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Linking Water Column, Vegetation and Soil Data in Treatment Wetlands Using a Mechanistic Model

FOR THE #GATORGOOD

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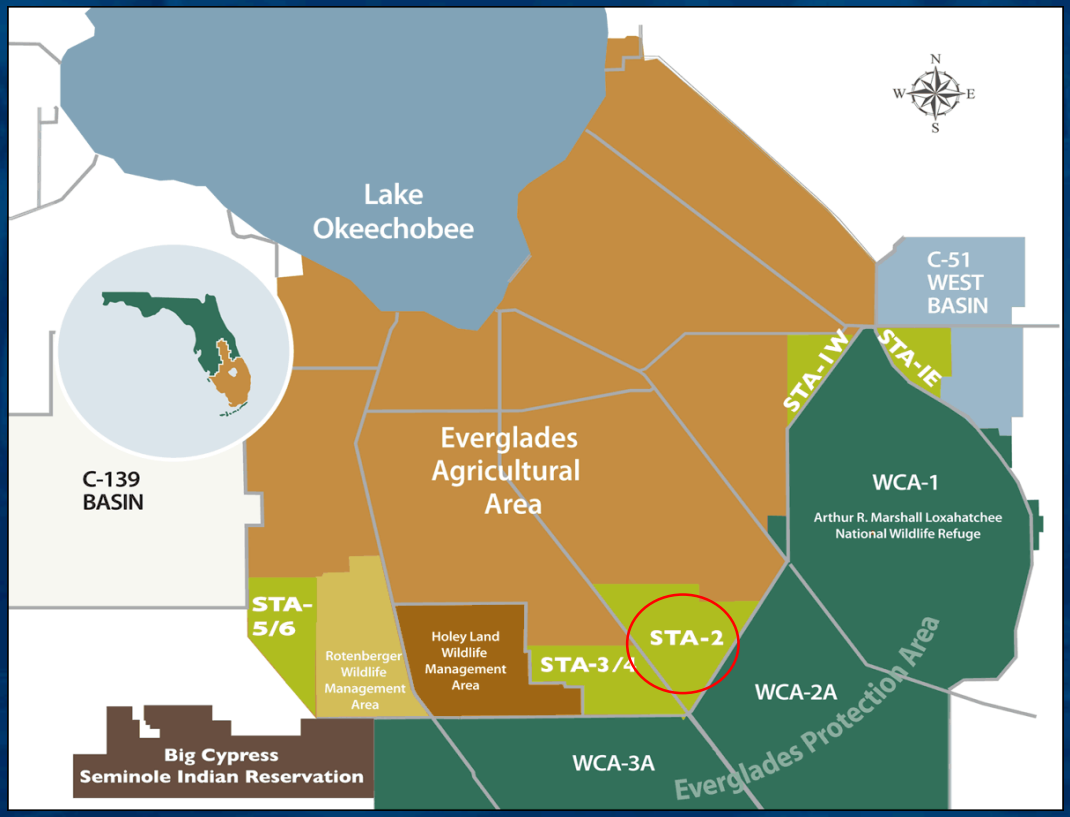
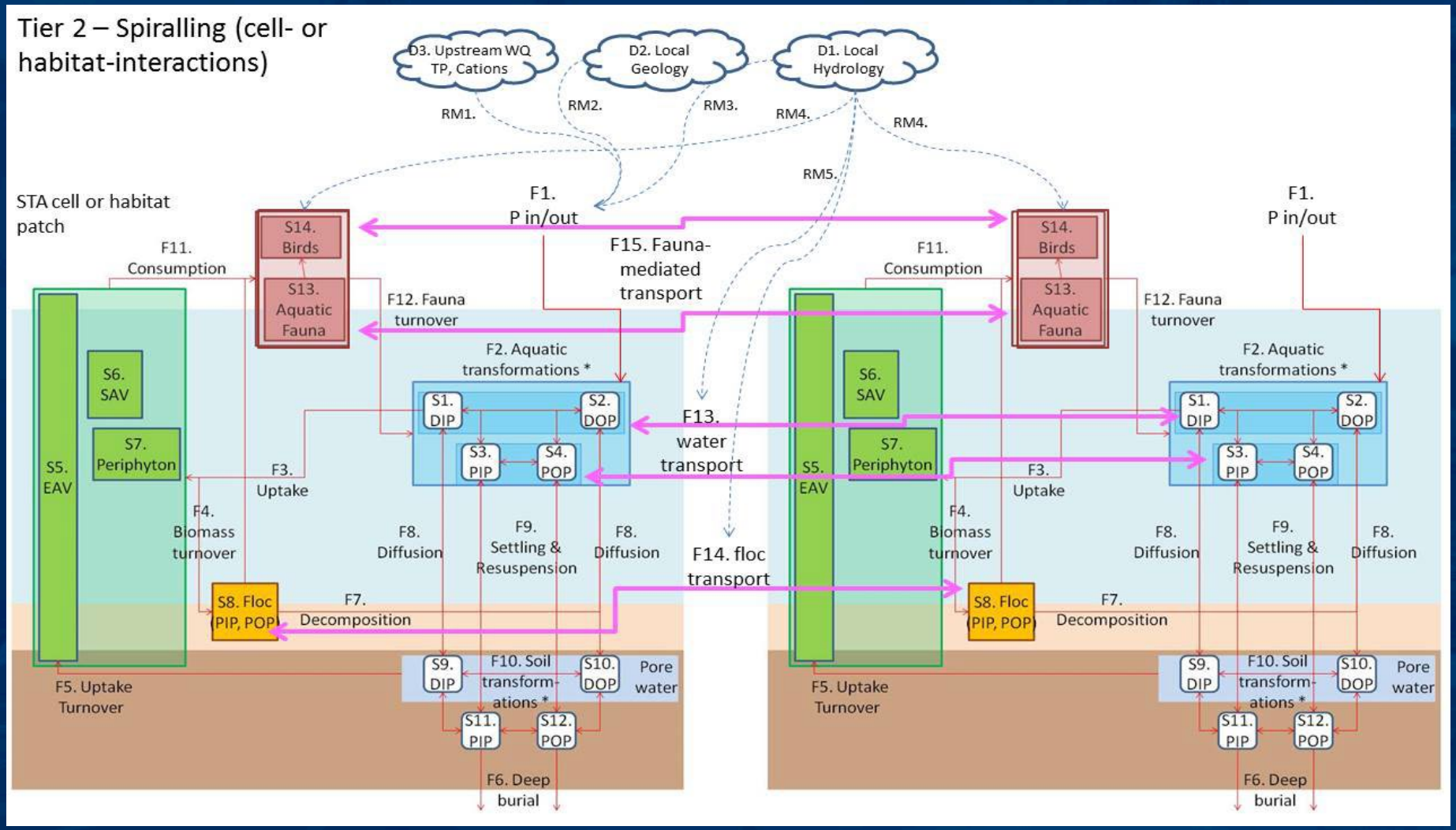
Stormwater treatment areas (STAs)



Project Key Questions (SFWMD Pflux Project)

- Can internal loading of phosphorus (P) to the water column be reduced or controlled, especially in the lower reaches of the treatment trains?
- Can the biogeochemical or physical mechanisms be managed to further reduce soluble reactive, particulate and dissolved organic P concentrations at the outflow of the STAs?

