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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Constraining regional greenhouse gas emissions using geostationary concentration measurements: a theoretical study" *by* P. J. Rayner et al.

Anonymous Referee #1

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The manuscript investigates the use of geostationary measurements of CO2, CO and CH4 trace gases for constraining carbon sources and sinks at regional scale. The authors test a proposed observing system for GEOCARB by calculating posterior uncertainty for theoretical emission sources over Shanghai, China. Despite improved sampling density compared to orbiting satellites, CO2 alone does not lead to significant uncertainty reductions at 3 km grid scale. This is because CO2 can't disentangle urban sources from power plants. The authors use theory and practice to show that a joint inversion with CO helps constrain combustion sources and can therefore significantly improve knowledge of fluxes. Key innovations in this work include a high resolu-

tion satellite inversion, development of a plume model applicable for column CO2, and careful accounting of effects due to slantwise column measurements (which are typically ignored at coarser resolutions). Additionally, the text is lucidly written and easy to follow. I highly recommend this paper for publication after addressing a few conceptual points below.

General Comments

I am a bit naïve on the subject, but the plume concentration model seems quite a novel way to represent the statistics of column integrated concentrations and thus a potentially powerful tool in our rapidly expanding GHG satellite era. Despite the detailed description of the model, however, I found it a bit difficult to visualize how the parameters in Eqn (4) represent the 3D structure of the plume. As mentioned by the authors, this task has received little attention but is likely to receive much more, so it may be useful to provide a schematic to help illustrate the concept.

Please comment on potential limitations of the proposed observing system for constraining winter emissions at high latitudes; i.e., is it feasible to reduce uncertainties at high spatial resolution given high solar angles and uncertainty of winter boundary layer dynamics?

Specific Comments

Please provide more detail regarding the normalization constant Q in Eqn (4).

In describing the prognostic equation for spread starting on P1374L7, rates of dispersion due to turbulence, divergence and shear are referred to in Eqn (6), but only terms due divergence (phi_D) and shear (phi_S) are shown. Please check on this. All three terms are described in the subsequent discussion, so it is likely the terms was mistakenly omitted in Eqn (6).

At the beginning of Sec 3, tracer emissions are described as occurring near the center of the domain. In Fig. 1, however, the source is centered at x = y = 101.5 km, which appears to be in the northeast corner of the domain. Please clarify. A star in Fig. 1 indicating the power plant location could be helpful. It is also not clear whether the power point is intended to be in the same location in Figs. 1 and 2-4.

It is interesting that peak values of uncertainty reduction in Fig. 3 occur upstream of the power plant. If the prevailing wind is northeast to southwest, it seems highest reductions would be centered more on the power plant and/or downstream of the source. Please comment on this.

I am trying to get my head around the combined effects of viewing geometry and prevailing wind direction on signal-to-noise and error reduction. If the satellite is sitting equatorward of the power plant and looking north into the prevailing wind, presumably the effect of wind shear is to tilt the plume into the satellite such that it aligns vertically with the slantwise measurement. I wonder if this will increase the signal and hence total error reduction, compared to a prevailing wind which moves away from the satellite. This may be a moot point, but in case it affects our interpretation of results, it could be worth commenting on.

All figures need some labeling on the x- and y- axes.

Technical Corrections

P1369L14: Misspelled 'Mesurements"

P1375L7: First instance of WRF should be defined here. Currently defined later, on P1379L10.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 1367, 2014.