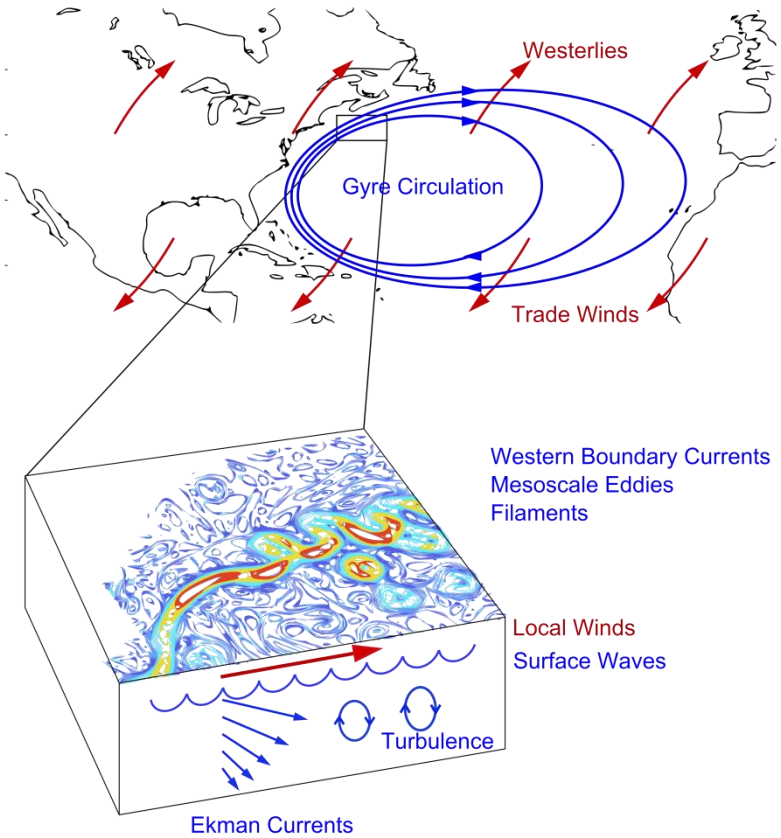
Dr. Kathleen Dohan

Physical Oceanography
(The Physics of Ocean Movements)
(Ocean Motion)



How did I get to the point of being an oceanographer?

Really, I'm a Mathematician.
But I like physics,
and I wish I learned more about writing.

High School

- Math, physics, … (puzzles on paper) … and art.

Undergraduate University (College)

- MORE Math, physics, chemistry … a little bit of English, some fun non-science courses (like cinema)
- WORK terms (physics co-op)
  - Atomic Energy of Canada
    - Hardness, size of crystals in the metals they use for pressure tubes in nuclear reactors
    - Diffusion of hydrogen through pressure tube metal
  - What I learned
    - That knowing statistics is important
    - How math really gets used to understand physics
  - What I should have learned
    - That nothing you do means anything if you don’t write it up and share it.

Undergraduate University

- WORK terms (physics co-op)
  - Environment Canada
    - Studying the variability of river water properties using a very new and sophisticated mathematical technique
  - What I learned
    - What scientific papers are and how they're where the newest work gets published, not text books.
    - i.e. How to do research
    - That I LIKE research
    - That I like studying something directly relevant to the environment using both math and physics. The best of everything!
- Final Semester: Took a course in Fluid Dynamics
- Graduated as a Mathematics major, Physics minor

Did some traveling in Europe (went to the Munich science museum) … then Graduate School

Graduate School

- PhD in Applied Mathematics studying Fluid Dynamics
  - Laboratory work studying turbulence and waves
    - Small tanks with salt water
  - Numerical Simulations of turbulence and waves

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)+\rho g_x$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}+\frac{\partial^2 v}{\partial z^2}\right)+\rho g_y$$

$$\rho\left(\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}\right)=-\frac{\partial p}{\partial z}+\mu\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+\frac{\partial^2 w}{\partial z^2}\right)+\rho g_z$$

Wish I did some traveling in Europe … but instead went straight to a postdoctorate in San Diego (OK not bad).

