



# 107° CONGRESSO NAZIONALE della SOCIETÀ ITALIANA DI FISICA

## *Geomagnetic jerks and South Atlantic Anomaly: a link during satellite era*

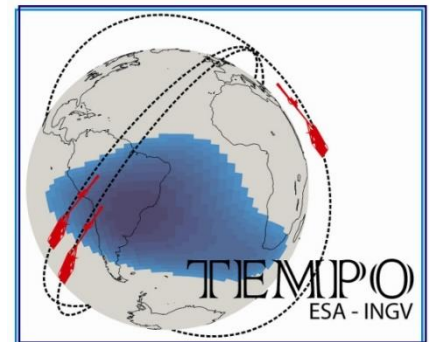
**Saioa A. Campuzano**, A. De Santis, F. J. Pavón-Carrasco,  
A. González-López, E. Qamili

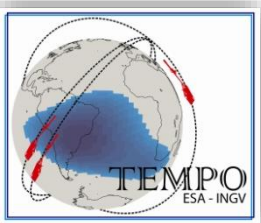


ISTITUTO NAZIONALE  
DI GEOFISICA E VULCANOLOGIA



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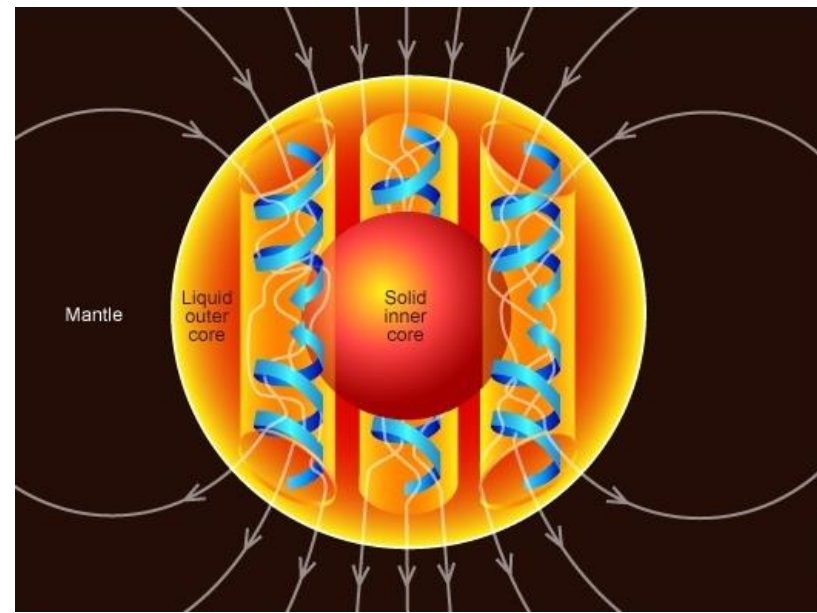
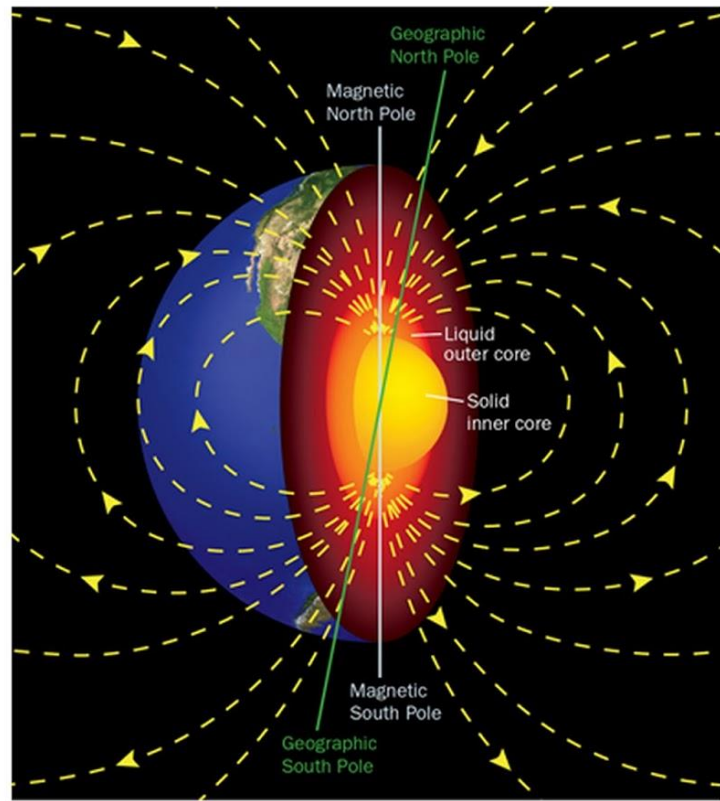


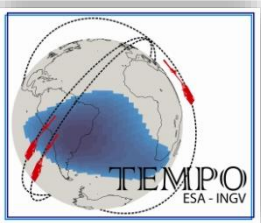


# 1. Internal geomagnetic field

Earth's magnetic field is mainly of internal origin and dipolar. It is generated due to electric currents in movement in the liquid outer core. The geomagnetic field changes on different time scales. Changes on a time scale of a year or more are named *secular variation*, being generally smooth.

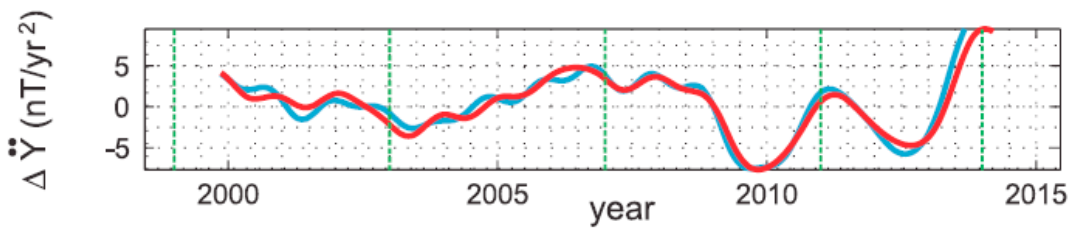
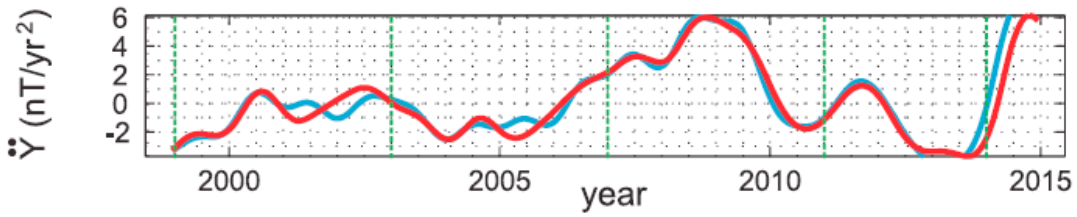
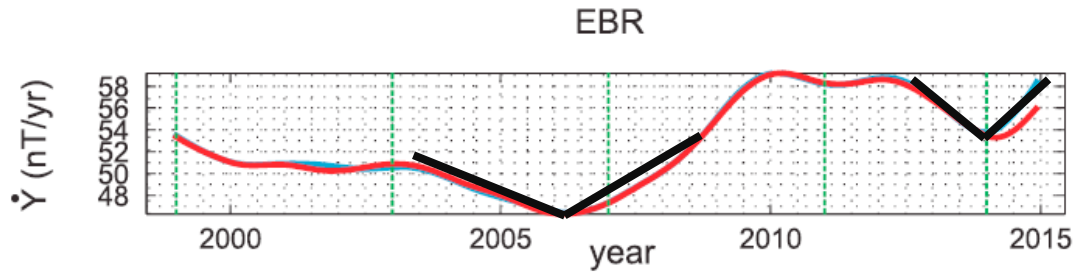
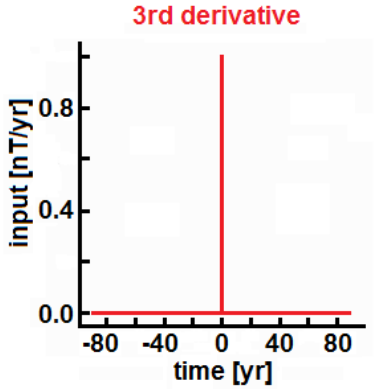
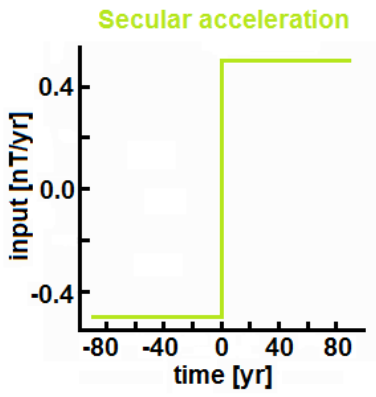
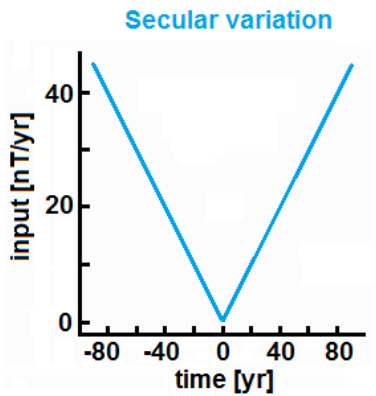
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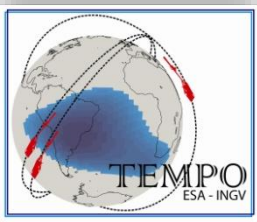




