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Impact of GPS ZTD observations in HIRLAM 3D-Var analyses and forecasts

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Outline

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4) Verification

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- Categorical forecasts of accumulated precipitation

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Motivation

Motivation

The HIRLAM-CIS (Comprehensive Impact Study) will explore the impact of high-resolution observation types on 4D-Var analyses and forecasts of summertime convection

The number of GPS observing sites continues to increase

- Zenith Total Delay (ZTD) data from Finnish receiver stations has become available in May 2008

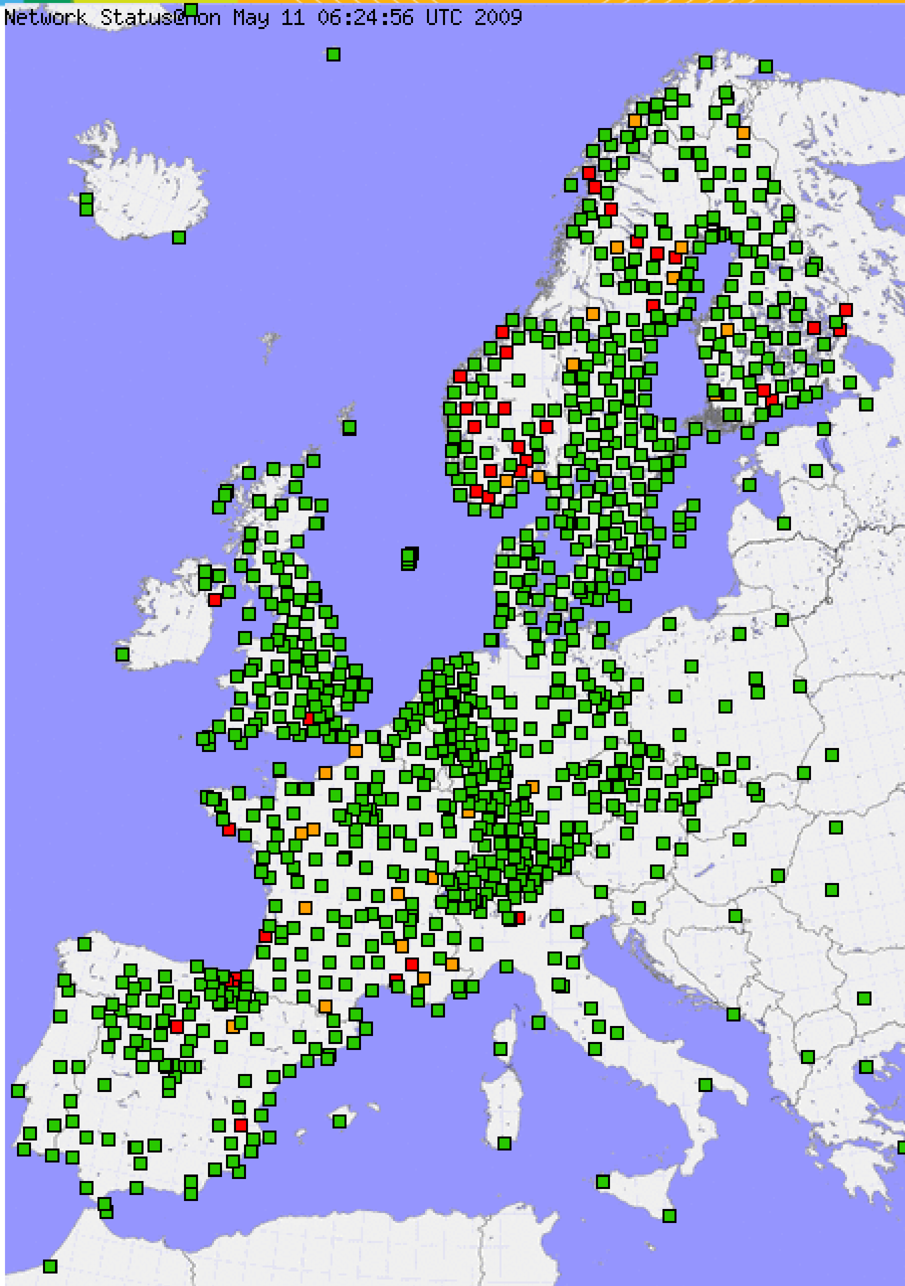
There have been improvements in GPS ZTD data assimilation code of HIRLAM

