Karlsruhe Institute of Technology

# Analysis of diurnal IWV cycle and evaluation of artificial mismatches in ERA5 over Europe by using GNSS

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# Motivation

- Atmospheric water vapor is generally characterized by a diurnal cycle
- The diurnal water vapor cycle is known to be related to various hydrometeorological processes
- The accurate estimation of diurnal IWV cycle remains a challenge due to the limitations in precision and temporal resolution in many water vapor sensing techniques
- GNSS water vapor sensing is characterized with its high-accuracy and high temporal resolution
- The latest ERA5 with a resolution of 1-h provides a great potential to quantify the diurnal cycle
- However, only a few studies have evaluated the diurnal IWV cycle modelled by ERA5

# Map of stations

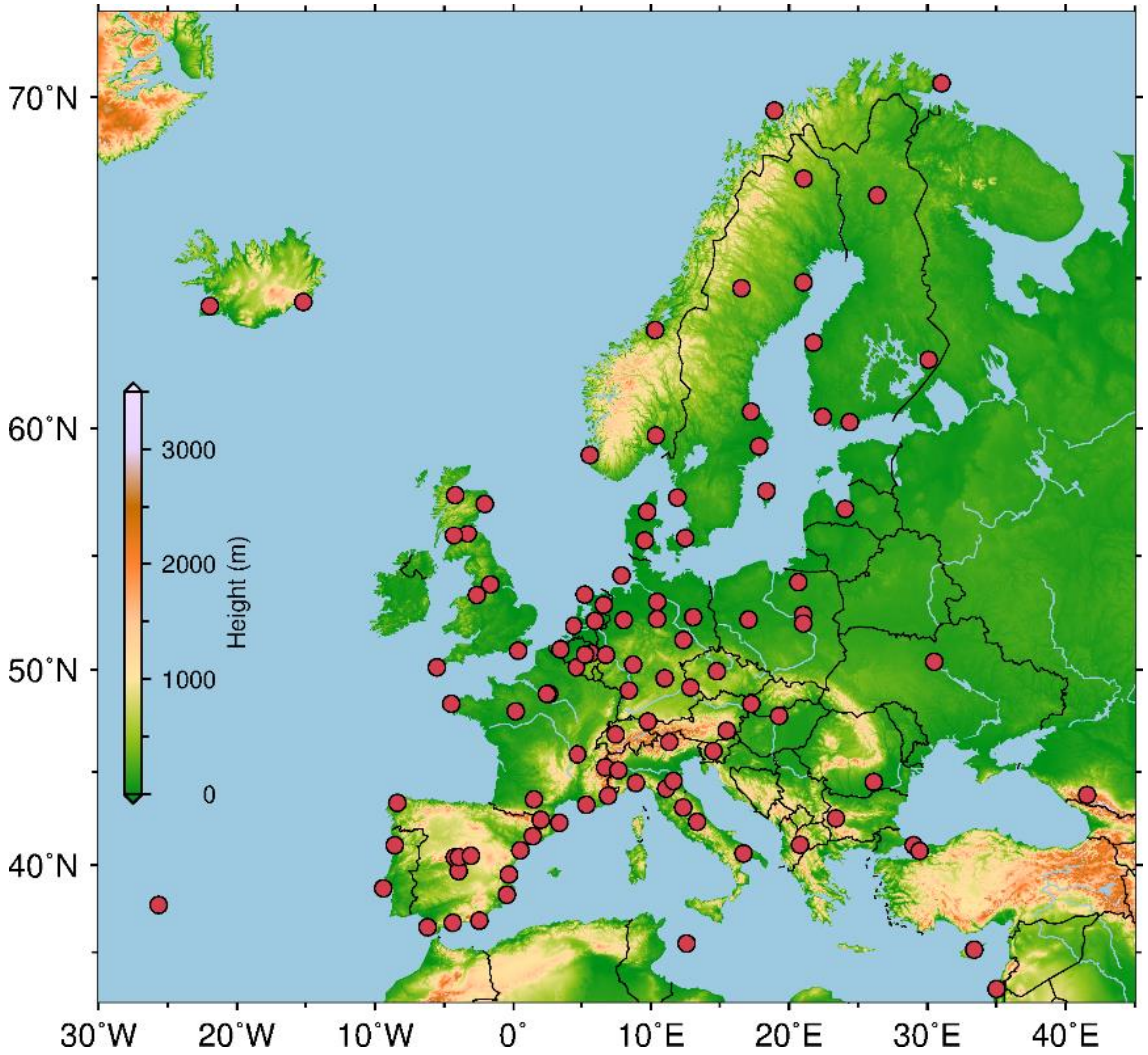


**Fig. 1** Geographical distribution of the 108 GPS stations covering more than two decades (1994-2018)

# Diurnal IWV cycle

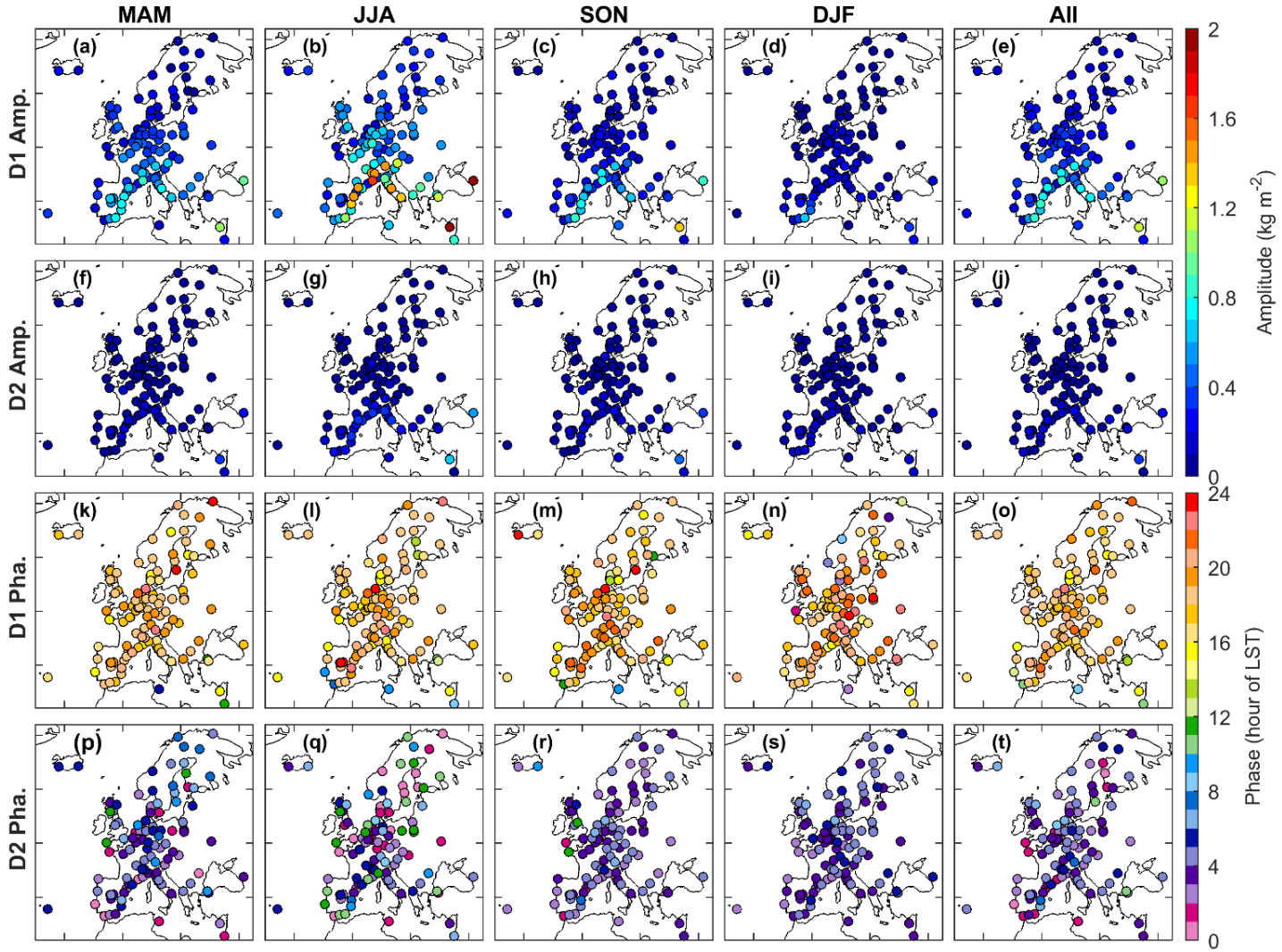


**Fig. 2** the first (D1) and second (D2) harmonics of diurnal GPS IWV cycle

# Classification and analysis

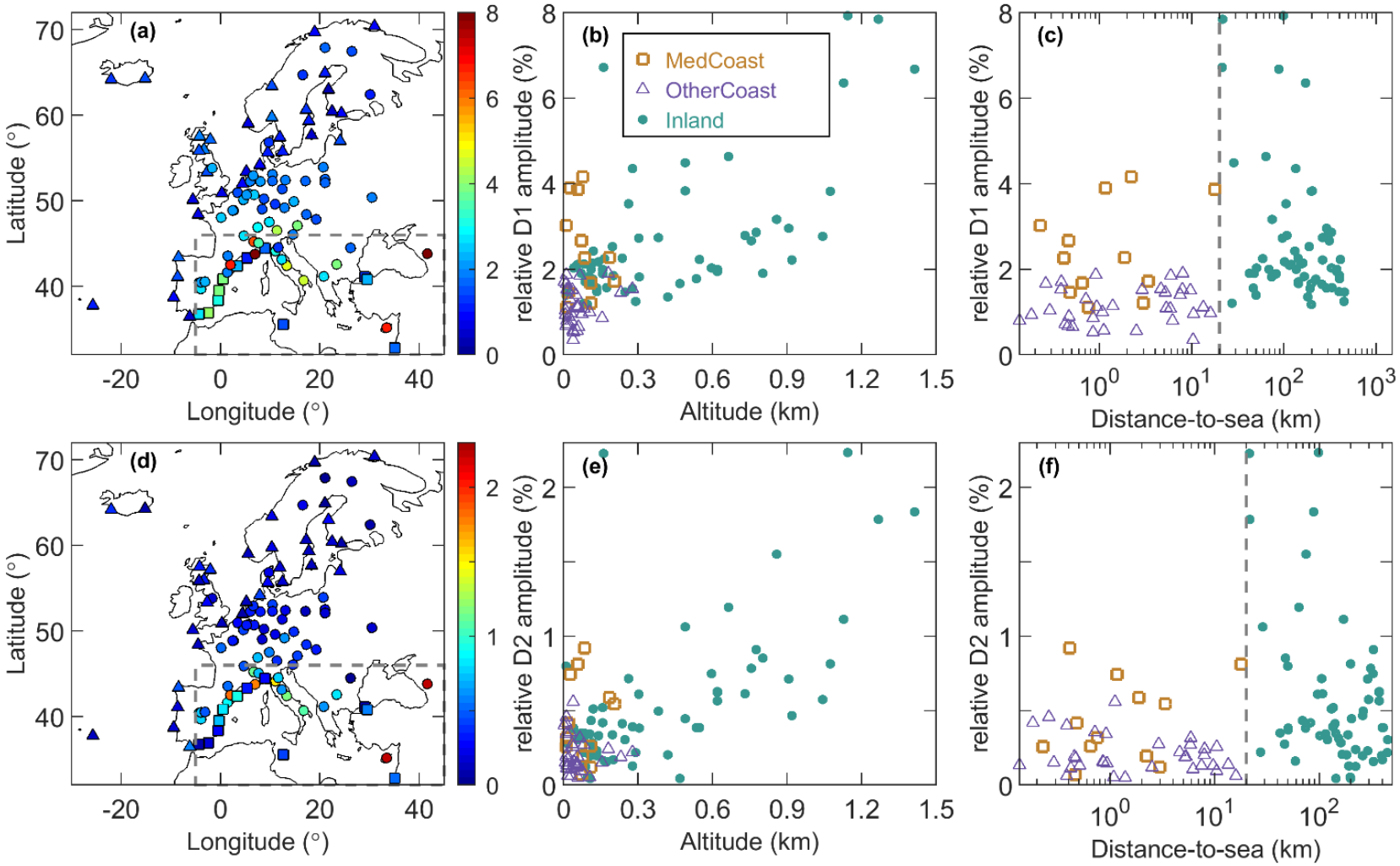


