AOGS 2005

A Comparison of Martian and Terrestrial Atmospheric Dynamics

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The Martian atmosphere experiences a range of motions or "weather" arguably as rich as that of the Earth. These motions run the range of spatial and temporal scales from the microscopic domain of turbulence to the global scale of storms.

Major similarities between the Earth and Mars are their relatively rapidly (the Martian day is only a few tens of minutes longer), and their moderate obliquity (roughly 25°). The closeness of rotation rate affects the strength of the Coriolis forces, and means that both planets experience similar scales of weather systems and types of large-scale atmospheric motions. The closeness of obliquity means that Mars experiences seasons, just as the Earth does.

Major differences include atmospheric mass and the abundance of water. The surface pressure on Mars is only 610 Pa (6.1 mbar) compared to roughly 10^5 Pa (1 bar) for the Earth. The "greenhouse effect" on Mars is weaker than on the Earth, and the thermal capacity of the air is also lower. Parcels of air tend to warm up or cool off much more rapidly than on the Earth, and moving parcels are less able to retain the temperature "memory" of the region the started from.

The more significant difference is water. Water plays a powerful force in terrestrial meteorology, through latent heat exchange by the evaporation and condensation of water. On Mars, the abundance of water is much less, despite the presence of two mostly water ice caps. The latent heat transferred is not comparable to rates from radiation. In contrast, dust plays the role for Mars that water does for Earth. Dust interacts with both the visible and thermal infrared radiation. The amount of dust suspended in the atmosphere changes with time, and the lifting and depositing of dust onto the surface is one of the important interactions between the Martian atmosphere and surface.

Keywords: Mars; Meteorology; Atmosphere; Dust; Water; Boundary Layer