ATSC 201 - Study Guide for Fall 2007
Roland Stull

Midterm Exam


1. Thunderstorms
   Characteristics: appearance, associated clouds, cells & evolution, movement, climatology
   Thunderstorm types & organization:
   - Basic storms: air-mass storms, multicell storms, orographic storms,
   - Mesoscale convective system: MCS, squall line, bow echo, MCC, MCV
   - Supercells: LP, classic, HP
   Key altitudes: zi (ML), LCL, LFC, EL. Also determination of tropopause depth (Ch 6)
   Conditions needed for Tstorm convection
   - High humidity in the ABL
   - Nonlocal Instability and CAPE (SBCAPE, MLCAPE, MUCAPE, nCAPE, etc.)
   - Wind shear in the Environment: shear vector, mean shear, total shear, mean wind (storm motion),
     supercell storm motion (right and left-moving storms), bulk Richardson number
   Triggering mechanisms vs. convective inhibition CIN
   Tstorm hazards
   - Heavy rain
   - Hail: nomenclature, sizes, formation, forecasting, damage, locations, mitigation, BWER
   - Downbursts: characteristics, forces, precipitation drag, evaporative cooling, DCAPE, pressure
     perturbation, microbursts, affect on aircraft
   - Outflow winds & gust fronts: characteristics and forcings, haboob, arc cloud
   - Lightning: electrical charge formation, behavior, appearance, detection, hazards, safety
   - Thunder: shock front, sound wave, ray paths, audibility distance
   - Tornadoes: tangential velocity (Rankine combined vortex), core pressure deficit, Fujita scale,
     TORRO scale, tornado components, types of tornadoes and vortices, outbreaks, storm-relative
     winds, vorticity (both Ch 12 & 16), mesocyclones & helicity, storm-relative helicity, swirl ratio &
     multi-vortex tornadoes
   Tstorm forecasting
   - Outlooks, watches, warnings
   - Stability indices for Tstorms: new, old
   - Storm chasing, photography, and safety

2. Meteorological Tools (covered in Labs, Tutorials, and Stull course pack):
   - Hodographs (basics: p29-42; tornadoes: 87-88, 90-94) - be able to plot and use hodograph
   - Weather radar - fundamentals (wavelengths, operations, scans, displays, beam propagation,
     Reflectivity: dBZ, radar equation, bright band, how to interpret radar images, storm tracking
     Doppler velocity: radial velocities, VAD, max range & velocity, tornado & downburst signatures
   - Polarimetric: uses
   - Soundings/Thermo diagrams (all except θ-z) - be able to plot soundings and use thermo diagrams

3. General Meteorology
   Atmosphere Basics - meteorological conventions, earth frameworks & time zones, processes.
   - Thermodynamic state (P, T, p), structure/layers,
   - Equations: Ideal gas law, hydrostatic, hypsometric
   Radiation - orbital factors, seasonal effects, daily effects,
   - Radiation principles: propagation, emission, distribution, absorption, reflection, transmission, Beer's law,
   - Surface radiation budget: solar, IR, net.
   Actinometers (radiometers)
   Heat - Sensible and latent
   - Lagrangian heat budget for unsaturated air (from Ch 3): air parcels, first law thermo, adiabatic processes,
     dry lapse rate, potential temp.
   - Lagrangian heat budget for saturated air (from Ch5): moist lapse rate, liquid-water pot. temp,
     equiv. pot. temp, wet-bulb pot. temp.
Eulerian heat budget: advection, conduction, turbulence, radiation, body sources, net budget
Surface heat budget, Bowen ratio

**Moisture** - saturation
Variables: vapour pressure, mixing ratio, specific humidity, absolute humidity, relative humidity,
dew-point, LCL, wet-bulb temperature,
Total mixing ratio
Lagrangian water budget: conservation of $r_T$ on thermo diagram
Eulerian water budget: advection, precipitation, surface fluxes, turbulent transport

**Static Stability** –
Thermo diagrams: components, pseudoadiabatic assumption, identification of diagram type.
Thermo diagram types: emagram, Stuve, Skew-T, Tephigram
Thermo diagram applications: state, processes (dry, moist), precipitation, radiative heating/cooling
Parcels vs. environment: soundings, buoyancy, Brunt-Vaisala freq.
Flow stability vs. turbulence: parcel method, layer method,
extension of nonlocal parcel method for Tstorms (Ch 16).

**Dynamics** - Newton’s 2nd law, Lagrangian momentum budget
Eulerian momentum budget, eq. of motion
Forces: advection, pressure gradient, centrifugal, Coriolis, Turb. Drag
Winds: geostrophic, gradient, boundary-layer, BL-Gradient, cyclostrophic
Mass conservation, continuity, incompressible assumption, boundary-layer pumping
Measuring winds.

B. **Textbook Readings** (in numerical order)

1. Rauber, Walsh, & Charlevoix 2nd Edition Chapters:
   - Ch 1. Atmosphere - all
   - Ch 2. Measurements - all
   - Ch 3. Vorticity - p54 (Focus box 3.1)
   - Ch 6. Forces & Winds - p 115-124
   - Ch 17. Thunderstorms - all
   - Ch 18. Tornado - all
   - Ch 19. Hail - all
   - Ch 20. Lightning - all
   - Ch 21. Downbursts - all

2. Stull Chapters (from Course Material Pack.):
   - Ch 1. Atmosphere - all
   - Ch 2. Radiation - all
   - Ch 3. Heat - all except wind chill and heat indices
   - Ch 5. Moisture - all
   - Ch 6. Static Stability – (all except: $\theta$-z diagrams, dynamic stability)
   - Ch 9. Weather Radar - 22-41
   - Ch 10. Dynamics - all
   - Ch 12. Vorticity - p34-36
   - Ch 16. Thunderstorms - all
   - Appendix A. Science - all
   - Errata (from web page [home page/textbooks]) - all for the Chapters we covered

C. **Friday Videos & DVDs** (I do NOT test content from these videos. Just reminding what you saw.)
   Supercell storms, Tstorm types,
   Art of storm chasing
   Tornado Spotters Guide, Extreme tornadoes, Violent Prairie Tornadoes, Tornadoes 2002
   Multi-vortex tornadoes;
   Mesocyclones
   Hail
   Lightning
   Downbursts, gust fronts