**Response to anonymous Referee #3**

**Specific comments**

**REFEREE COMMENT:**

Abstract

Please correct the latitude and longitude of the Ragged Point (7.9S, 14.4W).

**AUTHOR COMMENT:** done

**REFEREE COMMENT:**

**1 introduction**

The description of motivation in this paper may be not clear and slightly weak. This is the first ground-based column measurement in "inner" tropics. The observation in the region which belongs to the both of northern and southern meteorological hemisphere is important to evaluate spatial bias of CO2 in the tropical region. It should be better to describe and appeal the importance of ground-based column measurement in the inner tropics and climatological difference from Darwin which belongs to outer tropics.

**AUTHOR COMMENT:**

The introduction has been changed to the following:

"

Carbon dioxide ($CO_2$) is the most important anthropogenic greenhouse gas. Human activities, primarily fossil fuel combustion and deforestation, are responsible for a continuing increase of its atmospheric concentration. The oceans and terrestrial ecosystems currently act as sinks for atmospheric $CO_2$ and absorb approximately half of the anthropogenic emissions (IPCC, 2007). Inverse models have been used to infer the geographical distribution of the sinks from atmospheric measurements. Until recently inverse modelling studies were solely based on a

network of surface in-situ measurement stations. This approach is limited by the sensitivity of the sink estimates to vertical transport and by the sparse spatial coverage of the sampling sites. It is likely that remote sensing measurements overcome some of the limitations of the in situ network. Remote sensing measurements provide a column integral, a different kind of information than the in situ measurements. The $CO_2$ column is not sensitive to vertical transport and space-borne sensors provide global coverage. Column measurements have not contributed to carbon cycle studies in the past because their precision was not sufficient. This situation has changed in recent years and column measurements of precision better than 0.5% are now available for $CO_2$ from ground-based solar absorption measurements using FTIR-spectrometers. Spaceborne sensors show promising results and it is expected that data of sufficient precision will become available in the near future.

The tropics are among the key regions for the understanding of the atmospheric $CO_2$ budgets, but the atmospheric composition in the tropics is not well constrained by measurements. Reasons for the lack of observations in the tropics include the inaccessibility of the tropical forests, the lower priorities given to these observations by developing countries as well as the difficulty to long-term observations due to political reasons. The lack of measurements results in large uncertainties in the emissions and biosphere-atmosphere exchange fluxes in the tropics. Deforestation in the tropics has a significant contribution to the global $CO_2$ emissions, accounting for almost 20% of anthropogenic greenhouse gas emissions during the 1990s (Gullison et al., 2007). Another important issue is the uptake of $CO_2$ in the tropics by carbon sinks. Due to the lack of measurements the uncertainties about the sinks are high in the tropics (Guerney et al., 2002). Recent studies showed that a large set of atmospheric inverse model results, using only in-situ boundary layer measurements, were inconsistent with total column measurements and vertical aircraft profiles as a result of incorrect vertical transport in the models (Stephens et al., 2007, Yang et al., 2007). In contrast to previous studies Stephens et

al. (2007) suggests that the tropics are not a net source, but that the uptake of $CO_2$ in the tropics balances deforestation.

Ground-based column $CO_2$ measurements in the tropics are performed at only two sites, at Darwin (Australia) in the outer tropics as part of the Total Carbon Column Observing Network (TCCON) and at the inner-tropical site at Paramaribo (Suriname), which is presented in this work. Ground-based column measurements will play a vital role for the validation of current and upcoming satellite measurements. For satellite validation it is highly important to have sufficient ground truth in the tropics as well. The high abundance of water vapour as well as the frequent occurrence of (subvisual) cirrus clouds have previously caused problems in tropical satellite retrievals of greenhouse gases (Frankenberg et al., 2008, Schneising et al., 2008).

In this paper we present co-located surface and column measurements of $CO_2$ from the inner-tropical measurement site at Paramaribo (Suriname), discuss improvements needed for the measurements and compare the obtained measurements to TM3 model simulations.