Moving more towards Environmental Fluid Dynamics:

Postdoctorate in Physical Oceanography at Scripps

- Storm-driven mixing of the top few 10's of meters of the ocean
- The waves that get generated during the storm
  - Data from ocean moorings

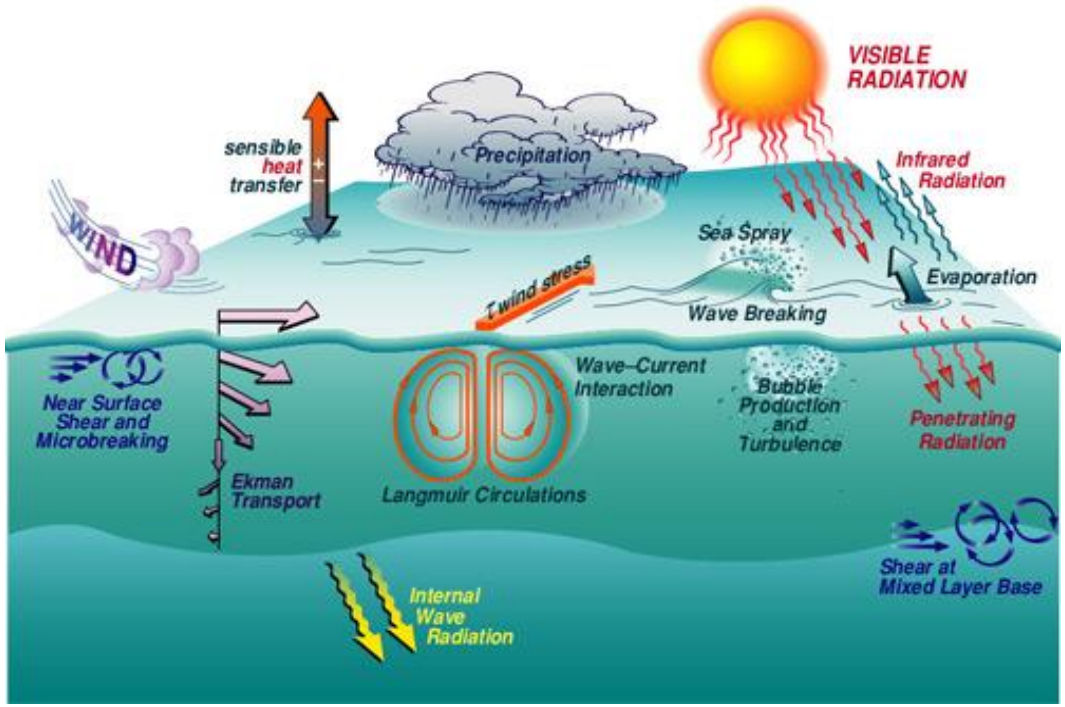
Next up:

