Review of

"Climate and CO_2 modulate the C3-C4 balance and $\delta^{13}C$ signal in simulated vegetation"
by O. Flores, E.S. Gritti and D. Jolly
for Climate of the Past

Topics:

This article intends to show that atmospheric CO2 concentration is a primary impacting factor in C3 towards C4 vegetation (and reverse) changes. It is based on modeling results performed for two sites, one in Africa and one in Africa on two periods: LGM and modern.
Based on these results, authors further argued that i- the use process-based model is of advantage for past climate studies and ii- not only one parameter drives changes in vegetation.

General comments:

This study is based on BIOME4 model and more precisely on the version, modified by Hatté and Guiot, that includes isotopic fractionation. In their paper, Hatté and Guiot expose changes they introduced in BIOME4 structure (ci/ca thereshold, …) that should drive both C4 and C3 isotopic fractionation, but strictly to d13C modeling, they only focus on Llyod and Farquahr model that only deal with C3 plants. In accordance, they effectively validate their new version on the solely C3 plants. What's about C4 plants? Did Flores et al. check the reliability of this new version of BIOME4 on C4 plants?
This would have been the first step of this study and this does not appear here. This is of great importance since Kaplan (thesis) effectively mentioned some weakness to simulate C4 plants and associated isotopic fractionation with BIOME4.

Second, a mixture equation based on strict and constant end-members to characterize both C3 and C4 poles is a poor approach. With a natural range of 8permil noticed for C3 plants and of 5permil for C4 plants, poles representative of C3 and of C4 are only very weakly defined in real conditions therefore can't be depicted by a unique value in a mixture equation. Remain at the level of trends and do not provide any value of ratio that would inevitably be suspect.

Discussion of d13C has to be rewritten.

Briefly: I'm almost sure that C4 isotopic fractionation was not check, I would thus recommend to focus on NPP.

=> major revisions.

Detail:

- **Title:**
- **Abstract:**
- **Introduction:**
  - p1188: CO_2 concentration effectively has impact on r_{C4} and $\delta^{13}C$ of C3 plants but NO effect on $\delta^{13}C$ of C4 plants…. even for Wang et al.
  - p1189: do you really read that Guiot 1994 already dealt with CO2 concentration? Would you rather consider Wu et al. 2007 Clim.Dyn. to illustrate this point?
- **Methods**
  - p1192: did you keep the same FAO values for LGM than today? Even if BIOME4 is not the best model to simulate soil hydrological cycle, it would have been more rigorous to use FAO values associated to LGM estimated soil (defined according to estimated LGM vegetation)
  - p1192: you mention "the current level of CO2 at 360ppmv" but in Figures 2 and 3, for the Chinese location, you seem to refer to 270ppmv …. Why??? Did you only mistake the legend of the figure or the data you're here discussing??
  - p1193: What a complicated way to describe that you simply adjust the mean annual value keeping annual distribution similar to current distribution. I had to re-read this part at least 4 times to understand your mind!!
  - p1193: ΔPa does not appear in the equation where it's replaced by Pa. What is δP for?
  - Keeping the current annual distribution of precipitation is really not a good idea. C4 plants are greatly influenced by free water availability (rather than by amount of precipitation), therefore by seasonality. To complete a life cycle, C3 plants need more than 2 months of water. If this condition isn't fulfilled, then C3 plants are replaced by C4 plants. Rather than decreasing annual precipitation level, it would be of more interest to change annual distribution.

- **Results**
  - p1195, table 2: for Kuruyange, we face an increase of C4 ratio (based on NPP) and a decrease of $\delta^{13}C$! Are you sure that the solely impact of CO2 concentration on C3 isotopic fractionation is high enough to counterbalance increase of C4 plants that show heavier d13C? if yes, why is it the casein Africa but not in Asia? We're discussing here a global parameter and not a local effect!
  - p1195: relationship between rC4 and d13C and precipitation… see above!
  - p1195: relationship between rC4 and temperature: biomes definition are greatly based on temperature, BIOME4 is based on optimization of NPP … you here only find back original definitions used for BIOME4 conception.
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- **Discussion**
  - P1199: WRONG!! n-alkane d13C does not better fit original plant d13C than does bulk d13C!!! this sentence is obviously wrong and reflects a total misunderstanding of organic isotopic geochemistry. Bulk d13C effectively does not reflect (except in some rare favorable conditions) original plant d13C and this because of organic matter degradation that is selective. Expected shift is of ca ±2‰. Bulk is a mixture of several components, each component with a specific isotopic signature. Bulk d13C reflects the mixture of each components d13C. A shift of bulk d13C as response of any environmental parameter is both a shift of any (or some) component d13C AND change within relative ratio of constitutive components! Previous studies show that n-alkane d13C wouldn't undergo isotopic shift during degradation and thus reflects original plant n-alkane d13C. Having a look at sediment n-alkane d13C inform you on plant n-alkane d13C but NO WAY on plant d13C. Change within record of sediment n-alkane d13C reflects only a part of change in plant d13C!!
  - All of discussion based on d13C is out of purpose since authors did not check BIOME4 ability to simulate C4 plants d13C.
  - I'm stopping here!!

- **Conclusion:**

- **Bibliography:**
  - Check all your bibliography: some remaing numbers are still at the end of each references
  - Why do you mention http links when articles are old enough to be fully refered by issue and pages? This part appears so boring with so many numbers. 6 lines for an unique reference… that's terrible!

- **Table and Figures**
  - Figures 2 and 3: what is wrong? the legend with 270ppmv or data interpretation that would have been done on 360ppmv simulation?

- Figures 2 and 3: asterisk is * ... and does not reflect what you intend to specify.
- Figure 3: add a digit on isolines.
- Figure 3: add “with regards to the current values”