Biogeosciences

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Interactive comment on "Research Paper: Detecting climatically driven phylogenetic and morphological divergence among spruce species (*Picea*) worldwide" *by* Guo-Hong Wang et al.

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Major Comment:

[Comment 1] Wang et al., analyzed the relations between current climate and ecological (phylogenetic and morphological) divergence among spruce species at a global scale. The topic is suitable for Biogeosciences, but I do not think it is suitable for this special issue "Ecosystem processes and functioning across current and future dryness gradients in arid and semi-arid lands". The range of spruce (we could see in Figure 1) is not only limited in arid and semi-arid lands, but also covers a lot of other more wet regions. The main results of this paper are clear that phylogenetic and morphological divergence is driven by different climate variables, i.e., temperature for phylo and

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precipitation for morpho. But I have several questions/comments, which need carefully revised by the authors.

[Response] The major reason why we submitted this MS to the special issue "Ecosystem processes and functioning across current and future dryness gradients in arid and semi-arid lands" is that most spruce species are very important taxa in arid and semi-arid lands worldwide. Detecting climatically driven phylogenetic and morphological divergence among spruce species worldwide would deepen the understanding of ecosystem processes and functioning in arid and semi-arid lands.

To address this point, in this response, we extracted the Aridity Index (AI) for each point from the Global Aridity Index (Global-Aridity) and the Global Potential Evapo-Transpiration (Global-PET) Geospatial Database (http://www.cgiar-csi.org/2010/04/134/), According the 1997 UNPE standard (Middleton Thomas, 1997) climate zone classification, 8 spruce species are in arid and Semi-Arid areas, 11 spruce species in Dry sub-humid areas, and 14 spruce species in humid areas. According to the scenario of global climate change, there would have severe and widespread droughts in the next 30-90 years over land areas resulting from either decreased precipitation and/or increased evaporation, and the significant increases in aridity do occur in many subtropical and adjacent humid regions [1, 2]. When overlapping the spruce sampling point to the future Aridity Changes Map (Fig. 1, 2 in this response), nearly all the spruce species whose original distribution in sub-humid and humid areas would subject to drought stress.

The Special issue "Ecosystem processes and functioning across current and future dryness gradients in arid and semi-arid lands" aims to provided platform for researches in plant species associations, plant distribution along environmental gradients, which is not only applicable for species distributed in arid and semi-arid areas, but also for the species subjected to aridity stress in future. Our findings would be helpful for management strategies and inform policy to climate change in future.

[Comment 2] Firstly, the abstract is not well written. There are too much information on methods and results. Usually, we first need some background, importance of the study, come up with the question, and what we do, what we found, and finally the importance of our findings. Furthermore, some information in the abstract are repeated, e.g., line 30-34 and line 40-41. Other minor problems in Abstract include: bioclimatic or climatic (should be consistent here and other parts of this paper); global and northern hemisphere are different; there are ecological divergence, phylo divergence, morpho divergence and divergence, should be consistent or clearly defined; younger nodes are called remaining/terminal/end nodes/splits, should be consistent.

[Response] Thank you for your comments. We will make these changes as suggested.

[Comment 3] The use of current climate: The author also discussed this problem. As far as I know, there are not only current climate data in worldclim, but also paleoclimate. Although the paleoclimate there only date back to LGM, it still could reflect the climate situation for a longer time to some extent. I am wondering if this paleoclimate could be a better choice than current climate.

[Response] Due to expansion and retreat occurred in the past, the present distribution of spruce is different from the distribution of the fossil locations. Thus, paleoclimate data does not necessarily match the present distribution. The 3388 data points of the 33 spruce species were sampled on present locations. Current climate data should be more appropriate to interpret current distribution pattern of spruce species.

[Comment 4] The authors did PCA analysis and found that the first three axes could explain 75.67

[Response] We actually ran the SEEVA by taking all the 16 climate factors into account. To illustrate the results briefly and clearly, we need to reduce the redundant variables. We focused on how mean value, extreme values of climate factors influence spruce divergence. In addition, The climatic variables must have higher divergence indices for the first split on the phylogeny and morphology of Picea, and relatively higher loading

on the five component axes. As a result, we mapped eight climate factors in the histograms on the phylogeny and morphology tree. Take an example, Min Temperature of Coldest Month and Mean Temperature of Coldest Quarter both have high loading on axis-1of PCA: 0.931 vs. 0.946, but the former has higher divergence indices than the latter (0.0764 vs. 05524 in the phylogeny and 0.18 vs. 0.08 in the morphology). We therefore illustrated the results of the former variable. Table-1 showed the eigenvalues, variance percentages, cumulative percentages and correlations of 19 bioclimatic factors but the rotated percentages were shown in the text. We will revise this inconsistency. Thanks. Spruce is elevation-sensitive. We selected elevation as a variable because it can demonstrate a direct view with respect to spruce divergence, which would be helpful to understand how topography influences spruce divergence.

Specific points:

[Comment 1]: The results do not need to be divided into 6 parts, I think the last 4 parts could be merged into 1.

[Response] Agree. We will reorganize the text. We think 3.3, 3.4 and 3.5 should be merged into one section.

[Comment 2]: Some logic in the text is not reasonable. For instance, in line 87, information before "thus" and after "thus", I don't think they are well connected; line 178-189, the sequence of these parts is mess, line 188-189 should move to the front of the introduction of the SEEVA. The come up with several hypotheses in the introduction also feel not well connected with the text there. Anyway, the authors need to carefully check this throughout in the text.

