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Changes in atmospheric composition discerned from long-term NDACC measurements: water vapor, ozone and temperature lidar and balloon measurements at the JPL-Table Mountain Facility, California

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Three lidars have been operating routinely at the Jet Propulsion Laboratory (JPL) Table Mountain Facility (TMF) in California (34.4N) to contribute to the NDACC long-term datasets. A differential absorption lidar (DIAL) was first built in 1988 to measure stratospheric ozone and aerosols (15-50 km) and middle atmospheric temperature (30-85 km). A second DIAL started operation in 1999 to measure tropospheric ozone (4-25 km), and in 2005, a high-capability Raman lidar was built to measure water vapor up to the lower stratosphere (3-20 km). This lidar has been optimized several times since 2005 and has now produced several years of stable, high quality profiles up to 15-20 km altitude. Results from all three lidars will be presented, with a particular focus on water vapor. Three validation campaigns (MOHAVE, MOHAVE-2, and MOHAVE-2009) allowed to characterize the performance of the evolving TMF Raman lidar. The latest campaign, which took place in October 2009, hosted a large number of instruments and techniques. Six ground-based lidars from three different Research groups provided over 350 hours of water vapor, ozone, and temperature measurements. Over 50 balloons were launched with RS92 PTU sondes onboard. Twenty of them included Frost-point Hygrometers (CFH and NOAA-FPH), allowing thorough validation of the Raman lidar measurements in the UTLS. The water vapor profiles obtained from the JPL Raman lidar showed no bias with the CFH up to 20 km. Outstanding water vapor-ozone correlations were observed, revealing for example the occurrence of a stratospheric intrusion. During this campaign, two GPS receivers, two microwave radiometers, and two Fourier Transform Spectrometers provided column water measurements. The excellent agreement found between these instruments suggests that these techniques can become important complements to the radiosonde for routine lidar calibration. The multiple and matured lidar and balloon instruments and techniques available at TMF demonstrate the unique potential of this subtropical Research station for high quality, long-term, routine measurements of atmospheric composition and structure from the ground to the mesosphere.