The Earth Observing System Microwave Limb Sounder (EOS MLS) on the Aura Satellite

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***Abstract*—The Earth Observing System Microwave Limb Sounder measures several atmospheric chemical species (OH, HO_2, H_2O, O_3, HCl, ClO, HOCl, BrO, HNO_3, N_2O, CO, HCN, CH_3CN, volcanic SO_2), cloud ice, temperature, and geopotential height to improve our understanding of stratospheric ozone chemistry, the interaction of composition and climate, and pollution in the upper troposphere. All measurements are made simultaneously and continuously, during both day and night. The instrument uses heterodyne radiometers that observe thermal emission from the atmospheric limb in broad spectral regions centered near 118, 190, 240, and 640 GHz, and 2.5 THz. It was launched July 15, 2004 on the National Aeronautics and Space Administration's Aura satellite and started full-up science operations on August 13, 2004. An atmospheric limb scan and radiometric calibration for all bands are performed routinely every 25 s. Vertical profiles are retrieved every 165 km along the suborbital track, covering 82°S to 82°N latitudes on each orbit. Instrument performance to date has been excellent; data have been made publicly available; and initial science results have been obtained.**

***Index Terms*—Microwave, remote sensing, stratosphere, submillimeter wave.**

I. Introduction

THE Earth Observing System (EOS) Microwave Limb Sounder (MLS), onboard the National Aeronautics and Space Administration (NASA) Aura satellite launched July 15, 2004, uses the microwave limb sounding technique [1] to provide information on Earth's upper troposphere, stratosphere, and mesosphere. It is an advanced follow-on to the first MLS [2], [3] on the Upper Atmosphere Research Satellite (UARS) launched September 12, 1991. The major objective of UARS MLS was, in response to the industrial chlorofluorocarbon threat to the ozone layer [4], to provide global information on chlorine monoxide (ClO)—the dominant form of chlorine that destroys ozone. The UARS MLS design was "frozen" before discovery of the Antarctic ozone hole [5], [6], and the design was for the middle and upper stratospheric measurements thought most important at the time. It was, however, able to provide valuable information for assessing the chlorine destruction of lower stratospheric ozone in the Antarctic and Arctic winters [7], [8]. UARS MLS also provided additional measurements beyond stratospheric ClO, O_3, and H_2O for which it was designed, most notable of which are upper tropospheric H_2O vapor [9]–[11] and cloud ice [12], stratospheric HNO_3 [13], [14], and temperature variances associated with atmospheric gravity waves [15], [16]. A summary of scientific highlights from UARS MLS through 1999 is in [3]. The MLS web site (http://mls.jpl.nasa.gov) contains an updated list of MLS-related scientific publications.

EOS MLS is greatly improved over UARS MLS in having: 1) many more stratospheric measurements for chemical composition and dynamical tracers; 2) more and better upper tropospheric measurements; and 3) better global and temporal coverage and resolution These improvements were possible because of: 1) advances in technology that have extended the spectral range and bandwidth of microwave heterodyne radiometer systems that can be operated on a satellite; 2) design of EOS MLS for upper tropospheric and lower stratospheric measurements; and 3) the Aura polar orbit that allows nearly pole-to-pole coverage on each orbit and measurements made in the orbit plane that enables more accurate handling of atmospheric gradients in the line-of-sight (LOS) direction. The EOS MLS atmospheric measurement objectives are shown in Fig. 1.

An overview of the Aura mission is in [17]. Companion instruments to MLS on Aura are the Tropospheric Emission Spectrometer (TES) [18], the Ozone Monitoring Instrument (OMI) [19], and the High Resolution Dynamics Limb Sounder (HIRDLS) [17].

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