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## ***Interactive comment on “Detecting regional variability in sources and sinks of carbon dioxide: a synthesis” by A. J. Dolman et al.***

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Received and published: 11 March 2009

This article introduces the main modelling and observational analysis achievements within the framework of the CERES experimental field campaigns. It presents way the research highlights which will be further discussed in the specific papers in this special issue. As such, it is a very interesting synthesis of our current knowledge of carbon dioxide at regional level.

I miss however a more thorough and comprehensive discussion on the specific original aspects introduced and applied in the modelling and data analysis during CERES. I realized that this is synthesis paper, but in my opinion it is relevant for the reader to stress the new understanding acquired during the project and point out clearly still the current gaps of knowledge. Below, I give my specific main comments.

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1.- I agree with the authors that it has been a large improvement in modelling carbon dioxide at regional scale as it is referred in the article. However, there are still large uncertainties. As an illustration, I would like to mention a couple of examples that are discussed or relevant for the paper. As it is written at page 2335 (line-5-6), there is a cold bias with the temperature (and probably a moist bias of the specific humidity) near the surface. I am not fully convinced that this is solely an initialization problem since majority of mesoscale models have still difficulties in reproducing the energy balance, the surface partitioning and boundary layer structure compared to surface and upper air measurements. This disagreement can have direct consequences on the results given by the dynamic vegetation model leading probably to deviation on the estimation of the carbon dioxide exchange fluxes. I will therefore recommend to write down the conclusions related to the model capabilities of the diurnal variability specifying the concrete advancements and the model limitations (page 2343, line 25-30).

Another key issue which is relevant for this synthesis paper is the interaction of spatial atmospheric scales in the carbon dioxide budget. The main discussion is focused on the sea-breeze phenomena and topography (meso-beta subclass), but there are very little comments occurring at smaller scales related to phenomena such as induced mesoscale by surface heterogeneity or boundary-layer clouds (meso-gamma sub class). These processes exert a strong influence on photosynthesis and I have my doubts (once again) if the current mesoscale models are capable to represent them adequately.

In concluding, I think the reader will appreciate very much a discussion and conclusions which includes a balance view of the achievements obtained in the modelling of carbon dioxide within CERES, but also a clear specification of the modelling shortcomings based on their recent experience. These are the future challenges.

2.-In relation with the observations, the use of new instruments or data analysis receives in the paper little attention (only in the first paragraph at section 5 and why in this section?). Recent research carried out within the campaign International H2O

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project (IHOP\_02) have shown the need to apply a special treatment to treat the spatially (aircraft) data in order to account for changes in the surface properties (see for instance the articles LeMone et al. (J. of Hydrometeorology 8, 68-87, 2008) to estimate the sensible and latent heat flux and Górska et al (Monthly Weather Review 136, 4435-4451, 2008) for carbon dioxide).

In view of the large surface heterogeneity shown at figures 4 and 7, I think it is convenient to briefly discuss how it is treated in the observations. I realize that this part will be more elaborated in other papers of the special issue, but as a synthesis paper it is necessary to point out the new data techniques and the analysis of carbon dioxide data in relation to thermodynamic variables and vegetation.

#### Minor comments

- Are all the papers of the special issue introduced (as far as I can count there are 7) on the reference list)?
- Some acronyms are not introduced (CERES, IOP, MLEF,...)
- Peters et al. (2008) is referred but it is not included in the reference list.

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Interactive comment on Biogeosciences Discuss., 6, 2331, 2009.

**BGD**

6, C11–C13, 2009

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