NASA's Geospace Dynamics Constellation—Providing the first Systematic Measurements of Global Magnetospheric Energy Inputs and Ionosphere-Thermosphere Responses

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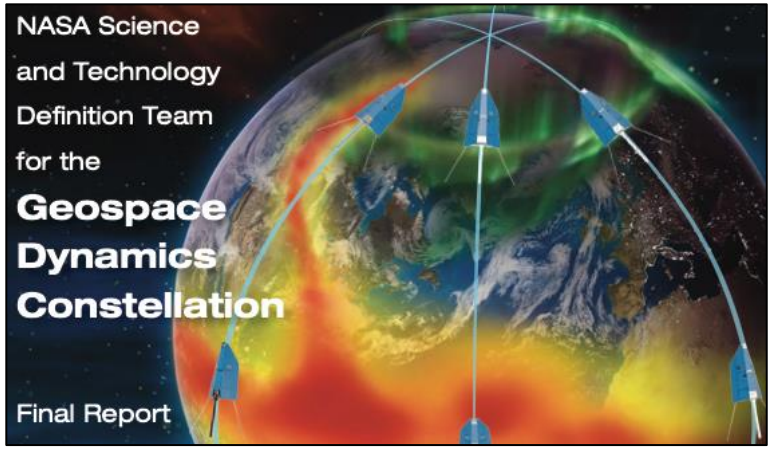
What is the Geospace Dynamics Constellation (GDC)?



GDC is a 2013 Decadal Survey-recommended Strategic Mission being developed for the Living With a Star program in the NASA Heliophysics Division.

The nominal mission is a low-earth orbit constellation of six satellites (350-400 km, high inclination ~82 deg) that will provide a comprehensive study of the upper atmosphere and its responses to forcing from the magnetosphere

