Flow impacts on P and OM Cycling in the Ridge and Slough:

Lessons from landscape budgets in the Decomp Physical Model and Shark Slough, ENP

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Greater Everglades Ecosystem Restoration

Coral Springs, FL. April, 2017

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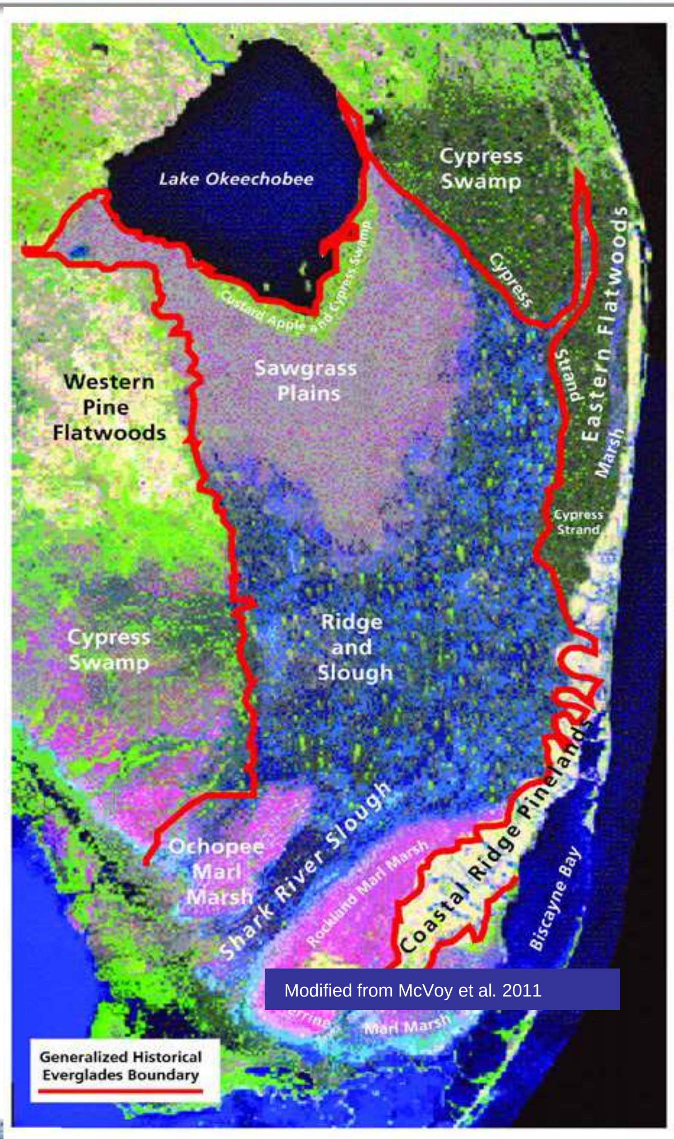
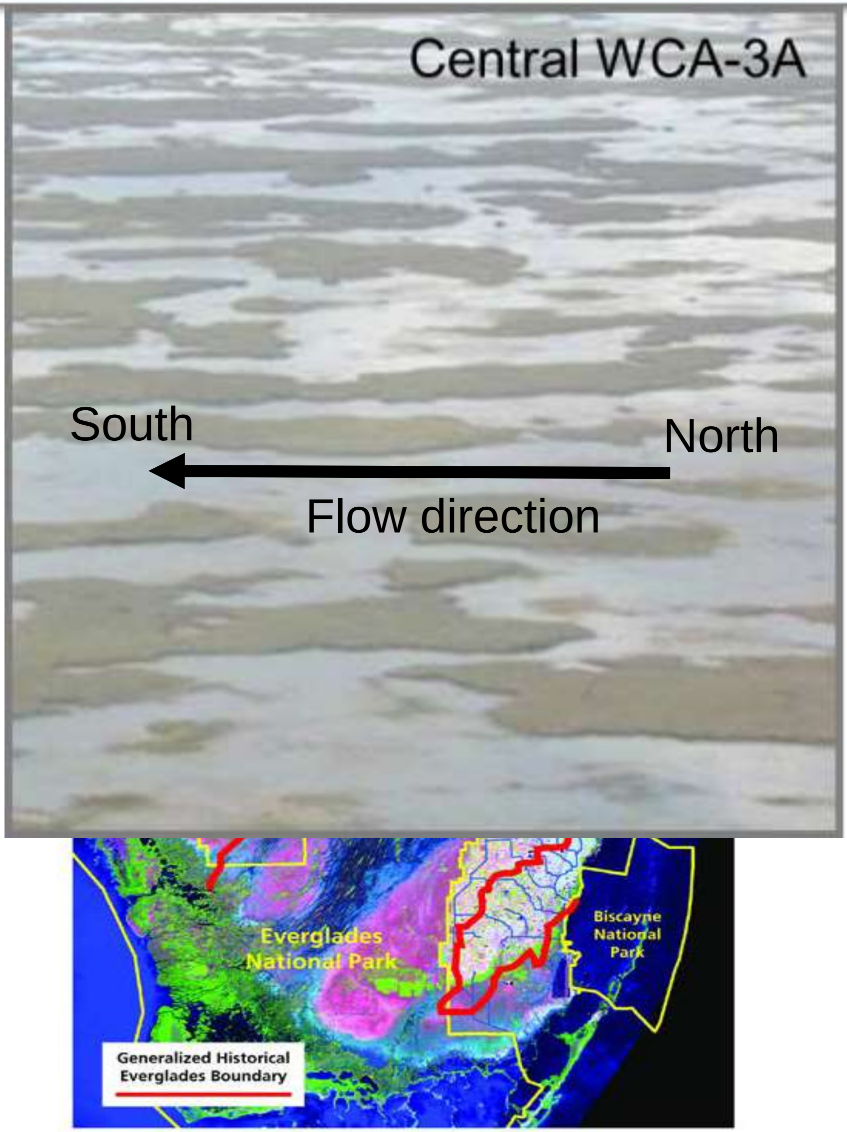
Outline

1. Introduction and DPM findings
2. Objectives
3. Approach: Phosphorus Mass Balance
4. Results
5. Summary and Next Steps

Restoring Connectivity to the Everglades Landscape



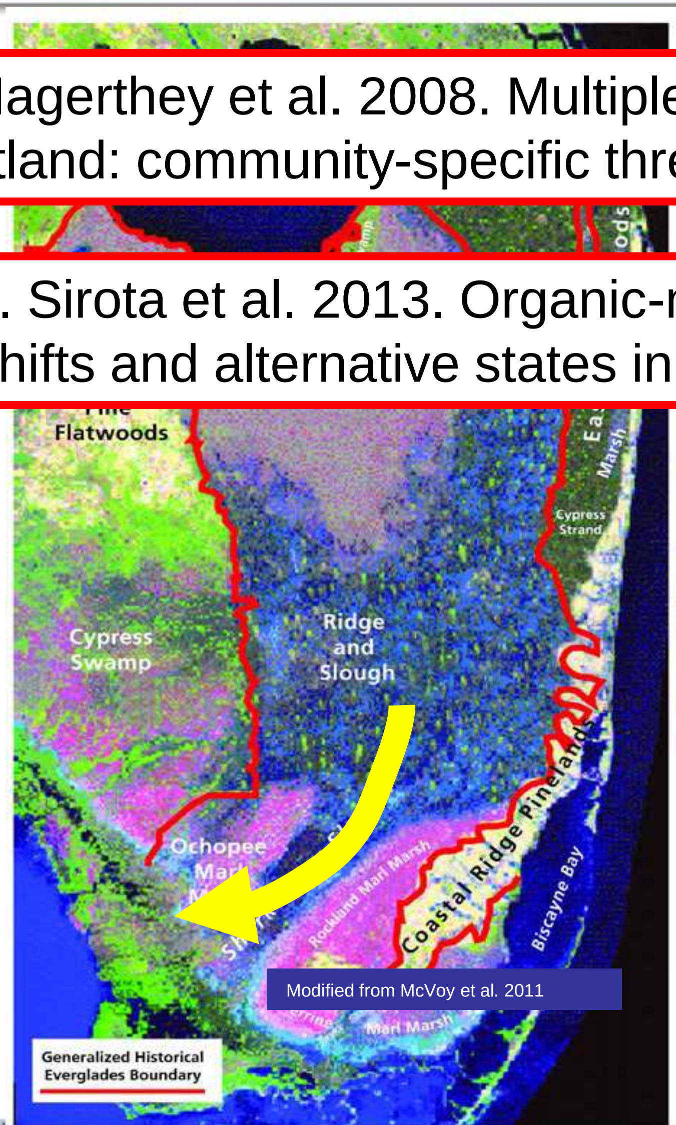
Modified from McVoy et al. 2011



Restoring Connectivity to the Everglades Landscape

S. Hagerthey et al. 2008. Multiple regime shifts in a subtropical peatland: community-specific thresholds to eutrophication. *Ecol Mon*

J. Sirota et al. 2013. Organic-matter loading determines regime shifts and alternative states in an aquatic ecosystem. *PNAS*



