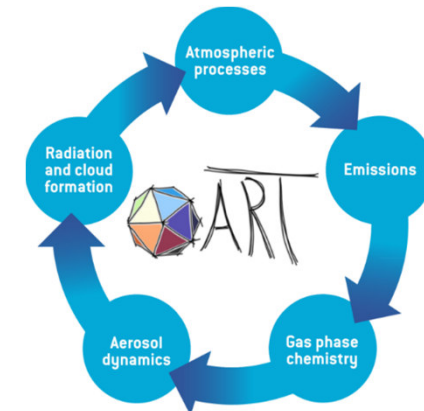
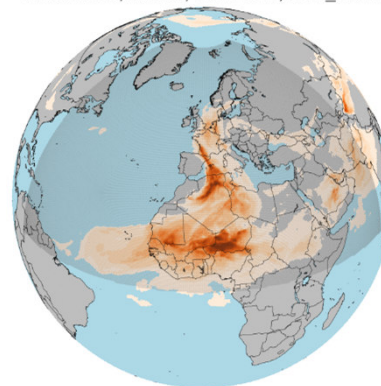


ICON-ART

Overview of recent developments

Ali Hoshyaripour and the ARTists

2018040800, vv: 003, ICON-ART, AOD_DUST

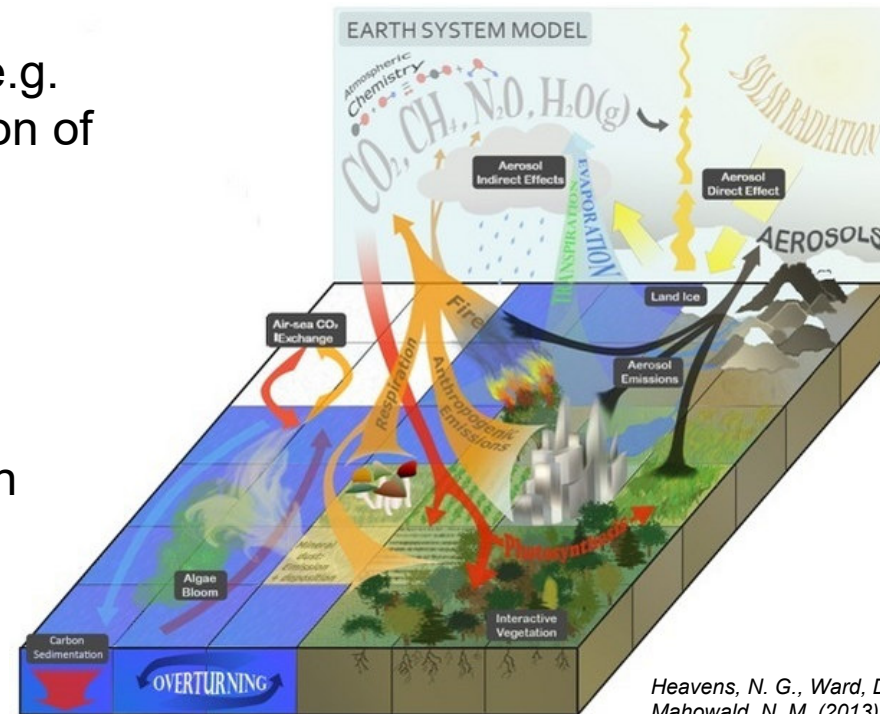


Atmospheric composition in the Earth system

Societal and economic challenges: e.g.

- air quality – health effects, evaluation of clean air measures,
- interactions with solar radiation – photovoltaic power yields,
- trends of greenhouse gases.

Atmospheric composition is relevant on **timescales of minutes to centuries.**



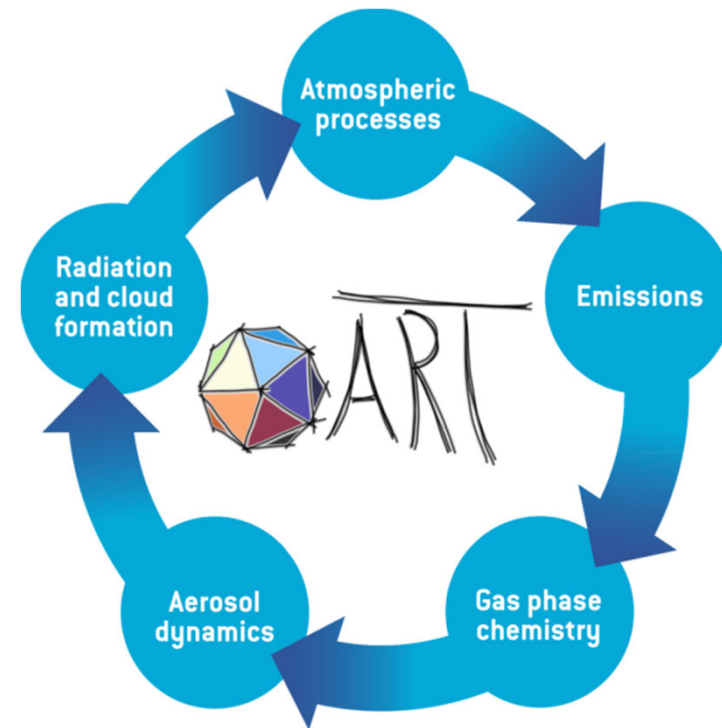
Heavens, N. G., Ward, D. S. & Mahowald, N. M. (2013), *Nature Education Knowledge* 4(5):4