Going global with a

new job in Seattle at

Earth and Space Research

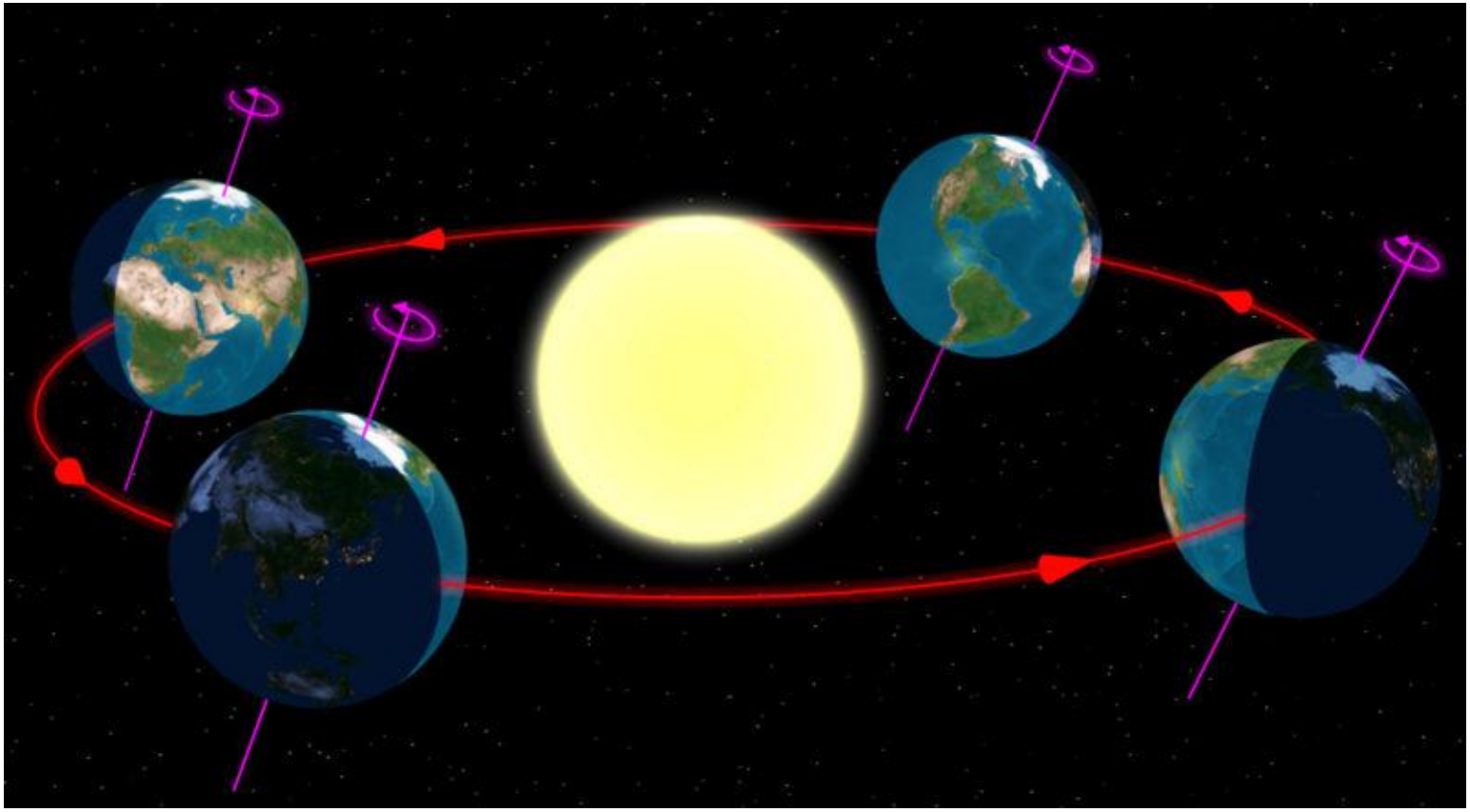
