Solar-Terrestrial physics studies at Tucumán, Argentina

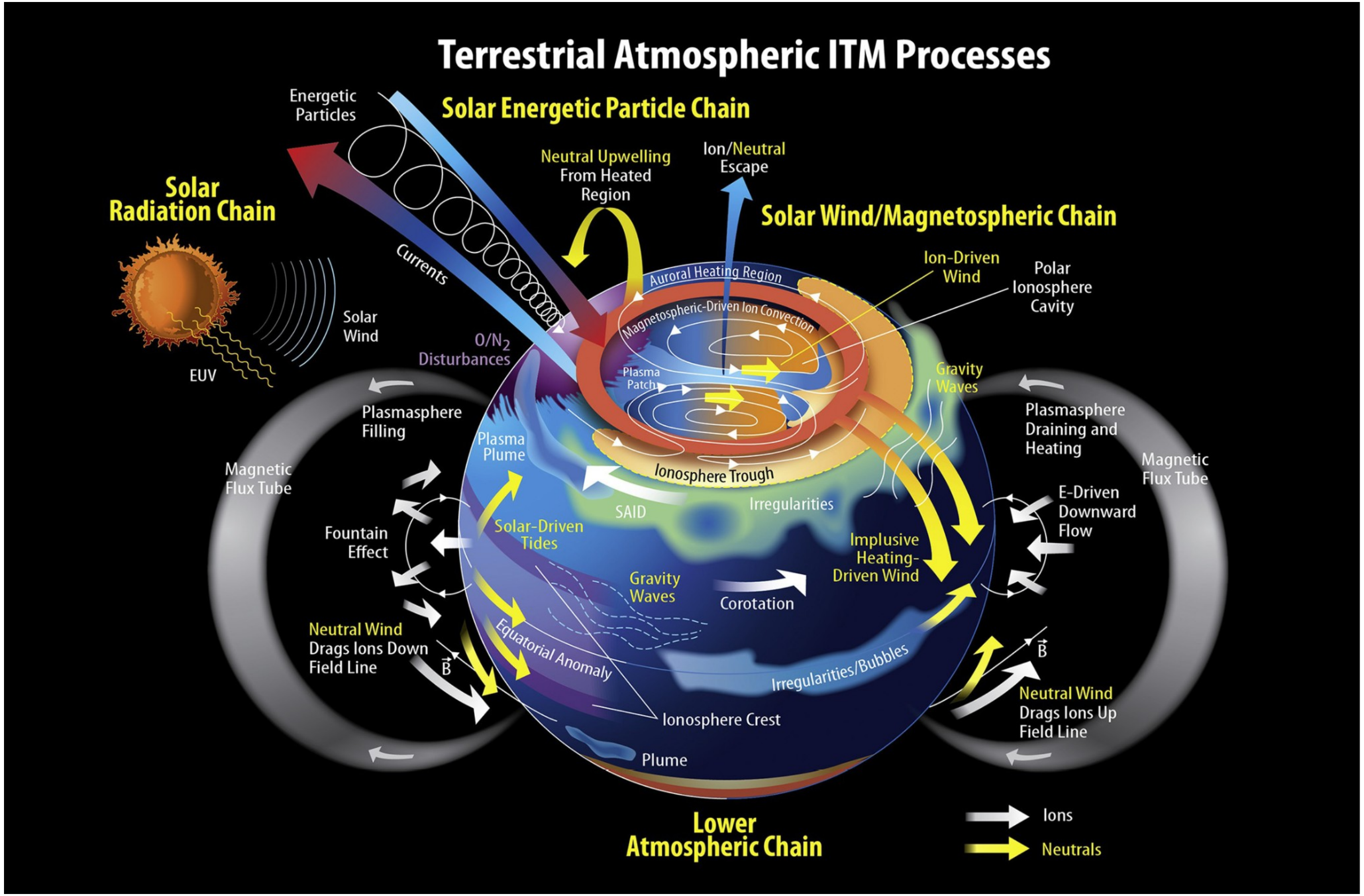
Gilda González
Universidad Nacional de Tucumán
Universidad del Norte Santo Tomás de Aquino

Laboratorio de Ionosfera, Atmósfera Neutra y Magnetosfera (LIANM)

Centro de Atmósfera Superior y Radiopropagación (CIASUR)

Main lines of research:

- Long-term variability and trends of atmospheric parameters of the lower, middle and upper atmosphere
- Effects of geomagnetic storms on the lower, middle and upper atmosphere
- Space weather
- Solar radiation on the Earth´surface
- Effect of secular variations in the Earth's magnetic field on the upper atmosphere and magnetosphere



Coupling components of upper atmosphere regions (SOURCE: NASA's Goddard Space Flight Center/Mary Pat Hrybyk-Keith).

Ionosphere

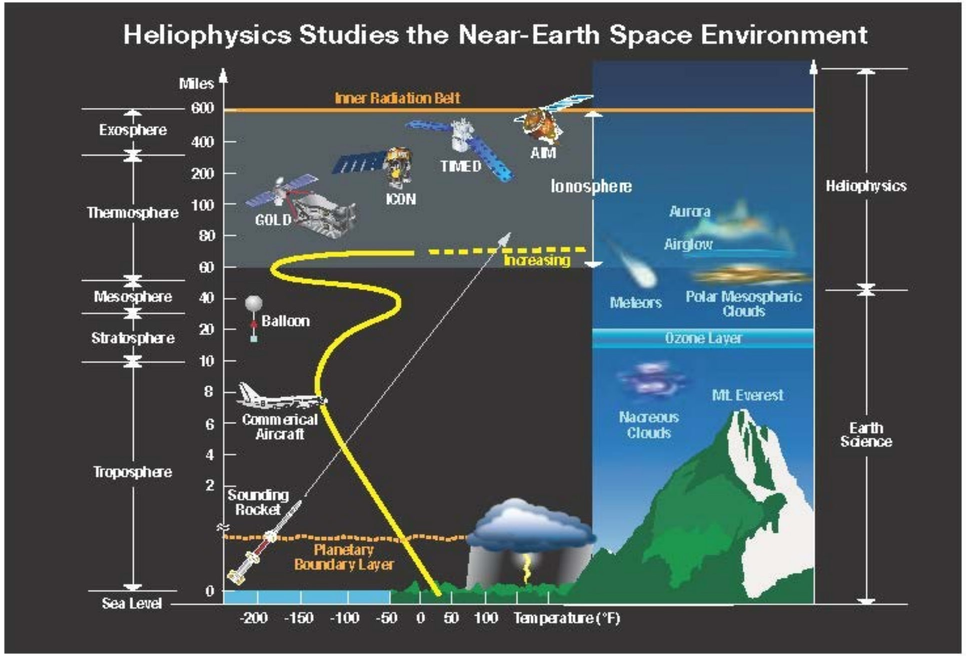
Plasma of ionized atmospheric gases (NO, O2, O, H, He)

