Comparison of CALIPSO and AeroCom 2019 modelled aerosol extinction profiles over the Arctic

Presentation by

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Group 2

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NEGI course 2019- Climate science at high latitudes: eScience for linking Arctic measurements and modeling

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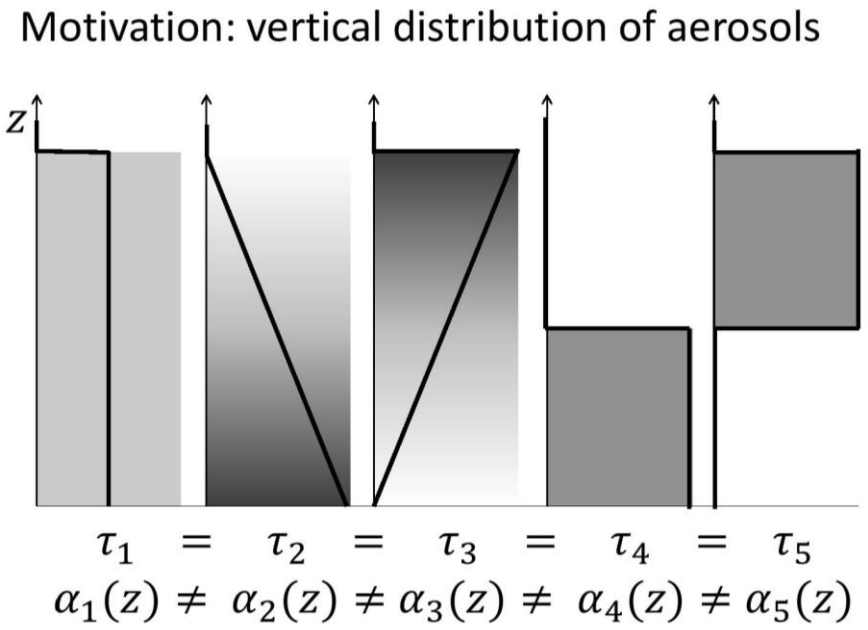
Motivation and objectives:



- **Motivation:**

1. The vertical distribution of aerosols highly impacts the transport of (shortwave and longwave) radiation through the atmosphere as well as the formation of clouds and precipitation patterns.
2. It also reflects aerosol life time, higher up aerosols indicating a longer life time of these particles in the atmosphere.
3. This will ultimately impact the assessment of climate relevant parameters such as the anthropogenic aerosol radiative forcing, which is among the highest uncertainties in climate models.

- **Objectives:**

The objective of this project is to answer the following questions.

1. Which model simulates the best aerosol extinction profile and mean aerosol extinction height in the arctic over different time scales (annual and seasonal)?
2. Are there any seasonal variations in the aerosol extinction profile and mean extinction height?

Data

Data Used	Details	Temporal resolution	Spatial resolution (lon x lat x levels)
CALIPSO (satellite)	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) lev-3 gridded data	monthly (2010)	5^o X 2^o X 60m
GFDL (model)	Geophysical Fluid Dynamics Laboratory (GFDL)	monthly (2010)	1.25^o x 1^o x 33
MIROC-SPRINTARS (model)	Model for Interdisciplinary Research on Climate (MIROC) Spectral Radiation-Transport Model for Aerosol Species (SPRINTARS)	monthly (2010)	0.56^o x 0.56^o x 57

Methods

- All the data were initially cropped for latitudes > 70 N to approximate the Arctic region.
- The mean extinction height is calculated for heights up to 10 kms as per Koffi et al. (2012) using the formula

$$Z = \frac{\sum_i^n \mathcal{B}i \times Hi}{\sum_i^n \mathcal{B}i}$$

Where, Z is the mean aerosol extinction height (in km),
$\mathcal{B}i$ and Hi are the aerosol extinction coefficient (in km-1) and altitude at level i respectively.

