Alternaria spores in the air across Europe: Abundance, seasonality and relationships with climate, meteorology and local environment

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Background

- *Alternaria*
  - Cause respiratory allergies[1,2]
  - Important plant pathogens[3,4]
  - Considered associated with agricultural landscapes [5,6]
- Complicating factors
  - More than 300 species [7]
  - May – or may not be- host specific [8]
  - Emissions of *Alternaria* spores can be substantial [5,9]
  - Emissions process of *Alternaria* can be both natural and man made [5]
  - Little is known on *Alternaria* compared to pollen, e.g. lack of area-wide assessments, fewer observations, fewer models, no source maps .. spores not addressed by EUPOL.[9]

[1] Burbach et al, 2003; [2] Knutsen et al, 2012; [3]; Gravesen et al, 1994 [4] Simmons 2007 [5] Skjoth et al, 2012 [6] Sadys et al, 2015 [7] Seifert et al, 2011 [8] Su'udi et al, 2013 [Damialis et al, 2015], [9] Sofiev and Bergman 2013

Idea

- Investigate overall seasonality of *Alternaria* in Europe
  - start
  - End
  - Duration
  - Severity (SFI)
  - Test for clustering
- Test if simple crop growth models are usable for assessing European-wide variability
- Separating into four main biogeographical regions with substantial crop production
  - Atlantic, Continental, Pannonian, Mediterranean
- Explore the importance of spatial vs temporal variation in SFI
  - What is most important: long time series or more stations.
- Explore if amount of agricultural areas is related to spore index

Input data

- Spore data
  - Based on observations from volumetric spore traps [10]
  - Observations follow standard methods in aerobiology
  - Use annual spore index from daily mean concentrations
  - 23 stations available, 242 annual data set
  - Denmark/UK in the North, Spain/Greece in the South.
  - Data during 2000-2014
- Other data
  - Corine Land Cover, 100m x 100m[11]
  - Daily climatological data from nearby stations from WMO programme

[10] Hirst 1952 [11] European Commission, 2005

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Input data

- Design of data exchange protocol
  - Follows previous published studies [12]
  - Observations follow standard methods in aerobiology, transverse traverses or longitudinal [13,14,15]

Name	Lat	Lon	CountingMethod	Year	Startday	Endday	Seasonlenght	SFI	Peakday	Peakvalue
Budapest (HU)	47.5000	19.0667	2 x longitudinal	2000	147	284	137	11174	273	608
Budapest (HU)	47.5000	19.0667	2 x longitudinal	2001	165	277	112	39686	188	1664
…	..	..	..	..	..	..	..	..	..	..
Copenhagen	55.71555	12.56199	12 x vertical	2000	174	260	86	9184	232	873
Copenhagen	55.71555	12.56199	12 x vertical	2001	172	242	70	8488	229	1016
Copenhagen	..	..	..	..	..	..	..	..	..	..
Copenhagen	55.71555	12.56199	12 x vertical	2001	199	242	43	4792	217	390
..	..	..	..	..	..	..	..	..	..	..

[12 Kasprzyk and Worek 2006[13] Sikoparija et al, 2011 [14] Kapyla and Penttinen 1981[15] Galan et al., 2014

