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University of Chinese Academy of Sciences

Increasing trend of Precipitable Water Vapor in Antarctica and Greenland

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Motivation

PWV acquisition methods

Reanalysis data

- ✓ global coverage
- ✓ spatial integrity
- ✓ homogeneous record

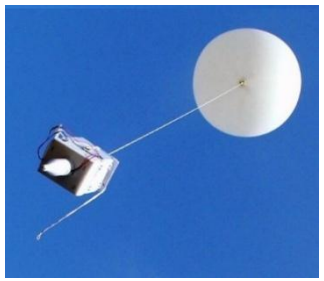
less reliable for areas where no or limited data assimilation observations are available.

Observations directly measured

- ✓ incomplete observations
- ✓ sparse global distribution
- ✓ non-uniform global distribution

high accuracy of the measurements obtained at each station.

The booming and fast-growing technology – GNSS, rapid coverage of polar regions

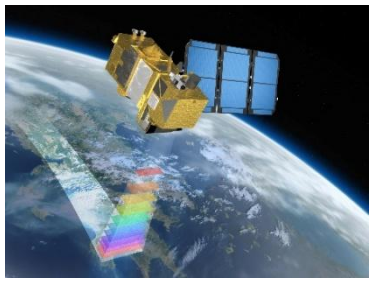


Radiosonde

Microwave Radiometers

Sunphotometer

Weather Rader



Remote Sensing

GNSS

