

Connecting model – observations aerosol typing

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IMPORTANCE

- **impact of the different aerosol sources on climate, precipitation and air quality.**
- **aerosol emissions policies**
- **local authorities and hazards**

The **inhomogeneity** among satellite (and not only) aerosol **typing schemes decreases** fundamental long-term datasets (multi sensors) **consistency**

Typing procedures - overview

- Confusing and misleading **nomenclature**
- Remote-sensing can provide **optical constraints** interpreted as **particle size, shape, and indices of refraction**
- A further **interpretative step**, entailing additional assumptions, reports particle **Source/Chemical Composition**
- **Validation Data** for aerosol type are very **limited**
- **Model** simulations and **in situ** measurements can help



Needs

- Making clear the variety of typing meanings, names, procedures
- Review the differences and try to explain them
- Identify gaps and further needs
- Comparing algorithms
- Overcoming limitation in reference datasets

Something else?

Reference database for aerosol typing (**REDAT**)

- **The idea:** collecting information about aerosol typing from each sensor for each aerosol type and each algorithm.
- A set of pure aerosol components + their mixtures
- Labeled and identified with sensor typing procedures and grouping them in big categories.

Its development could provide a common platform for in-depth investigation well beyond our current knowledge.



REDAT

- REDAT could provide the opportunity for

- ❑ Finding matching / **translating rules** (which will be non-unique) between words belonging to a “controlled vocabulary”
- ❑ Providing an indication of typing products **reliability**
- ❑ Overcoming the “small” dataset limitation
- ❑ Construction of a **multi-dimensional** and **multi-platform** space of characteristic optical properties

Design

- Identified **needs**:

Hierarchical structure

Flexibility for accommodating substantially different data

Pointing to the specific typing algorithm and procedures



REDAT

Table1

Algorithm
ID
Sensor
Instrument type
.....

Table2

Aerosol type characteristics
ID
Algorithm ID
Type name
.....

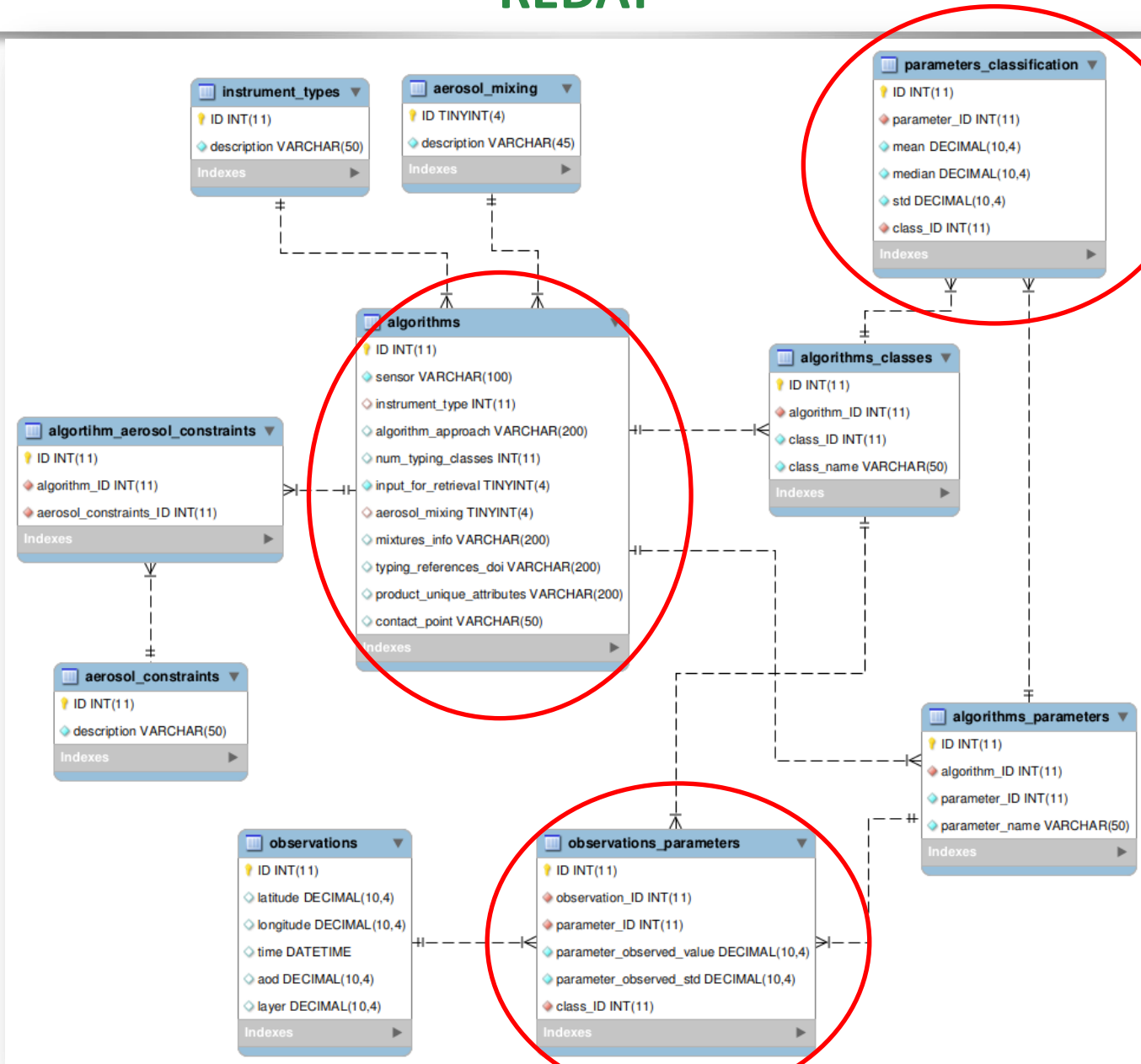
***PostgreSQL database
under development at
CNR-IMAA***

