Reply to anonymous Referee #2

Thank you very much for very carefully reading the manuscript and providing us with useful suggestions to improve the clarity of the paper. Please find our detailed replies (in black) to your specific comments (in grey).

Land use flux emission & Biome-inventory Different sources of data with different scale and methodology followed in inventory estimates. No. of plots laid out for diverse biome type in different regions. These inventory estimates (table 3) are sporadic and not consistent done over years. How these estimates area comparable over different time periods? and with ecosystem models (0.5 degree grid) for assessing contribution of land use change to net carbon flux (Table 3).
The spatial and temporal extents of the estimations given in Table 3 are not consistent and reflect the estimates of different studies using different methods and assumed areas. We found informative to provide a synthesis of the work done so far, and how those estimates are or are not consistent with the overlapping periods for which we do provide data. All values correspond to India only (as indicated in the Table 3 caption).

Moreover, increased sink capacity of carbon in South Asia from 1980s, to 1990s and 2000s perhaps more linked to climate signal (El Nino). In 80s, more prevalent drought episodes may be the reason for more release of C and more wetter years in 1990s could have strengthen C sink. More discussion is needed to exclusively single out contribution of land use change.
Increasing atmospheric CO2 and the CO2 fertilization effect on photosynthesis is a very important driver in the model that leads to the growing sink. Likewise, as discussed in the LUC section, the rapidly increase extend of forest plantations has also contributed to the increased sink.

Inter-annual variability of carbon fluxes Results presented does not clearly brings out role of increasing atmospheric CO2, land use change and climate in controlling variability of net carbon flux. Clarity on relative contribution from these factors is more important in evaluating carbon budget particularly in monsoon regions where all three factors interplay and affects on CO2 budget in integrated manner. It would be interesting if author addresses role of land use changes (crop establishment and crop intensification predodimantly taking place in south Asia) in carbon budget. Can Ecosystem model simulations (LPJ or trifid) of varying climate and constant LUC and vice-versa is possible to present in results. It would be interesting to have atleast inter-annual variability of total NEP for top-down and bottom-up approaches (best of ecosystem models) and their comparison with past studies over south Asia region (Tian et al., 2003, Global planetary Change 37:201-217)
We find that inter-annual variability is largely controlled by interannual variability in precipitation and temperature as it influences the NEP, this suggesting that the climate exerts a larger effect on biomass production (NPP) than over heterotrophic respiration. We have now further explain this effects in section "3.8 Interannual variability of carbon fluxes" and Figure 4.

Unfortunately, our data on land use change relies on the FRA 2010 which provided a decadal change for the 1990s, for 2000-2005, and 2006-2010, in all cases not enough resolution to study the effects on inter-annual variability of changes in crops. On trends, we do discuss in the LUC section the importance of the two major drivers of LUC fluxes, which are tree plantations and industrial and fuelwood harvest, and deforestation.

Unfortunately, the Tian et al. did not include the most part of the 1990s and the whole of 2000s, which is the focus of this work. Therefore, we are not able to compare our results directly with theirs and come up with some conclusions.

Similarly, for the comparison of trends and interannual variability from DGVMs (discussed in the paper) have not compared with those from atmospheric inversions. This is mainly because the inverse model results are not well constrained by atmospheric observations for the South Asia region before 2007 (ref. Patra et al., 2011a, Niwa et al., 2012).

Seasonality of carbon fluxes

Page 13577 fig. 3. X-axis is it total NEP of South Asia? On monthly basis, why unit on X-axis is Tg C per year? Decadal averge of Annual mean NEP ranges from 193 to 220 Tg C per year (Page 13552 line 20-21). Monthly CO2 flux or NEP on X-axis is unrealistic. It is advised to present mean NEP (g c m-2 per month) and discuss results for seasonality of CO2 flux.

It has been agreed that units of regional carbon fluxes will be given in TgC/yr for consistency over all the papers in this RECCAP special issue. Thus, we have adhered to TgC/yr units throughout the manuscript.

We have also rechecked the numbers for monthly CO_2 fluxes, and they appeared to be correct. The annual mean CO_2 flux is a balance between large uptake during the summer and release during the winter.

Page 13548 line 13: is it 2009 or 2002 (see table 3) Page 13555 line 25 remove “and” after the Page 13555 line line 7-9 cite reference of ensemble results for south Asia. Agreed GPP in monsson belt controlled by seasonality linked to precipitation but in this study some models are not reflecting dominant control by climate particularly precipitation.

Yes, we agree with your observations, and have tried to bring up this issue by showing these plots for inconsistent seasonal cycle predicted by both the ecosystem models as well as the atmospheric inversions. Advanced modeling systems and a variety of observations are needed from the region to further explore these aspects.

References

page 13562. Chhabra et al. (2009a) not in text page 13563. Fekete et al. (2010) not in text page 13564. Kucharik et al. (2010) not in text page 13564. Lele and Joshi (2009) not in text page 13573, line 16?. Patra et al. (2011) not in references.

These corrections are made.