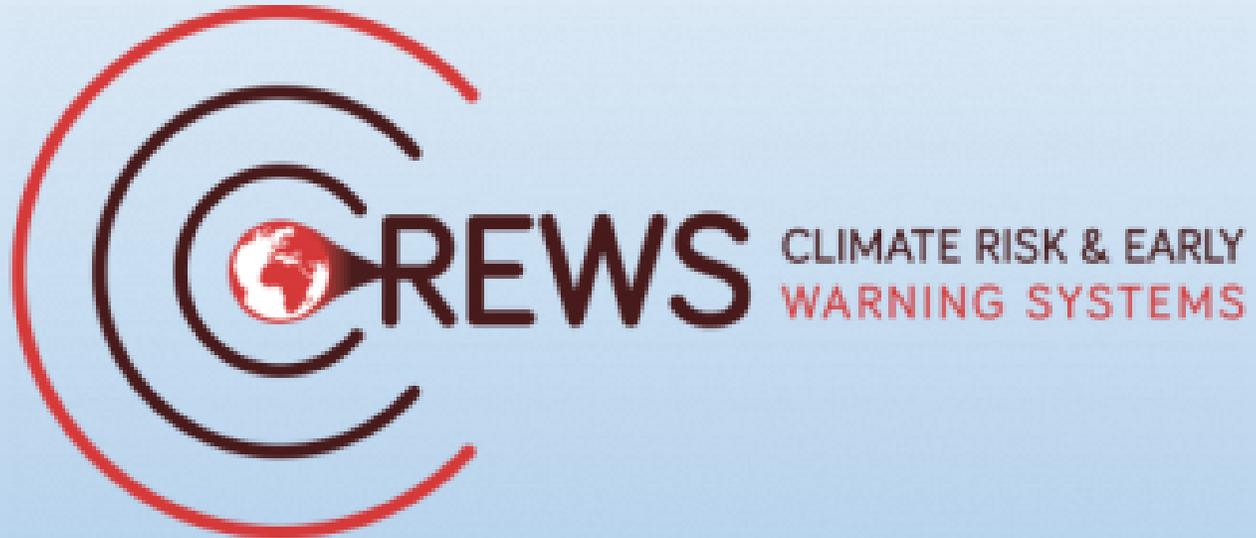




GOBIERNO  
DE ESPAÑA

VICEPRESIDENCIA  
TERCERA DEL GOBIERNO

MINISTERIO  
PARA LA TRANSICIÓN ECOLÓGICA  
Y EL RETO DEMOGRÁFICO



# Installation et utilisation d'instrumentation

*15/02/2022*

*Installation and performance of  
instrumentation*

**Dr. África Barreto**

PI Aerosol Group

Izaña Atmospheric Research Center – AEMET

# INTRODUCTION TO ATMOSPHERIC AEROSOLS AND SUN PHOTOMETRY

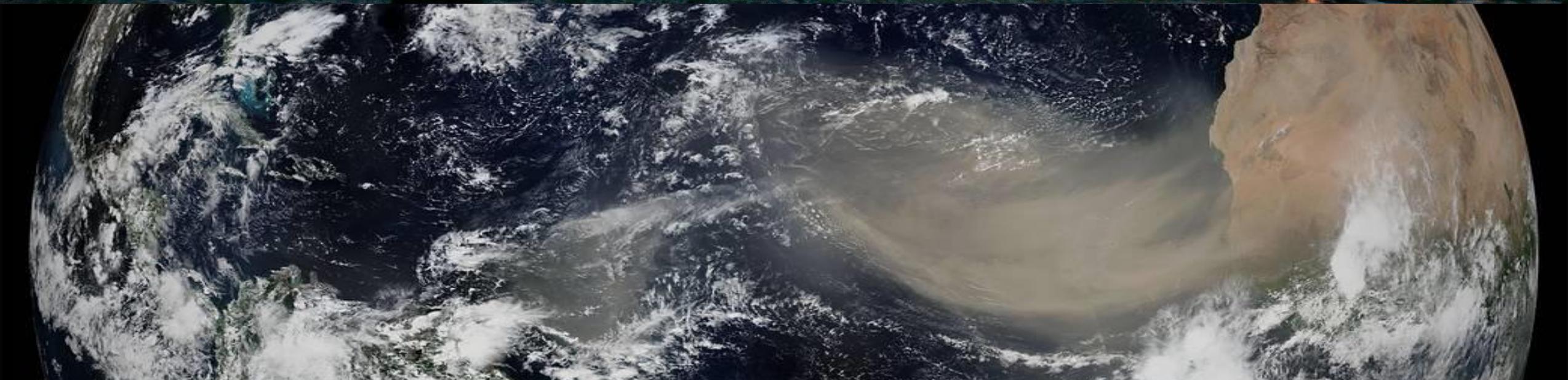
# Natural and Anthropogenic

The image is a vertical split. The left side shows a city skyline, likely New York City, with a massive, thick, brownish-grey plume of dust or ash rising from the horizon and covering the sky. The right side shows several tall industrial smokestacks emitting thick, yellowish-brown plumes of smoke or steam against a clear blue sky.

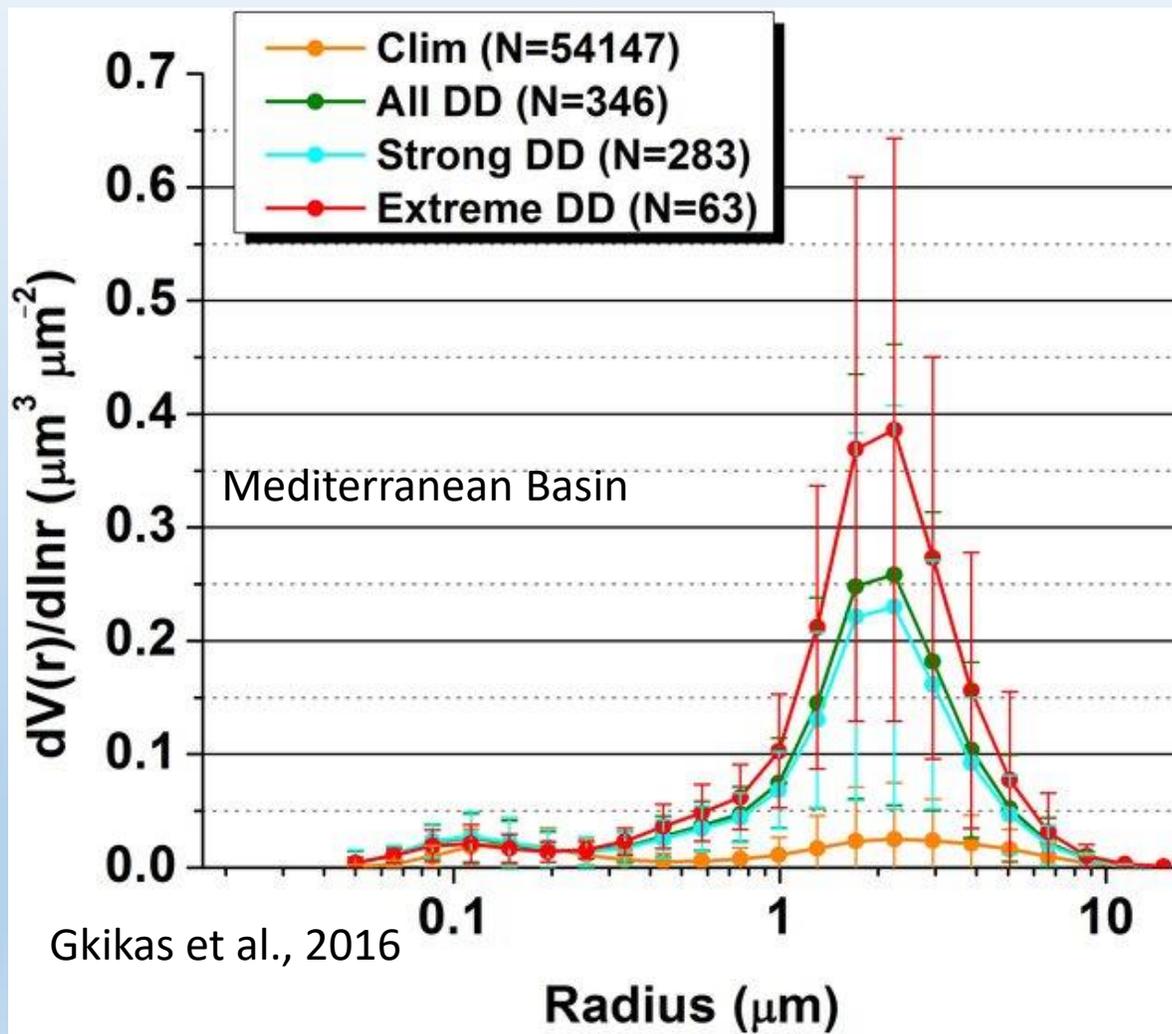
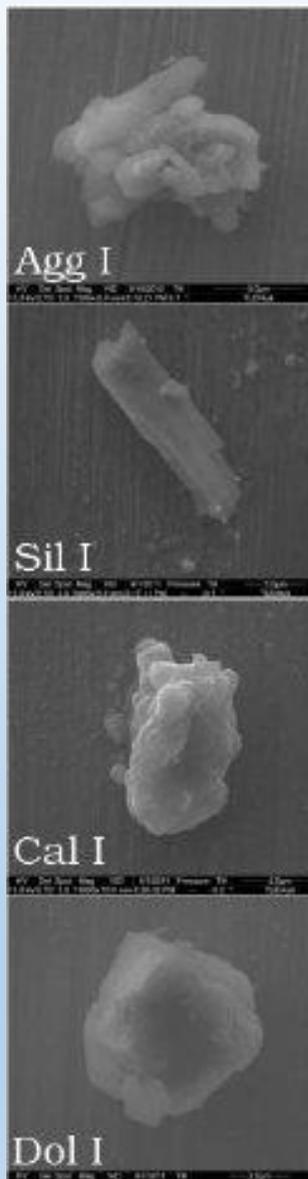
**90 %** in mass of **natural origin**  
(e.g. sea salt, mineral dust, volcanic eruptions, bacteria, viruses, pollens)

**10 %** in mass of **anthropogenic origin**  
(e.g. industrial emissions, vehicle exhaust, agricultural and forest burns)

