Assessment of middle atmosphere representation in GCMs using satellite temperature data

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Introduction

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- Comparison approach
  - Models: MetUM, Coupled Middle Atmosphere Thermosphere (CMAT)
  - Satellites: EOSMLS, SABER
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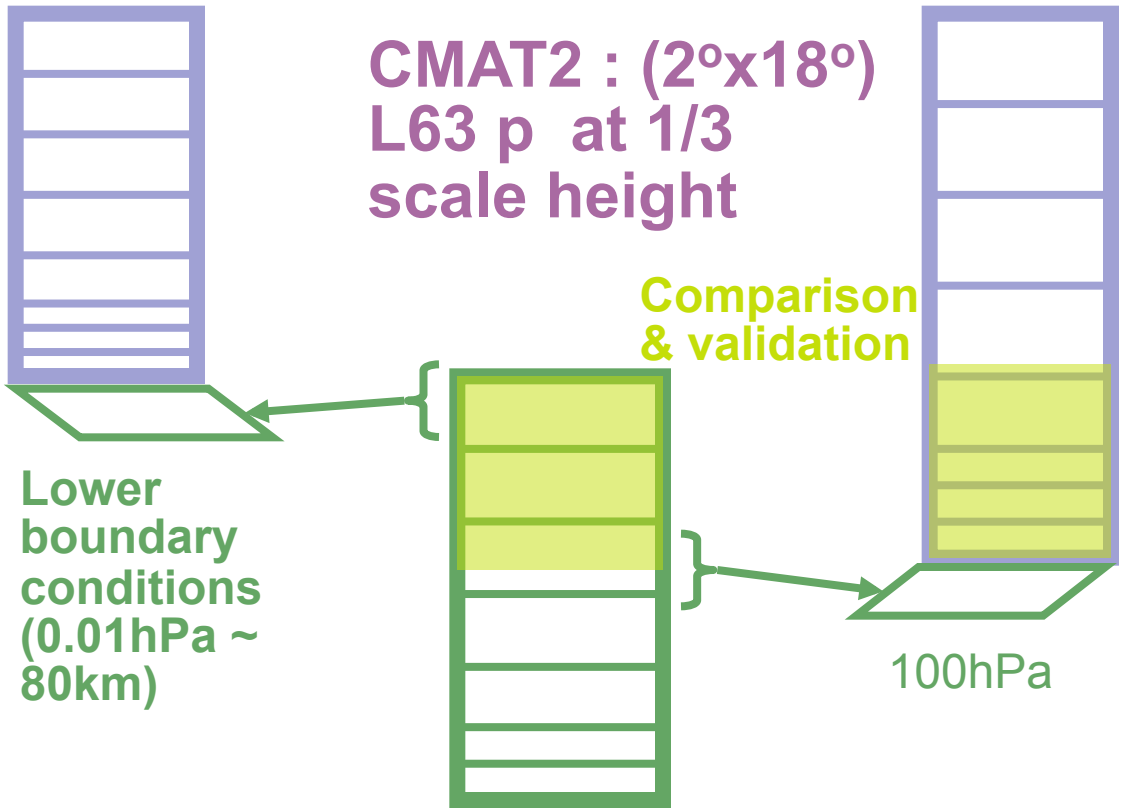
Rationale

- Interest in Middle Atmosphere
  - Operational MetUM now has 70 levels (80km top)
  - HadGEM3 opting for 85 levels (still 80km top)
  - Satellite Data Assimilation mesospheric T important
  - Posters: David Long, Sana Mahmood
- COST ES0803: Developing space weather products and services in Europe
  - Assessment of upper atmosphere physical models
  - Q: What can meteorology say about ‘fitness for purpose’?
  - Q: What DA assumptions need reassessment for space weather?
  - Q: What are key metrics to support strategic choice of model/DA?
- Constraining lower b.c. of Upper Atmosphere models
  - Collaboration with UCL to explore issues of coupling models
  - Q: Can meteorological analyses/GCM output benefit physical model simulations of thermosphere & ionosphere?

Models

Upper atmosphere GCMs (from UCL)



Meteorological GCM (surface to 85km)

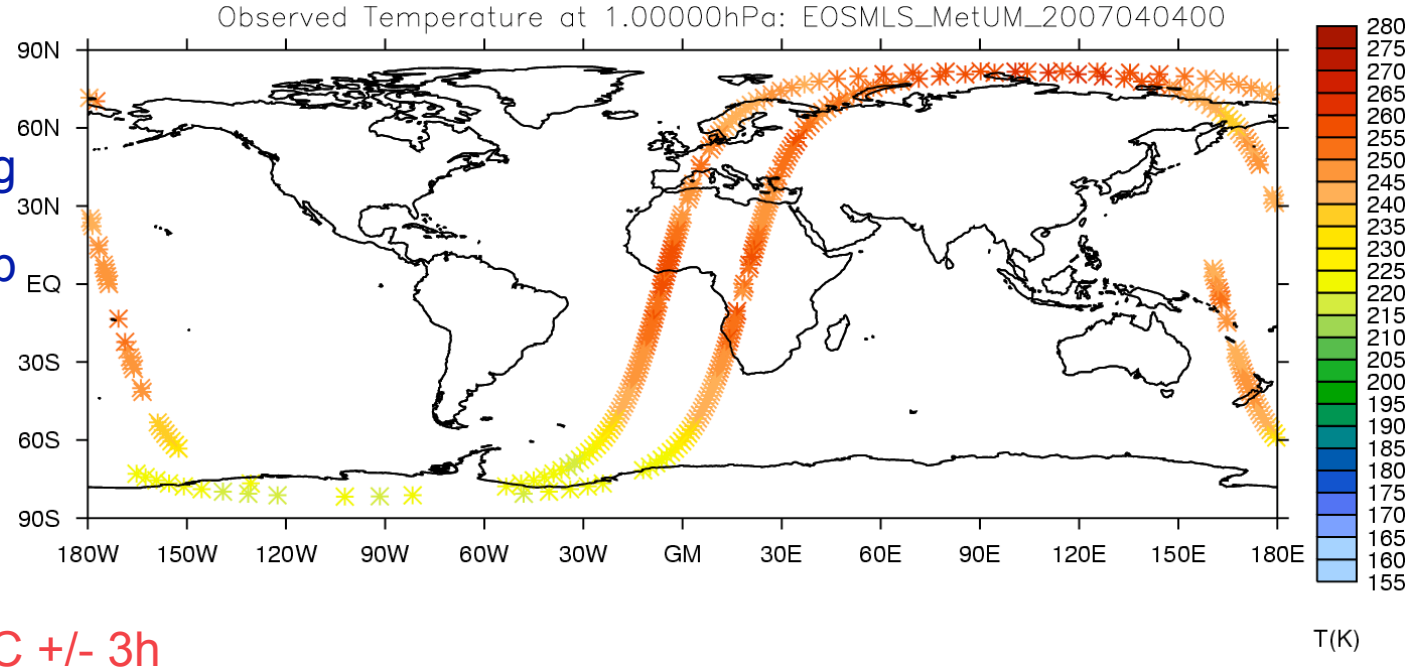
MetUM : N48 (2.5°x3.75°) L60

Analysis Procedure

1. Choose model time T (e.g. 1200UTC) then select satellite data in range T-3hr to T+3hr
2. Identify 4 nearest-neighbour model points to satellite data lat-long then create model profile from mean of 4 points at each model vertical level
3. Interpolate model vertical profile to satellite data vertical levels to generate model values at the observation location
4. Difference profiles to generate innovations [model – observation]
5. Aggregate profile data by binning (e.g. latitude-pressure) to generate monthly mean fields.

