A 5-year Statistics of Aerosol and Fair-Weather Cumulus at ARM SGP

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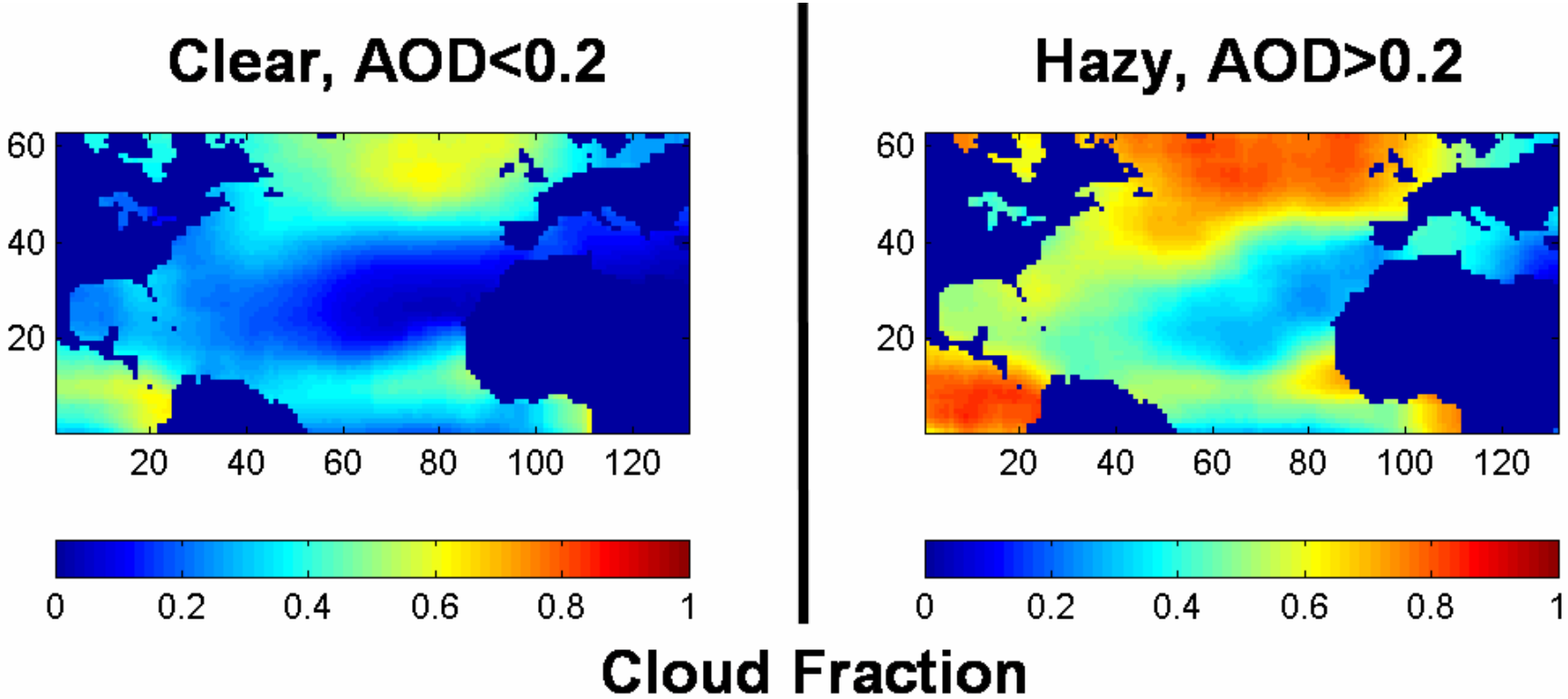
Outline

- Motivation
- Approach
- Aerosol & Cumulus Properties
- Preliminary Conclusions
- Future Activities

Motivation



- Increase in CF is associated with increase of AOD

Koren et al., 2005: *Aerosol invigoration and restructuring of Atlantic convective clouds*, JGR

Motivation

- **Satellite** Observations: Systematic strong relationship between convective clouds and pollution

- Can we observe such relationship from **surface** observations?

Approach

- Use long-term ARM data at SGP summers: 2000-2004
- Derive statistics of fair weather **cumulus** (macrophysics) and **aerosol** (optics).
- Examine relationship between **cloud** (e.g., CF) and **aerosol** (e.g., SSA) properties.

