Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

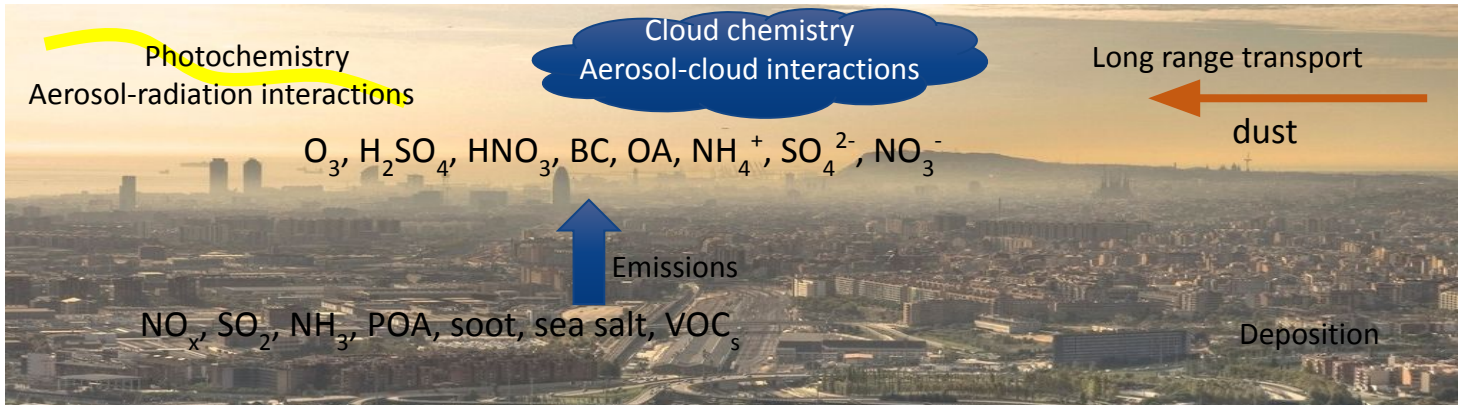
The Atmospheric Composition Group in a nutshell

Department Day meeting

27/05/2021

Main goal

To understand, constrain and predict the spatiotemporal variations of atmospheric pollutants across scales along with their effects upon air quality, health, weather and climate.



Keywords

Emission inventories, natural emissions, source apportionment

Ozone, mineral dust, secondary organic aerosols, iron cycle

Variability and trends, aerosol chemistry, aerosol-radiation-cloud, climate

Model development, global, mesoscale, urban

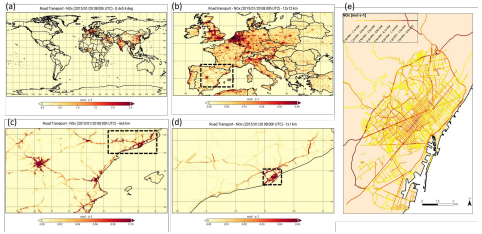
Forecasting, reanalysis, data assimilation, machine learning, observations

Field campaigns, health effects

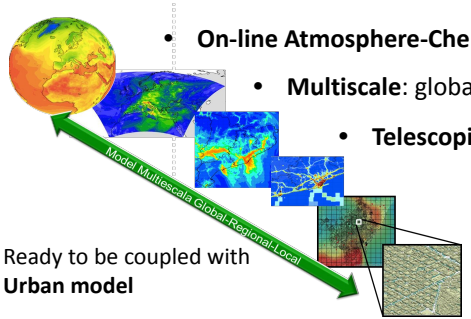
Model and tool developments

HERMESv3

A **python-based, open source, parallel and multiscale** emission model



MONARCH

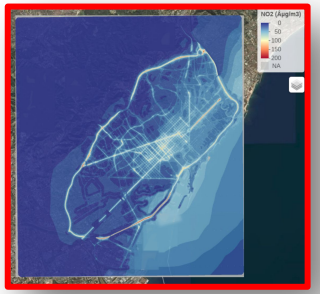


- **On-line Atmosphere-Chemistry coupling**
- **Multiscale**: global to local (1km)
- **Telescoping nesting**

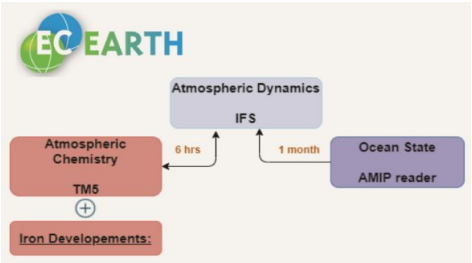
Ready to be coupled with **Urban model**

CALIOPE-Urban

Street-scale dispersion model

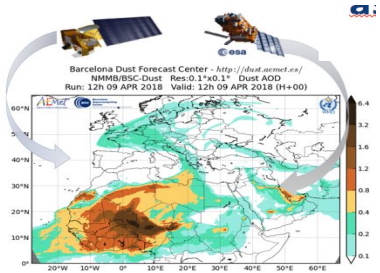


EC-Earth3-Iron



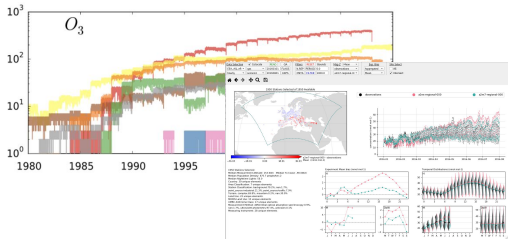
LETKF DA

Ensemble based Data Assimilation system



GHOST/Providentia

Harmonised treatment of observations and **dynamic/flexible evaluation** system



Strong co-development with CES and ESS and starting with CP

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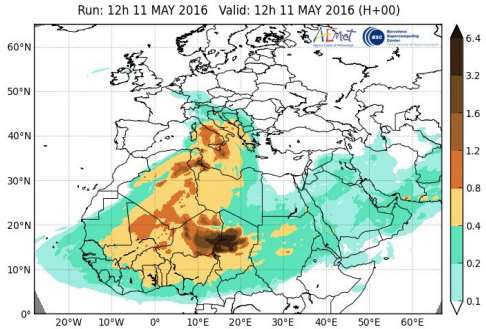
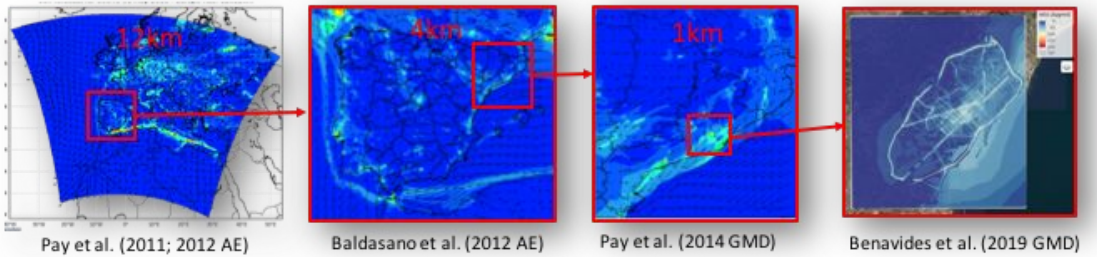
Forecasts, reanalysis, services

WMO Dust Regional Centers

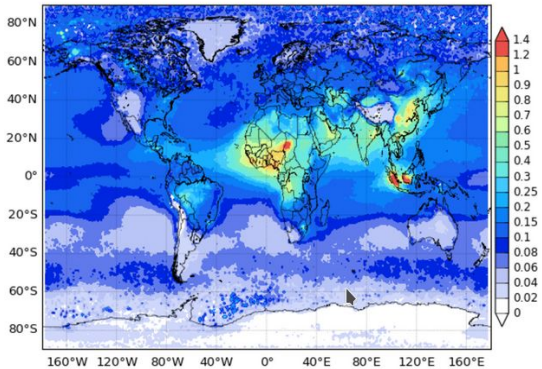
Dust forecasts and and renalysis



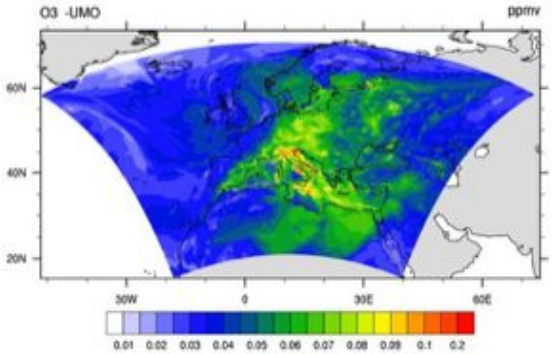
CALIOPE Forecast system



ICAP global aerosol ensemble



Soon joining the CAMS air quality regional ensemble



In collaboration with CES and ESS

Ongoing and near-future projects

AXA Research Fund	**AXA Chair on Sand and Dust Storms**
ERC Consolidator	**FRAGMENT**
NASA	**EMIT**
H2020	**SOLWARIS, FORCES, AQ-Watch, CoCO2**
CAMS	**43, 50, 61, 81, 84, COP_66, COP_79, 2_35, 2_40**
ERA4CS	**DustClim**
ESA	**CCI, DOMOS**
National Retos	**NUTRIENT, BROWNING, VITALIZE**
Cost Action	**InDust**
Contracts and other	**Encomienda Dust, Service agreement, Sedema, Generalitat**

COVID-19

Health effects

THE LANCET
Planetary Health

CORRESPONDENCE | VOLUME 4, ISSUE 7, E268, JULY 01, 2020

Reduction in air pollution and attributable mortality due to COVID-19 lockdown

Hicham Achebak • Hervé Petetin • Marcos Quijal-Zamorano • Dene Bowdalo • Carlos Pérez García-Pando • Joan Ballester

Open Access • Published: July, 2020 • DOI: https://doi.org/10.1016/S2542-5196(20)30148-0

NO_2 reductions, in situ, Spain

Atmos. Chem. Phys., 20, 11119–11141, 2020
https://doi.org/10.5194/acp-20-11119-2020
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Atmospheric Chemistry and Physics

Meteorology-normalized impact of the COVID-19 lockdown upon NO_2 pollution in Spain

Hervé Petetin[1], Dene Bowdalo[1], Albert Soret[1], Marc Guevara[1], Oriol Jorba[1], Kim Serradell[1], and Carlos Pérez García-Pando[1,2]

NO_2 reductions, satellite, models, Europe

Atmos. Chem. Phys., 21, 7373–7394, 2021
https://doi.org/10.5194/acp-21-7373-2021
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Atmospheric Chemistry and Physics

Estimating lockdown-induced European NO_2 changes using satellite and surface observations and air quality models

Jérôme Barré[1], Hervé Petetin[2], Augustin Colette[3], Marc Guevara[2], Vincent-Henri Peuch[1], Laurence Rouil[3], Richard Engelen[1], Antje Inness[1], Johannes Flemming[1], Carlos Pérez García-Pando[2,4], Dene Bowdalo[2], Frederik Meleux[3], Camilla Geels[5], Jesper H. Christensen[5], Michael Gauss[6], Anna Benedictow[6], Svetlana Tsyro[6], Elmar Friese[7], Joanna Struzewska[8], Jacek W. Kaminski[8,9], John Douros[10], Renske Timmermans[11], Lennart Robertson[12], Mario Adani[13], Oriol Jorba[2], Mathieu Joly[14], and Rostislav Kouznetsov[15]

Emission reductions

Atmos. Chem. Phys., 21, 773–797, 2021
https://doi.org/10.5194/acp-21-773-2021
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Atmospheric Chemistry and Physics

Time-resolved emission reductions for atmospheric chemistry modelling in Europe during the COVID-19 lockdowns

Marc Guevara[1], Oriol Jorba[1], Albert Soret[1], Hervé Petetin[1], Dene Bowdalo[1], Kim Serradell[1], Carles Tena[1], Hugo Denier van der Gon[2], Jeroen Kuenen[2], Vincent-Henri Peuch[3], and Carlos Pérez García-Pando[1,4]

PM, O_3 changes and implications

Contents lists available at ScienceDirect

Science of the Total Environment

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

Lessons from the COVID-19 air pollution decrease in Spain: Now what?

Xavier Querol[a,*], Jordi Massagué[a,b], Andrés Alastuey[a], Teresa Moreno[a], Gotzon Gangoiti[c], Enrique Mantilla[d], José Jaime Duéguez[d], Miguel Escudero[e], Eliseo Monfort[f], Carlos Pérez García-Pando[g,h], Hervé Petetin[g], Oriol Jorba[g], Víctor Vázquez[i,j], Jesús de la Rosa[k], Alberto Campos[l], Marta Muñóz[l], Silvia Monge[l], María Hervás[l], Rebeca Javato[l], María J. Cornide[l]

Avoided short-term mortality in Spain

Contents lists available at ScienceDirect

Environmental Pollution

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

Trade-offs between short-term mortality attributable to NO_2 and O_3 changes during the COVID-19 lockdown across major Spanish cities☆

Hicham Achebak[a,b,*], Hervé Petetin[c], Marcos Quijal-Zamorano[a], Dene Bowdalo[c], Carlos Pérez García-Pando[c,d], Joan Ballester[a]

In collaboration with ISGlobal, CSIC and ECMWF

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Who are we?


Carlos P.


Oriol J.


María G.


Enza Di T.


Marc G.


Sara B.


Jerónimo E.


Dene B.


Montse C.


Arnau B.


Santiago E.


Roger G.


Franco L.

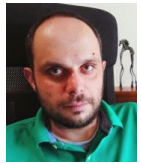

Hector N.


Ruben S.


Elisa B.


Adolfo G.


Cristina G.


Visitors ex-BSC and collaborators

\+ *long list of close collaborators from CES, ESS and CP Thanks!*

\+ ***4 Open positions***

Today

Aerosol modeling
MONARCH

Hector N.

Ruben S.

Iron modeling
EC-Earth

Elisa B.

Dust field campaigns
FRAGMENT

Adolfo G.

Cristina G.

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

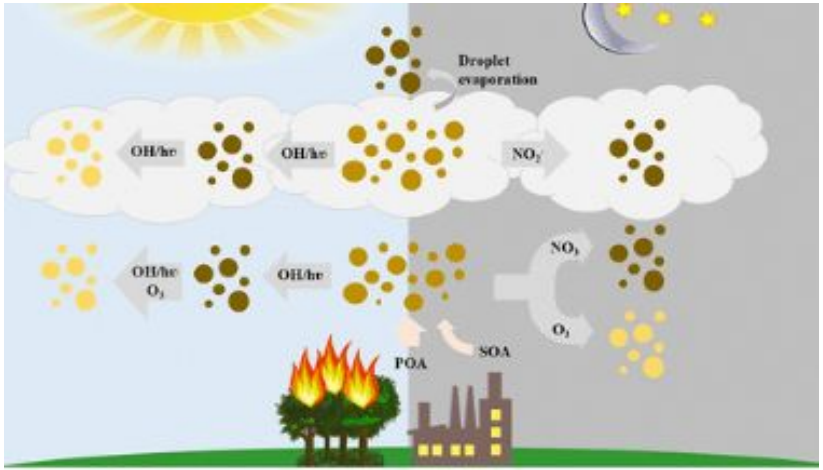
EXCELENCIA SEVERO OCHOA

MONARCH: organic aerosol and dust heterogeneous chemistry

Hector Navarro - PhD Student

Ruben Sousse - PhD Student

Why studying Organic aerosol (OA) ?



Sources and chemistry of OA (Hems et al., 2021)

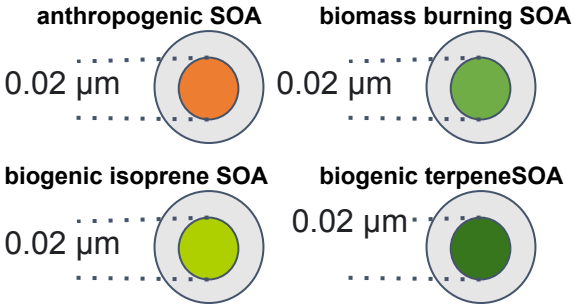
- OA represents in some places more than 50% of total aerosols mass.
- Chemistry of OA is currently not well understood.
- Certain primary and secondary OA have a strong influence on radiative effect absorbing solar radiation. This type of OA is known as **Brown Carbon (BrC).**

OA and BrC representation in MONARCH

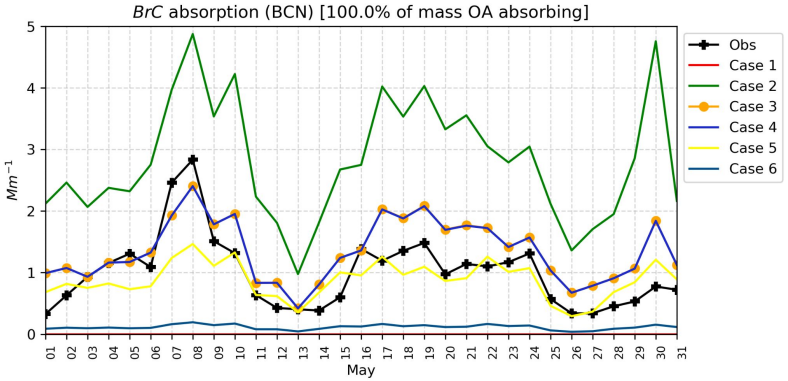
OA scheme based on Pai et al. (2020):

1) **Primary Organic Aerosols (POA)**

2) **Secondary Organic Aerosols (SOA)**



We have performed sensitivity tests with different BrC fractions of OA to reproduce observations over Barcelona, Montseny, and Montsec EGAR stations:



In collaboration with:

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EGAR ENVIRONMENTAL GEOCHEMISTRY AND ATMOSPHERIC RESEARCH

Dust heterogeneous chemistry

Assessing role of dust mineralogy in atmospheric chemistry
(as part of the **FRAGMENT (ERC) project**)

1 Different sources → different dust mineralogies

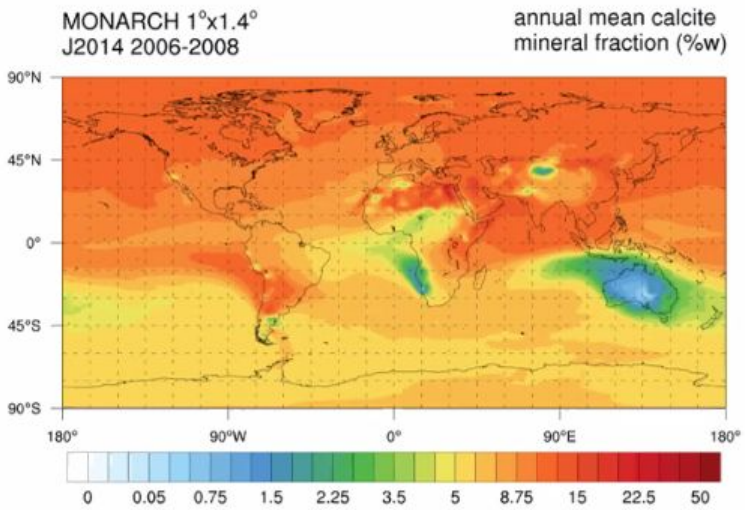
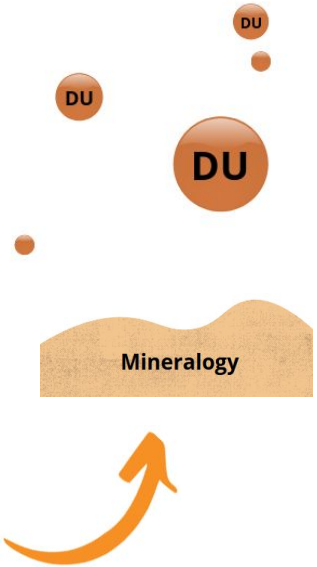
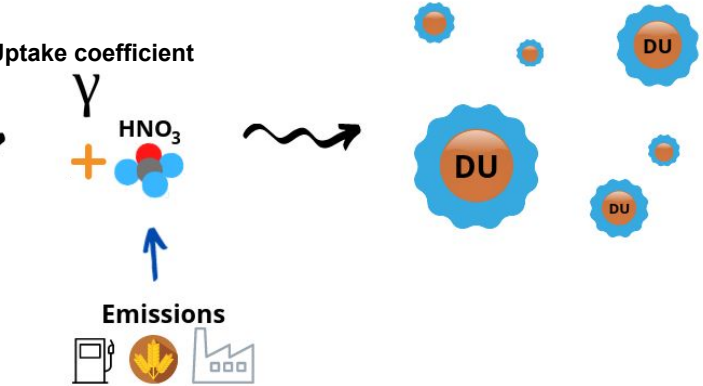


Image credit: María Gonçalves

2 Dust is emitted and transported into the atmosphere

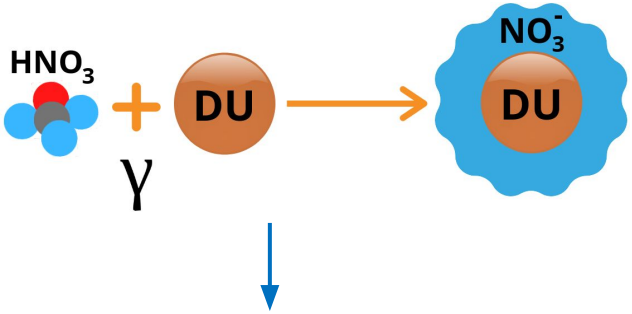


3 Heterogeneous chemical reactions forming liquid coatings



MONARCH implementation

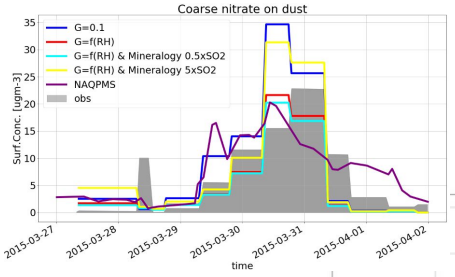
4 In MONARCH we i**mplemented the HNO_3 heterogeneous reaction** on dust surface:

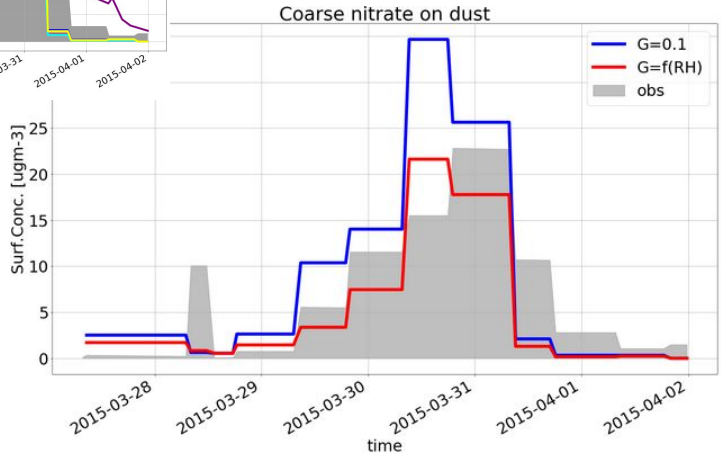


Uptake coefficient (γ) depends on:

- Dust mineralogy (source)
- Ambient humidity
- etc.

5 **Sensitivity studies** are performed and evaluated with observations





6 Implementations are used in other FRAGMENT working groups (i.e. **aerosol radiation**, **aerosol cloud interaction**)

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EXCELENCIA SEVERO OCHOA

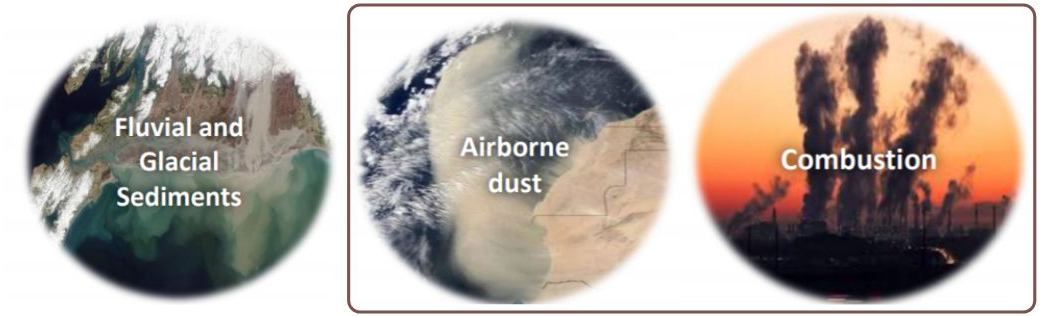
Iron Modeling - EC-Earth

Elisa Bergas-Massó - PhD Student

The Atmospheric Iron Cycle

Ocean productivity (specially in ocean remote regions) relies upon bioavailable Fe for photosynthesis, respiration, and nitrogen fixation, which makes the Fe biogeochemical cycle a key modulator of the ocean's ability to uptake atmospheric CO2.

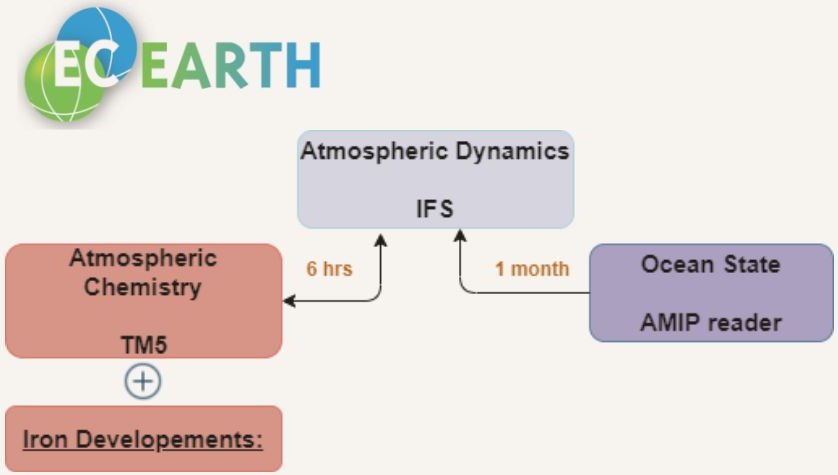
1 Emissions



2 Atmospheric Processing

3 Wet & Dry Deposition

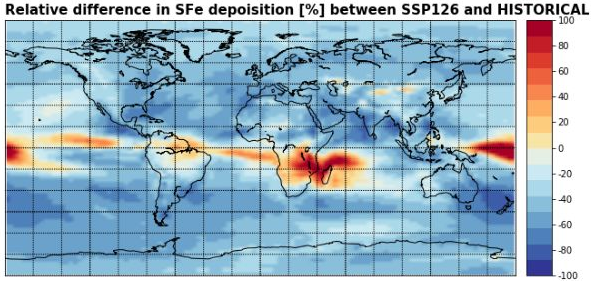
Iron CMIP6 Scenarios



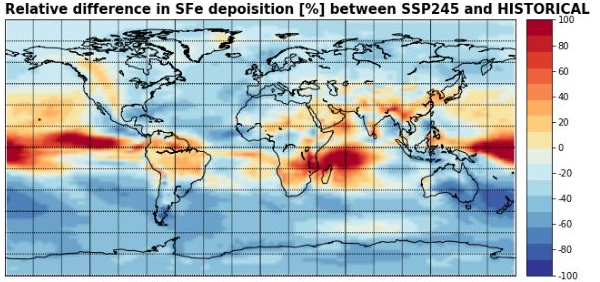
- Atnhropogenic Emissions
- Atmospheric Acidity
- Soluble-Fe Deposition

Relative differences with PD

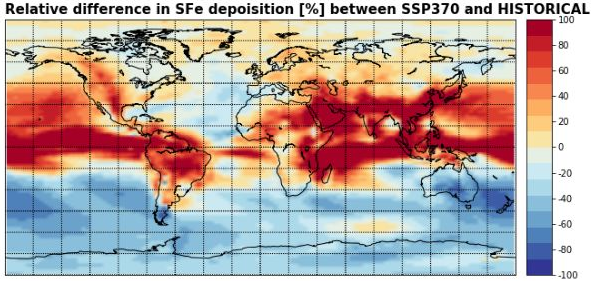
SSP126



SSP245



SSP370



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EXCELENCIA SEVERO OCHOA

Field campaigns in FRAGMENT

Cristina González Flórez - PhD Student

Adolfo González Romero - PhD Student

Frontiers in dust minerAloGical coMposition and its Effects upoN climaTe (FRAGMENT)

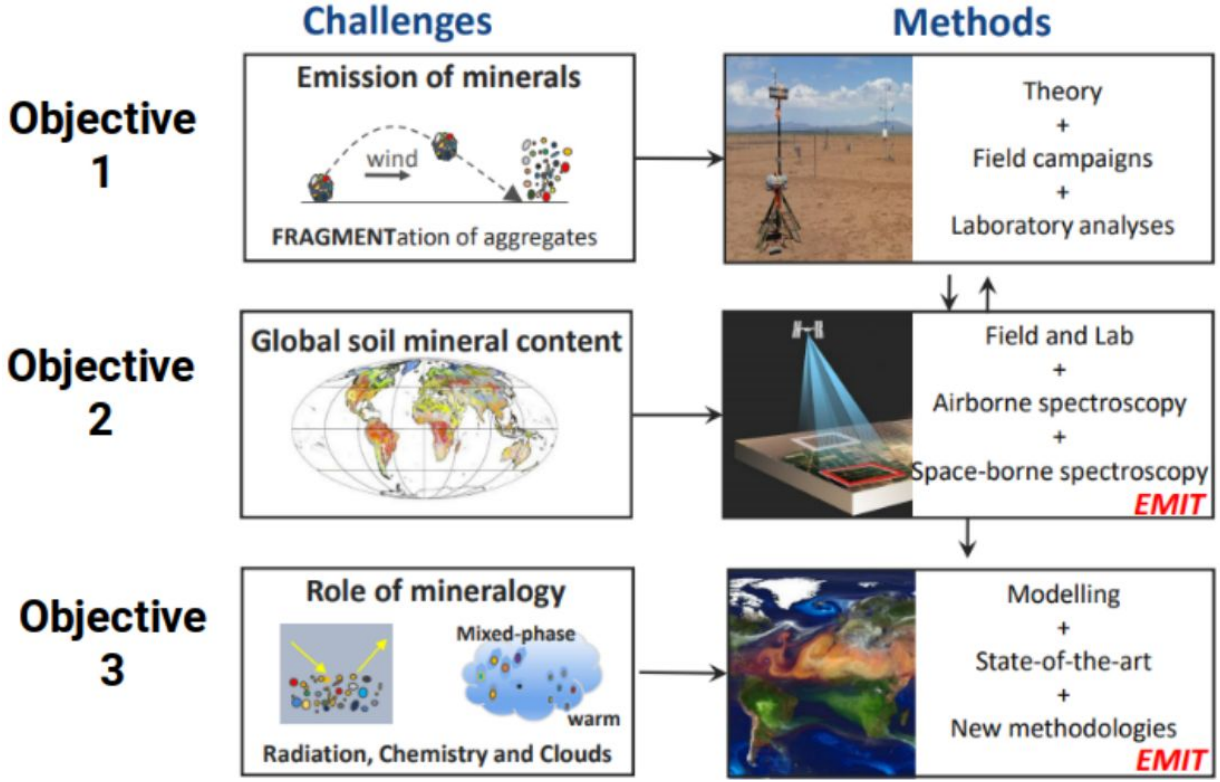

Image credit: C. Pérez García-Pando (PI of FRAGMENT)

Host institution:

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Partner institutions:

CSIC

TECHNISCHE UNIVERSITÄT DARMSTADT

Other collaborators:

NASA

Caltech

JPL Jet Propulsion Laboratory California Institute of Technology

MARRAKECH UNIVERSITÉ CADI AYYAD

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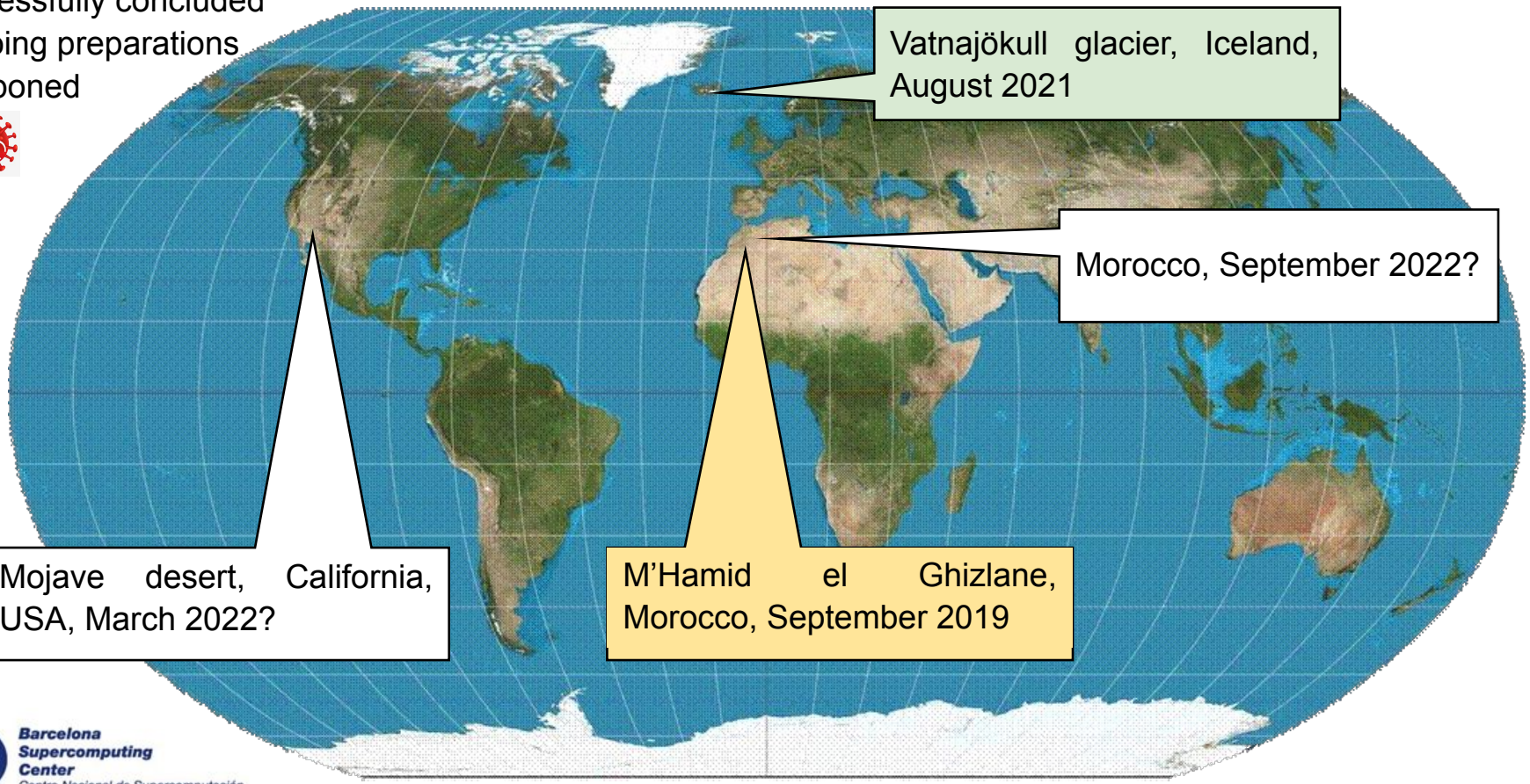
Field campaigns in FRAGMENT

- Successfully concluded
- Ongoing preparations
- Postponed



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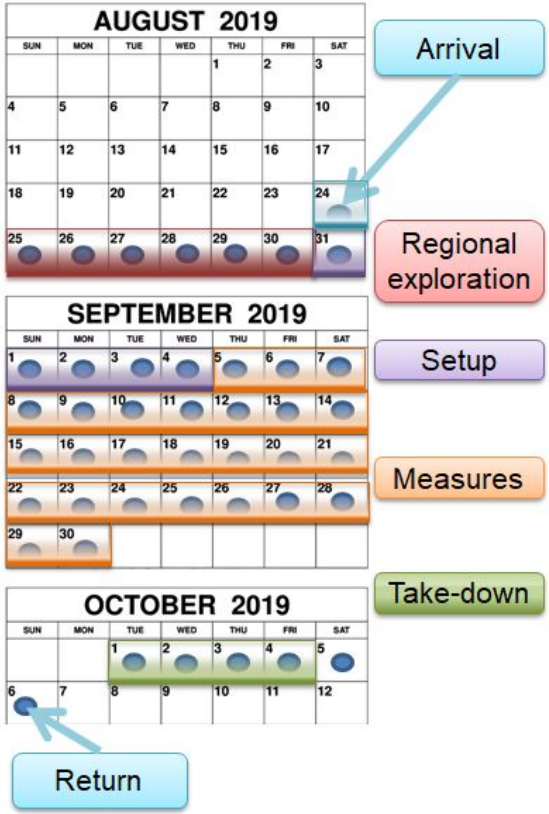
Experimental setup



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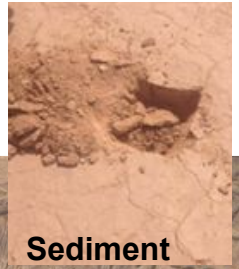
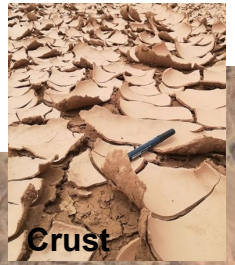
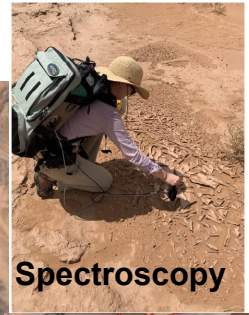
Meteorological & airborne measurements

Local & regional soil sampling







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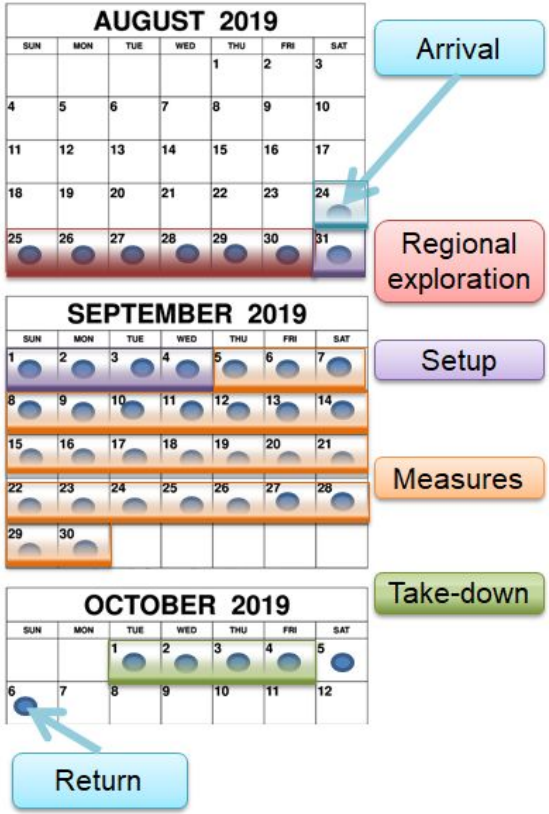

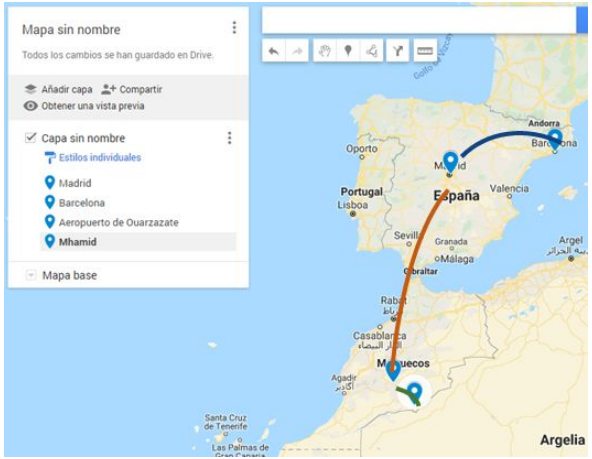

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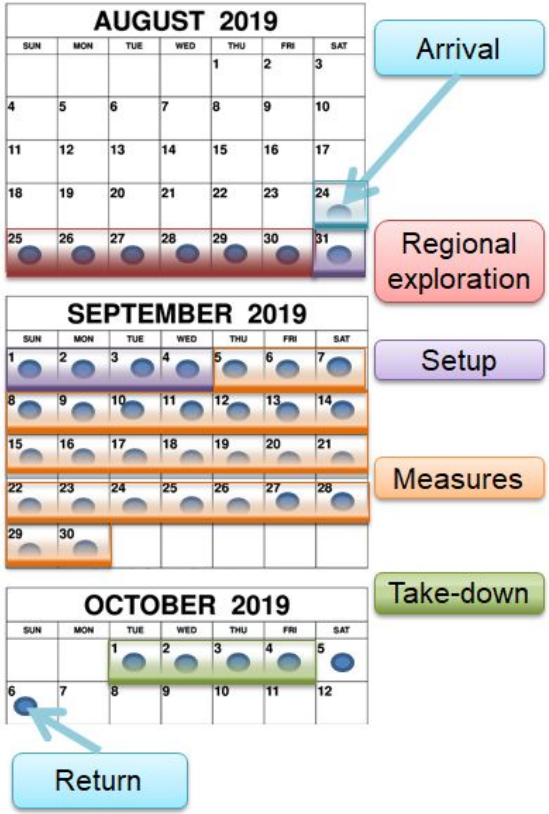

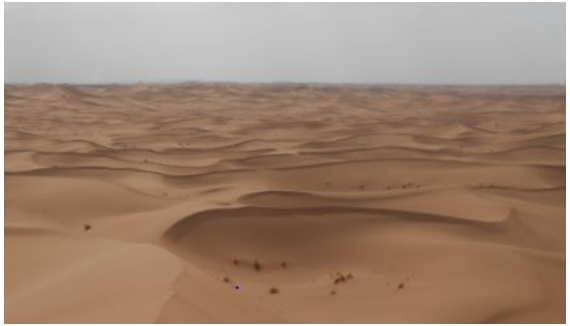

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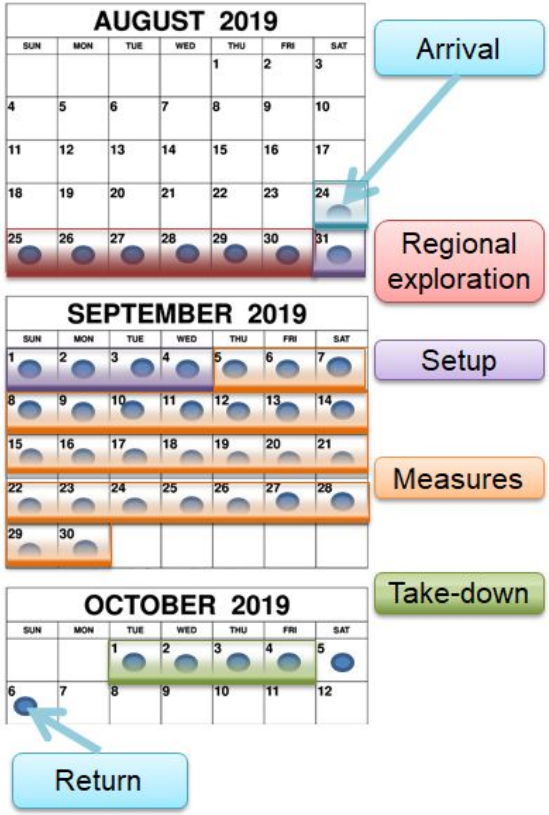
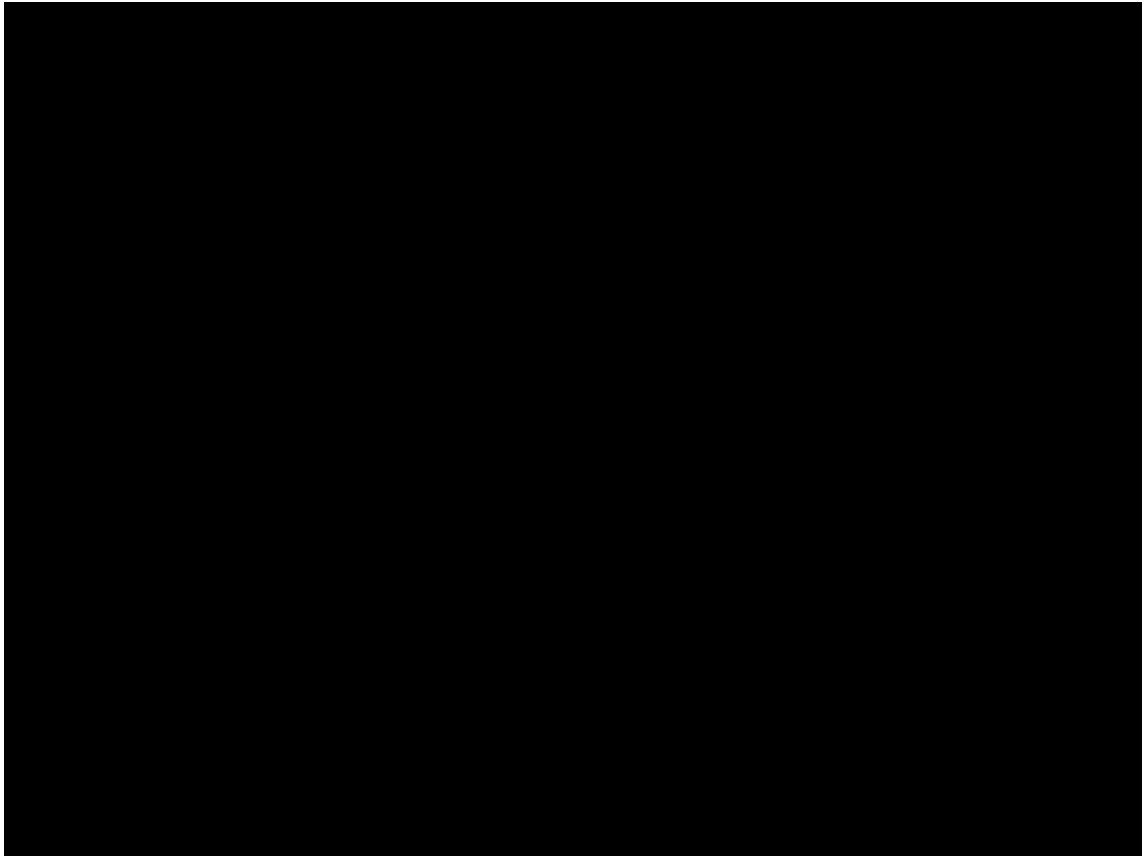
Dust event





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The main goal of these campaigns is to evaluate, monitor and sample dust events on the source area


Next challenge….
Iceland

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EXCELENCIA SEVERO OCHOA

Thank you!!