

Weather and Climate Research in Taiwan: Potential Application of GPS/MET Data

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ABSTRACT

Meteorological research in Taiwan mainly includes the East Asian climate, the heavy rainfall system (Mei-Yu front) and the typhoon research. In addition to these research components, an operational center on numerical weather prediction is actively run at the Central Weather Bureau. There are strong collaborations between Taiwan and the international meteorology communities. The COSMIC program in Taiwan is a new Taiwan-U.S. joint program designed to launch eight low-earth-orbiting satellites in 2004 for GPS/MET soundings.

Accurate profiles of temperature and water vapor in the troposphere are essential for the meteorological research in Taiwan. Low-level moisture convergence is important for the maintenance of the monsoon system. Moisture convergence also plays an important role in the formation and maintenance of the heavy rainfall events in the Mei-Yu frontal system. For an accurate typhoon track and intensity prediction, an accurate analysis of atmospheric flow field as well as an accurate representation of heating profile in the typhoon model is required. This means better data on the wind, the temperature and, in particular, the moisture field are needed for improved research. With the potential for providing temperature and moisture information at high vertical resolution, the GPS/MET technique may make a significant contribution to meteorological studies in Taiwan.

The GPS/MET soundings available from COSMIC provide an excellent opportunity for meteorological research in Taiwan. Preparation work has to be done in Taiwan to take a full advantage of GPS/MET data associated with the launching of COSMIC. A powerful computing facility is required to meet the time constraint for the operational data assimilation in numerical weather prediction (NWP). Procedures for the reception, distribution and archiving of the GPS/MET data, the procedures for quality control of the data flow, as well as the 3D and 4D-variational data assimilation

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systems for assimilation of GPS/MET data on both regional and global scales, need to be developed at the Central Weather Bureau. The assimilation schemes should also incorporate the GPS/MET data with other types of remote sensing observations, as well as other conventional observations. The observational and background error covariances need to be developed. It is also important to assess the impact of GPS/MET data on the NWP and to demonstrate the added value relative to other data sets. Carefully designed assimilation experiments need to be performed to verify the usefulness of GPS/MET soundings. It is intriguing to conduct a field experiment during the Mei-Yu or typhoon season to validate the GPS/MET soundings during the initial in-orbit operations of COSMIC. Finally, it is crucial to set up a well-equipped COSMIC data center in Taiwan.

(Key words: COSMIC, GPS/MET, East Asian climate, Heavy rainfall system, Typhoon, 3DVAR, and 4DVAR)

1. INTRODUCTION

COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate) is a collaborative U.S.-Taiwan science experiment to demonstrate the utility of atmospheric limb soundings from a constellation of low-earth orbiting (LEO) satellites in operational weather prediction, space weather monitoring, and climate monitoring and research. This project is jointly undertaken by the National Space Program Office (NSPO) in Taiwan and the University Corporation for Atmospheric Research (UCAR) in the U.S., in collaboration with the Jet Propulsion Laboratory (JPL), and with the participation of many governmental, academic and private institutions in both Taiwan and the U.S.

As shown in Kuo et al. (1998), the scientific and operational goals of COSMIC are to (a) improve global and regional weather forecasting; (b) improve global space weather monitoring and forecasting; (c) provide datasets for climate and global change research; and (d) advance earth gravity field knowledge. In order to reach these ambitious goals, the scientific requirements and milestones need to be defined and specified in greater detail. To maximize the benefit of COSMIC to meteorological studies in Taiwan, the potential use of the GPS/MET data has to be carefully examined, and preparation work has to be done before the actual launching of the COSMIC satellites.

Meteorological research in Taiwan mainly includes the heavy rainfall system during the Mei-Yu season (typically in May and June), the typhoon, and the East Asian climate research. Typhoons and heavy rainfall systems are the most serious and threatening weather events among all natural disasters in Taiwan. Because of the lack of data over the vast Pacific ocean and the strong interaction between the typhoon circulation and the rainfall system with the mesoscale Central Mountain Range (CMR), making good forecasts of these systems in the vicinity of Taiwan is highly challenging.

On the other hand, as Taiwan is situated at the boundary of the Eurasian continent and the