Update of FROGS and adaptation to PEARL 4.4.4 and FOCUS groundwater II guidance

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Introduction and Objective

FROGS (French Refinement of Groundwater Scenarios) is a PEARL-based simulation tool established as a higher-tier option within the authorization process for plant protection products in France. The current FROGS 2.2.2.2 (FROGS 2011) is based on PEARL 3.3.3 and was published in July 2011. Meanwhile, the new FOCUS-PEARL 4.4.4 has been released, which incorporates various updates and amendments recommended by the FOCUS groundwater group (FOCUS, 2009). Consequently, the FROGS development group decided to update the tool to (i) adapt it to PEARL 4.4.4, (ii) integrate the adaptations from FOCUS (2009) that were considered to be appropriate and meaningful to the specific FROGS assumptions and (iii) improve the method for allocating crop surfaces.

(i) Inclusion of PEARL 4.4.4 and its new hydrologic model version of SWAP 3.2.34
The main change in FROGS to adapt it to PEARL 4.4.4 is the **adaptation of the input template file**.

(ii) Adaptations to the FOCUS gw II guidance implemented in FROGS 3.3.3.3
- The most appropriate method for calculating **reference evapotranspiration** for Southern European scenarios and conditions according to FOCUS (2009) is considered to be the FAO method. As France belongs to the Southern regulatory zone, this method was implemented.
- In accordance with FOCUS (2009) harmonisation of the implementation of **crop factors**, which are needed for the calculation of actual evapotranspiration, was adopted.
- **80th percentile PEC_{gw}** is calculated according to FOCUS (2009) based on the annual average of the 16th & 17th highest PEC_{gw} values.

Some points that changed in FOCUS (2009) compared to the former guidance have not been adopted. Thus, the extensive method in which realistic **irrigation** amounts were identified for the previous FROGS version was kept and the adaptation of **rooting depth** up to the target depth was not considered relevant since rooting depth was already limited to the target depth in the previous version of FROGS.

(iii) Additional updates implemented in FROGS 3.3.3.3
The approach to allocate **crop surfaces** within the agronomic units (AU) was improved: the surface of each combination of soil, crop and AU is now estimated using the cultivated area of each crop within each AU (based on the 2000 agricultural census), the distribution of soils in the cropping region and the area of each soil within each AU.
Finally, the **mitigation template** was updated to enable mitigation based on soil pH.

Assessing the impact of changes in comparison to results obtained with FROGS 2.2.2.2
Test runs based on the FROGS internal default application rates and dates were conducted for all eight field crops parameterised in FROGS with FOCUS dummy substances C, D and Metabolite of C to evaluate the overall effect of the changes. Main input parameters are provided in Table 1.

Results

Example results are provided in Figure 1 as cumulative aerial distribution of overall 90th percentile PEC_{gw} (80th percentile aerial combined with 80th percentile temporal). Table 2 provides an overview of all test run results obtained with either FROGS 3.3.3.3 in comparison to FROGS 2.2.2.2.

Benefits of FROGS 3.3.3.3 in short

- ✓ current model versions of SWAP and PEARL
- ✓ no crashing of PEARL runs (9 out of 1481 scenarios aborted in the previous FROGS version due to a problem with the former SWAP version)
- ✓ splitting of extreme rainfall events over several consecutive days in selected scenarios is no longer required
- ✓ inclusion of 4-year crop rotations
- ✓ following current FOCUS gw II recommendations where appropriate:
  - FAO evapotranspiration integrated
  - crop factors updated
  - 80th percentile PEC_{gw} estimation updated
- ✓ more accurate total area modelled for each crop
- ✓ ca. 25% less scenarios (1097 in total in FROGS 3.3.3.3) resulting in decreased simulation time
- ✓ mitigation based on soil pH enabled

