**WORLD METEOROLOGICAL ORGANIZATION**

CIMO/ET-NTTB-1/Doc. 7.6(2)
(18.II.2013)

**COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION**

ITEM: 7.6

**EXPERT TEAM ON NEW TECHNOLOGIES AND TESTBEDS (ET-NTTB)**
**First Session**

Original: ENGLISH

Geneva, Switzerland
26 – 29 November 2012

# DEVELOPMENT AND IMPLEMENTATION OF NEW REMOTE-SENSING TECHNOLOGIES AND THEIR OPERATIONAL APPLICATION

## Light Optical Particle Counter

(Submitted by J.-B. Renard and R. Pépin)

**Summary and purpose of document**

This document provides information on the LOAC (Light Optical Particles Counter) which is a new aerosols counter to be used under meteorological balloons for the determination of the aerosol sizes and their main nature.

## ACTION PROPOSED

The Meeting is invited to take note of the information provided in this document in its deliberation and in developing guidance on new remote-sensing technologies for aerosol and volcanic ash detection that are ready for operational use by WMO Members.

# LOAC (Light Optical Particles Counter)

## A new aerosols counter under meteorological balloons for the determination of the aerosol sizes and their main nature

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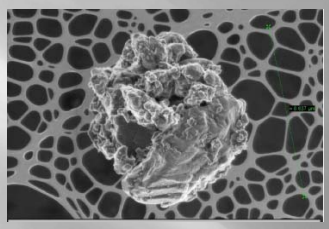
## There are different types of aerosols in the troposphere and in the stratosphere/mesosphere, having different origins

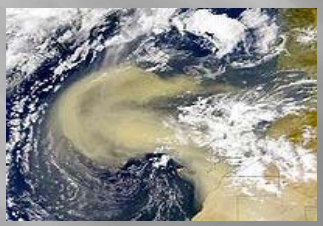
***Disintegrated meteorites***



***Interplanetary grains***

***Volcanic ashes / droplets***

***Biomass burning***



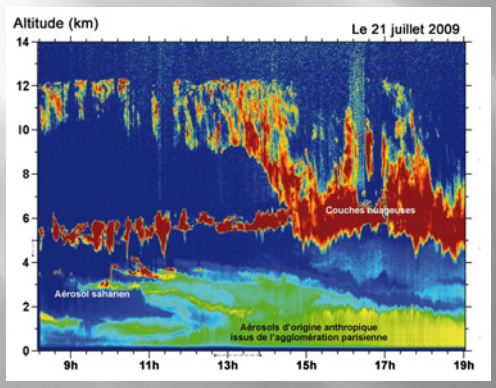
***Transported sands***

***Pollution***

**Aerosols participate in the climate, and are not well taken into account in modeling works**

**Aerosols measurements :**

**Remote sensing from ground (lidar, photometer) and space (lidar, extinction, scattered light)**




*Example of lidar measurements from ground*

**There is a need for an aerosol counter that can be launched under meteorological balloons (and other kinds of balloons)**

**- "Low cost" (the instrument can be lost after the flight)**

**- Light instrument (~1 kg with the gondola)**

**- Insensitive to the aerosols nature (=> accurate determination of size), which is not the case with the usual aerosol counters**

**- Concentration measurements in different size classes**

**- Estimation of the main nature of the aerosols**

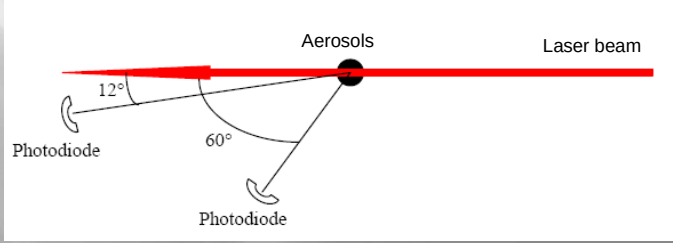
## LOAC : Light Optical Aerosol Counter
### (patented concept)

**Aerosol counter : measurements of the light scattered by the aerosols crossing a laser beam (injected by a pumping system)**

**Scattered light dependant on the diameter of the aerosols, and of their nature**

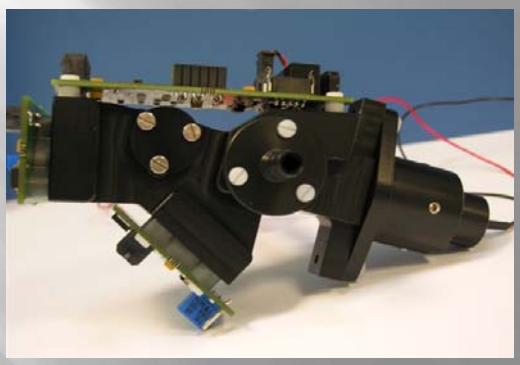
**Measurements at 2 scattering angles where :**

