Schweizerische Eidgenossenschaft
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Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

THE POLLEN MODULE OF COSMO-ART: CONCEPT, PROCESSES AND PERFORMANCE

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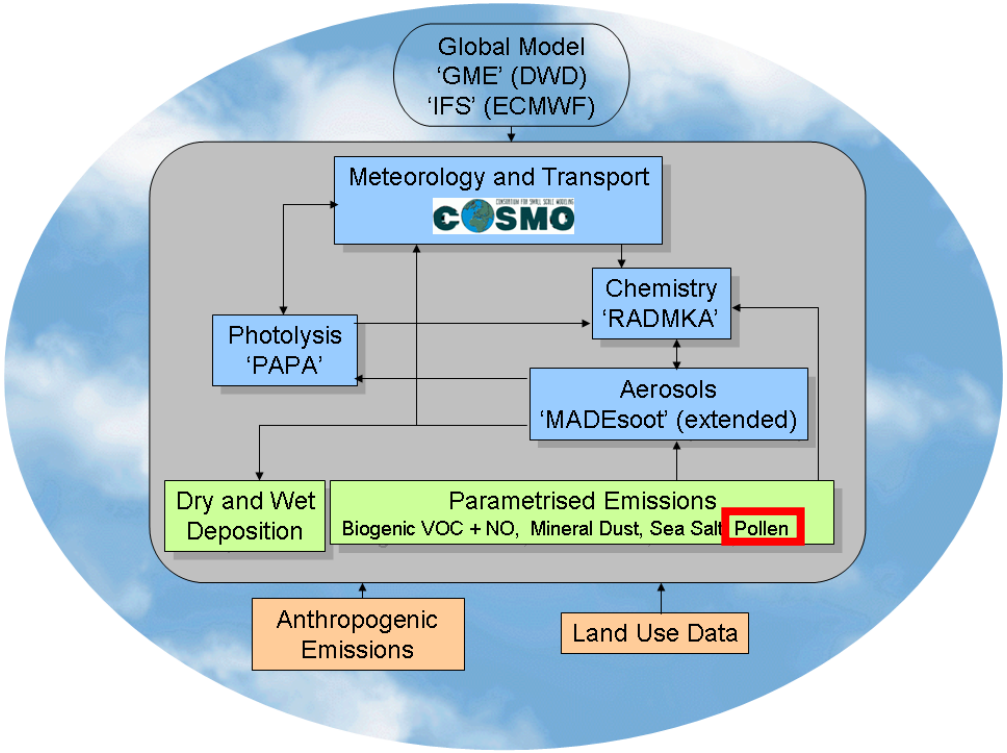
COSMO User Seminar, March 2015, Offenbach, Germany

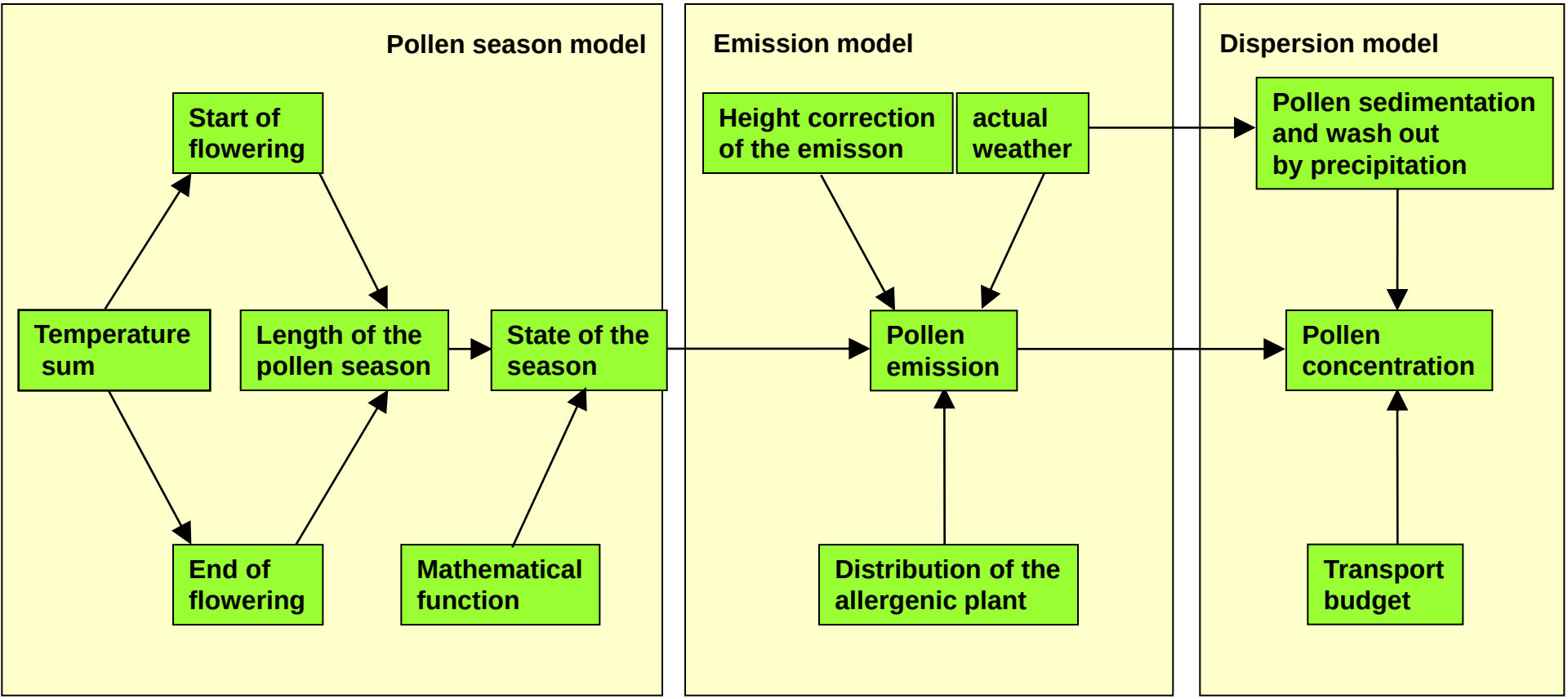
Pollen in COSMO-ART

ART (Aerosols and Reactive Trace gases): online-coupled extension of COSMO developed at the Karlsruhe Institute of Technology (KIT) and MeteoSwiss to study Aerosols and Reactive Trace Gases (including pollen)



