Synthesis of MGS Observations of the 2001 Global Dust Storm on Mars: Implications for Atmospheric Dynamics

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Objective

• Understand role of large-scale dynamics in onset and evolution of 2001 GDS

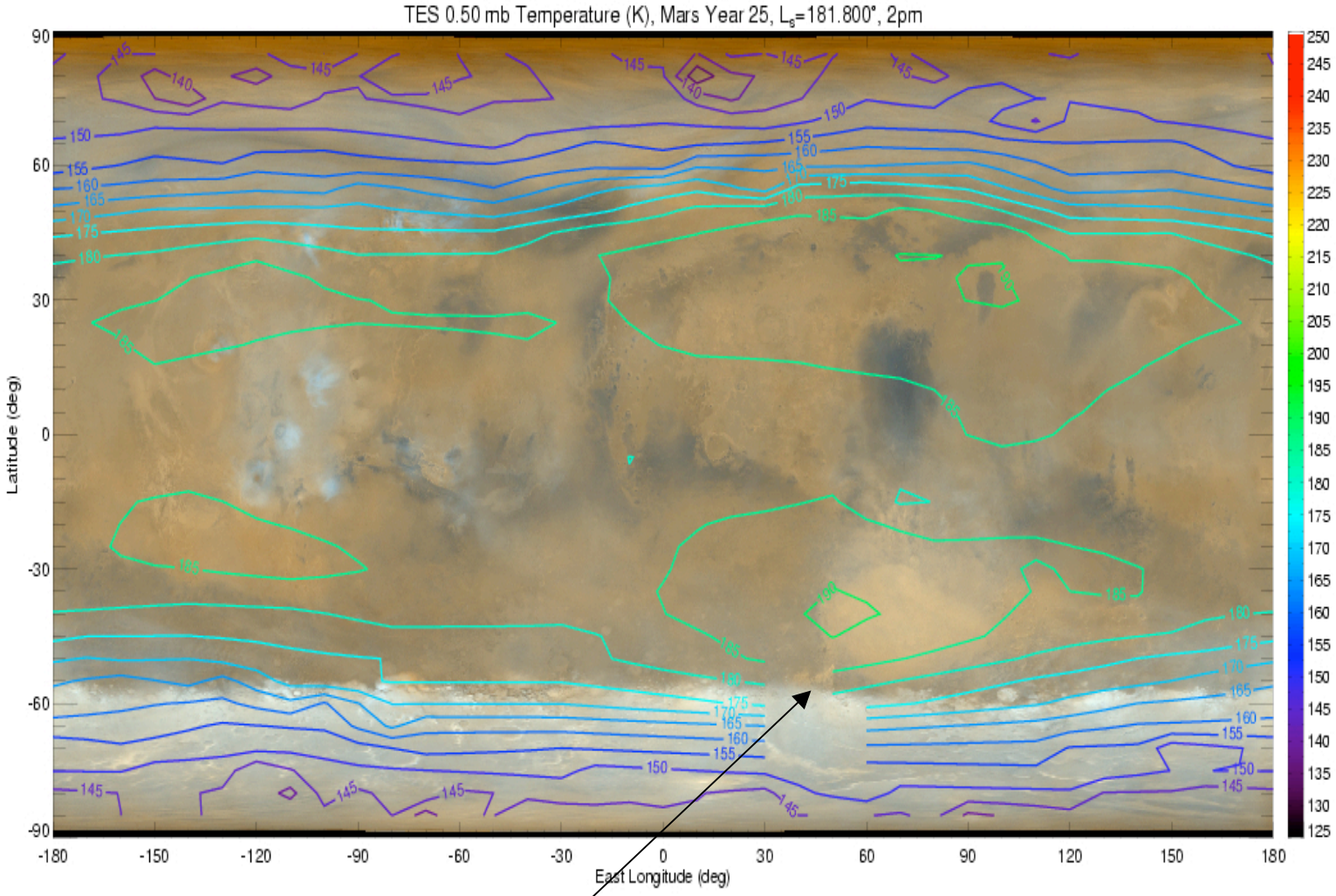
Key Data Sets

• MOC daily globals (Mike Malin and Bruce Cantor)
• TES temperature/opacity data (Phil Christensen and Mike Smith)
• MHSA (Terry Martin & Jim Murphy)

