F3/C GPS Radio Occultation: A New Data Source of Pressure Field for Space Geodesy in Antarctica

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Abstract

Most modern, high-precision geodetic measurements of time variable processes can benefit from accurate knowledge of atmospheric pressure. For example, precise space-based positioning methods (e.g., Global Positioning System GPS, very long baseline interferometry, satellite laser ranging, and sea surface altimetric height) require estimates of surface pressure and temperature to model the air contribution to the signal delay. Radio occultation technique, first demonstrated by the GPS/MET experiment in 1995, can provide improved spatial and temporal resolutions in the pressure, temperature and water vapor profile observations for the neutral atmosphere, in addition to traditional ground-based measurements. Traditionally, Numerical Weather Prediction (NWP) models provide spatially uniform coverage and internally consistent datasets to cover the globe based on unevenly distributed meteorological observations, for example those from ECMWF, NCEP, and JMA. We here quantify the current errors in using these modeled pressure fields for the computing of atmospheric mass load over Antarctica, the removal of which is necessary for its separation from climate sensitive signals (such as hydrology, mass balance and oceanic mass variations) observed by the gravity mapping satellite GRACE. The pressure errors and uncertainties embedded in NWP models thus degrade the GRACE recovered gravity change. The anticipated pressure error should be under 1 hPa, whereas the examination of the uncertainties found that the discrepancy can be as large as 6-8 hPa around the Southern Ocean and Antarctic regions on daily and monthly time scale. FormoSat-3/COSMIC (F-3/C) was successfully launched into an orbit of 72° inclination in April of 2006, and it contributes an unprecedented spatial coverage per day (Fig.1 & 2) especially in polar regions. Using F3/C data we can assess and help eliminate atmospheric pressure aliasing from time-variable gravity data leading to more accurate estimation of sea level, ice sheet, and climate change in Antarctic region.

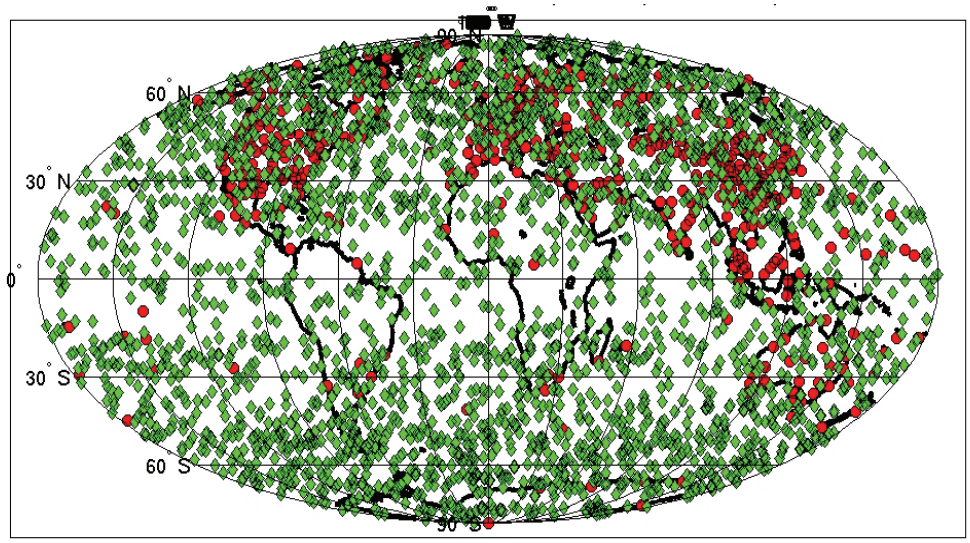

Fig. 1. The distribution of the ~2500 data points obtained in one day by F3/C (green dots, each representing a vertical profile of the certain ionospheric and atmospheric parameters derived from the refractivity), compared to the daily radiosonde balloons from the (unevenly distributed) Automatic Weather Stations (red dots).

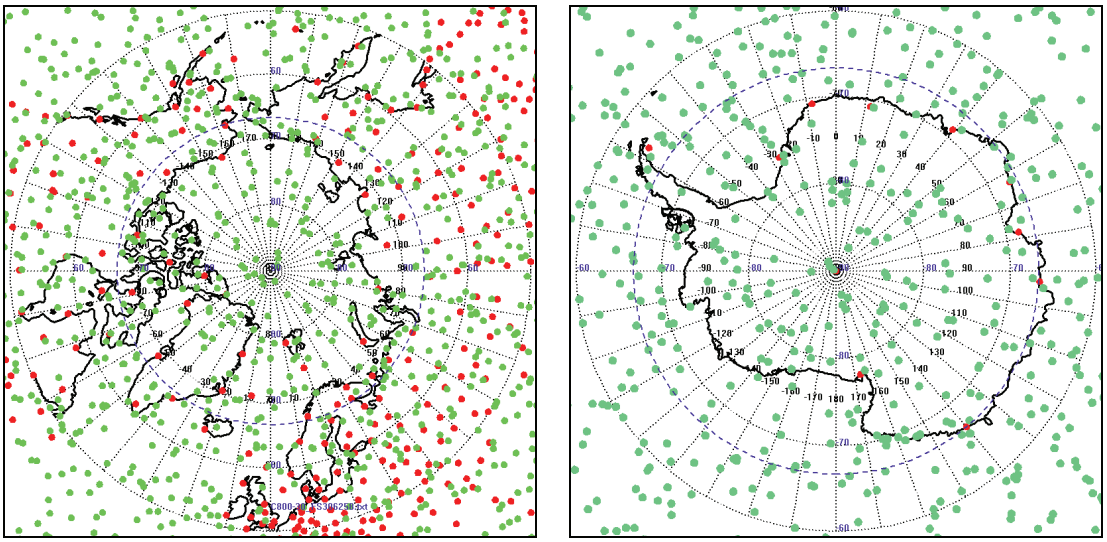

Fig. 2. Same as Fig.1, but only for the polar regions polewards of 60° latitudes.