Summary

New Results on the Assimilation of GPS Data at DWD

Mariella Tomassini and Christoph Schraff, DWD

From GPS-derived precipitable water (PW), profiles of (pseudo-)observations of specific humidity are obtained by simple scaling of the present model humidity profiles. Quality weights for each level reflect the relative contribution of the model layers to the vertically integrated information (see slide 2). The profiles can then be assimilated similarly to radiosonde profiles, yet with a reduced horizontal radius of influence.

Half-hourly data from about 100 GPS stations mainly located in Germany (slide 3) have been used in a 12-day parallel assimilation cycle and forecast experiment with three daily forecasts in August 2002. This complements a previous similar 9-day experiment for August 2001. The GPS experiment is compared to the operational cycle without using these data. For the August 2002 period, however, a second experiment has been performed. In this, the GPS IWV data have been bias-corrected prior to their use so that the mean diurnal cycle of the assimilated data approximates that of the free model forecasts (see slide 4). This is to diminish the tendency of erroneous triggering of the convection which occurs when the extra amount of moisture present in the (probably correct) original GPS data at noon and in the early afternoon tries to change the (probably erroneous) model climate.

As is shown for the Elbe flood case (slide 7) and for another case (slide 6), the assimilation of GPS can have a moderate positive impact on precipitation patterns and amounts beyond a forecast lag time of 12 hours. The bias correction has little effect on the rainfall patterns, but improves the amounts slightly. The overall impact of the GPS data on the LM forecasts in the 2 summer periods (upper-air verification in slide 5, summary in slide 8) is slightly positive. However, there are cases with a negative impact on precipitation. A key contributing factor to this is probably an incorrect vertical distribution of the vertically integrated observational information (slide 9). For one case, this has been shown in the previous year. The deficiency cannot be solved without using further observational information, either from the GPS system itself (e.g. tomography) or from other observing systems (e.g. information on cloudiness).

Results and status of assimilation of GPS-Derived Integrated Water Vapour in LM

M. Tomassini and Ch. Schraff
Deutscher Wetterdienst

This work was carried out within the
GPS Atmospheric Sounding Project
http://www.gfz-potsdam.de/pb1/GASP/

Assimilation of GPS-derived IWV

Nudging of GPS data in LM

Integrated Water Vapour IWV derived from total zenith delay using pressure and temperature from synop, if not available from model fields.

GPS specific humidity at model level k:

$$q_v^{obs}(k) = \frac{IWV^{obs}}{IWV^{\mathrm{mod}}} \cdot q_v^{\mathrm{mod}}(k)$$

