Consiglio Nazionale delle Ricerche

Aerosol typing
a key information

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Typing Importance

✓Satellite measurements in recent years are providing valuable information about the global distribution of **aerosol types**, showing for example the main source regions and typical transport paths.

✓Climatological studies of **aerosol load** at global and regional scales often **rely on inferred aerosol type**.

✓There is still a **high degree of inhomogeneity** among satellite aerosol typing schemes, which makes the use different sensor dataset in a consistent way difficult.

✓Knowledge of the **4d aerosol type distribution** in a consistent way is essential for understanding the **impact of different aerosol sources** on climate, precipitation and air quality.

Review of typing procedures

ASPECTS

PLATFORMS

1. General approach
2. Number of components
3. Components
4. Mixing
5. Methods
6. External inputs
7. Affecting retrievals

BASIC DATABASE

The general approach

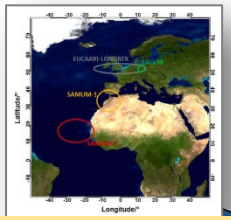
Identify the source for defining the aerosol characteristics

Investigate characteristics for understanding the source

More common in Ground Based observations

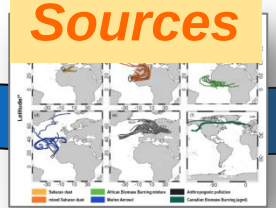
More common in satellite observations

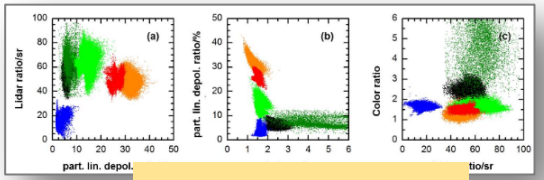
Input for defining automatic procedures for typing



