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Circulation regimes and bimodality of the planetary-scale atmospheric wave amplitude index

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An important question in the study of atmospheric low-frequency variability in the extra-tropics is whether multiple atmospheric regimes exist. Although there has been a large recent interest in the subject, the existence of multiple regimes in the troposphere is not universally accepted in the scientific community. An early and much cited observation of bimodality in the extra-tropical atmospheric variability was presented in papers by Hansen and Sutera, who studied a planetary-scale atmospheric wave amplitude index (WAI). The present study has been largely motivated by the diverse and conflicting results on the bimodality of the WAI in the previous literature.

We investigate the bimodality in the WAI calculated from the longest existing datasets of the 500 hPa geopotential height. Our analysis differs from previous analyses mainly by introducing the rate of change of the WAI and by showing that when only the slow parts of the index are considered the bimodality becomes much clearer and its statistical significance increases drastically. The increased statistical significance also allow us to study the low-frequency changes in the probability distribution of the WAI.

The probability distribution of the WAI shows a strong low-frequency variability. In particular the last decade stands out with a strong affinity for the disturbed regime. This recent change is statistically significant at least at the 90 % level. The sign of the change is consistent with the concurrent change in the North Atlantic Oscillation towards its positive phase.

By systematically varying the latitudinal interval included in the definition of the WAI we find that although the WAI is sensitive to this parameter, statistically significant bimodality is present for a range of intervals. Studying the WAI at other vertical levels than 500 hPa shows a consistent picture in particular during the period 1979-2003

where bimodality is seen at almost all tropospheric levels.

Applying different kinds of clustering algorithms to the northern hemisphere tropospheric geopotential height often results in three clusters. We will compare the *two* WAI regimes with the *three* regimes found by these clustering methods. Part of the solution to this paradox may come from the fact that many clustering methods will identify multiple regimes in distributions that are skewed but otherwise smooth and without bumps or shoulders.