



Mass Loading Products at NASA GSFC

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Agenda



- Hydrology loading product
 - Uses GLDAS hydrology model
 - Comparisons with loading from GRACE data
- Pressure loading product
 - Petrov & Boy series
 - Uses NCEP Reanalysis pressure fields
- Conclusions and Outlook

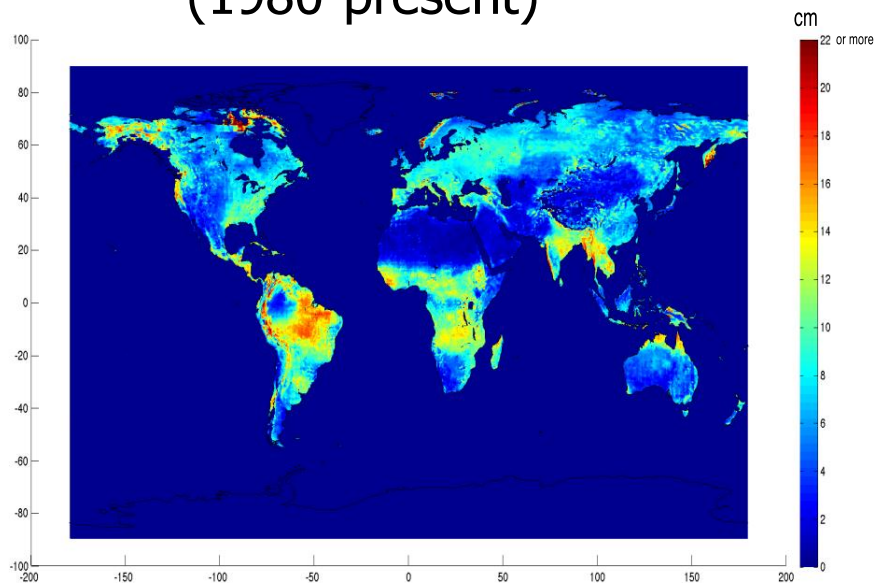


Hydrology Loading Data

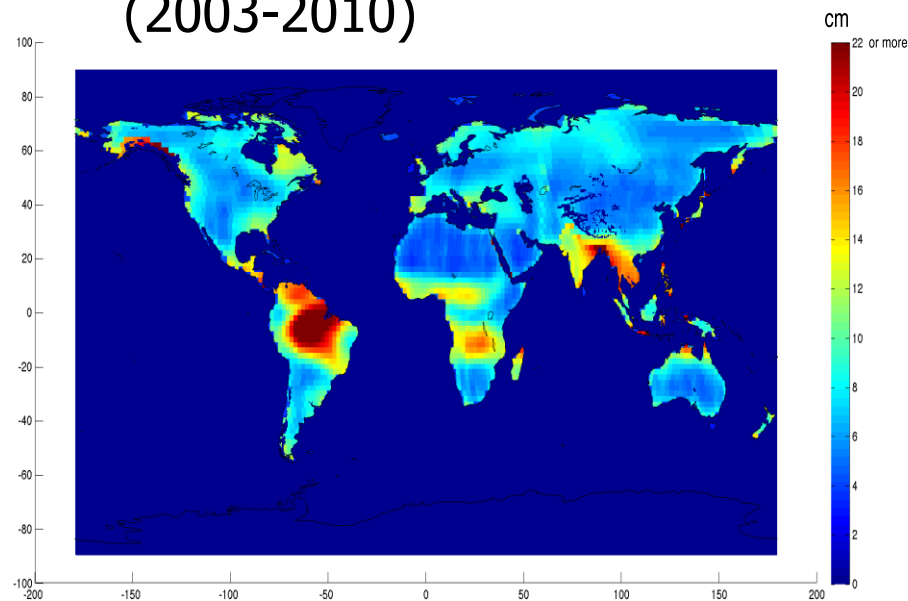


- GSFC GLDAS (Global Land Data Assimilation System, Rodell et al., 2004)
 - soil moisture + snow water+ canopy water
 - does not account for ice sheet processes
 - $0.25^\circ \times 0.25^\circ$ global resolution, both 3-hour and monthly time resolution
 - loading computed from 1980-present
- NASA GSFC GRACE mascons (Rowlands et. al, 2005)
 - measures total surface mass change
 - removed ice areas from loading calculation
 - 10-day resolution
 - loading computed from 2003-2010

GLDAS Model
(1980-present)

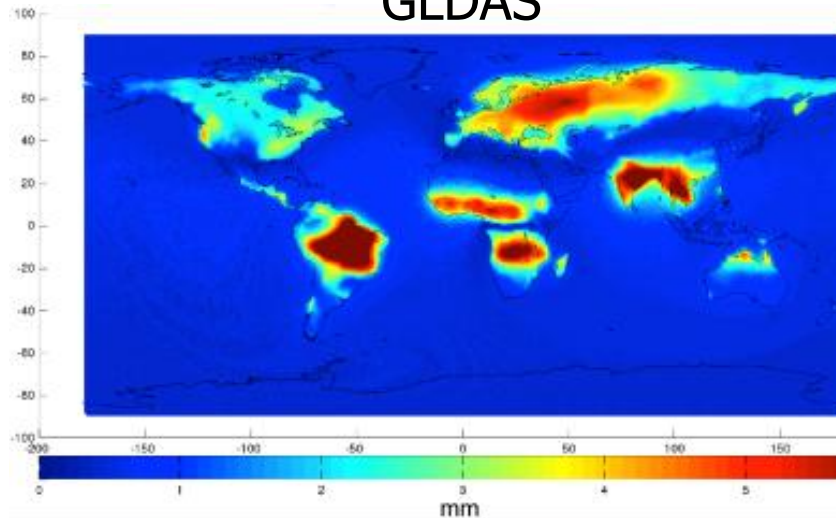


GRACE
(2003-2010)