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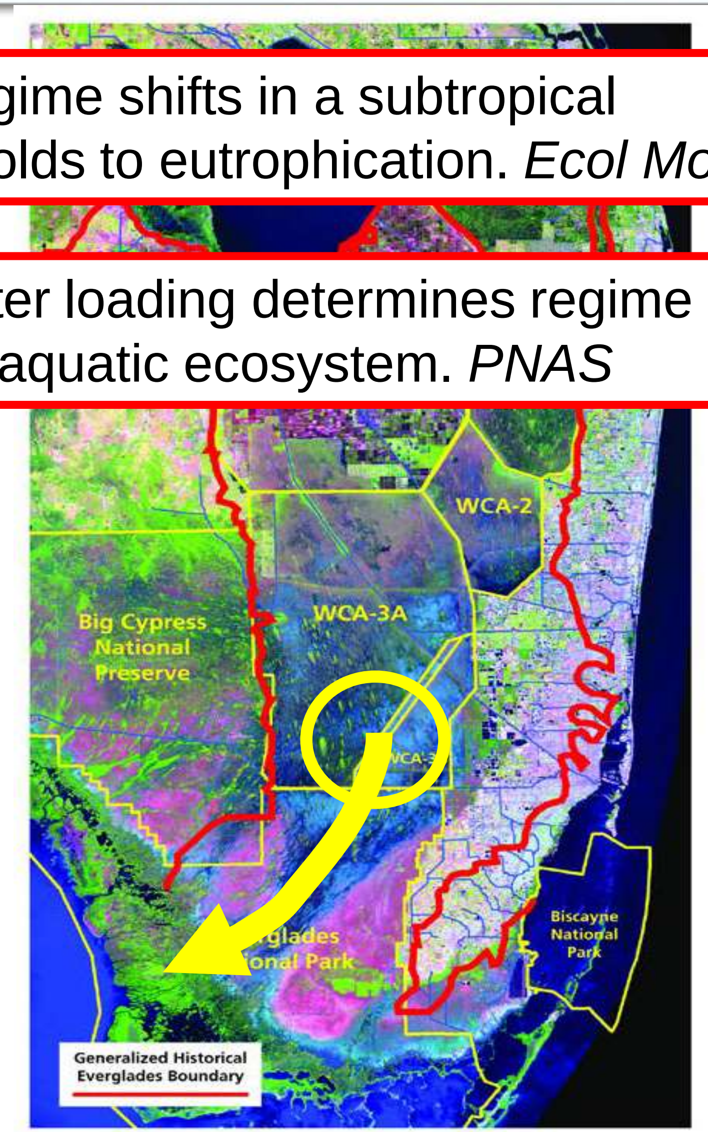
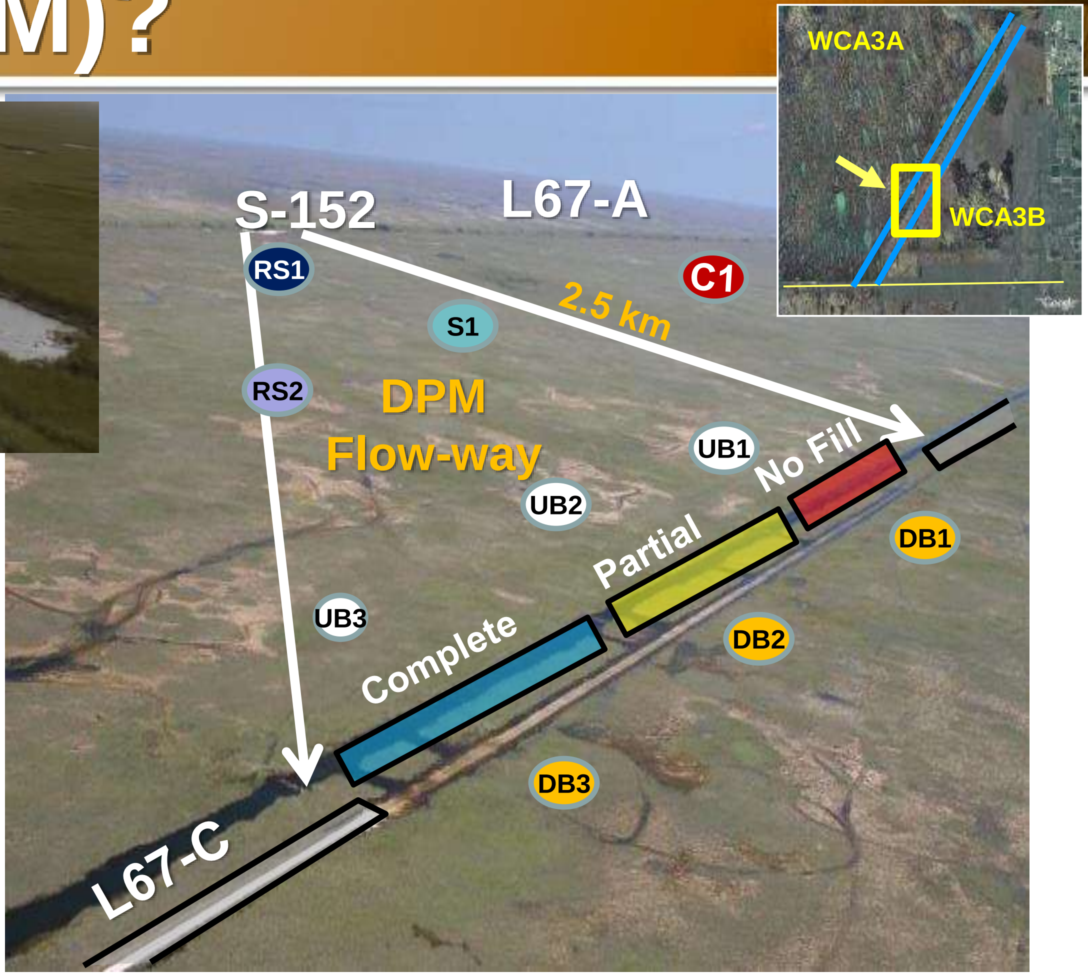
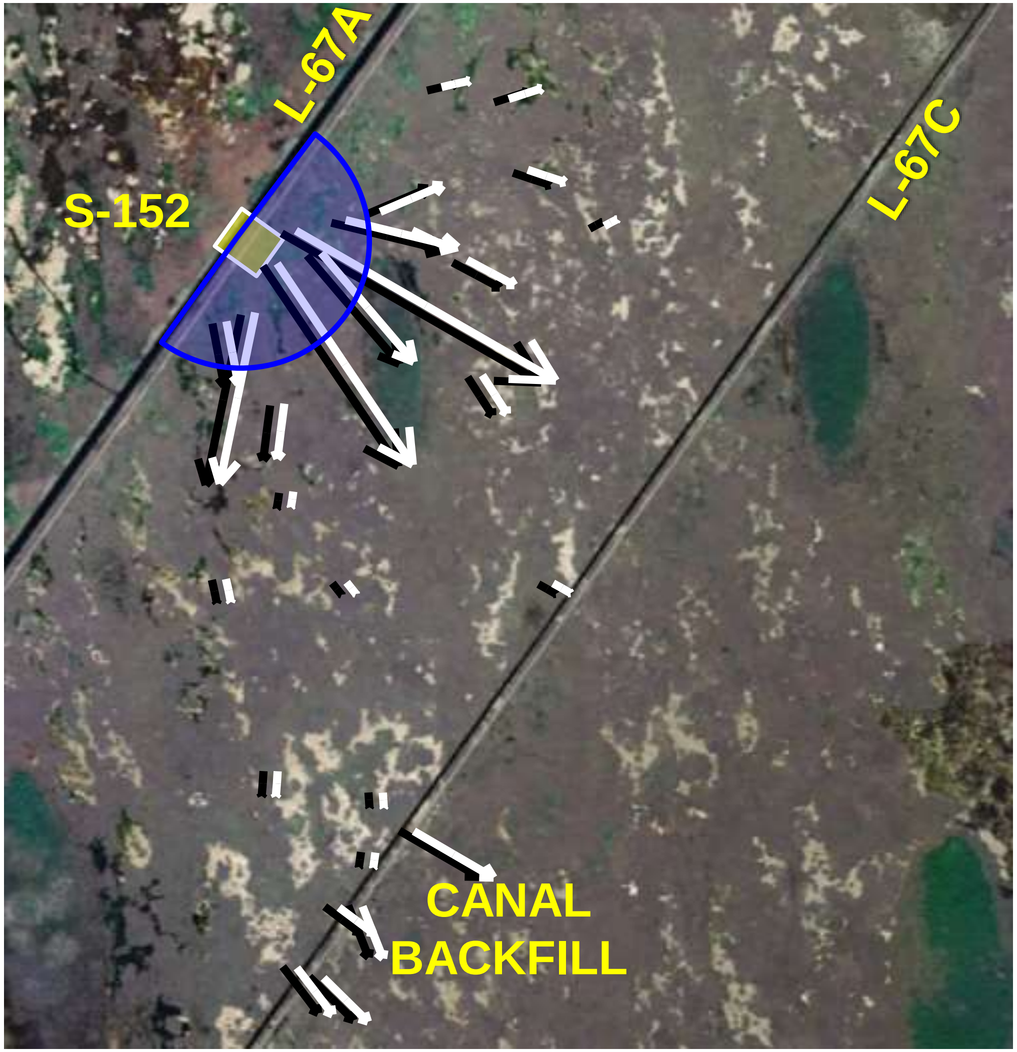


What is the Decomp Physical Model (DPM)?



