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Implementation of Tank Experiments in a sophomore Physics Lab and a general education course

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Thanks: NSF. John Marshall and Lodovoca Illari
More: <http://paoc.mit.edu/labguide/>



Weather in a Tank

A Laboratory Guide to Rotating Tank Fluid Experiments and Atmospheric Phenomena

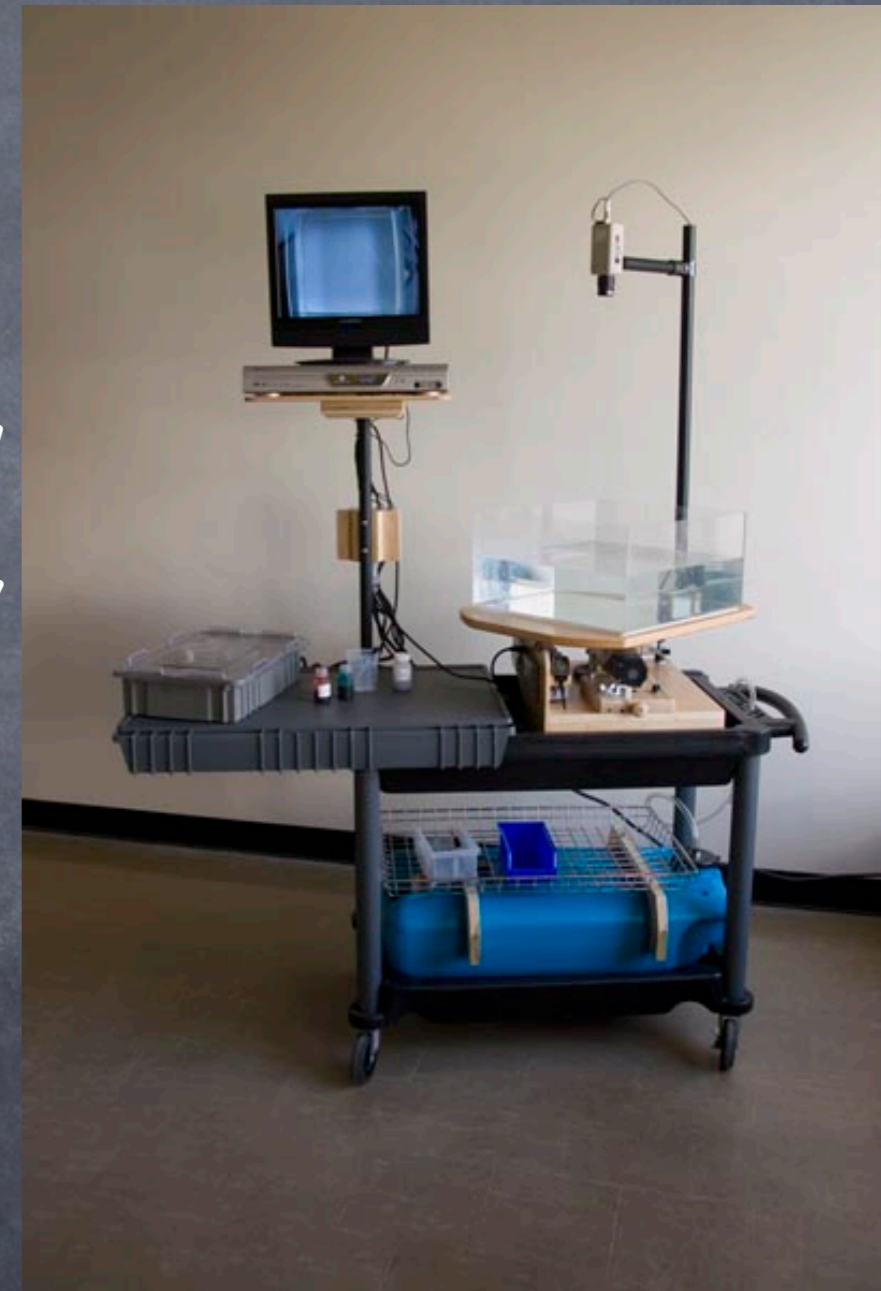


Teaching with the rotating tank

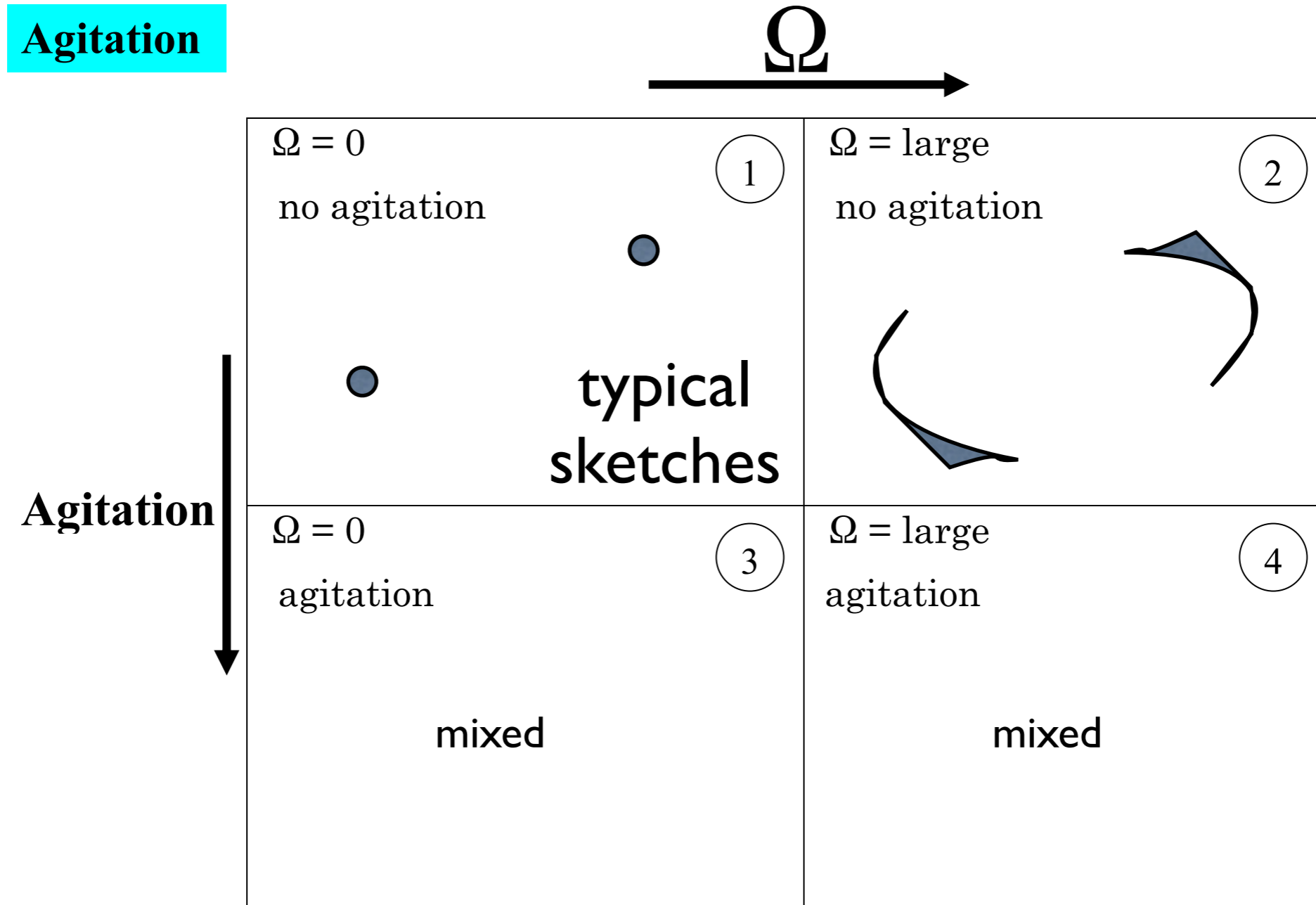
- **Hands-on** experiments are **more fun** than seeing sketches on the board or you-tube clips. Students learn.
- **Delivery** is key: Elements of Science (Socratic questioning) and theatre (suspense).
- **Stretch** the students and myself by asking for extensions of experiments or new ideas.

