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Is the atmosphere interesting? A projection pursuit study of the circulation in the northern hemisphere winter

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The Northern hemisphere winter circulation is probed for deviations from Gaussianity. A projection pursuit approach is applied that search for directions in phase space that maximize an index of interest. Different indices gauging different aspects of non-Gaussianity such as flatness, bimodality, and multimodality are considered. The projection pursuit approach allows high-dimensional data spaces to be investigated and it therefore complements previous studies that usually have been confined to spaces of a few dimensions. Both the stratospheric and tropospheric circulations are studied at daily, monthly, and annual timescales.

The statistical significance of the results is considered by a Monte Carlo method where results from the atmospheric data are compared with results from Gaussian distributed surrogate data. The surrogate data are generated so that they have the same temporal structure as the original data. Careful considerations of the statistical significance are of particular importance in studies with exploratory methods such as projection pursuit.

In the stratosphere the moderate evidence for bimodality in the inter-annual variability of extended winter means is confirmed. On monthly and daily timescales strong evidence for non-Gaussianity but no evidence for bi- or multimodality is found. In the troposphere only evidence for non-Gaussianity is found and mainly on the shortest timescales.