**Sea breeze + LCS**

1. Introduction
   1. Offshore wind
      1. Importance of wind resource/variability assessment
      2. Reduce risks for development
   2. Summertime peak demand
   3. Sea breeze
      1. Peak in spring, summer
   4. Upwelling
      1. Peak in summer, early fall
   5. Sea breeze has divergence/convergence zones, calm zones
      1. Not known offshore because no observations (Steele et al. 2014)
      2. Spatial scales of offshore sea breeze more difficult to distinguish, unlike onshore sea breeze where frontal boundary well defined (Simpson, 1994)
      3. What does offshore component of sea breeze look like?
         1. Secondary circulation (size, structure)?
         2. Offshore divergence?
         3. Calm zone?
      4. What effect does cold coastally-upwelled water have on the offshore sea breeze component?
         1. Does offshore sea breeze “front” occur?
         2. Is low level divergence/calm zone modified?
      5. Need to better understand these in relation to location of offshore wind turbines
2. Methods
   1. WRF
      1. Configuration
         1. 3km (600m inner nest)
         2. WRF-ARW 3.6.1
         3. YSU PBL (justification for not MYNN)
         4. MM5 Monin-Obukhov surface layer
      2. Reference BPU validation
   2. LCS
      1. MTS, Committee meeting slides
         1. Definition
         2. Importance/benefits in general
            1. Comparison between standard div and LCS
         3. Importance for sea breeze
      2. Josh proposal
      3. Configuration for trajectories, LCS
         1. On 3km WRF winds
         2. Hourly, 1700 UTC to 2300 UTC (peak sea breeze time)
         3. 10km grid
         4. Forward trajectories
         5. 10, 50, 100, 150, **200, 250, 300, 350, 400, 450,** 500, 600, 700, 800, 900, 1000, 1500, 2000, 2500m through marine boundary layer
         6. Use relative dispersion to identify LCSs
   3. Case studies
      1. June-Aug (peak load)
      2. Classify synoptic wind
         1. Gradient wind: 12Z synoptic 925hPa winds
         2. Pure:
            1. Largest gradient wind component perpendicular to coast & in offshore direction (257-345 for NJ)
         3. Corkscrew:
            1. Largest gradient wind component parallel to coast w/ coast to left (250-256 degrees)
            2. Most likely sea breeze type with coastal upwelling
         4. Backdoor:
            1. Largest gradient wind component parallel to coast w/ coast to right (346-30 degrees)
      3. Case 1:
         1. April 27, 2013: pure, no upwelling **(FIG- radar, SST)**
            1. Pure because of large inshore extent of sea breeze to PHL (although NAM, WRF wind dir was 6-9 degrees; NARR was 330)
         2. How does offshore component propagate (distance, size, speed) through the NJ WEA during a sea breeze where onshore component propagates all the way across the state (extreme case)
      4. Case 2:
         1. August 13, 2012: pure, upwelling **(FIG- radar, SST)**
            1. NAM: 287, WRF: 303, NARR: 287
         2. During peak energy demand period, with upwelling, more stationary front (because of strong NW 925 hPa winds), how does offshore component propagate accordingly? What is effect of upwelling?
      5. Case 3:
         1. August 13, 2012: pure, remove upwelling- Aug 11 SST **(FIG SST)**
         2. What is effect of upwelling?
3. Results
   1. Case 1:
      1. Linear speed analysis-> assumption for running LCS
         1. In words (no figure)
      2. Planar LCS 100m at 1700, 1900, 2100, 2300 UTC **(FIG)**
         1. With cross section location
      3. Cross section LCS at 1700, 1900, 2100, 2300 UTC **(FIG)**
         1. With radar front location
      4. Hovmoller 50-100-150m average **(FIG)**
         1. Standard LCS (Distance from coast (0 at coast))
         2. Modified LCS (Distance from front (0 at front))
         3. Wind Speed?
         4. Correlation LCS vs. wind speed?
      5. Time series of boxes
         1. LCS avg. in 50-150m box over NJ WEA (Lagrangian) vs. wspd in box (Eulerian)
            1. Correlation between wind speed and divergence?
         2. LCS avg in 50-150m box onshore same distance as offshore NJ WEA (Lagrangian) vs. wind speed in box (Eulerian)
            1. Correlation between wind speed and convergence?
      6. Other time series
         1. Max convergence
         2. Max divergence
         3. Width of divergence
         4. Height of divergence
         5. Height of reversal from surface conv to aloft div and vice versa?
   2. Case 2 minus 3:
      1. Planar LCS 100m at 1700, 1900, 2100, 2300 UTC **(FIG)**
         1. With cross section location
      2. Cross section LCS at 1700, 1900, 2100, 2300 UTC **(FIG)**
         1. With radar front location
      3. Hovmoller 50-100-150m average **(FIG)**
         1. With radar front location
      4. LCS avg. in 50-150m box over NJ WEA (Lagrangian) vs. wspd in box (Eulerian)
         1. Correlation between wind speed and divergence?
      5. LCS avg in 50-150m box onshore same distance as offshore NJ WEA (Lagrangian) vs. wind speed in box (Eulerian)
         1. Correlation between wind speed and convergence?
4. Discussion
5. Old Introduction
   1. Sea breeze
      1. processes driving sea breeze
      2. off NJ: relevance for offshore wind
         1. peak energy demand periods
   2. “Surface” (hub height) divergence/convergence offshore
      1. within reach of blades
   3. Does region of divergence occur offshore?
      1. Convergence onshore with sea breeze front validated with weather radar
      2. Size/structure (vertical)
      3. Divergence🡪 calm zone