Overview of VFSMOD explorations by PMRA

Johnny Westgate
Pest Management Regulatory Agency
Health Canada
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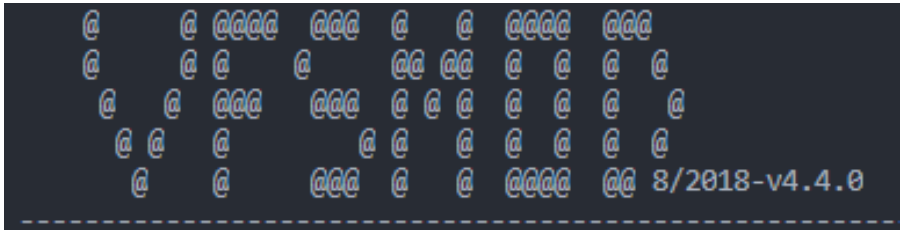
VFSMOD



- Vegetative Filter Strip Model
  - "VFSMOD is a field scale, mechanistic, **storm-based** model designed to route the incoming hydrograph and sedimentograph from an adjacent field through a vegetative filter strip (VFS) and to calculate the outflow, infiltration and sediment trapping efficiency."*
  - Created by Dr. Rafael Muñoz-Carpena under the supervision of Dr. John E. Parsons
  - "…an educational and research tool…"*

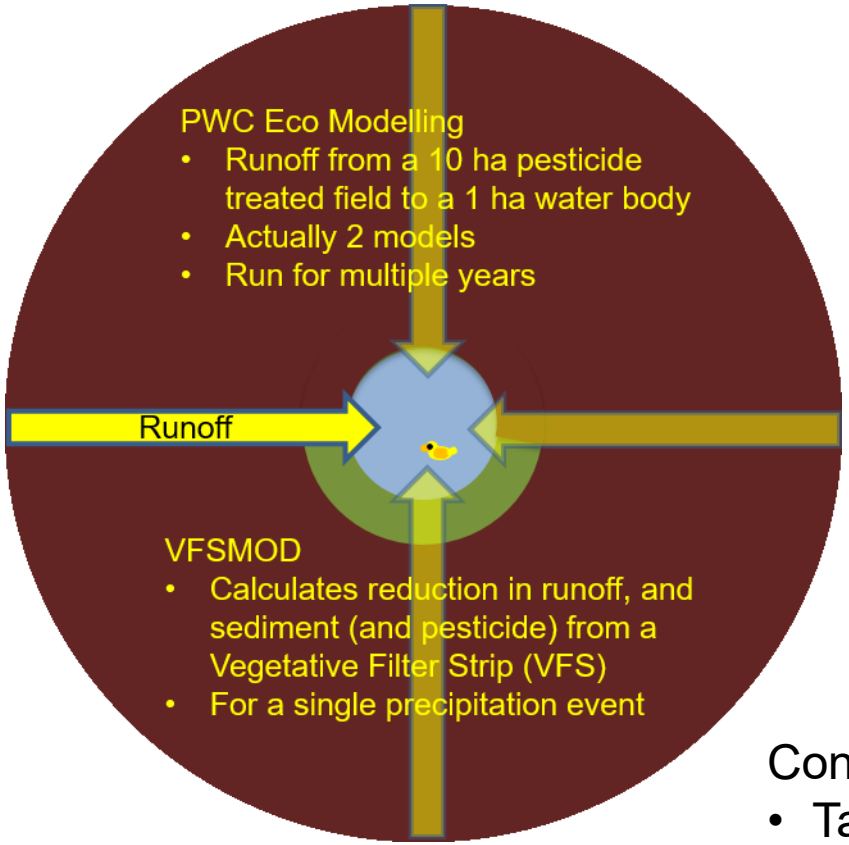
* https://abe.ufl.edu/faculty/carpena/files/pdf/software/vfsmod/VFSMOD_UsersManual_v2d3.pdf

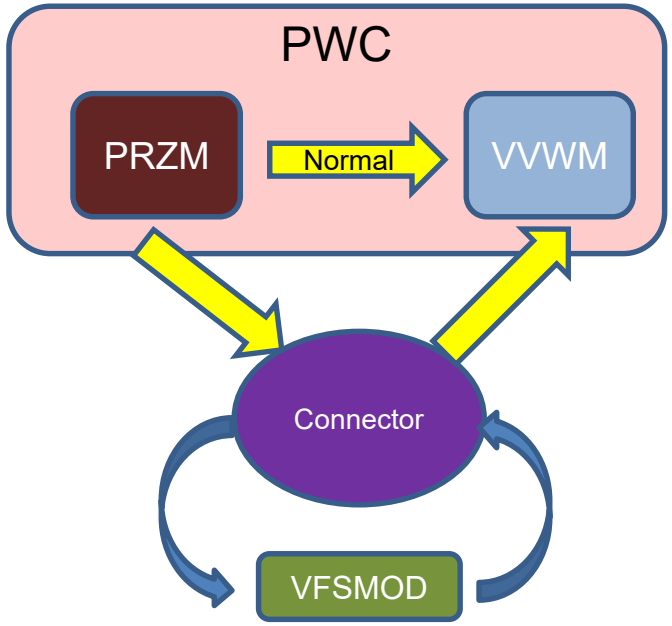
Exploring VFSMOD

- If/how VFSMOD might be integrated with our existing ecological (runoff) modelling when a VFS is being considered
- Initially, use VFSMOD to predict:
  - How effective is the 10m VFS?
  - Is the 10m width necessary?
  - Would it help for less soil-sorbed/more soluble compounds?
  - To what elements of our approach is VFSMOD sensitive?

- *Not* an assessment of the accuracy of VFSMOD predictions
- *Not* a model validation

Objective 1 - Integrating PWC and VFSMOD





Connector tool
- Takes output from PRZM
- Writes inputs for VFSMOD
- Runs VFSMOD for every precipitation event
- Consolidates outputs from VFSMOD
- Writes input for VVWM

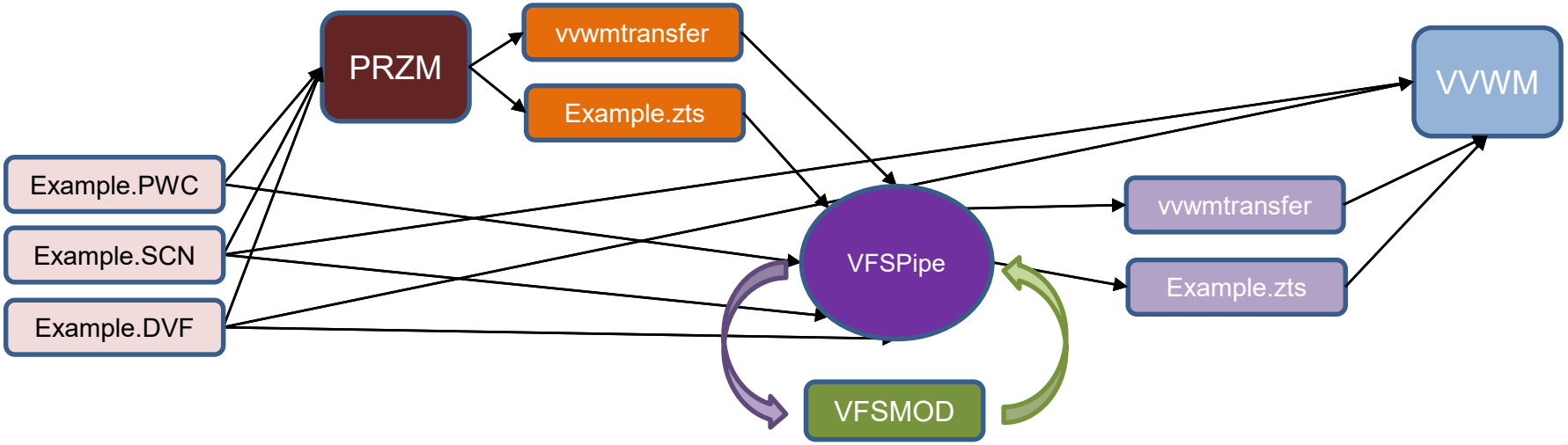
PRZM – Plant Root Zone Model
VVWM – Variable Volume Water Model
PWC – Pesticide in Water Calculator

