IC 4.3: Overview of Radiational Cooling at KFOK (Westhampton Beach Francis S. Gabreski Airport)

Ashley Sears, NWS WFO-OKX

February 7, 2012

Overview

Situated along the Atlantic Ocean and at the base of the Appalachian Mountains, the county warning area for WFO OKX (Upton, NY) provides an extensive set of challenges in forecasting. While the land right along the coast may be near sea level, it does not take long for the elevation to increase as one heads inland into central New York, Connecticut and New Jersey. Wind complexity is noted near the waters, with sometimes a distinct difference in wind speed and direction for the North Shore of Long Island versus the South Shore. Temperatures vary greatly, with the urban heat effect taking foot around the New York City metro region. Although OKX must deal with many microclimates, there was one that stood out and was more distinguished than others when I first began forecasting here.

The west end of Long Island is dominated by New York City and thus temperatures tend to be warmer in this region. One can go east on Long Island for a good while before the effects of the city are no longer discernible. However, as western Long Island is warmer, I have come to notice that there is a section towards the eastern end of the island that can become drastically cooler than its surrounding areas. The ASOS located at Francis S. Gabreski Airport in Westhampton Beach (FOK) consistently reports overnight low temps anywhere between two up to twenty degrees cooler than the surrounding AWOS/ASOS sites.

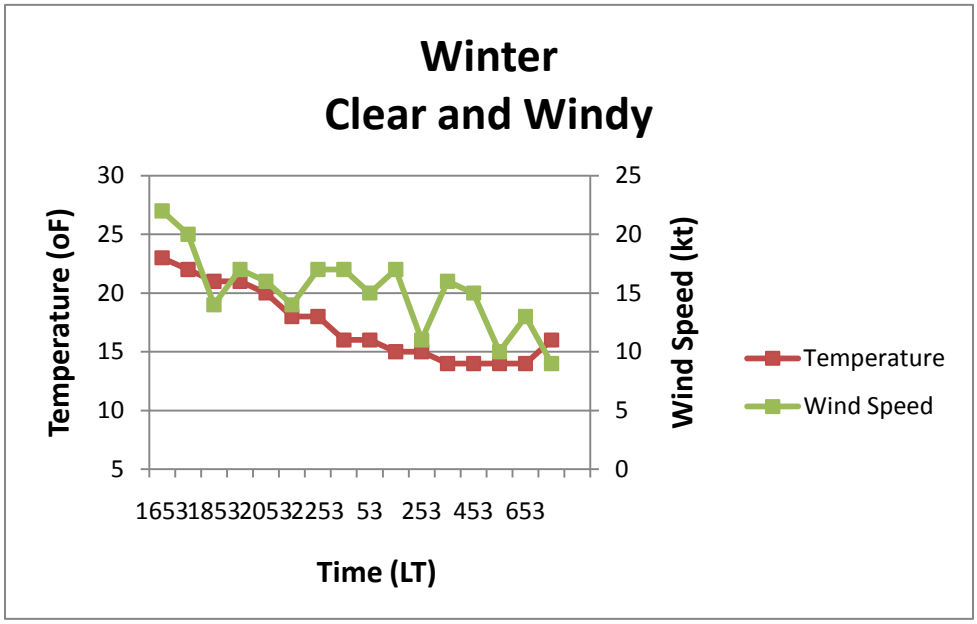
This paper will analyze eight different cases to determine the most likely time one should forecast FOK with much lower temps than the surrounding areas. I will provide plots comparing temperature and wind on both clear and cloudy nights for both winter and summer months to discern if it is a seasonal thing. For the nights that proved the greatest variability, I have also included the low temps from Central Park ASOS (NYC) and Long Island MacArthur Airport (Islip) to highlight the significant different. In addition, I will look at MOS Guidance to determine if the models are able to pick up on this variability and if it can be used in the future for forecasting low temps.

