Orbital Analysis Based on GDC Mission Science Requirements

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Introduction:

• **Definition:** The Geospace Dynamics Constellation (GDC) is a strategic, Living With a Star (LWS) mission with 6 satellites.

• **Mission Objectives:**

• **Goal 1: Understand high-latitude IT responses to variable solar wind and magnetosphere forcing.**

Obj 1.1: Upper atmospheric impacts on neutral winds.

Obj 1.2: Evolution of localized plasma density features.

Obj 1.3: Atmospheric drivers impacts on neutral-density structures.

• **Goal 2: Understand how internal processes in the global IT system redistribute mass, momentum, and energy.**

Obj 2.1: Role of electric fields and winds in plasma density at mid and low latitudes during geomagnetic storms.

Obj 2.2: Processes shaping and altering IT structures.

Obj 2.3: Winds, temperature, and neutral density interactions at mid and low latitudes.

Obj 2.4: Effects of asymmetries, seasons, and magnetospheric inputs on the IT system.

Study Objective:

• Aims to investigate various orbital configurations for GDC's six satellites in order to compare and contrast qualitatively the strengths and weaknesses of each configuration for addressing GDC science objectives.

Methodology:

Define 4 orbital configurations
Fixed at 300 km altitude, 82° inclination, 90-minute cycle

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Run GITM for March 17, 2013, storm event
0.5° latitude by 2.0° longitude resolution

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Fly the 6 satellites through the orbits

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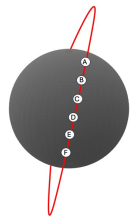
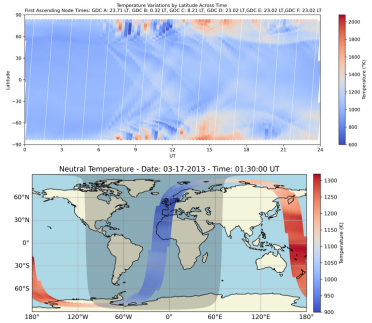
Extract IT parameters

Takeaway Message: The Hybrid configuration captures atmospheric wave dynamics globally with high temporal resolution.

Option 1: One orbital plane



1a)



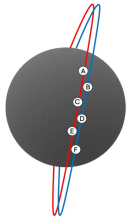
2a)

3a)

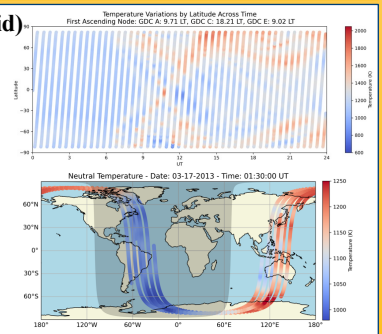
• 6 satellites 15 minutes apart.

Presents IT dynamic evolution but lacks global coverage.

Option 2: Two orbital planes (Hybrid)



1b)



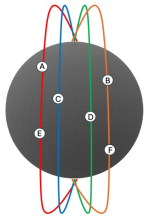
2b)

3b)

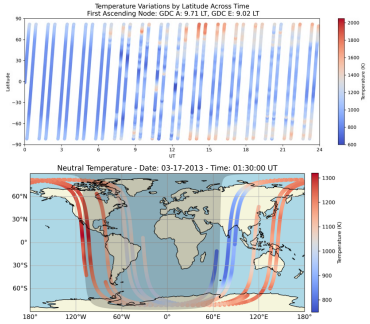
• Satellites on one plane are are 15-minute apart.
• Planes offset by 15 minutes.

Provides a balance between IT dynamic evolution and global coverage.

Option 3: Four orbital planes



1c)



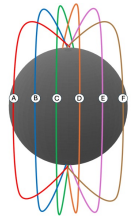
2c)

3c)

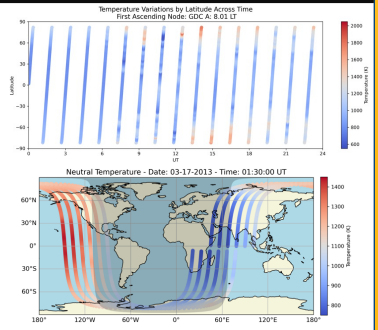
• Satellites on the same plane are 60-minute apart.
• Four planes spaced 1h, 2h, 1h apart.

Offers notable global coverage but limited IT dynamic evolution.

Option 4: Six orbital planes



1d)



2d)

3d)

• Planes spaced one hour apart.

Delivers broad global coverage but lacks IT dynamic evolution.

Figure 1 (a, b, c, d): These figures provide a view of different orbital configurations of the six GDC satellites around the Earth.
Figure 2 (a, b, c, d): These figures show variations in neutral temperature by latitude across Universal Time on March 17, 2013. Each panel represents data from a single representative orbit for the four configuration options, captured in ascending node view.
Figure 3 (a, b, c, d): These figures capture the global variations in neutral temperature from the last frame of a 90-minute animation, showing all six satellites completing one full orbit. Scan the QR code for the full animation.

Subjective Assessment:

• Each orbit configuration offers critical IT insights to achieve the mission objectives.
• Option 2 (Hybrid configuration) resolves dynamics and provides global converge.

Figure 4: This figure illustrates the transition from 'IT Dynamic Evolution' to 'Global Coverage', highlighting the four orbit options.

Future Work:

• Quantitative analysis of the four orbital configurations will be conducted to evaluate their efficiency in covering GDC mission science objectives.

Acknowledgments:

• Sincere appreciation is extended to Prof. Douglas Rowland, Project Scientist of the GDC mission, for his invaluable feedback and expertise.

Scan to view global neutral temperature variations for each configuration