Evaluation of the atmospheric water vapor content in the regional climate model ALARO-0 using GNSS observations

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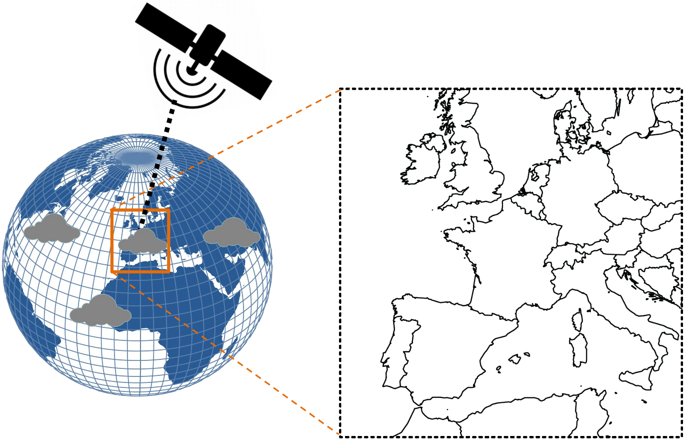

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EUREF Symposium

Wroclaw

Outline

- Introduction
- Data
- Methods
- Results
- Discussion and future research

Research topic

Aim

Evaluation of water vapor in regional climate models using observations from GNSS

Motivation

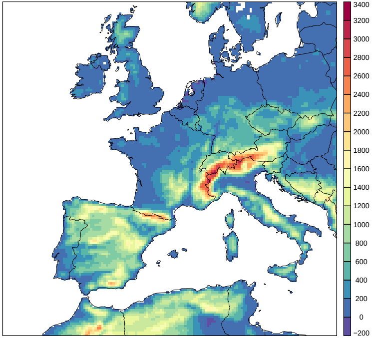
Lack of validation by regional climate models, new reprocessed dataset ready for climate studies

Relevance

Quality of regional climate model for climate projection

Climate model

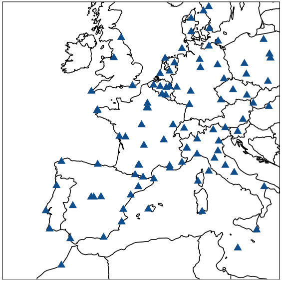
ALARO



- Configuration of the ALADIN model (v0)
- Lateral boundary conditions ERA-Interim
- Land surface model SURFEX
- Details:
  - Size: 149 x 149 grid points
  - Horizontal resolution: 20 km
  - Vertical 46 levels: from 17 m to 72 km
  - Lambert conformal projection
  - Radiation scheme ACRANEB

ALADIN International Team (1997), Gerard et al. (2009), De Troch et al. (2013), Giot et al. (2016), Masson et al. (2003, Masson et al. (2013)

GNSS Observations



EPN tropospheric product repro 2 1996-2014, selection criteria:

- fit within domain
- min. 10 years of data
- min. 15 days per month

100 stations selected

Pacione et al. (2016)

IWV calculation

ZTD observations to IWV

$$IWV = \Pi . ZWD = \Pi . (ZTD - ZHD)$$

$$\Pi = \frac{10^6}{\varrho_w R_v \left(\frac{k_3}{T_m} + k_2' \right)}$$

[Askne and Nordius, 1987]
[Hogg et al., 1981]

$$ZHD = 0.0022768 \frac{P_{GPS}}{f(\lambda, H_{GPS})}$$

$$f(\lambda, H_{GPS}) = 1 - 0.00266 \cos(2\lambda) - 0.00000028 H_{GPS}$$

[Saastamoinen, 1972]
[Davis et al., 1985]
[Elgered et al., 1991]