→ An impact study with 3D-Var was decided to be performed as a preparation to the HIRLAM-CIS experiment

GPS ZTD data

Observing system status in Europe

- The observing system is controlled by the EUMETNET programme E-GVAP
- The observing system consists of ground-based receiver networks that are specific to each country
- Increasing number (>1000) of receiver stations is included in near-real-time processing
- The processing is done at ~10 processing centres, including both geodetic and meteorological institutes



Experiment design

NWP model domain and time period

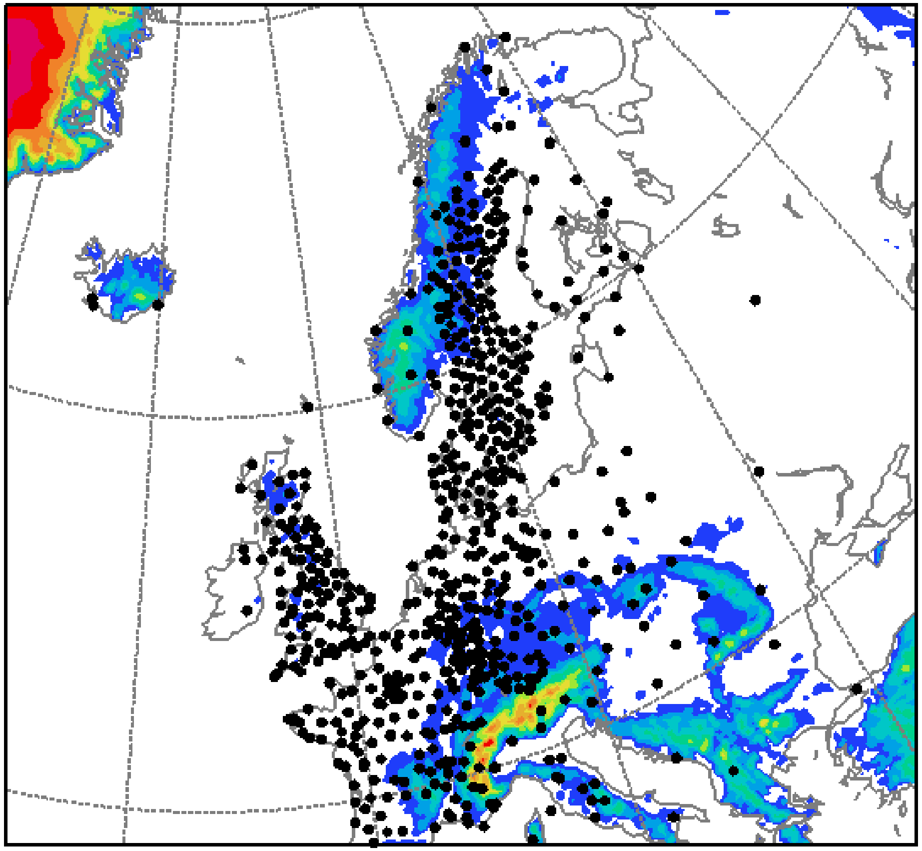
HIRLAM 3D-Var in a regular grid of 406 x 320 grid points

0.1° horizontal grid resolution at 60 model levels

A deterministic +48 hour forecast is produced every 6 hours

A 10-day ”warming up” period of 18—27 July 2008

A 35-day forecast period of 28 July—31 August 2008



Experiment design

Performed NWP model runs

Control run with only a few modifications on top of the HIRLAM 7.1.4 reference system:

- Horizontal domain and grid spacing are modified
- ATOVS observations are not assimilated

Regular GPS run: as control, but ZTD observations are included in data assimilation (651 receiver stations)

Thinned GPS run: as regular GPS run, but a horizontally thinned subset of ZTD observations is used (437 receiver stations)

Bias-corrected GPS run: as regular GPS run, but ZTD observation biases are corrected using a static site-dependent bias-correction algorithm

Observation selection and σ_o specifications

Five ”most productive” GPS data processing centres are used

Analysis-centre dependent observation error standard deviations σ_o are determined on the basis of OmB statistics over a three-week period in July 2008:

- σ_o=10 mm for ZTD processed at METO and GFZ
- σ_o=11 mm for ZTD processed at SGN
- σ_o=15 mm for ZTD processed at NGAA and ROB

Background error standard deviation σ_b is assumed to be 9 mm

The OmB dataset serves as the basis for the bias-corrections as well

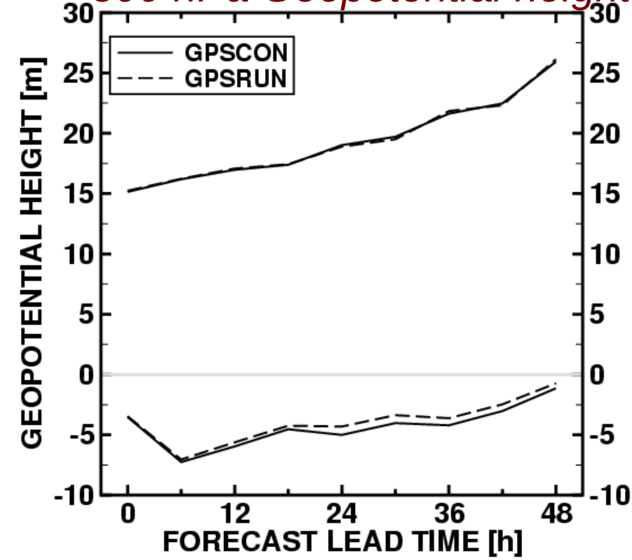
Observation verification

EWGLAM radiosonde stations

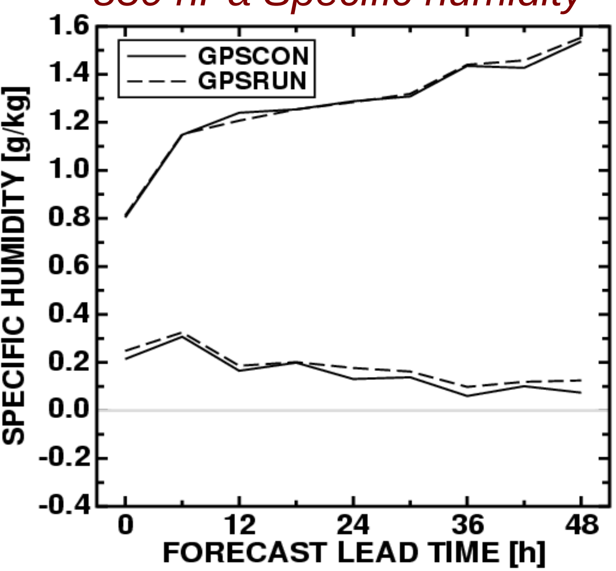
Mean forecast errors show a systematic positive (negative) impact in the upper (lower) troposphere