ICON-ART

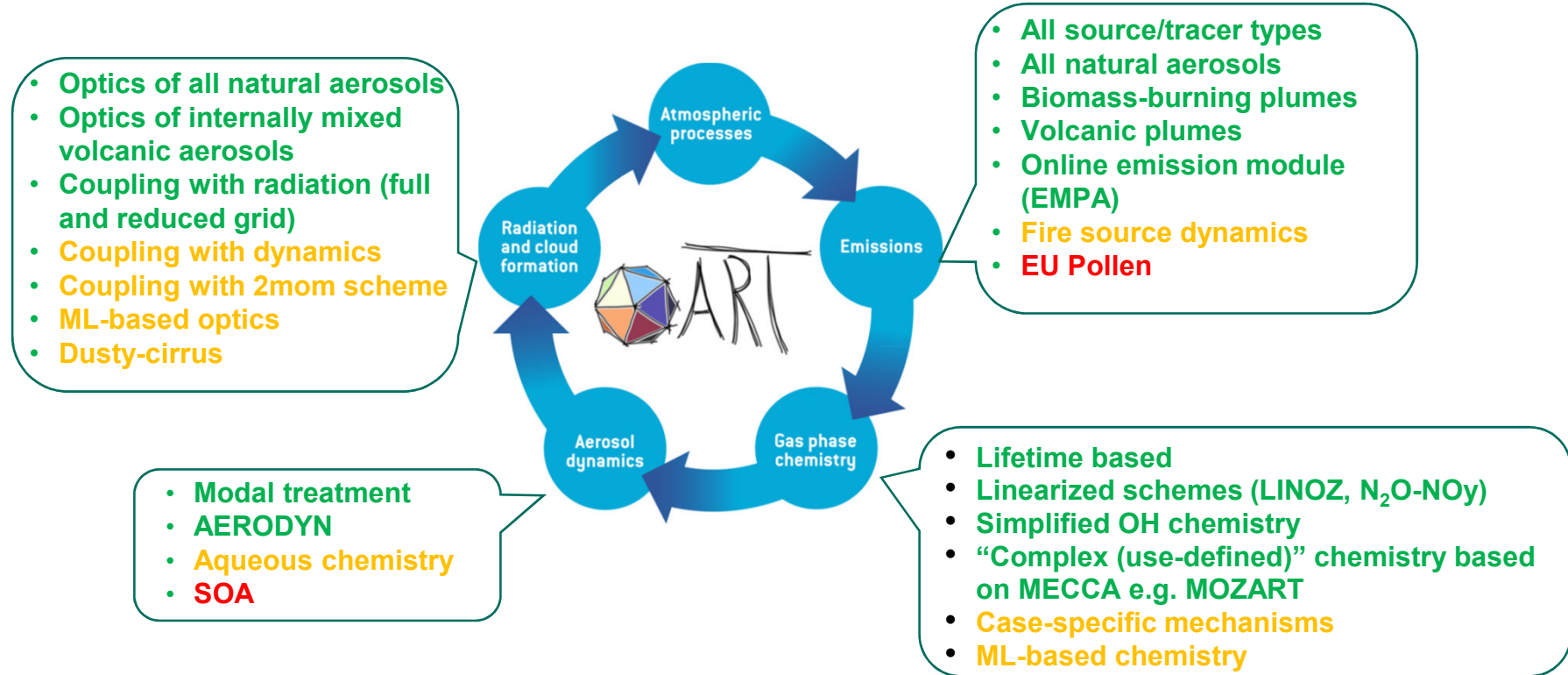
- Developed at KIT together with DWD since 2010 (as the successor of COSMO-ART)
- Focus on near-operational applications and case studies on NWP scale

ICON-ART in operational forecasting

- Mineral dust ↔ *DWD*
- Pollen ↔ *DWD, MeteoSwiss*
- Radionuclides, volcanic ash, accidental release ↔ *DWD*



