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

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Datasets

- TES dust opacity → Michael Smith
- FFSM temperatures → Jeffrey Barnes
  - Fast Fourier Synoptic Mapping
- MOC DGMs MY 24-26 → Michael Malin & Bruce Cantor (MSSS)
- MOC DGMs MY 26 → Helen Wang (Ashima Research)
- GCM-derived opacity → John Wilson (NOAA GFDL)

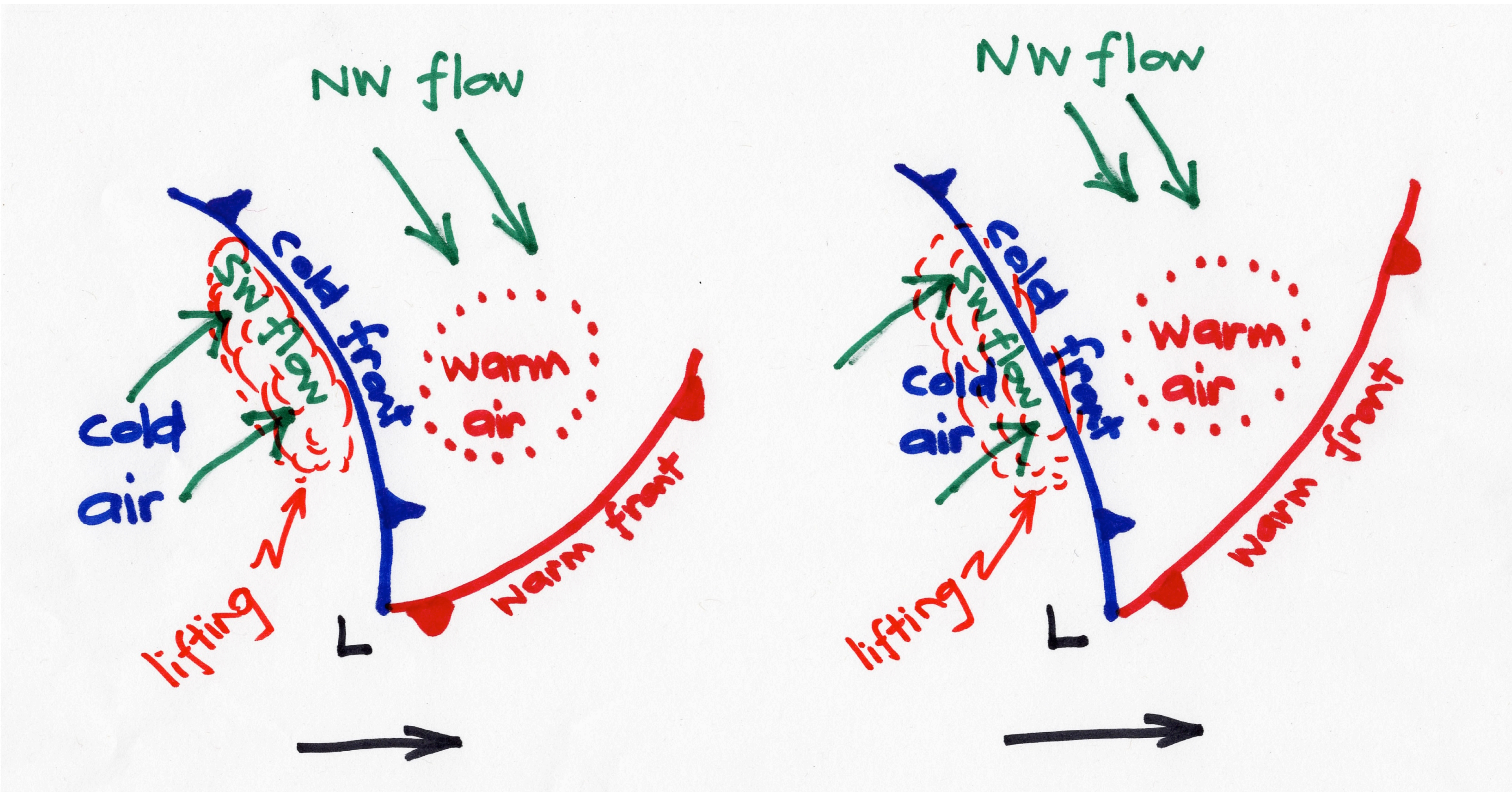
Objectives

Better understand and characterize the dynamical processes responsible for MY 25 global dust storm (GDS) initiation & expansion, specifically examining the following questions:

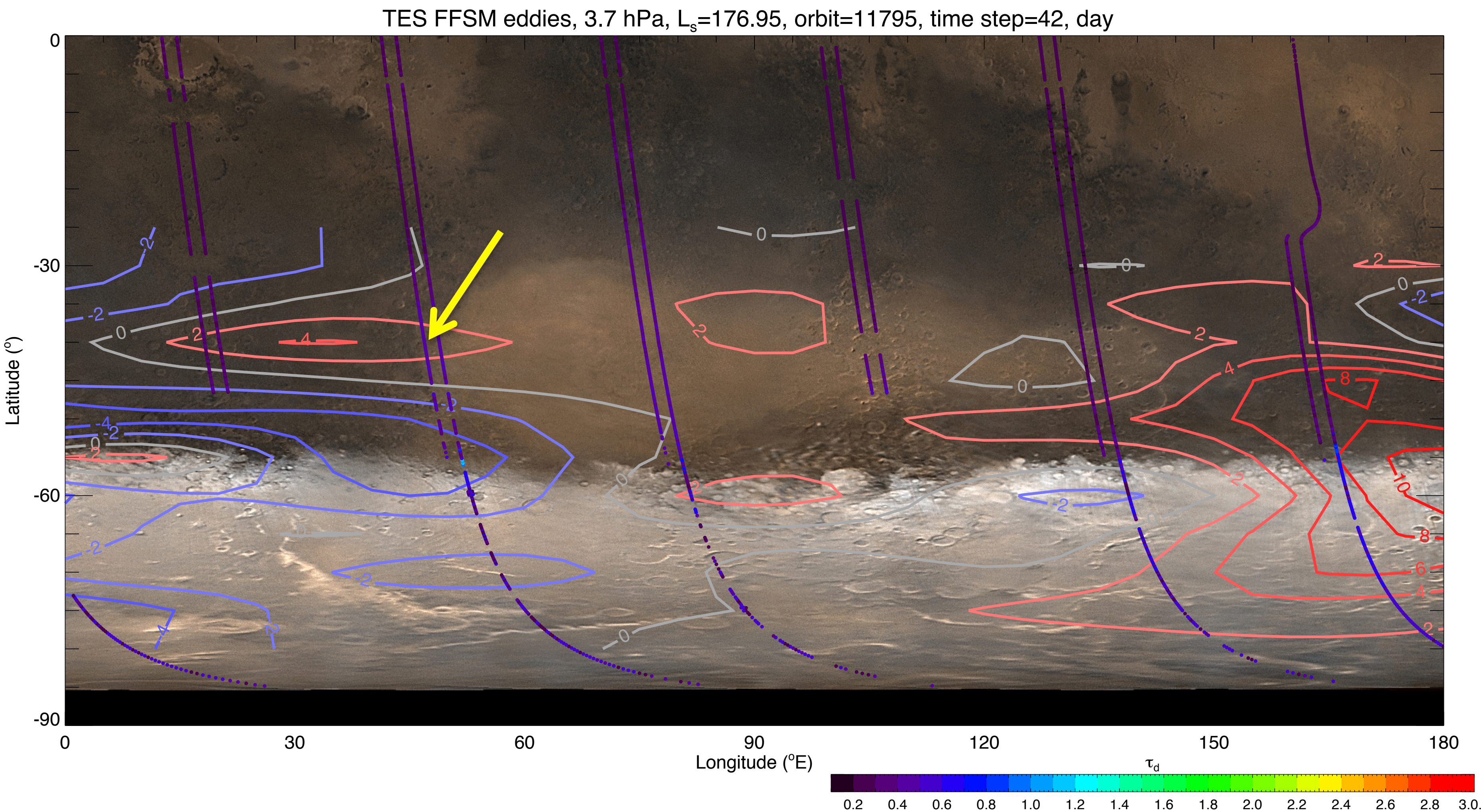
1. Which circulation components were involved in storm onset and evolution?
2. How did the temperature and dust opacity fields evolve together?
3. Do MGS data show interannual variability that suggests why a GDS formed in MY 25 and not in MY 24 or 26?