- **the scattered light is insensitive to the aerosols nature (12°)**
- **the scattered light is strongly sensitive to the aerosol nature (60°)**




**Combining the measurements at the 2 scattering angles :**

- **Accurate determination of the size distribution**
- **Estimation of the main nature of the aerosols**



**LOAC was designed and tested by French research institutes (CNRS) and by the Environnement-SA and MeteoModem companies**

**LOAC :** 19 size classes in the ~0.3 - 50 μm range

Optical chamber and pump: 250 grams

Meteo balloon gondola, including telemetry, PTU sensors, 2 alkaline batteries (3 hours of autonomy): 1 kg

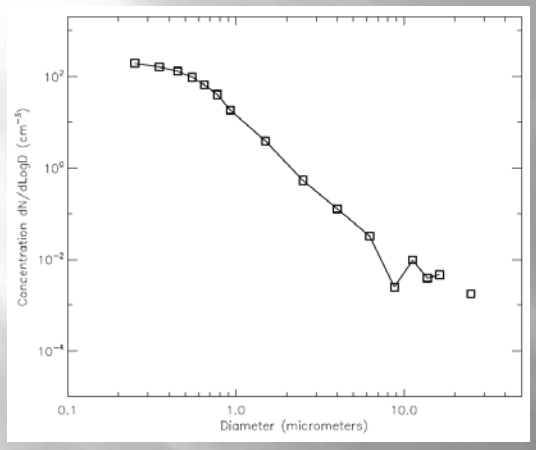
*Meteo balloon*

Adapted for other kinds of b

*Long duration stratospheric balloon*

*Low altitude troposheric balloon*

Counting performances: Up to 200 particles per $cm^3$

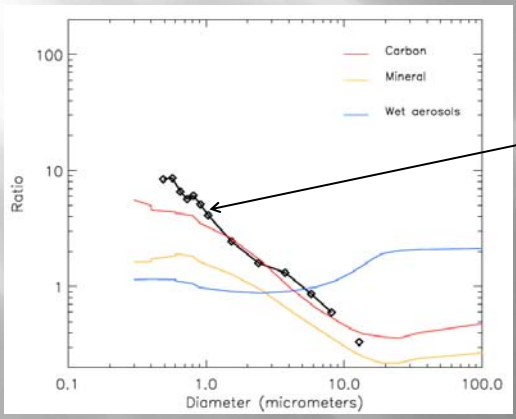



Example of detected size distribution (droplets)

On-flight recalibration / background noise control

## Identification of the main nature of aerosols from the ratio of the 2 channels measurements

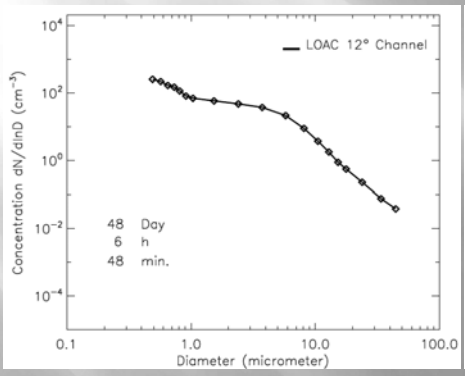
- **Liquid/ wet aerosols**
- **Carbon particulates (soot)**
- **Mineral dust (sand)**

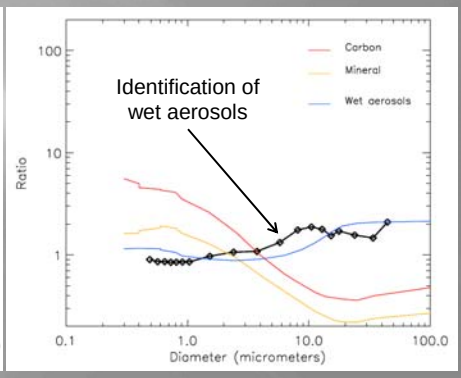



Ratio of the 2 channels
Identification of carbon aerosols

**Measurements (at ground) of ambient air**

## Automatic correction in case of dense aerosols concentration (ex. clouds / haze / fog ), up to 1000 particles per $cm^3$

