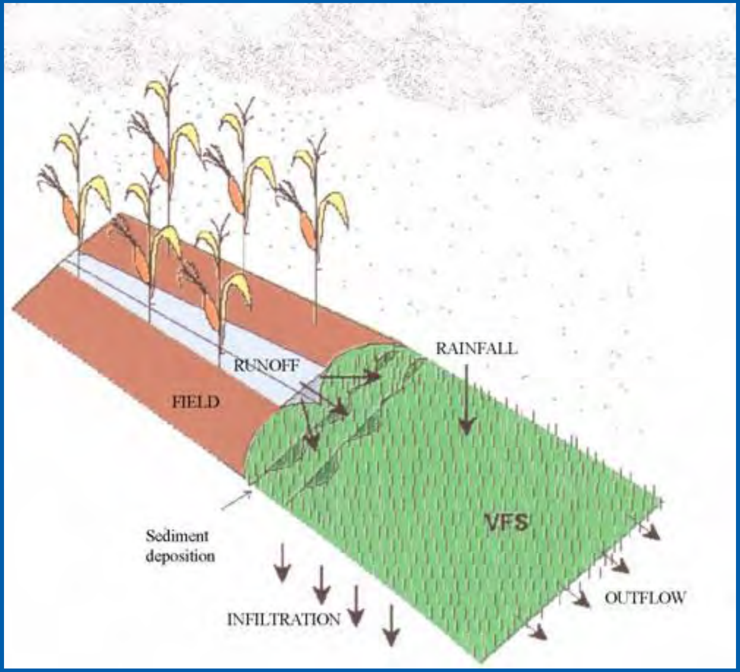
Modelling the fate of pesticides in vegetated filter strips using VFSMOD-W



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Piacenza, 30th August - 1st September 2011

Overview

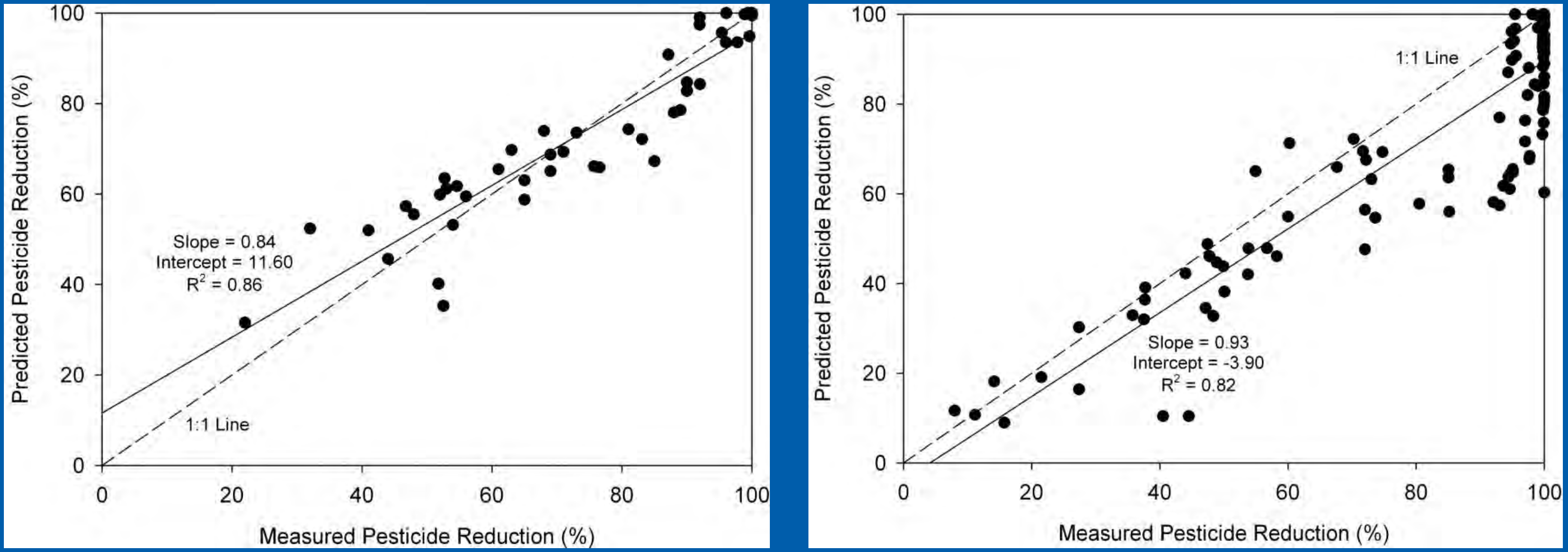
- Including risk mitigation into risk assessment
- VFSMOD-W model to simulate pesticide transfer through vegetated filter strips
- Generation of European scenarios for vegetated filter strips
- Soil conditions within the strip
- Outlook

