

THE TIME-VARIABLE GRAVITATIONAL EFFECTS OF SNOW AND SOIL MOISTURE ON THE ORBITS OF THE GLOBAL POSITIONING SYSTEM SATELLITES

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For over a decade, laser-ranging satellites, notably LAGEOS I and II, have been used to study variations in the low-degree terms of the Earth's gravitational field. The primary non-tidal source of these variations is the redistribution of the mass contained in the Earth's atmosphere, oceans, and continental hydrology. In an earlier study, USNO presented an independent detection of these variations using four years of Global Positioning System (GPS) satellite orbits from the International GPS service. This detection was based on comparisons of observed Earth-referenced positions for the GPS satellites with orbit planes predicted in Earth-centered inertial coordinates. The difference between a GPS UT1-like quantity (UTGPS) and UTC represents the net nodal drift of the GPS constellation and contains both changes in the difference UT1 - UTC and effects from zonal variations in the Earth's gravitational field. Results indicated that J_2 variations at monthly to annual time scales predicted by the National Centers for Environmental Prediction (NCEP) atmosphere model are, in fact, significantly correlated with variations in UTGPS - UT1, and the contributions of the oceans and continental hydrology are not negligible. This paper will more closely investigate the effects of the snow and soil moisture on the motion of the GPS satellite orbits, using NCEP Reanalysis daily values of snow and soil moisture data, in comparison with its atmospheric water content and flux variations.