Forecast error standard deviations show a neutral impact

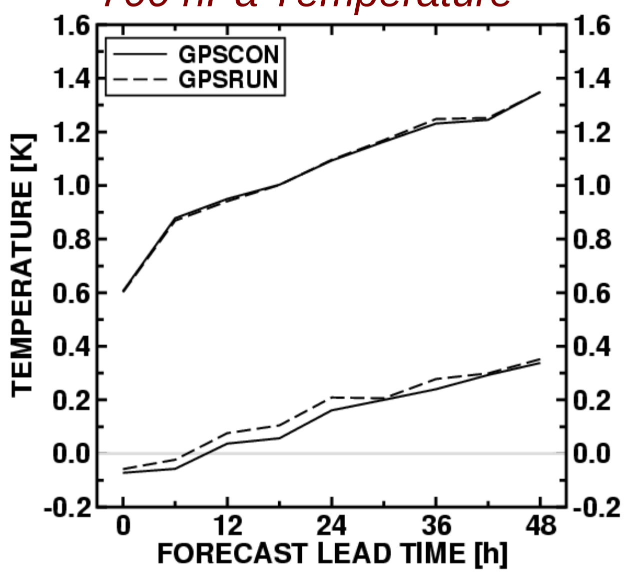
300 hPa Geopotential height



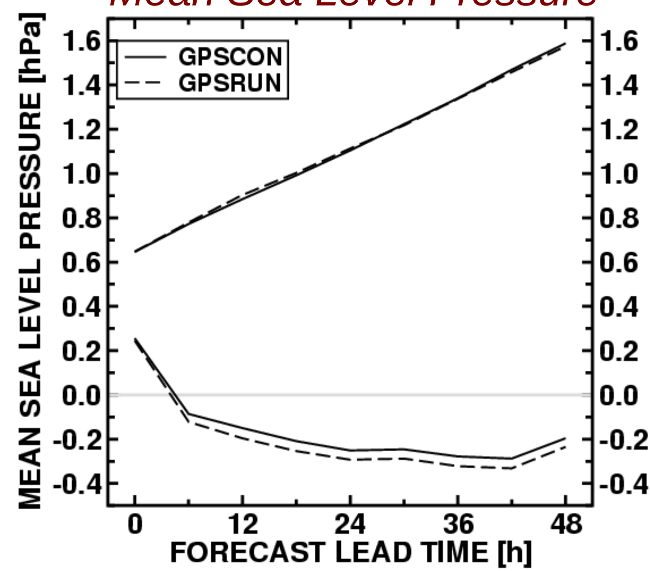
850 hPa Specific humidity



700 hPa Temperature

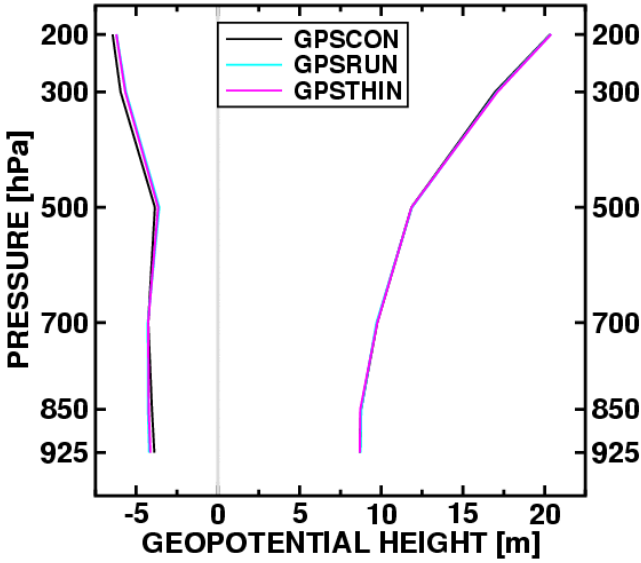


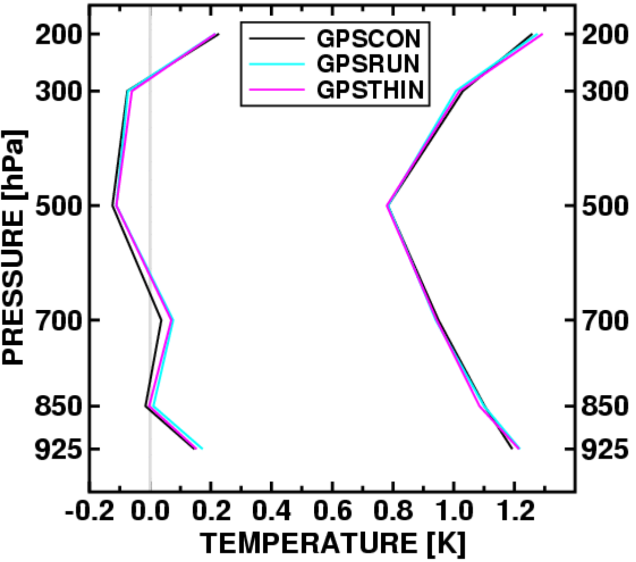
Mean Sea Level Pressure

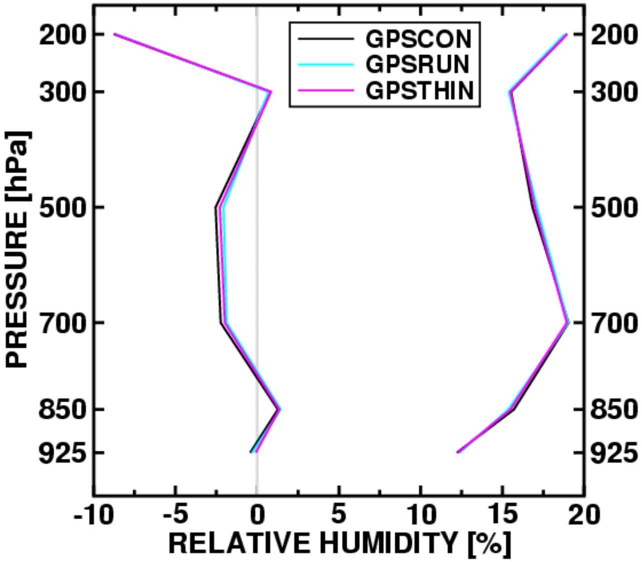


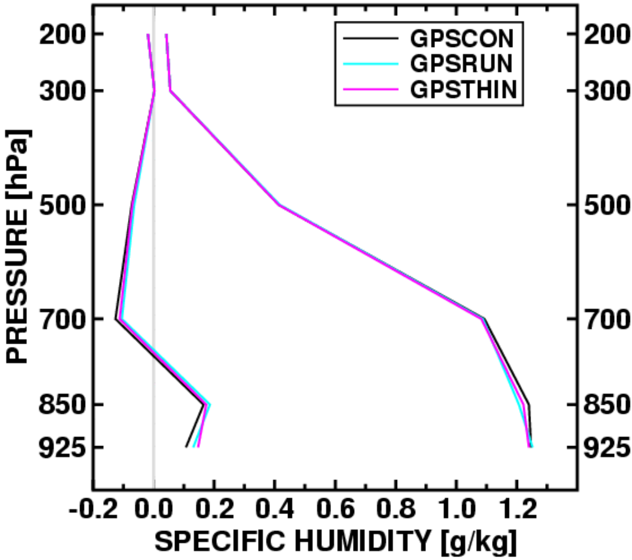
Horizontal thinning

Thinning has very little impact on top of the regular GPS run







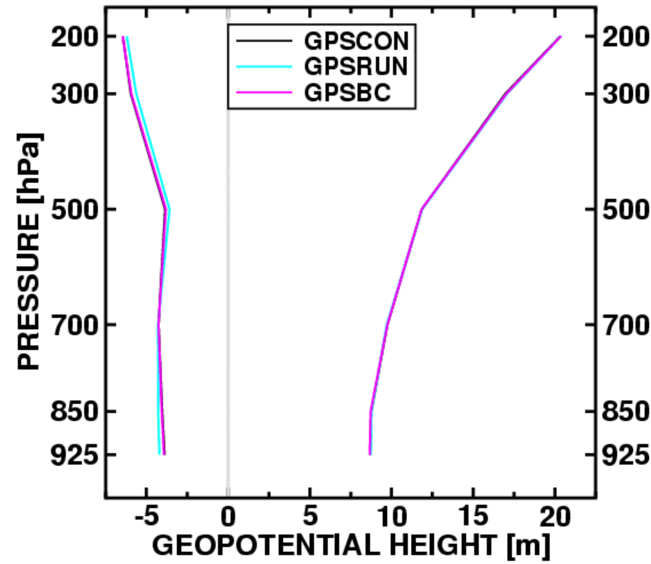


