



# MÉTHODES D'OBSERVATION DE LA POUSSIÈRE

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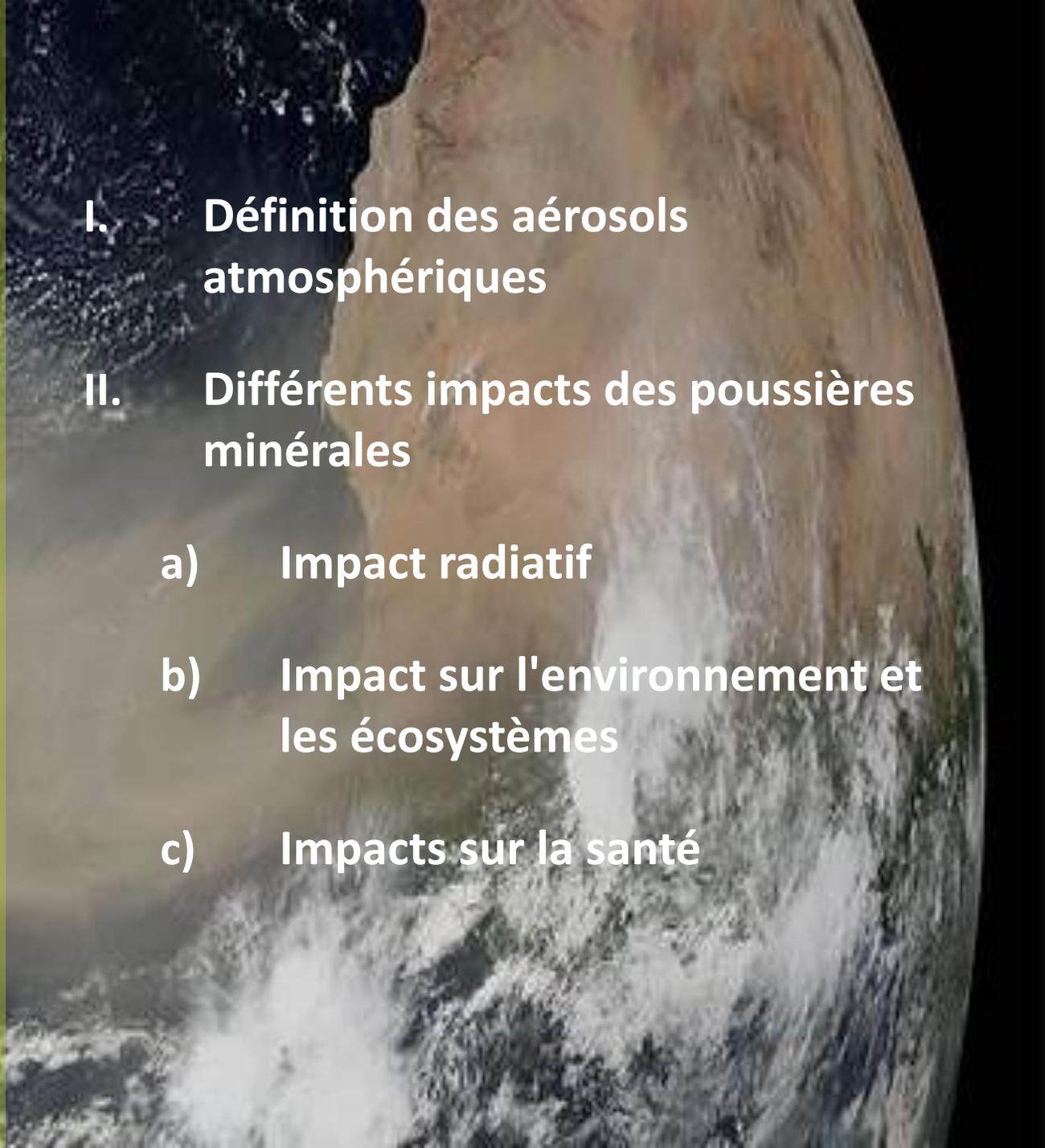
*WMO SDS-WAS CREWS Training Course for Africa: Niger (Online, March 11 2025)*

# Contour

- I. Pourquoi mesurer les poussières minérales?
- II. Aspects de la qualité de l'air
- III. Mesures in situ
- IV. Mesures par télédétection
- V. État des observations de la qualité de l'air en Afrique
- VI. État des observations de poussières en Afrique

# 1.

## Pourquoi mesurer les poussières minérales?

- 
- I. Définition des aérosols atmosphériques
  - II. Différents impacts des poussières minérales
    - a) Impact radiatif
    - b) Impact sur l'environnement et les écosystèmes
    - c) Impacts sur la santé

# DÉFINITION DES AÉROSOLS ATMOSPHÉRIQUES

## Aérosols Atmosphériques

*“Particules solides ou liquides en suspension dans l'air”*

*Naturel et Anthropique*

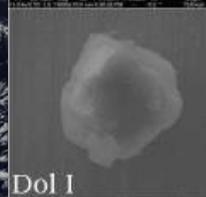
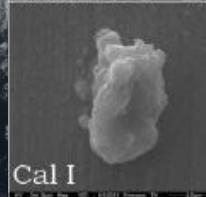
Sel de mer, poussières minérales,  
aérosols volcaniques, bactéries,  
virus, pollen

Émissions industrielles, gaz d'échappement  
des véhicules, combustion de  
biomasse/foresterie – composés carbonés,  
sulfates, nitrates ou autres composés  
organiques –

# DÉFINITION DES AÉROSOLS ATMOSPHÉRIQUES

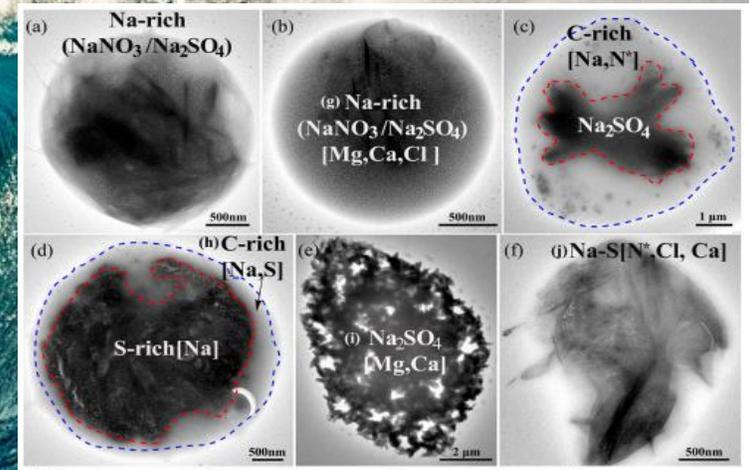
## Naturel – Poussière minérale

- Émission régie par des processus mécaniques (vent)
- Importance de la minéralogie (modifiable selon les sources)
- Forme irrégulière : effet sur la polarisation de la lumière
- Dominance du mode grossier
- Effet radiatif important



## Naturel – Sel de mer

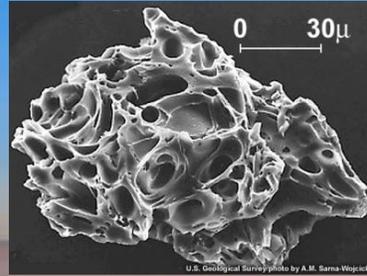
*Chi et al. (2015)*



- Composition: NaCl, sulfates et composés organiques/minéraux solubles
- Très hygroscopique – forme sphérique
- MBL (couche limite marine)
- Effet radiatif important

# DÉFINITION DES AÉROSOLS ATMOSPHÉRIQUES

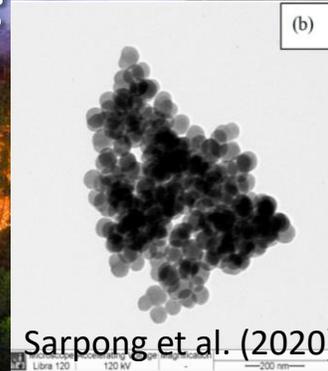
- Cendres (oxydes de Si, Al, Fe), gaz (SO<sub>2</sub>, H<sub>2</sub>S, CO<sub>2</sub>...) & WV
- Effet radiatif important
- Distribution granulométrique bimodale (sulfates & cendres).



Ash

## Naturel/Anthropique – Brûlage de biomasse

- Carbonés (BC + POA/SOA), sulfates, nitrates et composés volatils
- BC : effet radiatif important



Sarpong et al. (2020)

## Naturel – Aérosols volcaniques

- Différentes sources : extraction de charbon ou combustion d'énergies fossiles
- Mode fin : sulfates, nitrates et composés carbonés

## Anthropique – Industriel et trafic

# DÉFINITION DES AÉROSOLS ATMOSPHÉRIQUES

2006-08-17 00:00



10-km GEOS-5 Aerosol Optical Depth

Dust | Organic & Black Carbon | Sulfates | Sea Salt

Global Modeling and Assimilation Office - William.M.Putman@nasa.gov



# DIFFÉRENTS IMPACTS DES POUSSIÈRES MINÉRALES

## Plages typiques de taille des particules de poussière minérale

En termes de qualité de l'air: **Particules PM**

**PM<sub>10</sub>** Concentration massique ( $\mu\text{g}/\text{m}^3$ ) de tous les aérosols inférieurs à  $10\ \mu\text{m}$  (particules de  $\varnothing < 10\ \mu\text{m}$ )

**PM<sub>2.5</sub>** Concentration massique ( $\mu\text{g}/\text{m}^3$ ) de tous les aérosols inférieurs à  $2,5\ \mu\text{m}$  (particules de  $\varnothing < 2,5\ \mu\text{m}$ )

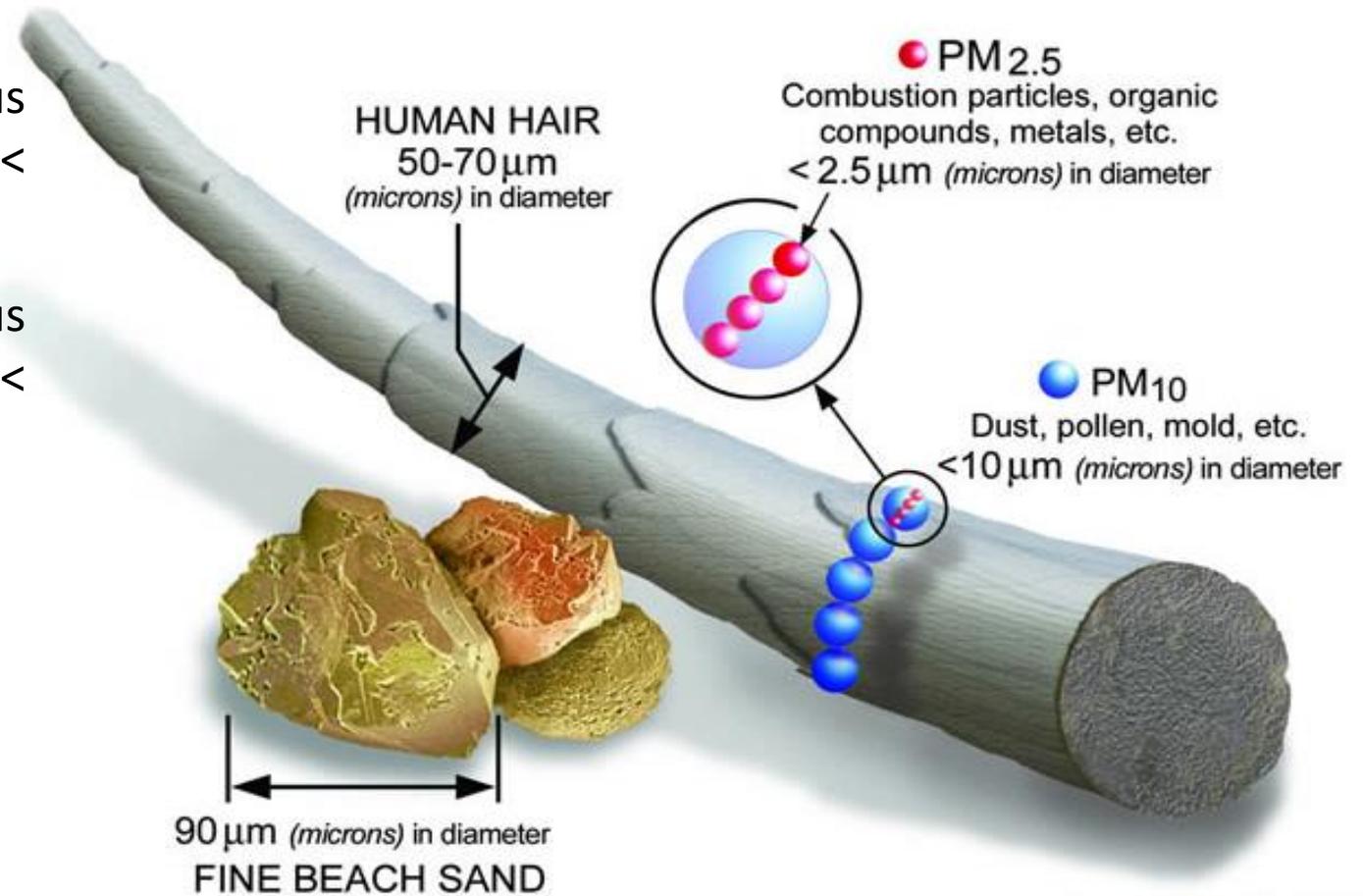
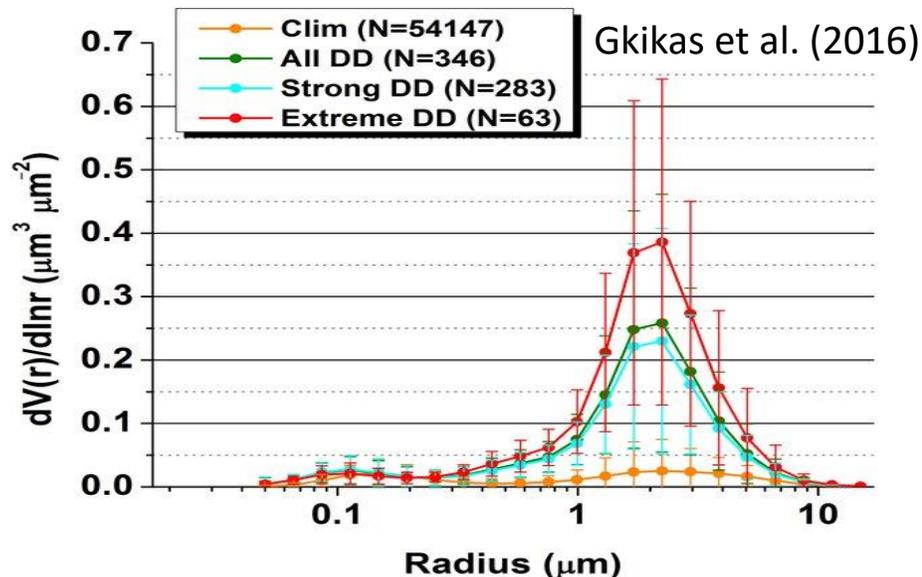
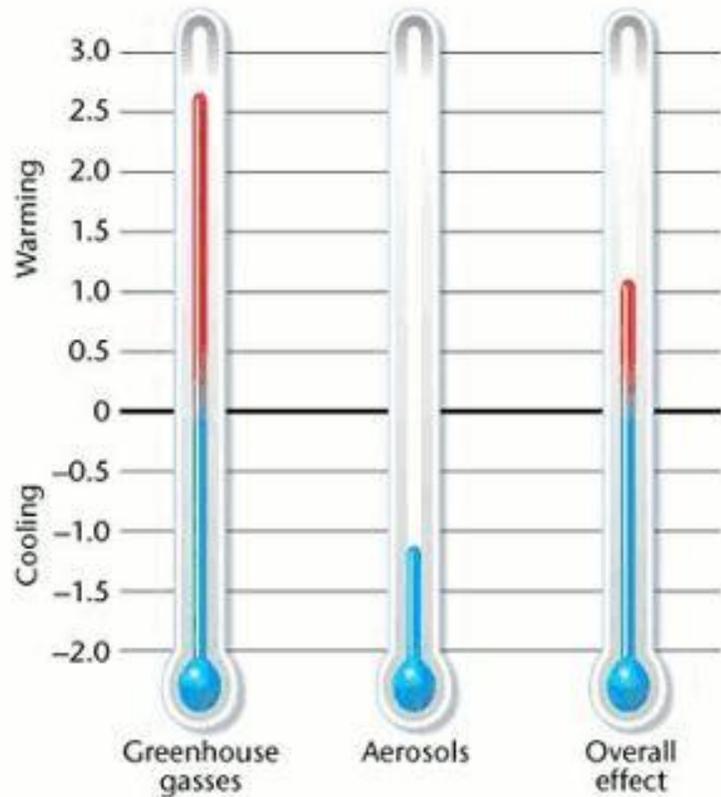


Image courtesy of the U.S. EPA

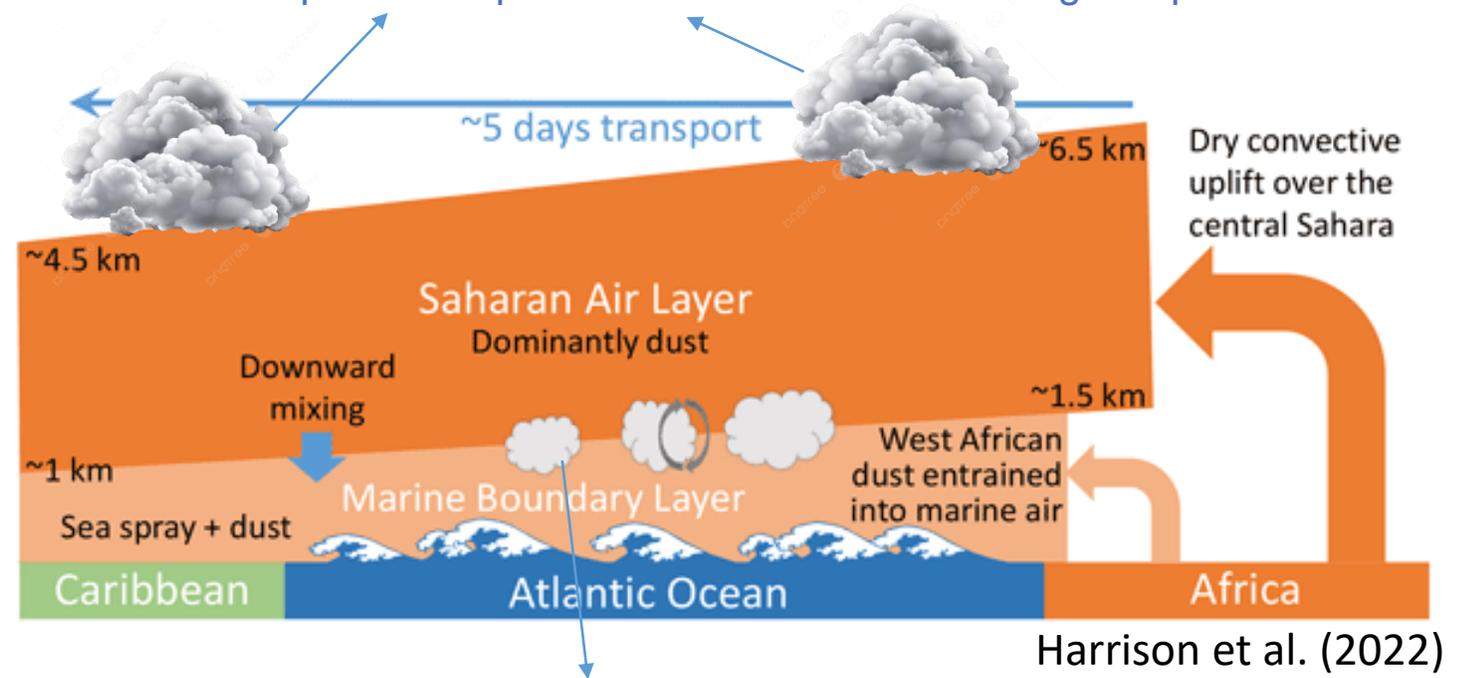
# DIFFÉRENTS IMPACTS DES POUSSIÈRES MINÉRALES

## Impact radiatif (direct) + Effet sur la formation des nuages (indirect)



L'effet global de la poussière minérale est de refroidir le système

Des nuages de niveau moyen peuvent se former dans la partie supérieure du SAL où la poussière peut favoriser la formation de glace primaire



Des nuages relativement peu profonds ont tendance à se former au sommet de la MBL

# DIFFÉRENTS IMPACTS DES POUSSIÈRES MINÉRALES

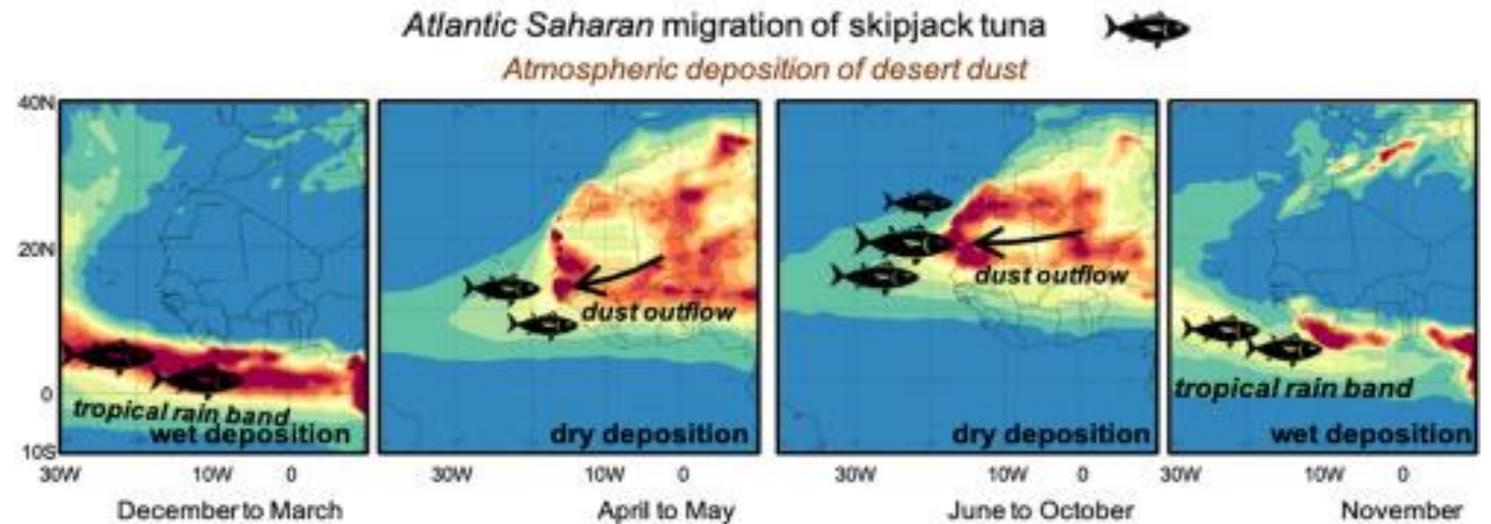
## Impacts sur l'environnement et les écosystèmes

La poussière est capable de:

- ❖ Fournir des nutriments essentiels tels que le fer, le phosphore et l'azote dans les eaux de surface
- ❖ Transport à longue distance de ces composants
- ❖ Augmenter la solubilité du fer – biodisponibilité

Phosphore – Fertilisation de la forêt amazonienne

Fe, P et N dans les eaux de surface – Impact sur les schémas de migration



Rodríguez et al. (2023)

# DIFFÉRENTS IMPACTS DES POUSSIÈRES MINÉRALES

## Aérosols et santé

- ❖ Les particules en suspension dans l'air pénètrent dans notre corps lorsque nous respirons
- ❖ Les risques associés dépendent de la composition chimique et de l'endroit où elles se déposent dans le système respiratoire
- ❖ Ces effets comprennent des maladies infectieuses (méningite et fièvre de la vallée), des problèmes respiratoires ou des maladies cardiovasculaires, pouvant parfois même conduire au cancer
- ❖ Réponse inflammatoire – Stress oxydatif – Dommages à l'ADN – Mort cellulaire