Measurements

Sources

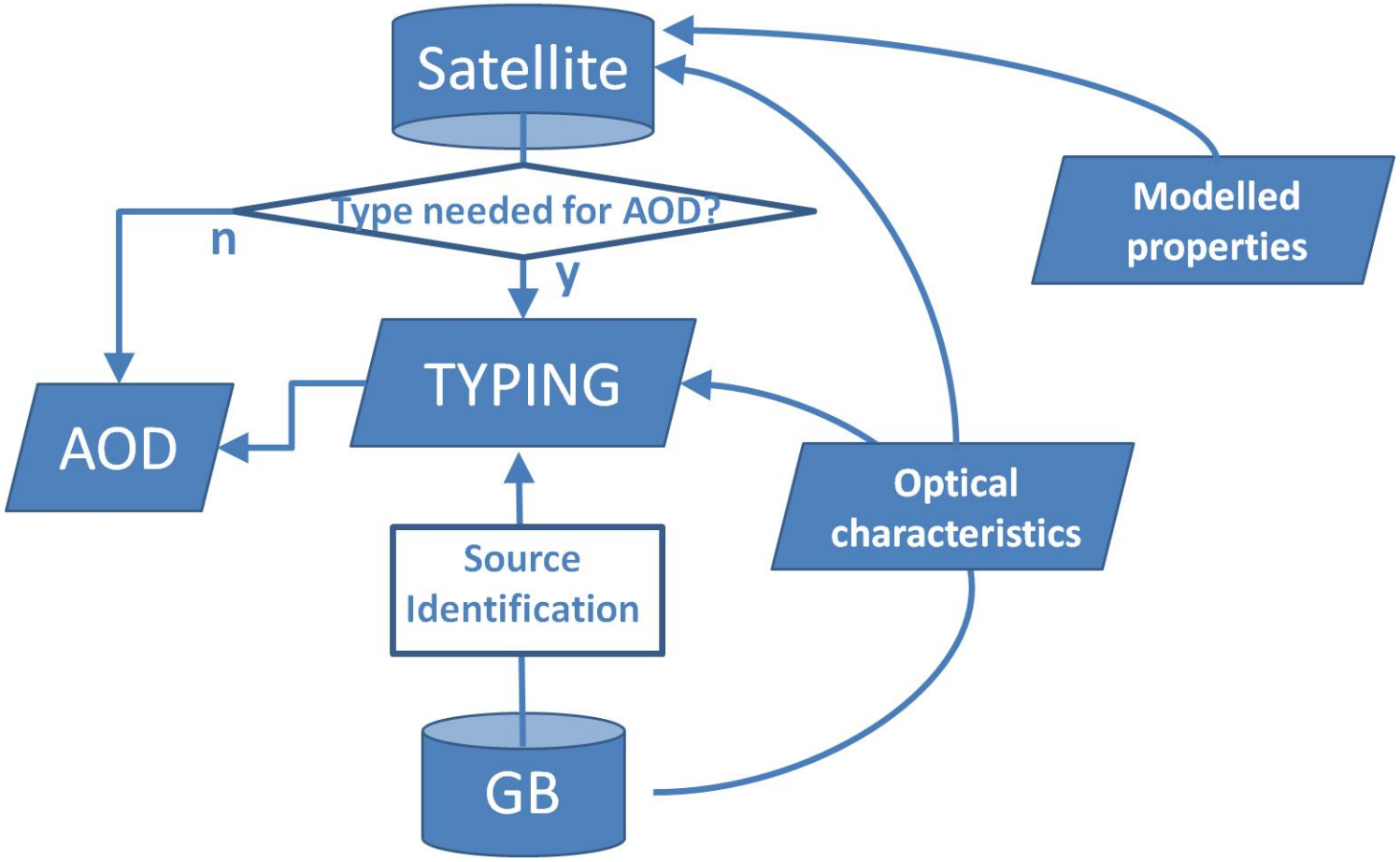




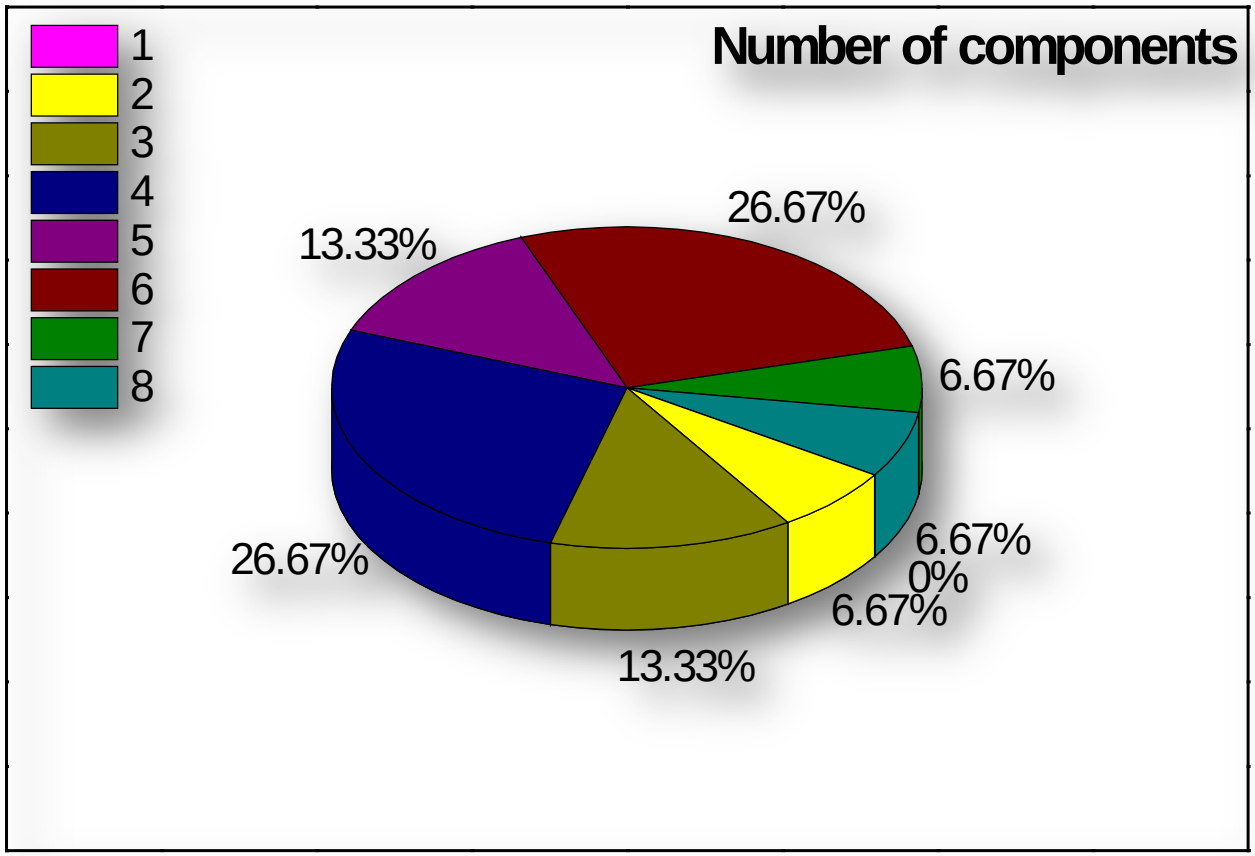
Procedures

Gross 2013

The general approach



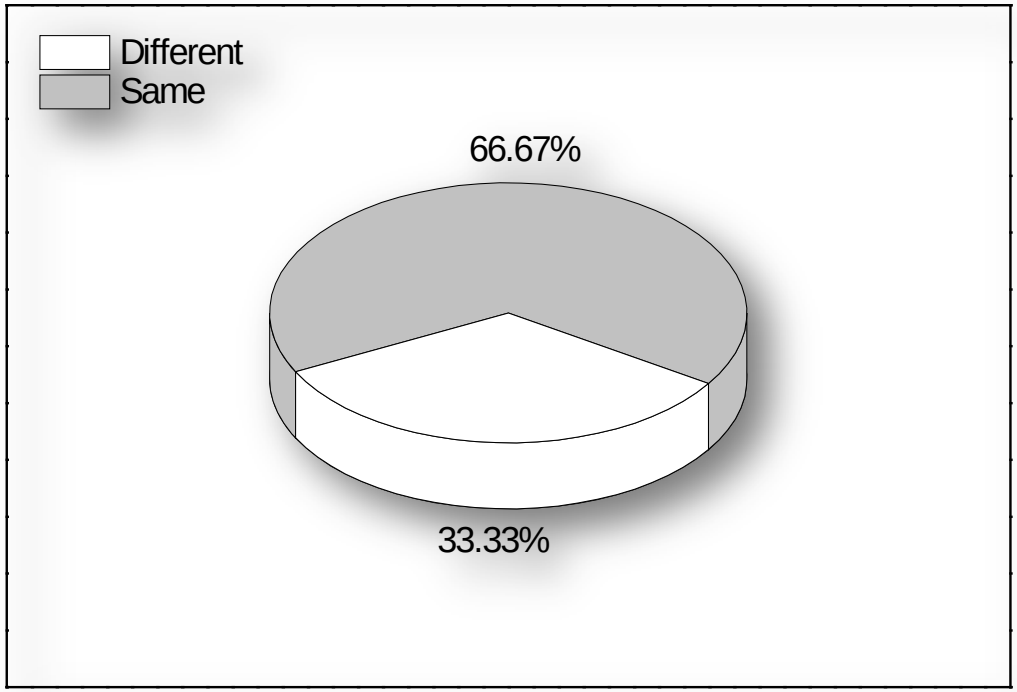
Number of components



Even if different the aerosol typing procedures typically classify aerosol in 4-6 types. Never exceeding 8 components.

Nomenclature

Two main approaches reflecting the source-related or characteristic-related approach for the typing.