Incorporation of mitigation into risk assessment

European Crop Protection Association
member of CropLife International

- Established practice, e.g. no-spray zones to reduce aquatic exposure via spray drift
- Requirement for methods to mitigate surface runoff strongly signposted
  - FOCUS Landscape and Mitigation
  - PPR Opinion on FOCUS LM
- Clear principles for implementation
  - Mitigation measure must be **effective** and **practicable**
  - Requires an **accepted approach** to incorporate into the estimate of exposure

VFSMOD-W: model to describe reduction in pesticide transfer across a vegetated filter strip



Predicted *vs*. measured reductions in pesticide transfer across vegetated filter strips (Sabbagh et al., 2009):

- development (n=47; left-hand figure)
- evaluation (n=120; right-hand figure) datasets

Use of VFSMOD-W in regulatory modelling

Explore the integration of the vegetated filter strip model VFSMOD-W into exposure assessment

- Mechanistic basis
- Validation
- Documentation and version control
- Fit with existing tools (FOCUS-PRZM)

Software development

FOCUS PRZM → VFSMOD-W → FOCUS TOXSWA

SWAN

Edge-of-field runoff

Interception in VFS

Fate in surface water

Requirements for regulatory modelling

- Standardisation
- Conservatism
- Transparency

→ Use agreed parameter sets (scenarios) based on robust analysis of conditions within the target area

EU VFS scenario development project

Objective:

Analyse European datasets to develop representative scenarios for VFSMOD-W for use in simulating the efficiency of vegetated filter strips

Insensitive parameters

Sensitivity analysis → **Parameter separation**

Sensitive parameters

Step 1 – Sensitivity analysis

- Existing analysis based on field experiments reported in the literature
- Two soil types and six pesticides with a range of different properties
- Two approaches to sensitivity analysis
  - Screening method - Morris
  - Variance based – extended Fourier analysis

Muñoz-Carpena et al. (2010). JEQ 39:630-641

Step 2 – parameter separation (examples)

Sensitive parameters	Insensitive parameters
Soil	Vegetation
- saturated hydraulic conductivity (**Ksat**)	- spacing of stems
- saturated water content (**θsat**)	- height
Sediment	- hydraulic resistance
- average diameter of particles	
- organic carbon content	
- clay content	

