

# MEMENTO:

Towards a New Estimate of  
Global CH<sub>4</sub> and N<sub>2</sub>O  
Emissions

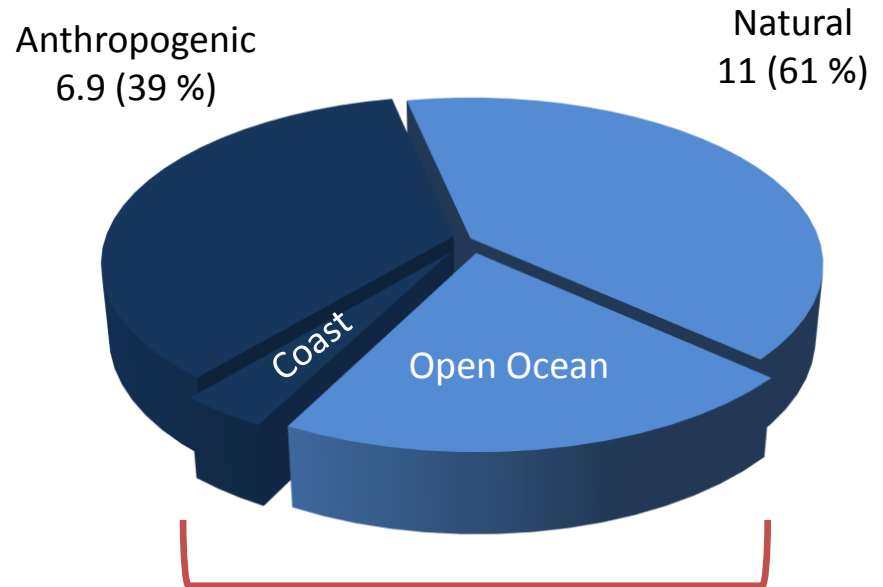
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+ data contributors



## Oceanic emissions of N<sub>2</sub>O

- Greenhouse gas and Ozone depleting substance
- Increasing concentrations in the atmosphere:  
1750: ~270 ppb  
2015: ~328 ppb
- Microbial production:  
Nitrification (aerobic)  
Denitrification (anaerobic)
- Ocean: subsurface accumulation @ decreasing O<sub>2</sub>. Elevated emissions in upwelling and coastal areas.

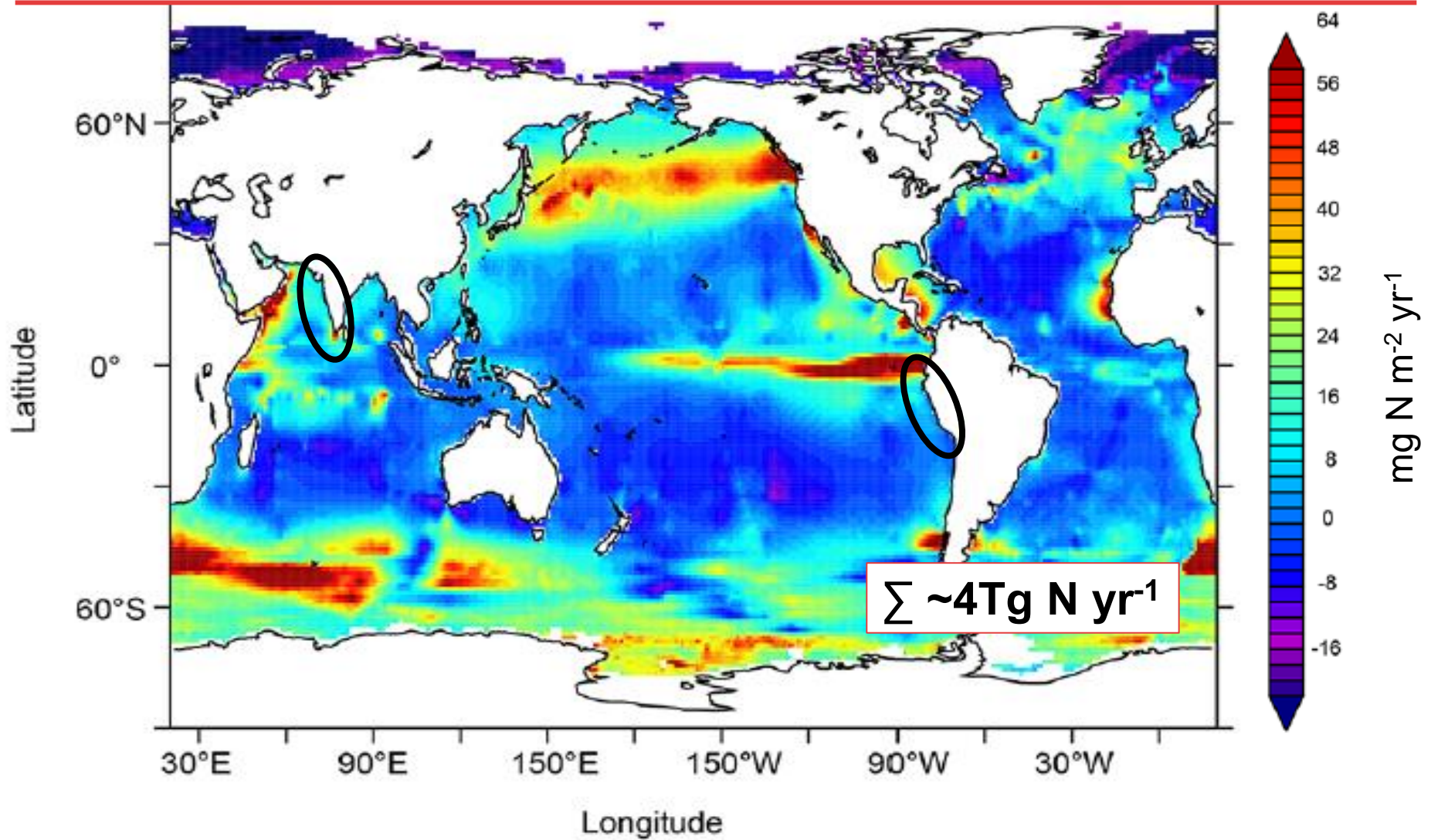
### Global N<sub>2</sub>O emissions [Tg-N<sub>2</sub>O yr<sup>-1</sup>]



