

# Measurements and Modelling of Vegetation Effects on Flow in Ridge and Slough Landscape



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**Supported by:**

Everglades National Park

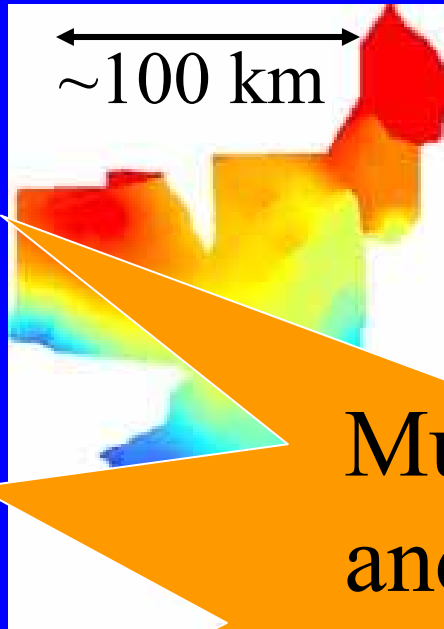
The Critical Ecosystem Studies Initiative Program  
(CESI)



**Special Thanks To:**

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Dan Childers

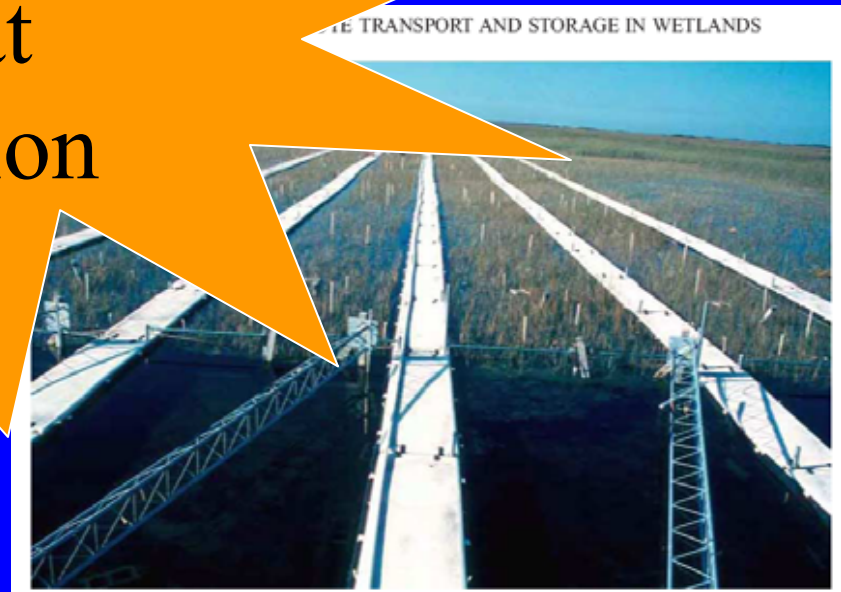
# Existing Hydrodynamic Measurements



Entire Everglades at  
