



# A multi-spacecraft reanalysis of the atmosphere of Mars

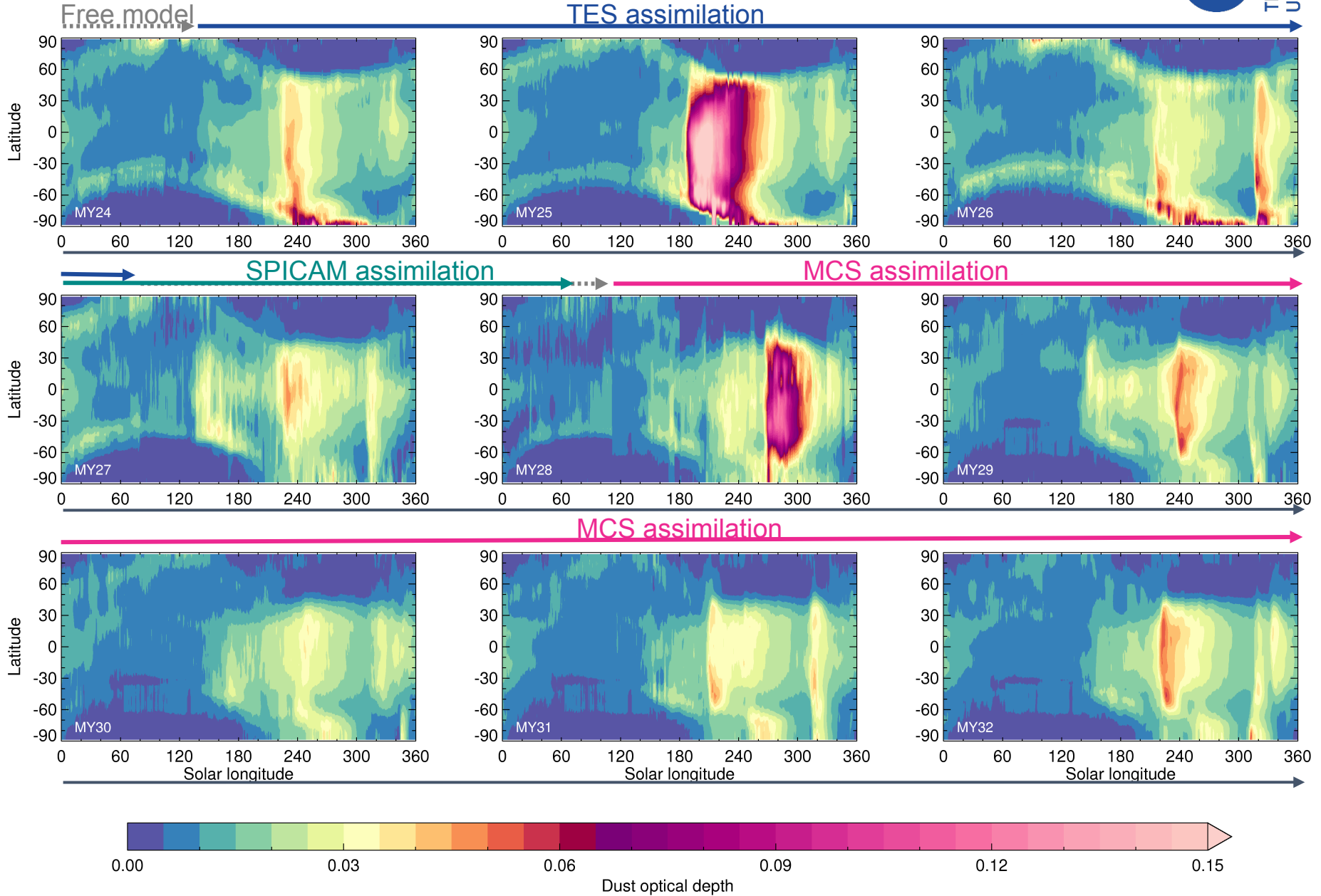
*S. R. Lewis, J. A. Holmes and M. R. Patel, The Open University*



