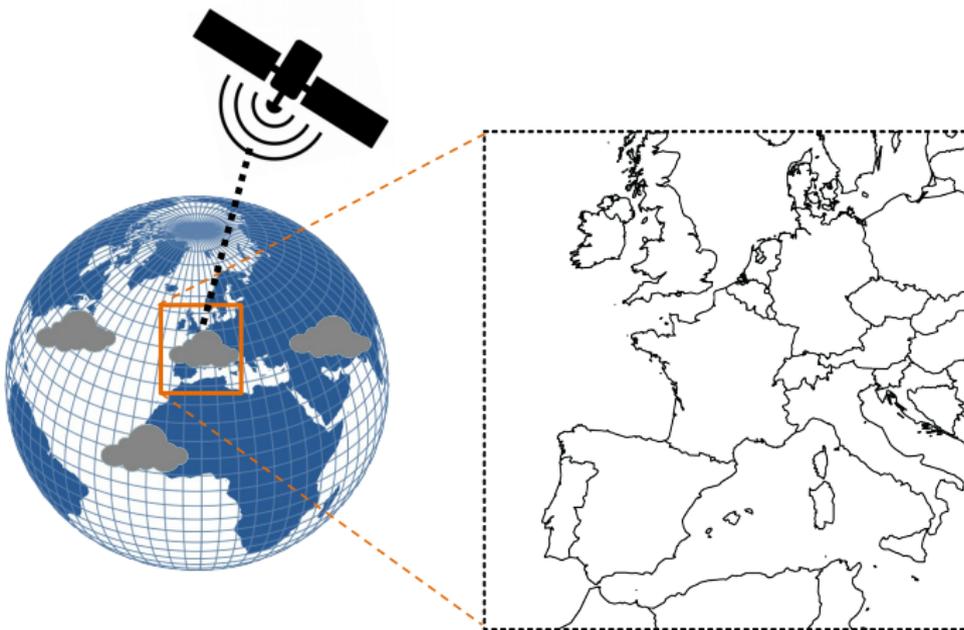


Evaluation of the atmospheric water vapor content in the regional climate model ALARO-0 using GNSS observations

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GNSS4SWEC

ESTEC Noordwijk

- Introduction
- Data
- Methods
- Results
- Conclusions

Aim

Evaluation of water vapor in RCM using observations from GNSS

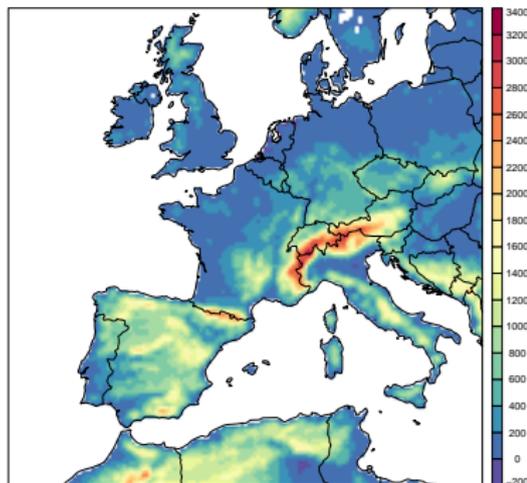
Motivation

Lack of validation by RCMs, new homogenised dataset ready for climate studies

Relevance

Quality of RCM for climate projection

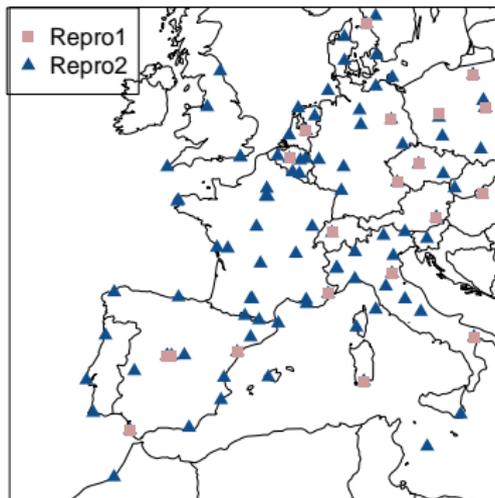
ALARO



- Version 0
- Configuration of the ALADIN model
- Size 149 × 149 grid points
- Horizontal resolution 20 km
- Lambert conformal projection
- Vertical 46 levels
- Radiation scheme ACRANEB
- Lateral boundary conditions ERA-Interim
- Land surface model SURFEX

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)

