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ST4.2 Session Chat Mon,
04 May, 08:30–10:15
EGU2020-18174

aguerrero@uah.es



REALTIME GEOMAGNETIC INDICES FOR MID-LATITUDES

MID-R, MID-E, MID-U AND MID-L

Antonio Guerrero, Elena Saiz and Consuelo Cid
SWE (Space Weather) research group, University of Alcalá

[Abstract](#)

[ACKNOWLEDGEMENTS](#) 

ABSTRACT

Mid latitudes around 40 degree are influenced by effects typically found at both high and low latitudes. Moreover, the focus of the Solar Quiet ionospheric current system, drifts around these mid-latitudes. Consequently they have been considered as a complicated place to infer the geospace state from the ground and also complicated for practical procedures to generate geomagnetic indices.

The procedure designed at the University of Alcala specially focused on removing solar regular variations at mid-latitudes is delivering a geomagnetic Local Disturbance index (LDi) in realtime. The same procedure can be used to produce global geomagnetic indices when applied to several geomagnetic stations at these latitudes.

We present in this work the high-resolution (one minute) realtime production of ring current and auroral indices (MID-R, MID-E, MID-U and MID-L) similar to the well known Dst and AE indices for mid-latitudes which will help in the understanding of the complex physical processes that emerge at these latitudes. At the same time they fill a gap in the current operational space weather products available for these latitudes.



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MOTIVATION

DAY TO DAY VARIABILITY AND SHAPE
NEAR THE FOCUS OF THE SQ

MID LATITUDES ARE AFFECTED
BY STORMS AND SUBSTORMS

EXTREME GEOMAGNETIC STORMS ARE
STILL NOT WELL UNDERSTOOD

SPACE WEATHER USERS' NEEDS

A SENTENCE FROM FUKUSHIMA, N. (1994)



MOTIVATION

PROCEDURE

LOCAL INDICES

GLOBAL INDICES

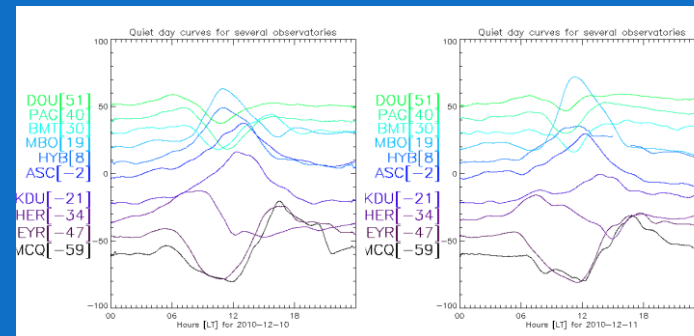
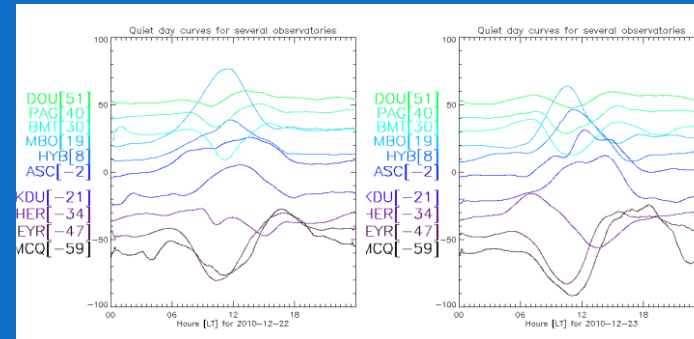
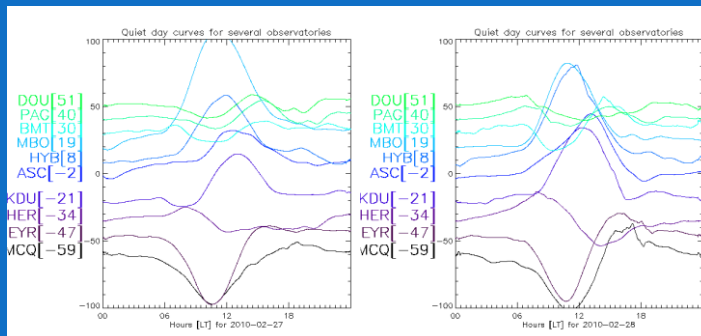
REALTIME

MOTIVATION

DIFFERENT CONSECUTIVE DAYS ON INTERNATIONAL QUIET DAYS

Considerable variability from one day to the next one of:

- The intensity during quiet days
 - See MBO at top-right figures
- The shape of the curve
 - See HER (near the focus of the Sq)



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MOTIVATION

PROCEDURE

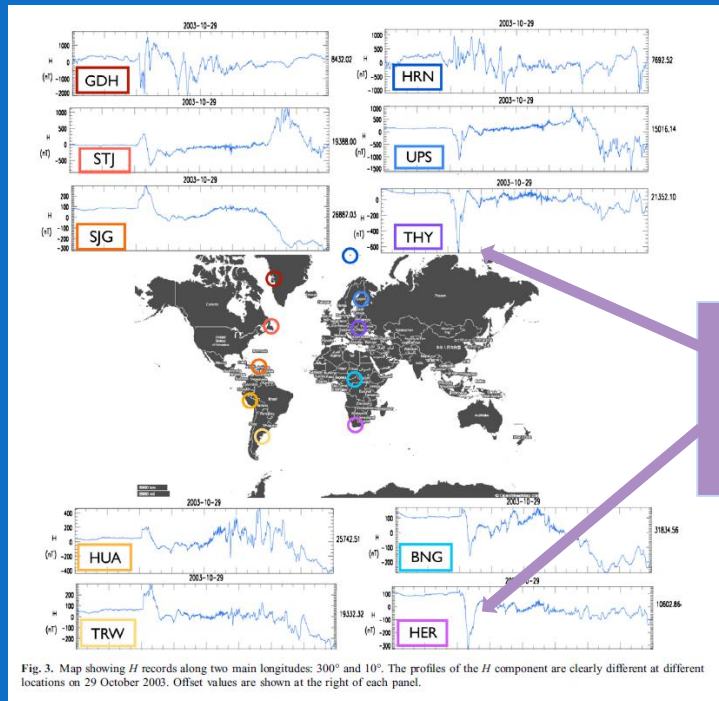
LOCAL INDICES

GLOBAL INDICES

REALTIME

MOTIVATION

EXTREME GEOMAGNETIC STORMS ARE STILL NOT WELL UNDERSTOOD



Cid, C., Palacios, J., Saiz, E., Guerrero, A., & Cerrato, Y. (2014).

On extreme geomagnetic storms.

Journal of Space Weather and Space Climate, 4, A28.



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MOTIVATION

PROCEDURE

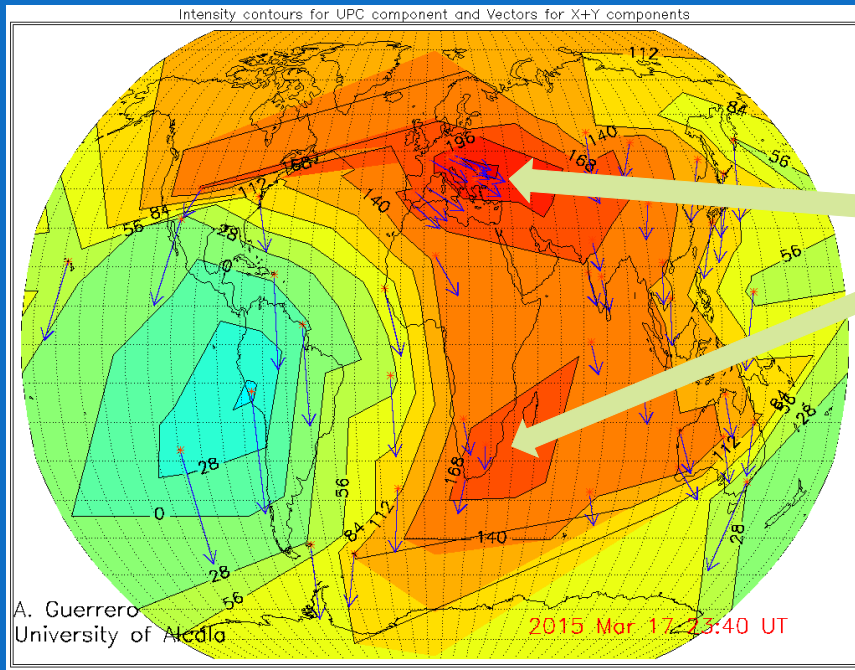
LOCAL INDICES

GLOBAL INDICES

REALTIME

MOTIVATION

MID LATITUDES ARE AFFECTED BY STORMS AND SUBSTORMS



Unpredicted substorm effects
during the San-Patrick storms

UPC SIGNAL FROM GUERRERO ET. AL, 2017

Guerrero, A., Palacios, J., Rodríguez-Bouza, M., Rodríguez-Bilbao, I., Aran, A., Cid, C., ... & Cerrato, Y. (2017).
Storm and substorm causes and effects at midlatitude location for the St. Patrick's 2013 and 2015 events.
Journal of Geophysical Research: Space Physics, 122(10), 9994-10.