Weather in a tank

- **Portable**; Great for new and mechanically challenged instructors.
- Website covers a number of facets: **how to** conduct the experiment; how to link it to **observations** (John's talk, Galen's poster)
- **Delivery** is important! Socratic questioning, suspense, resolution.



Dye-stirring



1. sketch, explain

2. at what time scale? this can be answered at many levels: dimensional for sophmores, in terms of spin-up times and non-dimensional analysis for GFD students.

In-class Demonstrations (general education)

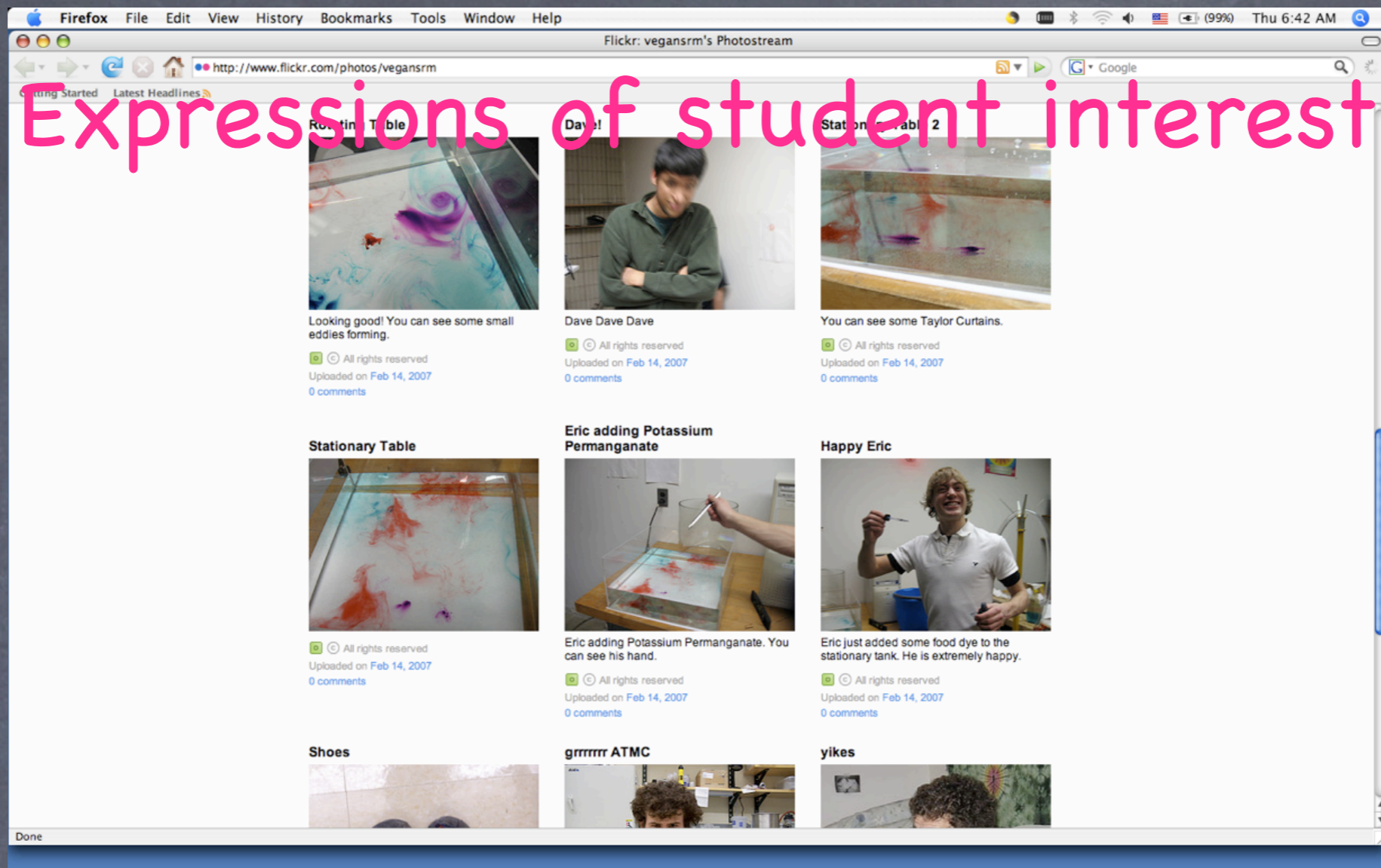
- Convection (4 beaker as well as 2 layer)
- Dye stirring (Rossby Number)
- Fronts and Thermal wind balance
- Hadley cell and Baroclinic eddies