Step 3 – insensitive parameters

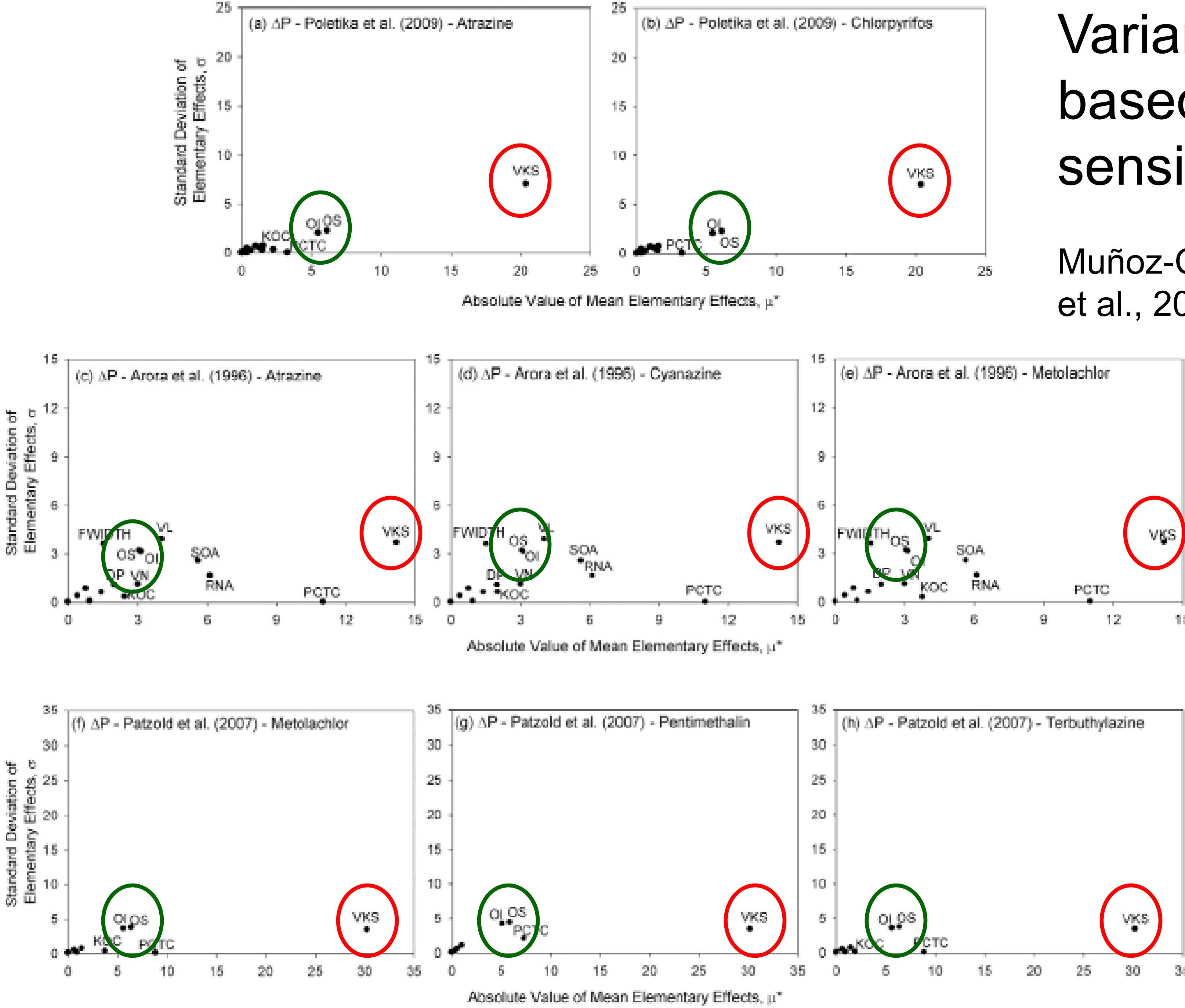
- For example: average distance between stems of grass...
- Assess likely range in values
- Propose default values relevant to the Step 3 scenarios
  - Appropriate level of conservatism
  - Documentation to justify selection from published sources

Step 4 – sensitive parameters

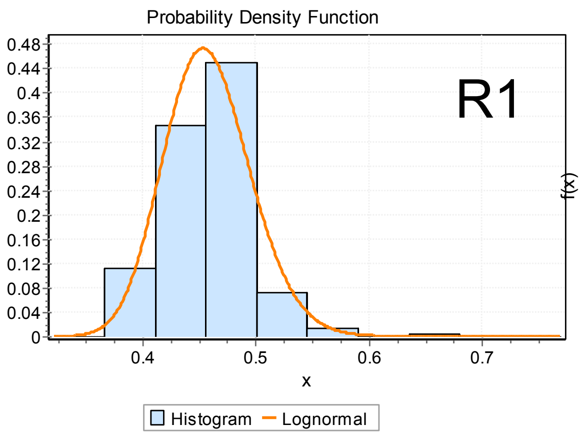
- Assess variation across the European Union
- GIS analysis within the framework of FOCUS Step 3 scenarios
- Generate distributions for each parameter
  - Support selection of conservative values
  - Allow testing of alternative assumptions
  - Facilitate higher-tier modelling, e.g. probabilistic approaches

