

Balanced Vortices Generated by Ice in a Rotating Fluid

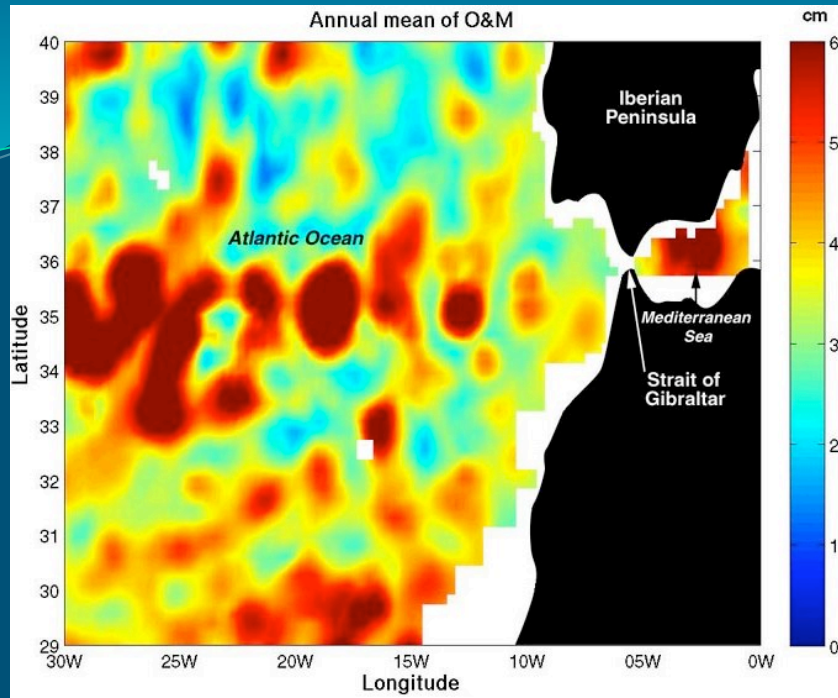
Theory and Laboratory Experiments



Cara Taber

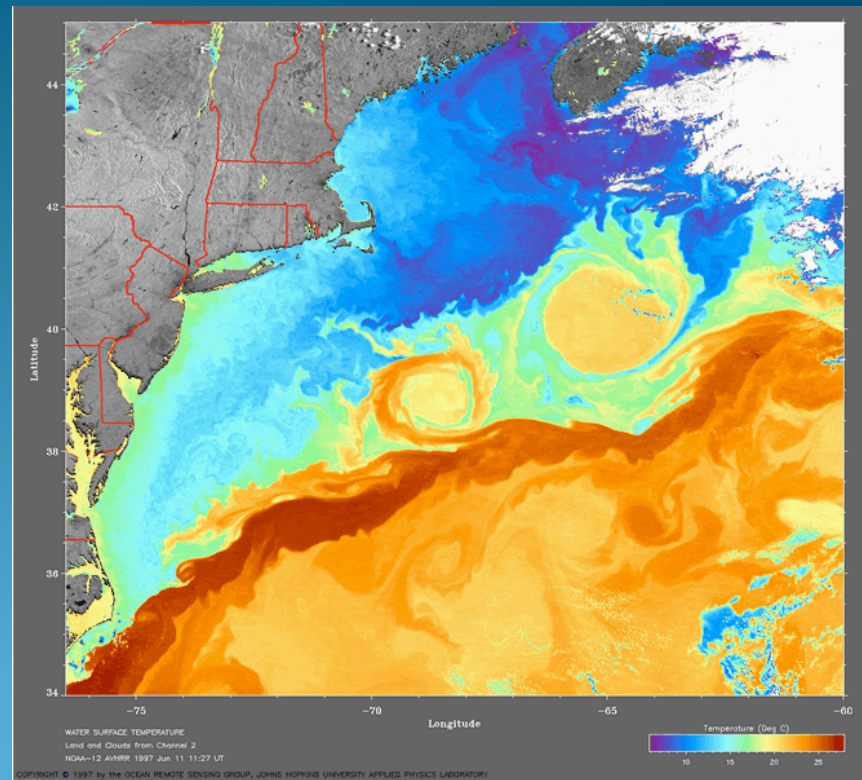
Applied Physics,
Colorado State University

