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Dynamics of the atmospheric boundary layer response to ocean mesoscale sea surface temperatures

Niklas Schneider (1), Bunmei Taguchi (2), Masami Nonaka (3), Akira Kuwano-Yoshida (3), and Hisashi Nakamura (2)

(1) University of Hawaii, International Pacific Research Center, Honolulu, United States (nschneid@hawaii.edu), (2) Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan, (3) Application Laboratory, Japan Marine-Earth Science and Technology, Yokohama, Japan

A recent theory for the mid-latitude atmospheric response to ocean mesoscale sea surface temperature (SST) variations is tested in the Southern Ocean using an extended integration of an atmospheric general circulation model. The theory is based on a linearization of the steady state, atmospheric boundary-layer dynamics, and yields the atmospheric response as classical Ekman dynamics extended to include advection, and sea surface temperature induced changes of atmospheric mixing and hydrostatic pressure. The theory predicts the response at each horizontal wave number to be governed by spectral transfer function between sea surface temperature and boundary layer variables, that are dependent on large-scale winds and the formulation of boundary layer mixing. The general circulation model, AFES, is shown to reproduce observed regressions between surface wind stress and sea surface temperatures. These 'coupling coefficients' are explained by SST induced changes of the surface stability, that directly impact surface stress, and changes of the surface winds. Estimates of the spectral transfer function between the latter and surface temperature are consistent with the theory, and suggest that it faithfully captures the underlying physics.