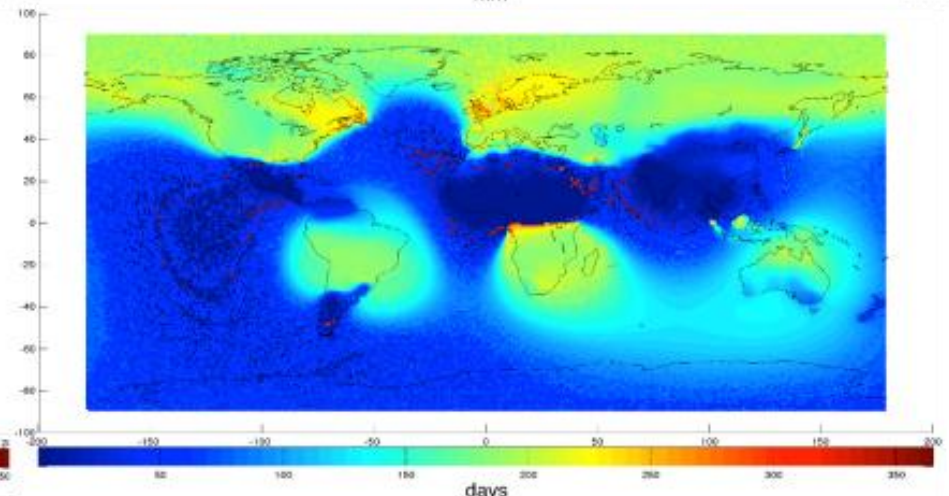
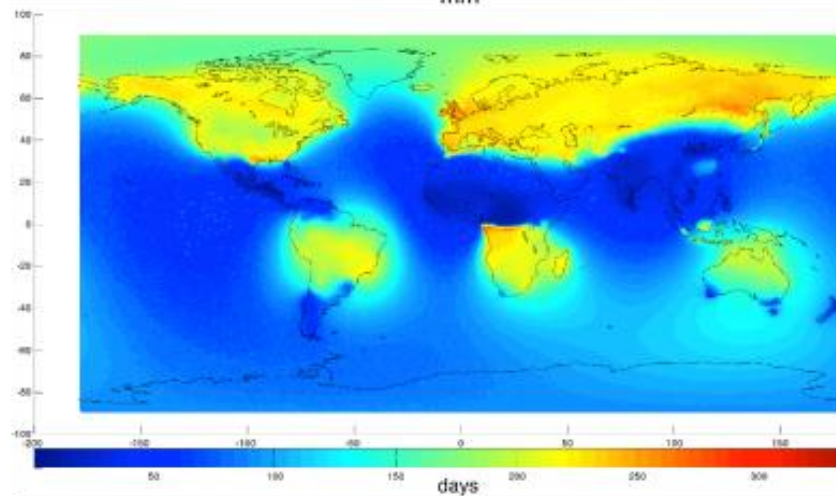
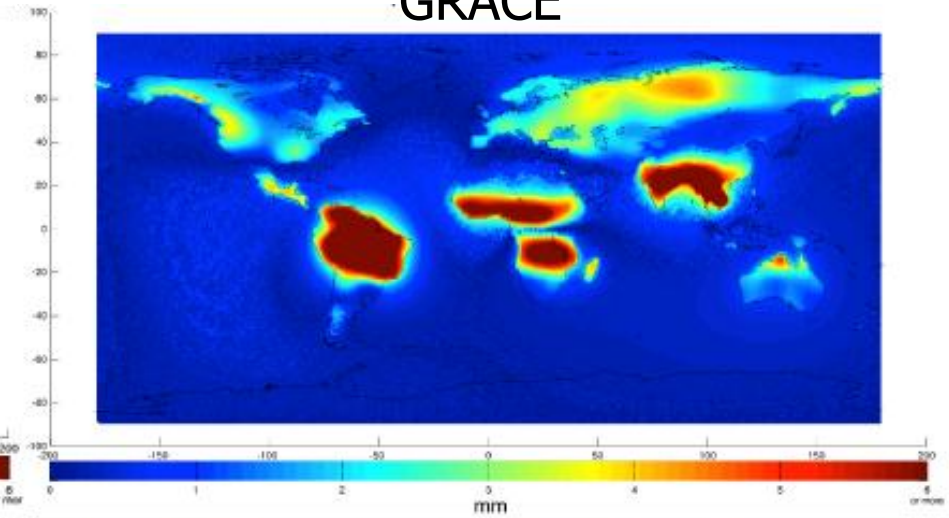


Standard deviation of hydrology mass (cm of water)

