European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

USING WRF-HYSPLIT IN GIS TO STUDY BIOAEROSOLS

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year 2: 1 July 2013 - 30 June 2014 (*Ongoing Action*)

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(WG Member (since September 2013))

University of Worcester

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COST European Cooperation in Science and Technology

EuNetAir

European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

Scientific context and objectives

(RECYCLED FROM THE COPENHAGEN MEETING!)

- **Background / Problem statement:**
  - Seasonal Allergic Rhinitis reduce quality of life
  - Seasonal Allergic Rhinitis is expensive
    - In some countries total costs exceed costs of Asthma
  - One of the most common causes is birch (*Betula*) pollen
    - Little is known about oak (*Quercus*) and alder (*Alnus*)
    - Sensitisations: *Betula* (25%), *Quercus*(20%), *Alder*(?)
  - Considerable cross reactivity between families of trees
  - Considerable effects of co-exposure of air pollution
  - Known effects on chemicial transformation of allergens in pollen

Scientific context and objectives

<u>(RECYCLED FROM THE COPENHAGEN MEETING!)</u>

- **Brief reminder of objectives:**
  - Studies on new sensor systems (WG2/WG3)
  - Development of air quality modeling (WG3)
  - Environmental observations of bioaerosols (WG3)

Scientific context and objectives

(RECYCLED FROM THE COPENHAGEN MEETING!)

- **Background / Problem statement: The target**

***Alnus* (alder) pollen**
allergenic potential 4 (scale 1-5)

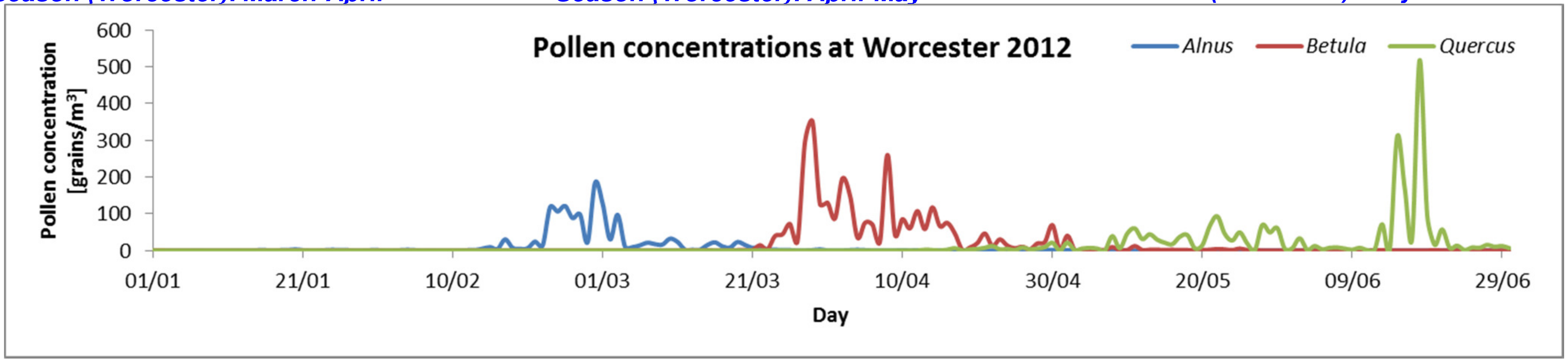
Size: ~ 25 um
Season (Worcester): March-April

***Betula* (birch) pollen**
allergenic potential 5 (scale 1-5)

Size: ~ 20 um
Season (Worcester): April-May

***Quercus* (oak) pollen**
allergenic potential 4 (scale 1-5)

Size: ~ 30 um
Season (Worcester): May-June



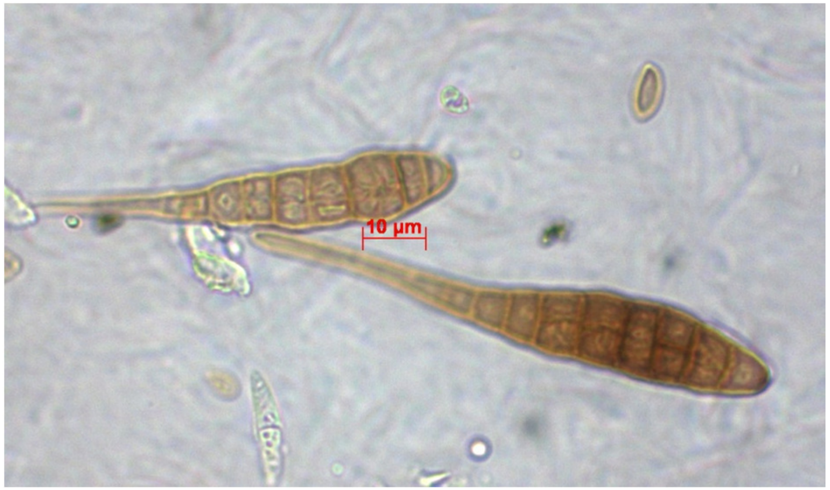
Current activities of the partner

(RECYCLED FROM THE COPEHAGEN MEETING!)

