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Potential vorticity, angular momentum and inertial instabilities in the Martian atmospheric circulation from assimilated analyses of MGS/TES observations

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Data based on re-analyses of the MGS/TES observations have been used to map distributions of potential vorticity and axial absolute angular momentum per unit mass. The data stretches over nearly three Martian years and cover a wide range of atmospheric conditions. The spatial distribution and variation in time of angular momentum and potential vorticity are closely related to the zonal-mean circulation. Maps of potential vorticity distributions have been used to establish regions and times favourable for inertial instabilities. A narrow region near the equator which extends throughout the atmosphere is shown to be able to sustain inertial instabilities at different times of the year. The presence of inertial instabilities is predicted from the necessary (but not sufficient) condition for the occurrence of regions of atmosphere with PV of opposite sign to that of the planetary vorticity (PV-anomalies). These regions are characterized as being favorable to mixing on small scales, while at larger scales there may be potential links to Rossby wave breaking (Knox et. al. 2005, J. Geophys. Res. Vol. 110 D06108).

Barnes et. al. (J. Atm. Sci., 1996 (53) p 3143) used a global Martian circulation model to find that, during dusty solstice conditions, the Martian tropical and mid-latitude atmospheric circulation approximates to an angular-momentum conserving Hadley circulation, and is responsible for creating regions near the equator of low potential vorticity. Using the assimilated data we re-examine these results for a wider range of atmospheric states, including the period of the 2001 planet-encircling dust storm.