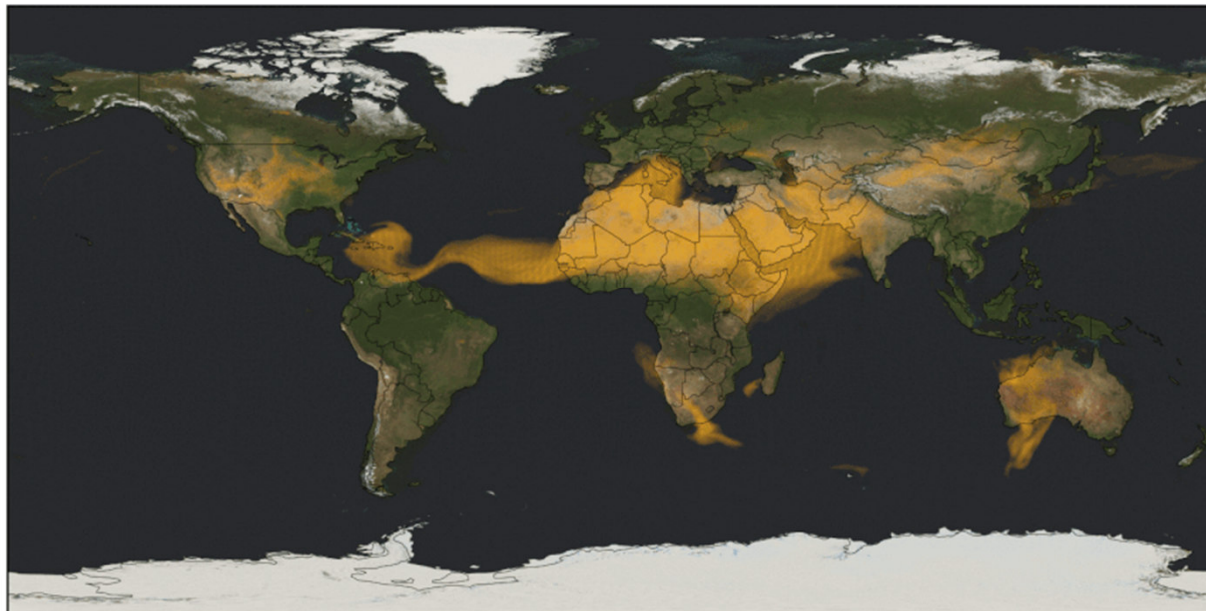
ICON-ART : current features



Multi-aerosol simulations

R2B06

22-06-2019 00:00



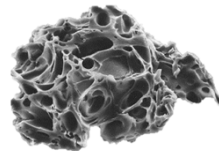
Mineral Dust

Sea Salt

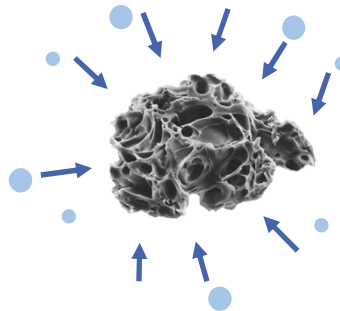
Biomass Burning
Aerosols

Dust aging: first steps

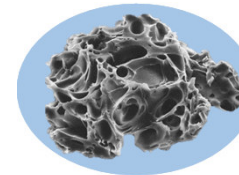
1) Fresh emitted particles



2) Condensation and coagulation



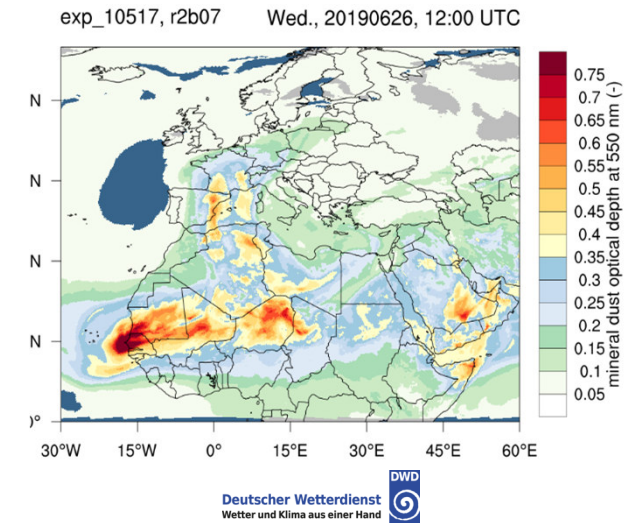
3) Coated/aged particles



- Consideration of „anthropogenic emissions“
- Which processes are important for the aging of dust?
- What are the components of the shell?
- Impact of coating on aerosol-cloud-radiation interactions?
-

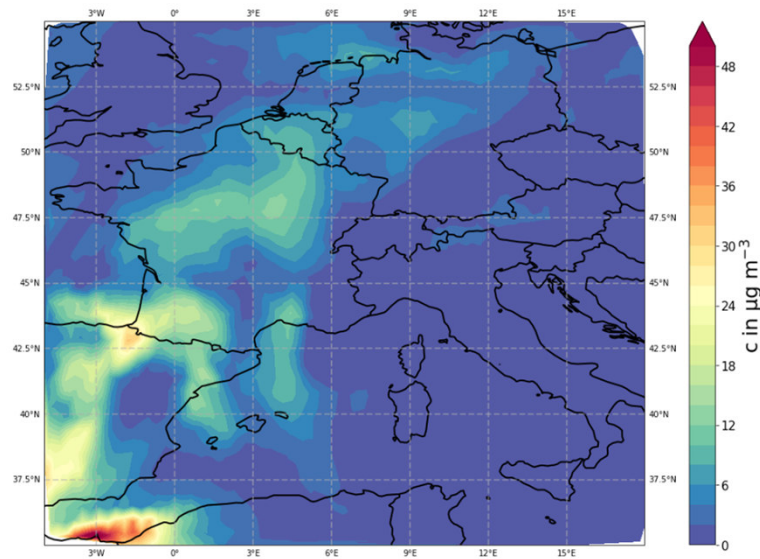
Experiment set-up for dust episode 22.-27.06.2019

- Emission of sea salt, dust, soot
- Restart every day, but only chemical species will be reinitialized
- Initialization with gas phase concentrations of CAM-chem every day, 0 UTC: SO_2 , O_3 , CH_4 , CO , HNO_3 , NH_3 , H_2O_2
- Simple OH chemistry: oxidation of $\text{SO}_2 \rightarrow \text{H}_2\text{SO}_4$
- Initialization of dust from exp_10517
- Nucleation, condensation, coagulation:
 - SO_4 , NO_3 , NH_4 , H_2O , Na , Cl , soot, dust