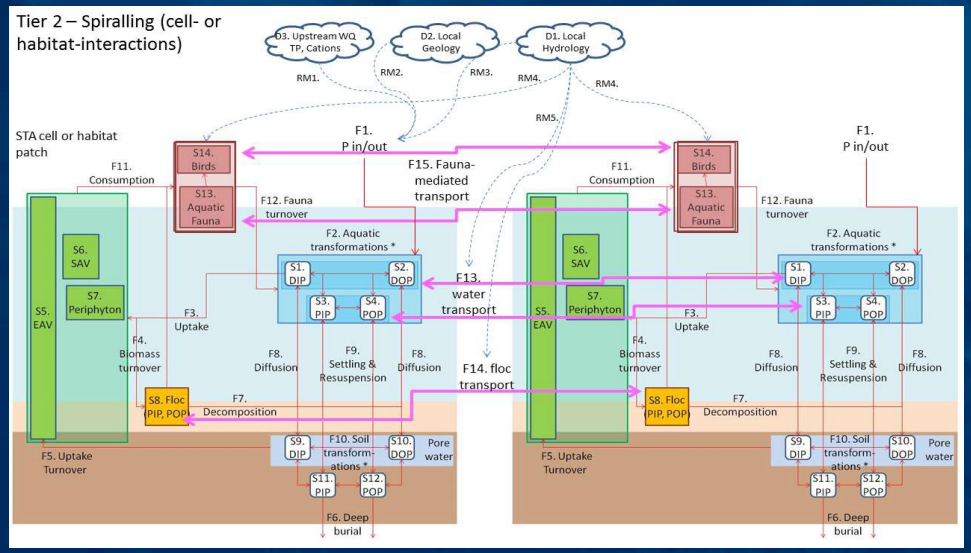
Conceptual Model



South Florida Water Management District

Inversion Approach

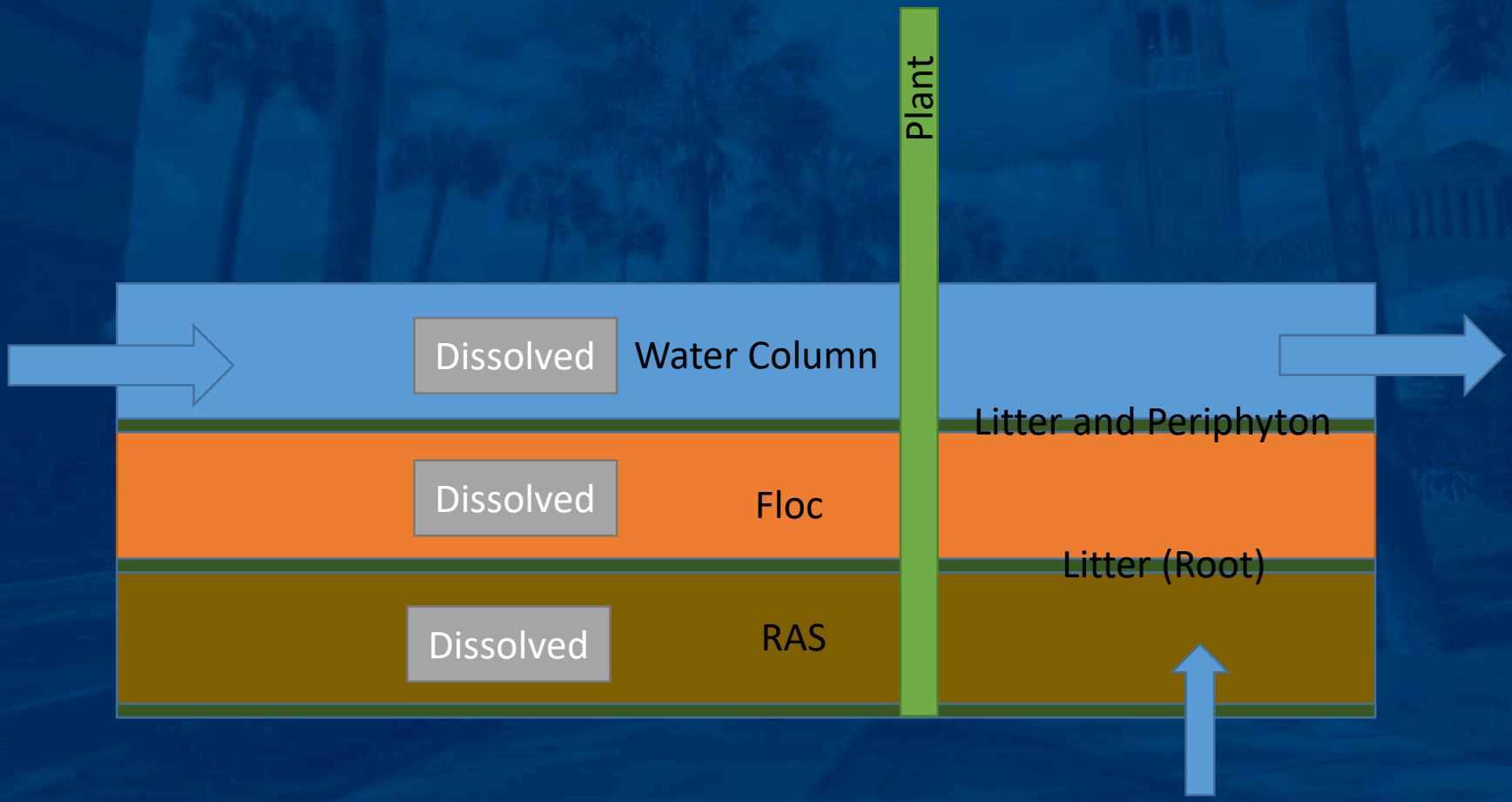
Given the data, can we reduce the gap between data and model, and infer important associated processes?



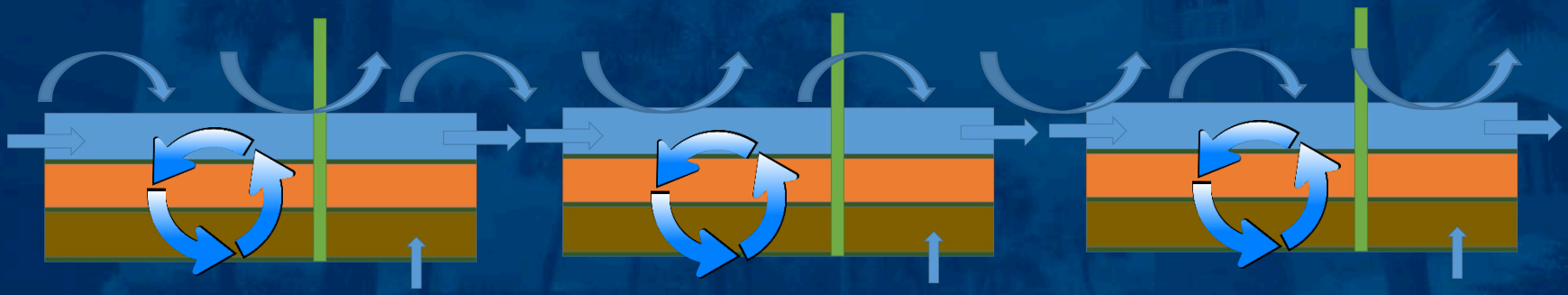
Data used:

- P outflow concentration
- P fractions in Floc and Soil
- Macrophyte P

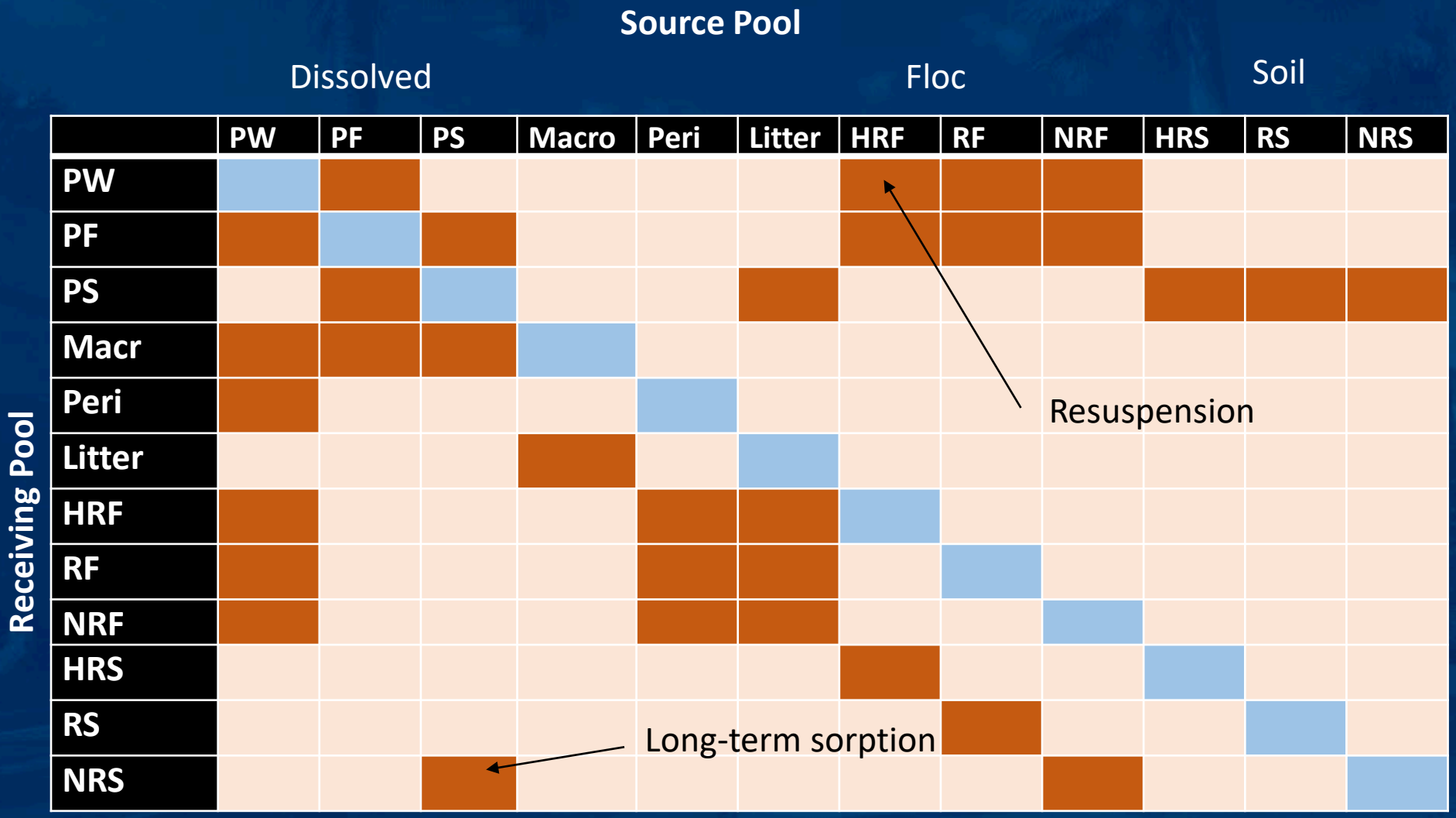
From Conceptual to Mechanistic Model



Spiraling



Model in matrix form



Bayesian inversion STA2 C1

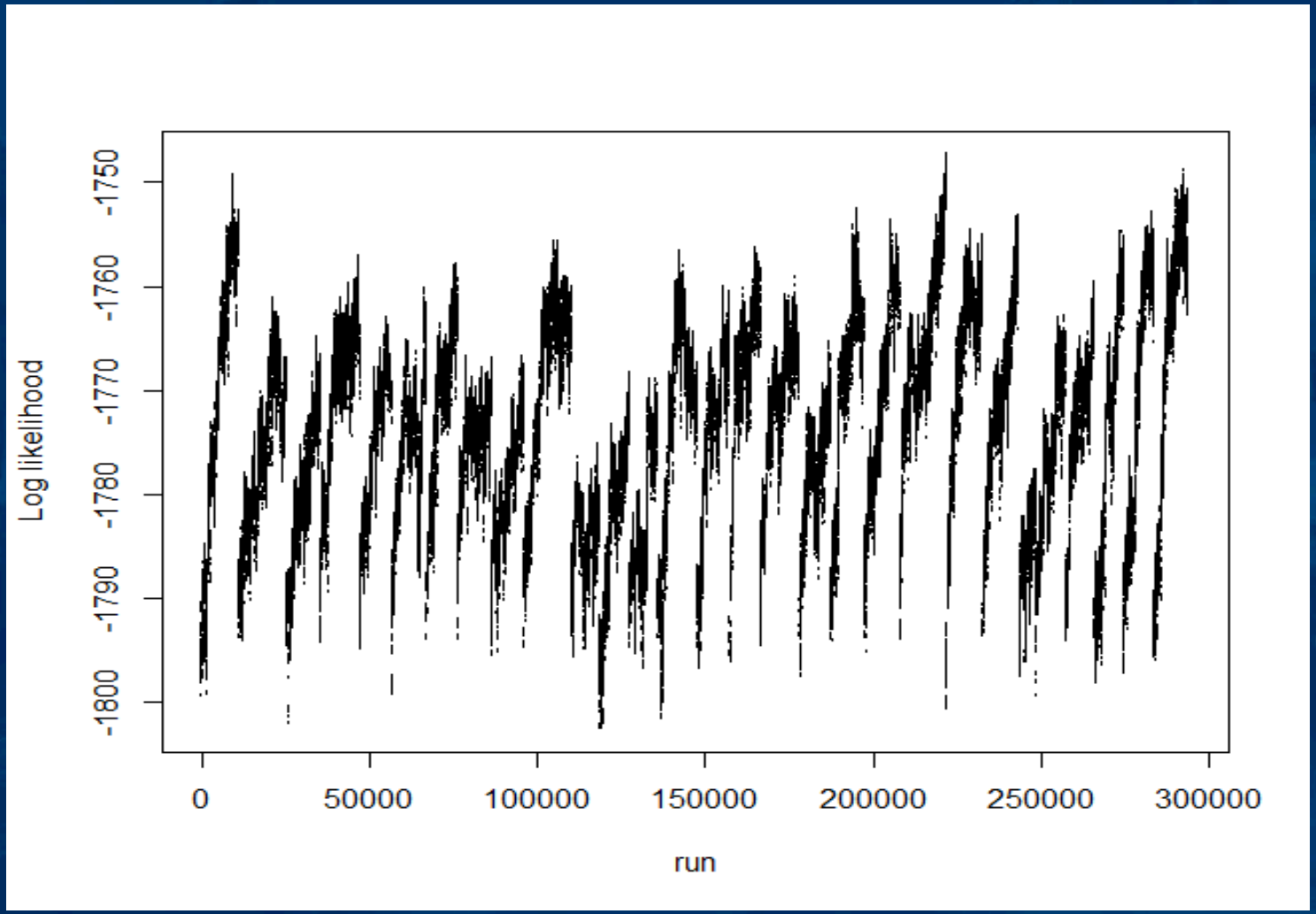
Given the data, and the desire to minimize the gap between data and model, what is the potential range of the parameter (and associated processes).

