Tropical Stratospheric Cloud climatology from the PATMOS-x dataset - an assessment of convective contributions to stratospheric water.

J. K. Nielsen <jkn@dmi.dk> (DMI), Andrew Heidinger, Mike Foster (SSEC,UW)

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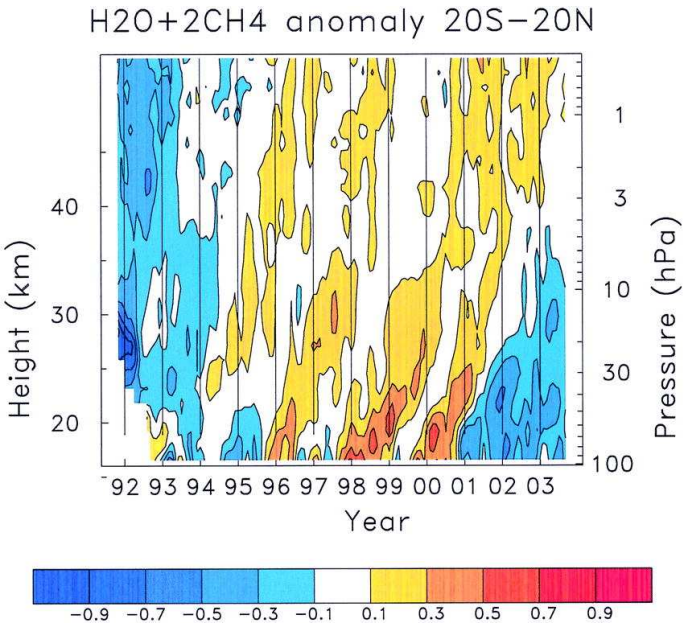
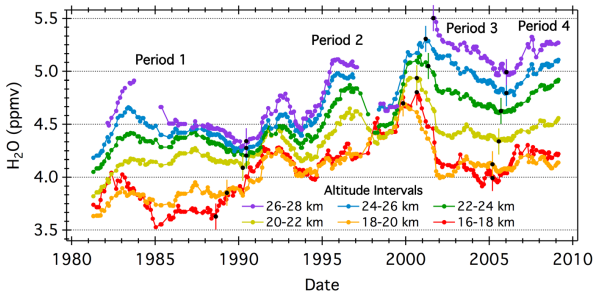
Outline



Randel (2006)



Hurst et al. JGR (2011)
Reduced trend of surface temperature over 2000-2009 by 25%
Solomon et al (2010)

Dehydration at the tropopause

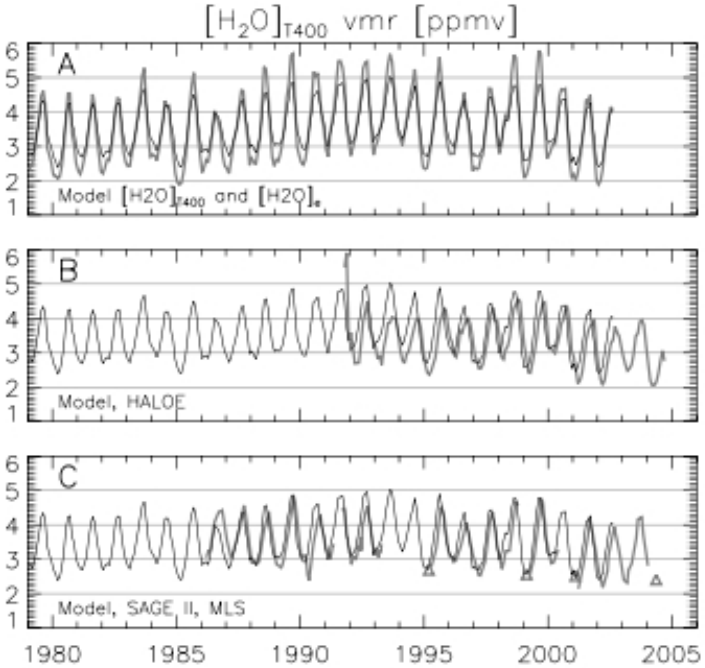
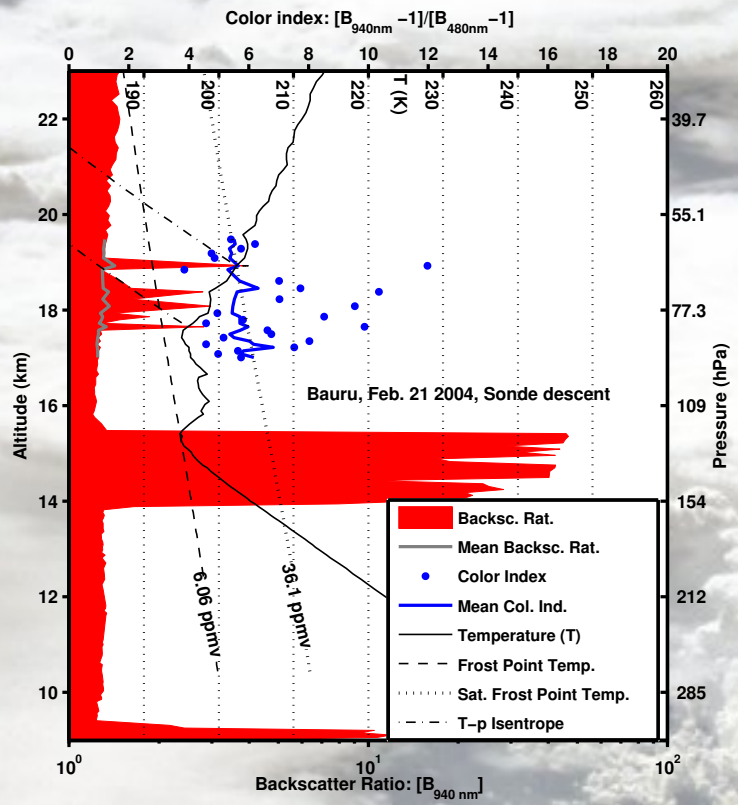


