Improving Nitrous Oxide Measurements in the Ocean

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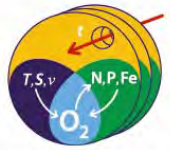
future ocean
KIEL MARINE SCIENCES



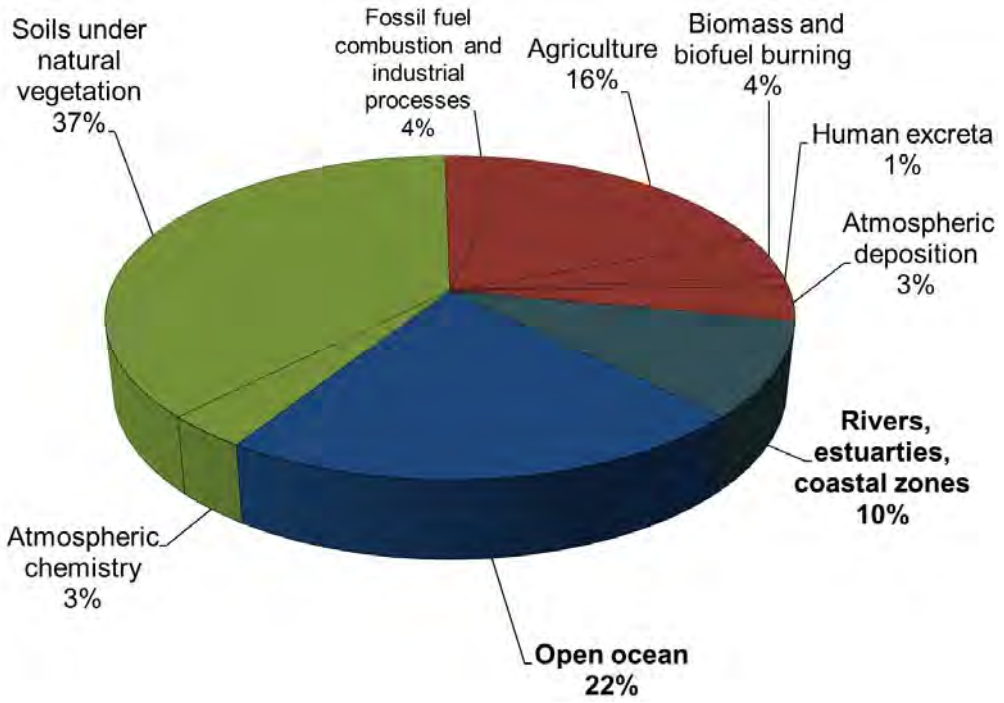
SFB 754

Outline

- Motivation and aims during InGOS
- Continuous seawater measurements of N_2O
  - Key regions and processes
- Boknis Eck Times Series Station
- Summary

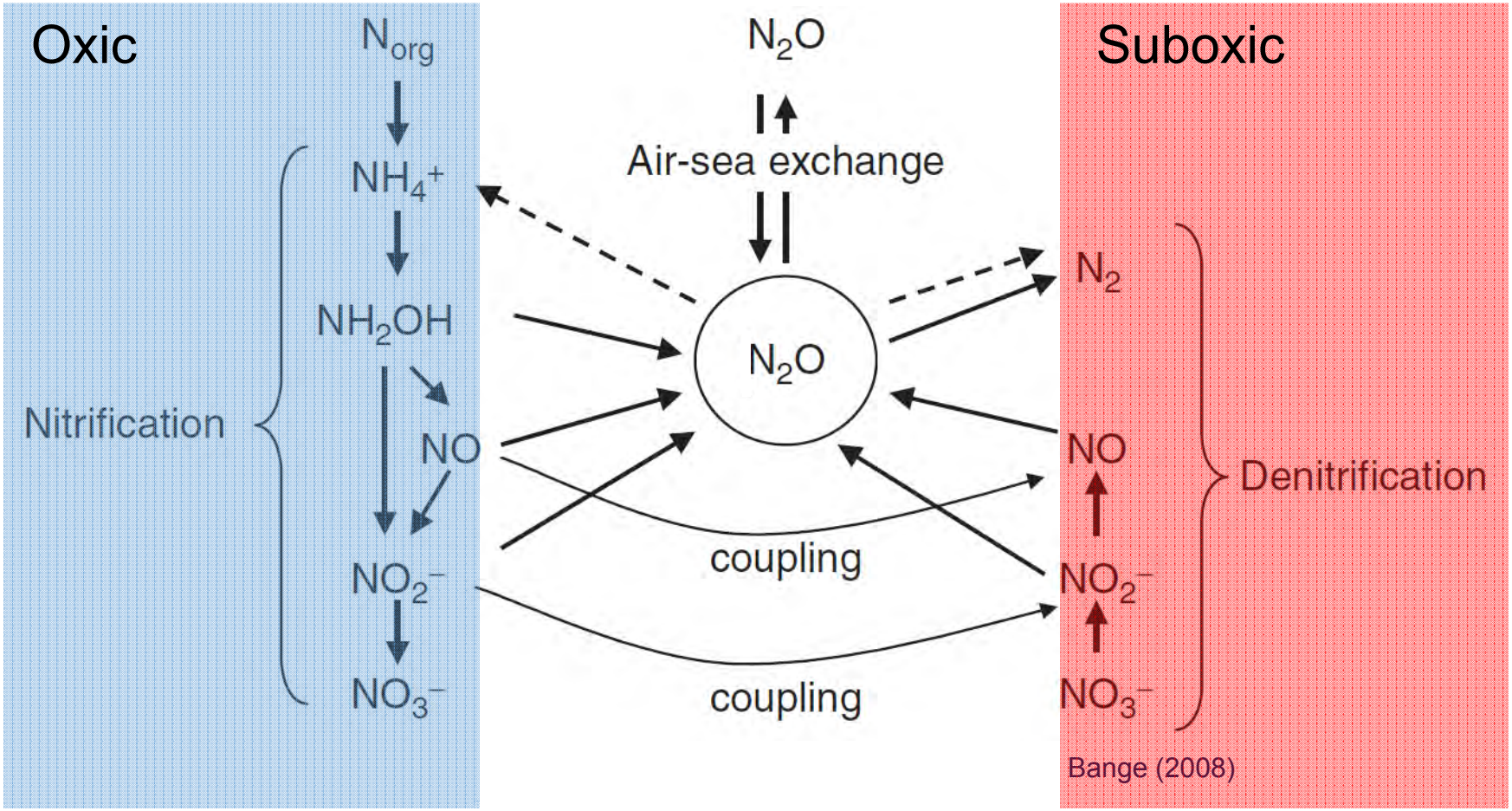
Nitrous oxide (N_2O)

- Potent greenhouse gas
- Stratospheric ozone depletion
- Increasing terrestrial emissions
- **Ocean is a net source**



After Denman et al. (2007)

