Consiglio Nazionale delle Ricerche

Aerosol typing: a key information

Update of aerosol type inventory

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Thomas Holzer-Popp and Ralph Kahn

Overview of typing procedures

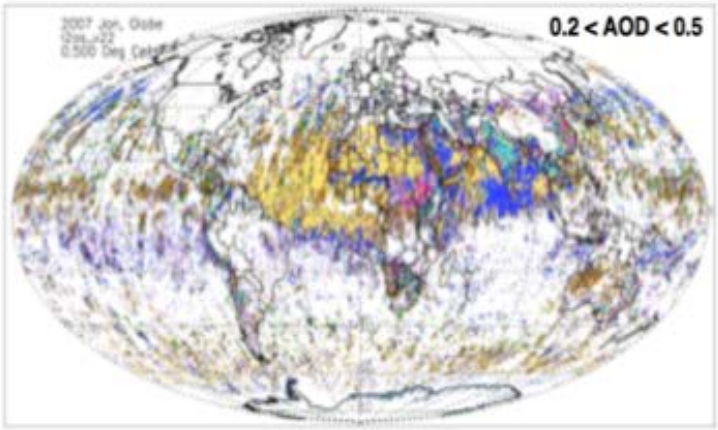
- **21 aerosol typing procedures included in the review**
- **15 classify particles in source classes with an interpretative scheme**
- **6 stays with the optical observables**

