

Tangential winds of a vortex system in a planetary surface layer

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Abstract

The planetary boundary layer (PBL) mediates interactions between the surface and free atmosphere. In Martian PBL, surface can force convective vortices leading to dust devils. We use the Navier Stokes equation and the continuity equation to determine mean (with respect to time) tangential wind velocity in cylindrical co-ordinate system within the surface layer of a planetary atmosphere. We utilize Martian surface layer properties for theoretical derivation of our solution. We theoretically estimated tangential velocities for both Earth and Mars surface layers. In general, our theoretical values of the tangential wind velocity lie well within the range of observed values. The derived equation represents the dependency of tangential velocity on both radial distances from the center of vortex, and the altitude. As we move further away from the vortex center the effect of vortex becomes non-significant, and velocities start following the standard logarithmic profile. Due to dependency of tangential wind velocity on altitude the tangential velocity increases as we move higher up in the vortex system. At 100 m altitude, for an order of magnitude increase in the radial distance, the mean tangential wind velocity drops by about a factor of 1.5 in magnitude.

References

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