

MAPPING THE MARTIAN METEOROLOGY. M. Allison¹, J. D. Ross², and N. Solomon³, ¹NASA/Goddard Institute for Space Studies, 2880 Broadway; New York, NY 10025; email: mallison@giss.nasa.gov, ²Pennsylvania State University, Department of Meteorology, ³Science Systems and Applications Inc., Goddard Institute for Space Studies.

Introduction: The Mars-adapted version of the NASA/GISS general circulation model (GCM) has been applied to the hourly/daily simulation of the planet's meteorology over several seasonal orbits. The current running version of the model includes a diurnal solar cycle, CO₂ sublimation, and a mature parameterization of upper level wave drag with a vertical domain extending from the surface up to the 6 μ b level. The benchmark simulations provide a four-dimensional archive for the comparative evaluation of various schemes for the retrieval of winds from anticipated polar orbiter measurements of temperatures by the Pressure Modulator Infrared Radiometer [1].

Zonal Mean Structure: The simulated zonal-mean circulation over a full Mars orbit shows a polar westerly jet for each winter hemisphere at the 0.1mb level (approximately 40km altitude) exceeding 100m/s and seasonably variable equatorial easterlies, nearly vanishing at the autumn equinox. The associated zonal-mean temperature appears to be in qualitative agreement with measurements by the Thermal Emission Spectrometer on Mars Global Surveyor [2], and its seasonal evolution includes the appearance of a rapid polar warming with the approaching northern winter solstice, as previously modeled by Wilson [3]. The simulated zonal-mean potential vorticity (PV) at upper model levels exhibits a remarkable smoothing over latitude, consistent with previous reports of its near-zero distribution throughout much of the atmosphere [3, 4, 5]. The GISS GCM results suggest that that the zonal-mean Ertel PV at the 10 μ b level is less than half its polar value below 60° latitude in both hemispheres and for both the equinox and solstice seasons.

Global Surface Maps: The accompanying color figures on the second page of this abstract represent a small sample of the animated time-lapse sequences of the global Martian weather simulated with the GISS GCM. The selected example depicts a single solar day beginning at Ls271° (near the southern summer solstice) with four mapped "snapshots" at 6hr intervals. The bright colors plotted over a brown-shaded albedo map correspond to surface temperature contours as indicated by the horizontal bar scales graduated in 10K intervals. Arrows show the surface wind vectors scaled in relation to the 10m/s reference shown just above the color bars. The numbers plotted at the top of each chart mark the Local Mean Solar Time, at this season only 15min ahead of the Local True Solar Time [6].

The diurnal solar tide is the single most obvious feature of the sequence, as indicated by the brightest red contours following the mid-afternoon meridian. Certain locations show an accompanying diurnal rotation

of the surface wind vector, as in the Tantalus Fossae region to the north of the Tharsis ridge and the Thaumasia Fossae region to the south of the Solis Planum. Others exhibit instead a semi-steady flow structure, as in the sinuous core of the famously simulated surface westerly at 30°S latitude [7], apparently strongest in the GISS simulations between 100 and 200°West longitude, and in the region extending from Noachis west to the Nirgal Vallis. The meridional flow is variably northerly at almost every longitude just to the south of the equator, consistent with a rising branch of the Hadley circulation near the sub-solar latitude.

Also of interest is the steepening evolution of an apparent baroclinic wave in the northern (winter) hemisphere, as revealed by the slowly moving, comma-shaped green contour bordering the colder polar region just above 60°N latitude in the Utopia Planitia, at 260°W longitude in the final frame. The associated cyclonic vorticity of this feature is clearly indicated by the plotted wind vectors, as is the anticyclonic swirl to the southeast over the northern tip of Syrtis Major. The longitudinal undulation of the green-blue border marking the 180°K contour gives the visual impression of a zonal wavenumber index of about 4 - 6, consistent with previous interpretations of wind and pressure measurements by the Viking2 Lander [8, 9].

In Progress: Ongoing studies of Martian weather mapping are focused on the development of objective analysis schemes for the interpretation of winds from temperatures sounded from polar orbit. An interesting possibility bearing further investigation, in addition to gradient thermal wind and "nonlinear balance" estimates [10], is the prospect of exploiting the inferred near-zero PV state over much of the Martian atmosphere as a further constraint on the inferred distribution of the upper-level flow. Future progress will be posted at <http://www.giss.nasa.gov/research/planets/mars/>.

Acknowledgments: This work was supported by the NASA Planetary Atmospheres Program and the Mars Climate Orbiter Project.

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