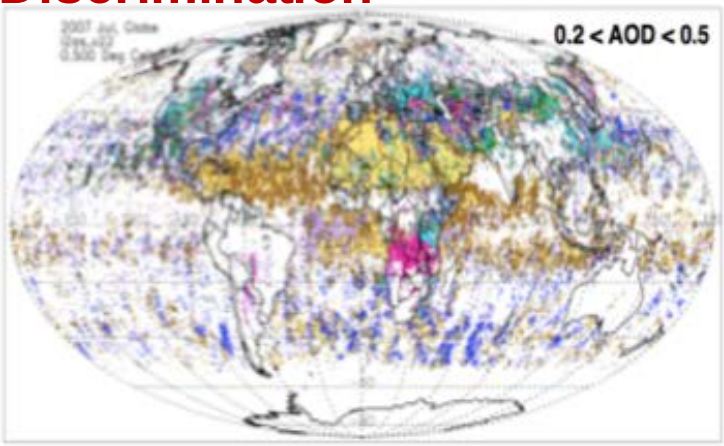
Overview of typing procedures

- 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

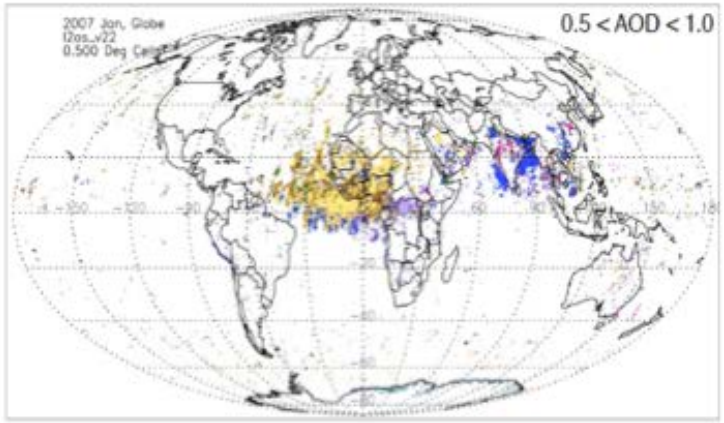
Optical classification scheme

MISR Aerosol Type Discrimination

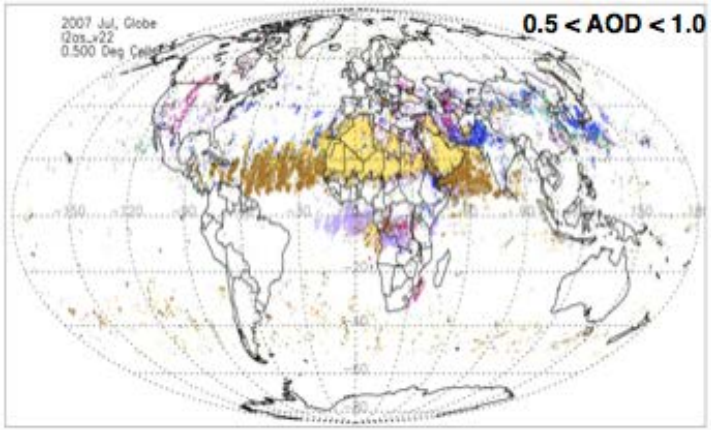




January 2007



July 2007



1-10 11-20 21-30 31-40 41-50 51-62 63-70 71-74 Mixture Group

Spherical, non-absorbing

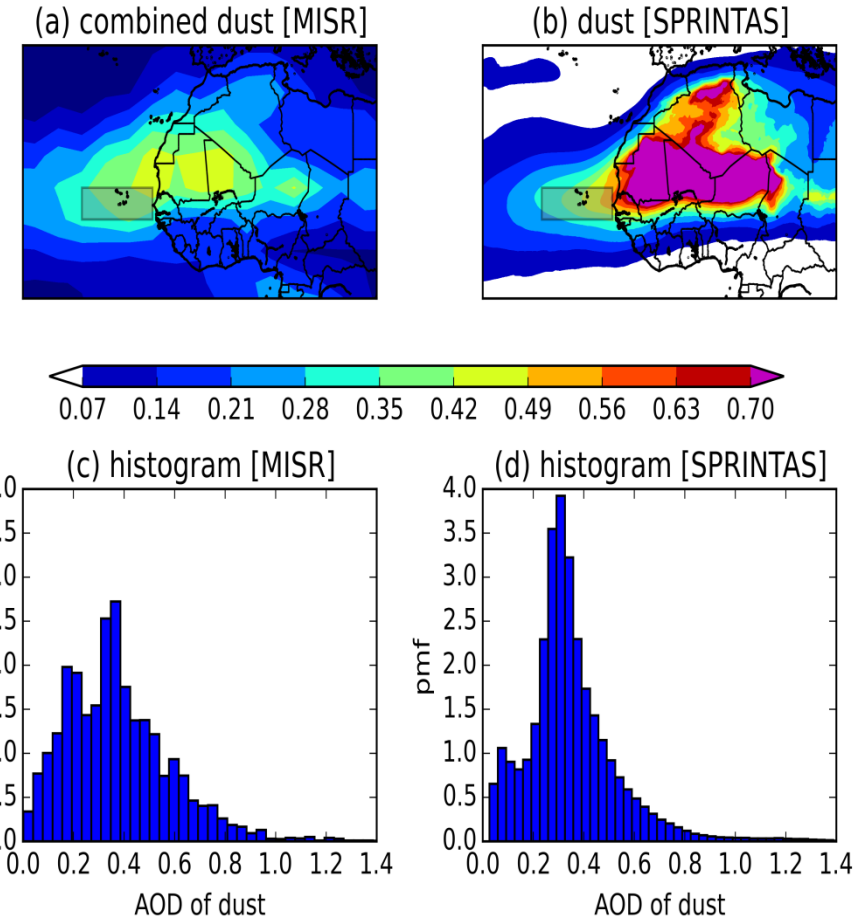
Non-spherical

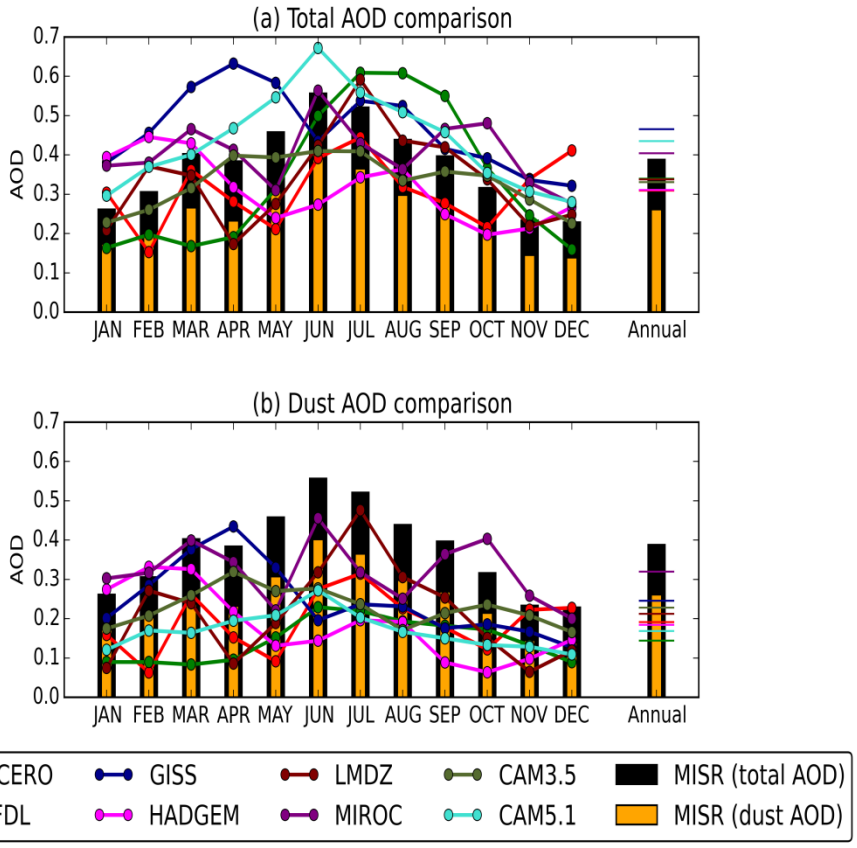
