

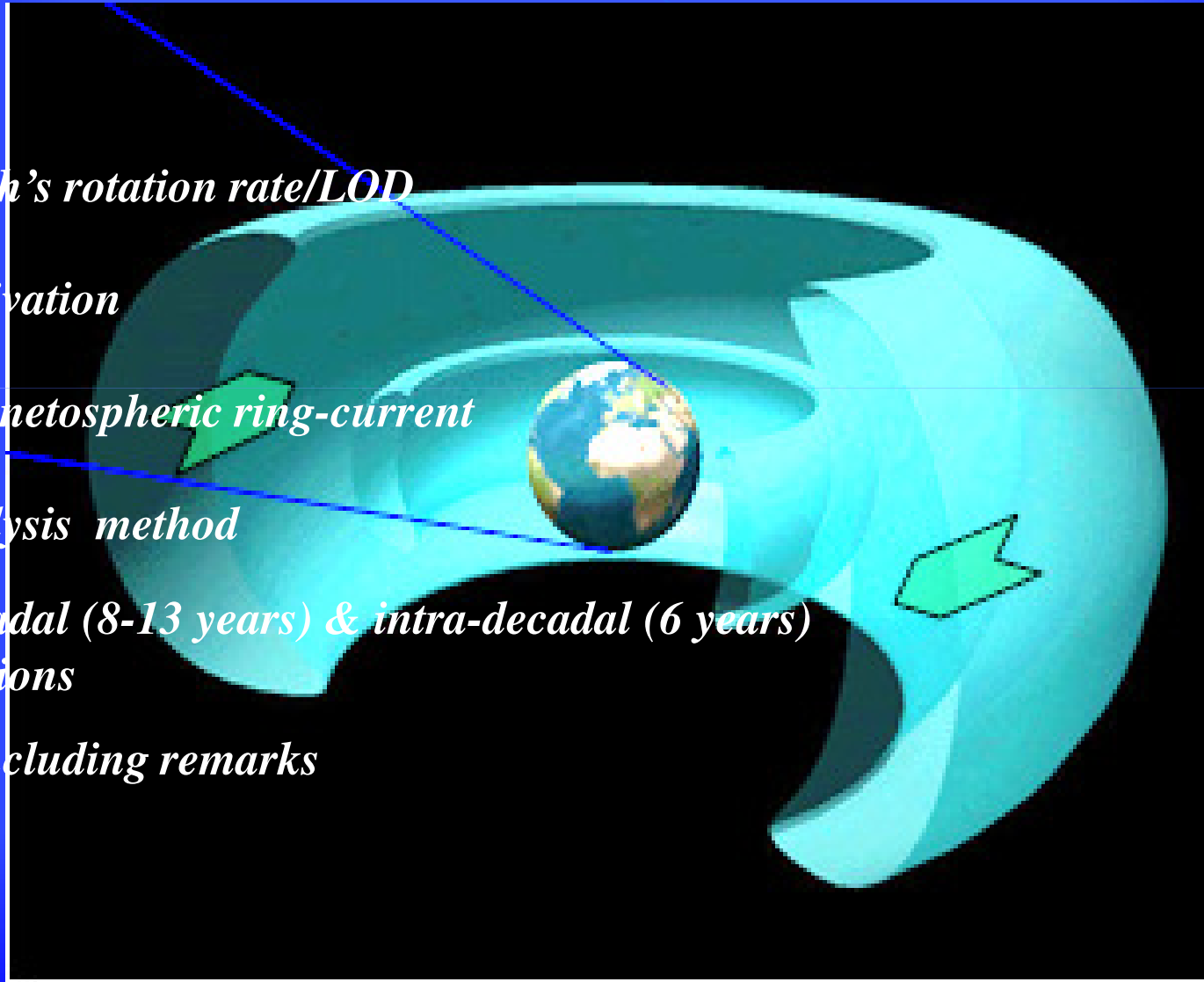
External drivers of decadal variations in the geomagnetic field and Earth's rotation

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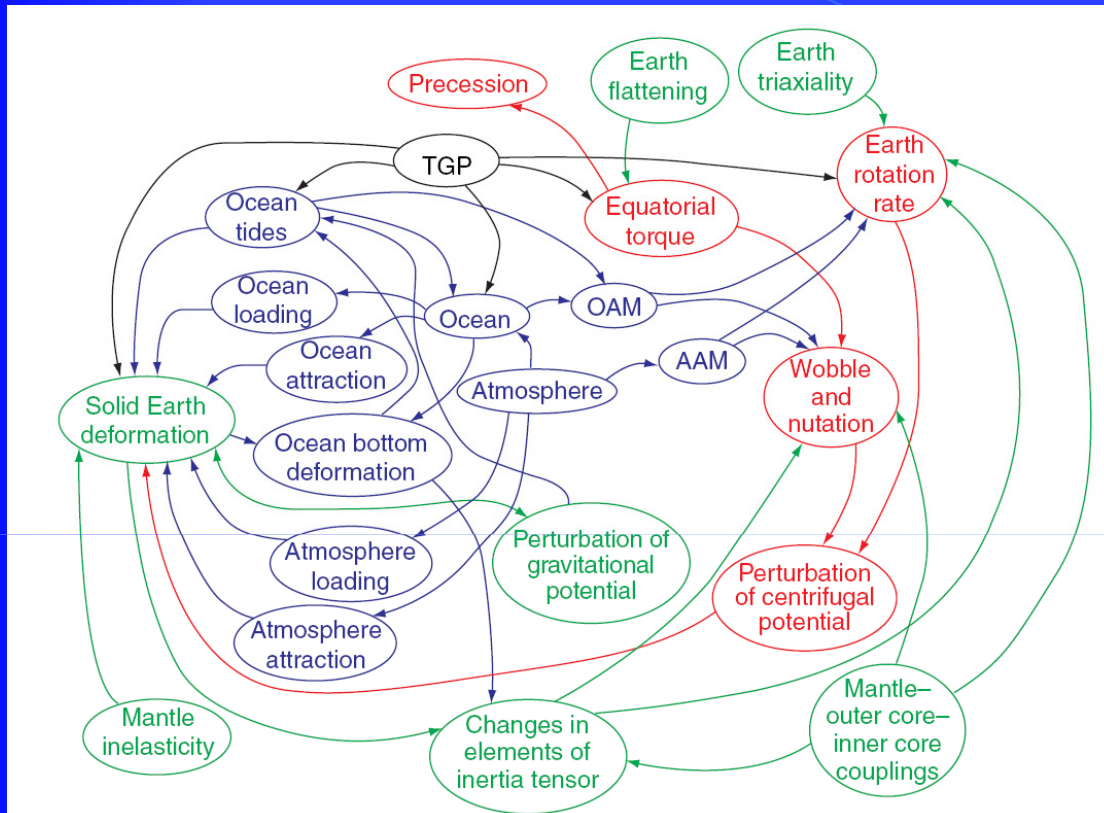
Acknowledgements: This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCDI-UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0266/SAFESPACE, within PNCDI III and the Joint Research Project between Bulgarian and Romanian Academies

Outline

- *Earth's rotation rate/LOD*
- *Motivation*
- *Magnetospheric ring-current*
- *Analysis method*
- *Decadal (8-13 years) & intra-decadal (6 years) variations*
- *Concluding remarks*



Earth's rotation rate (LOD = length of day)