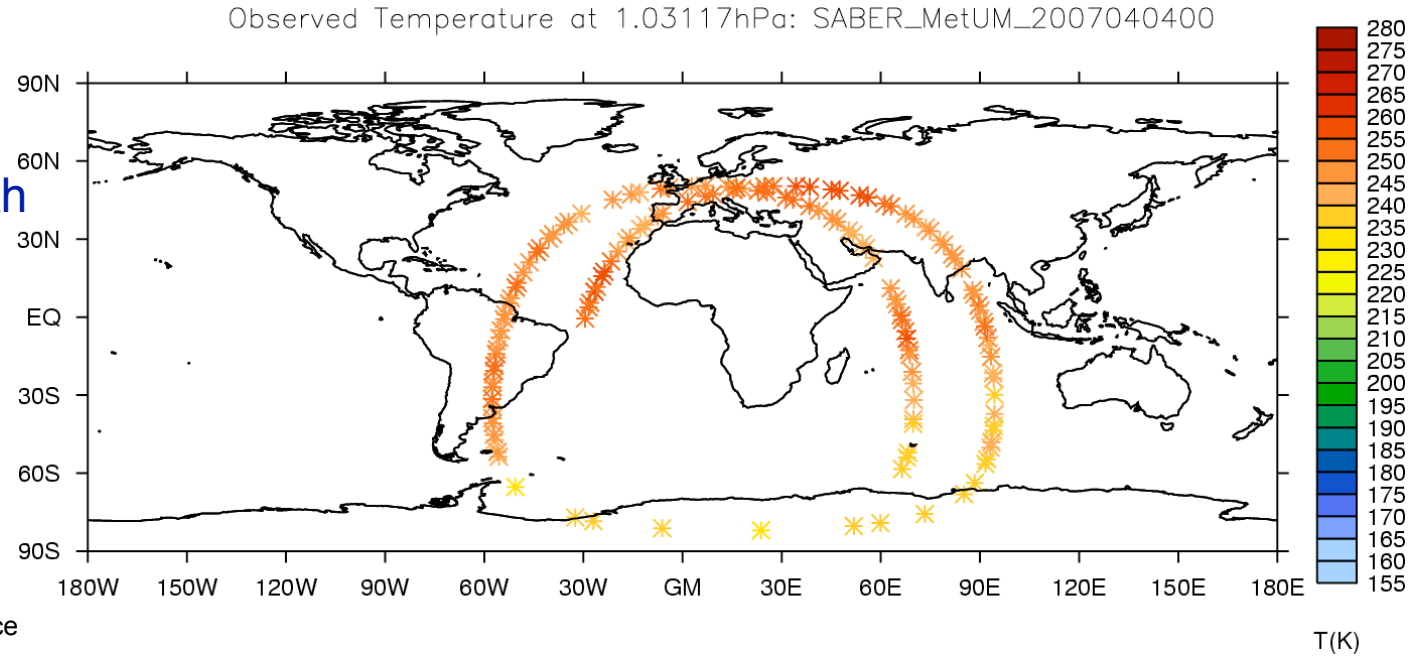
Satellite Observations

Earth Observing System (EOS) Microwave Limb Sounder (MLS)