- Pollen/spore research, monitoring and forecasting

Spatial analysis of pollen emissions

Start, duration and severity of pollen & spore seasons



Current activities of the Partner (1/2)

(RECYCLED FROM THE COPEHAGEN MEETING!)

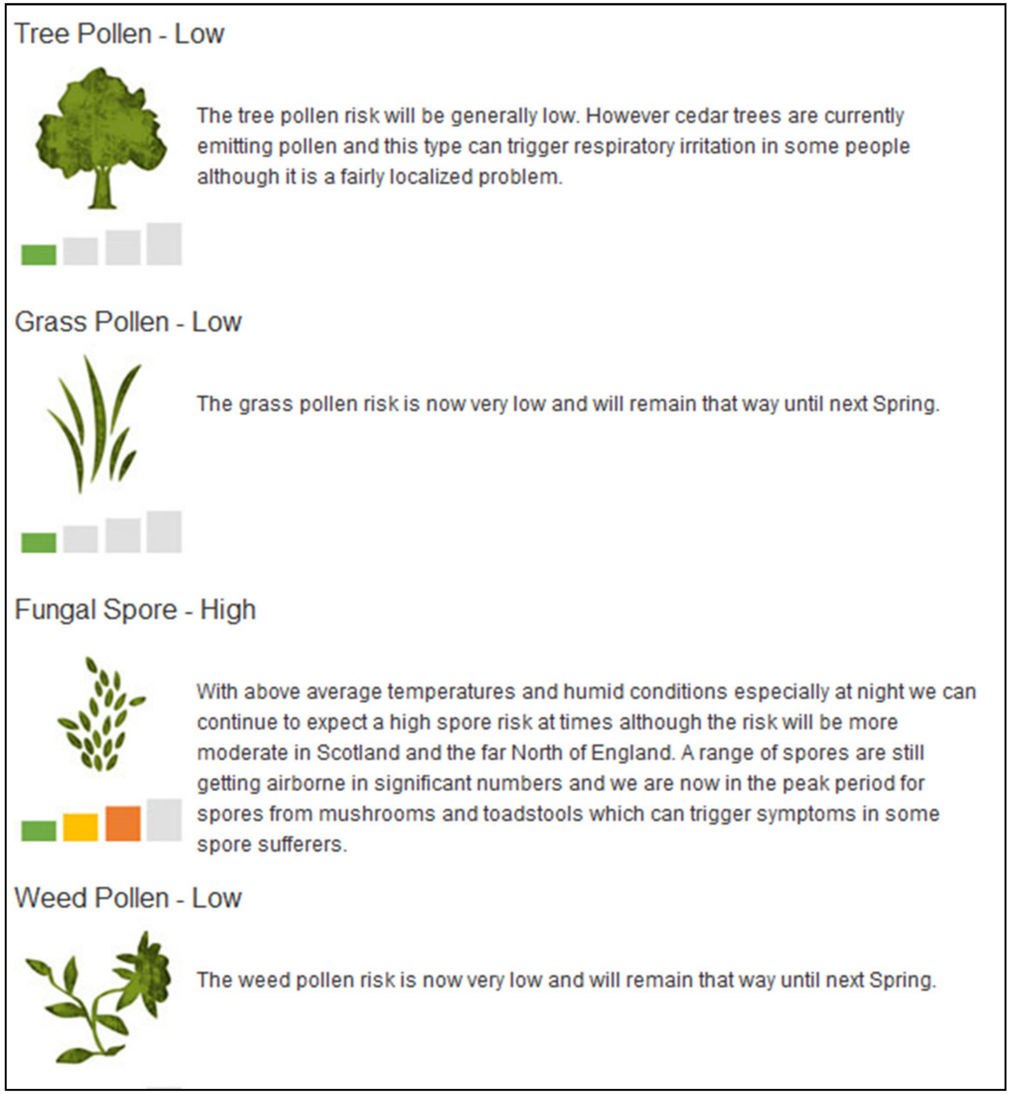
- **Pollen/spore research, monitoring and forecasting**

Pollen, spore and weather monitoring

Current activities of the Partner (1/2)

(RECYCLED FROM THE COPEHAGEN MEETING!)

- **Pollen/spore research, monitoring and forecasting**



Tree Pollen - Low

The tree pollen risk will be generally low. However cedar trees are currently emitting pollen and this type can trigger respiratory irritation in some people although it is a fairly localized problem.