Spherical, absorbing

Kahn & Gaitley JGR 2015

Optical classification scheme

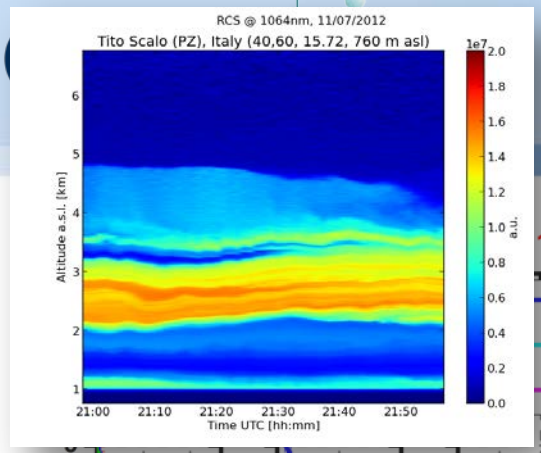
MISR Aerosol Type Discrimination

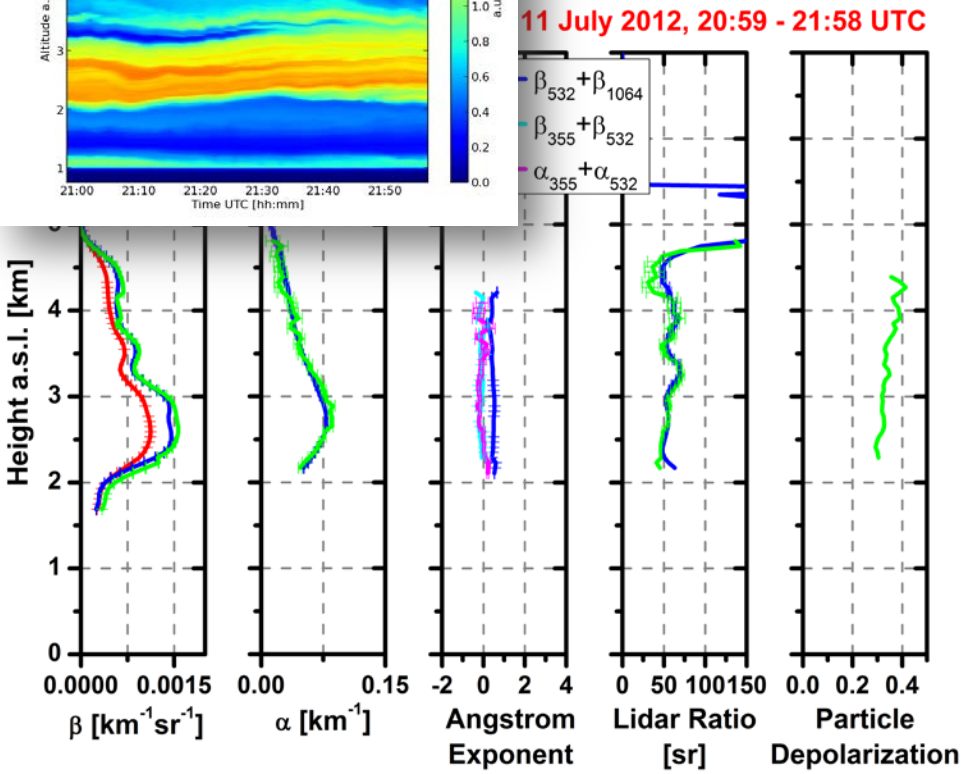


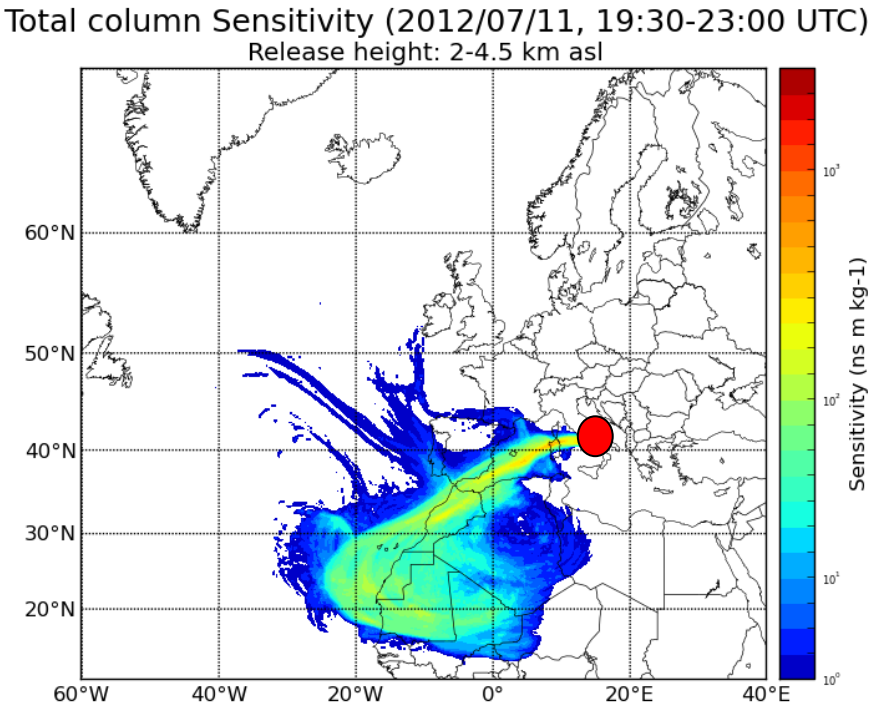


See: Poster by Huikyo Lee, Olga Kalashnikova, Kentaro Suzuki, &Amy Braverman

Interpretive scheme







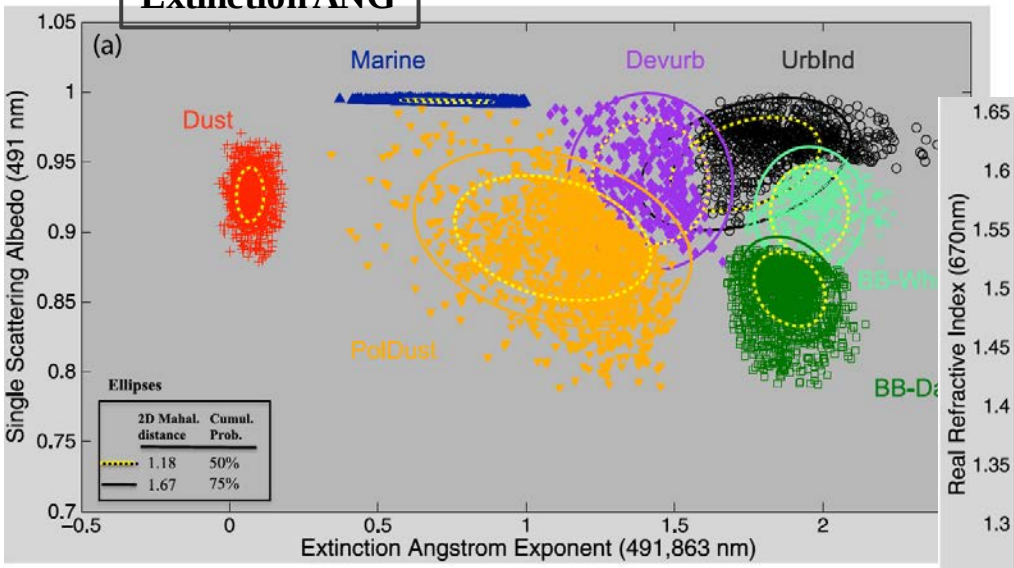
- AE indicates coarse particles (values around 0) ➔ could be dust