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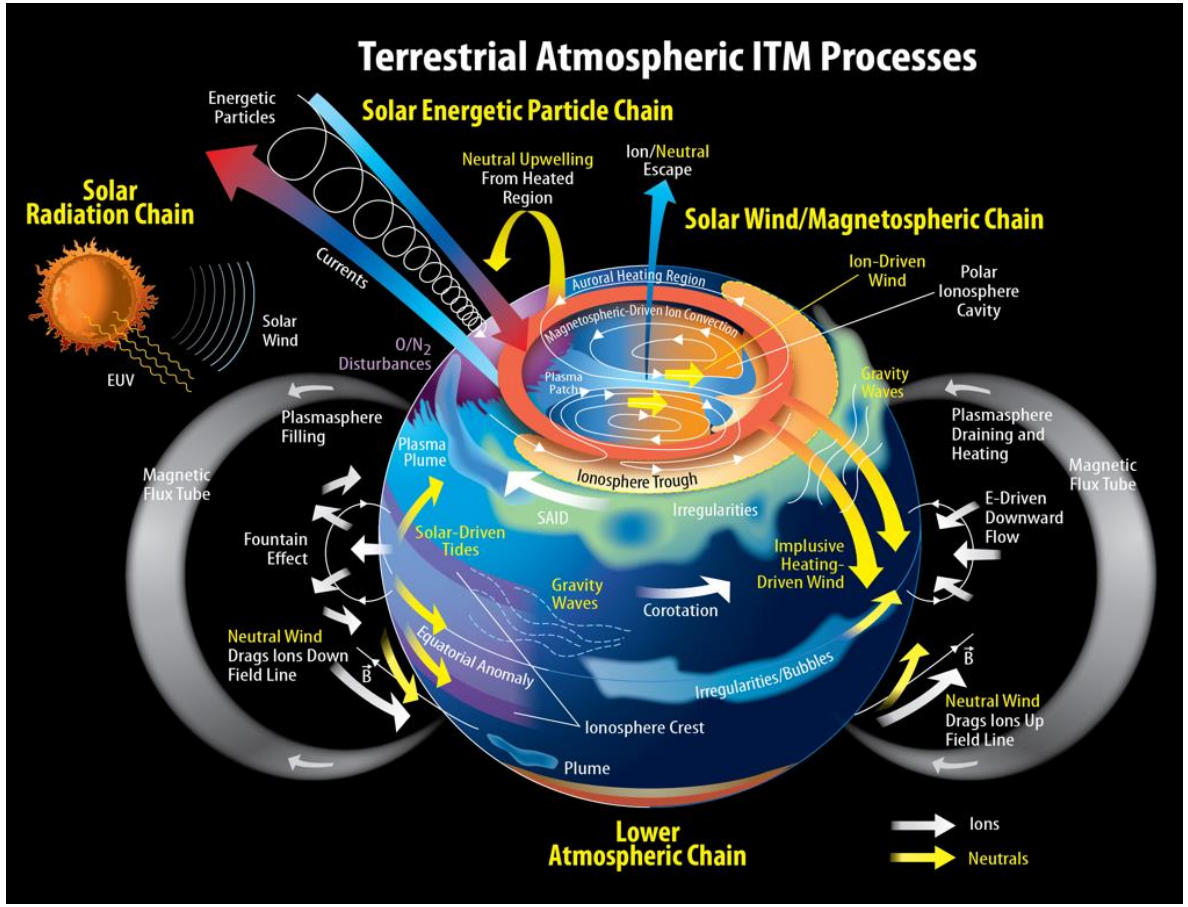
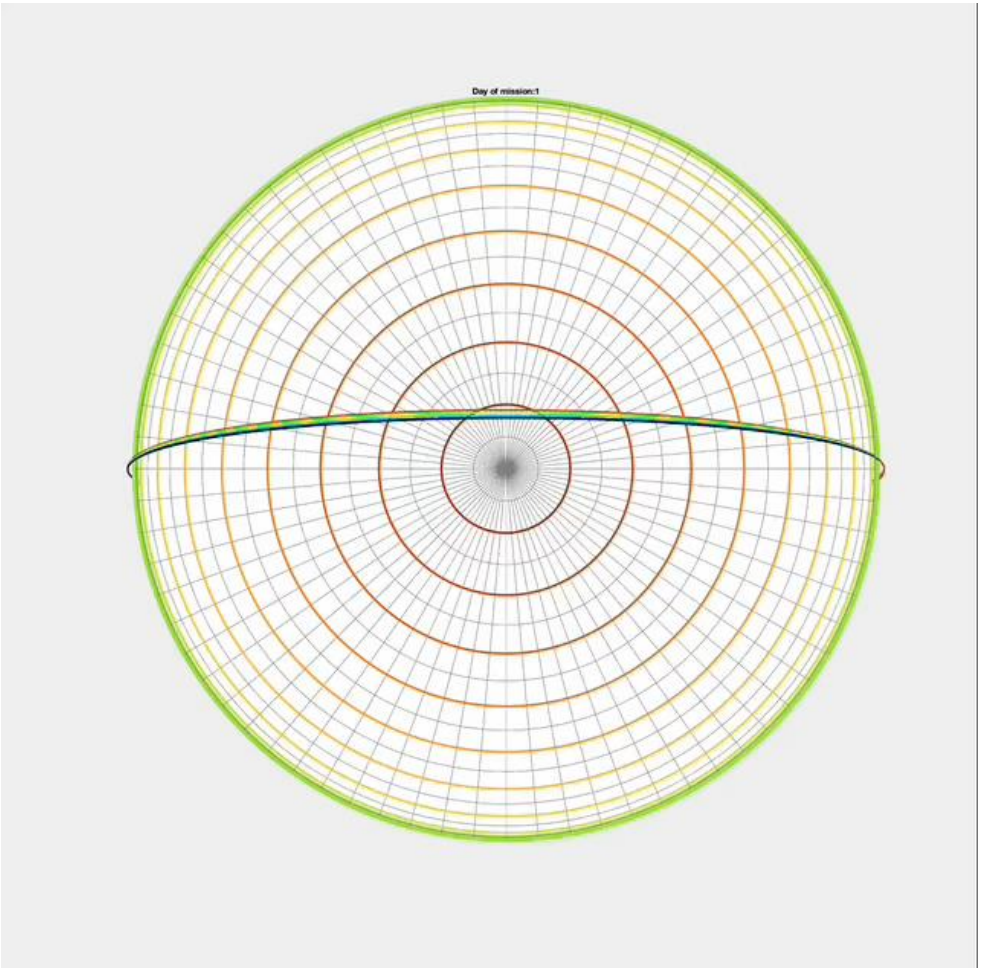


STDT Report

Goal 1: Investigate the high-latitude response to magnetospheric forcing

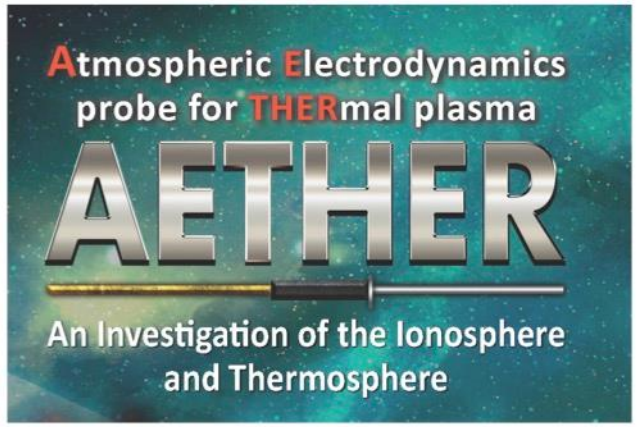
Goal 2: Investigate the Internal processes that globally redistribute mass, momentum, and energy

How will GDC meet its Objectives?

