Techniques for Analyzing a Long-Term Observational Dataset Using Global Water Vapor Data from the NVAP-M Blended TPW* Dataset

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*Tropospheric total precipitable water

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Introduction

Long-term observational datasets are extremely useful for trend analysis but due to the temporary and imperfect nature of instrumentation, there are unavoidable breakpoints in these datasets that arise due to changes or issues in instrumentation rather than physical changes. The NVAP-M tropospheric water vapor dataset created under the NASA-MEaSUREs program is not unique in its vulnerability to these changes in instrumentation. Therefore a key question for broader work with NVAP-M is how can we detect and quantify the effects of sensor and sampling changes on the troposheric water vapor record?

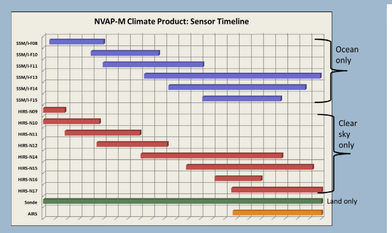
The NASA Tropospheric Water Vapor Dataset: NVAP-M

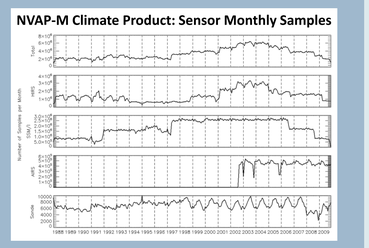
- 22-year (1988-2009) global water vapor dataset from blended from 16 satellite and surface sources
- Observationally-driven with minimal weather model dependence
- Serves a variety of user communities (climate model comparison, hydrologists, weather event and process studies)
- Contains total precipitable water (TPW) and a 4-layer layered precipitable water (LPW) products at two resolutions

Climate TPW	Climate LPW	Weather TPW	Weather LPW	Ocean TPW
Daily, 1°	Daily, 1°	6-hourly, 1/2°	6-hourly, 1/2°	Daily, 1°

Presented here

- 135 users and 309 orders as of April 2015
- Data is available at the NASA Langley Atmospheric Data Center (ASDC): https://eosweb.larc.nasa.gov/project/nvap/nvap-m_table
- For more information, see Vonder Haar, T. H., J. L. Bytheway, and J. M. Forsythe (2012), Weather and climate analyses using improved global water vapor observations, *Geophys. Res. Lett.*, **39**, L15802, doi:10.1029/2012GL052094 (17 Citations)

