CAMAERA

ONGOING WORK TO REPRESENT HIGH LATITUDE DUST SOURCES IN THE GLOBAL CAMS SYSTEM

9th HLD workshop, 13/2/2025

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HYGEOS, Lille, France

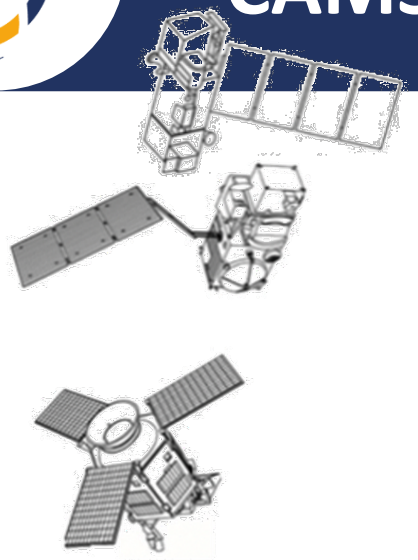
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

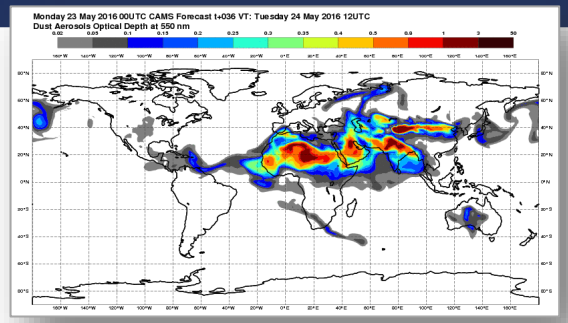
IMPLEMENTED BY ECMWF

Coordinated by HYGEOS

CAMS in a nutshell

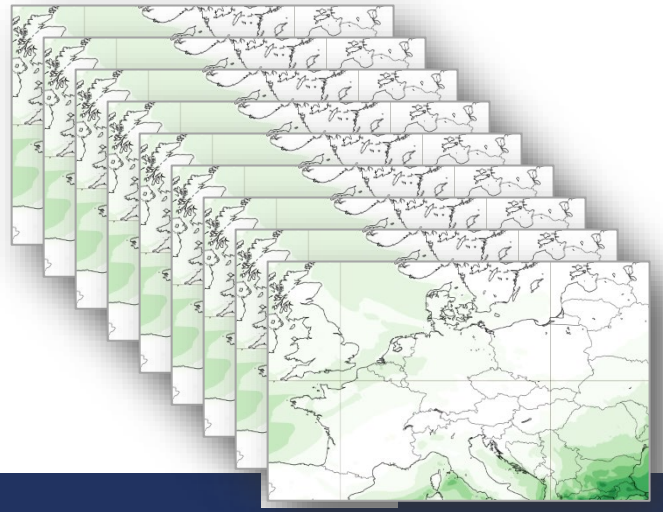


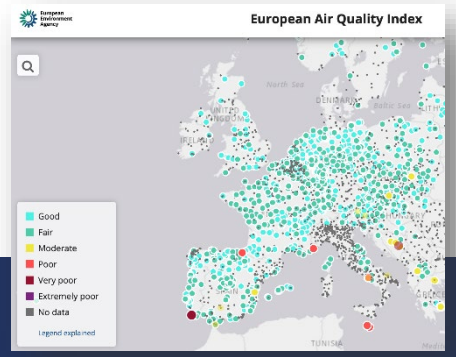
Earth Observation from satellite (>75 instruments) and in-situ (regulatory and research)

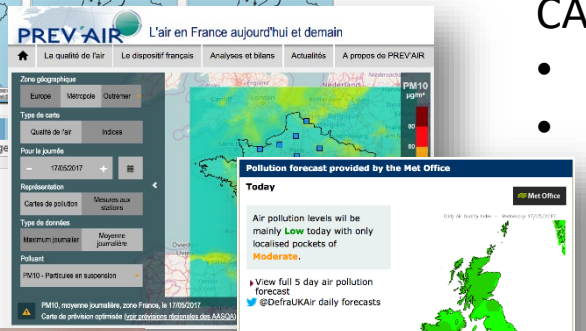


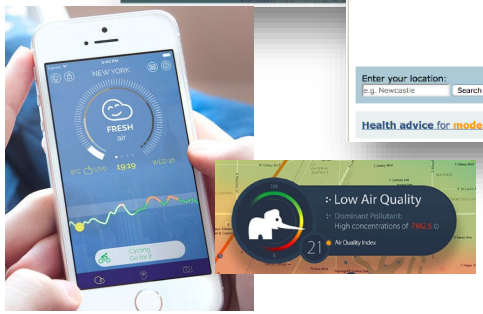
IFS-COMPO 40km (oper) / 80km (reana) Global

CAMS main operational data assimilation and modelling systems









CAMS users
- Applications
- Policy products

CAMAERA in a nutshell

- **CAMS AERosol Advancement (CAMAERA)** is a Horizon Europe Project to support the development of the Copernicus Atmosphere Monitoring Service (CAMS)
- CAMS provides consistent and quality-controlled information about atmospheric composition relevant for air pollution, solar energy, greenhouse gases monitoring and climate forcing …
- CAMAERA is one of a family of Horizon Europe projects dedicated to improving CAMS products:
  - **CAMEO** (started 1/1/2023, led by ECMWF), which focuses on uncertainties and data assimilation
  - **CATRINE** (started 1/1/2024, led by ECMWF), which focuses on transport applied to greenhouse gases

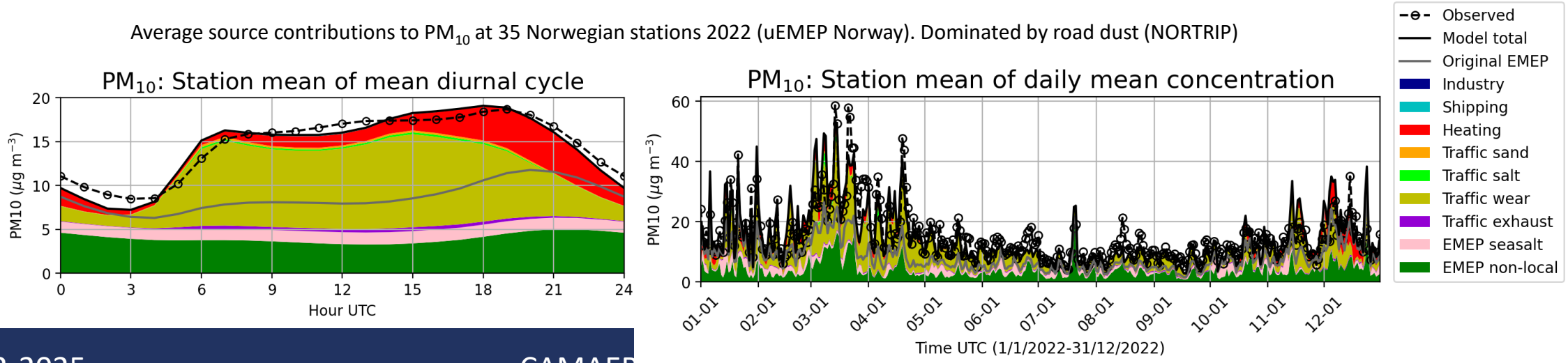
Scope of CAMAERA:

- Focus on aerosols and precursor gases
- Improve aerosol modeling capacities of regional and global systems
- Development of new data assimilation methods
- Foster exchanges between regional and global components of CAMS

CAMAERA – planned dust related work

- Best estimate of global dust emissions (online with IFS-COMPO and offline)
- Machine learning to estimate global dust emissions, using the best estimate IFS-COMPO dust emissions
- Assimilation of infra-red radiances (link with CAMEO – dust control variable)
- Development of a gridded version of the NORTRIP road dust emission scheme and implementation into EMEP, EURAD-IM, LOTOS-EUROS
- Focus on high-latitude dust (HLD) for IFS-COMPO

Average source contributions to PM_{10} at 35 Norwegian stations 2022 (uEMEP Norway). Dominated by road dust (NORTRIP)



