



Quantitative Impact of Surface Pressure Variations on the Earth Gravity Field



E. Fagiolini¹, F. Flechtner³, T. Gruber², T. Schmidt³, G. Schwarz¹,
T. Trautmann¹, J. Wickert³, L. Zenner²



- (1) DLR-IMF, Oberpfaffenhofen, Germany
- (2) TU-IAPG, München, Germany
- (3) GFZ, Potsdam, Germany

Introduction

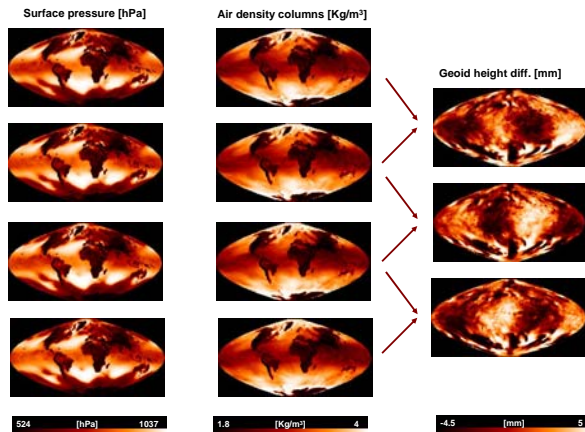
The actual gravity field of the Earth depends, apart from several other factors, also on the local and time-dependent mass distribution of the atmosphere. To this end, we analyzed the typical characteristics of surface pressure data provided by the European Centre for Medium-Range Weather Forecasts and assessed their influence on the results currently obtained by GRACE (we did not consider oceanic and ground compensation effects).

Typical Diurnal Cycle Effects

ECMWF surface pressure data allow us to analyze diurnal effects every 6 hours. Typical results mapped on an Earth lat/lon grid are shown in the left column below. One can see high and low pressure zones.

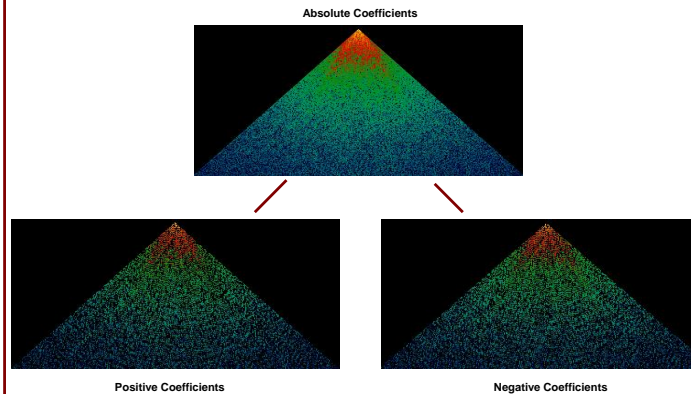
After transformation into air density columns, one can clearly discriminate the ice surfaces of the South Pole and Greenland.

Air density column differences can then be displayed as 6 hour geoid height differences with a typical range of -5 to +5 mm. One can clearly recognize the diurnal cycle in the tropical belt (the data refer to the same Universal Time). In addition, one can also get an impression of the circumpolar circulation near the South Pole.



Top to bottom: 6h intervals on June 27-2008 at 0h, 6h, 12h, and 18h UT.

When we transform the geoid height differences into the typical geodetic harmonic order/degree representation (logarithmically scaled), one can either display the absolute coefficients, or positive and negative coefficients separately (see below).



The most remarkable result is that 6 hour differences contain visible ray structures superimposed on the usual coefficient falloff.

Typical Daily Effects

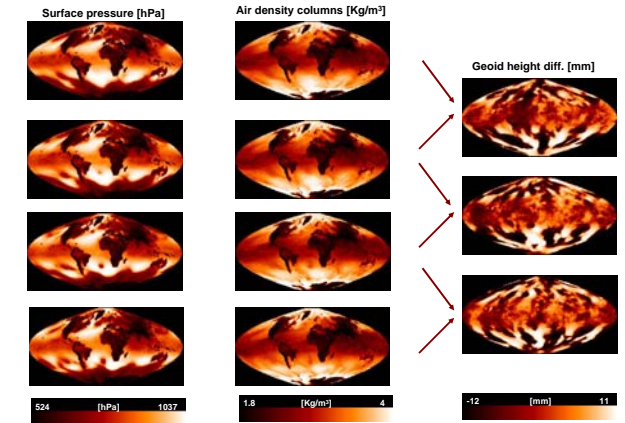
ECMWF surface pressure data also allow us to analyze daily effects occurring every 24 hours. Typical results are shown in the next Figure. One can see the global atmospheric circulation.

Again, after transformation into air density columns, one can clearly recognize the ice surfaces of the South Pole and Greenland.

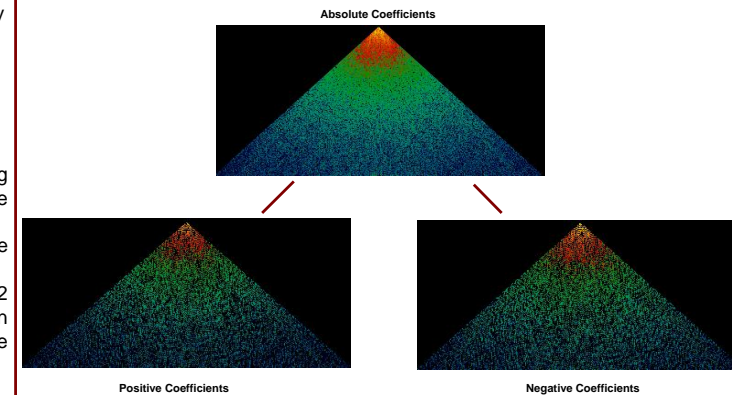
The 24 hour geoid height differences have now a typical range of -12 to +12 mm, much more than the 6 hour differences. Now, the circumpolar circulation near the South Pole becomes the most prominent effect. Moreover, the circulation near the North Pole is also clearly visible.

When we transform the 24 hour geoid height differences into the harmonic order/degree representation (logarithmically scaled), we see a symmetrical falloff of the coefficient magnitudes that simply depends on the distance from the (0,0) component. The local ray structure seen in the 6 hour differences have completely disappeared.

This opens the way towards the data analysis in the transform domain.



Top to bottom: 24h intervals on June 27.28.29.30-2008 at 0h UT..



References

- <http://www.massentransporte.de>
- <http://tau.fesg.tu-muenchen.de/~iapg/web/index.php>
- http://www.gfz-potsdam.de/pb1/pg3/index_S13d.html
- <http://www.dlr.de/cai/desktopdefault.aspx/tabid-2537>