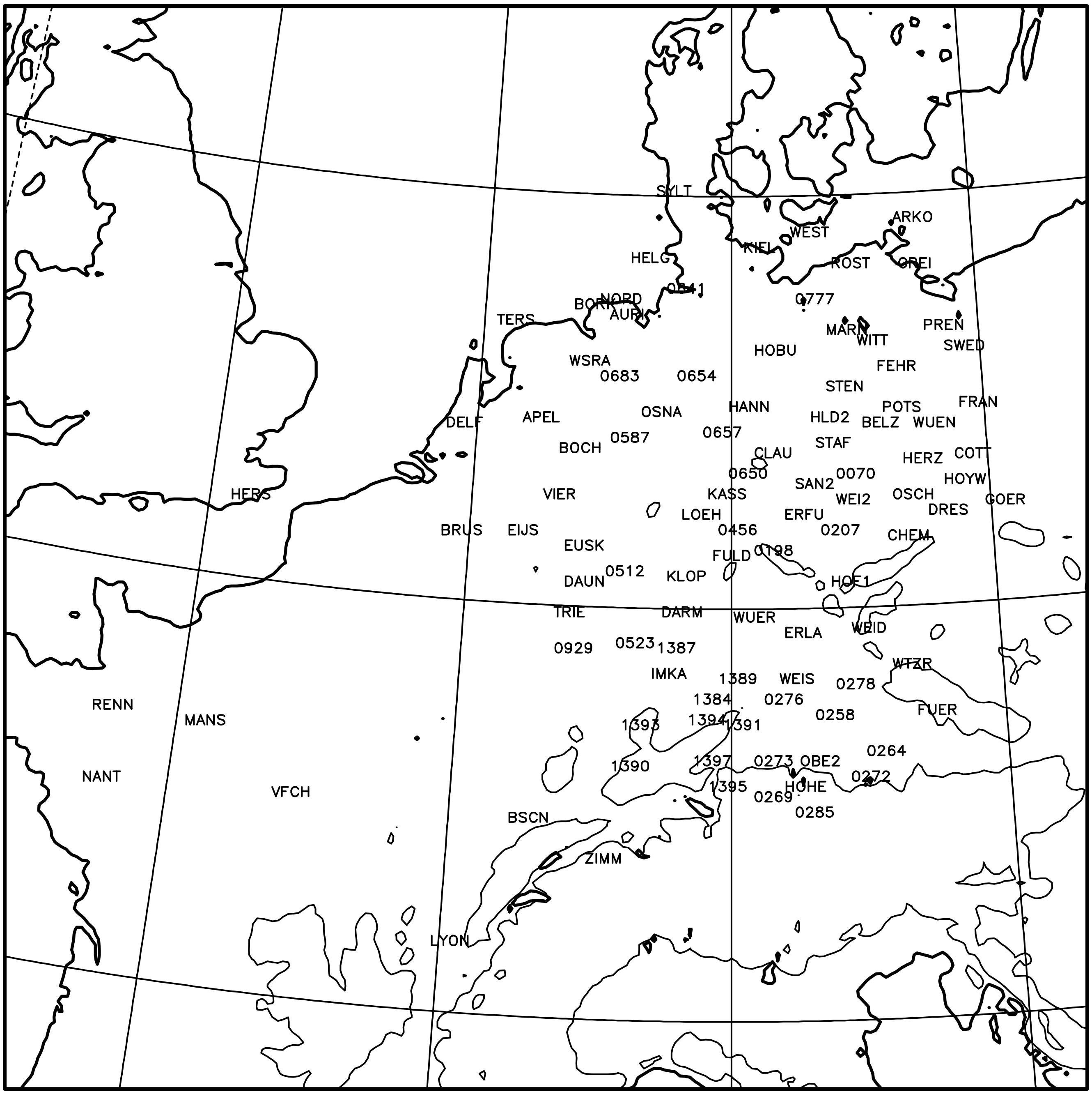
Quality weight assigned to GPS obs:
(w(k) ~ 1 between 700-800 hPa)

$$w(k) = \frac{q_v^{sat}(k)\ \Delta p(k)}{\max\ [w(k)]}$$

Retrieved GPS humidity profiles are treated as radiosonde except:

- used only below 500 hPa
- smaller horizontal radius of influence (~ 50 km at 850 hPa)

