Modeling transport of Saharan mineral dust over the Iberian Peninsula: A multi-scheme assessment of size distribution and optical properties

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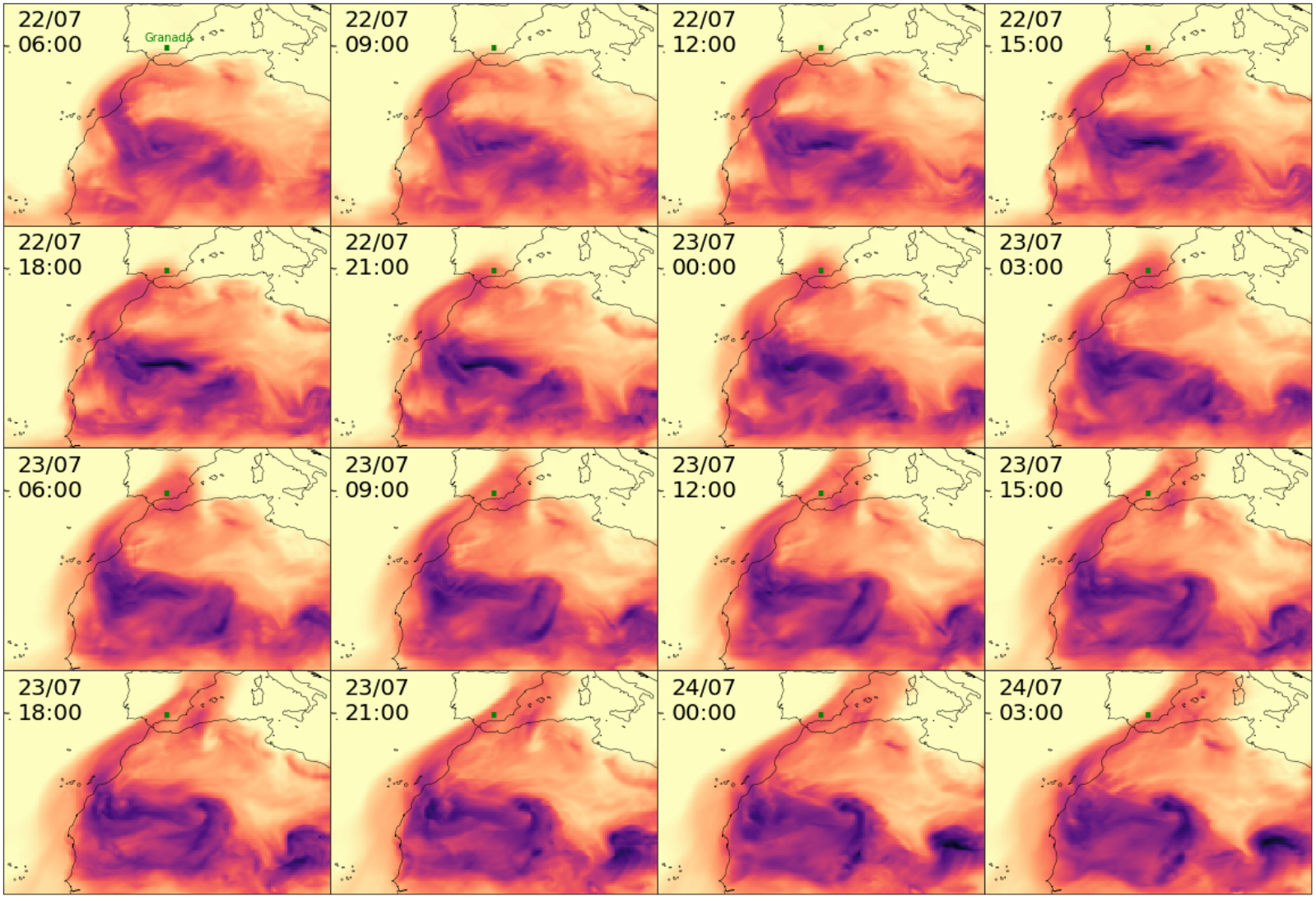
Study context

Objective **Evaluation** of three of the most usual aerosol schemes available in WRF-chem (**GOCART, MOSAIC and MADE**) under a strong **dust outbreak** in the south of the Iberian Peninsula.

How? We divide the task in two steps:

- **Calibration** of the **amount of dust** predicted with respect to AERONET inversion data;
- **Intercomparison** of **AOD** outputs against two AERONET stations.

