Exploiter la base de données du SIRTA pour la prévision du brouillard: étude préparatoire de PreViBOSS

T. Elias(1), J.C. Dupont(2), M. Haeffelin(2), L. Gomes(3), F. Burnet(3), and D. Jolivet(1)

(1) HYGEOS, Euratechnologies, av. de Bretagne, 59000 Lille, France
(2) IPSL, Ecole Polytechnique, 91128 Palaiseau cedex, France
(3) CNRM / Météo-France, 41 Av Coriolis, 31057 Toulouse cedex, France

te@hygeos.com
http://sirta.ipsl.polytechnique.fr/parisfog

PreViBOSS: Predict change of visibility from ground-based and satellite observation

The PreViBOSS project (Prévision de la Visibilité dans le cycle de vie du Brouillard, à partir d'Observations Sol et Satellite) aims to identify pertinent associations of atmospheric visibility change predictors (hourly short term), among observation data sets. Data sets are extracted from the SIRTA data base generated by observation of the thermodynamical conditions of the atmosphere, as well as radiative and dynamical processes and particle properties. The project notably plans 3 6-month observation campaigns to extend the data base concerning microphysical and optical properties of aerosols and droplets, and to complete the data base by MSG/SEVIRI satellite observation. The Generalized Additive Model (GAM) statistical method will allow to hierarchise the observed parameters in function of their pertinence to predict the visibility change.

Change of visibility during ParisFog: fog, mist and clear air

Visibility observed at surface level at the SIRTA Observatory during ParisFog 2010-2011 is highly variable (all showed values are 15-min averages). Atmospheric particles are responsible of light extinction, level of visibility depends on particle number, size, shape and nature. Particle properties vary with source, sinks and transport, and particle size also depends on relative humidity.

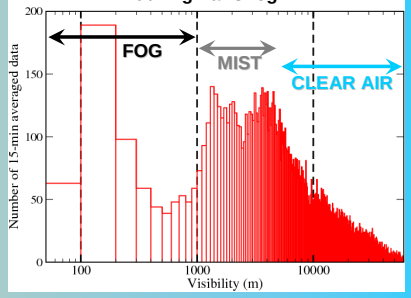
In terms of visibility, three regimes are distinguished:

-Fog: visibility generally smaller than 1000 m, due to some aerosols activated into droplets. Around 150 hours of fog are observed during ParisFog 2010-2011;

- Clear air: visibility larger than 5000 m. Aerosols are relatively dry, visibility change is due to aerosol number, size and nature;

- Mist: transition between clear air and fog, visibility ranges between 1000 and 5000 m. Aerosols grow up to micrometic size by taking up water from ambient atmospheric humidity [Elias *et al.*, 2009]. Around 900 hours of mist are observed during ParisFog 2010-2011.

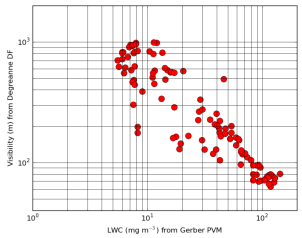
Frequency distribution of visibility values during ParisFog



Particle properties modify visibility

FOG

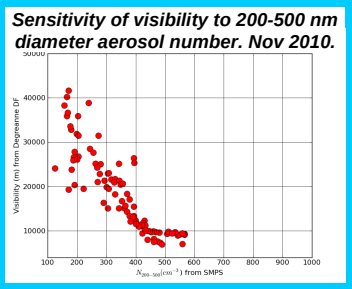
Sensitivity of visibility to LWC. Nov 2010.



Considering droplets are spherical, volume size distribution is computed from number size distribution measured by the FM100 instrument. Size integration of the volume size distribution provides the Liquid Water Content (LWC) expressed in mg m^{-3}. In fog, where visibility (provided by the DF20 instrument) is smaller than 1000 m, LWC varies between 5 and 150 mg m^{-3}. When LWC increases, particle surface also increases, with consequent decrease of visibility.

CLEAR AIR

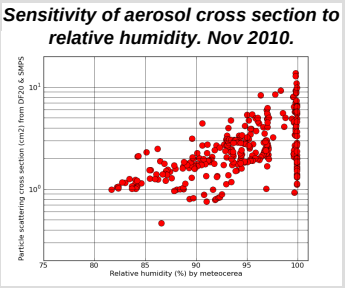
Sensitivity of visibility to 200-500 nm diameter aerosol number. Nov 2010.



In clear air regime, when relative humidity is smaller than 80%, aerosols are relatively dry. SMPS therefore provides aerosol size distribution close to ambient conditions. Contribution to extinction increasing with aerosol size, visibility is highly correlated with number of aerosols included between 200 and 500 nm diameter, which remains relatively small compared to total aerosol number (N_a).

MIST

Sensitivity of aerosol cross section to relative humidity. Nov 2010.



Sensitivity of aerosol extinction to relative humidity (RH) is estimated by computing the aerosol extinction cross section (AECS), as the extinction coefficient delivered by the DF20 visibilimeter divided by the aerosol number between 200 and 500 nm diameter, delivered by the SMPS particle counter.
In mist regime, relative humidity is included between 80 and 100%. There is a tendency of AECS to increase with RH, such increase rate however depending on the aerosol nature.

PreViBOSS data set: comparison of parameters

The GAM will help answer these questions:

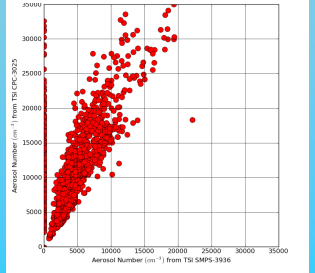
- Do we observe parameters able to predict change of particle properties in each regime ?

- Do we observe parameters able to predict the change of regime ?

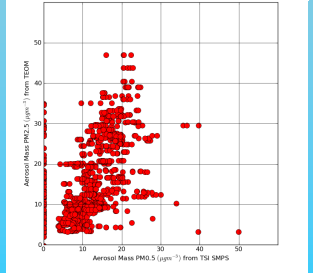
The PreViBOSS data set, to process with the GAM, is composed of observed parameters: 1) independent, 2) quality-checked, 3) even temporal resolution.
For example, Liquid water content (LWC) is provided by two instruments. Two questions: what instrument do we use to provide this one parameter ? Can we evaluate uncertainty by making comparisons of LWC ? Another example is the aerosol number concentration (N_a) also provided by two instruments.

Comparison for November 2010 shows good correlation between LWC provided by two instruments. Within the fog, LWC varies consistently over two orders of magnitude. Comparison also shows that LWC provided by Gerber PVM is around 1.4 times larger than LWC provided by DMT FM100.
Similarly, the correlation is good for the aerosol number concentration provided by two instruments. N_a varies consistently by more than one order of magnitude, however TSI CPC indicates twice more aerosols than TSI SMPS. Another example provided with aerosol mass concentration PM.

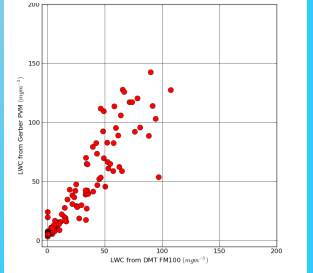
Comparison of aerosol number concentration measured by TSI CPC and TSI SMPS. Nov 2010



Comparison of aerosol mass concentration measured by TEOM and TSI SMPS. Nov 2010



Comparison of liquid water content measured by Gerber PVM and DMT FM100. Nov 2010



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