- LR mean values of 56.7±6.1 and 54.1±10.1 sr, for 355 and 532 nm in respective ➔ probably dust
- Linear particle depolarization ratio of 34±3 % consolidates the hyp➔ Dust
- Finally, backward trajectory analysis indicates the pathway travelled of air masses ➔ foothills of Atlas

Interpretive scheme

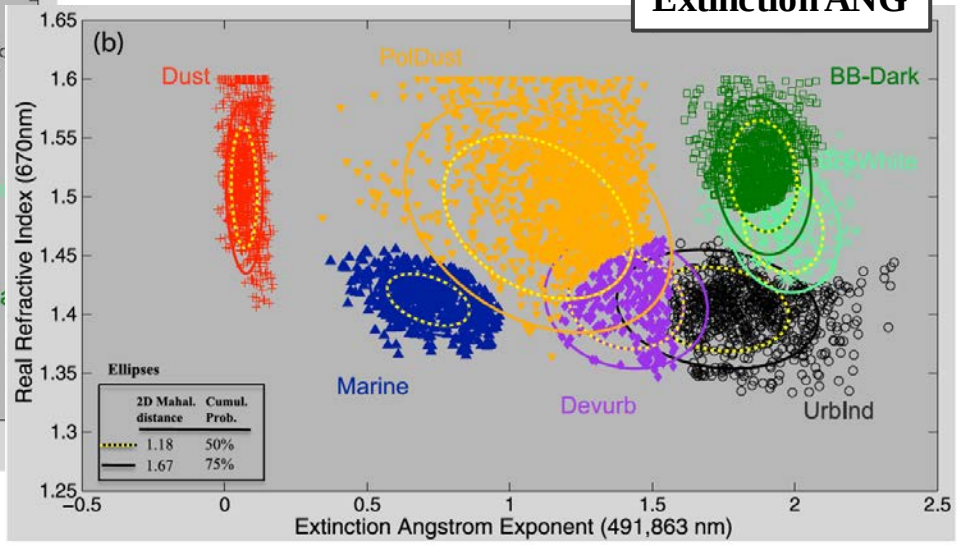
On the base of case studies the observed optical properties are ascribed to certain aerosol classes

AERONET Aerosol Type 7-Grouping Classification based on EAE491,863, SSA491, RRI670, dSSA491,863