Dec 2007



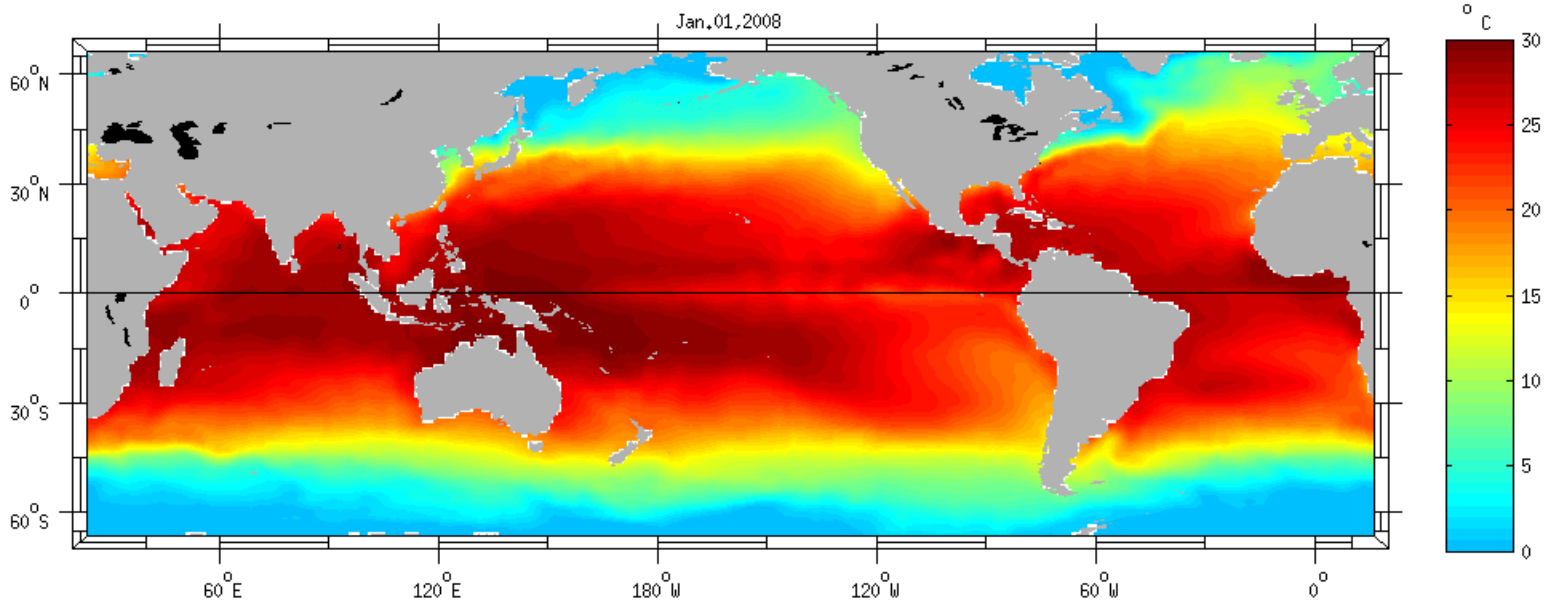
http://www.hpl.umces.edu/ocean/sml_main.htm