A couple notes before I jump in. One, I am only analyzing low temperatures for this paper. From my experience, it seems that day time highs for FOK are comparable to other local forecasting sites. Second, a forecaster at OKX had previously researched this location to determine if it was non-meteorological conditions that contributed to the lower temps. One conclusion that was met was the fact the ASOS at FOK is situated on a sand field, which allows for temps to vary at a greater rate than the surrounding forests. For this paper, we will just be looking at meteorological occurrences to take into consideration.

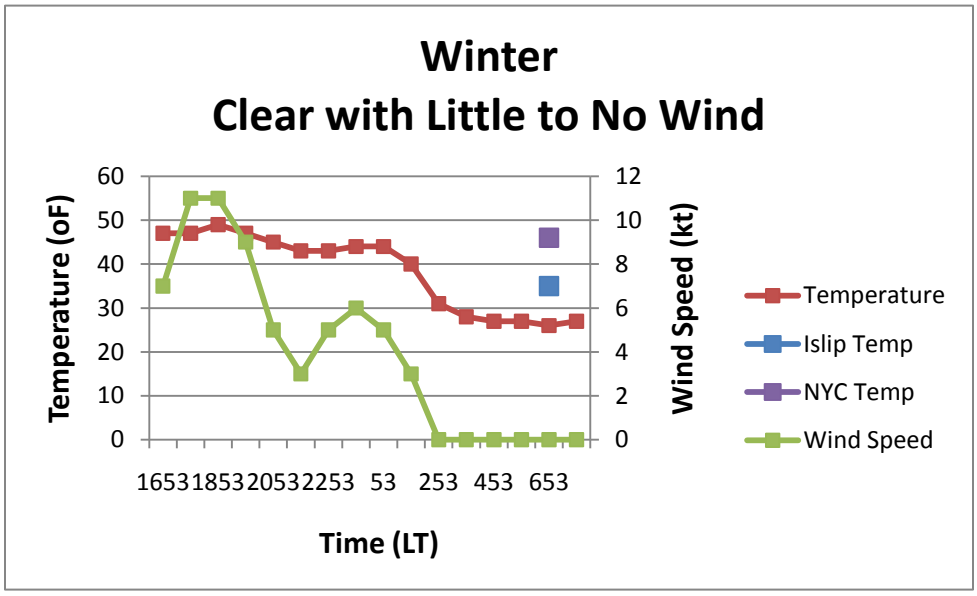
Map of Long Island. The salmon circle shows the location of FOK. The green circle is Long Island MacArthur Airport (Islip) and the purple circle identifies Central Park (NYC).

Graphs

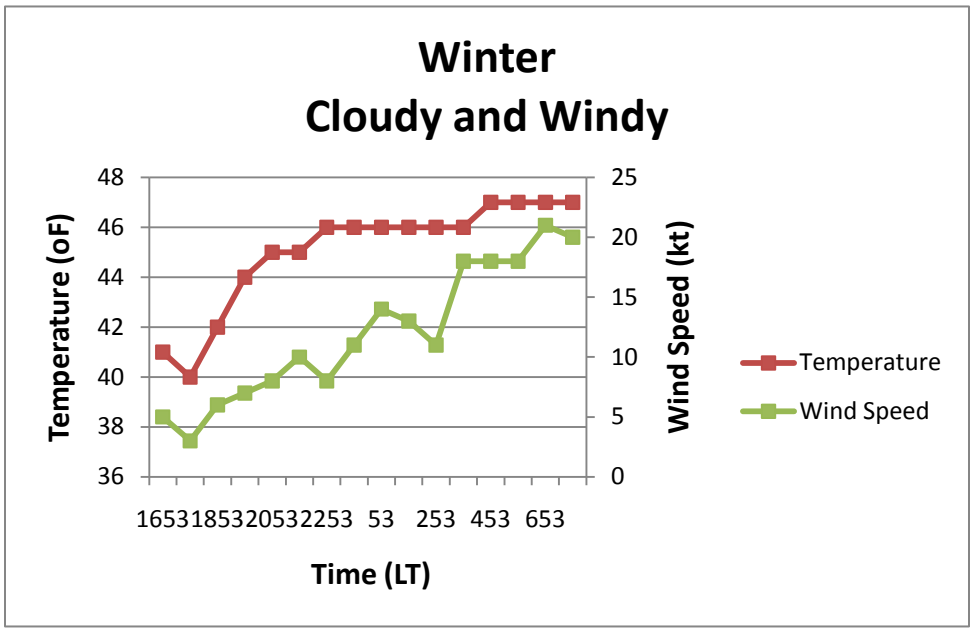
Below are eight different plots. There are four plots per season: clear night with little to no winds, clear night with windy conditions, cloudy night with little to no winds and cloudy night with windy conditions. Data used was collected by the ASOS at FOK, ASOS at Central Park (NYC) and ASOS at Islip (ISP) and was derived from hourly METARs from the individual stations. Data from Central Park and Islip were only depicted if there was a significant difference between the low at these locations and at FOK.