Source: Karlsruhe Institute of Technology
http://www.imk-tro.kit.edu/3509.php

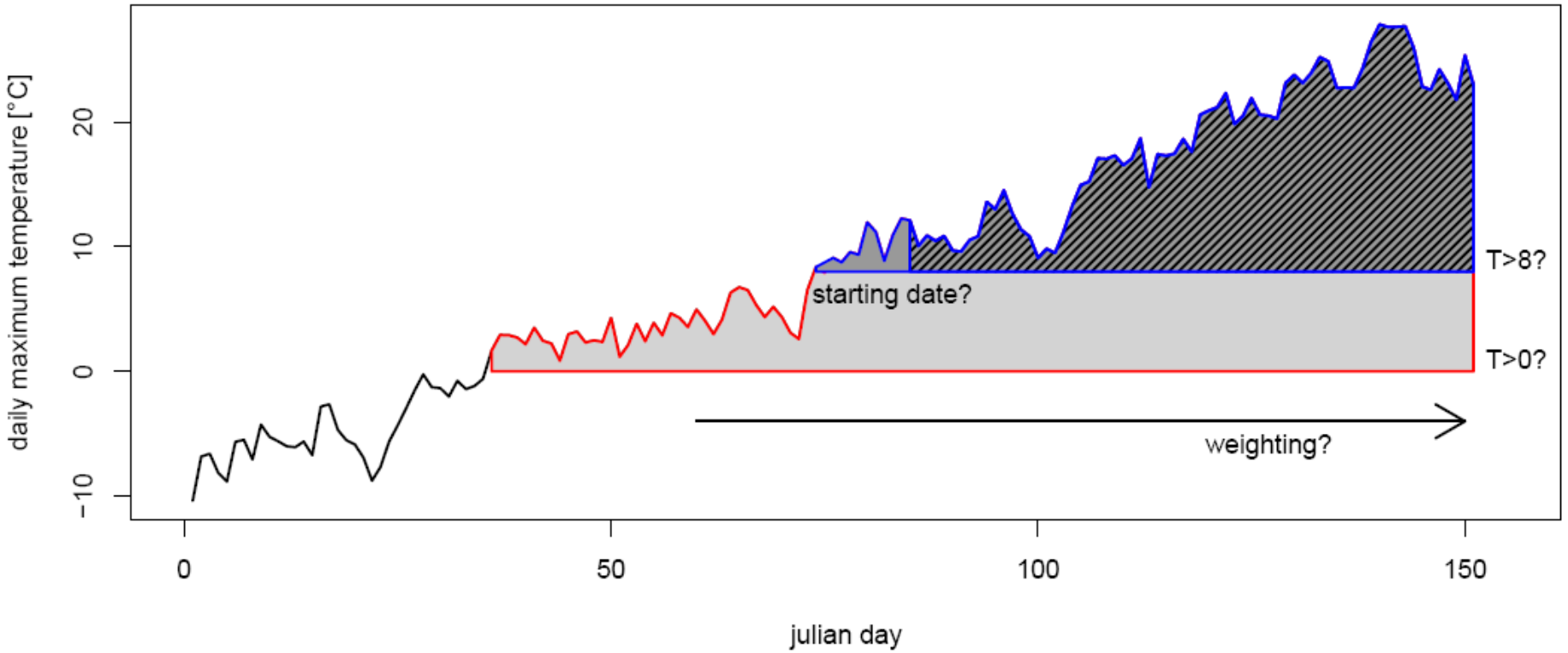
The concept of the pollen module



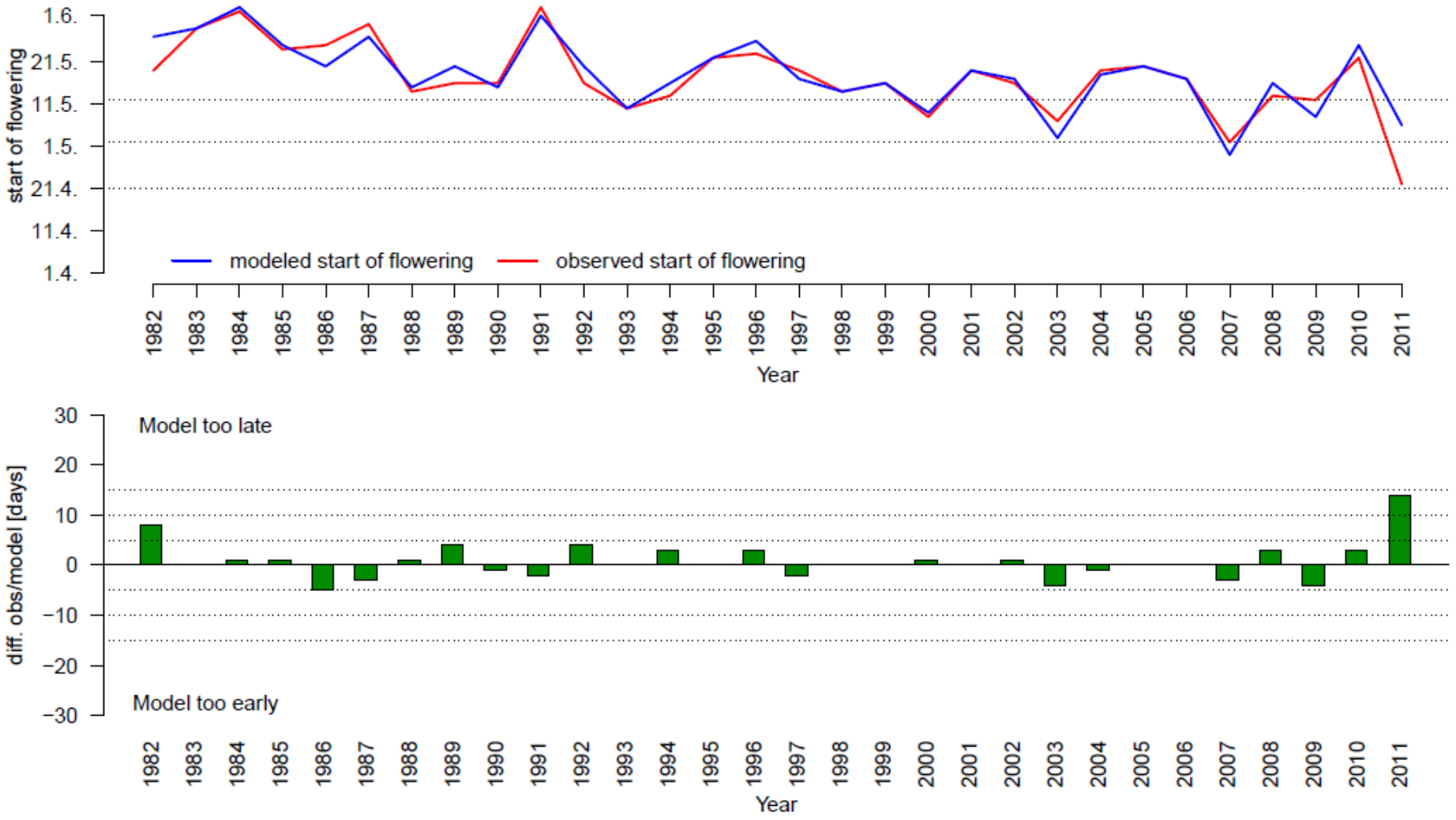
Calculating the temperature sum

Variables:

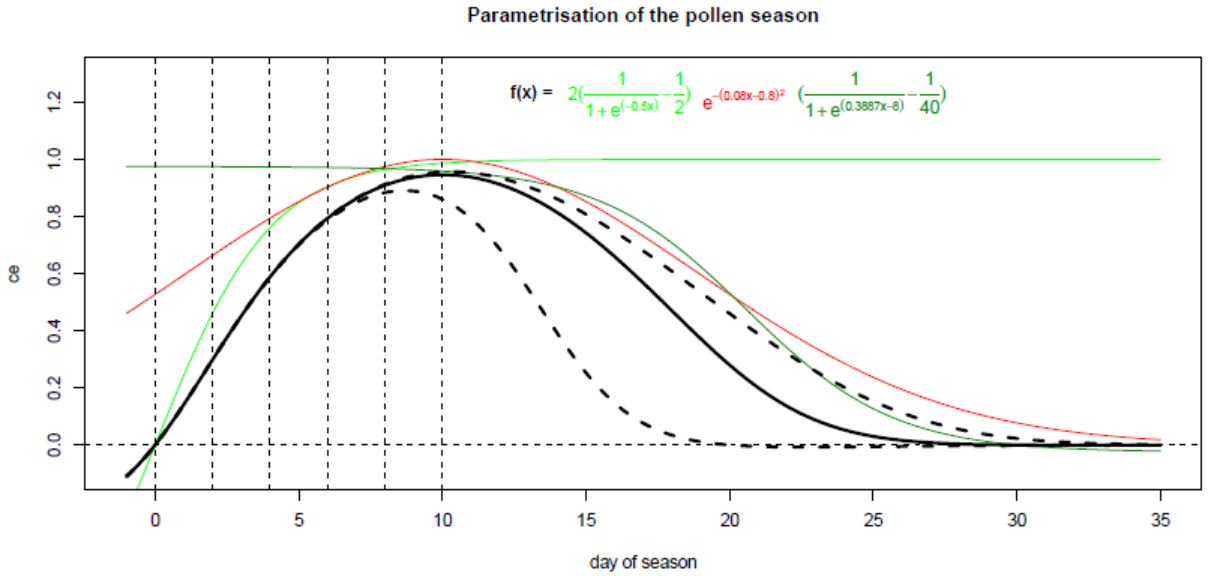
1) start of temperature sum
2) base temperature
3) weighting
4) definition of start of pollen season