N_2O in the ocean



N_2O yield is higher at low O_2 concentrations

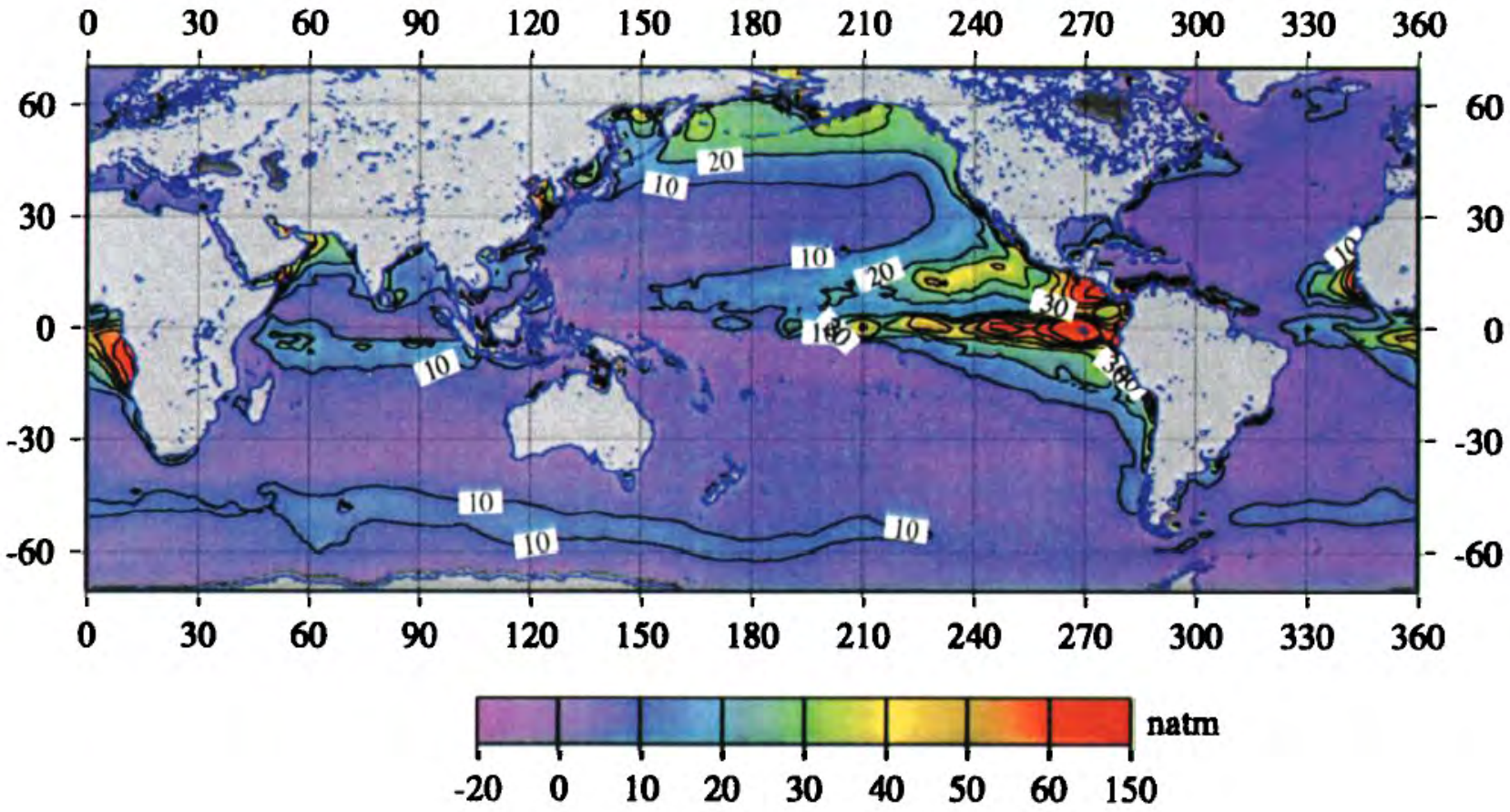
Aims during InGOS

InGOS
Integrated non-CO_2 Greenhouse gas Observing System

"harmonize and integrate oceanic measurements of N_2O and CH_4 in different open ocean and coastal regions"

- Time series stations
- Underway measurements
- VOS lines
- Intercomparison exercises

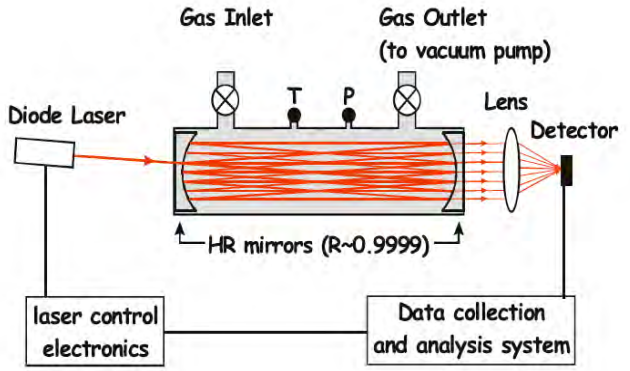
Surface ocean N_2O



Suntharalingam and Sarmiento (2000)

New approach to measure N_2O

Underway, high-resolution, seawater and atmospheric N_2O with OA-ICOS



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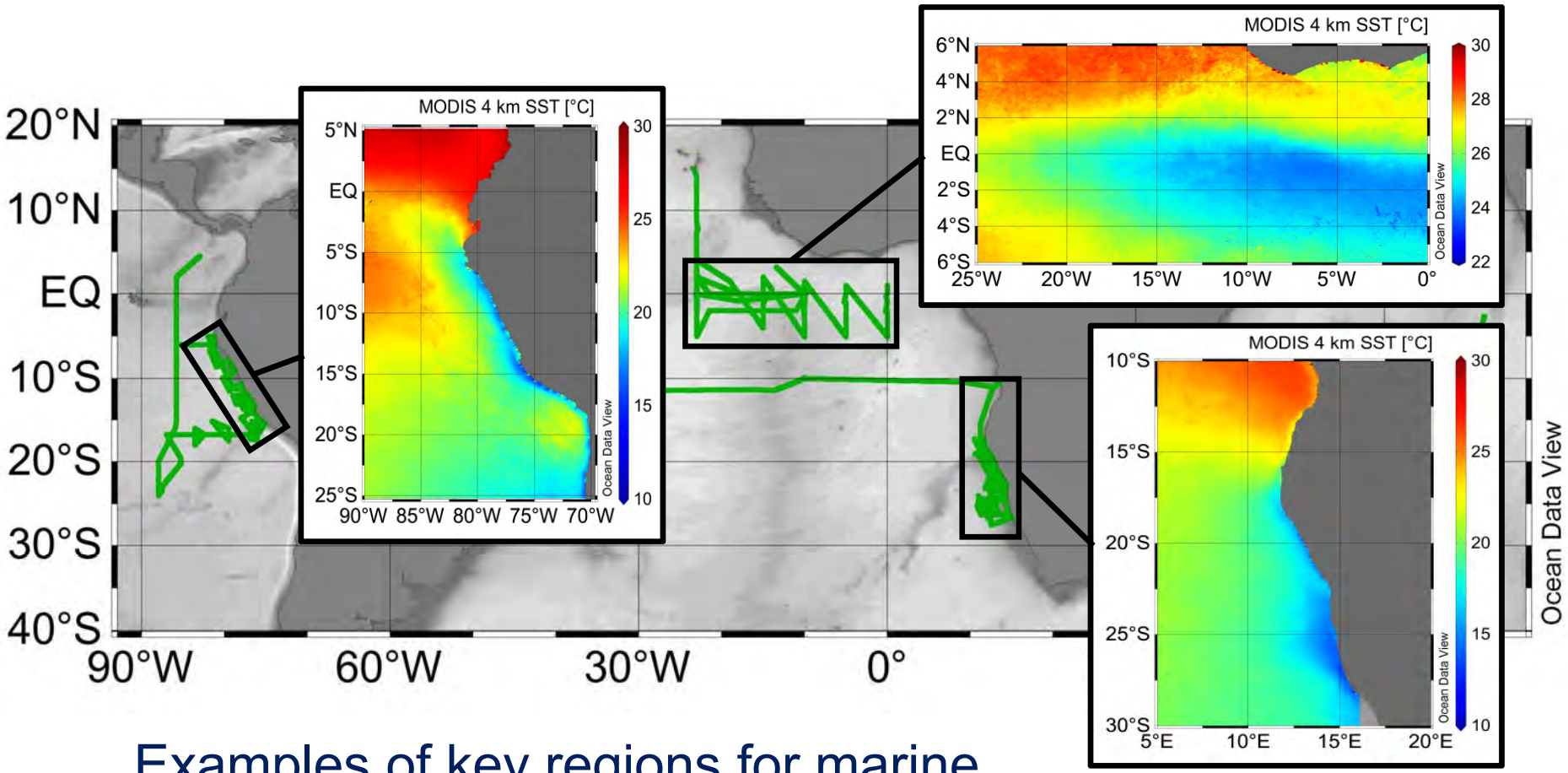
doi:10.5194/os-9-1071-2013

