Tropical cyclone activity and its effect on global averages of total precipitable water

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Introduction

The NASA Water Vapor Project (NVAP) has recently been reprocessed and extended to now span 22 years (1988-2009) while also removing past known biases. The new dataset supersedes its predecessor and makes for a much more accurate and reliable water vapor dataset. The NASA Making Earth Science Data Records for Research Environments (MEaSUREs) project released the NVAP-MEaSUREs (NVAP-M) dataset back on April 1, 2013. NVAP-M is broken down into three separate tiers, NVAP-M Climate, Weather, and Ocean, which vary in format based on user needs. NVAP-M is a blend of multisensor water vapor instruments which make for an excellent global water vapor dataset.

Data

NVAP-M Ocean (1988-2009)	•1 degree spatial resolution •TPW values averaged once daily •Uses only SSM/I data inputs •TPW measured over ocean only
NVAP-M Climate (1988-2009)	•Same spatial and temporal resolution as above •Able to measure TPW over land and ocean in 4 different layers •Data input from SSM/I, HIRS, Sonde, and AIRS
NVAP-M Weather (1988-2009)	•Higher 0.5 degree spatial resolution •Temporal Resolution: 4 times daily •Same data input as Climate but with GPS added •Ability to measure TPW in 4 layers

My Motivation

1. To observe the effects that tropical cyclones have on current global averages of total precipitable water (TPW).

2.With tropical cyclones being an intense precipitation event, this hinders the ability of currently used instruments, such as the Special Sensor Microwave/Imager (SSMI), to make accurate readings.

3.Consequential to this error is that there is a large amount of missing high TPW values within each tropical cyclone. These missing values are currently not taken into consideration when computing a global TPW average.

The Problems

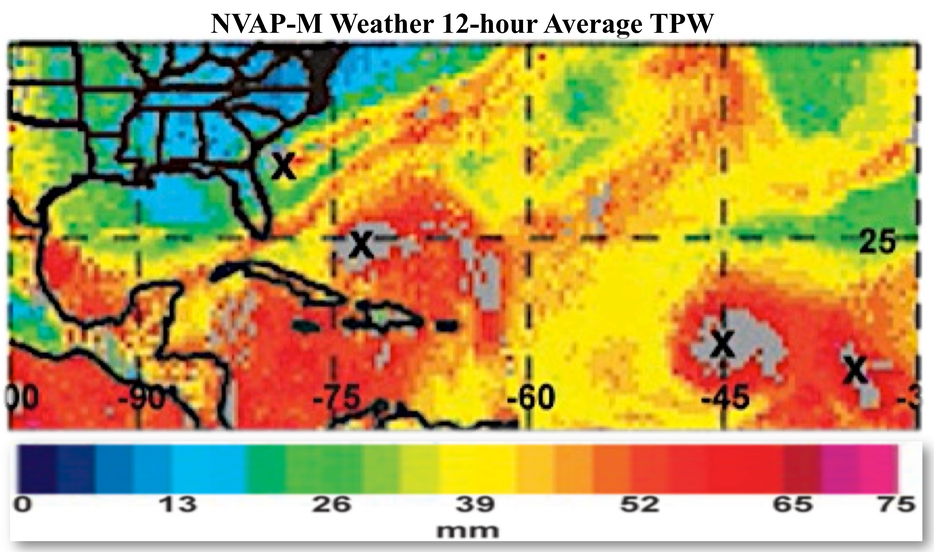
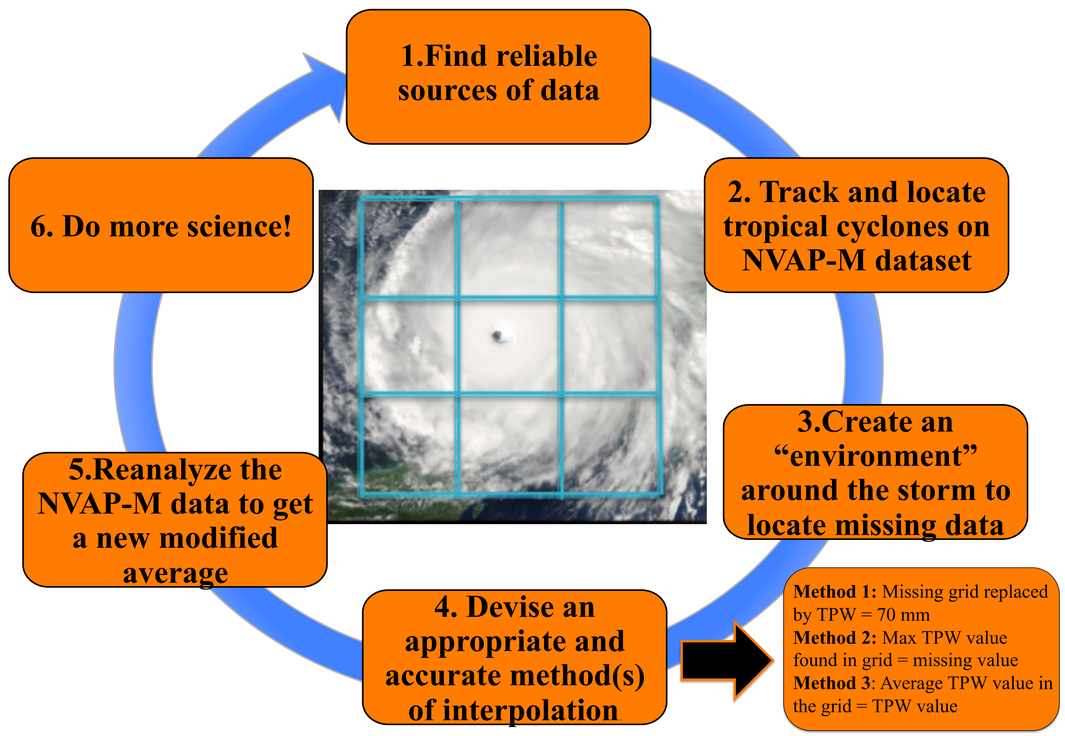