Southern hemisphere cold fronts and winds

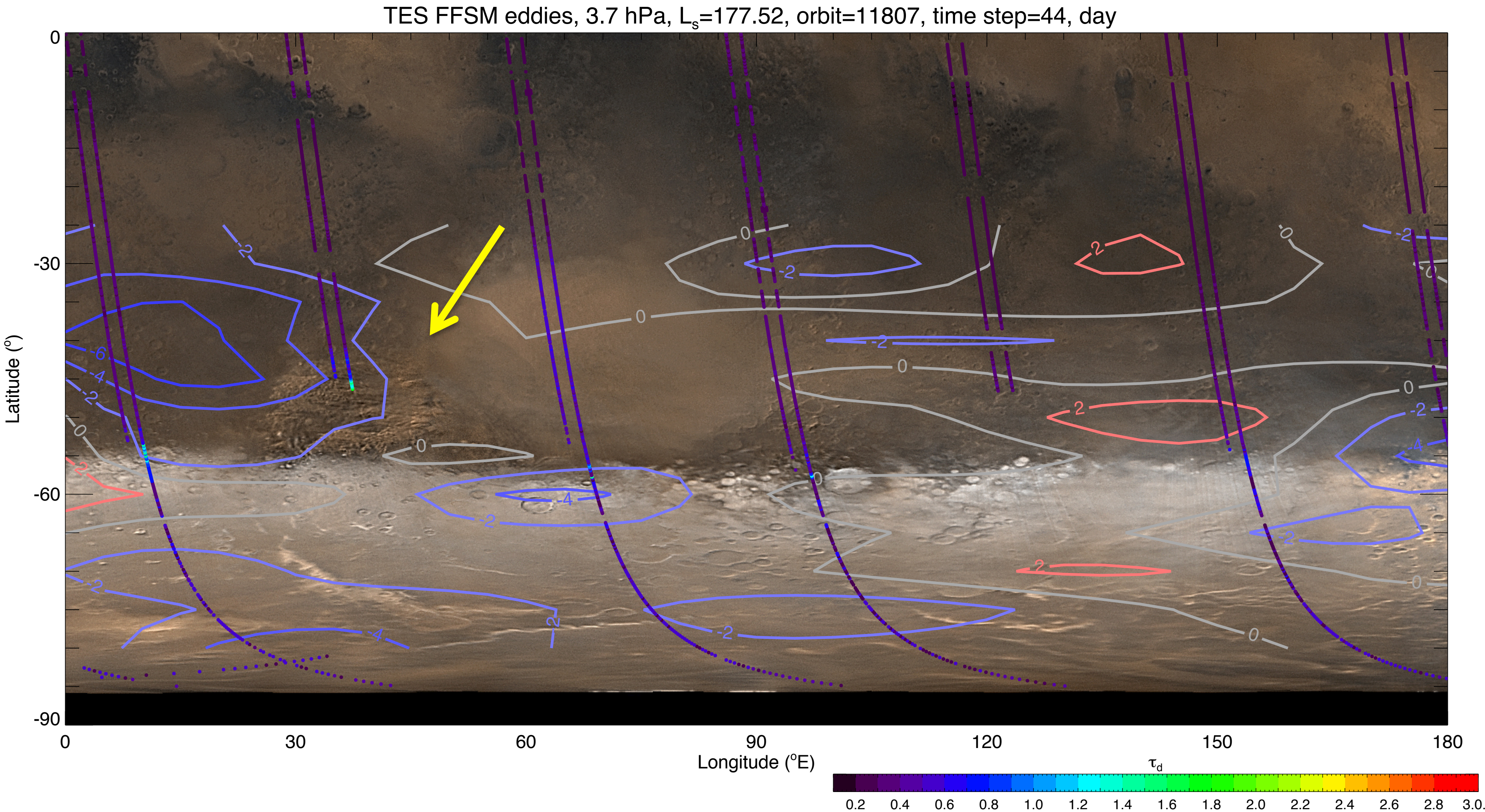
Southwesterly west of cold front flow causes dust lifting



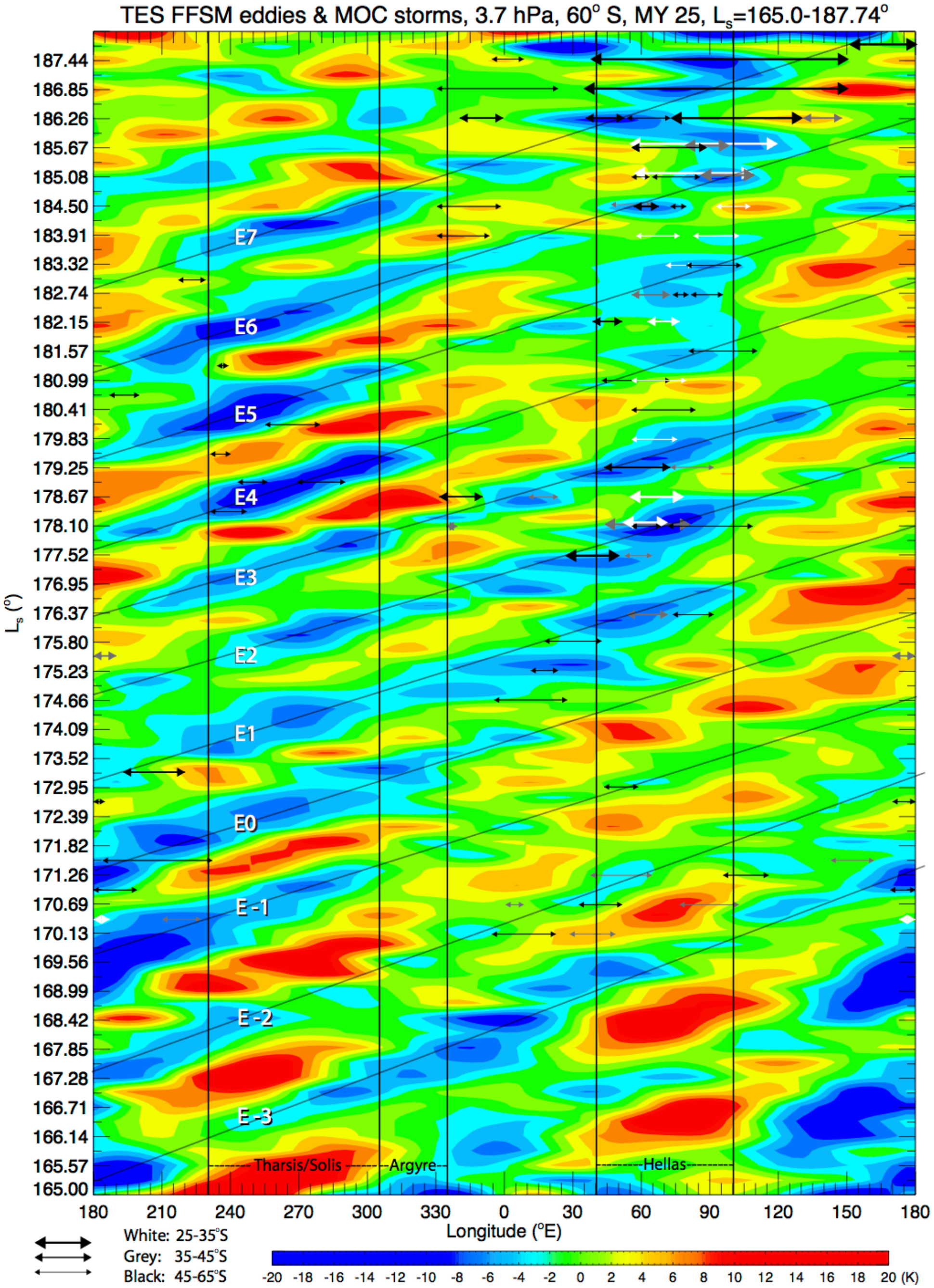
TES FFSM eddies, 3.7 mb, MY 25, L_s=176.95°



