High Resolution CO_2 Transport Modeling System WRF-VRPM and Its Application in Interpretation of CO_2 Measurements

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The global scale coarse resolution atmospheric models that are used in the inversions of CO_2 have difficulties to properly resolve complex mesoscale circulations around continental measurement sites. Moreover vertical mixing and boundary layer dynamics over the continent remain a big challenge for all transport models. In order to better understand the impact of mesoscale transport effects and vertical mixing on atmospheric CO_2 distributions, we have used the Weather Research and Forecasting (WRF) model coupled to the diagnostic biosphere model Vegetation Photosynthesis and Respiration Model (VPRM), which provides high-resolution biospheric CO_2 fluxes based on MODIS satellite vegetation indices. We have run WRF-VPRM for different seasons in 2005 and 2007, covering the intensive measurement periods of the Carbo Europe Regional Experiment Strategy (CERES) campaign held in the South West of France.

Here we present the model validation for CO_2 and a wide range of meteorological fields obtained on surface and aircraft platforms during the campaign. In addition we have compared the modeled CO_2 concentration time series against observations at two towers operated during the campaign - Biscarosse (40 m high) and Bellegarde (56 m high) located in the vicinity of the coastline and inland respectively. The comparison against meteorological data reveals the ability of WRF to capture the small mesoscale flows which have also a strong impact on CO_2 measurements at the towers. This work shows how the near-field of these towers play an important role in the formation of the measured concentration signals. We also have investigated the vertical mixing of CO_2 by using different planetary boundary layer (PBL) parameterization schemes available in WRF. The results reveal that using more advanced PBL schemes within the high-resolution modeling framework enables us to better characterize the vertical distribution of CO_2, especially in stable boundary layer during nighttime. Thus only with high resolution modeling tools such as WRF-VPRM can a large fraction of the CO_2 continuous data be properly used in inversion studies at the global and regional scales.

Finally we discuss the perspectives of WRF-VPRM applications for several North American CO_2 monitoring sites and measurement intensives operated by NOAA ESRL.

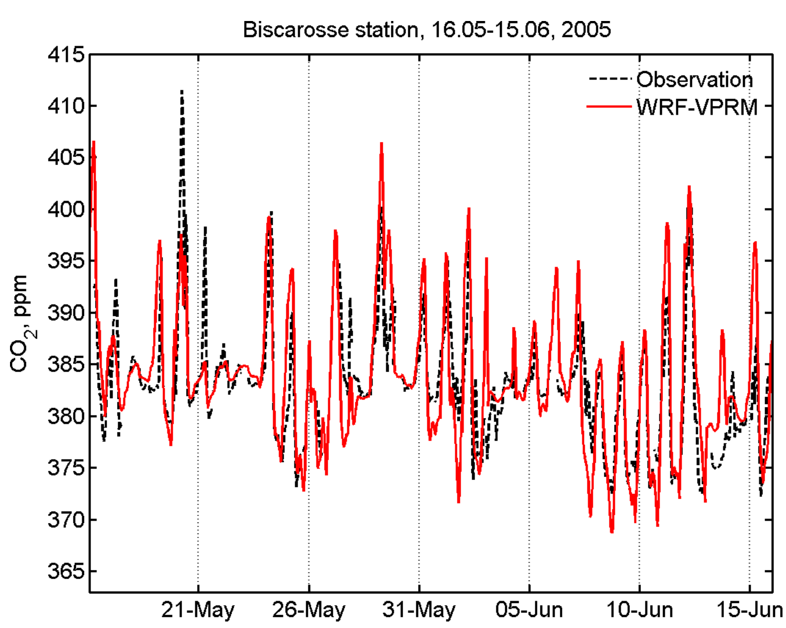

Figure 1. Comparison of hourly CO_2 concentration time series from the Biscarosse tower and the WRF-VPRM model.