

CEDAR Science Past the Next Decade – A Long-Term Vision

Long-Term Vision I: 9-10am MT Thursday, 25 June 2020

CEDAR Science \pm 30 years

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University of Colorado



Grand Challenge

UNIVERSITY OF COLORADO BOULDER

SPACE WEATHER CENTER



Past 30 years – Moving ahead by Looking Back

1990 CEDAR MEETING AGENDA

TUESDAY
June 12, 1990-NIST/NCAR

8:30-8:45 Welcome at NIST
Killeen/Gardner, NCAR/HAO,
Bierly/NSF

8:45-10:00 Introductions
CEDAR post docs
CEDAR prize lecturer
Students

10:00-10:15 BREAK

10:15-10:45 CEDAR Prize Lecture

10:45-11:00 CEDAR Post-Doc report
Julie Moses

11:00-12:30 NASA Future Programs:
Ionosphere-Thermosphere-Mesosphere
and Magnetospheric Physics
Killeen, Szuszczewicz and community
discussion

12:30-2:00 LUNCH (adjourn to NCAR)

2:00-5:30 Workshops at NCAR

5:30-6:30 Reception at NCAR

10:45-12:30 Instrument updates and short
talks

12:30-2:00 LUNCH (adjourn to NCAR)

2:00-5:30 Workshops at NCAR

about 6:30 Bar-B-Q at NCAR on *tree plaza*

THURSDAY
June 14, 1990-NIST

8:30-9:30 Tutorial 2 - Larry Lyons
Ionosphere/Magnetosphere
Coupling and Auroral
Acceleration Processes

9:30-10:30 Poster previews
(2 min or 2 figures)

10:30-10:45 BREAK

10:45-12:30 Poster session at NIST

12:30 Adjourn for the day

WEDNESDAY
June 13, 1990-NIST/NCAR

8:30-9:30 Tutorial 1 - Peter Stubbe
Review of Ionospheric
Modification

9:30-10:30 Instrument updates and short
talks

10:30-10:45 BREAK

FRIDAY
June 15, 1990-NIST/NCAR

8:30-9:30 Tutorial 3 - Tom Slanger
Aeronomical Laboratory Work

9:30-10:30 Instrument updates and short
talks

10:30-10:45 BREAK



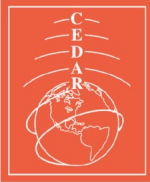
CEDAR budget for FY 1990

As a component part of NSF's Global Geosciences Program (GGP), CEDAR has received \$1.5M in new funds for FY 1990. The total support for CEDAR within the GGP is now at a level of ~ \$2.6M and is split between the Aeronomy and Upper Atmosphere Facilities Programs of the Upper Atmospheric Research Section. A further \$1.2M is in the President's request for CEDAR in FY 1991 - again as part of the GGP.

A total of 41 proposals requesting ~ \$4M were received at NSF in response to the latest proposal deadline in October 1989. The review process for these proposals included the traditional mail-in reviews plus a subsequent panel review. On the basis of this process and the available level of funding, it appears that NSF will be able to support ~18 of these proposals at a total level of ~1.5M for the next fiscal year.

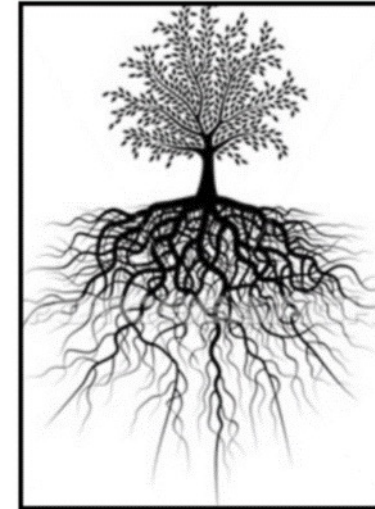


The 1990 CEDAR Workshop attracted 267, more than 50 institutions in the United States, Germany, Sweden, Finland, United Kingdom, Norway, Peru, and Puerto Rico. On the afternoon of June 14, the CEDAR "crew" gathered in the NCAR courtyard for a group photograph of all attendees (top) and for a special photograph of the student attendees (bottom).



The Cedar Post

Winter 2010 Issue 58



CEDAR Roots

This section of the Post is to clarify terms or common concepts that are rooted in CEDAR science. The goal is that this material will help educate the community and the masses by also posting this material to Wikipedia. Through a culmination of material we hope the CEDAR science and program can be more visible to the general public through Wikipedia pages provided by experts in the field.

CEDAR Student Workshop official start 1996



Tuesday, June 22, 1993 - NIST Auditorium

Chairman: R. Robinson, National Science Foundation

8:30 - 9:00 NSF/CEDAR Issues - R. Behnke

9:00 - 9:45 Tutorial Lecture #2
R. Meier - UV Spectroscopy

9:45 - 10:00 Break

Chairman: R. Behnke, National Science Foundation

10:00 - 12:30 CEDAR 10th Anniversary Celebration

A light-hearted look at:

Conception - M. Biondi

Early Days - G. Romick

NSF Perspective - R. Behnke

Growth of Program - T. Killeen

From Student to CEDAR Awardee - J. Thayer

LTCS Campaigns - J. Salah

GISMOS Campaigns - O. De la Beaujardiere

GTMS ETS GTS GITCAD CADITS CAT Campaigns -

A Retrospective of Collaborative Thermospheric

Studies - M. Hagan

AIDA Campaigns - J. Meriwether

Present Days - M. Kelley

12:30 - 1:30 Lunch

1:30 - 5:30 Workshops at Foothills

5:11 - 6:16 Extra-Curricular Extra-Fare Activity

Buses leave Boulder bus terminal for Stadium

7:05 - ? Colorado Rockies vs Cincinnati Reds Baseball Game

Past 30 years – A Learning Experience

Approaches / Resources

- Student Support from Day 1
- Campaign-driven science
- NSF Upper Atmosphere Facilities
- NCAR HAO resources
- NASA collaborations (CEDAR-TIMED initiative)
- NSF GeoSpace Program

