Evaluating planetary boundary layer depths in CarbonTracker for a region around the Moody tall tower in Texas

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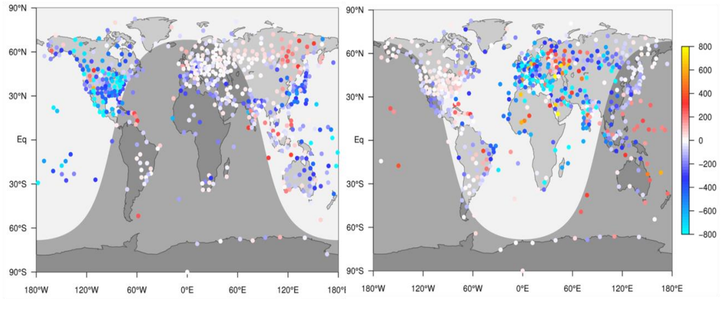
BACKGROUND

The difficulty of modeling atmospheric transport and mixing processes introduces significant uncertainties in the fluxes estimated with inverse carbon transport models. Of particular importance for a correct estimation of carbon fluxes is the simulation of vertical transport and mixing within the planetary boundary layer (PBL) and between the PBL and the free troposphere. An important diagnostic for vertical transport and mixing is the PBL depth, the height above the surface up to which surface fluxes of heat, moisture, momentum, and trace gases such as CO_2 are transported and mixed on a diurnal time scale. Despite its importance, there is large uncertainty in how well current transport models simulate PBL depths and how biases in PBL depths translate to uncertainties in CO_2 fluxes. The diurnal and seasonal cycle of CO_2 concentrations near the surface and in the PBL is strongly dependent on vertical mixing within the PBL. if we want to have confidence in inverse modeling estimates of continental CO_2 fluxes, then the transport models driving the inverse models must also be capable of predicting the variation in PBL depth and structure.

In this poster, we evaluate the performance of the atmospheric transport model TM5 that drives global carbon inverse models in its simulation of regional scale PBL depths



TM5 Evaluation: Global assessment:

IGRA: Integrated Global Radiosonde Archive (IGRA: Seidel et al., 2012). Number of stations: 938

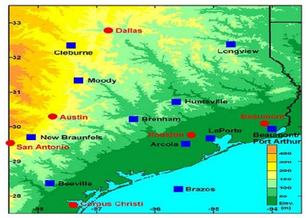
comparing TM5 and IGRA PBL depths

results show in general an underestimation of midday and afternoon PBL depth

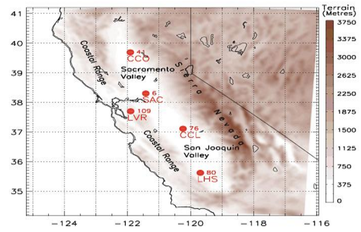
TM5 Evaluation: Regional assessment:

For our regional assessment of PBL depths, we are using high resolution data sets from field studies, e.g. TEXAQS 2006 and California's Central valley

Texas: 11 wind profiler sites
"simple" terrain

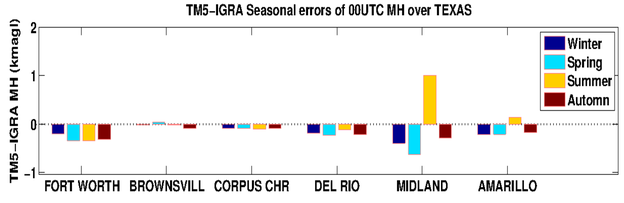


California: 5-8 wind profiler sites
complex terrain



Seasonal mean biases of the PBL depth at 00 UTC for 6 IGRA Stations in Texas (for 1996-2005)

TM5 typically underestimates the PBL depth over the continental stations. For Midland and Amarillo however, TM5 overestimates the PBL depth in summer. These biases are not well understood



WRF simulations

Simulations with the Weather Research and Forecasting (WRF) model are performed to investigate the spatial PBL depth variability and to illustrate the challenges of evaluating simulated PBL depths with local scale observations. Simulations are performed using 3 nested domains with the domains centered over Moody, TX. The innermost domain has a domain of 100x100 km with a grid resolution of 1 km

ACKNOWLEDGMENTS

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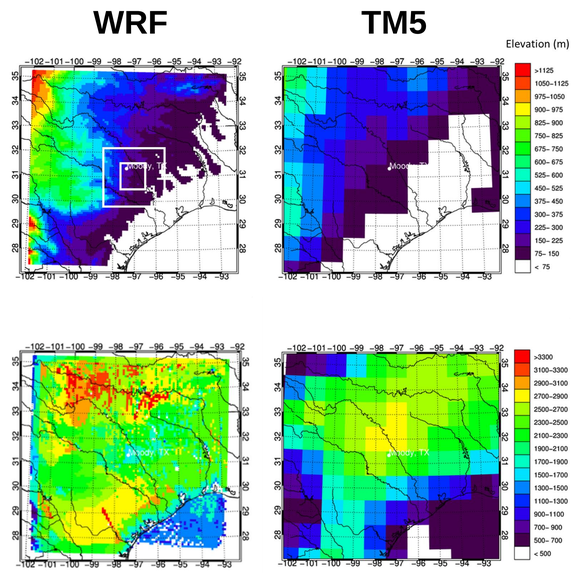
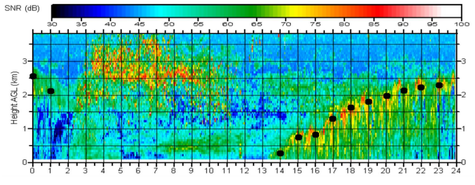


TOPOGRAPHY

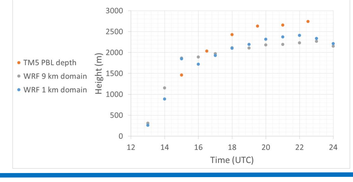
AFTERNOON PBL DEPTH

For a particular case study (3 August 2006), large differences in the spatial PBL depth variability between WRF and TM5 are observed for a 10x10 degree domain. However, for the location around the Moody, TX, tall tower, the PBL depth evolution compares well

PBL DEPTH EVOLUTION FROM WIND PROFILER



PBL DEPTH EVOLUTION IN TM5 AND WRF



SUMMARY

We started an evaluation of TM5 PBL depths on a regional scale
10-year climatology shows that TM5 typically underestimates PBL depths
During Texas AQ -2006, large differences exist in spatial PBL depth variability between TM5 and WRF.
For specific locations such as Moody, TX, simulated PBL depths from TM5 and WRF and PBL depths from observations compare well.
Issues related to e.g. PBL depth determination in evening transition period and spatial PBL depth variability need to be considered carefully.