We would like to thank the reviewers for their useful and productive comments that have helped us to improve the clarity and quality of the manuscript.

Reviewer 2

Specific Comments My main comment is that after reading the paper, I was unsure of the point. A majority of the paper focuses on division of observations into certain regions, and describing the observed CO2 seasonal cycle in these regions. This detracts from what I think the main idea of the paper actually is: That using a new set of CO2 emissions and a new land surface model results in improved atmospheric CO2 and enhanced carbon emissions from land. Less time should be spent on describing seasonal cycles in every region, and more focus should be put on when, where, and why the new model produces different and improved results. In particular, revisions of the Introduction and Conclusion should make the overall picture of the paper more clear.

This paper focuses on the new evaluation method of regional CO2 observations to evaluate the observation-model differences of CO2. We introduce how to get the regional CO2 surface concentration based on the seasonal cycles of all stations at first, and then compare the observation-model differences using the regional CO2 surface concentration in detail.

We have deleted the sentence P2246, line 4 and added more explain about the regional CO2 concentrations. The texts from P2245 line 26 to the end of this paragraph (in the introduction) have been modified:

"**In this article we propose a new technique to evaluate the regional surface fluxes by comparing the regional CO2 concentration from model simulations with observations, rather than the difference at every single observational station. Several stations in one region were grouped according to the regional temporal characteristics of the seasonal cycle which have been derived from a new atmospheric CO_2 observation dataset from GLOBALVIEW-CO_2 2010. The averaged concentration of CO2 at all stations in one region represents the regional CO2 concentration in this region.**

To validate the usefulness of the new evaluation method about regionally averaged CO2 concentrations, we compared two simulations using two different emission inventories with observations. One emission inventory is the original surface fluxes in GEOS-Chem, including the NEP from CASA. Another new emission inventory, including the land-atmosphere fluxes from VEGAS, was selected to reproduce CO2 concentrations in this study. The land-atmosphere fluxes from VEGAS were used in the GEOS-Chem model, replacing all the current inventories except anthropogenic emissions and ocean fluxes.."

The last sentence in the abstract "This implies possible large uncertainties in the fluxes there" has been modified to **"The regionally averaged CO2 concentrations will be helpful for comparing CO2 concentrations modeled results and observations and evaluating regional surface fluxes from different methods.**"

The last paragraph in the conclusion has been modified to "**The regional CO2 surface fluxes can be estimated by different methods. It's very useful for evaluating regional surface fluxes by comparing the CO2 regionally averaged**

values from modeled results with observations. The differences of regionally averaged values between observations and model results can be used to estimate the uncertainty of regional fluxes and optimize the regional fluxes with inversing methods in future work."

Some other general comments for the paper: 1) In regards to nomenclature for land carbon fluxes, take care to be consistent, and be clear about the sign convention. Define NEP, NBP etc.

We have defined NEP as "Net Ecosystem Productivity" and deleted "NBP". Land-atmosphere fluxes are used to replace "NBP".

2) I think the Introduction needs to end with a better explanation of what is being done in the study. Things that need to be included are:

- A summary of the models compared, and justification for replacing CASA with Vegas. Is it because of the inclusion of biomass burning in Vegas? What is the expected impact of including this (for example what are the estimates for CO2 lost to atmosphere during biomass burning)?

We have added some detailed descriptions about CASA and VEGAS in Section 2.2 to explain the difference between CASA and VEGAS models.

P2248 line 7-10 (Section 2.2,now Modeling the land carbon fluxes)have been rewritten to **"It was run at 2.5°×2.5° resolution and forced by precipitation and temperature, the seasonal climatologies of radiation, humidity, and wind speed. The driving data of precipitation for VEGAS come from a combination of the Climate Research Unit (CRU: New et al., 1999; Mitchell and Jones, 2005) data set for the period of 1901–1979 and the Xie and Arkin (1996) data set of 1980–2006 (which has been adjusted with the 1981– 2000 climatology of CRU data set). The surface air temperature driving data use the dataset from the NASA Goddard Institute for Space Studies (GISS) by Hansen et al. (1999), adjusted by CRU climatology of 1961–1990.A fire module includes the effects of moisture availability, fuel loading, and plant functional types dependent resistance. Unique features of VEGAS include a vegetation height dependent maximum canopy which introduces a decadal timescale that can be important for feedback into climate variability and a decreasing temperature dependence of respiration from fast to slow soil pools. Specially, two lower soil pools have weaker temperature dependence of decomposition due to physical protection underground in VEGAS(Q10 value of 2.2 for the fast pool,1.35 for the intermediate pool, and 1.1 for the slow pool. The monthly land-atmosphere fluxes simulated by VEGAS is regridded offline to the GEOS grids （2°×2.5°）in this study, which is equal to the magnitude of NEE. The seasonal cycle of land-atmosphere fluxes from VEGAS is shown in Fig.1. A positive flux indicates a flux of CO2 from the land to atmosphere and negative is uptake by the land."**

P2248 line 11-14 has been written to **"Monthly mean NEP fluxes for 2000 from CASA are constructed from Gross Primary Production (GPP) and ecosystem respiration (Re) (Olsen, 2004). Inputs to CASA included a 1990 monthly normalized difference vegetation index(NDVI) product derived from the**

NOAA/NASA Pathfinder data set, surface solar insolation(Bishop and Rossow,1991),mean temperature and precipitation from the period 1950 to 1980(Shea,1986)，soil texture(Zobler,1986) and a land cover classification based on NDVI(DeFries and Townshend,1994). The response of heterotrophic respiration to surface air temperature is described by using a Q10 function of 1.5(Raich and Potter,1995). The net global contribution from CASA is set to 0 Pg C/yr in order to represent terrestrial fluxes with no anthropogenic interference. The seasonal cycle of NEP from CASA is shown in Fig.1"

Ref:

Mitchell, T. D. and Jones, P. D. :An improved method of constructing a database of monthly climate observations and associated high-resolution grids. Int. J. Climatol. 25, 693–712,2005.

New, M., Hulme, M. and Jones, P.: Representing twentiethcentury space–time climate variability. Part I: development of a 1961–90 mean monthly terrestrial climatology. J. Clim. 12, 829–856,1999.

Xie, P. and Arkin, P. A.: Analyses of global monthly precipitation using gauge observations, satellite estimates, and numerical model predictions. J. Clim. 9, 840– 858,1996.