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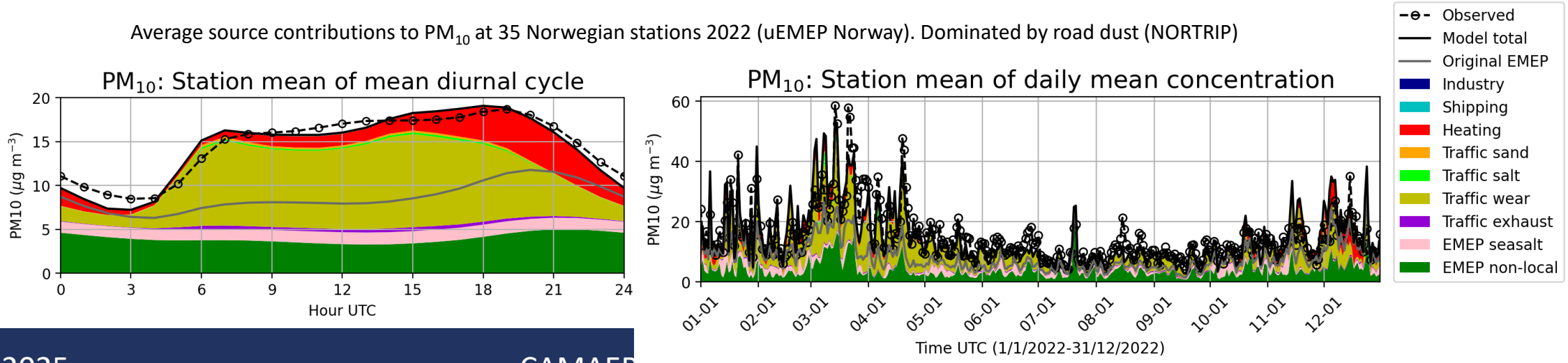
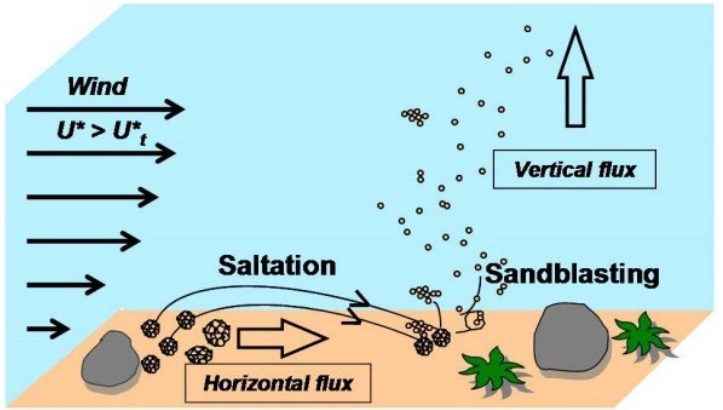


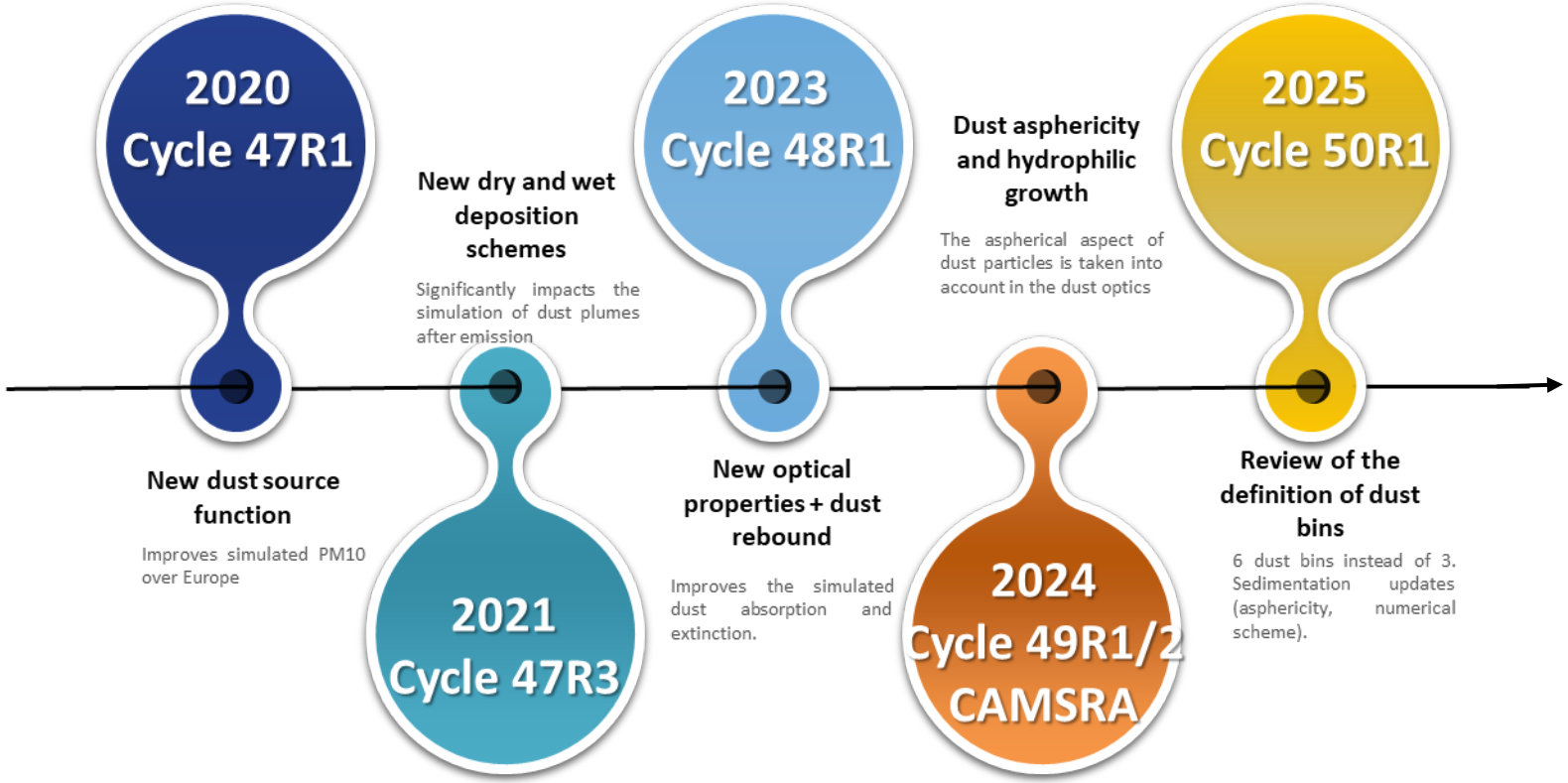
Modelling of dust emissions in IFS-COMPO

- Dust is emitted in the atmosphere through the saltation and sandblasting processes,
- These processes depend on meteorological (friction velocity) and surface (soil wetness, silt/sand/clay fraction) parameters,
- In IFS (CAMS Global), we use the Marticorena and Bergametti (1995) scheme to represent saltation and sandblasting, associated with a Kok et al (2011) dust size distribution at emissions,
- Dust emissions are tuned by a « dust source function » (DSF) computed by comparing simulated and retrieved dust AOD
- 3 dust bins (0.03-0.5, 0.5-0.9, 0.9-20 micron radius)
- Experimental version with 6 bins (0.03-0.5, 0.5-0.9, 0.9-2.5, 2.5-5, 5-10, 10-20 micron radius) – **work shown here uses this version**
- Several challenges:
  - Uncertainty of some inputs (soil typology in particular)
  - Representation of small scale processes with a 40x40km grid cell
  - For high latitude dust – often small signal in retrieved dust AOD, so ignored in the DSF



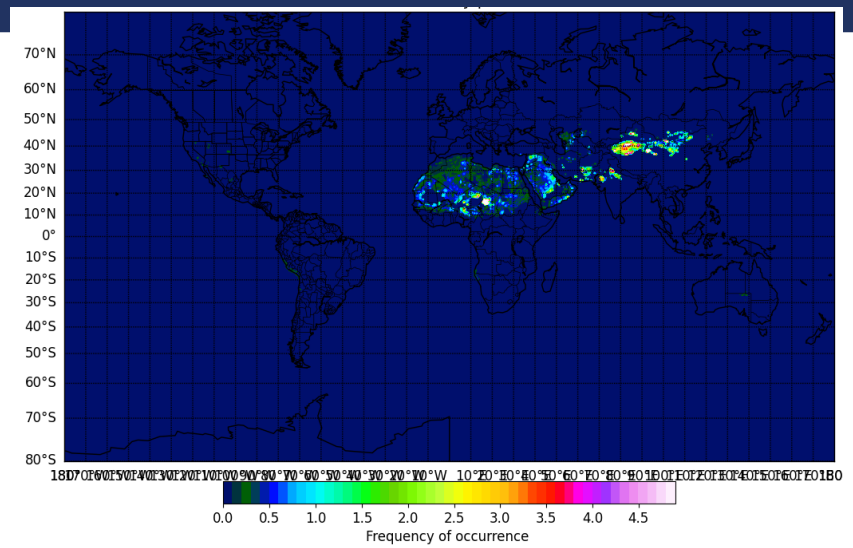
Schematic from LISA representing the key processes for the production of desert aerosols.

