Aerosol remote sensing under *partly* cloudy conditions: How well are we doing?

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Background

- **Ground-based/airborne lidar** observations:

  Raman Lidar (*RL*), *Micropulse Lidar* (*MPL*)
  High Spectral Resolution Lidar (***HSRL***)

- Can they be extended by **other** observations?

Outline

- Q1: **Why** it is important?
- Q2: **What** issues do we have?
- Q3: **How** can we address them?

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Q1: IAE and Aerosol RF

Simultaneous and **coincident** measurements of ***aerosol*** and ***cloud*** properties are desirable:

- Indirect Aerosol Effects (IAEs)
- Aerosol Radiative Forcing (RF)

Ghan and Schwartz, BAMS, 2007

Myhre et al., ACP, 2009

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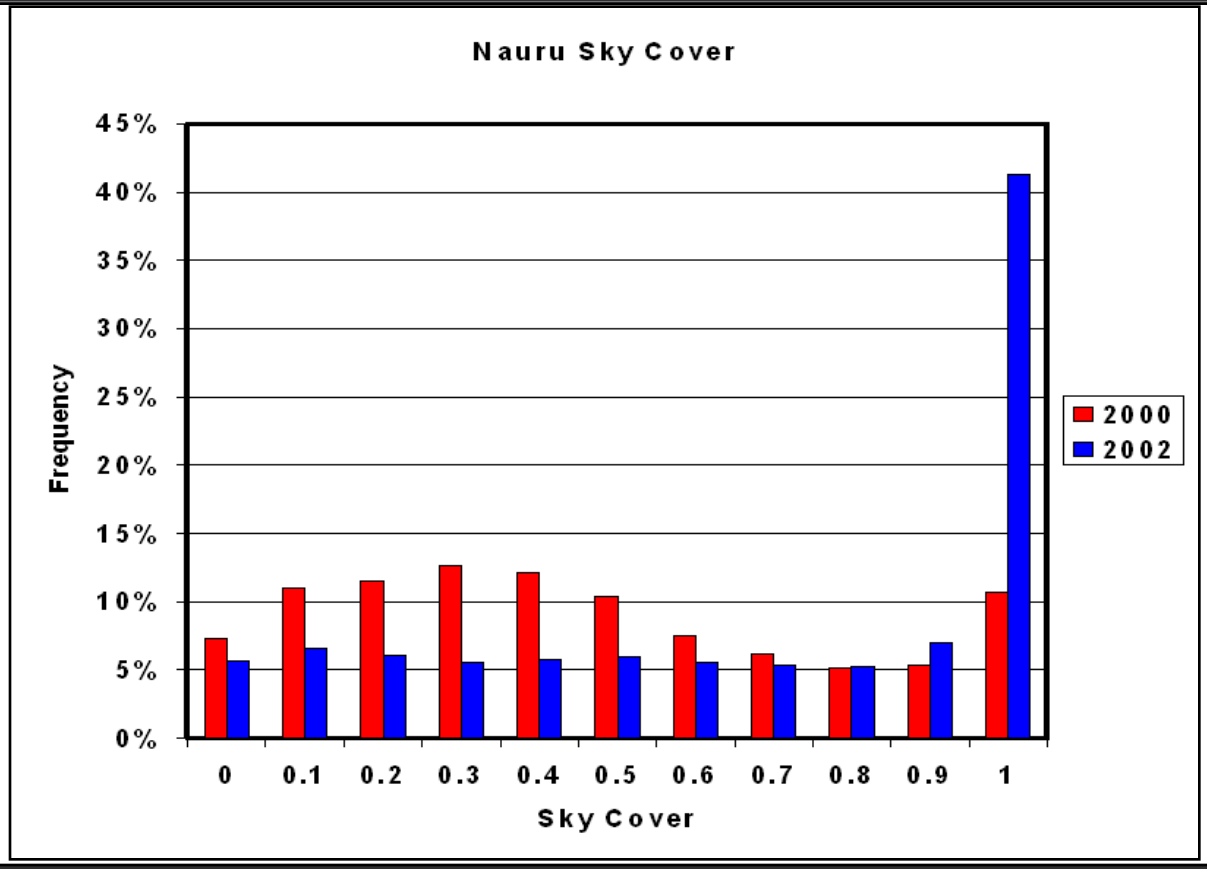
Q1: Occurrence