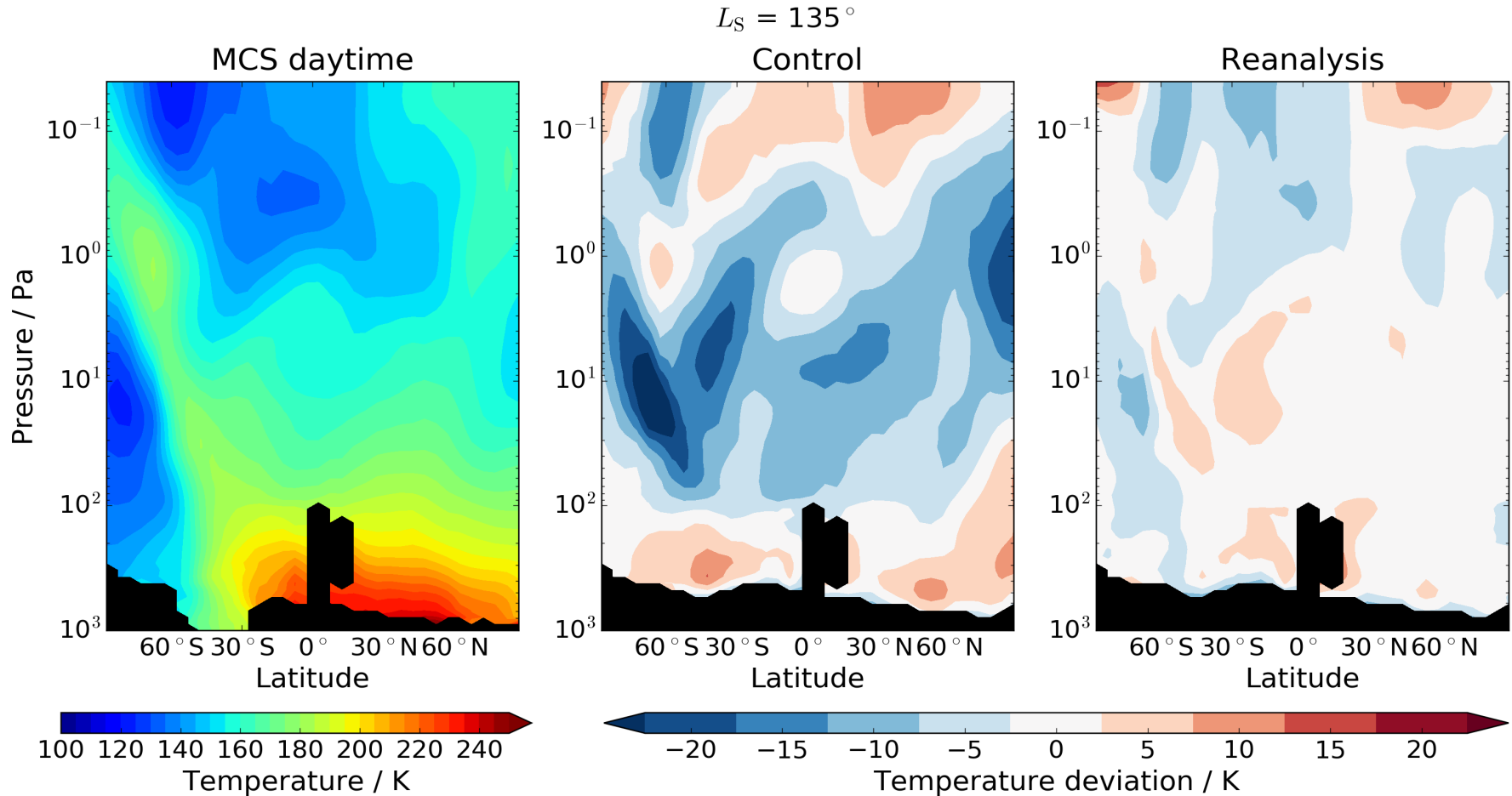
The Open  
University

## A multi-spacecraft reanalysis of the atmosphere of Mars

- MGS, MEx, and MRO data, covering over ~8 MY, have been assimilated in a continuous 9 MY integration with the latest UK version of the LMD Mars Global Climate Model
- Includes water cycle and improved dust representation
- Includes ozone photochemistry
- Thermal profiles and total dust opacity (TES) or dust profiles (MCS) are assimilated on 10 km (TES) or 5 km (MCS) vertical scales
- Water vapour is assimilated by matching total column abundance with MGCM prediction
- Ozone is assimilated by matching total column abundance with MGCM prediction
- Baseline assimilations at T31 resolution (roughly  $3.75^\circ$  or  $< 225$  km horizontal grid) with 35 vertical levels
- Focused studies at higher horizontal and vertical resolution (100 levels)