Table3

Reference Typing Data
ID
Algorithm ID
Location
.....

Simplified version...

REDAT



REDAT

Table1

Algorithm
ID
Sensor
Instrument type
.....

Table2

Aerosol type characteristics
ID
Algorithm ID
Type name
.....

***Inputs from community
are needed***

Table3

Reference Typing Data
ID
Algorithm ID
Location
.....

***Database hosted at CNR &
Linked to AEROSAT, AEROCOM, ACTRIS
and relevant web site***

Table 1

Database filled in with info coming for the overview of typing procedures

- **21 aerosol typing procedures** included in the review

To be checked and updated

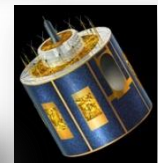
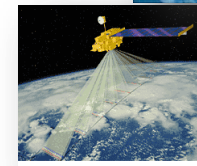
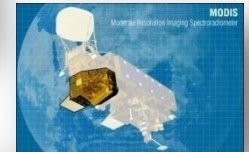
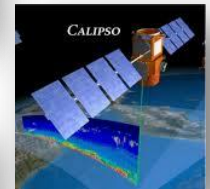
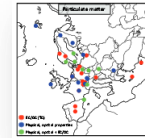


Table 1

Google form module set up for this purpose

The screenshot shows a Google Form interface with a blue header bar. The form is titled "Aerosol typing - REDAT Table1 - Algorithm". It has two tabs: "DOMANDE" (selected) and "RISPOSTE". The form contains the following sections:

- Descrizione modulo**: A text input field.
- Sensor/Platform/Model ***: A text input field with the instruction "Report here the Instrument/Model name including its version if any".
- Testo risposta breve**: A text input field.
- Instrument/Model type ***: A radio button selection menu with the following options:
 - active GB
 - passive GB
 - in situ GB
 - active satellite
 - passive satellite
 - regional model
 - global CTM
 - global GCM

***Link will be sent for
adding further
algorithms by 10 Nov***

Table 2

Definition of the properties for each class of each algorithm

Aerosol class

Characteristics of the class in term of each one of typing properties:

Mean , std, median, 10-90 percentile

or

Thresholds used in the typing decision tree

For models, source info used and which one



To be finalized by at least 1 representative for community:

GB, satellite, model

Lucia, Ralph, Kostas

To be checked and updated through a Google Module

sent to AEROSAT mailing list by 30 Nov

Table 1+2

Core for BAMS paper

The problem of aerosol typing: its relevance

2 approaches: optical, interpretative scheme

Nomenclature

Classes

Aerosat initiative

Setting up a REDAT

The call for “external” contribution

The starting point

Structure and first sections by end of January

Table 3

Quantitative set of information and optical properties measurements for the different aerosol types/sensor/algorithm