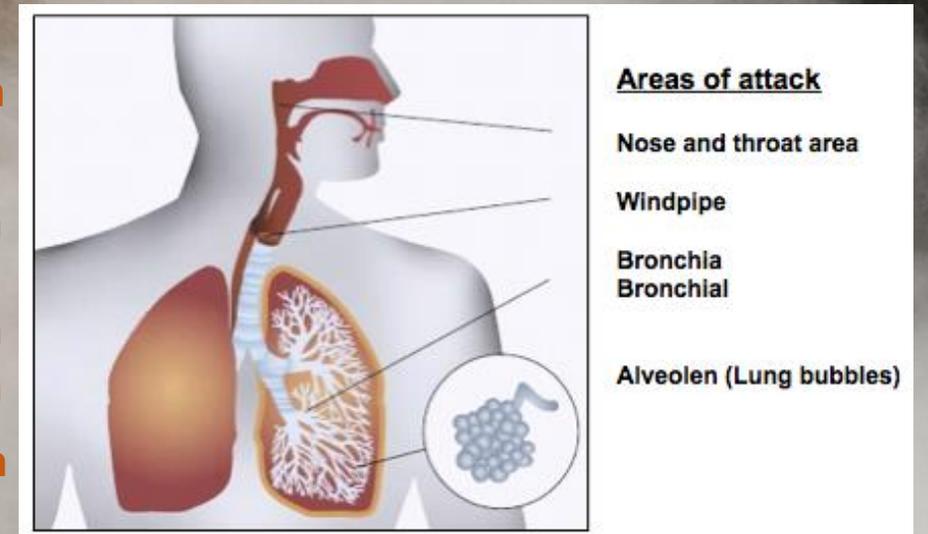
5-10  $\mu\text{m}$

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

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

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

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



**PM<sub>2.5</sub> + UFP (<1 $\mu\text{m}$ )**

# DIFFÉRENTS IMPACTS DES POUSSIÈRES MINÉRALES

## Quelques données épidémiologiques

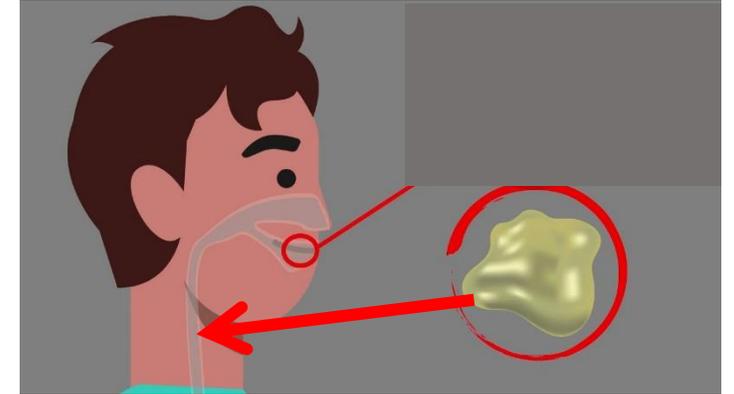
### Poussière du désert et maladies cardiovasculaires

- 1 Chaque  $+1\mu\text{g}/\text{m}^3$  de poussières dans  $\text{PM}_{10}$  est associé à une augmentation de molécules biomarqueurs de processus inflammatoires dans les expectorations des patients
- 2 Chaque  $+10\mu\text{g}/\text{m}^3$  de poussières dans  $\text{PM}_{10}$  est associée à une augmentation de 2 % du risque de mortalité cardiovasculaire

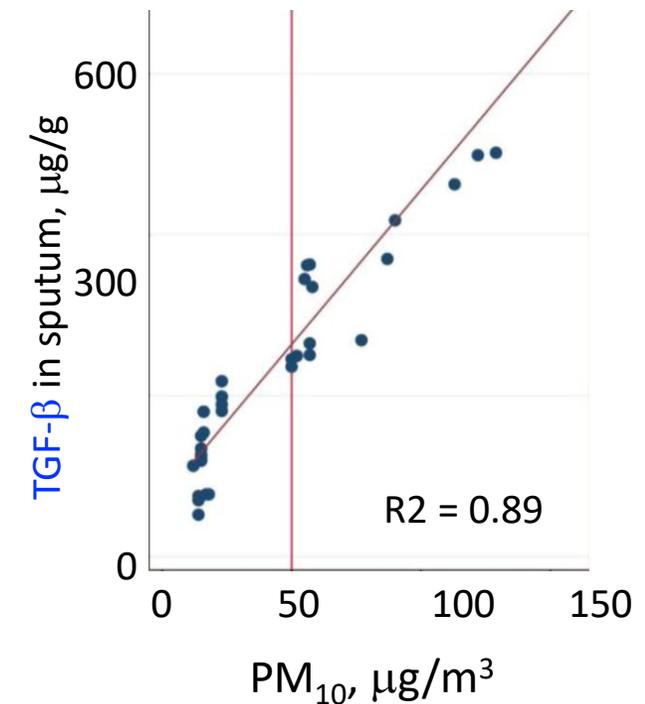
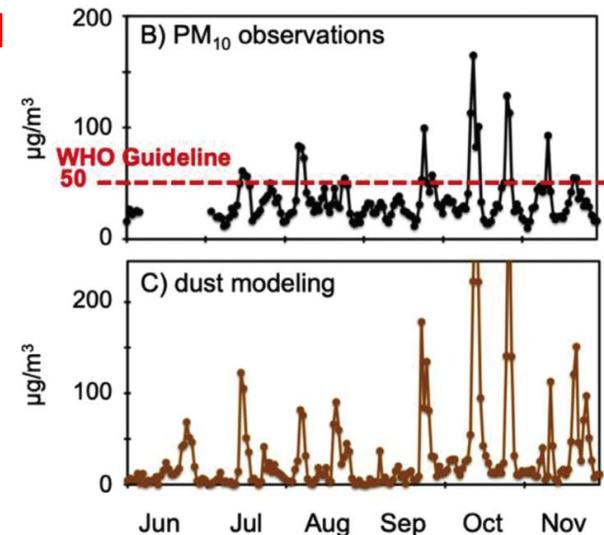
Les effets de la poussière sur la santé s'aggravent lorsqu'elle la concentration de poussière augmente

- 3 2014-2017 : 86 % des décès par défaillance cardiaque à l'hôpital sont survenus chez des patients admis lors d'épisodes de poussières graves ( $> 50\mu\text{g}/\text{m}^3$ )

L'inhalation de poussières sahariennes présentes dans l'air ambiant provoque une inflammation des voies respiratoires



Domínguez-Rodríguez et al. (2020, 2021)



# DIFFÉRENTS IMPACTS DES POUSSIÈRES MINÉRALES

## Quelques données épidémiologiques

### Poussière du désert et ceinture de méningite

Maladie méningococcique dont l'incidence est la plus élevée dans la « ceinture de la méningite » de l'Afrique subsaharienne dans des conditions « favorables » : conditions sèches et poussiéreuses pendant la saison sèche (de décembre à juin).

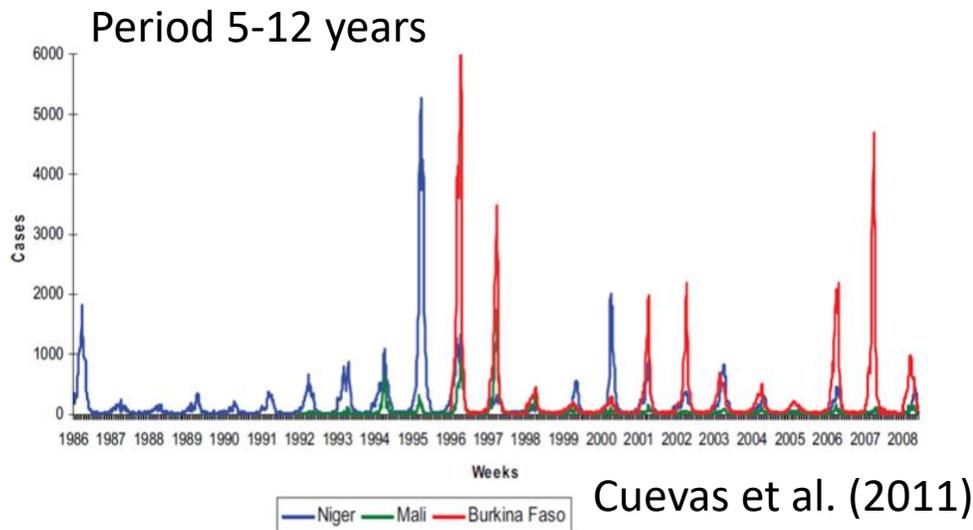
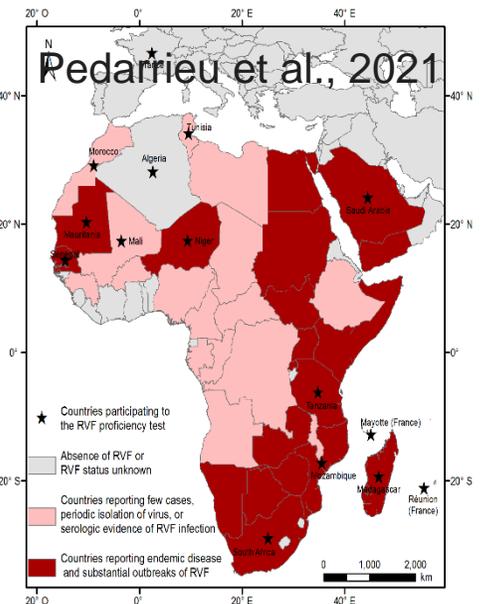


Figure 6.1; Meningitis epidemic weekly evolution over the years in Burkina Faso (1997–2008), Mali (1992–2008), and Niger (1986–2008) (Djingarey et al., 2008).

### Présence de poussière du désert et de fièvre de la vallée

Infection fongique causée par des spores de champignons généralement présentes dans le sol de régions spécifiques et agitées dans l'air par des processus mécaniques (agriculture, construction ou mouvements de poussière)



# 2.

## Aspects de la qualité de l'air

- I. **Qualité de l'air**
- II. **Lignes directrices internationales normalisées pour la gestion de la qualité de l'air**
- III. **Techniques de mesure**

## Qu'est-ce que la pollution de l'air ?

- \*<sup>\*</sup> Selon l'Organisation mondiale de la santé (OMS), la pollution de l'air est un mélange complexe de particules solides, de gouttelettes liquides et de gaz. Elle peut provenir de nombreuses sources : combustion de combustibles domestiques, cheminées industrielles, gaz d'échappement des véhicules, production d'électricité, combustion à ciel ouvert de déchets, pratiques agricoles, poussière du désert...
- \*<sup>\*</sup> Différentes sources peuvent conduire à différents mélanges de pollution atmosphérique.
- \*<sup>\*</sup> Notre préoccupation est spécifiquement de définir les polluants dont il a été démontré qu'ils ont des effets nocifs sur la santé humaine et de **développer efficacement** nos capacités de surveillance de ces composants atmosphériques.
- \*<sup>\*</sup> Ces polluants se répartissent en deux grandes catégories :

## Gaz et aérosols

## Criteria Air Pollutants (Polluants Critiques )

La plupart des pays ont défini comme « polluants critiques », en établissant des limites de qualité de l'air pour chacun d'eux, les espèces atmosphériques suivantes :



**Sulfur Dioxide (SO<sub>2</sub>)**



**Nitrogen dioxide (NO<sub>2</sub>)**



**Ozone (O<sub>3</sub>)**

**Carbon Monoxide (CO)**



**Particulate matter**



# LIGNES DIRECTRICES NORMES INTERNATIONALES POUR LA SURVEILLANCE DE L'AQ

Selon le UNEP, il existe trois lignes directrices internationalement acceptées pour les réseaux ou programmes de gestion de la qualité de l'air :

Organization	Title/Link to Guidelines	(Clear Air Asia, 2016)
WHO	Monitoring Ambient Air Quality for Health Impacts Assessment <a href="http://www.euro.who.int/__data/assets/pdf_file/0010/119674/E67902.pdf">http://www.euro.who.int/__data/assets/pdf_file/0010/119674/E67902.pdf</a>	
USEPA	Air Planning and Standards <a href="http://www.epa.gov/airquality/montring.html">http://www.epa.gov/airquality/montring.html</a> Guidance for Network Design and Optimum Site Exposure for PM <sub>2.5</sub> And PM <sub>10</sub> <a href="http://www.epa.gov/ttn/amtic/files/ambient/pm25/network/r-99-022.pdf">http://www.epa.gov/ttn/amtic/files/ambient/pm25/network/r-99-022.pdf</a> Guidance for Using Continuous Monitors in PM <sub>2.5</sub> Monitoring Networks <a href="http://www.epa.gov/ttn/amtic/files/ambient/pm25/r-98-012.pdf">http://www.epa.gov/ttn/amtic/files/ambient/pm25/r-98-012.pdf</a>	
EU	Directives for Monitoring Atmospheric Pollution (Directive 2008/50/EC) <a href="http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&amp;from=EN">http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&amp;from=EN</a>	

Ces lignes directrices présentent:

- Des normes de qualité de l'air ambiant (limite et période d'exposition) basées sur de nombreuses preuves scientifiques reliant les principaux polluants à leurs effets néfastes sur la santé publique.
- Instruments/techniques de référence
- Procédures : AQ/CQ

**Méthode de référence (RM)**

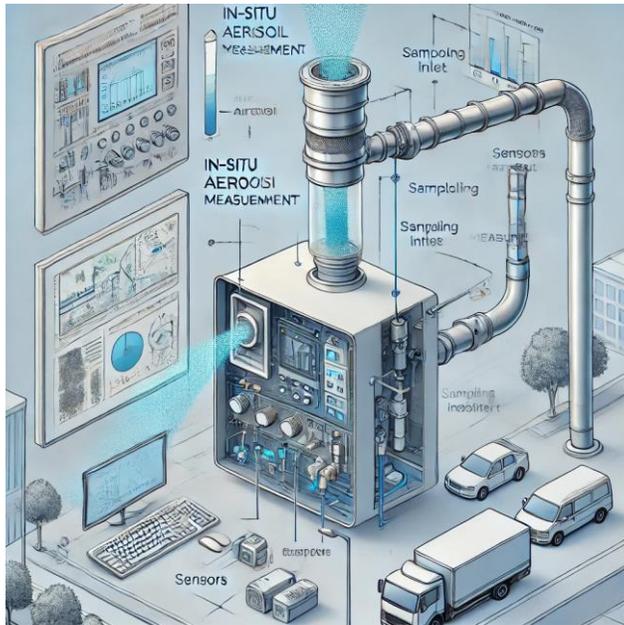
**Méthode équivalente (EM)**

Développé scientifiquement pour fournir une quantification pour les réglementations AQ (NAAQS)

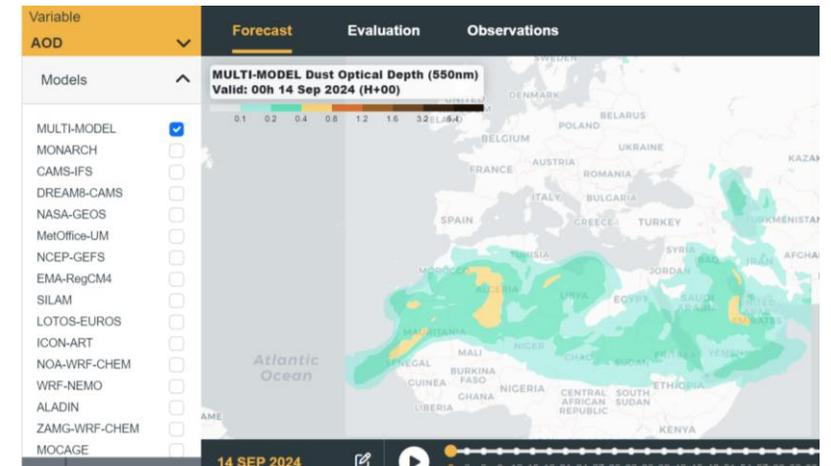
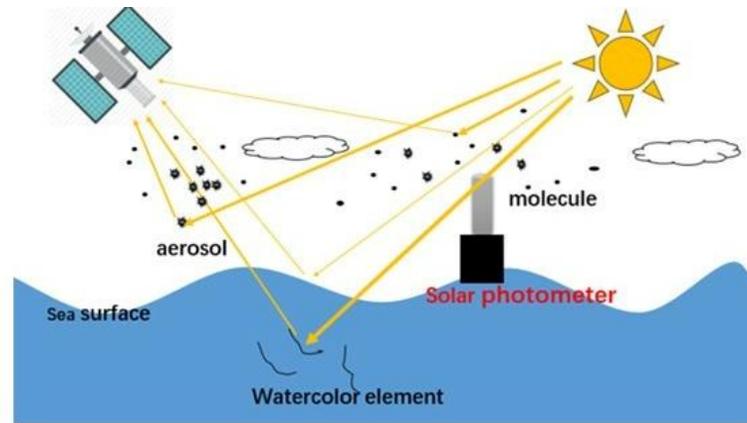
# TECHNIQUES DE MESURE

Pour surveiller la présence et l'évolution des gaz et des aérosols dans l'atmosphère (polluants principaux), nous devons examiner leur contenu dans l'air à l'aide de différentes techniques de surveillance :

## In-Situ

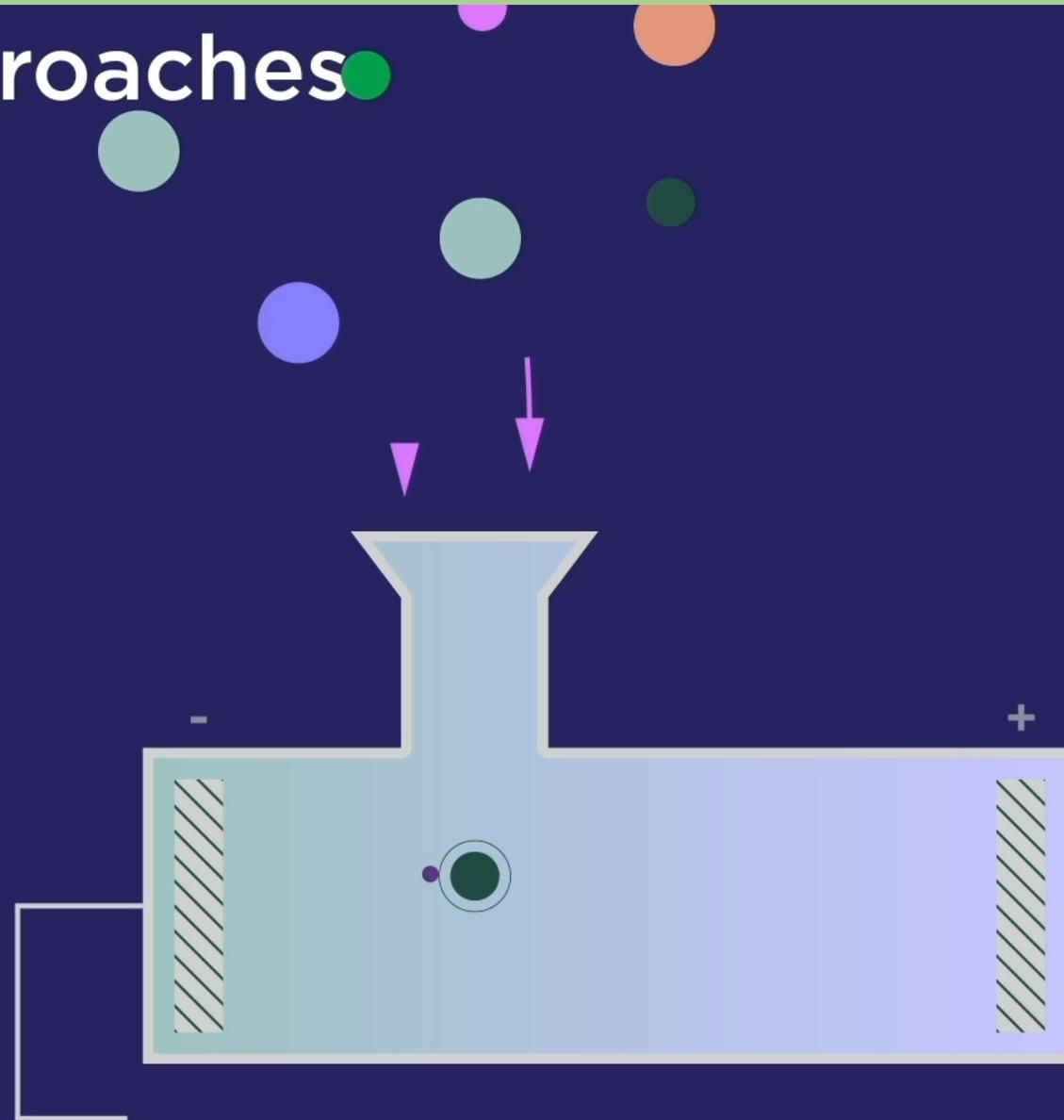


## Téledétection



## Modèles numériques

## in situ approaches



# 3. ■

## Mesures in-situ

- I. Criteria Pollutants**
- II. Principe de fonctionnement des mesures de PM**
- III. Lignes directrices internationales sur les normes pour la gestion de la qualité de l'air**
- IV. Réseaux de surveillance (mondial)**
- V. Indice de qualité de l'air**

# CRITERIA AIR POLLUTANTS



Sulfur Dioxide ( $\text{SO}_2$ )

Carbon Monoxide (CO)



Nitrogen dioxide ( $\text{NO}_2$ )

Ozone ( $\text{O}_3$ )

Particulate matter



# CRITERIA AIR POLLUTANTS



Sulfur Dioxide ( $\text{SO}_2$ )



Nitrogen dioxide ( $\text{NO}_2$ )



Ozone ( $\text{O}_3$ )

Carbon Monoxide ( $\text{CO}$ )



Particulate matter



# CRITERIA AIR POLLUTANTS: PM

## Criteria Air Pollutants

- Les particules en suspension dans l'air représentent un mélange complexe de substances organiques et inorganiques
- Désignées par différents diamètres aérodynamiques :  $PM_{10}$  (grossières) et  $PM_{2.5}$  (fines)
- Variation quotidienne des concentrations de particules
- Effets sanitaires importants (mortalité, maladies respiratoires et cardiovasculaires) même à de faibles niveaux de concentration (en particulier pour les particules fines et en fonction de la composition chimique)
- L'exposition à long terme aux particules est associée à une réduction des taux de survie et de prévalence des maladies respiratoires et cardiovasculaires
- Rôle important des capteurs à faible coût (LCS)

## Particulate matter ( $PM_x$ )

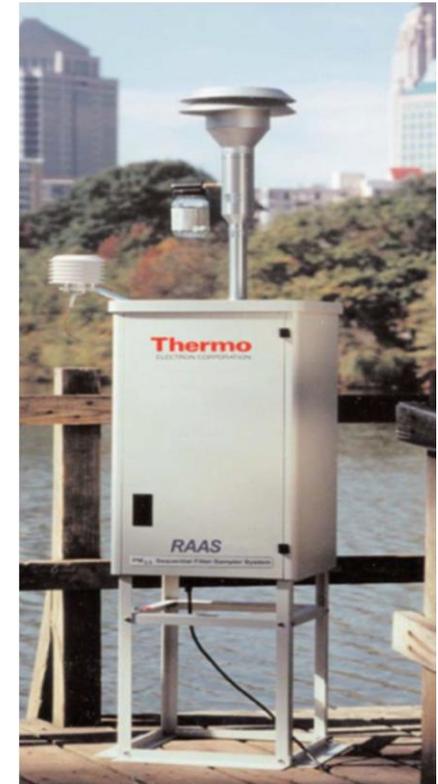


**Méthode de reference (RM): In-Stack Particulate Filtration**  $PM_x$  sampler

**Méthode équivalente (EM): Beta-Attenuation Monitoring, Tapered Element Oscillating Microbalance (TEOM®), Laser Aerosol Spectrometry, Dichotomous Air Sampler**



Beta attenuator  $PM_x$  monitor

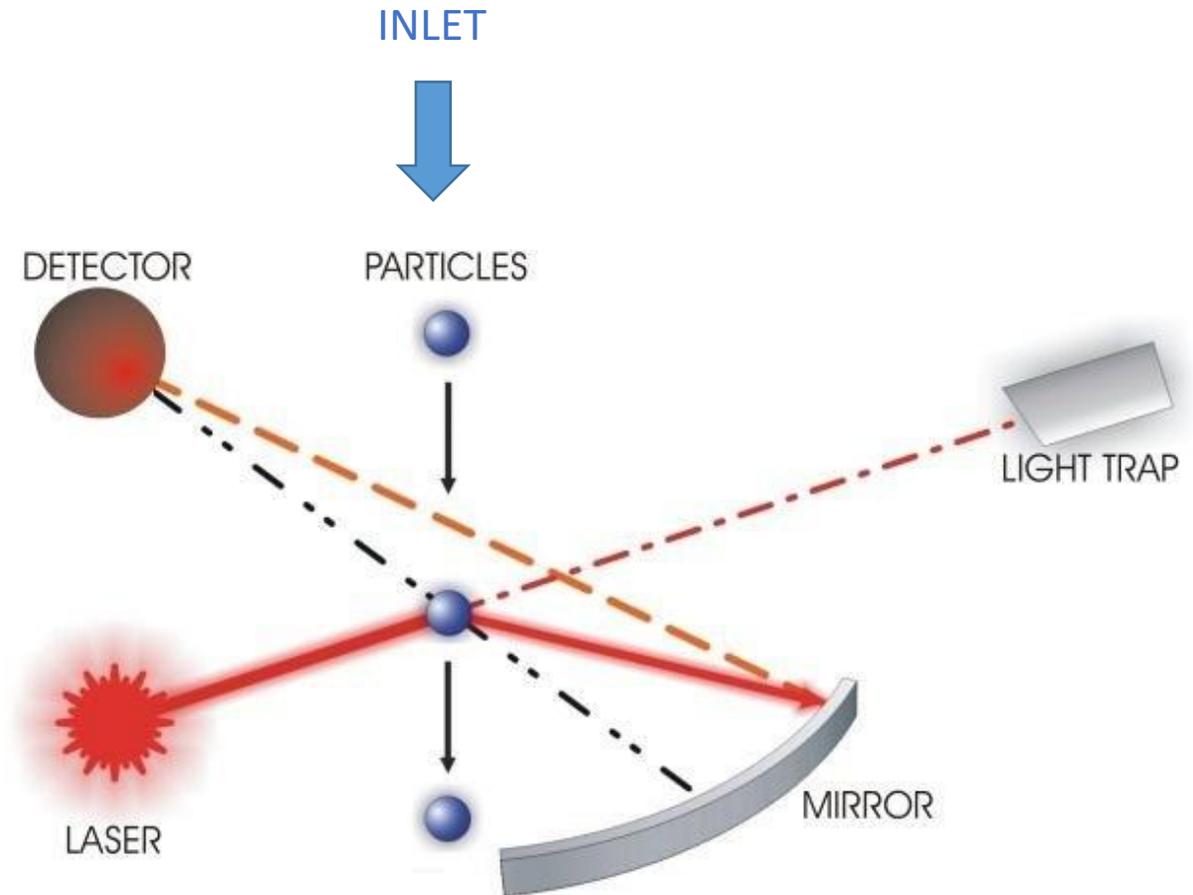


# PRINCIPE DE FONCTIONNEMENT DES MESURES PM\*

## Optical Particle Counter (OPC, Compteur de particules optiques)

Ce principe est basé sur la diffusion de la lumière.