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Results

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Temporal variation
Aix-en-Provence					11725#	17741	15583	18073	25637	16461	14818	16969	14636	14180	17580	83
Badajoz										8415	8678	13696				
Barcelona	8355	10531	11637	9139	7014	6112	5589	4458	6401	10060	9934	10494	8266	10130	6740	86
Bordeaux	21130	18275	17105	10790	10125#	20045#	12540#	4260#	5260#	6300#	8960#	8500#	6880#	6781#	2749#	173
Budapest		39686	15350	48442	45187	44813	59414	38621	42883	36461	49853	59587	58723	24394	25171	105
Copenhagen	9184	8488	6341	4039	5086	7327	9703	7032	4748	9460	6841	3641	2282	4792	11038	131
Derby	30281	23580	19666	26189	29450	26690	20910									42
Girona	15714	6104	11488	11035	12261	11572	5729	11178	15907	13471	12037	14563	12877	13196	14330	84
Kraków	2018	12859	14684	9664	13791	9841	9338	18867	10856	17215	8958	14757	16545	8358	7735	144
Krasne*		7598	26234								6629*	7522*	13152*			160
Leicester							21430	17378	15147	22039	16729	18756	14995	15539	31996	88
Lleida	17240	23190	24657	26569	28605	41163	27504	18155	32267	36033	40197	49932	53172	59875		125
Lyon									27559#	7953#	9207#	17391	7465	15109	15651	140
Nantes			10823#	10880#	9655#	12221#	17705#	5486#				19238#	6536#	21855#	23219#	129
Paris			12665+	10297+	12376+	15137+	13544+	18242+	11931+	10569+	21645+	32175+	10179+	28353+	37206+	150
Roquetes-Tortosa							11130	9066	11172	11791	16260	16162	11651	10772	15775	57
Rzeszow	8101	10274	9369							14424	8807	6333	20884			130
Szczecin					17742	26140	10651	21511	11719	19876	19683	11656	9051	11549		107
Tarragona	4970	7650	7258	9125	10668	8005	10198	12132	11556	7848	12522	12079	7490	9484	8856	81
Thessaloniki	8787			6005	6049											
Toulouse		16850+	25405+	14896+	10315+	11195+	16780+	11225+	15720+	13565+	11560+	11245+	8040+	8155+	15895+	127
Vielha					1221	1476	815	876	2134	2111	1504	3548	2755	1660	2139	149
Worcester							9297	6966	8092	8519	6022					42
Spatial Variation	225	218	131	293	304	251	380	287	267	239	332	322	376	375	223	

Table 2. Seasonal fungal spore index for the sites with temporal (rows) and spatial variation (columns). * Marks that the trap was located at ground level for the years 2010-12 during the period 15April-15 October.#Marks that the data were available from mid-May to end September.+ Marks that the data were available from Mid February to end September.

- 23 sites, n=3-15
- 3 month gradiant in start of season (April-June)
- 4 month variation in season length (90% method)
- Peak dates n=180-240 (Continental & Atlantic) or outside n=180-240 (Pannonian & Mediterranean)
- High SFIs scattered throughout region, no connection with season length
- No connection between land cover and SFI European wide, strong connection with cropland under rotation at biogeographical level

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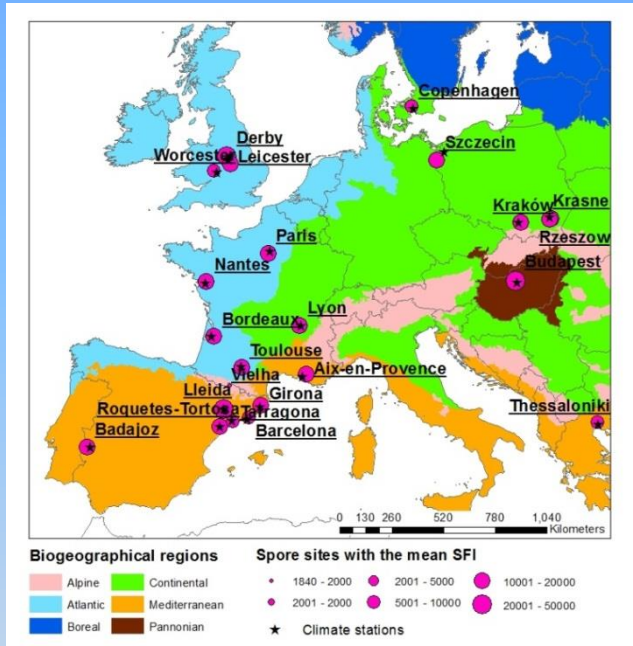
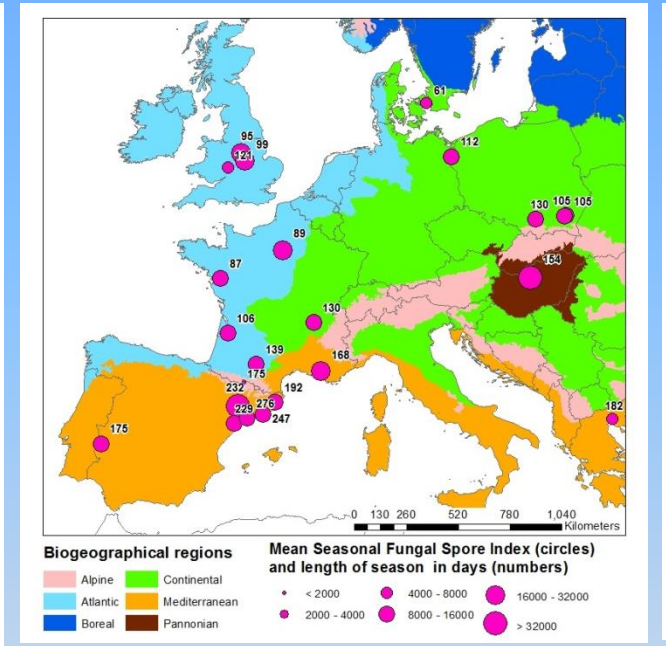
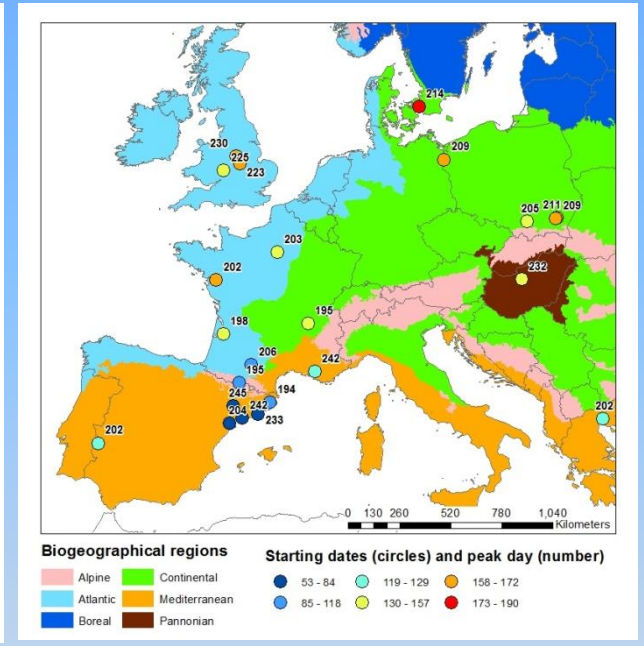
Results







