COMPARISON OF SURFACE-DERIVED AND ISCCP CLOUD OPTICAL PROPERTIES

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INTRODUCTION - One objective of the FIRE Project is to validate the cloud parameters given on ISCCP tapes. ISCCP first defines whether or not a region is clear or has clouds based on two threshold algorithms. If the region has clouds, then a cloud optical depth is given as well as a cloud height. Special high-resolution ISCCP CX tapes were created for the time period of the Wisconsin FIRE experiment. These tapes did not include the cloud height product, however, other parameters used to make up the standard ISCCP C1 products were available. It is the purpose of this paper to compare the ISCCP cloud/no cloud and cloud optical depth parameters with surface-derived values for the Wisconsin FIRE region during the October 27 and 28 case study days.

DATA - A total of 6 daylight scenes on October 27 and 28 were examined. For sake of brevity, only 3 scenes are presented in this paper to illustrate typical results. Four types of images are presented for each scene as shown in figures 1 through 3.

For each figure, both images on the left side of the figure are based on instrument measurements from the surface at various ground-truth sites during the experiment. Cloud fraction and optical depth are half-hour averages shown as lines based on wind velocity and direction at cloud altitude. Cloud fraction results were obtained from hemispherical surface radiometers. Optical depth values were obtained from a narrow-beam radiometer at Ft. McCoy, a combination of shadow-band and hemispherical radiometers at Wausau, and a lidar at Madison. (See reference 1 for a more complete description of these data and instruments used for the measurements.)

The images on the right side of the figure are based on data from the special ISCCP CX tape. Data are given for pixel locations based on sampling of the basic satellite data every 30 km instead of at the ground truth sites. The pixel locations are held constant for each month, but may change from month to month. Cloud/no cloud conditions were determined using 3 parameters from the CX tapes in the same manner as used to obtain C1 cloud parameters. If the

parameter CLOUD CODE indicated clear, then the "no cloud" condition was assumed. If CLOUD CODE indicated as either undecided, mixed, or cloudy, an additional test was done. If either the VIS THRESHOLD or IR THRESHOLD codes had a value of 4 or 5, it was assumed that "cloudy" conditions existed, otherwise the sky was assumed to be clear. (Undecided clear skies existed on Oct. 27.) A zero value in the ISCCP cloud optical depth image indicates clear sky locations.

RESULTS - Figure 1 is a scene when nearly clear sky conditions existed. Surface cloud fraction values are zero for much of the scene except for the most western site (Ft. McCoy) and patches near the most southeastern site (Madison). The ISCCP data indicates totally clear skies. Review of the original 1-km satellite images indicates that clouds did exist suggesting that the ISCCP procedure may not detect some thin clouds because of either threshold or navigation errors.

Figure 2 is a cirrus cloud day at the same solar angle as figure 1. Surface data show broken or overcast cloud fractions over every site, and most ISCCP locations are indicated as cloudy. Non-zero surface cloud optical depth values are indicated at each station where ground measurements were made. At Wausau, the ISCCP optical depth at a nearby pixel is of the same magnitude as the surface measured value, but a precise comparison is impossible. The Ft. McCoy optical depth value (0.22) is probably of the same magnitude as ISCCP values (between 0 and 0.75), however, ISCCP values near Madison (1.42 - 2.55) appear much larger than the ground truth value of 0.24.

Figure 3 is a cirrus scene with a higher solar angle than figures 1 and 2. Again surface-measured cloud fraction is non-zero, and ISCCP indicates clouds over the central and eastern portions of the region. Surface-measured optical depth at Ft. McCoy is very low, explaining why ISCCP is indicating no clouds in that region. ISCCP cloud optical depth values near Madison range from 0 - 1.73 which may be near the measured value of 0.34. A large discrepancy exists at Wausau, however. ISCCP nearby-pixel values range from 1.82 to 5.45 as compared with a measured value of 0.98. Examination of the original 1-km satellite imagery indicates sharp changes in cloud reflectance around Wausau. Again the satellite pixel to ground station navigation mismatch may be the reason for the large discrepancy in cloud optical depth values.

