# SEMINAL PAPERS IN ATMOSPHERIC AND CLIMATE SCIENCE

ATS 781 (2 credits)

Fall 2015

**Instructor:** Thomas Birner

**Meeting Times:** Tue/Thu 10-10:50 in ATS 101

**Prerequisites:** none

**Class Website:** http://birner.atmos.colostate.edu/ats781.html

**Course Description:** Seminal papers in atmospheric and climate science will be discussed with a focus on historical papers up to about the 1950's (although some selected later papers may also be included). The purpose of studying these classic historical papers is to gain an appreciation for the development of our field and the origins of our current understanding of many atmospheric and climate science phenomena. The papers will be studied from the perspective of what made them seminal in the context of both, the state of the art at the time of their writing, and our current understanding. Many of these seminal papers also exhibited serious flaws, misinterpretations, or misunderstandings and these will be discussed as well. Furthermore, the protagonists and their role in shaping the field will be highlighted.

The class will be taught in journal club style with every student leading at least one paper discussion during the semester. A partial list of papers is given below, other papers may be selected depending on students' interests.

Grades will be based on student presentations (33%), corresponding written notes (e.g. presentation slides, 33%), and participation in class discussion (33%).

At least 2 hours of effort are expected to complete readings and assignments outside of class for each hour of class time.

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf) and the Student Conduct Code (http://www.conflictresolution.colostate.edu/conduct-code). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.

*note: this list is not meant to be conclusive; other seminal / classic papers may be covered*

A great resource is Geoff Vallis' website on "Classic and historical papers in GFD and Atmospheric and Oceanic Dynamics":
`http://empslocal.ex.ac.uk/people/staff/gv219/classics.d/index.html`.

## Relevant Books, Monographs, Reviews

- Archer & Pierrehumbert, The warming papers: the scientific foundation for the climate change forecast, Wiley-Blackwell 2011, 432 pages
- Friedman, Appropriating the weather. Vilhelm Bjerknes and the construction of a modern meteorology, Cornell University Press, 1989, 251 pages
- Fleming, The Callendar Effect, AMS 2007
- Bergeron, Methods in scientific weather analysis and forecasting. An outline in the history of ideas and hints at a program, in The atmosphere and the sea in motion, Scientific contributions to the Rossby memorial volume, Oxford University Press, 1959, pages 440-474
- Lorenz, A history of prevailing ideas about the general circulation of the atmosphere, 1983
- Hoinka, The tropopause: discovery, definition and demarcation, Meteorol Zeitschrift, 1997
- Thorpe & Volkert, Potential vorticity: A short history of its definitions and uses, Meteorol. Zeitschrift, 1997
- Bjerknes, Half a century of change in the "meteorological scene", BAMS, 1964
- Persson, The Coriolis Effect: four centuries of conflict between common sense and mathematics, Part I: A history to 1885, History of Meteorology 2005
- Persson, Hadley's principle: Part 1 – A brainchild with many fathers, Weather, 2008

# Seminal Papers (chronological)

## General Circulation

Halley, 1686: An historical account of the trade winds, and monsoons, observable in the seas between and near the tropicks, with an attempt to assign the phisical cause of the said winds

Hadley, 1735: Concerning the cause of the general trade winds

Ferrel, 1856: An essay on the winds and the currents of the ocean

Jeffreys, 1919: On travelling atmospheric disturbances

Defant, 1921: The circulation of the atmosphere in the mid-latitudes of Earth

Jeffreys, 1926: On the dynamics of geostrophic winds

Walker, 1928: World weather

Brewer, 1949: Evidence for a world circulation provided by the measurements of helium and water vapor distribution in the stratosphere [include a discussion of Dobson et al. 1929]

Munk, 1950: On the wind-driven ocean circulation

Munk & Palmen, 1951: Note on the dynamics of the antarctic circumpolar current

Eliassen, 1952: Slow thermally or frictionally controlled meridional circulation in a circular vortex

Lorenz, 1955: Available potential energy and the maintenance of the general circulation

Phillips, 1956: The general circulation of the atmosphere: A numerical experiment [also Lewis, 1998]

Bjerknes, 1966: A possible response of the atmospheric Hadley circulation to equatorial anomalies of ocean temperature.

Gill et al., 1974: Energy partition in the large-scale ocean circulation and the production of mid-ocean eddies

## Basic Dynamics

Laplace, 1775: Dynamic theory of tides

Kelvin, 1869: On vortex motion

Kelvin, 1879: On gravitational oscillations of rotating water

Ekman, 1905: On the influence of the Earth's rotation on ocean-currents

Rossby, 1938: On the mutual adjustment of pressure and velocity distributions in certain simple current systems, II

Rossby, 1939: Relation between variations in the intensity of the zonal circulation of the atmosphere and the displacements of the semi-permanent centers of action

Haurwitz, 1940: The motion of atmospheric disturbances on the spherical earth

Ertel, 1942: A new hydrodynamic vorticity theorem

Charney, 1947: The dynamics of long-waves in a baroclinic westerly current

Charney, 1948: On the scale of atmospheric motions

Eady, 1949: Long waves and cyclone waves

Hovmöller, 1949: The trough-and-ridge diagram

Greenspan & Howard, 1963: On a time-dependent motion of a rotating fluid

Hoskins et al., 1985: On the use and interpretation of isentropic potential vorticity maps

## Weather Forecasting

Bjerknes, 1904: The problem of weather forecasting, considered from the point of view of mechanics and physics

Bjerknes, 1914: Meteorology as an exact science

Lorenz, 1963: Deterministic nonperiodic flow

## Climate Change

Fourier, 1824: On the Temperatures of the Terrestrial Sphere and Interplanetary Space

Tyndall, 1861: On the Absorption and radiation of Heat by Gases and Vapours, and on the Physical Connexion of Radiation, Absorption, and Conduction

Arrhenius, 1896: On the influence of carbonic acid in the air upon the temperature of the ground

Callendar, 1938: The Artificial Production of Carbon Dioxide and its Influence on Temperature

Manabe & Wetherald, 1967: Thermal equilibrium of the atmosphere with a given distribution of relative humidity

## Stratosphere & Ozone

Teisserenc de Bort, 1902: The variations of the temperature of the free air at great altitudes

Assmann, 1902: On the existence of a warmer air flow at heights of 10 to 15 km

Chapman, 1929: A theory of upper-atmospheric ozone

Scherhag, 1952: The explosive stratospheric warmings of the late winter 1951/1952

Reed et al., 1961: Evidence of a downward propagating annual wind reversal in the equatorial stratosphere [and Ebdon & Veryard, 1961]

Danielsen, 1968: Stratospheric-tropospheric exchange based on radioactivity, ozone, and potential vorticity

Molina & Roland, 1974: Stratospheric sink for chlorofluoromethances; chlorine atom-catalysed destcruction of ozone