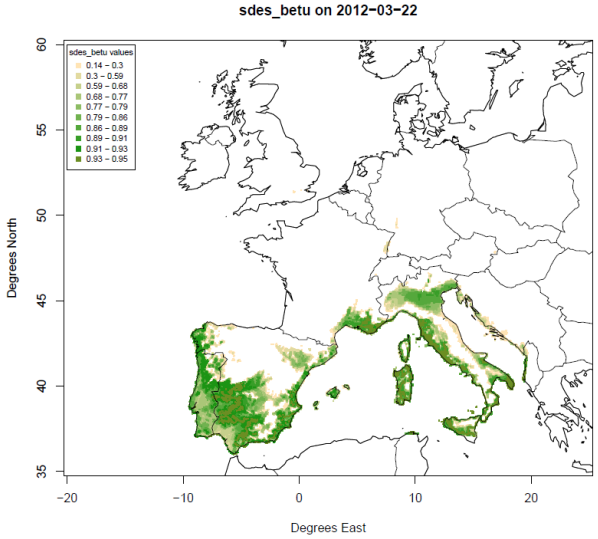


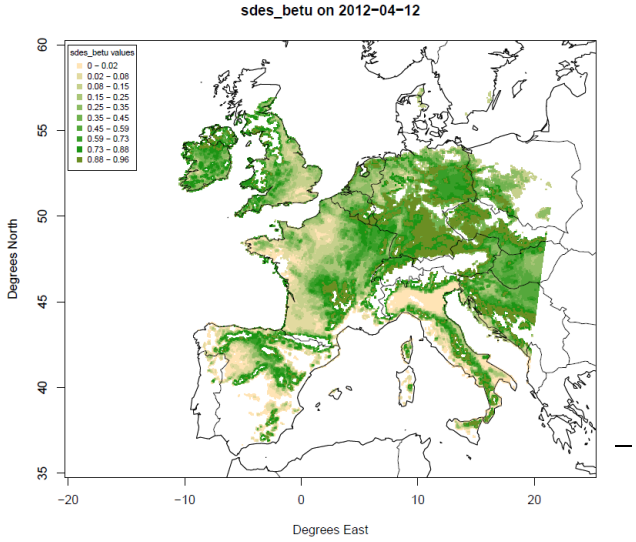
Modeled (leave−one−out cross−validation) and observed start of flowering (Poaceae at Zurich). Best of 6460 combinations. MAE =2.40, Definition Pollen>40 used

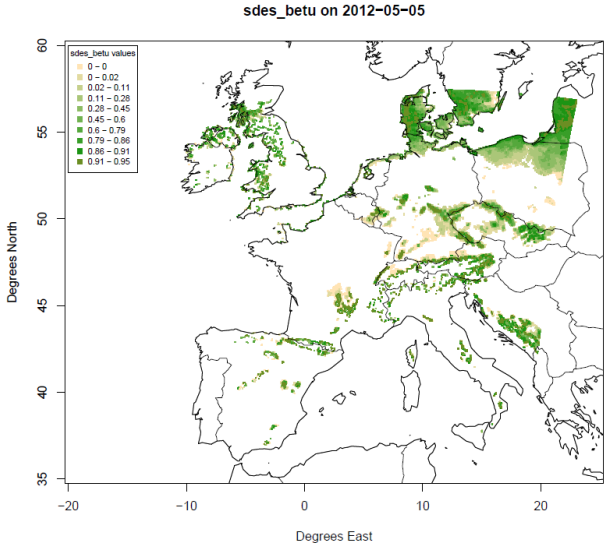


Description of the pollen season







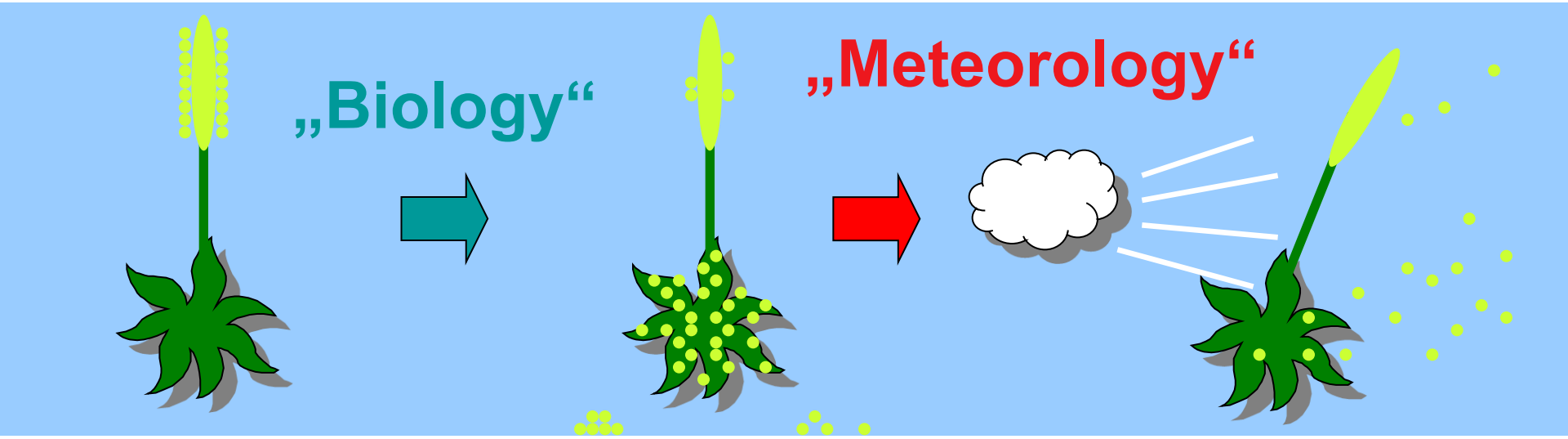


Pollen emission

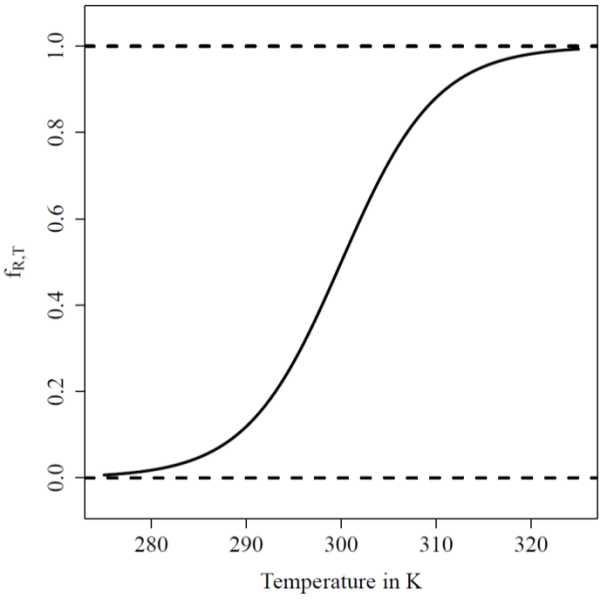
Concept of a „pollen reservoir“:

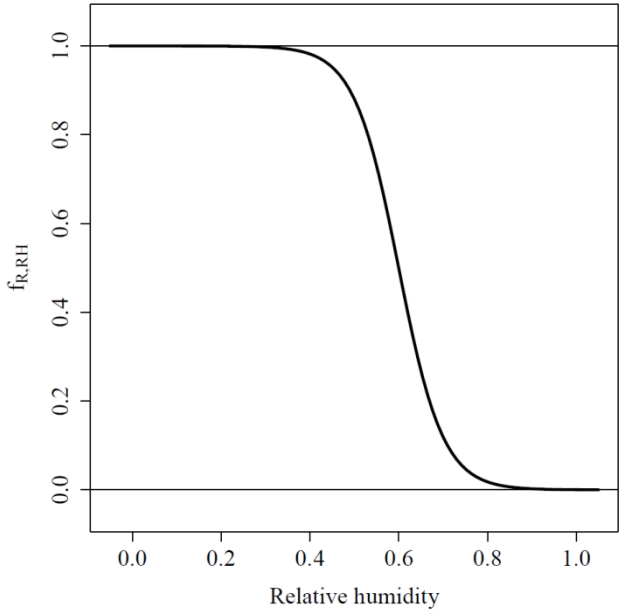
1. **Release of the pollen from the flower. Filling of the reservoir.**
   „Biology“
2. **Emission of the pollen from the reservoir into the atmosphere.**
   „Meteorology“

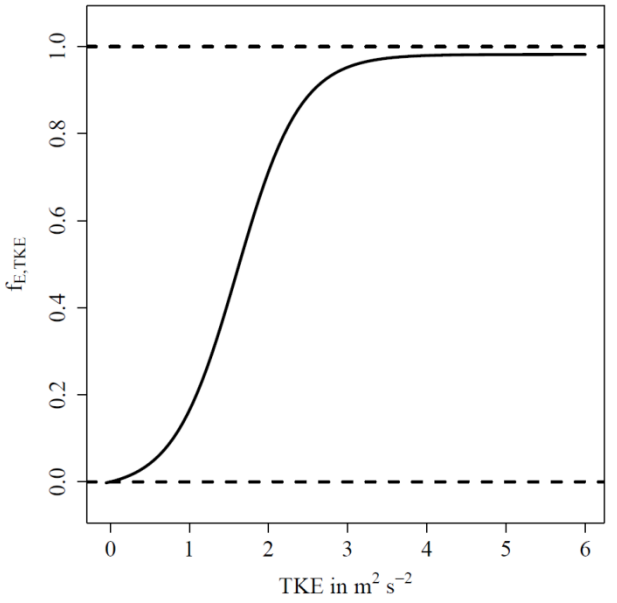
Source: Katrin Zink



The meteorological impact on filling the ragweed pollen reservoir (T, RH) and entrainment into the atmosphere (TKE)