7 Groupings SSA_{491} vs. Extinction ANG



7 Groupings Real RI_{670} vs. Extinction ANG



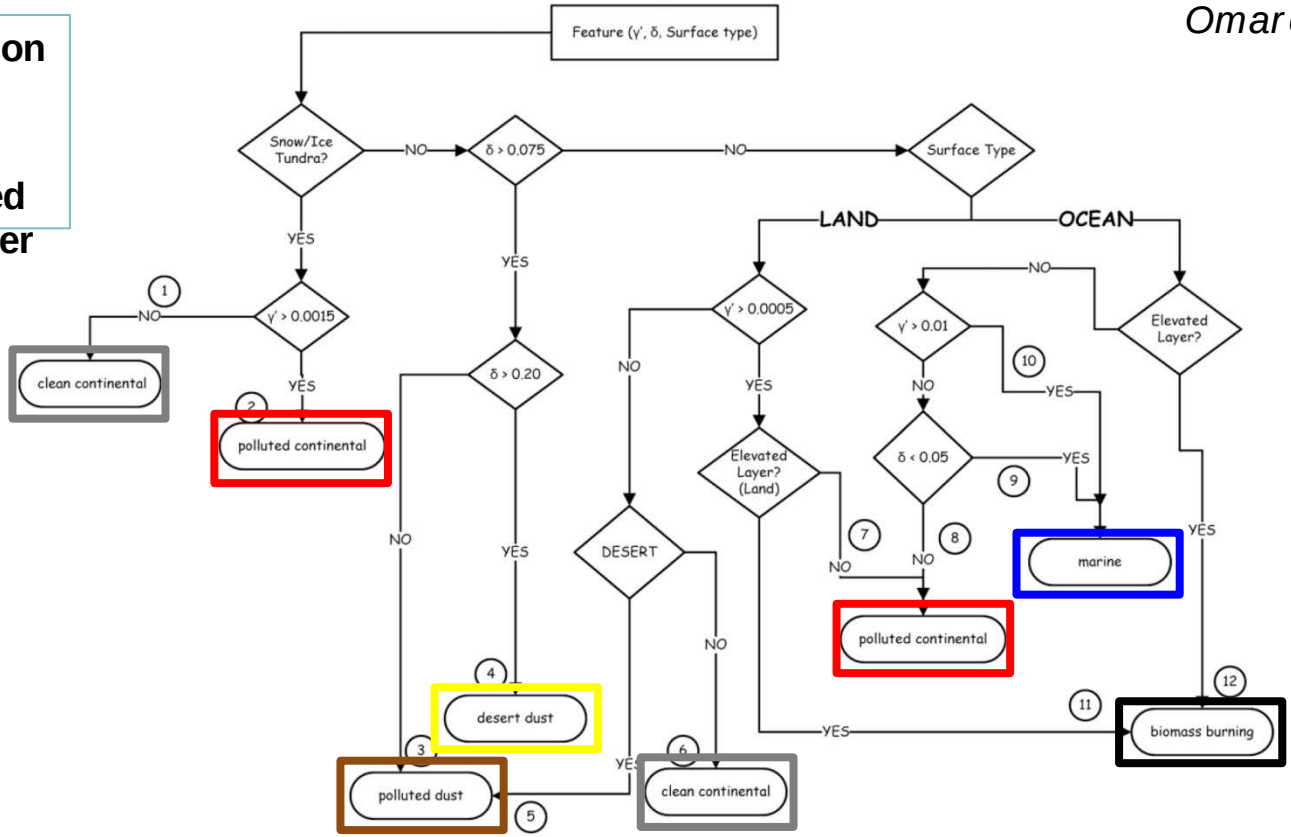
Russell et al. JGR 2014

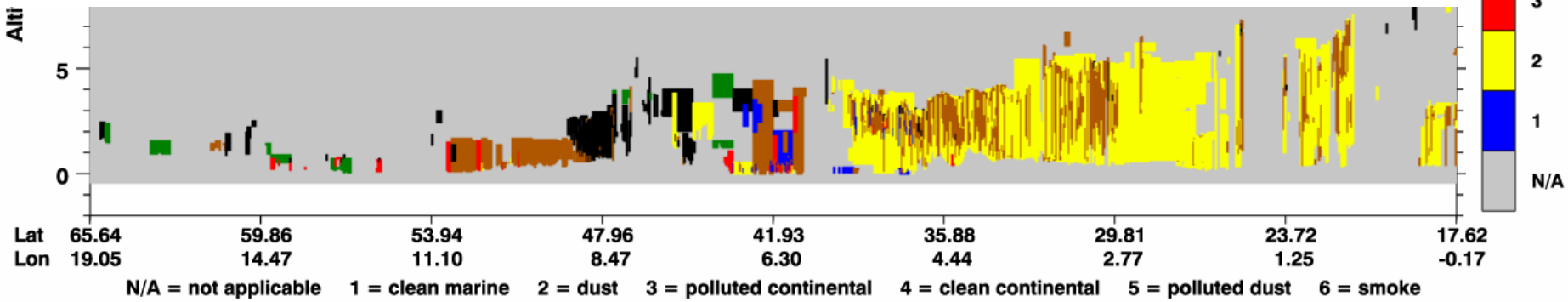
Interpretive scheme

δ – depolarization

γ' – layer-integrated attenuated backscatter

Omar et al., JAOT 2009





Which were the plans?

Reference database for aerosol typing (REDAT)

The idea: collecting a set of measurements from each sensor for each aerosol type.

A set of pure aerosol components + their mixtures

Labeled and identified with sensor typing procedures and grouping them in big categories.