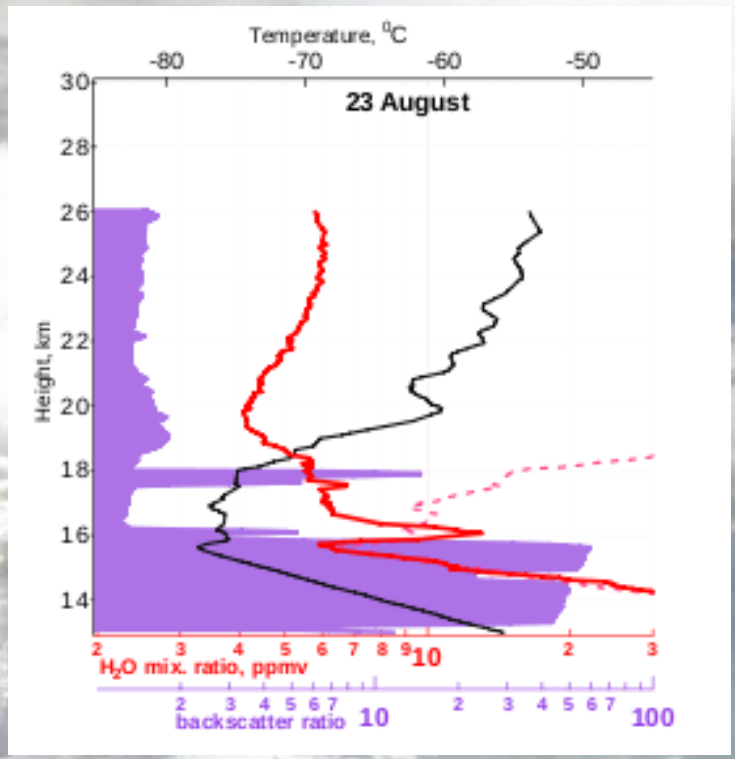
Figure 1. Tropical mean (30°S to 30°N) water vapor mixing ratios in the lowermost stratosphere at 400 K ($[H_2O]_{T400}$). (a) Model results (black) and model results for $[H_2O]_e$ (grey). (b) Model results (black) and HALOE observations (grey). (c) Model results (black), SAGE II (grey), and MLS (grey, 1991–1993).

Correlation between tropopause temperature and stratospheric water: 0.81. Fueglistaler (2005)

Tropical Stratospheric Clouds



Nielsen et al. (2007)