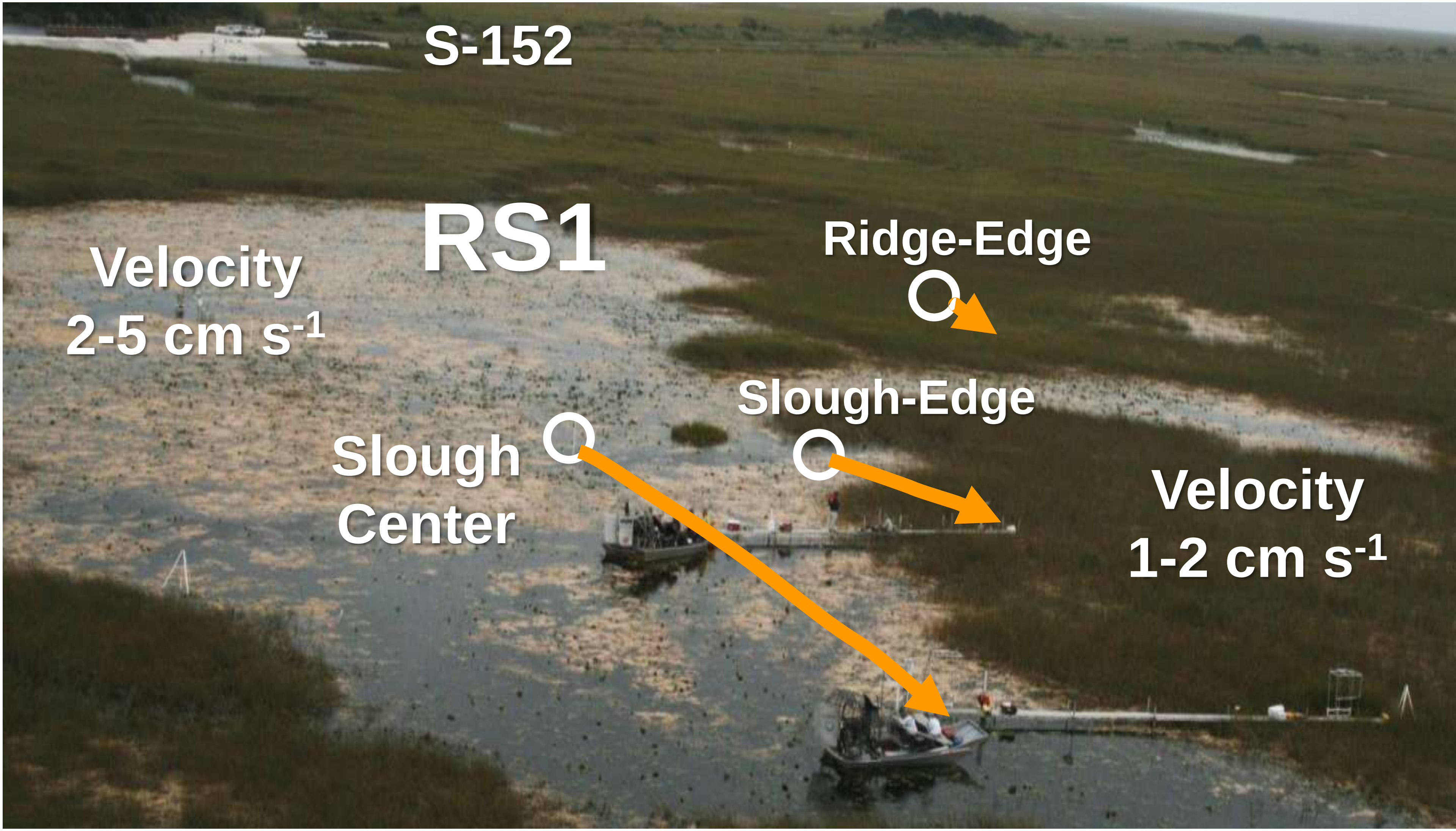
- <u>Uncertainty 1</u>: Do high velocities (>2 cm/s) generate sediment movement needed to restore the ridge and slough topography?
- <u>Uncertainty 2</u>: To what extent does sheetflow alter P and OM cycling and ultimately foodwebs

DPM Hydrologic Flow Fields



- Flows did not follow the ecologically preferred (north-south) pattern
- Velocities ranged from 0.5 - 10 cm s^{-1}
- High flows (2-5 cm s^{-1}) were limited to ~500-m

Tracking particle movement: slough to ridge

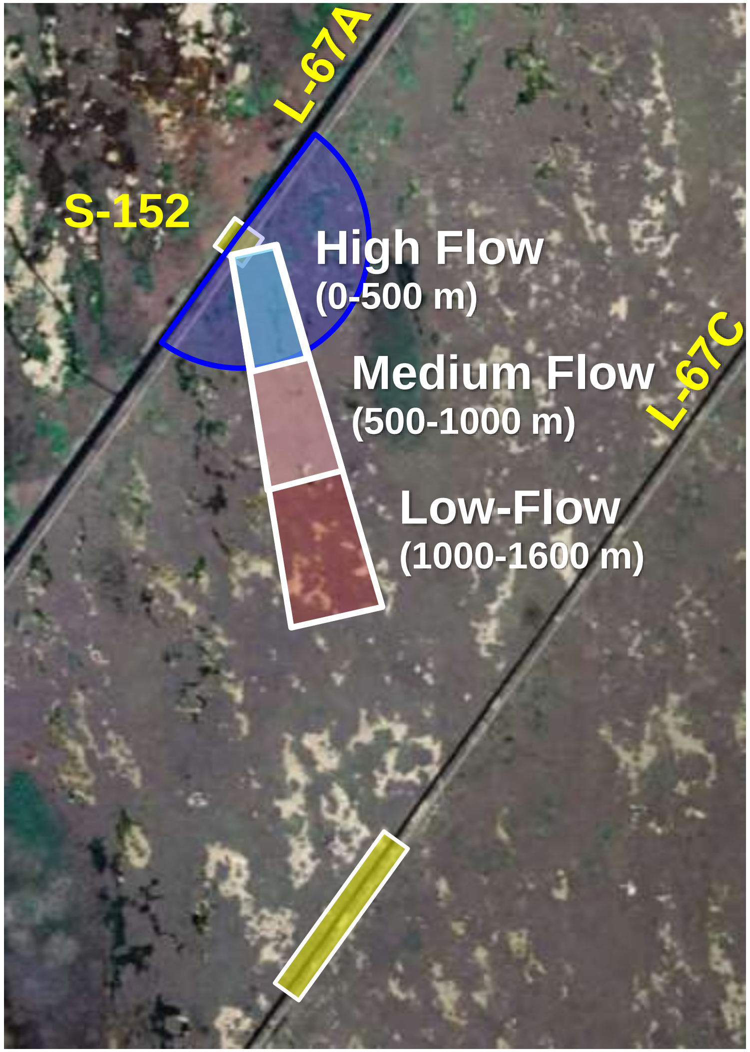


Flow alters slough structure

Other flow observations

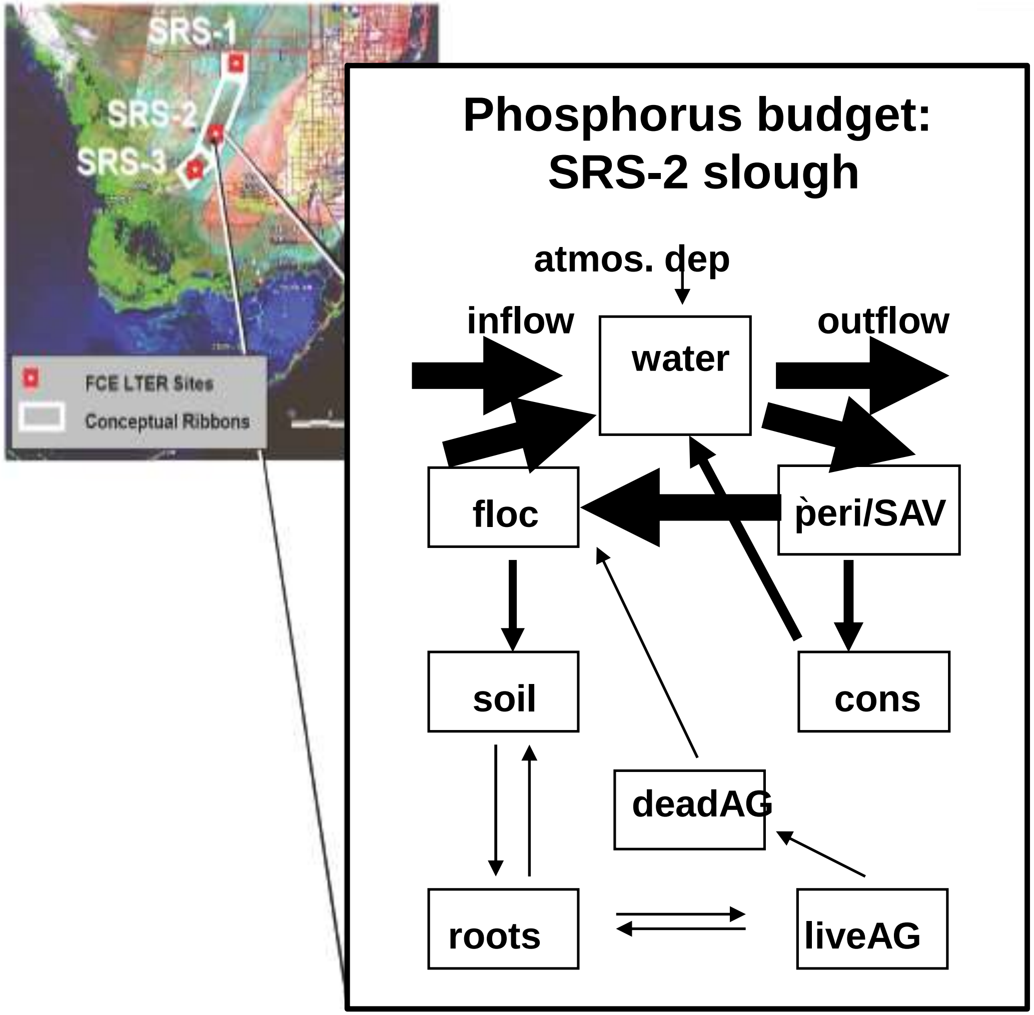
- Velocity, sediment transport increase with flow duration
  - Sediment traps, Flowtracker ADVs (C. Saunders)
- Aquatic primary production & respiration reduced
  - Metabolism studies (Tate-Boldt et al., GEER)
- Floc more erodible, more labile(?) with flow
  - Benthic flume (S. Newman, M. Manna)
  - Molecular biomarkers (R. Jaffe', P. Regier)
  - Algal taxonomy (B. Rosen)

2. Objectives for DPM data synthesis: Phosphorus mass balance model



- Which flow-mediated mechanisms are needed to explain observed changes in ecosystem P stocks (mainly water TP and floc P)?
- Using a "linked" mass balance, to what extent does flow impact P cycling beyond 500-m? How fast do changes migrate downstream?

