PRIMAVERA WP 3

WP3 aims: Quantify the need for improved representation of levels of complexity of a range of physical processes within the atmosphere, land, sea ice and ocean in a high resolution environment.

To provide improved parameterisations/ processes into the Stream 2 runs

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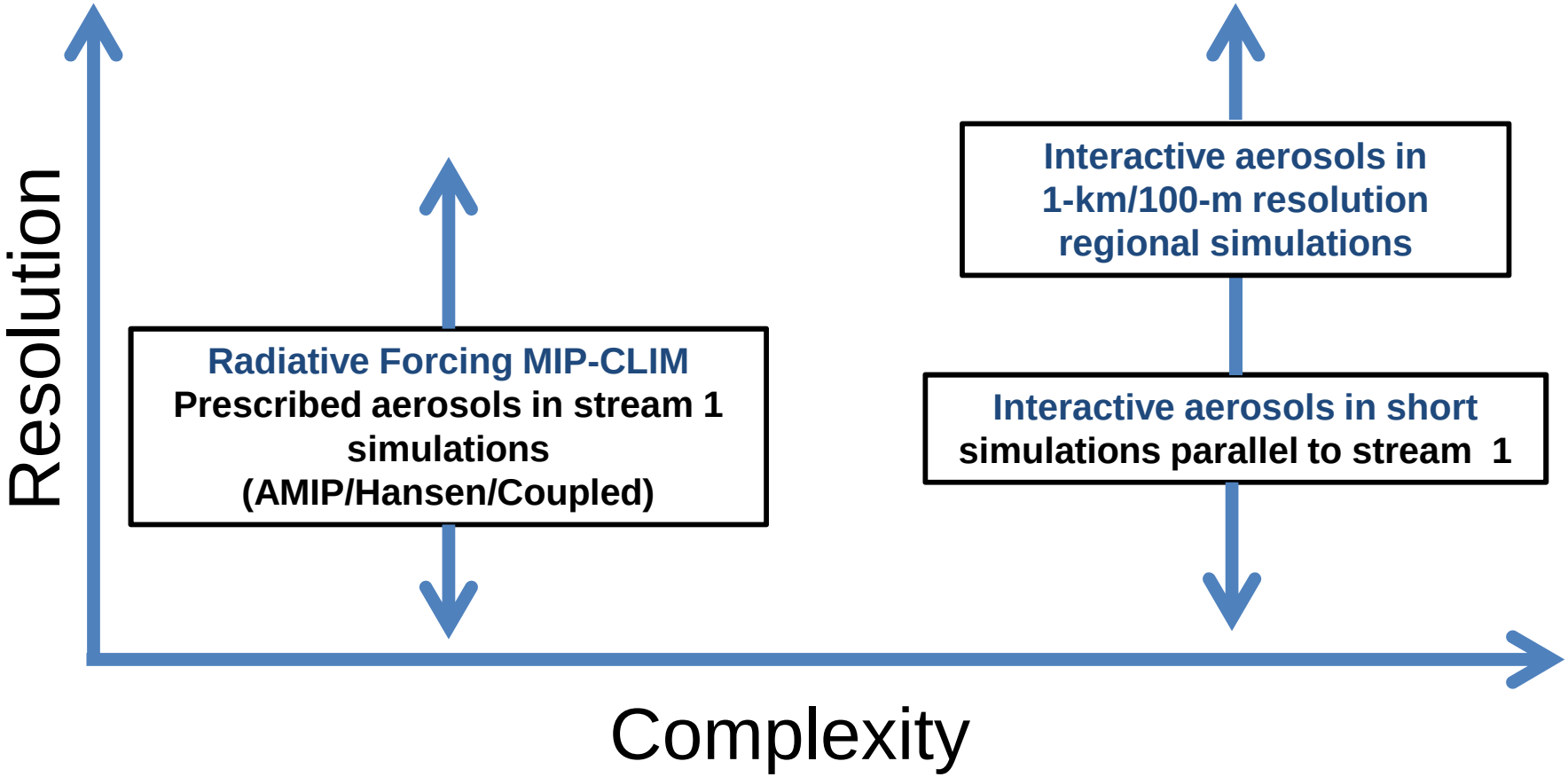
WP3a: Clouds and Aerosols

