

Oxygen observation activities within the FP7 EU–project HYPOX: a step towards hypoxia monitoring a rapidly changing world

Felix Janssen¹, Christoph Waldmann², A. Boetius^{1,3}
& the HYPOX project team

¹Max–Planck–Institute for Marine Microbiology, Bremen, DE

²MARUM, University Bremen, DE

³Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, DE



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EU-project HYPOX

»In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies«

Apr. 2009 – Mar. 2012 *EC grant 226213*

16 partners + 4 associated partners

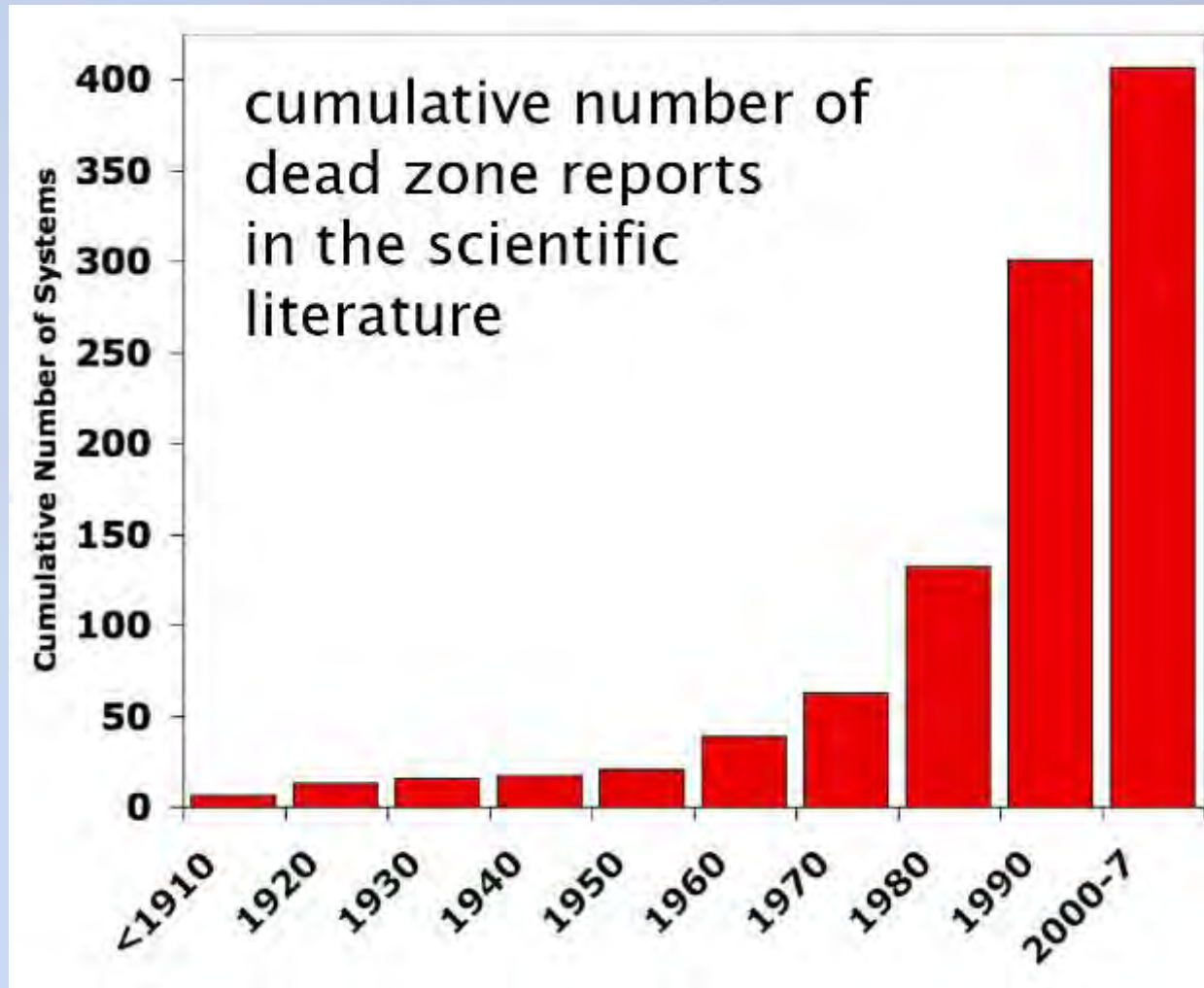
project website: www.hypox.net



HYPOX motivation

- increasing oxygen depletion due to increasing anthropogenic pressure
climate change & eutrophication

HYPOX motivation



HYPOX motivation

- increasing oxygen depletion due to increasing anthropogenic pressure
climate change, eutrophication
- lack of appropriate and accessible monitoring data
- poor representation of hypoxia monitoring in earth observation

HYPOX approach

- conduct O₂ monitoring pilot studies in contrasting ecosystems adjusting to hypoxia spatio-temporal scales
- investigate drivers & ecosystem response
- improve measurement quality & data access

Introduction to HYPOX monitoring sites



Map design: Sabine Luedeling, www.medieningenieure.de

Site classification

Open / coastal seas & **land-locked waters**



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Examples of HYPOX approaches and achievements (1):

Observing oxygen at the appropriate temporal and spatial scales

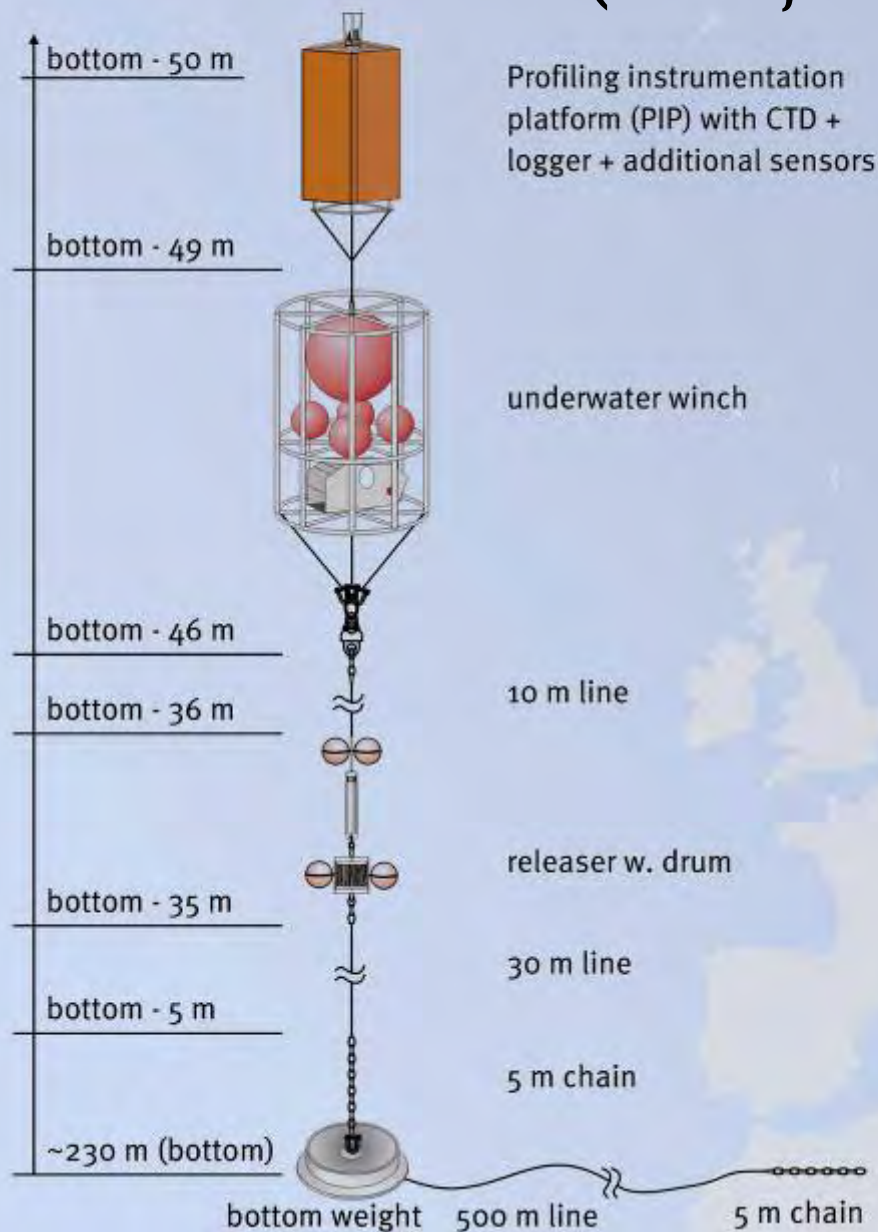
Resolving fast oxygen changes at chemoclines



● Gotland Basin

● Crimean Shelf

Gotland Basin (IOW, DE)



