2017 SEMINAR SERIES

Dr. Mikael Witte of NCAR's Earth Observing Laboratory presents

Scaling analysis of cloud and rain liquid water content and implications for microphysical parameterizations

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NCAR-Foothills Laboratory
3450 Mitchell Lane
Bldg 2 Large Auditorium (Rm 1022)

Abstract:

The spatial covariance of cloud and rain water (or in simpler terms, small and large drops, respectively) is an important quantity for accurate prediction of process rates in bulk microphysical parameterizations that account for subgrid variability using assumed probability density functions (pdfs). Past diagnoses of this covariance from remote sensing, in situ measurements and large eddy simulation output have implicitly assumed that the magnitude of the covariance is insensitive to grain size (i.e. horizontal resolution) and averaging length, but this is not the case because both cloud and rain water exhibit scale invariance across a wide range of scales – from tens of centimeters to tens of kilometers in the case of cloud water, a range that we will show is primarily limited by instrumentation and sampling issues. Since the individual variances systematically vary as a function of spatial scale, it should be expected that the covariance follows a similar relationship.

In this study, we quantify the scaling properties of cloud and rain water content and their covariability from high frequency in situ aircraft measurements of marine stratocumulus taken over the southeastern Pacific Ocean during the VOCALS-REx field experiment of October-November 2008. First we confirm that cloud and rain water have distinct scaling properties, indicating that there is a statistically and potentially physically significant difference in the spatial structure of the two fields. Next, we demonstrate that the covariance is a strong function of spatial scale, which implies important caveats regarding the ability of limited-area models with horizontal domains smaller than a few tens of kilometers across to accurately reproduce the spatial organization of precipitation. Finally, we present multifractal analyses of cloud and rain water, the results of which provide a framework for the development of a scale-aware parameterization of cloud-rain water subgrid covariability intended for application in large-scale model microphysics schemes.

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