Figure 1. 1200-2359 UTC on 19 September, 2004 in the North Atlantic Ocean and Caribbean Sea shows NVAP-M Weather composite of total precipitable water. Notice the grey areas indicating missing data. Majority of the missing data is located within tropical cyclones denoted by an X.

Methodology



Results

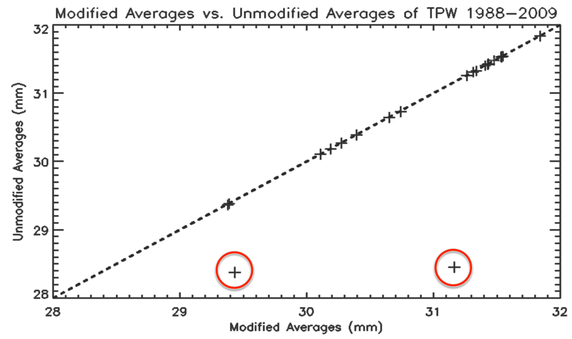


Figure 2. This is a graph of modified global averages vs. unmodified global averages of TPW over the span of the dataset (1988-2009) using interpolation method (1). It is plotted with a 1:1 line and modified averages on the x-axis (mm) and unmodified averages on y-axis (mm). Two outliers from years 1988 and 1990 are circled in red. Although the change was small, tropical cyclone consideration did in fact increase the current global average of TPW on the NVAP-M Ocean dataset by approximately +0.18 mm. According to an article by Trenberth et. al., TPW is increasing at a rate of +0.37 mm/decade (+1.3%).

Conclusions & future work

1. Not considering tropical cyclones is a bias when determining the global average of TPW.
2. Sampling tropical cyclones do increase global averages of TPW averages in both NVAP-M Ocean and Climate by a approximately +0.18mm. Although this change is small, only the Atlantic basin was taken into consideration.
3. Future work involves tracking and locating all tropical cyclones across the globe as opposed to only the Atlantic. There also has to be a more accurate method for interpolating the missing data within the storm. Possible ideas include modeling a typical, moist tropical (MT) sounding in combination with hurricane dropsonde measurements to get a more accurate TPW value to experiment with.

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References

Trenberth, K.E., J. Fasullo, L. Smith, Trends and variability in column-integrated atmospheric water vapor, Climate Dynamics (2005) 24: 741-758 DOI: 10.1007/s00392-005-0017-4

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