TES FFSM eddies, 3.7 mb, MY 25, L_s=177.52°



TES FFSM eddies and MOC-observed storms, 3.7 mb, 60° S, MY 25



- Concurrent eastward propagation of storms & eddies

- Northward evolution of storms as eddies pass though Hellas on 2nd & 3rd sols

We hypothesize that:

- Six eastward-traveling baroclinic eddies triggered the precursor storms due to the enhanced dust lifting associated with their low-level wind and stress fields.

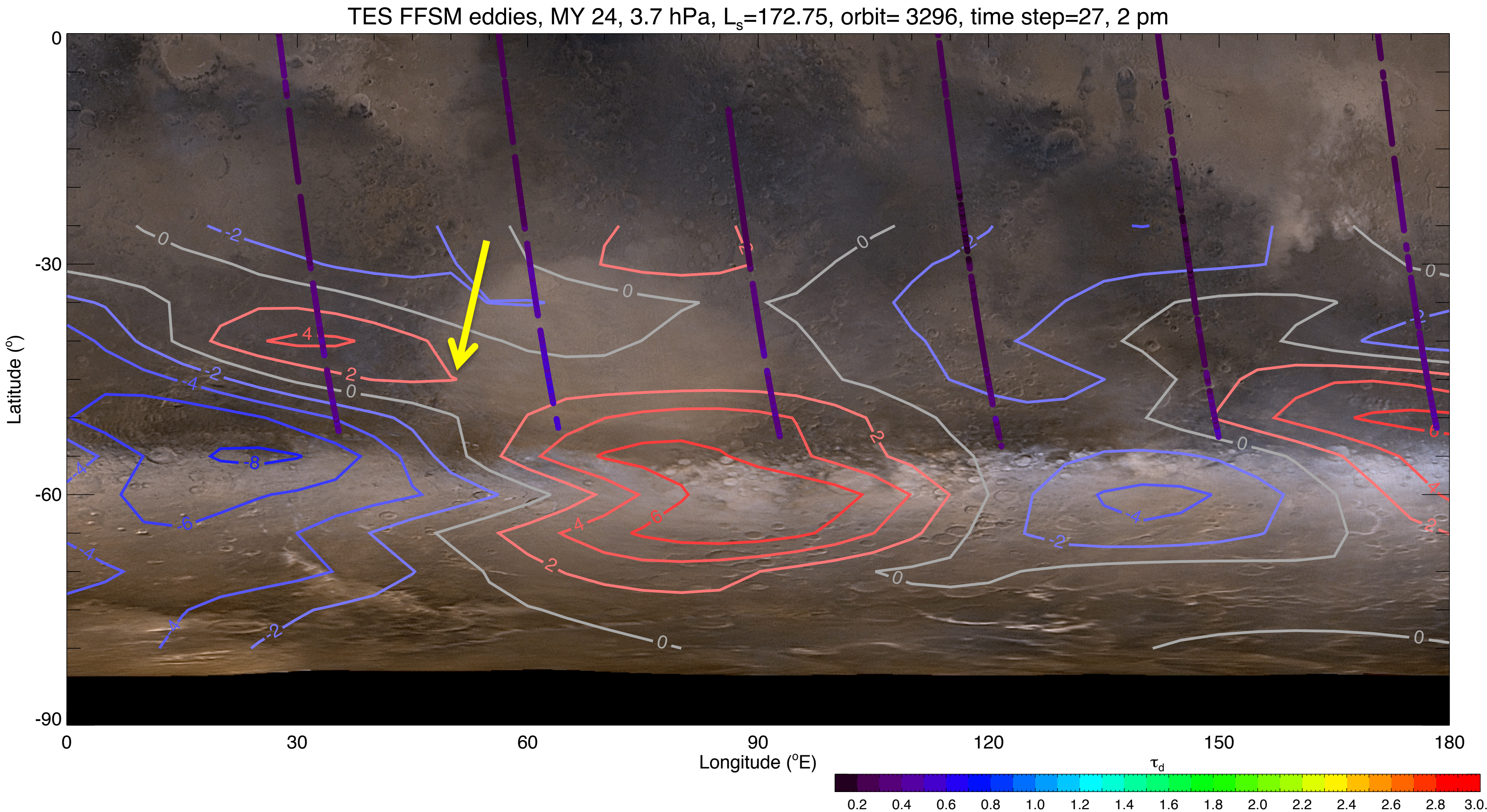
- Increased opacity and temperatures from dust lifting associated with E1–E3 enhanced thermal tides which supported further storm initiation and expansion out of Hellas.

