Fate & Transport Modeling of the herbicides Metazachlor & Flufenacet using SWAT

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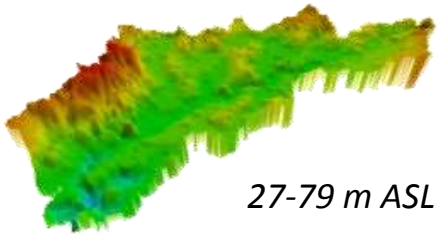
Project motivation

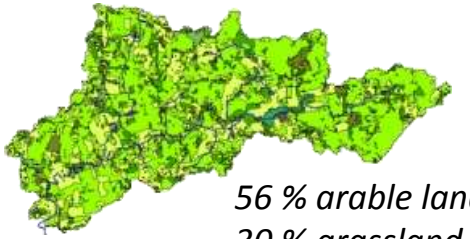
- Good ecological status as goal of EG-WFD (2000)
- pesticide emission from agricultural fields
- 3 year monitoring project to determine main entry pathways

Development of management options to reduce herbicide loads *(State Agency for Agriculture, Environment and Rural Areas (LLUR))*

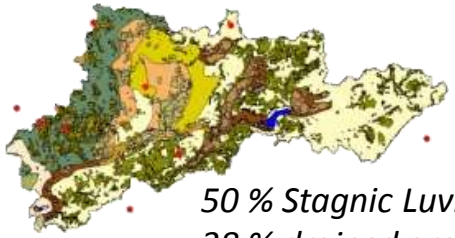
Study Area – Rural lowland catchment Kielstau



27-79 m ASL



56 % arable land
30 % grassland / fallow
9 % forest



50 % Stagnic Luvisols
38 % drained area
(FOHRER ET AL. 2007)

Low hydraulic gradients, near-surface groundwater

- 2 % Slope on average

High potential for water retention

- Riparian wetlands and interaction between groundwater & surface water
- Depression areas
- 1 Lake

Anthropogenic influences

- Fertilizer and pesticides application
- 5 sewage treatment plants
- River regulations
- Drainages

Area: 50 km²
Mean T: 8.2 °C
PCP: 870 mm/a

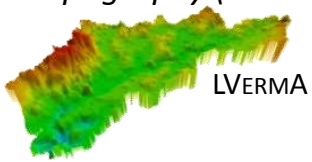
Setup of SWAT 2009

Initial Setup

Climate (1993 – 2009)

Precipitation, Wind, Humidity, Temperature DWD (2010)

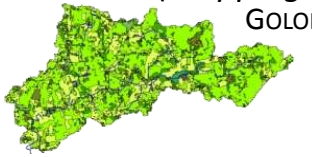
Topography (DEM 5x5 m)



LVERMA (2005)

Land use (mapping in 2008)

GOLON (2009)