Parametrization of the sedimentation

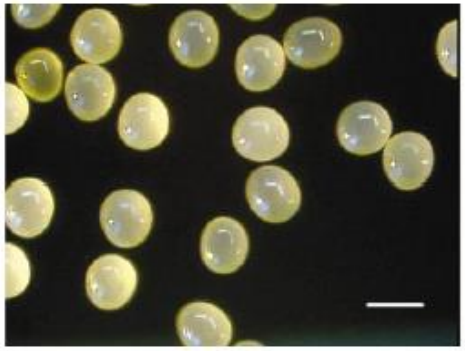
$$v_s^2 = \frac{4 \rho_p d_e g}{3 \rho c_d}$$

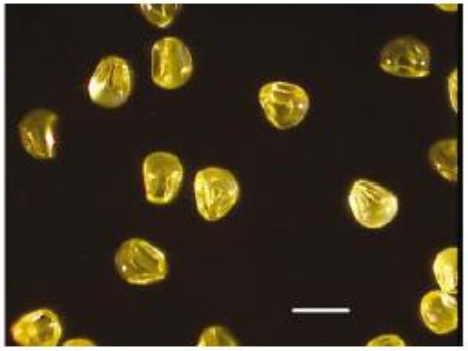
ρ_p: **The pollen density depends on the content of water (Aylor, 2002)**

c_d: **drag coefficient parameterized after Fuchs (1964) und Friedlander (1977)**

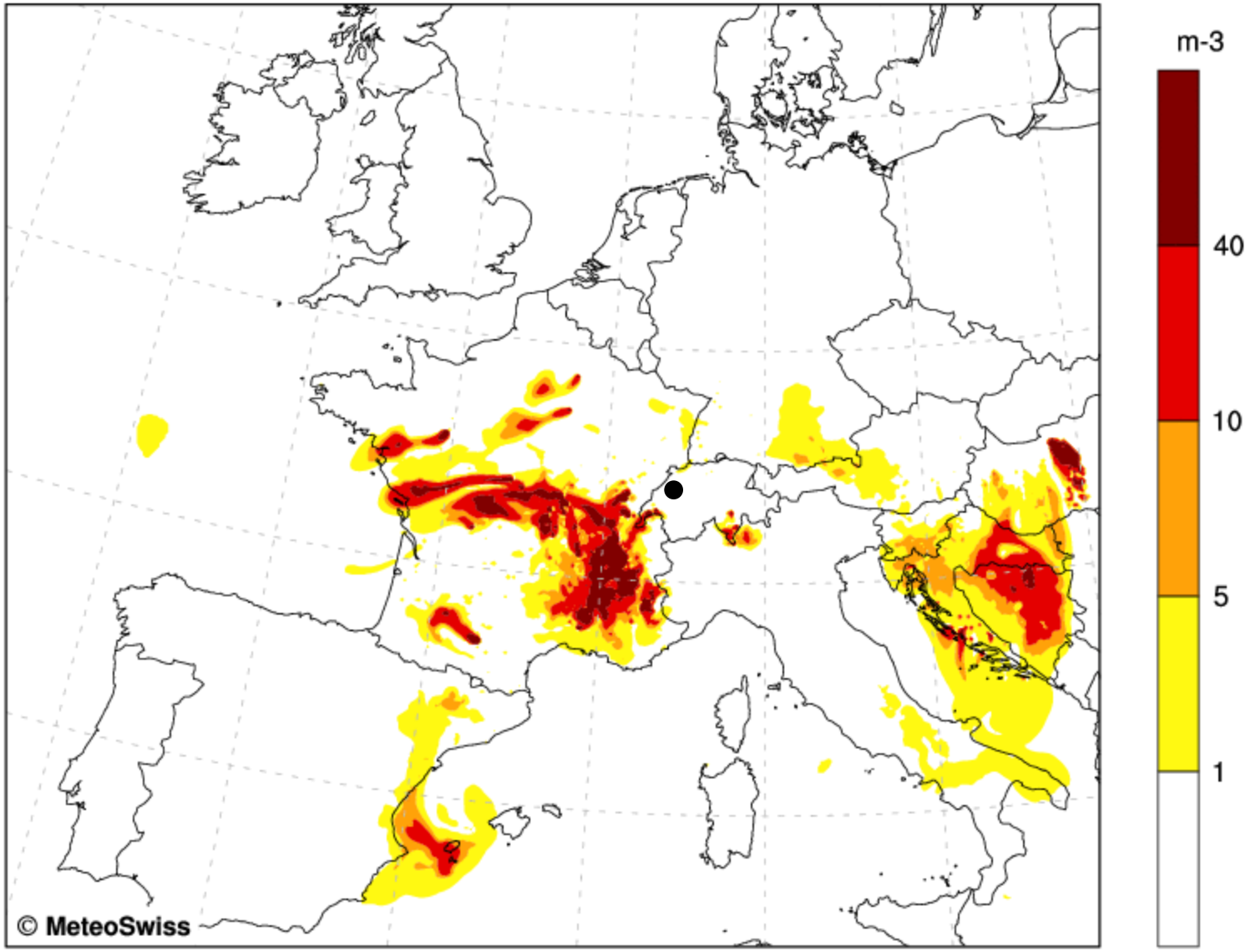
d_e: **diameter of the pollen (Hinds, 1982)**

ρ: **density of the air**

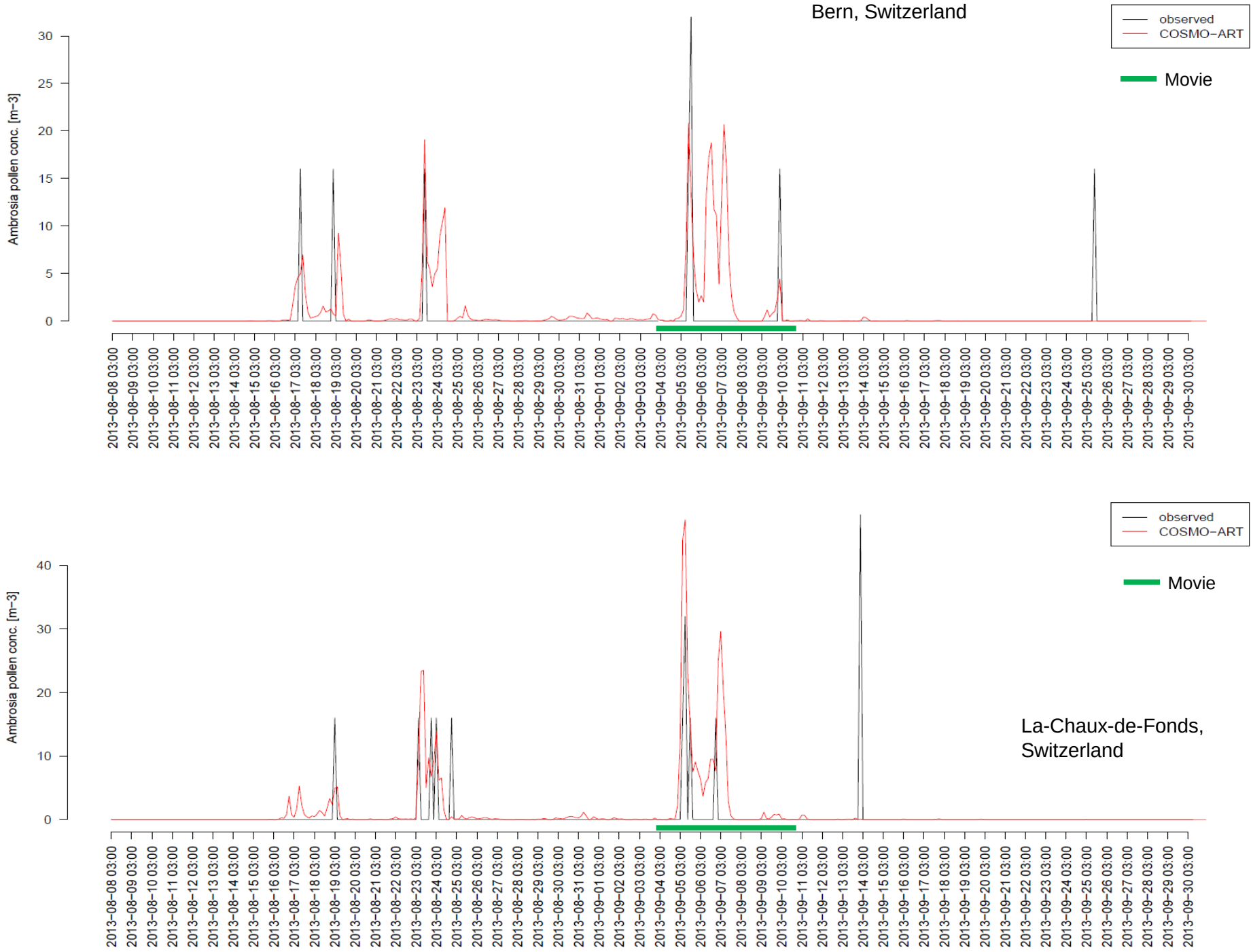




COSMO-7 ANALYSIS
Version: 937
Wed 04 Sep 2013 00UTC
Ambrosia Pollen Concentration
04.09.2013 00UTC +00h



