

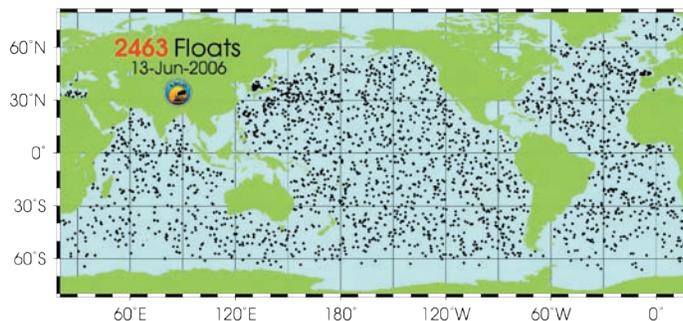
# Measuring Deep Ocean Currents: A New Velocity Data Set

The international Argo program is observing the global ocean with more than 2400 profiling floats (Figure 1). These floats are an unprecedented source of hydrographic data and necessary for climate monitoring and keeping track of the ocean state. The floats sink to about two kilometers below the surface and as they rise, they measure temperature and salinity. When they reach the surface again, which is every 10 days or so, they relay conductivity, temperature, and depth measurements and their location via the Argo satellites. National Data Assembly Centers and two Global Data Acquisition Centers make the data available within 24 hours.



The Argo floats were not designed with deep-ocean current measurement in mind. While “parked” at depth, however, the floats are transported by deep horizontal currents. **Hiroshi Yoshinari, Nikolai Maximenko, and Peter Hacker** at IPRC’s Asia-Pacific Data-Research Center (APDRC) developed a method by which they could estimate the velocity of such currents with these floats. They calculated deep current velocities from float-displacements during the submerged phase of each cycle, and surface velocities from the float-drift during the sea surface phase (Figure 2).

These new, fully public, data sets are now available at IPRC’s Asia-Pacific Data-Research Center under the name



**Figure 1, left:** A PROVOR float shortly before recovery by the Japanese coastguard vessel Takuyo. Courtesy Argo Picture Gallery. **Above:** Position of floats that delivered data during May 13–June 13, 2006.

“YoMaHa’05” (the first two letters of the three scientists’ last names). The set includes almost 167,000 values of velocity from 3039 floats, stored at nine Data Assembly Centers worldwide. The data span the period August 1997 to December 2005. Because the floats are transported by intermediate currents during their brief rise and descent and by time-varying surface currents during their stay of several hours at the surface, both surface and deep velocity data are accompanied by error estimates. These estimates are typically an order of magnitude smaller than the velocity values.

To illustrate how the YoMaHa’05 data can be used, the team calculated mean velocity at depth and at the sea surface by averaging data in  $3^\circ \times 3^\circ$  bins. The deep velocities were calculated from all measurements at parking levels deeper than 750 m and velocity errors less than 2 cm/s. The surface velocities were calculated from all measurements with the sur-

**Figure 2 (top right):** Schematic of float descent, at depth, and ascent. Courtesy of the Southampton Oceanography Center.

