IMPLEMENTING PRIMARY BIOGENIC AEROSOL PARTICLES IN REGIONAL AND GLOBAL SCALE MODELS (TASK 7.3)

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Coordinated by

- **PBAP** : <u>Fungal spores</u>, bacteria, virus, pollen, plankton, plant debris

  - Not well included in most models, but can account for up to 20% of PM_{10}!

- <u>Fungal spores</u>: Well correlated with sugar alcohols (mannitol, arabitol)

- Some common parameterizations :

Land use classes

Constant flux per land type $[m^{-2}s^{-1}]$

Fraction of grid cell

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

Specific humidity [kg/kg]

Leaf-area index $[m^2/m^2]$

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

Temperature $[^{\circ}C]$

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

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

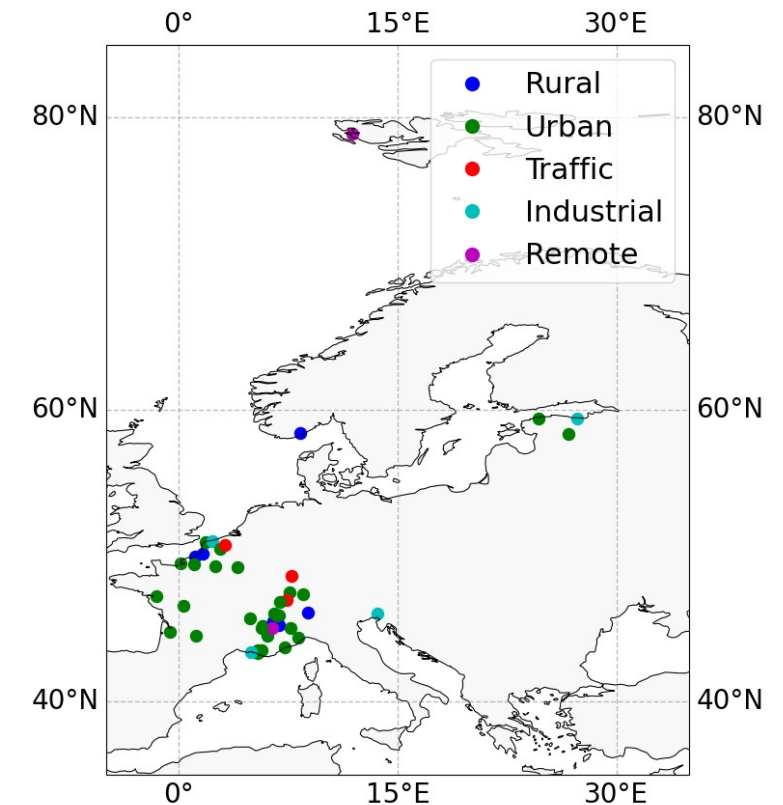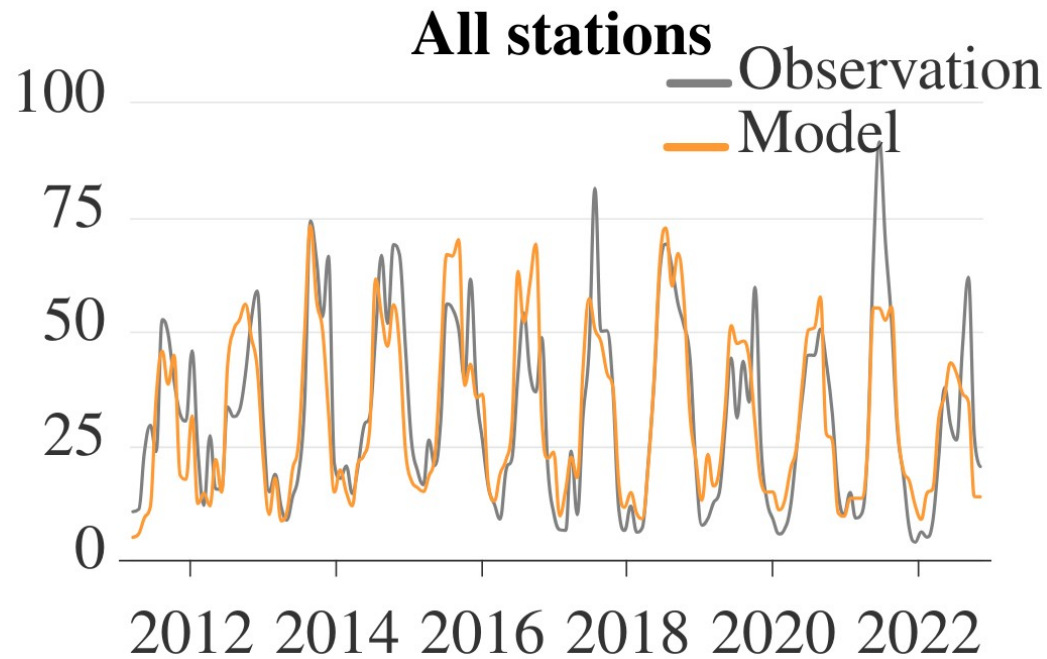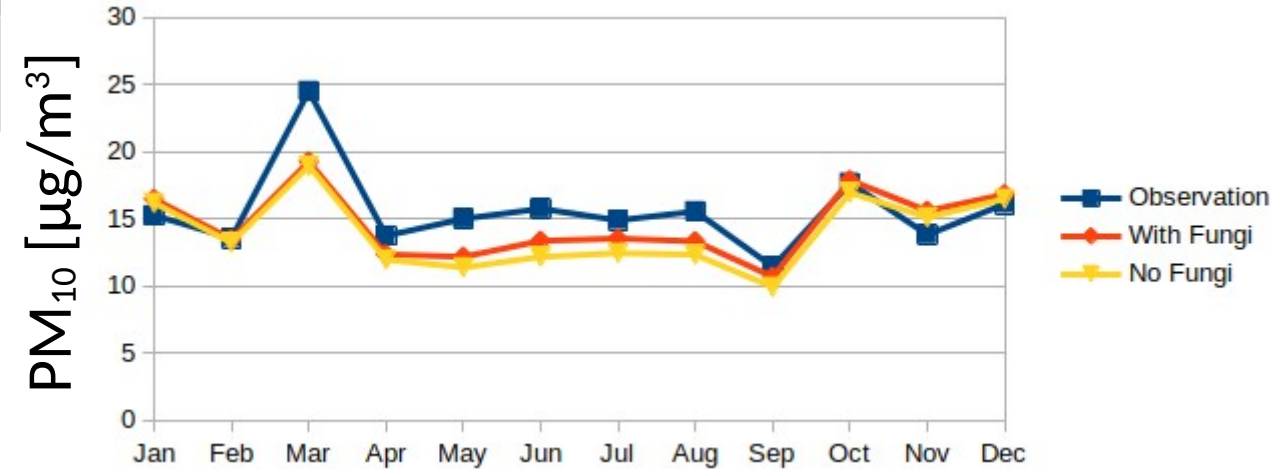# Fungal spores

- Assumed monodisperse, spore diameter 5μm

- Density of 1000 kg/m³

- Mass ratio of Arabitol + Mannitol to spore mass of 4.5%

- Implemented in EMEP and IFS-COMPO

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

Specific humidity [kg/kg]

Leaf-area index [m²/m²]