**Global Ocean: ~4**

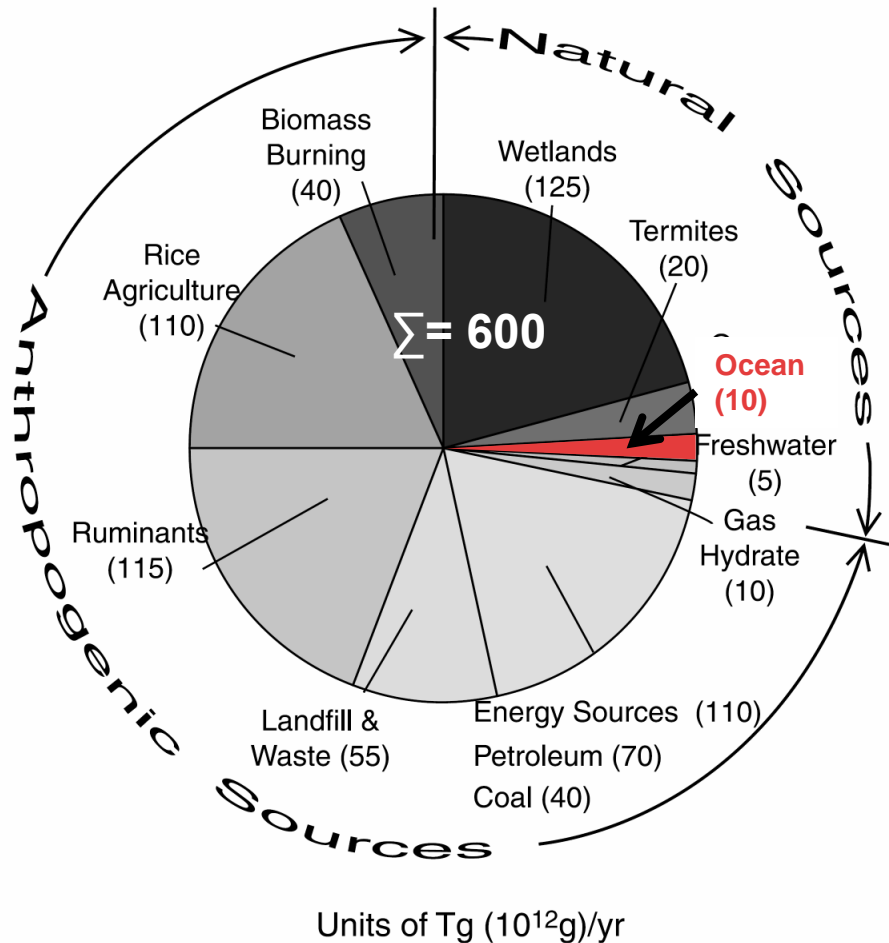
**(1.8 - 9.4)**

## N<sub>2</sub>O Emissions from previous data interpolation



Data from Nevison et al. 2004 (figure: Martínez-Rey et al. 2015)

# Oceanic emissions of CH<sub>4</sub>



Different sources for CH<sub>4</sub>: geological, biogenic

CH<sub>4</sub> production in sediments  
CH<sub>4</sub> oxidation in water column

Oceanic Methane Paradox: CH<sub>4</sub> supersaturation in oxygenated waters @ depth of chlorophyll maximum

Large variability of emission estimates:

0.2 – 50 Tg CH<sub>4</sub> yr<sup>-1</sup>

(Rhee et al. 2009)

Kvenvolden and Rodgers (2005)

# Motivation

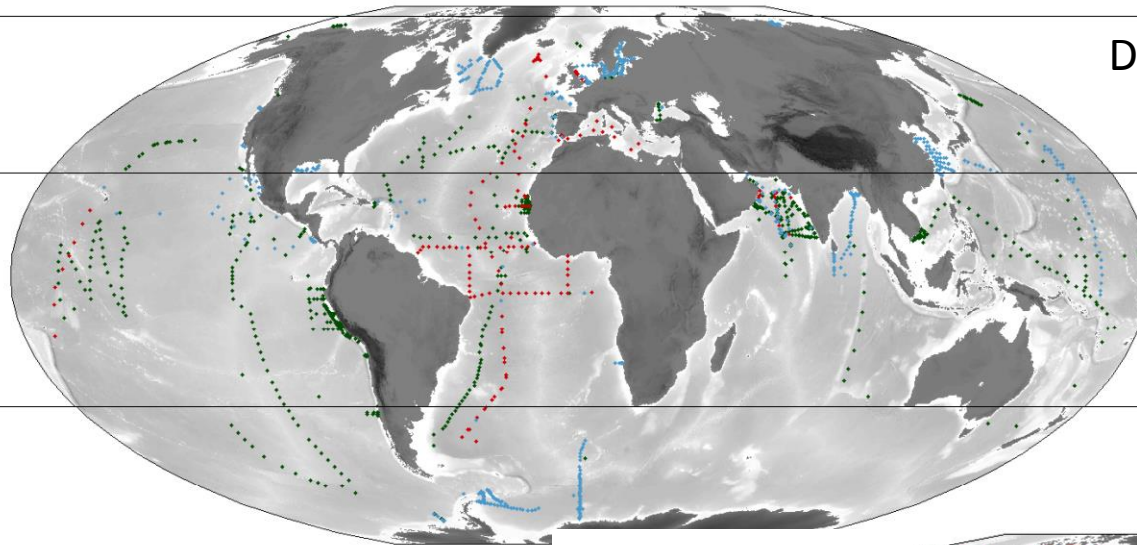
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## **MEMENTO was initiated in 2009 to:**

