WINDS, CURRENTS, AND CORES

Saturday Workshops for Educators

at

Lamont-Doherty Earth Observatory

March 4, 2000

Dr. Michael J. Passow, Organizer

Assembling a 100-Year Record of Ocean Winds from Ships and Satellites

Dr. Donna Witter

NASA's new QuikSCAT satellite scatterometer returns high-quality data that will be used by oceano-graphers and atmospheric scientists to study winds over the ocean on a wide variety of time scales.

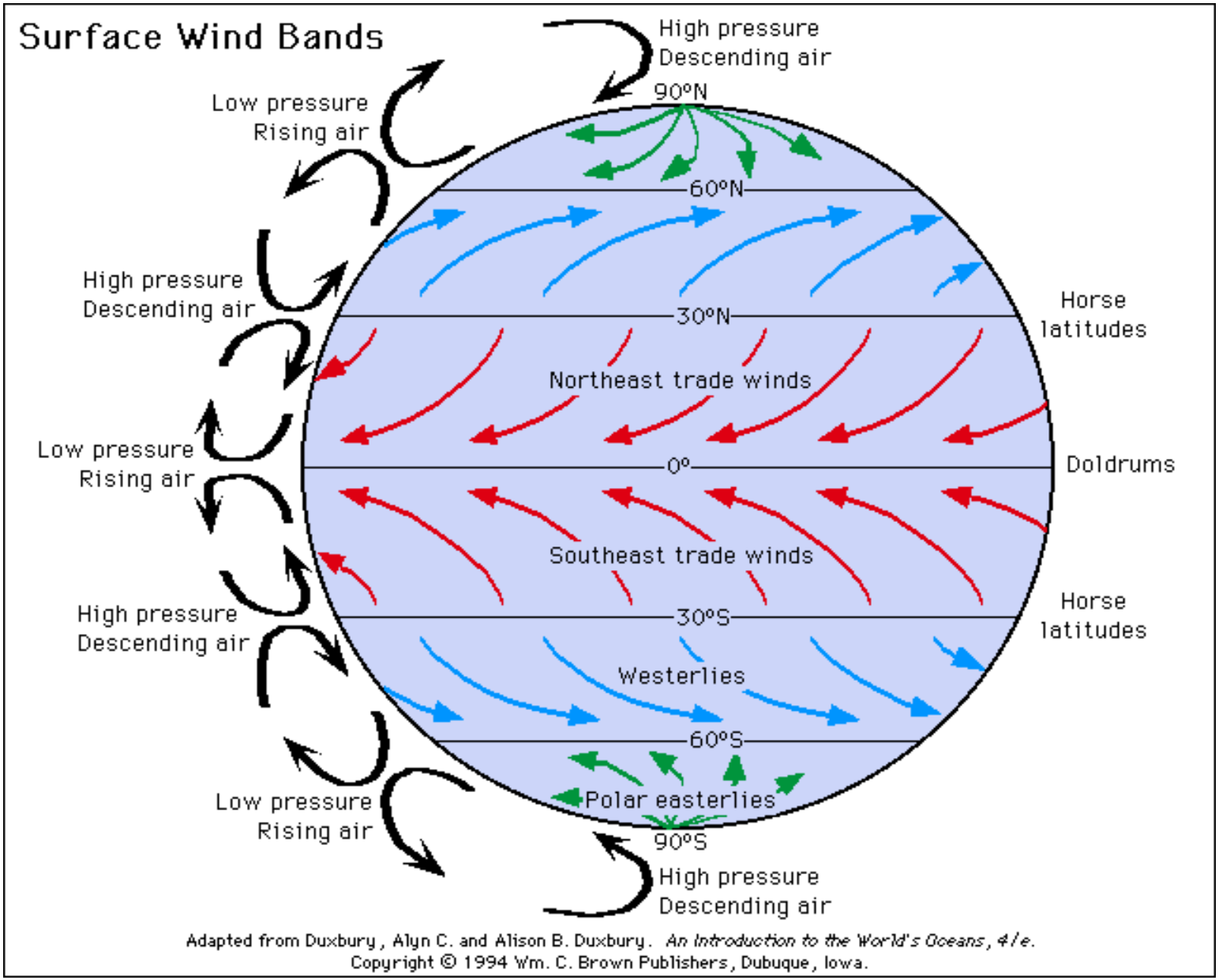
The LDEO Deep-Sea Sample Repository

Curator Rusty Lotti Bond will provide a tour of the world's greatest collection of materials brought up from the sea floors.