“

**REFEREE COMMENT:**

**2 Measurements and data analysis**

The characteristics of season in Paramaribo are separately described in “The Intertropical Convergence Zone (ITCZ) migrates twice a year over the measurement site resulting in two dry and two rainy seasons. During the short dry season from February to March the measurement site belongs to the meteorological Northern Hemisphere and during the long dry season from August to November to the meteorological Southern Hemisphere.” and “The air is transported from the Atlantic Ocean to the measurement site by the easterly tradewinds. During the short dry season (SDS) from February to March the air passes directly over the Surinamese coastal region to the measurement site. During the long dry season (LDS) from August to November the air passes frequently over French Guiana resulting in a longer passage of the air over the South American continent, which can also be seen in stronger impact by biomass burning during the LDS (Petersen et al., 2008).” If possible, please organize them. Readers will be happy if details of these campaigns are organized in the table. I want to know the reason you used optical infrasil-glass filter and the wavenumber coverage of the filter. Please check the description of “The initial vmr-profiles are taken from the GFITpackage and are based on balloon observations at Ft Sumner (35N, 104W) using the JPL MkIV Interferometer.”, because the description in the current version of GFIT may be different.

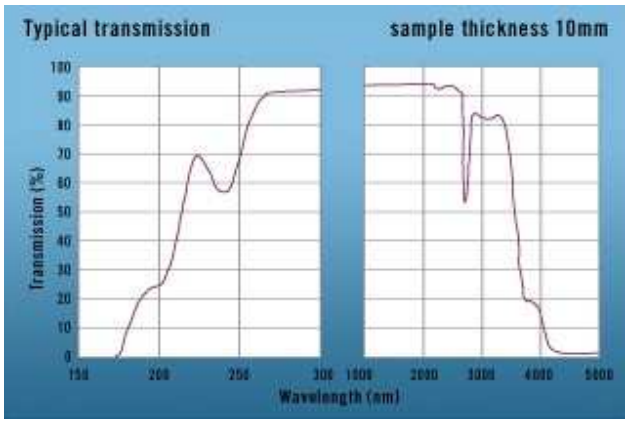
**AUTHOR COMMENT:**

**The following table giving an overview of the campaigns has been inserted.**

| | | | |
|---|---|---|---|
| **Short dry season (SDS)** | **Meteorological Northern Hemisphere** | **March - April** | **Northeast trade winds** |

| | | | |
|---|---|---|---|
| **Long dry season (LDS)** | **Meteorological Southern Hemisphere** | **Mid August - November** | **Southeast trade winds** |

**We used the InSb detector for the measurements. The Infrasil glass filters decrease the spectral range measured, thus increasing the signal-to-noise ratio of the measurements..**



