Session 4
Atmosphere and GPS Meterology

04-01

GASP - "GPS Atmosphere Sounding" Project in Germany

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ABSTRACT

GFZ has started together with three other large research centers of the German Helmholtz Association the "GPS Atmosphere Sounding" Project (GASP) using ground-based (Subproject 1) and space-based (Subproject 2) GPS observations for applications in numerical weather prediction, climate research and space weather monitoring.

Operational precision determination of water vapor in near real-time within dense German GPS network (~ 70 sites) is being carried out since May 2000 and has demonstrated an accuracy of better than 2 mm with a standard deviation at the level of better than +- 1 mm. The results are validated regularly with the local weather model LM1 of German Weather Service. Assimilation studies are in preparation.

Space-based GPS sounding of the atmosphere and ionosphere is entering a new era with the German CHAMP satellite: CHAMP is the first mission aiming at the quasi-continuous monitoring of the atmosphere with GPS. Launched last summer, the satellite has only recently delivered its first set of atmospheric data. Once in full operation, CHAMP will deliver about 200-250 daily vertical profiles of temperature, tropospheric humidity and ionospheric electron content. Some first results and intercomparisons will be presented.

04-02

Overview on Ground and Space Based GPS/Met and the Applications

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ABSTRACT

An updated summary of ground and space based GPS/Met, including the accomplishment in recent years, current development, and the future direction. The strength and weakness of different techniques, the limitations of various implementation schemes, and the requirements for major applications will be discussed.

04-03

Controls of the Sounding Points in Space-based GPS/LEO Meteorology

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ABSTRACT

GPS radio occultation technique was developed from the application of remote sensing technique in planet atmospheric limb sounding pioneered by JPL and Stanford University in 1960s. Since the launch of the experimental satellite MicroLab1 on Apr. 3, 1995, the primary results from this LEO satellite had proved potential scientific values and practical significance of this innovation in GPS meteorology. For MicroLab1, the sounding locations on the Earth's surface were globally pseudo-randomly distributed, that is good for data assimilation in atmospheric and ionospheric research. As another strategy, as similar to mountain-based or airborne GPS receiver, sequential occultation footprints falling within adjacent regions of some specific points on the Earth's surface are expected in the following possible cases: comparing and cross-calibrating radio occultation data with other techniques, such as ground-based GPS, radiosonde and lindar; continuous monitoring local atmospheric refractivity field and local hazard weather within a specific time period. In this paper, we discussed a possibility to get sequential atmospheric profiles near a specific ground location by optimally designing LEO satellite orbit. This may has potential benefits in applications of GPS/LEO occultation technique in atmospheric science, numerical weather prediction, and the monitoring of hazard weather and atmospheric refractivity field, and data assimilation. Such an orbit design of LEO satellite may influence the regulation of the future GPS launch plan, and may include proposal of new generation of LEO satellite with propulsion.

04-04

Error Analysis in the Estimation of Precipitable Water Vapor Using Ground-Based GPS Data

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ABSTRACT

The accurate Precipitable Water Vapor (PWV) information is beneficial for the weather prediction and geodynamic research, but several error sources limit the accuracy of PWV estimation. In this study, three error sources, namely as lateral water vapor effect, model error of dry tropospheric delay and mapping error from wet zenith delay to PWV, are addressed and analyzed. The results have demonstrated that lateral water vapor effect induced more than 2 mm PWV error in severe weather. The model of dry zenith delay exhibits a systematic error. It will indirectly contribute 2-3 mm equivalent PWV error if this systematic model error cannot be corrected efficiently. The weighted mean tropospheric temperature dominates the conversion between wet zenith delay and PWV. This local and temporal parameter will cause 1 mm PWV error if its inaccuracy is larger than 3 K. This also shows the fact that the weighted mean temperature should be determined by the regional meteorological data.

04-05

Earth Rotation and Activities of Atmosphere and Ocean

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ABSTRACT

The rotation of the Earth, including the variation of the rotational rate and polar motion, represents the statement of the Earth's overall movement and interactions among the solid Earth, atmosphere and ocean on a variety of space-time scales. They make the Earth's complex dynamical system under the conservation of angular momentum. The present report introduces some of our research works on the Earth rotation and the activities of atmosphere and ocean and prospect future theoretical investigations.

04-06

To Estimate The Regional Ionospheric TEC Model From GEONET Observation

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ABSTRACT

Dual frequency phase observations of Global Positioning System (GPS) prove a possibility to detect the total election content (TEC) perturbations with high precision above a super-dense network of GPS receivers. A method is discussed to estimate a regional TEC distributions above the Japan Islands, with the observation data obtained by the GPS Earth Observation Network (GEONET), which is belong to the Geographical Survey Institute (GSI) of Japan. By using the GPS phase observations of GEONET during the Summer of 1999, daily TEC distribution maps of high resolution and high precision have been obtained. It has been compared with the global TEC model published by IGS.