Approach

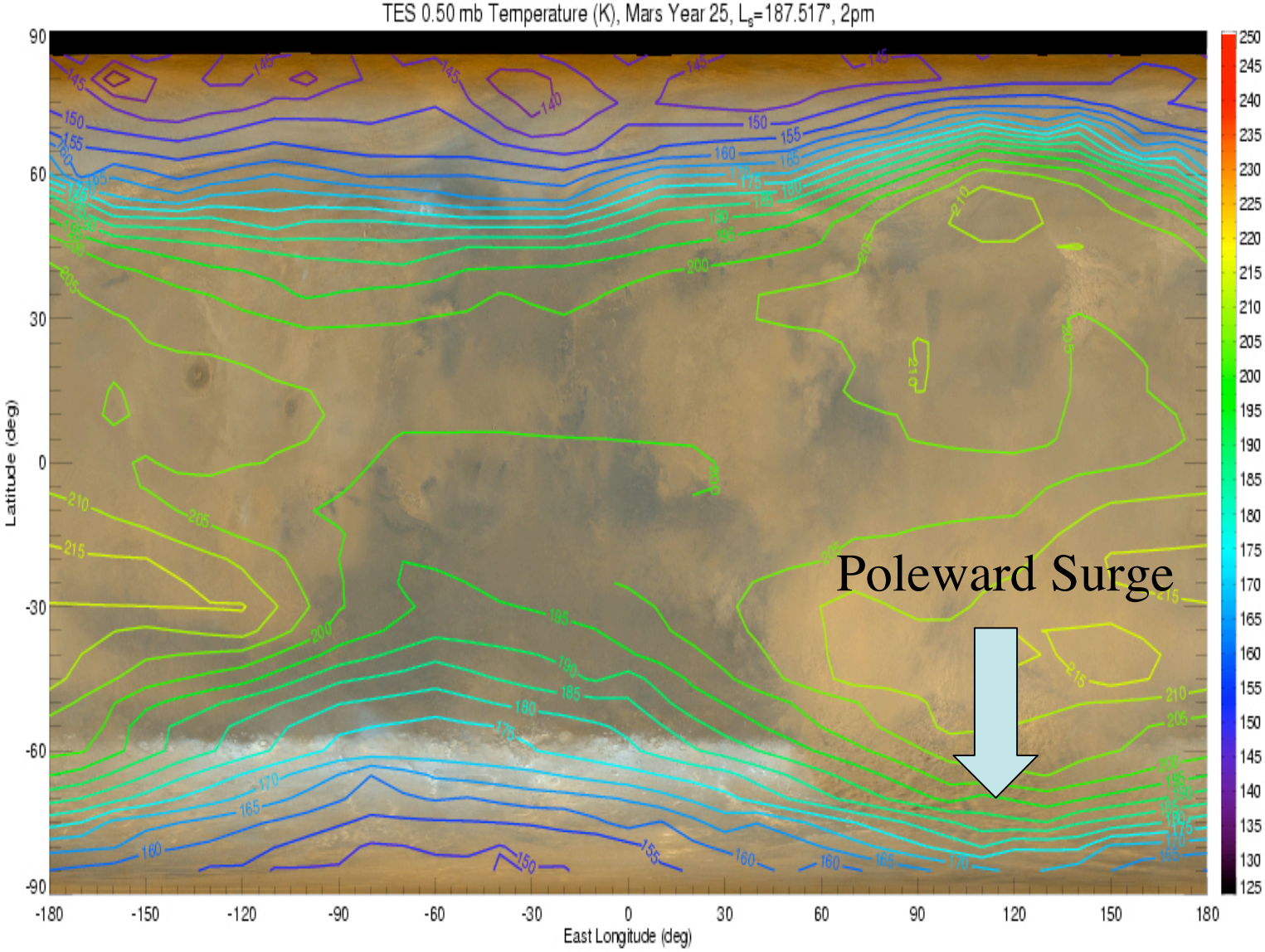
• Superimpose binned TES/MHSA data on MOC daily global maps
  – Better sense of how dust and temperature fields evolve
• Interpret Dynamics using Ames GCM
  – Force model with TES opacities