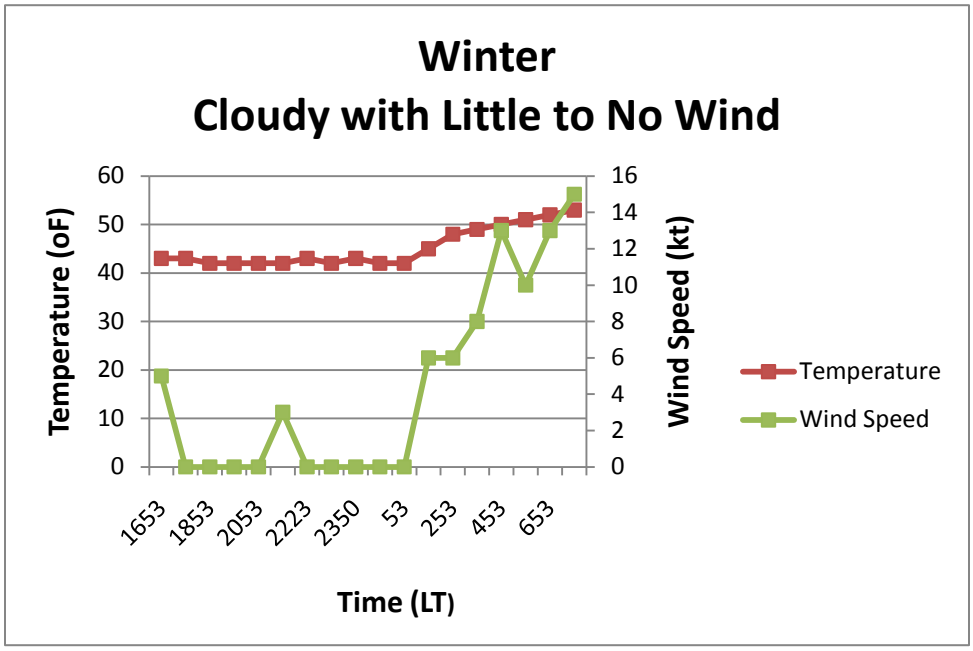
Night of January 3 - 4, 2012



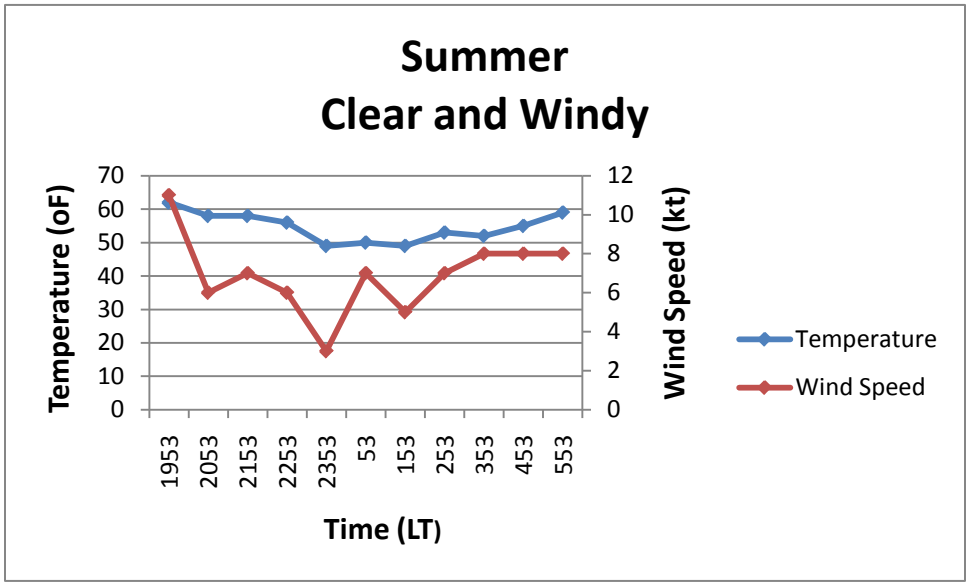
Night of January 6 - 7, 2012



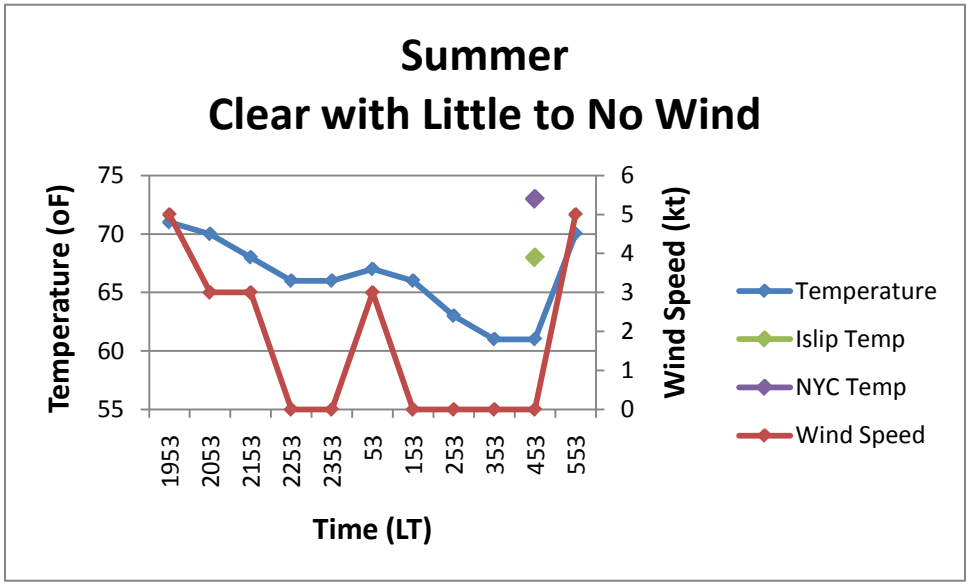
Night of January 11 – 12, 2012



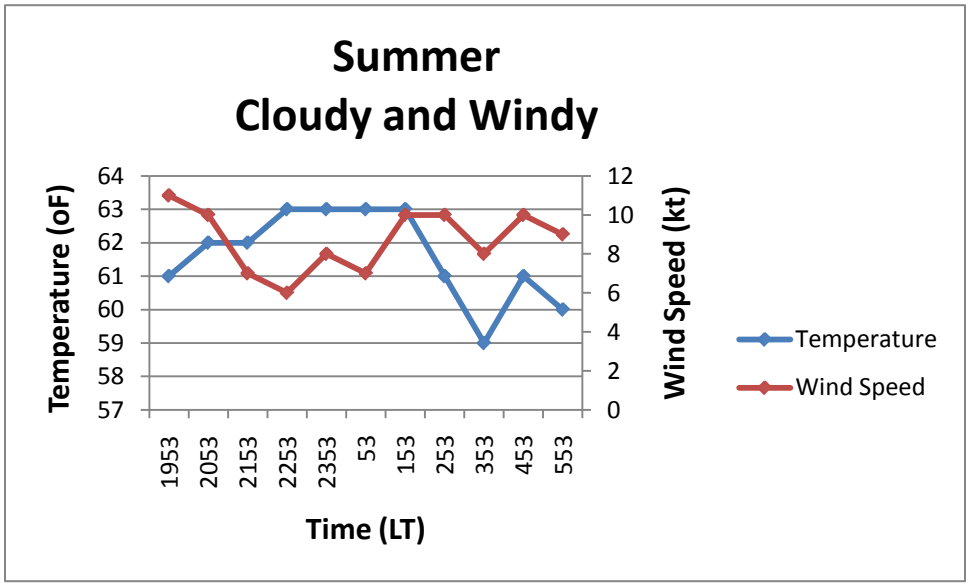
Night of January 12 – 13, 2012



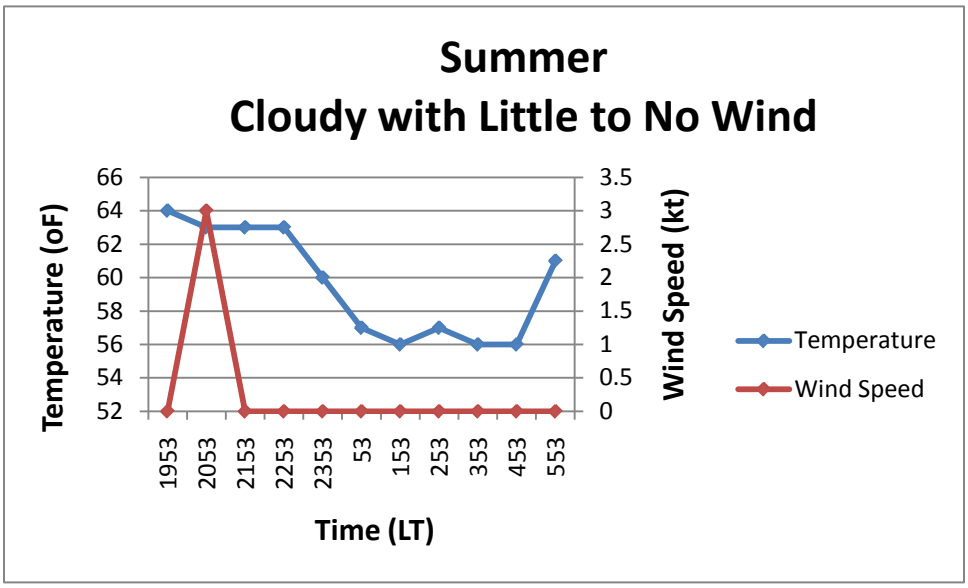
Night of June 2 – 3, 2011



Night of June 7 – 8, 2011



Night of June 10 – 11, 2011



Night of June 17 – 18, 2011

<u>Analysis and Application</u>

Radiational cooling is the cooling of Earth's surface, when the net heat lost by Earth is greater than the absorption of any incoming heat. Considering the fact that the temperature difference is much more pronounced at night than during the day, it would make sense that radiational cooling be the culprit in explaining the lower temperatures at