Connector Tools

- VFS Working Group collaborators have generously shared their tools
  - Bayer's connector tool
    - Connects VFSMOD with models used prior to PWC
  - Waterborne's connector tool
    - Connects PRZM and VFSMOD
    - Requires some manual editing of input files
    - Includes a binary that runs VFSMOD for the 50 years
- VFSPipe
  - Development relied heavily on the work in the Waterbourne connector tool
    - Documentation describing sources for all VFSMOD inputs
  - Written using the julia language
    - Open source
      - GoC moving towards Open Government
    - No cost
      - Fortran and Visual Basic require licenses
  - "So up-to-date, it's not even done yet!"
    - Currently run from within the editor
    - On Github but not ready for distribution

VFSPipe

- VFSMOD: > 52 input values in 7 files – not including filenames
  - > since some inputs are time series
- VFSPipe: 3 inputs – not including filenames/paths
  - Strip width (m)
  - Flag for daily or hourly weather*
  - Length of storm (h) if daily weather
- All others derived from weather file, PWC scenario, or PRZM output



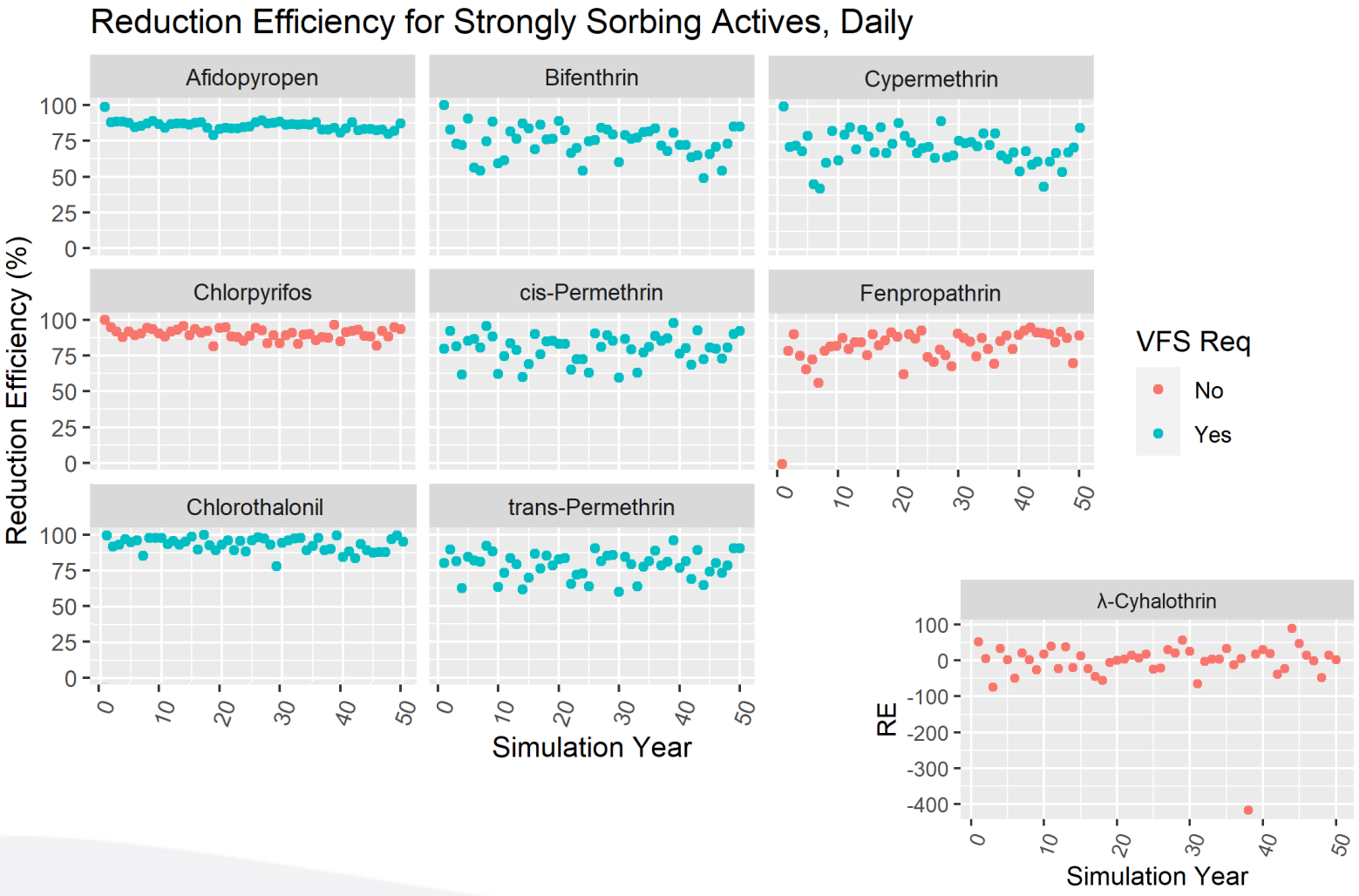
PRZM – Plant Root Zone Model
VVWM – Variable Volume Water Model
PWC – Pesticide in Water Calculator

*could be based on file extension

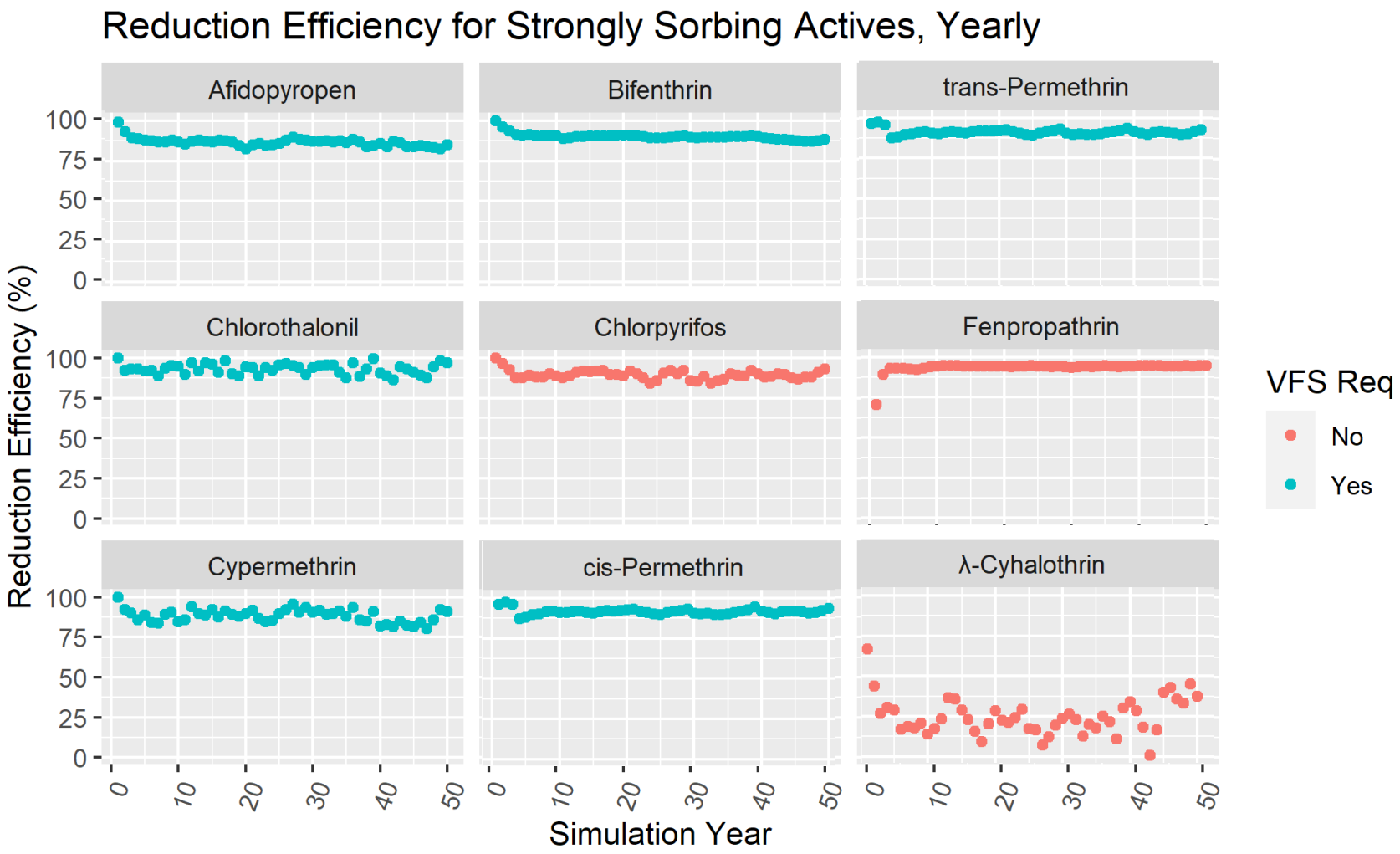
Objective 2 - VFSMOD Predictions for 10m VFS