 $O(\text{km})$  resolution

Multiples ridges  
and sloughs at  
 $O(\text{m})$  resolution

100 m flume at  
 $O(10 \text{ cm})$  resolution



# Key Question = Hydrodynamics

Advection, Dispersion, Drag, and  
Gradients across landscape



# Methods

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Evan Variano



# Methods

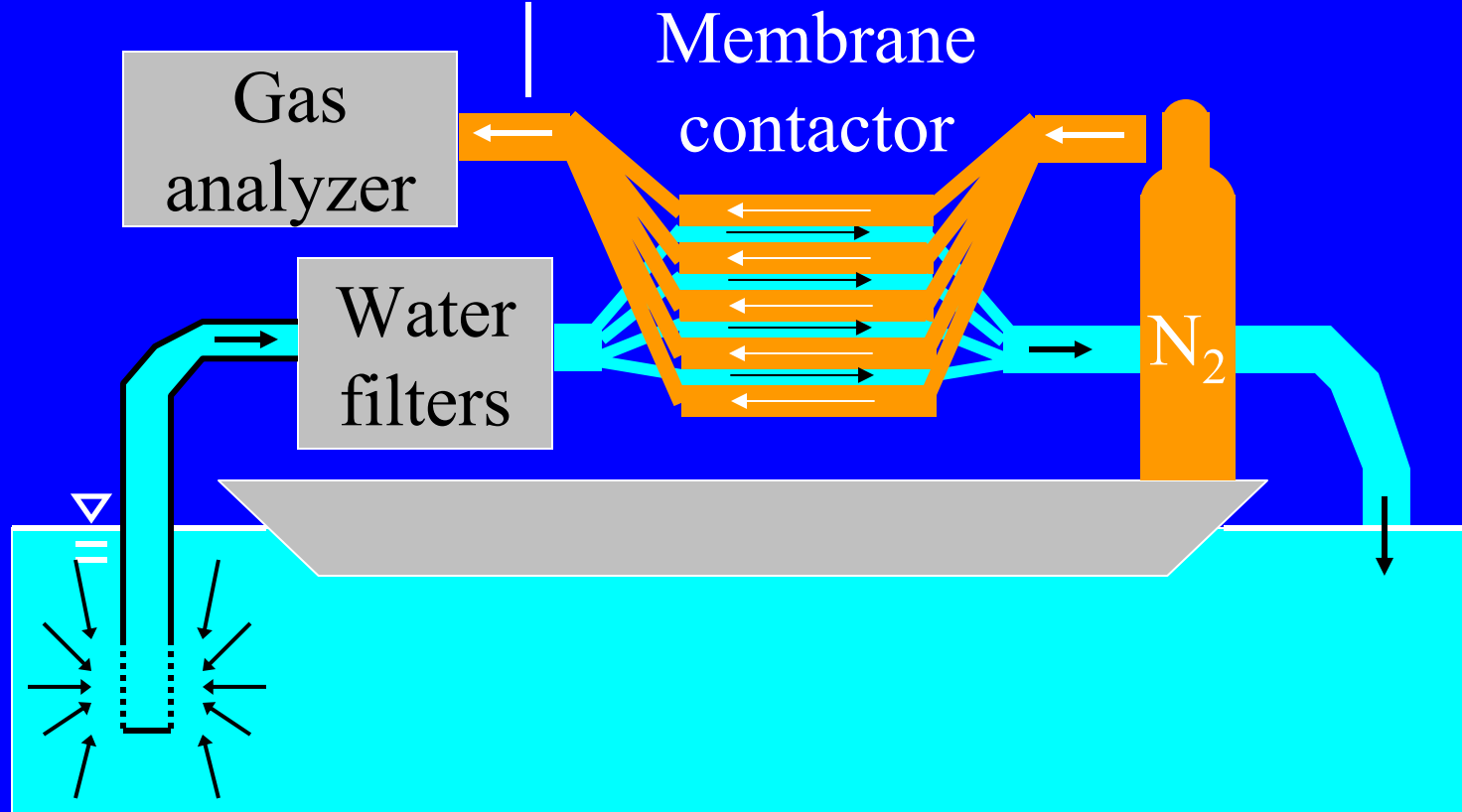


Extract dissolved gases from water

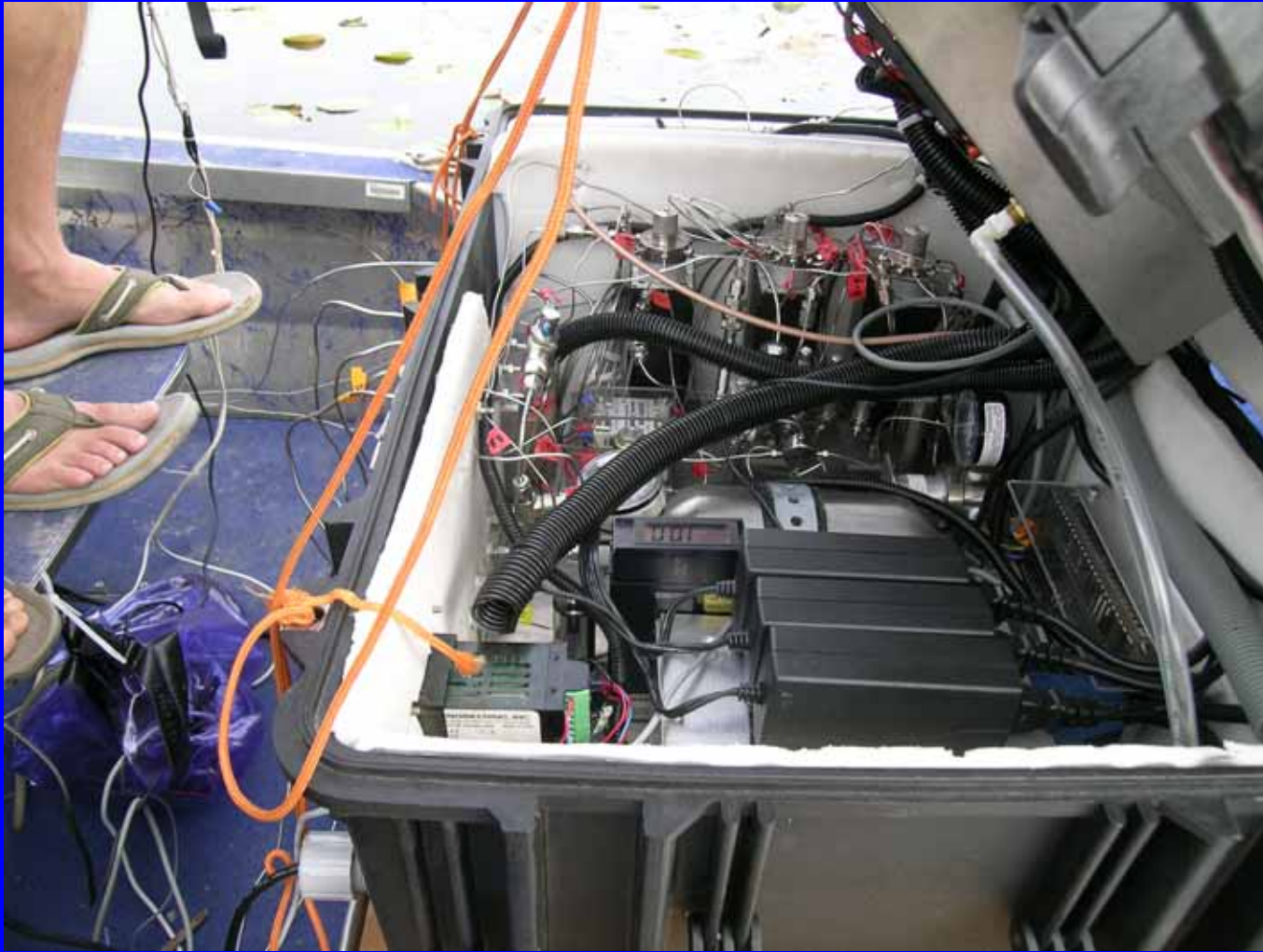
# Methods

Extract dissolved gases from water