[Response] Thanks. We will check these during the revision stage.

[Comment 3] Line 148, mainland China and Taiwan?

[Response] Agree. "mainland China and Taiwan" should be more formal. We will check these.

[Comment 4] Line 158-166, I am wondering if it's necessary to list all the climate variables here.

[Response] Agree. A full list of climate variables has been shown in Table 1. We will check these during the revision stage.

[Comment 5] Line 349-350, how did the authors conclude like that? 6. Cannot or could not?

[Response] This paragraph highlighted the exceptions observed for a few sister groups or species in the phylogenetic tree to the overall pattern. We explained these exceptions as a result of geographical isolation and the limitation of the selected climate parameters that do not adequately describe the climatic determinants of spruce distributions.

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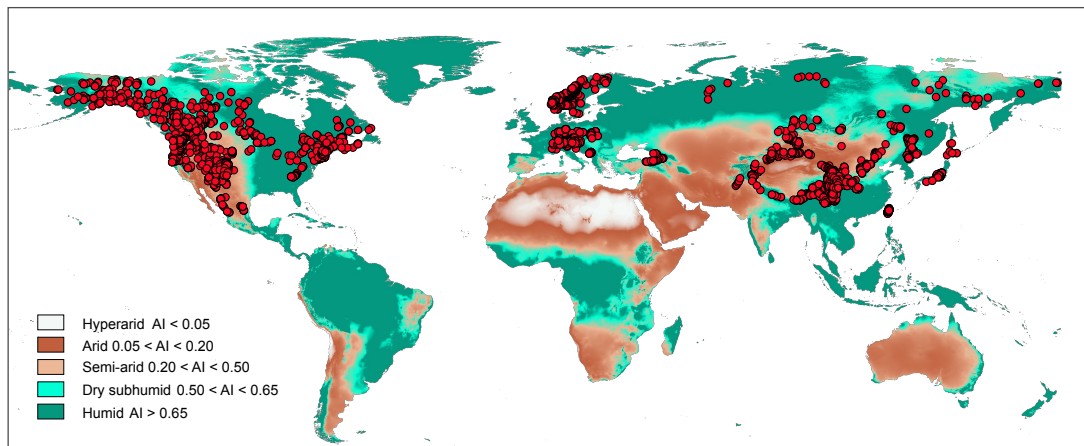
Figure 1. The locations of sampling point in the study at different climate zone. The background image was the map of Global Aridity Index which obtained online (http://www.cgiar-csi.org)by the CGIAR-CSI with the support of the International Center for Tropical Agriculture (CIAT).

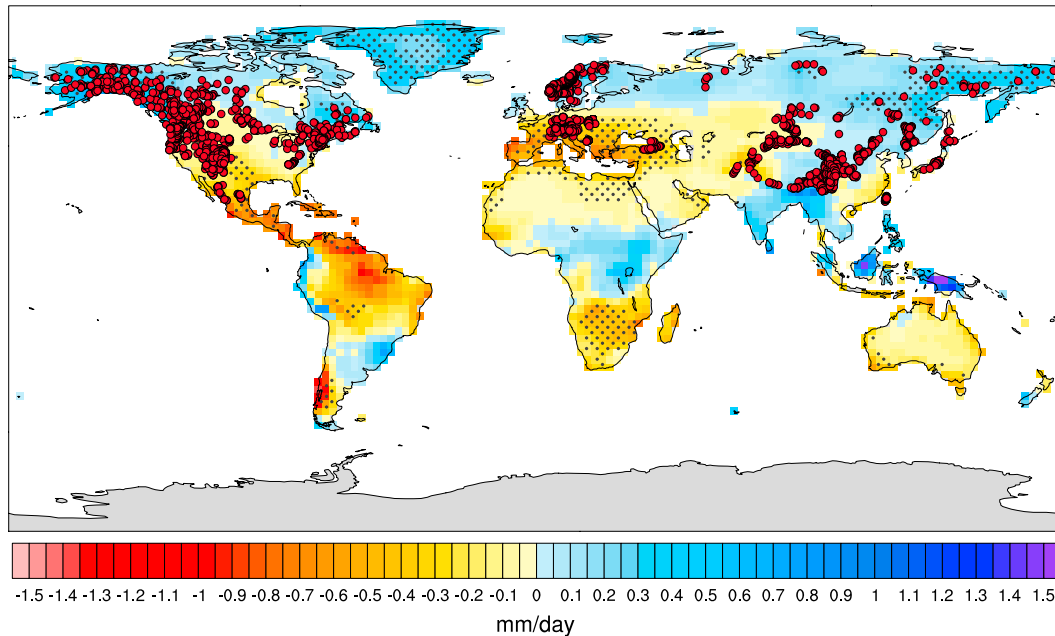**Fig. 1.** The locations of sampling point in the study at different climate zone

Figure 2. The locations of sampling point in Aridity changes within the 21st century. The background image was the map of Changes in P–Rn∕λ comparing present-day (1980–2000) and future climate (2080–2100) following the RCP8.5 pathway.(P, precipitation; Rn, net radiation; , latent heat of vaporization).(Greve & Seneviratne, 2015).

Fig. 2. The locations of sampling point in Aridity changes within the 21st century.