Confronting UKCA with MIPAS Observations

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National Centre for Atmospheric Science

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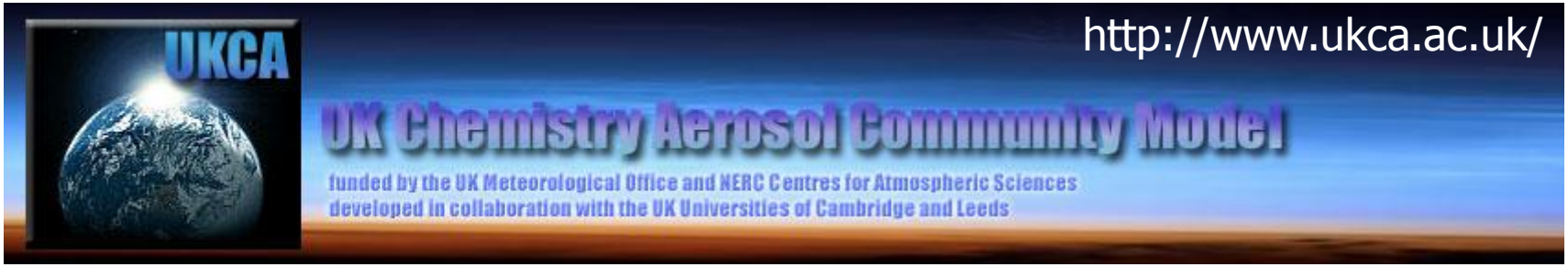
Structure

- What is UKCA?
- Validation of zonal mean quantities
  - Age-of-air zonal mean
- Validation beyond the zonal mean
  - Age-of-air maps (Monsoon and planetary wave patterns)
  - Tropical N2O PDFs (existence of sub-tropical barrier, strength of tropical upwelling)
- Summary and Outlook

What is UKCA?

- UKCA is a community chemistry-climate model based on the Met Office's new dynamics Unified Model.



- It is a joint development between the Met Office, University of Cambridge (chemistry) and University of Leeds (aerosol), with many contributing partners, e.g. University of Reading and University of Oxford (L60).
- UKCA will be part of the forthcoming Joint Climate Research Programme (JCRP).

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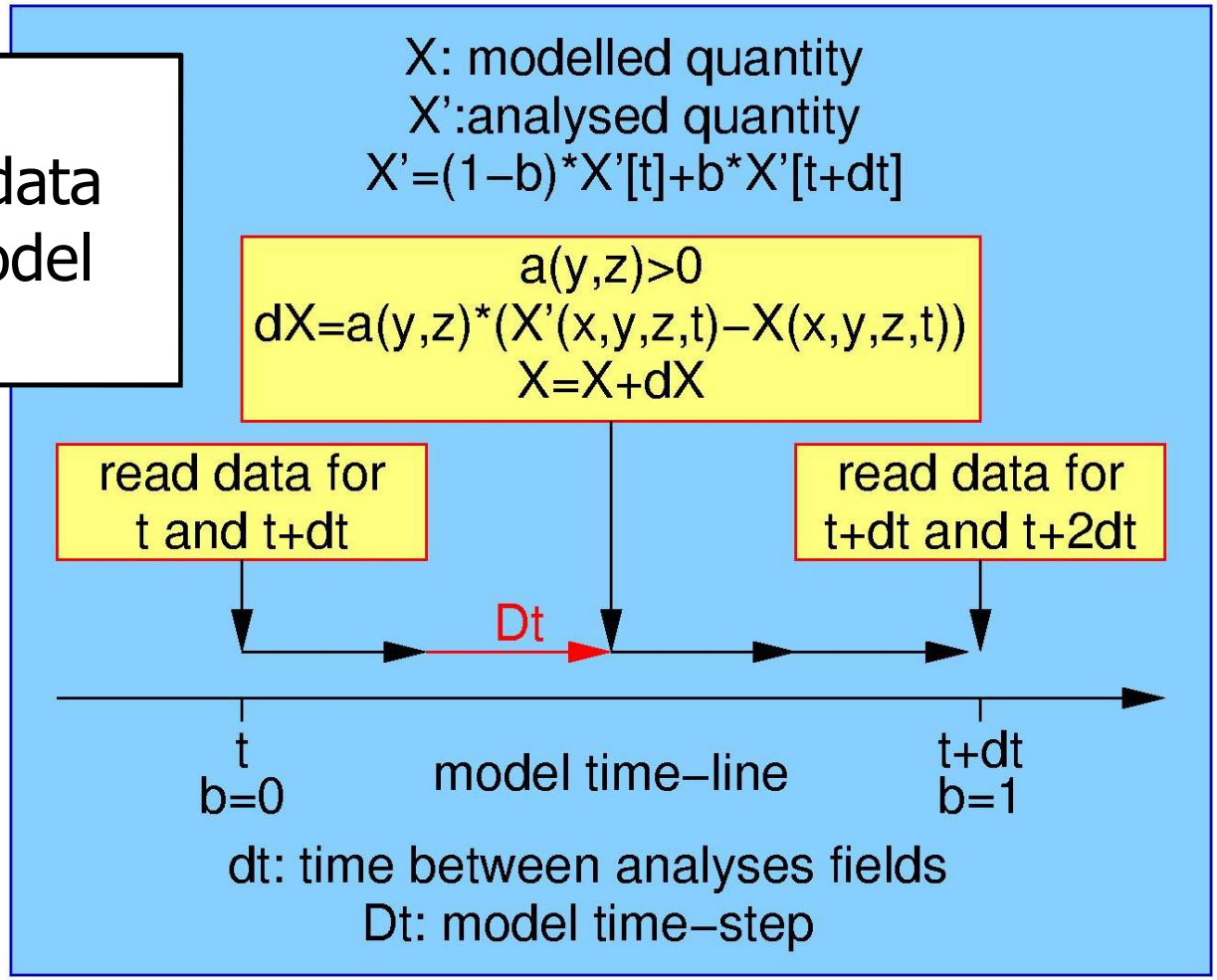
Model Setups

- Tropospheric UKCA
  - Resolutions: N48L38, N48L60, (N96L38)
  - Tropospheric chemistry
- Stratospheric and "Whole Atmosphere"
  - Resolutions: N48L60, (N96L60)
  - Stratospheric chemistry with tropospheric background
- Future: all resolutions supported by the underlying Met Office model.

Nudged UKCA

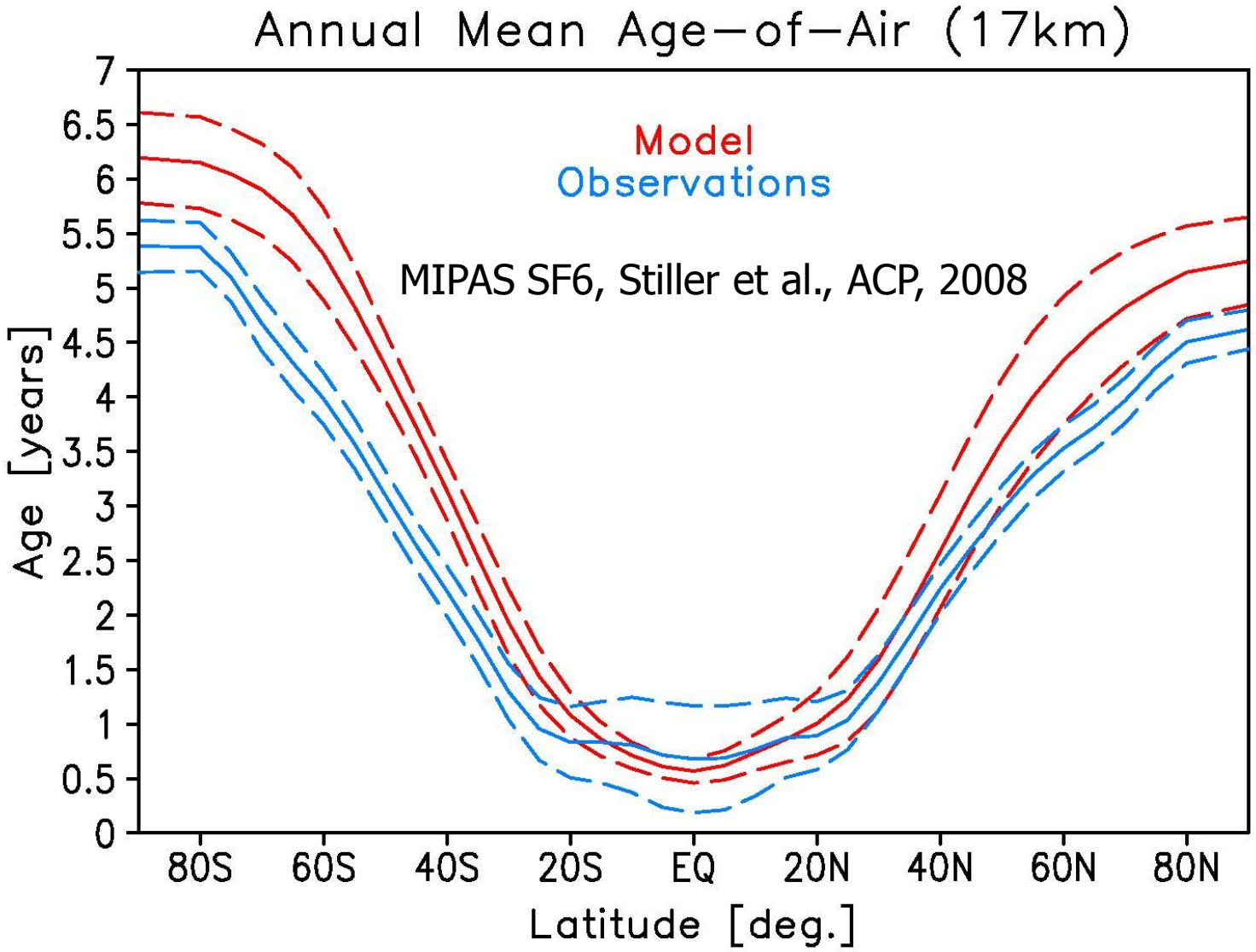
Timescales:
6 hourly ECMWF data
15-30 minutes model time step

