Long term application and evaluation of IAPP using global radiosonde and CHAMP measurements

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Overview

- Data from ATOVS, radiosondes, CHAMP.
- Methodology.
- Evaluation – GUAN radiosondes.
- Evaluation – CHAMP.
- Conclusions and future plans.

CM-SAF products from ATOVS I

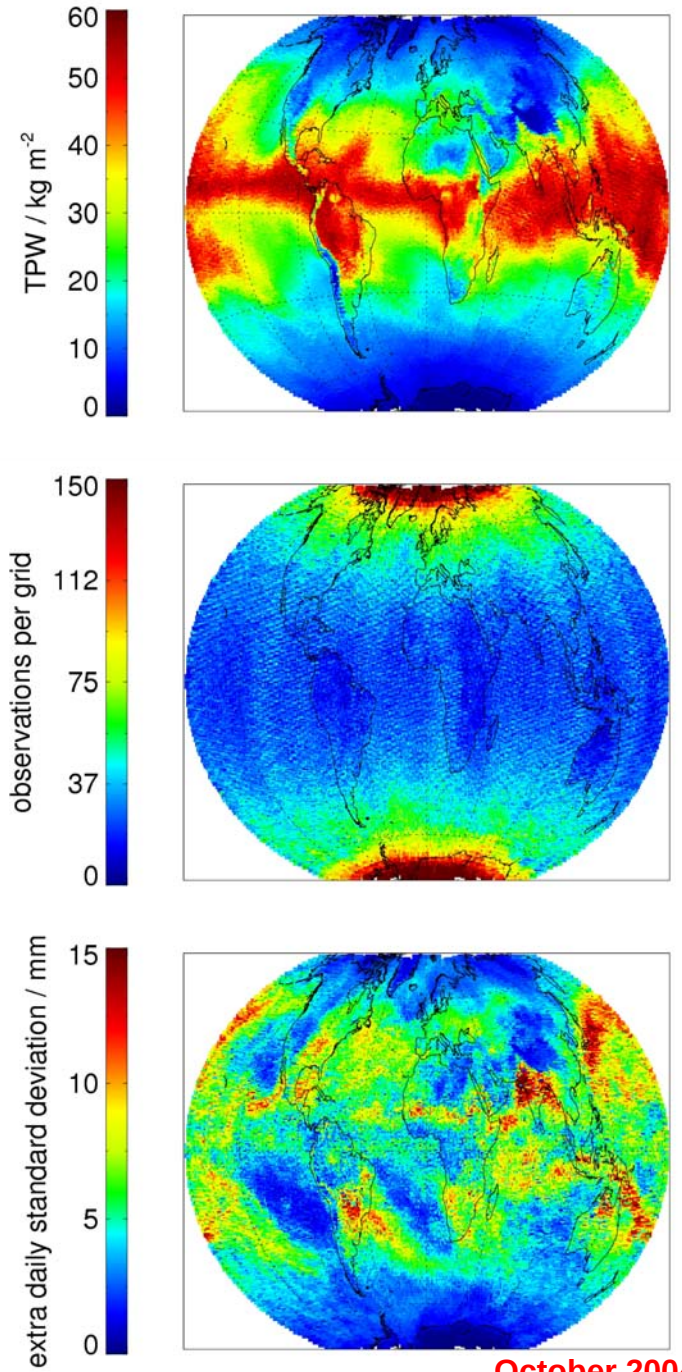
- Apply AAPP 5.3 and IAPP 2.1 to ATOVS observations from NOAA-15, -16, and -18 to get water vapour and temperature products at 42 pressure levels.

- TPW: Vertically integrated water vapour (surface – 100 hPa).
- LPW1-5, T1-5, RH1-5: Layered vertically integrated water vapour and layer mean temperature and relative humidity for 5 layers.
- T1-6, q1-6: Temperature and mixing ratio at 6 pressure levels.

layer	1	2	3	4	5	--
Pressure [hPa]	300-200	500-300	700-500	850-700	Surface-850	--
level	1	2	3	4	5	6
Pressure [hPa]	200	300	500	700	850	1000

CM-SAF products from ATOVS II

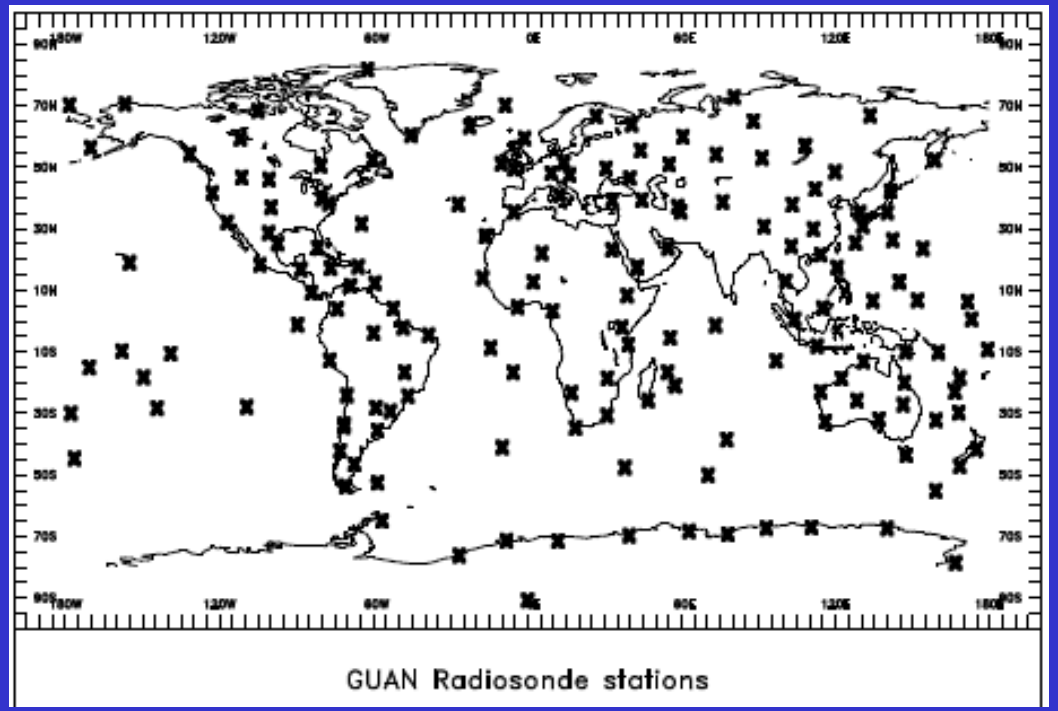
- Swath-based output of IAPP is quality controlled,
- integrated and averaged.
- A kriging routine (Lindau+Schulz, 2004) is applied to provide:
  - global products on fixed grid (90 km)^2 (top)
  - number of observations (middle)
  - standard deviations (bottom)
  - daily and monthly averages.
- Operational processing.



