

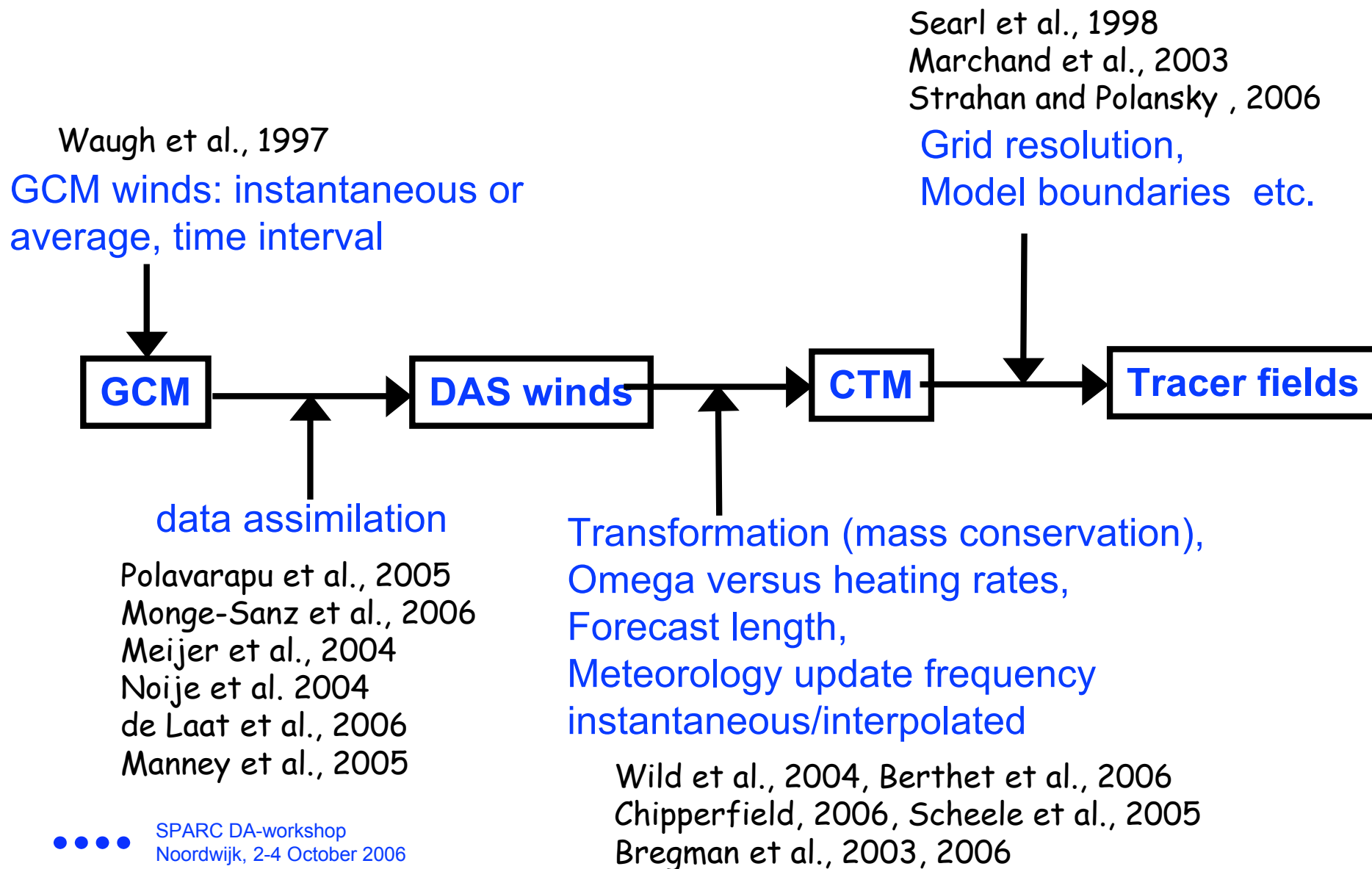
# Diagnosing stratospheric winds and their use in CTMs

Bram Bregman

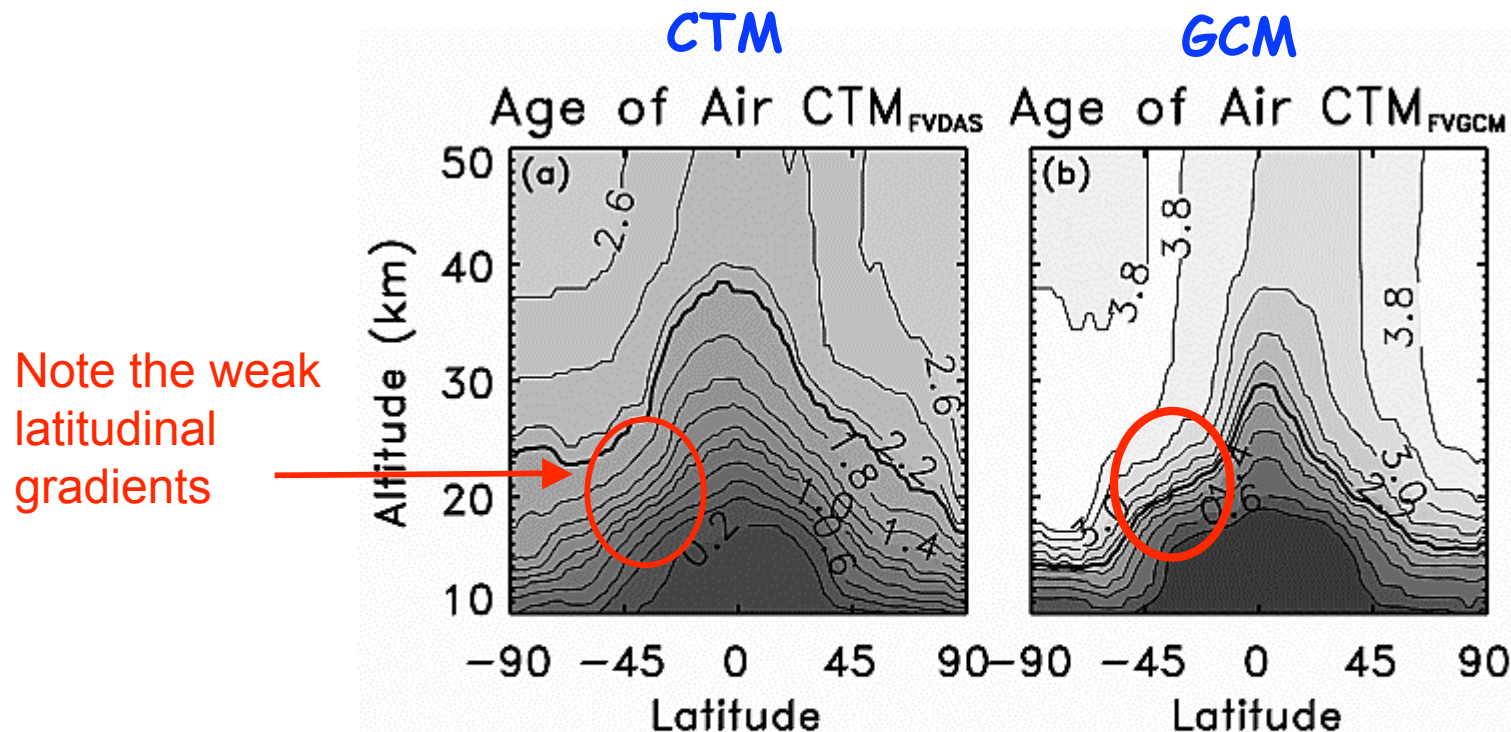
Royal Netherlands Meteorological Institute



# 'From GCM to CTM'



# Assimilated winds produce much younger mean age of air than GCM winds

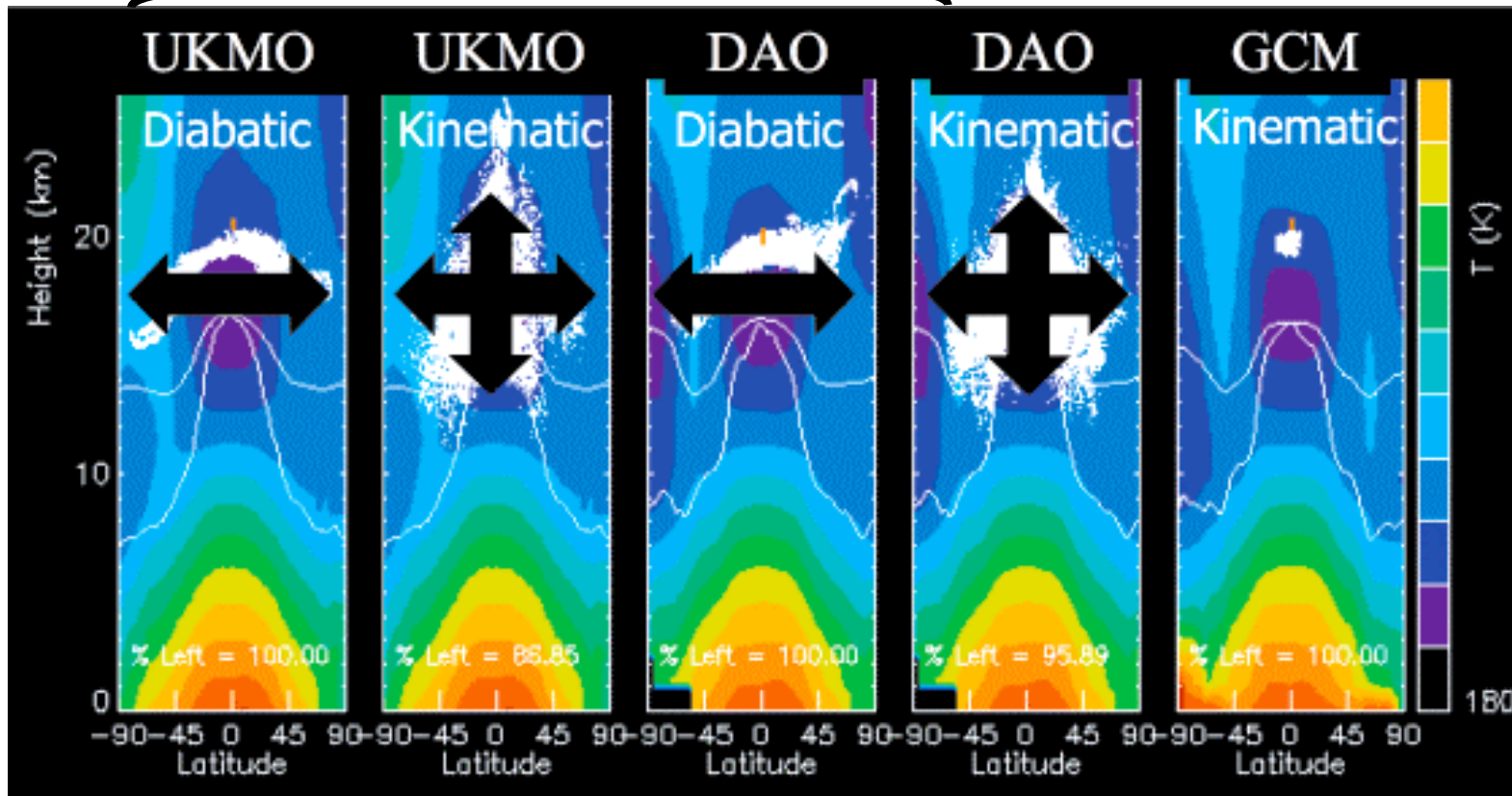


**Figure 6.** (a) Age of air (years) calculated from an SF-6 simulation using CTM<sub>FVDAS</sub>. The age calculation converges after 5 years integration. (b) Same as Figure 6a but using CTM<sub>FVGCM</sub>. The age calculation converges after 9 years integration. The contour interval is 0.2 years; the 2-year contour is bold for both panels.