Telford et al., ACP, 2008

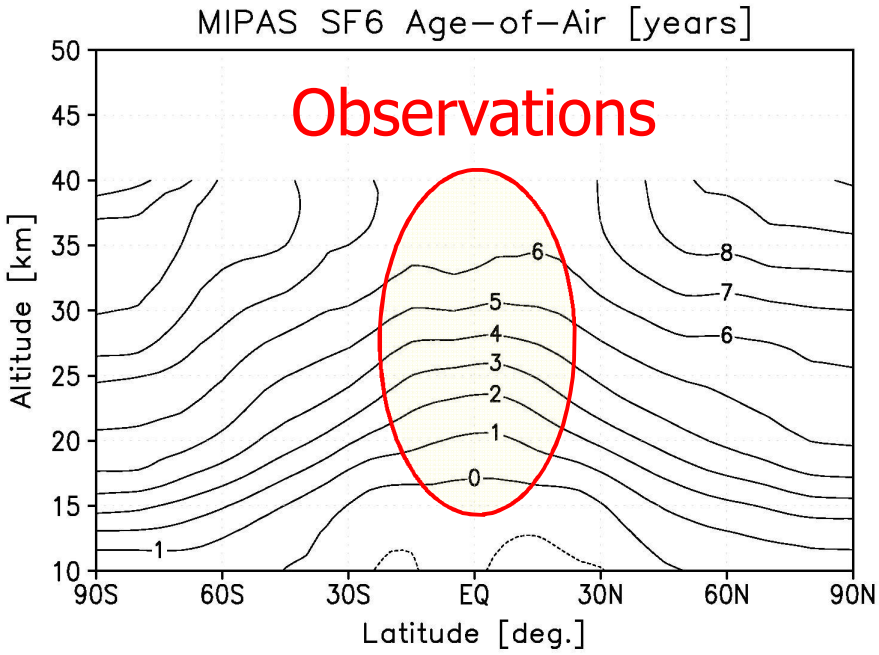


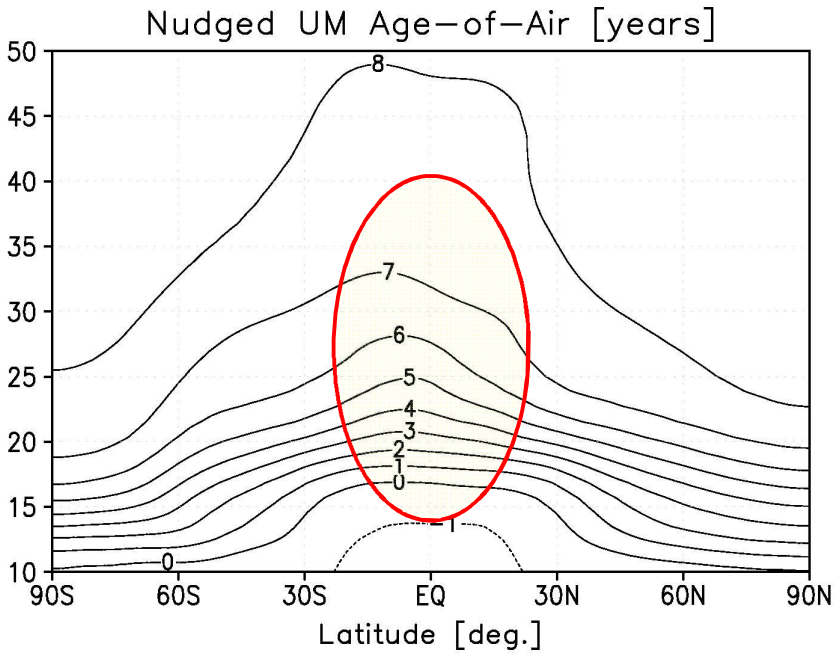
Model is constrained in zonal wind, meridional wind and potential temperature. The vertical velocity in the UM is a prognostic (and not a diagnostic) quantity!

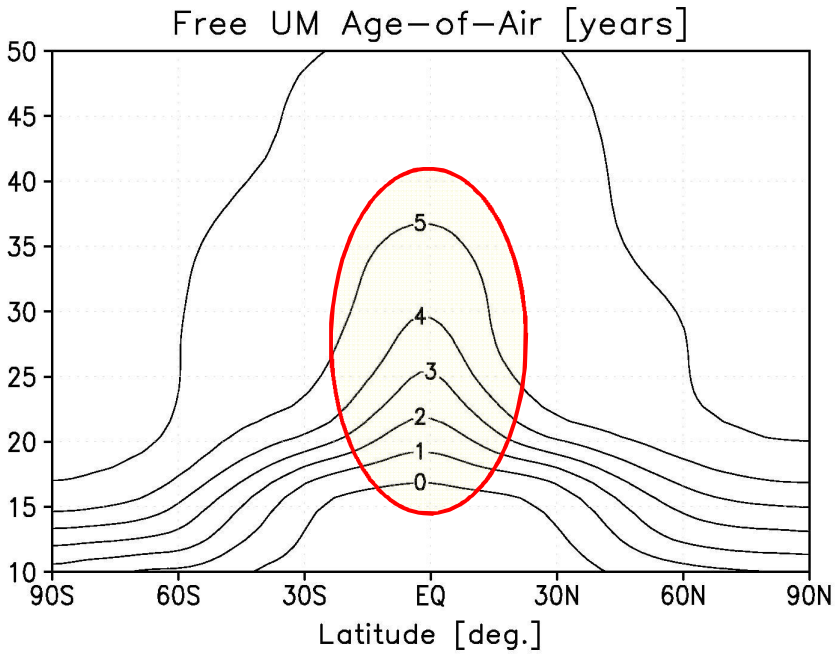
Age-of-air at 17km



Age-of-air

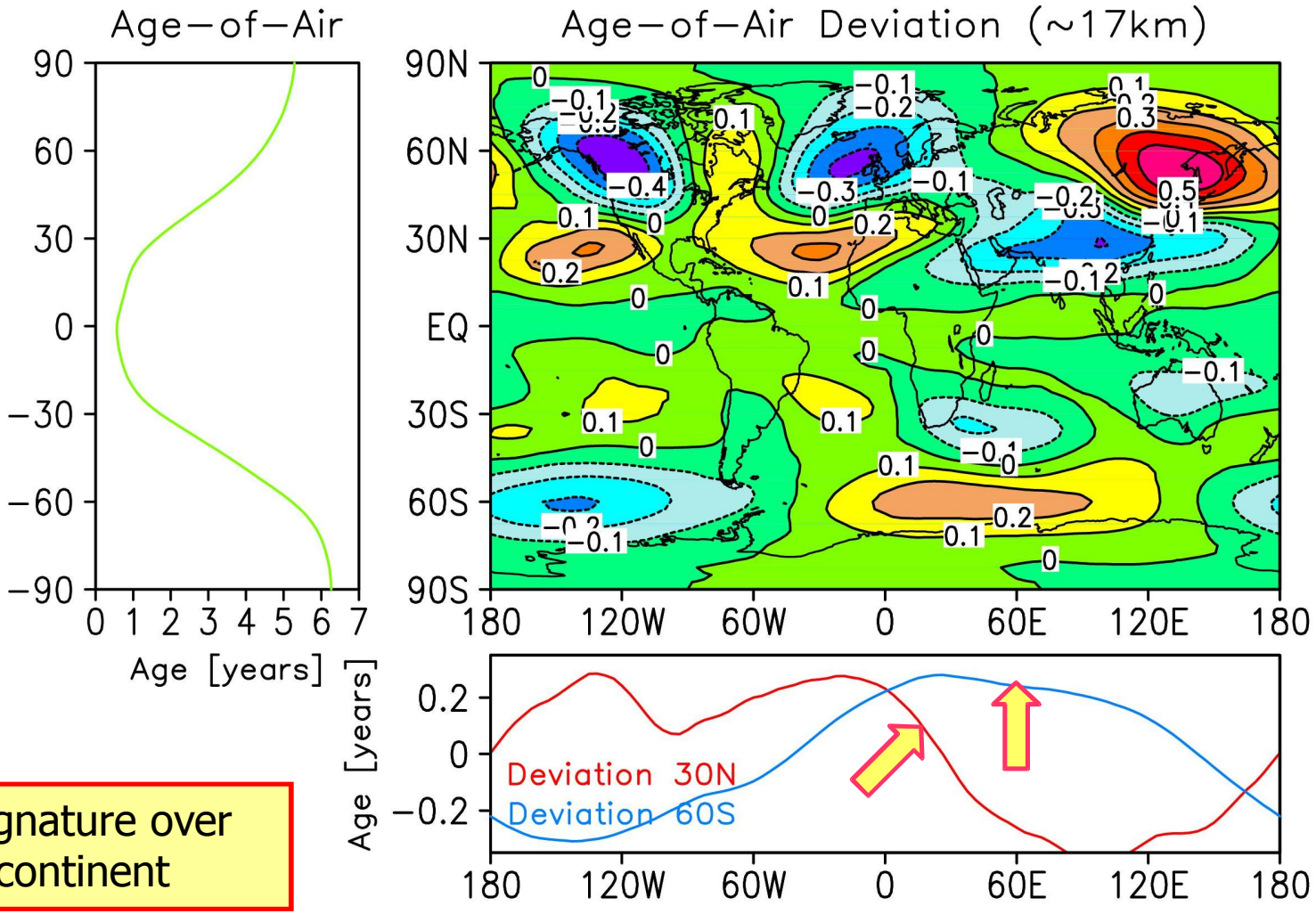






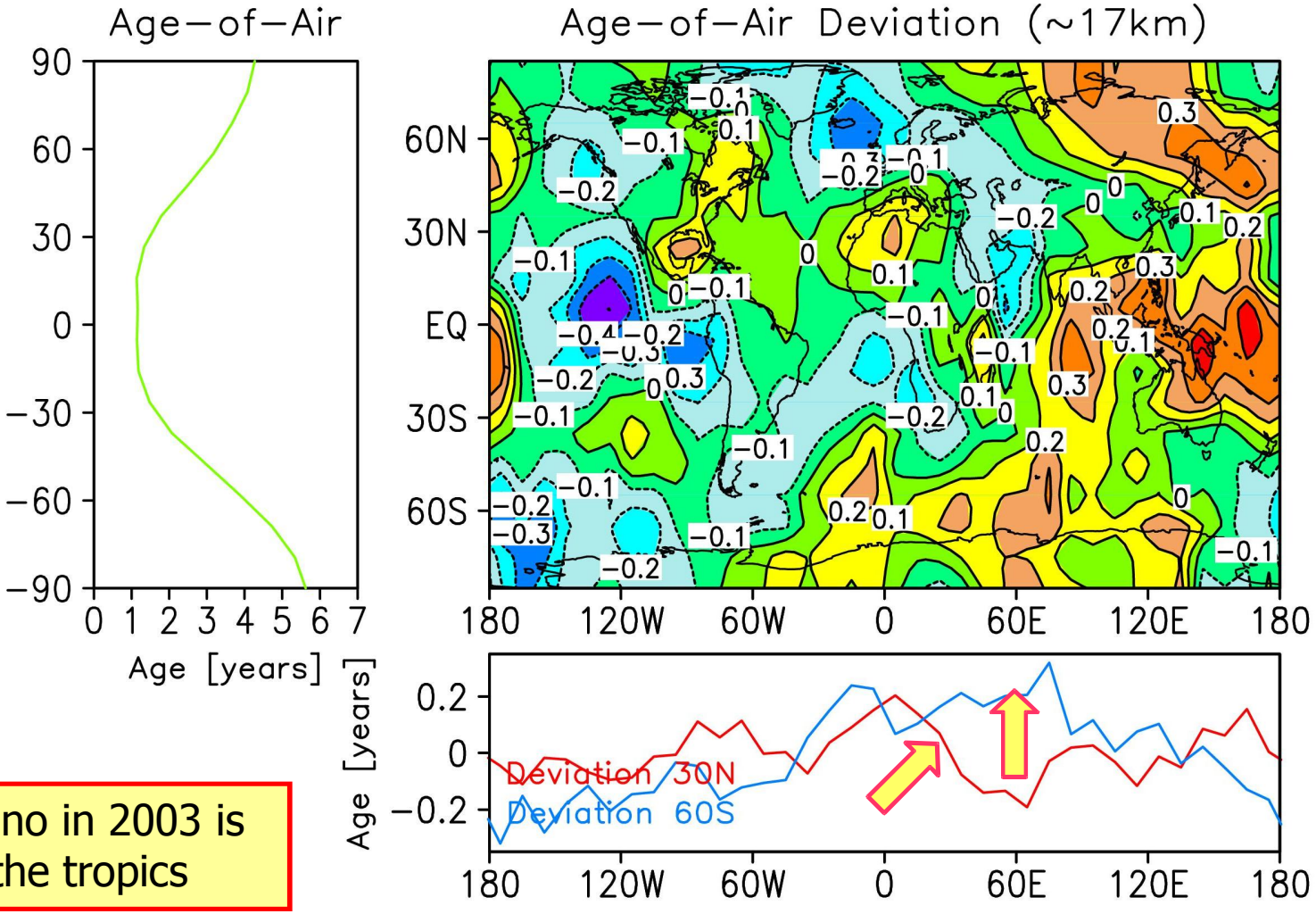
Caveat: Observations of SF6 still sparse!
Model results are from equilibrated 10 year integrations.