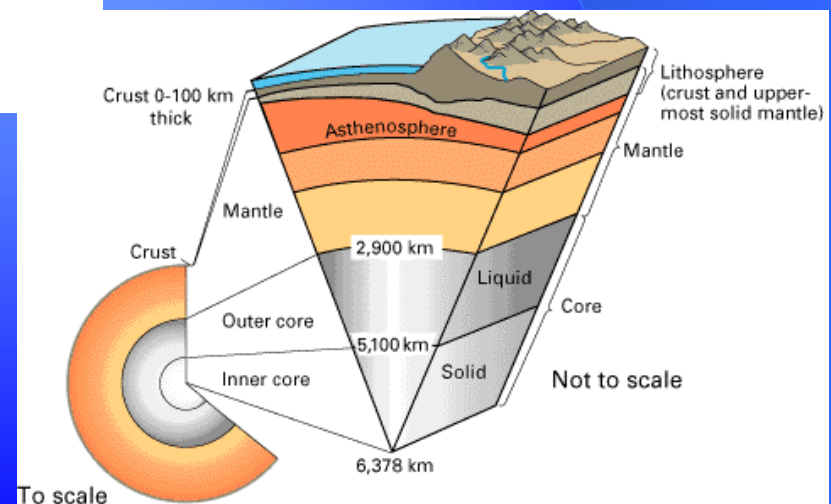
Fluctuations:

- variable external couples
- internal mass redistribution
- hydrodynamic and magnetohydrodynamic tensions at fluid/solid interfaces

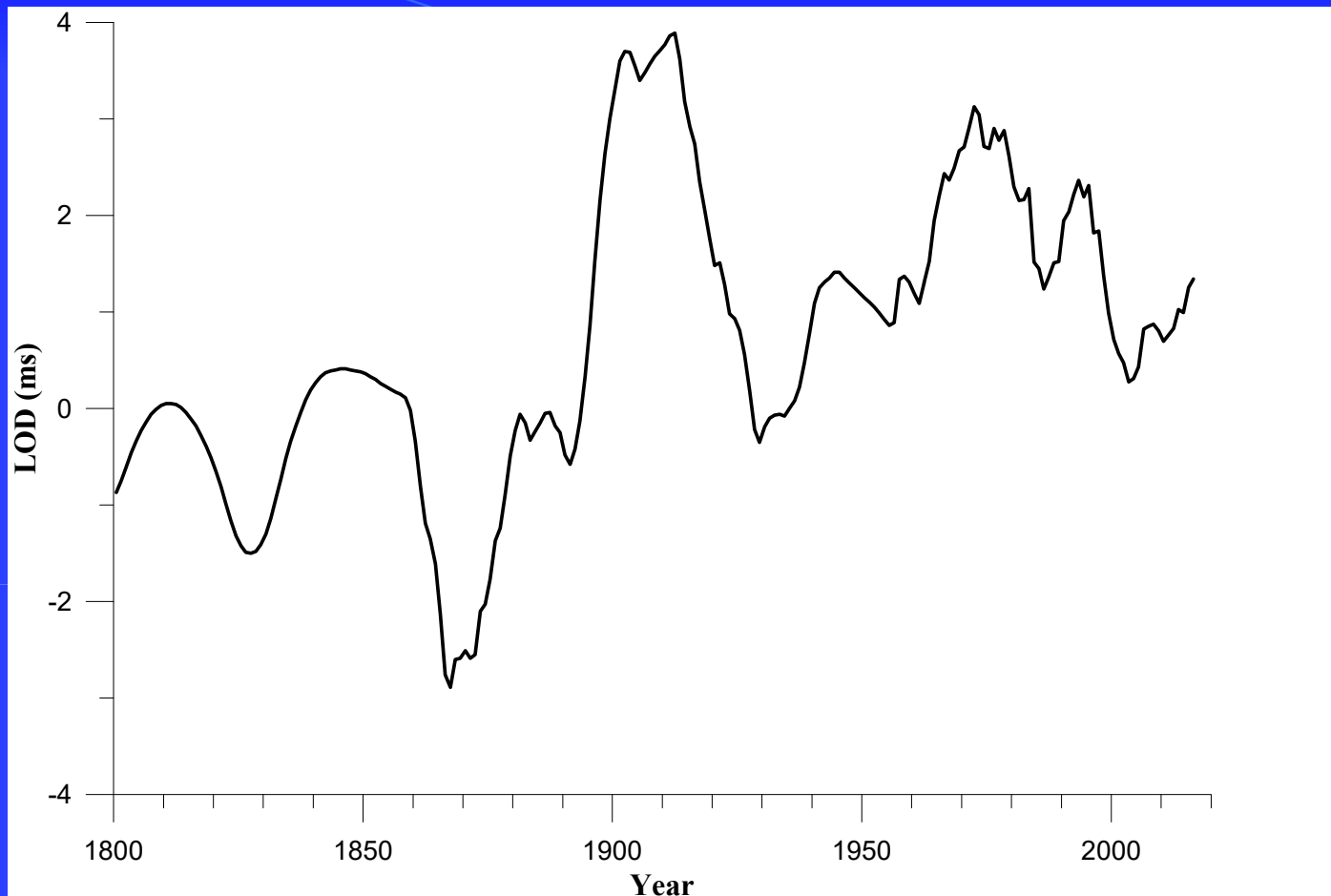
Principle: conservation of the angular momentum of Earth

In general: the transfer of the angular momentum between the solid part of the Earth (mantle + inner core) and fluid volumes in contact:

- Atmosphere + Oceans
- Outer core



LOD – Earth's rotation

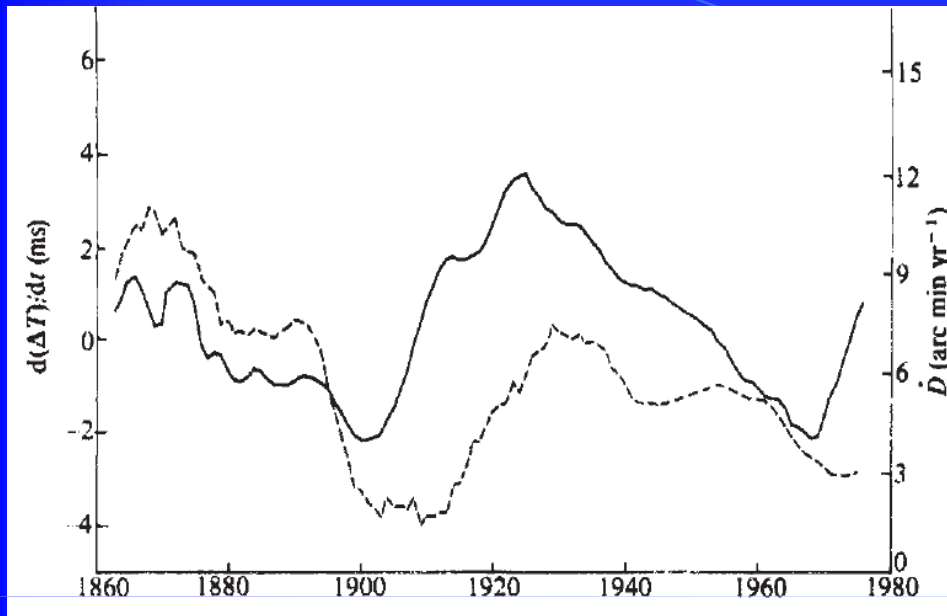


• <https://www.iers.org/IERS/EN/DataProducts/EarthOrientationData/eop.html>

Explanation (sources):