- collect available  $\text{N}_2\text{O}$  and  $\text{CH}_4$  data from the global ocean in a database with open access to the scientific community.
  - create a quality controlled, harmonized dataset of global  $\text{N}_2\text{O}/\text{CH}_4$  data to
  - compute a global climatology of dissolved  $\text{N}_2\text{O}/\text{CH}_4$  concentrations and an updated global  $\text{CH}_4/\text{N}_2\text{O}$  emission estimate.
  - provide a global dataset of depth profiles of  $\text{N}_2\text{O}/\text{CH}_4$ , interpolated to standard depth levels and transformed to uniform units
  - keep the database alive by regularly uploading new data submissions and updating concentration and flux field calculations.
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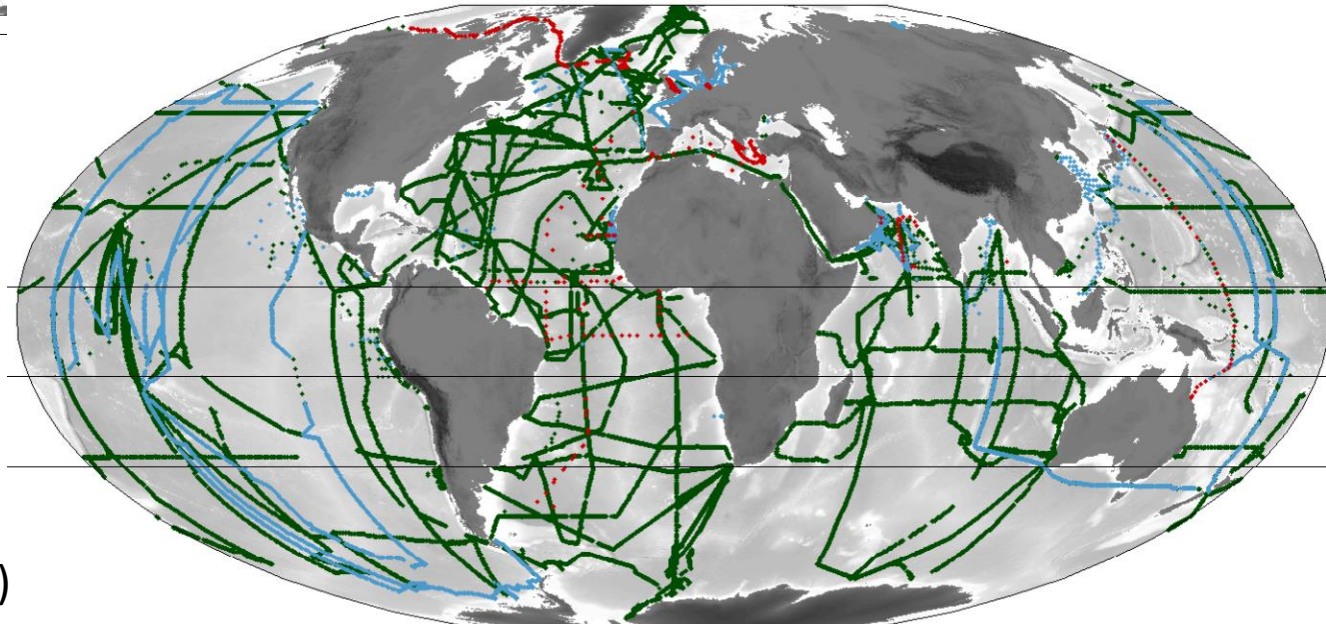
# The data collection



Depth Profiles (Sampling Depth >10m)

> 100,000 data entries for N<sub>2</sub>O  
> 20,000 data entries for CH<sub>4</sub>

CH<sub>4</sub>  
N<sub>2</sub>O  
CH<sub>4</sub> + N<sub>2</sub>O



Surface Measurements  
(Sampling Depth <10m)

# The data collection

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## **Original data included in MEMENTO:**

- Depth profiles
- Underway surface measurements and corresponding atmospheric measurements (if available)

### Parameters included:

- N<sub>2</sub>O and/or CH<sub>4</sub>, position, date & time, sampling depth (mandatory)
- Temperature, salinity, oxygen, nutrients (optional)

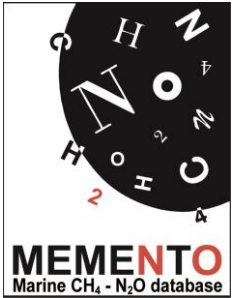
## **Planned data products:**

- 1° x 1° gridded surface concentration and emission maps
  - A global dataset of depth profiles, interpolated to standard depths and transformed to uniform units.
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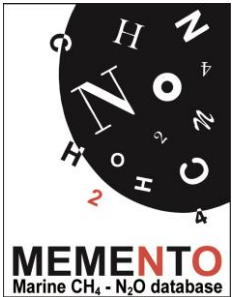
# The MEMENTO website

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Homepage with database access:



<https://memento.geomar.de/home>



<https://memento.geomar.de/database>

-> login information upon request

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# Data processing in MEMENTO