- 8 pesticides for which a VFS is required or is/was being considered as a requirement
  - Required:
    - Afidopyropen (RD2018-18)
    - Bifenthrin (RD2017-19)
    - Chlorothalonil (RVD2018-11)
    - Cypermethrin (RVD2018-22)
    - Permethrin (RVD2019-11)
  - Considered:
    - Chlorpyrifos
    - Fenpropathrin
    - Lambda-cyhalothrin
- 3 soluble pesticides:
    - Clothianidin, imidiclorpid, thiamethoxam
- For each pesticide:
  - A single run of 50 years
    - Scenario that gave highest 1 in 10 Year EEC
    - Initial Application Date that gave highest EEC

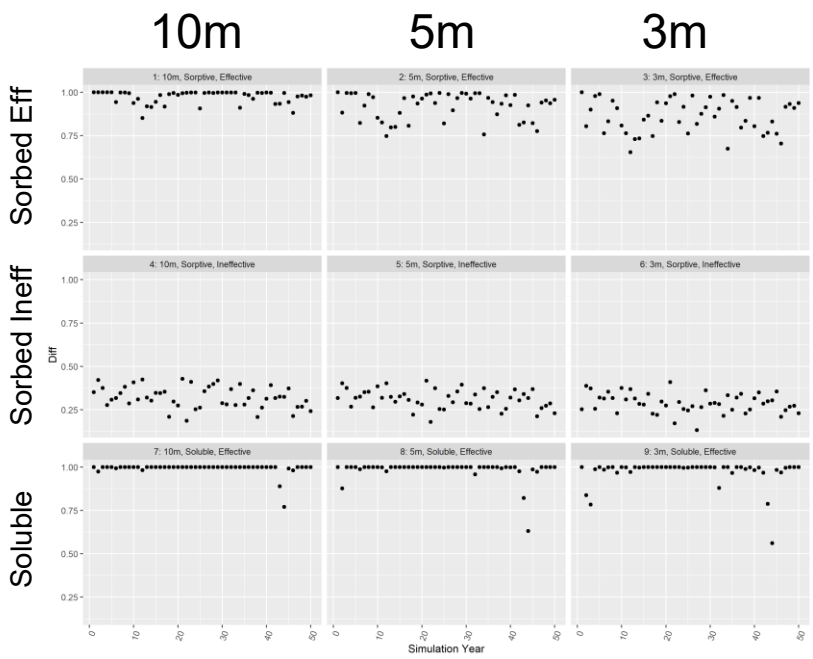
VFSMOD Predicted RE, Sorbed, 10m VFS, Daily EECs



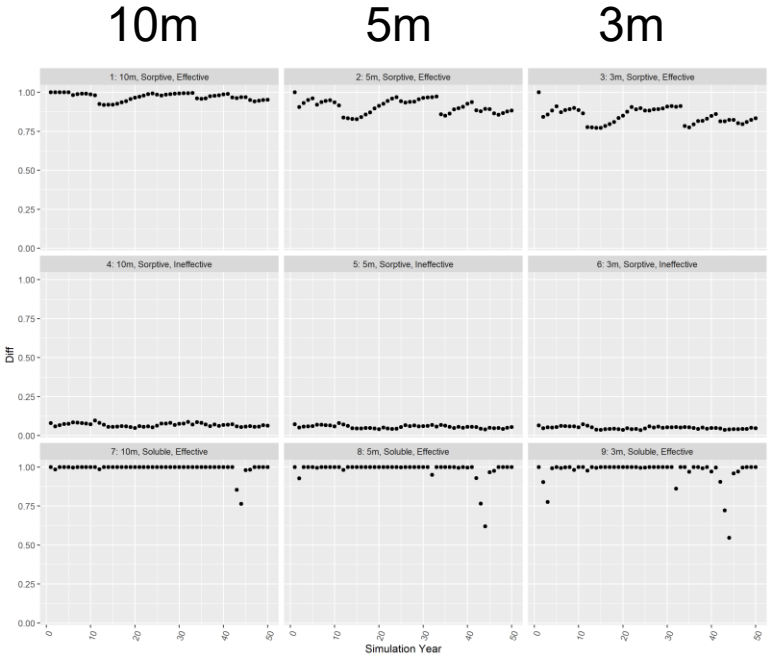
VFSMOD Predicted RE, Sorbed, 10m VFS, Yearly EECs