Storm Onset in Hellas

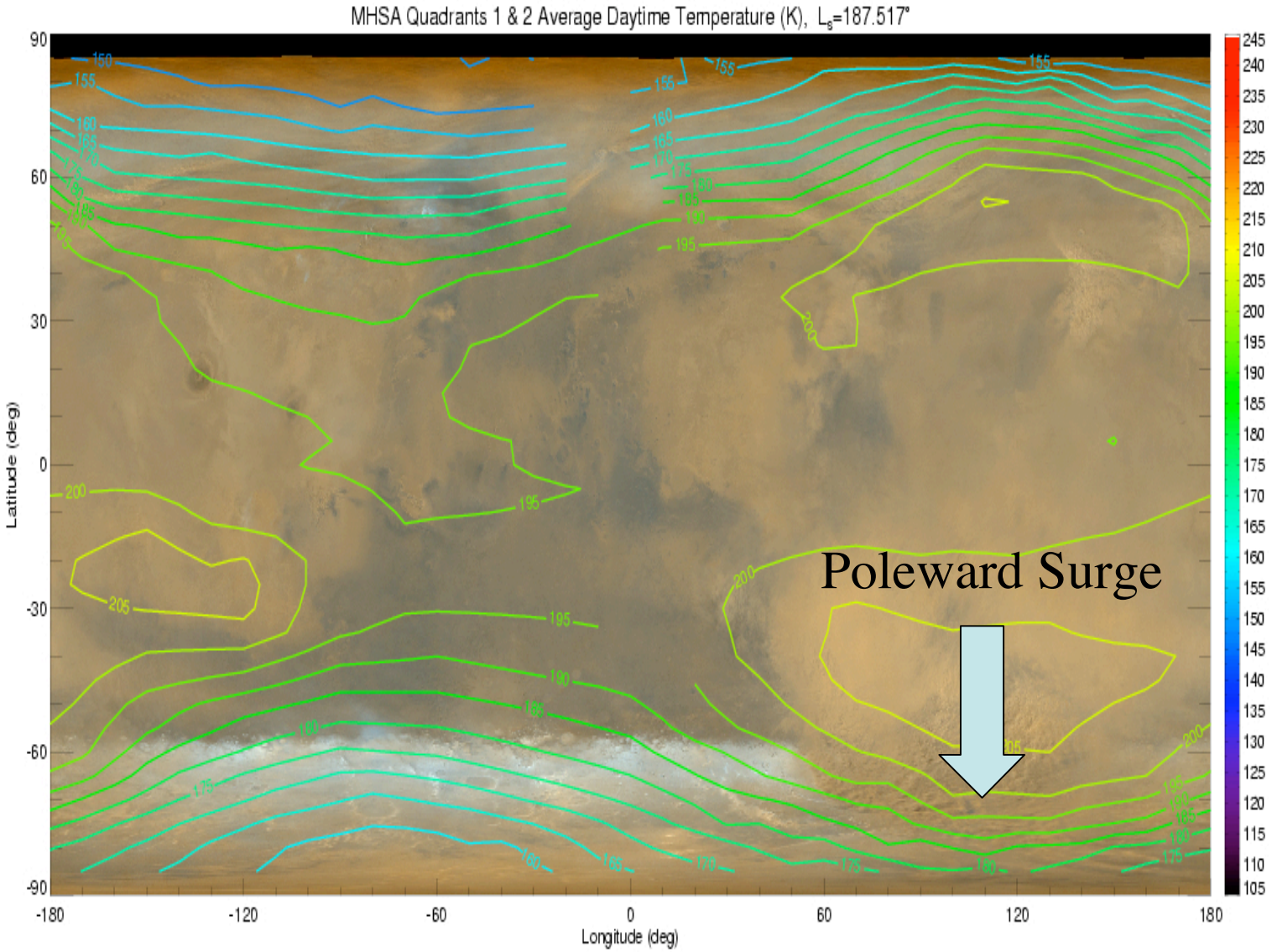


Last of 7 “pulses”