## 2. Geomagnetic jerks at surface

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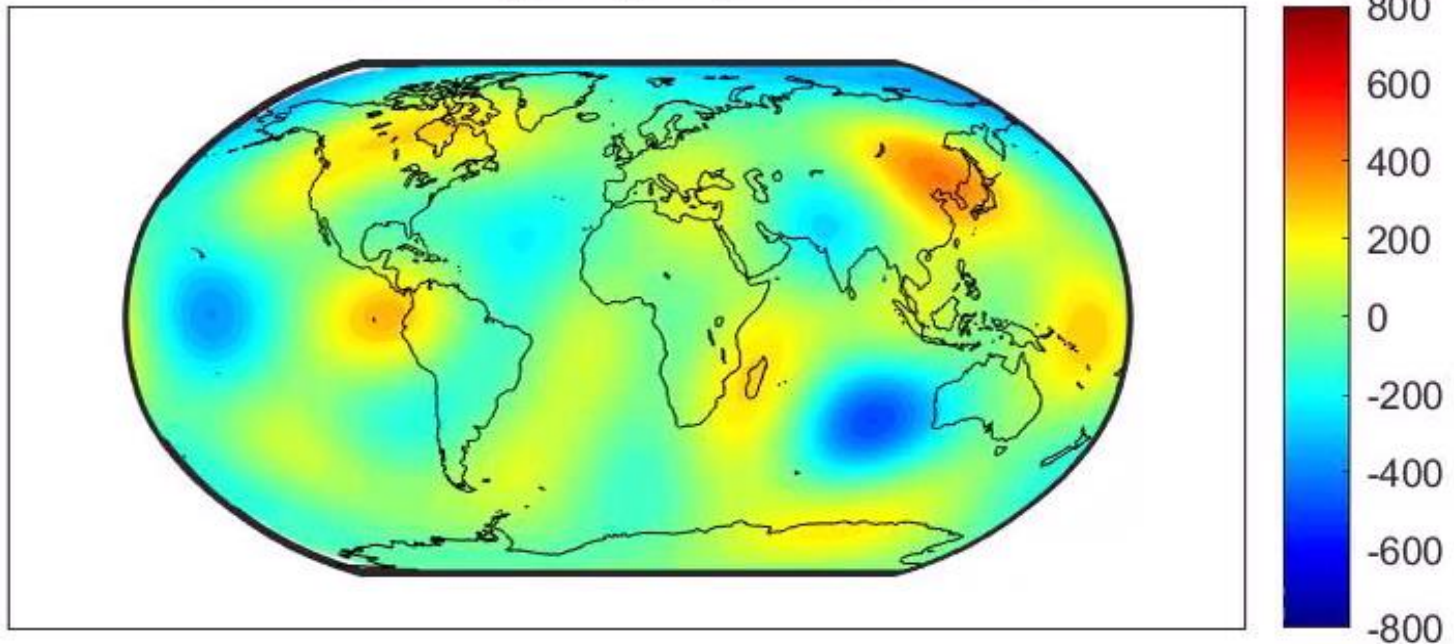




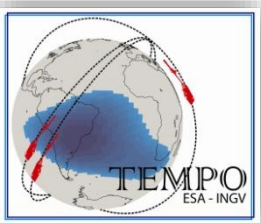
## 2. Geomagnetic jerks at core-mantle boundary (CMB)

Secular acceleration of the radial component ( $B_r$ ) of the geomagnetic field at core-mantle boundary (CMB) for the last two decades.