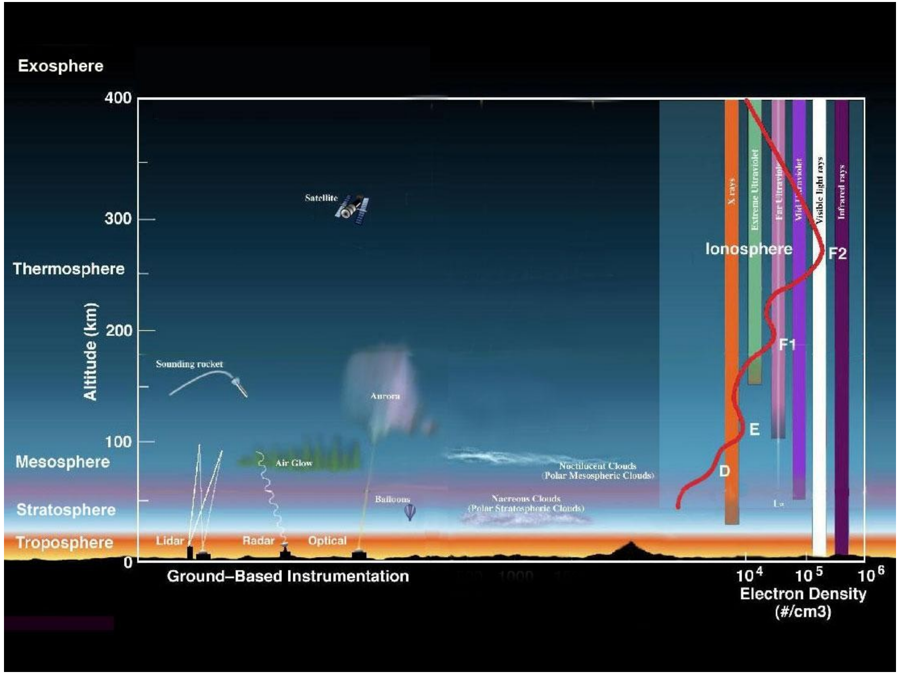
Produced mostly by solar EUV

~50 – 1000 km altitude

The ions, electrons, and neutrals can be considered as three interpenetrating fluids coupled by collisions and, in the case of ions and electrons, their self-generated electric and magnetic fields.

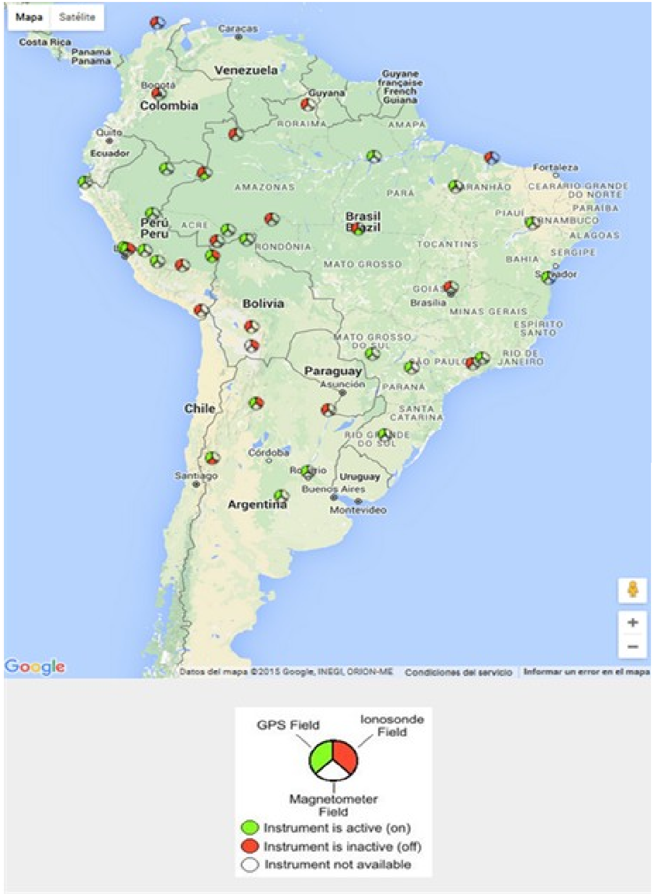
“The ionosphere is somewhat of a battleground between the earth’s neutral atmosphere and the sun’s fully ionized atmosphere in which the earth is embedded. One of the challenges of ionosphere research is to know enough about these two vast fields of research to make sense out of ionospheric phenomena.” Kelley, 2009



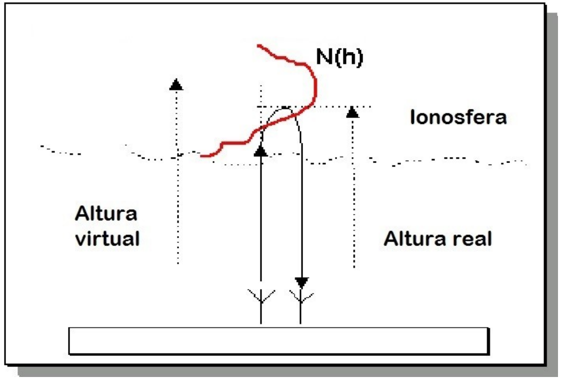


Earth's atmospheric layers further shield the planet and airborne and space-borne assets from harmful solar particles and radiation.
Credit: NASA's Goddard Space Flight Center/Mary Pat Hrybyk-Keith