Results

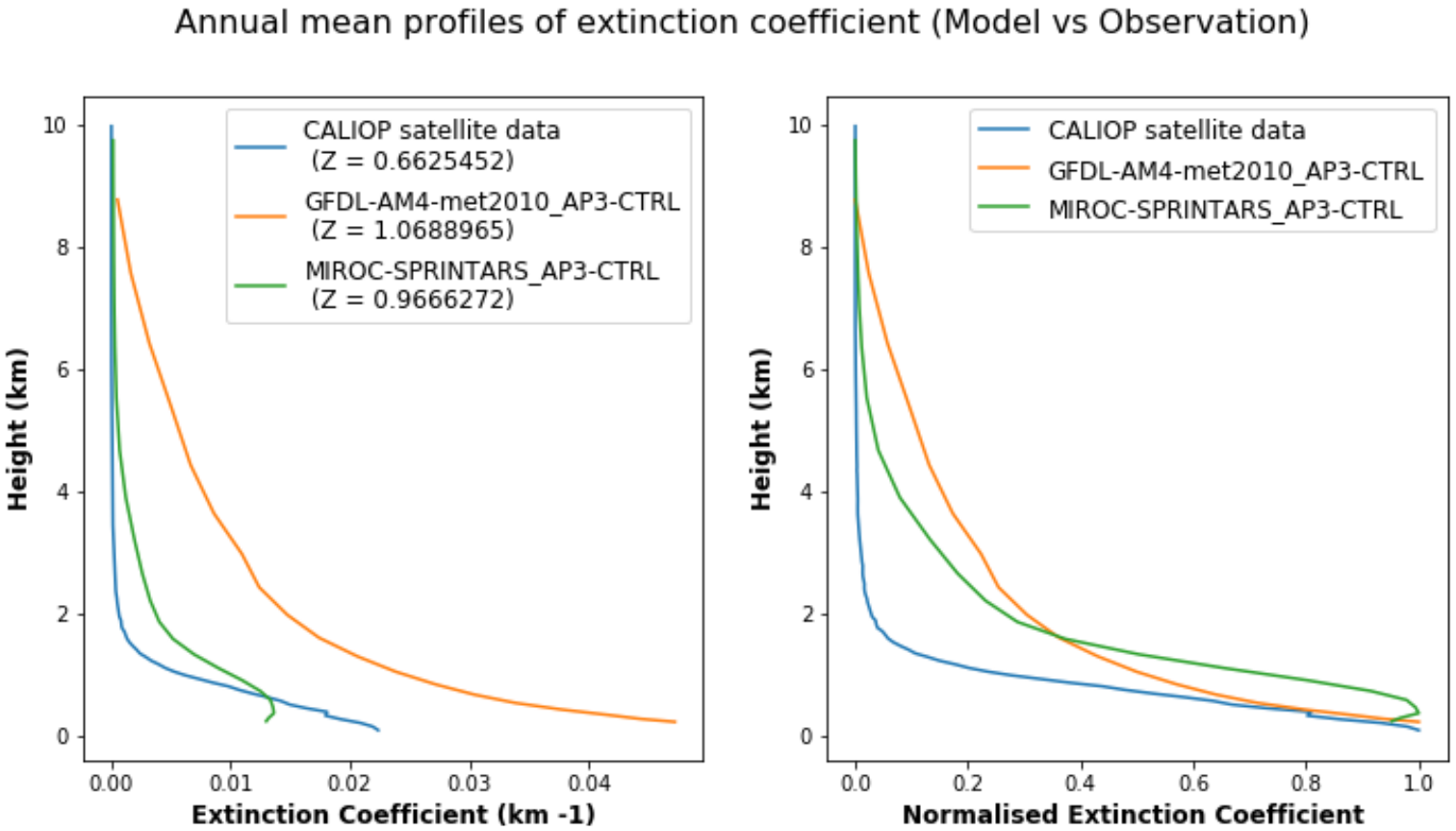


Figure 1: Absolute and normalized profiles of annual mean aerosol extinction coefficient (km-1) and mean aerosol extinction height (Z in km) for the year 2010 averaged over the Arctic

- The MIROC-SPLINTARS model performs better in simulating the annual mean aerosol extinction profile as compared to the GFDL model

Results

- The CALIOP extinction profile shows relatively higher values close to the surface in D-J-F and S-O-N (winter and autumn months).
- Such higher values close to the surface may occur because of accumulation of aerosols due to stable atmosphere (temperature inversion) or because of lesser frontal activities.
- The GFDL model performs better than MIROC-SPLINTARS model in simulating the lower level extinction profile in D-J-F and S-O-N months. Whereas MIROC-SPLINTARS performs better in rest of the months.