Hansen, J., Ruedy, R., Glascoe, J. and Sato, M. GISS.: analysis of surface temperature change. J. Geophys. Res. 104, 30997–31022,1999.

Bishop, J.K.B., and Rossow,W.B.: Spatial and temporal variability of global surface solar irradiance, J. Geophys. Res., 96(C9), 16,839-16,858, 1991.

Shea, D.J., Climatological atlas: 1950-1979, Technical Note NCAR TN-269+STR, Nat. Cent. for Atmos. Res., Boulder, Colo., 1986

Zobler, L.A.: World soil file for global climate modeling, NASA Tech. Memo., 87802, 32 pp., 1986.

DeFries, R.S., and Townshend, J.R.G.:NDVI-derived land cover classifications at a global scale,I nt. J. RemoteS ens.,1 5(17), 3567-3586, 1994.

Raich, J .W., and Potter, C.S.: Global patterns of carbon dioxide emissions from soils, Global Biogeochem cycles, 9 (1), 23-36, 1995.

- In Section 4 you explain the fluxes of CO2 to the atmosphere, I think these should be introduced sooner for the benefit of readers not familiar with CO2 inversion studies. Then you can also explain that in the Vegas experiment, the NEP flux into GEOS-Chem is changed from CASA to Vegas.

We have added a new paragraph and explained that in Section 2.2 after the paragraph above.

"Anthropogenic interferences such as biomass burning were specified as 2.96 Pg C/yr separately in GEOS-Chem. To account for the total annual sum of biospheric uptake and emission of CO2, the residual annual terrestrial exchange of inverse results from TransCom, a global total of -5.29 Pg C/yr, was included in the land-atmosphere fluxes (Nassar et al., 2010). The seasonal cycle of total land-atmosphere fluxes used in GEOS-Chem is shown in Fig.1."

3) The methodology is not 100% clear (at least not the motivation behind the modeling methods). For example, Section 2.2 should start with a clear description of what the two land surface models represent. Explain right away that CASA simulates NEP as GPP minus ecosystem respiration, while Vegas simulates NBP, which is the NEP minus CO2 lost from biomass burning. Then it should also be explained if there are other differences in the models that will affect the results: ie how do they calculate

photosynthesis and respiration differently? Also I think an explanation of the big picture would be helpful. The GEOS-Chem transport model requires net fluxes of CO2 from the land in order to predict global atmospheric CO2 concentrations. It usually uses NEP from CASA but now you are using NBP from Vegas instead. Finally, I think the Appendix should be in this section. It is very relevant to the model differences and the results of the overall simulations.

The detailed explanations about VEGAS and CASA have been given in the response to comment 2).The net global contribution from CASA is set to 0 Pg C/yr in order to represent terrestrial fluxes with no anthropogenic interference. To account for the total annual sum of biospheric uptake and emission of CO2, the residual annual terrestrial exchange of inverse results from TransCom, a global total of -5.29 Pg C/yr, was included in land-atmosphere fluxes in GEOS-Chem. The net land-atmosphere fluxes in the original emission inventory include NEP from CASA, biofuel burning, and the residual annual terrestrial. NBP from VEGAS represents the net land-atmosphere flux.

We have moved some texts in the Appendix to the place after the paragraph "Anthropogenic interference…" (see our response above) in section 2.2.

"**The original CO_2 fluxes used in this study include 7.8 Pg C (anthropogenic emissions), -1.4 Pg C (net ocean-atmosphere fluxes),-2.3 Pg C (net land-atmosphere fluxes) for 2006. The original global annual net CO_2 flux for 2006 is 4.1Pg C. The new CO_2 fluxes used in this study include 7.8 PgC (anthropogenic emissions), -1.4PgC (net ocean-atmosphere fluxes),-1.9 Pg C (net land-atmosphere fluxes) for 2006. The new global annual net CO_2 flux for 2006 is 4.5 Pg C. There are also little differences between the total fluxes from other inversion results. JENA S99V3.2 data(3.78PgC) is available from http://www.bgc-jena.mpg.de/~christian.roedenbeck/download-CO2/;LSCE V1.0(3.43PgC) (Chevallier et al., 2010) is available from http://www.carboscope.eu/; Carbon Tracker -2009(4.15 PgC) is available from http://www.esrl.noaa.gov/gmd/ccgg/carbontracker/; and two inversion results (4.1Pg C, 4.7Pg C) are from (Feng et al., 2011;Nassar et al., 2011).**

The land-atmosphere flux from VEGAS in January is 270 Tg C less than that from CASA. These differences are distributed over tropical land regions as shown in Fig.2. The fluxes from VEGAS are smaller than the original land-atmosphere flux in GEOS-Chem, especially from June to August（about 460 Tg C, 770 Tg C, and 180 Tg C, respectively）.The differences between the flux from VEGAS and that from CASA in July are distributed over the regions of Asia, temperate North America, and South America tropical (Fig.3), which reaches about 500 Tg C in total."

4) I think that the grouping of CO2 observational sites is best described as "regionally averaged", rather than "group averaged". What is different in these divisions as compared to the TransCom study? In the abstract and Section 3, you refer to grouping based on atmospheric mixing regimes, but I think this is a misuse of the term. To me this refers to stability of the atmosphere. It would be better to say "seasonal cycles" or just "seasonality".

We have modified “group averaged” to “regionally averaged” at all places in this paper, “atmospheric mixing regimes” has been changed to “seasonal cycles”
We grouped the stations in one region based on the seasonal cycle at each station in our study. The stations in one region were grouped based on the amplitudes and phases of seasonal cycle at each station. The average of CO2 at all stations in one region represents the regional CO2 concentrations. The ocean is split into 15 regions where there is at least one station with its seasonal cycle in one region. The amplitude and phase of the seasonal cycle of the regional CO2 concentration for one ocean region is different from that of the regional CO2 concentrations for another ocean region.
The first paragraph in Section 3.1 has been modified to “**We grouped the stations in one region based on the seasonal cycle at each station in our study. The average of CO2 at all stations in one region represents the regional CO2 concentrations. The amplitude and phase of the seasonal cycle at each station in one group is similar, while the average amplitude and phase of the seasonal cycle for each group is different from that of other groups….**”

The last paragraph in Section 3.1 has been modified to “**The amplitude and phase of seasonal cycles at stations on the ocean are different, for example, CO2 decreases in April for one region while in August for another region. The stations on the ocean were grouped based on the amplitude and phase of the seasonal cycle. The stations on the ocean were grouped into 15 groups and the ocean was divided into 15 regions in this study. The 11 ocean basis regions were chosen to approximate circulation features such as gyres and upwelling regions in TransCom study(Gurney et al.2002).**”

Introduction

Page 2245:

Line 4-5: Remove “Piao’s results show that”

We have removed it.

