

**GGG 754: Earth Science Data and Advanced Data Analysis
(Updated on Wednesday, January 08, 2025)**

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Time & Place: Tuesdays, 4:30pm-7:10pm, Exploratory Hall 2310

Office Hours: by appointment. Zoom: <https://gmu.zoom.us/j/4655943637>

Text Books (non-standard citation):

- **Text 1 (required):** Daniel S. Wilks, 1995/2005/2011: “*Statistical Methods in the Atmospheric Sciences: An Introduction*,” Academic Press, January 1995 (ISBN: 0127519653); 2nd edition, December 2005 (ISBN-10: 0127519661); 3rd edition (ISBN-13: 978-0123850225); 4th edition, 2020.
- **Text 2 (recommended):** [Hans Von Storch](#), [Francis W. Zwiers](#), 1999: “Statistical Analysis in Climate Research,” Cambridge University Press. Paperback: January 2001. (ISBN: 0521012309); Hardback: January 1999, (ISBN: 0521450713).
- **Text 3 (recommended):** William J. Emery and Richard E. Thomson, 1998: “Data Analysis Methods in Physical Oceanography,” Pergamon, 1998 (ISBN: 0080314341). [2nd Revised Edition (April 2001), Elsevier Health Sciences (ISBN-13: 978-0444507570 for paperback and ISBN-13: 978-0444507563 for hardcover)]. 3rd edition (September 2014, available online) (ISBN-13: 978-0123877826 for paperback).

GMU Catalog Entry:

[GGG 754](#) - Earth Science Data and Advanced Data Analysis (Credits: 3)

Covers accessing and applying Earth observations and remote-sensing data for Earth system science research and applications. Major topics are data formats, analysis and visualization tools, advanced data analysis methods, and data applications. Also covers combining innovative information technology techniques and Earth science data to set up online data centers for accessing data through the web.

Prerequisites

[GGG 579](#) (Remote Sensing) or permission of instructor

Computing Requirements: Programming is an essential part for homework assignments and possibly for the final project. If you do not have any programming experience, you may encounter difficulty to meet the course requirements. It is your choice to use specific programming environment, tools or languages to perform the tasks. Nevertheless, for certain problems such as working with data in special formats ([HDF](#), [netCDF](#) and [GRIB](#)), the choice of programming languages and environment may be limited. That means if you are not familiar with the right programming language such as Matlab, you may need to learn it or search for a substitute. Either approach may need substantially extra time. As a result, Matlab, Python, and/or IDL/ENVI are highly recommended for this course.

Goals and Objectives:

To introduce data, data formats and data analysis methods for earth sciences. Emphasis is on advanced data analysis for time series and spatio-temporal data sets, which are widely used in publications and recently emerged.

Learning Outcomes:

After successful completion of this course,

1. Students will become familiar with earth science data in various formats.
2. Students will understand and utilize data analysis methods for Earth science data analysis.
3. Students will be knowledgeable on certain modern data analysis methods which are potentially useful for earth science data analysis
4. Students will be able to analyze earth science data sets and to write a technical report based on the analysis results.

Course Web Site: Canvas, the University's enterprise learning management system at <https://canvas.gmu.edu/> (or <https://lms.gmu.edu/>). You must use the system for accessing course materials/assignments and for the final project submission. Note: this system is a new system for the university to use it, and I am learning it.

Email Communication: Based on the university policy, students must use their MasonLive email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address. See <http://masonlive.gmu.edu> for more information on Mason Email System. Please use "GGG 754" in your subject line when initiate an email.

Grading Policy:

Homework Assignments:	50%
Final Project	50%
Total	100% (Letter grades based on relative/absolute numbers)

- *The Canvas provides summary of current status for each student. Please note the numbers are only of reference values because we have different weights for the assignments, mid-term and final. The final letter grade will be based on the weighted mean values.
- If optional opportunities would be provided, the Canvas summary will count the optional as a regular one, which would mess up the summary values. Please ignore the impact by the optional assignments. The instructor will do the final calculation without the optional base points before issuing the final grade.

General Course Policies

- Attendance will not be considered in the final grade.
- Extra credit points may be granted to extra efforts, especially those including creative thinking.

Notes on Assignments:

- If multiple files are involved, the assignments will be distributed in .7z (zipped). If you need, you can check Mason ITS site at <https://its.gmu.edu/service/software-listing-7-zip/> for installing the software on your computer.
- Assignments should be submitted only through the Assignment submission section of the Canvas system - DO NOT email assignments directly to the instructor.
- It is expected that your submitted reports will be in either PDF or Word format. Other supporting materials could be in any format (Excel and/or programs). Please put major results in your reports including displays.
- Please make sure you have a backup of all the materials you submit.
- Please make sure to put your name with your assignment, and use your name or other identification information for your file names.
- If more than one file is submitted, you should submit a single **ZIP** file (such as the .7z) containing all the assignment files. In that case, it is strongly suggested that you put all the files into a folder and name the folder with your identity.
- The grace time is the noon of the following day after the due day. Submission after the grace time may result in losing of points, 10% per day for the first two days. No grading for submission later more than 2 days.
- Different weights may be applied to assignments in the final points calculation.