### SA of $B_r$ ( $\text{nT}/\text{yr}^2$ ) at 1/1999



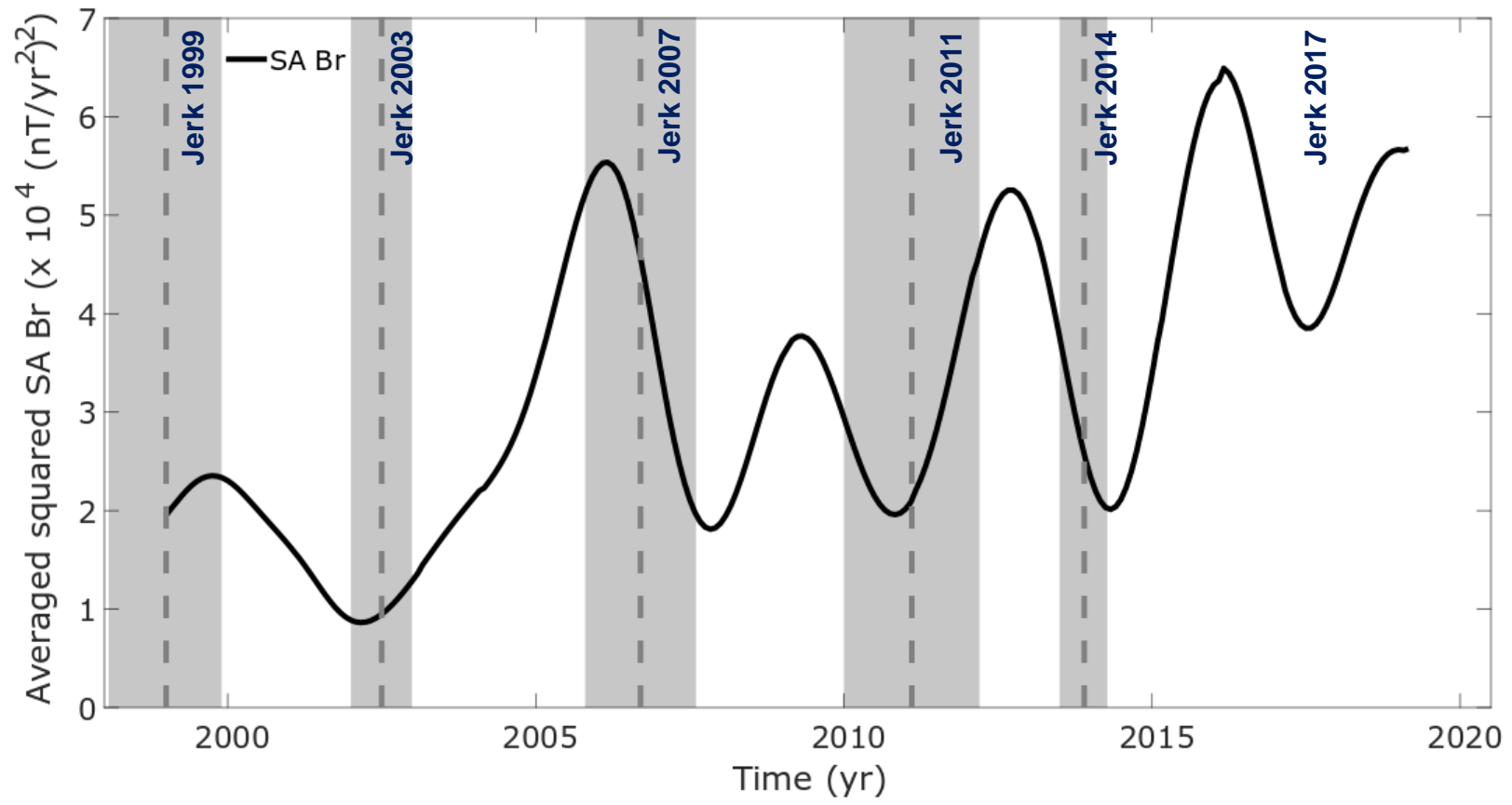
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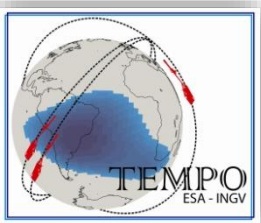


## 2. Geomagnetic jerks at core-mantle boundary (CMB)

Squared secular acceleration power of the radial component of the geomagnetic field at CMB.

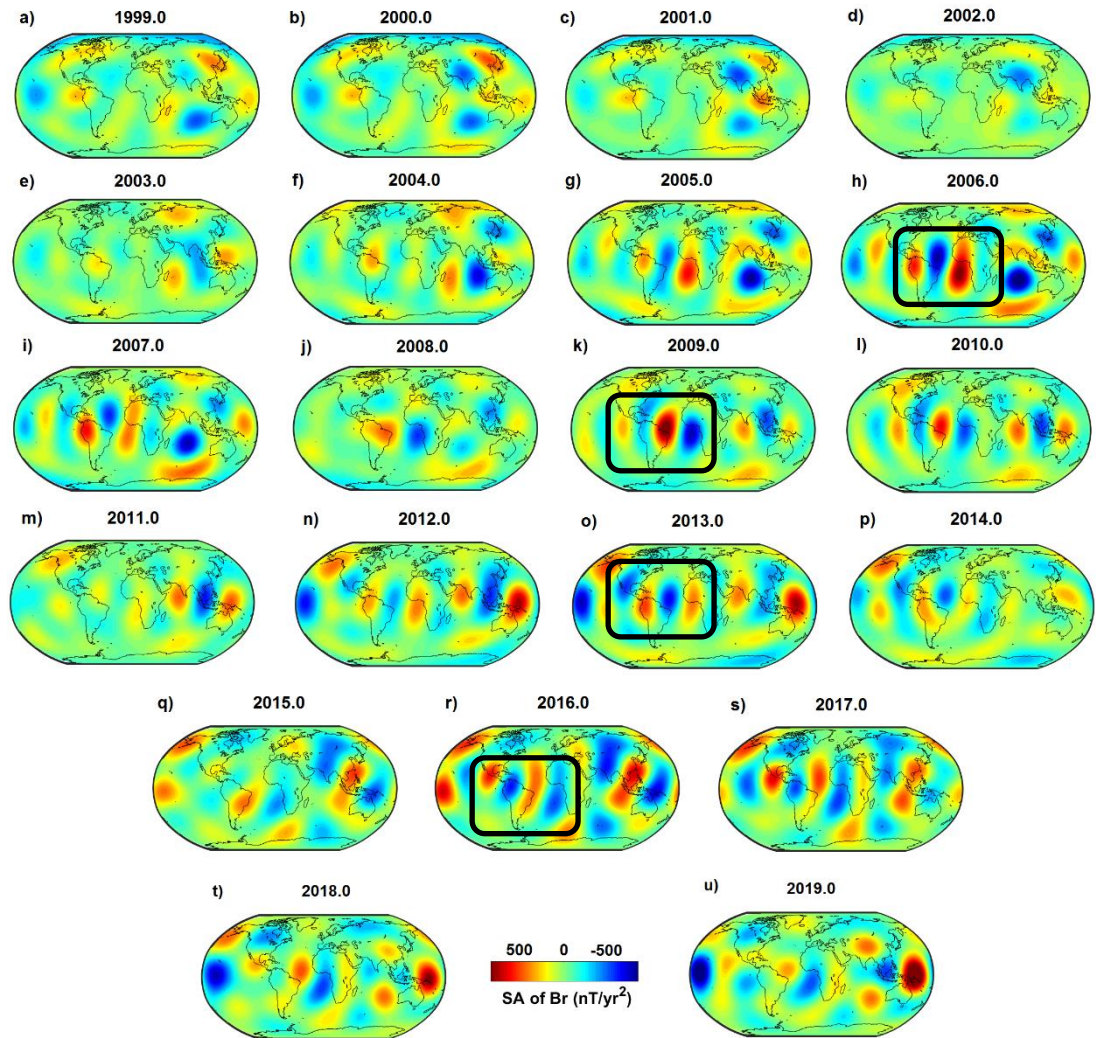
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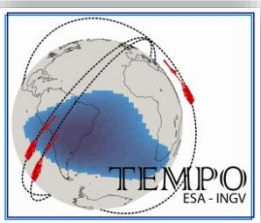
# 2. Geomagnetic jerks at core-mantle boundary (CMB)

Maps of the secular acceleration of the radial component of the geomagnetic field at CMB (every year)