Study context

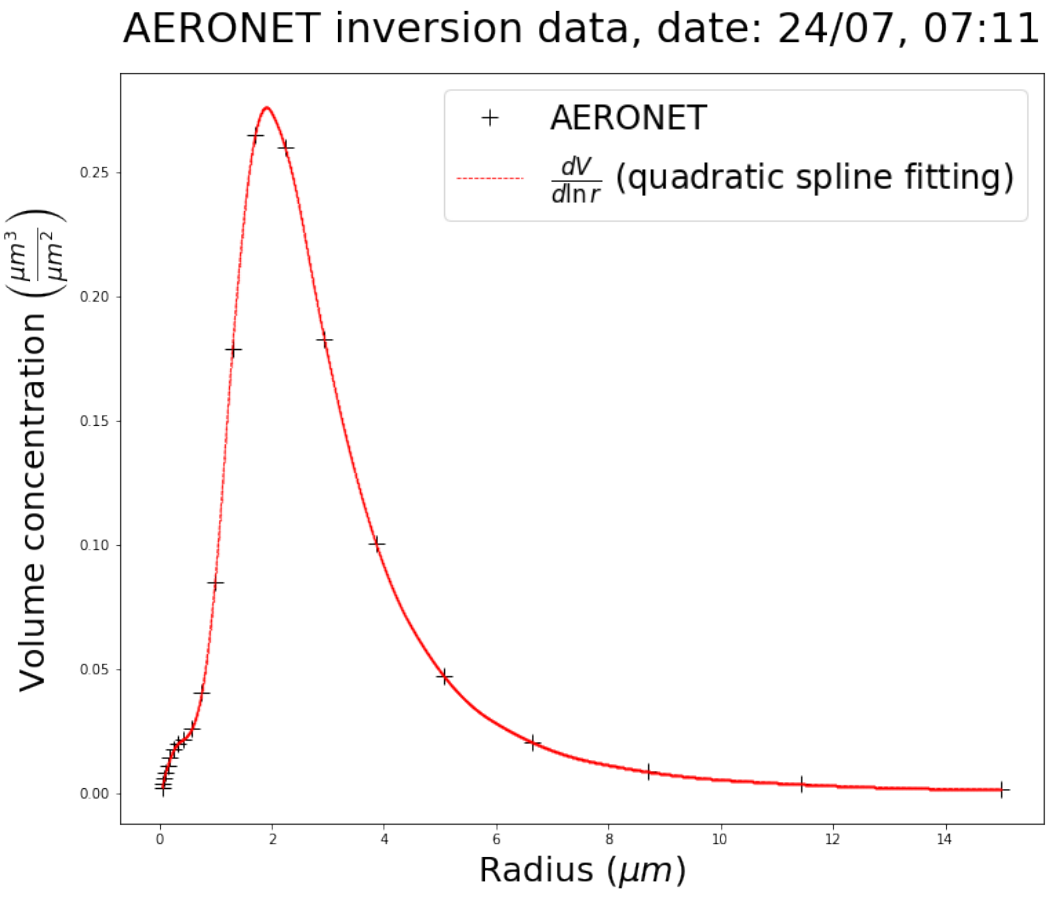


Study context

AERONET stations:

- Granada (37.164 N,3.605 W), elevation=680 m.
- Cerro Poyos (37.109 N,3.487 W), elevation=1809 m.

Study context



$$\text{Total volume concentration} = \int_{r_{min}}^{r_{max}} \frac{dV}{d\ln r} d\ln r \quad .$$

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Calibration of dust emission

How can we make this calibration?

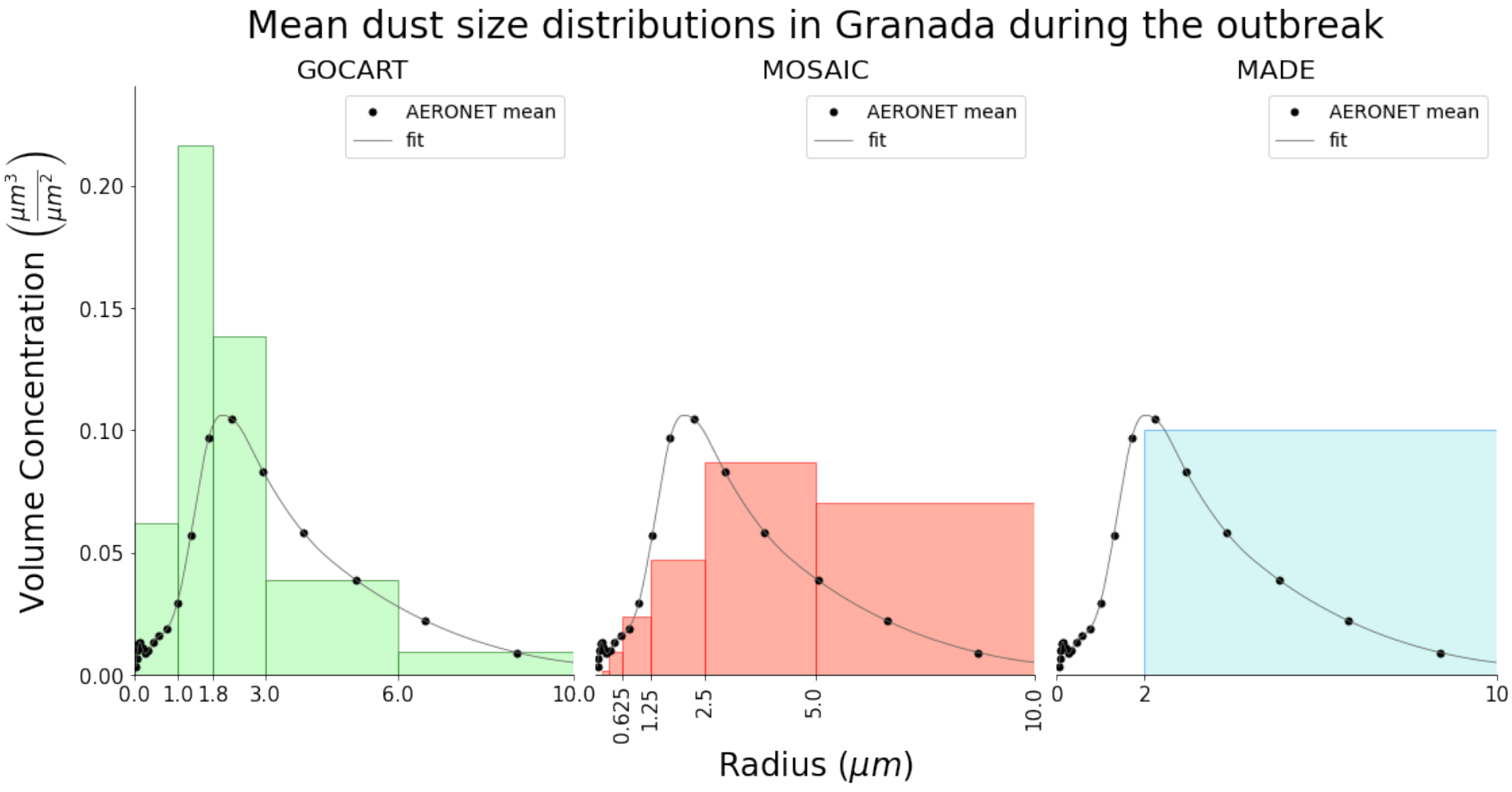
- The dust flux emission for GOCART, MOSAIC and MADE is modeled using the **GOCART dust emission scheme**.
- The dust emission flux is governed by the equation