Age-of-air map: Model



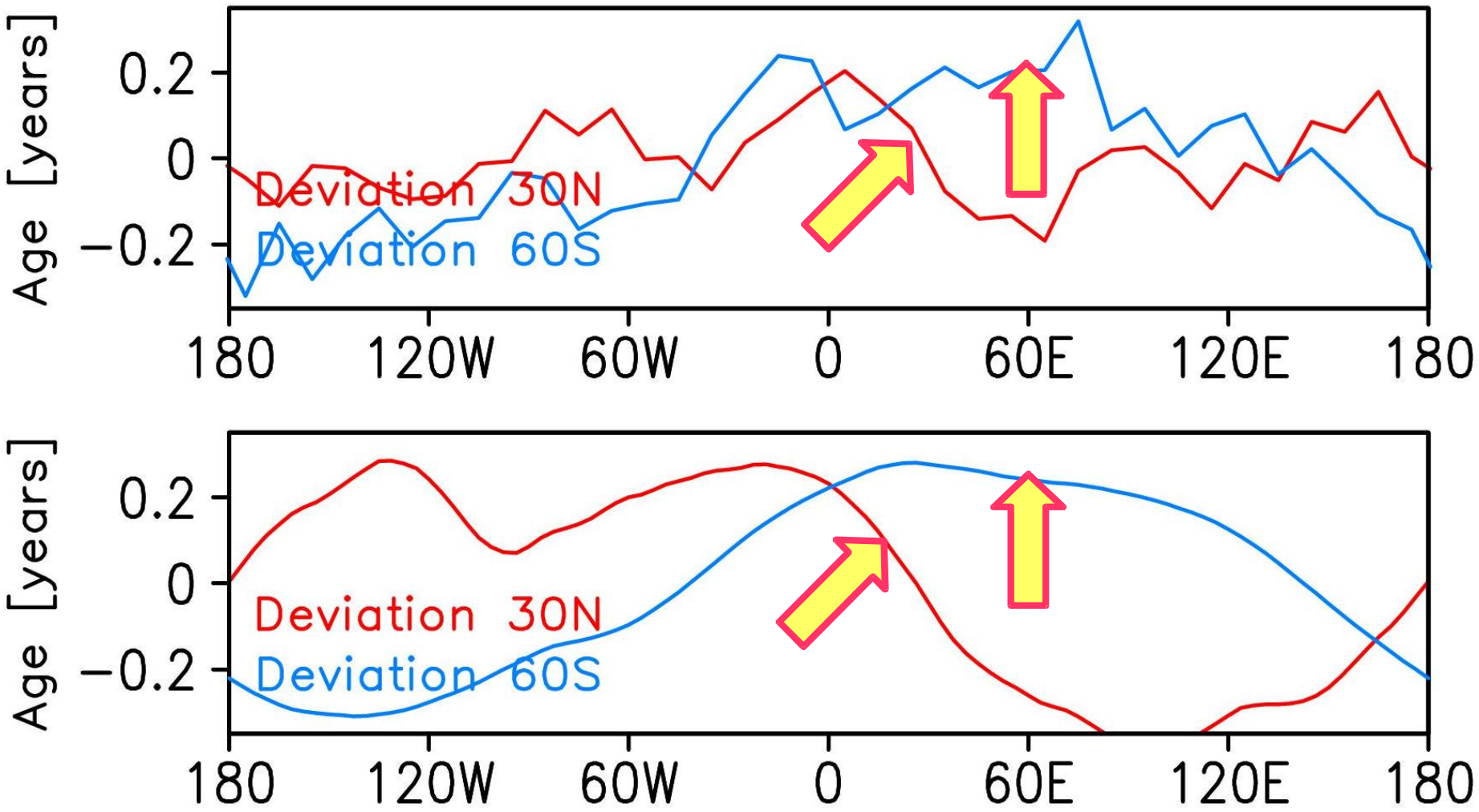
Monsoon signature over Indian sub-continent

Age-of-air map: Observations

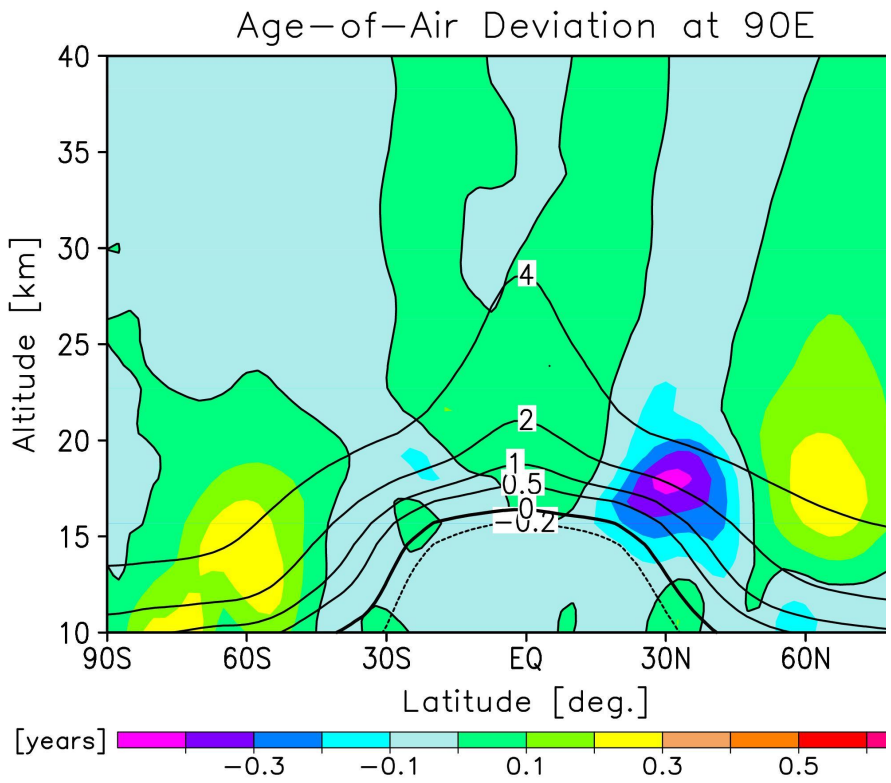


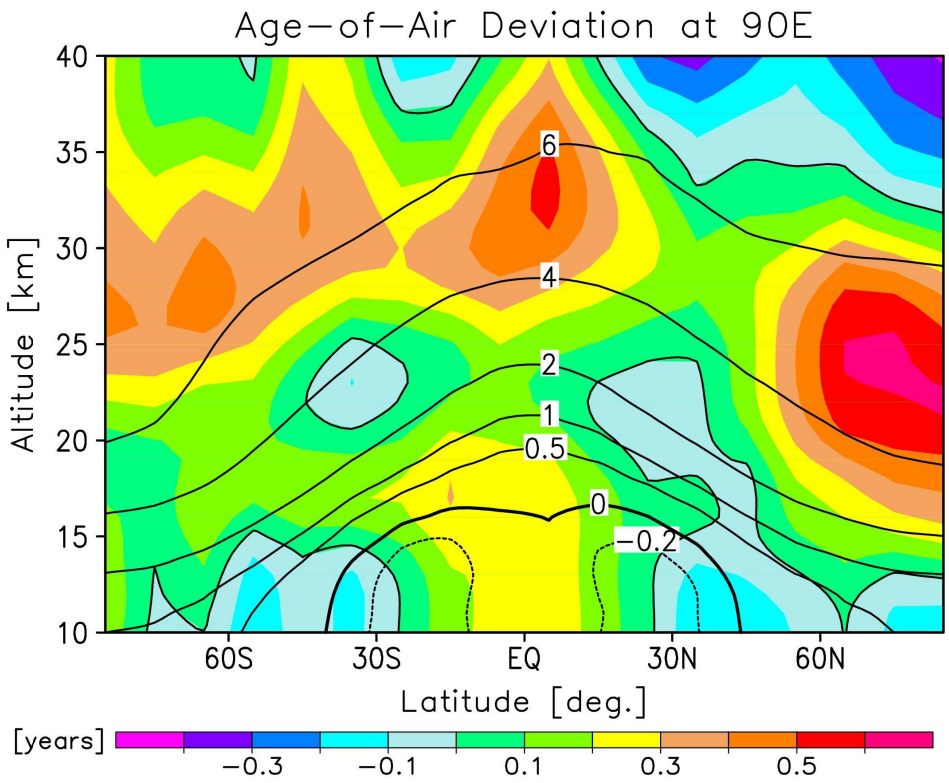
Strong El Nino in 2003 is "visible" in the tropics