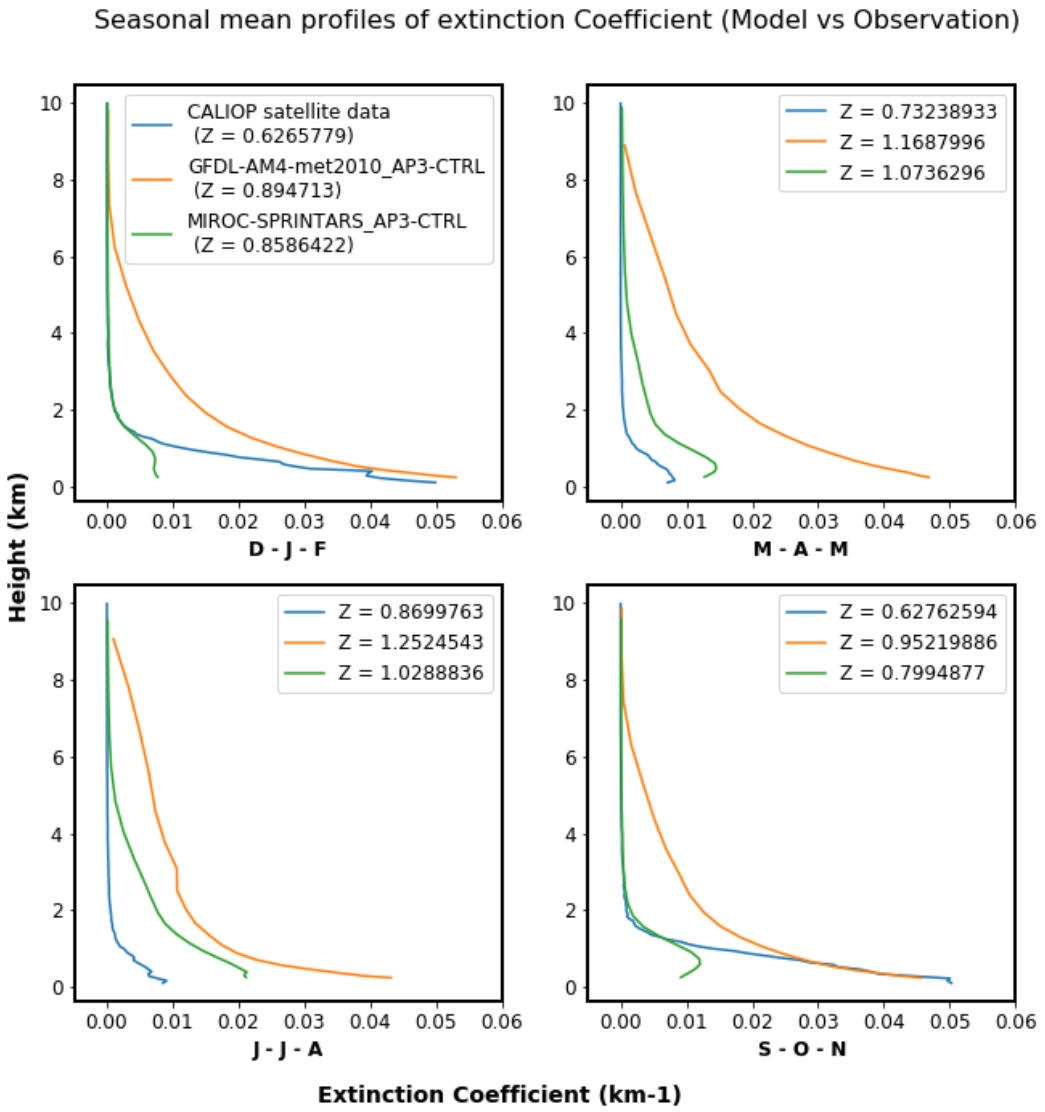


Figure 2: Seasonal mean extinction coefficients in km-1 and mean aerosol extinction height (Z) in km) for model outputs and CALIOP data for the year 2010

