Water vapour in the tropics

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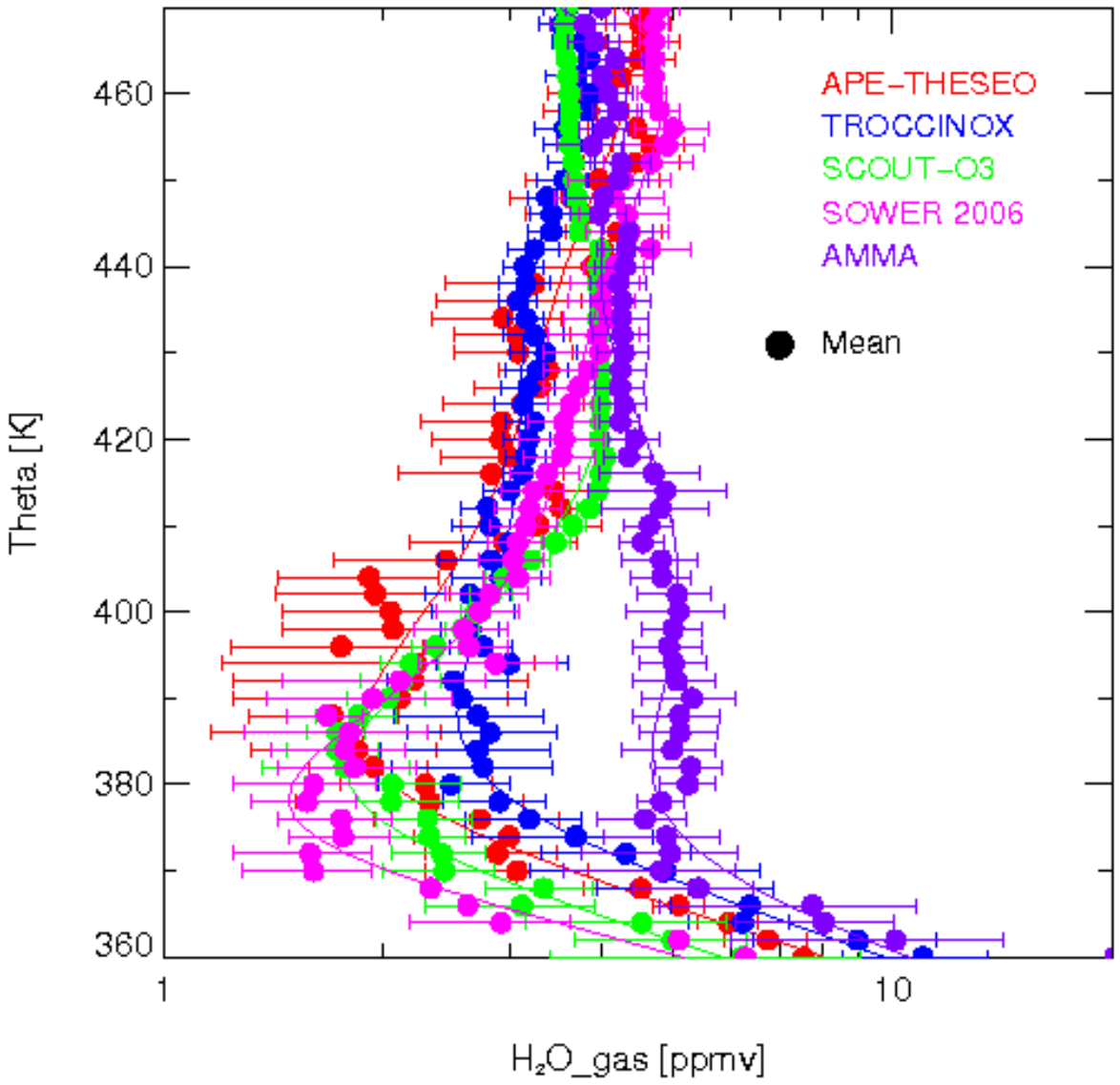
Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