A first proposal could be:

Mineral dust - Biomass burning – Marine - Urban/industrial - Volcanic ash – Sulfates

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)

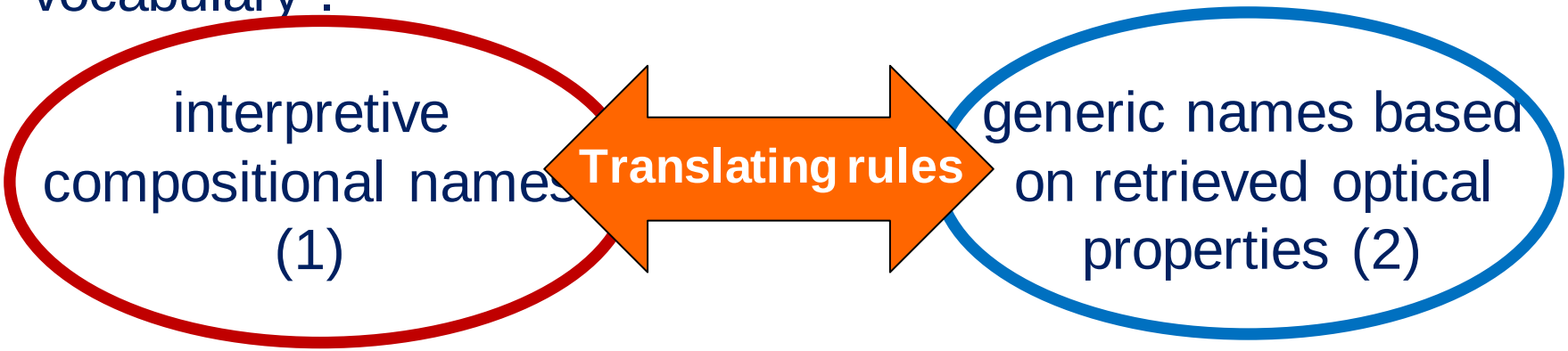
-Providing a reference dataset and a link with the modeling community

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

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**

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 of the “small” dataset
- Construction of a **multi-dimensional** and **multi-platform** space of characteristic optical properties

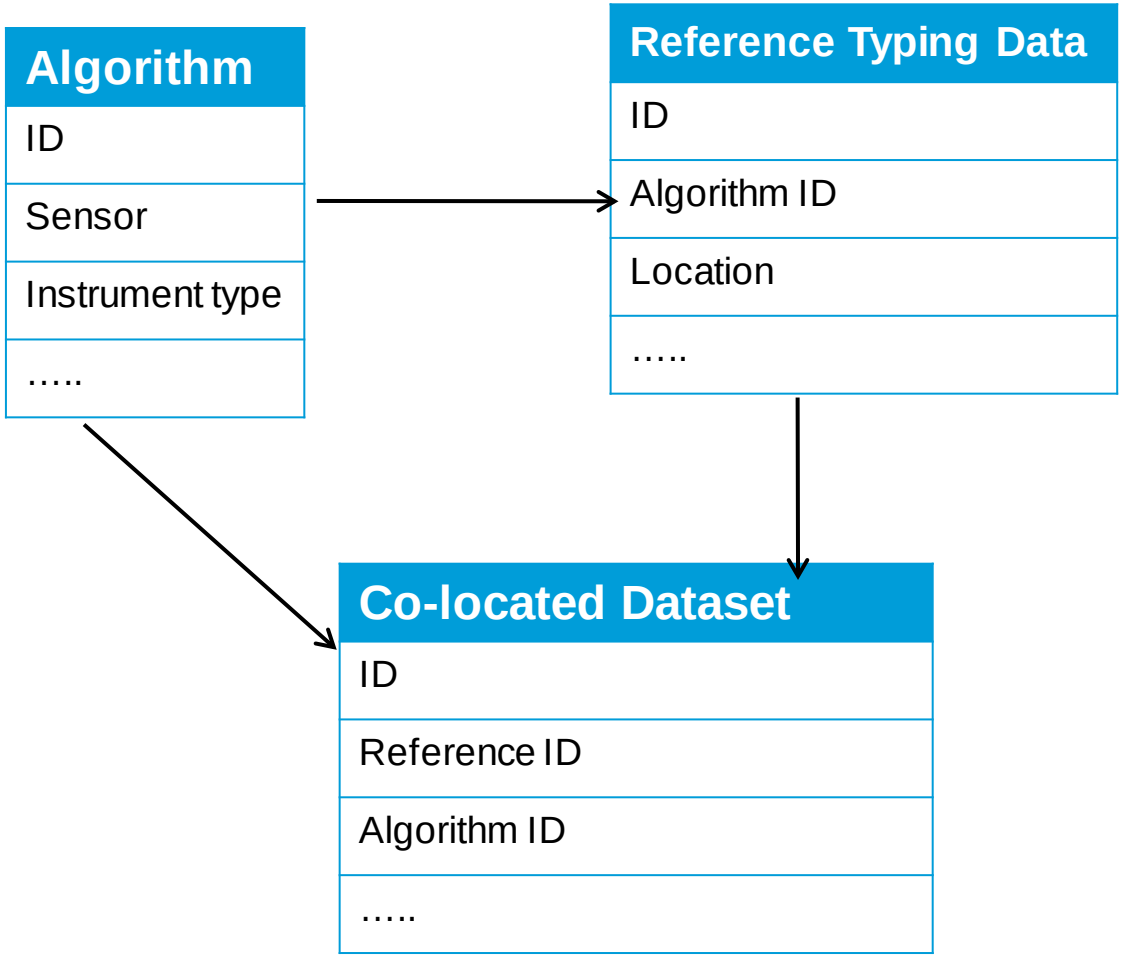
Design

Indentified **needs**:

- Hierarchical structure
- Flexibility for accommodating substantially different data
- Pointing to the specific typing algorithm and procedures

Design

Relational database with cross references between the different tables.