Radiosonde observations (RO)

- Radiosondes: Quality controlled radiosonde observations from DWD archive, GCOS upper air network stations (173).

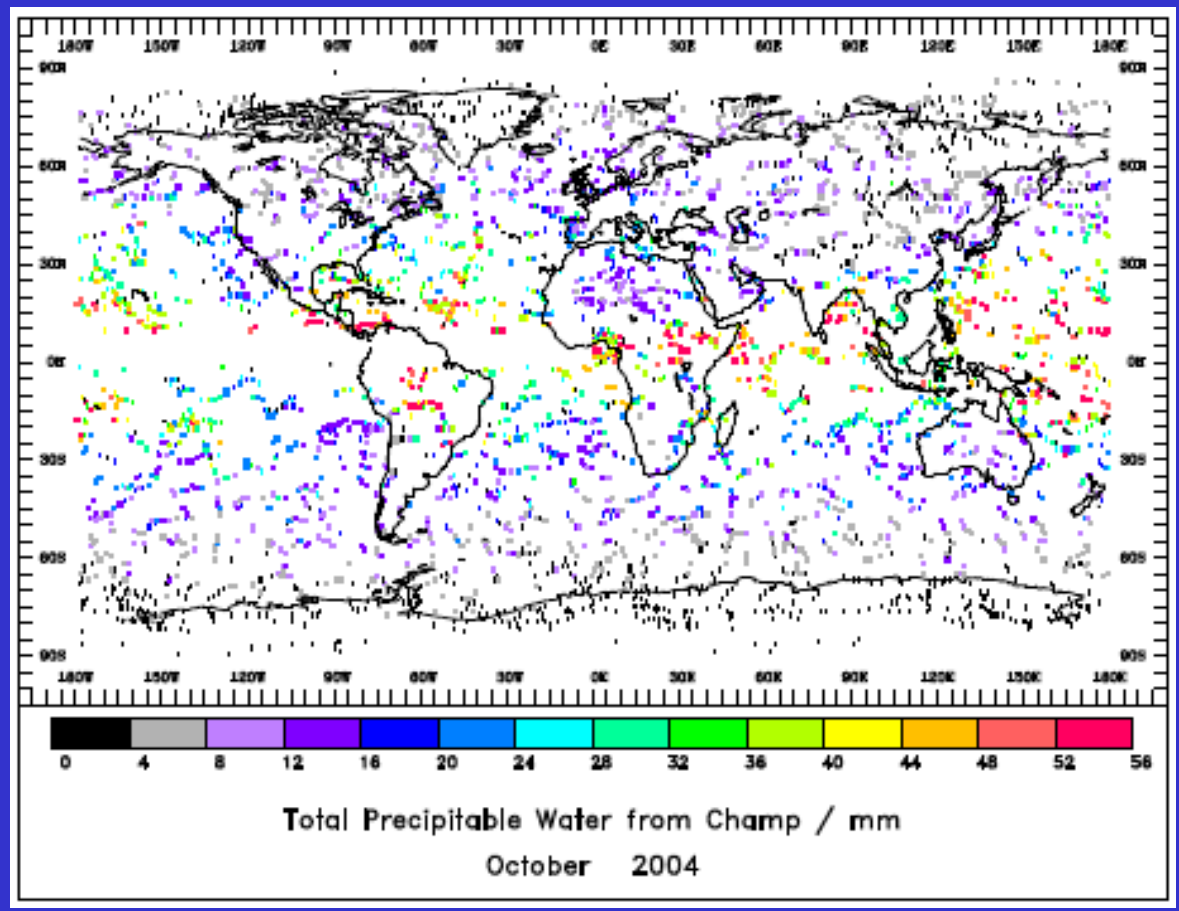
  - Integrate + average,
  - 2 observations per day,
  - All products,
  - Apply extreme outlier screening.