Tropical experiments with the M55 and Falcon aircraft

Jan-Feb 2005 Aug 2006 Feb-Mar 1999 Nov-Dec 2005

H_2O vertical distribution in the tropics



APE-THESEO
Seychelles, Feb-Mar 1999

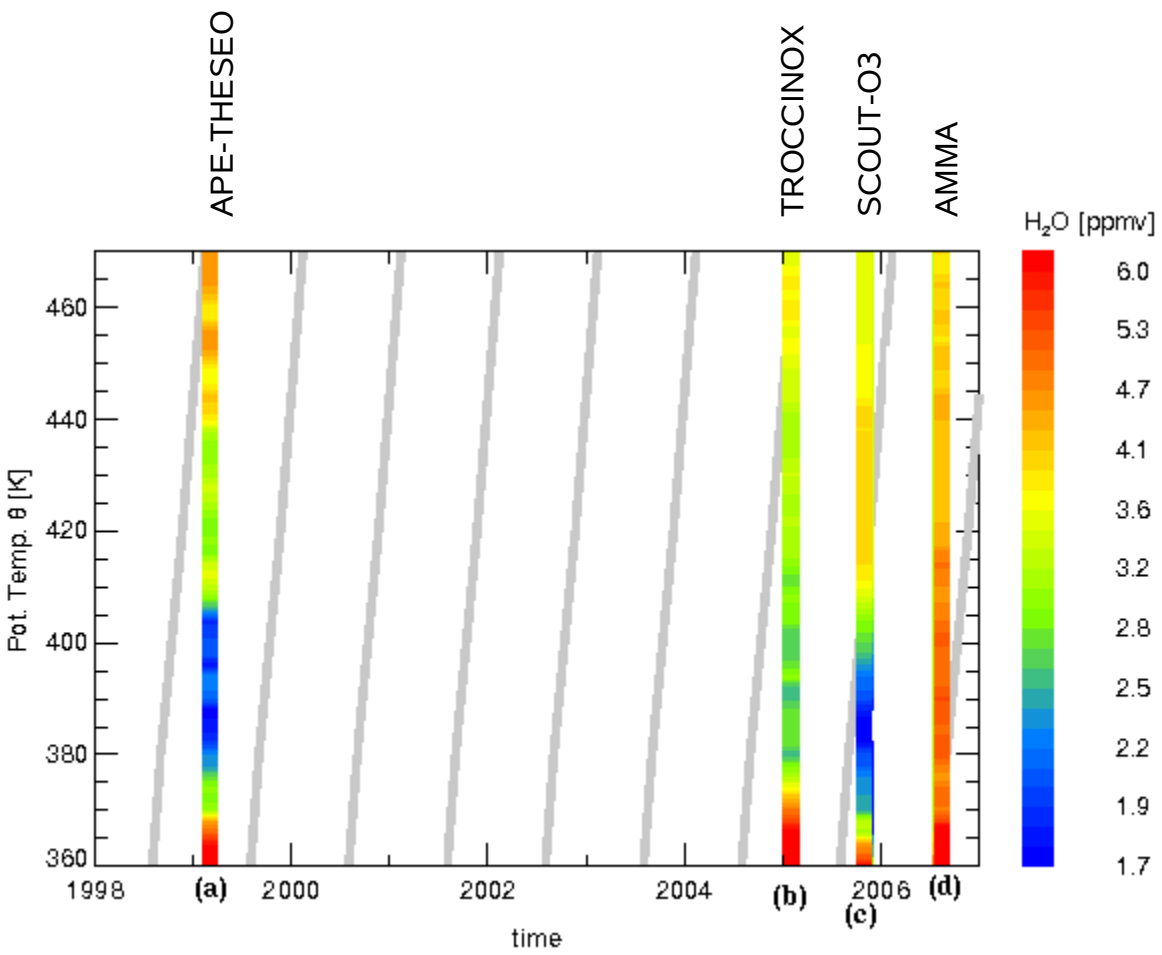
TROCCINOX
Brazil, Jan-Feb 2005

SCOUT-O3
Australia, Nov-Dec 2005

SOWER
Indonesia, Jan-Feb 2006

AMMA
West Africa, Aug 2006

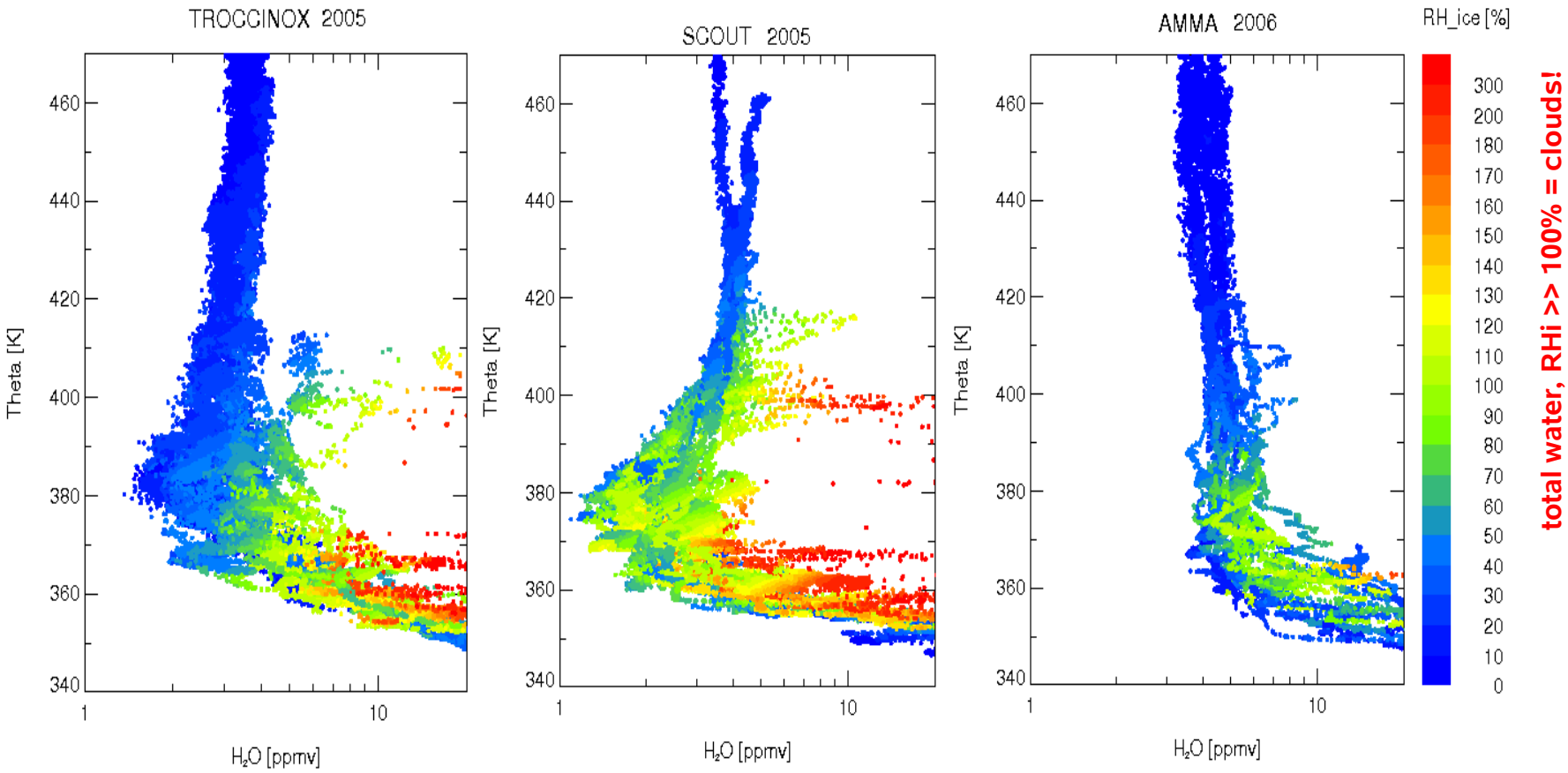
The H_2O tape recorder from in situ sounding