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MOTIVATION

PROCEDURE

LOCAL INDICES

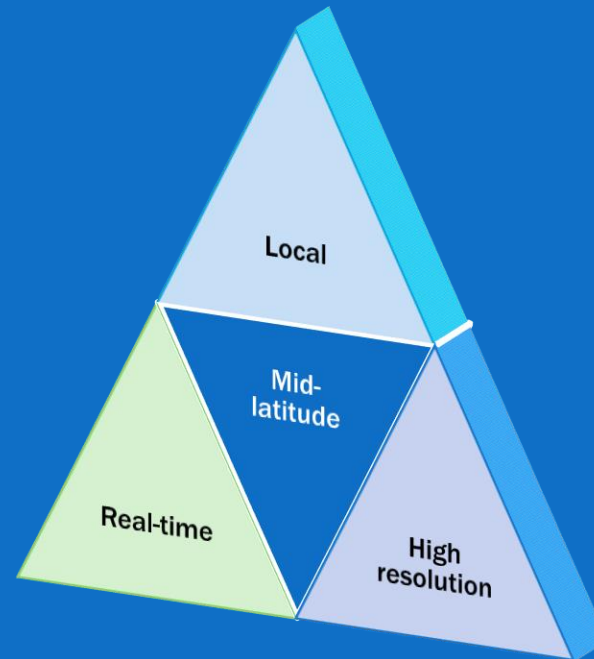
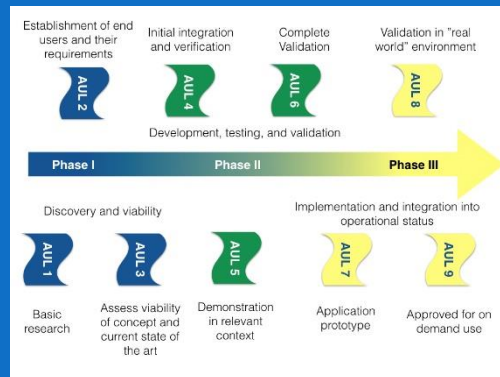
GLOBAL INDICES

REALTIME

MOTIVATION

SPACE WEATHER USERS' NEEDS

MID LATITUDE GEOMAGNETIC INDICES PRESENTED IN THIS WORK ARE BASED ON LDI, WHICH IS A PROCEDURE TO OBTAIN LOCAL GEOMAGNETIC INDICES. THIS PROCEDURE HAS BEEN AN EXAMPLE OF HOW TO REACH THE LAST LEVEL OF THE AUL FRAMEWORK, SPECIALLY DESIGNED FOR SPACE WEATHER USERS'S NEEDS.



Cid, C., Guerrero, A., Saiz, E., Halford, A. J., & Kellerman, A. C.
 Developing the LDi and LCi geomagnetic indices, an example of application of the AULs framework.
Space Weather. 2019



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MOTIVATION

PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME

MOTIVATION

“The complicated phenomena, such as magnetic storms, must be discussed both statistically and for individual examples; these two different approaches are really complimentary and not to be confronted each other. In fact, we must pay attention to the fact that the study of individual storms was initiated by scientists living in high latitudes, whereas those living in moderate or low latitudes preferred to deal with them statistically.”

Fukushima, N. (1994), Some topics and historical episodes in geomagnetism and aeronomy, J. Geophys. Res.,99(A10), 19113–19142, doi:[10.1029/94JA00102](https://doi.org/10.1029/94JA00102).



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MOTIVATION

PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME

PROCEDURE

FROM LOCAL TO GLOBAL INDICES

LDi-FRN

LDi-SPT

LDi-IRT

LDi-BSL

LDi-SUA

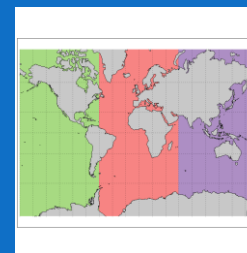
LDi-MMB

MID-R, MID-U, MID-L, MID-E

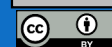
STEP 2: Process local indices to obtain global indices

STEP 1: Obtain Local Disturbance indices [LDi] for six stations at mid latitude.

- The stations are located around 40° geomagnetic latitude.
- Located wide in longitude
- Representing three geographical sectors



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MOTIVATION

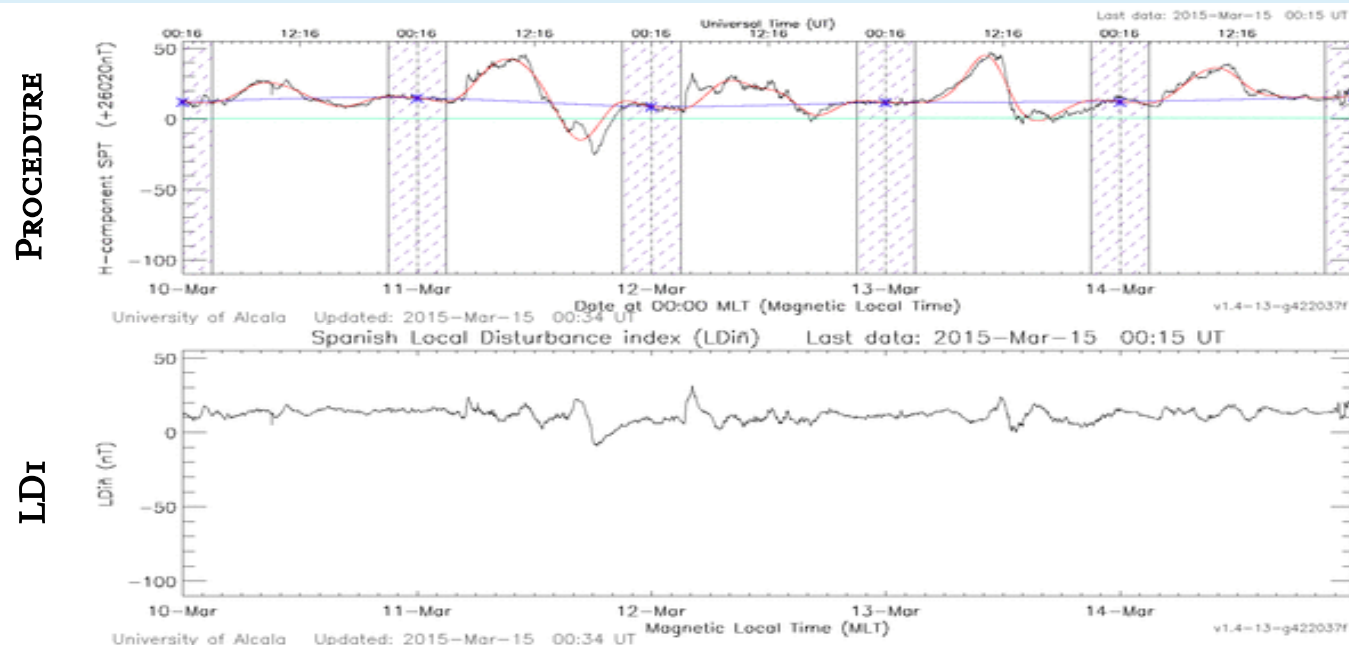
PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME

LOCAL INDICES



RETROSPECTIVE LDI (1999-2018) FOR THE STATIONS INVOLVED

LDi-FRN

LDi-SPT

LDi-IRT

LDi-BSL

LDi-SUA

LDi-MMB

HOW ARE THEY
PRODUCE?