CF – *cloud fraction*
SSA – *single-scattering albedo*

Aerosol and Cloud Properties

Aerosol: AOS, MFRSR

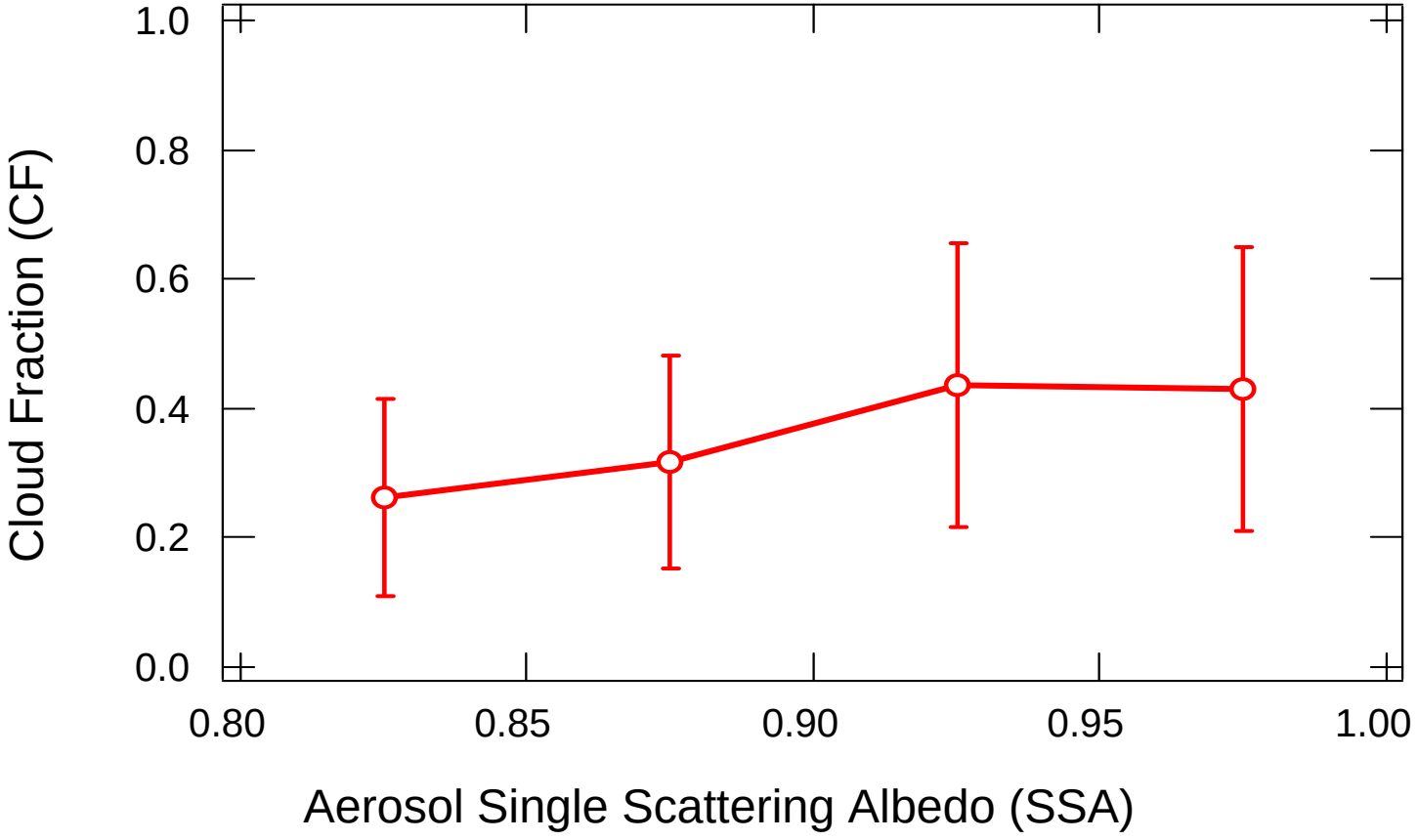
Clouds: ARSCL

TSI (Visual inspection):

