Localized Effects of Wind Turbines on Weather Conditions
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MOTIVATION

• Minor research has been pursued in how wind turbine establishments affect local weather conditions
• Knowledge of how local wind farms affect weather around their vicinity is important to farmers in the area

Hypothesis:
• More turbulent rotation within the vicinity of turbines
• Mixing of air causes cooler day time temperatures and warmer night time temperatures
• Drier conditions downwind

BACKGROUND

Positive aspects of wind turbines:
• clean, efficient, abundant source of wind, wind is free
• Roy and Pacala (2004):
  • Nocturnal jet causes well mixed boundary
  • Early morning most prevalent
• Changes temperature, humidity, and latent heat flux
• Frandsen and Emeis (1993):
  • States “momentum loss is due to an infinite cluster of obstacles, [in other words] wind turbines.”
• Roy and Traiteur (2003):
  • Turbines change local weather by changing air flow patterns
  • Near-surface air temperatures downwind of the wind farm are higher than the upwind regions during night, and cooler during day
  • Nocturnal warming of the air helps protect crops from frosts

METHODS

Equipment:
• 4 WXT510s
• 1 MAWS101
• 3 evaporation containers
Parameters measured: temperature, pressure, wind speed, wind direction, relative humidity, rainfall amount

Timeframe:
• 29 Oct – 17 Nov 2010
  • 2 min intervals for 20 days
  • 29 Oct – 4 Nov: NE & SE sites
  • 4 Nov – 11 Nov: MAWS & NE sites
  • 11 Nov – 17 Nov: MAWS, SW, NW, NE sites

RESULTS

Weather during experiment:
• 29 October – 6 November
  • Cold front went through between 4-5 November, causing higher wind speeds, lower barometric pressure, and lowered the temperatures slightly. Accumulating rain occurred 5 November.
• 6-13 November
  • Dry cold front went through 8-9 November. On 13 November, the a cold front went through the area lowering pressure and temperature slightly. Wind speeds were between 5-10 mph. Little precipitation occurred with this front.
• 14-17 November
  • No precipitation during 16-17 November. There was a brief drop in surface pressure with winds at 10 mph. Temperatures stayed steady throughout this time period.

CONCLUSIONS and FUTURE WORK

Conclusions:
• Warmer temperatures occurred in localized areas downwind of turbines, especially late night/early morning
• Cooler temperatures were observed downwind of turbines during day time hours due to surface mixing caused by wind turbines
• Decrease in RH were found as winds progressed through wind farm
• As wind progressed through the wind turbines, higher evaporation rates occurred downwind

Future Work:
• Perform statistical analyses to delineate instrument error and biases
• Evaluation of soil moisture content of localized farm land
• Further experimentation to include cooler seasons to assess the decrease of frost down wind of wind turbines

References:

