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Simulation of CO_2 concentrations using coupled (Eulerian/Lagrangian) model with global high resolution (1km x 1km) surface fluxes.

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We prepared and tested a high resolution flux set for simulations of the CO_2 at the observation points using combination of grid based Eulerian transport model running at medium resolution of 2.5 degrees and a Lagrangian plume dispersion model that uses 1 degree resolution wind and surface fluxes at 1 km resolution. Several regional studies already reported usefulness of coupled Eulerian/Lagrangian approach with 1-2 km resolution fluxes and winds. Our work is aimed at extending this technique to the global scale. Use of the 1km surface fluxes with lower resolution wind is justified by observations that in relatively flat areas the wind field in well mixed daytime conditions is dominated by large scale geostrophic motion most of the time and spatial radius of correlation between meteorological parameters on the order of 50 to 100 km is commonly observed. To reduce memory and storage requirements we propose several other simplifications. The gridded fossil fuel CO_2 emission inventory was developed at 1 km resolution on annual basis, applying a combination of a country level fuel consumption statistics, a global power plant database, and satellite-observed nightlight data. Seasonal variation of the emissions was simulated with monthly varying factors on 1 x 1 degree grid derived from the 21 country national monthly emissions available. The vegetation CO_2 fluxes are simulated with a terrestrial biospheric model VISIT at 0.5x0.5 degree resolution at daily time step for each of 15 vegetation types potentially present in the vicinity. Then the fluxes are interpolated to each 1 km pixel of the global vegetation map. Oceanic fluxes simulated with 4D-Var assimilation system based on reanalyzed currents are remapped to a regular 1x1 degree grid and extended to coastal area using 1 km resolution land-ocean mask. To validate model performance we have compared the simulation results with observations at continuous CO_2 monitoring site at Hateruma, Japan. Comparisons show that we get improvements with 1km resolution fluxes over simulation with 50-100 km resolution fluxes within the same coupled modeling framework.