Data

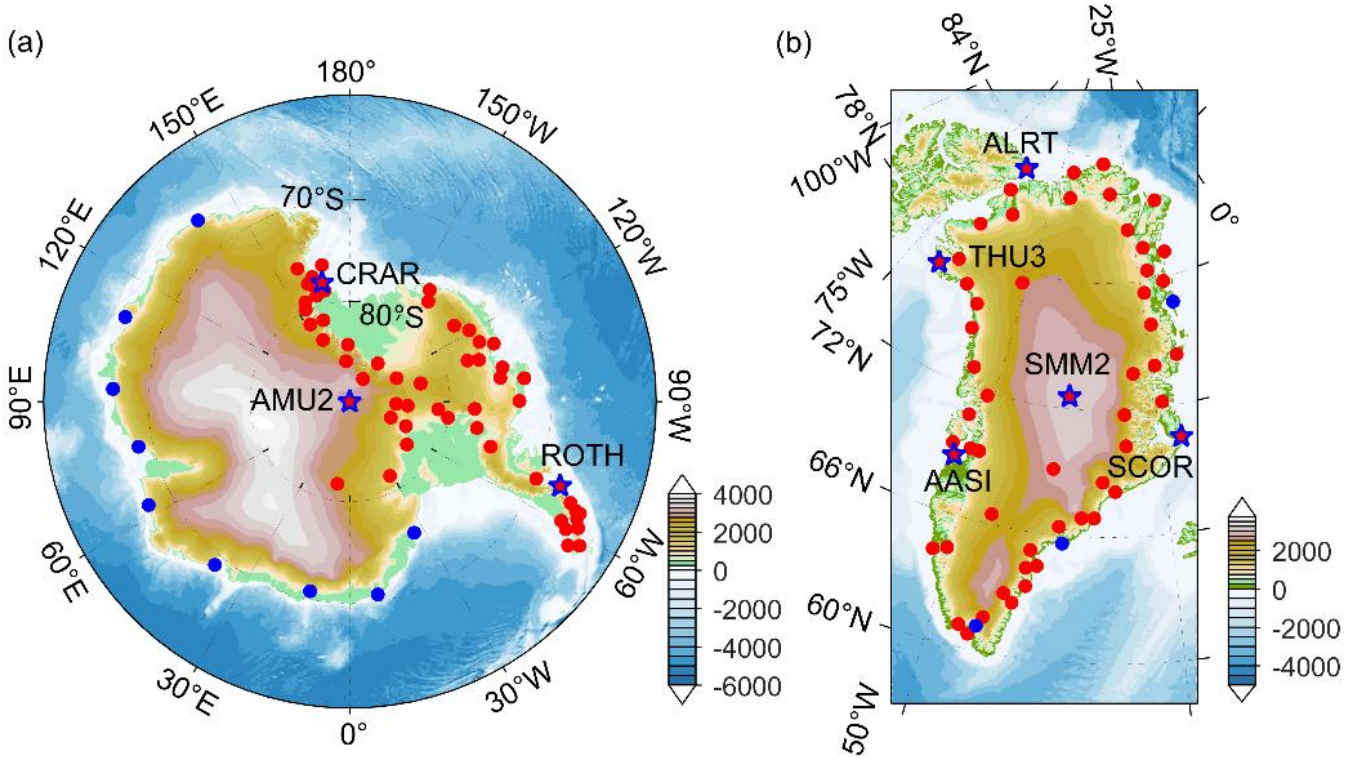
NGL troposphere products

NGL reprocessed and updated the data products with improved models including:

- ✓ VMF1/NWM grid
- ✓ Higher order ionospheric calibrations
- ✓ Improved JPL Repro 3 orbits
- ✓ Latest global reference frame IGS14
- ✓ Stations exceeded 19 thousand
- ✓ Data exceeded 43 million station-days

Integrated Global Radiosonde Archive (IGRA) V2

- ✓ More than 2,800 globally distributed stations
- ✓ The earliest data date back to 1905
- ✓ Recent data become available in near real time from about 800 stations worldwide



Antarctica

12 IGRA2 RS and 55 NGL GNSS

Mean altitude: 970 m

Greenland

8 IGRA2 RS and 50 NGL GNSS

Mean altitude: 711 m

Time span: 1994-2020

Sample Interval: 12 hour (RS), 5 min (GNSS)

Data source: ftp://ftp.ncdc.noaa.gov/pub/data/igra/ (RS)

http://geodesy.unr.edu/gps_timeseries (GNSS)

