Geophysical Research Abstracts, Vol. 9, 10553, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10553

Mars dust: effects of large-scale extratropical cyclogenesis

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Mars, like Earth, is a rapidly rotating, differentially heated, solid planet with a seasonally-varying shallow atmosphere where traveling weather systems occur. Both planets exhibit continental-scale orography. During late autumn through early spring, Mars' northern extratropics exhibit profound equator-to-pole temperature contrasts (i.e., mean meridional ''baroclinicity"). From data collected during the Viking era and recent observations from the Mars Global Surveyor (MGS) mission, the imposition of such strong baroclinicity supports intense and vigorous eastward traveling weather systems (i.e., transient synoptic-period waves). On large scales, these systems have accompanying sub-synoptic scale ramifications on the atmospheric environment through cyclonic/anti-cyclonic winds, deformations and contractions/dilations in temperatures, and sharp perturbations amongst atmospheric tracers (e.g., dust and volatiles). Mars' frontal waves exhibit meridionally-extended structure and appear short-lived compared to models of cyclo-, fronto-genesis on Earth. Additionally, the midlatitude synoptic-scale cyclones tend to develop, travel eastward, and decay preferentially within certain geographic regions (i.e., storm zones). Here, we utilize a version of the NASA Ames Mars general circulation model at high horizontal resolution that includes the lifting, transport and sedimentation of radiativiely active dust to investigate the nature of cyclogenesis and frontal-wave circulations (both horizontally and vertically), and dust structuring and transport within the atmosphere. For the prescribed dust lifting schemes we impose, we assess the importance and relevance at high-resolution of (i) wind stress lifting versus (ii) dust-devil lifting, and their implications on Mars' dust cycle. Given similarities between Earth and Mars, characterization of baroclinic waves, frontal cyclones and evolution, and the nature of storm zones on Mars may offer insights into fundamental mechanisms active in the terrestrial case.