(Douglass et al. JGR, 2003)

# DAS winds are dispersive

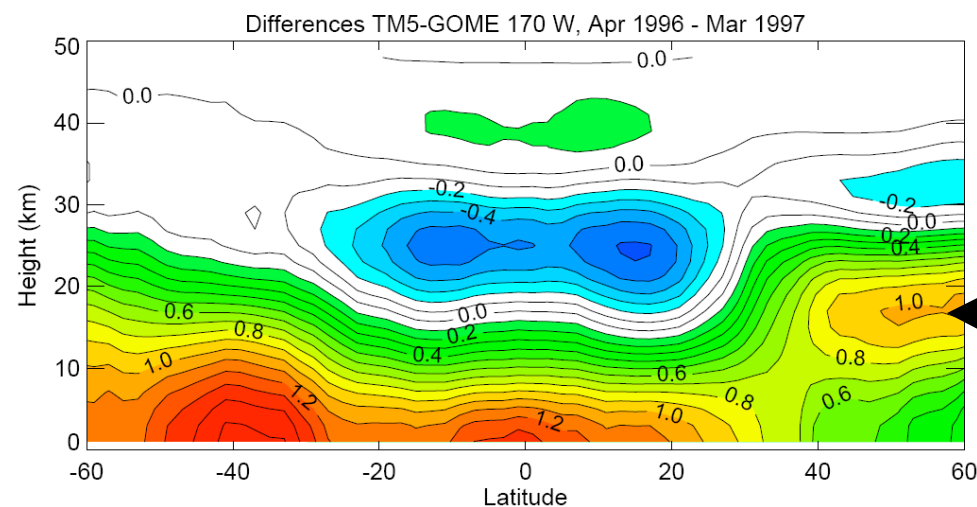
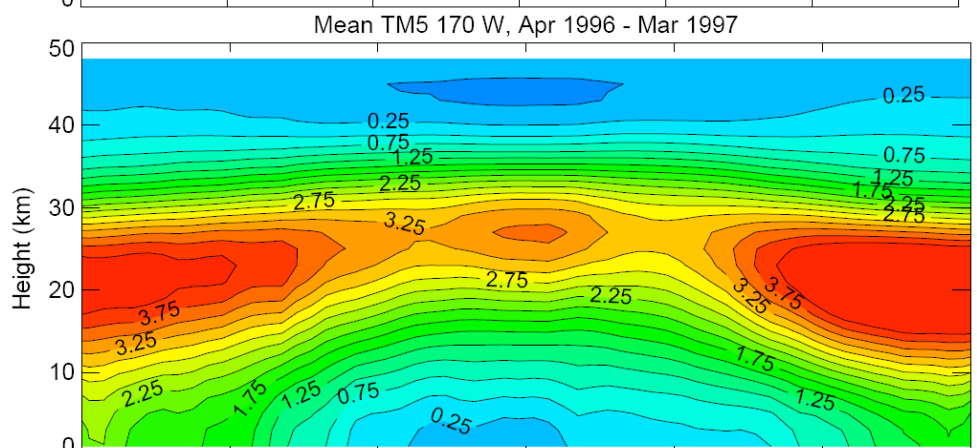
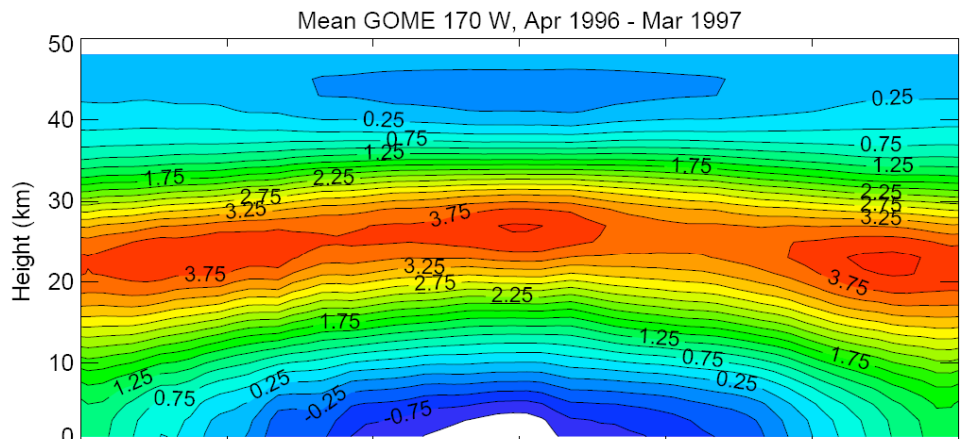
DAS



Kinematic: considerable vertical and horizontal dispersion  
Diabatic: vertical dispersion reduced (smooth heating rates)  
GCM: very little dispersion, regardless of method used:



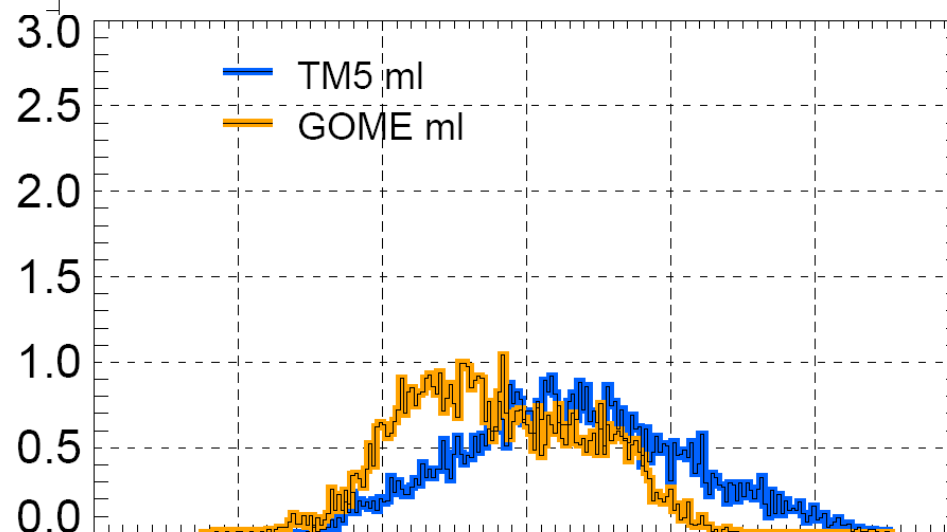
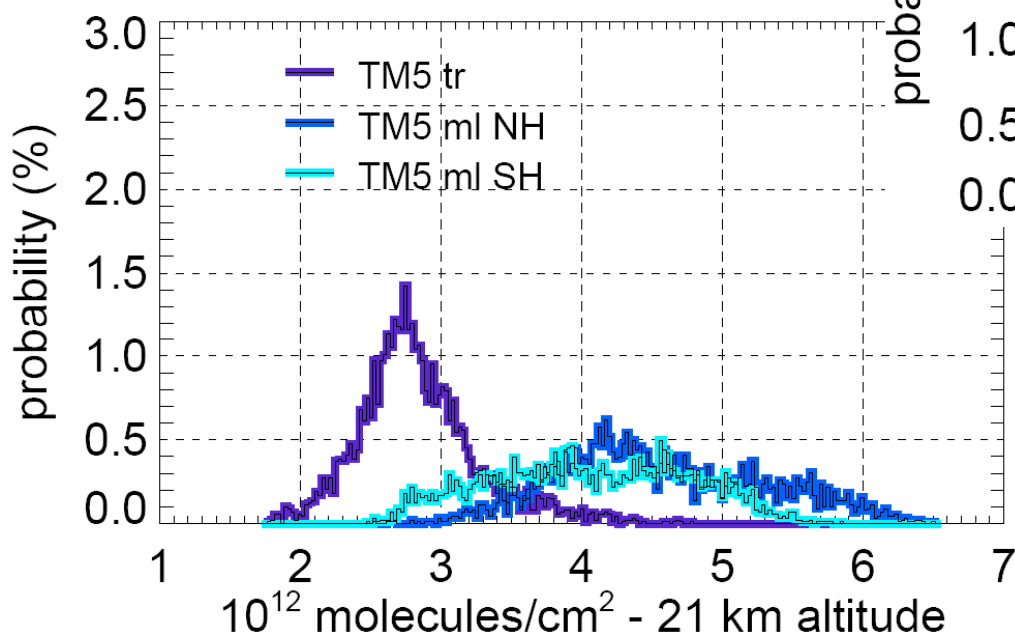
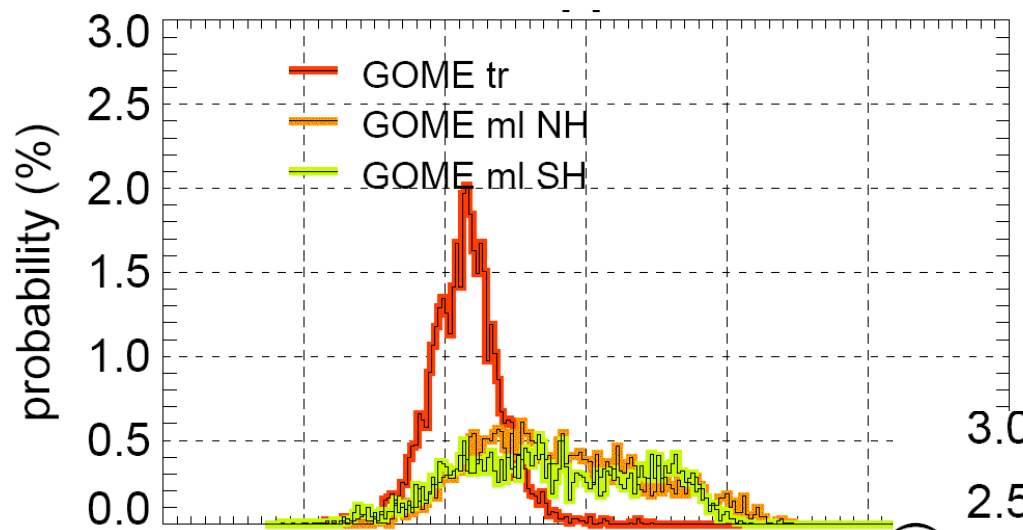
# Latitudinal ozone cross-sections: ECMWF Operational Data (OD) in TM5 - GOME