Concentration of Ambrosia Pollen [m-3]
Max: 2935.2 m-3


Bern, Switzerland
observed
COSMO−ART
Movie
Ambrosia pollen conc. [m−3]
0
5
10
15
20
25
30
2013−08−08 03:00
2013−08−09 03:00
2013−08−10 03:00
2013−08−11 03:00
2013−08−12 03:00
2013−08−13 03:00
2013−08−14 03:00
2013−08−15 03:00
2013−08−16 03:00
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2013−08−18 03:00
2013−08−19 03:00
2013−08−20 03:00
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2013−09−21 03:00
2013−09−22 03:00
2013−09−23 03:00
2013−09−24 03:00
2013−09−25 03:00
2013−09−26 03:00
2013−09−27 03:00
2013−09−28 03:00
2013−09−29 03:00
2013−09−30 03:00
observed
COSMO−ART
Movie
Ambrosia pollen conc. [m−3]
0
10
20
30
40
La-Chaux-de-Fonds,
Switzerland
2013−08−08 03:00
2013−08−09 03:00
2013−08−10 03:00
2013−08−11 03:00
2013−08−12 03:00
2013−08−13 03:00
2013−08−14 03:00
2013−08−15 03:00
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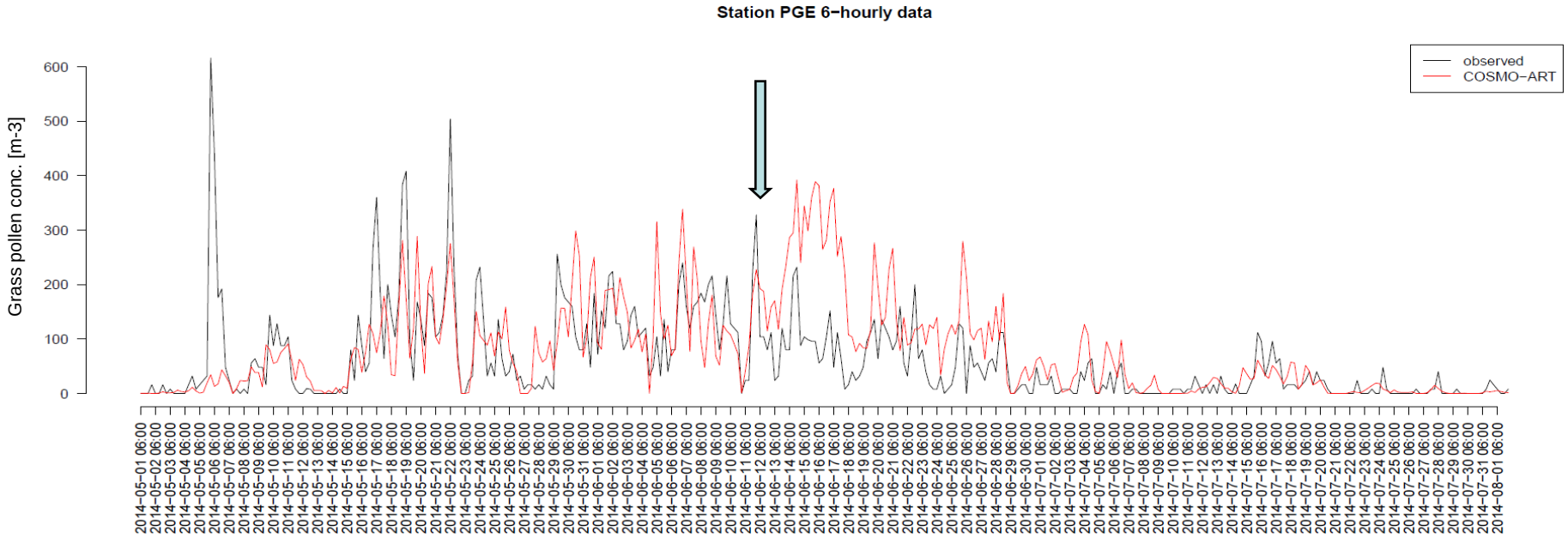
Station PGE 6−hourly data
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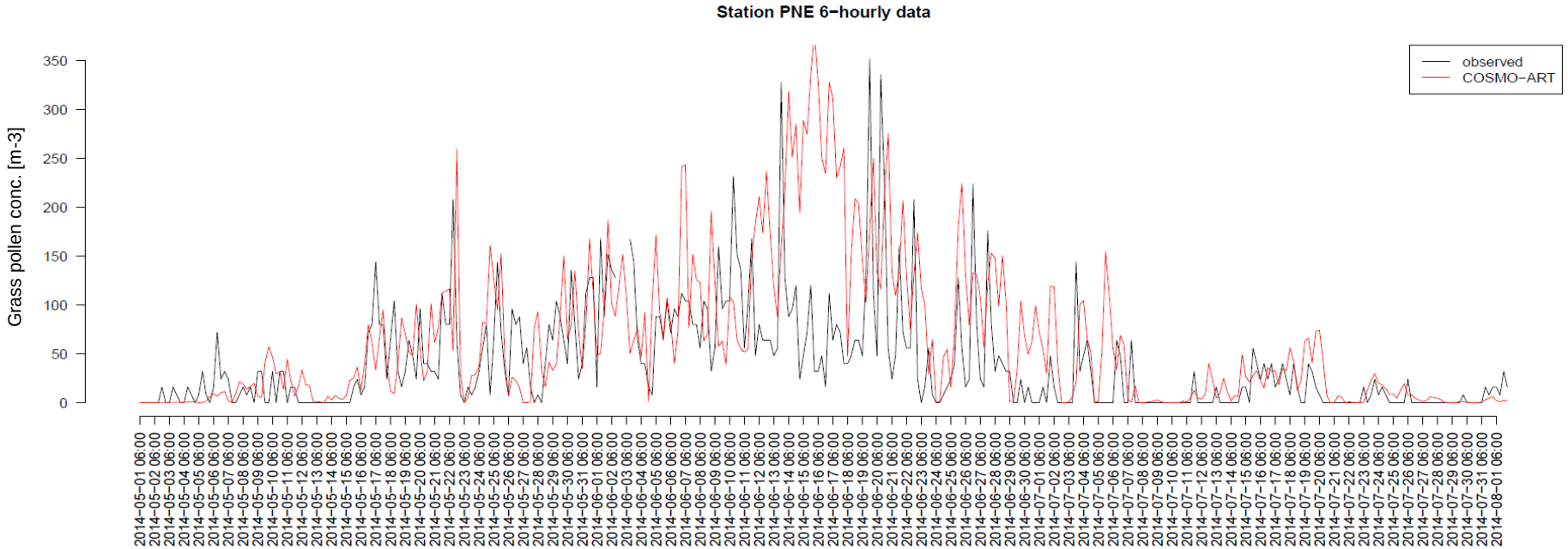
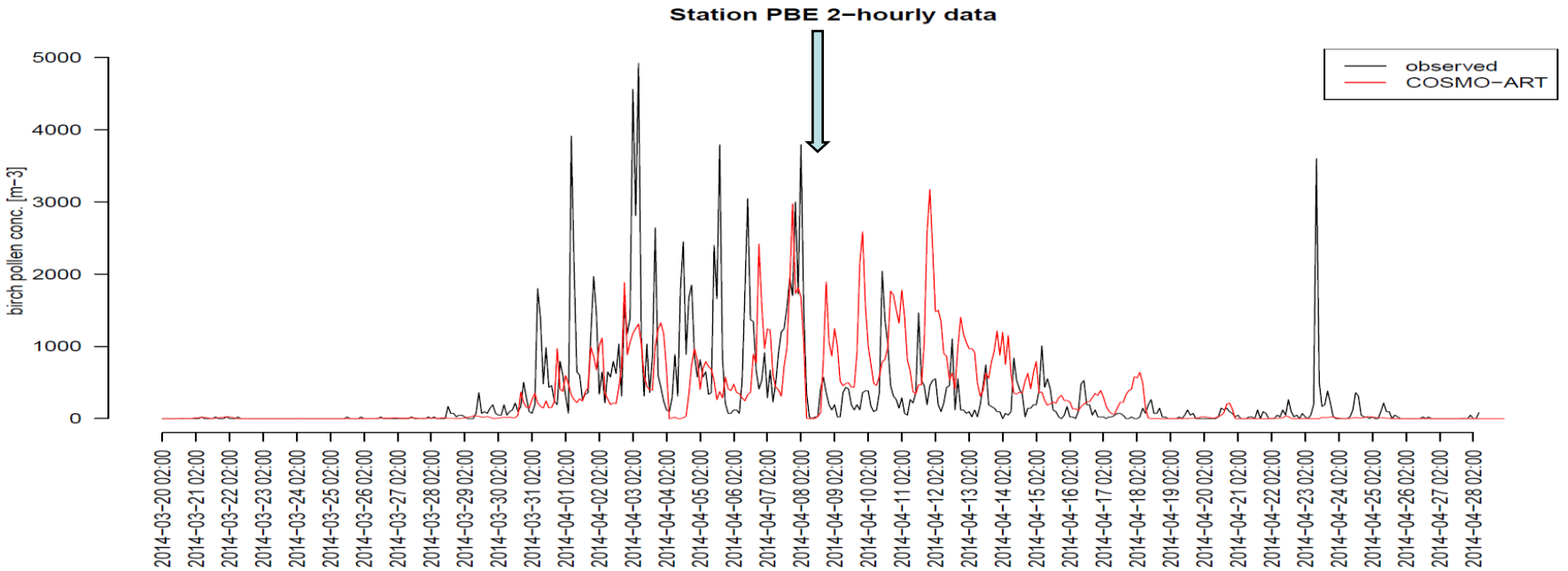
COSMO−ART
Grass pollen conc. [m-3]
0
100
200
300
400
500
600
2014−05−01 06:00
2014−08−01 06:00