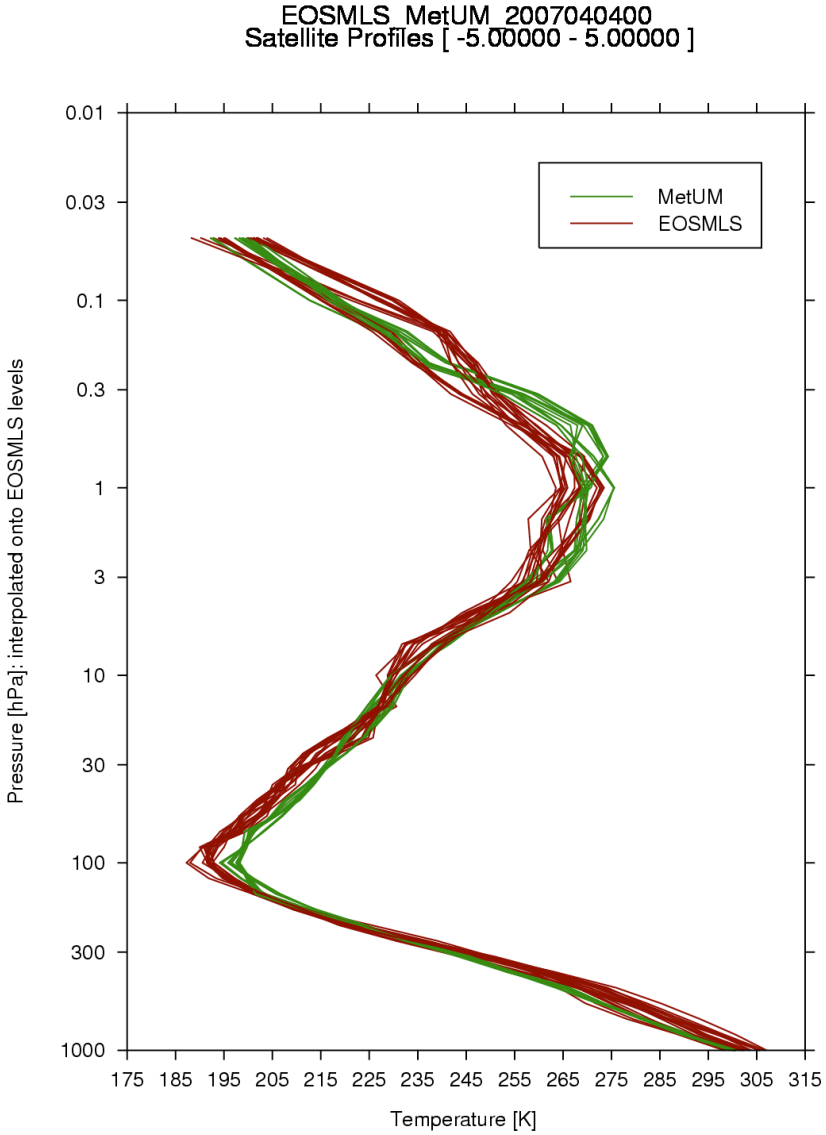


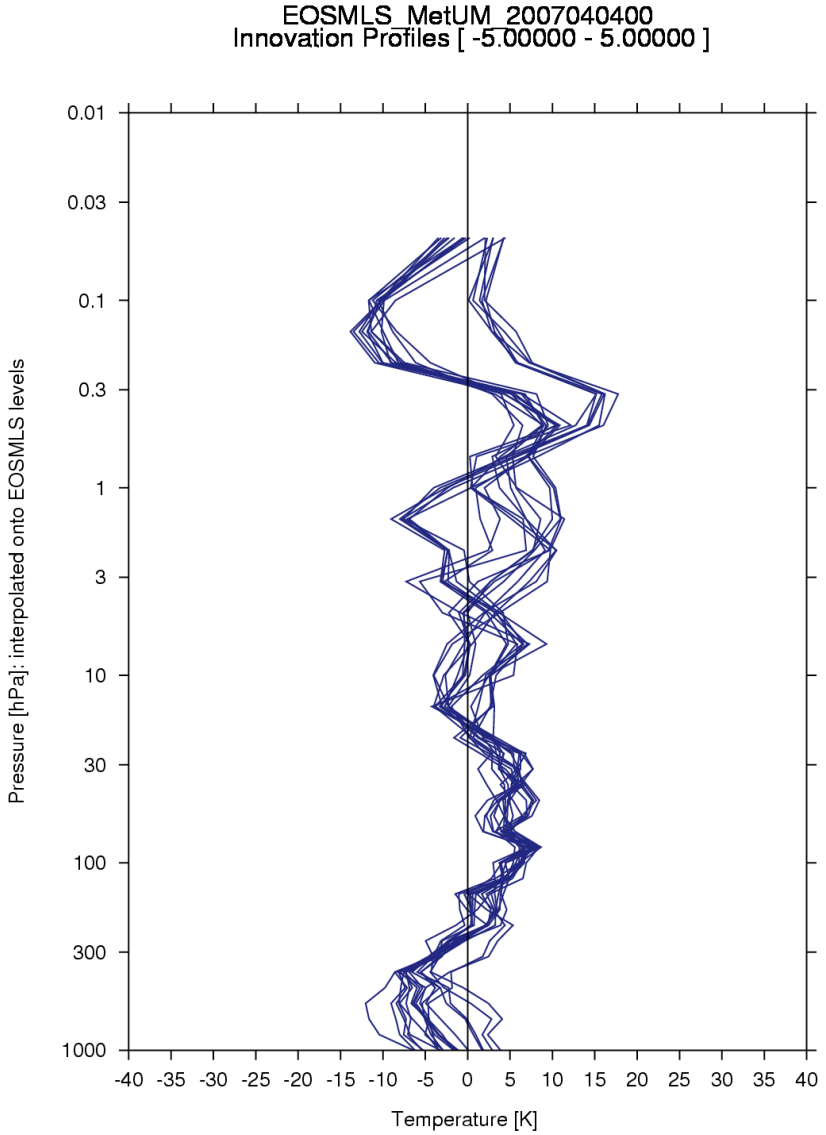
00UTC +/- 3h

Sounding Atmosphere with Broadband Emission Radiometry (SABER)