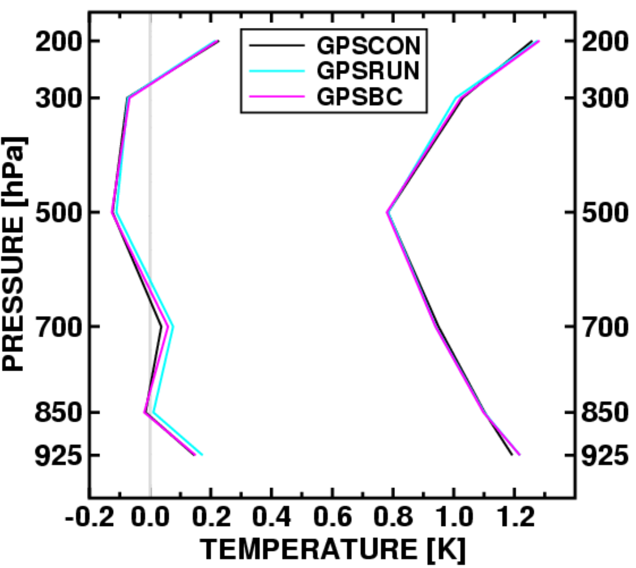
Observation bias correction

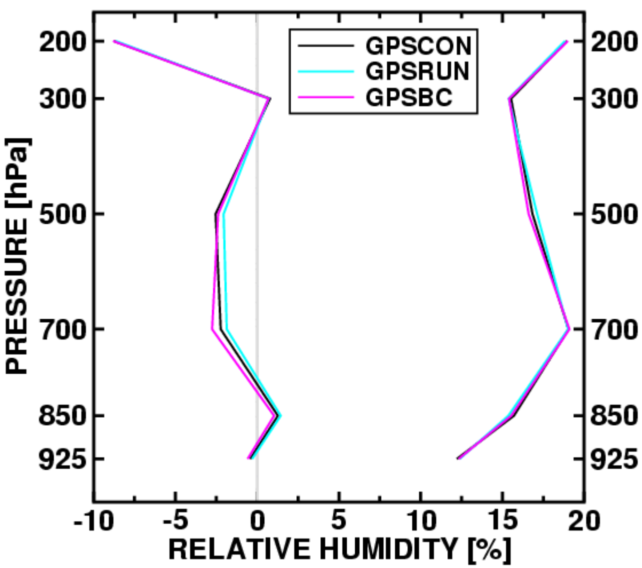
Bias correction reduces the impact of GPS data

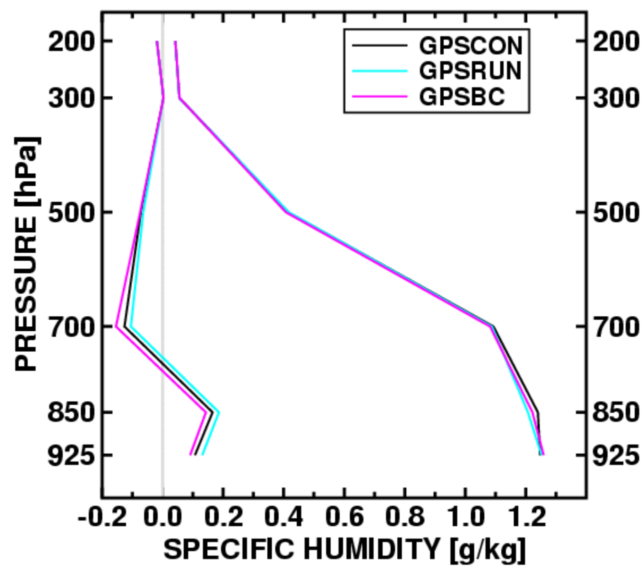
A positive (negative) impact in the lower (upper) troposphere

Impact on forecast error standard deviations remains neutral









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24-hour forecasts of 12-hour accum. precipitation

Verification of categorical forecasts

		≥1 mm	≥3 mm	≥10 mm
Probability of Detection	control run	.761	.606	.349
	regular GPS run	+.012	+.012	+.016
	thinned GPS run	+.012	+.009	+.032
	bias-corrected GPS run	-.002	-.008	+.021
False Alarm Rate	control run	.524	.554	.706
	regular GPS run	-.007	-.001	-.002
	thinned GPS run	-.001	+.004	-.006
	bias-corrected GPS run	-.008	+.001	-.013
True Skill Score	control run	.237	.051	-.357
	regular GPS run	+.020	+.014	+.018
	thinned GPS run	+.014	+.005	+.038
	bias-corrected GPS run	+.006	-.008	+.034
Equitable Threat Score	control run	.328	.294	.173
	regular GPS run	+.010	+.005	+.005
	thinned GPS run	+.004	.000	+.011
	bias-corrected GPS run	+.007	-.003	+.012

