The 60-year Cycle of Earth's Climate and the Eccentricity of Jupiter's Orbit

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Abstract

The 60-year cycle of eccentricity of Jupiter's orbit is shown to be closely related to the 60-year cycle of Earth's climate. Changes in Jupiter's orbit affect the Earth's rotation rate. The following phenomena have been shown to be related to these changes: the 1992 El Chicon eruption, the 1991 Pinatubo eruption, the occurrence of strong earthquakes in the period 1900–2022, the AMO index, low flows in the period 1920–2020 on the Punkva River in the Moravian Karst, precipitation extremes in the Czech Republic after 1995, the catastrophic floods of 2002 in Central Europe, and the unusually long drought of 2014–2019 in Central Europe.

Keywords: Climate cycles; Earth's rotation rate; Jupiter's orbital eccentricity

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1. Introduction

Many papers analysing climate change periods show (e.g., Schlesinger, Ramankutty 1994; Scafetta 2012, 2019) that a period of about 60 years is very significant in several climate parameters (AMO, PDO, global temperature, sea level, Palmer drought index, etc.), but also in a number of geophysical parameters (LOD, seismicity, volcanic activity). We therefore looked for the cause of this cyclical effect on the Earth.

2. Cyclical influences on climate and geophysical parameters

We have identified three physical mechanisms that cyclically influence climate and geophysical parameters. (Kalenda, Šír 2021; Šír et al. 2022):

(1) The gravitational influence of the planets in Solar System planets on solar activity (Mackey 2007).
(2) The transfer of the orbital rotational moments of all Solar System bodies to the spin rotational moment of the Earth, which affects the motion of the atmosphere, the ocean, and the solid Earth (Kalenda, Malek 2008). Jupiter, together with the Sun, plays a dominant role and has the greatest influence on the rotational momentum of the solar system bodies. The physical mechanism of the transfer of rotational moments from one body to another is described, for example, by Wilson et al. (2008) and Wilson (2013).
(3) The tidal action of Solar System bodies on atmosphere, ocean and solid Earth.

The gravitational influence of the planets of the Solar System on the activity of the Sun has the following periods:

(1) A dominant 11-year (22-year) period, generated mainly by the tidal action of the planets

(Mercur-Venus-Earth-Jupiter) on the Sun.

(2) The nearly 60-year impact period of Jupiter-Saturn relative to Uran-Neptun, which distinguishes a 60-year period of ordered and 120-year period of chaotic motion of the Sun around the barycenter of the Solar System in the José cycle of 178.9 years (Charvátová 1988; Mackey 2007).

(3) The 60–62-year long period of Jupiter's eccentricity.

(4) Common periods of all planets in the Solar System, including Plane Nine (Batygin, Brown 2021), which give rise to climatic periods of 89 years (Gleisberg period) and 6256.5 years (Xapos-Burke cycle).

The approximately 60-year period of solar activity is evident, for example, in all temperature series and subsequently in the series of global ocean level heights (Jevrejeva 2008). It is also manifested in auroras (Křivský, Pejml 1988; Scafetta 2012), which have nothing to do with the Earth's climate.