HOME



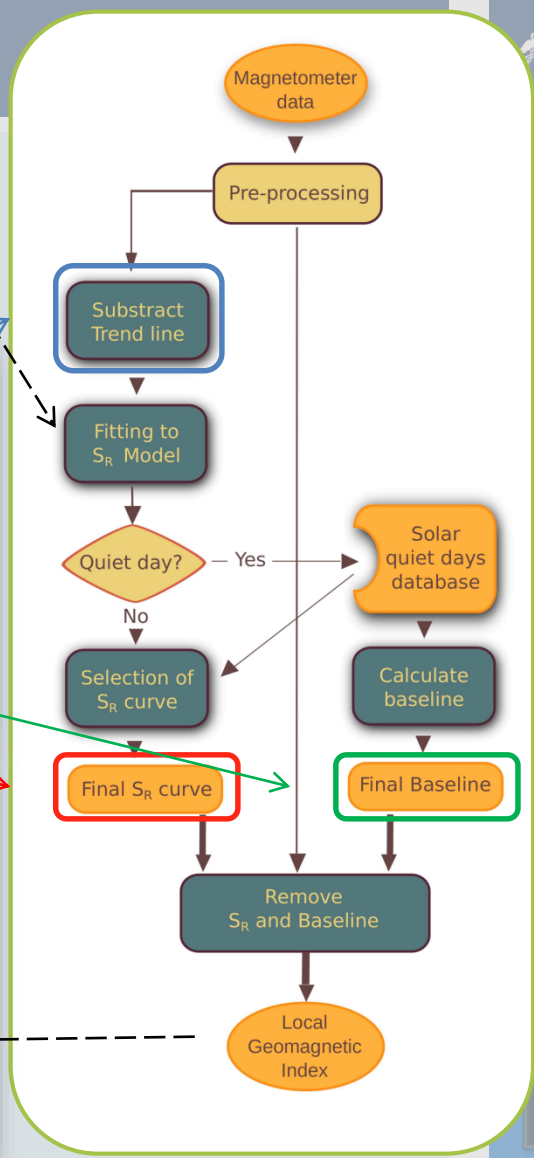
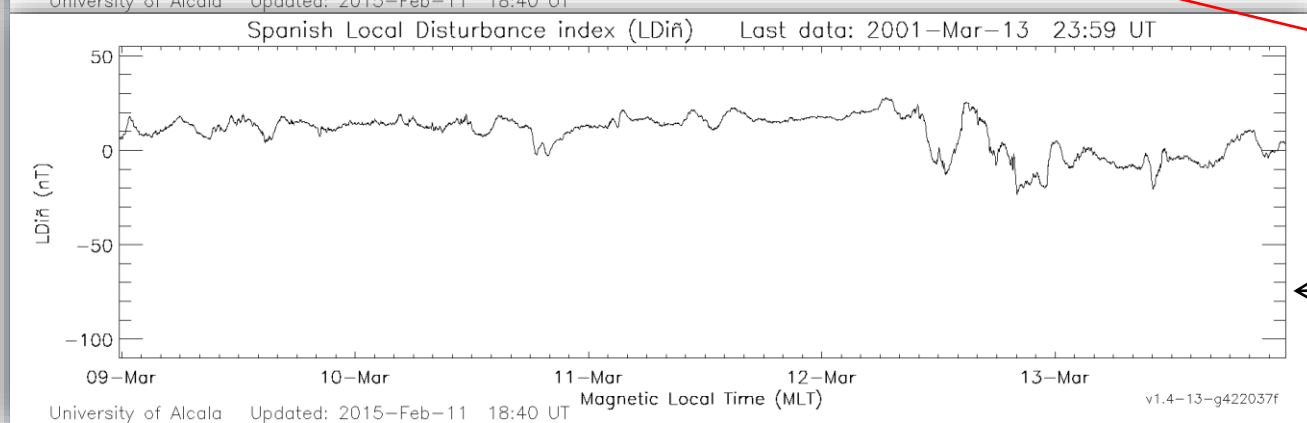
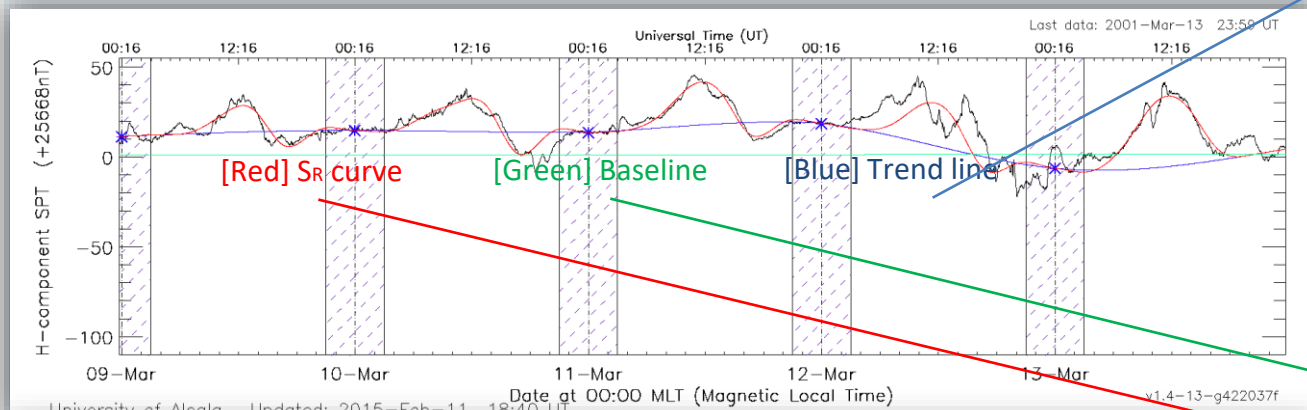
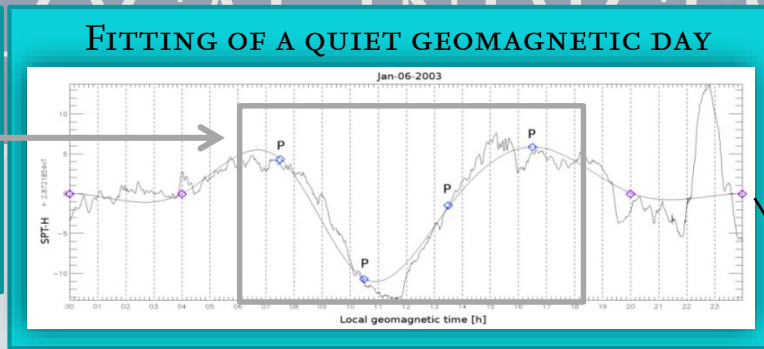
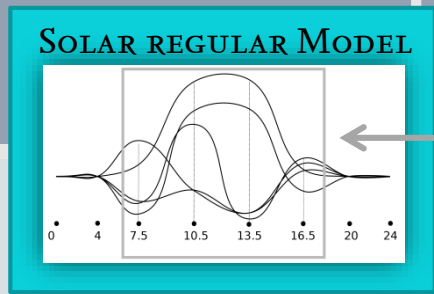
MOTIVATION

PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME



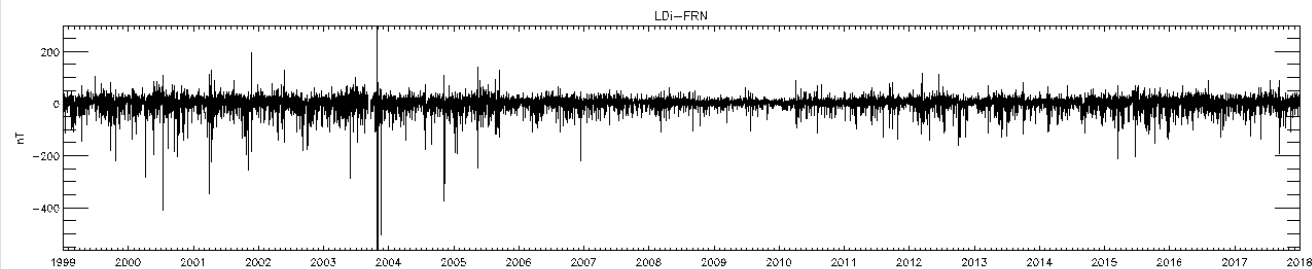
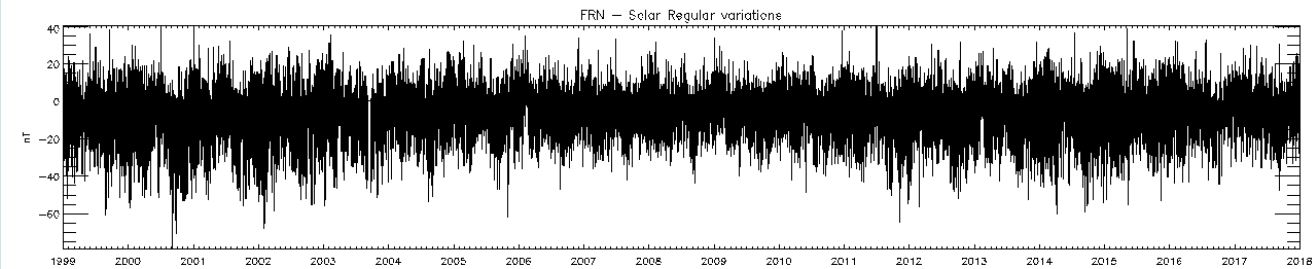
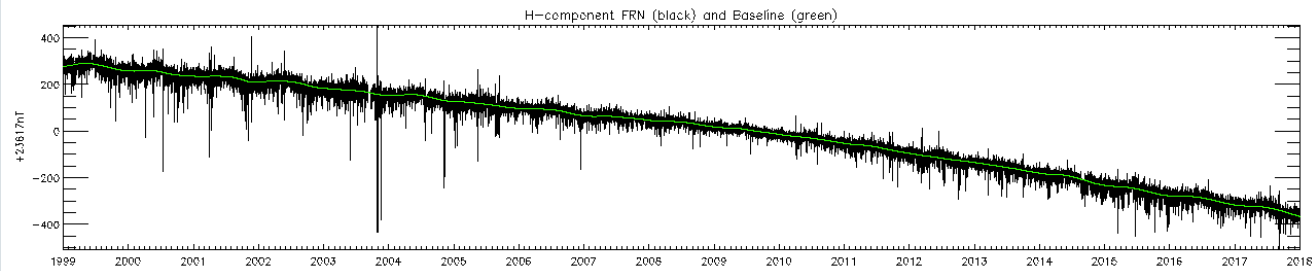
GUERRERO A, CID C, SAIZ E,
PALACIOS J & CERRATO Y.
DEVICE AND METHOD FOR
OBTAINING LOCAL
GEOMAGNETIC
DISTURBANCES AT MID-
LATITUDES
PATENT N°: EP17778719.9A