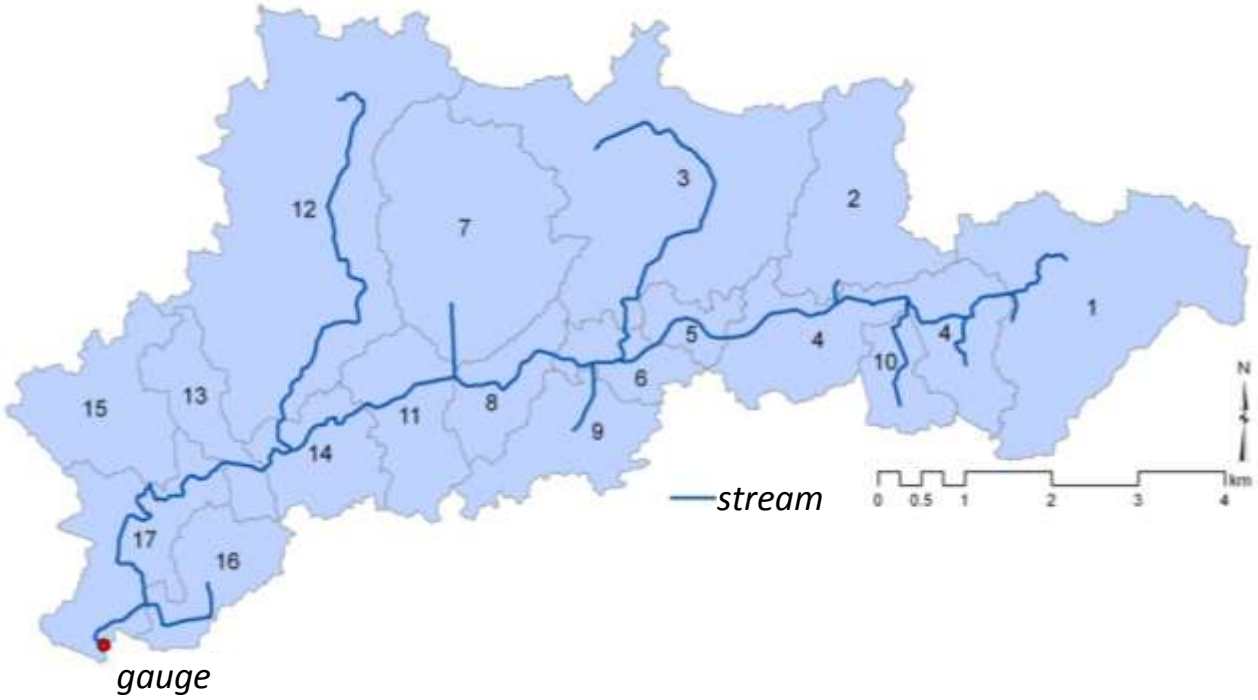


Soils (1:200.000)

BGR (1999)

Calculating ALPHA_BF

(Baseflow Program; ARNOLD ET AL. 1995)



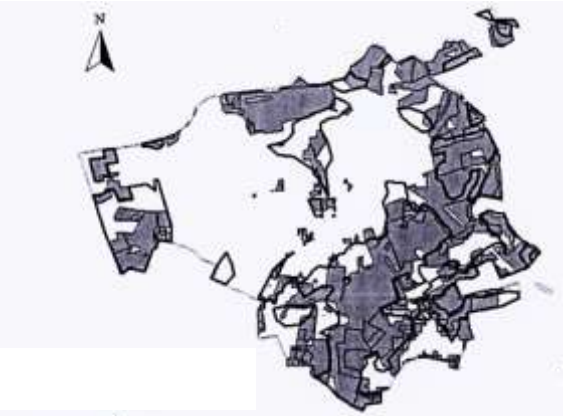
Subbasins: 17
HRU: 938
Thresholds: (0% land use, 20 % soil, 20 % slope)

Drain input:

- Artificial drained areas calculated after FOHRER ET AL. (2007)
- Via soil properties (Ksat, AWC)

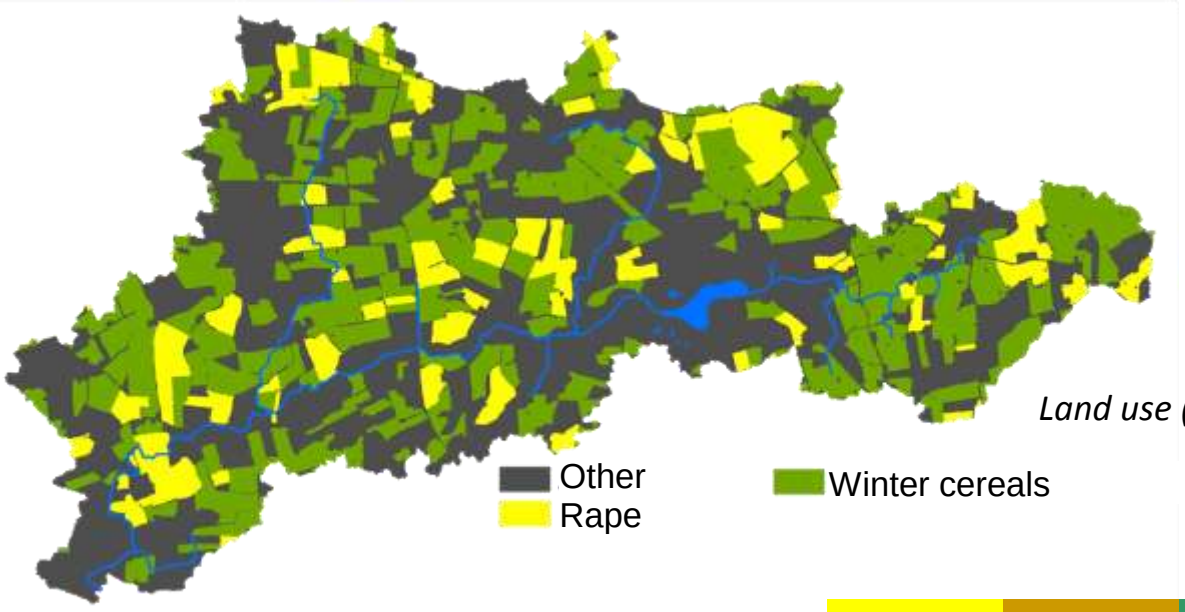
Depression input:

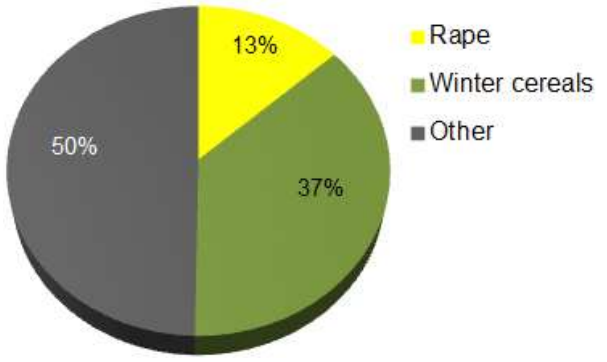
- After the approach by KIESEL ET AL. (2010)
- Input as Wetlands



Digitalised drained area
Simulated drained area (FOHRER ET AL. 2007)

KIESEL ET AL. (2010)

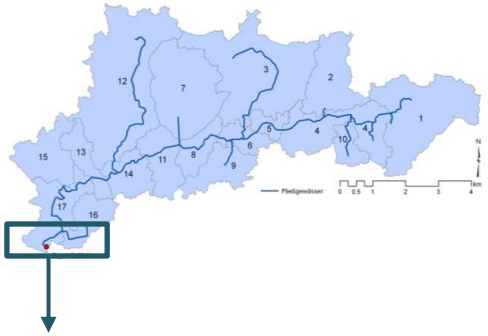




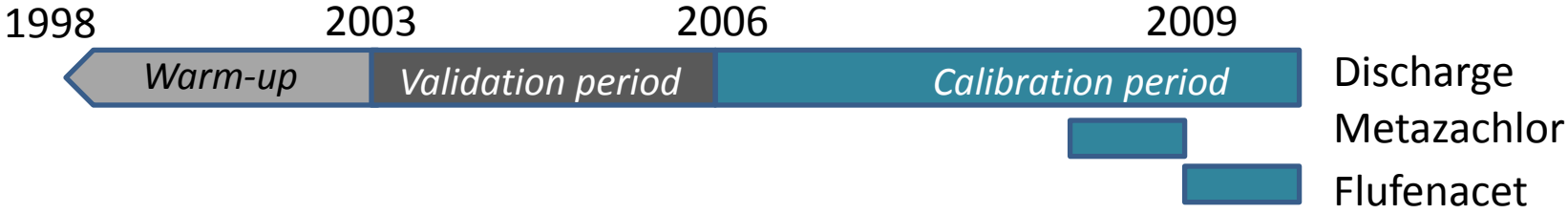
Land use (mapping in 2008, GOLON 2009)

RAPE	WWHT	WBAR
POTA	WWHT	WBAR
RAPE	WWHT	WWHT
Maize	Maize	BARL

- Measurements at the outlet by ULRICH 2010, LLUR 2010
  MET: 2008 (09/01-11/30/2008)
  FLU: 2009 (09/24-12/05/2009)



- Farmer interviews
  - application date
  - application rate
    - MET: 49 % of rape fields
    - FLU: 44 % of winter cereal fields