3. Approach – P budgets of Landscape "Ribbons"



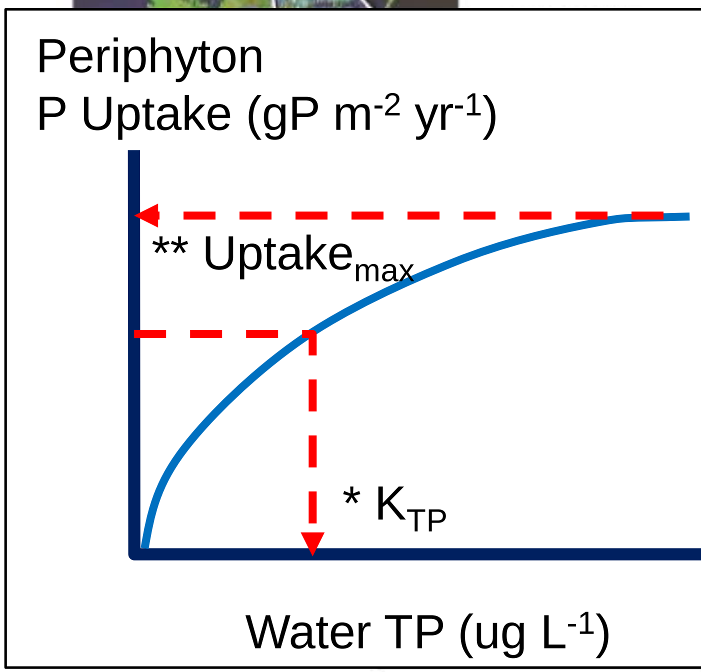
Noe & Childers (2007) summarized P stocks, fluxes for ridge & slough habitats, Everglades-wide

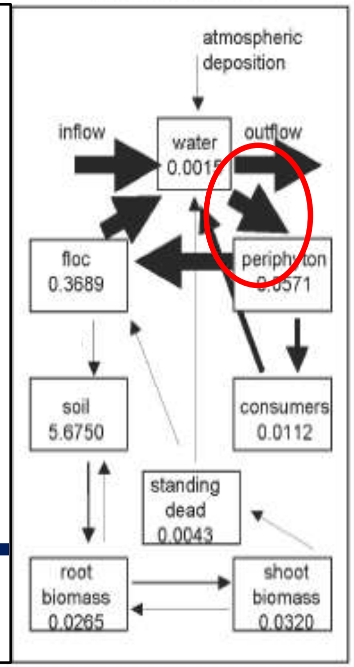
FCE LTER data to generate ridge, slough budgets for conceptual landscape "ribbons" in ENP: near-canal, interior, coastal ecotone

Highlights most important fluxes, discrepancies among data, data gaps, & uncertainties

3. Approach – P budgets of Landscape “Ribbons”

Phosphorus budget: SRS-2 slough





** Noe et al., 2002 & FCE LTER data

* Hwang et al., 1998

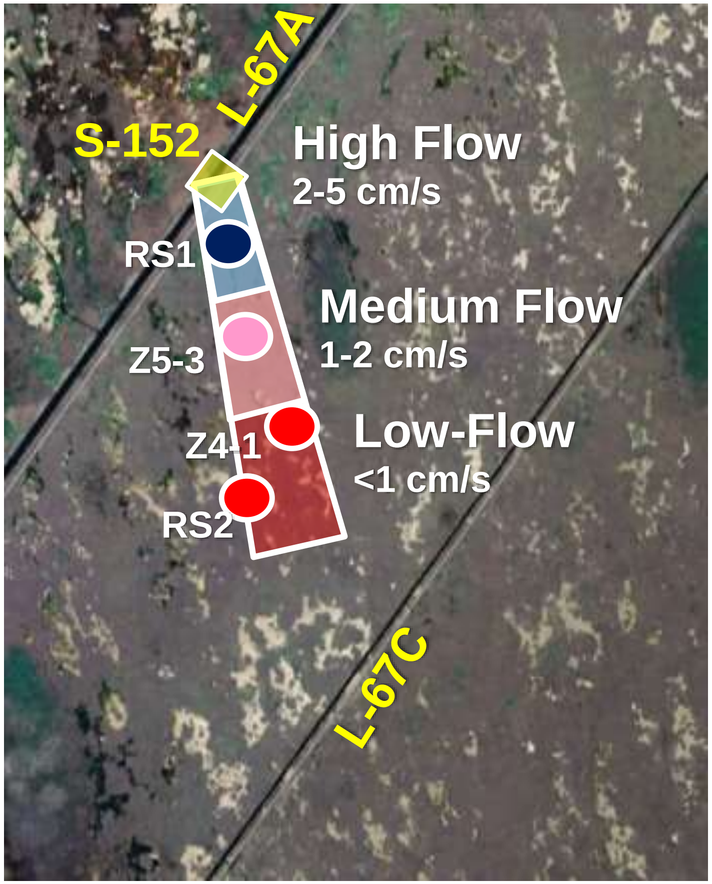
Noe & Childers (2007) summarized P stocks, fluxes for ridge & slough habitats, Everglades-wide

FCE LTER data to generate ridge, slough budgets for conceptual landscape “ribbons” in ENP: near-canal, interior, coastal ecotone

Highlights most important fluxes, discrepancies among data, data gaps, & uncertainties

Dynamic budget models in STELLA to compare observed & predicted time series of P stocks & fluxes

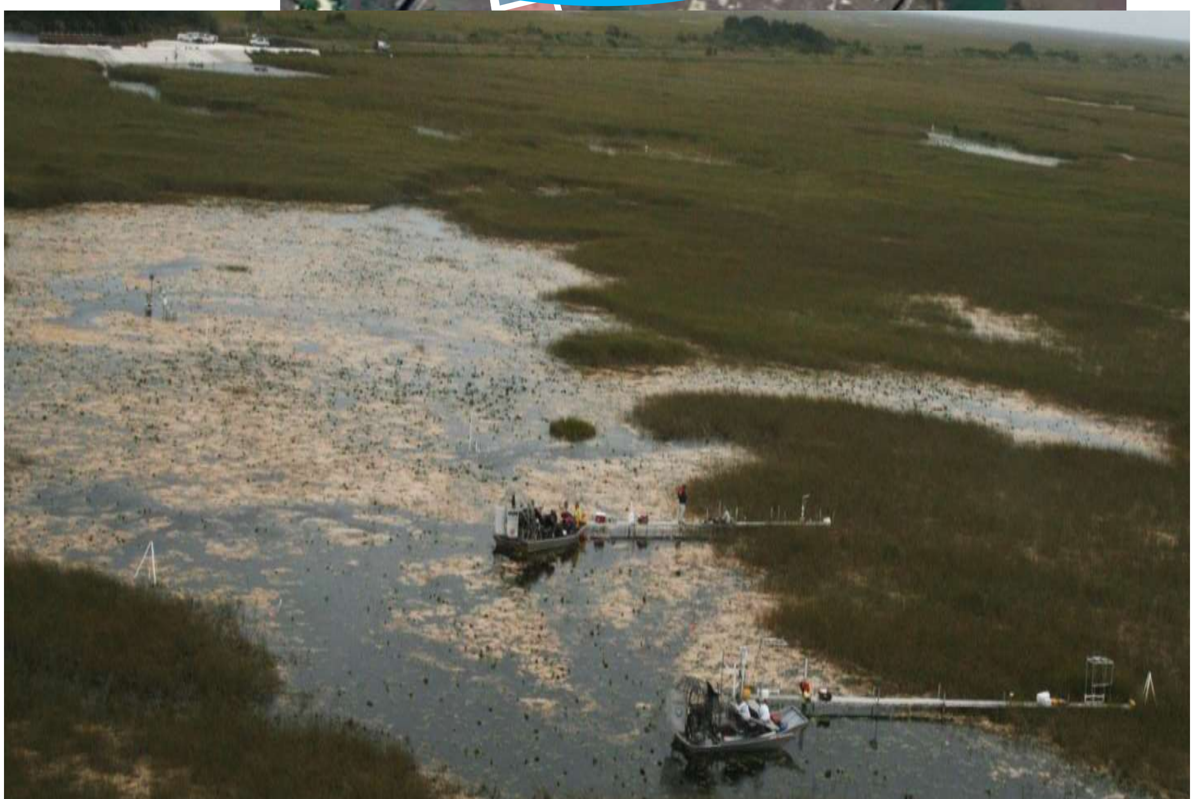
Application to DPM landscape

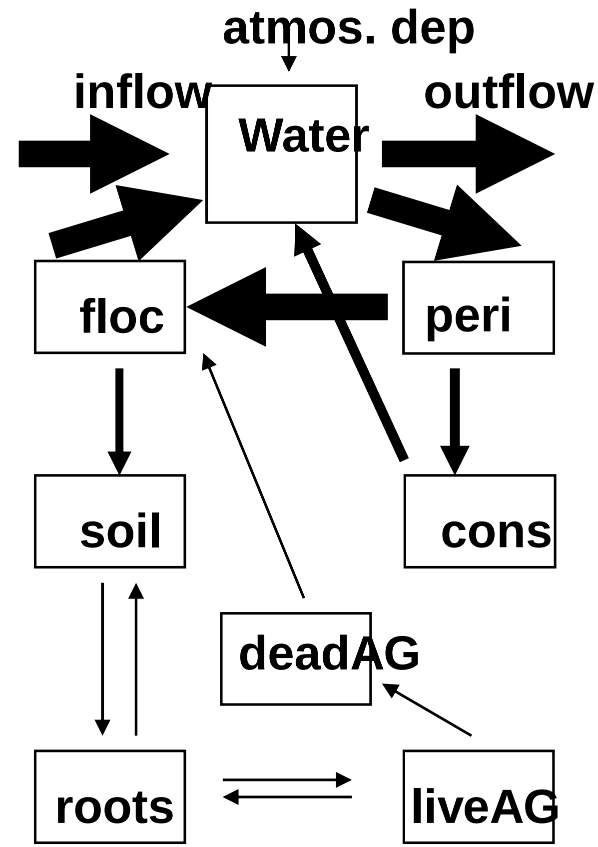


- **Slough habitats in three 500-m landscape ribbons**
  - **High-, Medium-, Low-Flow**
- **Simulation period 2012–2016**
  - **2 Baseline Years**
  - **3 Flow Events**
- **Drivers:**
  - **Daily water depth & velocity**
  - **Upstream TP (S152 inflow TP)**
- **Observed vs predicted time series**
  - **Periphyton P (g P m^{-2})**
  - **Floc P (g P m^{-2})**
  - **Water TP, TPP (ug/L)**
  - **Sediment transport (g cm^{-2} FA d^{-1})**