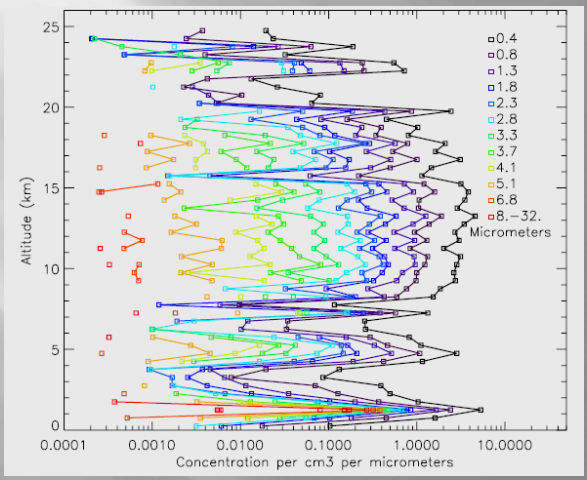



**Measurements (at ground) during fog conditions**

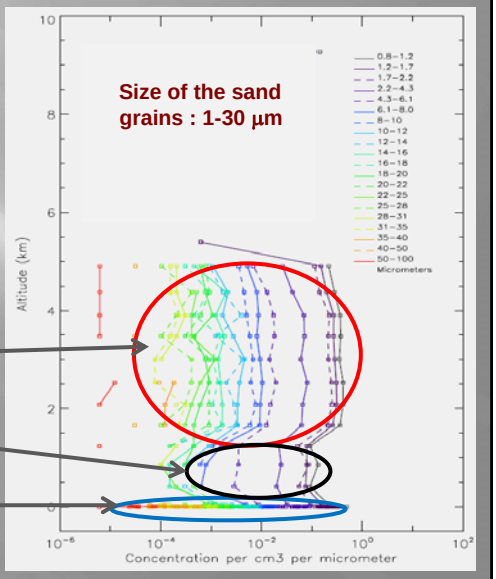
## Example of vertical distribution of aerosols

**Kiruna, Northern Sweden, 1 April 2011**
**Strong variability of aerosol content**




**Sausset-les-Pins (France), 28 June 2012 (meteo balloon)**

**Flight during an strong episode of sand above Mediterranean sea**

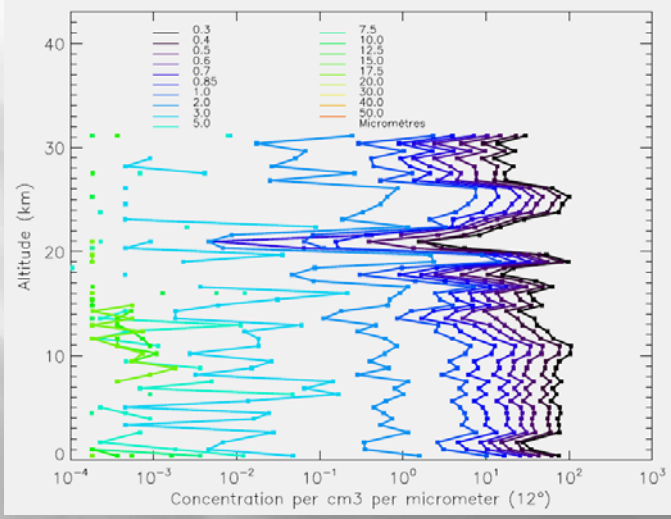



***Sand***

***Soot (pollution)***

***Sea droplets***

**Ury (South East of Paris), 28 January 2013**




## Some applications (in the free atmosphere):

**Better determination of the size distribution and concentration for :**

- **Pollution aerosols**
- **Transported atmospheric sand**
- **Volcanic ashes (aviation)**

**Detection of thin clouds**

**Analysis of the strong variability of aerosol content in the stratosphere**

**Determination of the main nature of the aerosols in the various parts of the atmosphere**

## LOAC is already involved in several scientific projects

**Winter 2012-2013: ParisFog, study of fog, tethered balloon**

**Summer 2013: Charmex campaign, study of aerosols transport above Mediterranean sea: 30 LOAC, meteo balloon and low pressured altitude balloon (CNES)**

**Summer 2013 : Lanches from Etna volcano**

**2013 and beyond : Collaboration with Iceland meteo institute; launch of LOAC under alerts (volcanic events)**

**2013-2015: Aerowave, stratospheric aerosols content and variability, large stratospheric balloons (CNES)**

**2018 : Strateole phase 2, tens of long-duration stratospheric balloons above equatorial regions (CNES)**