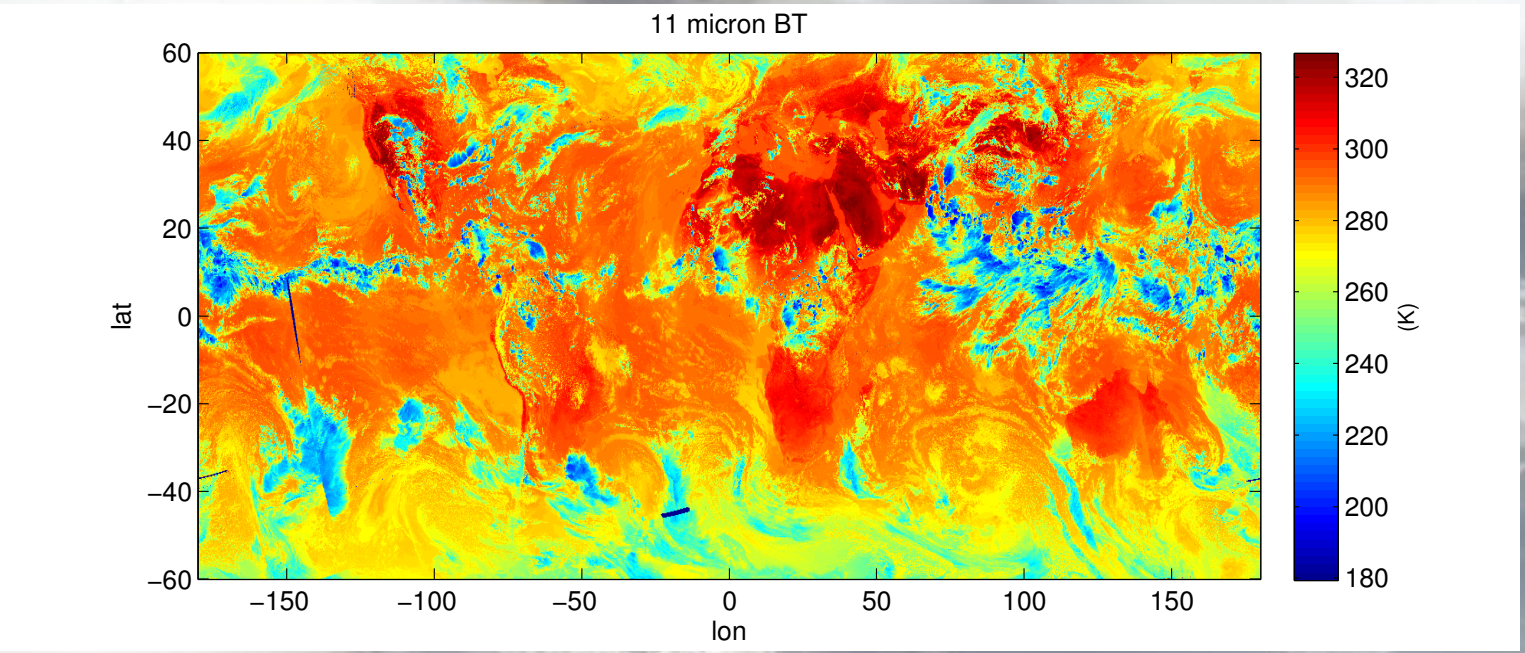


Khaykin et al. (2009)