**Fig. 3** Classification and analysis of diurnal GPS IWV cycle

# All-time averaged comparisons

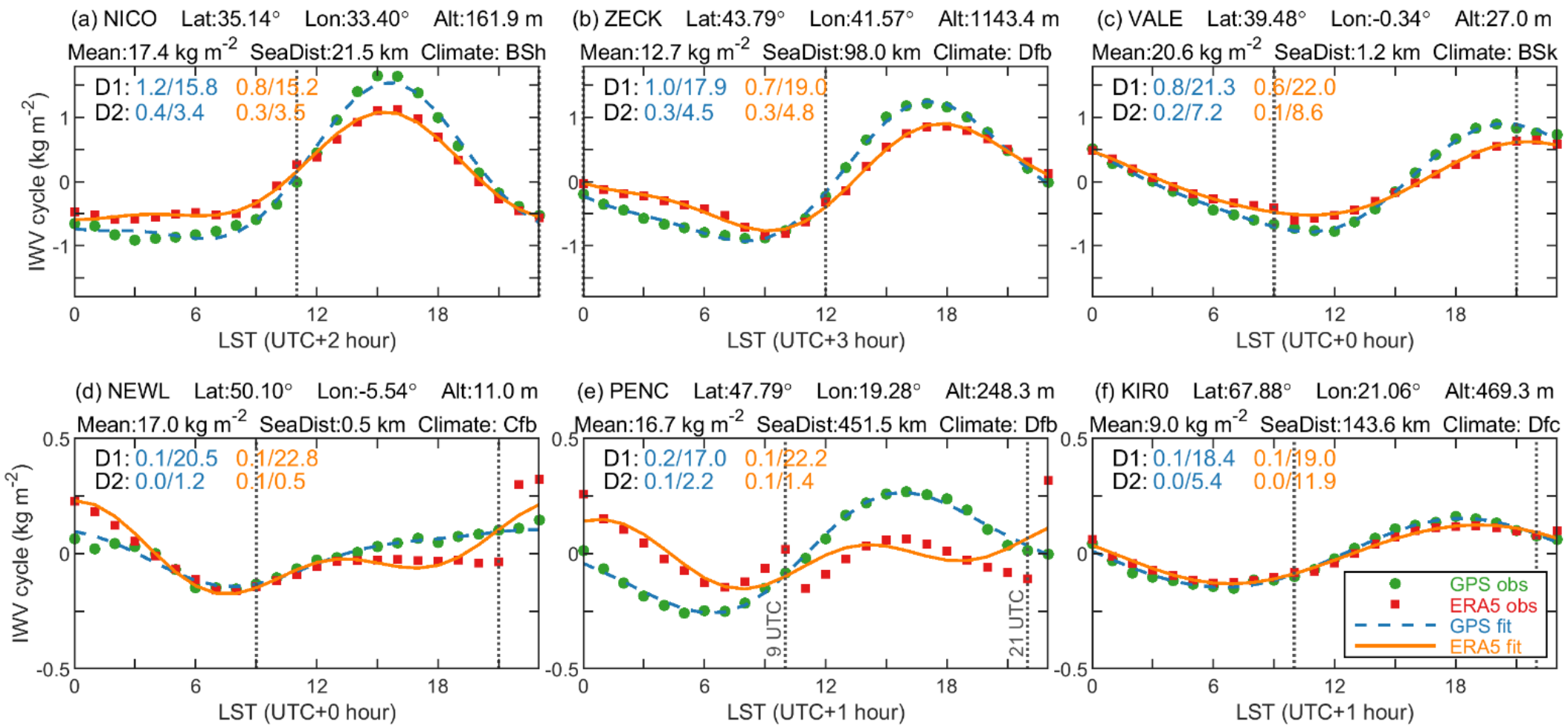


**Fig. 4** Comparison on the diurnal IWV cycle from GPS and ERA5

# Seasonal and all-time averaged comparison

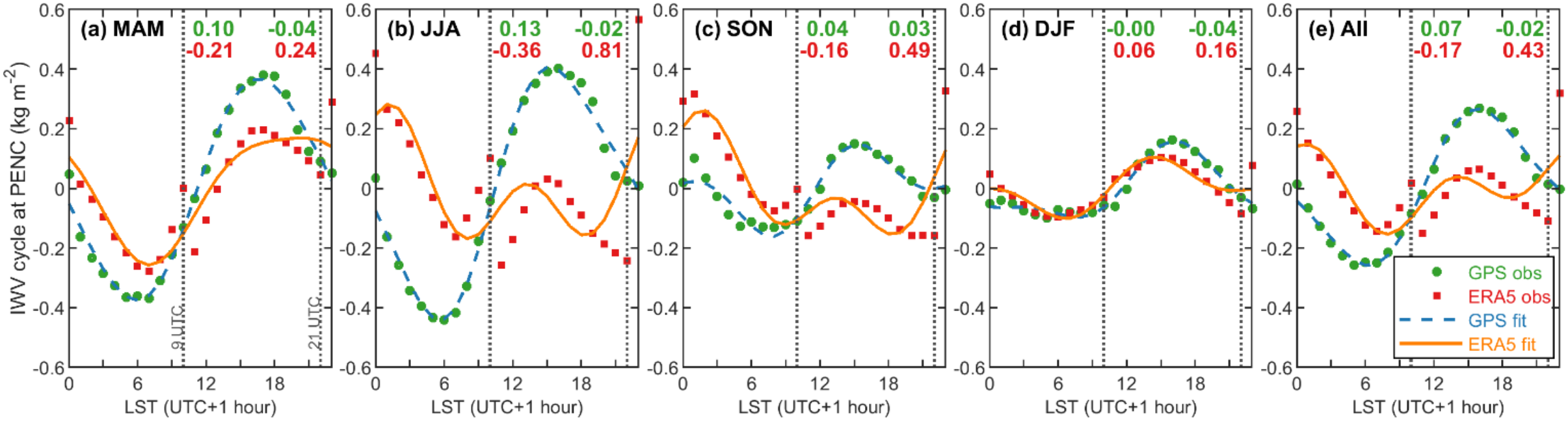


**Fig. 5** Comparison on the seasonal and all-time averaged diurnal IWV cycles at station PENC in Hungary

# Mismatches over Europe

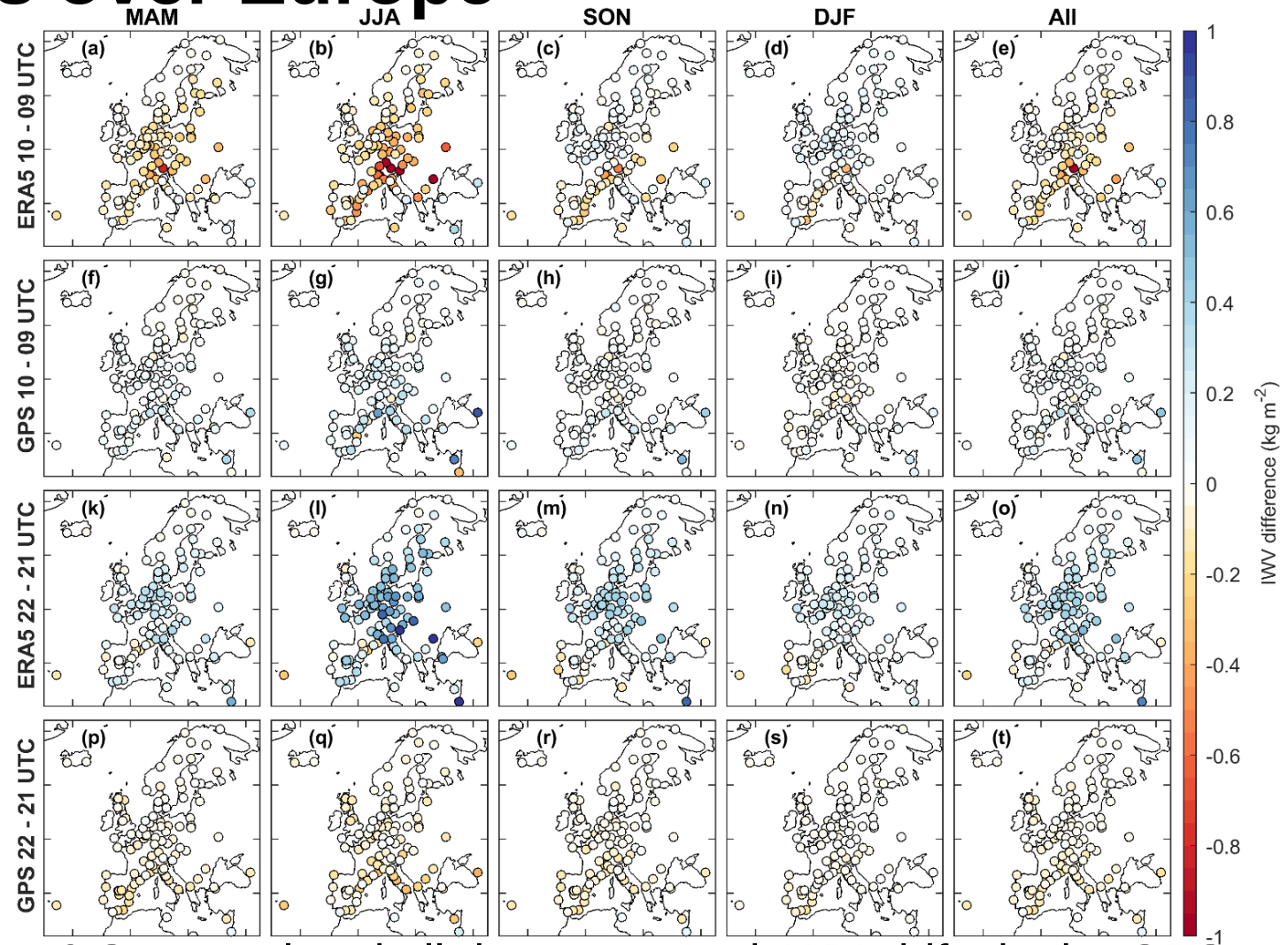


**Fig. 6** Seasonal and all-time averaged IWV shifts in the GPS and ERA5 diurnal cycles from 09:00 to 10:00 UTC and from 21:00 to 22:00 UTC

# Summary

- Mismatches in the diurnal cycle of ERA5 IWV product were found and evaluated from 09:00 to 10:00 UTC and from 21:00 to 22:00 UTC.
