Laboratory observations of inertia-gravity waves

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Rotating two-layer annulus experiment

- Camera
- Super-rotating lid
- Slightly different densities
- Rotating turntable

Experiment setup includes a rotating turntable, a super-rotating lid, and a camera. The densities are slightly different, and the setup is designed to study rotational dynamics.
[Image of a graph with the x-axis labeled 'hue (degrees)' and the y-axis labeled 'interface height (mm)'. The graph shows multiple curves for blue, red, and yellow colors.]

Williams, Read & Haine (GAFD; 2004)
A word of warning…!

• “d-limonene ... can be harmful when vaporized and breathed.”
  US Environmental Protection Agency

• “… the primary ingredient of Citrus Burst®, d-limonene, is plant derived. It is extremely safe…
  Florida Chemical Company, Inc.”
Application #1: polar vortex splits

Acknowledgements: Thomas Birner
‘Noise’-induced transitions in the lab?

without gravity waves:

with gravity waves:
Noise-induced transition in QUAGMIRE quasi-geostrophic model

Williams, Read & Haine (GRL; 2003)
Arctic polar vortex split

25 Nov (2001) | 26 Nov | 27 Nov

28 Nov | 29 Nov | 30 Nov
Ruzmaikin et al. (2003) model + noise

noise activated

Birner & Williams (JAS; 2008)
Application #2: clear-air turbulence

Acknowledgements: John Knox & Don McCann
QUAGMIRE MODEL:

interface height

Ford (1994)
IGW source term

LAB:

interface height

Williams, Haine & Read (JFM; 2005)
Ford source term calculated using the North American Regional Reanalysis (NARR)

Knox, McCann & Williams (JAS; 2008)
Application #3: deep ocean mixing

Acknowledgements: Tom Haine & Peter Read
Energy budget for global ocean circulation

Williams, Haine & Read (JAS; 2008)
Conclusions

• Laboratory observations of IGWs have inspired new insights into:
  – the dynamics of polar vortex splits
  – the prediction of clear-air turbulence
  – the energetics of deep ocean mixing

• … and may have a useful role when explaining these phenomena in the classroom