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11-Year Solar Cycle and Its Relationship with the Atmosphere

New and significant atmospheric observations correlated with solar variations have recently been confirmed by Karin Labitzke, head of the Stratospheric Research Group of the Institute of Meteorology at the Free University of Berlin, and NCAR scientist Harry van Loon.

Labitzke reported in 1982 that major midwinter warmings of the stratosphere over the northern hemisphere had never occurred during the 11-year solar-cycle minima when the Quasi-Biennial Oscillation (QBO) in the low equatorial stratosphere was in the west phase. During a visit to NCAR in the spring of 1987, Labitzke verified this lack of correlation over a period of three solar cycles. She noted, furthermore, that the stratospheric temperature at the North Pole in winter was well correlated with the solar cycle during the years when the QBO was in its west phase.

Van Loon, of NCAR's Climate and Global Dynamics Division, then spent six weeks in Berlin, collaborating with Labitzke. Both scientists began, as an extension to their earlier work, to study the atmosphere north of 10 deg. N and at heights up to approximately 30 kilometers. Their studies revealed that when the measurement data were arranged according to one phase---the westerly phase, in this instance---of the QBO, both the troposphere and stratosphere were clearly affected in winter by the 11-year variability during the last three solar cycles. Thus analyzed, the stratospheric temperatures and geopotential heights were positively correlated with the solar cycle at higher latitudes; they were negatively correlated at middle and low latitudes. During the minima, or when the sunspot number was low, in the westerly phase of the QBO the stratospheric temperature was lower. The opposite was observed in the easterly phase of the QBO.

The significance of these recent correlations, according to van Loon, lies in the new point of reference: the phase of the QBO. Earlier research efforts to identify solar-atmospheric relationships revealed little or no correlation because the total QBO series (both east and west) was analyzed. The key to the solar cycle in the atmosphere, it now appears, is the phase of the QBO.

Labitzke and van Loon showed that, in the troposphere, relationships are especially clear in the west phase over North America and adjacent ocean areas. In the stratosphere, there was strong evidence that the solar maximum's influence serves to depress the extratropical signals of the QBO whereas the solar minima appear to enhance these signals.

Expanding their research focus, both scientists are now investigating the surface air temperature where a strong effect is found in the west phase of the QBO over the United States east of 105 deg. W, between 25 and 40 deg. N. Their work will also encompass the near-equatorial troposphere and stratosphere, the sea surface temperature, and the fluxes in the long waves in the troposphere and stratosphere.

Ray Roble, of NCAR's High Altitude Observatory, has expressed interest in pursuing this relationship in connection with his thermospheric general circulation model that predicts "weather" at the satellite altitude.

Labitzke has been invited to speak on these solar-atmospheric relationships at the Solar Radiative Output Variations Workshop to be held at NCAR in November 1987.

The End

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