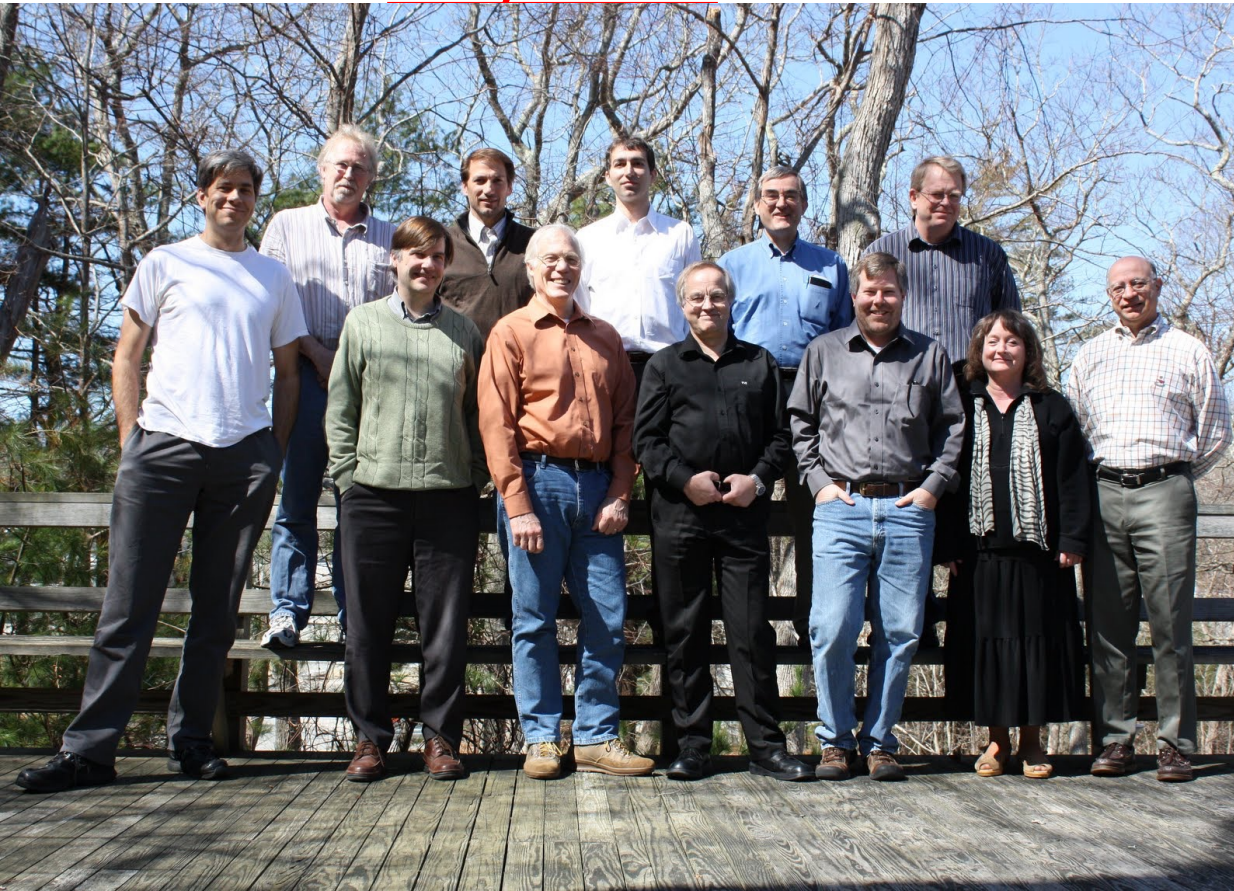
Initiatives / Programs

- Polar cap observatory - AMISR
- DASI
- GPS and TEC
- Lower atmosphere influences
- Data assimilation - AMIE
- CubeSats
- Data science

CEDAR Strategic Vision – The New Dimension (2010)

CEDAR is a grass roots initiative that provides the community an opportunity to self-organize and exchange ideas. It also provides strategic guidance to NSF. With its emphasis on ideas, inclusivity, and education, CEDAR has become the intellectual engine of aeronomy.

Why Now?



out of date (13 years old)

