# Primary Biological Aerosol Particle (PBAP) modelling in EMEP

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Funded by the European Union

emep

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# Primary Biological Aerosol Particles (PBAP): What and Why?

PBAPs:

- Fungal spores
- Bacteria, viruses,...
- Plankton
- Pollen, plant debris, ...

**Can account for up to 20% of $PM_{10}$!**
Fungal spores are correlated with:

- Mannitol, arabitol
- Trehalose, glucose
- OC (particularly coarse fraction of $PM_{10}$)

Assumptions:

- Fixed (Arabitol+Mannitol)/spore mass ratio of 4.5% [Refs. 1,2]
- Monodisperse with $d = 3\ \mu\mathrm{m}$ [Ref. 3]


Figure: Stations available

[1] Elbert, W. *et al.* Atmos. Chem. Phys., 7, 4569–4588 (2007)
[2] Bauer, H. *et al.* Atmos. Environ., 42, 5542–5549 (2008)
[3] Hoose, C. *et al.* Environ. Res. Lett. 5 024009 (2010)

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LRTAP Long-range Transboundary Air Pollution

# Parameterizing fungal spore number flux $F_{\mathrm{FNG}}$

There exist multiple parameterization in the literature. Some common parameterizations:

Land use classes; Constant flux per land type [$\mathrm{m^{-2}s^{-1}}$]; Fraction of grid cell

$$F_{\mathrm{S\&D}} = \sum_{i=1}^{\mathrm{LC}} a_i \times F_i \quad [\mathrm{Ref.\ 4}]$$

Specific humidity [kg/kg]; Leaf-area index [$\mathrm{m^2/m^2}$]

$$F_{\mathrm{H\&S}} = c \times \frac{q}{7.5 \cdot 10^{-2}} \times \mathrm{LAI}\,, \quad c = \begin{cases} 2315\ \mathrm{m^{-2}\ s^{-1}} & d = 3\ \mu\mathrm{m} \quad [\mathrm{Ref.\ 3}] \\ 500\ \mathrm{m^{-2}\ s^{-1}} & d = 5\ \mu\mathrm{m} \quad [\mathrm{Ref.\ 5}] \end{cases}$$

Temperature [$^\circ$C]

$$F_{\mathrm{Hm}} = 20.426 \times (\ T\ - 275.82) + 3.93 \times 10^4 \times q \times \mathrm{LAI} \quad [\mathrm{Ref.\ 6}]$$

[3] Hoose, C. *et al.* Environ. Res. Lett. 5 024009 (2010)
[4] Sesartic, A. and Dallafior, T. N., Biogeosciences, 8, 1181–1192 (2011)
[5] Heald, C.L and Spracklen, D.V. Geophys. Res. Lett., 36, L09806 (2009)
[6] Hummel, M. *et al.* Atmos. Chem. Phys., 15, 6127–6146 (2015)

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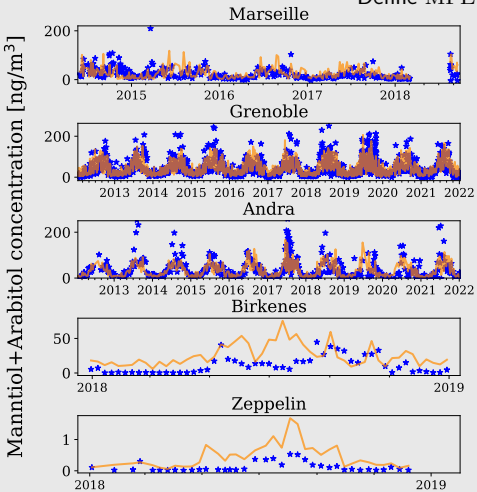
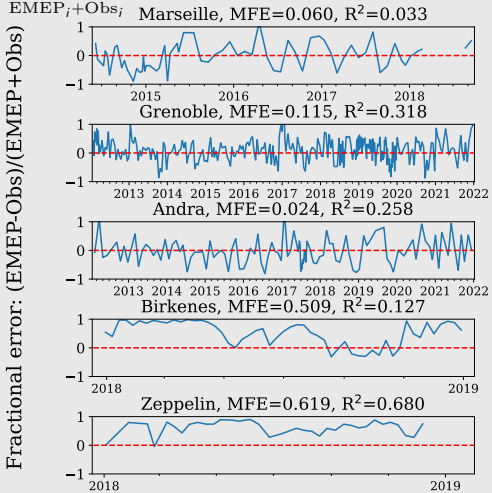
# Results - Mannitol + Arabitol

