Aerosol Optical and Microphysical Properties from Passive Remote Sensing during CARES: Temporal and Spatial Changes

E. Kassianov, J. Barnard, M. Pekour, C.Flynn

Pacific Northwest National Laboratory

R. Ferrare, C.Hostetler, J.Hair

NASA Langley Research Center

T. Jobson

Washington State University

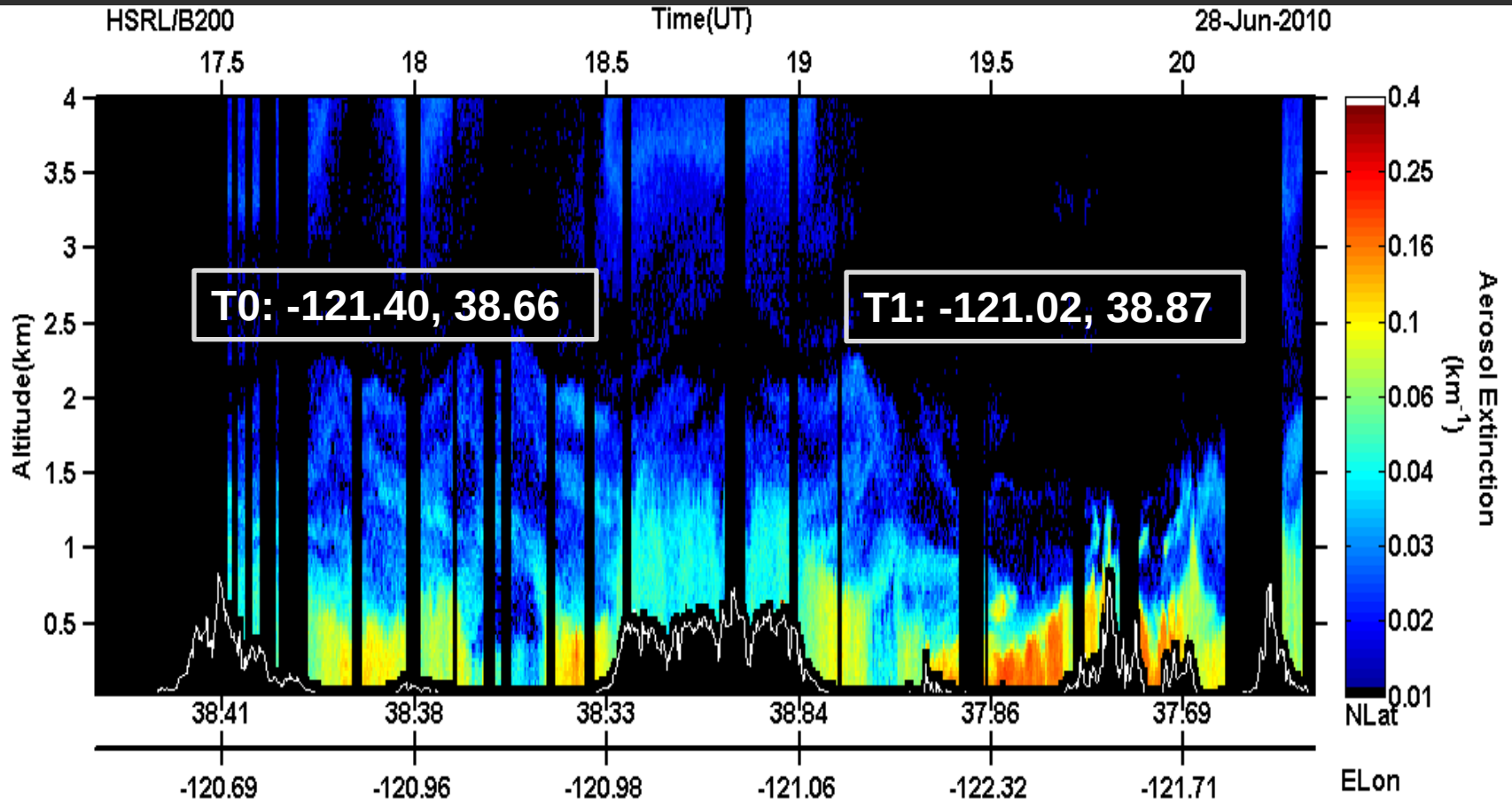
Pacific Northwest
NATIONAL LABORATORY

Outline

- Q1: **How large** are variations of aerosol **optical/radiative** properties?
- Q2: **How large** is contribution of **coarse mode** to these properties?