evolving

research and resource envelop of CEDAR

sed to contribute to high-priority,

ns

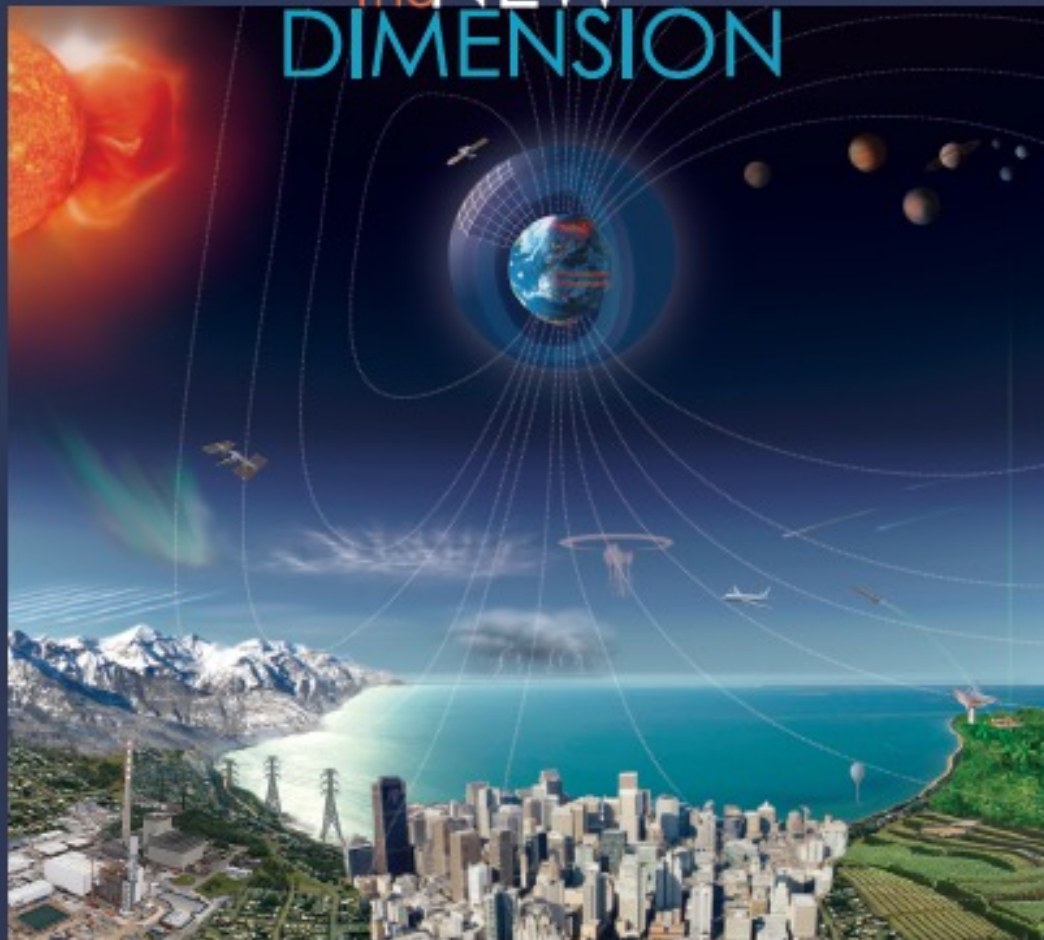
preeminent aeronomic body and is

cept forward to advance new

1 Boulder, CO

CEDAR

The **NEW**
DIMENSION

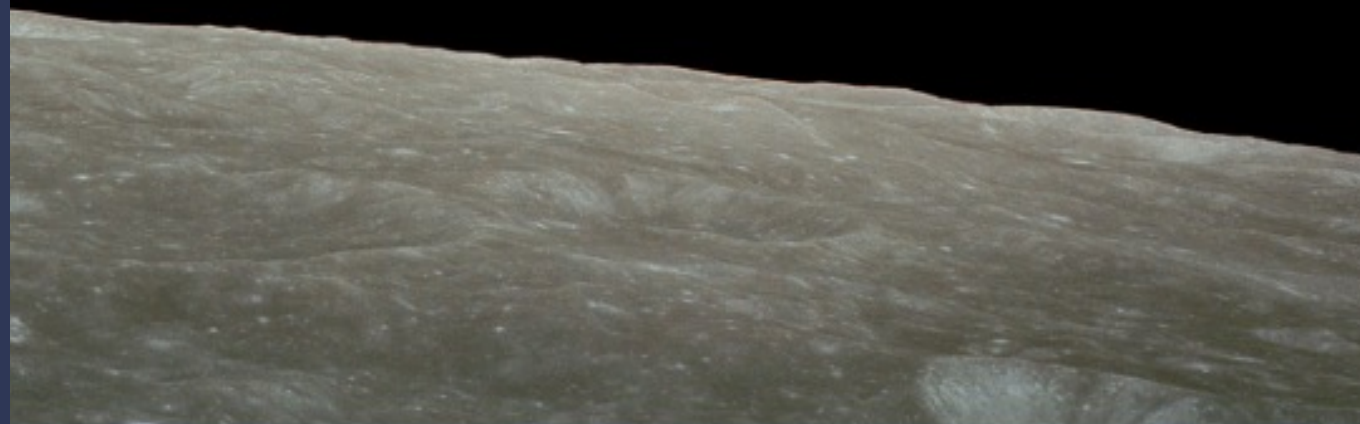


STRATEGIC VISION
for the National Science Foundation Program on
COUPLING, ENERGETICS AND DYNAMICS OF ATMOSPHERIC REGIONS



**Man must rise above the Earth – to the top of
the atmosphere and beyond – for only thus will
he fully understand the world in which he lives.**