Evolution of dust modelling in IFS-COMPO



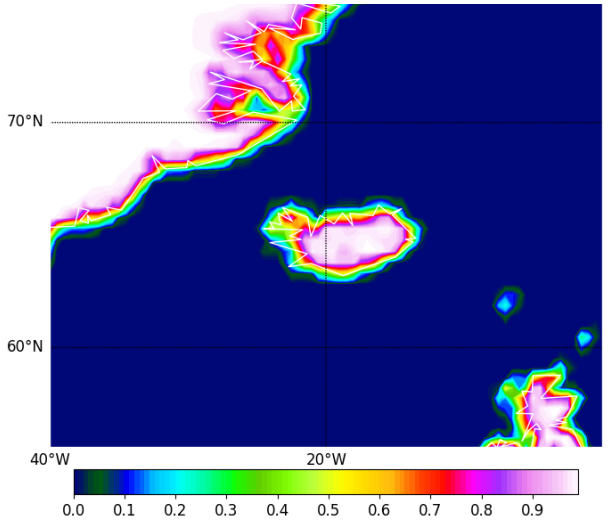
Specific challenges for HLD sources in IFS-COMPO

- Dust sources are modulated by a monthly dust source function (DSF) that has been computed using remote sensing derived dust AOD (MIDAS product), which shows little signal over HLD source regions



OPER DSF (May)

- The horizontal resolution (Tl511 – 40km grid cell) is quite coarse for most of HLD source which are quite local

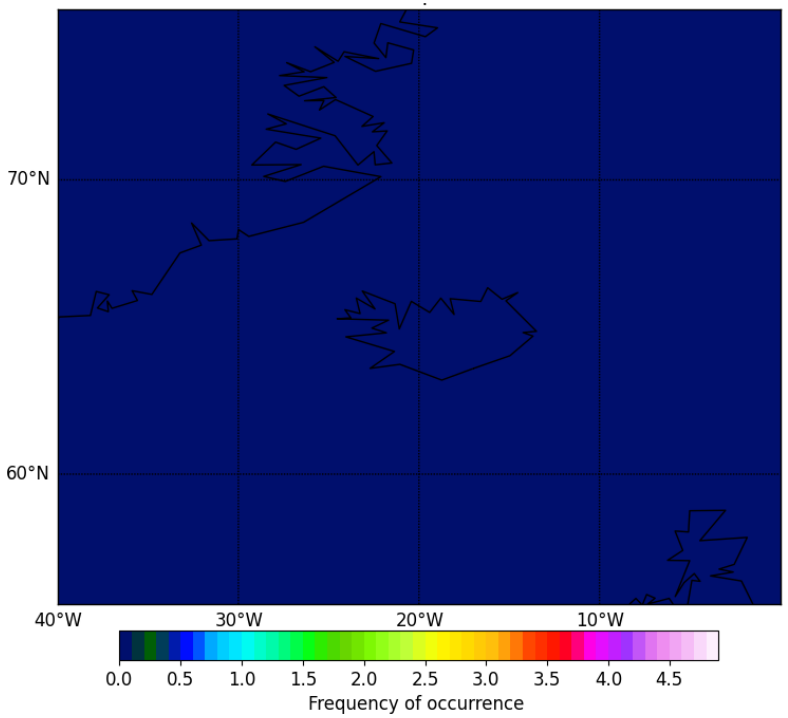


OPER Land sea mask

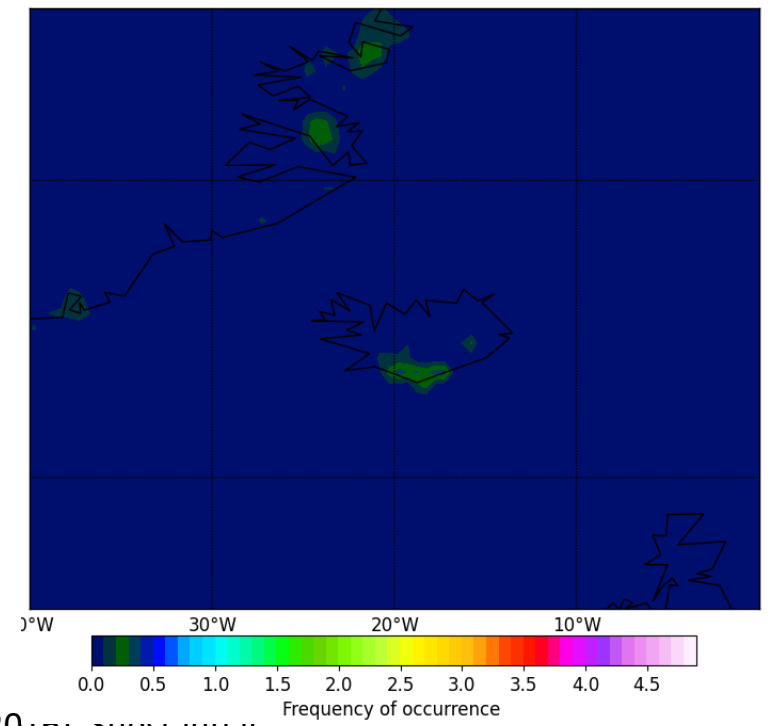
PATHWAYS TO IMPROVE HLD IN IFS-COMPO

A first option is to update the DSF to take into account HLD sources. For this, data from Groot Zwaftink et al (2016) is merged with the operational DSF. Over Iceland, this uses data from Dagsson et al. (2014).

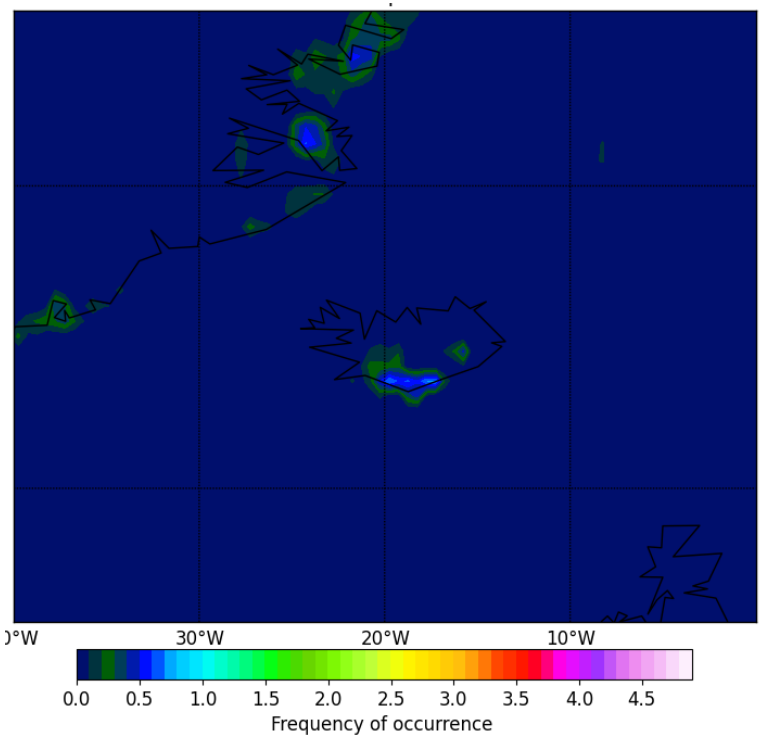
OPER DSF



HLD1 DSF



HLD2 DSF

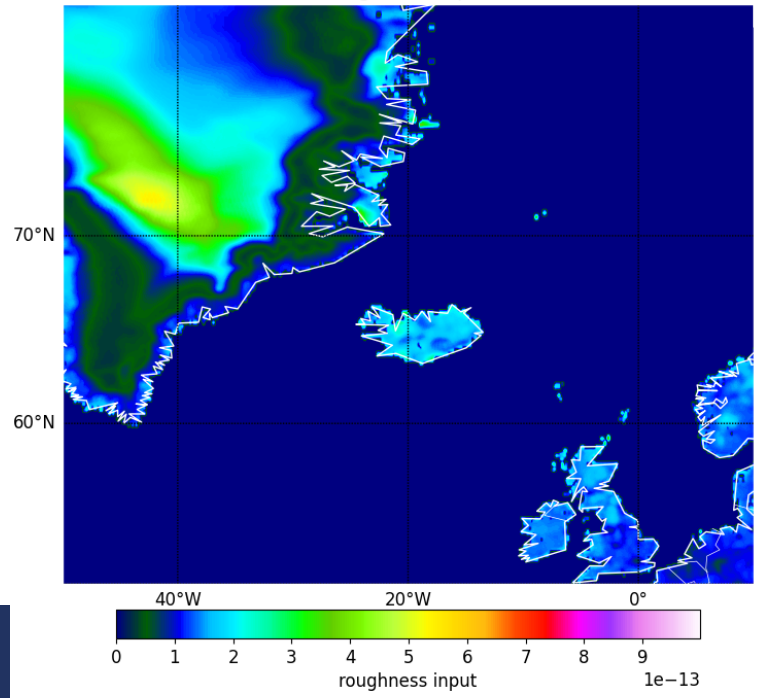


G 2016), Substantial contribution of northern high-latitude sources to mineral dust in the Arctic, J. Geophys. Res. Atmos., 121, 13,678–13,697, doi:10.1002/2016JD025482.