- E7 contributed to expansion on L_s=186.3°.

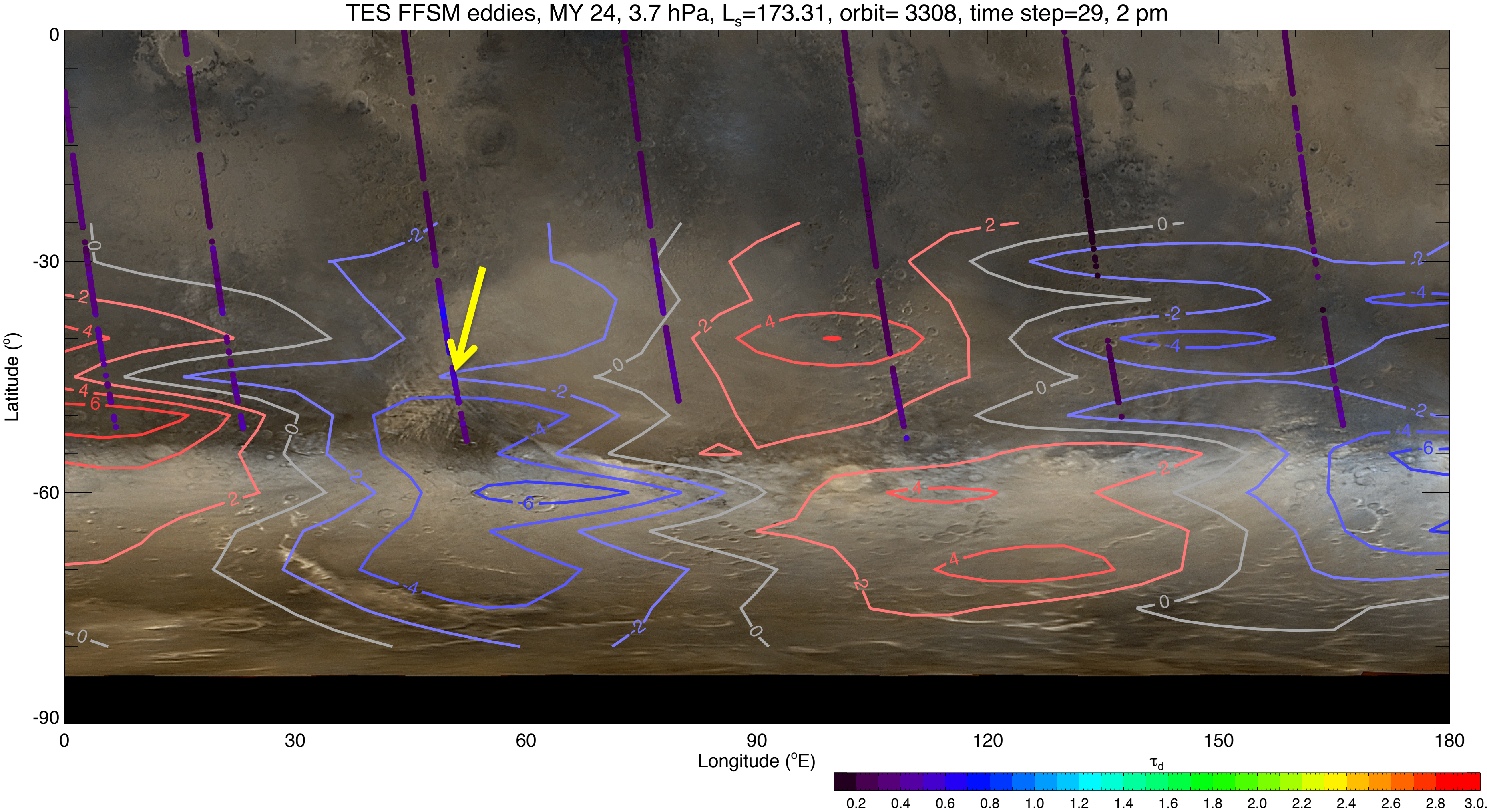
Arrow colors = storm latitude

White	**25–35° S**
