Experiments of GPS slant path data assimilation with an advanced MM5 4DVAR system

FLORIAN ZUS¹*, JENS WICKERT¹, HANS STEFAN BAUER², THOMAS SCHWITALLA ² and VOLKER WULFMeyer²

¹Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Potsdam, Germany
²University Hohenheim, IPM Institute for Physics and Meteorology, Stuttgart, Germany

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Abstract

In a previous study the authors developed and optimized tools for 4-dimensional variational assimilation (4DVAR) of Global Positioning System (GPS) ground-based Slant Total Delay (STD) data in the framework of the Mesoscale Model 5 (MM5) system. In this study, advantage is taken from the parallel implementation of 4DVAR and the availability of STD data processed at the Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ), providing data for a large and continuously operating network of ground-based receivers in Germany. The results of two long-term assimilation experiments are presented. The first assimilation experiment, performed over a period of two weeks (1–14 August 2007), shows that the impact in STD observation space of an independent network of GPS receivers is positive. After the assimilation window the impact is decreasing with time, lasting in average for 12 h. The second assimilation experiment, performed over a period of one month (1–31 August 2007), indicates that the impact on the precipitation forecast is weak but positive.

Zusammenfassung


1 Introduction

Recent results in shortrange weather forecasting indicate that variational data assimilation is a promising approach for improving the quality of Quantitative Precipitation Forecasting (QPF) (ZOU et al., 1995; VEDEl and HUANG, 2004; XIAO et al., 2005; BAUER et al., 2011). The availability of continuous observations related to water vapor is crucial. Observations derived from measurements of ground-based Global Positioning System (GPS) receivers, assembled into dense networks, potentially close data gaps in the existing observation network. One distinct advantage compared to other satellite observations is that data is provided in all weather conditions, i.e. the measurements are not affected by clouds. As water vapor is often under-observed both in time and space during active weather, this capability of the GPS data is expected to improve the skill of short range predictions of medium to heavy rainfall systems. The first application of ground-based GPS meteorology involved the measurement of Integrated Water Vapor (IWV) in the atmosphere above ground-based receivers (BEVIS et al., 1994). To date, most of the ground-based data assimilation studies have been conducted using Zenith Total Delays (ZTD). It was found that their assimilation has a weak, but mainly positive impact on the NWP forecasts of precipitation (VEDEL and HUANG, 2004; POLI et al., 2007).

Processing techniques were developed to determine Slant Total Delays (STD), i.e. phase delays between ground-based receivers and each of a number of satellites in view (ALBER et al., 2000; BRAUN et al., 2001). Compared with ZTDs, STDs potentially contain azimuthally asymmetric (ERESMAA et al., 2007) and vertical profile information (SOKOLOVSKII et al., 2001; LOWRY et al., 2002). It may be possible to recover a significant amount of information about the 3D structure of the atmosphere from STDs. However, partly due to a number of unsolved questions concerning processing of STDs and possibly due to the complexity con-