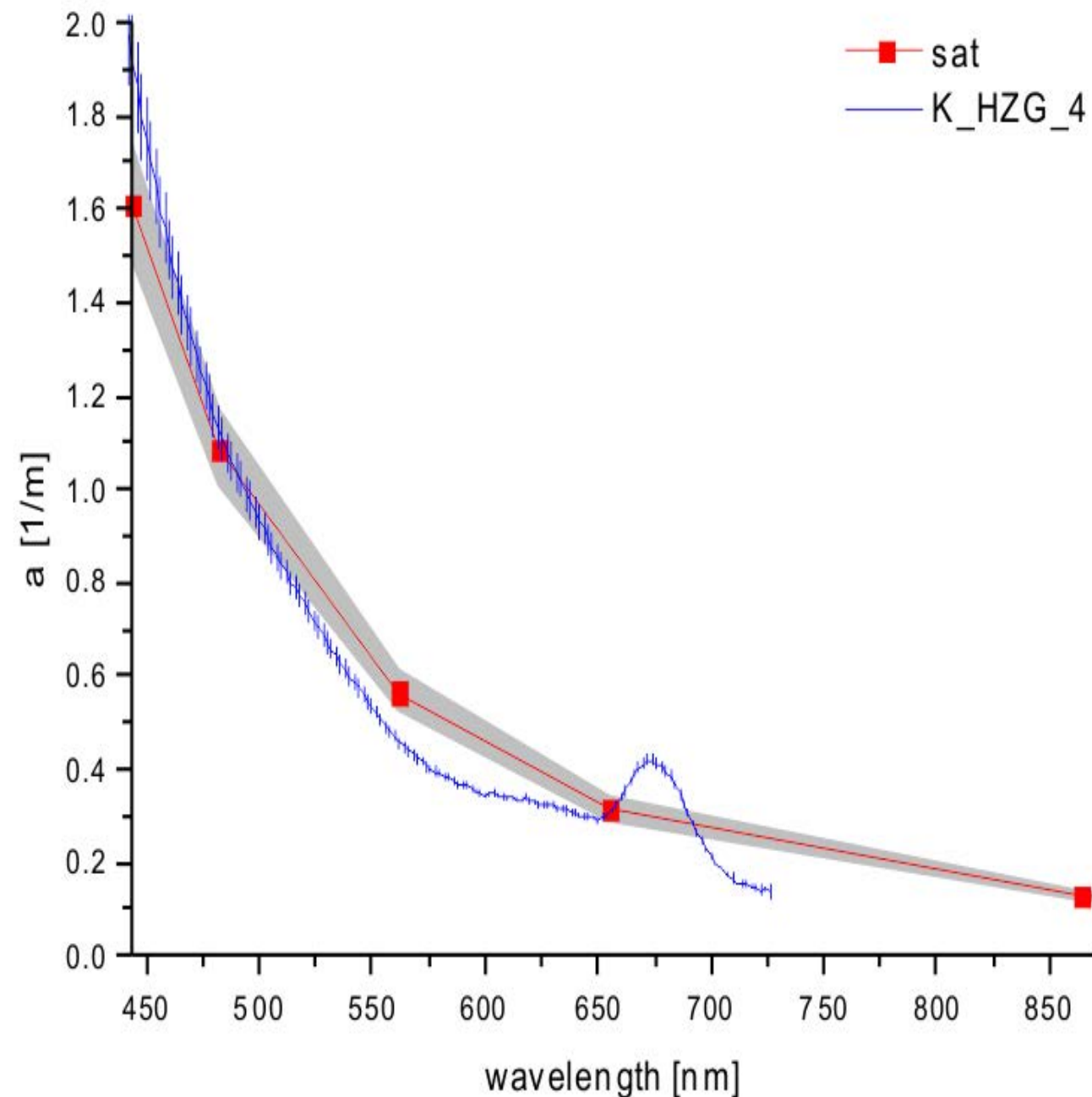
- Blue algae indicator

harmfull algae bloom HAB

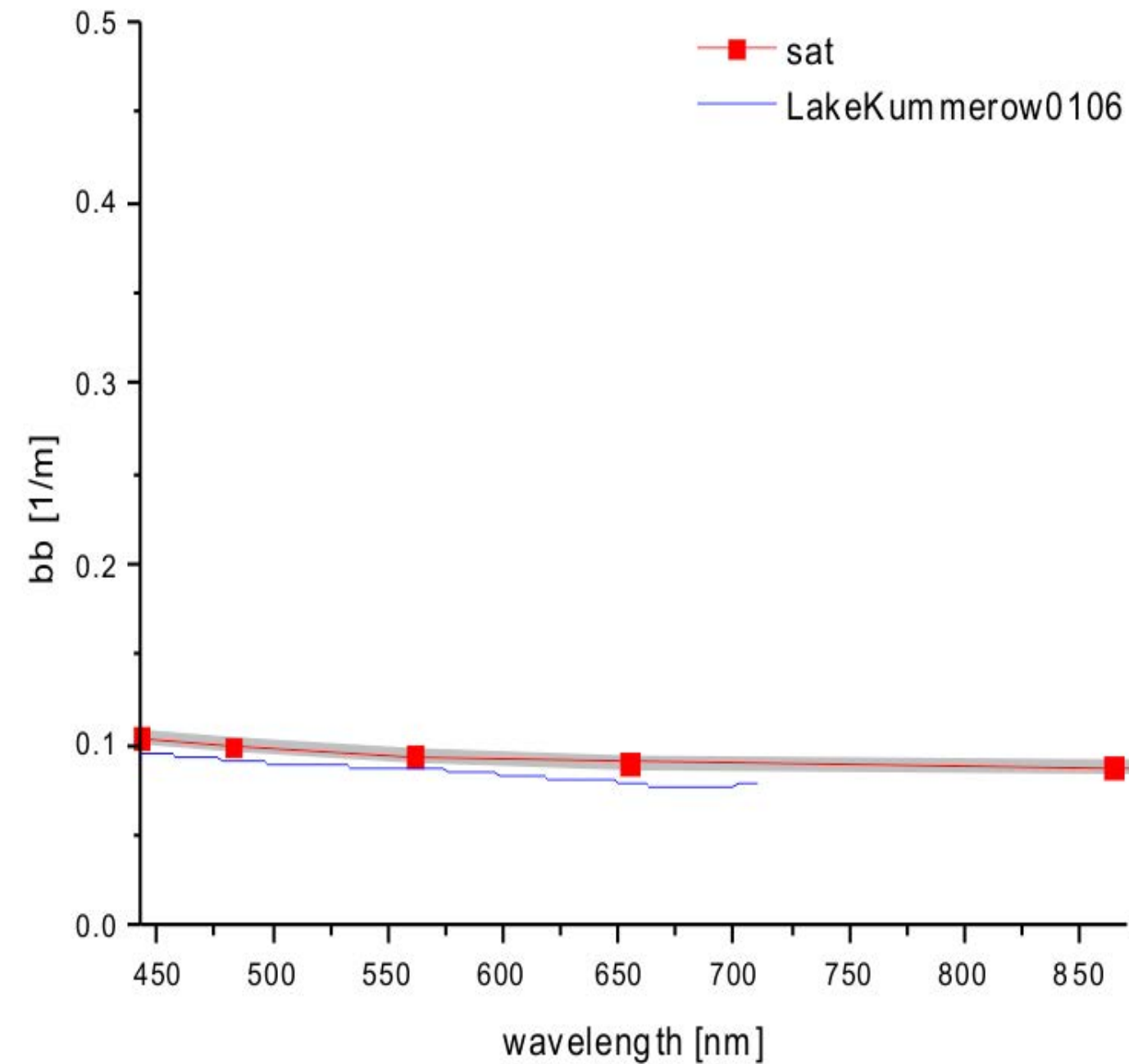
Comparison of reference properties: Absorption und Backscattering

In-situ measurements 30.5./1.6. (blue) and satellite based measurements 6.6.16 (red: MIP)