Lien 6: Larger than what?

We have added “**than the results of the TransCom-3 study for 1992-1996** ”

Line 8: Second half of sentence should read: “sinks in every part of the globe.” Also might be good to reference satellite data, which does not tell us all the sources and sinks but do give a good idea of distributions of CO2.

We have deleted this sentence based on a request from the 1st reviewer.

Line 13-21: The second half of this paragraph (starting with “The mean annual meridional/”) is unclear. What exactly was learned in these studies that is relevant to the current work?

There were different methods to compare the model values and observations in earlier studies. “The mean annual meridianal ….” are some examples.

We have deleted “In early studies concentration…” and added these sentences “**The GEOS-Chem atmospheric transport model has been widely used in the assimilation of CO_2 and inverse of CO_2 flux. It has been used to evaluate the**

influence of reduced carbon emissions on the distribution of atmospheric CO_2 and described in early studies (Suntharalingam et al., 2004, 2005). The land-atmosphere fluxes in GEOS-Chem include monthly biomass burning CO2 emissions, annual inventory of biofuel burning 3-hourly Net Ecosystem Productivity(NEP) for 2000(Olsen, 2004), and annual climatology based on TransCom CO2 inversion results in Nassar et al.(2010). The differences between CO2 model simulation using surface fluxes and observations have been used to improve our understanding of the global surface fluxes.There were different methods to compare the model values and observations in earlier studies." before the "The mean annual…(Rodenbeck et al.,2006))"

Page 2246:

Line 4-6: This is true but does not explain what can be learned from comparing the concentrations in ocean regions since as the authors point out later in the paper,neighboring land often influences the CO2 concentration above oceans.

We have changed this sentence to "The difference of the regional CO2 concentration between two modeled results and observations will be helpful for correcting the regional surface fluxes."

To make the overall picture of the paper more clear, we have added more explain about the difference between VEGAS and DGVMs based on a request from the first reviewer. The texts from P2245 line 26 to the end of this paragraph (in the introduction) have been modified:

"Where and when atmospheric CO2 is absorbed by land ecosystems and oceans is a major issue for the global carbon cycle. Optimized estimates of surface sources and sinks have been produced by different ways. One is a top-down way. For example, CO_2 in the atmosphere is affected by surface fluxes. Information about regional carbon sources and sinks can be derived from variations in observed atmospheric CO2 concentrations via inverse modeling with atmospheric tracer transport models (Gurney et al., 2002). Another is a bottom-up way. For example, the land-atmosphere fluxes can be simulated by different Dynamic Global Vegetation Models(DGVMs) (Sitch et al., 2008). Terrestrial carbon cycle model Vegetation-Global-Atmosphere-Soil(VEGAS) is one of the DGVMs，which was developed to simulate the net land-atmosphere fluxes and described by Zeng(Zeng et al.,2003). The land-atmosphere flux simulated by VEGAS agrees well with the CO_2 growth rate observed at Mauna Loa both in terms of interannual amplitude and phase(Zeng et al.,2005).

The GEOS-Chem atmospheric transport model……There were different methods to compare the model values and observations in earlier studies (this paragraph see the response above)**.**

However one persistent ….or missing processes in the model. In this article we proposed…replacing all the current inventories except anthropogenic emissions and ocean flux(see the response to the first main comment). **The difference of the regional CO2 concentration between two modeled results and observations will be helpful for correcting the regional surface fluxes**."

Line 8-9: Sentence beginning “It is significant for using” is confusing.
We have deleted these sentences “It is significant for using …top-down ways” and added a new sentence and a new reference (Gurney et al., 2002). Please see the response to P2246 Line 4-6.

Line 9: What about fluxes from land cover and land use change?
The fluxes from land cover and land use change are included in “land-atmosphere fluxes”.
“emission from fossil fuel, net ecosystem exchange of the terrestrial biosphere and ocean-atmosphere carbon exchange” has been changed to **“anthropogenic emissions, land-atmosphere fluxes, ocean-atmosphere fluxes”**

Line 16: Begin sentence with “Nassar et al. (2010) …” and then remove reference at the end of the sentence. Also, this sentence explains the differences between the “original” and “new” CASA-based fluxes in Figure 1, but it is easy to forget the reason for these differences as the reader goes through the paper. A reminder to the reader in the results section would be helpful: Reiterate that the difference between the new CASA and original results is the inclusion of updated fossil fuel inventory, shipping and aviation emissions, and atmospheric production of CO2. Finally, I had to read the abstract of Nassar et al. to understand that CO2 shipping is really emissions of CO2 from ships.
The CO2 shipping is not used in this study. So we delete this.
Line 16-29 “Nassar made ….Zeng,2003)” has been changed to **“**The land-atmosphere fluxes in GEOS-Chem include monthly biomass burning CO2 emissions, annual inventory of biofuel burning 3-hourly Net Ecosystem Productivity(NEP) for 2000(Olsen, 2004), and annual climatology based on TransCom CO2 inversion results in Nassar et al.(2010).” Please see the response to P2245, Line 13-21
The differences between the original and new emission inventory has been added in the introduction and the section 2.2(now Modeling the land carbon fluxes). “One emission inventory is the original surface fluxes in GEOS-Chem, including the NEP from CASA. Another new emission inventory, including the land-atmosphere fluxes from VEGAS, was selected to reproduce CO2 concentrations in this study. The land-atmosphere fluxes from VEGAS were used in the GEOS-Chem model, replacing all the current inventories except anthropogenic emissions and ocean flux.” Please see the response to the first comment.

Line 20-26: What is meant by balanced? Also define NEP.
The net global contribution from CASA is set to 0 Pg C/yr in order to represent terrestrial fluxes with no anthropogenic interference, so The NEP from CASA is balanced. NEP has defined as “Net Ecosystem Productivity”. Please see the response to the specific comment 2) and P2245, Line 13-21.

