HIGH RESOLUTION CURRENT VELOCITY PROFILING FLOATS PRELIMINARY RESULTS FROM SUBANTARCTIC WATERS

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ABSTRACT

The Southern Ocean plays a crucial role in controlling the global climate system. To understand and predict climate variability, it is essential to know the mechanisms and the pathways of circulation in the global ocean. The EM-APEX (ElectroMagnetic-Autonomous Profiling EXplorer) is a recent addition to the Argo float fleet, capable of making very precise measurements of ocean velocities over a wide spatial and temporal range. Here we present some of the EM-APEX float capabilities and preliminary data from the Kerguelen Plateau region in the Southern Ocean.

1. EM-APEX ARGO FLOAT

Argo floats have been providing temperature and salinity profiles around the globe for the past ten years. In addition to taking standard temperature (T), salinity (S) and pressure measurements with a Sea Bird Electronics SBE-41 CTD, the EM-APEX floats also carry an electromagnetic subsystem that measures motionally induced electric fields generated by ocean currents (V) moving through the vertical component of the Earth's magnetic field. There are two visible differences between Argo and EM-APEX floats: the EM-APEX has electrodes around the upper end cap below the CTD, and a collar below this with inclined blades to rotate the float as it descends and ascends, exposing the electrodes to 360° of the current field. Internally, the electromagnetic subsystem has a compass, accelerometers, magnetometers and a processor to convert the voltage difference measured by the electrodes to velocity components relative to a depth-independent offset [1]. Float position is determined by the global positioning system (GPS) when the float surfaces. The T, S, V, position, and other observations are processed within the float and transmitted over the Iridium global cell phone system. The Iridium link is bi-directional, allowing not only data uploads but also downloads of mission changes to the floats. Rather than using standard alkaline batteries, the EM-APEX floats are fitted with lithium batteries providing a far longer life to the floats.

Within the framework of SOFINE (The Southern Ocean FInestructure Experiment), a U.K., U.S. and Australia collaborative experiment investigating the finescale processes that control fluxes in the Antarctic Circumpolar Current (ACC), eight EM-APEX floats were deployed in November 2008 at the northern edge of the Kerguelen Plateau. Within the region of interest (65°E-78°E and 40°-48°S), the floats were programmed to sample rapidly, with a 24 hr cycle made up of four half profiles composing two inertial pairs, to a profiling depth of 1,600 dbar. Once advected past the Kerguelen Plateau region, the sampling strategy changed to a standard Argo 10 day cycle.

2. COLLECTED DATA

Over a two month period, these floats collected four vertical profiles (0-1600 dbar a day, with a vertical sampling of 2-3 dbar for the CTD and of 2-5 dbar for the velocity measurements, depending on the fall rate (Fig. 1). Operating with Lithium batteries, the floats have already recorded in excess of 2,100 profiles. The floats covered a wide range of temperatures (1.9-16°C), salinities (33.7-35.4 psu) and dynamic heights (0.4-1 m on the 500 dbar surface relative to 1,500 dbar). The relative velocity profiles can be converted to absolute velocity using the GPS surface positions. The depth-independent offset is determined by combining the trajectory from integrating relative velocity along the subsurface path of consecutive down and up profiles, and the GPS surface positions of those two profiles. The result is absolute velocity profiles to 1600 dbar.