Natural – Mineral dust



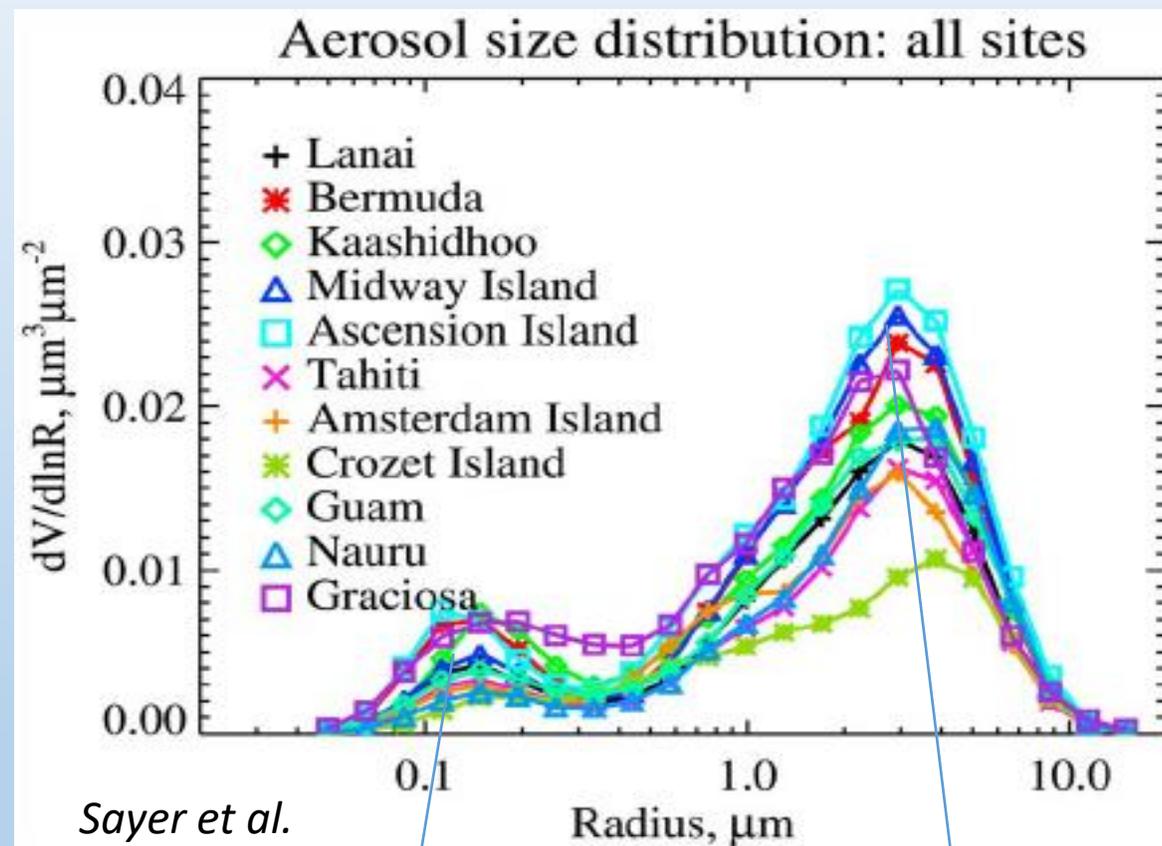
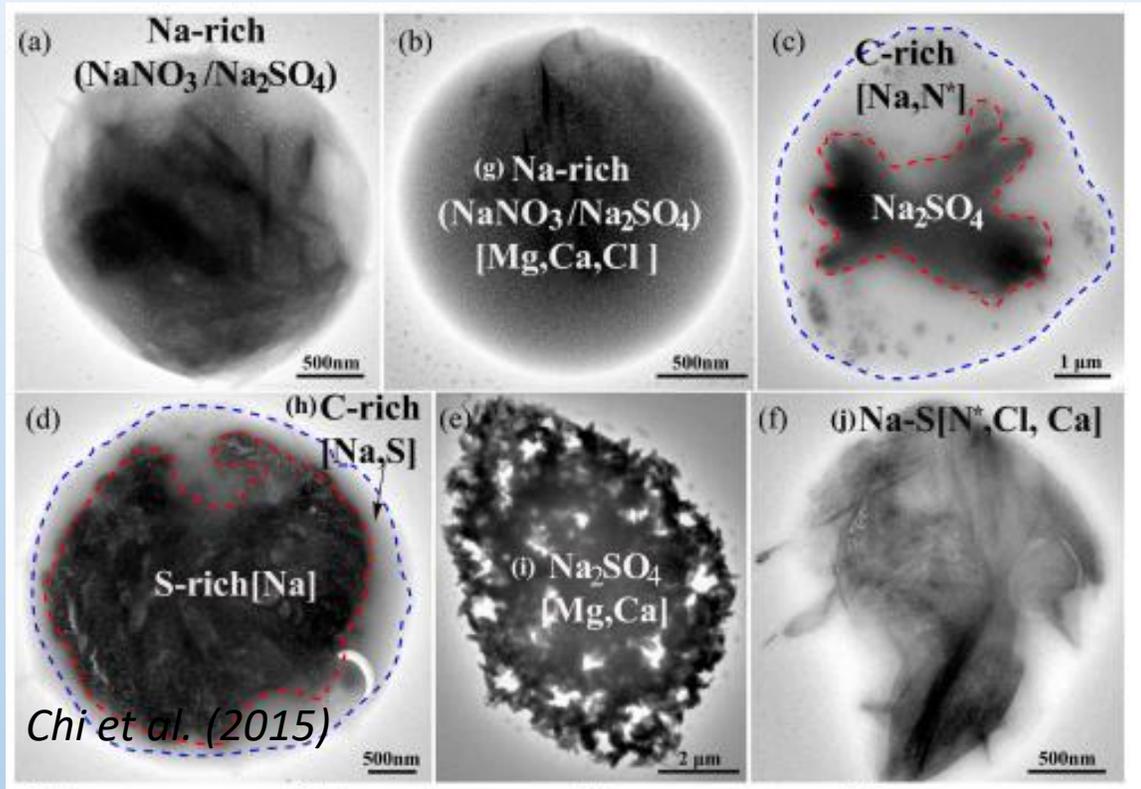
Lindqvist et al. (2014)



coarse mode increased by factors  $\approx 10$

# Natural – Marine aerosols





Sayer et al. (2012)