GLOBAL INDICES

REALTIME

LOCAL INDICES

LDi-FRN



OBSERVATORY DATA

BASELINE

SOLAR REGULAR
VARIATIONS

LOCAL GEOMAGNETIC
INDEX FOR FRN



HOME



MOTIVATION

PROCEDURE

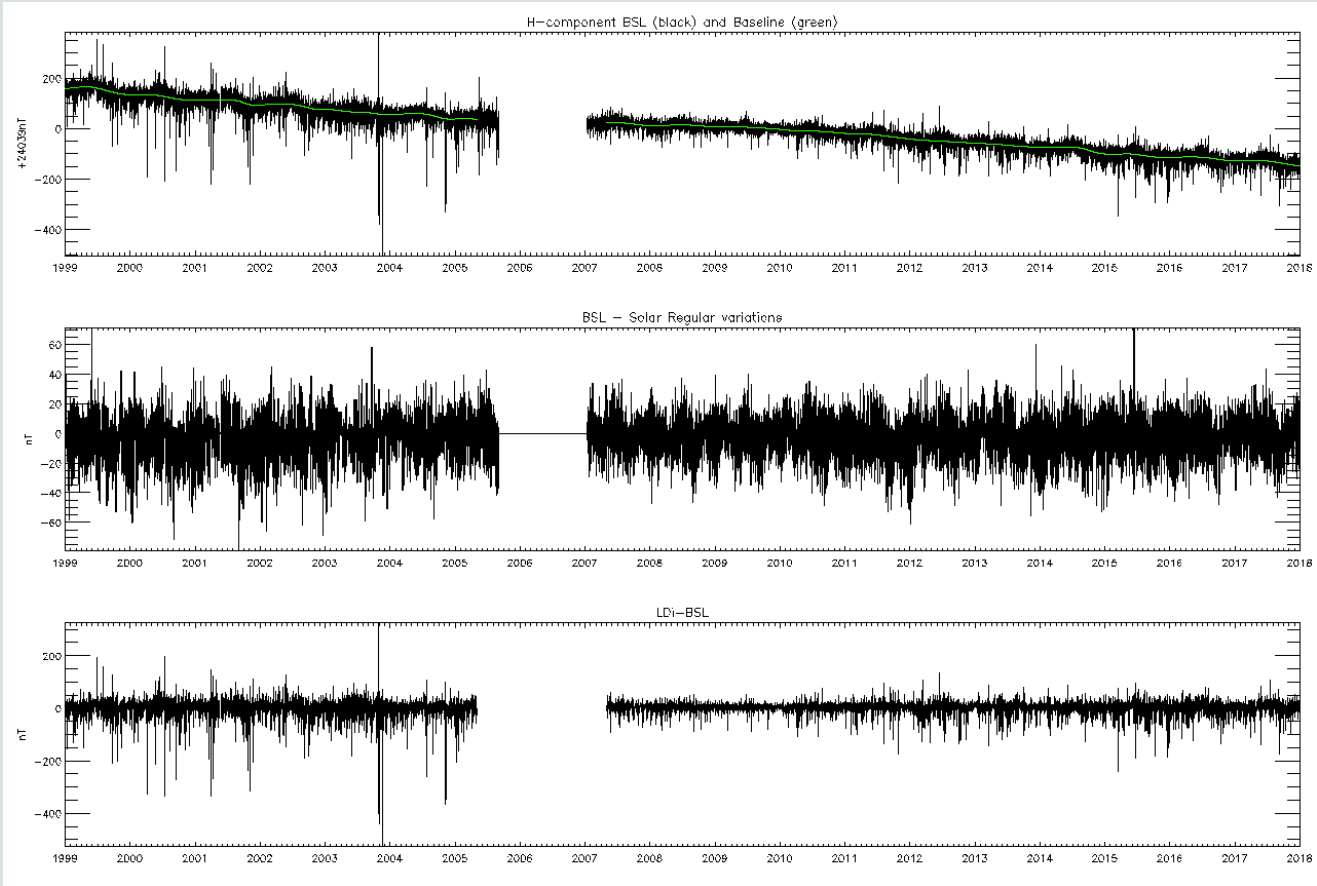
LOCAL INDICES

GLOBAL INDICES

REALTIME

LOCAL INDICES

LDi-BSL



OBSERVATORY DATA

BASELINE

SOLAR REGULAR
VARIATIONS

LOCAL GEOMAGNETIC
INDEX FOR FRN



MOTIVATION

PROCEDURE

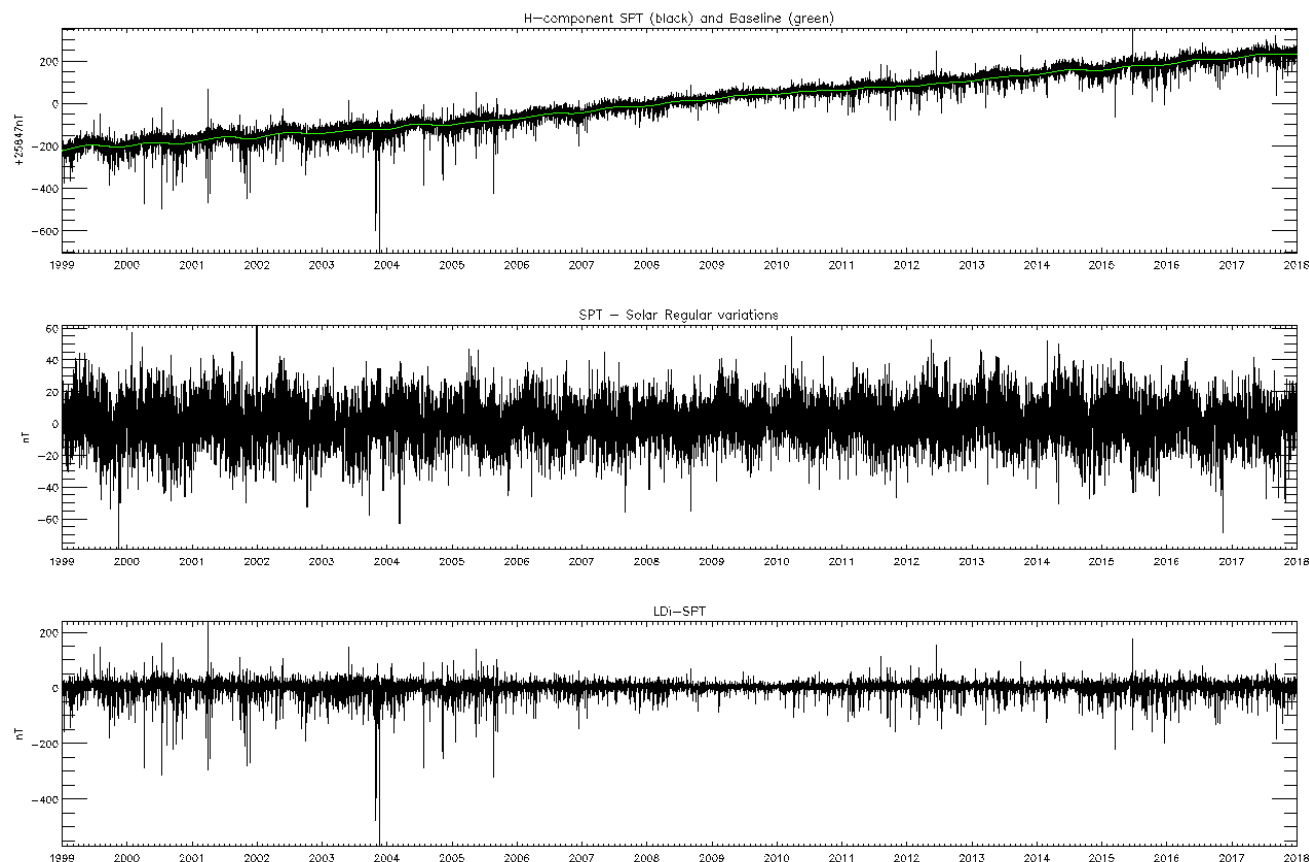
LOCAL INDICES

GLOBAL INDICES

REALTIME

LOCAL INDICES

LDi-SPT



OBSERVATORY DATA

BASELINE

SOLAR REGULAR
VARIATIONS