cara.taber@rams.colostate.edu



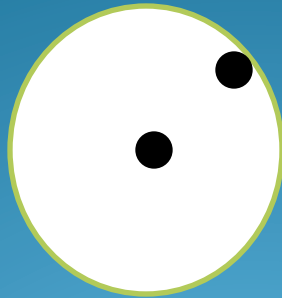
← Meddies

Gulf Stream →

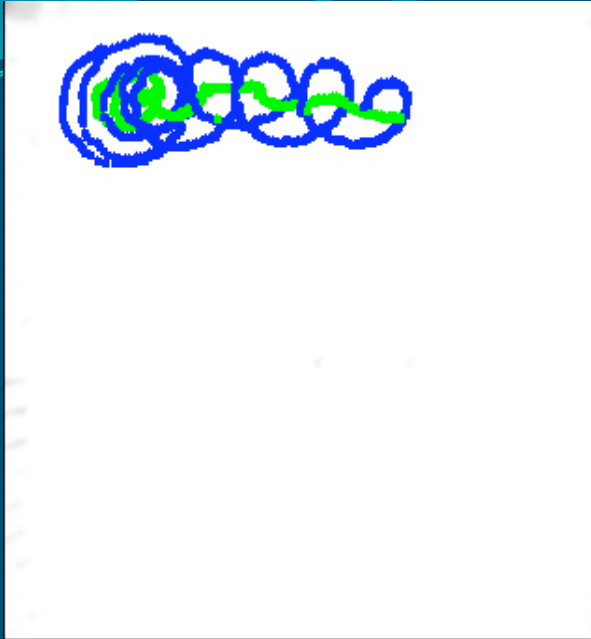




- Solid body rotation
- Introduce Ice into centre
- Ice spin up
- Balanced vortex



Experimental Setup



RPM	$\tau = \frac{60s}{RPM}$	$\Omega = \frac{2\pi}{\tau}$	$f = 2\Omega$
-----	--------------------------	------------------------------	---------------

3rpm	20	~0.3	0.6
------	----	------	-----

5rpm	12	~0.5	1
------	----	------	---

10rpm	6	~1	2
-------	---	----	---

15rpm	4	~1.5	3
-------	---	------	---

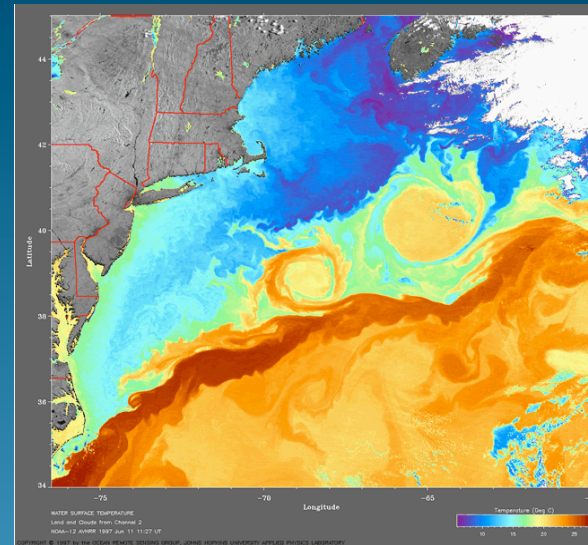
Experimental Setup

Is rotation important?