Allows for estimation of range of parameters (understanding how constrained the process is).

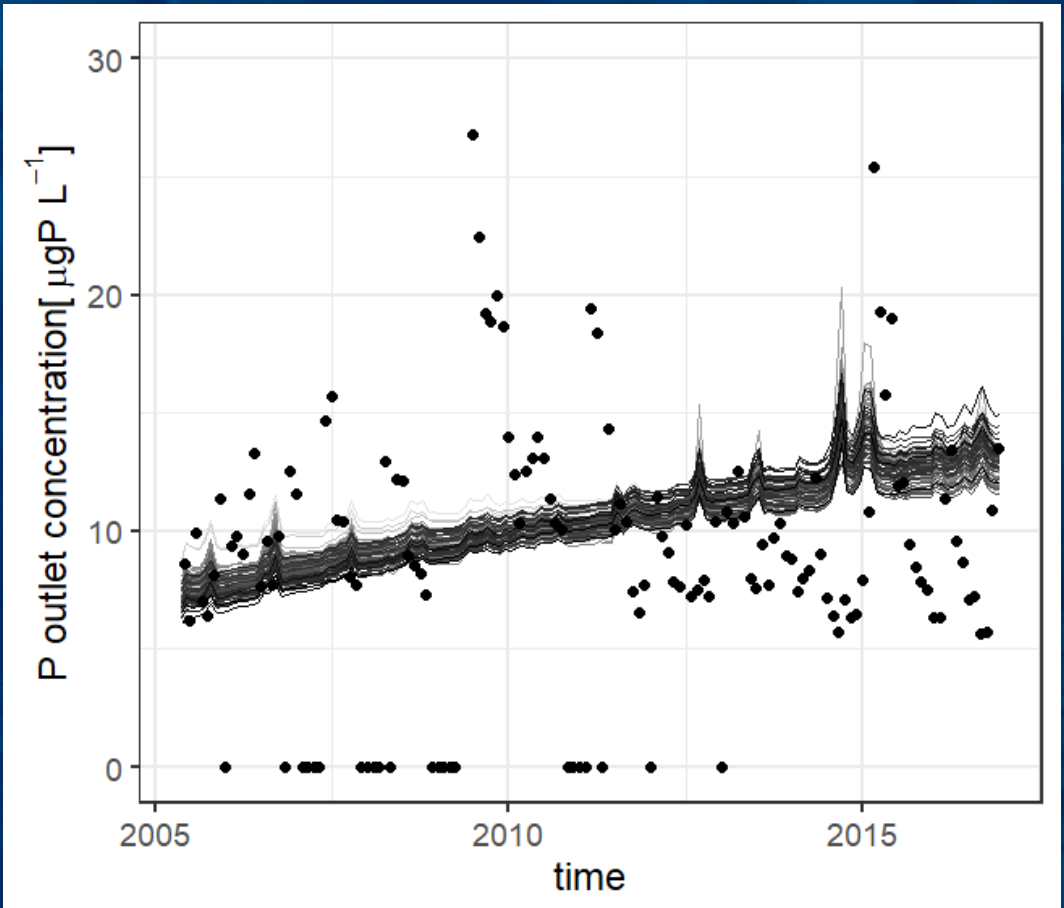
Data used:

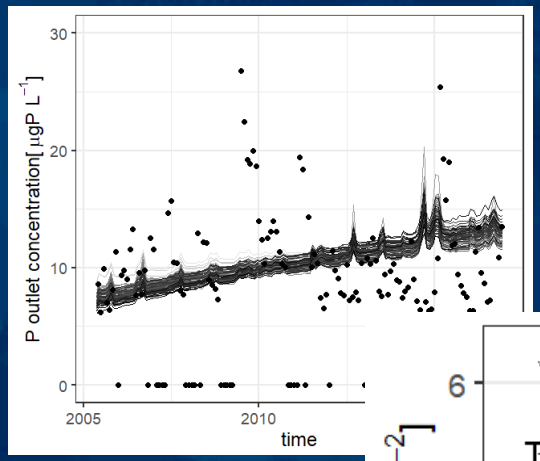
- P outflow concentration
- P fractions in Floc and Soil
- Macrophyte P