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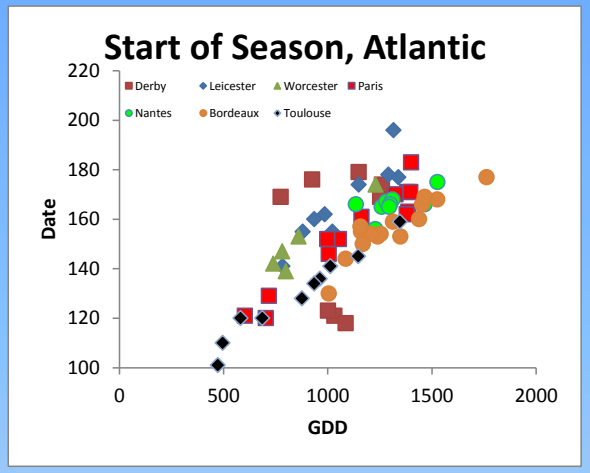
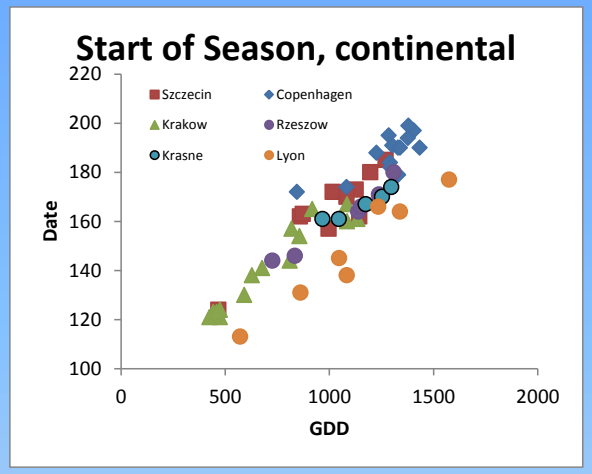
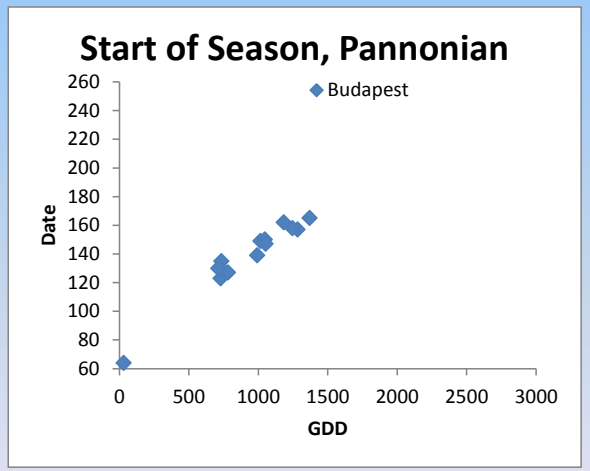
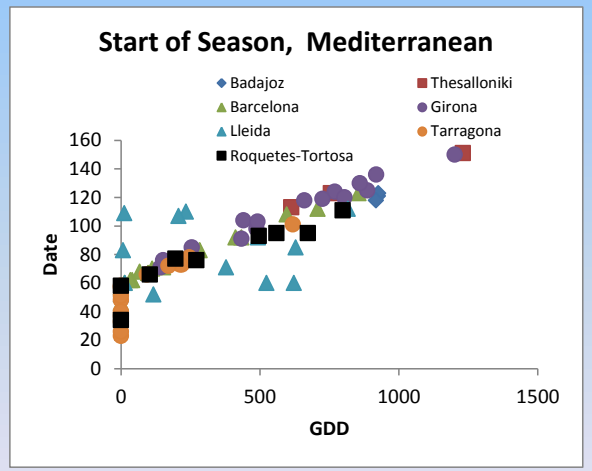
Results