Objective 2 - Effect of Strip Width on EEC Reduction – generic chemical



Peak EECs

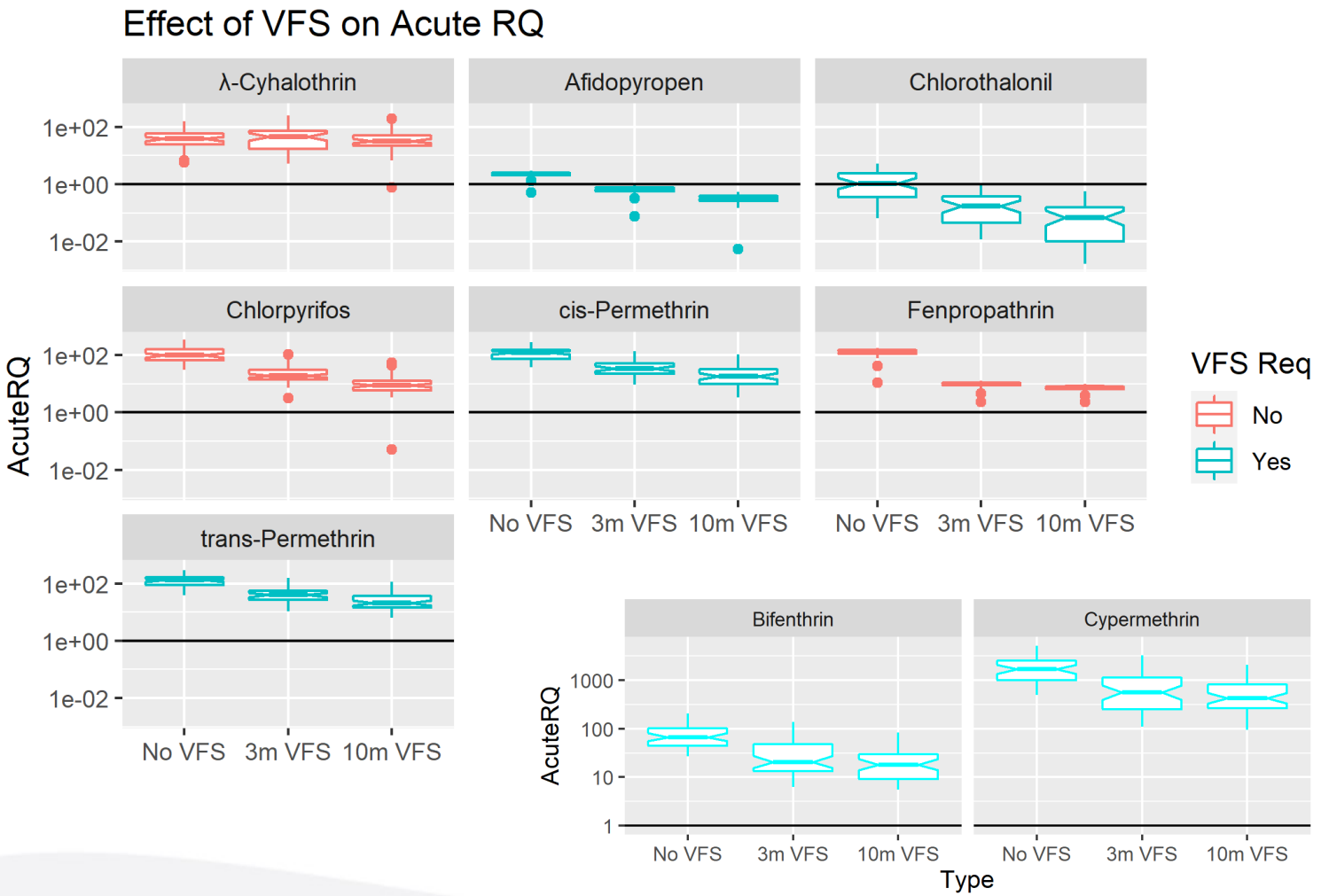


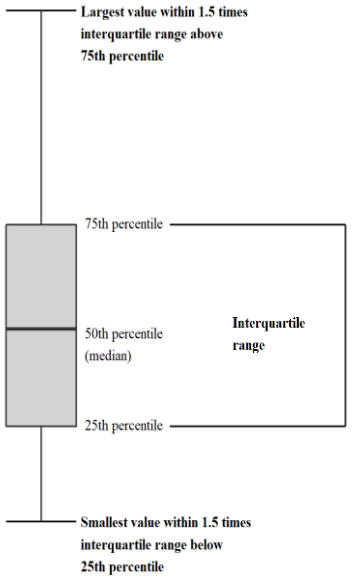
Yearly EECs

Objective 2 – Reduction in RQs

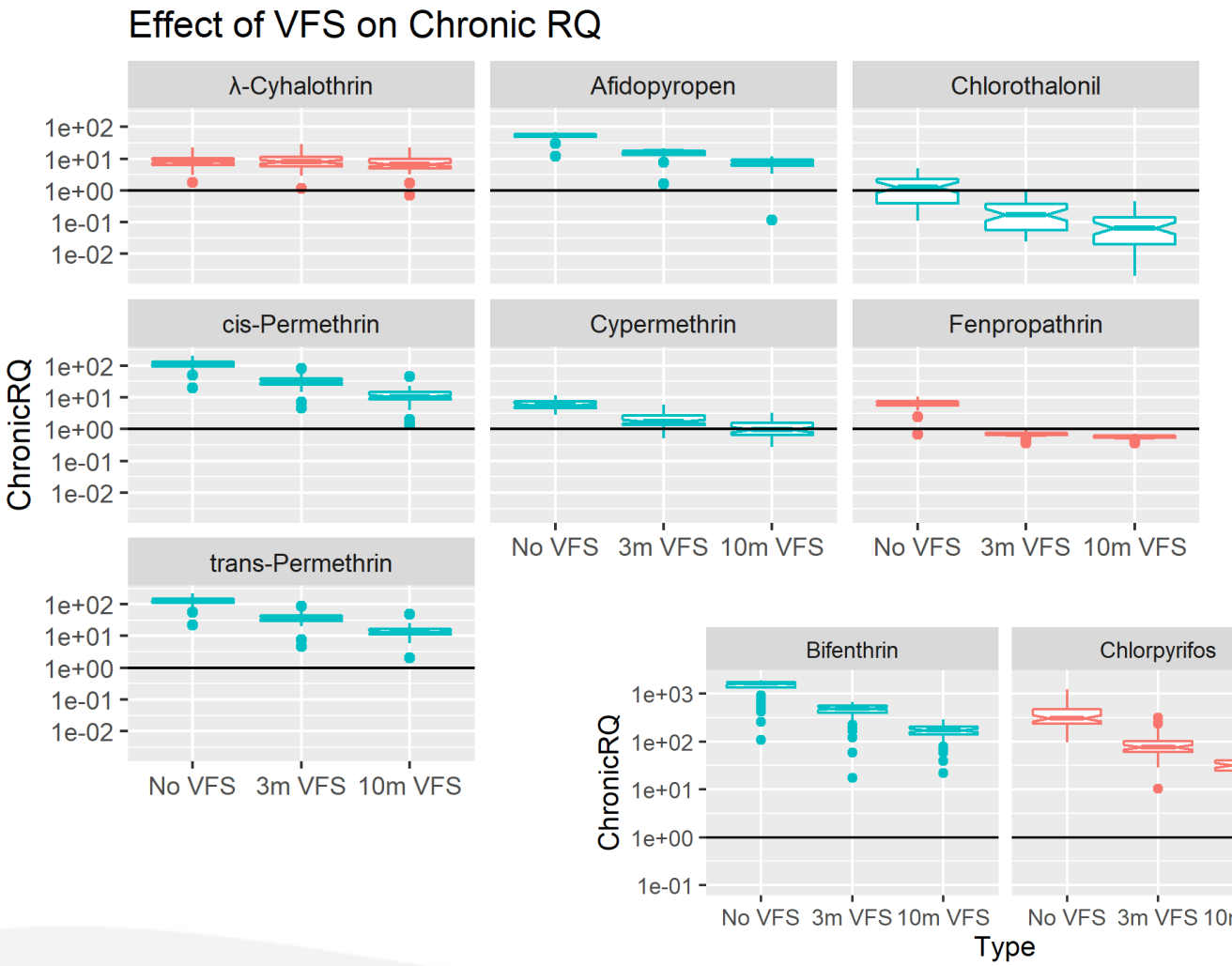
- VFSMOD predicts %RE of ~50% or greater for most pesticides modelled
  - More like 80% for yearly averages
- What size of difference would these reductions make in RQs?