Wave One Peak Amplitude

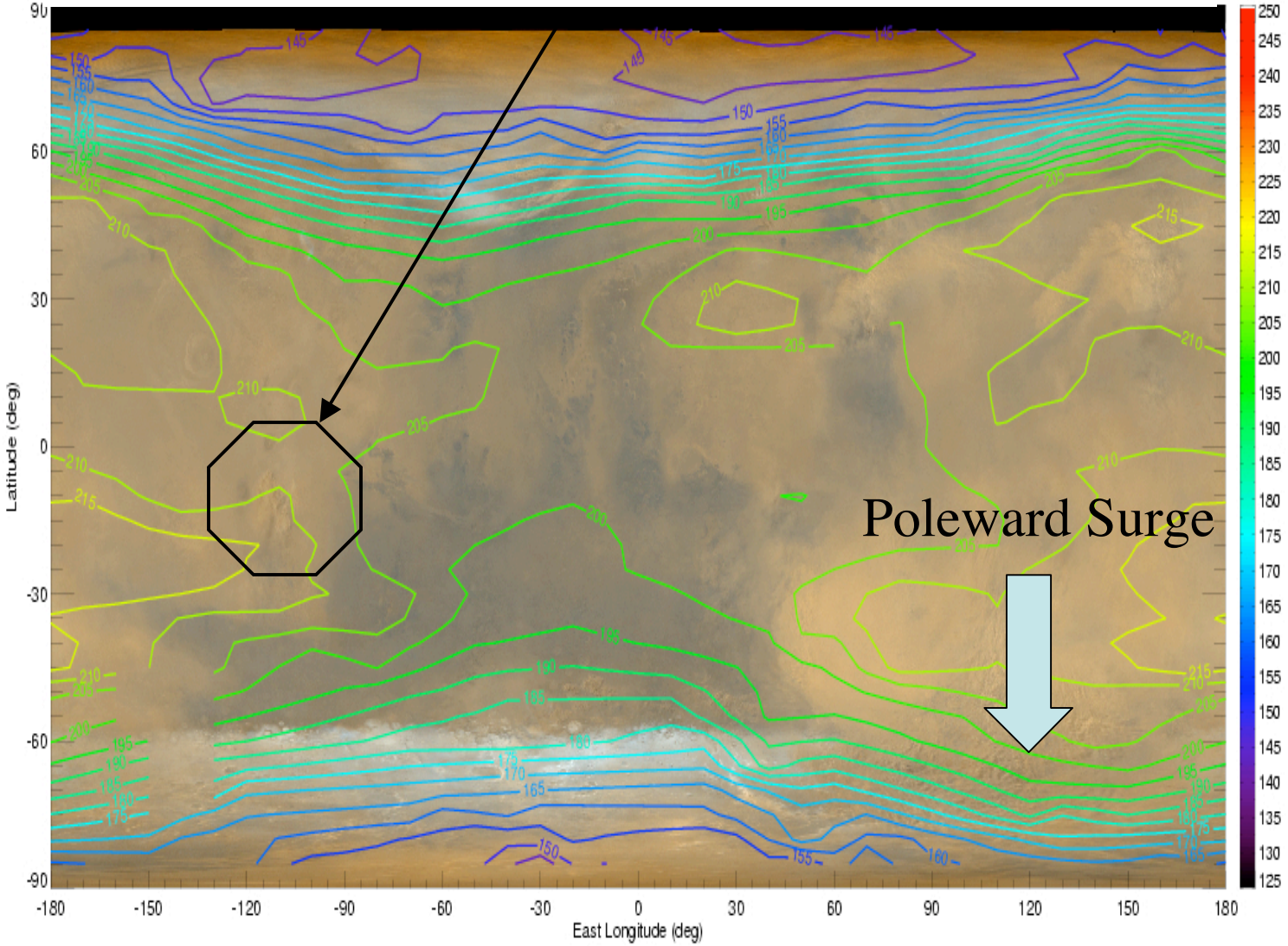


MHSA Gives Similar Results



Claritas Storm Begins on the Next Sol

This Region is Major Source of Dust for this Storm



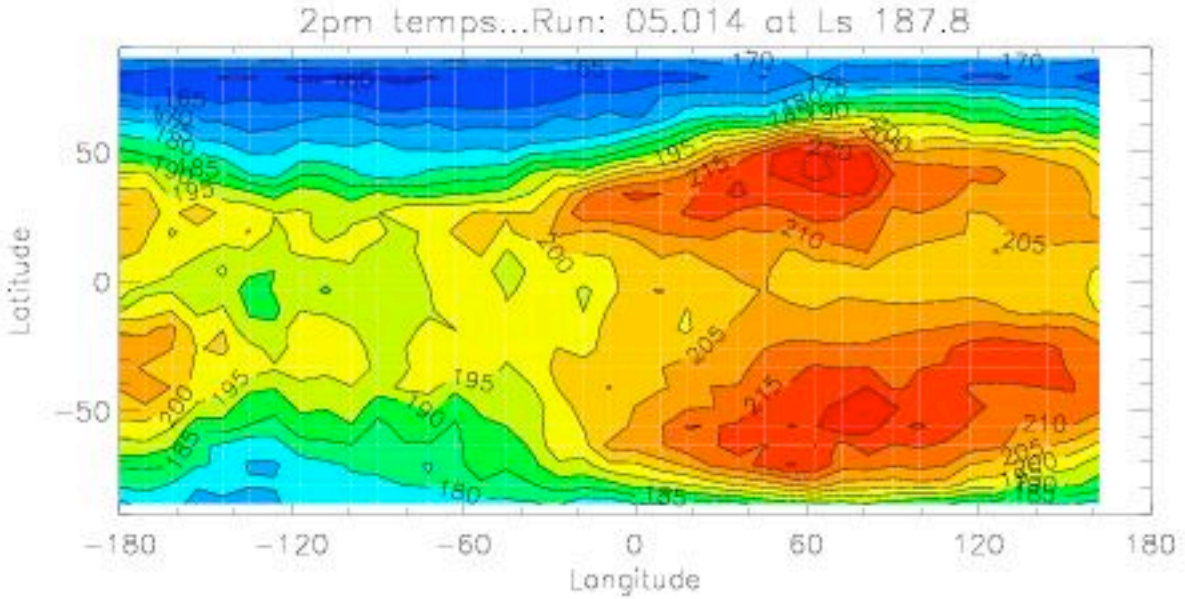
Is there a dynamical connection between Hellas and Claritas?