Grey	**35–45° S**
Black	**45–75° S**

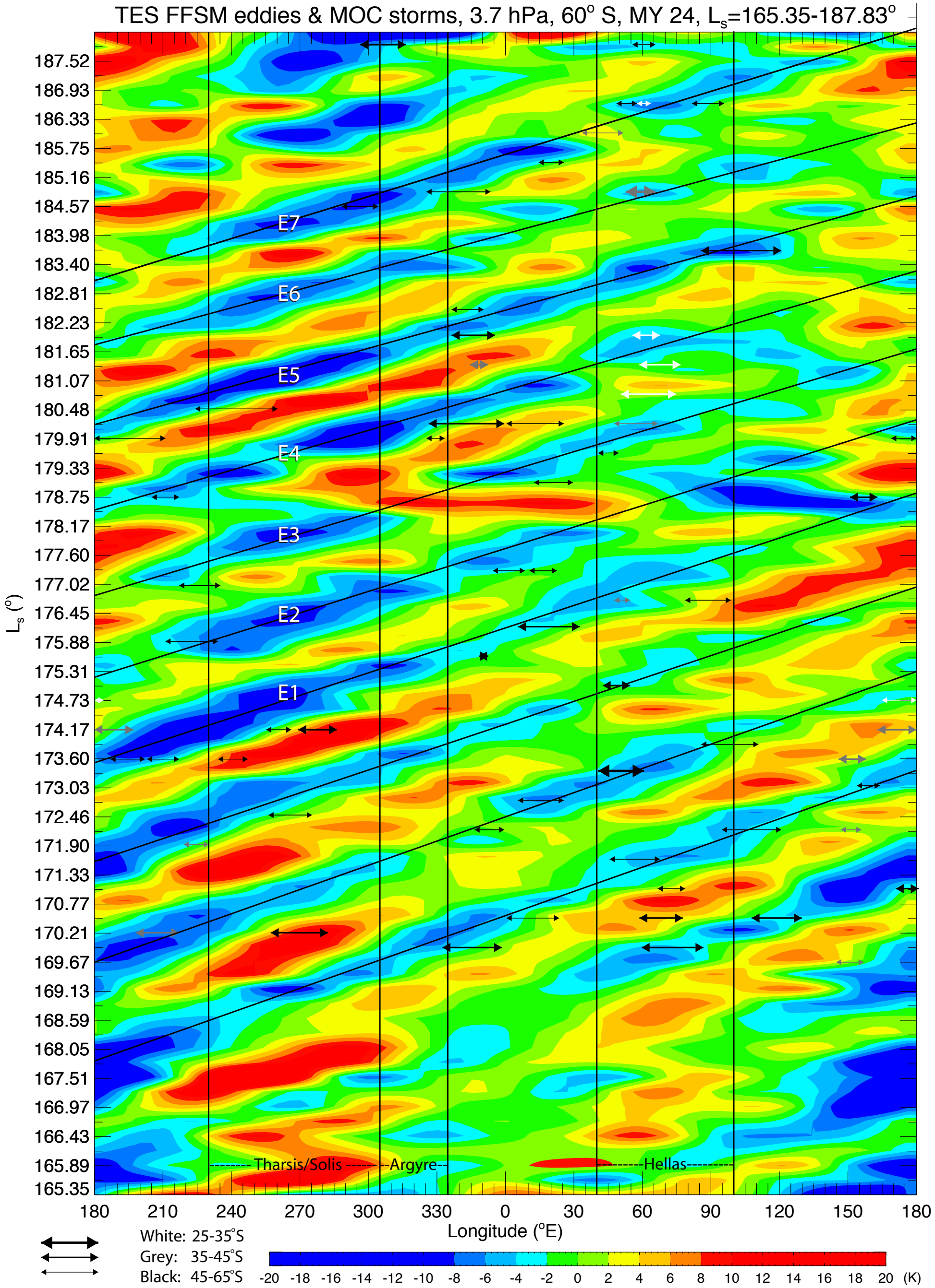
TES FFSM eddies, 3.7 mb, MY 24, L_s=172.75°



