Lessons learnt from Ragweed and Birch studies

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Background

- Hayfever: a large impact on life
  - Affects life quality [1]
  - Is expensive [2]
  - Interacts with asthma [3]
- Exposure to birch and ragweed pollen is important:
  - Europe/USA - YES [4]
  - All major continents - Maybe

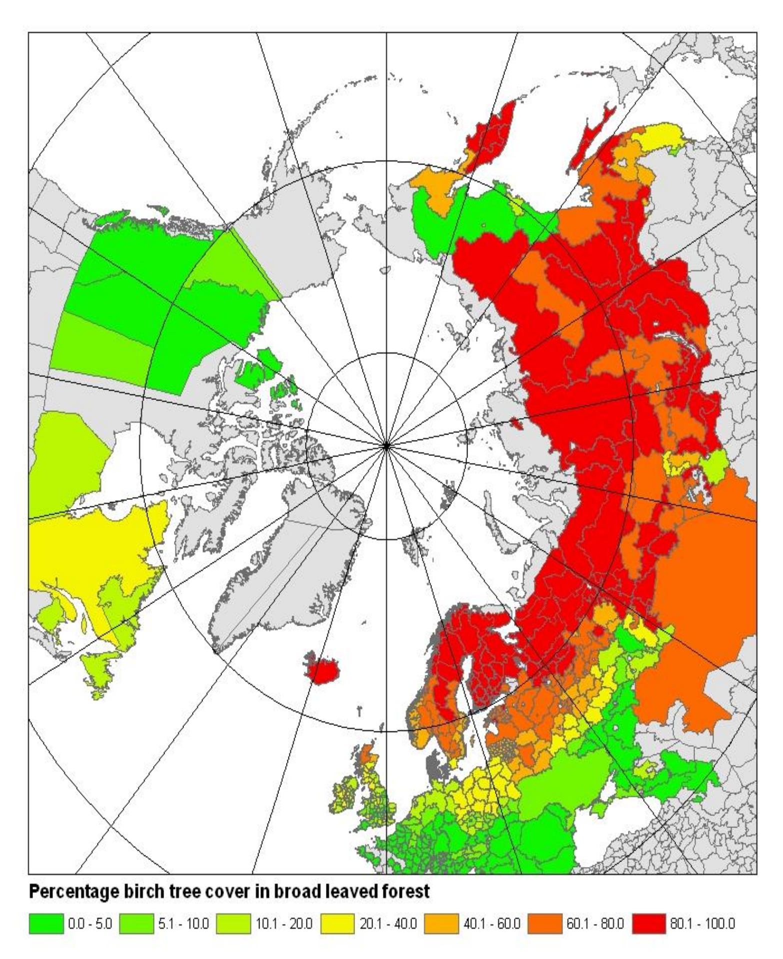
	SSR - birch	SSR - ragweed
Europe	24.2	14.1
Austria	19.4	8.5
Belgium	17.6	3
Denmark	57.4	17.1
Germany	37.6	14.4
Greece*	9.8	11.7
Finland	34	2.3
France	8.4	9
Hungary	20.1	53.8
Italy	9.4	3.5
Netherlands	26.9	18.6
Poland	27.7	10.8
Portugal	6.8	12.4
Switzerland	50.3	18.6
UK*	19	7.9

Standard Sensitization Rates from allergy centres in different European Countries[4]

[1] de Monchy et al, 2003; [2] Petersen et al, 2008; [3]; Molfino et al, 1991; [4] Burbach et al, 2009

Sources

- Birch trees
  - Found in many parts of the world [1]
  - Common in forests [2]
  - Very common at northern latitudes [3,4,5]



Birch tree density extracted from global data set from the Nordic Top Researcher Initiative[1]

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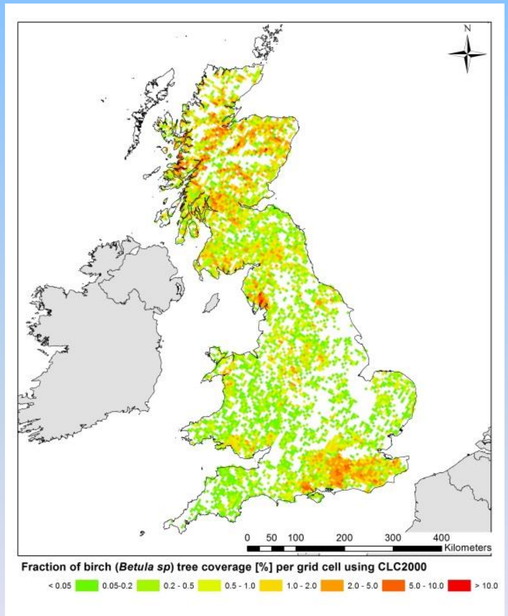
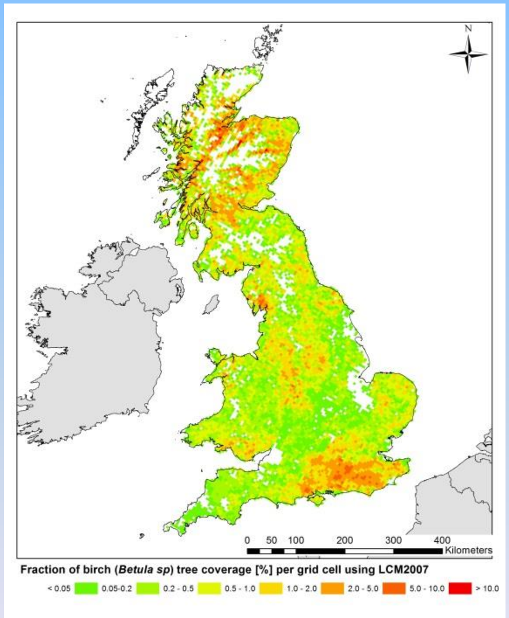
[1] Skjoth et al, 2011; [2] Skjoth et al, 2008a; [3] Simpson et al, 1999; [4] Skjoth et al, 2008b; [5]Siljamo et al ,2013