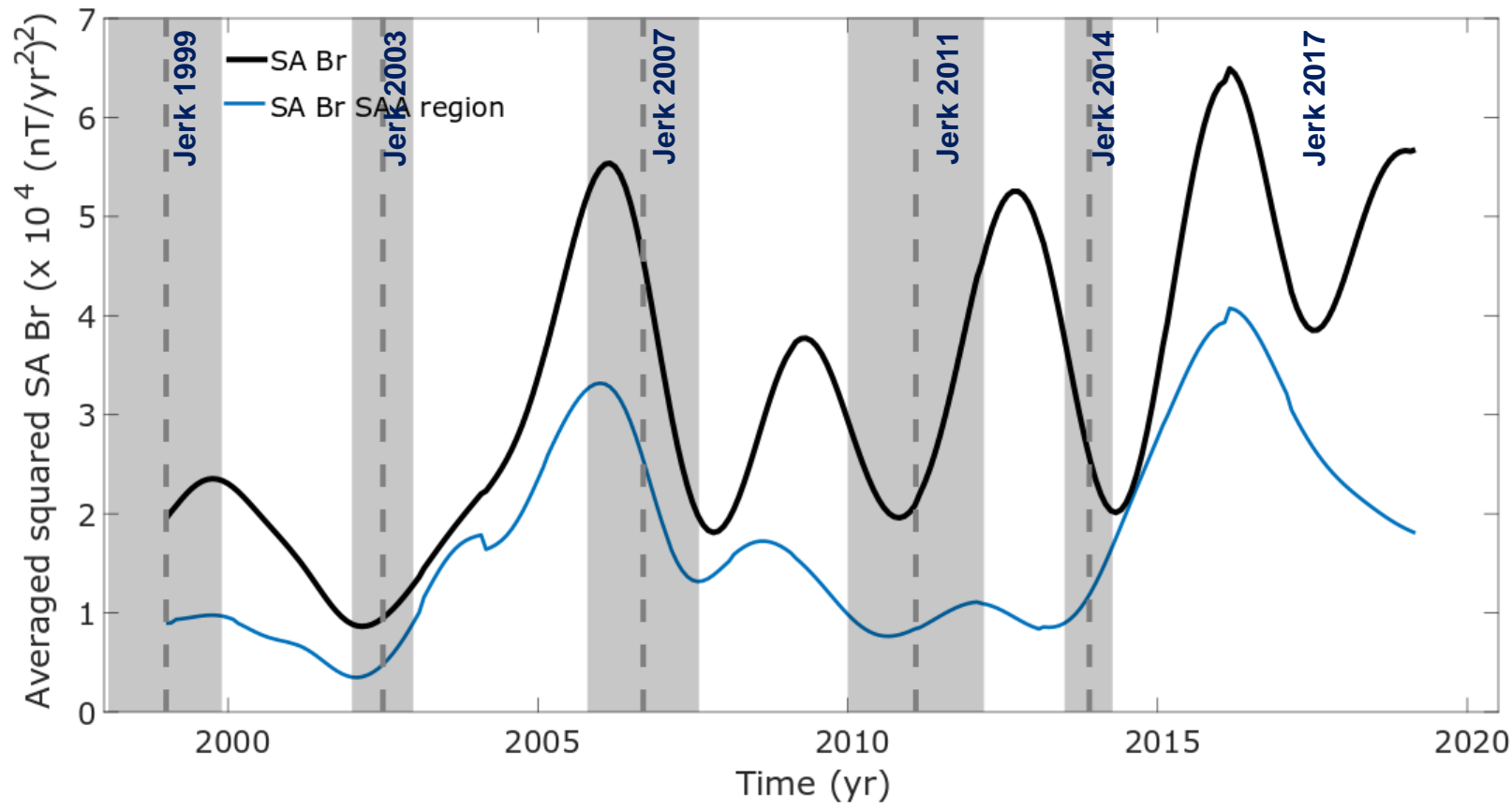
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**Standing MHD wave**

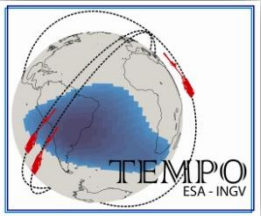


## 2. Geomagnetic jerks at core-mantle boundary (CMB)

Squared secular acceleration power of the radial component of the geomagnetic field at CMB beneath the South Atlantic Anomaly region



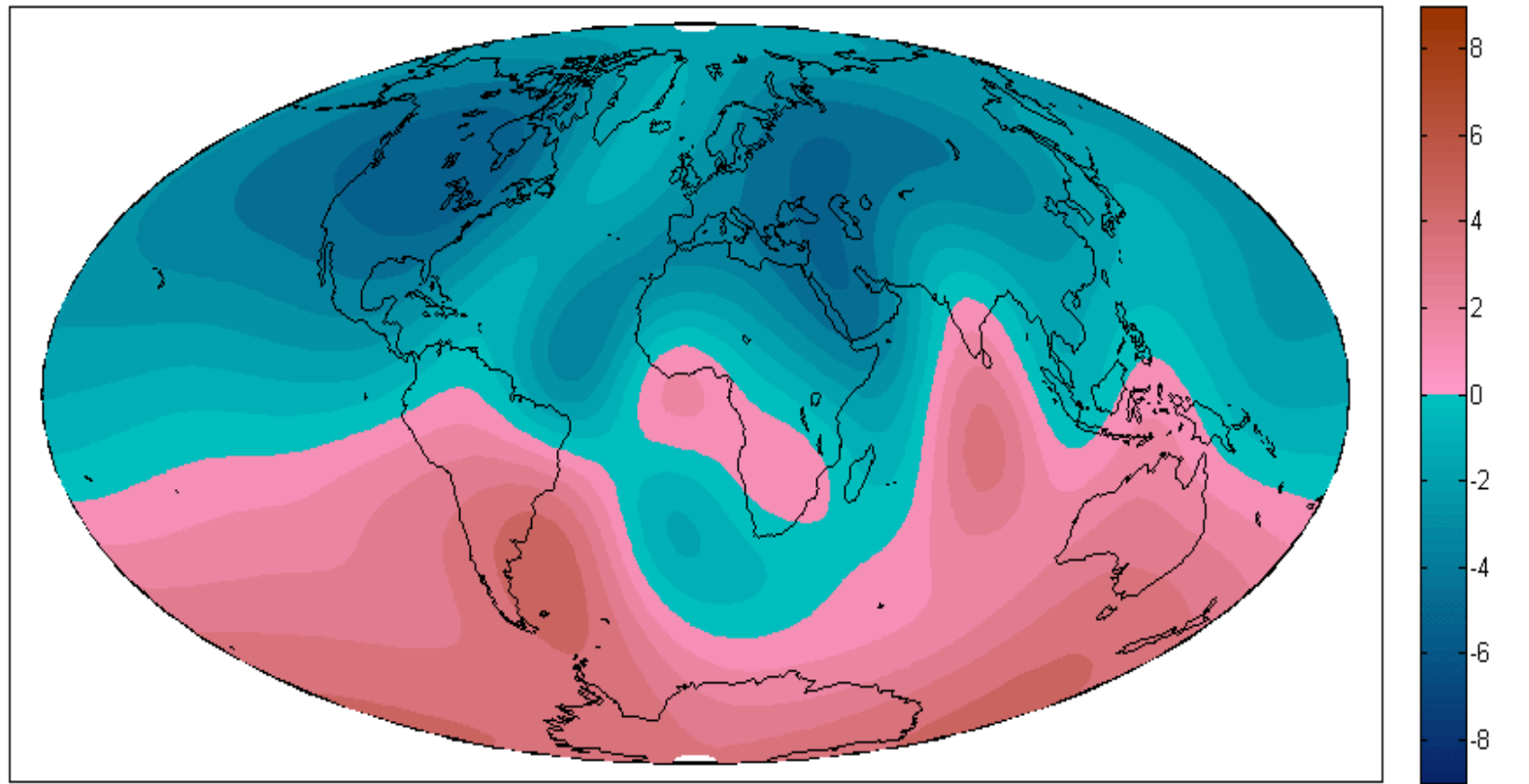
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### 3. South Atlantic Anomaly (SAA) at CMB

Time evolution maps of the radial component of the geomagnetic field at CMB from 1590 until now (every 5 years): reversal flux patches (RFPs).