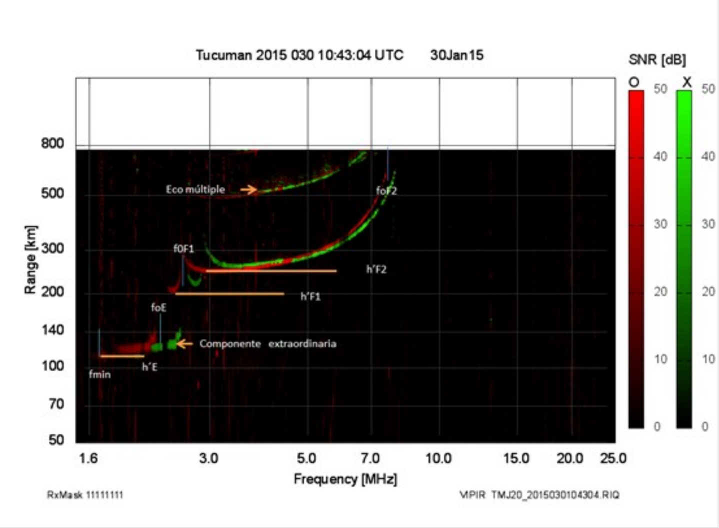
Low-latitude Ionospheric Sensor Network



GPS, Ionosondas y magnétometros que forman parte de la red LISN

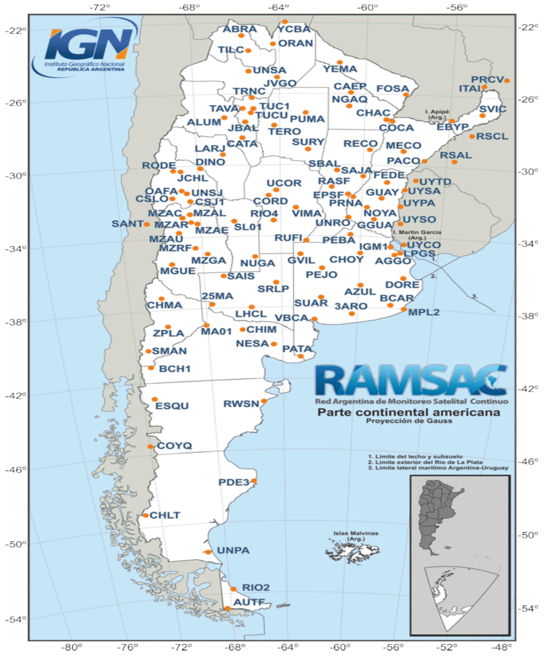


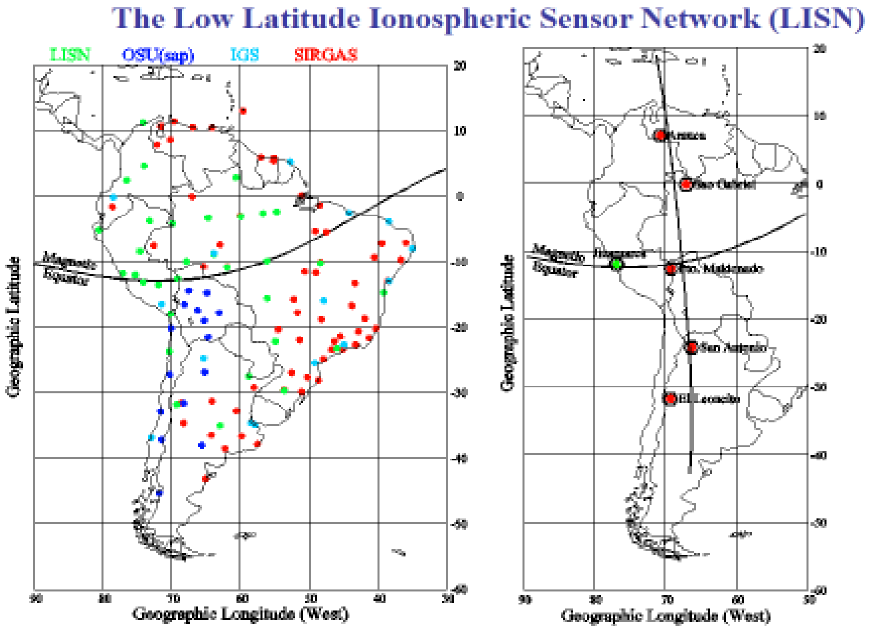
Ionosonde



Receiving antennas (8 dipoles).

Transmitting antenna





95 GPS stations

Red **A**rgentina de **M**onitoreo **SA**telital **C**ontinuo (RAMSAC)

Incidence of solar cycle 24 in nighttime foF2 long-term trends for two Japanese ionospheric stations, de Haro Barbás, B.F., Elias, A.G., Fagre, M. & B.S. Zossi, Studia Geophysica et Geodaetica, 64, 407–418, 2020.

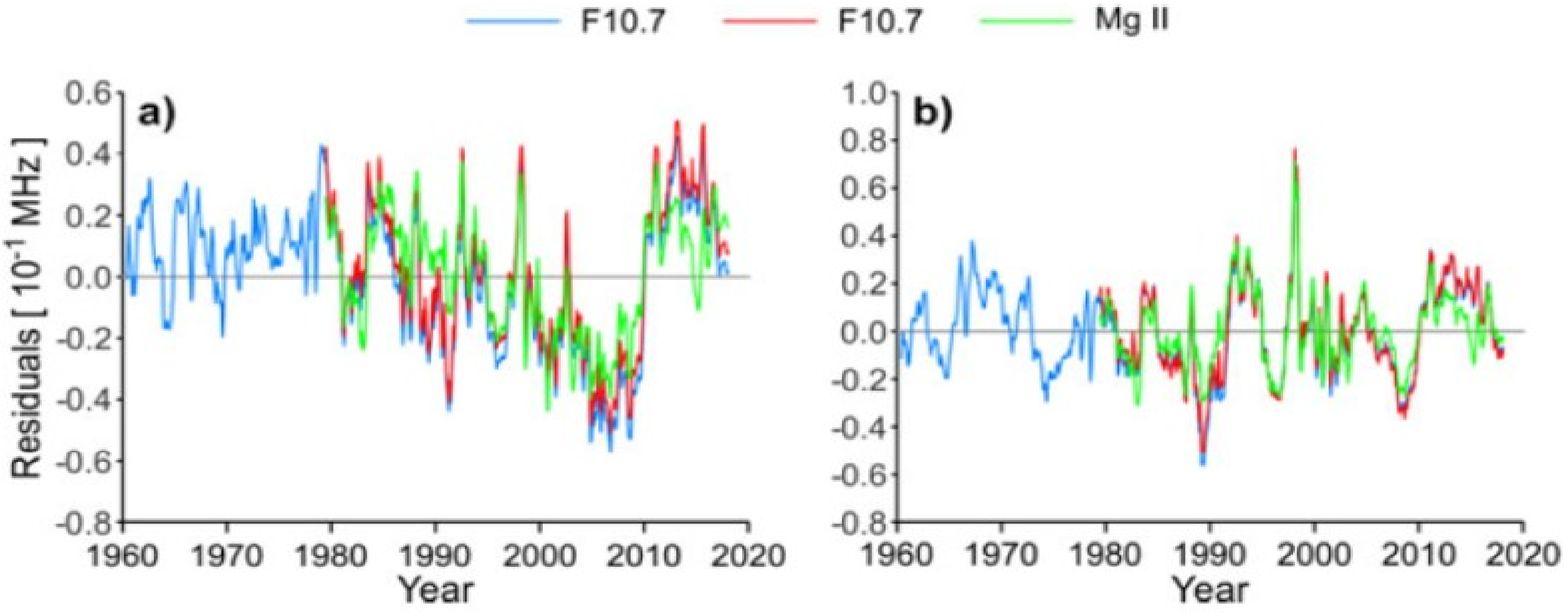


Fig. 4. Residuals estimated for period 1960-2018, filtered with the solar radio flux at 10.7 cm (*F*10.7), 1979-2018, filtered with *F*10.7, and 1979-2018, filtered with the Mg II index for **a)** Kokubunji and **b)** Wakkanai station.

Ionospheric disturbances at low and mid-low latitudes of the South American sector during the March 2015 great storm, G.A. Mansilla, Advances in Space Research, 63, 3545–3557, 2019.

