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Traveling Weather Disturbances in Mars' Southern Extratropics: Sway of the Great Impact Basins

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As on Earth, between late autumn and early spring on Mars middle and high latitudes within its atmosphere support strong mean thermal contrasts between the equator and poles (i.e. "baroclinicity"). Data collected during the Viking era and observations from both the Mars Global Surveyor (MGS) and Mars Reconnaissance Orbiter (MRO) indicate that this strong baroclinicity supports vigorous, large-scale eastward traveling weather systems (i.e. transient synoptic-period waves). Within a rapidly rotating, differentially heated, shallow atmosphere such as on Earth and Mars, such large-scale, extratropical weather disturbances are critical components of the global circulation. These wave-like disturbances act as agents in the transport of heat and momentum, and moreover generalized tracer quantities (e.g., atmospheric dust, water vapor and water-ice clouds) between low and high latitudes of the planet. The character of large-scale, traveling extratropical synoptic-period disturbances in Mars' southern hemisphere during late winter through early spring is investigated using a high-resolution Mars global climate model (Mars GCM). This global circulation model imposes interactively lifted (and radiatively active) dust based on a threshold value of the instantaneous surface stress. Compared to observations, the model exhibits a reasonable "dust cycle" (i.e. globally averaged, a more dusty atmosphere during southern spring and summer occurs). In contrast to their northern-hemisphere counterparts, southern synoptic-period weather disturbances and accompanying frontal waves have smaller meridional and zonal scales, and are far less intense synoptically. Influences of the zonally asymmetric (i.e. east-west varying) topography on southern large-scale weather disturbances are examined. Simulations that adapt Mars' full topography compared to simulations that utilize synthetic topographies emulating essential large-scale features of the southern middle latitudes indicate that Mars' transient barotropic/baroclinic eddies are significantly influenced by the great impact basins of this hemisphere (e.g., Argyre and Hellas). In addition, the occurrence of a southern storm zone in late winter and early spring is keyed particularly to the western hemisphere via orographic influences arising from the Tharsis highlands, and the Argyre and Hellas impact basins. Geographically localized transient-wave activity diagnostics are constructed that illuminate fundamental differences amongst such simulations and these are described.