Before Satellites: Some Historical Notes about Understanding the Ocean Floors and Currents

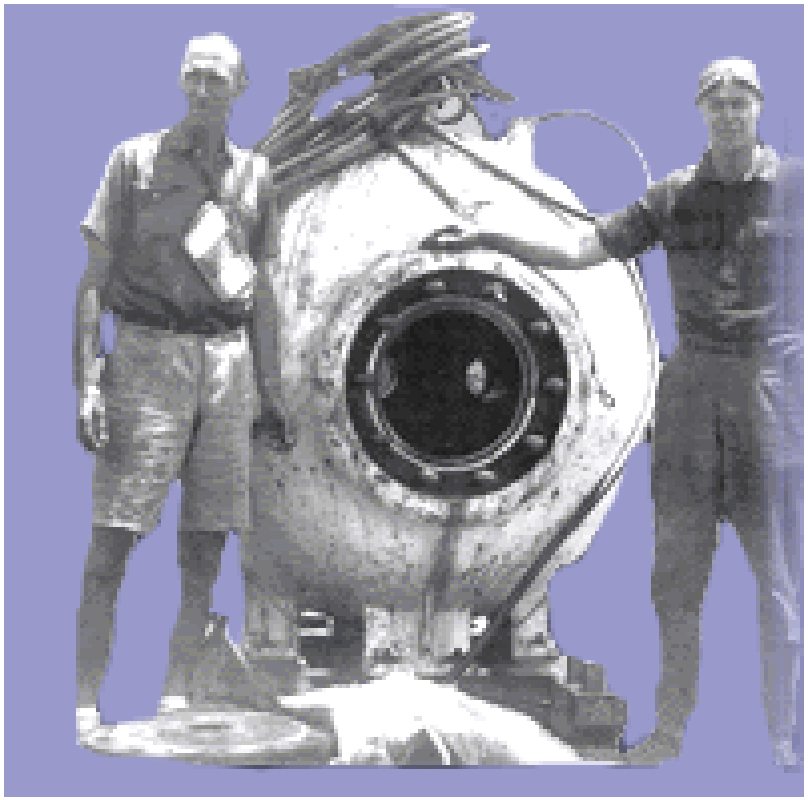
- “Ancient history through Ben Franklin’s chart of the Gulf Stream”
- Ship logs and M. F. Maury's "Physical Geography of the Sea
- H.M.S. "Challenger" (1872 - 1876)
- “Sampling the sea—Nansen bottles” (Much of this and other background can be found in any oceanography text or electronic encyclopedia.)

The connection between global winds/ pressure belts and surface currents has been well known for centuries. The next slide shows a generalized representation of the planetary wind pattern.



With a general understanding of what was happening at the surface, people began to try to find out more about what lay beneath the surface in the ocean depths.

How Low Can You Go? – Beebe's "bathysphere"