Total absorption



Backscattering

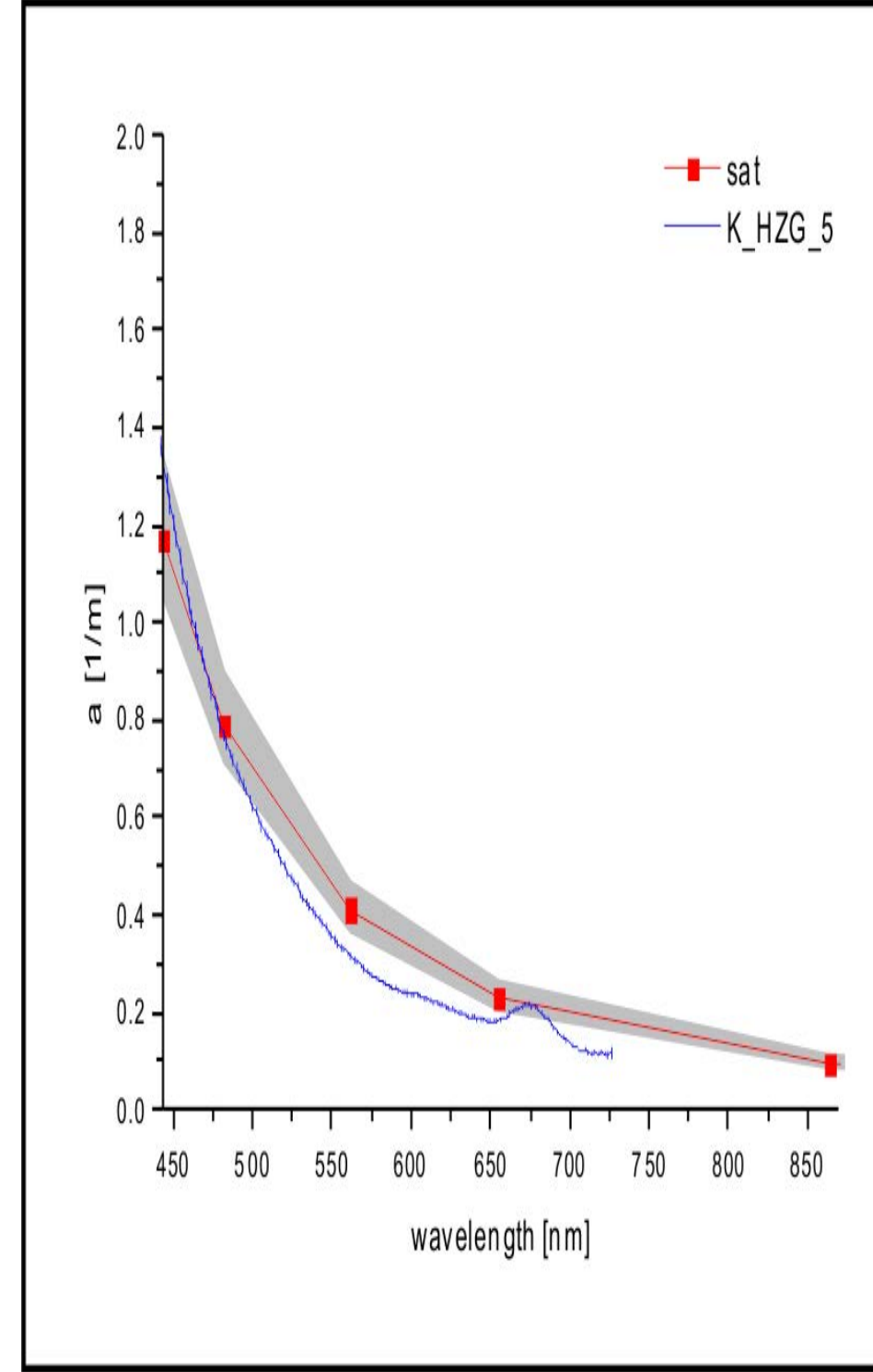