Rossby Number: Inverse measure of rotation effect



Huge Ro ($\gg 1$)

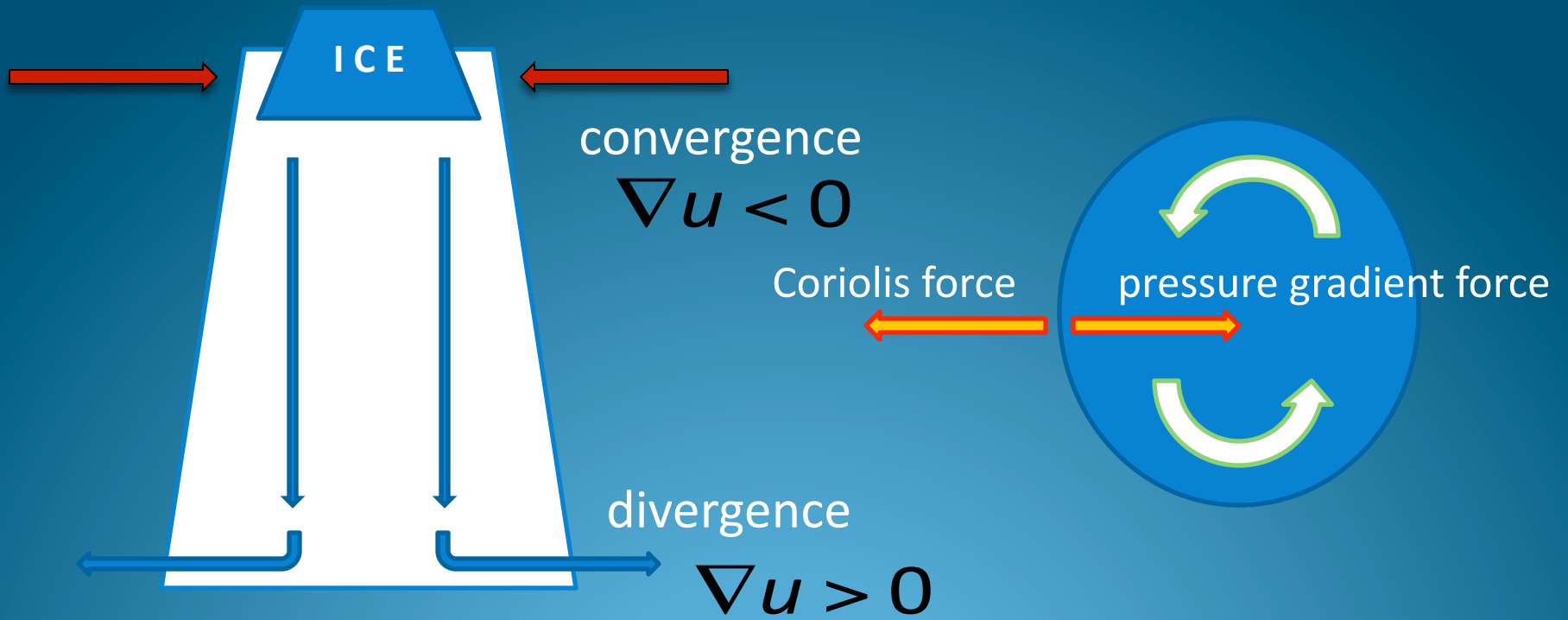


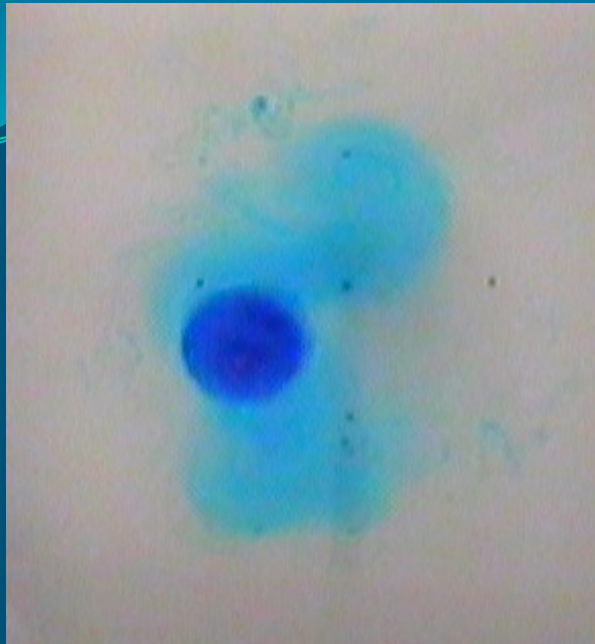
Tiny Ro ($\ll 1$)
(significant in calculation)

