Mixed-Layer Depth and Air-Sea Exchange in the Southern Ocean: Examples from Drake Passage

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The Southern Ocean is known for extreme winds and cold weather that are favorable for the formation of deep mixed layers. Mixed-layer depth is important for air-sea heat exchange, because the mixed layer is the conduit from the atmosphere to the ocean, and deeper mixed layers imply the possibility of greater oceanic uptake of heat and CO_2 from the atmosphere. In Drake Passage, repeat XBT and XCTD transects collected since 1996 reveal variability in mixed-layer depth (MLD) at a range of spatial and temporal scales. A seasonal cycle dominates the temporal variability; the mixed layer is shallowest and its variance is smallest at the start of austral summer, when mixed layers can be shallower than 10 meters. In contrast, winter mixed layers can reach depths greater than 400 meters. Considerable interannual variability is evident, particularly in the timing and location of deep mixed layers. South of the Polar Front, mixed layers are comparatively shallow and exhibit minimal spatial variability. In contrast, the deepest mixed-layers are localized north of the Polar Front, where small-scale (O(20 km)) variability is common. Oceanic eddies may be responsible for the localized deep mixed layers, but it remains unclear whether the role of eddies is primarily to precondition the ocean stratification, allowing deep mixed layers to form easily, or whether oceanic eddies also influence local air-sea heat fluxes in a way that further contributes to the formation of deep mixed layers.