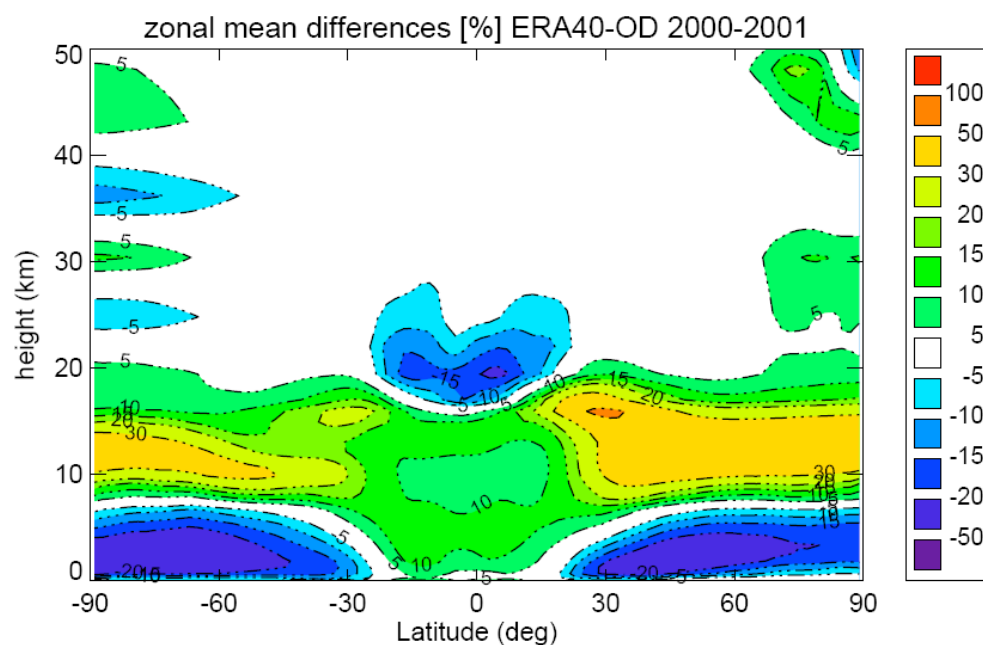
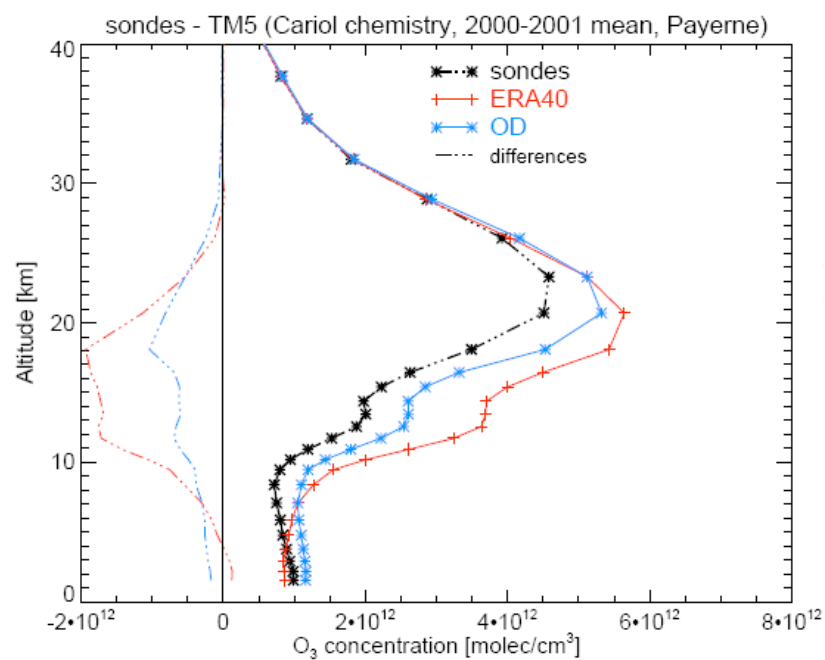
ozone accumulation

(De Laat et al., JGR, 2006)

# GOME and TM5 ozone: PDF's

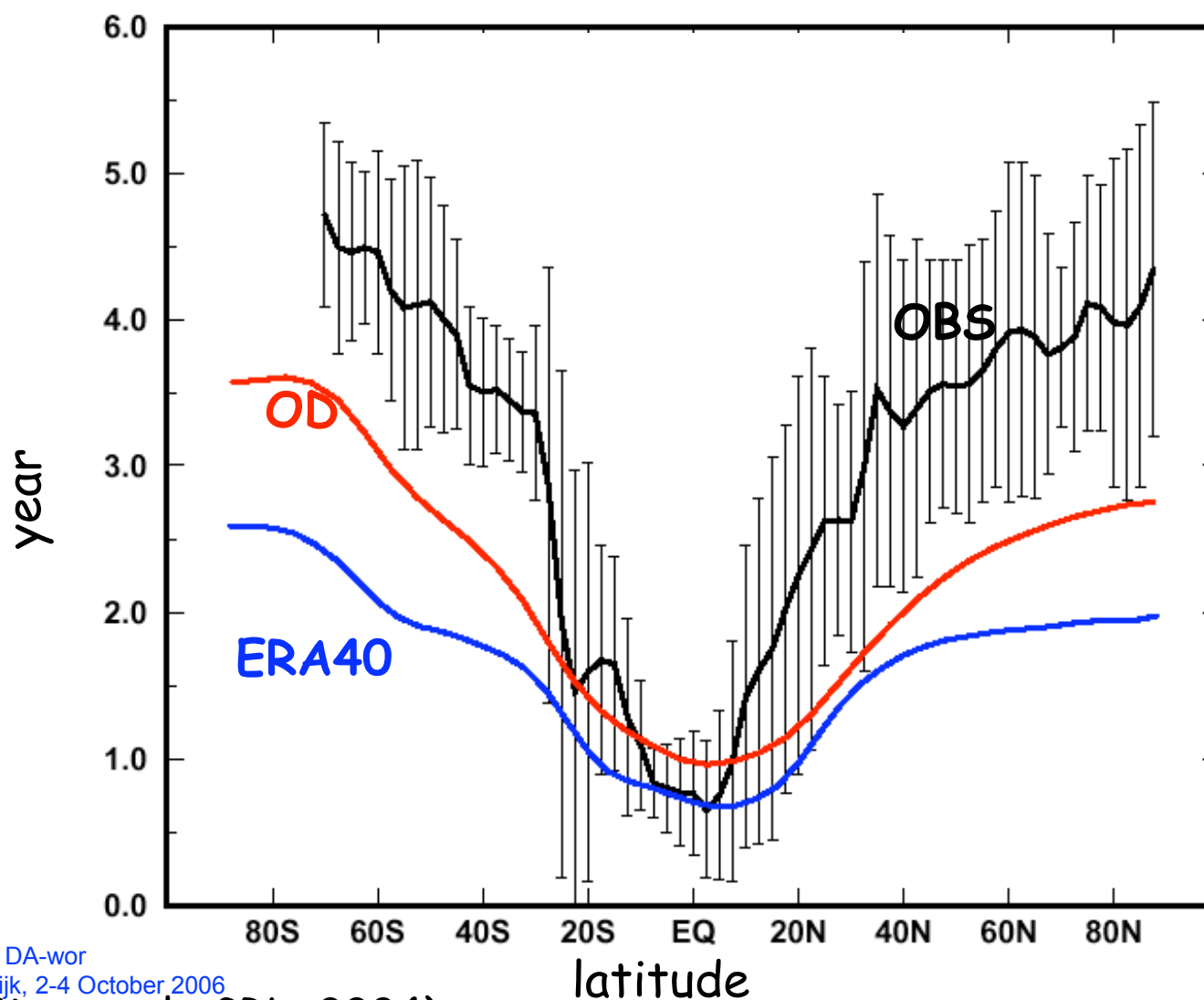


# Ozone: OD – ERA40



(De Laat et al., JGR, 2006)

