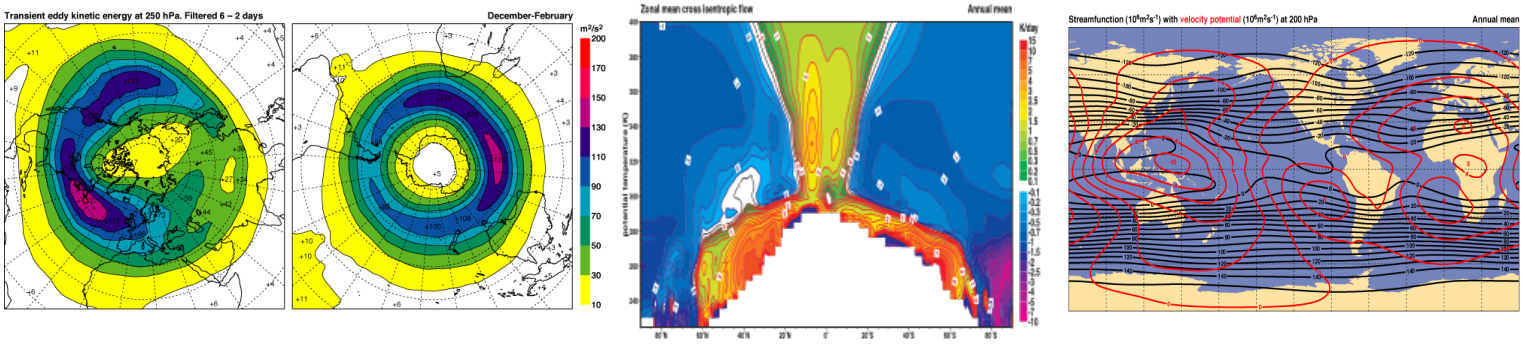
Climate Dynamics 753

The General Circulation of the Atmosphere

DJF kinetic energy [2-6 day time scales] 250hPa **Heating in Θ [isentropic] Coord.** **Circulation at 200 hPa ψ and χ**



Figures Courtesy of European Center for Medium Range Weather Forecasts
Kallbert, P. P. Berrisfort, B. Hoskins, A. Simmons, S. Uppala, S. Lamy-Thepaut and R. Hine, 2005. ERA-40 Atlas. ERA-40 Project Report Series No. 19

Course Syllabus Fall 2022

Course Instructor: David M. Straus
(Department of Atmospheric, Oceanic and Earth Sciences)

Instructor Contact:
David Straus Office Hrs Tue-Thur 11AM-12PM or by arrangement
dstraus@gmu.edu

Class location: Research Hall 121

Class time: Tues and Thurs 12:00 PM to 1:15 PM

- **First class: Tues Aug 23**
- **No class Tues Sep 8 - rescheduled for Tues Oct 11**
- **No class Tues Dec 27 - (make up day TBA)**
- **Last class: Thurs Dec 1**
- **Final Exam: Thurs Dec 8 (10:30 AM - 1:15 PM)**

Course Goals and Student Learning Outcomes

- **Acquire knowledge of the basic components of the observed atmospheric circulation.**
- **Understand the relationships among these components.**
- **Understand the role of different circulation components in transporting energy and momentum.**
- **Be able to articulate the ways in which the general circulation relates weather phenomena to the climate.**
- **Become familiar with the application of the mathematical theories to the observed circulation.**
- **Acquire basic skills for carrying out original research on the general circulation.**
- **Develop the ability to read current journal papers on the subject, and report the main findings.**

Student Work Components

1. **Homework Sets = 33% percent of grade**
2. **Mid-Term and Final Exams = 33% percent of grade**
3. **Project = 33% of grade**

Primary Required Reading

- (Course Notes): http://mason.gmu.edu/~dstraus/CLIM_753_syllabus.htm
- Atmospheric, Oceanic and Climate Dynamics; An Introductory Text by Marshall and Plumb

Supplementary Reading:

- Andrews D.G., J.R. Holton and C.B. Leovy. *Middle Atmosphere Dynamics*. Academic Press, 1987.
- Grotjahn, R. *Global Atmospheric Circulations*. Oxford University Press, 1982.
- Haltiner, G.J. and R.T. Williams. *Numerical Prediction and Dynamic Meteorology*. John Wiley & Sons, 1989.
- Masaki, Satoh. *Atmospheric Circulation Dynamics and General Circulation Models*. Springer, 2004.
- James, I.N. *Introduction to Circulating Atmospheres*. Cambridge University Press, 1994.
- Salby, Murry L. *Fundamentals of Atmospheric Physics*. Academic Press, 1996.

Course Topics

1. Introduction: The Frame of the General Circulation
    - Associated Reading for Topic 1: Chapters 1 - 3 and 4.3-4.5 of Marshall and Plumb
2. The Mean Meridional Circulation: Hadley and Ferrel Cells
    - Associated Reading for Topic 2: Chapter 5 of Marshall and Plumb
3. The basic structure of horizontal momentum of the Atmosphere: Divergence and rotational flow.
4. Stationary waves: Introduction and Observations.
5. Theory of Zonal Propagation of Rossby Waves.
6. Theory of Zonal and Meridional Propagation of Rossby Waves.
7. Theory of Vertical Propagation of Rossby waves.
8. Mid-latitude Transient Fluctuations.
9. Global Energy and Enthalpy Transport.
10. Available Potential Energy.
11. Angular Momentum Transport.
    - Associated Reading for Topics 8 - 11: Chapter 8 of Marshall and Plumb
12. Life cycles of Baroclinic Instability.
13. Advanced Statistical Description of Mid-Latitude Transient Fluctuations.
14. Introduction to Equatorial Waves.
15. Simple theory of Forced Tropical Stationary Waves.
16. Interactions between the Eddies and the Zonal Flow.
17. Introduction to Global Scale Interactions and the atmospheric spectrum.

Some Topics for Projects

1. Introduction to the Stratospheric Circulation: Sudden Warmings
2. The mean meridional circulation in the stratosphere: Brewer-Dobson Circulation.
3. Preferred and Persistent States in the Atmosphere: Teleconnections.

Academic Integrity

The homeworks and are designed to be undertaken independently. You may discuss your ideas with others and conference with peers on drafts of the work. However it is not appropriate to give your paper to someone else to revise. You are responsible for making certain that there is no question that the work you hand in is your own. If only your name appears on an assignment, your professor has the right to expect that you have done the work by yourself, fully and independently.
The course projects may be done in teams, but it should be made very clear to the professor and the rest of the class what the responsibility of each student was. Please see the University Honor Code