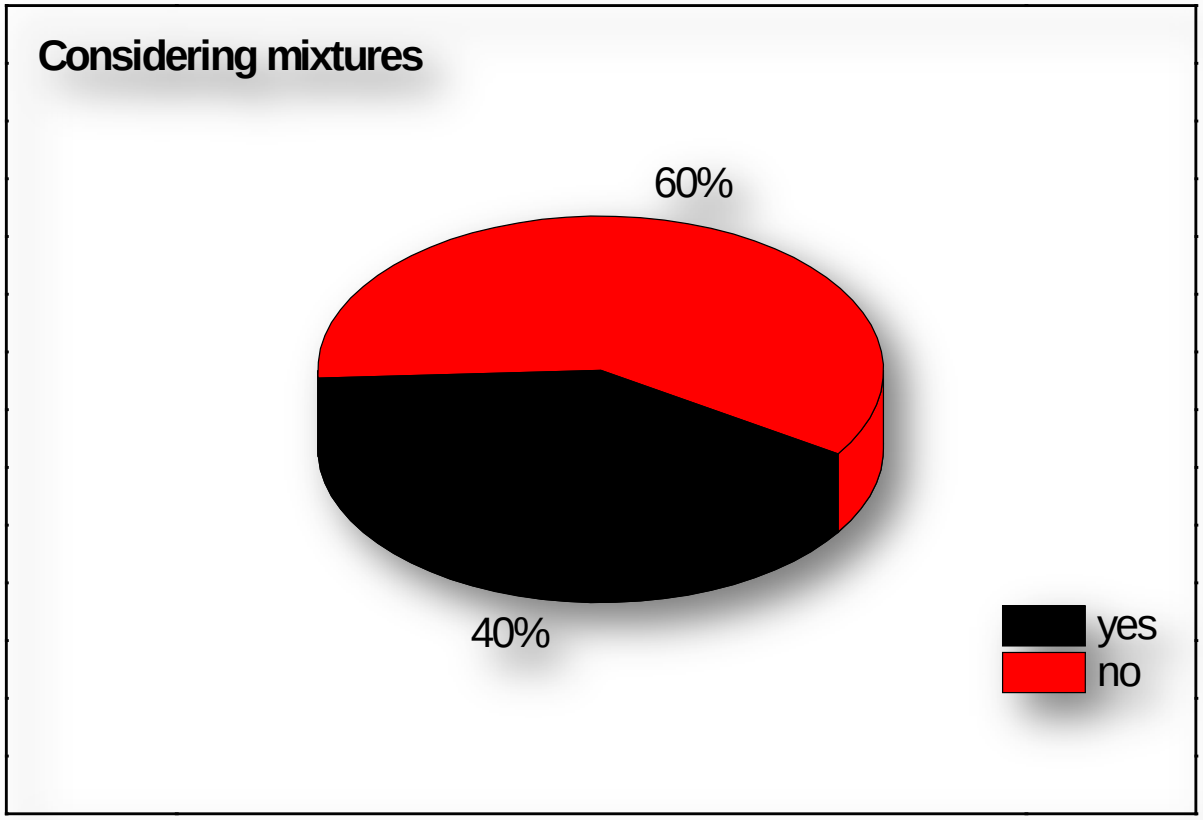
Out of 70 reviewed classes, 45 different names were found.

Nomenclature

The nomenclature is very heterogeneous among different platforms.

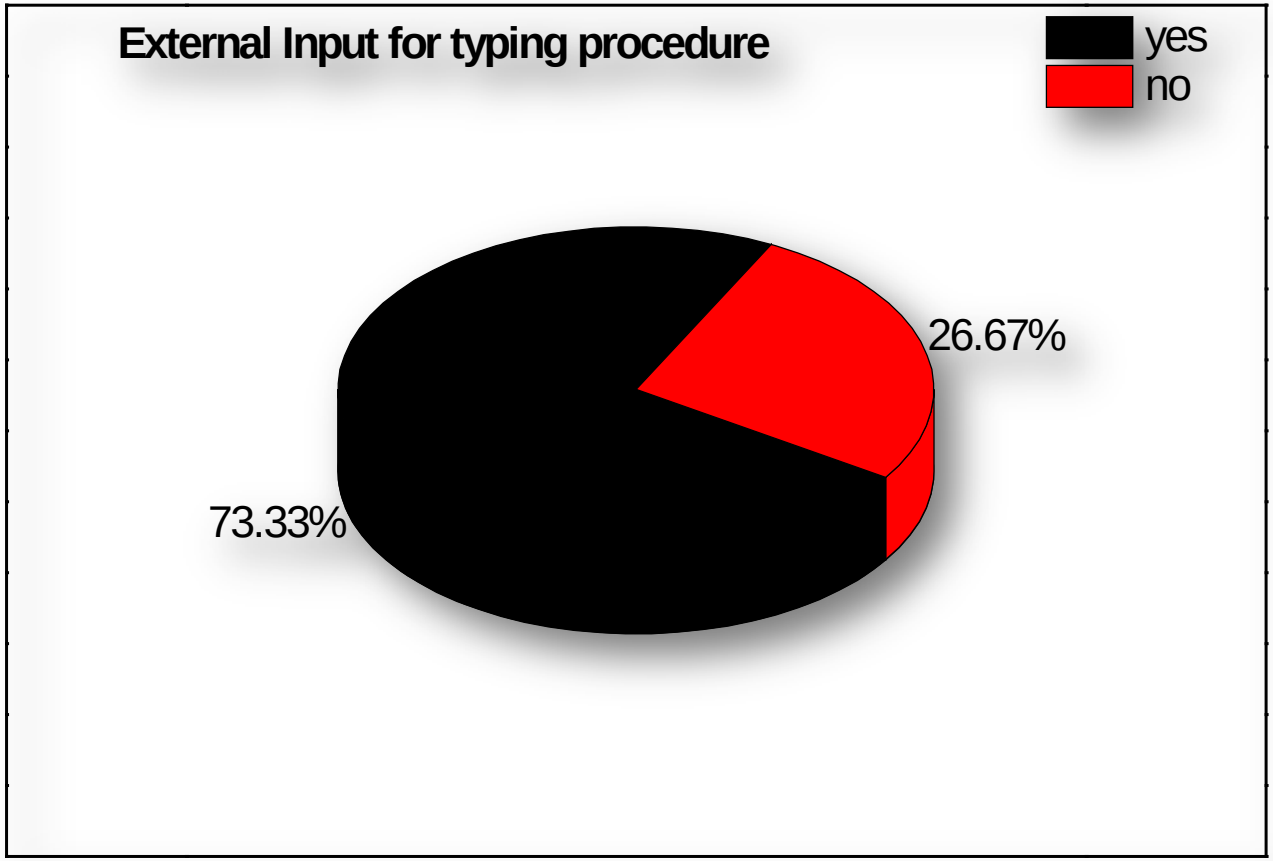
6 main classes could be identified grouping the different nomenclatures.