$N_2, O_2, CO_2, H_2O(v), SF_6$



# Methods

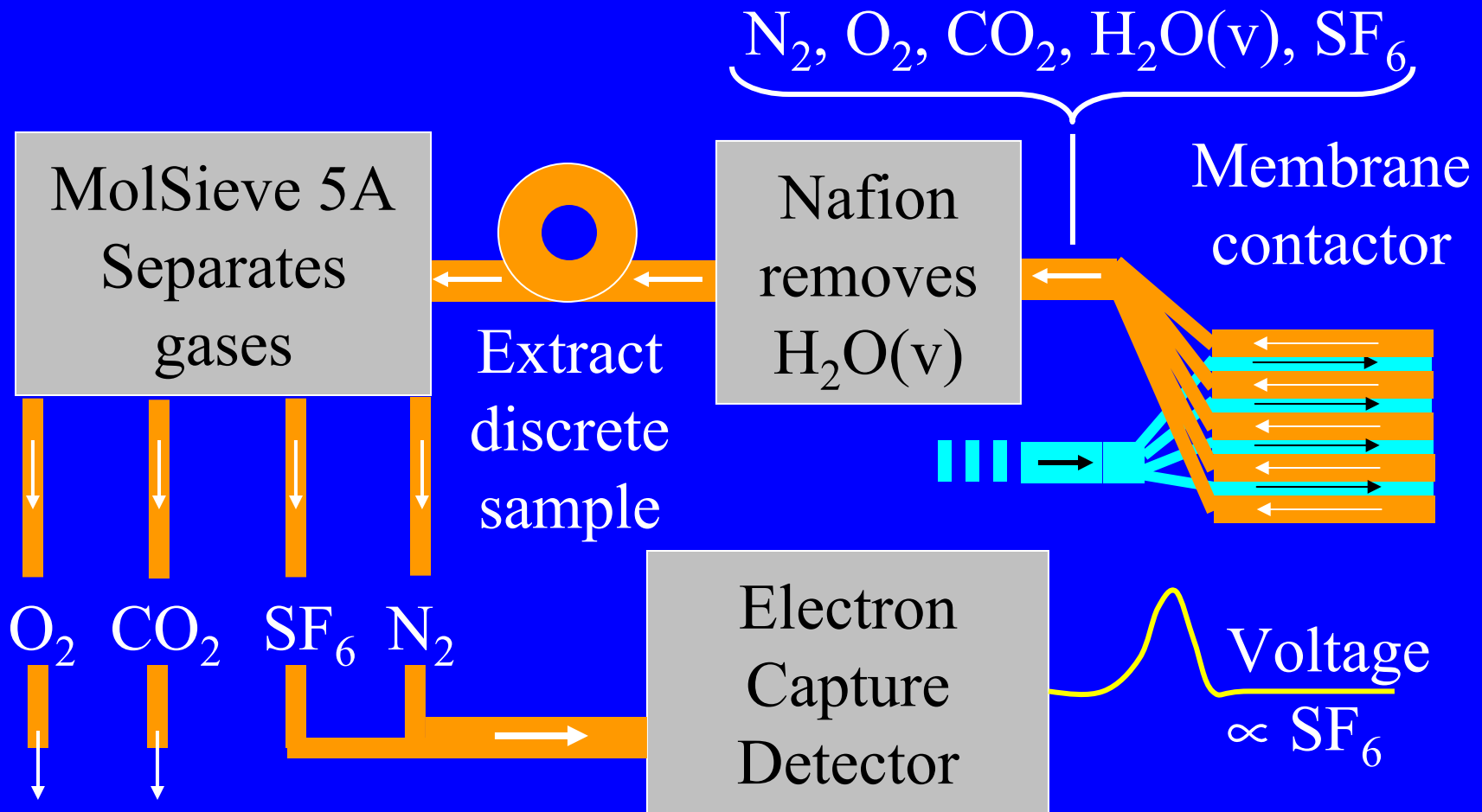


Measure concentration of  $\text{SF}_6$  in gas sample



# Methods

## Measure concentration of SF<sub>6</sub> in gas sample

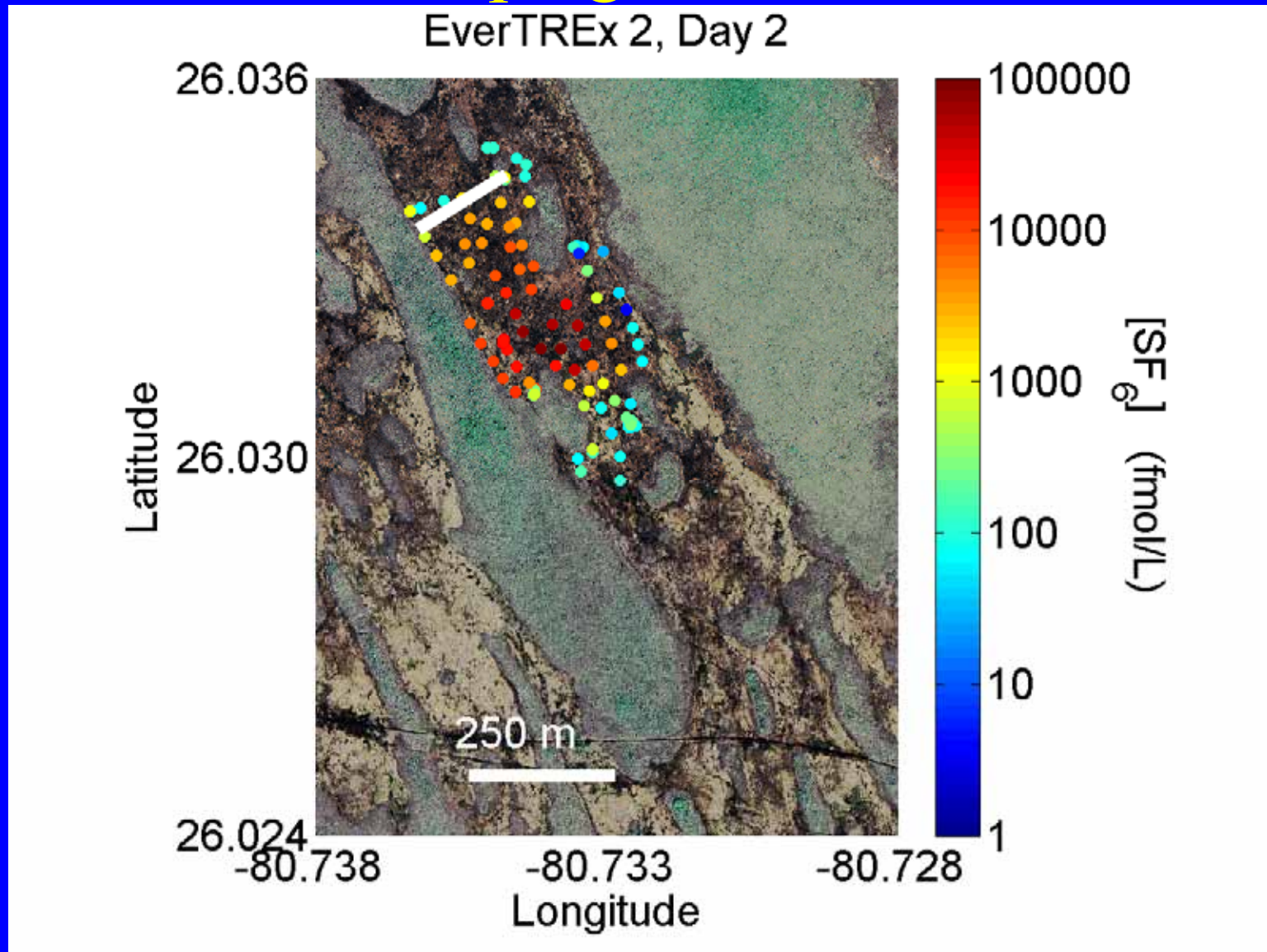


# EverTREx Field Campaigns



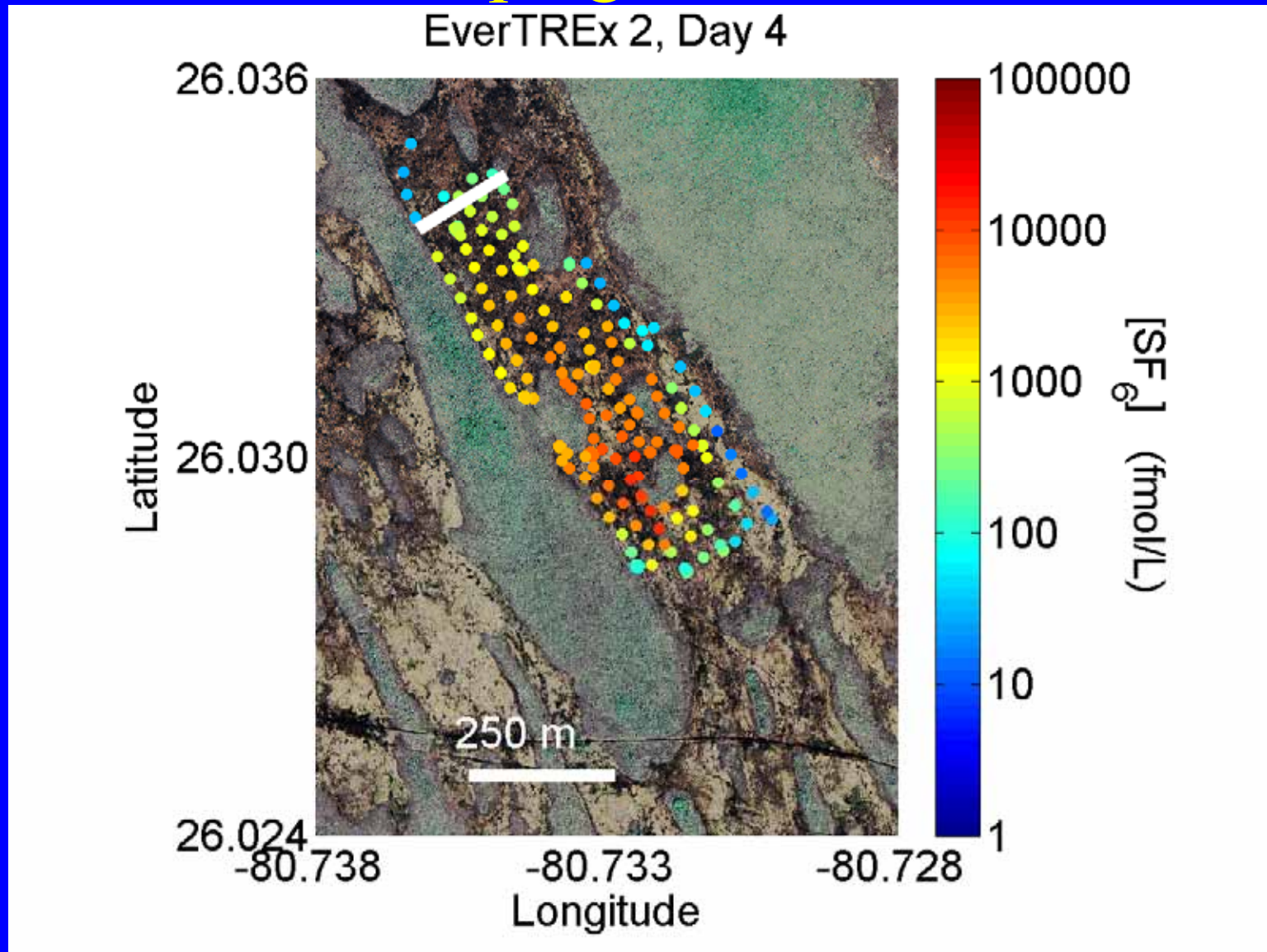
② Patterned ③ Flooded ④ Drained

# Field Campaign 2 – Patterned



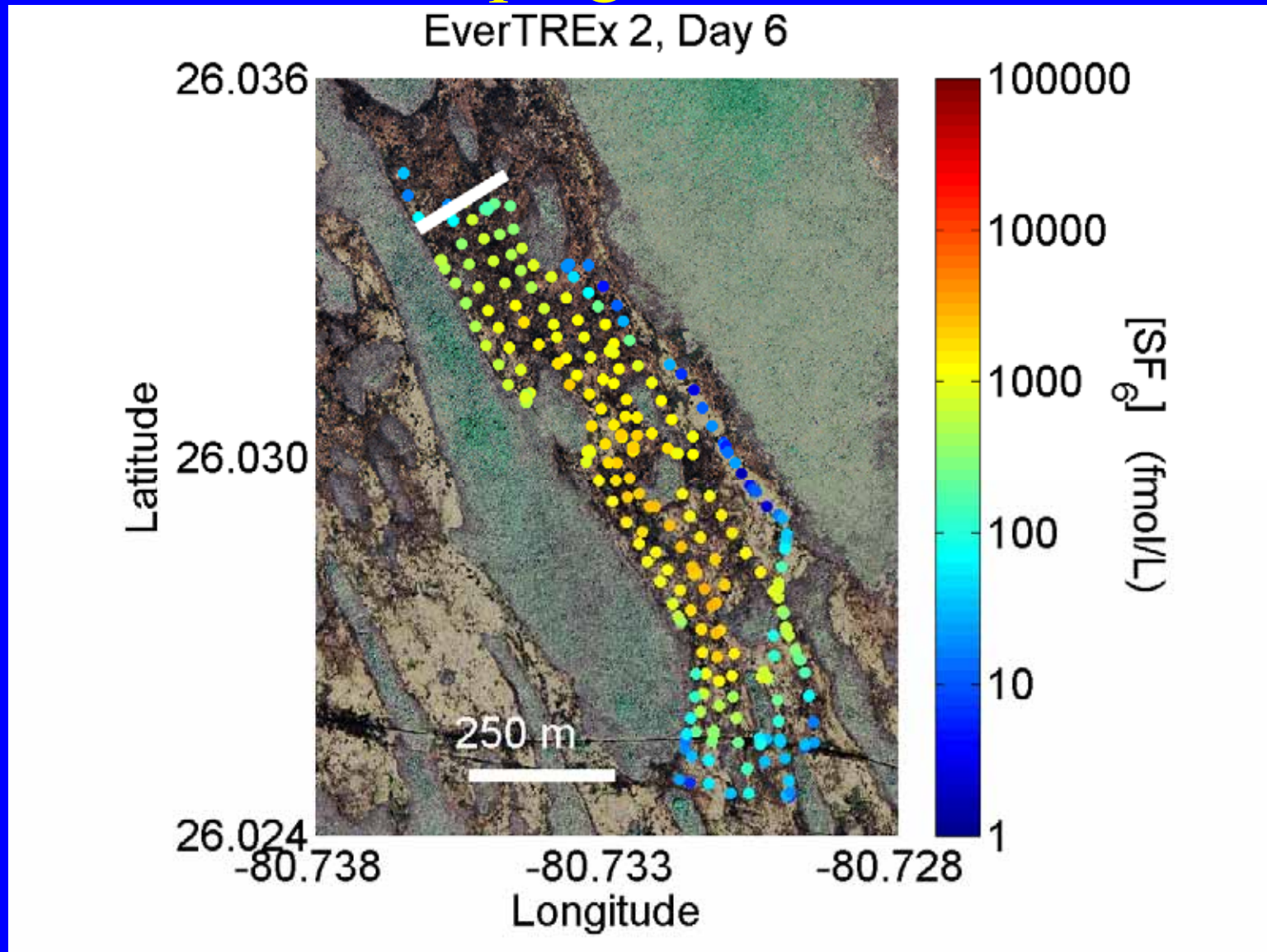


