

Excellence for NWP

Weather model view on the Saharan dust event 2021

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> The 2nd of February 2022 National Snow Seminar Helsinki, FMI

Murcia 19 Feb 2021 towards south. Photo Jakob Lödjquist

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From Sahara to Helsinki, February 2021





Helsinki sea ice on 15 UTC 25 Feb 2021 Photo Laura Rontu

Fog and snow on Helsinki sea ice

Between Tammisalo, Laajasalo, Vartiosaari. Photo Laura Rontu 24.2.2021

Melting snow on Helsinki sea ice



Between Tammisalo, Laajasalo, Vartiosaari. Photo Laura Rontu 25.2.2021

Saharan dust seen from Canary islands 2013



Izaña observatory on Teide, Tenerife 30.1.2013. Photo Laura Rontu

Source of Saharan dust on Canary islands 2013

10-metre winds over Sahara: eastern, up to 12 m/s 30.1.2013. Data: GFS

Weather maps for February 2021 Helsinki case

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Aerosol optical depth at 550 nm (provided by CAMS, the Copernicus Atmosphere Monitoring Serv

20210223 09UTC

Dust concentration in total column for particles with diameter 0.01-1um [g/m2]

Dust concentration in total column for particles with diameter 2.5-10um [g/m2]

Dust concentration in total column for particles with diameter 0.01-30 um [g/m2]

Dust concentration in total column for particles with diameter 10-30um [g/m2]

Result of SILAM (https://silam.fmi.fi) dust simulation experiment for 09 UTC on 23 February 2021

Total-column mass of dust aerosol [g/m²] of four size classes and their sum. The maximum dust load over Helsinki sea ice was around 0.15 g/m², over Tampere 0.25 g/m²

Aerosol total column optical depth according to CAMS/IFS-chem, dust particle sizes from 0.03 to 20 mkm (left) and all aerosols (right)

Vertical distribution of dust aerosol optical density [1/m] on 23 February 2021

according to SILAM (left for Harmaja lighthouse, middle for Tampere) and CAMS (right for Harmaja)

Aerosols and weather

Atmospheric aerosol influences evolution of clouds, precipitation and fog. Dust particles are insoluble, thus they influence in formation of cloud ice.

Cloud droplet and crystal number concentration depends on aerosol concentration and influences both precipitation and, via cloud particle size, radiation transfer in clouds. Most studies have focused in liquid cloud microphysics.

In clear-sky cases, the global SW radiation at the surface may reduce tens of W/m² due to direct radiation impact of aerosol. Influence of dust on visible and near-infrared solar radiation can be significant.

Aerosols and weather models

Where to take the aerosols from? HARMONIE-AROME: Aerosol climatology has been used for years for radiation parametrizations. Now we can import near-real-time aerosols from global chemical transport models like CAMS/IFS-chem, also for cloud parametrizations.

How to parametrize the direct and indirect radiation effects? HARMONIE-AROME: improvement of aerosol radiation transfer is ongoing in the framework of several radiation schemes.

How to handle the aerosols in cloud microphysics? HARMONIE-AROME: studies related to liquid and solid cloud particles and precipitation are ongoing within two different microphysics shemes.

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It is not easy to identify aerosol effects in the forecast

Which variables to use as indicators? Example: diagnostic precipitation type.

For model development we need more tools.

20°E 24°E 28°E

20°E

24°E

3

· hail

graupel

- fr.rain

fr.drizzle

- snow

· sleet

rain

28°E

drizzle

MUSC is the single-column version of the HARMONIE-AROME forecast model

We can modify the initial values of aerosols in air - climatological aerosol optical depth - reanalysis-based aerosol mass mixing ratios - near-real time mixing ratios - no aerosols at all

We can play with radiation and cloud microphysics parametrizations

different radiation schemes and options
different microphysics schemes and options
different ways to use aerosol data

We can learn about sensitivities and uncertainties but we cannot do real forecasts with MUSC

Example of MUSC sensitivity experiments on 23 February 2021. CAMS aerosols were used as input for different cloud microphysics parametrization options. MUSC was run for 3 hours from initial time.

THANK YOU – DISCUSSION, QUESTIONS!

Saharan dust on melting snow on Helsinki sea ice 25.2.2021. Photo: Laura Rontu

Result of SILAM (https://silam.fmi.fi) dust simulation experiment

Dust aerosol total-column optical depth for 09 UTC on 23 February 2021

Total dust AOD for particles with diameter 2.5-10um [unitless]

Total dust AOD for particles with diameter 1-2.5um [unitless]

rad0 - rad1 PFRSO

rad0 - rad2 PFRSO

rad0 - rad3 PFRSO

- 25

20

- 15

- 10

5

rad0 - rad4 PFRSO

rad0 - rad5 PFRSO

rad0 - rad6 PFRSO

rad0 - rad7 PFRSO

rad0 - rad9 PFRSO

rad0 - rad10 PFRSO

PFRSO

rad0 - rad11 PFRSO

rad0 - rad12 PFRSO

rad0 - rad13 PFRSO

Time (h)

Tegen

Aerosol MMRs for cloud microphysics parametrizations

FMI requested people to collect a cup of snow with Saharan dust, filter it by a coffee filter and send to researchers for analysis and to be studied in nucleation chamber. They got 525 citizen samples. Studies are ongoing.

This case is interesting from the point of view of cloud microphysics parametrizations. Unfortunately, it was too cloudy and too little SW radiation to estimate accurately the aerosol optical depth based on radiation measurements.