- Absence of large-scale cloud system
- Predominate occurrence of cumuli

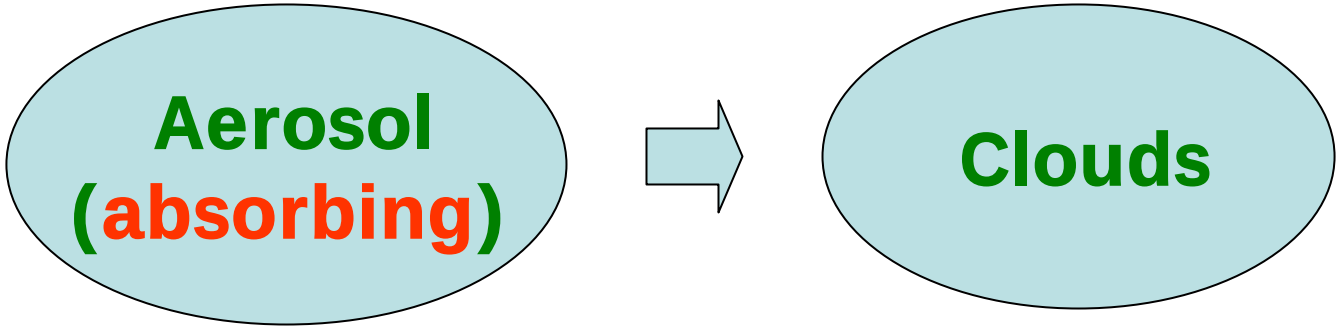
Meteorology: SMOS

Cloud Fraction vs Aerosol SSA



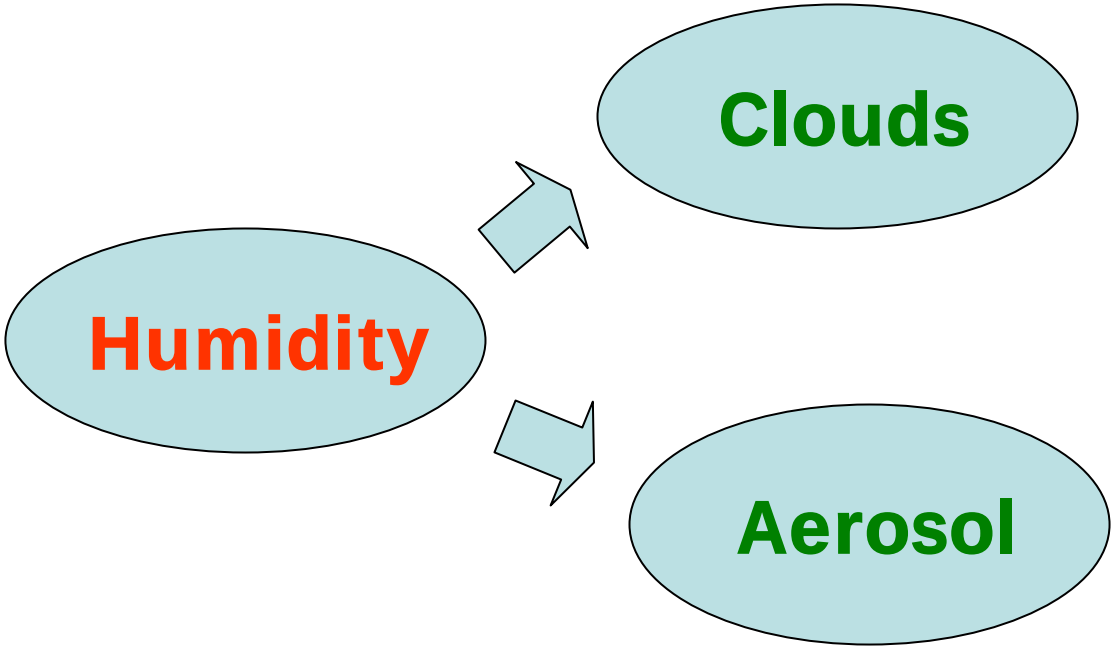
- Wide variations of **CF** for a given **SSA**
- **CF** increases strongly with increase of **SSA**