1. **Admission d'air** : Le capteur utilise un petit ventilateur ou une pompe pour aspirer l'air dans la chambre de mesure.
2. **Source lumineuse** : À l'intérieur de la chambre, il y a une source lumineuse, généralement une diode laser ou une LED infrarouge, qui éclaire les particules en suspension dans l'air.
3. **Diffusion de la lumière** : Lorsque les particules (PM<sub>2,5</sub> ou PM<sub>10</sub>) traversent le faisceau lumineux, elles diffusent la lumière dans différentes directions.
4. **Détecteur de lumière** : Un photodétecteur ou un capteur optique mesure la lumière diffusée. La quantité de lumière diffusée est proportionnelle à la taille et au nombre de particules présentes dans l'air.
5. **Traitement du signal** : Les données du détecteur sont traitées pour calculer la concentration de particules dans l'air, exprimée en microgrammes par mètre cube ( $\mu\text{g}/\text{m}^3$ ).

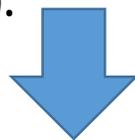


# LIGNES DIRECTRICES DES NORMES INTERNATIONALES POUR LA AQM (in-situ)

\* L'OMS recommande des valeurs pour limiter les concentrations de polluants atmosphériques et l'exposition à des niveaux où le risque d'effets sur la santé est faible.

\*\* Les recommandations relatives à la qualité de l'air sont basées sur des preuves purement épidémiologiques et toxicologiques.

\*\* Les recommandations relatives à la qualité de l'air sont destinées à être utilisées dans le **monde** entier pour atteindre une qualité de l'air sûre pour la santé publique : circonstances locales (niveau de développement, capacité de gestion de la qualité de l'air, conditions socio-économiques et politiques, questions culturelles et traditionnelles, etc.).



National Ambient Air Quality Standards  
(**NAAQS**, Normes nationales de qualité de l'air ambiant)

Table 0.1. Recommended AQG levels and interim targets

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual	35	25	15	10	5
	24-hour <sup>a</sup>	75	50	37.5	25	15
PM <sub>10</sub> , µg/m <sup>3</sup>	Annual	70	50	30	20	15
	24-hour <sup>a</sup>	150	100	75	50	45
O <sub>3</sub> , µg/m <sup>3</sup>	Peak season <sup>b</sup>	100	70	-	-	60
	8-hour <sup>a</sup>	160	120	-	-	100
NO <sub>2</sub> , µg/m <sup>3</sup>	Annual	40	30	20	-	10
	24-hour <sup>a</sup>	120	50	-	-	25
SO <sub>2</sub> , µg/m <sup>3</sup>	24-hour <sup>a</sup>	125	50	-	-	40
CO, mg/m <sup>3</sup>	24-hour <sup>a</sup>	7	-	-	-	4

<sup>a</sup> 99th percentile (i.e. 3-4 exceedance days per year).

<sup>b</sup> Average of daily maximum 8-hour mean O<sub>3</sub> concentration in the six consecutive months with the highest six-month running-average O<sub>3</sub> concentration.

# LIGNES DIRECTRICES DES NORMES INTERNATIONALES POUR LA AQM (in-situ)

## Adoption de la norme AQ dans différentes régions

WHO region	Countries in the region (n)	Countries with standards for at least one pollutant and averaging time		Countries without standards		Countries with no information	
		n	%	n	%	n	%
African Region	47	17	36	21	45	9	19
Region of the Americas	35	20	57	13	37	2	6
South-East Asian Region	11	7	64	3	27	1	9
European Region	53	50	94	2	4	1	2
Eastern Mediterranean Region	21	11	52	1	5	9	43
Western Pacific Region	27	12	44	13	48	2	7
<b>Total</b>	<b>194</b>	<b>117</b>	<b>60</b>	<b>53</b>	<b>27</b>	<b>24</b>	<b>12</b>

Source: Kutlar Joss et al. (2017).

\*\* Les directives de l'OMS sur la qualité de l'air sont adoptées dans de nombreux pays (au moins pour un polluant)

\*\* De nombreux pays n'ont aucune norme (ou les informations manquent)

\*\* Écart entre les directives de l'OMS sur la qualité de l'air et les réglementations nationales

# RÉSEAUX DE SURVEILLANCE AQ (Global)



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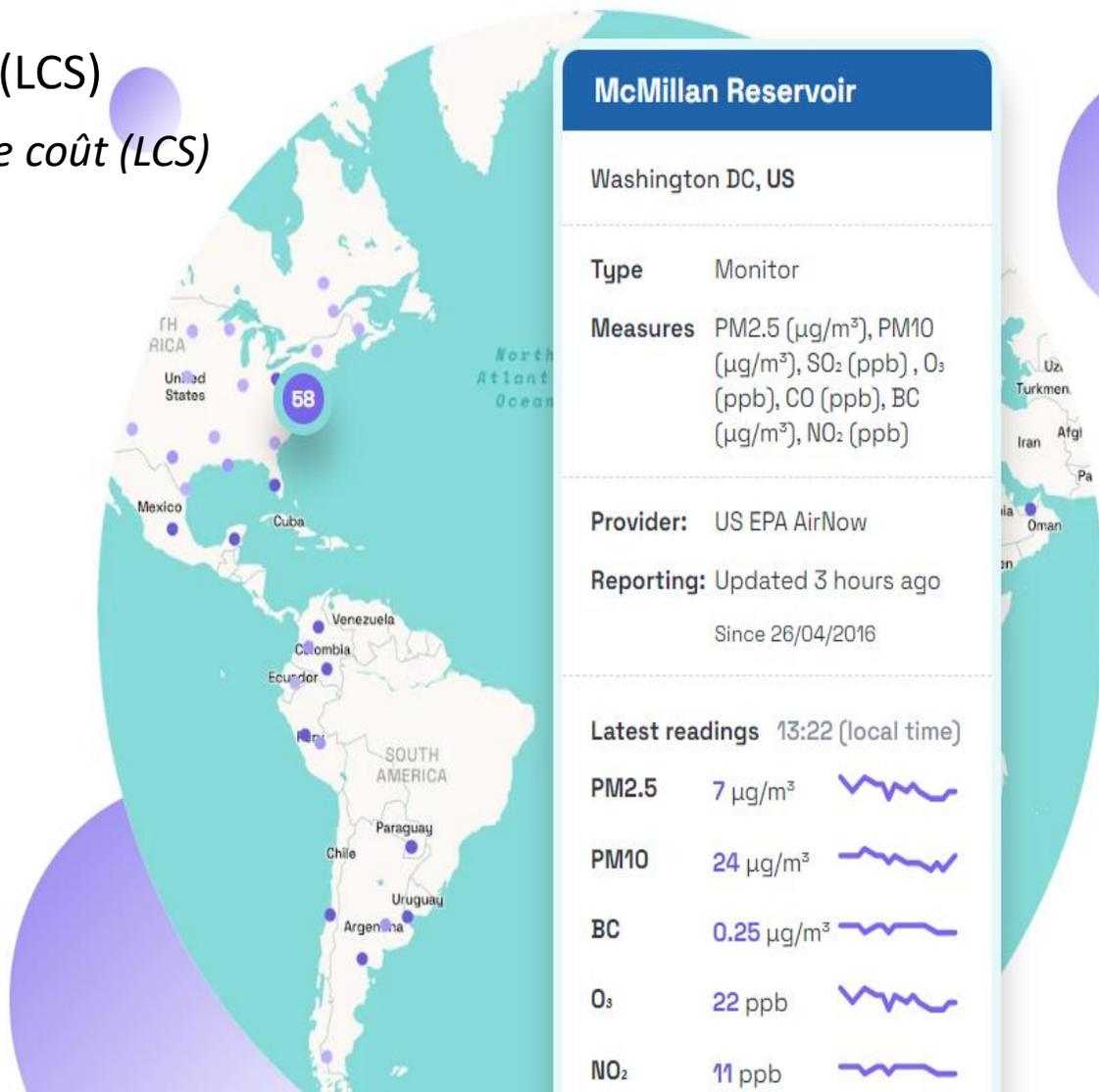
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Reference Grade Monitor (RGM) + low-cost sensors (LCS)  
*Moniteur de qualité de référence (RGM) + capteurs à faible coût (LCS)*

## Fighting air inequality through open data.

OpenAQ is a nonprofit organization providing universal access to air quality data to empower a global community of changemakers to solve air inequality—the unequal access to clean air.

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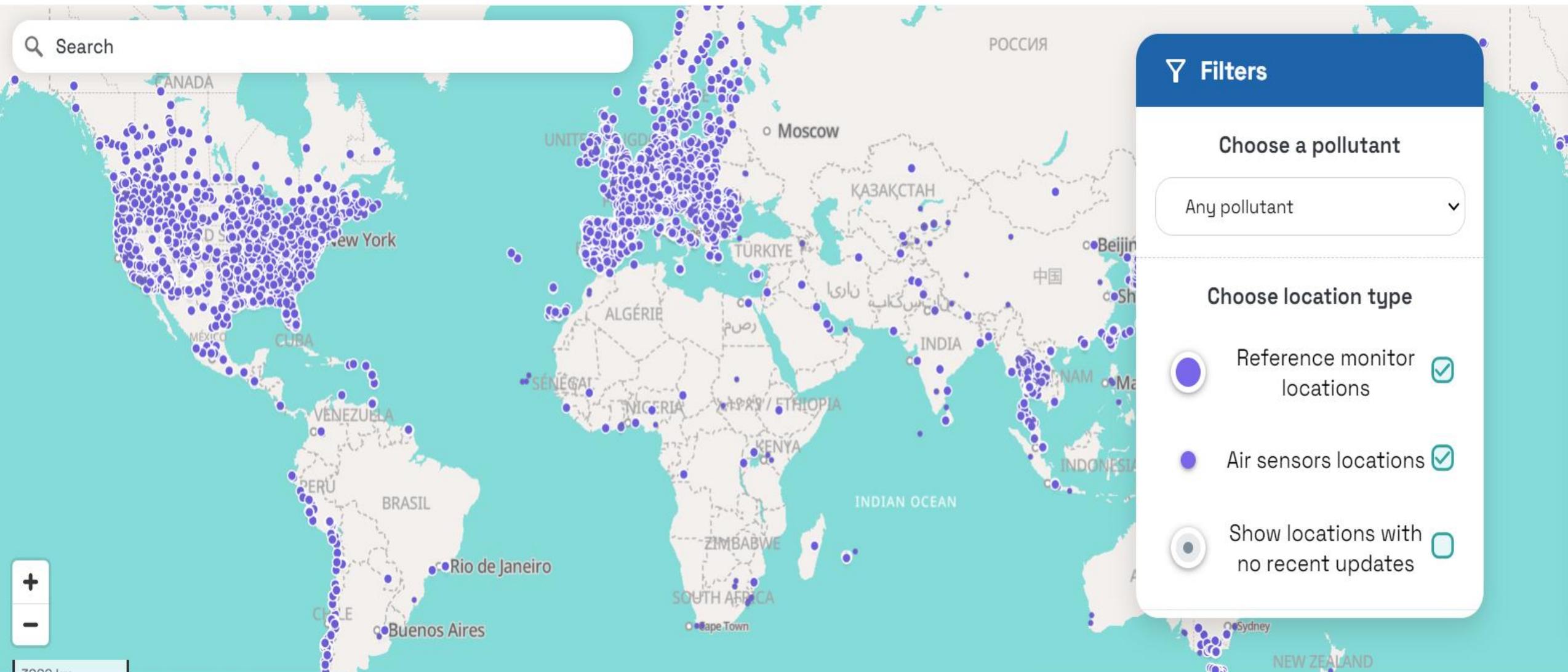
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## Filters

### Choose a pollutant

Any pollutant

### Choose location type

- Reference monitor locations
- Air sensors locations
- Show locations with no recent updates



## Air Quality Index (AQI, Indice de qualité de l'air)

\*\* Un outil efficace pour informer le public sur l'exposition et les risques encourus.

\*\* Les gouvernements du monde entier élaborent et mettent en œuvre des normes de qualité de l'air qui fixent des limites d'exposition officielles pour aider à évaluer les niveaux de qualité de l'air.

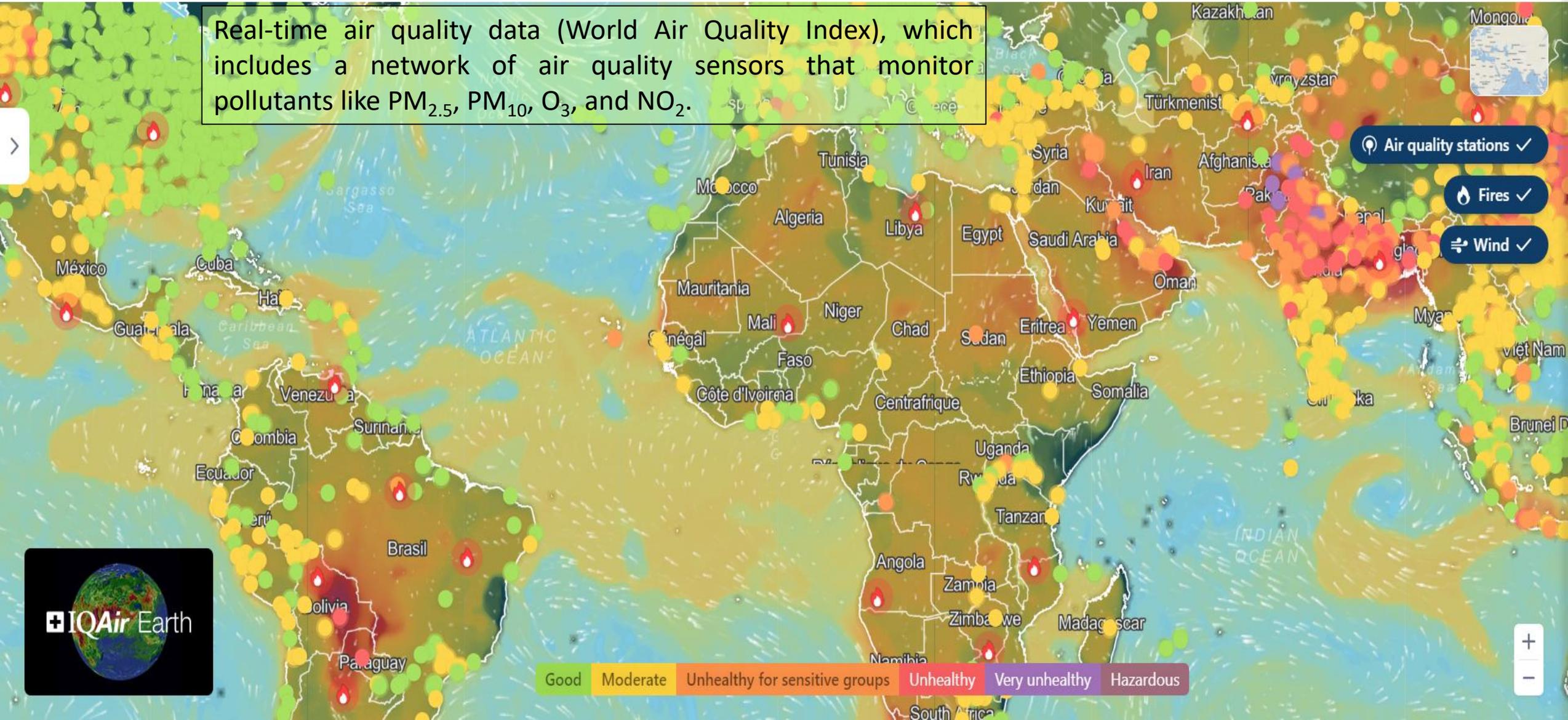
\*\* Ces normes sont généralement conformes aux directives de l'OMS ou de l'EPA américaine.

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

*AQI from US EPA*

# RÉSEAUX DE SURVEILLANCE AQ: AQI

Real-time air quality data (World Air Quality Index), which includes a network of air quality sensors that monitor pollutants like PM<sub>2.5</sub>, PM<sub>10</sub>, O<sub>3</sub>, and NO<sub>2</sub>.

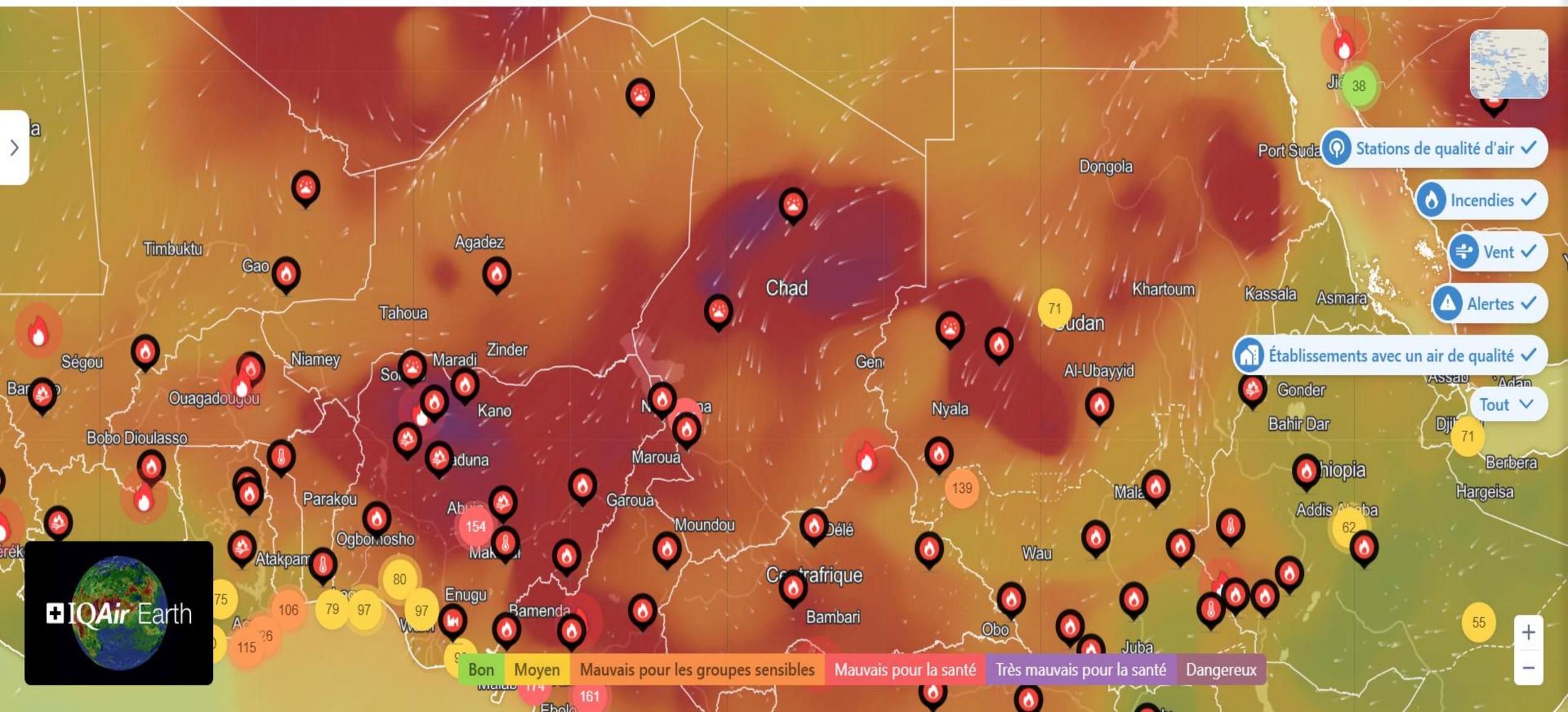


# RÉSEAUX DE SURVEILLANCE AQ: AQI

 Qualité de l'air Moniteurs d'air Purificateurs d'air Masques Entreprise Actualités Nos Causes



