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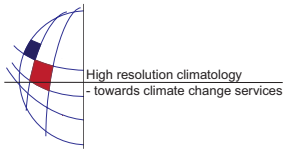

Observations of Upper-level Turbulence Statistics

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Direct observations of $\varepsilon^{1/3}$ (where ε is the eddy dissipation rate) from specially-equipped commercial aircraft and estimates based on velocity structure functions of velocity measurements from AMDAR-equipped aircraft and rawinsondes are now available in sufficient numbers to provide robust climalotogies of upper level turbulence statistics. A review of these observations will be presented. In particular it is shown that a lognormal distribution of $\varepsilon^{1/3}$ is a robust description. However average values of $\varepsilon^{1/3}$ show a significant geographic, altitude, and seasonal dependence. The horizontal spatial statistics are essentially equivalent for calculations on constant pressure surfaces or constant altitude surfaces.

Upper-level spectra obtained from research aircraft are also presented. They show a robust k^{-3} (where k is horizontal wavenumber) at the largest scales transitioning to two $k^{-5/3}$ regions at smaller scales. We speculate that the superposition of random gravity waves is responsible for some of this small scale behavior.

These resulting climatologies provide a useful metric for NWP evaluations, i.e. the observed spatial statistics should be reproduced in NWP model output. In addition, these results can be used to help evaluate various theoretical and empirical predictions for mesoscale turbulence.