Towards a street-level pollen *concentration* and *exposure* forecast

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Background

Atmospheric pollen are an increasing source of nuisance for people in industrialised countries and are associated with significant cost of medication and sick leave. Until now little is known about the small-scale temporal and spatial variation of pollen concentrations: when and where are people exposed to the majority of pollen? And what choices do people have to minimize their exposure?

Objective

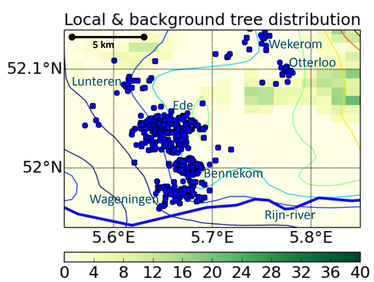
Our objective is to quantify hourly and km-scale variations in pollen concentrations, and in exposure

Model components

1. Tree distribution

- **Local tree distribution**: Municipal tree databases, mapping individual trees;
- **Large-scale tree distribution:** European tree species distribution map @ 1x1 km^2 (Statistical Mapping of tree species over Europe, Brus et al, Eur. J. For. Res., 2010).

2. Phenology:
Temperature sum approach based on local observations;

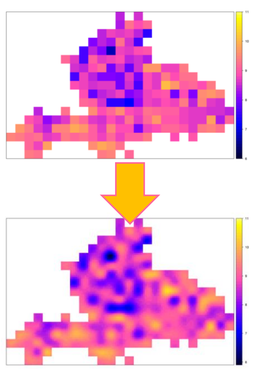


Distribution of trees around Wageningen, according to the background map and municipal data

3. Meteorology & dispersion
WRF over Europe @ 48 km^2;
Full meteo & turbulent mixing;
Nested zoom to city @ 1x1 km^2

4. Pollen:
Pollen as online, passive tracers;
Separate tracers for local and total pollen;

5. Downscaling:
geo-statistical downscaling: area to point kriging;



Area to point kriging

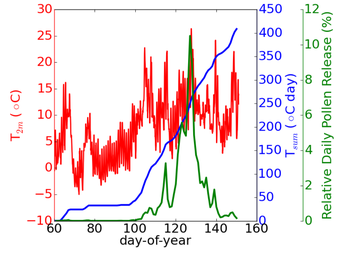
6. Validation:

- pollen traps Leiden, Helmond
- patients nuisance scores at www.allergieradar.nl
- pharmacy medicine use stats
- geo-tweets

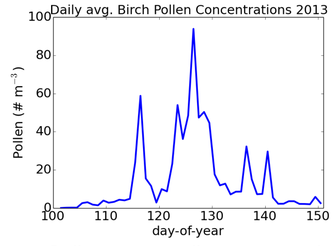
Allergy patient nuisance score Monday 13 April 2015, www.allergieradar.nl

Results: Temporal variability

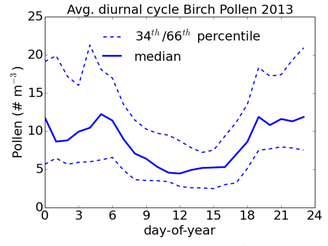
- WRF-Chem reproduces the Birch pollen season ($T_{threshold}$=3.5 °C with a bias correction of +0.7 °C)
- The pollen season is episodic: 18 days with > 10 pollen m^{-3} and 10 days with > 25 pollen m^{-3}
- Nocturnal pollen concentrations are double the daytime concentrations (*, see future developm.)



Temperature, temperature sum and daily pollen release.



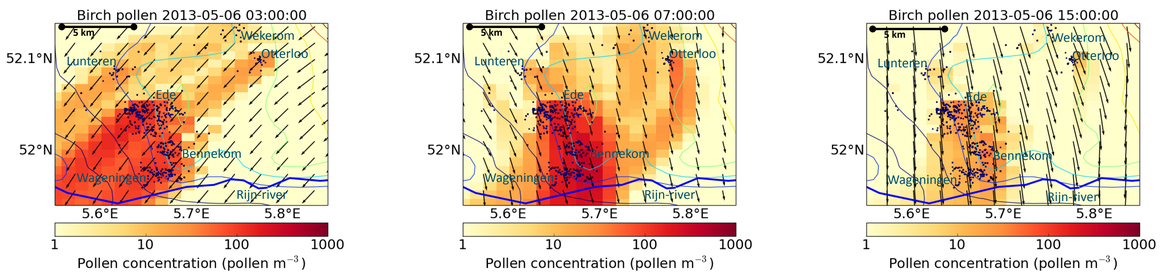
Daily average pollen concentrations in the 2013 season in Wageningen



Average diurnal cycle of pollen concentrations.

Results: Spatial variability

The Birch pollen concentration maps below (5:00h, 9:00h, 17:00h LT) show that the concentration in pollen emitted from local sources is variable on short spatial scales: the concentration may change from 4 to 400 pollen m^{-3} over 5 km distance.



Simulated Birch pollen concentrations from local sources at 3:00h, 7:00h, and 15:00h UTC. LT=UTC+2h. The blue dots indicate the locations of the Birch trees. Arrows indicate wind direction and speed. Contour lines indicate topography.

Conclusions

- Birch pollen concentrations from local sources are variable: diurnally by a factor 2 and spatially by a factor 100.
- This allows hay fever patients to **manage their exposure**, if high spatial and temporal resolution information is available.

Future developments

- (*) Model improvement: pollen deposition and pollen release due to wind & turbulence
- Validation with observations and citizen science data.
- Quantification of exposure options and travel planner.

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