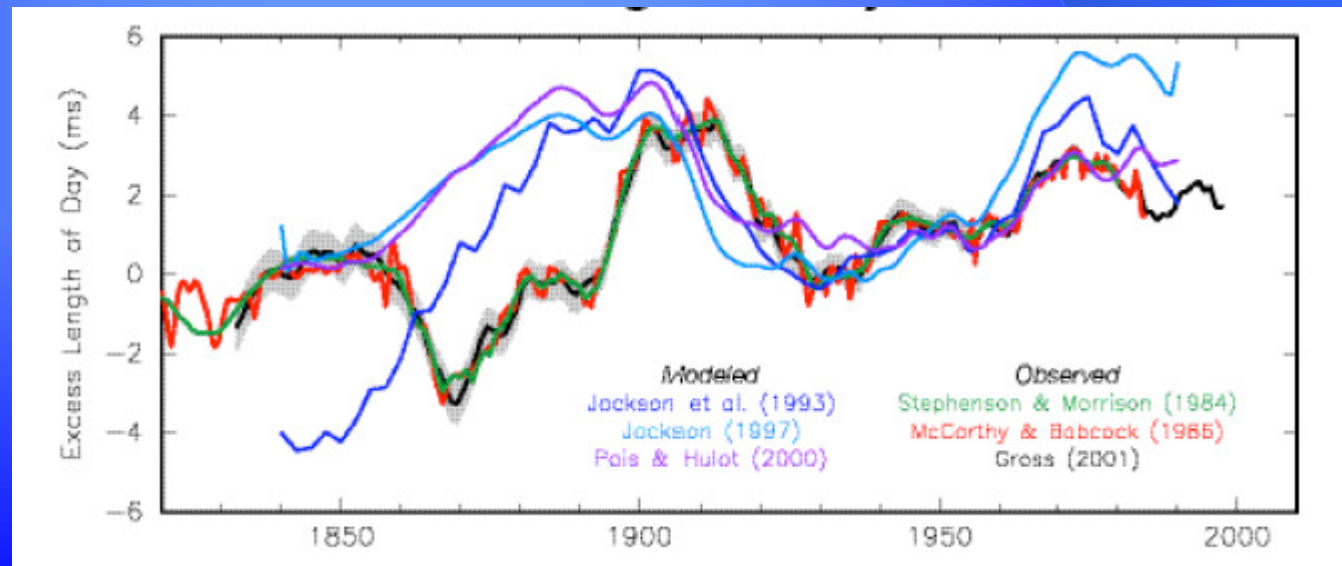
- Zonal movements of the outer core fluid (geodynamo) geomagnetic data

Motivation: LOD – Earth's magnetic field

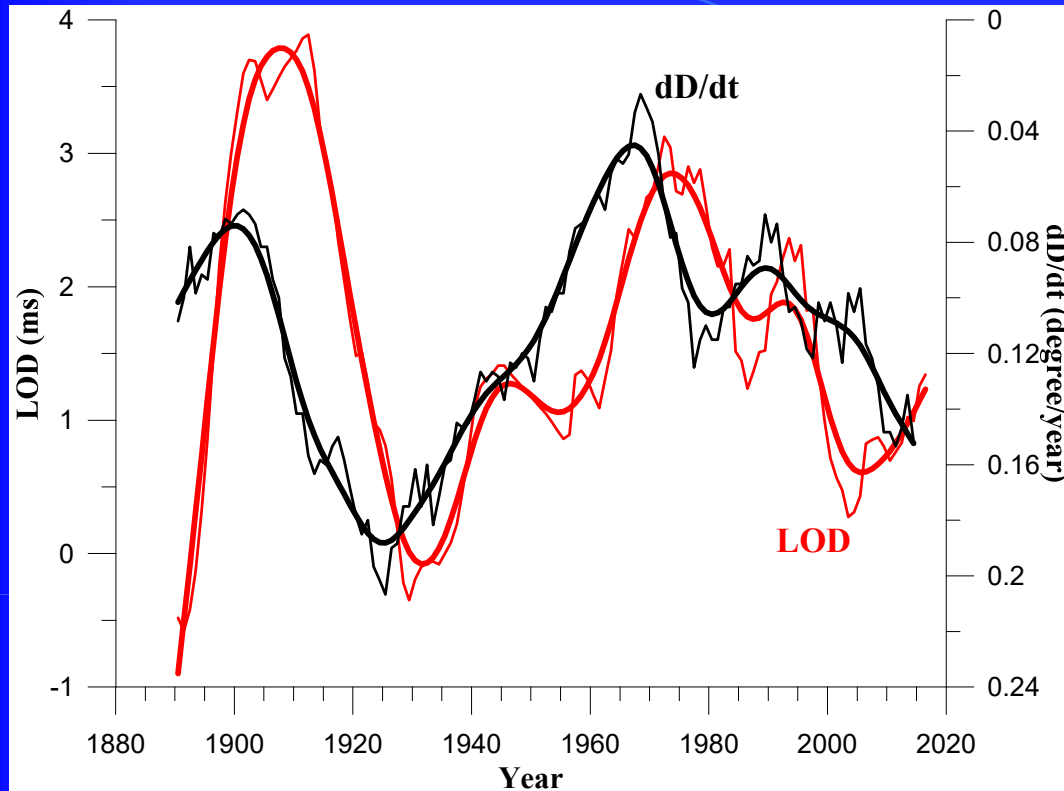


Le Mouel et al., Nature, 1981: 1860-1975
Earth rotation rate linked to geomagnetic
field variations (D) (jerks)

