**Progress Report Title:** Geostrophic Turbulence and Active Tracer Transport in 2 Dimensions  
**Workshop March 13-15, 2013**

**Principal Investigator:** Isaac Held (GFDL)

**Other Participating Researchers:** Peter Constantin (Princeton), Bill Young (Scripps Institution of Oceanography)

**Task 1:** Administration & Outreach

**NOAA Sponsor:** Brian Gross (GFDL)

**Education/Outreach**

**NOAA Goals:**

**Climate Goal:** Understand Climate Variability and Change to Enhance Society’s Ability to Plan and Respond

**Objectives:** The goal of this interdisciplinary workshop was to familiarize mathematicians and atmosphere/ocean scientists with ongoing research outside of their fields, and possibly fertilize new work within both groups.

**Methods and Results/Accomplishments:**

Many idealized models of atmospheric and oceanic flows reduce to the two-dimensional (2D) advection of a tracer that in turn determines the flow field. The classic example is non-divergent 2D flow on a plane (or a sphere), where the tracer is the vertical (or radial) component of the vorticity. Of special interest is the "geostrophic turbulence" generated in systems with two interacting active tracers, representing flow at the tropopause and the earth’s surface in the simplest atmospheric case. Another example of special interest is surface quasi-geostrophic (SQG) flow, in which the state of the system is completely determined by the temperature at the surface. SQG flows bear some formal resemblance to 3D incompressible flows – for example, dimensional arguments suggest a \(-5/3\) kinetic energy spectrum for the direct turbulent cascade to small scales, just as in 3D. SQG has developed into a model problem for those interested in singularity formation in 3D Euler or Navier-Stokes. The possible formation of singularities in SQG remains unsolved. There is also interest in possible blow-up of active scalar equations with more singular constitutive laws and in questions relating to long time behavior in the limit of small dissipative mechanisms.

The workshop provided the opportunity for mathematicians and AOS scientists to find some common ground, and exposed participants to new methods and models that will possibly fertilize new work within both groups. Approximately one dozen graduate students and post-docs attended from several U.S. universities, and 5 graduate students presented posters.