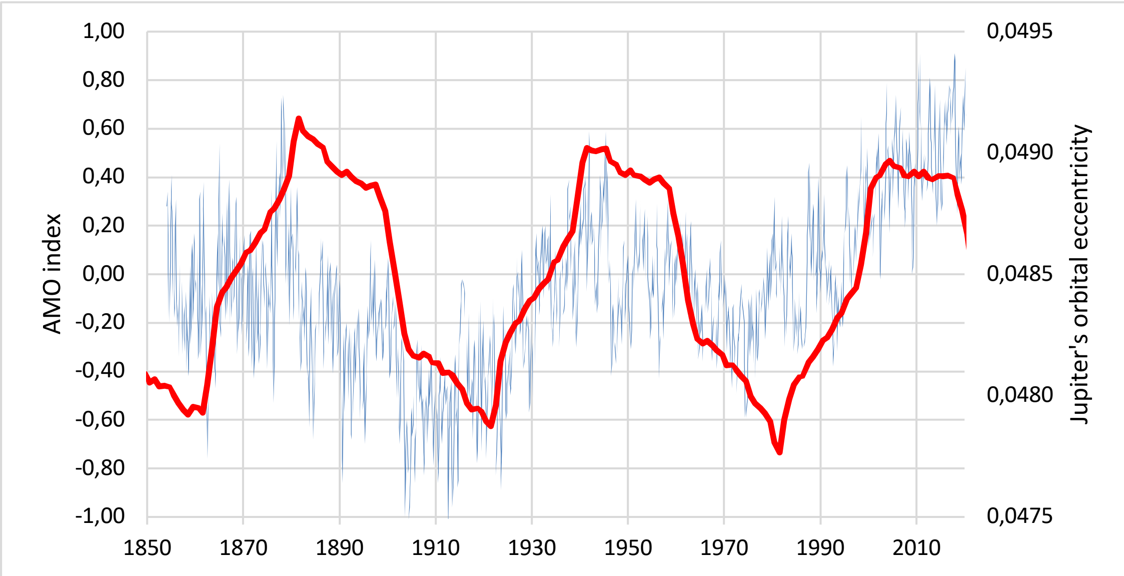

Figure 1: AMO index (blue) and the Jupiter's orbital eccentricity (red) during the period 1856–2023. Source: AMO [online], Jupiter's orbital eccentricity (Bretagnon, Francou 1988)

The transfer of Jupiter's orbital rotational momentum to the Earth's spin rotational momentum is influenced by the eccentricity of Jupiter's orbit (Bretagnon, Francou 1988). The latter is subject to changes that have two fundamental periods of about 900 years and 61 years:

(a) The approximately 900-year period is closely related to three warm climatic periods in the last 2000 years: the Roman climatic optimum of 250–400, the Medieval climatic optimum of 950–1250, and the current warm period after 1980. During the two historical warm periods, the greatest reduction in Jupiter's orbital eccentricity occurred while solar activity was high (Steinhilber 2009). In the current warm period, solar activity and Earth's climate have a similar pattern to the two previous warm periods.

(b) The 61-year period is represented by the climate index AMO (Atlantic Multidecadal Oscillation), which is defined by the water temperature in the North Atlantic (0°–70°N). Fig. 1 shows the AMO index and the Jupiter's orbital eccentricity during the period 1856–2023. It clearly shows that the evolution of the AMO index from 1980 to the present is no different from the previous evolution during the period 1856–1980. The course of the AMO index correlates well (even in phase) with the course of the evolution of the eccentricity of Jupiter's orbit, because the transfer of Jupiter's orbital momentum to the Earth's spin rotational momentum affects the motion of the atmosphere and ocean, and hence the temperature of the water in the North Atlantic. Consequently, the approximately 61-year cycle is very evident in the changes in the positions of pressure bodies in the atmosphere and the associated synoptic frequencies, precipitation intensities and river flow magnitudes in central Europe (Kalenda, Šír 2021; Kalenda et al. 2021; Šír et al. 2022).

3. Earth's rotation rate LOD as a key parameter

The influence of Jupiter on the spin rotation moment of the Earth is reflected in the deviation of ΔLOD from the Earth's standard rotation period 86,400 seconds (Length of Day). Fig. 2 shows that ΔLOD has a similar pattern to the eccentricity of Jupiter's orbit. The deviations of both quantities are caused by the gravitational effects of other bodies outside Jupiter, particularly the effect of Saturn. Many papers suggest that the Earth's rotation rate LOD is a key parameter that determines both climate and climate-independent geophysical parameter changes.