This set could become a reference dataset for the whole community and will provide opportunities for:

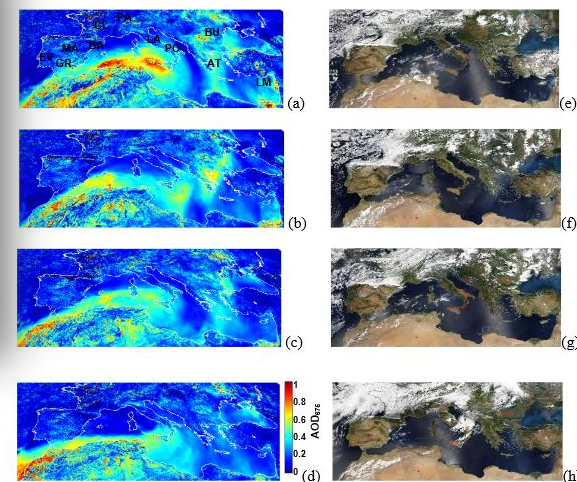
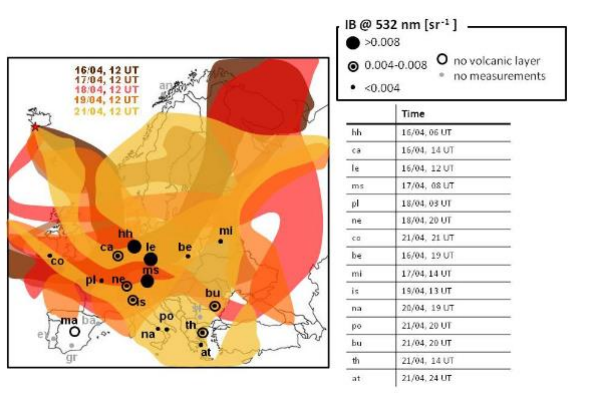
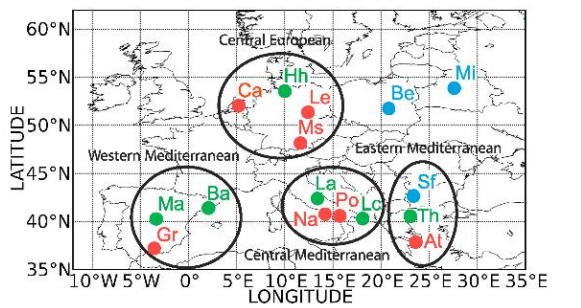
-Comparing typing procedures

-Providing a reference dataset and a link between observational and modeling community

EARLINET/ACTRIS Reference dataset

Using published and full characterized data

1. CALIPSO- EARLINET dataset
2. Eyja volcanic eruption EARLINET dataset
3. ACTRIS summer 2012 campaign



1. Pappalardo et al., JGR 2010

2. Pappalardo et al., ACP 2013

3. Sicard et al., AMT 2015

Aerosol typing within EARLINET/ACTRIS

A lidar stand-alone procedure has been realized in harmonization efforts with aerosol typing from HSRL lidar in US.

Method:

a distance-based multivariate analysis depending only on lidar intensive properties [Burton et al., 2012].

The method is set up using a training dataset and then results of the method are compared vs manual typing of the data (backtrajectories analysis + model inputs + satellite images).

