

# **Responses to Referee #1 comment on “Contrasting behaviors of the atmospheric CO<sub>2</sub> interannual variability during two types of El Ninos**

Dear Referee and Editor, Thank you very much for your efforts to deal with our manuscript 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 the comments.

Wang et al describe the different behaviour of CO<sub>2</sub> fluxes during the two types of El Nino event, the eastern Pacific (EP) and central pacific (CP) El Ninos. They use the atmospheric CO<sub>2</sub> growth rate and dynamic global vegetation models, and show differences for the two types of El Nino in the global CO<sub>2</sub> fluxes, as well as CO<sub>2</sub> fluxes separated regionally and by process. This is a relevant subject within the scope of ACP, the results will be useful and the paper is generally clearly written. I recommend the paper for publication after minor revision.

## **Detailed comments**

- (1) Given the strong similarity of broad focus of this work with the recent Chylek et al paper, it might be worth adding a paragraph to the discussion that summarises the differences and similarities in approach and results e.g. exclusion of events that coincide with volcanic eruptions, identification of different events, inclusion of TRENDY and inversion results, focus on lag by Chylek, conclusions etc. Do you also see a difference in the lag? Is there anything from the TRENDY results that could shed light on the hypothesis from Chylek that the shorter time lag between the temperature rise and an increase in CO<sub>2</sub> emissions with CP El Ninos is influenced by fire response, while the longer time lag in EP El Ninos is dominated by vegetation response, noting although that the TRENDY models exclude or underestimate the effect of fire (maybe therefore there isn't anything you can add here, but at least worth thinking about)? Although there is a strong overlap of focus

of this work with Chylek there are also significant differences, so I do believe that there is value in both studies.

Reply: Thanks very much. We have added a paragraph in the discussion section to simply illustrate the differences and similarities between our work and Chylek et al. (2018). Details can be referred to the text *“As above mentioned, when finalizing our paper, we noted the publication of Chylek et al. (2018) who also focused on atmospheric CO<sub>2</sub> interannual variability during EP and CP El Niño events. We here simply illustrated some differences and similarities. In the method of the identification of EP and CP El Niño events, Chylek et al. (2018) took the Niño1+2 index and Niño4 index to categorize El Niño events, while we adopted the results of Yu et al. (2012), based on the consensus of three different identification methods, and additionally excluded the events that coincided with volcanic eruptions. The different methods made some differences in the identification of EP and CP El Niño events...”*.

We can still hardly determine whether the fire response can explain the early CGR anomaly response in CP El Niño, because of TRENDY models exclude or underestimate the effect of wildfires. However, as shown in Figure 4d, the evolution of GPP anomaly in CP El Niño plays an important role in  $F_{TA}$  anomaly.

Consider adding a figure (perhaps in the Supplement) with the CO<sub>2</sub> flux behaviour of separate El Niño events for EP and CP shown in comparison with the composite, to show how much the individual events vary from the composite.

Reply: Thanks very much. We have added a figure with the CGR anomalies in the individual EP and CP El Niño events in the supplementary file (Fig. S5).

(2) page 2, line 36 - mention near the beginning of the sentence that you are considering the two types, e.g. "... evolutions of MLO CGR anomaly during the two El Niño types have three clear ..." otherwise it isn't clear until you get to the end of the long sentence.

Reply: Thanks for your constructive suggestion. We have modified it accordingly.

(3) page 2, line 44 - the sentence that begins "Regionally, significant anomalous ..." is long and you don't know which type of El Nino event this sentence refers to until the end. I suggest beginning the sentence something like "Regional analysis shows that during EP El Nino events significant anomalous ..." or some other way to mention EP at the start.

Reply: Thanks for your suggestions. We have modified it accordingly.

(4) Page 5, line 111 - word "carefully" should be unnecessary

Reply: Thanks very much. We have deleted it.

(5) Page 7, line 154 - did the more recent version of LPX-Bern satisfy the minimum performance requirement?

Reply: Thanks very much. The recent version of LPX-Bern can satisfy the requirement.

(6) Page 8, line 181 - say (broadly) what quantities you are calculating the anomalies in (e.g in model results, observations)

Reply: Thanks very much. We have modified it accordingly.