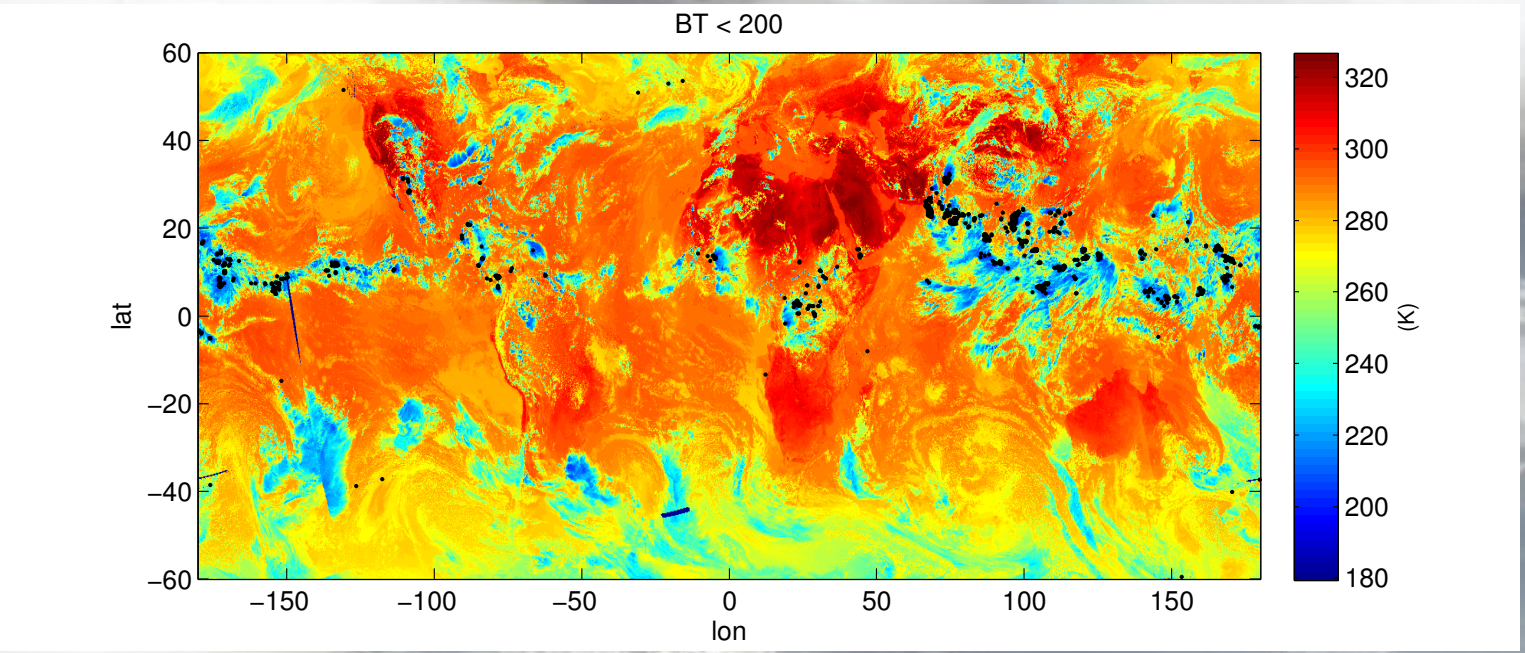
Outline

1981-now
NOAA 7-19
Sun Sync. polar orbit
AVHRR instrument same 11 micron channel throughout the epoch
2 km horizontal resolution, down sampled to 0.2 deg. lat/lon.
At least two daily overpasses
Lots of derived cloud / surface products

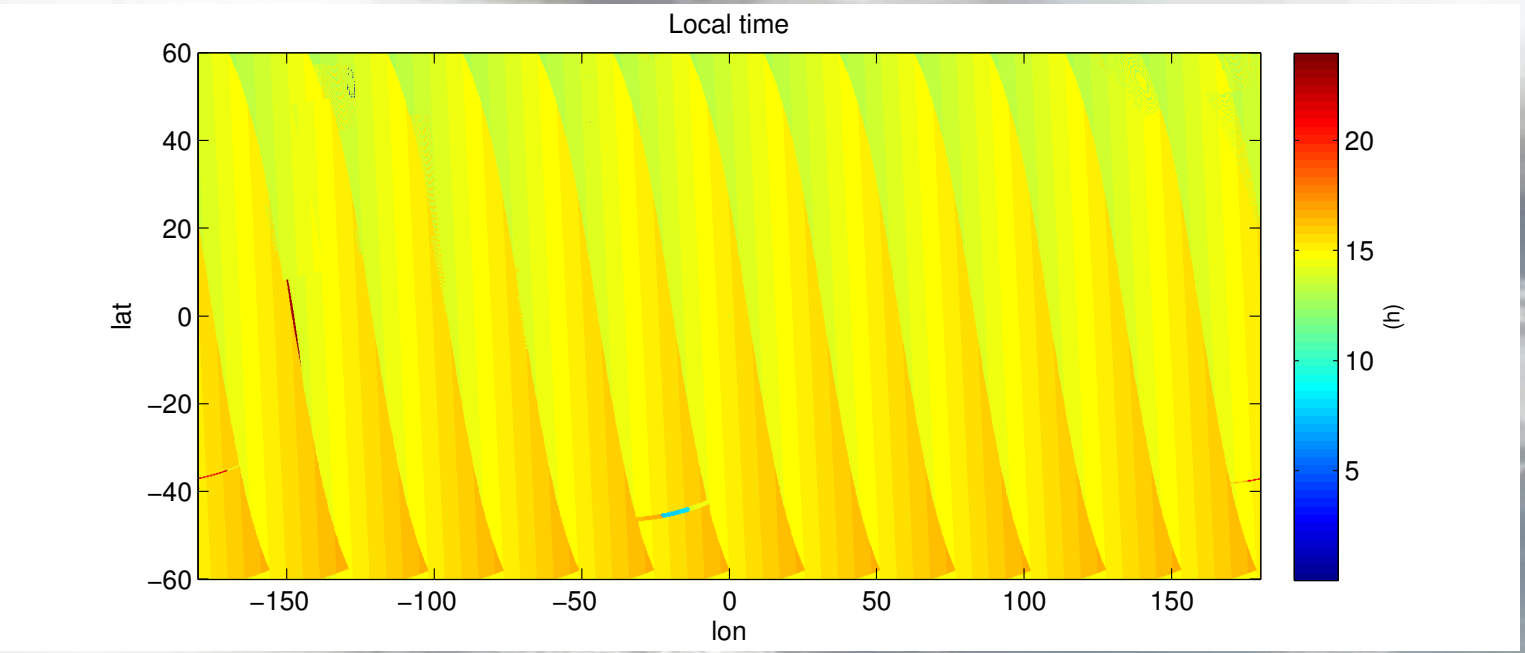
$T_{11\mu m}$


11 micron BT
60
40
20
0
−20
−40
−60
lat
−150
−100
−50
0
50
100
150
lon
320
300
280
260
240
220
200
180
(K)

