Black carbon in the Arctic: how about them models?

Understanding processes and radiative effects of black carbon within CMIP6 models

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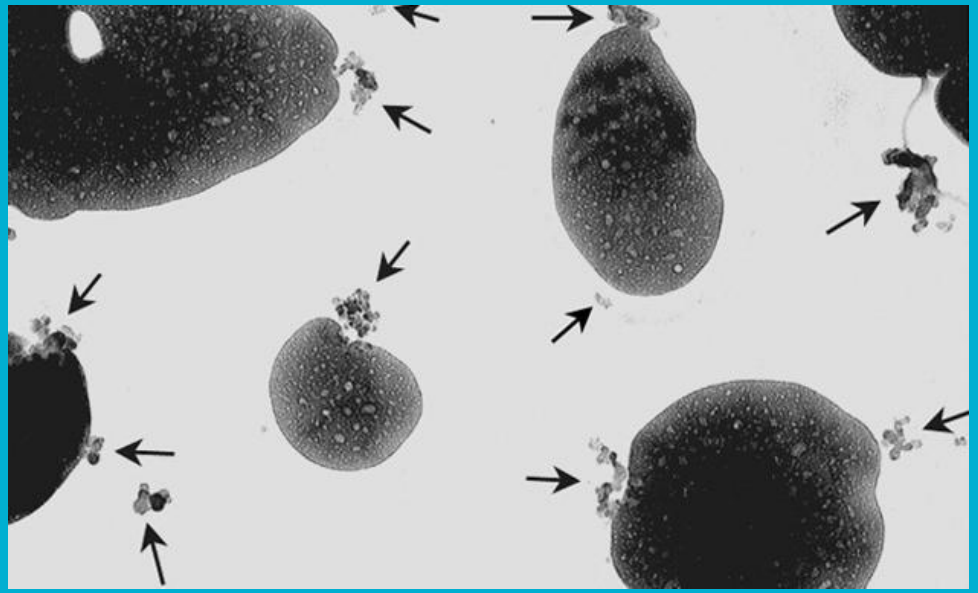
Black carbon in the atmosphere

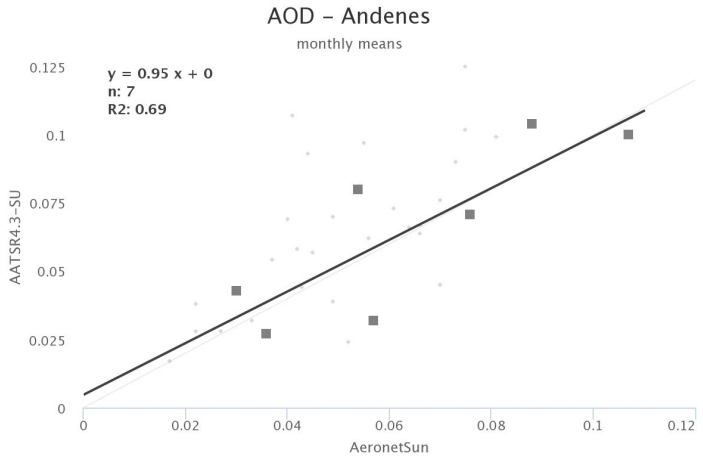
- High uncertainty in radiative forcing
- Variable interaction with radiation depending on age
- **What can models reproduce** and **how much of an effect does it have in models?**



Source: NASA.gov

Can models reproduce AOD?