Ocean Science Open Access

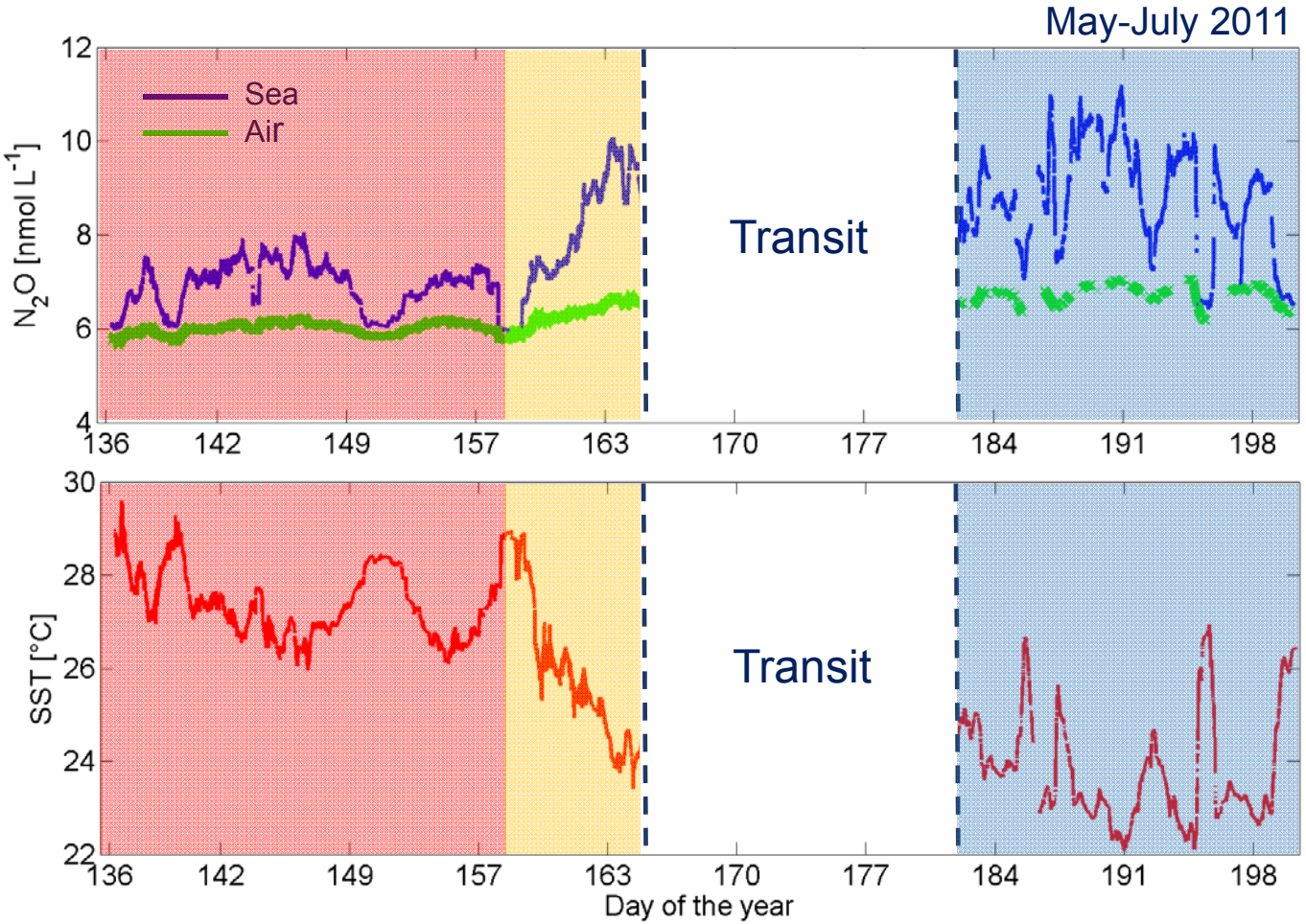
Arévalo-Martínez et al. (2013)

Underway measurements of N_2O



Examples of key regions for marine N_2O emissions

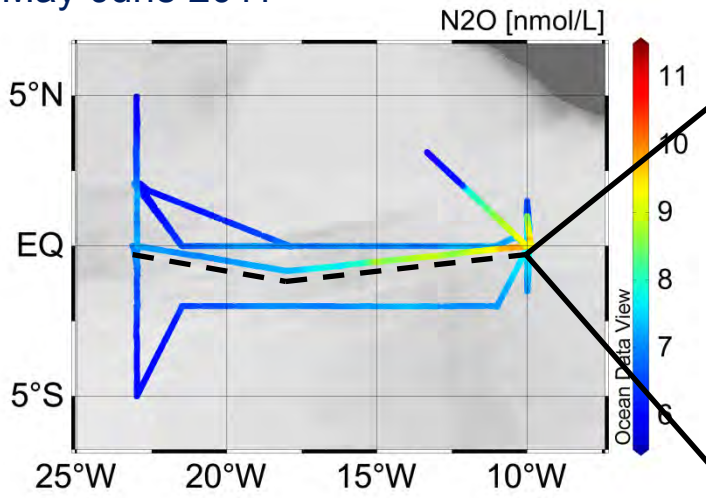
Upwelling on the equatorial Atlantic



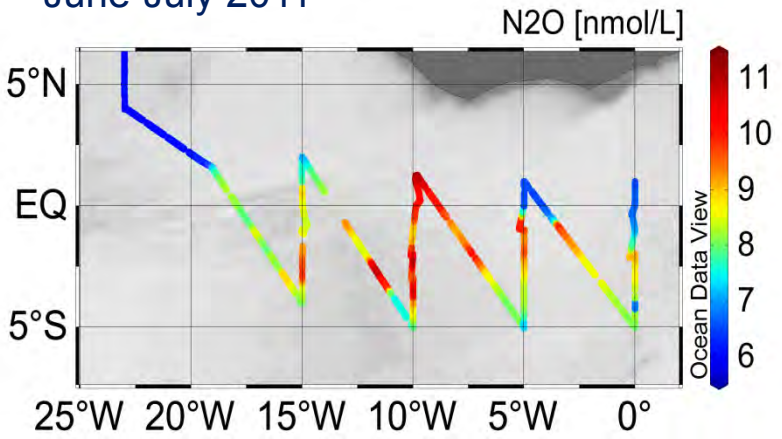
Seasonal fluctuation of surface N_2O with equatorial upwelling