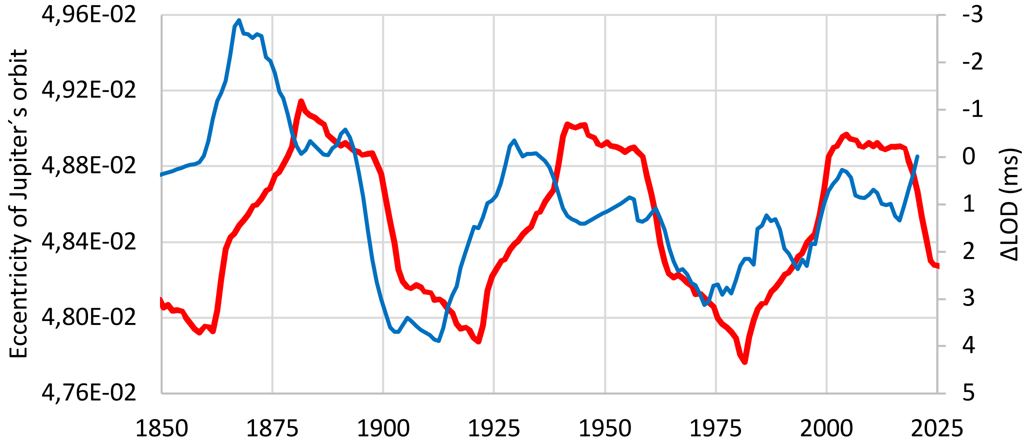

Figure 10: Jupiter's orbital eccentricity during the period 1856–2023 with a period of 60–63 years (red) and the deviation of ΔLOD from the Earth's standard rotation period 86,400 seconds with periods of 60–63 years and of about 10 years (blue). Source: IERS [online], Jupiter's orbital eccentricity (Bretagnon, Francou 1988)

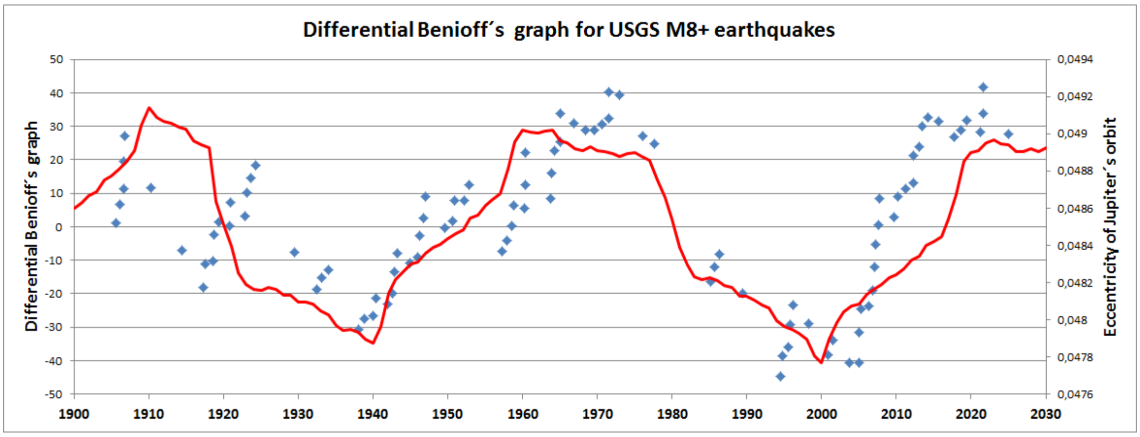

Figure 11: Differential Benioff's graph for M8+ events expressing the difference from the mean released seismic moment (blue), Jupiter's orbital eccentricity shifted by +18 years (red). Source: USGS [online], Jupiter's orbital eccentricity (Bretagnon, Francou 1988)

In the Fig. 2, large changes in LOD in about 60-year cycle and small changes in about 10-year cycle are clearly visible. Changes in LOD cause variations in the Coriolis force, which affects the rotation of the solid Earth, atmosphere and ocean currents. This is well observed in the frequency of earthquakes (Fig. 3) and volcanic eruptions. Changes in LOD result in weather and climate fluctuations, as shown at the scale of the Czech Republic by the course of the synoptic situations (Kalenda, Šír 2021), droughts (Fig. 4), floods (Fig. 5, Fig. 6), and on the scale of the whole Earth by AMO index (Fig. 1) and variations in global temperature (Schlesinger, Ramankutty 1994, Dickey et al. 2011, Mackey 2023).