- The problem can be attributed to the edge effect in each ERA5 assimilation cycle, and it has been noticed in some other meteorological variables provided by ERA5.
- The average artificial shifts in ERA5 IWV are -0.08 and 0.19 kg $m^{-2}$ at the two epochs, respectively. In contrast, the natural shifts in GPS IWV are 0.05 and -0.05 kg $m^{-2}$, respectively.
- The ERA5 shifts are dependent on seasons and locations.
- The ERA5 shifts are more significant in summer than in winter.
- As the average diurnal IWV amplitude obtained from GPS is only 0.32 kg $m^{-2}$, the artificial shifts in ERA5 IWV cannot be ignored in diurnal IWV cycle analysis in these regions.

# Thank you for your attention


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# Publications

Atmos. Chem. Phys., 23, 3517–3541, 2023
https://doi.org/10.5194/acp-23-3517-2023


Atmospheric Chemistry and Physics
Open Access
EGU
Research article

## Characterisations of Europe's integrated water vapour and assessments of atmospheric reanalyses using more than 2 decades of ground-based GPS

**Peng Yuan[1], Roeland Van Malderen[2], Xungang Yin[3], Hannes Vogelmann[4], Weiping Jiang[5], Joseph Awange[6], Bernhard Heck[1], and Hansjörg Kutterer[1]**

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# Publications

Earth Syst. Sci. Data, 15, 723–743, 2023
https://doi.org/10.5194/essd-15-723-2023


Open Access Earth System Science Data

Karlsruher Institut für Technologie

## An enhanced integrated water vapour dataset from more than 10 000 global ground-based GPS stations in 2020

**Peng Yuan[1], Geoffrey Blewitt[2], Corné Kreemer[2], William C. Hammond[2], Donald Argus[3], Xungang Yin[4], Roeland Van Malderen[5], Michael Mayer[1], Weiping Jiang[6], Joseph Awange[7], and Hansjörg Kutterer[1]**

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