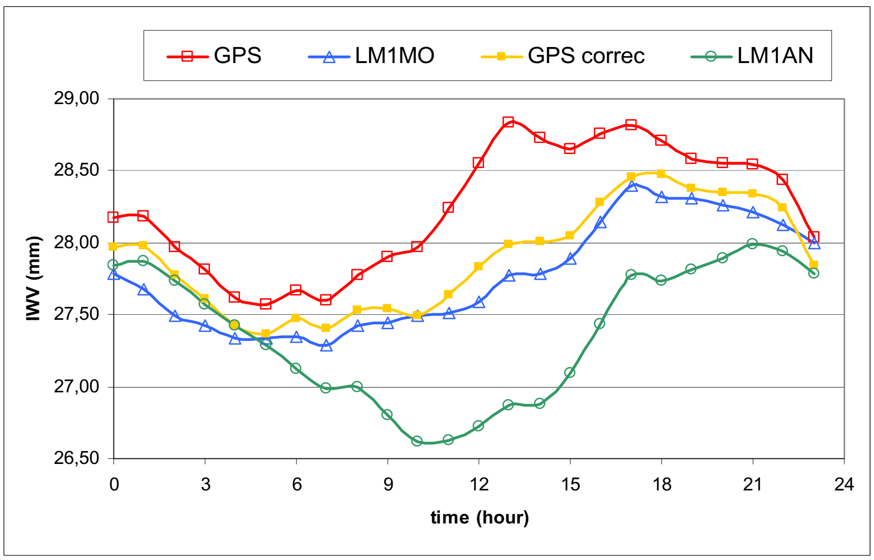
horizontal distribution of GPS stations



Assimilation of GPS-derived IWV

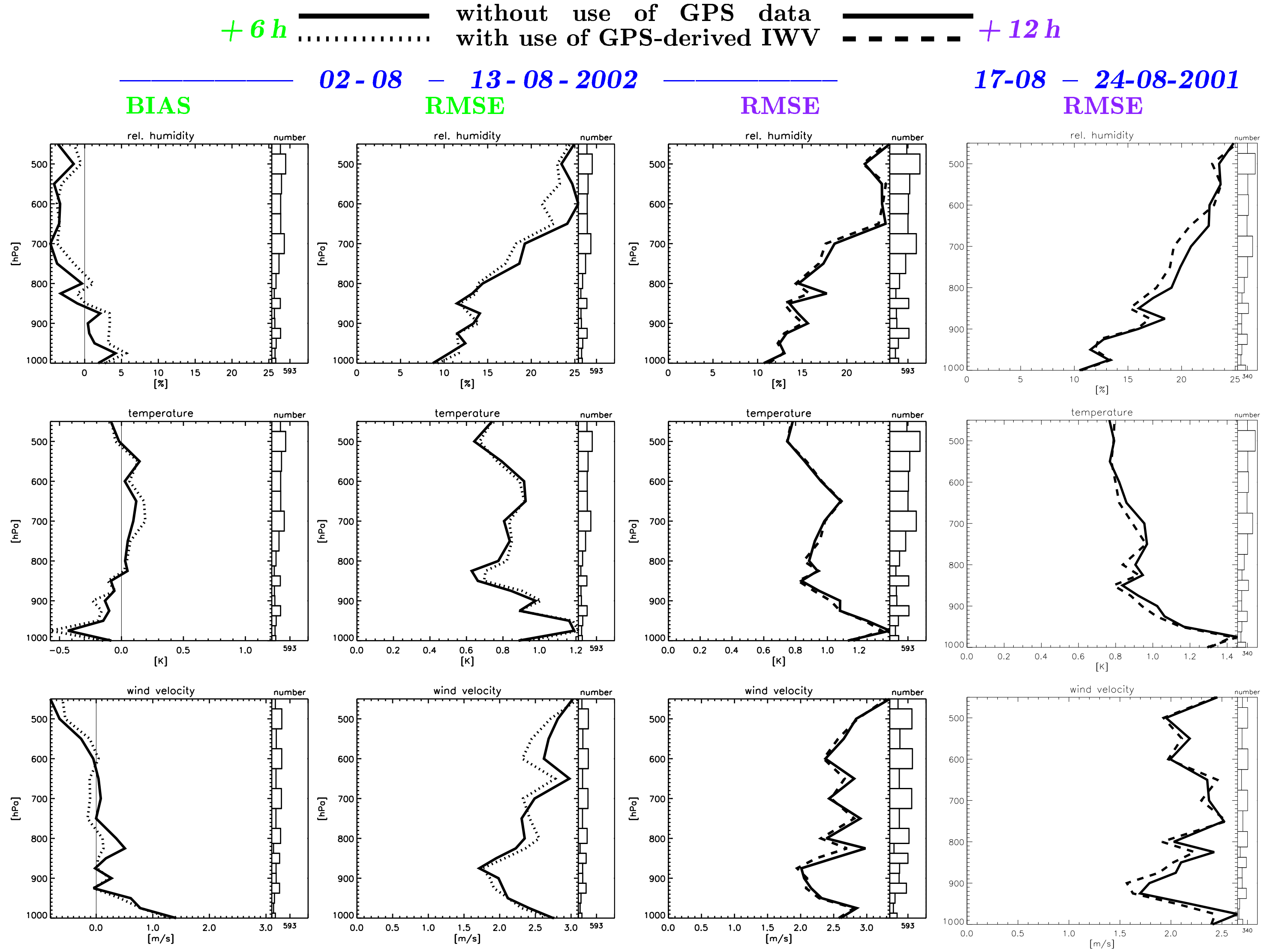
Bias of GPS relative to LM IWV

› positive in summer, almost zero in winter
› in summer different IWV daily cycle
==> daytime-dependent bias correction of GPS IWV (Aug. 2002)



