

RECENT ADVANCES AND PROSPECTS OF THE JSG1

JSG1: Coupling Processes between Magnetosphere, Ionosphere, and Thermosphere



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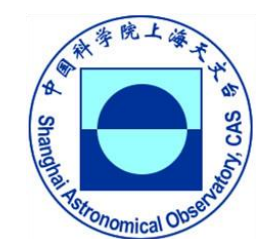


<https://ggos.org/about/org/fa/geodetic-space-weather-research/groups/jsg1-coupling-processes/>



20.09 - 22.09

ALCALÁ DE HENARES



This Joint Study Group (JSG T.27) is :

- implemented at the IAG Inter-Commission Committee on Theory (ICCT);
- joint with IAG GGOS Focus Area on Geodetic Space Weather Research (FA-GSWR);
- implemented at the IAG **Commission 4 Positioning & Applications**;
- and implemented at the IAG **Sub-Commission 4.3 Atmosphere Remote Sensing**.

Chair: Andres Calabia (Spain, andres@calabia.com)

Vice-Chair: Munawar Shah (Pakistan, shahmunawar1@gmail.com)

Research Coordinator: Binod Adhikari (Nepal, binod.adhi@gmail.com)

Members: 17



GGOS
Global Geodetic
Observing System



NCAR



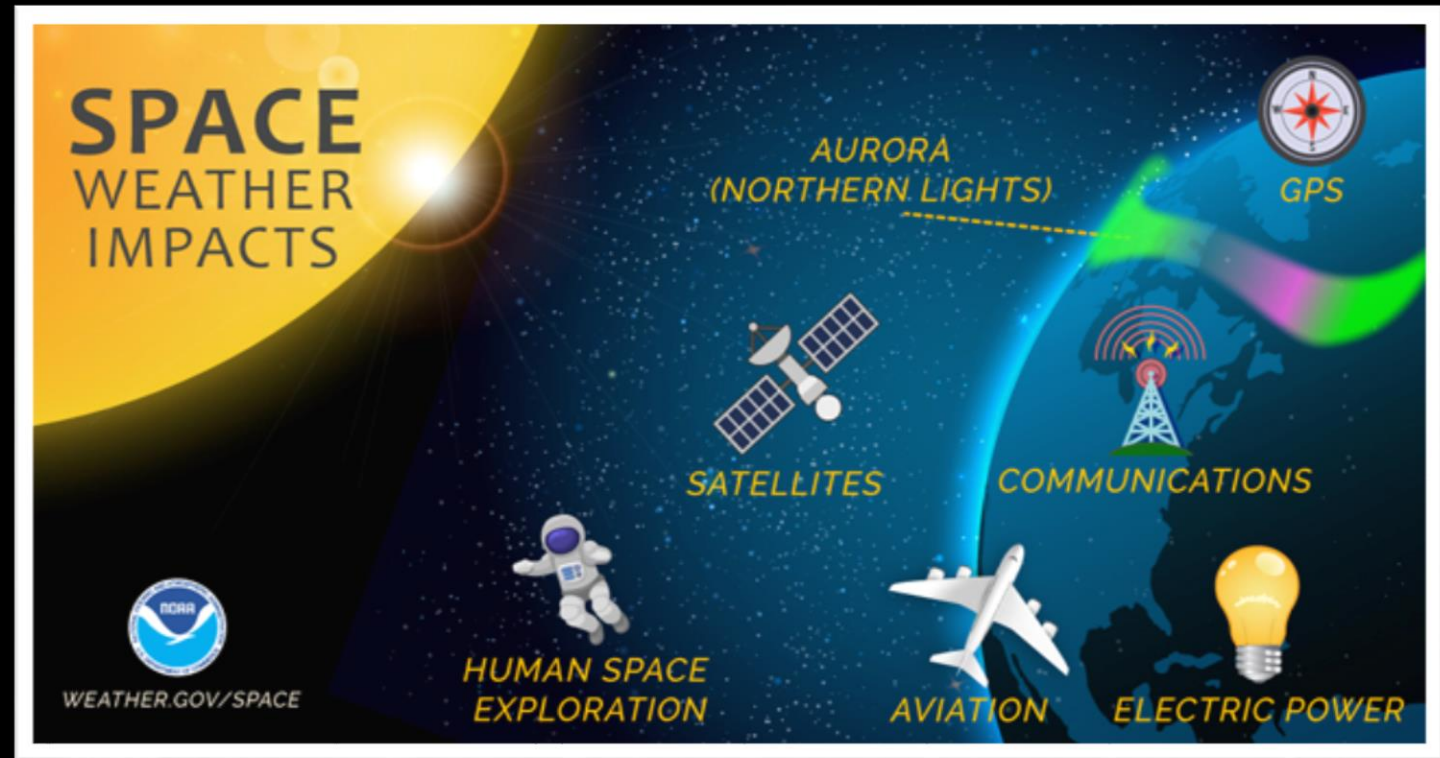
OUTLINE

1. Introduction
 - Significance
 - Objectives
 - State-of-the-art
2. Strategy
3. Conclusions
4. Achievements



THE IMPORTANCE OF STUDYING THE COUPLING PROCESSES IN THE MAGNETOSPHERE-IONOSPHERE-THERMOSPHERE

- **Radio signal propagation** in the ionosphere, affecting GNSS, communications, ...;
- **Drag force** on **Low Earth Orbit** (LEO) satellites, debris monitoring, ...;
- **Power and internet outages** due to intense **electric currents** induced during geomagnetic storms, ...

