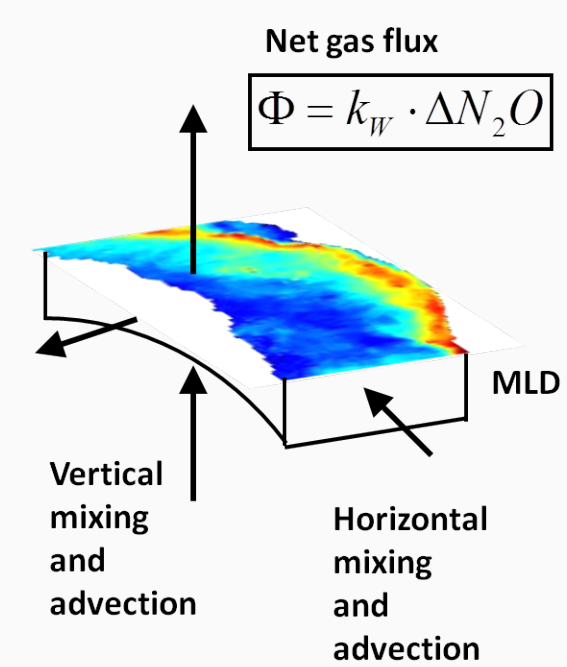


Bias of oceanic N₂O emission estimates by multi-day near-surface stratification in the Peruvian upwelling regime

T. Fischer, A. Kock, D.L. Arévalo-Martínez, M. Dengler, P. Brandt, H.W. Bange

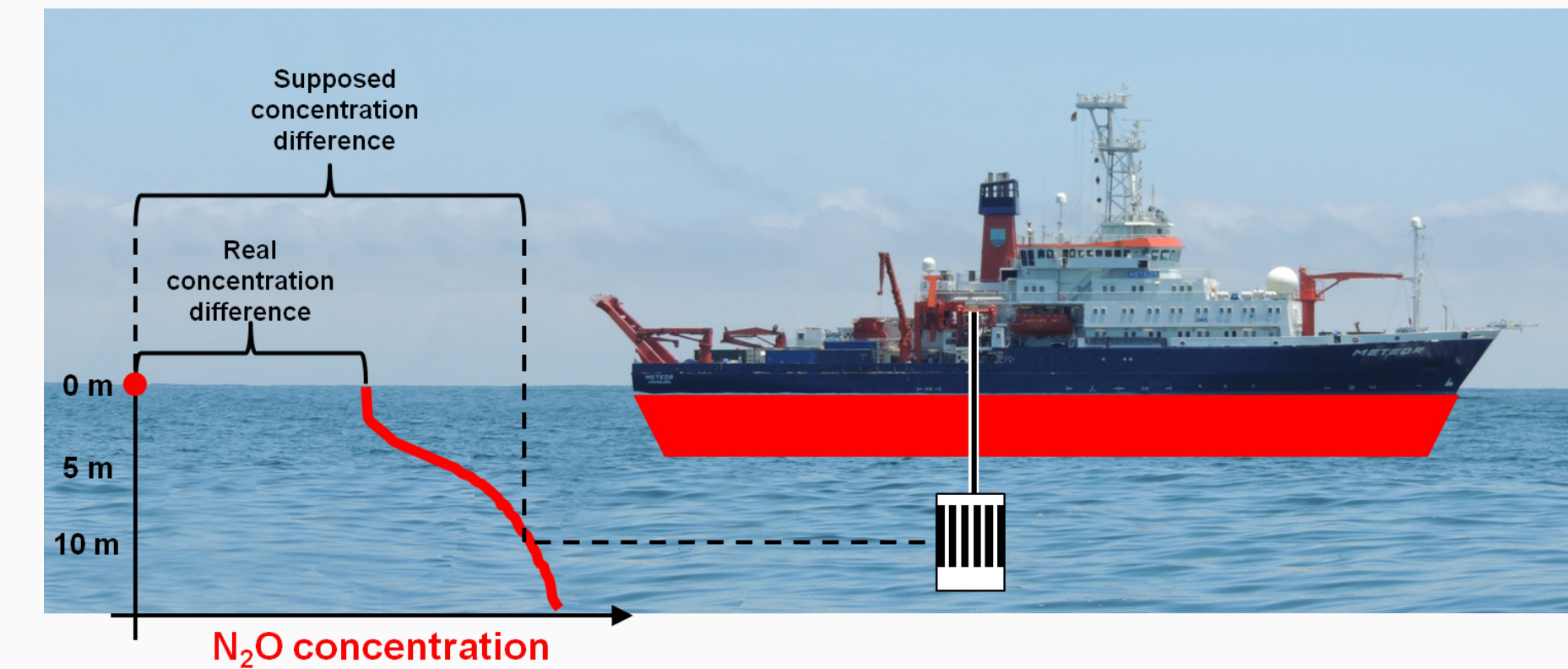
Measuring nitrous oxide (N₂O) in the top 10 meters of the Peruvian upwelling

Motivation



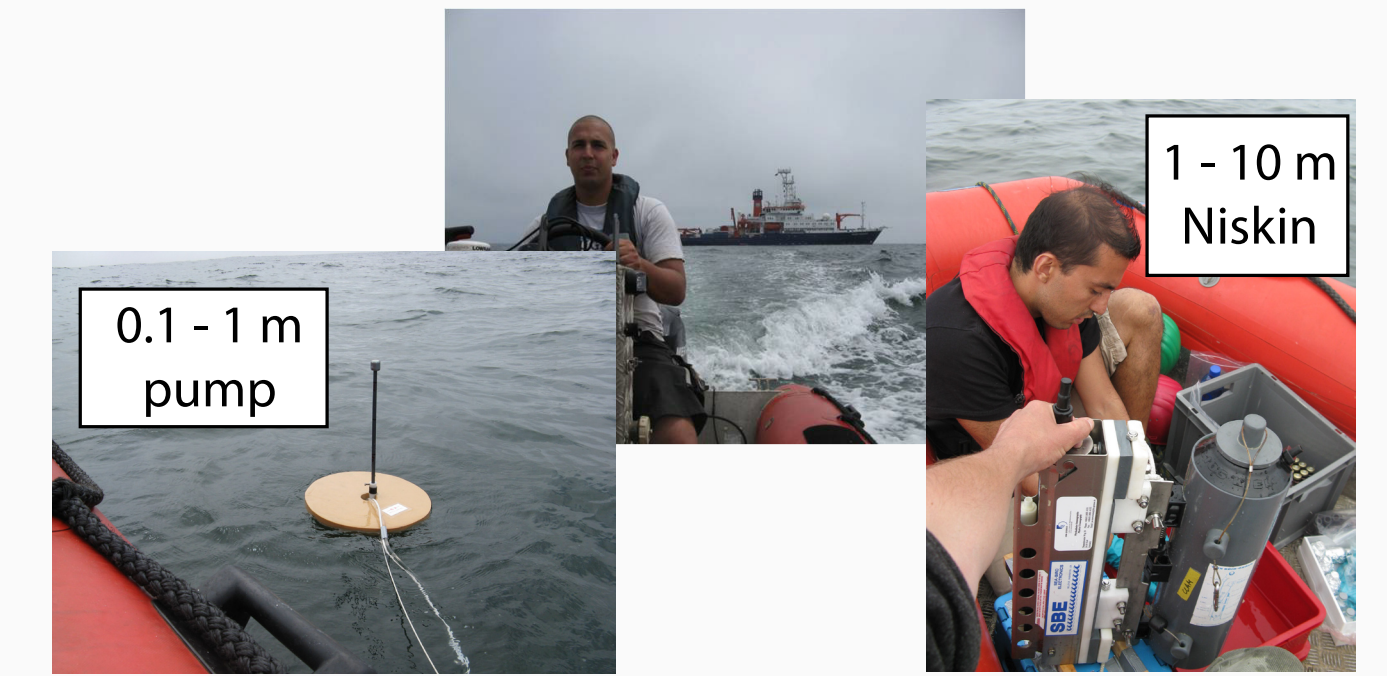
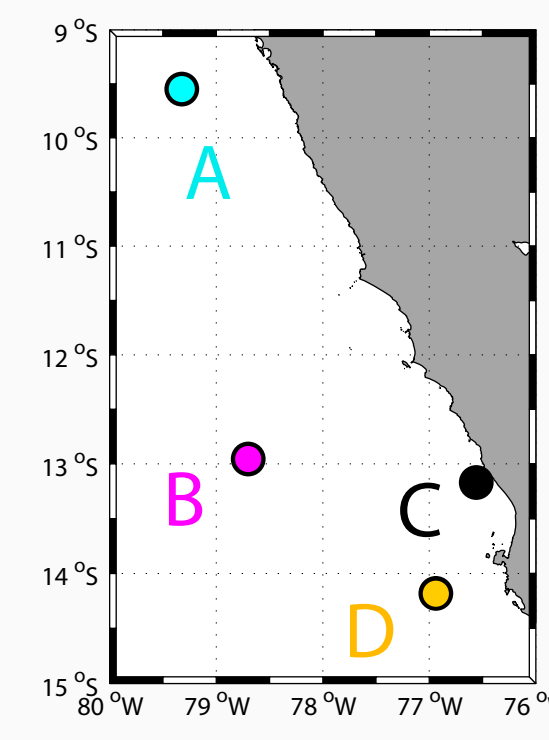
In the Mauritanian upwelling regime, N₂O supply from below is much lower than the calculated N₂O emissions. [Kock et al., 2012]