The followings are university wide required information from Office of the Provost:

UNIVERSITY POLICIES

- **University Catalog:** The University Catalog, <http://catalog.gmu.edu>, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at <http://universitypolicy.gmu.edu/>. All members of the university community are responsible for knowing and following established policies.
- **Sexual Harassment:** *As a faculty member and designated “Responsible Employee,” I am required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason’s [Title IX Coordinator](#) per [university policy 1412](#). If you wish to speak with someone confidentially, please contact the [Student Support and Advocacy Center](#) (703-380-1434) or [Counseling and Psychological Services](#) (703-993-2380). You may also seek assistance from [Mason’s Title IX Coordinator](#) (703-993-8730; titleix@gmu.edu).*
- **Academic Integrity** (from Mason [Stearns Center for Teaching and Learning](#)): Mason is an Honor Code university; please see the [Office for Academic Integrity](#) for a full description of the code and the honor committee process. Three fundamental principles to follow at all times are that: (1) all work submitted be your own, as defined by the assignment; (2) when you use the work, the words, or the ideas of others, including fellow students or online sites, you give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment or exam, ask for clarification. No grade is important enough to justify academic misconduct.
- **Generative-AI (GenAI) Tools:** Use of GenAI tools will sometimes be in alignment with the learning outcomes for this course. It is expected that the GenAI for this course is very limited. If used, one should follow the fundamental principles of the Honor Code. This includes being honest about the use of these tools for submitted work and including citations when using the work of others, whether individual people or Generative-AI tools. When

meeting the outcome requires original human action, creativity or knowledge, AI tool use would not align with the stated course goals.

- **Office of Disability Services:** If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS, <http://ods.gmu.edu>.
- **Diversity and Inclusion:** Mason, an intentionally inclusive community, promotes and maintains an equitable and just work and learning environment. We welcome and value individuals and their differences including race, economic status, gender expression and identity, sex, sexual orientation, ethnicity, national origin, first language, religion, age, and disability.
- **Name and Pronoun Use:** If you wish, please share your name and pronouns with me and how best to address you in class and via email. I use he/him/his for myself and you may address me as "Dr./Prof. Yang."
- **Full Mason [Common Course Policies](#).**

OTHER USEFUL CAMPUS RESOURCES:

- **WRITING CENTER:** Johnson Center, Room 227E;
Phone: [703-993-1200](tel:703-993-1200); Email: wcenter@gmu.edu; <http://writingcenter.gmu.edu>
- **UNIVERSITY LIBRARIES "Ask a Librarian."** <http://library.gmu.edu/ask>
- **Counseling and Psychological Services (CAPS):** (703) 993-2380;
<http://caps.gmu.edu>
- **University Calendar:** Details regarding the current Academic Calendar.
[Calendars | Office of the University Registrar | George Mason University \(gmu.edu\)](#)

Tentative Course Contents:

- **This is for your information only for the main contents of the course. Both the contents and the schedule will be changed during the semester.**
- **Grayed materials will not be covered this semester.**
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Week 1: Introduction; Satellite Orbit Theory

- Course Introduction
 - Course Requirements
 - NASA's Earth Observing Systems (EOS)
 - [Related URL's](#)
- Satellite Orbit Theory
 - Basics: Newton's laws and Kepler's laws
 - Circular orbits and geostationary orbits
 - Concepts of orbit elements, inclinations
 - Orbit perturbation and Sun-synchronous orbits
 - Space-time samplings

Week 2: Radiation Transfer Theory; Map Projections

- Radiation Transfer Theory
- Map Projections
 - ✓ Basic concepts on distortions, projection planes and projection points
 - ✓ Classifications
 - ✓ Earth model and mathematical theory
 - ✓ Mathematics of specific mappings
 - ✓ Links
 - [USGS Map Projections Poster](#)
 - [CMAPF Mapping Routines](#)
 - [An example](#)

Week 3: [Data Formats](#)

- ASCII
- Binary
- [GRIB](#);
- [HDF](#) and [HDF-EOS](#)
 - Demos with Grid and Swath Data
- [GRIB](#) (short introduction only)
- **Project topic due (2/4/25)**
- Assignment #1 given

Week 4: Data Processing Procedures

- Measurements, Nyquist Frequency
- Data Representation
- Multi-variant data presentation
 - Parallel Coordinate
 - Grand Tour
- Tools: [GrADS](#); [WebWinds](#); [IDV](#); [CrystalVision](#)

Week 5: Time Series

- Basic Concepts

GG5 754 Syllabus (Spring 2025)

- TS Components
 - General Decompositions
 - STL Decomposition
 - Assignment #1 due
 - Assignment #2 given
- Week 6: Time Series (Cont.)
- Autocorrelation
 - Correlations
 - Assignment #3 given
- Week 7: Time Series (Cont.)
- Regression
 - [Granger Causality](#)
 - Assignment #2 due
 - Assignment #4 given
- Week 8: Time Series (Cont.)-Integral Transforms
- Fourier Analysis
 - [Wavelet](#) Analysis
 - Assignment #3 due
- Week 9: Time Series (Cont.)-Integral Transforms
- Wavelet Analysis (Cont.)
 - The 2nd Generation Wavelets
 - Assignment #4 due
 - **Project outline due (3/25/25)**
 - Assignment #5 given
- Week 10: Time Series (Cont.)
- HOC
 - Hilbert-Huang Transformations
 - Compressive Sensing
- Week 11: Principal Component Analysis
- Assignment #5 due
 - Assignment #6 given (optional)
- Week 12: Nonlinear Principal Component Analysis
- Week 13: Google Earth Engine (GEE) Practice and Applications
- Week 14: Machine Learning (CNN): Idea and Applications
- Introductions on Data Systems
- [OPeNDAPS](#)
 - SIESIP and [GDS](#)
 - [LAS](#)
 - Project Presentation (if arranged)
 - Assignment #6 due
- Week 15: **Final Exam Day (May 13th)**
- Project Report due
 - Project Presentation (if arranged)
 - All late HW assignments for consideration due