✓Partly cloudy sky: **30**% (SGP), **40-80**% (TWP)

Credit: C. Long

Q2: 3D Problem

Examples of **3D Cloud** Impacts:

- ***Positive*** Cloud Radiative Forcing (RF)
- Reflectance ***Enhancement***
- ***Cloud*** Screening

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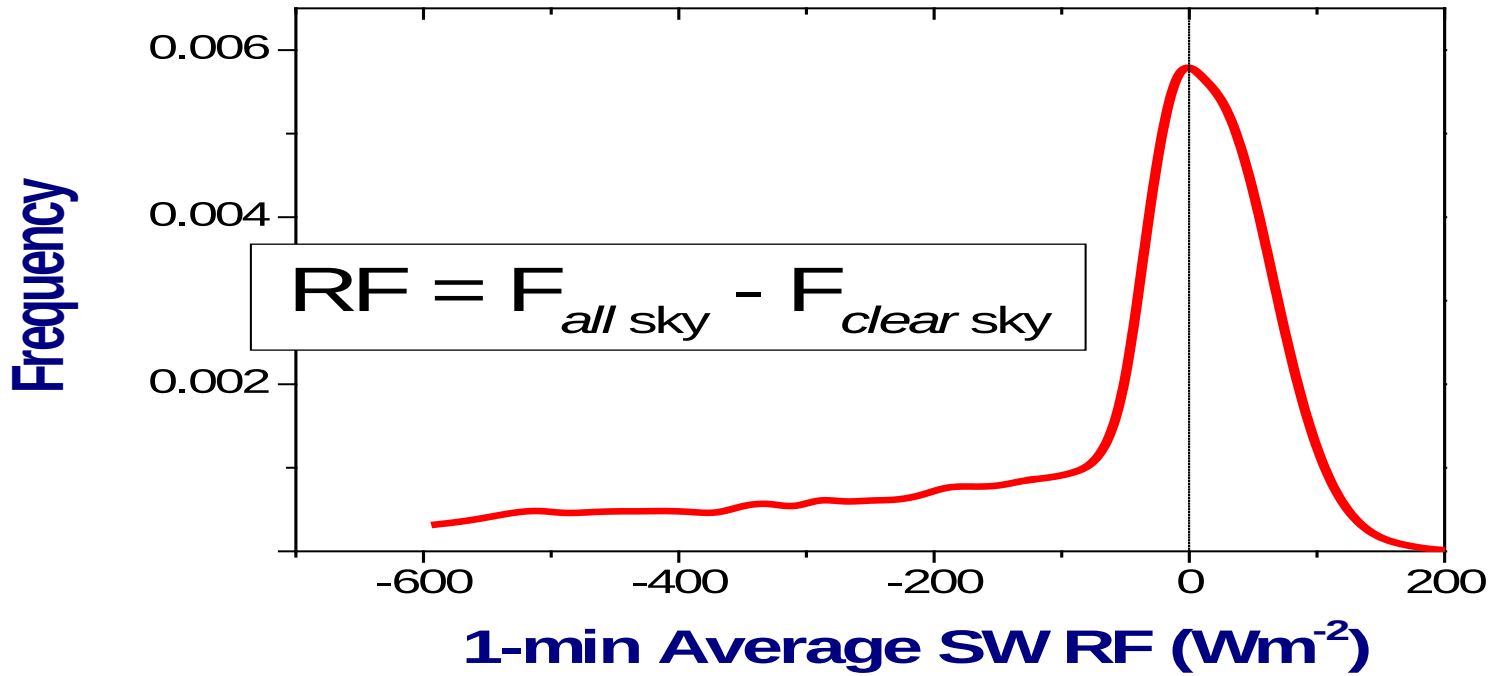
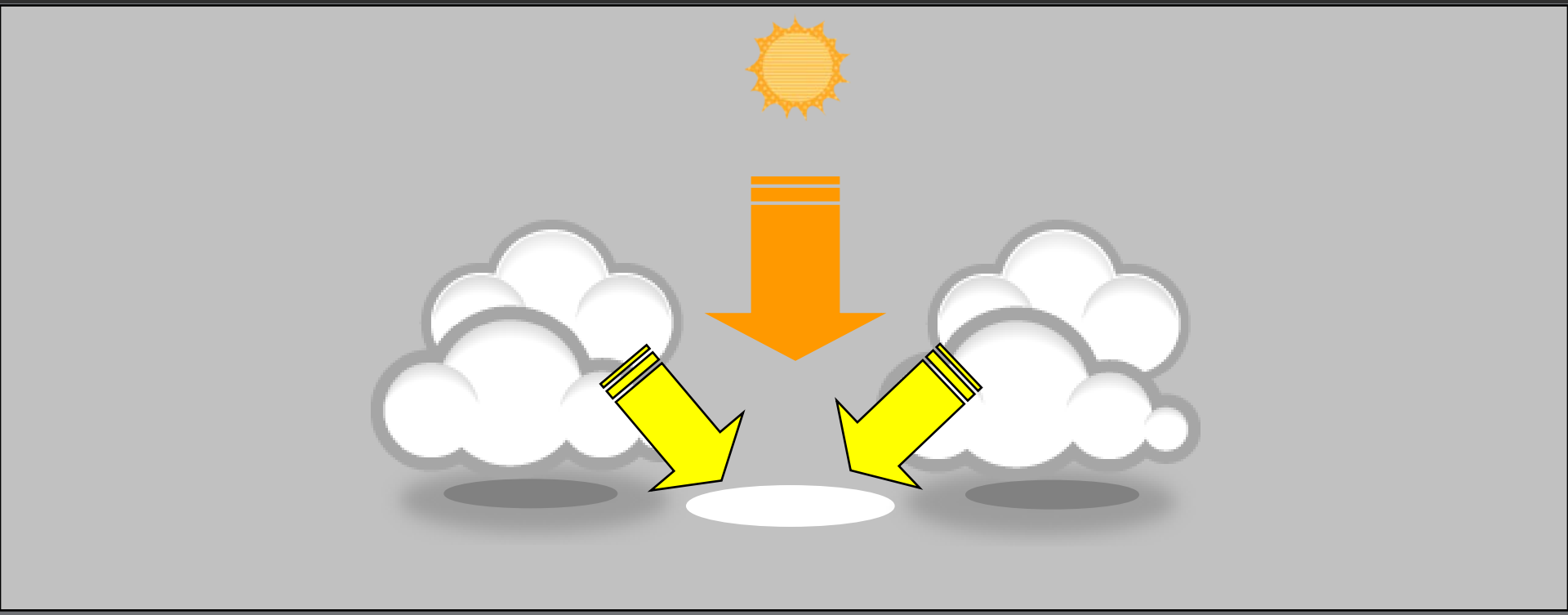
Q2: Positive Cloud RF