Do we estimate gas emissions from adequate concentrations?



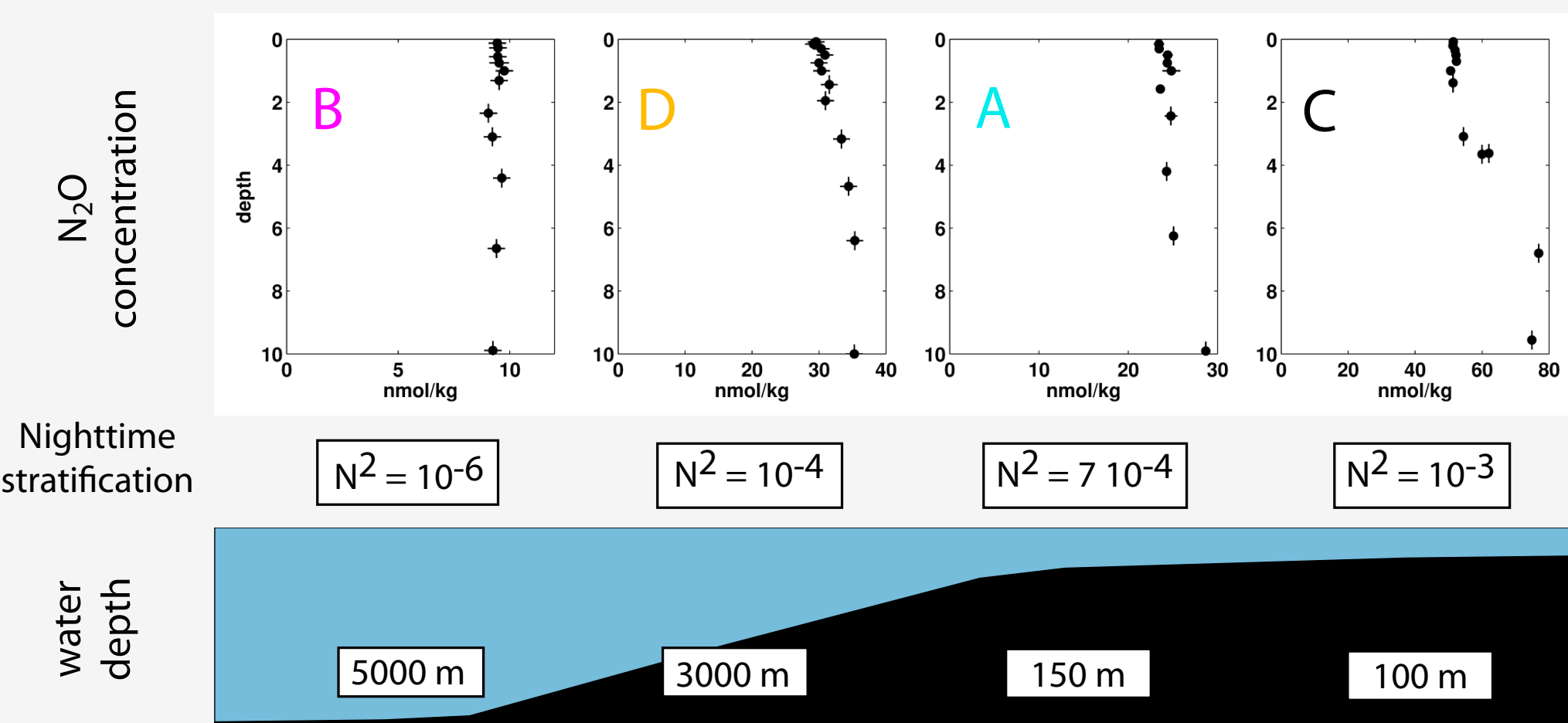
N₂O measurements during Meteor cruise M91 in December 2012

