GPS Ground Station Data for CHAMP Radio Occultation Measurements

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Summary

Several aspects of using GPS ground station data for the realization of the CHAMP Atmospheric Profiling experiment are discussed. First, the profiling activities at GFZ Potsdam are shortly described. Results of simulation runs of the CHAMP occultation experiments using the JPL & GFZ network configurations to study the relationship between network topology and attainable global coverage of occultation events are discussed. Latency aspects are studied in view of the challenging future task of providing atmospheric occultation data for operational weather forecast. Furthermore, 1 Hz data of Dunedin GPS ground station of May 2, 2000 are used to investigate a possible reduction of the required data rate for occultation data as a result of the termination of SA.

1 Introduction

The German CHAMP satellite is due for launch on July 15, 2000. CHAMP is a geoscientific mission for the determination of the Earth's gravity and magnetic field and for GPS-based atmospheric sounding (Reigber et al., 2000).

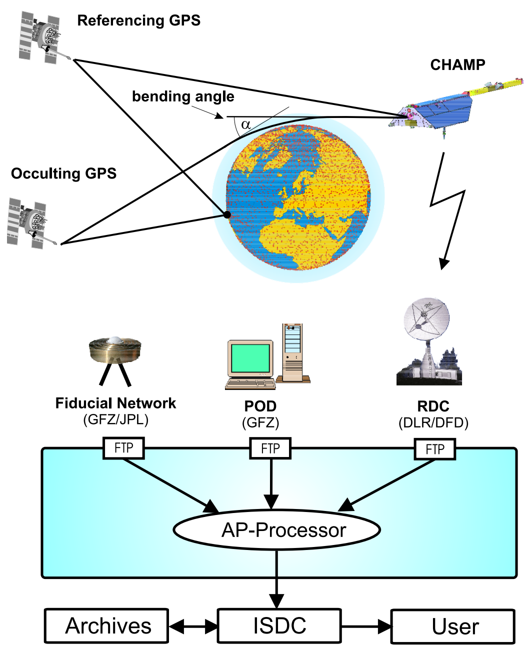

Fig. 1: Infrastructure for Atmospheric Profiling with CHAMP

In preparation of CHAMP's Atmospheric Profiling experiment the infrastructure for the derivation of globally distributed vertical atmospheric profiles was established. The main components of this infrastructure are sketched in Fig. 1.

The key elements are: the BlackJack GPS receiver onboard the CHAMP satellite (provided by JPL), the downlink station including the Raw Data Center (RDC), the fiducial GPS ground network, the Precise Orbit Determination (POD) facility, the occultation processing system (AIP Processor) and the archiving and distribution System, ISDC. All components, except the Raw Data Center (operated by DLR), will be maintained by GFZ Potsdam.

This contribution will focus to aspects for establishing and running the fiducial GPS network for the CHAMP GPS radiooccultation experiment, which is used for applying double differencing technique for the correction of satellite clock errors (Fig. 1). That is, the precise phase measurements of the onboard GPS receiver of the main (occulting) and referencing GPS satellite have to be differenced with those from a ground receiver.

2 Global coverage of the occultation events

In order to create double differences, appropriate geometry between CHAMP, the ground station and the GPS satellites is required. To investigate this and to get information about the redundancy of ground station measurements for the occultation processing, a simulation study was performed, using the actual configuration (June 2000) of the established JPL & GFZ "High Rate & Low Latency" networks. As an example, Fig. 2 shows a simulation result for the joint JPL & GFZ network. The calculations indicate, that the joint network enables the processing of globally distributed occultation events complying with the CHAMP mission requirements.

