We thank you for the interest in our paper and your comments that we discuss in the following.

F. Chevallier: *Using a regional inversion system, five satellite products of XCO2, and a few sensitivity experiments, the authors suggest that the European carbon sink is 2-3 times larger than estimated by bottom-up studies.*
Authors: A "few sensitivity experiments" implies that only a limited analysis was undertaken. Actually, we analysed and discussed the influence of 13 different potential influences on our results: background model, convection, receptor grids, number of particles, integration time, meteorology, aggregation error N/S, aggregation error E/W, aggregation error temporal, potential regional biases in mean wind direction, error correlation length, error scaling factor, and sampling at in situ sites. Please see Appendix B (Error analysis and ensemble set-up) for more details.

F. Chevallier: *They do not speculate on what could be that wrong in bottom-up studies.*
Authors: P9, L25: "Inverse modelling studies are the focus of this paper. However, recent findings reveal that carbon accumulation increases continuously with tree size (Stephenson et al., 2014). This potentially contributes to explaining the discrepancy with bottom-up inventories. In this context, it should also be noted that the flux estimates of Schulze et al. (2009) concentrated on the period 2000–2005 including years (e.g., 2003) with little uptake in Europe (Ciais et al., 2005)."

F. Chevallier: *The inconsistency (and actually other inconsistencies in other regions of the globe, which should be accounted for in the discussion) was seen before with global inversion systems also assimilating satellite data, but this study is the first one that isolates satellite data over Europe in the inversion.*
Authors: We agree that our study is a regional study addressing Europe only. We consider that a lengthy discussion about differences in in situ and satellite inversions in other regions of the world found by others would, therefore, add little and distract the reader from the main topic of the paper.

F. Chevallier: *In global inversions, all regional seasonal fluxes are coupled to some extent, because mass is conserved at the global scale. By using a regional framework, the authors decouple the seasons: their STILT back-trajectories are ended after 480h or even sooner (Appendix A).*
Authors: As described on P12, $\mathbf{S}_a$ has off-diagonal elements resulting in a temporal coupling. Using longer trajectories would not change the results because air particles left Europe or become well mixed. See discussion on P15/16 and Fig. B1a.

F. Chevallier: *As a consequence, decreasing the annual sink based on January-April increments (RemoteC results) is rigourously distinct* *from decreasing the annual sink based on growing season increments (the other satellite-based results). Therefore the results presented are internally inconsistent, behind an apparent agreement about the annual sink. In other words, the RemoteC results seem to invalidate the increasing sink inferred from the other products and vice-versa.*

Authors: The statement about the consistency of results within the abstract refers to annual averages showing consistently a larger sink. In order to avoid misunderstandings, we make this clearer now within the abstract: "We show that the satellite-derived European terrestrial carbon sink is indeed much larger (1.02 ± 0.30 GtC/a in 2010) than previously expected. This is qualitatively consistent among an ensemble of five different inversion set-ups and five independent satellite retrievals ..."

Seasonal fluxes (especially those from RemoteC) are discussed on P7: "... This pattern is stable over the years and consistent among the satellite derived fluxes in 2010 with the exception of the RemoTeC fluxes which are similar to CarbonTracker fluxes in June and July but which are the lowest in January–April. As a result, the annual fluxes for RemoTeC show the weakest sink (0.74 ± 0.33 GtC/a)." Additionally, we discuss a potential reason for the observed difference: "Note that RemoTeC has also the lowest number of soundings which can result in sparsely sampled regions." Therefore, it cannot be concluded that RemoteC results invalidate the increasing sink inferred from the other products or vice-versa. Please also note that monthly fluxes have a stochastic uncertainty component. As an (exaggerated) example. Throw a coin 12 times and you'll get 0.5 times head on average. Repeat the experiment and you'll get approximately the same average. Both (average) results are consistent even if the sixths throws were different.

F. Chevallier: *One of the satellite products assimilated here (UoL FP v4.0) and an earlier version (v2.1) of a second one (RemoteC v2.11) were evaluated in an ESA report (Notholt et al., 2013), that is coauthored by some of the present authors, including the first one, that says in its summary: The demanding relative accuracy (regional-scale bias) requirement of ¡ 0.5 ppm is however somewhat exceeded by all products (typically 1 ppm or even somewhat better has been achieved). This statement casts some doubts on the reliability of the extra seasonal regional gradient of ' 0.5 ppm in the satellite data1 that would drive the ' 0.5 PgC unexpected sink inferred by this inversion system over Europe.*

Authors: i) The 0.5ppm requirement originates from the GHG-CCI project's User Requirements Document (URDv2, Tabel 1) for which you have acted as lead author (http://www.esa-ghg-cci.org/?q=webfm_send/173). The requirement is based on inverse modelling studies with synthetic data using global mass conserving models (see references in the URD). In such models, measurement biases in, e.g., North Africa can corrupt the inferred fluxes in Europe or elsewhere. According to Miller et al. (2007) (who is cited in the URD) "coherent biases on 100–5000km horizontal scales pose the greatest threat to the integrity of space-based XCO_2 data ...". Additionally, Miller