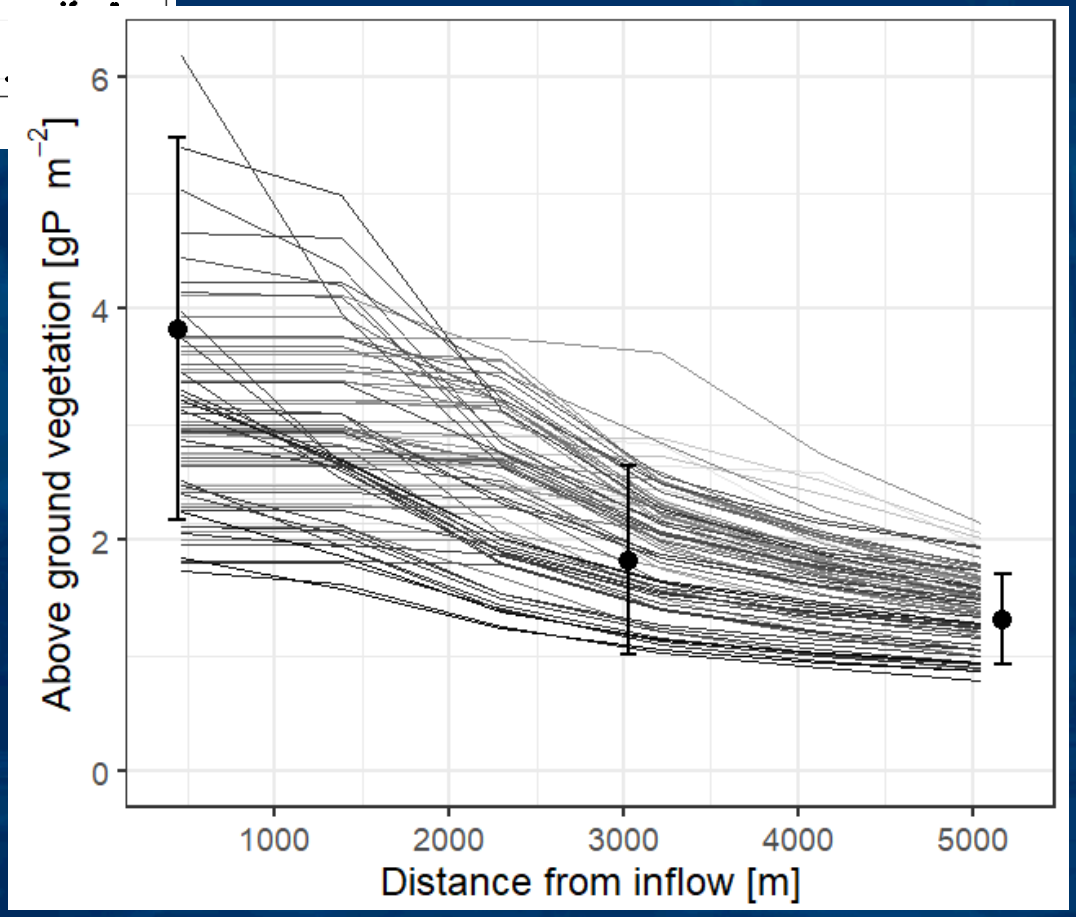
200000+ Model runs

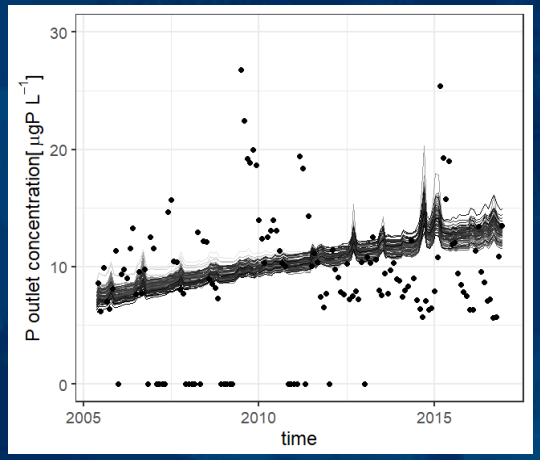


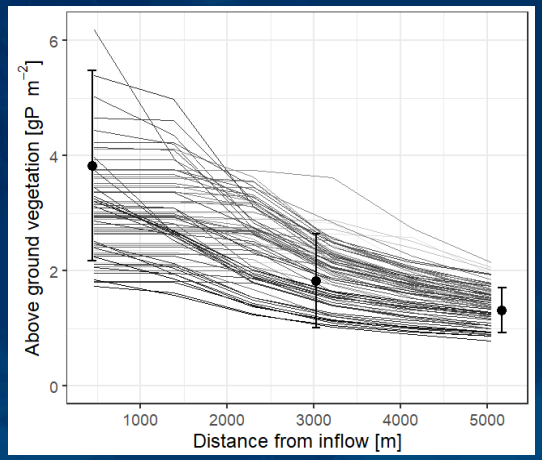
Modeled outflow concentration

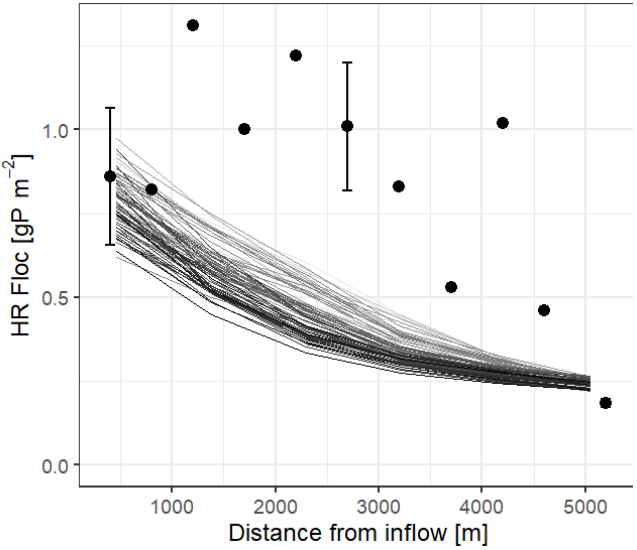


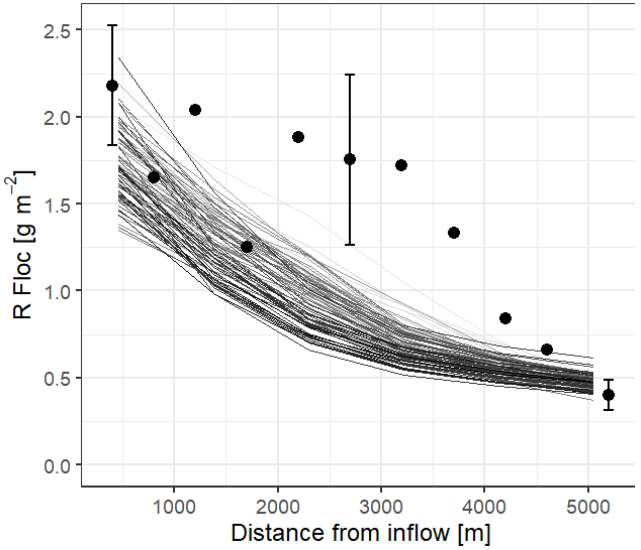

P outlet concentration[µgP L^{-1}]
30
20
10
0
2005
2010
time

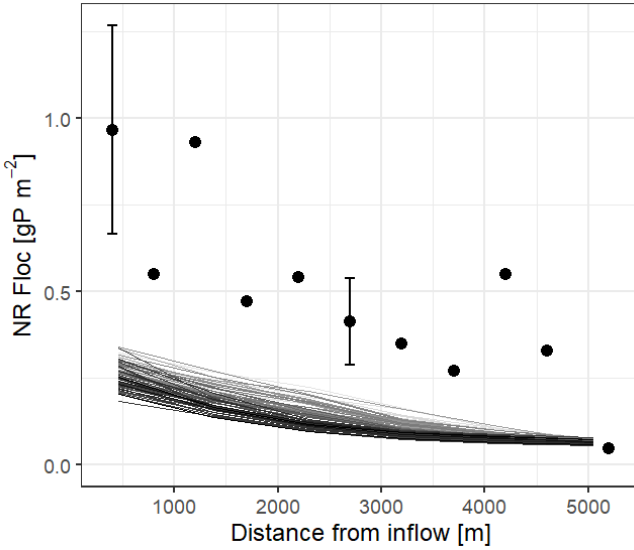

Above ground vegetation [gP m^{-2}]
6
4
2
0
1000
2000
3000
4000
5000
Distance from inflow [m]