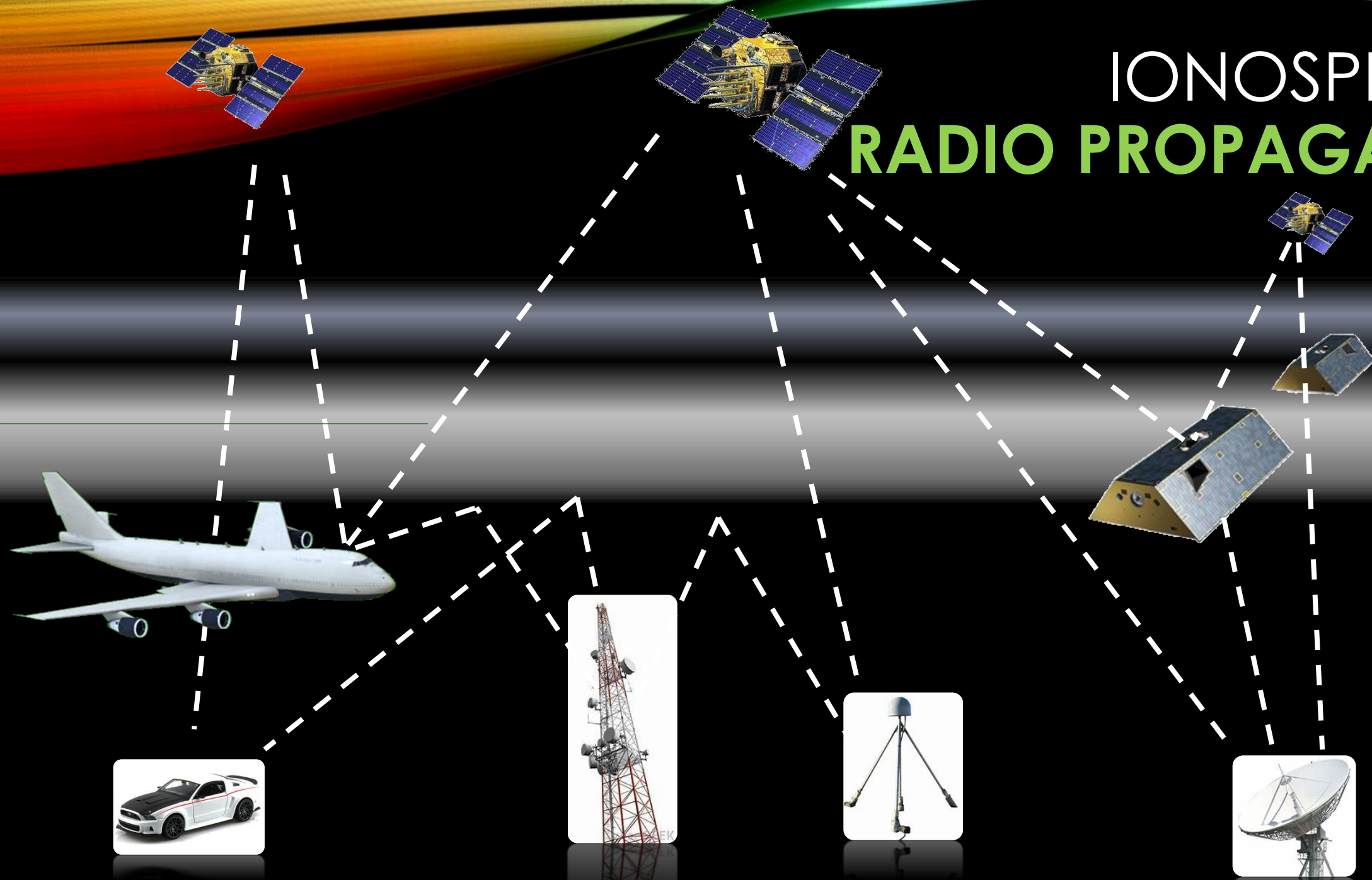


CCO S DAYS

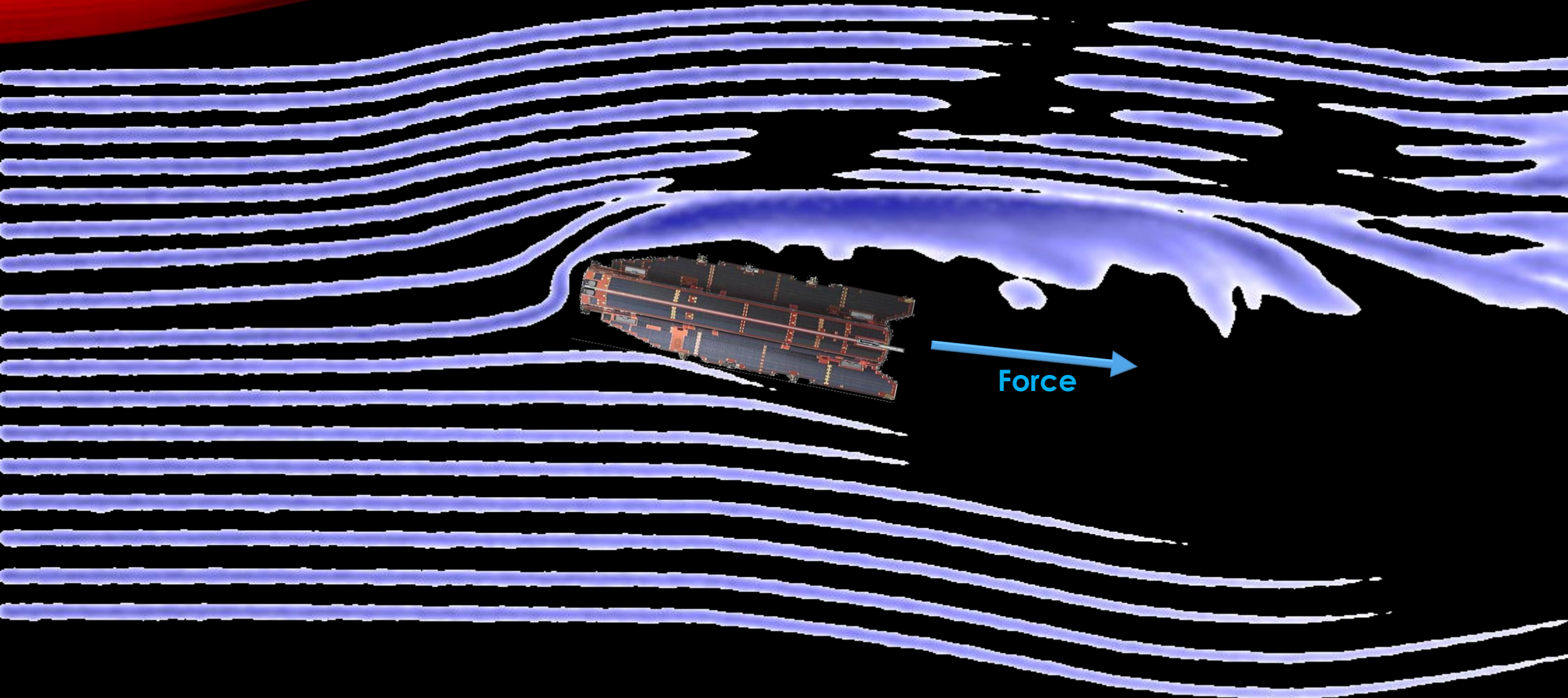


2023

IONOSPHERIC RADIO PROPAGATION



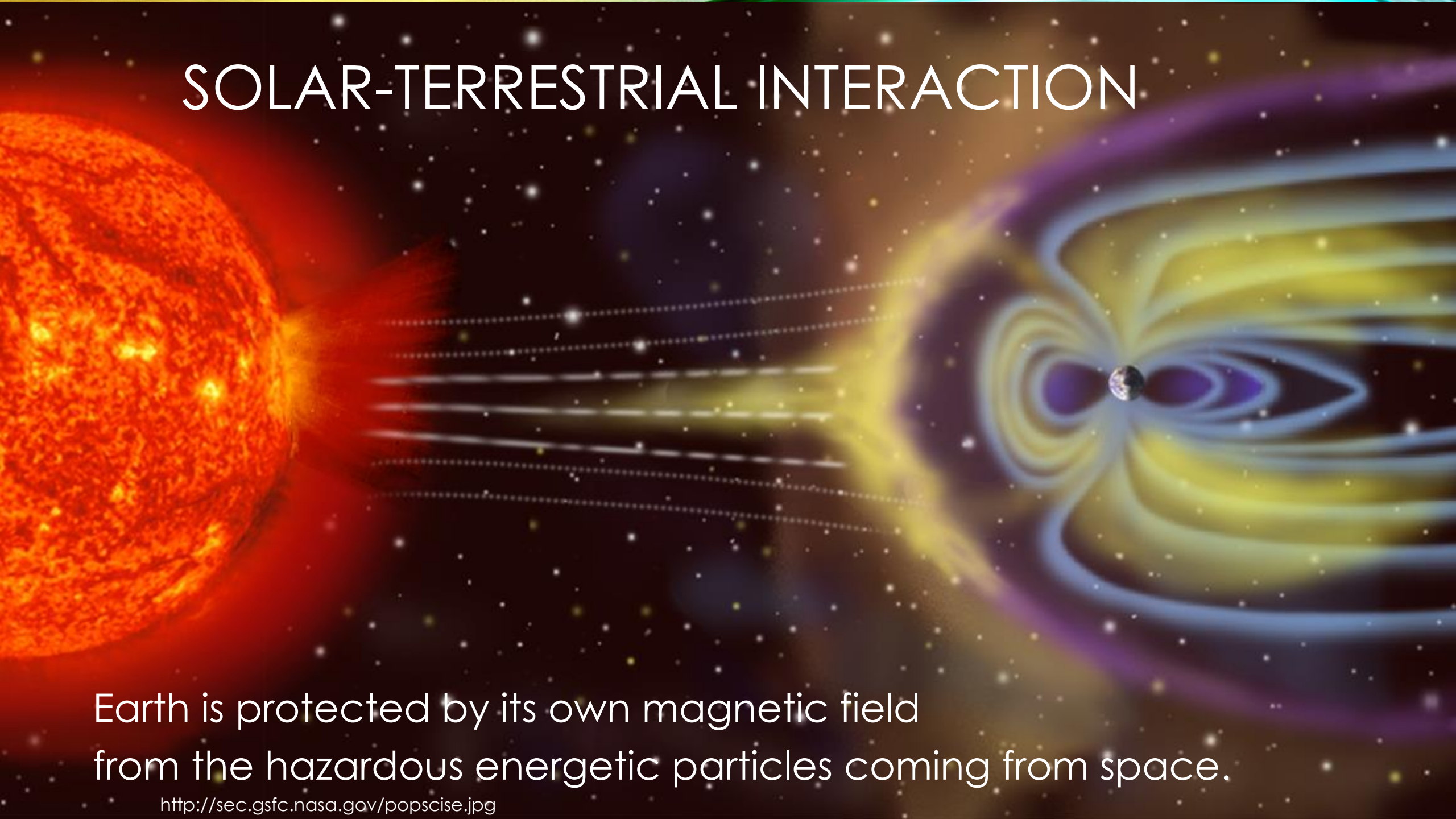
DRAG FORCE ON LEO SATELLITES



OBJECTIVES JSG1

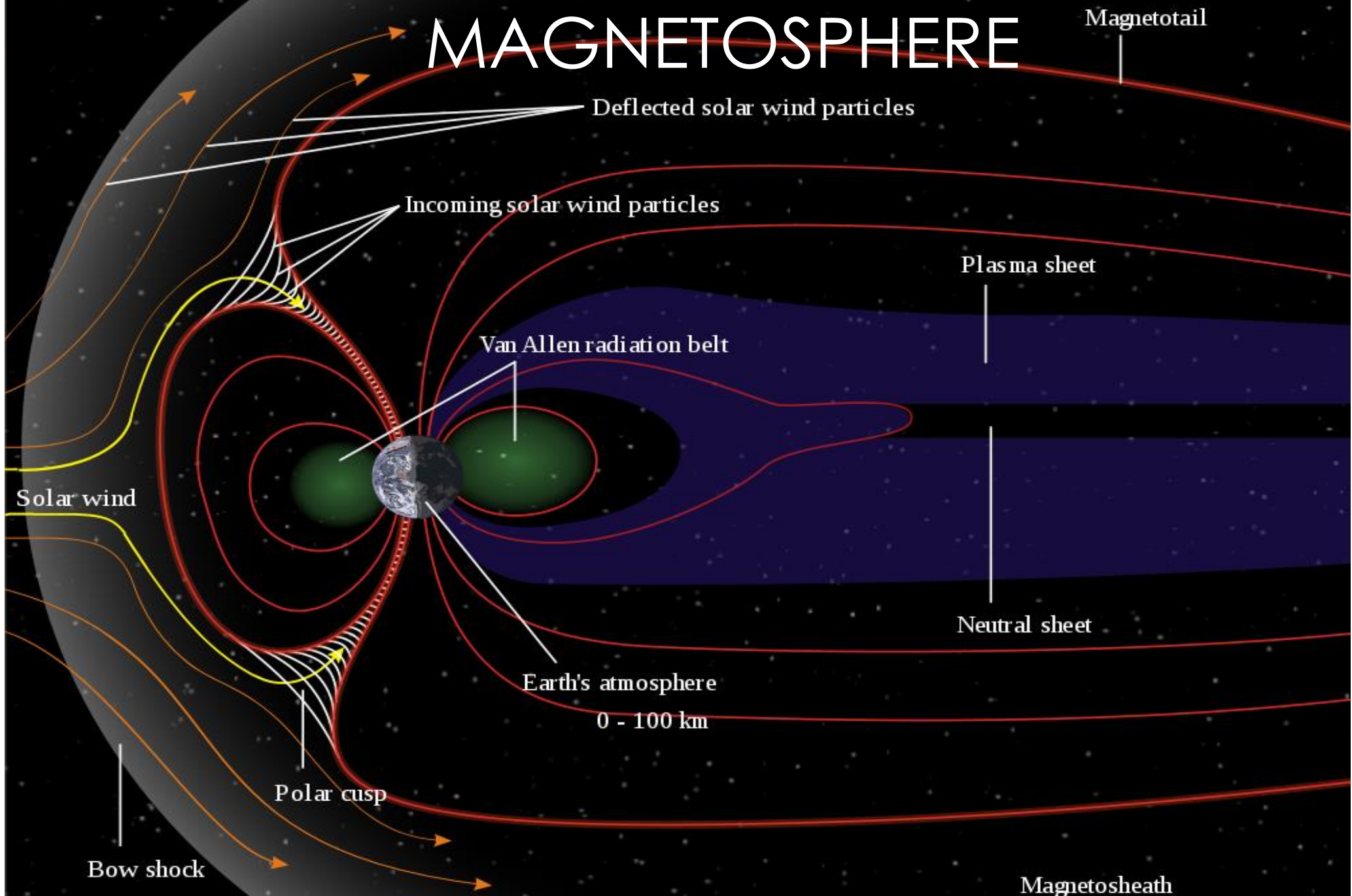
- To characterize and quantify the **global modes** of Magnetosphere-Ionosphere-Thermosphere (MIT) variations associated with diurnal, seasonal, and solar wind drivers, as well as the lower atmosphere forcing and other possible contributions.
- To determine and understand the mechanisms responsible for discrepancies between **measurements and predictions** by present models, and explore parametrizing the effect of this mechanism.
- To investigate and evaluate the importance of **coupled processes** in the MIT system based on physical laws and principles such as continuity, energy and momentum equations and solving partial differential equations.
- To reveal the peculiarities of MIT dynamics during **geomagnetic storms**.