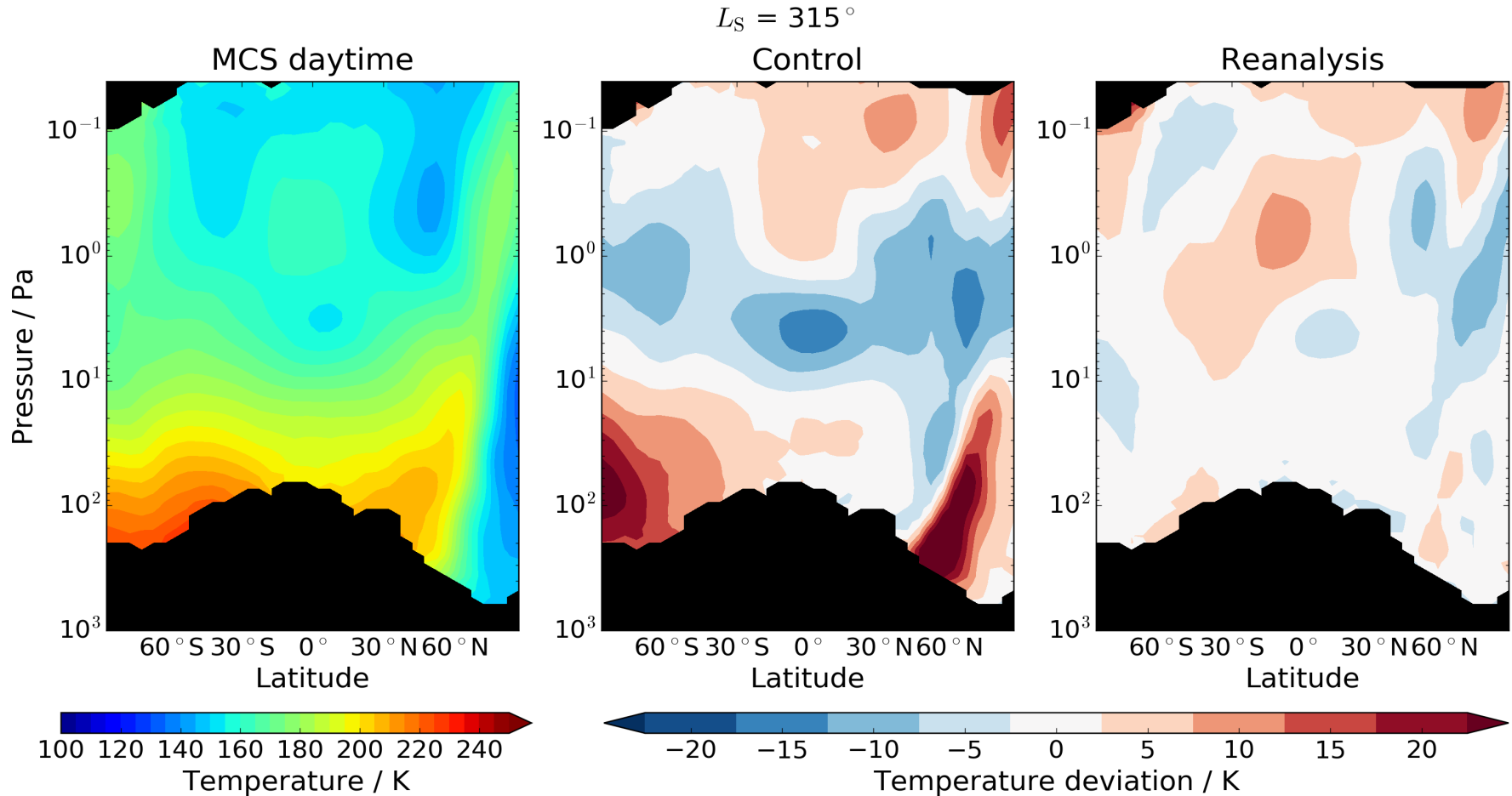


# Validation of the 9-year reanalysis



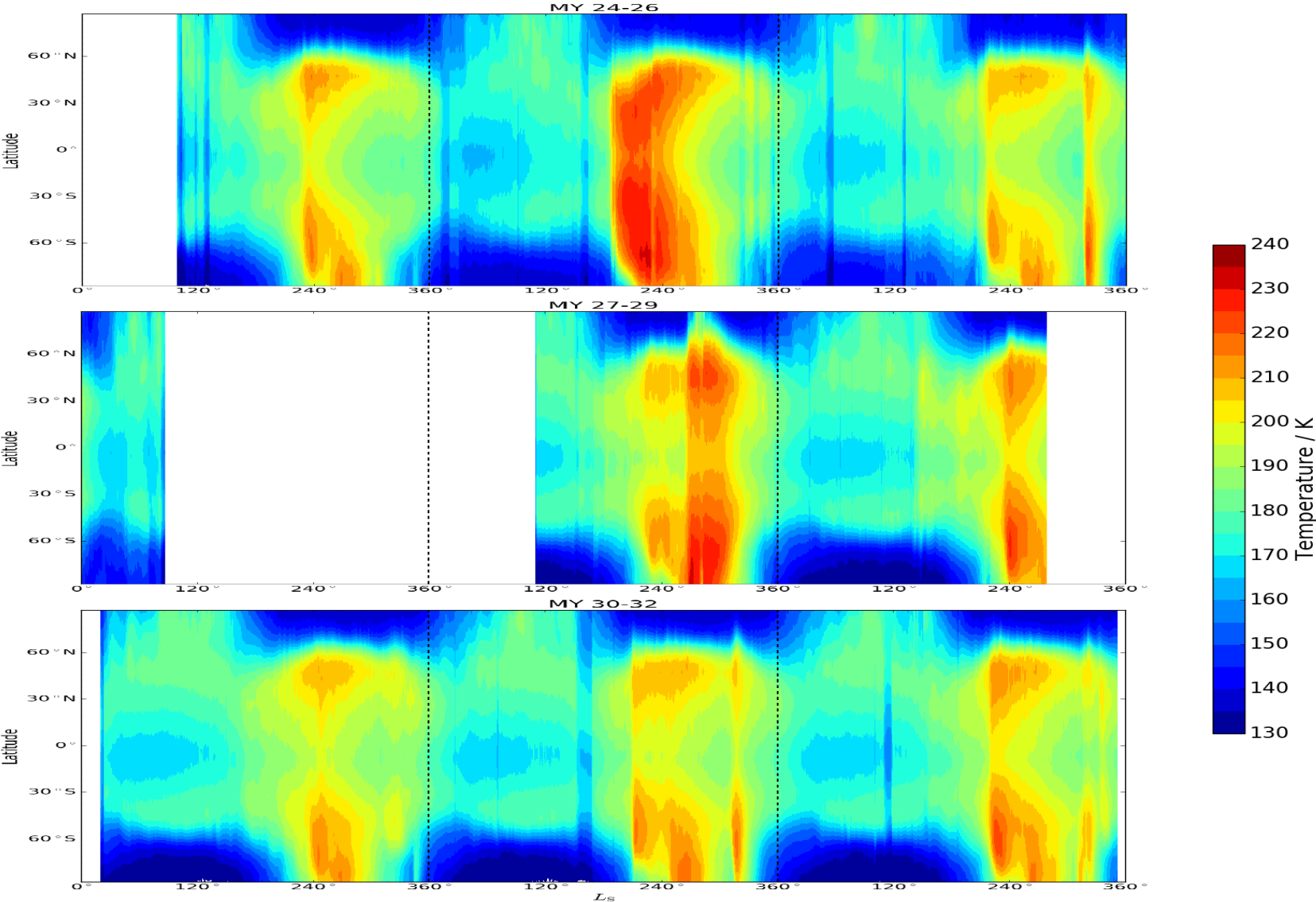
(Left) MCS daytime retrievals, (middle) temperature deviations in the free-running GCM and (right) temperature deviations in the new reanalysis averaged over  $L_S = 120-150^\circ$