FOK. There are two main components to analyze in determining radiational cooling: sky and wind conditions. Ideally, a calm, clear night would be the perfect set up for maximum radiational cooling. From looking at the graphics, it is noted that in both winter and summer that the clear, windless nights produced the greatest drop in temperatures. Comparing FOK to Islip and NYC, during winter there was between a 10 and 20 degree difference in the low temps and around a 10 degree difference in summer. These numbers help to confirm that it is radiational cooling causing the significant difference.

Another thing to note from the above cases is the impact the winds had versus the sky conditions. There seems to be a higher correlation between the winds and temperatures than the sky conditions. Whether the sky conditions were clear or cloudy, the temperatures seemed to respond to the wind (i.e. wind increases, temp increases and vice versa), which follows in line with typical mixing results. This would be important to remember for the future, that even if the skies remain clear, if the winds are forecasted to increase near morning, we might actually see a low temperature earlier in the night when it is still calm. Even in the summer when it is cloudy, as soon as the winds drop off, the temperatures begin a fairly steep decrease over a period of just a couple of hours. Comparing winter to summer, it seems the effect occurs in both seasons, though it is more pronounced in winter as compared to the other locations. This is probably due to the heating of the city allowing for the locations closer to NYC to not cool as much as the outer areas, such as FOK.