Comparing Aerosol typing in EARLINET/ACTRIS

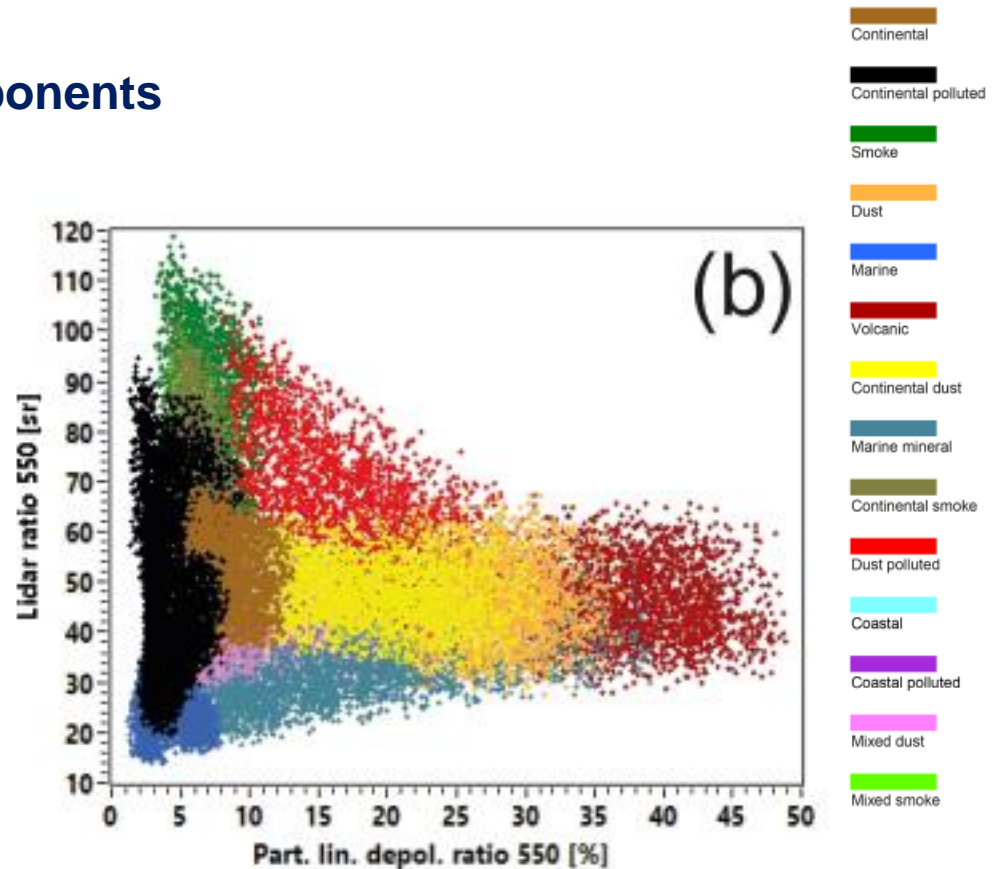
NATALI- Neural network aerosol typing algorithm based on aerosol lidar data

**Neural network algorithm based on OPAC + RH,
GDAC microphysics**

Mischenko spheroidal model

Linear mixing of different components

Nicolae et al., ACP 2018



Comparing Aerosol typing in EARLINET/ACTRIS

Systematic comparison of the 2 EARLINET algorithms on

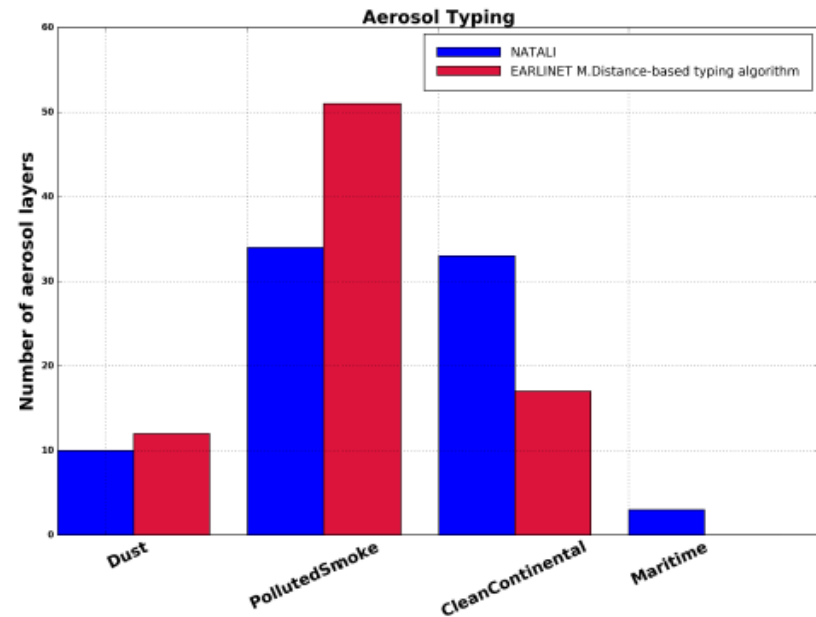
- 54 Raman lidar cases of aerosol measurements (backscatter coefficient profiles at 1064nm, 532nm and 355nm, as well as the extinction coefficient profiles at 532nm and 355nm)
- Thessaloniki
- period 2012-2015



