Scale-dependence of observed wind stress response to ocean-mesoscale surface temperatures

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Ocean-mesoscale sea surface temperatures (SST) leave a strong imprint on surface wind stress. To explore the dependences of underlying dynamics on length-scale and on large-scale wind direction and speed, we represent the spatial co-variability of wind stress and SST by spectral transfer functions. These relate spectral amplitudes of winds and SST as a function of wave numbers aligned with, and perpendicular to, large-scale winds. Together with the large-scale wind speeds, the former defines the downwind Rossby number. Application in the Southern Ocean shows distinct sensitivities to the direction and speed of the large-scale winds. For large Rossby numbers, ocean-mesoscale SST induced wind speeds are large and include, for swift large-scale winds, a lagged component. This suggests modulation of vertical mixing as underlying process. SST induced changes of wind speed peak are largest for Rossby numbers of order one, and suggest advection, rotation and SST induced vertical mixing pressure gradients are important. For large wave--numbers perpendicular to background winds, responses of wind speed and direction reflect vertical mixing and pressure gradients. Conversions of wind components to wind divergence and curl shows the former dominated by large Rossby numbers, while the latter is significant for large wave-numbers perpendicular to large-scale winds.

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