CHAMP

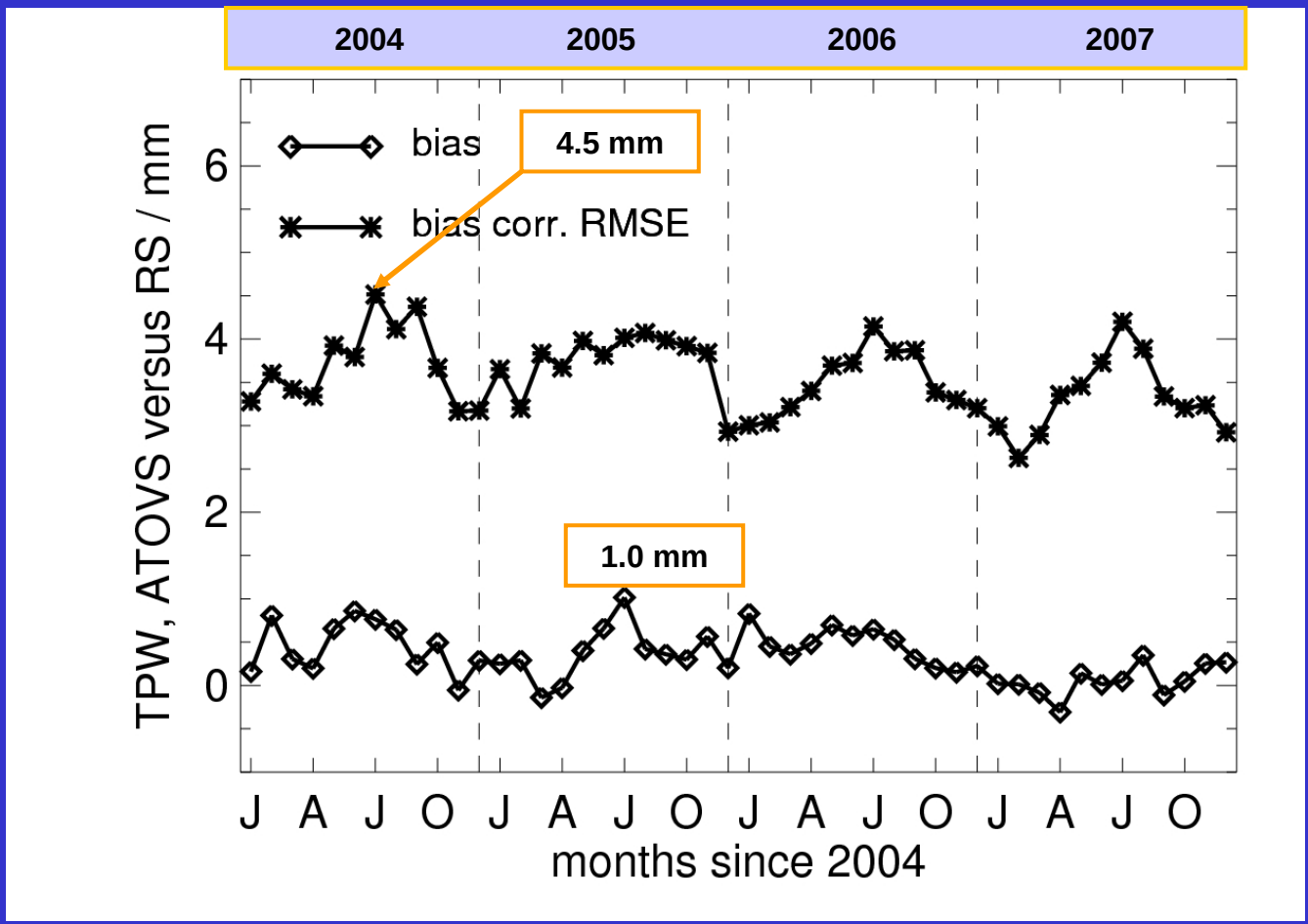
- CHAMP: CHAllenging Minisatellite Payload, GPS receiver, radio occultation method.

- TPW only.

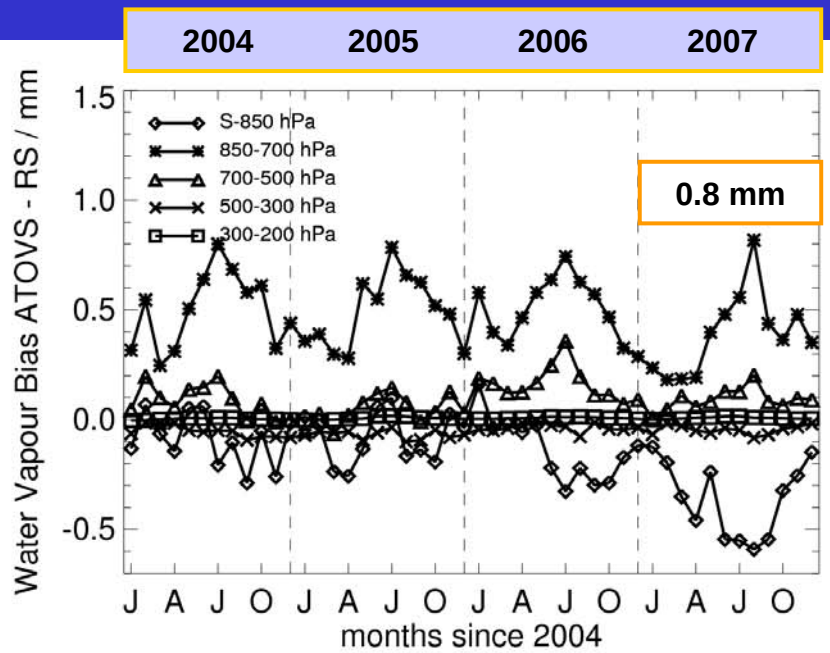


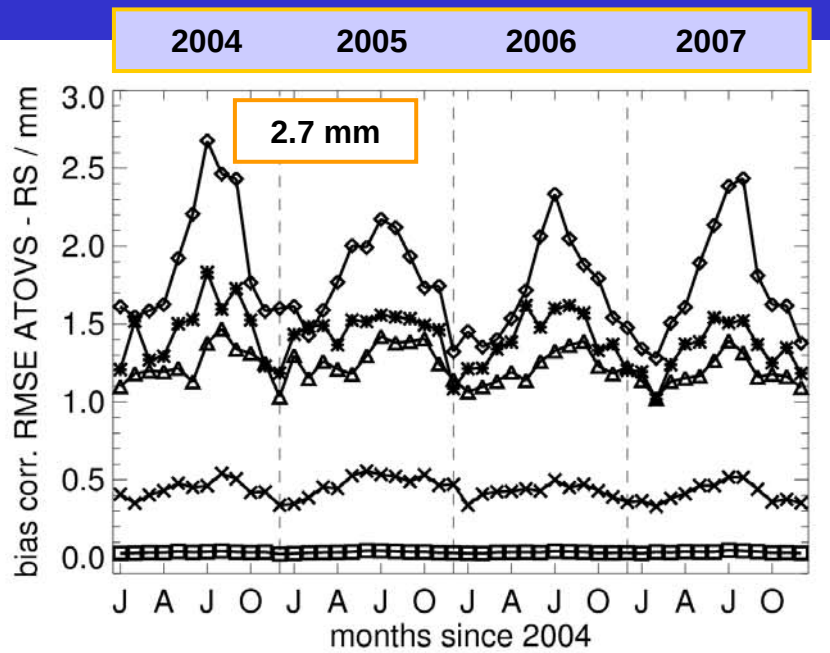
ATOVS evaluation
- TPW -

- ATOVS – RO.
- Evaluation: January 2004 – December 2007.