PWV comparison

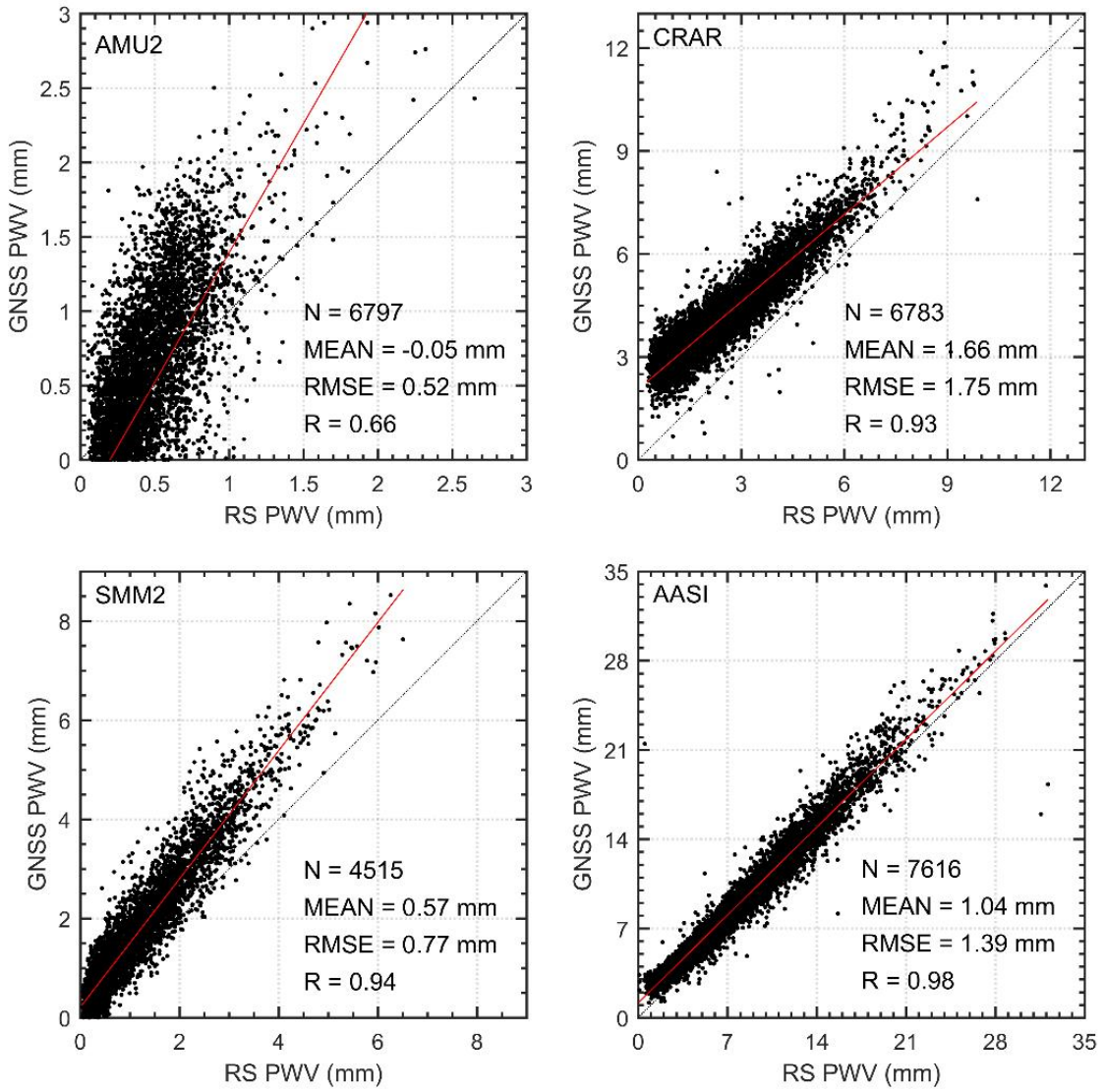
Co-located stations

Antarctica: AMU2/CRAR Greenland: SMM2/AASI

Station name	Number of epochs	Mean bias	RMSE	Correlation coefficient
AMU2	6797	-0.05 mm	0.52 mm	0.66
CRAR	6783	1.66 mm	1.75 mm	0.93
SMM2	4515	0.57 mm	0.77 mm	0.94
AASI	7616	1.04 mm	1.39 mm	0.98

- ✓ AMU2, center of Antarctica, small PWV and almost no periodic properties.
- ✓ The correlation coefficients of the other stations are greater than 0.9 and the RMSE are within 2 mm.

The two types of PWV have high similarity and consistency.



PWV mean and std

The mean PWV values:

Antarctica: 2-9 mm, Greenland: 5-10 mm

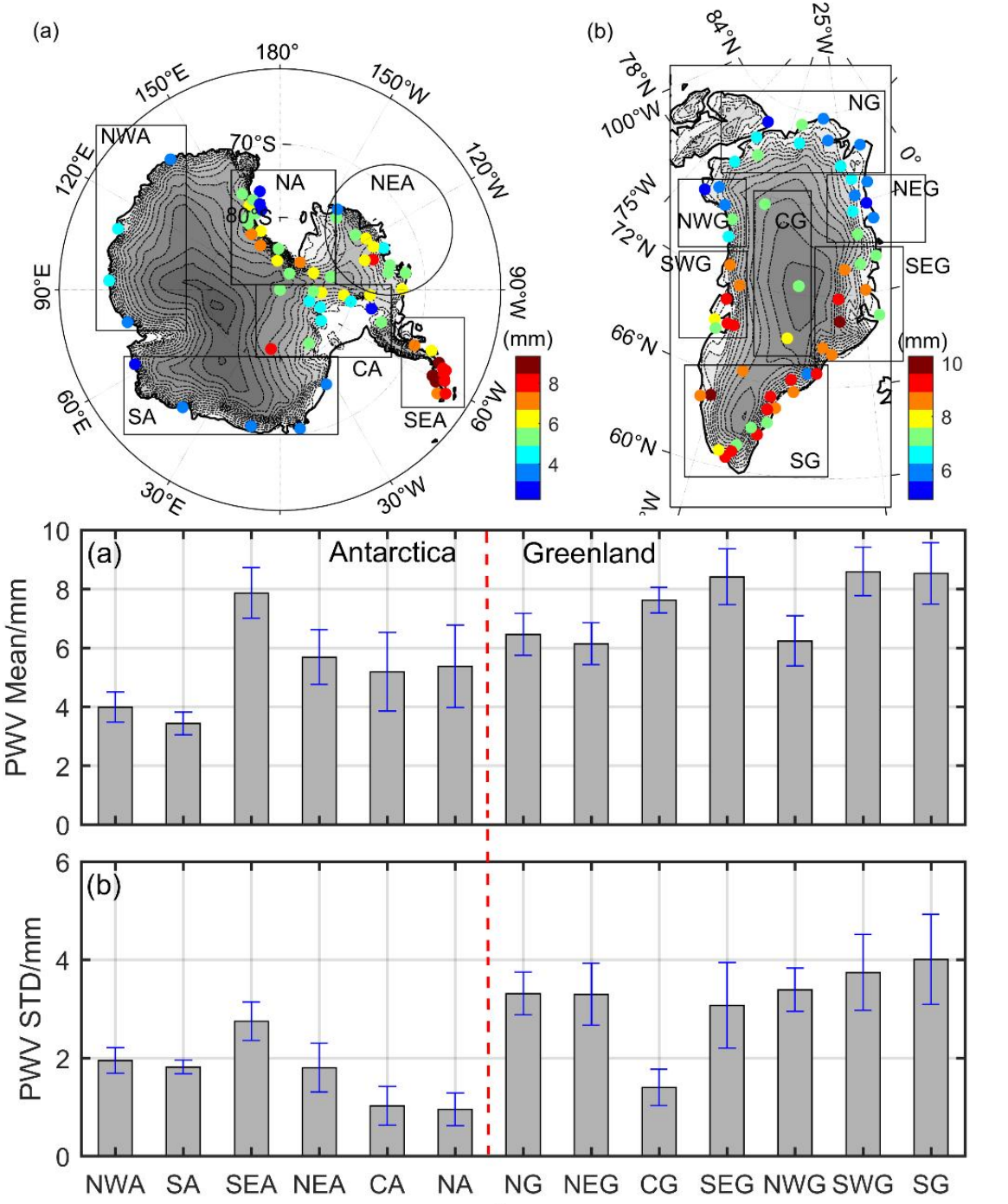
The PWV decreases with increasing latitude.

- The PWV mean is larger at the edge of the island, away from the ocean, than near the ocean.
- While the PWV is not higher at the center of the island, even though the station is farther away from the ocean.