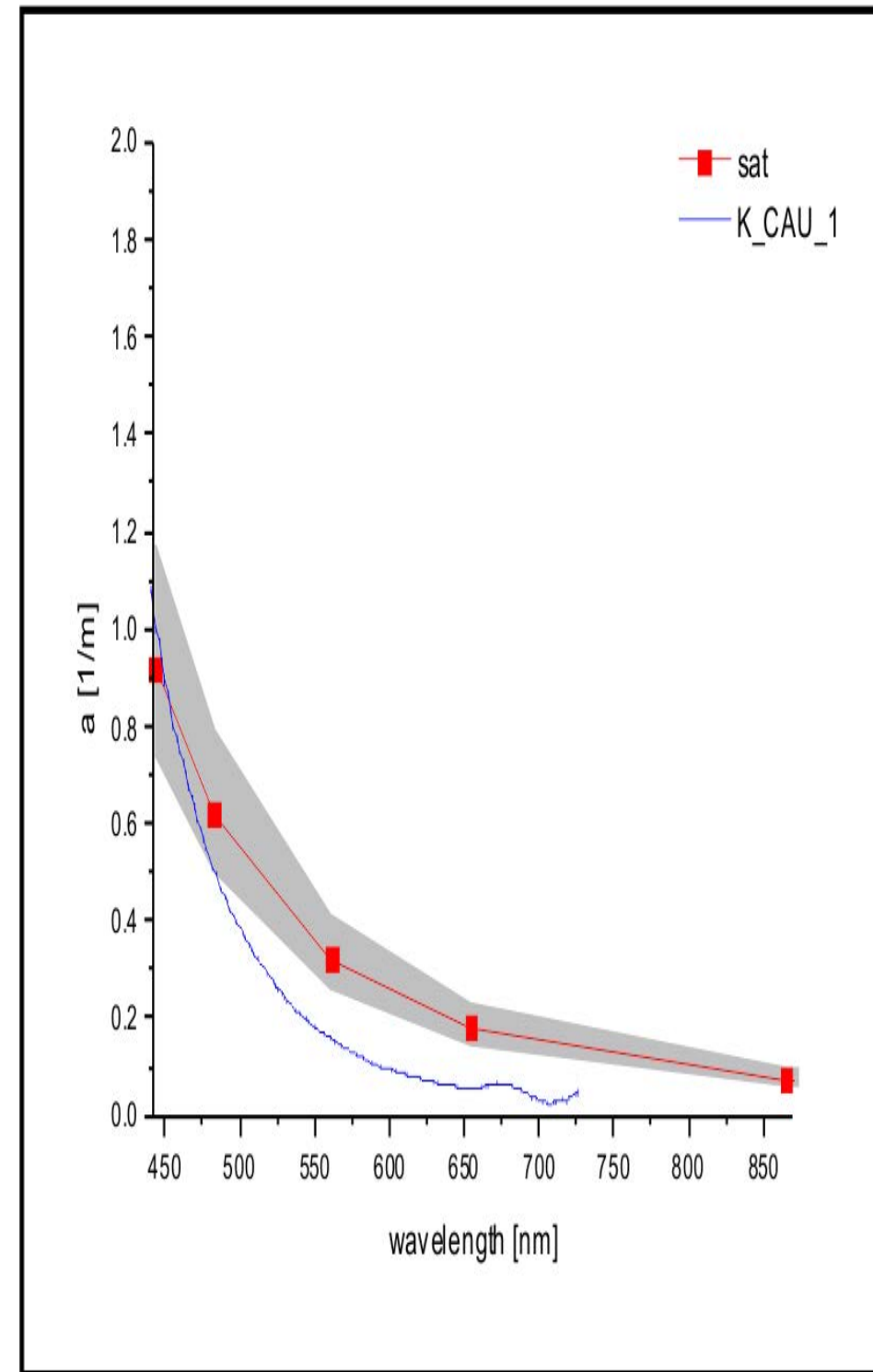
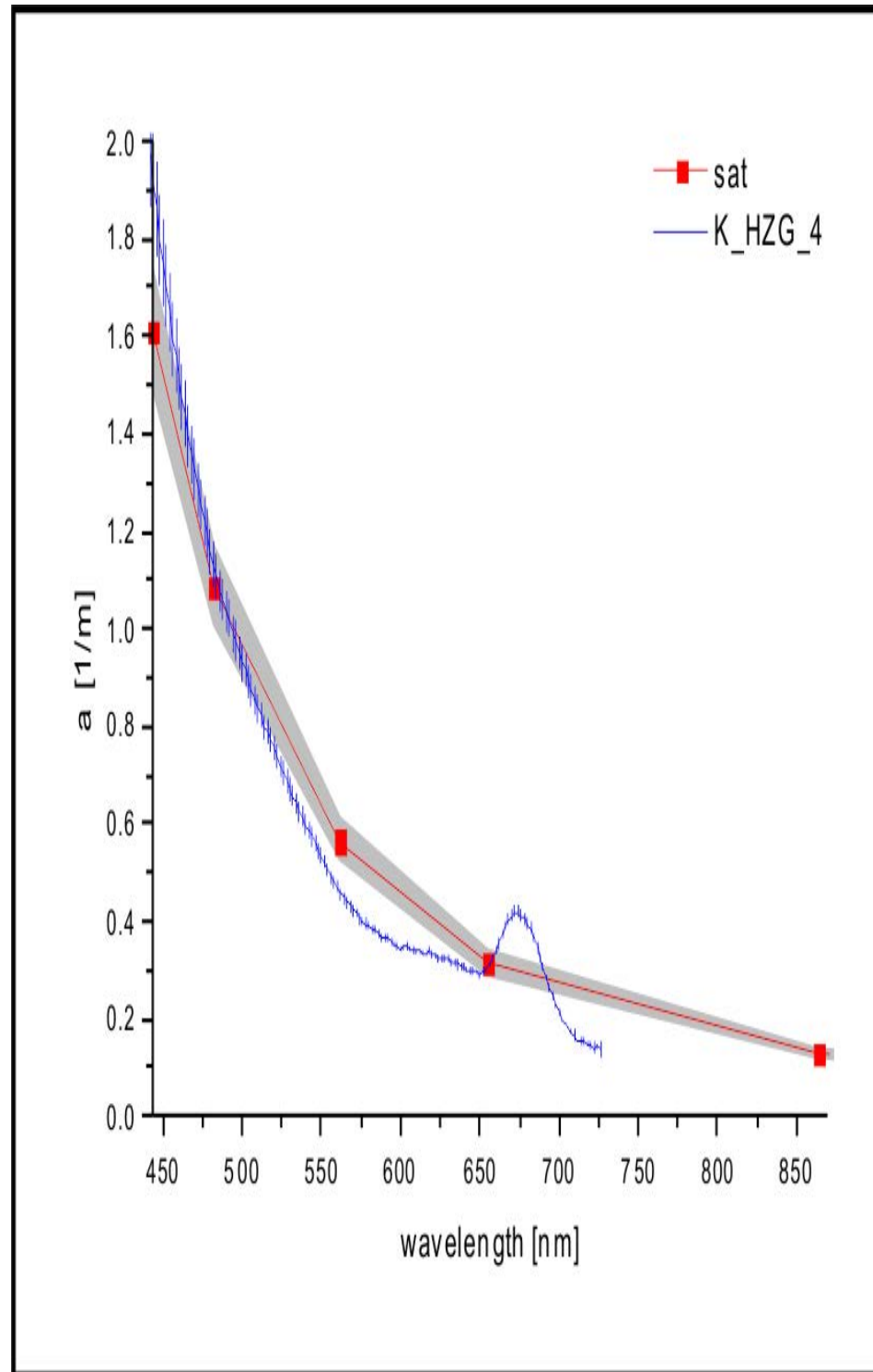


