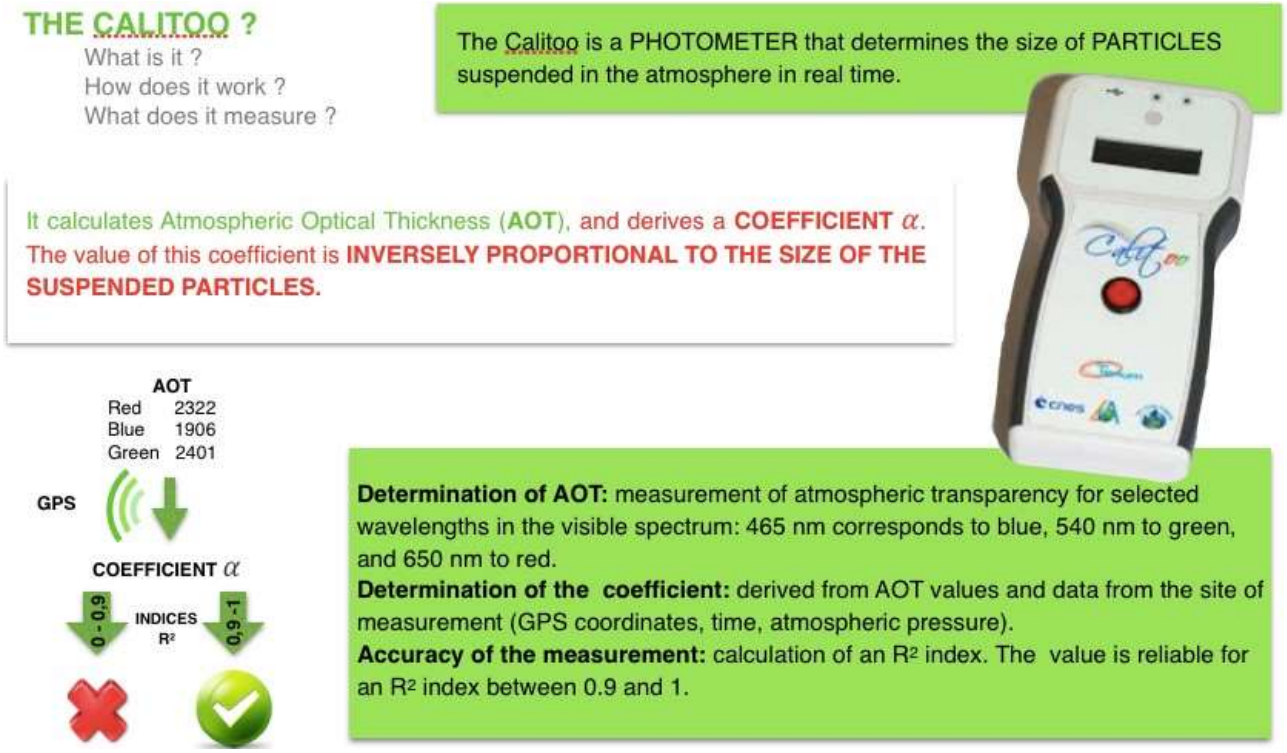
PRACTICAL TEST: A PERIOD OF POLLUTION IN WESTERN EUROPE

實作測驗:一段西歐的空氣汙染時期

In the past decade, public health problems (chronic illnesses, allergies) linked to air quality have multiplied. Fine particulates (≤ 2.5 μm, $PM_{2.5}$) are clearly a prominent factor specified by theWorld Health Organization. **We are interested in monitoring particles that results from human activities (transport, burning of fossil fuels, etc…).**

在過去十年，公共健康問題(例如慢性病或過敏性疾病等)和空氣品質的關係越來越密切，其中世界衛生組織更特別強調細微粒(粒徑小於 2.5 微米的 PM2.5)空氣汙染物對健康之影響。我們很有興趣去監測源自人類活動(如交通運輸、化石燃料燃燒等)的懸浮微粒。



The CALITOO? 這是甚麼? 它有甚麼功能或作用?它可以用來測量甚麼?
The Calitoo 是一種光度計，可以用來測量即時真實大氣中懸浮微粒的大小或粒徑
它可以用來計算大氣之光程厚度(AOT)並推導出係數 α ，這一個係數的值和懸浮微粒之粒徑成反比

AOT 值的決定:利用選擇可見光之波長來量測大氣之透明度，465 nm 波長對應到藍光，540 nm 波長對應到綠光，650 nm 波長對應到紅光
係數的決定；利用 AOT 的值以及測量地點其他量測之環境參數(GPS 座標，時間，氣壓)可以推導出係數。
測量之準確性；計算 R^2 指標，若 R^2 的值介於 0.9 和 1 之間，其準確性是可以信賴的。

PART I : Direct measurement of Atmospheric Optical Thickness (AOT).