GLDAS



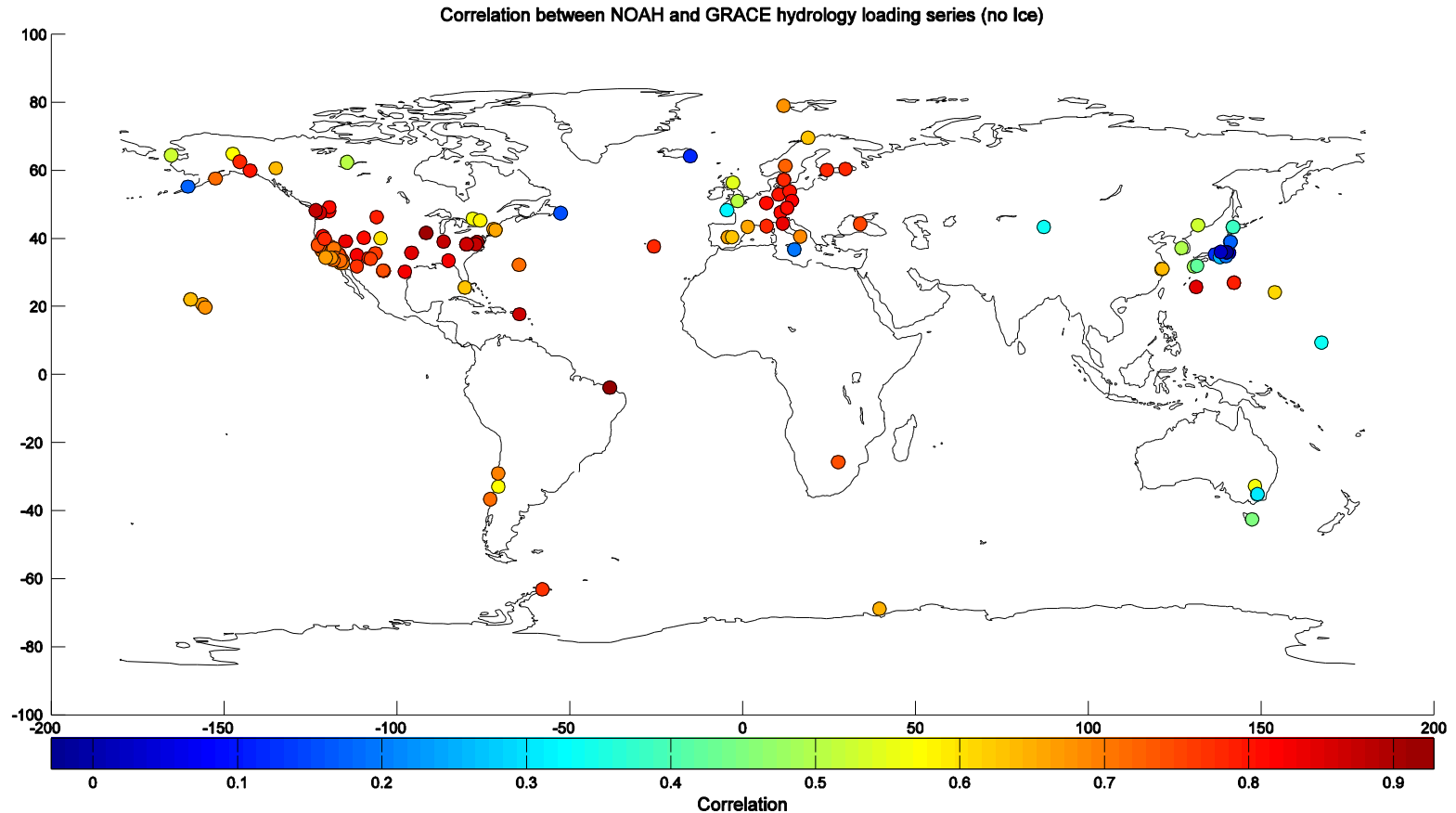
GRACE



- Annual amplitude scale for loading is 0 to 6 mm (or greater)
- Phases are similar



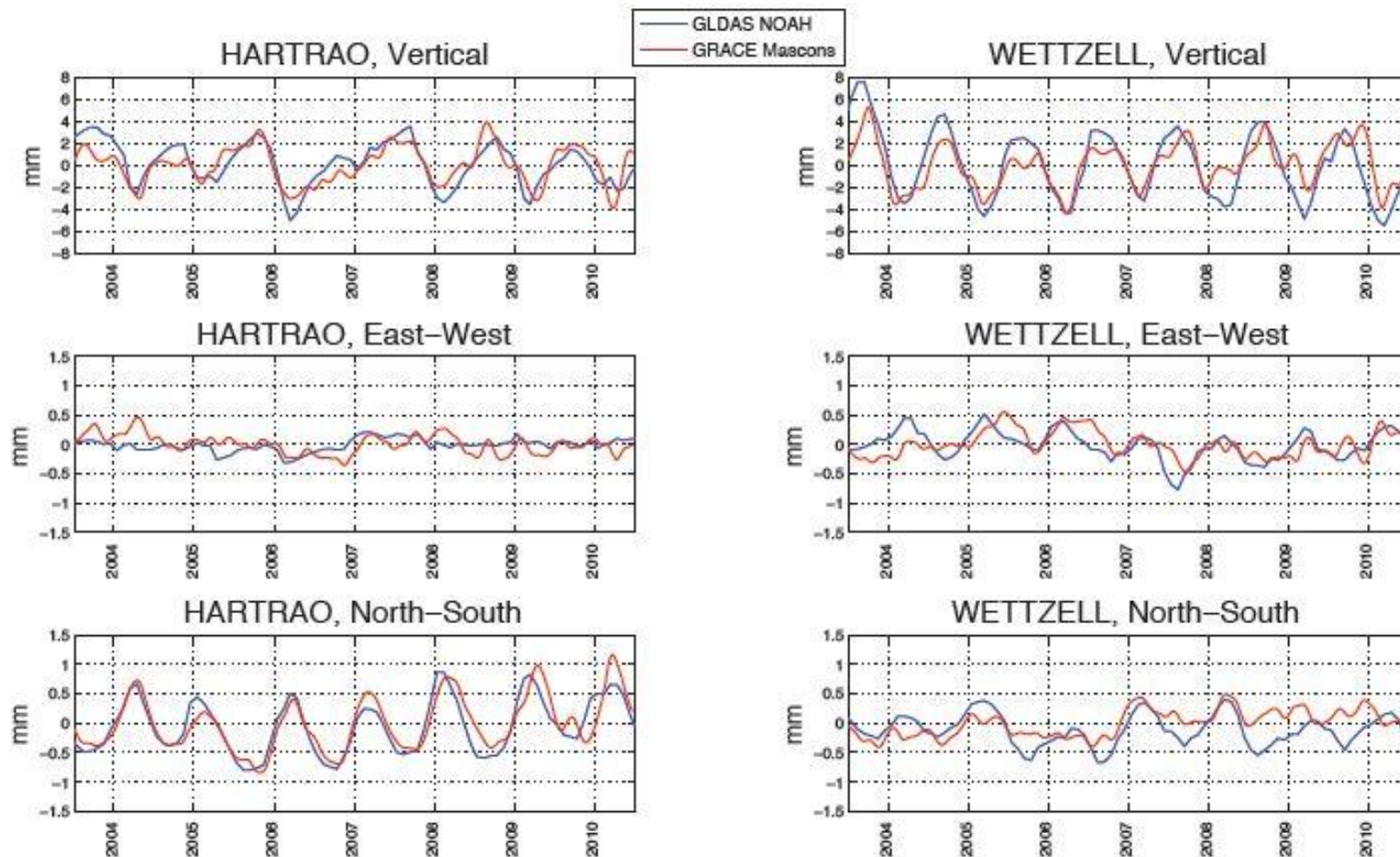
Hydrology Loading Correlation



- Correlation between GLDAS and GRACE $> 0.7-0.8$ for most VLBI sites
- Worse correlation for some sites near coasts

