Application of precise satellite positioning for monitoring the Earth's environment

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The global warming occurred in the latter half of twentieth century significantly affect on the global atmospheric circulation and the water cycling, which changed the climate, water resources and vegetation environment. It is also recognized that it causes the sea level rise resulting from the sea surface temperature rising and the polar ice sheet melting. It is required to develop a stable long-term satellite observation system of the Earth's environment in order to understand these effects quantitatively. A main aim of our project is to develop a calibration free satellite measurement system for monitoring the Earth's environmental changes related to global warming, water cycling and space weather. We are studying the application of the precise satellite positioning for monitoring Earth's environment by means of two major techniques; (1) GPS occultation and (2) satellite gravity missions. The first technique measures profiles of water vapor, temperature and electron density by analyzing propagation characteristics of GPS radio signals in the atmosphere and ionosphere, while, the latter technique provides detailed spatial and temporal variations of the gravity field of the Earth, from which distribution of groundwater and deep ocean current will be determined. We now aim at conducting a down-looking GPS occultation experiment from an airplane. We also propose a GPS occultation experiment from a LEO satellite as one of 6 PI's of the Equatorial Atmosphere Research Satellite (EQUARS) on board, in the collaboration with the Brazilian space agency (INPE). Data analysis system for these occultation experiments is developed. Then, the system for data assimilation to a numerical weather prediction model with global (3D-var) and regional (4D-var) scales is studied by the Japan Meteorological Agency (JMA) and the Meteorological Research Institute (MRI), respectively. For future satellite gravity missions we also study basic techniques, such as a precise orbit determination (POD) software, satellite-to-satellite (laser) interferometry (SSI) and an accelerometer by applying a laser interferometer. Then, a basic design for a future Japanese mission will be discussed. This project has been approved as one of the projects on 'Challenge to Leading Edge of Science and Technology' during 2002-2004. We introduce current status of this project.