T_m and P_s from ERA-Interim

IWV calculation

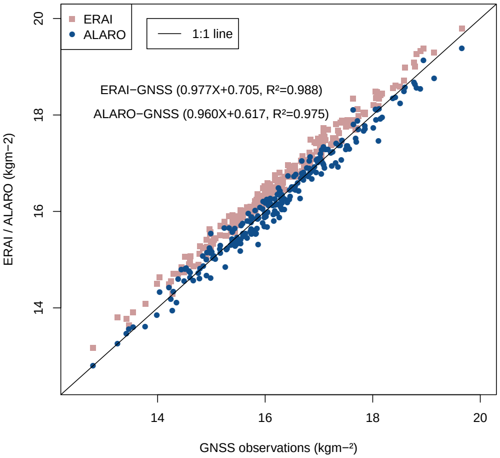
Model calculation of IWV

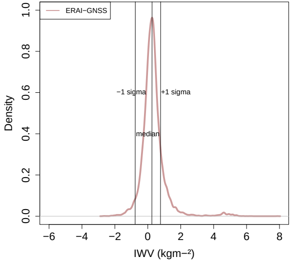
- Horizontal interpolation: 4 nearest grid points (weighting: inverse distance)
- Vertical linear interpolation based on Hagemann et al. (2003) but using:
  - Pressure station level using barometric formula
  - T, Sfpres, H from model
  - Standard lapse rate for temperature -0.0065K/m
  - Vertical levels from lowest to +/- 20 km

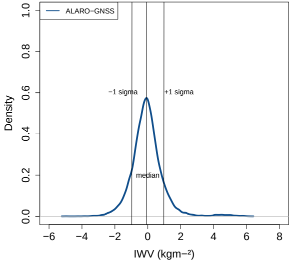
Hagemann et al. (2003)

Model performance

Differences between models and observations

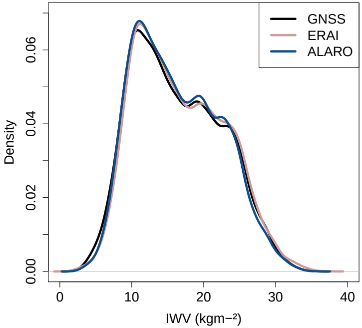




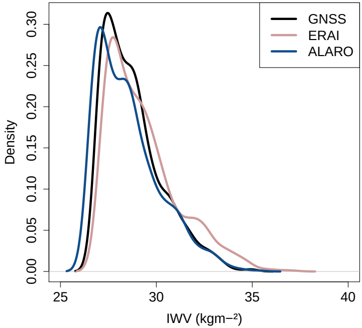


Model performance

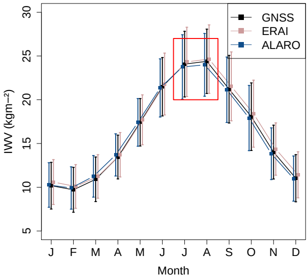
Distribution of all data

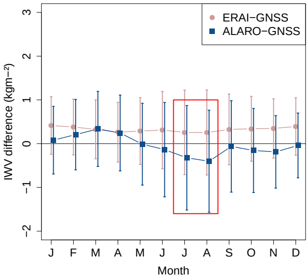


Distribution of the 95th percentile



Seasonal variability

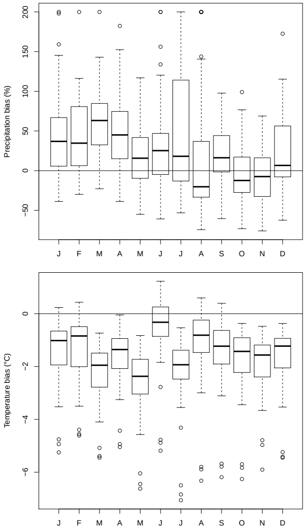




IWV bias

- Overestimation ERAI, constant
- Larger standard deviation in summer, both ERAI and ALARO
- ALARO performs better than ERAI, except for July-August
- Large underestimation ALARO in July-August

Seasonal variability



ALARO - E-OBS: **precipitation bias**

- Good performance for May,June, Sep,Oct,Nov
- Large neg. bias August
- Large spread July

