"Cloud-mode" Optical Depth Observations – Example of Adaption of ARM to AERONET

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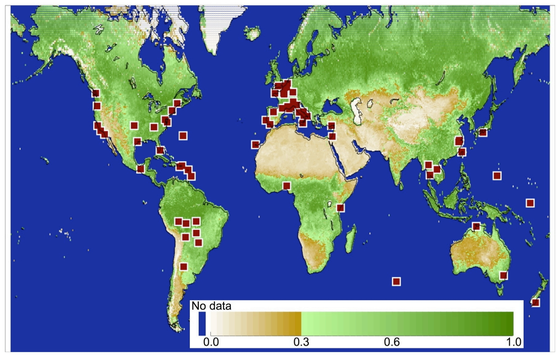
We use sunphotometers' idle time to observe clouds

- The ARM sunphotometer was originally designed to measure aerosol properties (photo at left). When clouds block the sun, the radiometer is placed into sleep mode.
- We propose to use some of this idle time to monitor clouds and have dubbed this new operational mode "cloud-mode" (photo at right).

Normal aerosol mode (sun-seeking)

Cloud mode (zenith-pointing)

This cloud mode is adopted by AERONET and will dramatically increase the global coverage of cloud observations

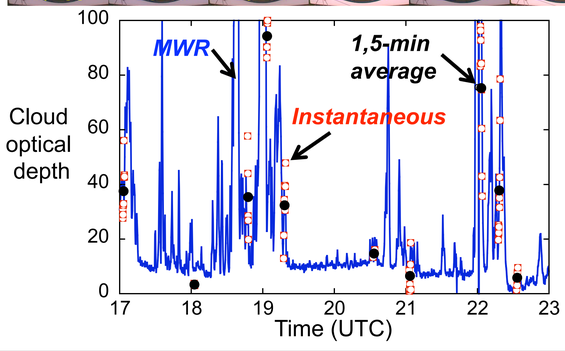


Captions: A map of potential cloud-mode sites, based on NDVI (normalized difference vegetation index) during year 2005–2008.

Summary

- We demonstrate a new way to enhance the existing AERONET infrastructure to observe cloud optical properties on a global scale.
- Good agreement was found between cloud-mode retrievals and those from ARM MWR and MFRSR.
- AERONET monthly-mean cloud optical depths are generally larger than cloud radar retrievals due to the current cloud-mode observation strategy.

Evaluate cloud-mode observation strategy

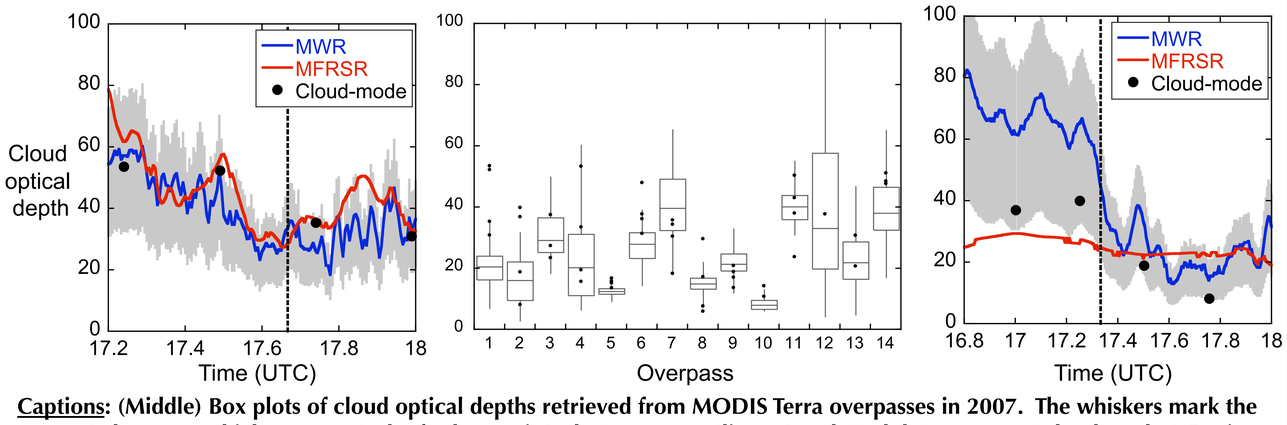


- Cloud-mode average retrievals show good agreement with MWR values. However, we note that no cloud-mode measurement was made during 19:30–20:30 and 21:15–22:00 UTC even though scattered cumuli were around.