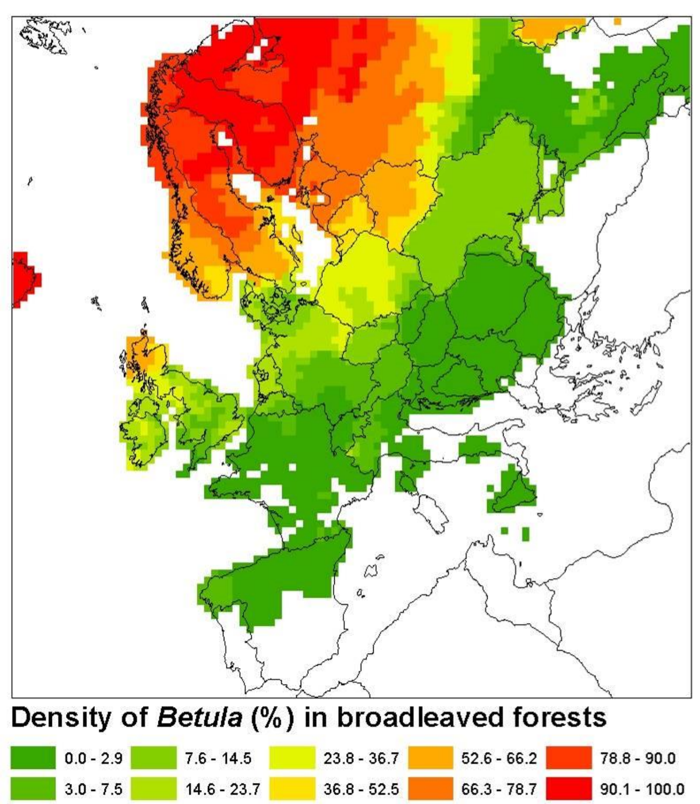
Sources

- Birch trees
  - Abundant in Europe[1,2]
  - Common in Small woodlands and as ornamentals[3,4,5]





Birch tree coverage, only forests (left) and forests+small woodlands(right) [5]



Birch tree density in European forests [1]

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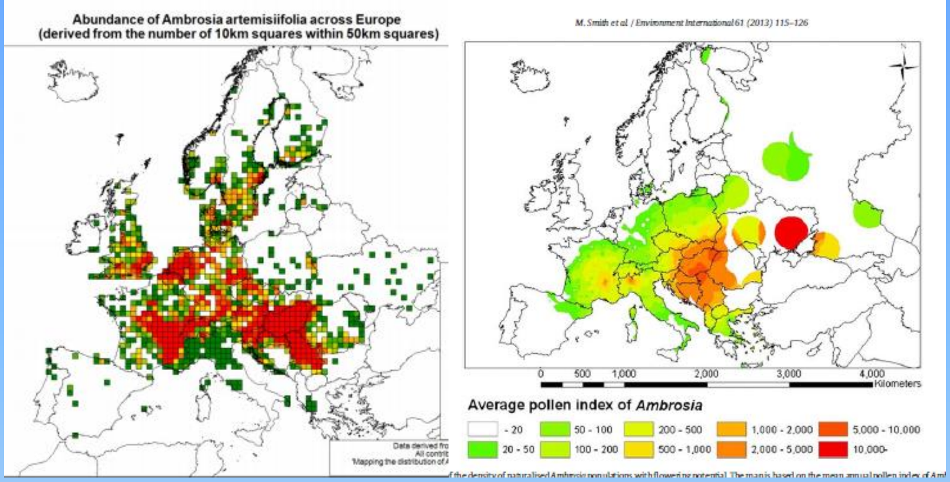
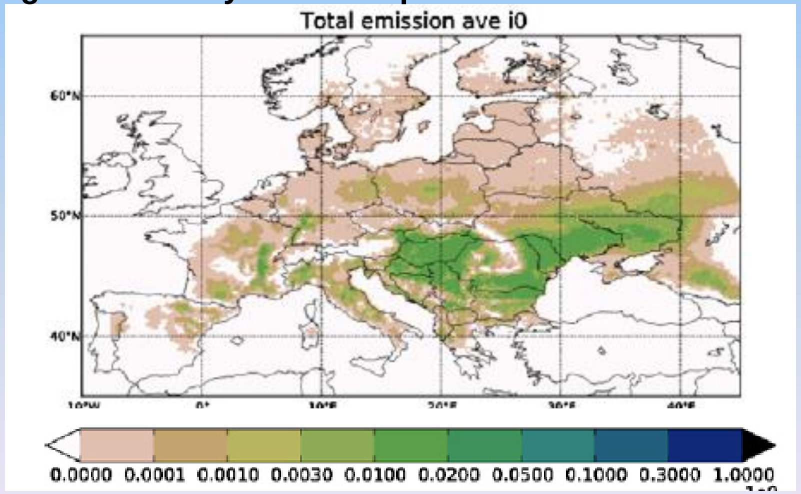
[1] Skjoth et al, 2008a; [2] Siljamo et al, 2013; [3]; Pauling et al 2012; [4] Skjoth et al, 2008; [5] Skjoth et al, 2014

Sources

- Ragweed
  - Native to North America[1]
  - Invasive in Europe, China, Australia[1]
  - Appear to have centres with large abundance[2,3,4]
  - Disagreement on abundance outside main centres



(left) Ragweed density based on plant observationstree[2]. (right Ragweed density based on pollen index[3]



Ragweed emission potential used by the SILAM model[4]