Head of tape recorder below 410 K: strong regional signal overlaid

Stratosphere: consistent seasonal cycle, but AMMA (NH) higher

RH_i during tropical aircraft experiments

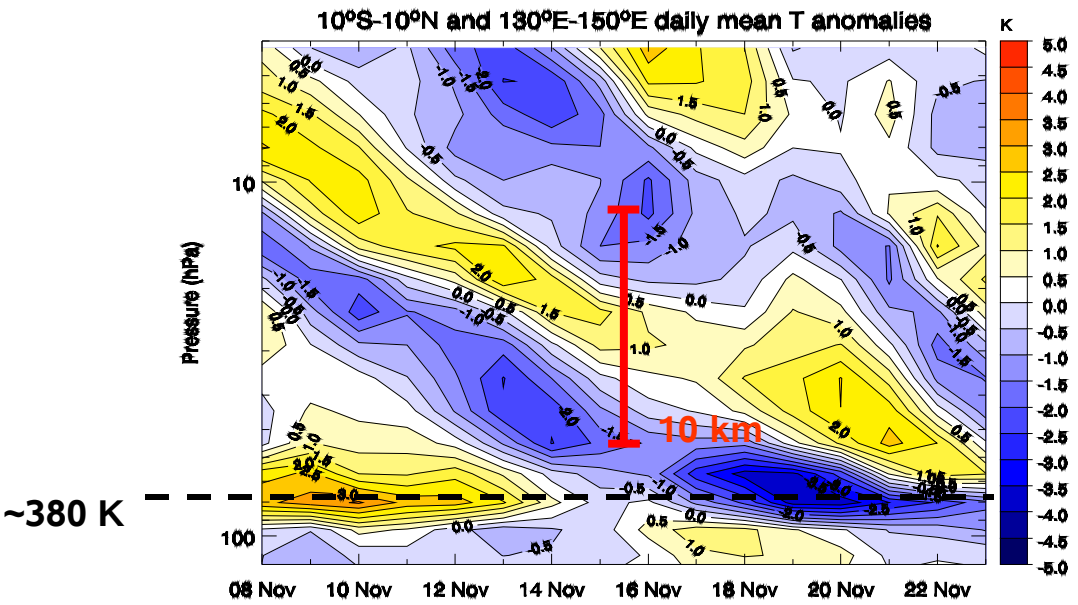


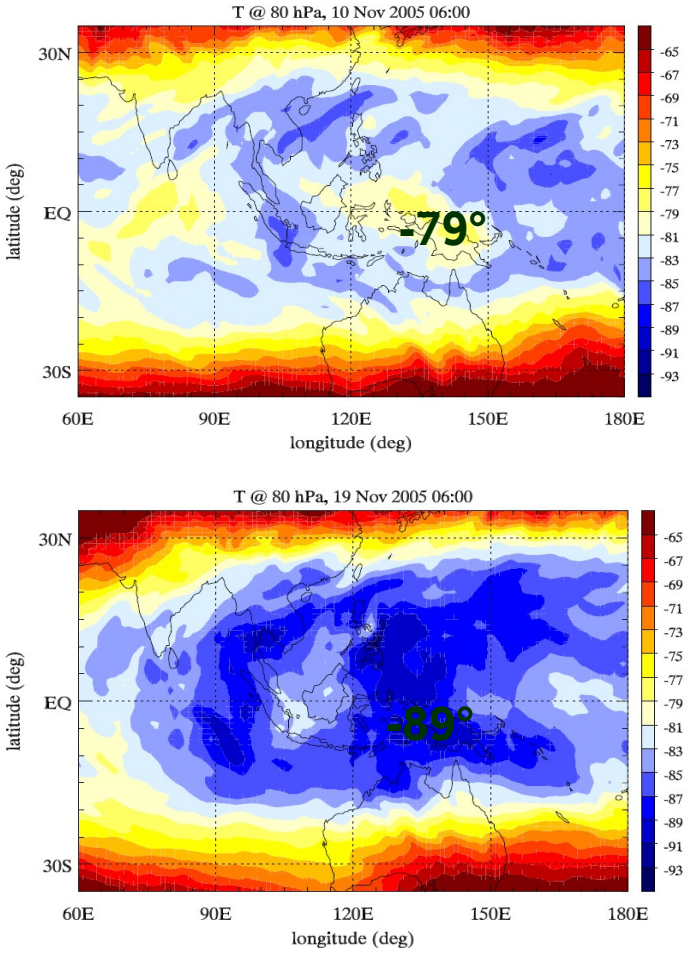
lowest H_2O m.r. (< 2 ppmv), high RHi during SCOUT-O3 (and APE-THESEO)

convection above TP: injection of particles in low RHi environment

only few cases of saturation at TP during TROCCINOX and AMMA

The Kelvin wave during SCOUT-O3





perturbation at tropopause ~10 K peak-to-peak
(10 November vs. 19 Novemver)

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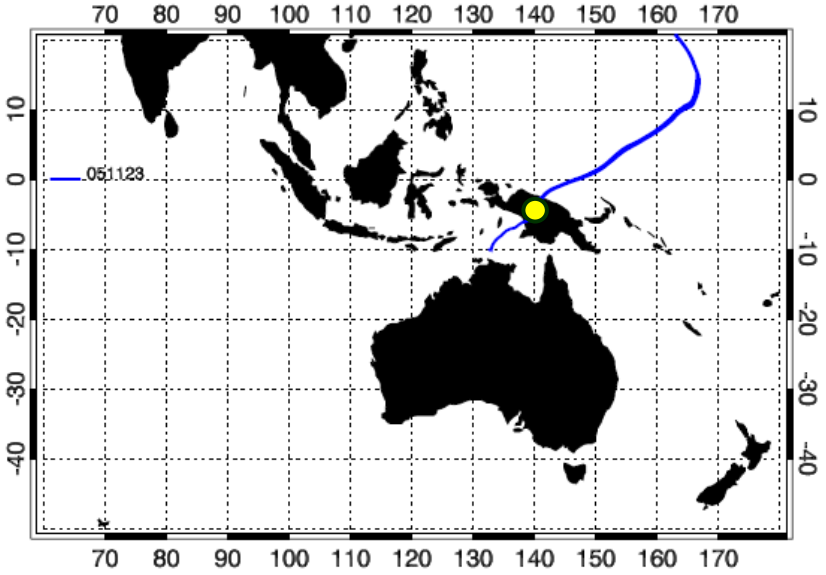
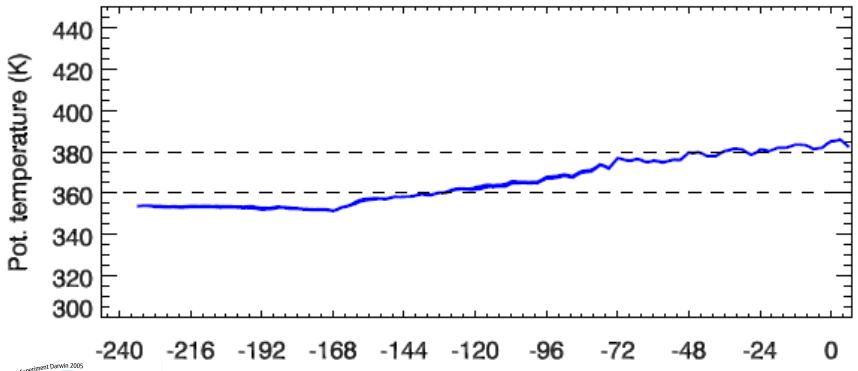
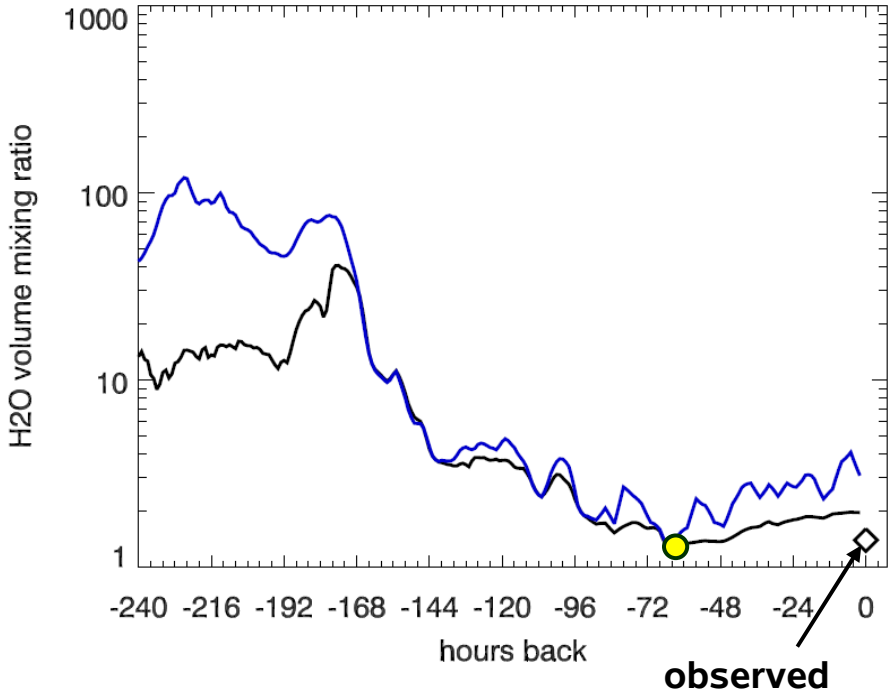
Impact of T_{min} along trajectories on H_2O