sulphates and fine Sea Salt

large Sea Salt particles and nitrates

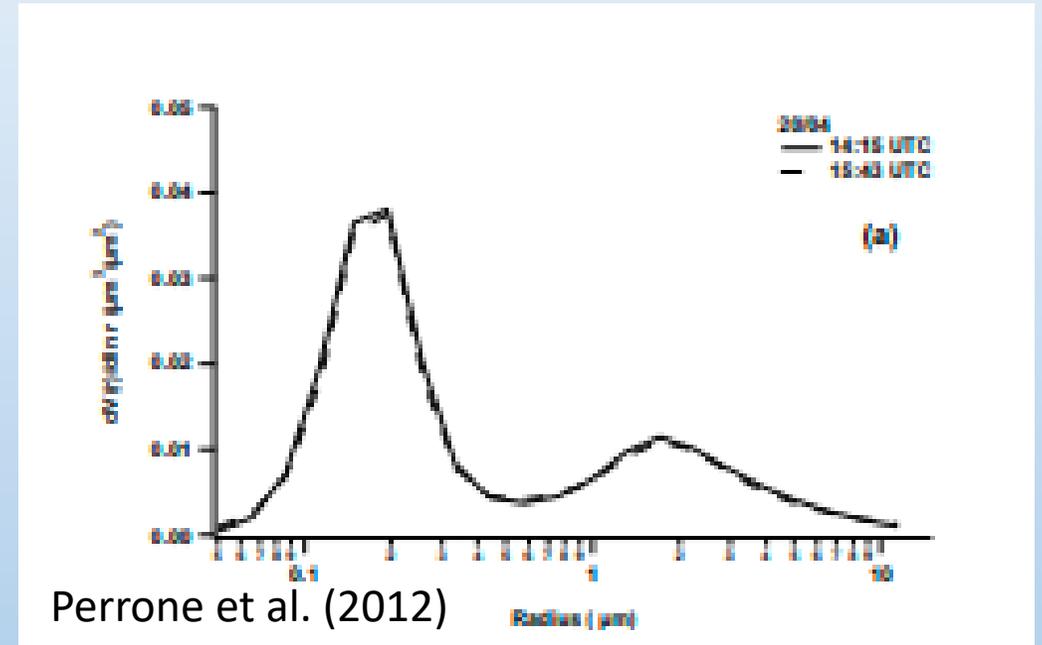
# Natural – Volcanic aerosols



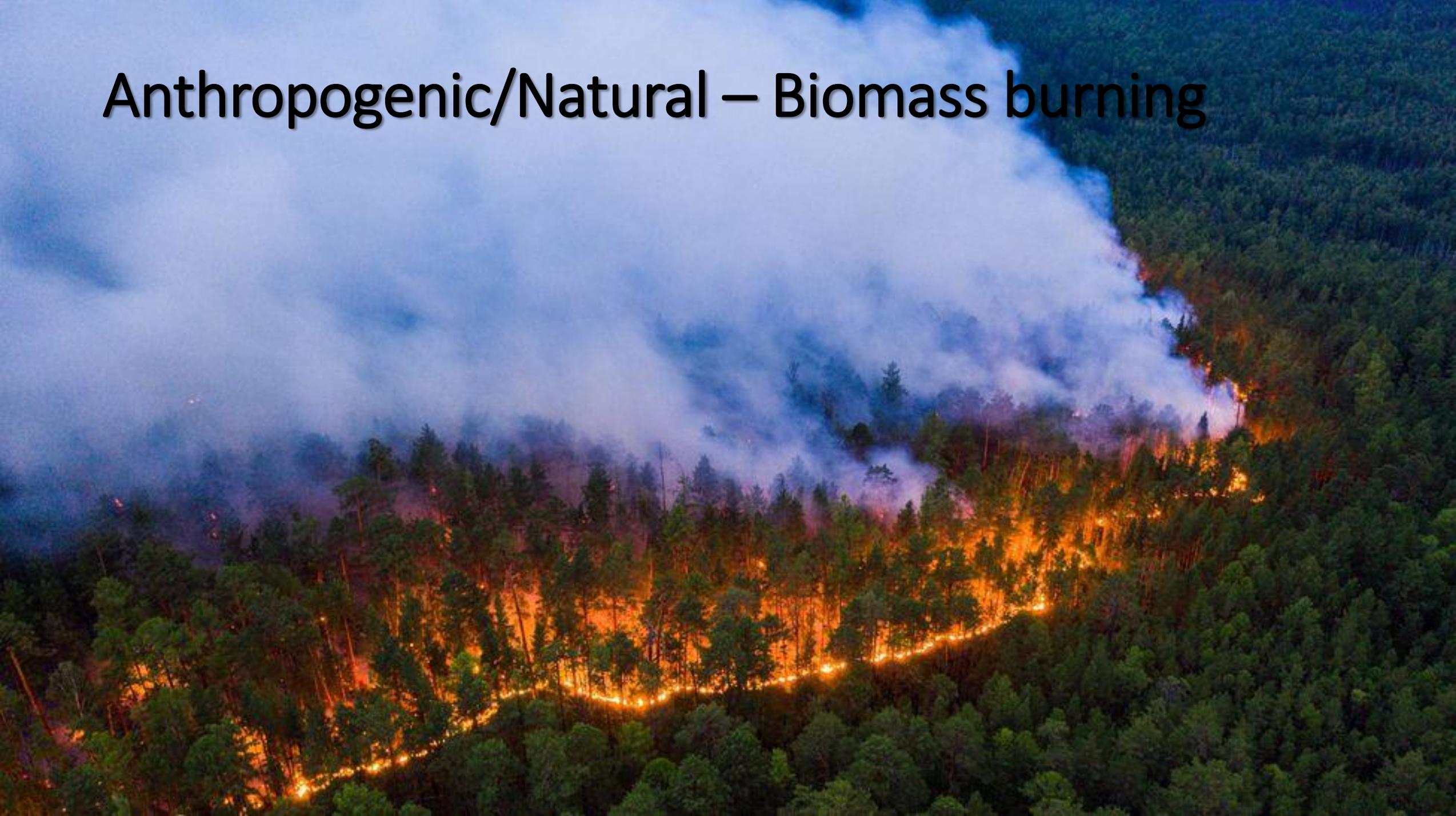
# ASH



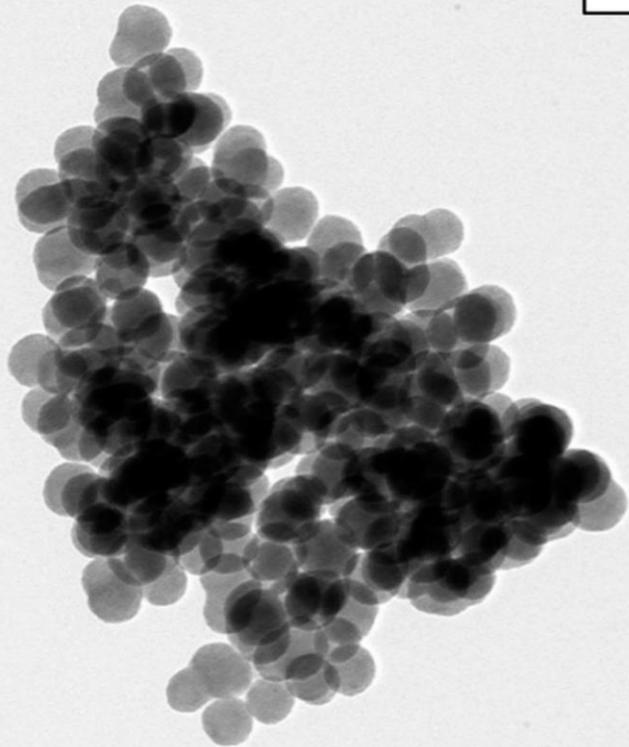
# SULPHATES + ASH



# Anthropogenic/Natural – Biomass burning

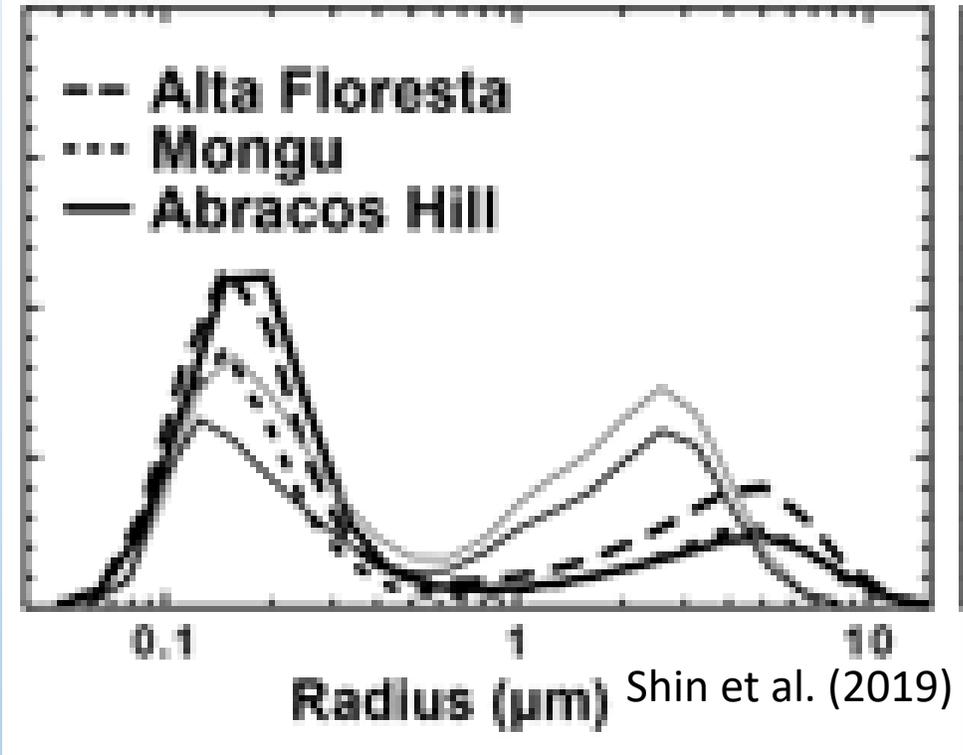


(b)



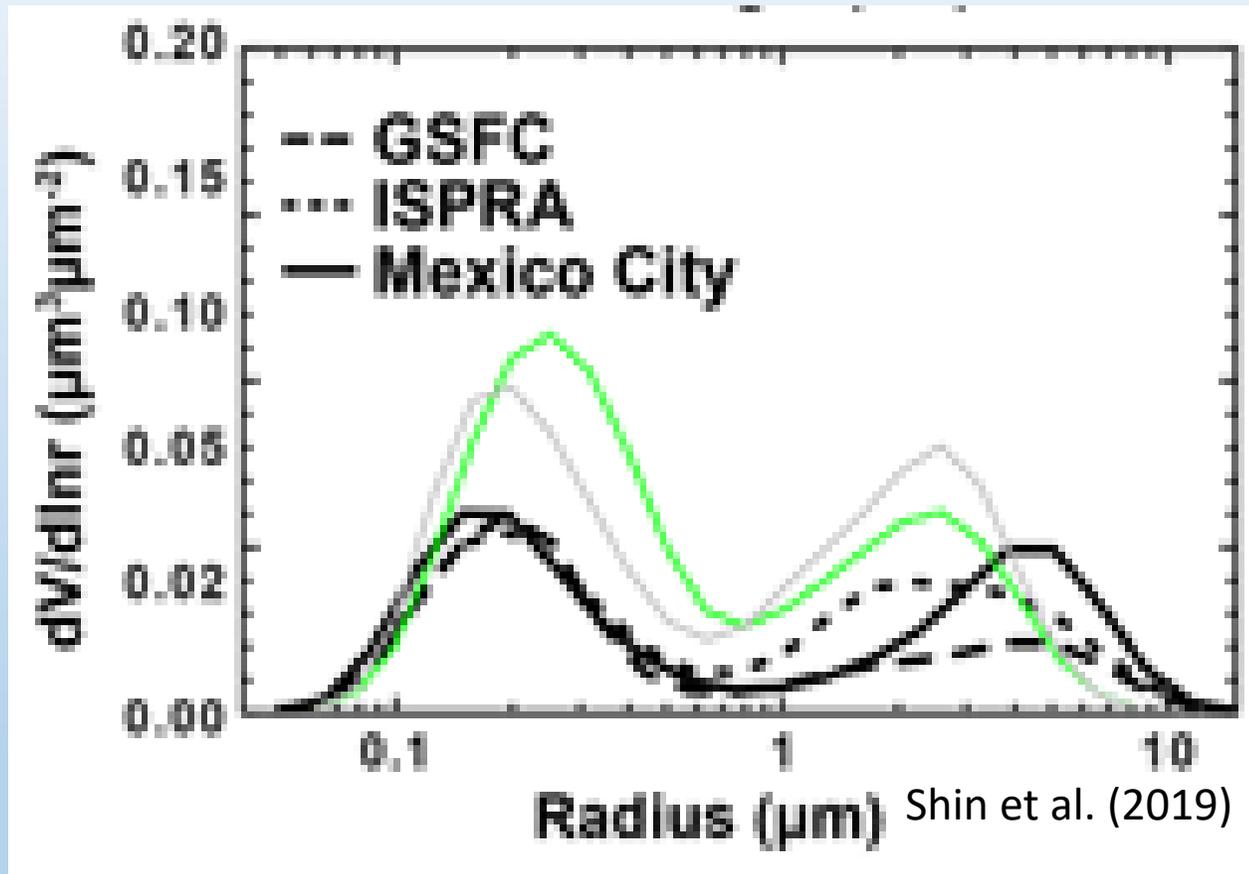
Sarpong et al. (2020)

Microscope	Accelerating Voltage	Magnification	
Libra 120	120 kV	-	—200 nm—





Anthropogenic – Industry and Traffic



Fine mode: sulphates, nitrates and carbonaceous

# Aerosols and Health

- Particles suspended in the air enter our body when we breathe
- Associated hazard depend on chemical composition and where they deposit within the respiratory system
- These effects includes **infectious diseases** (meningitis and valley fever), **respiratory problems** or **cardiovascular diseases**, sometimes even leading to cancer

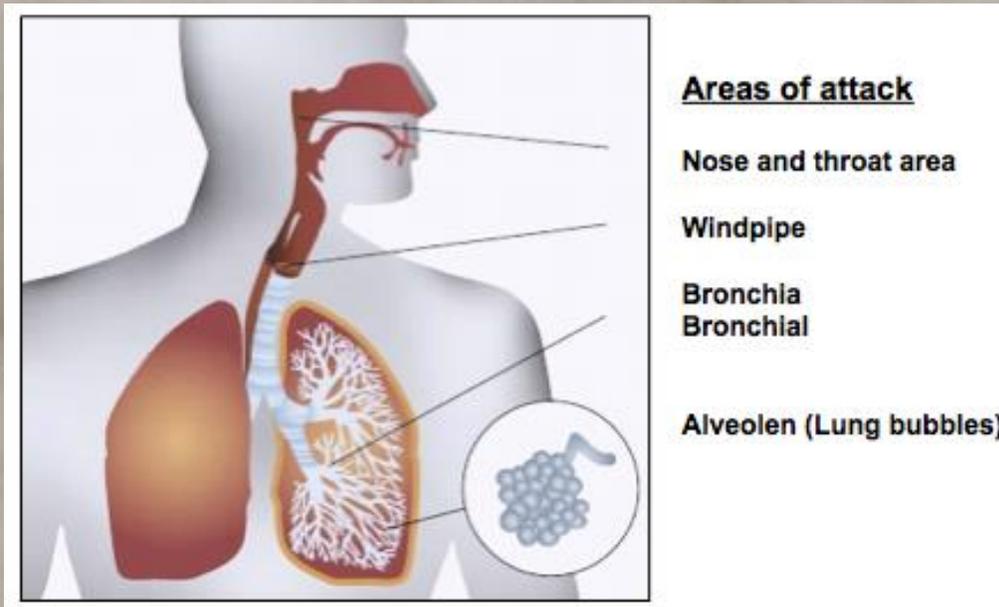
5-10  $\mu\text{m}$

3-5  $\mu\text{m}$

2-3  $\mu\text{m}$

1-2  $\mu\text{m}$

0.1-1  $\mu\text{m}$



# Aerosols and Visibility

- Aerosol particles cause a degradation of visibility due to the extinction of light produced when light passes through the atmosphere