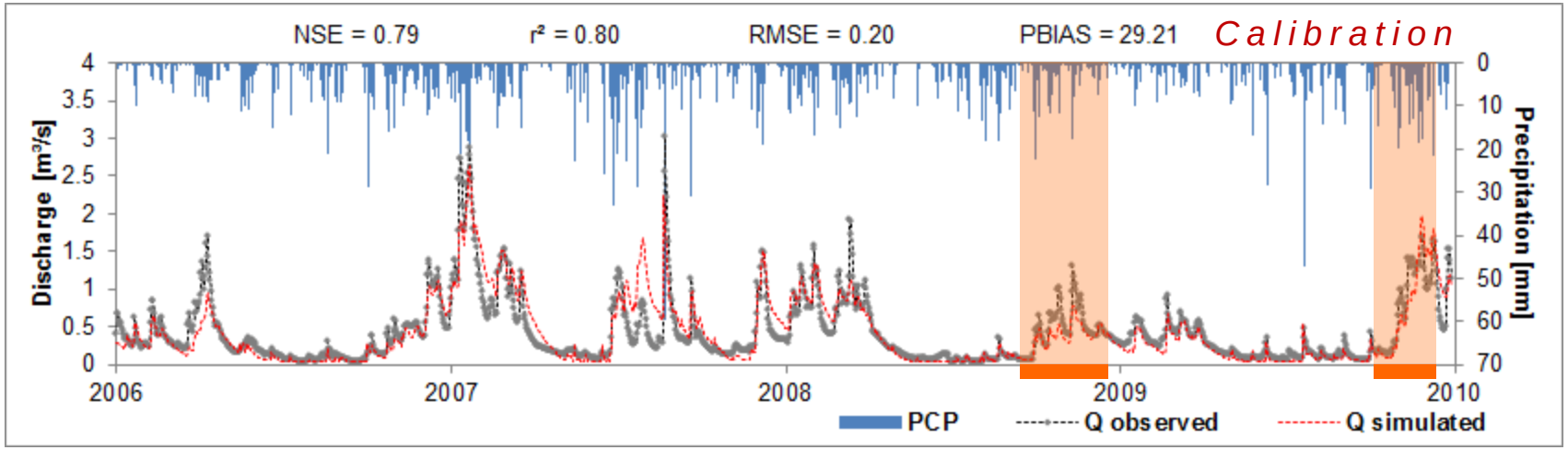
Metazachlor in RAPE

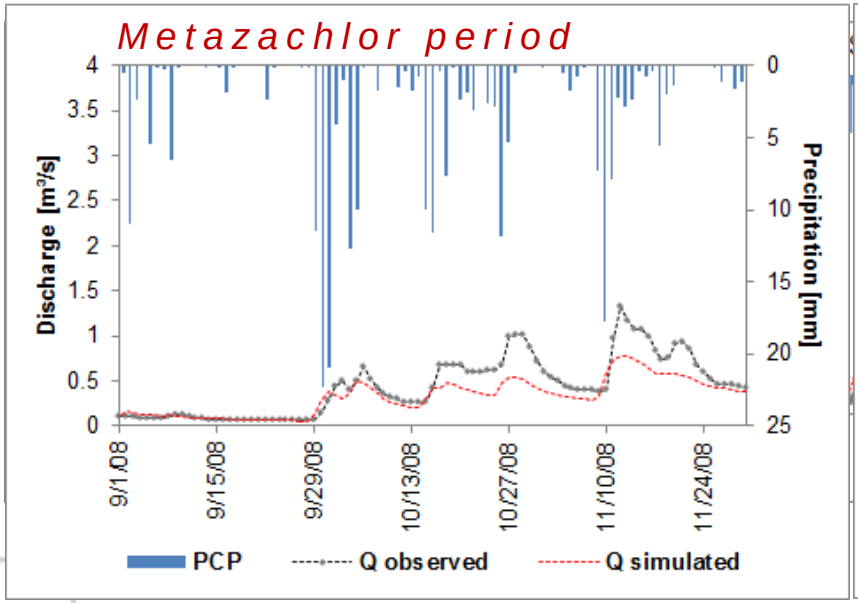
Flufenacet in WWHT, WBAR

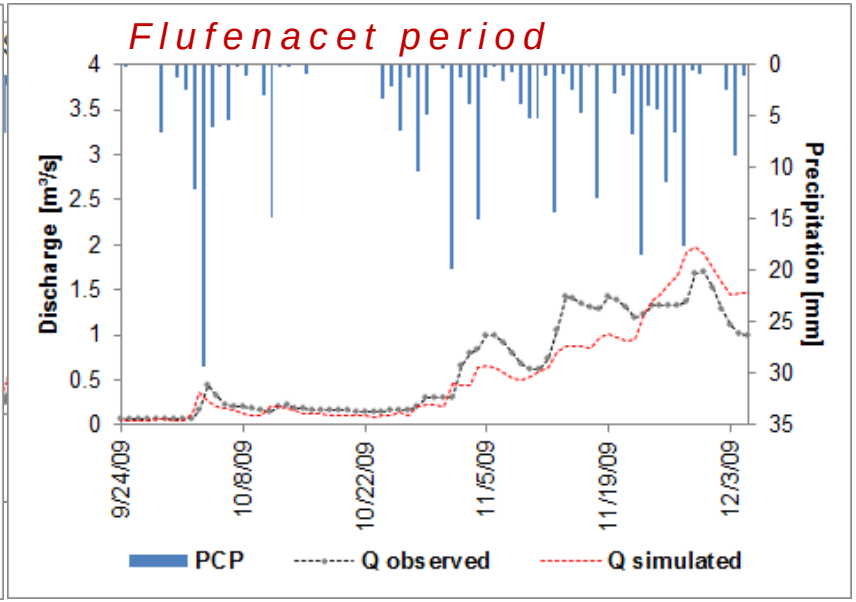
both not implemented in SWAT so far

Properties	Flufenacet	Metazachlor	SWAT Variable	Reference
Soil adsorption coefficient (Koc)	345	134	SKOC	PPDB (2009), ROBERTS (1998),
	(202-401)	*(53.8-220)*		PERKOW & PLOSS (2007), TOMLIN (2003)
Wash-off fraction	0.65	0.7	WOF	AFTER SWAT DATABASE
Half-life (foliage) [d]	10	4	HLIFE_F	HALF-LIFE (SOIL) X 0.25 AND 0.5, RESPECTIVELY
	(10-20)	*(2-4)*		
Half-life (soil) [d]	40	8	HLIFE_S	PPDB (2009), ROBERTS (1998),
	(15-53)	*(3-8)*		PERKOW & PLOSS (2007), TOMLIN (2003)
Application efficiency	0.75	0.75	AP_EF	DEFAULT
Solubility in water [mg/l]	56	450	WSOL	PPDB (2009), ROBERTS (1998),
		(430-450)		PERKOW & PLOSS (2007), TOMLIN (2003)
Amount of applied pesticides [kg/ha]	0.36	0.7	PST_KG	ULRICH (2008, 2010)
Time of application	10/04	09/05	Date	ULRICH (2008, 2010), ELLMER
				(UNPUBLISHED, IN DIEPENBROCK ET AL. 2005)