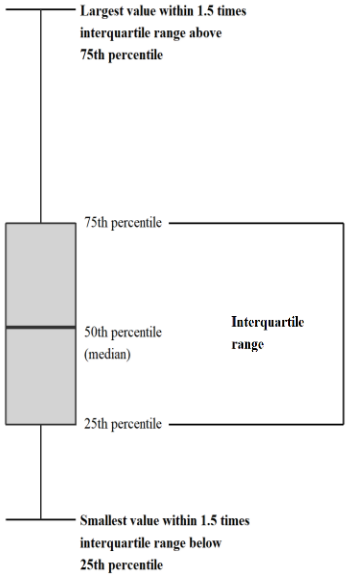
Efficacy of VFS for Acute RQ Reduction





Efficacy of VFS for Chronic RQ Reduction

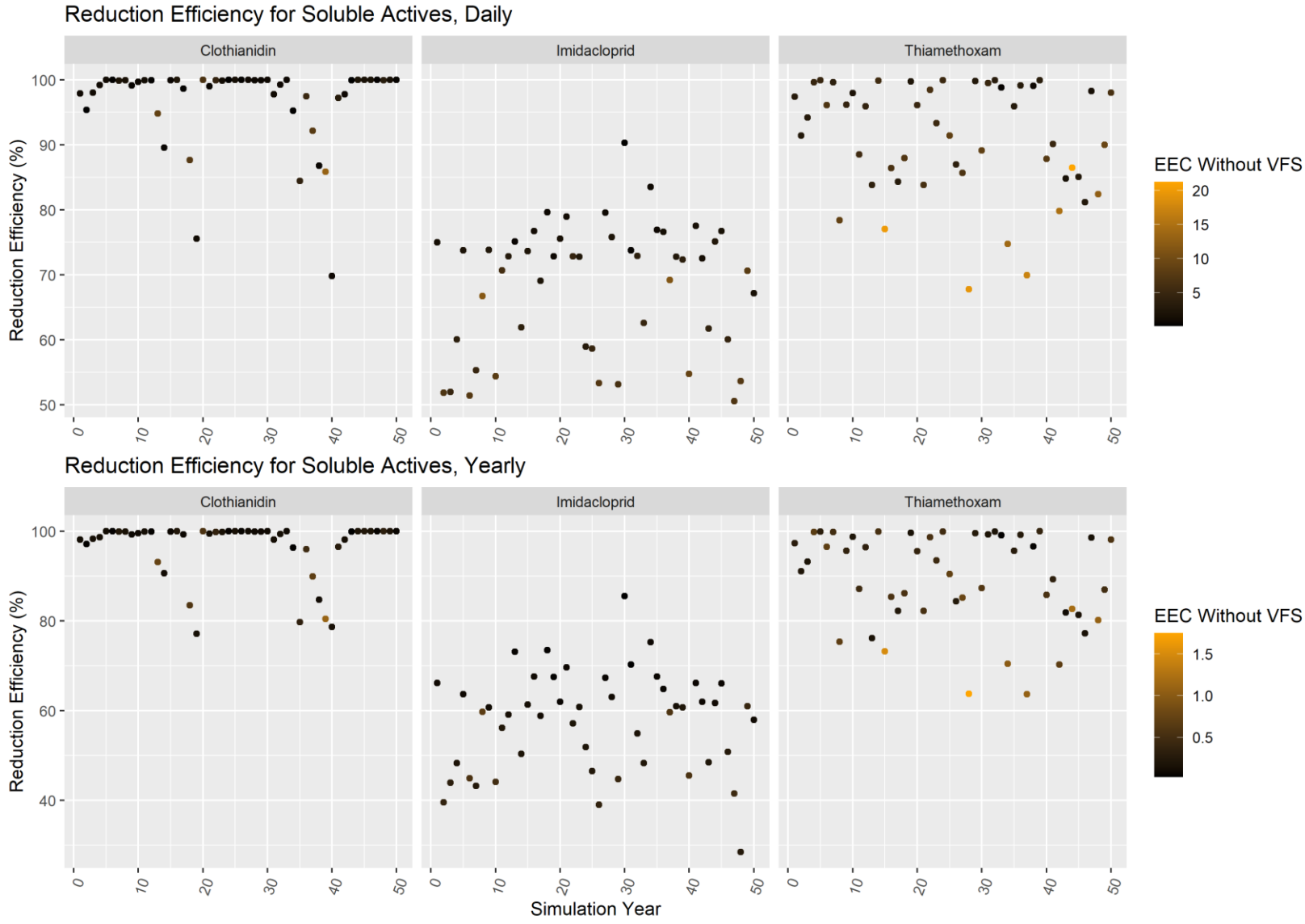




Objective 2 – Reduction in RQs

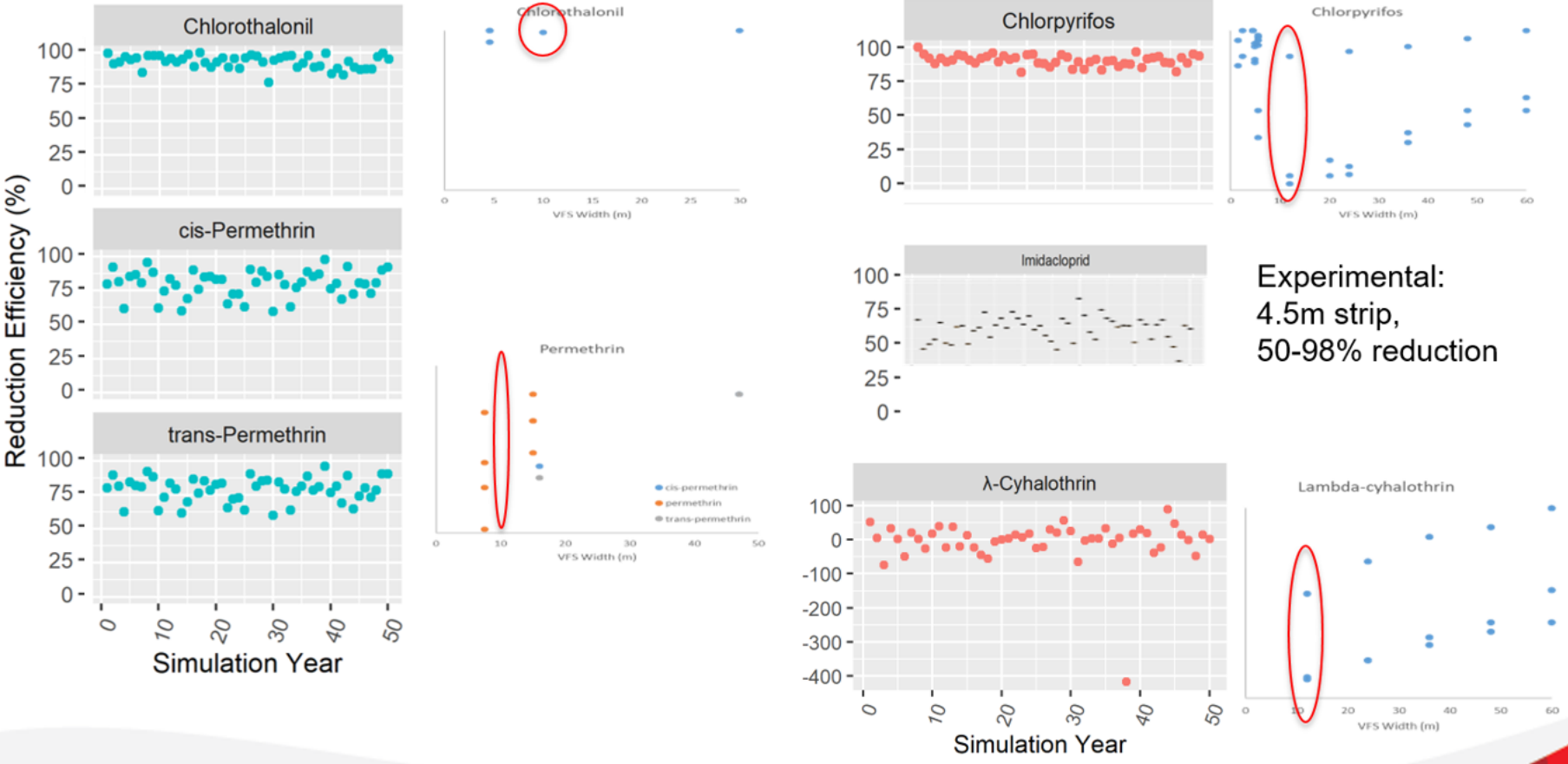
- VFSMOD predicts order-of-magnitude reductions in risk with the implementation of a 3m VFS
  - 10m VFS is more effective still
- Λ-cyhalothrin continues to be the exception when viewed through the risk lens