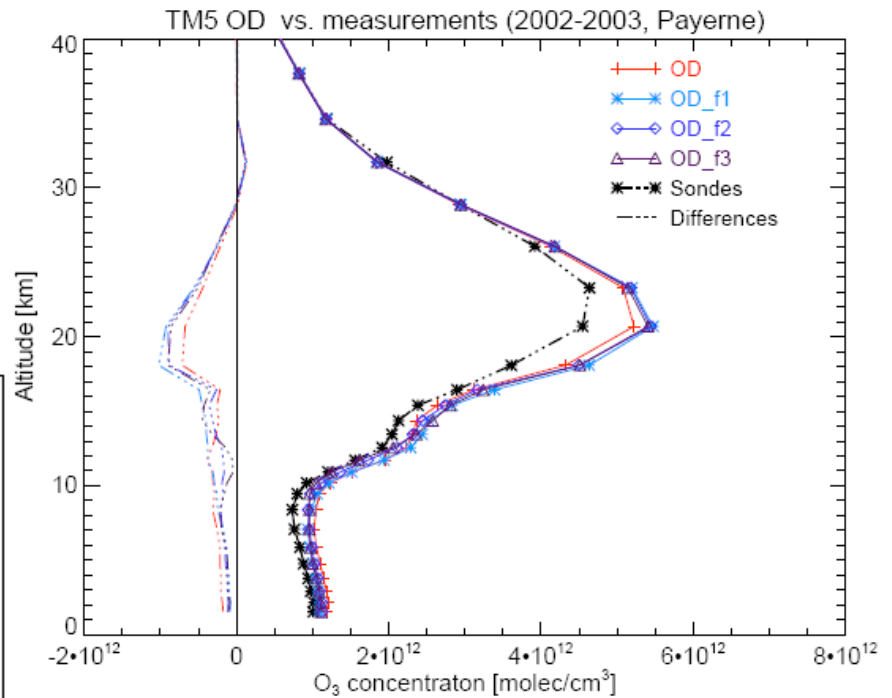
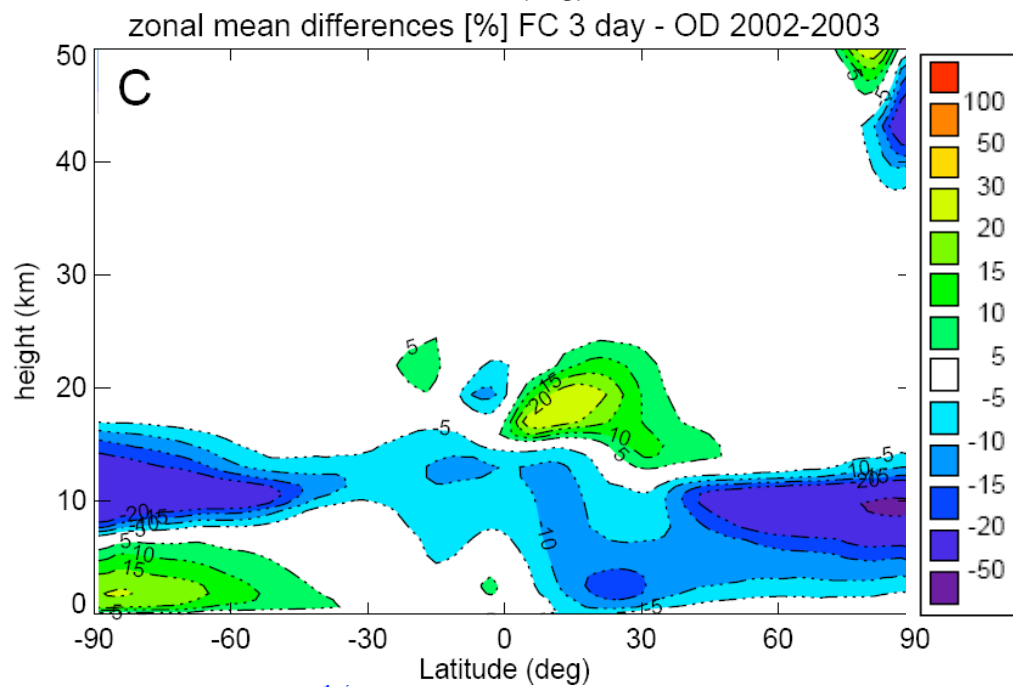
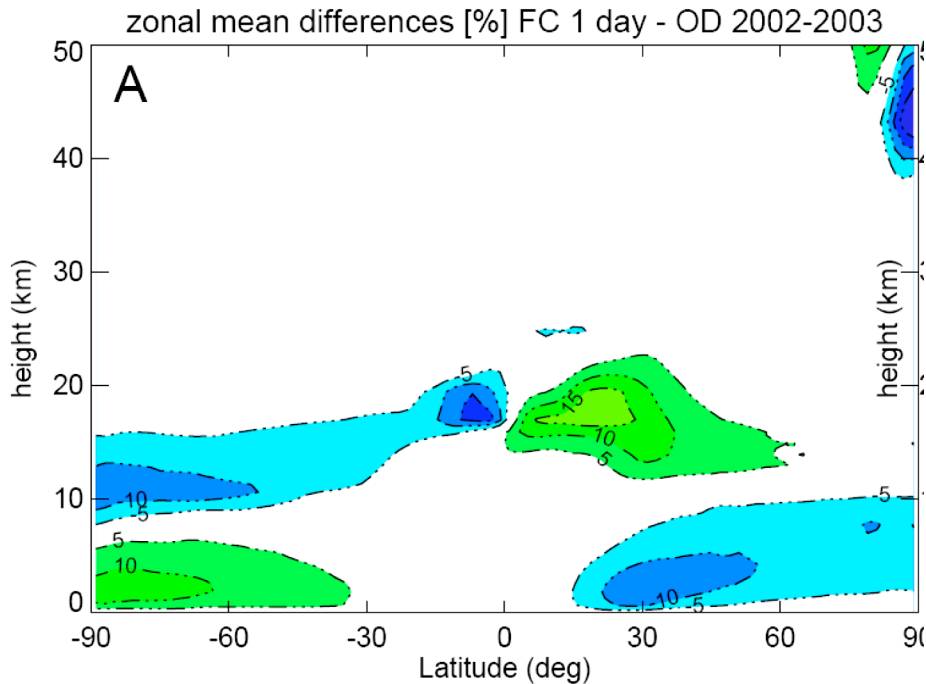
# Mean age of air: OD – ERA40



SPARC DA-wor  
 Noordwijk, 2-4 October 2006  
 (Meijer et al., GRL, 2004)

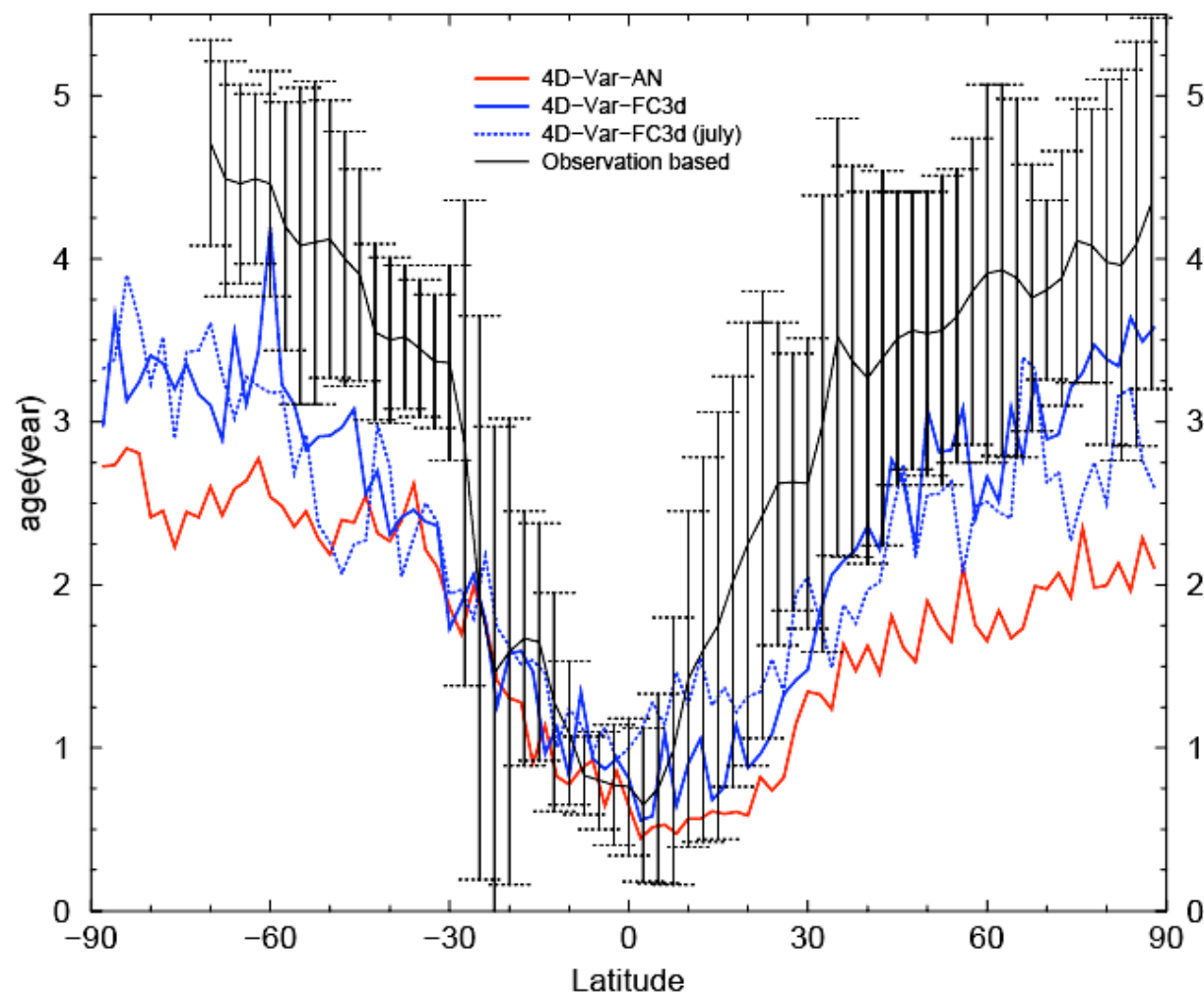


# Forecast length +1 day up to +3 days



(De laet et al., JGR, 2006)

# Mean age of air: forecast length



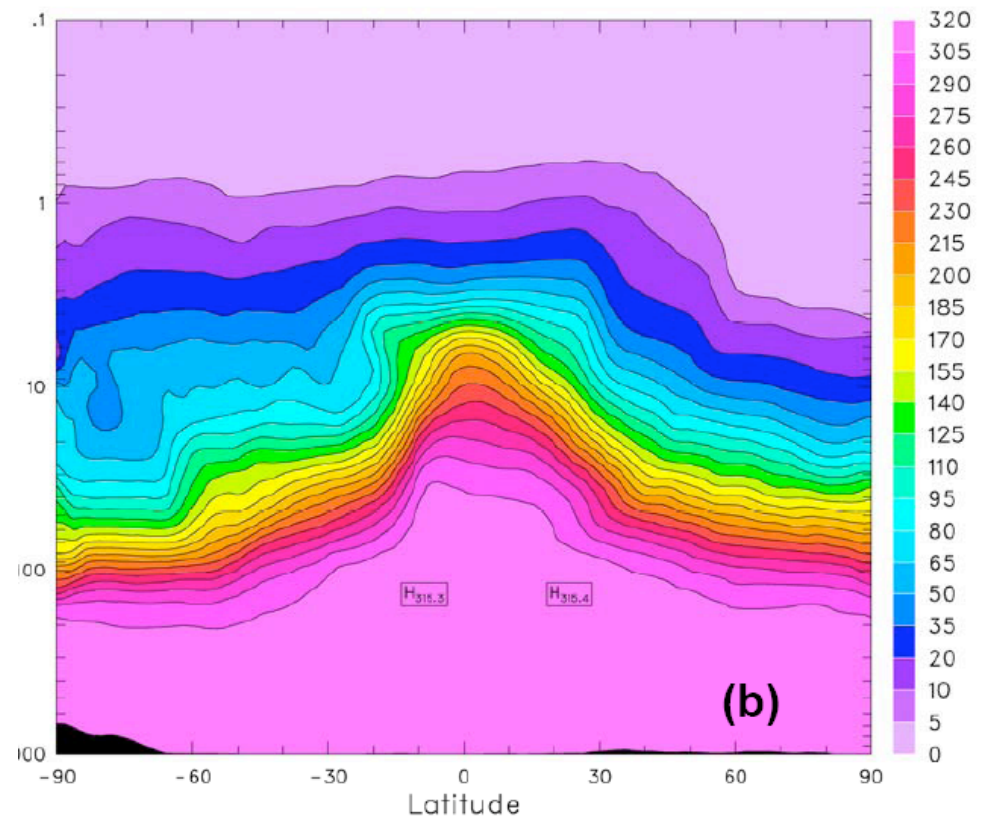
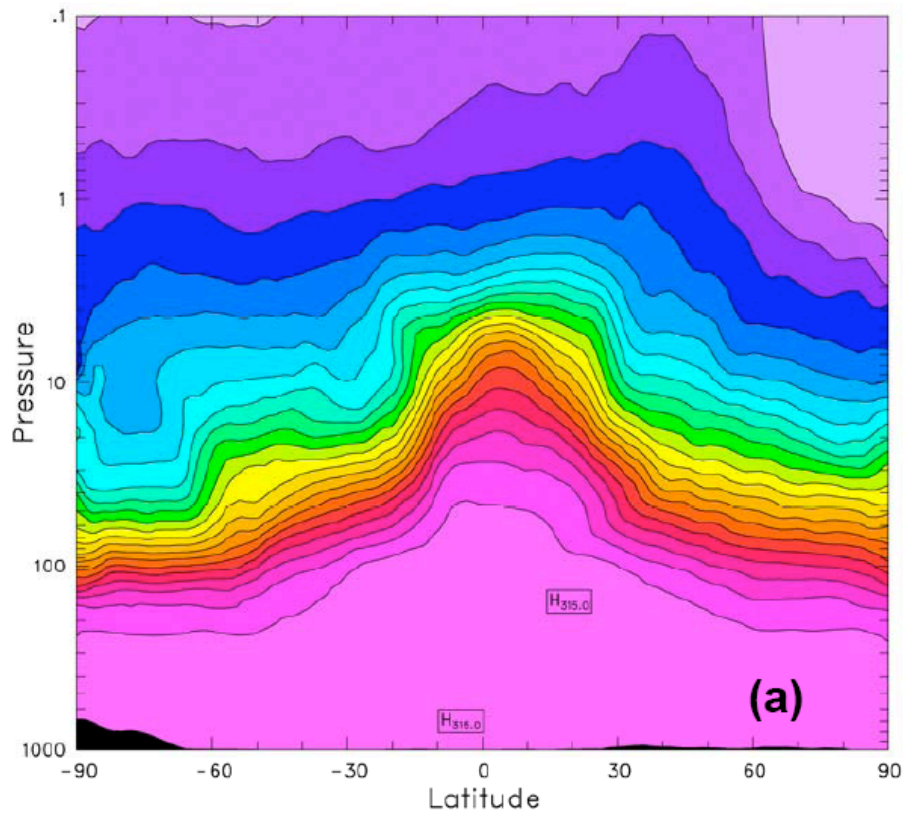
# N<sub>2</sub>O distributions and update frequency: 3-hrly versus 6-hourly



