Impact of short period atmospheric loading signals

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Abstract: Atmospheric pressure loading in a center of figure reference frame primarily affects the vertical positions of sites with the typical horizontal displacements being about 10 times smaller than the vertical ones. The high frequency part of the spectrum of the vertical displacements has strong peaks at the S1 and S2 tidal lines that arise from thermal atmospheric tides. However, in a center of mass reference frame, current models show that the horizontal displacements are comparable in size to the vertical ones and at the S1 and S2 tidal lines the horizontal signals are often large than the vertical ones at specific locations. In addition, the S1 and S2 tidal lines are of thermal origin and are not of constant amplitude and phase. When the current S1 and S2 center of mass system tidal loading corrections are applied to center of mass load calculations, there is typically still a large amount of power remaining in the loading signal at the S1 and S2 frequencies especially in the horizontal components. Most of this power arises from center of mass position changes relative to center of figure.

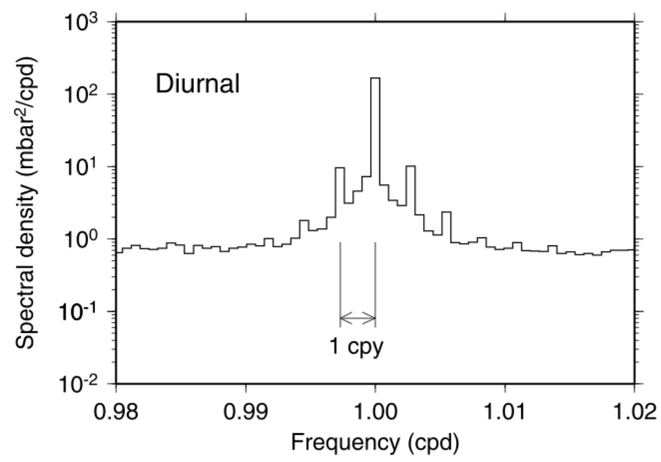
SUMMARY:
Figures below and to the side are illustrative of the uncertainty in the sub-daily loading signals.
(1) There are differences between the IERS 2010 conventions model and the one used at the IERS Fluid Center (figures to the right).
(2) The S1 and S2 thermal "tide" coefficients are not constant but are treated that way in the current standards.
(3) The impact of changes in the amplitudes can be seen in the figures below where the largest effects are seen in the Center of Mass frame and in the horizontal components.
(4) Annual modulation of the amplitude of the S1/S2 coefficients is likely to explain most of the variations (upper right figure) or monthly coefficient models could be used.
(5) Effect is in Center of Mass frame and so impact could be larger than expected from ~1mm level signals.

Comparison of S1/S2 thermal "tide" loading between IERS geophysical fluid center and IERS 2010 conventions

	S1 Cos (mm)	S1 Sin (mm)	S2 Cos (mm)	S2 Sin (mm)
IERS Fluid Center http://geophy.uni.lu/ggfc-atmosphere/tide-loading-calculator.html				
X	-0.03	-0.66	-0.04	-0.06
Y	-0.68	-0.01	-0.08	-0.03
Z	0.02	0.00	-0.04	0.01
IERS conventions (Table 7.6)				
X	0.21	-0.77	0.14	-0.18
Y	-0.73	-0.24	-0.33	-0.16
Z	-0.01	0.03	-0.10	0.02

Differences mainly at the S2 frequency where the conventions are larger than Fluids Center. Impact is shown below for Churchill NEU position changes

Ponte and Ray (2002)GEOPHYSICAL RESEARCH LETTERS, VOL. 29, NO. 24, 2153, doi: 10.1029/2002GL016340, 2002



The I cpy side bands show that the S1 thermal tide has an annual modulation which is not accounted for the current models and conventions. The impact of the differences can be seen in the figures below.