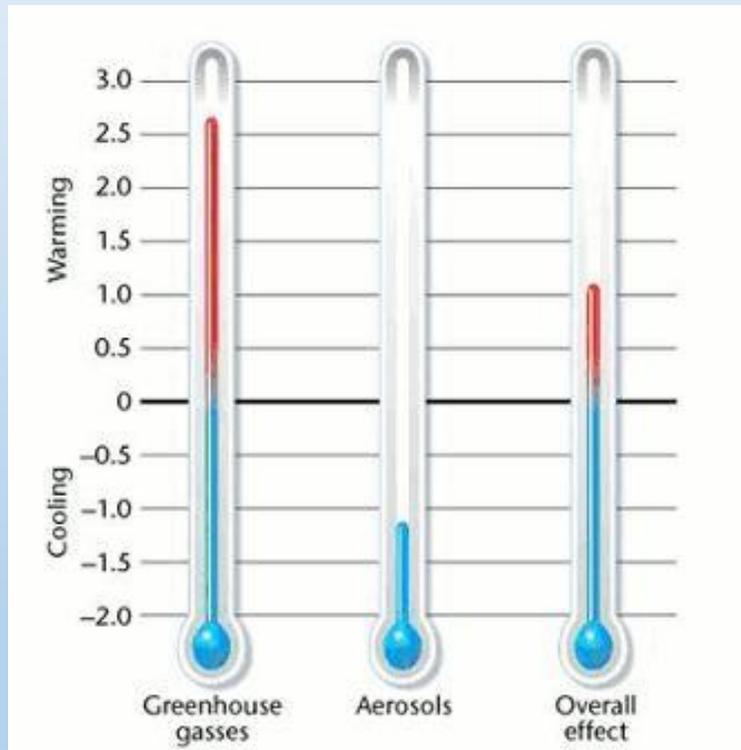
*A country landscape view near Marrakech, Morocco.*

# Aerosols and Socio-economic Impacts

- Including negative effects on ground transport, aviation, agriculture and generation of solar energy



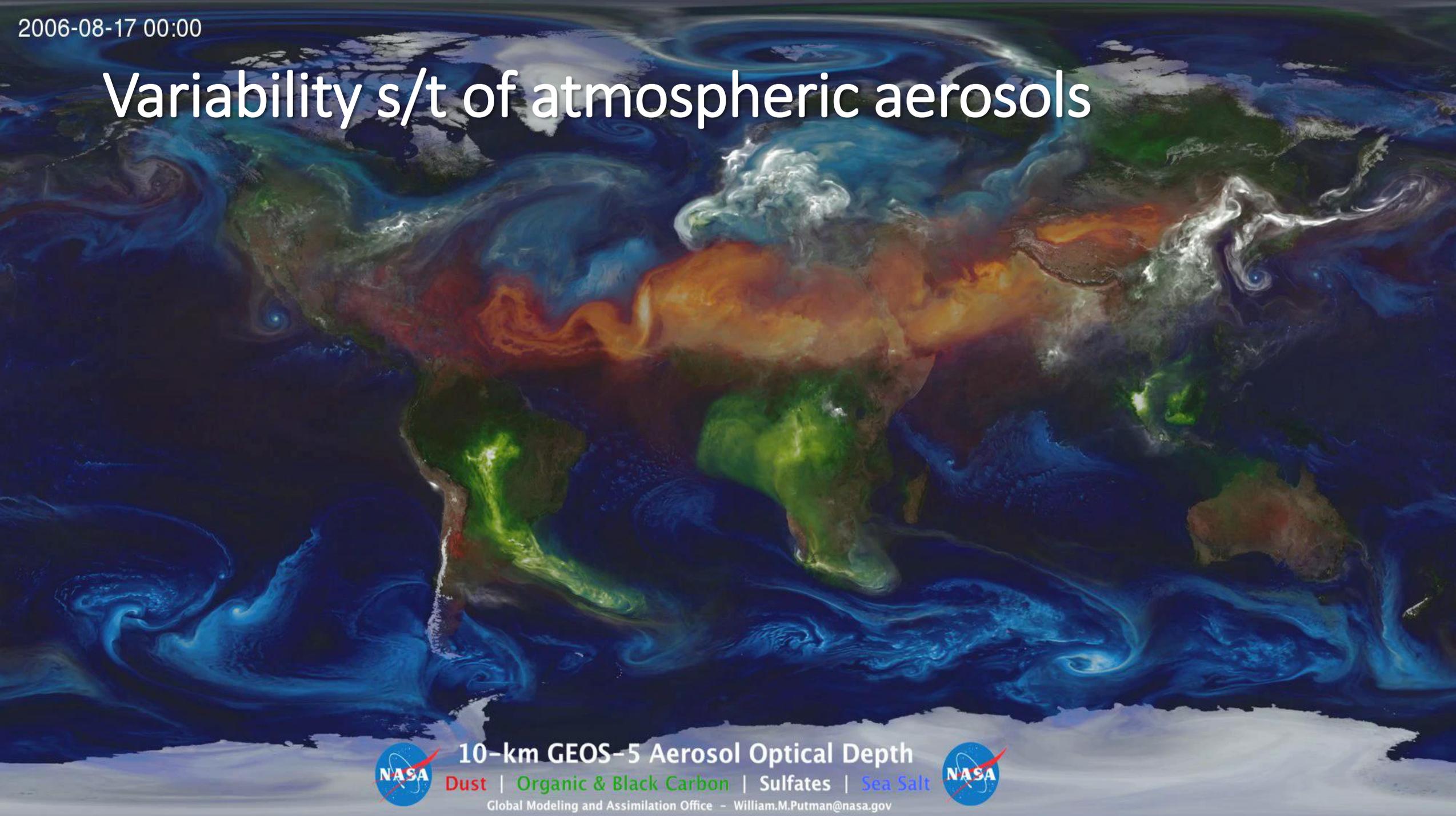
# Aerosol Effect on Climate – Global Scale



- On global scale, aerosol pollution induce a **cooling** of the planet
- partly counteract the famous global **warming** effect of greenhouse gases

2006-08-17 00:00

# Variability s/t of atmospheric aerosols



10-km GEOS-5 Aerosol Optical Depth

Dust | Organic & Black Carbon | Sulfates | Sea Salt



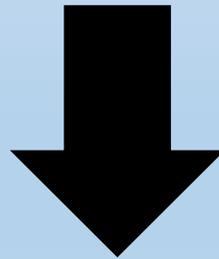
Global Modeling and Assimilation Office - [William.M.Putman@nasa.gov](mailto:William.M.Putman@nasa.gov)

# Summarizing...



Lack of information:

- 1) To extend our knowledge on the effect of aerosol on climate and its role in the climate system
- 2) To validate the current aerosol forecasts and therefore the numerical weather prediction models



**MORE MEASUREMENTS IN STRATEGIC SITES!!!!**



# AOD Observations at your site: Sun Photometry

Beer's Law

$$I_{\lambda} = I_{0,\lambda} \cdot e^{-\tau_{\lambda} \cdot m}$$

$$(I_{\lambda} < I_{0,\lambda})$$

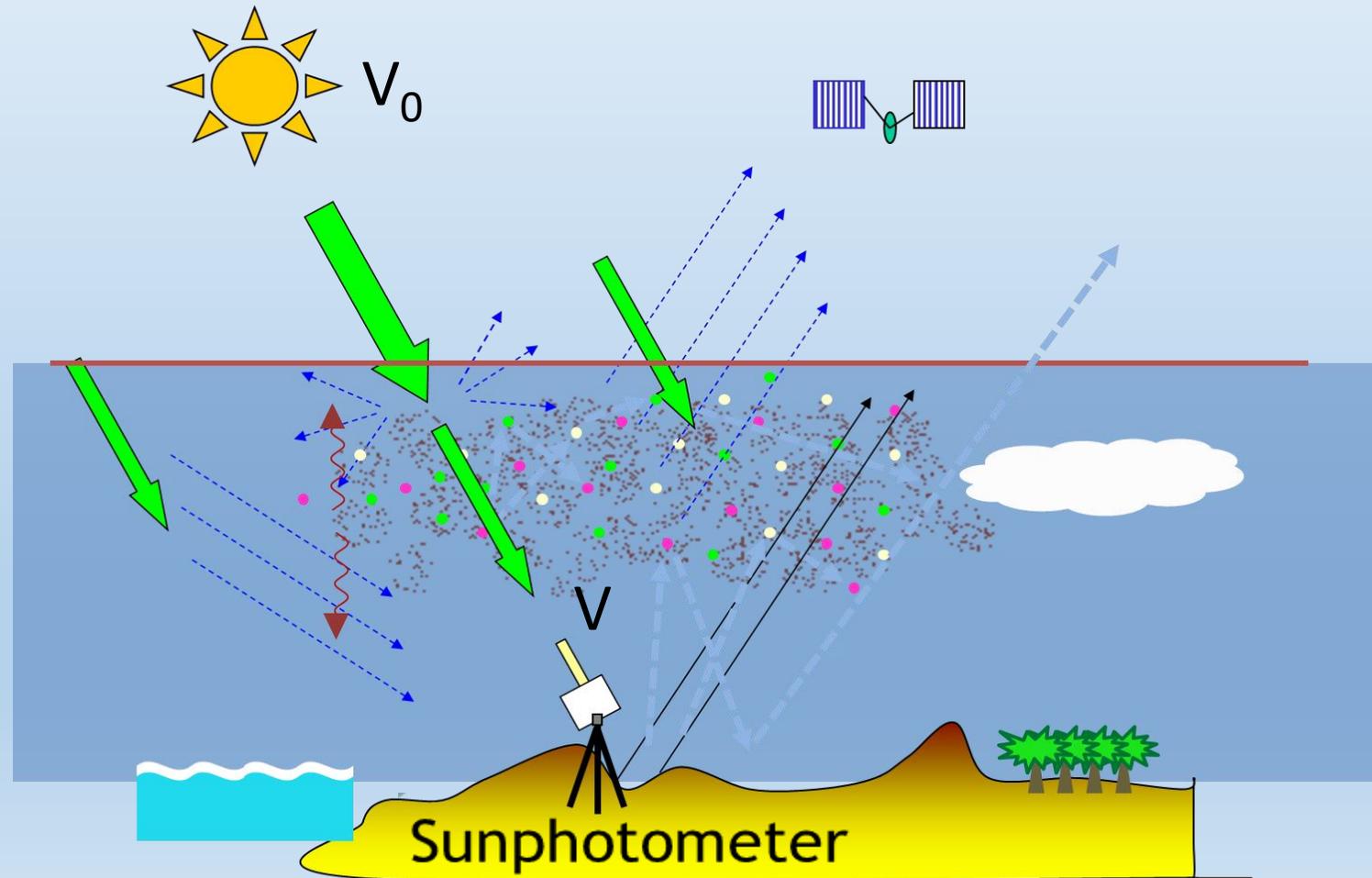
$$\tau_{\lambda} = AOD_{\lambda}$$

Angstrom Eq.