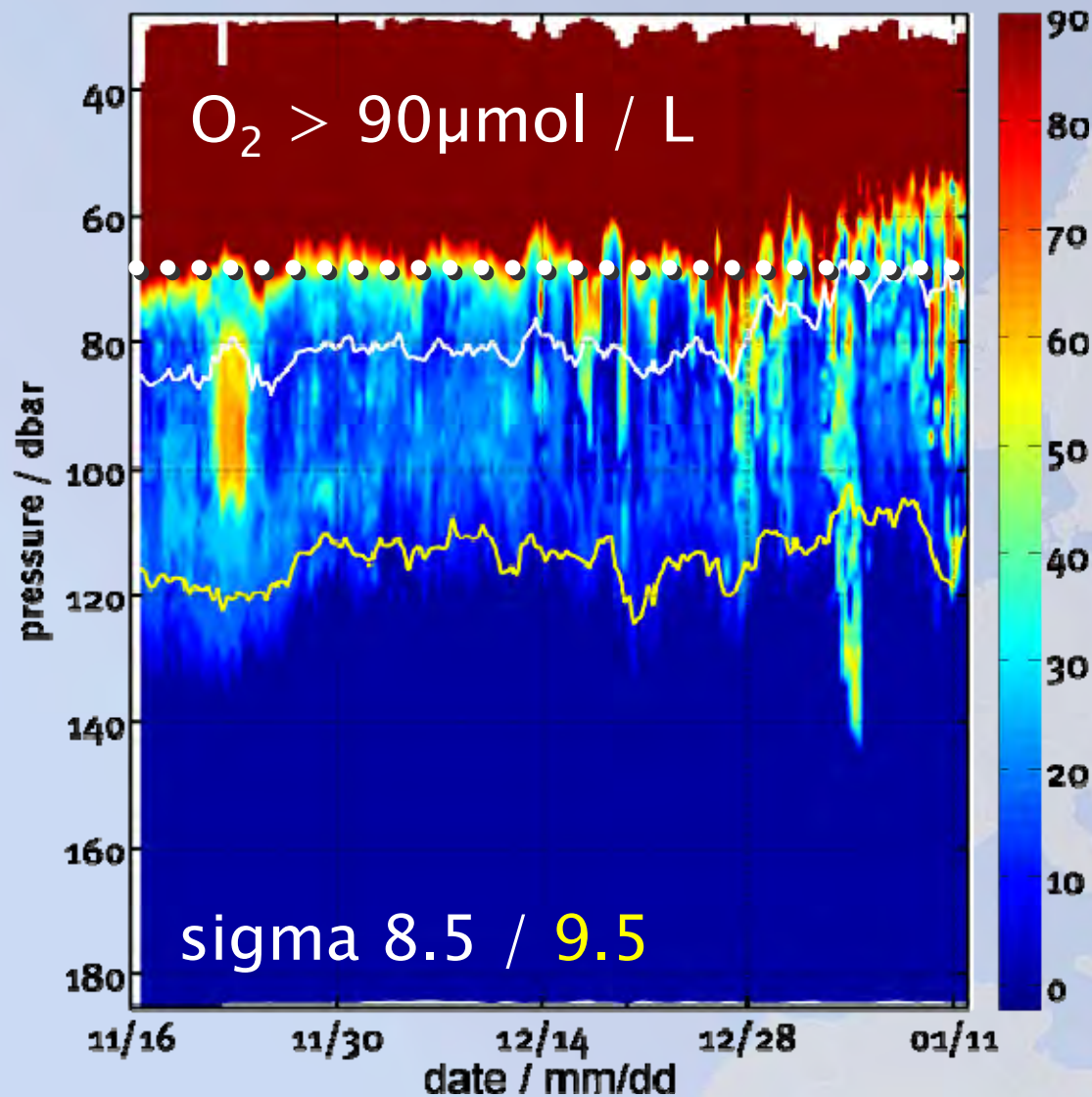
● Gotland Basin

....fast oxygen changes at chemoclines

www.hypox.net

Gotland Basin (IOW, DE)

GODESS (57.32°N, 20.133°E, 230 m depth) diss. oxy. / $\mu\text{mol/l}$



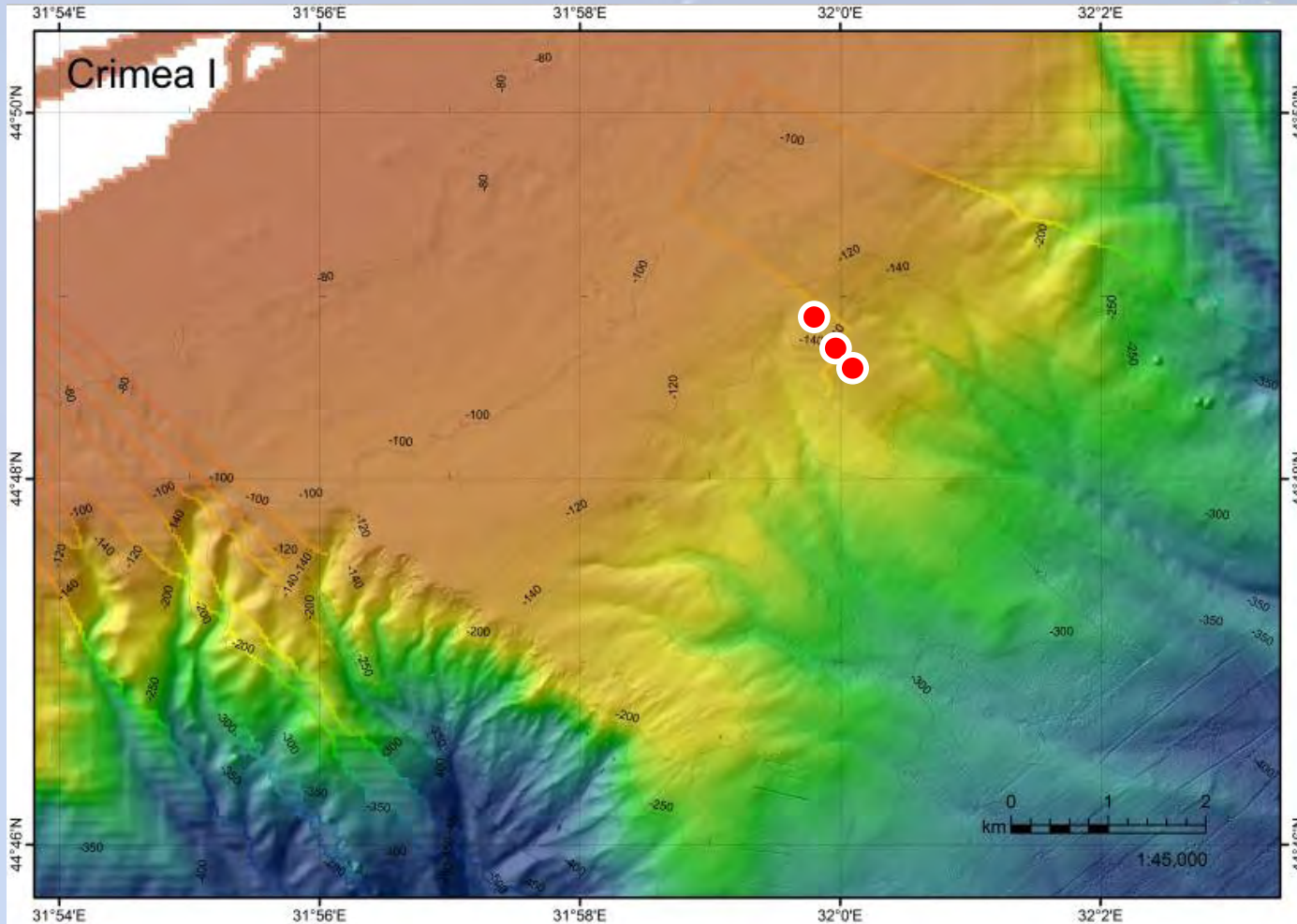
● Gotland Basin

data courtesy of Ralf Prien

....fast oxygen changes at chemoclines

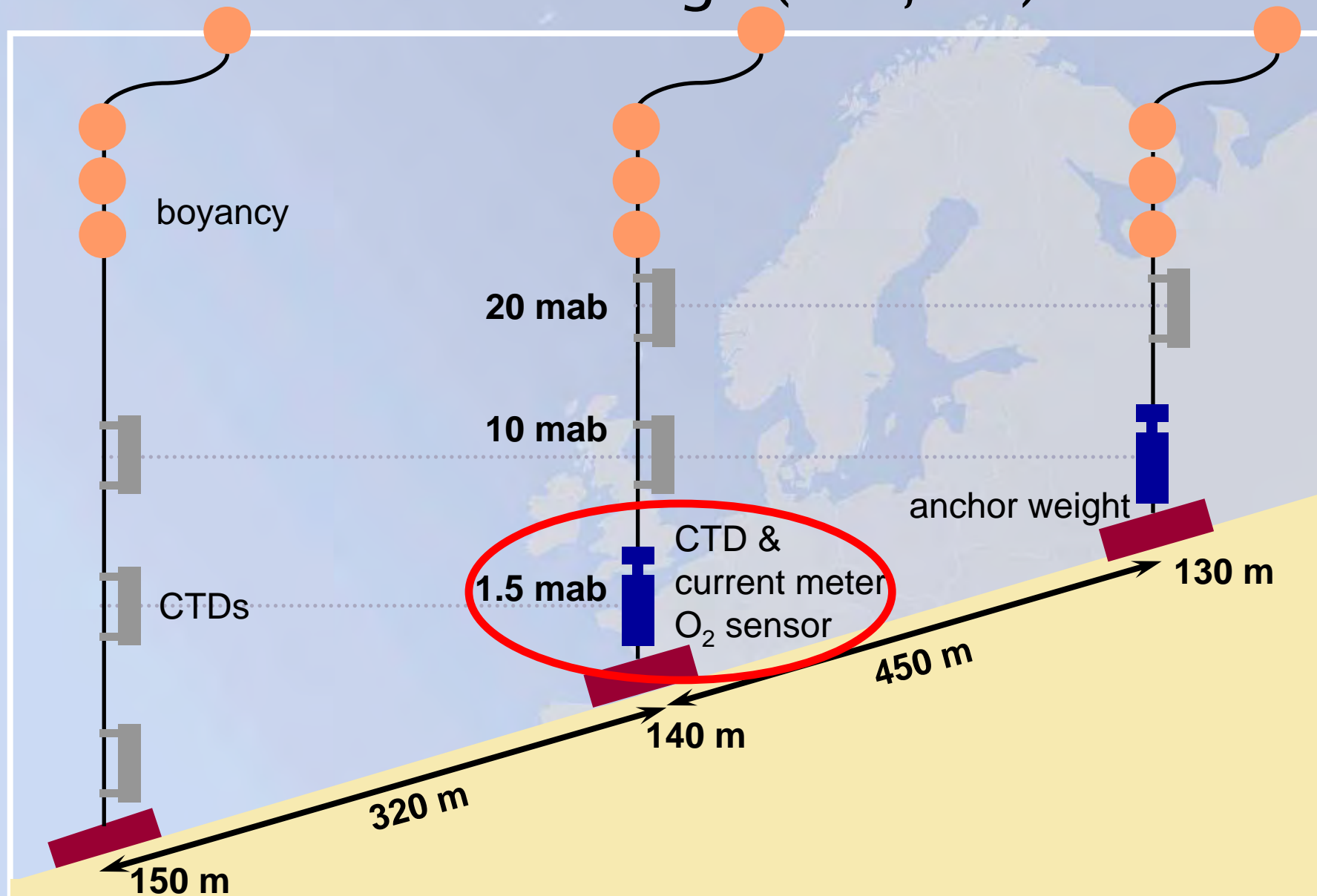
www.hypox.net

Crimean Shelf moorings (MPI, DE)