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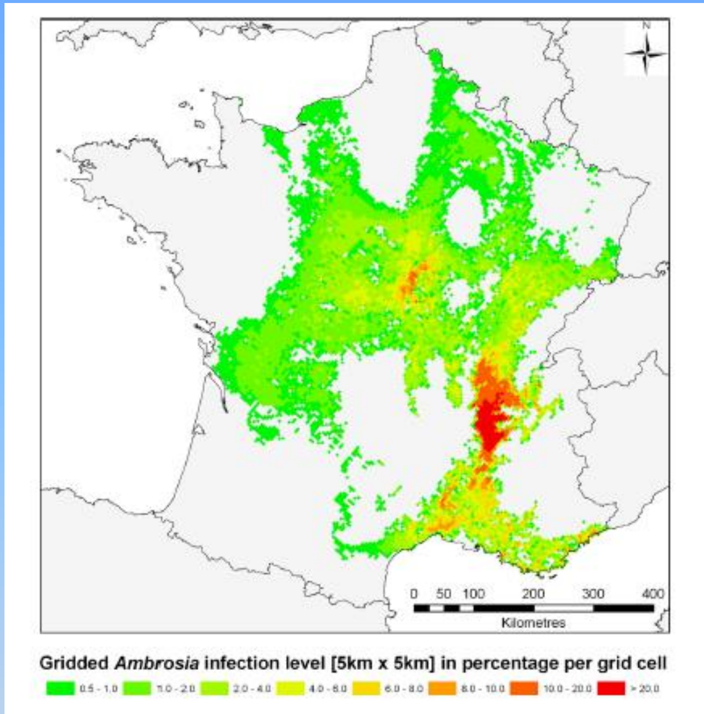
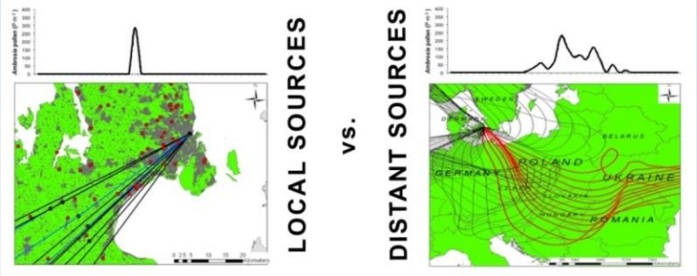
[1] Smith et al, 2013; [2] Bullock et al, 2013; [3] Skjoth et al, 2013; [4] Prank et al, 2013

Sources

- Ragweed
  - Abundance vary locally[1]
  - Prefer lowlands, occupy marginal and disturbed land[2]
  - Isolated populations in urban areas[3]
  - Spread through: Natural methods, Bird seeds, Fodder, Machinery .. [4,5]



Detailed ragweed inventory for France [1]



Identifying isolated urban sources in Denmark [3]

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[1] Thibaudon et al, 2014; [2] Skjoth et al, 2010; [3]; Skjoth et al, 2014; [4] Smith et al, 2013; [5] Vitalos & Karrer, 2009

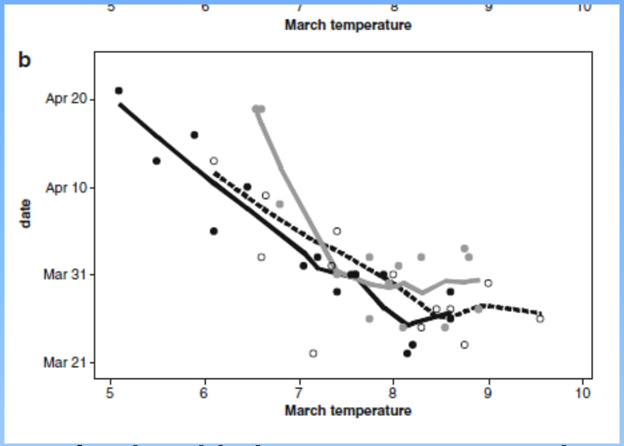
Sources – lessons learnt

- Birches:
  - Found almost everywhere (forests, woodlands, gardens), but abundance vary a lot depending on location
- Ragweed:
  - prefer lowlands, not present in mountains
  - Occupy marginal terrain
  - Small isolated populations outside main centres

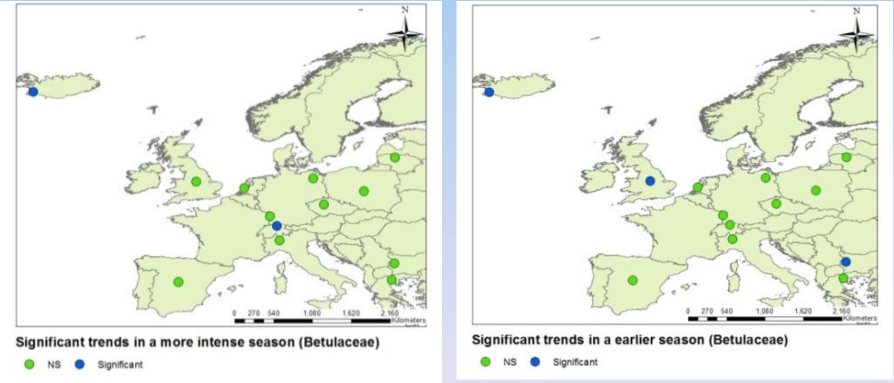
- Future research directions:
  - Birch: Improve quality and resolution of inventories
  - Birch: Include the urban fraction
  - Ragweed: Include major centres as well as local populations
  - Ragweed: Focus on all major continents

Phenology

- Birch: Season start
  - North South Gradient[1]
  - Depends on temperature, e.g. earlier season[1,2]
  - Climate change effect not trivial[2,3]



(Non-linear releationship between mean march temperatures and the beginning of the birch season in Worcester[3]



(left) Birch intensity of the season. (right birch, earlier start of the season. Maps based on published data[2]