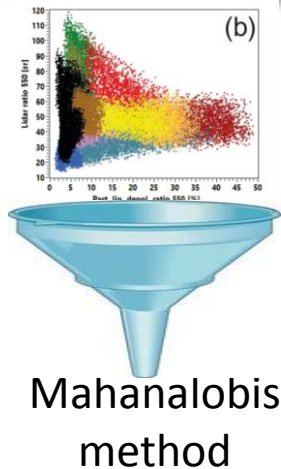
The 2 methodologies agree on the Thessaloniki characteristics in terms of typical aerosol content

Vodouri et al., submitted ACPD 2018

Classes rearranged for doing the “comparison”



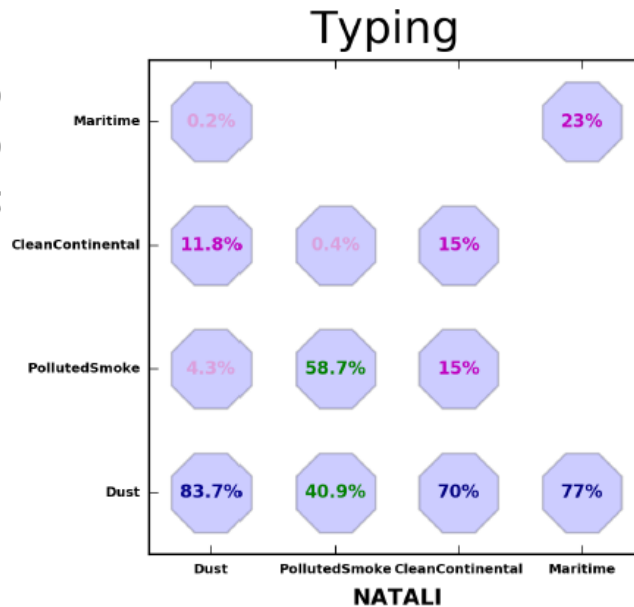
Comparing Aerosol typing in EARLINET/ACTRIS



Results:

- Dust-CleanContinental mismatch is probably due to the fact that rural conditions fall in CleanContinental type for NATALI while this is meant as background clean conditions in the EARLINET distance-based typing algorithm.
- NATALI considers pure marine layers while the EARLINET Mahalanobis distance based typing algorithm considers a mixture of marine with other aerosol types.
- NATALI modelled big particles are typed by the EARLINET distance method as Maritime but also as Dust category, probably because of the different range of large lidar ratio values allowed in the NATALI synthetic data

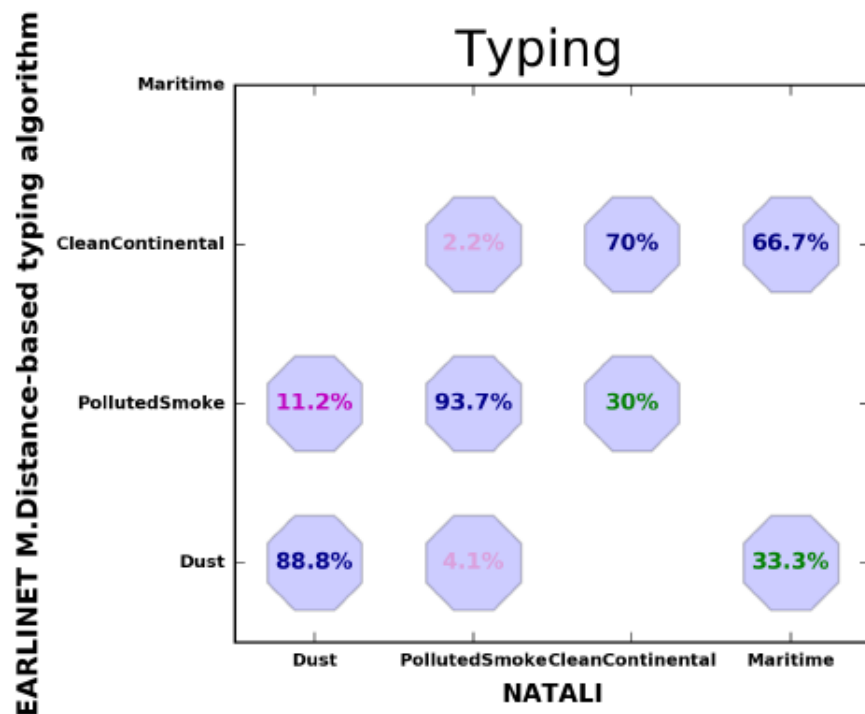
EARLINET M.Distance-based typing algorithm