Working Hypothesis

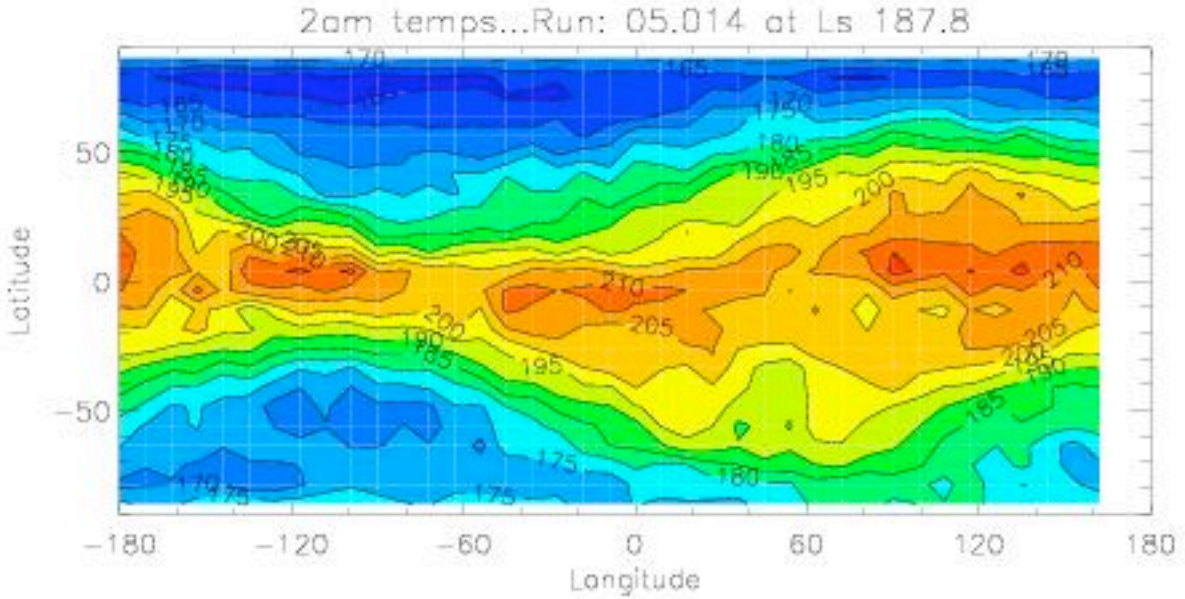
- Precursor pulses associated with traveling baroclinic eddies in combination with…..
- Amplification of apparent wave 1 is due to quasi stationary wave 1 response to enhanced dust heating in Hellas
- Claritas lifting (and possibly others) triggered by Rossby Wave Trains emanating from Hellas