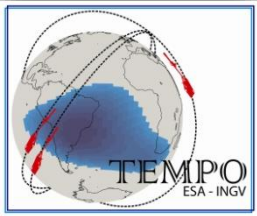
Br (nT) at the CMB at 1590



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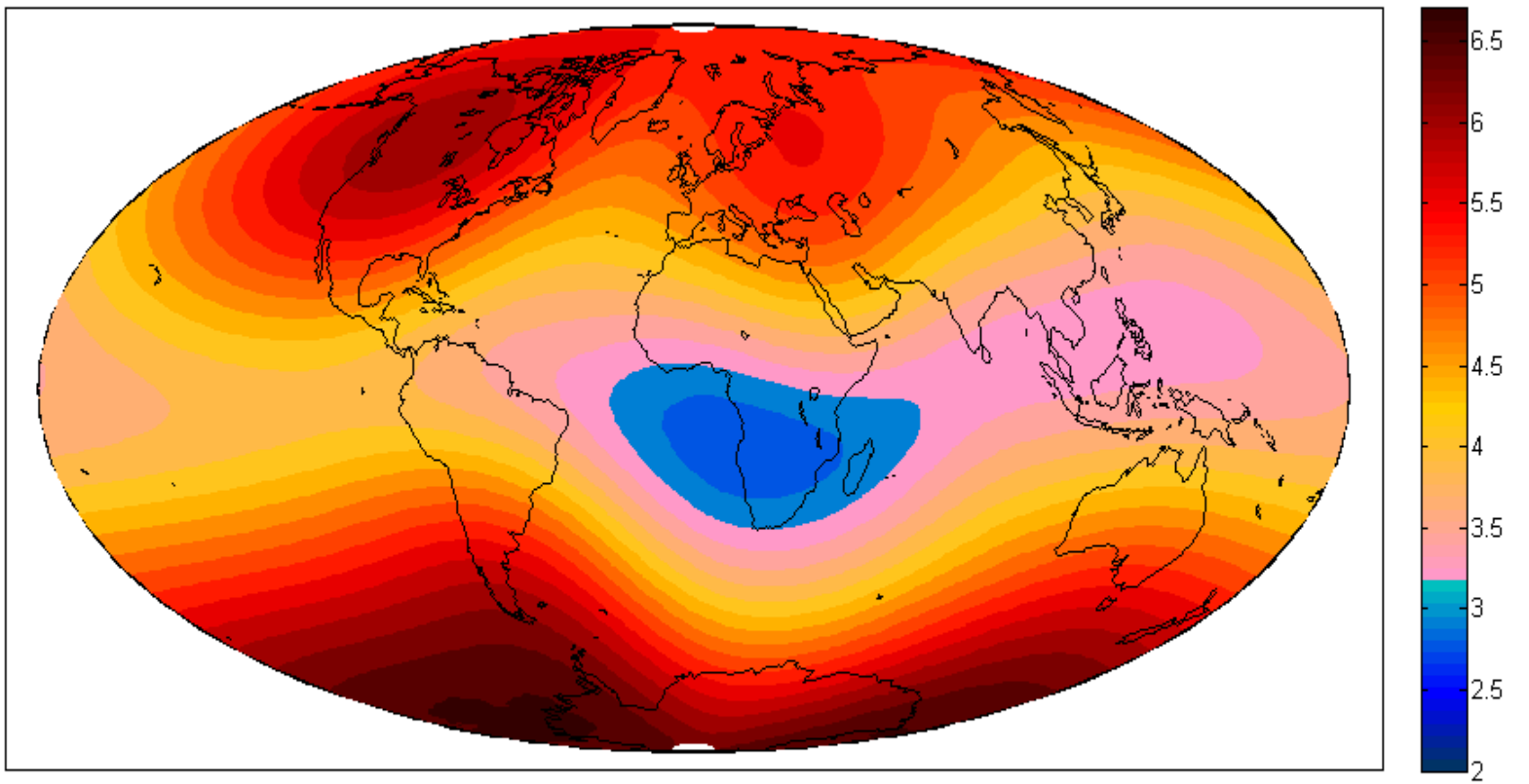




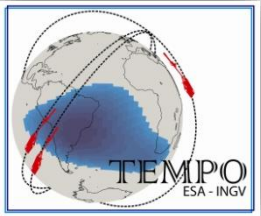
### 3. South Atlantic Anomaly (SAA) at surface

Time evolution maps of the geomagnetic field intensity at Earth's surface from 1590 until now (every 5 years). The SAA extent area is given by the isoline of 32000 nT.

Intensity (nT) at 1590

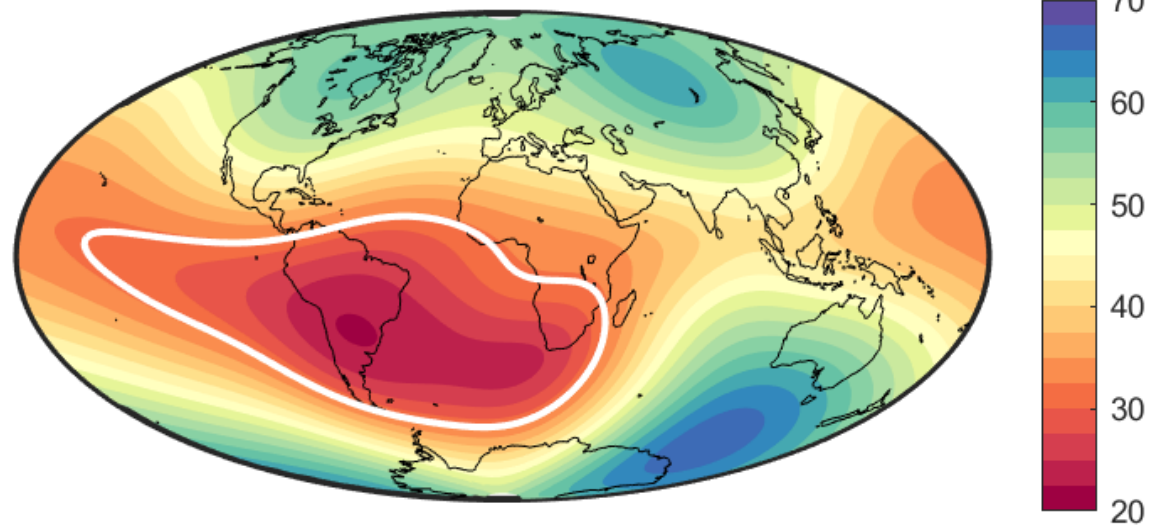


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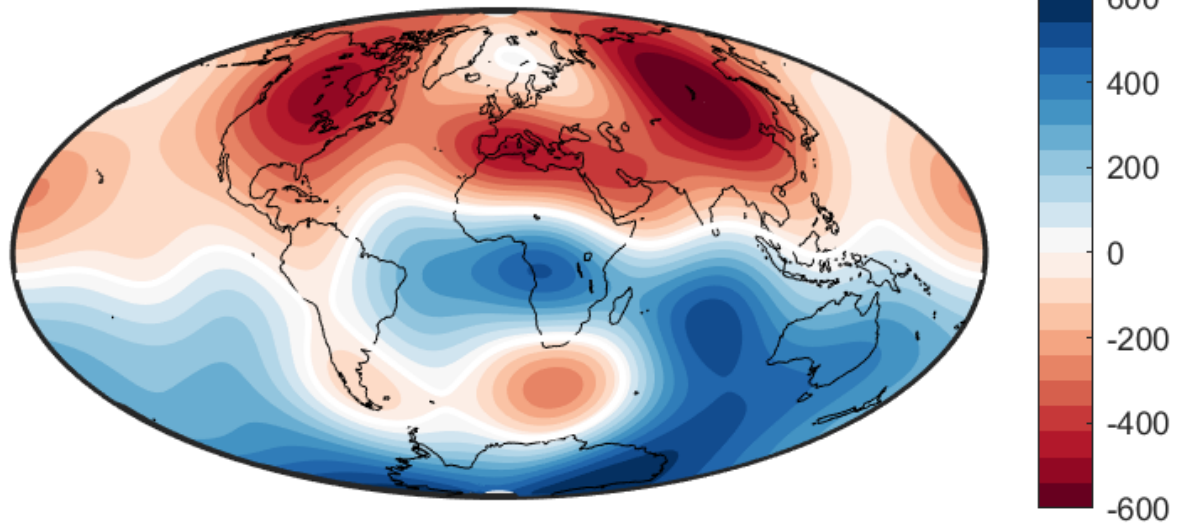