6-hourly

2 oktober 2002 8 UT

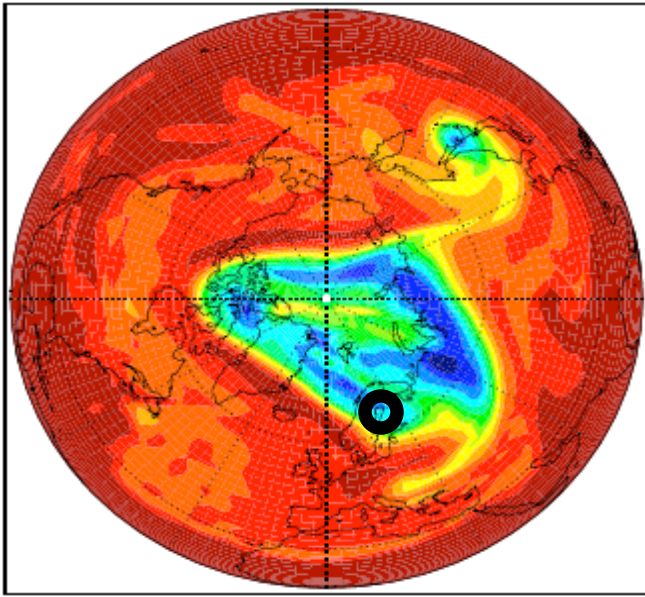
3-hourly



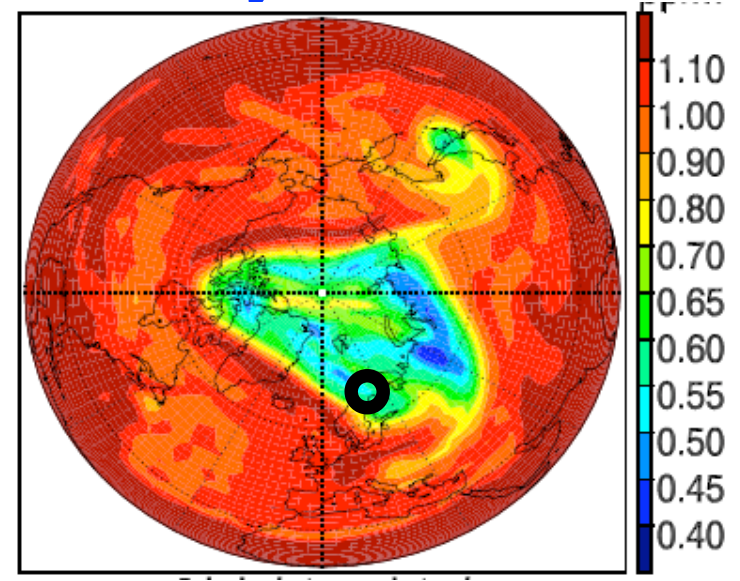
# CH<sub>4</sub> distribution: update frequency



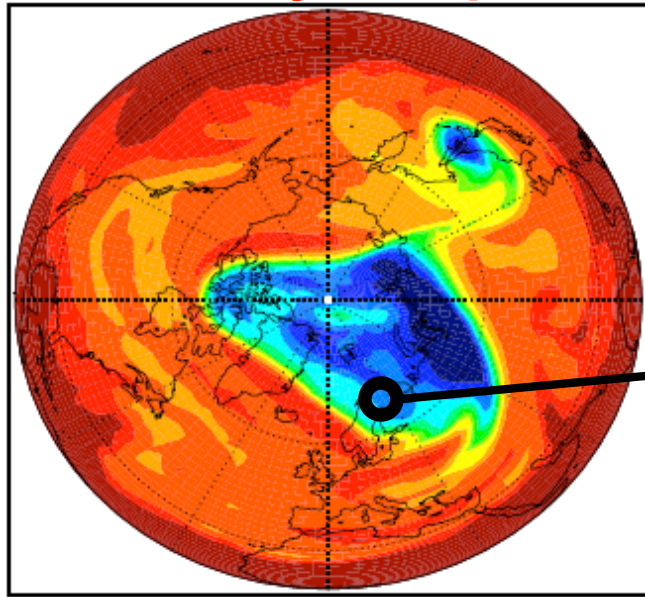
6-hourly interpolated



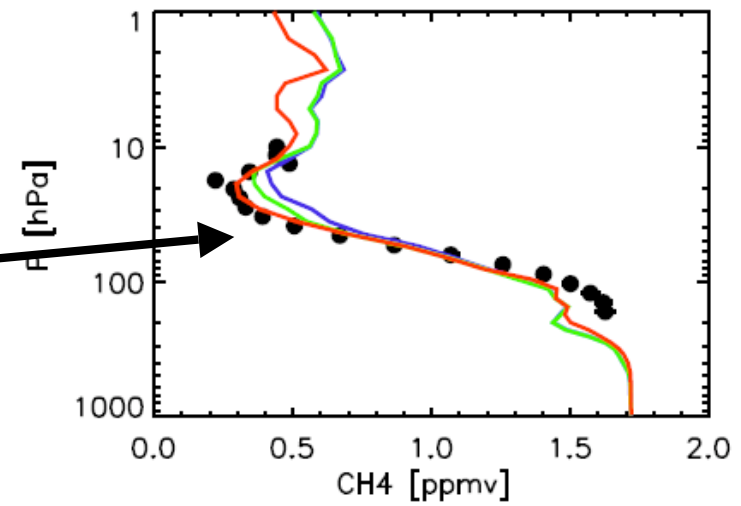
6-hourly instantaneous



3-hourly interpolated



2000-03-15

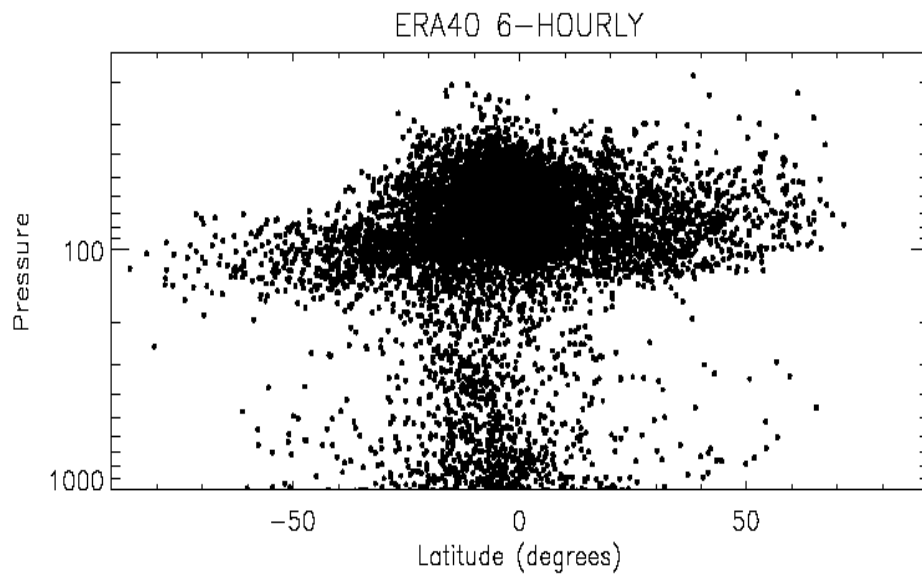
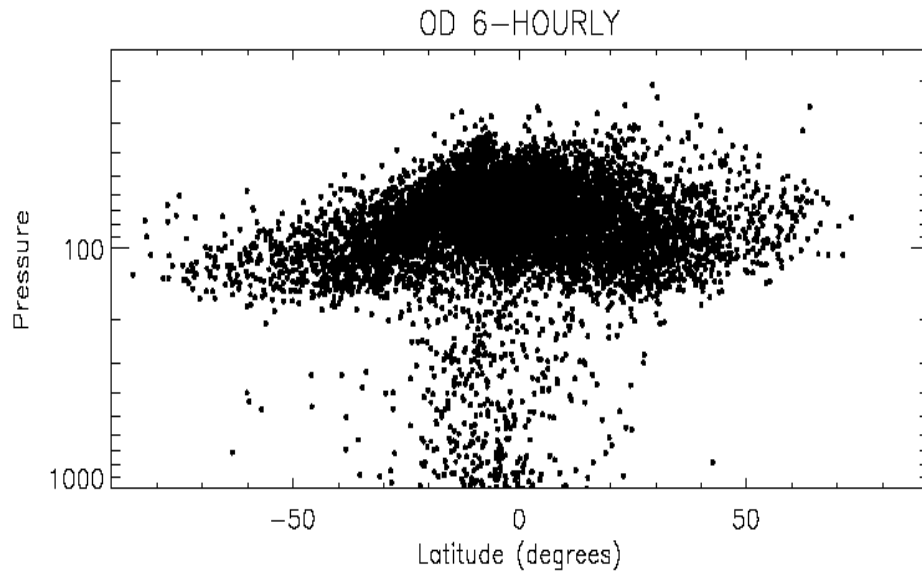


6hrly inst.  
6hrly interp.  
3hrly interp.

