Connections between tropical convection and the tropical stratosphere

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The tropical troposphere is characterized by waves on a range of timescales, and once forced by convection these waves propagate both horizontally and vertically. The vertical propagation and associated momentum flux of these waves drives the quasi-biennial oscillation (QBO), which dominates the variability of the equatorial stratosphere. On subseasonal and seasonal timescales, changes in the location of convection due to the Madden Julian Oscillation or El Nino leads to an altered planetary wave field in both the tropical and extratropical troposphere.

Recently, significant progress has been made in the theoretical understanding of the "Kelvin" and mixed Rossby-gravity waves, two of the most important waves for the driving of the QBO. Specifically, we demonstrate how the analytical theory for these waves, which traditionally has been derived on the beta-plane, can be performed directly on the sphere. We highlight (the subtle) differences in the properties of these waves on the sphere.

In early 2016 the regularity of the QBO was disrupted for the first time since regular radiosonde observations became available, and we present model integrations that provide context for such a disruption with a focus on the tropical waves that can drive the disruption.

Finally, we consider whether the tropical stratospheric response to La Nina and El Nino events of equal strength is equal and opposite, and whether the response to extreme El Nino events is proportionately stronger to more moderate El Nino events. We provide evidence for pronounced nonlinearities in the March-June tropical lower stratospheric response to El Nino.

References

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