Station PNE 6−hourly data
observed
COSMO−ART
Grass pollen conc. [m-3]
0
50
100
150
200
250
300
350
2014−05−01 06:00
2014−08−01 06:00


Station PBE 2−hourly data
observed
COSMO−ART
birch pollen conc. [m−3]
5000
4000
3000
2000
1000
0
2014−03−20 02:00
2014−03−21 02:00
2014−03−22 02:00
2014−03−23 02:00
2014−03−24 02:00
2014−03−25 02:00
2014−03−26 02:00
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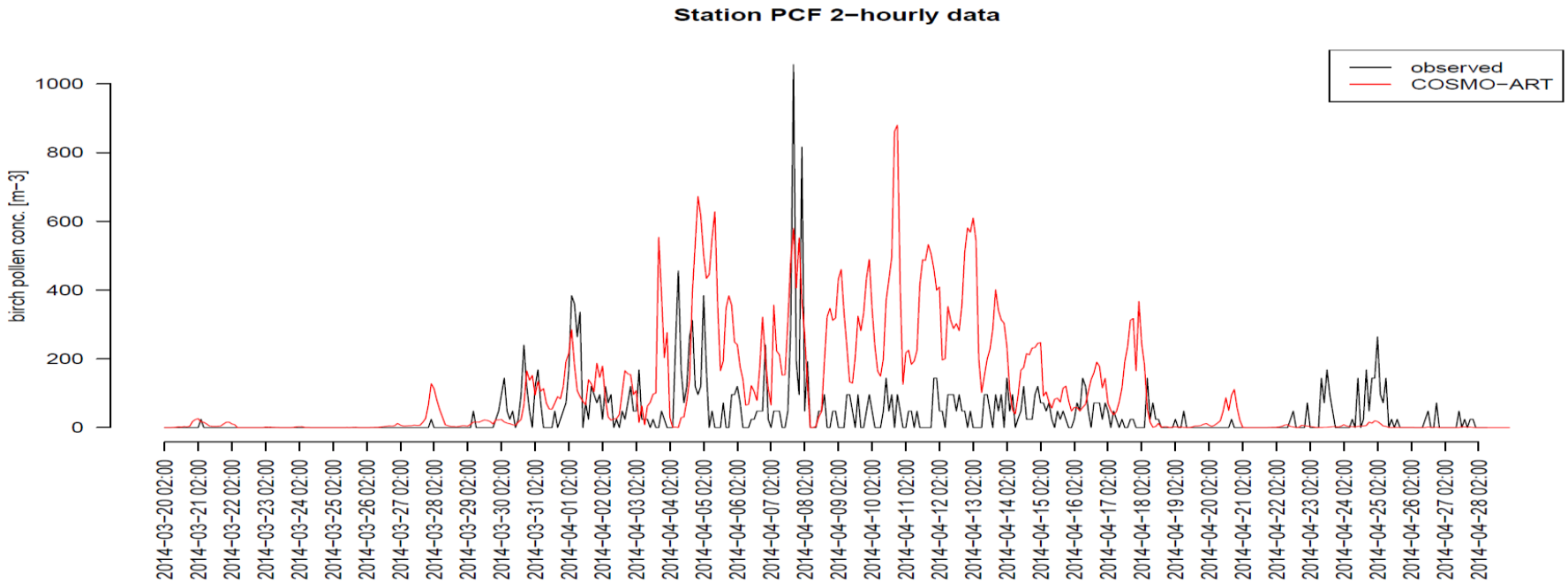
Station PCF 2−hourly data
observed
COSMO−ART
birch pollen conc. [m−3]
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800
600
400
200
0
2014−03−20 02:00
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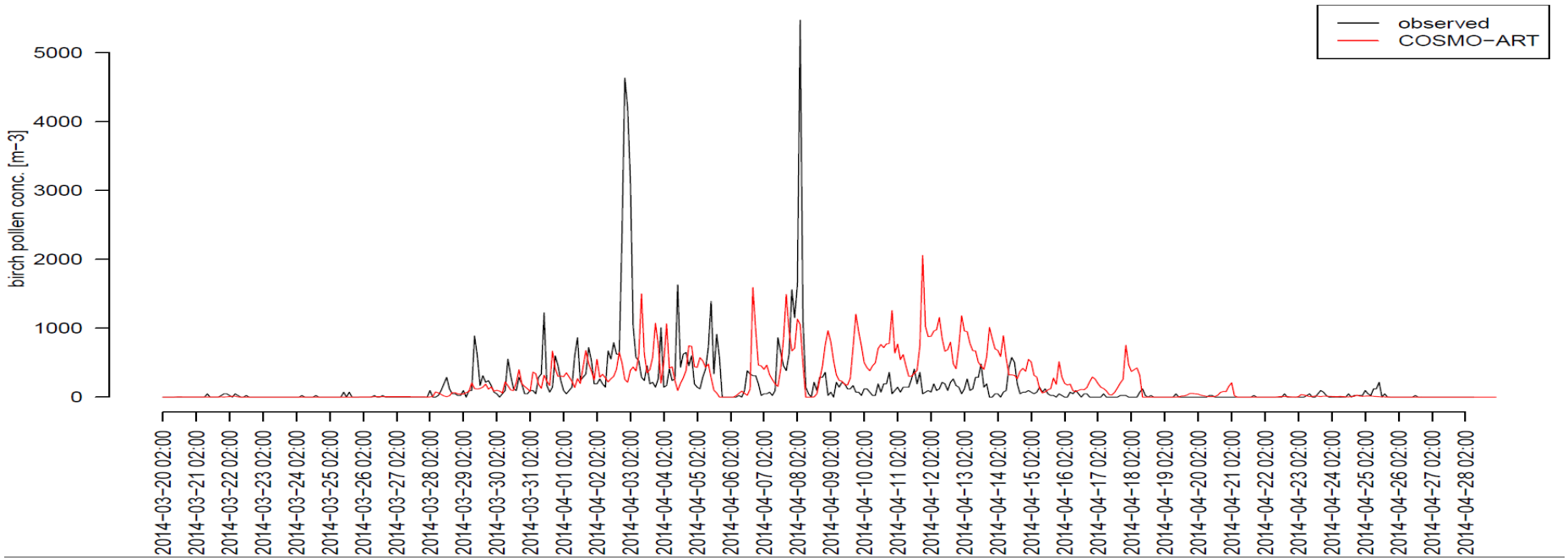
Station PLZ 2−hourly data
observed
COSMO−ART
birch pollen conc. [m−3]
0
1000
2000
3000
4000
5000
2014−03−20 02:00
2014−03−21 02:00
2014−03−22 02:00
2014−03−23 02:00
2014−03−24 02:00
2014−03−25 02:00
2014−03−26 02:00
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2014−03−28 02:00
2014−03−29 02:00
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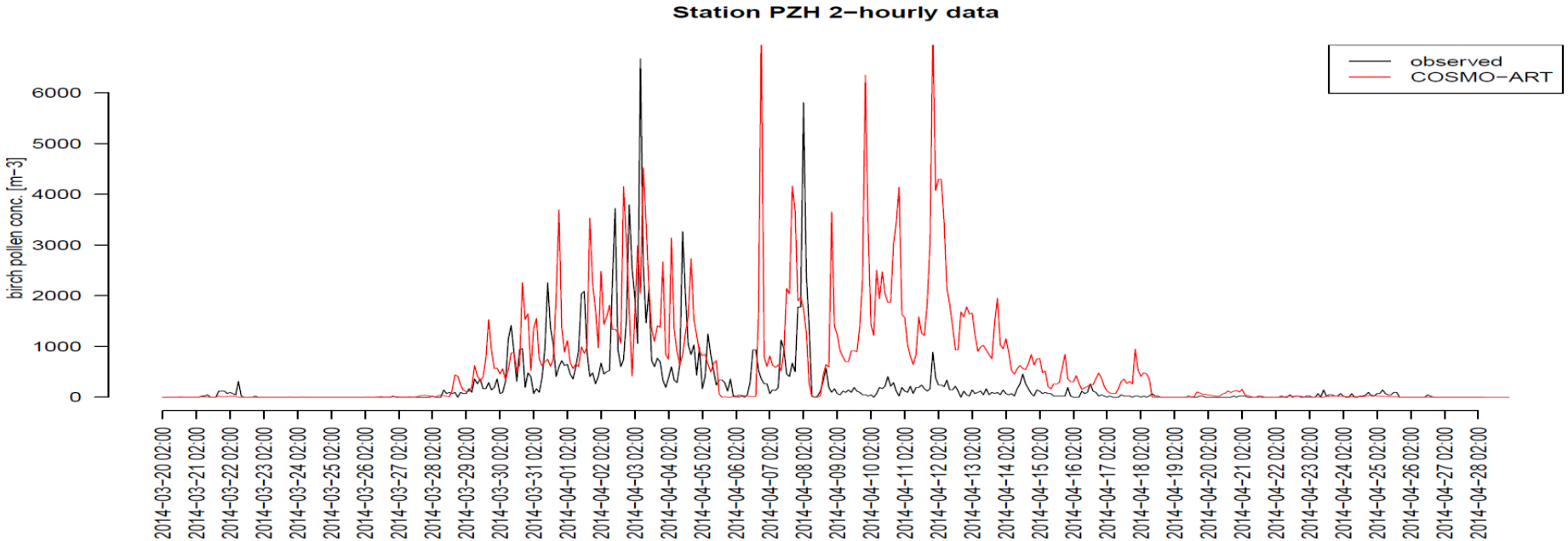
Station PZH 2−hourly data
observed
COSMO−ART
birch pollen conc. [m−3]
0
1000
2000
3000
4000
5000
6000
2014−03−20 02:00
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2014−04−23 02:00
2014−04−24 02:00
2014−04−25 02:00
2014−04−26 02:00
2014−04−27 02:00
2014−04−28 02:00