Shallow sampling away from ship's influence

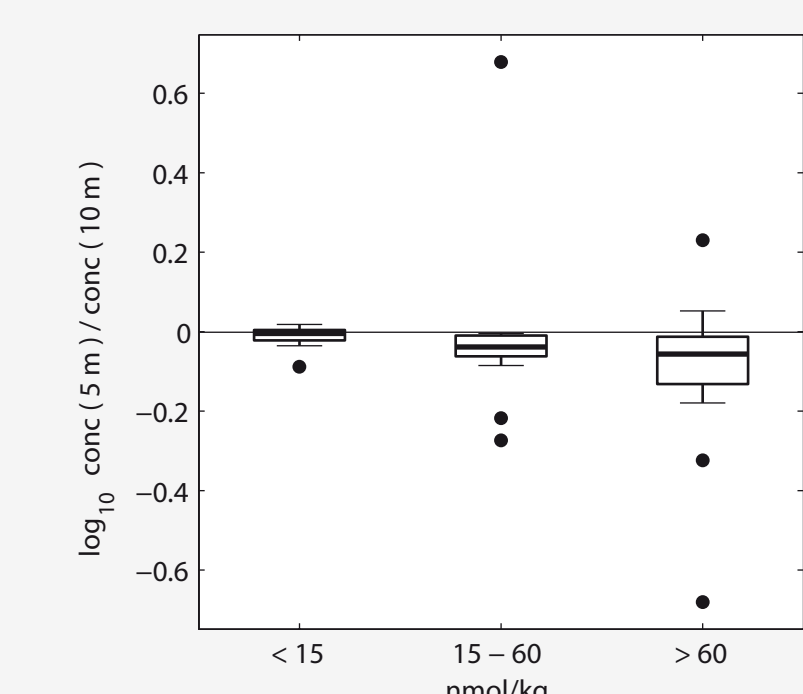


Near-surface N₂O gradients exist - associated with shallow nighttime stratification

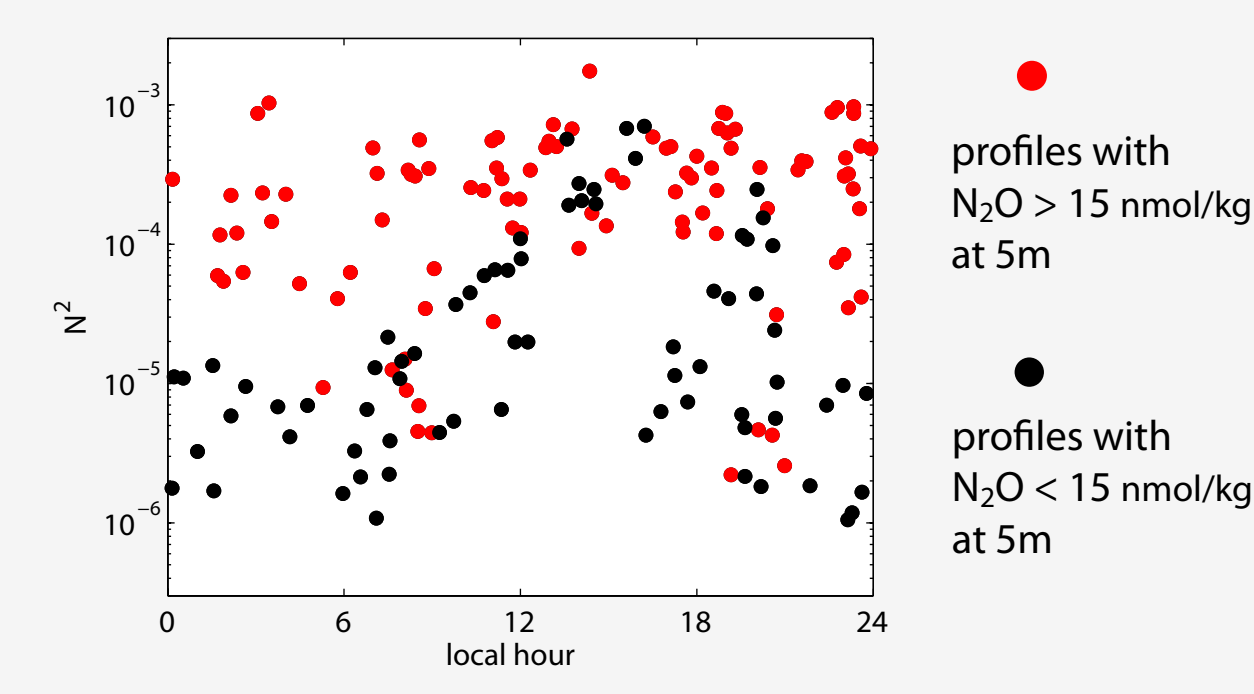
Vertical concentration gradients in top layer exist and vary regionally. Shape of concentration profiles resembles density profiles at night.