What causes the global movements of the oceans?

•The heating by the sun is not even



- Earth is tilted with respect to Sun
- Length of day changes throughout the year



- Temperature at the sea surface as measured by satellite sensors over one year
- The hot regions shift during the seasons
- Hot air/water is lighter than cold air/water
- Temperature changes drive winds/ocean currents

OSCAR: Ocean Surface Current Analyses – Realtime

satellite sensed fields

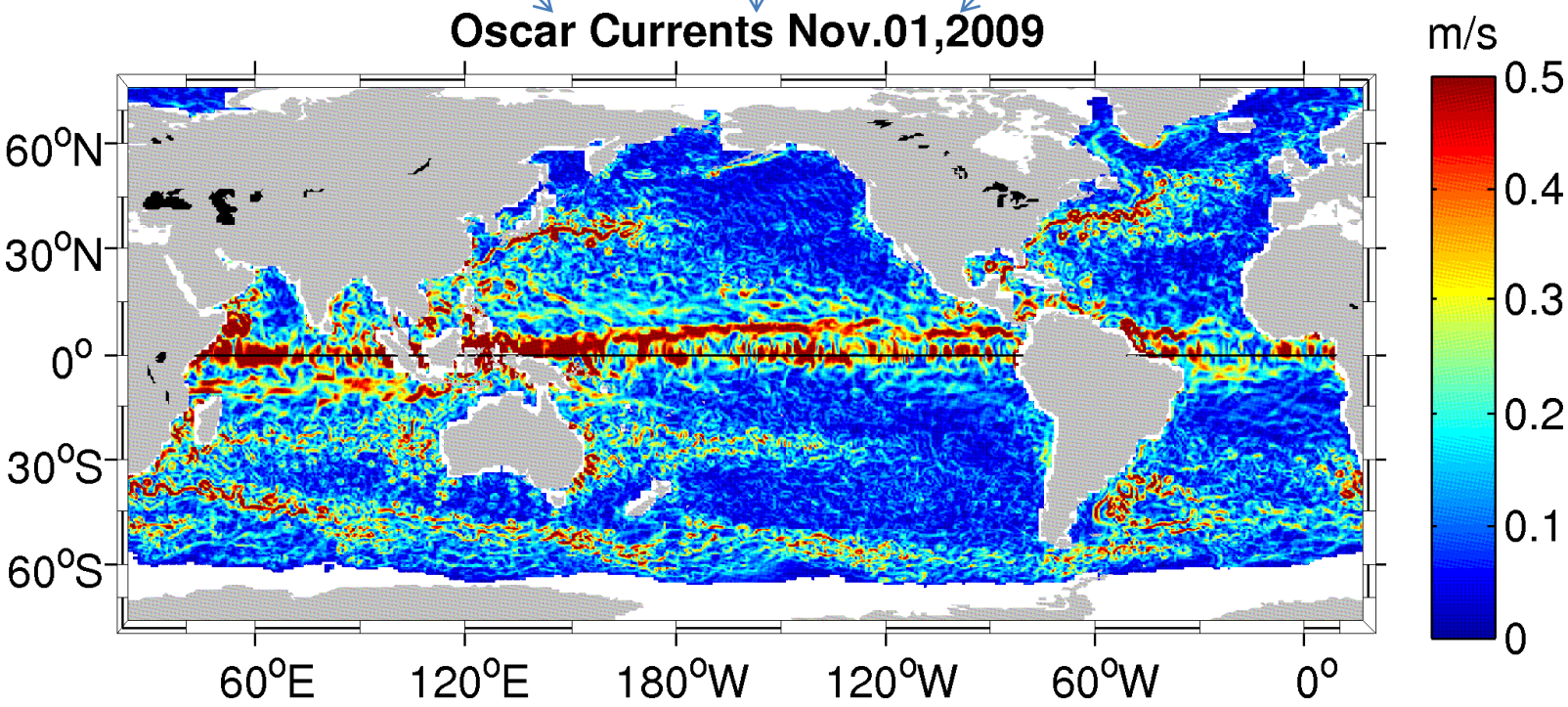
Sea Surface Height

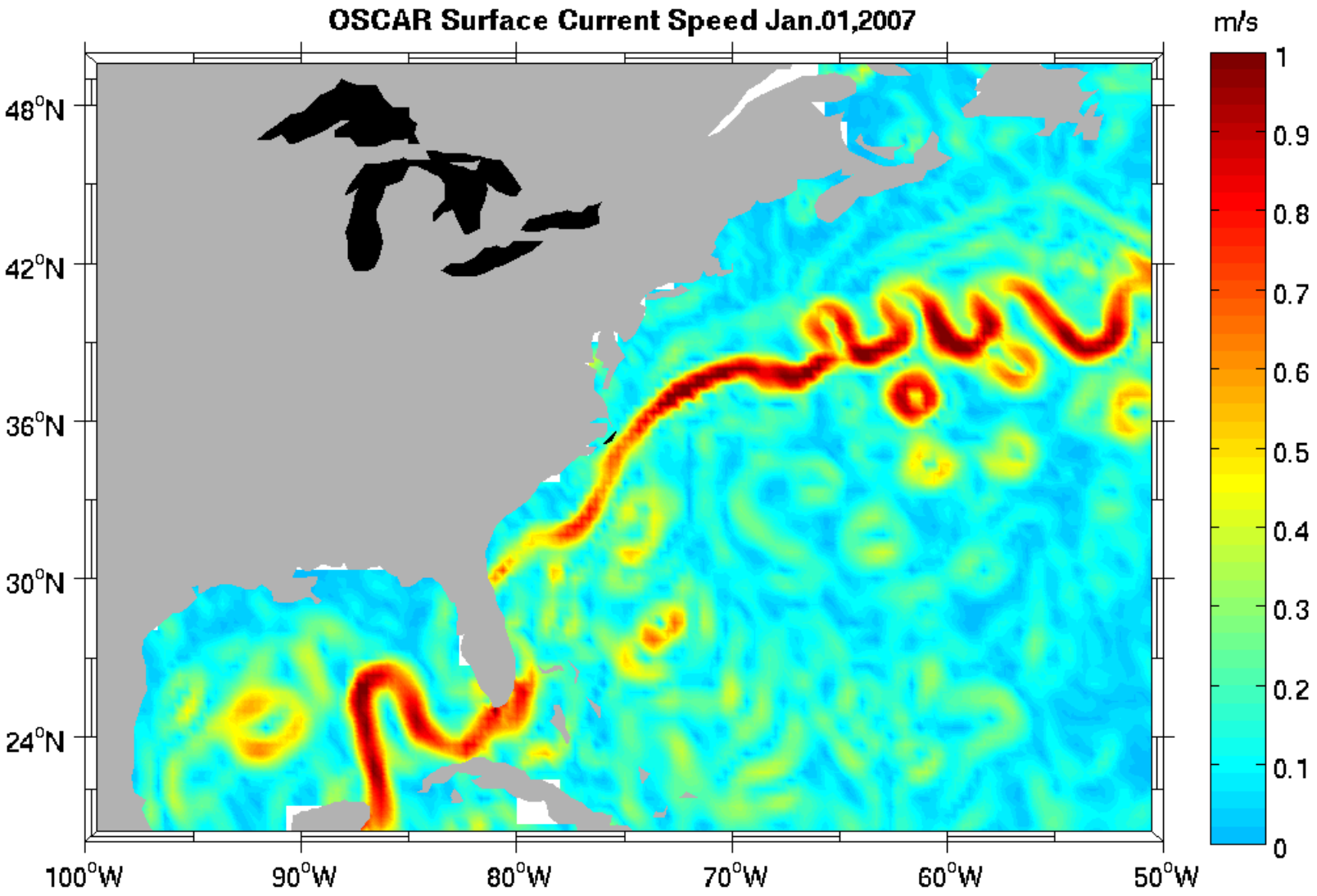
Surface Winds

Sea Surface Temperature

analytical model

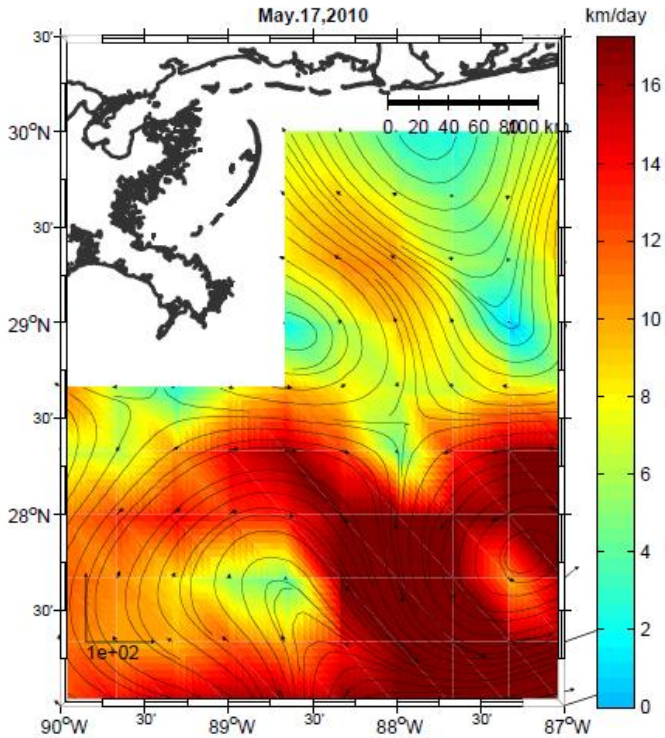
MATH!

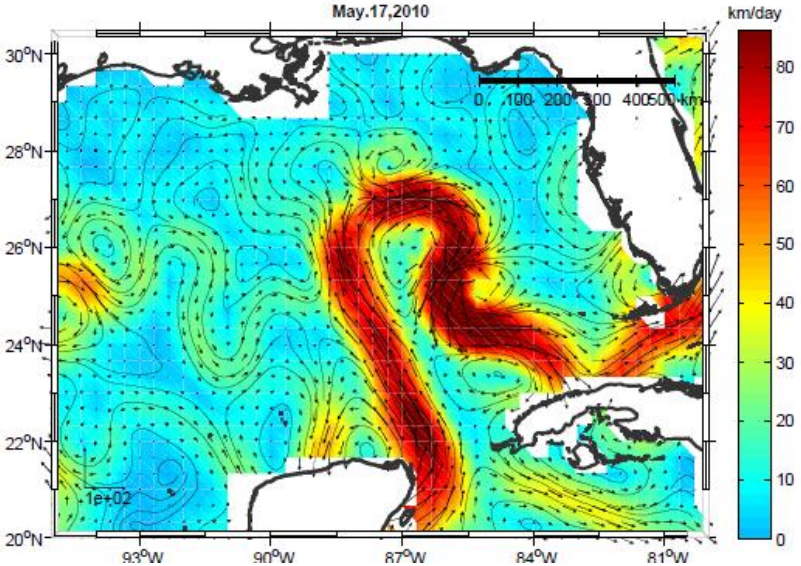



OSCAR Surface Current Speed Jan.01,2007
m/s
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
48°N
42°N
36°N
30°N
24°N
100°W
90°W
80°W
70°W
60°W
50°W