Results

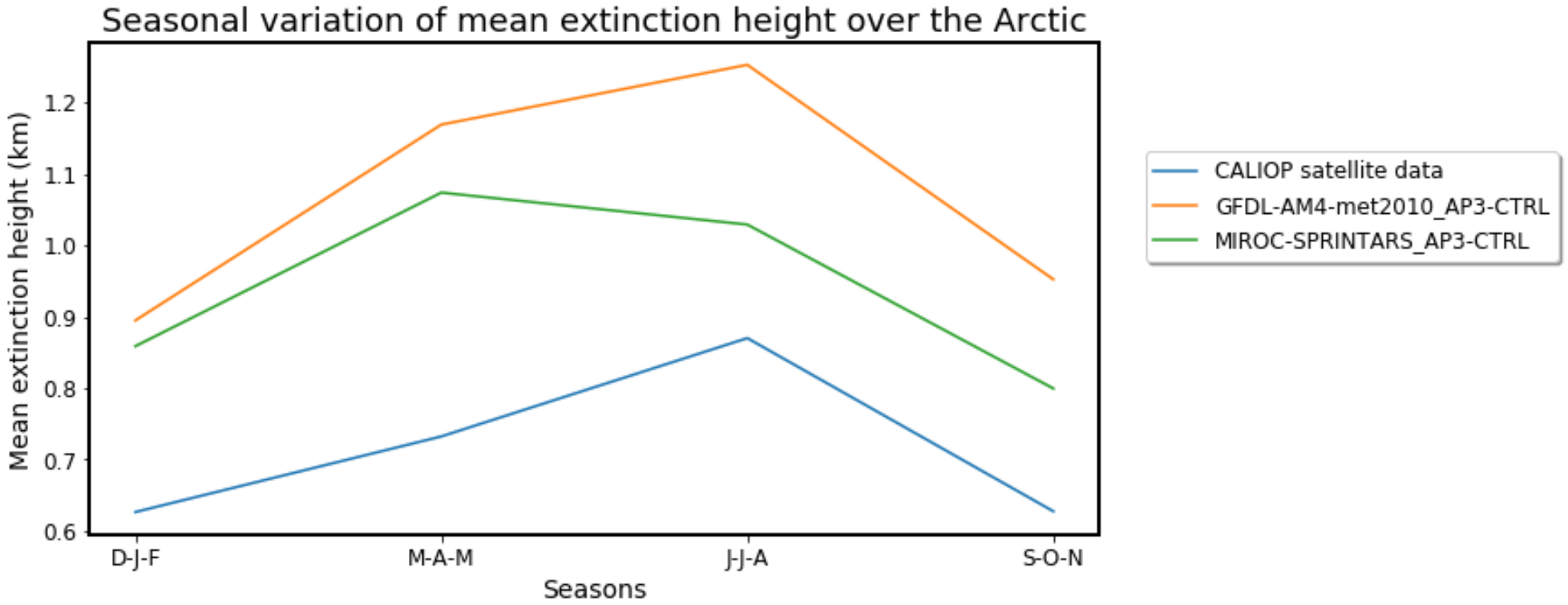


Figure 3: CALIOP and modelled mean extinction height (in km) for different seasons over the Arctic

- The mean extinction height is comparatively less in D-J-F and S-O-N months in both the models and observations.
- The models overestimate the mean extinction height in all the season.
- The models are capable of simulating the seasonal variation of mean extinction height.
- MIROC-SPLINTARS performs relatively better in simulating the seasonal mean extinction height .

Conclusion

- The MIROC-SPLINTARS model performs better in simulating the annual mean aerosol extinction profile as compared to the GFDL model.
- The CALIOP extinction profile shows relatively higher values close to the surface in D-J-F and S-O-N (winter and autumn months).
- The models overestimate the mean extinction height in all the season but are capable of simulating the seasonal variation of mean extinction height.
- MIROC-SPLINTARS performs relatively better in simulating the seasonal mean extinction height .