

# **Evaluation of Time-Dependent (Aged) Sorption Studies**

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# Acknowledgements

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# Outline

- Overview of draft guidance
- Evaluation of studies and main findings
- Recommendations for adaptation of the draft guidance

# Overview of draft guidance

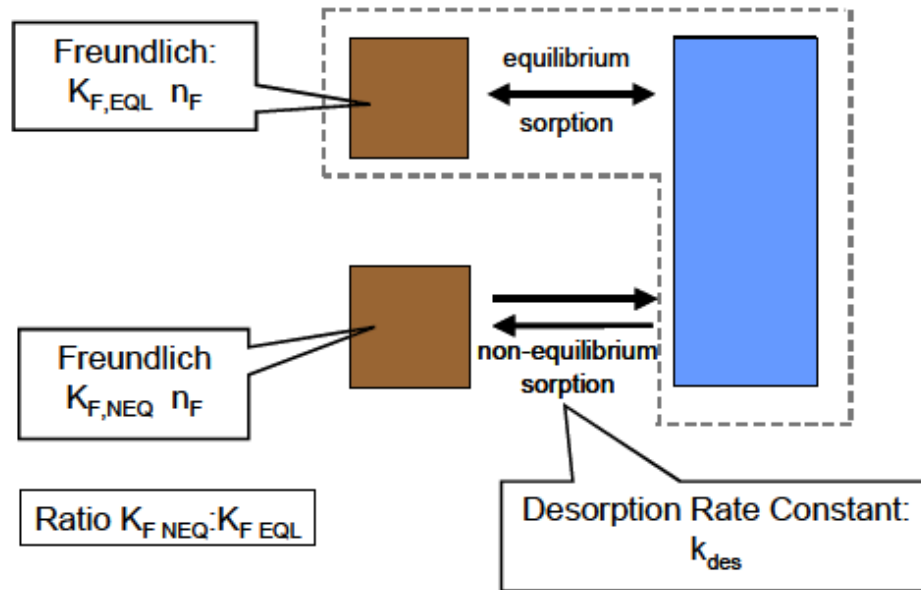
- The UK Chemicals Regulatory Directorate (CRD) commissioned a DEFRA R&D project (PS2235) to develop a guidance document for the conduct and evaluation of aged sorption studies
- These are also known as time-dependent sorption (TDS) studies
- Joint project between FERA (UK) and Alterra (NL)
- Sabine Beulke, Wendy van Beinum, Jos Boesten and Mechteld ter Horst

# Overview of draft guidance

- The draft guidance was presented at a workshop in York in April 2010:
  - **‘Proposed guidance on how aged sorption studies for pesticides should be conducted, analysed and used in regulatory assessments’**
- [http://www.pesticides.gov.uk/applicant\\_advice.asp?id=2940](http://www.pesticides.gov.uk/applicant_advice.asp?id=2940)
- The guidance document was always envisaged to help regulators and applicants in the whole European regulatory context and not to be Member State specific

# Overview of draft guidance

- The guidance document is based on the standard two-site model:



Degradation occurs only in the equilibrium domain  
 $DT_{50eq} \neq DT_{50}$

$$f_{NE} = K_{f,neq} / K_{f,eq}$$

$$k_{des} = crd = k_d$$

- This is the approach implemented in the FOCUS models – PEARL, PELMO, PRZM and MACRO 5
- Key parameters are  $DT_{50eq}$ ,  $K_{om,eq}$ ,  $f_{NE}$  and  $k_{des}$

# Overview of draft guidance

- The draft guidance document gives an excellent overview and description of the PEARLNEQ (with PEST) and ModelMaker 4.0 evaluation tools
- Detailed model control/parameter settings are given for both tools
- Clear guidance is given for the selection of starting parameters, parameter ranges, data weighting and statistical evaluations for parameter robustness