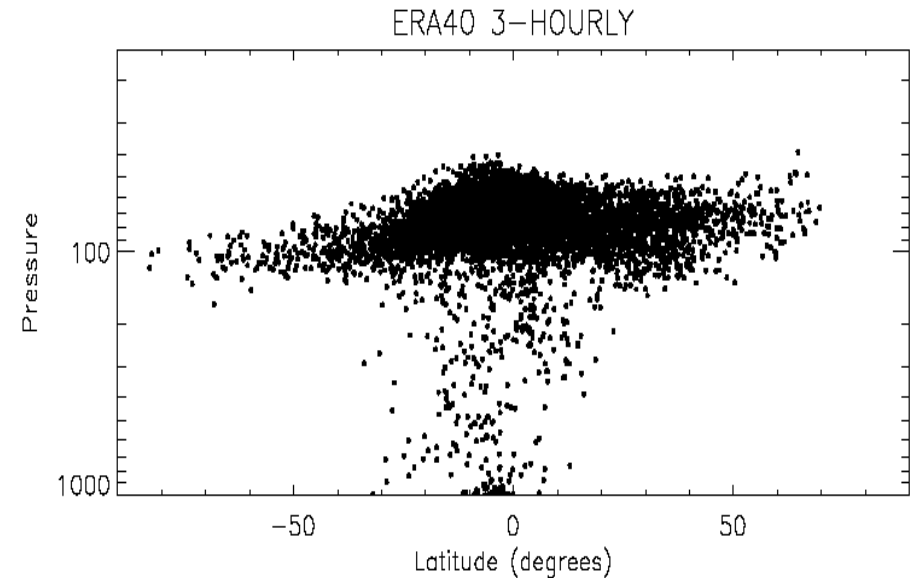
(Bregman et al.,  
ACP, 2006)



# Air parcel dispersion and update frequency

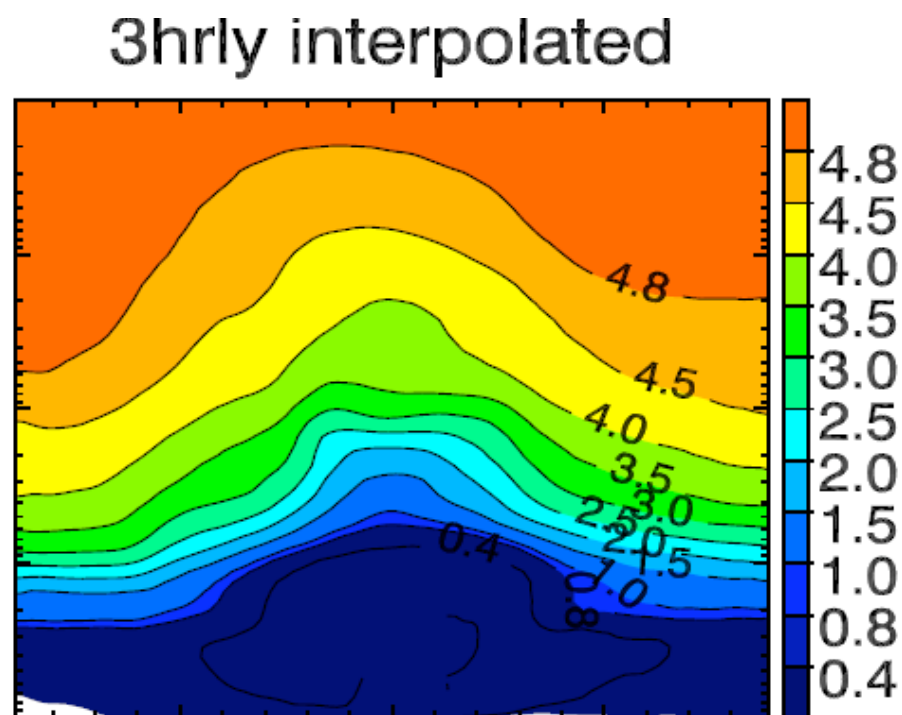
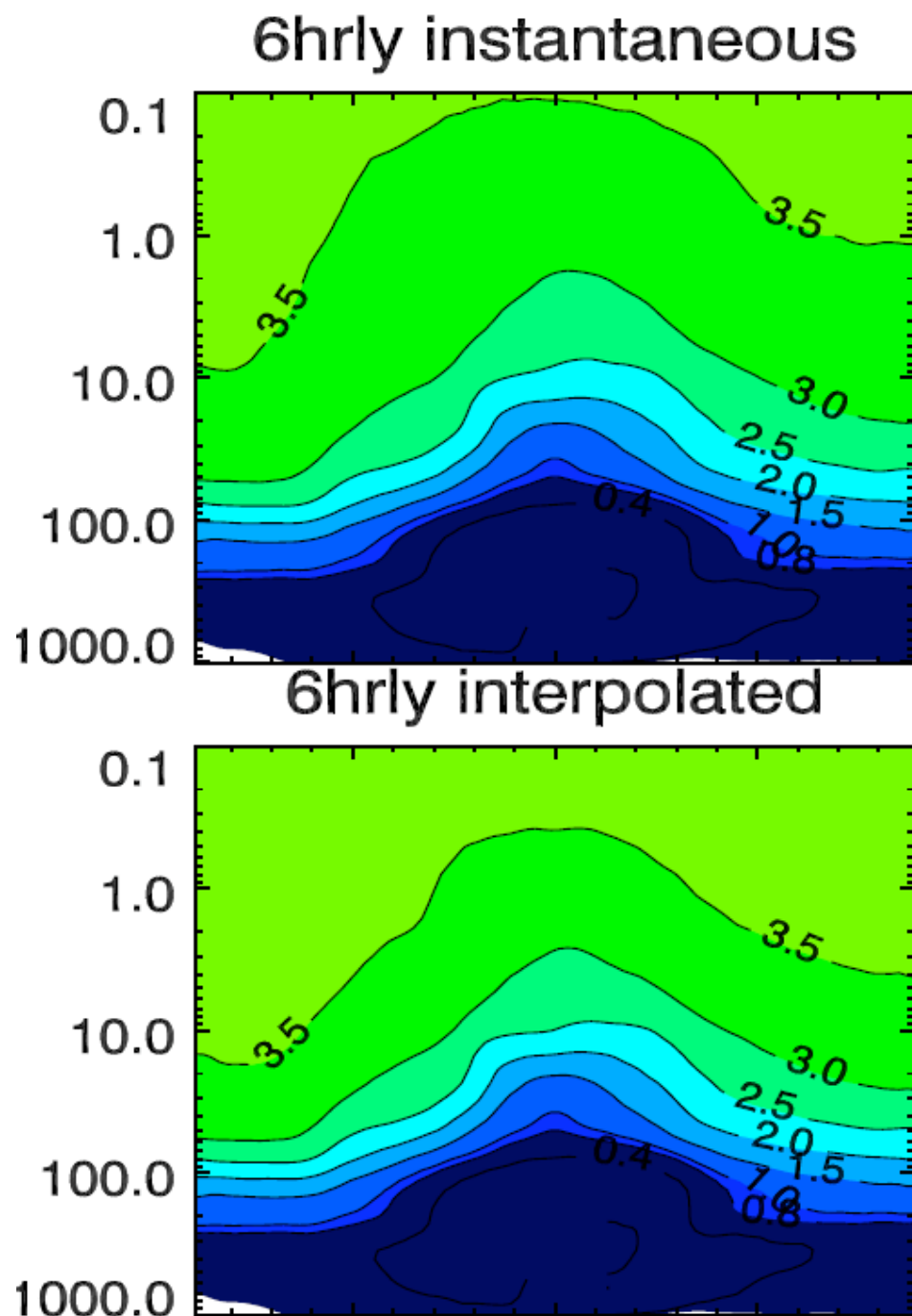


even ERA40 less dispersive than OD!



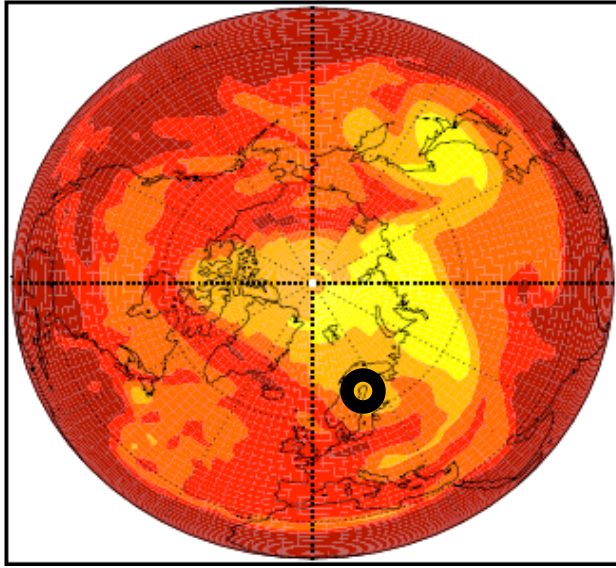
Bregman et al., ACP, 2006

# Mean age of air and update frequency

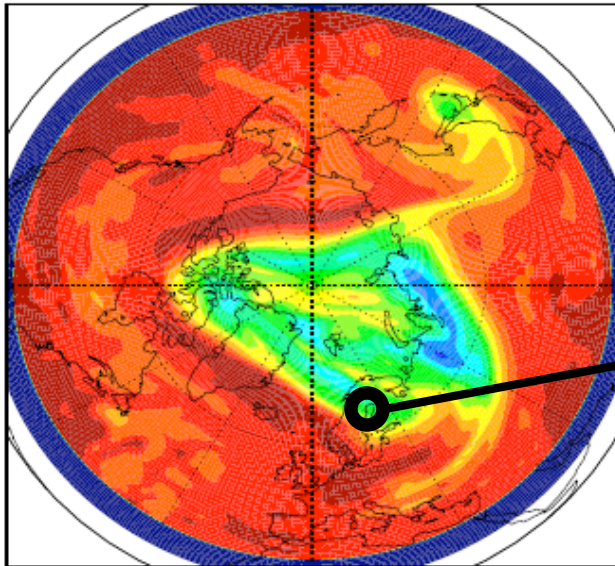


Bregman et al., ACP, 2006

3x2 first-order adv./ Red. polar grid



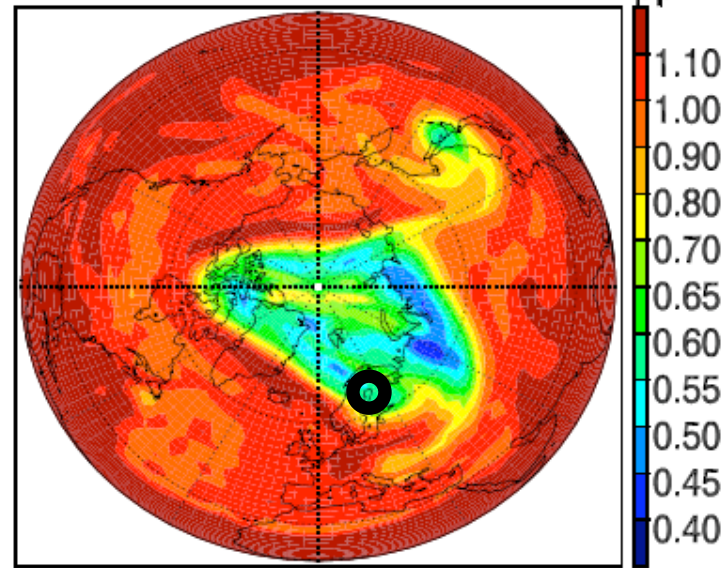
1x1 first-order adv.