Mixing



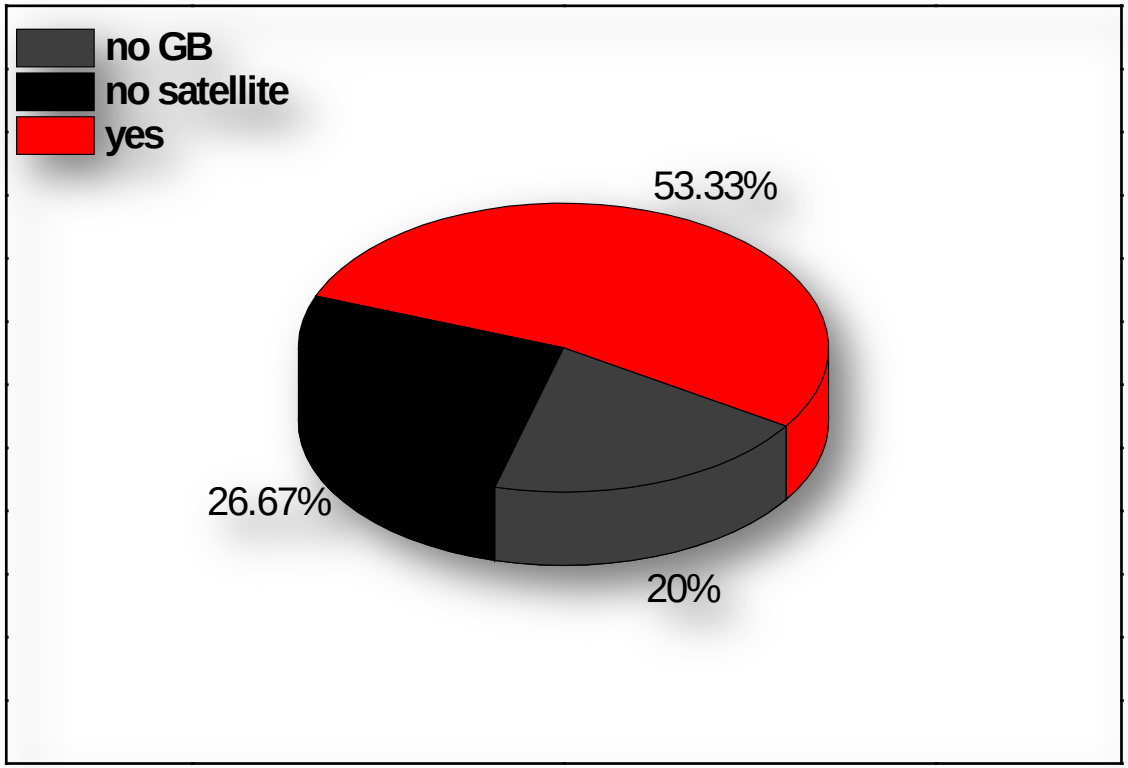
Some algorithms take into account the possibility of mixtures between components.

External inputs



Typical external inputs are datasets from GB measurements or from models + in some cases info about the locations

Affecting products



Typically, aerosol retrievals from satellite measurements make a priori assumptions about aerosol type, and the accuracy of the derived aerosol products strongly depends on the reliability of these assumptions.

One example: DUST

DUST *word is used very often to mean desertic particles.... but* ***DUST*** *is also used in different community for coarse particles in general*

Important to avoid not-needed confusion

- Within remote-sensing community
- With respect to near-surface and modelling communities
- Taking into account “external” users

One example: DUST

DUST *is typically identified thanks to its asphericity and dimension.*

- **Angstrom exponent + Angstrom exponent curvature [AERONET-Gobbi 2007]**
- **Desert region [AERONET-Catrall 2005]**
- **Particle Depolarization Ratio + Attenuated Backscatter+ Location [CALIPSO- Omar 2009]**
- **Particle Depolarization Ratio [EARLINET- Gross]**
- **Particle depolarization Ratio + Angstrom +Lidar Ratio + Backtrajectories [EARLINET Wandinger 2010]**
- **Brigthness temperature at 800 and 1200 cm−1+ clean scenario reference [IASI Clarisse 2013]**
- **Radiances /models for AOD + Angstrom + SSA [MISR Kahn 2015]**
- **Reflectance at 440, 412 and 2130 nm [MODIS, Ciren 2013]**

One example: DUST

- Different observables
- Same observable : Different “thresholds”?

Linear Depolarization Ratio 0.3-0.35 Pure Dust [HSRL Burton]
Linear Depolarization Ratio >0.2 Pure Dust [Omar et al., 2009]

- Combination of observables
- External constraints

How do the different observables change when particles properties changes?