Kummerow See
HZG-station
CAU-Station

Bumberger et al.
In prep. by
UFZ, EOMAP,
HZG/GKSS, Uni-Kiel

Comparison of absorption measurements at 3 stations

In-situ measurements 30.5./1.6. (blue) and satellite based measurements 6.6.16 (red: MIP)



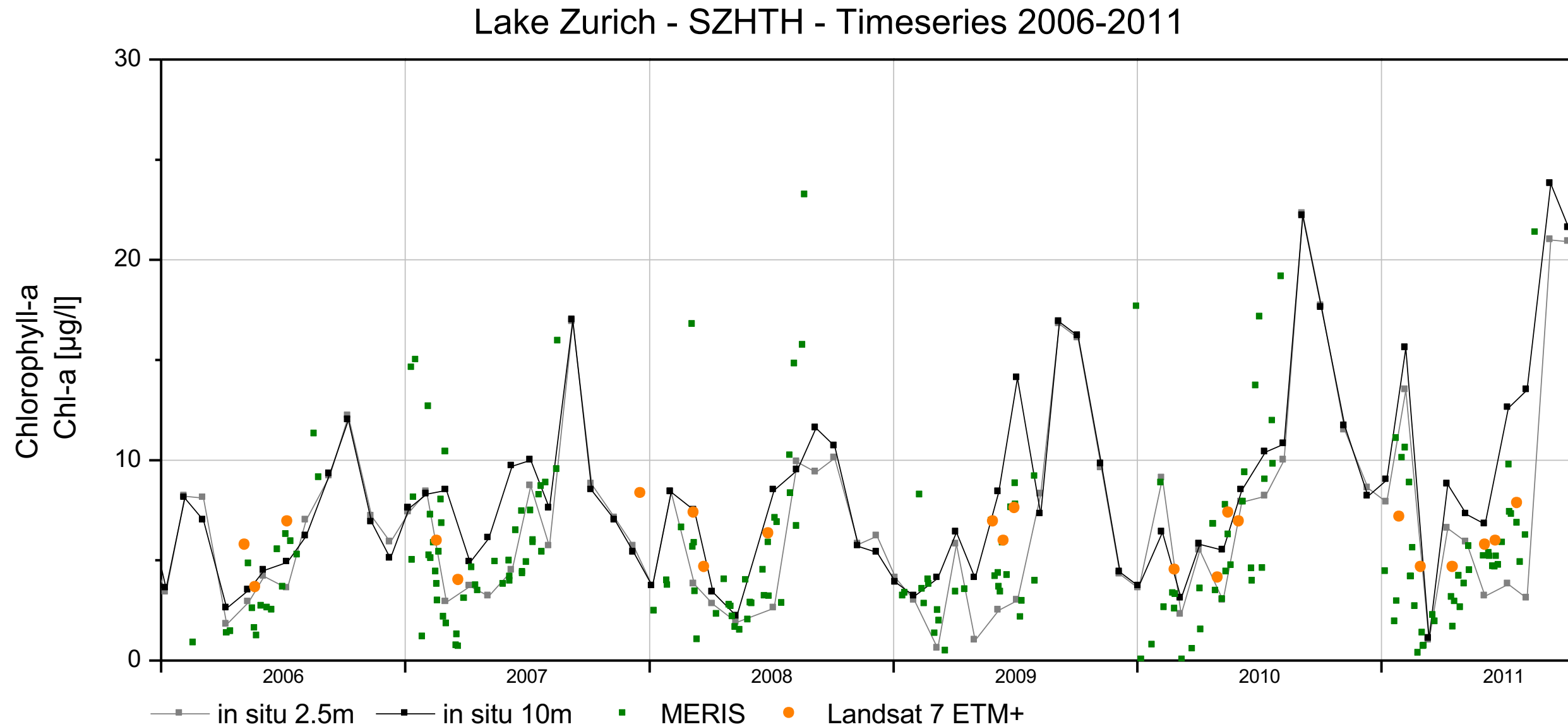
Bumberger et al.
In prep. by
UFZ, EOMAP,
HZG/GKSS, Uni-Kiel