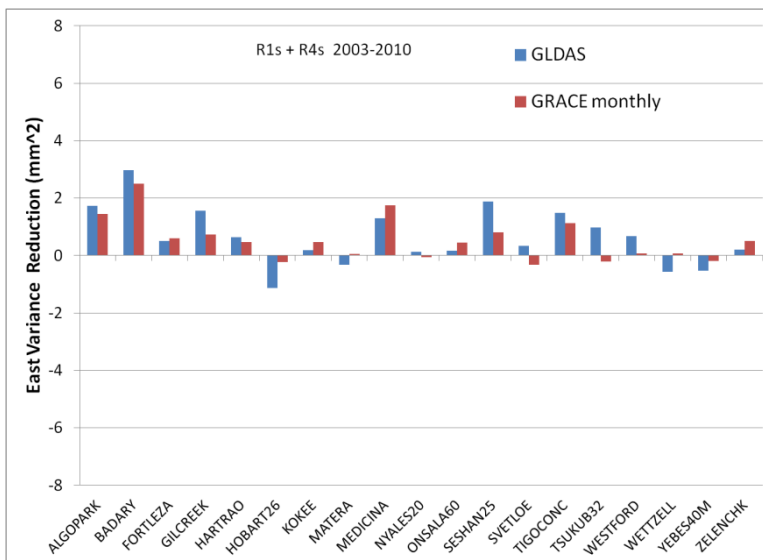
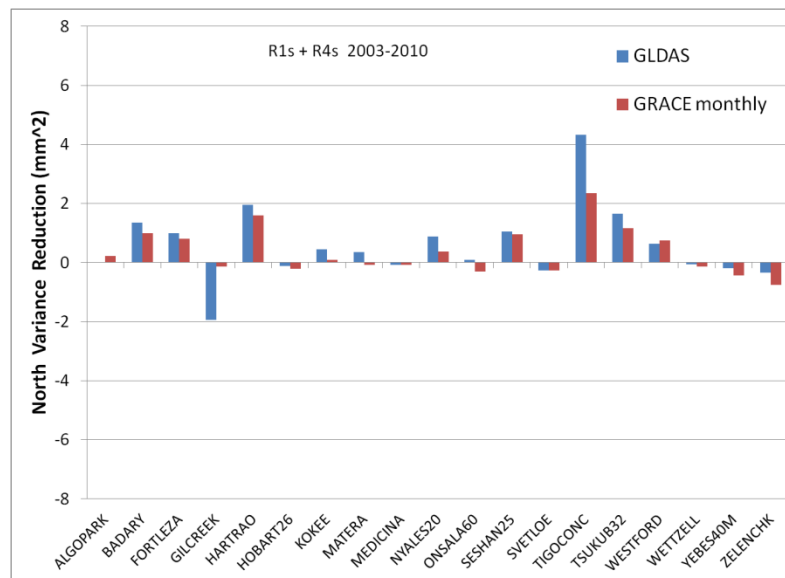
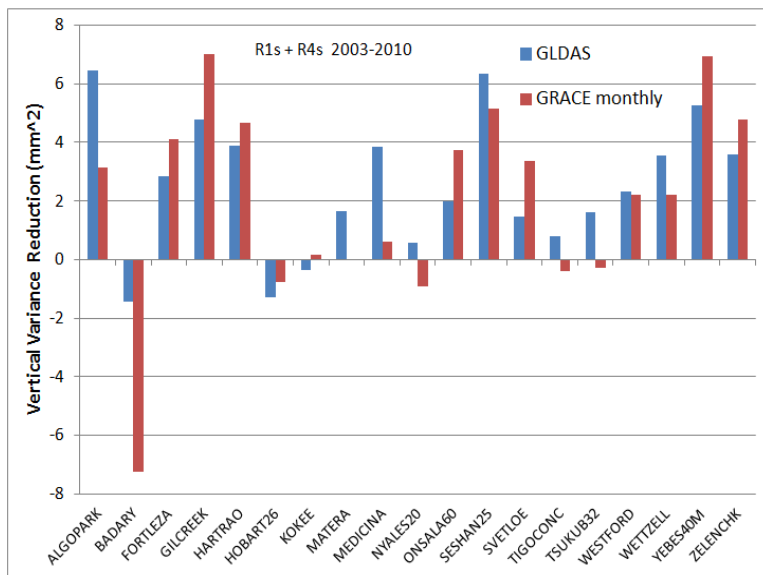


Hydrology Loading Correlation





Hydrology Loading Tests

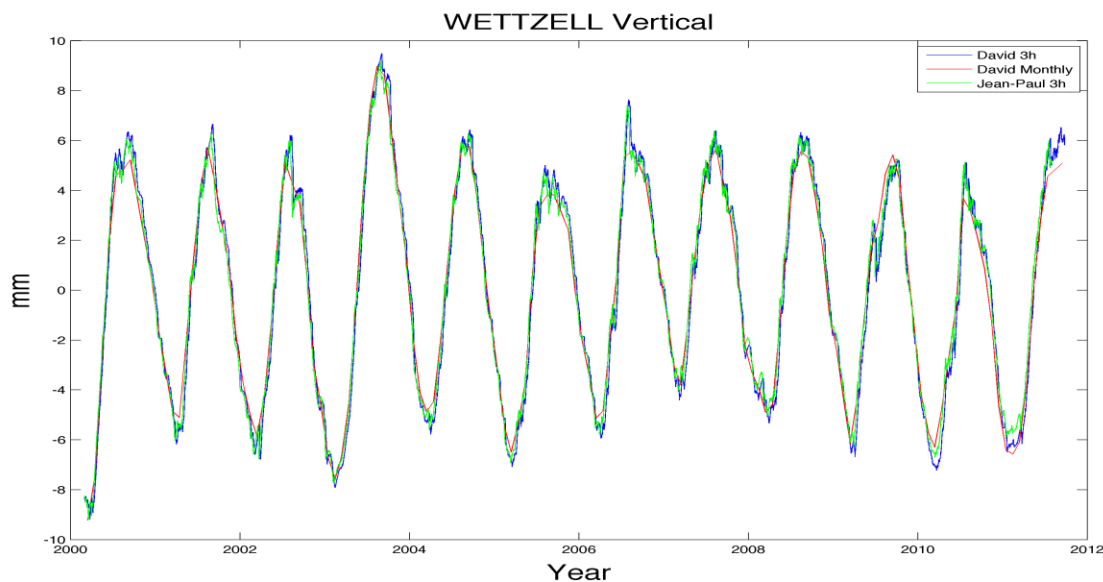


Calc/Solve tests of loading series:

- R1/R4 weekly operational VLBI sessions
- 2003-2010 (over GRACE period)
- Site UEN scatter reduced using GLDAS or GRACE loading series
- Baseline length scatter reduced for 80% of baselines



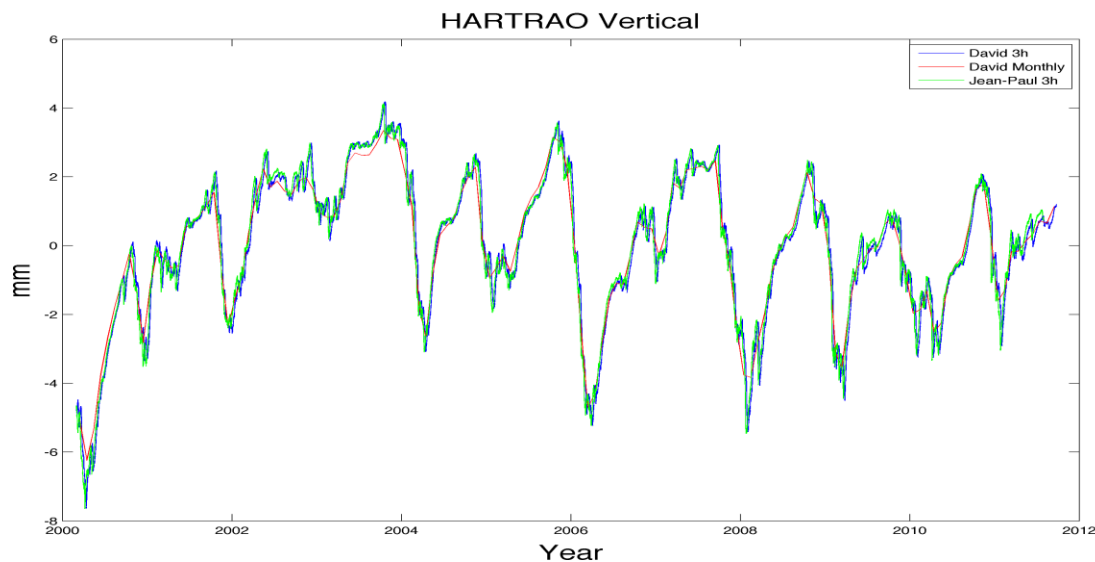
Hydrology Loading Comparisons



Comparison between:

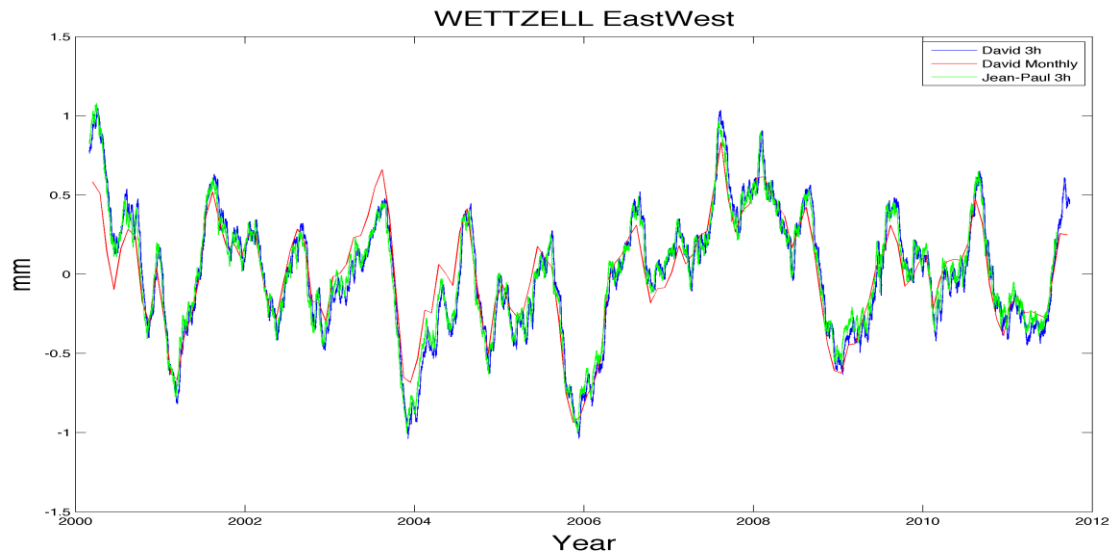
- 1) GSFC 3hr GLDAS
- 2) GSFC GLDAS monthly
- 3) J.-P. Boy 3hr GLDAS

