Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Optimal Transient Growth of Submesoscale Baroclinic Instabilities BRIAN WHITE, VARVARA ZEMSKOVA, PIERRE-YVES PASSAGGIA, UNC Chapel Hill — Submesoscale instabilities are analyzed using a transient growth approach to determine the optimal perturbation for a rotating Boussinesq fluid subject to baroclinic instabilities. We consider a base flow with uniform shear and stratification and consider the non-normal evolution over finite-time horizons of linear perturbations in an ageostrophic, non-hydrostatic regime. Stone (1966, 1971) showed that the stability of the base flow to normal modes depends on the Rossby and Richardson numbers, with instabilities ranging from geostrophic ($Ro \to 0$) and ageostrophic (finite Ro) baroclinic modes to symmetric ($Ri < 1$, $Ro > 1$) and Kelvin-Helmholtz ($Ri < 1/4$) modes. Non-normal transient growth, initiated by localized optimal wave packets, represents a faster mechanism for the growth of perturbations and may provide an energetic link between large-scale flows in geostrophic balance and dissipation scales via submesoscale instabilities. Here we consider two- and three-dimensional optimal perturbations by means of direct-adjoint iterations of the linearized Boussinesq Navier-Stokes equations to determine the form of the optimal perturbation, the optimal energy gain, and the characteristics of the most unstable perturbation.

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Date submitted: 02 Aug 2016 Electronic form version 1.4