Overall aim is to explore the resolution/complexity space of aerosol-radiation-cloud interactions to:

- Quantify the added value of complexity in a high resolution context
- Test the robustness across resolutions and complexities
- Quantify the impact on European climate metrics



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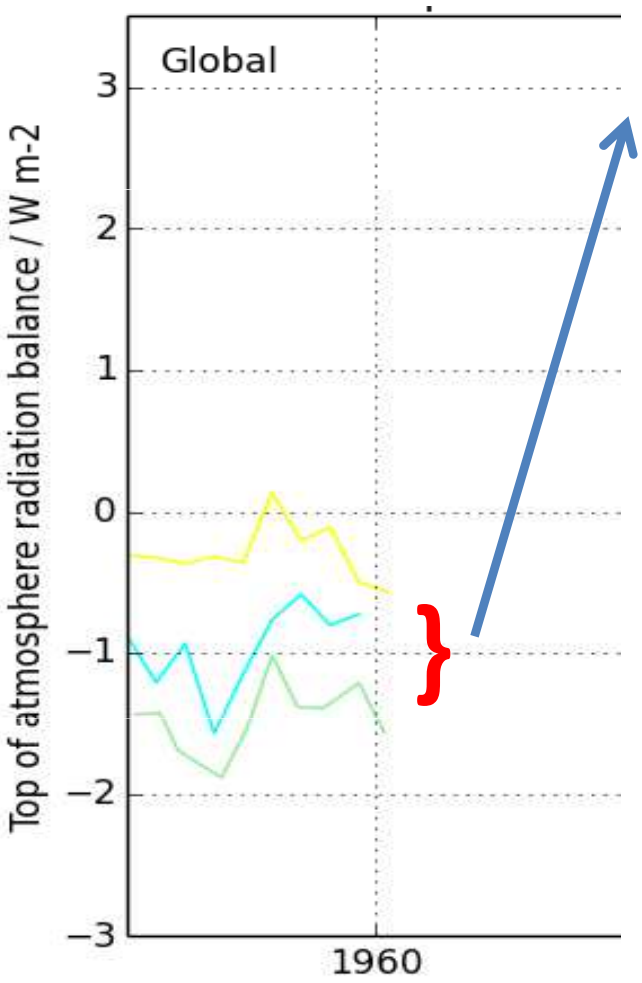
WP3a: Clouds and Aerosols

Overall Status so far (as Stream 1 delayed, and PDRA recruitment 2017):

Task 1: New cloud microphysics scheme (tested at 4km resolution on aquaplanet, see separate talk by Dan McCoy).

Task 2: With Malcolm Roberts (WP6), used “EasyAerosol/RFMIP-CLIM” developments in HadGEM as opportunity to **compare prescribed vs. interactive aerosols** in AMIP simulations. Will try and do the same with NorESM and EC-Earth.



Q: Can we match TOA radiative balance between interactive (cyan) and prescribed (green) aerosols?

A: Yes, within 0.5 W m^{-2}, if direct, 1st indirect, and 2nd indirect effects of aerosol-cloud interactions are included in the prescription.

Differences largest in South Hemis.: high frequency interactions of marine aerosols with clouds?

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WP3b: The Land Surface and Terrestrial Hydrology

Overall status: not started in earnest yet pending recruitment in mid-2017. But aims are:

1. Investigate key physical processes in the land surface (LS) – Planetary Boundary Layer (PBL) system

    - Terrestrial surface albedo and dependence on HR landscape definition
    - Plant response to incoming radiation: depends on aerosols and clouds (WP3a)
    - Runoff generation and treatment of orography + river networks
    - Turbulent transfer, particularly in the surface layer, and resolution-dependence of parametrisation

1. Sensitivity tests on the definition of the land surface

    - Vegetation cover and its height dependence
    - Orography, its definition at HR and impact on the definition of the landscape → turbulent vs. mesoscale fluxes, transports, etc.