Along Track Scanning Radiometers (ATSR) and Advanced ATSR

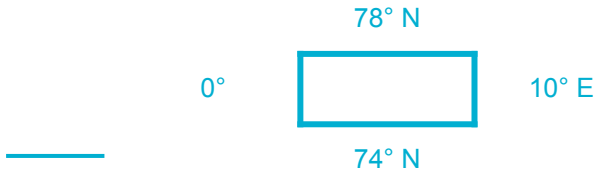


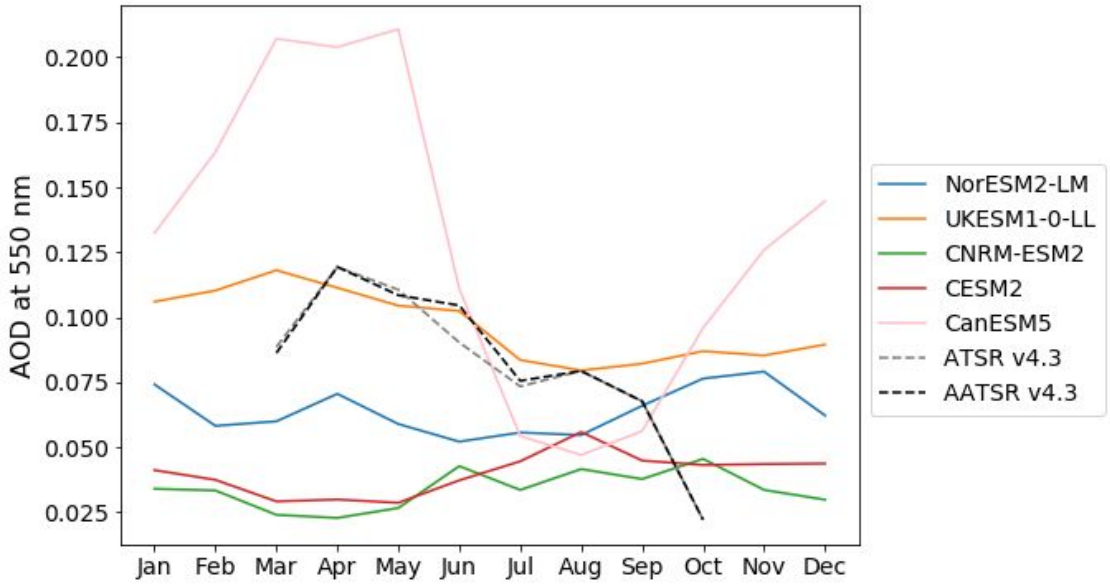
Source: aerocom-evaluation.met.no

- ATSR v4.3 data plotted against Aeronet sun photometer measurements
- Andenes: 69.28° N, 16.01° E

Can models reproduce AOD?

- Choose a relatively ice-free swath to compare to
- 40 pixels vs
- Calculate the monthly mean cycles from a collection of models