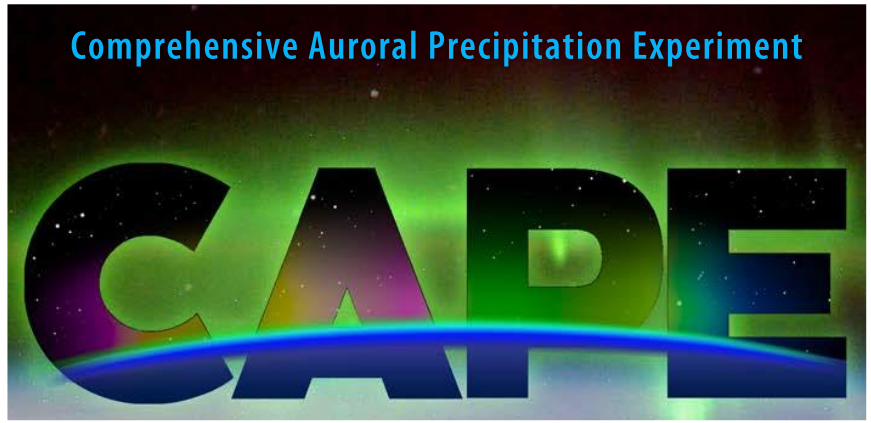


- **6** polar-orbiting satellites at ~375 km
- **6** science instrument teams
- **3** interdisciplinary science teams
- **1** space weather radiation environment sensor
- 1 space weather real-time downlink
- **2** GNSS / Precise Orbit Determination antennas for TEC and POD solutions (Poster #57)

How will GDC Meet its Objectives?

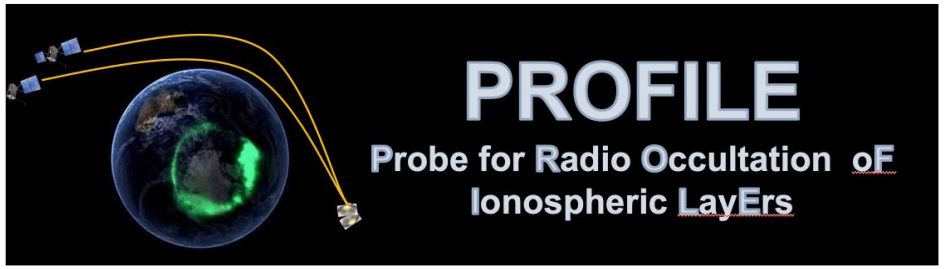


Electron temp. and density
Small-scale irregularities, waves

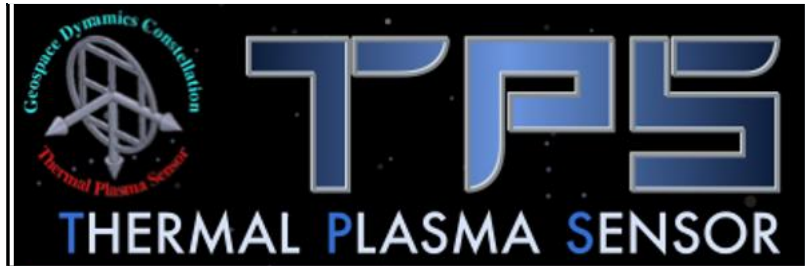


Energy/pitch angle distributions of electrons up to 30 keV (ions up to 40 keV)

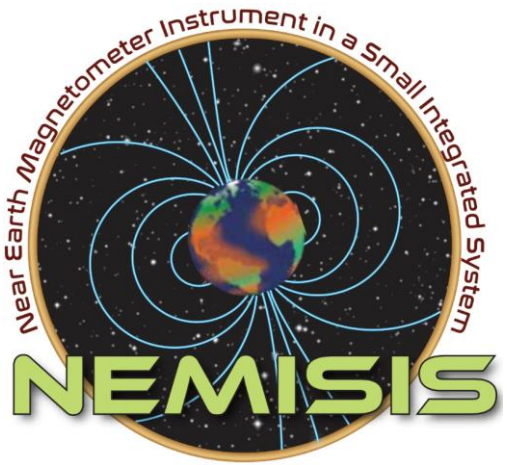
Density, temperature, chemical composition, and 3-D bulk motion of ionized and neutral gas