$$Ro = \frac{u}{fL} = \frac{F_{\text{acceleration}}}{F_{\text{rotational}}}$$

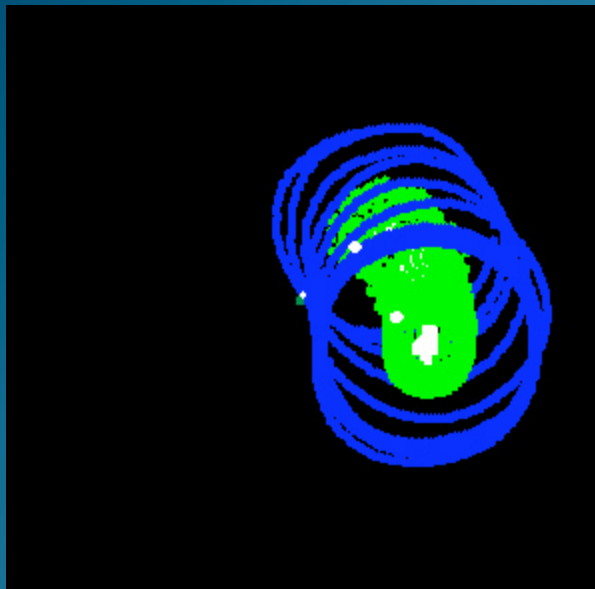
What's Happening?