Observed and simulated H_2O on Geophysica flight on 23 November



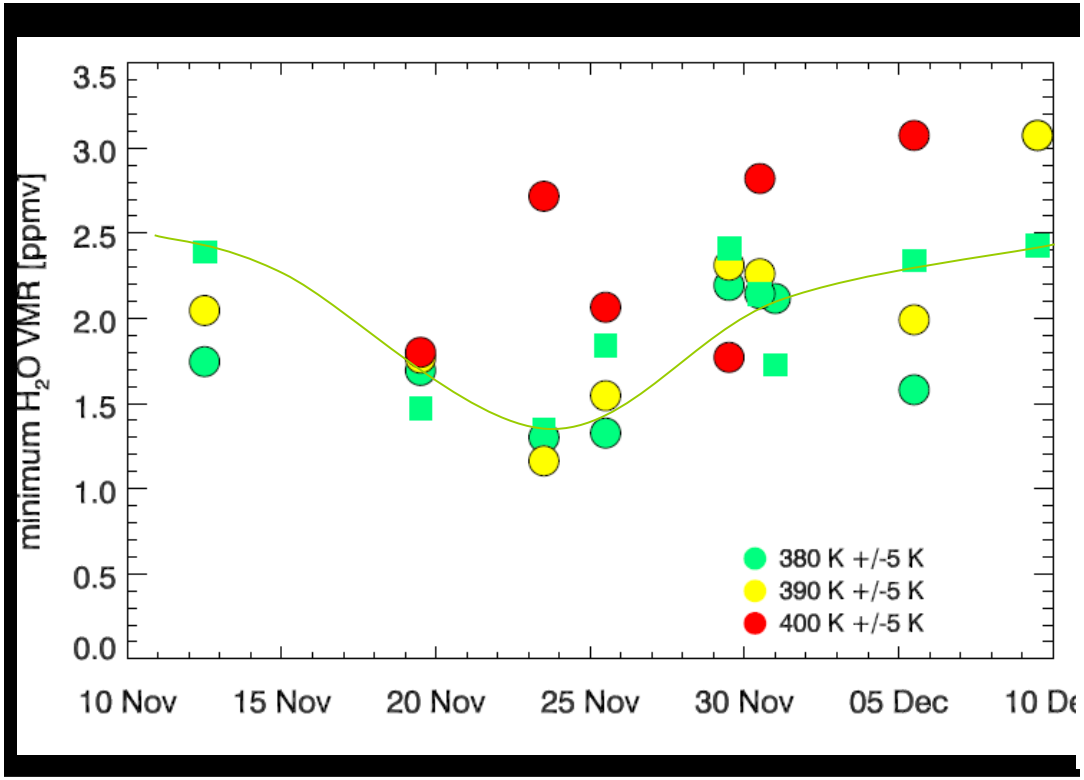




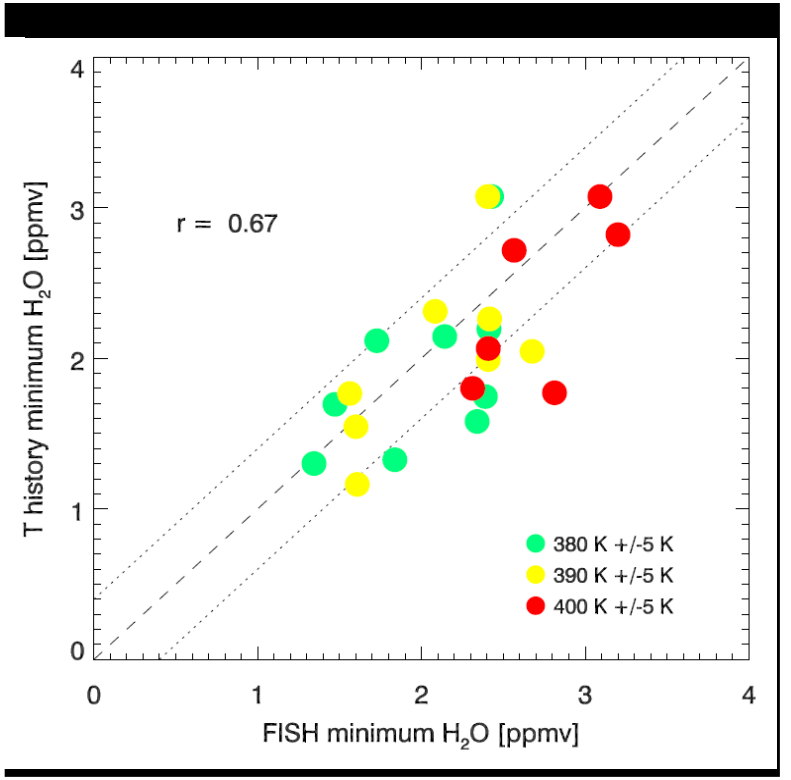
Brunner et al.

Impact of T_{min} along trajectories on H_2O

Mininum values of H_2O_{traj} on all flights
(10% percentiles of all values < 10 ppmv)



Scatter plot of H_2O_{traj}
versus H_2O observed by FISH



Trajectory based estimates

FISH

Brunner et al.

SCOUT - O3

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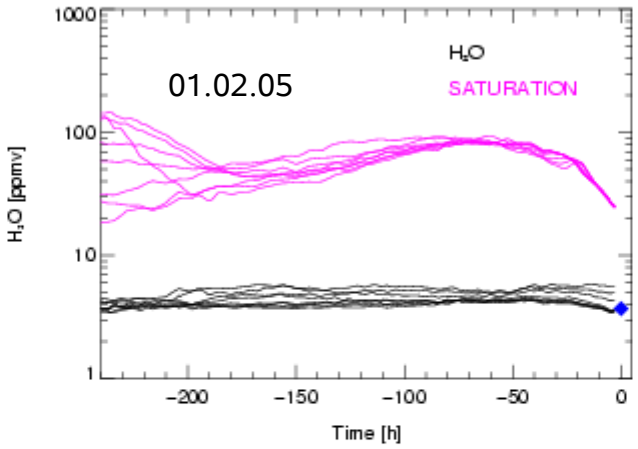
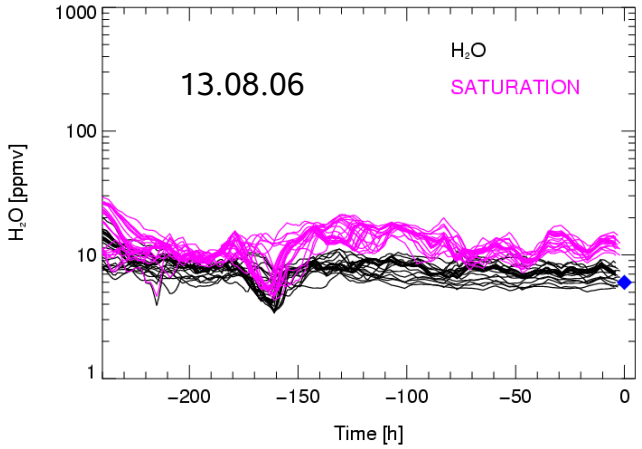
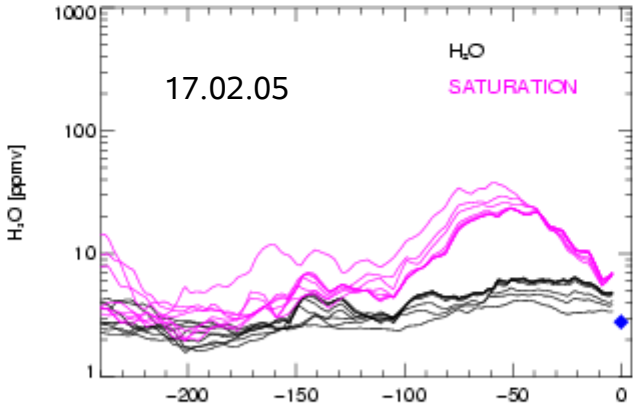
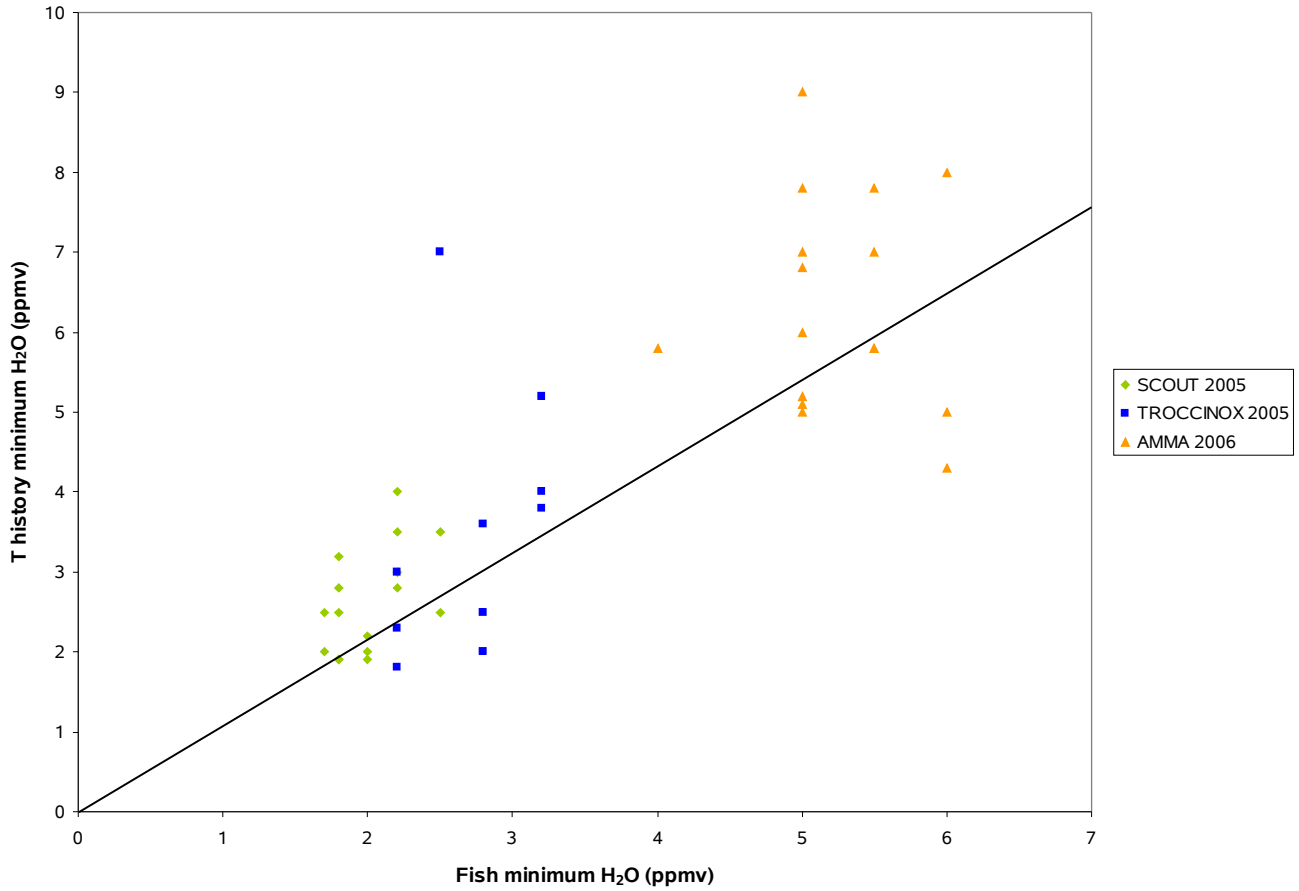
Impact of T_{min} along trajectories on H_2O