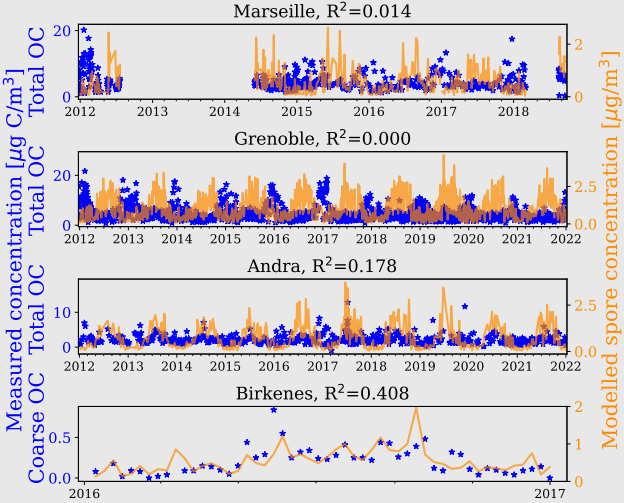
Define $\mathrm{MFE} = \frac{1}{N}\sum_i \frac{\mathrm{EMEP}_i - \mathrm{Obs}_i}{\mathrm{EMEP}_i + \mathrm{Obs}_i}$



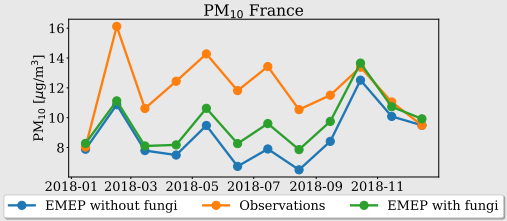

Data provided by nilu

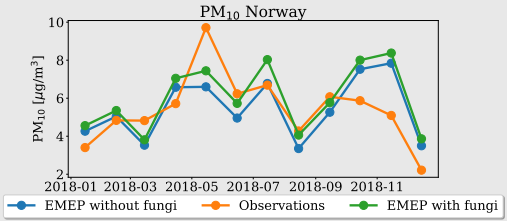
# Results - Total OC in $PM_{10}$ & OC in $PM_{10}$-$PM_{2.5}$ (coarse)

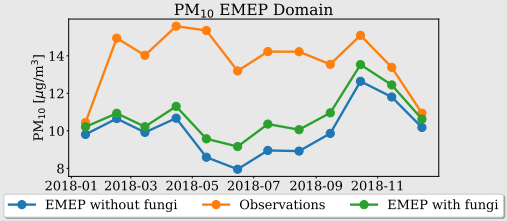



Data provided by nilu, IGE, ANDRA, INERIS, LCSQA Laboratoire Central de Surveillance de la Qualité de l'Air

# Effect on $PM_{10}$




| | No fungal | With fungal |
|---|---|---|
| NMB | −27.3% | −21.5% |
| R-space | 0.66 | 0.65 |
| R-temporal | 0.57 | 0.61 |

Data provided by nilu IGE ANDRA INERIS LCSQA Laboratoire Central de Surveillance de la Qualité de l'Air

# Summary of results

$$F_{\mathrm{H\&S}} = c \times \frac{q}{7.5 \cdot 10^{-2}} \times \mathrm{LAI}$$

- Excellent agreement with mannitol+arabitol in central France (Andra, Grenoble)
- Marseille: less pronounced seasonal variations
- Fungal parameterization *significantly overestimates* Norwegian concentrations
- Coarse OC is decently correlated but not OC
- Including fungal spores improves bias and temporal correlations of $PM_{10}$, slightly deteriorates spatial correlations


Figure: Stations available

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# Discussion

$$F_{\mathrm{H\&S}} = c \times \frac{q}{7.5 \cdot 10^{-2}} \times \mathrm{LAI}$$

- Marseille: less pronounced seasonal variations
  - Different vegetation?
- Parameterization overestimates Norwegian concentrations
  - Different vegetation/fungal types?
- Coarse OC is decently correlated but not OC
  - OC contributed to from many other sources


Figure: Stations available

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# Conclusion & Acknowledgement

- Simple parameterization of fungal spores gives good results in central France
- Less good results on the coast and in Norway
- More complex parameterization in the future?

Data kindly provided by Karl Espen Yttri (NILU), Jean-Luc Jaffrezo (IGE), Gäelle Uzu (IGE), Sébastien Conil (ANDRA DISTEC/EES), Olivier Favez (INERIS/LCSQA), Nicholas Marchand (LCE Marseille) and many others in the field and lab at NILU, IGE, OPE, INERIS, Atmo Aura, and Atmo Sud.

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