1. Develop methods and data sets suitable for the computation of key metrics in WP1.

    - Collect catchment scale precipitation into HR river network and use to validate model performance at local to regional scale (link with WP1)
    - Compute land-atmosphere coupling strength at various resolutions (for WP1)

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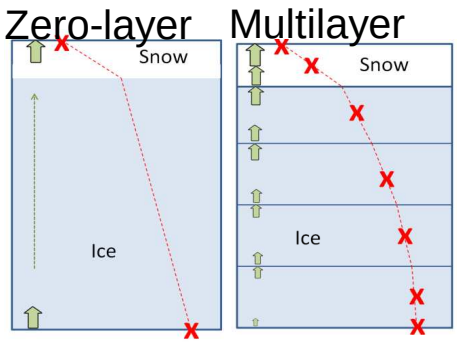
WP3c: Sea-Ice Development

Overall Status: Simulations not yet started but work advancing well; developing improvements for both CICE and LIM sea-ice models.

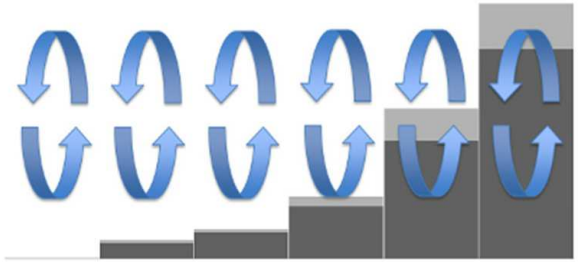
- CICE (v5.1.2) sea ice model with:
  - Prognostic melt ponds (radiative effects)
  - 4 ice layers plus 1 snow layer (BL99 thermodynamics)
  - Thickness-dependent ice-atm coupling (surface exchange for each category)
  - Salinity-dependent ocean freezing temperature
  - CICE 4-band albedo scheme

Prognostic melt ponds

Multi-layer sea ice thermodynamics



Independent coupling for each thickness category



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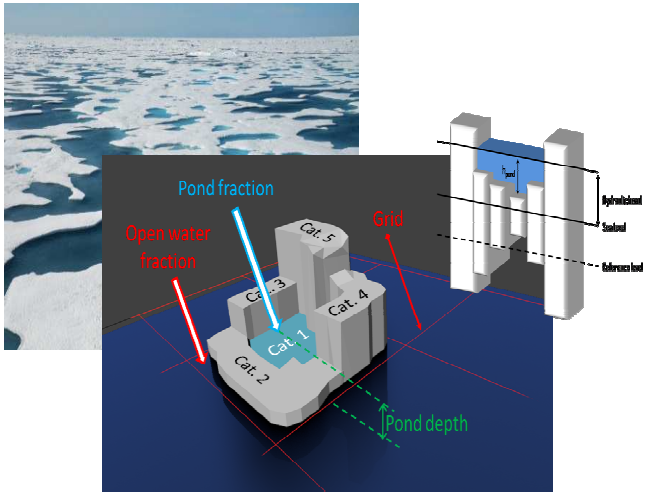
WP3c: New snow and melt pond physics in NEMO-LIM3.6 (prescribed atmosphere) and EC-Earth (WP3, T3C, UCL)

Starting point:

Multilayer snow scheme and melt pond module in a former version of NEMO-LIM (prescribed atmosphere)

Implementation

Implementation in NEMO-LIM3.6 (including energy, mass and salt conservation issues)



Model evaluation tests (ocean only)

Implementation in EC-Earth and WP3 simulations/ analysis

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WP3c: Integration of a Maxwell-elasto-brittle rheology in NEMO-LIM3.6 and EC-Earth (WP3, T3C, UCL)

Starting point:

Development of a new paradigm for sea ice rheology.