There are two well-known cycles in the LOD and periodical global temperature changes (Mackey 2023):

1) 10-year cycle: Roughly every ten years, the Earth's rotation rate increases or decreases significantly by three to five milliseconds (Fig. 2). These decadal rotational variations likely arise from gravitationally driven electromagnetic coupling between inner and outer cores and the mantle. When the Earth's rotation rate increases over a ten-year period, the Earth is warming globally; when the rate decreases, the Earth is cooling globally. Global temperature changes some eight years after the Earth's rotation rate changes (Dickey et al. 2011). The most recent estimates of temperature changes accompanied by 10-year changes in the Earth's rotation rate are ± 0.8 ºC.
2) 60-year cycle: Cycles of global warming and cooling repeat approximately every 60 years. These 60-year cycles may be due to changes in the Earth's rotation rate caused by changes of Jupiter's orbital angular momentum, which is expressed by changes of its orbital eccentricity (Kalenda, Šír 2020).

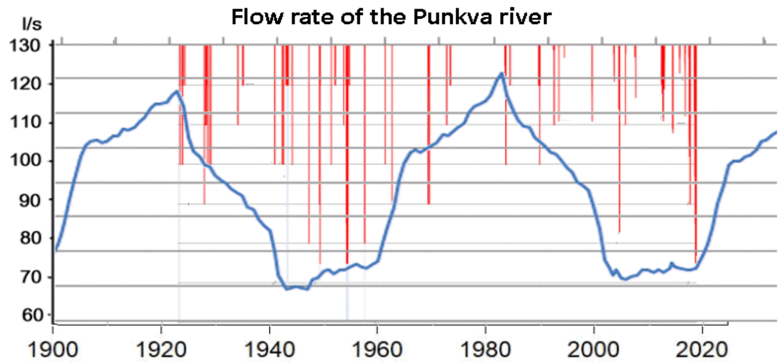

Figure 12: Observed extremely low flows of the Punkva River in the Moravian Karst in Czech Republic (red bars) and the eccentricity of Jupiter's orbit (blue). Source: Lejska et al. (2019), Jupiter's orbital eccentricity (Bretagnon, Francou 1988)

4. The influence of the LOD on weather at the small catchment scale

At the small catchment scale, the rate of the earth's rotation significantly affects precipitation and runoff, as shown in the Liz catchment example (Fig. 5, Fig. 6). The Liz basin lies in the foothills of the Šumava Mts. (Bohemian Forest). The closing profile is located at 49.0697603N, 13.6820850E. The Liz catchment area is situated on a slope between 828 and 1024 m above sea level with a mean slope of 16,6 %, the catchment area is 0.998 km^2. The geological subsoil is made up of paragneiss, the soil cover is made up of dystric Cambisol. The catchment area is covered with mature spruce forest.

Fig. 5 shows that the 1982 El Chicon eruption was preceded by a significant decrease and re-increase in eccentricity in the period between 1979 and 1982 with a minimum in 1981. The 2002 catastrophic floods in the Czech Republic, Italy, Spain, Austria, Germany, Slovakia, Hungary, Romania, Bulgaria, Croatia, Ukraine and Russia were preceded by a sharp increase in eccentricity from 1998. Both episodes of significant changes in the eccentricity of Jupiter's orbit are indicated by ovals in Fig. 5.

