P1.70

Cloud-Top Temperatures for Precipitating Winter Clouds

Jay Hanna and **Antonio R. Irving**, *Satellite Services Division, NOAA/NESDIS, Camp Springs, Maryland*
David M. Schultz, *CIMMS, University of Oklahoma, and NOAA/National Severe Storms Laboratory, Norman, Oklahoma*

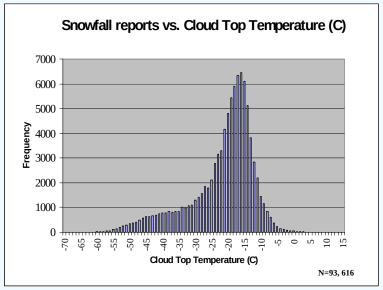
METHODOLOGY

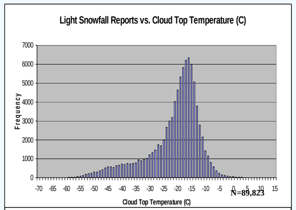
A study of precipitating clouds using remotely sensed brightness temperatures from the Geostationary Operational Environmental Satellite (GOES) 8/12 Imager was conducted during the second half of the winter of 2003 (February through March) and during the winter of 2004 (December through March). Data were collected using an acquisition algorithm to retrieve cloud-top temperatures above every surface station reporting precipitation throughout the contiguous United States (CONUS). Cloud-top temperatures were determined using a 2 x 2 pixel box surrounding the station with pixel resolution at satellite subpoint of 2.3 km x 4.0 km. This method was chosen to alleviate parallax and navigational errors in satellite data. Data were included in the sample if the standard deviation of the surrounding 4 pixels were less than or equal to 1ºC. The data were then separated into four categories based on the surface precipitation type (rain, snow, freezing rain, and snow) and graphed in a frequency distribution as a function of cloud-top temperature.

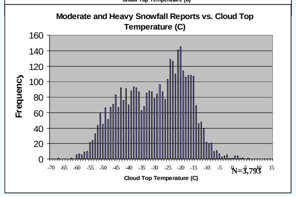
Three key critical assumptions in the study are 1) the cloud that produced the hydrometeor behaves as a blackbody, 2) the remotely sensed cloud-top temperature is the cloud that produced the hydrometeor, and 3) cloud-top temperature is the coldest temperature in the cloud.

SNOW

- Gaussian distribution skewed to lower temperature
- Pronounced mode at –16°C, likely due to ice nuclei experiencing maximum depositional growth
- Sharp drop warmer than –10ºC, indicative of the inactivation of ice nuclei





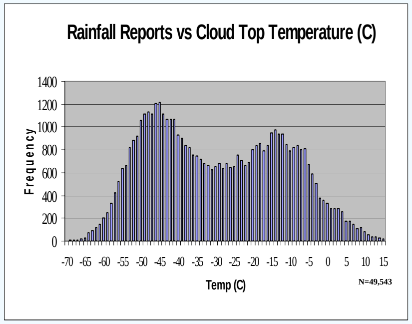


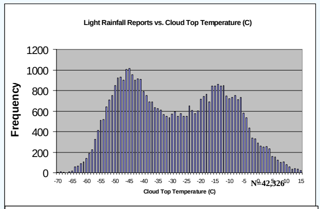
Comparing Light vs. Moderate/Heavy Snow Reports

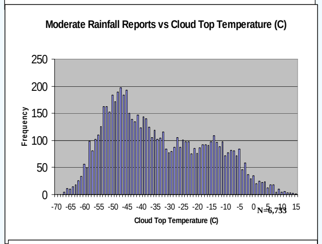
- moderate and heavy snow are grouped together based on the small sample size for heavy snow
- light snow reports mimic the total snow reports—expected given the dominance of light snow reports in the total sample
- moderate/heavy snow reports exhibit a bimodal distribution, with second peak at lower temperatures

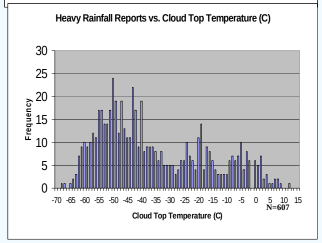
RAIN

- most pronounced mode at –47ºC, believed to be the average equilibrium level temperature for deep convection
- second mode at –14ºC, similar to the snow data with a peak at the maximum depositional growth temperature
- gentle decline warmer than –10°C indicates the importance of warm-rain processes in shallow clouds with warm tops







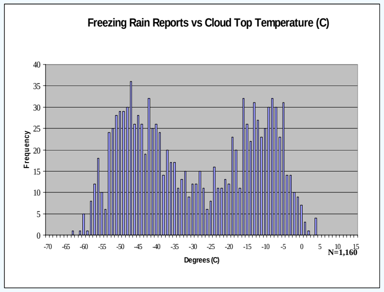


Comparing Light, Moderate, and Heavy Rain Reports

- light rain reports mimic the total rain reports—expected given the dominance of light rain reports in the total sample.
- all three graphs exhibit a bimodal distribution
- primary mode near –47ºC
- second mode near –15°C, the maximum depositional growth temperature.
- –15°C mode is less pronounced as the intensity of the rainfall increases

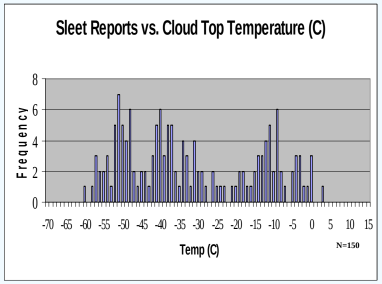
FREEZING RAIN

- similar to the distribution for rain reports
- bimodal distribution with modes near –47ºC, likely due to the average equilibrium temperature for deep convection, and also between –10ºC and –8ºC
- the similarity between the rain and freezing rain graphs suggests that the only difference between these two processes is the near-surface temperature profile**.**



SLEET

- distribution of sleet reports appears similar to those of rain and freezing rain
- small sample size limits interpretation of this graph



CONCLUSIONS

- The distribution of the satellite-derived cloud-top temperatures for different types of precipitation observed at the surface show the dominance of **different cloud microphysical processes** occurring.
- All precipitation types except light snow show a **bimodal distribution**. One mode is associated with **deep convection**, the other is associated with the temperature at which **maximum ice depositional growth** occurs.
- Snow requires the **activation of ice nuclei** in the cloud, a process that usually happens at temperatures colder than –5°C, although our results indicate a range of temperatures is possible.
- **Heavier precipitation** tends to shift bimodal distributions towards **colder cloud tops**.