



## **The Impact of Stratospheric Waves on the Deepening of North Atlantic Winter Cyclones**

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The development and intensity of cyclones in the North Atlantic storm track during northern hemispheric winter are subject to many tropospheric factors such as upper-level jet characteristics or the distribution of moisture. Case studies of some of the strongest cyclones with regard to mean sea level pressure have shown that changes in stratospheric geopotential related to stratospheric waves can also contribute considerably to cyclone deepening.

Here we present the first systematic analysis of this impact of stratospheric waves on the 100 deepest North Atlantic winter cyclones in the ERA-Interim re-analysis data set between 1979 and 2015. Tropospheric cyclones and stratospheric waves are identified using objective cyclone tracking and trough identification tools, respectively. The contribution of the change in stratospheric geopotential to changes in mean sea-level pressure is diagnosed using the pressure tendency equation (PTE). For an objective analysis of the connection between stratospheric PTE contribution to cyclone deepening and stratospheric wave activity, trough objects are used that are defined in a time-longitude space by averaging all identified trough points between 40°N and 70°N for the life time of each cyclone.

Characteristics of the trough objects and their relation to the cyclone tracks allow us to cluster the 100 storms into different groups: (i) track east of trough, (ii) track west of trough, (iii) track far away from trough or (iv) no trough present in study domain. We can further distinguish between stationary and mobile waves. This clustering reveals that conditions for a positive influence of the stratosphere on cyclone deepening are good when the trough is west of the cyclone track at a distance between 0° and 50° and exists for at least 40% of the cyclone's life time. It is also conducive when waves are mobile and move eastwards together with the cyclone track. There are, however, deep cyclones without or even with a negative impact of the stratosphere on its core pressure. The latter occurs when the track is west of a trough beneath a stratospheric ridge or if the trough is moving westwards.

So far, the causal relationship between cyclones and a stratospheric contribution to their deepening is unclear. This question will be investigated in future model studies with a relaxation of the stratosphere towards a climatological state.