Gross R., Physical Geodesy,
Treatise on Geophysics, 2007

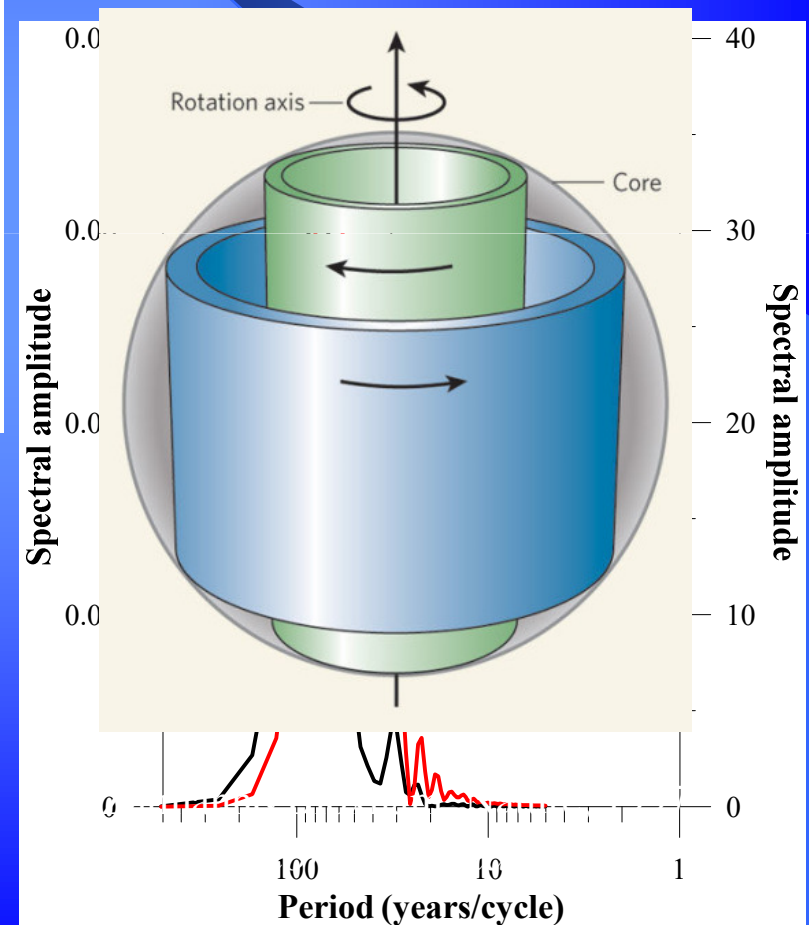


Motivation: LOD – Earth's magnetic field

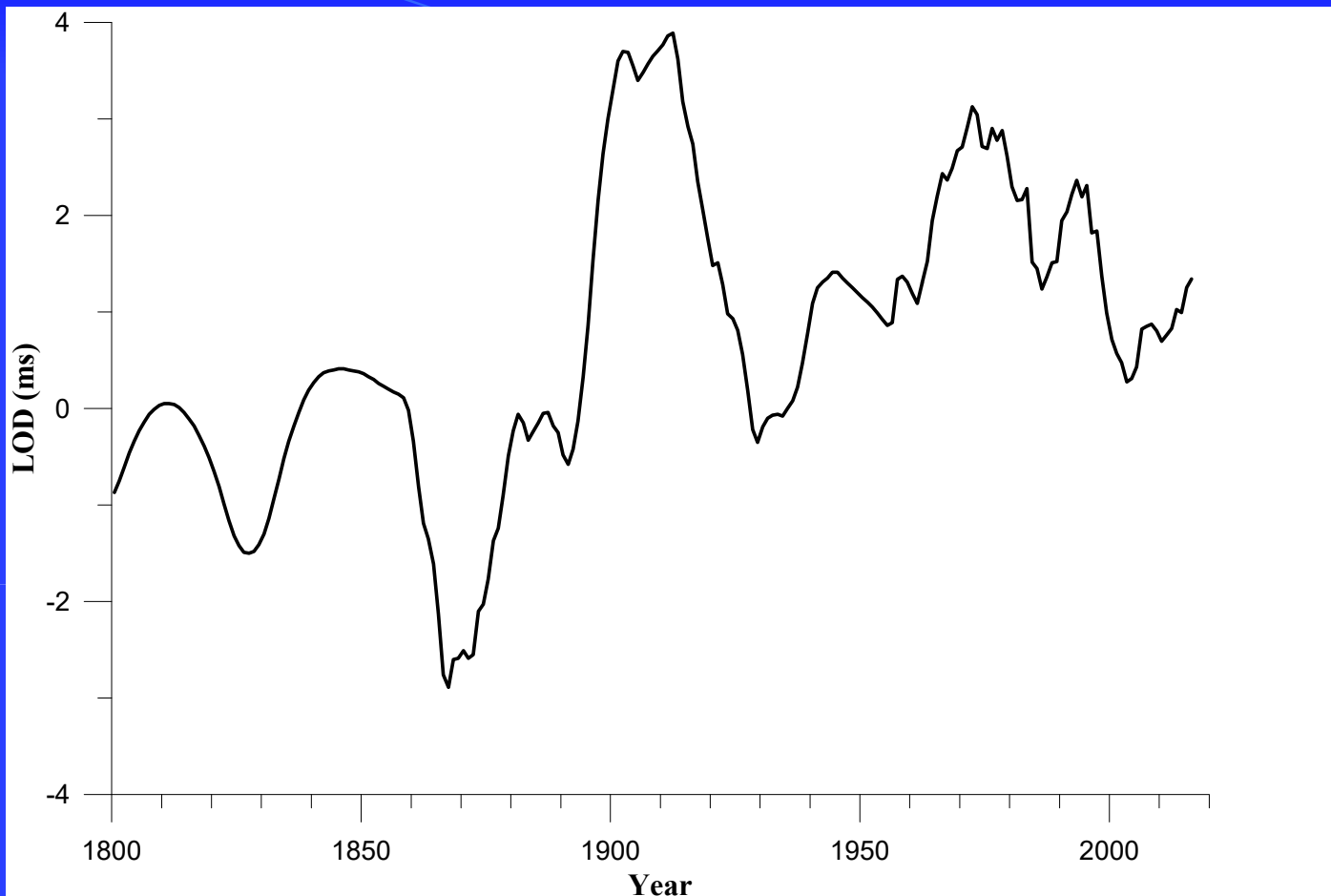


Dobrica&Demetrescu, 2019, submitted

- sub-centennial timescale (60-90 years): 1.5 ms
- inter-decadal timescale (20-35 years): 1 ms



Motivation: LOD – External sources

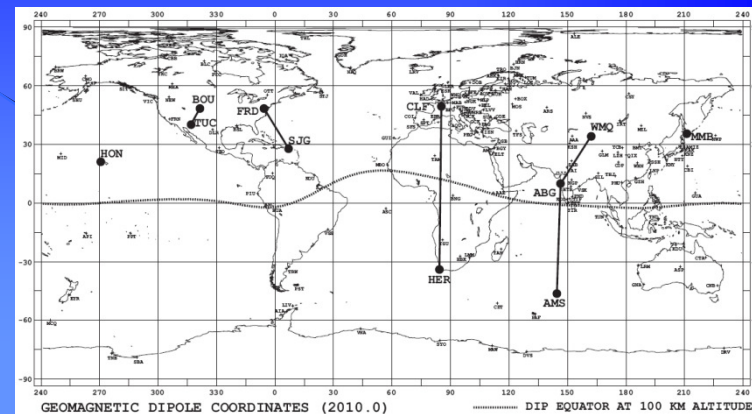
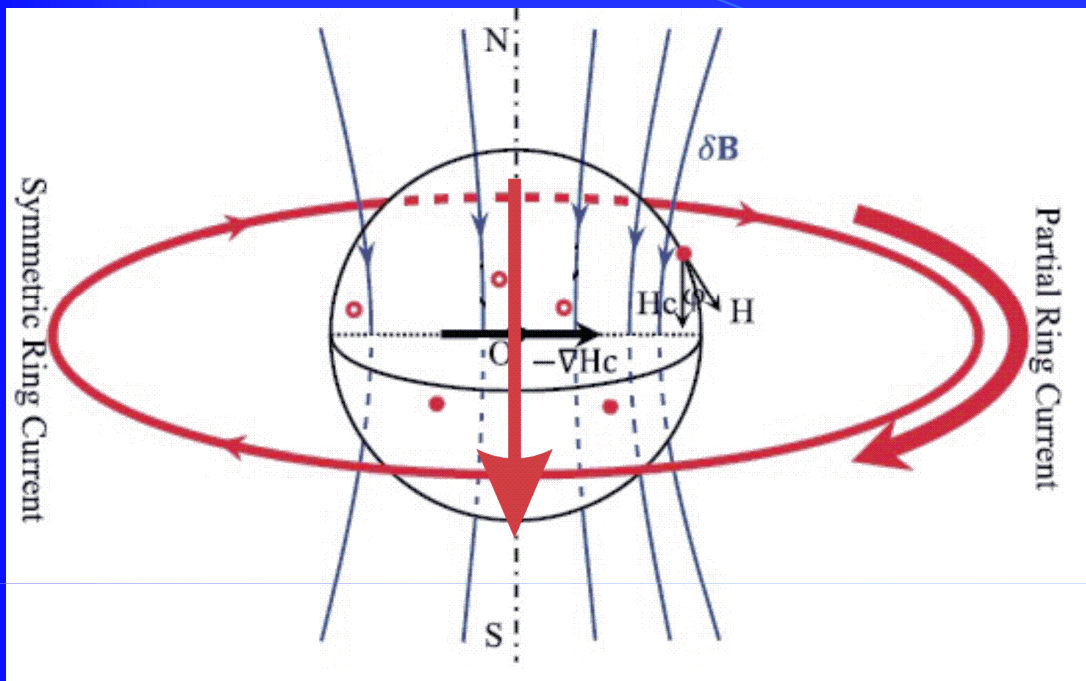


• <https://www.iers.org/IERS/EN/DataProducts/EarthOrientationData/eop.html>

Explanation (sources):