- ✓ # of cases with ***positive*** RF is **large**
- ✓ RF peaks at about **200** Wm^{-2}

Credit: Berg et al. (Poster **B8**)

Q2: Positive Cloud RF

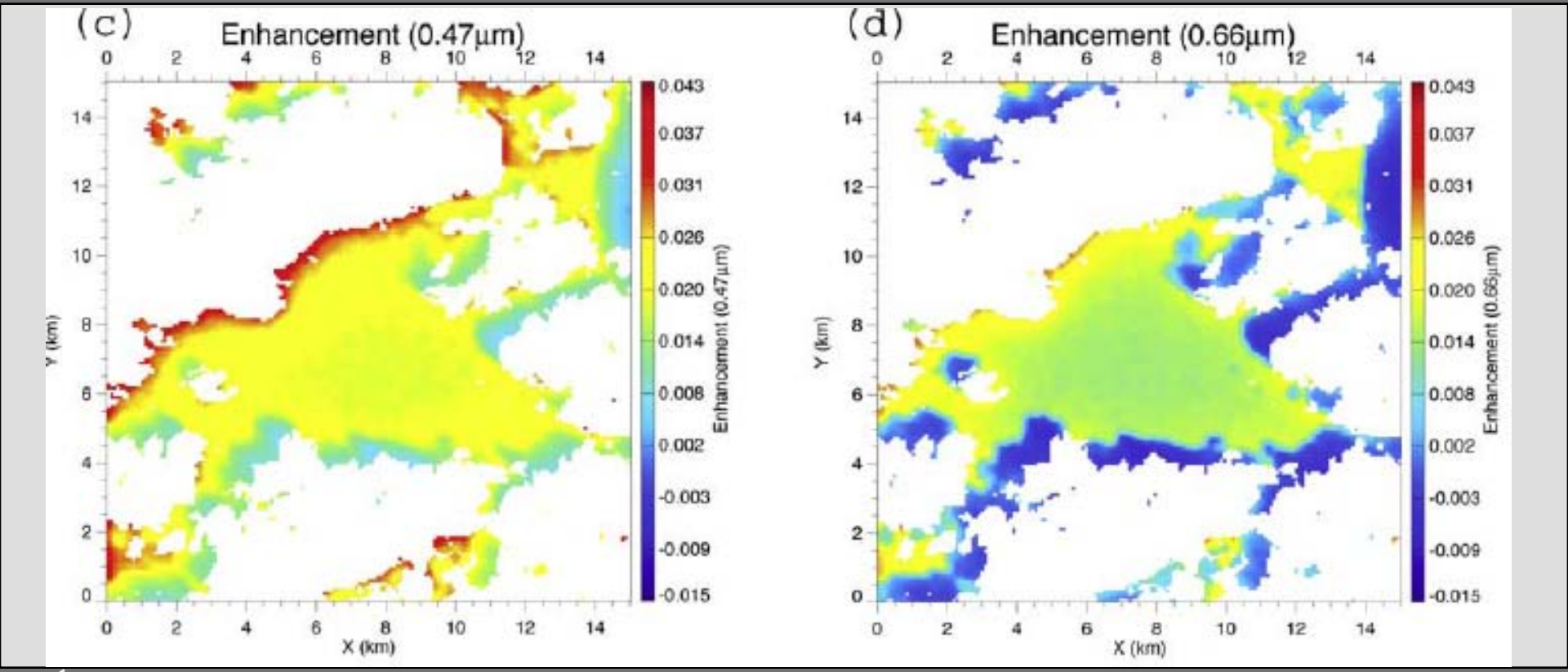


Total = Direct + Diffuse

✓ Direct (**all** sky) = Direct (**clear** sky)

✓ Diffuse (**all** sky) > Diffuse (**clear** sky)