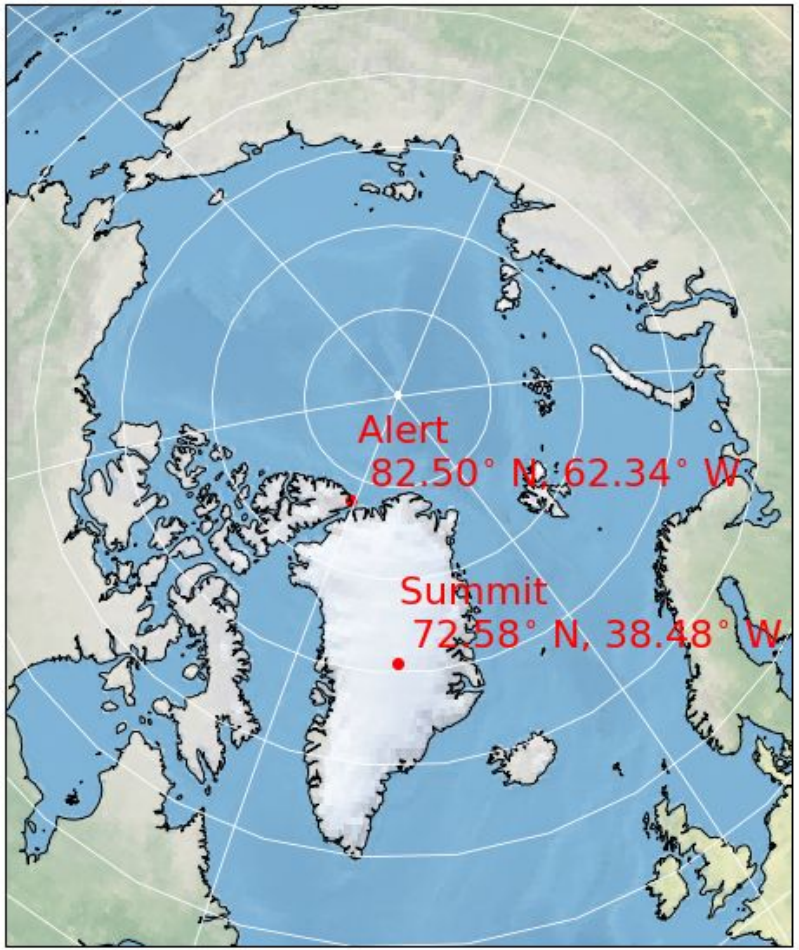


AOD observations versus models

- High spread and variability
- Some models do not have an annual cycle
-

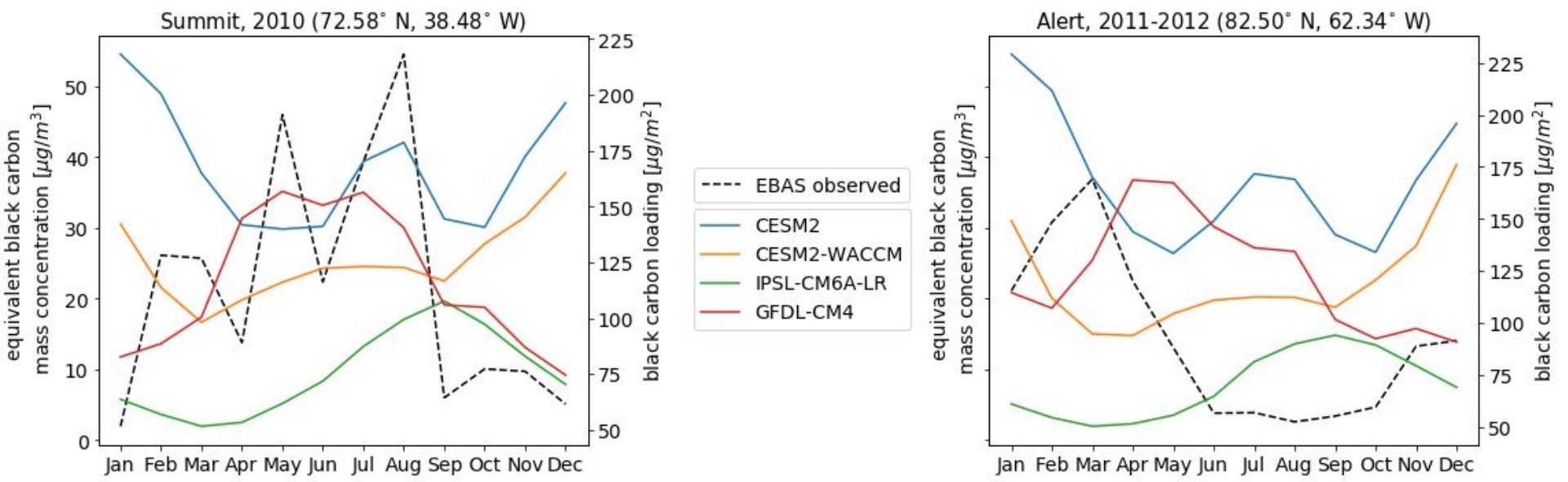
Black carbon cycles in the Arctic

- EBAS has two available observation campaigns in the Arctic
- Summit (2010) (3200 m.ö.h.)
- Alert (2011-2012) (30 m.ö.h.)
- In-situ volumetric mass concentration measurement by Magee AE16 aethalometer