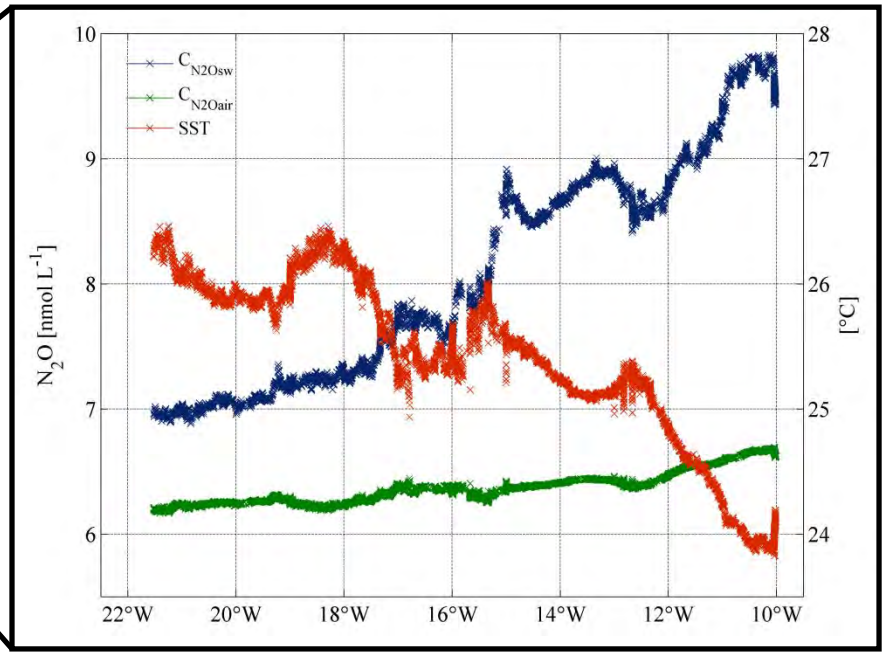
Upwelling on the equatorial Atlantic

May-June 2011



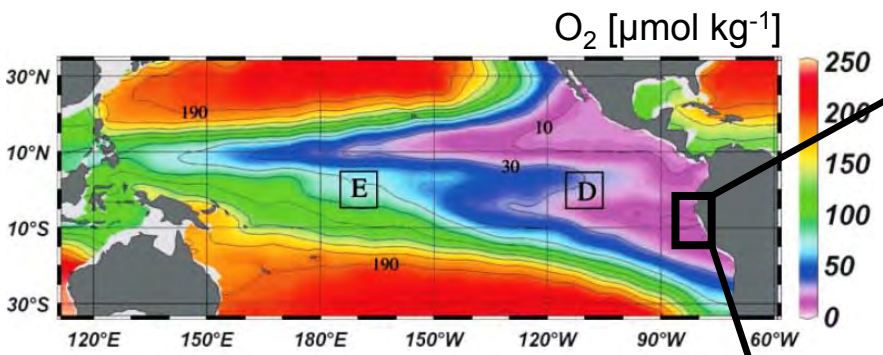
June-July 2011



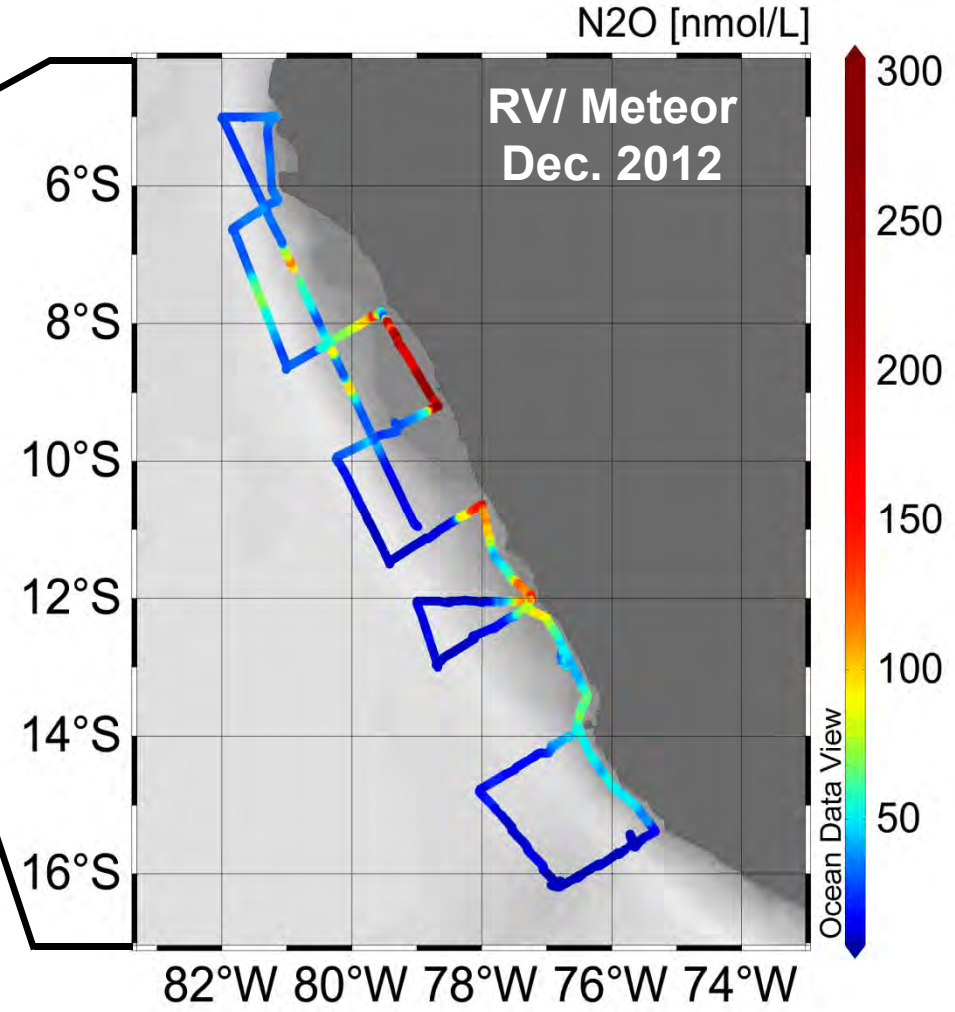


- Good agreement with SST
- Enhanced N_2O at 10°W

N_2O surface distribution off Peru

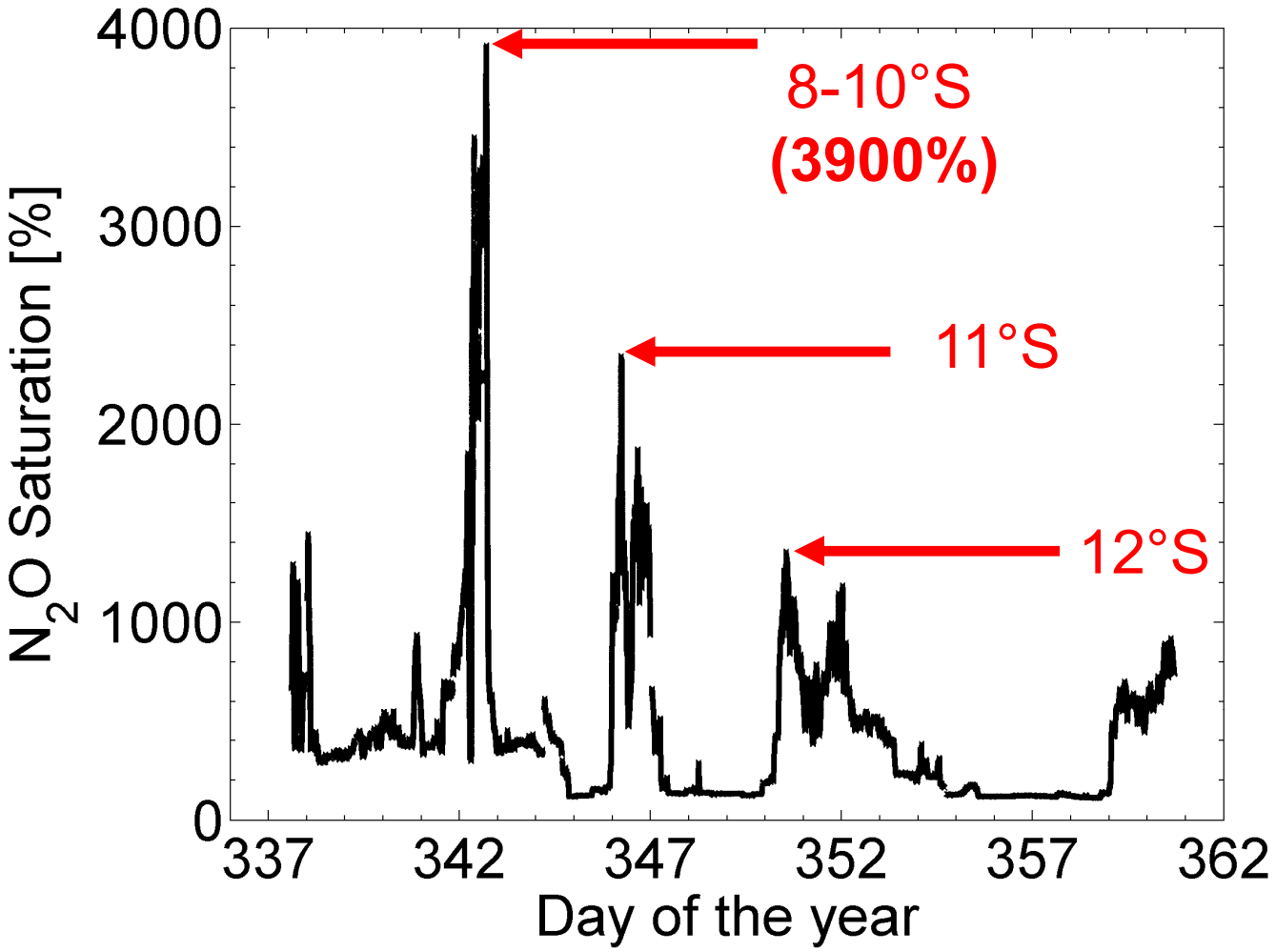


Stramma et al. (2008)



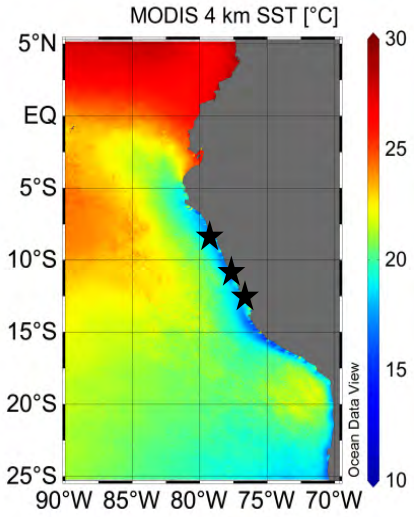
- Highest N_2O at the coast
- North-south gradient
- Extremely high N_2O at 8-12°S