Stations with some data available 2011-2022

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

2011-2022	NMB (%)	R-space	R-time
Spores	−0.8	0.72	0.77

All stations

Observation
Model

PM$_{10}$ in 2022

Observation
With Fungi
No Fungi

2022	NMB (%)	R-space	R-time
PM$_{10}$	−8	0.78	0.64
PM$_{10}$ +spores	−2.8	0.79	0.67

Data provided by

Global results, same parameterization as in EMEP + snow cover

Fungal spores January 2019
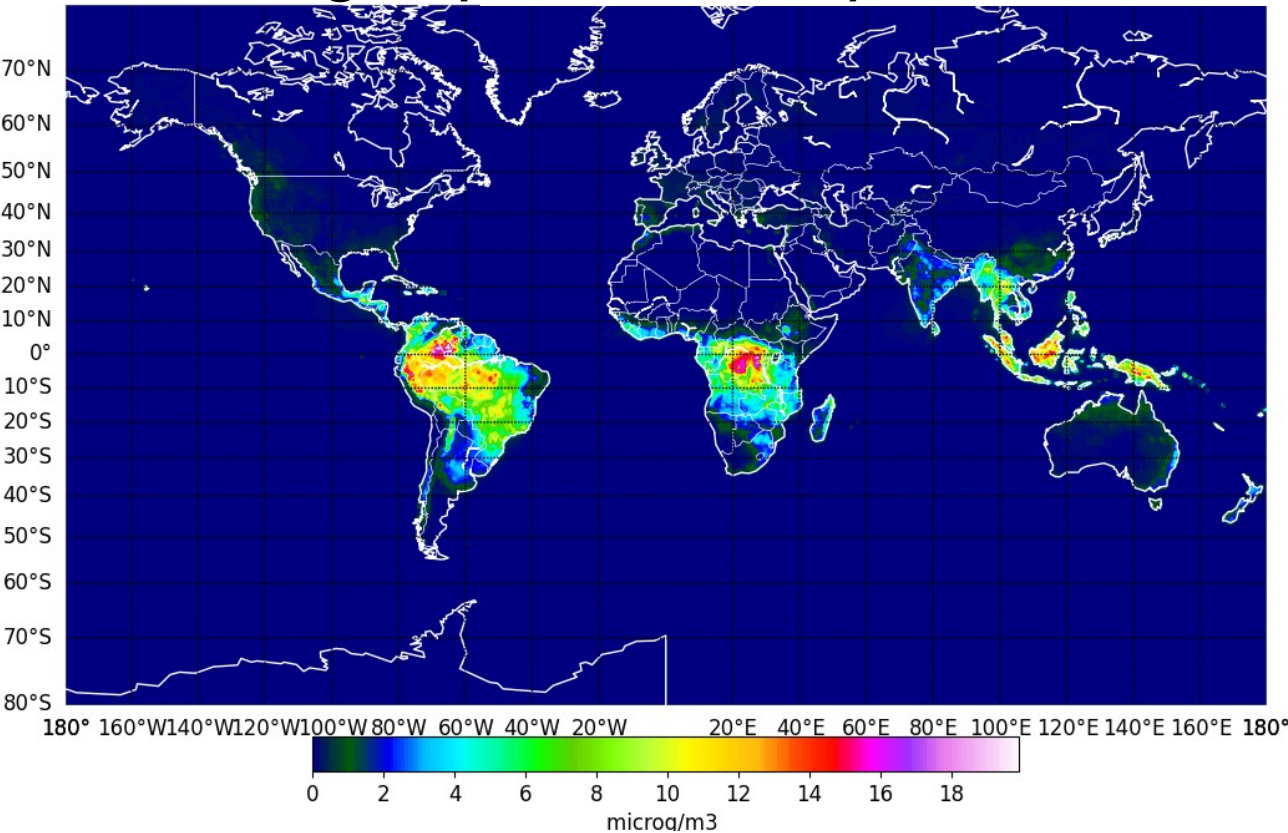
Fungal spores July 2019
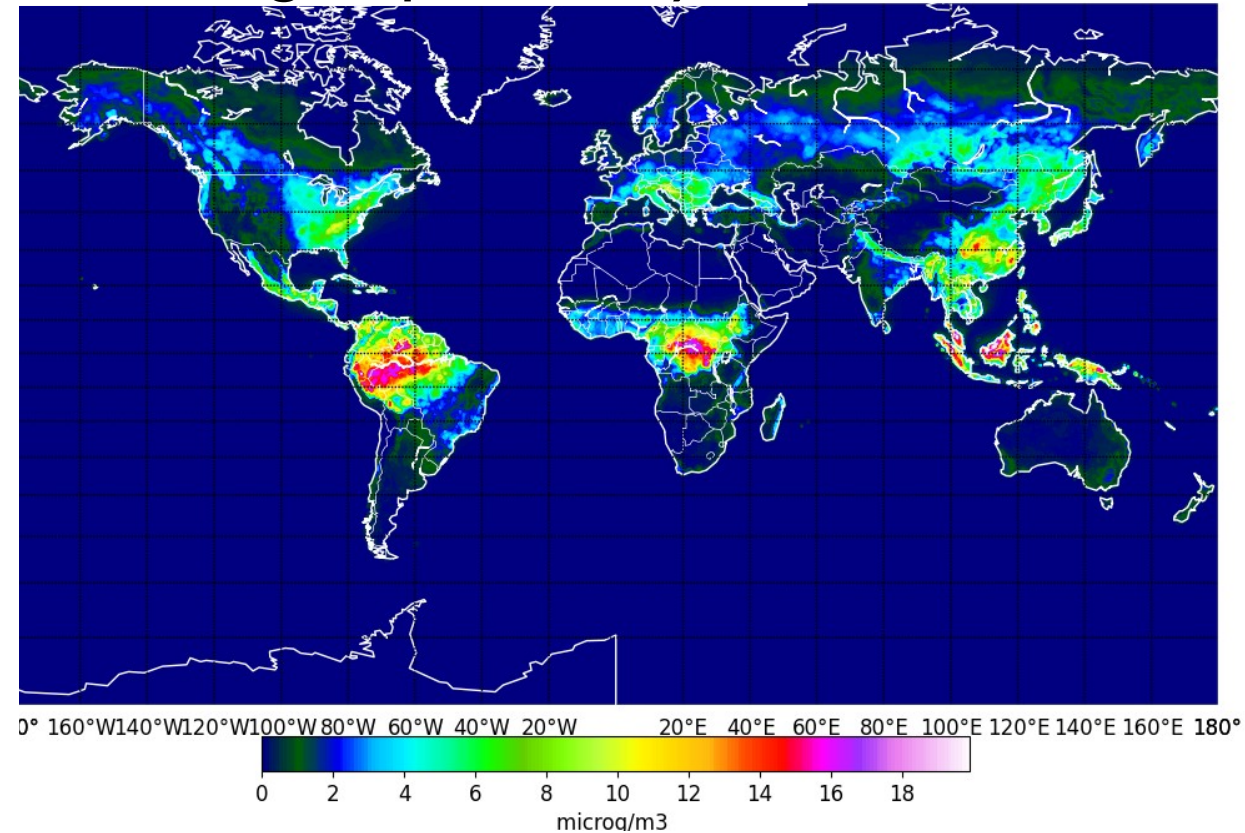
Global results, same parameterization as in EMEP + snow cover