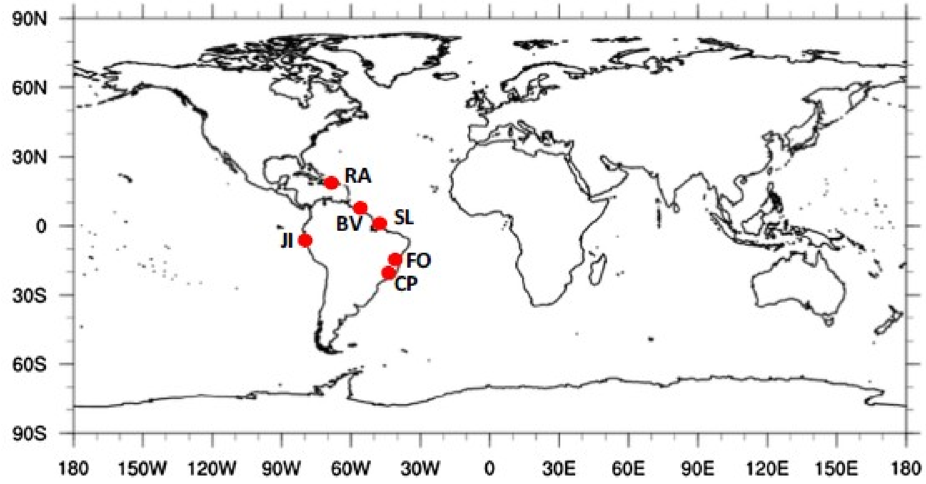


Fig. 1. Map with the geographical locations of the stations used in this study.

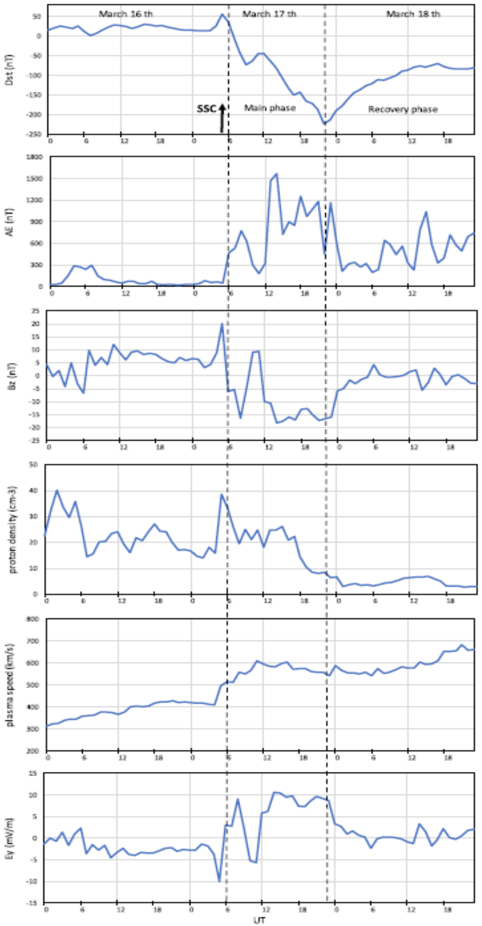


Fig. 2. Variations of Sun-Earth parameters during 16–18 March 2015: (from top to bottom) Dst magnetic index (in nanotesla), the AE magnetic index (in nanotesla), the Bz component of the IMF (in nanotesla), the proton density (in cm3), the solar wind speed (in km/s). and interplanetary electric field (in mV/m). The arrow indicates the storm sudden commencement and the vertical dashed lines, the main phase of the storm.

Effects on the equatorial and low latitude thermosphere and ionosphere during the 19–22 December 2015 geomagnetic storm period, G.A. Mansilla & M.M. Zossi, Advances in Space Research 65,2083–2089, 2020.

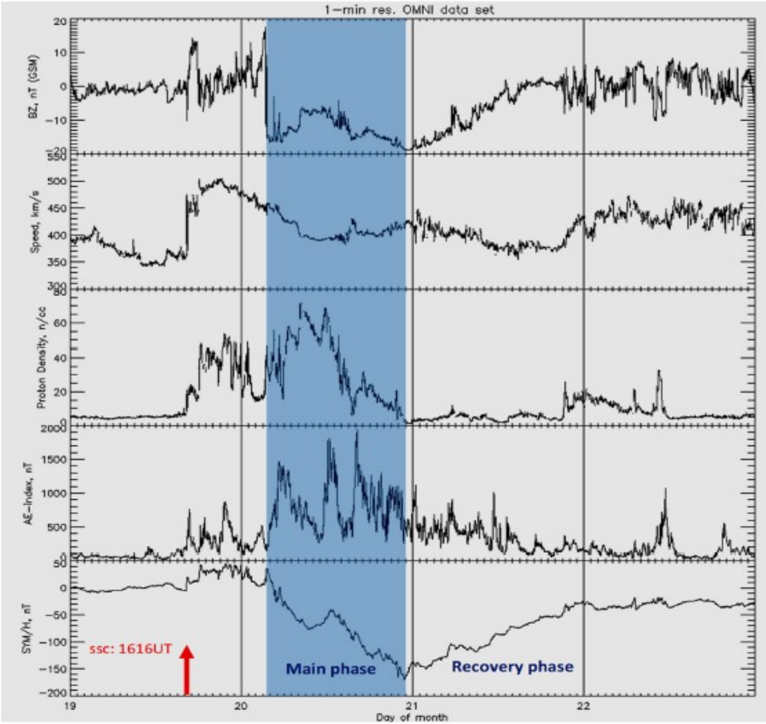


Fig. 2. Variations of Sun-Earth parameters during 19–22 December 2015 (from top to bottom): the Bz component of the IMF (in nanotesla), the solar wind speed (in km/s), the proton density (in cm3), the AE magnetic index (in nanotesla) and the SYM-H index (in nanotesla). All data are 1-min-averaged data from the OMNIWeb Service. The arrow indicates the storm sudden commencement.

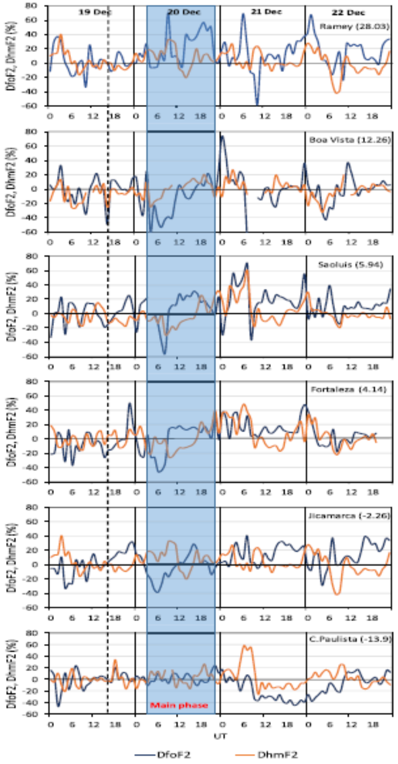


Fig. 3. Hourly variations of DfoF2 and DhmF2 from 19 to 22 December 2015 at Ramey, Boa Vista, Sao Luis, Fortaleza, Jicamarca and Cachoeira Paulista. Vertical dashed line indicates the storm sudden commencement. The light blue rectangle defines the period of the main phase of the storm.)

