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Linking surface and sub-surface variability in Drake Passage

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The Antarctic Circumpolar Current (ACC) is one of the major oceanic currents, and exerts a controlling influence on the climate of Antarctica. The flow of around 130 Sv is concentrated along three fronts — the Subantarctic Front (SAF), the Polar Front (PF) and the South Antarctic Circumpolar Current Front (SACCF). Heat transport across these fronts is primarily driven by eddy processes, with fronts developing meanders and budding cyclonic eddies to the north and anticyclonic eddies to the south. Monitoring of the size, location and frequency of generation of these features is thus critical to an understanding of the heat transport across the ACC.

Satellites are ideal for following the surface expression of eddies, both through the sea surface height measured by radar altimeters, and by records of sea surface temperature (SST). Unfortunately patchy but frequent cloud cover makes infra-red observation of the surface difficult, whilst passive microwave sensors, such as AMSR-E, have instrumental footprints comparable to the Rossby radius of deformation at this latitude. Consequently the latter can only be used to detect warm and cold features, but are not able to resolve much of the detail within them. Another issue is that some of the key fronts have a strong temperature and salinity signature at depth, but do not have a pronounced thermal gradient at the surface due a layer of relatively warm fresh water on top. Ocean colour data, usually derived chlorophyll concentrations from sensors such as SeaWiFS, can also be used for monitoring, as the difference in productivity across a front can be quite marked.

In this work, we study the fronts and eddy generation and propagation near Drake Passage, the narrowest "choke point" across the ACC. During austral summer, when the coverage by sea-ice is much reduced, there are almost monthly hydrographic sections using XBTs or CTDs that can help reveal the subsurface thermal structure. Initially we have focussed on the high-resolution XBT lines performed by the LM Gould en route to supply the US base on Antarctica, but we plan to incorporate data from SR1b, the annual repeat section run by the UK from Burdwood Bank (south of the Falklands) to Elephant Island. By using the 800m deep XBT transects in combination with satellite data we are better able to follow the development of features within altimetry and assess the satellites' rate of success in identifying features.

We use the Okubo-Weiss parameter to give a clear decision as to the presence or not of an eddy. The number of cyclonic and anticyclonic eddies are roughly the same, except for in the most intense category. The peak in eddy kinetic energy (EKE) lies just to the south of the SAF, whereas the peak in temperature variability is found further south near the mean position of the Polar Front. A number of the eddies can also be observed in ocean colour, with the signals sometimes persisting for more than a month, probably indicating that the upwelling within the eddy is prolonging the lifetime of the biology in that closed system.