# Overview of draft guidance

- Key recommendations:
  - Five parameters,  $M_{ini}$ ,  $K_{om,eq}$ ,  $DT_{50eq}$ ,  $k_{des}$  and  $f_{NE}$  optimised
  - Soil-specific  $1/n$  value from batch OECD106  $K_{oc}$  study to be used (ideally on the same batch of soil)
  - Four combinations of  $f_{NE}$  and  $k_{des}$  to be used as starting values
  - A fifth evaluation to be conducted with aged-sorption switched off, i.e. equilibrium sorption;  $f_{NE}$  and  $k_{des} = 0$
  - Data weighting: inverse measured – to ensure equal weighting between Mass and Liquid phases
  - The first time point to be included in the evaluations is between 48 and 72 hours (i.e. time 0 and 1 day not included in optimisations)



# Overview of draft guidance

- **Goodness of fit and parameter acceptance criteria to be evaluated:**

- Assessment of the visual fit ( $M_{\text{tot}}$ ,  $C_L$  and apparent  $K_d$ )
- A  $\chi^2$ -test to assess and compare the goodness of fit
- Relative Standard Error (RSE)  $< 0.25$

$$RSE = \frac{\text{95\% Confidence Interval}}{4v}$$

- Fitted  $K_{\text{om,eq}}$  within  $\pm 20\%$  of batch  $K_{\text{om}}$
- Fitted  $M_{\text{ini}}$  within  $\pm 15\%$  of measured initial amount
- $0.001 < f_{\text{NE}} < 10$
- $0.00001 < k_{\text{des}} < 0.5$