Stronger N₂O gradients are associated with higher N₂O concentrations and night time stratification

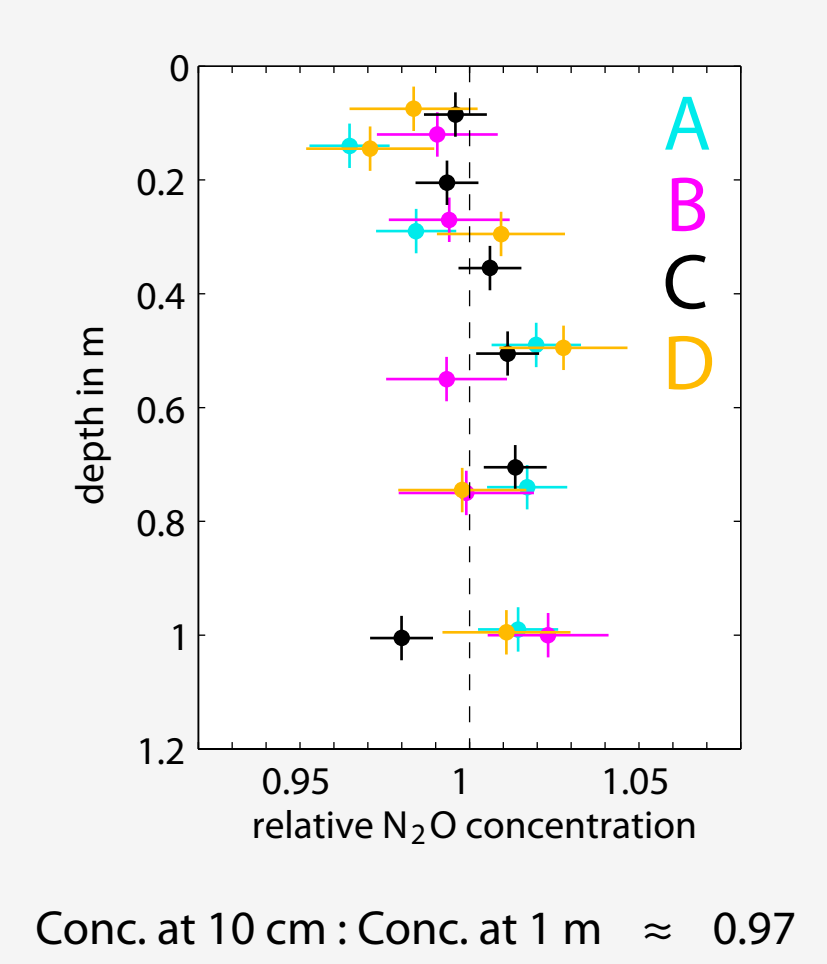


Ratio of N₂O at 5m and N₂O at 10m from 45 CTD casts



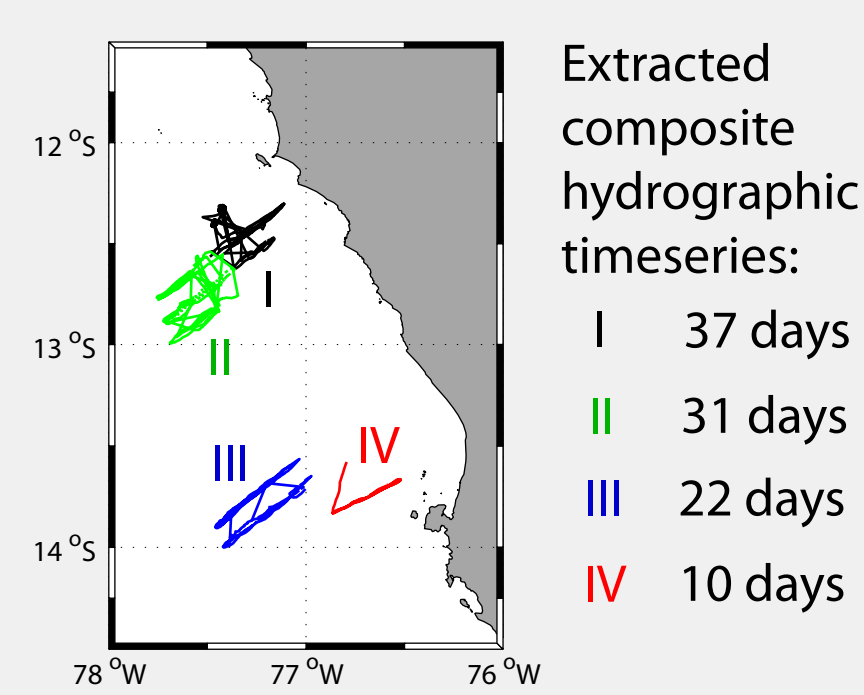
Stratification of top 10m vs. time of day for regions of high and low N₂O concentrations.