ATOVS evaluation
LPW1-5



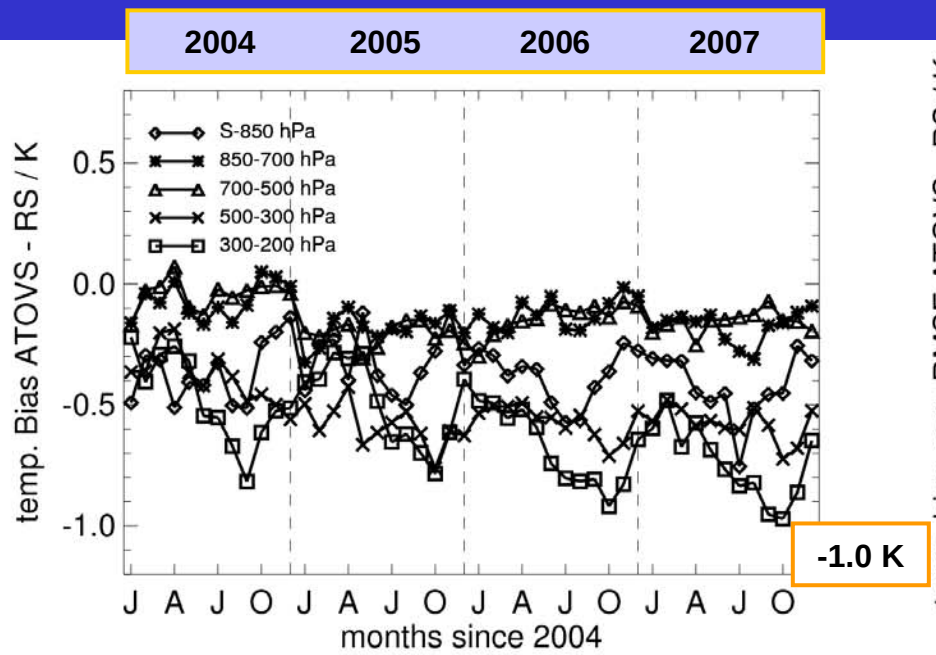


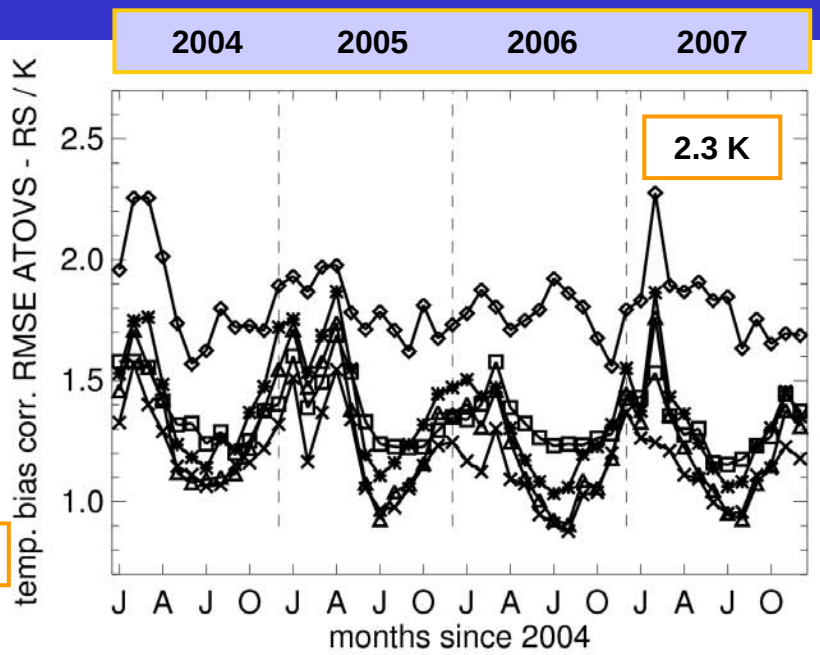
Small biases in LPW with maximum in layer 850-700 hPa.

Annual cycle in RMSE in near-surface layers.

Decreasing RMSE for increasing layer height.

ATOVS evaluation
T1-5



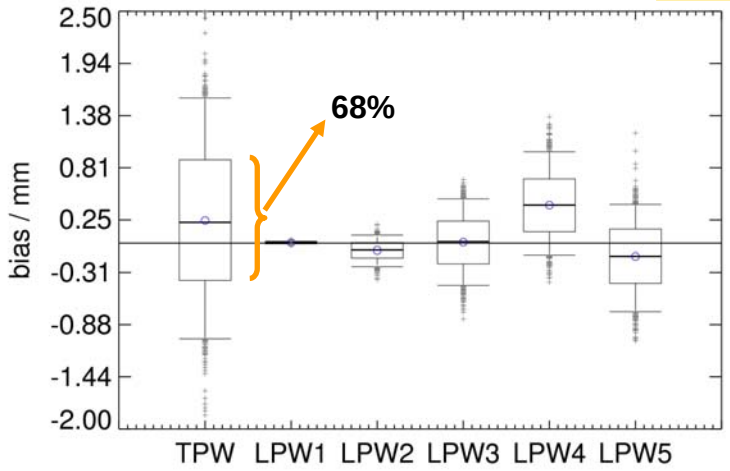


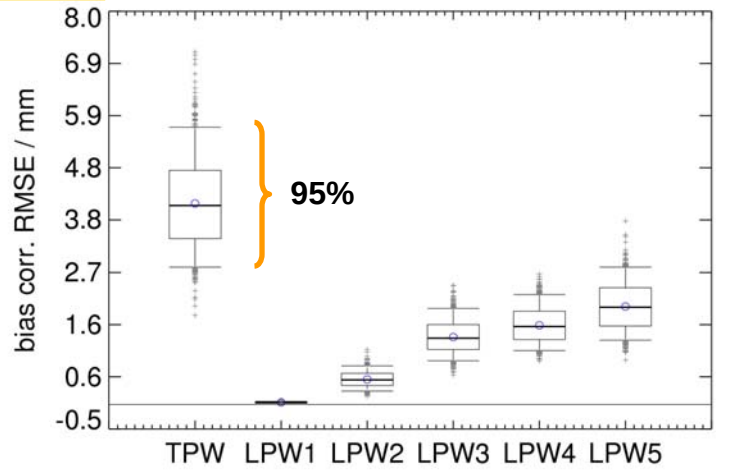
High quality of temperature products.

