Orographically Induced Cirrus Clouds East of the Southern Appalachian Mountains

Ryan Ellis
NOAA/National Weather Service, Raleigh, NC
Ryan.Ellis@noaa.gov

Motivation

The development of orographically induced cirrus clouds east of the southern Appalachian Mountain chain can result in areas of unanticipated cloudiness downstream across the Carolinas and Virginia. Both the degree of cloudiness and its impact on surface temperatures can have an adverse effect on forecast accuracy. The general environmental conditions favorable for orographic cirrus development are known and have been qualitatively documented (Ellrod 1983), but to this point have not been extensively quantified. This study will attempt to quantify the conditions necessary for orographic cirrus development across the southern Appalachian Mountains.

Data and Results

40 unique cases of orographic cirrus were observed along the Southern Appalachians on 24 calendar days from March 2009 through February 2010. *Note: The case study shown from 2008 is not included in the composite data.

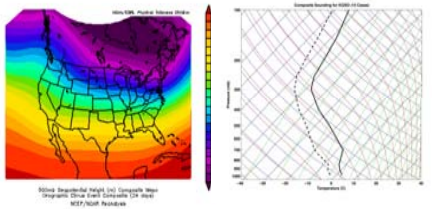

Figure 1: Composite 500 mb geopotential height (left) and a composite sounding from all events observed at the KGSO upper air station.

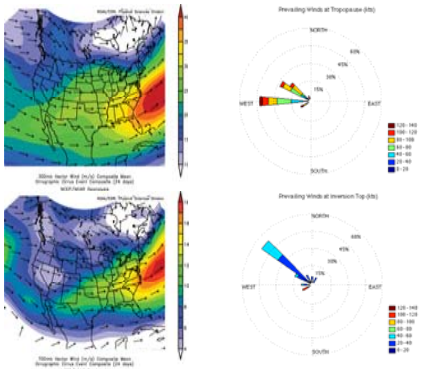

Figure 2: Composite wind vectors at the tropopause (top left) and inversion top (bottom left). Wind speed is shaded. Wind roses depicting prevailing winds at the tropopause (top right) and the inversion top (bottom right) are also shown.

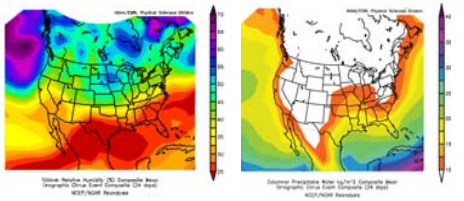

Figure 3: Composite data showing 500 millibar relative humidity (left) and precipitable water (right). Data provides evidence that a pre-existing upstream moisture trigger is needed for orographic cirrus to occur.

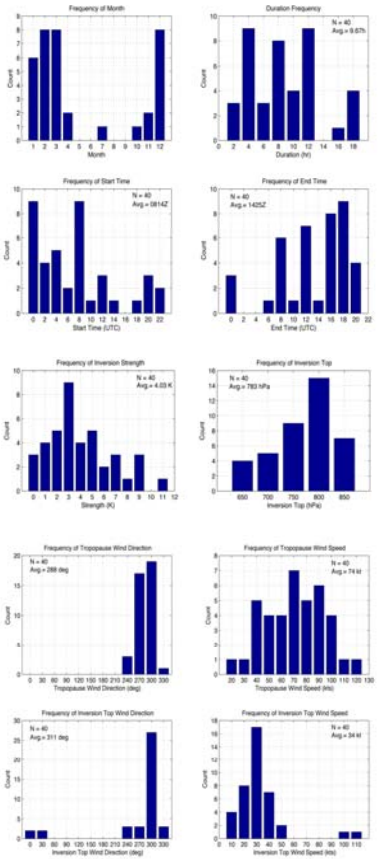

Figure 4: Histograms depicting climatological and physical statistics from the 40 cases of cirrus outbreaks observed.

Case Study: October 29th, 2008

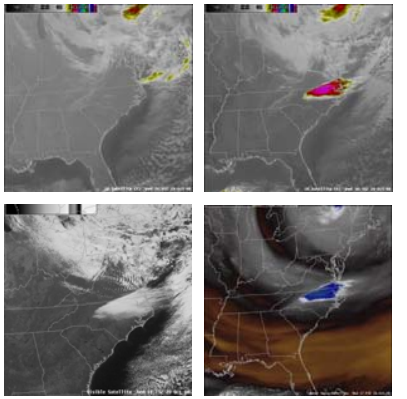

Figure 5: Orographic cirrus outbreak on October 29th, 2008 as seen from GOES satellite imagery including 1400 UTC (top left) and 1800 UTC (top right) infrared images from before and after the onset of the outbreak. Also included are an 1800 UTC visible image (bottom left) and 1800 UTC water vapor (bottom right).

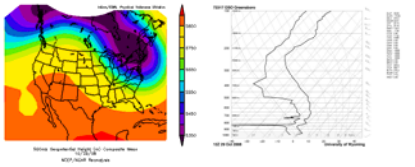

Figure 6: Composite of 500 mb geopotential height (left) and 1200 UTC sounding from KGSO (right) from October 29th, 2008 showing the environmental conditions present during the orographic cirrus outbreak.

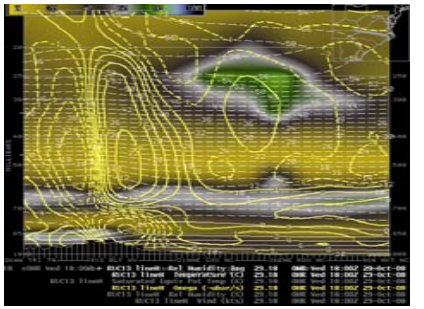

Figure 7: 1800 UTC RUC13 zero hour relative humidity cross section with omega field shown by the yellow contours.

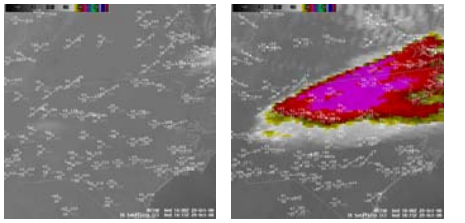

Figure 8: METAR plots overlaid on GOES infrared satellite images from 1400 UTC (left) and 1800 UTC (right). Station observations from underneath the cirrus shield show temperature differences on the order of 10˚F from those observations not under the cirrus shield. It is clear from the 1400 UTC image that these temperature differences were not present prior to the onset of the outbreak.

Conclusions and Future Work

- Orographic cirrus outbreaks can affect temperature forecasts by as much as 10˚F.
- Outbreak events usually set up in a stable environment with a mid to upper level low pressure system to the northeast and a strong upper level ridge to the west.
- An inversion typically exists between 850 and 700 millibars.
- Winds are generally unidirectional from the northwest with some slight backing throughout the profile from the top of the inversion to the tropopause.
- Quantification statistics listed on the graphs in figure 4 are all conclusions of this work.
- In the future we would like to attempt to compile verification statistics for temperature and cloud cover data during orographic cirrus outbreaks. We would also like to install operational forecasting procedures for predicting orographic cirrus events in the Mid-Atlantic region.

References

Ellrod, G., 1983: “Orographic cirrus along the Appalachian Mountains”, *Satellite Applications Information Note,* **83/2.**

Acknowledgements

I would like to thank Jonathan Blaes for his contributions to this research. Data provided in part by the NCAR/NCEP Reanalysis and the University of Wyoming.