# A FOUR-LIDAR VIEW OF CIRRUS FROM THE FIRE IFO:

## 27-28 OCTOBER 1986

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The four ground-based lidar systems that participated in the 1986 FIRE IFO were configured in a diamond-shaped array across central and southern Wisconsin. Using the analogy of a baseball diamond, the base paths were 125 km long. Stationed at home plate at Madison was the University of Wisconsin High Spectral Resolution Lidar (HSRL) with a 0.51 μm wavelength; first base at Oshkosh, the NOAA/WPL scanning $CO_2$ Doppler lidar (10.6 μm); second base at Wausau, the University of Utah polarization ruby lidar (0.69 μm); and third base at Ft. McCoy, the NASA/LRC polarization cloud lidar (frequency-doubled Nd YAG at 0.53 μm). Data were generally collected in the zenith-pointing mode, except for the Doppler lidar, which regularly operated in a scanning mode with intermittent zenith observations.

As a component of the cirrus case study of 27-28 October 1986 selected for initial analysis, data collected by the remote sensor ensemble from 1600 (on the 27th) to 2400 UTC (on the 28th) will be described and compared. Data were collected nearly continuously over this period by the HSRL, but night operations at the three other sites were suspended for operator rest periods, and fog and low stratus cloud conditions occasionally interrupted data collection at Wausau and Oshkosh. Nonetheless, the 32-h dataset provided an interesting and fairly comprehensive view of the movement of cirrus clouds over the central Wisconsin area. Note that the average cirrus level winds were ~30 m $s^{-1}$ out of the northwest late on the 27th, changing to westerly on the 28th, such that cloud advection was approximately orthogonal to the north-south axis of the lidar field site grid.

In general, the cirrus studied on the 27th consisted of intermittent layers of thin and subvisual cirrus clouds. Particulary at Wausau, subvisual cirrus was detected from 11.0-11.5 km MSL, just below the tropopause. At lower levels, occasional cirrus clouds between ~8.0-9.5 km were detected from all ground

sites. These layers were thickest at Ft. McCoy and Oshkosh. Although measurements are only available for the Madison lidar between 0200-0800 UTC, these data reveal the passage of an exceptionally well-defined Mesoscale Uncinus Complex (MUC) from 0500-0630 UTC. Although this structure attained a maximum cloud depth of nearly 4 km and was ~150 km in horizontal extent, the high resolution view provided by the HSRL provides evidence for the ~1 km scale of numerous cirrus uncinus generating cells and fallstreaks. Subsequently, as the full complement of lidars was restored, the develoment of a ~5 km-thick cirrus cloud system was observed. Initially, rather thin cloud layers were intermittently present at about 8.0 and 11.0 km. Laser depolarization data indicate that the lower layer was an altocumulus cloud containing supercooled cloud droplets, which produced virga. With continued upper level cloud develoment, however, it appears that the altocumulus cloud became incorporated in the cirrus ice cloud system. Following the passage at Wausau of a well-defined cloud band, all sites recorded little or no cirrus from 1800-1900 UTC, before clouds again began developing from cirrus generating cells located near the tropopause.

In summary, preliminary analysis of the four-lidar dataset reveals the passage of surprisingly consistent cloud features across the experiment area. A variety of types and amounts of middle and high level clouds occurred, ranging from subvisual cirrus to deep cloud bands. It is expected that the ground-based lidar measurements from this case study, as well as the airborne observations, will provide an excellent data base for comparison to satellite observations.

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