Biogeosciences Discuss., 7, C5304–C5308, 2011
www.biogeosciences-discuss.net/7/C5304/2011/


Biogeosciences
Discussions

# *Interactive comment on* "The role of plant functional trade-offs for biodiversity changes and biome shifts under scenarios of global climatic change" *by* B. Reu et al.

**B. Reu et al.**

breu@bgc-jena.mpg.de

Received and published: 2 April 2011

We thank Sandra Lavorel for her constructive comments and raising some interesting points. We addressed all of these points below. However, we note that some very interesting suggestions go beyond the scope of this manuscript and may stimulate future modeling studies.

**RC: refree comment** , AC: author comment

**RC: As the first reviewer, I would prefer if the term biodiversity was not used so generically, but rather using specific terminology, especially relating to different dimensions of functional diversity. It is not helpful to participate in the confusion**



**of the term, nor does it serve the purpose of delivering unique information on the functional dimension of biodiversity.**

AC: We agree and replaced the term "biodiversity" with "plant functional richness". For sake of brevity we solely kept the term "biodiversity" in the title.

**RC: Although this terminology has already been established in the first published paper, I am having trouble with calling 'functional identity' the mean functional trait value of a pixel. Functional identity rather refers to the presence of a particular functional trait category or value.**

AC: Functional identity is not 'the mean functional trait value of a "pixel", it is the mean functional trait value of all PGS that could tolerate the climate in a pixel. It is the centroid in the multidimensional trait space represented by the PGS in a grid cell, which is similar to the concept of the community-aggregated trait (Garnier et al. 2004). For the sake of consistency we will continue to use functional identity (FI) as defined in Section 2.1 and Reu et al. 2010. We added a sentence for clarification (see Definition of FI in Section 2.1):

*Secondly, we define functional identity (FI) as the mean vector of plant functional traits, i.e. the centroid in the multidimensional trait space, calculated among all PGS that are able to tolerate the climatic constraints of a grid cell. FI is similar to the concept of community-aggregated traits (sensu Garnier et al. 2004).*

**RC: Biome shifts: to what extent are these shifts related to the magnitude of climate change in the sensitive regions (i.e. amount of exposure) (temperate-tundra and tundra-polar boundaries)? Although this is discussed very little (too little!) the general consistency of predicted changes with other models is likely to simply result from the effect of amount of exposure. In the case of hot / cold deserts the question may also be refined in terms not of magnitude only, but of crossing specific physiologically relevant thresholds (i.e. the climate becoming more 'livable' for plants). This could be discussed specifically in relation to the**

**traits included in the model, and to those identified as relevant to explaining the observed shifts.**

AC: It is true that in the actual version of the paper we are discussing how FR changes and FI shifts differ among regions and in relation to particular functional traits, but not how they differ between magnitude of climate change for the emission scenarios. We did some initial analyses on the magnitude of trait change with respect to the magnitude of climatic change and how these changes differ among biomes. This analysis however did not reveal a straight forward or easy interpretable result. Since climate encompasses multiple aspects (i.e. mean states of temperature and precipitation, but also in the variability) and since traits are strongly interrelated with each other, the consideration of the magnitude of climatic change and its effect on trait changes (e.g. identification of physiologically thresholds) is not trivial and perhaps deserves more in depth consideration than possible in this paper. We therefore only expand on the discussion on changes between the two scenarios (A2, B1), which represent different scenarios of exposure (Section 3.2), but do not provide an in depth analysis of the effect of differential magnitudes of climate change rates:

*The trends of FR changes and biome shifts are similar under both, the A2 and B1 scenario, but more pronounced under the A2 scenario (Fig. 2a, b, Fig. 3b, c). This is to be expected as the latter exhibits the stronger climatic change. When comparing FR and FI changes per 1degree Celsius of warming among grid cells between the two emission scenarios, we find that the responses are qualitatively similar, indicating that the magnitude of climatic change is a key driver of the simulated FR and FI changes.*

**RC: Trait trade-offs: interestingly the trade-offs that are highlighted as responsible for changes in FR and FI, and discussed for the different focal regions seem to be quite different from those trade-offs identified as most important for the current distribution of different biomes. This is quite interesting and deserves more in depth discussion. In other terms, responses to climate change scenarios appear to relate to traits that are not necessarily discriminating in present**



**conditions. This is of particular interest because it suggests that diversity for such traits, rather than for the current 'response traits' is likely to become a key factor in the response to changing climate.**

AC: Our results do not offer a basis for such a firm statement. While the hypothesis is true for some cases, it does not hold generally. For example, the amount of carbon allocated to above ground structure delineates biomes under present day conditions (trees vs. no trees) but is also influential where biome shifts are predicted. Conversely, seed size and light use efficiency relate to FR changes, but these do not necessarily lead to biome shifts. For this reason, we do not explore this change in trait relevance further in this paper. However, we do agree that this is an interesting hypothesis worth further exploration.

**RC: The conclusion of the paper states that the observed patterns, while consistent with previous studies, are of greater interest because they can be explained mechanistically by trait responses rather than by empirically derived bioclimatic relationships. This is a bit of a short conclusion and it would be desirable to summarise how or where this approach brings significant improvements. In particular, such a mechanistic approach is likely to be important to address responses to novel combinations of climate parameters. This is well illustrated for the change in precipitation regimes in Central China, and would deserve more in depth discussion.**

AC: We added this important aspect to the conclusion (Section 5):

*To better understand the responses as well as sensitivity of the identified mechanisms to climatic change a better empirical knowledge about trade-offs in plant ecophysiology is needed, to lay the basis for a more explicit and detailed representation of plant functional trade-offs in vegetation models used for global change research. Such a mechanistic approach based on ecophysiological processes and trait characteristics rather than on empirically derived bioclimatic relationships, may be particularly rele-*

*vant when addressing vegetation responses to climatic changes that encounter novel combinations of climate parameters, which do not exist under contemporary climate.*

---

Interactive comment on Biogeosciences Discuss., 7, 7449, 2010.