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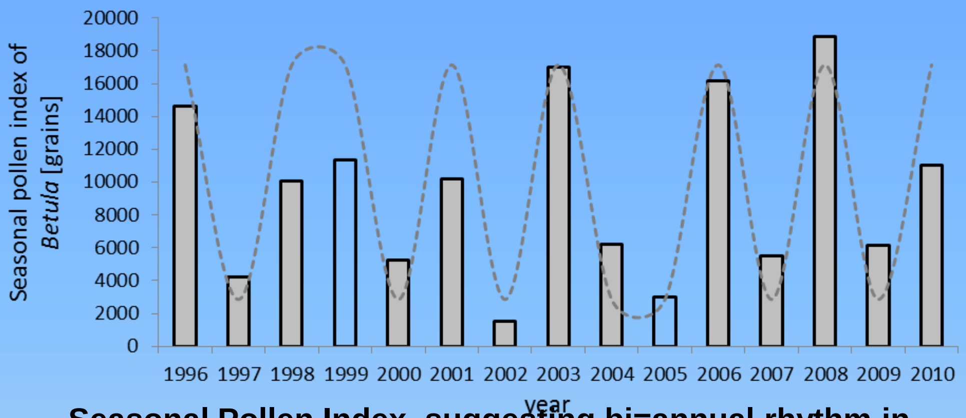
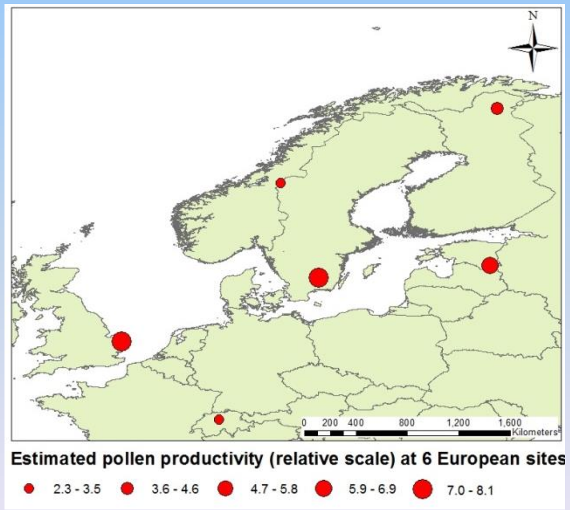
[1]Emberlin et al, 2002; [2] Smith et al, 2014; [3] Newnham et al, 2013

Phenology

- Birch: trends
  - Increased long term pollen production and annual variations[1,2]
  - Recent trends unclear[3]
  - Spatial variation in productivity[4]
  - Daily flowering cause roof top cyclic concentrations[5]



Seasonal Pollen Index, suggesting bi=annual rhythm in pollen production [2]



Mean annual birch tree pollen productivity. Maps based on published data[4]

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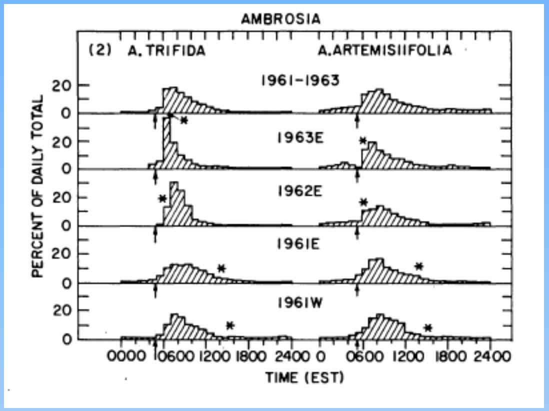
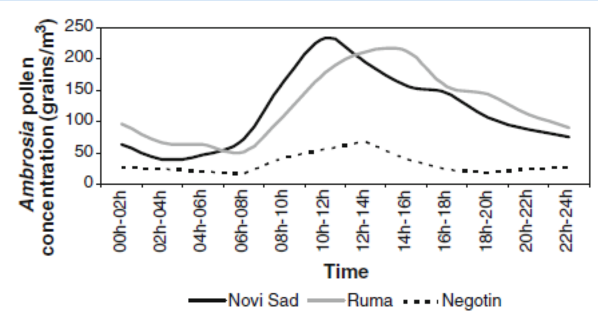
[1]Hansen (ed) 2014; [2] Grewling et al, 2012; [3] Smith et al, 2014; [4] Brostrom et al 2008 [5]Skjoth et al, 2009

Phenology

- Ragweed: Season
  - Depends on photoperiod and temperature - > North-South gradient [1,2,3,4]
  - Climate change effect[5]
  - Daily flowering depends on T and RH[3,4] cause rooftop cyclic concentrations[6]



Hourly ragweed concentrations, averaged annually, from a circular experimental plot of the surface[7]



Averaged bi-hourly ragweed concentrations,, from three rooftops in Serbia in 2007 [3]

[1]Smith et al, 2013; [2] Ziska et al 2003; [3] Bianchi et al, 1959; [4] Allard et al, 1945; [5] Ziska et al, 2011; [6] Sikoparija et al, 2009; [7] Ogden et al, 1969