Plans

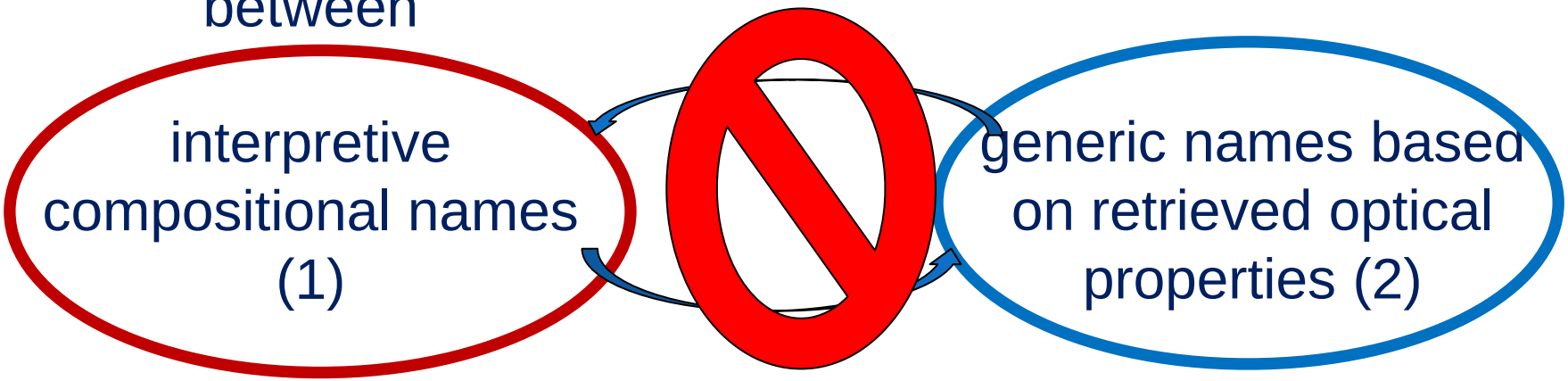
A. Nomenclature issue:

Two main approaches, classes named on the base of the:

1) “source” examples dust, ash, sulfate

2) “discriminating properties” examples absorbing, non-spherical, size

The challenge: not a one-to-one correspondence between



Plans

A. Nomenclature issue:

-no scientific users probably more interested in aerosol source and to source identification (1) nomenclature

-naming convention (2) is more correct from a scientific point of view

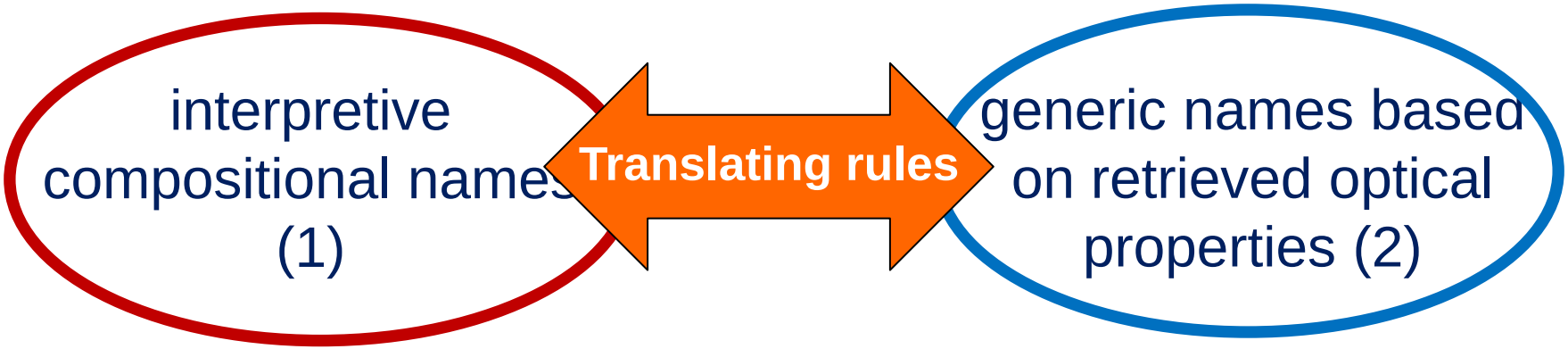
-approach (2) risks being more fragmentary and specialized

It is therefore essential to properly define the translation rules between approach 1 and 2 (and within them, translation rules among the different procedures).