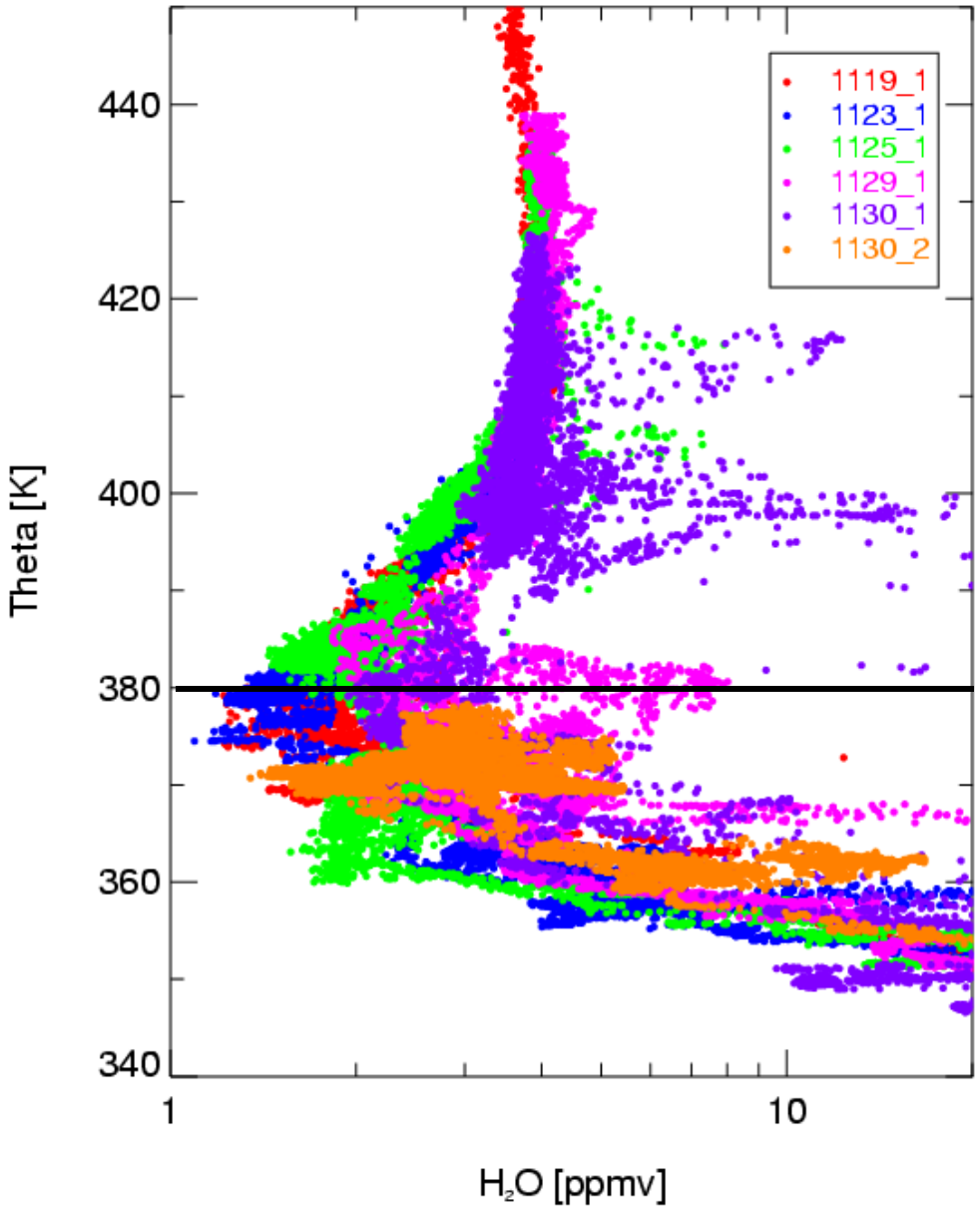




Impact of T_{min} along trajectories on H_2O



Impact of convection on H_2O: the shooting gun



flights close to convection

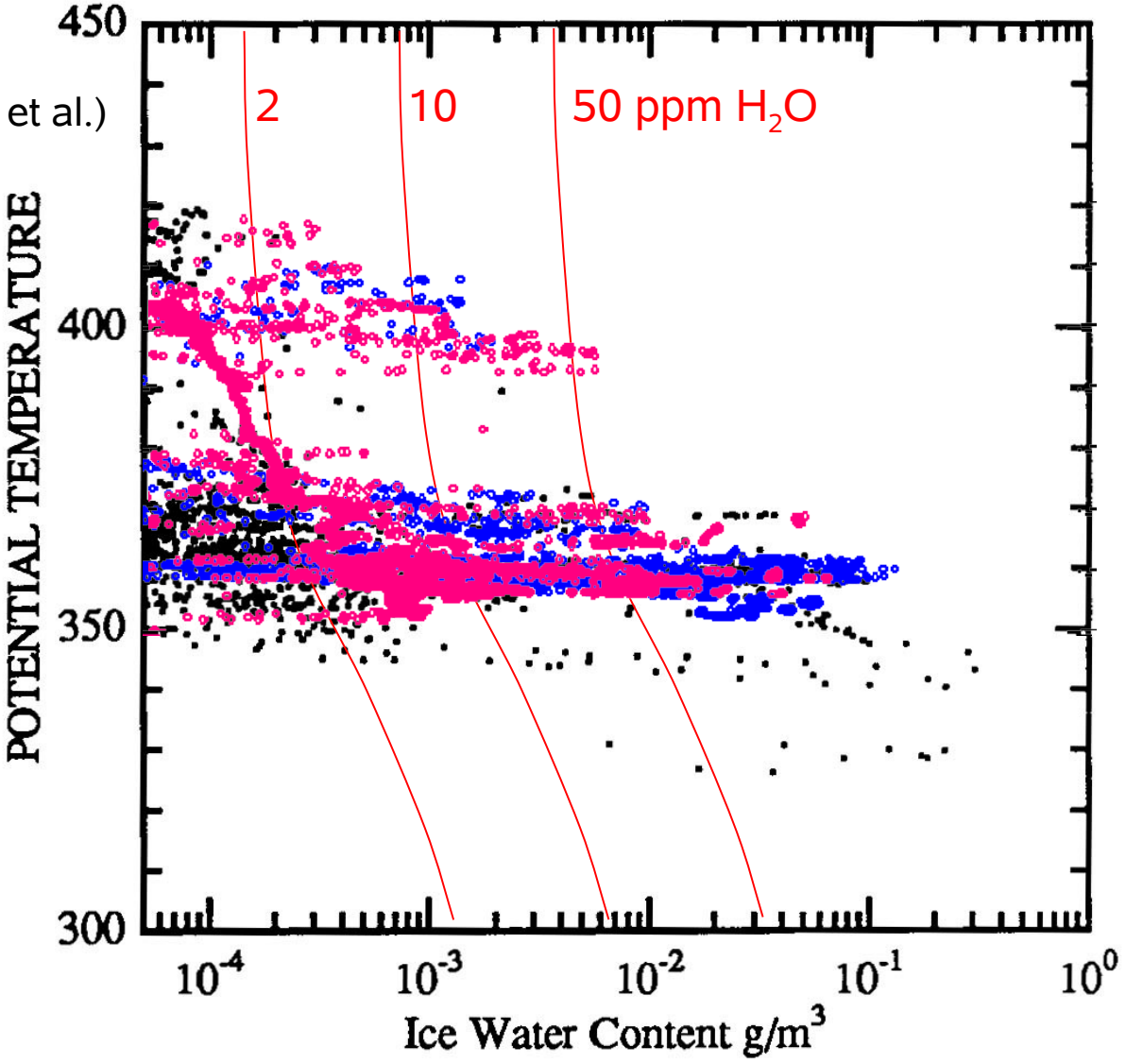
tropopause (17 km): cold point and cold trap

Ice water content in cirrus clouds above the cold point

STEP-Tropical (Kelly et al.)