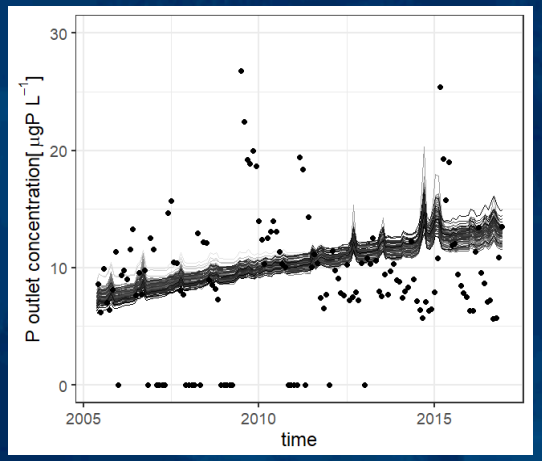

P outlet concentration[µgP L^{-1}]
time

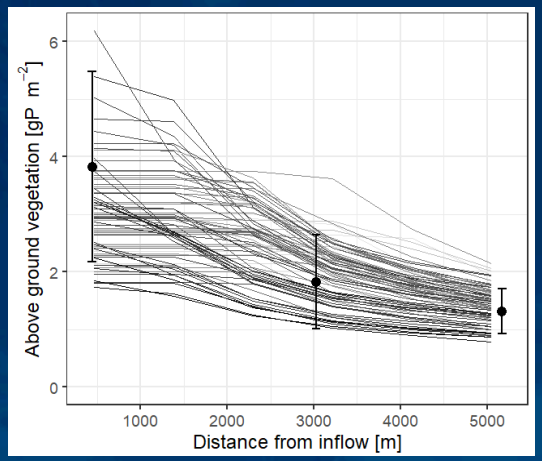

Above ground vegetation [gP m^{-2}]
Distance from inflow [m]

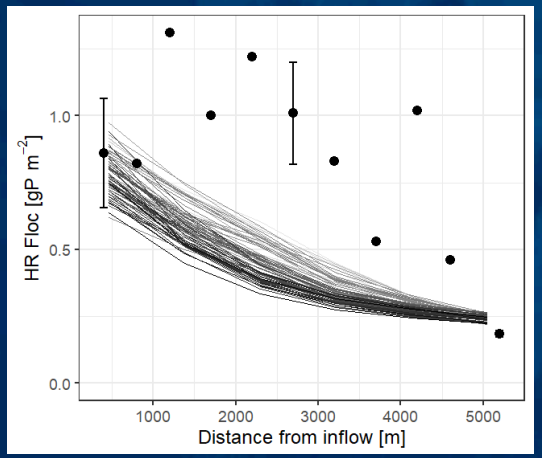

HR Floc [gP m^{-2}]
Distance from inflow [m]

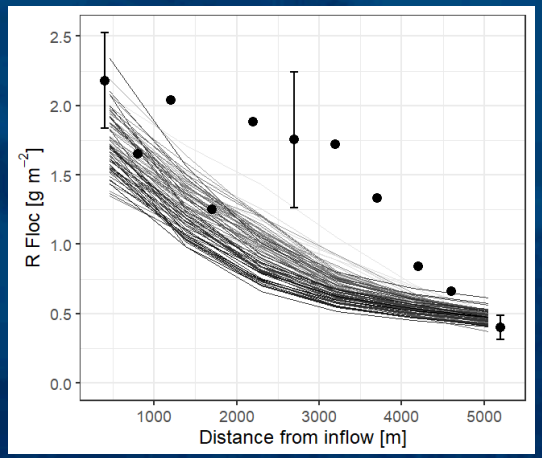

R Floc [g m^{-2}]
Distance from inflow [m]

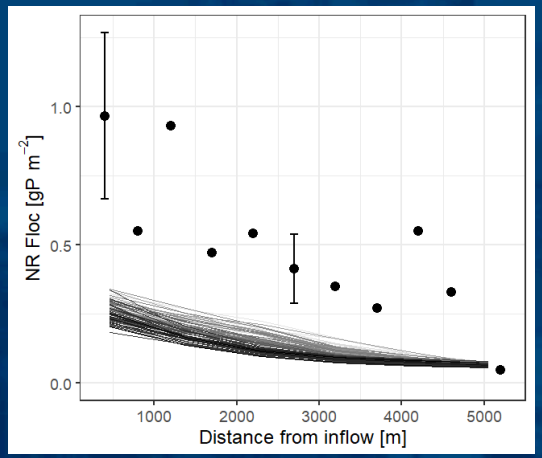

NR Floc [gP m^{-2}]
Distance from inflow [m]

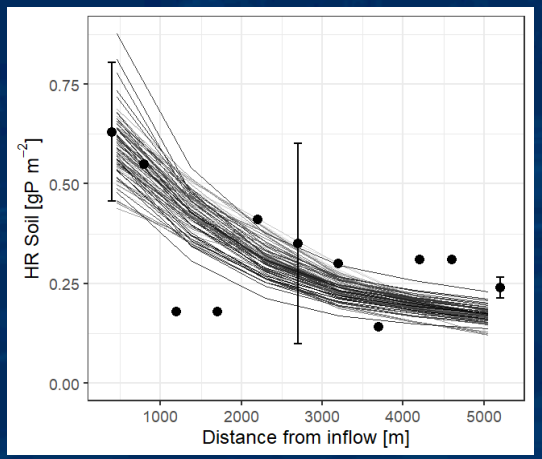

P outlet concentration[µgP L^{-1}]
time

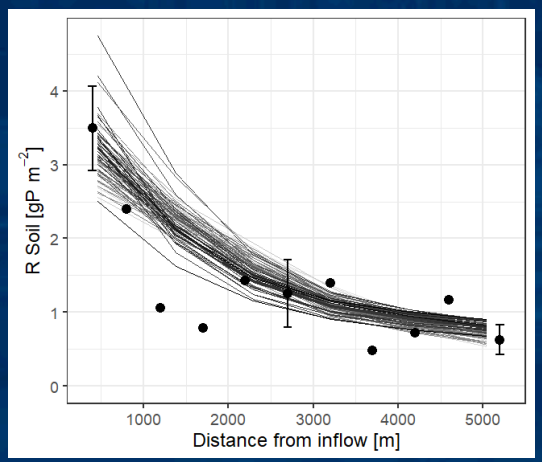

Above ground vegetation [gP m^{-2}]
Distance from inflow [m]

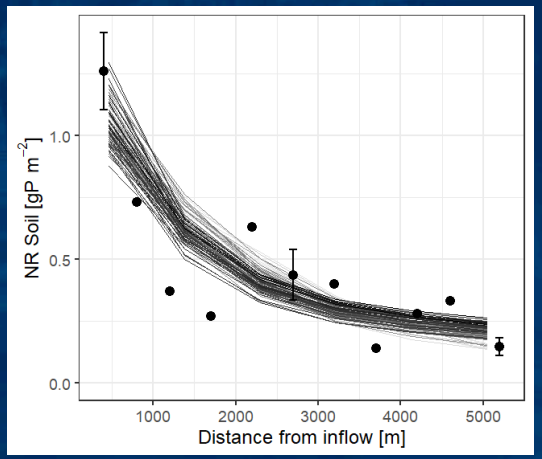

HR Floc [gP m^{-2}]
Distance from inflow [m]


R Floc [g m^{-2}]
Distance from inflow [m]

