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The ECCO Consortium: What caused the record warming event in the South Pacific associated with El Niño 2009-10?

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Satellite and in-situ measurements of the ocean and atmosphere, an ECCO ocean state estimation product, and NCEP/DOE-II reanalysis products are used to document the evolution of an extreme oceanic and atmospheric event in the South Pacific and western Antarctica associated with the 2009-10 El Niño. Observations revealed a five-standard deviation, record warming event in a large mid- to high-latitude region of the South Pacific Ocean from late 2009 to early 2010. Analysis suggests that the warming is associated with a huge, unusually strong and persistent anticyclone over the South Pacific. The anticyclone blocked off synoptic weather systems and reduced synoptic wind variability, causing a significant reduction in latent heat loss. The easterly wind anomaly in the northern flank of the anticyclone cut off the usual Ekman advection of cold Southern Ocean water (associated with the normal circumpolar westerly wind). These two processes are found to account for a major portion of the warming. However, the observational analysis cannot close the budget, in large part because of the unresolved vertical processes. An ECCO product, characterized by heat budget closure and reproducing the observed changes in mixed layer properties, is used to provide a complete description of the heat balance. The results indicate that surface heat flux and ocean processes play comparable roles in causing the warming. Ocean processes are dominated by the meridional Ekman advection of heat (due to less northward intrusion of cold water) and detrainment warming due to a dramatic shoaling of the mixed layer (caused by weaker synoptic wind fluctuation).