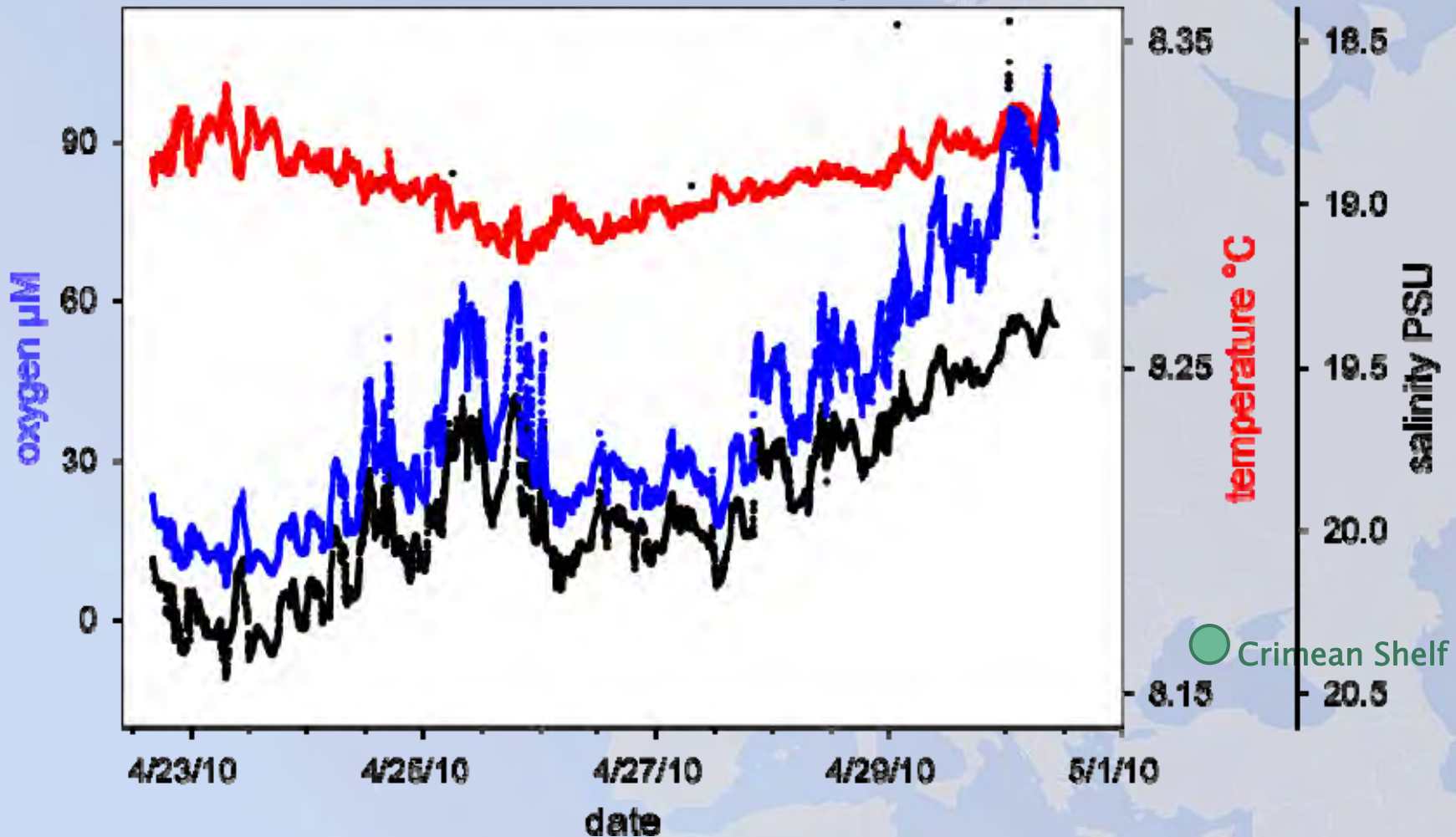
 Crimean Shelf

Crimean Shelf moorings (MPI, DE)

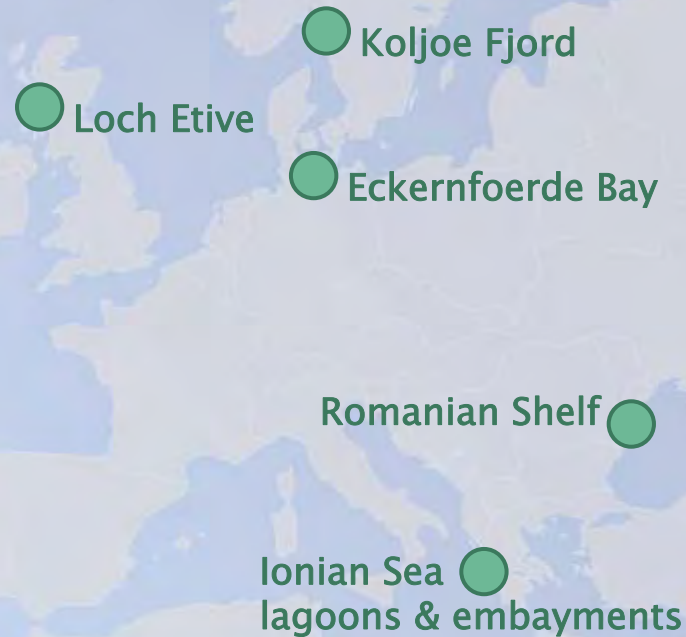


Crimean Shelf moorings (MPI, DE)

mooring at $44^{\circ} 48.88' N$ $31^{\circ} 59.80' E$
1.5m mab at 130m water depth



Monitoring seasonal and episodic changes in oxygenation



....seasonal and episodic oxygen changes

www.hypox.net

Loch Etive cabled observatory (SAMS, UK)

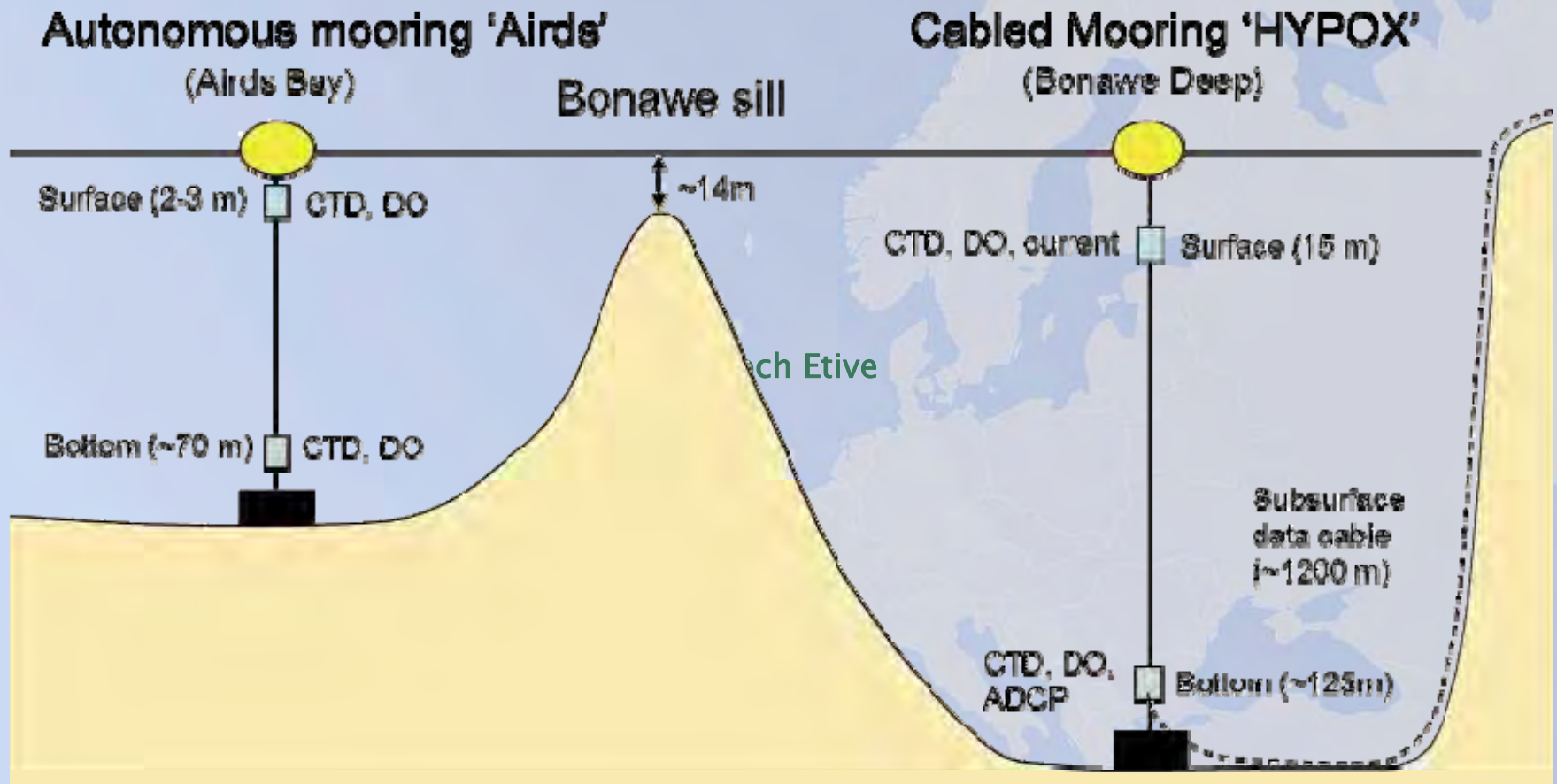


A map of Europe with a green dot marking the location of Loch Etive in Scotland. The text 'Loch Etive' is written next to the dot.