Lines 23-26: The models used in this study need to be better explained. I have several questions:

- What is “it”? (It is available for the simulation of global CO2 concentration …”)
It is available for us to use different land-atmosphere flux to simulate CO2. There are many different land-atmosphere fluxes simulated by different Dynamic Global Vegetation Models. We have deleted this sentence. This paragraph has been modified. Please see the response to P2245, Line 13-21 and P2246 Line 4-6.
- Is the DGVM you reference Vegas?
Vegas is one of Dynamic Global Vegetation Models(DGVMs). Please see the response to P2246, Line 4-6.
- I don’t think the last sentence really adds much to the discussion.
We delete this sentence. Please see the response to Line 16-29.
- If you have replaced on non-DGVM with a DGVM, does this mean you are now predicting vegetation coverage? Or is there a prescribed land surface map for each model? Are these the same?
The land-atmosphere fluxes in GEOS-Chem include the NEP from CASA. Land-atmosphere flux can be simulated by DGVMs. VEGAS is one of the DGVMs. The original land-atmosphere fluxes include the NEP from CASA. The net land-atmosphere fluxes simulated by VEGAS were used as the new land-atmosphere fluxes. To validate the usefulness of the new evaluation method about regionally averaged CO2 concentrations, we compare two simulations with two different emission inventories and observations. Please see the response to the first comment and P2246, Line 4-6.
-Why was CASA replaced with Vegas?
Please see the response above and the response to the first comment and P2246, Line 4-6
- I don’t know what you mean by “All DGVMs are consistent with the global carbon land budget”
We have deleted this sentence.

Page 2247:
2 Data
Line 10: I think this section should begin with the description of what GLOBALVIEWCO2 is, rather than where it comes from. How many stations are in the dataset? It’s not a globally gridded product, is it?
We have deleted “It can be downloaded…..html”. “This updated… the benchmark trend values” has been modified to “**This data product includes more than 300 extended records derived from observations made by 22 laboratories from 15 countries between the period January 1,1979 to January 1,2010. Data in the files with a seas qualifier that contain a statistical summary of the average seasonal pattern by month were used to analysis the seasonal cycle of the observation stations. Data in the files with an ext qualifier that contain synchronized smoothed values were compared with model results. Where there are several measurements at different altitudes for the same station we only use the lowest in altitude. This gives a total of 108 measurements that have been used.** ”
Line 11: Remove “While”

We have removed “While”.

Line 21-23: I don’t know what this means.

We have removed this sentence. Please see out response to Line 10.

Page 2248:

2.2 Vegas data

Line 1: This section is really about the land carbon cycle models/fluxes, not just Vegas. Maybe rename it “Modeling the land carbon fluxes”

“VEGAS data” has been changed to “**Modeling the land carbon fluxes**”

Line 1-2: Not just DGVMs simulate NEE, any land surface model will do this. Is CASA a DGVM?

This sentence has been changed to “The net ecosystem exchange (NEE) is simulated by land models and equals the heterotrophic respiration (RH) subtracted from the net primary productivity (NPP).”

Lines 3-4: Are the sink numbers from Vegas? CASA? Also which DGVMs simulate a greater uptake?

The land-atmosphere exchange from Lund-Postdam-Jena(LPJ) is -1.52 PgC/yr, the land-atmosphere exchange from Sheffield-DGVM(SHE) is -2.75PgC/yr.

We have modified these sink numbers to “**-1.52 PgC yr^{-1} (Lund-Postdam-Jena(LPJ) model) and -2.75 PgC yr^{-1} (Sheffield-DGVM(SHE) model)**”. “DGVMs” has been modified to “The **DGVMs**”

Line 8: What is the source for the driving meteorology? Are there other drivers needed to run Vegas (like shortwave/longwave radiation, winds, humidity)?

We have rewritten line 7-10. Please see our response to the specific comment 2).

Line 9: Define NBP? Again, be consistent and clear with nomenclature and sign conventions.

Please see our response above. “The monthly NBP flux as net land-atmosphere carbon exchange” has been changed to “The land-atmosphere flux simulated by VEGAS”

Line 12: What does CASA stand for?

We have rewritten line 11-14.Please see out response to the specific comment 2).

Line 14: Here is a good place to say that: 1) A positive flux indicates a flux of CO2 from the land to atmosphere and negative is uptake by the land; and 2) The CASA flux is always higher than the Original flux because of the added emissions from Nasser et al.(2010).

We have added a new paragraph to explain the original flux .Please see out response to the specific comment 2)

Line 15: Delete “It is evident that”. Do you mean temperate North America instead of boreal South America? Are all of the model differences attributable to the fact that Vegas includes biomass burning?

Line 14-20 “The difference of spatial distribution is……Northern Africa.” has been changed to **“**The land-atmosphere flux from VEGAS in January…in total.**”.** See response to the specific comment 2).

The differences of two models have been added. See response to the specific comment 2).

Line 18-19: Would be easier to say the difference is distributed over tropical land.
We have modified it. Please see our response above.
Page 2249:
Section 3.1
Consider renaming Section 3 "Regional CO2 observations", which would also mean changing the title of the paper. This section could be made more clear. Basically, you have used 108 sites that are broken into 11 land groups and 15 ocean groups based on the regions in the TransCom experiments (why do you have 4 more ocean groups than TransCom?). 72 sites are in the ocean, and 36 are on land. It would be helpful to explain this clearly upfront, before getting into the details of how you chose the regions etc. Also in general the description of the ocean grouping is very hard to follow.
"Grouped CO2 observations" has been modified to "Regional CO2 observations".
The title has been modified to "**Improved simulation of regional CO2 surface concentrations using GEOS-Chem and fluxes from VEGAS.**"
"All 108 stations (see Table A1) are classified into 26 groups and 72 sites in 15 ocean regions" have been modified to **"There are 36 stations on the land and 72 stations on the ocean (see Table A1). These stations were classified into 26 groups. A map of all grouped stations is shown in Fig. 4."**
We have rewritten these sentence(Line 15 to Line 22) as following :"**The amplitude and phase of seasonal cycles at stations on the ocean are different, for example, CO2 decreases in April for one region while in August for another region. The stations on the ocean were grouped based on the amplitude and phase of seasonal cycle. The amplitude and phase of the seasonal cycle for each station in one group is similar, while the average amplitude and phase of the seasonal cycle for each group is different from that of other groups. The stations on the ocean were grouped into 15 groups and the ocean was divided into 15 regions.**"