04-07

Assimilation of Ionospheric Occulted Data by Artificial Neural Network

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ABTRACT

Artificial Neural network (ANN) enjoys an increasing popularity in space physics. As ANN is universal approximations, this tool can approximate any continuous function with an arbitrary precision. Hence, they may yield important contributions to finding solutions to a large variety of space physical applications.

In this paper, the power of ANN will be embodied in assimilation of GPS occulted ionospheric data. It's well known that GPS occulted data are a huge amount and global distributing, which is advantaged in sounding the ionosphere. How to take full advantage of the data is an important issue in the ionospheric monitoring and the ionospheric forecasting applications. This paper started with a short introduction to one type of the feed−forward ANN with full connected (Fig1) and explains their general way of working. Next, a strategy is described to deal with occulted data problems, especially the check of occulted data, the select of input neurons, the generalization of input physical parameters, the determination of the exact numbers of hidden neurons, the technique of fasting training, and so on. Finally, this method is illustrated on a series real data example, which is based on the GPS/MET occulted data provided by UCAR on 24th, May 1996. Random choosing data from the full-day data trained the ANN, and using the well-trained ANN assimilates the residual data. Comparison between the observed data with the calculated data showed that they are quite in agreement (Fig2), some discussion will be given in details.

We are grateful to UCAR for providing GPS/MET data for this study.

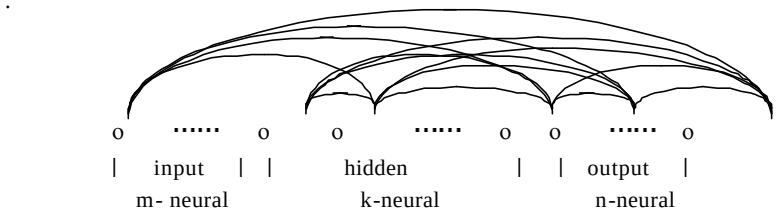

Fig1. The ANN with full connection

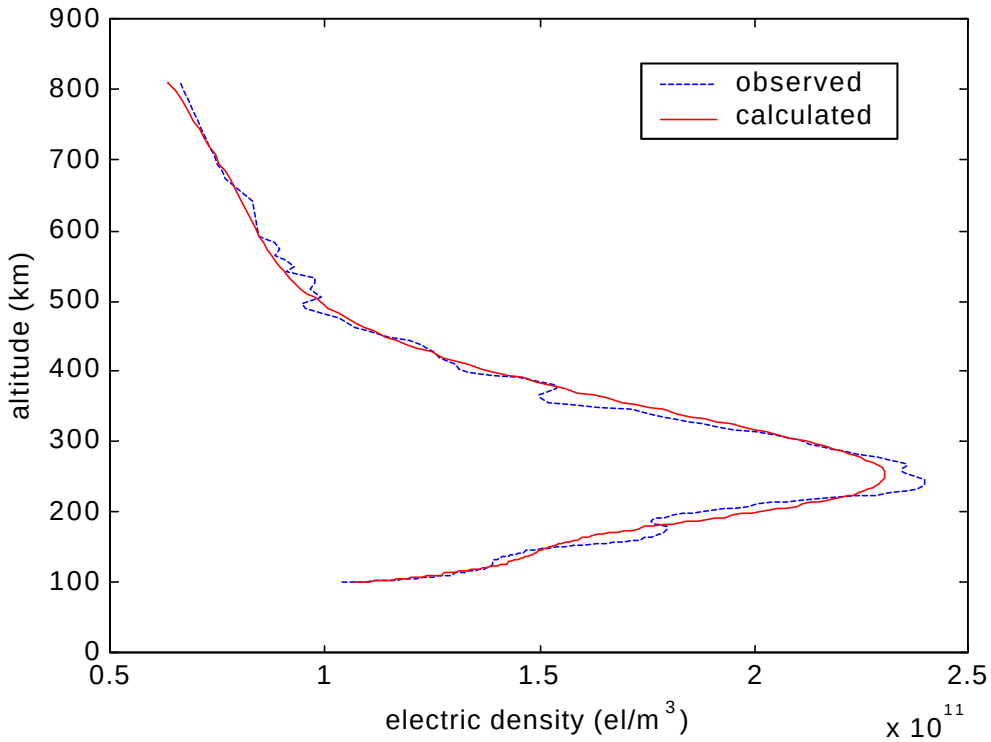

Fig2. The preliminary results of assimilation by ANN