…..others could be added

Design

Algorithm table: describes the algorithm applied at a specific (multi) platform observation.

Algorithm	
ID	
Sensor	
Instrument type	active passive GB satellite model near surface etc
Algorithm approach	
Mixing Flag	if mixture are considered
# classes	
Input for retrieval Flag	if typing is needed as info for the retrieval of AOD …
# of aerosol constraints	
Aerosol constraints	optical (radiance in case of passive sensors), geographic (space and/or time), source (aerosol transport model defined source type
Algorithm reference (DOI)	
Climatological Typing Reference (DOI)	
Product Unique Attribute	
Contact point	

Design

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

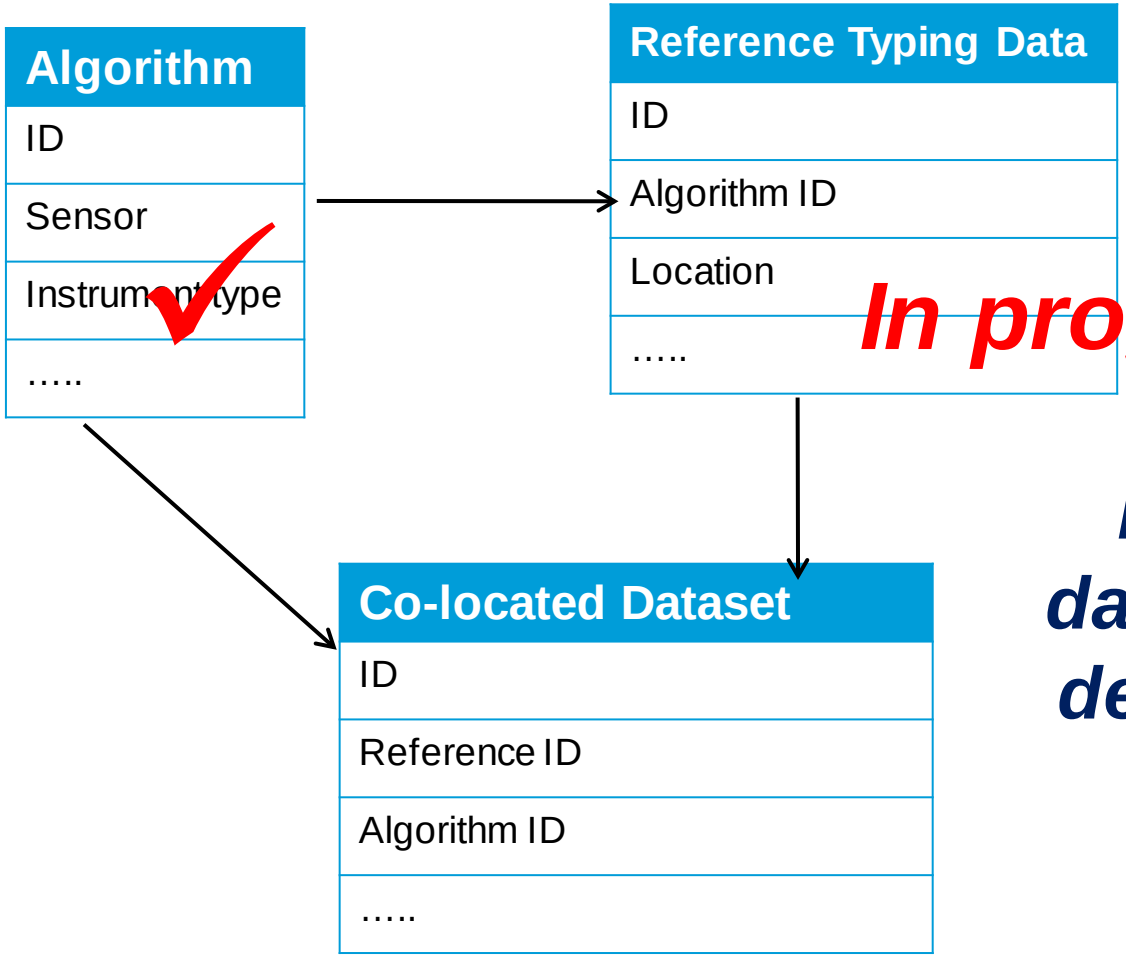
Reference Typing Data	
Reference Data ID	
Algorithm used	
Location	Long, lat, time , altitude asl
Resolution	Effective resolution
Layer altitude	base and top for vertical resolved measurements (for total-column TOA)
Surface type	Land, ocean …other possibilities to be included?
Observing geometry	Zenith limb
Type	Type number respect to the classes in the Algorithm table
Measured parameters for typing	Measured parameters used/important for the typing (with uncertainty): multi dimensional field with observed value + uncertainty
Columnar AOD	
Layer AOD	if available + below and above from profiling techniques

Design

Co-located dataset: Quantitative set of information and optical properties measurements for the different aerosol types/sensor/algorithm in correspondence of the reference dataset of Table2 (not all the sensors can have it for all the cases, of course)

Co-located Dataset	
Co-located data ID	
Reference Data ID	
Sensor/algorithm ID	
Location	Long, lat, time , altitude asl
Resolution	Effective resolution
Layer altitude	base and top for vertical resolved measurements (for total-column TOA)
Surface type	Land, ocean …other possibilities to be included?
Observing geometry	Zenith limb
Type	Type number respect to the classes in the Algorithm table
Measured parameters for typing	Measured parameters used/important for the typing (with uncertainty): multi dimensional field with observed value + uncertainty
Columnar AOD	
Layer AOD	if available + below and above from profiling techniques

What we have now?