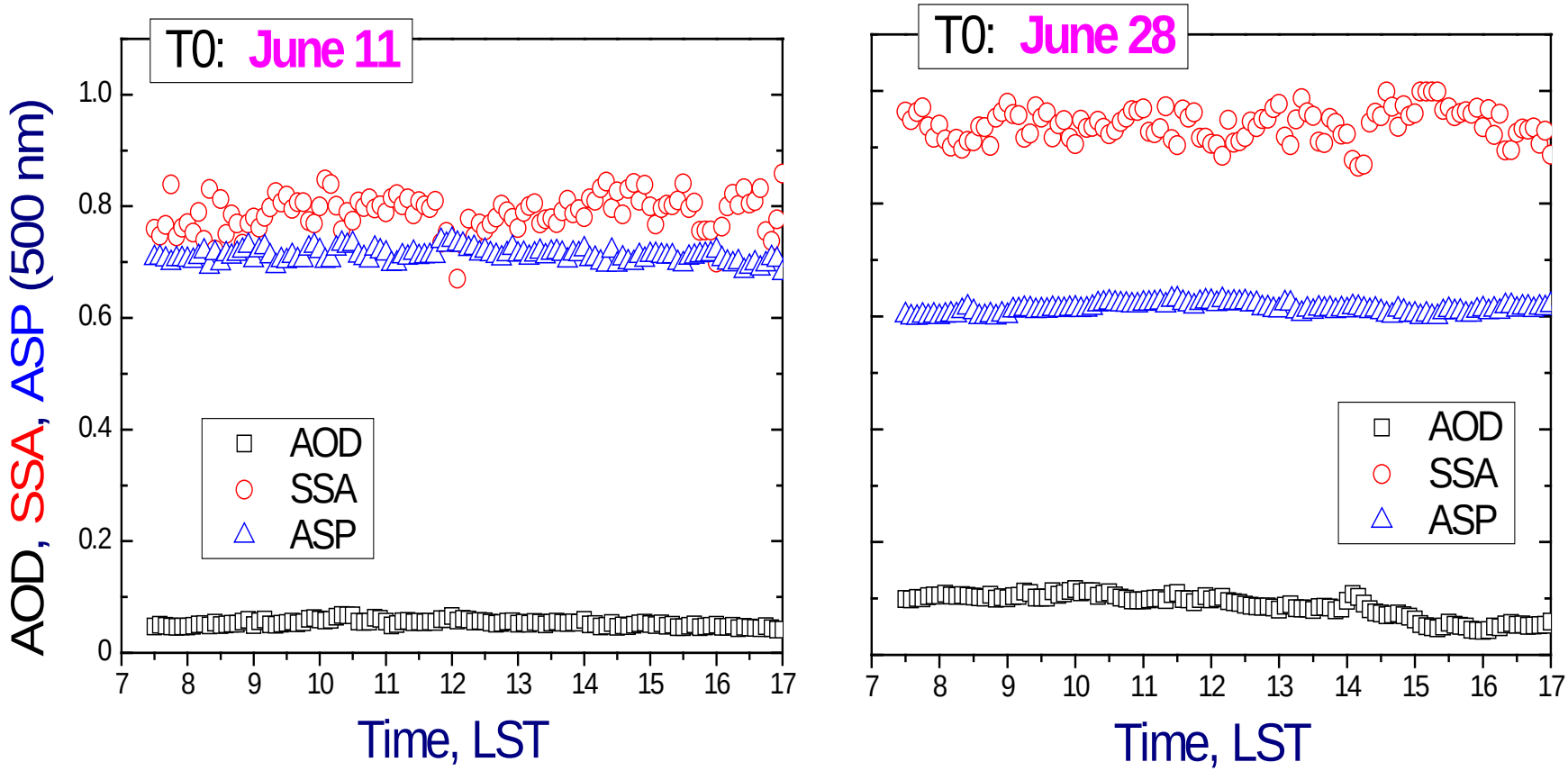
Pacific Northwest
NATIONAL LABORATORY

Q1: Vertical Variations



✓**Vertical**/**horizontal** changes of HSRL-based aerosol extinction are **substantial**

