Representing truncated structures in simple planetary wave models

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Abstract

In traditional simple planetary wave models the effect of unresolved structures on the resolved waves is accounted for through Rayleigh damping and noise that is white in space and time. For some purposes this representation is adequate but for other applications it is not. One of the prime reasons for its inadequacy is that momentum fluxes generated by unresolved scales are highly organized and this organization depends on many properties including the resolved state of the system, the time scale of the unresolved structures and their geographical location. In this presentation we analyze data from nature and from atmospheric general circulation models to highlight some of the properties of these momentum fluxes as a way of demonstrating important properties that any means of representing these unresolved scales should strive to have. Then, given these properties, we present several examples of planetary wave models that are able to capture at least some of the properties of the unresolved structures. These include a linearization of the observed statistical relationship between observed state and associated eddy momentum fluxes, incorporation of such linear feedbacks via linear inverse modeling, and use of the fluctuation dissipation theorem. All of these approaches lead to linear representation of the effects of unresolved on resolved scales. Further analysis of system states shows that for some large scale patterns a linear approximation of these feedbacks is not a good approximation. For

these patterns we present two approaches that may be able to capture the essence of the nonlinearity. The first fits simple functions to historical associations between resolved state and tendencies. The second relies on the fact that the statistics of the unresolved structures can often be well approximated from stochastic models linearized about the resolved structures.