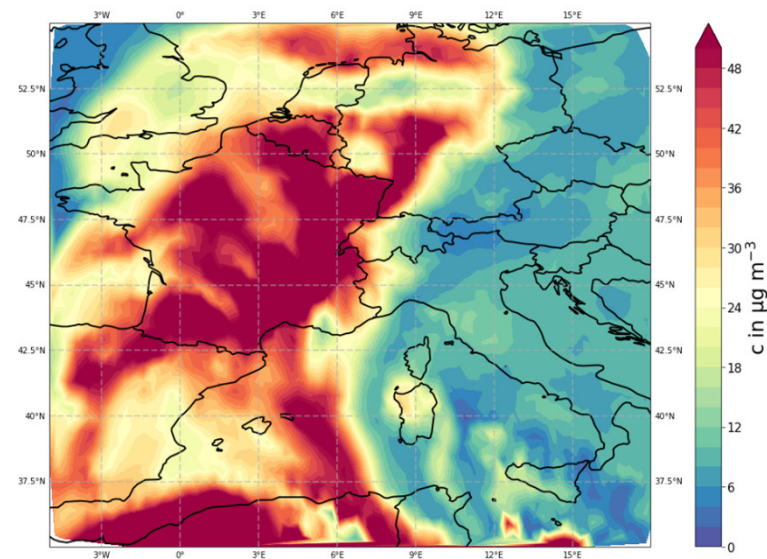


Dust cloud, 27.06.2019, 00 UTC

Uncoated dust



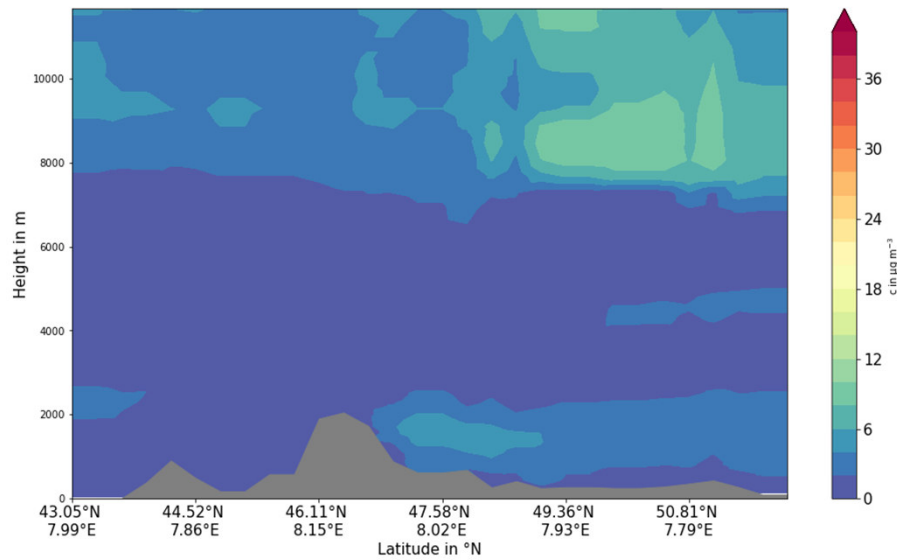
Coated dust



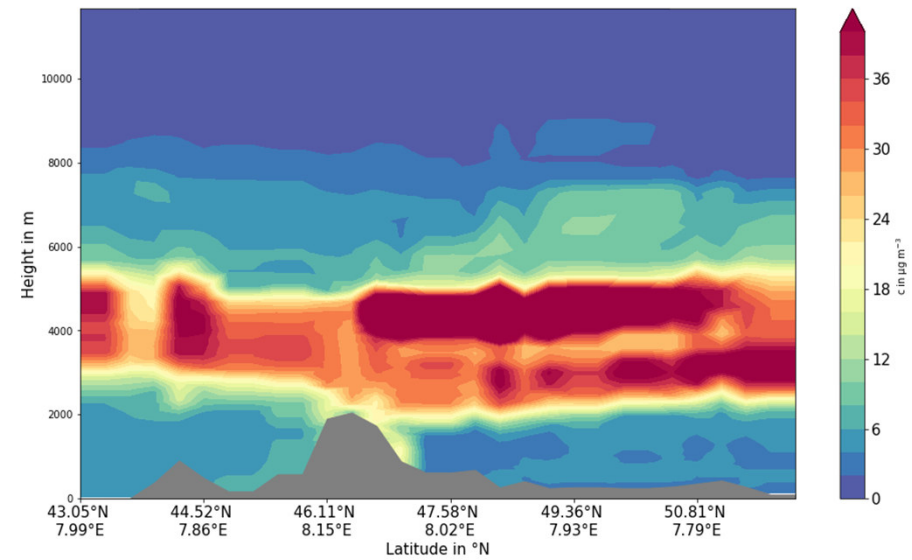
Dust (acc), 27.06.2019, 00 UTC



Uncoated dust

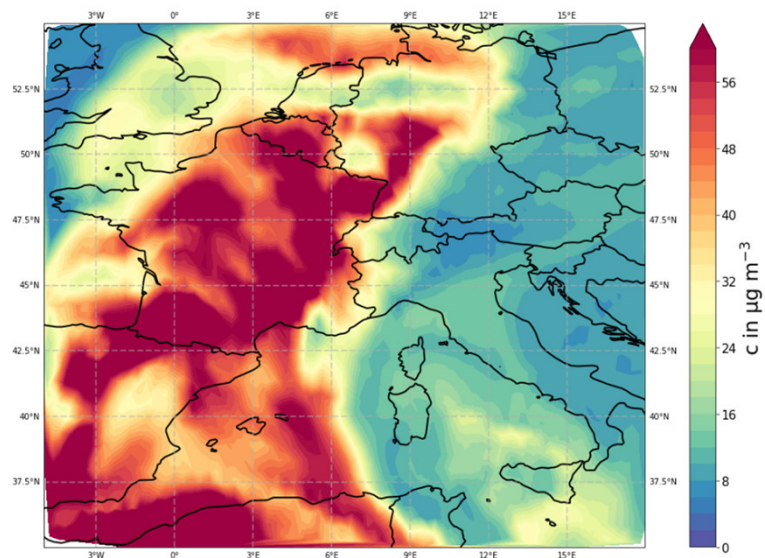


Coated dust

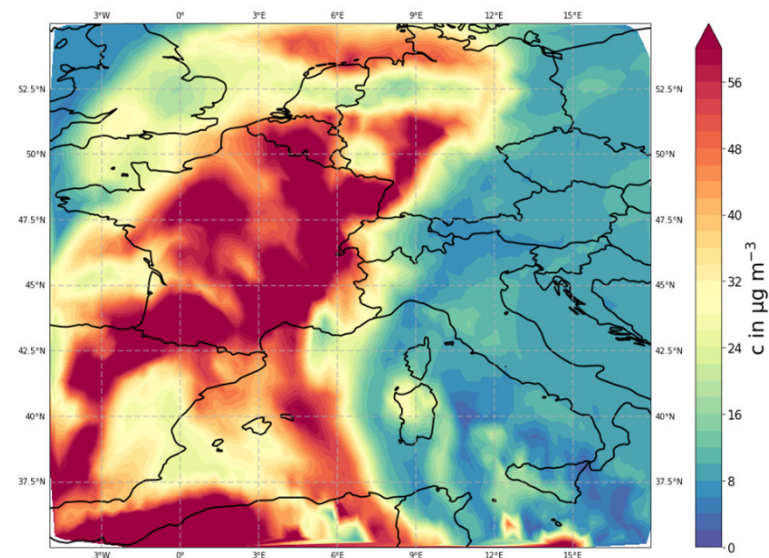


Dust cloud, 27.06.2019, 00 UTC

without aging

