Community Ocean Vertical Mixing (CVMix) Project: Introduction and Status Report

Stephen Griffies + NCAR, LANL, and GFDL players

Presentation to the
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Outline

1. Guiding Principles

2. Project Status

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1 Guiding Principles

2 Project Status

Mission

What is our mission?

- Provide transparent, robust, flexible, well documented, shared Fortran code for use in parameterizing ocean vertical mixing processes.
- A consensus of first-order closures that return a vertical diffusivity, viscosity, and possibly a non-local transport.
- Fortran modules used in a stand-alone manner or incorporated into ocean models.
- Development within a community of scientists and engineers who make use of CVMix modules for a variety of research needs.
- CVMix modules will be freely distributed under GPLv2 using an open source methodology.

Motivation

Why we are considering this project?

- Scientists at GFDL, LANL, and NCAR are overwhelmed with the needs of developing global model configurations using state-of-the-science physical parameterizations.
    - We wish to share the load for physical parameterization coding/testing.
- Shared parameterizations in various model configurations will facilitate understanding model differences.
    - Facilitate moving beyond the "show-and-tell" phase of CMIP and CORE.
    - Understanding model differences at the process level is key to improving climate models.

Vision

What is our vision?

- Scientists will share code used to parameterize ocean vertical mixing, providing added scrutiny to the code integrity and allowing for easier comparison of various parameterizations.
- Process modelers will incorporate new parameterizations into CVMix to optimize distribution of their ideas to the wider research community.
- Research will be stimulated by availability of schemes for testing in a suite of process and large-scale models.
- As CVMix matures, it will be followed by community code for lateral parameterizations, such as mesoscale and submesoscale eddy schemes.

Why not GOTM?

Why not tie into the GOTM[1] project?

- Scientific Focus
  * CVMix focuses on first-order closures used in the climate community.
    GOTM focuses on higher order closures used in the coastal community.
- Control
  * We wish to control the aims and methods used for CVMix code.
- Trust and Understanding
  * Understanding and trust of code comes best through doing the work oneself.
- Sharing experience and code may come
  * As CVMix matures, there will be opportunities to share experience and code
    with GOTM or other similar projects.

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[1] GOTM (General Ocean Turbulence Model) includes a suite of first and higher order closures for vertical mixing. It has been embraced by the coastal ocean modeling community.

Outline

1 Guiding Principles

The players and their roles

- Core team:
    - Mike Levy (NCAR): software
    - Stephen Griffies (GFDL): physics/numerics design and documentation
    - Gokhan Danabasoglu (NCAR) and Todd Ringler (LANL): chief scrutinizers.
- Commitment from GFDL, LANL, and NCAR
    - To incorporate CVMix code to their new model configurations (MOM6, MPAS-ocean, and POP).
    - We anticipate all interested modelers at GFDL, LANL, and NCAR will have direct input to CVMix software, numerics, and physics.
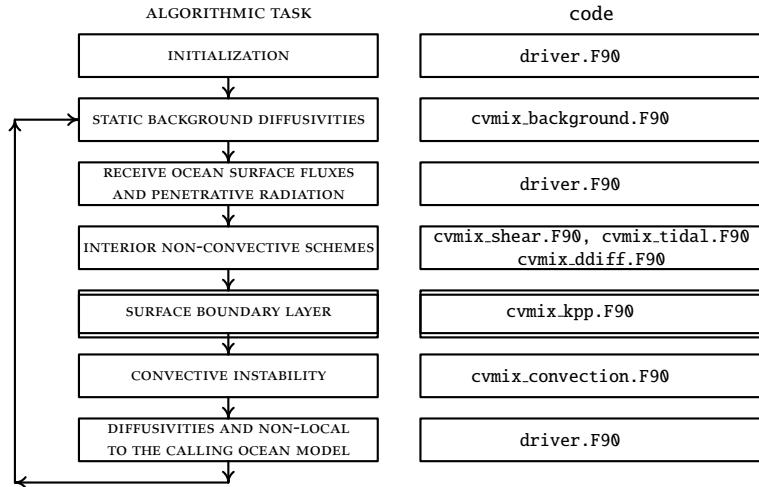
Phase I CVMix parameterizations

- Static background mixing:
  - Bryan-Lewis (1979)
  - Henyey et al. (1986)
  - Schemes used in Jochum (2009)
- Shear induced mixing:
  - Pacanowski and Philander (1981)
  - Large et al (1994)
  - Jackson et al (2008)
- Tidally induced mixing:
  - internal tides: Simmons et al (2004) and Melet et al (2013)
  - bottom mixing: Legg et al (2006)
- Double diffusive processes:
  - as in Large et al (1994) and updates
- KPP surface boundary layer:
  - as in Large et al (1994) and updates
- Vertical convective mixing:
  - enhanced diffusivity with $N^2 < 0$

Flow diagram

Flow diagram for CVMix Parameterization modules

ALGORITHMIC TASK	code
INITIALIZATION	driver.F90
STATIC BACKGROUND DIFFUSIVITIES	cvmix_background.F90
RECEIVE OCEAN SURFACE FLUXES AND PENETRATIVE RADIATION	driver.F90
INTERIOR NON-CONVECTIVE SCHEMES	cvmix_shear.F90, cvmix_tidal.F90 cvmix_ddiff.F90
SURFACE BOUNDARY LAYER	cvmix_kpp.F90
CONVECTIVE INSTABILITY	cvmix_convection.F90
DIFFUSIVITIES AND NON-LOCAL TO THE CALLING OCEAN MODEL	driver.F90

What is provided for each scheme

CVMix is based on inter-linked code, tests, and documentation.

- Each CVMix scheme is coded as part of a Fortran module.
- Each scheme has an associated stand-alone driver with inputs and outputs allowing for testing in various 1d, 2d, and/or 3d contexts.
- Documentation of both the software (online) and the physics/numerics (CVMix manual), helping users to test their implementation and understand what the code aims to do.

Requests from this group

- Sanction/support from the CESM OMWG and Ocean Mixing CPT
- Participation
  - code contributions
  - comments/critiques
  - recommendations for new schemes
  - use the schemes for process and global modeling research
- Specifically from the CESM OMWG:
  - We need highest priority of resource(s) (i.e., Mike Levy) focused on CVMix during the next 3 months to realize Phase I aspirations.

Thanks, and please stay tuned

We are early in the project, but hope for rapid progress during 2013.

Please stay tuned.