1077-86-1504 **Peiliang Xu*** (pxu@rcep.dpri.kyoto-u.ac.jp), Disaster Prevention Research Institute, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan. *Mathematical challenges arising from earth-space observation: mixed integer linear model, measurement-based perturbation theory and data assimilation for ill-posed problems.*

Earth-space observation has not only revolutionized the way we observe the Earth but also presented a unique opportunity for mathematical challenges. We focus on three of such challenges. The first is about mixed integer linear models, which arise from precise GNSS positioning. The unknowns are real-valued and integer. We review approximate and exact numerical solutions, the representation of the integer least squares estimator, probabilistic bounds and two hypothesis testings on integers. The second is to precisely recover the Earth's gravity field from continuous and high precision space data. Conventional perturbation is based on a reference orbit to linearize measurements and has to divide a long arc into small pieces. Thus one cannot recover small gravity signals from space measurements. We develop a measurement-based perturbation theory for recovering the Earth's gravity field, which is valid for an orbit of any length. The new model is able to recover small gravity signals from continuous and unprecedented precise measurements. Finally, we solve inverse ill-posed problems from many different sources of data. Assuming no prior weights, we let data speak for themselves and develop a biased-corrected variance component estimator to determine the weights of data. (Received September 20, 2011)