MACC-II Deliverable D_104.2

# Routines for grass, olive and ambrosia pollen emissions


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**Lead Beneficiary:** FMI (#15)

**Nature:** O

**Dissemination level:** PP


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The current deliverable is a combination of the current report, the source term technical description, a scientific paper mentioned in the current report, a dedicated modelling seminar, and a program code to be used as a starting point by the modelling teams for the source implementation.

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# Executive Summary / Abstract

The modelling source terms for the three pollen species – generic grass, olive, and ragweed – developed by FMI during recent years in co-operation with European Aeroallergen Network EAN have been described and made available for the MACC regional modelling consortium. This work was done in addition to the birch source that has been implemented in MACC ENS models and tested in trial operational forecasts in 2013-2014 seasons. The results of these tests (2013 has been a joint exercise between MACC and EAN), as well as the joint MACC-EAN re-analysis of 2010 for birch, comprise a dedicated scientific publication in MACC special issue.
Current deliverable consists of the following parts:

- Basic principles descriptions and their relation to the birch source term already familiar for the modellers (included in this report)
- Scientific description of the most-sophisticated source term for ragweed (open scientific paper, quoted in this report)
- Input datasets for the sources: maps of the plant habitation, flowering thresholds, etc. (http://silam.fmi.fi/MACC, has been outlined in MACC ENS meetings, detailed explanations will be given at the dedicated implementation seminars for each taxon, planned within the scope of MACC-III).
- Program code specifics, in comparison with the birch source term (touched during the birch source implementation seminar, will be reiterated and put in details at the implementation seminar for each taxon, planned within the scope of MACC-III).

## 1. Olive source term

The olive tree pollination is believed to depend on essentially the same processes as the ones driving the birch flowering: cumulative heat sum as the main driver, and a series of the release modulators, such as wind speed, turbulent mixing, relative humidity, and precipitation rate.
The similarity is largely a matter of assumption made during the source term development: both tree species were assumed to be regulated by the same set of processes. Specific behaviour of each species is then controlled by the individual parameters in the functional dependences. Such approach has been supported by numerous aerobiological publications arguing that essentially the same models describe the flowering of many tree species including birch and olive.
Therefore, the source terms implemented in MACC ENS models are directly usable for olive modelling, with a corresponding switch of parameters and habitation maps. Those are available from http://silam.fmi.fi/MACC.

## 2. Grass source term

The grass source term is both the most-complicated and the simplest among the four species. From one side, there are over 200 grass species, each flowering in accordance to own calendar, driving processes, area of habitation, etc. Mechanistic description of even major of these species is impossible. From the other side, grass pollen looks the same for all herbaceous species: microscopic analysis cannot distinguish between them. Therefore, a common approach in aerobiology, also followed by the SILAM team, is to consider generic grass as a "lumped taxon". Parameterization for such taxon is next to trivial: individual specifics and reactions to external forcing are efficiently smeared out during lumping, so that the simple fixed flowering calendar appeared to be the best approach.
Programming code for the grass source term is therefore a simplification of the existing birch source term, excluding all dependencies, except for the humidity- and rain-dependent shutting of the inflorescences. Necessary input is available from http://silam.fmi.fi/MACC.

## 3. Ragweed source term

The ragweed source term differs from the other sources, mainly because this is the first annual taxon in the SILAM aerobiological collection. Therefore, it turned out necessary to follow up the plant growth from the seed starting from its activation early in spring, through the growth phase, and finally to flowering. High complexity of the source required a dedicated scientific publication analysing all dependencies and suggesting means of their parameterization and mechanistic modelling (Prank et al, 2013).
Implementation-wise, the complexity of the processes described does not affect the philosophy that has been developed already for the birch: a series of early-spring processes

driving the plant preparation to the flowering, a trigger or a set of triggers controlling the flowering start, and the flowering itself, also controlled by a few meteorological variables. At the starting stage, we recommend using a very simple approach: fixed-day start of flowering (appeared very good for major source areas as ragweed flowering is controlled by sunlight duration, similar to sunflower), and flowering intensity of prescribed shape and parameters as shown in the below table (details are presented in (Prank et al., 2013)). Necessary input is available from http://silam.fmi.fi/MACC.

**Table 1. A list of parameters describing the ragweed source term. Adapted from Prank et al, 2013.**

| | |
|---|---|
| ***Logistic function of habitat climatic quality*** | |
| Middle point (*a*) | 0.88 |
| Slope (*b*) | -16.0 |
| Maximum emission (*Emax*) | 1.5e7 pollen/m2 |
| ***Flowering start thresholds (2 sigma = 2.5%)*** | |
| Photoperiod | 14.5 h |
| Bioday | 25 +- 10% |
| ***Vegetation (bioday accumulation) start and flowering end (2 sigma = 97.5%) thresholds*** | |
| Photoperiod | 12.0 h |
| Daily mean temperature | 7.5 C |
| Instant temperature | 0.0 C |
| ***Bioday accumulation*** | |
| Minimum temperature | 0.9 C |
| Maximum temperature | 40 C |
| Optimal temperature | 31.7 C |
| Maximum optimal photoperiod | 14.5 hr |
| ***Pollen release (diurnal variations - bimodal normal distribution Martin et al 2010)*** | |
| Peak 1 peak time (after sunrise) | 135 min |
| Peak 2 peak time (after sunrise) | 285 min |
| Peak 1 standard deviation | 15 min |
| Peak 2 standard deviation | 100 min |
| Fraction of pollen in peak 1 | 40% |
| ***Other parameters*** | |
| Pollen diameter | 18 µm |
| Pollen density | 800 kg/m3 |
| Emission injection height | ABL height |

## 3. Reference

Prank, M., Chapman, D. S., Bullock, J. M., Belmonte, J., Berger, U., Dahl, A., … Sofiev, M. (2013). An operational model for forecasting ragweed pollen release and dispersion in Europe. *Agricultural and Forest Meteorology*, *182-183*, 43–53. doi:10.1016/j.agrformet.2013.08.003