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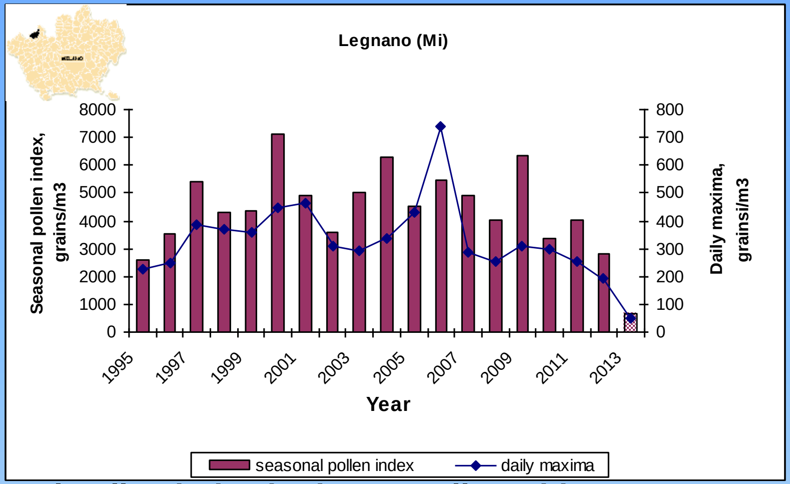
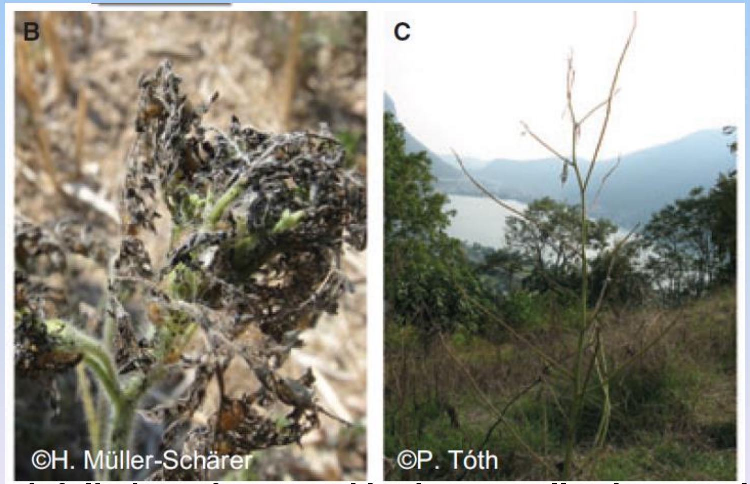
Phenology

- Ragweed: trends
  - Invasive: Expands in coverage[1,2]
  - Affected by Urban climate and CO2 [3,4]
  - Affected by "accidental mitigation"[5]



Seasonal pollen index in the Po-Valley with severe pest attack in 2013 (pers. Comm: M.Bonini, in prep)



Severe defoliation of ragweed in the Po-Valley in 2013 due to *Ophraella Communa*[5]

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[1]Smith et al 2013; [2] Thibaudon et al, 2014; [3] Ziska et al 2002; [4] Rogers et al, 2006; [5] Müller-Schärer et al., 2014

Phenology – lessons learnt

- Birches:
  - Effect by the environment unclear
- Ragweed:
  - Expansion appear to continue
  - Biocontrol a possible mitigation method

- Future research directions:
  - Birch: Spatial variations in trends
  - Birch: Effects on the environment (soil, nutrients, climate, urbanisation…)
  - Ragweed: Effect as invasive species
  - Ragweed: Effect of mitigation and pest attacks
  - Both: Use of process based vegetation models (e.g. focus on competition, pests, climate change ….)

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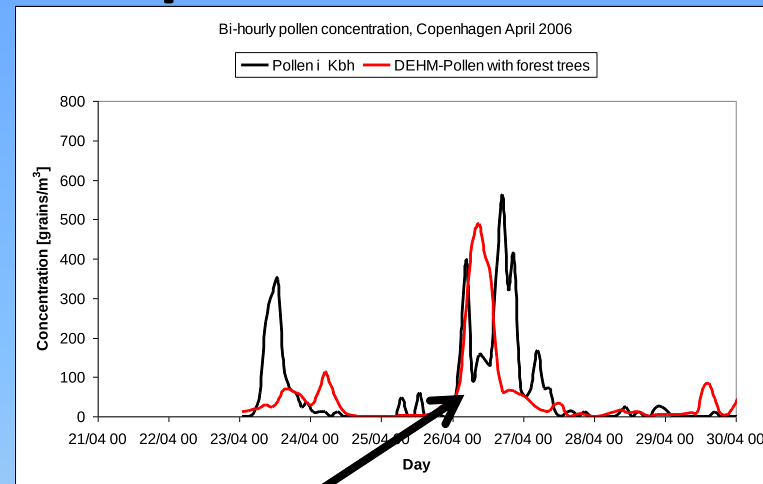
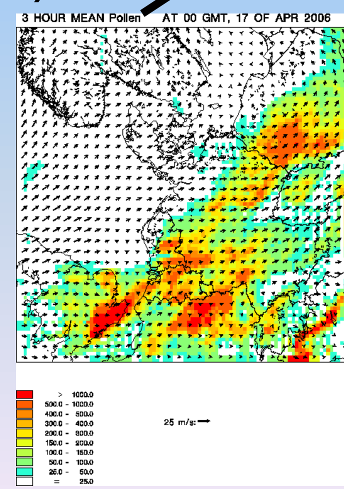
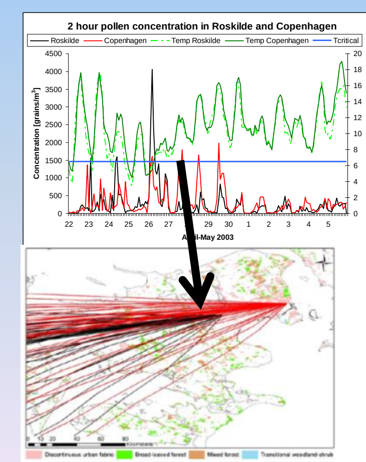
Transport & Dispersion

- Birches
  - Beginning of season often due to LDT[1]
  - Transport & dispersion can be simulated with regional scale atmospheric models[2,3,4,5]
  - Local scale (0-20km) simulations rarely addressed[6]



Simulations of atmospheric transport of birch pollen over the Danish area using either the DEHM model[2] (top, lower left) or the ACDEP model (lower right) [6]





[1]Skjoth et al, 2007; [2] Skjoth, 2009; [3] Zink et al, 2013; [4] Siljamo et al, 2013; [5] Zhang et al, 2014; [6]Skjoth et al, 2008b

