Responses to interactive comment of Anonymous Referee #1 on "Interannual variability of the atmospheric CO2 growth rate: relative contribution from precipitation and temperature"

Dear Referee,

Thanks a lot for your efforts to deal with our manuscripts and provide constructive comments. We have tried our best to re-summarize the results, and modify this manuscript accordingly. The following is our point-by-point reply to your comments.

1. I felt that the conclusion of the manuscript, 'Because NPP is largely driven by precipitation, this suggests a key role of precipitation in CGR IAV despite the higher CGR correlation with temperature (P19074, L19-21 in abstract)' is not sufficiently supported by the results. Therefore, this statement should be toned down (or add some more clear analysis). The authors claimed that 'NPP is largely driven by precipitation (e.g. P19074L19, P19085L12-13)', however, the statement is not based on this analysis, but based on existing literature. Important factors of tropical NPP are, I believe, still debatable and depending on the study (e.g. Clark et al. 2003 (cited in this study) suggests importance of temperature, plus many literature are listed in the introduction section). If the authors would like to clarify the importance of temperature/precipitation on NPP, further model sensitivity test is required.

Reply: Thanks very much for your suggestions.

Firstly, to be precise, we changed this statement in abstract as "the models consistently show the variability in net primary productivity (NPP) dominates CGR, rather than heterotrophic respiration. Because previous studies have proved that NPP is largely driven by precipitation in tropics, it suggests a key role of precipitation in CGR IAV despite the higher CGR correlation with temperature."

Secondly, if we re-run some sensitive experiments to clarify the relative importance of temperature and precipitation on NPP, we think we will get the same results, indicated by Zeng et al. (2005) and Qian et al (2008), that precipitation dominates NPP variability. Of course, in another separate work, we decide to make some comparisons between the linear statistical decomposition and model sensitive

experiments, in order to clearly illustrate the importance of the analysis on the biological process.

Thirdly, previous most studies that suggested the importance of temperature on CGR IAV are primarily based on the high correlation coefficient between them (Clark et al., 2003; W. Wang et al., 2013; X. Wang et al., 2014). In the first half of this work, we also give out these correlation coefficients. In the second half, we show the NPP variability dominates the CGR IAV, based on 7 state-of-the-art DGVMs participating in TRENDY project. In addition, we can find out that tropical land precipitation and temperature are highly correlated (Figure 1), partly owing to that less land precipitation (for instance during El Niño) can inhibit the evapotranspiration over Tropics, promoting the higher temperature (Zeng et al., 2005a), and also is due to ENSO-related circulation adjustments (Gu and Adler, 2010). Precipitation will mislead the correlation coefficient between temperature and CGR. Therefore, mechanistic analyses may give out more convincing explanations than the correlation coefficients.

2. Furthermore, it might be helpful to add why this study made a different conclusion compared with Wang et al. (2013) PNAS paper (cited in the manuscript) in discussion section. Wang et al. (2013) claimed importance of temperature in tropics on Mauna Loa CO2 growth rate based on the datasets similar to this study. Therefore, adding some statement is helpful to understand the differences between this study and Wang et al. (2013).

Reply: Thanks very much for your good suggestions. Actually, the result of Wang et al. (2013) is based on the high correlation coefficient between Mauna Loa CGR and temperature. They point out the temperature-CO2 coupling is owing to the additive responses of Rh and NPP to temperature, while the weaker interannual precipitation-CO2 coupling is because of the subtractive responses of Rh and NPP to precipitation. In this study, we also find out that the correlation coefficient between CGR and temperature is somewhat higher than that between CGR and precipitation. However, the state-of-the-art DGVMs consistently show that NPP is the dominant process (standard deviation is 0.99 PgC yr^{-1}), while Rh is relative smaller with standard deviation 0.29 PgC yr^{-1}. This weak Rh variability is resulted from its

subtractive responses to temperature and precipitation. Previous biogeochemical terrestrial models have proved that tropical NPP is largely driven by precipitation. Therefore, we conclude that precipitation is the dominant factor for CGR IAV beyond the statistical correlation coefficient.

Here we add some statements as follows:

"Simultaneously, given that tropical land precipitation and air temperature are dynamically correlated (Fig. 1), we think these correlation coefficients favor neither temperature nor precipitation as the dominant factor of CGR IAV. It contrasts with the result of W. Wang et al. (2013) that is based on the high correlation coefficient between Mauna Loa CGR and temperature. Further, They pointed out that the temperature-CO_2 coupling is mainly owing to the additive responses of NPP and R_h to temperature, while the weaker precipitation-CO_2 coupling is because of the subtractive responses of NPP and R_h to precipitation. However, in this study, the biological dynamics underlying CGR IAV, based on 7 DGVMs, reveal that NPP is the dominant process, and R_h variability is obviously weaker caused by the opposing effects of precipitation and temperature. In the tropics, NPP turned out to be largely driven by precipitation through process-based terrestrial ecosystem models (Zeng et al., 2005a; Qian et al., 2008), indicating the key role of precipitation in CGR IAV. These mechanistic analyses may give out more convincing explanations than the correlation coefficients."

3. P19074 L19: soil respiration -> heterotrophic respiration P19080 L23: (5) missing model name.

Reply: Thanks very much for your suggestions. We have changed “soil respiration” into “heterotrophic respiration” and added the model name “OCN” there.

References:

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