Guidance on Forecasting Orographic Cirrus Events East of the Southern Appalachian Mountains

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.

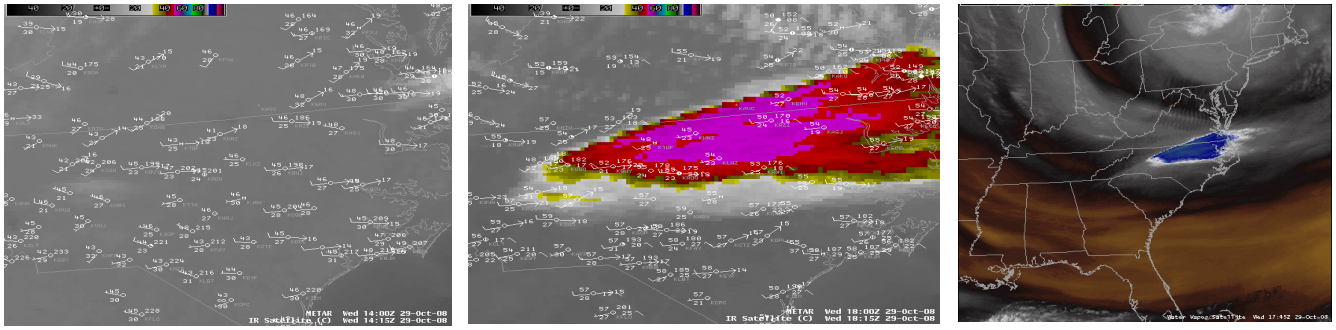

Figure 1: METAR plots overlaid on GOES infrared satellite images from 1400 UTC 29 October 2008 (left) and 1800 UTC 29 October 2008 (middle). Station observations from underneath the cirrus shield show temperature differences on the order of 10°F from those observations not under the cirrus shield. GOES water vapor imagery (right) from same time showing cirrus outbreak and upstream moisture fetch.

Environmental Conditions

The following environmental conditions are ideal for an orographic cirrus outbreak.

- Predominantly in the cool season
- Favored during evening hours persisting into the morning but can occur at any time of day
- Upper air pattern dominated by low pressure system over New England with a ridge over the central CONUS
- Water vapor imagery shows upstream moisture source
- Inversion or isothermal layer usually present near the mountain top level between 850 and 750 mb
- Winds increasing with height (35 knots on average at the inversion top to 70 knots at the tropopause)
- Winds typically northwesterly at the top of the inversion backing with height to westerly at the tropopause
- Largest outbreaks occur with winds orthogonal to the ridge

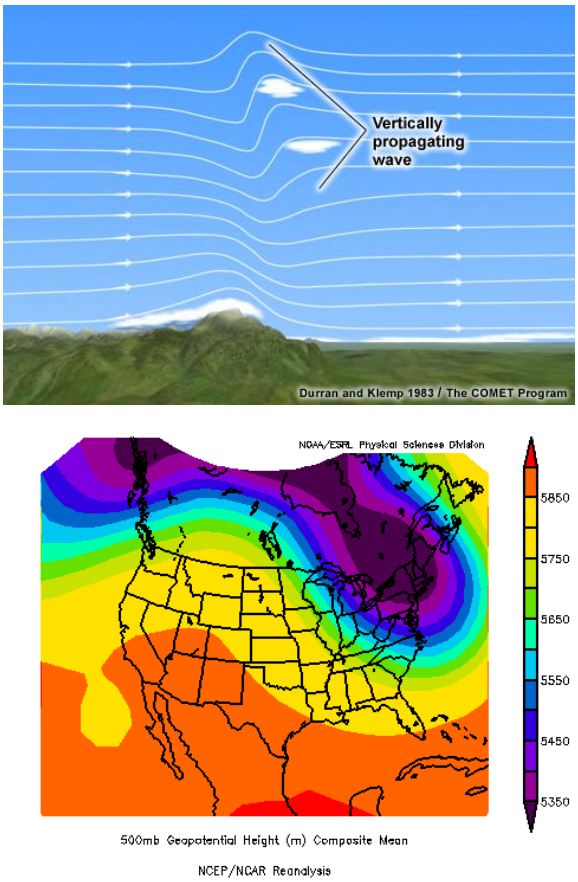

Figure 2: Schematic diagram of a vertically propagating standing wave (top) and 500 mb geopotential height field for 10/29/08 (bottom).