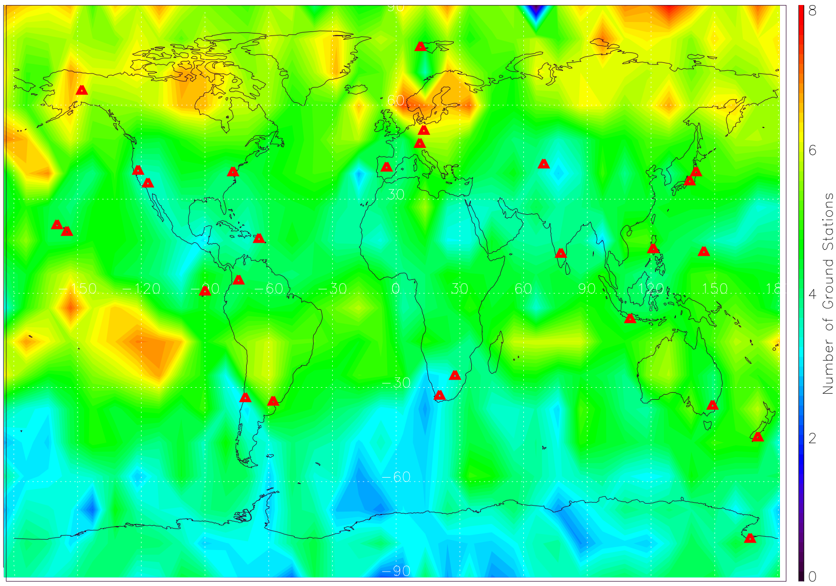

Fig. 2: JPL & GFZ ground stations available for double differencing

3 Operational aspects

Simulations using variational data assimilation techniques by NCAR and ECMWF (Eyre, 1994; Zou, 1999) have shown that profiles of bending angles from radio occultation experiments can strongly support climate and numerical weather predictions (NWP) analyses.

The impact of a single satellite occultation mission such as CHAMP on weather predicition is however limited by the low density of occultations in space and time. But in near future, systems such as COSMIC and Metop with a few thousand of occultations per day (Yunck et al., 1999) will meet operational requirements of meteorological services. Nevertheless, with a single satellite mission such as CHAMP very important first experiences are obtained in collecting and processing of radio occultation data under pre-operational conditions.

The operational meteorology tolerates a maximum time delay between measurement and available atmospheric information of 3 hours (Wergen, 2000). The interplay of the various components of the GPS occultation infrastructure (Fig. 1) and its consequences for providing of GPS ground data are discussed.

4 Data rate of the fiducial network measurements

The supporting network for the GPS/MET experiment provided high rate 1 Hz phase data to perform double differencing with the satellite measurements (Rocken et al., 1997). High data rate was required for elimination of the effect of Selective Availability (SA). SA was terminated on May 2, 2000 about 04:00 UTC. The possible reduction of the required GPS data rate for GPS clock interpolation was investigated by using ground data of the GFZ high rate (1 Hz) station Dunedin on 02/05/00. It is shown, that a data rate reduction might be possible.

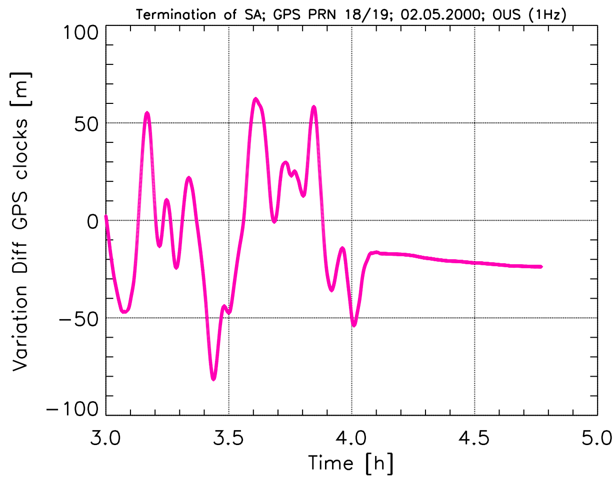

Fig. 4 Variation of GPS clocks during termination of SA (02/05/00)

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