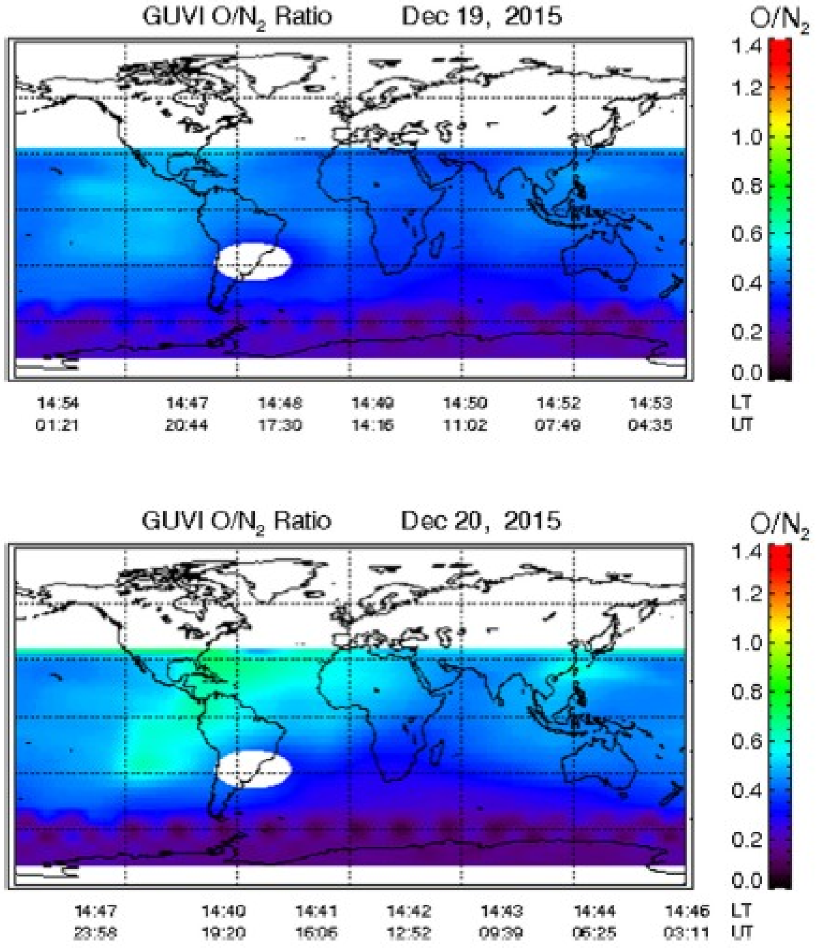


Fig. 6. Maps with the thermospheric O/N2 ratio derived from TIMED/GUVI during 19–22 December 2015.

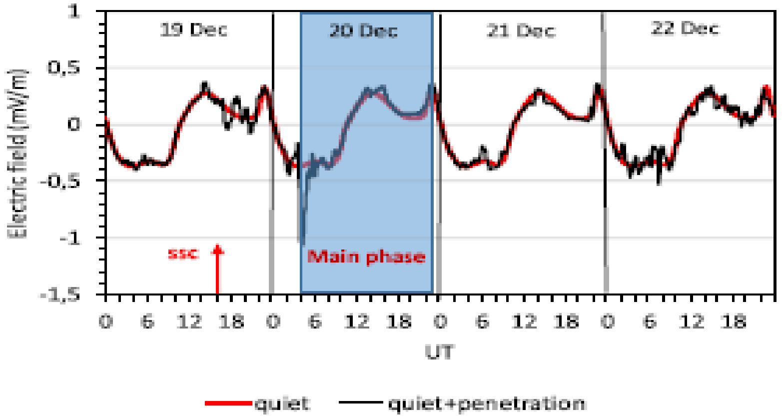


Fig. 4. Prompt penetration electric field at the longitudes of the stations used on 19–22 December 2015.

Polar caps during geomagnetic polarity reversals, Bruno Zossi , Mariano Fagre , Hagay Amit, & Ana G Elias, Geophysical Journal International, 216, 1334–1343, 2019.

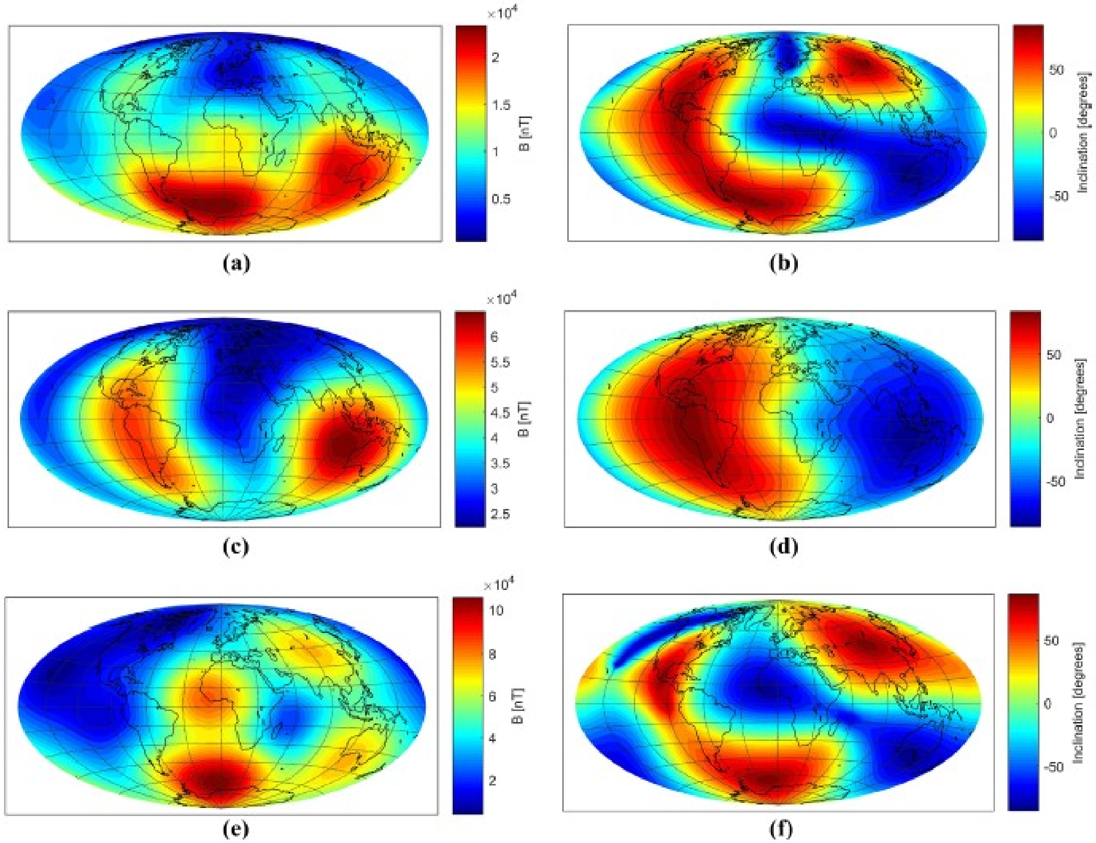


Figure 2. Intensity of the Earth's magnetic field **|B|** (nT) and inclination I (degrees) obtained from IGRF-12 for (a and b) axial dipole collapse, (c and d) dipole rotation where axial dipole energy is transferred to the equatorial dipole and (e and f) energy cascade where dipolar energy is transferred to the quadrupolar and octupolar terms. Note the different scales for intensity.