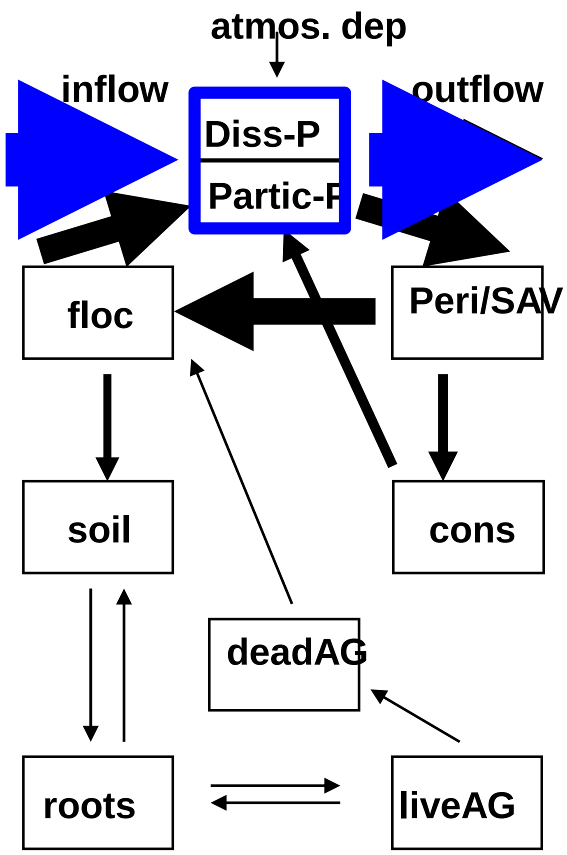
Application to the DPM study

High Flow Slough





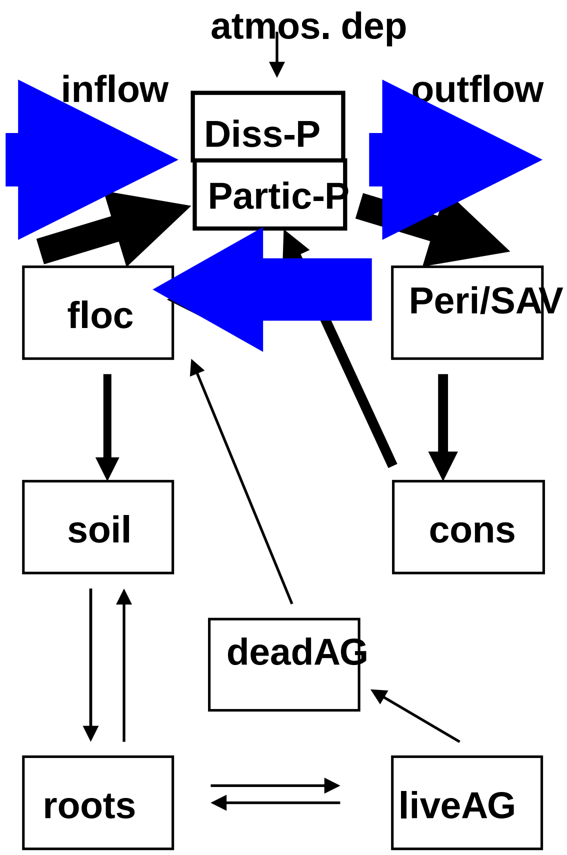
Application – High Flow Conditions



Application – High Flow Conditions

Flow-mediated Mechanisms

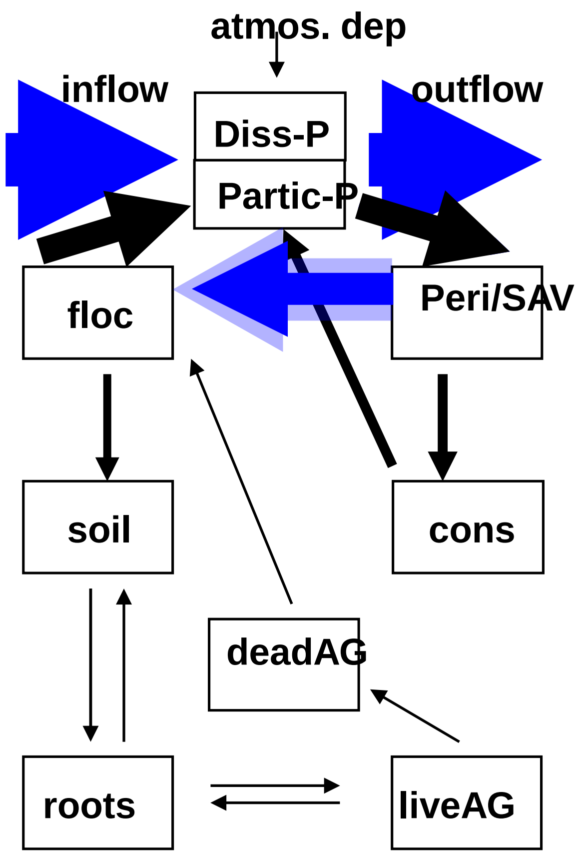
- Peri/SAV sinking



Application – High Flow Conditions

Flow-mediated Mechanisms

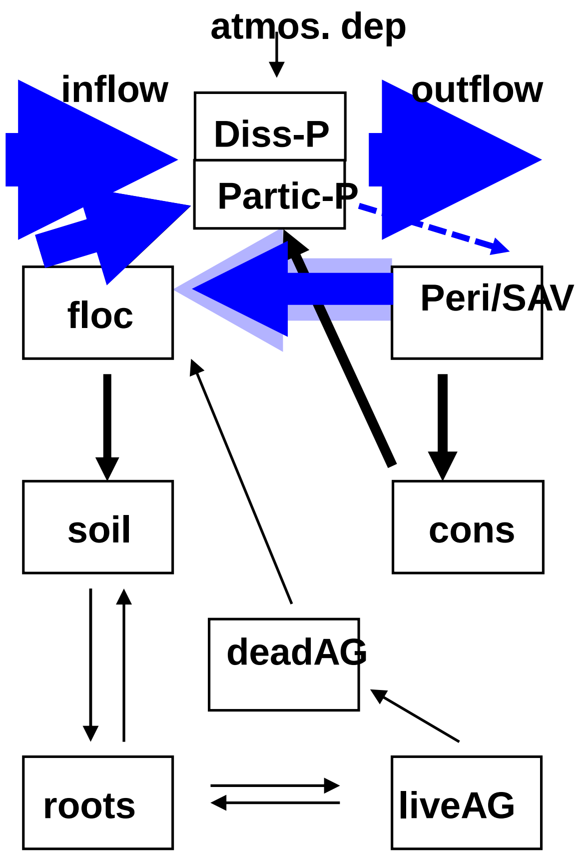
- **Peri/SAV sinking**
- **Peri/SAV stays low (-uptake, +turnover)**



Application – High Flow Conditions

Flow-mediated Mechanisms

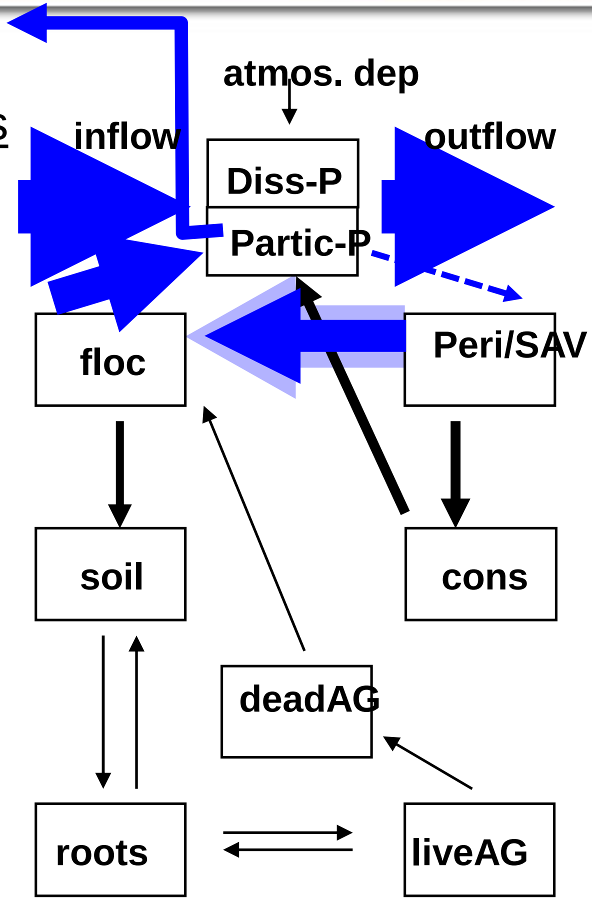
- **Peri/SAV sinking**
- **Peri/SAV stays low (-uptake, +turnover)**
- **Floc more erodible (+turnover)**



