Toward a new ice-shelf melt rate parameterization with large-eddy simulations

Carolyn Branecky Begeman[1], Xylar Asay-Davis[1], Luke Van Roekel[1]

[1]Los Alamos National Laboratory

EGU2020-10848, 7 May 2020, 16:15–18:00

Contact Carolyn:
cbegeman@lanl.gov

Funding: U.S. DEPARTMENT OF ENERGY | Office of Science | ProSPect a SciDAC project | a fellowship from the Center for Earth and Space Science | Los Alamos NATIONAL LABORATORY EST. 1943

The problem

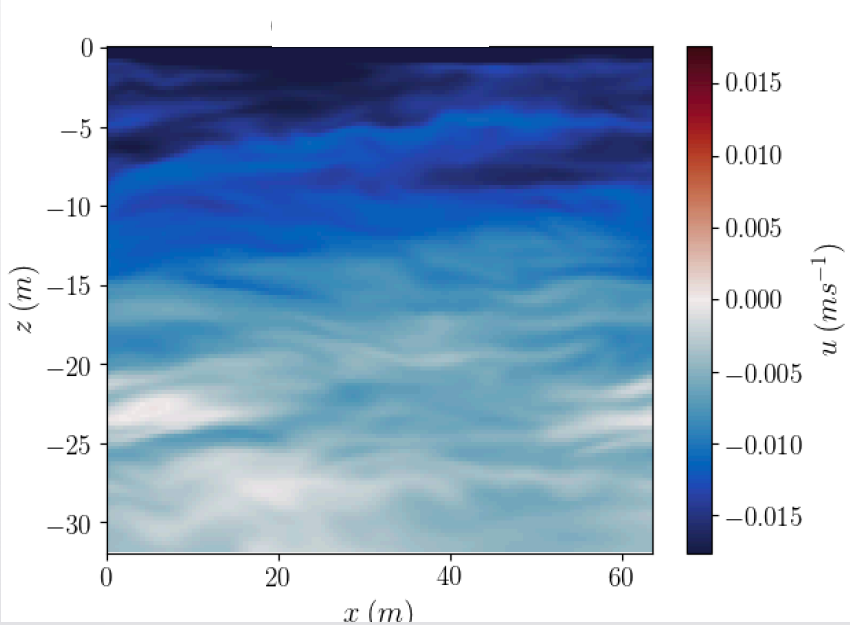
- Ice-shelf ocean boundary layers show a wide range of behavior depending on the buoyancy forcing and background pressure gradients
- In situ oceanographic observations haven't yet provided enough information to understand these boundary layer dynamics

Our approach

- We investigate ice-shelf ocean boundary layer dynamics under a range of conditions with **Large-Eddy Simulations** (LES)
- The key feature of LES is having fine enough resolution to capture most of the TKE and having a turbulence closure scheme to represent the sub-grid fluxes of momentum and scalars.

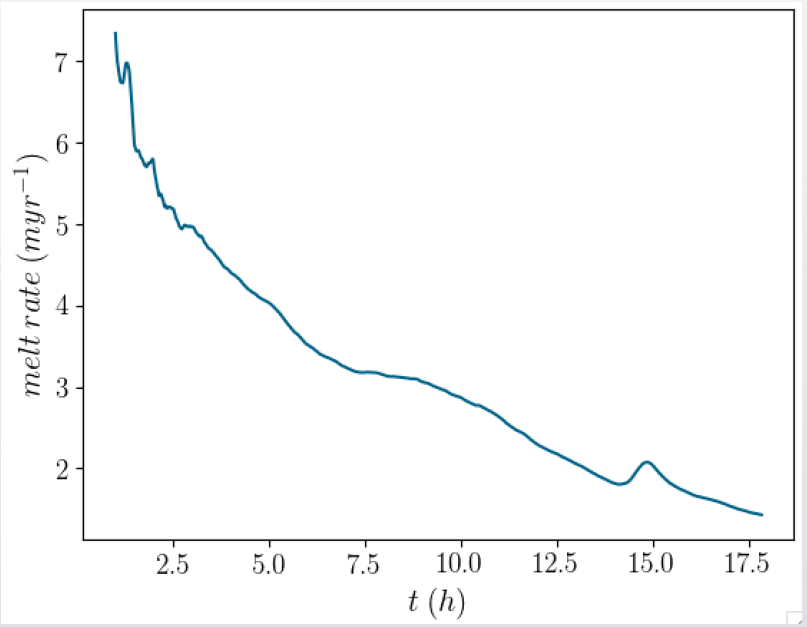
What advantages does LES offer?

LES can capture features associated with stratified turbulence



Simulation output with stabilizing stratification and ice-shelf melting and horizontal flow is primarily driven by background pressure gradients.

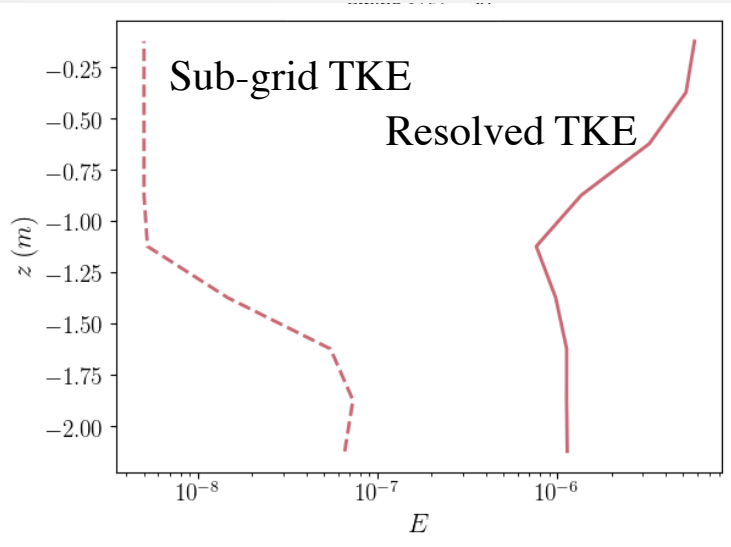
Melt rate field evolves with the turbulent dynamics



Melt rate timeseries from a simulation in which stratification increases through time resulting in steadily decreasing melt rates.

Some challenges with LES for ice-shelf ocean BL dynamics

BL dynamics can be sensitive to the sub-grid scheme



For example, the sub-grid scheme Dynamic Smagorinsky depletes TKE close to the ice base due to the combination of the boundary and strong stratification.

The choice of sub-grid scheme is not obvious

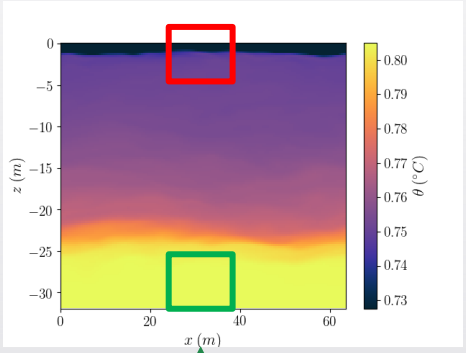
- We implement the Anisotropic Minimum Dissipation model following Vreugdenhil et al. (2019), but it hasn't been fully validated for stratified dynamics

Two approaches to parameterization development

We plan to use both approaches to allow for multiple model implementation options

A regression problem for bulk behavior

Output: melt rate



Inputs: far-field conditions (T, S, **u**, slope, …)

New shape functions that describe BL dynamics

Goal: to reproduce mean BL properties in coarse resolution ocean model by representing heat, salt, and momentum fluxes