==> This is a novel concept for Mars GDS <==

GCM Predicts Similar 0.5 mb Patterns

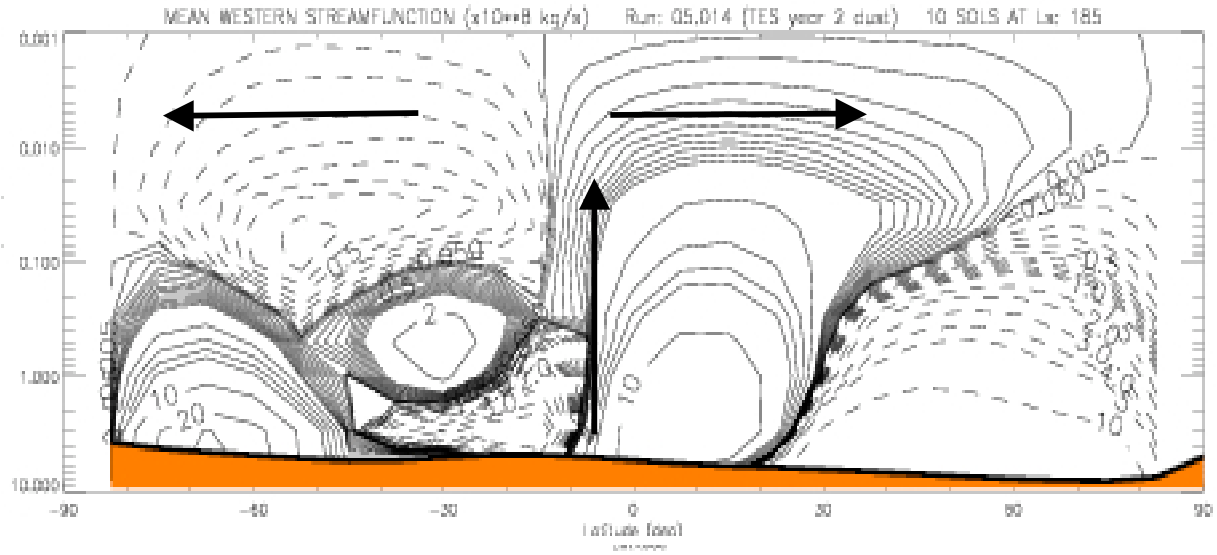


2PM Temperatures

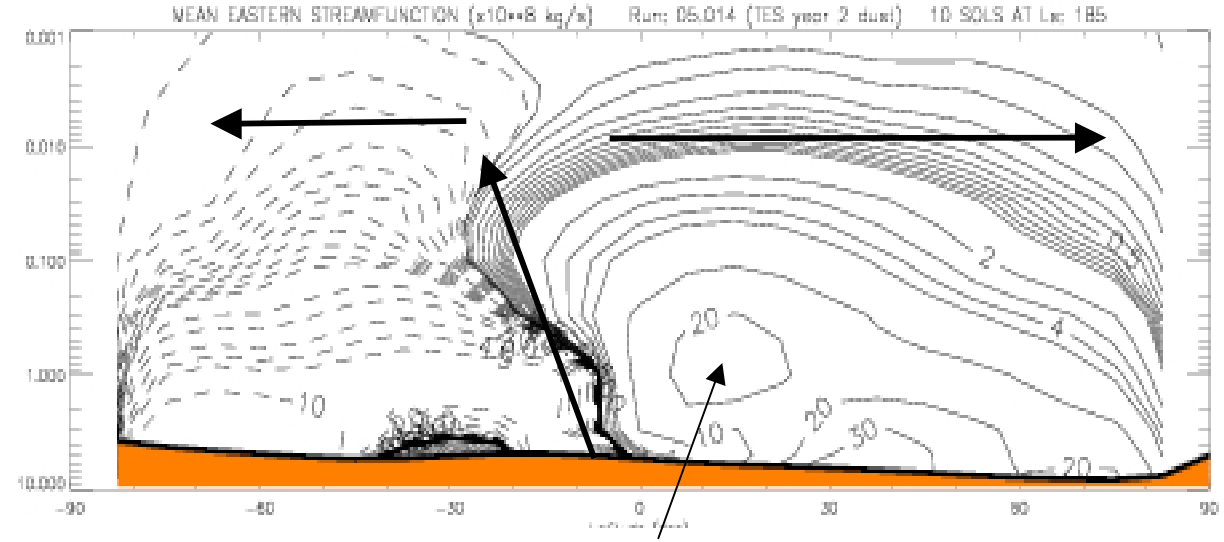


2AM Temperatures