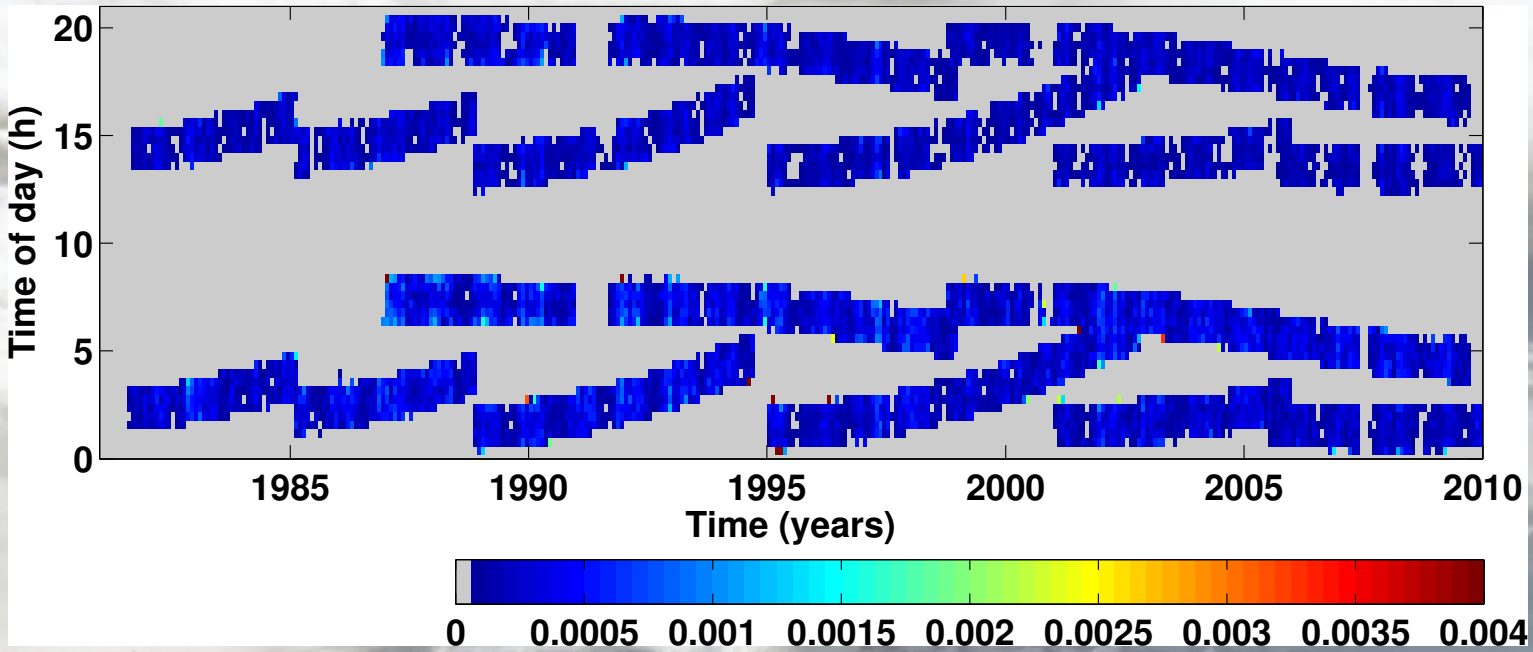
T11μm $<$ 200 K


BT < 200
60
40
20
0
−20
−40
−60
lat
−150
−100
−50
0
50
100
150
lon
320
300
280
260
240
220
200
180
(K)