- 3-hour series are very similar
- Differences < 0.5 mm





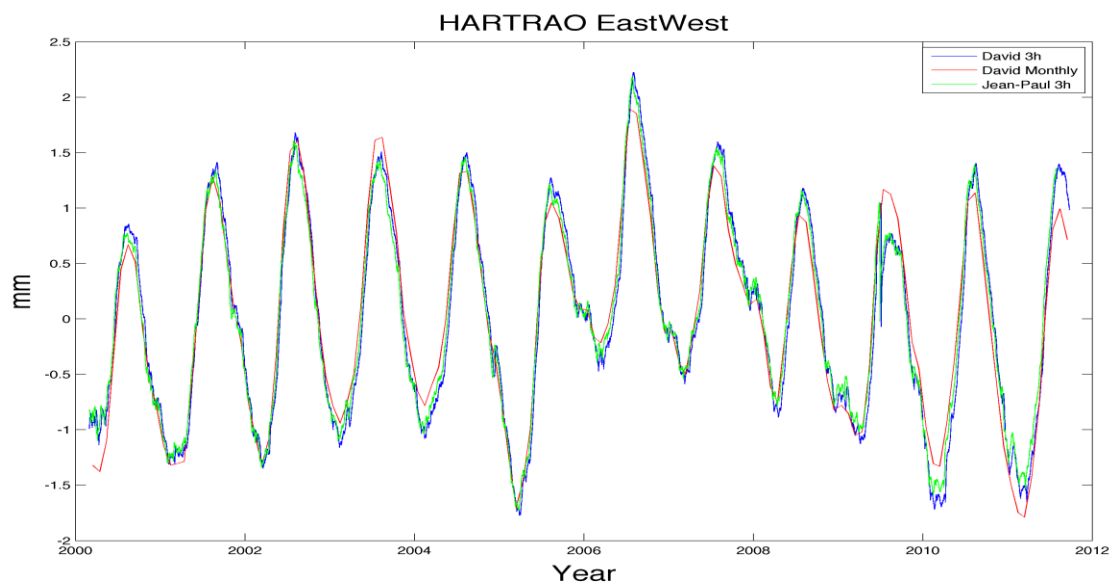
Hydrology Loading Comparisons



Comparison between:

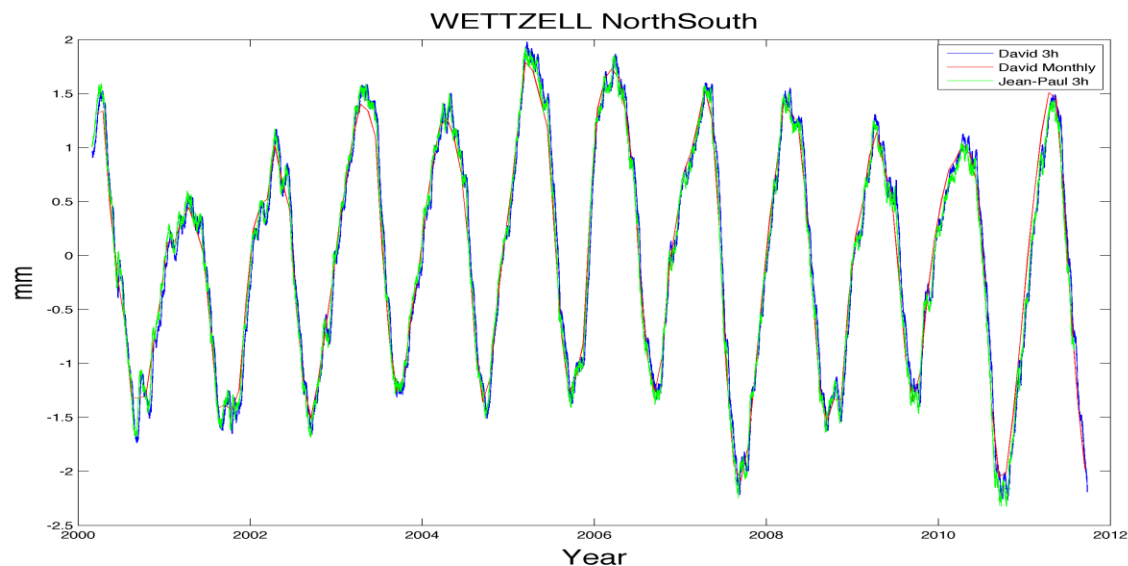
- 1) GSFC 3hr GLDAS
- 2) GSFC GLDAS monthly
- 3) J.-P. Boy 3hr GLDAS

- 3-hour series are very similar
- Monthly series differ by up to ~ 0.4 mm

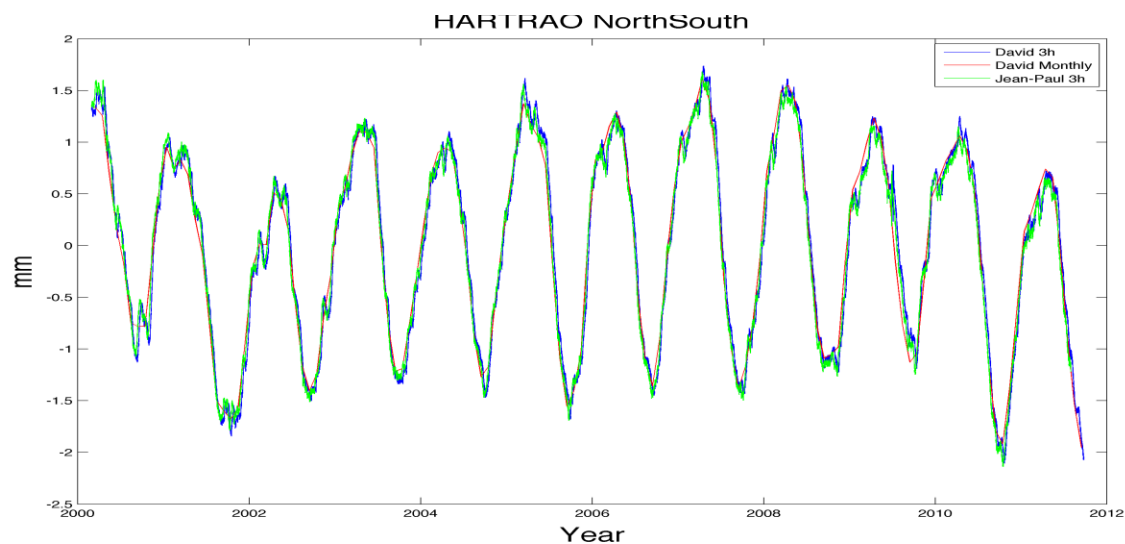




Hydrology Loading Comparisons



- Comparison between:
- 1) GSFC 3hr GLDAS
 - 2) GSFC GLDAS monthly
 - 3) J.-P. Boy 3hr GLDAS





Hydrology Loading Service Specifications



- Loading service <http://lacerta.gsfc.nasa.gov/hydlo/>
- Compressed directory: loading series for 170 VLBI sites
- Separate text files each site: new sites added on request
- Loading series also on global grid with resolution 1x1 deg
- Latency of GLDAS model is currently 1-2 months



Pressure Loading Series



- GSFC pressure loading service
 - first established in 2003 by L. Petrov and J.-P. Boy
 - displacement series for 824 VLBI, SLR, GPS sites
 - loading computed from 1980-present
- Calculation of loading series
 - loading series discussed by Petrov & Boy (2004)
 - calculated from NCEP Reanalysis pressure fields with $2.5^\circ \times 2.5^\circ$ global resolution given every 6 hours
 - ocean assumed to have inverted barometer response



