IMAGe Seminar

Institute for Mathematics Applied to Geosciences at NCAR

The Impact of Rapid Wind Variability upon Air-Sea Thermal Coupling

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Abstract:

The basic effect of extratropical atmosphere-ocean thermal coupling is to enhance the variance of both anomalous sea surface temperatures (SST) and air temperatures (AIRT) due to a decreased energy flux between the atmosphere and ocean, called reduced thermal damping. In this presentation it is shown that rapidly-varying winds have an important effect upon the turbulent surface heat fluxes that drive this coupling during wintertime, acting to effectively weaken the coupling and thus partially counteracting the reduced thermal damping.

The nonlinear relationship between the rapidly-varying wind speed anomalies and SST and AIRT anomalies results in a rapidly varying component of the surface heat fluxes. It is shown, however, that the clear separation between the dynamical timescales of the ocean and atmosphere allows a simple approximation of this rapidly varying flux by a stochastic process. In many previous studies such a stochastic term is approximated by Gaussian white-noise with fixed variance (that is, additive noise). However, as it is shown from first principles, this stochastic heat flux term depends upon not only the fast winds but also upon the more slowly-evolving thermal anomalies. Such state-dependent (multiplicative) noise can alter the dynamics of atmosphere-ocean coupling because it induces an additional heat flux term (the noise-induced drift). The noise-induced drift acts to effectively weaken coupling but also to effectively weaken dissipation. A key consequence of the outlined theory is that air-sea coupling includes both deterministic and stochastic components. The hypothesis is tested by examining daily observations at several Ocean Weather Stations (OWSs) and other observational SST/AIRT datasets.

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