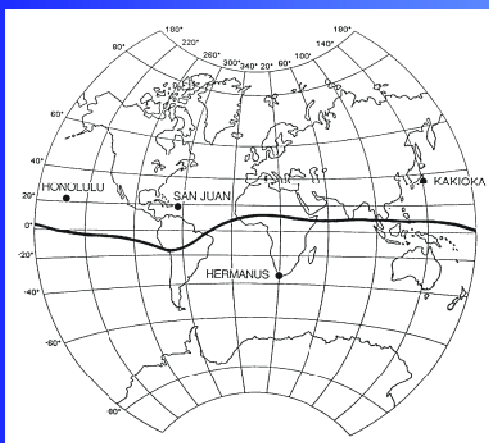
- Zonal movements of the outer core fluid (geodynamo) geomagnetic data
- Fluctuations in the magnetospheric ring current

Magnetospheric ring current. Geomagnetic indices

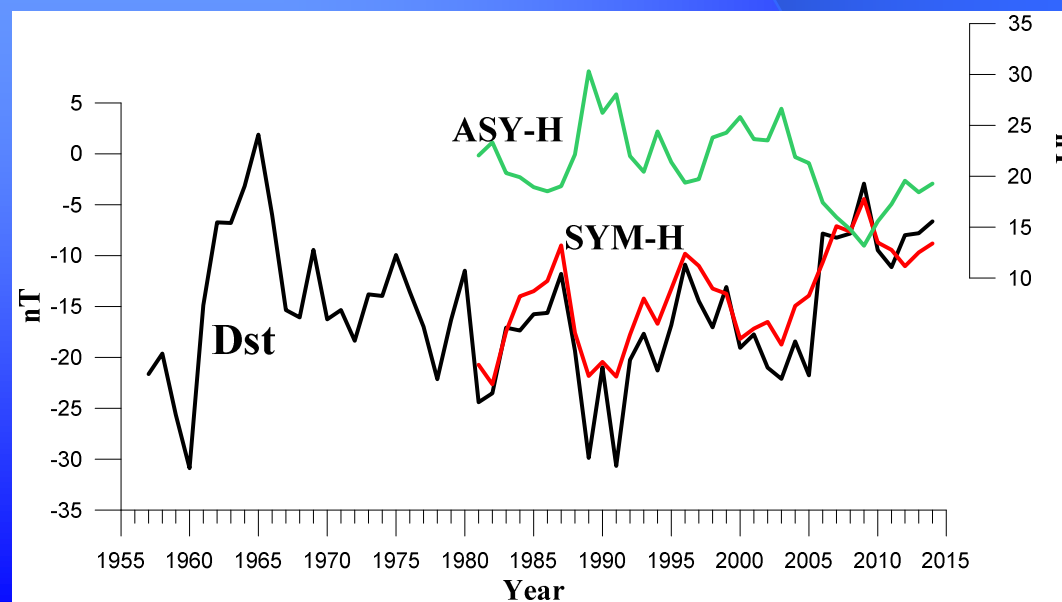


Iyemori (1990); <http://wdc.kugi.kyoto-u.ac.jp/>

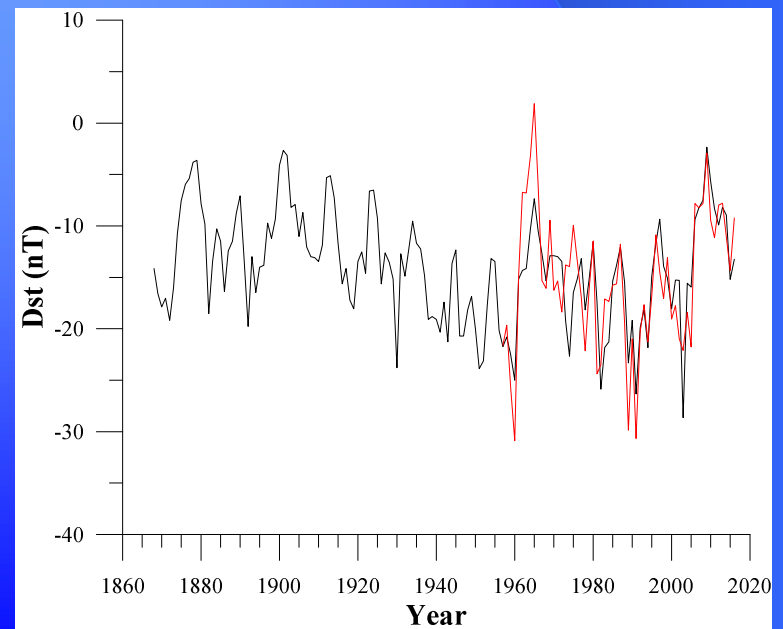
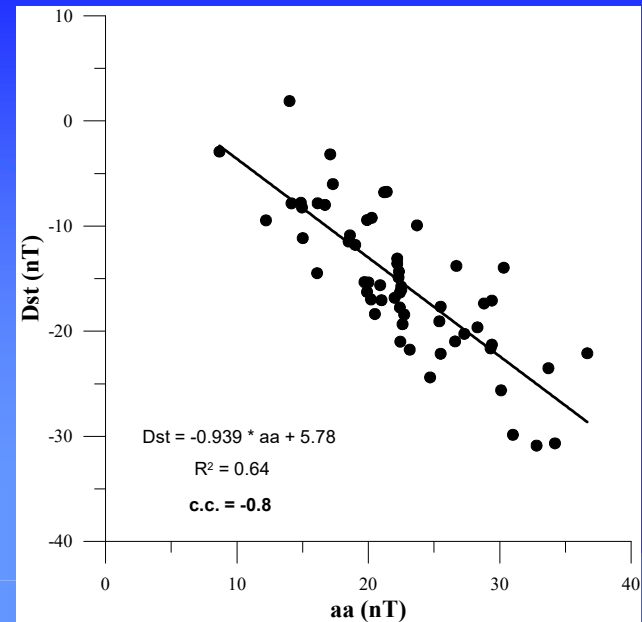
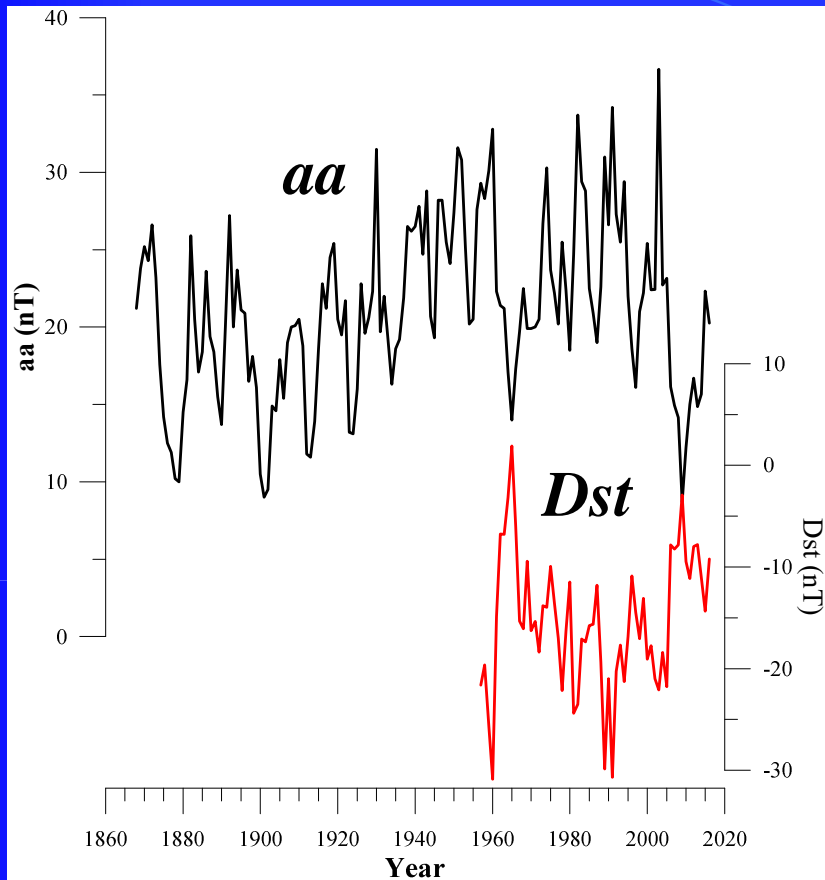
adapted from Shen et al. (2015)