CONCLUDING REMARKS - Satellite pixel to ground station navigation mismatch precludes a direct quantitative validation of ISCCP cloud/no cloud and cloud optical depth parameters. In a qualitative sense, ISCCP procedures seemed to predict cloud/no cloud conditions reasonably well over grassland and forests, with a slight tendency not to detect very thin clouds. It is not known how well the algorithm operates over more difficult surfaces such as snow and deserts. Accuracy of ISCCP cloud optical depth values is not known. Comparisons were inconsistent with factor of 10 differences in some cases. A revised validation strategy is desirable.

REFERENCE

1. LeCroy, S. R., Whitlock, C. H., Poole, L. R., Alvarez, J. M., Robinson, D. A., Starr, D. O'C., and Cox, S. K.: Surface Radiation Observations of Cirrus Cloud Properties During the Wisconsin FIRE/SRB Experiment. IRS 88: Current Problems in Atmospheric Radiation. A. Deepak Publishing, 1989, pp. 22-25.

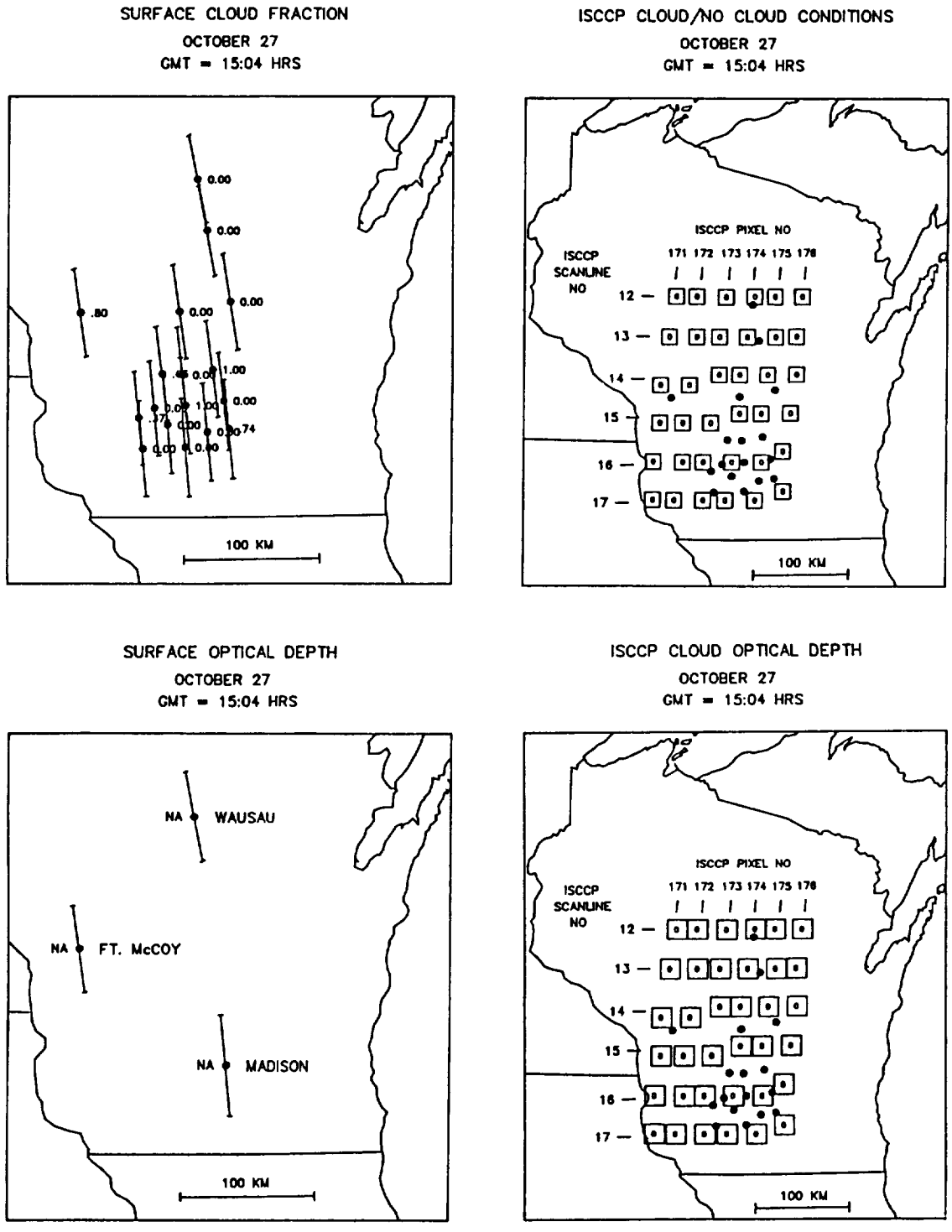

Figure 1. Surface-measured cloud fraction and cloud optical depth compared to ISCCP cloud parameters under nearly clear sky conditions with solar zenith angle = 67.3°.