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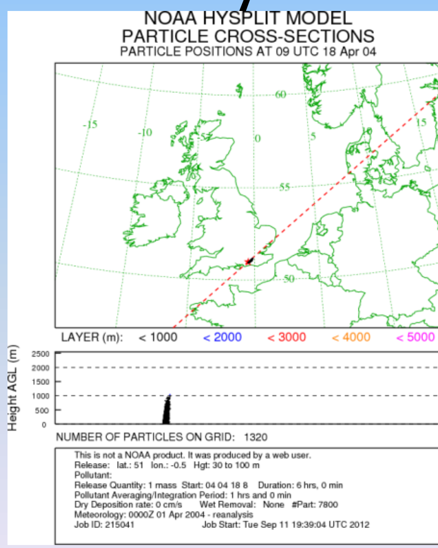
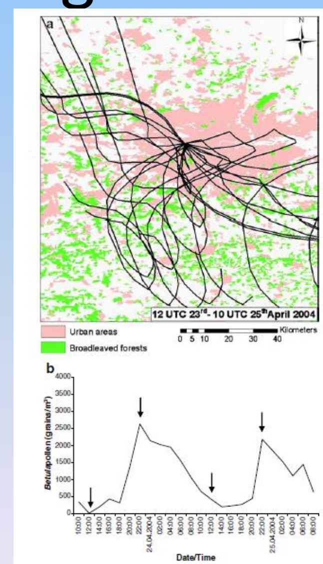
Transport & Dispersion

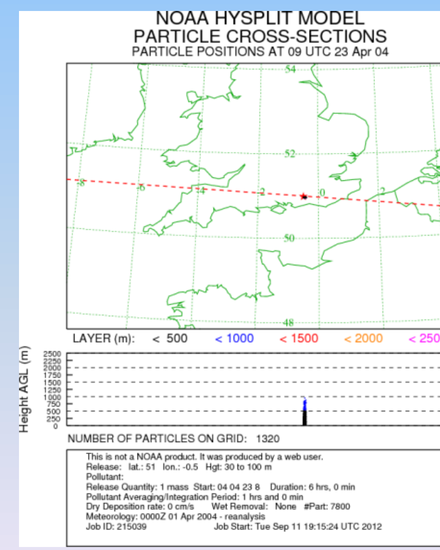
- Birches
  - Local scale + LDT difficult to detect using observations[1]
  - Physicial micro-scale effects difficult to address with many existing regional scale models[2,3,4]



A typical day – handled well by many models – here shown by particle dispersion model



Identified episodes from birch tress outside London[1]



The episode – very difficult to handle well by many models

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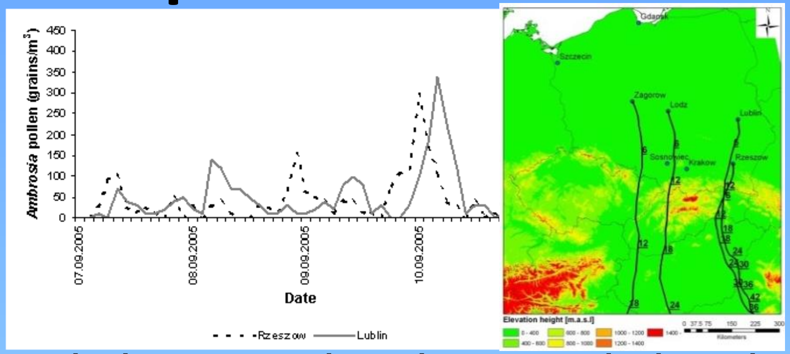
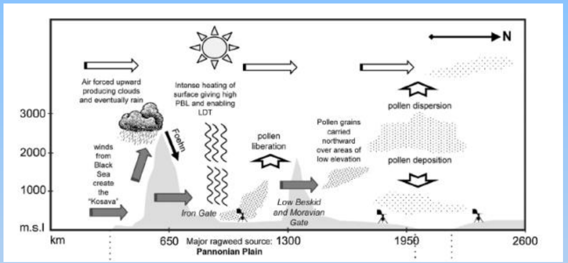
[1]Skjoth et al, 2009; [2] Skjoth et al, 2013; [3] Baklanov et al, 2014; [4] Skjoth, 2009

Transport & Dispersion

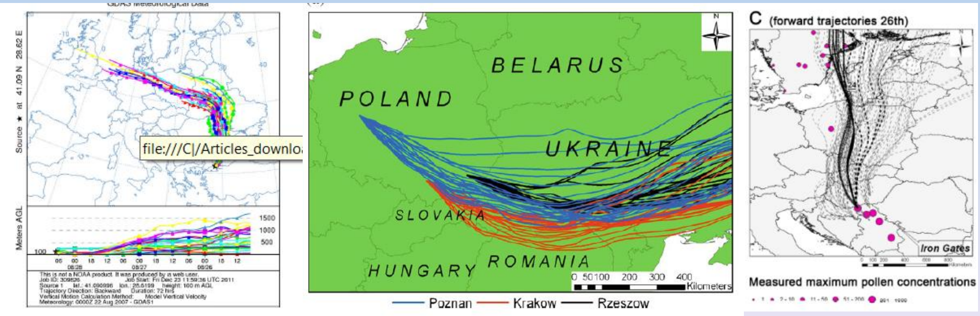
- Ragweed
  - LDT episodes are intermittent[1]
  - Related to atmospheric physics[2]
  - LDT episodes from Pannonian Plain and Ukraine repeatedly observed[3,4,5]



Atmospheric transport shown by a atmospheric trajectory model[1]



A physical mechanism providing LDT of ragweed pollen from the Pannonian Plain [3]



LDT transsport of ragweed pollen from Ukraine (left)[3] middle [3] and PannonianPlain[5]