Sugiura (1964); <http://wdc.kugi.kyoto-u.ac.jp/>



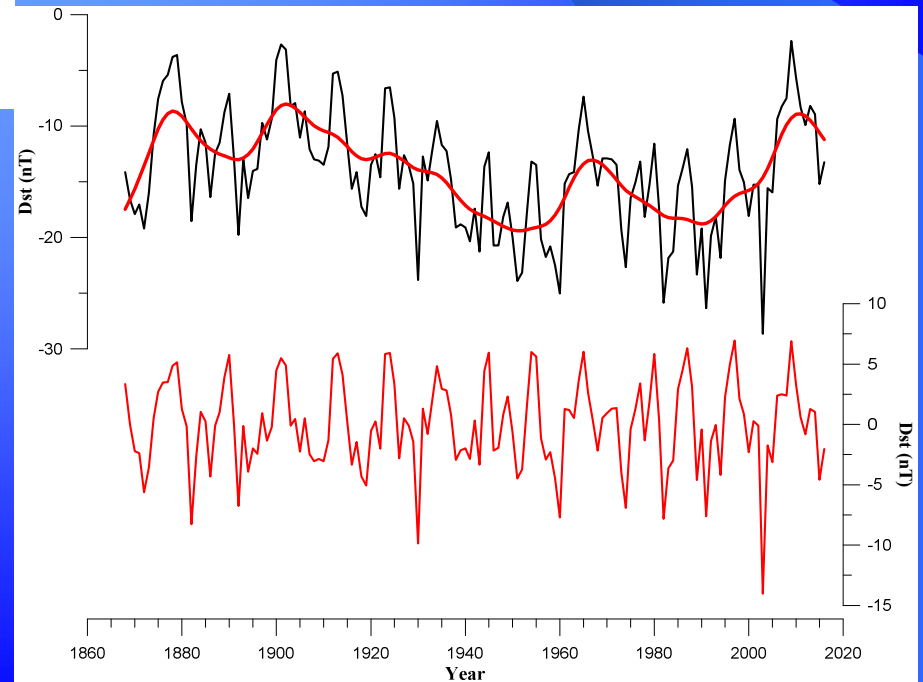
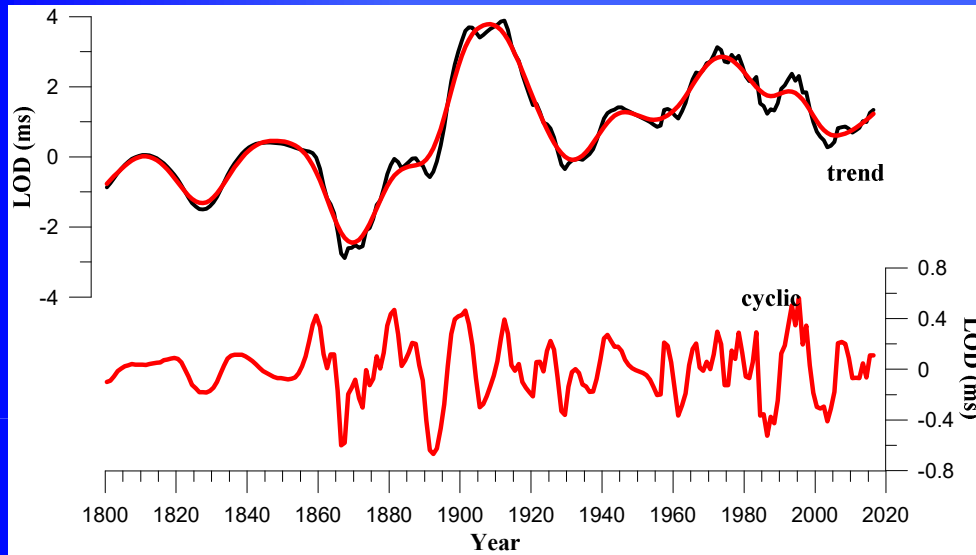
Magnetospheric ring current. Dst reconstruction to 1868



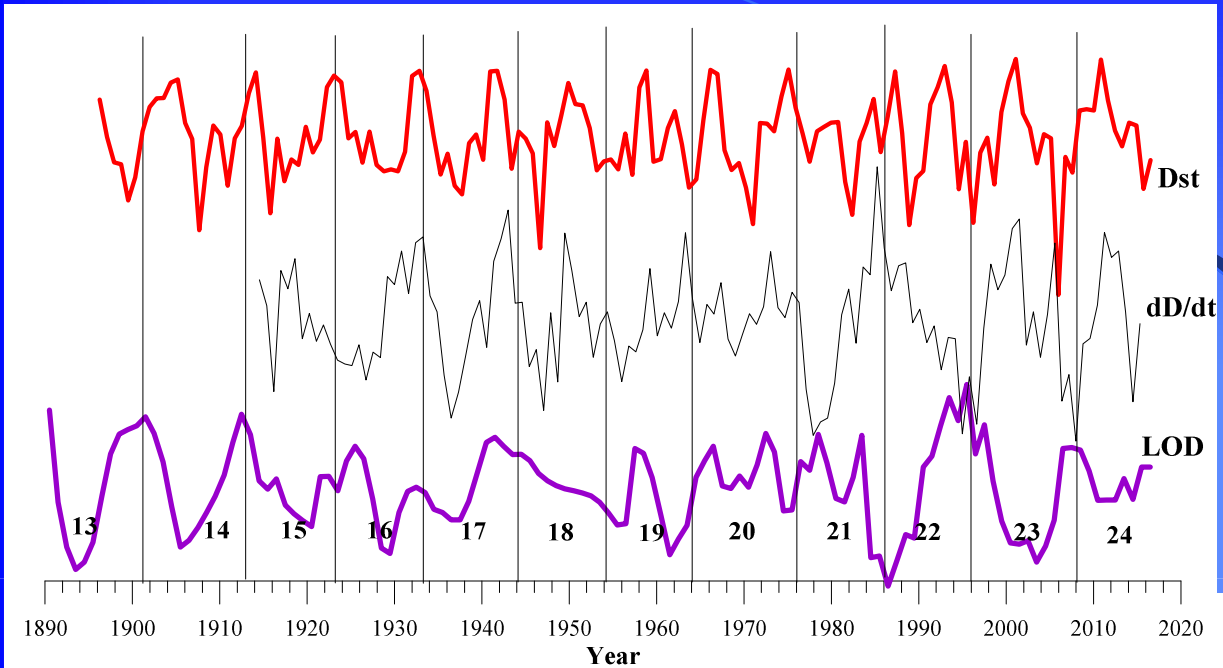
Analysis of LOD and ring current decadal variations

$\text{Data} \xrightarrow[\text{filter}]{\text{HP}} \text{Trend} + \text{cyclic}$

