Study Guide for Midterm Exam #2
METR 4403/5403 – Spring 2024

The second midterm exam will cover materials taught in lectures from Feb 21 (convective modes) through April 15 (Derechos).

Format:

- Closed notes (like traditional in-class exam), 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 last page of exam.

Materials needed:

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

Topics we covered:

1. Convective modes
    a. Modes (ordinary, multicell, supercell) and environment conditions
    b. Importance of vertical wind shear in determining the modes
    c. Cell movement versus system propagation of multi-cell storms
    d. Supercell characteristics, features, types and motion
    e. Recipe for a squall line
    f. Recipe for discrete storms
    g. Case examples

2. Fire weather forecasting
    a. Basics of fire weather forecasting
    b. Ingredients for wildfire
    c. Fire weather regimes and circulation patterns (synoptic, mesoscale, and local)

3. Supercell dynamics and pressure perturbations
    a. Origin of mid level rotation in supercells (linearized vorticity equation)
    b. Supercell propagation and diagnostic pressure equation.
    c. Linear versus nonlinear dynamic forcing.
    d. Forecasting supercell motion/Bunker's supercell motion.

4. 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 vortivity
f. Nonsupercell tornadogenesis (no rotating updraft) and tornado life cycle.

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)
        STP = f(MLCAPE, MLCIN, EBWD, ESRH, MLLCL)
        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. 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

8. Derechos
    a. MCS and derecho definitions.
    b. Derecho types and 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.