Peruvian upwelling as a „Hotspot“ for N_2O emissions

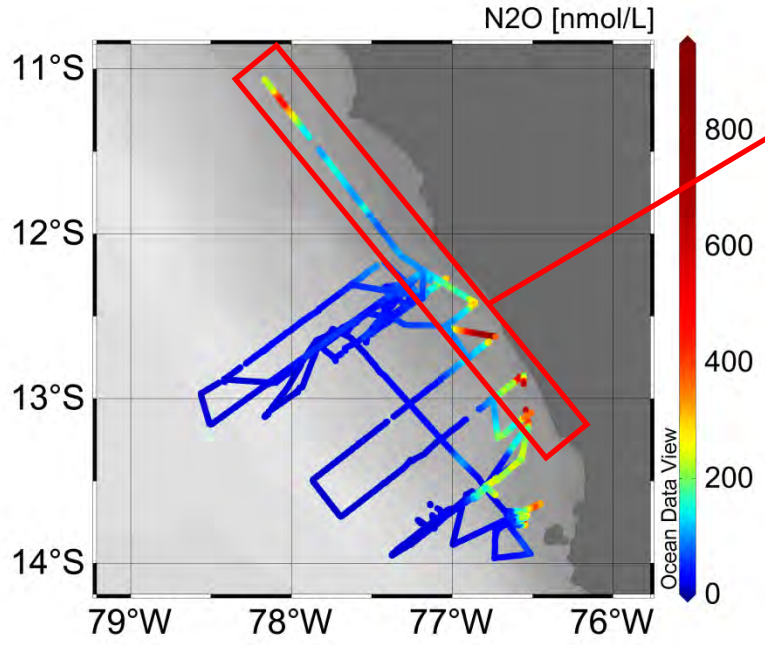


$$Sat = \frac{C_{sw}}{C_{air}} \times 100$$

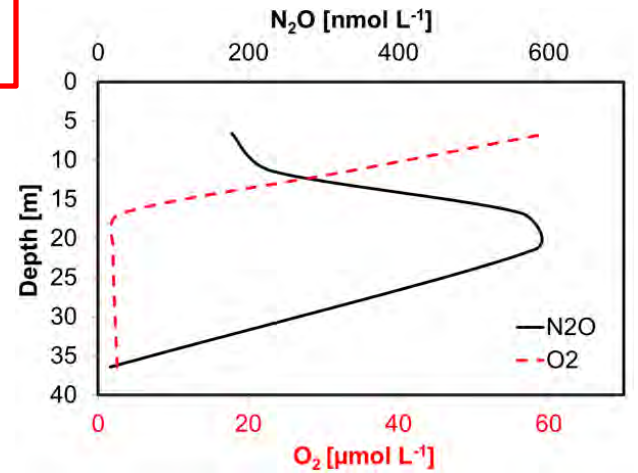
Max. Conc.
304 nmol L^{-1}

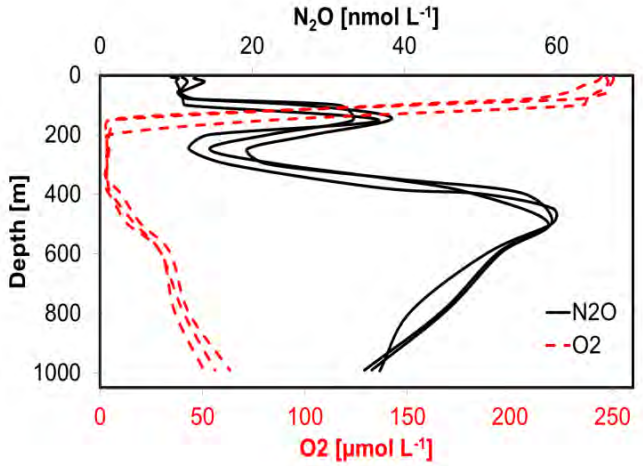


Peruvian upwelling as a „Hotspot“ for N_2O emissions



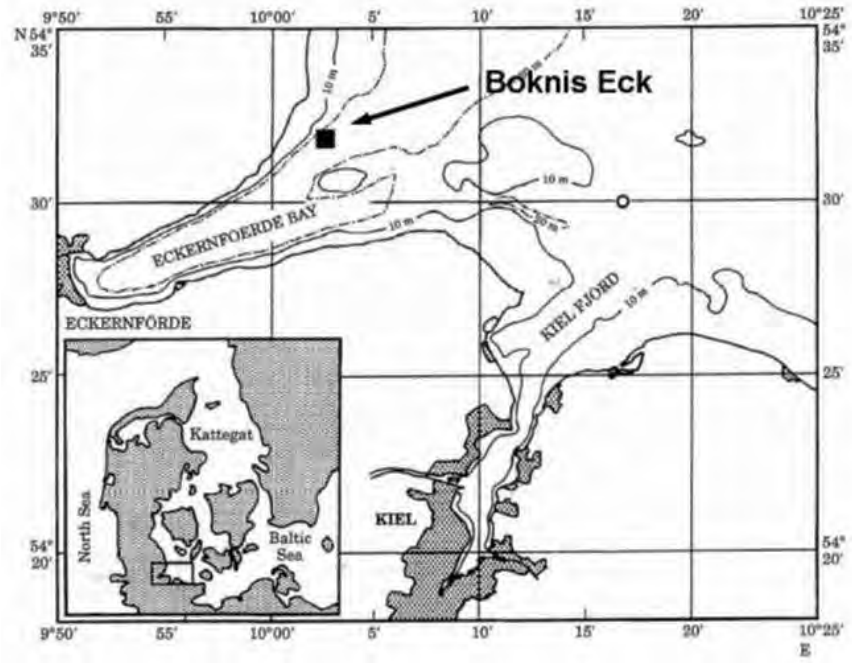
Max. Conc.
986 nmol L^{-1}





- Weaker correlation with SST
- Sharp shallow gradients
- Combined nitrification-denitrification