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Data Submissions



**Availability, range check**

Original Data



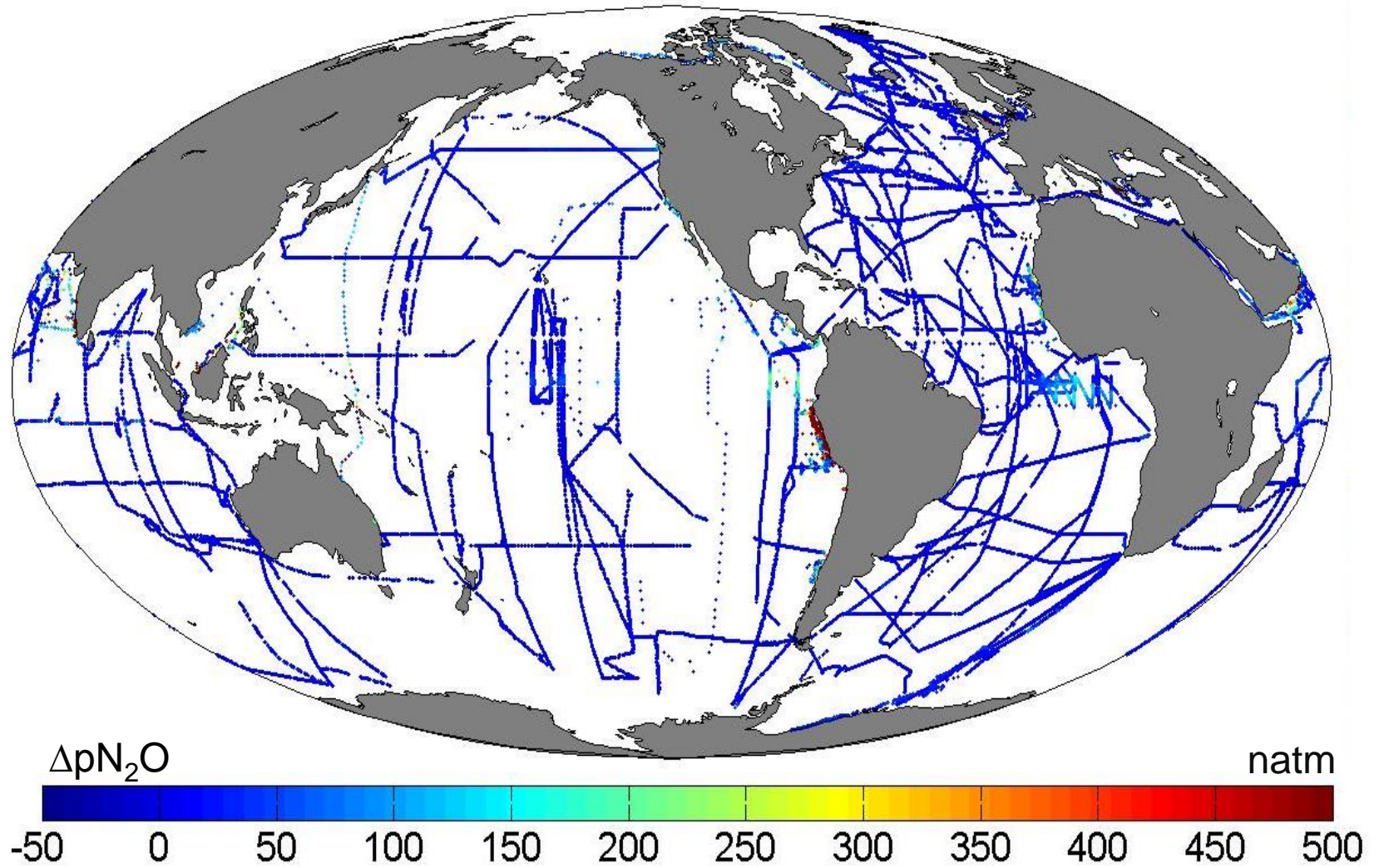
**Interpolation to standard depth levels,  
complementation of missing (T),S data and atmospheric mole fractions,  
conversion to common units, calculation of saturation and  $\Delta$ -values**

Harmonized Data

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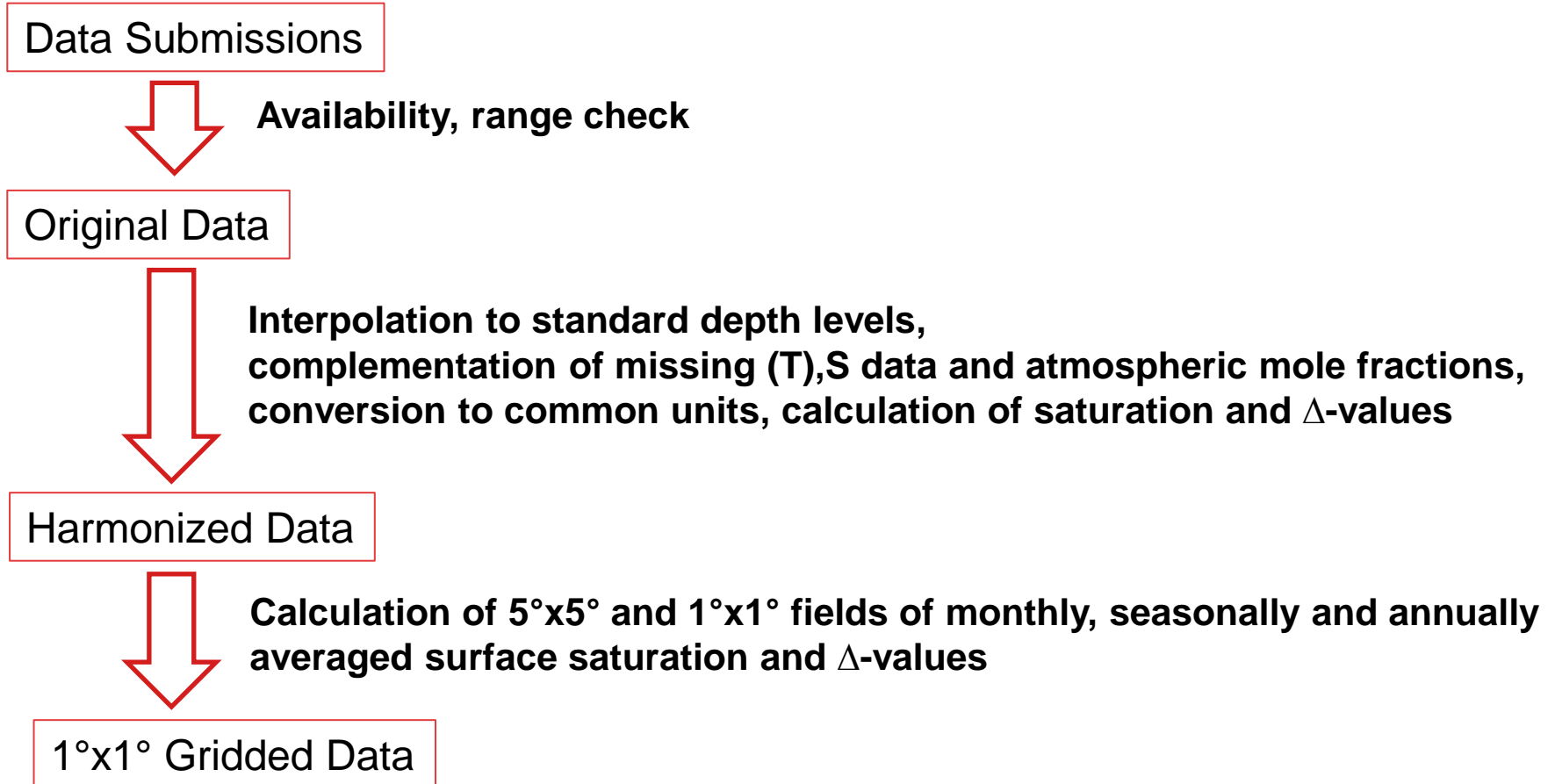
## Individual measurements