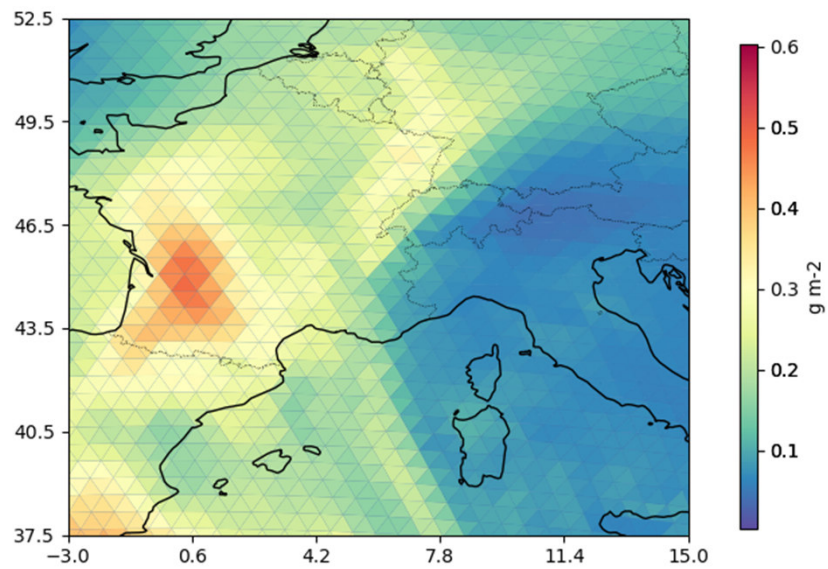


with aging

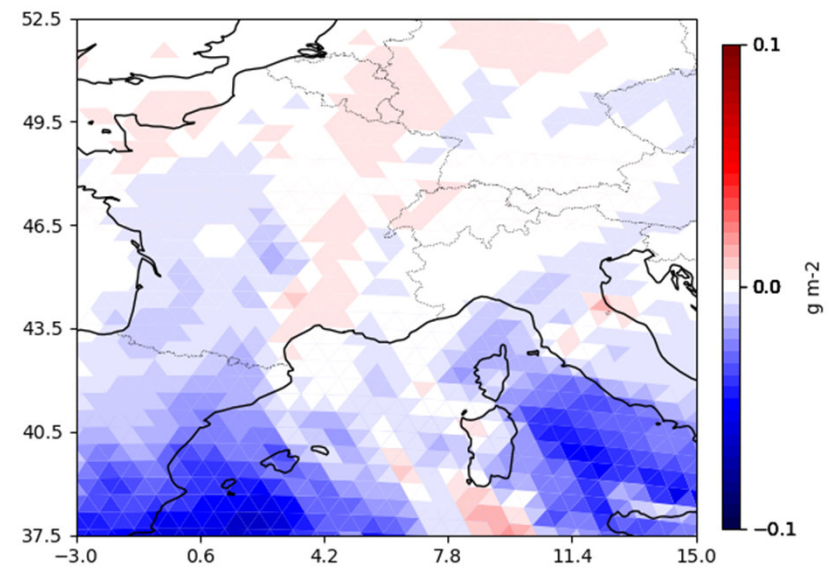


Column-integrated dust, 27.06.2019, 00 UTC

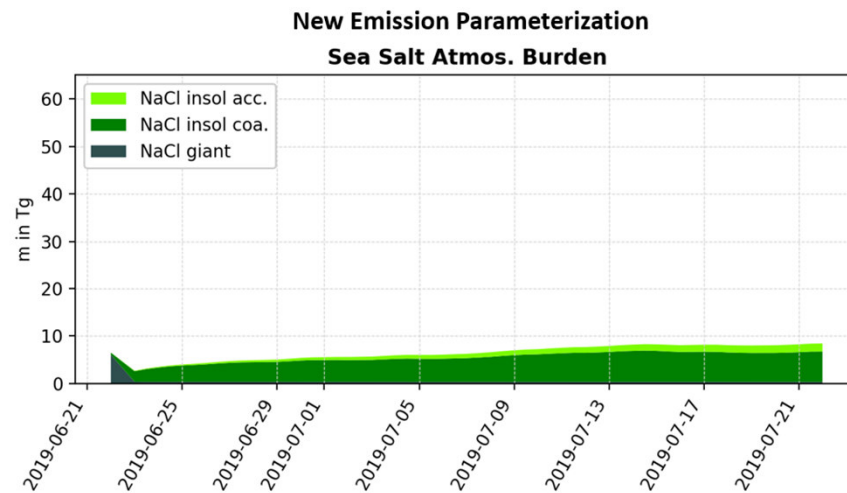
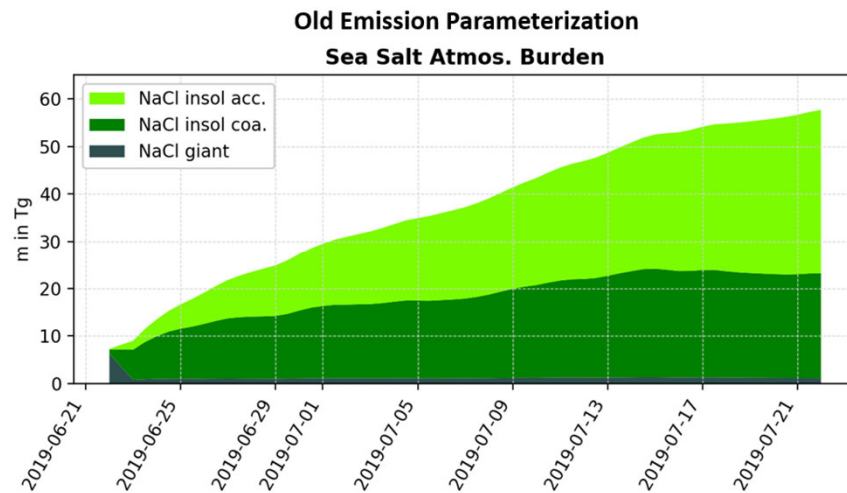
with aging



Δ



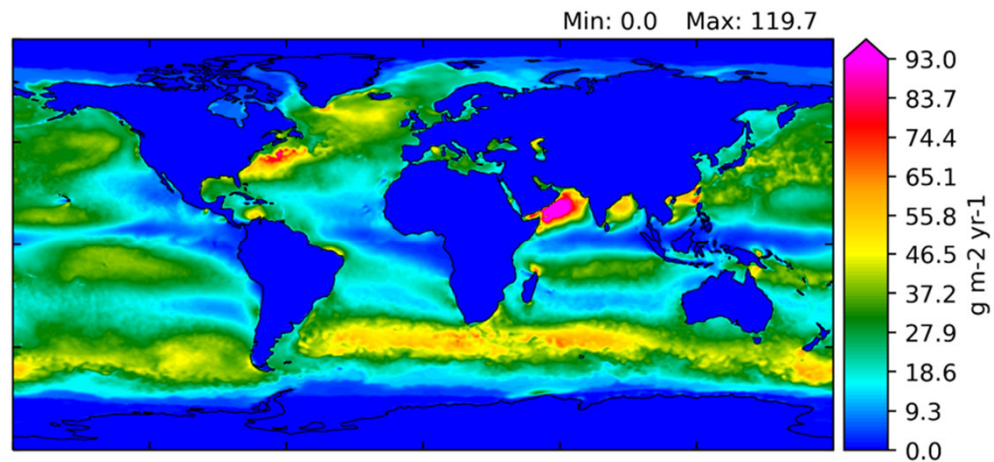
New sea salt emission parameterization



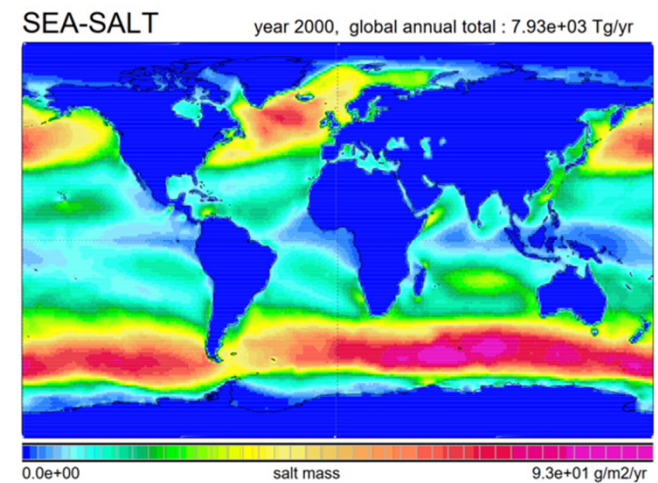
Parameterization based on Grythe et al., 2014

