PBO Borehole Response to Atmospheric Pressure

Strain-tilt Short Course
June 2008

Surface Load From Atmospheric Pressure Changes
Features in 4-16 day band

- No tidal signal expected
- Long-term trends removed
- Expect mainly atmospheric pressure unless some other form of strain is being imposed
- Atmospheric pressure has equilibrated over the ocean
  - Distribution of loading should be uniform with frequency in this band

Atmospheric pressure load is fairly uniform spatially
Example: B004, Hoko Falls

- Entire band 4-16 days
- 4 channels track pressure
- Similar amplitudes all 4 channels

B004, Hoko Falls: Sub-bands, Apr & May 2007

- Elliptical paths indicate phase lags
  - At these periods, seems unlikely to be an instrument effect
- Relative gains of gauges vary between bands
B004, Hoko Falls: Sub-bands, June & July 2007

- Gain differences not same as Apr&May
- Relative amplitudes vary between bands
Example:
B005, Shores 1

- Entire band 4-16 days
- 4 channels track pressure
- Different amplitudes
B005, Shores 1: Sub-bands, Apr & May 2007

• Phase lags seem smaller than at B004

B005, Shores 1: Sub-bands, June & July 2007

• Gain differences similar to Apr&May
B005: Selection of Data

- B005 turns out to have a big seasonal signal, especially on CH1
- This is why one does not get good tidal analyses on arbitrary 90-day stretches of data
Example:
B009, PGC 1

- Entire band 4-16 days
- 4 channels track pressure approximately but not in detail
- All coastal stations seem to behave this way

B009, PGC1: Sub-bands, June & July 2007

- This behavior would seem likely to impede accurate determination of atmospheric loading effects
- Are long-period signals in the tide gauge data?
B035 and B036 Grants Pass OR

• These two sites about 100 m apart behave similarly in that they do not track atmospheric pressure much of the time

B035, Grants Pass1: Sub-bands, Aug-Sep 2007

• There seems to be a strain signal in the 13-15 day band that does not come from the atmospheric pressure
  – It could be a shear strain signal because CH1 and CH3 are mirror images
B036, Grants Pass2: Sub-bands, Aug-Sep 2007

- In 13-15 day band there is a signal similar to B035
  - As at B035, CH1 and CH3 are nearly opposite
- Behavior in all bands resembles B035

B035, Grants Pass1: Sub-bands, Feb-April 2007

- All 4 channels track atmospheric pressure well at this time
- Barometer now has lots of energy in 13-15 day band, and strain channels track it
- No B036 data for this time period
B035 and B036, Grants Pass OR

- Time series plots show a similar signal for B035 and B036 from about 12 July to 1 August on the EN-shear
- Both stations have longer-period variations in the data that are not “self-consistent”
  - Probably due to recency of installation at B036 (8 May 2007)

Summary, 1

- In the 4-6 day passband
  - amplitudes of the response change with time at some stations
  - relationship between the responses to atmospheric pressure of the 4 different gauges does not change much
  - Implies the product of relative gauge gain and atmospheric pressure-induced strain is approximately time invariant in this passband
  - Strongly suggests time stability of individual gauge gains
- For passbands at longer periods, the relationship among the 4 gauges is not as repeatable with time.
  - May be due to difficulty of finding longer periods of data without other extraneous signals
Summary

- Azimuthal variation of atmospheric pressure-induced strain accounts for little, if any, of the variation among the gauges.
- For the stations where lab measurements of the relative gains are available, the relative responses to atmospheric pressure do not correlate with these lab measurements.
- The ratios of the atmospheric pressure coefficients are not just relative gauge gains - they don’t improve fits to the tidal analysis.