Societal Applications

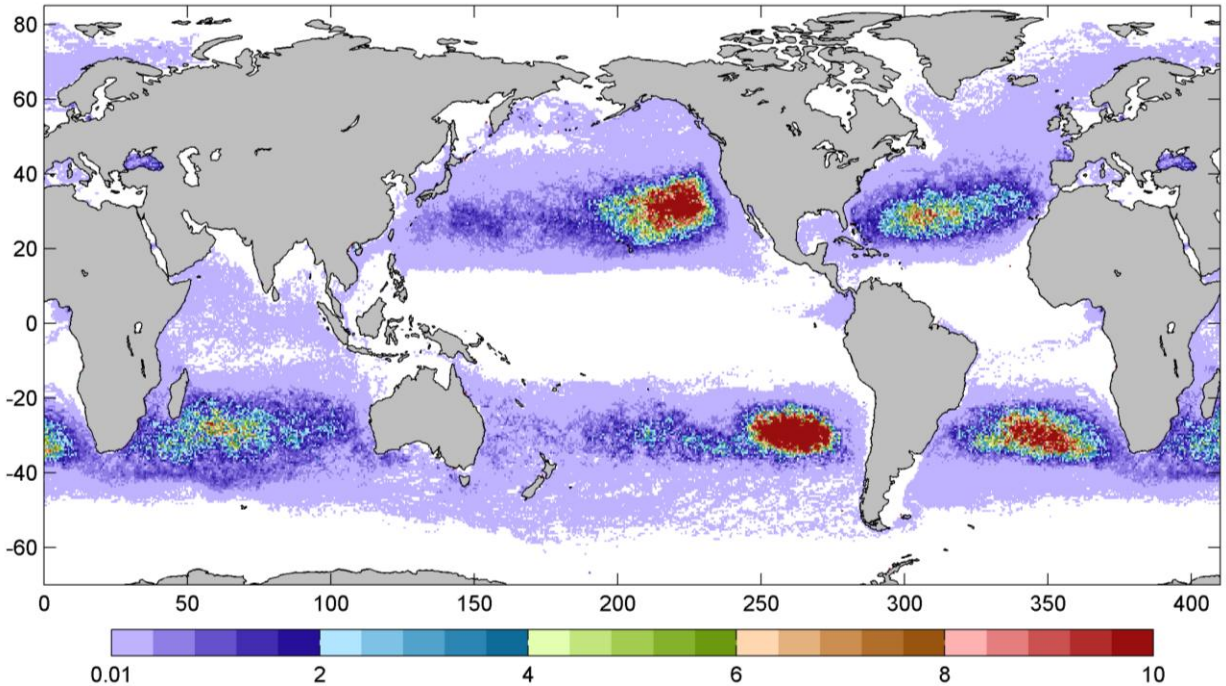
OSCAR Gulf of Mexico





Societal Applications

Tracer density distribution after 10 years of advection by surface currents (Dohan and Maximenko, 2010).

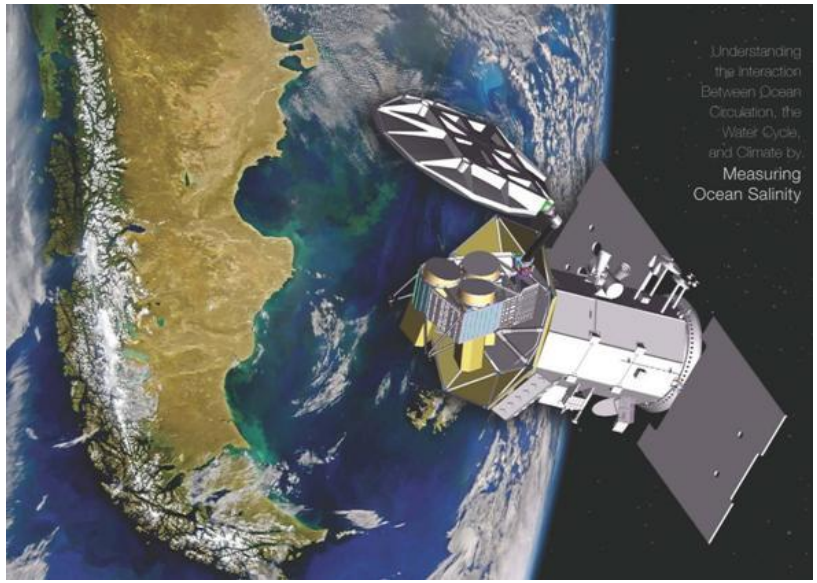


The coolest parts of my job:

- I get paid to research what interests *me*
- I feel it's worthwhile work

- Travel
  - Hawaii, France, Portugal, Spain, Portland, Maryland, Pasadena, Denver, …
  - For some, go to sea to take measurements

- Work with the smartest people in the world
  - e.g. NASA Aquarius satellite system
  - Gary Lagerloef of ESR heading it up
  - Will measure surface salinity
  - Launch June 2011