– Socrates

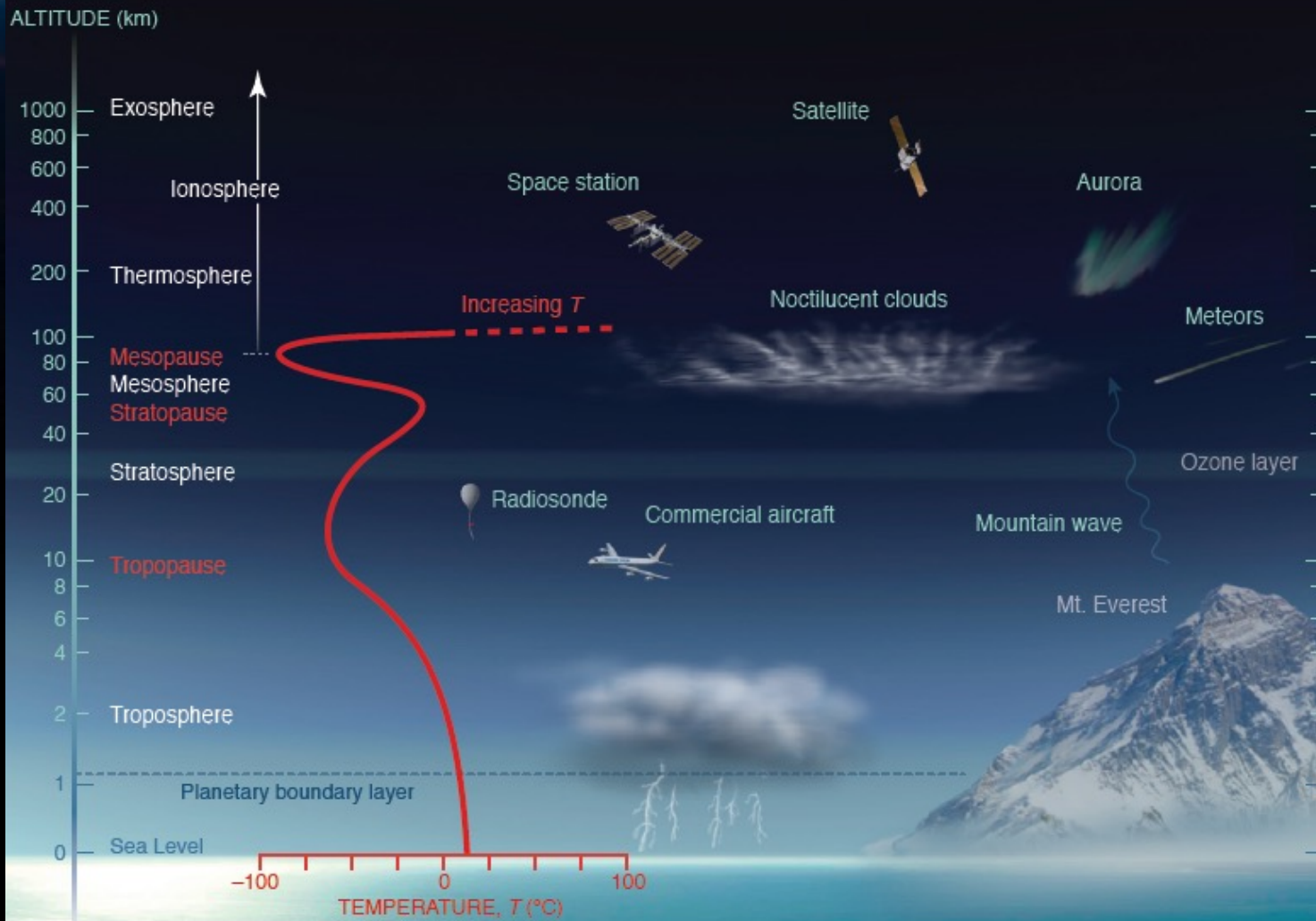
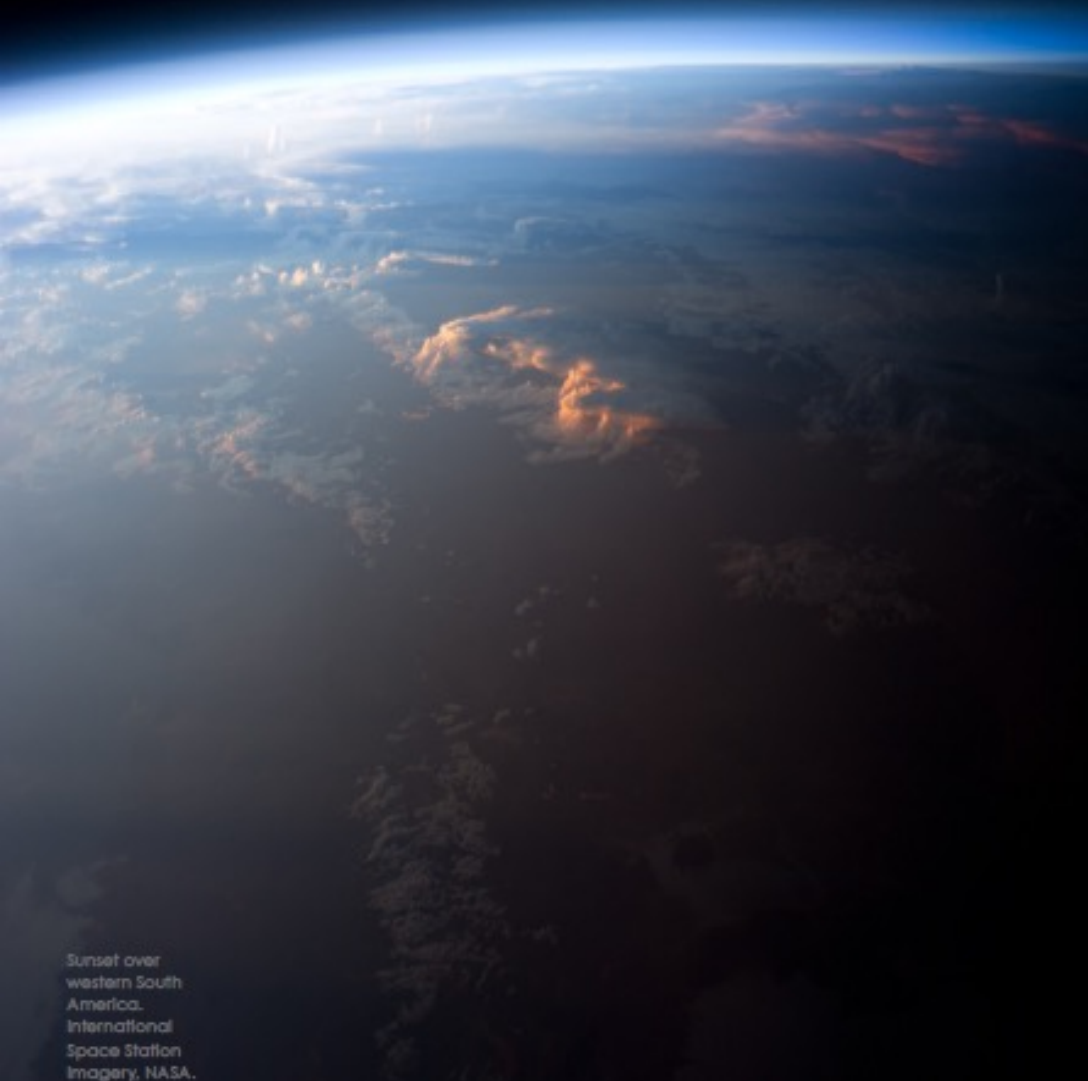


The CEDAR mission is to understand the fundamental properties of the space-atmosphere interaction region (SAIR); identify the interconnected processes that define the SAIR's global behavior, evolution, and influence on the Sun-Earth system; and to explore the SAIR's predictability.