LOCAL GEOMAGNETIC
INDEX FOR FRN



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MOTIVATION

PROCEDURE

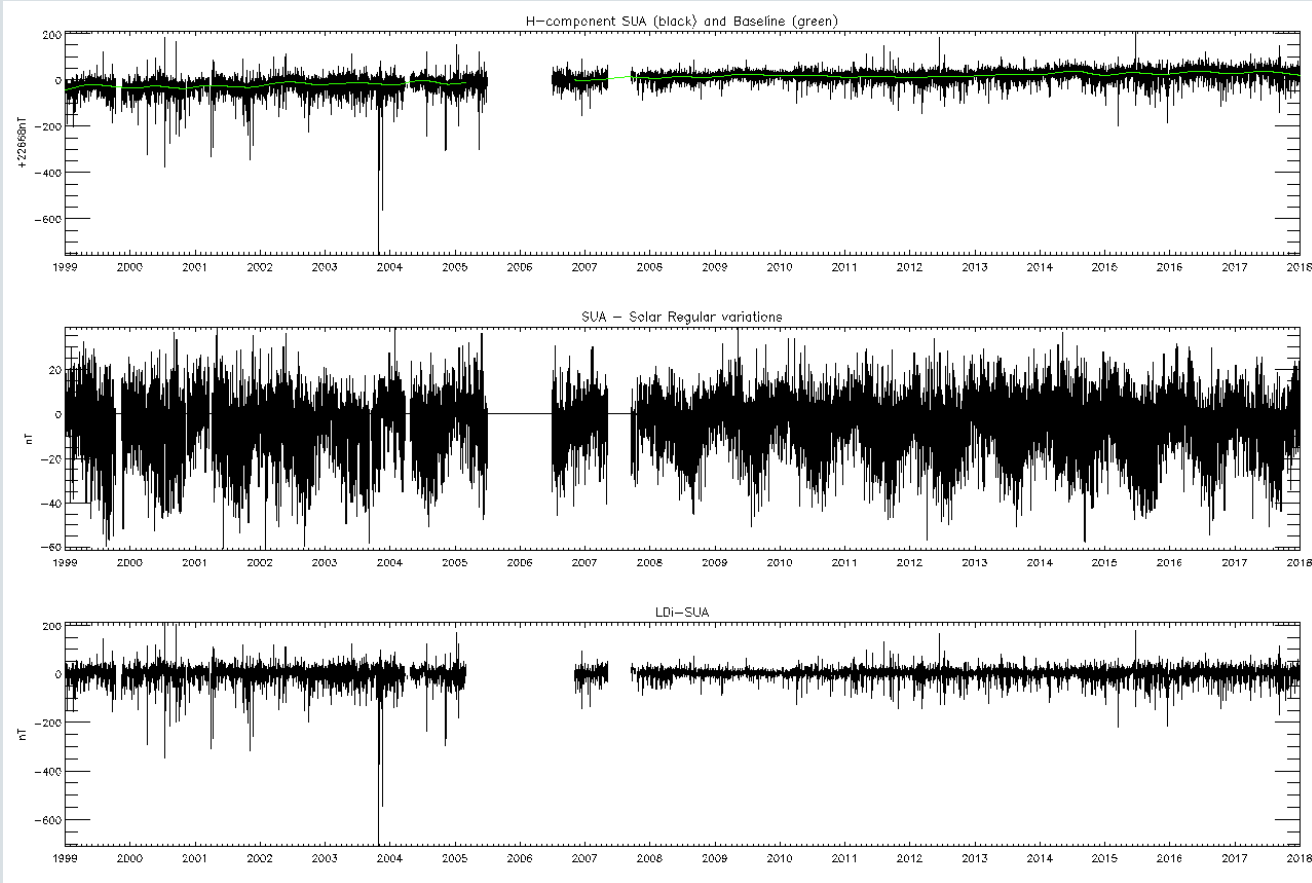
LOCAL INDICES

GLOBAL INDICES

REALTIME

LOCAL INDICES

LDi-SUA



OBSERVATORY DATA

BASELINE

SOLAR REGULAR
VARIATIONS

LOCAL GEOMAGNETIC
INDEX FOR FRN



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MOTIVATION

PROCEDURE

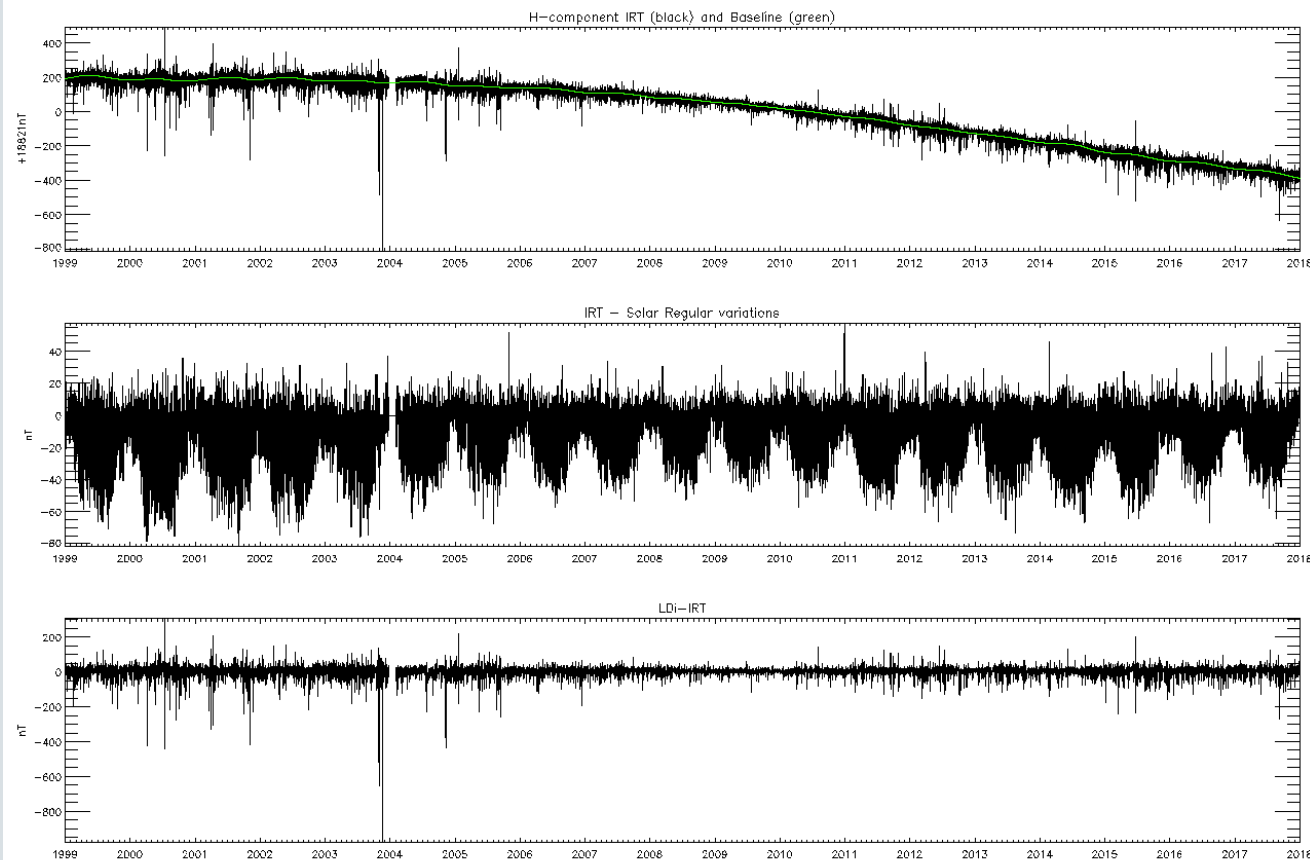
LOCAL INDICES

GLOBAL INDICES

REALTIME

LOCAL INDICES

LDi-IRT



OBSERVATORY DATA

BASELINE

SOLAR REGULAR
VARIATIONS