# Evaluation of studies

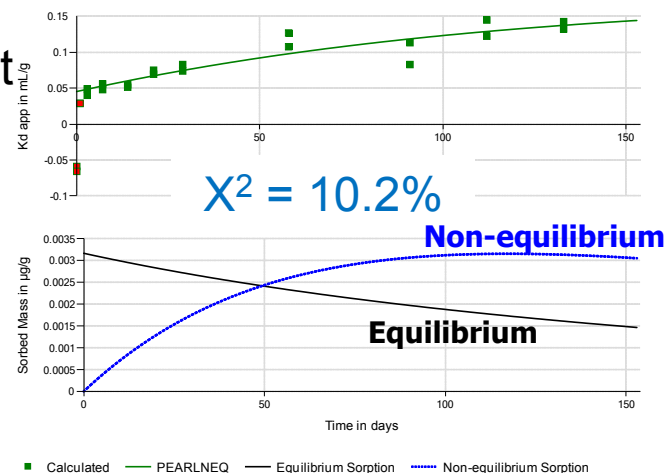
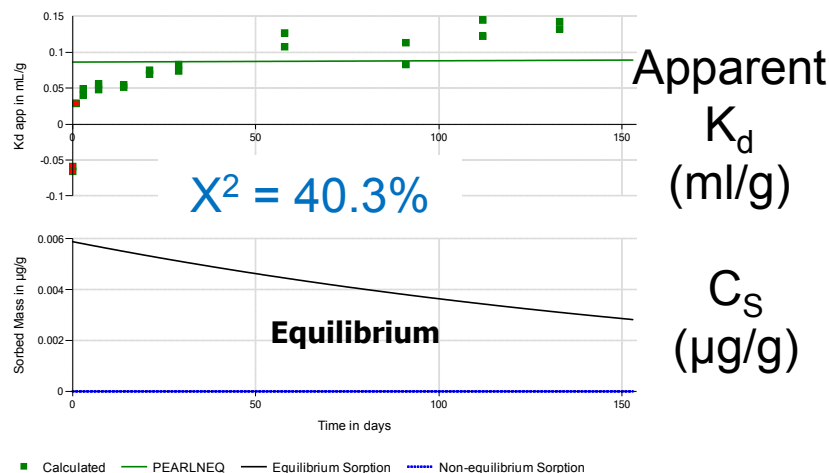
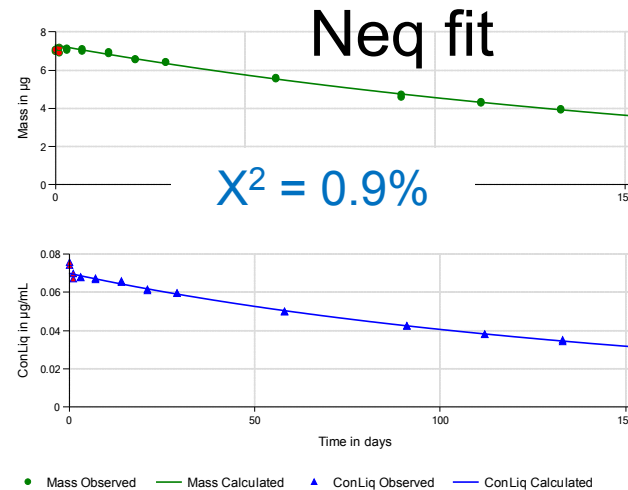
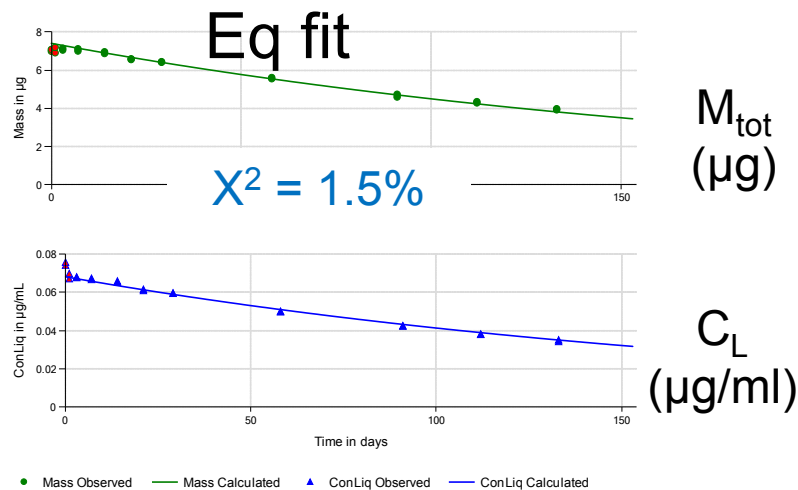
- At the workshop in April 2010, it was agreed by the delegates that it would be useful to test the draft guidance against a wider range of available studies
- Following the workshop, ECPA set up a project with Battelle to collate and evaluate the available aged sorption studies against the draft guidance document

# Evaluation of studies

- The initial plans were for a ‘few’ studies to be evaluated, but it turned into 46
- An initial sift, found 16 studies not to be suitable for a variety of reasons (too few time points, wrong study design, insufficient data etc.)
- 30 studies were taken forward for evaluation (total of 134 individual datasets to evaluate, with 127 final sets of results)
- **I don't have time to go through all of the results, but here are a few findings/recommendations....**

# Evaluation of studies - findings

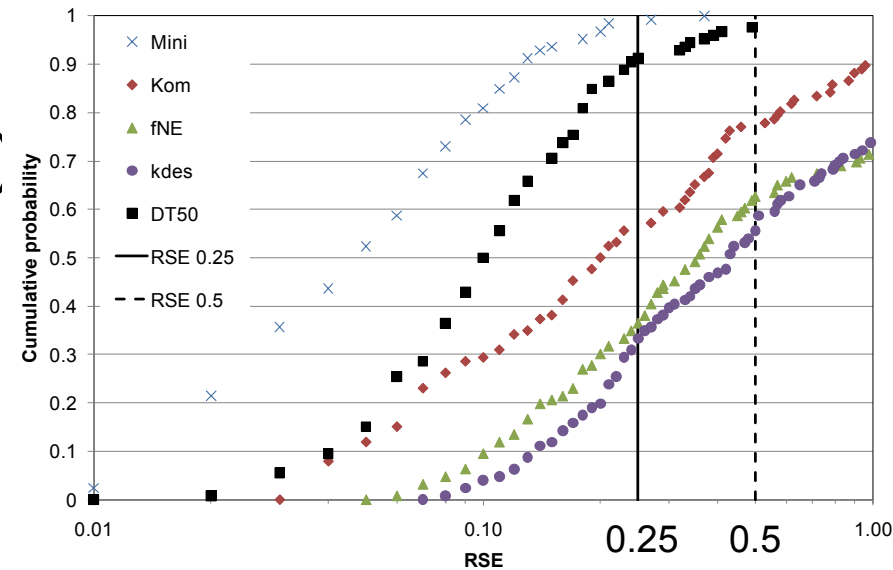
- Visual and  $\chi^2$ -test assessment between Eq and NEq fits