PATHWAYS TO IMPROVE HLD IN IFS-COMPO

A second option is to update the dust emission scheme – implementation in IFS-COMPO of dust emission scheme adapted from the SILAM dust emission scheme, which uses an input derived from remote sensing surface roughness. 3 options are being tested:

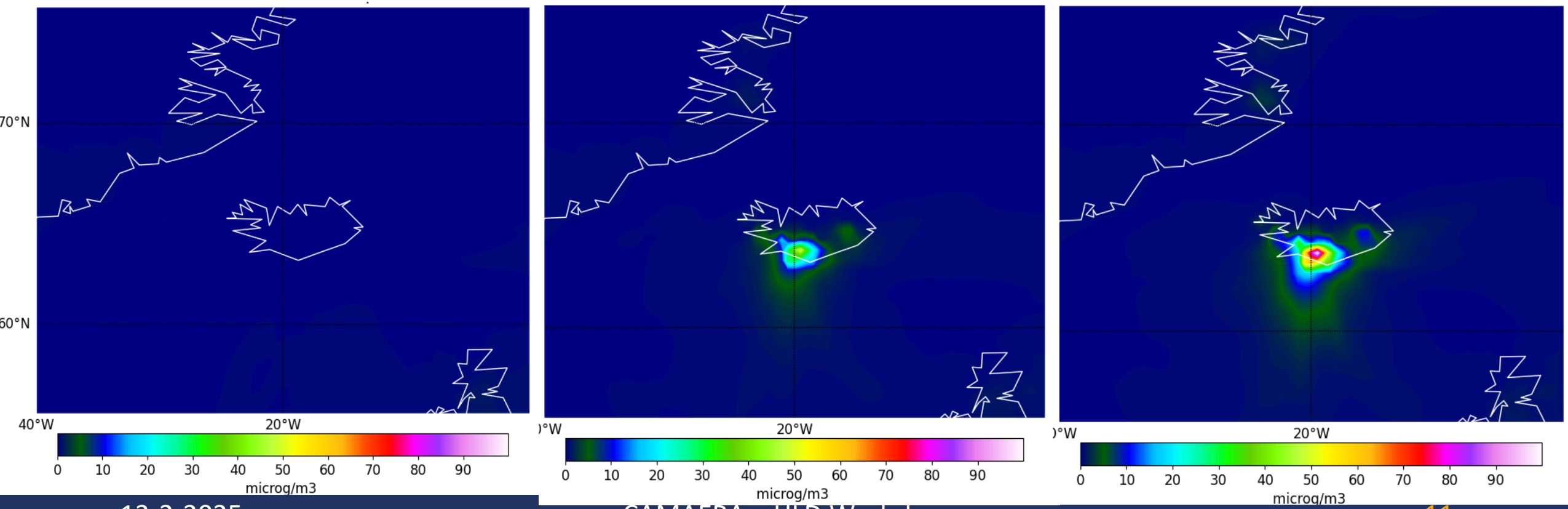
- Surface roughness from ERS (Prigent et al 2012) – DSF1
- Surface roughness from ASCAT provided by FMI – DSF2
- Surface roughness from ASCAT modulated by orography – DSF3



IMPACT ON SIMULATED DUST SURFACE CONCENTRATION

IFS-COMPO simulations without data assimilation have been carried out for the year 2019, in forecast only, to test the proposed changes. Here, impact of the proposed changes in DSF with the operational scheme, for June 2019. The total dust surface concentration is shown.

OPER DSF **HLD1 DSF** **HLD2 DSF**



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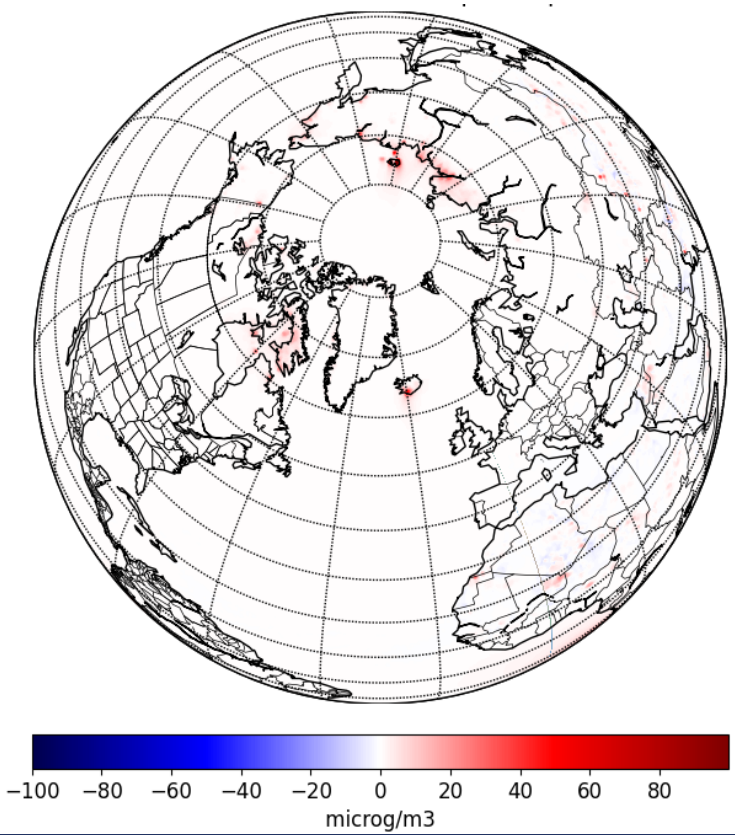
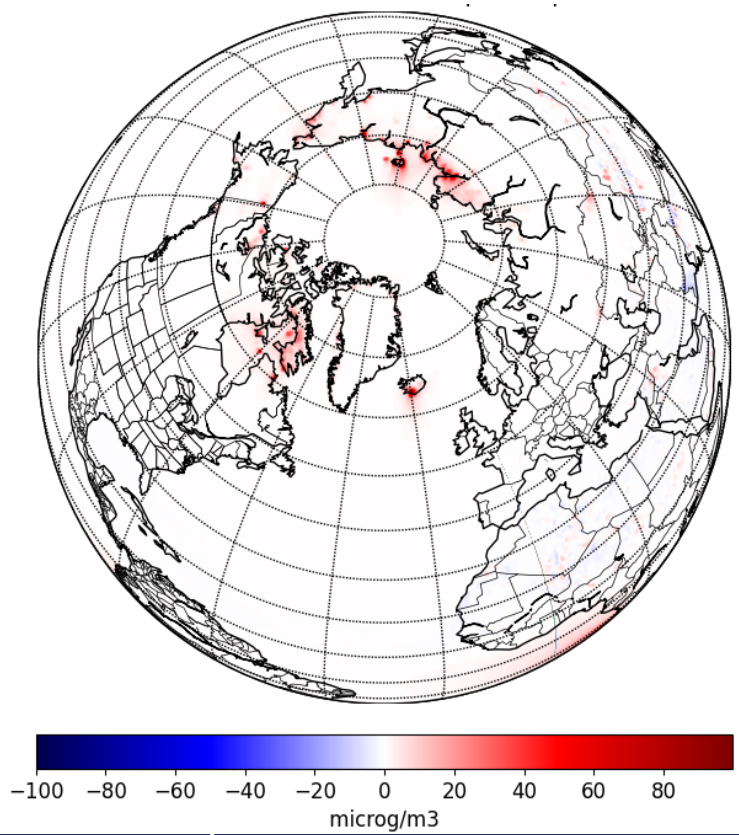
HLD1 DSF - OPER



HLD2 DSF - OPER



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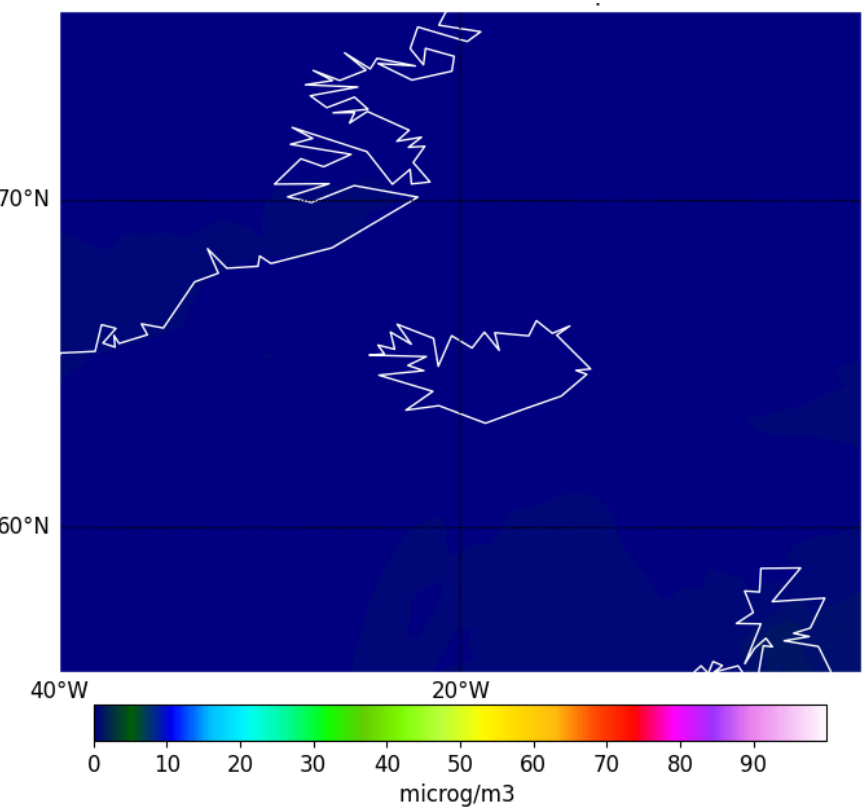
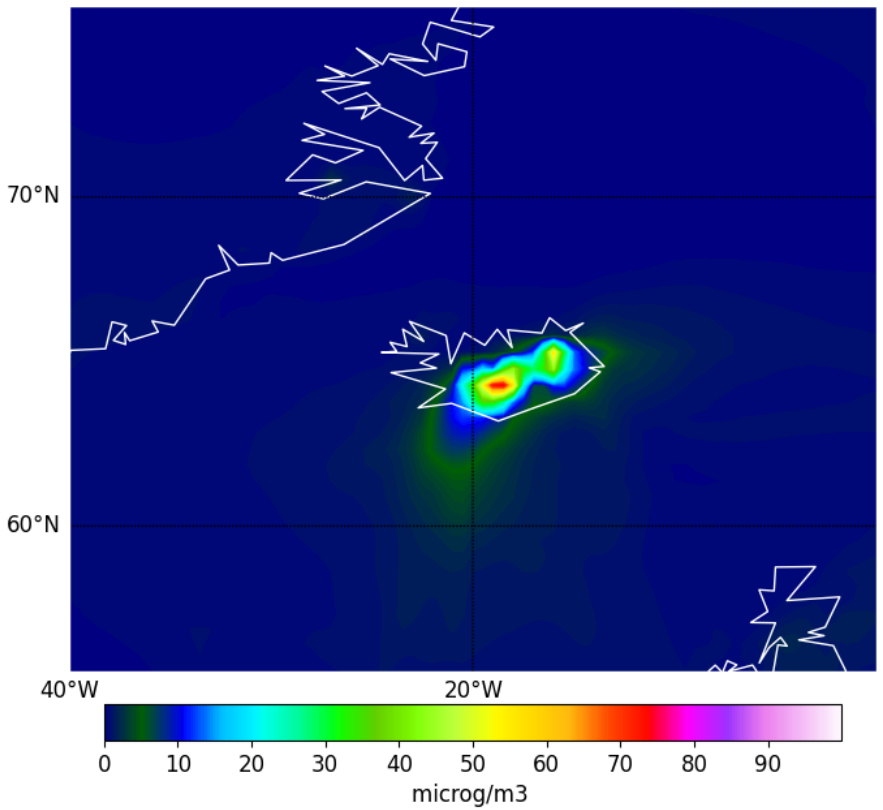