LOCAL GEOMAGNETIC
INDEX FOR FRN



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MOTIVATION

PROCEDURE

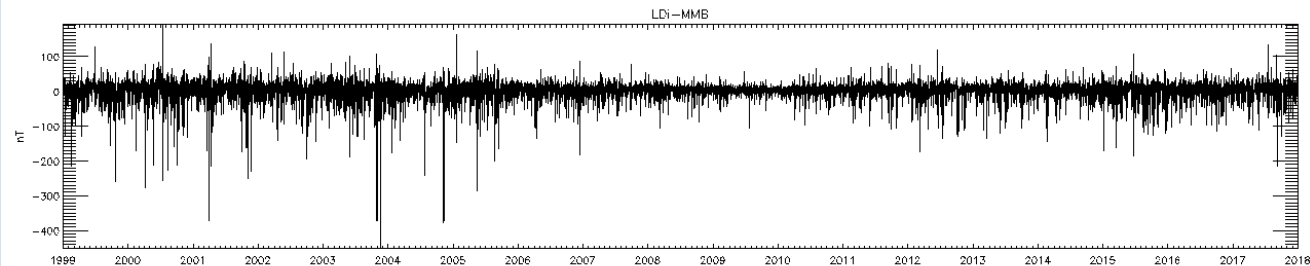
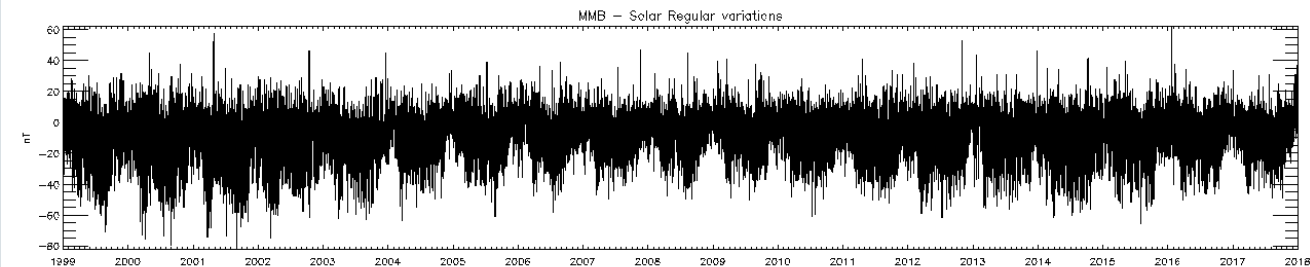
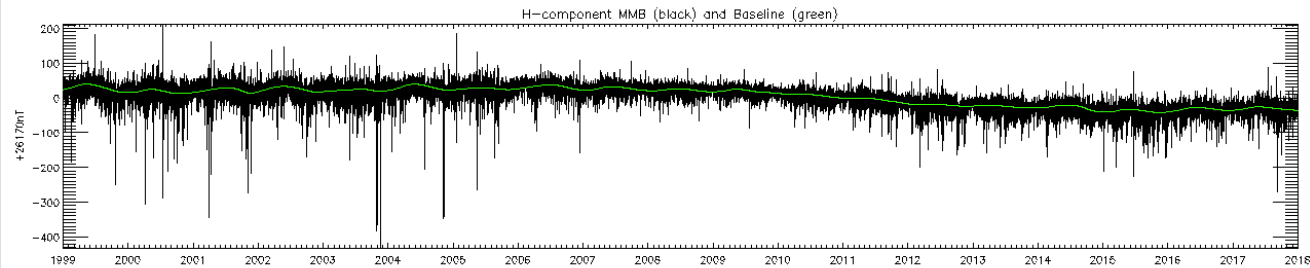
LOCAL INDICES

GLOBAL INDICES

REALTIME

LOCAL INDICES

LDi-MMB



OBSERVATORY DATA

BASELINE

SOLAR REGULAR
VARIATIONS

LOCAL GEOMAGNETIC
INDEX FOR FRN



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MOTIVATION

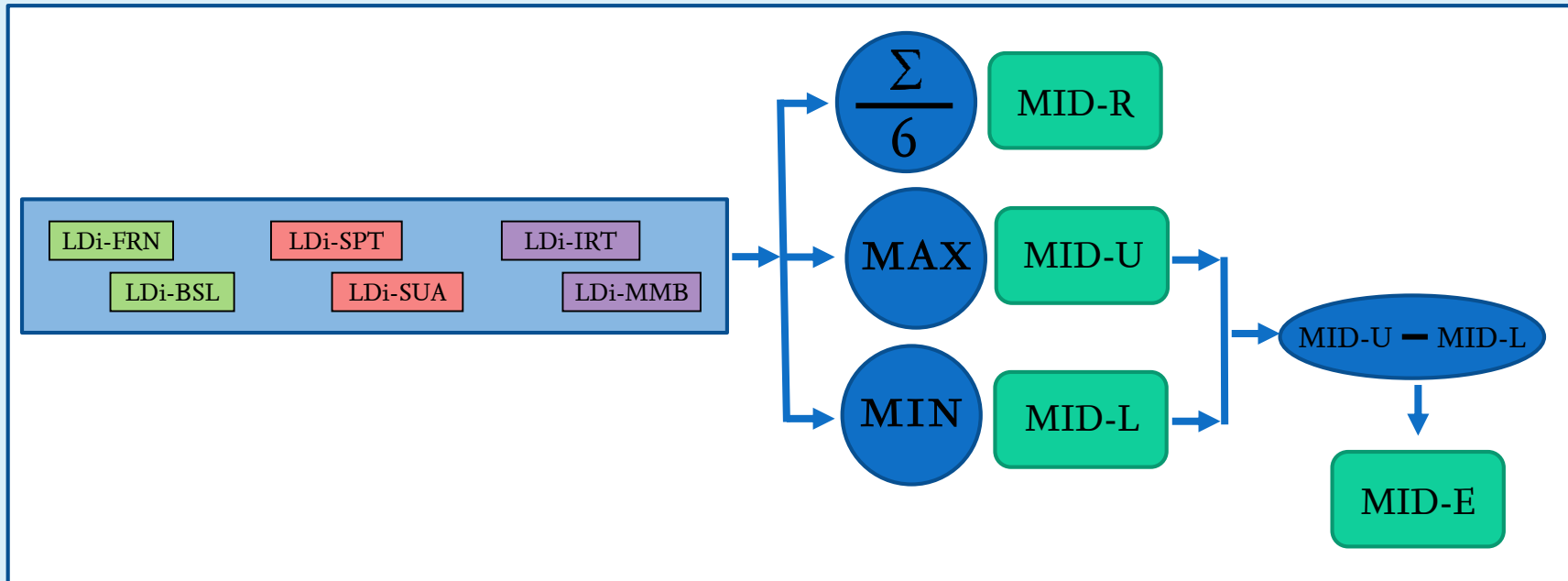
PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME

GLOBAL INDICES



SOME INTERESTING EVENTS:
STORM AND SUBSTORM EFFECTS

RETROSPECTIVE (1999-2018)
MID-R, MID-U, MID-L, MID-E



MOTIVATION

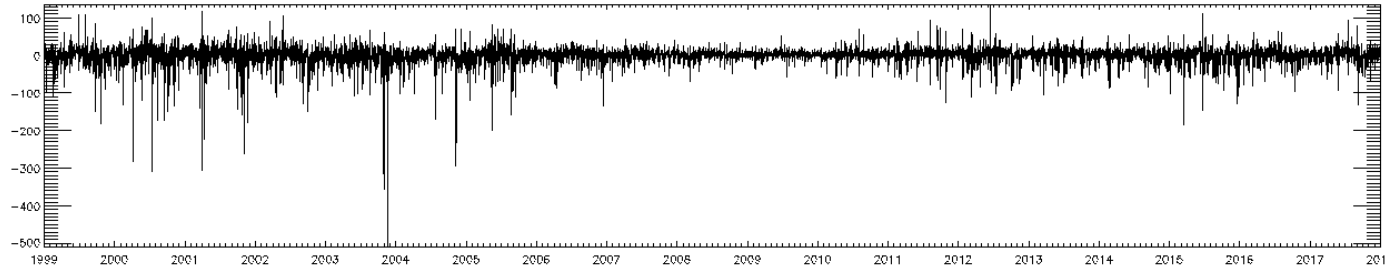
PROCEDURE

LOCAL INDICES

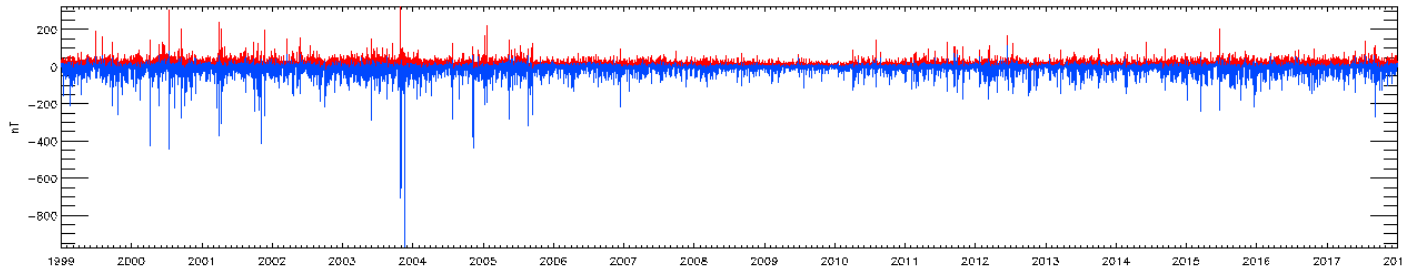
GLOBAL INDICES

REALTIME

GLOBAL INDICES

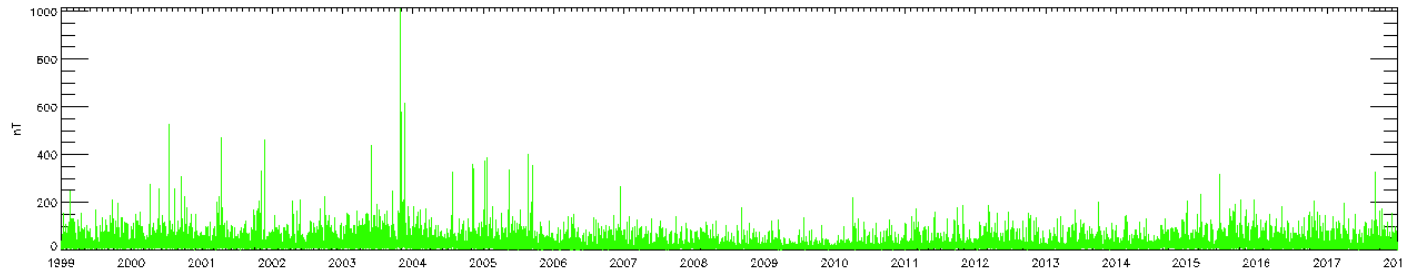


MID-R



MID-U

MID-L



MID-E



MOTIVATION

PROCEDURE

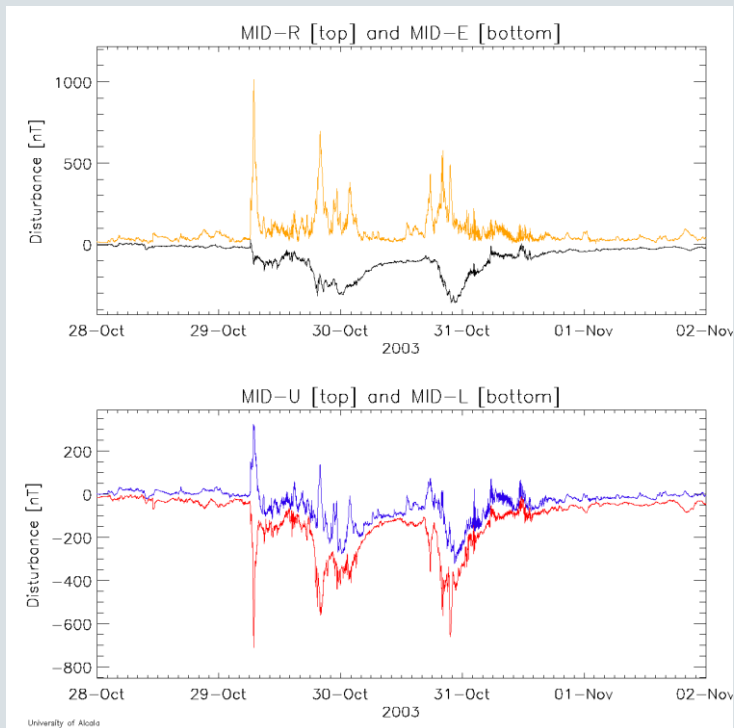
LOCAL INDICES

GLOBAL INDICES

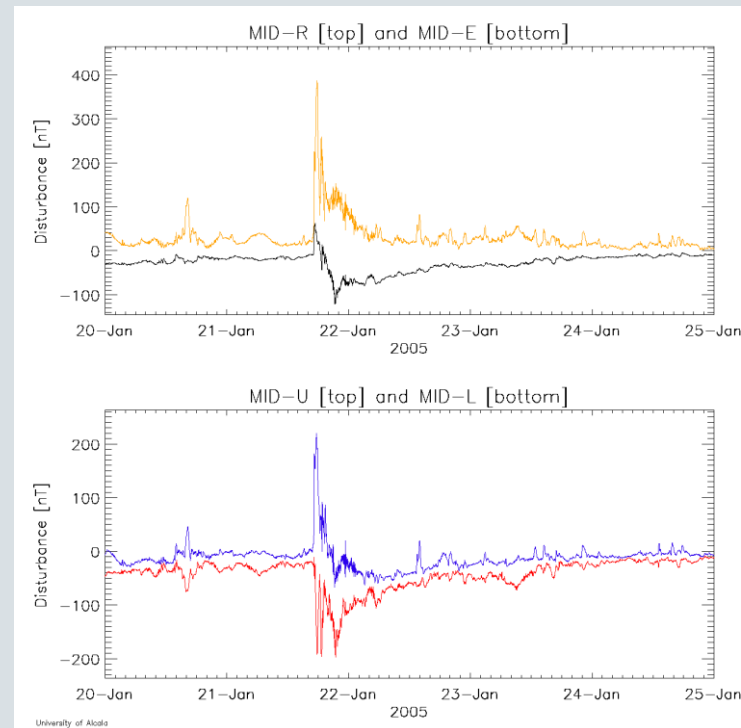
REALTIME

GLOBAL INDICES

SHOW ME THE STORM AND SUBSTORM EFFECTS



OCTOBER 2003: HALLOWEEN STORMS



JANUARY 2005

- BOTH EVENTS START WITH STRONG SPIKES DETECTED BY MID-U, MID-L AND MID-E
- THE SPIKES ARE UNDETECTABLE BY RING CURRENT INDICES (Dst, SYM-H OR MID-R) WHICH
- WHY?: THE STRONG DIVERSITY IN LOCAL DISTURBANCES [TO KNOW MORE ABOUT THE EVENTS]