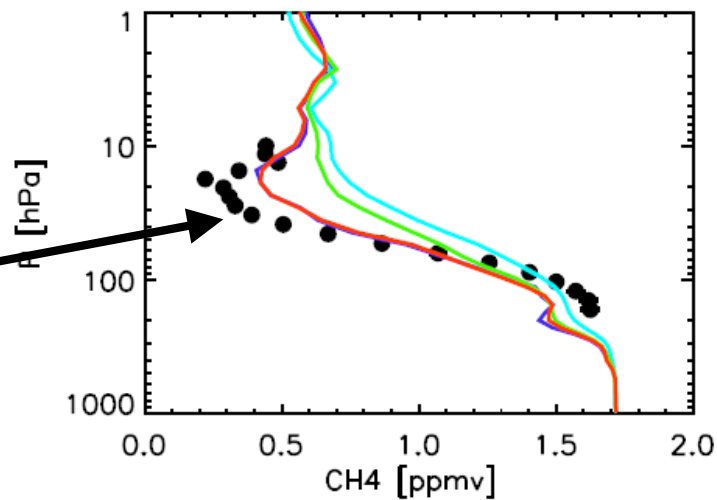
effects:  
reduced polar grid



6-hourly instantaneous

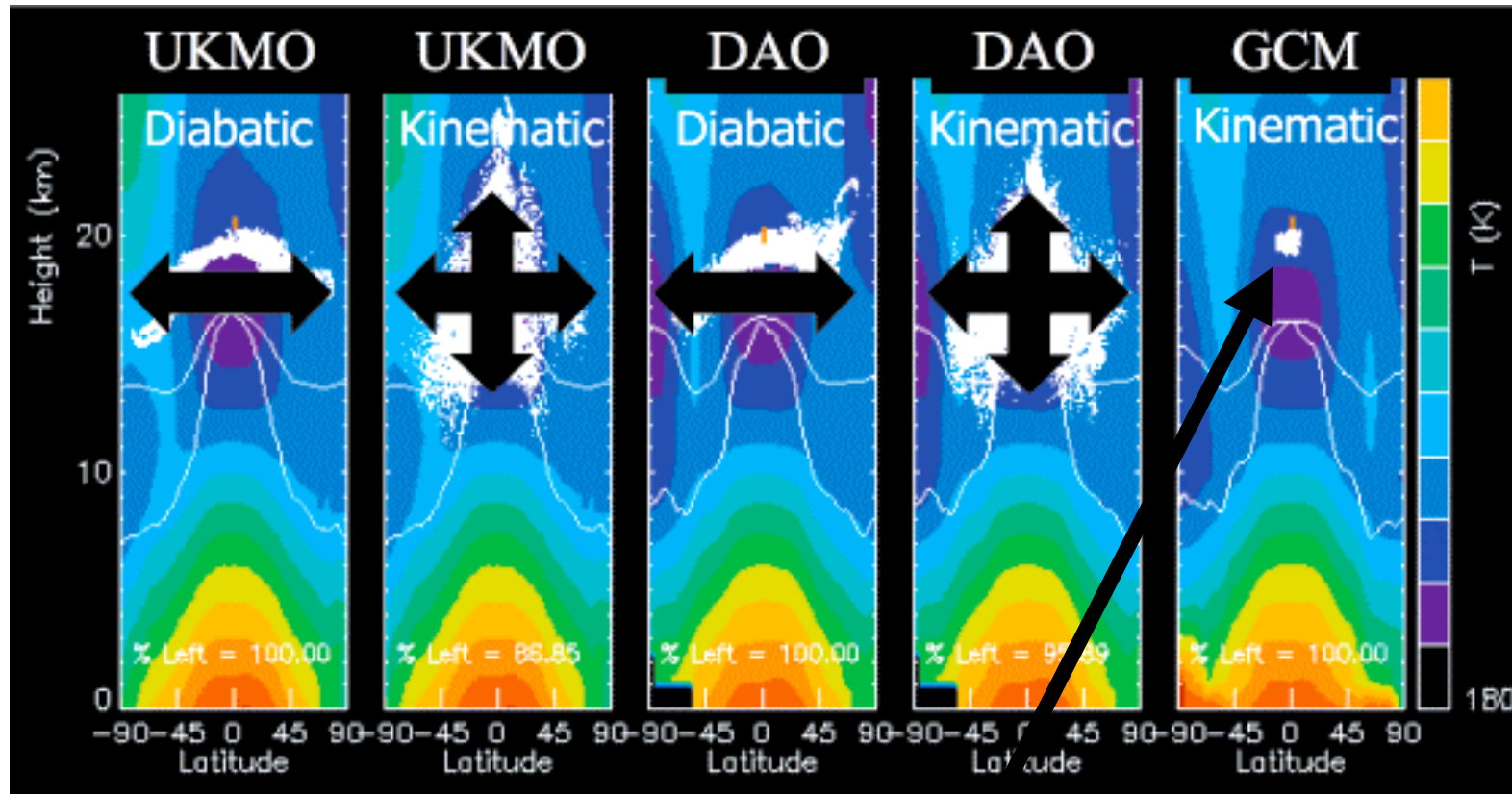


2000-03-15



3x2 slopes  
Red Grid  
6hrly inst.  
1x1 slopes

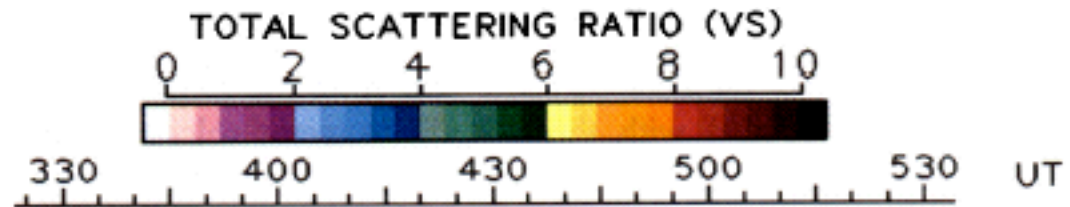
# Are DAS winds too dispersive?



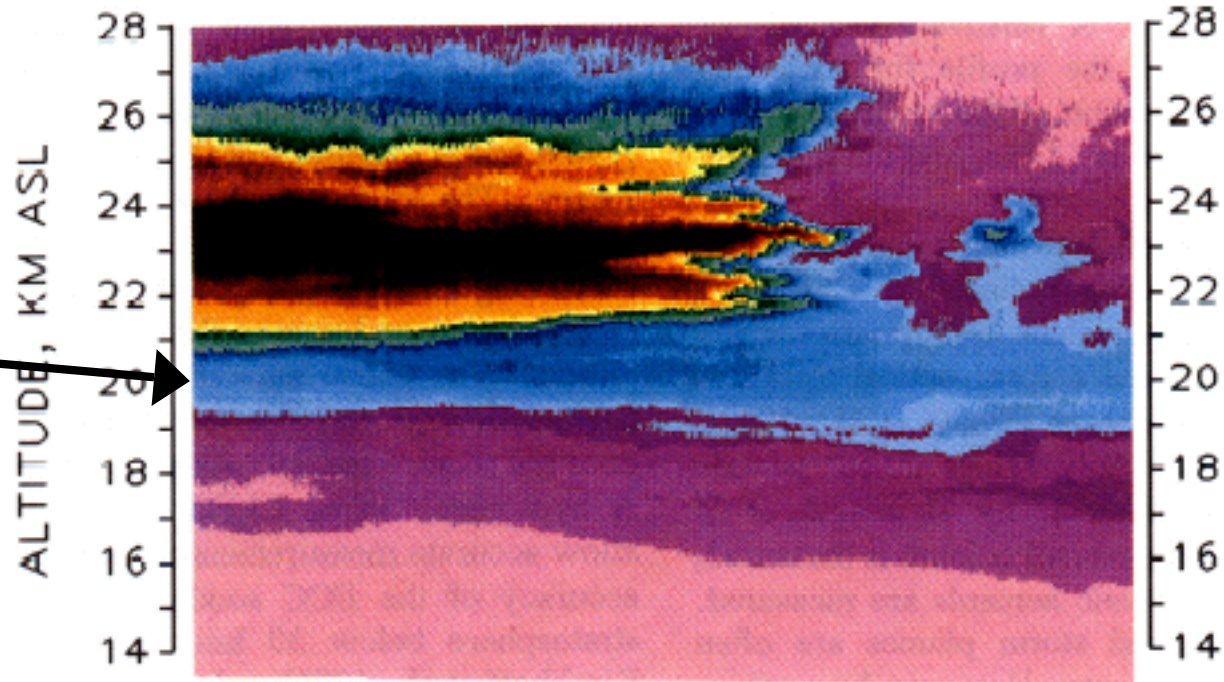
GCM results regarded as the reference. But what is the "reference"?