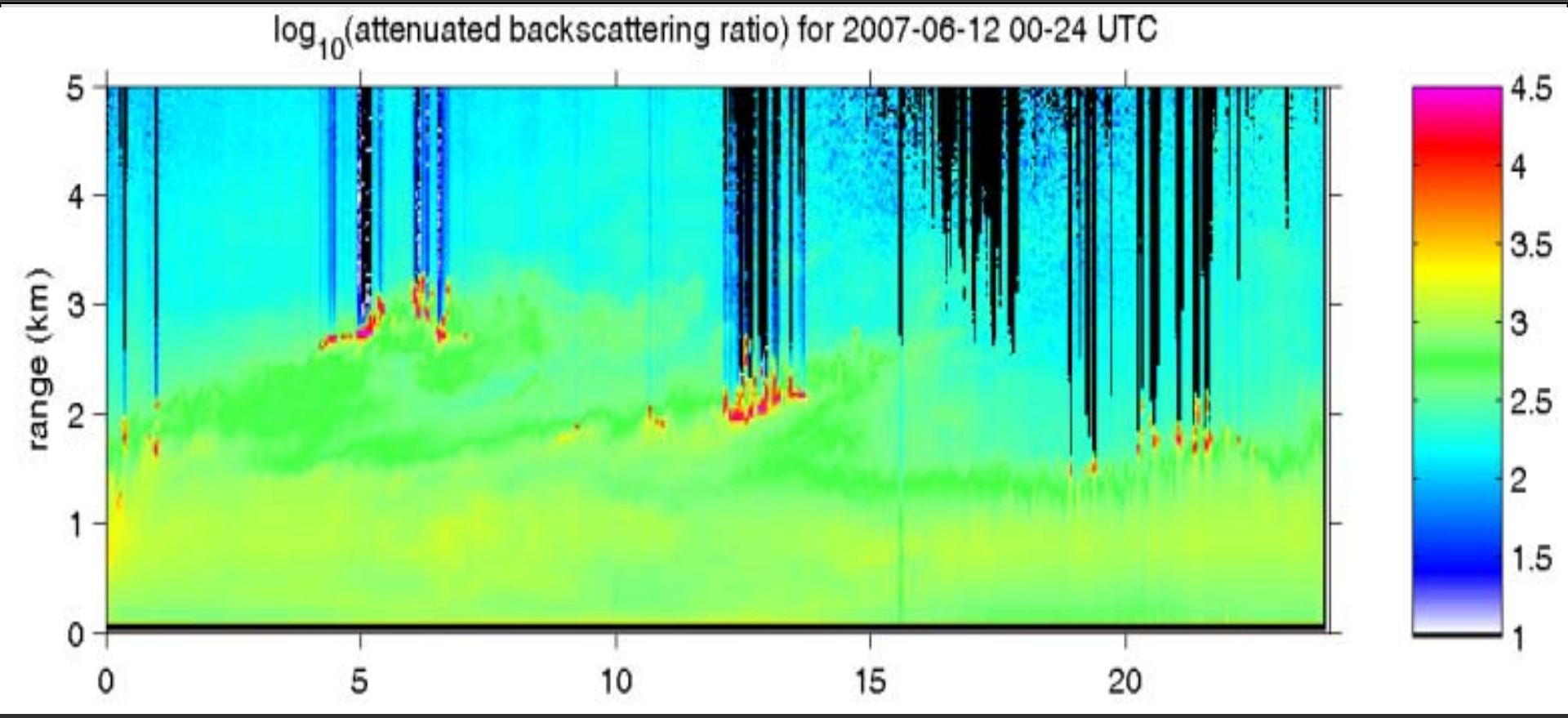
Q2: Reflectance Enhancement



- ✓ Enhancement (**3D-1D**) depends on cloud properties
- ✓ Associated errors in retrieved AOD (up to 140%)