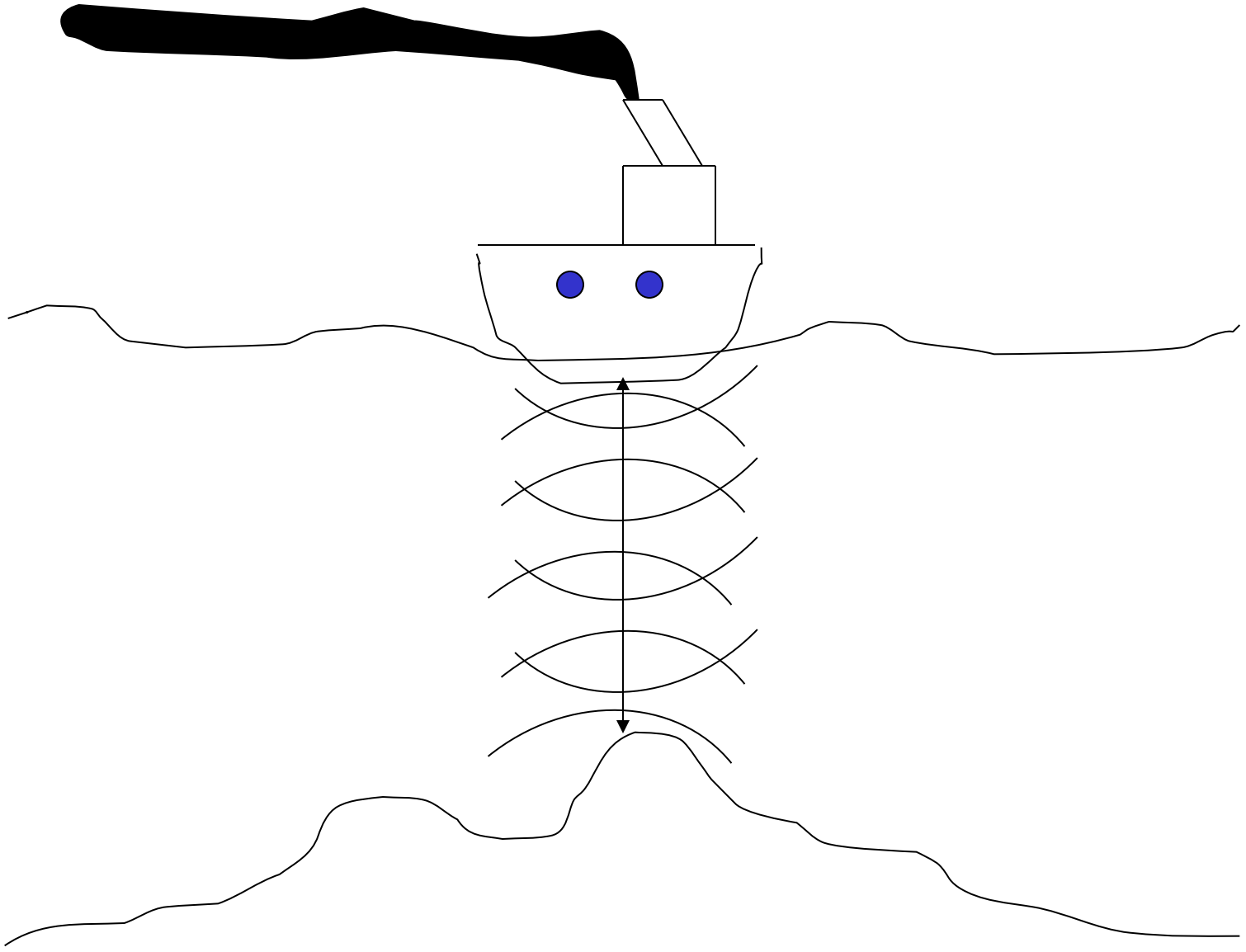
In the 1930s, William Beebe and Otis Barton descended more than half a mile in this steel ball. It is now on display at the Aquarium for Wildlife Conservation in Coney Island.

Piccard's "Trieste"

In 1960, the U. S. Navy and Swiss inventor Auguste Piccard developed the bathyscaphe "Trieste." This "underwater balloon" took Jacques Piccard and Lt. Donald Walsh to the bottom of the Mariannas Trench. They proved that life can exist even in the greatest depths of the oceans.