Boknis Eck Time Series Station

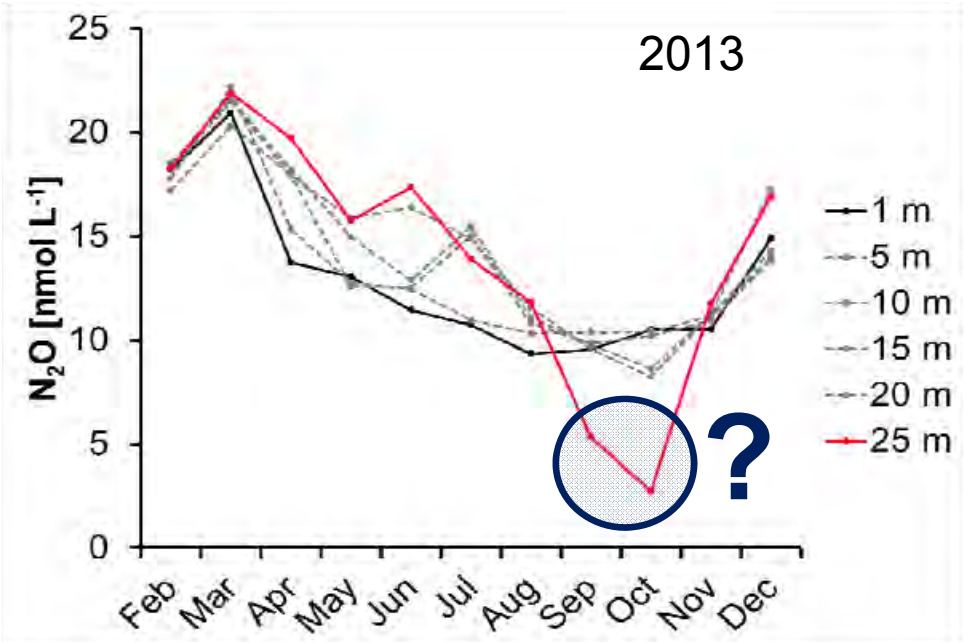


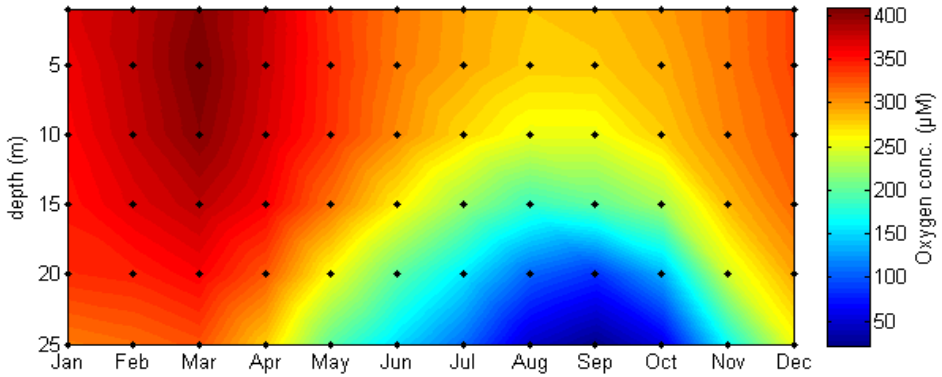
Hansen et al.(1999)

- Monthly sampling since 1957
- Water depth: 28 m
- Salt water inflow from North Sea
- Seasonal stratification