Credit: Wen et al., JGR, 2007

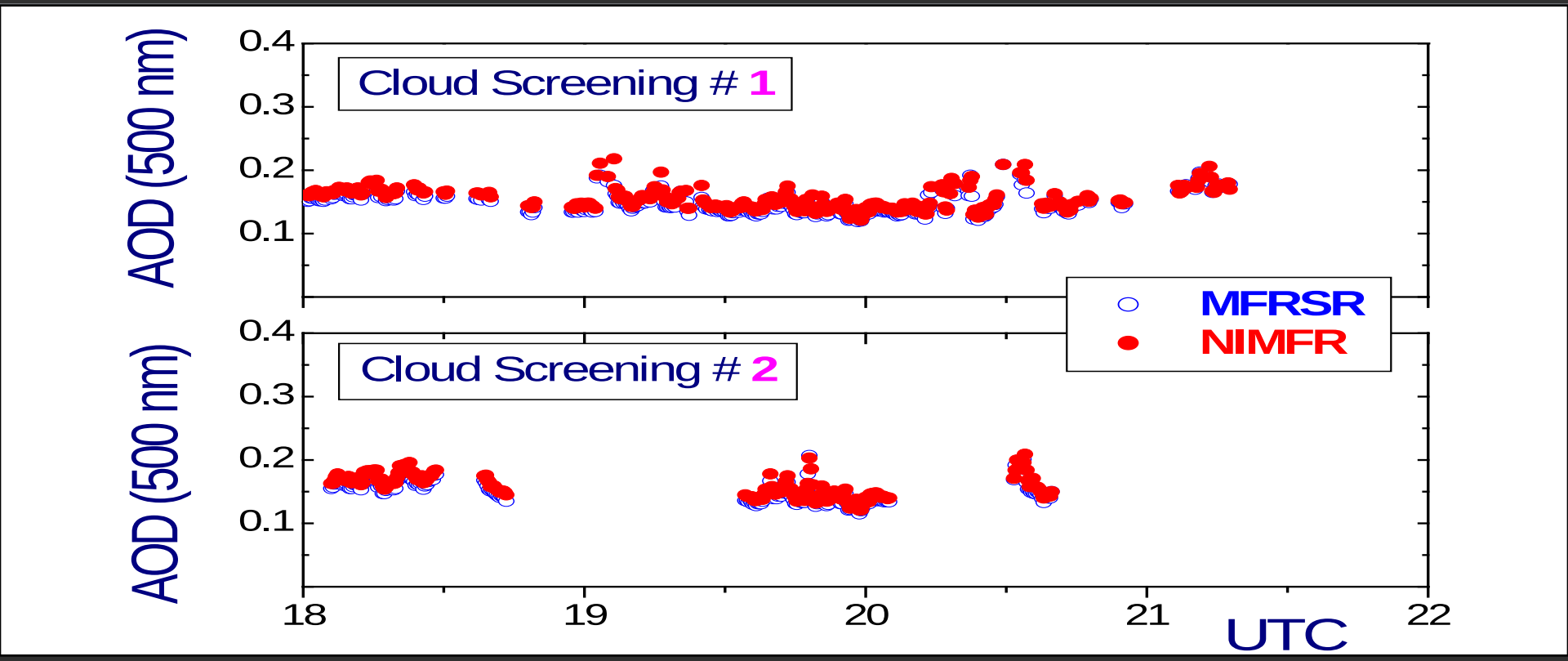
Q2: Cloud Screening



✓ June 12, 2007: Scattered cumulus clouds

Credit: C. Flynn

Q2: Cloud Screening



- ✓ Cloud screening (CS) is **subjective**
- ✓ **# of points** with retrieved AOD depends on CS

Credit: C. Flynn

Q3: Cloud Screening

- CS analyzes **variability** of irradiance (*direct* component)
- Variability is related to **cloud** properties (vertical and horizontal changes)
- Incorporating **cloud** information into CS (e.g., **cloud field type**) *could improve* its performance

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Q3: Enhancement + Diffuse

- Aerosol remote sensing also examines **diffuse** radiation (surface, TOA,…)
- Diffuse radiation depends on **cloud** properties (**3D** cloud effects)
- These **3D** cloud effects can be *parameterized* [1] or *reduced* [2]