Connexion



Stations de qualité d'air ✓

Incendies ✓

Vent ✓

Alertes ✓

Établissements avec un air de qualité ✓

Tout ✓



# RÉSEAUX DE SURVEILLANCE AQ: AQI

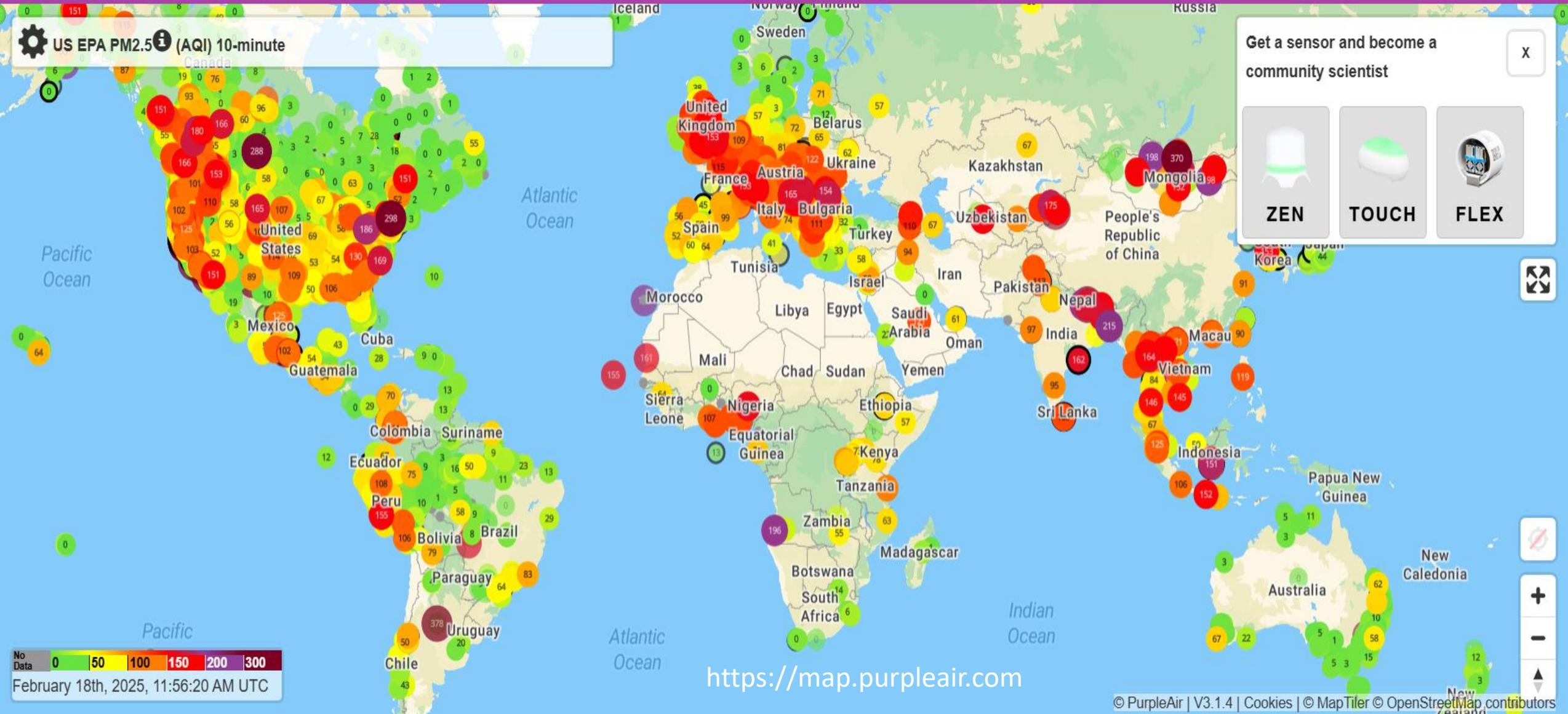
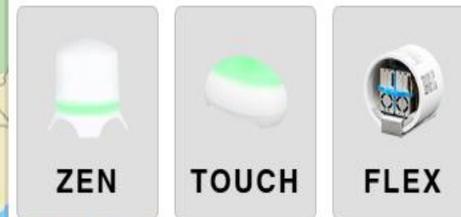


Map ▾ Sensors ▾ Data ▾ About ▾



⚙️ US EPA PM2.5 (AQI) 10-minute

Get a sensor and become a community scientist



<https://map.purpleair.com>

# 4.

## Mesures de télédétection

- I. **Criteria pollutants**
  - a) **Aerosol Optical Depth (AOD, Profondeur optique des aérosols)**
- II. **Réseaux de surveillance (monde)**
- III. **Capteurs à faible coût**
- IV. **Principe de fonctionnement d'un photomètre solaire**

# CRITERIA AIR POLLUTANTS: AOD

Teneur en aérosols en colonne mesurée à l'aide d'instruments de télédétection

Particulate matter  
(AOD)



Méthode de reference (RM): Photométrie Soleil - Lune - Étoile

Rôle important des capteurs low cost : Calitoo

# Aerosol Optical Depth AOD



# PRINCIPE DE FONCTIONNEMENT D'UN PHOTOMETRE SOLAIRE

## Observations AOD sur votre site : Photométrie solaire

Beer's Law

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

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

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

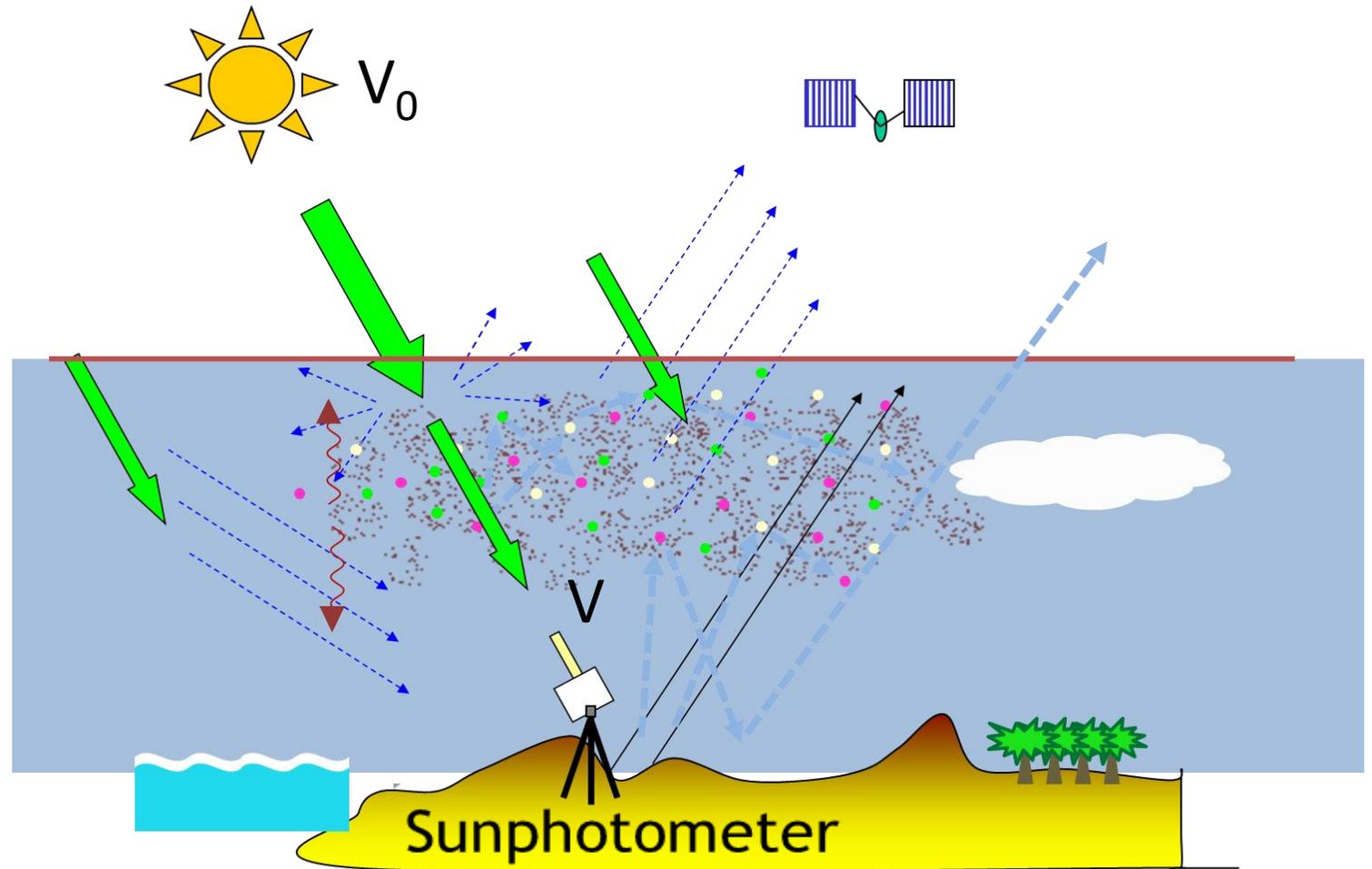
Angstrom Eq.

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

$\alpha$  = Angstrom Exponent

$\alpha \downarrow$  grosses particules

$\alpha \uparrow$  particules fines



# PRINCIPE DE FONCTIONNEMENT D'UN PHOTOMETRE SOLAIRE

Une augmentation du nombre d'aérosols dans l'atmosphère entraîne une augmentation de l'extinction et une diminution de l'énergie transmise à la surface. L'AOD est le degré auquel les aérosols empêchent la transmission de la lumière.

## Plages AOD typiques

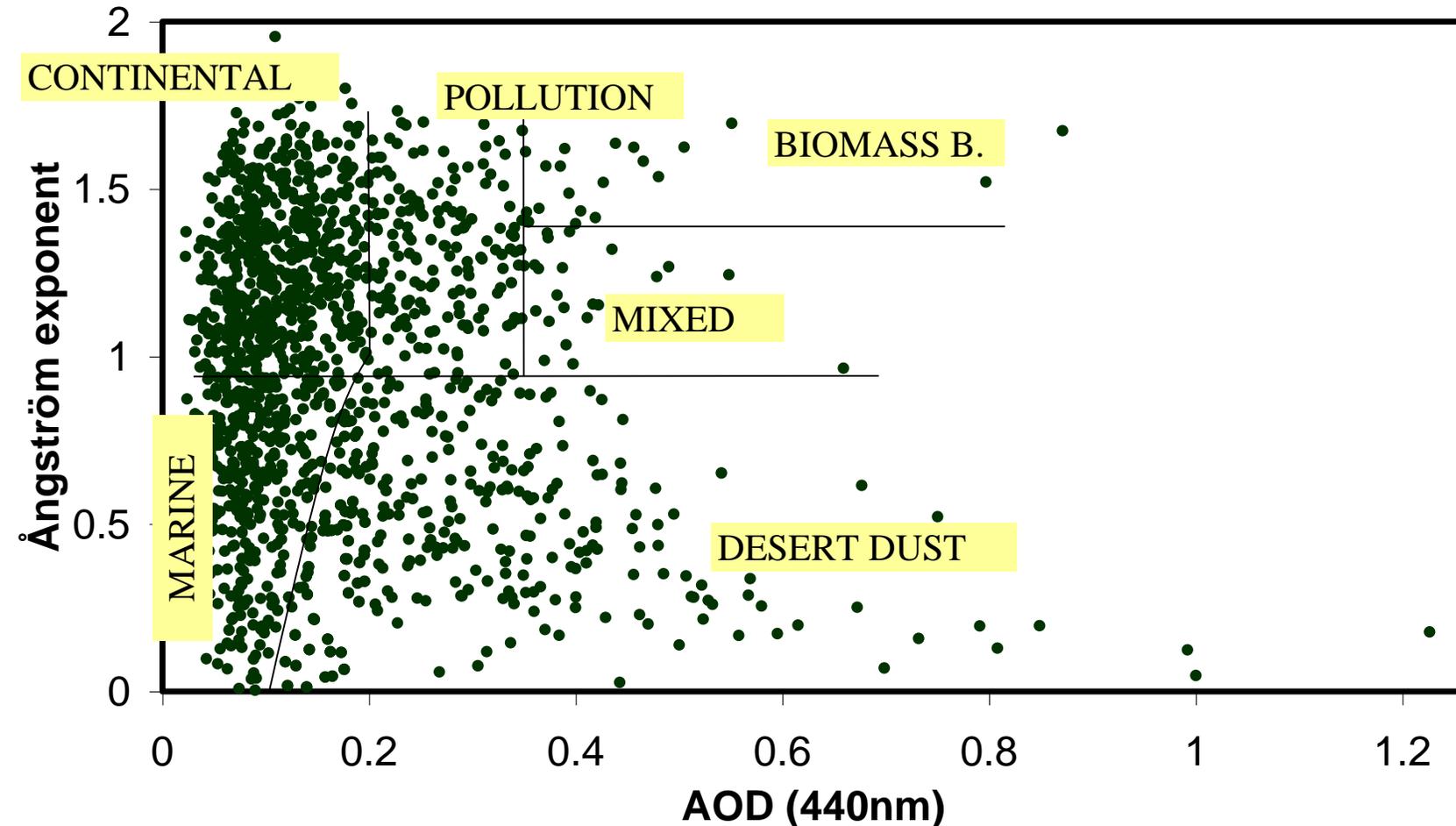
Conditions du ciel	500 nm	870 nm
Extrêmement clair	0.03 - 0.05	0.02 - 0.03
Clair	0.05 - 0.10	0.03 - 0.07
Un peu poussiéreux	0.10 - 0.25	0.07 - 0.20
Poussiéreux	0.25 - 0.5	0.20 - 0.40
Extrêmement poussiéreux	> 0.5	> 0.4



Notez que les valeurs **AOD du rouge** sont généralement inférieures à celles du **vert**. Cela est dû au fait que les aérosols classiques diffusent la **lumière verte** plus efficacement que la **lumière rouge**.

# PRINCIPE DE FONCTIONNEMENT D'UN PHOTOMETRE SOLAIRE

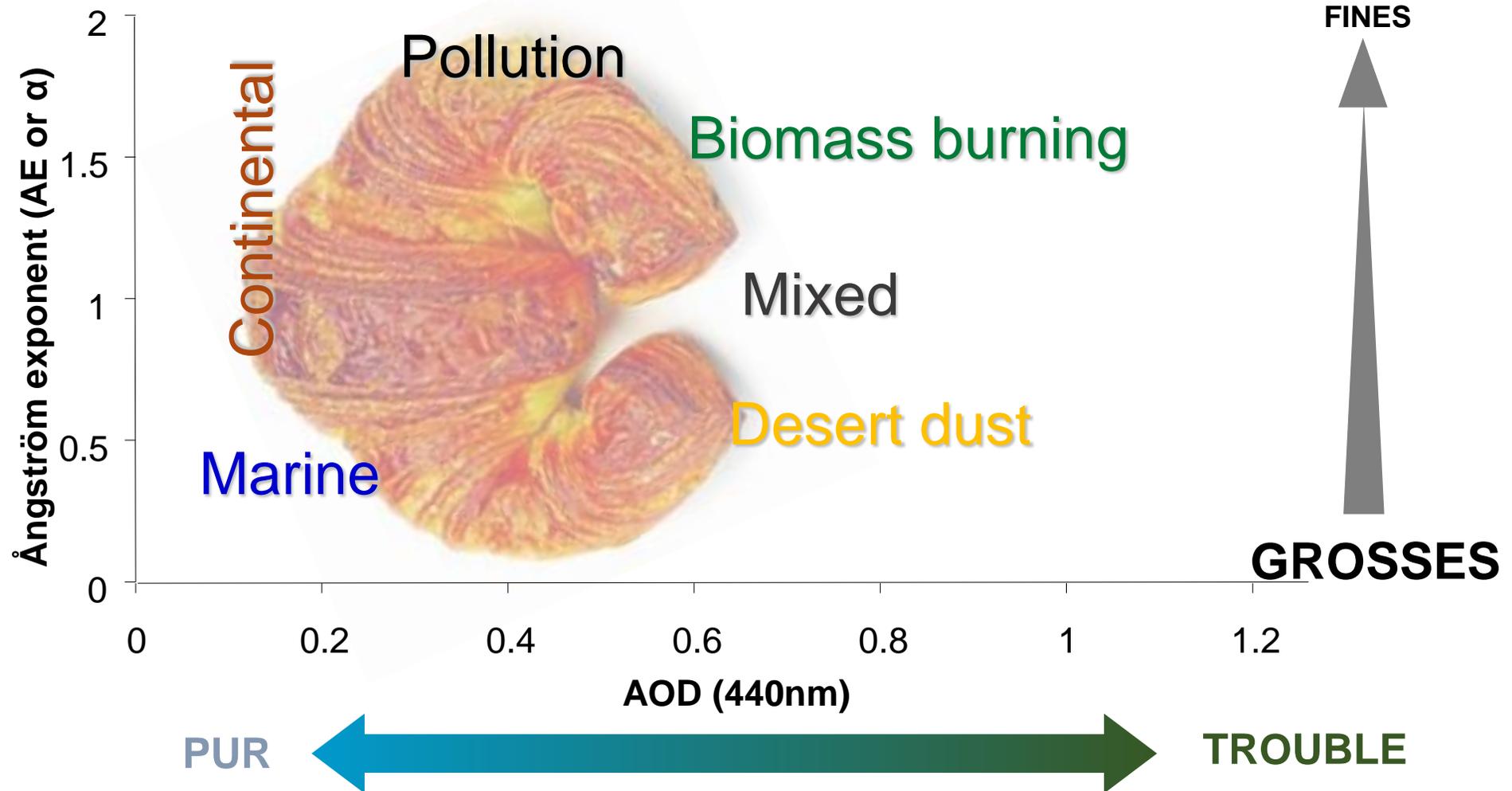
## Type d'aérosol avec diagramme AOD- $\alpha$



Le paramètre AE donne des informations supplémentaires importantes pour connaître la taille et le type d'aérosol

# PRINCIPE DE FONCTIONNEMENT D'UN PHOTOMETRE SOLAIRE

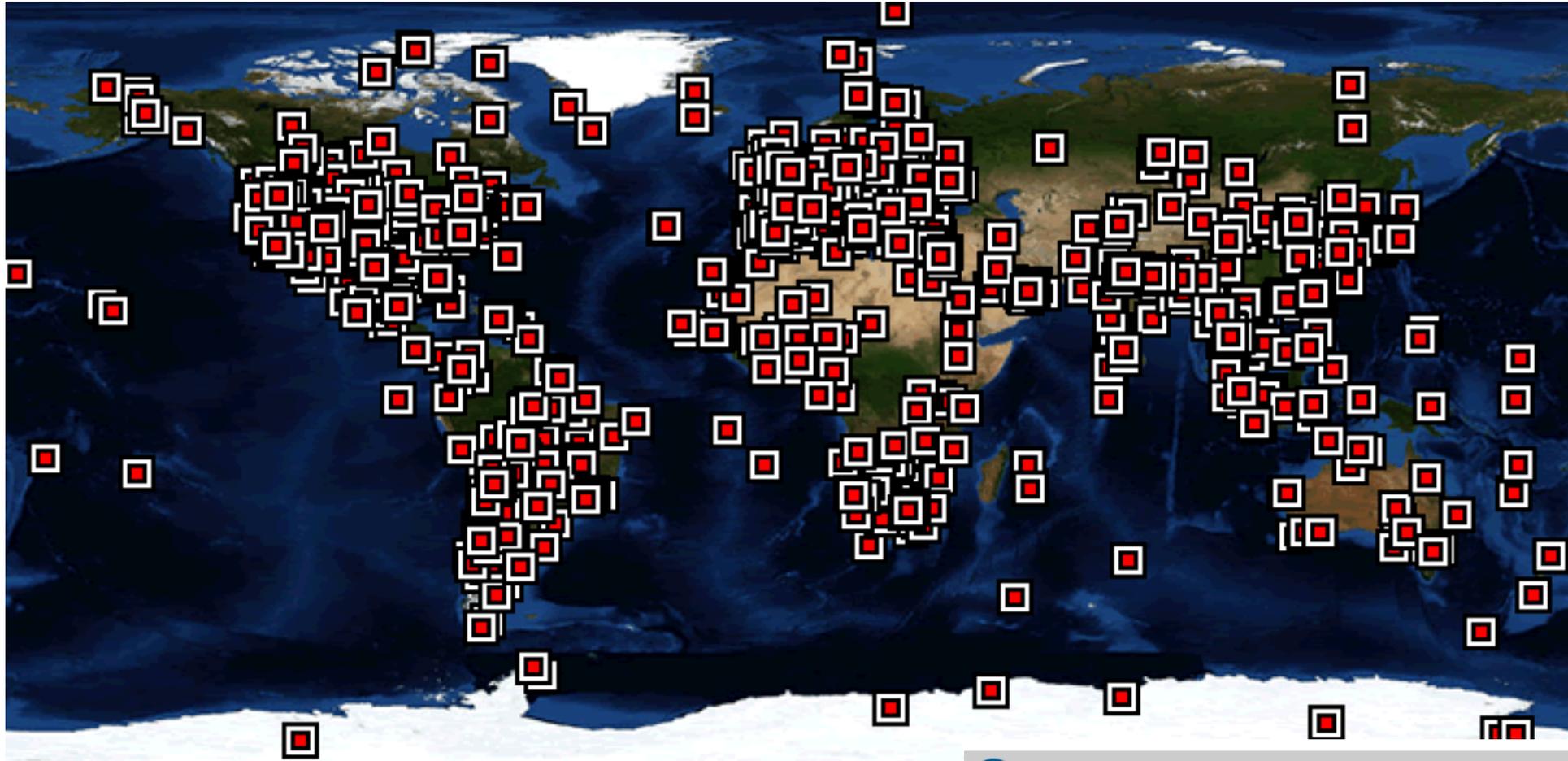
## Type d'aérosol avec diagramme AOD- $\alpha$



# RÉSEAUX DE SURVEILLANCE (Global): AERONET

## AERONET

<https://aeronet.gsfc.nasa.gov>



- \*\* Surveillance des aérosols à l'échelle mondiale + validation par satellite
- \*\* Plus de 500 stations dans le monde (mesures du soleil et de la lune)
- \*\* Hautement standardisé : instrumentation et traitement

 GODDARD SPACE FLIGHT CENTER

[+ Visit NASA.gov](#)

**AERONET**  
AEROSOL ROBOTIC NETWORK



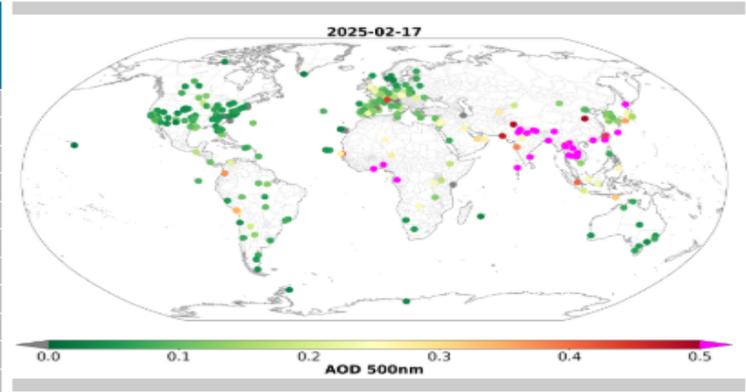
# RÉSEAUX DE SURVEILLANCE (Global): AERONET

**AERONET** <https://aeronet.gsfc.nasa.gov>



For receiving updates on AERONET - subscribe to the mailing list by sending an email to [aeronet-join@lists.nasa.gov](mailto:aeronet-join@lists.nasa.gov)

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- OPERATIONS
- PUBLICATIONS
- SITE INFORMATION
- STAFF
- SYSTEM DESCRIPTION



- AERONET DATA ACCESS**
- DATA VISUALIZATION**
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- AEROSOL OPTICAL DEPTH (v3)- SOLAR**
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  - Download All Sites

**About AERONET**

The AERONET (Aerosol RObotic Network) program is a federation of ground-based remote sensing aerosol networks established by NASA and PHOTONS (PHOTométrie pour le Traitement Opérationnel de Normalisation Satellitaire; Univ. of Lille 1, CNES, and CNRS-INSU) and greatly expanded by networks (e.g., RIMA, AeroSpan, AEROCAN, AEROSPAIN, NEON, and CARSNET) and collaborators from national agencies, institutes, universities, individual scientists, and partners. For more than 25 years, the project has provided long-term, continuous, and readily accessible remote domain database of aerosol optical, microphysical and radiative properties for aerosol research and characterization, validation of satellite retrievals, and synergism with other databases. The network imposes standardization of instruments, calibration, processing and distribution.

AERONET collaboration provides globally distributed observations of spectral aerosol optical depth (AOD), inversion products, and precipitable water in diverse aerosol regimes. Version 3 AOD data are computed for three data quality levels: Level 1.0 (unscreened), Level 1.5 (cloud-screened and quality-controlled), and Level 2.0 (quality-assured). Inversions, precipitable water, and other AOD-dependent products are derived from these levels and may implement additional quality checks.

The AERONET Ocean Color (AERONET-OC) is another component of the AERONET program, providing the additional capability of measuring the radiance emerging from the sea (i.e., normalized water-leaving radiance) with sun-photometers installed on offshore platforms like lighthouses, oceanographic and oil towers. Similarly, the Maritime Aerosol Network (MAN) component of the AERONET program provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the World's Oceans. The Solar Radiation Network (SolRad-Net) provides high-frequency solar flux measurements and is collocated with AERONET sites.

The processing algorithms have evolved from Version 1.0 to Version 2.0 and now Version 3.0. The Version 3 databases are available from the AERONET and PHOTONS web sites. Version 2 data may be downloaded from the web site through 2018 and thereafter upon special request. New AERONET products will be released as new measurement techniques and algorithms are adopted and validated by the AERONET research community. The AERONET website also provides AERONET-related news, a description of research and operational activities, data visualization, web services, related Earth Science links, and an AERONET staff directory.