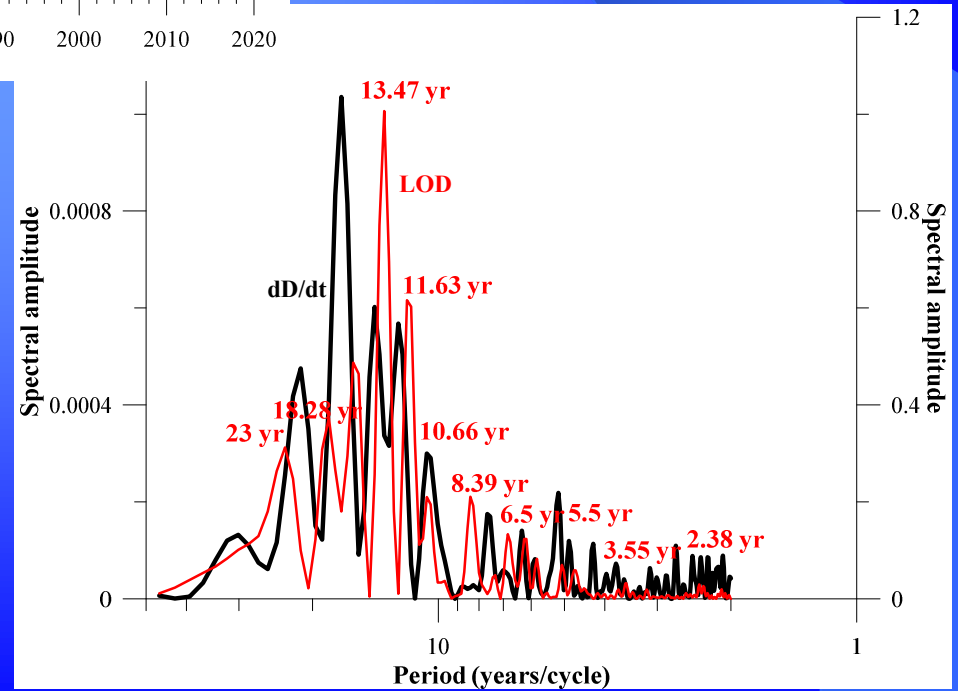
Hodrick & Prescott (1997)



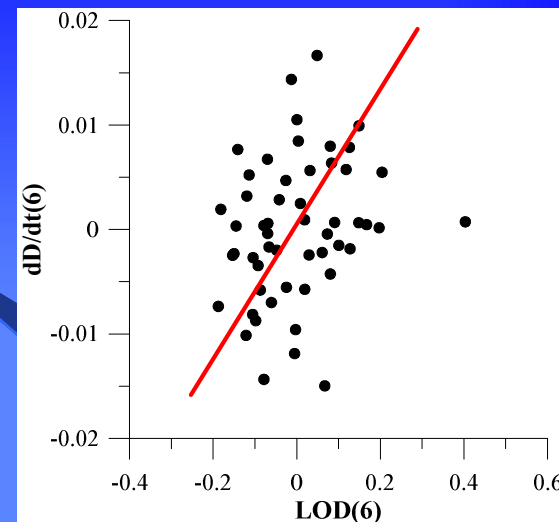
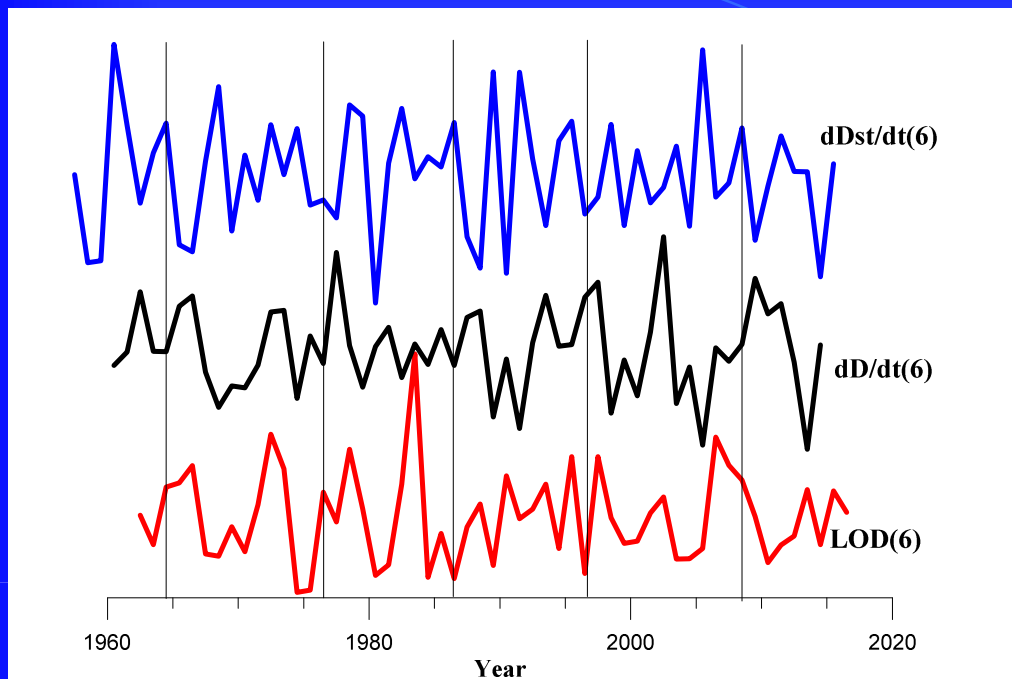
Decadal variations in LOD, Ring current, dD/dt



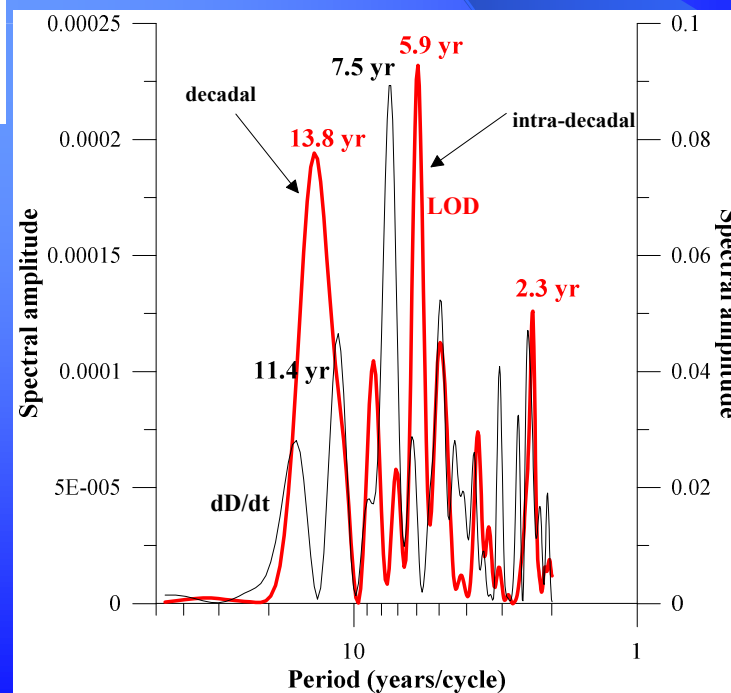
- decadal timescale (9-13 years): 0.5 ms