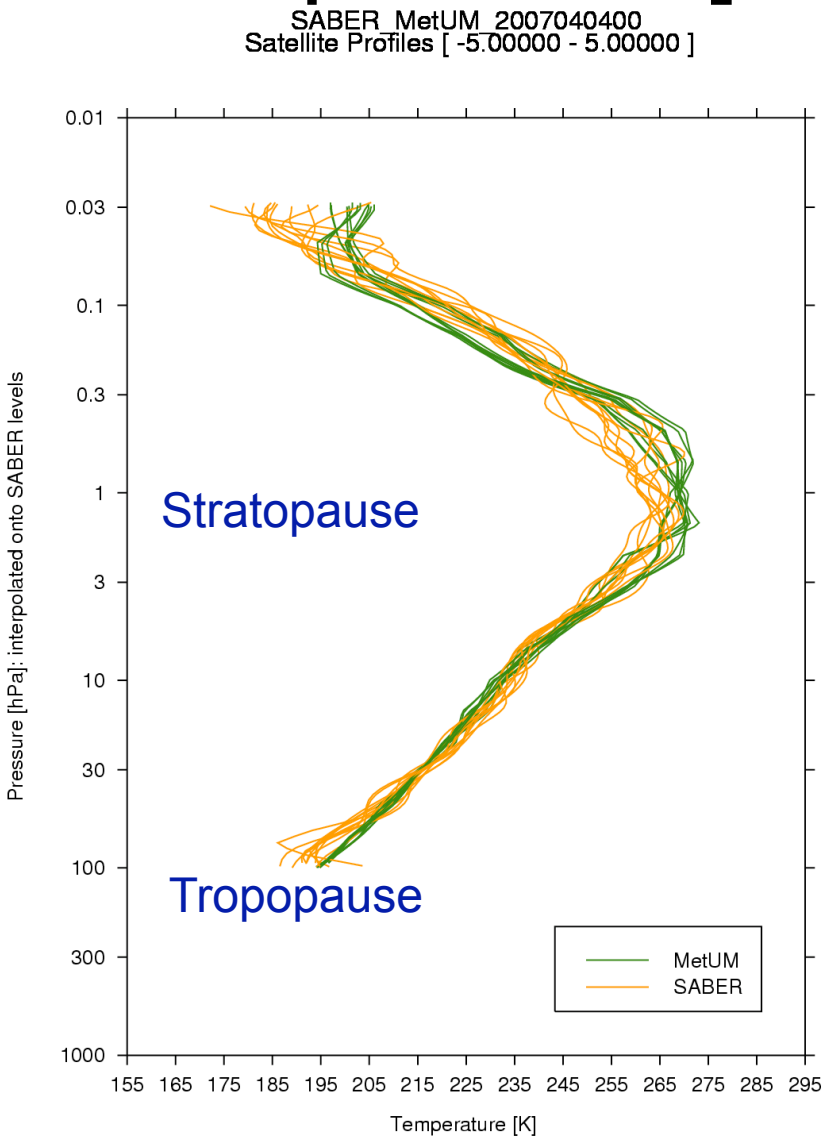


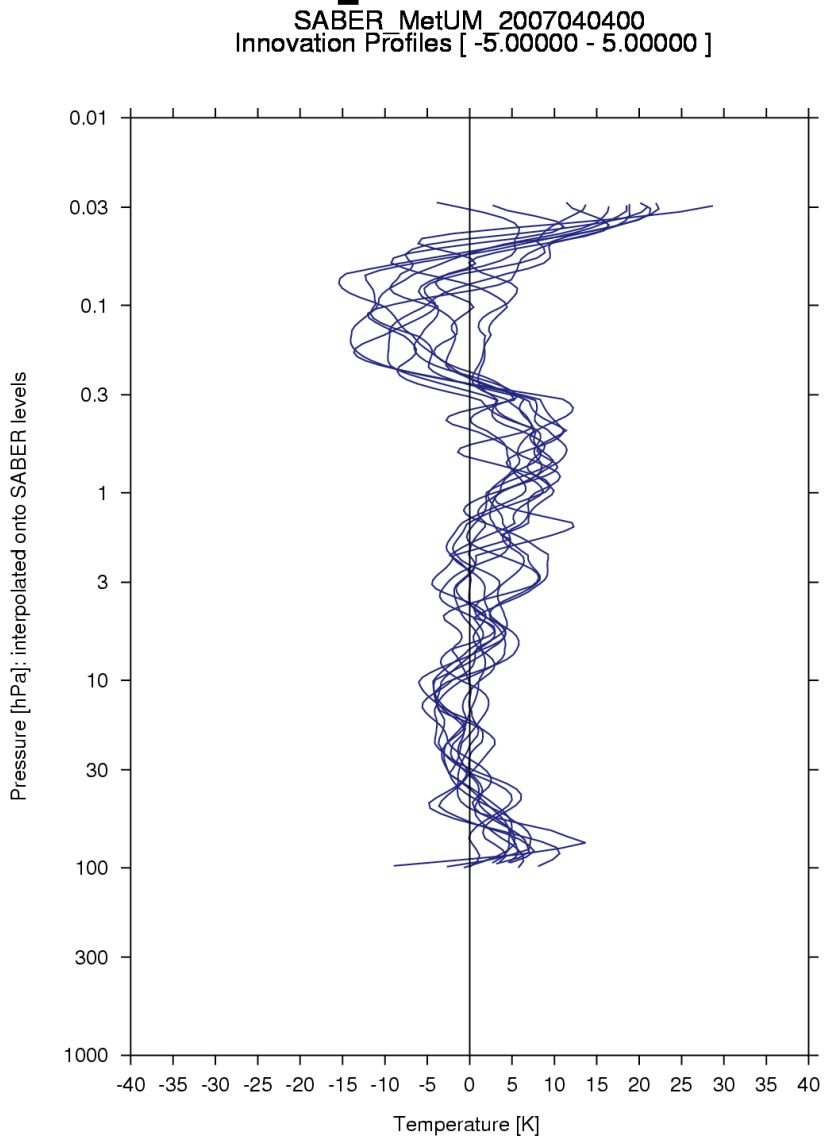
T Equatorial [5ºN – 5ºS] - EOS



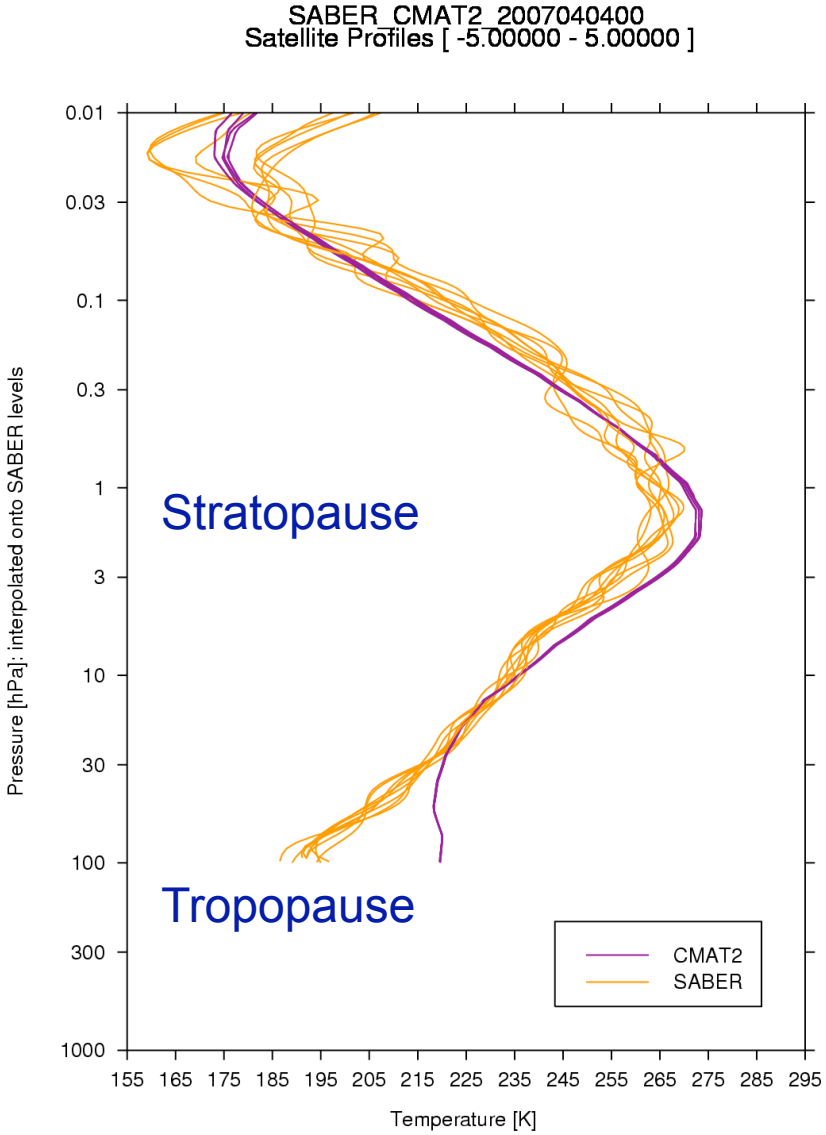


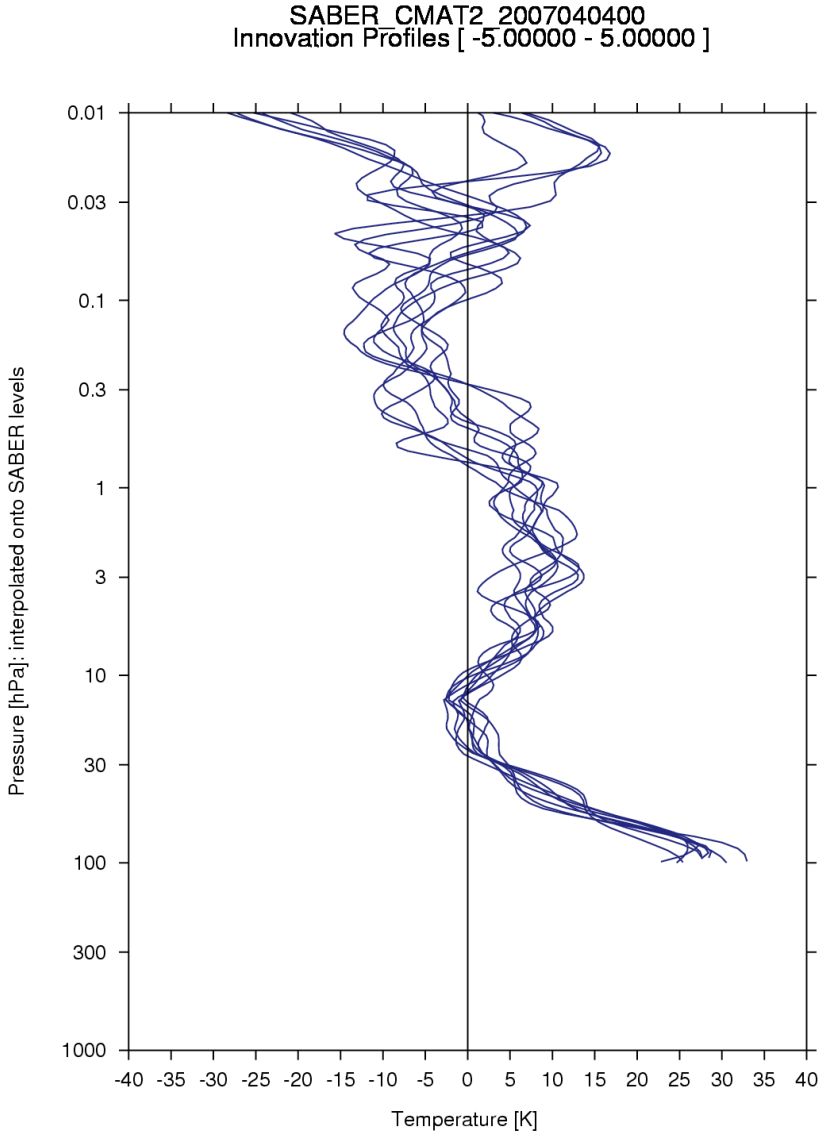
T Equatorial [5ºN – 5ºS] - SABER



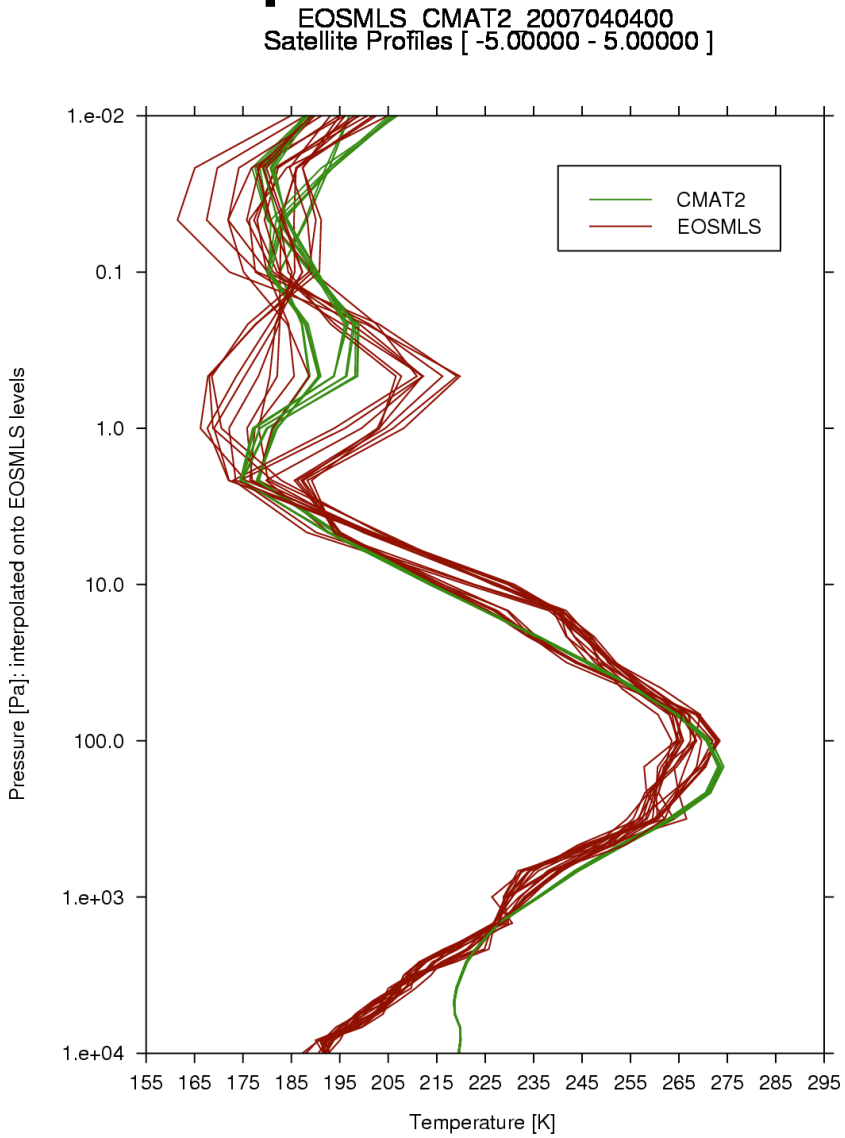