# Evaluation of studies - findings

- **RSE evaluation of parameter estimates (<0.25)**

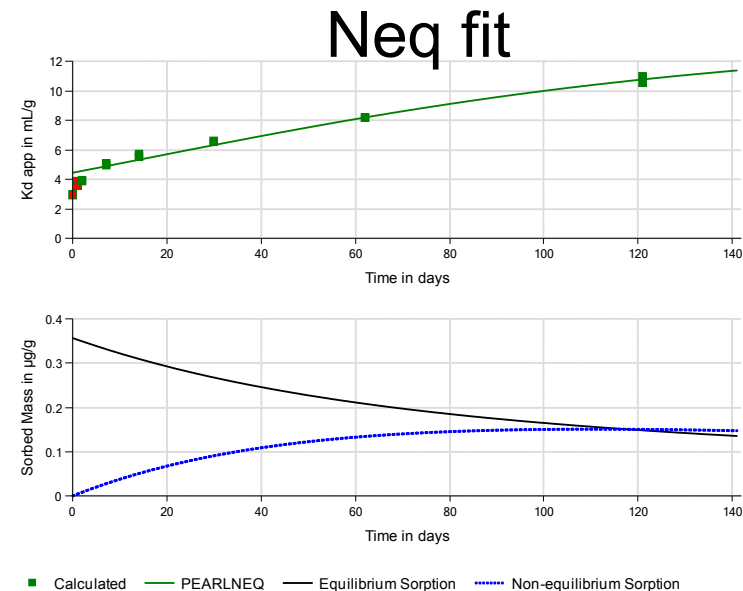
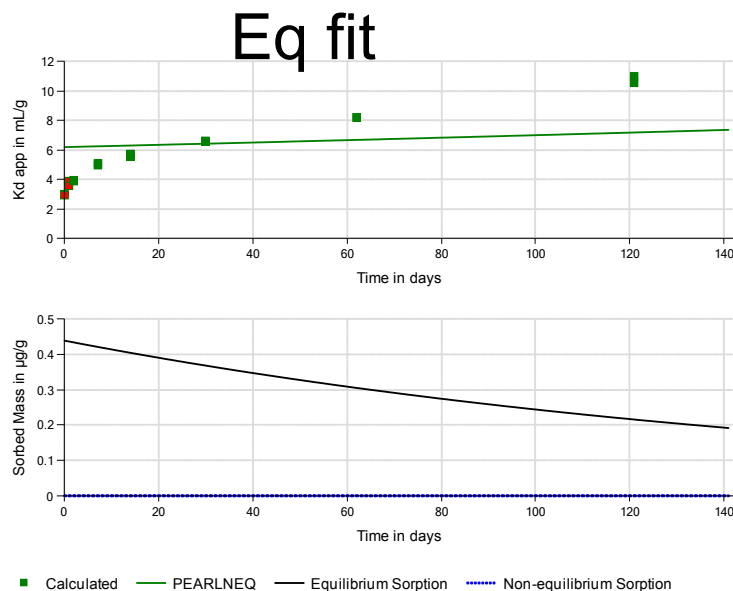
- RSE values for  $M_{ini}$  and  $DT_{50eq}$  are generally well below 0.25 (only 2/127 and 10/127 'failures')
- $K_{om,eq}$  – 56/127 RSE failures
- $f_{NE}$  – 80/127 RSE failures
- $k_{des}$  – 83/127 RSE failures