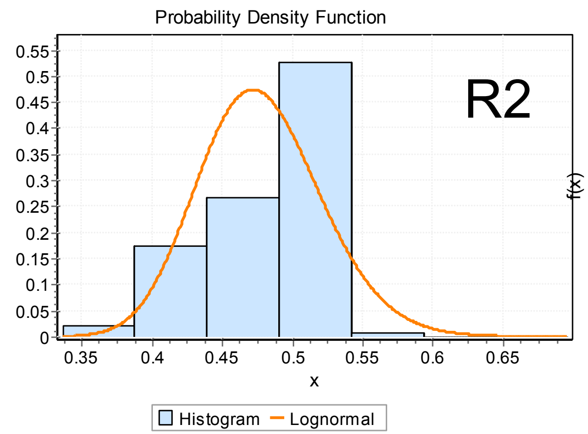
Variance-based sensitivity

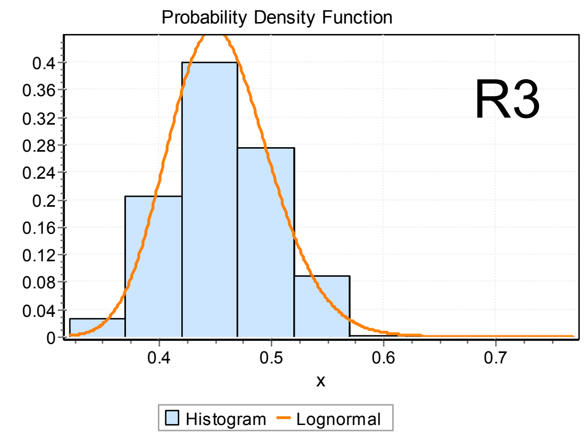
Muñoz-Carpena et al., 2010

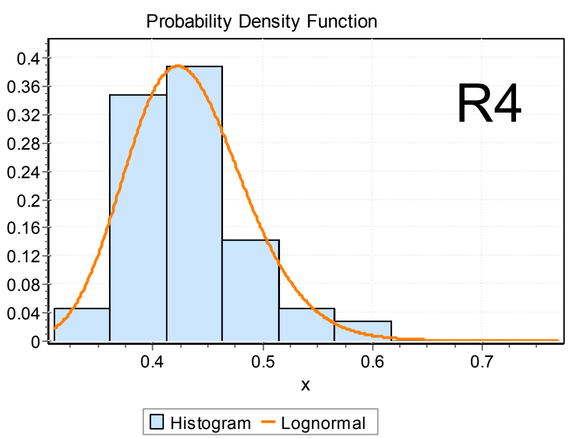


Probability distributions for Ksat