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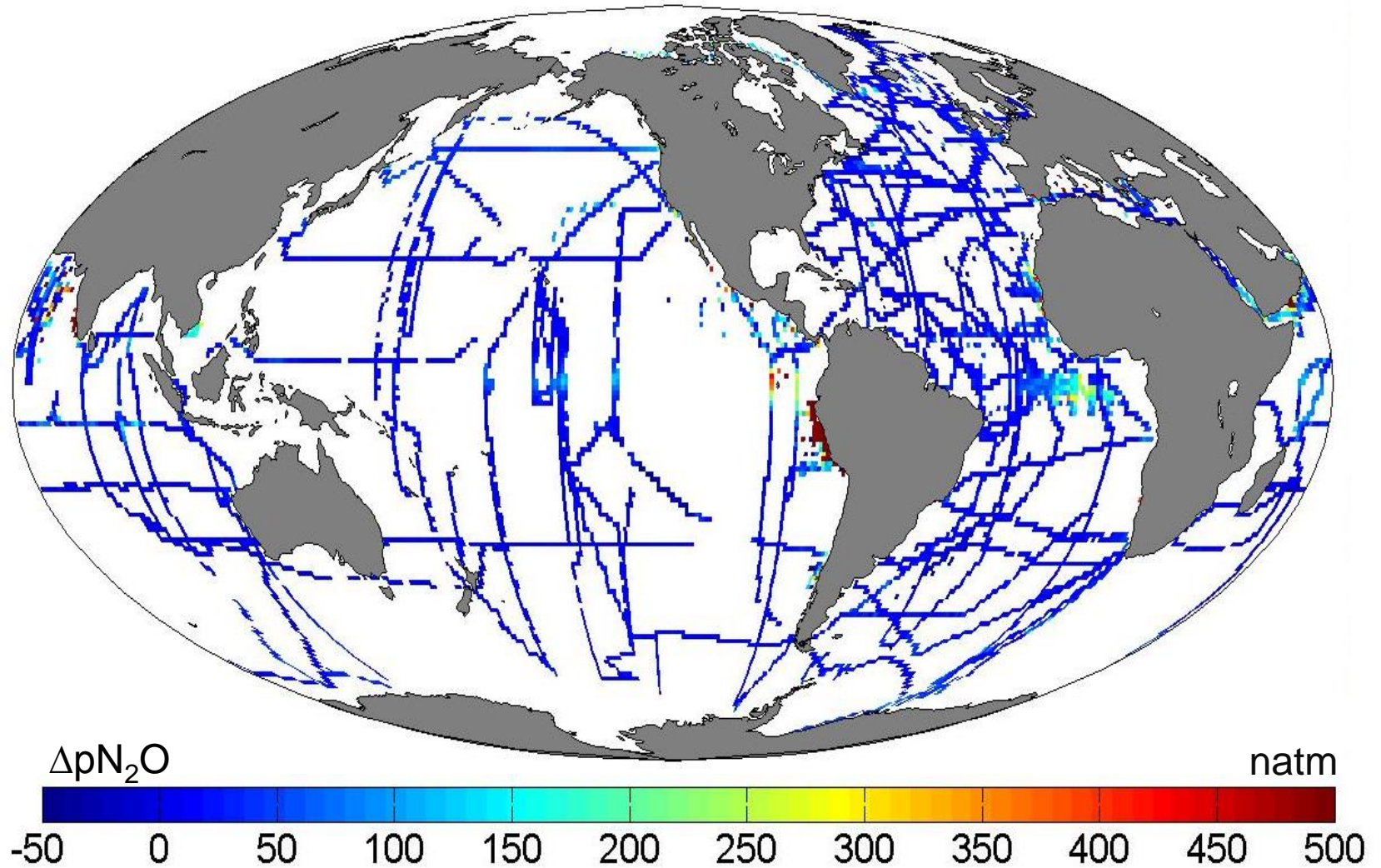
# Surface data processing in MEMENTO

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# 1° x 1° gridded surface $\Delta p\text{N}_2\text{O}$

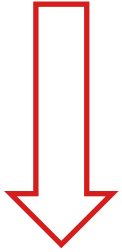
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# Data processing in MEMENTO (N<sub>2</sub>O)

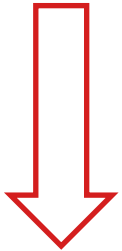
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1°x1° Gridded Data



**Data Interpolation (Lana et al. 2011): calculation of global first-guess fields based on Longhurst provinces; successive correction (Barnes, 1964)**

Global 1°x1° Fields of Annually and Seasonally Averaged  $\Delta\text{N}_2\text{O}$  &  $\Delta\text{pN}_2\text{O}$