SONAR before, during, and after WW II

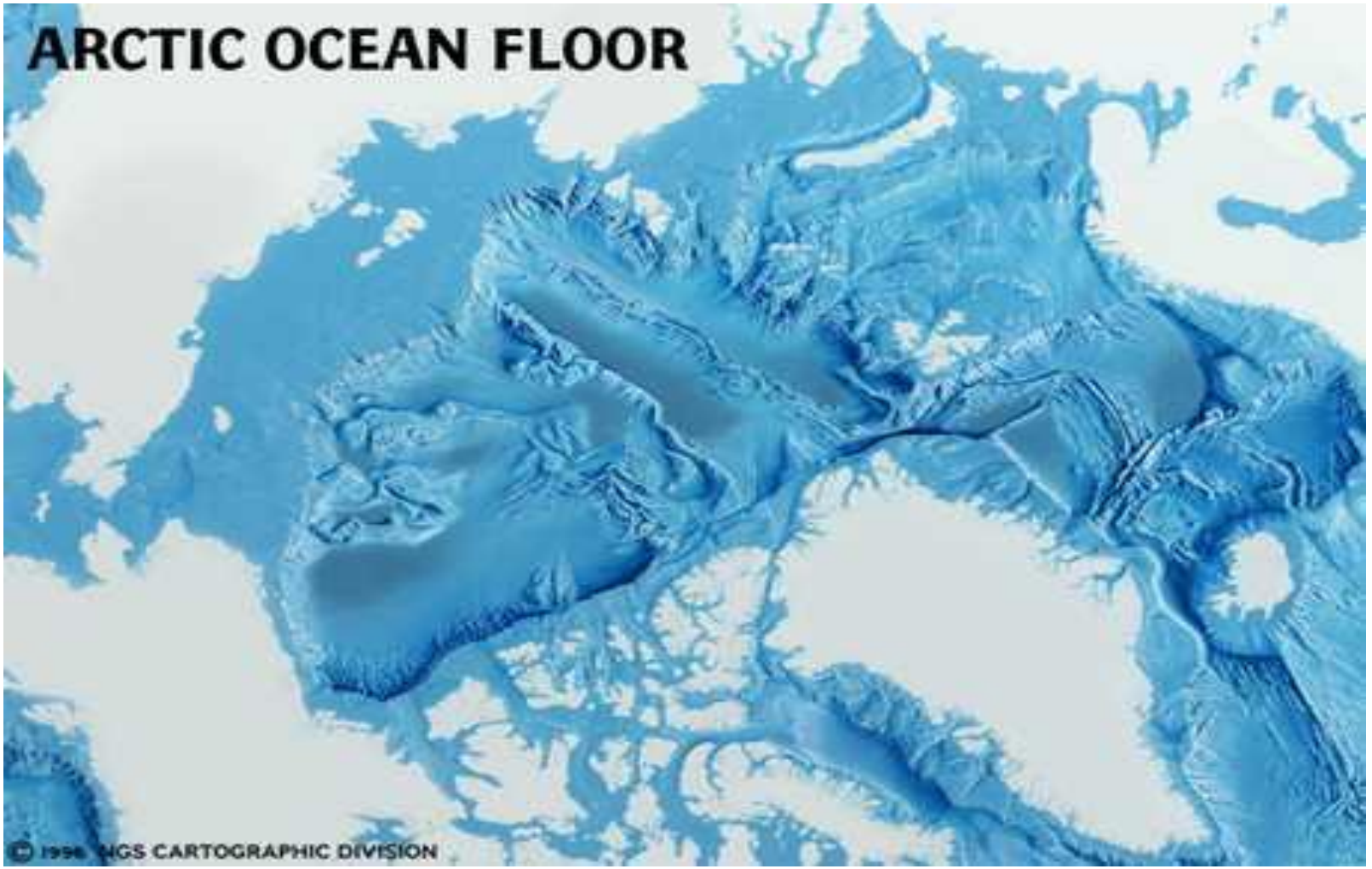
- Sound Navigation and Ranging provided a rapid method of looking through water to identify features on the sea floor.
- The next slide represents how a ship can send down a signal and detect the echo.



P(ic)assow

Heezen and Tharp's "physiographic maps"

- First used in the 1920s, SONAR was widely employed in WW II, and many records became available after the war.
- Bruce Heezen and Marie Tharp here at Lamont developed techniques to change these sonar records into physiographic charts.
- One version of this map is shown in the next slide.



Source: National Geographic Society
www.nationalgeographic.org

“Doc Ewing's 'A Core A Day' "

Almost from the start of LDEO’s ocean research, Doc Ewing established a policy of collecting at least one core each day. He didn’t know what would be found, but he knew that might be the only opportunity to collect something from that location.

Going deeper: DSDP and ODP

JOIDES Resolution is the only research vessel of its kind in the world.

The Ocean Drilling Program (ODP) is an international partnership of scientists and research institutions organized to explore the evolution and structure of Earth.

http://www.oceandrilling.org/

- Original concept was to drill through crust to mantle (“Project Mohole)
- DSDP’s “Glomar Challenger” drilled cores provided new insights into origin of oceans and other important discoveries
- “JOIDES Resolution” continues program, making new discoveries every year.
- LDEO houses the “East Coast Repository”