Longitudinal varying age

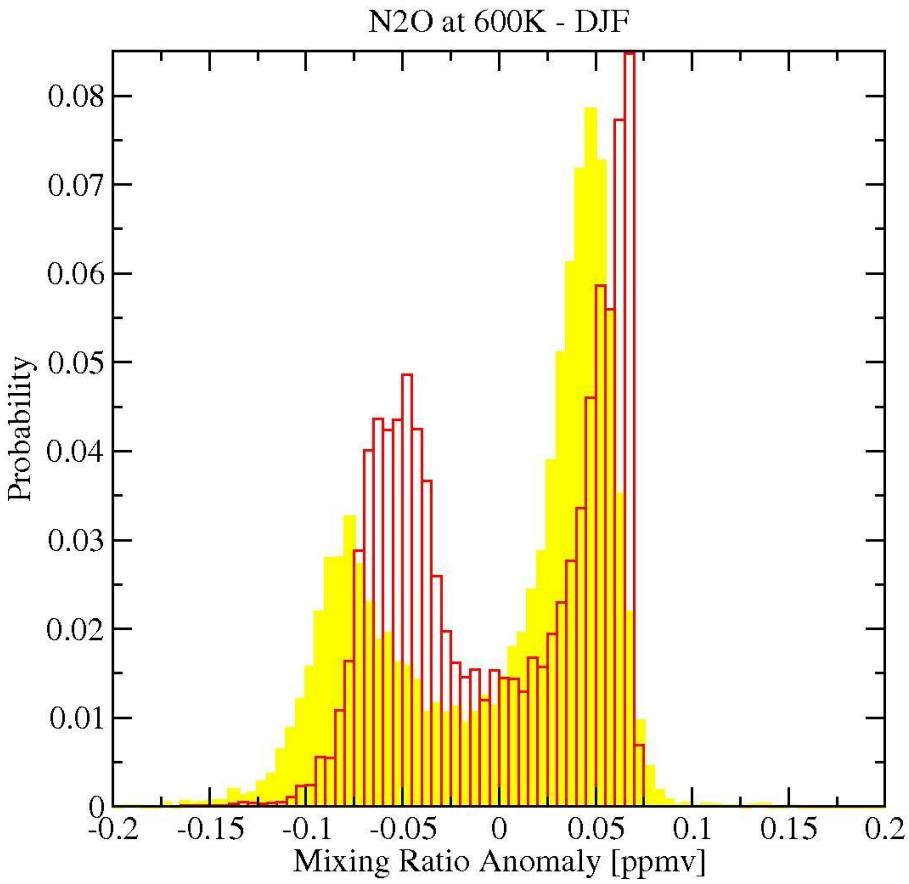


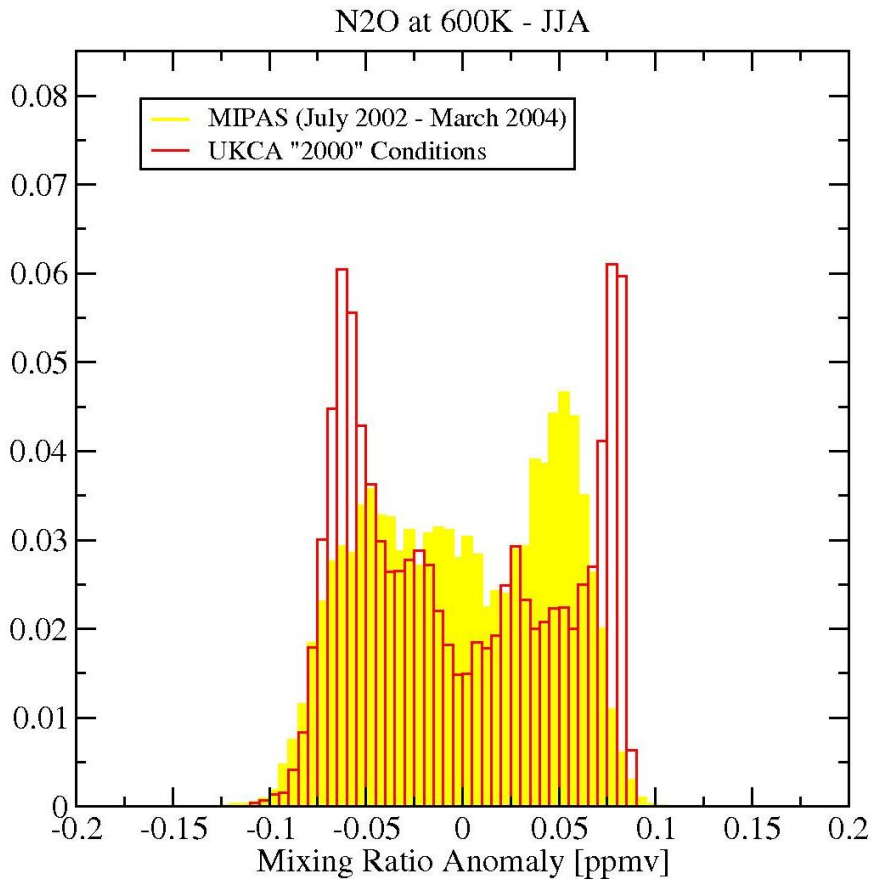
Age-of-air cross-sections



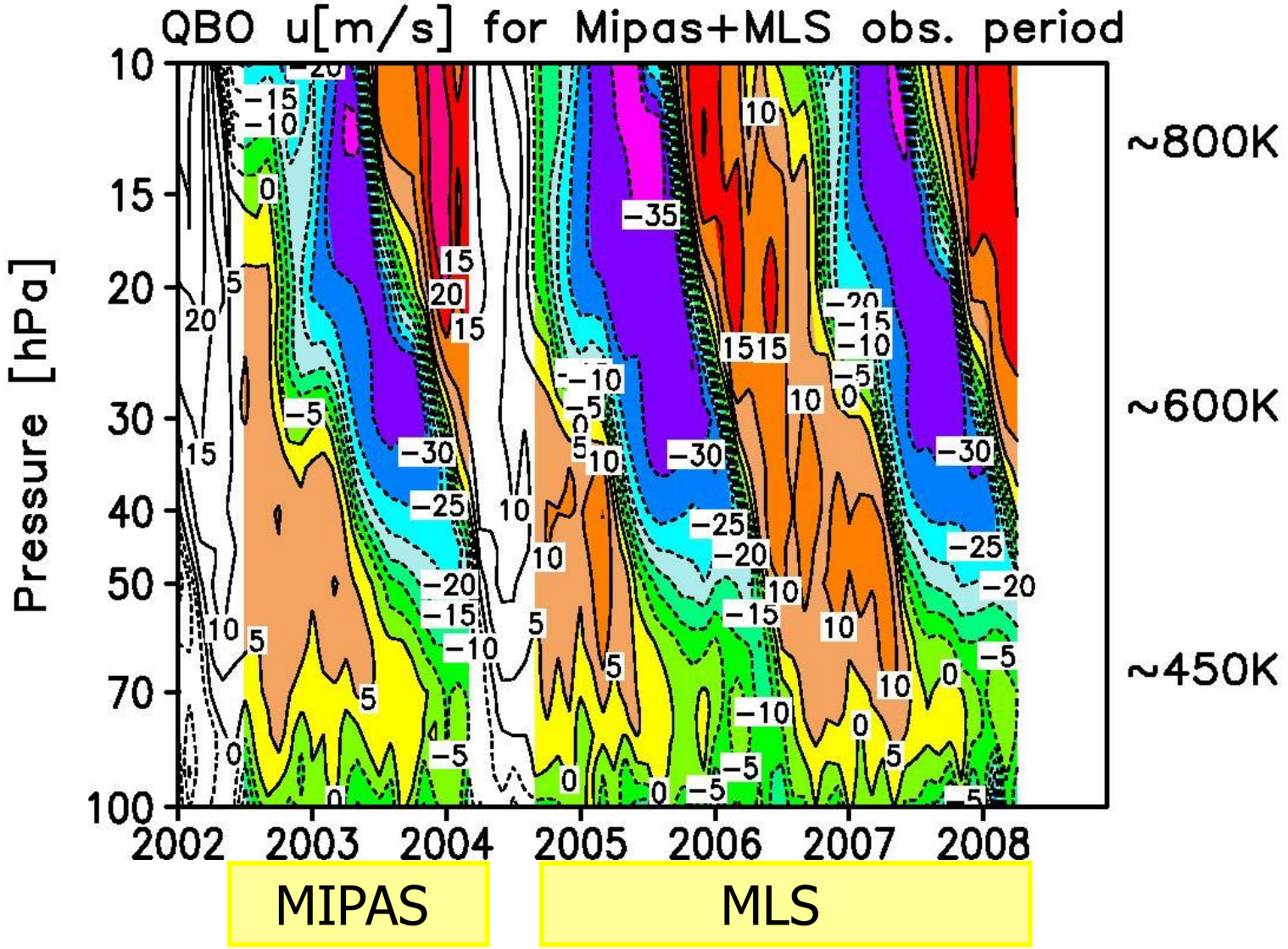


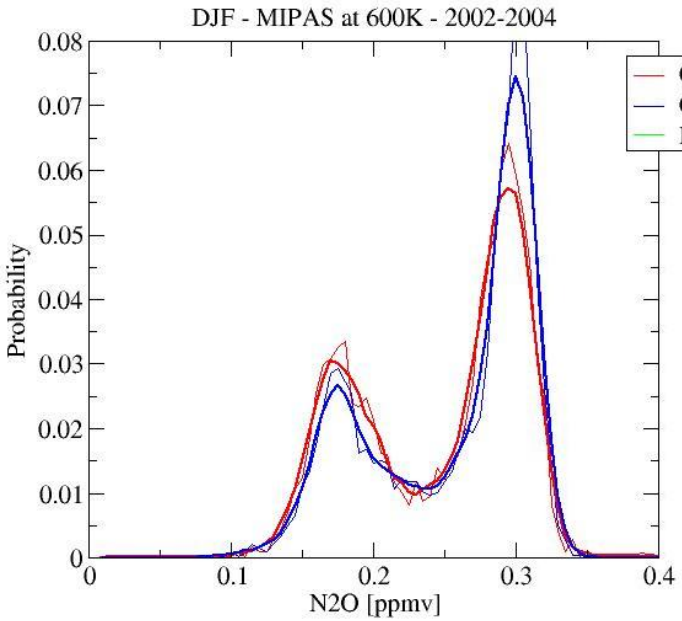
Recent N2O PDFs

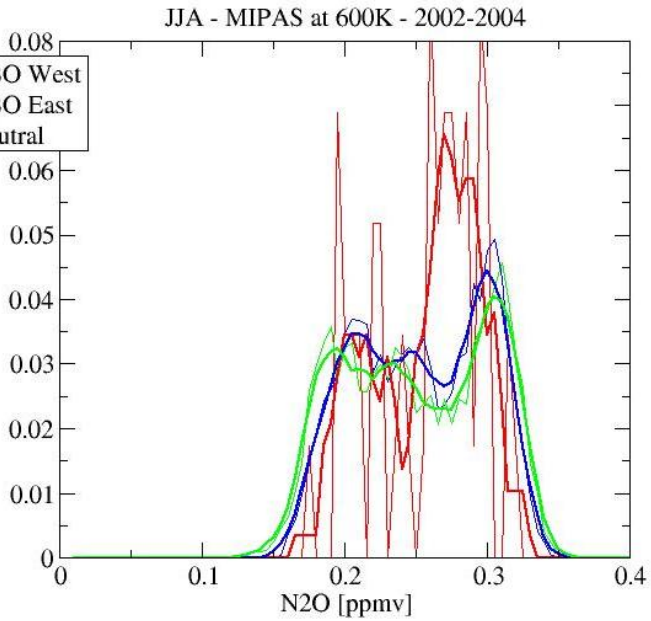


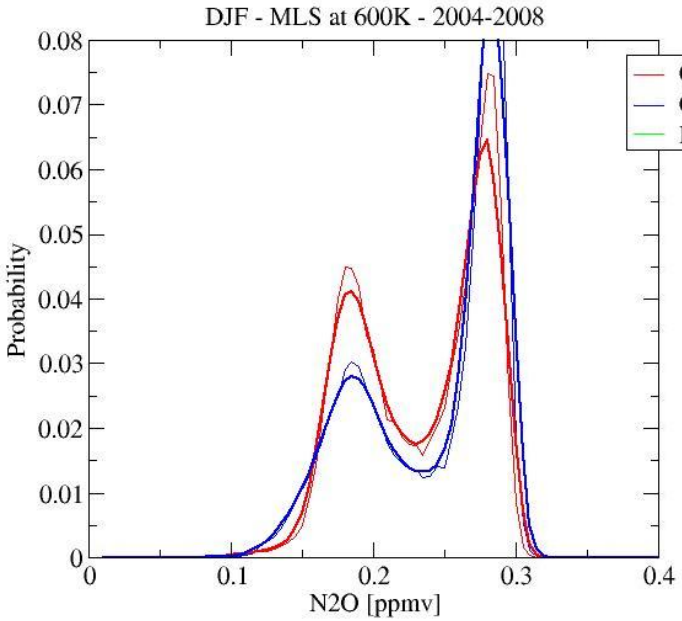


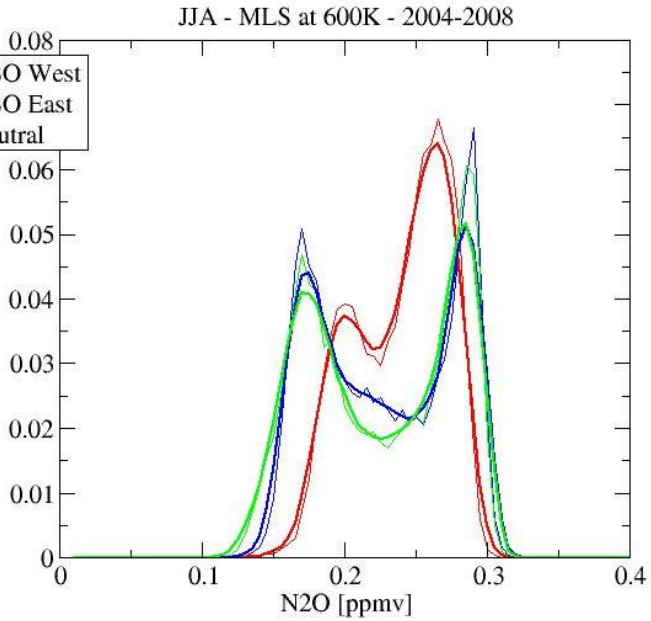
QBO during N2O observations




DJF - MIPAS at 600K - 2002-2004
QBO West
QBO East
Neutral
Probability
N2O [ppmv]
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.1
0.2
0.3
0.4


JJA - MIPAS at 600K - 2002-2004
N2O [ppmv]
0
0.01
0.02
0.03
0.04
0.05
0.06
0.08
0.1
0.2
0.3
0.4


DJF - MLS at 600K - 2004-2008
QBO West
QBO East
Neutral
Probability
N2O [ppmv]
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.1
0.2
0.3