PM$_{10}$ change January 2019   PM$_{10}$ change July 2019
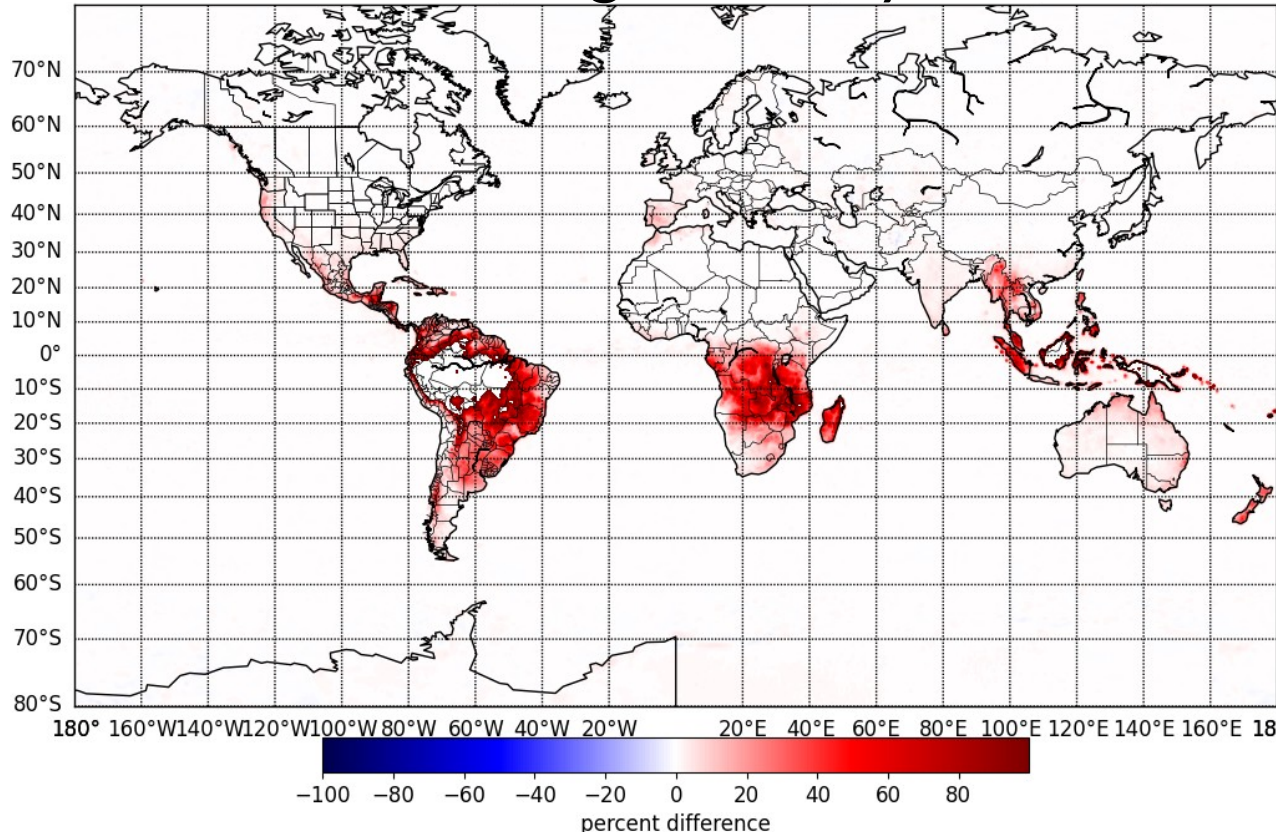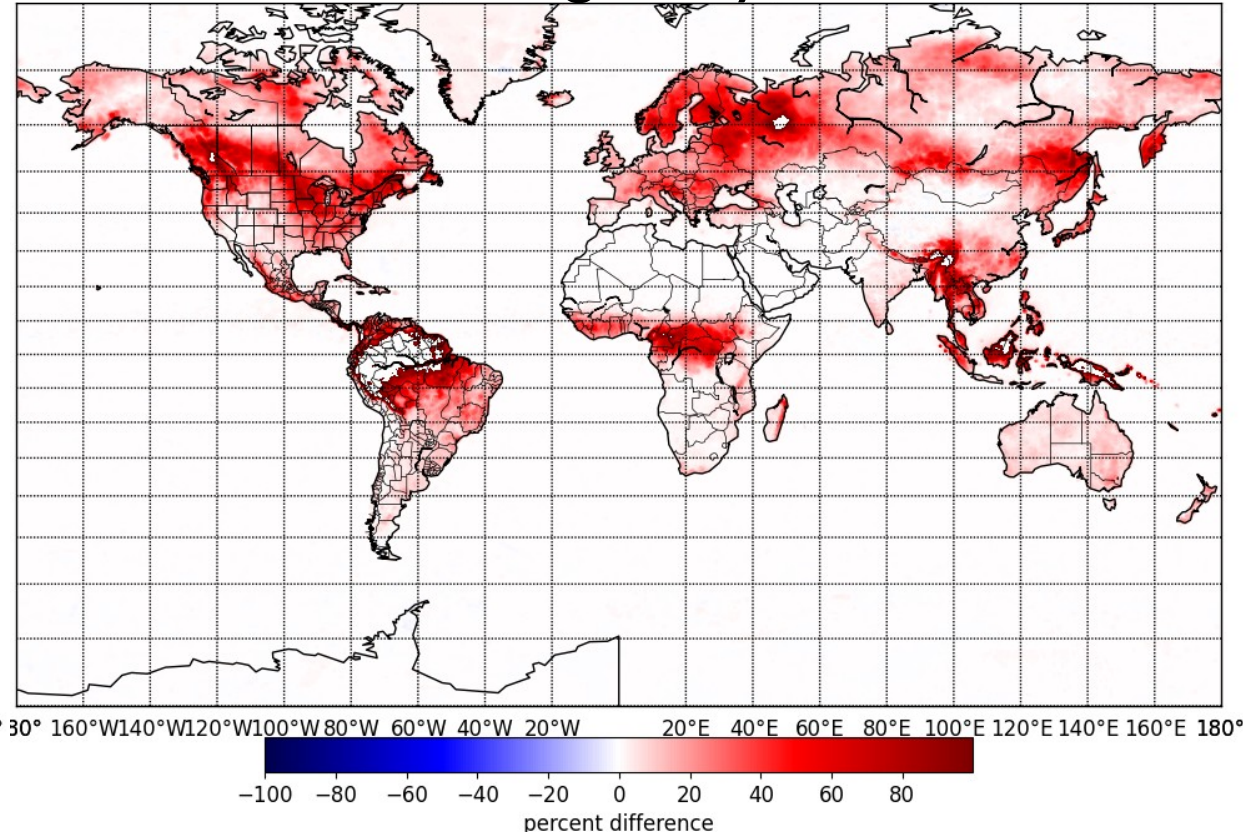