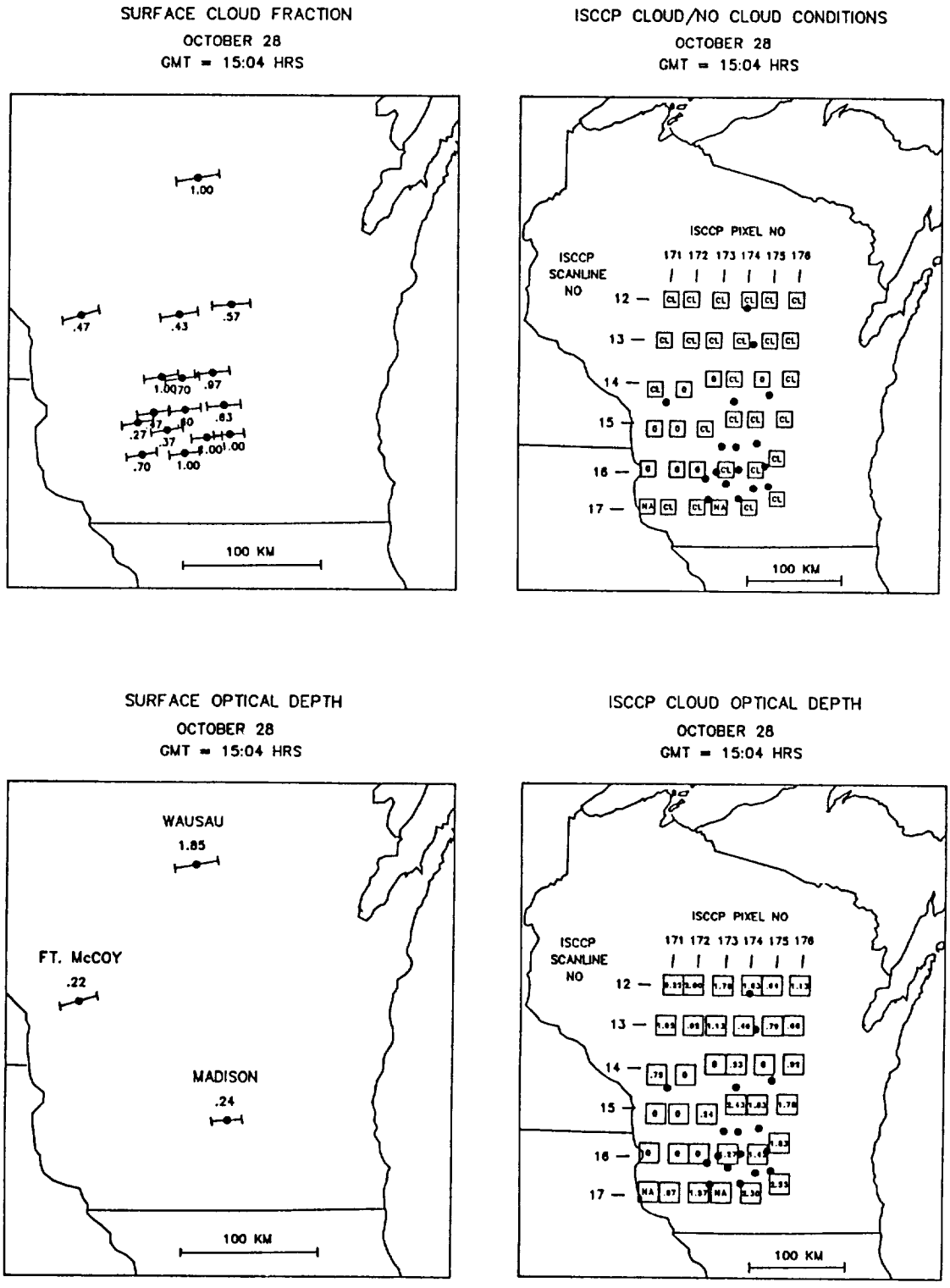

Figure 2. Surface-measured cloud fraction and cloud optical depth compared to ISCCP cloud parameters under cirrus cloud conditions with solar zenith angle = 67.7°.

