

General Comments

This manuscript makes use of a very impressive long-term data set of high precision CO₂ and 13C-CO₂ observations to investigate the patterns of 13C discrimination, their spatial coherence, and the factors controlling these large-scale patterns. The analyses push the use of these 13C-CO₂ data into a new direction and are ultimately used to examine how two different stomatal conductance algorithms (used in land surface schemes) represent the observed patterns and amplitude of discrimination. The manuscript is generally well written, but there are some important details missing and assumptions that require further explanation. The introduction could be better framed by developing a set of science questions or hypotheses to be addressed – rather than fishing for... “What can atmospheric measurements teach us about processes in the biosphere?”

Specific Comments

There needs to be a better description of the δ_s (source term) and big Delta – discrimination. These terms are vaguely defined (how are they related in your analysis – they are not the same thing). The big Delta (photosynthetic discrimination) values are usually defined as positive values in the literature...but not here. From the Keeling plot perspective the δ_s or δ_R value is often used as a surrogate for photosynthetic discrimination or ecosystem discrimination. This assumes that there is an isotope equilibrium between respiration and photosynthesis. I do not see how this can be the case – and it underlies much of your analysis. Please explain the rationale here and how your δ_s and big Delta values are related (what are the assumptions and limitations within your framework)?

The authors have ignored a rapidly growing body of literature that indicates significant short-term variation in the isotope composition of respiration. Both post photosynthetic fractionation effects and variability in the isotope composition of respiration undermine your analytical approach and data interpretation. Please justify your approach.

The Ball-Woodrow-Berry model or the Leuning model predict stomatal conductance and this can be used to evaluate the variation in photosynthetic discrimination associated with changes in relative humidity or vapor pressure deficit. I do not see how this can be used to predict δ_s because there is no information related to the other side of this important equation – ecosystem respiration.

There has been significant debate in the scientific literature regarding the use of RH or vpd in the BWB model and Leuning model. The key references from this debate should be noted since this manuscript indirectly begins to resurrect this old problem.

There is room in the discussion to consider that atmospheric water vapor and RH have been increasing significantly over time. How could trends in regional atmospheric water vapor impact your analyses and future patterns of photosynthetic discrimination?

Can you provide some explanation regarding the source footprint of your analyses based on the tower sampling?

In the methodology please describe the frequency of the flask measurement at the various towers.

Why are the analyses restricted to the dependence on atmospheric humidity and no other environmental drivers. Do other environmental variables also yield similar weak correlations or do RH and VPD stand out as key drivers? I worry about a spurious correlation.

Details

Abstract line 10 – “the Leuning model”

Page 4606 last line – delete response

Equation 4. I would explain what the background value is and how it is obtained when describing this equation. Not later.

Page 4609 line 1. Delete “values” repetitive

Page 4609 line 20. Do you mean R or RH here?

Page 4609 line 20. This should be Ball-Woodrow-Berry (BWB)

Be consistent with the sign of big Delta values (the intro and discussion sections seem to use a different convention)

Page 4611 line 1-20. Is this section necessary? The method has been used by Miller and others and Lai and others.

Page 4611 1-25. But is there any reason why this would not be the observed pattern? This seems obvious.

Page 4612 line 5 “Baltic Sea”

Page 4612 line 20. The meaning here is not clear. Please revise.

Page 4615 line 5-10. Can you select a different background value to see if the stair-step pattern persists?

Page 4619 line 10-15. This discussion is a bit awkward as written and should be revised for clarity

Page 4618 – last line. This is an incomplete sentence.

Page 4620. Check spelling on stomatal.

Page 4621. I think this discussion should be removed. These models have been tested at the leaf and ecosystem scale for a broad range of ecosystems. Some of the problems/disparities observed here could easily be problems related to the isotope analyses or the implementation of these stomatal models for grid cells where the land use is not properly prescribed.

Overall recommendation: Major revision