EGU22-6989
https://doi.org/10.5194/egusphere-egu22-6989
EGU General Assembly 2022

A naive Bayesian method to chase mantle plumes in global tomography models

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We propose a quantitative approach to search for mantle plumes in global seismic tomography models without prior assumptions on the associated mantle velocity anomalies. We design detection tests with a reasonable detection threshold while keeping false detections at a level lower than 5%. This is based on naive Bayesian clustering analysis, which is possible thanks to the varimax principal component analysis that provides components that are much more independent than the original number of depths slices in the models. We find that using such independent components greatly reduces detection errors compared to using an arbitrary number of depth slices due to correlations between the different slices.

We detect a wide range of behaviour of the seismic velocity profiles underneath the hotspots investigated in this study. Moreover, we retrieve locations away from hotspots that have a similar seismic velocity profile signature to that underneath some hotspots. Hence, it is not possible to obtain a unique definition of seismic velocity anomalies that are associated with mantle plumes and thus care needs to be taken when searching for mantle plumes using prior assumptions about the velocity anomalies that might be associated with them. On the other hand, we identify a criterion that allows establishing a probability distribution of the seismic velocity profiles that is specific to a sub-list of hotspots and we show that this distribution does not occur significantly elsewhere. Overall, the mantle plume zones identified in our analysis do not appear to surround the Africa and Pacific large low shear velocity provinces (LLSVPs) but are rather within them. This supports the idea that LLSVPs may correspond to bundles of thermochemical mantle plumes rather than to compact, dense piles.