Multidiurnal warm layer and inhibited gas exchange in the Peruvian upwelling regime


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

Motivation

In the Peruvian upwelling regime, gas exchange is strongly inhibited. Gas transfer rates to the atmosphere are low to explain the measured N₂O emissions. (Kok et al., 2012)

Do we estimate gas emissions from adequate concentrations?

Stronger N₂O gradients are associated with higher N₂O concentrations and the continuing out-gassing cause surface depletion.

Hypothesis:

Mixing is inhibited in a shallow stratified layer that is not eroded over one or more nights. The subsequent isolation of the surface layer ('the multidiurnal warm layer') from deeper layers, and the continuing out-gassing cause surface depletion.

Vertical N₂O gradients exist and are associated with a shallow stratified layer

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.

Existence of multidiurnal shallow stratification is verified by glider surveys

Glider fleet in Jan/Feb 2013

In total 120 glider days were performed by 8 gliders in 4 main regions, recording hydrography.

4 regional stratification timeseries with different grades of multidiurnal stratification

A 1-D model constrained by 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.

Region 1 - multidiurnal stratification causes distinct gradient

Region 3 - diurnal stratification not sufficient for strong gradient

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

Regional stratification timeseries with different grades of multidiurnal stratification

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

References

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