- **These result in very few datasets being 'robust' even when significant aging is clearly taking place (evidence from apparent  $K_d$  plots)**

# Evaluation of studies - findings

Soil D		95% CI		
<b>ECPA16</b>	Estimated	Lower	Upper	RSE
$M_{ini}$ ( $\mu\text{g}$ )	70.00	67.83	72.18	0.02
$K_{om,eq}$ (L/kg)	130.93	118.18	143.69	0.05
$f_{NE}$ (-)	0.57	0.37	0.76	0.18
$k_{des}$ (1/d)	0.0114	0.0044	0.0184	0.31
$DT_{50eq}$ (d)	124.9	111.1	138.6	0.06

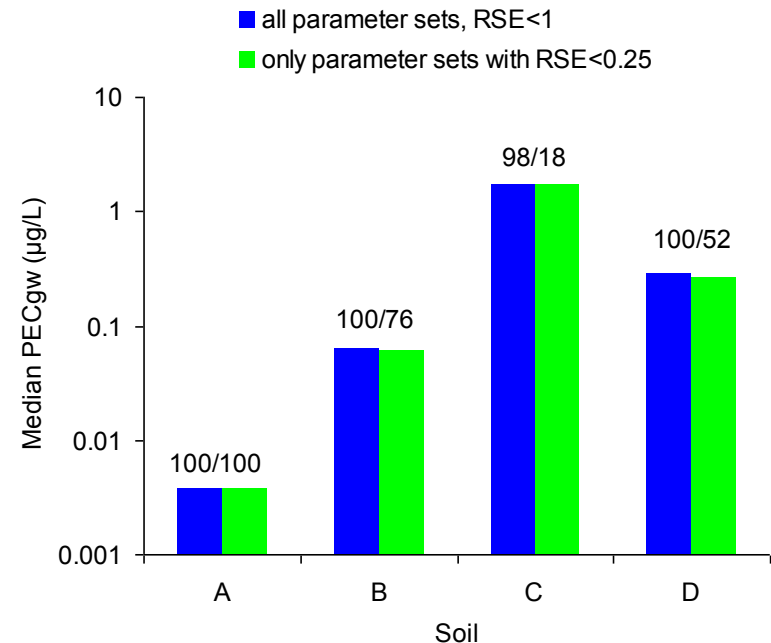


# Recommendations - summary

- Exclusion of  $t_0$  and  $t_1$  requires further investigation
  - propose to exclude  $t_0$  and  $t_1$  for the initial fit, but allow inclusion as refinement (can improve parameter robustness)
- Propose to include a goodness of fit comparator (e.g.  $X^2$ -test) on apparent  $K_d$  fits (delete for the total mass and liquid concentration)
- Re-evaluation of RSE criteria for  $K_{om,eq}$ ,  $f_{NE}$  and  $k_{des}$ 
  - propose 0.5 (0.25 to remain for  $DT_{50eq}$  and  $M_{ini}$ )

# Recommendations - summary

- The impact of relaxing the RSE for  $f_{NE}$  and  $k_{des}$  have been evaluated with some Monte-Carlo simulations
- 4 x 100 datasets created (from ECPA12)
- Median PECgw values from all 400 (398) datasets and those with  $RSE < 0.25$  were compared
- **Conclusion:**
- No significant difference in calculated PECgw between datasets with  $RSE < 0.25$  and  $RSE < 1$