Q1: MFRSR Retrievals



✓ **Large** **diurnal** and **day-to-day** variations:
Daily-averaged **AOD** (**0.05-0.15**) and **SSA** (**0.80-0.98**)

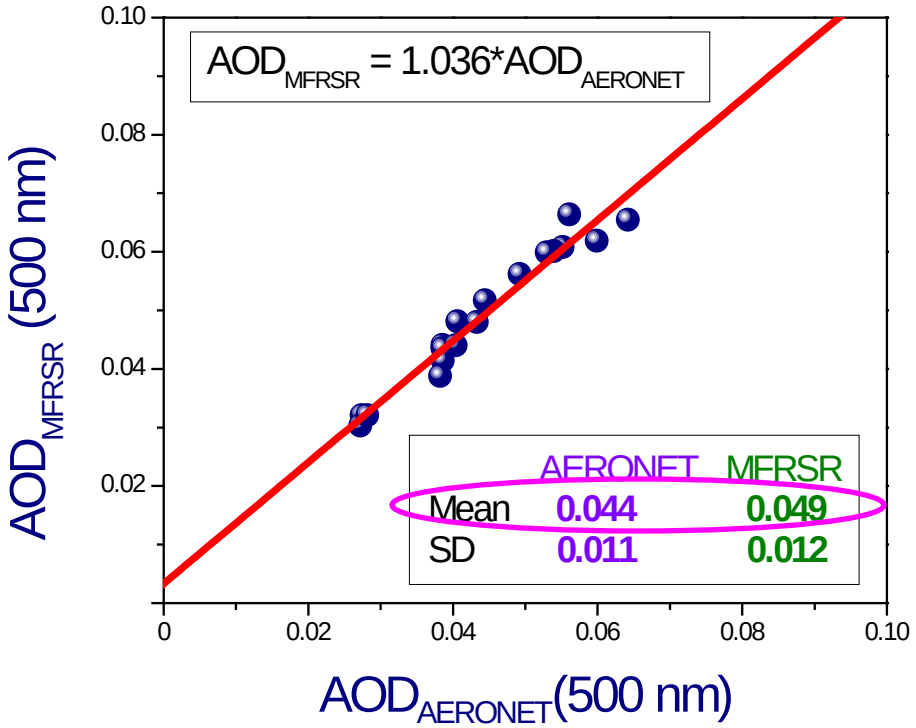
Q1: Evaluation

- **AERONET (level 2.0)**
- **Radiative Closure**
- **Aerosol Observing System (AOS):**
  - **Particle Soot Absorption Photometer (abs.)**
  - **Nephelometer (scattering)**
  - **Fine (< 1 μm), Total = Fine + Coarse (< 10 μm)**

Pacific Northwest
NATIONAL LABORATORY

Q1: AERONET AODs

AERONET (2.0):
Single Site (T0)
4 Days (June 9-12)
AOD and **Size Dist**.



