Integration of MGS TES FFSM eddies and MOC-observed dust storms, MY 24–26

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Introduction

Fast Fourier Synoptic Mapping (FFSM) of MGS (Mars Global Surveyor) Thermal Emission Spectrometer (TES) temperature data (3.7 hPa) shows the presence of eastward traveling waves in the southern hemisphere, with highest amplitudes from ~50-60° S (Barnes, 2006). We hypothesize that these waves are transient baroclinic eddies. We present an examination of these eddies and dust storms observed in Mars Orbiter Camera (MOC) imagery for MY 24-26, L_s=165-192°.

Integration of these data shows a strong association between eddies and dust storms, including: 1) comparable propagation speeds, and 2) comparable periodicities. These results suggest a causal relationship between baroclinic eddies and local storm initiation and migration.

Methodology

The longitudinal extent of dust storms was estimated from MOC daily global maps (Noble, 2016). Eddy phase speed and storm migration speed, c, was calculated using:

$$c(x) = \Delta x / \Delta t,$$

where $\Delta x = (r_{eq} \cdot \cos\varphi) \cdot \Delta\lambda$, r_{eq} is planetary radius, φ is latitude, λ is longitude, and t is time.

The eastern edge of dust storms was used in the calculation of their migration speed. A total of 82 storm pathways were calculated and are presented below. Since the majority of eddy speeds are based on a 360° change in longitude ($\Delta\lambda$), storms pathways were filtered to match eddy $\Delta\lambda$, and are presented in subsequent figures.

Distribution of TES FFSM eddy phase speed (3.7 hPa, 55° S) and MOC-observed dust storm migration speed (53° S), MY 24–26, L_s = 165-192°

Distribution of TES FFSM eddy phase speed (3.7 hPa, 55° S) and MOC-observed dust storm migration speed (53° S), MY 24-26, L_s = 165-192°, storm subset = $\Delta\lambda > 200°$

TES FFSM eddies & MOC-observed dust storms, 3.7 hPa, 55° S
MY 24 / MY 25 / MY 26

Kernel density estimates of TES FFSM eddy phase speed and MOC-observed dust storm migration speed, MY 24–26, L_s = 165-192°, 55° S

TES FFSM eddy phase speed (3.7 hPa, 55° S) and MOC-observed dust storm migration speed (53° S), L_s = 165–192°, MY 24–26

TES FFSM eddy phase speed (3.7 hPa, 55° S) and MOC-observed dust storm migration speed (53° S), MY 24

TES FFSM eddy phase speed (3.7 hPa, 55° S) and MOC-observed dust storm migration speed (subset = $\Delta\lambda > 200°$), MY 25, Ls = 165–188°

Summary

The various measures of comparison indicate a strong association between eddy phase speed and storm migration speed, and suggest a causal relationship. We hypothesize that dust storms in this season between 45-60° S are associated (in part) with cold fronts, a characteristic of baroclinic eddies. We invite the modelling community to conduct high spatial and temporal resolution simulations to test this hypothesis.

References

Barnes, J. R., 2006: FFSM Studies of Transient Eddies in the MGS TES Temperature Data. *Second International Workshop on the Mars Atmosphere: Modelling and Observations*, Granada, Spain

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