New sea salt emission parameterization

8 Pg yr⁻¹

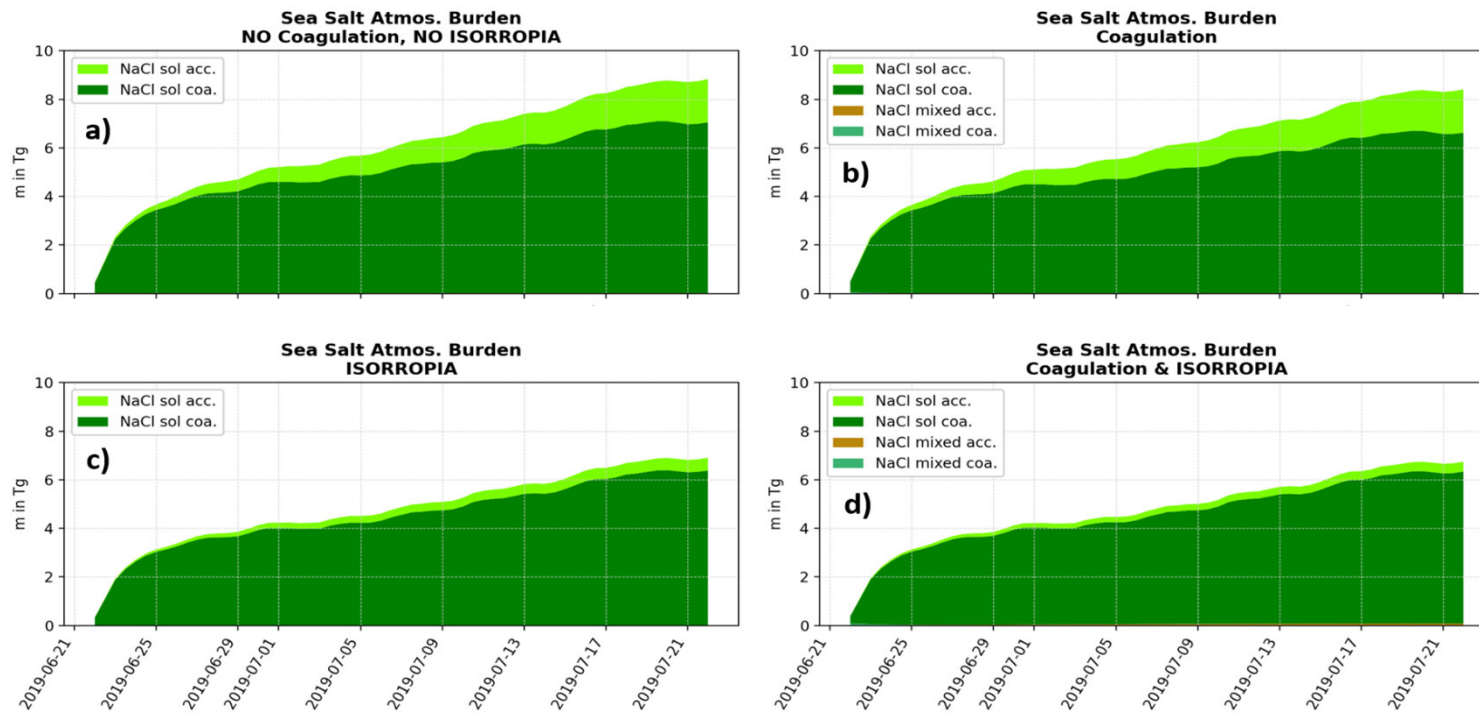


7.9 Pg yr⁻¹



Dentener et al., 2006

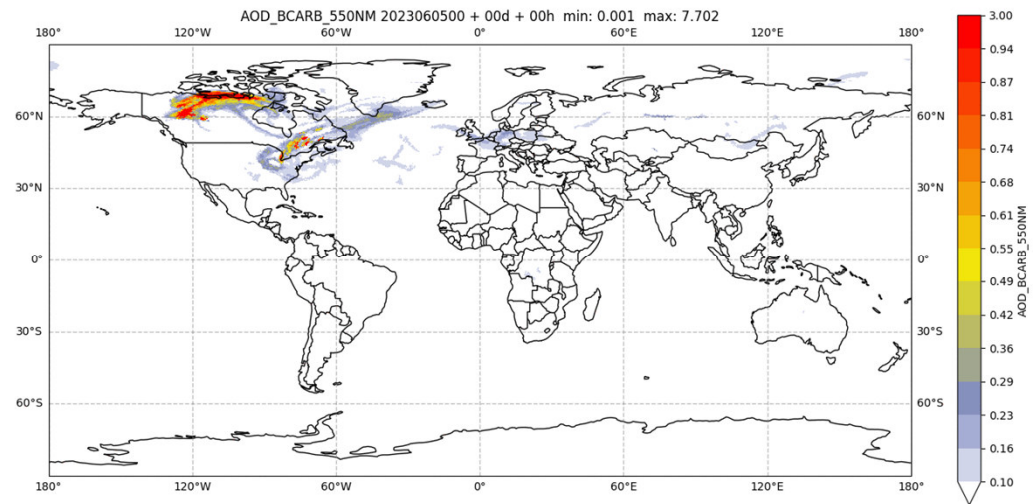
Effects of aerosol dynamics



Wildfire smoke from Canada arrives in NYC



PermaStrom@DWD



Australia's Black Summer 2019/20

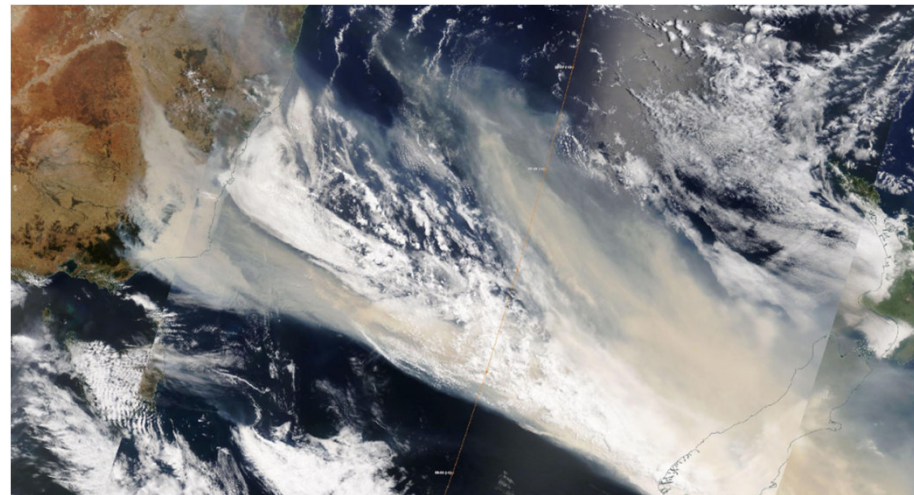
Objective:

To explore the effects of energy and material fluxes on:

- Smoke plumes
- Local weather

Experiment:

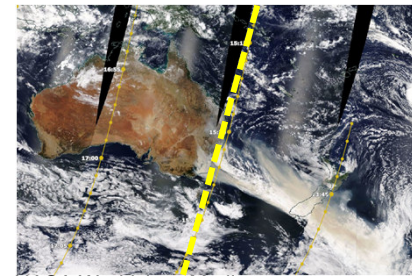
- 30.12.19 to 02.01.2020
- LAM with 6 km grid spacing
- Emission based on GFAS
 - OC + BC
 - FRP
 - Emission factor *3.4
 - Injection using plume rise model
- with ecrad & aerosol aging



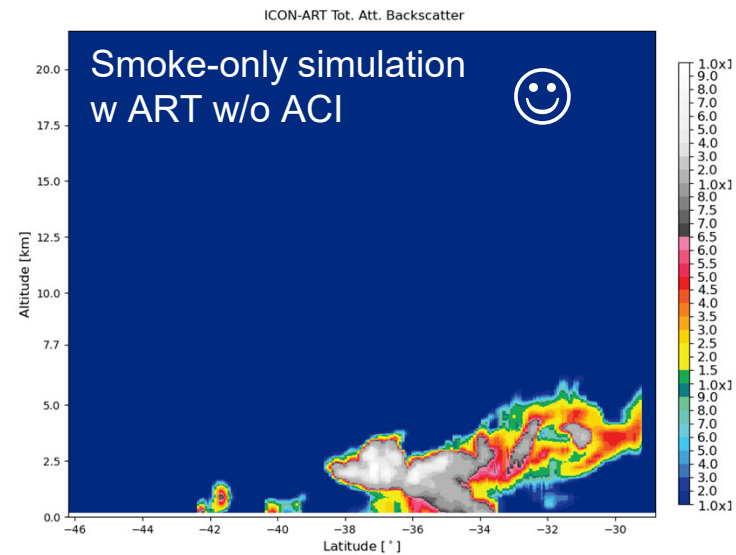
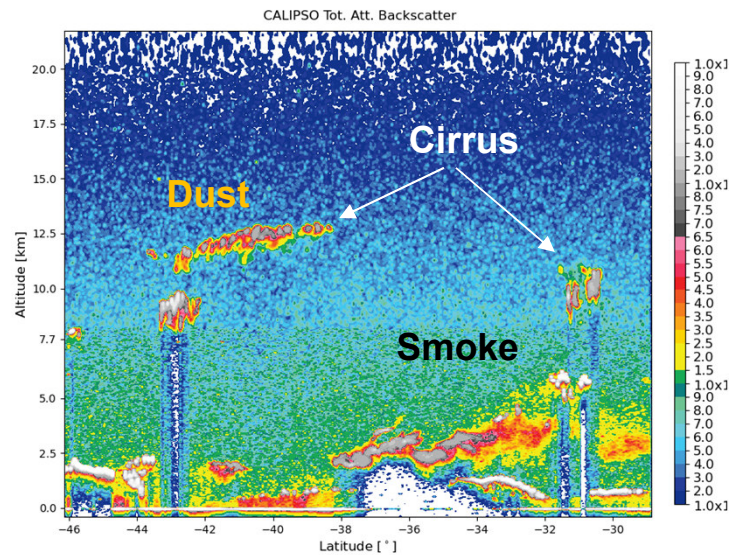
NASA Worldview: Modis 31.12.19 ~23:15 UTC

Australia's Black Summer 2019/20

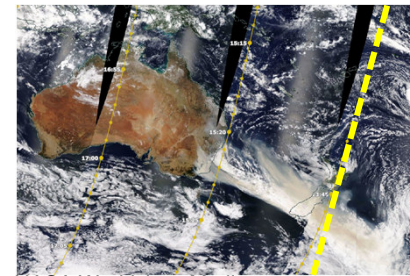
CALIPSO view on 01.01.2020 15:30 UTC
(Dusty- and smoky-cirrus?)



NASA Worldview: Modis

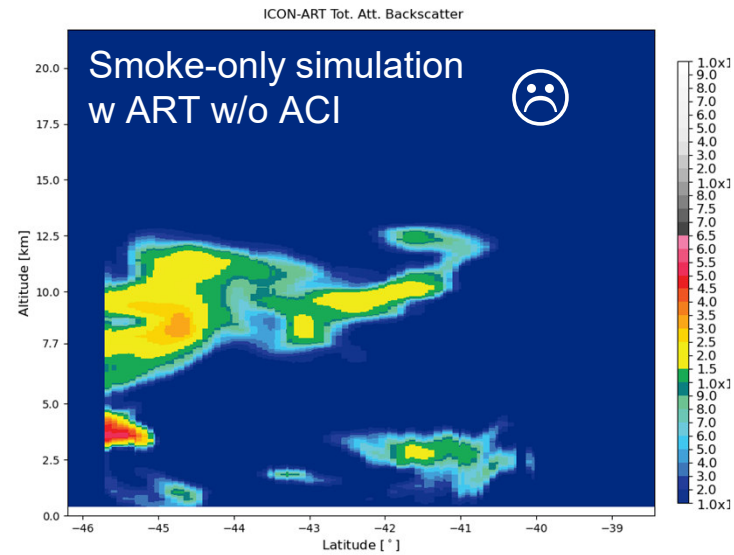
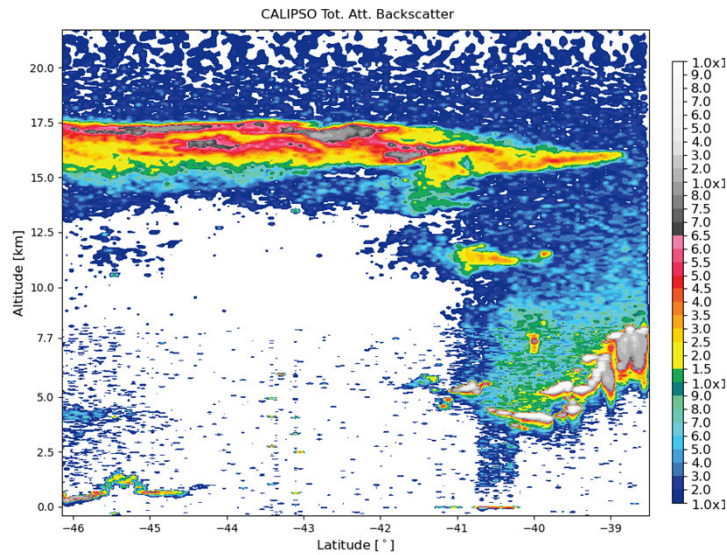


