Spring 2011 Syllabus for METR 5223: Atmospheric Radiation

Brian Fiedler

Spring, 2011

Who, when, where:

- **Instructor: Prof. Brian Fiedler, bfiedler@ou.edu**
- **Lectures on MWF, 10:00 AM - 10:50 AM in NWC 5600**
- **Office hours will be by walk-in or by appointment, NWC 5636**

Grading:

- **50% Questions of the Week**
- **30% 2/3-term Exam - Provisionally scheduled for: Wednesday, April 6, 2011**
- **20% Final Project**

Knowledge Expectations:

1. **Know the basic history of the principle conservation of energy. Know the various forms of energy and energy conversion. Know how to apply conservation of energy accounting to a variety of natural, technical and meteorological phenomenon.**
2. **Know the basics of light, at the level of introductory physics, as a wave phenomenon and as a quantum phenomenon.**
3. **Know about the interactions of various frequencies of light with matter, especially the distinction between visible and infrared radiation.**

4. **Know the basics of thermal physics, the significance of Boltzmann's constant and the Maxwell speed distribution.**

5. **Know how to use the Planck function for the distributions of intensity of radiation over frequency.**

6. **Know Kirchoff's law and the basics of absorption, reflection and transmission.**

7. **Know the Stefan-Boltzmann law, and how to make useful predictions of the transfer of energy by thermal radiation.**

8. **Know how to configure, and solve for temperature in simple radiative equilibrium models.**

9. **Know how to configure and solve the first-order differential equation, linear and non-linear, for adjustment of temperature in a zero-dimensional model, in response to radiative forcing, either variable or constant.**

10. **Know how to configure, and solve for temperature in, idealized plane-parallel models of a surface with an isothermal greenhouse atmosphere.**

11. **Know the basics of spherical trigonometry and how to derive the solar radiative flux at the top of the atmosphere. Know the integral of these fluxes over the daily cycle (know the seasonal distribution).**

12. **Know the observations of Earth's basic energy budget and transport.**

13. **Know the Milankovitch theory of the ice ages, and how to predict how changes in Earth's orbital parameters affect the solar radiation distribution.**

14. **Know the geological evidence for the extent and chronology of the ice ages.**

15. **Know the mathematical analysis of sensitivity and feedback in either a zero-dimensional model, or a globally-averaged model or observation.**

16. **Know about the analysis of multiple equilibria in Earth's global climate, as a result of variable ice cover.**

17. **Know the phenomenon of hysteresis, especially as it applies to Earth's global climate.**

18. **Know about the geological evidence for a Snowball Earth, and the theory for it's onset and demise.**

19. **Know how GCMs are used to study climate sensitivity and change.**

20. **Know the important feedbacks in Earth's radiative equilibrium and adjustment.**

21. **Know the solution for radiative equilibrium in a so-called "gray" atmosphere.**

22. **Know how to use broad-band emissivities to calculate IR fluxes and heating rates in the terrestrial atmosphere.**

23. **Know the atomic processes for absorption and emission, and how the theory for spectral lines is used to construct broad-band emissivities.**

24. **Know about the science of global warming, the key facts and the key controversies.**

25. **Know about the scattering and absorption of solar radiation in the atmosphere.**

26. **Know about the effects of clouds on radiative fluxes and heating rates.**