### 3. South Atlantic Anomaly (SAA) in 2020

Intensity ( $\mu\text{T}$ )



$B_r$  ( $\mu\text{T}$ ) at CMB



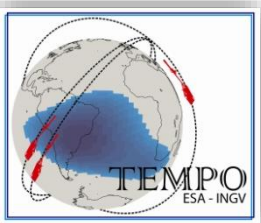
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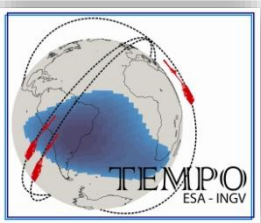


## 4. Swarm mission (ESA)

- 3 identical satellites (Alpha, Bravo, Charlie).
- Data from 26 Nov, 2013.
- Alpha and Charlie fly at 460 km of altitude.
- Bravo at 510 km of altitude.

Swarm (ESA, 2013 – now)

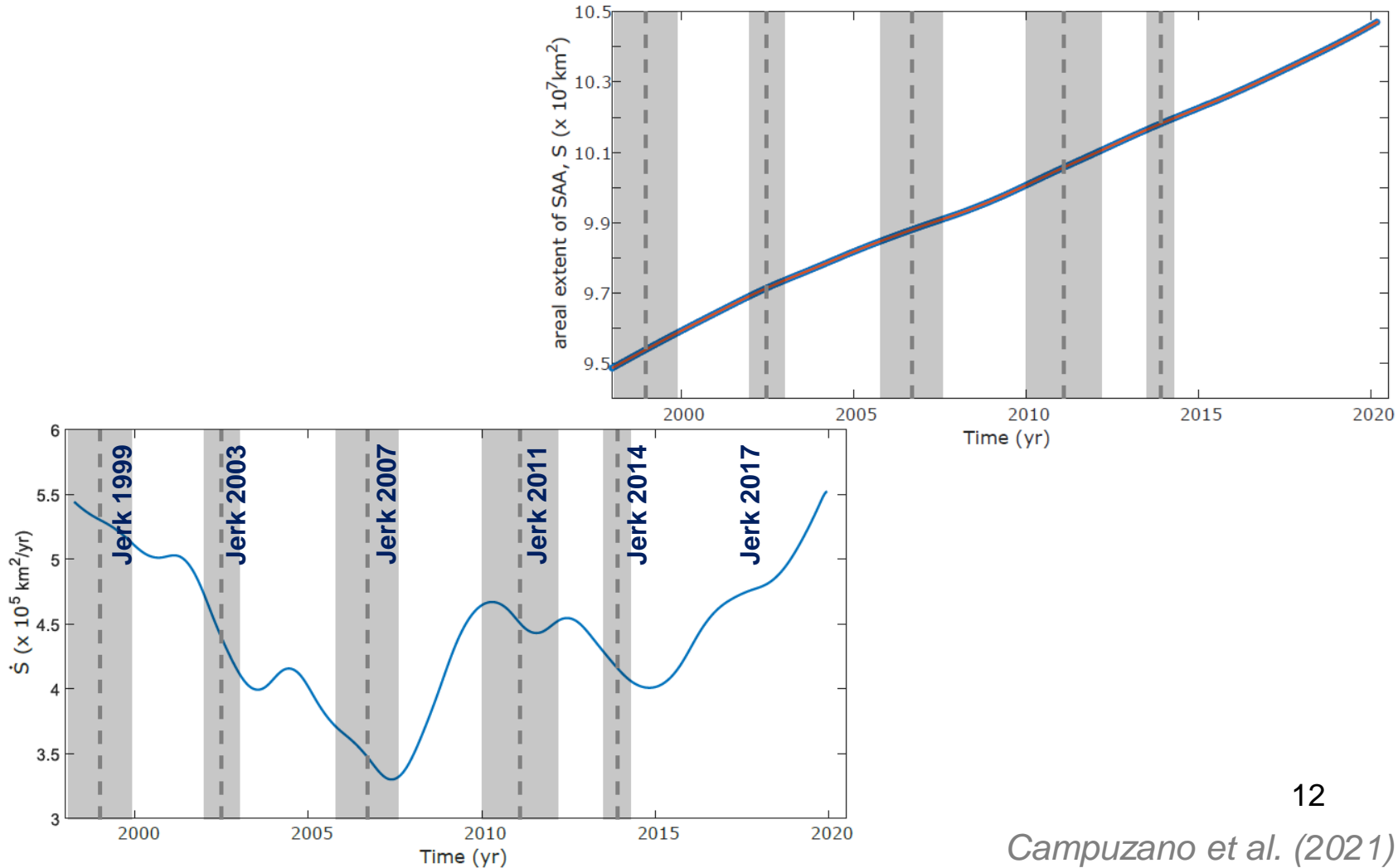


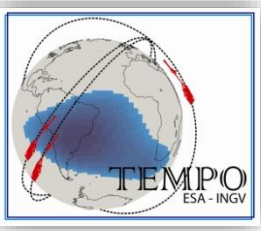


# 5. SAA – geomagnetic jerks

Areal extent of SAA and first time derivative using the CHAOS-7.2 model. The time-rates of the SAA are an indicator of global geomagnetic field changes:

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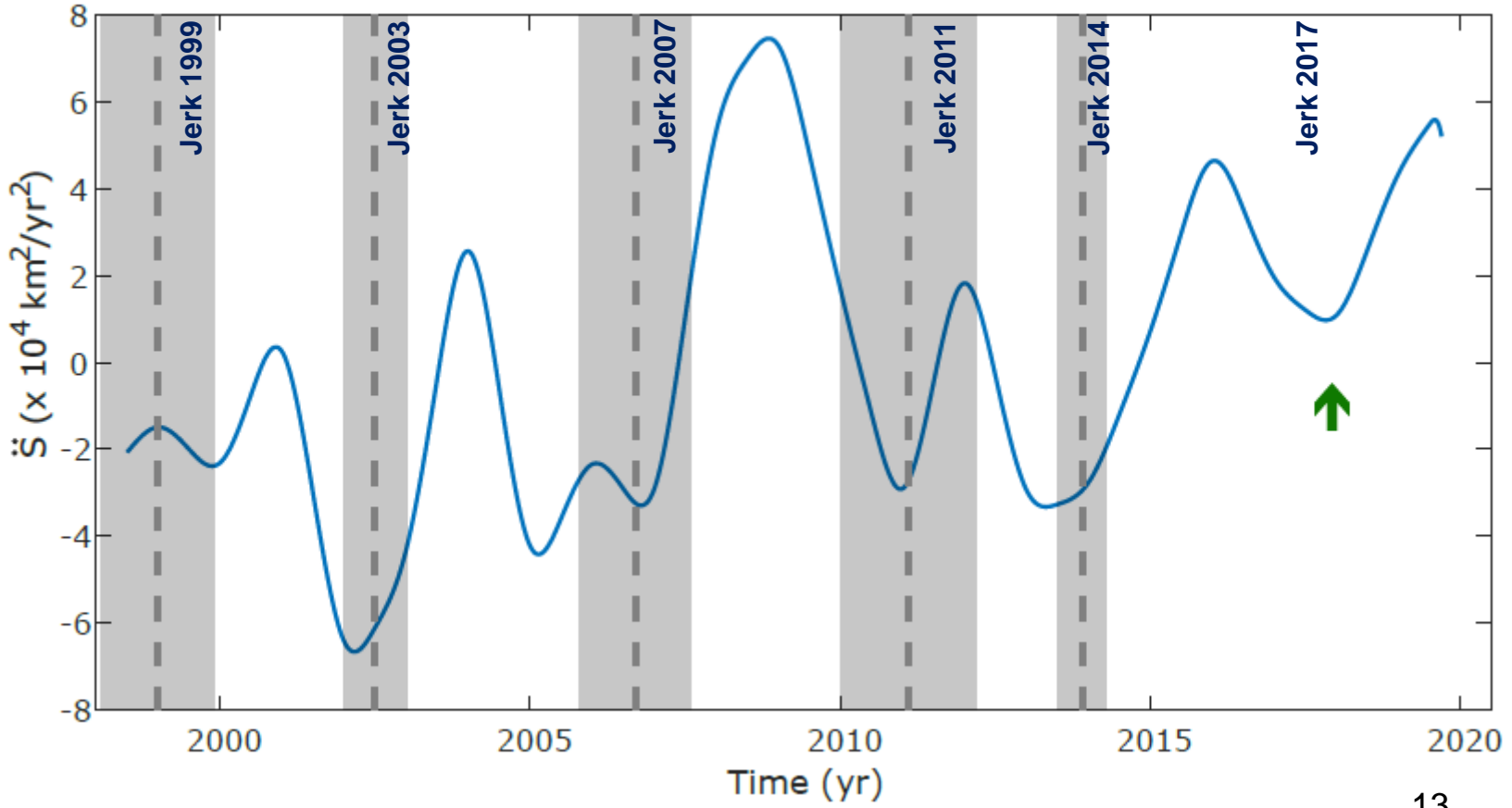


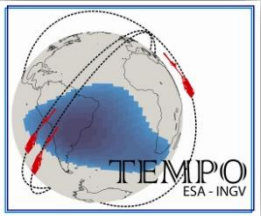
## 5. SAA – geomagnetic jerks

Second time derivative of the SAA areal extent using the CHAOS-7.2 model. The time-rates of the SAA areal extent are an indicator of global geomagnetic field changes:

***the geomagnetic jerks***

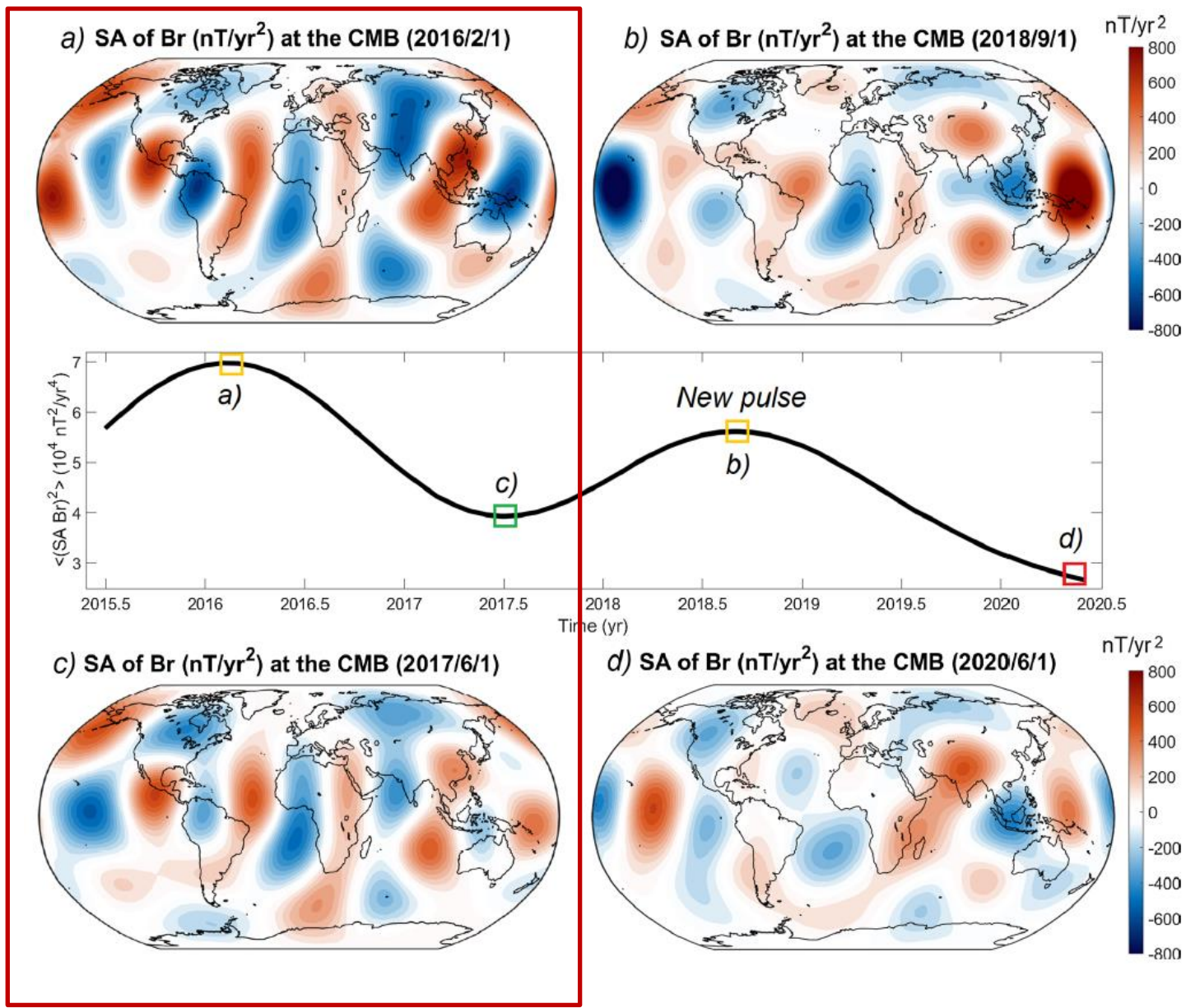
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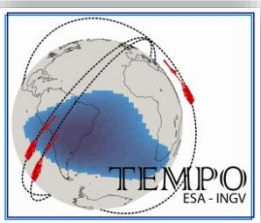




# 5. SAA – geomagnetic jerks

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# 6. New geomagnetic jerk!