CF & SSA: Model 1



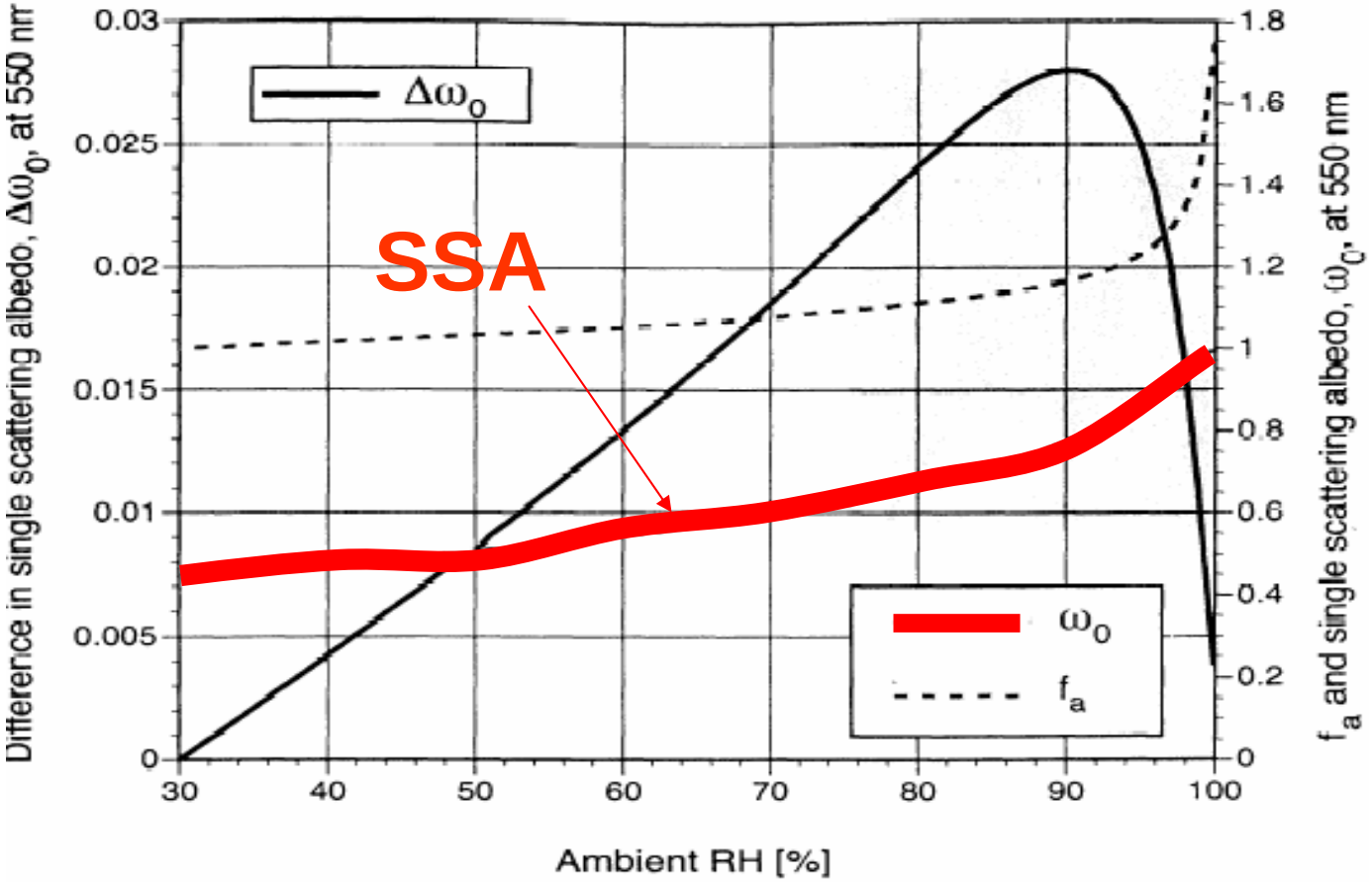
- **Aerosols** (SSA<1) absorb sunlight and stabilize low atmosphere
- **CF** increases as **SSA** increases

CF vs SSA: Model 2



Humidity can affect substantially both **cloud** and **aerosol** properties

SSA vs Ambient RH



- **SSA** increases as **RH** increases

Redemann, Russell and Hamill, 2001: Dependence of aerosol light scattering and SSA on ambient RH for sulfate aerosols with black carbon cores, JGR