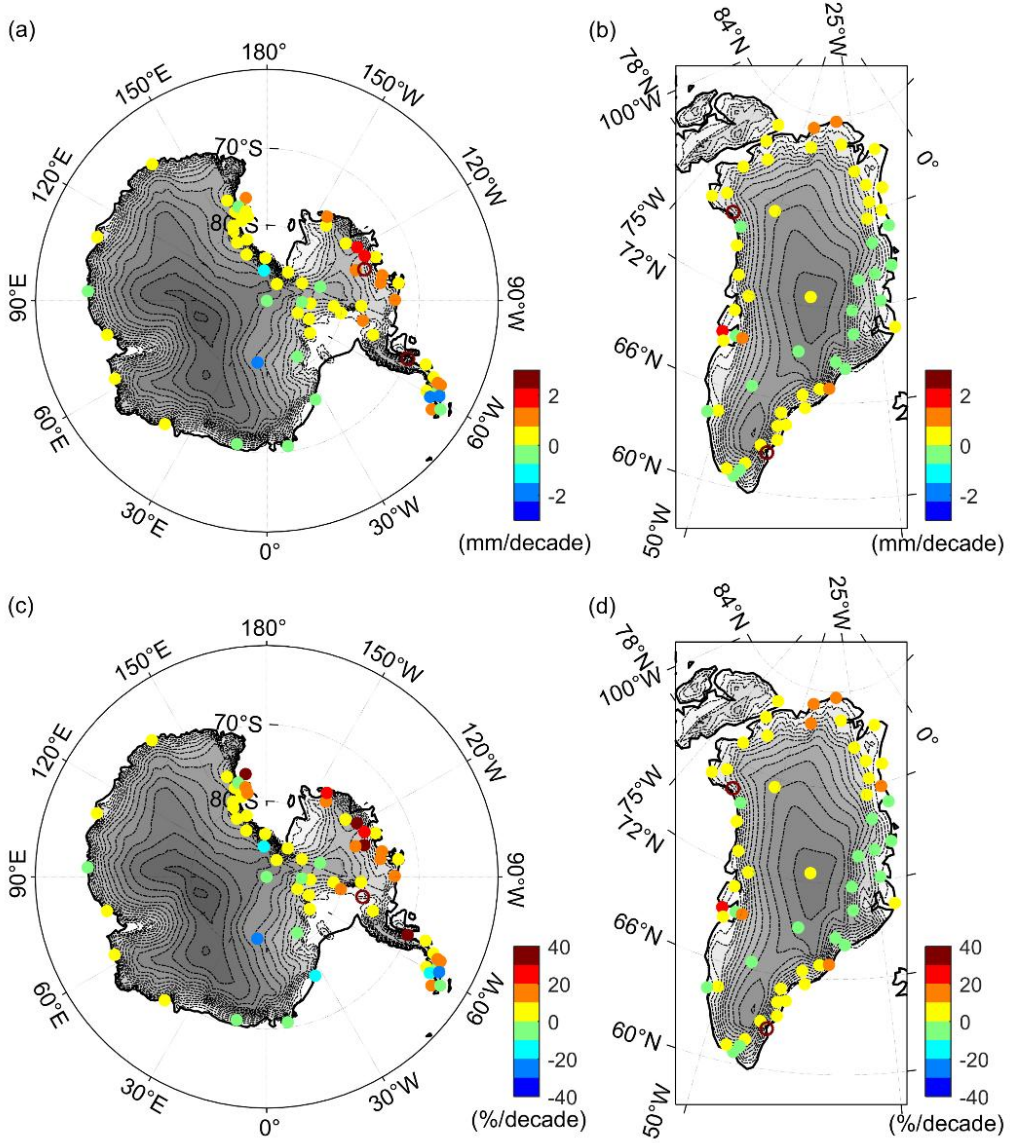
The std ranging from 0-3 mm for Antarctica and from 1-6 mm for Greenland.

- In Antarctica, the std of PWV decreases with increasing latitude, while in Greenland does not vary significantly with dimension.
- But it can be found significantly that the further away from the coastline, the smaller the std of PWV is.

STD is not correlated with Mean, the closer to the centre of the island, the smaller the STD.



Interannual variation



1. The linear trends of the vast majority of stations are within ±1 mm/decade, and the number of stations with positive values is significantly more than those with negative values;

2. The overall trend of PWV is **positive** for both **Antarctica** and **Greenland**. This indicates that the PWV content at both poles has been increasing in the past two or more years;

3. The linear and relative linear trends are smaller overall for Greenland Island compared to Antarctica, and the differences between stations are also smaller.

Summary

1. The multi-year mean values of PWV for **Antarctica** and **Greenland** are **5.63 ± 1.67 mm** and **7.63 ± 1.35 mm**, respectively, and **the annual standard deviations** of PWV are **1.60 ± 0.77 mm** and **3.44 ± 0.92 mm,** respectively.

2. The annual STD of PWV showed **a gradual increase** from the land center to the edge in both **Antarctica** and **Greenland**; while **the mean PWV decreased with increasing latitude** in **Greenland**, and there was no significant latitudinal correlation in **Antarctica**.

3. There is no significant regional difference in PWV **liner trends**, and from the statistical results, both **Antarctica** and **Greenland** show **an increasing trend from year to year.** The PWV trends were **0.29 ± 0.77 mm/decade** and **0.27 ± 0.64 mm/decade** for **Antarctica** and **Greenland**, respectively, with relative PWV trends of **5.98 ± 12.93%/decade** and **3.87 ± 8.45%/decade**, respectively.

Given that existing data are still sparse in the central regions of Antarctica and Greenland, increased efforts to establish more long-term PWV measurements in these regions are warranted.

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Thank you for your attention!

Q & A

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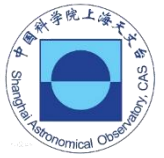

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