# tracer experiment in nature: Pinatubo aerosol

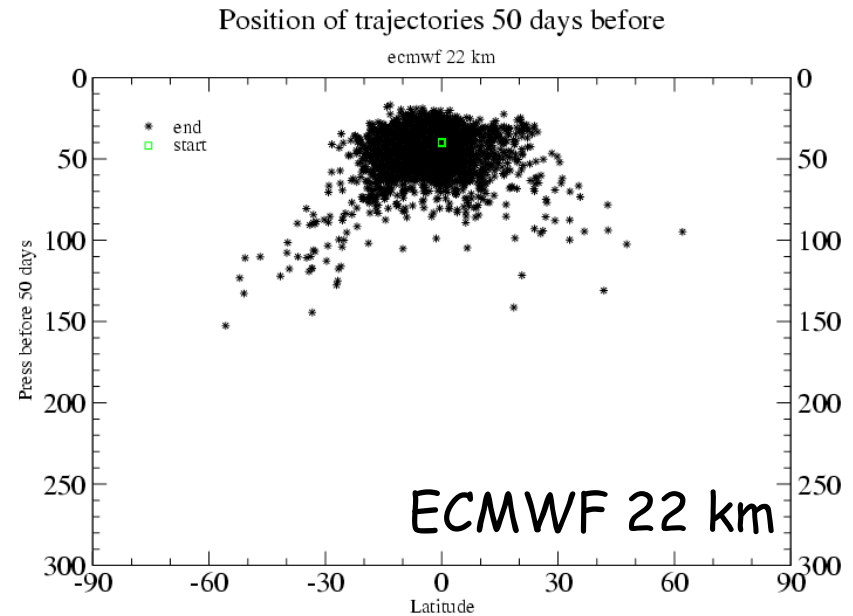
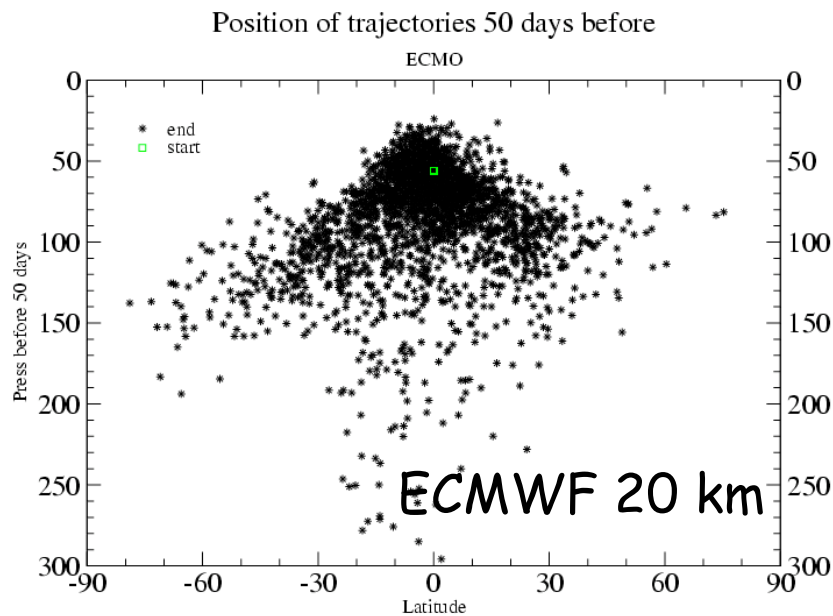
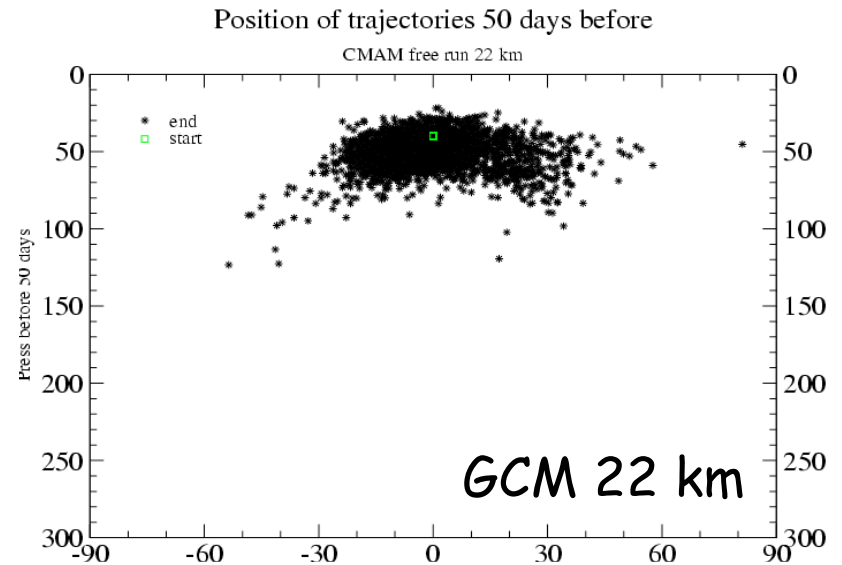
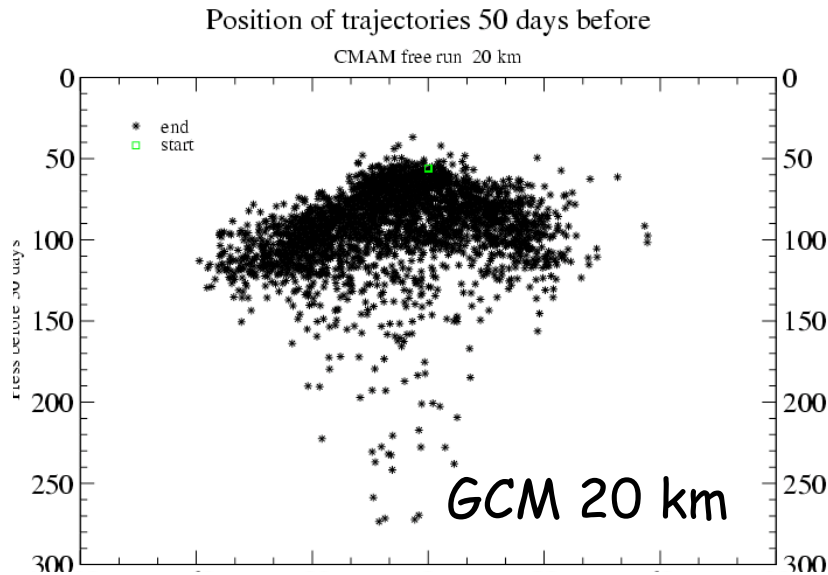


Ini level traj. exp.  
Schoeberl et al.



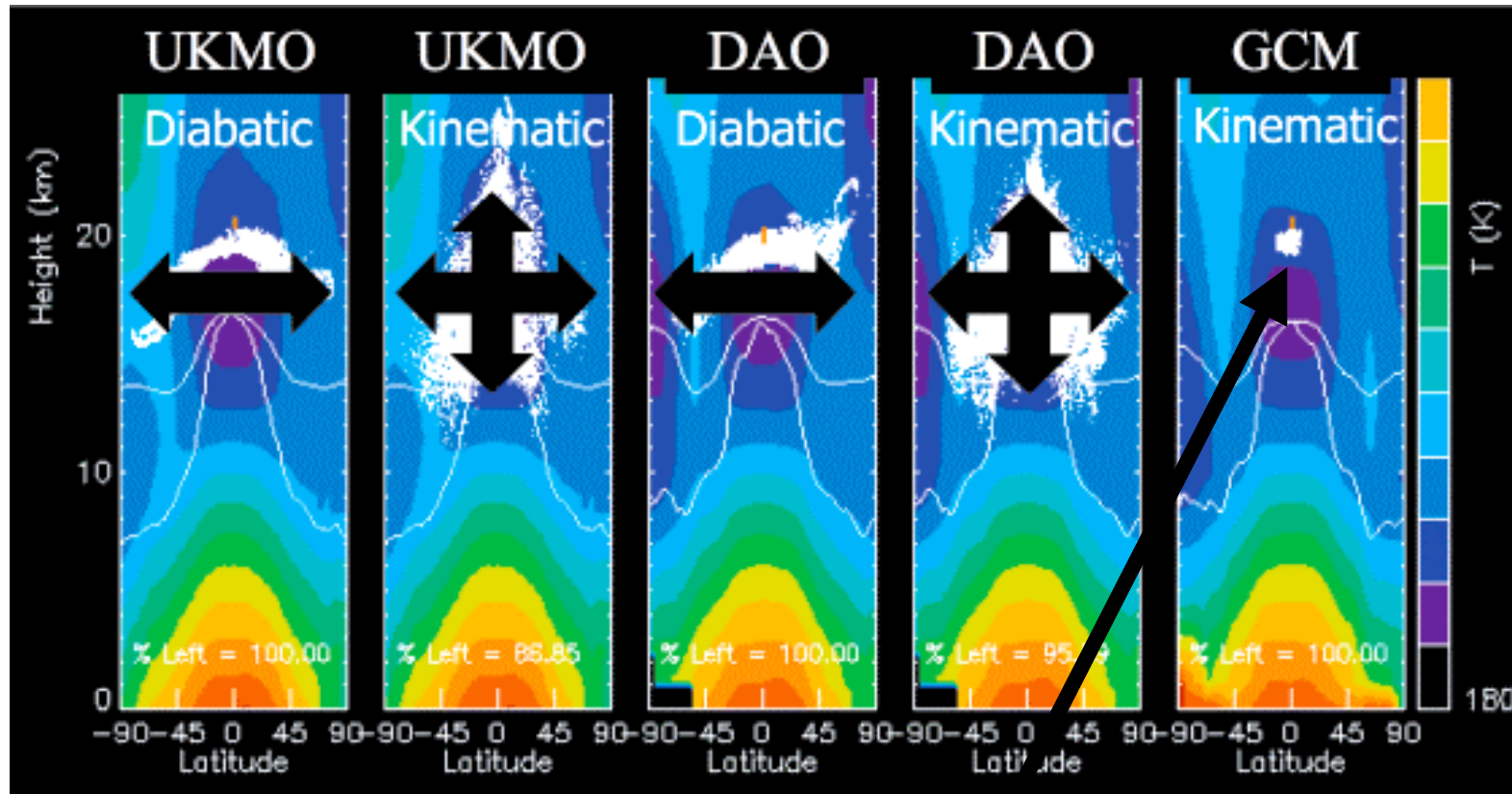
(Grant et al. JGR, 1994)

# altitude



Bregman et al., ACP, 2006, GCM results provided by D. Sankey, UofT

# Are DAS winds too dispersive?



How does 12-24 hour wind averaging reduce dispersion?

(Schoeberl et al., JGR, 2003)

## Summary

- λ More insight in the implementation of GCM winds in CTMs (assimilation, forecasts, wind variability)
- λ Forecasts and more wind variability improve stratospheric tracer transport on various spatial scales, although the circulation remains too fast.
- λ The impact of GCM wind variability remains to be investigated: what is the required variability?
- λ Tropical air parcel dispersion should be interpreted with care
- λ Proper investigation of model grid resolution can only be performed without 'hidden' polar grid reduction

“...current DAS products will not give realistic trace gas distributions for long integrations” – Schoeberl et al. (2003)

“Current” was 2002. Now (2006) significant improvements have been made in the assimilation procedures and there is much more insight in the implementation of DAS winds in CTMs.

“ we may have hit a wall in the use of DAS winds for stratospheric tracer transport” – R. Rood (2005)

No! Stratospheric assimilation is a relatively new and active field and subject of on-going development. Also the treatment of DAS winds in CTMs leaves room for improvement. Regions of concern are the tropical stratosphere and the mesosphere.