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The Role of daily surface forcing in setting the temperature and mixed layer structure of the Southern Ocean

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The role of high-frequency surface forcing in setting the temperature and mixed-layer structure in the Southern Ocean is investigated in an ocean general circulation model. The analysis suggests that daily fluctuations in the momentum flux, and the enhanced vertical mixing they produce, have the biggest effect on the time-mean temperature and mixed layer structure. In particular, summer-time surface temperatures are cooler, subsurface temperatures are warmer, and the summer-time mixed layer is thicker in the experiment with daily forcing than in the one without. The winter-time mixed layer in the Pacific sector is, however, thinner in the presence of daily forcing due to the enhanced density contrast between the mixed layer and the ocean below.

Daily fluctuations in the surface momentum flux are the leading cause of the high-frequency temperature variability at the high latitudes of the Southern Ocean, whereas the daily variability in the surface heat flux is more important at the mid latitudes. Since the air and sea-surface temperatures do not co-vary on short time scales in this study, daily fluctuations in the air temperature/humidity cause substantial variability in the air-sea turbulent exchanges of heat. The high-frequency part of the wavenumber-frequency spectrum of the daily SSTs is interpreted using a conceptual model of the response of the Southern Ocean to passing atmospheric storms. For high-to-medium frequencies, the preferred wavelengths in the conceptual model are determined by fast atmospheric advection; preferred low frequencies, in contrast, are determined by slow oceanic advection.