Diurnal cycle Aug 2002: IWV hourly mean at 103 GPS stations

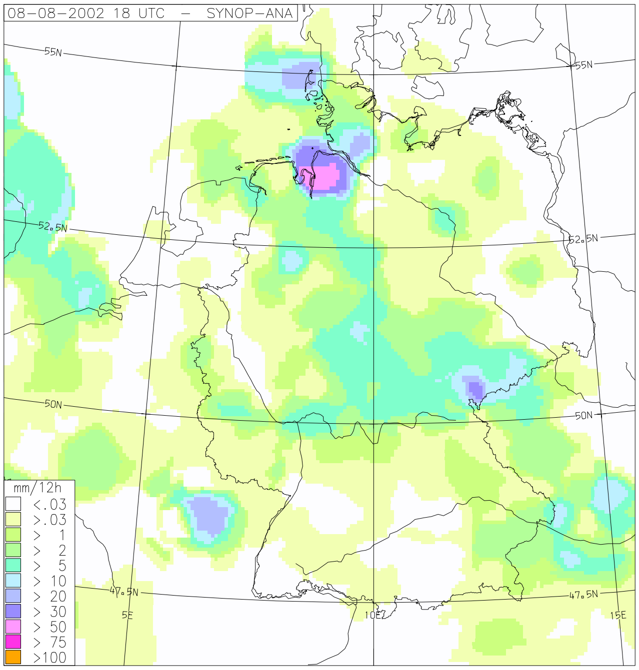
verification against 0-, 12-UTC radiosonde data around Germany (lon. 3°−15° ; lat. 46°−57°)