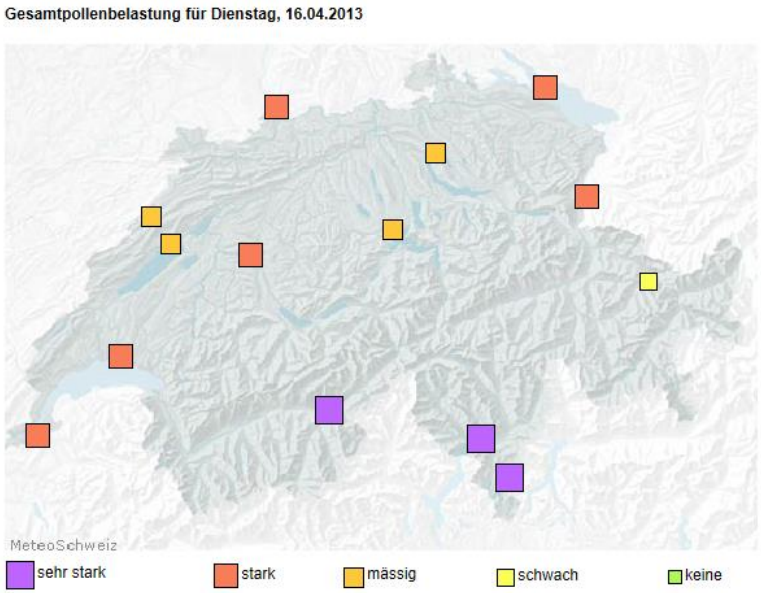
Birch tree next to the pollen station in Zurich, Switzerland, on April 9, 2014

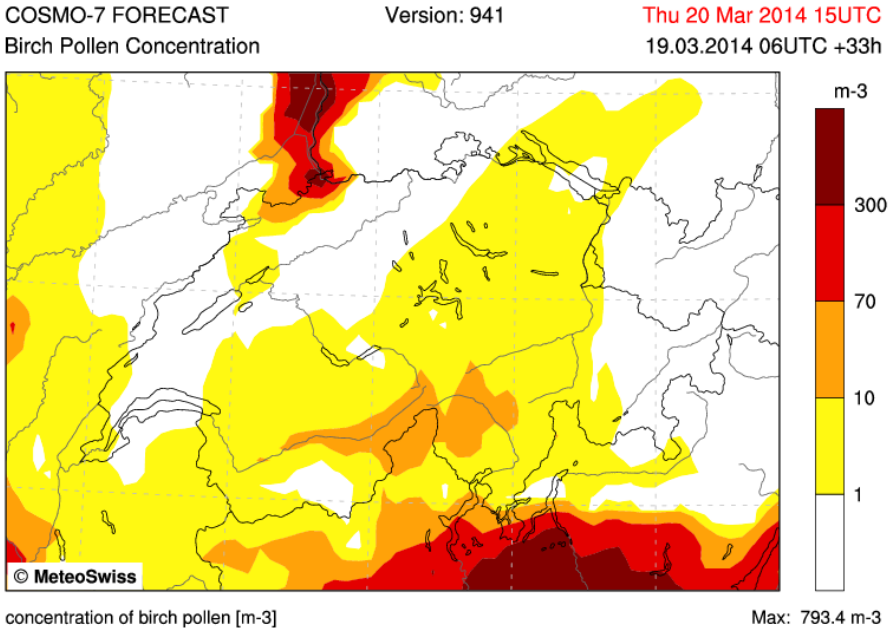
Fotos: A. Pauling, MeteoSwiss

Take home messages and outlook

- The pollen module von COSMO-ART provides spatially and temporally highly resolved pollen forecasts
- Currently, **birch, grass, alder** and **ragweed** are operationally calculated at MeteoSwiss
- COSMO-ART emission parameterization is focused on biological processes
- Other influences such as mowing or catkin is not (yet) considered
  Important uncertainty: plant distribution
- Good overall agreement with observations
- Increase of the resolution to 2km in 2016?

