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Interactive comment on "A multi-year methane inversion using SCIAMACHY, accounting for systematic errors using TCCON measurements" *by* S. Houweling et al.

Anonymous Referee #2

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General comments

This manuscript examines biases in SCIAMACHY XCH4 retrievals and how these may best be dealt with in atmospheric inversions. Moreover the manuscript examines the sensitivity of optimized CH4 emissions from several inversions using different bias corrections. This is a sound study, which is well presented and thorough in its analyses. I recommend publication, however, I do have a few minor comments and suggestions.

Specific comments

Abstract, L20: The authors should specify which systematic errors these are as it is

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not clear from the context.

P28126, L17: The authors should state approximately how big the correction to CH4 is above 50hPa

P28127, L5-6: Is the total error in observation space for NOAA data calculated as the quadratic sum of the representation and measurement errors? Could the authors please specify.

P28127, L22: How large is the retrieval uncertainty?

P28127, L25-27: If the SCIAMACHY data are averaged over 3-hourly intervals at 4° by 6°, then there are no data at higher frequency/resolution so why do you need to account for correlation of retrievals within 3 hours and 4° by 6°?

Section 2.3: Although TCCON data are not used in the inversion, they are used to calculate the biases in the SCIAMACHY data, therefore, a short description of the TCCON data should be added to this section.

P28131, L18: The authors should include a brief description of the "fix" inversions. In this test are the a priori values of parameters a2 and a3, respectively, set to one (as in Table 3)? This is not clear.

P28134: The results shown in Fig. 5 are discussed only in terms of how well the bias correction performs compared with the NOAA-only inversions, however, it is conceivable that part of the NOAA-only versus SCIAMACHY difference may be due to the detection of a real signal by SCIAMACHY that is not detected in the NOAA surface data, which is particularly sparse in the tropics. Could the authors please comment on this?

P28135, L9-13: Deviations from a Gaussian distribution centred on the origin may also result in the SCIAMACHY inversions if the TM5 model has errors in vertical mixing?

P28139, L2-8: The authors state that there was a reduction in the SCIAMACHY de-

rived flux in 2005, and 2005 was a drought year. However, the authors state that this reduction is not easy to explain and discuss other possible reasons such as the instrument performance. The way this is presented doesn't quite follow. Perhaps the authors are referring to the flux minimum over South America in 2006?

P28140, L14-15: From Fig. 13 there appears to be a small trend in NOAA-only derived fluxes, so likely there is some real trend in the flux. In the inversion SQGflex, the trend is weaker compared with NOAA-only and SQGfix because the latitudinal bias parameter is optimized for each of the 4-year interval inversions, hence this compensates for part of the trend. However, if the SQGflex was performed over the entire period, the trend should be similar to that in SQGfix?

P28142, L27: Add the uncertainty estimate to the contribution from South East Asia Conclusions: "Comparisons with inversion results from Bergamaschi et al. (2013) show that the SCIAMACHY-derived inter-annual emission variations become less robust when the bias correction is extended with additional degrees of freedom on inter-annual timescales." It is not clear where this conclusion is supported in the main body of the manuscript. Could the authors please add additional information to support this conclusion?

Fig. 4: SQfix performs more poorly for Jan-May at the beginning of the timeseries compared to at the end of the timeseries, why?

Technical comments

P28122, L7: "joined" should be "joint"

P28123, L6: "alternate" should be "alternating"

P28123, L6: suggest stating that the adjoint is the adjoint of the transport model TM5

P28123, L24: add "rate" after "inter-hemispheric mixing"

P28131, L18: revise use of "with" and "without" as this is confusing, perhaps just state

that there are two sets: "flex" and "fix"

P28131, L18: not sure what the parentheses are supposed to signify after "flex" and "fix", perhaps these should be removed

P28140, L21: "factor of 5"

P28140, L22: "variation" should be "variations"

P28141, L29: "...parameters that are..."

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