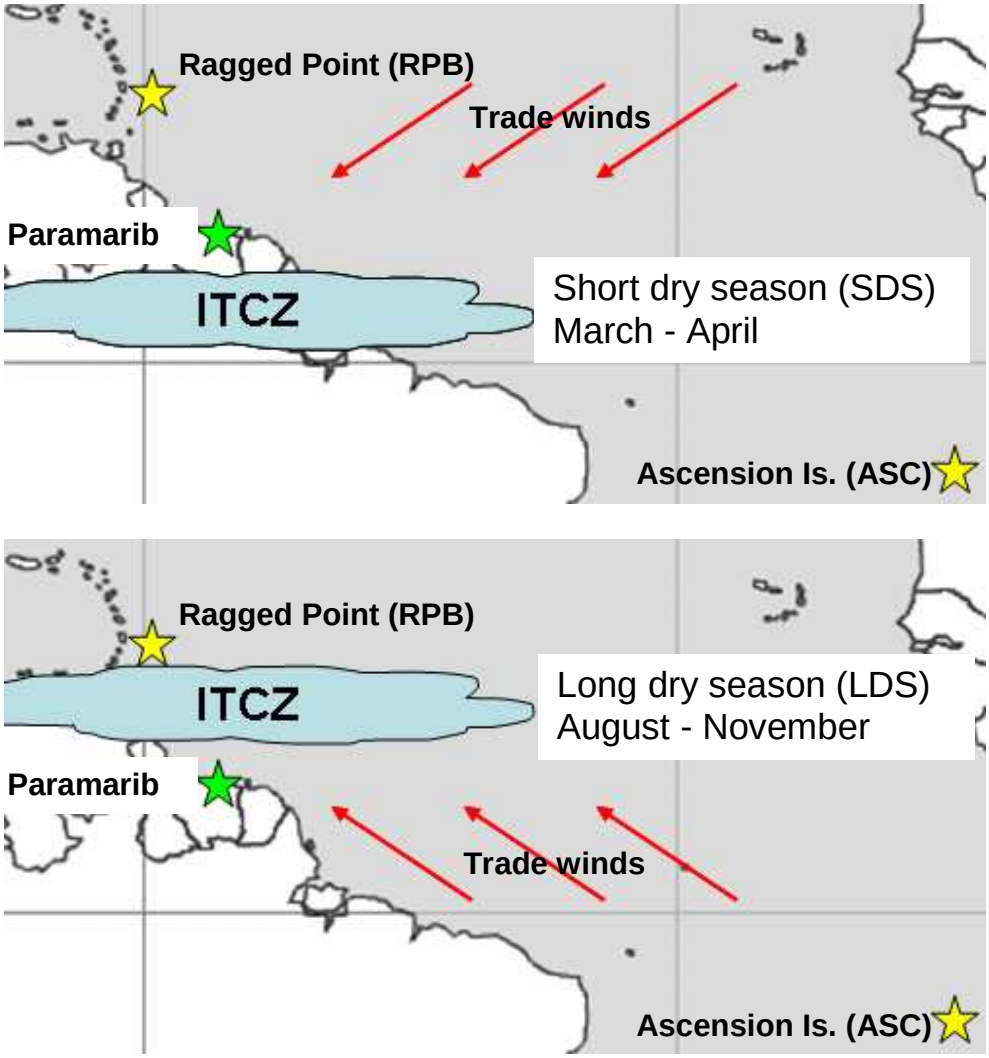

REFEREE COMMENT:

3.1 CO2 in surface air

“SDS”, “LDS” and “spring”, “fall” should be unified. Schematic map would be helpful for readers. The large variation of flask_surf in the Fig.2 top panel might depend on the time of sampling of the day. Comparison should be made using only mid-day data (air is well mixed by convection). How is the time matching of observation and model? Most of readers might not be familiar with geography around Suriname. It is difficult to imagine the wind system and trajectory of air mass based on only the text. Ascension Island is too far from the observation site to assume the air uniformity? In LDS, the eastward grid is downwind of the continent (Brazil)? Descriptions of C3 plants and C4 plants are needed. Description of TM3 model is needed.

AUTHOR COMMENT:

Spring and fall have benn substituted by the seasons SDS and LDS. The pictures below illustriate the wind system. We have not put them into the revised manuscript, because we think that the table describing the dry seasons is sufficient.




To describe C3 and C4 plants the following has been added:

The depletion depends on the type of carbon fixation during photosynthesis (C3, C4, CAM) and is strong for C3 plants and small for C4 plants and also depends on plant physiological parameters (Flanagan et al., 2005).

**REFEREE COMMENT:**

3.2 Column averaged volume mixing ratios of CO2

The reason of the Spitsbergen scaling factor can be applied to Paramaribo should be described. The method to sort out the spectra which are affected by cirrus should be explained in detail.

**AUTHOR COMMENT:** the scaling factor issue has been described in detail in author response to referee 1 and 2.

**REFEREE COMMENT:**

4 Conclusions

I want some more comments from the point of the site belongs to the inner tropical area. For example, is there comment against study by Stephens et al. (2007)?

AUTHOR COMMENT:

The precision of our measurements are not sufficient to study the differences compared to the study of Stephens. This is now clearly stated in the text.

**Technical corrections**

**REFEREE COMMENT:**

P. 3174 L. 21 “CO2” should be replace with “Carbon dioxide ”.

**AUTHOR COMMENT: done**

**REFEREE COMMENT:**

p. 7174 L. 10 Use “intertropical convergence zone (ITCZ)” rather than “ITCZ”.

**AUTHOR COMMENT: done**

**REFEREE COMMENT:**

P. 7175 L. 1 “in-situ boundary layer measurement stations” is able to understand, but not so clear. Please clarify.

**AUTHOR COMMENT:** substituted by “network of surface in-situ measurement stations”

**REFEREE COMMENT:**

P. 7175 L. 8 It should be added “(Total Carbon Column Observing Network)” after “TCCON”.

**AUTHOR COMMENT: done**

**REFEREE COMMENT:**

P. 3180 L. 2 Use “XCO2” in place of “The column averaged volume mixing of CO2 (XCO2)”, because “The column averaged volume mixing of CO2 (XCO2)” is already described.

**AUTHOR COMMENT: done**