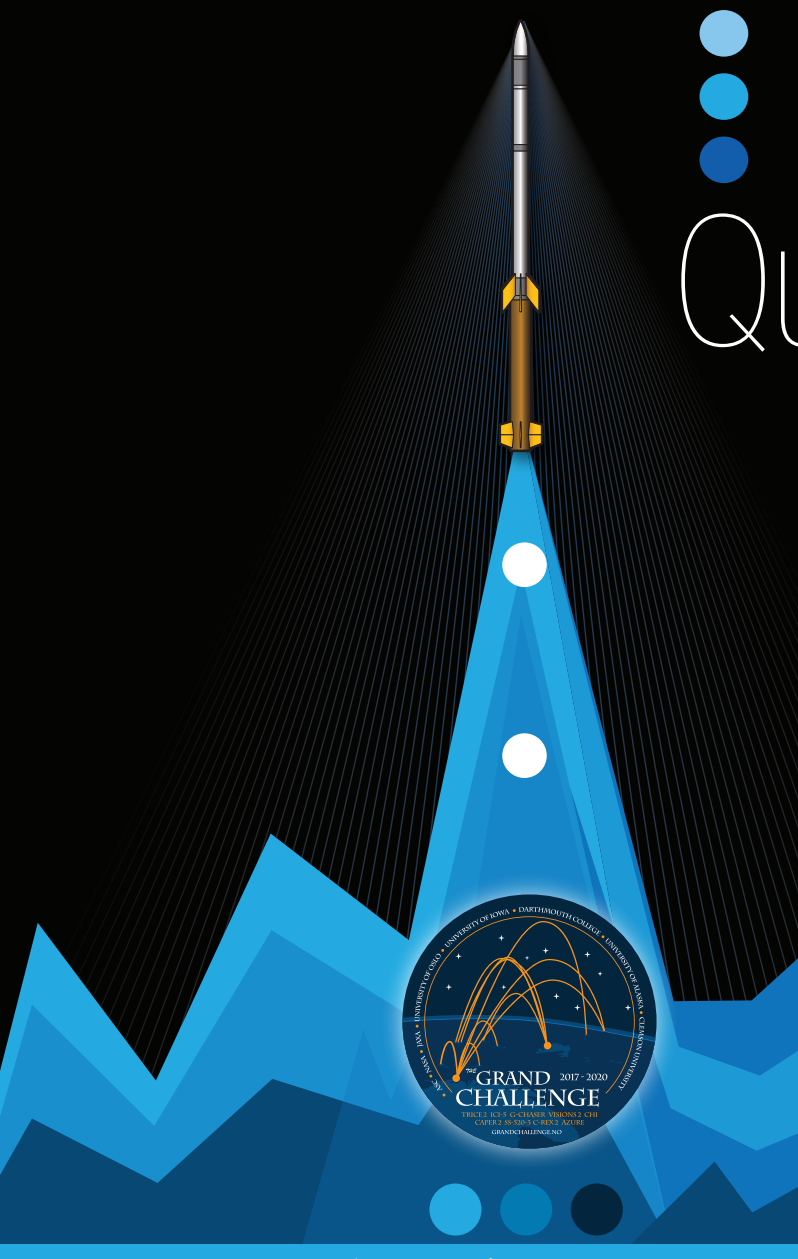
2018—2021

GRAND CHALLENGE INITIATIVE

Quick Look



NASA GSFC/WFF • Andoya Space Center • University of Oslo • JAXA • ISAS • Dartmouth College • University of Iowa • University of Alaska Fairbanks • Clemson University • University of Colorado