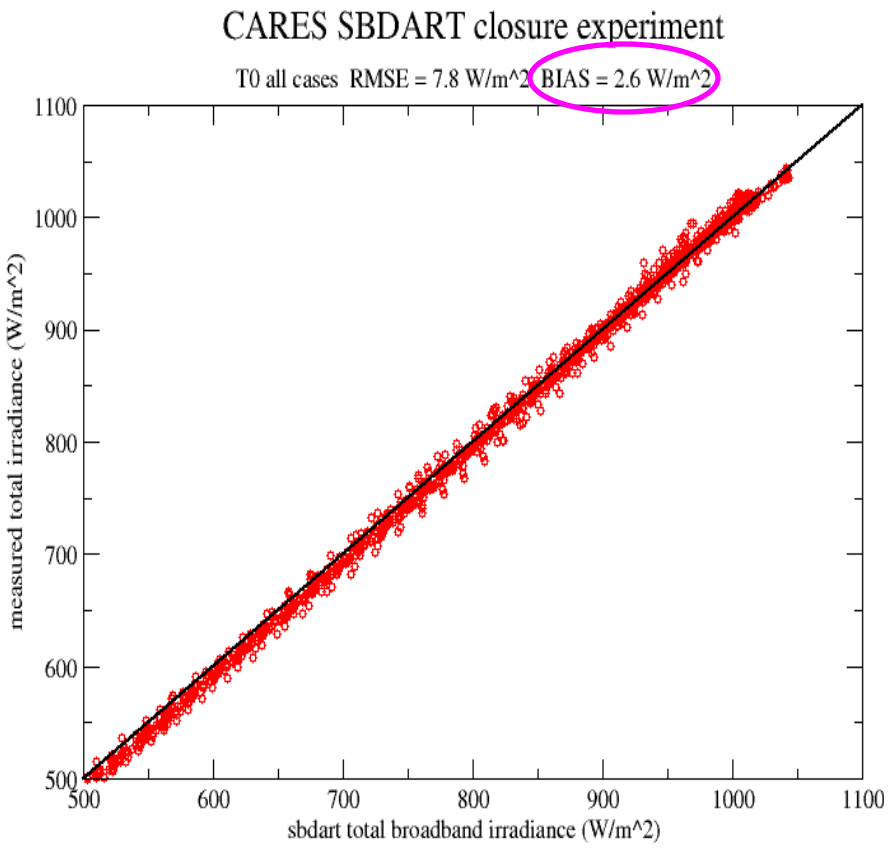
- ✓ **Strong** correlation (**0.97**) between **MFRSR**- and **AERONET**-based **AODs**
- ✓ Difference between **MFRSR**- and **AERONET**-based **AODs** is within uncertainties (**0.01**)

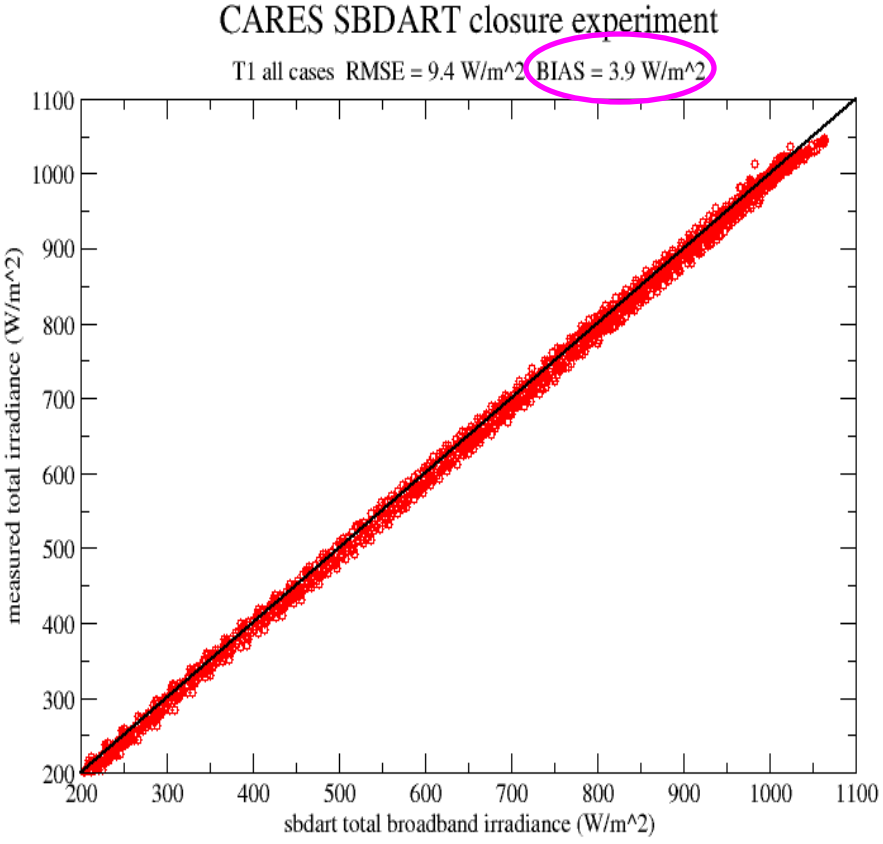
Q1: Radiative Closure

- Apply **estimated** aerosol properties as input for **RT** model
- Calculate surface broadband fluxes
- Compare **calculated** and **observed** fluxes

Pacific Northwest
NATIONAL LABORATORY

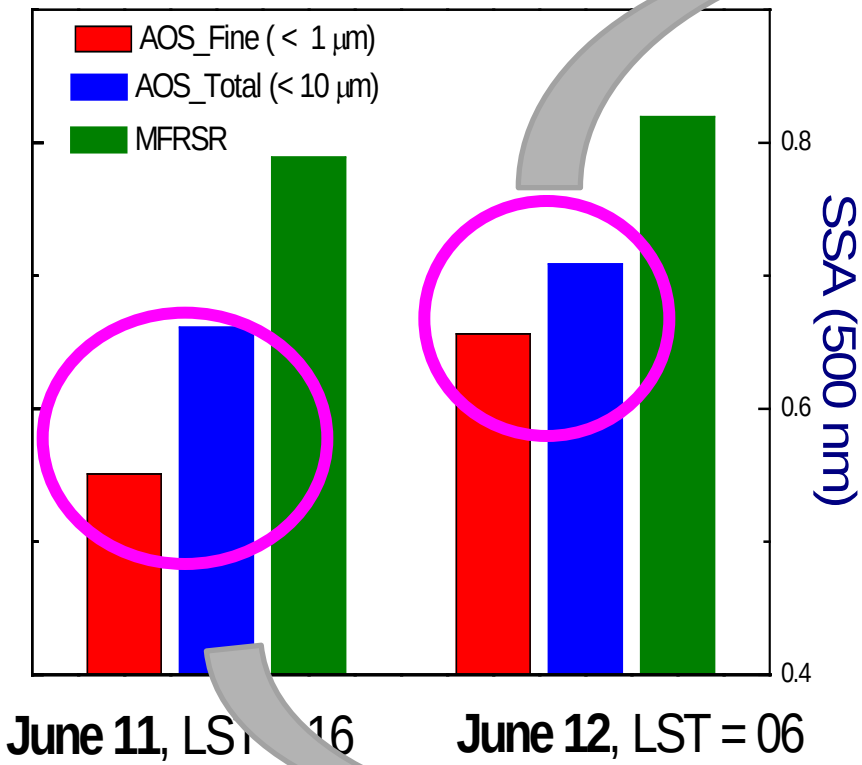
Q1: Radiative Closure

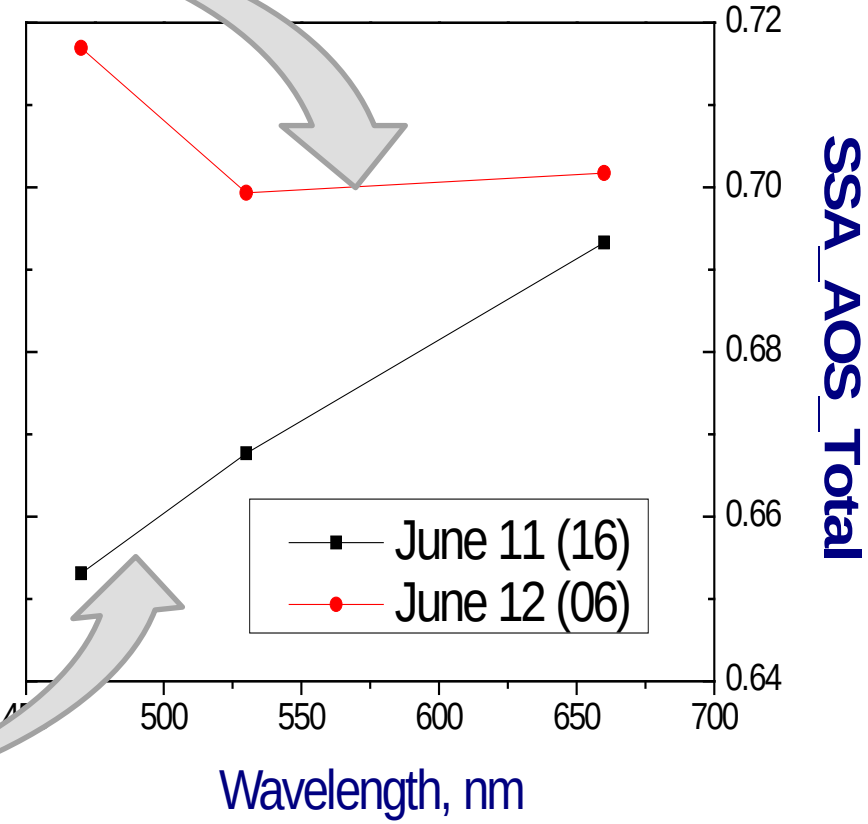




- ✓ Fluxes (direct + diffuse): **reasonable** agreement
- ✓ MFRSR-derived properties: **not too far off** the mark

Q1: AOS & MFRSR SSA





- ✓ **AOS**: Difference (Fine - Total) can be **large**
- ✓ **SSA**: **Decrease/increase** with wavelength

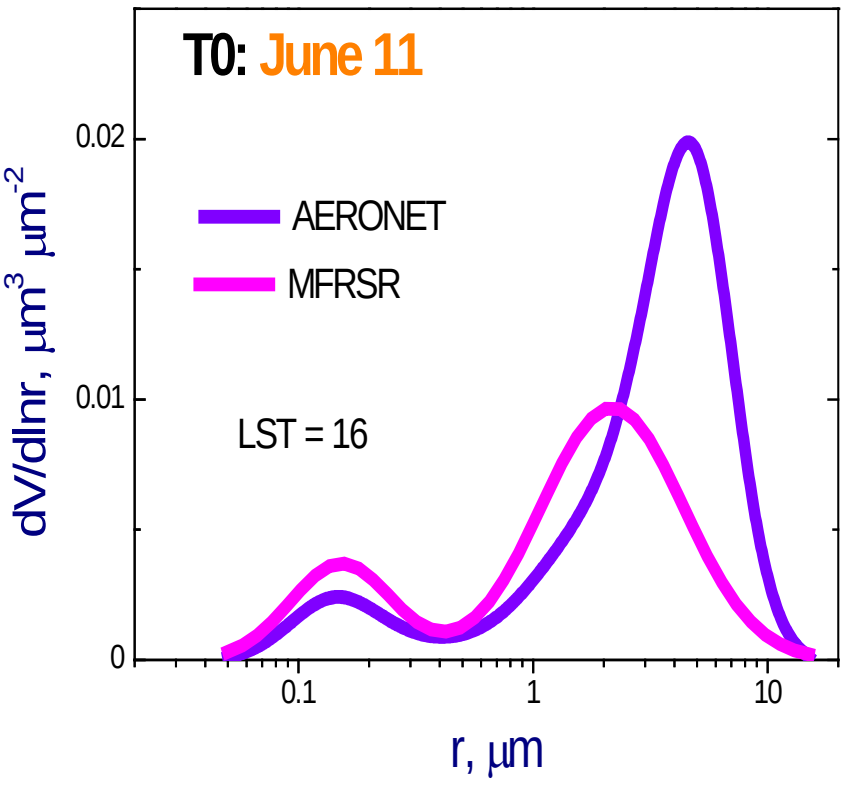
Q2: Coarse Mode

- **Evidence (?!)**
  - MFRSR
  - AERONET (level 2.0)
  - Aerodynamic Particle Sizer (APS): 0.5<D<20μm
- **Importance**
  - Aerosol Direct Radiative Forcing (DRF) at TOA
  - Two cases: Fine & Total