scenario	n	sigma	mu
R1	356	0.756	2.58
R2	75	0.694	4.35
R3	175	0.945	3.45
R4	223	0.859	3.62
lognormal distribution Ksat as variable and area as density			

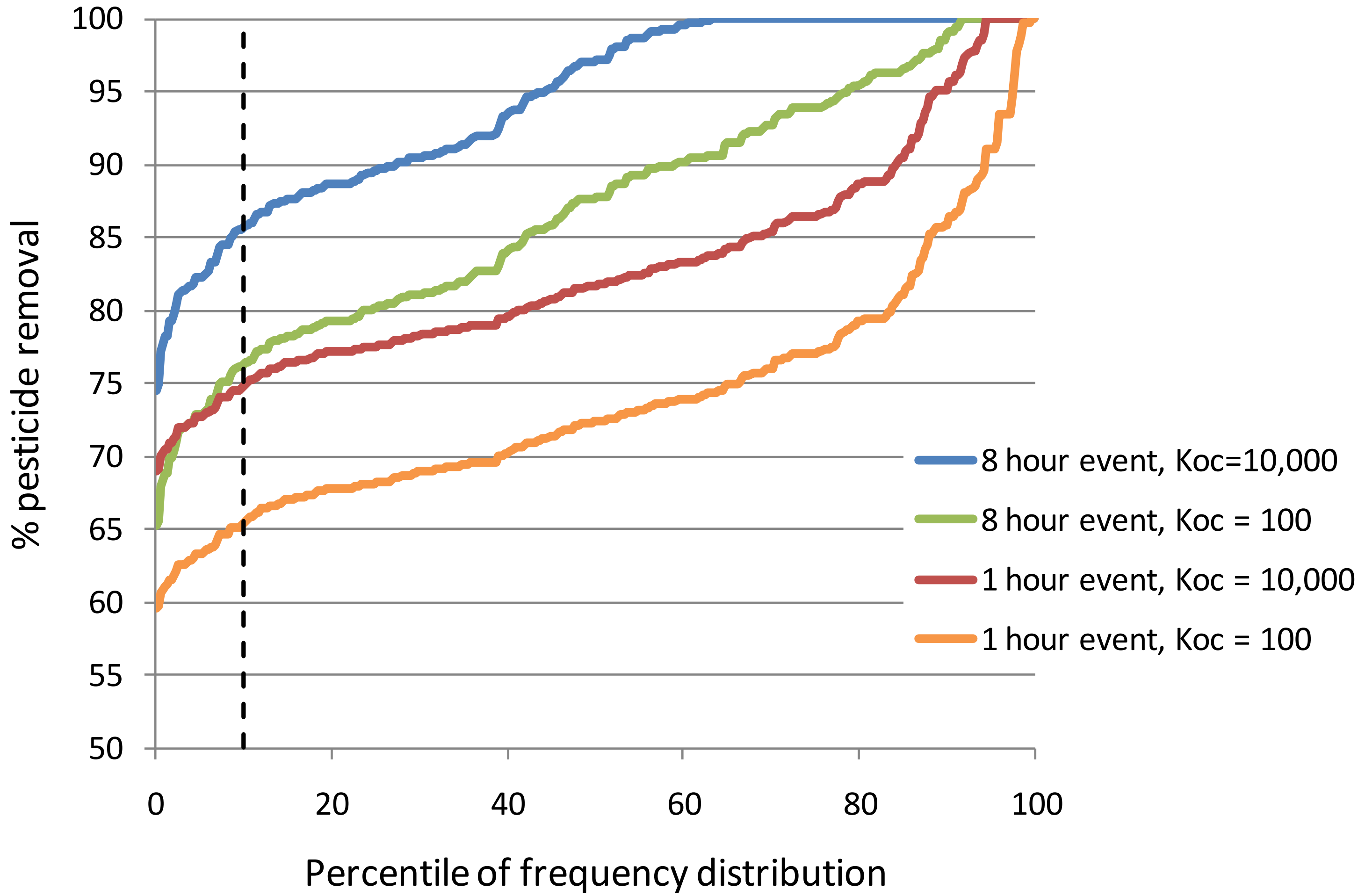
Deriving conservative values for Ksat and θsat