Annual start of season vs annual GDD at individual sites and grouped into the four major biogeographical regions: a) Atlantic, b) Continental, c) Pannonian and d) Mediterranean

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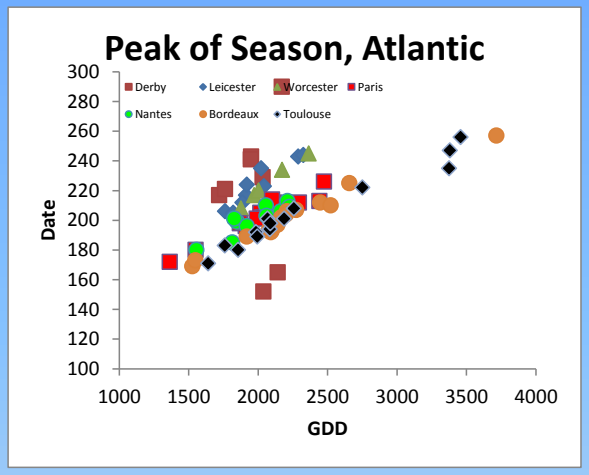
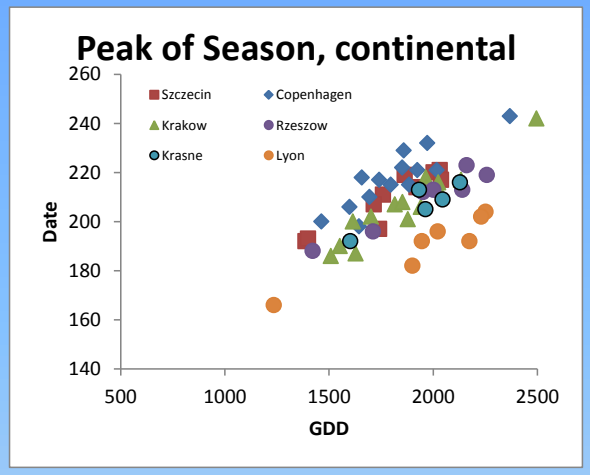
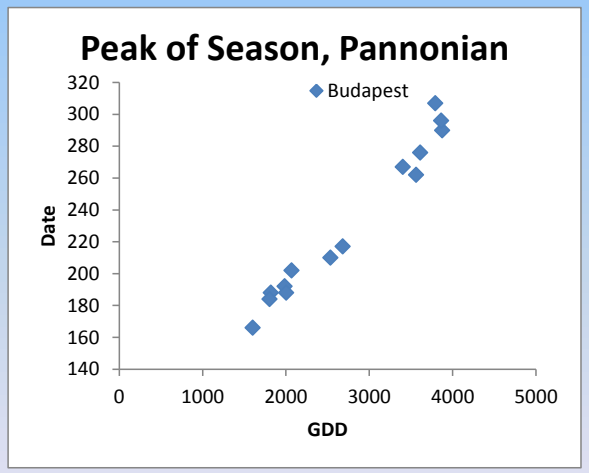
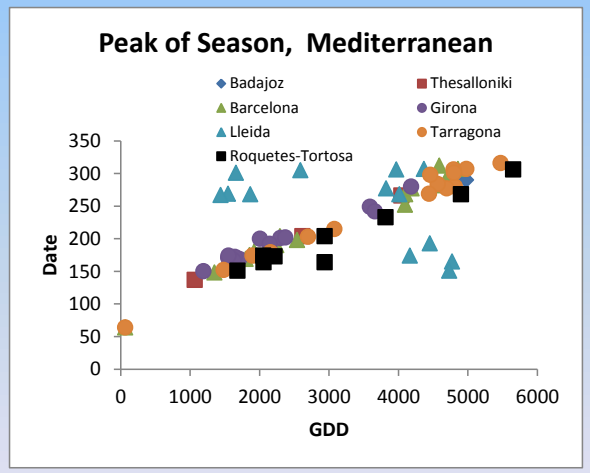
Results