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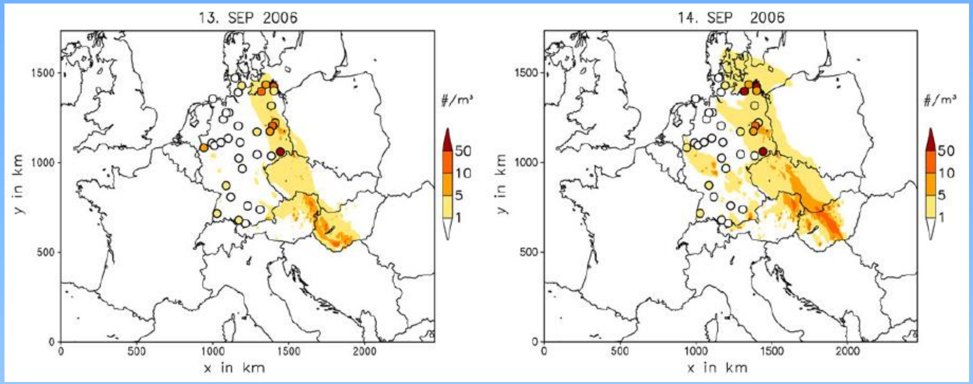
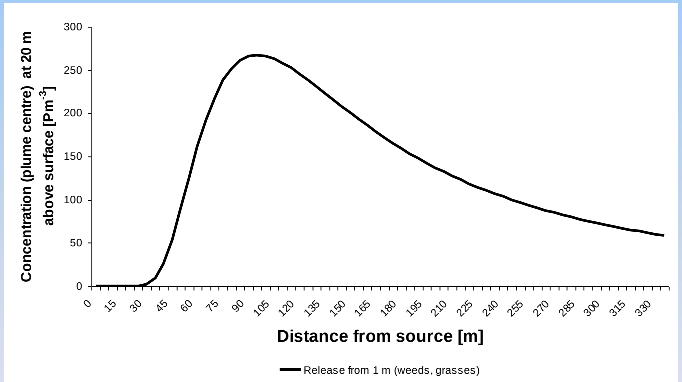
[1]Smith et al, 2008; [2] Sikoparija, 2013; [3] Kasprzyk et al, 2013; [4] Zemmer et al, 2012; [5] Sikoparija et al , 2009

Transport & Dispersion

- Ragweed
  - Dispersion and transport can be simulated with regional scale atmospheric models[1,2,3]
  - Local scale simulations possible with Gaussian models[4]
  - Combined local and regional scale approaches can be combined with observations[4]



Simulation of ragweed concentrations with the regional scale atmospheric transport model COSMO-ART [2]



Simulation of ragweed concentrations with the local scale atmospheric transport model OML [4]

[1]Smith et al, 2008; [2] Zink et al, 2012; [2] Prank et al, 2013; [3] Zink et al, 2013; [4] Skjoth et al 2014

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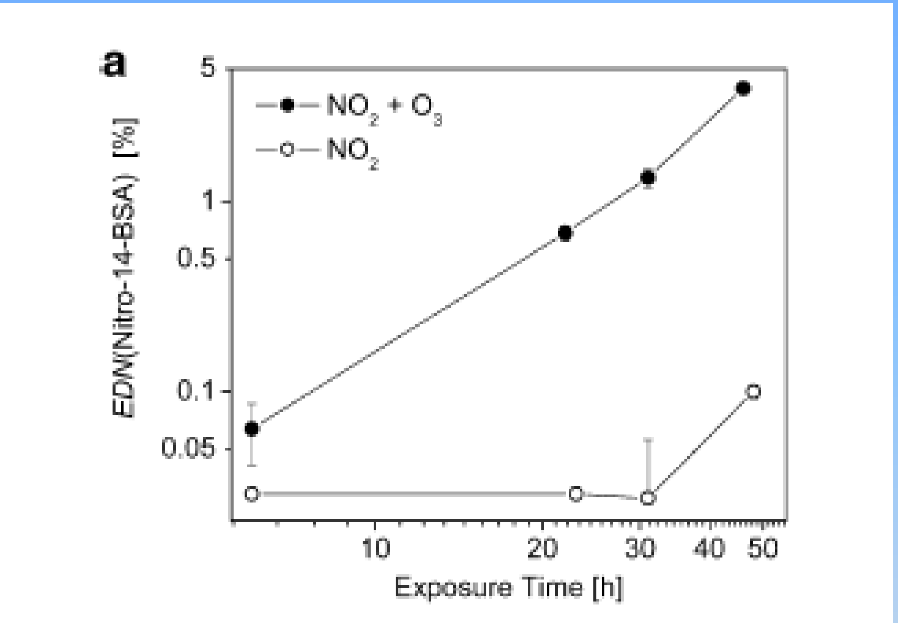
Transport and Dispersion – lessons learnt

- Birches:
  - Atm. physics in regional scale transport well understood, e.g. LDT
  - Micro-scale dispersion rarely addressed and challenging to detect
- Ragweed:
  - Atm. physics in regional scale transport well understood, e.g. LDT
  - Micro-scale rarely addressed but possible to detect

- Future research directions:
  - Birch: Importance of the urban source
  - Ragweed: Understanding both the regional scale and local scale
  - Both: Combining local scale & regional scale detection and modelling. Focus on PBL processes, micro and meso-scales (0-2km,2-20km,20-200km)
  - Both: Detecting pollen along their trajectory (thus in the free atmosphere and along their flight!)
  - Both: Atmospheric models can be improved by improving the emission flux

Transformation

- Birch
  - Allergens modified within the host[1]
  - Allergens modified by air pollution[2]
  - Humidity increase the reaction rate of tyrosine with the environment [3]



Change of proteins in birch pollen during exposure of air pollutants [2]

