ENHANCED CLOUD ALGORITHM FROM COLLOCATED CALIPSO, CLOUDSAT AND MODIS

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1. INTRODUCTION

Coincident profile information from CALIPSO's lidar and CloudSat's radar offers a unique opportunity to map the vertical structure of clouds over the globe with accuracies never before realized. The combination of these data with observations from other A-train instruments, CERES[1] and MODIS, will lead to new insight into cloud structure and properties, aerosol climate effects, and more accurate estimates of surface longwave fluxes and atmospheric heating rate profiles that are needed to improve climate prediction. An enhancement to NASA Langley's CERES Visible Infrared Solar-infrared Split-window Technique (VISST) [1] (Minnis et al. (2009) was developed to identify and account for situations when disagreement occurs between the VISST and CALIPSO cloud-top heights, particularly for multi-layer cloud systems where VISST retrievals are often incapable of accurately characterizing a particular thin cirrus cloud [2] (Chang et al. 2008). The enhanced retrieval scheme replaces the CERES cloud-top height with its CALIPSO counterpart, and then retrieves cloud temperature and optical depth, as well as cloud microphysical characteristics such as particle size, phase, and liquid or ice water path. This paper presents the implementation of the enhanced CERES clouds algorithm, case studies, and the statistics of cloud property comparisons before and after application of the enhanced scheme.

2. DATA

At present, the A-Train Data Depot at Goddard Earth Sciences Data and Information Services Center is operationally subsetting certain Aqua/MODIS Radiances and Atmospheres data along the CloudSat track. The CloudSat-collocated Aqua/MODIS subsets are provided in both narrow and wide swaths, corresponding to $\pm$5 km and $\pm$100 km along the CloudSat track, respectively. The subset data used in

this paper are wide swath (±100 km) data with geo-locations and 1-km Aqua/MODIS Level 1B calibrated radiances. The CALIPSO and CloudSat products used in the comparisons are the Vertical Feature Mask (VFM) and Cloud Scenario Classification (CLDCLASS), respectively. As indicated in figure 1, the three different data sources, MODIS, CALIPSO, and CloudSat, have very different horizontal resolutions: 1 km, 333 m and 1.1 km, respectively. Both CALIPSO VFM and CloudSat CLDCLASS are first collocated to each MODIS 1-km pixel. Any CALIPSO shot or the center of the CloudSat profile that falls within the MODIS 1-km pixel box is considered as collocated with the MODIS pixel.

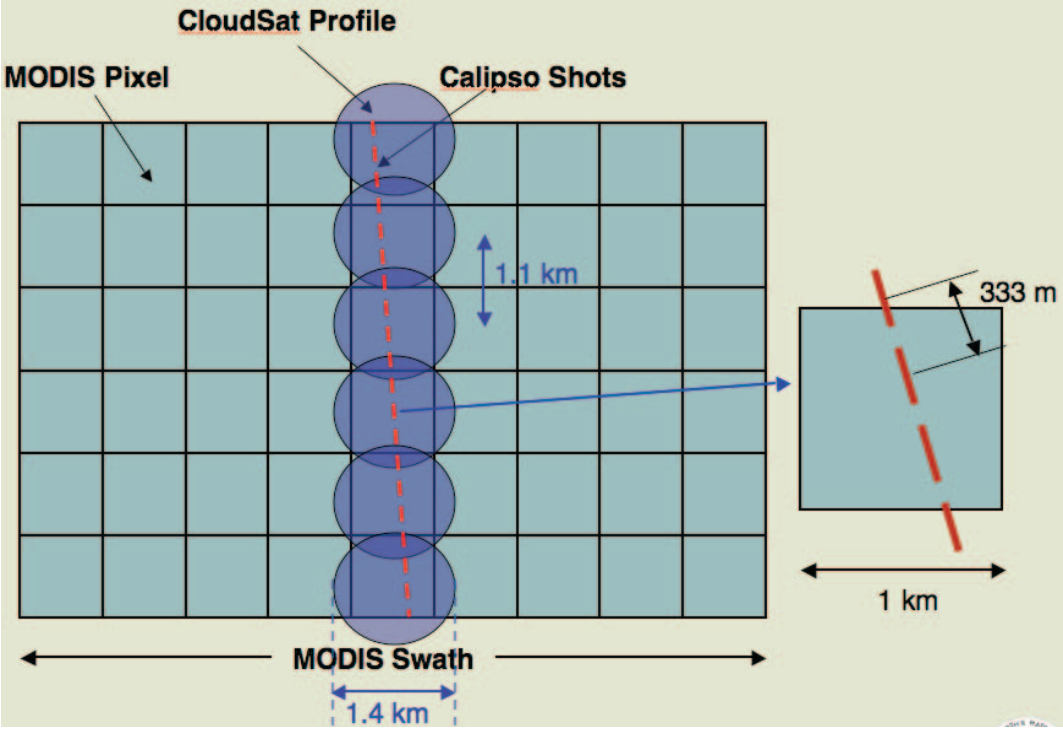

Figure 1: Diagram of horizontal resolutions for MODIS, CALIPSO, and CloudSat, where light blue box represents 1-km MODIS pixel, red dashed lines are CALIPSO shots with 333-m horizontal resolution, and dark blue transparent circles are 1.1-km CloudSat profiles.

3. CASE STUDIES

Figure 2 shows example nighttime results from before and after the enhancement at 0100 UTC over West Africa on July 15, 2006. The CERES water clouds and the much of the missing clouds before the enhancement are now classified as ice clouds after the enhancement, which agrees with CALIPSO retrievals.