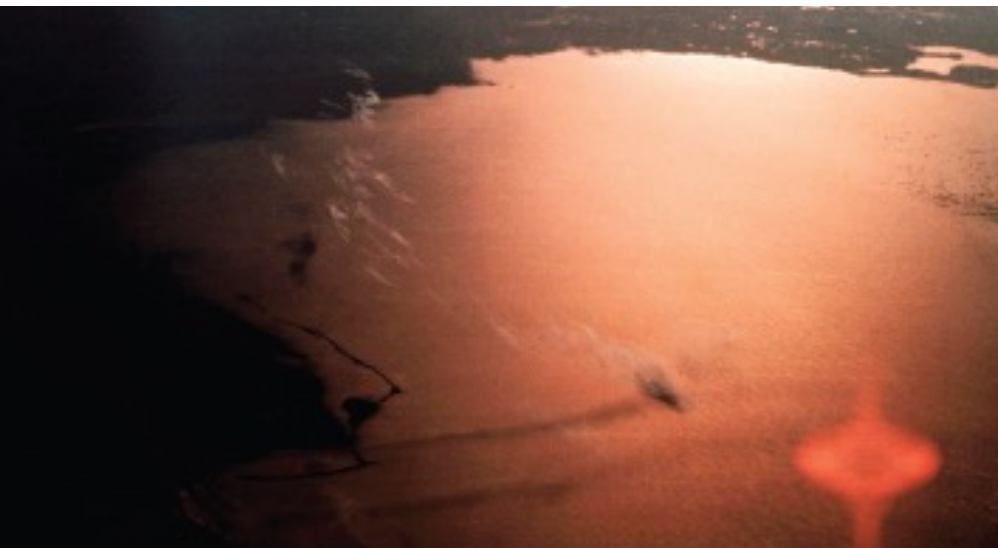
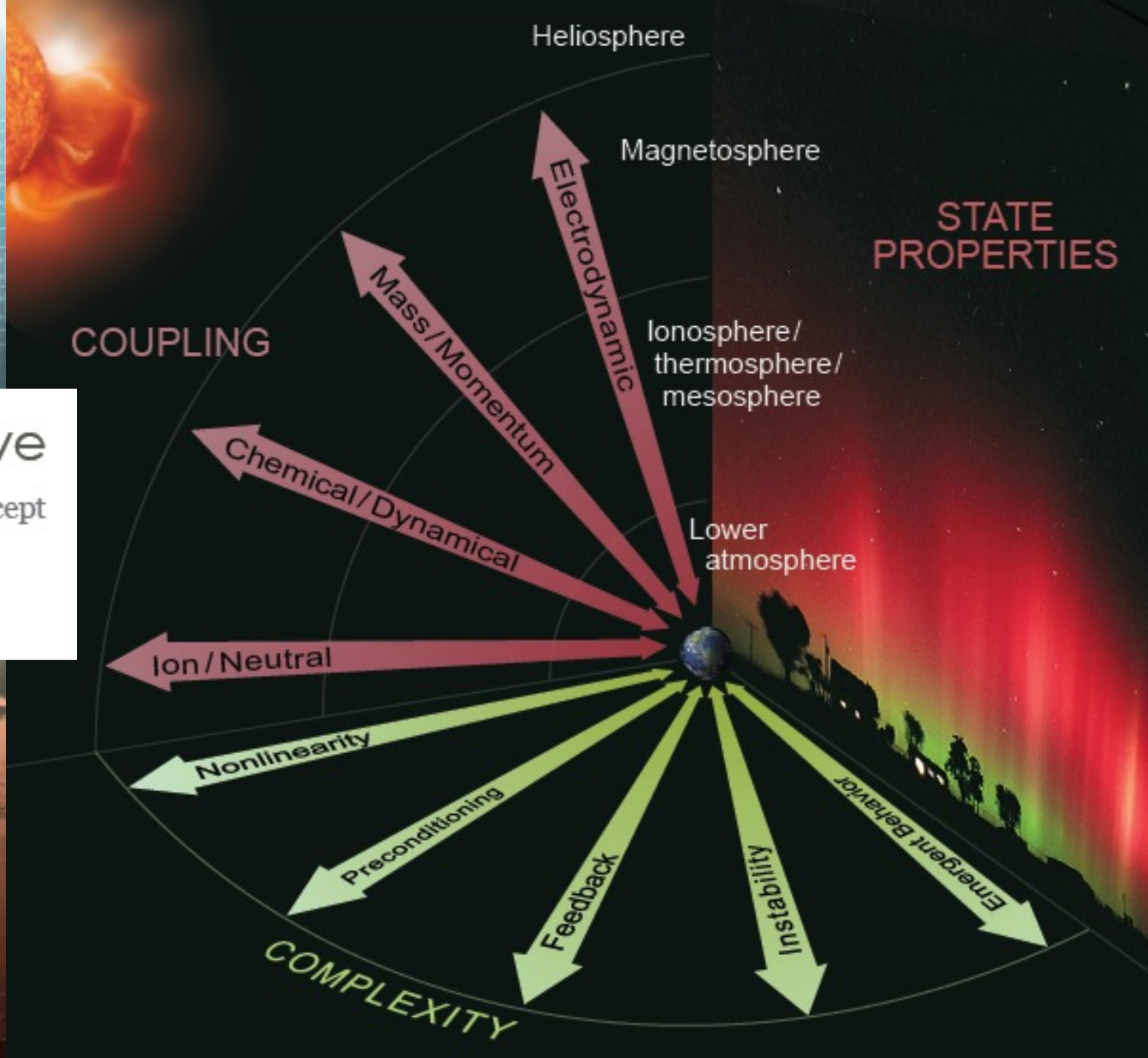
2 The Space-Atmosphere Interaction Region

To understand the processes that govern the coupling, energetics, and dynamics of the upper atmosphere, it is useful to envision this as an *interaction region*, coupling the lower atmosphere with space and the universe beyond.

