Thesis Plan

February 3, 2015

1 Introduction

1.1 Arctic Ocean

Why the Arctic is important for climate and ocean circulation.

1.1.1 Thesis Outline

Outline of hypotheses.

1.2 Arctic Ocean

Basically the Arctic part of my CofS Description of the constituents of the Arctic and its Dynamics. Topography, vertical stratification, water masses, circulation.

1.3 Numerical Models of Arctic

AOMIP and attempts to have predictive models of the Ocean. Prominent problems and successes.

1.4 Mean-Eddy Interaction Theory

Overview of Residual Theory from GM in 1990 and the stuff in the late 80's through to M and M 2013.

1.4.1 GM

1.4.2 PV Closure

I.e. Greatbach

1.4.3 TWA Equations

I.e. Young 2012

1.4.4 Eliason-Palm Tensor

I.e. M and M 2013

2 Shallow Water Equations

My own development of the layered shallow water equations

2.1 Shallow Water Theory

Rational for using shallow water equations and description. I.e. Arctic water masses, strong stratification.

Note the use of Rigid Lid approximation in simulations.

2.2 Model Discretisation

C-grid, AB time stepping, Preconditioned CG solver.

2.3 Forcing and Dissipation

The form of wind stress and bottom friction in shallow water models (e.g. τ/h and $-r\,|\boldsymbol{u}|^2\,\boldsymbol{u}/h$). Viscosity: laplacian, biharmonic as well as Smagorinsky. Linear, quadratic and n-polynomial bottom friction.

2.4 Eddy Stresses

Thickness weighted mean of the shallow water equation. Form of the momentum and pv eddy stresses. Thickness weighted PV vs PV derived from thickness weighted equations.

Time averaged diagnostics. Explain that this requires steady state dynamics. Need configurations with a unique mean steady state.

3 Model Descriptions and Mean balances

A description of the different dynamics that evolve in the models by using the forcings and dissipations described above. Different forcings such as different wind stresses or regional heating and cooling. Different dissipation from linear bottom friction to higher order bottom friction.

Break down of the tendency terms for the mean dynamics. A look at how the eddy stresses are in balancing the mean states (usually through balancing the ageostropic component of the momentum tendency).

3.1 Zero-Mean Wind Forced Models

Model where the mean forcing is effectively zero. Hence the model is forced by a wind stress which is absent from the mean system and hence forces the system by invoking a turbulent cascade. Hence Eddy-Mean interaction is entirely from the eddy to the mean.

3.2 PV Mixing and Unmixing

A look at models with some from strong pv gradient.

3.3 Strong Flow Models

A look at models with a strong mean state and hence a two way mean eddy interaction. E.g. Jets in channels or double gyres. Examination of the difficulty of defining a mean state.

4 Comparison of Mean PVs

An examination of the similarities and differences of the 2 PVs. A discussion of whether the thickness weighted and tracer decomposition forms of the PV eddy stresses can be used interchangeably.

5 Bounding of E-P Tensor

A look at how the E-P Tensor is characterised by the topography, eddy energy and enstrophy.

6 Diagnostic Summary and Eddy-Mean Interaction Predictions

Niave attempt to parameterise eddies using the results from the previous chapters, depending on what can be said about how the eddy stress can be characterised and constrained by the topography, eddy energy, eddy enstrophy etc.

Likely will need to carry the time and spatial evolution of eddy energy and eddy enstrophy and have some sort of step function to turn on and off the "GM like" and "holloway like" parts of the parametrisation at appropriate moments.

7 Conclusions