Landbúnaðarháskóli Íslands
Agricultural University of Iceland

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METEOROLOGISKA INSTITUTET
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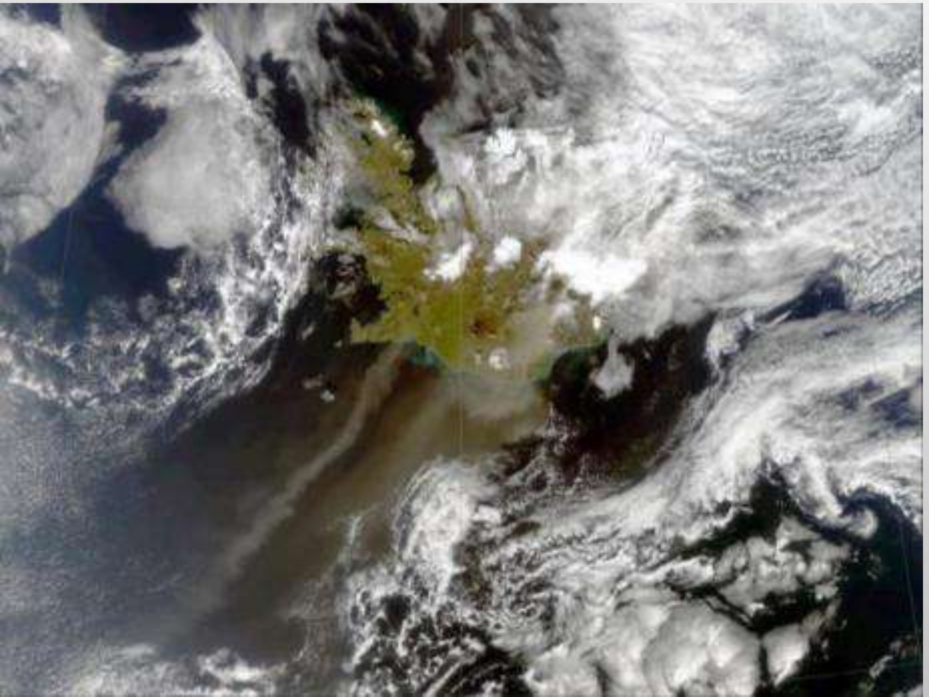
cnrs

Institute of Geology AS CR, v.v.i.

UNIVERSITY OF LEEDS

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

IMPACTS OF ICELANDIC DUST ON THE ENVIRONMENTAL SYSTEMS



PAVLA DAGSSON-WALDHAUSEROVA

O. ARNALDS, H. OLAFSSON, O. MEINANDER, M. GRITSEVICH, J. PELTONIEMI, J-B RENARD, J. HLADIL, L. CHADIMOVA, J. KAVAN, B. MORONI, D. DJORDJEVIC, D. URUPINA, A. SANCHES-MARROQUIN, B. MURRAY, J. BROWSE, C. BALDO, Z. SHI, AND MORE

THE 5TH HIGH LATITUDE DUST WORKSHOP

10-11 FEB 2021 I REYKJAVÍK I ICELAND

TALK OUTLINE

- UPDATE ON THE HIGH LATITUDE DUST SOURCES
- UPDATE ON DUST OBSERVATIONS IN ICELAND IN 2020
- IMPACTS OF DUST ON ATMOSPHERE, CRYSOPHERE AND OTHER SYSTEMS
- UPDATE ON THE ICELANDIC AEROSOL AND DUST ASSOCIATION (ICEDUST)

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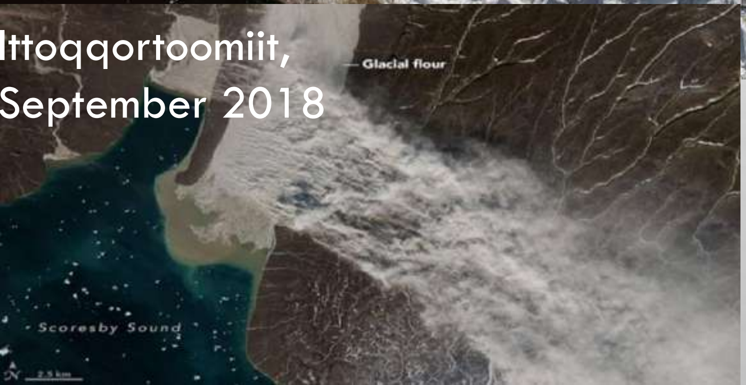
HIGH LATITUDE DUST AREAS

New paper/map in preparation by Meinander et al. on Merging > 20 new HLD sources

Nuussuaq Peninsula, October 2020



Ittoqqortoomiit, September 2018

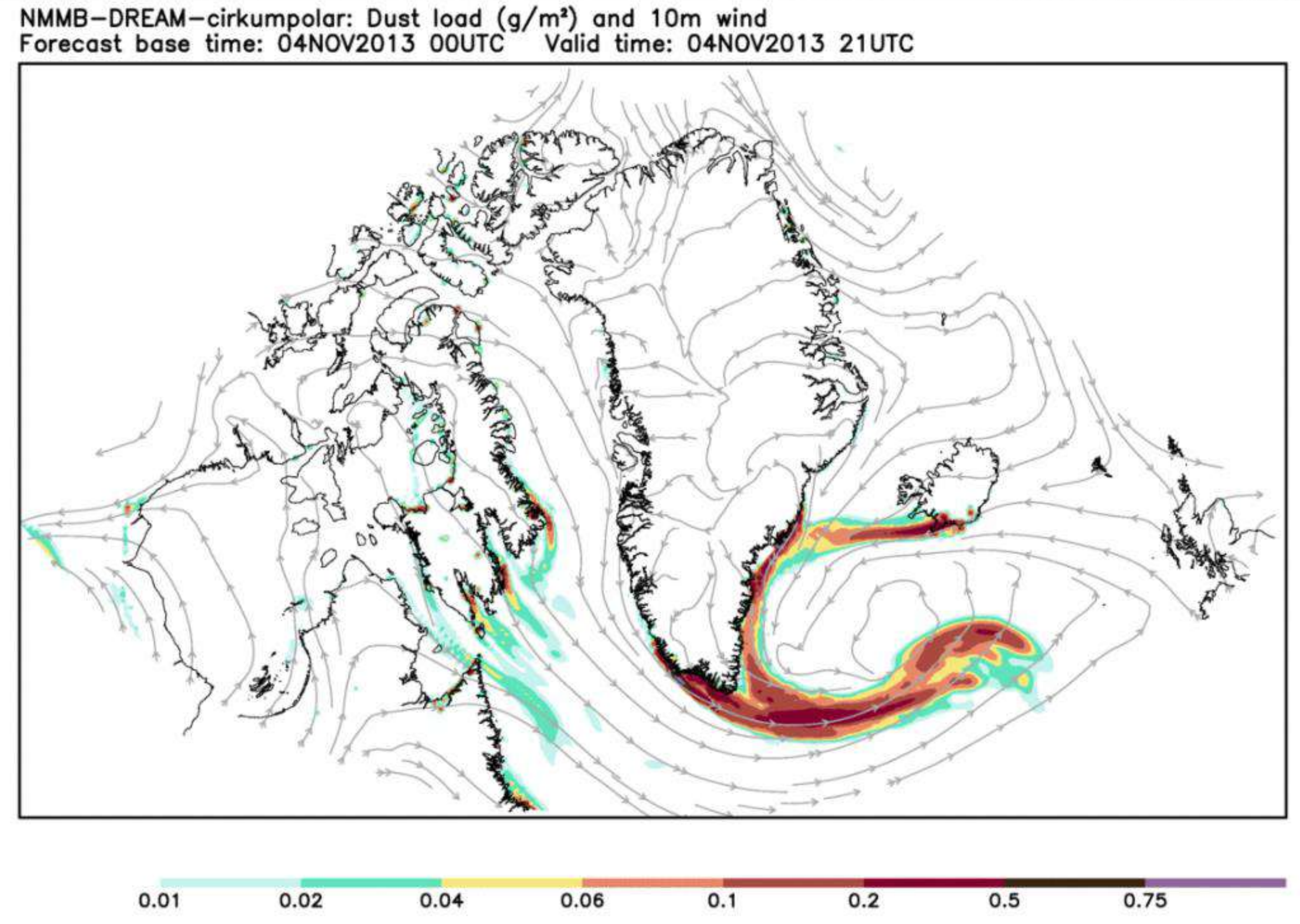
RUSSIA DISPATCH

In Russian Village Swallowed by Sand, Life's a Beach. Just Not in a Good Way.

Shoyna, a fishing village in the frigid far north, is slowly vanishing under dunes that engulf entire houses. For children, home is now a giant sandbox. Adults have to "say goodbye to my high heels."

HIGH LATITUDE DUST AREAS

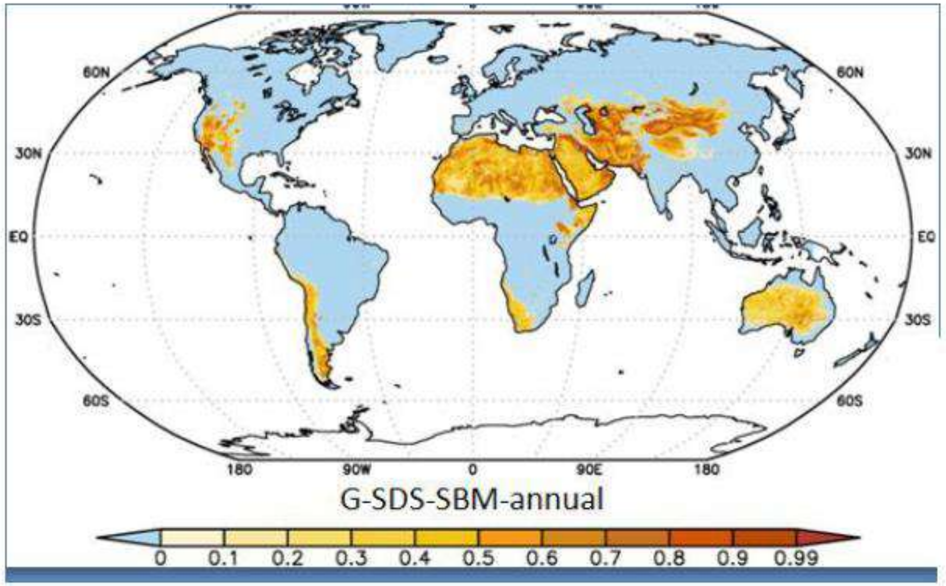
Nickovic, Cvetkovic et al. Circumpolar DREAM model for the HLD sources



HIGH LATITUDE DUST AREAS

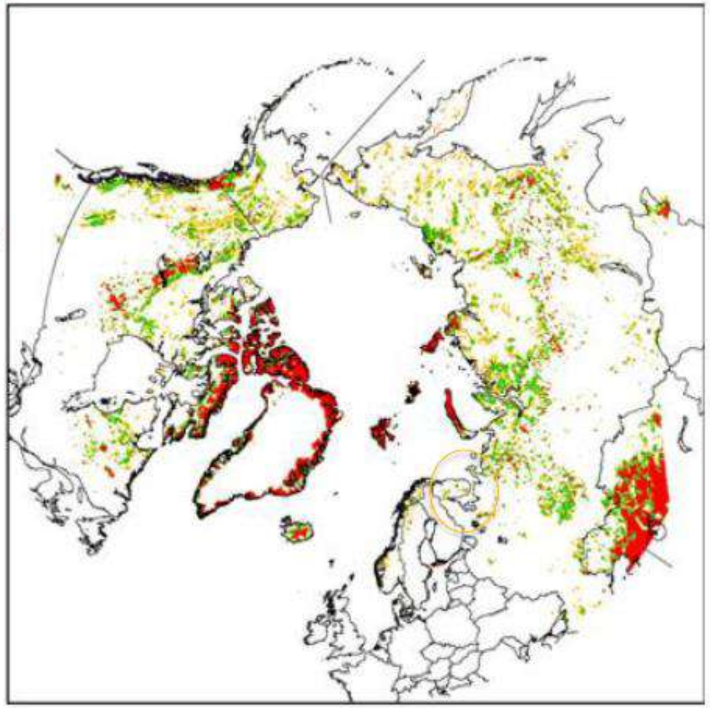
Vukovic, 2019. Sand and Dust Storms Source Base-map

https://maps.unccd.int/sds/



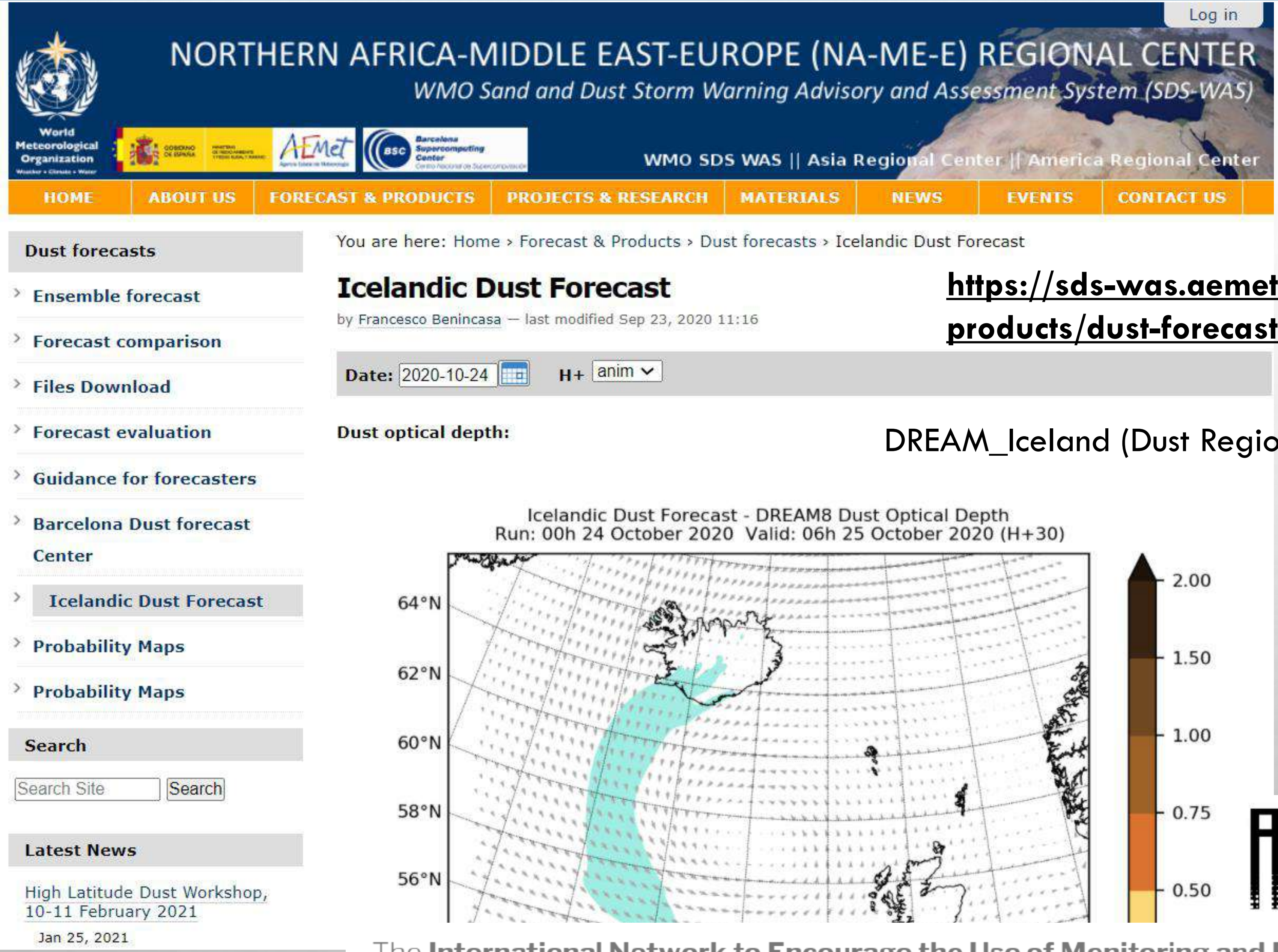
UNCCD 1km global dust mask (Ana Vukovic, 2019)

Dust sources in high latitudes



United Nations
Convention to Combat
Desertification

OPERATIONAL FORECAST FOR ICELANDIC DUST ON THE WMO SDS-WAS



https://sds-was.aemet.es/forecast-products/dust-forecasts/icelandic-dust-forecast

DREAM_Iceland (Dust Regional Atmospheric Model)

inDust

The International Network to Encourage the Use of Monitoring and Forecasting Dust Products

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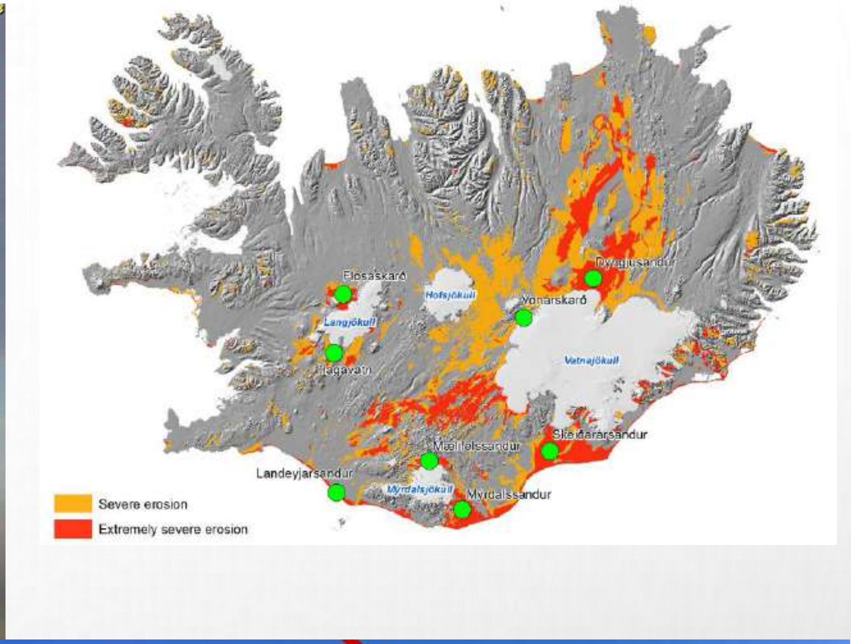
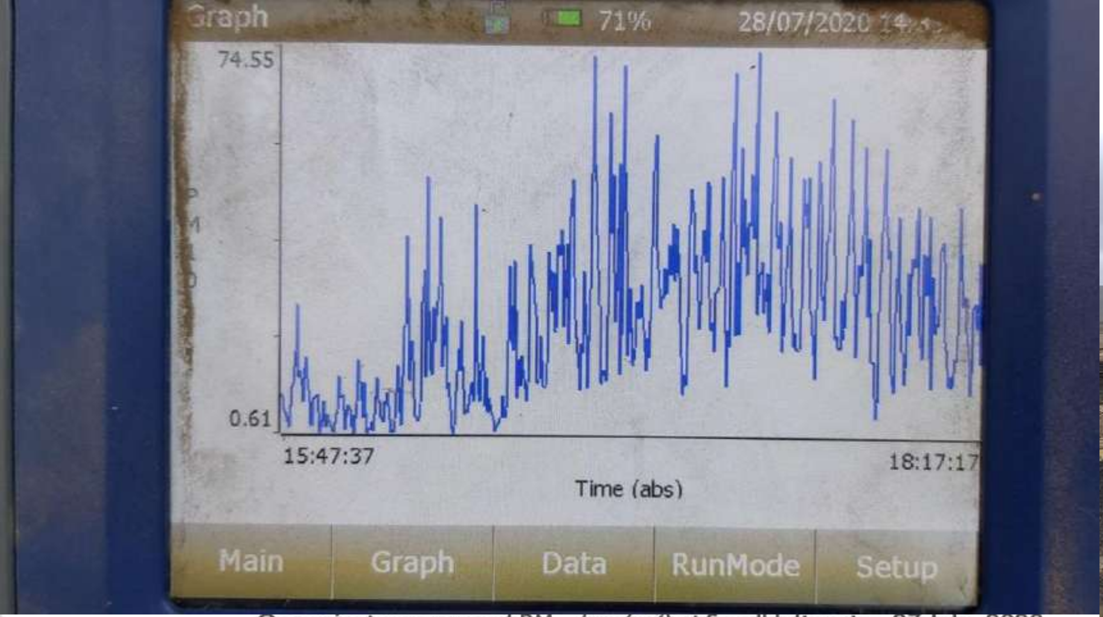
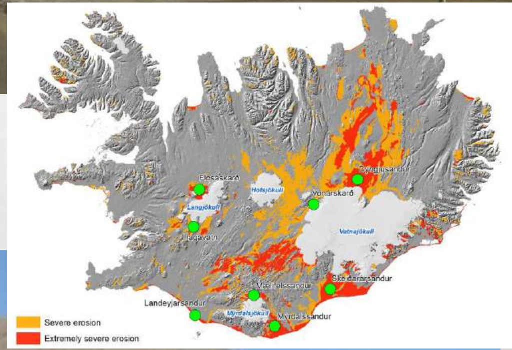
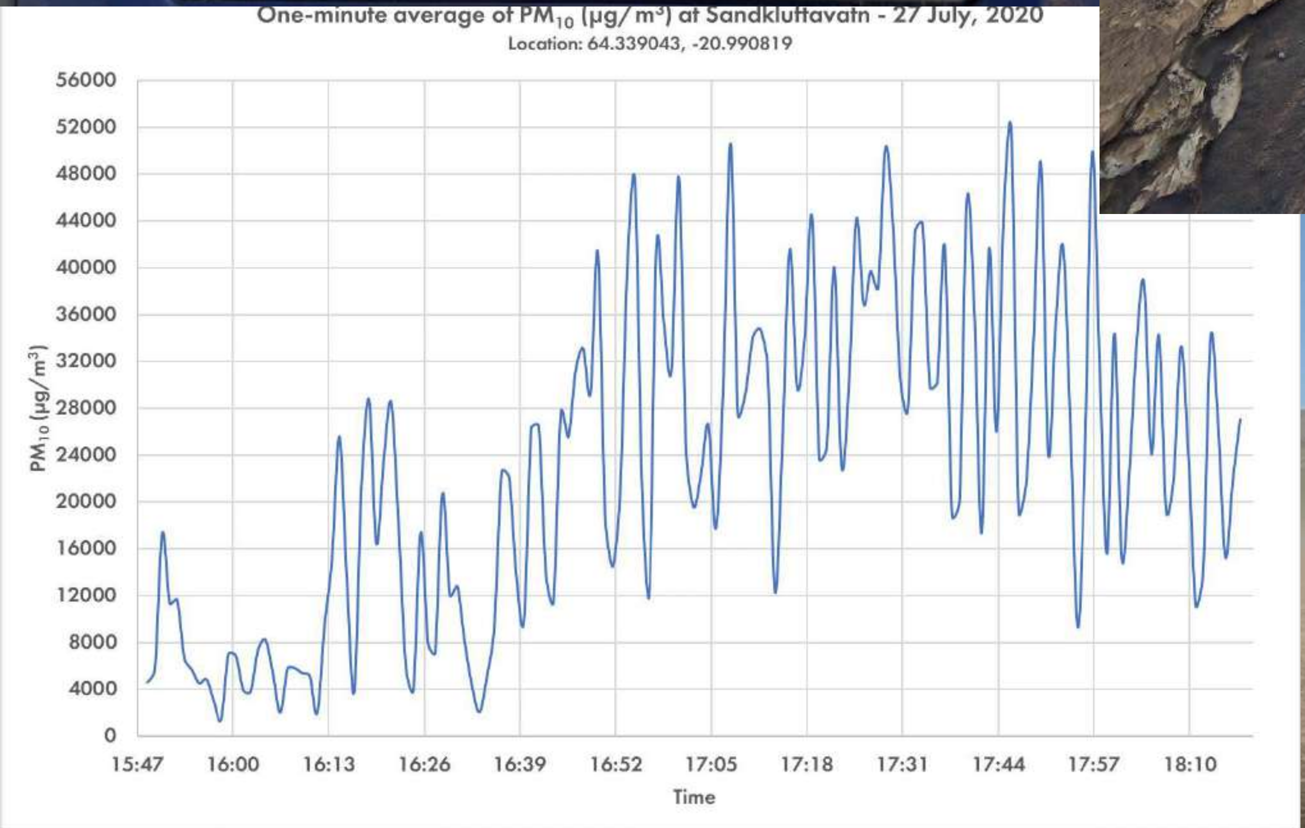
AGRICULTURAL UNIVERSITY OF ICELAND
CAMERA MONITORING SYSTEM – 4 MOST ACTIVE DESERTS



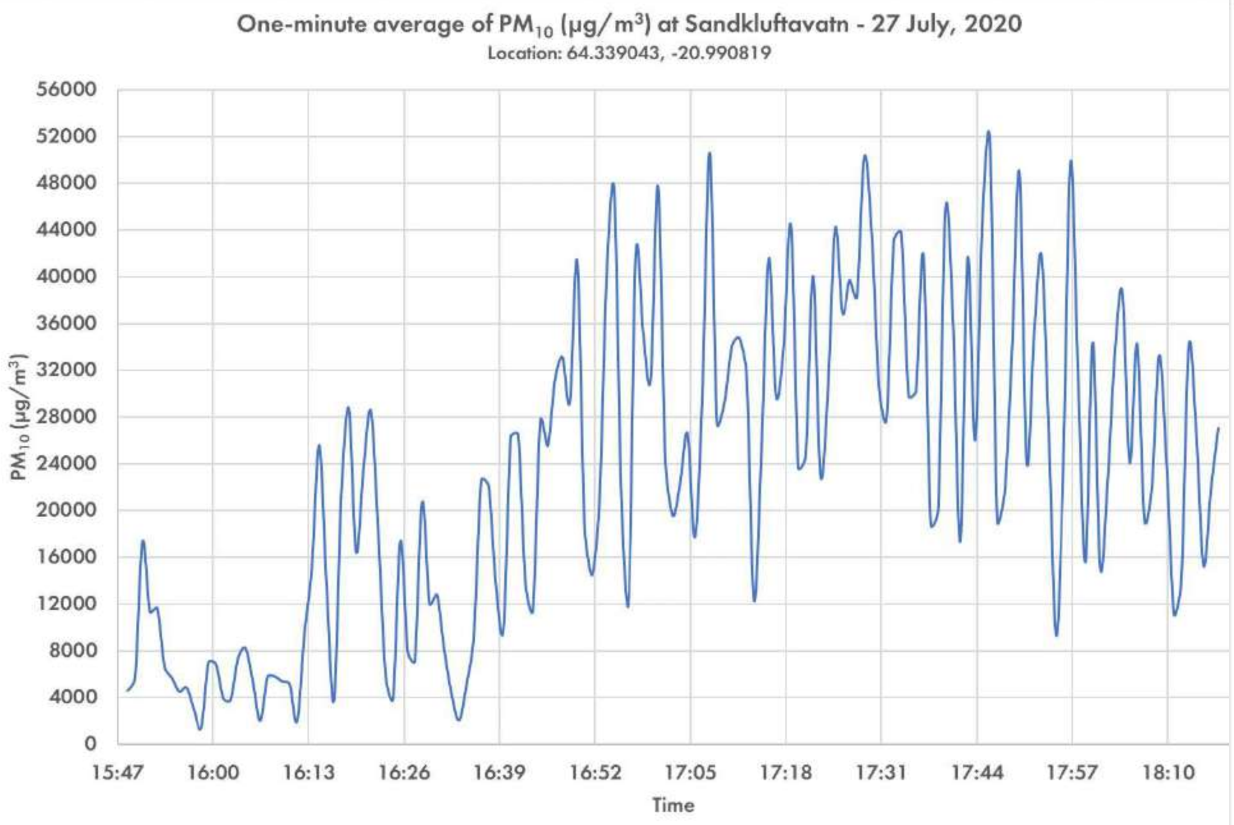
Field measurements in three Icelandic deserts 2020

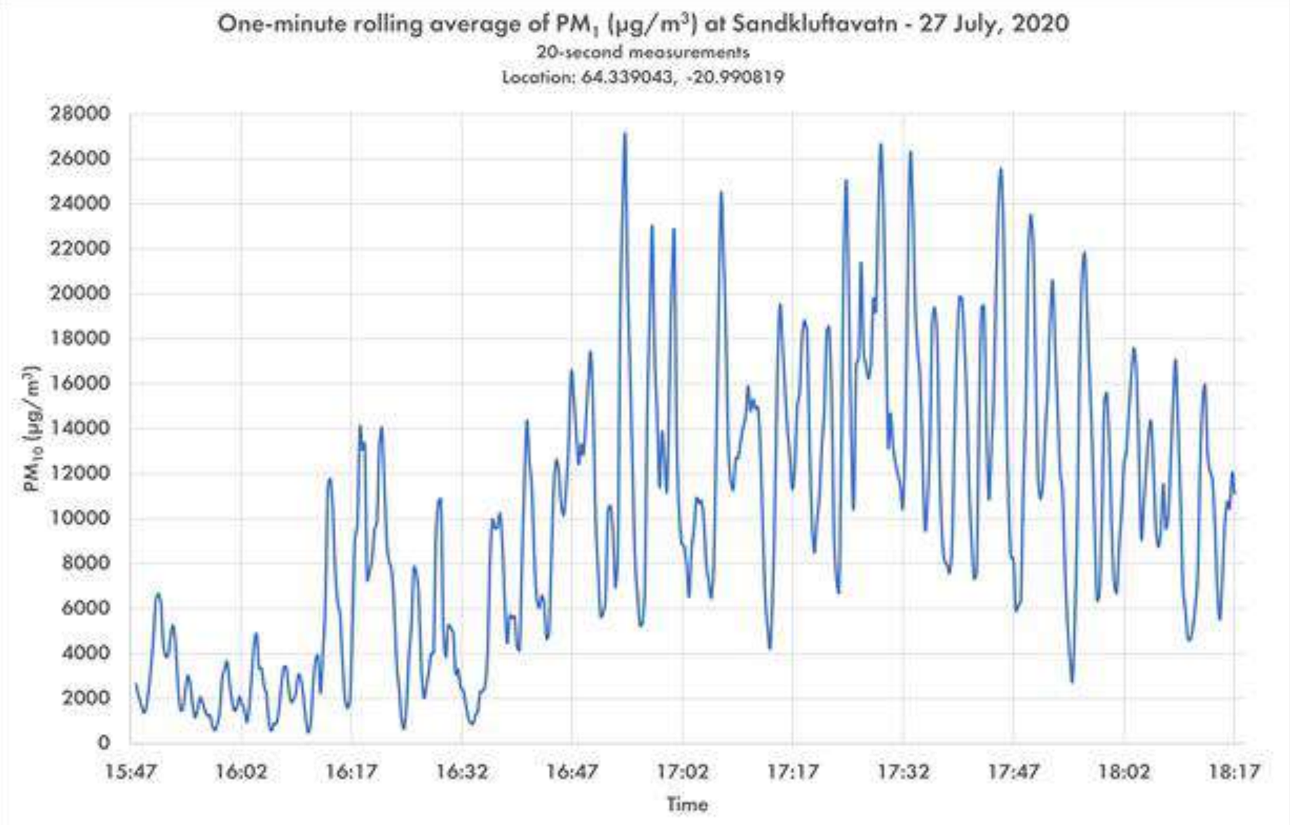






PM_{10} VS. PM_1 MEASUREMENTS INSIDE THE DUST STORM





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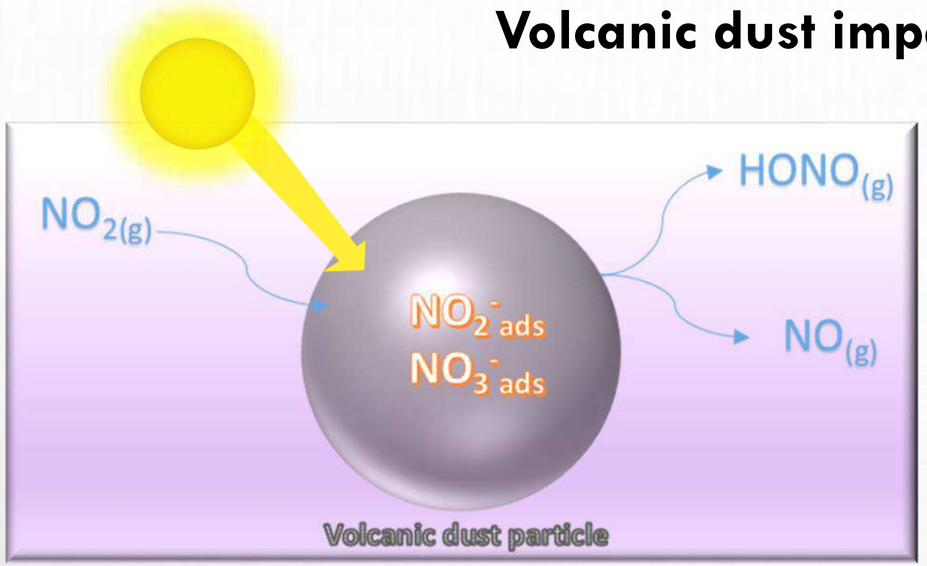
Volcanic dust impacts on atmospheric chemistry



Dust particles scavenge efficiently **NO_2** acting as transported media of surface nitrites and nitrates.

Dust particles convert NO_2 to HONO (nitrous acid), a very important precursor of OH radicals (HONO is photolysed during day time producing OH and NO)

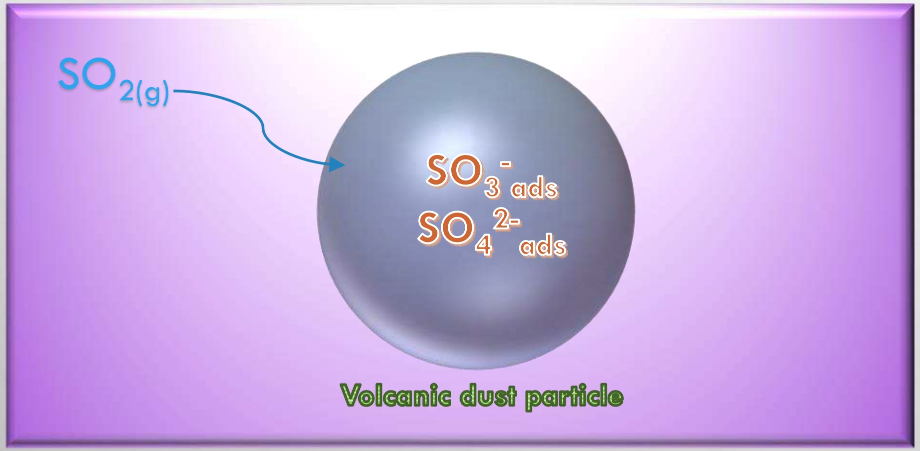

ELSEVIER

Journal of Environmental Sciences

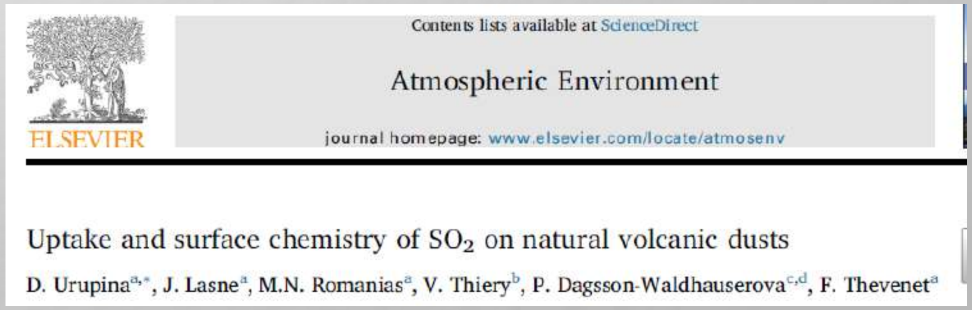
Volume 95, September 2020, Pages 155-164

Reactive uptake of NO_2 on volcanic particles: A possible source of HONO in the atmosphere

Manolis N. Romanias [1], Yangang Ren [2], Benoit Grosselin [2], Véronique Daële [2], Abdelwahid Mellouki [2], Pavla Dagsson-Waldhauserova [3, 4], Frederic Thevenet [1]



SO_2 is scavenged very efficiently on dust particles to form sulfites and sulfates. Therefore, the acidity of the particles can change as well as the hygroscopic and optical properties.


Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

ELSEVIER

Uptake and surface chemistry of SO_2 on natural volcanic dusts

D. Urupina[a,*], J. Lasne[a], M.N. Romanias[a], V. Thiery[b], P. Dagsson-Waldhauserova[c,d], F. Thevenet[a]

ICELANDIC DUST MAKES ICE IN CLOUDS

- Icelandic volcanic dust is an active Ice-Nucleating Particle (INP) similarly to Low Latitude Dust (LLD)

- Airborne Icelandic dust sampled from the aircraft is more active INP than LLD at temperatures above −17°C

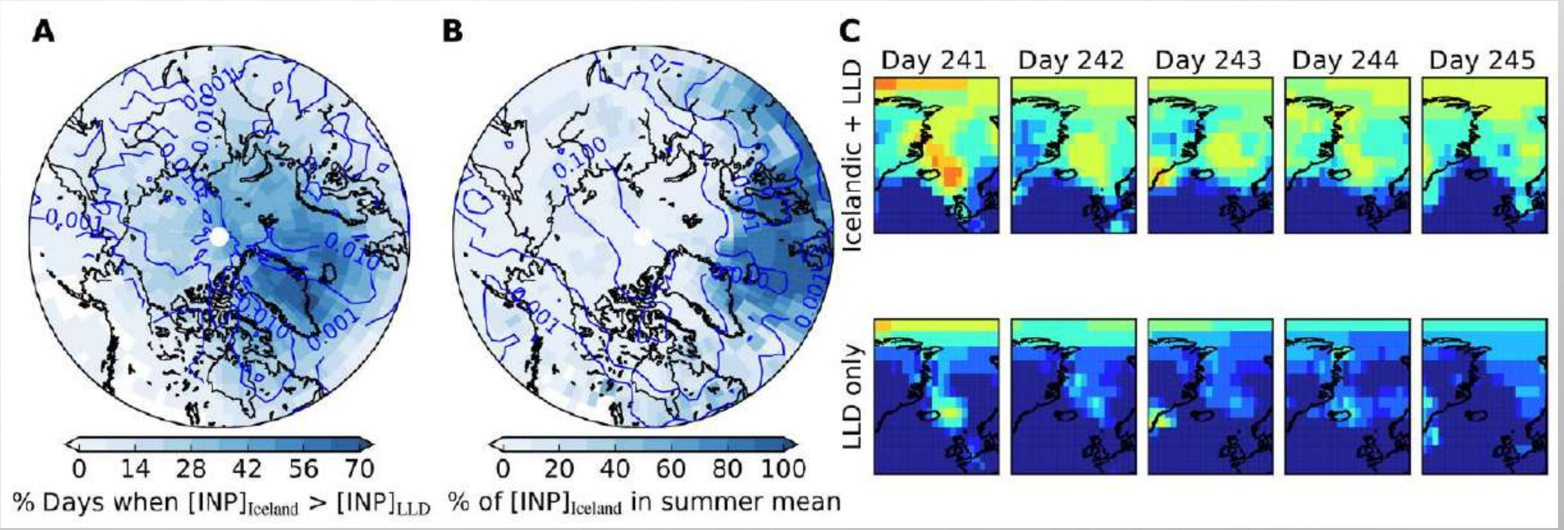
- The greatest contribution of Icelandic dust to the INP population occurs during the summer over large areas of the North Atlantic and the Arctic at altitudes between 3-5.5 km, where mixed-phased clouds are known to occur.
- In future, increased INP concentrations would lead to **a reduction in supercooled water** and a **decrease in shortwave reflectivity** of clouds to produce a positive climate feedback, which has not yet been considered in climate simulations

SCIENCE ADVANCES | RESEARCH ARTICLE

ATMOSPHERIC SCIENCE

Iceland is an episodic source of atmospheric ice-nucleating particles relevant for mixed-phase clouds

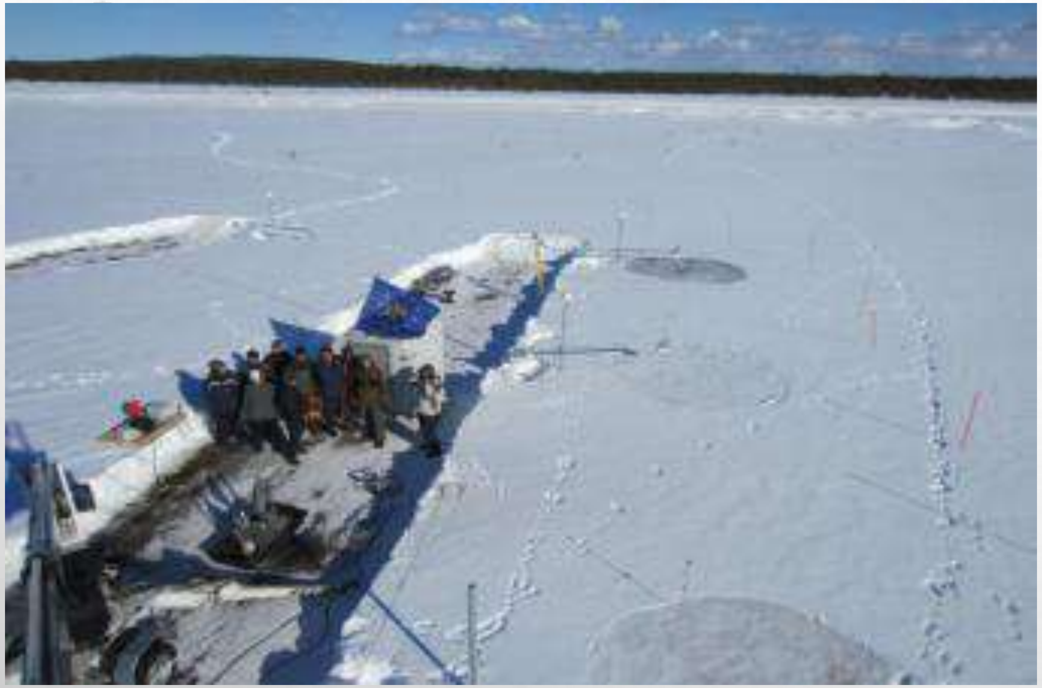
A. Sanchez-Marroquin[1]*, O. Arnalds[2], K. J. Baustian-Dorsi[1,3], J. Browse[1,4], P. Dagsson-Waldhauserova[2,5], A. D. Harrison[1], E. C. Maters[1,6], K. J. Pringle[1], J. Vergara-Temprado[7], I. T. Burke[1], J. B. McQuaid[1], K. S. Carslaw[1], B. J. Murray[1]

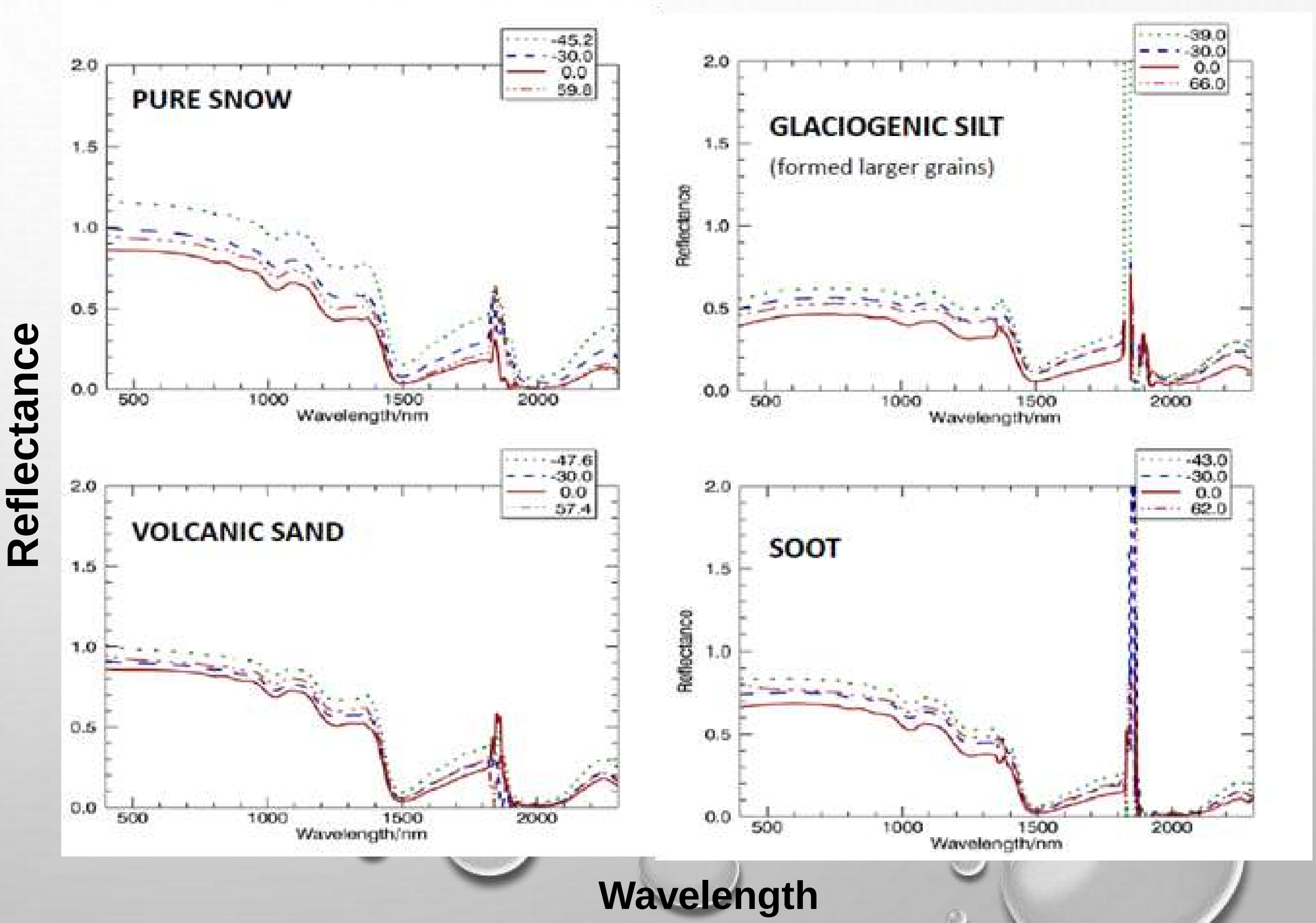


DUST IMPACTS ON CRYOSPHERE
IMPURITIES ON SNOW

SPECTRAL REFLECTANCE AT THE TIME OF THE DEPOSITION

Albedo - 1 white fresh snow, 0 black body





The Cryosphere, 9, 2323–2337, 2015
www.the-cryosphere.net/9/2323/2015/
doi:10.5194/tc-9-2323-2015

The Cryosphere

Soot on Snow experiment: bidirectional reflectance factor measurements of contaminated snow

J. I. Peltoniemi[1,2], M. Gritsevich[1,2,8], T. Hakala[1], P. Dagsson-Waldhauserová[5,6,7], Ó. Arnalds[6], K. Anttila[1,3], H.-R. Hannula[4], N. Kivekäs[3], H. Lihavainen[3], O. Meinander[3], J. Svensson[3,9], A. Virkkula[3], and G. de Leeuw[2,3]

The Cryosphere, 9, 2323–2337, 2015
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The Cryosphere

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Soot On Snow (SOS) 2013

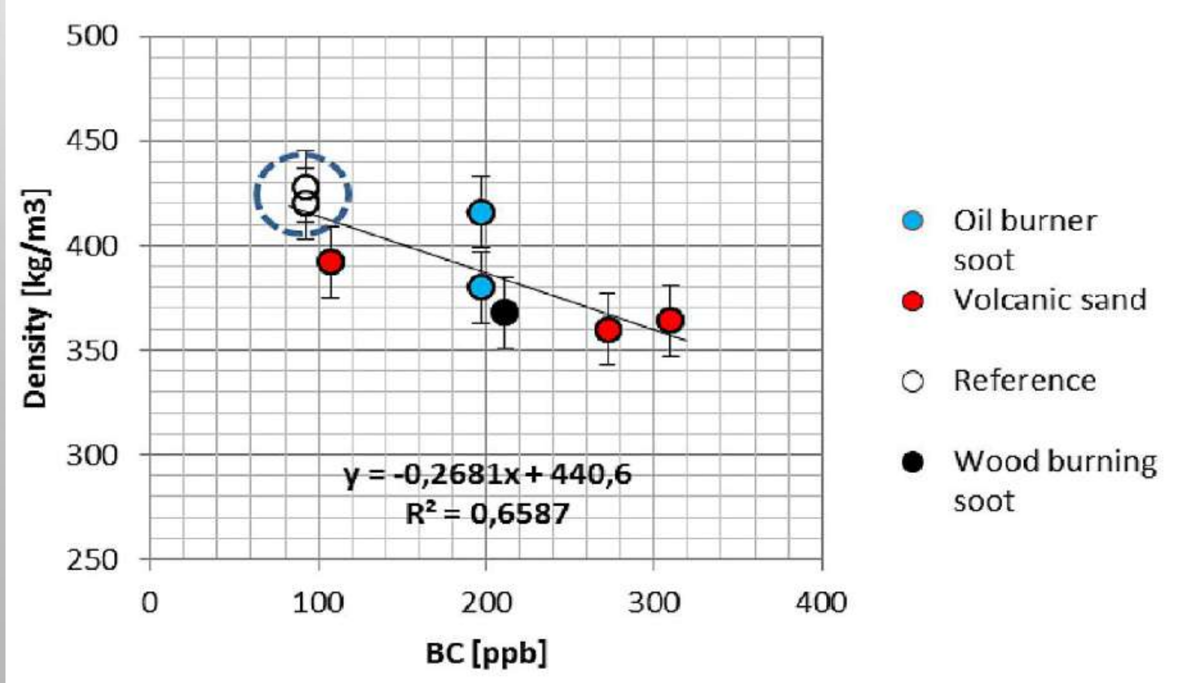
The Cryosphere, 8, 991–995, 2014
www.the-cryosphere.net/8/991/2014/
doi:10.5194/tc-8-991-2014

The Cryosphere

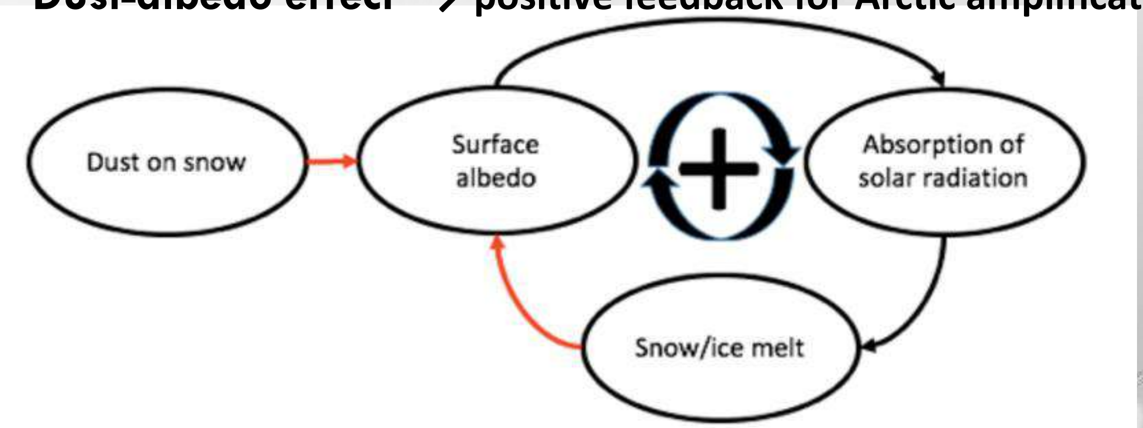
Brief communication: Light-absorbing impurities can reduce the density of melting snow

O. Meinander[1], A. Kontu[2], A. Virkkula[1], A. Arola[2], L. Backman[1], P. Dagsson-Waldhauserová[4,5], O. Järvinen[6], T. Manninen[1], J. Svensson[1], G. de Leeuw[1,5], and M. Leppäranta[6]

- VOLCANIC DUST DECREASES SNOW ALBEDO SIMILARLY **AS BLACK CARBON**
- SOOT DECREASES WATER RETENTION CAPACITY AND DENSITY OF SNOW



'Dust-albedo effect' → positive feedback for Arctic amplification



Atmos. Chem. Phys., 19, 2015–2061, 2019
https://doi.org/10.5194/acp-19-2015-2019

Atmospheric Chemistry and Physics

Interactions between the atmosphere, cryosphere, and ecosystems at northern high latitudes

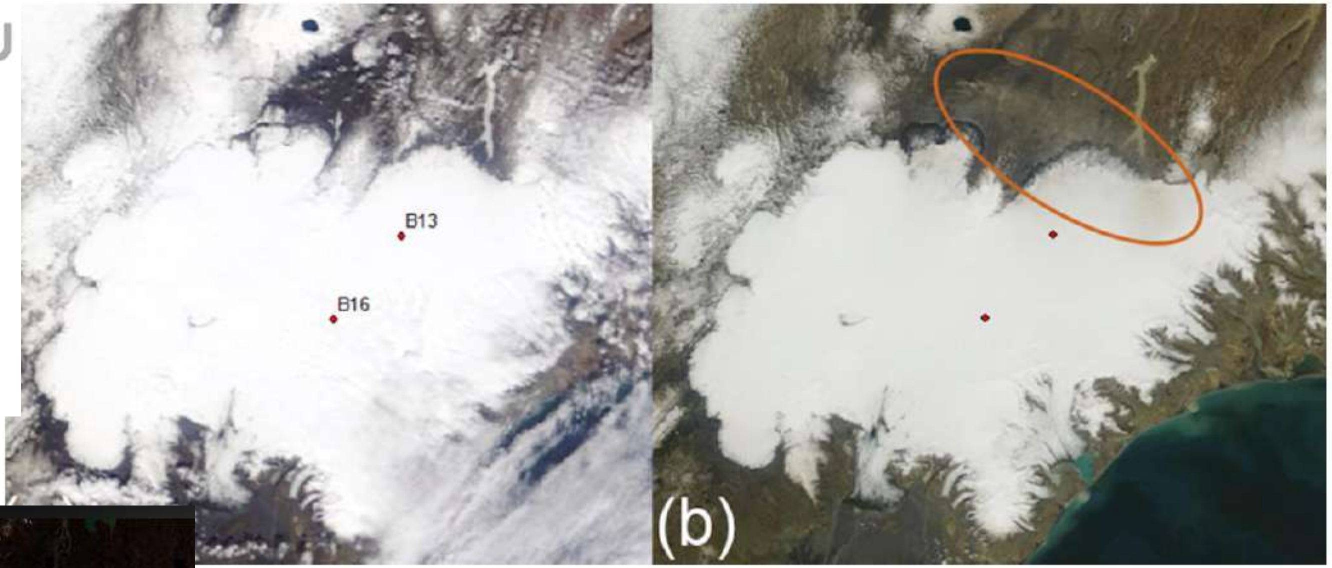
Michael Boy[1], Erik S. Thomson[2], Juan-C. Acosta Navarro[3], Olafur Arnalds[4], Ekaterina Batchvarova[5,6], Jaana Bäck[7], Frank Berninger[7], Merete Bilde[8], Zoé Brasseur[1], Pavla Dagsson-Waldhauserova[4,9,10], Dimitri Castarède[2],

The Cryosphere, 11, 741–754, 2017
www.the-cryosphere.net/11/741/2017/
doi:10.5194/tc-11-741-2017

The Cryosphere Open Access EGU

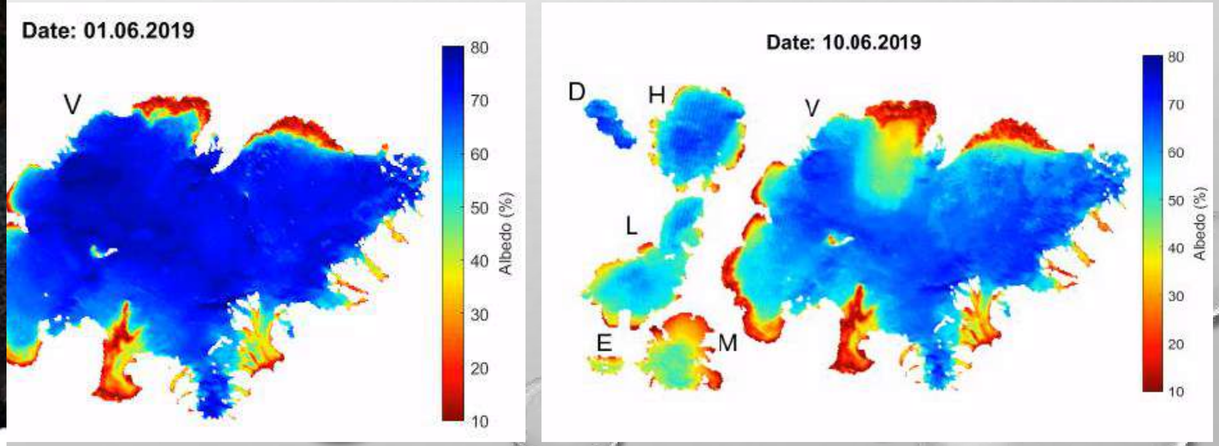
Impact of dust deposition on the albedo of Vatnajökull ice cap, Iceland

Monika Wittmann[1], Christine Dorothea Groot Zwaaftink[2], Louise Steffensen Schmidt[1], Sverrir Guðmundsson[1,3], Finnur Pálsson[1], Olafur Arnalds[4], Helgi Björnsson[1], Throstur Thorsteinsson[1], and Andreas Stohl[2]



f Iceland on **(a)** 20 May 2012 (day 141) and **(b)** 28 May 2012 (day 149). Notice the brownish hues (orange circle) hern Vatnajökull) after the dust event, which indicate that dust was deposited on the glacier. Image courtesy of ystem at NASA/GSFC. http://rapidfire.sci.gsfc.nasa.gov/

edo reduction due dust storms in June 2019



Courtesy of Andri Gunnarsson, IceDust, Landsvirkjun.

Icelandic dust has differenet composition that crustal dust

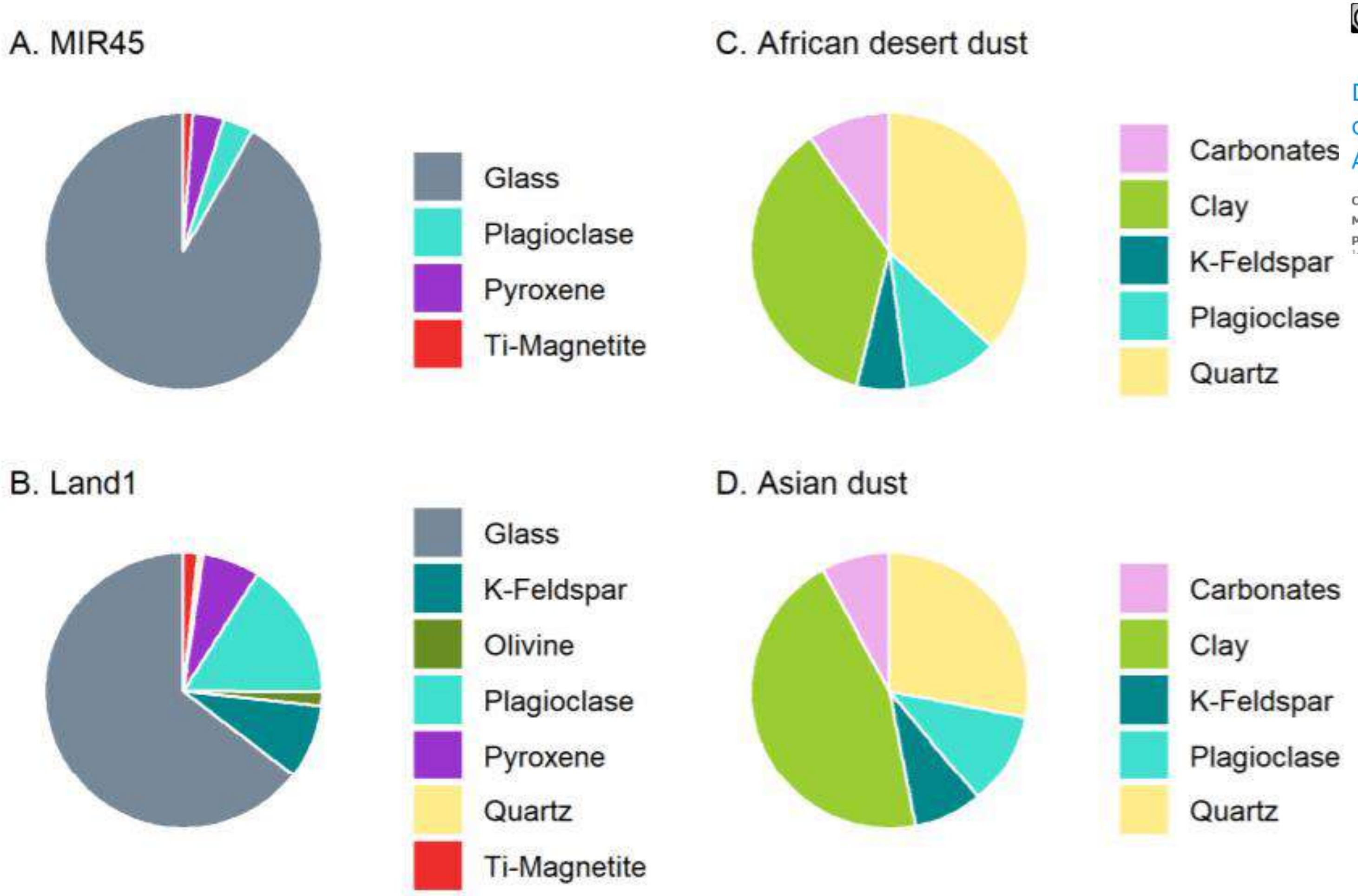


Figure 6: A-B. Mineralogy of Icelandic dust (MIR45 and Land1; PM_{10}). C. Mineral composition of North African desert dust (PM_{20}), representing the average bulk composition by X-ray diffraction of Tibesti, Western Sahara, Niger, and Mali samples (Shi et al., 2011b). D. Mineral composition of Asian dust (PM_{10}), average bulk composition by X-ray diffraction of dust from arid regions in Mongolia and North China collected in Seoul (Korea) during eight dust events in 2003-2005 (Jeong et al., 2008).

Abstract | Discussion

Distinct chemical and mineralogical composition of Icelandic dust compared to North African and Asian dust

Review status: A revised version of this pr... accepted for the journal AC... expected to appear here in... course.

Clarissa Baldo[1], Paola Formenti[2], Sophie Nowak[3], Servanne Chevaillier[2], Mathieu Cazaunau[2], Edouard Pangui[2], Claudia Di Biagio[2], Jean-Francois Doussin[2], Konstantin Ignatyev[4], Pavla Dagsson Waldhauserova[5,6], Olafur Arnalds[5], A. Robert MacKenzie[1], and Zongbo Shi[1]

Iron content and solubility of Icelandic dust

Abstract | Discussion

Distinct chemical and mineralogical composition of Icelandic dust compared to North African and Asian dust

Review status
A revised version of this pr... accepted for the journal AC... expected to appear here in... course.

Clarissa Baldo[1], Paola Formenti[2], Sophie Nowak[3], Servanne Chevaillier[2], Mathieu Cazaunau[2], Edouard Pangui[2], Claudia Di Biagio[2], Jean-Francois Doussin[2], Konstantin Ignatyev[4], Pavla Dagsson Waldhauserova[5,6], Olafur Arnalds[5], A. Robert MacKenzie[1], and Zongbo Shi[1]

- <u>high total Fe content (10-13 wt%)</u>
- **Fe chemical form:**
    - dithionite Fe (Fe oxides such as hematite and goethite) 1-6%
    - ascorbate Fe (amorphous Fe) contribute respectively 0.3-1.4% of the total Fe
    - magnetite 7-15% of total Fe and 1-2 wt% of PM10 (in orders of magnitude higher than in North Africa)
    - pyroxene and amorphous glass 80-90%

- <u>**the initial Fe solubility:** 0.08-0.6%</u>
- **the Fe solubility at low pH** (i.e., 2): significantly higher (up to 30%) than typical low latitude dust

- differences btw LLD and HLD:
    - low degree of chemical weathering
    - the basaltic composition of the parent sediments
    - glacial processes

- dust can impact primary productivity and nitrogen fixation in the N Atlantic Ocean
- lead to additional carbon uptake
- the ratios of nutrients in the atm. deposition can favour the growth of particular types of phytoplankton, leading to changes in community structure and thus biodiversity

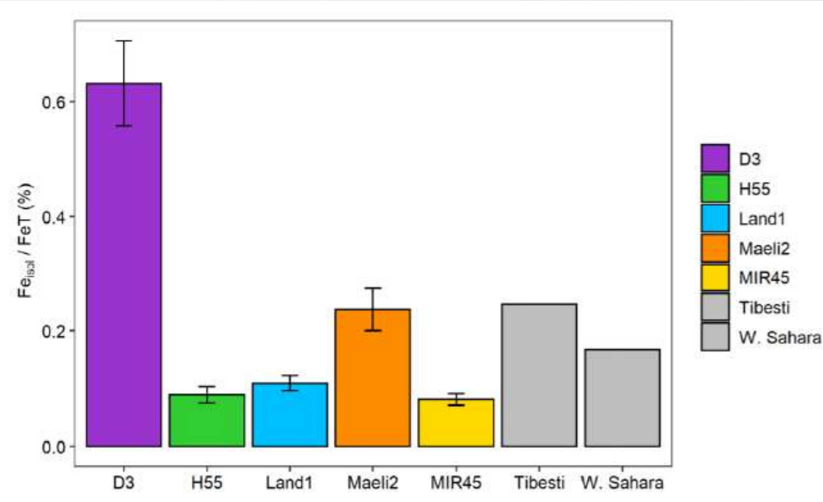
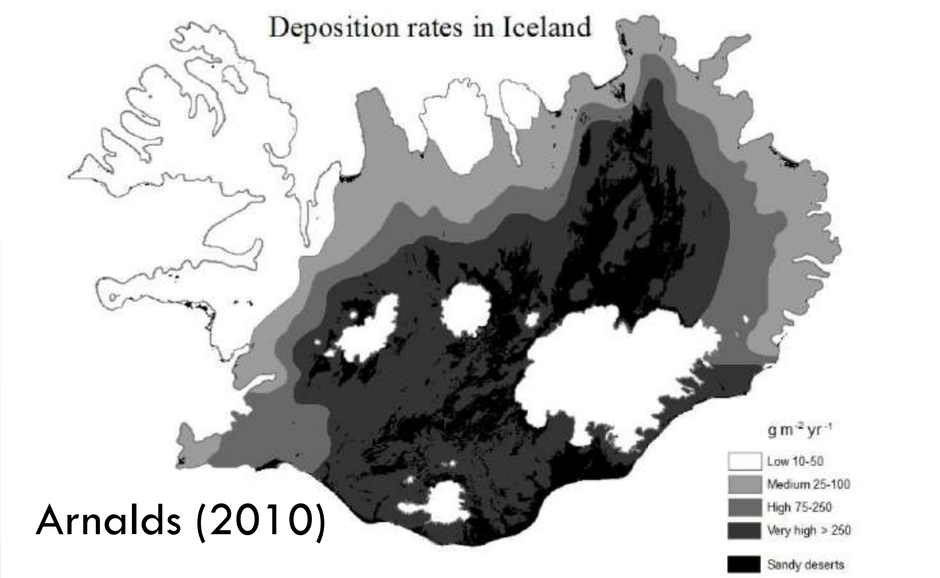
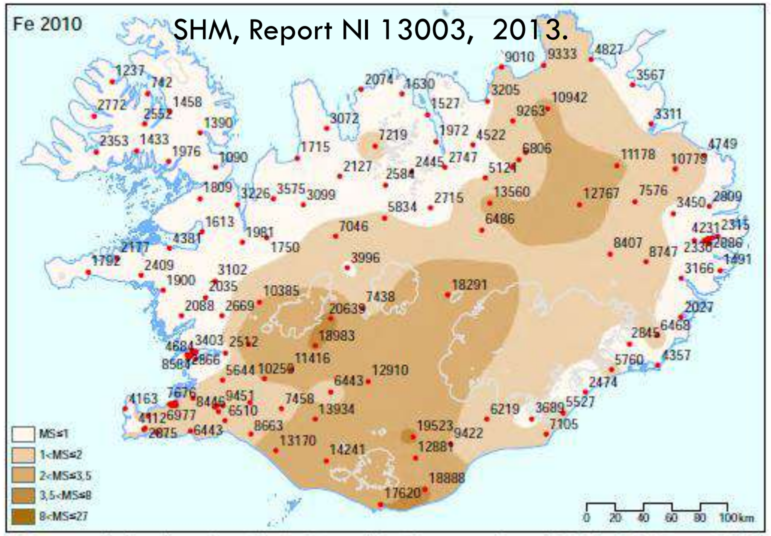


Figure 4: Initial Fe solubility (Fe_{isol} / FeT, %) of Icelandic dust (this study). The data uncertainty was estimated using th… propagation formula. Data for African dust samples (Tibesti and W. Sahara) were from Shi et al. (2011c).

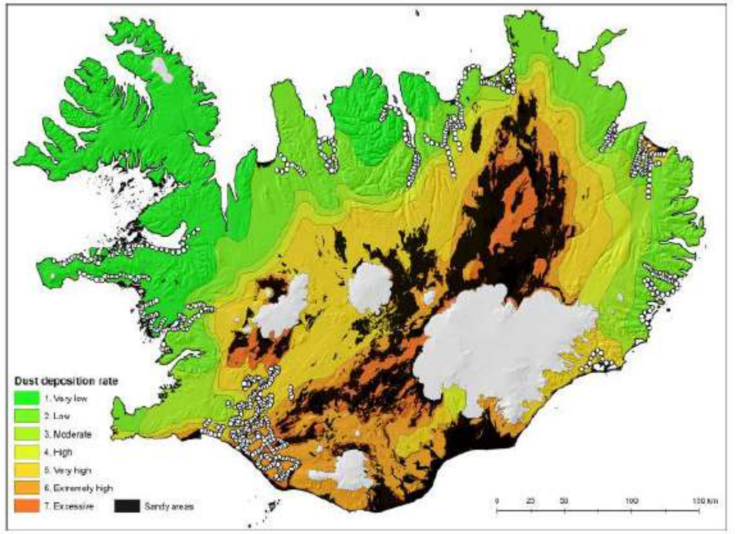
Direct impacts of dust on ecosystems





18. mynd. Styrkur (mg/kg) járns (Fe) í mosa árin 1990, 2000 og 2010.

Fe concentrations in mosses

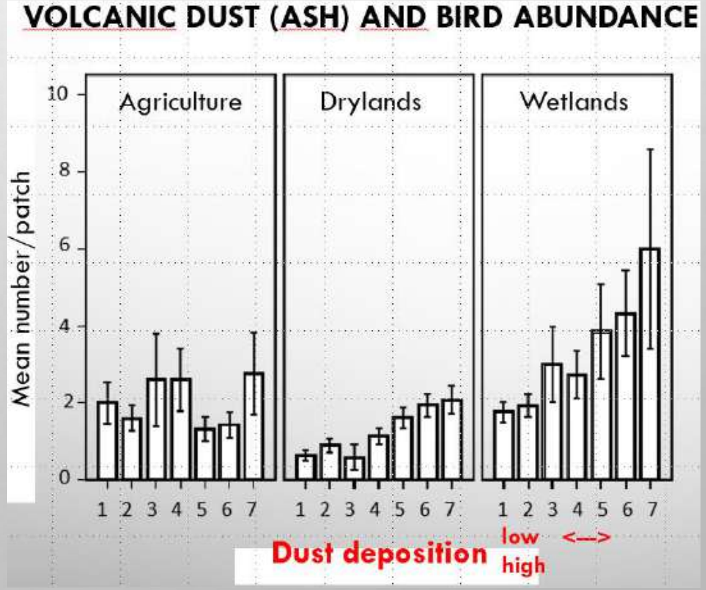


Unique bird and volcanic dust datasets indicate fertility associated with basaltic volcanic ash

Ecology and Evolution Open Access

Ecosystem recharge by volcanic dust drives broad-scale variation in bird abundance

Tómas Grétar Gunnarsson[1], Ólafur Arnalds[2], Graham Appleton[3], Verónica Méndez[1] & Jennifer A. Gill[4]

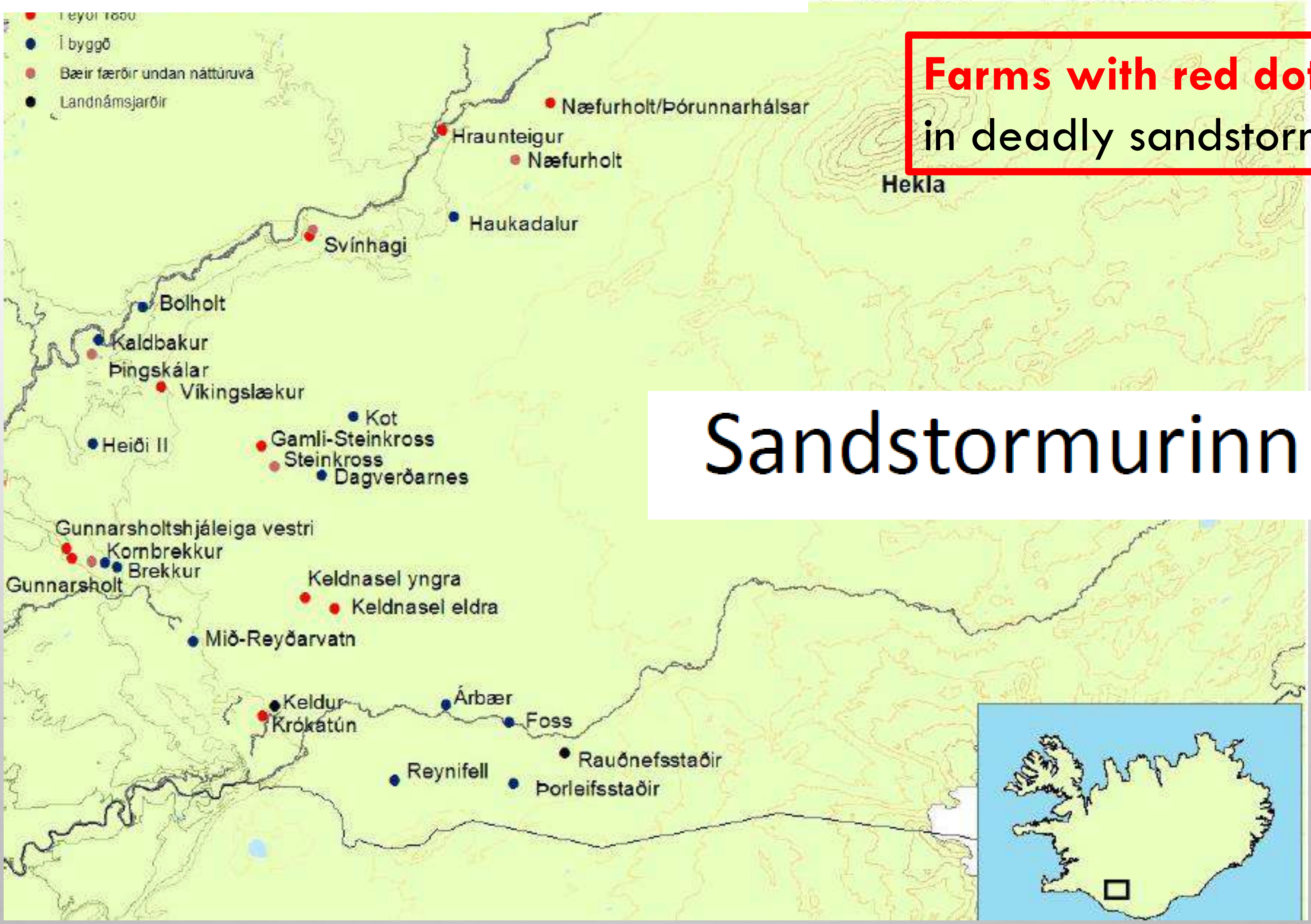


DUST DESTROYS HUMAN SETTLEMENTS

1801-1850

Farms with red dot destroyed in deadly sandstorm in1836

Sandstormurinn 1836



Direct impacts on land degradation, human settlement

M. Hejcman, L. Smejda, V. Pavlu, Sofus

Table 1. Studied farms with the oldest reference, period of habitation and code used in graphs.

Name of site	Oldest reference	In habitation
Kot	1687	1687-1981
Kastalabrekka	1711	900-1650
Steinkross (old site)	From 1270	1200-1849
Steinkross (new site)	From 1849	1849-1882
Dagverðarnes	From 16th century	1500-1912
Brekkur	1398	1350-1876
Valshóll	1849 (outhouse for sheep from Gunnarsholt)	(in use) 1350-1926

Name of site	1711	1841	1850	1860	1870	1880	1890	1901	1910
Kot	0	4	5	4	3	3	5	2	4
Kastalabrekka	---	---	---	---	---	---	---	---	---
Steinkross (old site)	211	231	---	---	---	---	---	---	---
Steinkross (new site)	0		236	327	421	600	----	---	---
Dagverðarnes	0	191	279	350	420	750	400	387	450
Brekkur		130	211	265	310	----	----	---	---
Valshóll	-------								

Table 2. Number of sheep at each farm

<u>Differences in nutrients were found in *plant species, nutrient in herbage and soil* between farm ruins and outside farms (control)</u>

Plant species: <u>Farms:</u> *Alopecurus pratensis, Equisetum pratense, E. arvense, Rumex acetosa, Elytrigia repens*, and *Poa pratensis*. <u>Outside:</u> *Festuca vivipara, Luzula multiflora, Carex bigelowii, Potentilla crantzii*, and *Galium boreale*.

Nutrient concentrations in herbage: <u>Farms</u>: High contents of P, K, Ca, and Mg. <u>Outside</u>: High contents of Fe, Mn, Zn, and Cu.

Nutrient concentrations in soil: <u>Farms</u>: High contents of P, K, Ca, Mg, Zn, Cu, Fe, Mn, and total N. <u>Outside:</u> Lower contents of all nutrients and higher pH than on farms.

CONCLUSION

- IMPACTS OF DUST ON ATMOSPHERE – AIR QUALITY, AIR CHEMISTRY, CLOUDS
- IMPACTS OF DUST ON CRYSOPHERE – ALBEDO, WATER RETENTION, NUTRIENTS
- IMPACTS OF DUST ON OTHER SYSTEMS – MOSS, BIRDS, MARINE ECOSYSTEMS
- HUMAN SAFETY AND SETTLEMENTS

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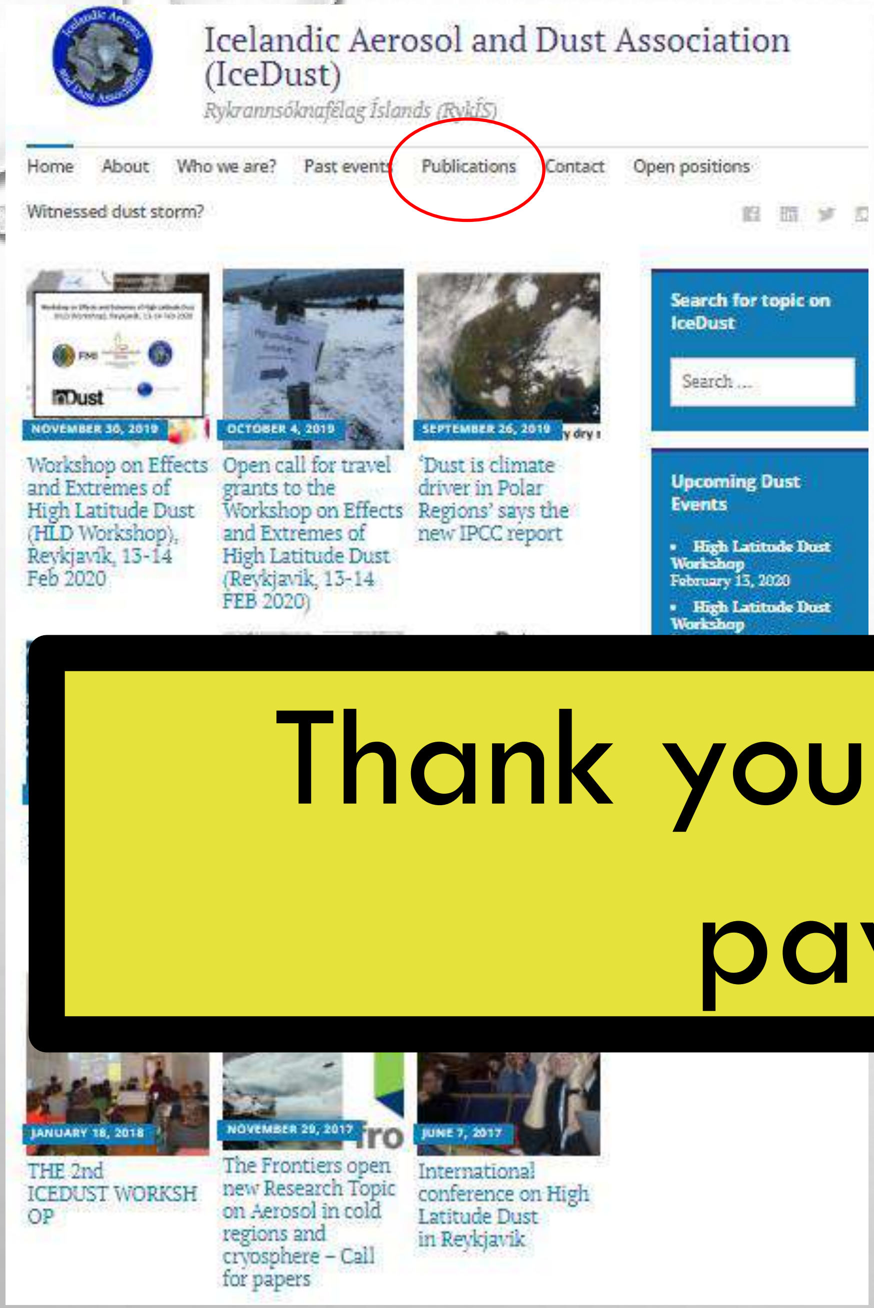
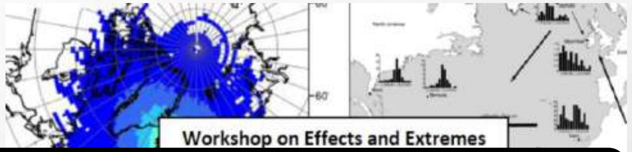


Dust Storms in Iceland
Public Group

IceDust facts 2021:
15 countries
30 research institutions
84 members
66 papers

ICEDUST Workshop IV
February 9-10 2022 (30.11. orals)
-free entrance, everybody welcome!



Thank you for your attention!
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EGU General Assembly 2021
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ITS3.12/AS2.10 EDI
Atmosphere – Cryosphere interaction with focus on transport, deposition and effects of dust, black carbon, and other aerosols
Co-organized by BG3/CL4/CR7/NH1
Convener: Pavla Dagsson Waldhauserova ECS | Co-conveners: Biagio Di Mauro, Marie Dumont, Outi Meinander ECS

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