See more at:
https://www.bokniseck.de

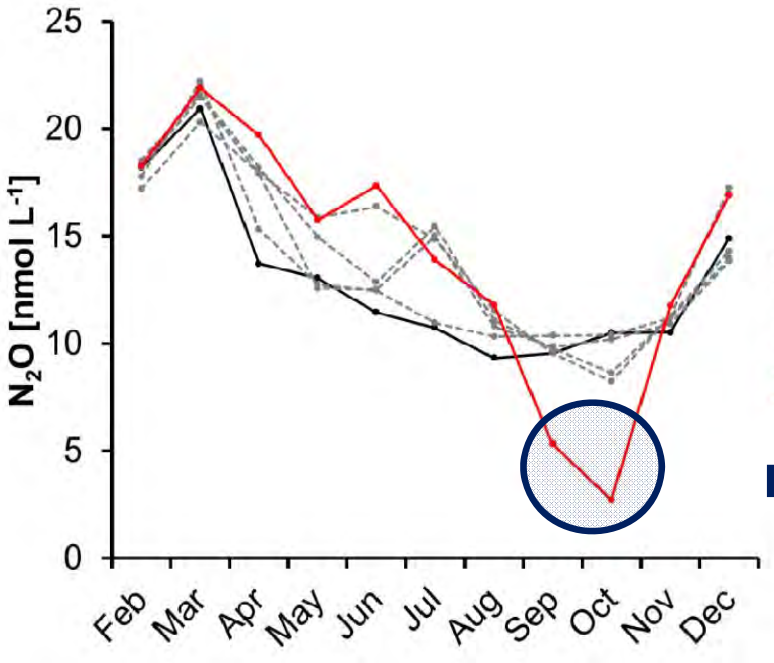
N_2O measurements at Boknis Eck

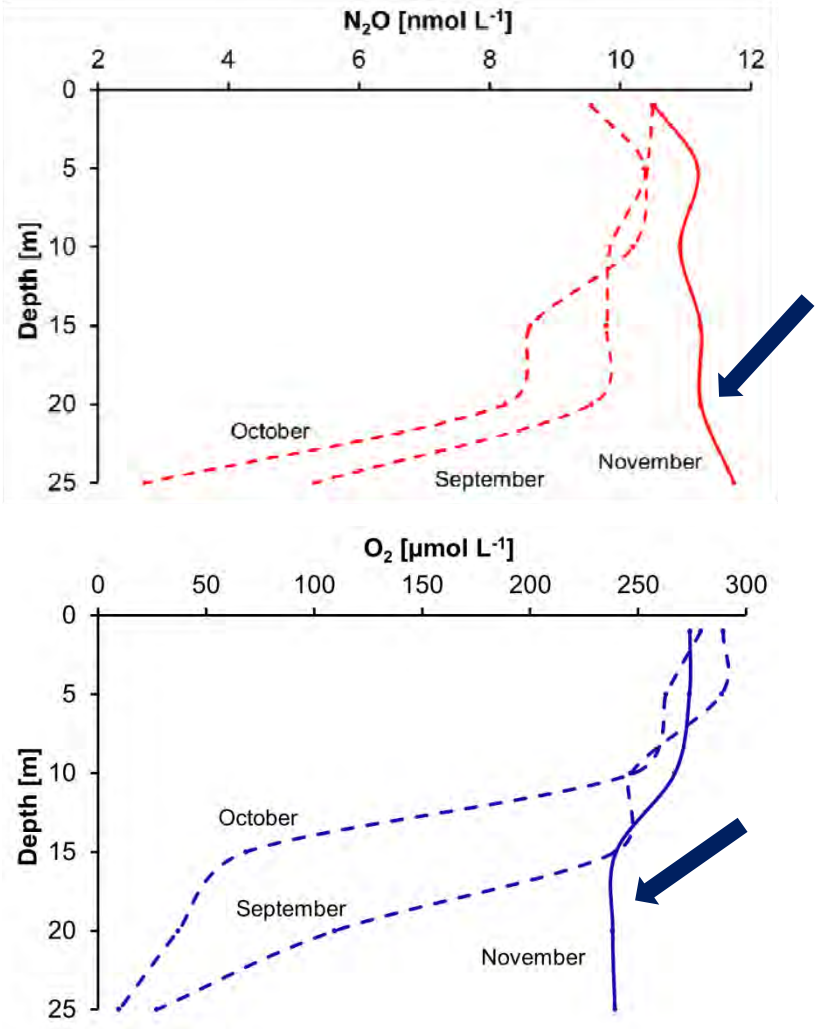




From Lennartz (2013)

Anoxic/hypoxic events at Boknis Eck





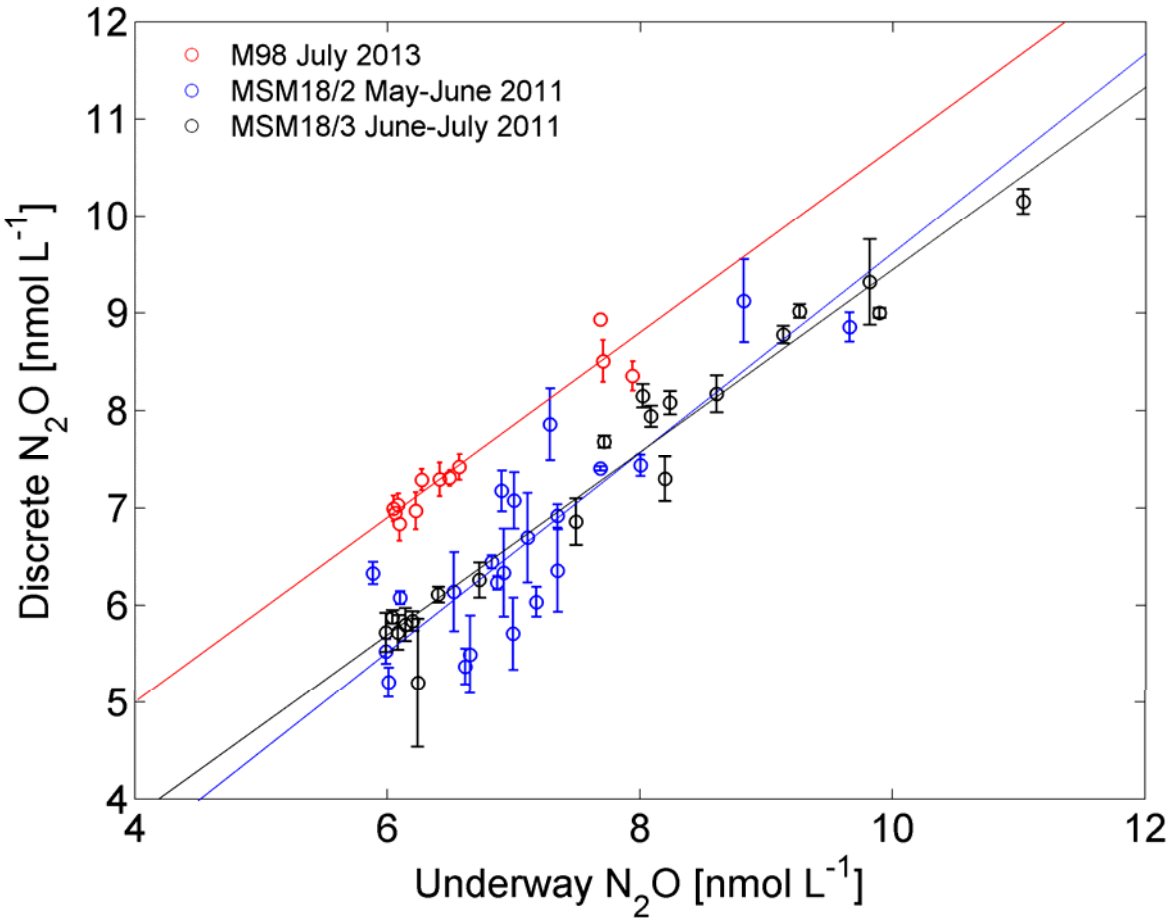
Stagnation (summer) → Water column ventilation → Incomplete Nitrification

See Schweiger et al. (2007)

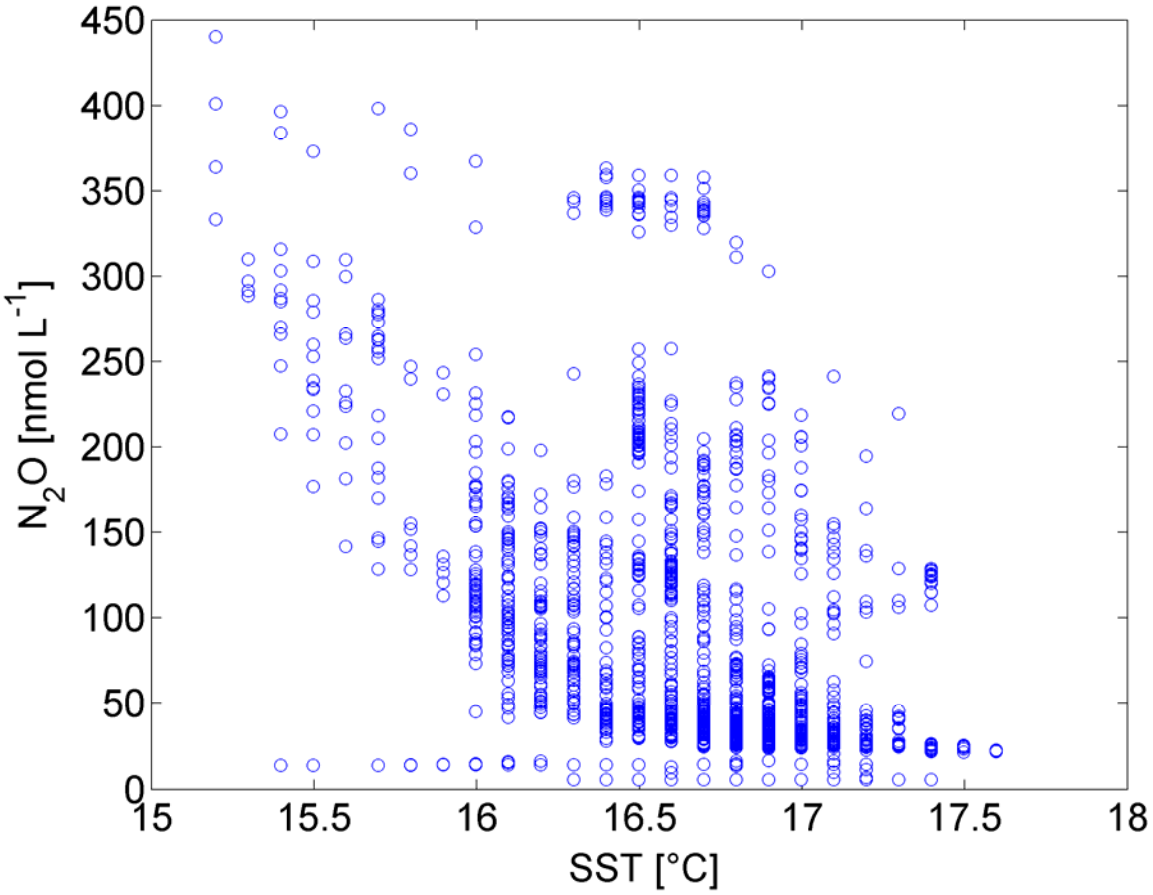
Summary

- Increased temporal/spatial resolution for N_2O with OA-ICOS
- Overview on key regions:
  - Seasonal cycle of upwelling visible in surface N_2O
  - Peruvian upwelling system as a hotspot for N_2O emissions
- BE time series station: seasonal cycle of N_2O, sensitivity to oxygen changes in different time scales
- Combined use of different observation platforms is a key strategy to constrain present and future emissions of GHG.