[1]Buters et al, 2010; [2] Franze et al, 2005; [3] Reinmuth-Selze et al, 2014

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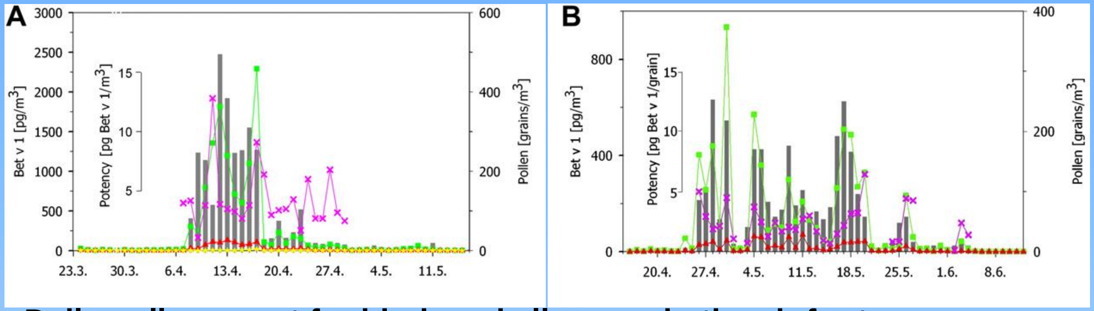
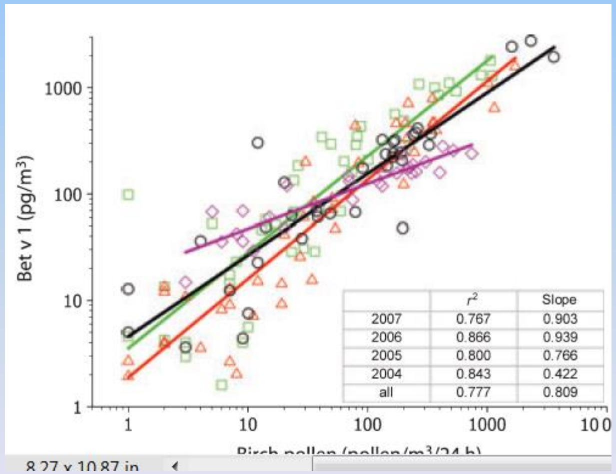
Transformation

- Birch
  - Allergens often correlates well with pollen – but not always [1,2]
  - Allergens modified by the environment[2]



Daily pollen count for birch and allergens in the air for two sites in the HIALINE project [2]



Daily pollen count for birch and allergens for Munich during a three year period [1]

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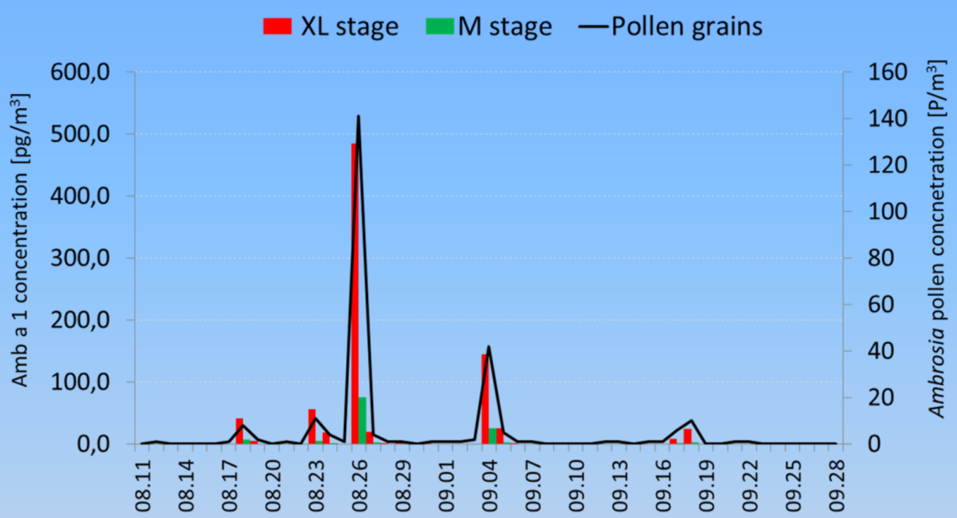
[1]Buters et al, 2010; [2] Buters et al, 2012

Transformation

- Ragweed
  - First study on ragweed allergens: can follow pollen count
  - Little is known about potential mechanisms between allergens and the environment



Daily measured pollen concentration and allergen content at Poznan for 2011 [1]

[1] Grewling et al, 2013

Transformation – lessons learnt

- Birches:
  - Ozone, NO_2 and humidity important in transformation
  - Allergenic potential connected with source
- Ragweed:
  - ???????

- Future research directions:
  - Birch: Description of biological mechanisms on the host
  - Birch: Description of atmospheric physic & chemistry and allergens – at the aerosol stage
  - Ragweed: Basic research is needed in all major aspects of transformation
  - Both: Explore potential feedback mechanisms between pollen and the environment

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Future research directions

NEW PROJECTS(EU), TOPICS, FUNDER, YEARS, CONTACT

- SMARTER, ragweed, COST, 2012-16, contact: heinz.mueller@unifr.ch
- EUNetAir, detection-modelling, COST 2012-16, contact: michele.penza@enea.it
- POLEMIC, ragweed-emission, SCOPES, 2014-16 contact: sikoparijabranko@gmail.com
- SUPREME, birch-modelling-detection, FP7, 2014-18, contact: c.skjoth@worc.ac.uk

RECENT PROJECTS(EU), TOPICS, FUNDER, YEARS, CONTACT

- EUPOL, pollen, COST, 2008-12, contact: mikhail.sofiev@fmi.fi
- ATOPICA, ragweed-birch, FP7, 2011-14, contact: secretariat@atopica.eu
- ENV.B2/ETU/2010/0037, ragweed, EU-Commision, 2010-12, contact jmbul@ceh.ac.uk

NEW OPPORTUNITIES, TOPICS, FUNDER, YEARS, CONTACT

- UK RESEARCH COUNCIL, aeroallergens and detection, 2015-18, two consortia £1.2mio each, to be decided
- HORIZON2020 ERC (Excellent Science, free topic)
  - ERC Starting grant, Consolidator grant and advanced grant, typically €1.5 mio
- HORIZON2020 Marie Skłodowska-Curie (Excellent Science, free topic)
  - Initial Training Networks (PhD Students and Post Docs)
  - Individual Fellowships (two years+ training)
  - Cofund (requires match funding, typical €2.3 mio

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Thank you for your attention

contact: **Carsten Ambelas Skjøth**

email: c.skjoth@worc.ac.dk

Reference list:

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