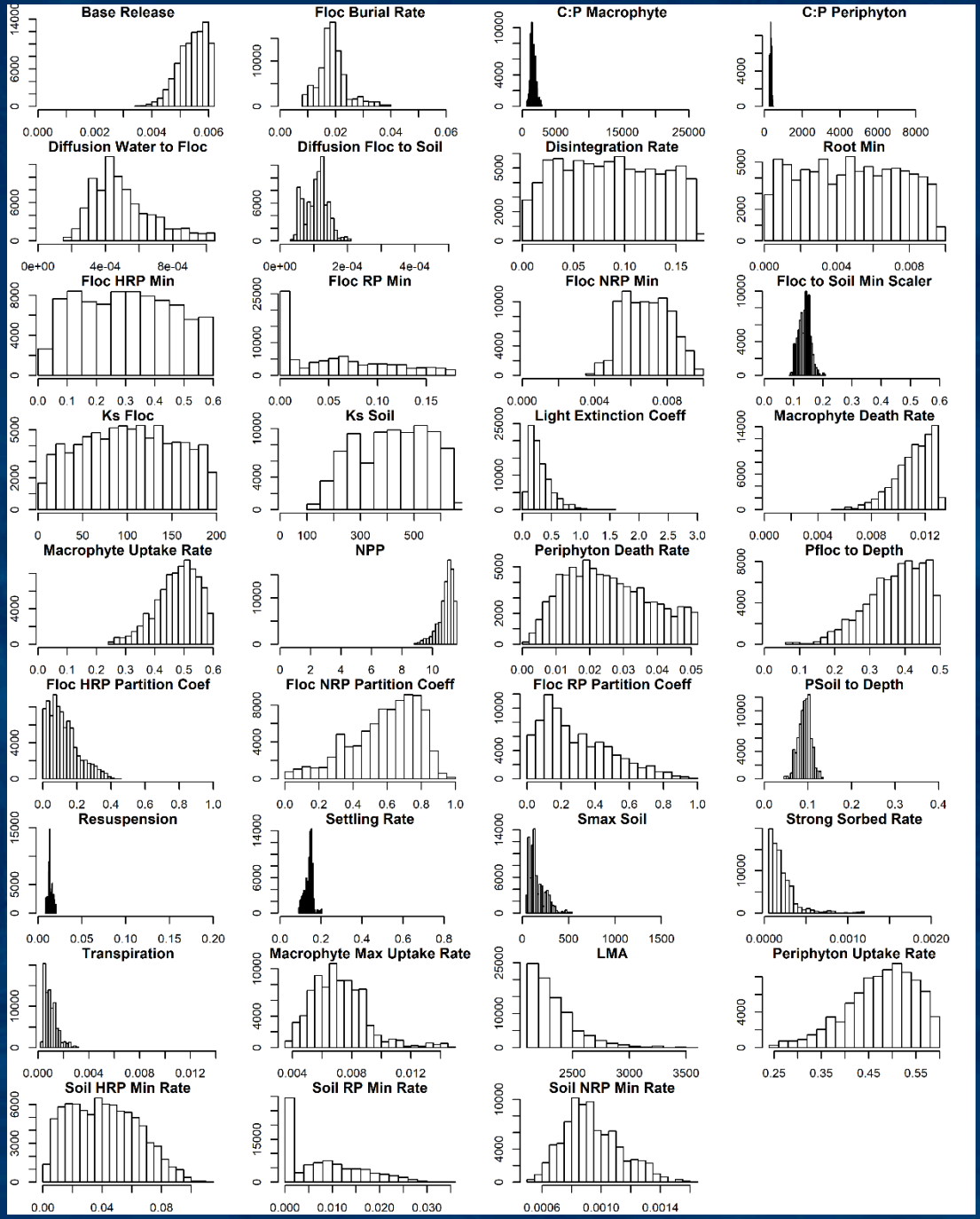

NR Floc [gP m^{-2}]
Distance from inflow [m]


HR Soil [gP m^{-2}]
Distance from inflow [m]

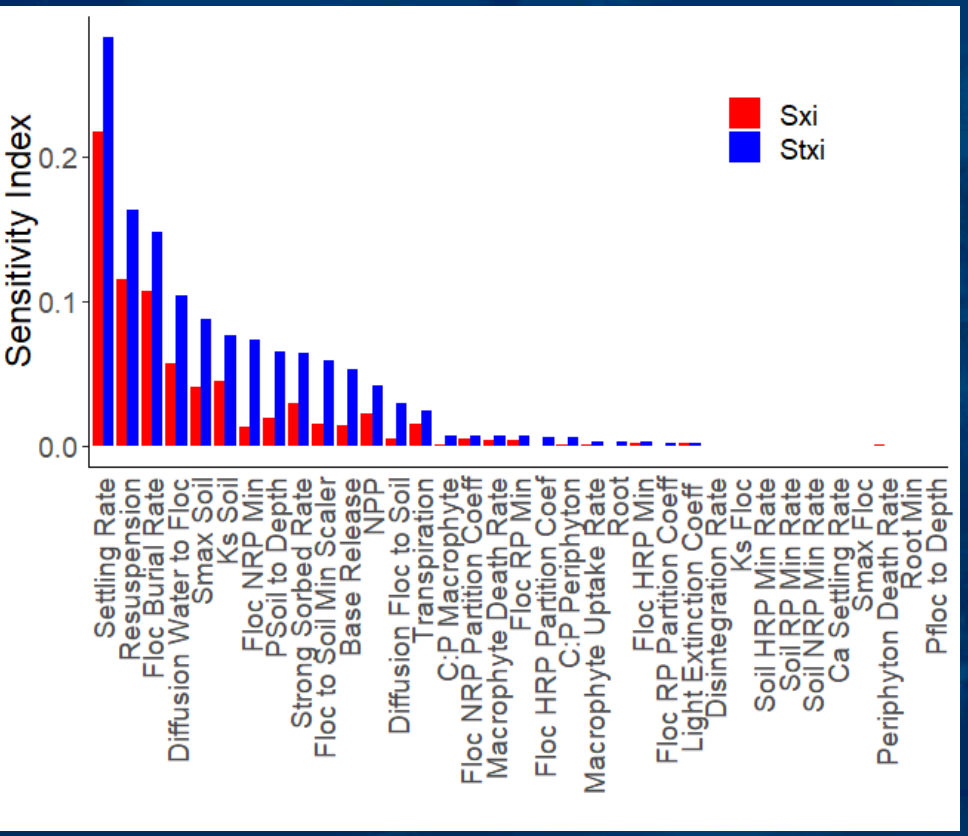

R Soil [gP m^{-2}]
Distance from inflow [m]