“ODP: From Mountains to Monsoons” CD

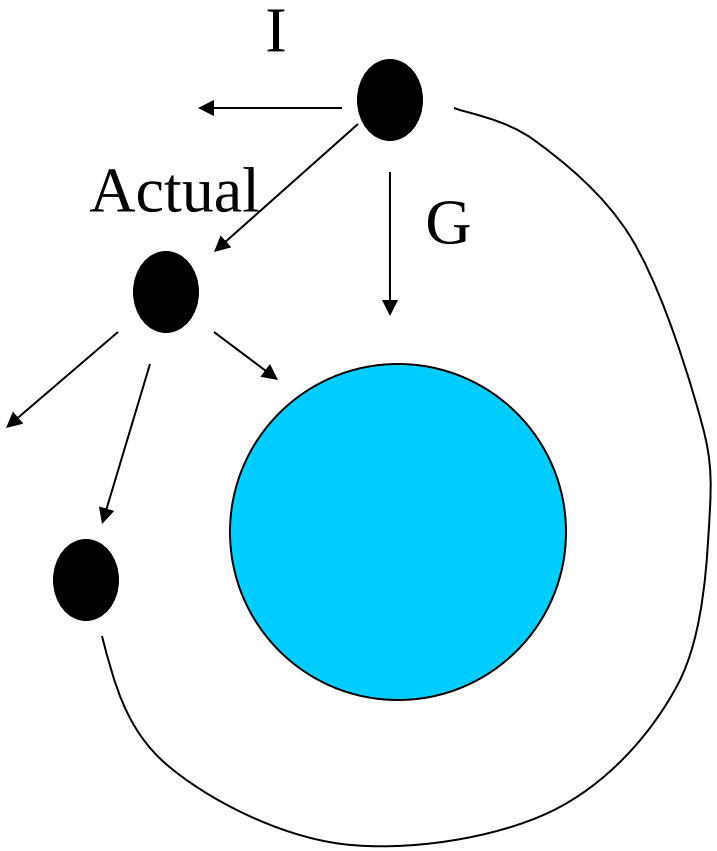
You can get some sense of what we have learned through the ODP through their interactive CD, “From Mountains to Monsoons.” This program features a virtual visit to the JOIDES RESOLUTION during a “leg” in the Indian Ocean, and the opportunity to work with some of the research scientists as they study the sea floors to find out more about monsoons (seasonal changes in precipitation and wind.)

"Satellite Oceanography"

- Sensors aboard satellites provide global views and allow temporal (time) studies not possible from surface vessels.
- Surface topography, El Nino, and ocean winds are some of the areas being investi-gated from space.

http://winds.jpl.nasa.gov/

What Keeps a Satellite in Orbit?

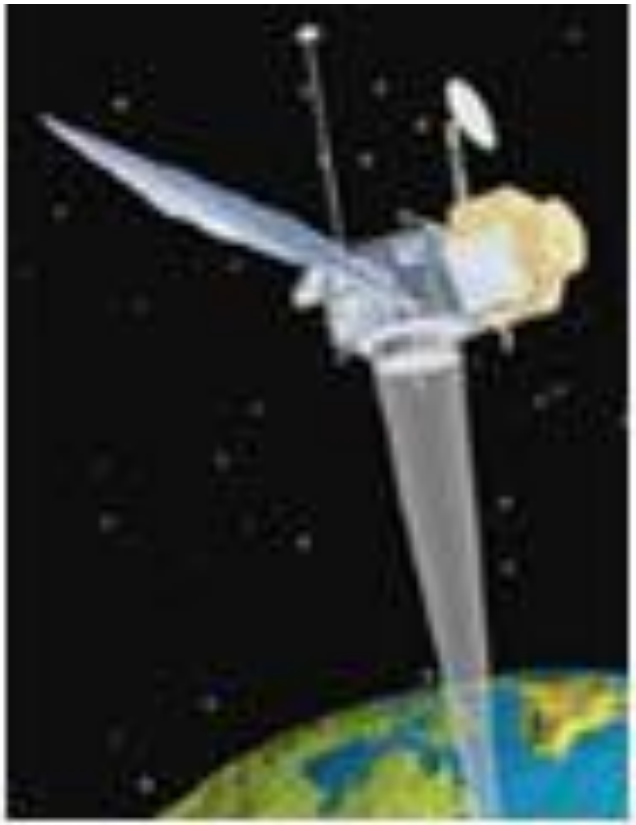


Satellites orbit when Gravity balances Inertia. The Actual path is a “vector” (magnitude + direction.) Keep clicking to create a model representing these interactions.

How Can Satellites "See"?