Longitudinally Asymmetric Hadley Cell



Western Hemisphere

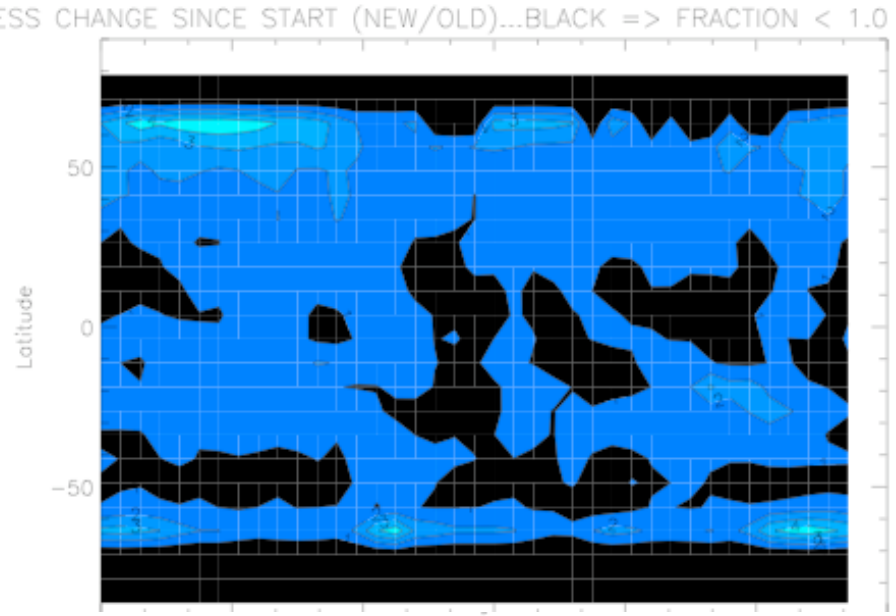


Eastern Hemisphere

Stronger and Broader HC

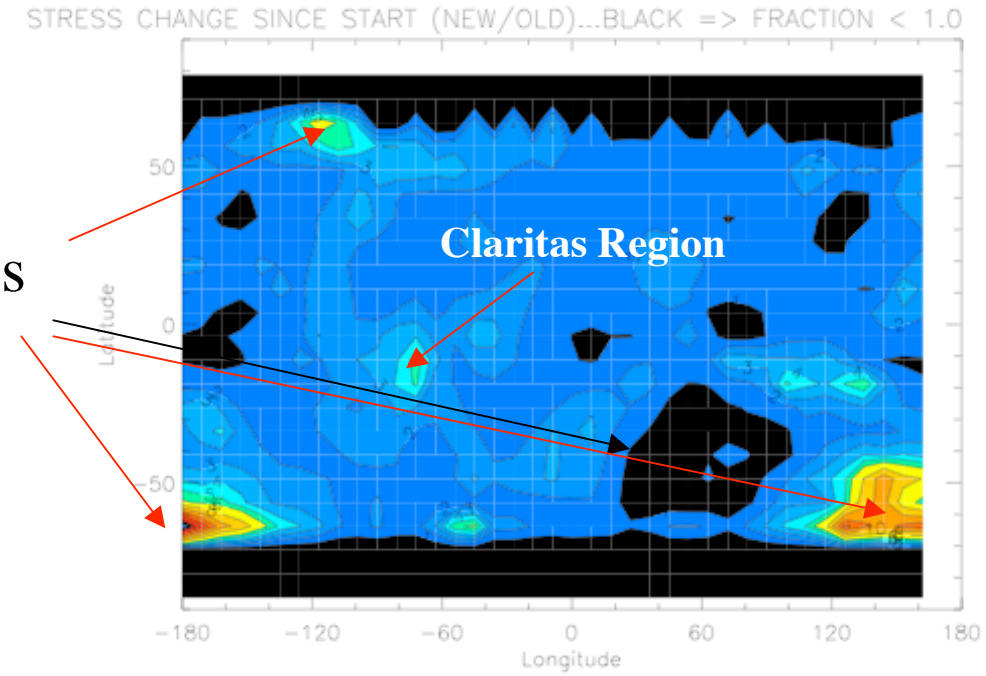
Change In Surface Stress Patterns from Ls=180° to 198°