**Calculation of gas exchange using daily ERA-interim wind speed, SST and sea ice data.  $k_w$  parameterized according to Nightingale (2000)**

Global 1° x 1° Fields of Annually and Seasonally Averaged N<sub>2</sub>O fluxes



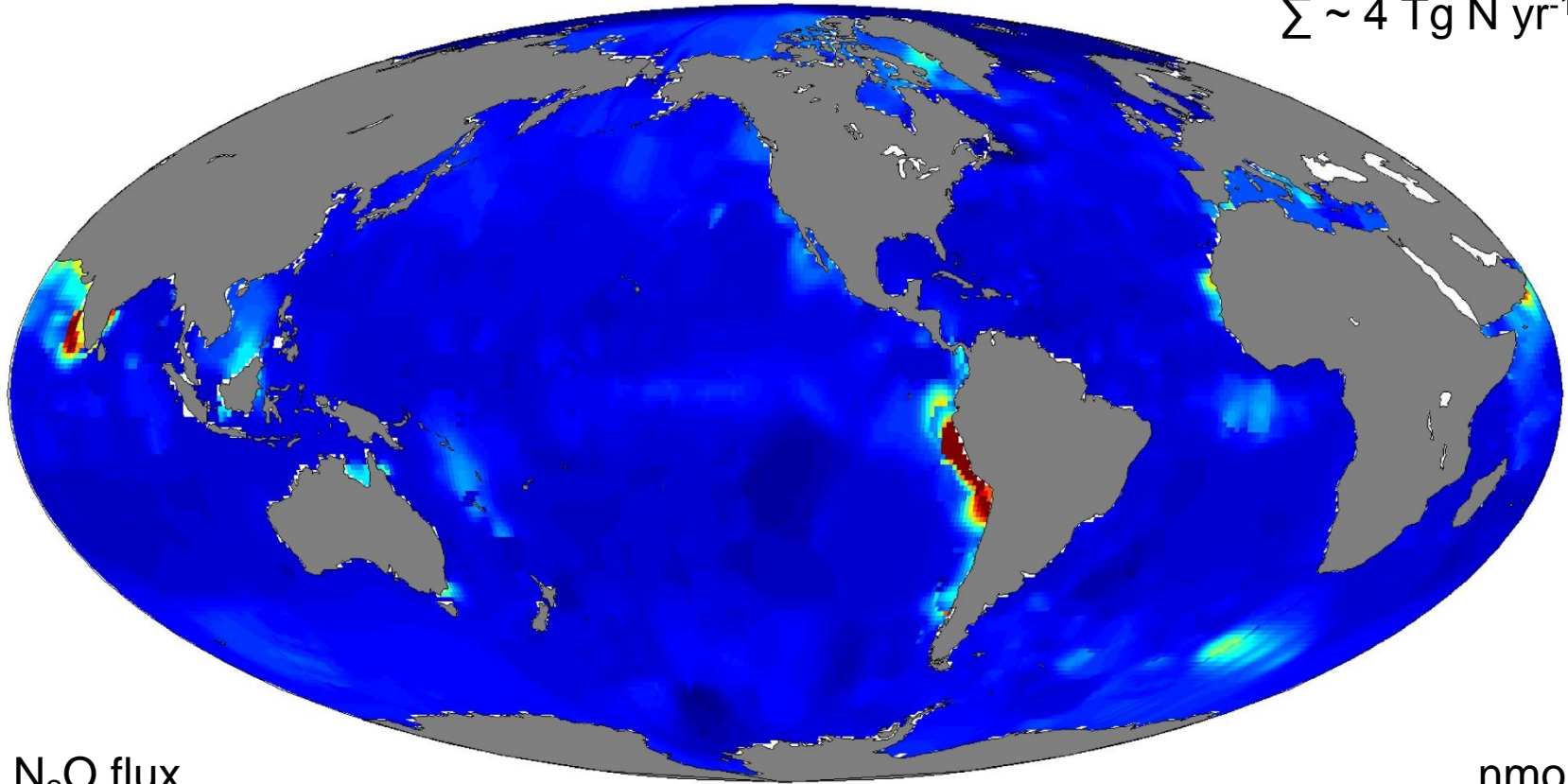
**Updated N<sub>2</sub>O Emission Estimate**



## Data processing in MEMENTO (N<sub>2</sub>O)

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Emissions:  
 $\Sigma \sim 4 \text{ Tg N yr}^{-1}$