Australia's Black Summer 2019/20



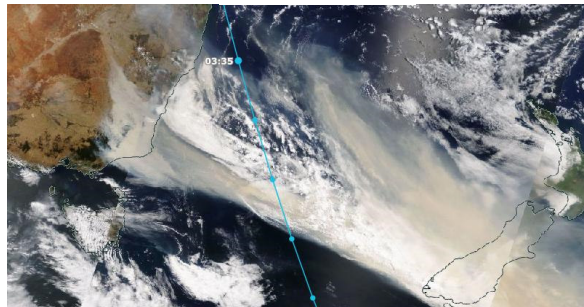
NASA Worldview: Modis

CALIOP view on 01.01.2020 13:30 UTC
(Missing source/processes?)



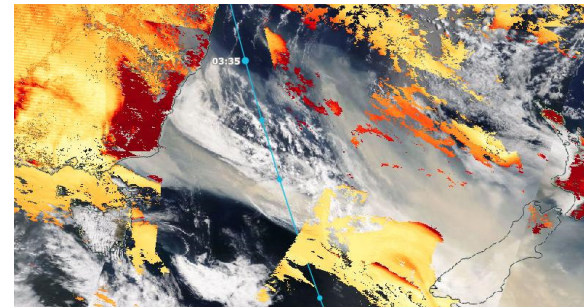
Plume top heights on 01.01.2020 03:30 UTC

MODIS View

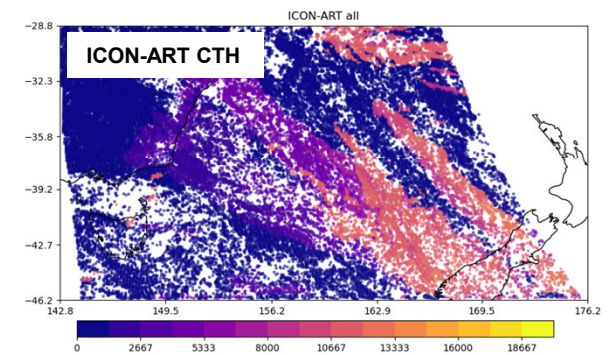
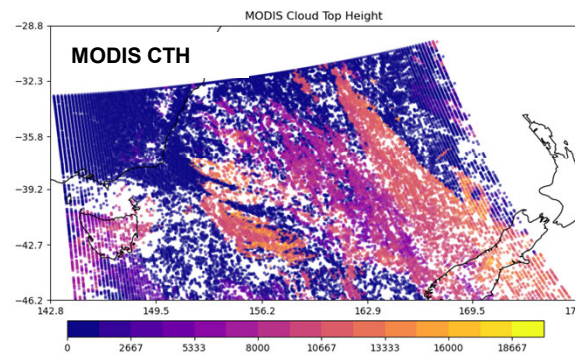
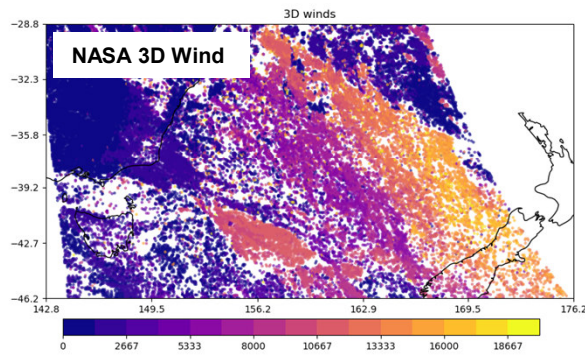


NASA Worldview: Modis

MAIAC AOD



NASA Worldview: Modis



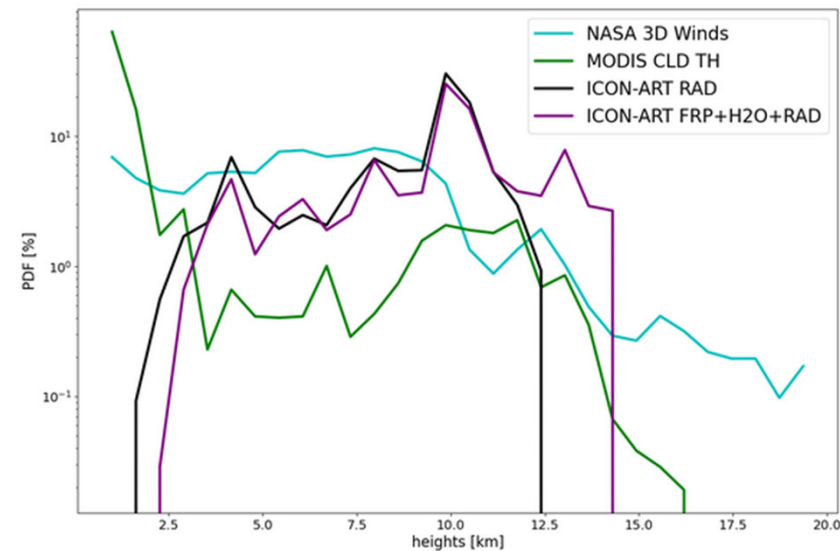
Plume top heights on 01.01.2020 03:30 UTC

Plume height is affected by:

- (Atmospheric conditions)
- Fire radiative power (FRP)
- H₂O emissions
- Aerosol-Radiation interaction (self-lofting)

Challenges:

- What is the truth?
- Missing/underestimated fires
- Heat flux and model resolution
- Plume rise / injection height



Summary

- New sea salt parameterization compares well with multi-model means
- Removal of sea salt mainly due to water absorption
- Aging of dust mainly due to condensation; shell mainly of SO_4 , NO_3 , NH_4 , H_2O
- No strong mixing of dust and sea salt
- Heat and H_2O fluxes improve the smoke plume height
- Coupling with radiation/microphysics?