Very Little Change



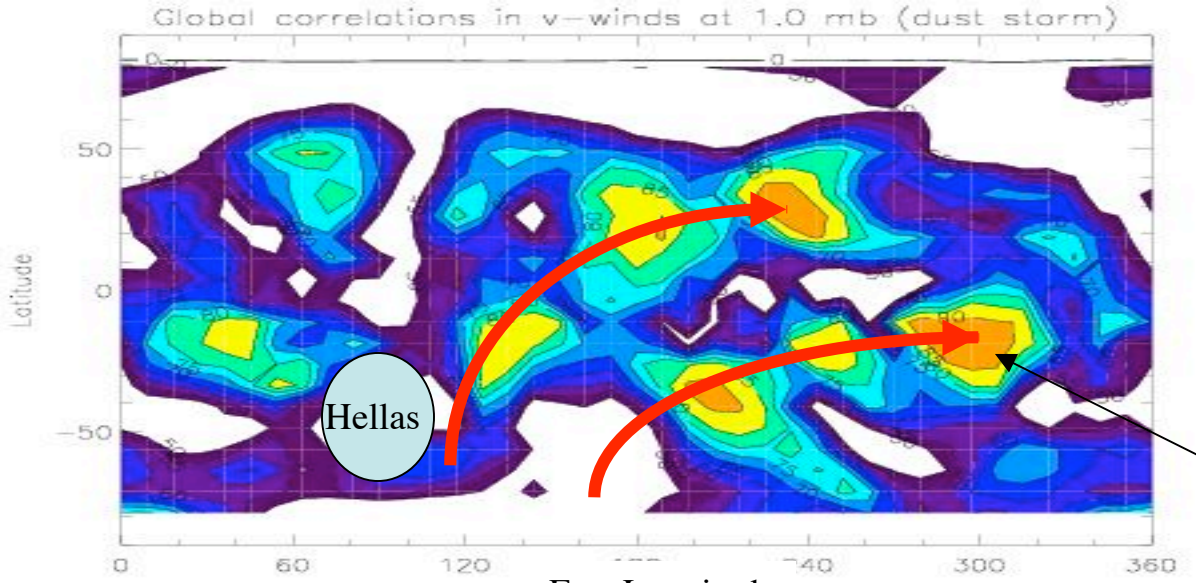
Yr 1

Significant Changes



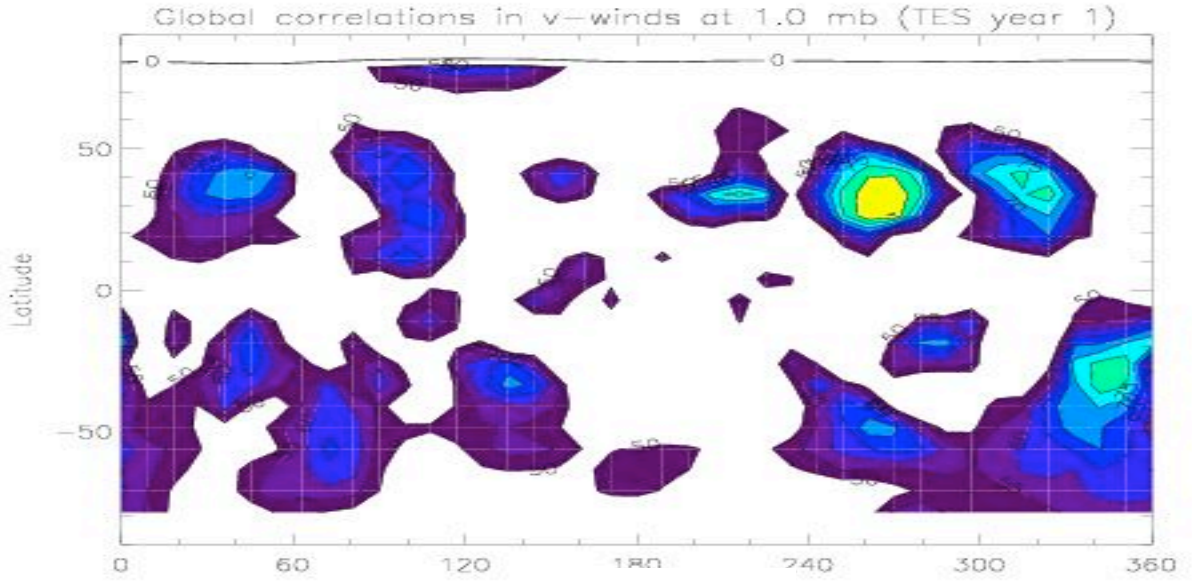
Yr 2

Global Correlations of V - Rossby Wave Trains?



GDS: TES Yr 2

Highest correlation in Claritas Region!



No GDS: TES Yr 1

Summary

- **Many components of the GC appear to play a role**
  - Traveling baroclinic eddies
  - Quasi stationary waves
  - Hadley circulation
  - Thermal Tides
- **Understanding cause of the lifting in Claritas is the key**
  - Rossby wave trains (action at a distance) are a novel idea for Mars dust storm theories
  - GCM results are very suggestive
  - But connection between them and surface stress needs to be understood