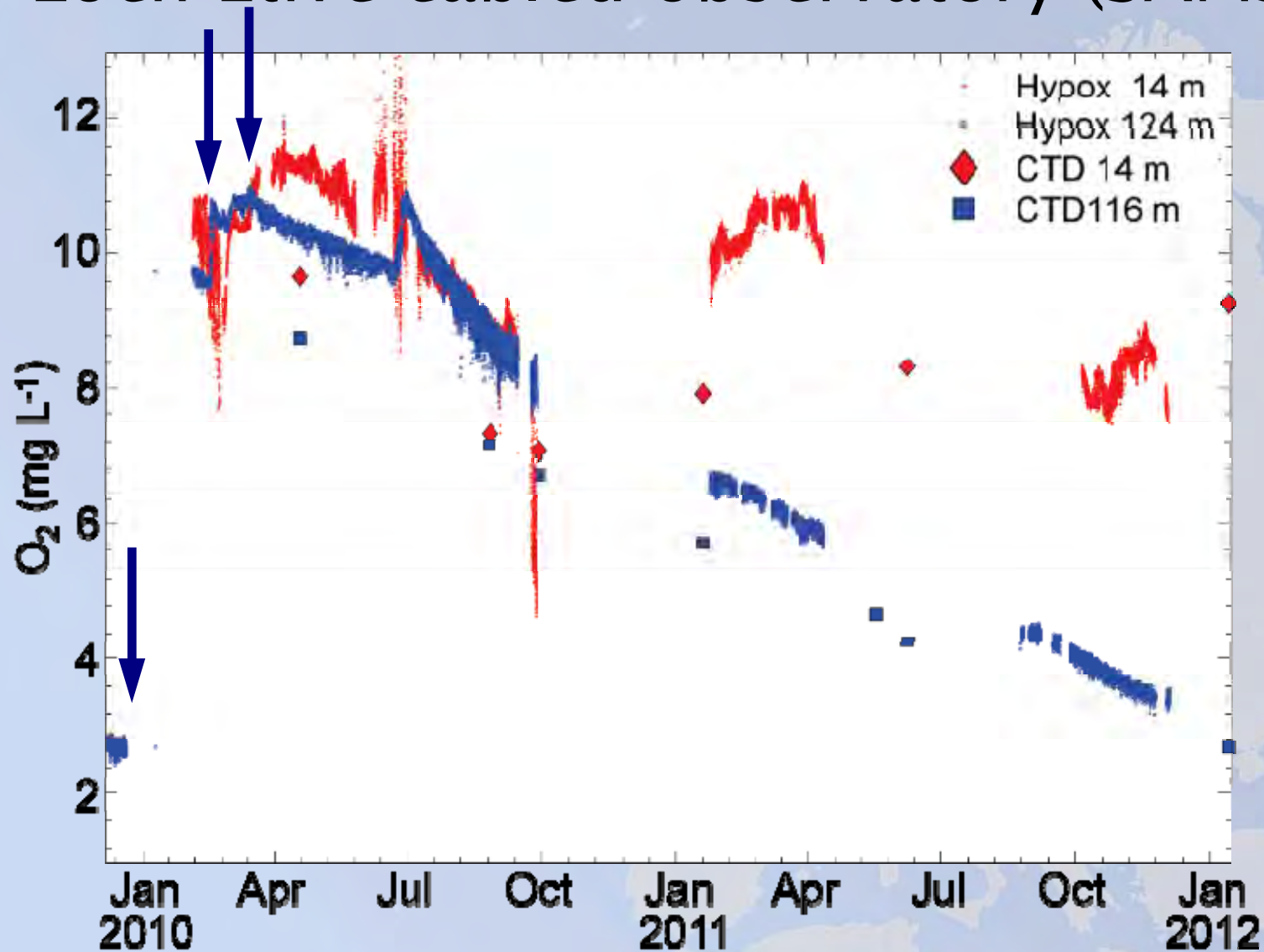
Loch Etive

scheme: Henrik Stahl

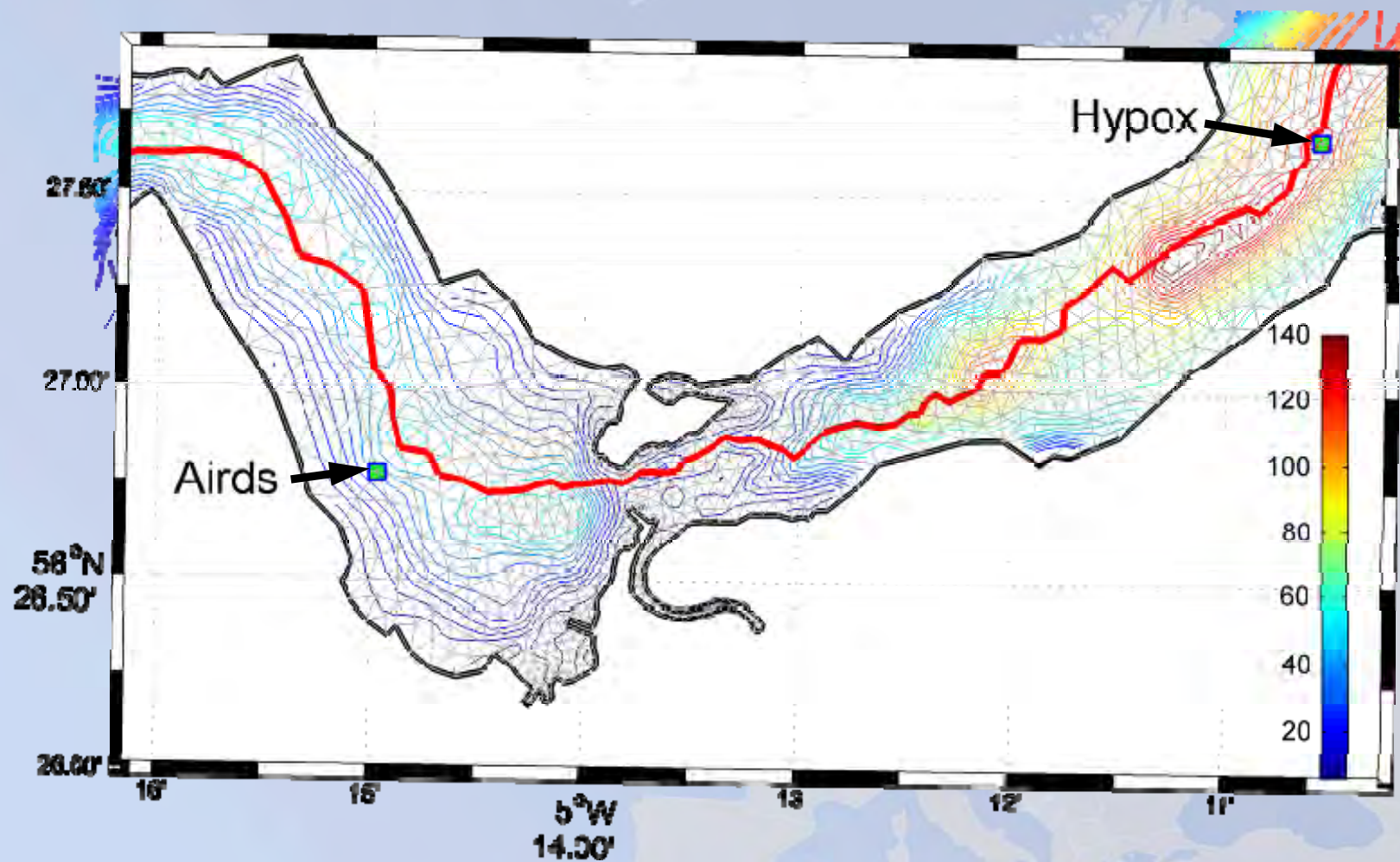
Loch Etive cabled observatory (SAMS, UK)



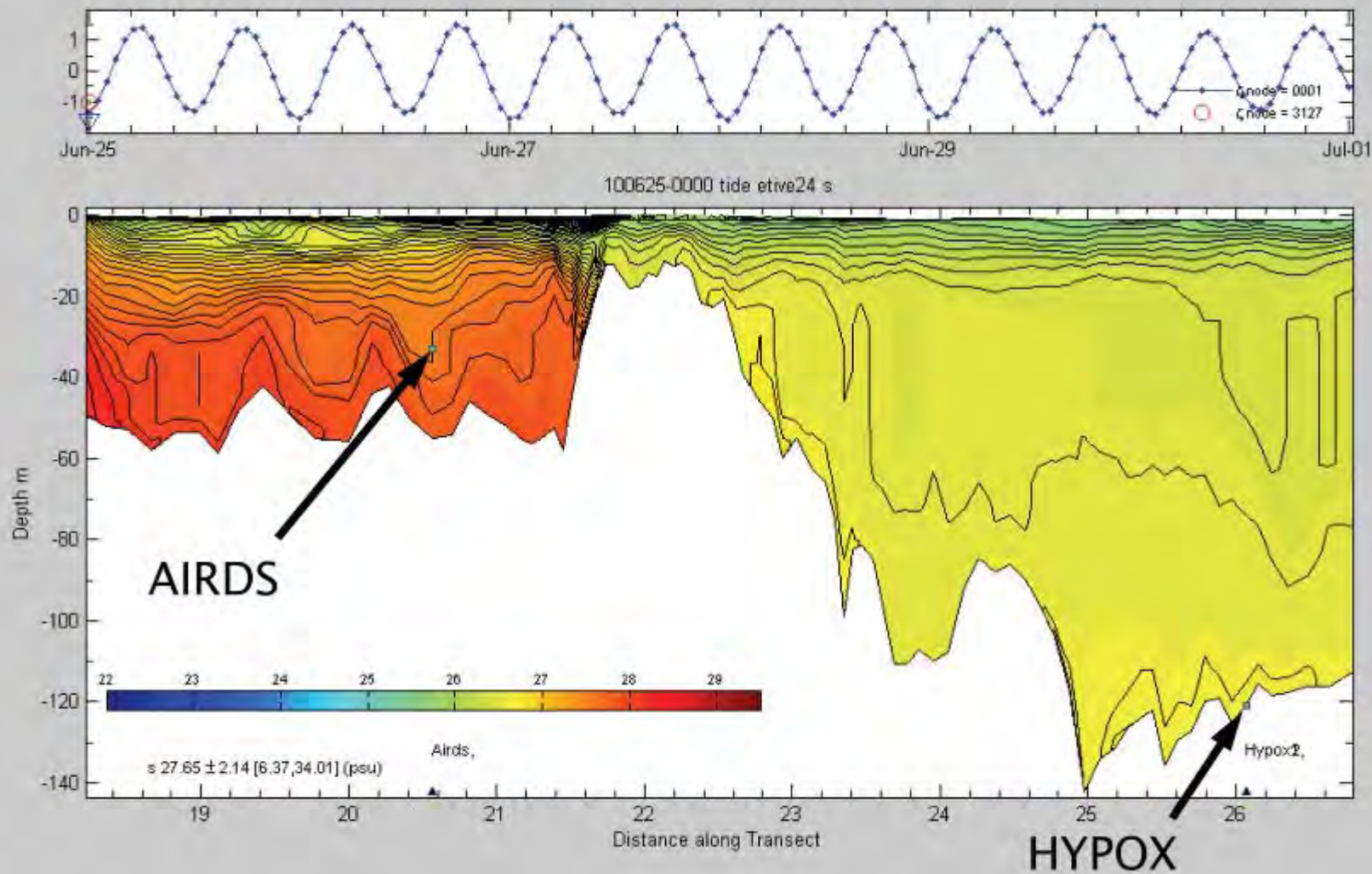
Loch Etive cabled observatory (SAMS, UK)



Loch Etive exchange modeling (SAMS, UK)

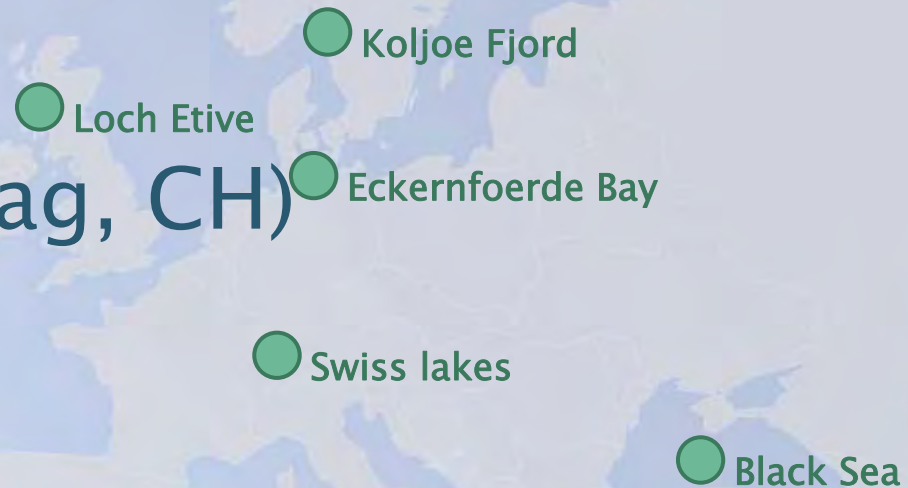


Loch Etive exchange modeling (SAMS, UK)



Other modeling target areas:

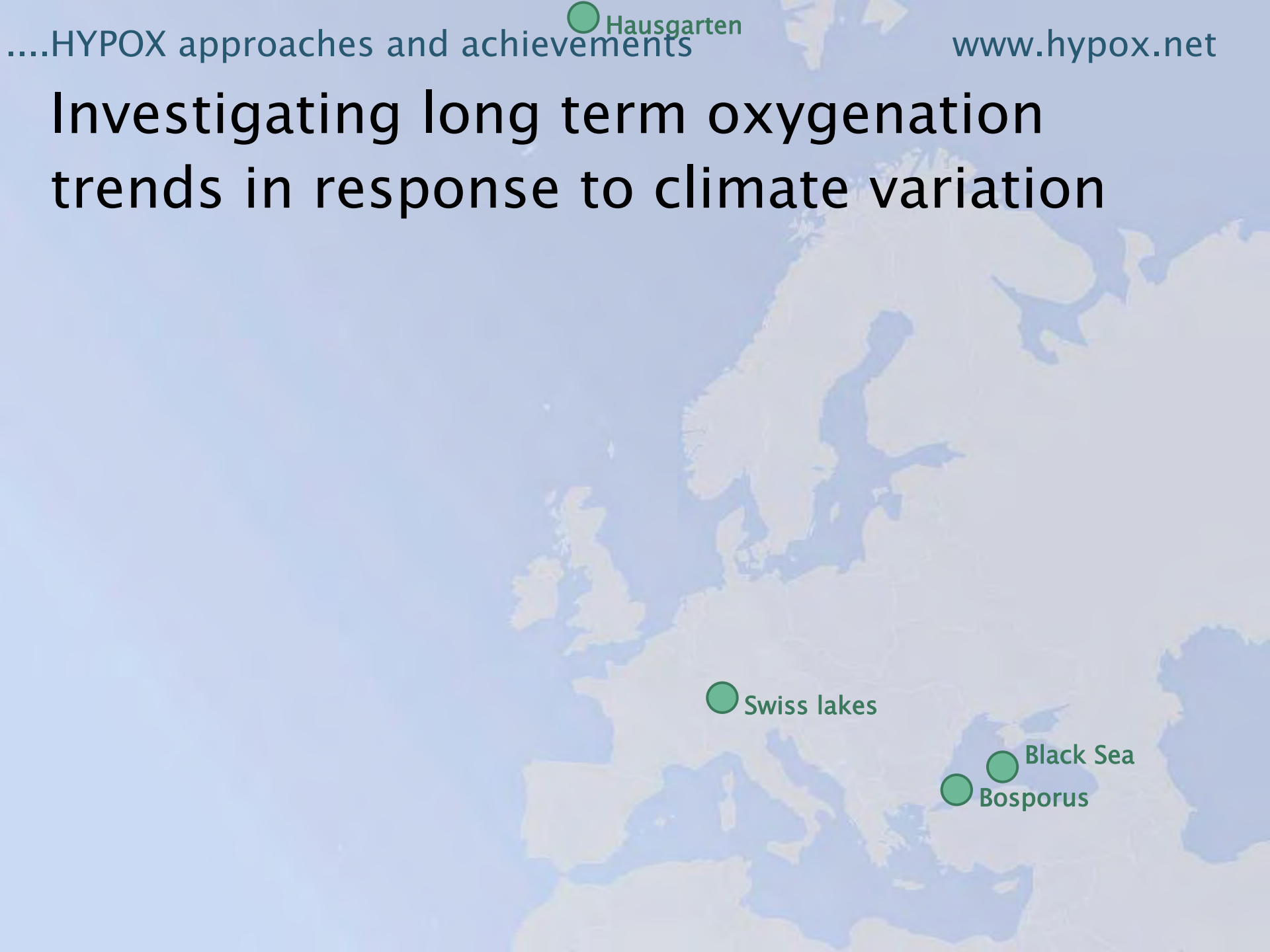
- Koljoe Fjord (UGOT, SE)
- Baltic Sea (Geomar, DE)
- Black Sea (HZG, DE; MARE-ULg, BE; NIVA, NO)
- Swiss lakes (Eawag, CH)



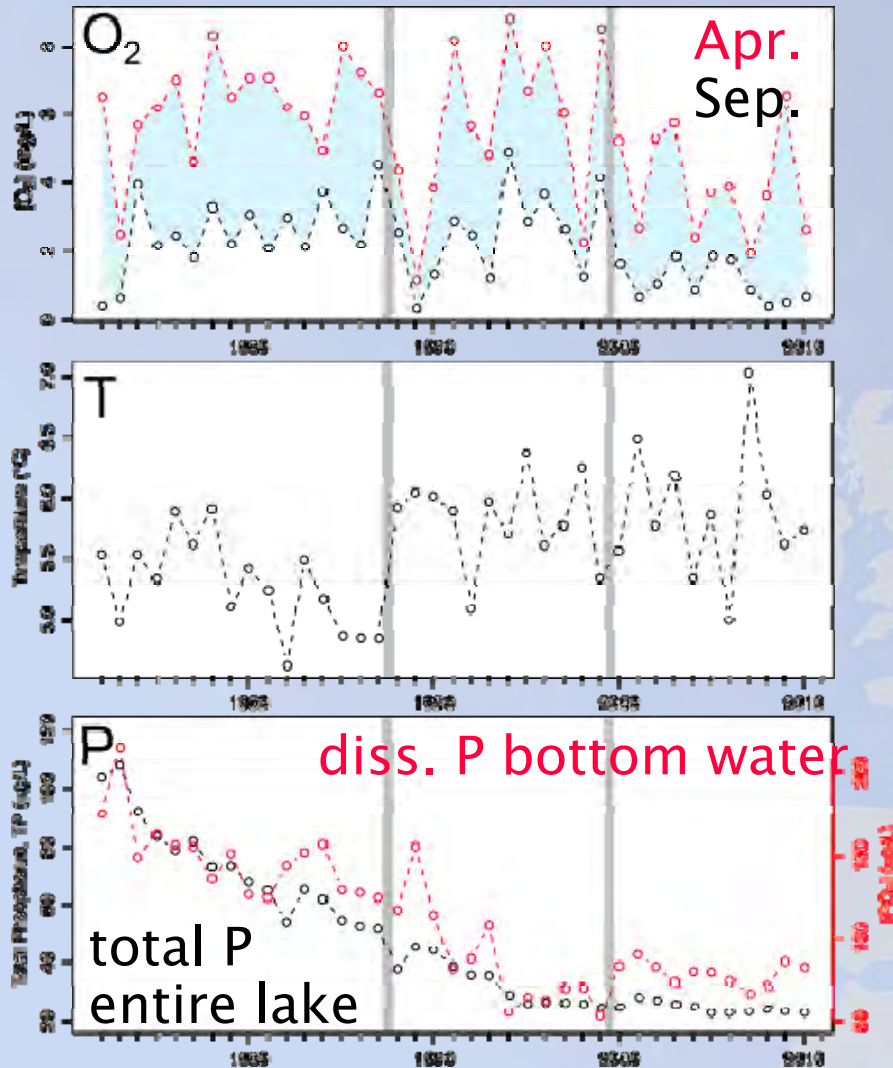
Investigating long term oxygenation trends in response to climate variation

Swiss lakes

Black Sea
Bosporus



Swiss lakes long term oxygen monitoring (Eawag, CH)



● Swiss lakes

Data source:
Wasserversorgung Zürich
Plot: D. Livingstone & R. North

....long term oxygen changes

www.hypox.net

Looking further into the past: biomarkers and inorganic proxies (Eawag, CH; ITU-EMCOL, TR)



Swiss lakes

Bosporus

Ionian Sea
lagoons & embayments

Investigating hypoxia spatial scales

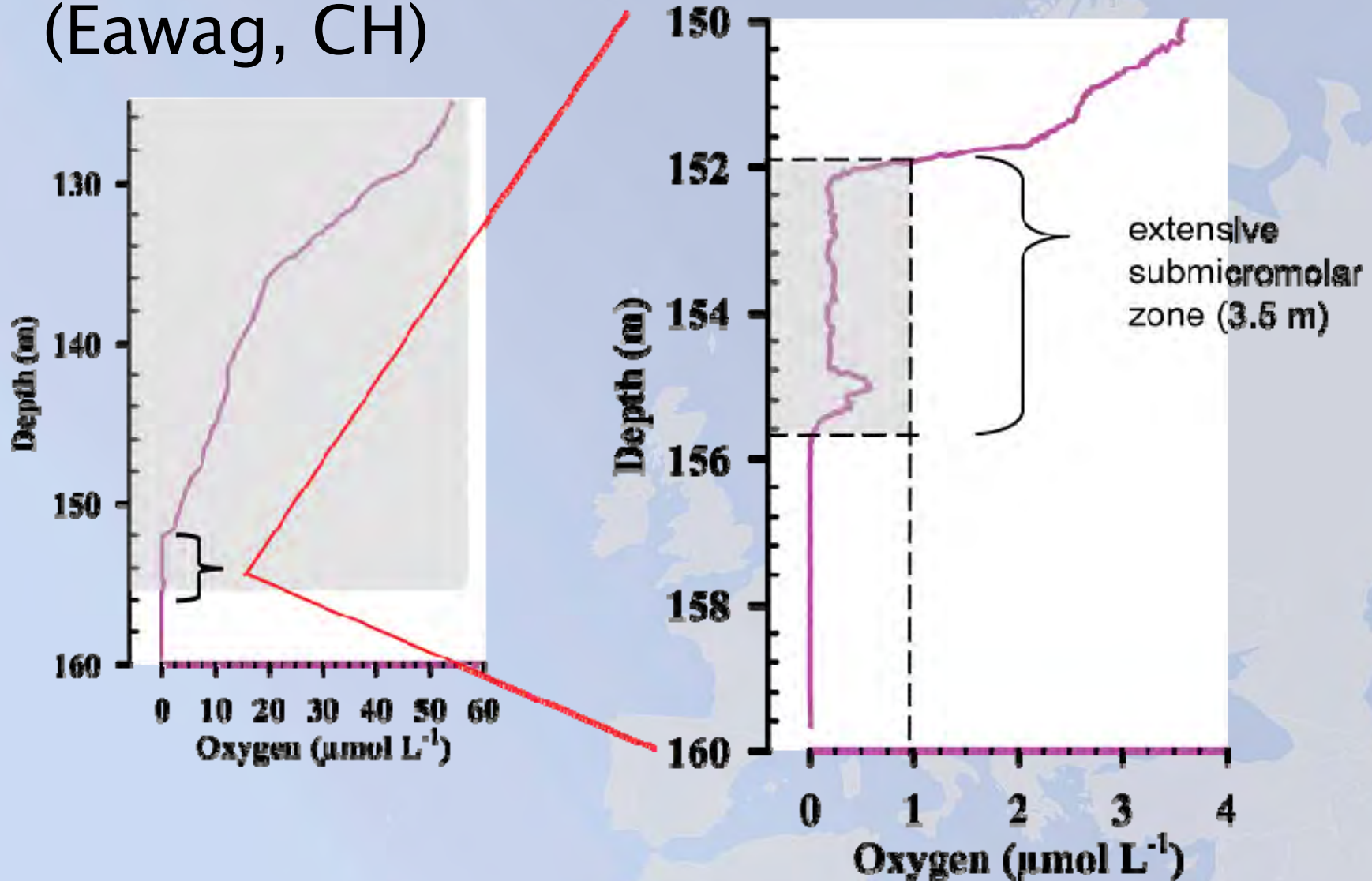
- 
- Swiss lakes
 - Crimean Shelf
 - Bosphorus
 - Ionian Sea lagoons & embayments

