

ASEN 4519:
Department of Aerospace Engineering Sciences
Syllabus, Spring 2023

Course Instructor: Dr. Thomas Berger / Office ASEN N433 /
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Time & Location: Tuesday 2:30 – 3:20pm MT, Aero N240

Prerequisites: None.

Course Purpose: To give students a basic understanding of space weather science, engineering, technological and biological impacts, forecasting operations, government policy and law, and economic impact on our global technological society.

The course is designed for non-STEM and STEM students alike, requiring only high school level physics and math.

After taking this course, students will be able to:

- **Define what space weather is and how and why it varies over timescales from days to decades.**
- **Explain how space weather impacts technological systems on a daily basis and how national and international monitoring and forecasting systems work.**
- **Differentiate between moderate, strong, and extreme space weather events and relate the impacts of historic extreme storms.**
- **Locate and use official and unofficial space weather forecasting and nowcasting data.**
- **Understand the policy and legal landscape surrounding space weather and space operations including the roles of the FCC, FAA, DOD, and NOAA in domestic policy, as well as the role of the UN in international space treaties.**

Course Objectives: Students will come away with knowledge of

- The history of space weather and how major storms over the past 150 years led to our understanding of the Sun and the Earth as an interconnected system.
- The basic structure and magnetic activity of the Sun and how it drives space weather throughout the “heliosphere” through solar wind and magnetic eruptions.
- The Earth’s near-space environment, including the magnetosphere and atmosphere/ionosphere systems, and how these systems interact with solar outputs and lower atmospheric inputs to create space weather phenomena such as the aurora, geomagnetic storms, and radiation storms.
- The major impacts of space weather on technological systems including radio communications and radar, GPS navigation, satellite orbital operations, aviation and space travel systems, and electric power transmission grids. Students will be able to differentiate impacts between moderate, strong, and extreme solar storms and understand the potential economic impacts of an extreme event.
- How space weather is currently forecast, how successful it is at providing warnings, how it could be improved, and what products and services are available for civilian, military, and international space weather customers.

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- How space weather forecasting integrates with current space operations and the policy and legal ramifications of current US and international space agreements, including issues of proposed Low Earth Orbit “mega-constellations” and the increasing problem of orbital debris.
- How space weather will impact human space travel to the Moon and Mars in the coming decades and the differences between space weather at Earth, on the Moon, and on Mars.

Textbook: An Introduction to Space Weather

Mark Moldwin
2nd Edition, Cambridge University Press, 2022

Schedule of Topics

Lecture	Date	Topic	Text chapter
1.	01/17	Space weather: definition and historical development	1
2.	01/24	The Sun as a magnetically active star – the solar cycle, solar wind, & magnetic eruptions	2
3.	01/31	The Heliosphere – the local interplanetary environment	3
4.	02/07	The Geospace environment – the Earth’s magnetosphere	4
5.	02/14	The Geospace environment – the Earth’s upper atmosphere	5
6.	02/21	Technological impacts 1: Solar Flares and communications and navigation	6
7.	02/28	Technological impacts 2: Geomagnetic Storms, the power grid and satellite orbits	6
8.	03/07	Technological impacts 3: Radiation storms and deep space travel	7
9.	03/14	Extreme space weather events in history	
10.	03/21	Final paper topic discussion	
	03/28	(Spring break)	
11.	04/04	Space weather forecasting 1: what is “space weather forecasting” and how well can we do it?	
12.	04/11	Space weather forecasting 2: models, observations, and products	
13.	04/18	Space policy and law in the US and internationally	
14.	04/25	Space Weather Data Portal demonstration	
15.	05/02	Final paper summaries and discussion	

Assignments

Students will be required to complete one assignment over the semester:

- A topical summary paper on a space weather topic of their choice. The paper is expected to be approximately 5 pages in length and can focus on, e.g., space weather research challenges, historical events and technological impacts, operational forecasting issues, domestic policy or law, international

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space weather policy, commercial opportunities in space weather, etc. Students will be expected to present an approximately 10-minute in-class summary presentation on their paper in the final class of the semester.

Course Grading:

- Attendance and participation (75%)
- Topical summary paper (25%)

University Policies

1. Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

2. Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

3. Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

4. Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

5. Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, [reporting options](#), and the support resources can be found on the [OIEC website](#).

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Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

6. Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must let the instructors know of any such conflicts within the first two weeks of the semester so that we can work with you to make reasonable arrangements. See the [campus policy regarding religious observances](#) for full details.