Captions: A broken cloud case at the ARM Oklahoma site on 15 June 2007. (Upper panel) Total sky images. (Bottom panel) Retrieved cloud optical depths from the ARM microwave radiometer (blue) assuming an 8-μm droplet effective radius. Red and black dots are cloud-mode instantaneous and 1.5-min average cloud optical depths.

Compare retrievals with MODIS for overcast cases

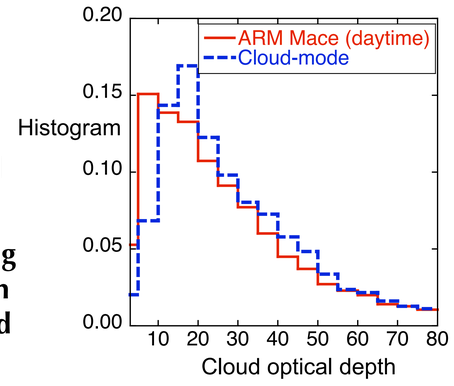
- Overall, the intercomparison results are encouraging but show the difficulty of comparing satellite and surface retrievals.



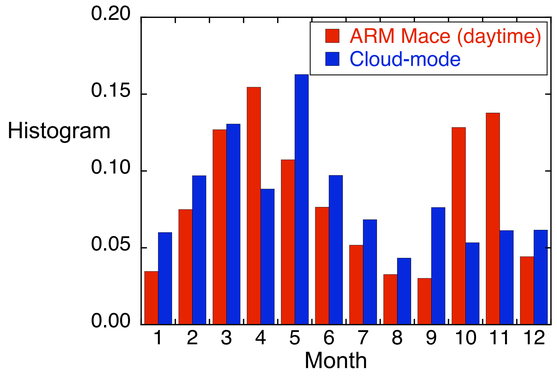
Captions: (Middle) Box plots of cloud optical depths retrieved from MODIS Terra overpasses in 2007. The whiskers mark the "accepted range", which represents the farthest points that are not outliers. Co-plotted dots represent cloud-mode 1.5-min average cloud optical depths. Cloud-mode retrievals from the overpass 1 (left) and 2 (right) are compared with those from the ARM MFRSR (red) and MWR (blue), assuming a cloud effective radius of 8 μm. The lower and upper limits for MWR values (grey) correspond to a change in droplet effective radius from 6 to 14 μm.

Compare cloud-mode retrievals with those from ARM cloud radar using 3-year data

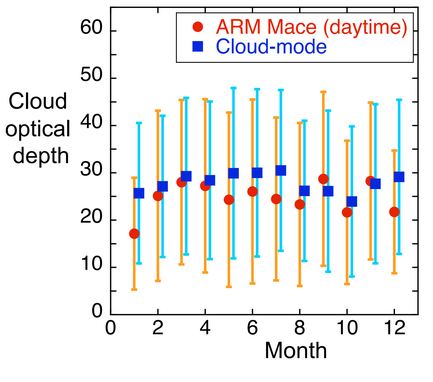
- We use Mace's cloud radar retrievals (available in the ARM Archive) to compare statistics of cloud optical depth retrievals over a three-year period.
- The most frequent cloud optical depth values from cloud-mode are larger than those from Mace's dataset by 5–10 optical depth units (Fig. upper-right).
- Both datasets reveal that non- precipitating cloud occurrence gradually increases from winter to spring, decreases in summer, and increases again in fall (Fig. below).
- A striking result in both datasets is the remarkably small range of monthly-mean optical depth (roughly 20 to 30) across the full annual cycle (Fig. bottom-right).



Captions: Plot of monthly average cloud optical depth with one standard deviation using cloud-mode retrievals and Mace's retrievals.



Captions: Normalized histogram of occurrence for overhead cloudiness at the ARM Oklahoma site. Red bars represent occurrences of Mace's retrievals during years 2002– 2004, while blue bars represent occurrences of cloud-mode retrievals during Nov 2004 – Jun 2008.



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