第一部分:直接測量大氣光程厚度(AOT)

Instructions: 操作指引

TECHNICAL EVALUATION 1 BY JURY

If sunny 如果是晴天

- Familiarize yourself with the equipment and its operation (Quick start guide).
- 先孰悉儀器設備以及其操作方法(參考簡易操作手冊)
- Take three measurements validated by an R^2 above 0.9.
  量測三次並查驗確保 R^2 是否高於 0.9
- Record the results on the answer form, then calculate the average of the measurements.
  在答案紙上記錄量測結果，計算測量之平均值

If cloudy 如果是有雲的天氣

you will not make any measurements. α-values will be provided.

你就不用測量，係數 α 值會直接提供給你

Here are two values recorded with a photometer :
這裡是利用光度計所紀錄兩個案例之值
- The eruption of the Eyjafjallajökull volcano in 2010: value close to 0.4 over France.
- 2010 年 Eyjafjallajokull 火山噴發時:在法國紀錄的值是 0.4
- Near the Antibes highway during this winter: value close to 1.6.
- 這個冬天靠近 Antibes 高速公路: 量測值是 1.6

Question 1: The average of your photometer measurements indicates that today the fine particles above Sophia Antipolis… (only one answer possible)
問題 1. 你的光度計測量平均值指出今天在 Sophia Antipolis 的細微粒是(單選題)

1- are larger than those produced by automobile exhaust. 比汽車排放之廢氣顆粒要大
2- are smaller than those due to automobile exhaust. 比汽車排放之廢氣顆粒要小
3- are larger than those of volcanic ash. 比火山灰要大
4- results obtained do not permit any evaluation of atmospheric particle size at the time of measurement
測量結果無法評估測量時大氣懸浮微粒之大小

PART II : Comparison of the values obtained with particulates of known size.
第二部分:比較量測值與已知的微粒大小

Instructions : 操作指引

- Familiarize yourself with the principle of measurement of the coefficient for a mixture in a test tube (See tutorial « Measuring global AOT of the atmosphere »).

孰悉量測試管中混合物係數的原理(參考觀看-量測全球大氣光程厚度 AOT 之教學素材)

- Make three measurements of the coefficient for each sample: milk with water (test tube 1), and clay with water (test tube 2).

對每一個樣本進行三次係數之量測:牛奶和水(試管 1)，黏土和水(試管 2)

- Record the results on the answer form and calculate the average for each sample.

在答案紙上紀錄測量結果，計算每一個樣本的測量平均值

Question 2: Based on the data you obtained, fine particulates above Sophia Antipolis are … (only one answer)
問題 2: 根據你測量得到的資料 Sophia Antipolis 的細微粒是？(單選題)

1- smaller than those of milk. 比牛奶小
2- larger than those of clay. 比黏土大
3- of a size between those of clay and milk. 粒徑大小在黏土和牛奶之間
4- The size cannot be determined from the results obtained today. 今天量測之結果無法辨認粒徑之大小

PART III : A particular situation in the spring of 2016.

第三部分:2016 年春天懸浮微粒之情況

One morning in April, the air was laden with fine particles visible to the naked eye. Car windscreens were covered with a deposit of fine yellow particles. **Your task is determine the nature of these particles.**