TES FFSM eddies, 3.7 mb, MY 24, L_s=173.31°



TES FFSM eddies and MOC-observed storms, 3.7 mb, 60° S, MY 24



Concurrent eastward propagation of storms & eddies

Northward evolution of storms as eddies pass though Hellas on 2nd & 3rd sols

However:

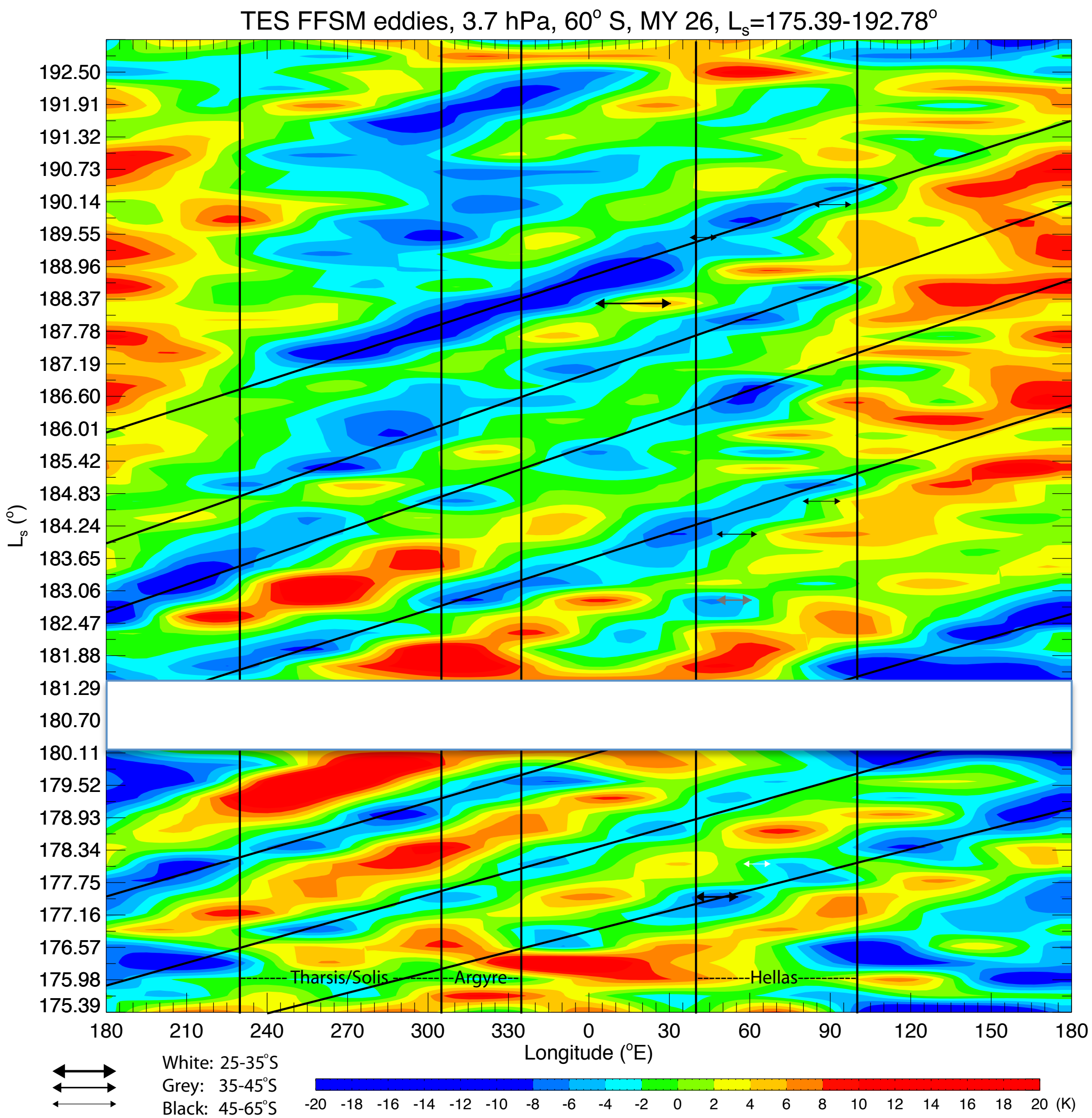
Major cap-edge storms south of Hellas occur less frequently in MY 24 compared to MY 25

- L_s=169.9° large cap-edge storms occurred east of Argyre at 345° E and within Hellas at 80° E.
- L_s=173.3° a large storm emerged west of Hellas, followed by a smaller one in SW Hellas three sols later at L_s=175.1°.