0.4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0.02
0.03
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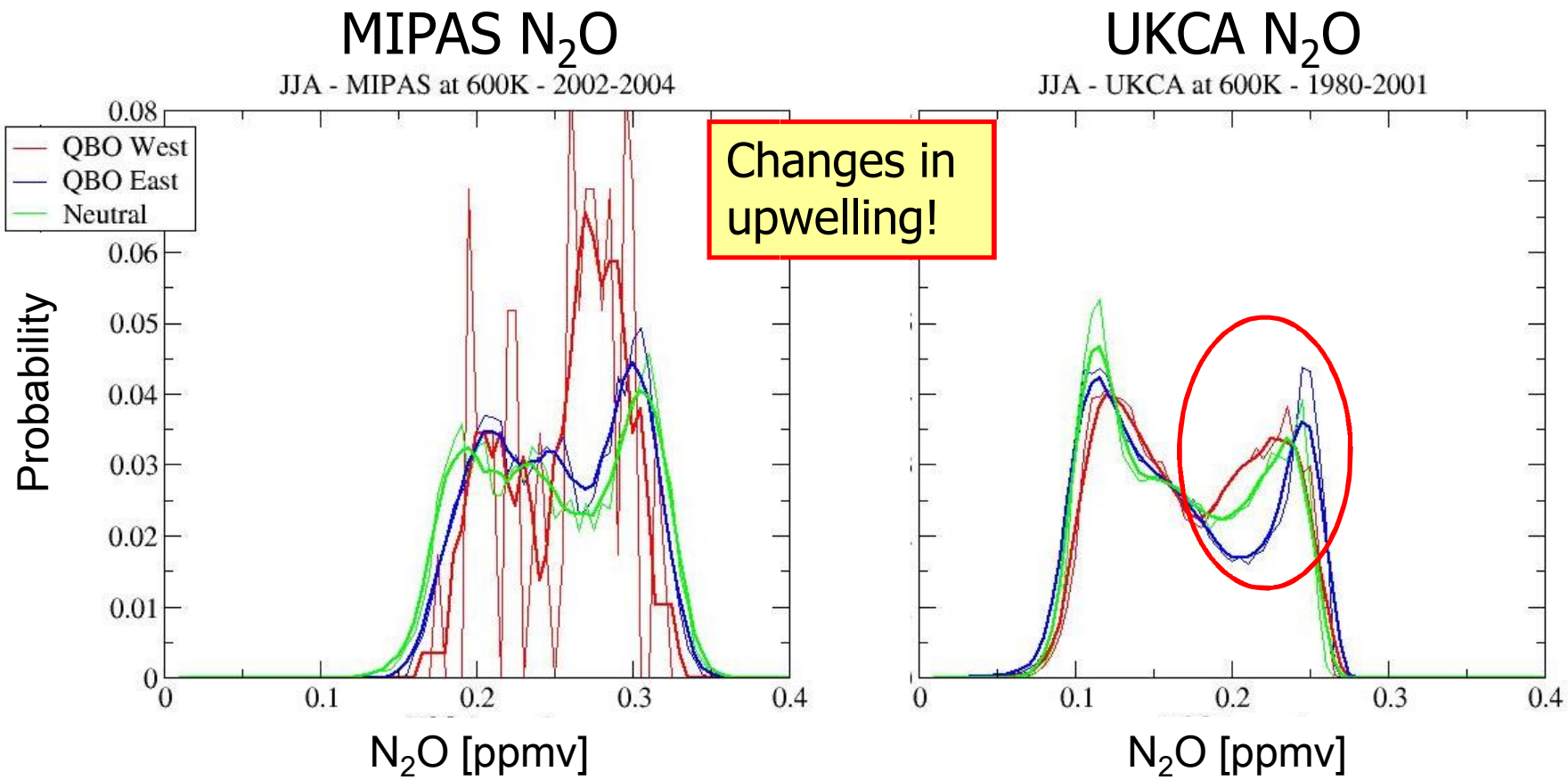
0.06
0.08
0.1
0.2
0.3
0.4

N2O JJA QBO Modulation



Snapshot versus 22 year climatology!

Summary and Outlook

- UKCA produces good agreement with observations.
- Nudging improves the meridional age gradient.
- Zonal asymmetries in age are reproduced.
- Snapshot N_2O PDFs compare well.
- QBO modulation of N_2O PDFs remains an issue.

- Improved UKCA simulations of the recent past.
- Hopefully more complete satellite data base:
  - Improved age observations?
  - Merged N2O climatology?

Met Office

Thank You!

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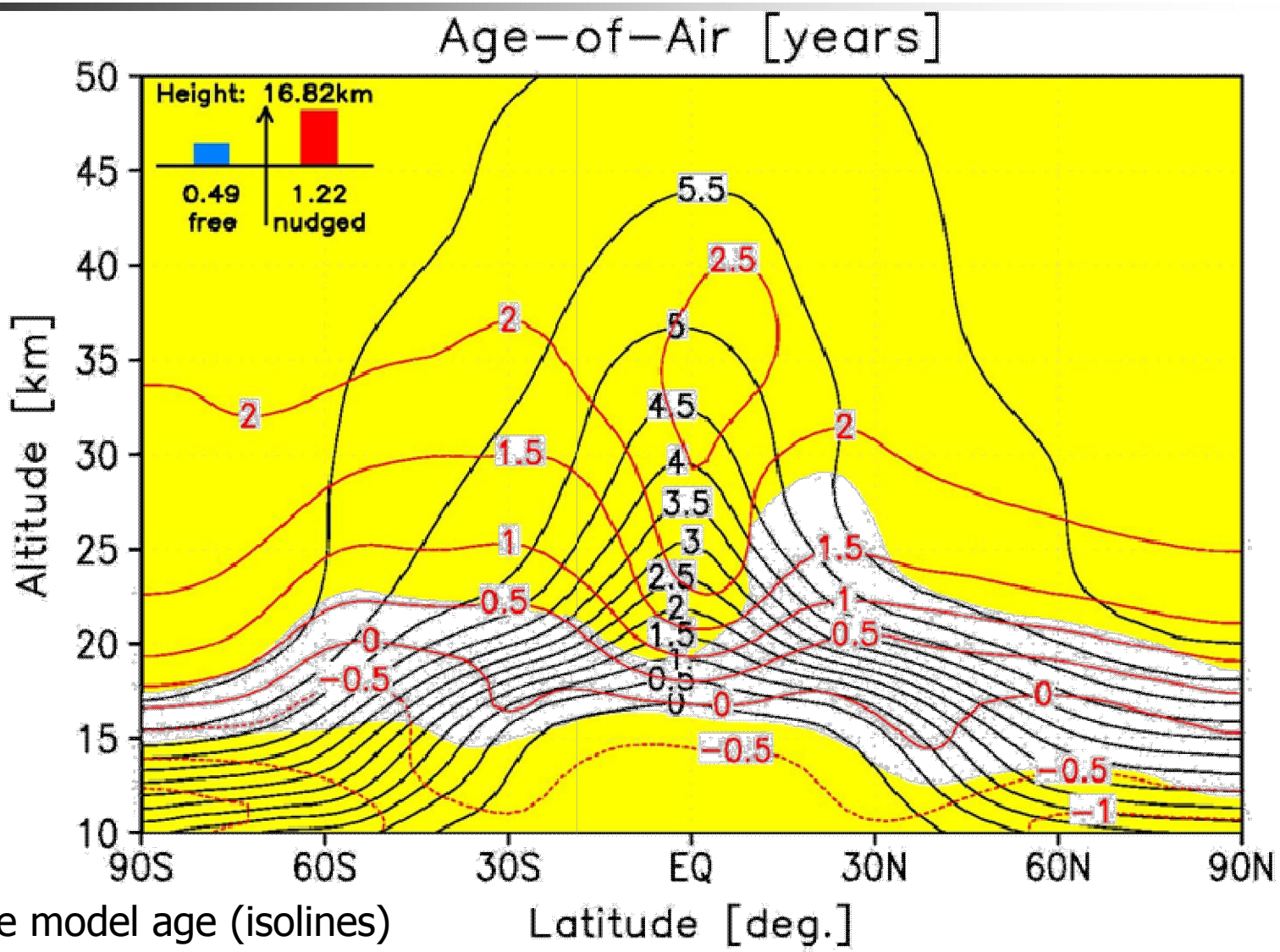
Age-of-Air: Nudged compared to climate UKCA