Objective 2 - Efficacy of VFS for Soluble Pesticides



Objective 2 - Comparison to Experimental Values

- Ross Breckels of PMRA provided literature values for comparison
- Note the x-axes differ: ~10m VFS circled

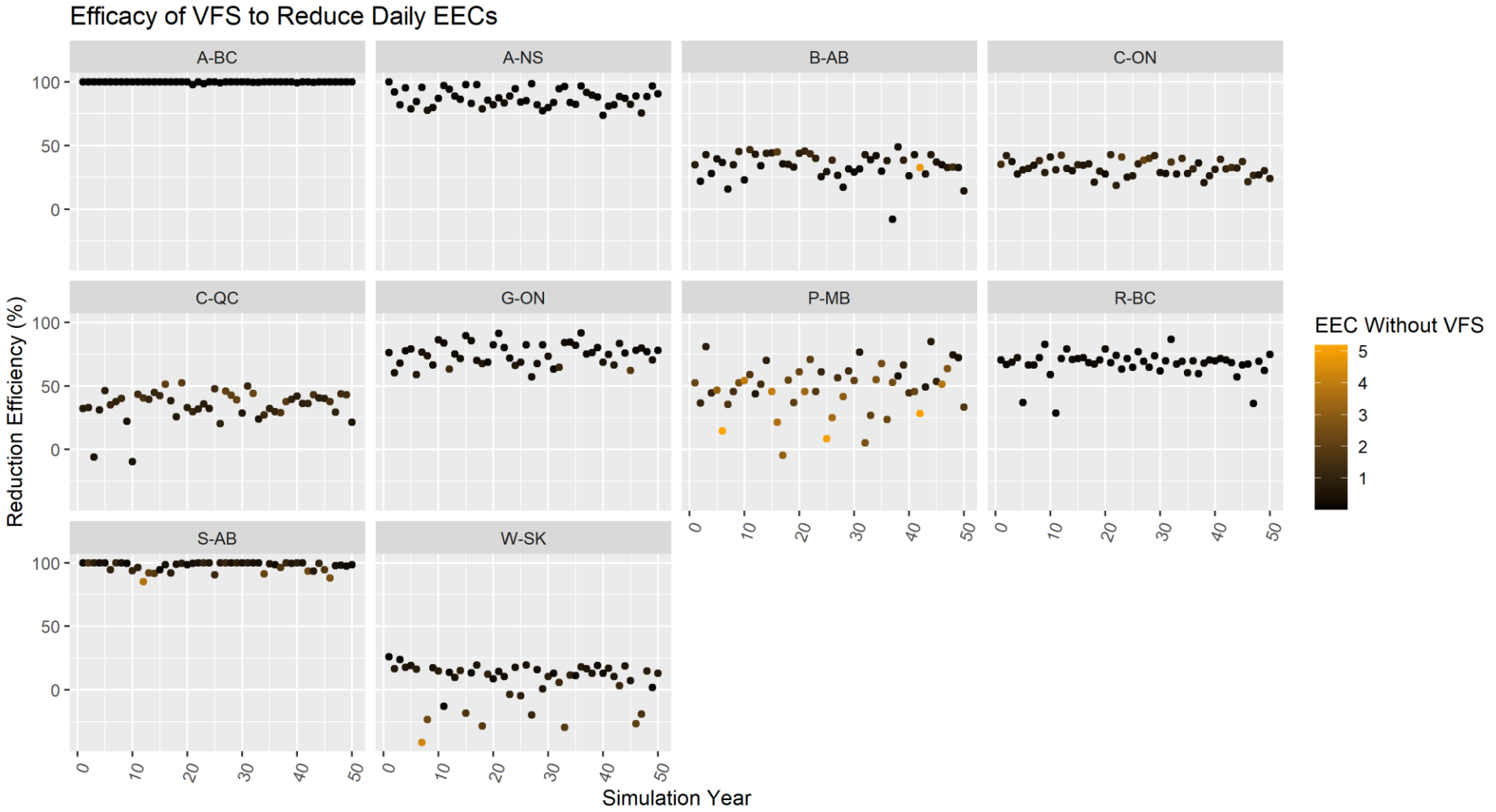


Objective 3 – Sensitivity analysis

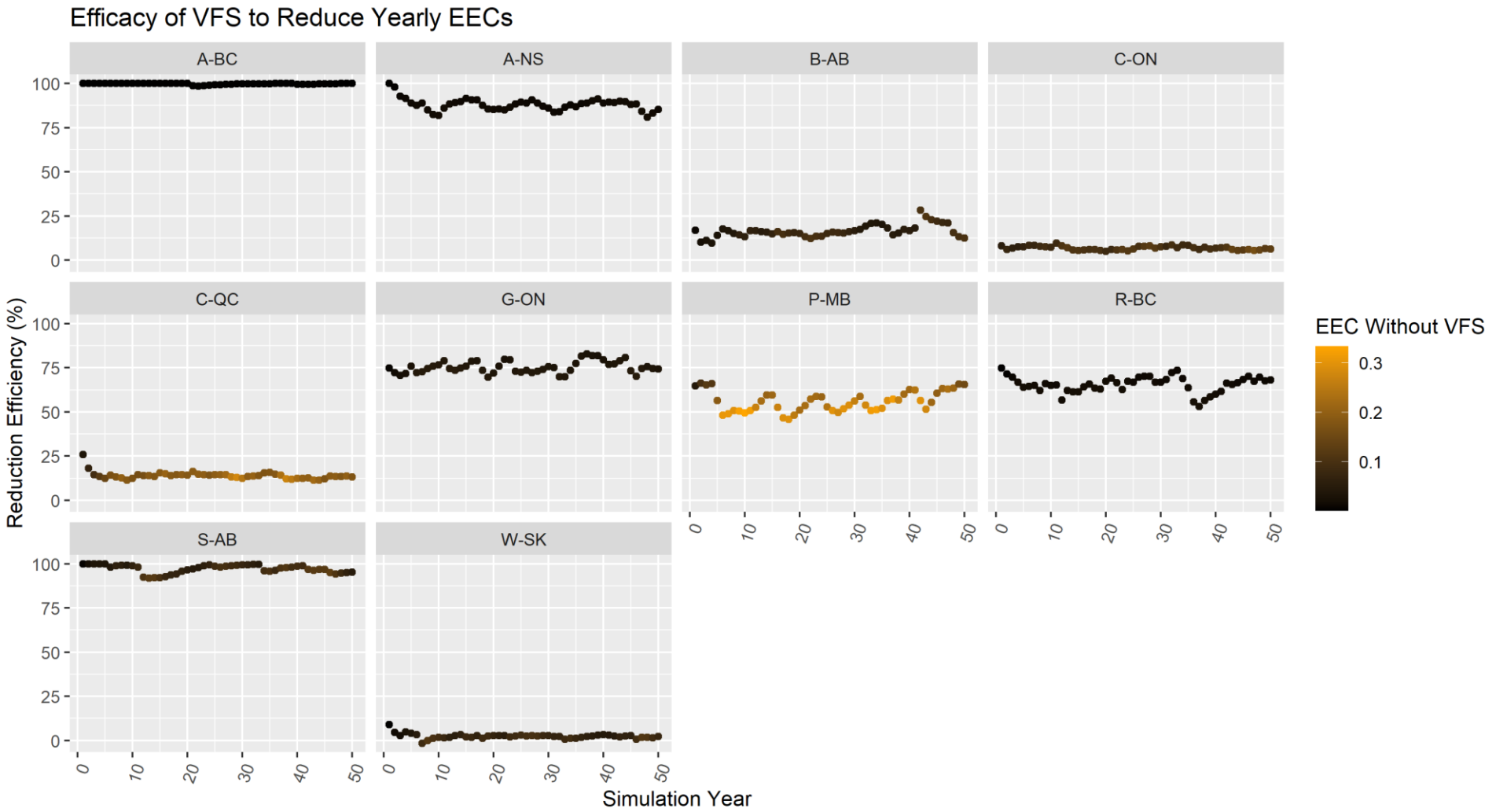
- VFSPipe not *yet* capable of an automated formal sensitivity analysis
- → Simpler approach
  - Modelled 1 pesticide: permethrin
    - VFS predicted to be relatively efficacious
      - Good, but not 100% all the time
    - Recently published decision using modelling done with PWC
  - Modelled 10 additional standard Canadian scenarios