[Read More](#)

**Announcements**

29 October 2024  
Time Shift QA - Improved Algorithm Reduces Data Elimination for Australian Sites



For receiving updates on AERONET - subscribe to the mailing list by sending an email to [aeronet-join@lists.nasa.gov](mailto:aeronet-join@lists.nasa.gov)

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- Data Display
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- V3 Data Display
- V3 Web Service
- Download All Sites

AERONET Aerosol Optical Depth Data Display Interface **Version 3 Direct Sun Algorithm**

Level 1.0 Data:  
The following data are unscreened and may not have final calibration applied.

Active Status: All | Total Data (Years): All | AOD Level: Level 1.0 | Year: All Years | Month: | Day: | Reset

Search for AERONET site: Search

AAOT(45.3N, 12.5E) [Venice, Italy]	AAQ10_MY_Banting(2.8N, 101.6E) [Liu Qiu, Taiwan]	AAQ12_Kx_Xiaofuqu(22.3N, 120.4E) [Liu Qiu, Taiwan]
AAQ13_Kx_Wanluan(22.6N, 120.6E) [Wanluan, Taiwan]	AAQ1_SK_Osan(37.1N, 127.0E)	AAQ2_SK_Suwon(37.3N, 127.0E)
AAQ3_SK_CBNU(36.6N, 127.5E)	AAQ4_SK_Jincheon(36.9N, 127.4E)	AAQ5_SK_Anungju(37.0N, 127.3E)
AAQ6_PH_Meycauayan(14.8N, 121.0E)	AAQ7_PH_Bilibid(14.4N, 121.0E)	AAQ8_MY_Kiang(3.0N, 101.4E)
AAQ9_MY_Cheras(3.1N, 101.7E)	AAU_ET(9.0N, 38.7E) [Addis Ababa, Ethiopia]	AAU_Jackros_ET(9.0N, 38.8E) [Addis Ababa, Ethiopia]
Abisko(68.3N, 18.6E) [Abisko, Sweden]	Abraços_Hill(10.8S, 62.4W) [Abraços Hill, Brazil]	Abu_Al_Bukhoosh(25.5N, 53.1E) [Abu Al Bukhoosh]
Abu_Dhabi(24.5N, 54.3E) [Abu Dhabi, United Arab Emirates]	Adelaide_Site_7(34.7S, 138.7E) [Adelaide, Australia]	Agen_Palissy(44.2N, 0.6E) [Agen, France]
AgiaGalini_AUTH(35.1N, 24.7E) [Agia Galini, Crete, Greece]	AgiaMarina_Xylatou(35.0N, 33.1E) [Nicosia, Cyprus]	Agoufou(15.3N, 1.5W) [Agoufou, North Mali]
Agri_School(10.1S, 56.2W) [Almeria, Spain]	AguaMarga(36.9N, 2.0W) [Almeria, Spain]	Aguas_Emendedas(15.6S, 47.7W)
AguaSalientes(21.7N, 102.3W)	Ah_De_Cara(37.1N, 3.4W) [Ah de Cara, Spain]	Ahmedabad(23.0N, 72.5E) [Ahmedabad, India]
Aire_Abdour(43.7N, 0.2E)	Al_Ain(24.2N, 55.7E)	Al_Dhafra(24.3N, 54.5E)
Al_Khaznah(24.2N, 55.1E)	Al_Osai(24.1N, 53.0E) [Al Osa, United Arab Emirates]	Albany_Oregon(44.6N, 123.1W)
Alberque_UGR(37.1N, 3.4W) [Granada, Spain]	Alboran(35.6N, 3.4W) [Alboran, Spain]	Albuquerque(35.1N, 106.5W)

liste des stations dans le monde

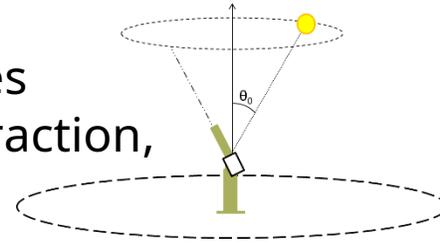
# RÉSEAUX DE SURVEILLANCE (Global): AERONET

## Produits AERONET

**Direct SUN-MOON:** Aerosols Optical Depth –**AOD**–, Angstrom Exponent –**AE**–, Single Deconvolution algorithm –**SDA**– pour les aérosols de mode fin/grossier, aérosols de mode fin SDA



**Inversion SUN-SKY:** Distribution des tailles d'aérosols, SSA, indice de réfraction,



**Data Display Controls**

AERONET AOD Data Product:  
 Water Vapor  
 440-870 Angstrom  
 SDA Fine/Coarse AOD  
 SDA Fine Mode Fraction

AOD Level (2024):  Level 1.0  Level 1.5  Level 2.0

Data Format:  All points  Daily averages

Triplet Variability (All Points Only):  Off  On

Related Product Availability for Tamanrasset\_INM (select each day below):  
 Show Terra MODIS  
 Show Aqua MODIS  
 Show VIIRS  
 Show Diagnostic Charts

Choose year: 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Choose month of 2024: JAN FEB MAR APR MAY JUN JUL AUG SEP

Choose day of SEP 2024: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

**AOD Level 1.5 data from SEP of 2024**  
 Tamanrasset\_INM , N 22.790, E 5.530, Alt 1377 m, PI : Sidi\_Baika and Africa\_Barreto, baika1971@gmail.com  
 Level 1.5 AOD; Data from SEP 2024

**AOD Level 1.5 data from SEP 14 of 2024**  
 Tamanrasset\_INM , N 22.790, E 5.530, Alt 1377 m, PI : Sidi\_Baika and Africa\_Barreto, baika1971@gmail.com  
 Level 1.5 AOD; Data from 14 SEP 2024

**AOD Level 1.5 data from SEP 14 of 2024**  
 Tamanrasset\_INM , N 22.790, E 5.530, Alt 1377 m, PI : Sidi\_Baika and Africa\_Barreto, baika1971@gmail.com  
 Size Distribution Almuantar Level 1.5; 14 SEP 2024

**AOD Level 1.5 data from SEP 14 of 2024**  
 Tamanrasset\_INM , N 22.790, E 5.530, Alt 1377 m, PI : Sidi\_Baika and Africa\_Barreto, baika1971@gmail.com  
 SSA Almuantar Level 1.5; 14 SEP 2024

**AERONET DOWNLOAD**  
 AOD Level 1.0  
 AOD Level 1.5  
 SDA Level 1.0  
 SDA Level 1.5  
 More AERONET Downloadable Products...

**Data Display Controls**

AERONET Inversion Data Product:  
 Size Distribution  
 Refractive Index (Real)  
 Refractive Index (Imaginary)  
 Absorption Optical Depth

Sky Scan Scenario:  Almuantar  Hybrid

Inversion Level (2024):  Level 1.5  Level 2.0

Related Product Availability for Tamanrasset\_INM (select each day below):  
 Show Terra MODIS  
 Show Aqua MODIS  
 Show VIIRS  
 Show Diagnostic Charts

Choose year: 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Choose month of 2024: JAN FEB MAR APR MAY JUN JUL AUG SEP

Choose day of SEP 2024: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

**Almuantar Level 1.5 data from SEP 14 of 2024**  
 Tamanrasset\_INM , N 22.790, E 5.530, Alt 1377 m, PI : Sidi\_Baika and Africa\_Barreto, baika1971@gmail.com  
 Size Distribution Almuantar Level 1.5; 14 SEP 2024

**Almuantar Level 1.5 data from SEP 14 of 2024**  
 Tamanrasset\_INM , N 22.790, E 5.530, Alt 1377 m, PI : Sidi\_Baika and Africa\_Barreto, baika1971@gmail.com  
 SSA Almuantar Level 1.5; 14 SEP 2024

**AERONET DOWNLOAD**  
 Level 1.5  
 Level 2.0  
 More AERONET Downloadable Products...

[Return to the World Map](#)

[Return to the World Map](#)

**AOD levels:** level 1.0 Données brutes (non filtrées)

level 1.5 Données préliminaires corrigées

level 2.0 Données validées (Ils peuvent ne pas exister et apparaître 1 à 2 ans après la mesure)

[https://aeronet.gsfc.nasa.gov/cgi-bin/data\\_display\\_inv\\_v3?site=Banizoumbou&nachal=0&year=2025&aero\\_water=0&level=2&if\\_day=0&if\\_err=0&place\\_code=10&DATA\\_TYPE=76&year\\_or\\_month=1](https://aeronet.gsfc.nasa.gov/cgi-bin/data_display_inv_v3?site=Banizoumbou&nachal=0&year=2025&aero_water=0&level=2&if_day=0&if_err=0&place_code=10&DATA_TYPE=76&year_or_month=1)

bin/data\_display\_inv\_v3?site=Banizoumbou&nachal=0&year=2025&aero\_water=0&level=2&if\_day=0&if\_err=0&place\_code=10&DATA\_TYPE=76&year\_or\_month=1

# Produits AERONET (Niger, Banizoumbou)

## Banizoumbou (Niger) depuis 1995!!!!

### Produits AERONET Jan-Fev 2025

**AEROSOL OPTICAL DEPTH**

+ AEROSOL OPTICAL DEPTH + AEROSOL INVERSIONS + SOLAR FLUX + OCEAN COLOR + MARITIME AEROSOL

For receiving updates on AERONET - subscribe to the mailing list by sending an email to [aeronet-join@lists.nasa.gov](mailto:aeronet-join@lists.nasa.gov)

AERONET Aerosol Optical Depth Data Display Interface Version 3 Direct Sun Algorithm

Level 1.0 Data:  
The following data are unscreened and may not have final calibration applied.

Active Status: All | Total Data (Years): All | AOD Level: Level 1.0 | Year: All Years | Month: | Day: | Reset

Latitude: 23.134934, Longitude: 25.539144

Search for AFRONET site: Search

**AERONET DATA ACCESS**

**DATA VISUALIZATION**

- + Synergy Tool
- + Map Explorer

**AEROSOL OPTICAL DEPTH (V3)- SOLAR**

- + Data Display
- + Download Tool
- + Download All Sites
- + Climatology Tables
- + Web Service

**AEROSOL INVERSIONS (V3)**

- + Data Display
- + Download Tool
- + Download All Sites
- + Web Service

**SOLAR FLUX**

- + Data Display

**OCEAN COLOR**

- + V3 Data Display

**Data Display Controls**

AERONET AOD Data Product:  
AOD  
Water Vapor  
440-870 Angstrom  
SDA Fine/Coarse AOD  
SDA Fine Mode Fraction

AOD Level (2025):  Level 1.0  Level 1.5  Level 2.0

Data Format:  All points  Daily averages

Triplet Variability (All Points Only):  Off  On

**Related Product Availability for Banizoumbou (select each day below):**

- Show Terra MODIS
- Show Aqua MODIS
- Show VIIRS
- Show Diagnostic Charts

SELECT CHARTS FOR LARGER IMAGES

Choose year: 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

Choose month of 2025: JAN FEB

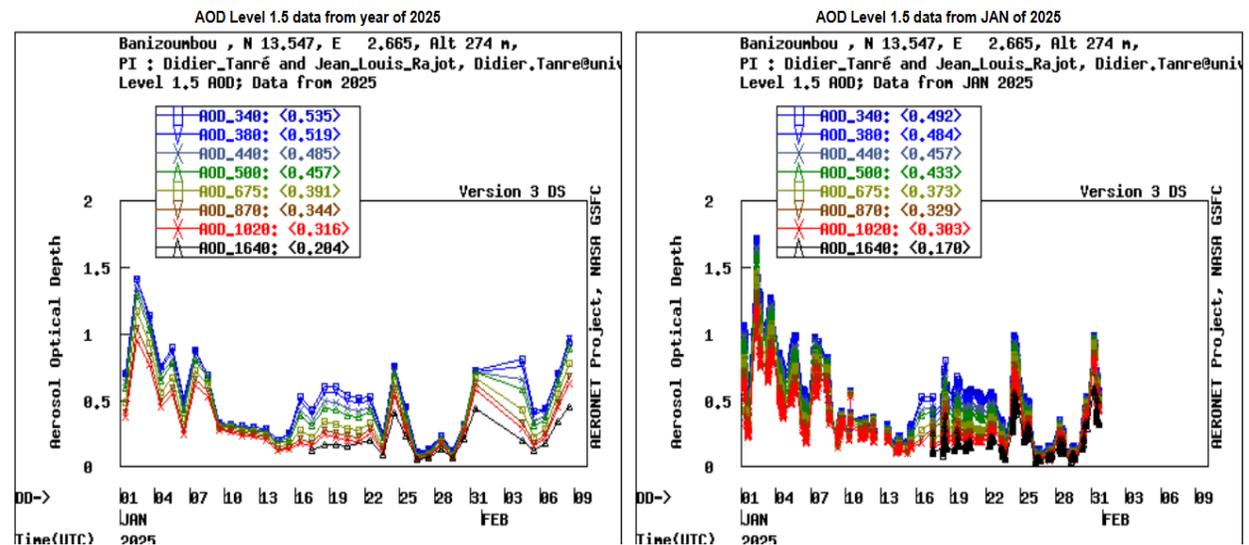
Choose day of JAN 2025:

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31					

## Stations proches de Niger

Les rouges sont des stations actives:

- Banizoumbou (Niger)
- Zinder Airport (Niger)
- Cinzana (Mali)
- Tamanrasset (Argelia)



[https://aeronet.gsfc.nasa.gov/cgi-bin/data\\_display\\_aod\\_v3?site=Banizoumbou&nachal=2&level=1&place\\_code=10](https://aeronet.gsfc.nasa.gov/cgi-bin/data_display_aod_v3?site=Banizoumbou&nachal=2&level=1&place_code=10)

# Produits AERONET (Niger, Banizoumbou)

## Produits AERONET Jan-Fev 2025: Angstrom Exponent

- + OPERATIONS
- + PUBLICATIONS
- + SITE INFORMATION
- + STAFF
- + SYSTEM DESCRIPTION

### AERONET DATA ACCESS

#### DATA VISUALIZATION

- + Synergy Tool
- + Map Explorer

#### AEROSOL OPTICAL DEPTH (V3)-SOLAR

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- + Download Tool
- + Download All Sites
- + Climatology Tables
- + Web Service

#### AEROSOL INVERSIONS (V3)

- + Data Display
- + Download Tool
- + Download All Sites
- + Web Service

#### SOLAR FLUX

- + Data Display

#### OCEAN COLOR

- + V3 Data Display

**Data Display Controls**

**AERONET AOD Data Product:**  
 AOD  
 Water Vapor  
 440-870 Angstrom  
 SDA Fine/Coarse AOD  
 SDA Fine Mode Fraction

**AOD Level (2025):**  Level 1.0  Level 1.5  Level 2.0  
**Data Format:**  All points  Daily averages  
**Triplet Variability (All Points Only):**  Off  On

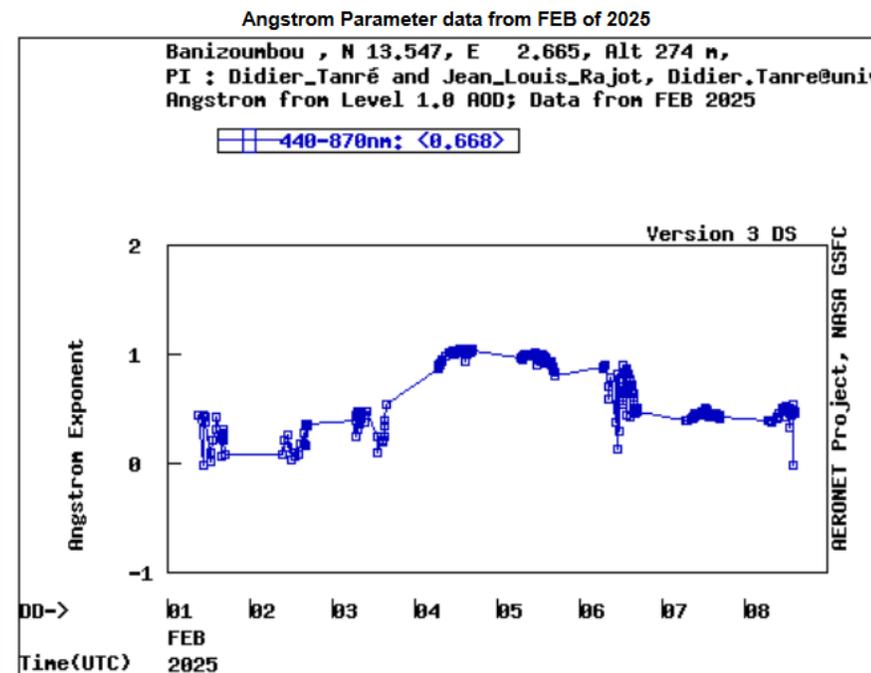
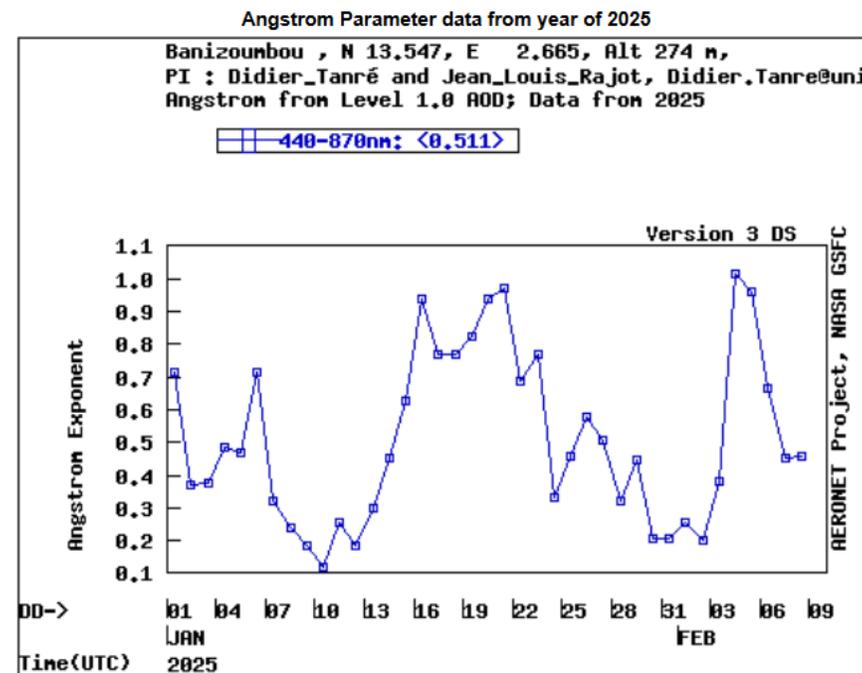
**Related Product Availability for Banizoumbou** (select each day below):

- [Show Terra MODIS](#)
- [Show Aqua MODIS](#)
- [Show VIIRS](#)
- [Show Diagnostic Charts](#)

SELECT CHARTS FOR LARGER IMAGES

Choose year :	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	2019	2020	2021	2022	2023	2024	2025					
Choose month of 2025 :	JAN	FEB										

Choose day of FEB 2025												
1	2	3	4	5	6	7	8	9	10	11	12	
13	14	15	16	17	18	19	20	21	22	23	24	
25	26	27	28									



# Produits AERONET (Niger, Banizoumbou)

Produits AERONET Jan-Fev 2025: contribution du mode fin et grossier à l'AOD totale

- + OPERATIONS
- + PUBLICATIONS
- + SITE INFORMATION
- + STAFF
- + SYSTEM DESCRIPTION

## AERONET DATA ACCESS

### DATA VISUALIZATION

- + Synergy Tool
- + Map Explorer

### AEROSOL OPTICAL DEPTH (V3)- SOLAR

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- + Climatology Tables
- + Web Service

### AEROSOL INVERSIONS (V3)

- + Data Display
- + Download Tool
- + Download All Sites
- + Web Service

### SOLAR FLUX

- + Data Display

### OCEAN COLOR

- + V3 Data Display

Data Display Controls

**AERONET AOD Data Product:**  
 AOD  
 Water Vapor  
 440-870 Angstrom  
 SDA Fine/Coarse AOD  
 SDA Fine Mode Fraction

**AOD Level (2025):**  Level 1.0  Level 1.5  Level 2.0  
**Data Format:**  All points  Daily averages  
**Triplet Variability (All Points Only):**  Off  On

**Related Product Availability for Banizoumbou** (select each day below):

- [Show Terra MODIS](#)
- [Show Aqua MODIS](#)
- [Show VIIRS](#)
- [Show Diagnostic Charts](#)

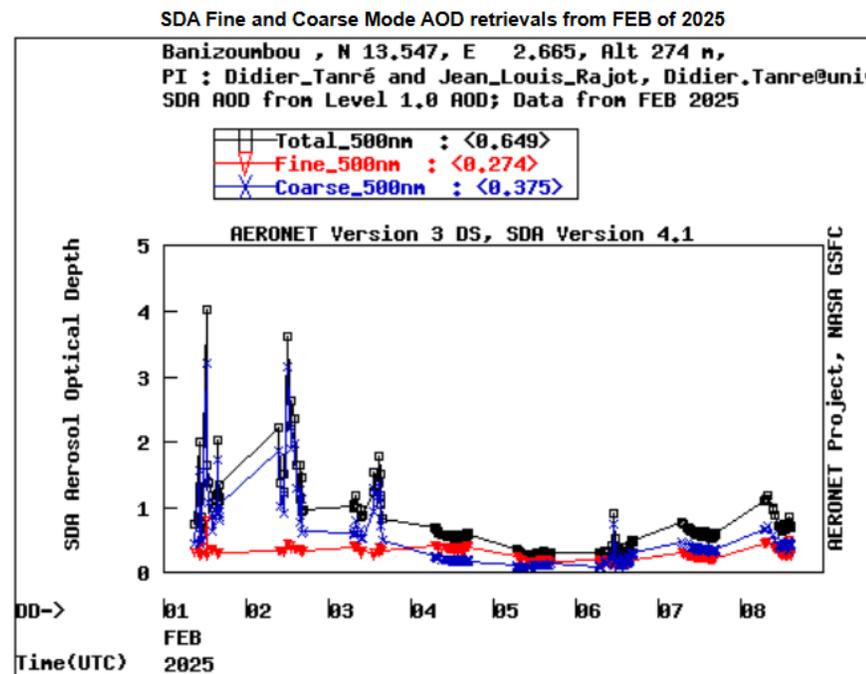
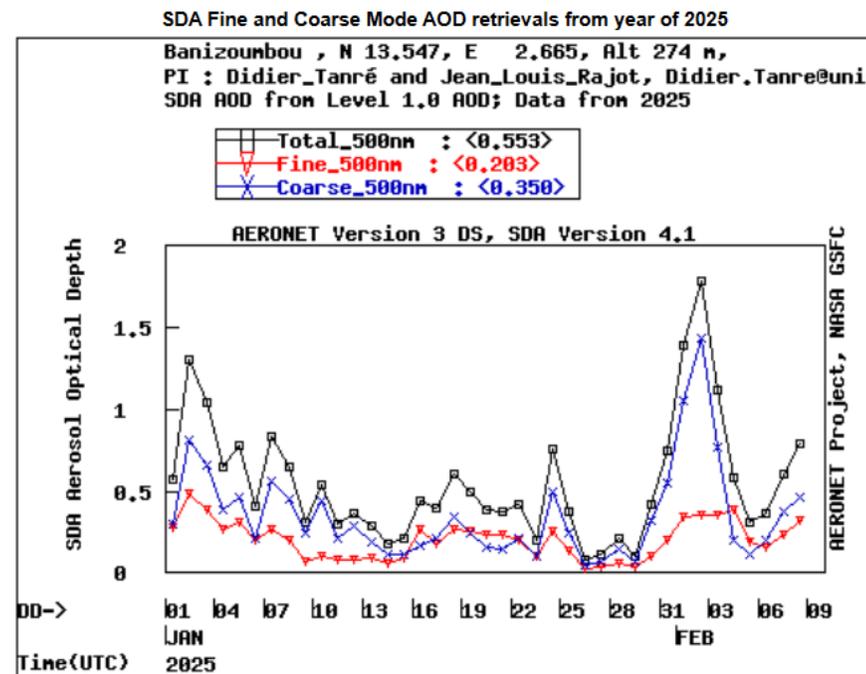
SELECT CHARTS FOR LARGER IMAGES

Choose year :	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	2019	2020	2021	2022	2023	2024	2025					

