

## ***Interactive comment on “Anthropogenic carbon dioxide source areas observed from space: assessment of regional enhancements and trends” by O. Schneising et al.***

**O. Schneising et al.**

oliver.schneising@iup.physik.uni-bremen.de

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We would like to thank R. Kawa for the constructive comments which are addressed in the following.

### **General Comments**

*Overall, this is a methodologically solid, stylistically accessible, and refreshingly concise paper that addresses a relevant scientific question well within the scope of ACP:*

*How well can satellite remote sensing CO<sub>2</sub> measurements constrain the location, magnitude, and changes of anthropogenic emissions? This issue is significant because space-based measurements are increasingly considered as a possible major contributor to global systems for monitoring, reporting, and verification of policy implementation for reducing greenhouse gas emissions.*

*The authors do a nice job of demonstrating how well one existing data set (SCIA-MACHY) can detect regional industrial CO<sub>2</sub> emissions, and illuminating some of the potential uncertainties in doing so. This is no mean feat, as they need to do extensive data manipulation to minimize apparent biases and extract significant signal levels even for large, intense emission regions.*

*The use of the SCIA CO<sub>2</sub> and application to the regional emission problem is novel, the methods are clear and valid, references appropriate, and the results are substantial, although perhaps a bit sobering. My only presentation request would be to make the 'delta' figures somewhat larger as they are difficult to see even on-screen.*

The mentioned figures and/or fonts will be larger in the revised versions. In this context it has also to be pointed out that Figures 2-4 were designed for a portrait format and therefore appeared quite small in the landscape ACPD format. All Figures will be easily readable in the revised (portrait) version.

## Specific Comments

*P. 31511, clarify that 'altitude in km' is the altitude of the observed surface.*

This is clarified in the revised version.

*P. 31515, expand the discussion of how the linear regression compensates for retrieval errors due to aerosols since there is no direct aerosol term in Eq. 1. Does this come in through the radiance term or elsewhere? Is this compensation to be expected for other*

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space sensors. Also, how good is the bias correction expected to be for the Yangtze since conditions may be quite different from the 8 sites for which the correlations are derived.

The compensation for retrieval errors due to aerosols mainly comes in through the combination of the radiance and the column error terms. It can actually be shown that the correlation of the difference of the WFMD retrievals to CarbonTracker with GEMS AOD is significantly reduced after the linear regression.

For other space sensors an analogous implicit compensation (using similar or other parameters in the regression) is easily conceivable.

One year of data at the 8 sites in Europe, North America, and Australasia already spans a large space of conditions. It is assumed that the found correlations represent systematic retrieval errors existing all over the world and at all times. An indication that this is actually true is the fact that the correlations of the difference of the WFMD retrievals to CarbonTracker with the parameters used in the linear regression and with GEMS AOD are also significantly reduced in the case of China after the linear regression.

The following paragraph is added to Section 3.2.1: “Although aerosols are not considered explicitly in the linear regression, the compensation for aerosol related errors mainly comes in through the combination of the radiance and the column error terms in the regression equation. An analysis of the difference of the WFMD retrievals to CarbonTracker confirms that the correlation with GEMS AOD is actually significantly reduced after the linear regression.”

*Finally, a comment on the implications of this study for future measurements and analyses seeking to establish a scientific basis for policy assessment: there is currently a huge gap between what the science can provide and what the policy user needs are likely to be. This paper’s admirable analysis says that the existence of major emitters can be detected from space (at SNR  $\sim 2$ ). The requirement, however, for detecting relatively gradual changes (e.g., 10%/ 10 years) and attributing them to the scale of small*

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*countries/cities/sectors is going to be much more difficult to achieve. Proposed future space sensors will be more capable and more precise, but this problem is not going to be solved by foreseeable satellite CO<sub>2</sub> measurements. It will require a network, perhaps constellation, of in situ and remote sensing; emission-point, ground, aircraft, and space-based measurements; and a multi-scale analysis system that is well-beyond current capability.*

To underline the advantages of a comprehensive monitoring system the following paragraph is added to the conclusions: “The objective of establishing a scientific basis for policy assessment in the future would benefit from a comprehensive monitoring system of accurate in-situ (surface, aircraft, balloons) and remote sensing (satellites, aircraft) measurements. Combining the different methods in a multiscale analysis system will be a significant prospective research topic.”

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 31507, 2012.

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