SOLAR-TERRESTRIAL INTERACTION

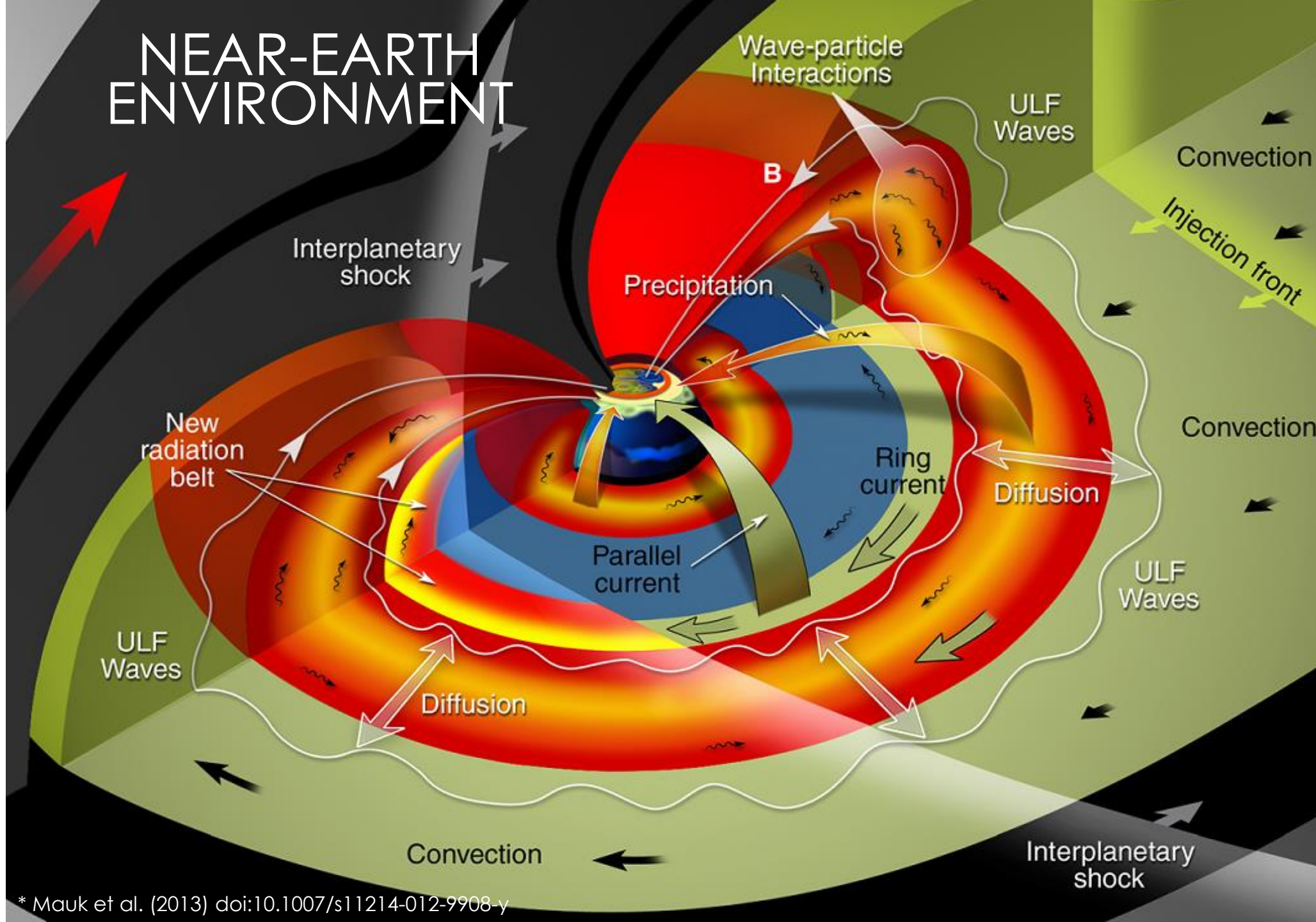


Earth is protected by its own magnetic field from the hazardous energetic particles coming from space.