NEW Dust scheme



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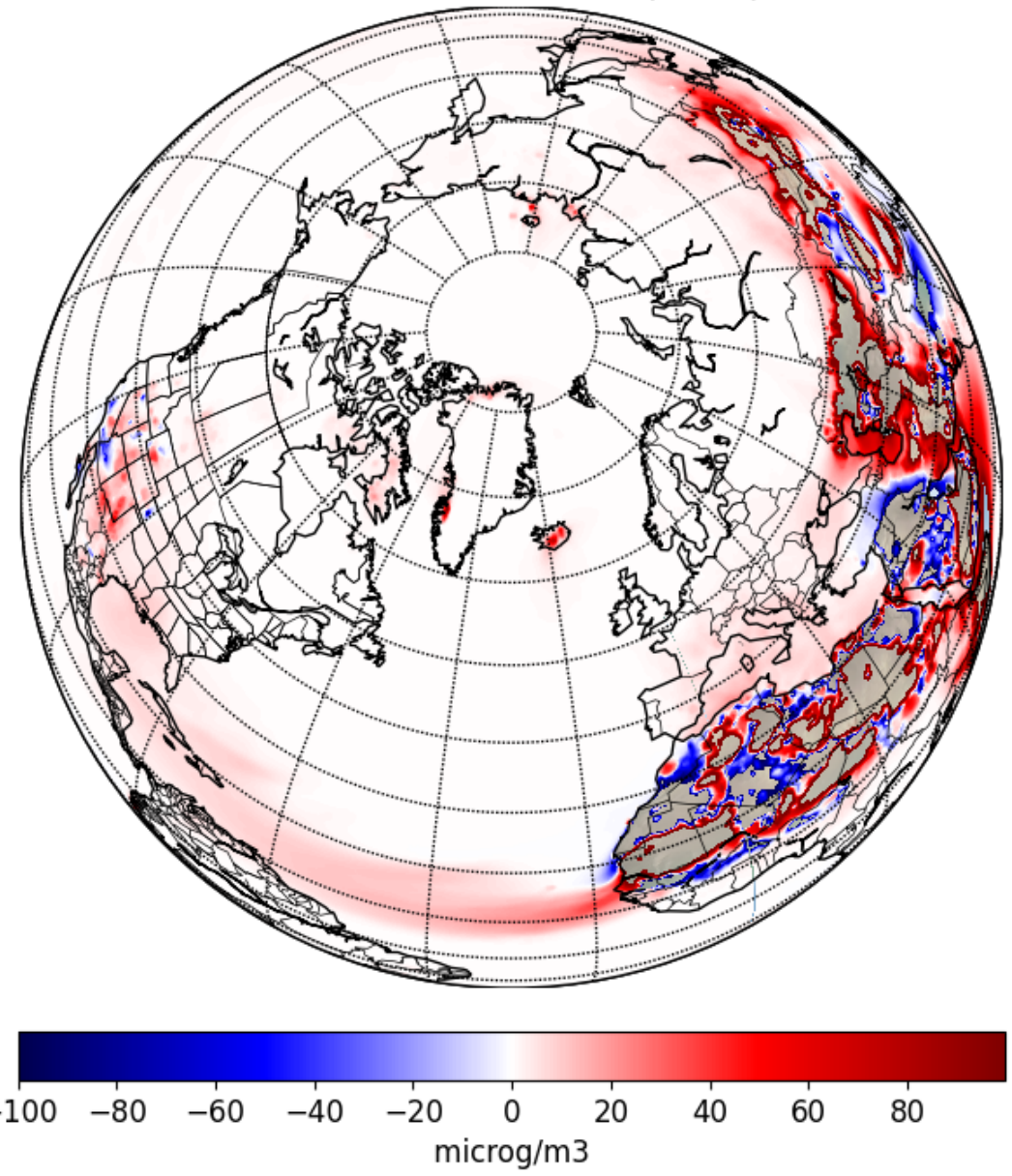

IMPACT ON SIMULATED PM10

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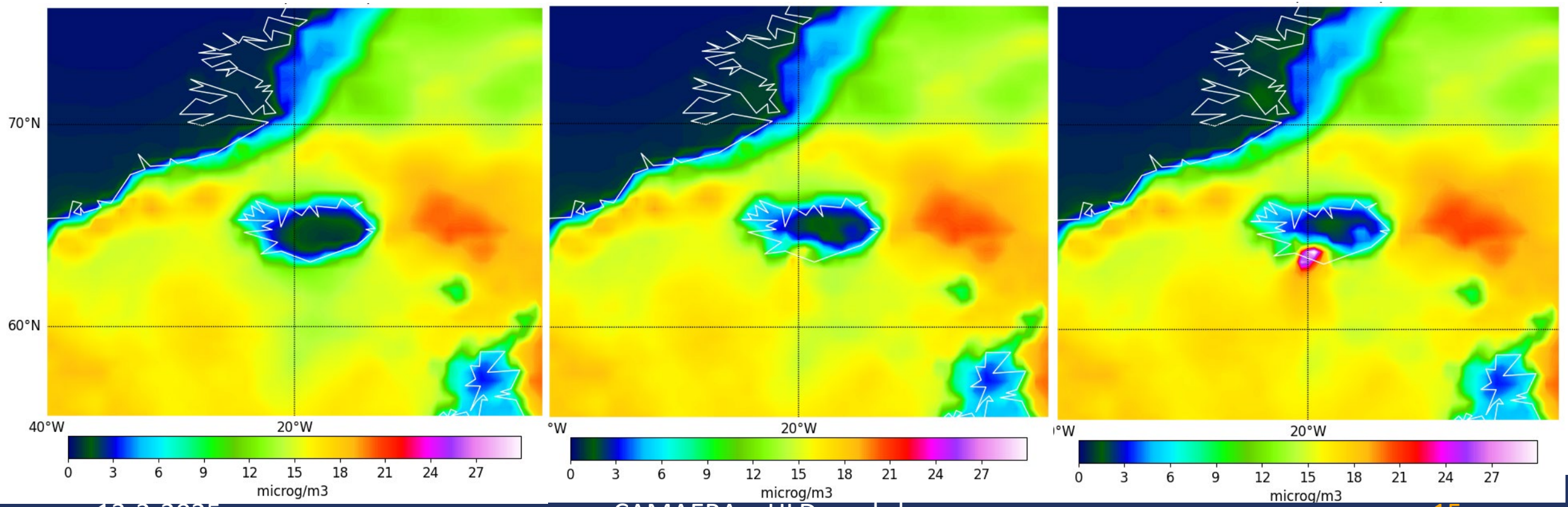