$$\tau_{\lambda} = \beta \cdot \lambda^{-\alpha}$$

$\alpha$  = Angstrom Exponent

$\alpha \downarrow$  large particles  
 $\alpha \uparrow$  fine particles



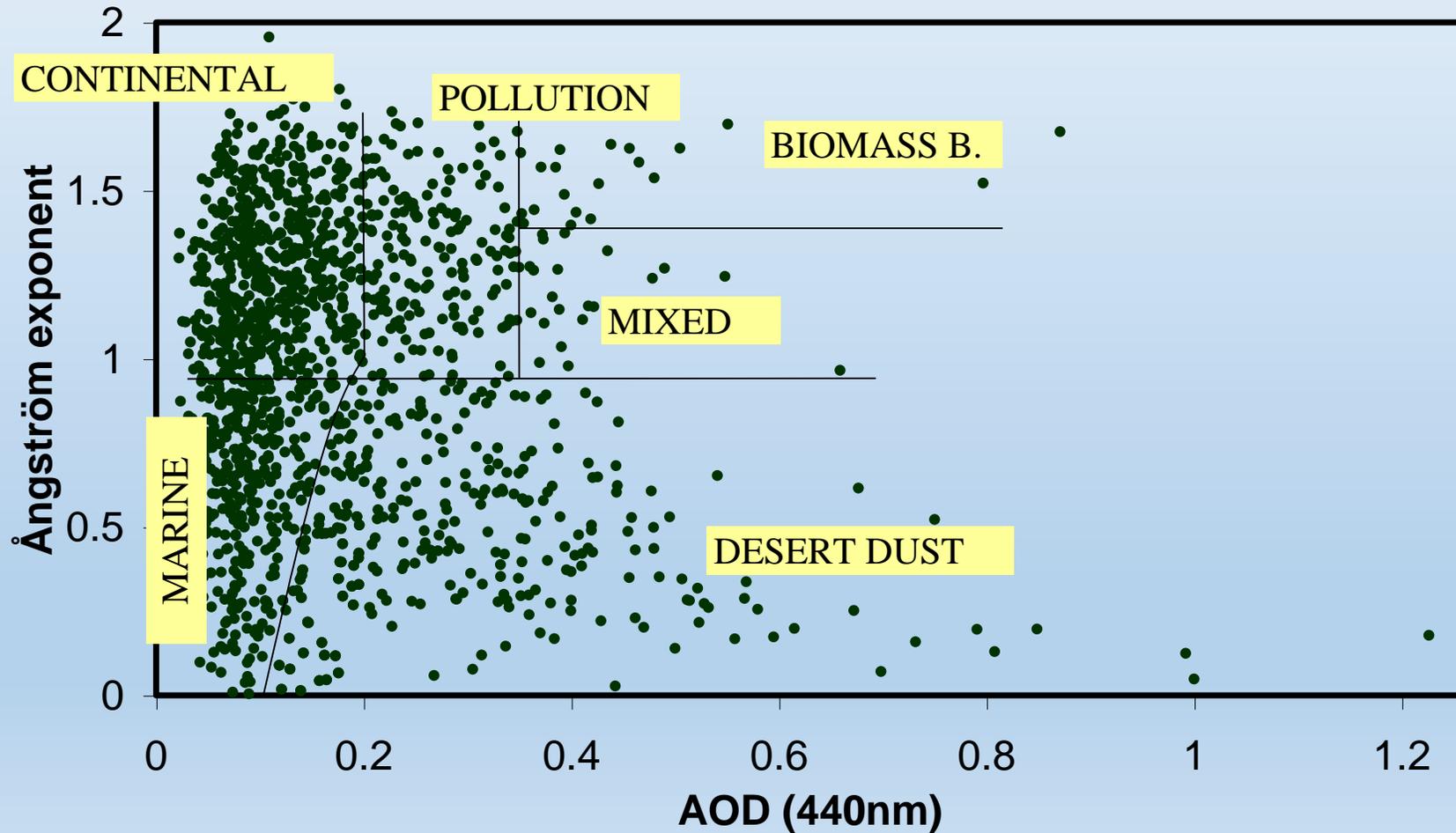
More aerosols in the atmosphere cause more extinction and less energy transmitted to the surface. AOD is the degree to which aerosols prevent the transmission of light.

### Typical AOD ranges

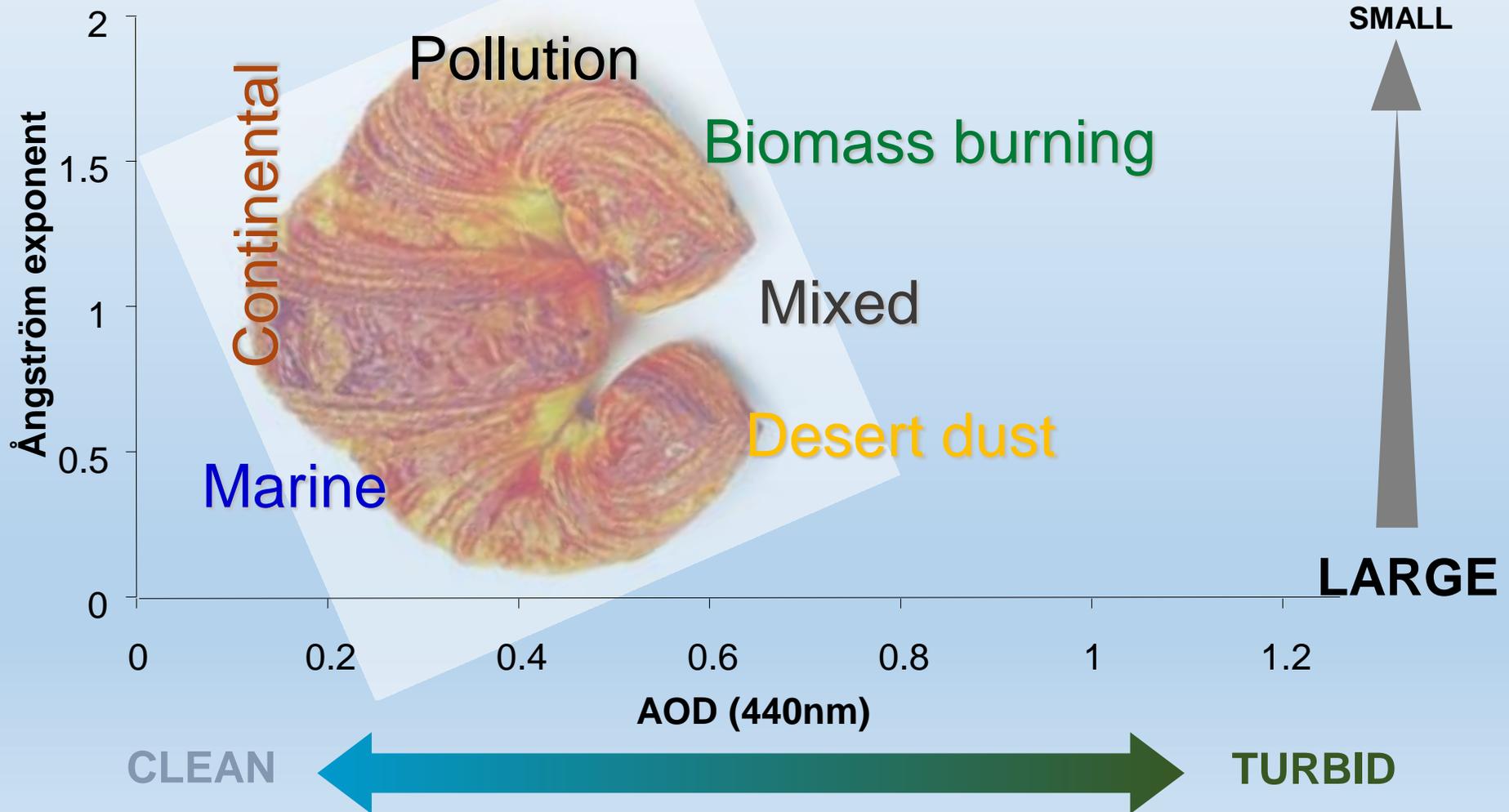
Sky conditions	500 nm	870 nm
Extremely clear (pristine)	0.03 - 0.05	0.02 - 0.03
Clear	0.05 - 0.10	0.03 - 0.07
Somewhat hazy	0.10 - 0.25	0.07 - 0.20
Hazy	0.25 - 0.5	0.20 - 0.40
Extremely hazy	> 0.5	> 0.4

Note that **red AOD** values are typically less than **green AOD** values. This is due to the fact that typical aerosols scatter **green light** more efficiently than **red light**.

# Aerosol Type with diagram AOD- $\alpha$



# Aerosol Type with diagram AOD- $\alpha$



# INSTRUMENTAL DESCRIPTION

## **Photometry: Calitoo handheld sun photometer**

### **Reconsidering hand-held sunphotometers for reporting dust AOD?**

Microtops-II, Calitoo-Tenum...

Many observations at airports (even in remote regions)

Operated by meteorological observers

Easy data transmission through WMO GTS/WIS communication system

NRT data for model evaluation and data assimilation

NRT data for satellite evaluation

NRT data for dust nowcasting

## Photometry: Calitoo handheld sun photometer

Technical characteristics:

- Light channels: 465 (B), 540 (G) and 619 (R) nm
- Possible 999 measures stored in memory
- AOD calculated in real-time
- USB data download
- Free software on web site.
- Supply : 4 batteries AA (1,5V)
- Dimensions : 210 x 100 x 35 mm
- Weight : 400 g (With batteries)
- Operating temperature : -20°C to 55°C

<http://www.calitoo.com>



How to use it?

<https://www.youtube.com/watch?v=4wCzw4rY9Hs>

## Photometry: Calitoo handheld sun photometer

### Products:

AOD @ 465, 540 et 619 nm

Angstrom Exponent

# Calibration provided!!!

(at Izaña testbed)



First pilot experiments at:  
Tamanrasset GAW Station (Algeria)  
Tehran (Iran)  
Aminabad Mt. Firoozkoh GAW station (Iran)



## Photometry: Calitoo handheld sun photometer

### Measurements

The measurement principle is to point the Sun and search for the maximum reading. The photometer keeps only the maximum measured and then calculated the optical depth.

The Sun alignment is done manually. It is facilitated by the sighting device located above the display of the Calitoo.

The calculation of optical depth use raw brightness measurements, calibration coefficients, date and GPS position as well as atmospheric pressure.



How to use it?

<https://www.youtube.com/watch?v=4wCzw4rY9Hs>

How to take measurements? Pag 10-15 [http://www.calitoo.fr/uploads/documents/fr/usermanual\\_2020\\_fr.pdf](http://www.calitoo.fr/uploads/documents/fr/usermanual_2020_fr.pdf)

Power ON by pressing for a few seconds on the red button

### 1.3 Premières mesures

Après la mise sous tension et la page de présentation passée, le photomètre indique qu'il est en mode mesure et affiche les informations de base :



Dès que le GPS du photomètre est en 3D, vous pouvez commencer les mesures.

