INTERANNUAL COMPARISON OF WATER VAPOR IN THE NORTH POLAR REGION OF MARS. L. K. Tamppari[1], M. D. Smith[2], A. S. Hale[3], and D. S. Bass[3], [1]NASA Jet Propulsion Laboratory (4800 Oak Grove Drive, Pasadena, CA 91109 leslie.k.tamppari@jpl.nasa.gov), [2]NASA Goddard Space Flight Center (Michael.D.Smith.1@gsfc.nasa.gov), [3]NASA Jet Propulsion Laboratory (MS 264-235, 4800 Oak Grove Drive, Pasadena, CA 91109 amy.s.hale@jpl.nasa.gov), [4]NASA Jet Propulsion Laboratory (MS T1722, 4800 Oak Grove Drive, Pasadena, CA 91109 deborah.s.bass@jpl.nasa.gov).

Introduction: The Martian water cycle is one of the three annual cycles on Mars, dust and CO2 being the other two. Despite the fact that detailed spacecraft data, including global and annual coverage in a variety of wavelengths, have been taken of Mars spanning more than 25 years, there are many outstanding questions regarding the water cycle.

There is very little exposed water on Mars today, in either the atmosphere or on the surface [1] although there is geological evidence of catastrophic flooding and continuously running water in past epochs in Mars' history [2] as well as recent (within about 10,000 years ago) evidence for running water in the form of gullies [3].

The north polar cap region is of special interest as the residual cap is the main known reservoir of water on the planet today. The south polar residual cap may contain water, but presents a CO2 ice covering, even during southern summer. This hemispheric dichotomy is unexplained and is especially puzzling due to the fact that the Martian southern summer is much warmer (due to Mars' eccentricity) than the northern summer. Recently, water has been found in the top meter of the surface in both the northern and southern high latitude regions [e.g. 4-5] indicating an even greater amount of water on Mars than previously known.

Background: In order to better understand the current climate of Mars, we seek to understand atmospheric water in the north polar region. Our approach is to examine the water transport and cycling issues within the north polar region and in/out of the region on seasonal and annual timescales. Viking Mars Atmospheric Water Detector (MAWD) data showed that water vapor increased as the northern summer season progressed and temperatures increased, and that vapor appeared to be transported southward [6]. However, there has been uncertainty about the amount of water cycling in and out of the north polar region, as evidenced by residual polar cap visible brightness changes between one Martian year (Mariner 9 data) and a subsequent year (Viking data). These changes were originally thought to be interannual variations in the amount of frost sublimed based on global dust storm activity [5-7]. However, Viking thermal and imaging data were re-examined and it was found that 14-35 pr μm of water -ice appeared to be deposited on the cap later in the summer season [9], indicating that some water may be retained and redistributed within the polar cap region. This late summer deposition could be due to adsorption directly onto the cap surface or due to snowfall. We seek to understand what happens to the water on seasonal and interannual timescales. We address these issues by examining water vapor in the north polar region of Mars during the north spring and summer period from MGS TES data and by comparing these results to the Viking MAWD results.

Method:

Water vapor. Smith *et al.* [10] have performed retrievals for the column-integrated abundance of water vapor using the rotational water vapor bands at 220-360 cm^{-1}. Atmospheric temperatures are first retrieved using the 15-μm CO_2 band (Conrath *et al.*, 2000). Next, a forward radiative transfer computation is used to find the column-integrated water abundance that best fits the observed water vapor bands. At this time water is assumed to be well-mixed up to the condensation level and then zero above that. A total of six water vapor bands between 220 and 360 cm^{-1} are observed in TES spectra and the widths and relative depths of all six bands are very well fit by the synthetic spectra. Because the spectral signature of water vapor is spectrally very distinct from those of dust and water-ice, we can easily separate the relative contributions from each component (dust, water-ice, and water vapor) on a spectrum-by-spectrum basis.