四月的某一天清晨，空氣中充滿了肉眼即可見的細懸浮微粒，汽車擋風玻璃覆蓋了一層沉降的黃色細微粒，你的工作就是要探討這些微粒之特性

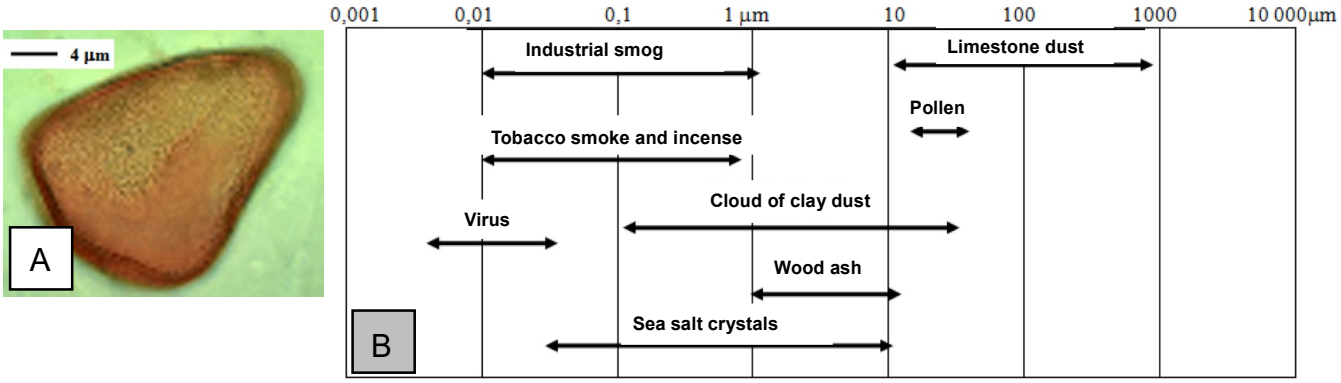


FIGURE 1 : (A) Light photomicrograph of a particle collected from a car windscreen. (B) Size range of different categories of fine particles. ***On this day in April, the value of α-value was smaller than that obtained from the suspension of wood ash (rich in calcium salts).***

圖 1. (A)從汽車擋風玻璃上收集之微粒的光顯微照片。(B)不同種類細微粒之粒徑大小分布範圍。四月的這一天係數 α的值比木灰懸浮微粒小(鈣鹽很豐富)。

Industrial smog	工業煙霧	Limestone dust	石灰岩粉塵
Tobacco smoke and incense	菸草煙霧增加	Pollen:	花粉
Virus	病毒	Cloud of clay dust	黏土粉塵雲
Wood ash	木灰	Sea salt crystals	海鹽結晶

Particle tested 測試之微粒	**Reagents, their quantities and the ensuing reaction** 試劑、數量及反應			
	HCl (1 drop)	**H_2O_2 (1 drop)**	**$AgNO_3$ (1 drop)**	**Ammonium oxalate (1 drop)**
Limestone 石灰岩	Fizzing	No reaction	No reaction	White precipitate
Biological molecule 生物分子	No reaction	Fizzing	No reaction	No reaction
Clay 黏土	No reaction	No reaction	No reaction	No reaction
Sodium chloride 氯化鈉	No reaction	No reaction	White precipitate	No reaction
Calcium salts other than carbonate 碳酸鈣以外的鈣鹽	No reaction	No reaction	No reaction	White precipitate

TABLE 1 : Chemical reagents used to determine the nature of particles. 用來決定微粒特性之化學試劑

Fizzing 氣體反應的聲音
No reaction 沒反應
White precipitate 白色沈澱

HCl *鹽酸* **H_2O_2** *雙氧水*
$AgNO_3$ *硝酸銀* **Ammonium oxalate** *草酸銨*

TECHNICAL EVALUATION 2 BY REFEREE

Instructions : 操作指引

- Familiarize yourself with the equipment available at your work station.
- 孰悉工作檯可用之設備
- Before you start working, **put on the safety glasses**.
- 開始實驗之前 請戴上安全護鏡
- Only perform two tests to determine the nature of the unidentified particles.
- 只能進行兩次測試實驗以決定待測微粒之特性

Question 3 : Using Figure 1 and Table 1, indicate the two reagents necessary to identify the chemical nature of the yellow dust. (Two answers expected)

問題 3:利用圖 1 和表 1 選出兩種必要之試劑以測定黃色塵之化學特性(應選兩項)

1- HCl 鹽酸

2- H_2O_2 雙氧水

3- $AgNO_3$ 硝酸銀

4- Ammonium oxalate 草酸銨

Question 4: From the results obtained, indicate the nature of these fine particulates. (only one answer)

問題 4: 從實驗結果指出這些微粒之特性(單選題)

1- Industrial smog 工業煙霧
2- Tobacco smoke or incense 菸草煙或香煙
3- Particles of clay 黏土微粒
4- Salt crystals 鹽晶
5- Virus 病毒
6- Ash originating from fire 火的灰燼
7- Pollen 花粉
8- Limestone dust originating from a nearby quarry 來自附近採石場的石灰岩粉塵

PART IV : A period of pollution in Western Europe during the winter of 2017.