Si le GPS n'est pas en 3D, vous ne pouvez pas faire de mesure enregistrable

How to use it?

<https://www.youtube.com/watch?v=4wCzw4rY9Hs>

How to take measurements? Pag 10-15 [http://www.calitoo.fr/uploads/documents/fr/usermanual\\_2020\\_fr.pdf](http://www.calitoo.fr/uploads/documents/fr/usermanual_2020_fr.pdf)

#### 1.4 Pointage du Soleil

Le pointage du photomètre est manuel, il est facilité par le dispositif de visée situé au dessus de l'afficheur.



Tutoriel video sur YouTube : [How to measure aerosols ?](#)

Vous devez vous positionner face au Soleil de manière stable et amener rapidement le point lumineux au milieu de la cible du pointeur et de l'y maintenir le temps des mesures.



Le Soleil est au centre de la cible :  
le photomètre est pointé.

How to use it?

<https://www.youtube.com/watch?v=4wCzw4rY9Hs>

How to take measurements? Pag 10-15 [http://www.calitoo.fr/uploads/documents/fr/usermanual\\_2020\\_fr.pdf](http://www.calitoo.fr/uploads/documents/fr/usermanual_2020_fr.pdf)

## 1.5 Maximum

Le but est d'obtenir la valeur maximale en RVB en environ 1 minute de pointage.



Cliquez sur le bouton du photomètre et vous passez à la page des maximums des mesures (nous supposons bien sûr que vous étiez restés sur la page de base décrite précédemment).

Tout en ayant un œil sur la cible, vous surveillez les valeurs numériques maximales mesurées sur l'afficheur. Lorsqu'elles ne changent plus, au bout d'environ une minute, vous procédez à la mémorisation des mesures.

How to use it?

<https://www.youtube.com/watch?v=4wCzw4rY9Hs>

How to take measurements? Pag 10-15 [http://www.calitoo.fr/uploads/documents/fr/usermanual\\_2020\\_fr.pdf](http://www.calitoo.fr/uploads/documents/fr/usermanual_2020_fr.pdf)

## 1.6 Affichage des AOT

Après la page des maximums, en appuyant une nouvelle fois sur le bouton rouge, le Calitoo réalise les calculs d'AOT et les affiche sur son écran.

Si les mesures vous paraissent aberrantes, vous pouvez choisir alors de ne pas les enregistrer à l'[étape 1.8](#).



## 1.7 Affichage du Alpha



Cliquez sur le bouton une nouvelle fois et vous voilà sur la quatrième page qui est celle du Alpha ou Coefficient d'Angström.

Ce coefficient, dont le calcul est expliqué en [Annexe 4.2](#), permet de caractériser le type des particules détectées.

Le R2 est un indice de confiance. 1.00 c'est une total confiance dans le Alpha calculé alors que 0,50 représente 50 % de confiance.

Le calcul de R2 est détaillé en [Annexe 4.2](#).

How to use it?

<https://www.youtube.com/watch?v=4wCzw4rY9Hs>

How to take measurements? Pag 10-15 [http://www.calitoo.fr/uploads/documents/fr/usermanual\\_2020\\_fr.pdf](http://www.calitoo.fr/uploads/documents/fr/usermanual_2020_fr.pdf)

## 1.8 Mémorisation



Cliquez sur le bouton une nouvelle fois et vous voilà sur la cinquième page qui est celle des enregistrements. La séquence complète des opérations liées au bouton est décrite en [Annexe 4.6](#).

Le photomètre vous demande si vous voulez enregistrer (les mesures).

**Be sure you store the measurement!!!**



Si c'est la cas, il vous faudra appuyer toujours sur le bouton mais cette fois-ci en le maintenant enfoncé jusqu'à ce que le message **Recorded!** apparaisse en bas de l'écran.

Vous relâchez alors le bouton et vous vous retrouvez sur la page de base pour un nouveau cycle de mesures.

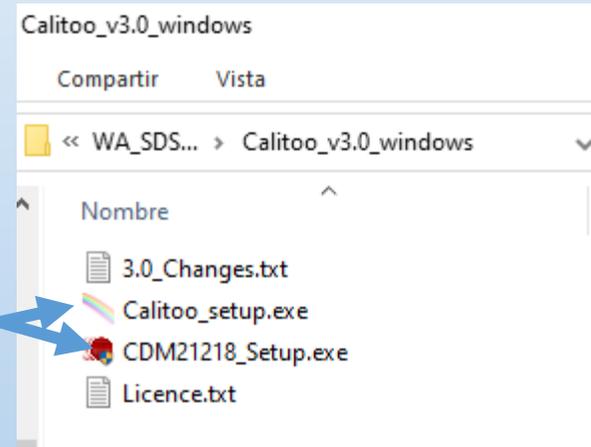
Si vous n'êtes pas satisfait de votre mesure et que vous ne voulez pas l'enregistrer, un simple clic annule l'opération et vous vous retrouvez de nouveau sur la page de base pour un nouveau cycle de mesure.

How to upload data?

First, software download: <http://www.calitoo.fr/index.php?page=software>

1<sup>o</sup> execute (install)

2<sup>o</sup> execute (install)



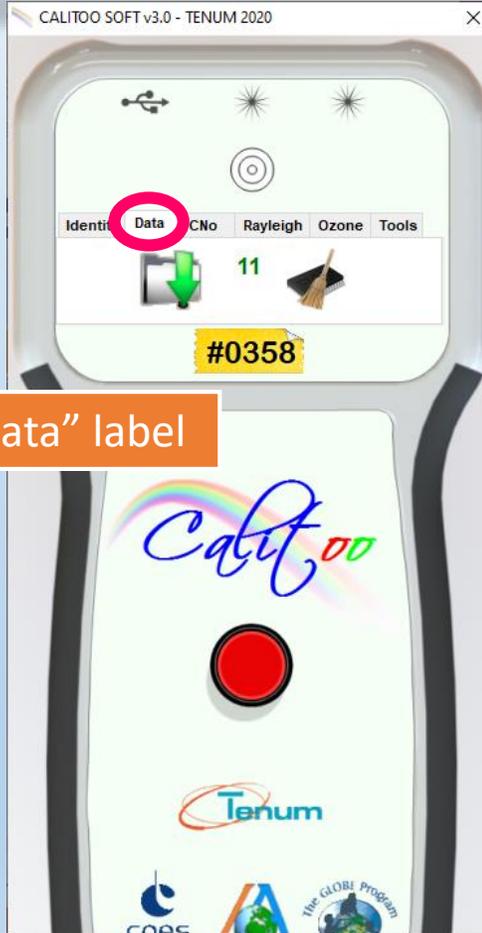
# Data Visualization

How to upload data?

Plug calitoo to PC in "Reading mode" with USB cable and open the Calitoo software



Automatic recognition



Go to "Data" label

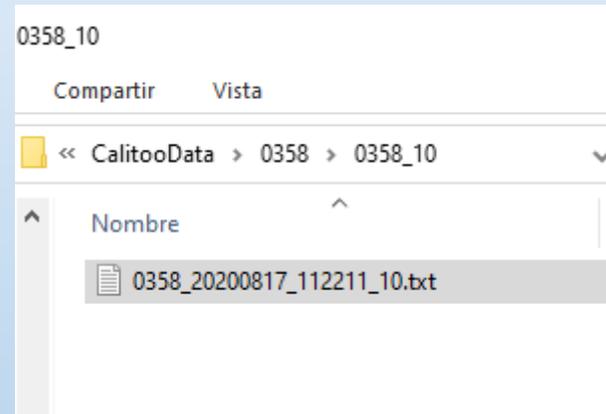


Press the Green row to download data (in this case 11 measurements)

# Data Visualization

How to upload data?  
Where are the data?

You need to look for the “CalitooData” folder, and there you will find .txt files with downloaded data



How to upload data?

Go to <https://calima.aemet.es/>

The screenshot shows a web browser window with the URL [calima.aemet.es](https://calima.aemet.es/). The browser's address bar and tabs are visible at the top. The main content area features a header with several logos: BSC (Barcelona Supercomputing Center), WMO (World Meteorological Organization), AEMet (Agencia Estatal de Meteorología), CREWS (Climate Risk & Early Warning Systems), and MACCLIMA. Below the logos, the text "Calima Project Graph View" is centered. A large instruction "Click on the Calitoo picture" is displayed above two image boxes. The left box contains a white cylindrical sensor labeled "TS11 GSENSE". The right box contains a handheld device labeled "Calitoo" with a rainbow light effect around it.

How to upload data?

Go to <https://calima.aemet.es/>

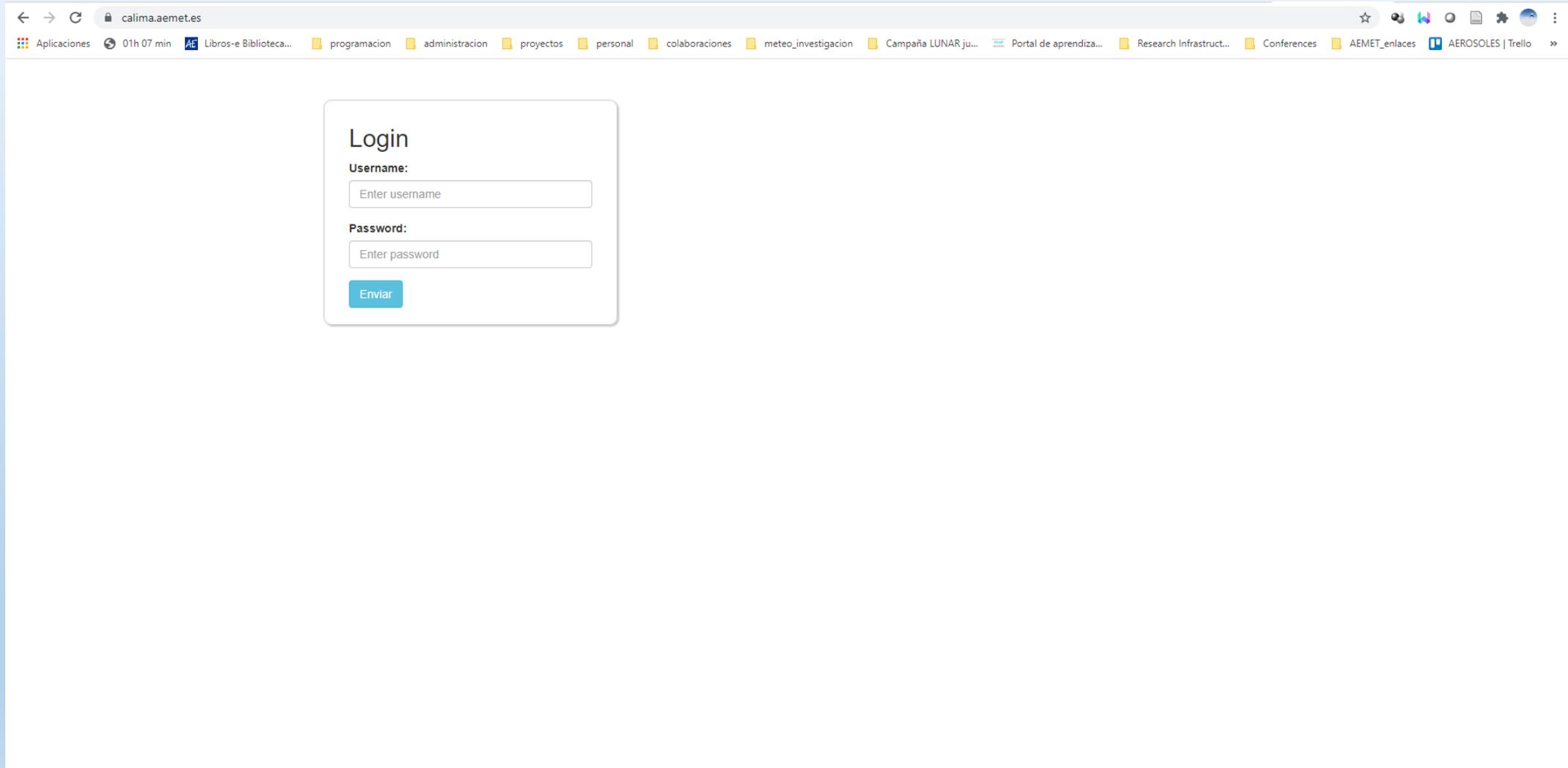
Input / Upload Data Login

Click on “Input/Upload Data Login”