Table 1: Main input parameters used for test runs

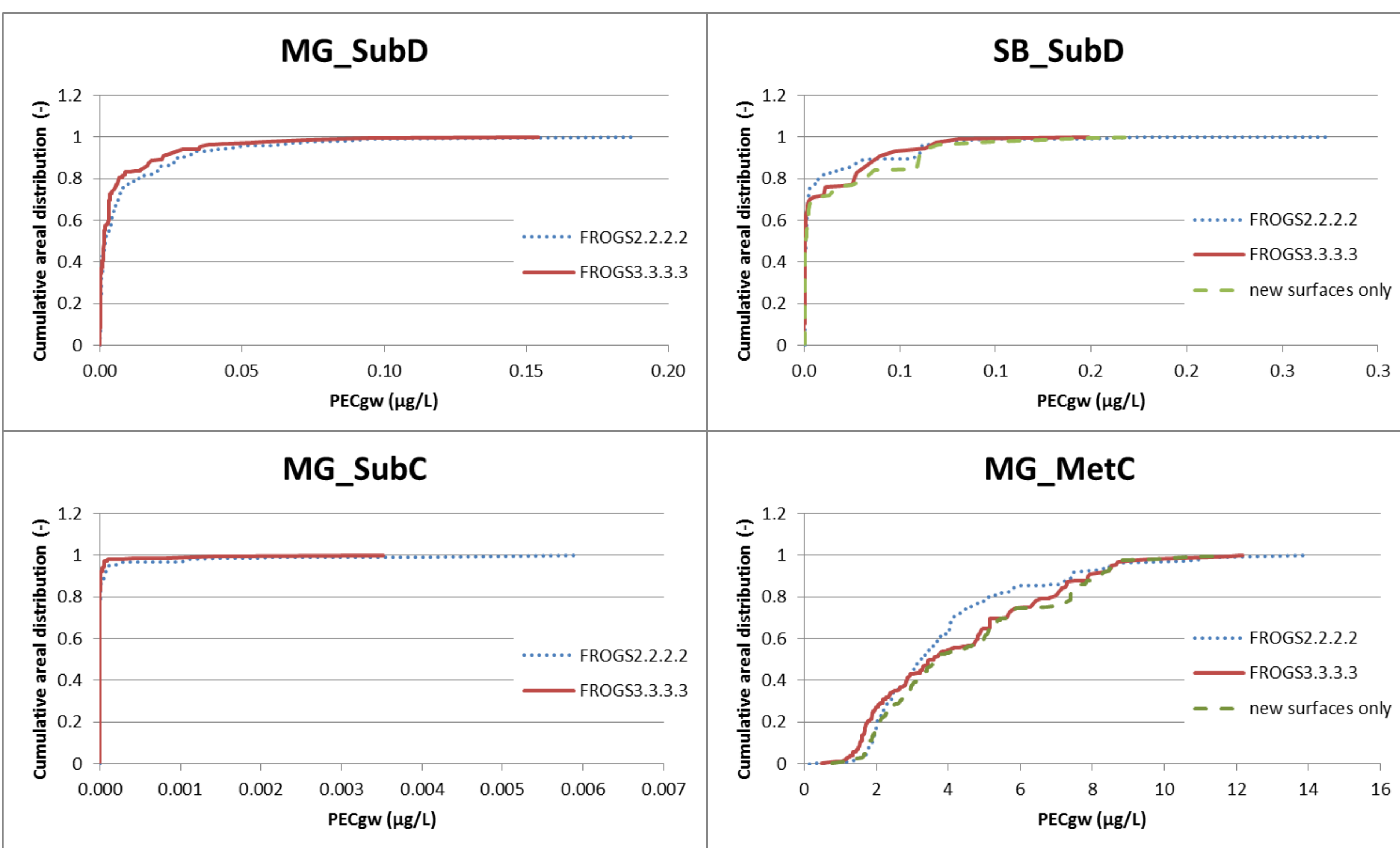|	Dummy C	Dummy C metabolite	Dummy D
DT50 (days)	20	100	20
ffM (-)	-	0.71 from parent	-
Kom/Koc (dm³/kg)	100 / 172	30 / 52	35 / 60
1/n (-)	0.9	0.9	0.9
MW (g/mol)	200	150	300
Crop uptake factor (-)	0.5	0.5	0.5
Q10	2.58	2.58	2.58
Application rate (g/ha)	350	-	200
Application date/stage	emergence	-	emergence

Figure 1: Cumulative areal distribution of PEC_{gw} for some selected combinations of crops (MG, SB) and Compounds (FOCUS Dummy substances C, D, and Metabolite of C).

Table 2: FROGS 3.3.3.3 vs FROGS 2.2.2.2 results

	FROGS	overall 90th percentile PEC_{gw} (µg/L)		
		Dummy C	Dummy C met.	Dummy D
SB	2.2.2.2	1.444E-07	3.760	0.0077
	3.3.3.3	3.855E-05	5.006	0.0262
WW	2.2.2.2	1.452E-05	6.178	0.0825
	3.3.3.3	4.945E-05	7.312	0.1010
OSR	2.2.2.2	2.014E-05	4.234	0.0393
	3.3.3.3	1.826E-06	3.949	0.0278
MF	2.2.2.2	4.126E-07	4.452	0.0077
	3.3.3.3	6.614E-08	3.877	0.0033
MG	2.2.2.2	1.337E-06	5.129	0.0130
	3.3.3.3	1.544E-07	6.891	0.0068
WB	2.2.2.2	2.167E-05	7.432	0.1150
	3.3.3.3	3.367E-05	7.548	0.0861
PO	2.2.2.2	5.300E-06	3.326	0.0112
	3.3.3.3	3.668E-06	3.546	0.0143
SF	2.2.2.2	1.162E-06	3.921	0.0095
	3.3.3.3	3.900E-06	3.238	0.0079

Legend: SB: Sugar Beet; WW: Winter Wheat; OSR: Winter Oilseedrape; MF: Fodder Maize MG: Grain Maize; WB: Winter Barley; PO: Potato; SF: Sunflower

higher overall 90th percentile in FROGS 3.3.3.3   **lower** overall 90th percentile in FROGS 3.3.3.3

Conclusions

FROGS was updated to reflect a more appropriate allocation of crop surfaces, current European guidance for groundwater modelling (FOCUS 2009) and PEARL model enhancements to meet the current status implemented in the regulatory groundwater modelling framework for pesticide authorisation at EU level. Test simulations show that the cumulative areal distribution of the 80th temporal percentile PEC_{gw} is slightly impacted by the modification included in FROGS 3.3.3.3. The main impact is introduced by the modification of the crop surface allocation (see right graphs in Figure 1).

The new FROGS 3.3.3.3 and the corresponding updated version of the FROGS report (FROGS 2013) outlining all the amendments in detail will be available soon on the FROGS webpage (http://frogs.eclosion-share.net).

References
FOCUS (2009). Assessing potential for movement of active substances and their metabolites to ground water in the EU. Report of the FOCUS Ground Water Work Group, EC Document Reference Sanco/13144/2010 version 1, 604 pp.
FROGS (2011). "French Refinement of Groundwater Scenarios" Report of the UIPP Environmental Methodology Working Group version 2.0, 314 pp.
FROGS (2013). "French Refinement Of Groundwater Scenarios" Report of the UIPP Environmental Methodology Working Group version 3.0. (in preparation)