Ionospheric conductance spatial distribution during geomagnetic field reversals, Bruno S. Zossi, And G. Elias, and Mariano Fagre, Journal of Geophysical Research: Space Physics, 123, 2379–2397, 2018.

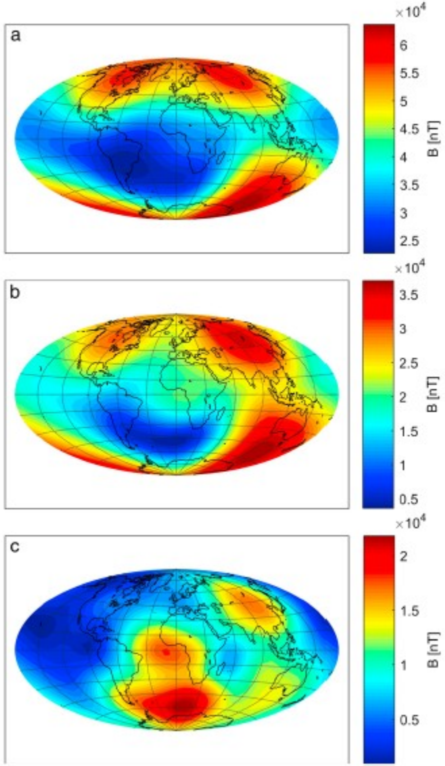


Figure 1. Intensity of Earth's magnetic field, B (nT), obtained from IGRF for 2008 (a) while keeping constant the multipolar field contribution, (b) 50% decrease of dipolar components, and (c) null dipolar components. Note the different scales.

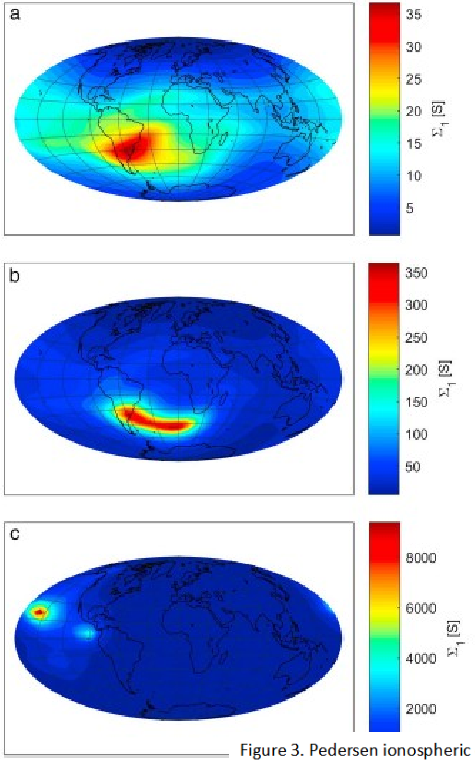


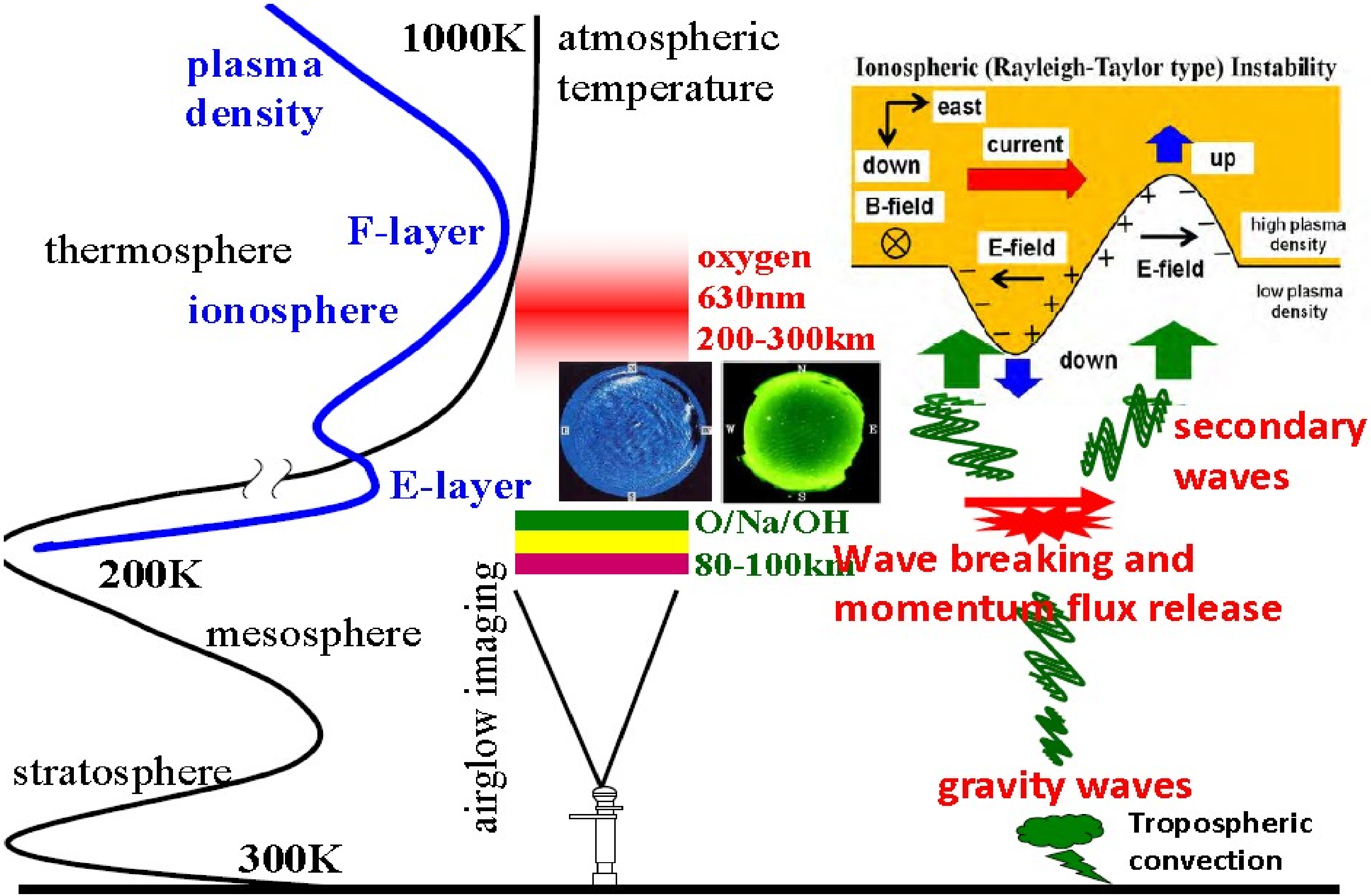
Figure 3. Pedersen ionospheric conductance considering Earth's magnetic field obtained from IGRF for 2008 (a) while keeping constant the multipolar field contribution, (b) 50% decrease of dipolar components, and (c) null dipolar components. Electron density and neutral parameters were kept constant for 3 January (quiet day) and 12 LT conditions. Note the different scales.

