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Re-scaling CO_2 natural fluxes over land to correct the global annual growth of CO_2 in the MACC CO_2 analysis

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In the Monitoring of Atmospheric Composition and Climate (MACC) project, analyses of atmospheric CO_2 concentrations are produced by assimilating satellite observations in the ECMWF Integrated Forecasting System (IFS) Numerical Weather Prediction model. One of the most important aspects in the assimilation and modelling of CO_2 is the representation of the correct annual growth rate in the atmosphere, which is a small residual of large source and sink fluxes. In the IFS transport model, the CO_2 fluxes are prescribed as inventories based on off-line statistical and physical models. Currently, the vegetation fluxes are from the CASA-GFED inventory; although in the future, fluxes from the CTESSEL model will be implemented on-line. Any small regional error associated with those fluxes can accumulate and produce large errors in the global annual budget, if not corrected by the assimilated observations. This leads to biases in the atmospheric growth of the model, and subsequently, of the analyses. This poster presents a simple vegetation flux correction method that can be applied off-line prior to the analysis.

The method aims to correct the CO_2 annual growth rate and reduce the errors of the background concentrations with respect to the NOAA Globalview processed observations of the marine boundary layer. The correction factors are computed separately over four latitudinal regions that have coherent seasonal cycles. This is done by converting the regional mean concentration error into a regional mean flux correction and then regressing the latter against the regional mean Net Primary Production (NPP) and heterotrophic respiration (Rh) fluxes. The regression coefficients for each region are then applied to the original NPP and Rh flux fields. This correction is time independent and it aims to improve the budget as well as the seasonal cycle and the interhemispheric gradient, without having any impact on the subseasonal and subregional variability.A final annually dependent global rescaling is also applied to match the global annual budget of the observed atmospheric growth.

The results of the flux corrections show that there is a great reduction in the CO_2 bias in the free troposphere. The original annual bias of 1.4 ppm is reduced to 0.3 ppm. There is also an improvement in the seasonal cycle and interhemispheric gradient with monthly biases ranging between -0.5 and 1 ppm compared to original monthly biases of up to 3ppm.The impact in the standard deviation of the error is small as expected, since the flux variability remains essentially unchanged. In the boundary layer the results show a mixed impact because of the large influence of tranport and mixing errors in the boundary layer which can compensate for flux errors. In summary, this simple method can produce a preliminary flux correction that greatly reduces the biases in the model and analysis. It can be applied easily in an operational context within the MACC project. The method can also be used as a diagnostic tool to evaluate the atmospheric CO_2 budget from vegetation models such as CTESSEL.