Resolving fine scale O_2 gradients (Eawag, CH)

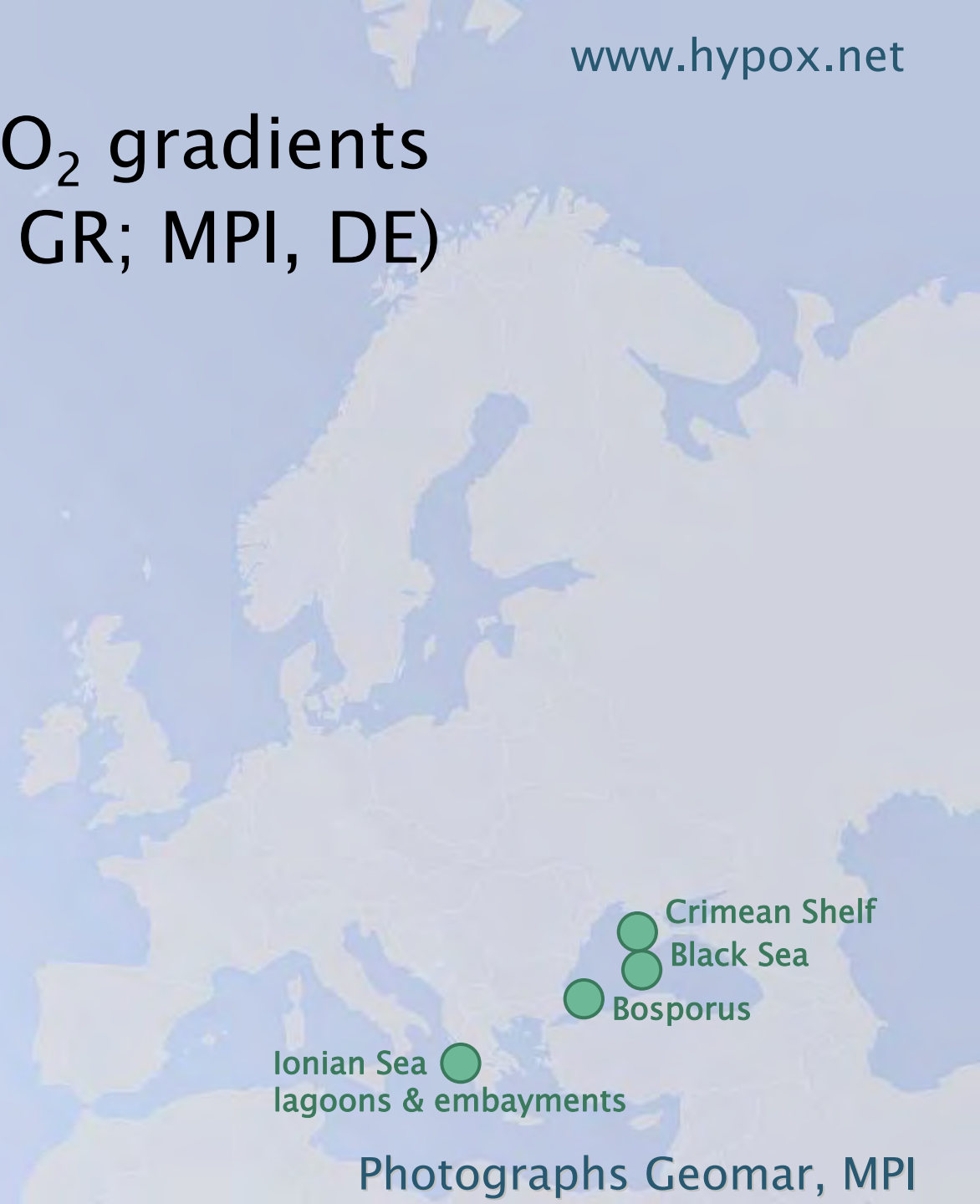


● Swiss lakes

Resolving fine scale O₂ gradients (Eawag, CH)

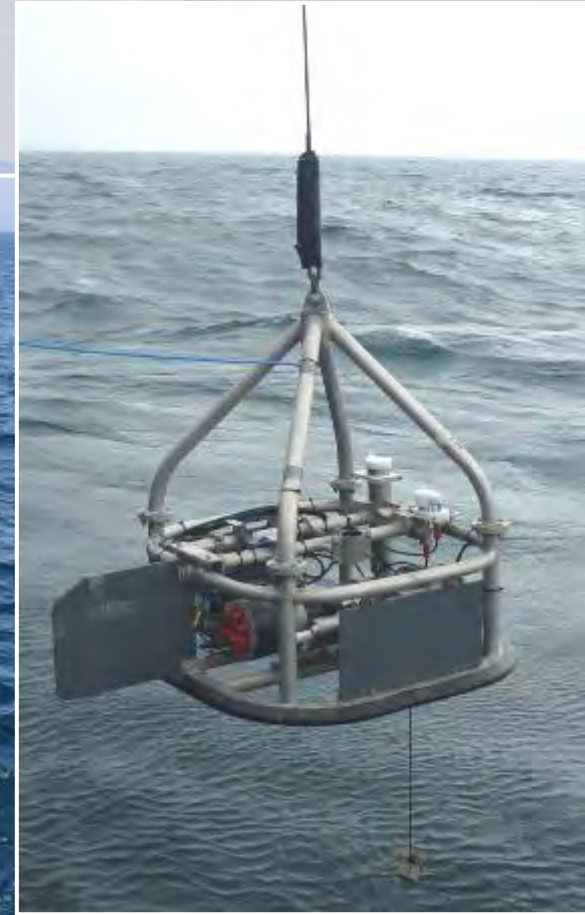
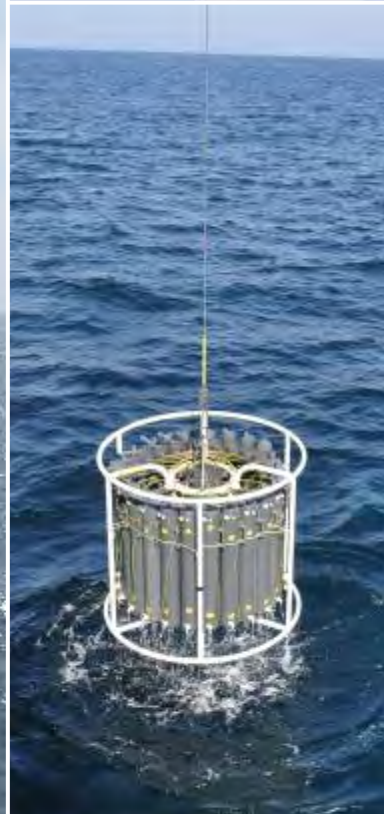


Mapping lateral O₂ gradients (INGV, IT; UPAT, GR; MPI, DE)



Crimean Shelf
Black Sea
Bosphorus
Ionian Sea lagoons & embayments

Mapping lateral O_2 gradients: methods



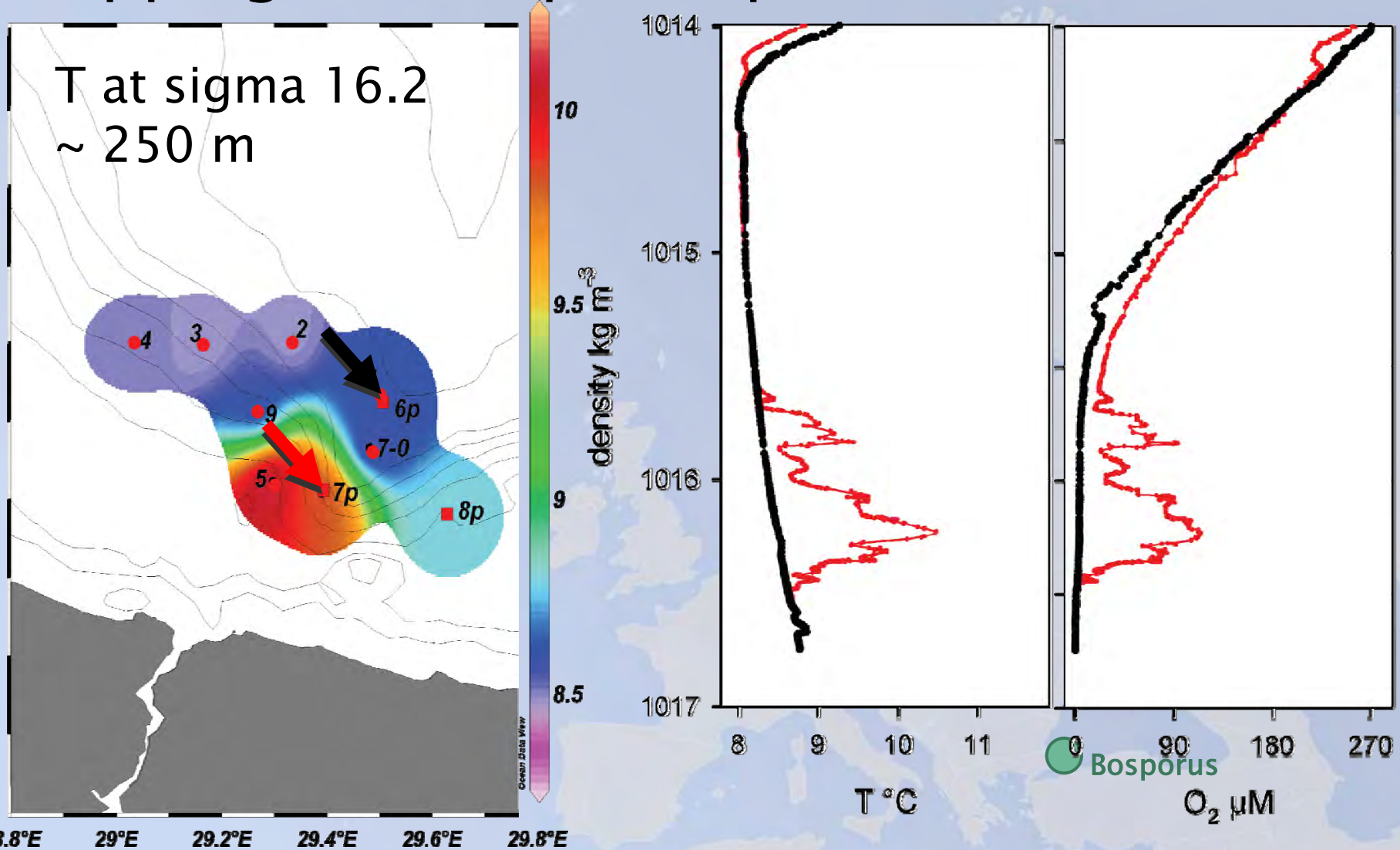
Mapping the Bosphorus plume (MPI, DE)



 Bosphorus

Photograph MPI

Mapping the Bosphorus plume (MPI, DE)