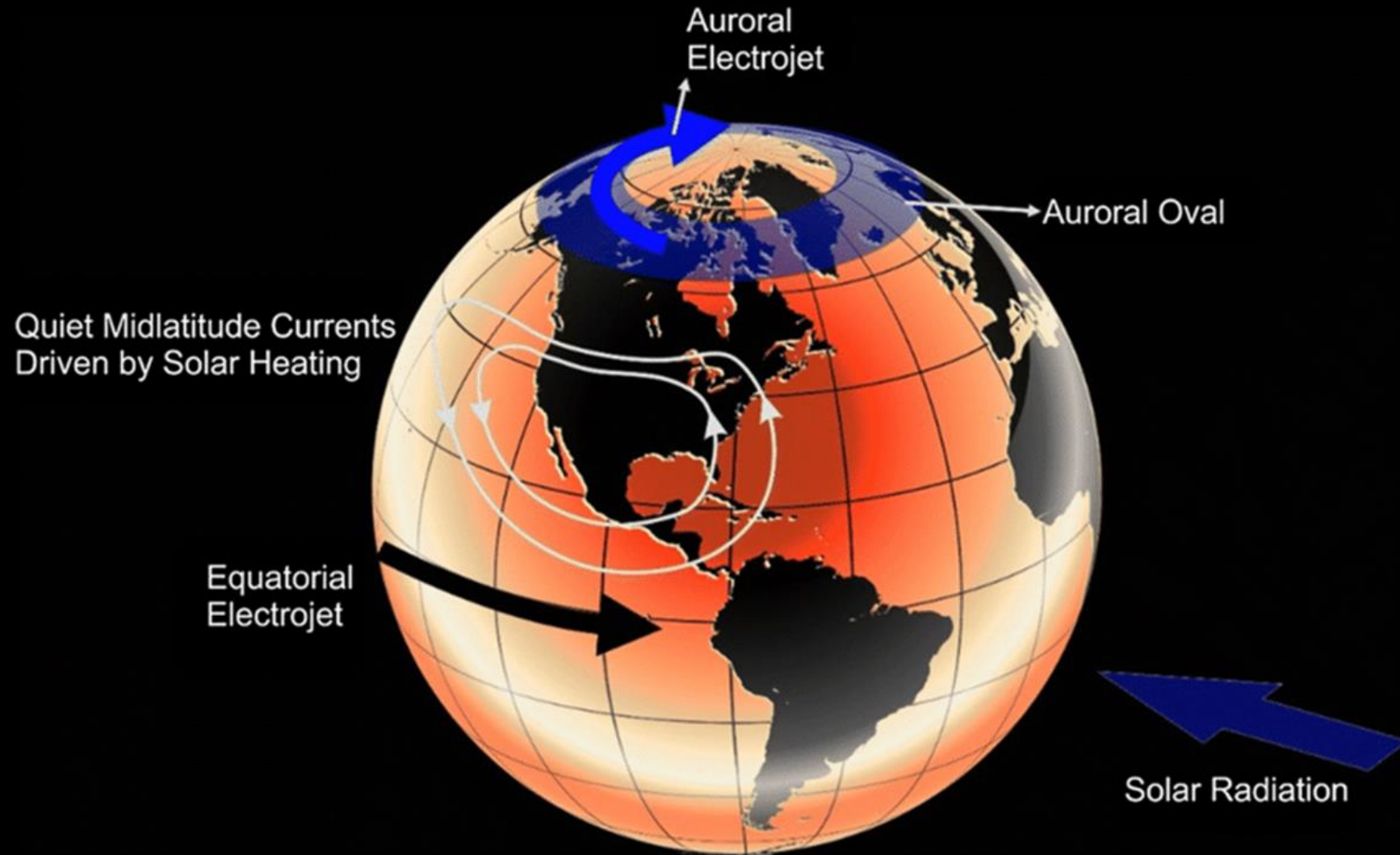
MAGNETOSPHERE



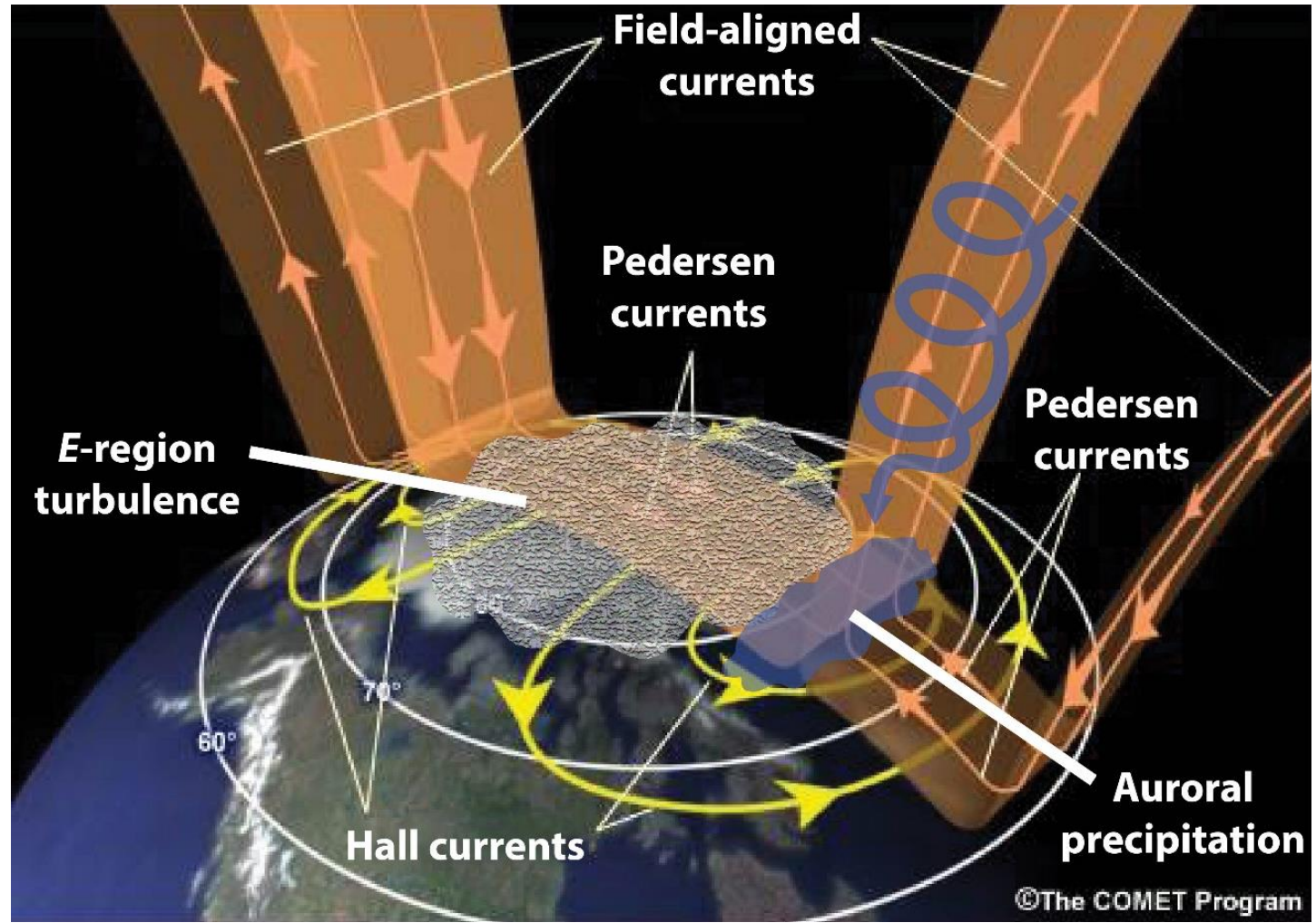
NEAR-EARTH ENVIRONMENT



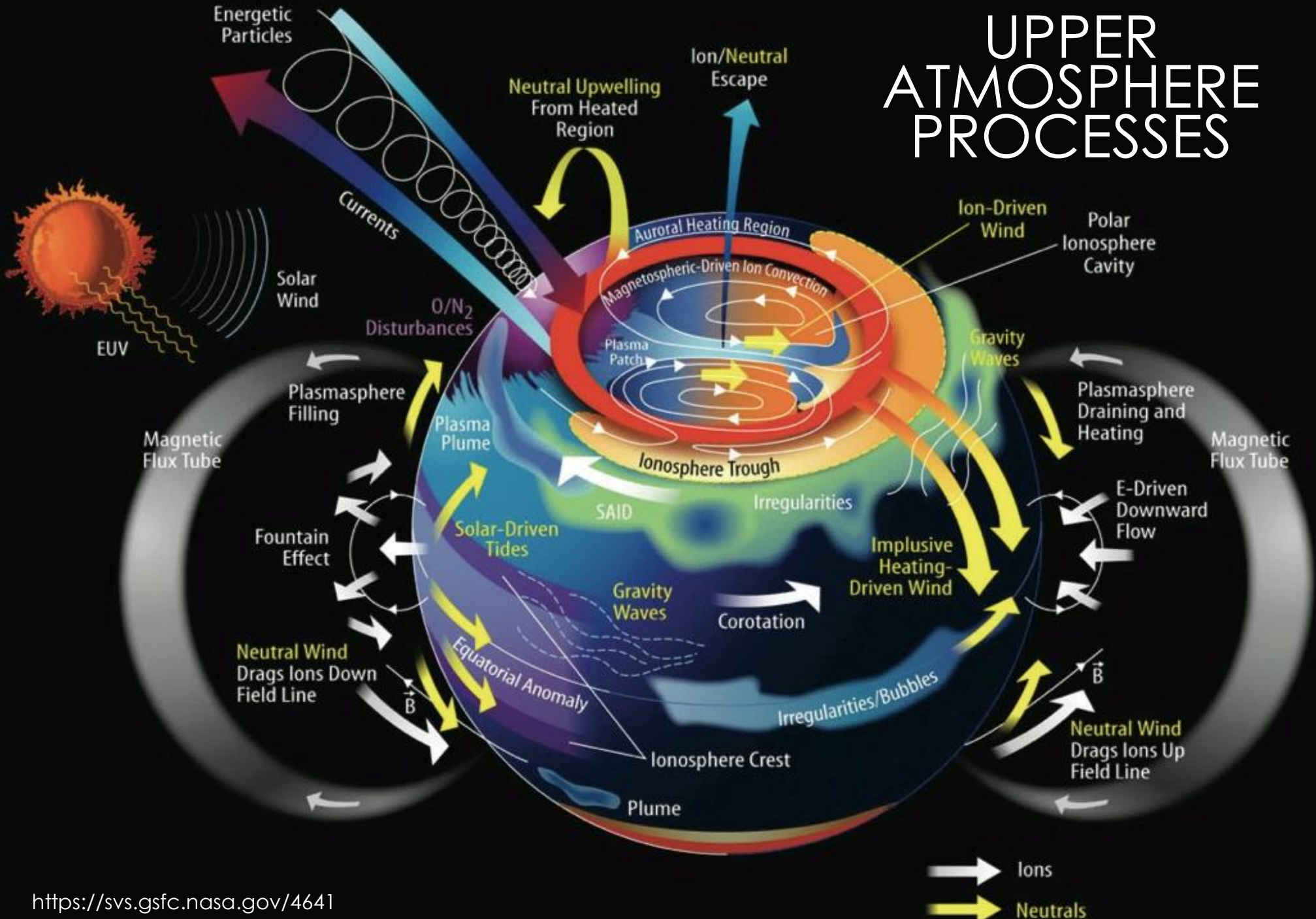
ELECTRIC CURRENTS



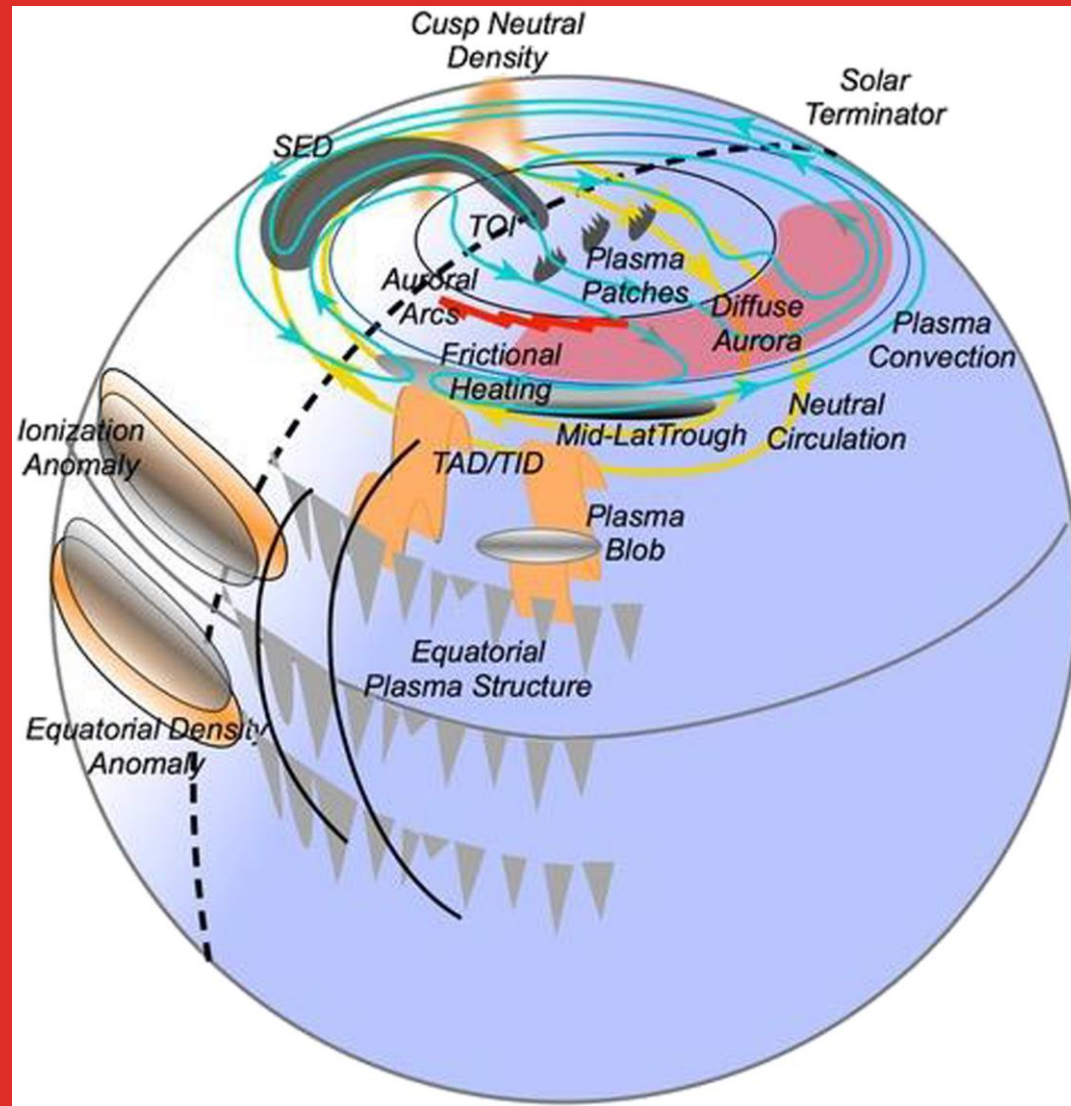