<u>Comparison to MOS Guidance/Future Use</u>

The three charts below compare the actual observed temperature with MET and MAV guidance three days, two days and one day prior. Both the MAV and MET do hint at trying to incorporate the routine lower temperatures. All three days of guidance indicate that the guidance has the hardest time accounting for the no wind nights, with it being clear in winter and cloudy during the summer. Without completely analyzing what the models were forecasting for each of these cases, it would make sense that in winter the clear nights may drop more than guidance forecasts due to the strength of the

radiational cooling. This was also the night that produced the most drastic difference in actual versus forecasted guidance. For the summer, the models may overdo the cloud cover a bit, which would help to keep the temperatures slightly warmer than what actually occurs. Overall, with the exception of the clear, windless night in winter, both MAV and MET guidance provide a decent starting point for the low temperatures. After a more in depth analysis, one can then make minor tweaks to the guidance numbers. In general, it seems the MAV is closer to the actual temperature, with the MET sometimes having a cold bias. This note is important to remember for the future as well.

As I have only forecasted for this region in the fall and winter, knowing what conditions to look for and how the guidance handles the lower temperatures should hopefully assist me for the coming summer forecasts as well as future winters.

Guidance 3 Days Prior

Date	Actual Low Temp	MAV Low Temp	MET Low Temp	Conditions
1/4/2012	14	11	9	Clear, Windy
1/7/2012	**26**	**33**	**36**	**Clear, No Wind**
1/12/2012	40	37	32	Cloudy, Windy
1/13/2012	42	41	30	Cloudy, No Wind
6/3/2011	49	46	45	Clear, Windy
6/8/2011	61	61	59	Clear, No Wind
6/11/2011	59	57	53	Cloudy, Windy
6/18/2011	**56**	**58**	**59**	**Cloudy, No Wind**

Guidance 2 Days Prior

Date	Actual Low Temp	MAV Low Temp	MET Low Temp	Conditions
1/4/2012	14	8	12	Clear, Windy
1/7/2012	**26**	**34**	**36**	**Clear, No Wind**
1/12/2012	40	39	41	Cloudy, Windy
1/13/2012	42	39	38	Cloudy, No Wind
6/3/2011	49	45	42	Clear, Windy
6/8/2011	61	63	60	Clear, No Wind
6/11/2011	59	60	58	Cloudy, Windy
6/18/2011	**56**	**59**	**60**	**Cloudy, No Wind**

Guidance 1 Day Prior

Date	Actual Low Temp	MAV Low Temp	MET Low Temp	Conditions
1/4/2012	14	9	9	Clear, Windy
1/7/2012	**26**	**33**	**35**	**Clear, No Wind**
1/12/2012	**40**	**41**	**42**	**Cloudy, Windy**
1/13/2012	42	40	36	Cloudy, No Wind
6/3/2011	49	47	47	Clear, Windy
6/8/2011	**61**	**63**	**62**	**Clear, No Wind**
6/11/2011	**59**	**63**	**64**	**Cloudy, Windy**
6/18/2011	**56**	**59**	**59**	**Cloudy, No Wind**

Guidance used was the 12z run from the respective day, assuming the low temperature is typically observed closest to 12z

Sources

http://mesonet.agron.iastate.edu/mos/

http://cdo.ncdc.noaa.gov/qclcd/QCLCD

http://xmacis.rcc-acis.org/OKX/

http://maps.google.com/maps?hl=en&q=westhampton+beach&gs_upl=&bav=on.2,or.r_gc.r_pw.,cf.osb&biw=1150&bih=886&wrapid=tljp1328646815930036&um=1&ie=UTF-8&hq=&hnear=0x89e8f6b0e86aed49:0x5479437b35d82117,Westhampton+Beach,+NY&gl=us&ei=pIoxT6CLAuH20gHL2YT5BQ&sa=X&oi=geocode_result&ct=image&resnum=1&sqi=2&ved=0CCsQ8gEwAA