Details: Lighting in lecture halls, student reaction.

Physics Lab module

A four week module in which the demonstrations were followed by experiments carried out by the students in groups of 2-3 students. Each student submitted one formal lab report with their own extension. In class discussion of theory and exploring the phenomenon in data followed the demonstrations.

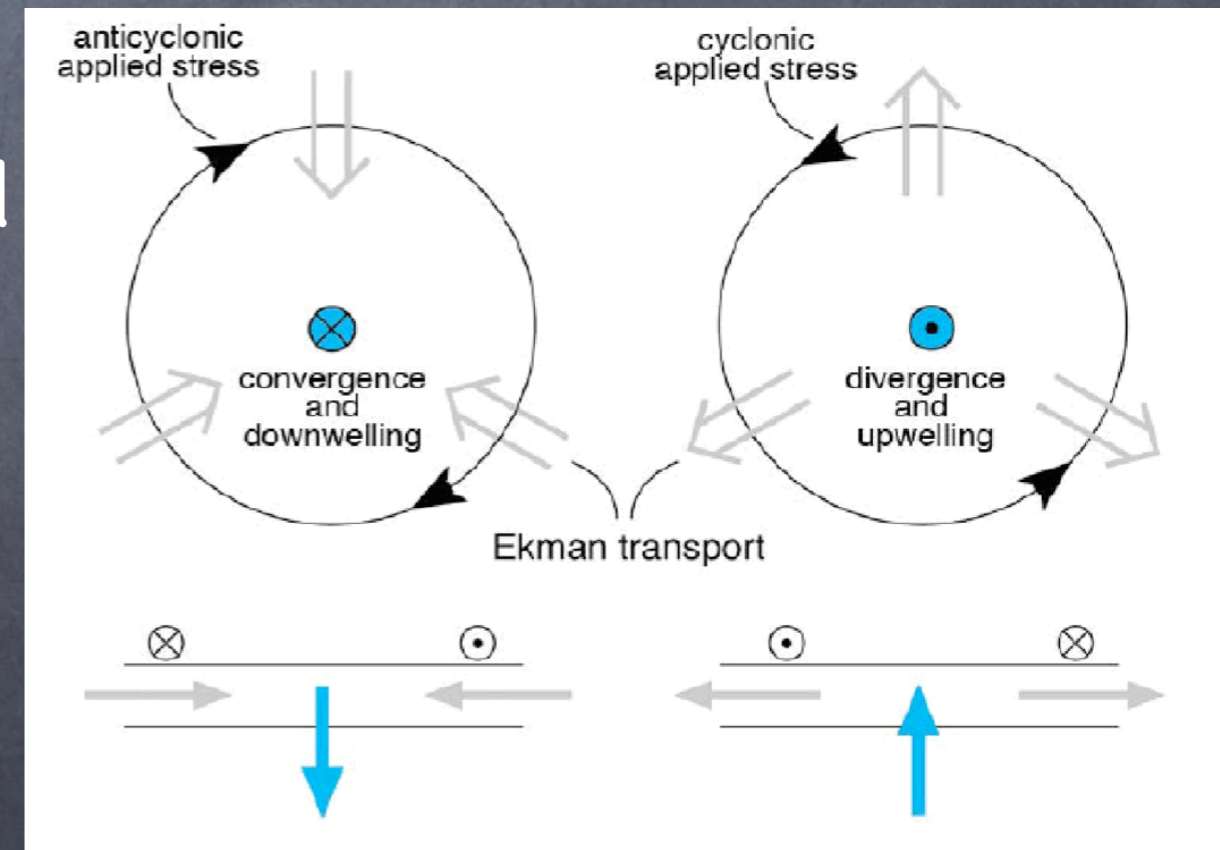
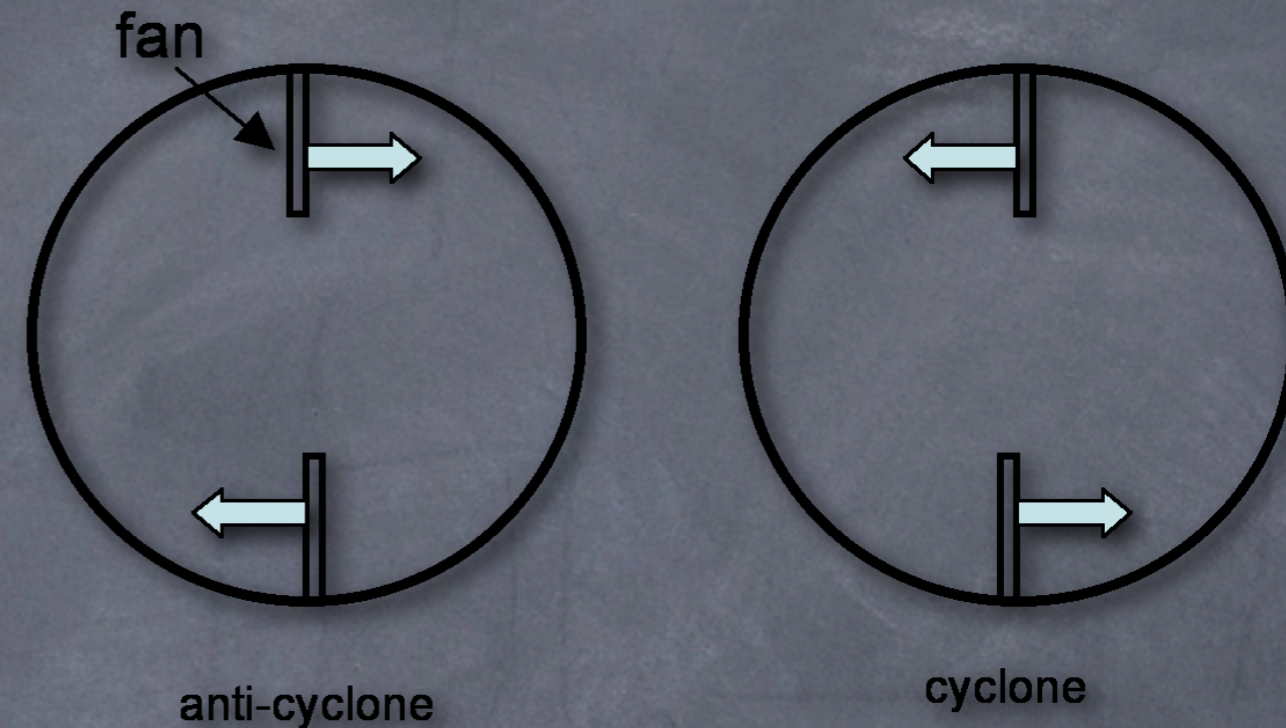
- Solid body rotation; Dye stirring
- Fronts
- Ekman layers
- Hadley cell and Baroclinic eddies



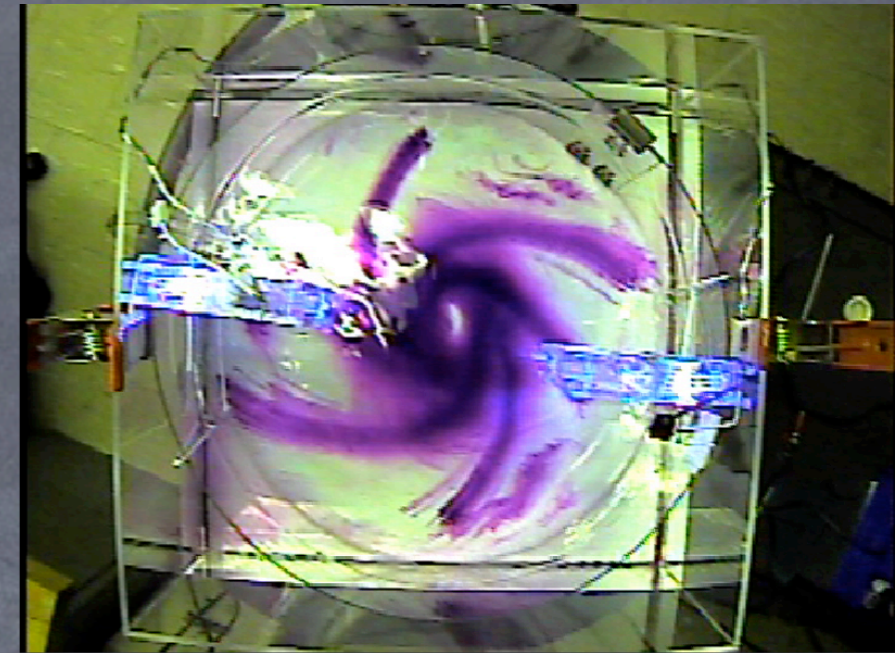
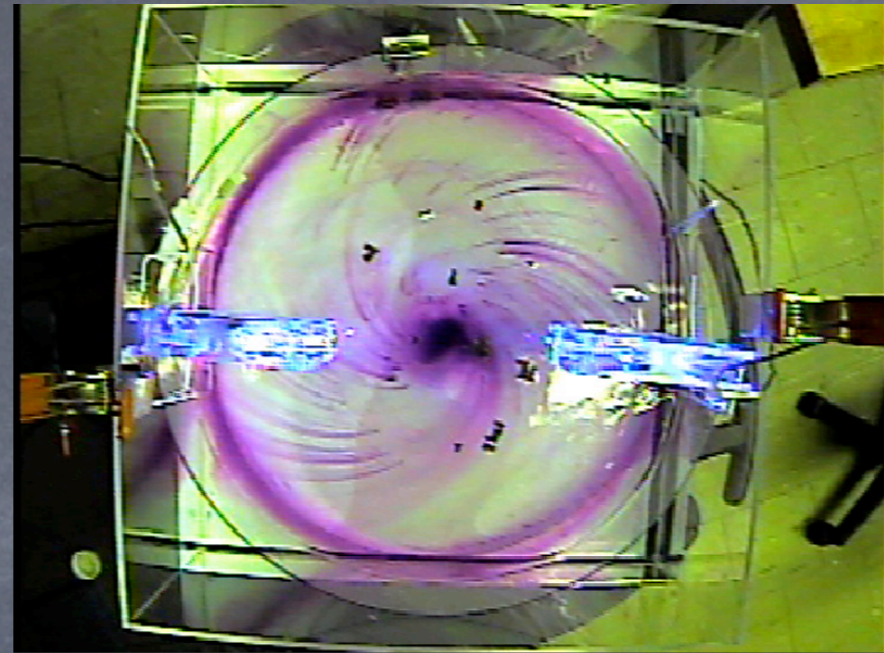
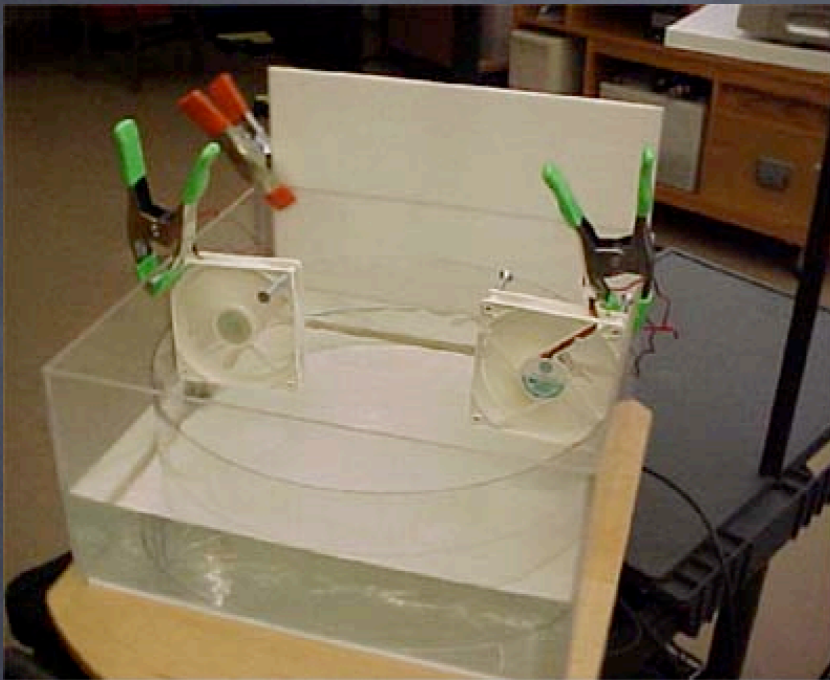
- **Voluntarily** worked on experiments **after hours** in the lab. One of them created a public **flickr online album** with their photos on their own.
- **Extensions:** Oil/Water; Warm/Cold water for fronts experiment; Other variations in parameter space.
- A new experiment would not have been possible without their interest.