Top 1 meter: barely any gradient



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

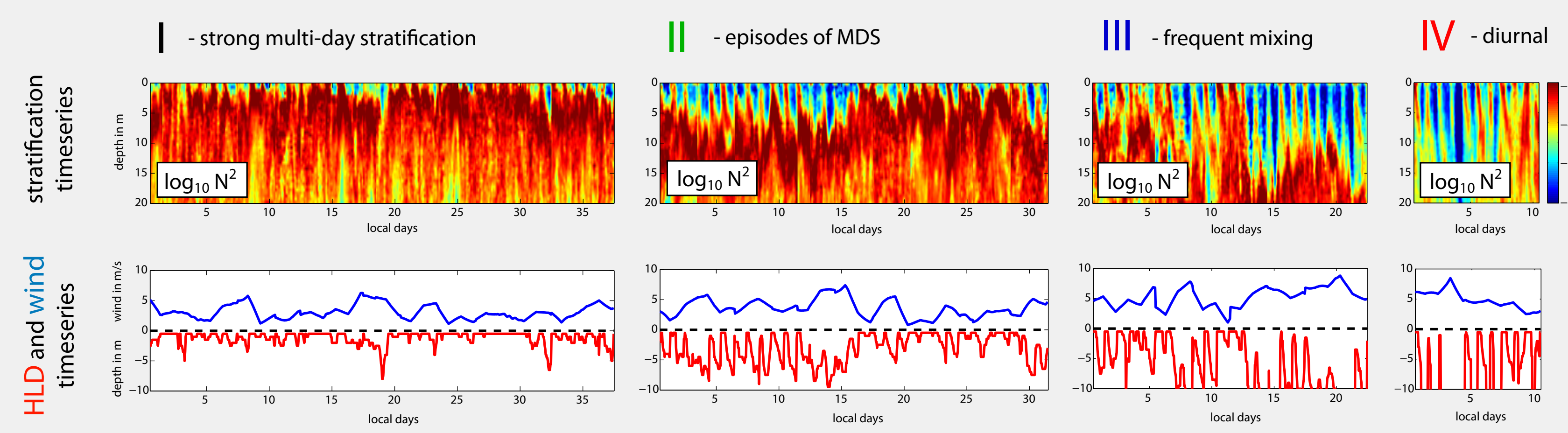
Glider fleet in Jan/Feb 2013



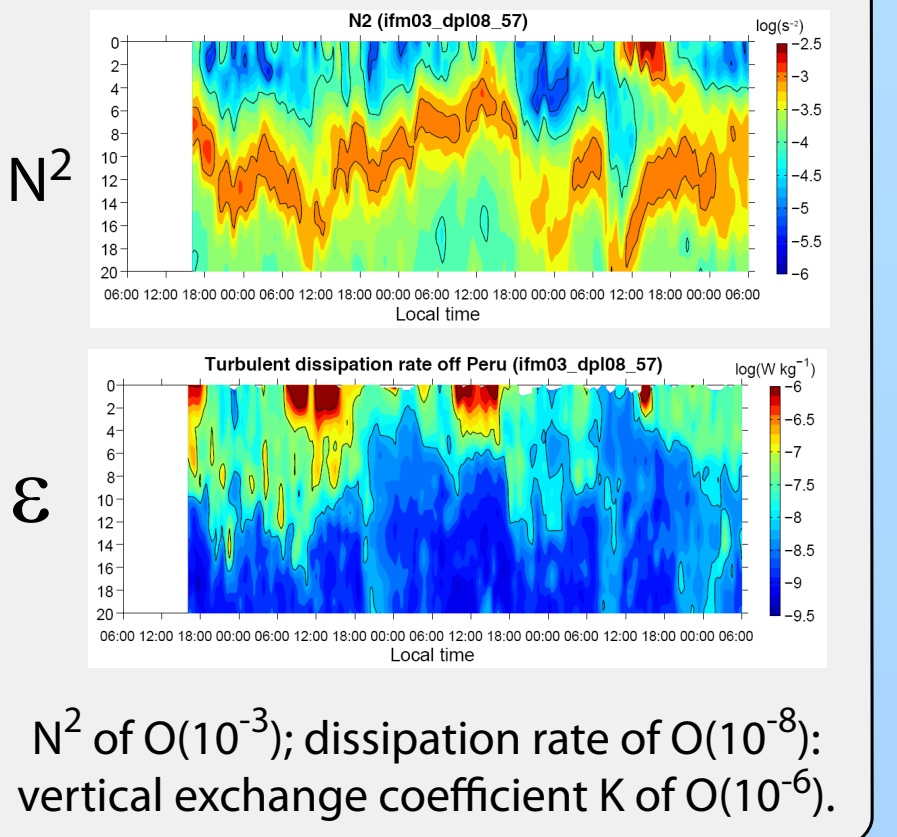
Extracted composite hydrographic timeseries:
I 37 days
II 31 days
III 22 days
IV 10 days