Satellites can detect what's on Earth in two ways:

- "passive" observation of energy reflected or radiated from the surface
- "active" collection of signals beamed down from the satellite and reflected back



http://topex-www.jpl.nasa.gov/

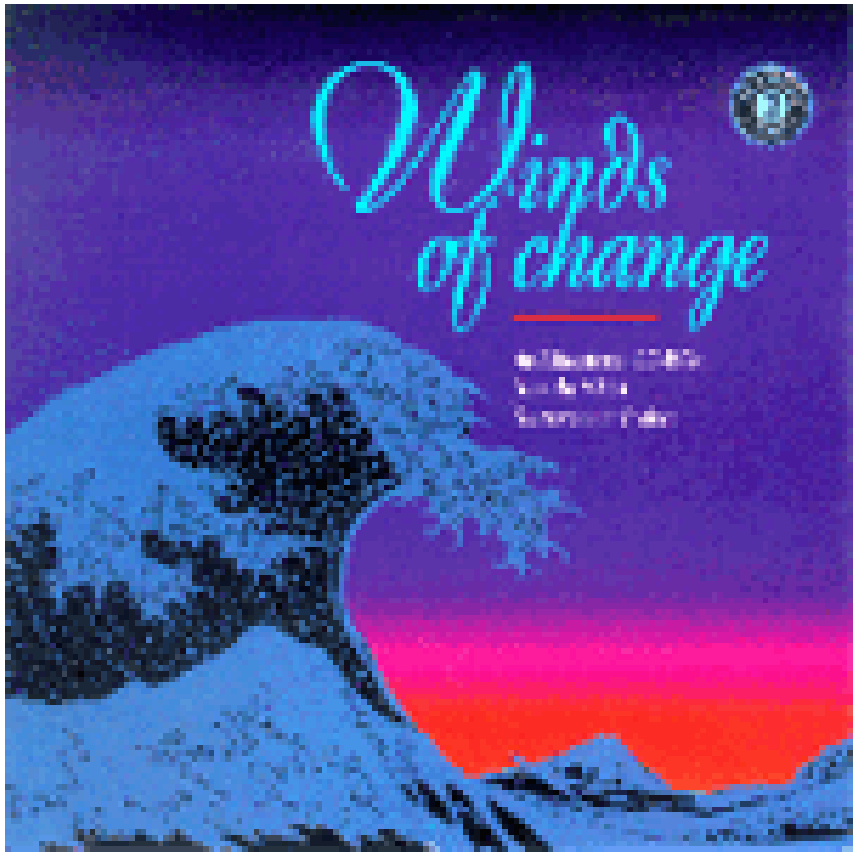
NASA's
"Earth Science Enterprise"

NASA has taken the lead in exploring our planet from space.

You can find out more at their web site:

http://www.earth.nasa.gov/

You can learn more with your "Winds of Change" CD



"Winds of Change" is an interactive CD-ROM designed as a science curriculum resource for middle school teachers. The CD focuses on the topics of oceans, weather, and the earth's atmosphere.

http://winds.jpl.nasa.gov/

"Up, Down, and All Around: Wind-driven and Density-driven Currents"