Arrow colors = storm latitude

White	**25–35° S**
Grey	**35–45° S**
Black	**45–75° S**

TES FFSM eddies and MOC-observed storms, 3.7 mb, 60° S, MY 26



Concurrent eastward propagation of storms & eddies

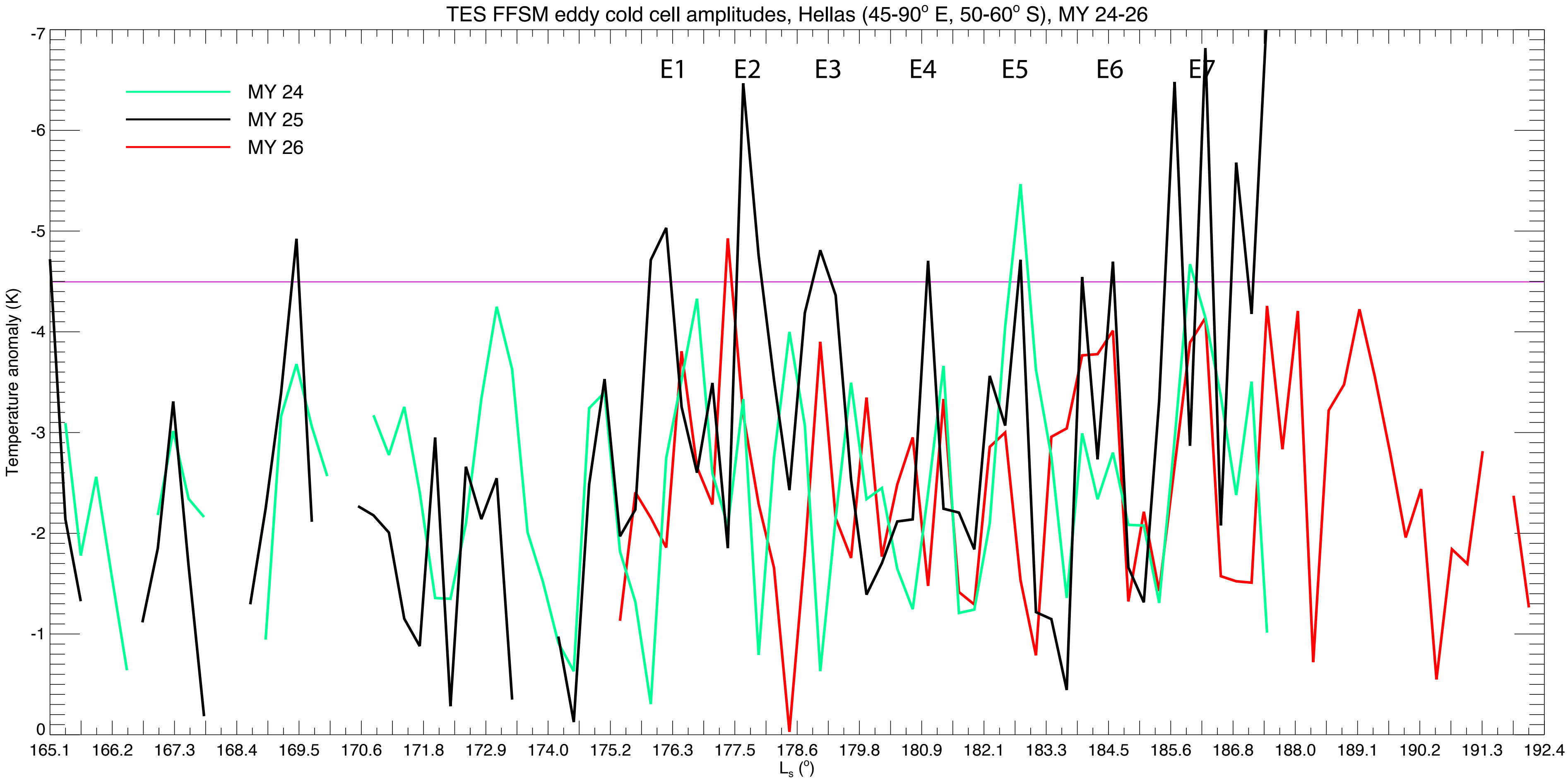
Northward evolution of storms as eddies pass though Hellas on 2nd & 3rd sols

TES FFSM 3.7 mb cold anomaly amplitudes *vs*. time, Hellas (45–90° E, 50–60° S), MY 24–26

MY 24: 2 eddies colder than –4.5 K

MY 25: 7 eddies colder than –4.5 K

MY 26: 1 eddy colder than –4.5 K



Conclusions

Temporal and spatial association of eddies and dust storms observed in all three Mars years

We hypothesize that:

- Six eastward-traveling baroclinic eddies triggered the precursor storms due to the enhanced dust lifting associated with their low-level wind and stress fields.

- The sustained series of high-amplitude eddies in MY 25 was a factor in GDS occurence that year.

- Constructive interference of MY 25 eddies and other circulation components may have led to the initiation and expansion of precursor storms:
  - CO_2 sublimation flow
  - anabatic winds (upslope)
  - diurnal tides
  - dust-induced thermal tides

Non-dynamical factors in GDS interannual variability include dust sources and sinks