Hochaufgelöste Ozeanmodellierung
U-UNI-HH-OZ 780

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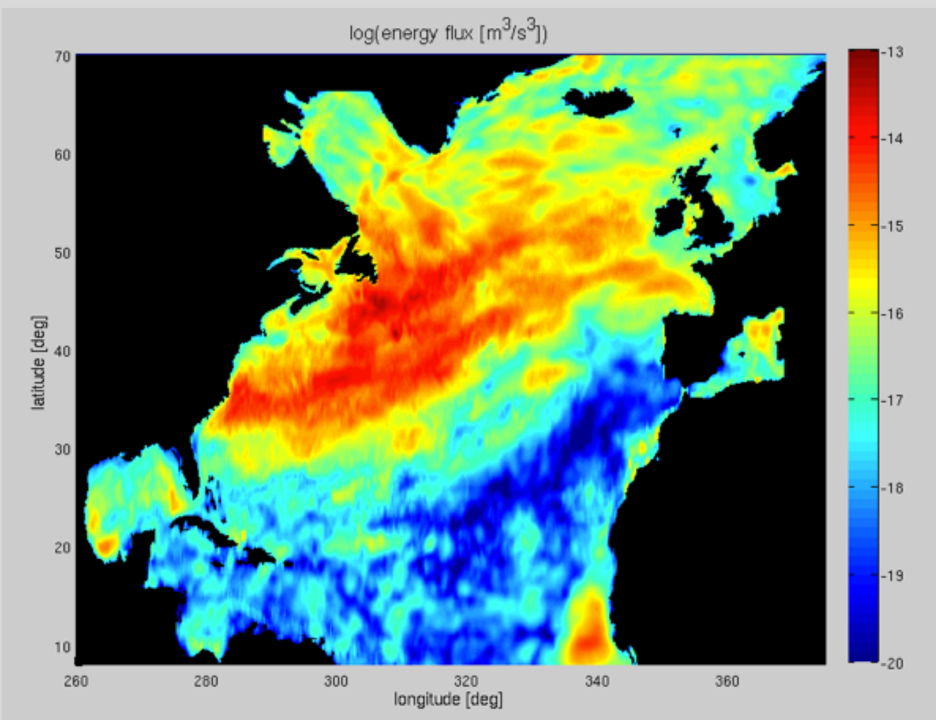
Introduction

In this project we simulate the ocean in all dynamic regimes ranging from the large-scale global ocean to small scale turbulence.
The focus lies on the dynamics of internal gravity waves, sub-mesoscale, mesoscale, and large scale processes and their interaction.

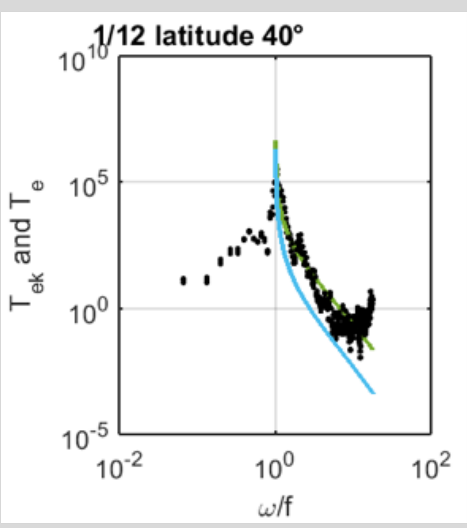
The modelling activity culminates in the continuous development of parameterisations for ocean models which are energetically consistent (Eden et al., 2014).

Wind-driven Radiation of Internal Gravity Waves from the Surface Mixed Layer



Energy flux of near-inertial energy into the ocean in January, 2004.

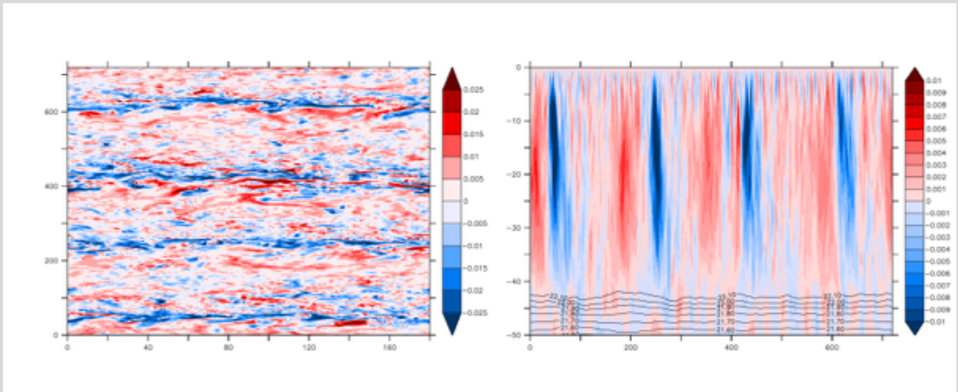
Horizontal kinetic energy spectrum at the base of the mixed layer. Black dots show numerical data from 40°N, 30°W. Blue and green curve show analytical solutions for two different assumptions regarding the prominent wave-numbers as proposed by (Olbers,Eden&Jurgenowski, in prep)



A 1/12° model of the North Atlantic ocean is forced by high-frequent wind.The energy input is integrated in Fourier-space over the near-inertial region 0.7 f < omega < 1.3 f. Clearly visible is the large input in regions with a lot of storm activity.