# Validation of the 9-year reanalysis

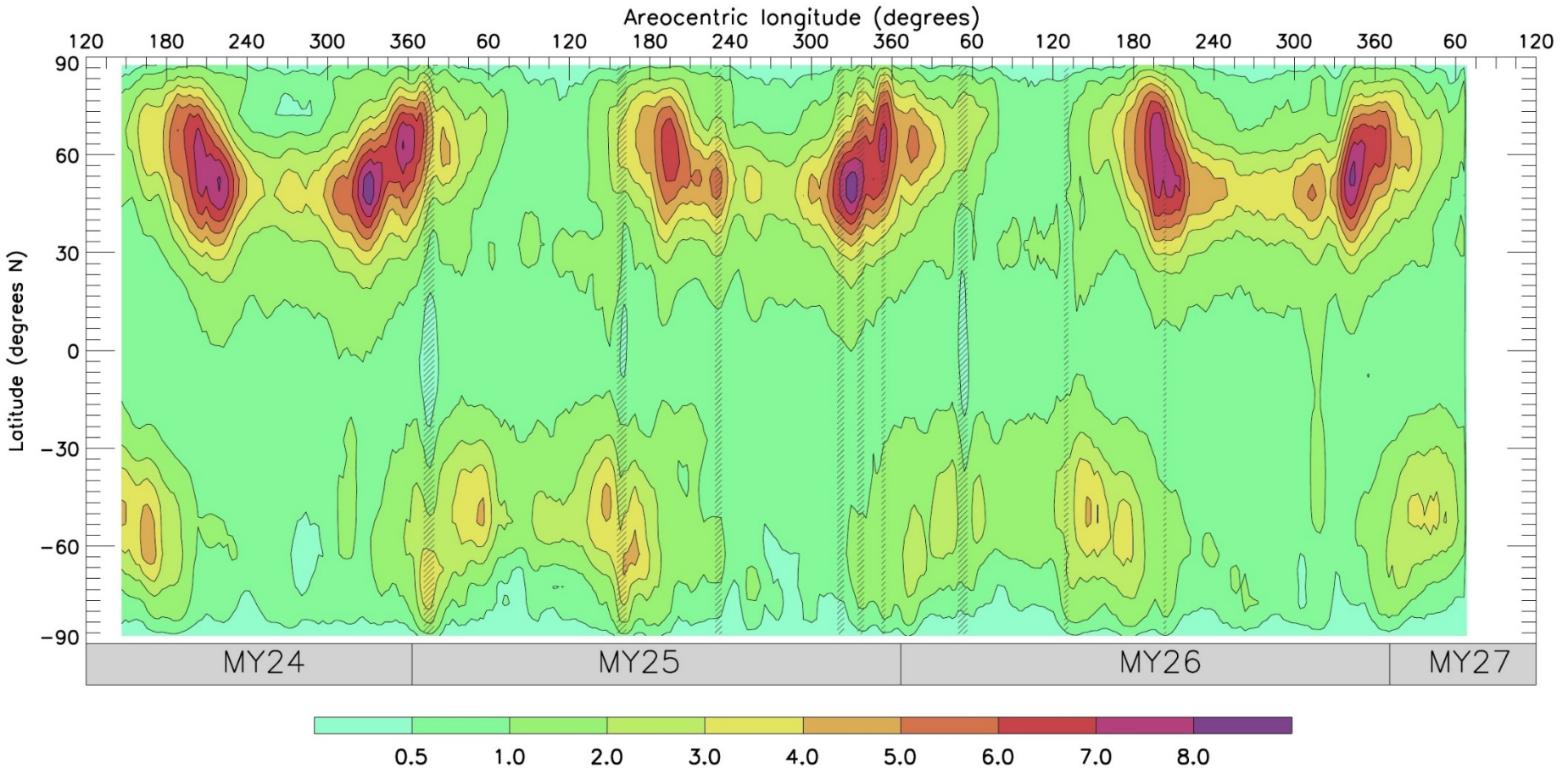


(Left) MCS daytime retrievals, (middle) temperature deviations in the free-running GCM and (right) temperature deviations in the new reanalysis averaged over  $L_S = 300-330^\circ$