ELECTRIC CURRENTS



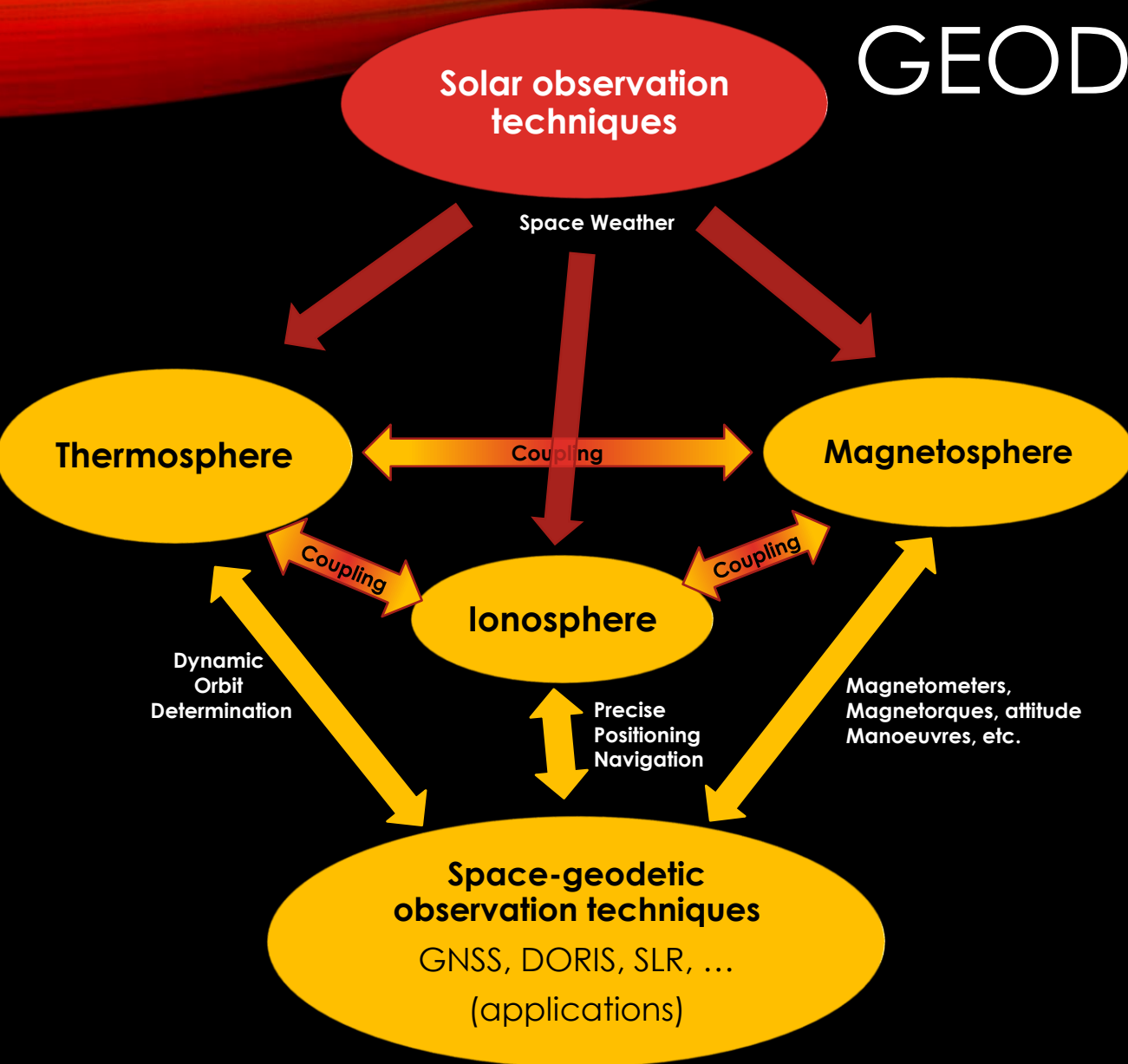
UPPER ATMOSPHERE PROCESSES



PLASMA AND DENSITY STRUCTURES

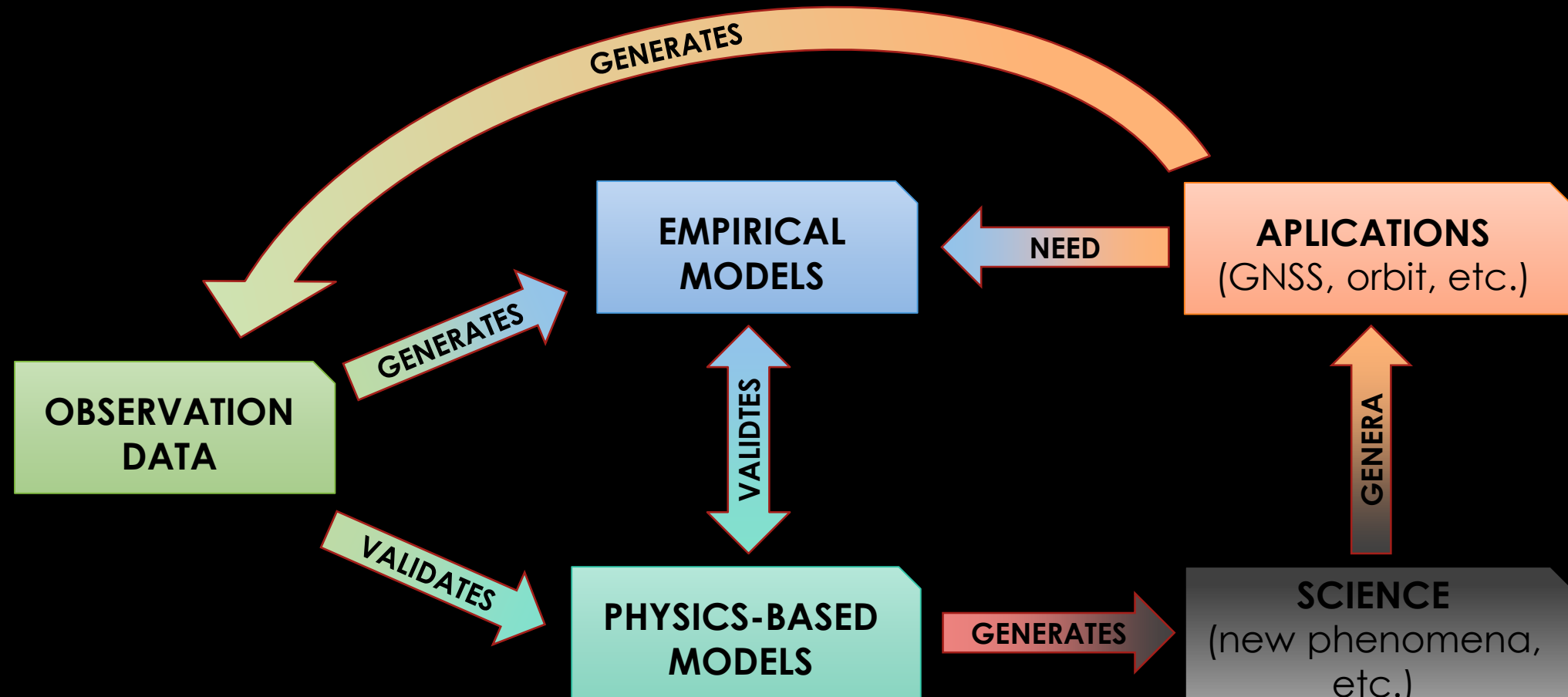


GEODETC SPACE WEATHER RESEARCH



- Research on upper atmosphere aims to contribute for a better understanding of **Space Weather** phenomena within the coupled Magnetosphere-Ionosphere-Thermosphere system, and for the formulation of **predictive models** of the near-Earth space environment.