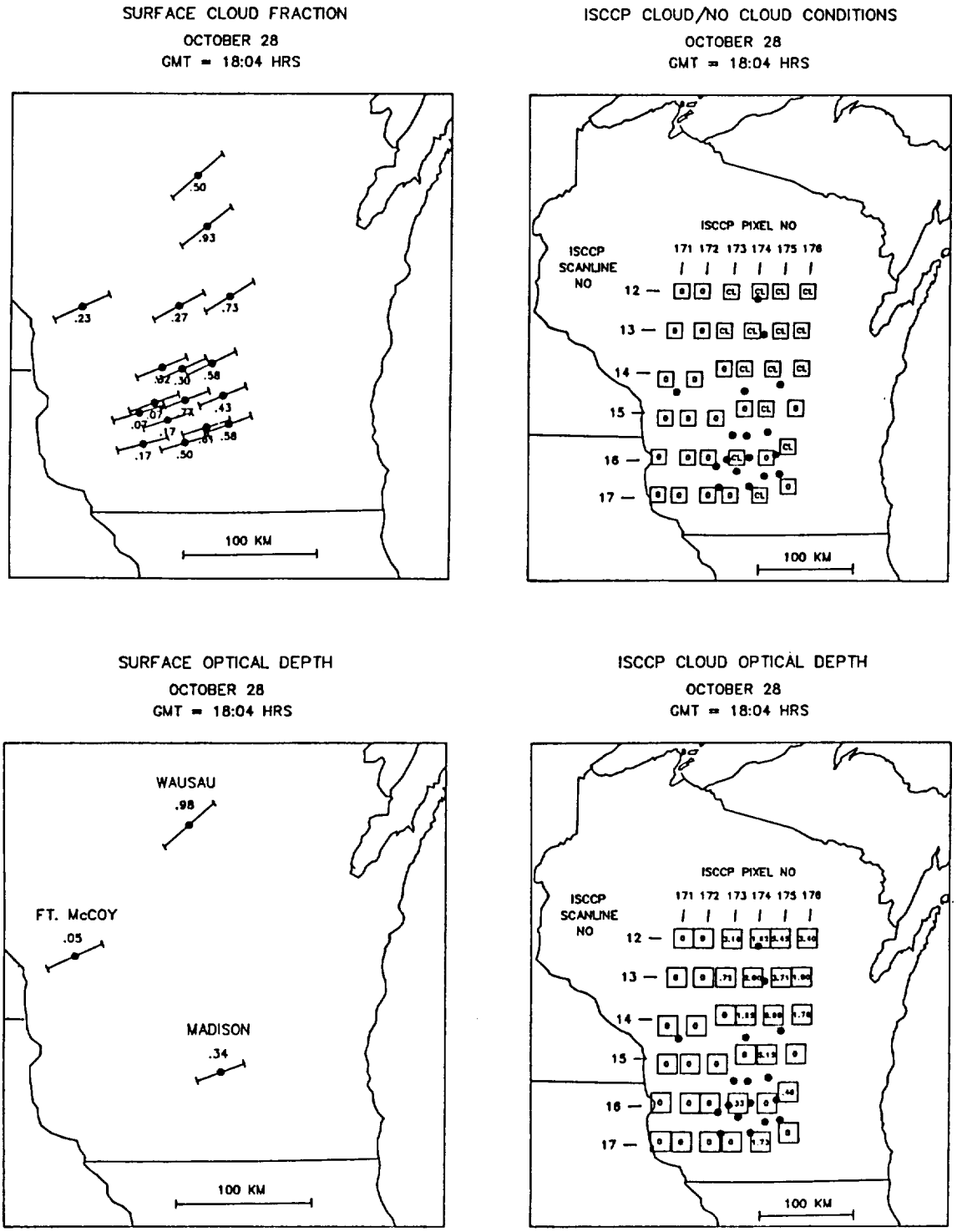

Figure 3. Surface-measured cloud fraction and cloud optical depth compared to ISCCP cloud parameters under cirrus cloud conditions with solar zenith angle = 61.3°.