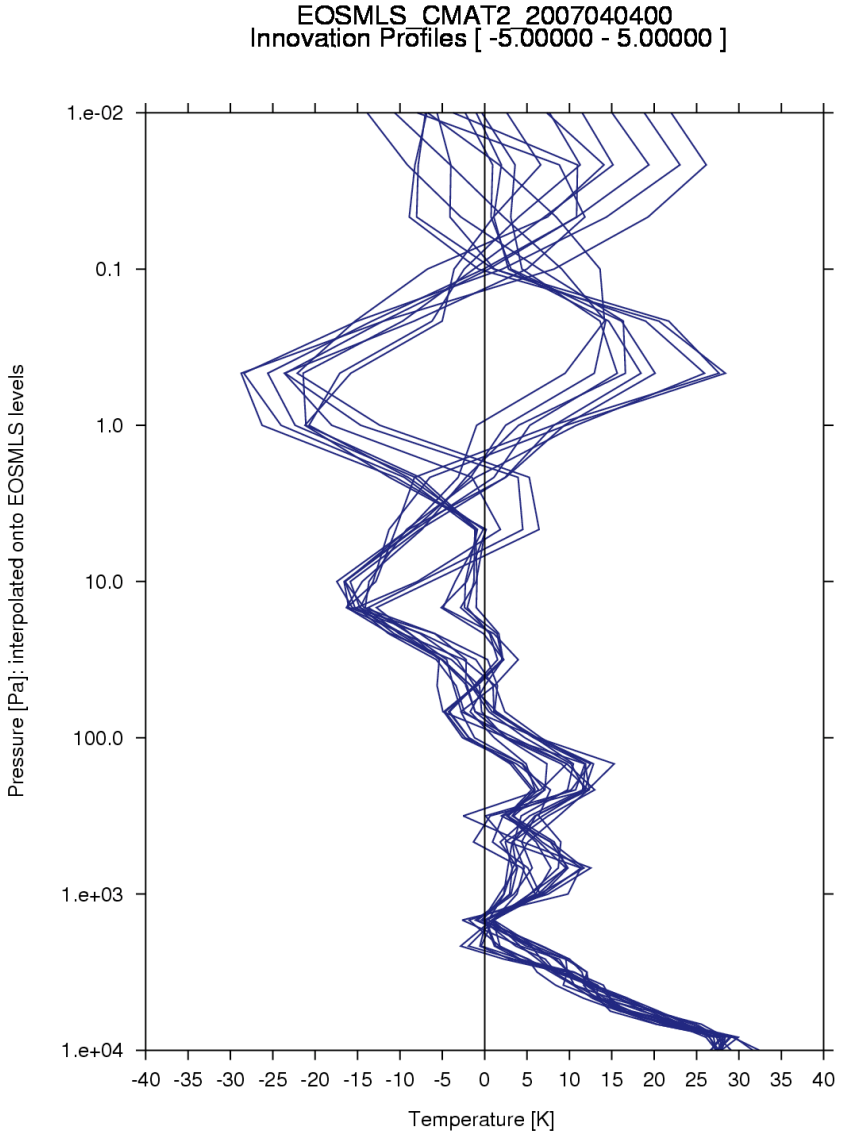
T Equatorial [5°N – 5°S] – CMAT2



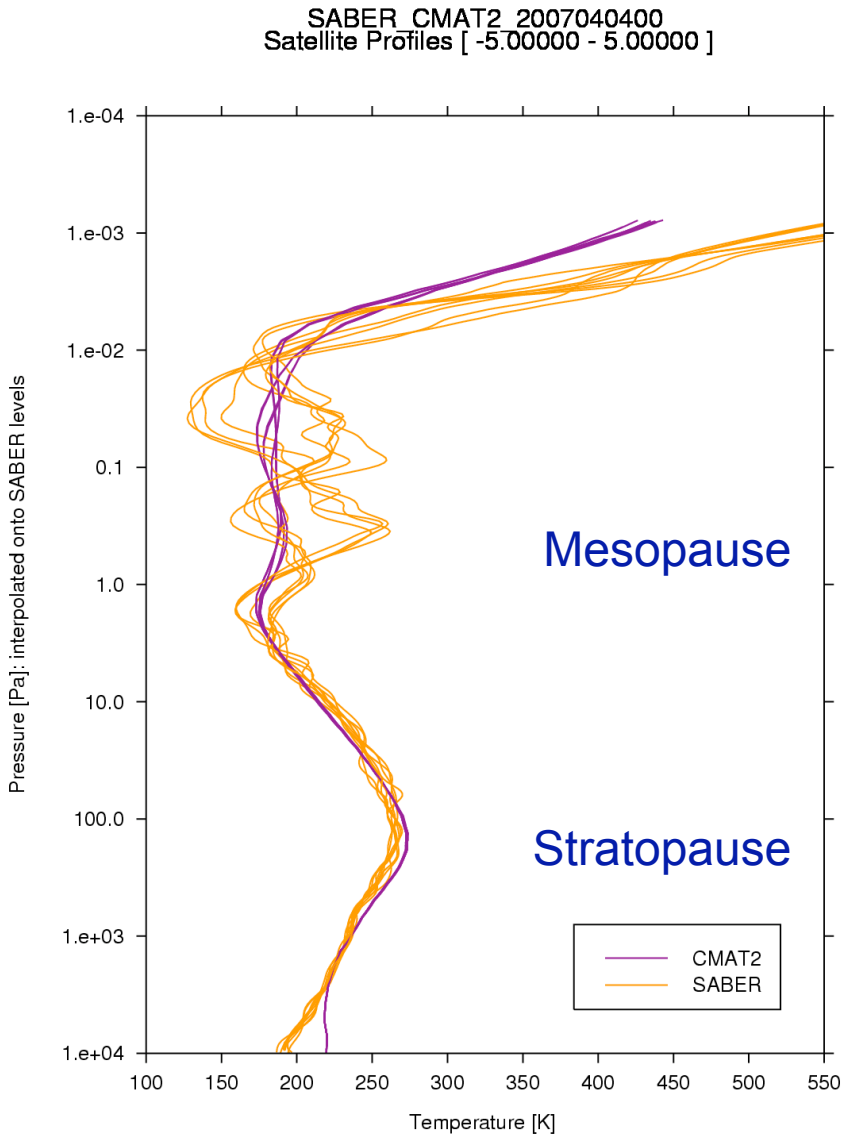


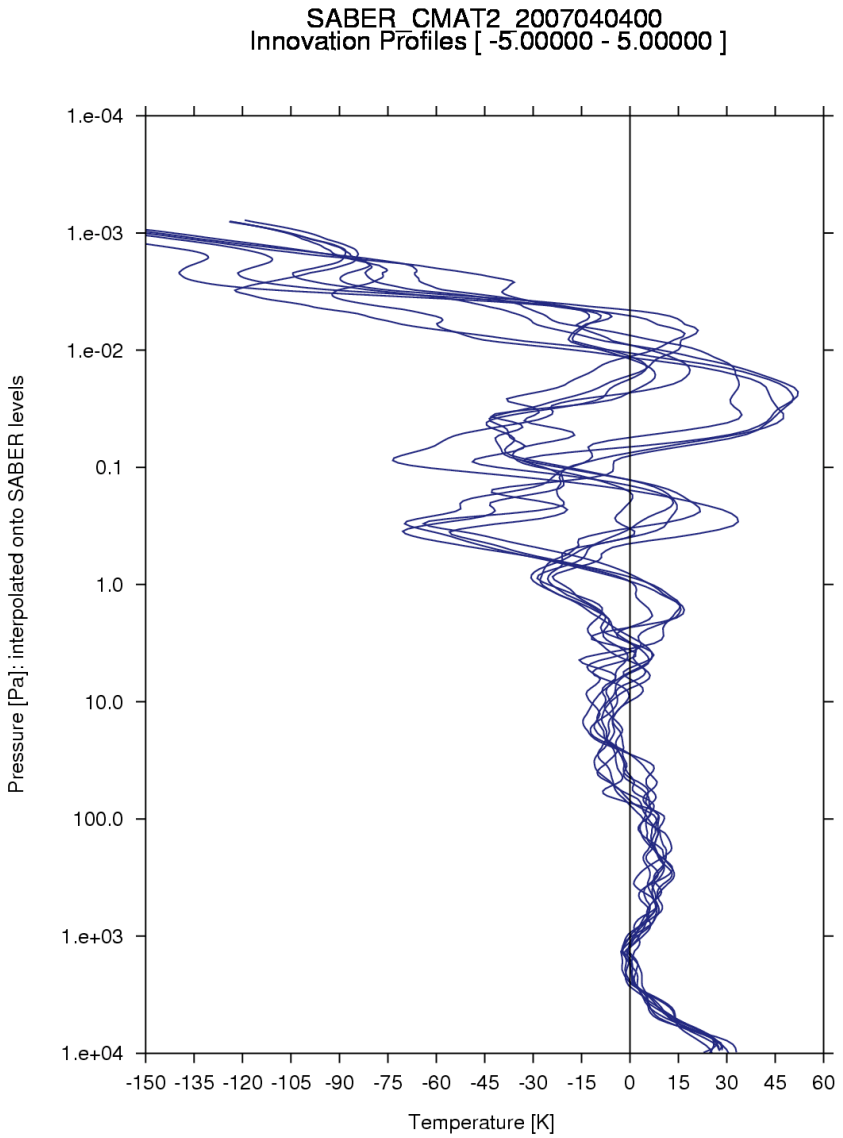
T Equatorial – CMAT2 vs EOS/MLS





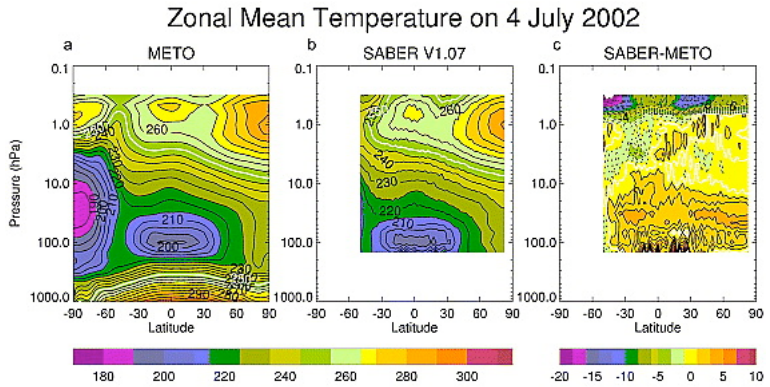
T Equatorial Upper atmos – CMAT2