Remote sensing of TEC (vertical and occultation)
HmF2, NmF2, scintillation
vertical TEC, Ne(z)



Thermal ion drift perpendicular and parallel to magnetic field
Thermal ion density
Thermal ion temperature



Vector magnetic field (3 nT accuracy, 0.1 nT precision)

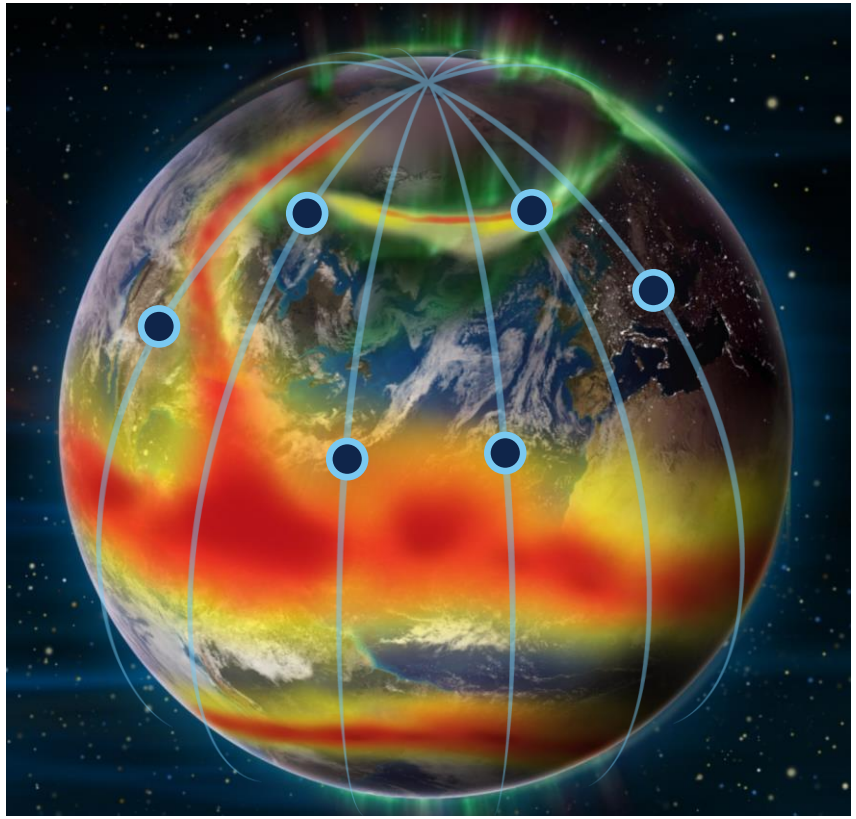
How will GDC meet its Objectives?

UNIVERSITY OF TEXAS ARLINGTON

Interdisciplinary Science Teams

- **NEXUS: N**eutral **EX**ploration **U**tilizing in-situ **S**ensors
- **ADAPTIVE: A**tmospheric **D**ata **A**nd mission **P**lanning **T**ool in an **I**nteractive **V**isualization **E**nvironment
- **SOPHIE: S**upport from **O**bservations and **Ph**ysics Mod**e**ls

Who is GDC?



- **P**rogram Scientist: Dr. Jared Leisner (NASA HQ)
- **P**roject Scientist: Dr. Doug Rowland (NASA GSFC)
- **D**eputy Project Scientist: Dr. Katherine Garcia-Sage (SWx Lead) and Dr. Larry Kepko (NASA GSFC)
- **S**cience Instrument Teams
  - AETHER Langmuir probe (PI Andersson, CU Boulder)
  - MoSAIC ion/neutral mass spec (PI Benna, UMBC)
  - CAPE auroral precipitation (PI Gershman, GSFC)
  - TPS Thermal plasma (PI Anderson, Univ of Texas, Dallas)
  - NEMESIS Magnetometer (PI Moldwin, Univ of Michigan)
  - PROFILE GNSS-RO (PI Verkhoglyadova, JPL)
- **I**nterdisciplinary Science (IDS) Teams
  - NEXUS (PI Thayer, CU Boulder)
  - ADAPTIVE (PI Bishop, Aerospace Corp)
  - SOPHIE (PI Deng, Univ of Texas, Arlington)

Why GDC?

- **To explore** the complex I-T system via comprehensive multi-property and multi-point measurements globally.
- **To reveal** the “missing links” in Solar-Terrestrial Space Weather through a systematic study of its terminus in the upper reaches of Earth’s atmosphere.
- **To provide** critically needed training of next-generation engineers and scientists and foster international collaboration.
- **To reduce** risk and **enable** innovation in low Earth orbit (LEO) utilization by improving the specification and prediction of the LEO space environment.