Grass Pollen - Low

The grass pollen risk is now very low and will remain that way until next Spring.

Fungal Spore - High

With above average temperatures and humid conditions especially at night we can continue to expect a high spore risk at times although the risk will be more moderate in Scotland and the far North of England. A range of spores are still getting airborne in significant numbers and we are now in the peak period for spores from mushrooms and toadstools which can trigger symptoms in some spore sufferers.

Weed Pollen - Low

The weed pollen risk is now very low and will remain that way until next Spring.

Key provider of quality pollen and spore forecasts

Facilities available for the Partner (2/2)

(RECYCLED FROM THE COPEHAGEN MEETING!)

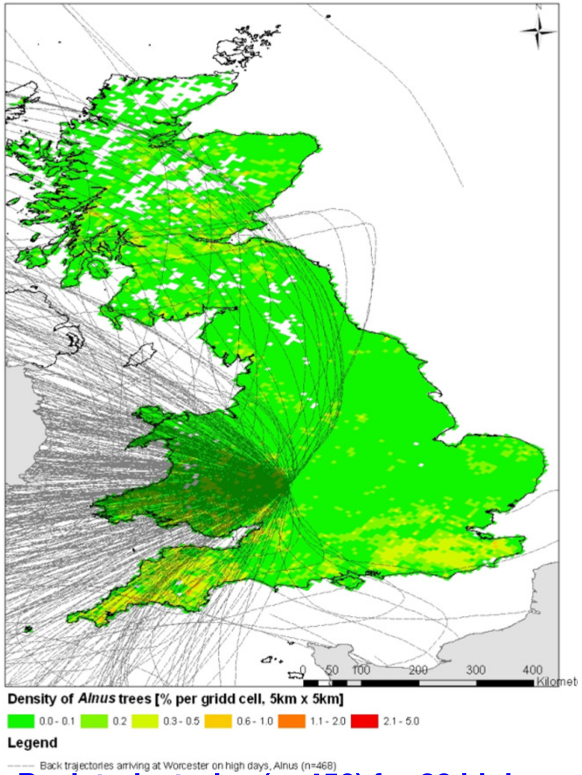
- **Research/Measurement/Service Facilities:**
- Long time series of observed bioaerosols (pollen and fungal spores)
- Environmental chamber + GCMS
- Good range of bioaerosol sampling equipment
- High quality laboratories (from 2010) and experienced staff
- Atmospheric models and own computing facilities
- Extended permission to use UAVs
- Rotary wing UAV (existing permission) and from 2014 a fixed wing UAV, designed for remote sensing and airborne sampling

Facilities available for the Partner (2/2)

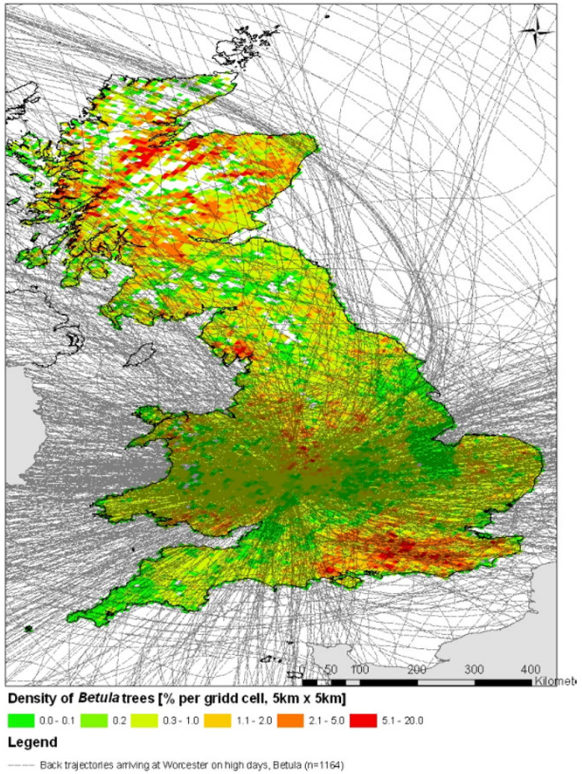
(RECYCLED FROM THE COPEHAGEN MEETING!)