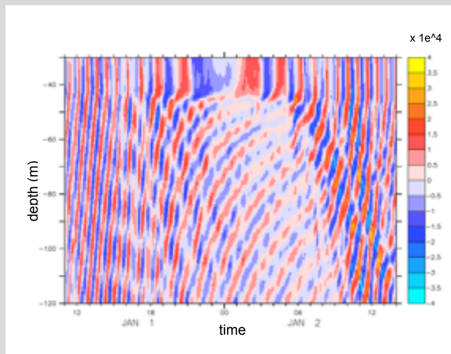
Our numerically produced data are compared to analytical considerations (lower panel). The agreement is promising.

Large Eddy Simulation of the surface mixed layer



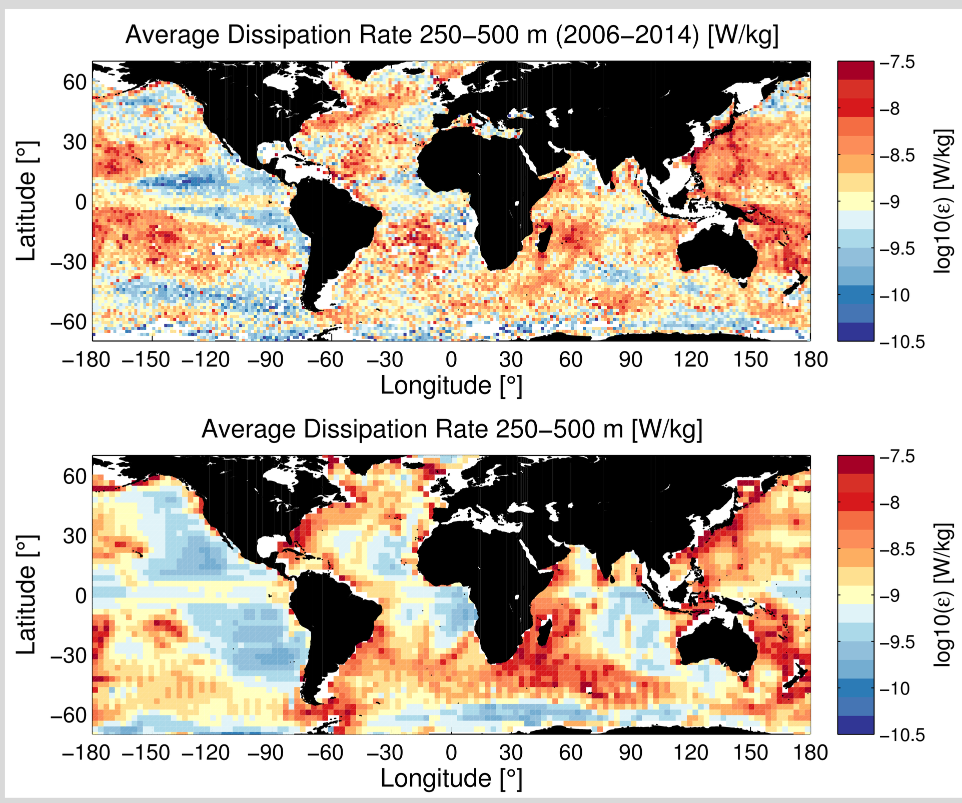
Snapshot of vertical velocity w [m/s] at 15m depth of a LES simulation forced with constant wind and constant surface heat loss (left). Zonal average of w (right). Contours of temperature indicate mixed layer depth.

Zonal averaged pressure anomalies p'/rho [m^2/s^2] at y=400m showing internal wave radiation from the base of the mixed layer depending on the phase of the inertial oscillation. The inertial period here is 12h.



Lumps and bumps at the base of the mixed layer associated with large turbulent eddies (e.g. convection cells, Langmuir) are advected by inertial oscillations and disturb the underlying stratified ocean layer, resulting in the generation of internal gravity waves.