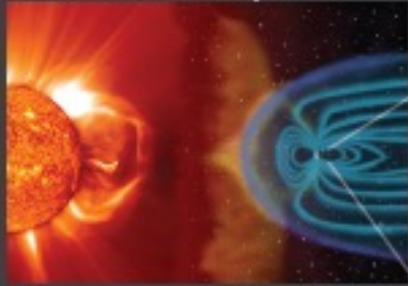


3 The Systems Perspective

The systems approach transcends the concept of scale, enabling the characteristics of a complex system to be generally applied to many problems in the Sun-Earth system.



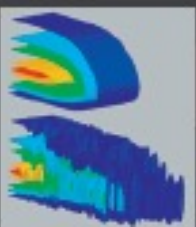
Solar-terrestrial System



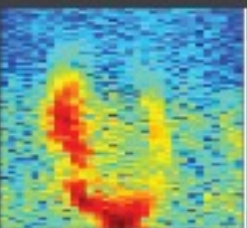
Geocorona



Equatorial Plasma Bubbles

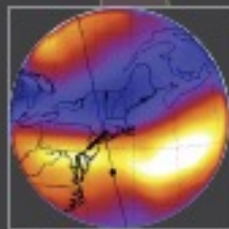
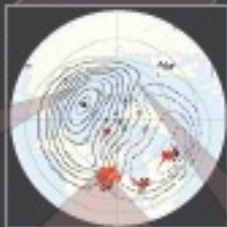