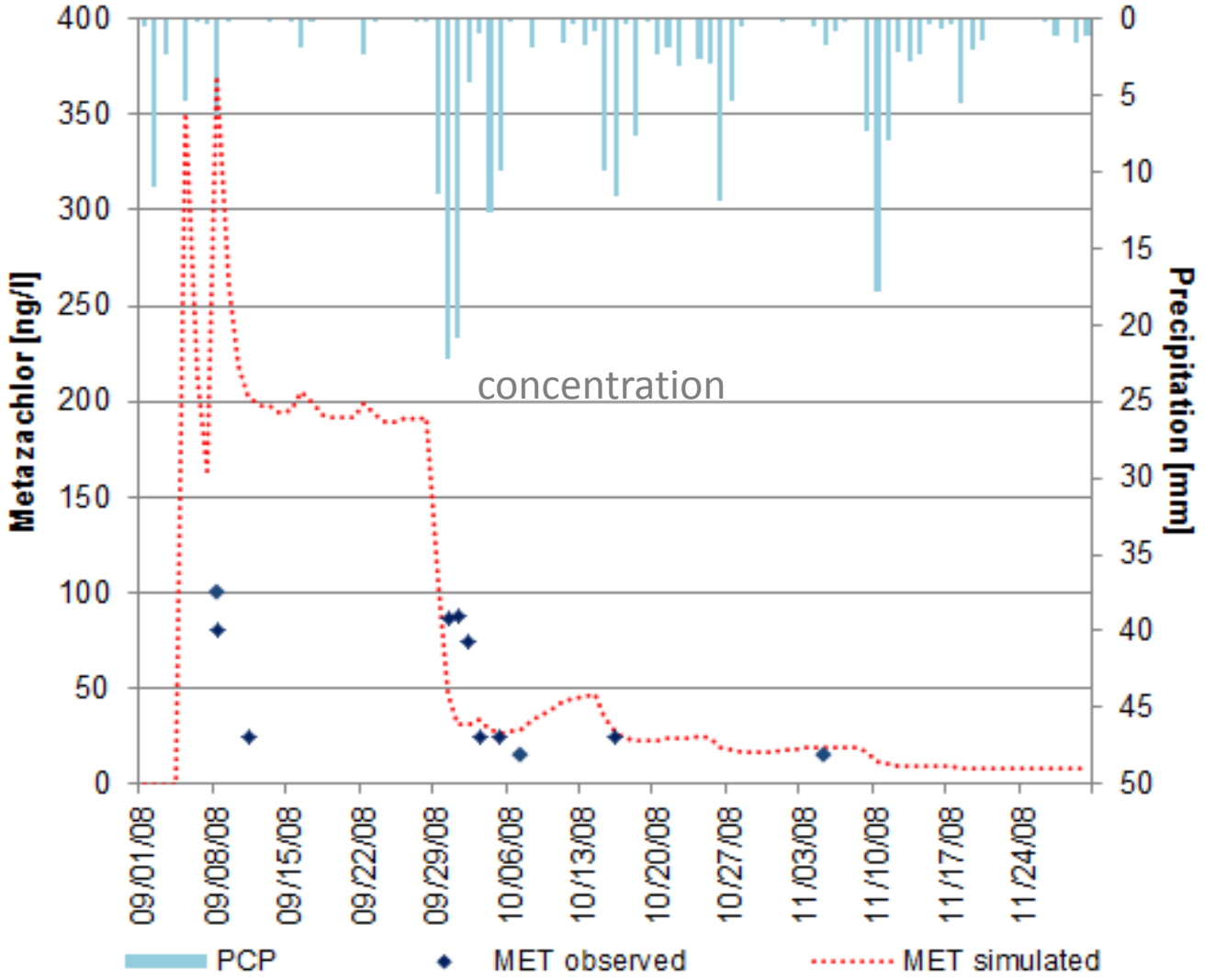
discharge simulations