Application – High Flow Conditions

Flow-mediated Mechanisms

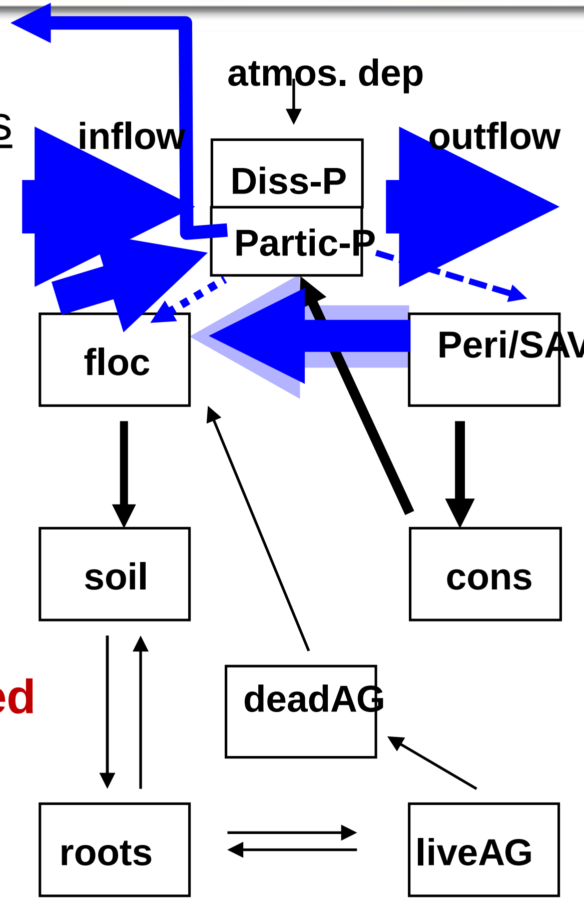
- **Peri/SAV sinking**
- **Peri/SAV stays low (-uptake, +turnover)**
- **Floc more erodible (+turnover)**
- **Partic-P into ridge**



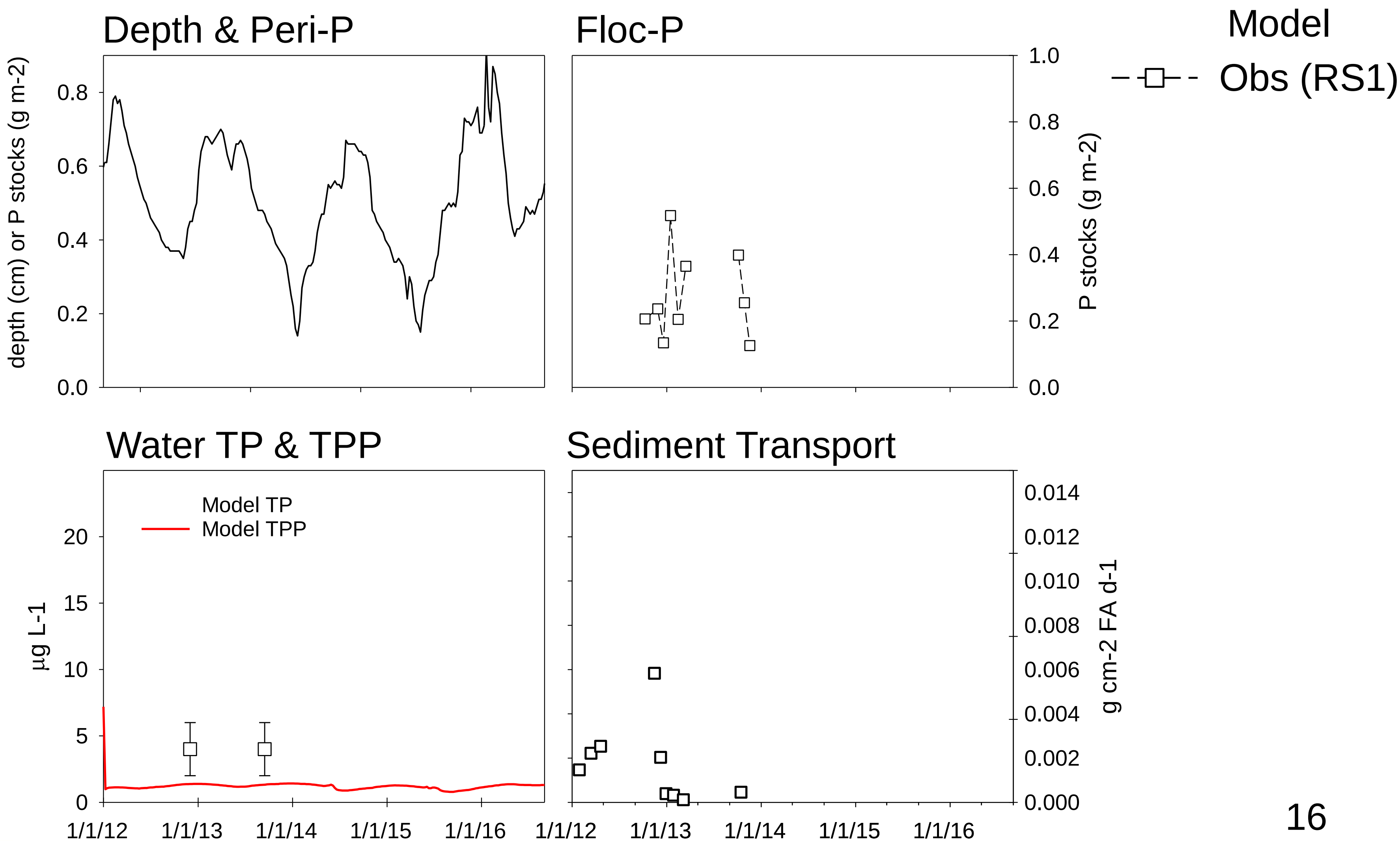
Application – High Flow Conditions

<u>Flow-mediated Mechanisms</u>

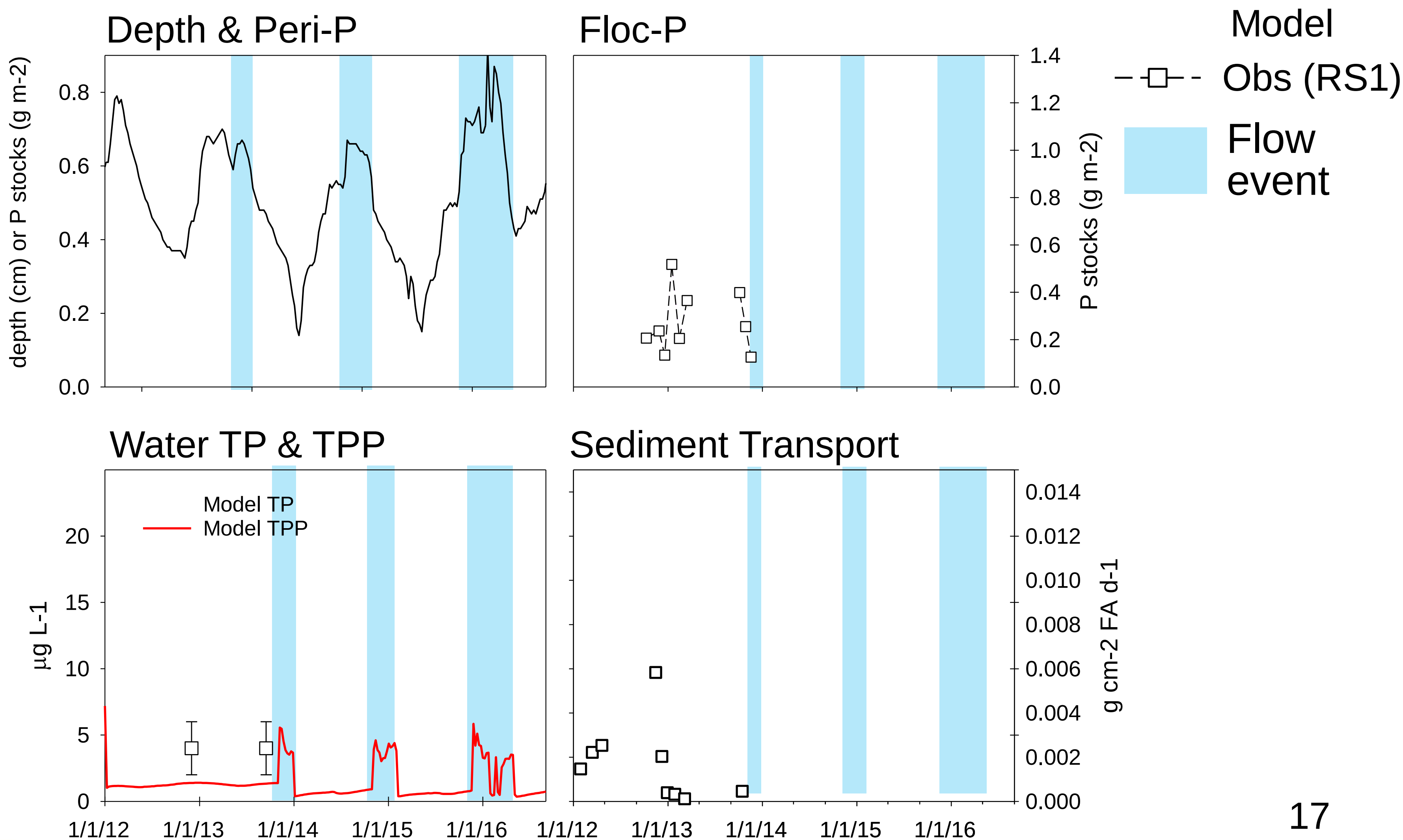
- **Peri/SAV sinking**
- **Peri/SAV stays low (-uptake, +turnover)**
- **Floc more erodible (+turnover)**
- **Partic-P into ridge**
- **Partic-P settling reduced**