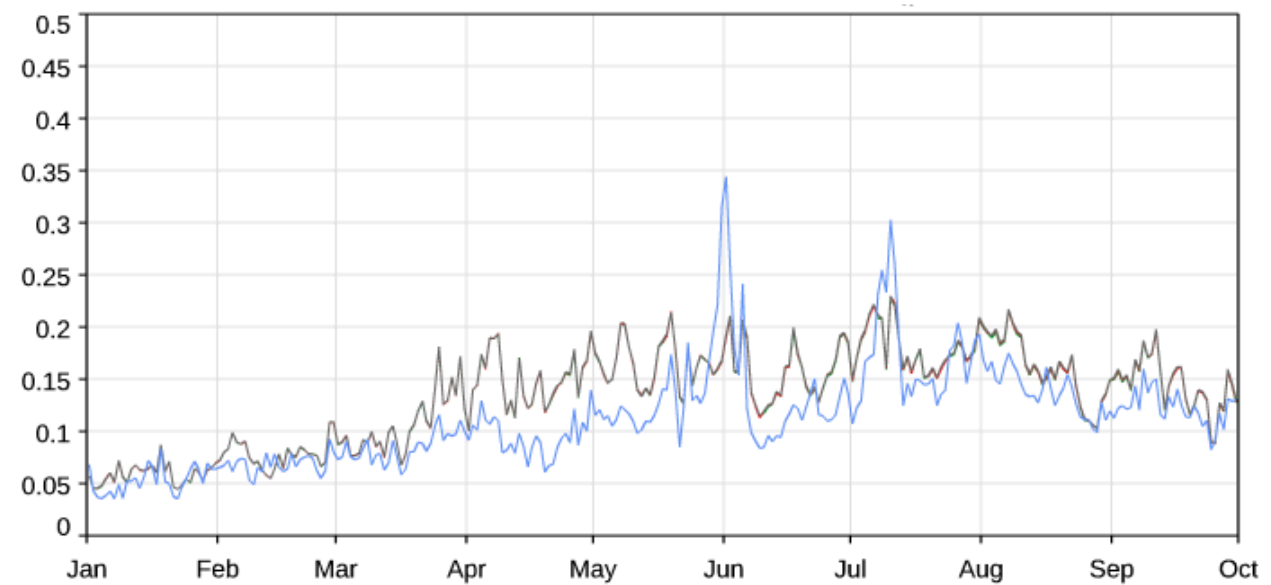
Reference PM$_{10}$ results
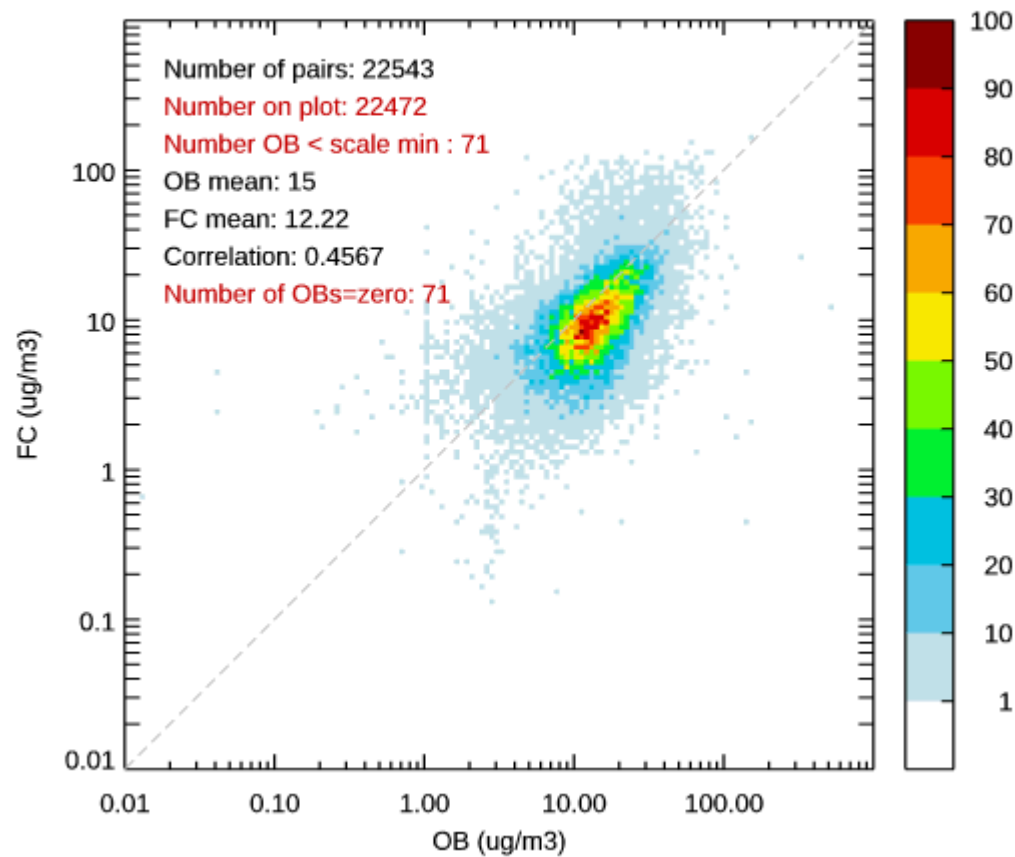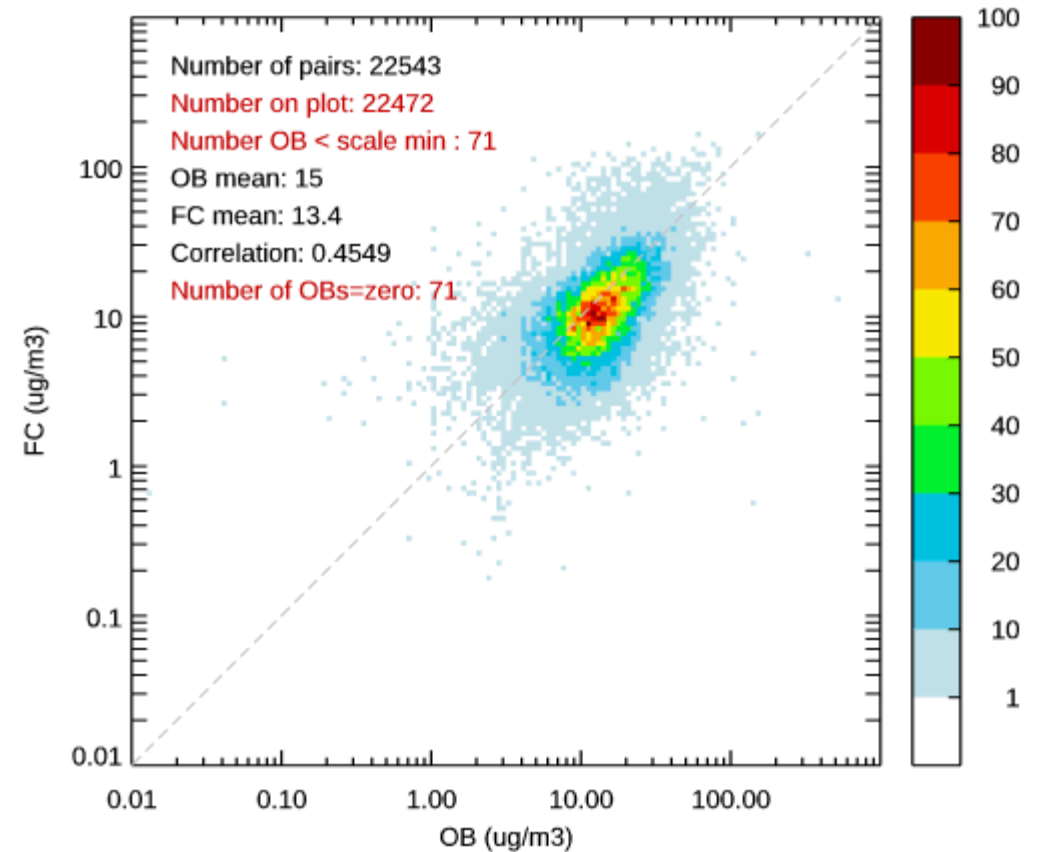
PM$_{10}$ with spores