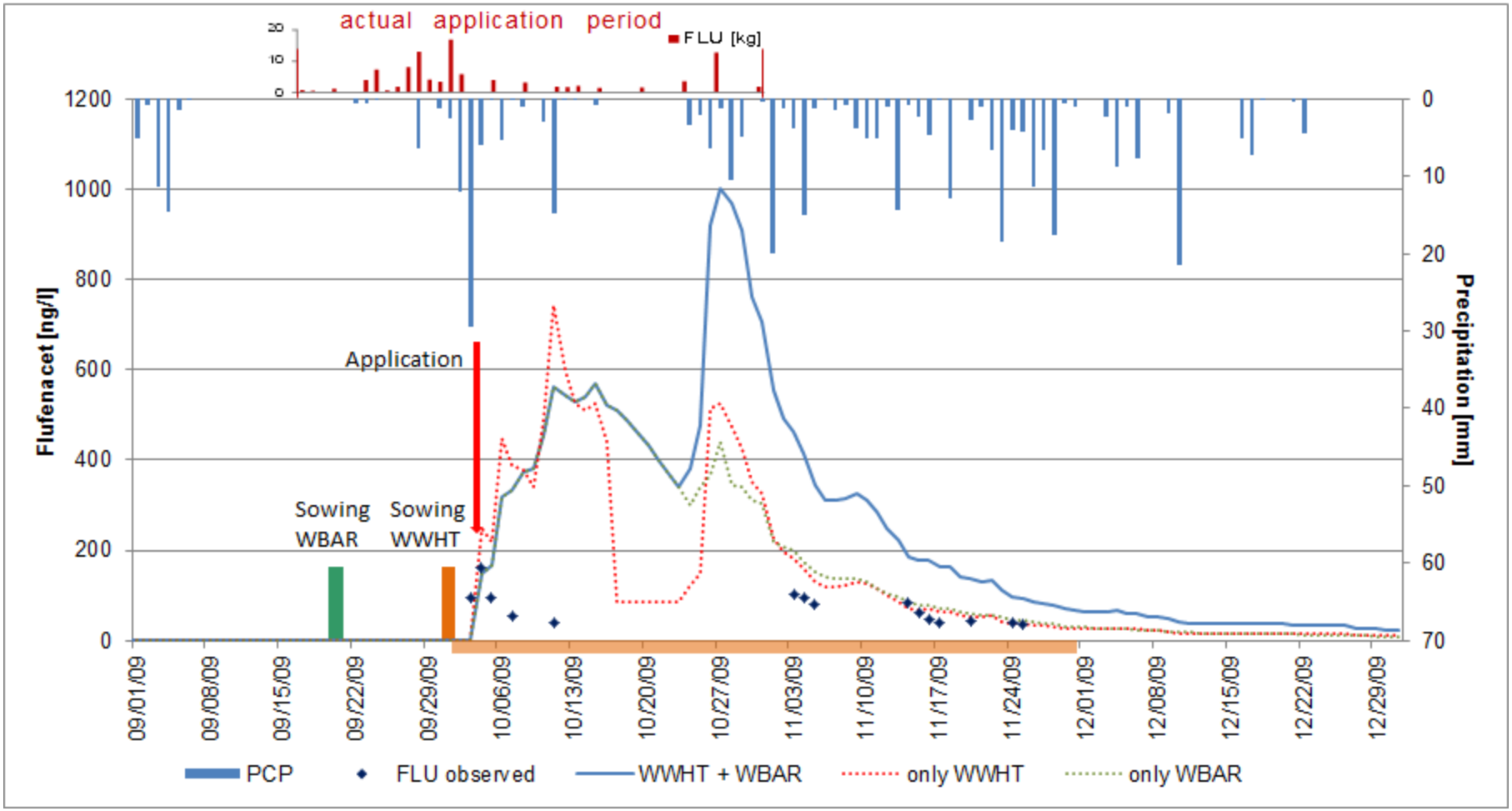




Simulation of Metazachlor concentrations (RAPE)