Plasma Density Patches

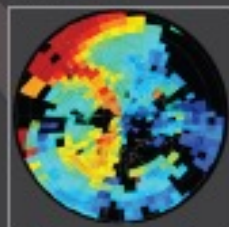


Ion-acoustic Turbulence

Ionospheric Convection



Stable Auroral Red Arcs



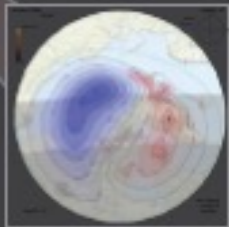
Plasmaspheric Drainage



Discrete Aurora

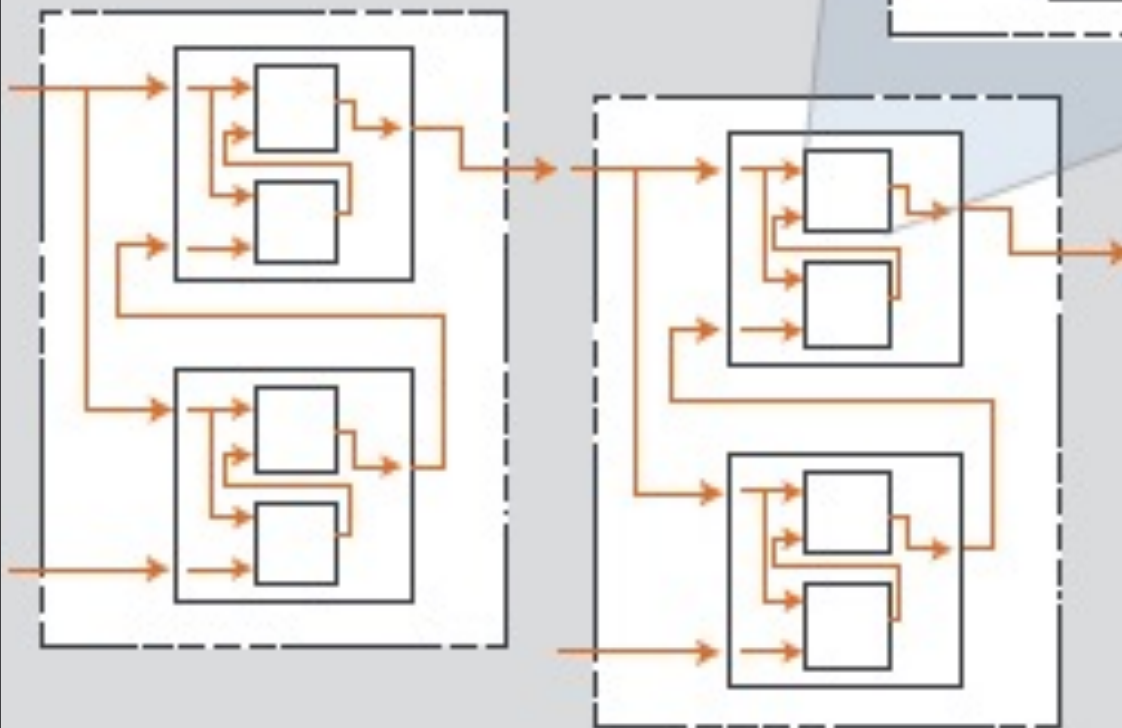


Ionospheric Outflow



Electrojet Instabilities

Systems Perspective



E-fields
Particles

Neutral wind

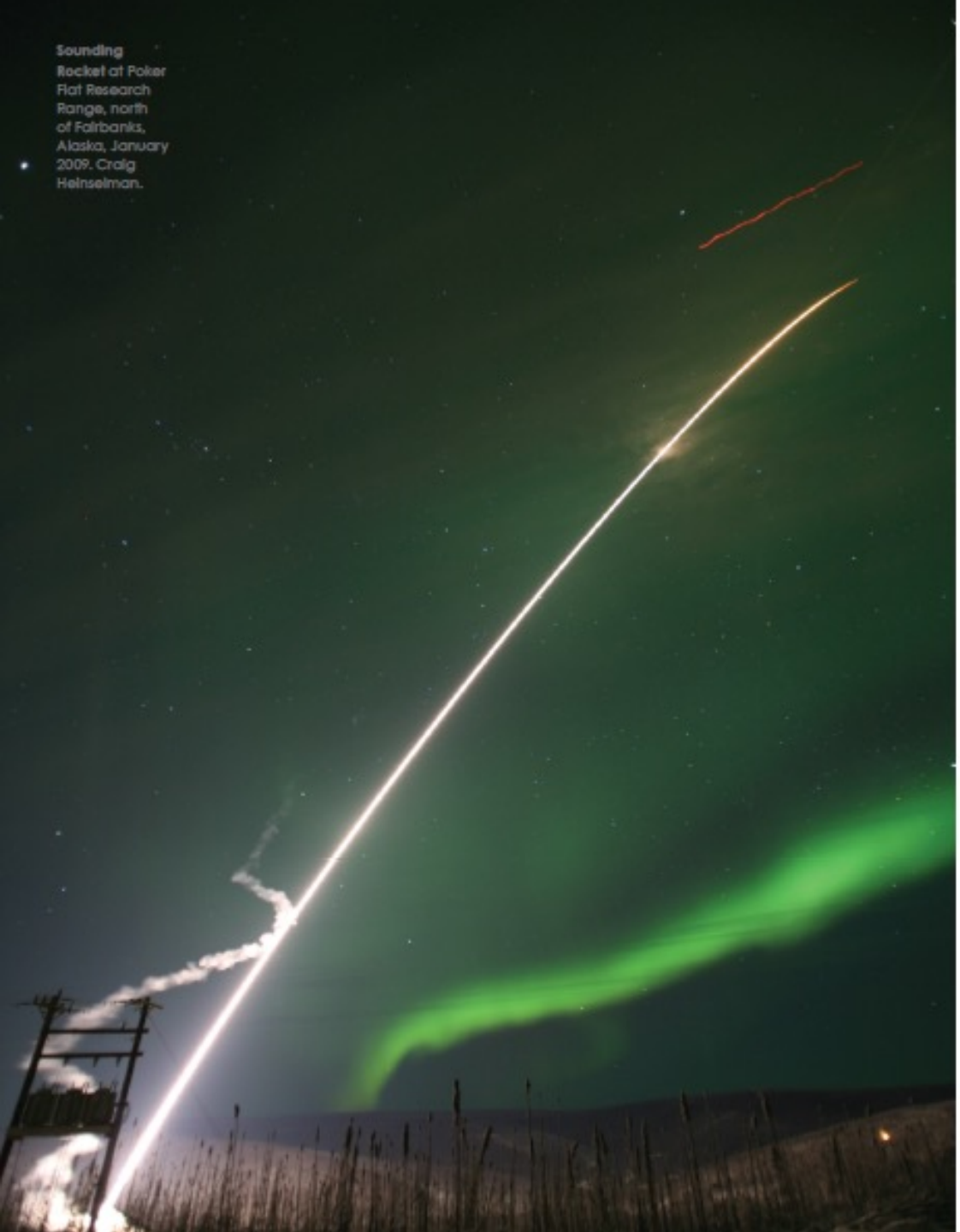
Thermosphere energy balance

Wave heating

Plasma waves

T_1 at 200 km

Radar scatter



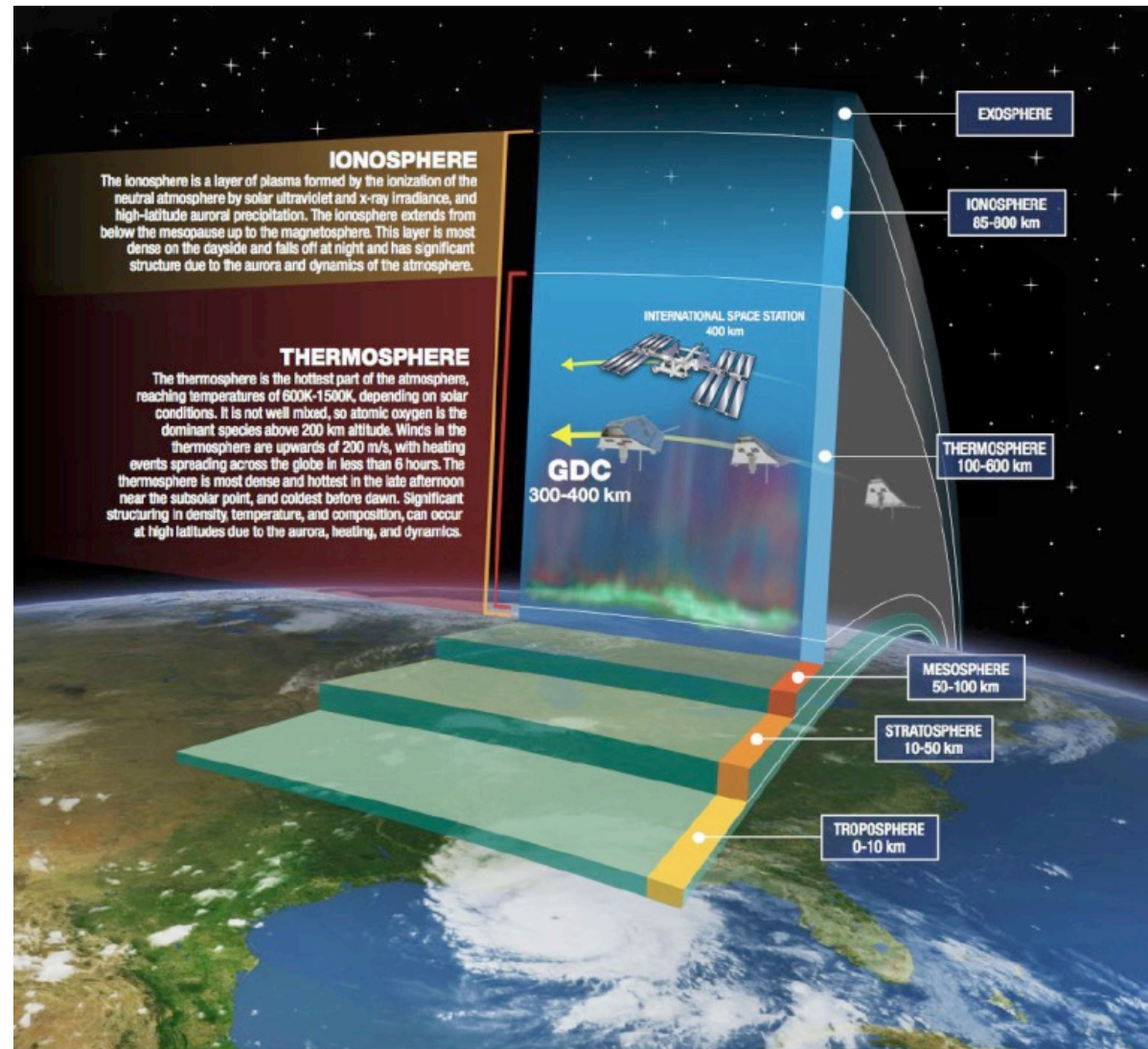
4 The Way Forward

The 21st century approach to understanding the Sun-Earth system is to explore new avenues of progress, building on past decades of accomplishments.

