RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

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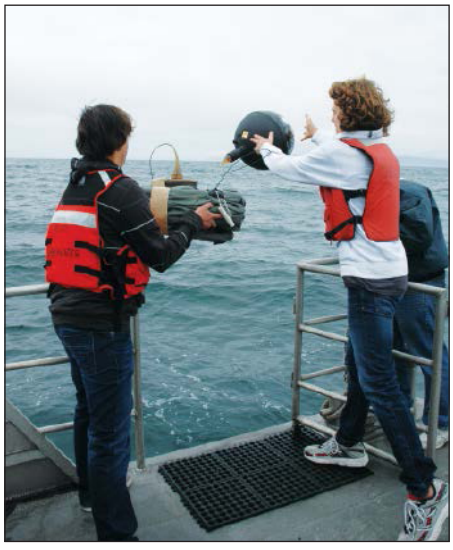
New surface ocean current maps created from drifter data

The Global Drifter Program, which began in 1979 in the tropical Pacific Ocean, now spans the globe with a total of 1250 sensors. Tracked from orbit by satellites, the array provides a way to observe global near-surface ocean circulation patterns.

To create an improved representation of the global ocean near-surface currents, *Lumpkin and Johnson* devised a new technique to analyze drifter records. Using 6-hourly drifter observations from 1979 to 2012, the authors isolated the drifter movement caused by near-surface currents. They then calculated the current properties on a 0.5° by 0.5° grid. Their approach was novel in that the data were analyzed in elliptical bins, with the shape of each ellipse representing the range of variability of the surface currents observed within that bin. The authors modeled both seasonal variations and interannual changes caused by the El Niño–Southern Oscillation. In this way the authors were able to compile monthly climatologies for each bin, visually representing not just the mean current speed but also its variability. Knowing the variability for each model bin gives an indication of the importance of both mean and eddy-driven currents in each region.

In their model the authors were able to represent many of the world's major ocean currents. They captured the seasonal cycle in current behavior, along with patterns and seasonal shifts in near-surface eddies. (*Journal of Geophysical Research-Oceans*, doi:10.1002/jgrc.20210, 2013) —CS



Shaun Dolk / NOAA

Students deploy drifters for the Global Drifter Program as part of the National Oceanic and Atmospheric Association's 2012 Earth Day events.

Isotope variability in water vapor over Southern California

Variations in the ratios of different isotopes of hydrogen and oxygen in water have long been used to trace water cycle processes, and the isotopic composition of water vapor in the atmosphere is known to change with weather events. *Farlin et al.* measured the isotopic composition of atmospheric water vapor in San Diego, Calif., at hourly intervals during February 2011 using a ground-based sensor. The time period included severe rainstorms and Santa Ana winds. They also used a general circulation model that included simulation of isotope variability to investigate how atmospheric and hydrologic processes affect isotope composition of water vapor near the surface.

They found that convective mixing of moist marine air and dry continental air causes most of the moisture and isotope content variation in their location and that Santa Ana winds are great examples of these mixing events. The authors use isotope and mixing ratios to infer the origin of moisture that contributes to the atmospheric moisture content in Southern California and show that transport of vapor from the tropical Pacific is a major source of this moisture. (*Water Resources Research*, doi:10.1002/wrcr.20305, 2013) —EB

The solar system has a bow shock after all—it is just slow

As our solar system travels through the Milky Way, the Sun's magnetic field interacts with the interstellar magnetic field and the interstellar medium, a mix of dust and gas that permeates interstellar space. At the edge of the heliosphere—the region of the solar system bounded by the Sun's magnetic field—the outflowing solar wind meets the interstellar medium to form the heliopause. On the far side of the heliopause the gas, dust, and cosmic rays of the interstellar medium slow down and pile up to form a structure known as a bow shock.