Plans

A. Nomenclature issue:

Go for **1** or **2** and then report, as in the metadata world, matching / translating rules (which will be non-unique) between words belonging to a “controlled vocabulary”.



The translation rules will allow users to correctly use the valuable aerosol type information.

Then each “platform” can continue to use its own algorithm /methodology/name convention for aerosol typing.

Plans

B. The basic components

A set of 6 pure aerosol components + their mixtures

A first proposal could be:

Mineral dust

Biomass burning

Marine

Urban/industrial

Volcanic ash

Sulfates

(or equivalent names).

Plans

C. Reference database for aerosol typing (REDAT)

The idea: collecting a set of measurements from each sensor for each class identified at Point B.

What information we want to collect?

location (time and space),
sensor,
layer altitude (total-column in many cases),
type,
Intensive parameters used/important for the typing (with uncertainty)
AOD (columnar for passive sensors, layer-specific (but also above and below) for lidars)
surface type
observing geometry

Plans

C. Reference database for aerosol typing (REDAT)

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

-Comparing typing procedures

(for this we should probably try to start from ground-based measurements, which are limited datasets, and check for satellite matches)

-Providing a reference dataset and a link with the modeling community

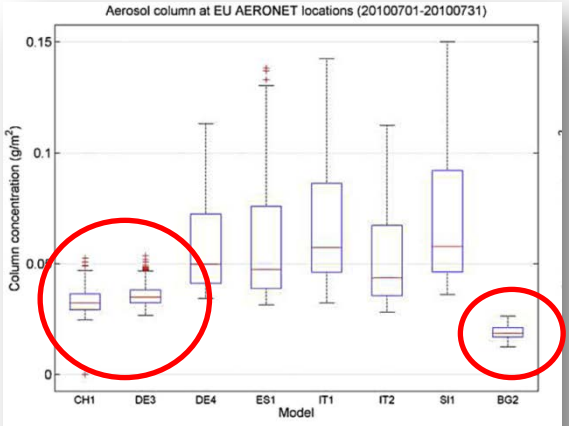
(also models typing and outputs could be relevant for this kind of database)

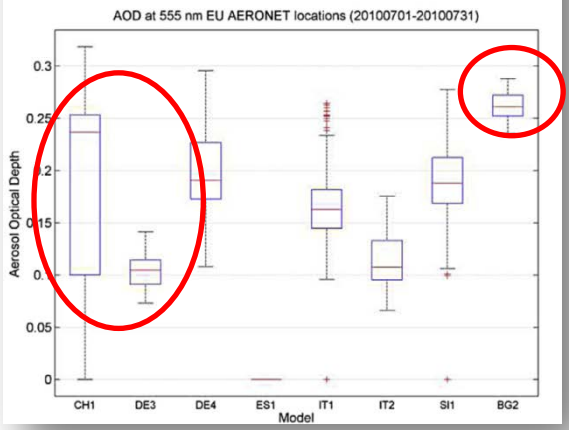
Link to models

AQMEII - Air Quality Modelling Evaluation International Initiative

Two-continents (Europe and North America) regional air-quality models intercomparison led by JRC and EPA

Aerosol load (column concentration, g/m²)





Aerosol Optical Depth (AOD, unitless)

Differences in simulated size distributions and assigns species densities, hygroscopicity, refractive index and mixing state for the models return anomalies for AOD comparison.

Curci et al., Atmos. Environ., vol.115, 2015

Conclusions

- REDAT database as instrument for identifiying translating rules
- Potential links with modelling simulated optical properties
- Overcoming of the “small” dataset issue
- Construction of a multi-dimensional and multi-platform space of characteristic optical properties

Thanks for your attention!