- 1 Encourage and undertake a Systems Perspective of Geospace
- 2 Explore Exchange Processes at Boundaries and Transitions in Geospace
- 3 Explore Processes Related to Geospace Evolution
- 4 Develop Observational and Instrumentation Strategies
- 5 Fuse the knowledge Base across Disciplines
- 6 Manage, Mine, and Manipulate Geoscience/Geospace Data and Models

Next 30 years – Winds of Change

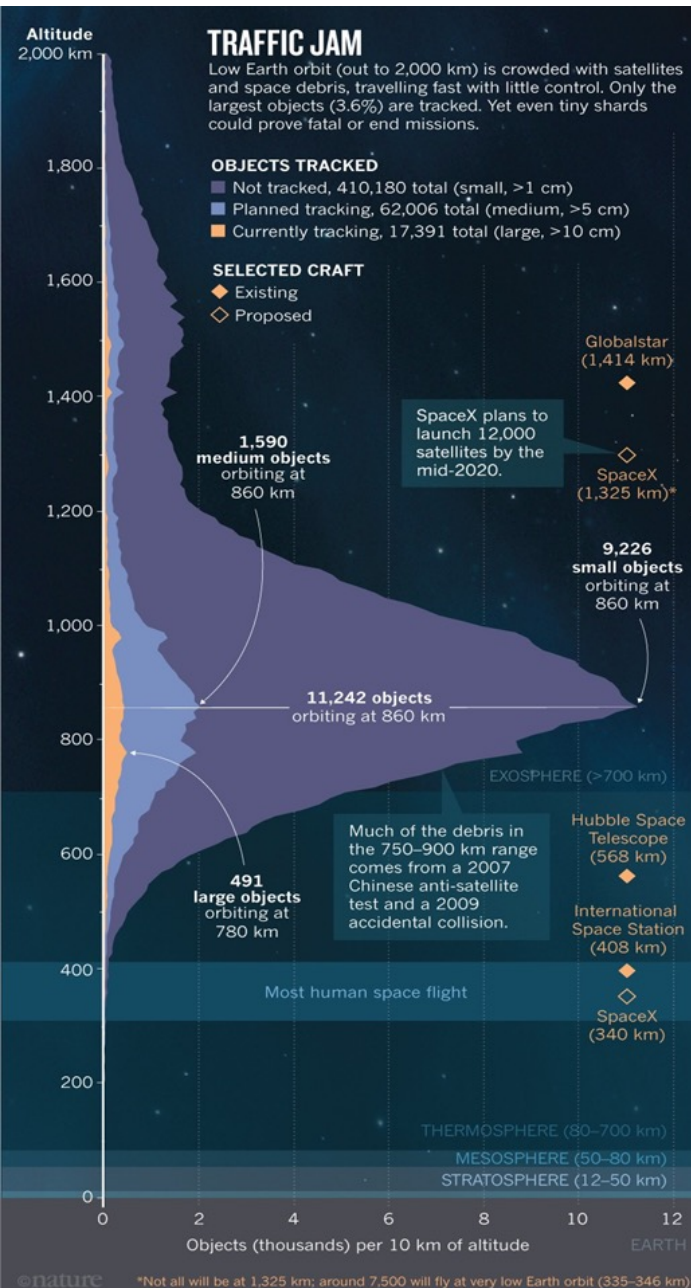
Literally, Figuratively, and Aspirationally



Literally:

- Close the thermosphere gap - Thermosphere neutral gas wind field requires observation but poses a significant challenge as the 4-D field, not just local motion, is required.
- Explore “integrative aeronomy” as a system that exhibits complexity – characterized by having multiple drivers, by featuring adaptive feedback and memory, by its nonlinear response and instabilities, and by exhibiting sensitivity to initial conditions.
- Apply CEDAR’s modeling, observational techniques, and insight beyond the Earth system and contribute to (exo) planetary coupling energetics and dynamics of atmospheric regions, i.e. planetary habitability, evolution and sustainability.

Next 30 years – Winds of Change



Figuratively:

ITM is rapidly becoming a crowded orbital domain involving a public-private enterprise with growing commercial use and mega-constellations concepts to provide such societal services as global internet connectivity and 5G wireless networks for Internet of Things devices.

- How can CEDAR science benefit from such a concentration of operating spacecraft?
- How can CEDAR science help inform society's future use of space in LEO?
- More generally, how can CEDAR science make NSF a major player in space research?

Next 30 years – Winds of Change

Aspirationally: *The most fruitful areas for growth of the sciences are those between established fields. Science has been increasingly the task of specialists, in fields which show a tendency to grow progressively narrower. Important work is delayed by the unavailability in one field of results that may have already become classical in the next field. It is these boundary regions of science that offer the richest opportunities to the qualified investigator.*

– Norbert Wiener

This can be applied more broadly to current and future times where inclusivity and equity of diverse thought, experiences, and backgrounds yield unbounded and undiscovered opportunities for personal and scientific enrichment and advancement.

I believe CEDAR has the opportunity to bridge across scientific and societal boundaries to enrich the field and the individual's experience, growth, and impact through inclusivity and equity.

Community

Equity

Diversity

Altruism

Respect