Achieved **RESULTS** and future activities

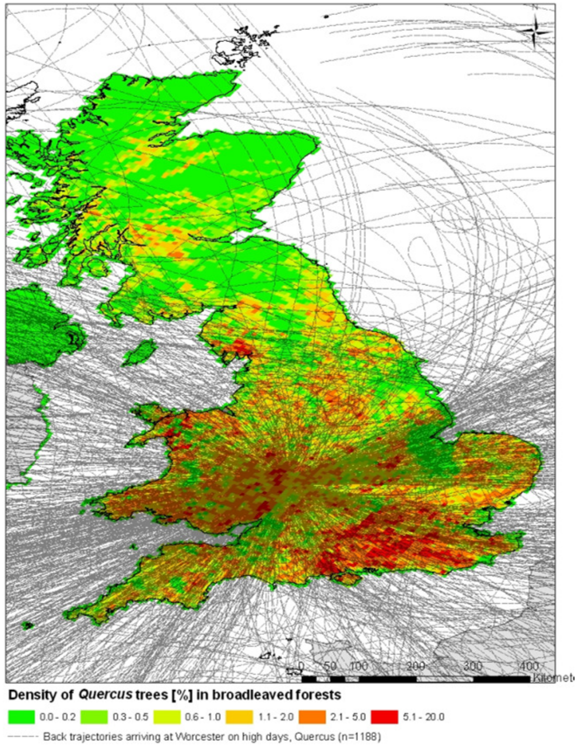
- **Activities directions as RESULTS:**
  - **(Submitted to Urban Climate, EUNetAir special issue, December 2013)**



Back trajectories (n=456) for 38 high days of *Alnus* (alder) pollen



Back trajectories (n=1164) for 97 high days of *Betula* (birch) pollen



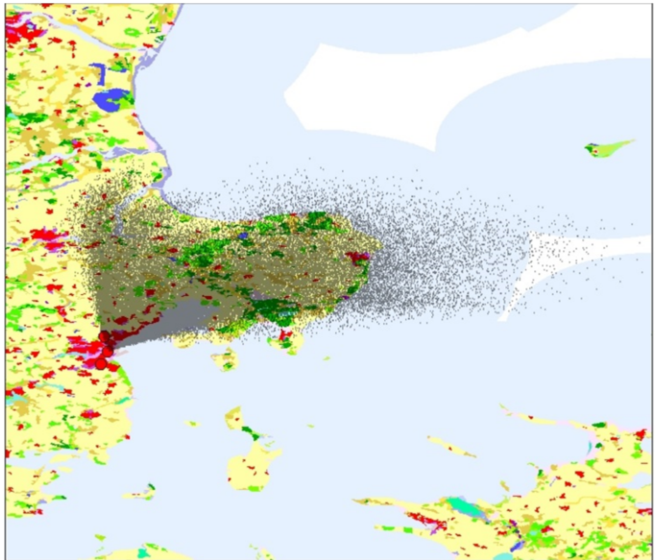
Back trajectories (n=1284) for 107 high days of *Quercus* (oak) pollen

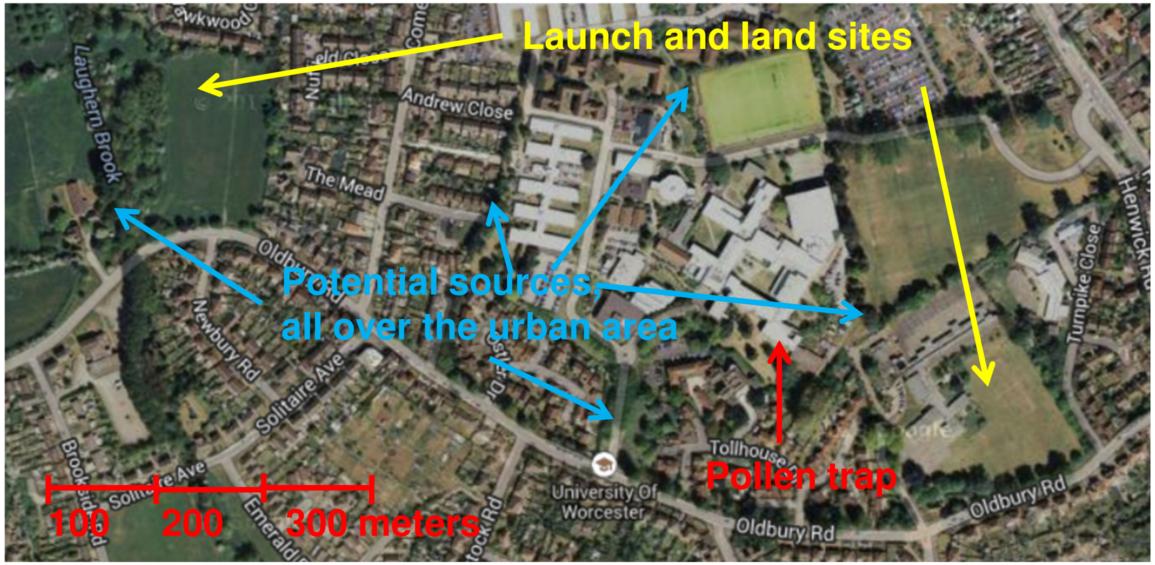
Future planned Activities

- **Activities directions as future ACTIVITIES:**
- Advanced spatial modelling bioaerosols (pollen, spores)
  - Neural Network Methods
  - Receptor based modelling (trajectories+particle dispersion models)
  - Source based modelling (WRF-Chem)
  - Dynamic Modelling of Chemistry and Biology. Focus on climate driven emissions
  - Use of UAVs for remote sensing in urban areas (2014-15, the SUPREME project)
- Improvement of current forecast products for the UK
- New applications for further development of UAVs as an generic platform for small sensors (1 proposal under contract neg.)