Synthetic data comparison

This potentially allows to understand the «sources» of different results when applied on the same datasets

Comparing Aerosol typing in EARLINET/ACTRIS



When compared
on real
observations



Results:

Vodouri et al., submitted ACPD 2018

- Very good result on the most polluted classes
- A not satisfactory agreement is observed for the Maritime, which is the aerosol type less encountered over Thessaloniki. Dual interpretation is found for Maritime / Clear continental cases, this can be ascribed to the different aerosol type definition.

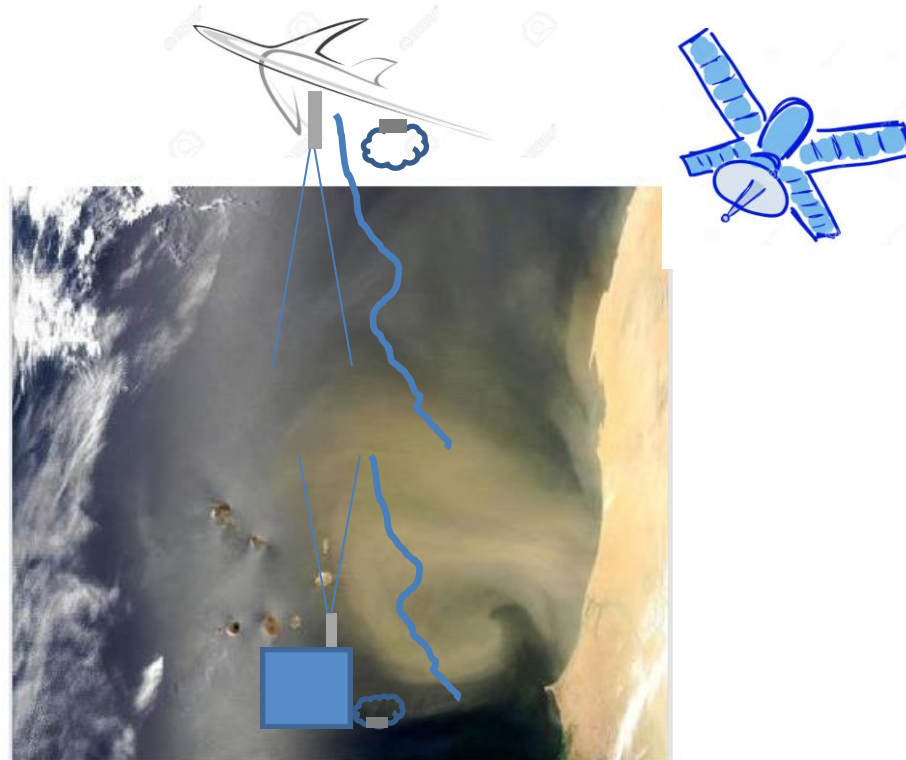
Working on first exercise for comparison/translating rules

- 1. Select one common «type» to be explored**
- 2. Identify experiments /campaigns as suitable for comparative study**

Working on first exercise for comparison/translating rules



**A campaign is under preparation for summer 2020 for ADM
Aeolus validation in Cape Verde, with special focus on dust.**



Satellite picture of Saharan sand storm above the Cape Verde Islands.

Credit: NASA

Discussion points

- **Are we considering the main needs?**
- **Is a collaborative information database sustainable for such kind of not-funded initiative?**
- **Is the contribution requested to the AEROSAT community feasible as unfunded?**