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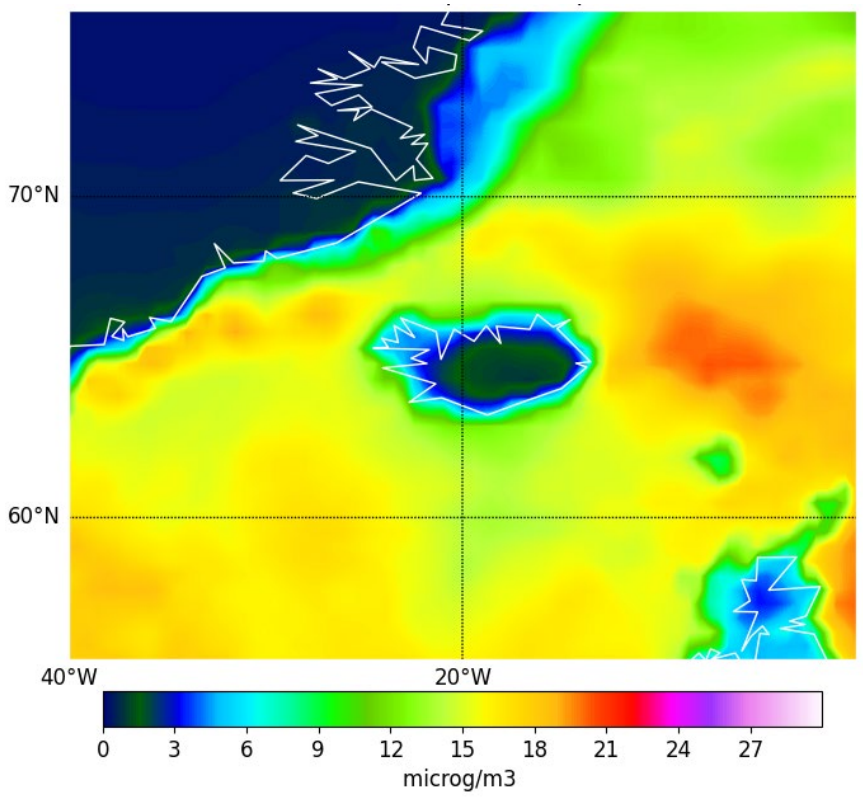

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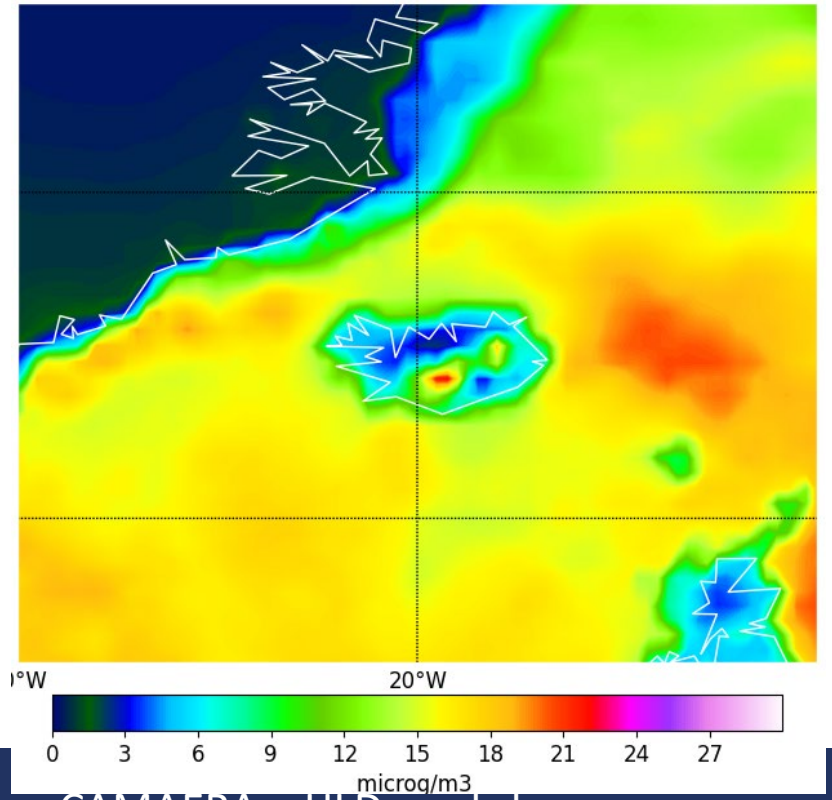
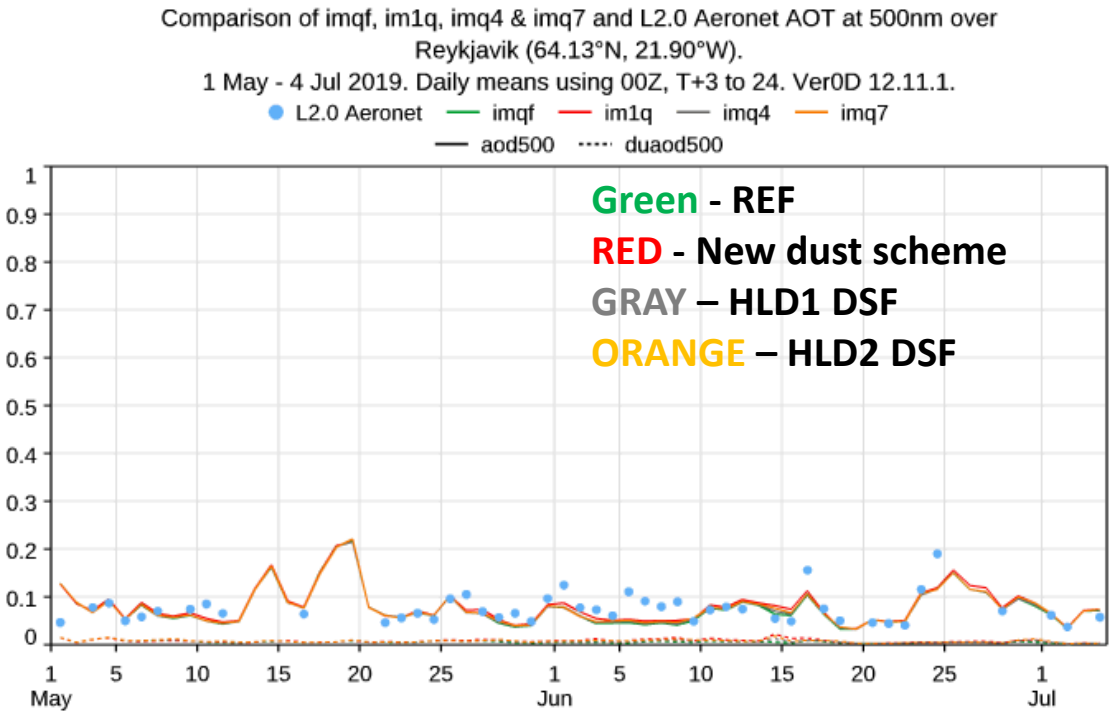
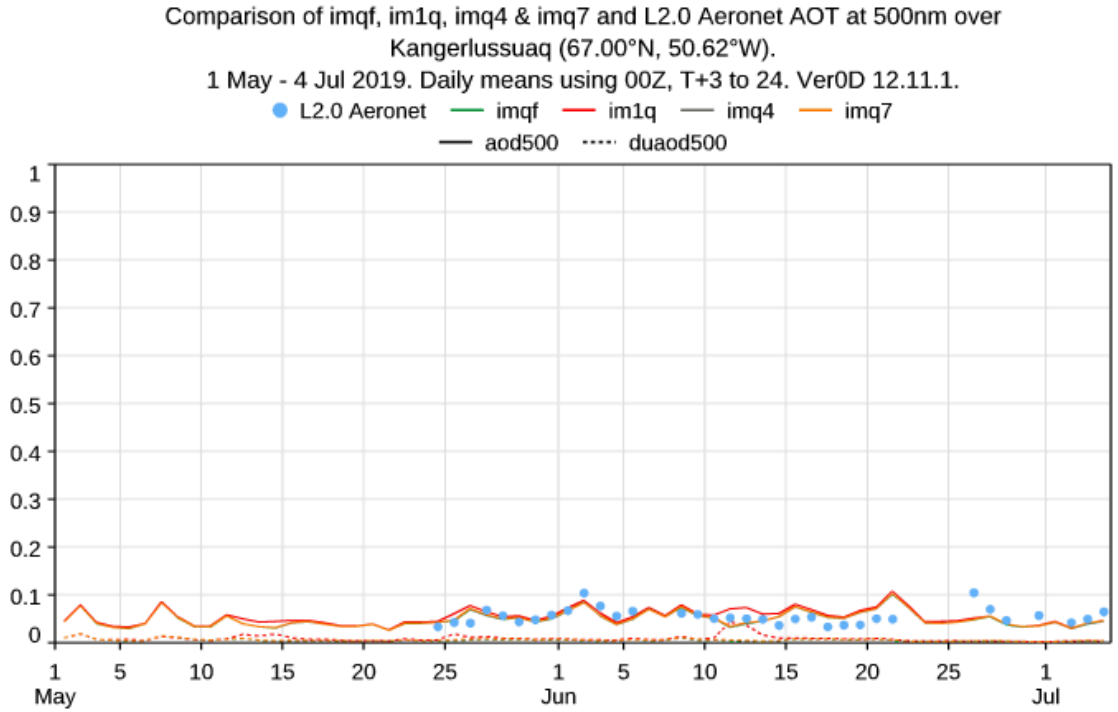