Choose month of 2025 : JAN FEB

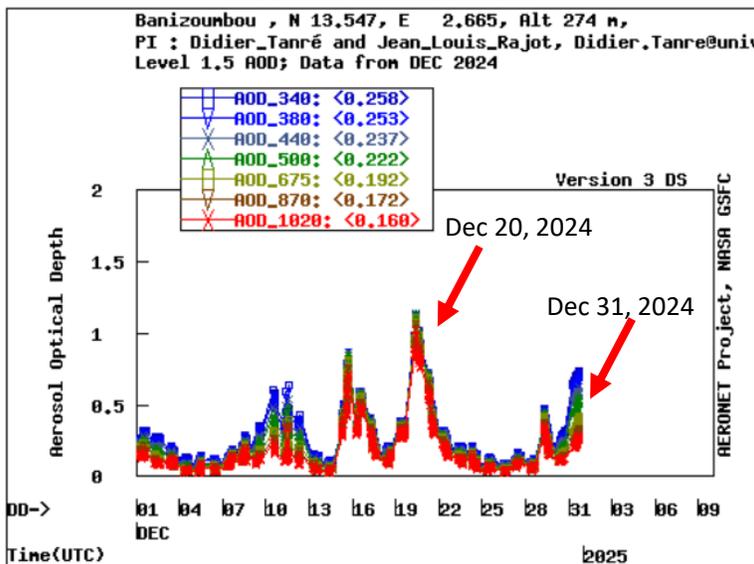
Choose day of FEB 2025

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28								

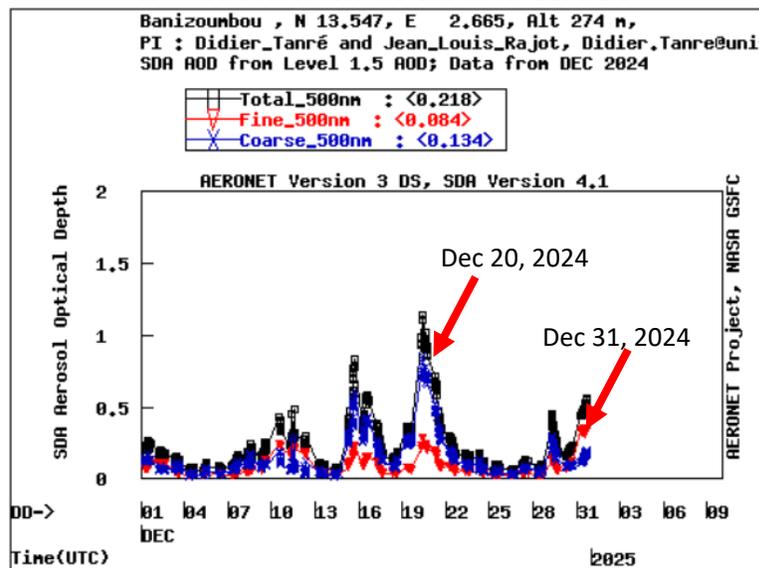


# Produits AERONET (Niger): exemple de cas

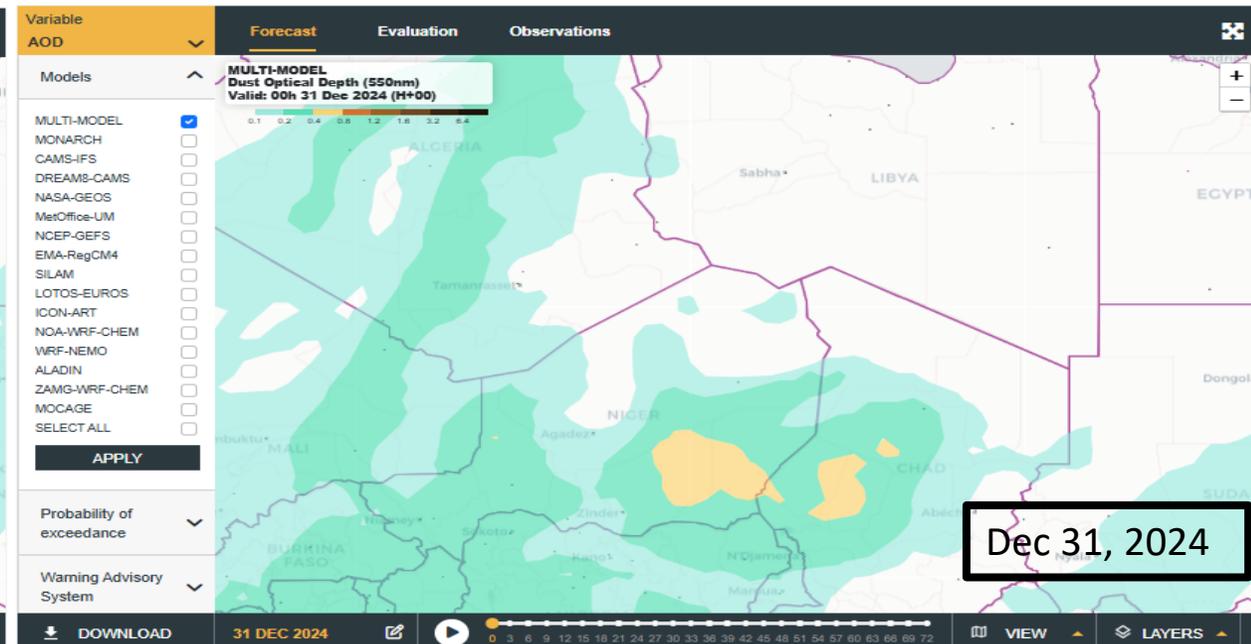
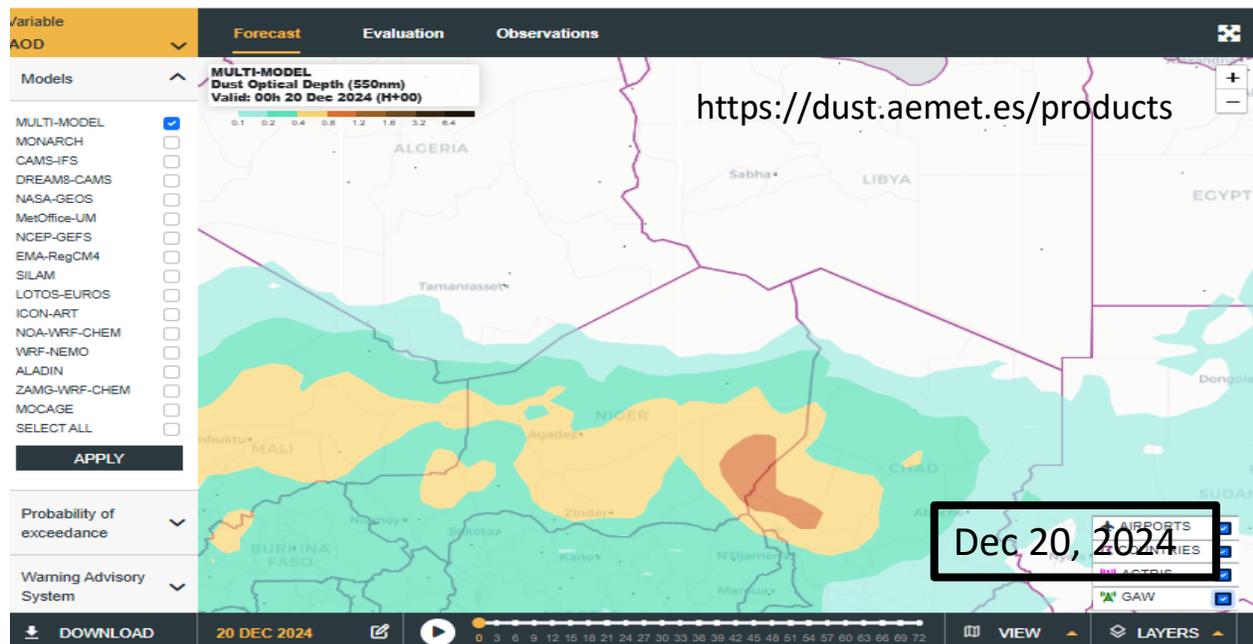
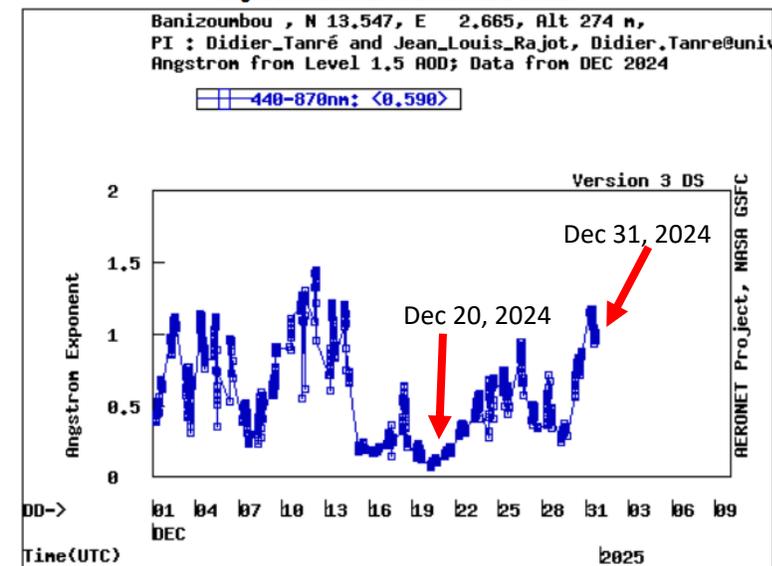
AOD Level 1.5 data from DEC of 2024



SDA Fine and Coarse Mode AOD retrievals from DEC of 2024



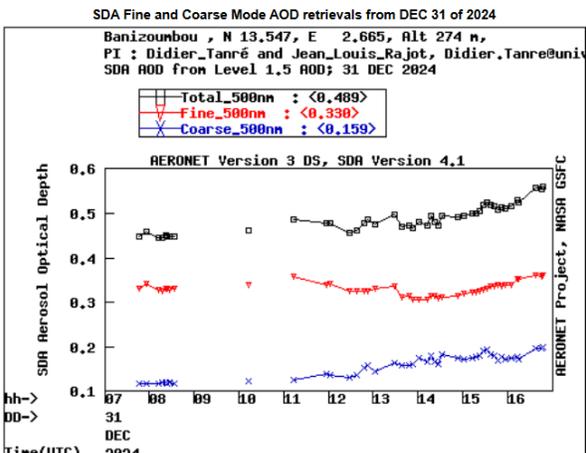
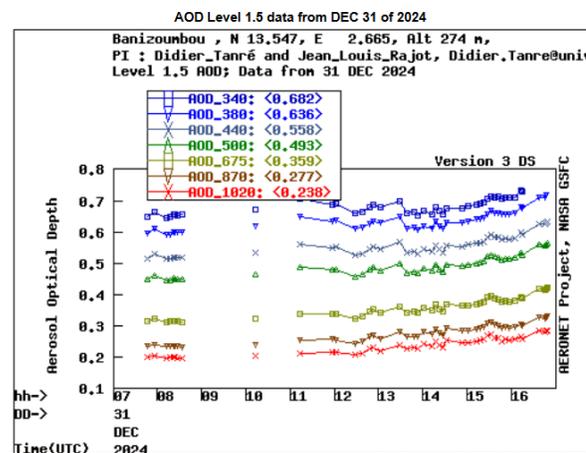
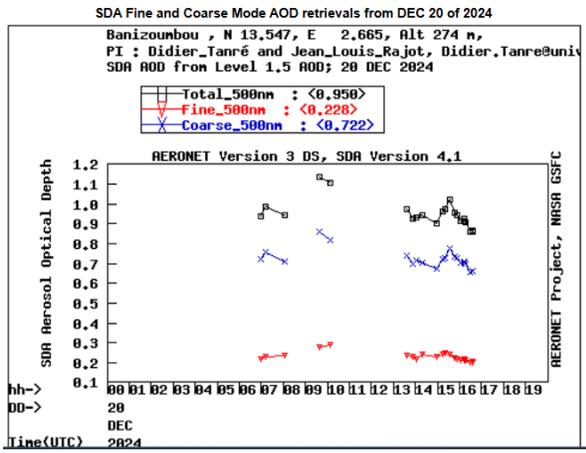
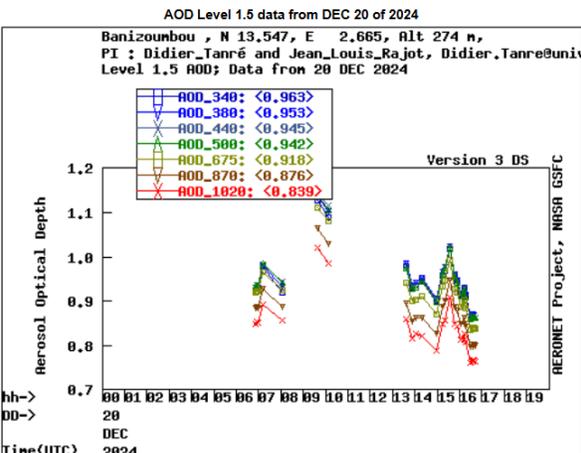
Angstrom Parameter data from DEC of 2024



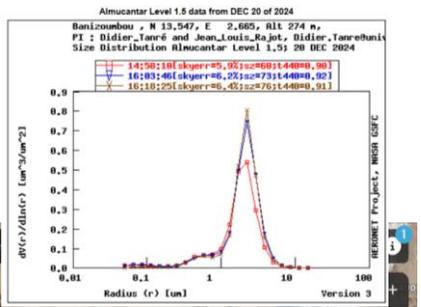
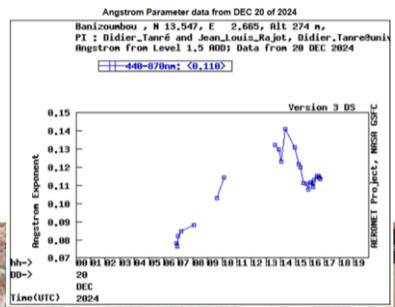
# Produits AERONET (Niger): exemple de cas

Dec 20, 2024

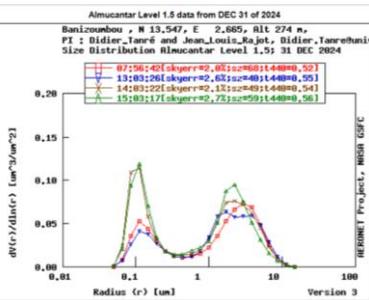
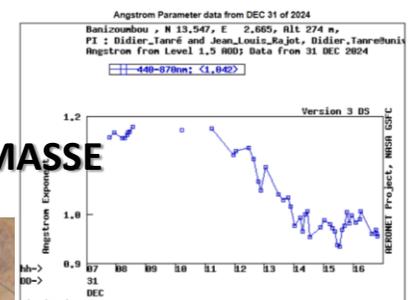
Dec 31, 2024



PURE POUSSIÈRE



POUSSIÈRE  
+  
COMBUSTION DE BIOMASSE



# CAPTEURS À FAIBLE COÛT : photomètres portables Calitoo et Microtops

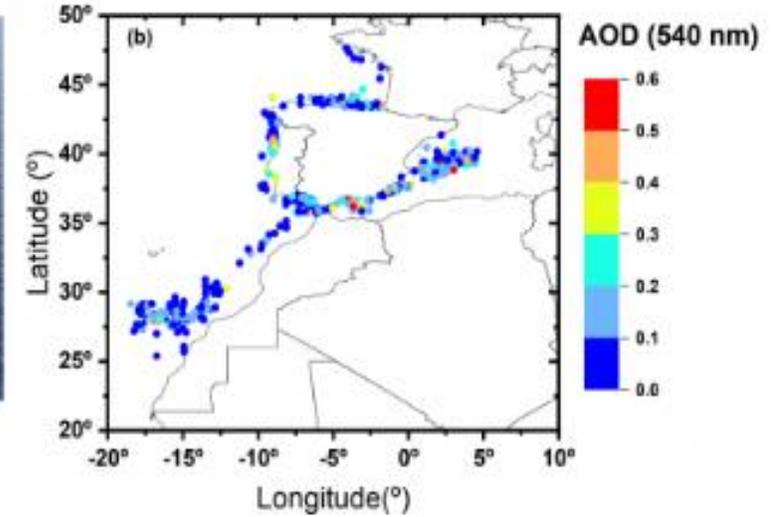
Aerosol retrievals derived from a low-cost Calitoo sun-photometer taken on board a research vessel\*

Rosa D. García<sup>a,b</sup>, África Barreto<sup>b,c,\*</sup>, Celia Rey<sup>b</sup>, Eugenio Fraile-Nuez<sup>d</sup>, Alba González-Vega<sup>d</sup>, Sergio F. León-Luis<sup>a,b</sup>, Antonio Alcantara<sup>b</sup>, A. Fernando Almansa<sup>e,b</sup>, Carmen Guirado-Fuentes<sup>b,c,f</sup>, Pablo González-Sicilia<sup>b</sup>, Victoria E. Cachorro<sup>c</sup> and Frederic Bouchard<sup>g</sup>

\*Submitted Atmos. Environ, (2024)



6 ans d'AOD au dessus de l'océan



## AERONET MARITIME AEROSOL NETWORK

+ AEROSOL OPTICAL DEPTH + AEROSOL INVERSIONS + SOLAR FLUX + OCEAN COLOR  
For receiving updates on AERONET - subscribe to the mailing list by sending an email to aeronet.

- +Home
- +AERONET Home
- Maritime Aerosol
- + AEROSOL/FLUX NETWORKS
- + COLLABORATORS
- + DATA
- + NASA PROJECTS
- + PUBLICATIONS
- + STAFF
- + SYSTEM DESCRIPTION

### AERONET DATA ACCESS

- DATA VISUALIZATION
- + Synergy Tool
- + Map Explorer

MARITIME AEROSOL NETWORK (MAN) - Version 3

#### Announcement

- 2 September 2022 - MAN data have been updated to Version 3

The Maritime Aerosol Network (MAN) component of AERONET provides ship-based measurements from the Microtops II sun photometers. These data provide an alternative to establish validation points for satellite and aerosol transport instruments have been deployed periodically on ships of opportunity and research properties over the World Oceans.

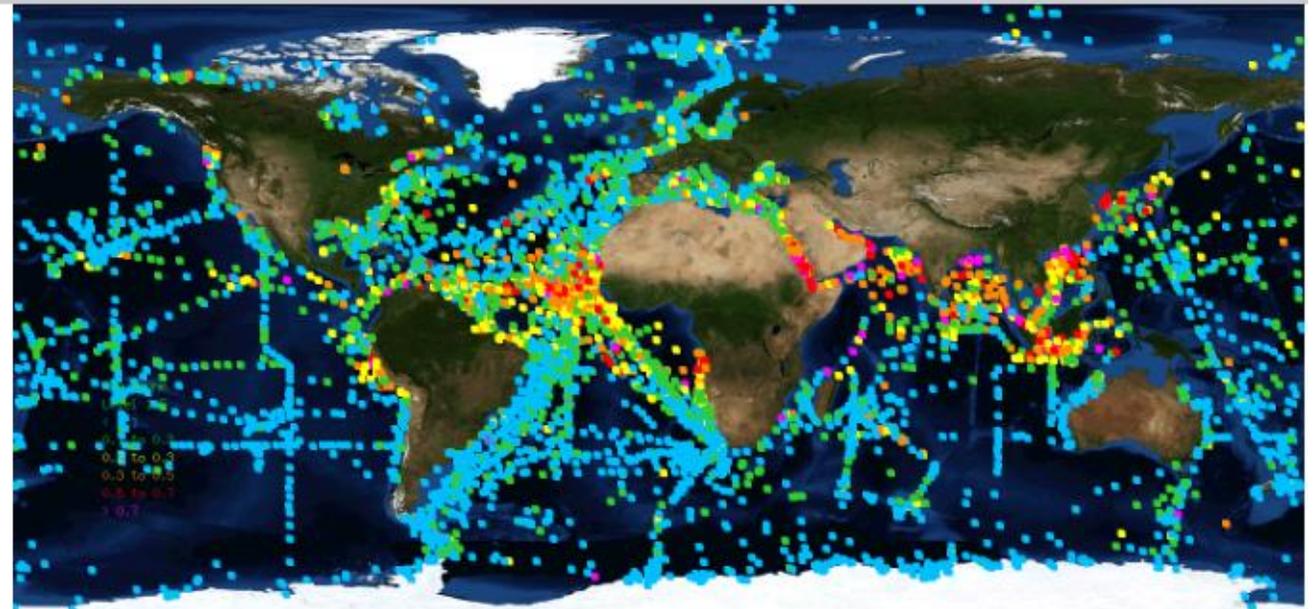


Microtops instruments currently in the network may have one of two configurations: 340, 440, 500, 675, 870, and 936nm. In addition, the temperature and pressure sensors as well as time and geographical position using a GPS. They are calibrated at the NASA Goddard Space calibration facility via a transfer calibration Microtops and the master Cimel sun photometer traceable to a Langley calibration of Mauna Loa, Hawaii. In general, the estimated optical depth in each channel does not exceed is slightly higher than the uncertainty of AEI instruments.

Additional information on data processing and quality may be found by choosing column.



## CRUISES



# 5.

## État des observations d'AQ en Afrique



## Surveillance de la qualité de l'air en Afrique

Faits marquants : urbanisation rapide, croissance démographique et inégalités sociales.

- ❖ En Afrique, l'AQ est un facteur majeur de décès prématurés et d'autres problèmes de santé.
- ❖ L'Afrique est actuellement le continent le moins urbanisé, mais c'est la région qui connaît le taux d'urbanisation le plus rapide au monde (inégalités et « urbanisation de la pauvreté »).L
- ❖ a pauvreté persistante et la pollution de l'air sont étroitement liées (inégalités sociales - dégradation de l'environnement).
- ❖ Stade de développement économique dépendant du statut de l'AQ : **économies inférieures** (manque de capacité de gestion de la qualité de l'air), **économies moyennes inférieures** (Sénégal, Kenya, Ghana, Nigéria, Zimbabwe, Tanzanie ou Mozambique avec une surveillance, une couverture et une fiabilité partielles) aux **économies émergentes** (Égypte ou Afrique du Sud avec un système de surveillance des données de qualité de l'air relativement complet).