Annual peak of season vs annual GDD at individual sites and grouped into the four major biogeographical regions: a) Atlantic, b) Continental, c) Pannonian and d) Mediterranean

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Results

Spore site name	Peak date, Cluster1		Peak date, Cluster2	
	Julian Date	GDD (AU-p)	Julian Date	GDD (AU-p)
Aix-en-Provence	159	1563.8 (100)	260	3850.5 (100)
Badajoz	-	-	-	-
Barcelona	181	2000.0 (100)	285	4446.5 (100)
Bordeaux	171	1537.4 (100)	203	2233.5 (100)
Budapest	193	2062.5 (100)	283	3684.7 (100)
Copenhagen	205	1608.8 (97)	222	1880.5 (97)
Derby	224	1992.0 (100)	242	2155.7 (100)
Girona	178	1819.3 (100)	257	3811.3 (100)
Kraków	193	1600.7 (96)	211	1955.3 (96)
Krasne*	211	2017.5 (100)	-	-
Leicester	217	1909.2 (97)	244	2306.9 (100)
Lleida	171	1820.0 (100)	283	4286.6 (100)
Lyon	190	1956.3 (97)	199	2219.1 (97)
Nantes	195	1851.8 (96)	208	2143.6 (96)
Paris	176	1456.9 (100)	208	2133.5 (100)
Roquetes-Tortosa	287	5277.4 (100)	180	2529.3 (100)
Rzeszow	192	1566.5 (99)	216	2102.1 (99)
Szczecin	193	1393.0 (100)	213	1884.0 (97)
Tarragona	165	1896.9 (97)	293	4780.4 (100)
Thessaloniki	-	-	-	-
Toulouse	192	1991.7 (100)	240	3240.7 (100)
Worcester	215	1950.0 (100)	240	2268.0 (100)

Sites in the study, outlier years and cluster results on peak date and the associated GDD values including the AU-p value for significance (similar table for start available).

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Discussion

- Local management and climate could be more important than year-to-year variations in weather
- Climate appear to affect start and peak season differently throughout Europe (e.g. spore production increase until a threshold temperature).
- SFI predictions should most likely use both climate and land cover
- Clustering of peak values suggests that several species of *Alternaria* are important -> several types of crops dominates the picture
- Large national variations (e.g. Catalonia or UK)
- Anthropogenic suppression of SFI (fungicides) and anthropogenic augmentation of SFI (harvesting engines)

Conclusion

- First continental scale assessment of *Alternaria*
- Large variations in seasonality
- Land cover local management more important than weather. Agriculture likely the dominating source.
- Direct observations very important to assess local load
- Conclusions relevant for both health and agriculture!
- Crop models appear to be a usable tool in modelling, clustering must be taken into account
- Peak concentrations synchronised in some regions
- This study close a knowledge gab, but spore information still sparse compared to pollen
- Coordinated activities on spores needed!

Thank you for your attention

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Read more in special issue in Aerobiologia (Magdalena Sadys, Guest editor): [16] C. A. Skjøth, A. Damialis, J. Belmonte,C. De Linares, S. Fernández-Rodríguez, A. Grinn-Gofroń, M. Jędryczka,I. Kasprzyk, et al, (2016) Alternaria spores in the air across Europe abundance, seasonality and relationships with climate, meteorology and local environment, Aerobiologia (2016) 32:3–22 DOI 10.1007/s10453-016-9

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