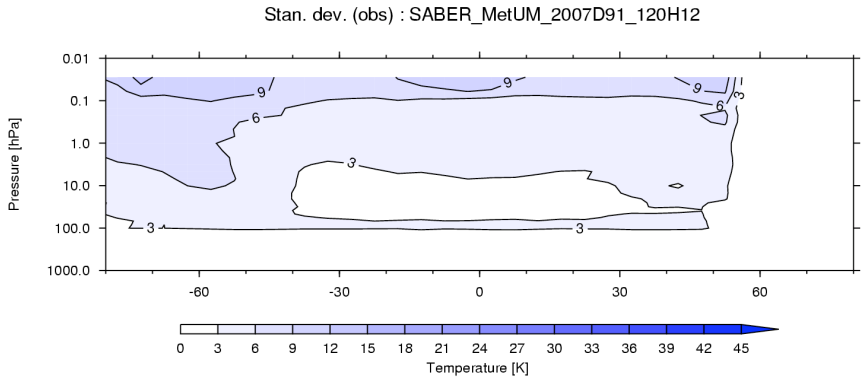


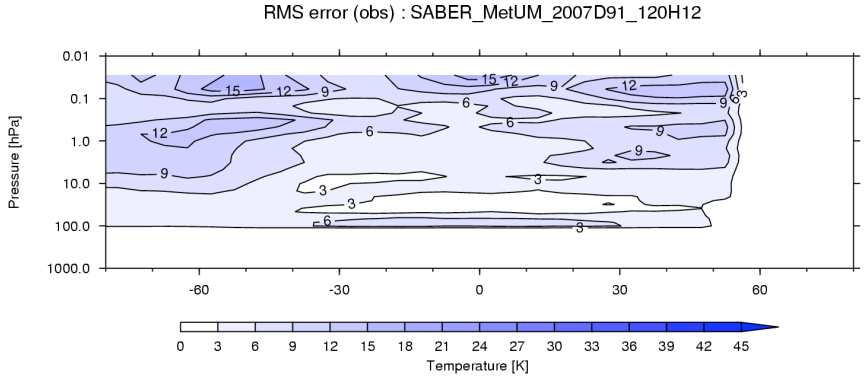


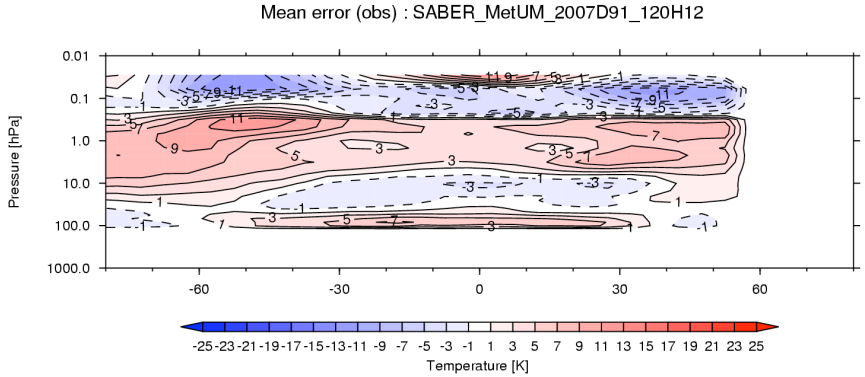
April mean T 12Z : MetUM

E.E.Remsberg et al. (2008) JGR
doi:10.1029/2008JD010013

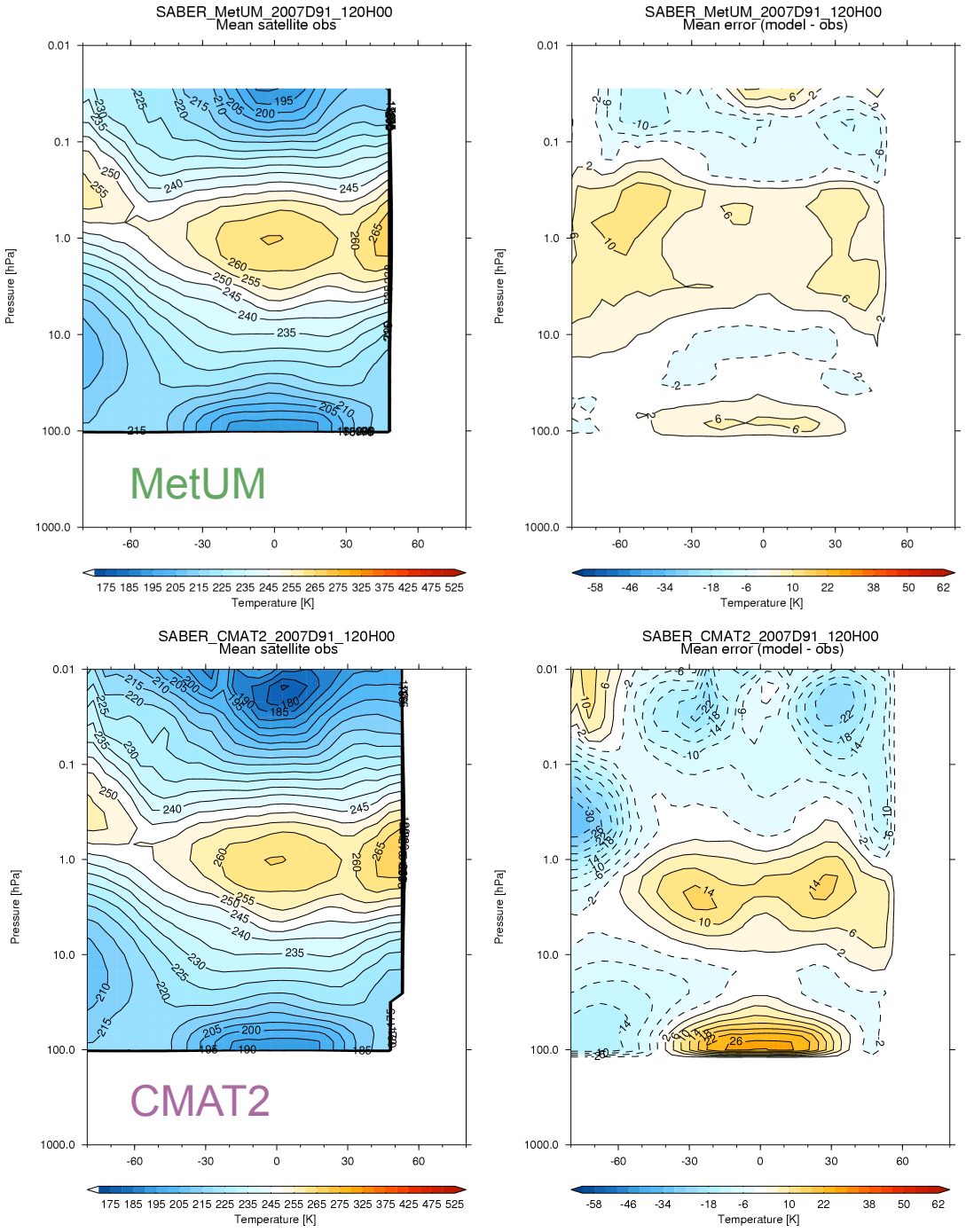