Line 4: Delete "regional characteristics of"
We have deleted "regional characteristics of"
Line 5, 6:
Lines 12-14: What do you mean by "except the boundary of two land regions"? And the latitude definition is confusing.
These sentences "The 11 TransCom land regions are used except the boundary of two land regions. The latitude is defined as the division for most two adjacent land regions in this work." have been rewritten as following: **"We can't split the land based on the seasonal cycles at stations on the land because the phase of seasonal cycles at all stations on the land is similar, for example, CO2 at all stations on the land decreases in autumn and increases in spring. The land was divided into 11 regions based on the TransCom land regions (shown in Fig.4). The land region north of 40°N in North America is called as Boreal North America(L1),and the region south of 40°N in North America is called as Temperate North America(L2). The region north of 5°S in South America is called as South America Tropical(L3), and the region south of 5°S in South America is called as**

South America Temperate(L4).The other six land regions are Northern Africa(L5),Southern Africa(L6),Eurasian boreal(L7),Eurasian Temperate(L8),Tropical Asia(L9),Australia(L10),and Europe(L11). The stations in one land region were grouped. The magnitude of the amplitude of the seasonal cycles at different stations in one land region may be different. To represent the regional CO2 concentration for the land regions, the average of seasonal cycles at more than two stations with similar amplitudes were required in one land region. There are more than 2 stations with similar amplitudes of seasonal cycles in only 5 land regions (North America, Temperate North America, Eurasian boreal, Eurasian Temperate and Europe). So the regional CO2 concentrations of these 5 land regions were used to evaluate the observation-model differences of CO2."

Section 3.2

General comment: It would be more helpful to give the names of the regions in the discussion rather than just the numbers.

Line 24-26 has been written.

The seasonal cycles at all stations in 5 land regions are shown in Fig.5. The annual mean has been removed. The average minimal value for each region is smaller than -7 ppm(-11.5 ppm for North America Boreal(L1), -7.1 ppm for North America Temperate(L2), -10 ppm for Eurasian boreal(L7), -8.7 ppm for Eurasian Temperate(L8), -8.1 ppm for Europe(L11)

Line 25: Remove "we can show that" and "from Figure 5". Also mention that the annual mean has been removed.

"we can show that" and "from Figure 5" have been moved.

Page 2250

Line 6-9: Can you give an example of where these comparisons can help with the understanding of surface fluxes?

We have added this example in the paper: "**The geographic domain from which surface fluxes influence the measured seasonal variation in gas concentration can be assessed through a footprint analysis（Randerson et al.,1997）. The fluxes in this domain could be adjusted according to the differences between the modeled regional CO2 concentrations and observations**."

Section 3.3

General: The last paragraph on this page seems to be more of an overview, while the previous paragraphs in the section were more specific. Consider rearranging this section to have this paragraph first.

Delete these sentences. "We require that….,it is helpful to distinguish when and where the sources and sinks are" .See the response to section 3.1

Lines 23-24: What is meant by "next to each other"? The meaning of this sentence is unclear.

Delete these sentences. Please see response to section 3.1.

Page 2251:

Are regions O4 and O5 dominated by air-sea exchange, since they are so far from

land?

We didn't change the air-sea flux in this study. The modeled concentrations of the two regions are changed while the land-atmosphere flux is changed. So they are influenced by the land-atmosphere flux.

Line 3: By special trend do you mean that they have two minima? It would be better to be specific about what is special/unique about the trend.

Line 2-Line 9 has been rewritten. "**Generally there is an increase period and a decrease period for one seasonal cycle. While CO2 increases from April to June and from October to December for the South Pacific Tropics(O4). CO2 decreases from January to April and from August to October for the South Pacific Temperate(O5).**"

Line 10: I think you mean "north of 35S"

Yes. Line 10 has been modified to "The seasonal cycle is more complicated in the Indian Ocean north of 35°S"

Line 12: delete "totally"

Thanks. "totally" has been deleted.

Lines 15-16: It looks like O10 and O11 do show a very weak seasonal cycle.

We have added more description for O10 and O11. "**The South Atlantic was divided into 2 regions (O10 and O11) with different amplitudes. The minimum and maximum values are -0.9 ppm and 0.7 ppm for the Atlantic Tropics (O10), while they are -0.3 ppm and 0.3 ppm for the South Atlantic Temperate (O11)"**

Lines 21-22: I think the word 'variations' is too vague – do you mean the seasonal anomalies of CO2?

Thanks. "seasonal variations" has been modified to "seasonal anomalies of CO2."

Line 23: remove "such as O15" since this is the only group south of 35S anyway.

"such as O15" has been removed.

Line 25-end: The discussion of the Southern Ocean is confusing, please be more specific.

These sentences have been rewritten. "**An increase of the seasonal cycle for Southern Ocean occurs in September, while the seasonal anomalies of CO2 in the northern hemisphere are negative at the same time. The two seasonal cycles of the Southern Ocean (O15) and the northern hemisphere are out of phase. Northern hemisphere terrestrial ecosystems contribute substantially to the seasonal cycle at many stations in the southern hemisphere, because of lags in transport and nonoverlapping growing seasons, some components from the northern and southern are out of phase with one another, thus an increase in seasonal cycle of NEP fluxes from terrestrial in the northern hemisphere could drive a decrease in the amplitude of the seasonal cycle of atmospheric CO2 at stations in the southern hemisphere(Randerson et al.(1997)).**

Page 2252:

Section 4

General comment: the first paragraph is a good overview of the study but I have a few questions/comments:

- Reiterate the difference between the original and new inventories. Then you can

move the sentence on Line 12 ("A detailed description …") to Line 7-8.

Thanks.Line7-8 have been modified to **"We carried out the simulations with the original emission inventory (ori) and the new emission inventory (new). A detailed description of the original emission inventory is given in Nassar et al.(2010)"**

- What is the residual annual terrestrial exchange? Is this the extra land flux needed to get the correct atmospheric [CO2] in GEOS-Chem?

Yes. The net global contribution of the fluxes from CASA is set to 0 PgC/yr. The terrestrial biospheric exchange is necessary to account for the total annual sum of biospheric uptake and emission of CO2, which we refer to as the residual annual terrestrial exchange (Nassar et al.2010).

- How is the ocean flux determined?

The ocean flux in the new emission inventory is the same as the ocean flux in the original emission inventory.

- Line 13: Which variable is spun-up?

"375 ppm for 1 January 2004 is set for a starting point of spin-up" has been modified to "**Our model simulation was initialized with a uniform global distribution of 375 ppm on 1 January 2004 and integrated forward to January 1st 2006 using the original emission inventory. The modeled CO2 distribution on January 1st 2006 was the initial concentration for two simulations with the original emission inventory(ori) and the new emission inventory(new) from January 1st 2006 to January 1st 2007**. **Figure 7 and 9 show differences between the model results with the original inventory and the results with the new inventory during 2006**"

- When the model is compared to a region with just one observation station I do not think broad conclusions can be made about the sources/sinks of CO2 over the entire region. The results in this section will be more robust if the model comparison focuses on regions with multiple stations.