Sample output of atmospheric temperature at 3 pm and 60 Pa altitude

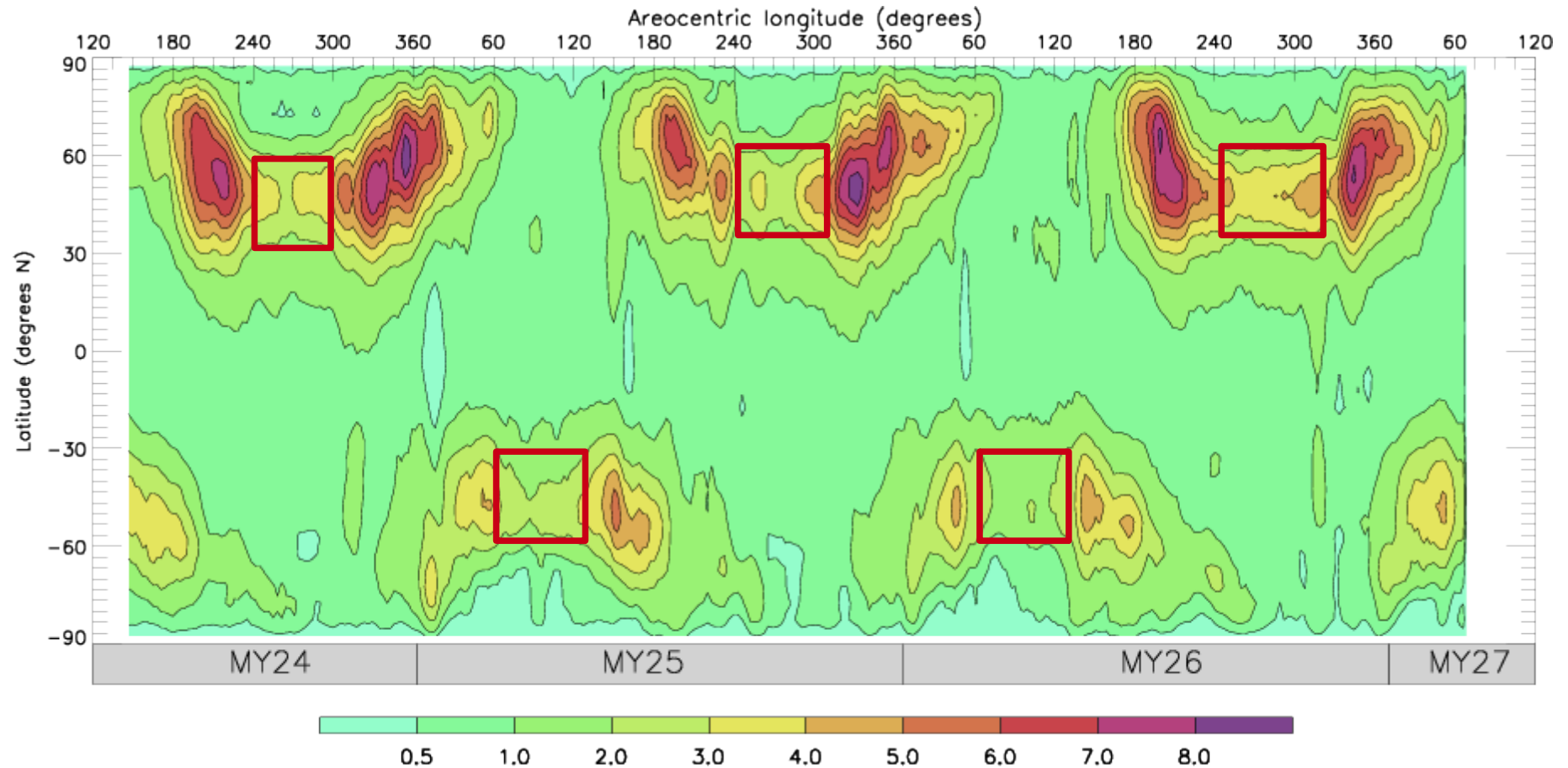


Lewis et al. (2016), *Icarus* 264, 456–464.



RMS temperature variability at 2.5 km altitude from the TES-period assimilation, band-pass filtered to periods of 1.5–30 sols and with a 20-sol running mean applied. Hatching indicates no TES