The screenshot shows the Calima Project Graph View interface. At the top, there are logos for BSC (Barcelona Supercomputing Center), WMO (World Meteorological Organization), AEMet (Agencia Estatal de Meteorología), CREWS (CLIMATE RISK & EARLY WARNING SYSTEMS), and MACCLIMA. Below the logos, the title "Calima Project Graph View" is displayed. The main content area features two empty line graphs for "Burkina Faso 2020-12-01 to 2020-12-16" and "Senegal 2020-12-01 to 2020-12-16". Each graph has a legend with the following items: Pred OD550, AOD 465, AOD 540, AOD 619, and AE Alpha. To the left of the graphs is an image of a handheld device labeled "Cast 00" with logos for "Torium" and "cnes". At the bottom left, there are input fields for "Station:" (a dropdown menu with "Choose station" selected), "From:" (a date field with "01/12/2020" and a calendar icon), and "To:" (a date field with "16/12/2020" and a calendar icon). A blue button labeled "Input / Upload Data Login" is located at the bottom center of the page, circled in red, with a red arrow pointing to it from the right side of the image.

## How to upload data?

### Enter username and password



The screenshot shows a web browser window with the address bar displaying "calima.aemet.es". The browser's tab bar contains several tabs, including "Aplicaciones", "01h 07 min", "Libros-e Biblioteca...", "programacion", "administracion", "proyectos", "personal", "colaboraciones", "meteo\_investigacion", "Campaña LUNAR ju...", "Portal de aprendiza...", "Research Infrastruct...", "Conferences", "AEMET\_enlaces", and "AEROSOLES | Trello".

The main content area of the browser displays a login form titled "Login". The form contains the following elements:

- Username:** A text input field with the placeholder text "Enter username".
- Password:** A text input field with the placeholder text "Enter password".
- Enviar:** A blue button with the text "Enviar".

## How to upload data?

Click on “Click to upload Calitoo TXT data file”

**BSC**  
Barcelona  
Supercomputing  
Center  
Centro Nacional  
de Supercomputación

**WMO**

**AEMet**  
Agencia Estatal de Meteorología

**CREWS** CLIMATE RISK & EARLY  
WARNING SYSTEMS

**MACCLIMA**

Calima Project  
Senegal  
Last data:

**Date** dd/mm/aaaa

**Time UTC** --:--

**Atmospheric Pressure hPa** Enter pressure

**AOD Blue 465** Value between 0 and 3

**AOD Green 540** Value between 0 and 3

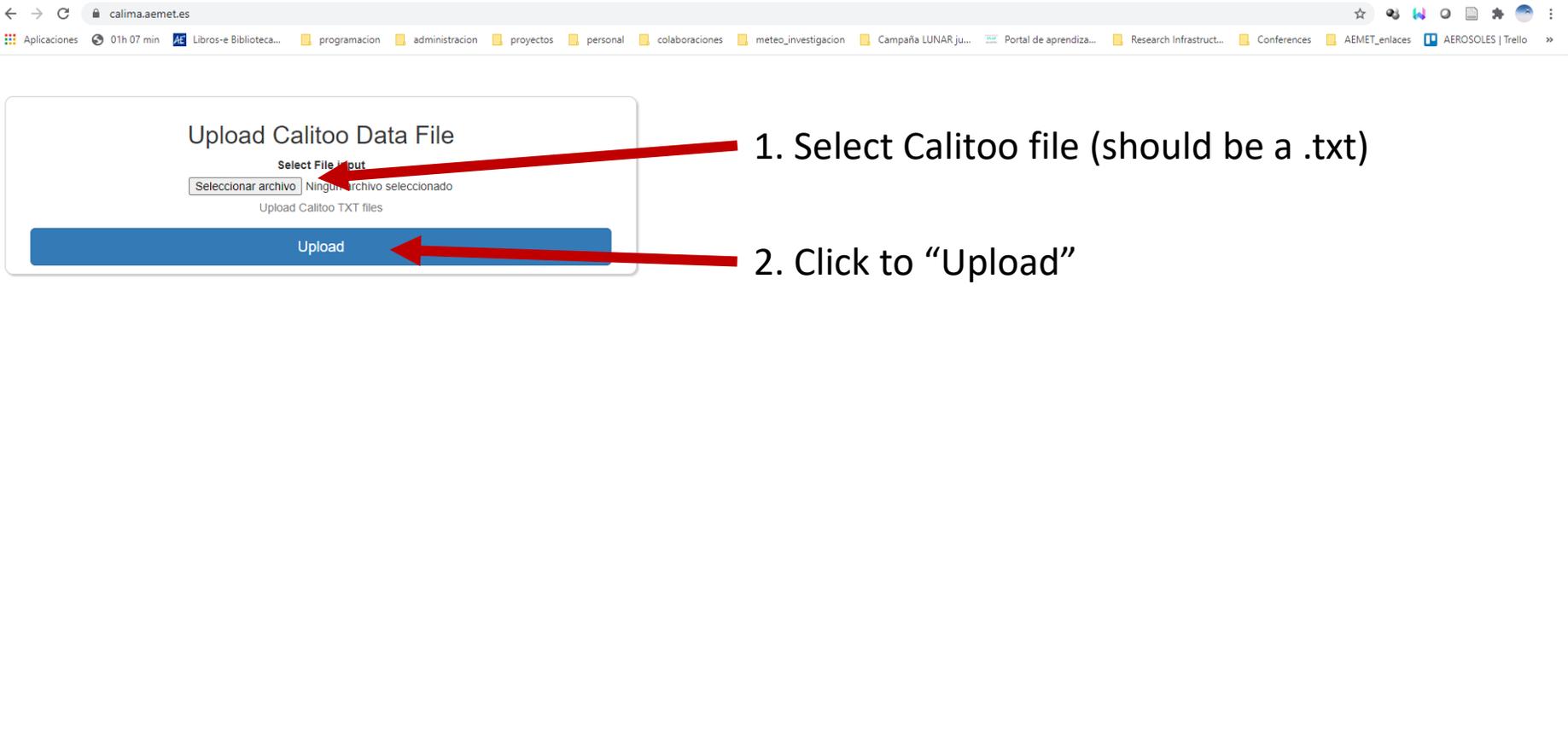
**AOD Red 619** Value between 0 and 3

**Alpha** Value between 0 and 4

Submit

Click to upload Calitoo TXT data file

## How to upload data?



The screenshot shows a web browser window with the URL `calima.aemet.es`. The browser's address bar and tabs are visible at the top. The main content area displays a form titled "Upload Calitoo Data File". Inside the form, there is a "Select File Input" section with a button labeled "Seleccionar archivo" and the text "Ningún archivo seleccionado". Below this, it says "Upload Calitoo TXT files". At the bottom of the form is a large blue button labeled "Upload". Two red arrows point from the text instructions to the "Seleccionar archivo" button and the "Upload" button.

1. Select Calitoo file (should be a .txt)

2. Click to "Upload"



## Calima Project Graph View

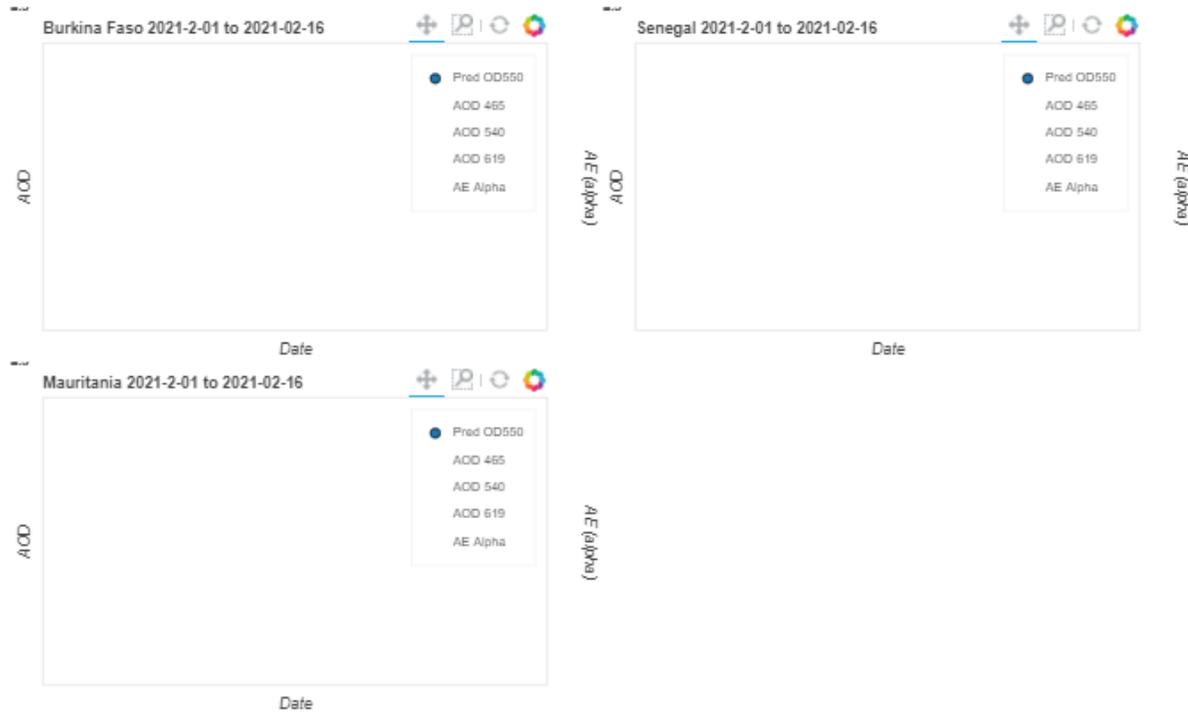


Station:

From:

To:

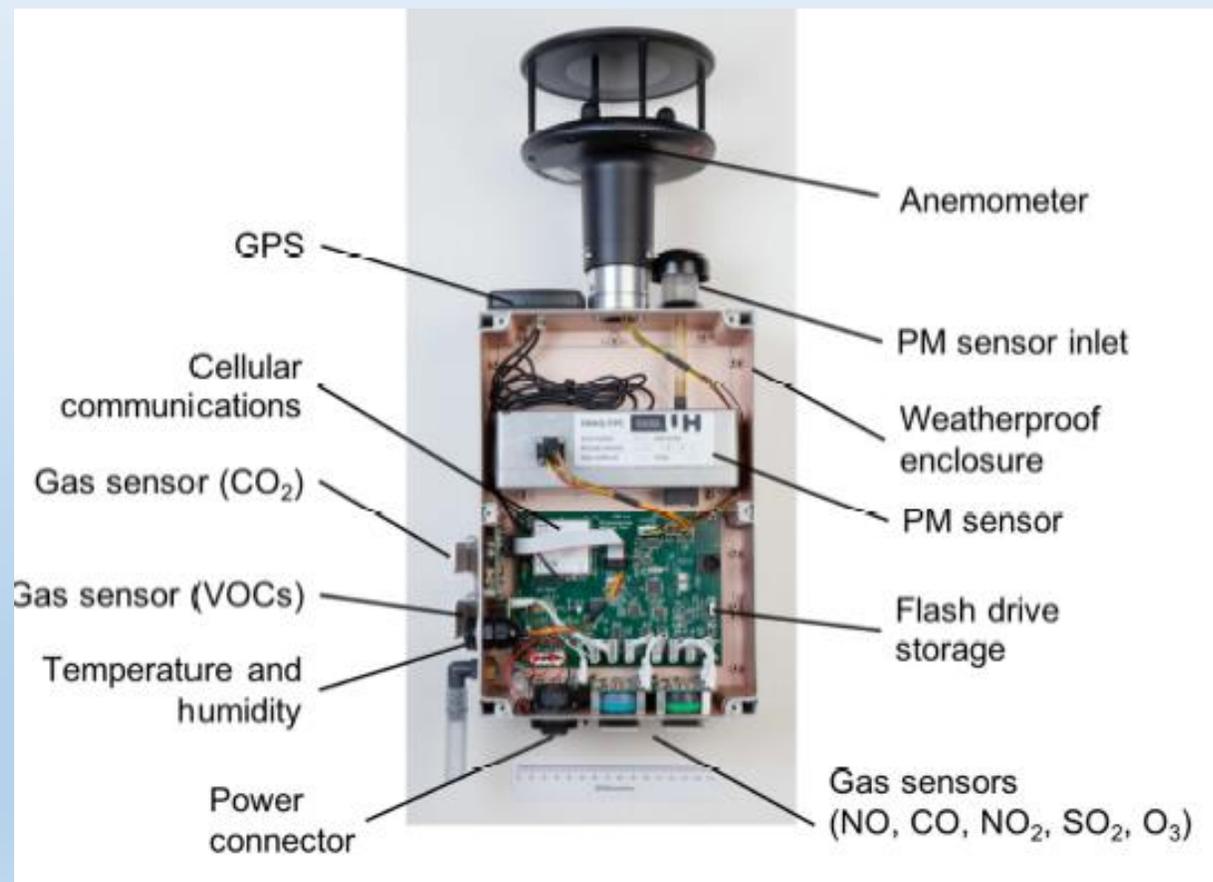
Plot Graph



<https://calima.aemet.es/>

# Low Cost PM Sensor (EXPERIMENTAL!!!)

Low-cost sensors for the measurement of atmospheric composition: overview of topic and future applications (WMO, 2018)



# Low Cost PM Sensor (EXPERIMENTAL!!!)

## IMDS

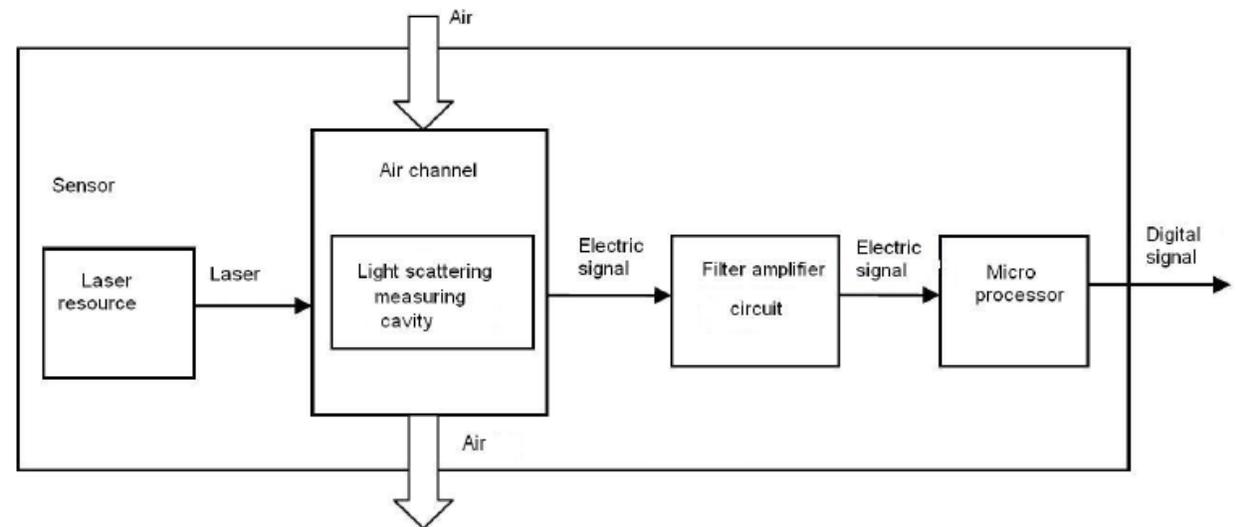
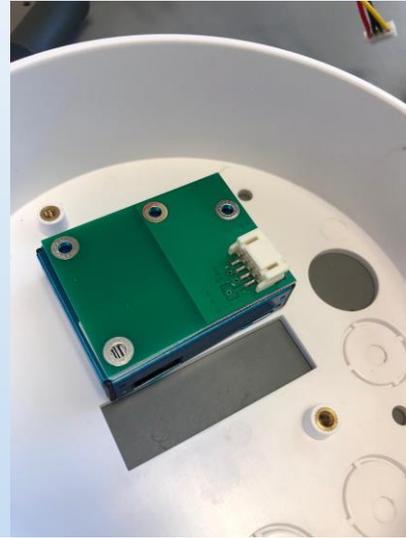


Figure 1 Functional block diagram of sensor

## How to install an IMDS sensor? (measuring PMx concentrations)

**Natalia Prats**  
[npratp@aemet.es](mailto:npratp@aemet.es)  
 Izaña Atmospheric Research Centre  
 AEMET

2

You will find inside the box:

- IMDS (PMx automatic) - Electronics box
- Sensor head
- IMDS (PMx automatic) - Electronics box
- Sensor head

3

IMDS (PMx automatic) - Electronics box

Sensor head

IMDS (PMx automatic) - Electronics box

Sensor head

4

Under the instructions, you will find a PPE sensor for replacement, when necessary.

Please remove it from the electronic box and store in a safety place.

5

★

Put the sensor to the mast.

ATTENTION!!! It should point to the wind direction.

6

Check the sensor head.

7

★

Power supply cable connection

At the time of removal, protection, it must be removed during the connection of the electrical supply.

Terminal cable connection

Cable not supplied

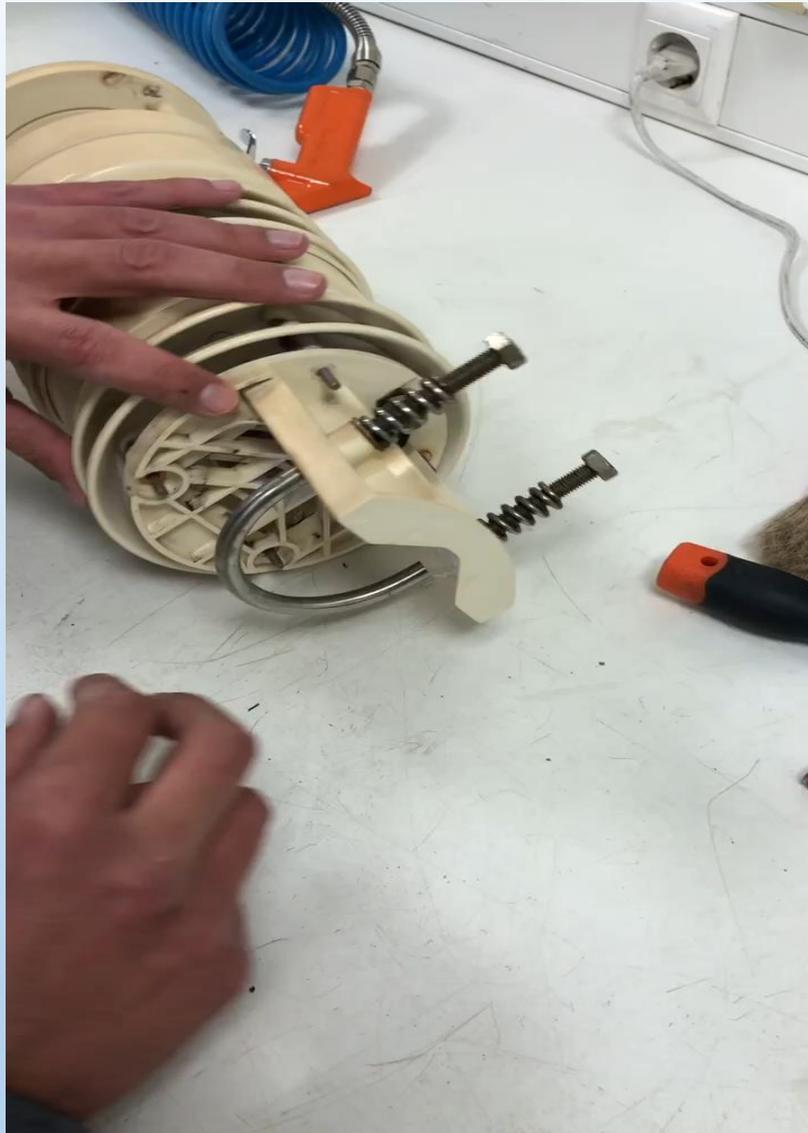
8

★

1. Turn on the switch of the general protection (power up)

2. Turn on the switch and check that the display light-up

When after that, check data are available in [www.izaia.aemet.es](http://www.izaia.aemet.es)



Is it possible to change the PM sensor inside IMDS  
(some problems have been found in your system)  
– This video explains how to do it.

# Merci!

<http://izana.aemet.es>  
[npratasp@aemet.es](mailto:npratasp@aemet.es)