AOD at 500nm

Blue: Observations, Green: No spores, Red: H&S5 (as in EMEP), Gray: Hummel

Europe
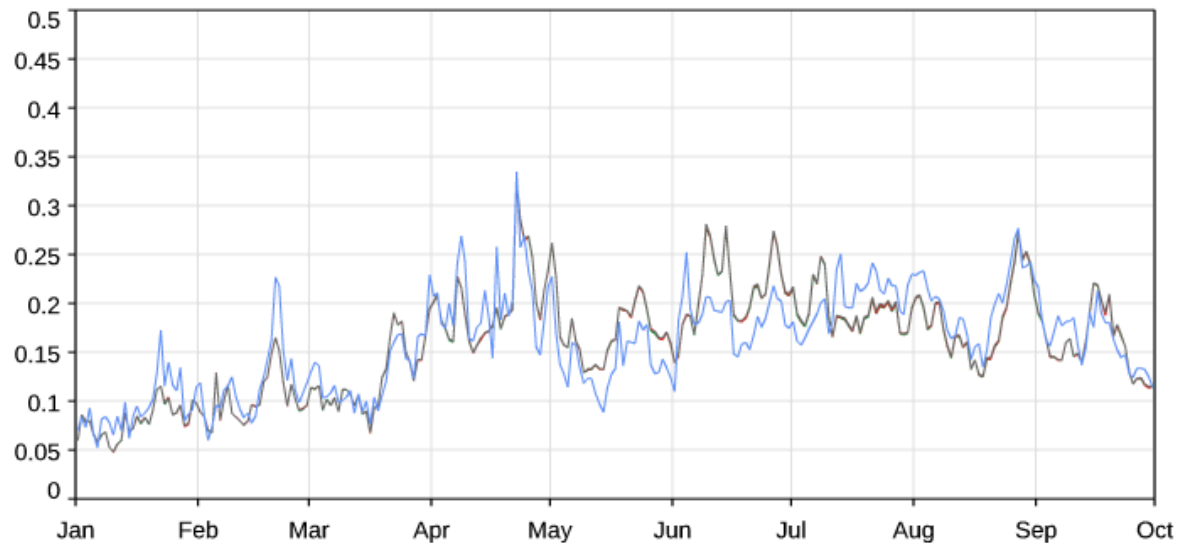
North America
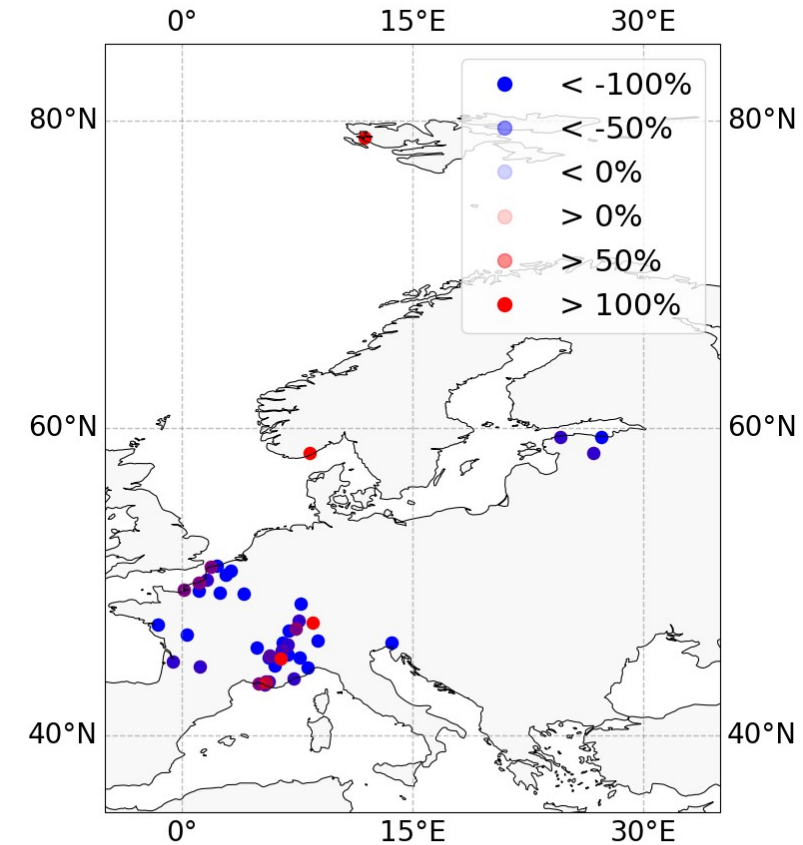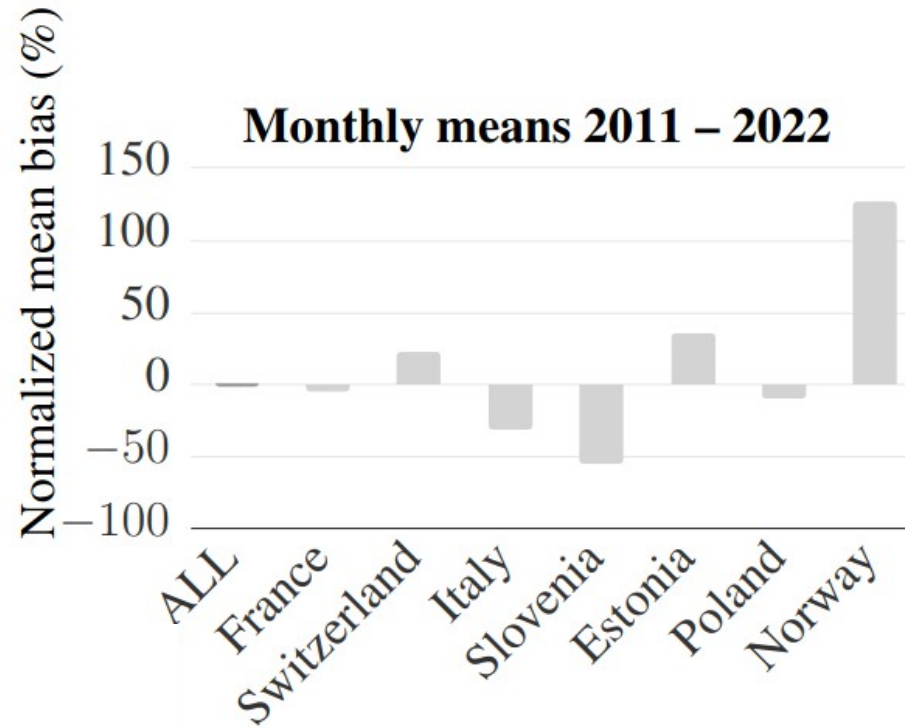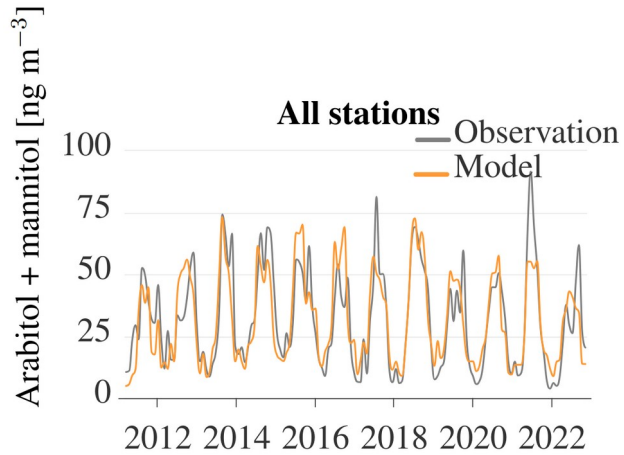
Normalized mean spore bias for available stations

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

ANDRA-OPE (France)

Birkenes (Norway)

