Geophysical Research Abstracts, Vol. 7, 08054, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08054

Assimilation of Continuous Cloud-to-Ground Lightning in Mesoscale Models

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A technique developed for assimilating regional lightning measurements into a meteorological model is presented in this study. The goal is to exploit how useful Cloud-to-Ground (CG) lightning information can be for improving the convective precipitation forecasting. The main concept of the technique is that utilizing real-time location, timing and flash rate data retrieved from a long-range lightning detection network, a regional/mesoscale meteorological model is informed about the deep moist convection spatio-temporal development and intensity. This information is then used to nudge the model-generated humidity profiles to empirical profiles as function of the observed lightning intensity. The nudging is based on (i) an empirical local humidity profile representing deep convection conditions, and (ii) a relationship that scales a local model-predicted profile towards that empirical profile. The definition of those two assimilation-technique parameters can be done either experimentally or through cloud resolving model simulations. In the present study, we determined them empirically from atmospheric sounding data (through trial and error analysis) on the basis of maximizing the assimilation impact on quantitatively precipitation forecasting accuracy.

For the numerical experiments the POSEIDON weather forecasting system was used, incorporating observed data from the ZEUS regional network of ground-based receivers (covering Europe and Africa) and from the US National Lightning Detection Network. The performance of the technique was verified in a set of experiments on major thunderstorm activities in a warm-season environment that occurred in the Mediterranean region and central USA. The assessment was performed using as reference 6-hourly rain accumulation measurements available from the network of

ECMWF gauges in Europe and rainfall fields (Radar) derived from a mosaic of hourly raingauge-calibrated WSR-88D rain estimates in USA. The results indicate that assimilation of CG lightning data can improve the model's convective precipitation analysis and short-range (e.g. up to 12 hours) forecasts.