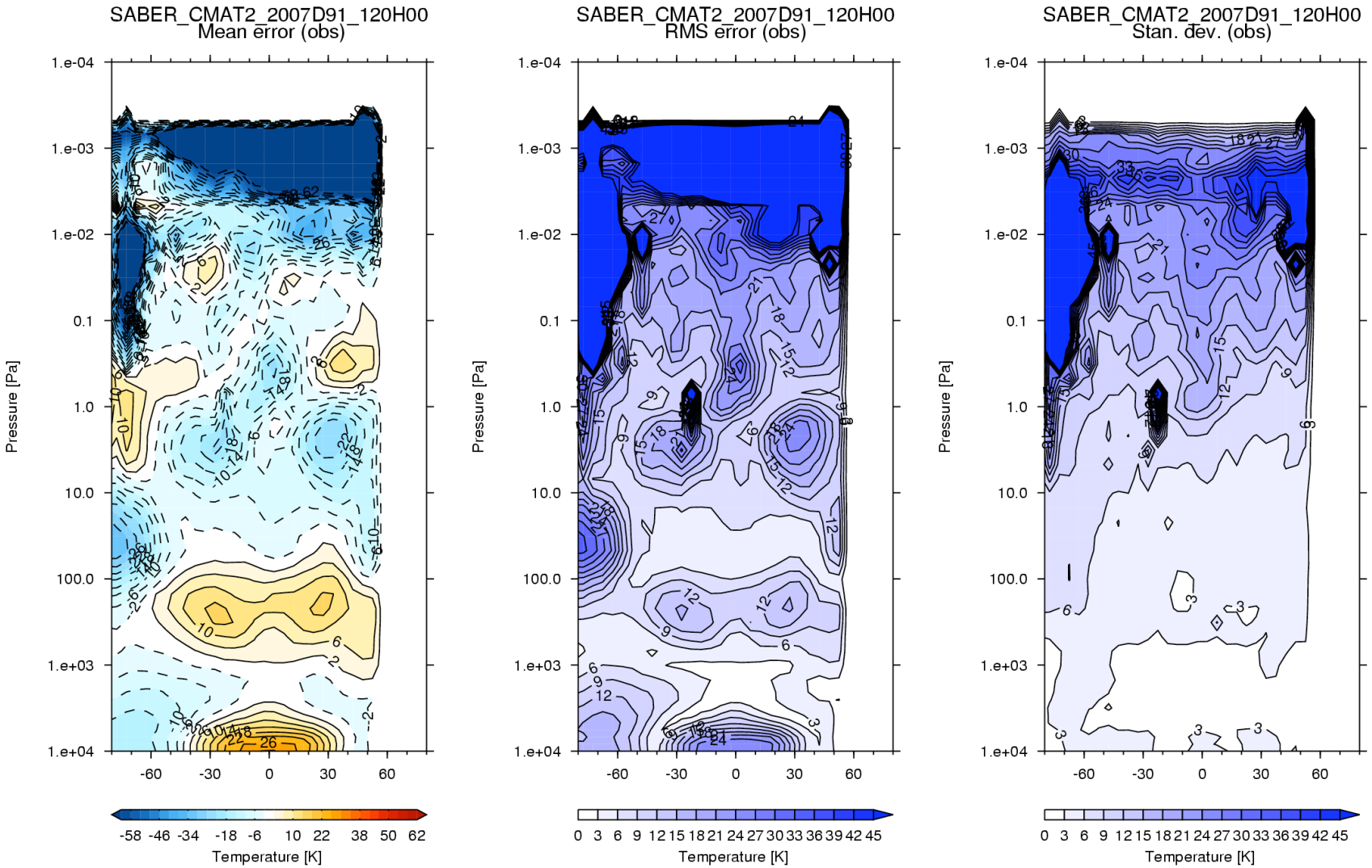




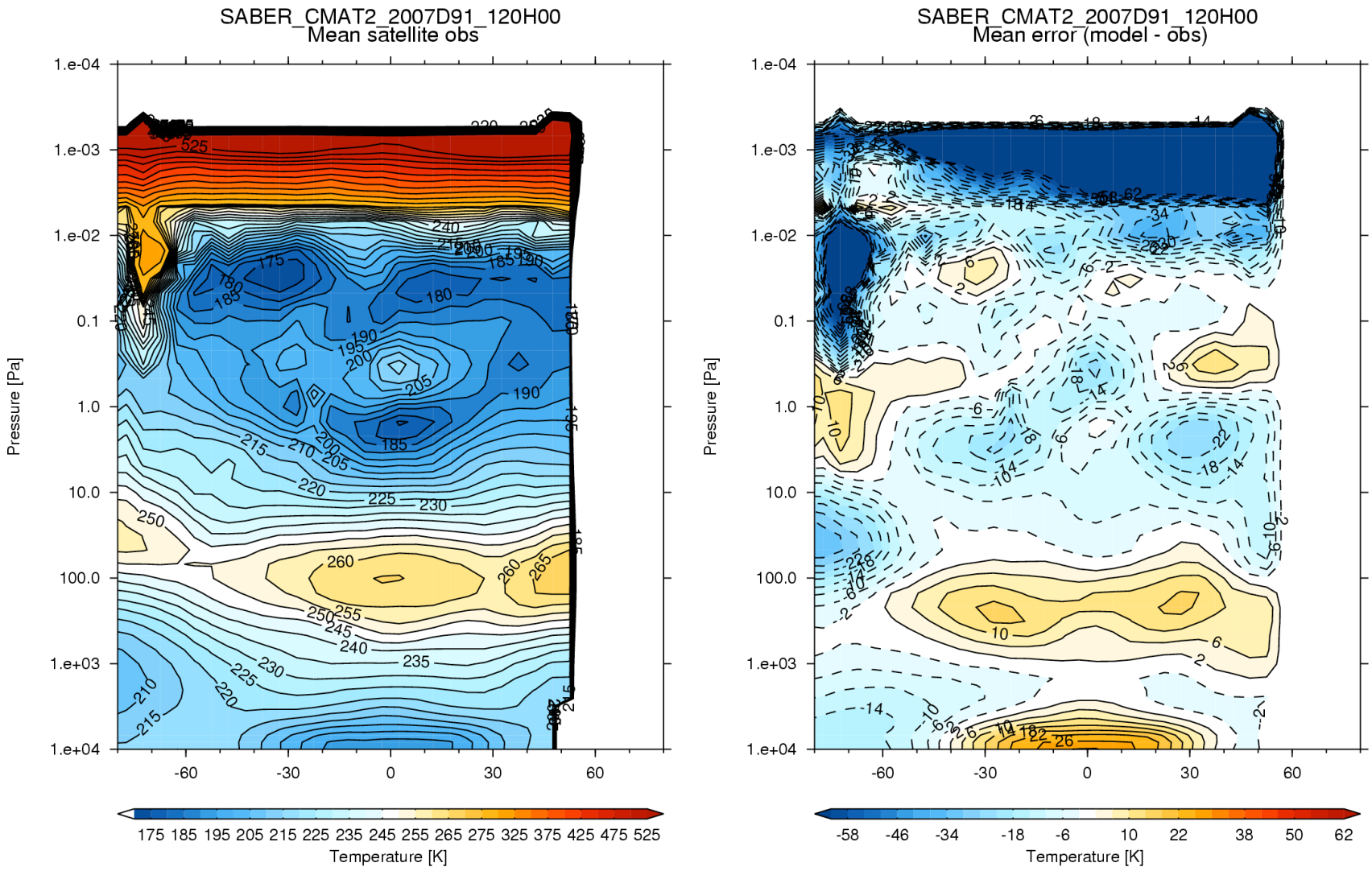
April mean T and T Bias at 0Z



April mean 0Z : CMAT2



April mean T & T Bias at 0Z : CMAT2



Preliminary Conclusions

- SABER & EOSMLS satellite T data clearly has potential for analysis of physical model performance in middle atmosphere and lower thermosphere
- Potential for ‘seamlessness’, comparison vs analyses, operational forecast, 30-60day forecast, …
- Model variability (resolution, tidal, resolved waves, gravity waves, …).

Any Questions or Comments?