Mesoscale Meteorology

Spring Semester 2022

Lecturer

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Assistant (homework grading)

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Textbooks

1. Mesoscale Dynamics, 2007, Y.-L. Lin, Cambridge University Press, 630 pp.
2. Cloud Dynamics, 2nd edition, 2014, R. A. Houze, Jr., Academic Press, 496 pp.

References

1. Mesoscale Meteorology in Midlatitudes, 2010, P. Markowski and Y. Richardson, Wiley-Blackwell, 407 pp.
2. Mesoscale Meteorology and Forecasting, 1986, P. S. Ray, Ed., American Meteorological Society, 793 pp.
3. Dynamics in Atmospheric Physics, 1990, R. S. Lindzen, Cambridge University Press, 310 pp. Chapters 8 and 10: Internal Gravity Waves
4. An Introduction to Atmospheric Gravity Waves, 2002, C. J. Nappo, Academic Press, 276 pp.
5. Atmospheric Convection, 1994, K. A. Emanuel, Oxford University Press, 580 pp.
6. Storm and Cloud Dynamics, 2nd edition, 2011, W. R. Cotton, G. H. Bryan, and S. C. van den Heever, Academic Press, 809 pp.
7. Advances in Geophysics, 1979, Vol. 21, Academic Press. The Influence of Mountains on the Atmosphere, R. B. Smith.
8. Topographic Effects in Stratified Flows, 1995, P. G. Baines, Cambridge University Press, 482 pp.
9. Hydrodynamic Stability, 1981, P. G. Drazin and W. H. Reid, Cambridge University Press, 527 pp.
10. 레이더기상학, 2010, 이종호, 류찬수, 시그마프레스, 260 pp.
11. 일기도와 날씨해석, 2011, 이우진, 광교이택스, 219 pp.

Grading

mid-term exam: 30%
final exam: 30%
homework: 25%
presentation: 15%

Lecture Contents

1. Overview

   scales of atmospheric motions, energy sources of mesoscale phenomena, scale interactions,

atmospheric predictability

2. Governing Equations and Approximations

simplified equations governing mesoscale motions, approximations to the governing equations (anelastic, Boussinesq)

3. Some Theorems for Stratified Flows

Taylor-Goldstein equation, Bolton's theorem, Miles' theorem (shear instability), Howard's semicircle theorem, Eliassen-Palm theorem, applications to atmospheric flows

4. Atmospheric Gravity Waves

roles of gravity waves in the atmosphere, generation mechanisms of gravity waves, detection of gravity waves, pure gravity waves, inertia-gravity waves, gravity-wave reflection, WKB approximation, critical level

5. Orographically Forced Flows

flow over sinusoidal mountains, stationary-phase method, flow over an isolated mountain, mountain drag, lee waves, severe downslope windstorms, gap winds

6. Thermally Forced Flows

shear flow with low-level heating, uniform flow with elevated heating, parameterization of convectively forced gravity-wave drag, thermally forced mesoscale phenomena

7. Mesoscale Convective Systems

general characteristics and the dynamics, leading-line/trailing-stratiform structure, details of the convective and stratiform regions

8. Tropical Cyclones

definition and climatology of tropical cyclones, tropical cyclogenesis, dynamic and thermodynamic structures of mature tropical cyclones, eye and eyewall of the tropical cyclone, rainbands and eyewall replacement