Normalized mean spore bias for available stations

Data provided by nilu · IGE · ANDRA · INE-RIS maîtriser le risque pour un développement durable · LCSQA Laboratoire Central de Surveillance de la Qualité de l'Air
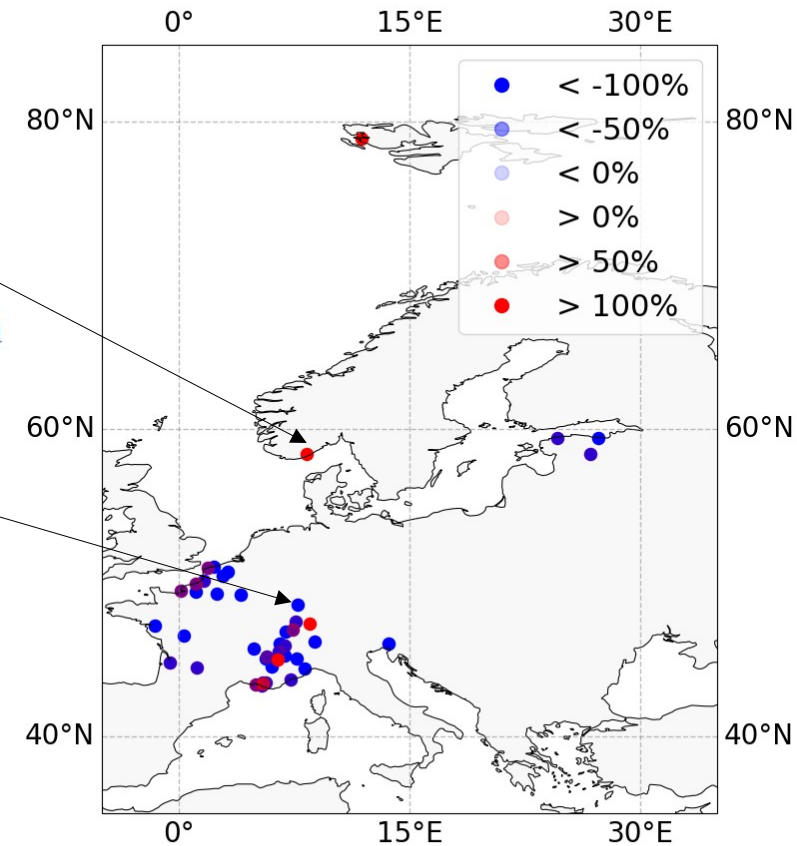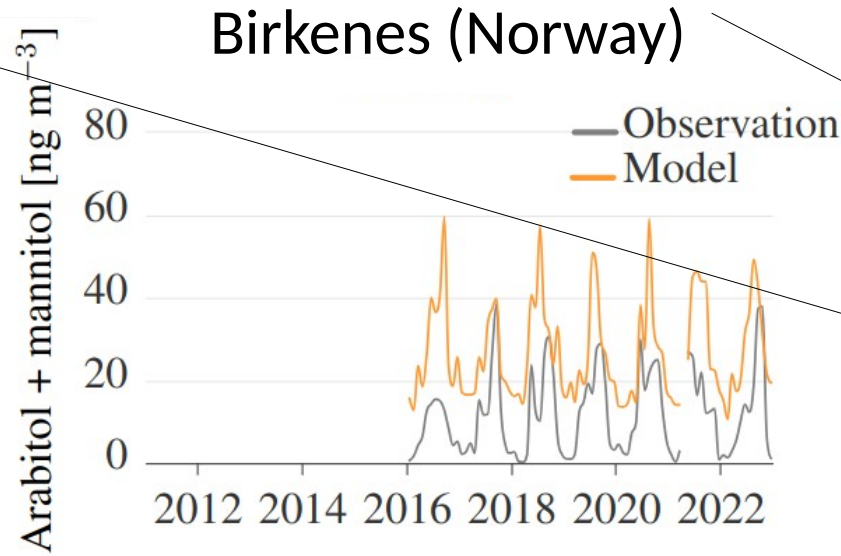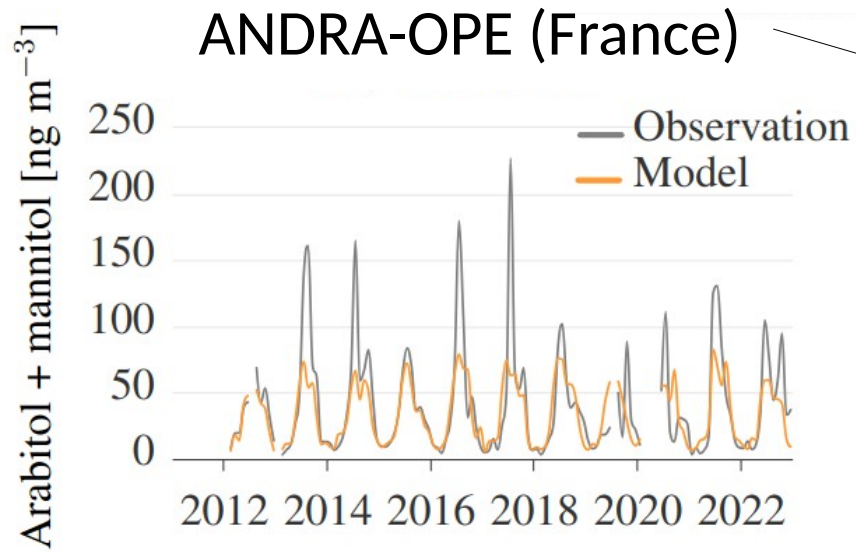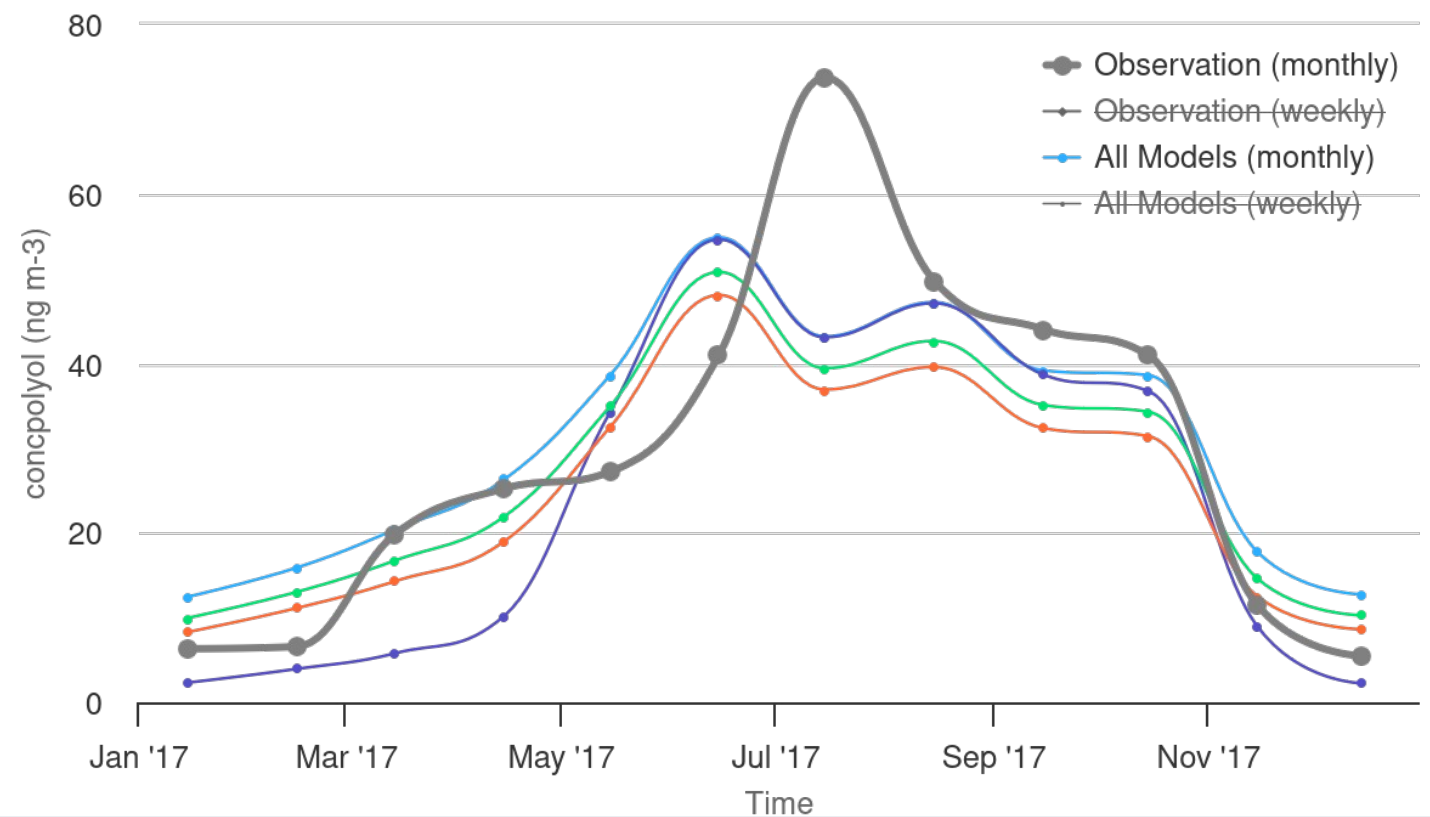
Tweaking of parameterization