Future planned **Activities**

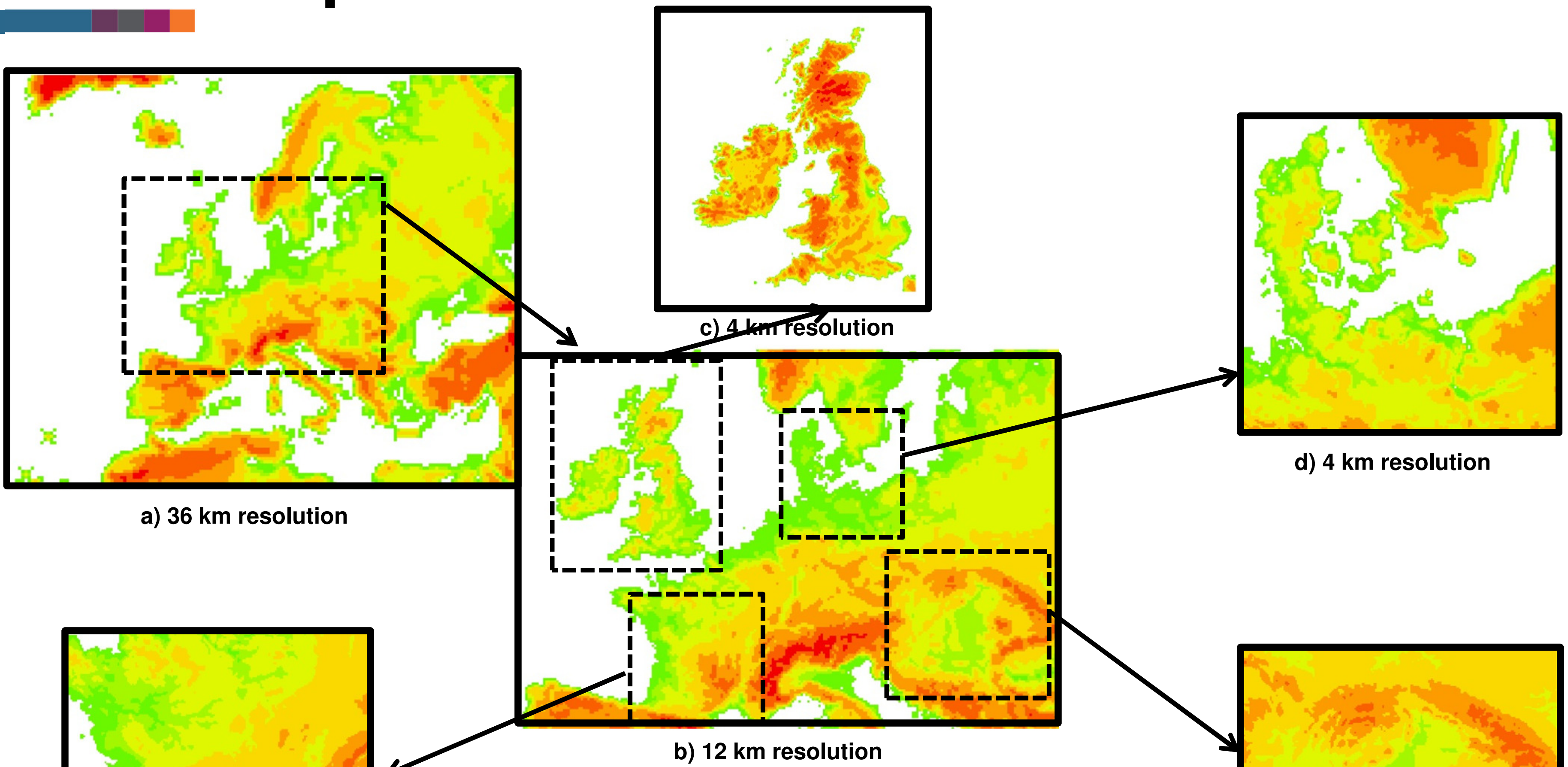
- **Activities directions as future ACTIVITIES:**
- 1. Use of UAVs and Atmospheric Modelling on bioaerosols
  - Planning of urban campaigns in 2014-15, training in using UAV
- 2. Use of WRF-Chem in relation to bioaerosols and climate driven emissions (especially ammonia and BVOCs)
- 3. Use of particle dispersion models