N<sub>2</sub>O flux

nmol m<sup>-2</sup> s<sup>-1</sup>

0

0.1

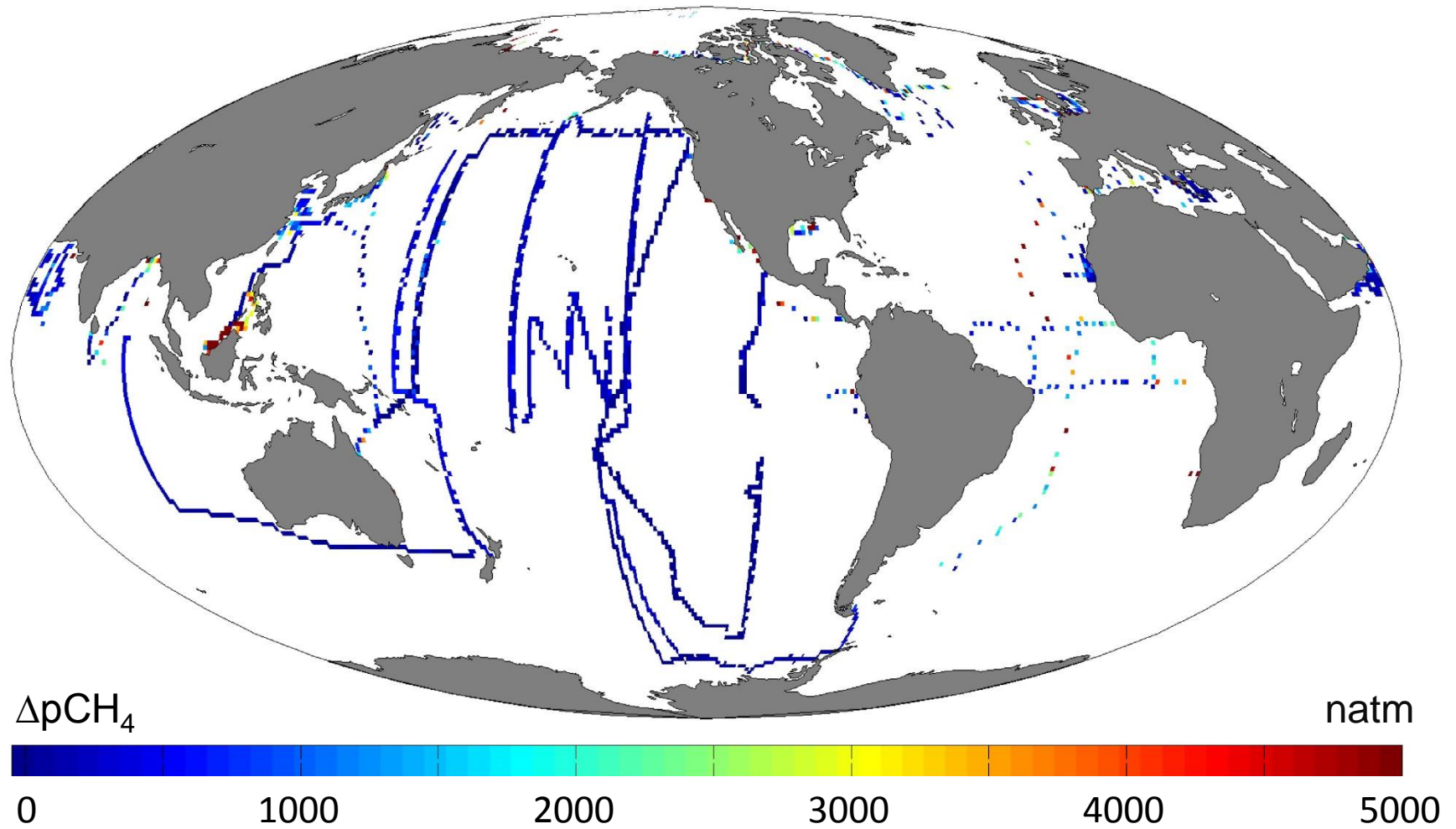
0.2

0.3



## 1°x1° gridded CH<sub>4</sub> data

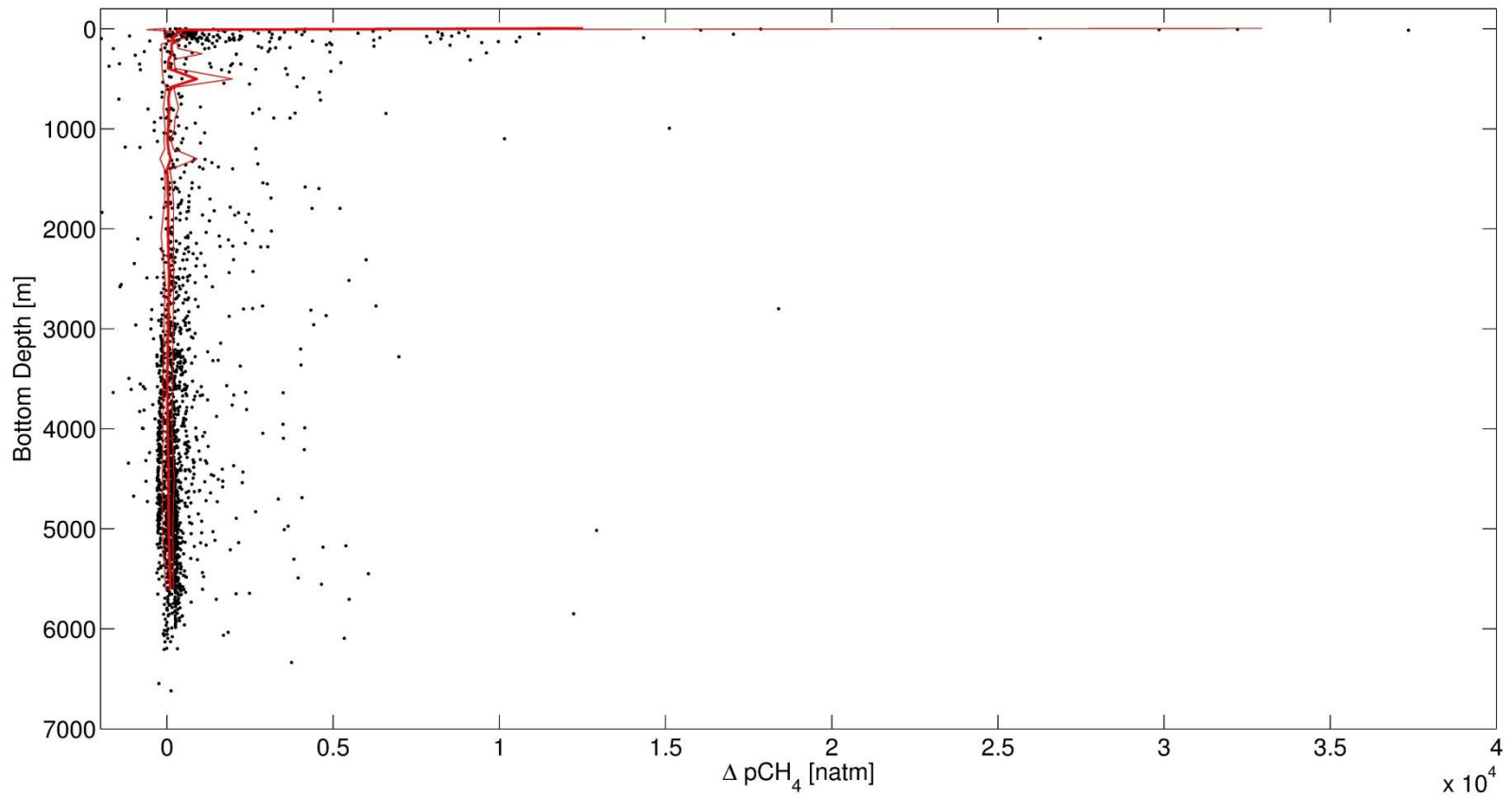
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# Data processing in MEMENTO (CH<sub>4</sub>)