In total 250 glider days were performed by 8 gliders in 4 main regions, recording hydrography.

Regional stratification timeseries with different grades of multi-day stratification



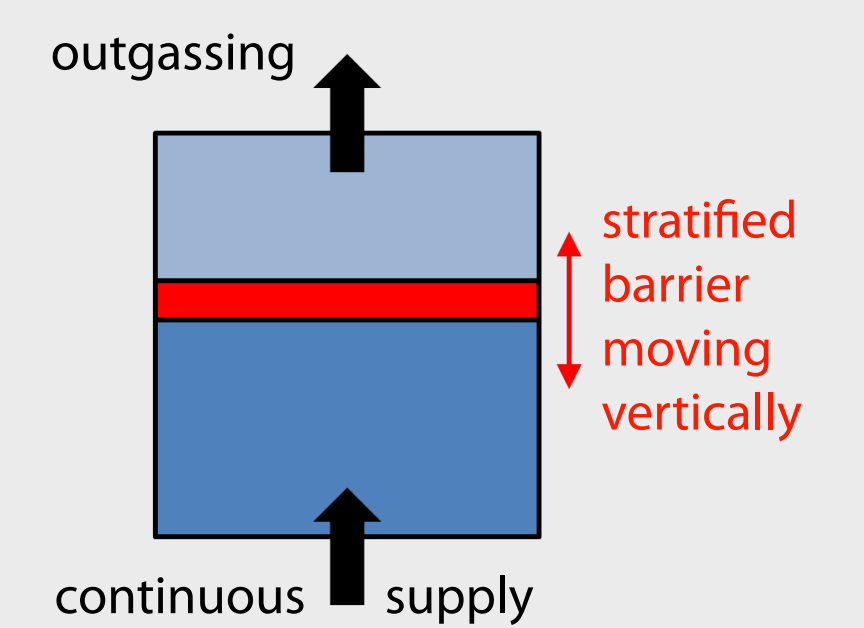
The stratified layer is extremely low in mixing



N₂ of O(10⁻³); dissipation rate of O(10⁻⁸); vertical exchange coefficient K of O(10⁻⁶).