Recent analysis with MGS TES data has shown evidence for water vapor "pulses" as the seasonal north polar cap sublimes [15]. This could be linked to the previous late-summer season deposition, discussed above. There appear to be significant differences in the details of the water vapor as a function of latitude and season between the Viking era and the current era (Figure 1). These differences may be a degree of interannual variability in the water vapor or a result of the coverage differences (Figure 2). Note that in Fig. 2, there are large differences in the MAWD coverage between the Ls=80°-95° bin (bin 7) vs. the Ls=95°-110° bin (bin 8). The TES coverage is much more uniform over time due to its orbit. An understanding of these possible interannual differences is important in several ways: (1) to understand the Martian climate, (2) to characterize the extent of interannual variability or lack thereof , and (3) to understand water-cycling within the north polar region and potentially in/out of the region. We will present our results of the investigation of the differences in these water vapor column amounts.

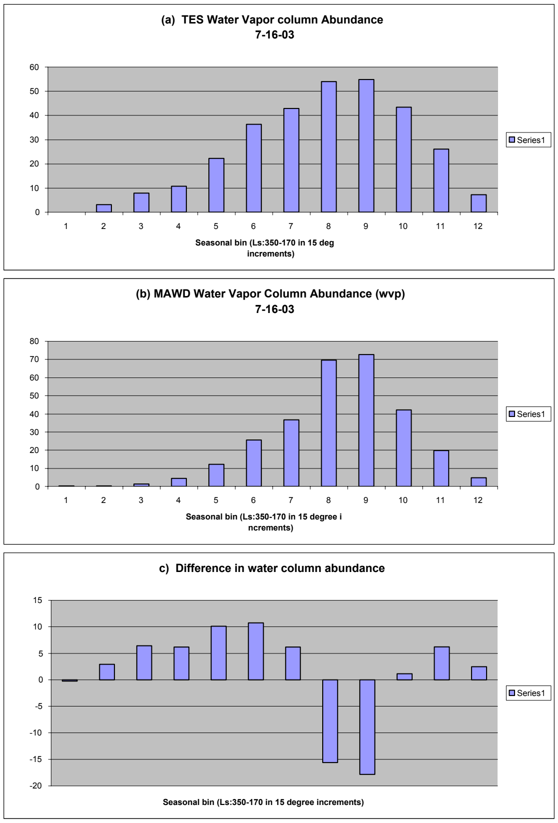

Figure 1. (a) TES water vapor column abundance in pr microns for the north polar region (60°-90°N). The seasonal binning is plotted Ls=15° increments, beginning at Ls=350° and ending at Ls=170°. Note that there is no TES data plotted for the first seasonal bin, Ls=350°-5°. (b) MAWD water vapor column abundance for same region and seasonal bins. MAWD data are shown for Ls=350°-5°. (c) The difference between the TES water vapor column abundance amount and the MAWD water vapor column abundance amount as a function of season.

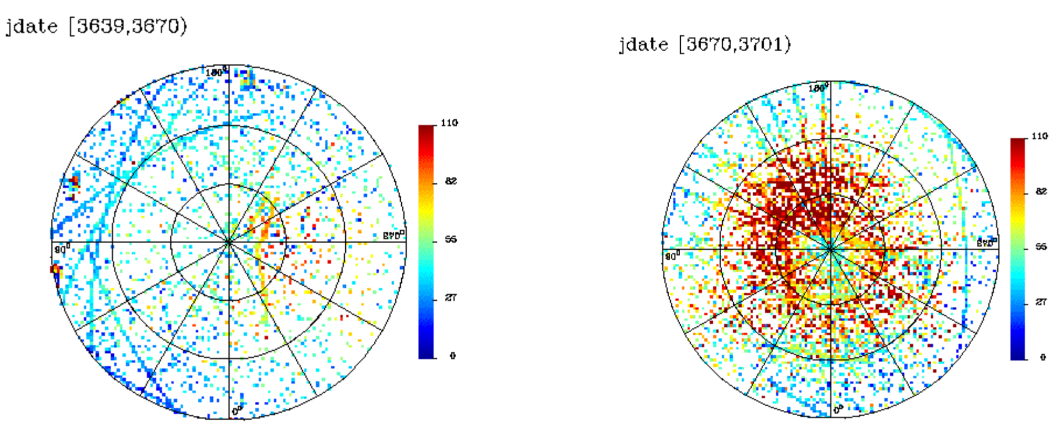

Figure 2. (Left) MAWD water vapor coverage shown for the Ls=80°-95° bin (bin 7). (Right) Similar for the Ls=95°-110° bin (bin 8). Note that the coverage near the cap center is much denser for the later season, possibly explaining the greater amount of water vapor measured during that season than in the previous season.

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