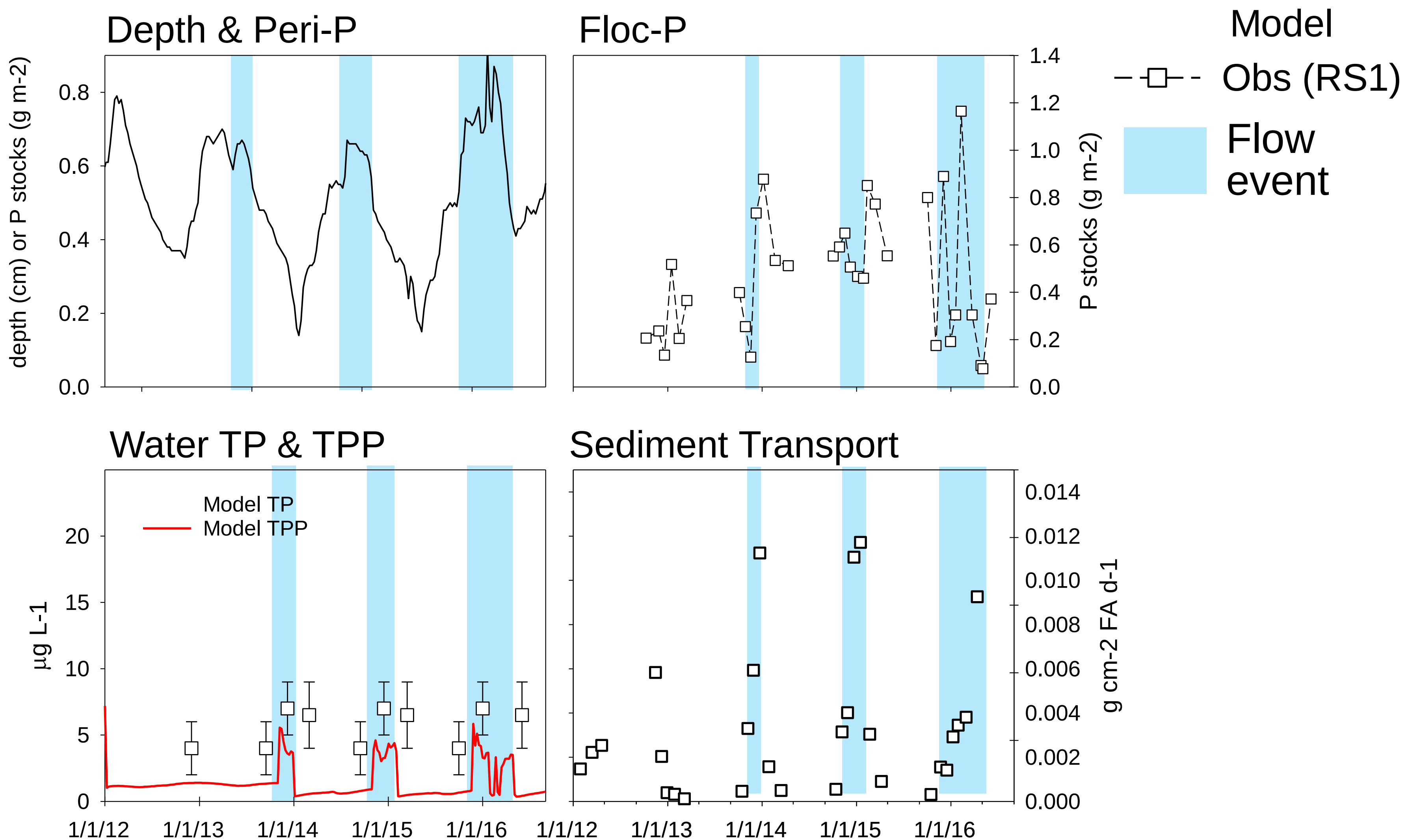
4. Results – Baseline (no-flow)



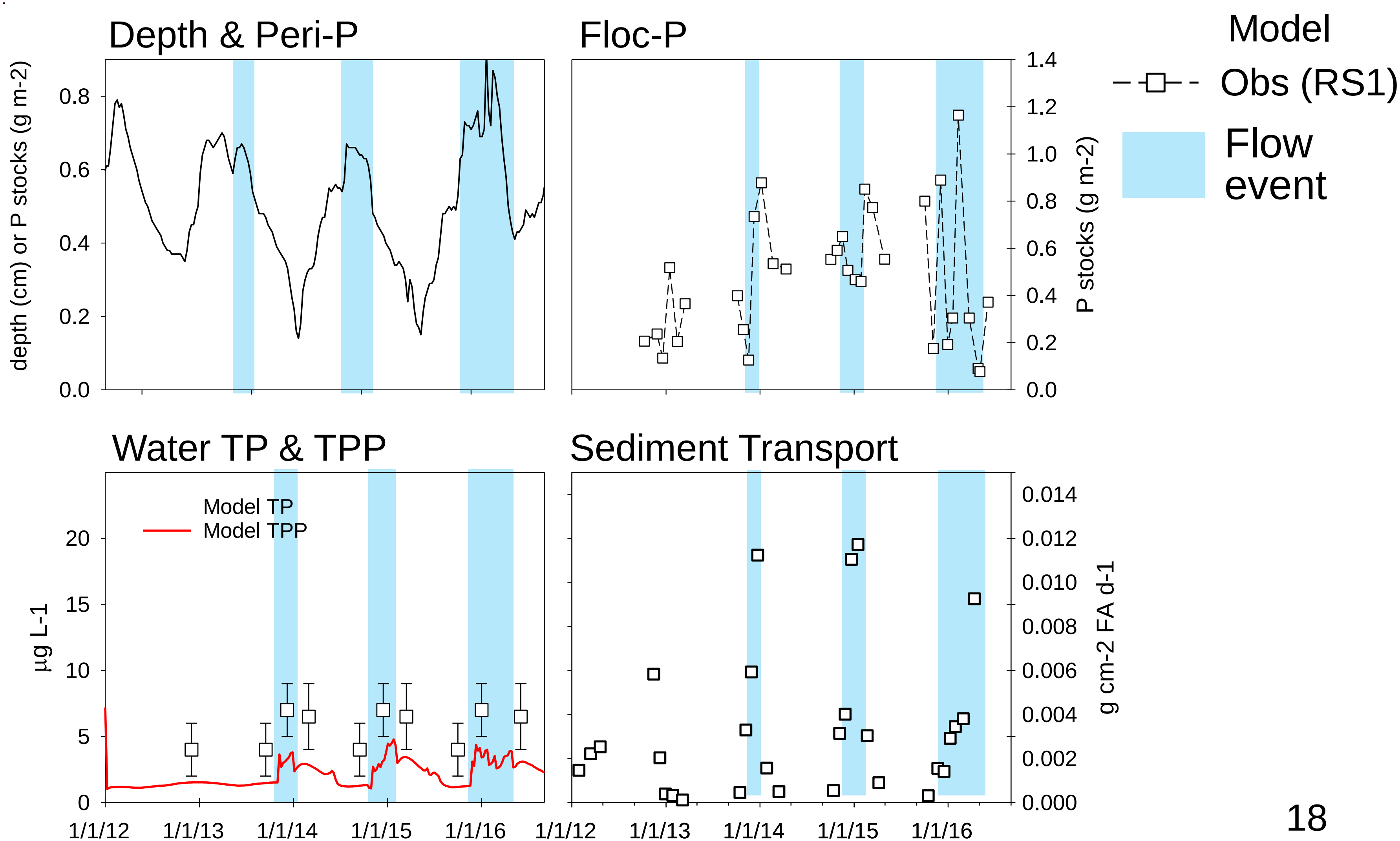
4. Results – All Flow Mechanisms (what we expected to see)



4. Results – All Flow Mechanisms



4. Results – "Fitted" Model



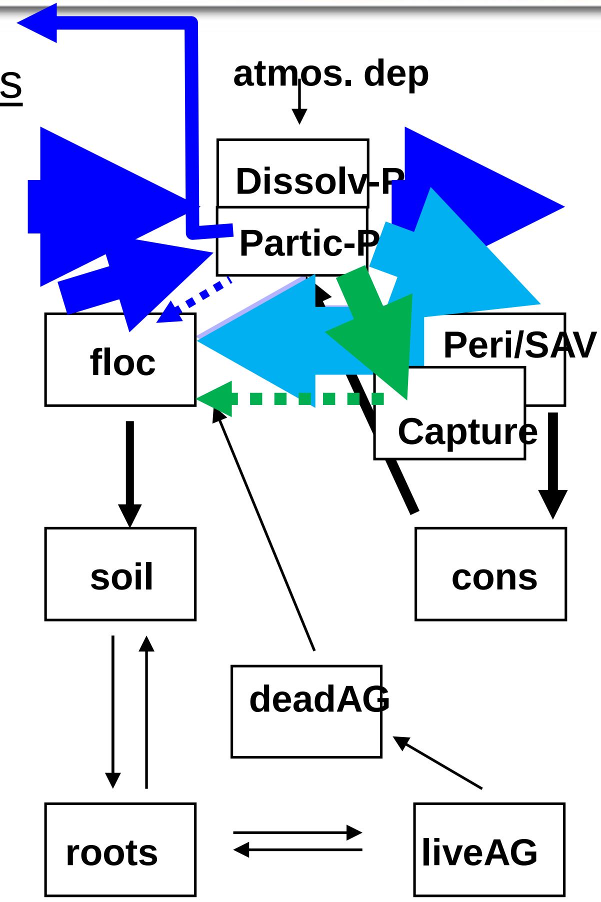
4. Results – What mechanisms are needed to fit to the data?