[1] *Marshak et al., JGR, 2008*

[2] *Kassianov et al., JQSRT, 2009*

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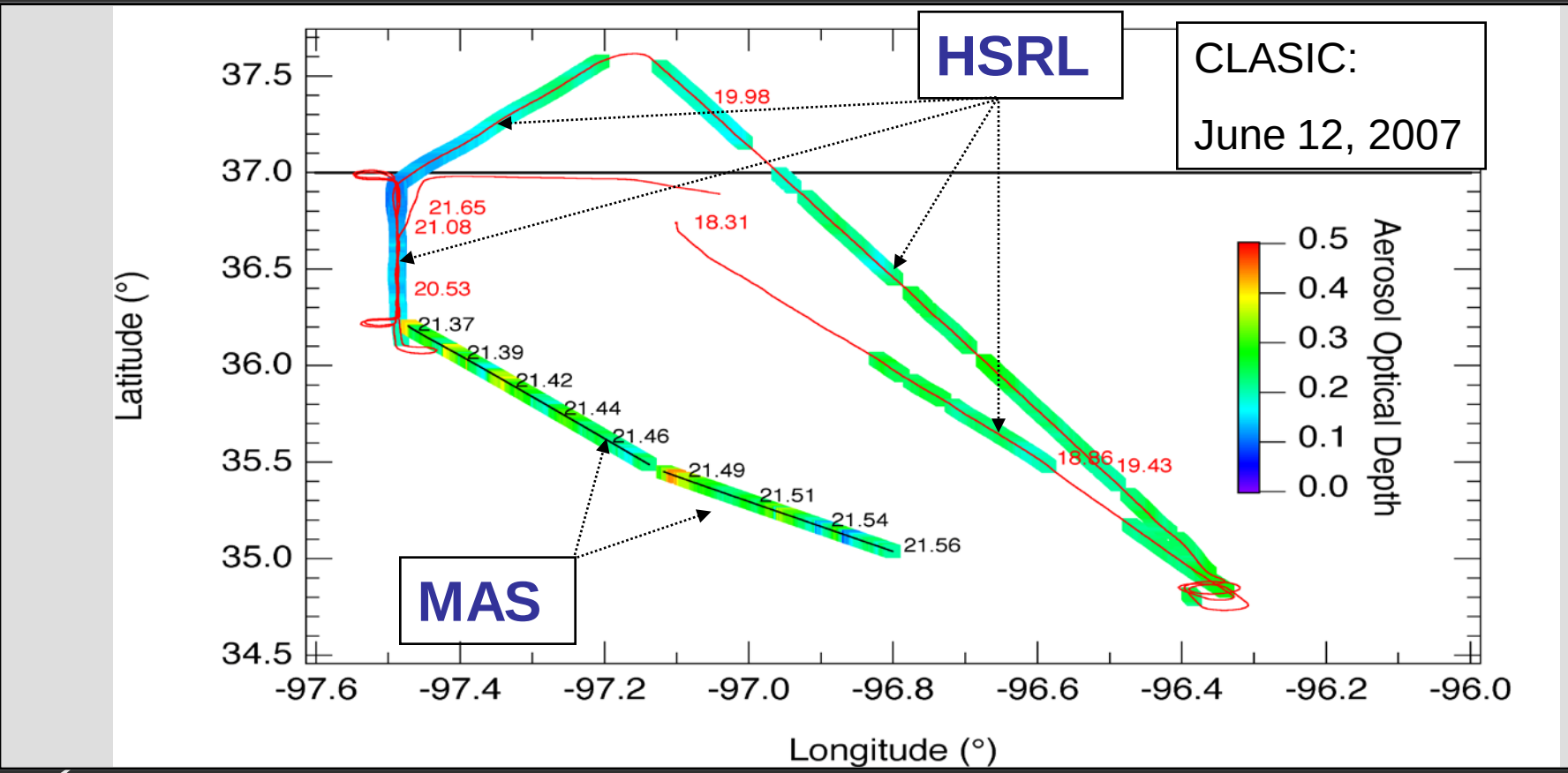
Q3: Diffuse (Example)



✓ On the average, AOD values derived from MODIS Airborne Simulator (MAS) and **HSRL** are **comparable**

Credit: Kassianov et al. (Poster G11)

Q3: Spectral & Angular Info

- **Spectral** information:

  MFRSR + **1.6 μm** (*Alexandrov*)

  UV-MFRSR (*Michalsky +Kiedron*)

  MFRSR + **AERI** (*Turner*)

- **Angular** + **Spectral** information:

  AERONET (*Holben*)

  Thin-Cloud Rotating Shadowband Radiometer (*Min*)

  4-STAR (*Schmid + Flynn*)

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Summary

- ✓ *Spatial*, *spectral* and *angular* variability of **radiation** can be used to improve our understanding of **aerosol** and **cloud** properties and their relationship.
- ✓ **Aerosol** and **cloud** properties obtained from *coincident* and *collocated* observations would be beneficial for **model** evaluations.

Thanks!

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