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Offline tracer transport modeling with global WRF model data

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This work describes the one-way coupling between a global configuration of the Weather Research and Forecasting (WRF) weather prediction model (http://wrf-model.org/) and the National Institute for Environmental Studies (NIES) three-dimensional offline chemical transport model (version NIES-08.1i). The primary motivation for developing this coupled model has been to reduce transport errors in global-scale simulation of greenhouse gases through a more detailed description of the meteorological conditions. We have implemented a global configuration of WRF model (version 3.4.1, ARW core) with 2.5 degree horizontal resolution and 32 vertical levels. The WRF model was driving with NCEP Final Analysis (FNL) reanalysis using combined techniques: FDDA + Cyclic Incremental Correction (like in intermittent data assimilation). Time-averaged mass-coupled horizontal velocities on sigma levels with approach supposed by Nehrkorn et al. (2010) are calculated to drive NIES TM. The NIES TM is designed to simulate natural and anthropogenic synoptic-scale variations in atmospheric constituents at diurnal, seasonal and interannual timescales. The model uses a mass-conservative flux-form formulation that consists of a third-order van Leer advection scheme and a horizontal dry-air mass flux correction. The horizontal latitude–longitude grid is a reduced rectangular grid (i.e. the grid size is doubled several times approaching the poles), with an initial spatial resolution of 2.5 deg x 2.5 deg and 32 vertical levels from the surface up to the level of 3 hPa. A simulations of the atmospheric tracer are used to evaluate the performance of the coupled WRF-NIES model. Simulated distributions are validated against in situ observations and compared with output from "standard" version of NIES TM driven by the Japanese 25-year Reanalysis/the Japan Meteorological Agency Climate Data Assimilation System (JRA-25/JCDAS) dataset. Fields calculated by WRF and used to drive NIES TM were also evaluated by comparing it with JRA-25/JCDAS reanalysis distributed on Gaussian horizontal grid T106 (320 x 160) with 40 hybrid σ–p levels and the 6-hourly time step.

Nehrkorn, T., Eluszkiewicz, J., Wofsy, S. C., Lin, J. C., Gerbig, C., Longo, M. and Freitas, S.: Coupled weather research and forecasting – stochastic time-inverted lagrangian transport (WRF–STILT) model, Meteorol. Atmos. Phys., 107, 51–64, doi:10.1007/s00703-010-0068-x, 2010.