$$\boxed{F_p = \mathbf{C} S s_p U^2 (U - u_{*t})} \quad . \tag{1}$$

- The **C** parameter (*ch_dust* in WRF) adjusts the total flux.

Calibration of dust emission

Different dust size distributions:

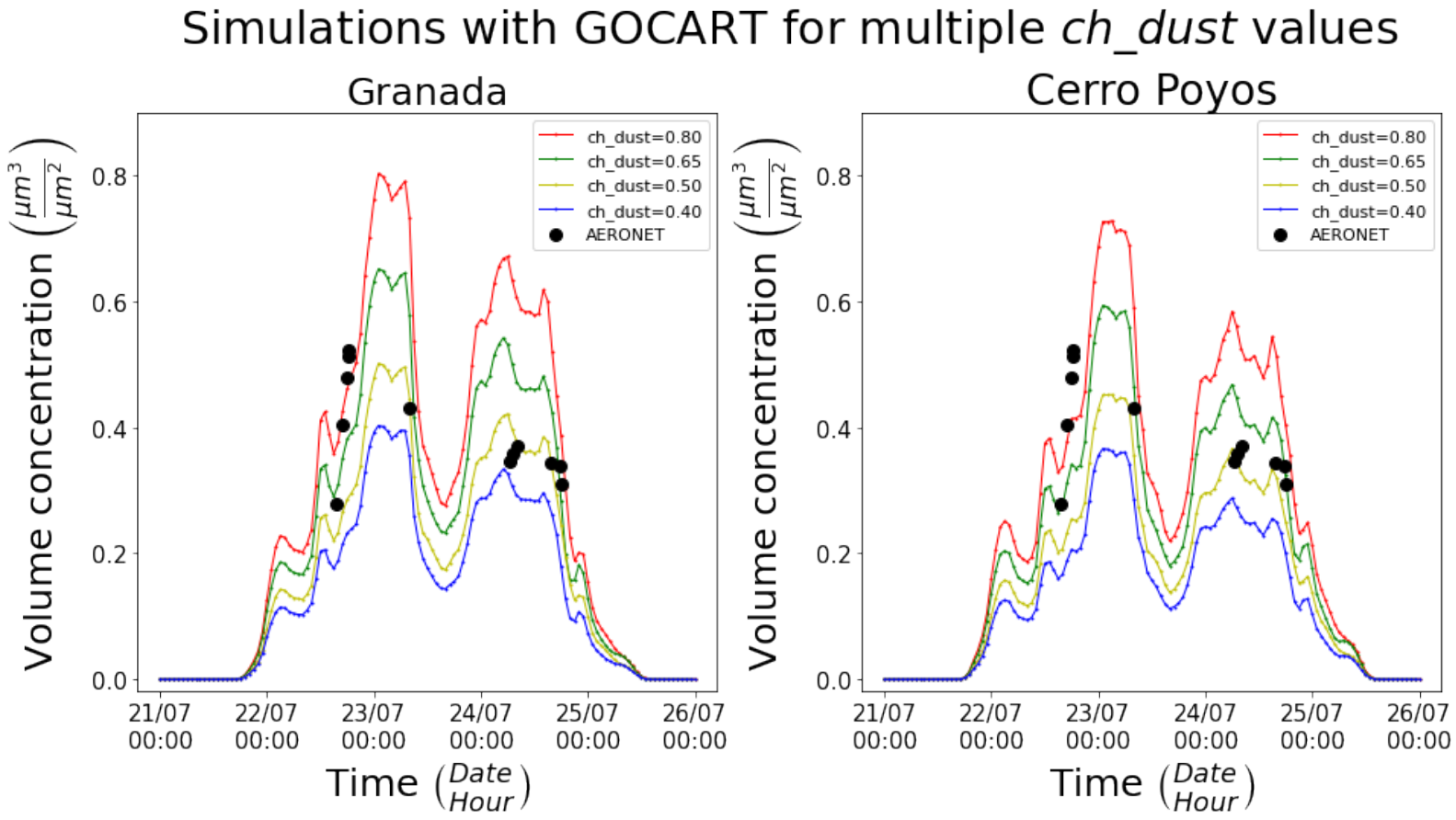


Calibration of dust emission

Approach:

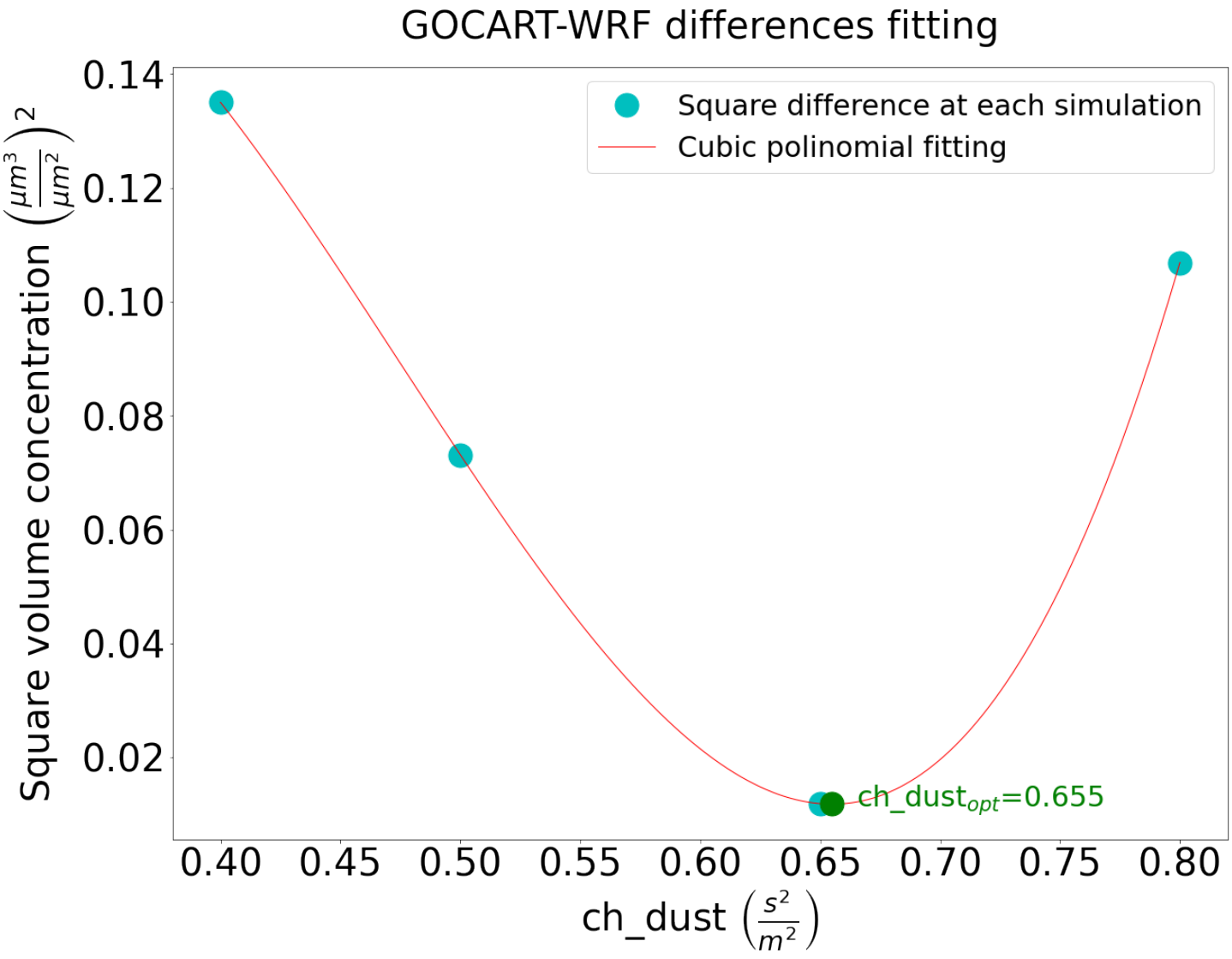
- Simulations with GOCART using **multiple values** for **ch_dust**.
- The **total dust volume concentration** predicted by **WRF** is compared **against** the observed one at the **AERONET** sites.
- The **optimal ch_dust** is the one that **minimizes** the total dust volume concentration **mean square differences** between GOCART and AERONET.