THE GRAND CHALLENGE INITIATIVE - CUSP

2018

LAUNCHED: December 8, 2018

TRICE-2

MISSION: Twin Rockets to Investigate Cusp Electrodynamics-2

LAUNCH VEHICLES: Black Brant XII • 2 Rockets

LAUNCH SITE: Andøya, Norway

PRINCIPAL INVESTIGATOR: Craig Kletzing, University of Iowa, USA

LAUNCHED: December 7, 2018

VISIONS-2

MISSION: VISualizing Ion Outflow via Neutral atom Sensing–2

LAUNCH VEHICLES: Black Brant X • 2 Rockets

LAUNCH SITE: Ny-Ålesund, Svalbard

PRINCIPAL INVESTIGATOR: Doug Rowland, NASA Goddard Space Flight Center, USA

2019

LAUNCHED: January 4, 2019

CAPER-2

MISSION: Cusp Alfvén and Plasma Electrodynamics Rocket-2

LAUNCH VEHICLE: Black Brant XII

LAUNCH SITE: Andøya, Norway

PRINCIPAL INVESTIGATOR: James LaBelle, Dartmouth College, USA

LAUNCHED: January 13, 2019

G-CHASER

MISSION: University Student Experiments

LAUNCH VEHICLE: Terrier-Improved Malemute

LAUNCH SITE: Andøya, Norway

PRINCIPAL INVESTIGATOR: Chris Koehler, Colorado Space Grant Consortium

LAUNCHED: April 5, 2019

AZURE

MISSION: Auroral Zone Upwelling Rocket Experiment

LAUNCH VEHICLES: Black Brant XI • 2 Rockets

LAUNCH SITE: Andøya, Norway

PRINCIPAL INVESTIGATOR: Miguel Larsen, Clemson University, USA

LAUNCHED: December 10, 2019

CHI

MISSION: Cusp Heating Investigation

LAUNCH VEHICLE: Black Brant IX

LAUNCH SITE: Ny-Ålesund, Svalbard

PRINCIPAL INVESTIGATOR: Miguel Larsen, Clemson University, USA

LAUNCHED: November 26, 2019

ICI-5

MISSION: 3D *in situ* Observations of Ionospheric Irregularities in the Cusp

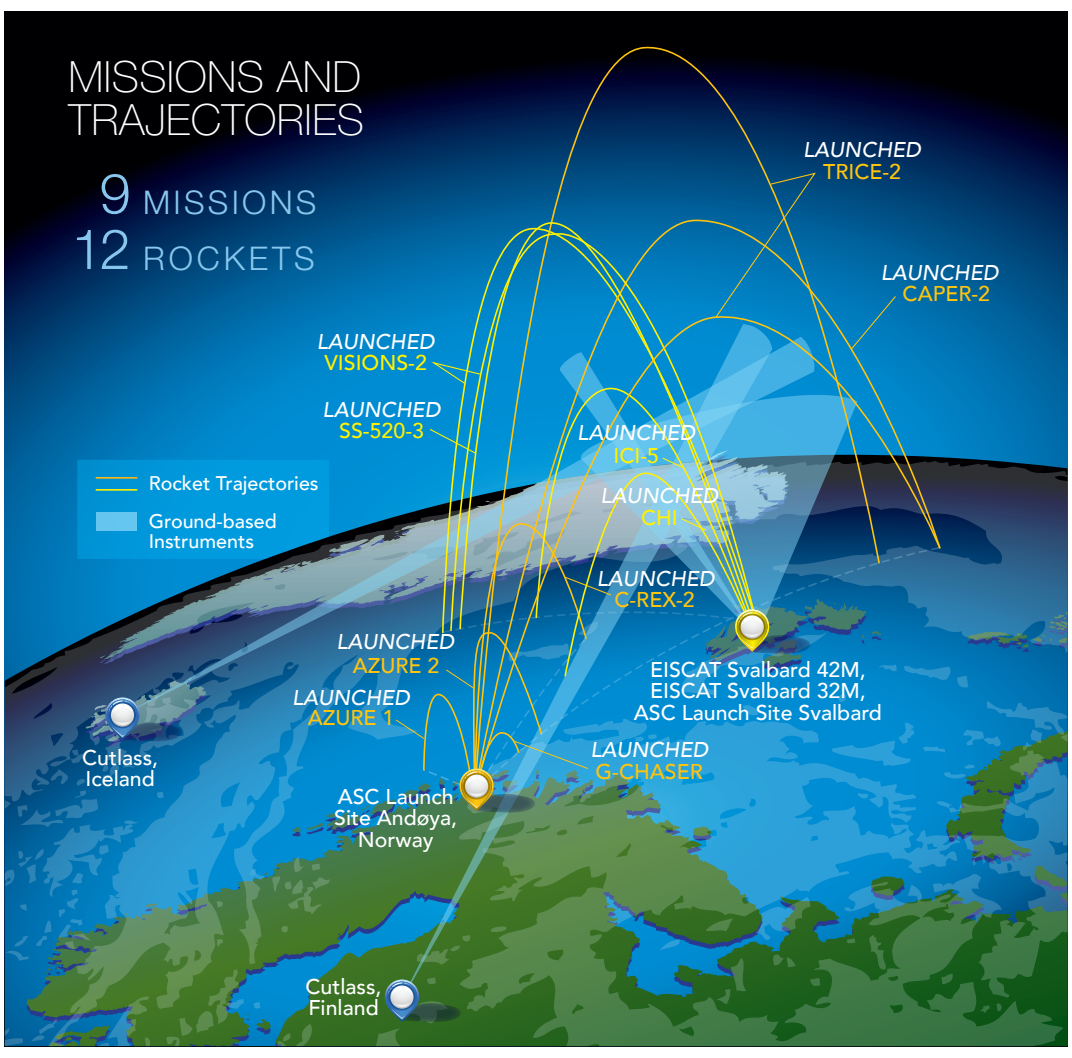
LAUNCH VEHICLE: VS-30 - Improved Orion

LAUNCH SITE: Ny-Ålesund, Svalbard

PRINCIPAL INVESTIGATOR: Jøran Moen, University of Oslo, Norway

SOUNDING ROCKET FAST FACTS

- Known as sounding rockets for the nautical term "to sound," meaning to measure, these rockets reach a region between 30 and 800 miles above Earth's surface.
- The lower end of this region is otherwise inaccessible, as it's above the maximum altitude for scientific balloons and below the minimum for satellites.
- The flight is a simple parabolic trajectory and flight time is less than 20 minutes—providing just 5 to 10 solid minutes of scientific observations from space.



2021

LAUNCHED: November 4, 2021

SS-520-3

MISSION: Ion Outflow in the Cusp

LAUNCH VEHICLE: SS-520-3

LAUNCH SITE: Ny-Ålesund, Svalbard

PRINCIPAL INVESTIGATOR: Yoshifumi Saito, Japan Aerospace Exploration Agency

LAUNCHED: December 1, 2021

C-REX-2

MISSION: Cusp-Region EXperiment

LAUNCH VEHICLE: Black Brant XII

LAUNCH SITE: Andøya, Norway

PRINCIPAL INVESTIGATOR: Mark Conde, University of Alaska Fairbanks, USA

For more information, please visit: *http://www.grandchallenge.no*

NP-2018-4-194-WFF (Rev 10/2021)

THE GRAND CHALLENGE INITIATIVE-CUSP

THE SCIENCE OF THE CUSP:

The Grand Challenge Initiative - Cusp is an international collaboration to explore the polar cusp—where Earth's magnetic field lines bend down to meet the poles and particles from space can enter our atmosphere.

9 MISSIONS • 12 ROCKETS

MAGNETOSPHERE

POLAR CUSP

AZURE* — *Auroral Zone Upwelling Rocket Experiment*

LAUNCHED APRIL 5, 2019

How do auroras impact the total amount of energy gained or lost by the atmosphere? AZURE measures ionospheric winds and circulation to better understand auroral effects.

ICI-5 — *Investigation of Cusp Irregularities-5*

LAUNCHED NOVEMBER 26, 2019

Turbulent hot patches of dense plasma exist inside the auroral region. ICI-5 seeks to understand the physical drivers of plasma turbulence, determine the size of the eddy structures, and explore how these plasma structures disturb radio signals.

VISIONS-2* — *Visualizing Ion Outflow via Neutral Atom Sensing-2*

LAUNCHED DECEMBER 7, 2018

How do ions get 'boiled' off the atmosphere? VISIONS-2 observes how ionized oxygen—a comparatively heavy element—acquires enough energy to escape our atmosphere. The mission tracks the escape by visualizing the otherwise invisible atoms as they flow outwards.

G-CHASER — *G-CHASER*

LAUNCHED JANUARY 13, 2019

G-CHASER is a collaboration between eight different student-led missions. It provides a unique opportunity for students to design, test, and ultimately fly their experiment from start to finish.

TRICE-2* — *Twin Rockets to Investigate Cusp Electrodynamics*

LAUNCHED DECEMBER 8, 2018

Researchers have observed step-like changes in ion energies near the pole. TRICE-2 distinguishes between two potential explanations: magnetic reconnection that turns on and off, like a light-switch, or steady magnetic reconnection occurring in varying locations.

C-REX-2 — *Cusp-Region Experiment*

LAUNCHED December 1, 2021

C-REX-2 measures winds and ion velocity at around 400 km in altitude in the cusp to track causes of increased density there. The mission differentiates between possible causes such as changes in wind, temperature, or ion velocity.

CHI — *Cusp Heating Investigation*

LAUNCHED DECEMBER 10, 2019

CHI will measure the flow of plasmas and neutral gases in the cusp, testing current models of how they interact with one another and become heated and accelerated in the process.

JAXA SS-520-3 — *SS-520-3*

LAUNCHED November 4, 2021

Atmospheric escape is a universal phenomenon occurring on Earth, Mars and other planets—but the mechanisms vary case by case. The SS-520-3 mission investigates the wave-particle interactions high in Earth's atmosphere that allow particles to heat up and escape.

CAPER-2 — *Cusp Alfven and Plasma Electrodynamics Rocket*

LAUNCHED JANUARY 4, 2019

Auroras are created when fast-moving particles from the sun crash into Earth's atmosphere. CAPER-2 investigates how such particles can be accelerated via Alfvén waves—oscillating, low-frequency waves that provide particles with extra energy and send them speeding toward Earth.

MAGNETOSPHERE

*TWO ROCKETS

NASA GSFC/WFF • Andøya Space Center • University of Oslo • JAXA • ISAS • Dartmouth College • University of Iowa • University of Alaska Fairbanks • Clemson University • University of Colorado

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Credit: Trond Abrahamsen, Andøya Space Center

NP-2018-4-195-WFF