## New jerk observed between 2019-2020!!

Pavón-Carrasco et al.  
Earth, Planets and Space (2021) 73:175  
<https://doi.org/10.1186/s40623-021-01504-2>

Earth, Planets and Space

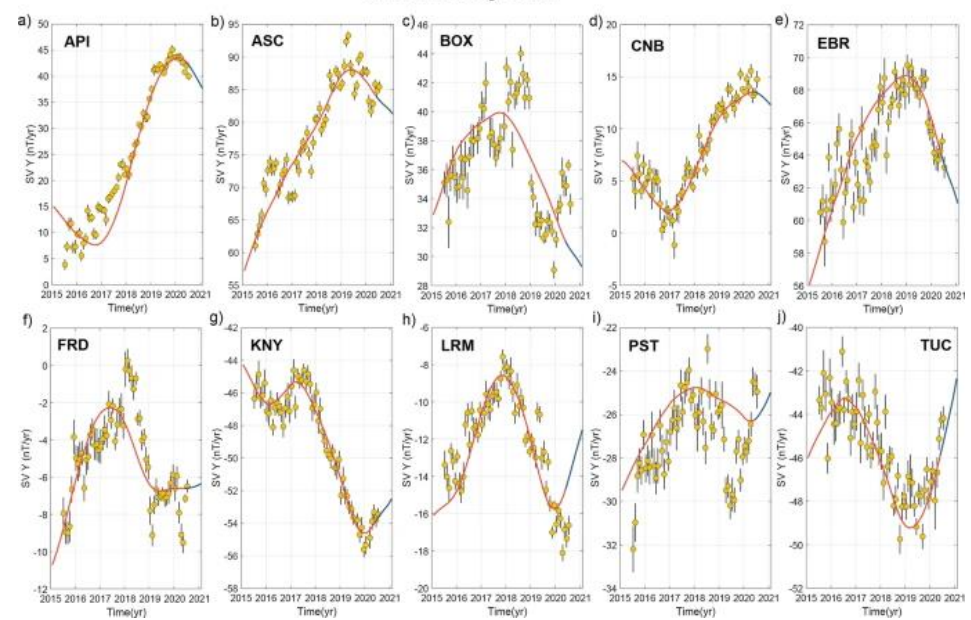
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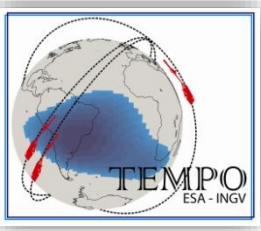
### Signs of a new geomagnetic jerk between 2019 and 2020 from Swarm and observatory data

F. Javier Pavón-Carrasco<sup>1\*</sup>, Santiago Marsal<sup>2</sup>, Saioa A. Campuzano<sup>3</sup> and J. Miquel Torta<sup>2</sup>

Signs of a new geomagnetic jerk between 2019 and 2020 from Swarm and observatory data



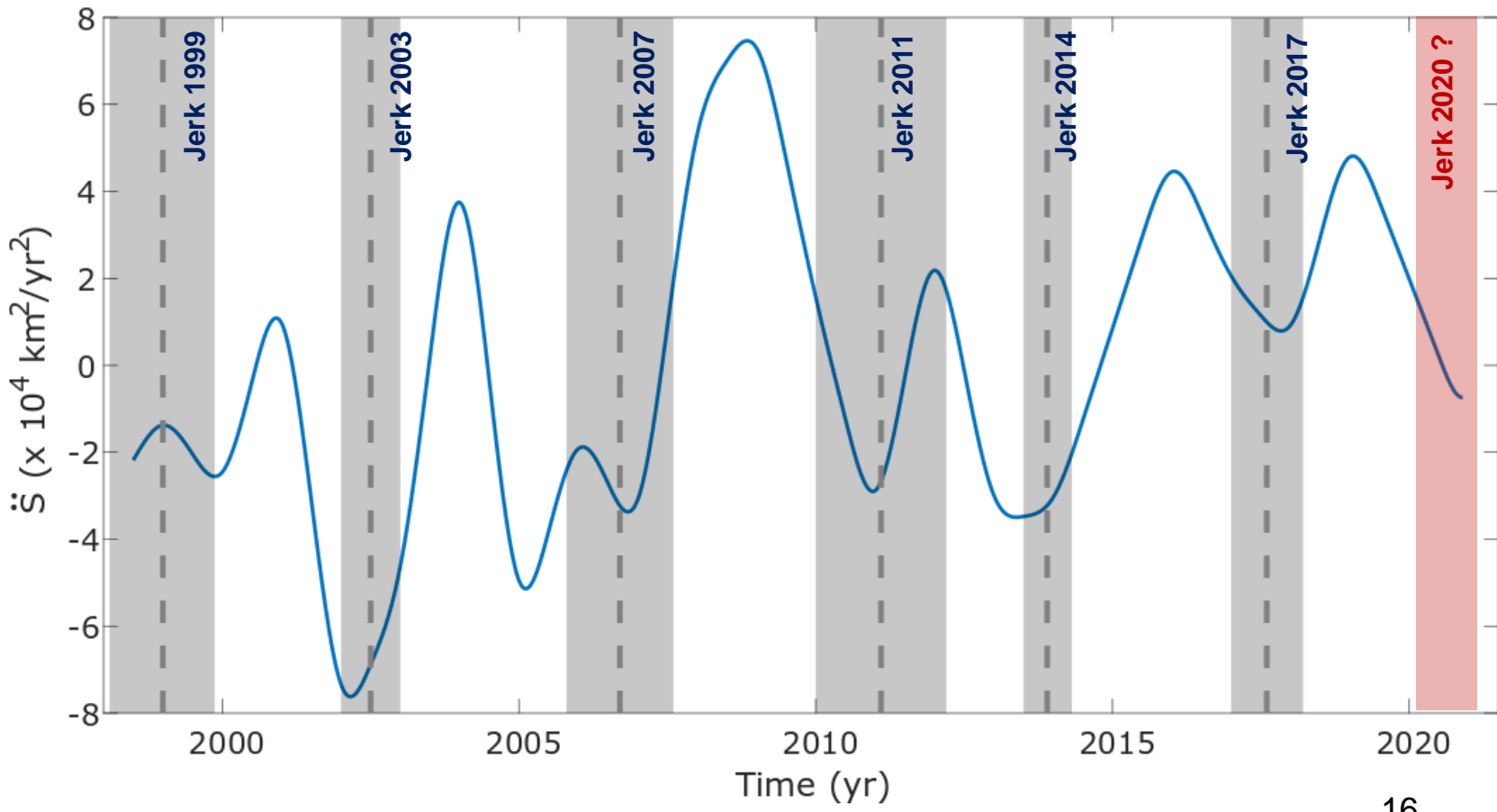
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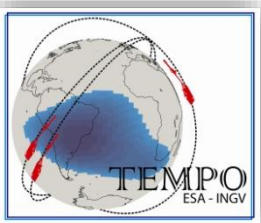
## 6. New geomagnetic jerk?

A new minimum of the secular acceleration of the SAA areal extent seems to be observed in the next few years (with CHAOS-7.8)

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## 7. Conclusions

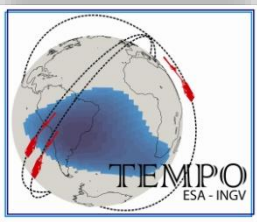
- South Atlantic Anomaly areal extent acceleration minima indicate geomagnetic jerks for the satellite era
- Link indicates a dynamic instability in the Earth's core at the origin of geomagnetic jerks



Alfvén waves and RFPs?

Jerk origin: Kloss and Finlay (2019), Aubert and Finlay (2019)

- The new geomagnetic jerk is indicated



This presentation is based on:

 **frontiers**  
in Earth Science

ORIGINAL RESEARCH  
published: 14 January 2021  
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# South Atlantic Anomaly Areal Extent as a Possible Indicator of Geomagnetic Jerks in the Satellite Era

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E. Qamili<sup>5</sup>*

**Thank you for your attention**  
**Grazie per la vostra attenzione**

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