Calibration of dust emission



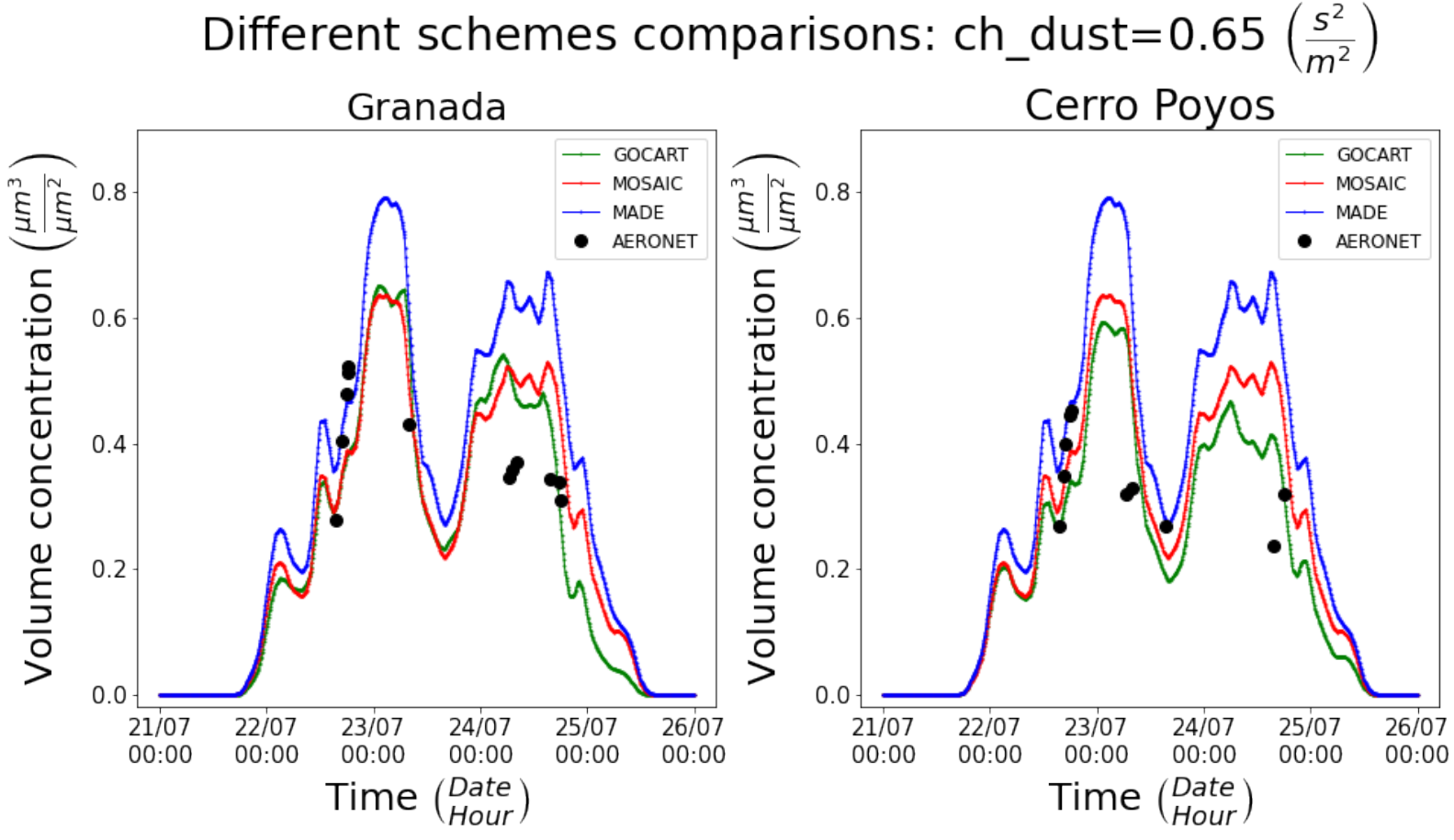
* *ch_dust* values are in $\frac{s^2}{m^2}$.

Calibration of dust emission



Calibration of dust emission: Schemes

- Optimal *ch_dust* value: 0.655, $\frac{s^2}{m^2}$, WRF recommends 0.65 $\frac{s^2}{m^2}$.
- We use *ch_dust* $= 0.65$ $\frac{s^2}{m^2}$ hereinafter.



Calibration of dust emission

Key observations:

- The optimal **ch_dust** is **consistent** with the one recommended in WRF.
- **Dust amount** predictions: MADE $>$ MOSAIC $>$ GOCART (however, similar time evolution).
- **Same** dust **emission** scheme + **different** dust size **distributions**.

Hypothesis: The dust size **redistributions** among models have a **impact** in the **total dust volume concentrations**.