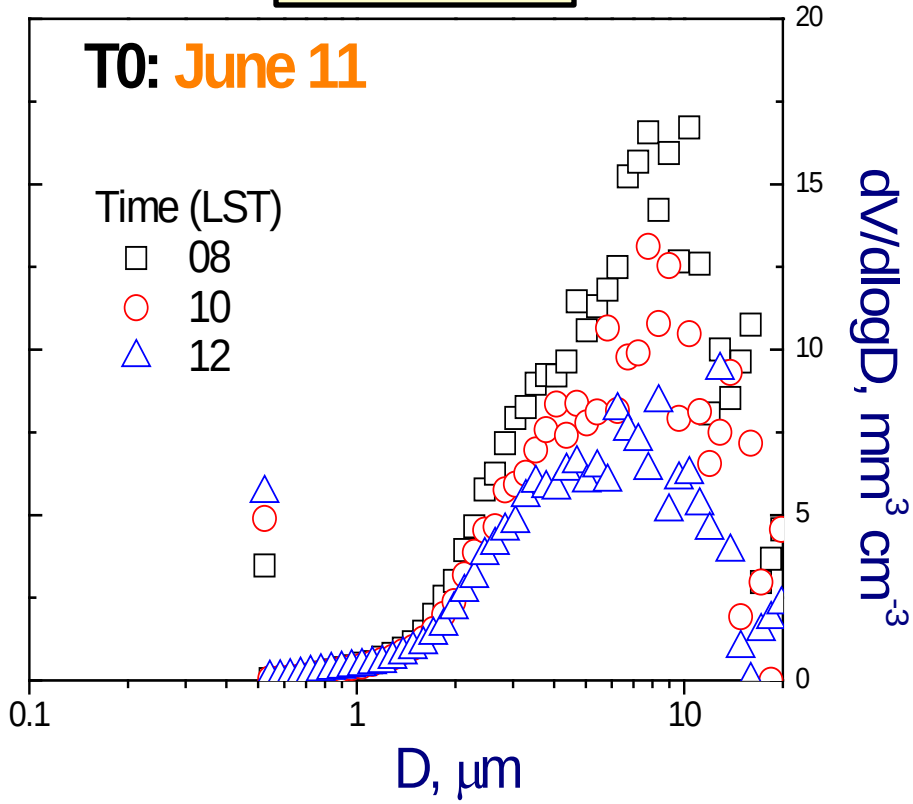
Pacific Northwest
NATIONAL LABORATORY

Q2: Evidence

AERONET & MFRSR



APS



✓**Remote sensing** & **In situ**: Contribution of **coarse** mode to size distributions can be **large**

Q2: Importance

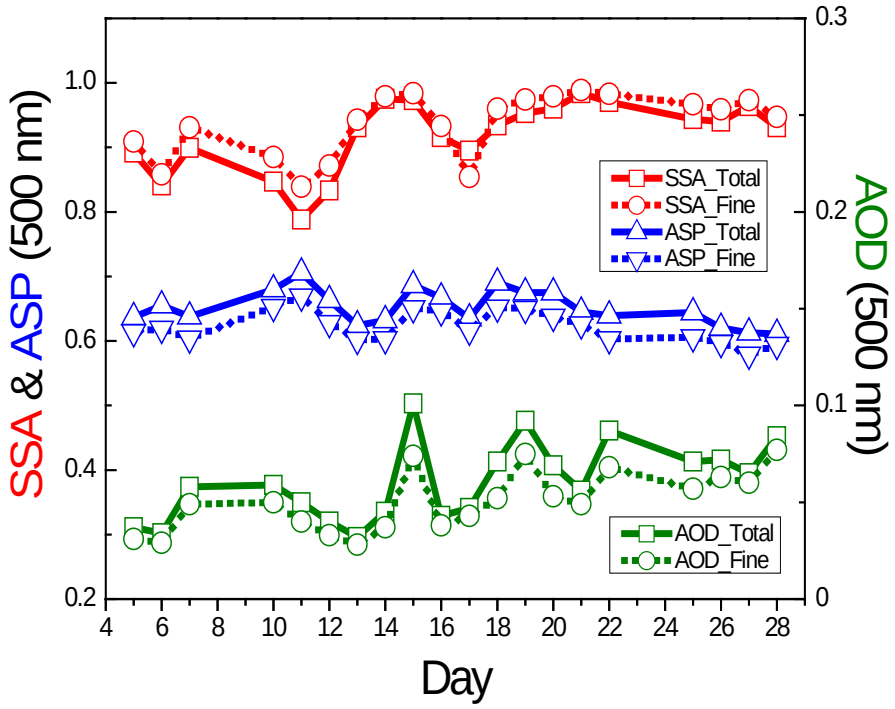
- **Aerosol optical properties** obtained from:
  1. **Single** mode (**Fine**)
  2. **Two** modes (**Fine** + **Coarse** = **Total**)