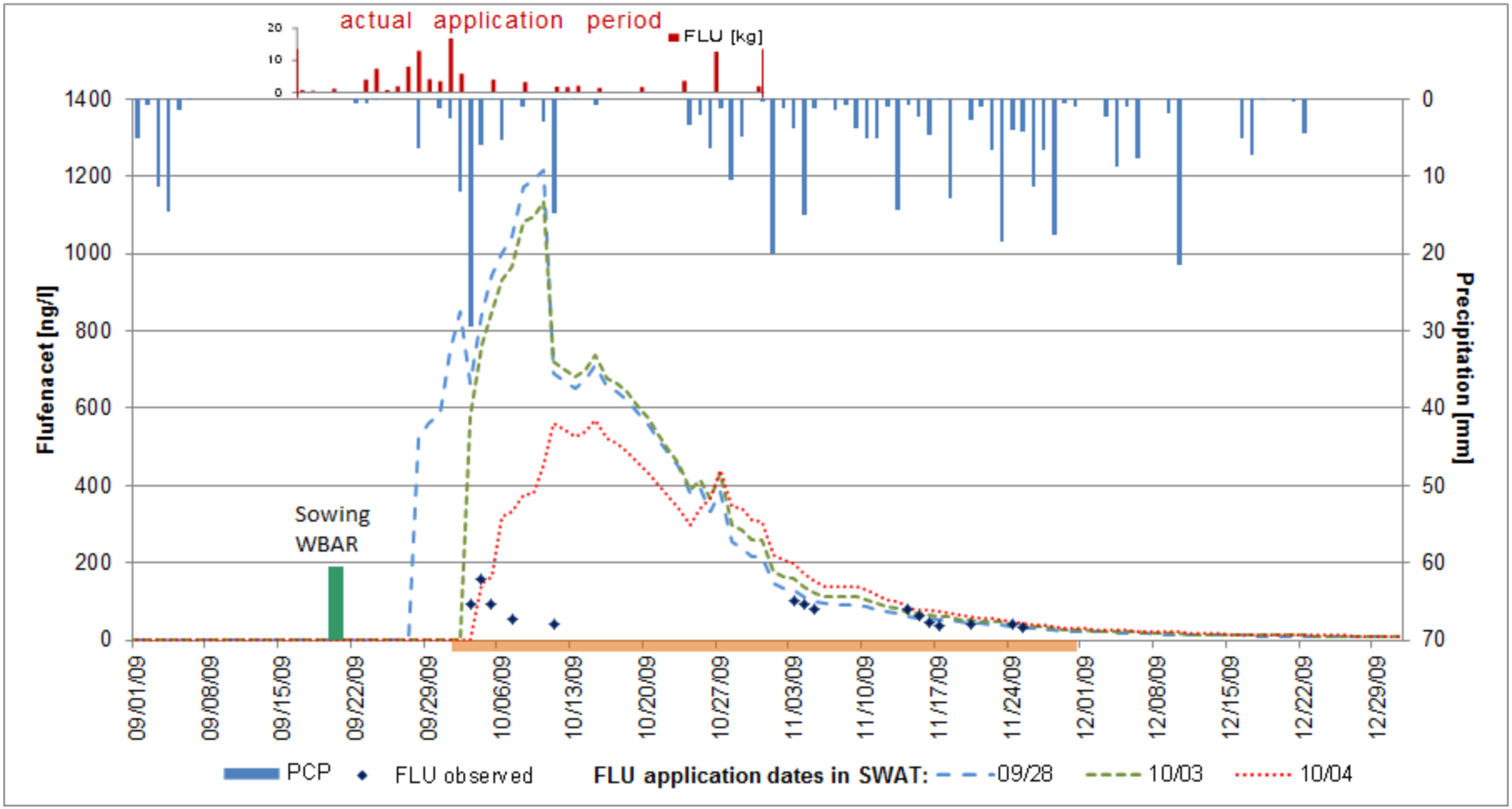


Flufenacet , multiple application (WWHT,WBAR)