My reasrche work focused on Ionospheric irregularities

- Ionospheric irregularities are regions in the ionosphere with electron density noticeably different from the background.
- Scale sizes from centimetres to hundreds of kilometres, and duration between minutes and several hours.
- Caused by plasma instability processes.
- Space pose engineering problems, mainly by interfering with radio communication, navigation, and imaging systems.
- The instability linear growth rate is:

$$\gamma_{FT} = \frac{1}{L_{FT}} \left(\frac{\sigma_P^F}{\sigma_P^F + \sigma_P^E} \right) \times \left(\frac{E}{B} - U_{FT}^P + \frac{g}{\nu_{in}} \right) - \beta_{FT}$$

E/B represents the evening prereversal vertical drift; g is the gravitational acceleration; v_{in} is the ion-neutral collision frequency, L_{FT} is the F layer flux tube integrated bottom side gradient scale length. σ_P is the field line integrated conductivity, U is the velocity of the meridional wind.

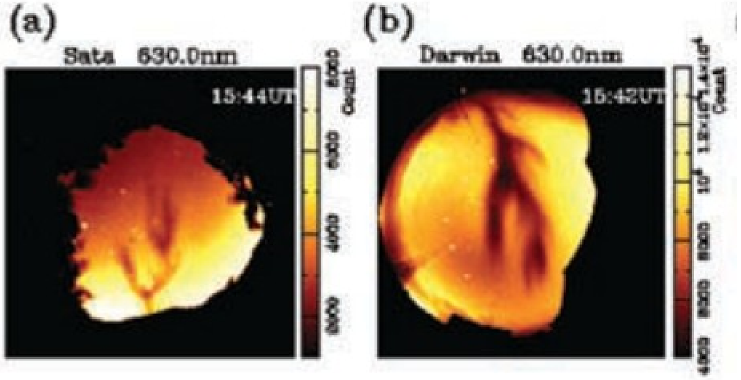


Scheme courtesy of Prof. Shiokawa Nagoya University

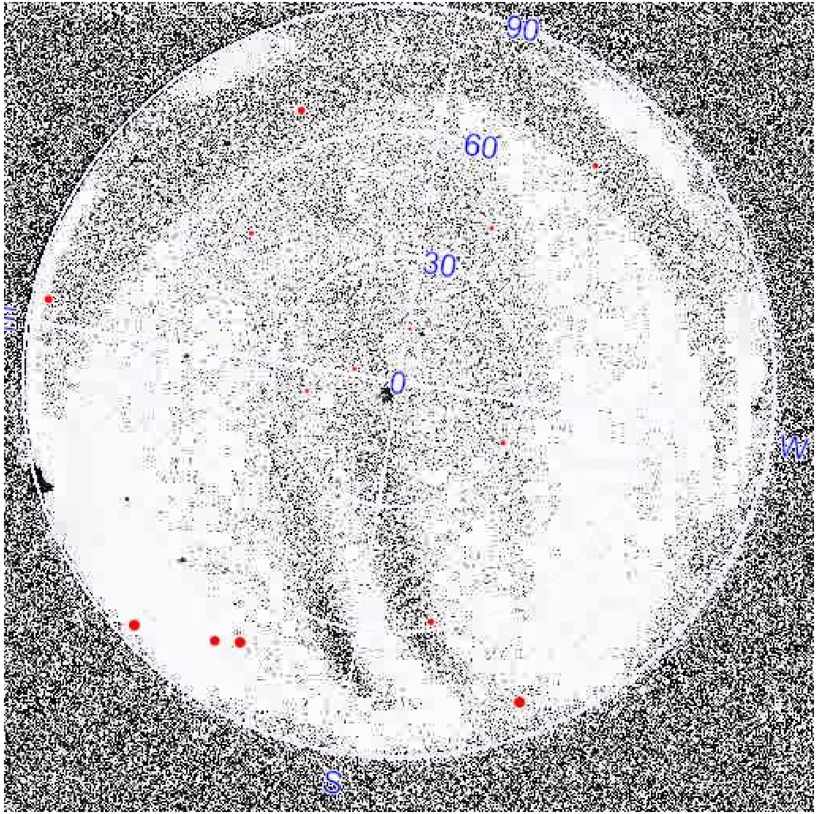
Plasma bubbles observed in the all sky images

Field of view is 180° solid angle, and radial field of view is 500 km

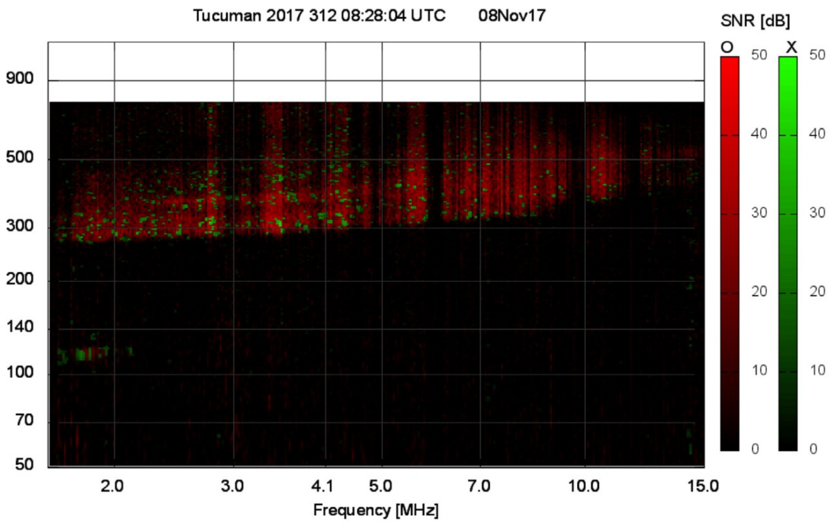
Scale size 10 – 1000 km
Field-aligned plasma irregularities