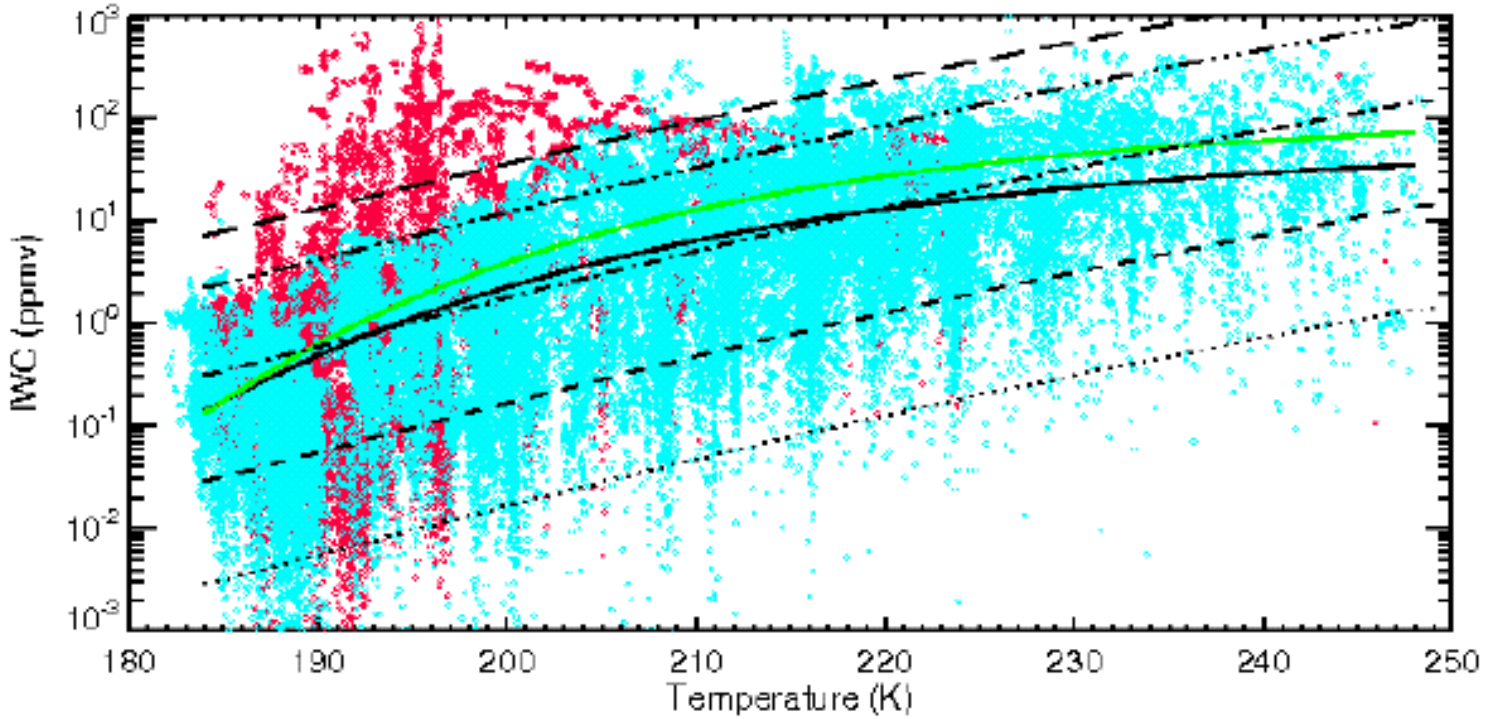
TROCCINOX

SCOUT-Darwin

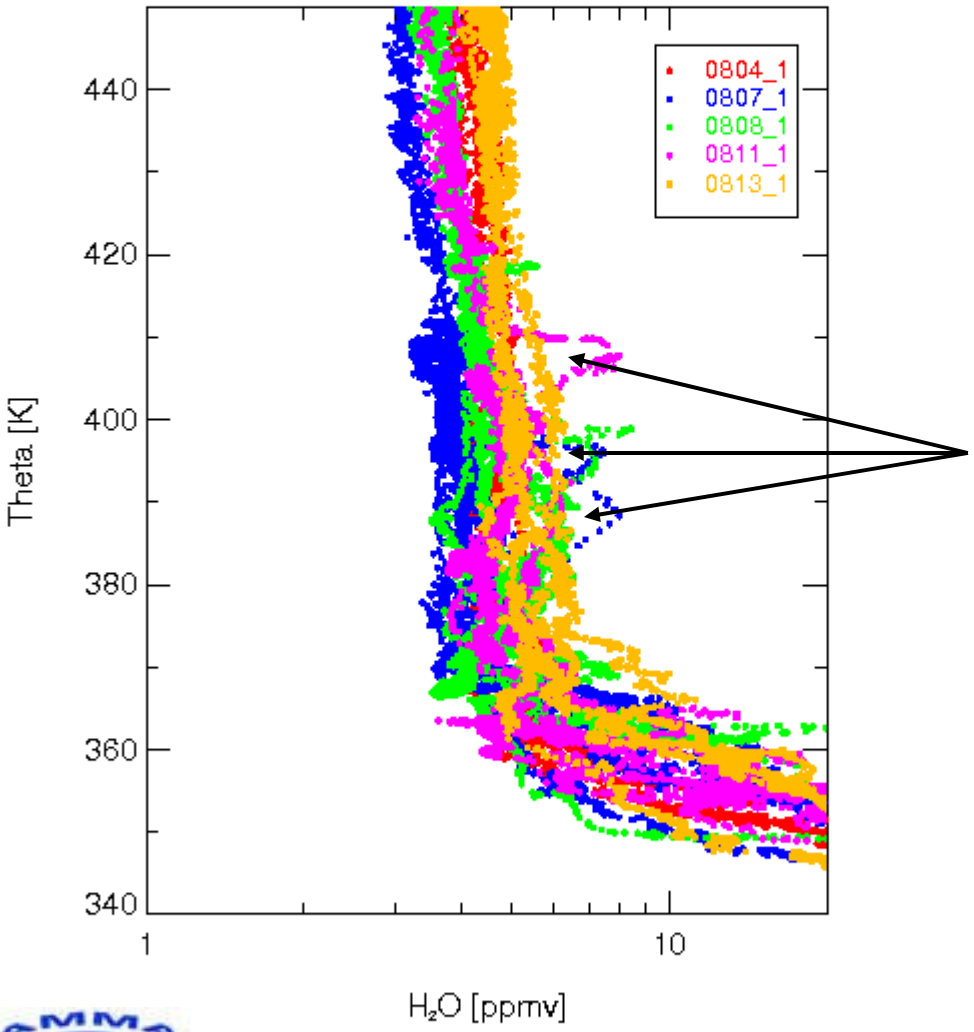


Corti et al.

Climatology of ice water content in cirrus clouds



