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Regional chemical weather forecast over the central Japan: The effects of diffusion and mixing parameterization on the tracer transport from the planetary boundary layer to free troposphere

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The Frontier Research Center for Global Change / Regional Chemical Weather Forecast System (FRCGC/RCWFS) has been developed based on a three-dimensional regional meteorological and chemical model WRF/Chem, and initial-boundary meteorological and chemical data from JMA MSM data and the global chemical module CHASER. For 15 hours daily, our forecast system predicts the regional distribution of ozone (O3) and its precursors, including carbon monoxide (CO), nitrogen oxides (NOx), and non-methane hydrocarbons (NMHCs).

In order to understand the effects of mixing and turbulence parameterization and land-surface model (LSM) on the land-sea breeze (LSB) and the planetary boundary layer (PBL) to free troposphere (FT) transport, several kinds of hind-cast experiments were conducted over the central Japan for June-August in 2005 and 2006 when photochemical oxidants more than 0.12 ppmv are frequently observed through the central Japan, The experiments exhibit a prominent diurnal cycle of the PBL height and a few time propagations of land-sea breeze front with a horizontal scale of 100 km. The result is in overall agreement with surface observation network AMeDAS (with 156 stations) and wind profiler network WINDAS (with 3 stations) with correlation coefficients of 0.88-0.91 for surface temperature and 0.60-0.67 for surface wind vector. However, the timing of change from sea breeze to land breeze and the location of convergence zone are not well simulated, possibly related to cold bias in the inland region at night time

as well as coarse resolution of terrain. To reproduce the return flow of air pollution by land-breeze, cold bias in the inland region is thought to be a key issue. A comparison with the Lidar aerosol data over Tsukuba shows a similar lift-up of trace gases to FT with a layer structure at altitudes of 1-2 km and its gradual increase with time.

Changing Mellor-Yamada-Janjic (MYJ) PBL scheme to Yonsei University PBL scheme and Medium Range Forecast Model (MRF) PBL scheme raises correlation coefficient for surface wind vector by raising surface temperature and the PBL height and by weakening surface wind, while providing vertical transport of trace gases over Tsukuba more rapid than actual one. On the other hand, changing cumulus parameterization scheme presents little difference from the result of default setting, possibly because the occurrence of moist convection is not frequent during the period. The difference of PBL height and surface temperature between experiments indicates that the PBL-FT and global transport of O3 and its precursors strongly depends on the choice of the PBL, turbulent-mixing, and LSM scheme.