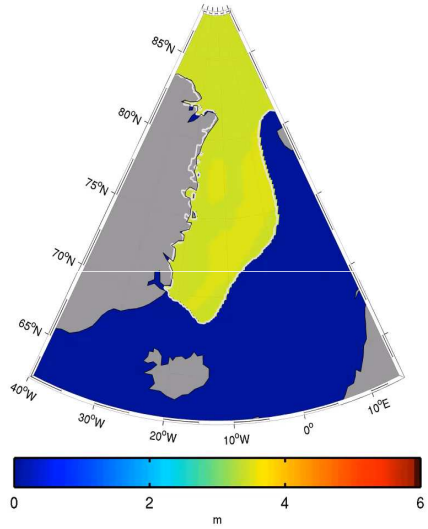
Implementation

Implementation of the rheology in a stand-alone version of LIM3.

Evaluation

Test of model performance and calibration.

Implementation in NEMO-LIM3.6



Simulated ice thickness in the Fram Strait in January 2000.

Implementation in EC-Earth and WP3 simulations/ analysis

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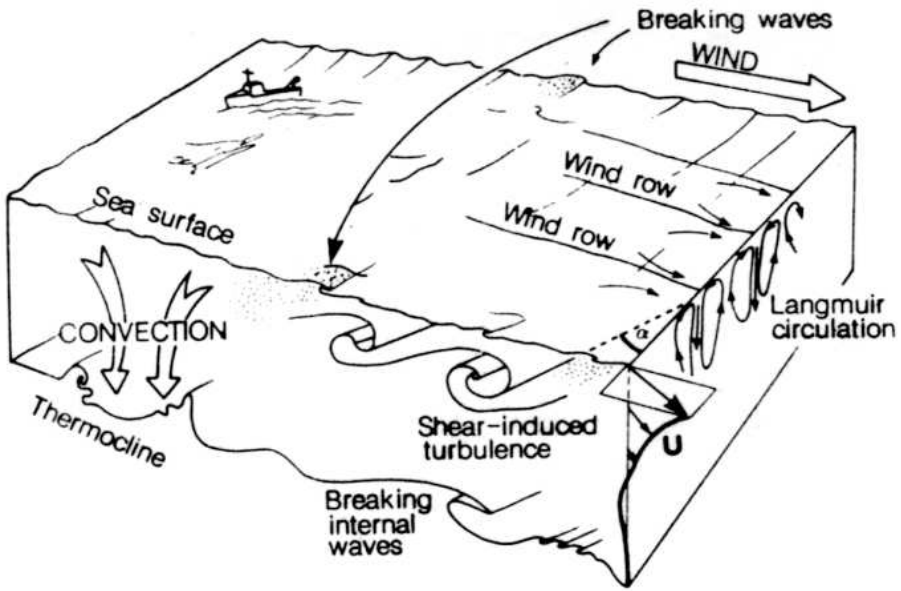
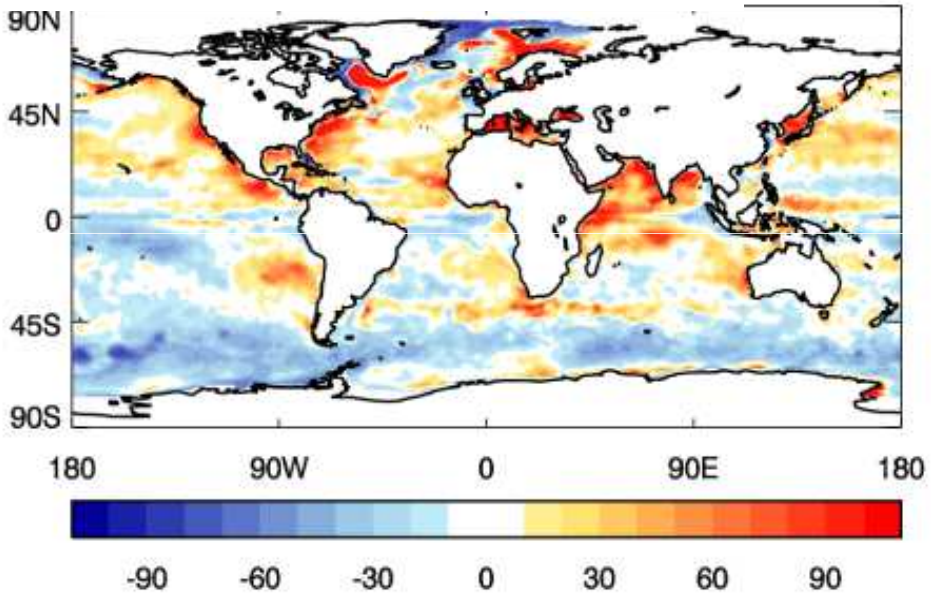
WP3d: Ocean Mixing