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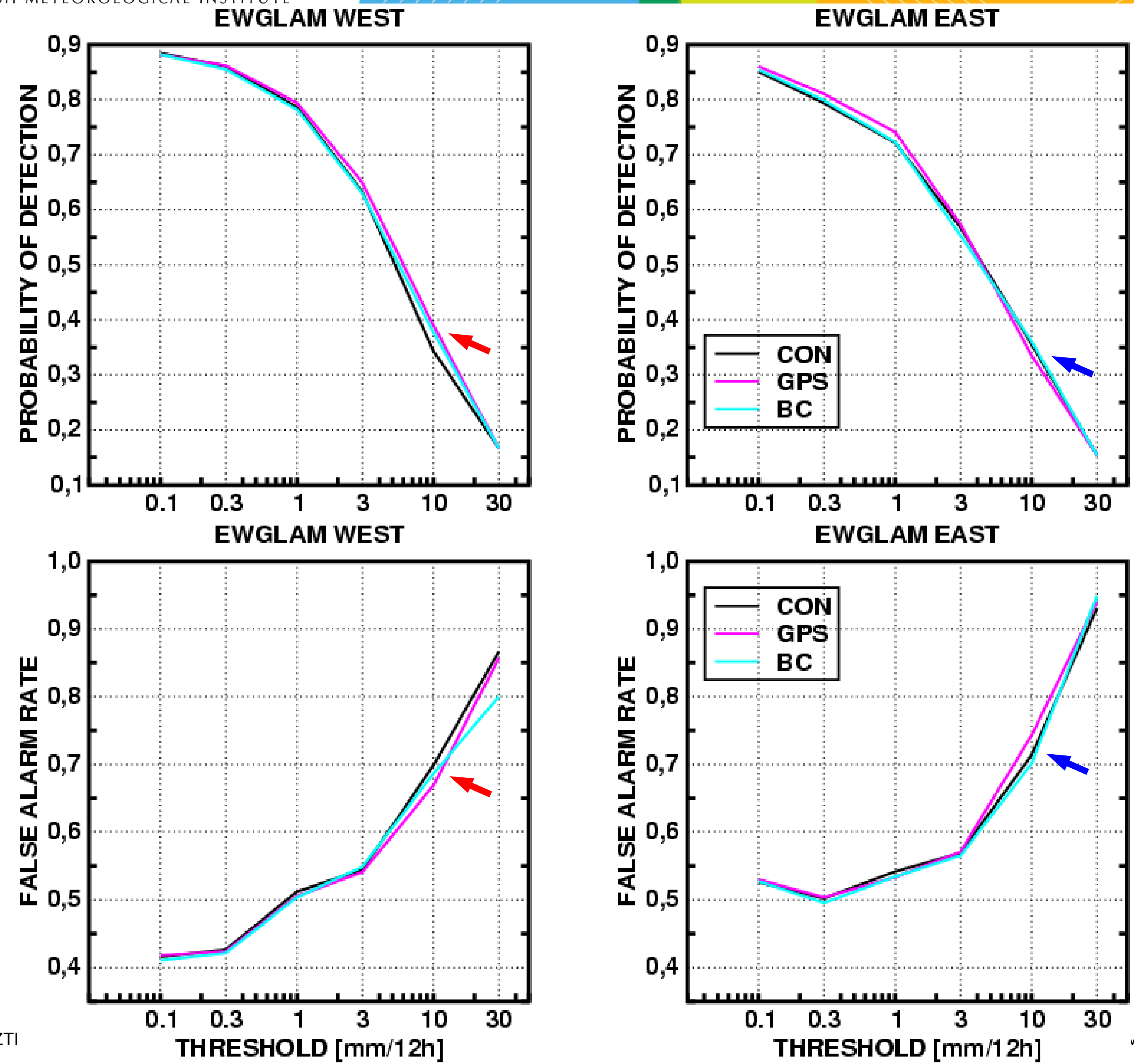

Conclusions

The impact of GPS ZTD data assimilation in standard verification scores is small

- *specific humidity, temperature and geopotential height in the upper troposphere are systematically increased*

Verification of categorical forecasts of 12-hour accumulated precipitation shows a positive impact on 12- and 24-hour forecasts in Western and Northern Europe

Horizontal thinning improves forecasts in cases of heavy precipitation

ZTD observation bias correction decreases forecast humidity and precipitation but does not provide a clear impact on verification scores