The need to develop calibration procedures for automatic bioaerosol monitors

Fiona Tummon[1], Kevin Auderset[2], Bernard Clot[1], Benoît Crouzy[1], Gian Lieberherr[1], Julia Schmale[3], Georgi Tancev[2], Konstantina Vasilatou[2], and Christian Wälchli[2]

[1]Federal Office of Meteorology and Climatology MeteoSwiss, Switzerland; [2]Federal Institute for Metrology METAS, Wabern, Switzerland; [3]Extreme Environments Laboratory, EPFL, Sion, Switzerland

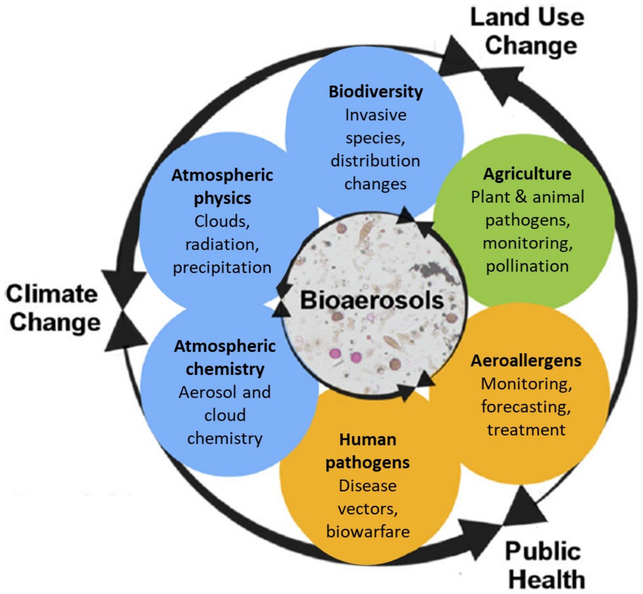
WHY BIOAEROSOLS?

Bioaerosols play a key role in:

- **Climate change**: hydrological cycle, species distributions
- **Human health**: allergens, disease vectors, biowarfare
- **Agriculture**: plant and animal pathogens, crop forecasts

Costs associated with certain impacts are significant:

- Well over **€50 billion/year** for **allergies** in Europe alone
- **Crop losses** related to fungal pathogens also cost **billions/year**



Importance of bioaerosol in the Earth system
Figure adapted from Santl-Temkiv et al., 2020

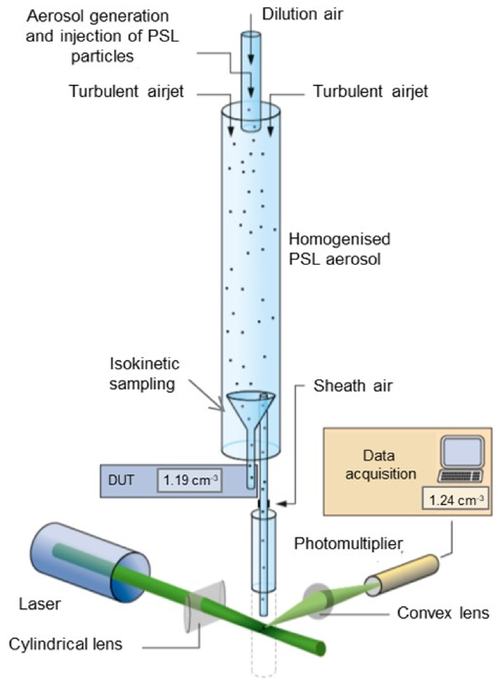
WHY NOW?

A number of different **automatic instruments** have come on to the market in recent years:

- **Flow cytometers**: DMT WIBS, Plair Rapid-E, Swisens Poleno
- **Impactors**: Hund BAA500, PollenSense APS

And new technologies are continuously being developed.

Automatic monitoring networks are being established but **no procedures to calibrate bioaerosol monitore exist** and results across different instruments are difficult to compare.



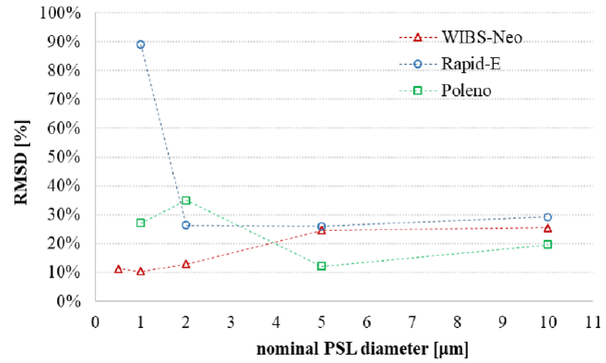
Experimental setup used to test various bioaerosol monitors at the Federal Institute for Metrology METAS
Figure from Horender et al., 2019

CURRENT METHODS

At present, traditional air quality instrument tests are used to calibrate bioaerosol monitors, but:

- Methods are **not adapted for typical bioaerosol sizes** (20-200µm)
- Or for **typical bioaerosol concentrations** (as low as 1/m^3)
- And there is **no procedure to aerosolise real bioaerosol**

More traditional experiments at the Federal Institute of Metrology METAS have provided good results for a limited range of PSL sizes and concentrations when testing several bioaerosol monitors.



Example results of experiments using PSL particles to test error related to particle size measurements from 3 bioaerosol monitors *(Figure from Lieberherr et al., 2021)*

DEVELOPMENT NEEDS

Methods need to be developed to address the following issues so that standard procedures to calibrate bioaerosol monitors can be established:

- Soft techniques to **aerosolise large particles** – from **20-200 µm** in size (for size distributions)
- Reference particle counters or reference measurement procedures for **low particle number concentrations** – down to **1/m^3** (for counting efficiency)
- Methods **to aerosolise real bioaerosol** particles in known quantities (e.g. pollen and fungal spores)
- Test results under **different environmental conditions** (e.g. humidity and temperature)
- **Portable instruments** that can be used to carry out **calibrations in the field**
- Well-defined (reference) bioaerosols for training the built-in AI algorithms for particle identification

Bibliography

- Horender et al., 2019, Facility for calibration of optical and condensation particle counters based on a turbulent aerosol mixing tube and a reference optical particle counter, Review of Scientific Instruments, doi:10.1063/1.5095853.
- Lieberherr et al., 2021, Assessment of Real-time Bioaerosol Particle Counters using Reference Chamber Experiments, Atmospheric Measurement Techniques, doi: /10.5194/amt-2021-136.
- Santl-Temkiv et al., 2020, **Bioaerosol field measurements: Challenges and perspectives in outdoor studies**, Aerosol Science, doi:10.1080/02786826.2019.1676395

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