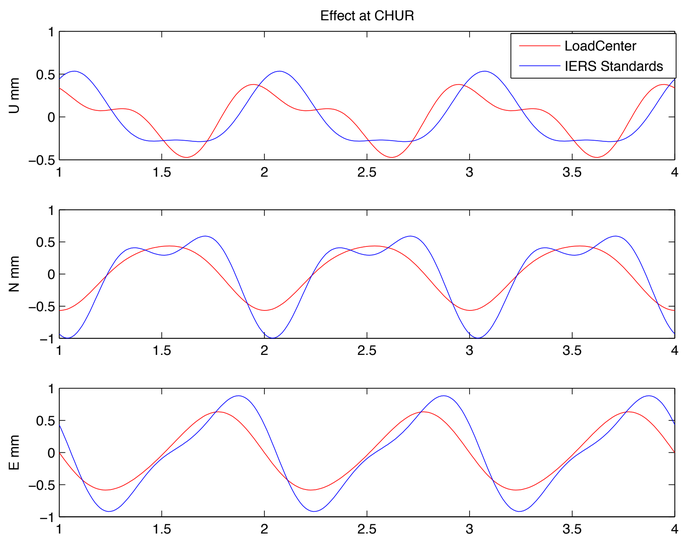
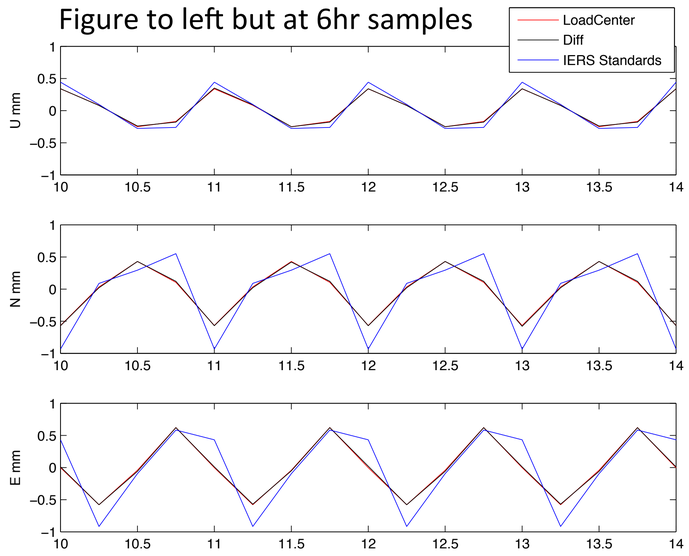
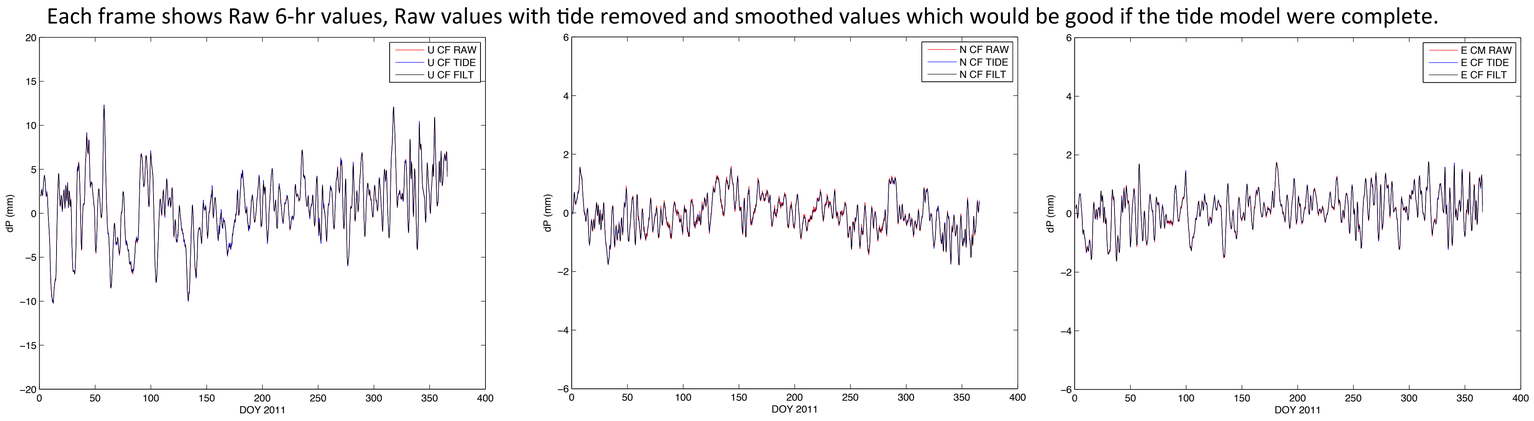


Figure to left but at 6hr samples



Loading signals during 2011 at CHUR. First row: Center of Figure (CoF), UNE; Second row: Center of Mass (CoM), UNE (note size of North signal); Difference between CoF and CoM results. Differences are all due CoM effect and effect all sites .
Each frame shows Raw 6-hr values, Raw values with tide removed and smoothed values which would be good if the tide model were complete.



Zoom of North component. Notice that in CF frame, little difference but in CM frame tide model does not match raw and signal is large