There is only one station for Atlantic Tropics, South Atlantic Temperate, and Indian Tropical (O10, O11, and O12).The conclusions about the sources/sinks over these regions have been deleted.

Page 2253:

Section 4.1

Line 4-5: Another possibility is that the sources are too high.

"which suggests that more sinks in North America may be required for this period" has been modified to "which suggests the flux in North America for this period should be improved. "

Line 6-13: This paragraph does not read well, I suggest rewording/rearranging some of the sentences that describe the model-obs differences.

We have rewritten this paragraph as following: **"The largest difference between simulation results with fluxes from VEGAS and observations is 2.8 ppm for the Northern America Boreal(L1), 2.9 ppm for Northern America Temperate(L2),3.1 ppm for Eurasian boreal(L7),3.5ppm for Eurasian Temperate (L8),4.3 ppm for Europe(L11),which is smaller than that of CASA(5.8 ppm,6.3ppm,14.5 ppm,10.9ppm,13.1ppm,respectively). The spread of**

the regional CO2 of Observations for each region is shown with error bars, which is determined by the concentrations of stations in the region.
The root-mean-square difference (RMSE) between two simulation results and observations for each station ranges from 0-2ppm. As shown in Fig.8, the largest RMSE between the simulation results with fluxes from VEGAS and observations for regional CO2 concentrations is 0.2 ppm, which is smaller than the value with fluxes from CASA (0.4 ppm).”

Section 4.2

General: At the end of this section, it is not clear what has been learned (in the big picture sense) from the ocean inventories. Do they elucidate any specifics about land surface processes? If so this should be more specifically addressed.

Line 20: Name the region with the largest discrepancy.

We have deleted this sentence and rewritten next sentence. “**The difference between the simulations with the new inventory and observations ranges from 0.02 ppm to 2 ppm (0.7ppm to 4 ppm for the old inventories) for the South Pacific Temperate(O5) during 2006.”**

Line 23: But there is only 1 point in O11 and it is right next to South Africa, and the stations in O5 are very far from S. America. Given the predominant wind directions (westerly) in these regions are there other explanations for the improvements?

We have deleted the conclusions about the fluxes over region O11 because there is only one station in this region. We didn’t change the ocean flux. The concentration of O5 is improved through the change of land-fluxes. We are not sure which land region contributes it. “It can be deduced that the sources and sinks are improved in the South American Temperate though there is no direct observations in this region” has been modified to “**It can be deduced that the regional CO2 concentration of the ocean regions could be improved through the improvement of the land fluxes.**”

Page 2254:

Line 1: Why the simulated April minimum?

It needs to quantify the contribution of the land fluxes to the regional CO2 concentration of this region in future study. We have added this sentence in the paper.

Lines 2-3: Reword to “The observed seasonal trends are very complex in the South Indian Temperate ocean region.”

This sentence has rewritten to “**The peak-to-trough amplitude of the regional CO2 concentration for this region is no more than 2ppm in 2006, while the spread of the observed concentrations in this region is larger than 2ppm for all months in 2006**.”

Lines 6-7: Isn’t it probable that the bias is due to the high bias of CO2 over the NA land?

Yes. It is probable. “More sinks may be required in this region or the surrounded land region” has been modified to “**It is necessary to improve the fluxes in this region or the surrounded land regions.**”

One paragraph (in the original Section 4.3) has been added at the end of Section 4.2.

“**The concentrations of CO_2 at stations on the ocean are influenced by the change of emission inventories in land. As shown in Fig.10, the RMSD of regionally averaged value between model results using fluxes from VEGAS and observation is less than the results using fluxes from CASA by 0.15-0.53 ppm for the North East Pacific, South Pacific and Southern Ocean (O1, O4, O5, O12, O13 and O15). There is little improvement for the North Pacific and Northern Ocean (O2, O6, and O14). It is convenient to evaluate the regional model results according to the comparisons of regionally averaged values.”**

Section 4.3

Line 22: remove “It is clear that”

This section has been incorporated into the section 4.1 and 4.2 based on the requirement of reviewer 1.

Figures

Figure 2-3: Are these Vegas fluxes minus CASA? It’s not clear from the caption. Also switch 2 and 3 since you discuss the differences in July first.

Discuss the differences in January first. See response to .

Figures 4-7: Give region names in the caption or on the figures themselves.

Region names are given in the caption.

Region names have been given in the caption.

Figures 7-8: Show the spread from the observations. For example, L11 has a large modelobs mismatch but also a large spread in the observations, so it’s hard to tell how far off the model really is.