Local solar time



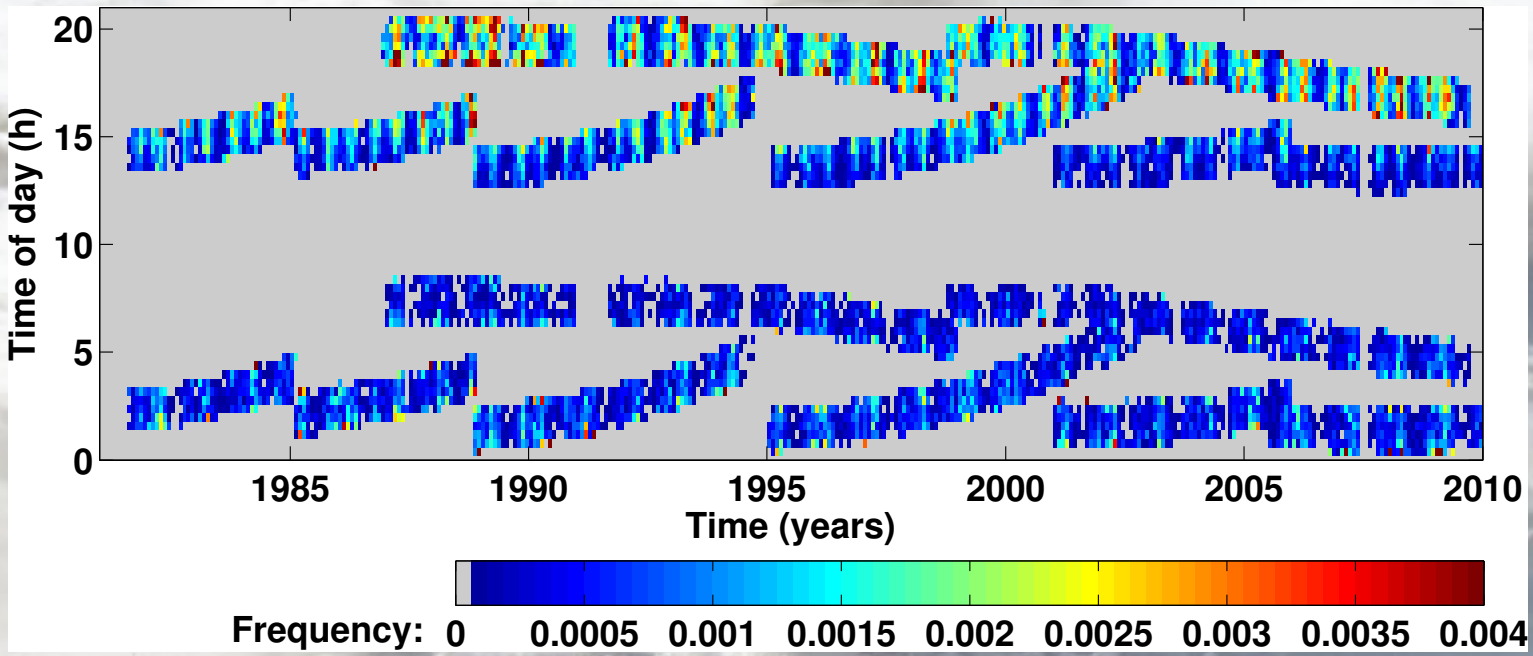
Intensity of clouds with $T_B < 200$ K (OCEAN!)



Focusing on brightness temperature (not contaminated with NWP)

Nielsen et al GRL (2011)

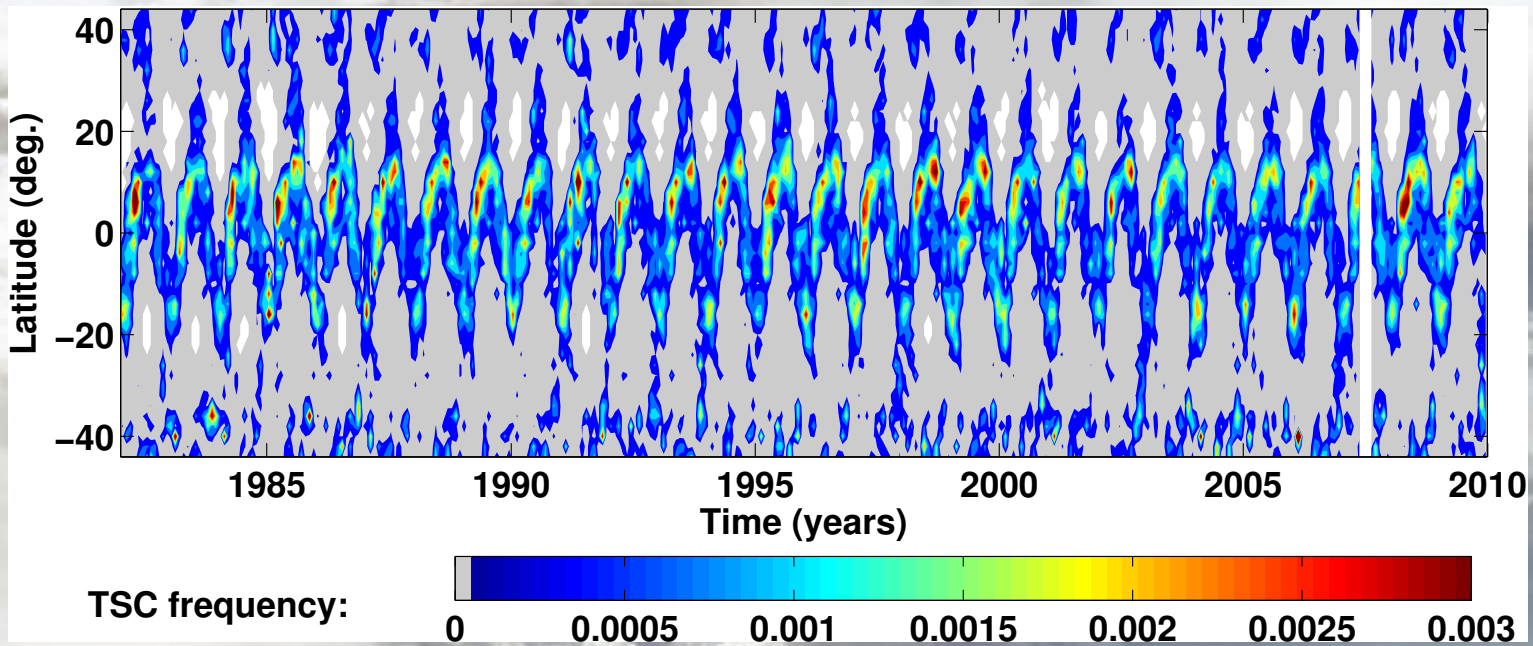
Intensity of clouds with $T_B < 200$ K (LAND!)