# ÉTAT DES OBSERVATIONS D'AQ EN AFRIQUE

## Surveillance de la qualité de l'air en Afrique

Table 1.3: Synopsis of country AQM capability

Country	Key pollutants	Sulphur content of diesel [ppm]†	Inspection & maintenance for mobile sources	Emissions inventory	Routine monitoring	Health impact assessment	Projects or plans with AQ benefit ongoing	Estimated stage of air quality management
Benin	SO <sub>2</sub> , NO <sub>x</sub> , NO <sub>2</sub> , O <sub>3</sub> , CO, HCs, PM	5,000	No	No	No	Two studies	Yes	Early*
Botswana	SO <sub>2</sub> , NO <sub>x</sub> , NO <sub>2</sub> , O <sub>3</sub> , CO, HCs	500	No	Yes, but incomplete	Yes	Few qualitative studies	No	Intermediate**
Burkina Faso	PM, SO <sub>2</sub> , HCs, NO <sub>x</sub> , SO <sub>2</sub>	5,000	No	Yes, but elementary	No	No	Yes	Early*
Burundi	Pesticides, Persistent Organic Pollutants, Pb	5,000	No	No	No	No	No	Absent <sup>†</sup>
Cameroon	PM, CO, HCs, NO <sub>x</sub> , SO <sub>2</sub>	5,000	Yes	No	No	No	No	Initial <sup>†</sup>
Congo-Brazzaville	PM, CO, HCs, NO <sub>x</sub>	10,000	No	No	No	No	No	Absent <sup>†</sup>
Congo-Kinshasa	PM, SO <sub>2</sub> , NO <sub>2</sub> , CO, HCs	3,500	No	No	No	No	Yes	Initial <sup>†</sup>
Ethiopia	PM <sub>10</sub> , CO, SO <sub>2</sub> , O <sub>3</sub>	10,000	No	No, but source apportionment for PM <sub>10</sub>	No, only campaign	No	No	Early*
Gabon	PM, CO, HCs, NO <sub>x</sub> , SO <sub>2</sub>	8,000	No	No	No	No	No	Absent <sup>†</sup>
Ghana	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , CO, PM <sub>10</sub> , manganese	5,000	In progress	No	Yes	Three studies	Yes	Advanced <sup>†</sup>
Guinea	PM <sub>10</sub> , PM <sub>2.5</sub> , NO <sub>2</sub> , SO <sub>2</sub> , formaldehyde, benzene	5,000	No	No	No	No	No	Absent <sup>†</sup>
Kenya	PM, CO, HCs, NO <sub>x</sub> , SO <sub>2</sub>	10,000	No	No	No	No	Yes	Initial <sup>†</sup>
Liberia	PM, CO, NO <sub>x</sub> , SO <sub>2</sub>	5,000	No	No	No	No	No	Absent <sup>†</sup>
Madagascar	PM, CO, HCs, NO <sub>x</sub> , SO <sub>2</sub>	5,000	Yes, mobile sources	No	Yes	No	Yes	Intermediate**
Malawi	PM, SO <sub>2</sub> , CO, NO <sub>x</sub> , HCs	5,000	No	No	No	No	No	Absent <sup>†</sup>
Mali	PM, NO <sub>x</sub> , CO, HC, VOC, SO <sub>2</sub> , Pb	5,000	No	Yes, for transport	No	No	No	Initial <sup>†</sup>
Mauritius	PM, NO <sub>x</sub> , CO, SO <sub>2</sub>	2,500	No	No	No	No	Yes	Initial <sup>†</sup>

Country	Key pollutants	Sulphur content of diesel [ppm]	Inspection & maintenance for mobile sources	Emissions inventory	Routine monitoring	Health impact assessment	Projects or plans with AQ benefit ongoing	Estimated stage of air quality management
Mozambique	PM <sub>10</sub> , PM <sub>2.5</sub> , Black Carbon, SO <sub>2</sub> , NO <sub>x</sub> , CO <sub>2</sub> , O <sub>3</sub>	5,500	No	Being developed	No	No	Yes	Early*
Nigeria	CO <sub>2</sub> , CO, NO <sub>x</sub> , O <sub>3</sub> , SO <sub>2</sub> , TSP, PM <sub>10</sub>	5,000	No	Yes, of 1990	No, one non operational station	No	Yes	Early*
Rwanda	Not identified	5,000	No	No	No	No	No	Absent <sup>†</sup>
Senegal	PM <sub>10</sub> , PM <sub>2.5</sub> , CO	5,000	No	No	Being initialised	No	Yes	Initial <sup>†</sup>
South Africa	PM <sub>10</sub> , PM <sub>2.5</sub> , NO <sub>x</sub> , SO <sub>2</sub> , O <sub>3</sub> , CO, Pb	500	Yes	Yes	Yes	Yes	Yes	Comprehensive <sup>††</sup>
Swaziland	Not identified	500	No	Qualitative	No	No	Yes	Early*
Tanzania	PM, CO, NO <sub>2</sub> , SO <sub>2</sub> , O <sub>3</sub> , Pb	5,000	No	No	Yes	No	Yes	Early*
Togo	Not identified	5,000	No	Yes, initial	No	No	No	Initial <sup>†</sup>
Uganda	PM, CH <sub>4</sub> , H <sub>2</sub> S, NH <sub>3</sub> , dioxins and furans, HCs, NO <sub>x</sub> , SO <sub>x</sub> , re-suspended dust	5,000	No	No	No	No	Yes	Initial <sup>†</sup>
Zambia	SO <sub>2</sub> , NO <sub>2</sub> , PM, black smoke, dust, CO, CO <sub>2</sub> and odours	7,500	No	Yes, initial, in copper belt	Yes	No	Yes	Intermediate**
Zimbabwe	SO <sub>2</sub> , NO <sub>2</sub> , PM, CO, VOCs	5,000	Yes, for stationary sources	No	Yes	Anecdotal evidence	No	Intermediate**

† Source: PCFV (2007); † Absent = None of the topics addressed; † Initial Any one topic addressed; \* Early = Any two topics addressed; \*\* Intermediate = Any three topics addressed; † Advanced = Any four topics addressed; †† Comprehensive = All topics addressed.

# ÉTAT DES OBSERVATIONS D'AQ EN AFRIQUE

## Surveillance de la qualité de l'air dans les pays d'Afrique subsaharienne

**Table 1.4:** Tools that can be applied in SSA countries to enhance AQM capability

Country	Air quality standard setting	Initial Emissions inventory*	Routine monitoring**	Health impact assessment†
Benin	WHO guidelines	Rapid inventory assessment (RIA)	Hybrid network	More studies needed using REA
Botswana	National standards exist	Completion and update by RIA	Is being performed	Rapid epidemiological assessment (REA)
Burkina Faso		Completion and update by RIA	Hybrid network	
Burundi	WHO guidelines	Rapid inventory assessment		Hybrid network
Cameroon				
Congo-Brazzaville				
Congo-Kinshasa				
Ethiopia				
Gabon				
Ghana	National standards exist	Rapid inventory assessment	Is being performed	More studies needed
Guinea	WHO guidelines	Rapid inventory assessment	Hybrid network	Rapid epidemiological assessment
Kenya	Exist			
Liberia	WHO guidelines	Rapid inventory assessment	Hybrid network	Rapid epidemiological assessment
Madagascar				
Malawi				
Mali				
Mali	National standards proposed	Completion and update by RIA	Hybrid network	Rapid epidemiological assessment
Mauritius		Rapid inventory assessment		
Mozambique	WHO guidelines	Completion and update by RIA	Hybrid network	Rapid epidemiological assessment

\* RIA = Rapid Inventory Assessment; \*\* HN = Hybrid Network; † REA = Rapid Epidemiological Assessment

**Table 1.4 (continued):** Recommendation to enhance AQM capability

Country	Air quality standard setting	Initial Emissions inventory*	Routine monitoring**	Health impact assessment†
Nigeria	WHO guidelines	To be updated and amended by RIA	Hybrid network	Rapid epidemiological assessment
Rwanda		Rapid inventory assessment	Is being initialised	
Senegal				Hybrid network
Swaziland			Is being performed	
Tanzania				More studies needed
Togo		To be enhanced by RIA	Hybrid network	
Uganda		Rapid inventory assessment		
Zambia		To be amended for vehicles	Revamping or hybrid network	
Zimbabwe		Rapid inventory assessment	Is being performed	

\* RIA = Rapid Inventory Assessment; \*\* HN = Hybrid Network; † REA = Rapid Epidemiological Assessment



# ÉTAT DES OBSERVATIONS D'AQ EN AFRIQUE: South-Africa



**SAAQIS** South African Air Quality Information System



Mozambique

Antananarivo

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Swakopmund **Namibia**

**Botsuana**

Gaborone

Johannesburg

Maputo

**Swatini**

Bloemfontein

**Lesoto**

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# ÉTAT DES OBSERVATIONS D'AQ EN AFRIQUE: South-Africa



**SAAQIS** South African Air Quality Information System



Login



## Dynamic Tables - Dynamic Table

Station Name	Time	PM10 µg/m3	PM2.5 µg/m3	NO2 ppb	NOX ppb	NO ppb	SO2 ppb	O3 ppb	CO ppm	Benzene ppb	H2S ppb
Secunda	13/09/2024 21:00	67.107	23.151	12.37	14.062	1.692	3.385	32.166	0.35		6.213
Diepkloof-NAQI	13/09/2024 21:00										
PTA West	13/09/2024 21:00	70.43	45.109	0	0.011	0.04	7.634		3.426		
Delmas MP	13/09/2024 21:00	0.523		0	0	0		3.259	0.869		
Hendrina - SAWS	13/09/2024 21:00	75.21	5.224	31.539	35.729	4.19	3.586	24.231	0.532		
Karoo-NAQI	13/09/2024 21:00	1.065	1.002						0.033		
Kliprivier	13/09/2024 21:00			20.253	26.515	6.262	3.09	13.462	0.51		
Lephalale-NAQI	13/09/2024 21:00	96.602	40.359	37.031	90.407	53.376	3.792		0.897		
Middelburg SAWS-NAQI	13/09/2024 21:00	57.305	51.073	49.459	97.24	47.781	3.357	1.441	1.185		
Middelburg MP	13/09/2024 21:00	106.833	26.167	28.166	32.698	4.537		30.222	0.946	1.005	
Mokopane	04/09/2024 16:00	43.117	6.059	4.618	6.492	1.874	0.628	41.169			
Rosslyn-NAQI	13/09/2024 21:00	426.393	144.265				4.462				
Sebokeng	13/09/2024 21:00	65.5	31.859	10.86	11.063	0.417	2.951	39.798	0.299		

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## Community engagement using LCS

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To effectively tackle air pollution, access to data and contextual evidence is important to show the scale and magnitude of air pollution.

We're providing an end-end air quality solution in major African Cities leveraging the locally built low-cost monitors and existing expertise to advance air quality management and, implicitly, air quality improvement in these African cities.

Makerere University (Uganda)

- \*\* Ensemble de données sur la qualité de l'air hyperlocal collectées à partir de LCS distribués spatialement
- \*\* Accès ouvert à un vaste référentiel (2 millions d'enregistrements de données brutes et calibrées sur la qualité de l'air en temps réel, historiques et prévues)
- \*\* Accès accru aux données probantes sur la qualité de l'air pour les aider à lutter contre la qualité de l'air urbain et à atteindre les objectifs d'un air plus pur.

# ÉTAT DES OBSERVATIONS D'AQ EN Niger: AirQo



## Air Quality Map

Navigate air quality analytics with precision and actionable tips.

Search villages, cities or country

All



Burundi



Cameroon



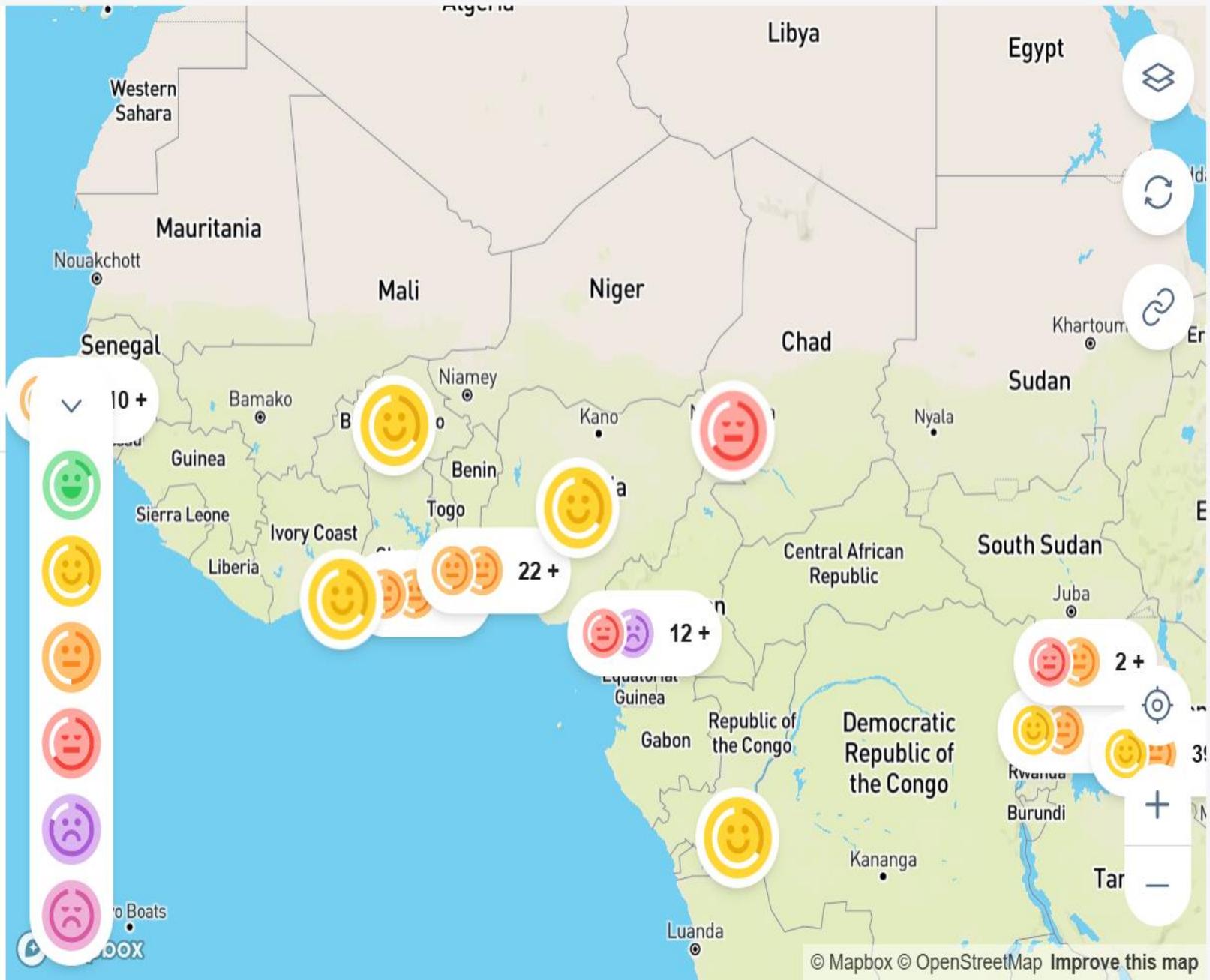
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And Applied Art  
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Kireka  
Central Region

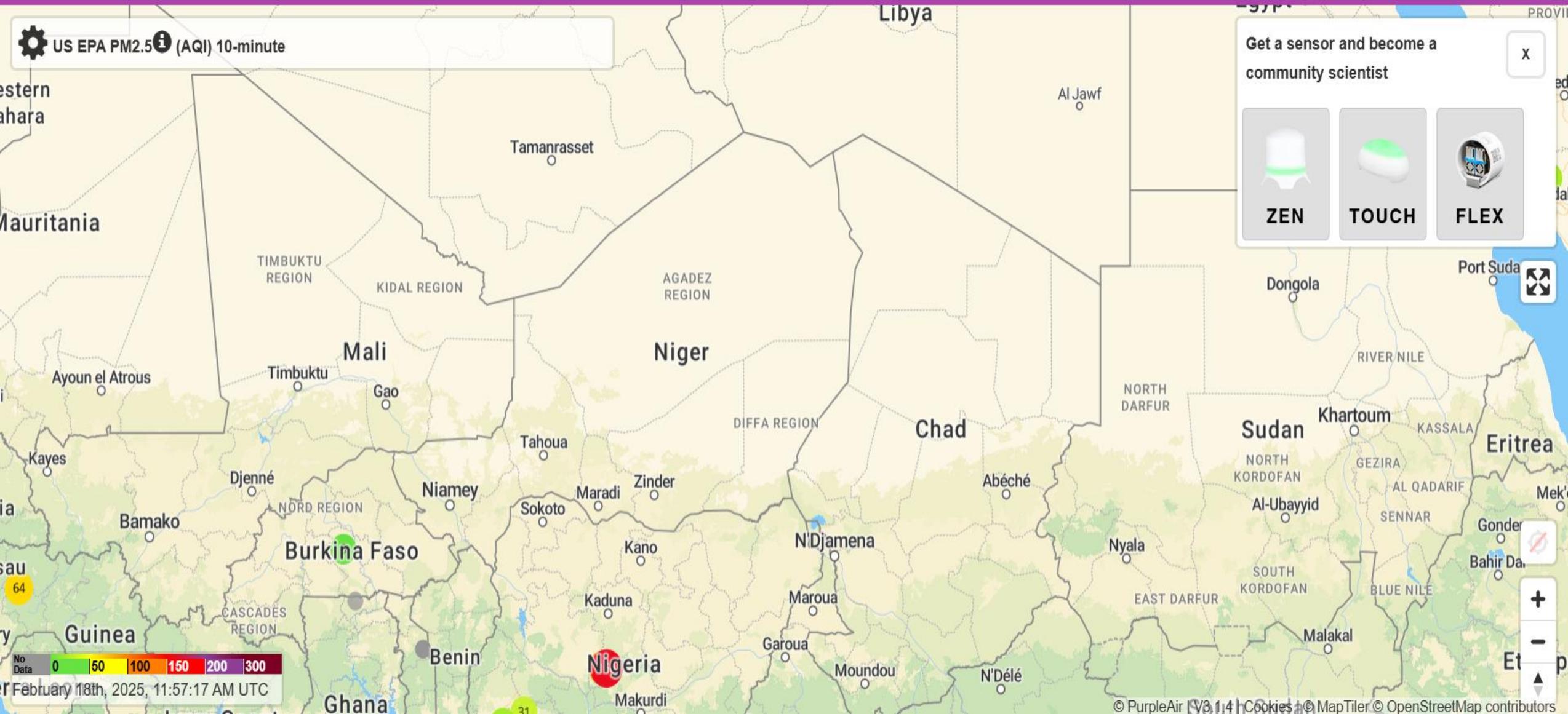
Akodo



# ÉTAT DES OBSERVATIONS D'AQ EN NIGER: Purple Air



Map ▾ Sensors ▾ Data ▾ About ▾



# ÉTAT DES OBSERVATIONS D'AQ EN NIGER : Sensors.Africa



## ABOUT sensors.AFRICA

sensors.AFRICA is a pan-African citizen science initiative that uses sensors to monitor air, water and sound pollution to give citizens actionable information about their cities. The air quality sensors use open source technology from the [Luftdaten project](#). The initiative was seed-funded by innovateAFRICA and is being incubated by Code for Africa.

## PROJECTS UNDER SENSORS.AFRICA

### AIR

The World Health Organisation reported in 2018 that air pollution causes about 7 million premature deaths globally each year. Indoor air pollution accounts for 3.8 million deaths globally, while outdoor (ambient) air pollution causes 4.2 million deaths every year. In addition to deaths directly attributable to air pollution, exposure increases the risk of respiratory diseases and cardiovascular conditions. The leading pollutant is particulate matter (PM), which is composed of sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water droplets. Citizens and governments are increasingly aware of the toxic health risks from air pollution but don't have easily accessible, hyper-local and real-time data that would provide actionable information to either avoid the effects, fight the causes, or stage interventions. sensors.AFRICA aims to change this with low-cost air quality sensors, which citizens and civic watchdogs will be able to use to measure, and monitor the quality of real-time air. The data from these air quality sensors are already being used by local watchdog NGOs and journalists to spotlight major public health risks using both the live data and data from our historical archives. We aim to ramp up these watchdog

### WATER

People living in developing nations face life-threatening environmental dangers from waterborne diseases, simply because they don't have reliable, timely and actionable data to help make decisions and/or campaign for change. The Global Burden of Disease (GBD) 2018 study projects 642,486 deaths annually due to contaminated drinking water. sensors.AFRICA seeks to change this, by deploying simple low-cost digital sensors and advanced algorithms that give citizens real-time and hyperlocal updates when there are local outbreaks of cholera or other waterborne diseases or their water is contaminated with either chemical or metallic pollutants. The project does this by applying several technologies which include deploying revolutionary new digital microscopy sensors, to test for coliforms (the organism that causes cholera) and other waterborne pathogens. The devices automatically photograph and magnify water samples on-site at key community water sources, and then use special software to analyse for coliforms in real-time. If dangerous levels are detected, a public alert is broadcast through social media / dark social channels and local authorities are summoned for definitive lab-based testing. This is a quantum leap for communities, who

### STORMWATCH

An estimated 5,000 fishermen drown during storms on just Lake Victoria every year. StormWatch will change this by using VIEWS (Lake Victoria Intense storm Early Warning System) to predict thunderstorms and send out public alerts to villagers ahead of extreme storms on Africa's great lakes. VIEWS uses data from satellite imagery and specially developed algorithms of the afternoon's land weather surrounding the lake to predict the occurrence of extreme storms later than the night with 93% accuracy. The prototype algorithm, produces predictions for all three countries bordering Lake Victoria, Kenya, Uganda and Tanzania. StormWatch will test the same methodology at two additional lakes in Tanzania, Lake Malawi and Lake Rukwa.

Capteurs installés au Kenya, en Tanzanie et au Nigeria

<https://sensors.africa/air>



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# ÉTAT DES OBSERVATIONS D'AQ EN NIGER

## United Nations Environment Programme (UNEP) Air Quality Policies in Niger (<https://www.unep.org/resources/policy-and-strategy/air-quality-policies-niger>)

### Niger Air Quality Policies

This document is based on research that UNEP conducted in 2015, in response to Resolution 7 of the UNEA 1. It describes country-level policies that impact air quality. Triple question marks (???) indicate that information for the section couldn't be found.

Please review the information, and provide feedback. A Word version of the template can be provided upon request. Corrections and comments can be emailed to [Vered.Ehsani@unep.org](mailto:Vered.Ehsani@unep.org) and [George.Mwaniki@unep.org](mailto:George.Mwaniki@unep.org).

Niger Air Quality Policy Matrix		
Goals	Status	Current Policies & Programmes
GENERAL OVERVIEW	<p><b>Overall situation with respect to air quality in the country, including key air quality challenges: ???</b></p> <p>Air quality monitoring system: ???</p>	<p><b>National Ambient air quality standards: ???</b></p> <p><b>National Air Quality Policy: ???</b></p> <p><b>Air Quality legislation / programmes: ???</b></p> <p><b>Other: ???</b></p>
REDUCE EMISSIONS FROM INDUSTRIES	<p><b>Industries that have the potential to impact air quality:</b></p> <ul style="list-style-type: none"> <li>The most important industries are: uranium mining, petroleum, cement, brick, soap, textiles, food processing, chemicals, slaughterhouses among others</li> </ul> <p><b>GDP of country:</b> USD 7.3B in 2013<sup>1</sup></p> <p><b>Industries' share of GDP:</b> 14.2%</p> <p><b>Electricity sources:</b></p> <ul style="list-style-type: none"> <li>100% of the installed electricity generating capacity (134,000 KW in 2010) is generated from fossil fuel.</li> <li>About 87% of the electricity consumed in the country is imported from Nigeria. The local production (thermal power from coal and diesel) contributes just 13%.</li> </ul>	<p><b>Emission regulations for industries:</b> There is a regulation in this area, but it is incomplete in terms of its coverage of pollutants and needs to be updated</p> <p><b>Small installation's emissions regulated: (Yes/No) ???</b></p> <p><b>Renewable energy investment promoted:</b></p> <ul style="list-style-type: none"> <li>The government aims at promoting renewable energy through the National Renewable Energies Strategy, which aims to increase the contribution of renewable energy to the national energy balance from less than 0.1% in 2003, to 10% by 2020<sup>3</sup></li> </ul> <p><b>Energy efficiency incentives: (ex: Subsidies, labelling, rebates etc) ???</b></p> <p><b>Incentives for clean production and installation of pollution prevention technologies: ???</b></p> <p><b>Actions to ensure compliance with regulations: (monitoring, enforcement, fines etc) ???</b></p> <p><b>Other actions at national, sub-national and / or local level to reduce industry: (can include incentives to move industries to less populated areas here) ???</b></p>

<sup>1</sup> 'Countries of the World - 32 Years of CIA World Fact Books', 2015 <<http://www.theodora.com/wfb/#R>>.

	<ul style="list-style-type: none"> <li>PM is the most important air pollutant in the country especially from Sahara desert dust <sup>2</sup></li> </ul>	
REDUCE EMISSIONS FROM TRANSPORT	<p><b>Key transport-related air quality challenges:</b> (ex: vehicle growth, old fleet, dirty fuel, poor public transport etc)</p> <ul style="list-style-type: none"> <li>Vehicle emissions are a major source of PM, NO<sub>2</sub> and CO</li> <li>Freight and passenger transport is usually provided by private companies or individuals</li> <li>Private car ownership is low with 7 car per 1000 individuals in 2009</li> <li>Motorcycle are also a common mode of transport outside the main city</li> </ul>	<p><b>Vehicle emission limit:</b> (Euro rating) ???</p> <p><b>Fuel Sulphur content:</b> (in ppm) Fuel (diesel) sulphur content restricted at 380ppm</p> <p><b>Fuel Lead content:</b> Unleaded gasoline restrictions since 2005</p> <p><b>Restriction on used car importation:</b></p> <ul style="list-style-type: none"> <li>Used vehicles from outside of the SACU area must be less than five years old; there is no age limit for SACU-originating used vehicles</li> <li>Pre-importation inspection is required for road worthiness</li> </ul> <p><b>Actions to expand, improve and promote public transport and mass transit: ???</b></p> <p><b>Actions to promote non-motorized transport:</b> (ex: include sidewalks and bike lanes in new road projects, car-free areas etc) ???</p> <p><b>Other transport-related actions: ???</b></p>
REDUCE EMISSIONS FROM OPEN BURNING OF WASTE (OUTDOOR)	<p><b>Outdoor, open burning:</b> (ex: is it commonly done? burning what kinds of wastes? etc)</p> <ul style="list-style-type: none"> <li>In Niger, municipal solid waste (MSW) management is ranked as the highest priority area for capacity-building<sup>4</sup>.</li> <li>MSW management in urban centres is particularly chaotic, due to a lack of controlled landfills and limited financial resources</li> <li>The problem is made worse by increasing rural to urban migration</li> </ul>	<p><b>Legal framework:</b> (ex: is burning banned?)</p> <ul style="list-style-type: none"> <li>MSW is only vaguely regulated as part of public hygiene legislation (n°93-13, 1993). Specific guidelines on disposal, as well as juridical procedures for the enforcement of legislation, are absent.</li> </ul> <p><b>Actions to prevent open burning of municipal waste and / or agricultural waste: ???</b></p>
REDUCE EMISSIONS FROM	<p><b>Dominant fuels used for cooking and space heating:</b></p>	<p><b>Indoor air pollution regulated: (Yes / No) ???</b></p> <p><b>Promotion of non-grid / grid electrification: ???</b></p>

<sup>3</sup> 'Reegle - Clean Energy Information Gateway', Reegle - Clean Energy Information Gateway <<http://www.reegle.info>> [accessed 22 September 2015].