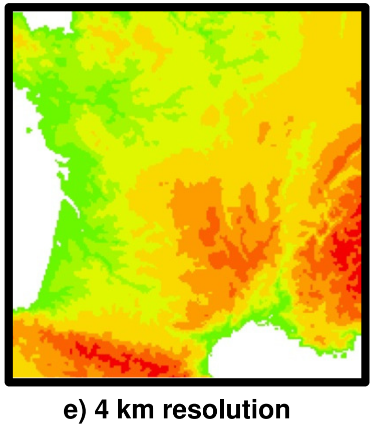


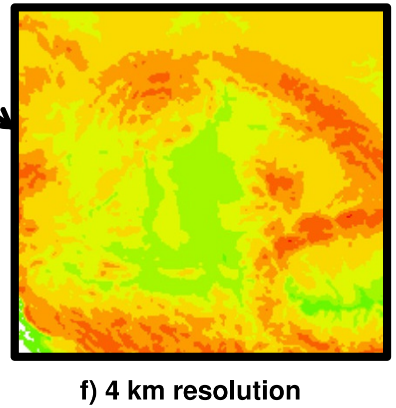


1. Funded by Danish Research Council (DRC)
2. Funded by DRC & commercial contracts on pollen forecasts
3. Funded by DRC & University of Worcester

Future planned Activities on WRF/WRF-Chem







Nests activated in relation to specific research activities funded by:

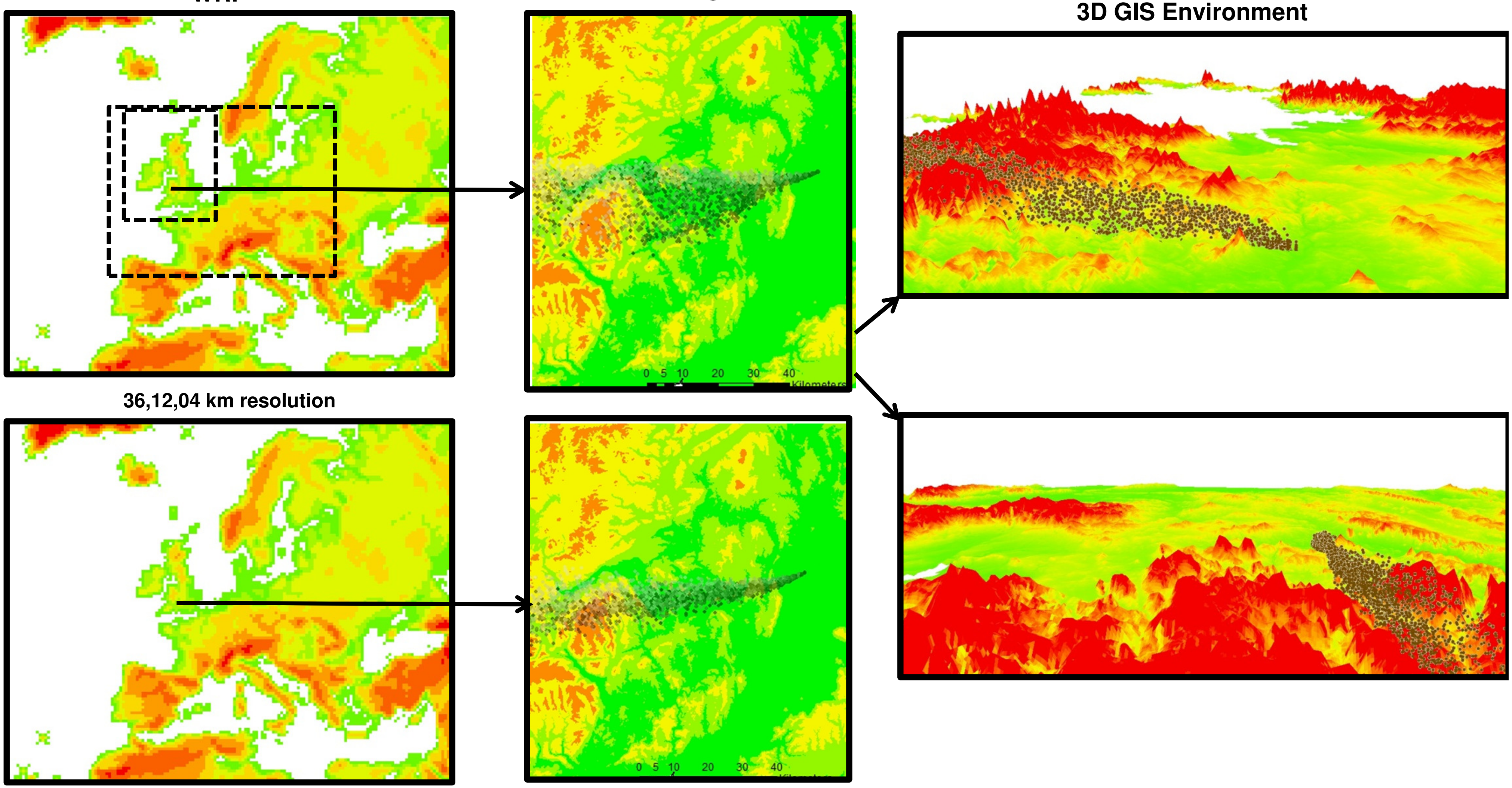
1. Danish Research Council (a,b,c,d)
2. Commercial contracts on pollen forecasts (a,b,c)
3. EU FP7 (a,b,c,d) - negotiation ongoing
4. COST Network SMARTER (a,b,e,f)
5. University of Worcester (a,b,c,e,f)