Some outliers still present.

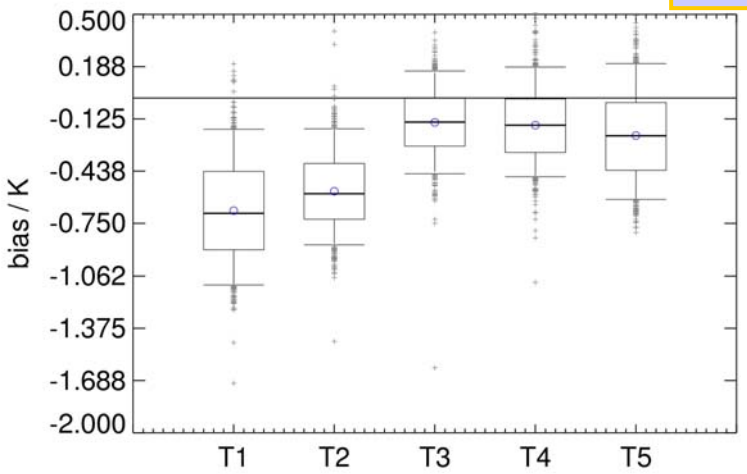
Daily variability
- Box-Whisker plots -

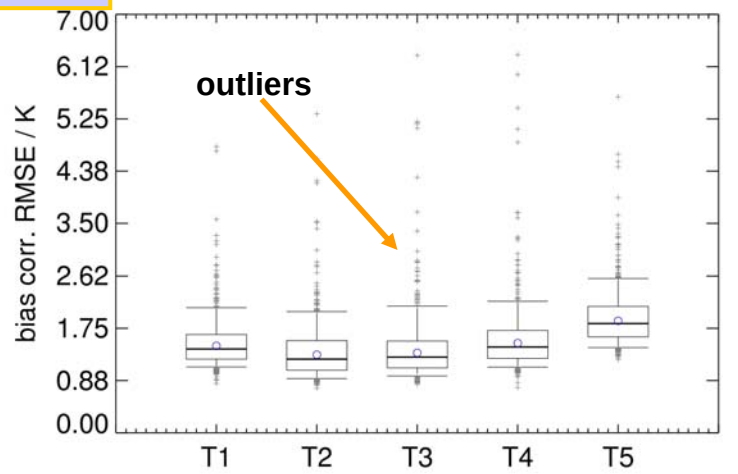
Water vapour





Temperature





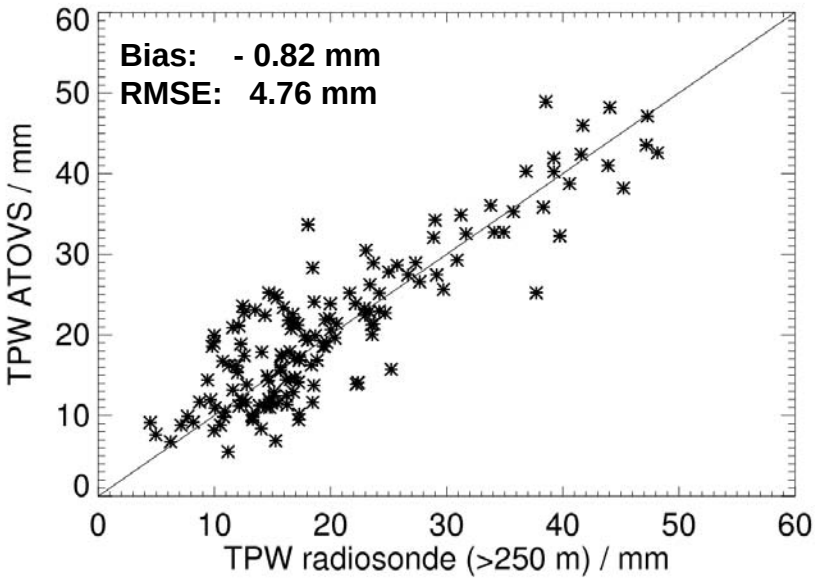
Uncertainty of kriged IAPP results

Temperature [K]			Layered precipitable water [mm]		
layer	bias	RMSE	layer	bias	RMSE
1	1.25	2	1	0.015	0.08
2	1.00	2	2	0.15	0.75
3	0.50	2	3	0.15	1.75
4	0.50	2.25	4	0.75	2.00
5	0.75	2.25	5	0.6	2.75
			TPW	1.0	4.50

