Multi-day near-surface stratification and its impact on N₂O emission estimates in the Peruvian upwelling system


Measuring nitrous oxide (N₂O) in the top 10 meters of the Peruvian upwelling system

Motivation

Do we estimate gas emissions from adequate concentrations?

N₂O measurements during Meteor cruise M91 in December 2012

Shallow sampling away from ship's influence

Near-surface N₂O gradients exist - associated with shallow nighttime stratification

Vertical concentration gradients in top layer exist and vary regionally. Existence of strong N₂O gradient is related to strong N² during night.

Ship based observations also indicate that N₂O gradients are associated with higher N₂O concentrations and nighttime stratification.

Top 1 meter: barely any gradient

Existence of multi-day near-surface stratification is verified by glider surveys

Glider fleet in Jan/Feb 2013

Extracted composite hydrographic timeseries:

Regional stratification timeseries with different grades of multi-day stratification

A 1-D model constrained by the glider timeseries can reproduce the N₂O gradients

A 1-D two layer model of N₂O transport

Example run: Region 1 - multi-day stratification causes distinct N₂O gradient

Integral effect: overestimation of emissions: model timeseries vs. glider timeseries

Conclusion: Multi-day (not diurnal) stratification seems the necessary condition here to cause considerable near-surface N₂O gradients and bias of emission estimates.

References:

Acknowledgements: This study was supported by the German Federal Ministry of Education and Research through the projects ECO2 impulsSOPRAN and SOPRAN PIV (D7 and D8). The friendly support of all crew members of research vessel Meteor during cruise M91 is highly appreciated. Particular thanks to Reiner Link for helping to construct the sampling equipment, and to the scientists who sampled N₂O during long hours in the darkness, drifting in the waves while sampling their breath. Thanks to Lenn Wolterink for preparing the global hydrographic data. The daily AIVI global wind field data were provided by R. Berntsen and O. Christensen of NCEP/NCAR.

Contact: tfischer@geomar.de, www.geomar.de

Düsternbrooker Weg 20
D-24105 Kiel

Discovery/Production for the Ocean and Climate Dynamics

Graph Series 127, Washington D.C., 181-185