Intra-decadal variations in LOD, Ring current, dD/dt



- intra-decadal timescale (6 years): 0.15 ms



Debated causal chain for the 6-year variation

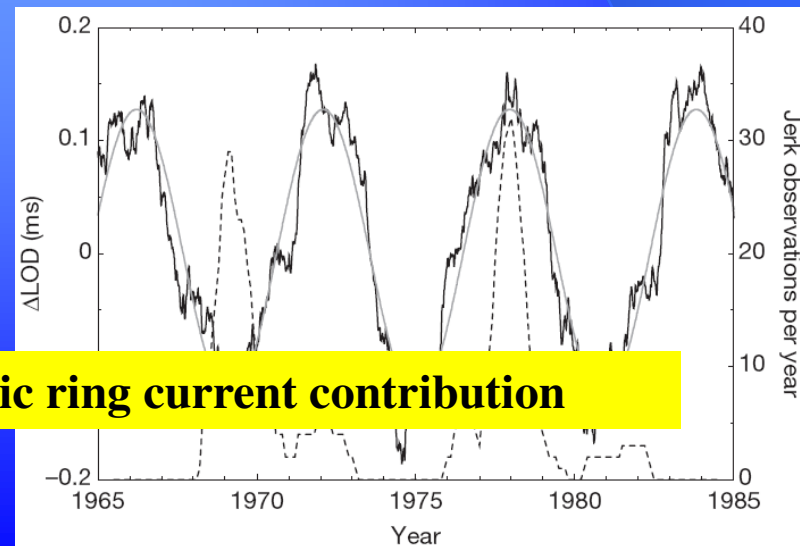
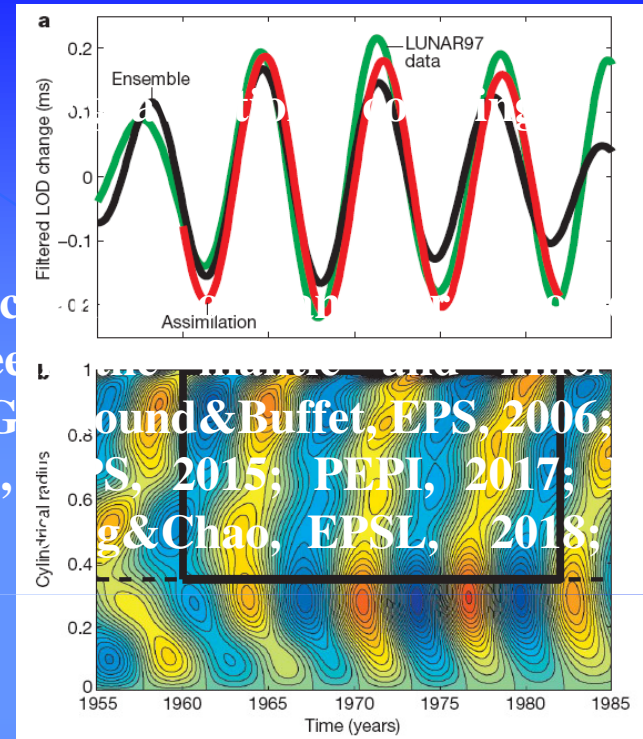
- geomagnetic field

- fast torsional waves with a 6-year variation period (Gillet et al., Nature, 2010)

- excitation of the mantle and inner core between MICG and the mantle and inner core (e.g., Gillet et al., 2018; Tardieu et al., 2019)

- geomagnetic jerks (Holme&deViron, Nature, 2013)

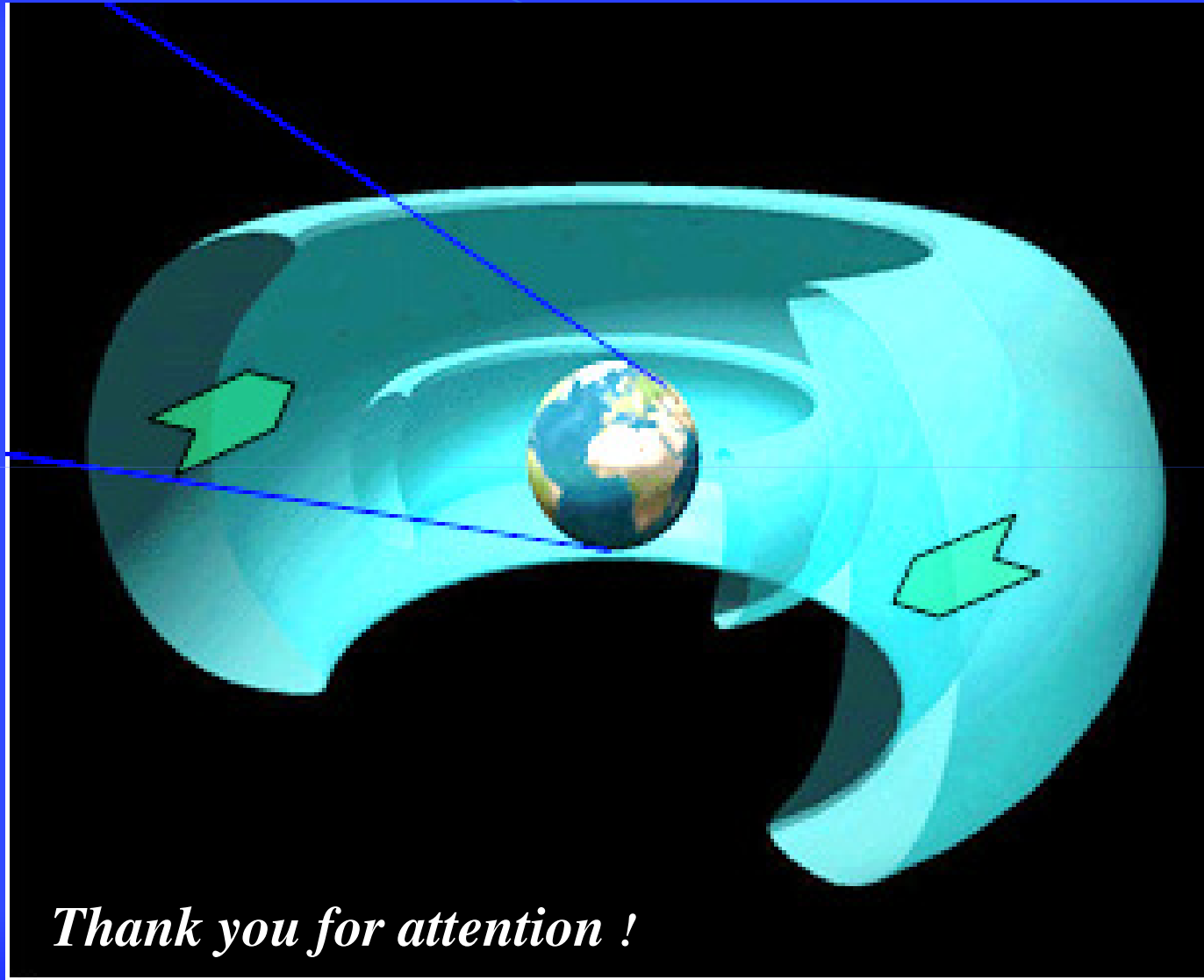
- we favour the magnetospheric ring current contribution



Concluding remarks

- The contribution of the magnetospheric ring current to variations in geomagnetic field and LOD at decadal (8-13 years) and intra-decadal (6 years) timescales was investigated;
- We characterized the amplitudes involved in variations at the two timescales:

Decadal (8-13 years)	ring current: -15 nT
	geomagnetic declination: 1.5 min
	LOD: 0.5 ms
Intra-decadal (6 years)	ring current: -10 nT
	geomagnetic declination: 0.9 min
	LOD: 0.15 ms
- Debated causal chain for the 6 years variation. We add the contribution of external sources of the geomagnetic field (magnetospheric ring current) to the three previously forwarded possibilities (fast torsional waves, implication of geomagnetic jerks, mantle – inner core gravitational coupling).



Thank you for attention !