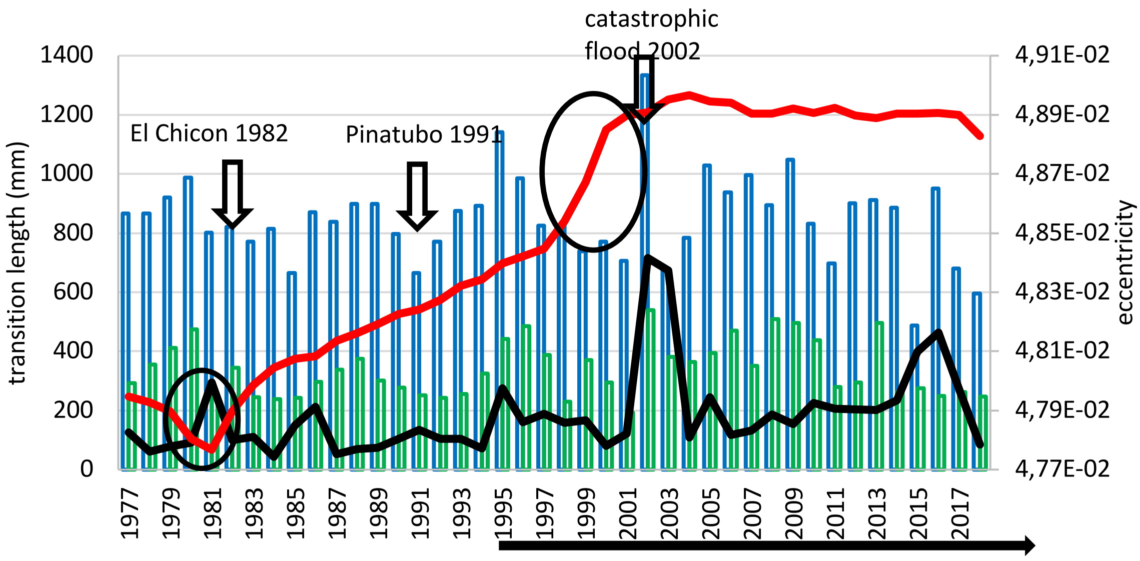

Figure 13: Catastrophic flood in 2002 in the Czech Republic demonstrated on the Liz basin in the Bohemian Forest. Ovals indicate significant changes in Jupiter's orbit eccentricity (the red line). The blue (green) bar – precipitation (runoff) depths for the hydrological year November 1 – October 30, the black line – the length of the interannual transition, the empty arrows – the year of the 1982 El Chicon and 1991 Pinatubo eruptions and the 2002 flood. Source: IH [online], VSOP87 [online]