Examples of HYPOX approaches and achievements (2):

Investigating Hypoxia consequences

Documentation of fish kills

Romanian Shelf (AWI, DE, GeoEcoMar, RO)



Romanian Shelf ●

Ionian Sea ●
lagoons & embayments

Documentation of fish kills Romanian Shelf (AWI, DE, GeoEcoMar, RO)



Romanian Shelf

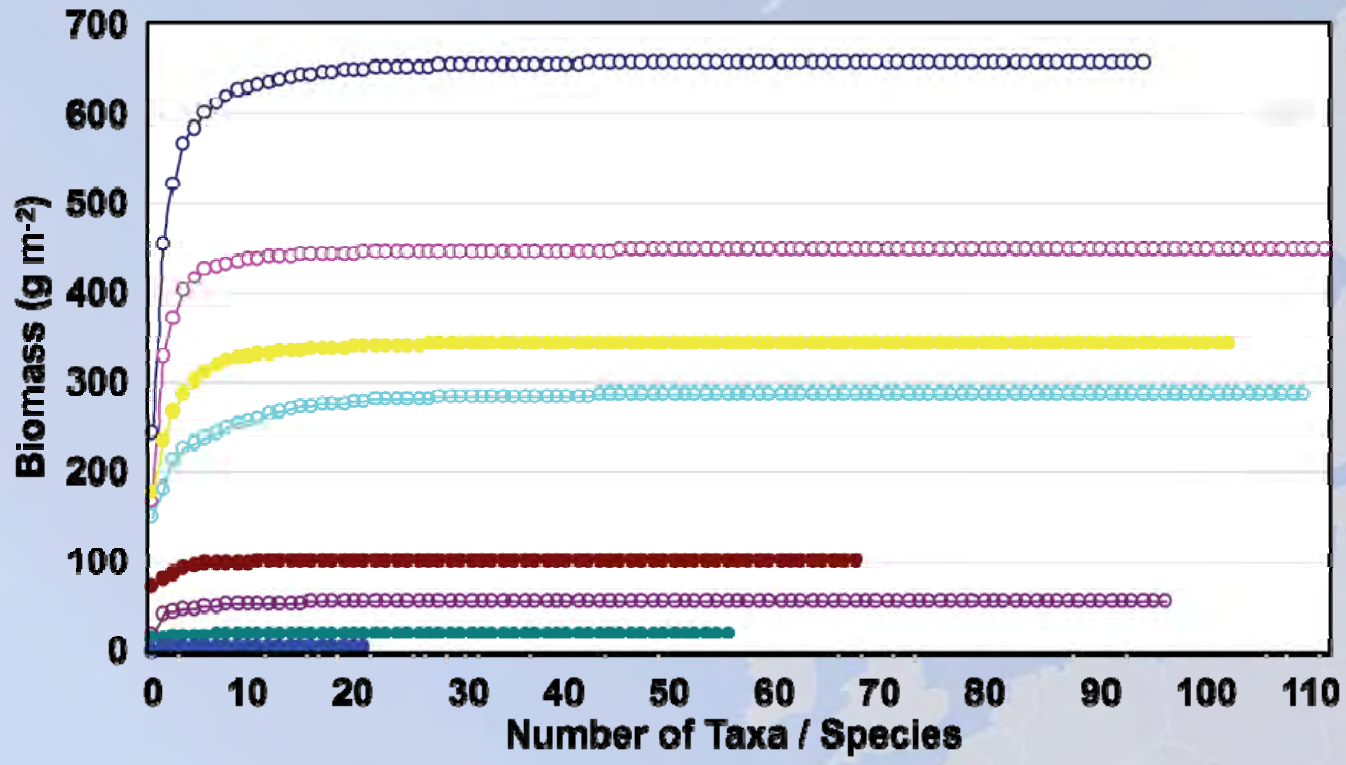
Faunal patterns along O₂ gradients

- Benthic communities (Macro- & Meio-, & Microfauna | Crimean & Romanian shelf (IBSS, MPI, GeoEcoMar)



Romanian Shelf ● Crimean Shelf

Biomass and Biodiversity (Romanian Shelf)



15 m 25 m 35 m 45 m 65 m 90 m 110 m 120 m

Romanian Shelf 

O₂ effects on biogeochemical processes

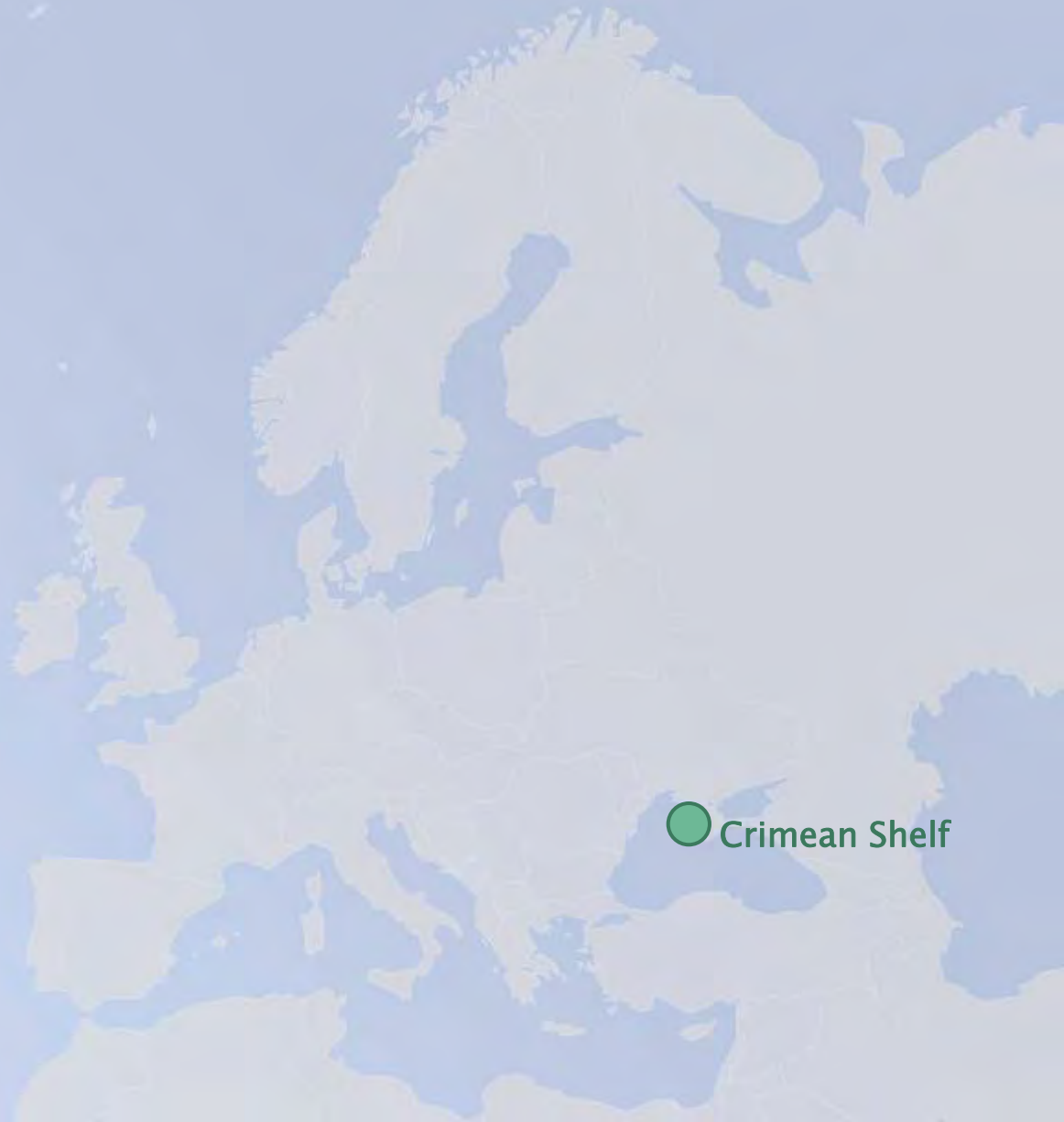


O₂ effects on biogeochemical processes

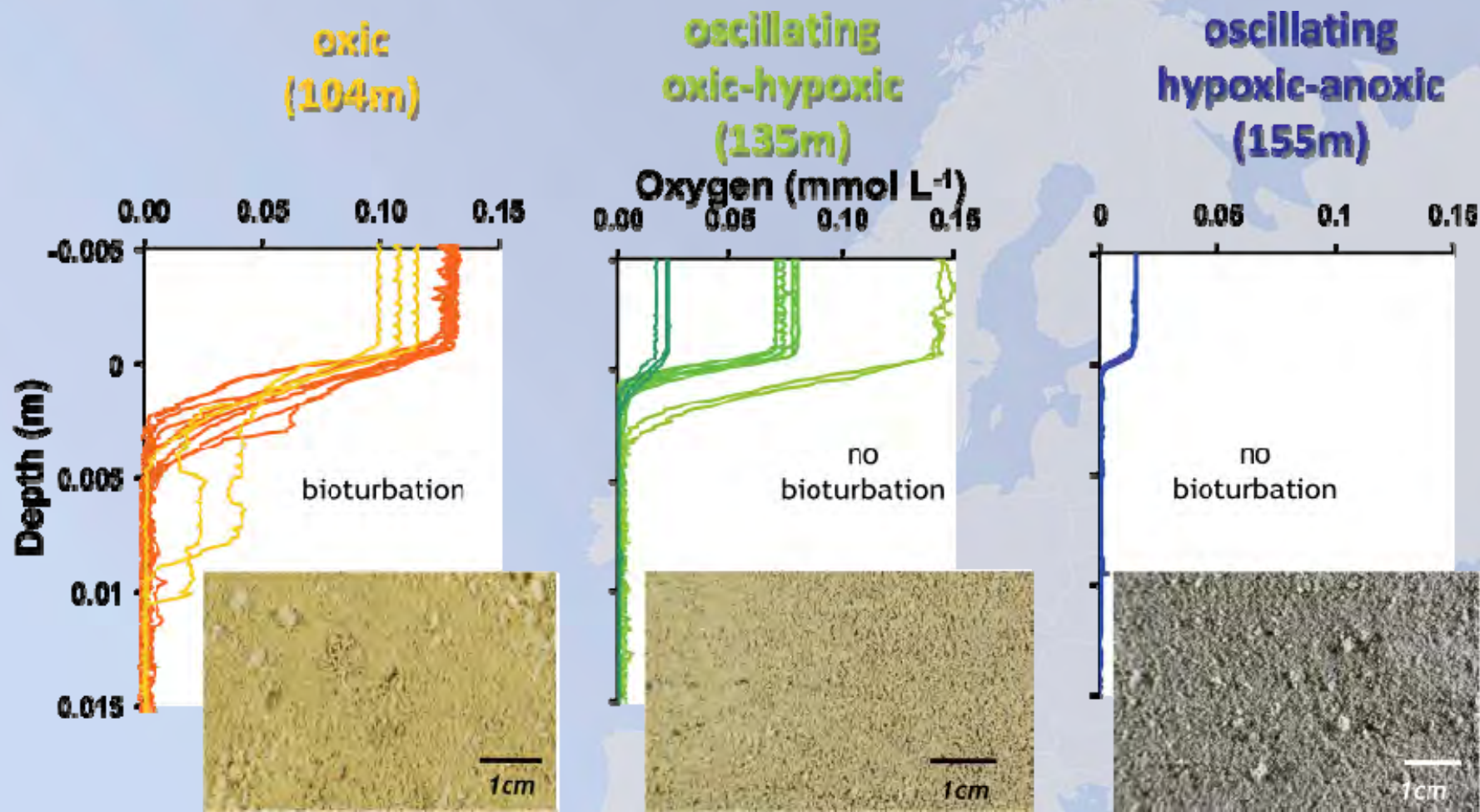
- Sediment organic matter mineralization & nutrient cycling | Crimean shelf, Romanian Shelf, Gotland Basin, Eckernförde Bay
(AWI, MPI, Geomar, DE, UGOT, SE)
- Water column Biogeochemistry, Redox-cycling | Bosphorus outlet, swiss lakes
(MPI, DE, Eawag, CH)



