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Geodynamics and Earth Tides Observations from Global to Micro Scale: Introduction

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The volume collects papers submitted to Pure and Applied Geophysics following a call on the topic "Geodynamics and Earth Tides". Partly, the authors had participated in the 18th Geodynamics and Earth Tides Symposium held in Trieste, Italy, in June 2016. The Earth tides constitute the leading thread through the book, since instrumentation sensitive enough to observe them, also records a broad spectrum of signals generated by Earth dynamic processes.

The topics discussed belong to space geodesy, terrestrial geodesy, seismology, tectonophysics, hydrology, and geodynamics, demonstrating the interdisciplinarity needed for understanding the observations.

The deepest Earth is studied with the core resonance at diurnal periods, which alters expected amplitude and phase of the diurnal frequencies of the observed Earth tide. The phenomenon is described from observations at surface, allowing conclusions on the core to be taken (Agnew 2017; Bán et al. 2017). The Earth globe yields to the tidal forces through deformation, from which Earth rheology is retrieved (Varga et al. 2017), and which could be a cause of triggering earthquakes (Varga and Grafarend 2017).

The ocean tides produce a change of ocean height driven by the same frequencies of the Earth tides. The changing mass produces a variable load on the crust, which in turn responds isostatically by flexure. Observation of the oceanic load tides with sophisticated geodetic instruments (Ruotsalainen 2017; Virtanen and Raja-Halli 2017) allows to improve the ocean tide models (Amoruso et al. 2017). Even river estuaries can be subject to level variations that must be modeled to correct their effect on these precise instruments (Oreiro et al. 2017). The very sensitive instrumentation as tilt and strain meters and continuously recording gravity meters sense hydrologic flows. The modeling of the induced signals is a complex topic of its own (Weise and Jahr 2017), with applications in hydrology and induced seismicity (Grillo et al. 2018; Vinogradov et al. 2017). Continuous gravity has been made at the sea floor for monitoring a gas field, but many other signals must be taken into account (Rosat et al. 2017). The terrestrial measurements of the time-variable gravity field are analyzed to match the observed with the theoretical tidal gravity field (Yu et al. 2018), with surprising results for co-located instruments (Virtanen and Raja-Halli 2017). The cryogenic gravimeters have highest precision, and require particular attention for checking scale factors and instrumental drift (Crossley et al. 2018).

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Recent improvements in the development of VLBI (Very Long Baseline Interferometry) and other space geodetic techniques like the global navigation satellite systems (GNSS) require very precise a priori information of short-period Earth rotation variations. Within the work of Karbon et al. (2018), a new model for the short-period ocean tidal variations in Earth rotation is developed with up to 251 partial constituents, based on modern ocean tides models and a reexamined theoretical description. An alternative to the conventional models is found; however, no significant improvement in the geodetic results can be reached.

Space geodetic observations such as GNSS have the drawback of being less sensitive to deformation at local scale, compared to the sophisticated high precision gravity and deformation measurements, but have the advantage of easier installation, reaching dense and global coverage. The studies are concerned with identifying hydrologic and temperature effects, developing modern spatio-temporal analysis methods (Gruszczynski et al. 2018; Gruszczynska et al. 2018; Klos et al. 2017), or identifying non-hydrologic common GNSS transient signals (Rossi et al. 2017).

The deformation at an active volcano (Elbruz, Caucasus) (Milyukov et al. 2017) and for a big earthquake (Gorkha, Nepal) (Morsut et al. 2017), demonstrates the importance of geodetic monitoring in hazard assessment.

In parallel to the Topical Volume in Pure and Applied Geophysics, a special volume in the open access journal Geodesy and Geodynamics was arranged, in which all abstracts of the meeting are published, and some selected manuscripts. A review of the meeting (Braitenberg 2018) includes a description of today existing geodetic stations worldwide. Instrumental and software aspects of continuous measurement of gravity with the superconducting (Meurers 2017) and automated Burris gravity meter (Jentzsch et al. 2018; Schulz 2017) are discussed. Use of Kalman filter in GNSS network monitoring is demonstrated by (Shults and Annenkov 2017). The detection of pore pressure changes induced by hydrologic pumping is recorded with tilt and strain observations at the geodetic station Moxa (Germany) (Jahr 2017). Hydrology in karstic areas is dominated by hydrologic flows in a macroscopic channel system, which in the classical Karst (Italy–Slovenia) gives rise to deformations during floods and an impressive river emerging at the foot of the Karst (Braitenberg et al. 2017). Geodynamic thermomechanical modeling of the subduction of the central Andes is presented by (Salomon 2018), while (Hazrati-Kashi et al. 2018) study inversion methods to define slow slip during the preparing phase of a large-scale earthquake at subduction zones.

This volume provides a representative cross-section on the recording, analysis and interpretation of the spectrum of signals generated by Earth dynamic processes. The material is of interest to scientists and students interested in the 4D Earth and keen to learn the latest achievements.

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