American Meteorological Society

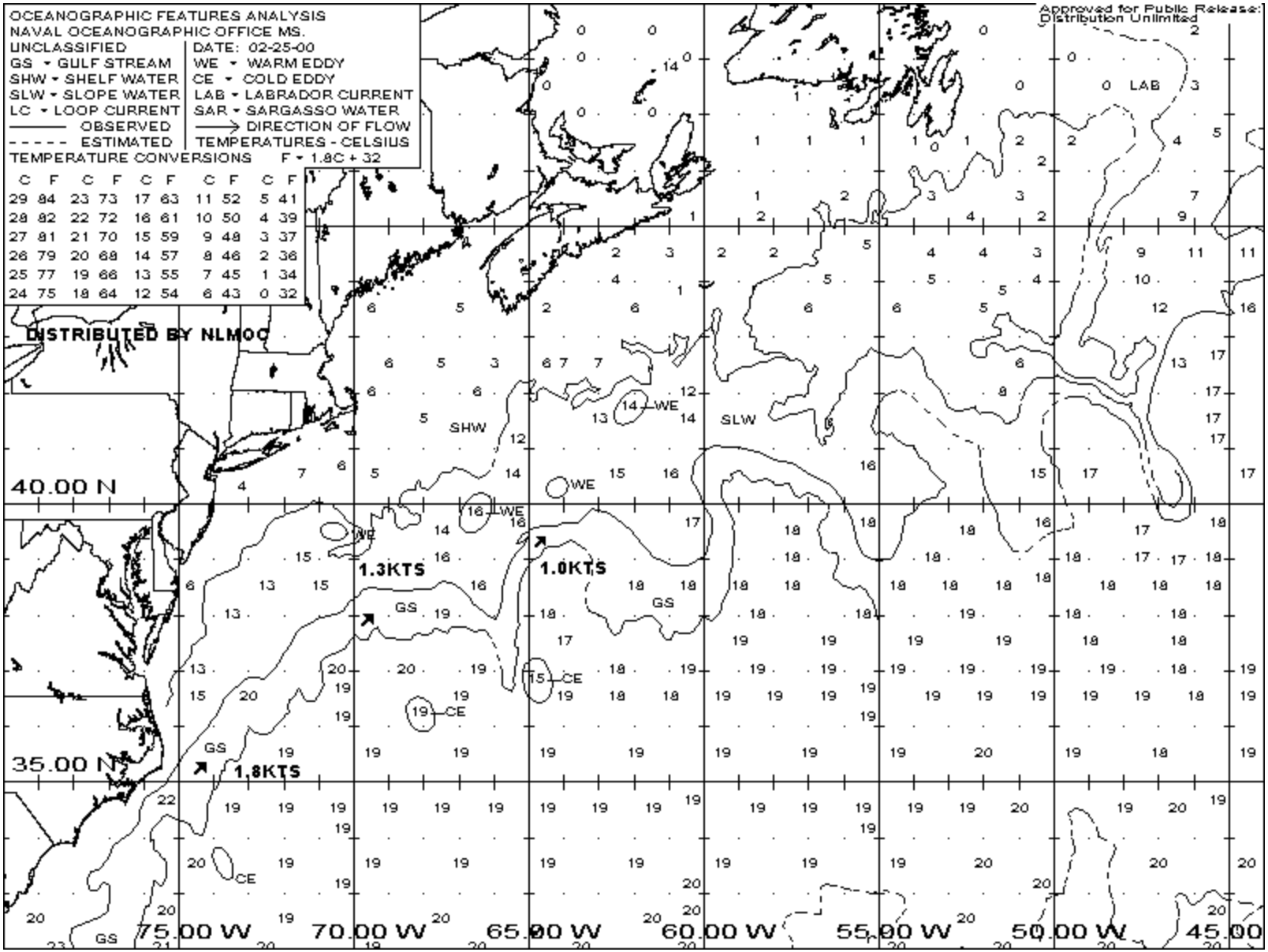
"Maury Project" teacher-training modules

For copyright reasons, we will provide printed copies of these activities, give you time to work through them, and then go over these activities.

How realistic are these models?

General drawings do not present a detailed picture of the true nature of currents.

Satellites and buoys provide more realistic representations. For example, the next slide shows part of the Gulf Stream (“GS”) information available at: http://www.nlmoc.navy.mil/home1.shtml


OCEANOGRAPHIC FEATURES ANALYSIS
NAVAL OCEANOGRAPHIC OFFICE MS.
UNCLASSIFIED
DATE: 02-25-00
GS - GULF STREAM
WE - WARM EDDY
SHW - SHELF WATER
CE - COLD EDDY
SLW - SLOPE WATER
LAB - LABRADOR CURRENT
LC - LOOP CURRENT
SAR - SARGASSO WATER
OBSERVED
DIRECTION OF FLOW
ESTIMATED
TEMPERATURES - CELSIUS
TEMPERATURE CONVERSIONS
F = 1.8C + 32
C F C F C F C F C F
29 84 23 73 17 63 11 52 5 41
28 82 22 72 16 61 10 50 4 39
27 81 21 70 15 59 9 48 3 37
26 79 20 68 14 57 8 46 2 36
25 77 19 66 13 55 7 45 1 34
24 75 18 64 12 54 6 43 0 32
Approved for Public Release:
Distribution Unlimited
DISTRIBUTED BY NLMOC
LAB
SHW
SLW
WE
CE
GS
1.3KTS
1.0KTS
1.8KTS
40.00 N
35.00 N
75.00 W
70.00 W
65.00 W
60.00 W
55.00 W
50.00 W
45.00