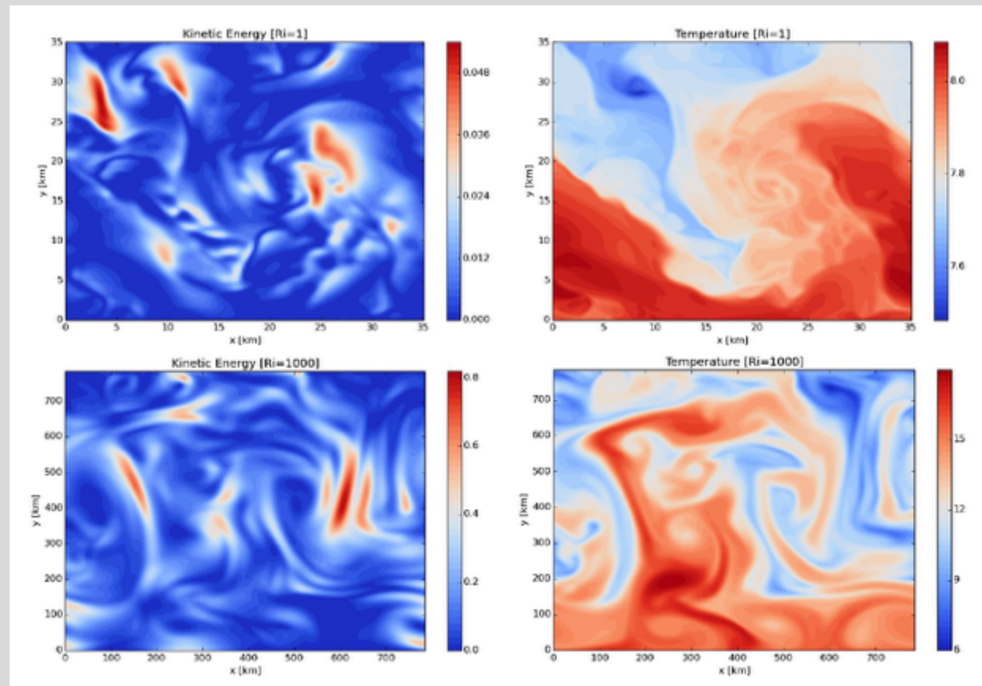
Validating the global internal wave model IDEMIX using finescale parameterizations



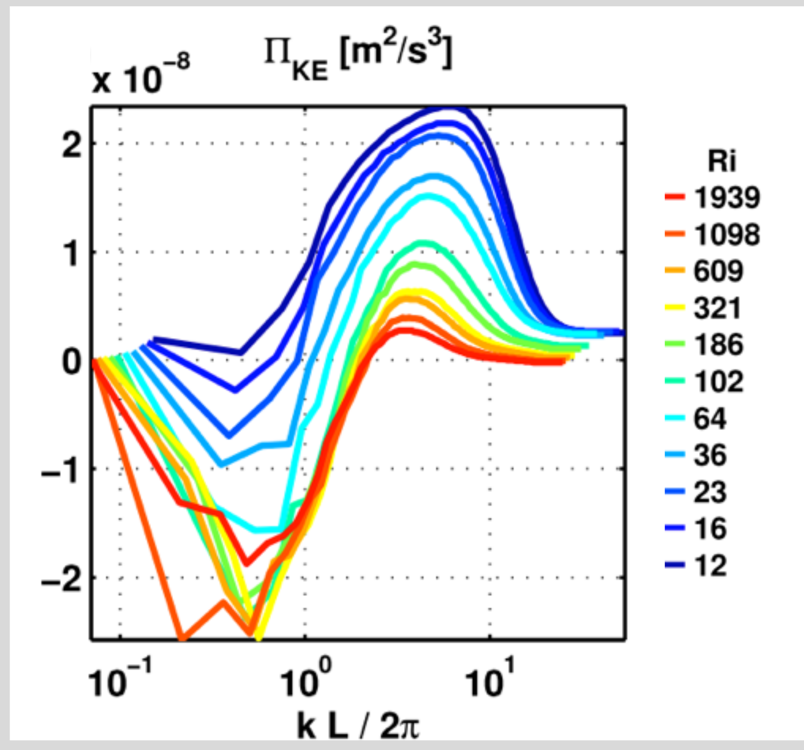
Annual mean dissipation rates from Argo data (top panel) and from a model simulation using IDEMIX.

IDEMIX reproduces the general pattern of observed dissipation rates.
The magnitude of observed dissipation exhibit strong temporal variability and is masked by meso-scale eddy mixing, which makes the comparison challenging.

Role of Gravity Waves in the Dissipation of Mesoscale Eddies



Snapshots of Kinetic Energy and Temperature from an idealized channel model setup, for different regimes with Richardson numbers (Ri) 1 and 1000, which represent ageostrophic (top panel) and quasi-geostrophic (bottom panel) regimes respectively.



Kinetic energy fluxes as function of scaled wavenumber for different Richardson numbers. Positive (negative) values indicate a forward (inverse) energy cascade (Brüggemann&Eden, 2015).

In the presence of ageostrophic dynamics, an energy flux toward smaller scales is observed while energy is transferred toward larger scales for quasi-gestrophic dynamics.
Decomposing the velocity field into its rotational and divergent components shows that only the divergent part, which becomes stronger for ageostrophic flows, features a downscale flux.

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