Continuous Estimates of GPS Precipitable Water Vapor During the DYNAMO Field Experiment

John J. Braun, Teresa Van Hove (UCAR/COSMIC)
William Brown, Tammy Weckwerth, Tim Lim, Gary Granger (NCAR/EOL)

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PW is computed through the estimation of the delay of the GPS signals as they propagate through the atmosphere.

The delay is a function of the atmospheric refractivity.

\[ N = 77.6 \left( \frac{p}{T} \right) + 3.73 \times 10^5 \left( \frac{e_w}{T^2} \right) \]
Simplistic GPS PW Explanation

\[ N = 77.6\left(\frac{p}{T}\right) + 3.73 \times 10^5\left(\frac{e_w}{T^2}\right) \]

\[ \Delta L = 10^{-6} \int [77.6\left(\frac{p}{T}\right) + 3.73 \times 10^5\left(\frac{e_w}{T^2}\right)] ds \]

\[ ZTD = ZHD + ZWD = \frac{SHD}{m_h(\cdot)} + \frac{SWD}{m_w(\cdot)} \]

\[ PW = \frac{IWV}{ZWD} \]

or

\[ PW = \frac{1}{IWV} = \int_v dz \]
Role of GPS PW in Dynamo

- A calibration source for the extensive set of radiosondes that were part of DYNAMO.
  - GPS is a fundamental measurement of Global Reference Upper Air Network (GRUAN) to help monitor sounding data.
- All-weather (insensitive to clouds and precipitation).
- High temporal resolution (30 min)
  - GPS and MWR provide highest temporal resolution data of water vapor field.
- GPS site is normally considered to be rigidly attached to ground.
  - Data onboard R/V Revelle requires different processing strategy.
Differences in Revelle Processing

- Kinematic positioning of ship
- 1 Hz positioning – 30 min PWV
- Precise Point Positioning
- Hour processing windows
Darwin site used to evaluate quality of Revelle results.

- Can compare to a “regular” Suominet site as a metric of data error.
- RMS agreement < 3 mm.

SA39 (Darwin) - Scatter
Revelle Comparisons to MWR
DY GAN – Met Observations

DYGA

Wind

Temperature (°C)

Pressure (hPa)

Accum. Precip. (mm)
DYDG – Met Observations

**DYDG**

- **PW (mm)**
  - Day of Year
  - 300 to 360
  - 0 to 80

- **Temperature (°C)**
  - 2011-12-07 to 2011-12-15
  - 20 to 35

- **Pressure (hPa)**
  - 2011-12-07 to 2011-12-15
  - 1000 to 1015

- **Wind**
  - 2011-12-07 to 2011-12-15
  - 0 to 40
Power Spectrum – Gan and Diego Garcia

DYOC Power Spectrum

\[ x_0 \leq 0 \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad x_5 = 1 \]
Results are initial evaluation of GPS data collected during Dynamo

- NCAR Deployments to Gan and Diego Garcia
- “normal” Suominet sites (ARM and IGS sites)
- R/V Revelle

Key points of data set.

- GPS PW data should now be ready for intercomparisons
- Gan and Revelle sites had more constant PW time series than Diego Garcia and Cocos Island.
- Arm sites in Manus and Nauru had much higher temporal fidelity than Gan.
- Diurnal signal does not appear to be particularly strong in PWV power spectrum.
- Revelle data appear to be slightly noisier than island sites, this agrees with some previous ship based data. To be expected.