Examples for related satellite derived Water Quality Parameters

1. Turbidity in [FTU] or Suspended Matter Conc. in [mg/l]
2. Total absorption of water constituents in [1/m]
3. Absorption of organic components in [1/m]
4. Chlorophyll a in [$\mu\text{g/l}$]
5. Indicators for Cyanobakterien
6. etc.

Chlorophyll-a Lake Zurich, Switzerland: Seasonal trends

Time Series MERIS 300m, Landsat 7, Station SZHTH 2006-2011



Satellite data: processing MIP © EOMAP, source data: USGS for Landsat 7ETM+, ESA for MERIS
In situ data © Wasserversorgung Zürich 2012 provided in context of FRESHMON project

Validation summary (Chlorophyll, Turbidity, Secchi, ..)

EOMAP Validation Report (2016)

www.eomap.com/services/water-quality/ und

www.eomap.com/exchange/pdf/EOMAP_Validation_Examples_Water_Quality.pdf

EU FP7-Projekt GLASS (2016)

WP4 Validation report:

www.glassproject.eu/assets/Deliverables/GLaSS-D4.2.pdf

EU FP7-Projekt FRESHMON:

WP54 Final Calibration and Validation Report:

www.freshmon.eu/static/media/uploads/fm_ph3_wp54_d543_update_pr.pdf

http://cordis.europa.eu/result/rcn/141731_en.html

EU H2020-Projekt SPACE-O:

Validation summary for basic products

Chlorophyll, organic absorption, turbidity and directly related parameters:

- Validity proved over 3 – 4 magnitudes of concentration ranges
- Uncertainties appr. 20 – 100 % higher in comparison to in-situ measures
- High level of consistency and harmonization globally

Restrictions or unknown validity in specific cases:

- Chlorophyll in rivers, high CDOM dominated lakes, iron- and calcareous dominated waters, optical shallow waters

Calibration / specific adaption might be required in specific cases

Validation report available at:

www.eomap.com/exchange/pdf/EOMAP_Validation_Examples_Water_Quality.pdf



Technical aspects of physics based approaches

- Accuracy and implementation level of forward model
- Implementation level of retrieval methodologies
 - Atmosphere & aerosols, adjacency effect, sunglitter, optical model adaptation, ...
- Capability of retrieval solver and retrieval concept
- Error propagation, quality control and flagging mechanisms
- Client access, data aggregation, data implementation technologies

Summary

➤ *Global reference standards required / available*

fostering user understanding and user acceptance

supporting comparability, independency on single approaches, global applicability

➤ *Growing user acceptance and user understanding*

Understanding natural variability & value of spatio-temporal high-resolution

Understanding of methodological differences, strength and weakness

Easy information access

➤ *Foster market take-up, user integration*

Aggregated products, reporting, regulatory awareness

integration with forecasting systems, ...

Copernicus <> Demand driven provision of quality data

THANK YOU