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Numerical aspects of thermal convection

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We present a systematic study of numerical aspects of advection/diffusion in thermal convection as realized in large-scale high-resolution numerical models. With rapid progress in computer technology the NWP models with 10 km horizontal resolution (or better) will become standard in the near future; cf. recent calculations by the Frontier Research Center group in Japan (Satoh et al, J. Comput. Phys. 2007, doi:10.1016/j.jcp.2007.02.006) conducted at 3.5 km resolution. While such resolutions are impressive by the standards of NWP, they are still overly coarse (by two orders of magnitude at least) to represent convection up to the standards of cloud-resolving models. In effect, NWP is entering a new regime, where traditional convection parameterization is already obsolete, but large-eddy-simulation is still beyond the reach. In this regime the convective response to advection/diffusion realization is extremely sensitive to filtering embedded in numerical model — e.g., via subgrid-scale models and/or numerical approximations employed — and can take variety of forms. This in turn reflects on simulated weather and climate due to their dependence on cloud field structure via precipitation and radiation. Here, we report on our investigation of numerical effects that influence structure of simulated convection at its roots; i.e., in planetary boundary layer. In particular, we focus on effective viscosity and diffusivity representative of contemporary numerical models.