Future planned Activities on WRF-HYSPLIT

WRF

WRF-HYSPLIT

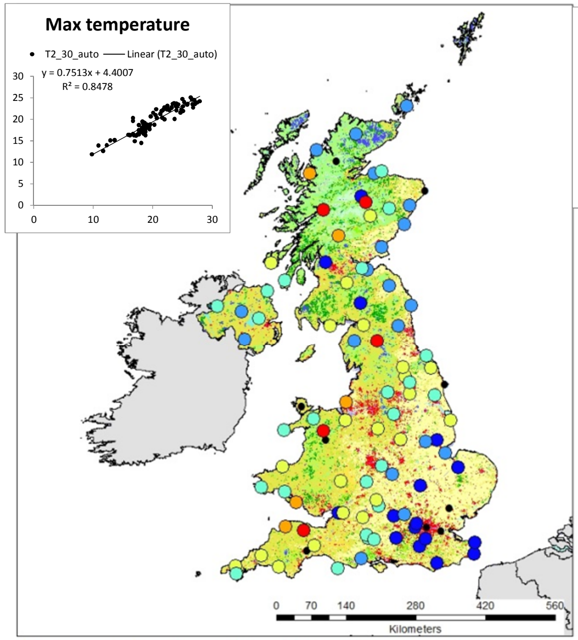
3D GIS Environment



36,12,04 km resolution

36 km resolution

Prelimenary results on WRF-HYSPLIT



Bias, max surface temperatures during 2009 study period

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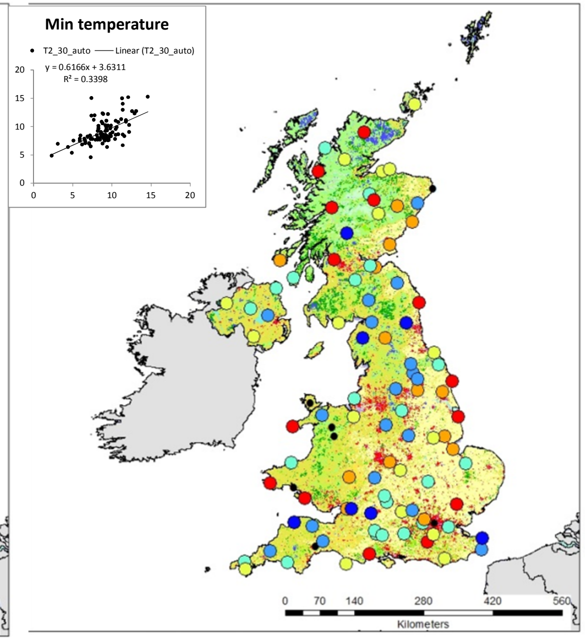
WRF-validation