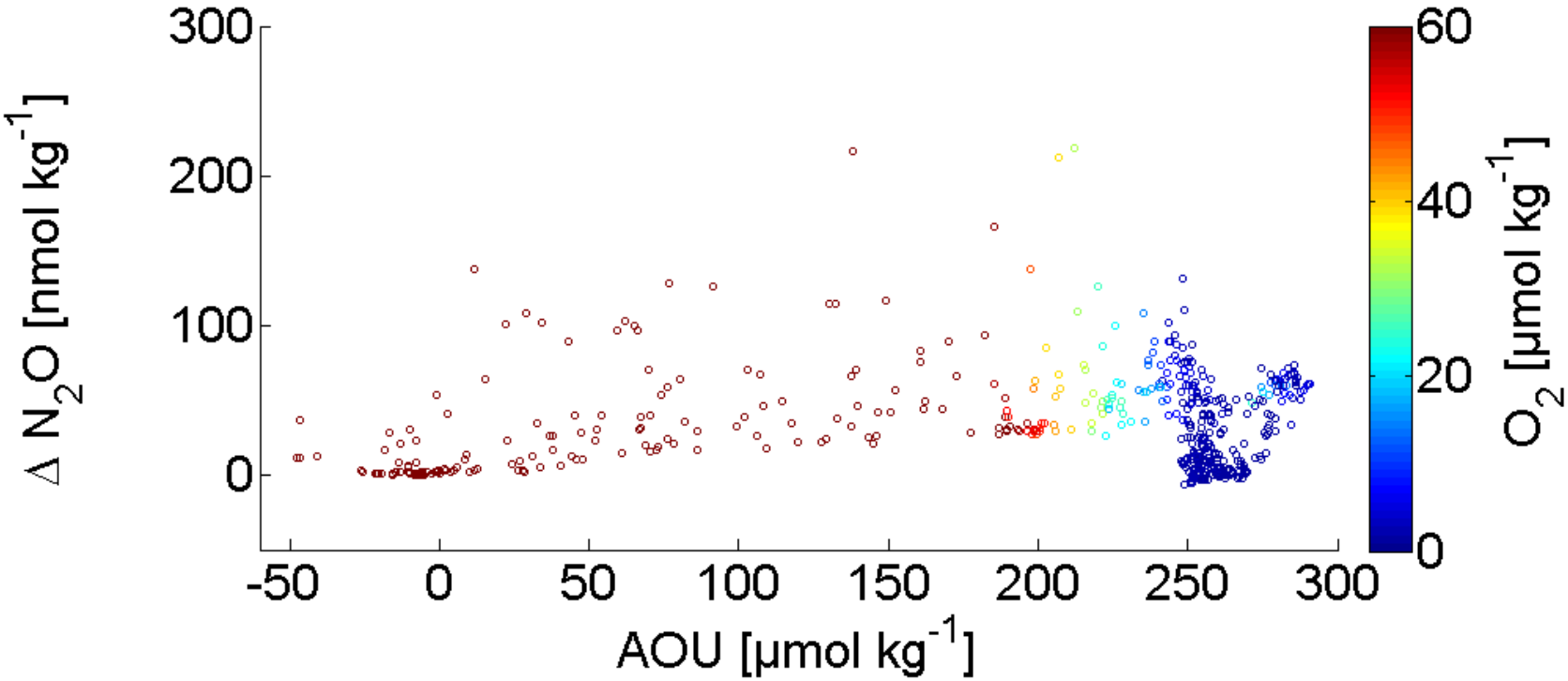
Discrete vs. underway methods



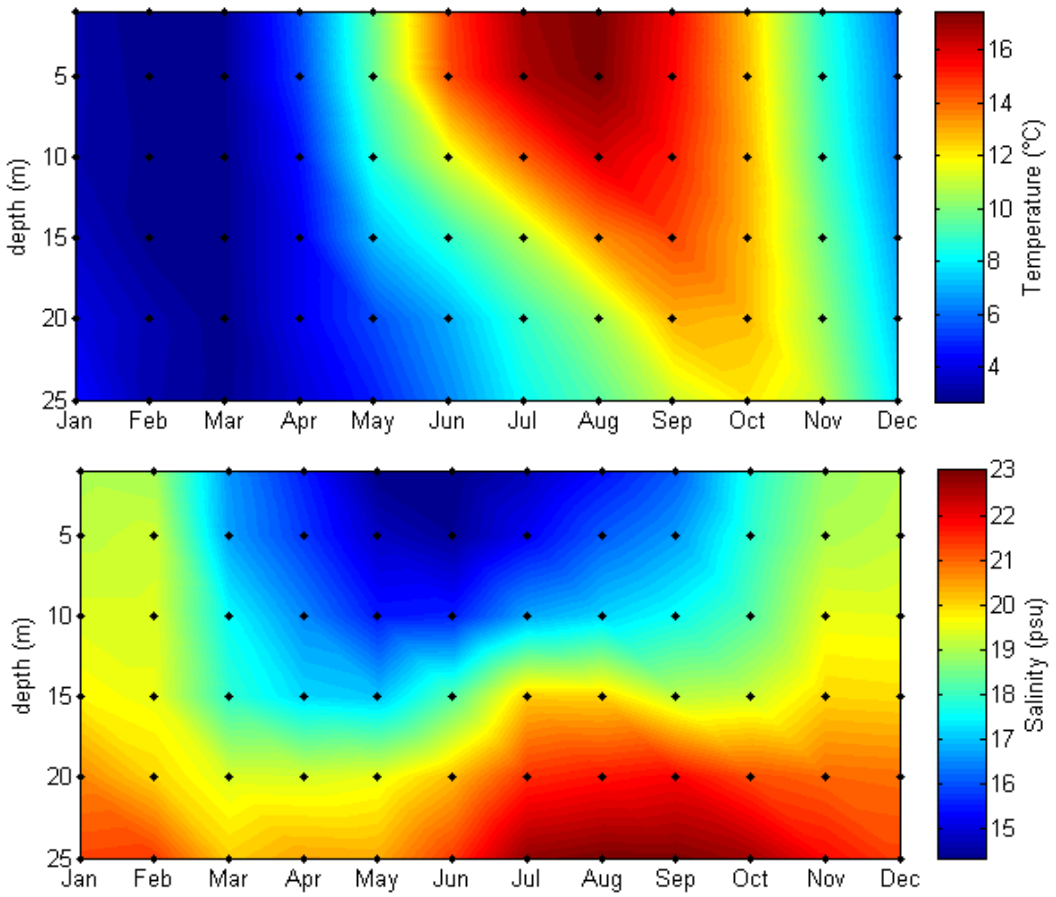
N2O *vs.* SST off Peru



ΔN2O *vs.* AOU off Peru



Boknis Eck Time Series Station



From Lennartz (2013)