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# Atmospheric $CO_2$ simulation with optimized surface flux climatology for use in GOSAT $CO_2$ retrieval

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In retrieval algorithms for atmospheric constituents such as methane and $CO_2$ prior constrain is often used. For example, use of seasonally varying concentration climatology has been tested by Barkley et al, ACP, 2006. For GOSAT $CO_2$ retrieval, $CO_2$ concentration field simulated operationally with tracer transport model is planned. In order to minimize biases in the retrieved concentration, the biases in the prior concentration field should be reduced. We are preparing a set of monthly mean fluxes optimized against existing atmospheric $CO_2$ observations, and try to reduce transport model biases at the same time. It was found recently, that seasonal cycle of the atmospheric $CO_2$ as simulated with our NIES offline transport model (and some others) has bias due insufficient mixing in the troposphere, thus reducing the ratio of amplitudes of the seasonal cycle in the free troposphere to that in the surface mixed layer. To reduce the effect of the biases and uncertainties in the vertical mixing, surface flux from terrestrial biosphere by CASA model is optimized versus partial column observations at the airborne sampling sites, which leads to increase in the $CO_2$ seasonal cycle amplitude in mid- and high latitudes. The $CO_2$ vertical gradient in lower troposphere depends on preprocessing procedure for analysed winds and can be regulated by additional mixing in cloudy conditions. Mass conservative winds with flux-form algorithm appear to produce realistic vertical gradient over continents. Biases in simulated seasonal cycle in Southern hemisphere are corrected by adjusting oceanic flux climatology with inverse model based on atmospheric observations.