Data Assimilation for Flows which Possess Many Scales of Motion

Chris Snyder

NCAR, Boulder, Colorado, USA.

As available computing increases, data-assimilation systems have begun to resolve multiple scales of motion. Lorenz (1969) demonstrated in a model of isotropic, homogeneous turbulence how the predictability of flows with a range of scales could change qualitatively depending on whether the exponent of their kinetic-energy power law was greater than, or less than or equal to, -3. Idealized data assimilation in the same model reflects this underlying behavior. When the kinetic-energy exponent is equal to -3 [the situation that characterizes atmospheric motions for scales larger than O(100 km)], cycling data assimilation generically captures scales smaller than those resolved by the observational network. In the opposite case, with an exponent larger than -3 and thus a flatter kinetic-energy spectrum, recovery of unobserved scales by the assimilation scheme is much more limited. In addition, the magnitude of the effects of forecast-model error, when that error is sufficiently small, depend sensitively on both their spectral shape, i.e. whether the model error affects primarily large or small scales, and the kinetic-energy power law of the flow. All these properties follow from the fact that the power law of the flow determines whether differences between two realizations of the flow grow most rapidly at large scales or small.

References

Lorenz, E. N., 1969: The predictability of a flow which possesses many scales of motion. *Tellus,* 21, 289-307.