Meteorology 4613: Satellite Meteorology

When: Tuesday/Thursday 11:30 -12:45 AM
Where: NWC 5600 (where ever that is)
Who: Dr. Mark Morrissey

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Office hours: By appointment until things are sorted out

COURSE DESCRIPTION

Satellite Meteorology introduces both the undergraduate and the graduate student to the current use of satellites to study weather and climate and the underlying **physics** related to variable measurement. Material presented includes the history of satellites, orbital dynamics (Newton and Keppler's Laws, etc.), radiation concepts (as related to satellites), algorithms, etc. See the Knowledge Expectations for a detailed description of course content.

Near the end of the semester, each student will be required to give a ½ hour presentation in class related to the satellite meteorology. The presentation will be basically be a review of a journal with the article selected by the student. It is advisable that the journal article not be too difficult or too technical (unless the student fully understands the content). Grading of the presentation will be a function of the work involved in the preparing and presenting, not necessarily the depth of understanding of the content. The purpose of the presentation is to get the class involved in discussing the article topic.

While this course isn't offered many times in our department, to those of you who are planning to become forecasting or research meteorologists (among other related profession), the use of satellite information will become extreme critical in your job.

Required Text: *Satellite Meteorology: An Introduction* by Kidder and Vonder Haar

Grading: Mid-term (25%), Final Exam (comprehensive 40%), Homework (25%) student presentations (10%). Final Exam Satellite Metr 4613 (5321) December 12th, 10:30-12:30PM.

Rough Course Outline (subject to change, student presentation after each topic, roughly one student per topic until all students have one presentation):

1. Brief history of satellite meteorology
2. Orbital dynamics and navigation
3. Radiative transfer
4. Image interpretation
5. Temperature and trace gases measurement

6. Winds
7. Clouds and aerosols
8. Precipitation
9. Earth Radiation Budget
10. Forecasting using satellite data

'Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your education opportunities'

Knowledge Expectations for METR 4613
Satellite Meteorology

Purpose: This document describes the principal concepts, technical skills, and fundamental understanding that all students are expected to process upon completing METR 4613, Satellite Meteorology. Individual instructors may deviate somewhat fro the specific topics and order listed here.

Pre-requisites: Grade of C or better in METR 4133, METR 4424.
Students should have a basic understanding of radiation and synoptic meteorology concepts and have technical skills in statistical methods and concepts. Knowledge of the Earth's climate and major climatic weather system is essential.

Goal of the Course: This course is designed to give the students a broad overview of past and current satellite systems, their missions and the physics underlying the variable retrieval algorithms. It is expected that the students will learn about the current and past satellite systems, the data they collect, along the necessary caveats to using these data to observe atmospheric conditions.

Topical Knowledge Expectations

I. History of satellite systems

- Be aware of early satellite systems and their missions
- Be aware of the current the earth satellite observing systems

II. Review of basic atmospheric radiation principles

- Understand the basic concepts of radiation in general and its measurement. These concepts include the basic laws of radiation, e.g. steradians, units, Plank function, Wien's law, the Rayleigh-Jean's approximation, etc.
- Understand the physical concepts of radiative transfer within the atmosphere which necessitates the knowledge of emissivity, absorption across the radiation spectrum for different atmospheric constituents.
- Understand and be able to utilize Schwarzschild's equation for infrared transfer through the atmosphere

III. Satellite instrumentation

- Understand the workings of a radiometer
- Know the orbital and geometrical characteristics of different observing platforms
- Know the instrumentation on different satellites radiometers, e.g. AVHRR

IV. Orbital dynamics

- Know Keppler's Laws. Be able to manipulate conic sections and compute orbits
- Understand the 3 body problem
- Understand the link between Keppler's observation and Newton's laws

- Understand the concepts behind different meteorological satellites orbits, e.g. geostationary, sun synchronous. Understand the time-space sampling issue.
- Understand the effects of Earth as a geoid and how this affects satellite lifetimes

V. Image Interpretation

- Know what atmospheric properties can be determined from the microwave, IR, visual and water vapor channels
- Learn through multispectral analysis, how to determine cloud type and thickness
- Learn about image enhancement, geolocation, gridding and calibration of images
- Understand the nature of errors in satellite data (e.g. attenuation, contrast, viewing angle, etc.)
- Learn how to identify different atmospheric systems through satellite imagery (e.g. tropical storms, extratropical cyclones, etc.)

VI. Vertical temperature profile retrieval

- Learn the basics about temperature sounding theory (e.g. know what weighting function mean)
- Learn about the different temperature and constituent density retrieval methods
- Understand both physical and statistical based retrieval methods
- Learn the split-window method

VII. Atmospheric variables. Learn about the retrieval methods for the following variables:

- Rainfall
- Winds
- Radiation budget
- Aerosols

VIII. Precipitation

- Understand the physical concepts behind the different precipitation algorithms
- Learn about the difficulties in validating of satellite retrievals of precipitation
- Learn about some techniques to conduct validation using surface observations