Coriolis Effect on the Wind driven ocean circulation

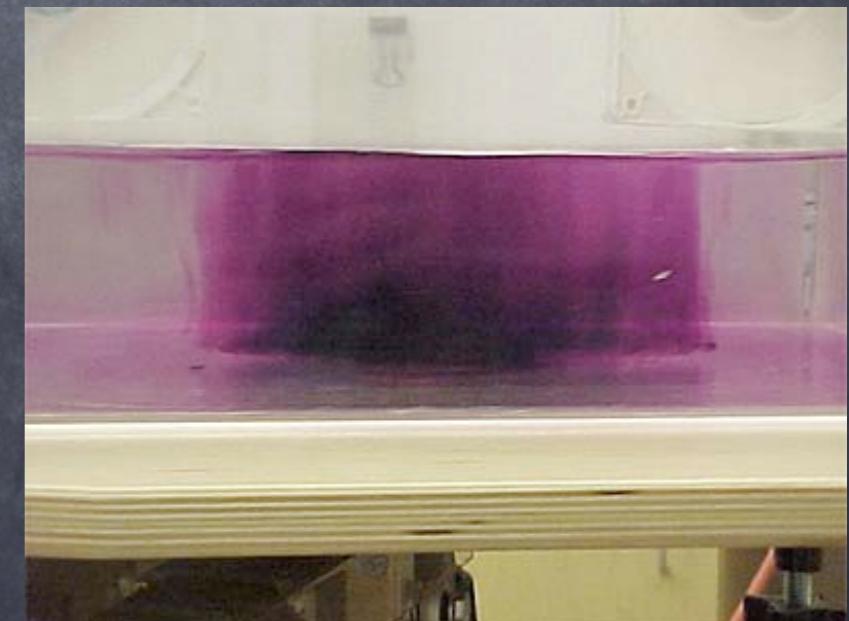
- A four week module was implemented in a sophomore/junior physics lab course. This experiment grew out of an extension.
- We used computer fans and tried out many sizes and placements. Lowest speeds work best, and the experiment is very robust.



Setup and Results



- Recommend dropping permanganate crystals at 3-4 places (near center for anti-cyclone, near outer edge for cyclone).
- Paper dots at the surface.
- Motivate students by connecting to Pacific ocean garbage patch.
- Oceanography article reprint!



Beesley, Olejarz, Tandon and Marshall 2008

Future Use

- **Demo Mode:** The experiments have been used and will continue to be used for gen ed course, open house and other outreach activities. A sustainability course module in Fall 2008 on Coastal Zone will feature demonstrations.
- **Student Use:** Starting Spring 2009, a four experiment set is now part of the junior/senior PHYSICS lab course. We will continue to use it in graduate FM and GFD course.