Typical Atmospheric Sounding Analysis for Orographic Cirrus Events

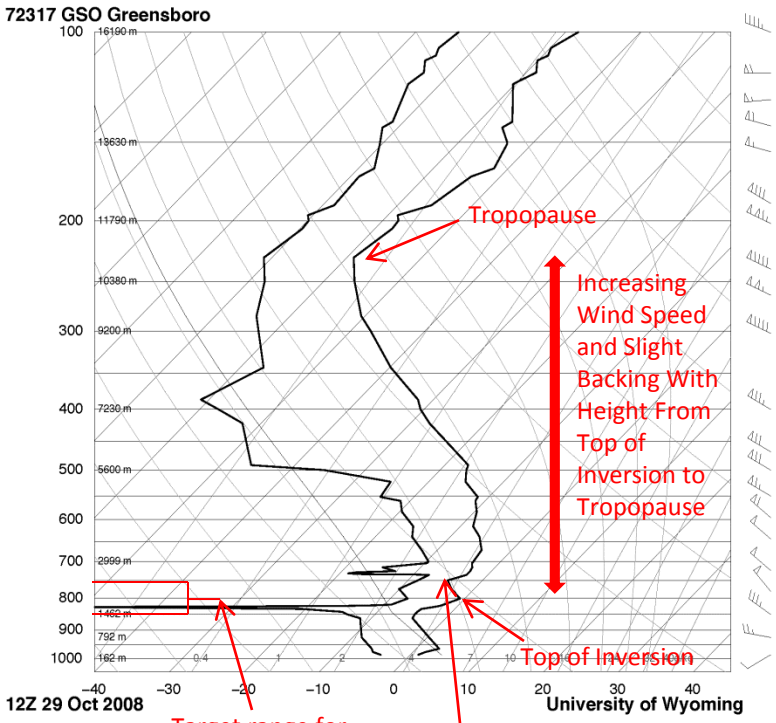

Figure 3

Target range for top of inversion (750-850 mb)

Multiple Inversions may or may not be present

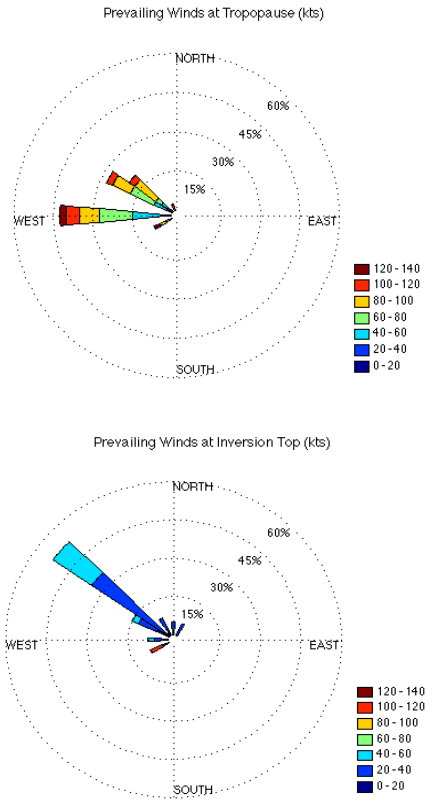

Figure 4: Wind Roses depicting most frequent wind direction (angle) and speed (color) at the tropopause (top) and top of the inversion (bottom).

Steps to Analyzing

1. When diagnosing an outbreak, analyze sounding data first for orographic cirrus trademarks.
2. Next look at water vapor imagery for an upstream moisture fetch. Event onset can sometimes be tracked by when an enhancement in the moisture flow reaches the Appalachians.
3. Check angle of flow to ridge axis. Orthogonal flow usual creates larger outbreaks that affect the temperature most.
4. The percentage of cloud cover and amount by which temperatures are affected (2-10 degrees) will vary and are hard to predict. Before an event begins, take a best guess forecast and then use the enhanced short term forecast to nowcast and make adjustments as needed.

Tips for Forecasting

- Orographic cirrus events can occur in clusters (2 or 3 successive days or nights) if synoptic conditions hold.
- Multiple inversions may be present. The one at or just above mountain top level (850-750 mb) is the one that matters.
- Inversion top may fall outside the target range but usually with less prominent results.
- Strength of the inversion does not matter as much as the presence of an inversion.
- Not all factors have to be present to get orographic cirrus but the presence of an inversion seems to be most important.
- Orographic cirrus events may not occur even with all factors present.
- Orographic cirrus events can still occur with a WSW wind (usually thin pencil-like streaming outbreaks of minimal impact).

Ryan Ellis - NWS Raleigh