The 2015–2016 Arctic winter: Perspectives on extremes in polar processing and meteorological variability from the 12-year record of Aura Microwave Limb Sounder measurements

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In the last decade, the Arctic lower stratosphere has seen some of the most dynamically disturbed winters, with stratospheric sudden warmings that curtailed polar processing early in the season and limited chemical ozone loss, as well as several winters marked by exceptionally cold conditions and severe chemical ozone loss. The occurrence in recent winters of different combinations of extreme meteorological conditions, and their impact on polar chemical processes, has underscored the Arctic stratosphere's sensitivity to a spectrum of dynamical variability. Launched as part of NASA's Aura satellite in July 2004, the Microwave Limb Sounder (MLS) provides an extensive suite of measurements enabling quantification of polar processing and chemical ozone loss. Here we use MLS observations in conjunction with meteorological analyses in a comprehensive analysis of the Arctic winter of 2015–2016. An unusually large volume of low temperatures in the early winter led to strong depletion in gas-phase HNO_3 and H_2O associated with polar stratospheric cloud formation. As a consequence of this early-winter processing and an elongated vortex with significant portions exposed to sunlight, substantial chlorine activation (enhanced abundances of ClO, depressed abundances of HCl) was evident far earlier than is typical in Arctic winter. The degree of polar processing and chemical ozone loss in this winter will be placed in the context of the previous 11 Arctic winters observed by Aura MLS.