Where is GDC?

History of Ionosphere-Thermosphere Science and Low Earth Orbit		
ERA	**Science**	**LEO Utilization**
Discovery 1925-1960	Discovery of the I-T via radio, rockets, and start of space age	Radio communications | national security issues
Connections 1960-1990	Identification of the coupled nature of the I-T via ground-based, rockets, and satellite systems	Space exploration | human habitation | national security issues
Characterization 1990-2020	Characterization through climatologies and correlations from broader data sets	Rapid commercialization | civil space | national security issues
Causation Needed Now	Realization of I-T entanglement	Large space economy > $5B annually | expanding commercialization | space sustainability
Comprehensive Future needs	Prediction of global I-T “weather” at high fidelity and resolution	Space-reliant and space-faring world | LEO capacity limits |debris constraints…

Where is GDC?

Ionosphere-Thermosphere Science and Low Earth Orbit		
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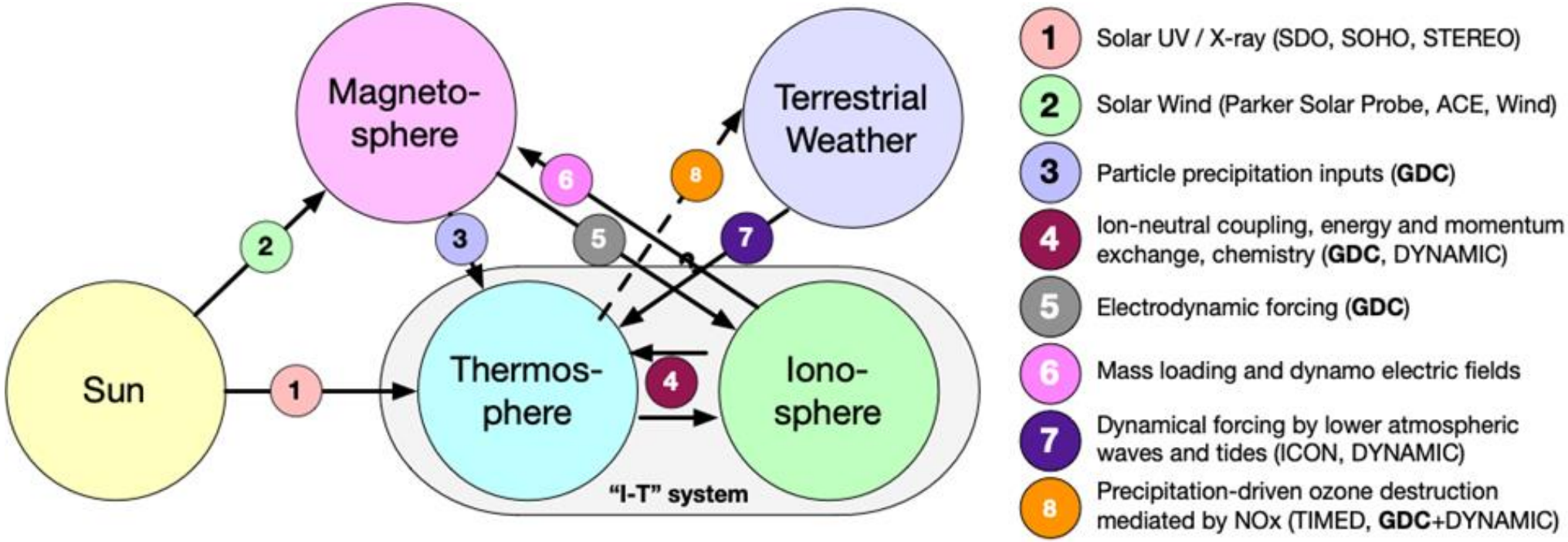

Where is GDC?

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I-T Entanglement: The collection of neutral and charged particles interacting and sharing spatial proximity in such a way that the state of one group cannot be described independently of the state of the other, including when spanning large distances.

- Because of this realization, observing and interpreting the I-T system requires multi-property, multi-point measurements at the same time to capture the true state of the system.
- GDC and DYNAMIC are future NASA I-T missions designed to meet this realization.

Where is GDC?

GDC 2024 Status:

- GDC project activities follow FY23 “pause” plan to maintain capability for early 2030s launch readiness.
- GDC is focusing on science and instrument development
- FY24 appropriation matches GDC planning for science/instrument activities.
- Congress has asked NASA for a plan to launch GDC by the end of the decade.
- Global science partners are sought for collaborative studies and synergistic activities.