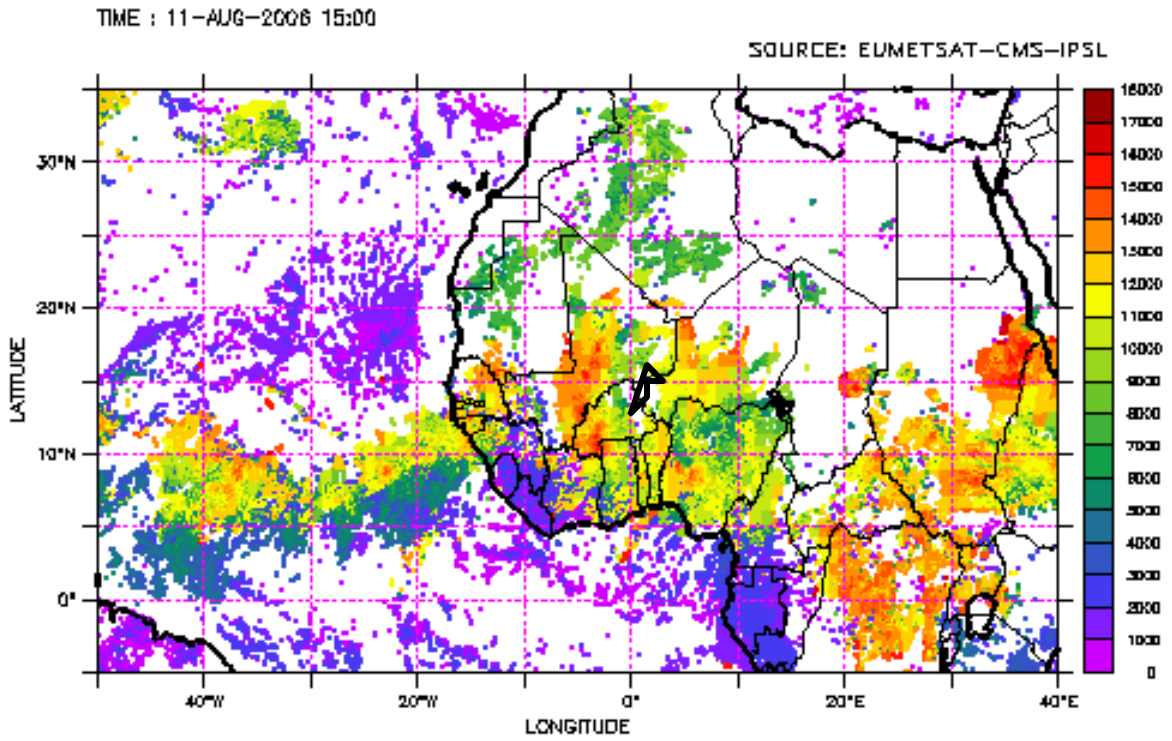
Impact of convection over West Africa: The smoking gun



layers of enhanced H_2O (several ppm)

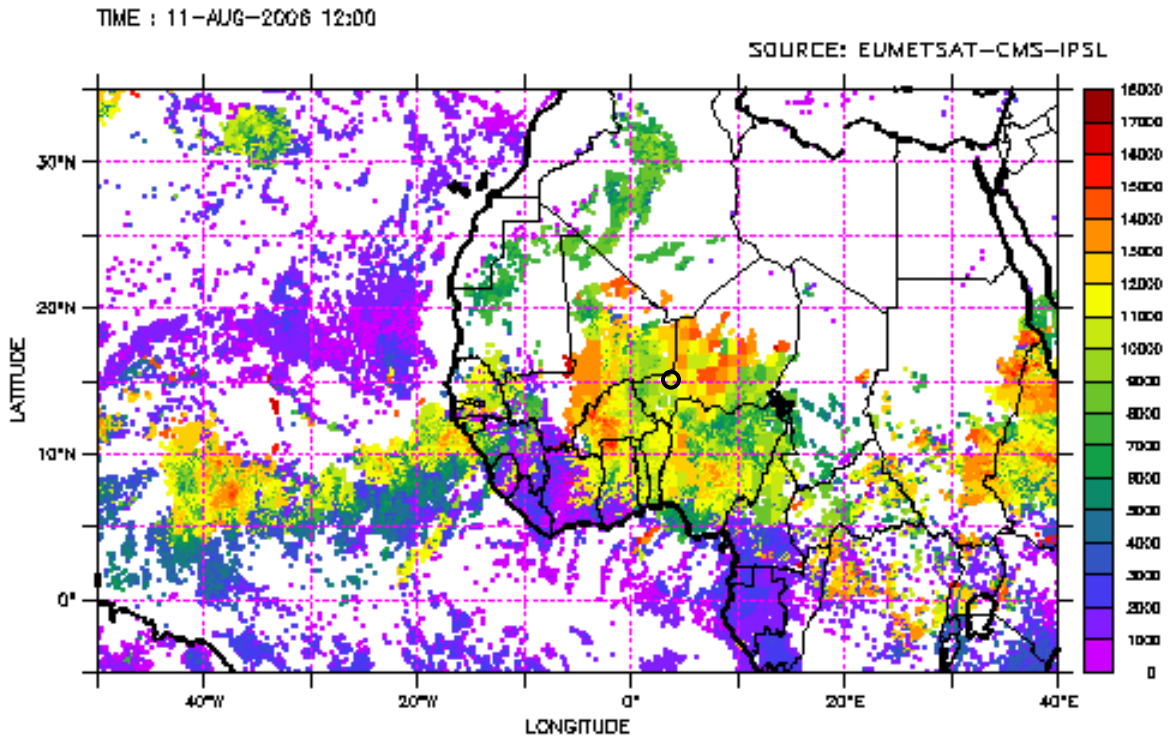
07.08, 08.08, 11.08.