Canadian Scenarios

Efficacy of VFS Across Scenarios - Daily



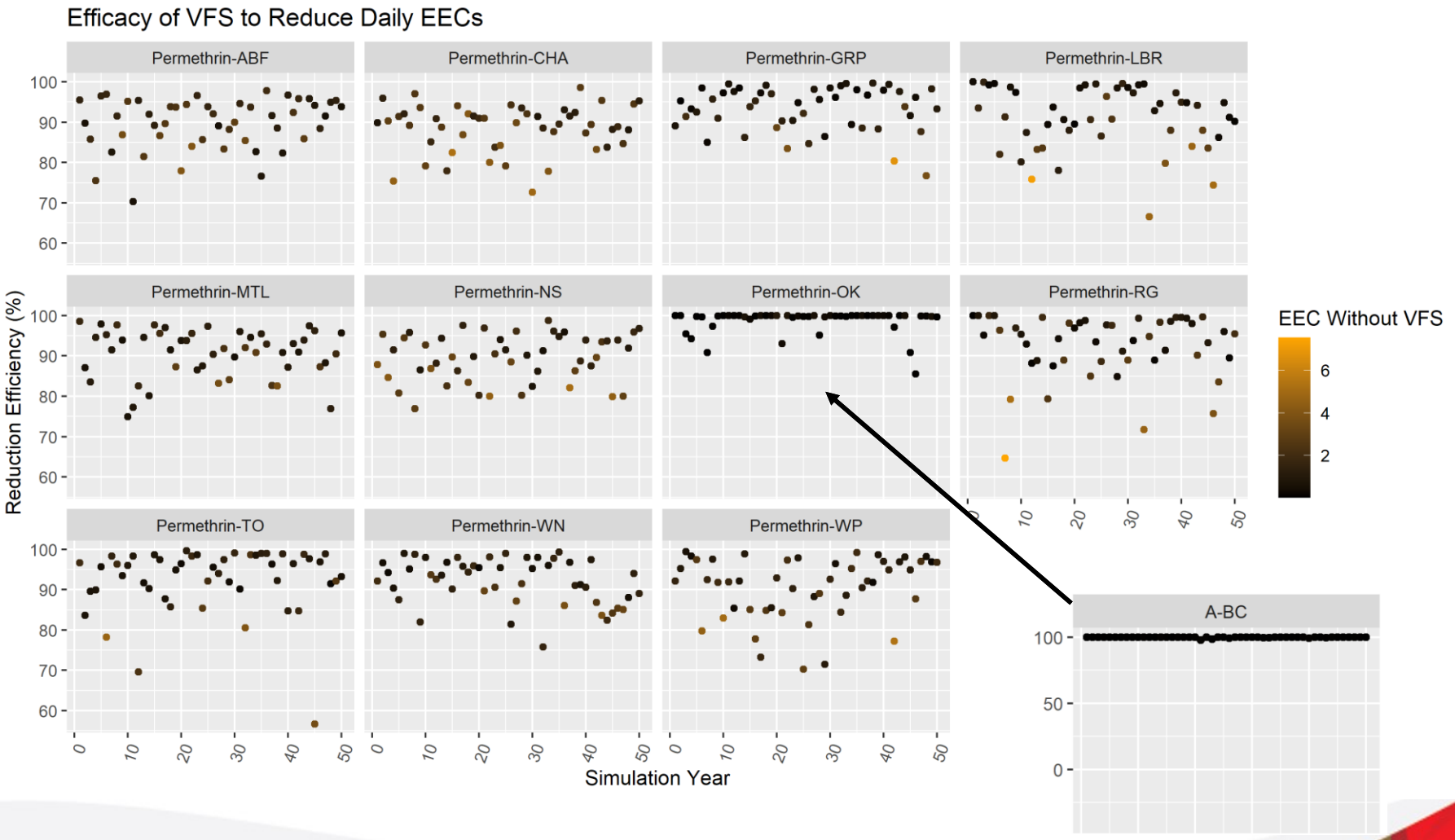
Efficacy of VFS Across Scenarios - Yearly



What drives the variation between scenarios?

- A very large variation in %RE between scenarios
- Could it be the **weather**?
  - Well understood that precipitation can drive surface water EECs in PWC
    - Especially large storms that cause erosion
- Ran 10 simulations varying only the weather file