第四部份:2017 年冬季西歐空氣汙染時段

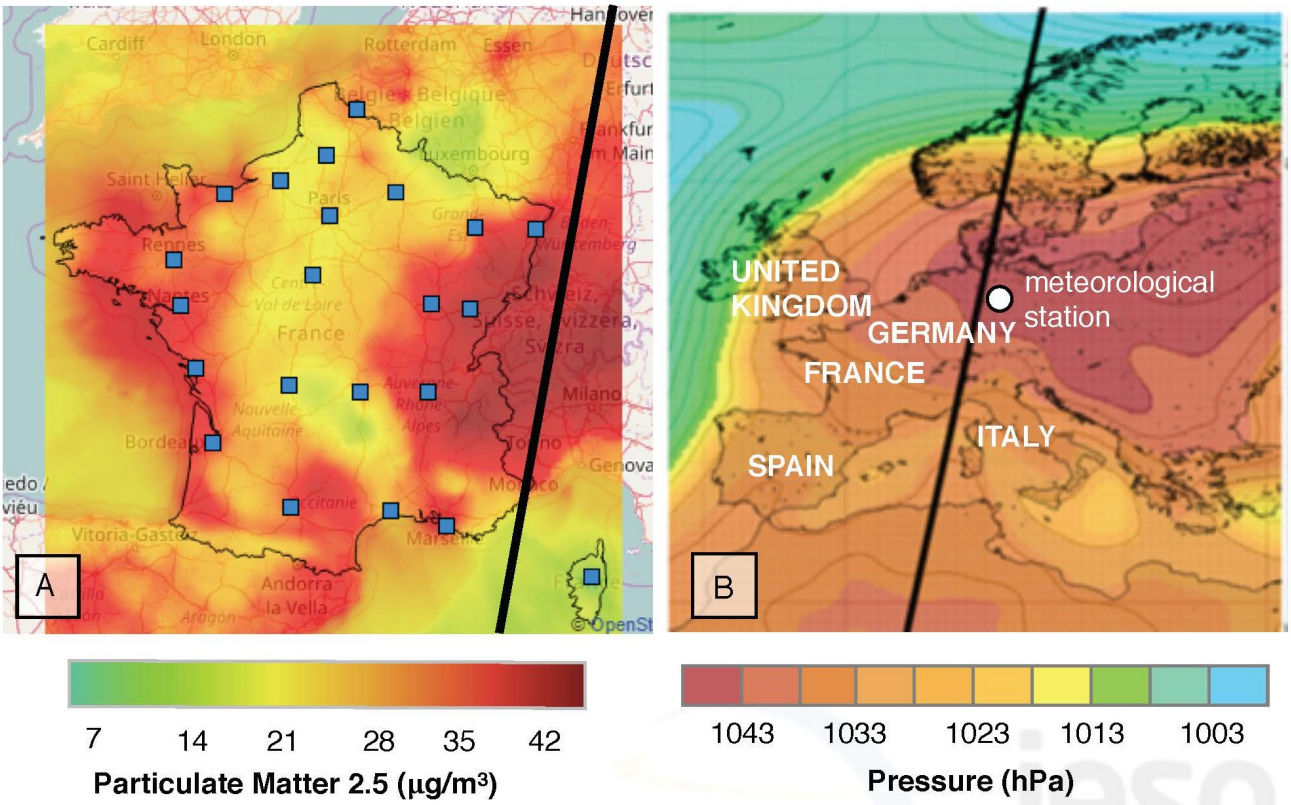


FIGURE 2 : (A) Concentration of atmospheric fine particles (<2.5 µm in diameter) on 25 January 2017. The map was prepared by measurement and application of a model (PREV'AIR network). (B) Map with isobars for Western Europe on 25 January 2017.The black line represents the path of the satellite in figure 3.

圖 2. (A)2017 年 1 月 25 日大氣細微粒(直徑 < 2.5 µm)的濃度分布。此圖整合量測與模型(PREV'AIR Network)之結果。(B) 2017 年 1 月 25 日西歐等壓線之分布，黑色實線表示圖 3 衛星之軌跡