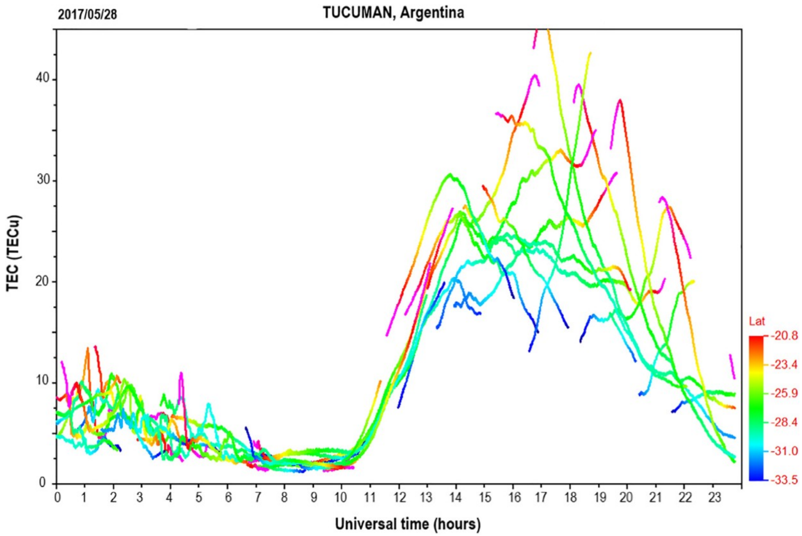
Otsuka el al. (GRL, 2002)

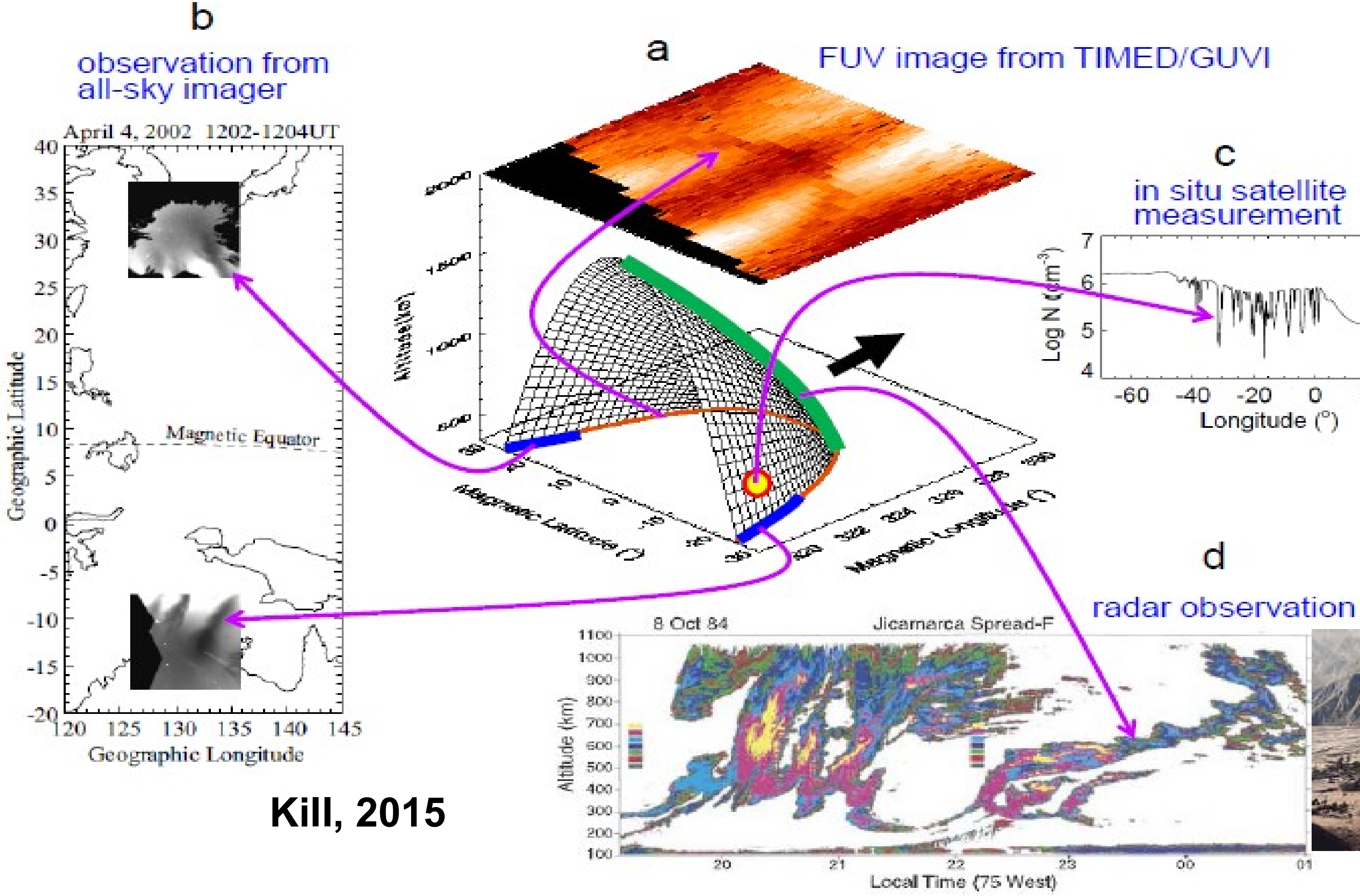


Plasma bubbles observed with ionosondes



TEC depletions (GPS data)





Three 1.5 MW transmitters and an antenna array of 18432 dipole elements, covering an area of approximately 85000 m2.

Kill, 2015

Do you want to know more about my work?

My last published paper is available at: https://doi.org/10.1016/j.asr.2020.10.051

ELSEVIER

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Spread-F occurrence during geomagnetic storms near the southern crest of the EIA in Argentina

Gilda de Lourdes González

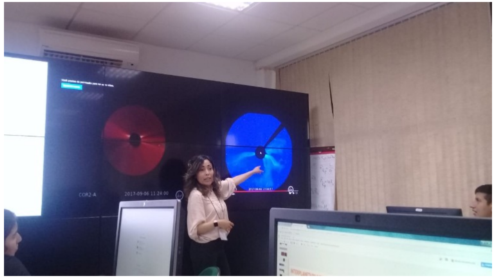
Universidad Nacional de Tucumán (UNT), Av. Independencia 1800, San Miguel de Tucumán 4000, Argentina
Universidad del Norte "Santo Tomás de Aquino" (UNSTA), 9 de Julio 165, T4000 San Miguel de Tucumán, Tucumán, Argentina

And here is a preprint of my latest paper

González, G. Spread-F characteristics at the southern anomaly crest in South America during the descending phase of solar cycle 24, 22 April 2021, PREPRINT https://doi.org/10.21203/rs.3.rs-452354/v1

Thematic areas:

- ➔ Plasma physics
- ➔ Physics of the Upper Atmosphere
- ➔ Lower Atmosphere Physics
- ➔ Physics of the Middle Atmosphere
- ➔ Solar Earth Physics
- ➔ Space Weather
- ➔ Ozone Chemistry and Nitrogen Component
- ➔ Magneto-hydrodynamics
- ➔ Electromagnetism
- ➔ Hydrology



THANKS