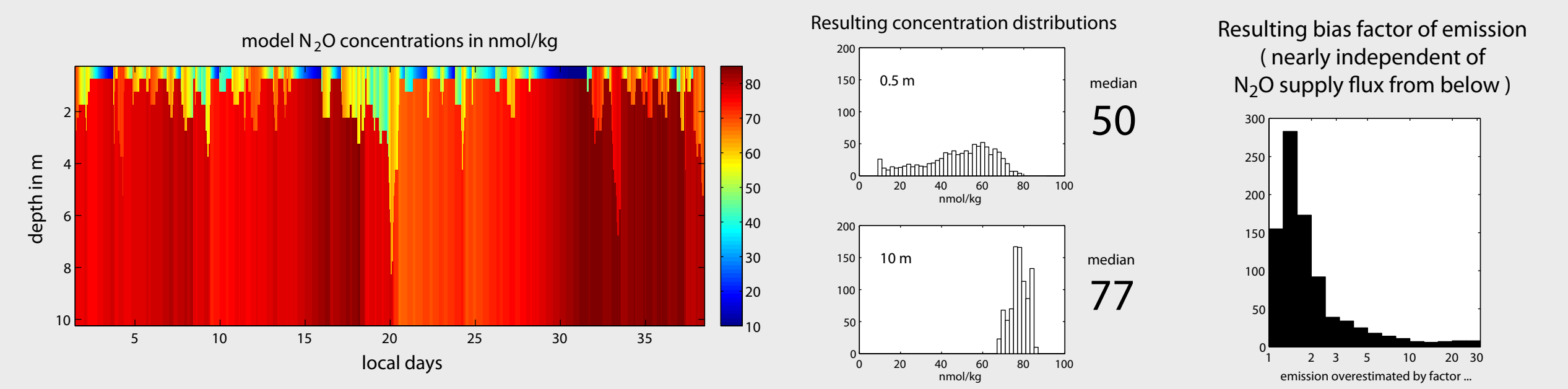
A 1-D model constrained by the glider timeseries can reproduce the N₂O gradients

Simple 1-D two layer model

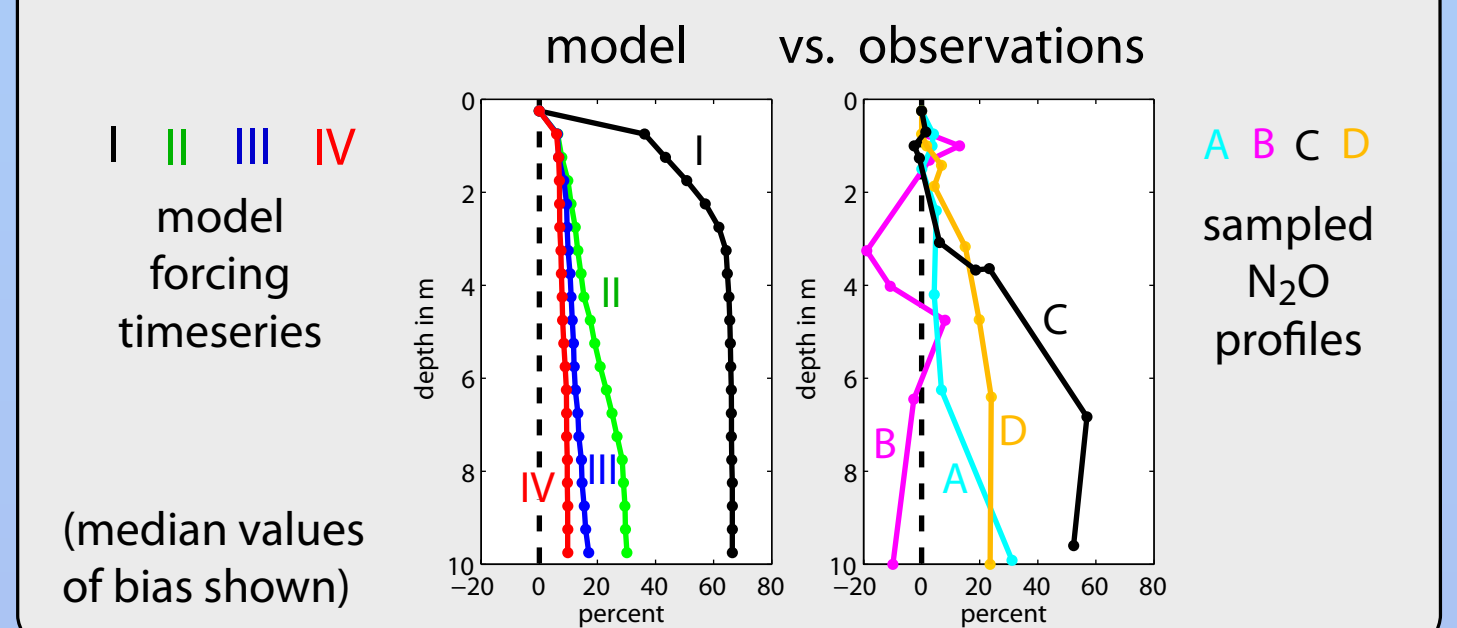


Exchange across the stratified barrier layer is only via entrainment. For the vertical movement of the barrier the observed HLD timeseries are used.

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



Bias of emission estimate if sampling at indicated depth



Conclusion: Not just diurnal but multi-day stratification seems the necessary condition here causing considerable near-surface N₂O gradients and bias of emission estimates.