# Field Campaign 2 – Patterned





# Field Campaign 2 – Patterned



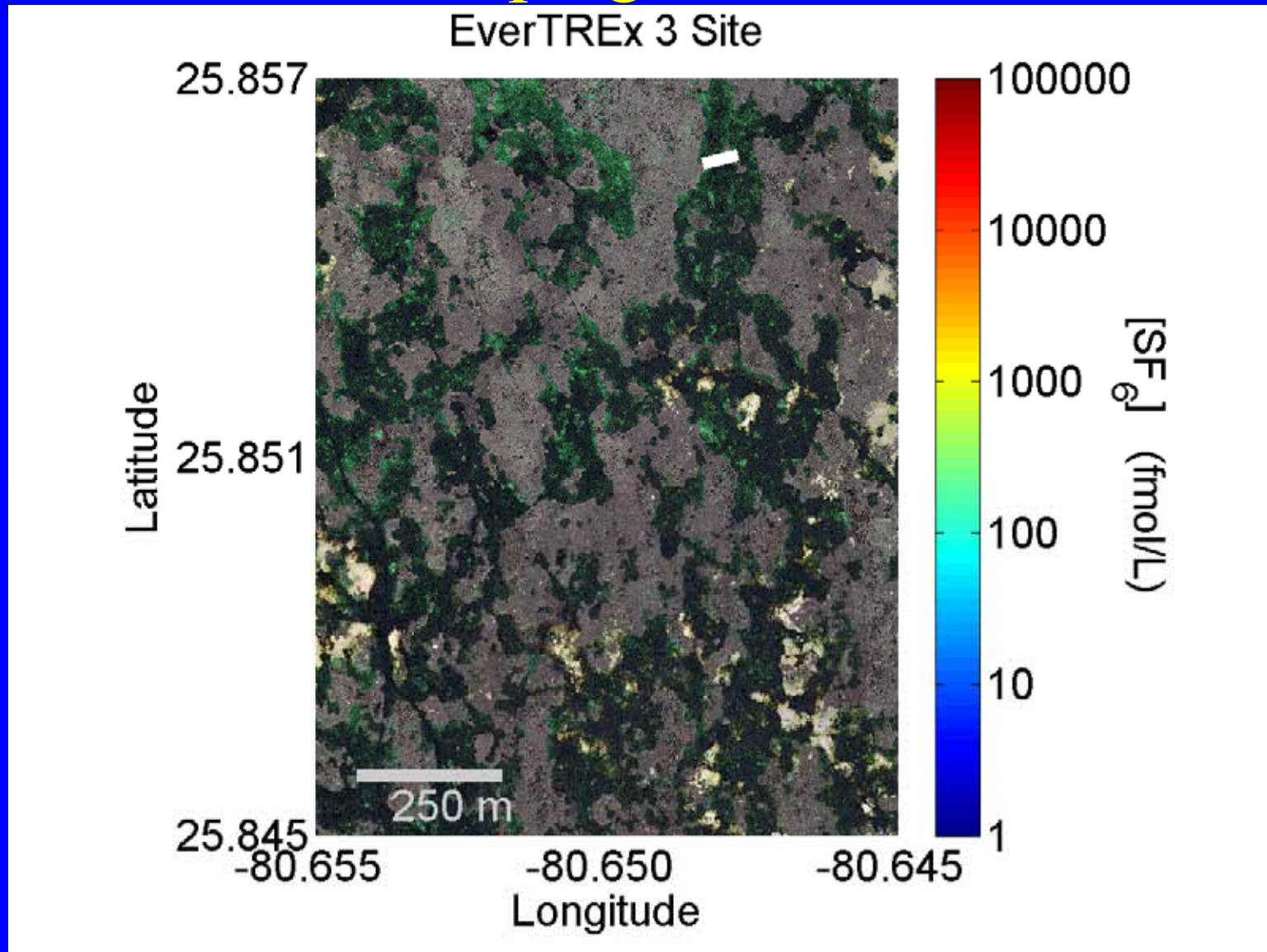
# Field Campaigns



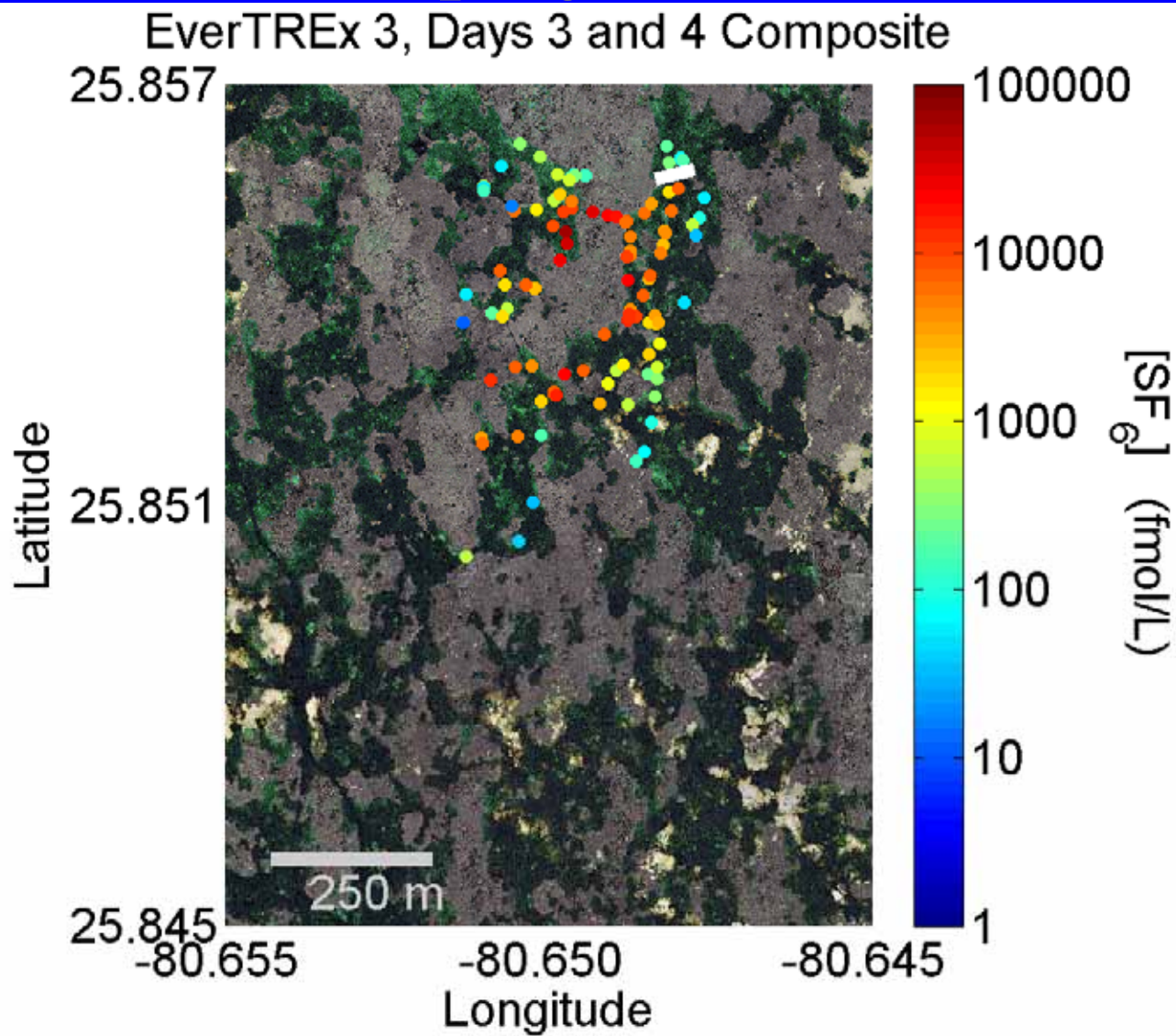
② Patterned ③ Flooded ④ Drained



# Field Campaign 3 – Flooded



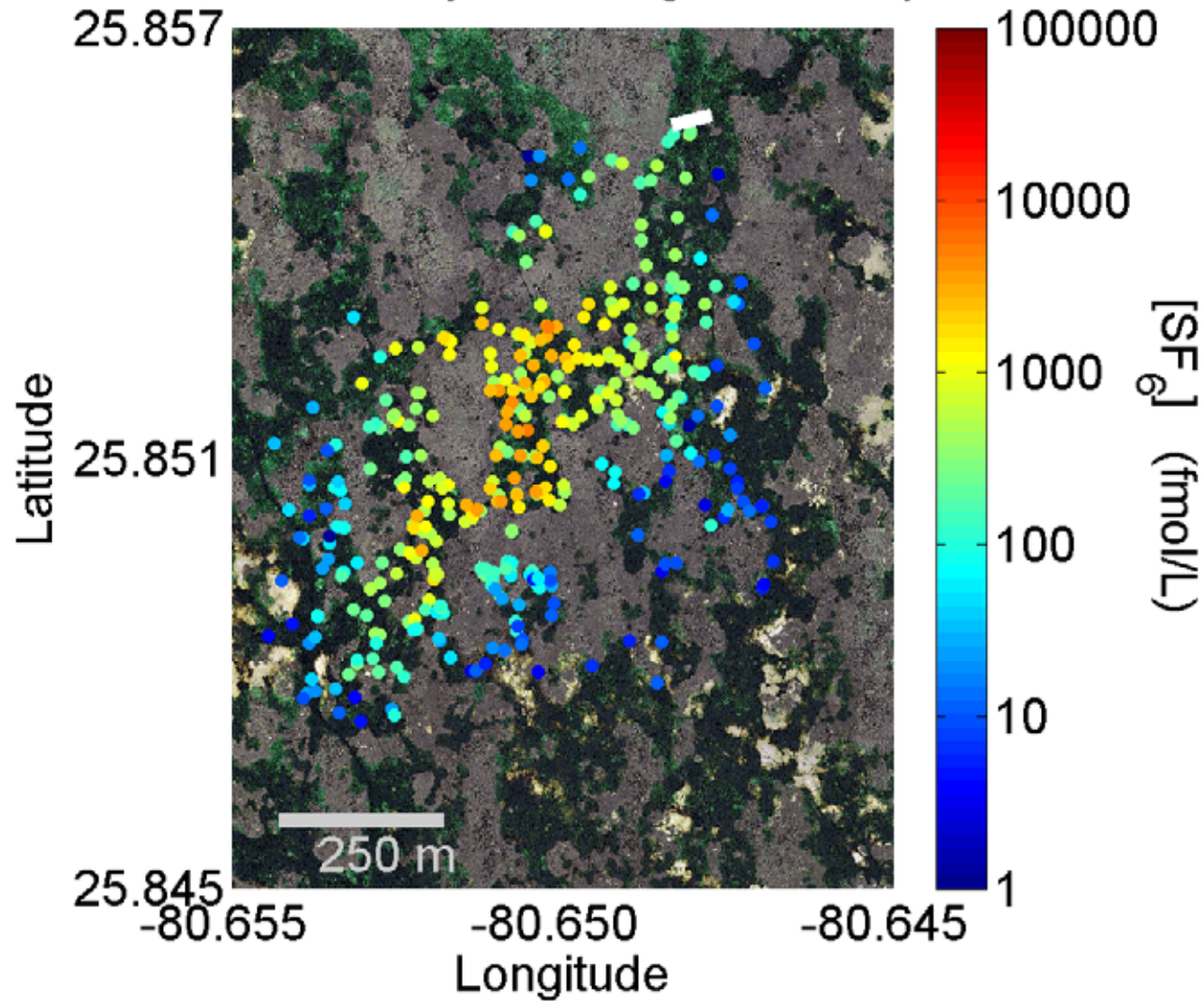
# Field Campaign 3 – Flooded





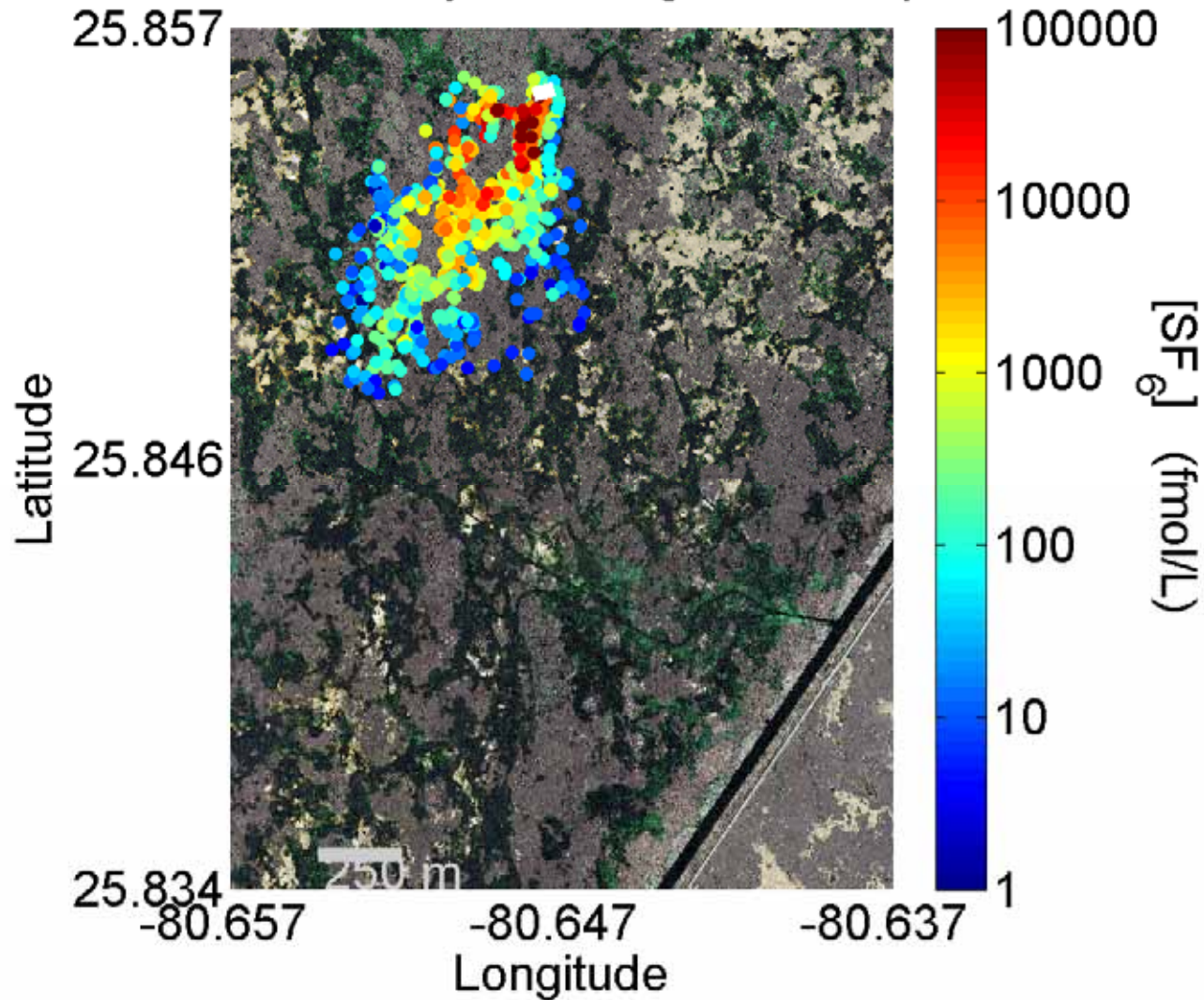
# Field Campaign 3 – Flooded

EverTREx 3, Days 9 through 11 Composite



# Field Campaign 3 – Flooded

EverTREx 3, Days 1 through 11 Composite