EVALUATION VERSUS OBSERVATIONS - AOD

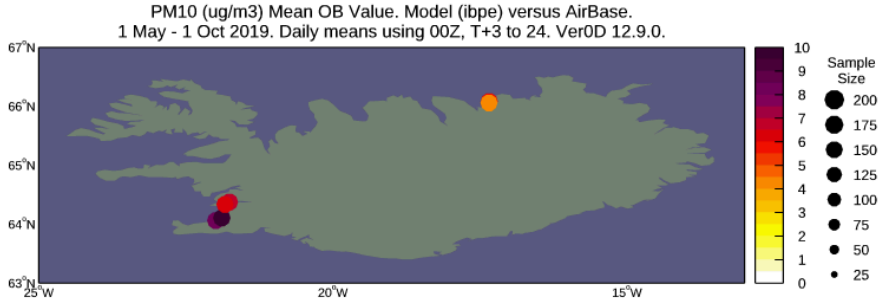
Evaluation of simulated AOD at 500nm versus AERONET observation at Reykjavik

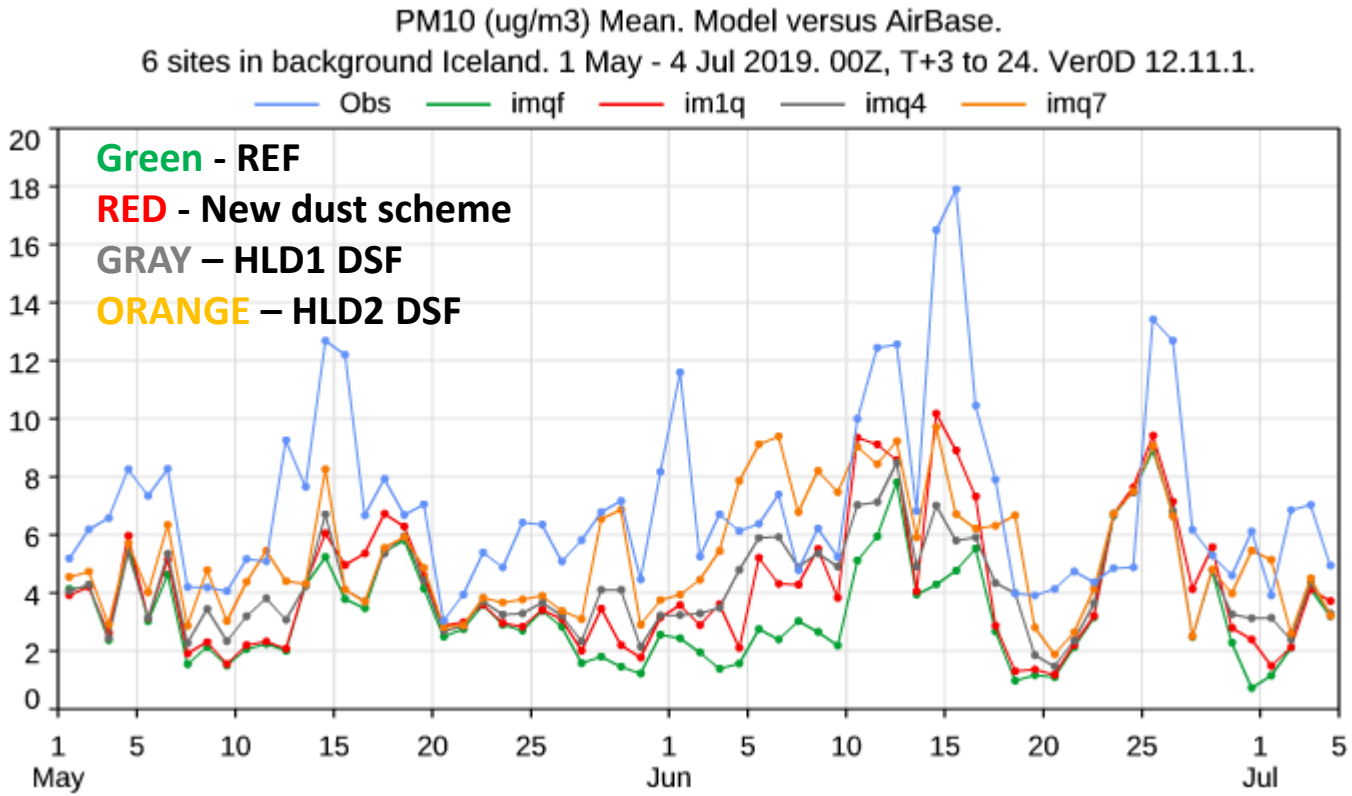




EVALUATION VERSUS OBSERVATIONS – PM10

Evaluation of simulated PM10 versus observations over Iceland





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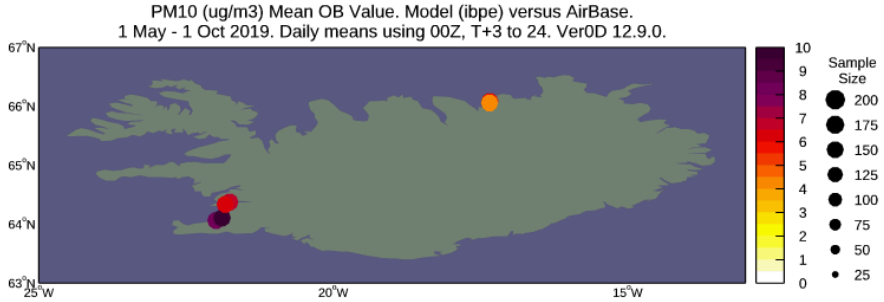

