Relationship Between Cumulus Cloud Fraction and Aerosol Optical Depth: a Five-Year Climatology at the ARM SGP Site

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Operated by Battelle for the U.S. Department of Energy

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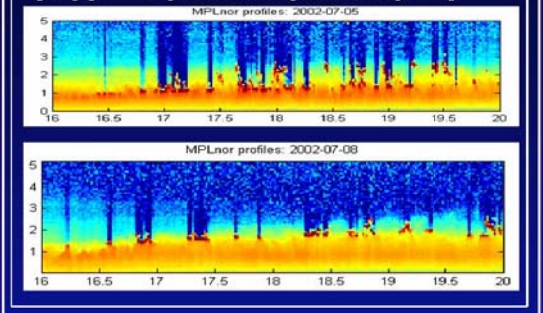
Motivation

- Satellite observations demonstrated positive and systematic correlation between cloud fraction (CF) of liquid water clouds and aerosol optical depth (AOD).
- Drop-size-dependent evaporation rates may be responsible for changes of cloud size and CF.
- Can we observe strong relationship between cumulus CF and AOD from surface observations?
- Does this relationship depend on cloud size?

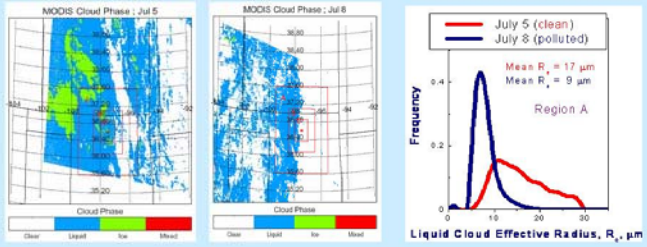
Case Study: MPL images for clean (top) and polluted (bottom) day



Summary

- We developed five-year climatology of fair-weather cumulus macrophysical (*Berg and Kassianov*, 2007) and aerosol optical properties.
- Relationship between CF and AOD appear to be time dependent: Positive/neutral (in morning) and negative (afternoon).
- Small and large clouds appear to have opposite response to increase of AOD: Positive (small clouds) and negative/neutral (large clouds).

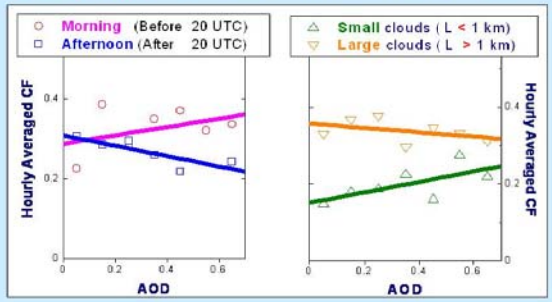
Case Study (5 and 8 July, 2002): Satellite Data



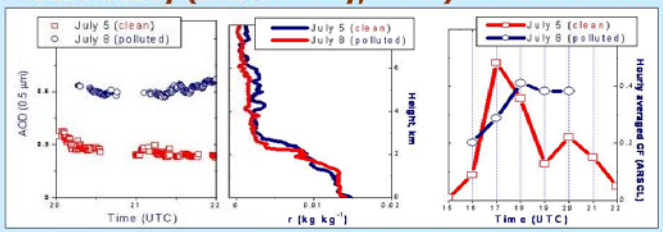
Liquid clouds + cirrus contamination; Polluted clouds have smaller droplets

Five-Year Climatology: 2000-2004

Relationship between **CF** and **AOD** as function of **time of day** (left) and **horizontal cloud size L** (right)



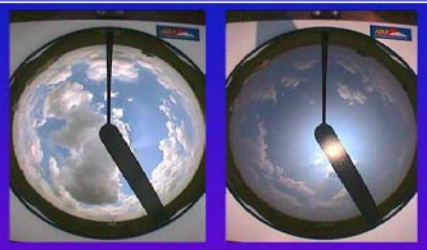
Case Study (5 and 8 July, 2002): Surface Data



Difference between AOD (thermodynamical properties) is large (small)
Clouds fade away afternoon on July 8 (polluted day)

Measurements

- Cloud properties come from the ARM Active Remotely Sensed Clouds Locations (ARSCL) value-added product (VAP).
- Aerosol and thermodynamical properties are obtained from Aerosol Observing System (AOS)/ MFRSR and SMOS, respectively.
- Surface measurements are accompanied by satellite (MODIS) observations.



Case Study: TSI images for clean (left) and polluted (right) day

Approach

- Collect data during 5 summers: 2000-2004 (single cloud layer, relatively non-absorbing aerosols)
- Develop climatology of fair-weather cumulus and combine it with available AOD dataset.
- Select a few days with similar thermodynamical properties and different AOD (e.g., 5 and 8 July, 2002).
- Perform statistical analysis.

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Reference: Berg and Kassianov, 2007: Temporal Variability of Fair-Weather Cloud Statistics at the ARM SGP Site, *J. Climate*, (in review).

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