Station-based => spatial coverage
daily mean => hourly mean

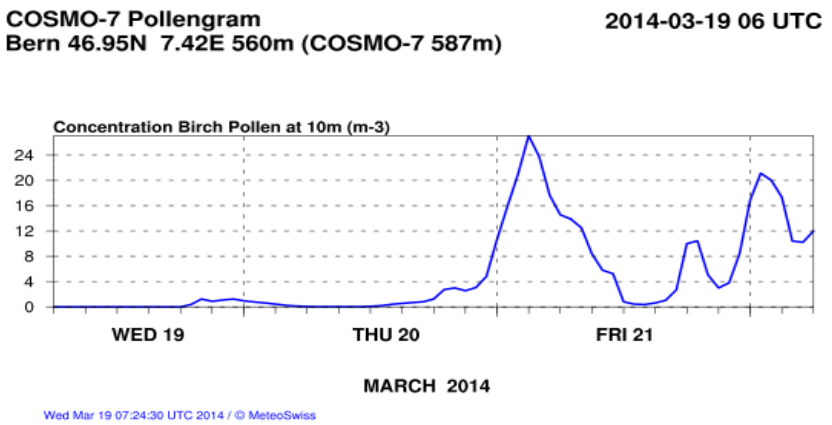




Visualisation:

[Modelbrowser (COSMO)]

[Climatebrowser]



Parameterization of the washout

$$\Lambda = \frac{3}{2} \cdot \frac{E p_0}{D_p}$$

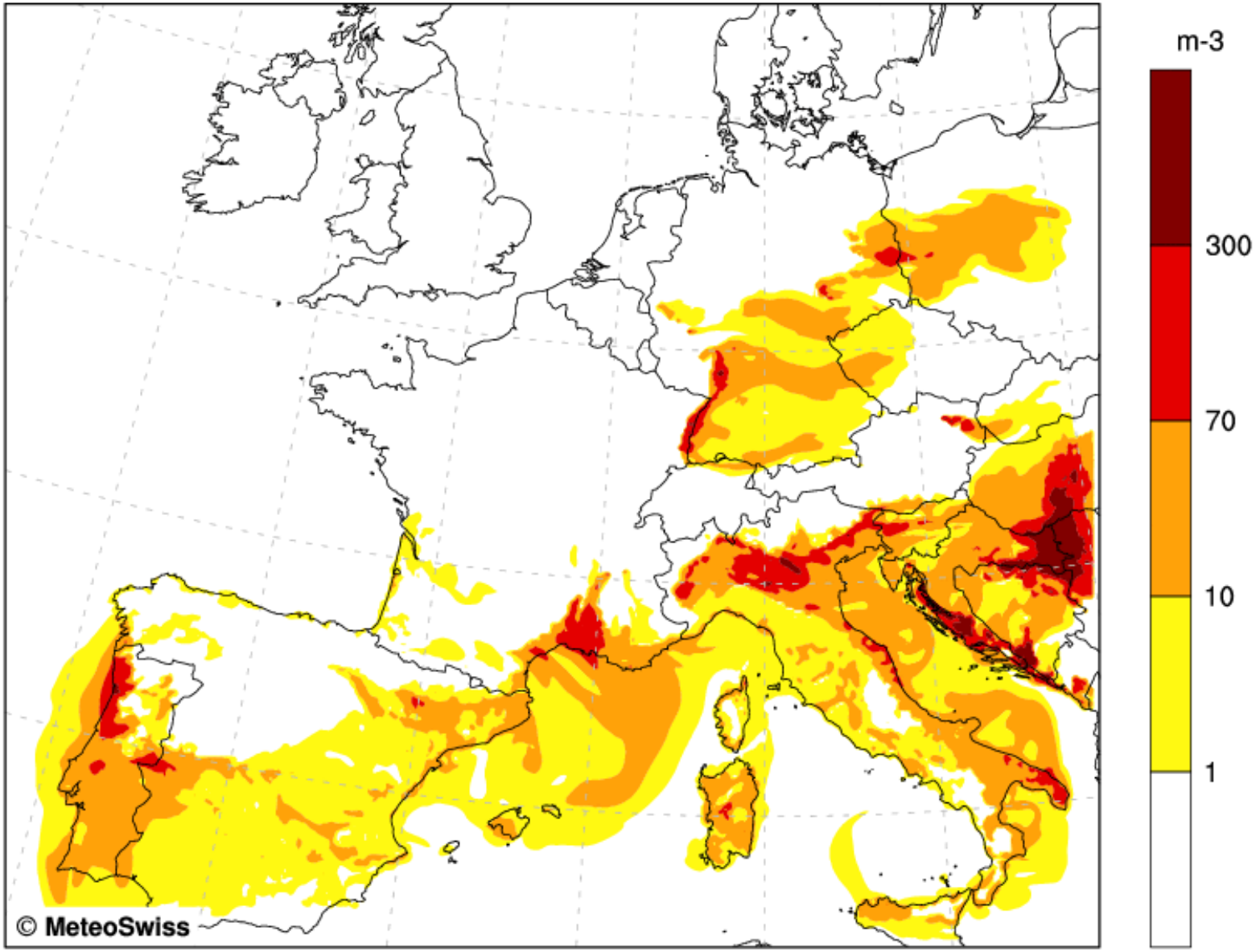
Λ: **scavenging coefficient**

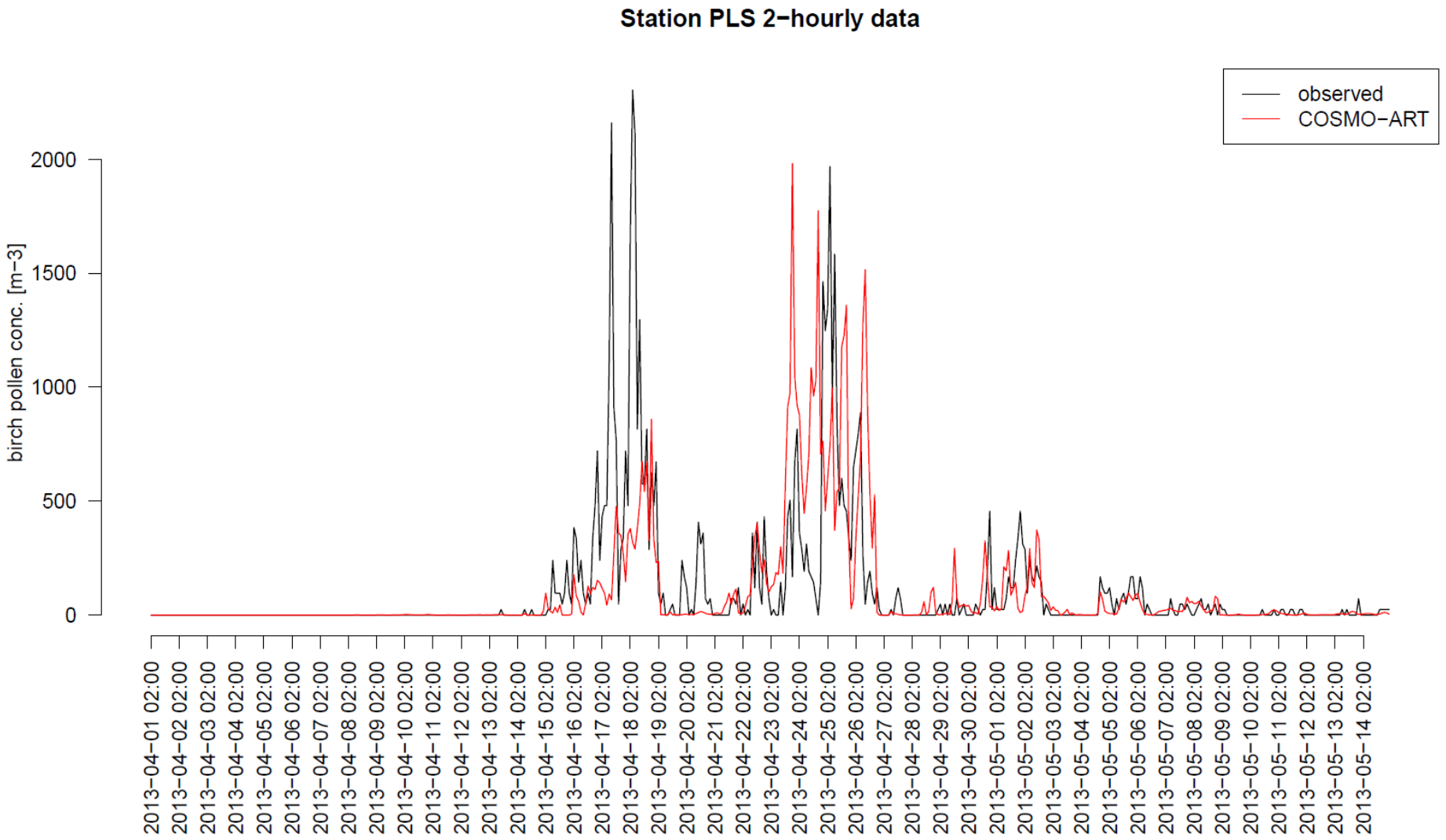
E: **efficiency**

D_p: **diameter of rain drops**

p_0: **rain intensity**

COSMO-7 ANALYSIS
Version: 941
Wed 19 Mar 2014 00UTC
Birch Pollen Concentration
19.03.2014 00UTC +00h



concentration of birch pollen [m-3]
Max: 1120.2 m-3

Verification: observations vs. forecasts (Lausanne, Switzerland)