HADGEM3 DJF ML depth error %



Additional mixing processes in upper ocean expected to give improved mixed layer depth and reduced sea-surface temperature errors.

Two components:

- IDEMIX scheme: energetically consistent, inertial and internal wave breaking: now starting in MPIOM following post doc joining: Oliver Gutjahr
- OSMOSIS scheme including Langmuir mixing from wind-wave breaking. Now implemented into NEMO and initial test done in 1D mode.

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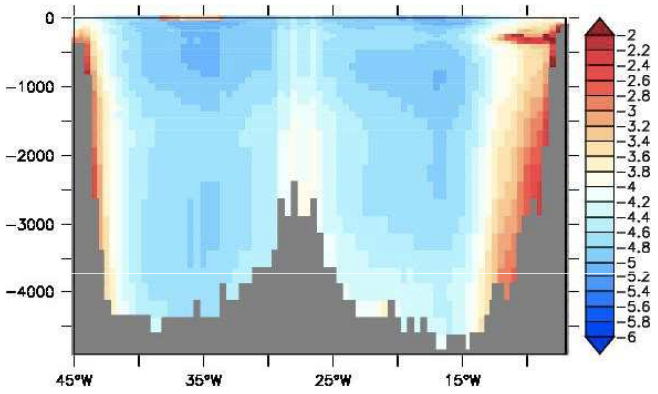
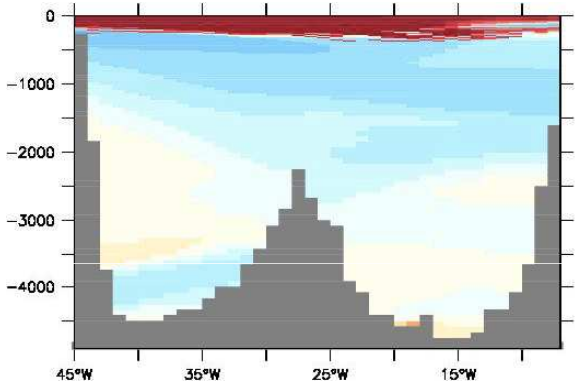
WP3d: IDEMIX

Log10 Diffusivity [m^2s^{-1}]

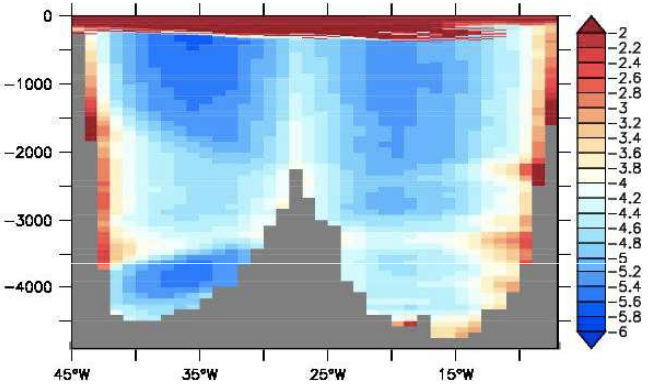
C. Eden pers. comm



from obs. N^2 (WOCE @ 48N)



from Gaspar (TKE) scheme



Gaspar + IDEMIX

- IDEMIX currently implemented in MIT-GCM and PyOM
- IDEMIX links to TKE (Gaspar et al., 1990)
- New PostDoc (Oliver Gutjahr) is now implementing TKE scheme in MPIOM