Clouds vs Humidity

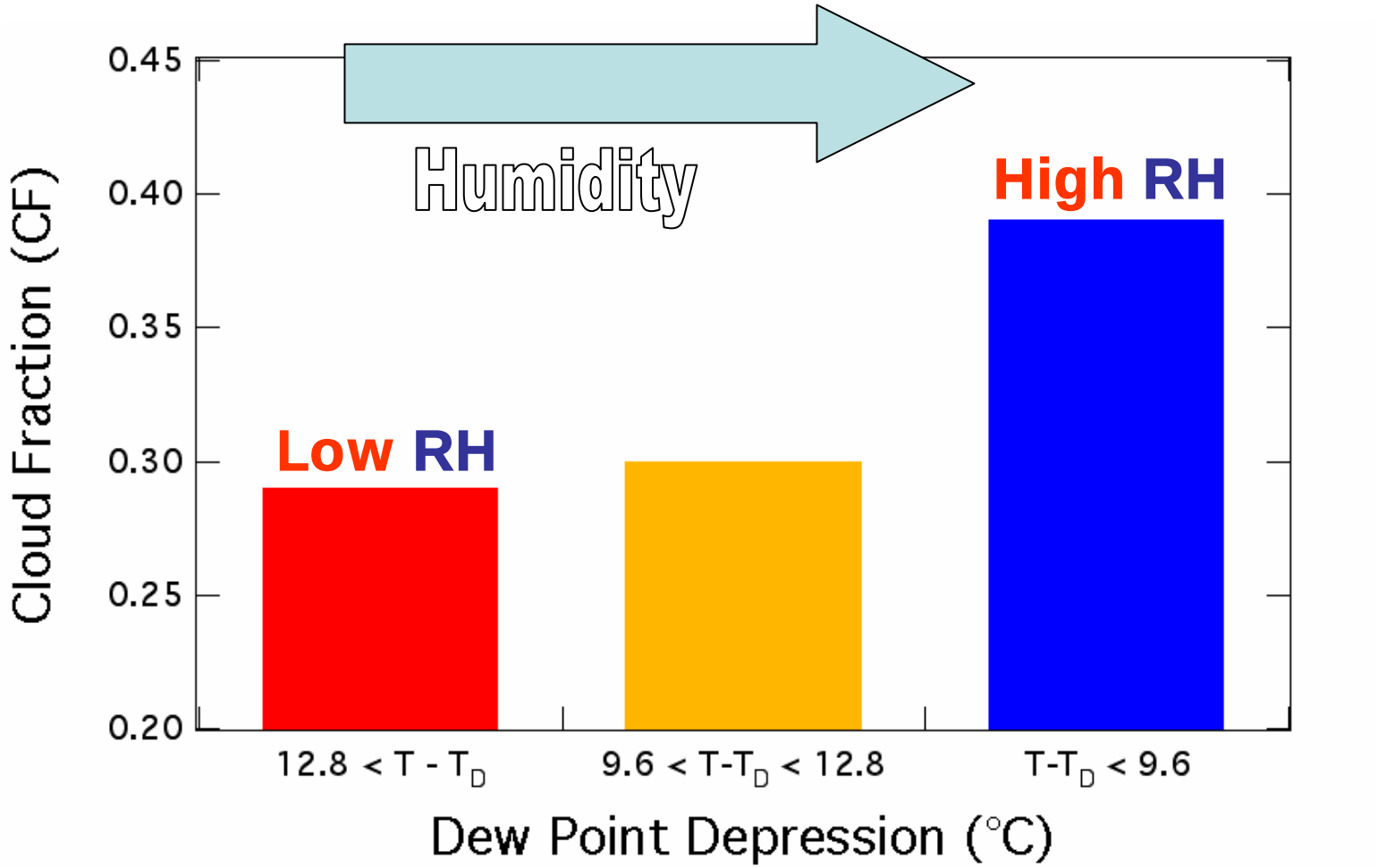
- Boundary layer is well mixed
- Clouds *are strongly coupled* to **humidity** and **temperature** of air near the surface