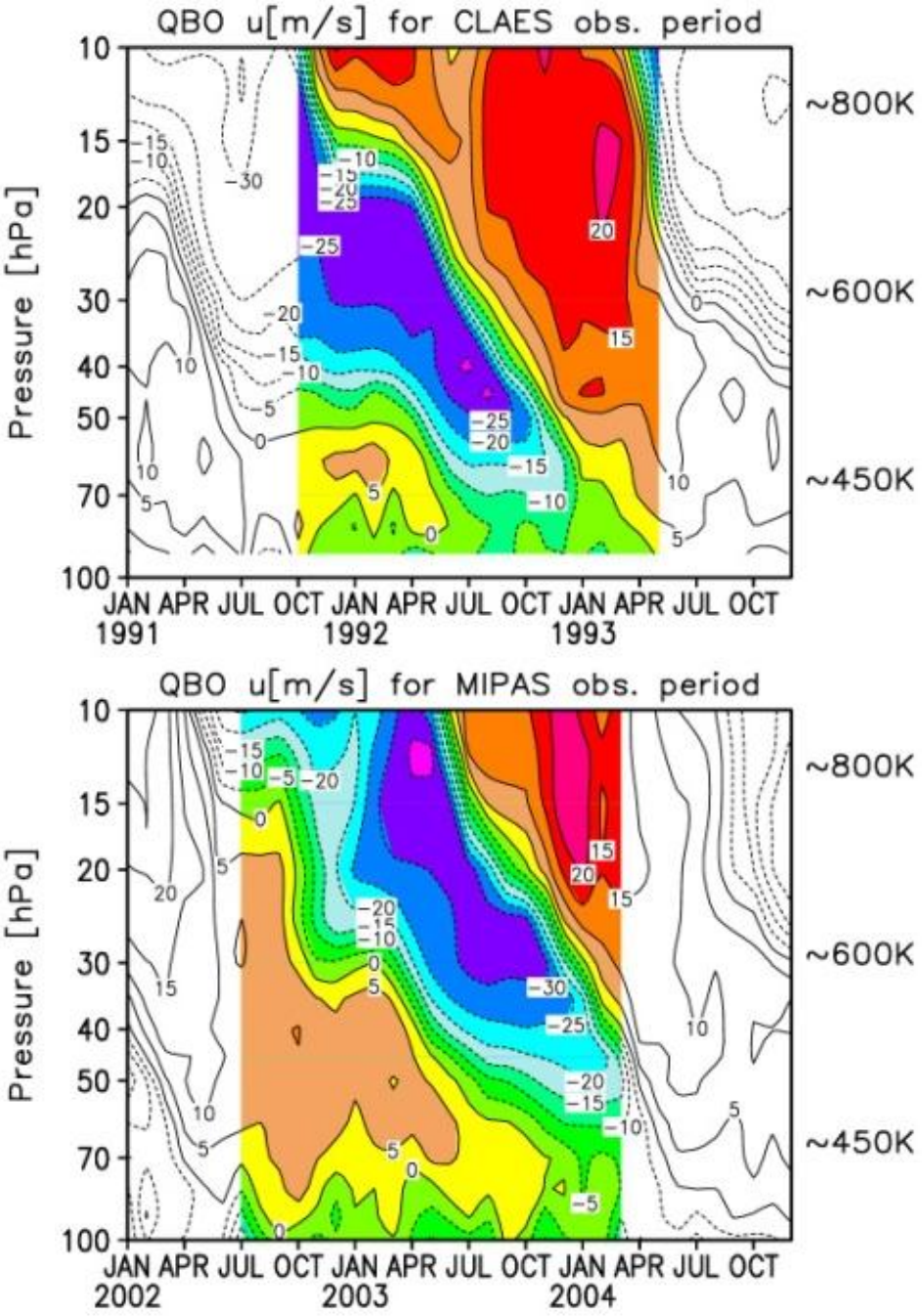


Mean climate model age (isolines)

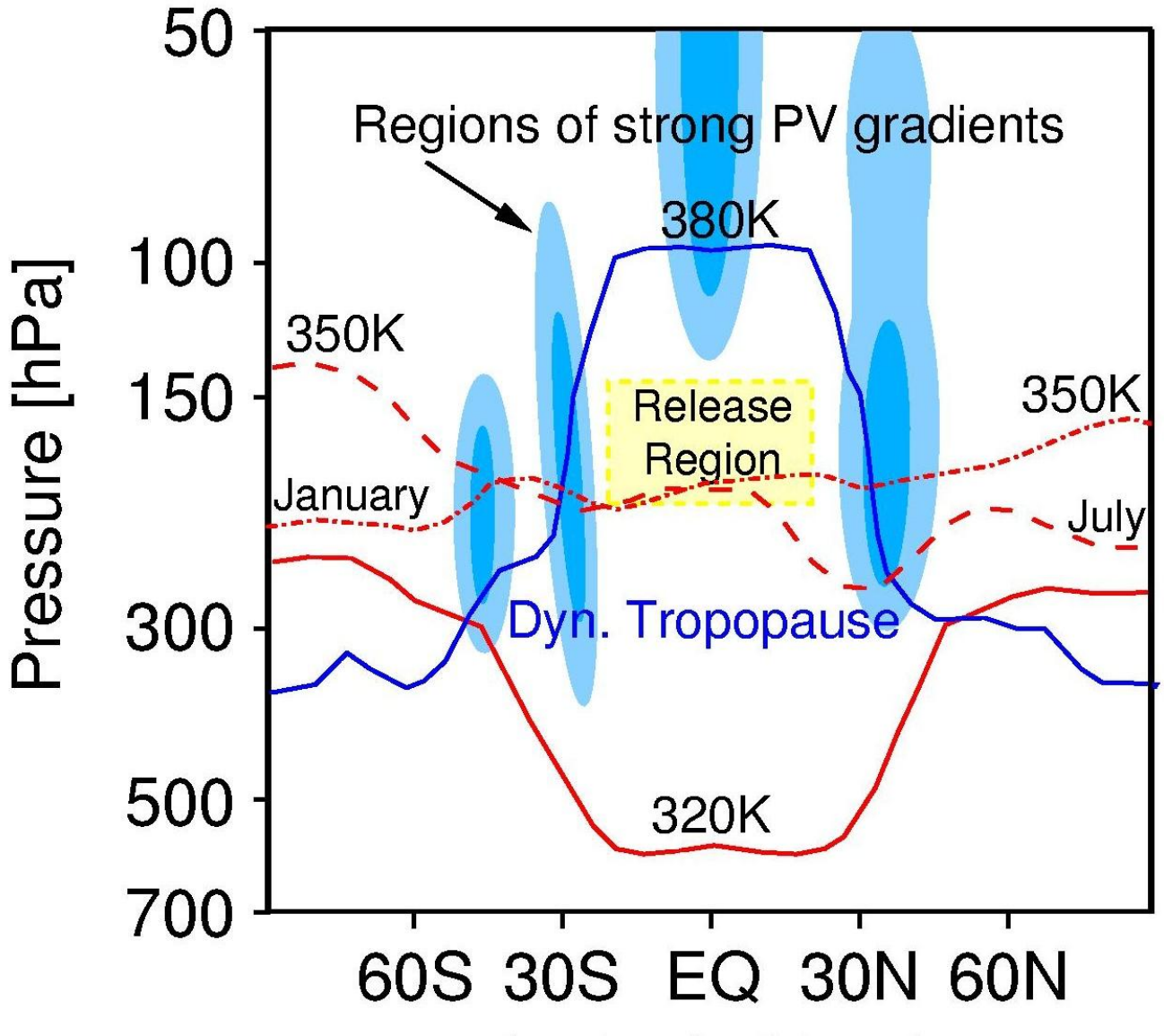
Age difference between nudged and climate model

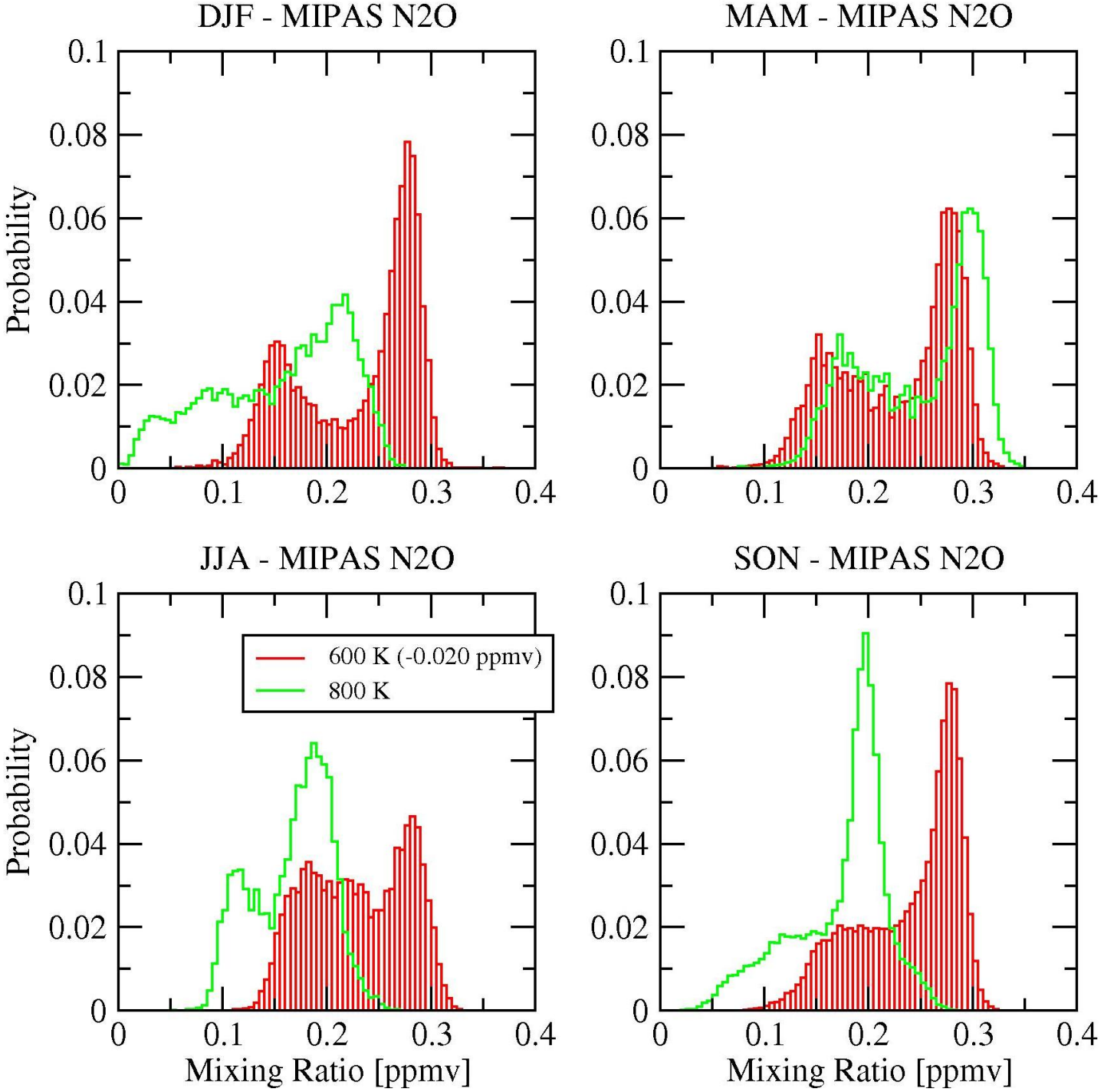
QBO?