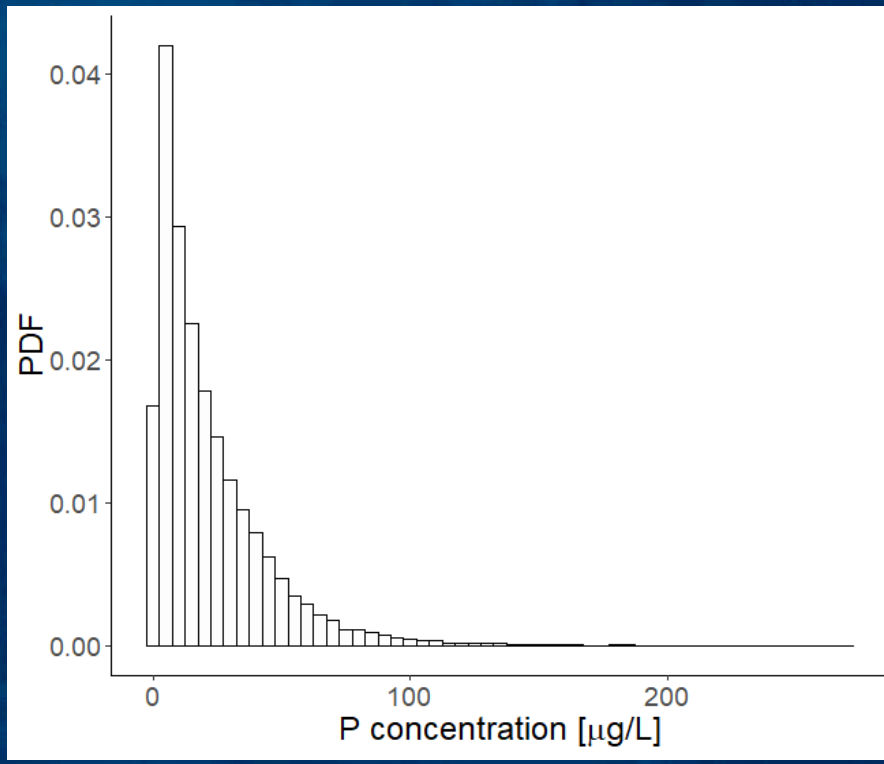

NR Soil [gP m^{-2}]
Distance from inflow [m]

Parameter distribution

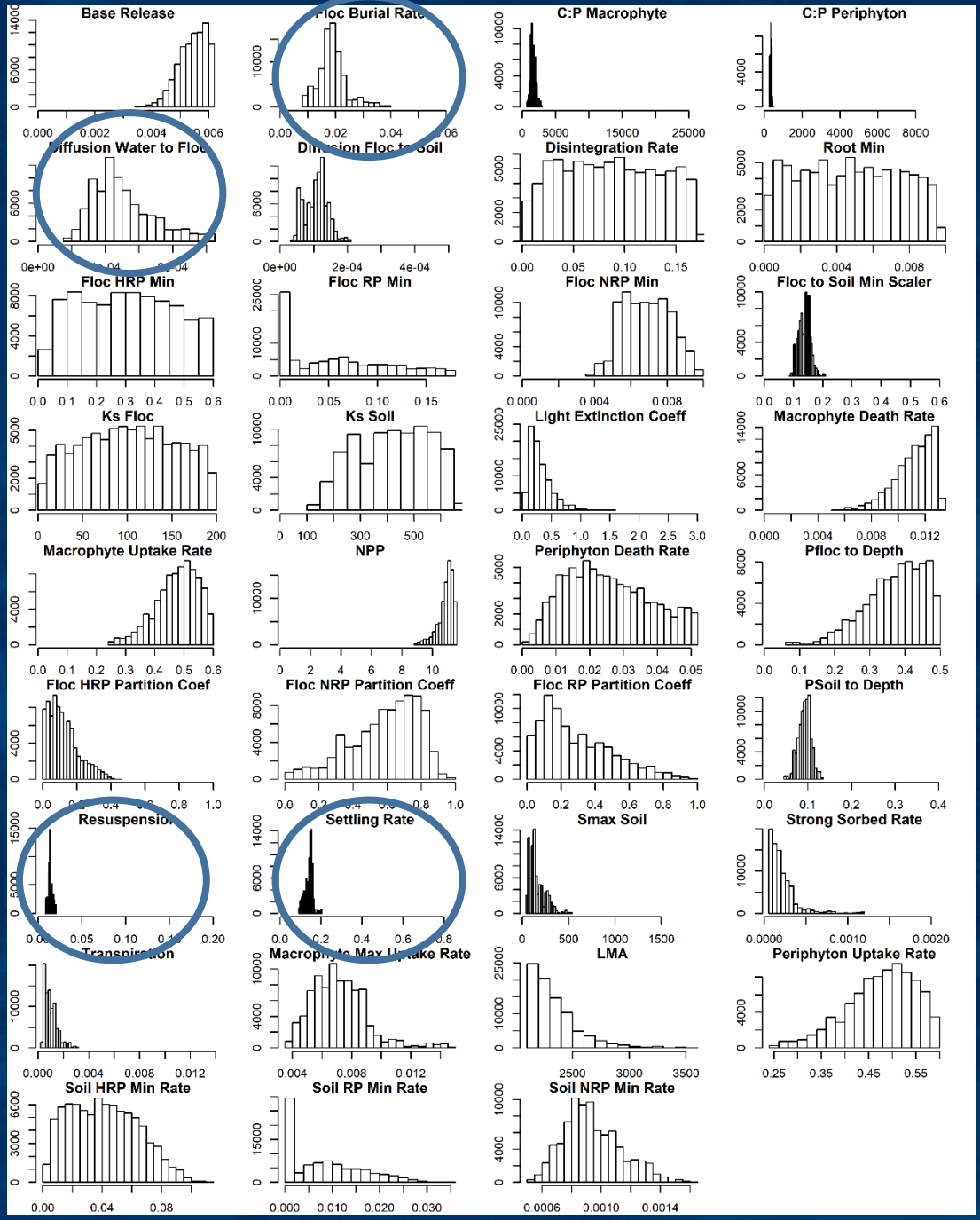


Sensitivity Analysis





Parameter distribution



Fluxes [g m^{-2} yr^{-1}] and their uncertainty

		PW	PF	PS	Macro	Peri	Litter	HRF	RF	NRF	HRS	RS	NRS
Dissolved	PW	5.15 (0.15)	2.83 (0.18)					0.38 (0.05)	0.83 (0.07)	0.13 (0.01)			
	PF	0.019 (0.02)	6.88 (0.42)	1.66 (0.44)				2.79 (0.13)	2.30 (0.18)	0.27 (0.04)			
	PS		3.36 (0.43)	4.61 (0.45)			0.40 (0.13)				0.36 (0.04)	0.76 (0.06)	0.16 (0.02)
	Macr	0.52 (0.05)	0.69 (0.12)	2.89 (0.28)	4.04 (0.16)								
	Peri	0.065 (0.03)				0.066 (0.032)							
	Litter				4.04 (0.16)		4.02 (0.18)						
Floc	HRF	1.93 (0.10)				0.029 (0.014)	1.60 (0.12)	3.54 (0.20)					
	RF	2.16 (0.14)				0.032 (0.016)	1.79 (0.14)		3.94 (0.26)				
	NRF	0.28 (0.03)				0.0042 (0.002)	0.23 (0.03)			0.52 (0.05)			
Soil	HRS							0.37 (0.04)			0.36 (0.04)		
	RS								0.81 (0.06)			0.76 (0.06)	
	NRS			0.061 (0.012)						0.12 (0.01)			0.16 (0.02)

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Conclusion

- Using a numerical version of a conceptual model allows assimilation of different (yet connected) data streams
- Observed state variables (P in vegetation, floc and soil) along the flowpath, as well as P outflow concentration, allow to establish linkages to individual P processing rates
- The data – at a first pass – allows to reasonably constrain key processes
- The model, however, represent hypotheses of how we think biogeochemistry works

Thank you

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