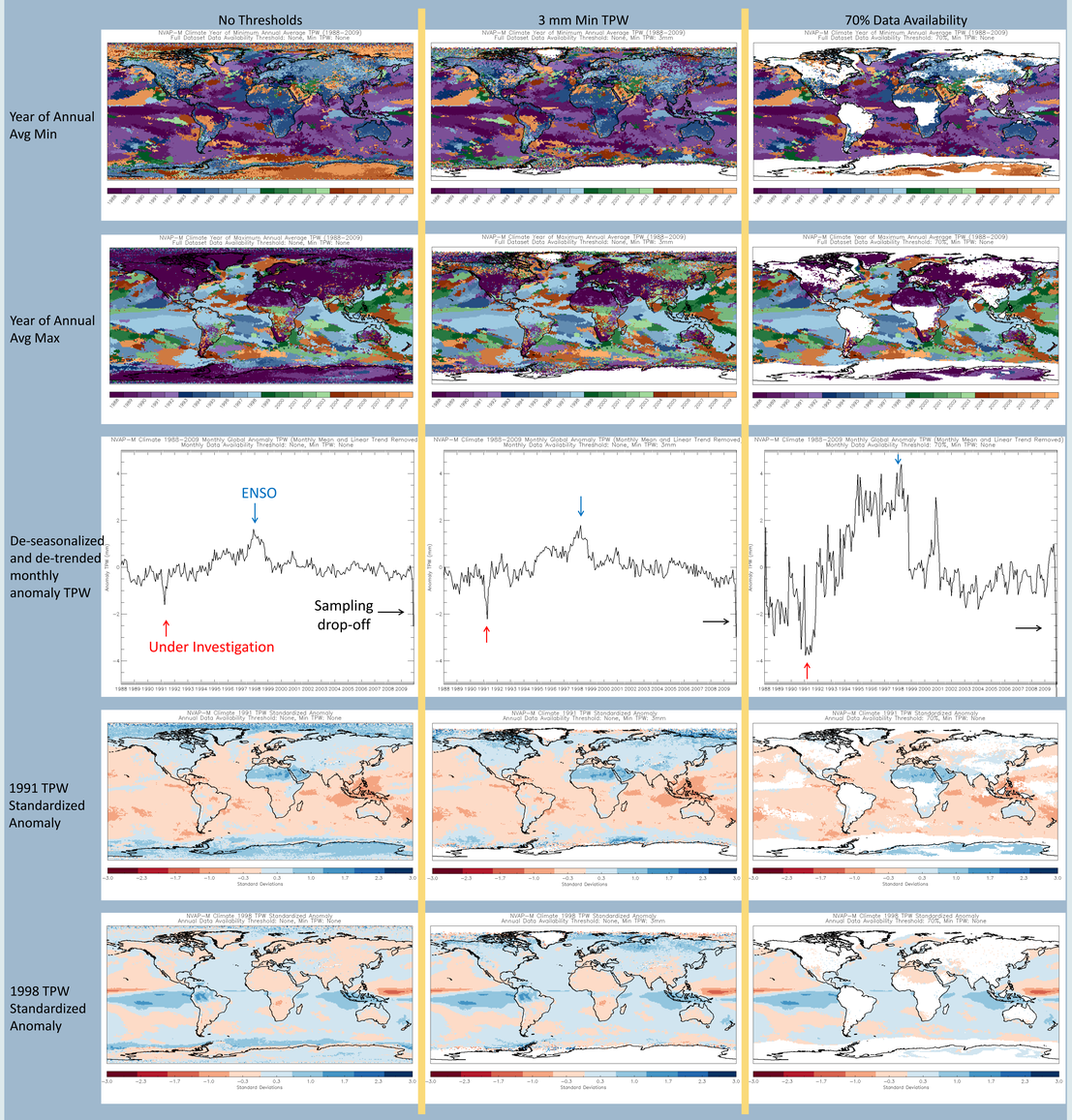




16 satellite and surface sources are blended to create the 22-year dataset, resulting in non-uniform data distribution and quality

Beyond a Basic Climatology: Investigating Extreme Values in NVAP-M Climate TPW Dataset

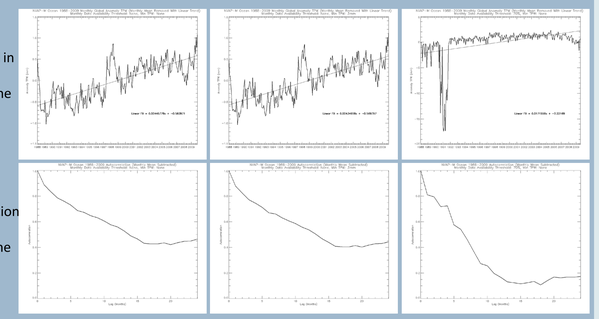
Previous analysis revealed an abundance of low (< 3mm) TPW values in the NVAP-M Climate dataset that are now under investigation. Adding **a minimum TPW threshold has particular impact in the northern mid-latitudes and polar regions and also high-altitude areas. Requiring a grid box to have valid data 70% of the time during the 22-year period disproportionately affects land and high latitudes** due to clear-sky measurement requirements for the HIRS infrared instrument.



Thresholding NVAP-M on monthly, annual, and full dataset scales allows for some quality control without removing so much data as to prevent further statistical analysis. Unsurprisingly, **thresholding NVAP-M data on a daily scale often causes large and frequent gaps in the resulting time series that prevent further statistical analysis.**

Trend and Interannual Variability Detection in the NVAP-M Ocean TPW Dataset

Long-term trend analysis requires many considerations in multi-sensor records. Data thresholds further complicate the process because data removal (even if the data is deemed poor quality for valid reasons) decreases the robustness or prevents the application of certain tests.



Penalized Maximal F (PMF) Test

[Wang, 2008 a,b]

A homogeneous time series is necessary for long term trend assessment, but observational datasets have inevitable and unavoidable discontinuities due to documented and undocumented changes in instrumentation; observing time, location, or procedure; and quality control. Wang's PMF test provides a means for detecting undocumented mean shifts in a long-term dataset with the following criteria:

1. A constant trend
2. Identically and independently distributed (IID) or AR-1 Gaussian error
3. A mean-shift magnitude that does not vary seasonally or with synoptic regimes

We are in the process of incorporating this test into our NVAP-M trend analysis.

Xiaolan L. Wang, 2008a: Penalized Maximal F Test for Detecting Undocumented Mean Shift without Trend Change. *Journal of Atmospheric and Oceanic Technology*, **25**, 368-384.

Xiaolan L. Wang, 2008b: Accounting for Autocorrelation in Detecting Mean Shifts in Climate Data Series Using the Penalized Maximal t or F Test. *Journal of Applied Meteorology and Climatology*, **47**, 2423-2444

Conclusions

- Data availability thresholds are unsurprisingly sensitive to sampling variations and, in the case of NVAP-M, disproportionately affect land and high latitudes and cause radical differences in the anomaly timeseries
- Periods of sparse or missing data from decreased sampling due to new instrument validation or instrument malfunction often disqualify for combined analysis with the full period of record