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Temporal variability of gravity wave drag - vertical coupling and possible climate links

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In the atmosphere, the internal gravity waves (IGW) are one of the fastest ways of natural information transfer in the vertical direction. Tropospheric changes that result in modification of sourcing, propagation or breaking conditions for IGWs almost immediately influence the distribution of gravity wave drag in the stratosphere. So far most of the related studies deal with IGW impacts higher in the upper stratospheric/mesospheric region and with the modulation of IGWs by planetary waves. This is most likely due to the fact that IGWs induce highest accelerations in the mesosphere and lower thermosphere region. However, the imposed drag force is much bigger in the stratosphere.

In the presented analysis, we have assessed the relationship between the gravity wave activity in the stratosphere and other climatic phenomena through statistical techniques. Multivariable regression has been applied to investigate the IGW-related eastward and northward wind tendencies in the CMAM30-SD data, subject to the explanatory variables involving local circulation characteristics (derived from regional configuration of the thermobaric field) as well as the phases of the large-scale internal climate variability modes (ENSO, NAO, QBO). Our tests have highlighted several geographical areas with statistically significant responses of the orographic gravity waves effect to each of the variability modes under investigation; additional experiments have also indicated distinct signs of nonlinearity in some of the links uncovered. Furthermore, we have also applied composite analysis of displaced and split stratospheric polar vortex events (SPV) from CMAM30-SD to focus on how the strength and occurrence of the IGW hotspots can play a role in SPV occurrence and frequency.