11.08.06 – remnants of convection in the stratosphere?



Cloud Top Altitude (m)

11.08.06 – remnants of convection in the stratosphere?



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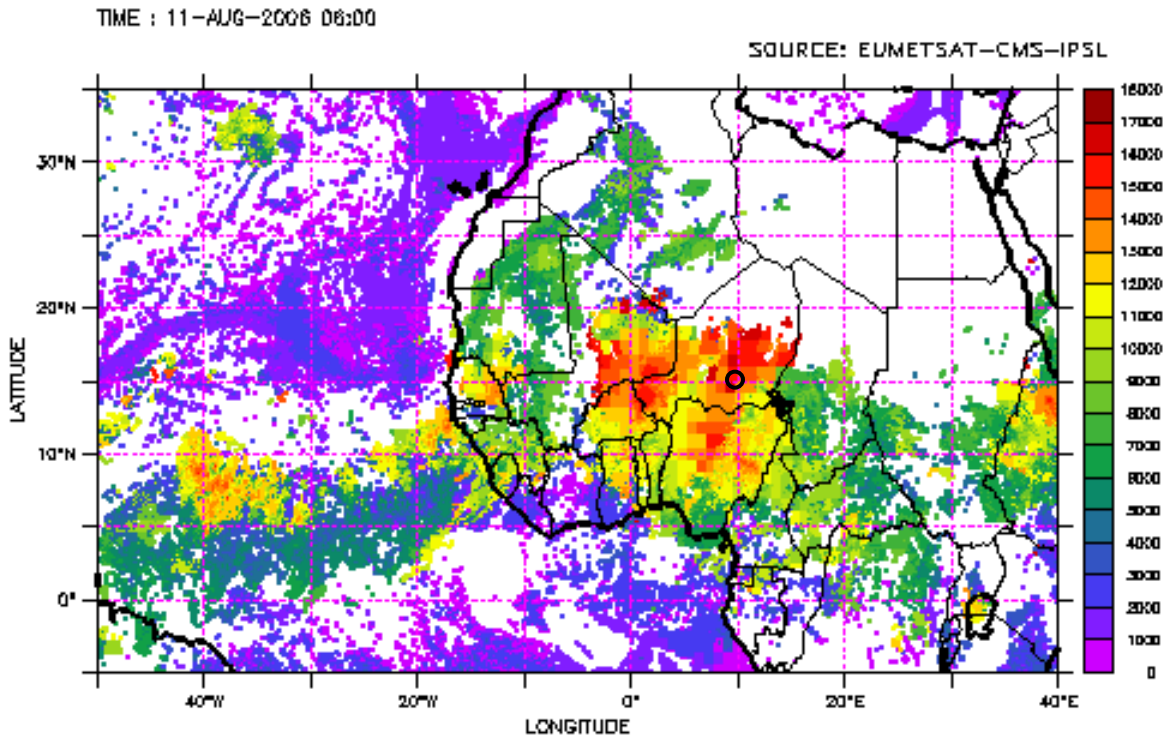

Cloud Top Altitude (m)

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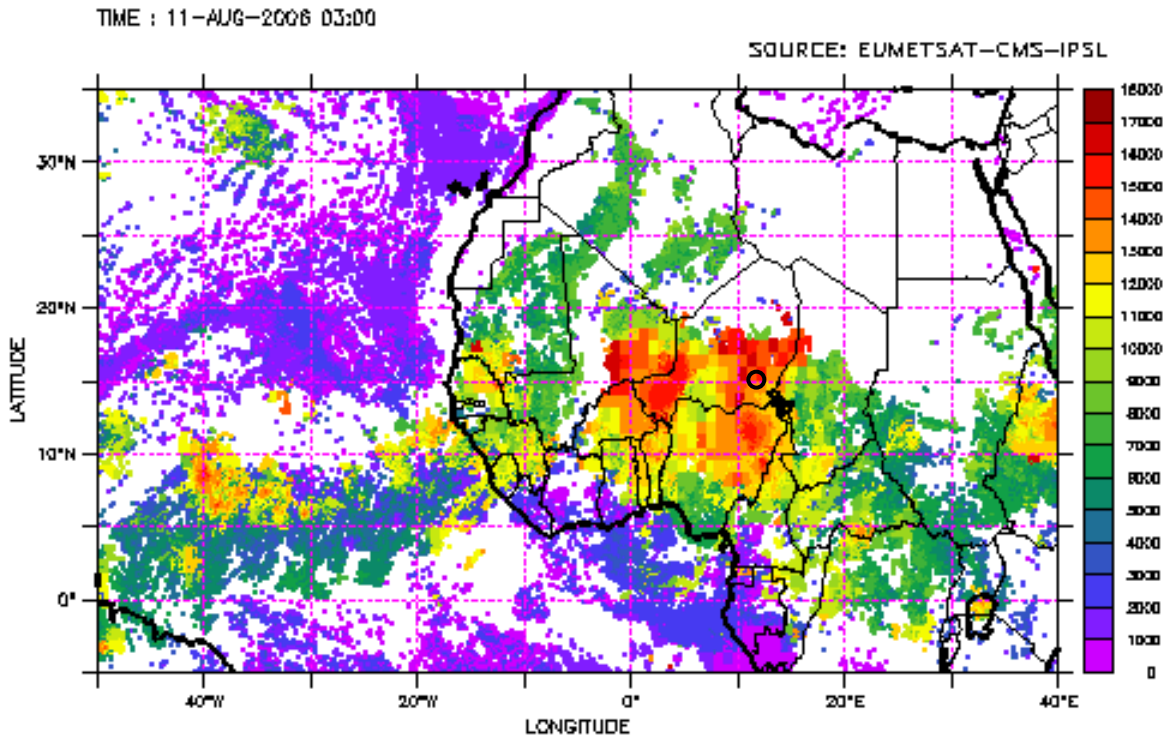

Cloud Top Altitude (m)

Upscaling: tropics 20°N-20°S

- → 1 Hector event: 60 t H_2O into stratosphere
- → About 300 comparable events per day in the tropics [Liu and Zipser, 2005]
- → They cover 1500 times the area of Hector
- → Convective transport: 2×10^4 t (upper limit: 10^5 t) H_2O per day
- → Compared to a total input of 10^6 t H_2O per day from large scale upwelling
- → 2-10 % of total H_2O input into stratosphere

Corti et al.

Summary and conclusions

seasonality of H_2O input observed

head of tape recorder variable with region

Moistening of the TTL (and above)

particles with IWC of up to 10 ppmv injected by deep convection up to 420 K

during AMMA moistening by aged convection (>12 h) still detectable

but: contribution on global scale only several percent

exchange with subtropics

Drying of the TTL

H_2O < 2 ppmv at TP during SCOUT-O3 and APE-THESEO

frequently RHi > 100% and cirrus → ongoing dehydration

minimum H_2O modulated by Kelvin wave during SCOUT-O3

H_2O frequently determined by T_{min} during preceeding 10 days