++*<u>uptake</u>*, ++turnover

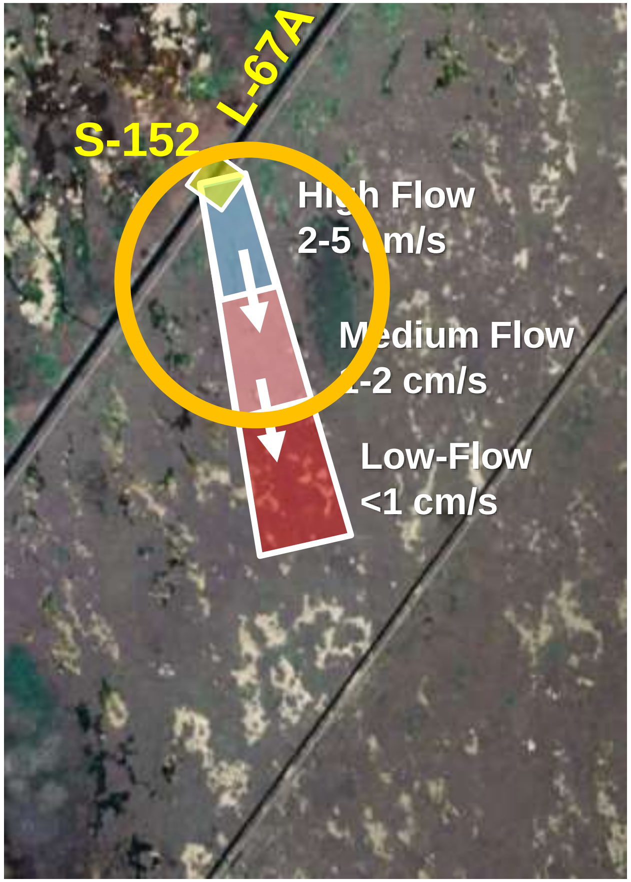
Post-flow: uptake, turnover remain high

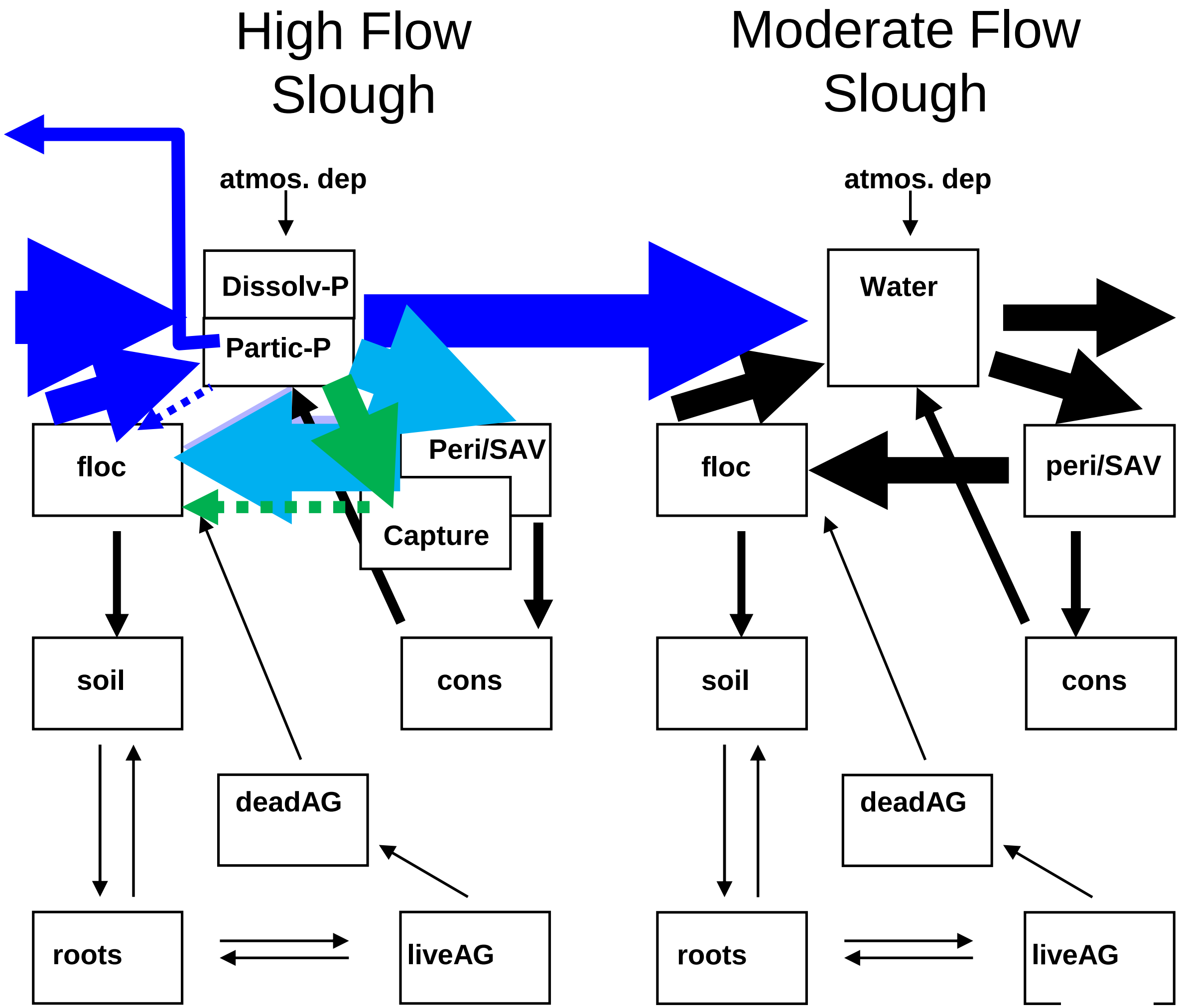
<u>Flow-mediated Mechanisms</u>

- ✓ **Peri/SAV collapses**
- ✓ **Peri/SAV reduced** ~~**(-uptake, +turnover)**~~
- ✓ **Floc more erodible, potentially more labile**
- ✓ **Partic-P into ridge**
- ✓ **Partic-P Settling reduced**
- ✓ **Partic-P capture (veg)**



Objective 2 – Linked P Budgets





Summary and Next Steps

- Mass balance provides a “common currency” to integrate physical and biological responses to flow
- Although flow “clears out” sloughs, floc-P stocks doubled
- ** ***Preliminary*** ** model suggests 2-20x increase in periphyton uptake and turnover (including post-flow)
- ***contrary*** to aquatic metabolism modeing (Tate-Boldt et al.) and periphyton incubations (Newman et al.)
- ***consistent*** with increases in periphyton TP on periphytometers, including post-flow effects (Newman et al.)
- synthesis with other DPM data still in progress…

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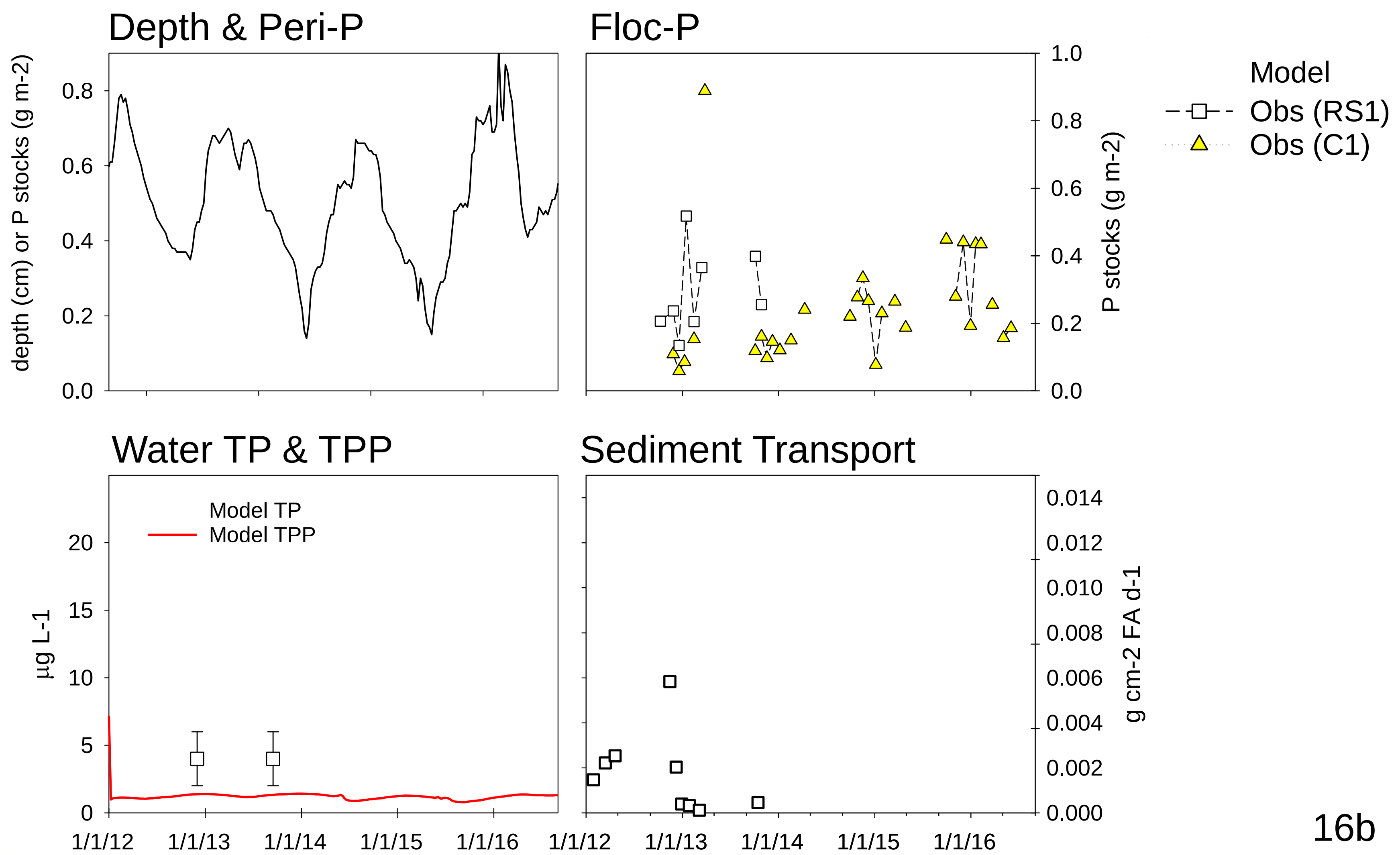
4. Results – Baseline (no-flow)



“Linked” Moderate Flow – Floc P