Focusing on brightness temperature (not contaminated with NWP)

Nielsen et al GRL (2011)

Intensity of clouds with $T_B < T_{\text{tropopause}}$ (LAND!)



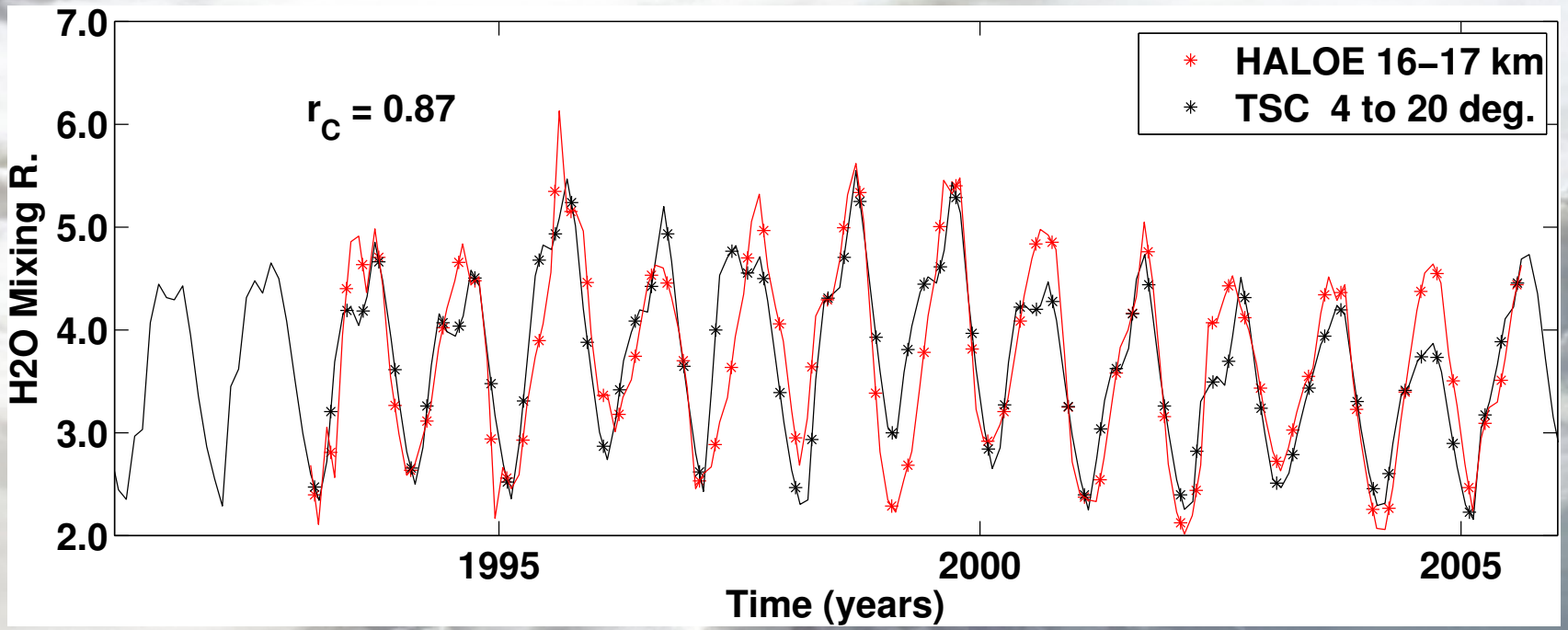
Nielsen et al GRL (2011)