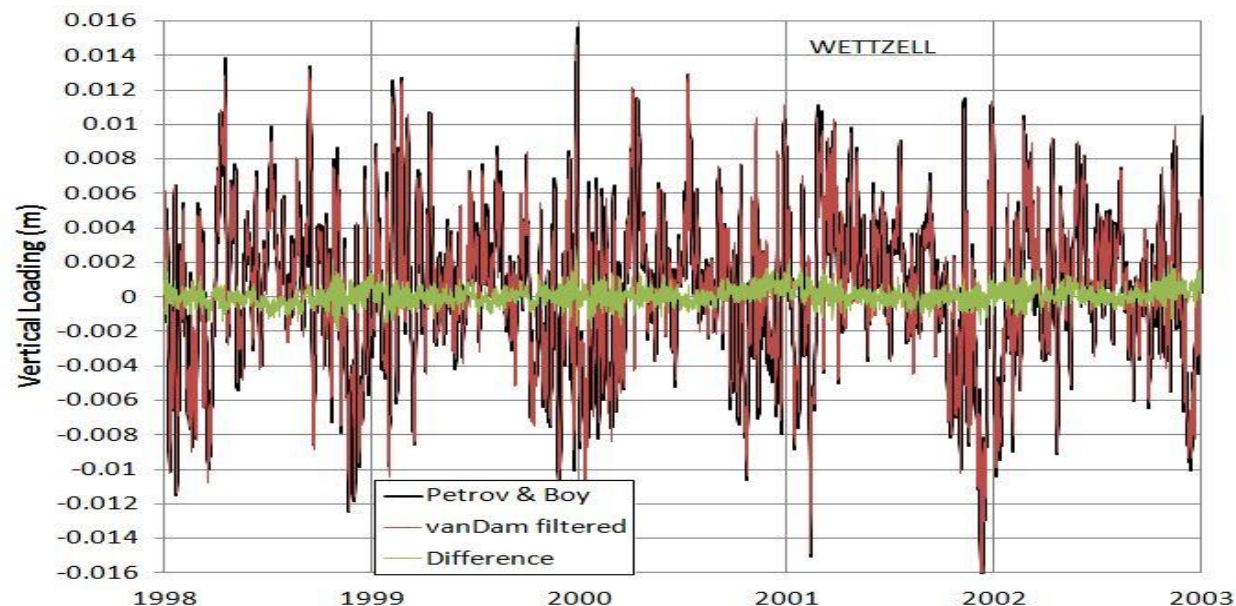
Pressure Loading Comparisons



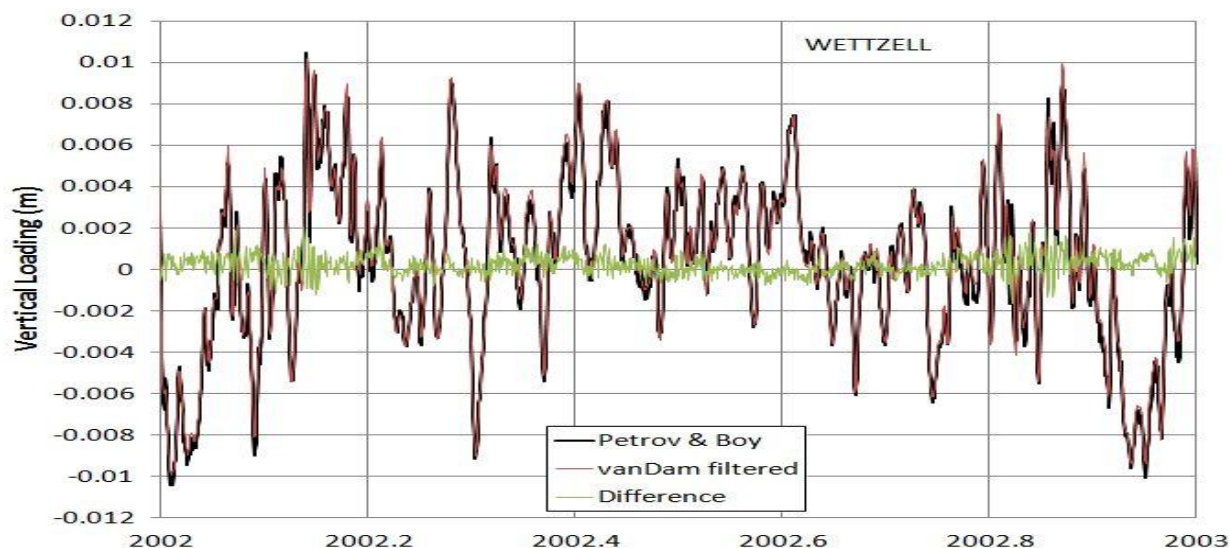
- Preliminary comparisons between nontidal vertical series
 - 1) NASA/GSFC (L. Petrov)
 - 2) T. van Dam
- T. van Dam computed the loading series using the raw NCEP reanalysis fields and then filtered out the S1 and S2 components
- Petrov first removed the S1 and S2 components from the NCEP pressure fields using the Ponte & Ray (2002) model and then performed the convolution with the loading Greens function