- Dew point depression: T-Td ~ RH

  T - air temperature

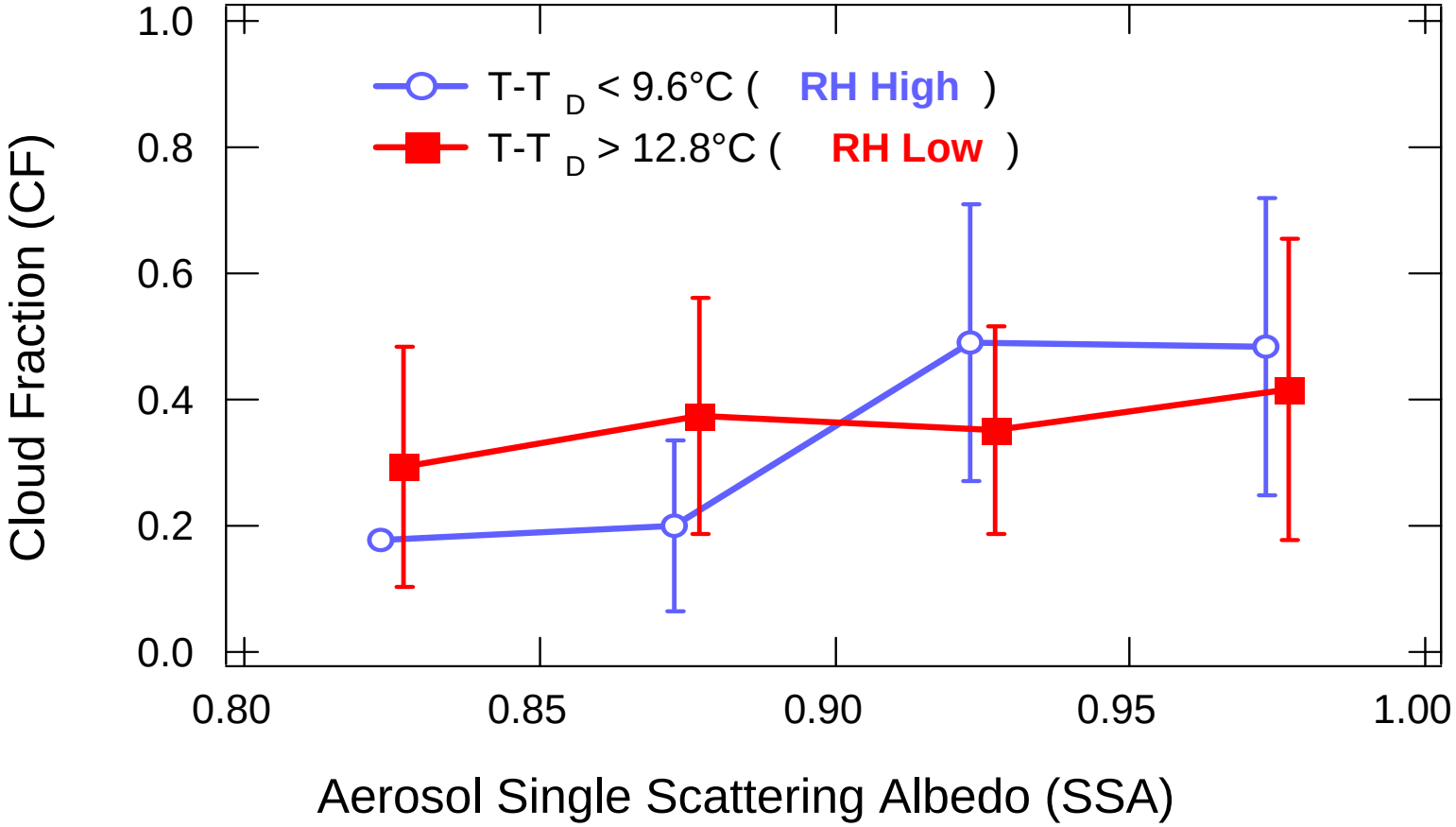
  Td - dew point

CF vs Dew Point Depression



- **CF** increases as **RH** increases

Cloud Fraction vs Aerosol SSA



- **Low RH**: weak relationship between **CF** and **SSA**
- **High RH**: strong relationship between **CF** and **SSA**

Preliminary Conclusions

- **Strong relationship** between **aerosol** properties and **CF** can be associated with *meteorological* influences (e.g., **humidity** and temperature).
- **Aerosol** and **cloud** measurements should be accompanied by **meteorological** ones.
- **Large variability** of **CF** suggests that *long-term* datasets of **aerosol** and **clouds** properties are appropriate to study their relationships.

Future Activities

- Repeat this study for hemispherical **CF** (from TSI data or SW analysis) and other macrophysical **cloud** properties (e.g., cloud top height).

- Examine effect of **aerosol vertical distribution** and **aerosol type** (SGP vs TWP sites) on **cloud** properties.

- Perform related **model** simulations.

Thanks!