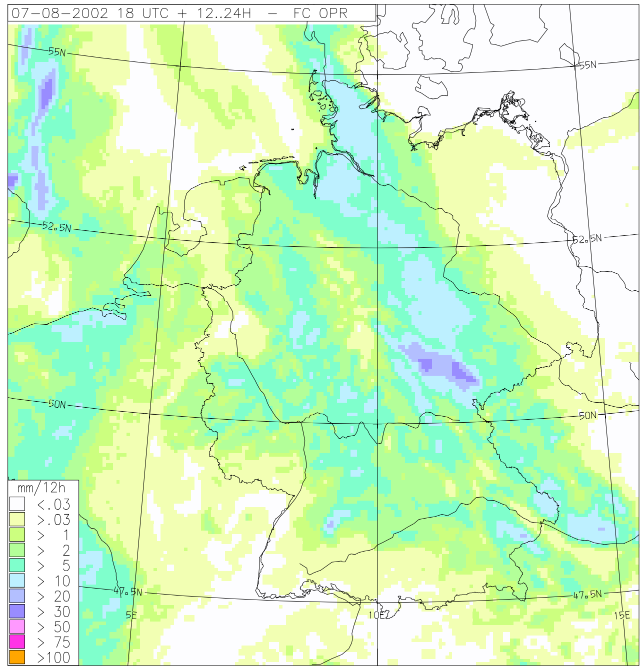
LM-FORECAST

12-24 hour precipitation forecast valid for 2002080818

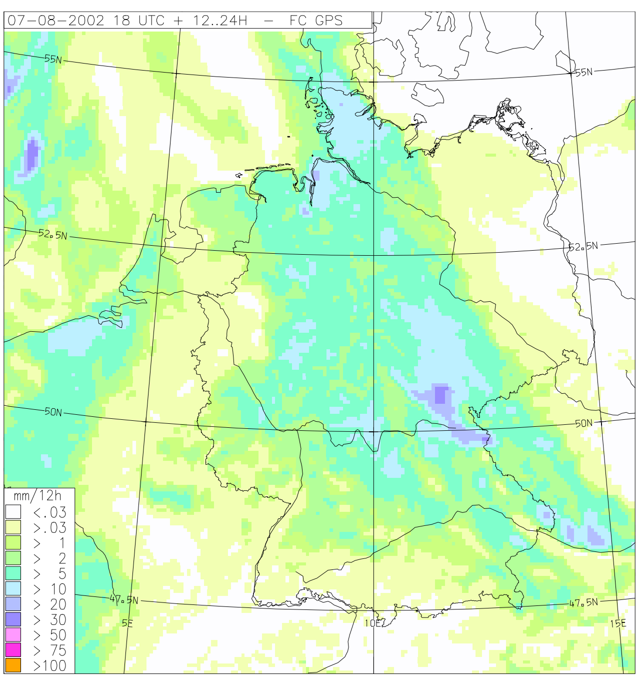
synop



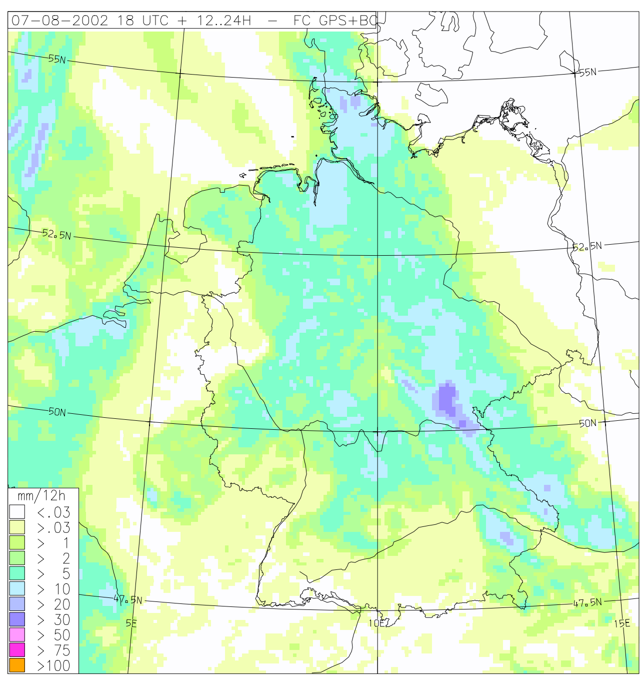
opr



gps



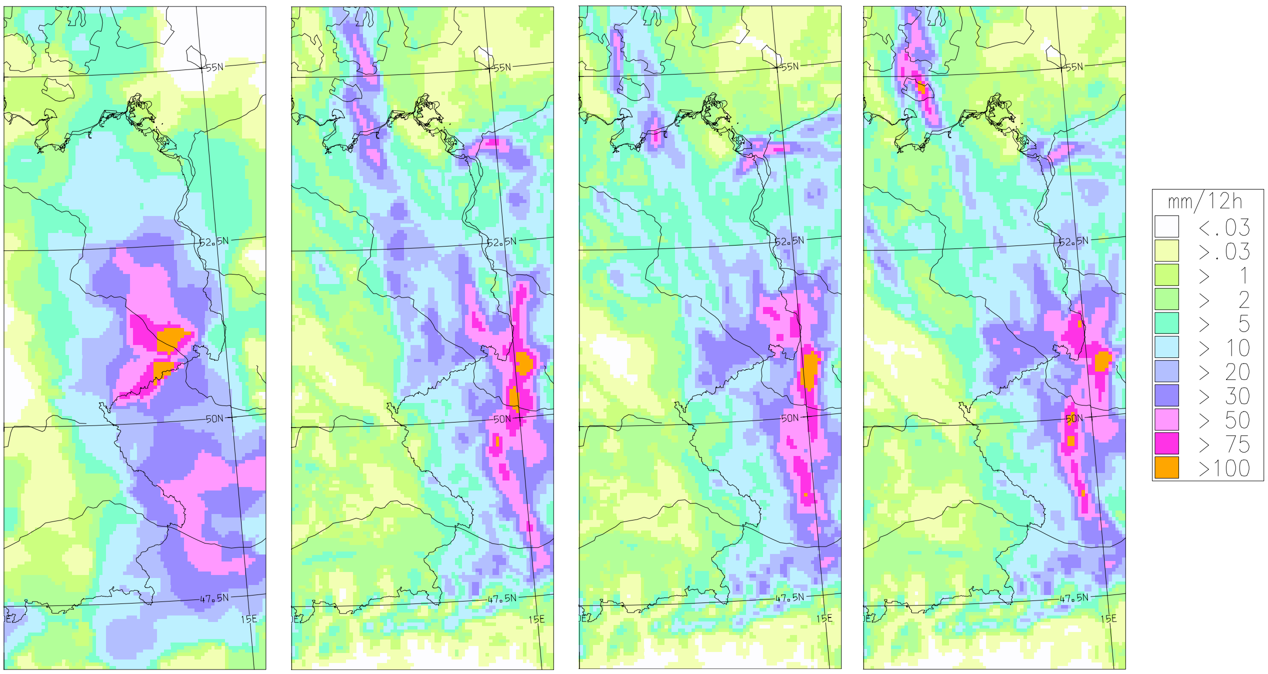
gpsbc



12-hourly precipitation valid for 12 August 2002, 18 UTC

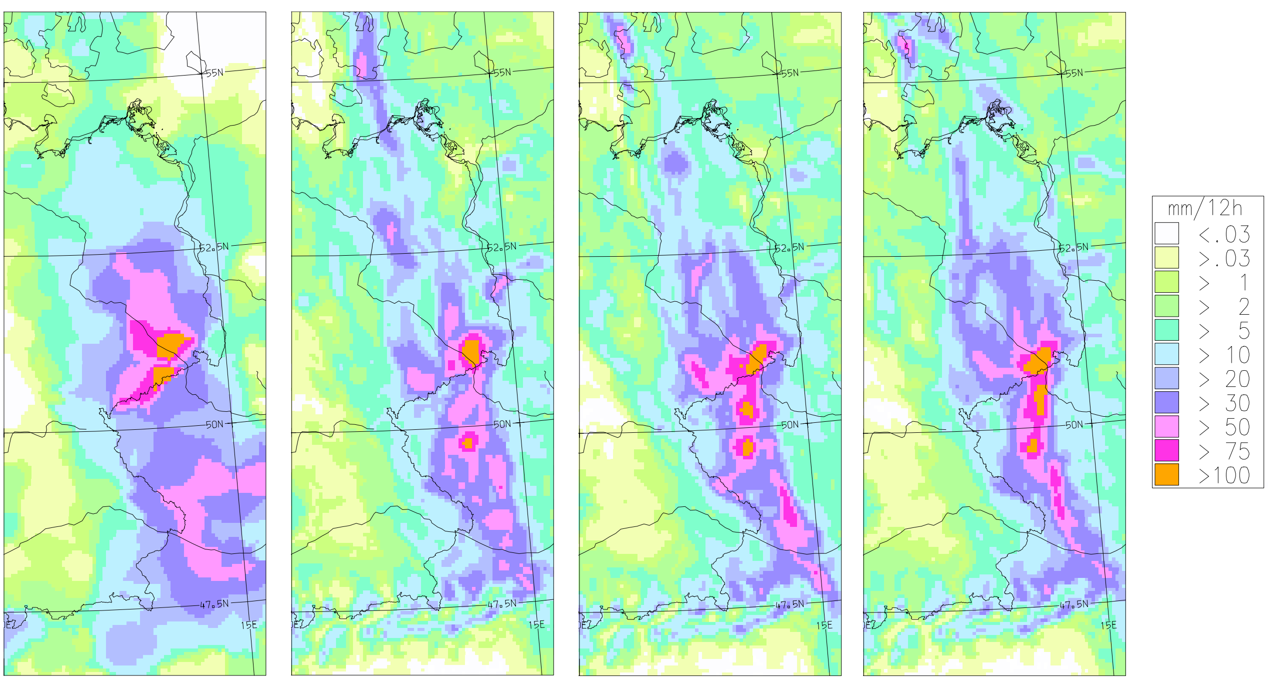
12 - 24 -hour LM forecasts *(starting from 11 August 2002, 18 UTC)*

observed (synop) | **control (no GPS data)** | **with GPS data** | **with GPS data & bias correction**



6 - 18 -hour LM forecasts *(starting from 12 August 2002, 0 UTC)*

observed | **control** | **GPS** | **GPS & bias corr.**



(M. Tomassini, Ch. Schraff, 2003, DWD)

Assimilation of GPS-derived IWV

Summary of Results

- ⋆ clear positive statistical impact on IWV & upper-air humidity

  slight positive statistical impact on upper-air temperature & wind

  in forecasts up to about +15 h

- ⋆ mixed (Aug. 01) or slightly positive (Aug. 02) overall impact on analyzed and predicted precipitation

- ⋆ negative impact on cloud cover of low stratus

Assimilation of GPS-derived IWV

Important Issues in View of the Operational Application

⋆ **bias of GPS IWV relative to LM IWV with a diurnal cycle in summer**

$\Rightarrow$ *daytime-dependent bias correction*

$\rightarrow$ *potential problem: adaptation of the bias correction to changes in the error characteristics of the IWV observations (and of the LM $\leftarrow$ convection parameterization)*

⋆ **vertical distribution of vertically integrated observational information**

$\rightarrow$ *no general solution* $\rightarrow$ *open question :*

What is the impact of assimilating IWV in combination with other types of data (e.g. cloudiness, radar reflectivity) that are not used operationally yet ?