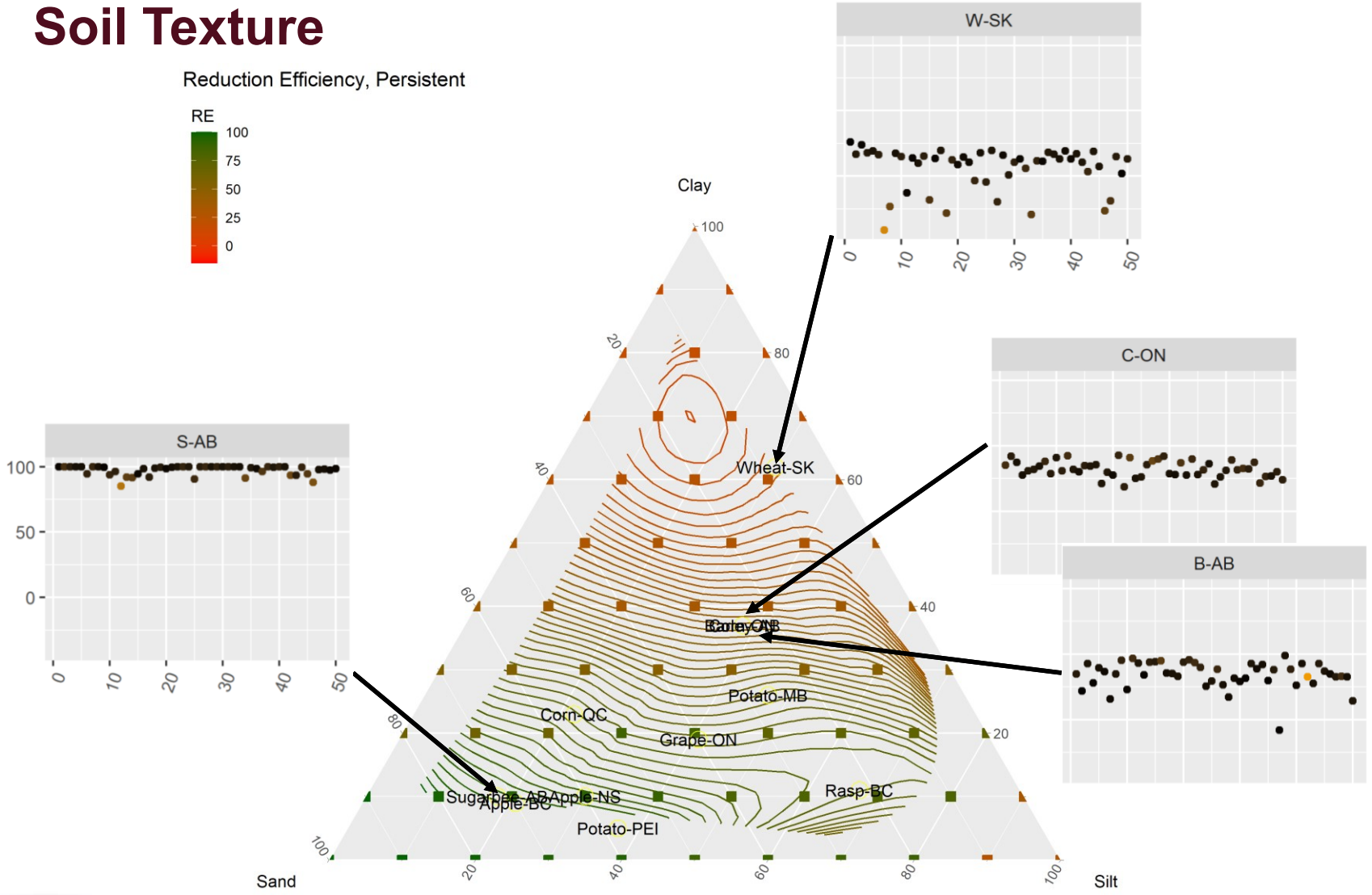
Efficacy of VFS Across Weather - Daily



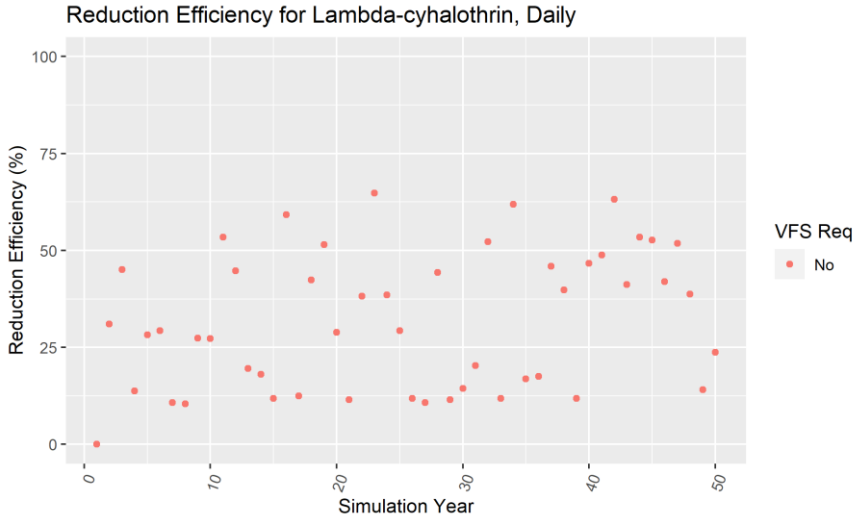
Objective 3 - Soil Texture

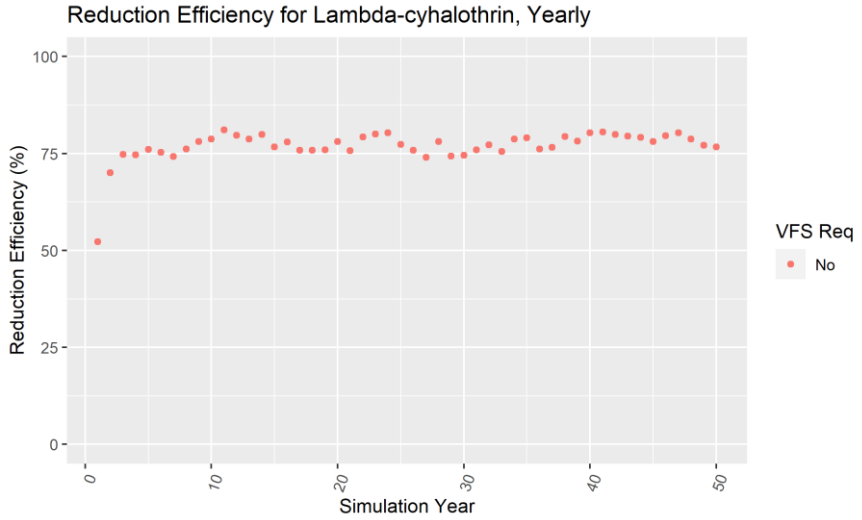
- The weather accounts for SOME of the differences in %RE, but not nearly all
- Could it be the soil texture?
- Simulations were run varying the clay and sand contents from 0% to 100% in 10% increments
  - Other parameters from the Potato-PEI scenario
  - Chemical properties of permethrin, but perfectly persistent

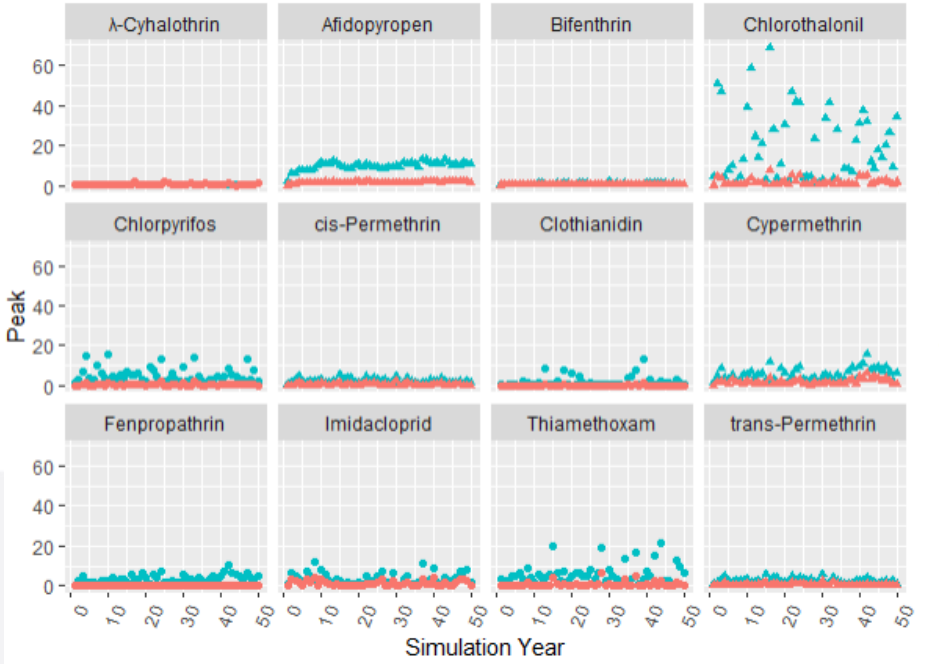
Soil Texture



λ-cyhalothrin, revisited







Summary and Next Steps

- Objective 1- Connector Tool
  - Have a working tool but still under development
  - Increase automation of VFSPipe: eliminate need for PWC interface
    - Allow for simple loops through variables
  - Adapt VFSMOD for use with library
    - Will decrease run time by at least an order of magnitude
    - User Interface
      - Easier to use and faster to set up runs
    - Still many assumptions coded in that should be up-front
      - E.g., VFSMOD User-manual default values for several inputs

Summary and Next Steps

- Objective 2 – Assess the 10m strip
  - VFSMOD predicts the 10m strip is a good choice as a default
  - Strip width is important for strongly sorbing compounds but less important for soluble compounds
- Objective 3 – Assess sensitivity of VFSMOD
  - Tested some ‘easy’ parameters model takes from PWC
    - Some sensitivity to weather
    - Strong sensitivity to clay content
  - Need a more systematic exploration of sensitivity
    - Test sensitivity to %OC, Slope, storm length, vegetation. etc
    - Will inform future modelling
    - Will inform approach to any online calculator

Questions

Questions?