Characterization of Atmospheric Data Quality for an Improved Determination of Earth Gravity Fields

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Introduction

Highly accurate satellite gravimetry requires a correct modelling of the atmospheric mass including its temporal and spatial variability as well its vertical structure [1]. Basic atmospheric input parameters used during the GRACE data processing are taken from meteorological data sets such as ECMWF or NCEP products. They are spatially resolved and time-tagged maps of surface pressure, temperature profiles and specific humidity. These are state-of-the art assimilation results combining various measurements and simulations. They include their assumed uncertainties (i.e. their estimated standard deviations) that have physical impact on the gravity field determination.

In order to understand the propagated gravity field uncertainties and to improve the gravity field determination, we studied and described the atmospheric error bars with respect to their spatial and temporal variations and their different behaviour.

Current Approach and Future Approach

Current determinations of atmospheric geoid heights are based on face value atmospheric data (see Fig. 1a); in future, error bars will be included [2], [3] (see Fig. 1b).

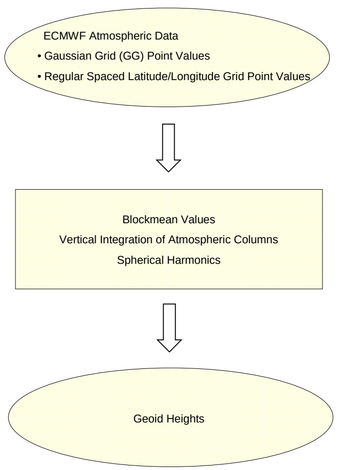

Fig. 1a

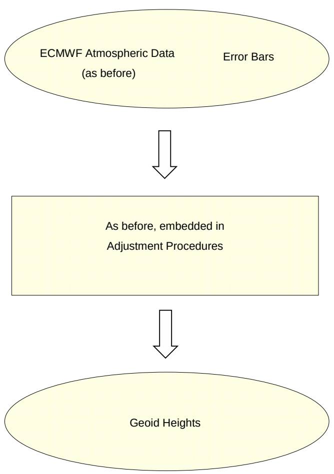

Fig. 1b

Analysis of Sensitivities

Sensitivity calculations of atmospheric parameters show that the vertical integration of atmospheric columns depends mainly on surface pressure. Temperature, specific humidity and geopotential heights are less critical.

Therefore, we concentrate on the impact of surface pressure errors.

Analysis of Surface Pressure Errors

The analysis of different surface pressure effects calls for a flexible tool to determine their impact. We set up a simulation environment for the analysis and verification of surface pressure effects [4].

As can be seen in Fig. 2, the simulator tool consists of a processing part under the control of Monte Carlo simulator and an analysis/manipulation part permitting the interactive manipulation of surface pressure errors. In particular, it allows the modification of single estimates, bias and random terms, sinusoidal components, geographically confined data as well as time-dependent and multi-scale effects (trends, etc.).

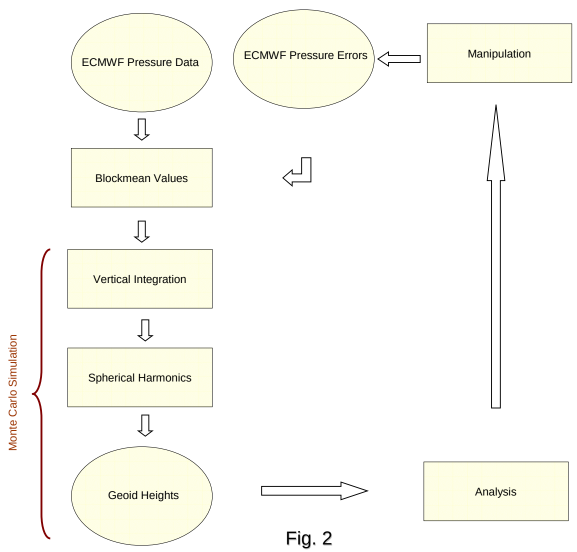

Fig. 2

ECMWF Pressure and Standard Deviations

Our analysis started with typical ECMWF pressure and standard deviations data. As shown in Fig. 3, surface pressure histograms are affected by elevated mountains that result in lower surface pressure values. In contrast, histograms of estimated pressure standard deviations show an opposite asymmetry caused by positive outliers (see Fig.4).

Fig. 5 illustrates the diurnal cycle during one month of tropical surface pressure near the equator and the zero meridian. One can see pronounced minima each 24 hours at 18:00 local time. At a first glance, this behaviour is not visible in the corresponding standard deviation data (see Fig. 6). As a consequence, our analysis has to investigate more intricate effects.

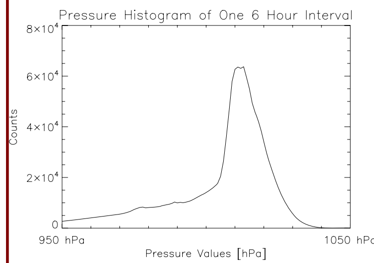

Fig. 3

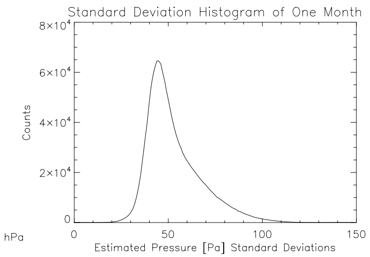

Fig. 4

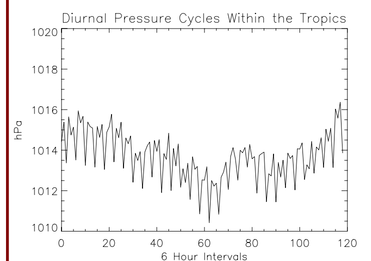

Fig. 5

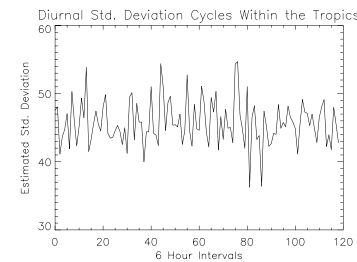

Fig. 6

References

[1] http://www.massentransporte.de

[2] http://tau.fesg.tu-muenchen.de/~iapg/web/index.php

[3] http://www.gfz-potsdam.de/pb1/pg3/index_S13d.html

[4] http://www.dlr.de/caf/desktopdefault.aspx/tabid-2537