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Large-Scale, Extratropical Weather Systems within Mars' Atmosphere

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During late autumn through early spring, extratropical regions on Mars exhibit profound mean zonal equator-to-pole thermal contrasts. The imposition of this strong meridional temperature variation supports intense eastward-traveling, synoptic weather systems (i.e. transient baroclinic/barotropic waves) within Mars' extratropical atmosphere. Such disturbances grow, mature and decay within the east-west varying seasonal-mean midlatitude jet stream (i.e. the polar vortex) on the planet. Near the surface, the weather disturbances indicated large-scale spiraling "comma"-shaped dust cloud structures and scimitar-shaped dust fronts, indicative of processes associated with cyclo-/fronto-genesis. The weather systems occur during specific seasons on Mars, and in both hemispheres. The northern hemisphere (NH) disturbances are significantly more intense than their counterparts in the southern hemisphere (SH). Further, the NH weather systems and accompanying frontal waves appear to have significant impacts on the transport of tracer fields (e.g., particularly dust and to some extent water species (vapor/ice) as well). And regarding dust, frontal waves appear to be key agents in the lifting, lofting, organization and transport of this particular atmospheric aerosol. In this paper, a brief background and supporting observations of Mars' extratropical weather systems is presented. This is followed by a short review of the theory and various modeling studies (i.e. ranging from highly simplified, mechanistic and full global circulation modeling investigations) which have been pursued. Finally, a discussion of outstanding issues and questions regarding the character and nature of Mars' extratropical traveling weather systems is offered.