- Decreasing fungi from coniferous forests

- Considering snow cover and temperature dependence

- Future : Implement different spore types/tracers in different regions
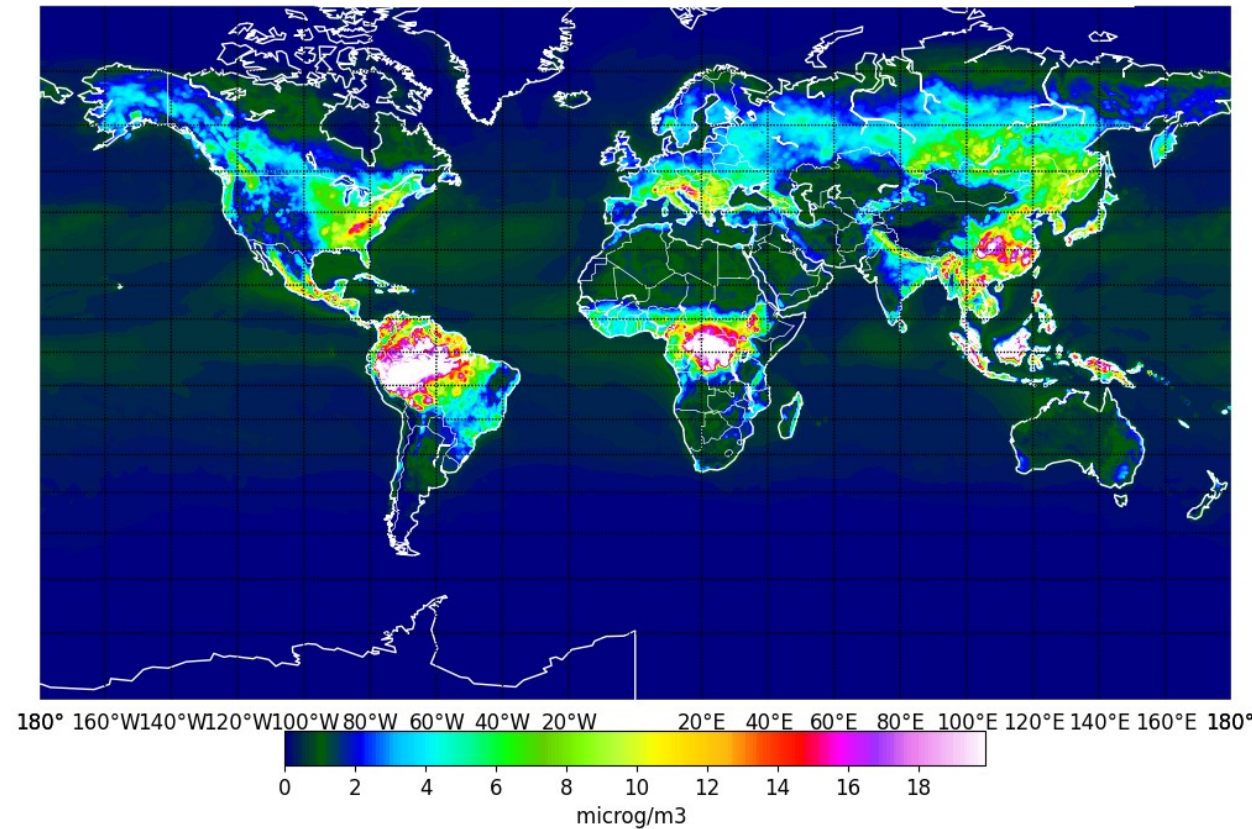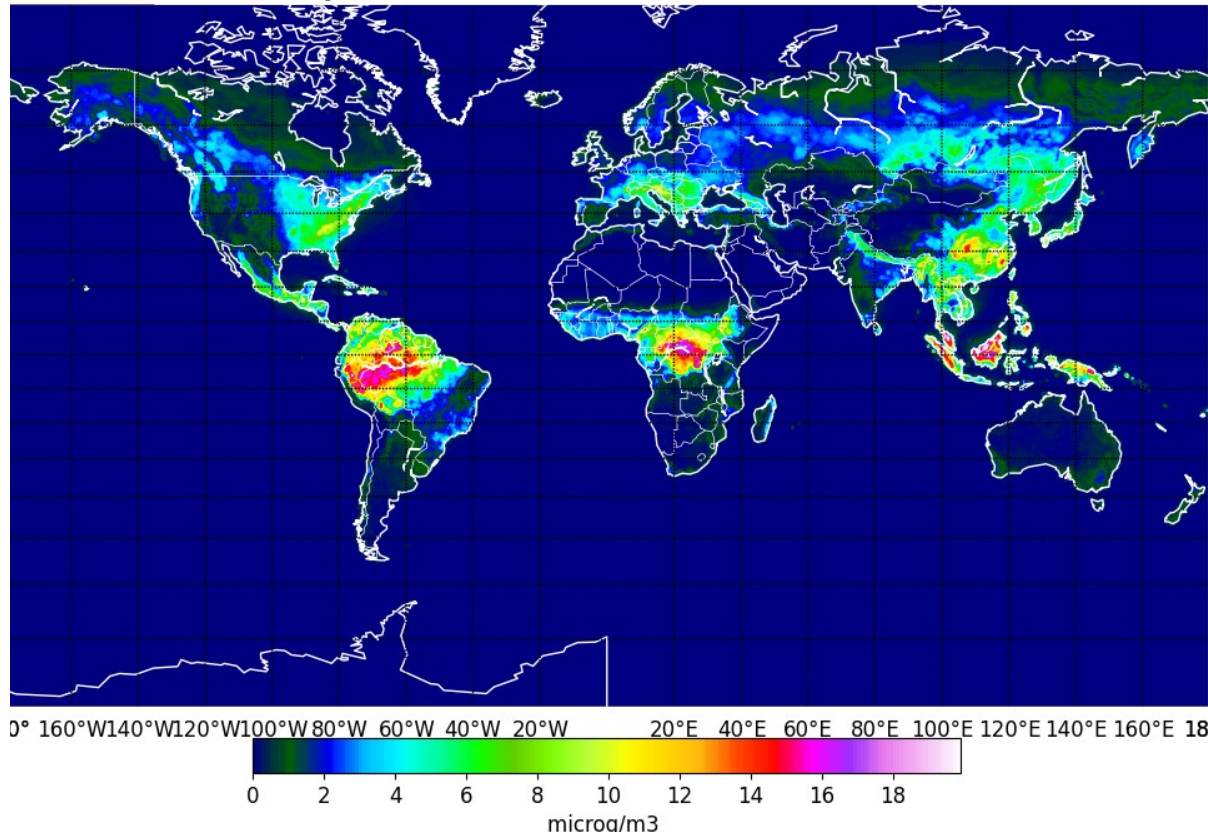
Monthly spores in 2017 - all