data. (Lewis et al. 2016, <http://dx.doi.org/10.1016/j.icarus.2015.08.039>)

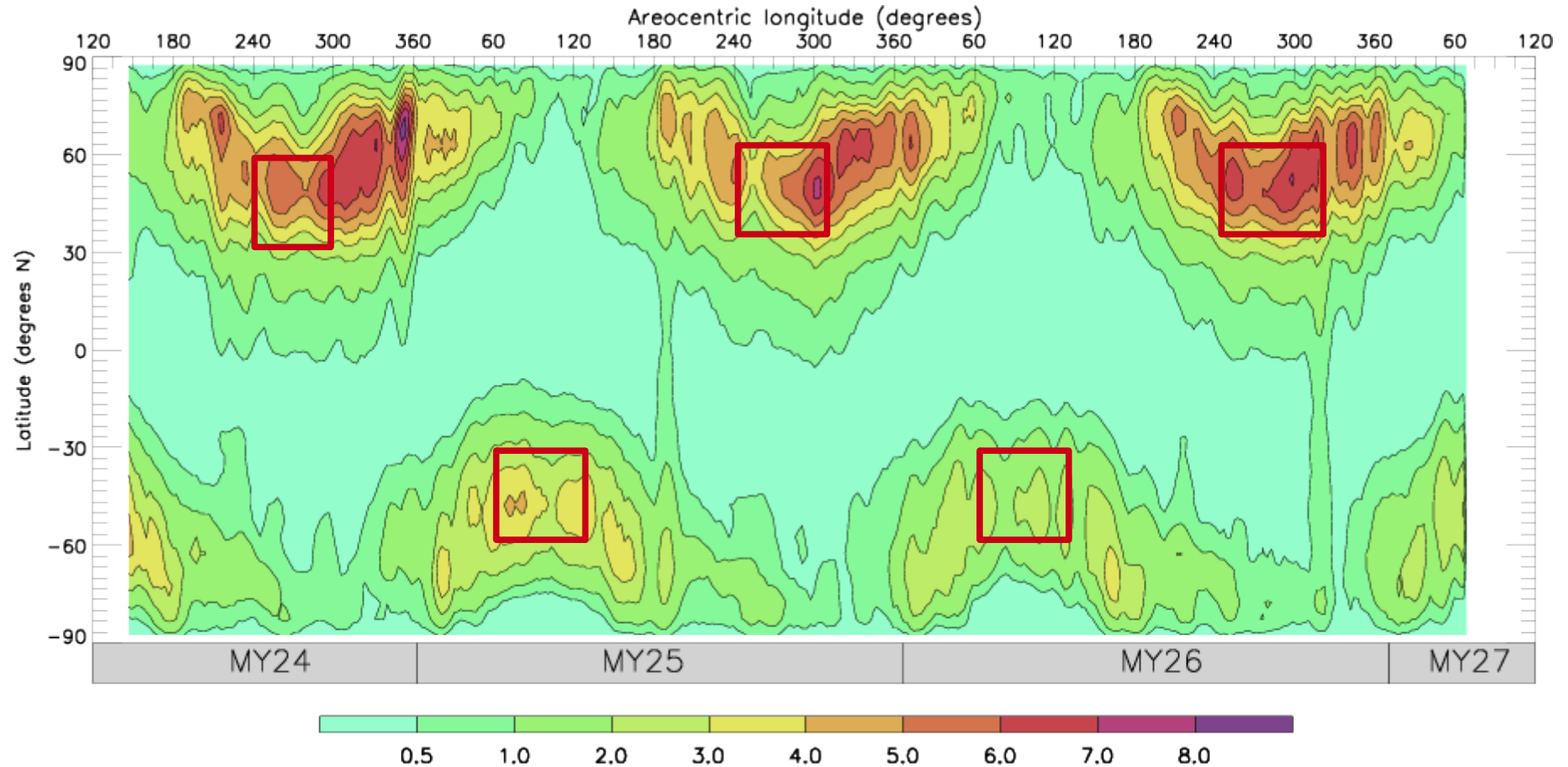
Same time period (TES) but from **new reanalysis** using updated GCM



RMS temperature variability at 2.5 km altitude from the TES-period assimilation, band-pass filtered to periods of 1.5–30 sols and with a 20-sol running mean applied.