1°x1° Gridded Data

Data distribution not sufficient for interpolation -> parameterization

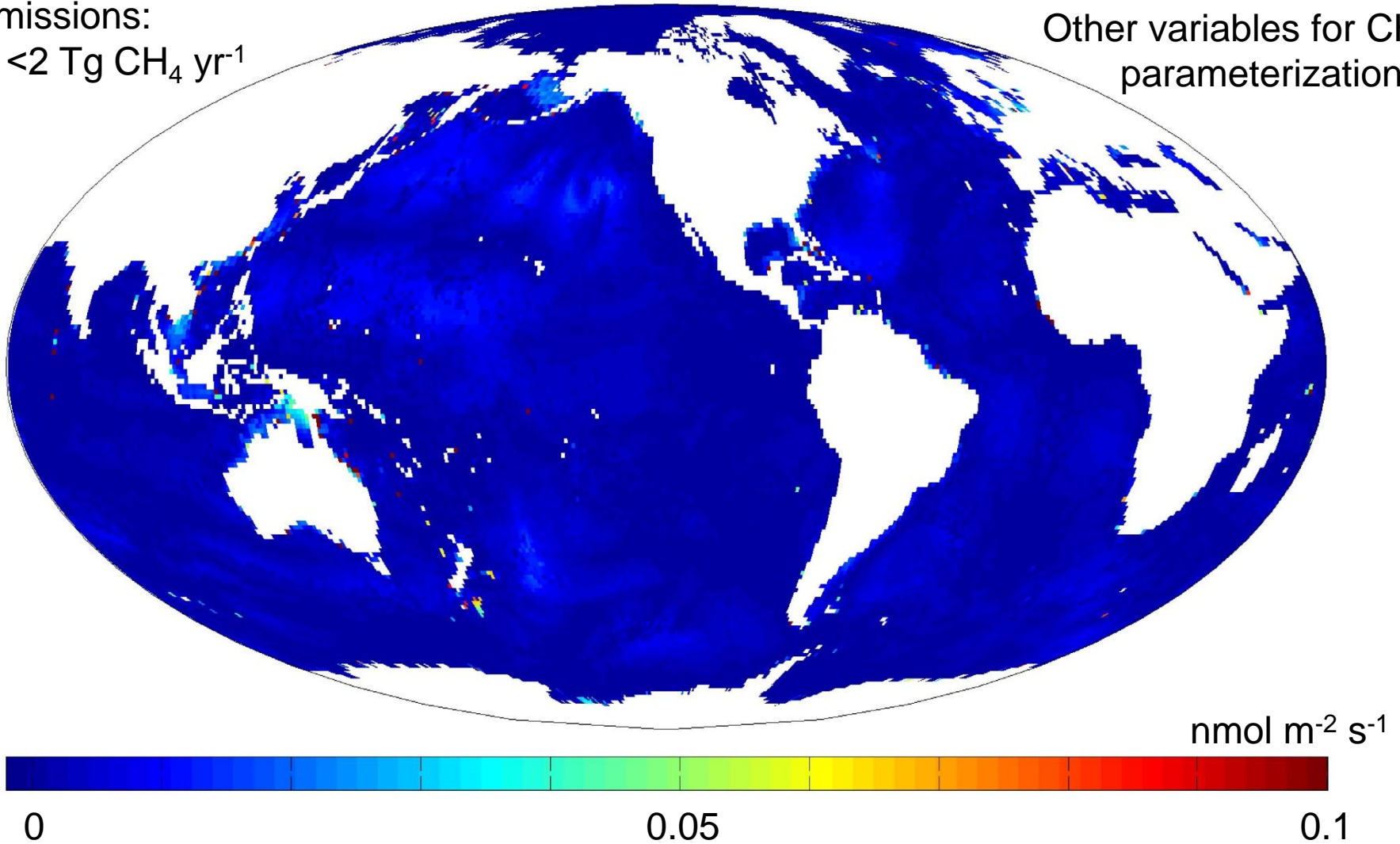


## Data processing in MEMENTO (CH<sub>4</sub>)

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Emissions:  
 $\Sigma < 2 \text{ Tg CH}_4 \text{ yr}^{-1}$

Other variables for CH<sub>4</sub>  
parameterization ?



# First results

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$\text{N}_2\text{O}$ :

- $\text{N}_2\text{O}$  mainly supersaturated in the surface ocean, elevated emissions from upwelling areas, Southern Ocean, North Pacific (consistent with Nevison et al. 2004).
- $\text{N}_2\text{O}$  emissions from Peru upwelling and West Indian shelf one order of magnitude higher than from other upwelling areas.
- Areas with undersaturation in high latitudes and subtropical gyres

$\text{CH}_4$ :

Emission estimate based on bottom depth -> small overall oceanic contribution to emissions

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## Next steps

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- Explore different methods for mapping of global  $\text{N}_2\text{O}/\text{CH}_4$  distributions
  - Explore methods to resolve seasonality of  $\text{N}_2\text{O}/\text{CH}_4$  distribution
  - New instruments -> increased number of measurements (e.g. on VOS lines)  
Intensify cooperation with SOCAT
  - Cross-calibration of depth profile data
  - SCOR Working Group 143: intercalibration exercise for  $\text{N}_2\text{O}/\text{CH}_4$  measurements; of „best practices“ for measurements  
-> Implementation of data quality criteria in MEMENTO
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