O₂-effects on OM mineralization (Crimea)



O₂-effects on OM mineralization (Crimea)

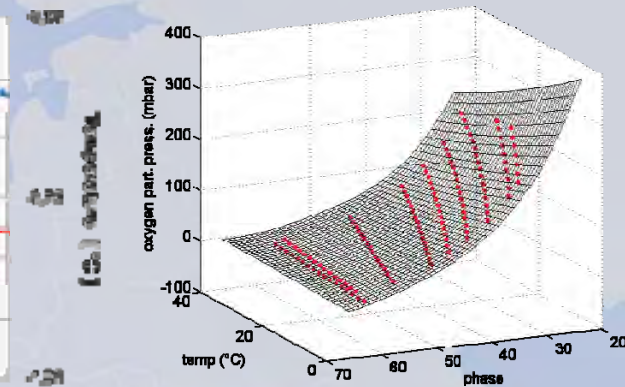
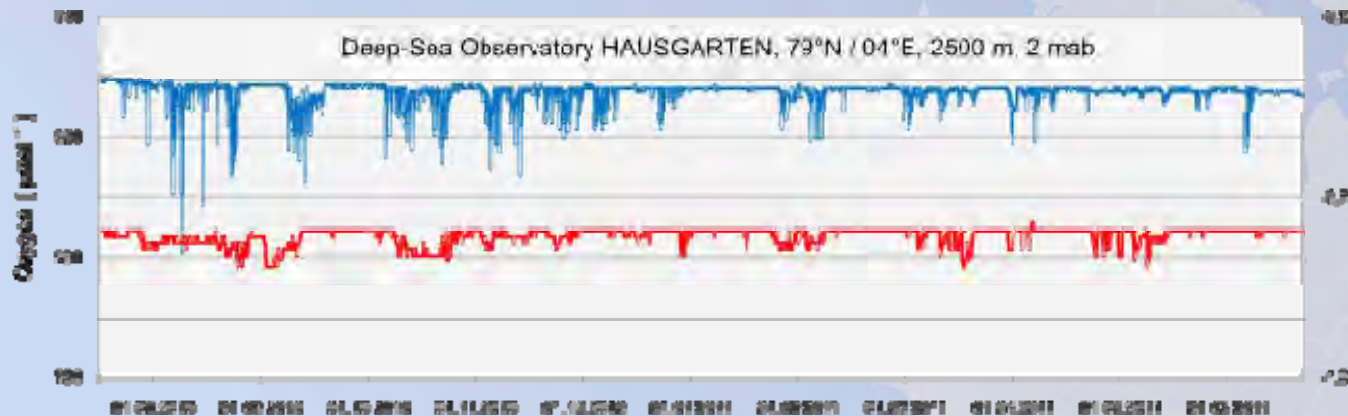


Examples of HYPOX approaches and achievements (3):

Improving data quality and access

Testing & improving sensor performance

- O₂ sensor calibration and reliability tests (MPI, INGV, UGOT, Ifremer)
- anti-biofouling measures (Ifremer)



HYPOX site information and data access: hypox data portal (www.hypox.net)

The screenshot shows the homepage of the hypox data portal. At the top, there is a navigation bar with links for Home, Contact, and Imprint. The main header features the 'hypox' logo and a tagline: 'In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open-seas, and land-locked water bodies.' Below this is a large red number '2'. The main content area is divided into several sections:

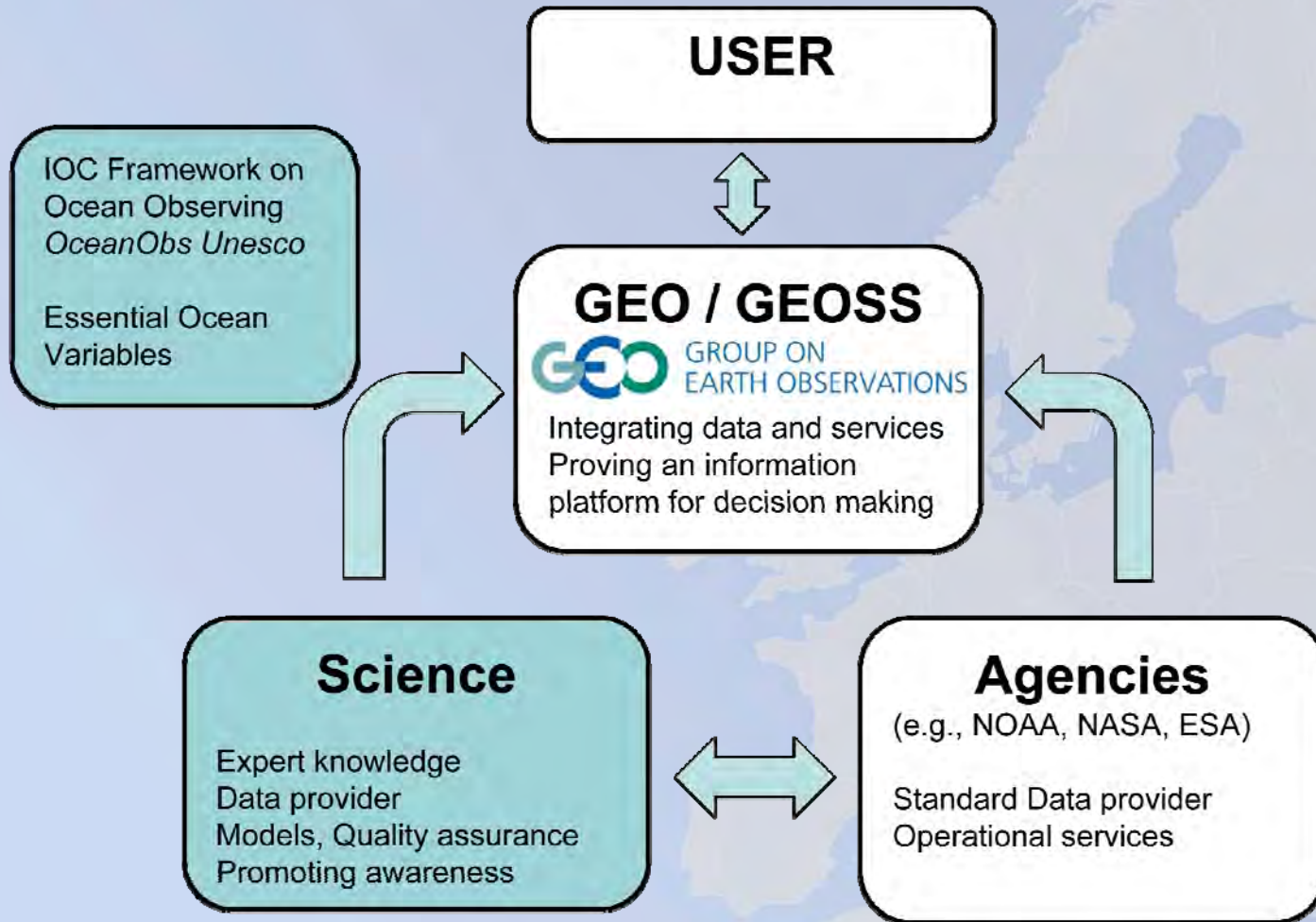
- Navigation:** Portal Home | Hypox Sites | Data Catalogue
- Shelf and Open Seas:**
 - Black Sea:**
 - North-western Shelf
 - Danube River delta
 - St. George Triadactylus shelf endpoint
 - St. George Triadactylus offshore endpoint
 - Crimean Shelf
 - Sheph'Gangon
 - Tarkhanichirovan
 - Olmeqa (Kryukovka) Bay
 - Sevastopol Bay (Inner and Outer Parts)
 - Bosphorus Region
 - Baltic Sea:**
 - Gotland Deep
 - North Atlantic - Arctic Ocean transition / Fram Strait**
- Land-locked Water Bodies:**
 - Loch Etive:**
 - Upper basin
 - Lower basin
 - Swedish Fjord:**
 - Koljö Fjord
 - Havstensfjord
 - Tonian Sea lagoons and embayments:**
 - Nassolungli-Aetalika Lagoon Complex
 - AmuPakikos Gulf
 - Katakala bay
 - Swiss lakes:**
 - Lake Lugano
 - Lake Zurich
 - Lake Rotsee
- Black Sea Details:**
 - Latitude:** 43.240935
 - Longitude:** 33.771973
 - Description:** The Black Sea is a 0.46 million km² large semi-enclosed brackish sea with a maximum depth of 2250 m. Via the Sea of Marmara, the Black Sea is connected to the Mediterranean through the Straits of Bosphorus and Dardanelles. A limited exchange with the Mediterranean due to the shallow sill depths of the Bosphorus and Dardanelles straits (35 and 65 m, respectively) and a substantial fresh-water input, mainly through the Danube, Dniestro and Dniopro ... [more](#)
- Archived data:**
 - [1. Secchiera, Dan & Sorin, Balan \(2010\): Physical oceanography and oxygen data during Mare Nigrum cruise MN87](#)
 - [2. Secchiera, Dan & Sorin, Balan \(2010\): Physical oceanography and oxygen data during Mare Nigrum cruise MN84](#)
 - [3. Secchiera, Dan \(2010\): Physical oceanography and oxygen data during Mare Nigrum cruise C9MN/01](#)
 - [4. Secchiera, Dan & Sorin, Balan \(2010\): Physical oceanography and oxygen data during Mare Nigrum cruise MN85](#)
 - [5. Holtappels, Horitz \(2010\): Physical oceanography during GRAC cruise in 2009](#)
 - [6. Friedrich, Jana \(2010\): Key parameters physical oceanography and oxygen time series in the Black Sea during summer 2010](#)

Adding to the global system of systems: implementation in GEOSS

THE GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS



Adding to the global system of systems: implementation in GEOSS



HYPOX partners

EC grant 226213

Max-Planck-Society

ICES / PICES / IOC