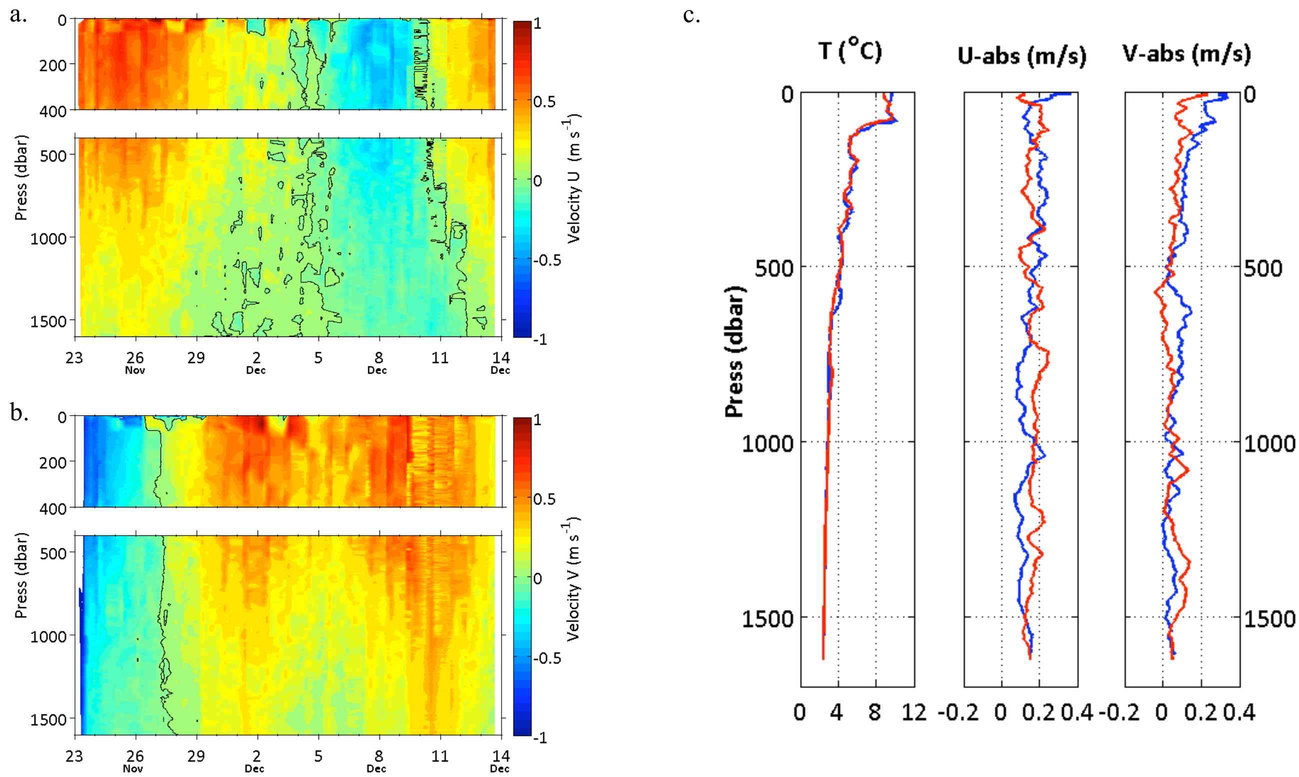

Figure 1. Float 3951 absolute velocities drape plot, (a) U and (b) V. Float 3952 inertial pairs of T and relative velocities (c) where profile 1 and 2 are sampled approximately half an inertial period (~8 hrs) apart

3. APPLICATIONS

Combining the geographic scope of floats with improved vertical and horizontal resolution as well as absolute velocity measurements, makes EM-APEX data particularly valuable. With the preliminary data analysis results, we can explore the ocean-atmosphere interaction and interior ocean wave propagation. The float's rapid profiling strategy can significantly facilitate our understanding of the internal wave climate. For example, having pairs of vertical profiles separated by half an inertial period allows easy identification of near-inertial shear. On the northern Kerguelen Plateau, two main jets of the ACC form a large standing meander. We anticipated that the strong geostrophic flow over the roughness of the Plateau's slope would generate some turbulence, be it via internal wave breaking or other instability processes. Improved vertical resolution not only allows far more accurate estimates of internal wave shear and strain, but in some instance could allow direct observation of turbulent overturns, potentially allowing us to derive internal mixing estimates from the EM-APEX float data, using finescale parameterisation methods such as the Thorpe scale method [2] and the Gregg-Henyey-Polzin shear/strain method [3].

In Fig. 2 the maximum value of N2 in the vertical indicates the depth of the thermocline and small-scale variability in upper 200 m, while in vertical profiles of the Thorpe scales, noticeable propagating features appear in the water column structure (not shown).

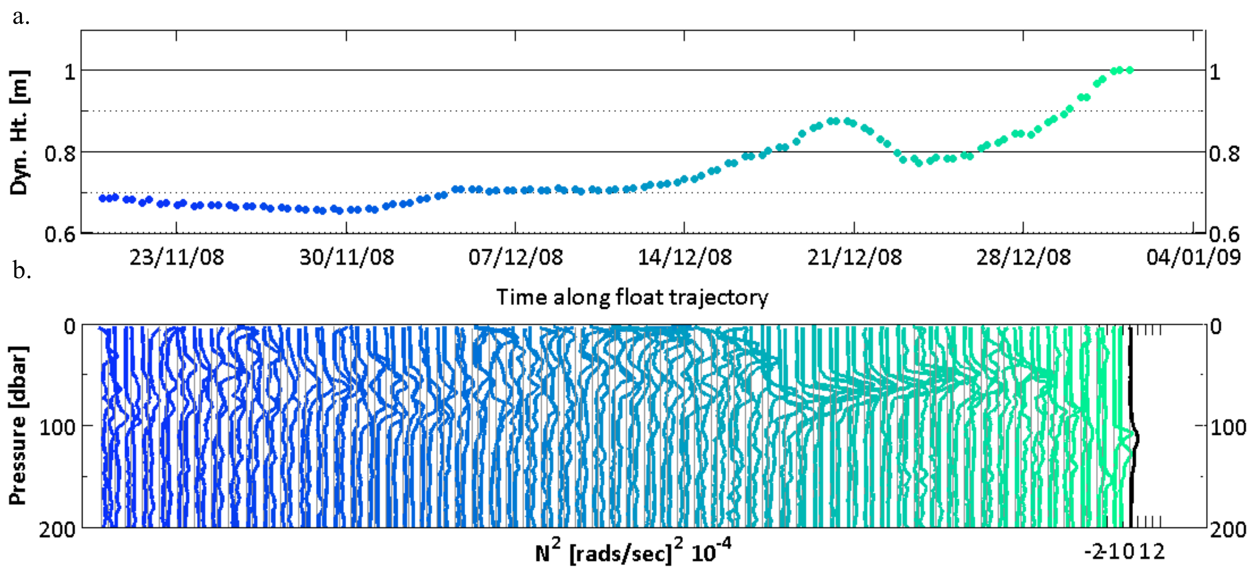

Figure 2. Float 3762 evolution of (a) dynamic height over time and distance on the 500 dbar surface relative to 1500 dbar. (b) Corresponding Brunt Väisälä Frequency (N^2) profiles. For clarity, only half the available profiles are represented here, each line corresponding to one profile and the last profile providing a reference scale for N^2

3. CONCLUSION

Preliminary results demonstrate that the EM-APEX float is an excellent tool to observe the ocean's thermohaline and velocity structure at high temporal and spatial resolution. These data have the potential to provide great insight into vertical and lateral mixing in the ACC, the evolution of the surface mixed layer, and the spatial structure of the velocity field with its implications for the meridional transfer of heat and other water properties.

4. REFERENCES

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