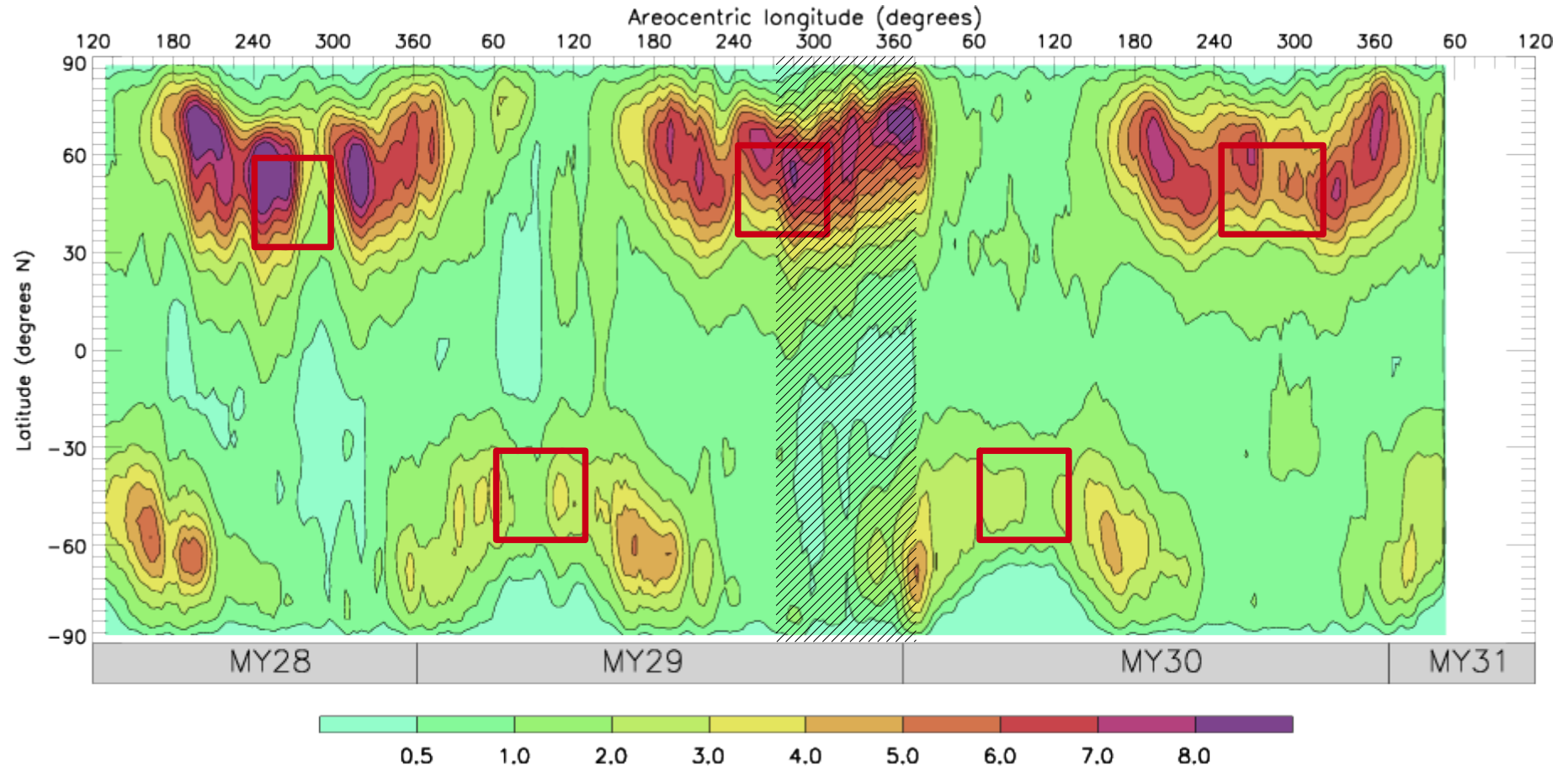


Same time period (TES) but **free-running** model using updated GCM



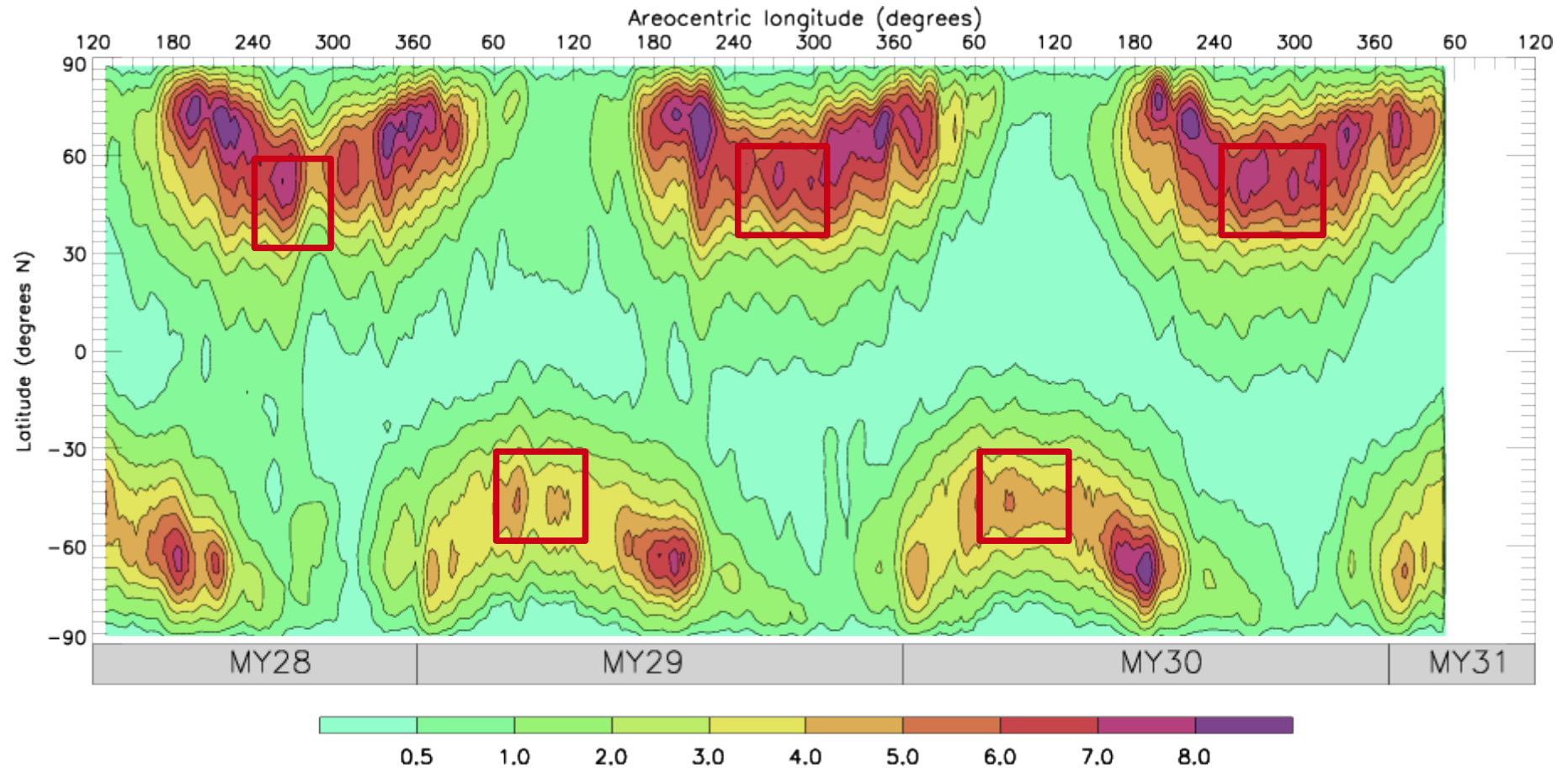
RMS temperature variability at 2.5 km altitude from the TES-period assimilation, band-pass filtered to periods of 1.5–30 sols and with a 20-sol running mean applied.

New time period (MCS) from **new reanalysis** using updated GCM



RMS temperature variability at 2.5 km altitude from the MCS-period assimilation, band-pass filtered to periods of 1.5–30 sols and with a 20-sol running mean applied.

New time period (MCS) but **free-running** model using updated GCM



RMS temperature variability at 2.5 km altitude from the MCS-period assimilation, band-pass filtered to periods of 1.5–30 sols and with a 20-sol running mean applied.

- MGS, MEx, and MRO data, covering over ~8 MY, have been assimilated in a continuous 9 MY integration with the latest UK version of the LMD Mars Global Climate Model
- Inter-annual variability in the solsticial pause investigation extended from TES period to now also include MCS period
- Preliminary results show enhanced wave activity during MY28 global dust storm, with brief solsticial pause present. General increase in wave activity during MCS time period
- Free-running GCM unable to adequately reproduce solsticial pause