Next steps:

- Connect MPIOM to IDEMIX, test in stand-alone ocean and coupled set-ups
- Develop interface to couple IDEMIX to different ocean models (eg NEMO which uses TKE)
- Implement diagnostics for energy budgets (available in PyOM)
- Close cooperation with IDEMIX developers in the US

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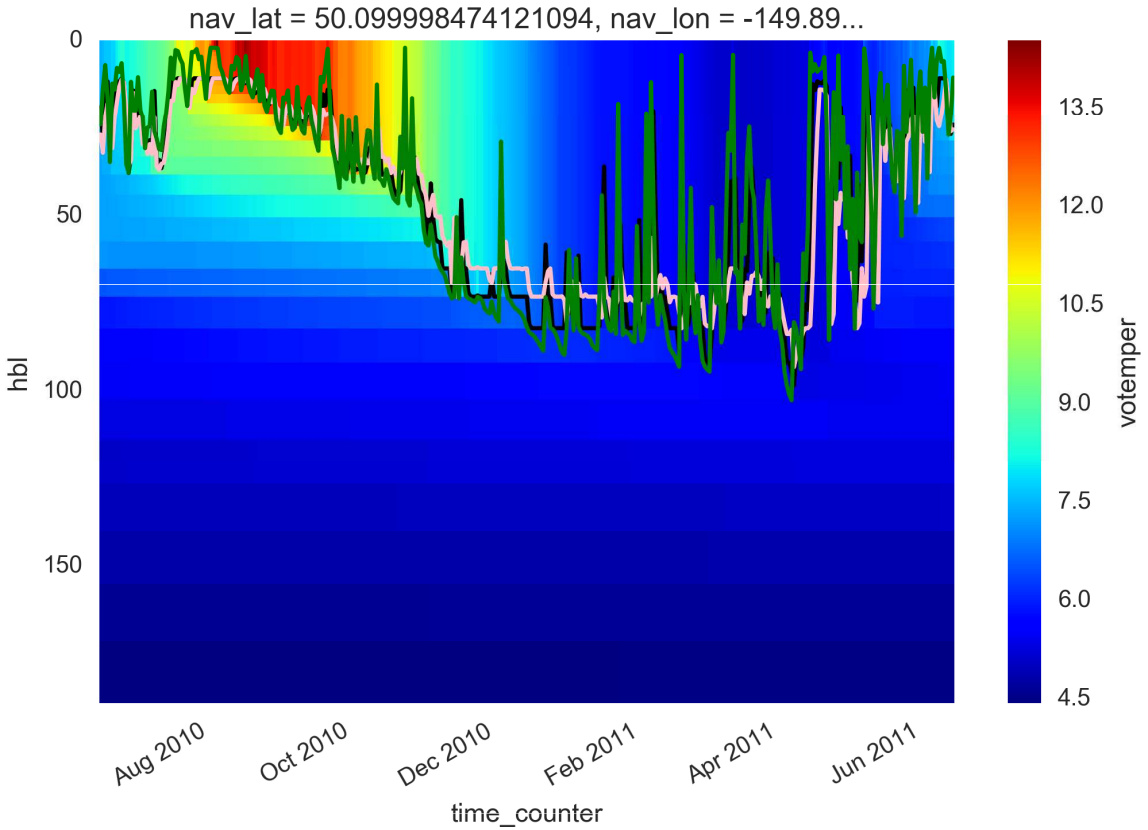
WP3d: OSMOSIS scheme now implemented in NEMO



Initial test in 1 D mode, for comparison with Ocean Weather Station Papa
Green line: OSMOSIS boundary layer depth (prognostic)
Pink: NEMO mixed layer depth from density difference criterion
Black: diagnosed from NEMO from diffusivity criterion (turbocline)
Compares well with observations and GLS mixed layer depth.

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Questions / Comments?

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