TO KNOW
MORE ABOUT
THE EVENTS



HOME



MOTIVATION

PROCEDURE

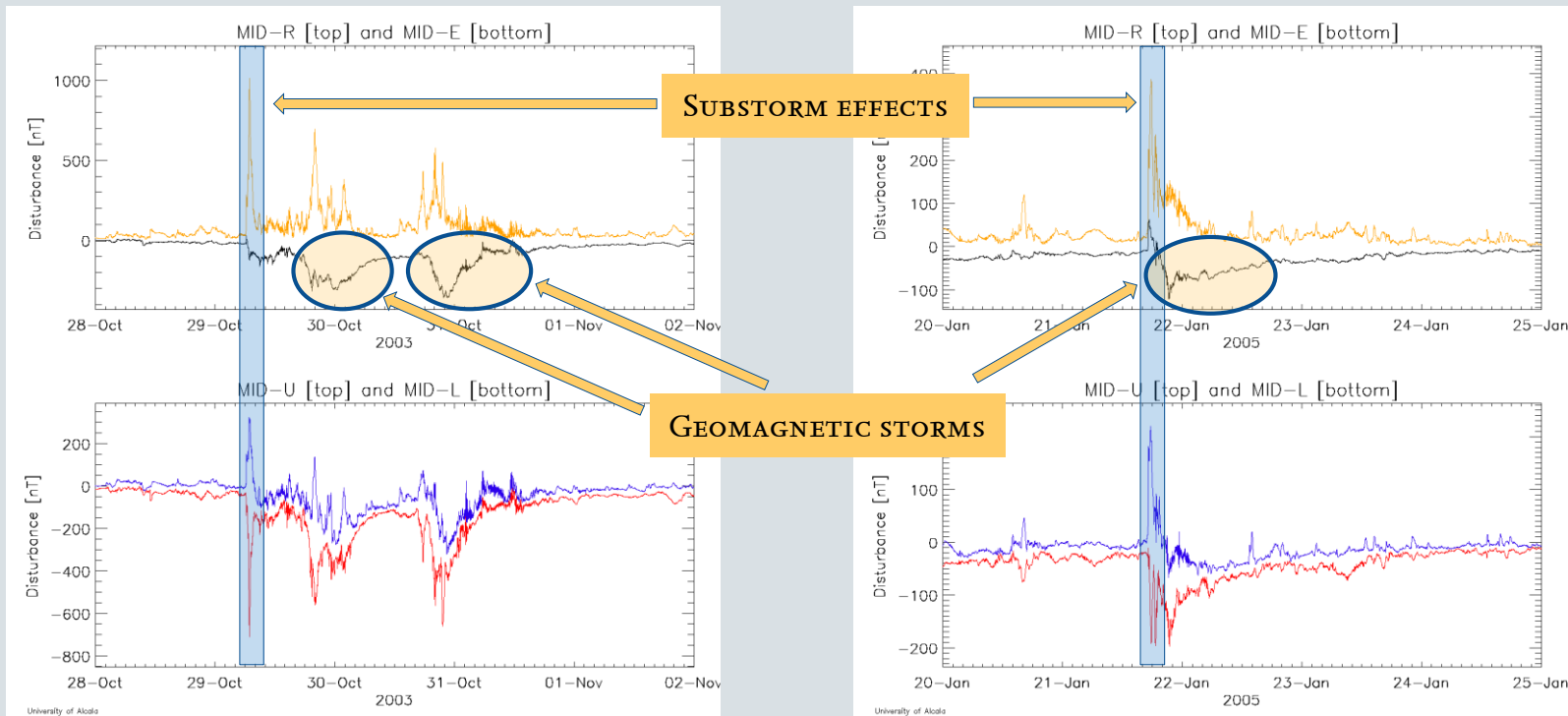
LOCAL INDICES

GLOBAL INDICES

REALTIME

GLOBAL INDICES

HIDE THE STORM AND SUBSTORM EFFECTS



OCTOBER 2003: HALLOWEEN STORMS

JANUARY 2005

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THE EVENTS



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MOTIVATION

PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME

GLOBAL INDICES

CID C, SAIZ E, GUERRERO A, PALACIOS J & CERRATO Y.

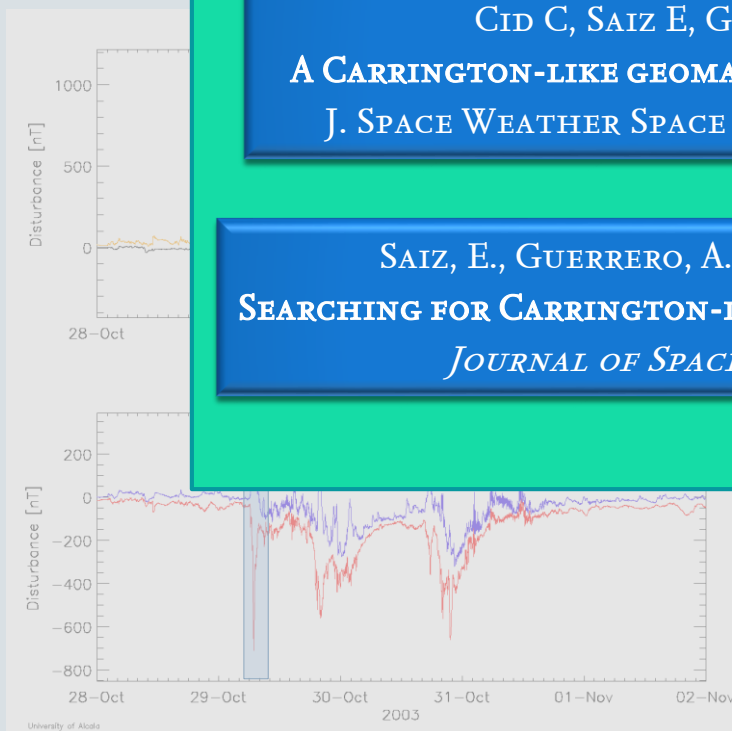
A CARRINGTON-LIKE GEOMAGNETIC STORM OBSERVED IN THE 21ST CENTURY.

J. SPACE WEATHER SPACE CLIM., 5, A16, 2015, DOI: 10.1051/swsc/2015017.

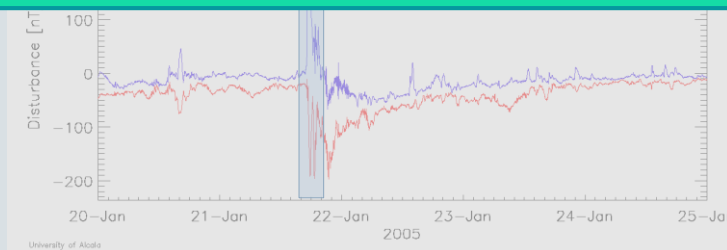
SAIZ, E., GUERRERO, A., CID, C., PALACIOS, J., & CERRATO, Y. (2016).

SEARCHING FOR CARRINGTON-LIKE EVENTS AND THEIR SIGNATURES AND TRIGGERS.

JOURNAL OF SPACE WEATHER AND SPACE CLIMATE, 6, A6.



OCTOBER 2003: HALLOWEEN STORMS



JANUARY 2005

- BOTH EVENTS START WITH STRONG SPIKES DETECTED BY MID-U, MID-L AND MID-E
- THE SPIKES ARE UNDETECTABLE BY RING CURRENT INDICES (Dst, SYM-H OR MID-R) WHICH
- WHY?: THE STRONG DIVERSITY IN LOCAL DISTURBANCES [TO KNOW MORE ABOUT THE EVENTS]

**TO KNOW
MORE ABOUT
THE EVENTS**



MOTIVATION

PROCEDURE

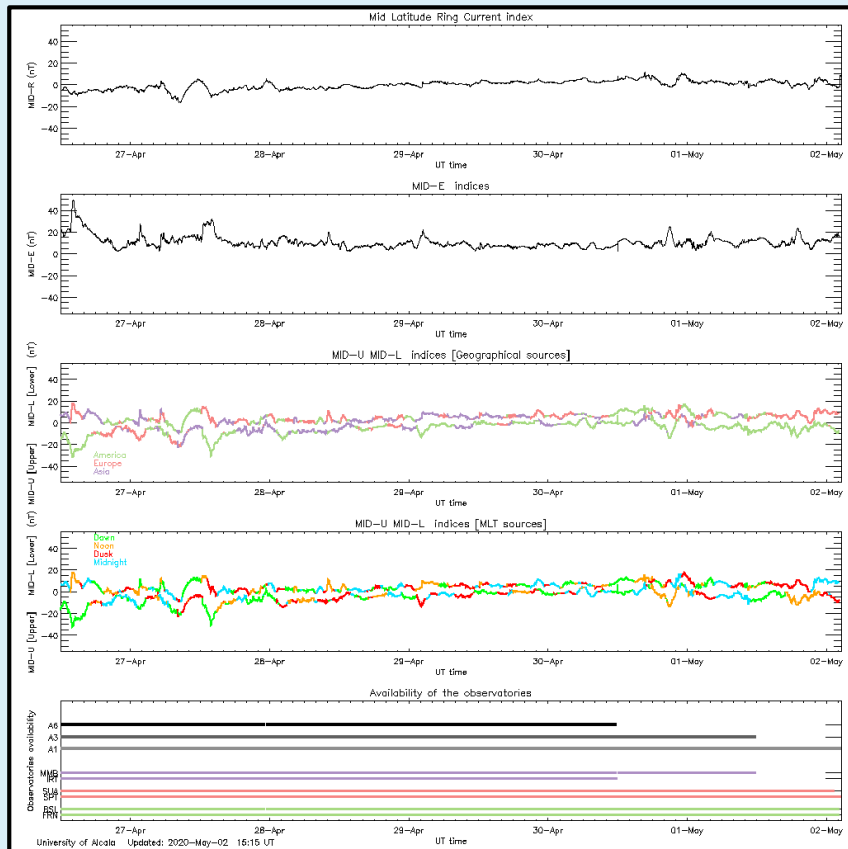
LOCAL INDICES

GLOBAL INDICES

REALTIME

REALTIME

WE RUN THE CODE TO CREATE
THE INDICES EVERY 15 MINS



MID-R

MID-E

MID-U

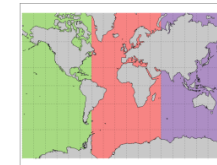
MID-L

MID-U

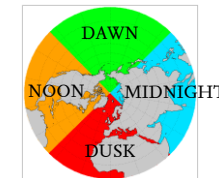
MID-L

THE UPPER AND LOWER ENVELOPES
(MID-U AND MID-L) ARE COLORED
DEPENDING ON WHICH OBSERVATORY IS
CONTRIBUTING TO THE INDEX

AMERICA
EUROPE
ASIA



BY GEOGRAPHICAL SOURCE
[ROTATES WITH THE EARTH]



BY MAGNETIC LOCAL TIME SOURCE
[FIX ON THE SUN REF. FRAME]

CHECK THEM ON REALTIME NOW

WWW.SPACEWEATHER.ES/MID/

User: guest Pass: invitado

HOME



MOTIVATION

PROCEDURE

LOCAL INDICES

GLOBAL INDICES

REALTIME

ACKNOWLEDGEMENTS

- Geomagnetic field data have been obtained from INTERMAGNET magnetic observatories
- The authors thank the Institutes that operate the observatories which provided data for this study and their staff for their job in recording high-quality data.
- The authors acknowledge funding from MINECO project AYA2016-80881P (including FEDER funds)

ACKNOWLEDGEMENTS →



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