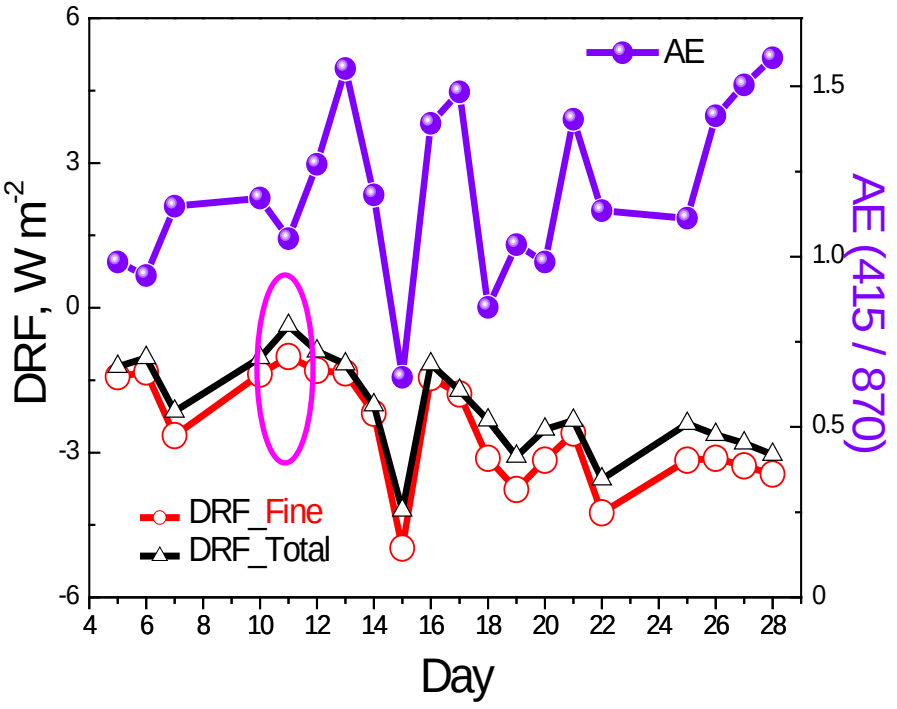
AOD = $\mathbf{AOD}_{\mathrm{MFRSR}}$, **fixed** (both cases)

- Calculate aerosol **DRF** for these two cases.
- Compare the corresponding **DRF**s.

Pacific Northwest
NATIONAL LABORATORY

Q2: Importance





Contribution of **Coarse Mode** can be **large**:

✓ Aerosol **optical** properties (up to **30** %)

✓ Aerosol **DRF** at TOA (> **60%**)

Summary

- Q1: **Diurnal** and **day-to-day** variations of aerosol **optical** and **radiative** properties are **substantial**.
- Q2: **Contribution** of the **coarse mode** to these properties and **DRF** can be **large** (~**20**% over CARES).

Pacific Northwest
NATIONAL LABORATORY

Future Activities

- **Why these variations are substantial?**

  Meteorology, Source(s), … Dust(?!)

- **Can we prove existence of Coarse mode?**

  Additional observations

- **Can we prove importance of Coarse mode?**

  Additional (detailed) simulations/calculations

Pacific Northwest
NATIONAL LABORATORY