Observations



Stations >10 years of data

Repro 1 - 20 stations - 1996:2011

Repro 2: 100 stations - 1996:2014 Pacione et al. (2016)

IWV calculation

ZTD observations to IWV

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

$$\Pi = \frac{10^6}{\rho_w R_v \left(\frac{k_3}{T_m} + k'_2 \right)}$$

[Askne and Nordius, 1987]

[Hogg et al., 1981]

Simplification for T_m :

$$T_m = 0.72T_s + 70.2$$

[Bevis et al., 1992]

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

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

[Saastamoinen, 1972]

[Davis et al., 1985]

[Elgered et al., 1991]

Hypsometric equation:

$$P_{GPS} = P_s e^{\frac{-g\Delta H}{R_d T}}$$

[Stull, 1995]

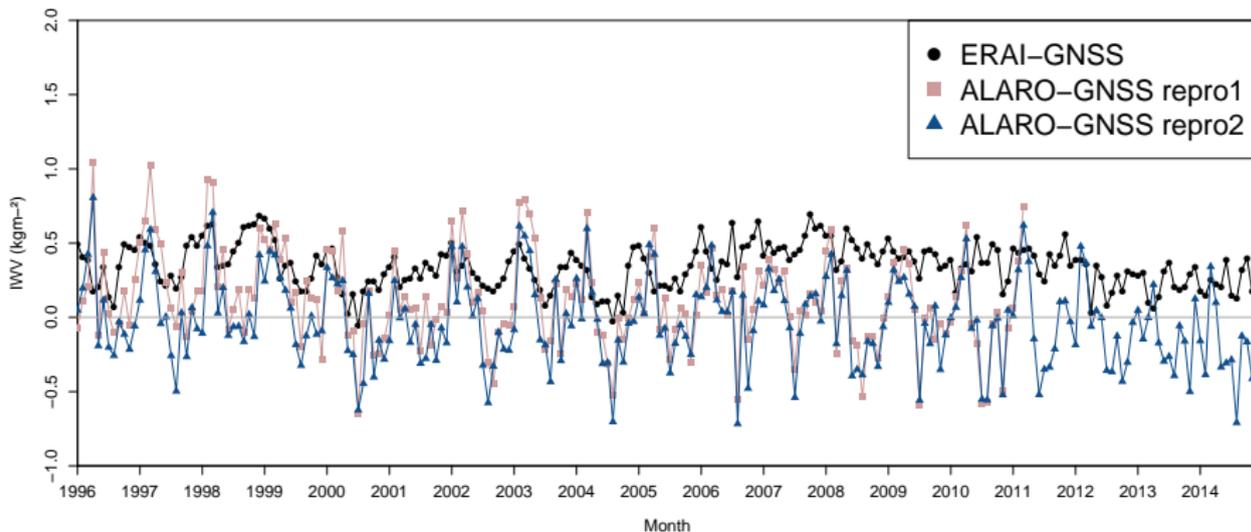
T_s and P_s from ERA-Interim

Model calculation of IWV

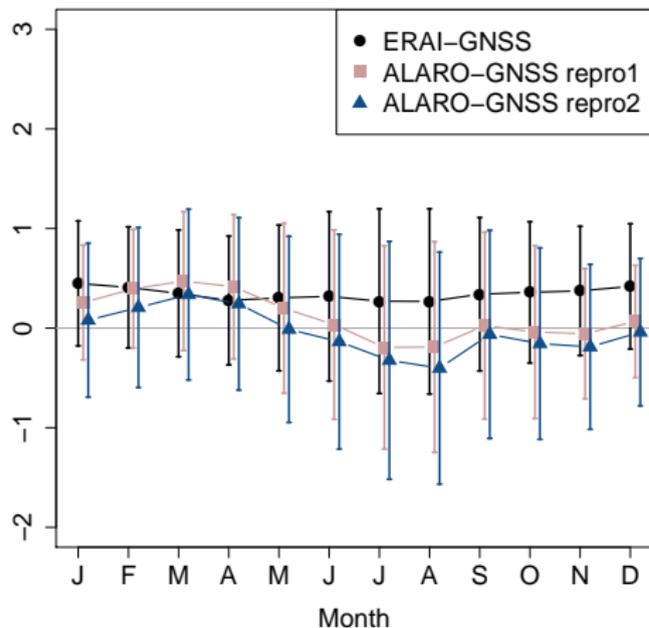
- Nearest gridpoint
- Horizontal interpolation
- Pressure station level using barometric formula
- T, Sfpres, H from model
- Standard lapse rate -0.0065K/m
- Vertical levels from lowest to ± 20 km
- Vertical interpolation