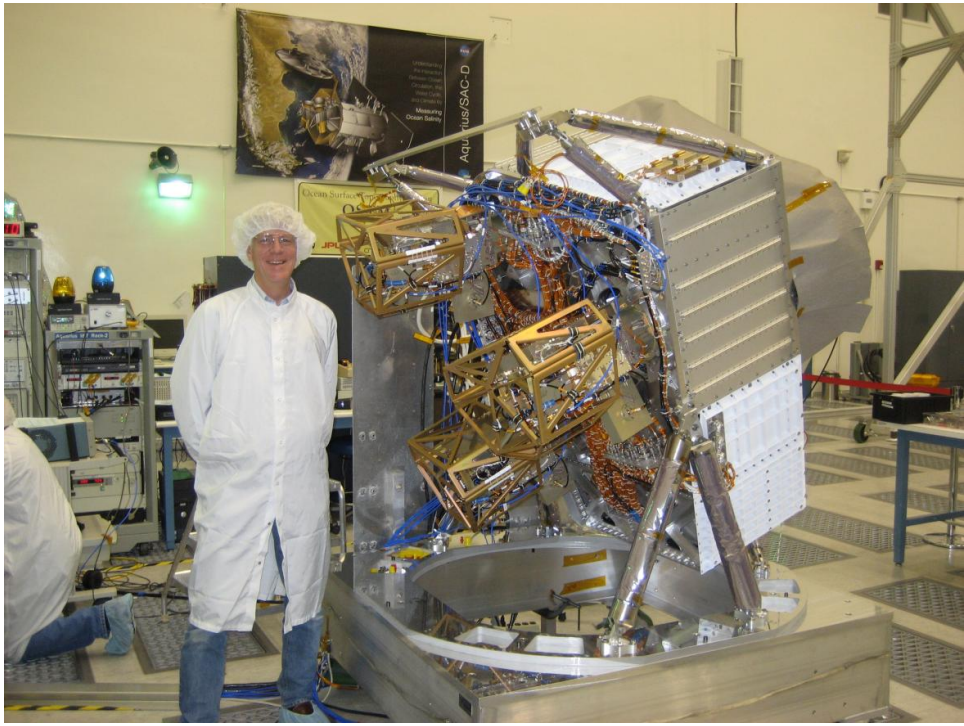


The worst parts of my job:

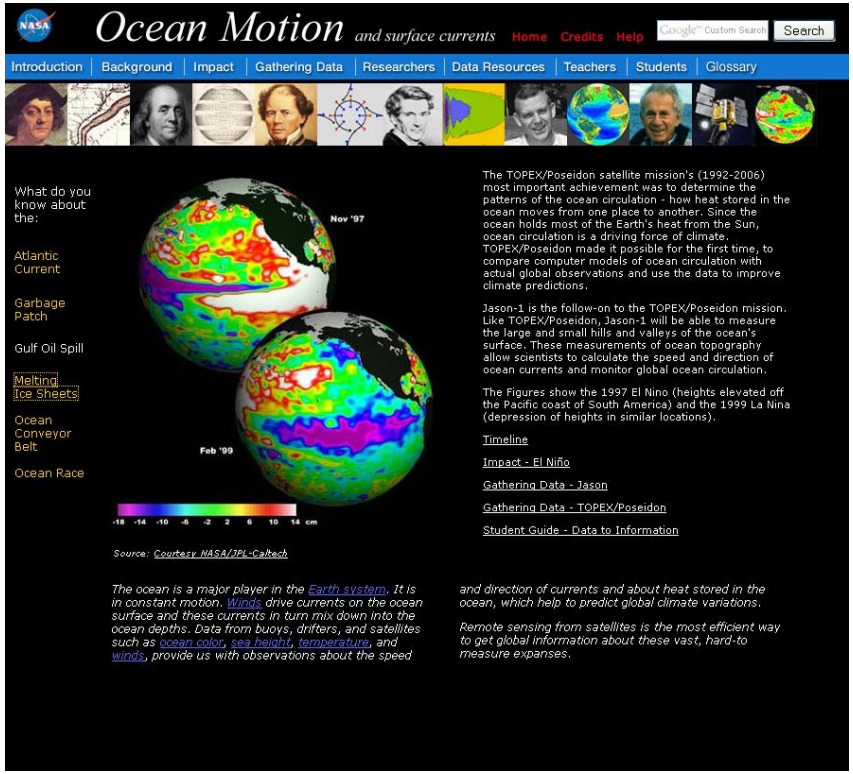
- Work with the smartest people in the world
  - Can get pretty competitive
  - No coasting
  - Have to learn to trust yourself
  - (Also the coolest part when you do)

- Many years of school
  before “working”

- Funding for Science!
  It’s all up to politics but my
  job directly depends on it.



End message: You have to love it.

And pay attention in math class.

- Want to Learn More About the Physics of the Ocean?
  - oceanmotion.org
  - www.esr.org