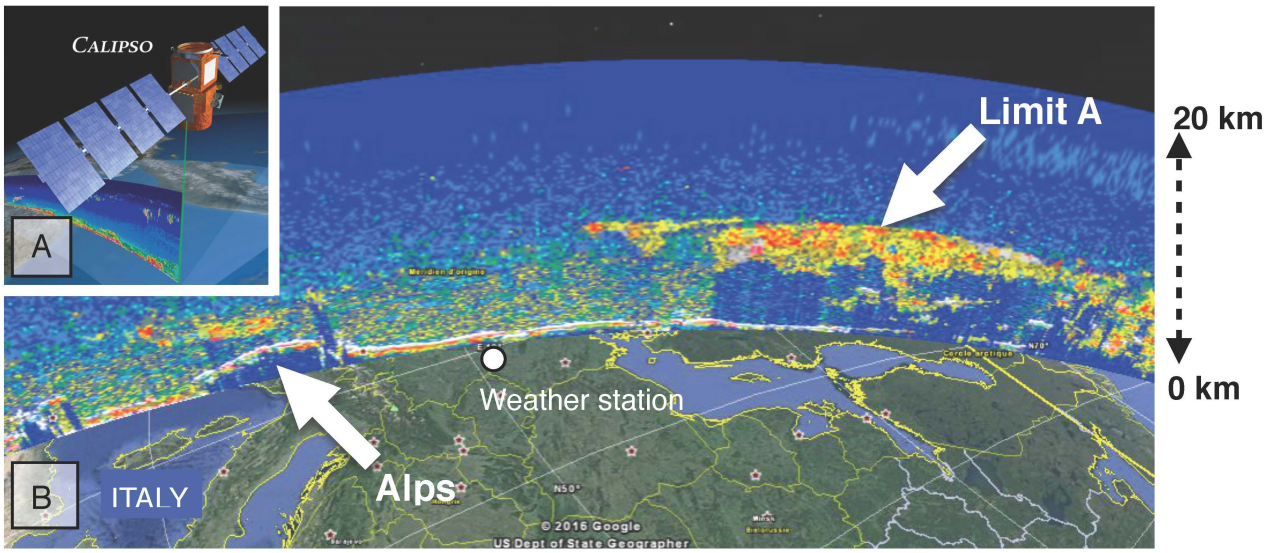


FIGURE 3 : (A) Explanatory thumbnail image of the method adopted for the imaging LIDAR (Light Detection and Ranging). During its passage above the region of interest, the CALIPSO satellite emitted a laser beam whose profile of dispersion was collected and analyzed to deduce the composition of atmospheric particles.The image is therefore a cross-section of the atmosphere. (B) Image obtained by the passage of the satellite over Western Europe on 25 January 2017.The yellow and red colors indicates the presence of $PM_{2.5}$ particulates. The grey trace close to the surface corresponds to clouds.

圖 3: (A)光達影像概略說明圖示，當通過測量地區之上空時 CALIPSO 衛星發射雷射光，該雷射光束被大氣粒子散射的資訊收集後可以分析大氣微粒之組成，因此光達影像是一垂直剖面分布圖。(B)2017 年 1 月 25 日衛星通過西歐之光達影像圖。黃色和紅色區代表 PM2.5 細微粒出現的地方。靠近地面的灰色痕跡對應出雲的所在。

Altitude (m) 高度	376	748	998	1,249	1,408	4,013	6,001	10,007	12,008	14,004
Temperature (°C)溫度	-4.7	-8.3	-10.1	2.1	3.3	-11.0	-25.3	-58.2	-69.2	-65.2

TABLE 2 : Results of temperature measurements for an atmospheric column.The weather balloon was released from a German weather station shown in Figure 3B (white dot).
表 2: 垂直大氣柱溫度量測之結果。探空天氣汽球是從圖 3B 德國地面天氣站施放(圖 3B 中白色點)

Question 5 : On the answer form, plot the curve of the air temperature as a function of altitude.
問題 5: 在答案紙上畫出空氣溫度隨高度之變化曲線

Question 6 : Name the Limit A marked in Figure 3B: (only one answer possible)
問題 6:標示在圖 3B 中的 Limit A 是在什麼位置？(單選題)
1- Stratopause 平流層頂
2- Tropopause 對流層頂
3- Mesopause 中氣層頂
4- The lower limit of the exosphere 外氣層的下限

Question 7: Refer to question 5. At what altitude do you find the layer of fine particulates above the German weather station? (only one answer possible)
問題 7: 延續問題 5 ，在德國地面天氣站上空的甚麼高度附近可以發現細懸浮微粒層(單選題)
1- about 500 m 大約 500 公尺
2- about 1,000 m 大約 1,000 公尺
3- about 2,000 m 大約 2,000 公尺
4- about 12,000 m 大約 12,000 公尺

Question 8: What conditions are necessary to obtain a cloud of fine particulates at low altitude? (several answers possible) :
問題 8:在甚麼必要條件下，可以在低高度出現細微粒之懸浮微粒層(多選題)
1- A zone of low pressure.
低氣壓區域
2- A zone of high pressure.
高氣壓區域
3- Emission of fine particulates by natural or anthropogenic activities.
自然或人為細微粒排放區域
4- A layer of cold air on the ground blocked by a temperature inversion.
被溫度逆溫阻隔在地面附近的冷空氣層
5- A layer of warm air on the ground blocked by a temperature inversion.
被溫度逆溫阻隔在地面附近的暖空氣層