Outline

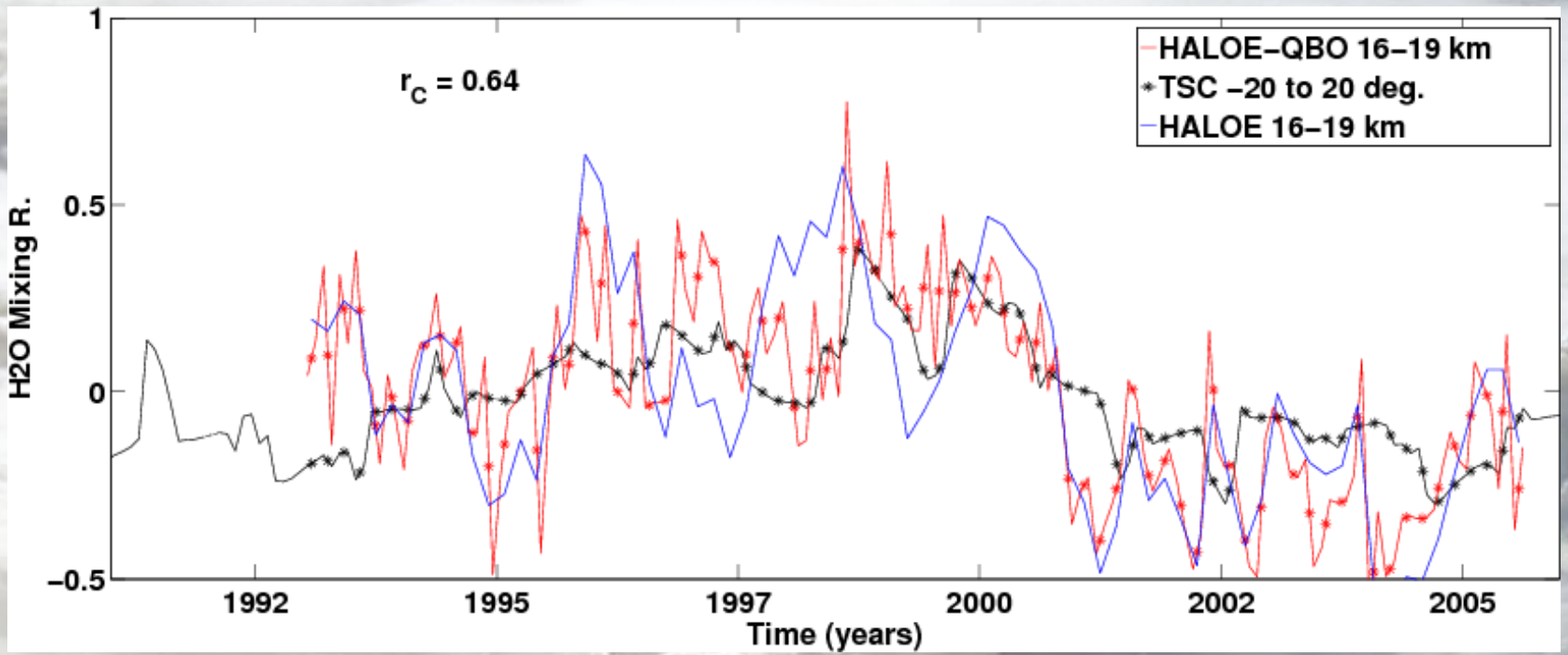
$$\dot{x} = -k(x - a) + cd(t) \tag{1}$$

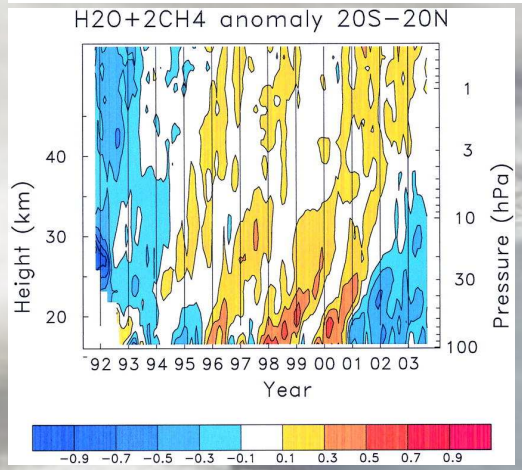
$x =$ Water Vapour Mixing Ratio
$d =$ Tropical Stratospheric Cloud frequency
$a =$ Mixing ratio of slow ascending air.
$c =$ Coupling
$k = \frac{\text{vertical velocity}}{\text{layer depth}}$ Inverse layer passing time

$$x = c\exp(-kt)\int_0^t \exp(kt)d(t)dt + a + x_0\exp(-kt) \tag{2}$$



Nielsen et al GRL (2011)


HALOE–QBO 16–19 km
TSC –20 to 20 deg.
HALOE 16–19 km
r_C = 0.64
H2O Mixing R.
1
0.5
0
–0.5
1992
1995
1997
2000
2002
2005
Time (years)


H2O+2CH4 anomaly 20S–20N
Height (km)
40
30
20
Pressure (hPa)
1
3
10
30
100
92 93 94 95 96 97 98 99 00 01 02 03
Year
−0.9 −0.7 −0.5 −0.3 −0.1 0.1 0.3 0.5 0.7 0.9

Outline

Conclusions

- The PATMOS-x dataset contains information about overshooting deep convection through 3 decades.
- Tropical stratospheric clouds correlate well with stratospheric Water Vapour Mixing Ratio

Outlook

- Redo analysis on new combined water/ozone dataset (SAGE, ALOE, MLS) -> SWOOSH (Sean Davis NOAA)!
- If it proves persistent in future studies, the convective contribution to stratospheric water has to be represented in climate models.

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