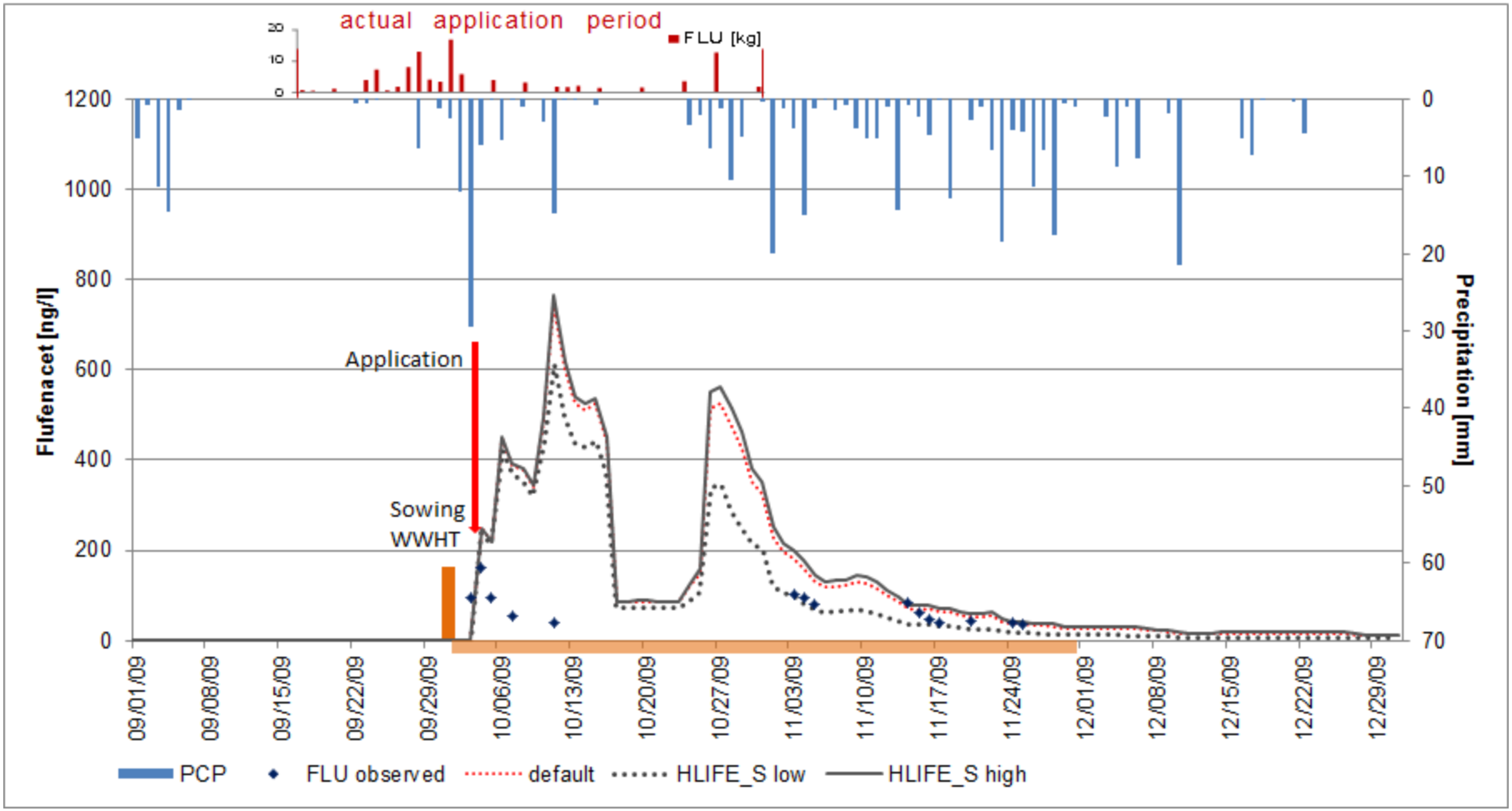
Effect of application date

Flufenacet only applied on WBAR



Effect of Flufenacet properties

KOC = Soil adsorbtion coefficient HLIFE_S = Half-life (soil)



Interim conclusion – major obstacles: data

- Information deficits on
  - crop rotation (which winter cereal?)
  - application location within the catchment ?

- Multiple application periods
- Rel. short measurement periods

- High variation of properties of pesticides

Interim conclusion – simulation

- Simulation results depend mainly
  - on flow parameters
    - dynamics of curve
    - high accuracy necessary
  - application date (initial peak)
  - Pesticide properties

    magnitude of conc.

    but NOT shape of curve

Thank you for your attention.

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Kielstau (Springer, 2007)