Hagemann et al. (2003)

Model performance



Model performance



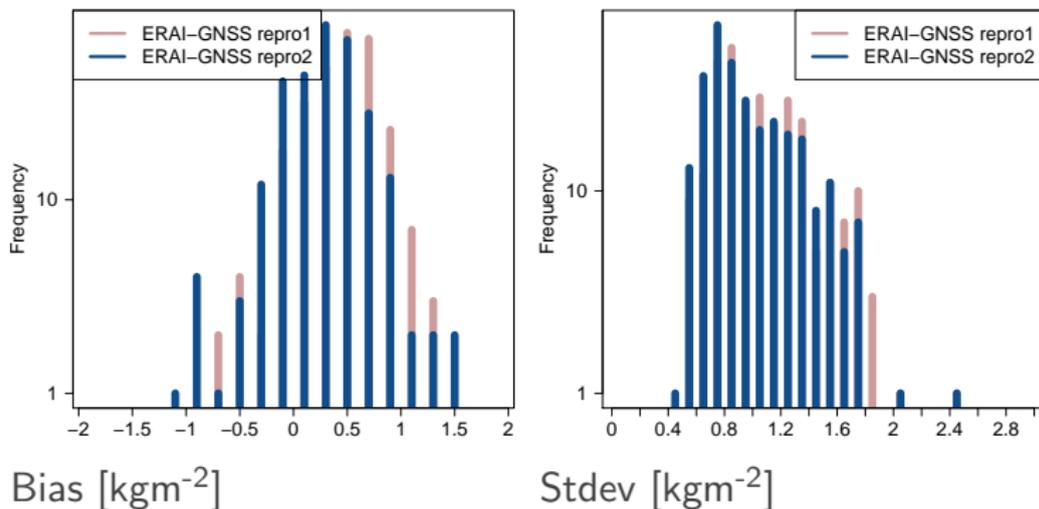
ERA1-GNSS: repro1 and repro2
All years and stations

Results

- Larger stdev summer
- Larger stdev repro2
- Underestimation summer model
- Overestimation ERAI

Repro1 vs Repro2

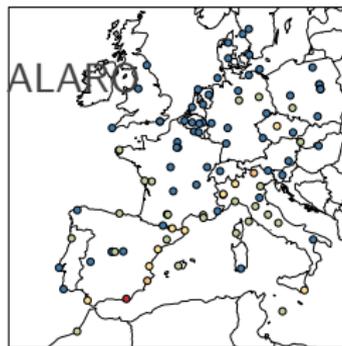
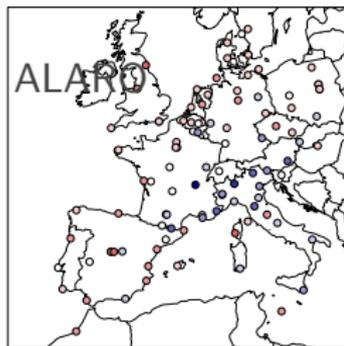
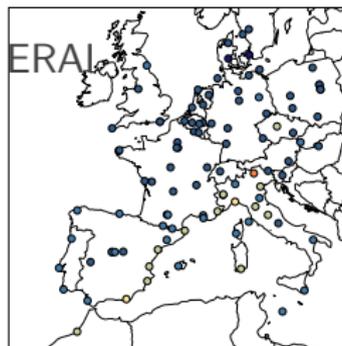
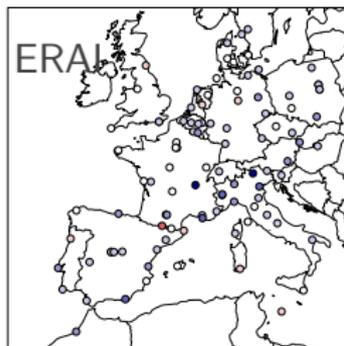
20 stations represented by repro1 and repro2



Spatial

Bias [kgm^{-2}]

Stdev [kgm^{-2}]



- Overestimation ERAI \approx Lucas-Picher et al. (2013)
- Larger differences in summer for both ALARO and ERAI \approx Ning et al. (2013)
- Underestimation of regional climate model in summer \approx Ning et al. (2013)
- Standard deviations larger using model than ERAI \approx Ning et al. (2013)
- Improvement by repro2 compared to repro1
- Largest differences ALARO and ERAI in Spain = dry bias
- Latitudinal dependence \approx Pacione et al. (2016)

Future research

- Latitudinal dependence
- Diurnal cycle
- Seasonal dependence