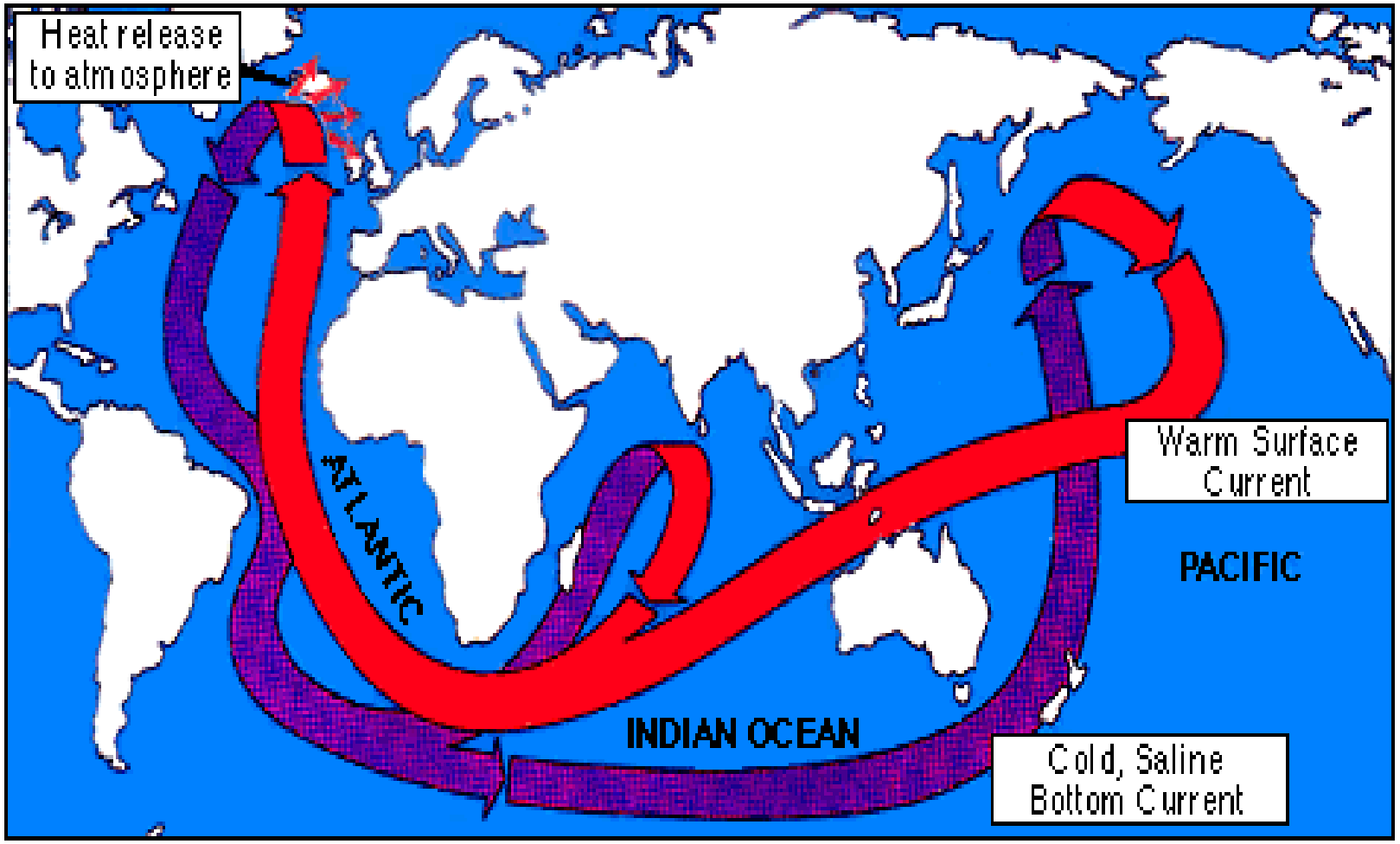
Is there a better model of ocean circulation than these generalized representations?

Greater understanding of ocean circulation from ships, satellites, and other methods led Dr. Wally Broecker of LDEO to propose a startling new theory:

the OCEAN CONVEYOR BELT

In the North Atlantic, water loses heat and sinks, beginning a slow, worldwide movement involving cold bottom currents and warm surface currents. One model of this is shown in the next slide.

Changes in global variables, such as CO2 levels, seem to be capable of producing “rapid” changes in this flow, which may alter global climate patterns.



The present large-scale ocean current system determines climate to a great extent. The huge "conveyor belt" reacts extremely sensitively to global temperature changes accompanying each increase and decrease in the content of carbon dioxide in the atmosphere. - Broecker

http://rainbow.ldgo.columbia.edu/ees/climate/slides/belt.gif

How can we find out about past changes? Evidence has been discovered in the micro-fossils and ice-rafted particles deposited in sediments blanketing the ocean floors.

LDEO's Deep-Sea Sample Repository is the greatest collection of these sediments.

Curator Rusty Lotti Bond hosts a tour of the Deep-Sea Sample Repository