Bow shocks are common features where a magnetic field meets a relatively fast flowing medium. For instance, there is a thin bow shock upstream in the solar wind of the magnetopause, where the Earth's magnetic field meets the solar wind. For years, scientists have hypothesized the existence of a bow shock out in front of the solar system. Observations made with NASA's recent Interstellar Boundary Explorer (IBEX) mission seemed to refute this claim. New research by *Zieger et al.*, however, found that the bow shock likely exists after all. The previous research using the IBEX observations only considered the presence of a bow shock like the one at Earth. In the present study the authors found that the bow shock would take a different form, what is known as a "slow bow shock."

The authors say that the Voyager 1 probe is expected to pass through the bow shock well after it leaves the heliosphere, although by then, its battery will be long dead. (*Geophysical Research Letters*, doi:10.1002/grl.50576, 2013) —CS

Can West African monsoon rainfall be predicted on decadal time scales?

The economies in much of West Africa are based on agriculture, which is strongly affected by rainfall variability. Thus, predictions of variations in West African monsoon rainfall could be valuable to people in those regions.

The West African monsoon system varies on time scales ranging from seasons to decades and is influenced by both local weather patterns and more distant phenomena. The dominant driver of West African monsoon variability is sea surface temperature, but atmospheric variability, global warming, and land surface vegetation with its dust feedbacks also contribute. These complicated factors make it challenging to simulate West African monsoon rainfall variability on decadal time scales.

How well do models do? To find out, *Garcia-Serrano et al.* assess the skill of models in the ENSEMBLES project in predicting two area-averaged precipitation indices that are representative of the Guinean and Sahelian rainfall on interannual to decadal time scales. They found that the models have no significant skill in predicting these rainfall indices; the scientists attribute this to the models' difficulty in simulating local tropical convection. However, they found encouraging results in how models simulate and predict the sea surface temperature forcings of these rainfall variability modes. (*Journal of Geophysical Research-Atmospheres*, doi:10.1002/jgrd.50465, 2013) —EB

Southern California ozone pollution declining and changing

Many studies have documented the decline in ozone pollution and its precursors in the Los Angeles air basin over the past several decades. Now *Pollack et al.* have analyzed new data from research aircraft, along with archived data from roadside monitors and ground-based instruments, to provide a synthesis of concentrations and emissions ratios of ozone, other secondary pollutants, and their precursors from 1960 to 2010.

The data show that photochemical processing rates have increased and that reaction pathways have changed, reducing not only ozone but also the organic nitrate compounds associated with eye irritation.

D. Lack/NOAA ESRL

Ground-level ozone is a main component of smog, seen here obscuring the air over Ontario, Calif., in 2010.

According to the authors' analysis, these reductions are the direct result of changes in emissions standards for precursors, indicating that emission control measures in Southern California have been effective. While emissions of precursors have declined, motor vehicles remain the dominant source of emissions in Los Angeles. (*Journal of Geophysical Research-Atmospheres,* doi:10.1002/jgrd.50472, 2013) —EB

Southern Ocean exports carbon less efficiently than previously thought

The Southern Ocean is a major source of gas exchange between the atmosphere and the ocean, accounting for almost 20% of global ocean carbon dioxide (CO_2) uptake. Phytoplankton fix CO_2, converting it to other carbon compounds, and some of this biogenic carbon sinks to the deeper ocean, where it is effectively removed from the atmosphere. Better understanding of the rate of export of carbon particulate matter from the upper ocean is key to improving uncertainties in models that include the Southern Ocean's role in the carbon cycle.

While most studies of carbon transport in the Southern Ocean rely on models, *Maiti et al.* analyzed in situ carbon export data to reexamine the relationships used in models between primary production, export efficiency, and temperature. They found that no single model accurately estimated biological export of carbon in the Southern Ocean. In particular, many models predict an increase in carbon flux with increasing primary productivity, but, in fact, the observational data indicate that carbon flux decreases with increasing productivity. The authors suggest that the Southern Ocean may have a lower potential for biological export of carbon than models had indicated. (*Geophysical Research Letters,* doi:10.1002/grl.50219, 2013) —EB

—Ernie Balcerak, Staff Writer, and Colin Schultz, Writer