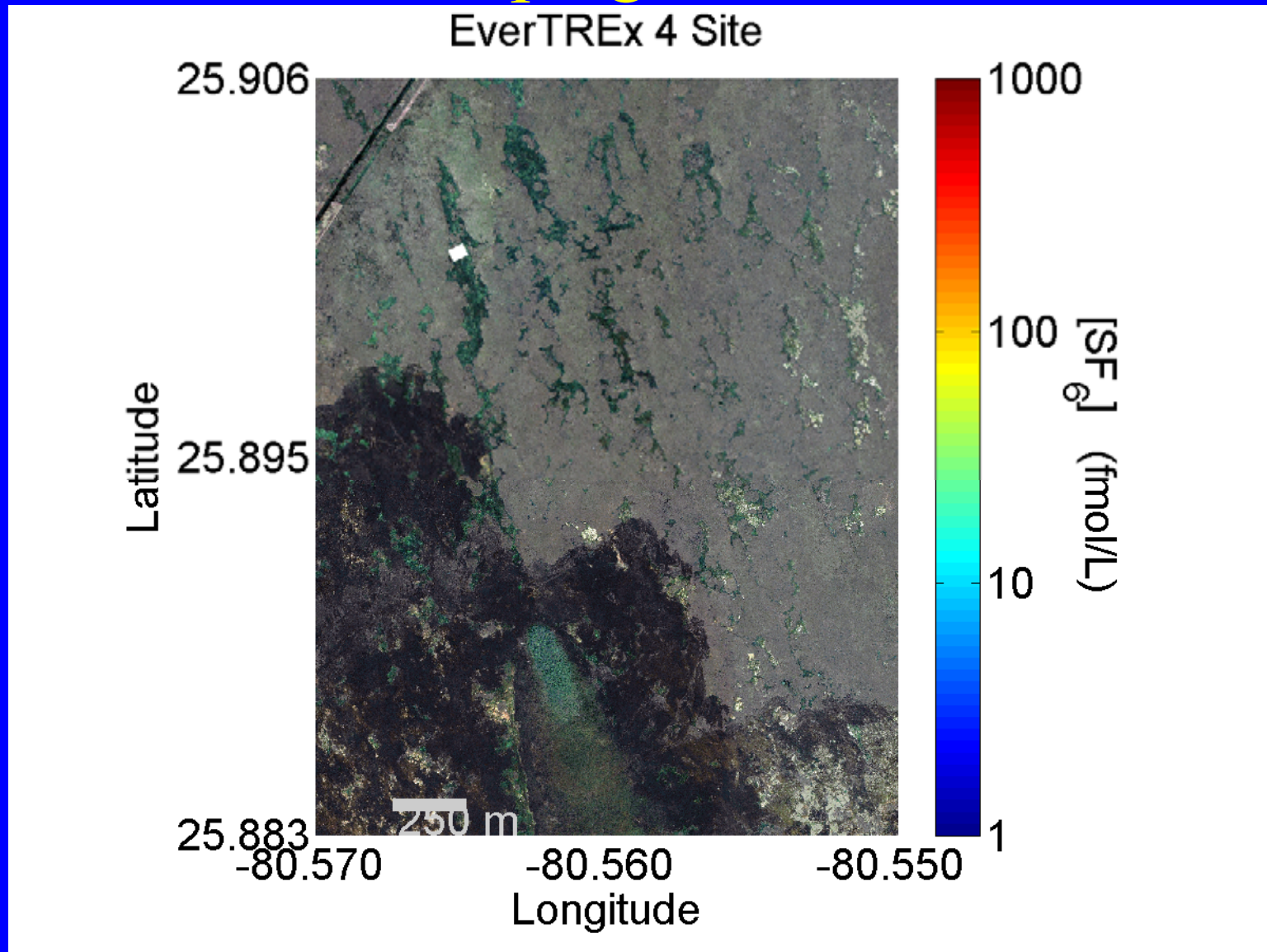


# Field Campaigns



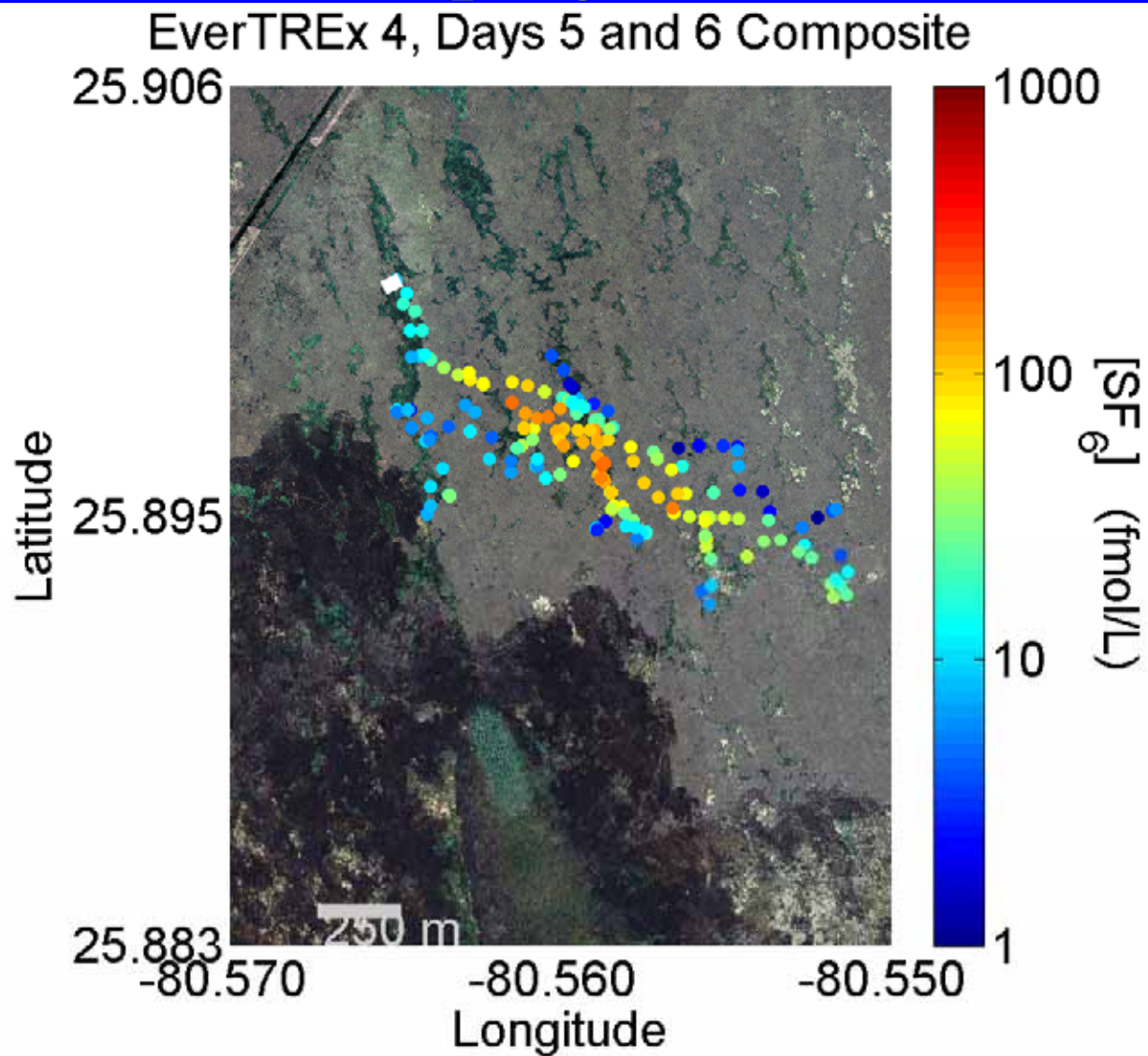
② Patterned ③ Flooded ④ Drained

# Field Campaign 4 – Drained





# Field Campaign 4 – Drained



## Qualitative Analysis

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Flow is often *not* aligned with  
landscape patterns

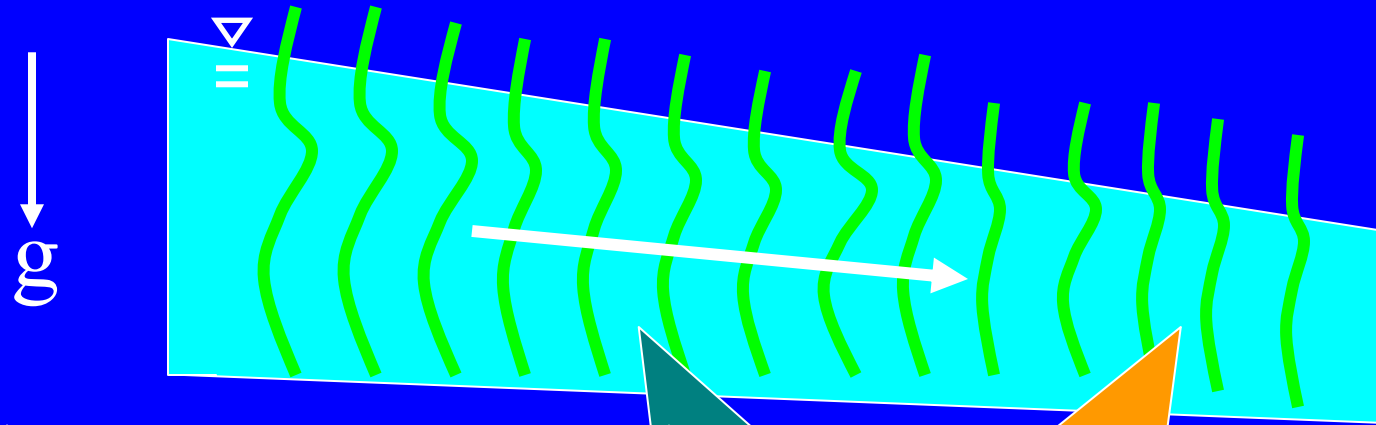
Loss of vegetation patterning

*3 Hydrodynamic Models ...*

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# 1-D Homogeneous model