Large underestimation of precipitation in August

+ Large underestimation of temperature

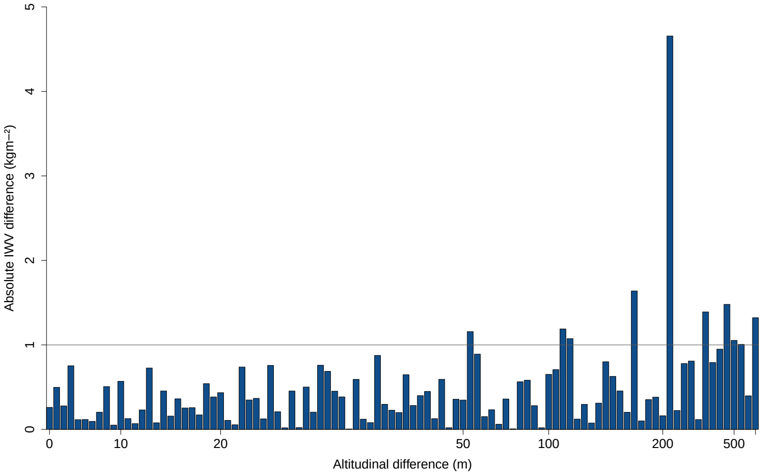
= smaller moister holding capacity

= explains negative IWV bias.

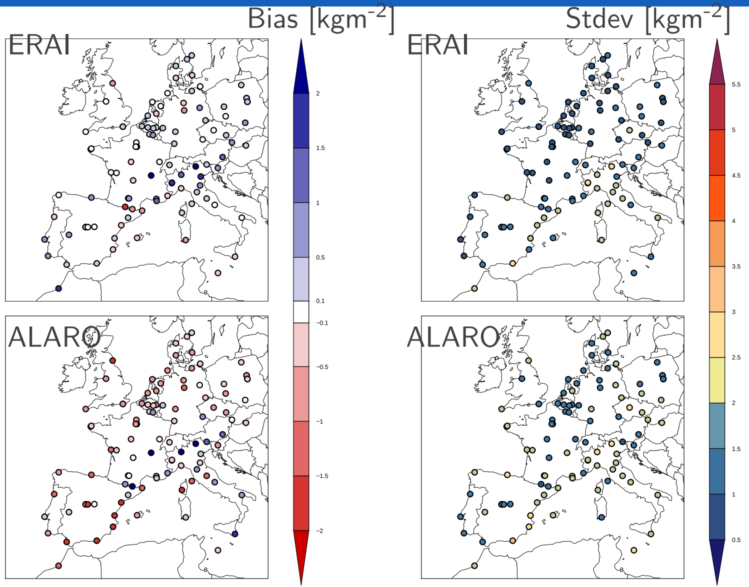
Spatial variability

ALARO - GNSS

Large outlier = SJDV



Spatial variability



Discussion

- Overestimation ERAI $\approx$ Lucas-Picher et al. (2013)
- Larger standard deviation is expected with regional model compared with ERAI
- Larger standard deviations in summer for both ALARO and ERAI
- Underestimation of regional climate model in summer
- Similar results as in $\approx$ Ning et al. (2013), but based on different GNSS dataset and regional climate model
- Relation precipitation and temperature model bias with IWV bias
- Largest differences ALARO and ERAI in southern Europe = dry model bias
- Latitudinal dependence $\approx$ Pacione et al. (2016)

Future research

- Closer look at spatial variability
- Closer look at intra-month variability
- Group stations based on similar characteristics
- Diurnal cycle

References

The EPN network has been evolving in time. It has been established in 1996 as a GNSS Network for Positioning, with the EUMETNET MoU in 2007 became the backbone of the E-GVAP Network for operational meteorology with EPN-Repro2 in 2017 is going to be recognized as a **GNSS Network for Climate**.

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Extra: precipitation bias summer