Geophysical Research Abstracts
Vol. 21, EGU2019-15046, 2019
EGU General Assembly 2019

Solar Cycle Signals in the Stratosphere as Observed by Microwave Limb Sounder

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In this presentation, we show solar cycle signals in the stratosphere and mesosphere and how they are coupled with each other, as observed by Aura Microwave Limb Sounder (MLS). Solar cycle variations in the middle atmosphere are balanced between chemical and thermal forcing driven by UV changes, and dynamic response by planetary wave modulations. In the stratosphere, substantial solar cycle variation in incoming solar UV radiation which is greater than several percent drives dynamical response, where abundant ozone layer warms the atmosphere by absorbing UV radiation and induces further circulation changes. While QBO is a dominant forcing mechanism in the stratospheric chemistry and dynamics, we still find significant solar cycle signals in the chemistry and dynamics in the stratosphere. In the mesosphere, planetary wave forcing in the winter hemisphere is enhanced with solar cycle variation due to greater regional solar heating with increased solar radiation. In favor of these conditions, the increased Carbon Monoxide (CO) anomaly signal produced by the Carbon Dioxide (CO_2) photolysis in the lower thermosphere extends to the stratosphere by the dynamical descent in the winter polar vortex, with a time lag that is consistent with the average descent rate. The continuous MLS observation, which covers more than fourteen years (2004-2018) including maximum of solar-cycle 24, allows us to estimate the solar cycle variation in the atmospheric tracers in the middle atmosphere.