Surface elevation gradient = driving force



Vegetation = driving force (Manning  $n$ ,  
C<sub>pa</sub> or  $\tau$ )

Fewer high-velocity  
events at degraded  
sites



## 2-D homogeneous transport model

② Patterned    ③ Flooded    ④ Drained

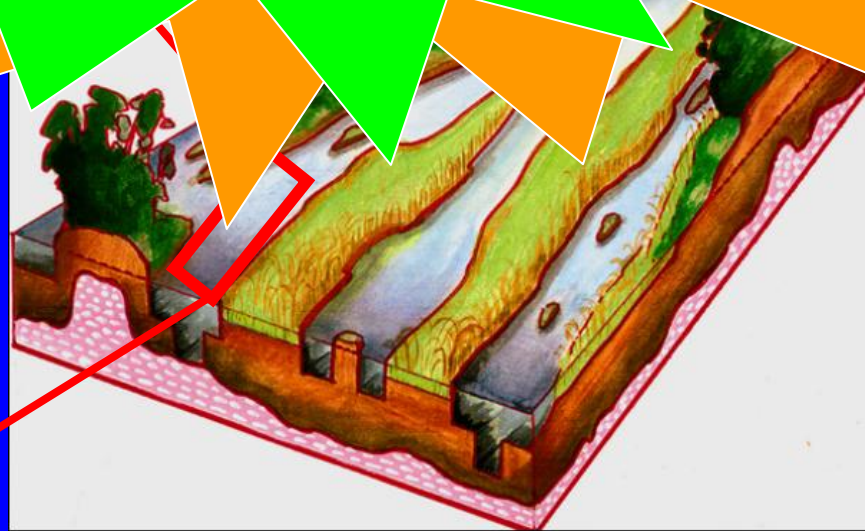
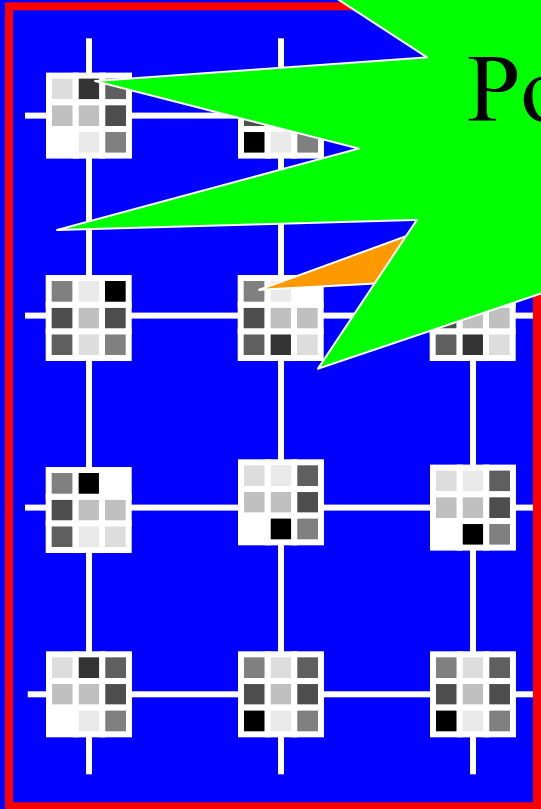
Flow velocity	1.5 mm/s	0.6 mm/s	2.0 mm/s
Rate of dispersion	0.03 m <sup>2</sup> /s	0.016 m <sup>2</sup> /s	0.181 m <sup>2</sup> /s