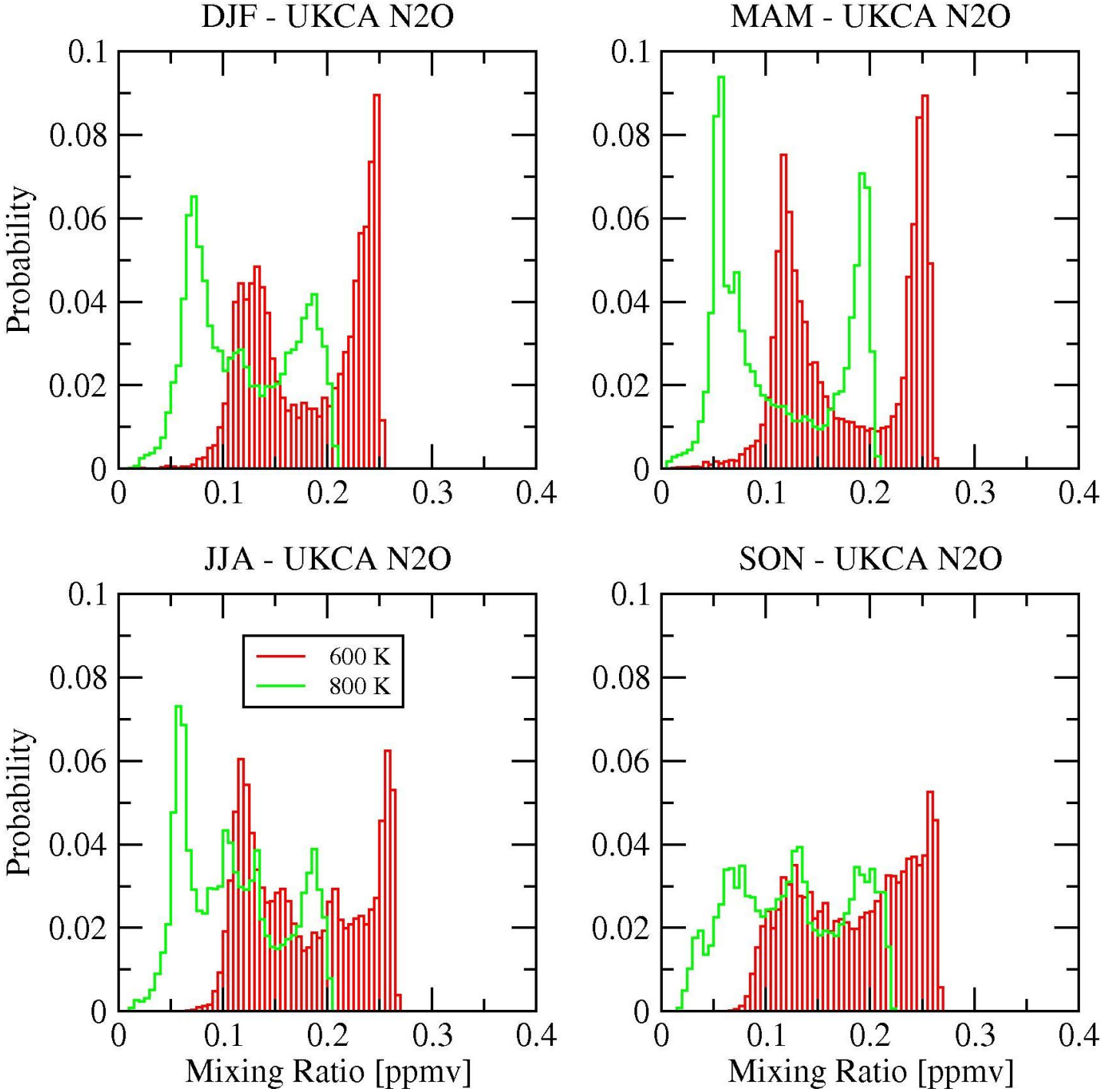
N2O Observation:
Sampling Issues?



PV Gradients




DJF - MIPAS N2O
MAM - MIPAS N2O
JJA - MIPAS N2O
SON - MIPAS N2O
Probability
Mixing Ratio [ppmv]
600 K (-0.020 ppmv)
800 K
0
0.02
0.04
0.06
0.08
0.1
0.1
0.2
0.3
0.4


DJF - UKCA N2O
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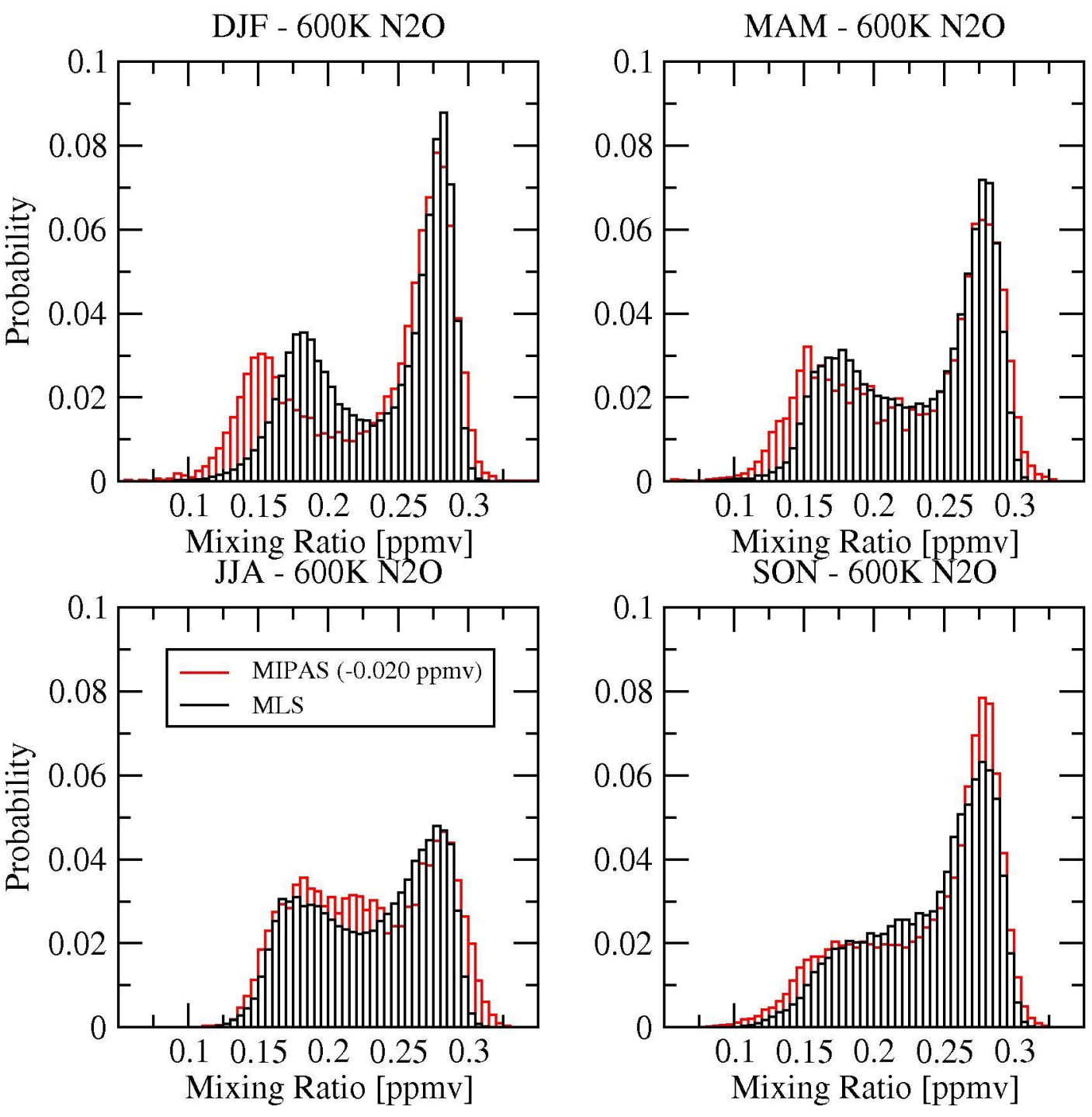
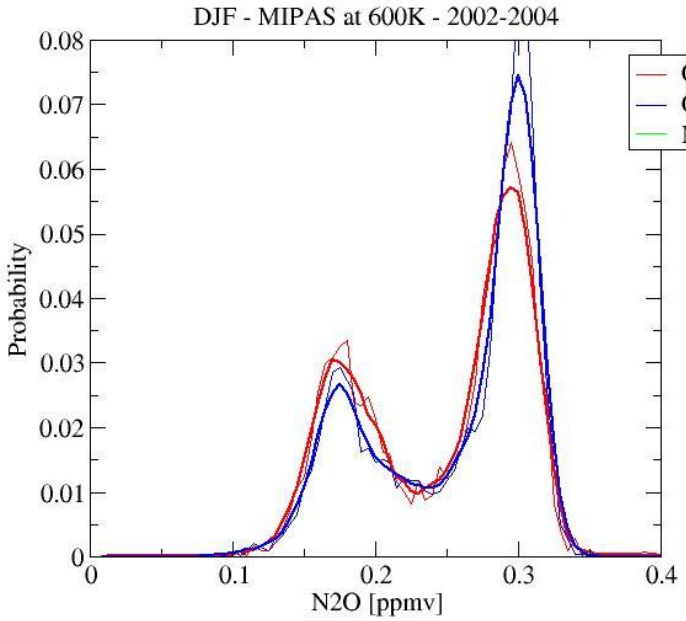
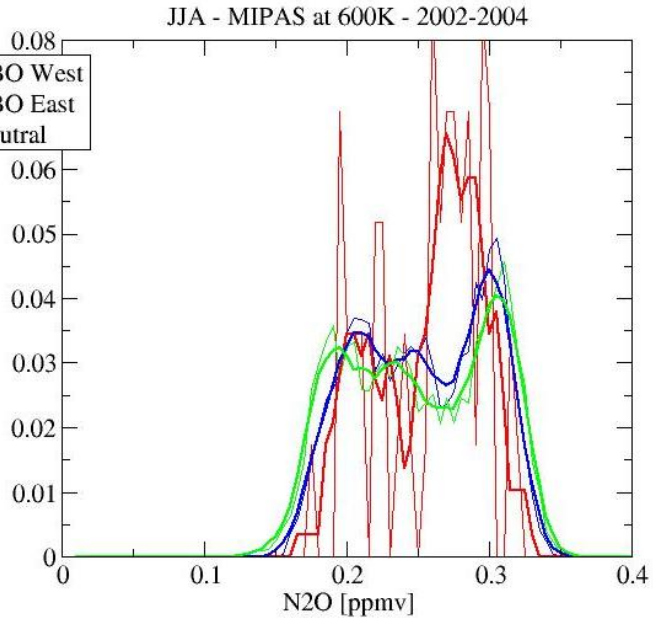

DJF - 600K N2O
MAM - 600K N2O
JJA - 600K N2O
SON - 600K N2O
Probability
Mixing Ratio [ppmv]
0.1
0.08
0.06
0.04
0.02
0
0.1 0.15 0.2 0.25 0.3
MIPAS (-0.020 ppmv)
MLS


