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Title: Investigation of the influence of geophysical phenomena related to climate change on non-tidal length of day changes

Abstract

Changes in the length of day (LOD), which are the first derivative of the universal time UT1-UTC changes, is one of the Earth Orientation Parameters (EOP) together with the x, y pole coordinates and dX, dY corrections for the IAU2000 precession-nutation model. The time series of non-tidal changes in the length of day LODR (Length Of Day Residuals) arises after subtracting the model of tidal oscillations from the LOD time series. The EOP parameters, along with the conventional IAU2000 precession-nutation model, are used for transformation between the international terrestrial and celestial reference systems.

The aim of the work is to show the relationship between non-tidal changes in the length of day and time series related to solar activity and climate changes, with the use of time-frequency analyzes.

The study covered the time series of non-tidal changes in the length of day LODR determined on the basis of observations of satellite and space techniques, such as: GNSS (Global Navigation Satellite System), SLR (Satellite Laser Ranging), LLR (Lunar Laser Ranging), DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) and VLBI (Very Long Baseline radio Interferometry) as well as time series describing selected geophysical phenomena related to climate change (the axial component of the atmospheric angular momentum - $\chi 3$ AAM, AAO (Antarctic Oscillation), AO (Arctic Oscillation), Niño (12, 3, 4, 34), NAO (North Atlantic Oscillation Index), PNA (Pacific - North American Pattern) indices and SOI (Southern Oscillation Index) and solar activity: Kp (planetary K_p-index), Lα (Lyman Alpha Solar Index), R (Wolf number), SFI (Solar Flare Index), TAVG (Daily Land Average Temperature) and TSI (Total Solar Irradiance). The work uses time-frequency analyzes of time series, such as: Fourier transform band pass filter (FTBPF), in order to determine the time-frequency and frequency-dependent correlation coefficients between two time series, and the FTBPF+HT algorithm being a combination of this filter with Hilbert transform (HT) to determine the time-frequency and frequency-dependent correlation coefficients between changes in the oscillation amplitudes in two time series.

The study positively verified the research thesis: in the time series of non-tidal changes in the length of day (LODR) there are irregular broadband oscillations which are excited randomly by the exchange of the angular momentum of the Earth with the angular momentum of the atmosphere AAM for oscillations with periods from a few days up to approximately 2 years and the ENSO (El Niño Southern Oscillation) phenomenon for several-year oscillations. Determination of the time-varying amplitudes and phases of these oscillations by means of time-frequency analyzes in LODR, AAM and ENSO indices as well as other geophysical processes related to solar activity and changes in the Earth's climate allowed for their mutual comparison and identification of processes that may have an impact on changes in Earth rotational angular velocity.

The results obtained in the framework of this study are important in higher and satellite geodesy, mainly in the field of providing new information on explaining the causes of changes in the length of day, which in the future will help to develop more accurate algorithms for real-time transformation between the international terrestrial and celestial reference systems.

Keywords: LODR, FTBPFT, HT, geophysical phenomena, solar activity

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