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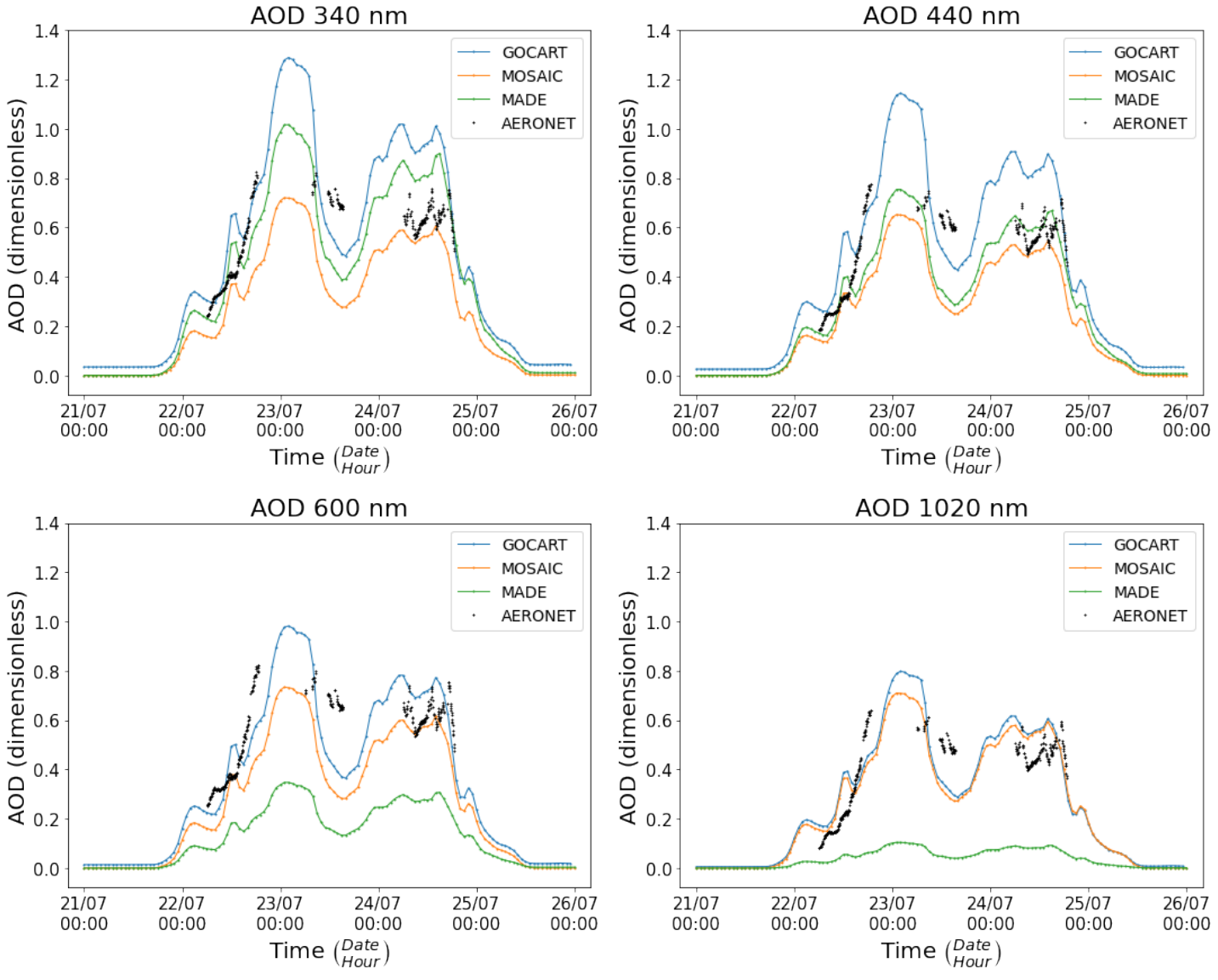
AOD comparisons

Approach:

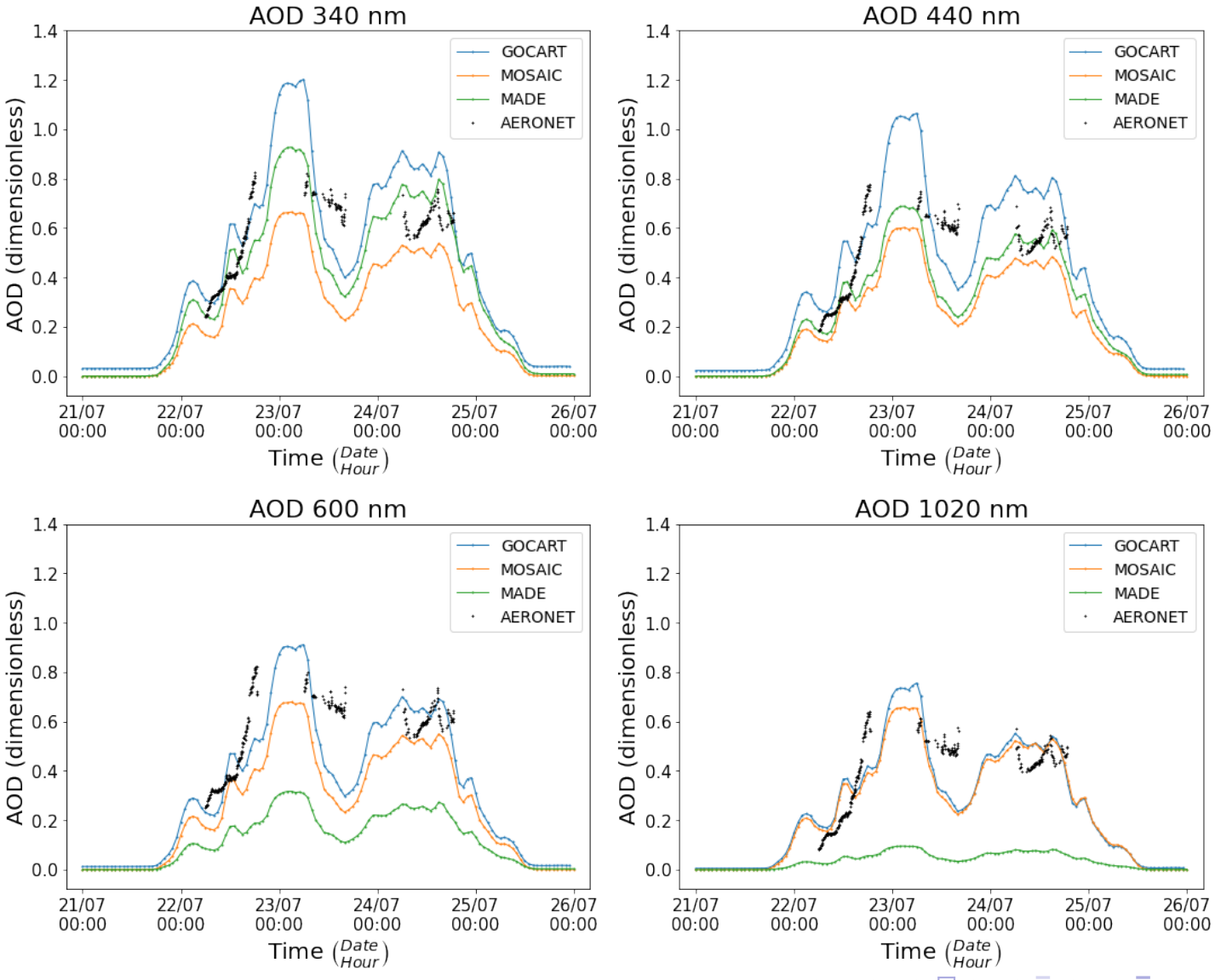
- Simulations with GOCART, MOSAIC and MADE using **ch_dust** $= 0.65$ with the optical scheme 1: volume approximation.
- The **AOD** predicted by **WRF** is compared **against** the observed one at the **AERONET** sites.
- The **AOD** predicted by WRF is studied by its **wavelength dependence**.