GENERAL FLOW DIAGRAM AND INTERRELATIONS BETWEEN THE DATA, MODELS, APPLICATIONS, AND SCIENCE.



CONCLUSIONS

- Variations in the **MIT system** are mainly influenced by **solar** and **magnetospheric** forcing.
- The **upper atmosphere** is also influenced by wave motions from the **lower atmosphere**, and is coupled through **energetic particle precipitation** and **field-aligned currents**.
- The understanding of coupled processes between **neutral gas** and **plasma** is a key factor in geodetic space weather research.

CONCLUSIONS

Addressing the challenge to improve the understanding of the MIT system requires:

- Advances in **geodetic observations** of **plasma** and **mass density** compositions and velocities, as well as the dynamics of **energetic particles** and field-aligned **currents** from magnetospheric energy inputs.
- **Advanced theoretic and numerical modeling** capabilities.

These advances can contribute to improved research on space weather, which is essential for various applications such as satellite navigation and communication systems.

SUMMARY ACTIVITIES JSG1

- International cooperation with developing countries by sharing knowledge and research tools, co-supervising thesis, etc.
- Enhance and achieve successful interaction and cooperation along with the 3 Joint Working Groups of the IAG GGOS FA GSWR and other IAG Commissions.
- Elaboration and submission of scientific manuscripts co-authored by JSG1 members.
- Elaboration and submission of projects.
- Elaboration of data and model products freely available for the scientific community.

SUMMARY ACTIVITIES JSG1

- Working effectively within the group members, through a common platform to increase communication. Prepare spreadsheet with interests of each group member.
- Increase international cooperation to break the existing isolation.
- Elaboration of proposal for International Workshop on MTI Coupling (IWMTIC2021): Prospects, Challenges, and Opportunities. Kathmandu, Nepal. June 2022?
- Advancement of MTI science in developing countries by organizing workshops, etc.
- Elaboration of a project draft to request funds for publications fees, etc.

PROJECTS, CONTRACTS, AND AWARDS

- **PROJECT:** Characterization of Plasma Depletions and Effects on Geodetic Applications, 1,000€, PITHIA-NRF EU Horizon 2020 Research and Innovation Programme Grant Agreement Trans-National Access, at Ebro Observatory, Spain. PI: A Calabria, July 2022,
- **PROJECT:** Variability, impacts, and applications of cosmic ray and radiation belt particles, 2,350€, Giner de los Ríos Grant, University of Alcalá, Madrid, Spain. A Calabria, Nov. 2021,
- **PROJECT:** EGNOS Next SBAS-PPP, ESA. Co-I: LL Yuan, 2021-...
- **PROJECT:** MEDUSE Data assimilation project, DLR. Co-I: LL Yuan, 2021-...
- **Post Doc:** KMITL, Prince of Chumphon Campus, Thailand. M Shah, 2021-2022,
- **PROJECT:** Space Education and GNSS lab, National Center for GIS and Space Application, Institute of Space Science, Pakistan. Co-PI: M Shah, 2022...
- **PROJECT:** GDC AETHER instrument proposal selected for the NASA GDC mission. It measures the electron density and temperature of the ionosphere (~400km) for the GDC mission. N Maruyama, 2022
- **AWARD:** Vikram Sarabhai Isro-Cospar Joint Medal, Indian Space Research Organisation (ISRO), Committee on Space Research (COSPAR), Ceremony Of Awards COSPAR 44th Athens July 18, 2022. C Amory-Mazaudier.

RECENT REPORTS AND PRESENTATIONS

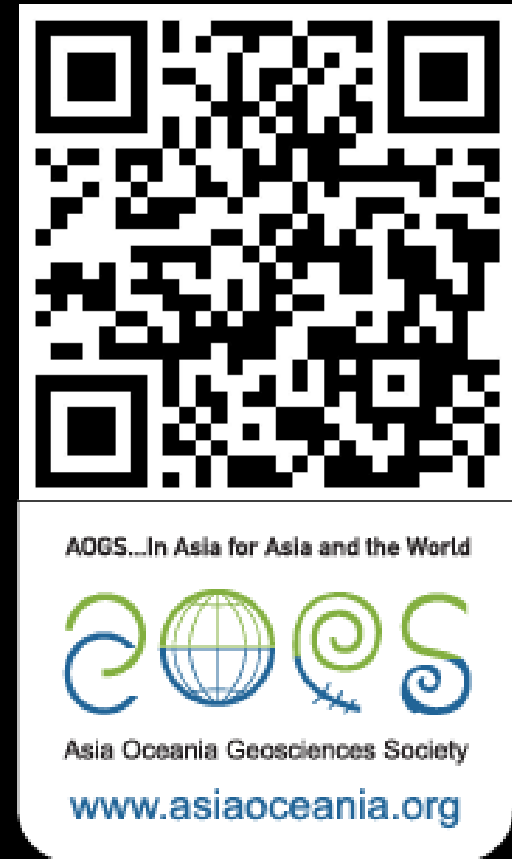
- Introduction to MTI system with figures and details concerning the results summarized in the IAG-FA-GSWR-JSG1 mid-term report (Report No. 2/2021). Available at:
<https://zenodo.org/record/4767575>
- IAG-FA-GSWR-JSG1 2021 **Mid-term Report** No. 2/2021.
doi: 10.13140/RG.2.2.22234.47048.
Available at:
https://www.researchgate.net/publication/351710303_IAG-FA-GSWR-JSG1_2020_Mid-term_Report

IN COOPERATION WITH THE LLWG OF THE AOGS - REGIONAL ADVISORY COMMITTEE

The **Low Latitude Ionospheric Research Working Group (LLWG)** connects different research groups in Asia to exchange information and collaborate on certain observing campaigns. This group aims to expand collaboration to low-latitude regions around the world with this working group as the main component.

The objectives of the LLWG:

- Information exchange.
- Identification of emerging scientific and technical issues for joint study.
- Publication of reports or publications on behalf of AOGS for NGOs or government agencies.





“The **YESS** community strives to help *shape the future* of Earth system science, by *fostering international and transdisciplinary leaders* of tomorrow who pioneer the development and delivery of research and knowledge, which provide solutions to benefit society, towards a more *equitable and sustainable future*”.



World Meteorological
Organisation



futureearth
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[https://www.yess-
community.org/](https://www.yess-community.org/)



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Curriculum Vitae

Contact



Dr. Andres Calabia Aibar

Space geodesy, navigation, and remote sensing. Data analysis and algorithm development.

Research interests

Upper atmosphere environments and coupling between Earth and space weather, the repercussions of these environments on satellites, and the utilization of geodetic techniques to interpret the planetary variability, and to test, validate, and develop geophysical models.

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CCOS DAYS

2023

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THANK YOU!

20.09 - 22.09

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