Unit 7 ATM478, ATM678 Mesoscale Dynamics

1. Undergraduate students: Explain why urban heat islands (UHI) have the following behaviors:

    - UHI intensity decreases with increasing wind speed.
    - UHI intensity decreases with increasing cloud cover.
    - UHI intensity is greatest during anticyclonic conditions.
    - UHI intensity is best developed in the summer or warm half of the year.
    - UHI intensity tends to increase with increasing city size and/or population.
    - UHI intensity is greatest at night.
    - UHI may disappear by day or the city may be cooler than the rural environs.
    - Rates of heating and cooling are greater at rural sites than the city.

2. Graduate students: Estimate the difference in the sea breeze wind velocity for Houston and Los Angeles. Assume that under unperturbed conditions (no UHI) the difference in land and sea temperatures is 10 K ($T_{land}>T_{ocean}$) during the day and 5 K. The UHI is about 2 K. Los Angles is closer to the water (~10 km) than Houston (~100 km). Assume spatial scales are small enough to justify neglecting Coriolis accelerations and reasonable values for additional quantities as needed. Estimate the difference in velocity over one hour if there were no city vs. there being a city. Compare the values you got for the two cities. Where is the sea breeze stronger? Why? What do you conclude from your results?

3. Undergraduate students: Read the documentation and use the excel file to examine how the temperature increase behaves as a function of the city size in the USA and China. For the USA and China, normalize the UHI temperature with the size of the respective city and determine the mean UHI effect for these countries. Discuss the consequences for buoyancy.

4. Graduate students: Read the documentation and use the excel file to normalize the UHI temperature with the size of the respective city. Plot the normalized UHI temperatures as a function of latitude and longitude. Examine how the temperature increase behaves as a function of latitude. Discuss your results in terms of buoyancy and mesoscale dynamics.