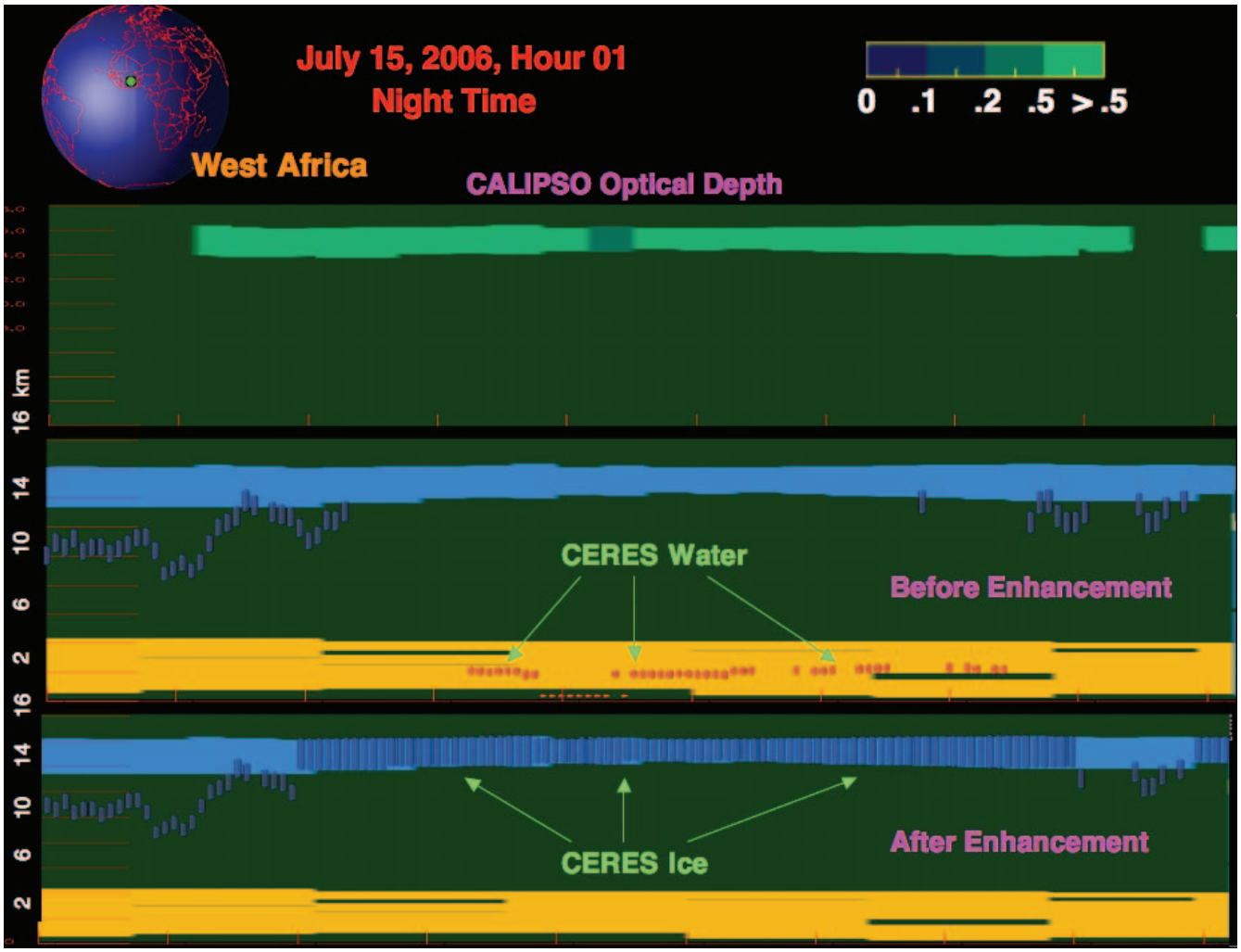

Figure 2: Before and after the enhancement scheme for July 15, 2006, hour 01. Bottom panel shows after the enhancement and 2nd panel from the bottom shows the before, with clouds (top layer) over aerosols (bottom layer). The third panel from the bottom is CALIPOS optical depth and is mostly less than 0.5 in the case indicated in the picture. The dash lines are CERES clouds.

4. PLANS

At least, one year of collocated CALIPSO, CloudSat and MODIS data will be processed with the CERES Cloud Retrieval algorithm VISST plus the enhanced scheme as mentioned in the introduction. Statistics on missed clouds (as a function of optical depth) before the enhancement and the same clouds having retrievals after the enhancement will be presented. Also, for clouds existing both before and after the enhancement, statistics will be calculated for pixels having misidentified cloud phase before the enhancement and cloud property comparisons before and after the enhancement. The goal is to utilize CALIPSO/CloudSat data to improve CERES clouds retrieval algorithms.

11. REFERENCES

[1] P. Minnis, S. Sun-Mack, D. F. Young, P. W. Heck, D. P. Garber, Y. Chen, D. A. Spangenberg, P. W. Heck, R. F. Arduini, W.,L.Smith, Jr., J. K. Ayers, S. C. Gibson, Y. Takano, K.-N. Liou, and Y. Xie, "CERES Edition 2 cloud property retrievals using TRMM VIRS and Terra and Aqua MODIS data: Part I: Algorithms," *IEEE Trans. Geosci. Remote Sens.* (submitted, 2009).

[2] F. Chang, P. Minnis, B. Lin, R. Palikonda, M. Khaiyer, and S. Sun-Mack, Retrieving cloud properties for multilayered clouds using simulated GOES-R data. AMS 5th GOES Users' Conf., New Orleans, LA, January 23-24, CD-ROM, P1.69 (2008).