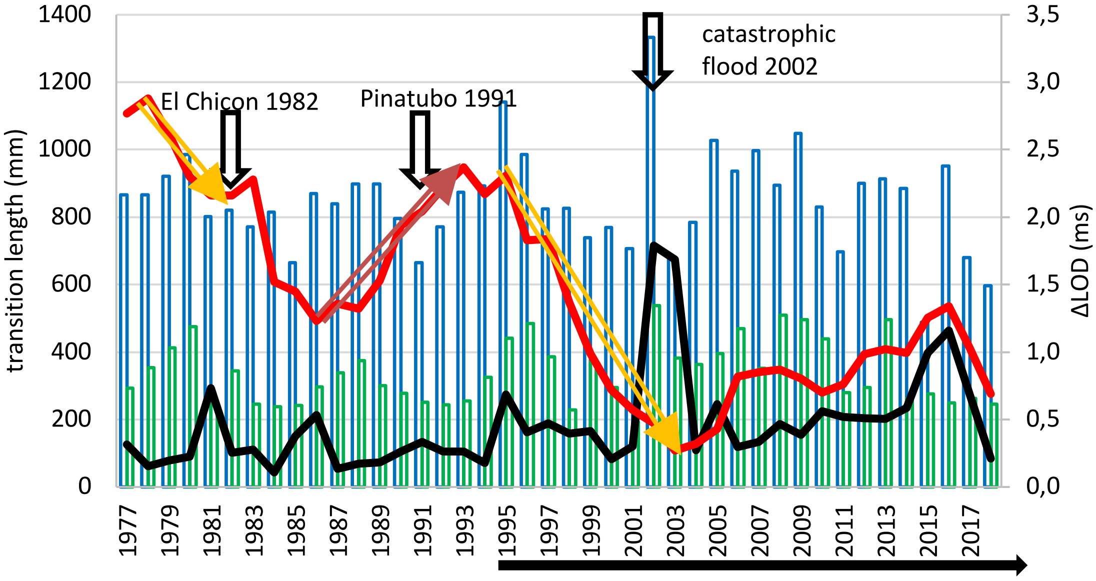

Figure 6: Interannual precipitation-runoff transitions in the Liz basin and deviation of ΔLOD (milliseconds) from the standard rotation period of 86400 seconds (the red line) for the hydro-logical years 1976–2018. The blue (green) bar – precipitation (runoff) depths for the hydrological year November 1 – October 30, the black line – the length of the interannual transition, empty arrows – the year of 1982 El Chicon eruption and 1991 Pinatubo eruption, and 2002 flood, the orange arrow – acceleration of Earth's rotation, the brown arrow – the deceleration of the Earth's rotation, the black arrow – the increase in standard deviation of transition length after 1995. Data source: IH [online], IERS [online]

In Fig. 6, the black arrow marks the onset of climate extremalisation after 1995. This is characterised by an increase in the inter-annual differences in rainfall and runoff. The strong 1991 Pinatubo eruption (VEI 5) resulted in a planet-wide decrease in atmospheric clarity until 1996 (Keen 2019). After the atmosphere cleared in 1996, however, large interannual differences in precipitation continued. Therefore, volcanic pollution of the Earth's atmosphere in 1991 cannot be considered the cause of the ongoing climate change. The cause was probably the acceleration of the Earth's rotation rate in 1995.

5. Conclusions

We present a causal chain that links a 60-year period of Jupiter's orbital eccentricity to a 60-year period of climate change:

1) 60-year cyclic changes in the eccentricity of Jupiter's orbit are the main cause of changes in the Earth's orbital rate.
2) Changes in the Earth's orbital rate cause climate changes with a period of about 60 years.

A close relationship to changes in the Earth's orbital rate has been demonstrated in the following phenomena:

1) 1992 El Chicon eruption,
2) 1991 Pinatubo eruption,
3) occurrence of strong earthquakes in the period 1900–2022,
4) AMO index,
5) low flows in the period 1920–2020 on the Punkva river in the Moravian Karst,
6) post-1995 rain extremes in the Czech Republic,
7) catastrophic floods 2002 in the Central Europe,
8) unusually long drought 2014–2019 in the Central Europe.

The accumulation of extreme events (6 to 8) in a short period is seen by some climatologists as evidence that essentially irreversible climate change is already underway. In contrast, we believe that this is a periodic climate change caused by the gravitational interaction of solar system bodies on the Earth and the Sun.

Guest-Editor: Stein Storlie Bergsmark

Data

AMO [online]: Atlantic Multidecadal Oscillation Index.
https://www1.ncdc.noaa.gov/pub/data/cmb/ersst/v5/index/ersst.v5.amo.dat

IERS [online]: Earth orientation parameter.
https://www.iers.org/IERS/EN/Science/EarthRotation/UT1LOD.html https://datacenter.iers.org/data/latestVersion/224_EOP_C04_14.62-NOW.IAU2000A224.txt

IH [online]: Institute of Hydrodynamics. https://www.ih.cas.cz/en/

USGS [online]: Earthquake Hazards Program. https://www.usgs.gov/programs/earthquake-hazards/earthquakes

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