$$\frac{D}{Dt} \xi \approx -f \nabla \cdot \vec{u}$$



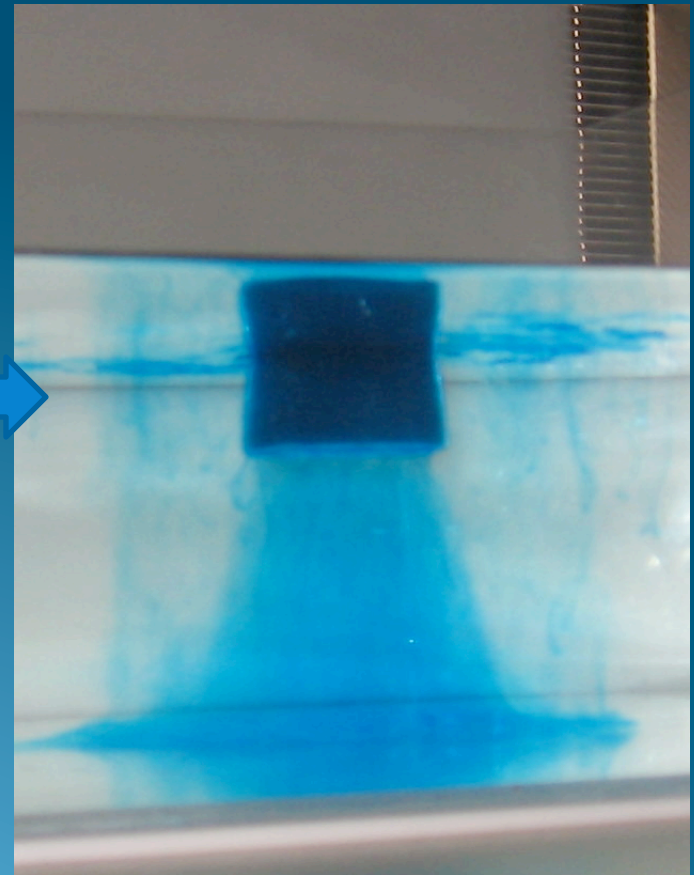


← co-rotating camera

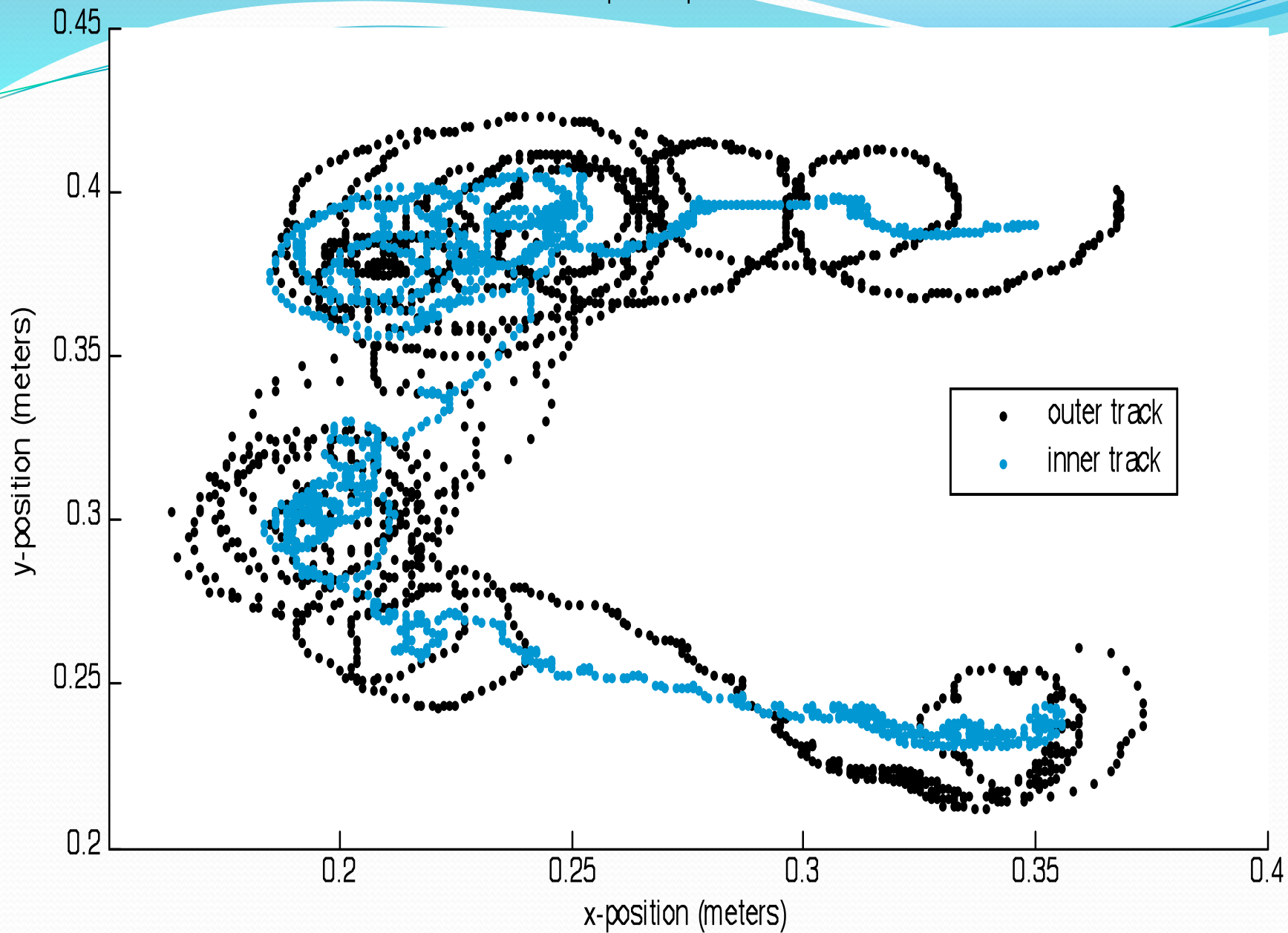


← particle tracker

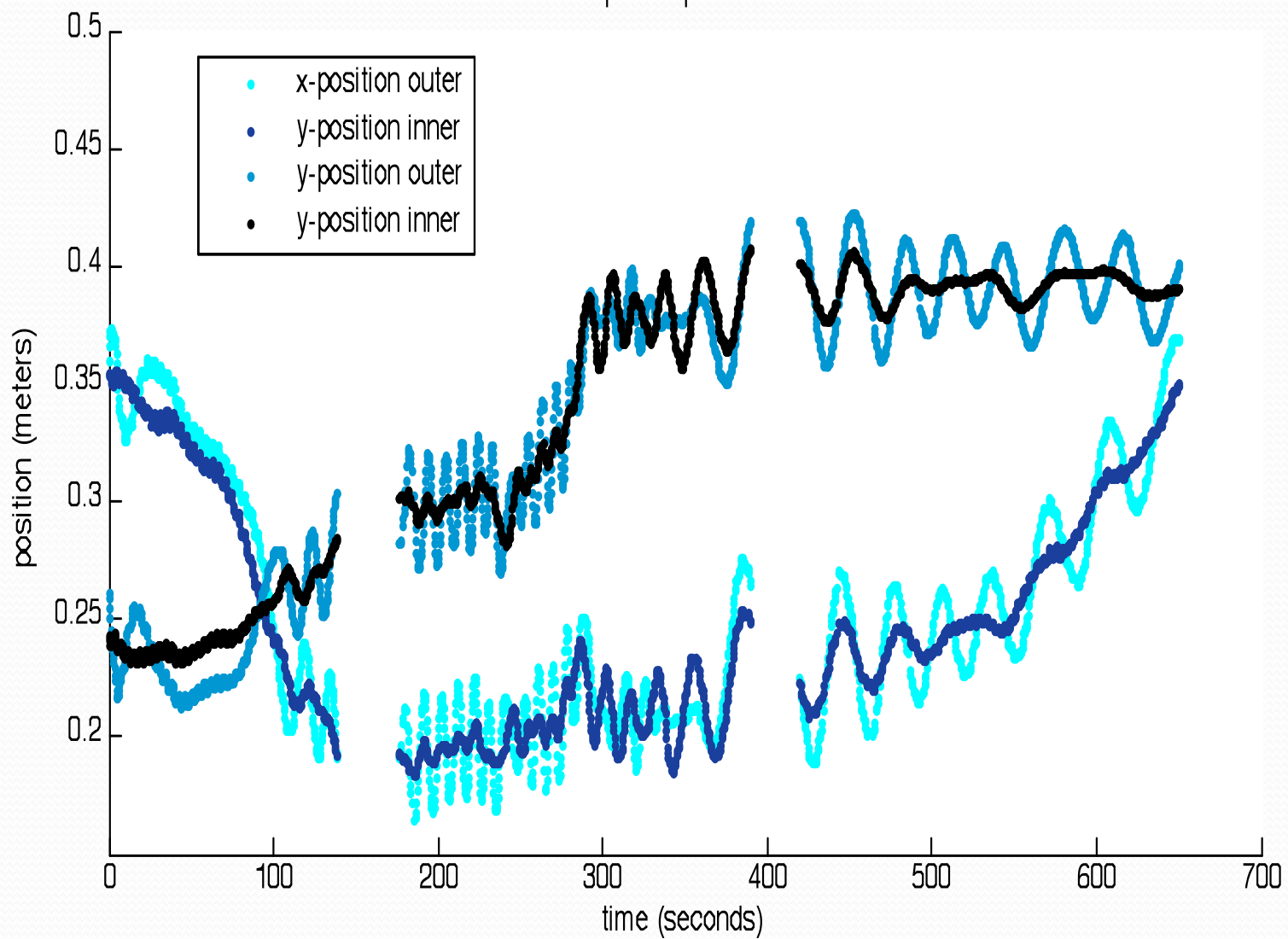
camera
outside
rotating
reference
frame



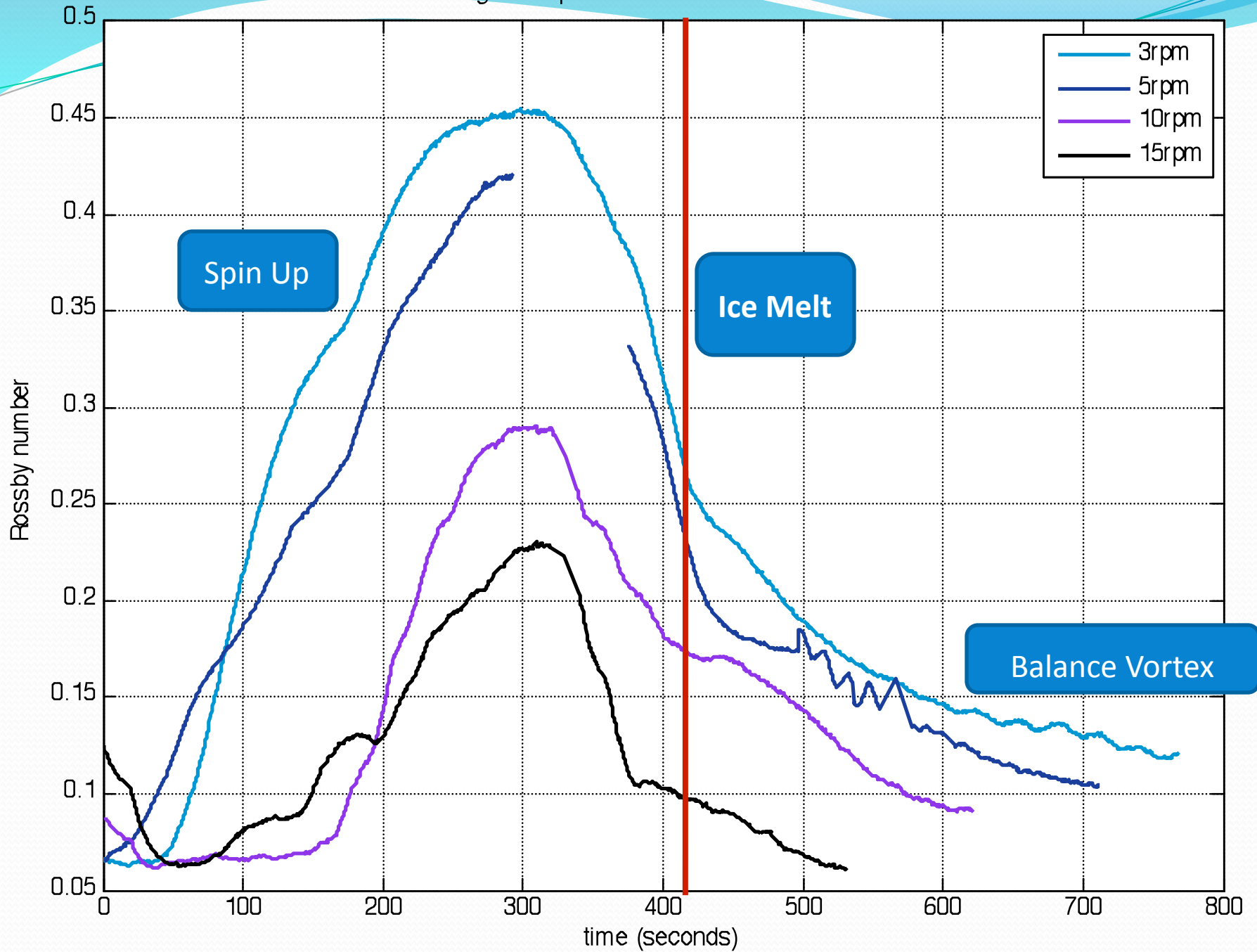
15rpm: Experiment 1



15rpm: Experiment 1



Rough Comparison between Rotation Rates



Summary

- Education applications
- Technology problems
- Unique Rossby results
(much smaller than 1)



Infrared Image of Meddies courtesy of
California Institute of Technology, Jet Propulsion Laboratory
<http://www.jpl.nasa.gov/news/news.cfm?release=2006-040>

Image of Gulf Stream Eddies courtesy of
Johns Hopkins University, Applied Physics Laboratory
[http://science.kennesaw.edu/~jdirnber/oceanography/
LecuturesOceanogr/LecCurrents/gulf_stream_rings.jpg](http://science.kennesaw.edu/~jdirnber/oceanography/LecuturesOceanogr/LecCurrents/gulf_stream_rings.jpg)

Sources