Modeled black carbon cycles

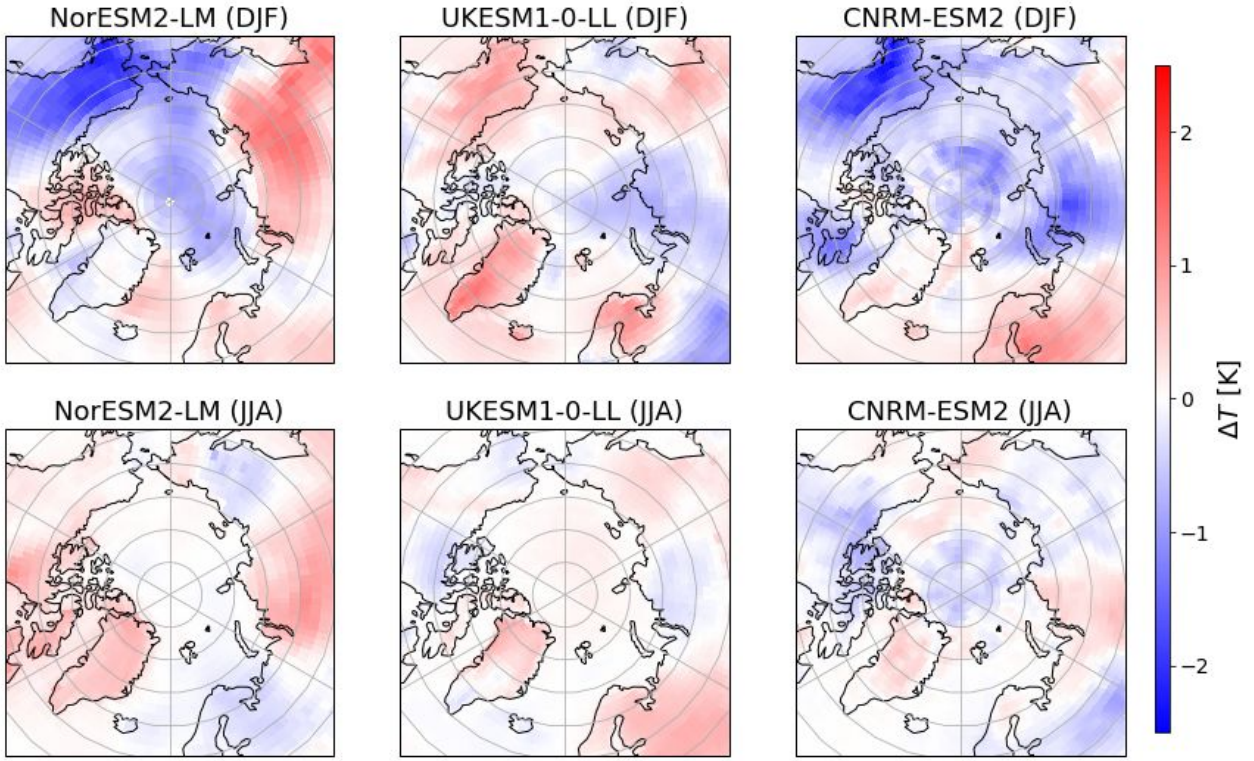
Model variable: column-integrated over surface area



CMIP6 black carbon experiment

Difference in surface temperature: pre-industrial control with 2014 black carbon emissions and pre-industrial control run

- Increased surface temperature over Greenland during summer
- Temperature response during winter
- Possible cooling response over Arctic ocean



Outlooks

What next?

	UKESM1	NorESM2-LM	CNRM-ESM2
Global	+0.0096	-0.0041	-0.0416
> 67° N	-0.0016	-0.0708	-0.1701

- Investigate sources, sinks and processes in the models
- Understand quirks of parameterizations of black carbon (anthropogenic and natural) interactions
  - Does implementing ageing change radiation balance?
- Difficult to do: observed natural variation

Things to consider:

Thanks!

- Modeling is one of the only methods of preparing for future climate change **(besides action)**
- High uncertainty, parameterizations that do not reproduce natural phenomena remain problematic
- CMIP6 remains to be explored!