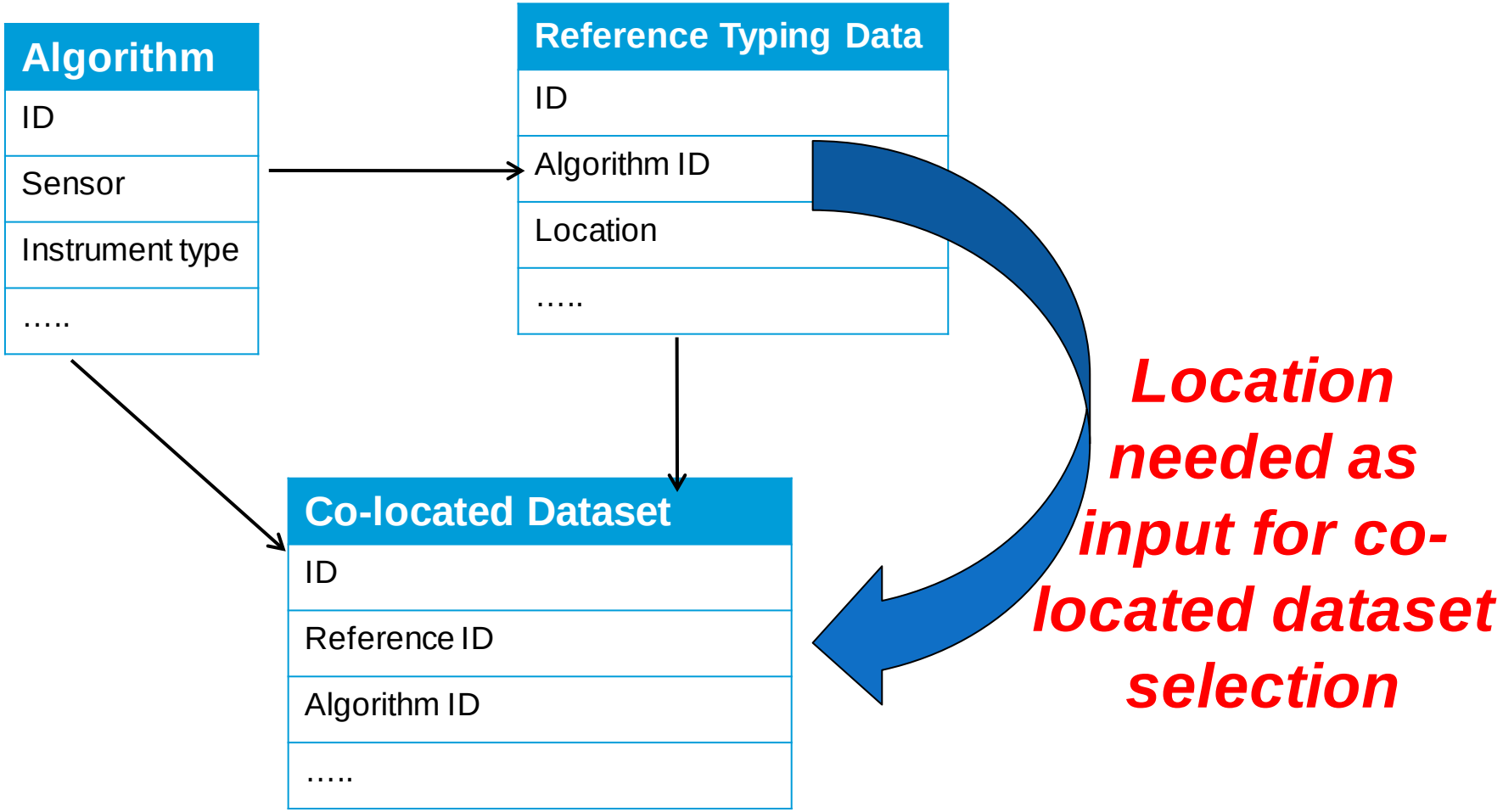


In progress

PostgreSQL database under development at CNR-IMAA

REDAT

Table 2 to be feeded



Conclusions

REDAT has the potentiality for addressing our Open Questions on aerosol type.

Seed *questions*

- is it possible to find translation rules between the two nomenclature approaches (physical observables vs interpretive composition)?
- can the inventory help to harmonize the mapping of retrieved properties and interpretive composition?
- how can we benefit from integrating multiple sources?
- how can we validate aerosol type information and their uncertainties?
- which (new) validation data for aerosol type information do we need?

Its development could provide a common platform for indepth investigation well beyond our current knowledge.