(7) Page 9, line 198 - "... with noticeable increases \*in CO2 growth rate\* during ..."

Reply: Thanks very much. We have modified it as "...with noticeable increases in CGR during El Nino and decreases during La Nina, respectively".

(8) page 9, line 210-212 - "... and a similar regression analysis as done with the MLO CGR shows a sensitivity of  $0.64 \text{ PgC yr}^{-1} \text{ K}^{-1}$ " - Rather than describing it in this way, it would be clearer to say exactly what this is "and regression analysis of FTA with Nino3.4 shows a sensitivity of  $0.64 \text{ PgC yr}^{-1} \text{ K}^{-1}$ ".

Reply: Thanks very much for your suggestion. We have modified it accordingly.

(9) page 12, line 267 - how are you defining the MLO CGR peak here?

Reply: Thanks very much. We have added the definition in the text. We define the peak duration as the period above the 75% of the maximum CGR or  $F_{TA}$  anomaly, in which the variabilities of less than 3 months below the threshold are also included.

(10)page 14, line 305 - "GPP anomalously increases ...etc" Can you check this sentence reflects the variations in Fig 4b? Would it be more accurate to say that there is a peak in GPP during austral fall (yr0), and is low from austral spring and winter (yr1)? Because austral summer spans from one year into the next, be more precise when you mention austral summer. Also be careful with the word increase (could be interpreted as talking about the trend) versus high values through this section.

Reply: Thanks very much for your suggestions. We have checked it and modified into "*GPP showed an anomalous positive value during austral fall (yr0), and an anomalous negative value from austral fall (yr1) to winter (yr1), with the minimum around April (yr1) during the EP El Niño (Fig. 4b), ...*"

(11)page 16, line 349 - perhaps swap the order of figs S3 and S4 in the supplement, as S4 is always discussed before S3.

Reply: Thanks for your suggestion. We have swapped their order.

(12)page 16, line 356-357 - "GPP is the dominant factor to FTA anomaly here" - I can see from Fig 4b that the GPP dominates globally at this time. Both GPP and TER look strongly anomalous in Feb-Aug, equator to 20N in Figs S3a and b, but the area of strongest flux is smaller for TER presumably therefore causing the dominance of GPP globally. If this is correct, maybe it is worth pointing out.

Reply: Thanks for your suggestions. We have pointed out this and modified as "*Both GPP and TER showed the anomalous decreases (Supplementary Figs. S3a and b), and stronger decrease in GPP than in TER makes the anomalous carbon releases here (Fig. 6c).*"

(13)page 16, line 364 - "others" - other what? periods? regions? both?

Reply: Thanks. The “others” here refer to the other regions and periods. We have modified it as “... *and other regions and periods were dominated by GPP*”

(14)page 17, line 378 - could mention the lag estimates from Chylek for CP and EP here.

Reply: Thanks very much. We have mentioned the lag estimates from Chylek in the added discussion paragraph.

(15)page 18, line 402 - is there a better way to refer to this report? The url in the text did not work for me, as the new line added characters (403) to the hyperlink that shouldn't be in the url. Maybe use UNDP (2017) in the text, and remove the hyperlink from the url in the references.

Reply: Thanks very much. We have modified it as a citation “*Thomalla, F., and*

*Boylund, M.: Enhancing resilience to extreme climate events: Lessons from the 2015-2016 El Niño event in Asia and the Pacific. UNESCAP, Bangkok.*”

(16)Fig 1 - the light red shaded area is difficult to see unless the size of the figure is increased on the screen - perhaps increase the size of the figure on the page. Other figures are also small in the printed copy and it is difficult to see some of their details.

Reply: Thanks very much. We have the vectorgraph in pdf/ps format, and will supply them to the editor during the publishing procedure.

(17)Fig 1 or text - it should be known by most people, but it wouldn't hurt to include some- where that high values of Nino3.4 correspond to El Nino (perhaps in the Fig 1 caption or on page 6 at line 140).

Reply: Thanks very much. Actually, in Fig. 1b we have plotted some bars in yellow and blue which represented the CP and EP El Ninos. Correspondingly, we can see their Nino3.4 Index in Fig.1a.

(18)Minor editing is need to improve the English in some places.

Reply: Thanks very much. We have polished the English writing by LetPub.