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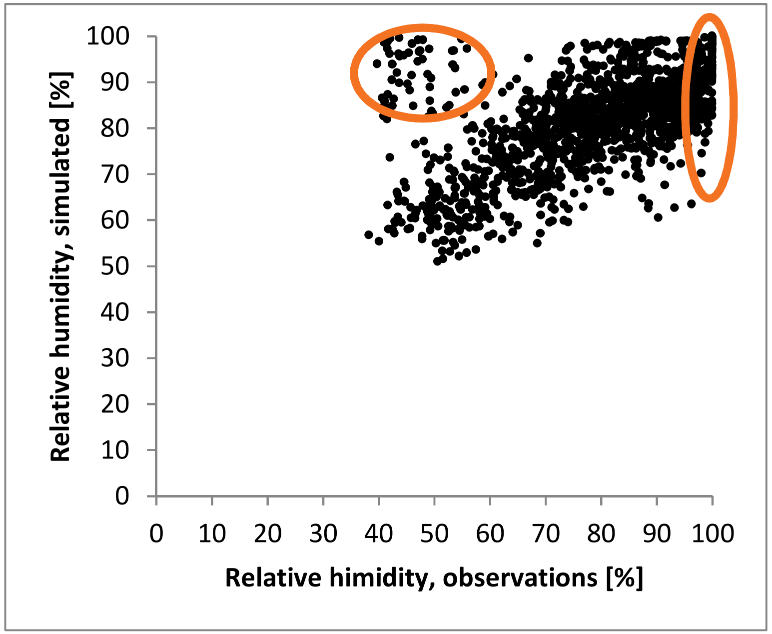
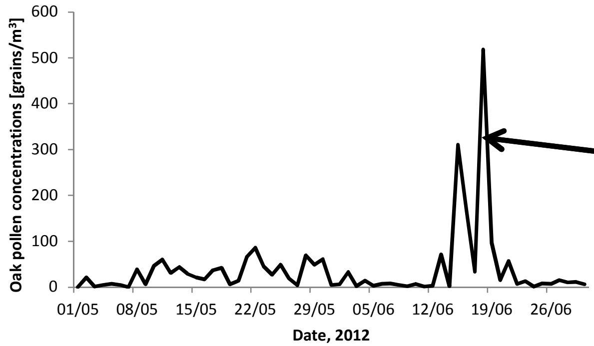
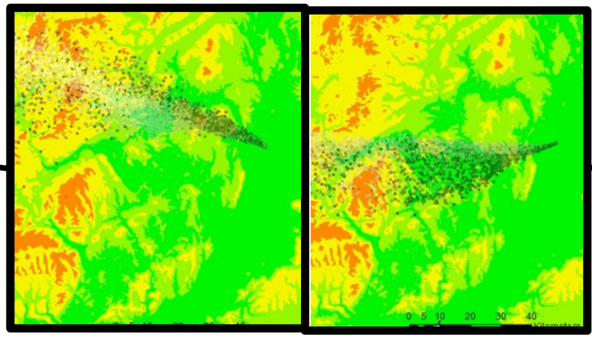
WRF-validation



WRF-validation

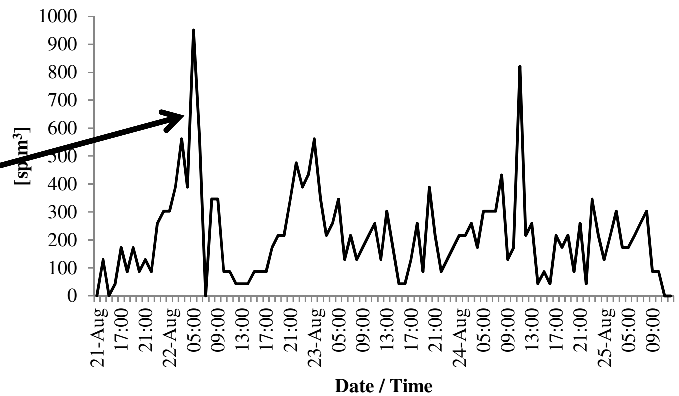


Observed *Quercus spp* (oak) concentrations



Daytime! **Nighttime!**

WRF-HYSPLIT simulations



Observed *Ganoderma sp* concentrations

Future planned Activities on UAVs (drone activities)

- **UAV development at University of Worcester:**

- Phase1: Current fixed wing solution:
  - Contain NIR camera, resolution 2-4 cm
  - On-line temperature, humidity and pressure observations
  - 1-2 hours of flight time
  - Using existing UAV (drone) in rural and urban environment
  - Minor visual modifications (picture) currently implemented
- Phase 2: New development of payload (2014-18)
  - Sampling methodology for bioaerosols for microscopic detection
  - New sampling methodology for *Alternaria alternata* (fungal spore)
  - Using new UAV (drone) in rural and urban environment
- Phase 3: New partners/project proposals:Horizon2020, ERC???

CONCLUSIONS

- Sources to bioaerosols:
  - Novel maps of bioaerosols and a methods for using GIS data with atmospheric models –paper submitted
- Modelling development
  - WRF-HYSPLIT established and connected with GIS environment
  - Scale seem to be a fundamental issue and sensitivity on setup of models.
  - Issues with respect to description of surface variables for climate driven emissions, especially bioaerosols (minT, maxT, humidity)
- Open problems – mainly related to modelling and use of UAVs
  - Limitations in modelling are unknown, biological processes are stochastic
  - Use of UAVs is restricted
  - Experience on the use of UAV is very limited -> learn as you go
- Possibilities (ERC and Horizon2020)
  - Mainly on WRF-HYSPLIT, WRF-Chem and drone technology