<sup>2</sup> Pierre Ozer and others, 'Estimation of Air Quality Degradation due to Saharan Dust at Nouakchott, Mauritania, from Horizontal Visibility Data', *Water, Air & Soil Pollution*, 178 (2007) <<http://dx.doi.org/10.1007/s11270-006-9152-8>>.

<sup>4</sup> UNEP, 'Global Partnership on Waste Management (GPWM) > Information Platform > Country Waste Management Profiles > Country List', 2015.

BIOMASS BURNING (INDOORS)	<ul style="list-style-type: none"> <li>Wood is the dominant fuels used for cooking for rural households</li> <li>The main source of lighting for households in Niger is kerosene, which lights 80.1% of households, with 84.4% in rural areas and 59.1% urban areas<sup>5</sup></li> </ul> <p><b>Impact:</b></p> <ul style="list-style-type: none"> <li>Air pollution from indoor sources is the single largest contributor to the negative health effects of air pollution in Senegal.</li> <li>Indoor air pollution causes an estimated 27,500 premature deaths every year<sup>6</sup></li> </ul>	<p><b>Promotion of cleaner cooking fuels and clean cook stoves:</b></p> <p>The government aims o increases access to clean fuels through the National Strategy for Access to Modern Energy Services, which aims to increase the percentage of the population with access to modern energies by 2015</p> <p><b>Other actions to reduce indoor biomass burning, or to reduce its emissions:</b></p> <ul style="list-style-type: none"> <li>Up to now, renewable energy is not subject to any legislative text in Niger. A law on renewable energy, however, is currently being formulated. Through this law, the government can provide support in the form of loans, subsidies, fiscal advantages etc. in order to promote the increased utilization of renewable energy.</li> <li>Companies importing renewable energy equipment can benefit from incentive measures, facilitating the acquisition of said equipment.</li> <li>The new law intends to exonerate all imported equipment used in rural electrification and rural water pumping from taxes. It also aims to create a national rural electrification fund.</li> </ul>
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# ÉTAT DES OBSERVATIONS D'AQ EN NIGER

SoGA Fact Sheet Niger 20190828 V02

## STATE OF GLOBAL AIR /2019



Nearly 15,500 deaths due to air pollution in 2017

3 years and 1 month's loss in life expectancy at birth due to air pollution exposure

94  $\mu\text{g}/\text{m}^3$  population-weighted average  $\text{PM}_{2.5}$  concentration

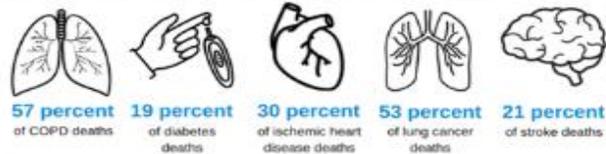
98% of the population uses solid fuels

### Niger

**Air pollution is the 3rd leading risk factor for premature death, accounting for nearly 9% of deaths — nearly 15,500 — in Niger in 2017 alone.**

Air pollution exposures, including exposure to outdoor particulate matter ( $\text{PM}_{2.5}$ ) and household air pollution (HAP), have been linked to increased hospitalizations, disability, and early death from respiratory diseases, heart disease, stroke, lung cancer, and diabetes, as well as communicable diseases like pneumonia. Exposure to outdoor ozone is linked to COPD.

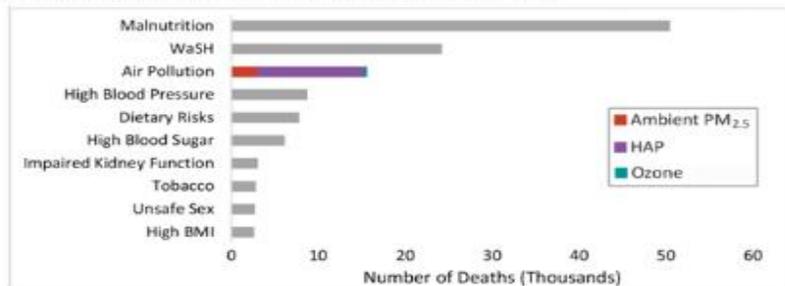
Percentage of deaths by cause attributed to air pollution in Niger.



### Key Facts

- Air pollution (total) is the 3rd leading risk factor in Niger in 2017, after malnutrition and sanitation (WaSH). Considered separately, household air pollution and outdoor air pollution are ranked as the 5th and 14th leading risk factors.
- The entire Nigerien population lives in areas with  $\text{PM}_{2.5}$  concentrations\* above the WHO Air Quality Guideline for healthy air ( $10 \mu\text{g}/\text{m}^3$ ).
- In 2017, there were 3,030 deaths attributable to exposure to outdoor  $\text{PM}_{2.5}$ , 12,300 deaths to HAP, and 178 to ozone.
- Exposure to outdoor PM accounted for a loss of nearly 1 year and 10 months of life expectancy, and exposure to HAP accounted for a loss of nearly 2 years and 1 month.

Leading risk factors for death and disability in Niger in 2017.



- ✘ La pollution de l'air est le troisième facteur de risque de décès prématuré
- ✘ Responsable de près de 9 % des décès – soit près de 15 500 – au Niger en 2017 seulement
- ✘ La pollution atmosphérique (totale) est le 3ème facteur de risque au Niger en 2017
- ✘ 3 ans et 1 mois de perte d'espérance de vie à la naissance en raison de l'exposition à la pollution atmosphérique
- ✘ L'ensemble de la population nigérienne vit dans des zones où les concentrations de  $\text{PM}_{2.5}$  sont supérieures à la ligne directrice de l'OMS sur la qualité de l'air pour un air sain ( $10 \mu\text{g}/\text{m}^3$ )



@HEISoGA

For more details, please visit [www.stateofglobalair.org](http://www.stateofglobalair.org)  
Contact us [soga@healtheffects.org](mailto:soga@healtheffects.org)

# 6. ■

État des  
observations de  
poussières en  
Afrique

# ÉTAT DES OBSERVATIONS DE POUSSIÈRES SUR L'AFRIQUE

**NASA Worldview**

Layers Events Data

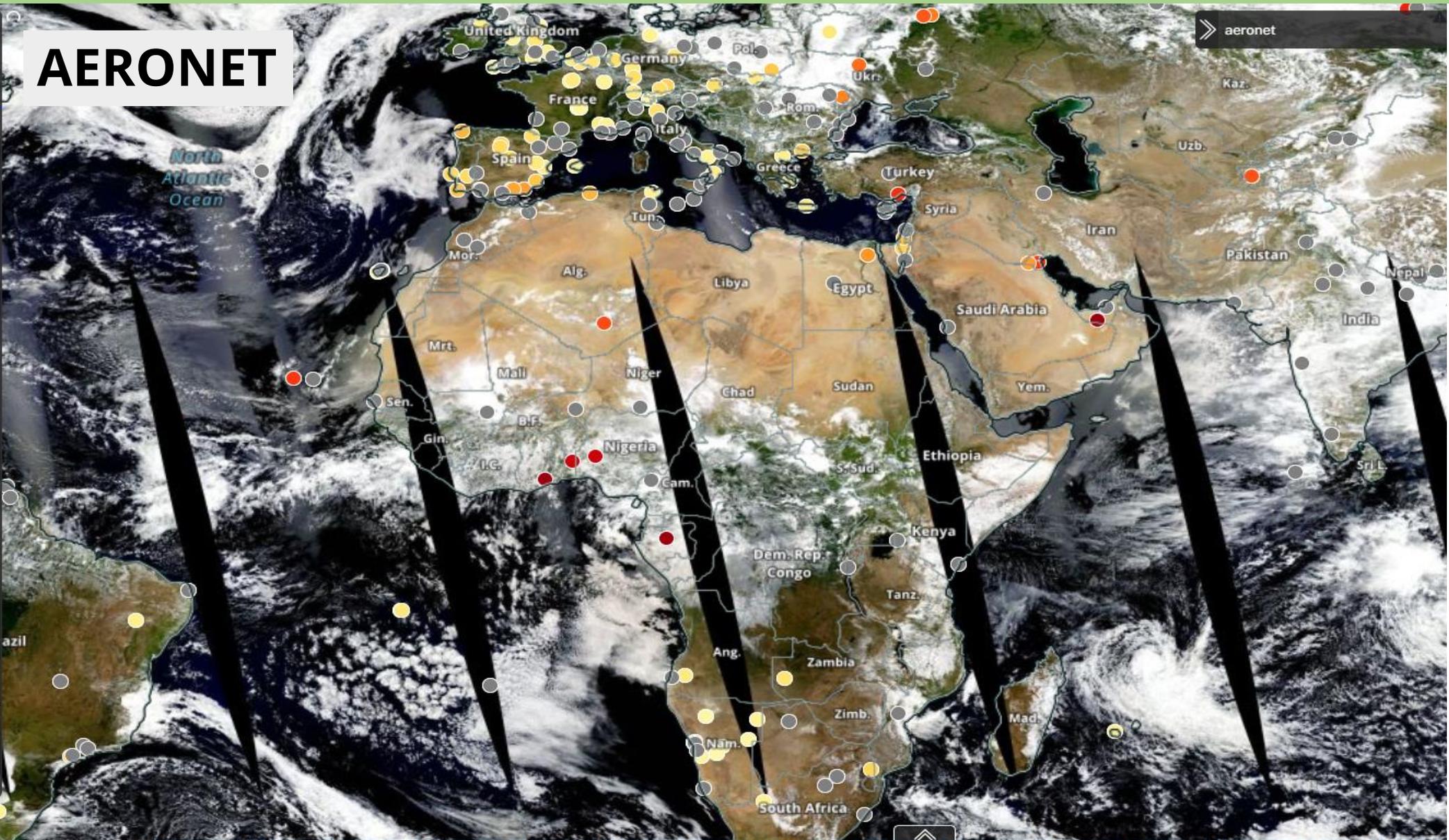
OVERLAYS

- Place Labels  
© OpenStreetMap contributors, Natural Earth
- Coastlines / Borders / Roads  
© OpenStreetMap contributors
- Coastlines  
© OpenStreetMap contributors
- Aerosol Optical Depth 500nm (Daily)  
AERONET  
 Inactive Site  
Aerosol Optical Depth  
Color scale: < 0.0 to 5.0
- Aerosol Optical Depth 500nm (Near Real-Time)  
AERONET  
 Inactive Site  
Aerosol Optical Depth  
Color scale: < 0.0 to 5.0
- Fires and Thermal Anomalies (Day and Night)  
Terra / MODIS  
 Fire
- Fires and Thermal Anomalies (Day and Night)  
Aqua / MODIS  
 Fire

Group Similar Layers

+ Add Layers Start Comparison

## AERONET



2016 JUL 18 09:57Z

60 MINUTE

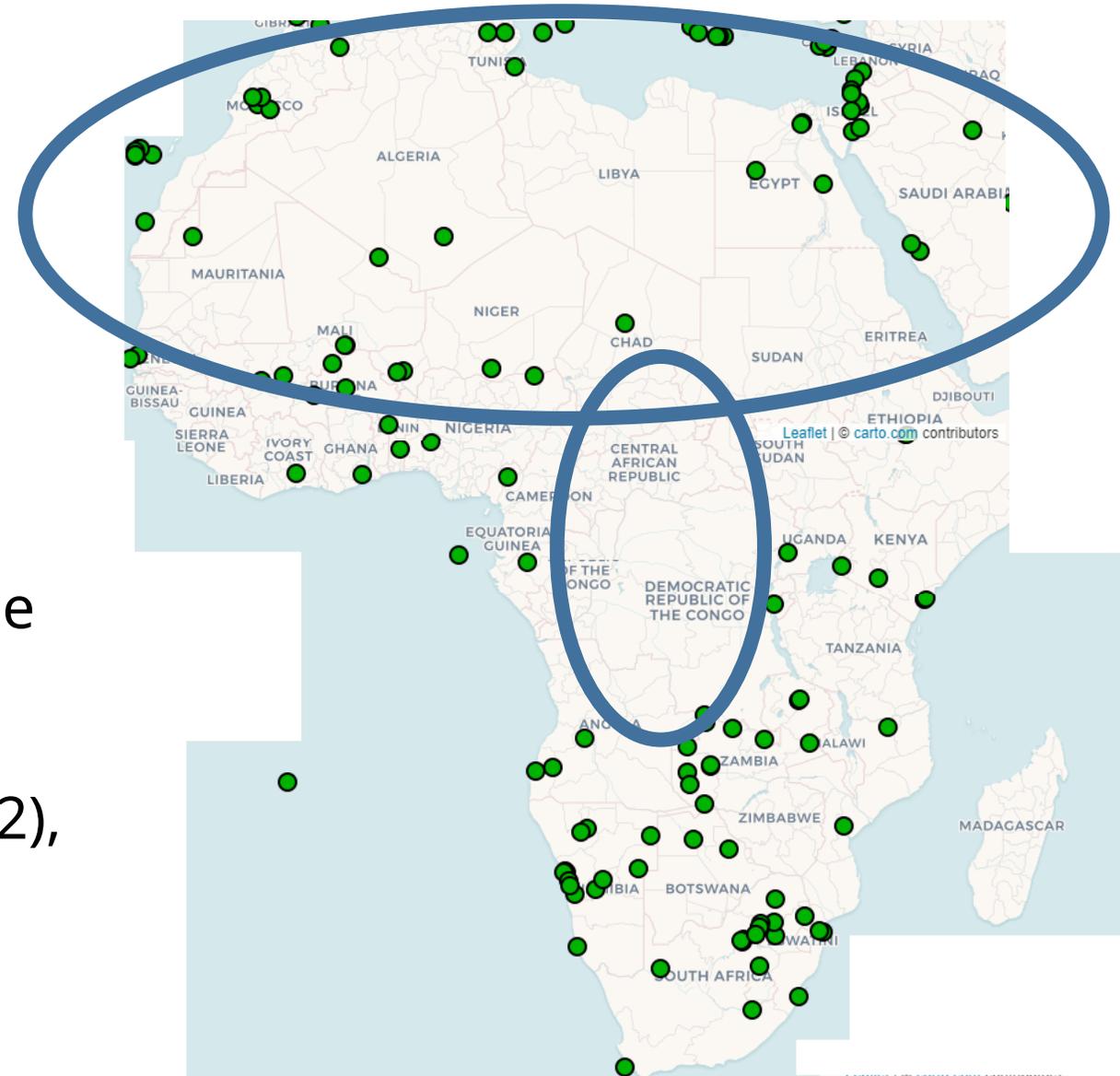
16 6:00 12:00 18:00 JUL 17 6:00 12:00 18:00 JUL 18 6:00

# ÉTAT DES OBSERVATIONS DE POUSSIÈRES SUR L'AFRIQUE

## AERONET au-dessus de l'Afrique



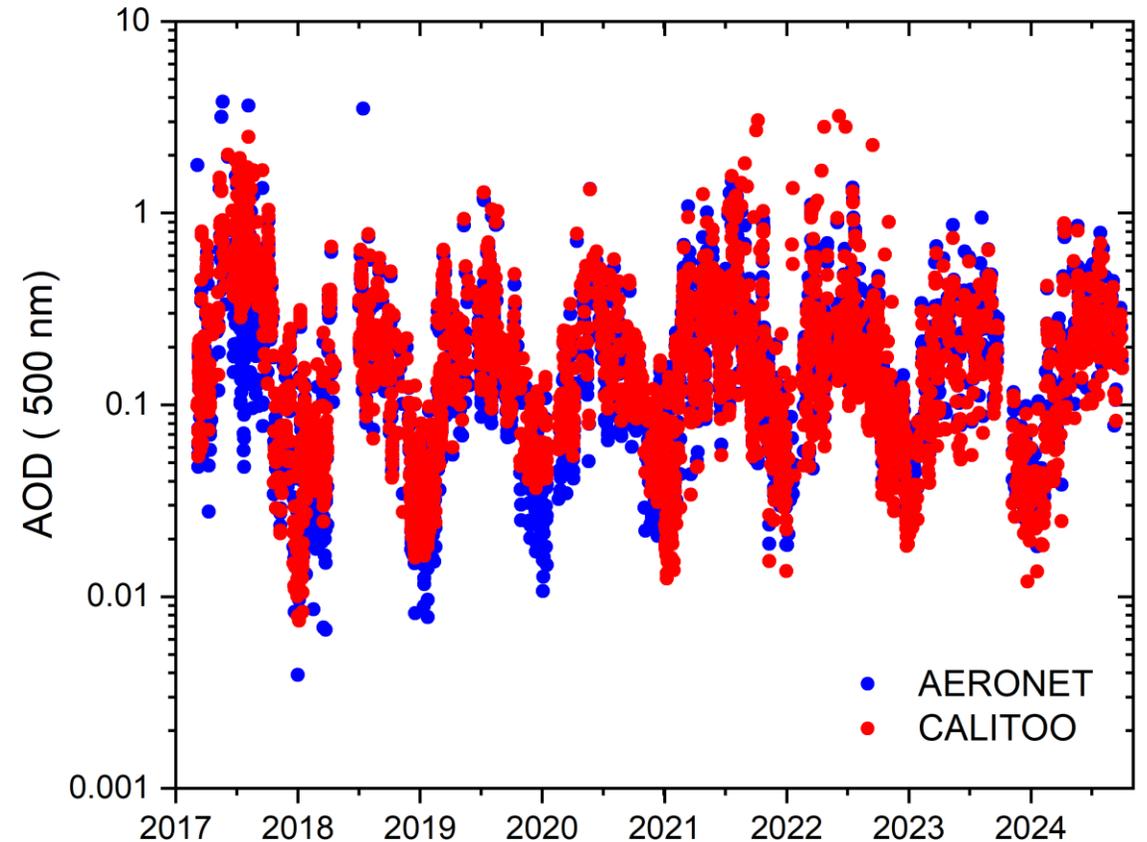
- \*\* 100 stations sur le continent
- \*\* Lacunes importantes sur la source de poussière la plus importante
- \*\* Actifs : Algérie, Maroc, Mali, Niger (x2), Tunisie, Senegal, Cameroon, Cape Verde, Egypte, Cote D'Ivoire, Ghana, Nigeria





# ÉTAT DES OBSERVATIONS DE POUSSIÈRES SUR L'AFRIQUE

## Tamanrasset (Algeria) GAW Global Station



RGM versus LCS!!

# ÉTAT DES OBSERVATIONS DE POUSSIÈRES SUR L'AFRIQUE

**Tunis (Carthage), Egypt (Cairo, ?), Morocco (Ouazarzate, Atlas),  
Lybia (TBD), Chad??**

En tant que centre d'étalonnage  
AERONET, nous proposons  
actuellement aux sites et  
opérateurs africains :

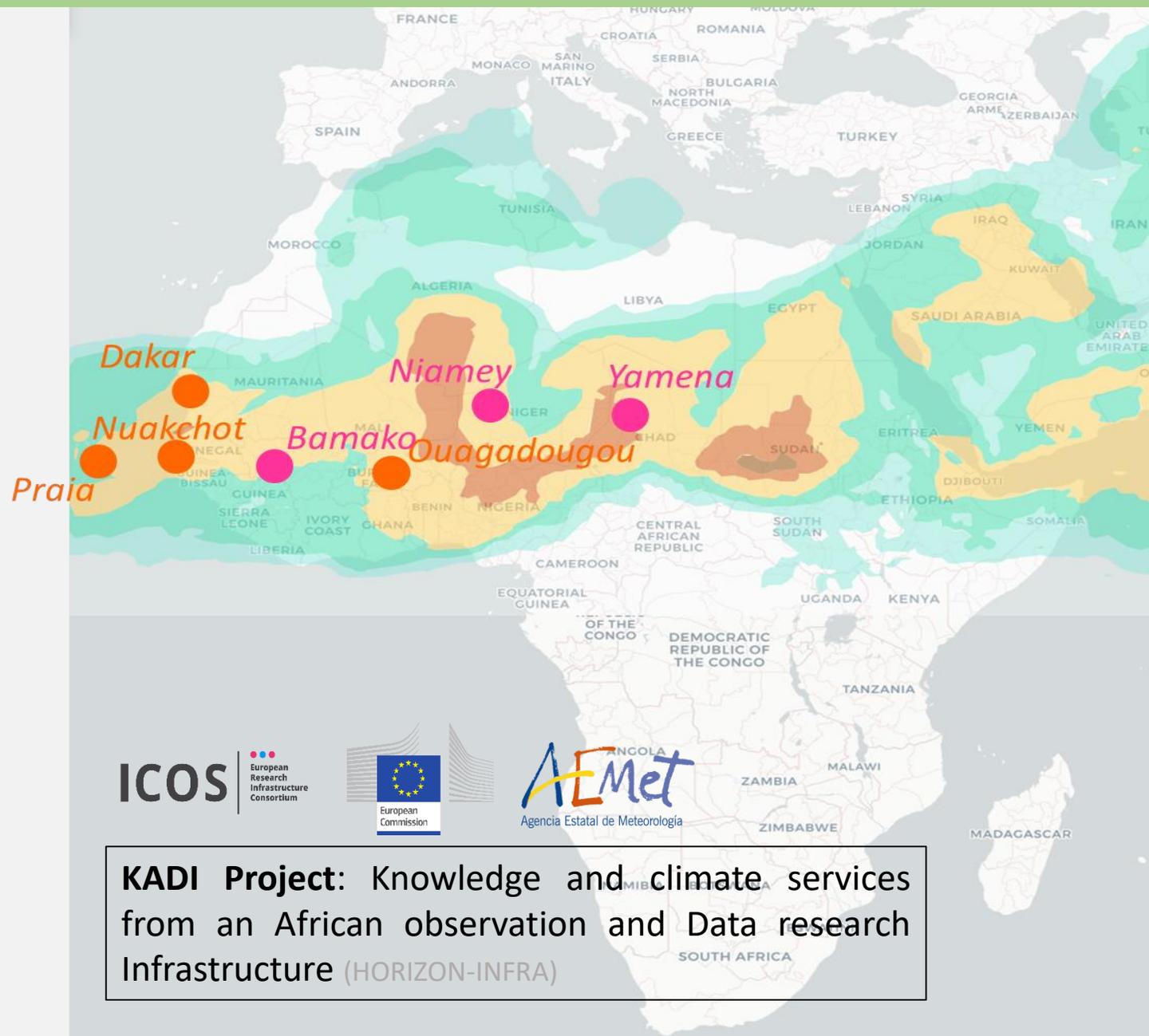
- Formation
- Étalonnage
- Support
- Ouvert pour combler les lacunes en  
Afrique !!



# ÉTAT DES OBSERVATIONS DE POUSSIÈRES SUR L'AFRIQUE



**CREWS & MAC-CLIMA Projects:** Training of personnel, development of new instrumentation and installation of climate monitoring systems in North Africa.



**KADI Project:** Knowledge and climate services from an African observation and Data research Infrastructure (HORIZON-INFRA)

# ÉTAT DES OBSERVATIONS DE POUSSIÈRES SUR L'AFRIQUE

N'OUBLIEZ PAS LE RÔLE IMPORTANT DES LCS (capteurs à faible coût) DANS LA SURVEILLANCE DES POUSSIÈRES/AÉROSOLS EN AFRIQUE





**Merci pour votre attention !!**

Vos commentaires: [abarretov@aemet.es](mailto:abarretov@aemet.es)