Faster spreading  
than small-scale  
experiments suggest

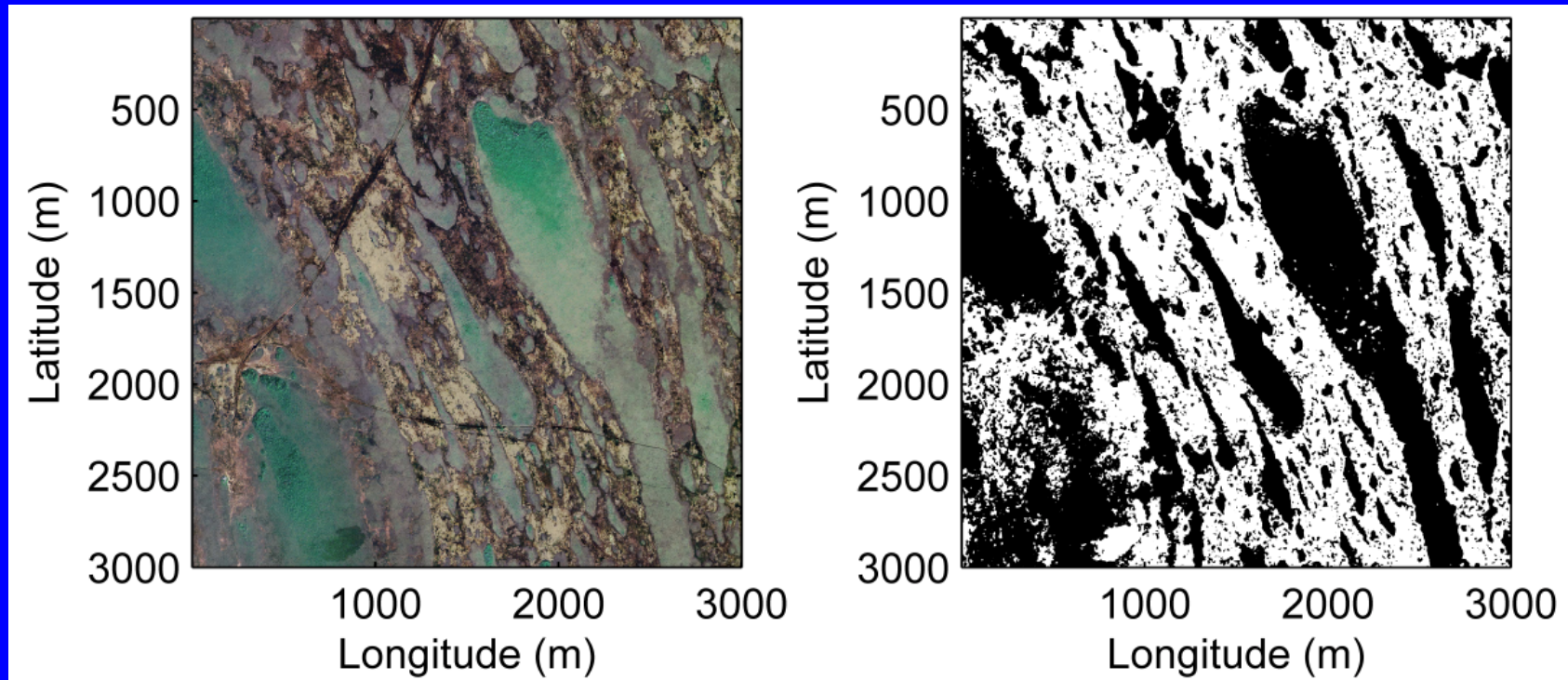
# 2-D Spatially explicit model

Lattice Boltzmann technique

Poster #38, tonight!



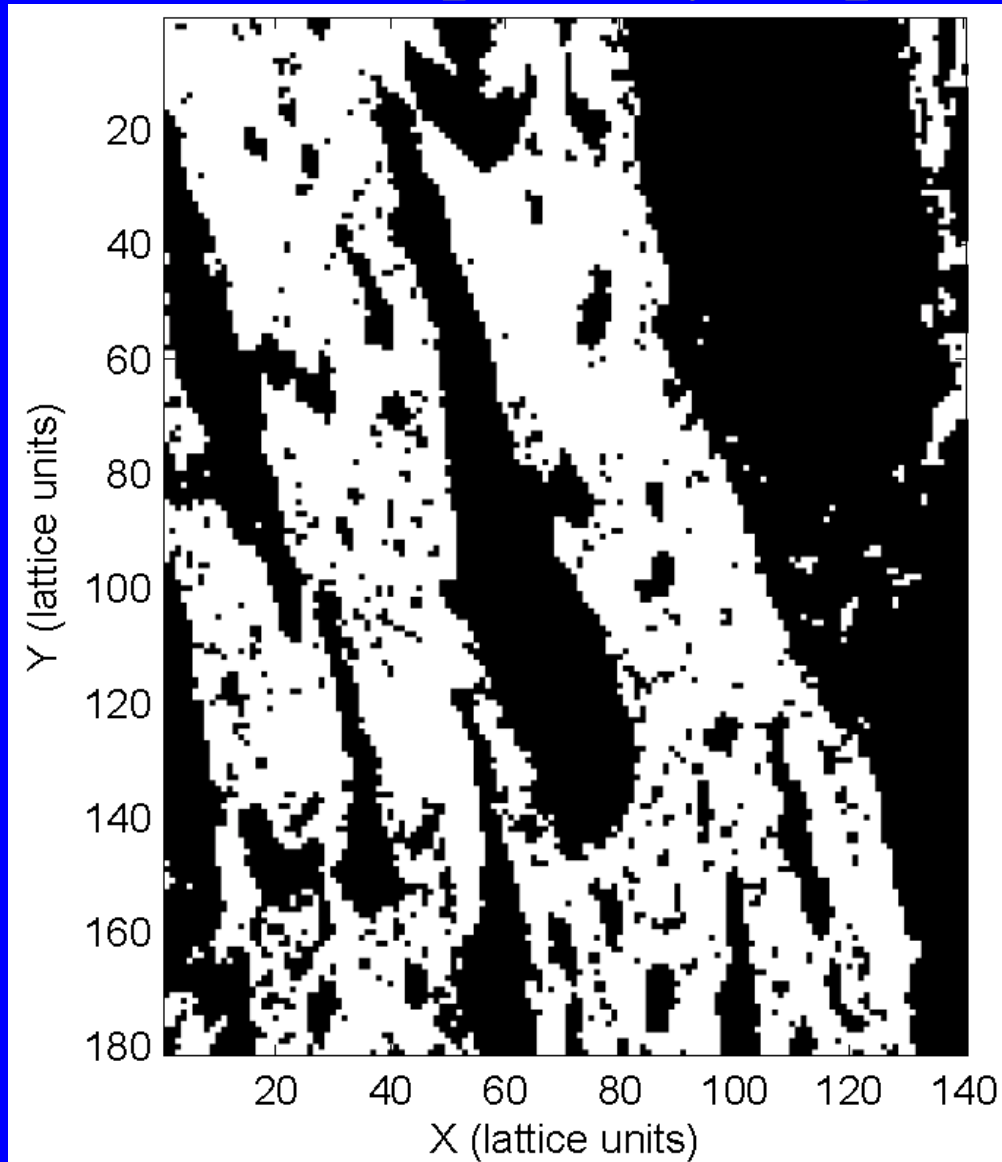
## 2-D Spatially explicit model



Create binary domain:  
ridge (high-drag) and slough (low-drag)