Pressure Loading Comparisons



RMS diff ~ 0.5 mm
Signal RMS ~ 4.5 mm
 $\sim 11\%$ error

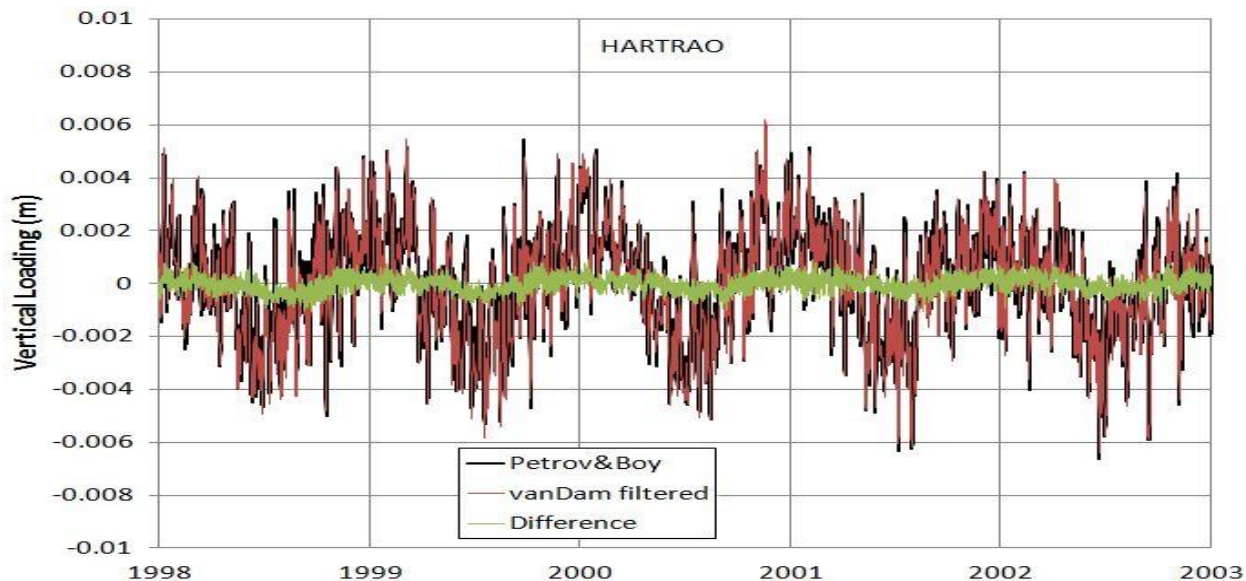


Error estimate
(Petrov & Boy, 2004)

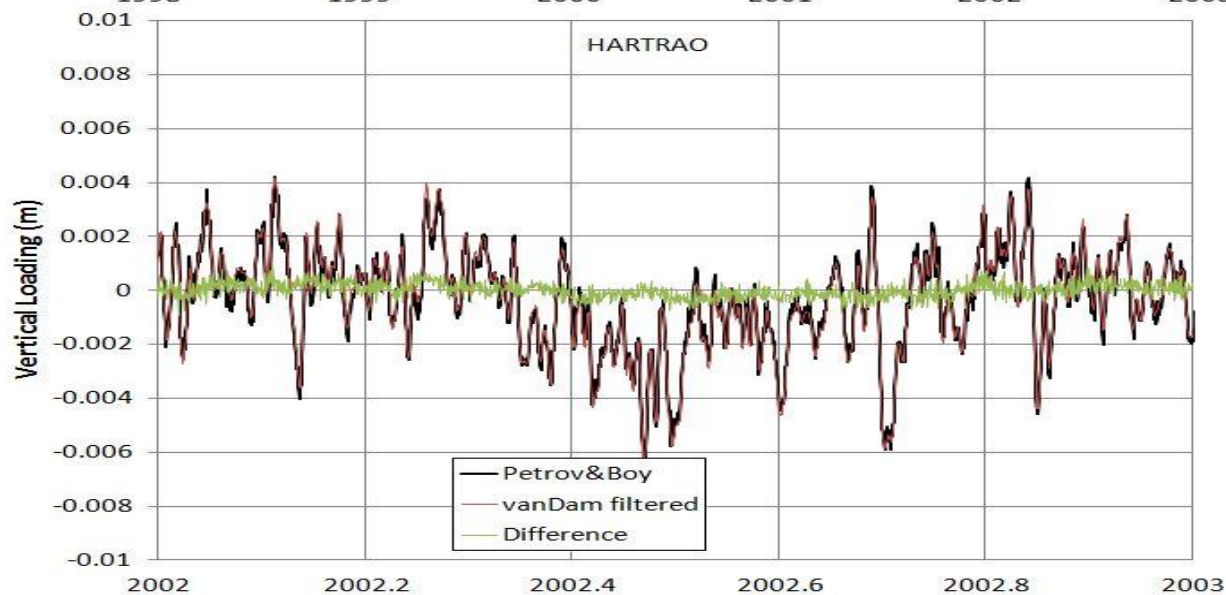
- pressure field (10%)
- ocean response (10%)
- land sea mask ($<5\%$)
- Total $\sim 15\%$



Pressure Loading Comparison



RMS diff ~ 0.3 mm
Signal RMS ~ 2.0 mm
 $\sim 15\%$ error





Pressure Loading Service Specifications



- Loading service http://lacerta.gsfc.nasa.gov/aplo_eph/
- Monthly ascii files with 3D site displacement series for 824 VLBI, GPS, and SLR sites
- Gridded monthly loading series also on global grid with resolution 2.5x2.5 deg
- Latency of loading series is currently ~2.5-3 days corresponding to availability of NCEP Reanalysis data.
 - Updates are made every night with the latest data



Conclusions and Future Work



- Both the GLDAS hydrology loading and GRACE loading reduce VLBI vertical and horizontal site and baseline length scatter
- Most VLBI sites show good correlation between GLDAS and GRACE vertical loading series
- Set up a hydrology loading service at VLBI sites using the GLDAS model (available over the full VLBI observing period 1980-present)
- We continue to maintain the pressure loading service developed by Petrov and Boy
- Analysis improvements due to pressure loading are well-documented
- Comparisons between Petrov and van Dam vertical pressure loading series show agreement at 10-15% level
- We are planning to set up a nontidal ocean loading service
 - JPL ECCO model
 - Improvements have been seen in geodetic results



Data Formats



Hydrology loading:

- One ascii text files for each site time series
- Format: MJD, Up, East, North
- Gridded format (0.25x0.25 deg)
- Not finalized, probably in netcdf format

Pressure loading:

- EPHEDISP format (ascii)
- Monthly files contain displacements for all sites
- Displacement block format:
 - Epoch #, MJD, Calendar date, site ID, Up, East, North
- Displacements are grouped by epoch, i.e., for each epoch, all site displacements are listed (one site per line)
- Gridded format (2.5 x 2.5 deg)
- Same as above except Site ID is replaced by gridpoint
- Displacements are listed for all gridpoints at each epoch