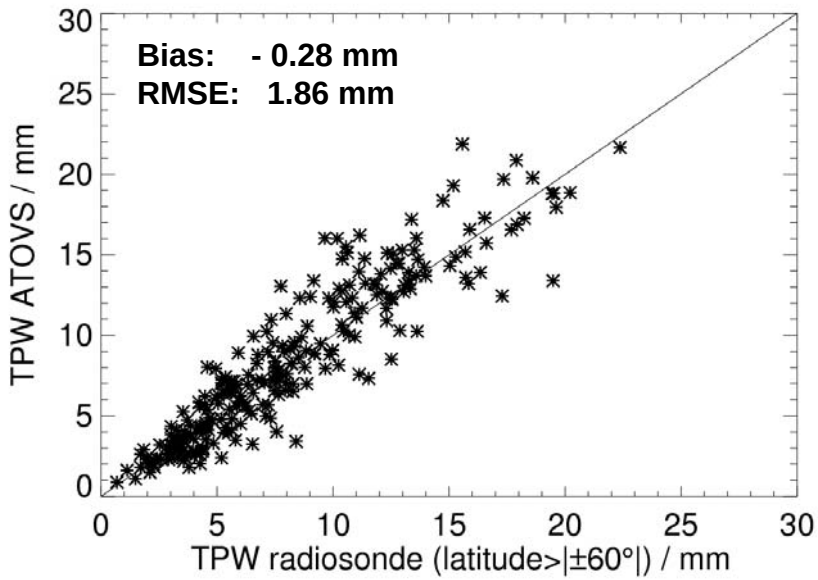
Special issues
- ATOVS vs. RO -

October 2004

Surface height > 250 m

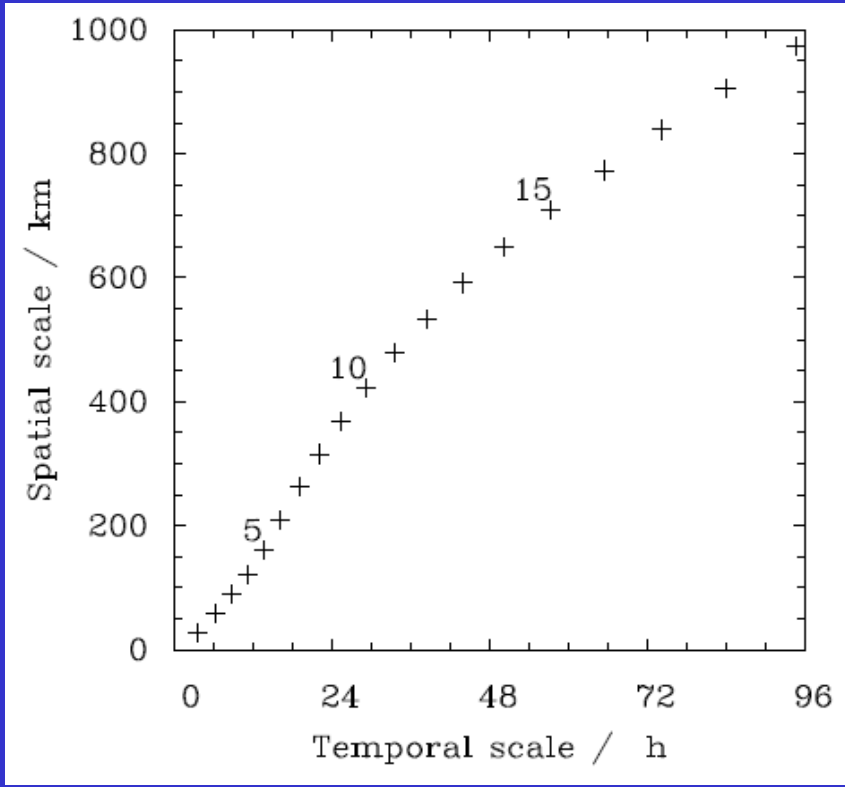


Position either >60° or < -60° latitude



High quality even in problematic areas.

Error / Uncertainty

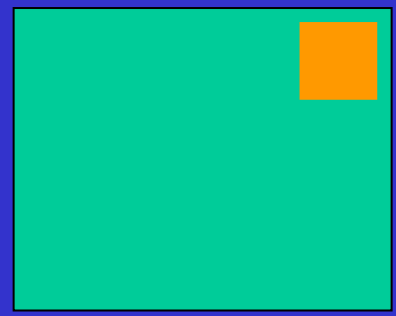


Water vapour variance within GPS data, Scandinavia (Lindau, 2000)

- Island effect:

St Helena: 414 km²
436 m

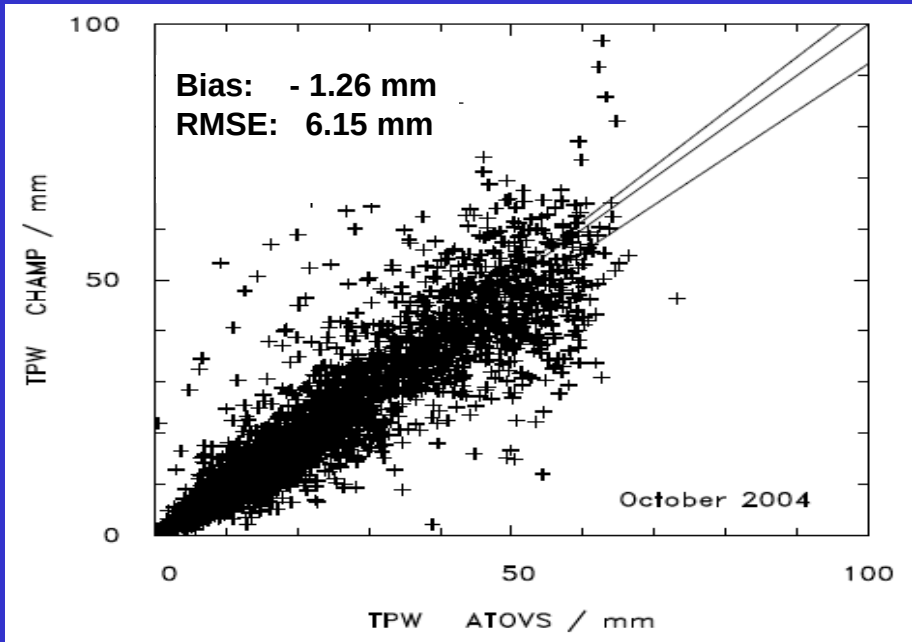
ATOVS: 8100 km²
0 m

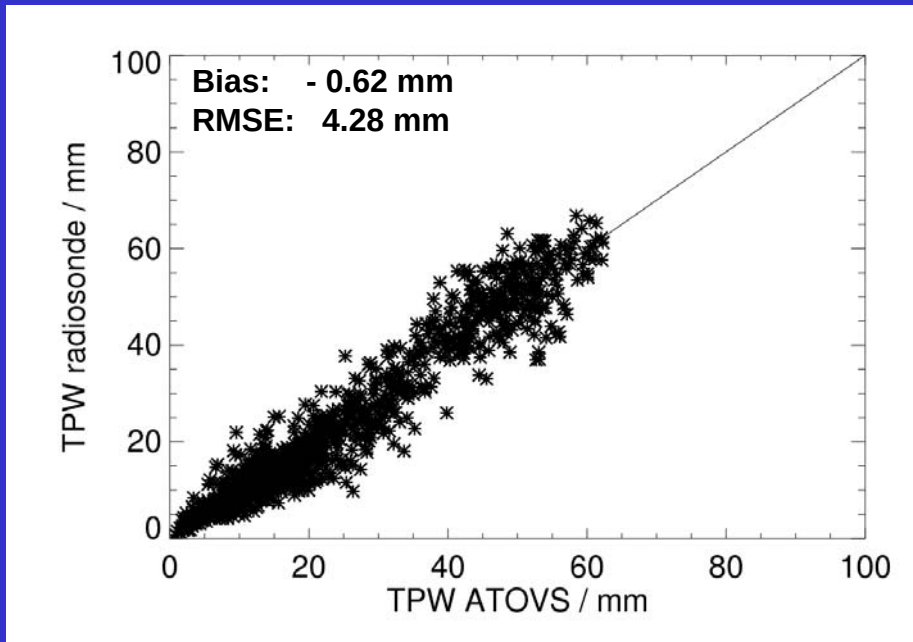


- Variable quality of RS observations (calibration / age).
- Dry bias (Miloshevich et al., 2005; Leiterer et al., 2005)

Evaluation - CHAMP

October 2004

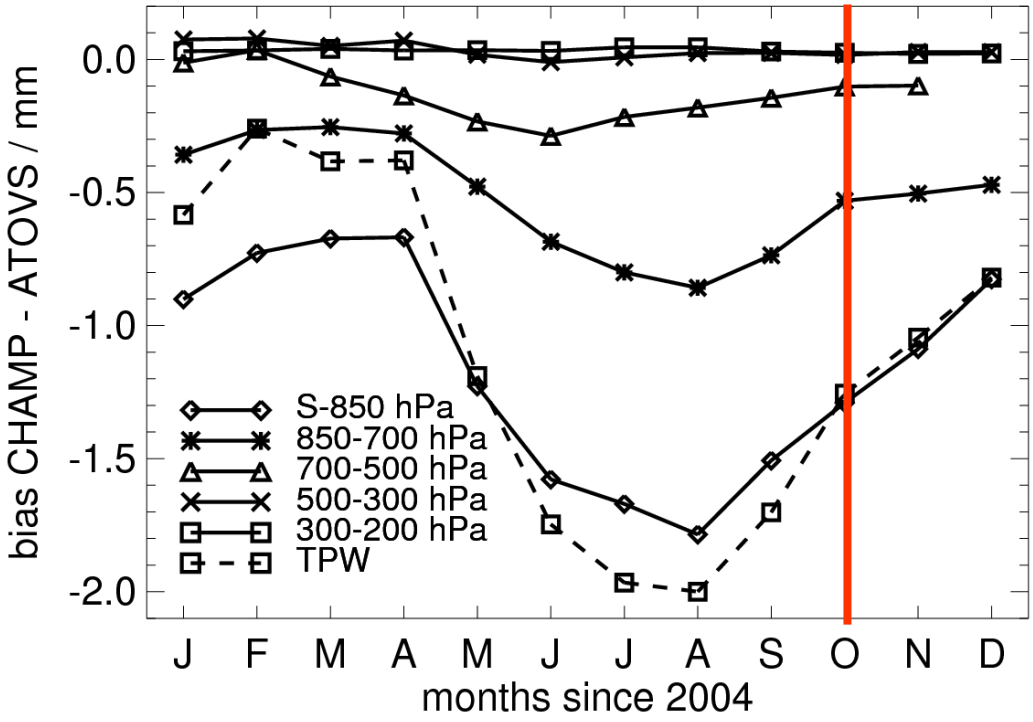




Larger bias and RMSE between ATOVS and CHAMP.

Evaluation - CHAMP

2004



TPW: maximum absolute bias: 2 mm.

Annual cycle in near surface layers and TPW.

Conclusions

- Water vapour and temperature products exhibit high quality.
- TPW bias fluctuates around 0 mm, with a mean value of 0.2 mm.
- LPW bias generally <0.5 mm (max. of 0.8 mm at 850-700 hPa).
- T bias usually <0.5 K (max. of -1 K at 300-200 hPa).
- Evaluation provides uncertainties. The error is most likely smaller.
- The quality for observations at high latitudes and above high land is surprisingly good.
- Comparison of ATOVS and CHAMP data gives larger bias and RMSE but still confirms the high quality of the ATOVS products.

Future plans

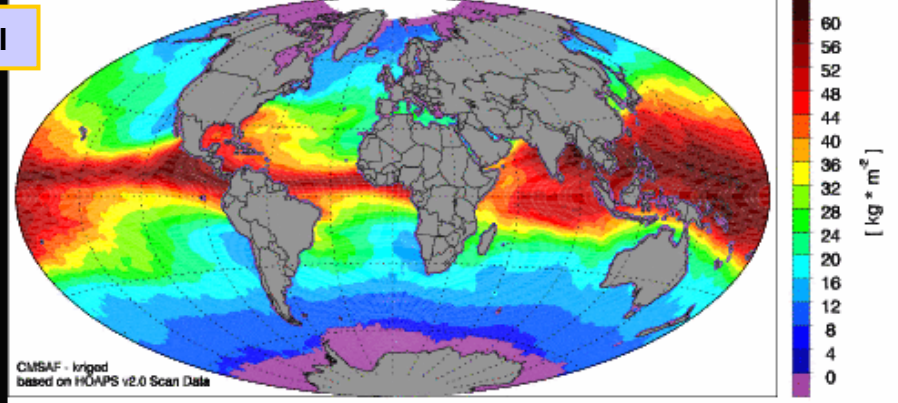
- Process ATOVS data from May 1998 onwards.

- Install new version of IAPP (done for new version of AAPP).
- Extend operational processing to MetOp data.
- Verify quality of extended ATOVS products.