et al. (2007) show at an example that biases of a few tenth of a ppm on larger (inter-hemispheric) scales also result in considerable flux errors.
TRANSCOM Europe covers an area of 10^{13} m^2 which correspond to a (hypothetical) square of 3160 km edge length. By design, our inversion system is insensitive to biases outside Europe, i.e., coherent biases on scales larger than $\approx$ 3200 km cannot influence the inversion. In this context please also note our discussion on P4: "Spatial gradients in the satellite data are more reliable over small scales than over large scales because potential retrieval biases are minimal when similar meteorology, surface characteristics, and observation geometry exist."
However, we agree that (even small) inner-European biases can hamper our inversion under unfavourable conditions. We discuss this in detail on P17: "Even though our regional inversion scheme is insensitive to retrieval biases outside Europe, it could in principle still suffer from retrieval biases within Europe arising, e.g., from persistent aerosol or cloud patterns, surface albedo, or chlorophyll fluorescence. However, this would only be the case if biases were correlated with the surface sensitivity."
For this reason we performed a sensitivity study analysing potential biases in mean wind direction (see P17 "Europe's weather is complex and characterised...") which we concluded in the revised manuscript by "...retrieval biases in mean wind direction are unlikely to explain the observed carbon sink.".

ii) We would like to remind how the 0.5ppm requirement of the URD needs to be considered to interpret it properly: "Based on these considerations the requirements on systematic errors are: REQ-GHGCCI-ERR-2: The XCO2 and XCH4 ECV data products over land shall meet the systematic error requirements given in Table 1. The required thresholds refer to global long-term statistics (i.e.,they refer to the ensemble of data products, i.e., individual retrievals). Locally in space and time larger values may be acceptable." This indicated that one cannot conclude from estimated biases exceeding 0.5ppm that the satellite data products are useless for the targeted application. In version 1 of the URD (http://www.esa-ghg-cci.org/?q=webfm_send/21), where you have been a co-author and which has been approved by you, the following was written to highlight this: "Note also that the requirements can only give an indication of the required values, i.e., are approximate values, which should not be over-interpreted."

F. Chevallier: *Further, in contrast to the authors (p. 21834, l.15; p. 21846, l.3), I see no reason why some (or even most) of the retrieval systematic errors would not be shared by the five satellite products, for instance simply because they share the same spectroscopy data or because they are all bias-corrected with the same sparse and imperfect reference measurements. But actually, as noted above and in contrast to some statements made in the paper (ibid), only four out of the five satellite products show the same unexpected pattern.*
Authors: We list several differences in the retrieval schemes: cloud and

aerosol screening / samplings, light scattering related at clouds and/or aerosols, surface albedo, chlorophyll fluorescence, empirical bias correction (see P17/18). These topics cover important potential sources for retrieval biases (see the cited retrieval literature of Reuter et al., 2010, 2011; O'Dell et al., 2012; Cogan et al., 2012; Butz et al., 2011; Yoshida et al., 2013, and references therein).

Spectroscopy: Except for the O2-A band, the SCIAMACHY retrieval uses different spectral fitting windows (see Reuter et al. (2013) for more details). Therefore, it is not possible to use the same spectroscopy. Additionally, different spectroscopic data bases are used and handled differently. Some examples: BESD uses ABSCO v4.0.2 for the O2-A band and HITRAN2008 (Rothman et al., 2009) plus water vapour from Jenouvrier et al. (2007) for the CO_2 band at 1580nm. ACOS uses ABSCO v4.0.2 or v4.1 but with some overall scaling factor applied to each band. RemoteC uses the line-mixing model of Tran and Hartmann (2008) and accounts for collision induced absorption in the O2-A band and uses HITRAN2008 (Rothman et al., 2009) plus a line mixing correction Lamouroux et al. (2010) for CO_2. Additionally, the O_2 absorption cross sections are scaled by a factor 1.03 as recommended by Butz et al. (2011). NIES uses Tran et al. (2006); Tran and Hartmann (2008) for the O2-A band, HITRAN2008 (Rothman et al., 2009) for H_2O and Lamouroux et al. (2010) for CO_2. UoL-FP uses rescaled ABSCO v4.1.1 cross sections. We added "The retrievals use different spectral fitting windows and spectroscopy" to P17 (differences of the retrieval algorithms).

Please note also the short comment of Dr. Nassar and our answer: "The results of Nassar et al. (2011) support a strong European sink in 2006, which they derived from global inversions of TES (Tropospheric Emission Spectrometer) satellite measurements. TES CO_2 retrievals conceptually differ from SCIAMACHY or GOSAT XCO_2 retrievals because the instrument measures thermal infrared radiation. The peak sensitivity for CO_2 is in the mid-troposphere and they used only soundings above oceans between $40°S - 40°N$. Remapping their results yields for the European TRANSCOM region 1.33 ± 0.20 GtC/a (Nassar et al., 2014) which agrees well with our result for 2006 (1.33 ± 0.33 GtC/a)."

Bias correction: Not all algorithms use an empirical bias correction (P18: "one retrieval uses no empirical bias correction (NIES)"). Additionally, the used bias correction schemes have large differences and you cannot conclude that biases are similar only because the same ground based data sets have been used. An (oversimplified) example may illustrate this: Retrieval a is biased high by 0.6ppm on the NH and 0.4ppm on the SH; retrieval b is biased high by 0.1ppm on the NH and 0.3ppm on the SH. Ground based measurement on the NH are used to correct this bias by globally subtracting 0.6ppm for retrieval a and 0.1ppm for retrieval b. The bias corrected versions of both retrievals are now bias free on the NH but produce still different (artificial) inter-hemispheric gradients.

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