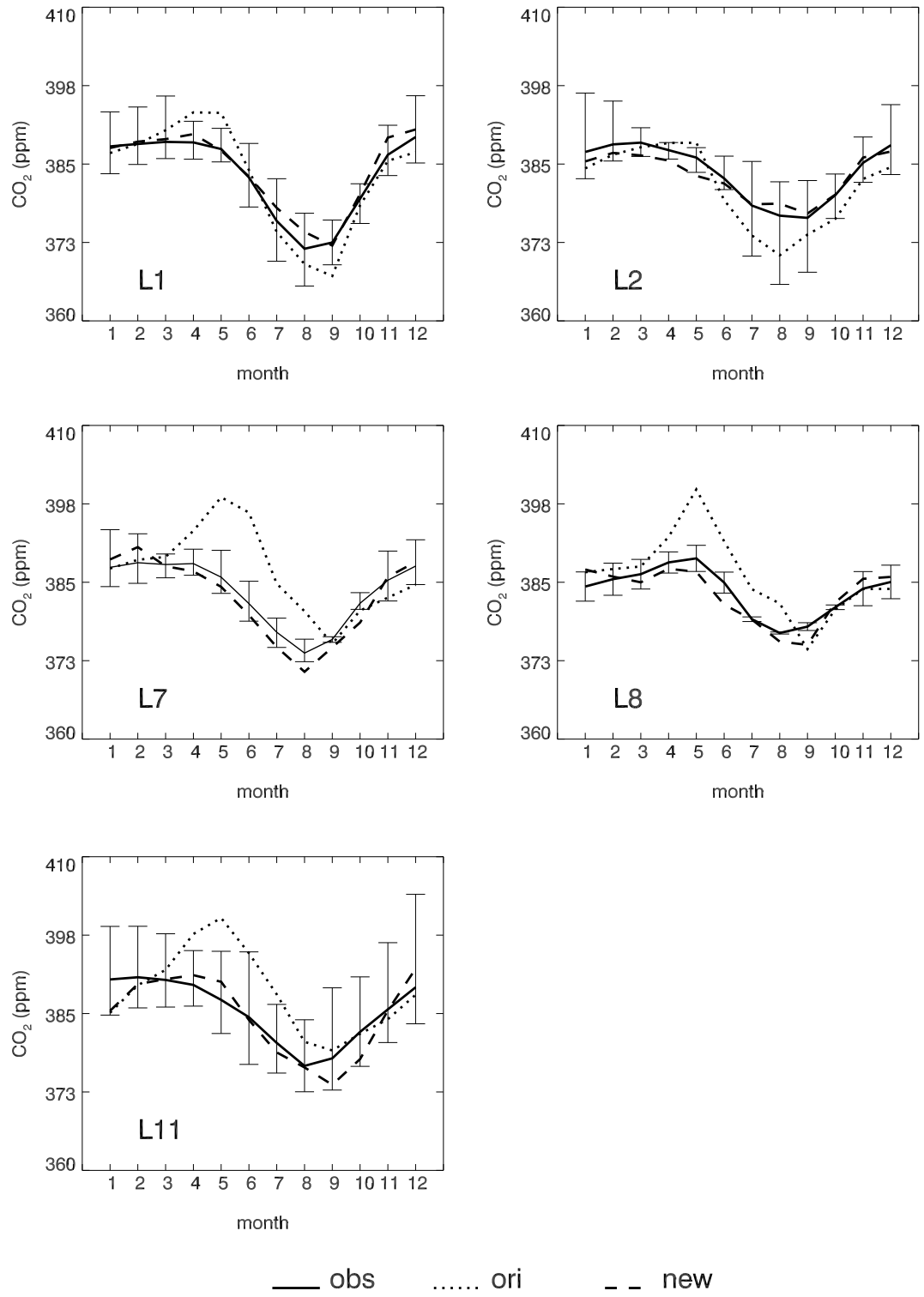

Fig. 7 Comparisons of regionally averaged values of CO_2 between model results from GEOS-Chem with the original emission inventory(dotted line) and the new emission inventory(dashed line) and GLOBALVIEW-CO_2(solid line) for 5 land regions (L1: Boreal North America, L2: Temperate North America, L7: Eurasian boreal, L8: Eurasian Temperate, L11: Europe) in 2006(5 regions are shown in Fig.4). The error bar represents the spread of the observations.

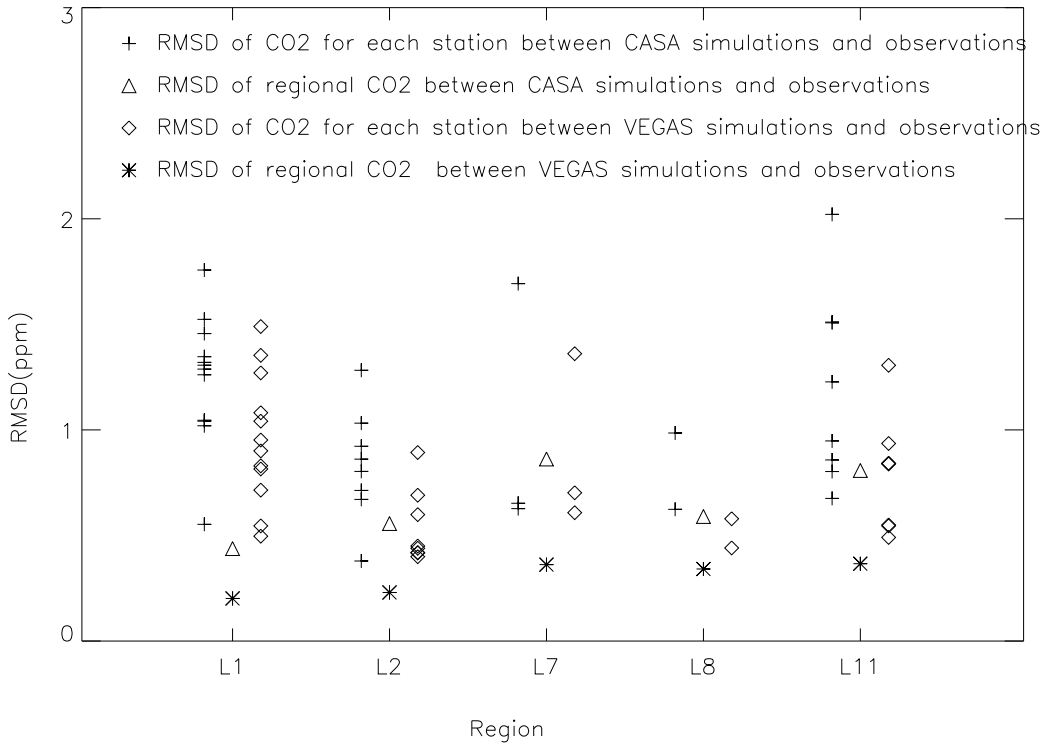

Fig. 8 Comparisons of RMSD at each station and regionally averaged values between model results and observations for 5 Land regions (L1: Boreal North America, L2: Temperate North America, L7: Eurasian boreal, L8: Eurasian Temperate, L11: Europe) in 2006. Each region is shown in Fig. 4. Triangle (Asterisk) denotes RMSD of regionally averaged values between model results using fluxes from CASA (VEGAS) and observations, cross (diamond) denotes RMSD of each station between model results using fluxes from CASA (VEGAS) and observations.