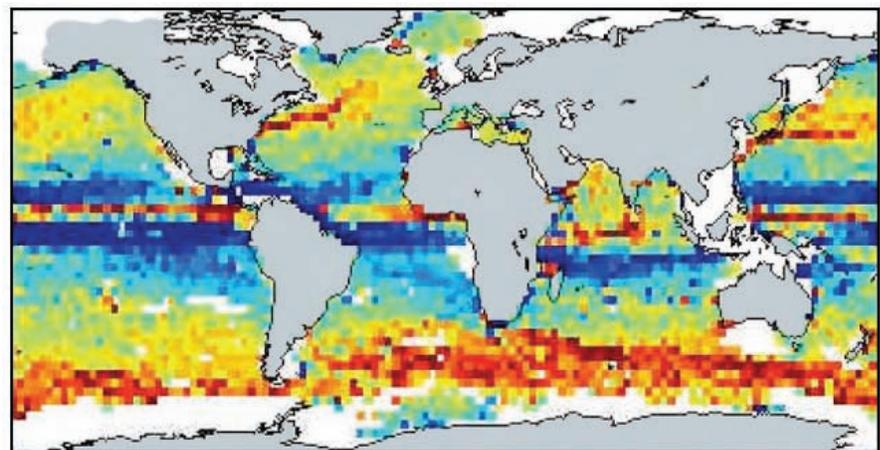
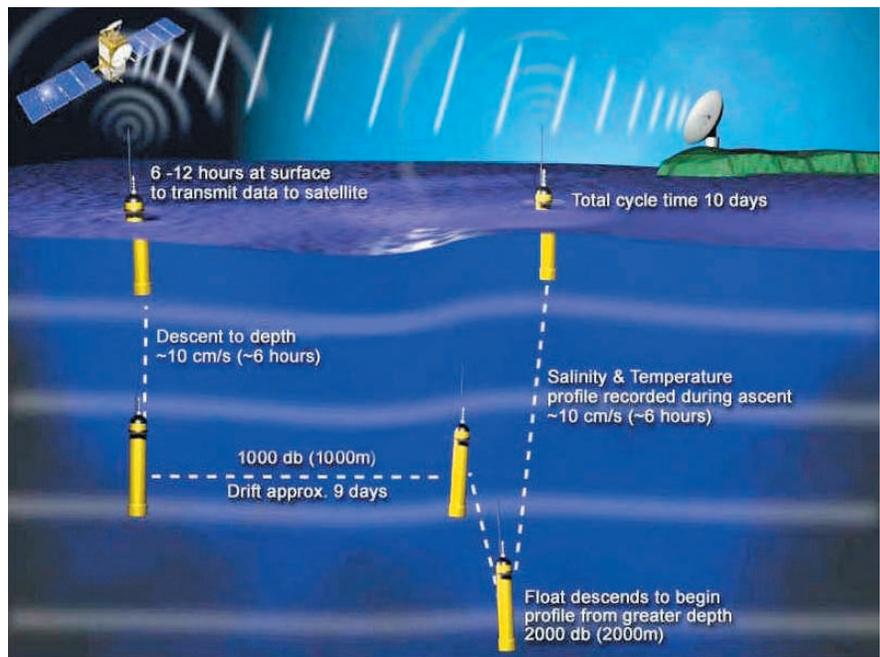
**Figure 3 (below right):** Example application: Shown are ensemble mean zonal velocities in cm/s from the YoMaHa'05 3° x 3° averaged values for the surface currents (top) and the deep currents (bottom).

face velocity errors less than 15 cm/s (Figure 3, top). The surface circulation pattern matches the one Maximenko and Niiler 2005 obtained using surface drifters. Figure 3, bottom, portrays the deep currents as charted by this new method. The currents are extraordinarily strong at depth in the Antarctic Circumpolar Current and contain a number of peculiar structures that invite further study.

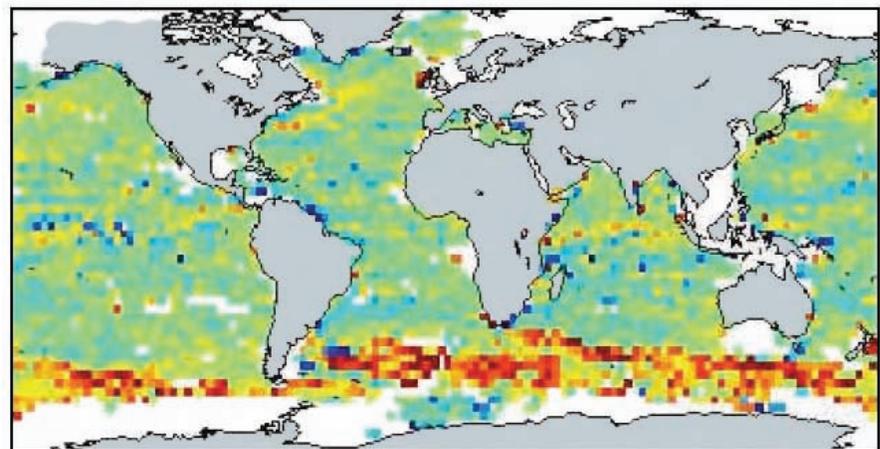
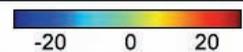
The team plans to combine the CTD (conductivity, temperature, and density) profiles from the Argo floats with the trajectories of the floats to create a high-resolution map of large-scale deep circulation. With such data they will explore the alternating deep zonal jets found by Maximenko and Richards (*IPRC Climate*, Vol. 5, No. 1) in satellite altimetry images and in such high-resolution ocean models as OFES.

The IPRC technical note, *YoMa-Ha'05: Velocity data assessed from trajectories of Argo floats at parking level and at the sea surface*, is available at [iprc.soest.hawaii.edu/publications/tech\\_notes.html](http://iprc.soest.hawaii.edu/publications/tech_notes.html). In the paper, the authors describe the data-distribution in space, time, and among Data Assembly Centers, as well as probability distributions of programmed float parameters and statistics of their displacements.

[iprc](http://iprc)



**Surface**



**Deep**