DJF - MIPAS at 600K - 2002-2004
QBO West
QBO East
Neutral
Probability
N2O [ppmv]
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.1
0.2
0.3
0.4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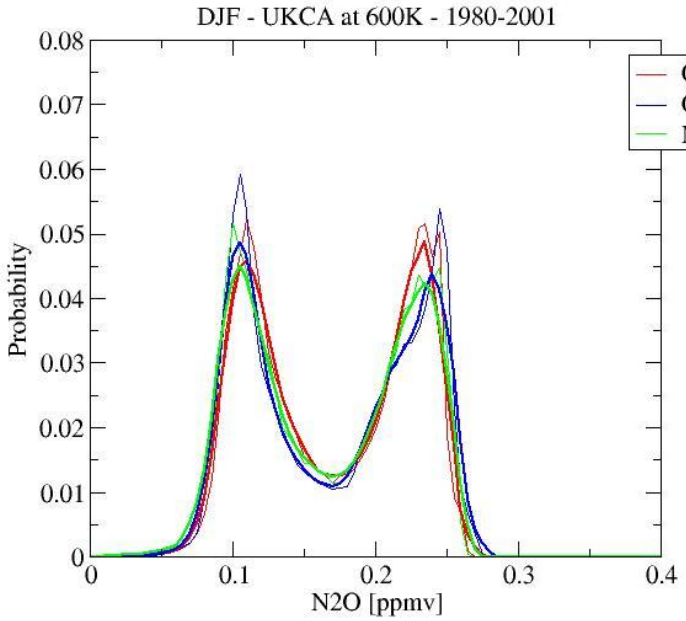
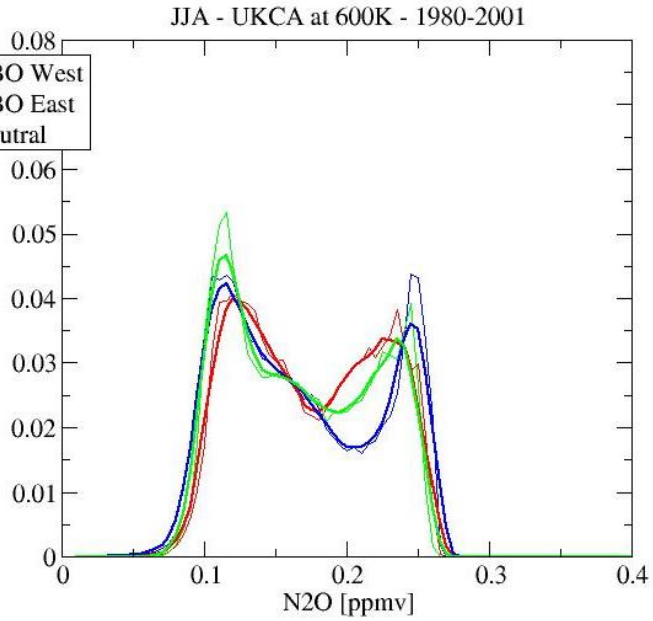
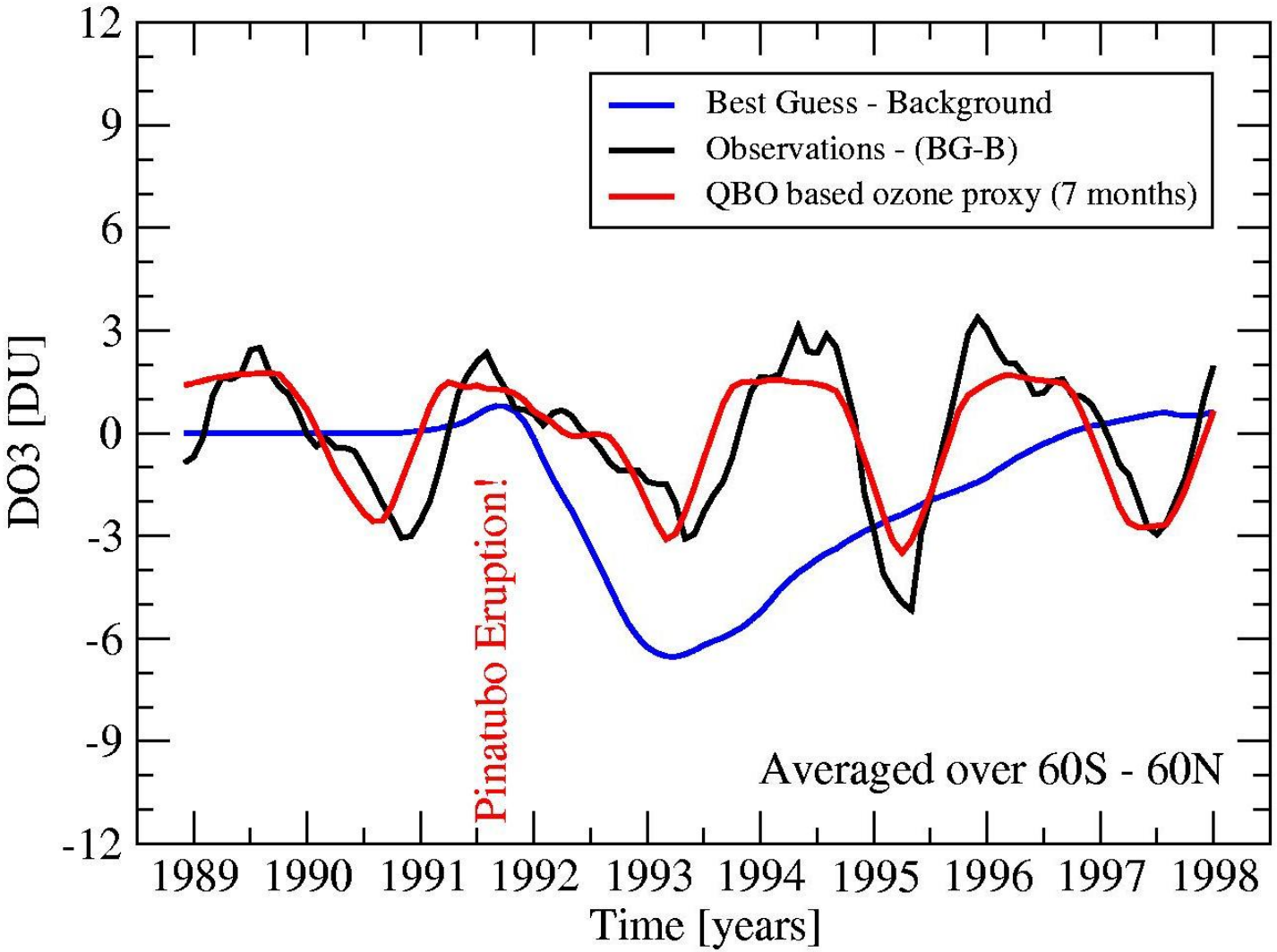
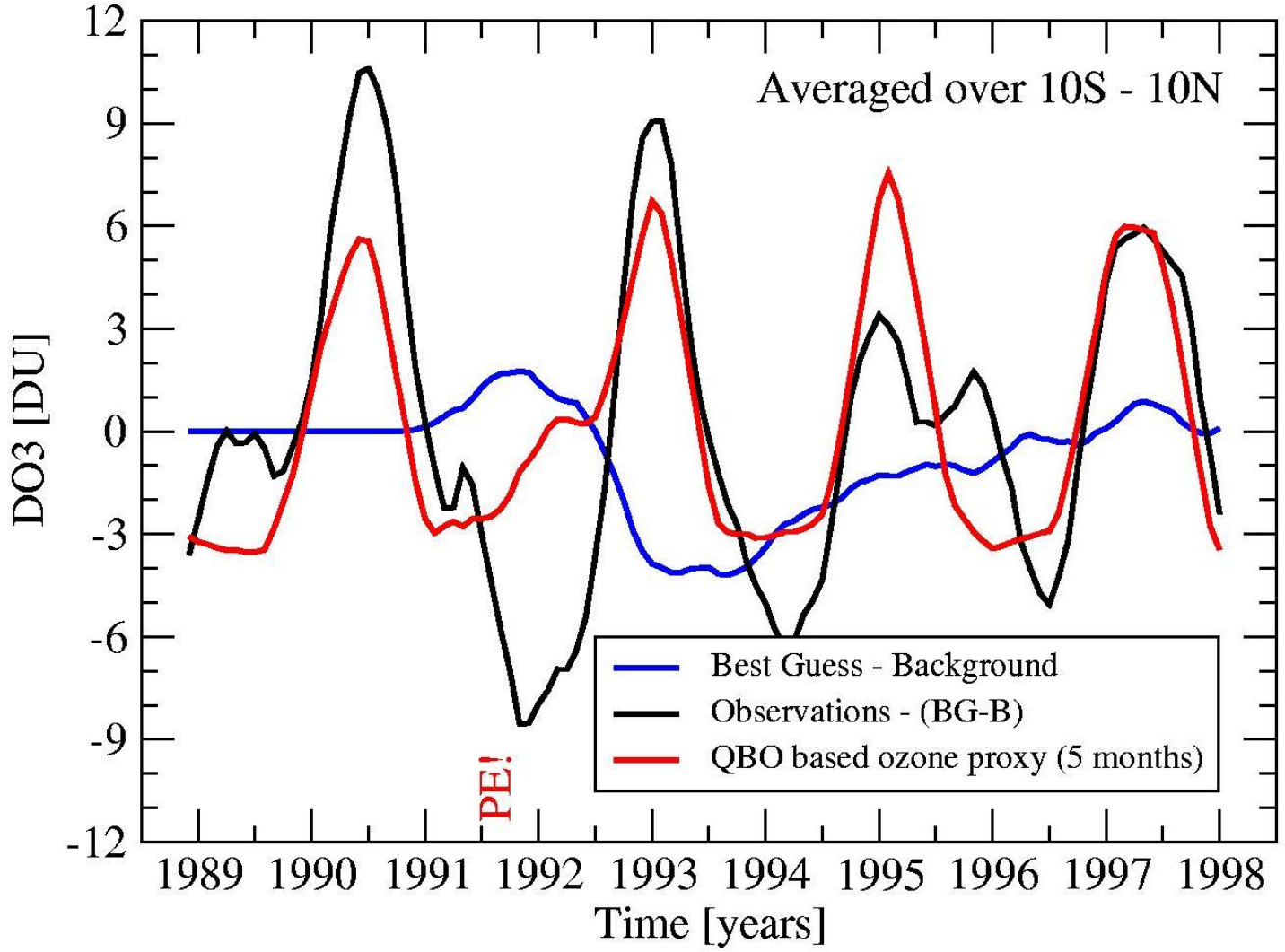

DJF - UKCA at 600K - 1980-2001
QBO West
QBO East
Neutral
Probability
N2O [ppmv]
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.1
0.2
0.3
0.4


JJA - UKCA at 600K - 1980-2001
N2O [ppmv]
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.1
0.2
0.3
0.4

Global O3 after Pinatubo



Tropical O3 after Pinatubo



Pinatubo in higher latitudes