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ABSTRACT

NASA's Geospace Dynamics **Constellation** (GDC) is the next Living With a Star strategic mission, designed to revolutionize our understanding of **Earth's upper atmosphere** and its response to solar and solar wind energy inputs.

Consisting of six identical spacecraft in polar low earth orbits, GDC will make the **first systematic** multipoint studies that can characterize how energy flows through and transforms this part of near-Earth space. With a launch expected early next decade, GDC will provide critical new scientific and space weather observations, and serve as a strategic hub for other efforts to understand Geospace.

For more information, see the GDC webpage: https://gdc.smce.nasa.gov



- GDC has a set of six scientific instruments

- more tightly focused.
- suborbital, and modeling efforts.

- sage@nasa.gov) for more information.

MEASUREMENT PARAMETERS

	GDC Expected Instrument Performance (12/05/2023)							Selected GDC Instruments (P-> prime, S -> support)					
Reference Number	Physical Parameter		Dynamic Range	Accuracy	Precision	Sample Rate	MoSAIC	CAPE	AETHER	NEMISIS	TPS	PROFILE	
a	Thermal ion velocity, in-track (horizontal)		± 5000 m/s	18 m/s	15 m/s		S				Ρ		
b	Thermal ion velocity, cross-track (horizontal, verticall		± 5000 m/s	18 m/s	15 m/s	I / sec	S				Ρ		
2	Thermal plasma density**		10 ² - 10 ⁷ cm ⁻³	± 25 cm ⁻³ or 2%	1% or 10 cm⁻³	2 / sec	S		Ρ		S		
3	Thermal ion temperature		100 - 10,000 K	2%	2%	1 / 2 sec*	Р				S		
4	Thermal ion composition		1 - 150 amu	1%	1%	1 / sec	Р				S		
a	Neutral wind, horizontal (in-track) Neutral wind, horizontal (cross-track)		± 4200 m/s	4.5 m/s	4.5 m/s		Р						
5 b			± 4200 m/s	4.5 m/s	4.5 m/s		Ρ						
С	Neutral wind, vertical (cross-track)		± 3000 m/s	3.5 m/s	3.5 m/s	1 / 0 000*	Р						
6	Neutral gas number density		10 ⁷ - 7 x 10 ¹² cm ⁻³	10%	1%	1/2580	Ρ						
7	Neutral gas temperature		100 - 10,000 K	2%	2%		Ρ						
8	Neutral gas composition		1 - 150 amu	1%	1%		Р						
9 a b	Auroral electrons energy / pitch angle distribution	Down	Energy range; 0.01 Energy flux range 0.1 - 500 m	0.01 - 30 keV, dE/E <11%, Pitch Angle resolution 8.18°, PA range 0°-90° 0 mW/m ² @ 15 % precision , 10% accuracy , dE flux 1x10 ⁶ - 1x10 ¹⁰ cm ⁻² sr ⁻¹ s ⁻¹ eV/eV				Ρ					
		Up	- Energy range; 0.01 Energy flux range 0.1 - 500 m	1 / sec		Ρ							
10 a	Auroral ions energy / pitch angle	Down	Energy range; 0.025 Energy flux range 0.1 - 100 mW	Energy range; 0.025 - 40 keV, dE/E < 17%, Pitch Angle resolution 8.18°, PA range 0°-90° range 0.1 - 100 mW/m ² @ 7 % precision, 10% accuracy, dE flux $1.4x10^{5} - 1.4x10^{9}$ cm ⁻² sr ⁻¹ s ⁻¹ eV/eV				Ρ					
b	distribution	Up	Not measured by AETHER, CAPE, MoSAIC										
a a	Cross-track AC electric field > 4 Hz		± 2.5 V/m [†] (> 4 Hz)	N/A	± 0.1 mV/m				Ρ				
b	Small scale thermal plasma density (0.1-25 km)		10 ² - 10 ⁷ cm ⁻³	N.A	1%	256 / Sec'			Ρ				
12	Thermal electron temperature		100 - 10000 K	± 100 K or 10%	> 50 K or 5%	2 / sec			Ρ				
13	Magnetic field (DC field, vector)		± 64,000 nT	2 nT	0.5 nT	10 / sec				Ρ			
a 14	HmF2		150-350 km (TBR)	25 km (TBR)	10 km (TBR)	1 per						Ρ	
b	NmF2		10 ⁵ - 5x10 ⁶ cm ⁻³ (TBR)	10% (TBR)	10% (TBR)	occultation						Ρ	

l cycle. If another measurement covered the ions, then MoSAIC could measure neutrals at 1 s cadence Thermal plasma density is measured by both AETHER and MoSAIC -- the values quoted here are combined performance

¹AETHER measures electric field spatial structure along a single cross-track axis with a roll-on frequency of 4 Hz (corresponding to about 4 km spatial structure). MoSAIC measures at scales larger than 32 km.



GDC STATUS

GDC is in the initial concept / design phase (Phase A)

• GDC development has been slowed while we wait for the available funding profile to synchronize with GDC development costs. The primary focus is on science and instrument development

GDC is working to **integrate the selected investigations** into the mission science traceability, for initial Mission Systems Requirements Review, nominally in Q4 2024

GDC is planned for launch in the early 2030s, but the exact launch date is TBD.

GDC's mission duration is three years, and GDC will carry expendables for 2 more years.

GDC IS A COMMUNITY MISSION

GDC is a strategic mission, led by NASA's Goddard Space Flight Center. It is structured so as to be accessible to the science community and to achieve broad and far-reaching goals, unlike PI-led missions, which must often be

GDC will serve as a "**strategic hub**" that can be leveraged by a host of other space-based, ground-based,

GDC's data will be **fully open**, and **software will be released open source**

GDC is looking to coordinate with scientists who utilize ground-based observations. Please contact Bea Gallardo Lacourt (<u>bea.gallardolacourt@nasa.gov</u>) if you are interested in learning more.

GDC is a science mission, but is expected to be of high value for Space Weather. GDC will carry a real-time broadcast capability for sending data to operational users. Please contact Katherine Garcia-Sage (katherine.garcia-







NASA'S GEOSPACE DYNAMICS CONSTELLATION

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- GDC will launch onto a single launch vehicle and then the spacecraft will be moved to **six orbit planes** with slightly different inclinations, so that they slowly drift apart to

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