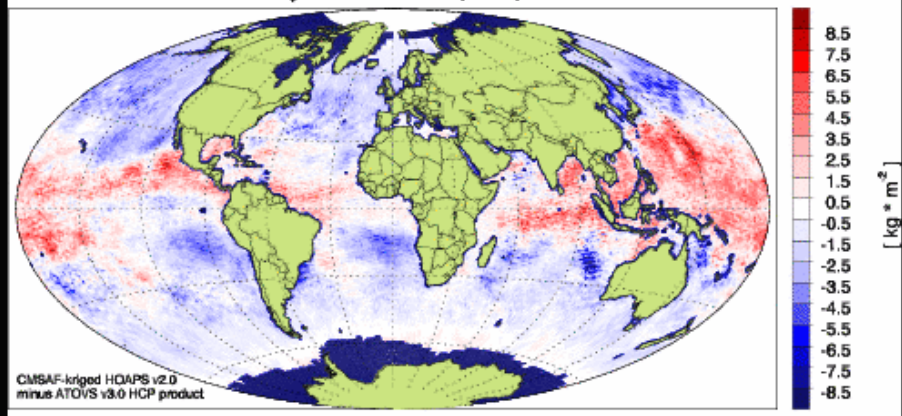
- Error propagation study for IASI.
- Implement error covariances into ATOVS processing.
- Incorporate IASI level 2 into the ATOVS chain.

ATOVS vs. SSMI

SSMI

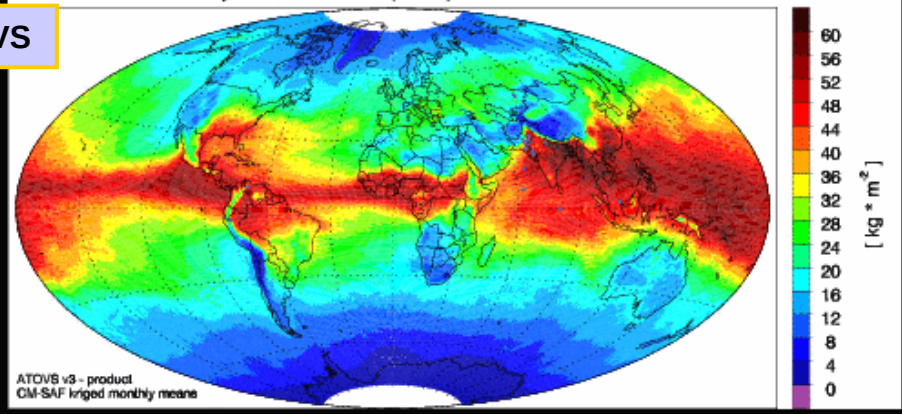


Difference in monthly mean water vapour path for JUN 2004



Monthly mean water vapour path for JUN 2004

ATOVS



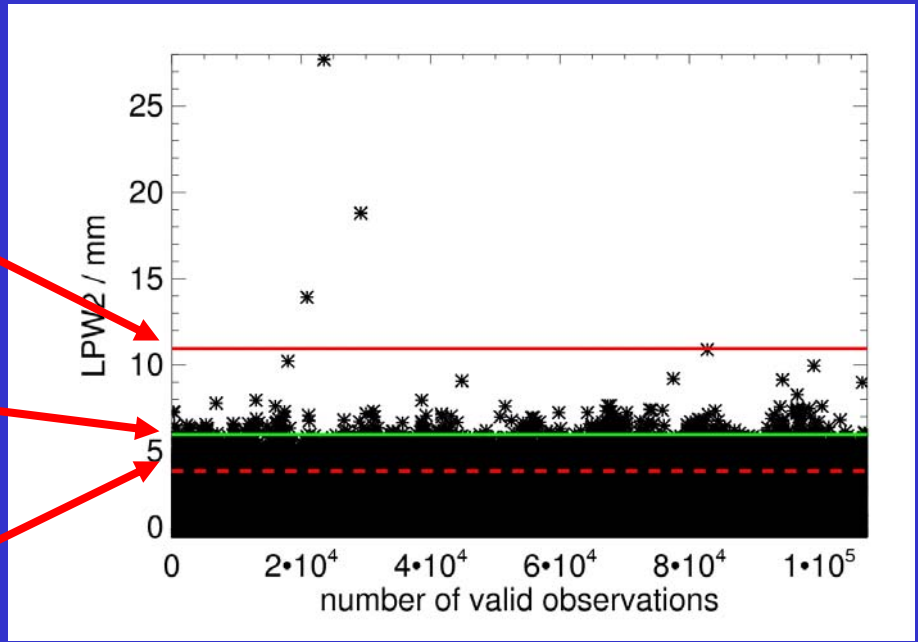
Screening

Validation: Apply extreme outlier screening (1):

(1) first bins x with
0=PDF(x) ;binsize= σ /2

(2) Q1,3 $\pm$ 3 x IQ

(3) 3 x σ



Future plans III

Trend analysis

- Visiting scientist at Uni Bremen.
  - Assessment of trends in the 22 GHz channel.
  - Comparison of brightness temperature differences in current, Wentz v6 and Level 1C data sets to analyse absolute intercalibration offsets.
  - Comparison of water vapour trends over global ocean: Spatial distribution and significance from SSM/I, GOME and SCIAMACHY data sets.

STATUS OF OPERATIONAL SATELLITES (Continued)

DRIFT RATES AND EQUATOR CROSSING NODES (ECN) As of May 2007

Spacecraft	Launch Date	Equator Crossing Times	Drift Rate
NOAA-18	MAY 2005	1338 Ascending	-0.3 min/month
NOAA-17	JUNE 2002	1011 Descending	-1.2 min/month
NOAA-16	SEPT 2000	1555 Ascending	+3.9 min/month
NOAA-15	MAY 1998	0521 Descending	-1.8 min/month
~~NOAA-14~~	~~DEC 1994~~	~~2155 Ascending~~	~~+2.4 min/month~~
NOAA-12	MAY 1991	0520 Descending	+1.5 min/month