- N for each R scenario small (75-356)
- Two parameters are strongly correlated
- Undertake runs with VFSMOD-W for all soil units and use results to derive conservative values

Deriving conservative values for Ksat and θsat

- Separate simulations for:
  - The four FOCUS R scenarios (n = 75 – 356)
  - Storm events with 30 mm rain over 1 hour or 8 hours
  - Pesticides with Koc of 100 L/kg or 10,000 L/kg
- Each run reads Ksat, θsat and θfc for one soil unit
  - θfc used as fixed (and correlated) input for initial water content
- All other parameters held at constant values relevant to the FOCUS R scenario

Distribution in VFS efficiency for FOCUS R1



Large event (30 mm); VFS at field capacity prior to event

Overview of simulation results

- Relative vulnerability ranking of soil units:
  - Independent of event size (prelim. runs 20 vs. 30 mm)
  - Virtually identical for the two pesticides when event length held constant
  - Some differences with differing event duration, but differences are very small at either end of the distribution

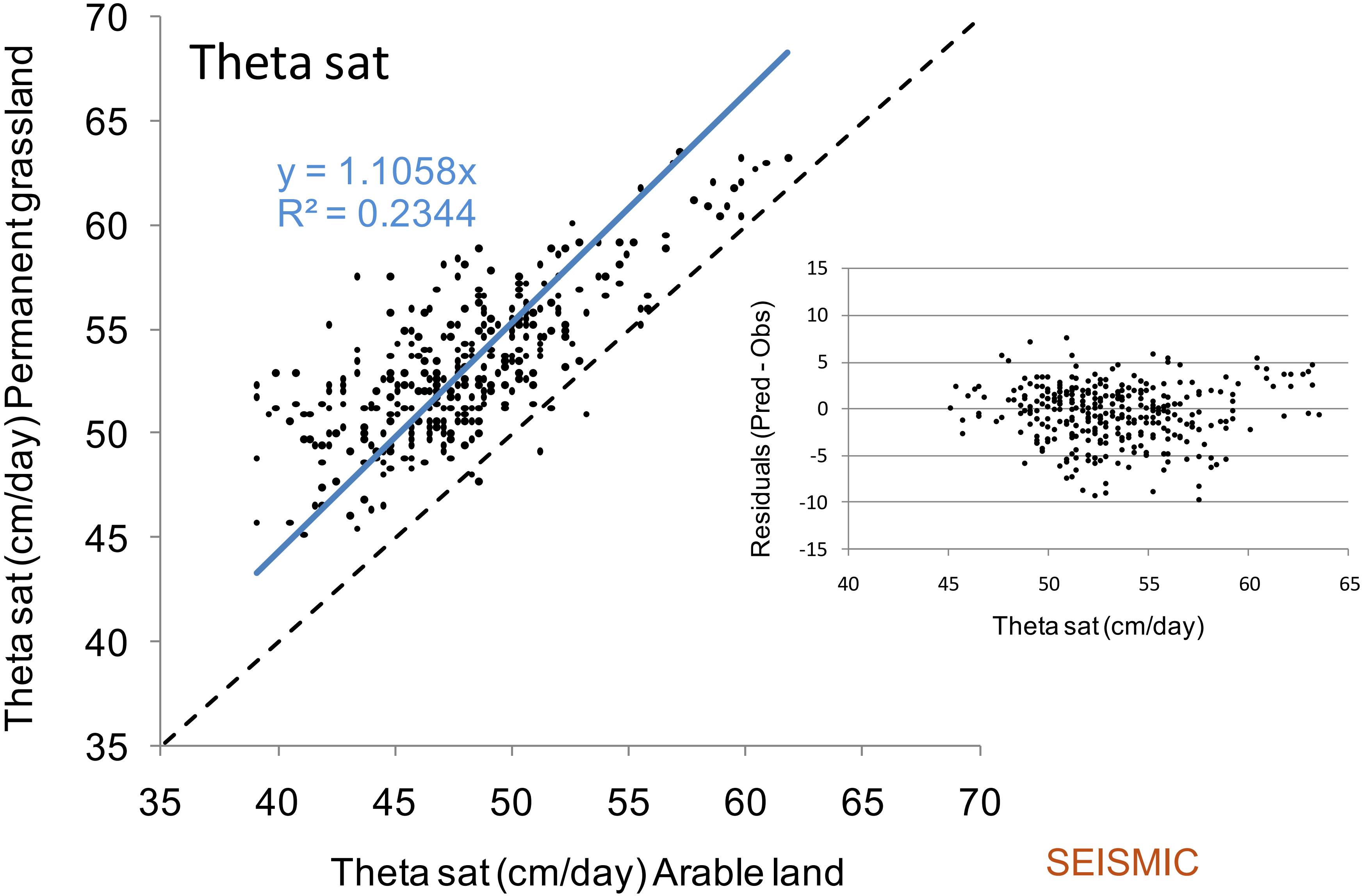
90th percentile worst-case for R1 pilot runs

Ksat drives the vulnerability of the scenario

worst-case %tile		Ksat	θsat
30 mm in 1 hr	30 mm in 8 hr	(m/s)	(cm^3/cm^3)
89.0	89.0	1.19×10^{-6}	0.437
89.3	89.7	1.13×10^{-6}	0.436
89.7	89.3	1.12×10^{-6}	0.400
89.9	89.9	1.15×10^{-6}	0.400
90.2	90.2	9.56×10^{-7}	0.478
90.4	90.7	9.05×10^{-7}	0.449
90.7	90.4	1.32×10^{-6}	0.476
91.0	91.0	1.10×10^{-6}	0.400

Changes to Ksat and θsat under permanent grass

- Largest dataset is from SEISMIC for soil series in England and Wales
- SEISMIC reports Ksat and θsat for each soil series and distinguishes between permanent grassland and arable land
- Use information to refine estimates of arable Ksat and θsat from batch analyses?
  - Account for influence of grass vegetation on soil properties



Theta sat
y = 1.1058x
R² = 0.2344
Theta sat (cm/day) Permanent grassland
Theta sat (cm/day) Arable land
70
65
60
55
50
45
40
35
35
40
45
50
55
60
65
70
Residuals (Pred - Obs)
Theta sat (cm/day)
15
10
5
0
-5
-10
-15
40
45
50
55
60
65

SEISMIC

Outlook

- European vegetated filter strip scenarios
  - Representative VFSMOD-W scenarios for use in conjuction with each FOCUS R scenario
  - Available for use in Step 4 calculations
  - Underlying data accessible
- Beta-version of SWAN incorporating VFSMOD-W available now; full implementation mid-2012
- Discussions with EFSA / Member States on uptake into risk assessment

With thanks to the co-authors and project steering group

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