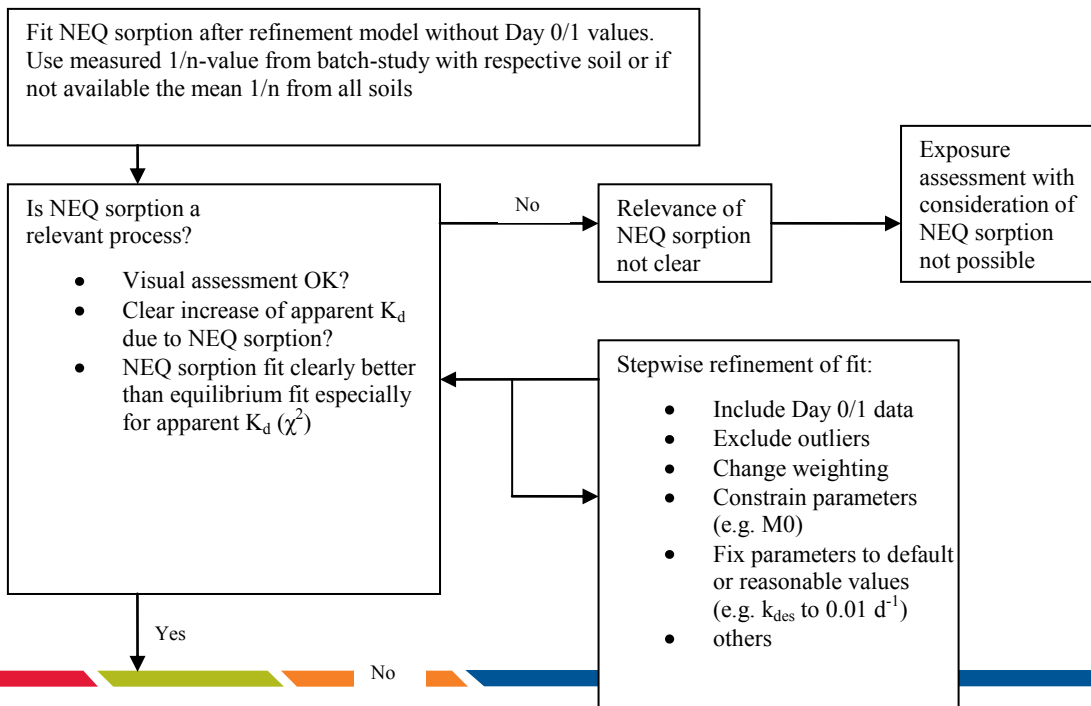


# Recommendations - summary

- Evaluations where  $K_{om,eq}$  does not agree with batch  $K_{om}$  require further investigation ( $\pm 20\%$  )
  - propose to use the lower of  $K_{om,eq}$  and  $K_{om,batch}$  for the exposure assessment
- Batch sorption study with same soil needed
  - propose to use average  $1/n$  for existing studies where specific data is not available (appears to have no significant impact on final PECgw evaluations)
- Where  $M_{ini}$  does not agree with measured mass
  - propose to exclude  $\pm 15\%$  criterion as it is the long-term behaviour that is important

# Recommendations - summary

- Propose to allow options for refinements where parameter estimates are not robust, but clear aging is taking place (identified by the apparent  $K_d$  fits) e.g. fixing of parameters or use of FOCUS gw2 defaults ( $k_{des}$  0.01 1/d and  $f_{NE}$  0.3  $\equiv$  10<sup>th</sup> percentiles)



See report for more details

# Recommendations - summary

- The draft guidance document recommends  $PEC_{gw}$  to be derived as the arithmetic mean of  $PEC_{gw}$  calculated with individual TDS parameter sets  
 - propose to be consistent with FOCUS principles and to use the arithmetic/geometric mean input parameters in a single run
- See the poster for more details:  
 ‘Using non-equilibrium sorption parameters for the prediction of environmental concentrations in groundwater for regulatory purpose’

# Recommendations - summary

- The results of the evaluations have been presented to CRD and FERA
- Consideration of the recommendations by FERA is ongoing
- When finalised, the detailed evaluation report will be available from ECPA on request

**Thank you for your attention**

**Any questions ?**