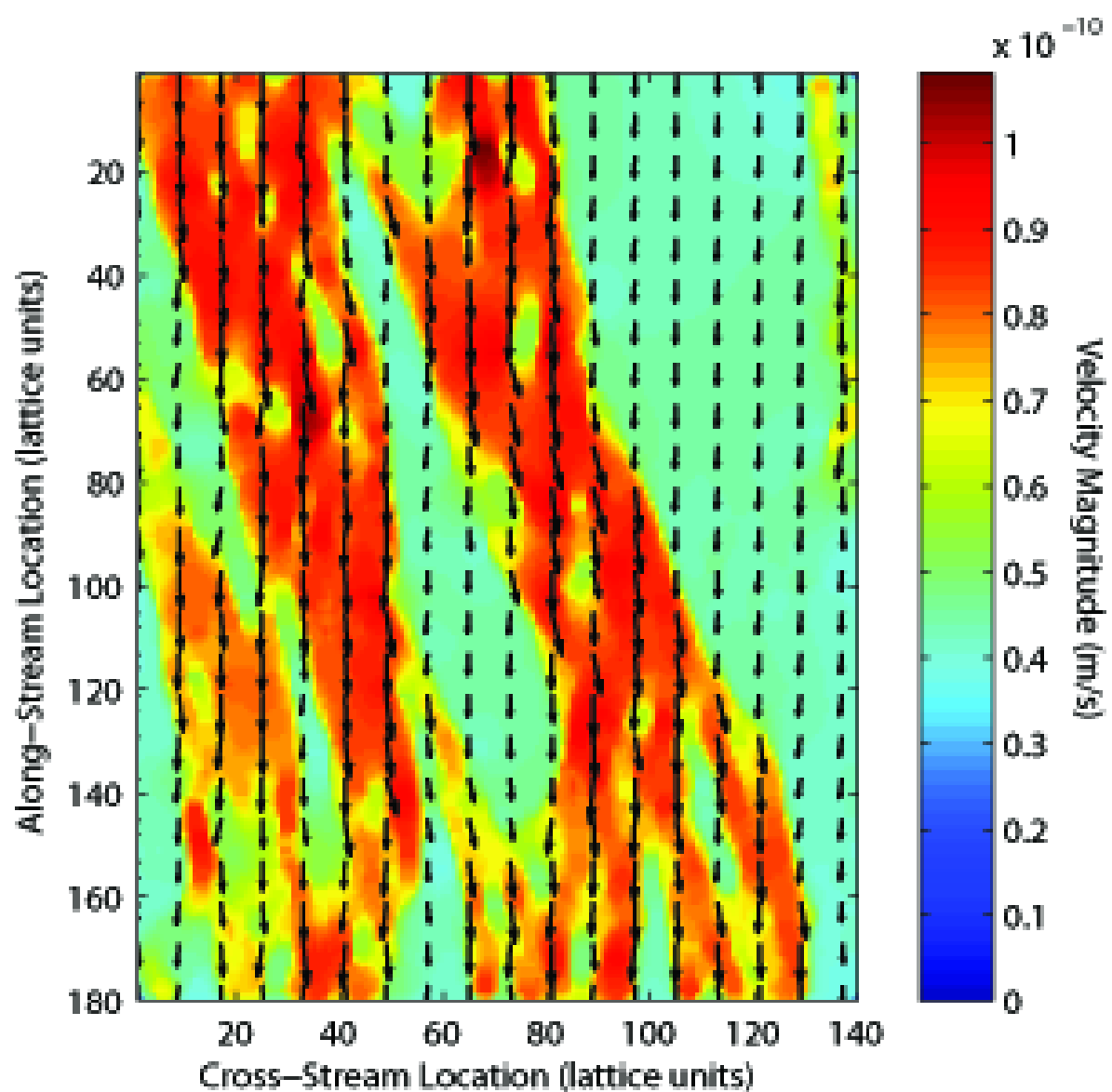
## 2-D Spatially explicit model



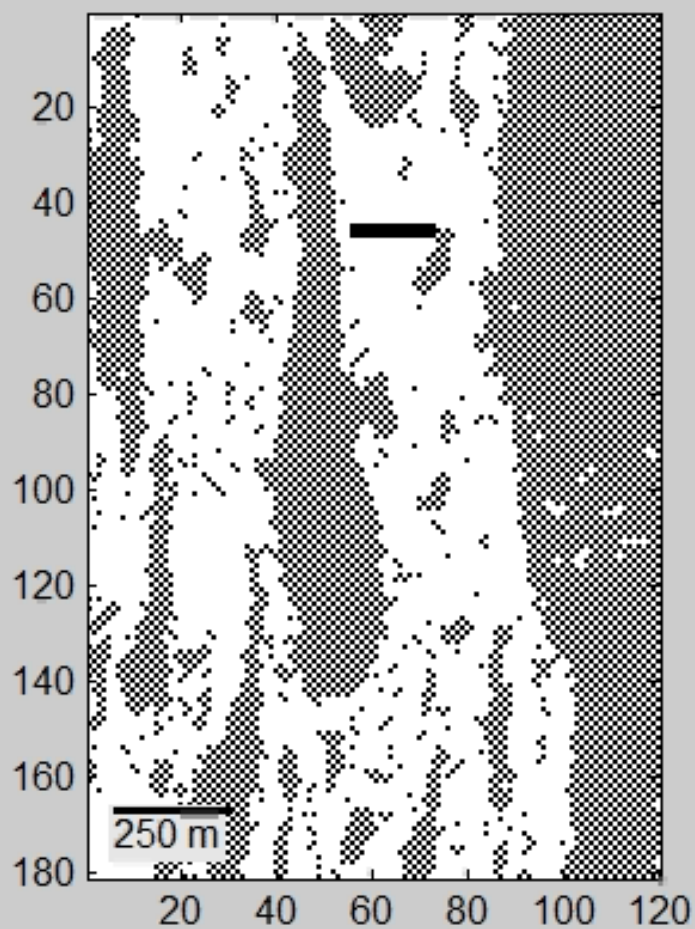
Surface  
elevation  
gradient  
is driving  
force  
(from  
EDEN)



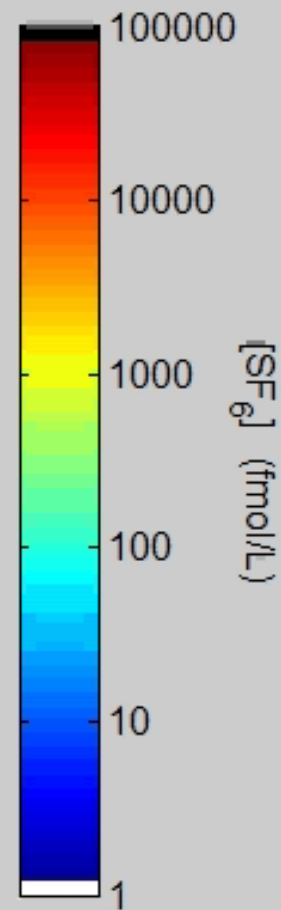
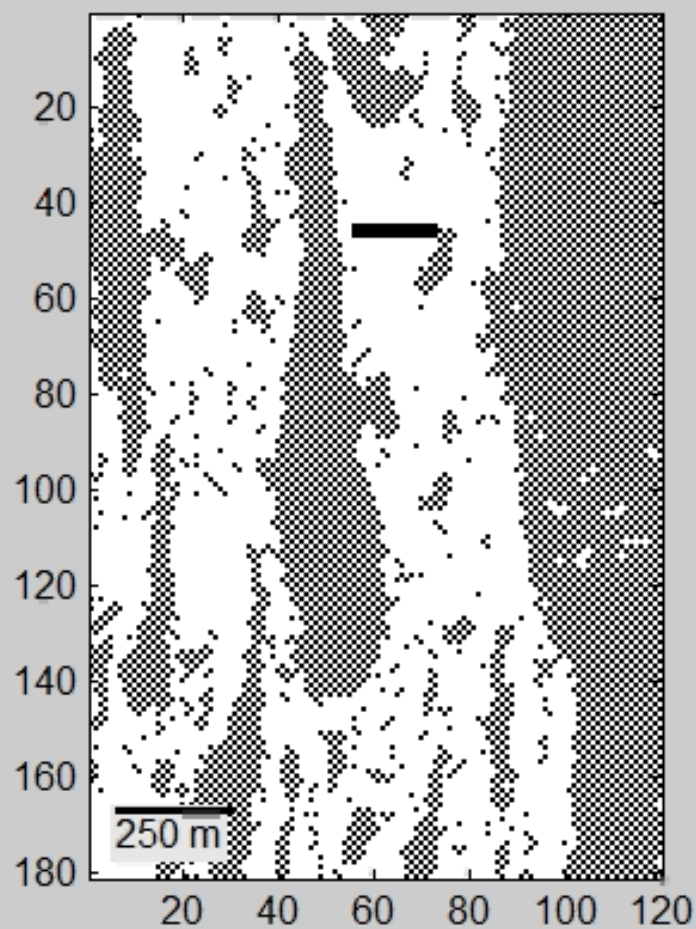
# 2-D Spatially explicit model



EverTREx 2 model v46



EverTREx 2 model v48



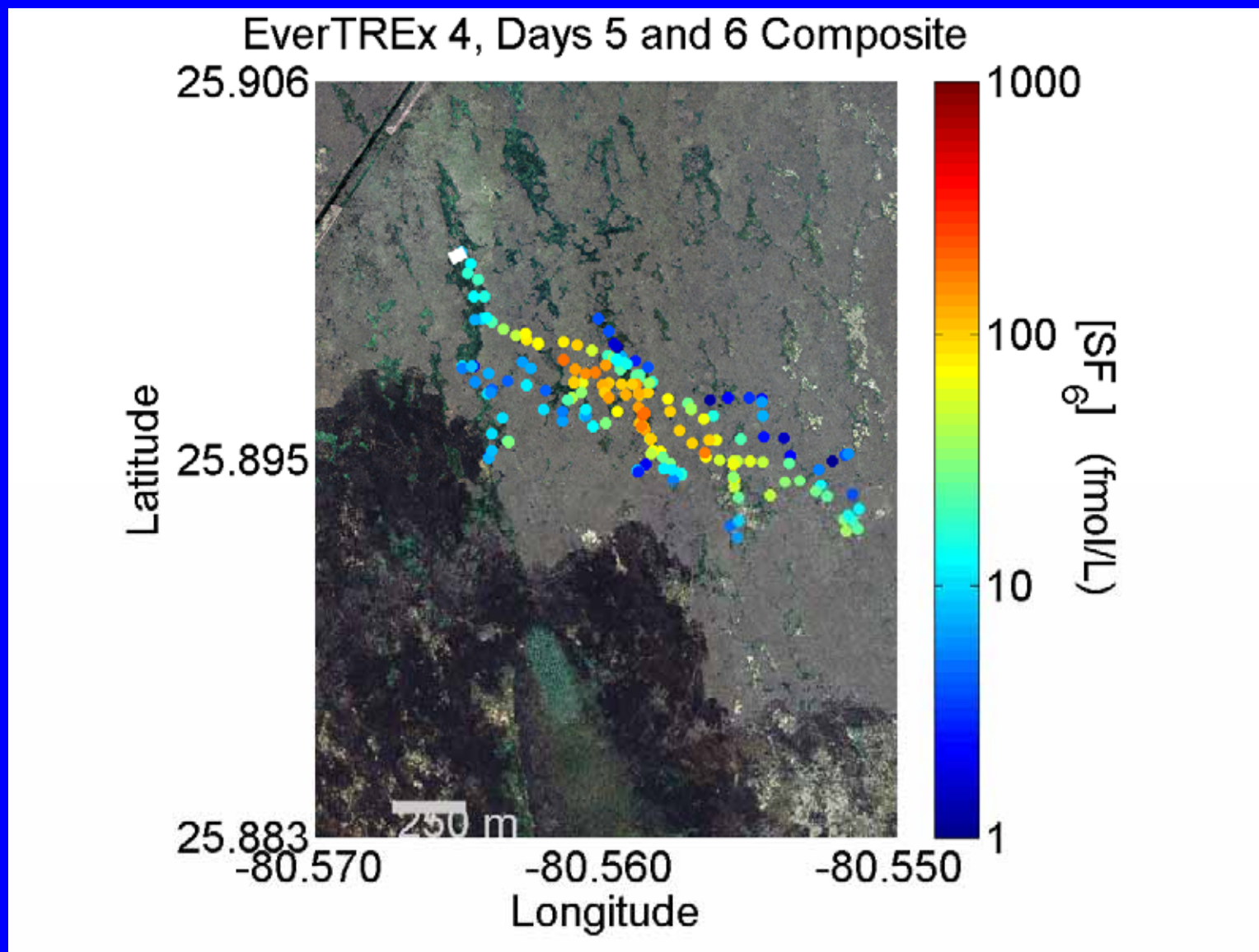


## Conclusions

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- Flow does not necessarily follow the direction of ridge/slough axes
  - Pattern loss in WCA-3B may be accelerated by feedback via increased vegetative drag
  - Dispersive transport is larger than previous measurements suggest
  - Lattice Boltzmann models can reveal velocity differences between adjacent ridges and sloughs
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# Thank You!



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