Study Guide for Midterm Exam #2
METR 4403/5403 – Spring 2025

Please note: the second midterm exam will cover materials taught in lectures from March 16 (supercell pressure perturbations) through April 16 (supercell radar applications).

Format:

- Closed notes (like traditional in-class exams), closed everything (e.g., phones, etc.).
- Everyone is expected to take exam in person in NWC 1350 (except for special situations)
- Several multiple choice, fill-in-the-blank, or true-false questions.
- 3-4 multipart questions.
- No calculations. There may be simple derivations starting from equations given. A list of equations will be provided to you on the last page of the exam.

Materials needed:

- Pen/pencils. You may find color pencils to be helpful as well. We will provide paper.

Topics we covered:

1. Supercell Pressure Perturbations
    a. Origin of mid level rotation in supercells (linearized vorticity equation)
    b. Be familiar with the diagnostic pressure perturbation equation and physically explain each of the terms.
    c. Be familiar with linear and non-linear dynamic forcing.
    d. Be able to explain the processes involved in splitting supercells, cell propagation, and why left or right splits are favored given certain wind profiles.

2. Tornadogenesis
    a. Source of mid-level versus low-level versus near-surface rotation in supercells.
    b. Role of low-level shear in tornadogenesis.
    c. Role of downdrafts and near-surface vorticity.
    d. Optimal situation for cold pool strength if low-level vorticity is primarily generated by horizontal buoyancy gradient.
    e. Alternative sources of low-level vorticity.
    f. Nonsupercell tornadogenesis (no rotating updraft) and tornado life cycle.

3. Tornado Climatology
    a. Be familiar with the climatology of tornado ingredients (lapse rates, moisture, wind shear, etc.)
    b. Be familiar with seasonal and diurnal tornado occurrences.
    c. Be able to explain seasonal variations in tornado frequency.

4. Tornado Intensity Estimation/Rating
    a. Be familiar with the origins of the F and EF scales.
    b. Know the difference between the two scales and how potential inconsistencies can arise when assessing higher-end tornadoes.
    c. Be familiar with alternative methods for tornado intensity estimation.

5. Tropical Cyclone tornadoes
    a. Tornado facts and climatology
    b. Climatological application to forecasting concepts
    c. Forecasting concepts (synoptic and mesoscale)
    d. Radar application
    e. Convection-allowing models and SPC forecasts
    f. Case examples

6. Severe Composite Parameters
    a. Supercell Composite Parameter and Significant Tornado Parameter.
        . SCP = f(MUCAPE, MUCIN, EBWD, ESRH)
        i. STP = f(MLCAPE, MLCIN, EBWD, ESRH, MLLCL)
        ii. Fixed-layer STP = f(SBCAPE, SBCIN, BWD, SRH3km, SBLCL)
    b. Understand how each is calculated.
    c. Be able to identify potential biases in each. Strengths and weakness of the parameters.

7. MCSs & Derechos
    a. MCS types and derecho definitions.
    b. Derecho climatology (warm season, cold season).
    c. MCS structure/how derechos form
        . Front to rear flow, precipitation, cold pool, rear inflow jet, bow echo, bookend vortices - stronger surface forward flow/winds
    d. Derechos environment
    e. Anticipating MCS severity and longevity/forecasting problem.

8. Supercell Radar Applications
    a. Be familiar with:
        . Basic radar variables (reflectivity, velocity, ZDR, CC, KDP)
        i. Side lobe contamination
        ii. Non-uniform beam filling
        iii. Beam blockage
    b. Know how to identify a supercell and its attendant mesocyclone in base radar variables.