Tweaking of parameterization

$$F_{\text{Hm}} = 20.426 \times (\underset{\text{Temperature [}^\circ\text{C]}}{T} - 275.82) + 3.93 \times 10^4 \times q \times \text{LAI}$$
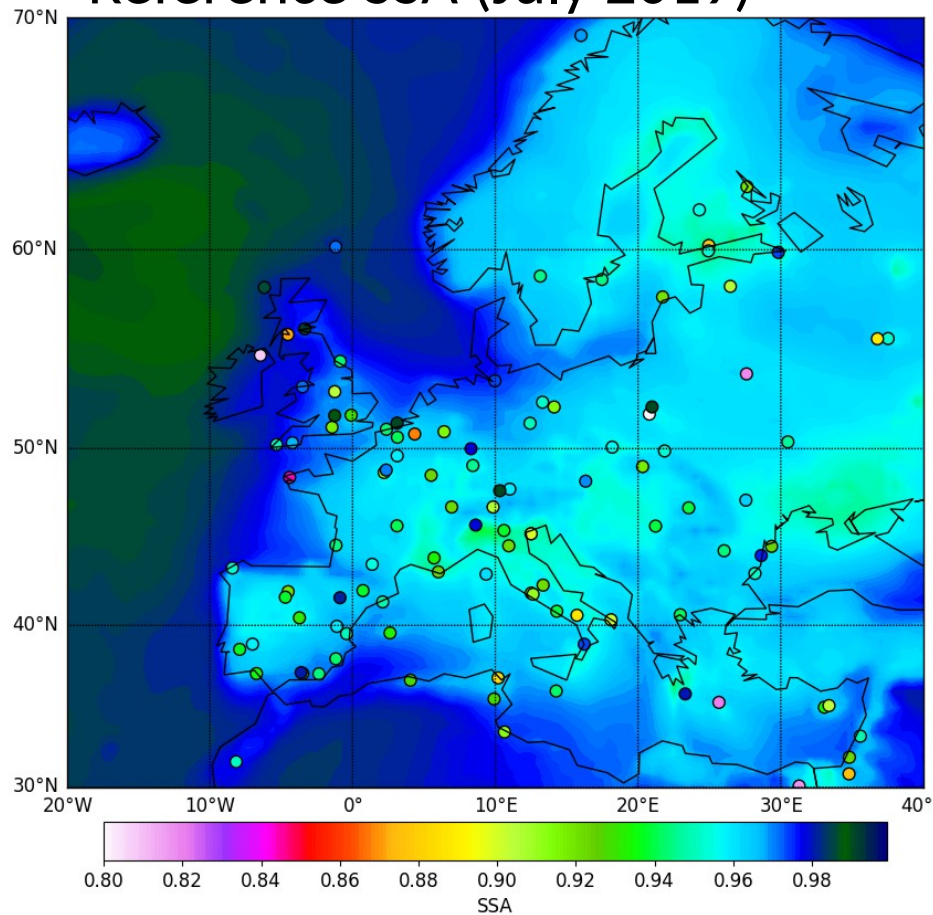
July 2019 HS5 (as in EMEP)   July 2019 Hummel
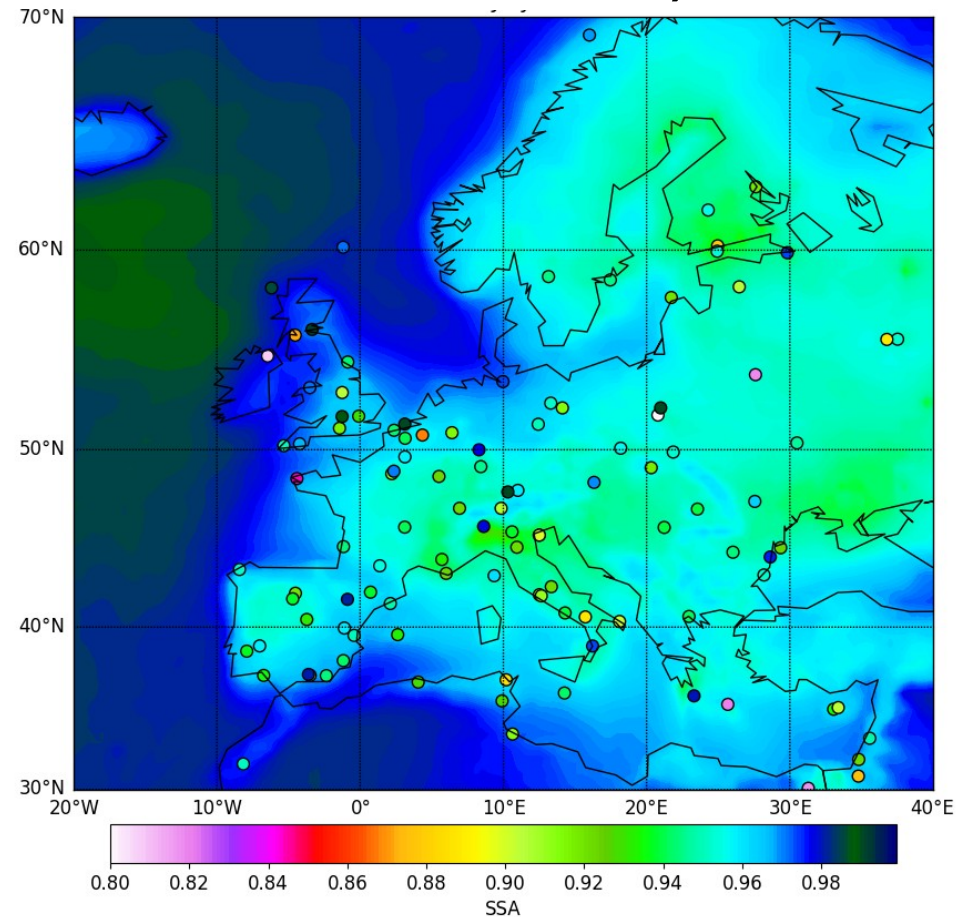
Single-scattering albedo (SSA) at 1020nm

Reference SSA (July 2019)

HS5, as in EMEP (July 2019)

- **Conclusion**

  - Spores are reasonably well represented in EMEP, but regional differences

  - PM_{10} bias improves in both models (but not over China), correlation stays comparable

- **Outlook**

  - More parameterizations, potentially more tracers, look at optical properties

  - Compare EMEP and IFS-COMPO directly