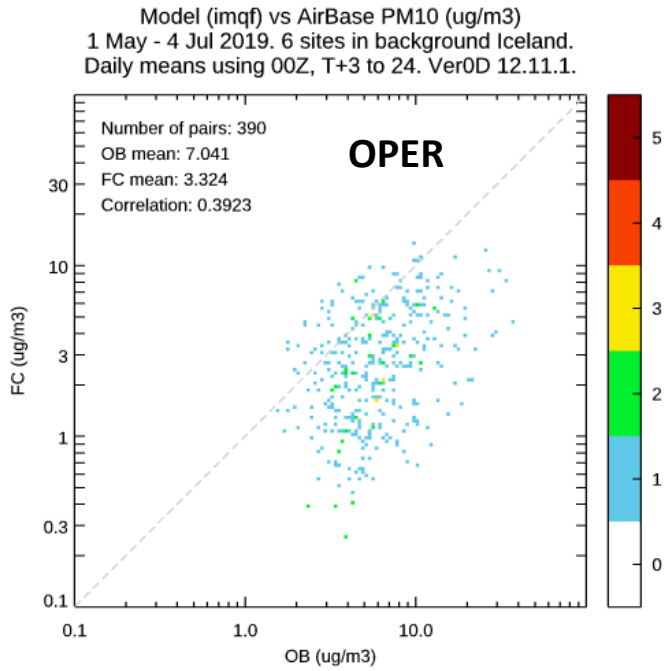

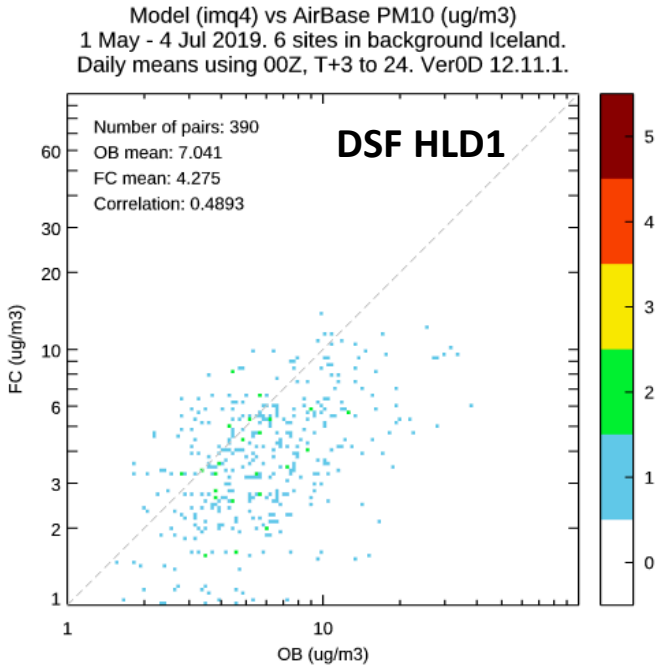

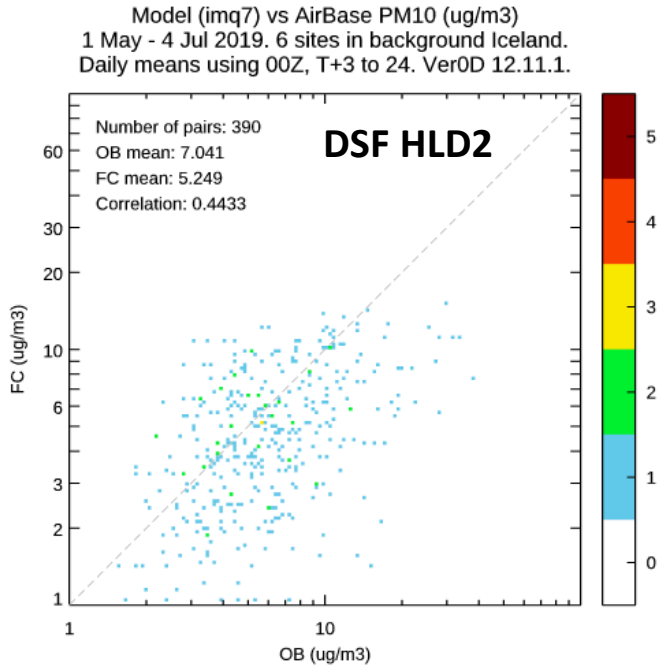

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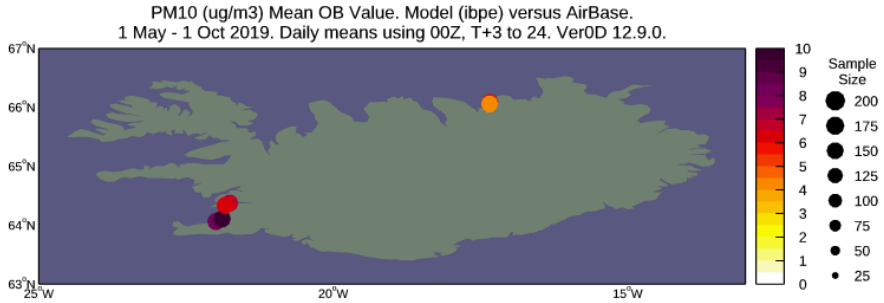
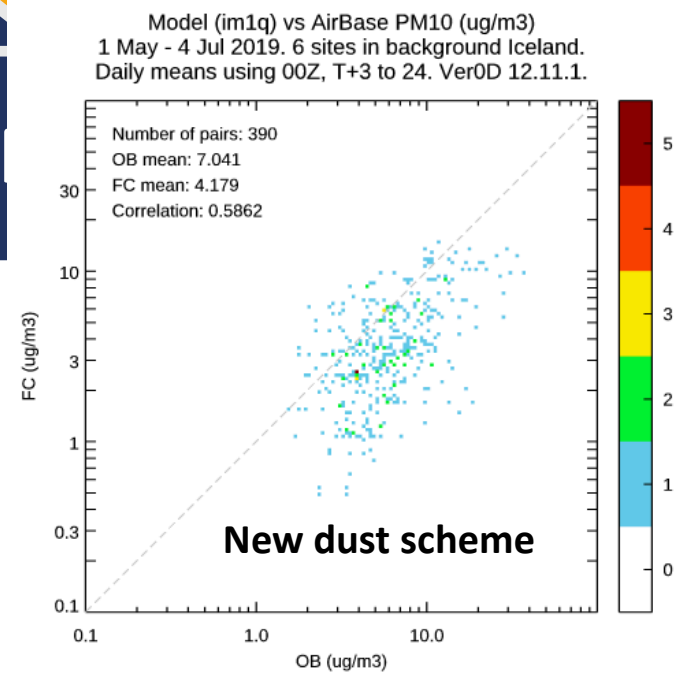
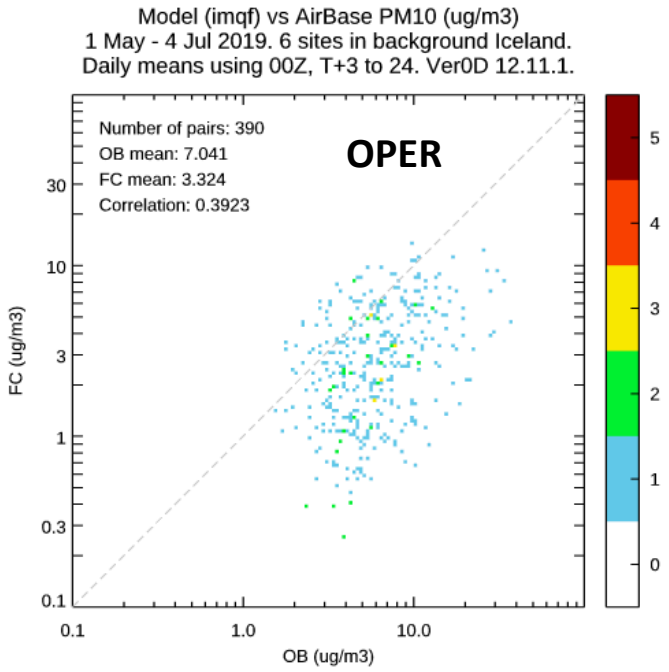
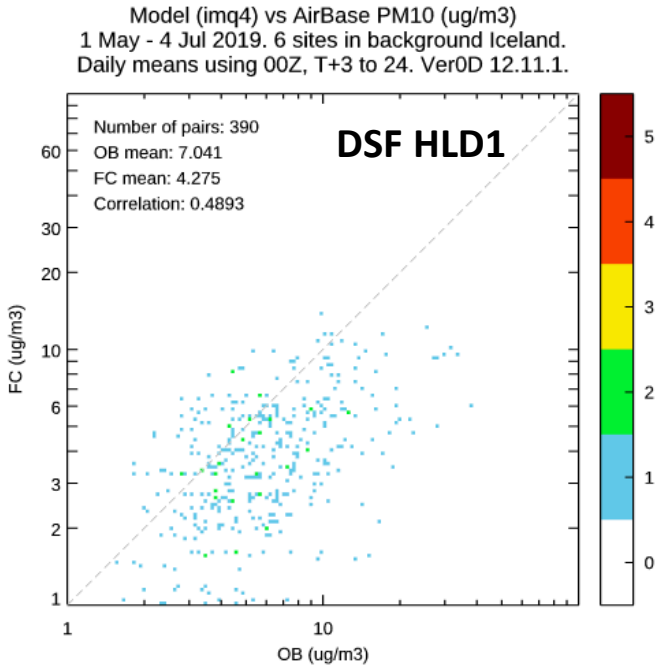
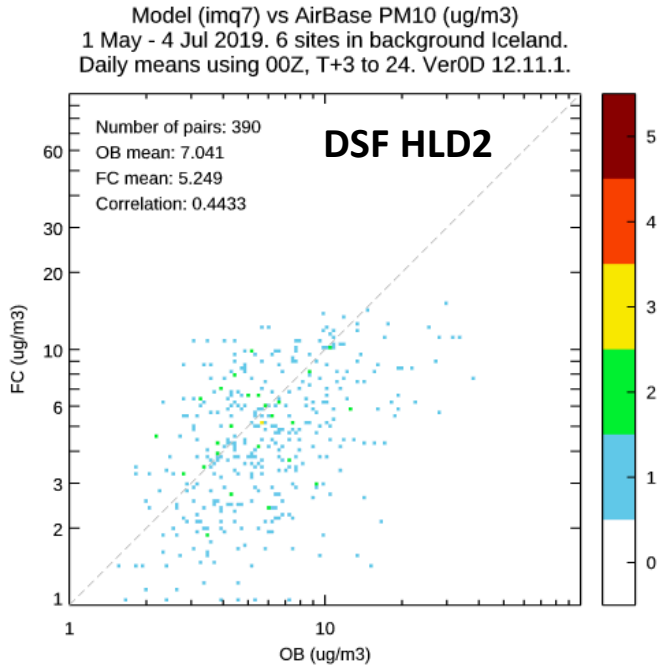




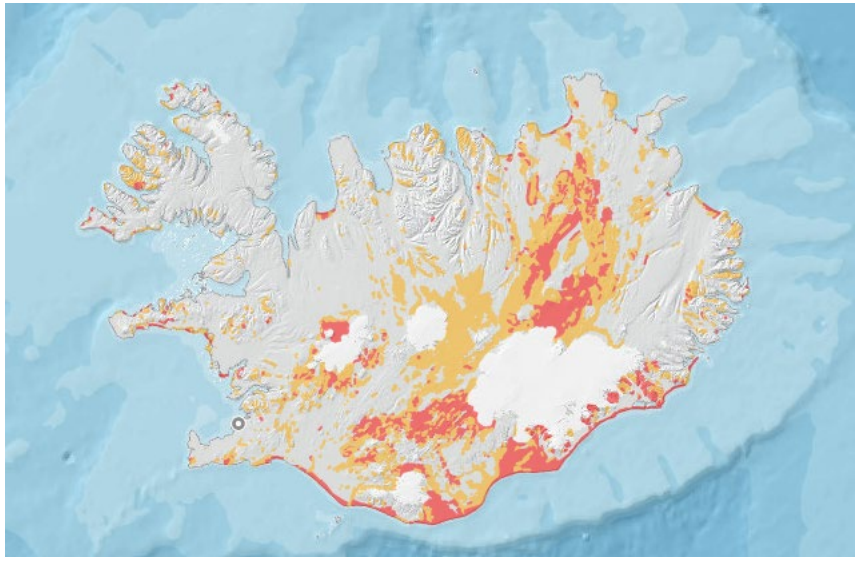






CONCLUSIONS - PERSPECTIVES

- For simulations of Icelandic dust sources, the new dust emission scheme seems to work better than updating the dust source function of the current operational scheme
- Longer evaluation needed
- Simulation of HLD sources seems improved – but evaluation is not easy because of sparse observations



What comes next

- Additional observations (PM in particular) to evaluate the model
- Dust sources – erosion map
- Comparison to DREAM-Iceland?