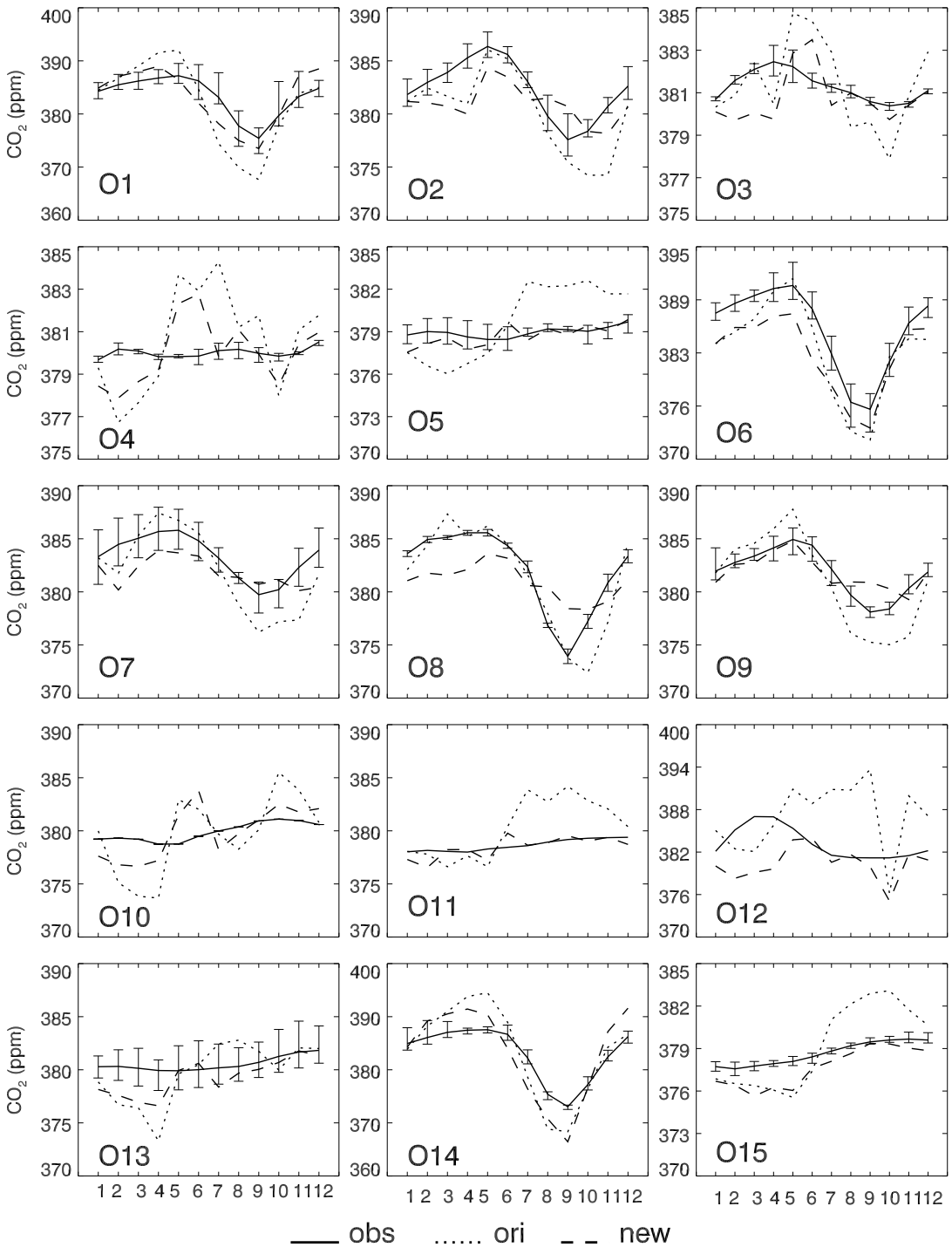

Fig.9 Comparisons of regionally averaged values of CO_2 between model results from GEOS-Chem with the original emission inventory (dotted line) and the new emission inventory(dashed line) and GLOBALVIEW-CO_2 (solid line) for 15 ocean regions in 2006(15 ocean regions are shown in Fig.4). The error bar represents the spread of the observations.

Figure 9: Add a legend.

We have added a legend in Figure 8. Figure 9 has renamed as Figure 10.

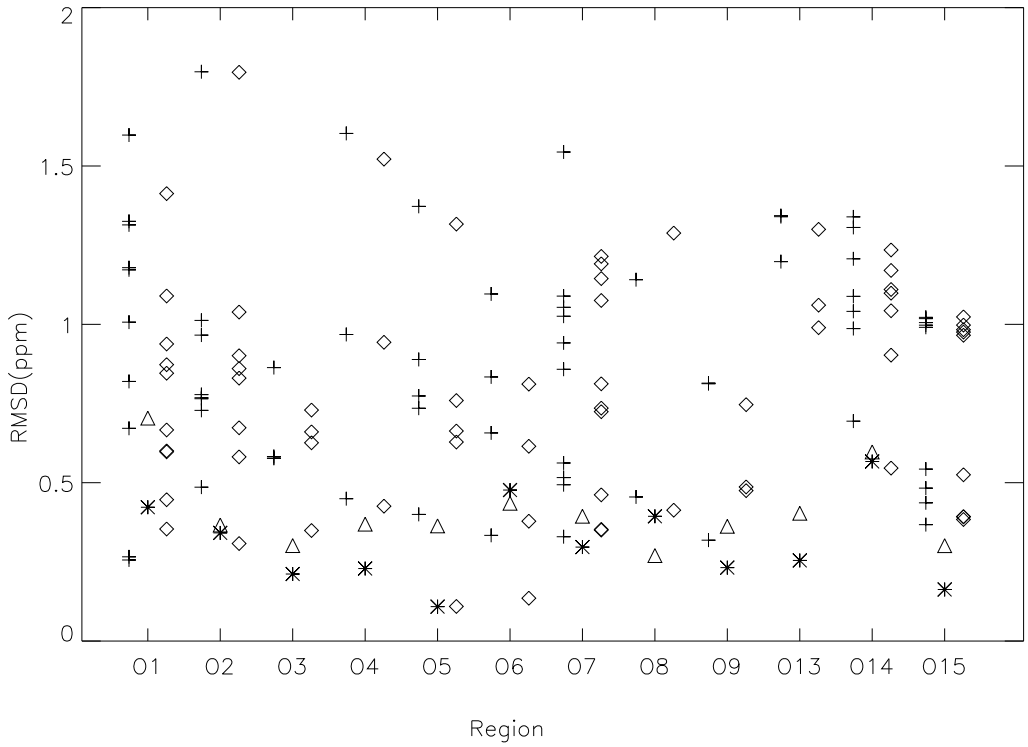

Fig. 10 Comparisons of RMSD at each station and regionally averaged values between model results and observations for the ocean regions in 2006. Each region is shown in Fig. 4. Triangle (Asterisk) denotes RMSD of regionally averaged values between model results using fluxes from CASA (VEGAS) and observations, cross (diamond) denotes RMSD of each station between model results using fluxes from CASA (VEGAS) and observations(See the legend in Fig.8).