AOD comparisons

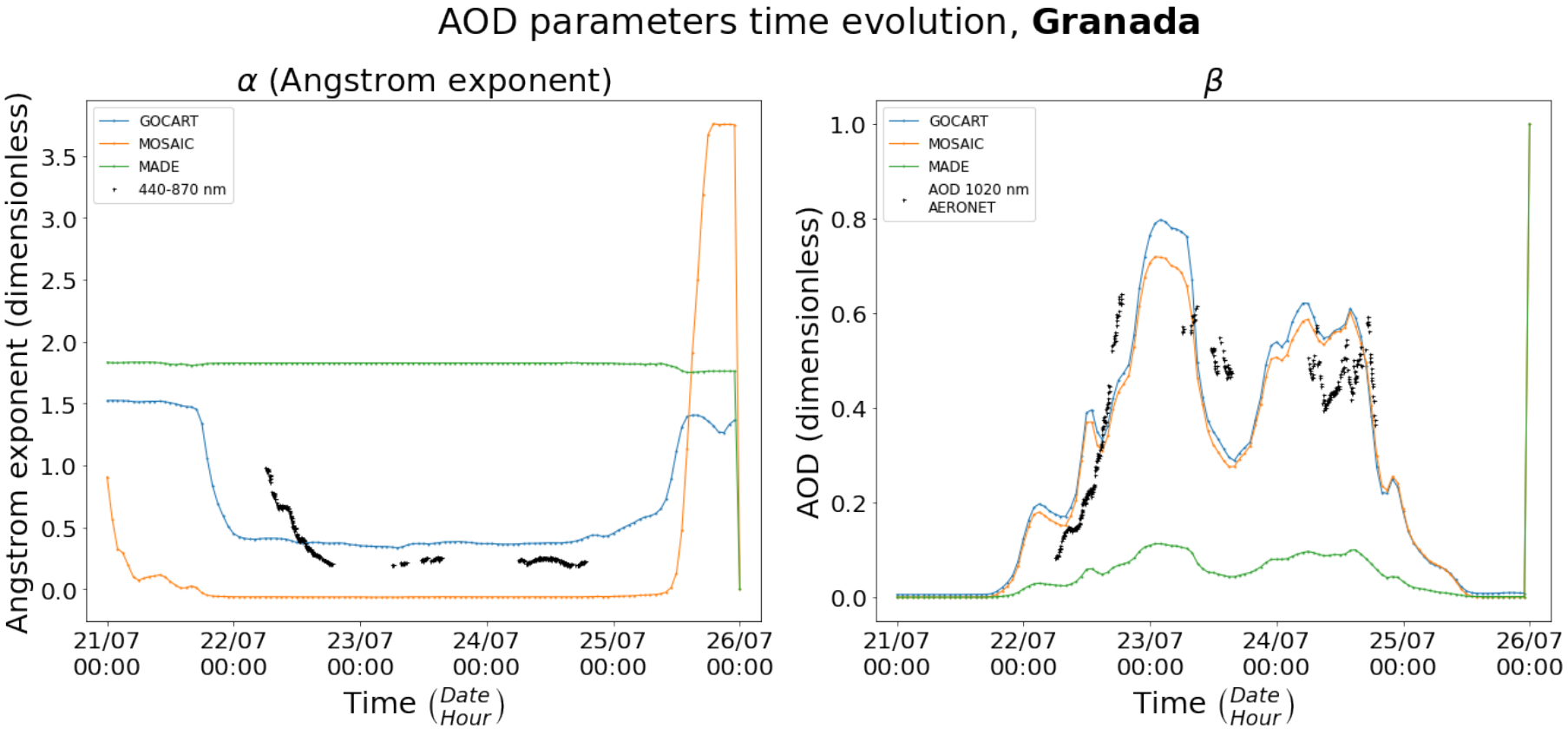


AOD comparisons

AOD time evolution at different wavelengths, **Cerro Poyos**

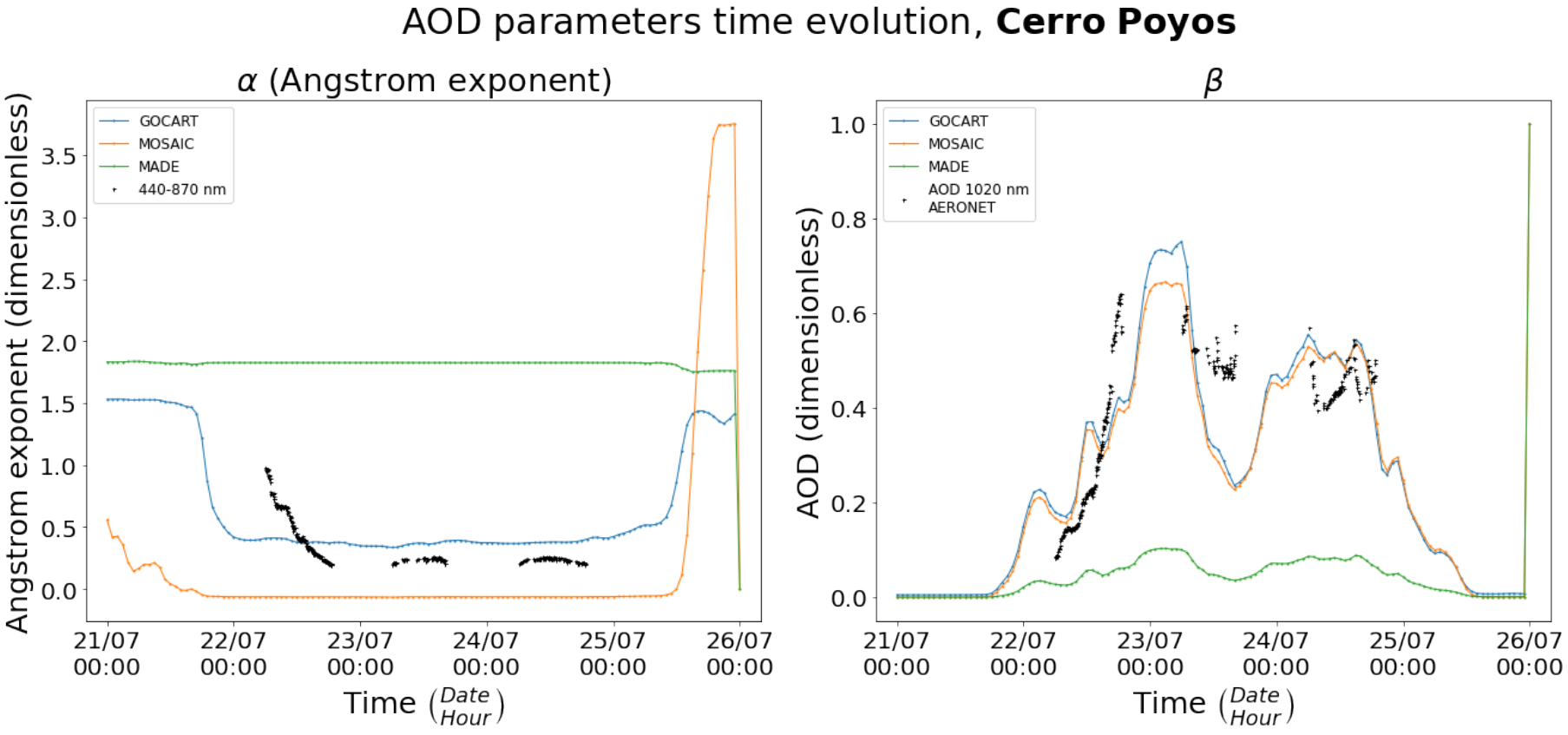


AOD comparisons



$$^{*}\tau_\lambda = \beta \left(\frac{\lambda}{1\ \mu m} \right)^{-\alpha}$$

AOD comparisons



$$^{*}\tau_\lambda = \beta \left(\frac{\lambda}{1\ \mu m} \right)^{-\alpha}$$

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Summary

- Under the same *ch_dust* (the optimal one for GOCART):
  - Dust predicted: MADE $>$ MOSAIC $>$ GOCART.
  - AOD predicted: MADE $<$ MOSAIC $<$ GOCART.
  - Agreement with AERONET β:
    - GOCART MOSAIC:  ;
    - MADE:  .
  - Agreement with AERONET α:
    - GOCART:  ;
    - MOSAIC MADE:  .
- Same optical module for GOCART, MADE and MOSAIC except for a redistribution pre-routine: