Using hydrogeophysical methods to understand disturbance in peat soils due to saltwater intrusion: from soil collapse to changes in biogenic gas dynamics

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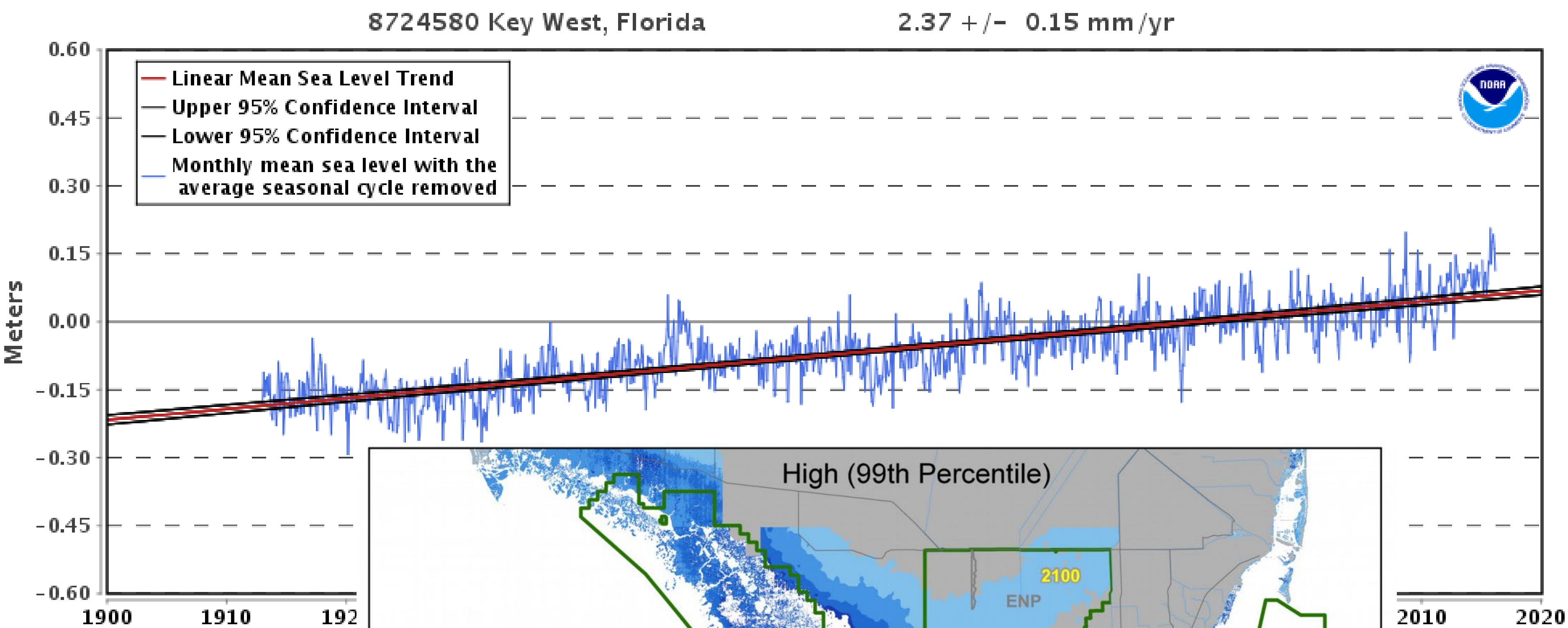
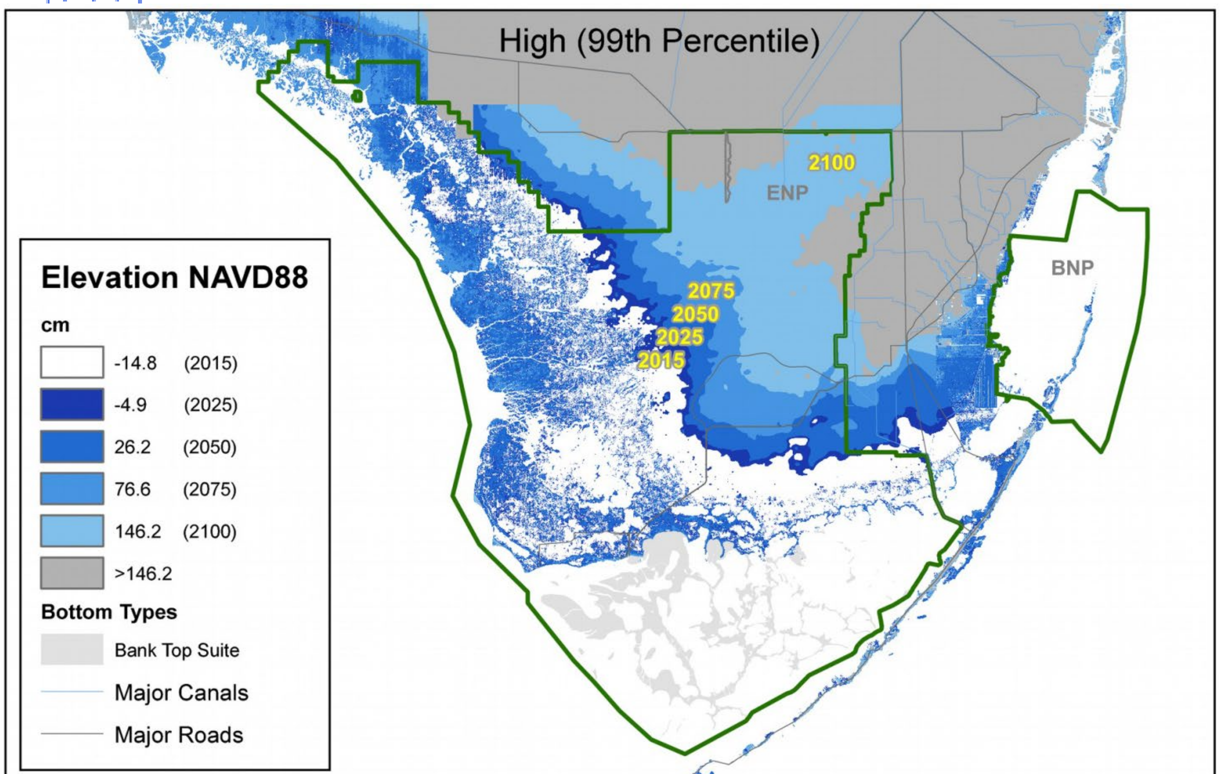
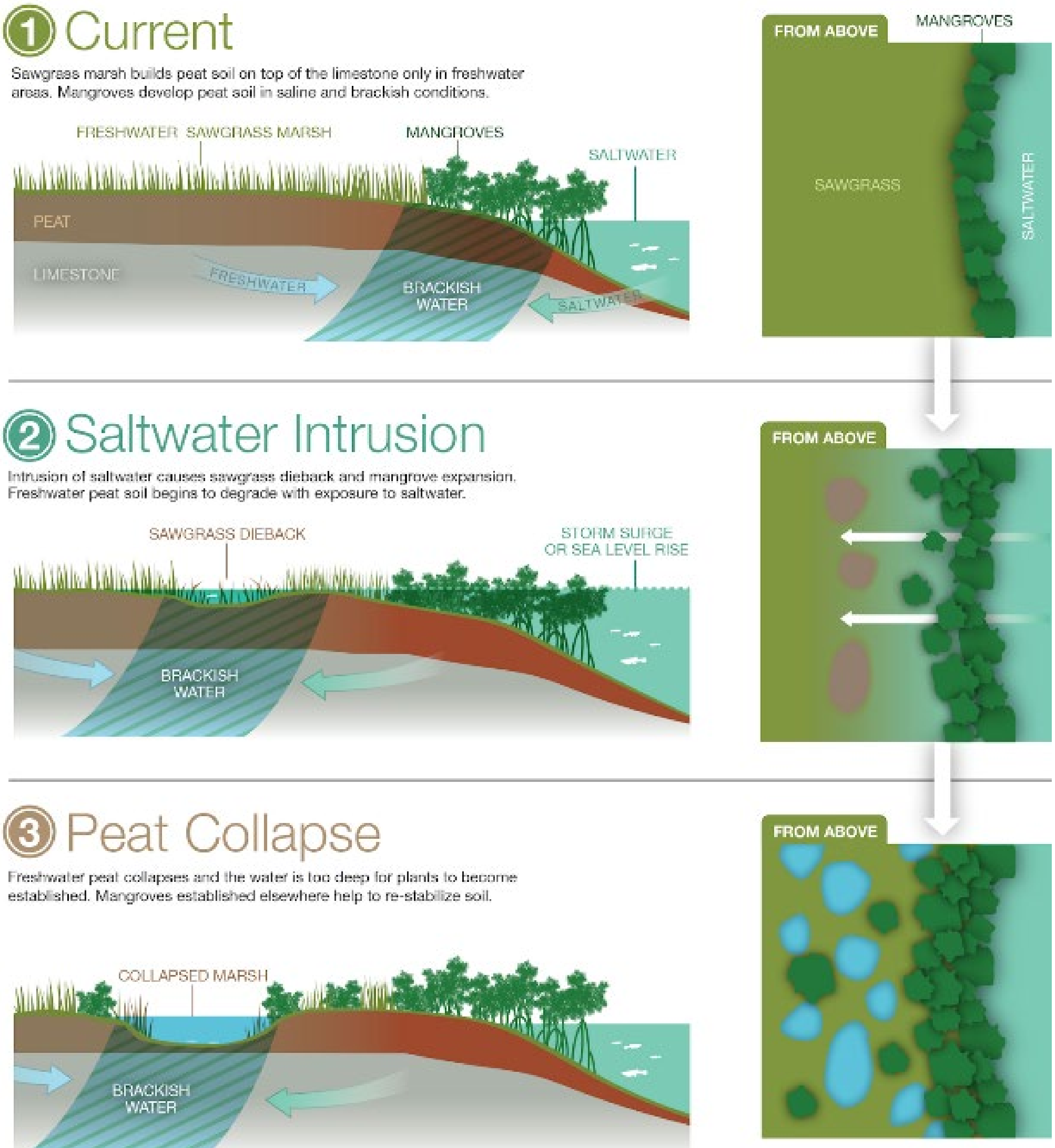
1.Introduction:



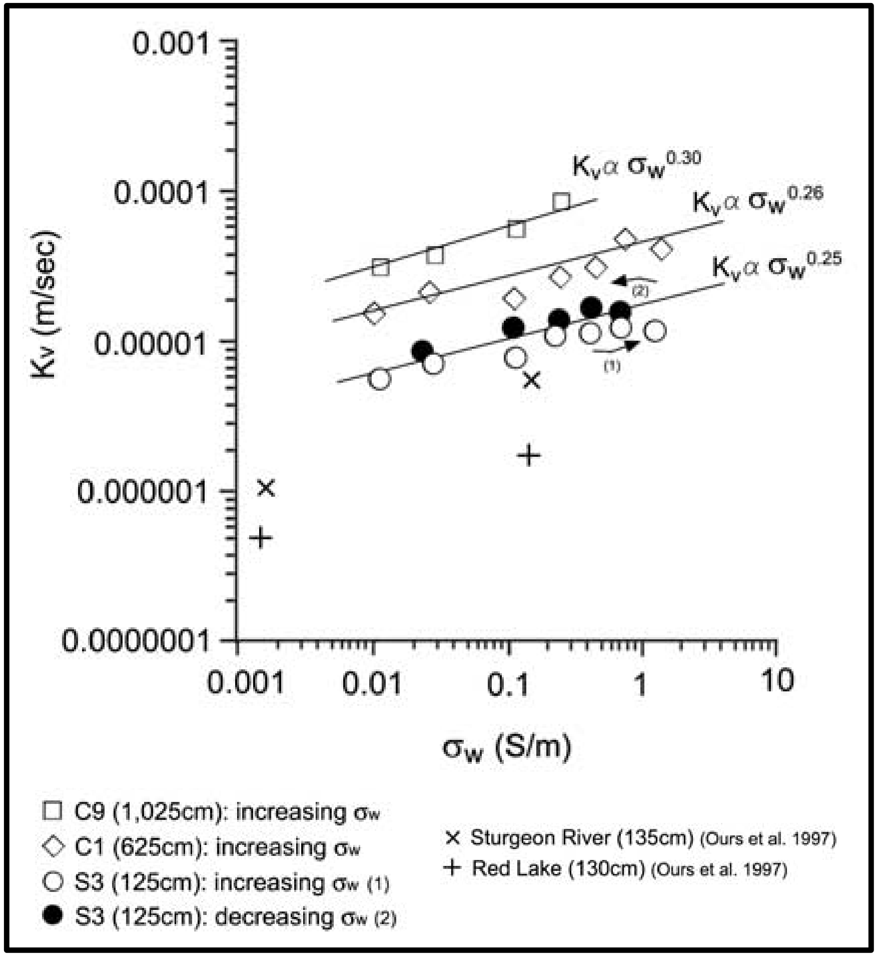


Worst-case scenario ≈1.5 m by 2100

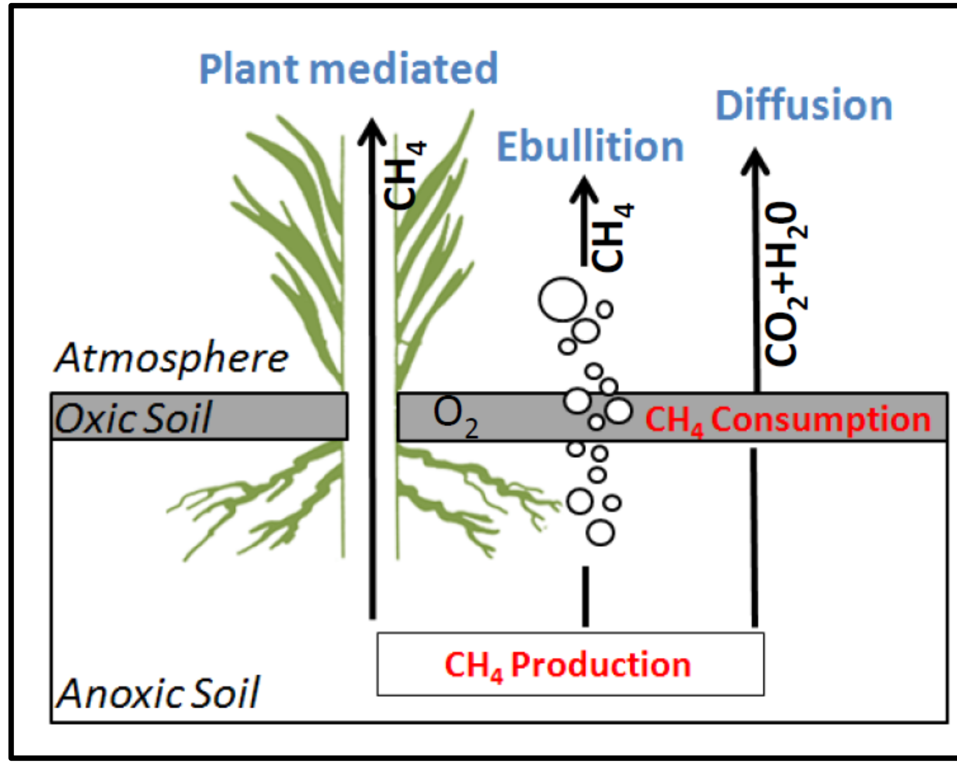
Park et al, 2016



From: Davis and Everglades Foundation



Comas and Slater, 2004



Ramirez et al, 2015

- <u>**Pore dilation in peat soils**</u>:
  - Ours et al, 1997; Hoag and Price, 1997
  - *Sphagnum* peat soils

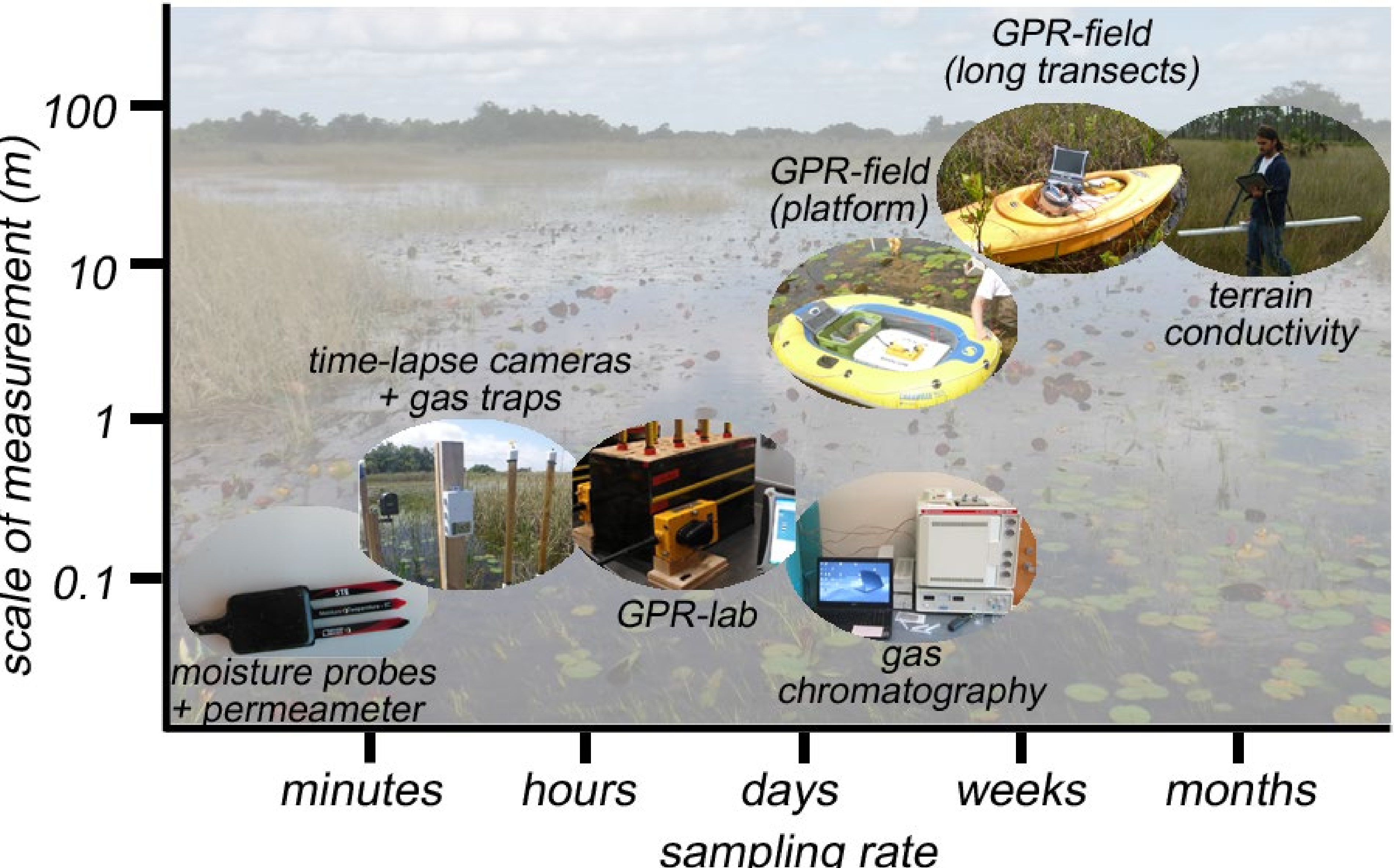
- <u>**Biogenic gas dynamics**</u>:
  - Increased dilation may increase biogenic gas release (i.e. ebullition)
  - Increased salinity decreases gas production (i.e. methane)

2. Objectives:

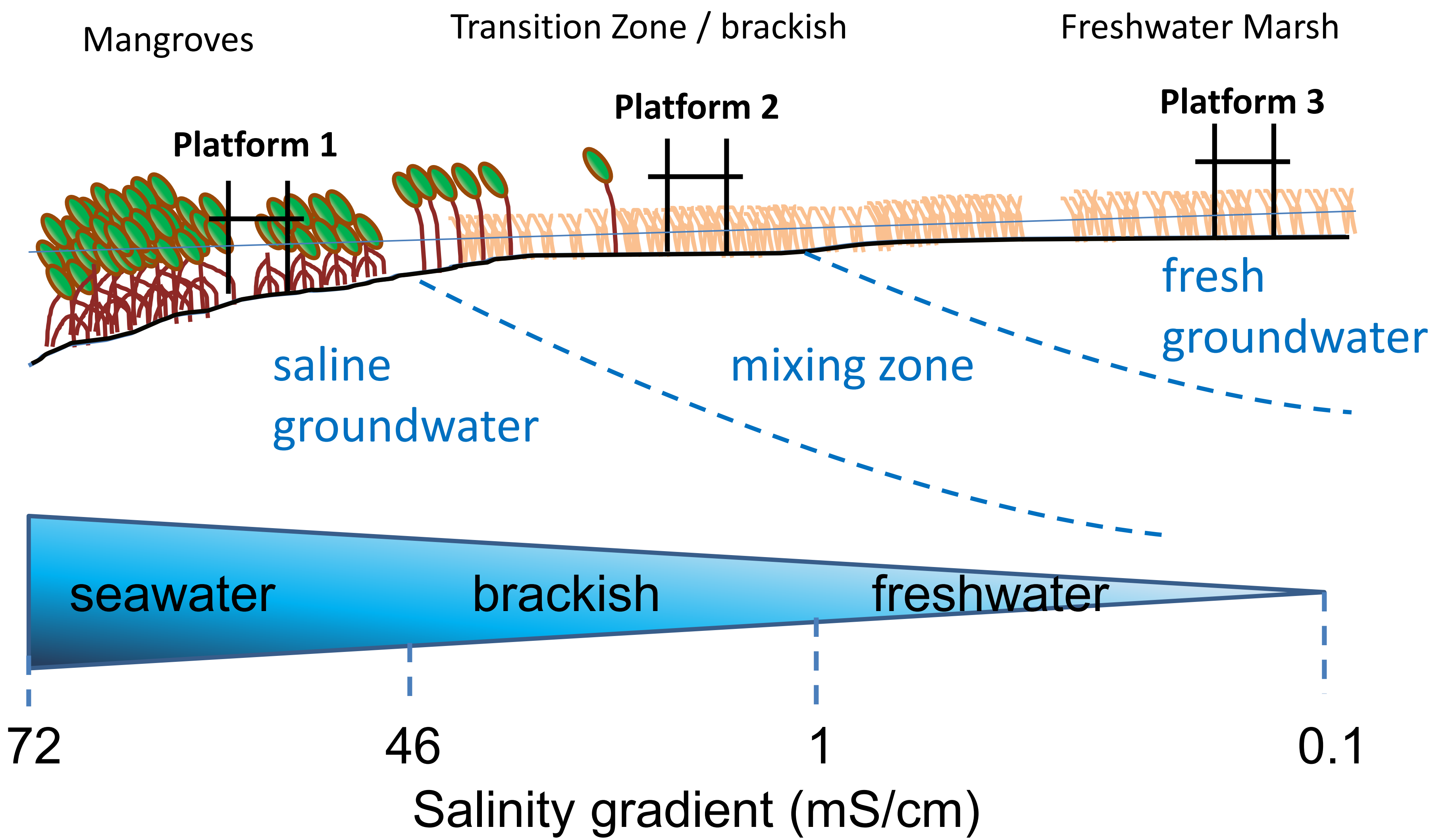
- **To investigate the effects of salinization on:**
  - **1) the peat matrix and potential peat collapse,** as induced by changes in the physical properties of peat (i.e. porosity or hydraulic conductivity)
  - **2) biogenic gas fluxes in peat soils,** particularly in terms of production, accumulation and release of biogenic gases in peat soils (such as methane and carbon dioxide)

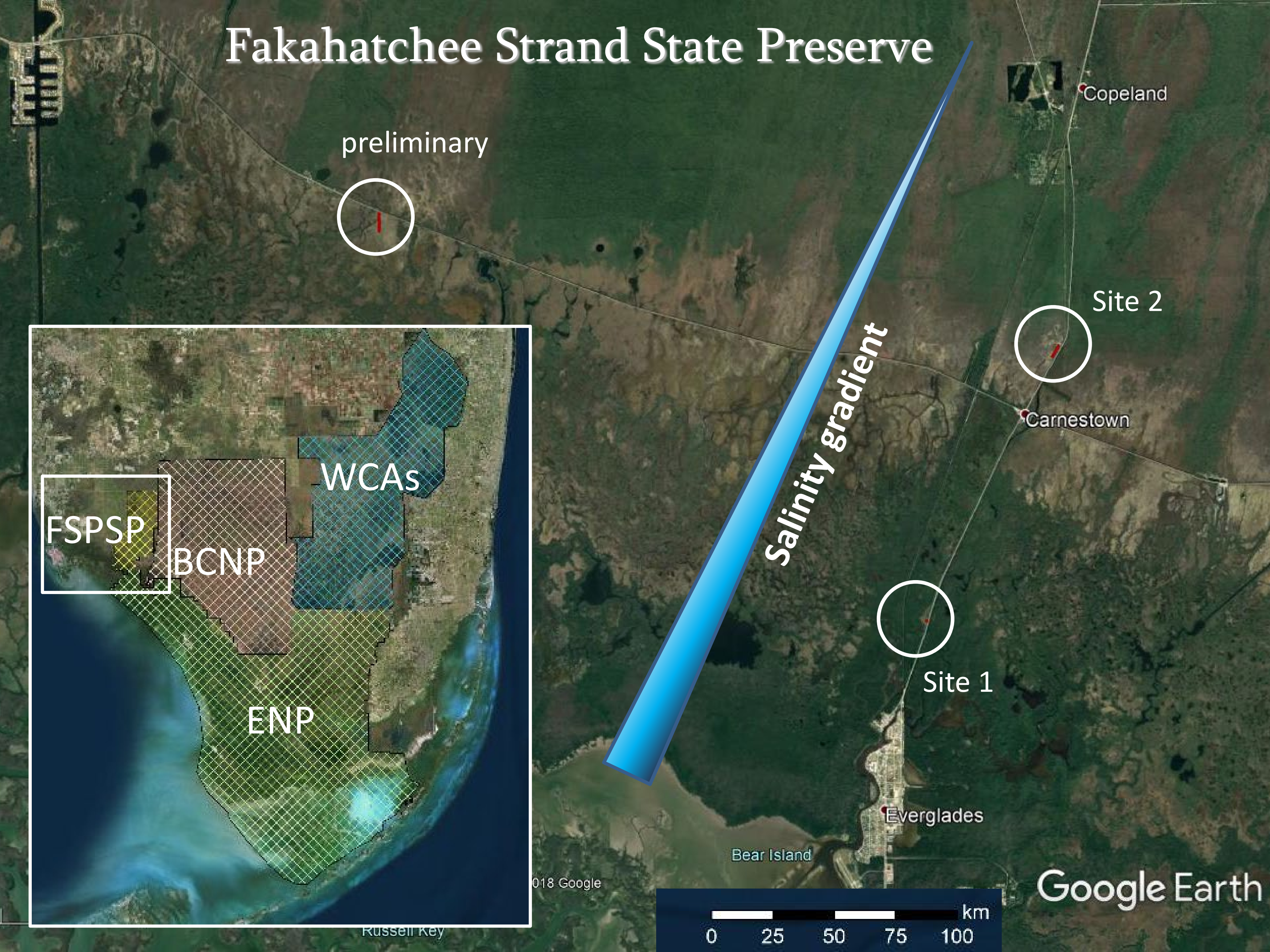
3. Methodology:

approach is: a) multi-method; b) multi-scale: both in space and time; c) field+lab based

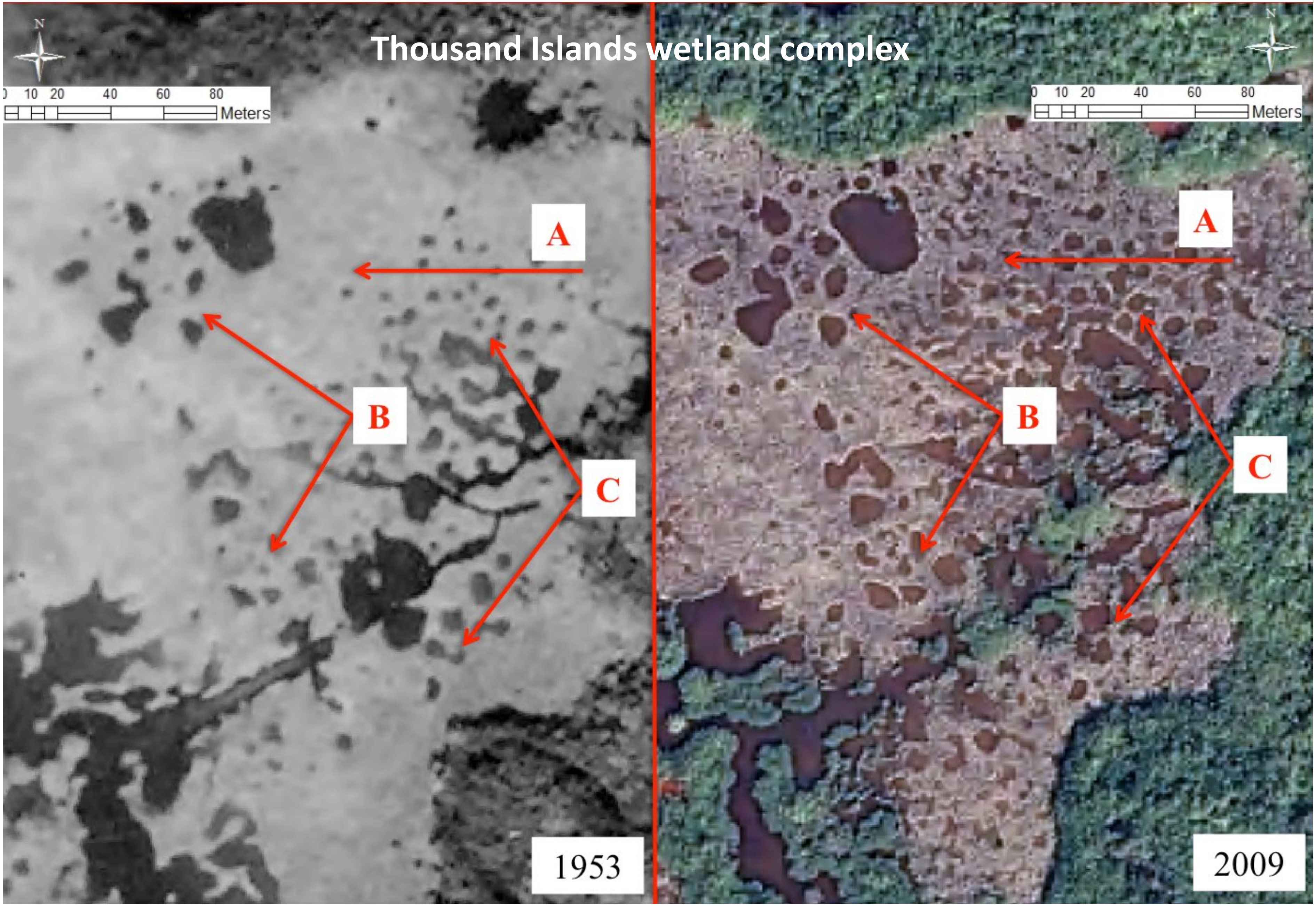


4. Fieldsites




Fakahatchee Strand State Preserve
preliminary
Copeland
Site 2
Carnestown
Salinity gradient
Site 1
Everglades
Bear Island
WCAs
FSPSP
BCNP
ENP
018 Google
Russell Key
Google Earth
km
0
25
50
75
100

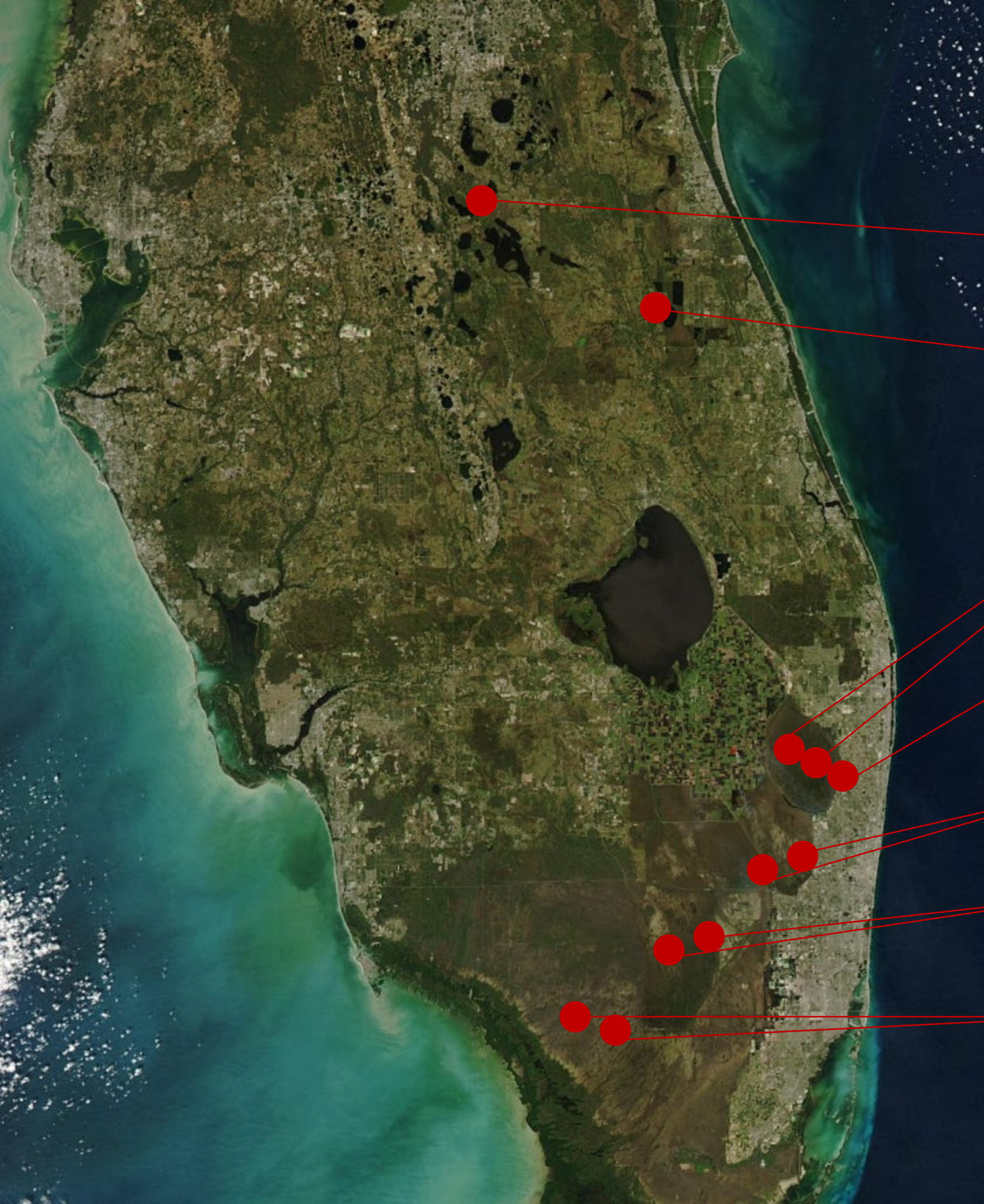

Site 1
Ponds and saltwater conductivity
40.7 mS/cm
Sirianni©
136 ft
Google Earth



Pocking and pond formation and growth; ***Andres, Savarese et al 2009***

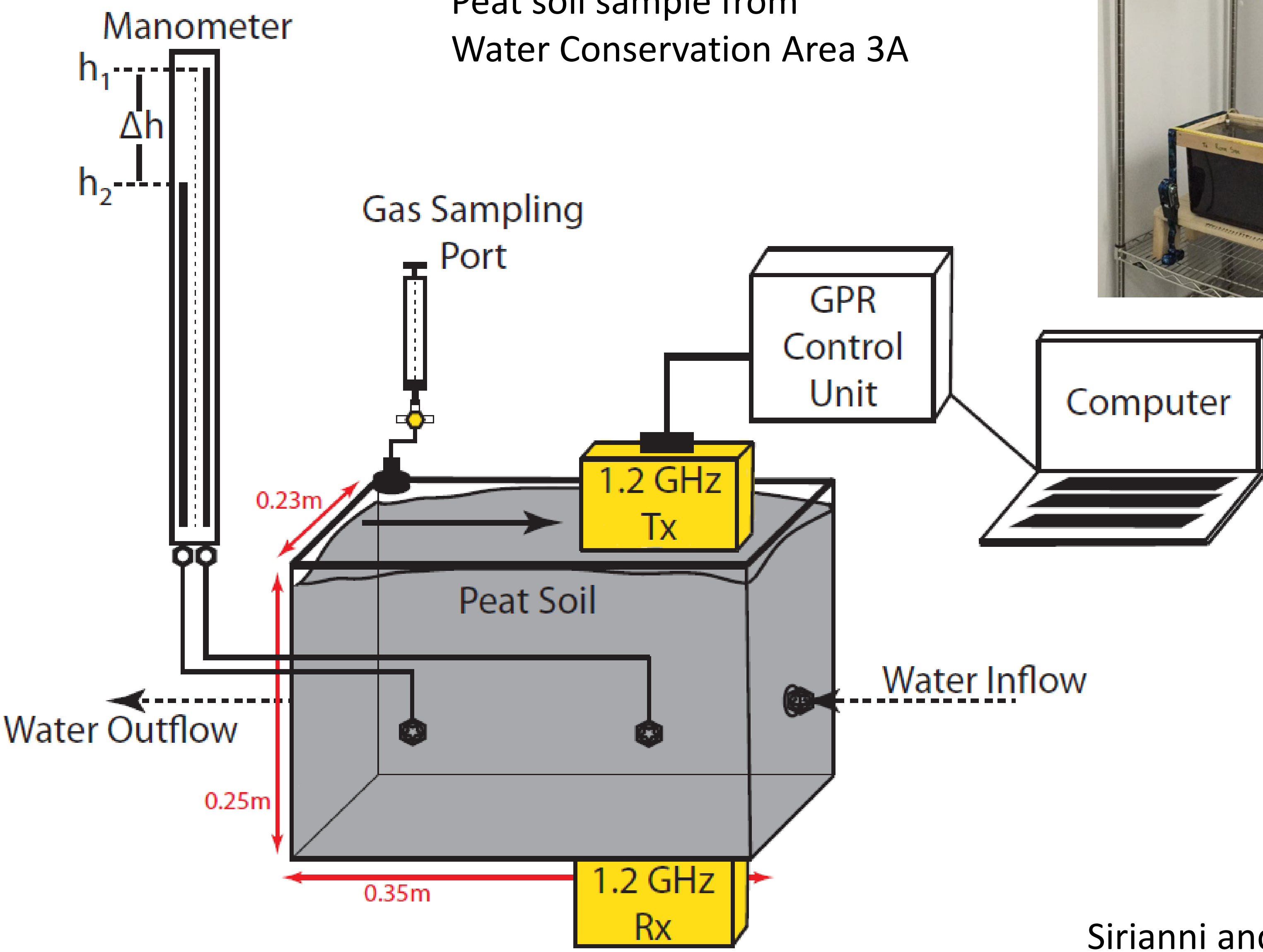

Site 2
No well defined ponds (precursors?) and brackish conductivity
21.5 mS/cm
1410 ft

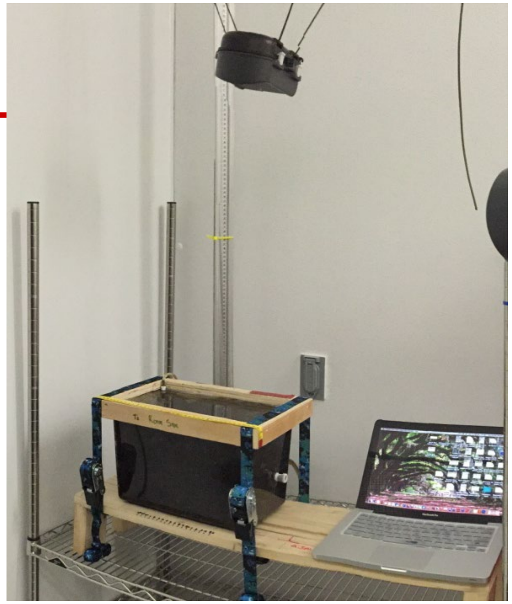
Site 3? freshwater



5. Results: a) laboratory scale

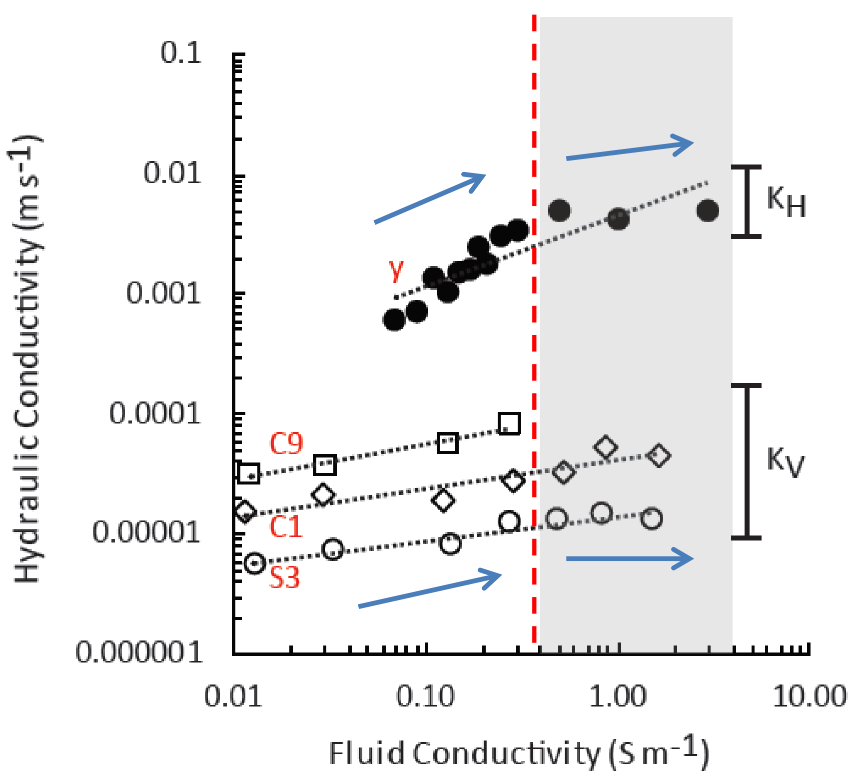
Preliminary results for
Peat soil sample from
Water Conservation Area 3A





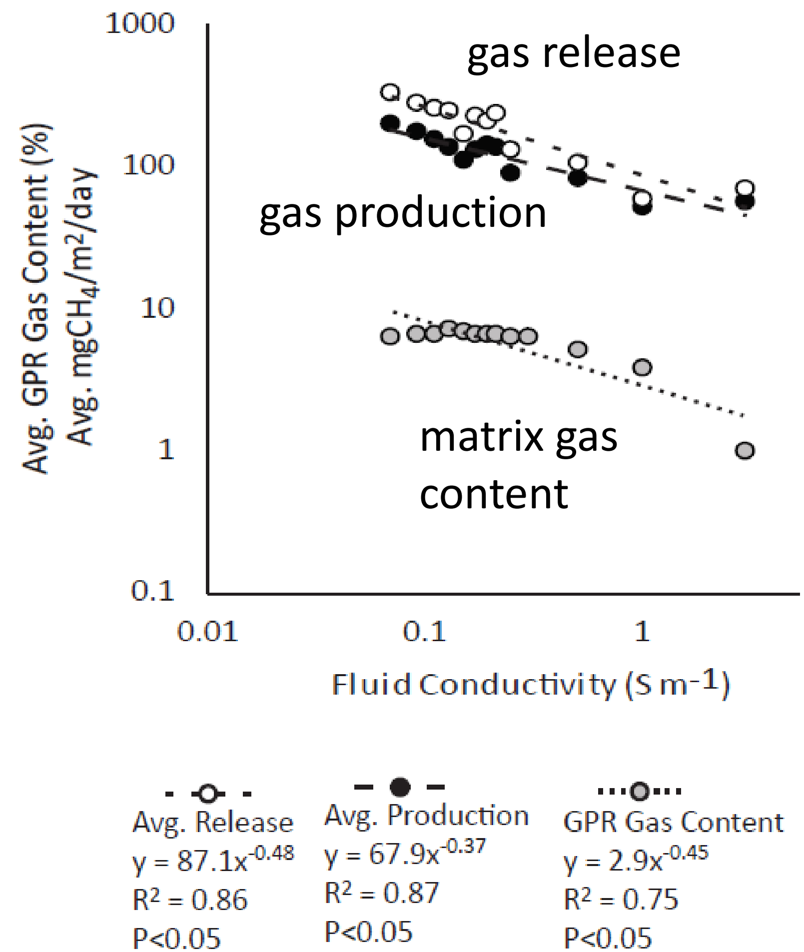
Sirianni and Comas, *in prep*

Physical properties, i.e. K

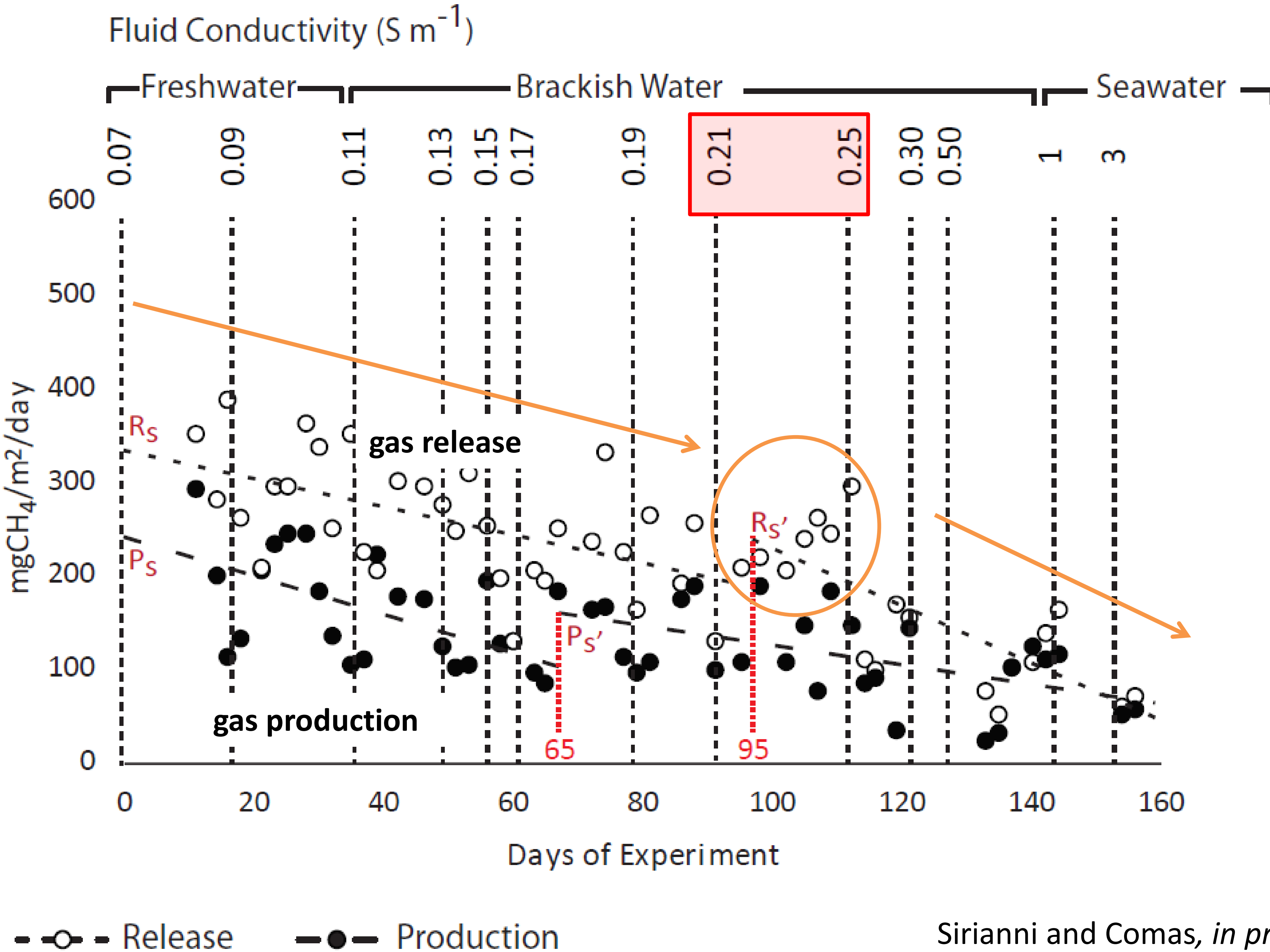


*Sub-tropical vs. boreal peat soils show strikingly similar **pore dilation** dynamics*

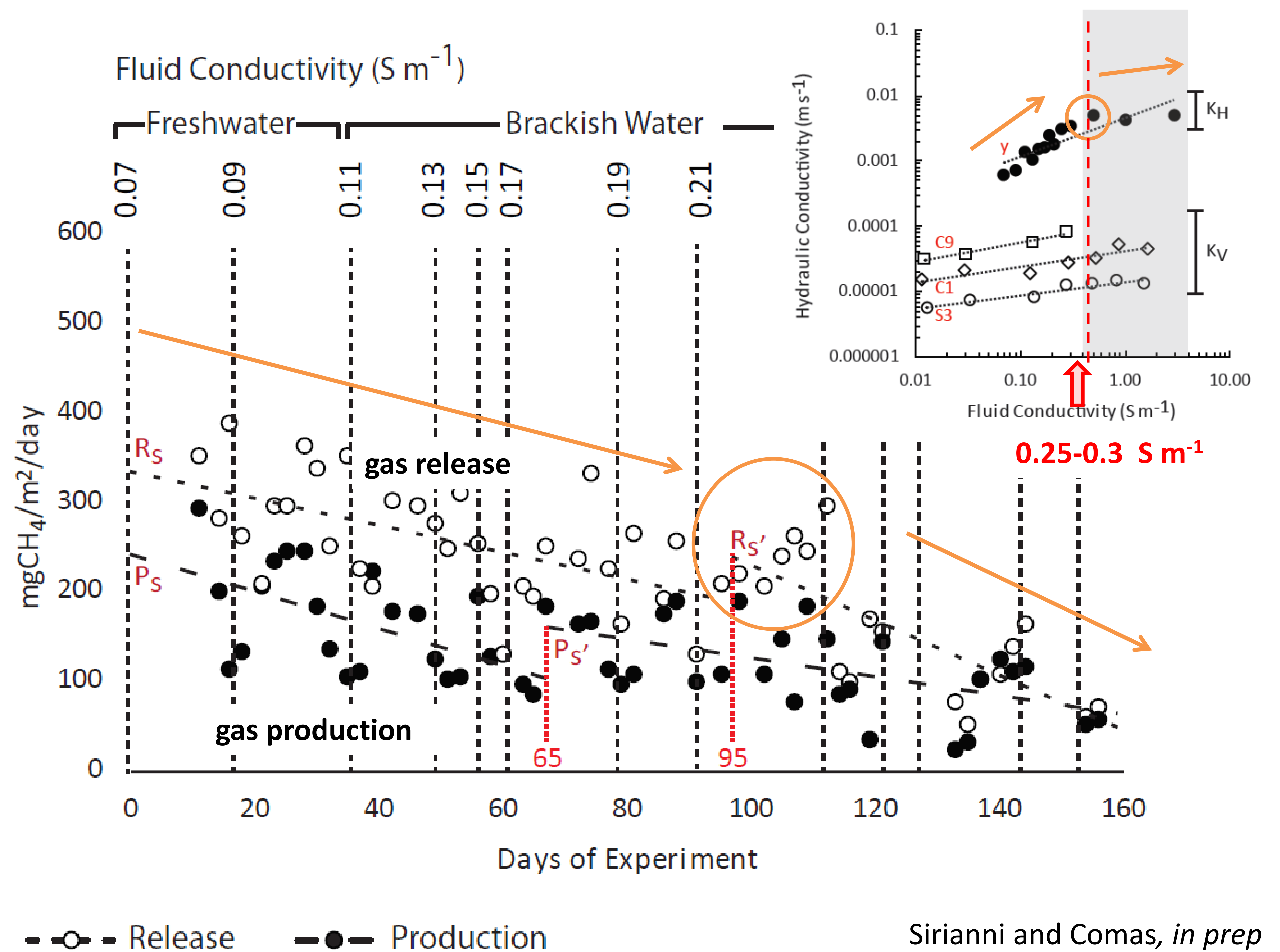
Biogenic gas dynamics



Sirianni and Comas, *in prep*



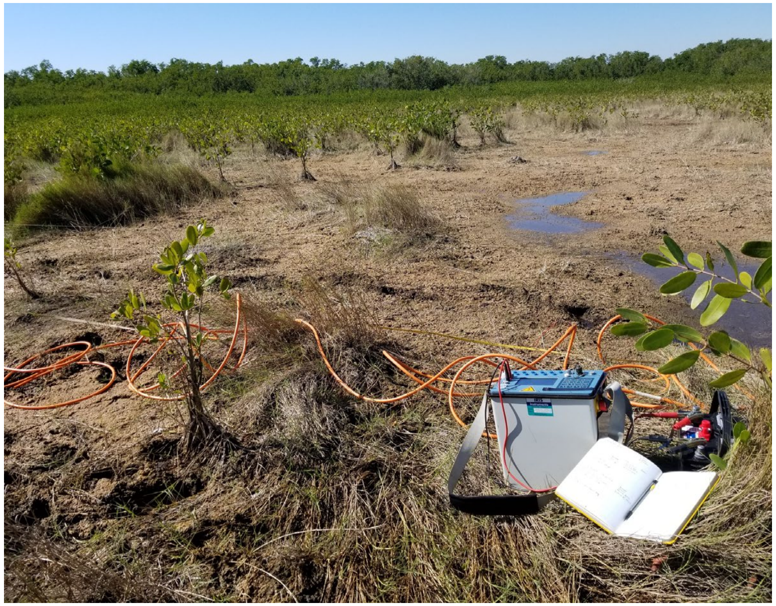
Sirianni and Comas, *in prep*



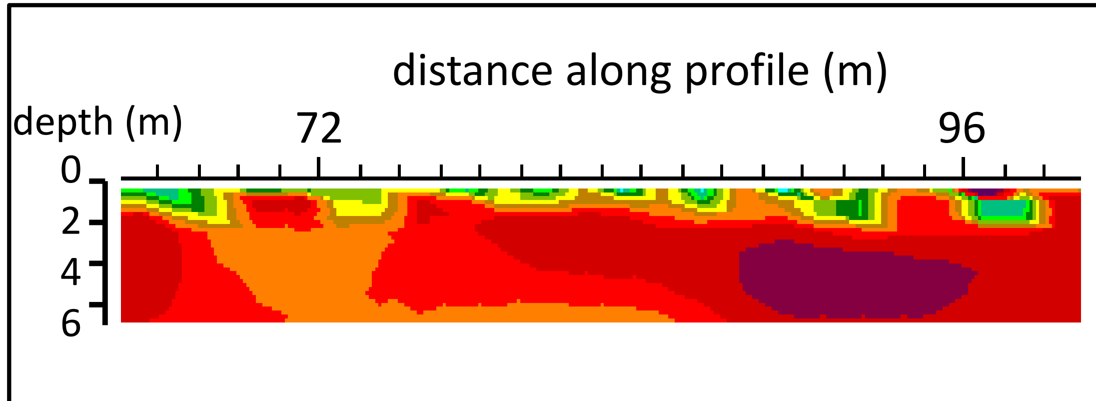
Sirianni and Comas, *in prep*

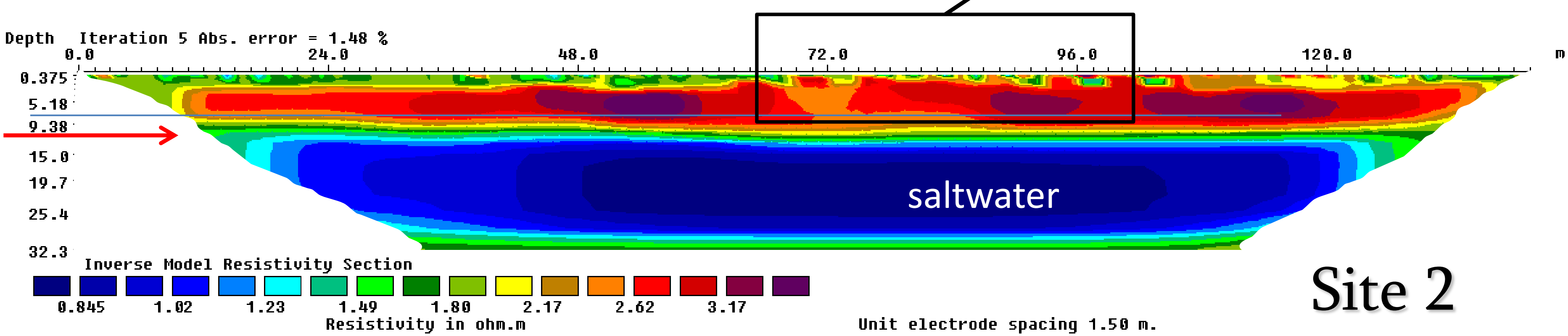

Site 1
Site 1
Site 2
Site 2

b) Landscape scale: geophysical characterization

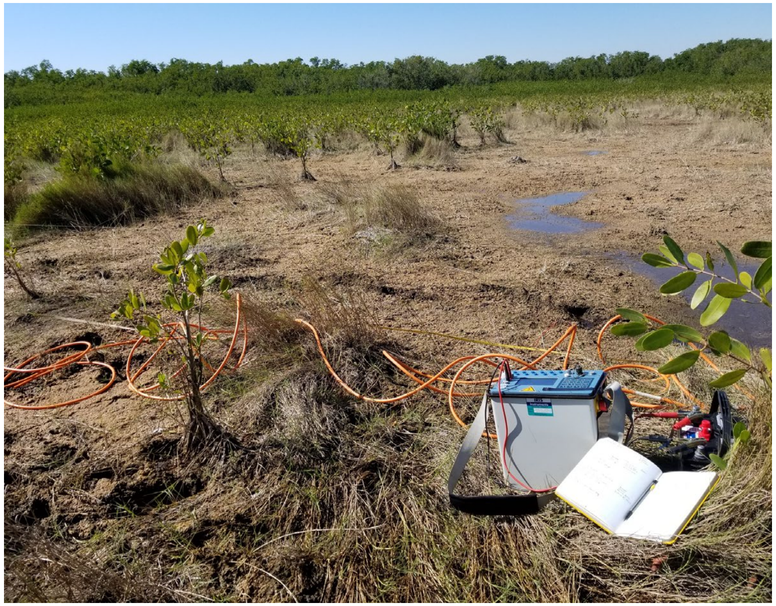


Electrical resistivity imaging (ERI)

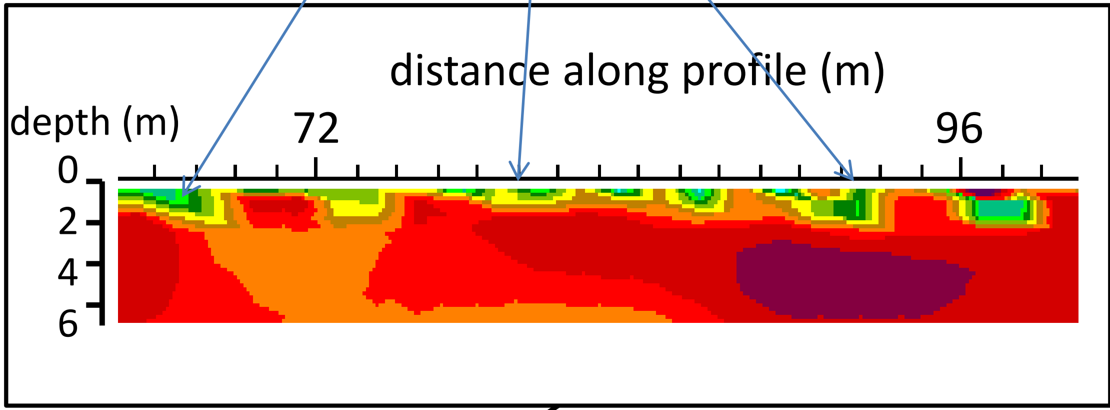


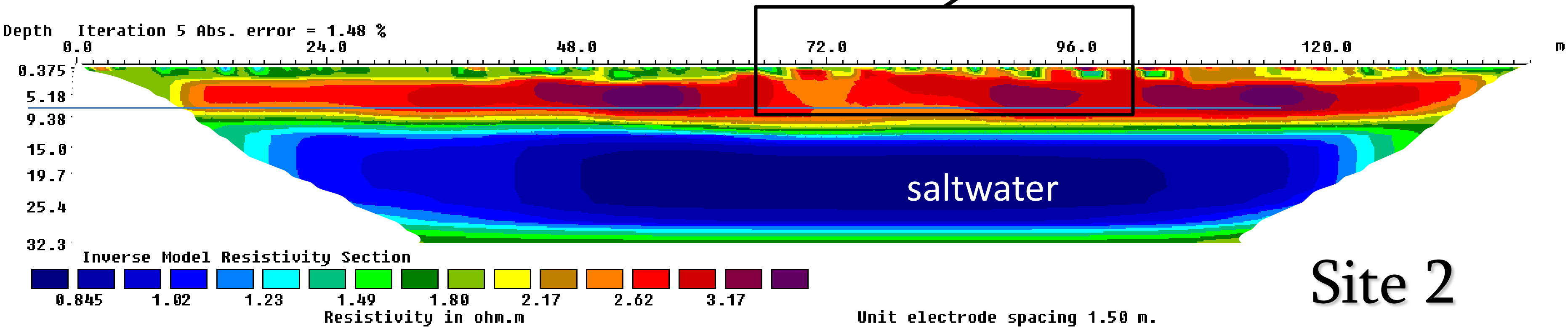


Site 2



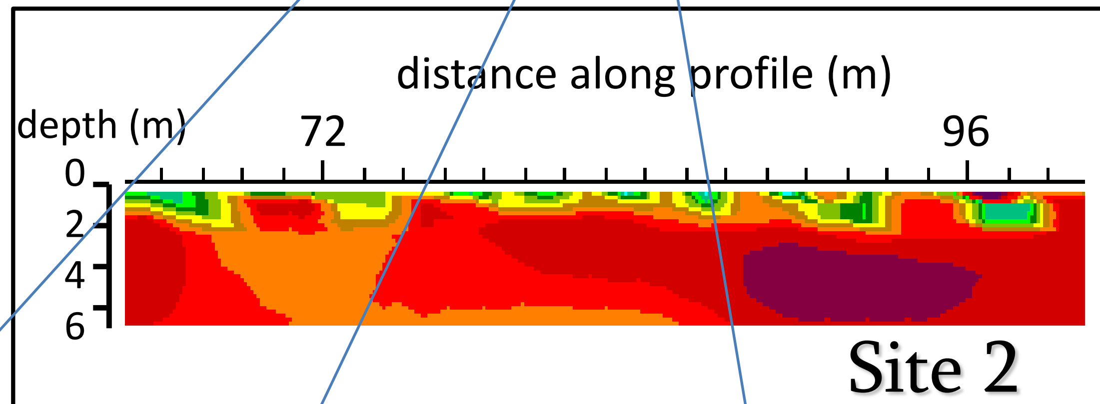
-*areas of increased electrical conductivity*
- *0.5 to 1 m deep; 2-3 m wide*
-*potential ponds?*

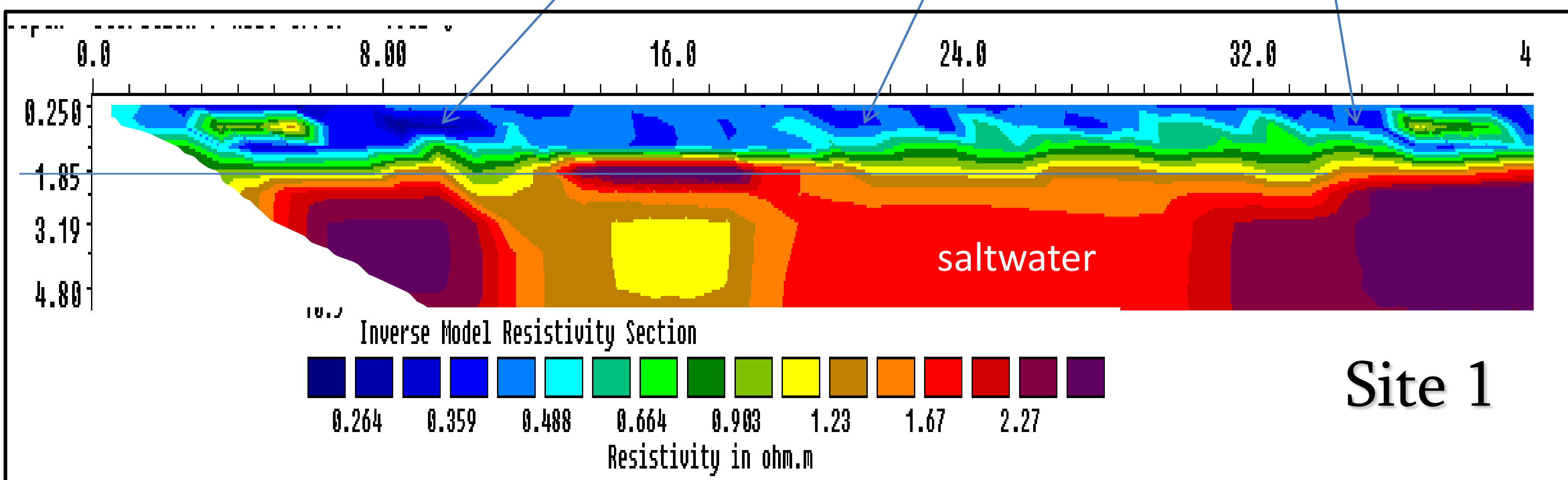




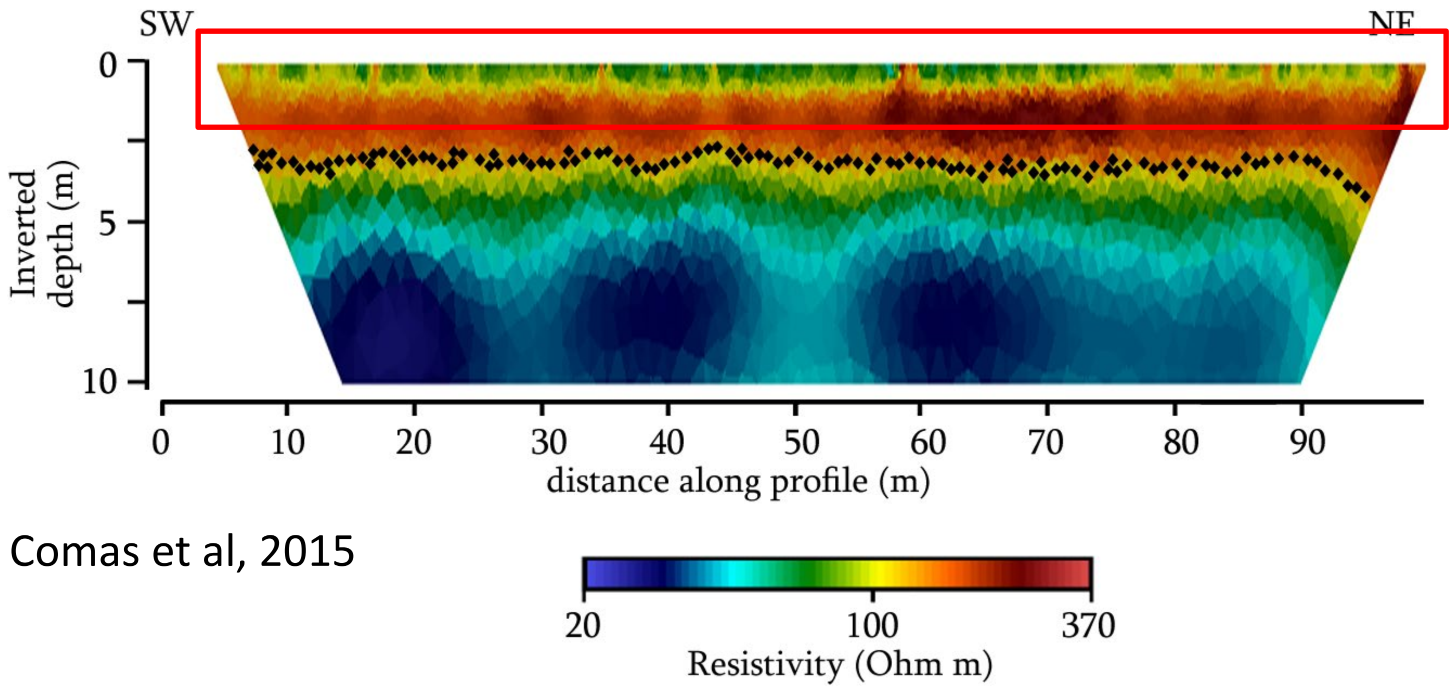
Site 2

-*areas of increased electrical conductivity*
-*Similar dimensions*
-*Better defined areas/ponds?*



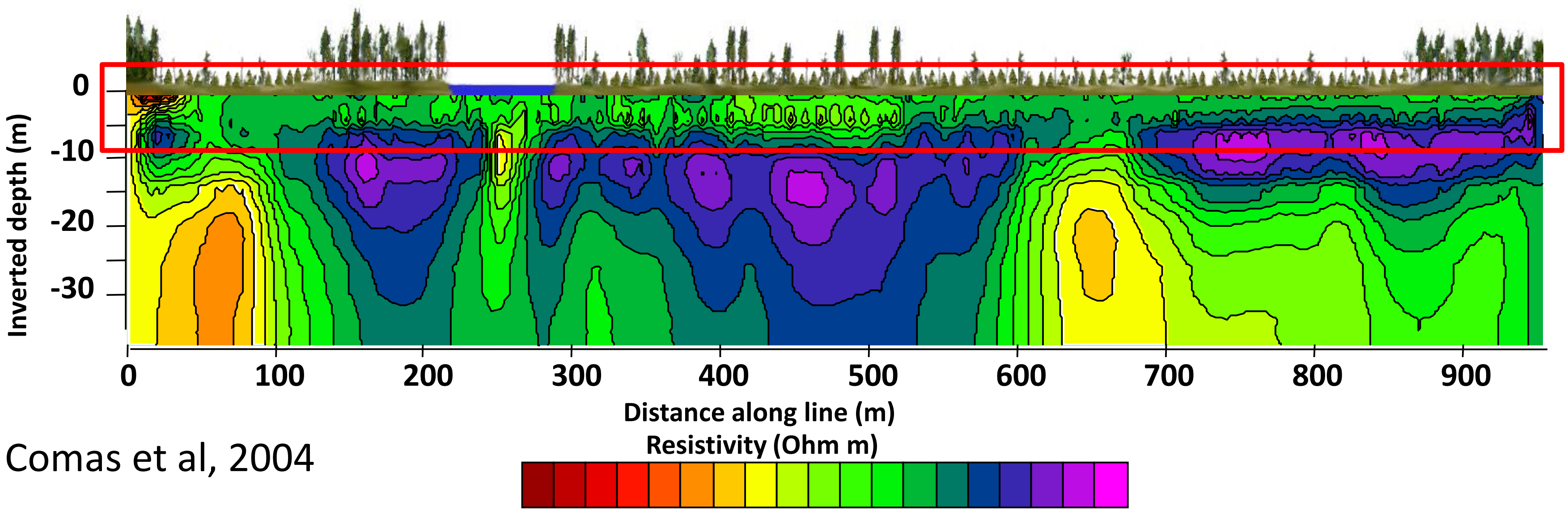


Tropical peat soils, West Kalimantan, Indonesia



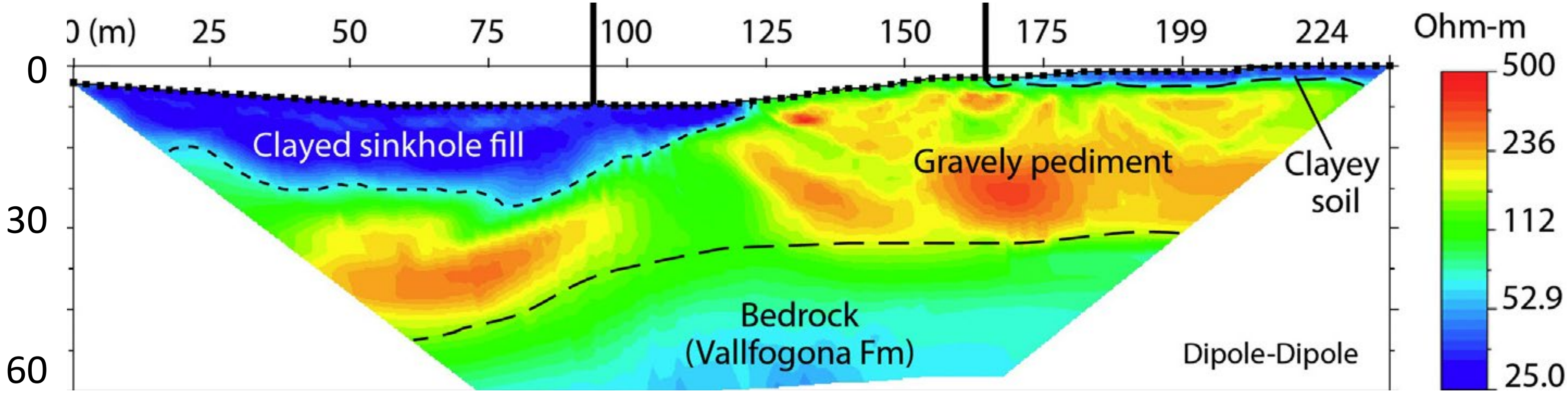
Comas et al, 2015

Boreal peat soils, Caribou Bog, Maine

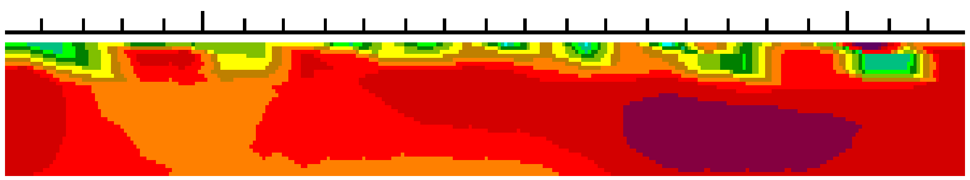


Comas et al, 2004

Sinkhole, Hostalnou, Spain

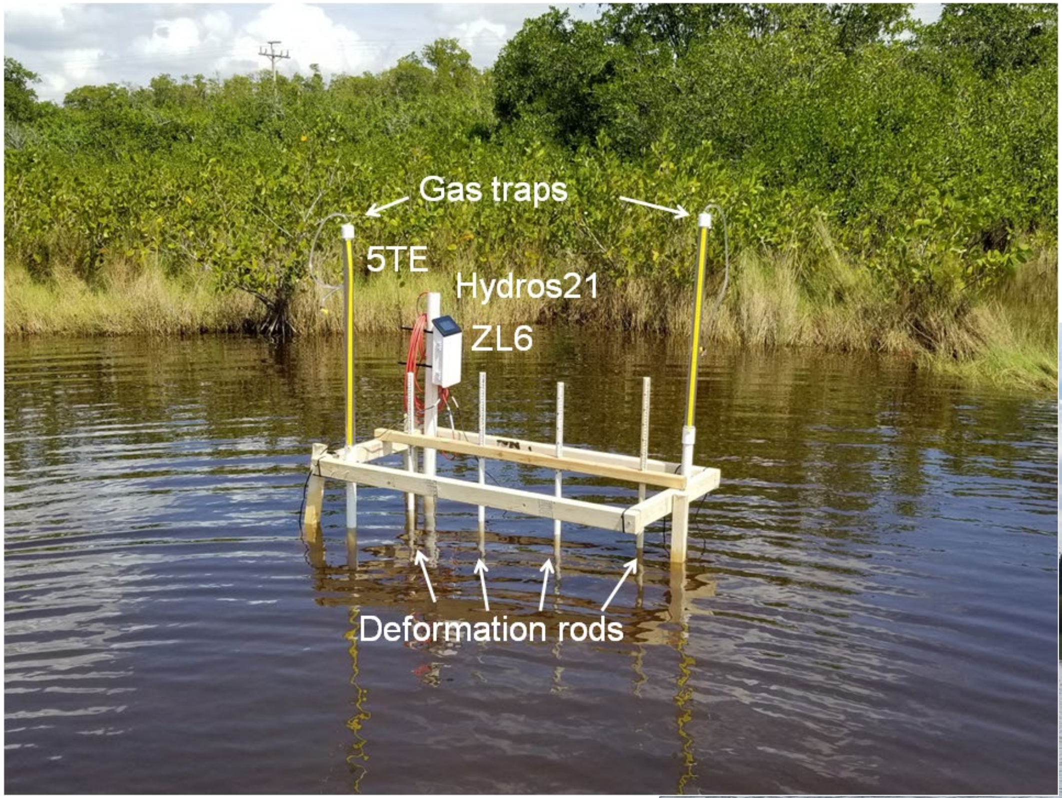


Fabregat, Comas et al, 2018



No continuity either laterally (like thicker peatland systems) or with depth (like sinkholes or dissolution features)

c) Plot scale: platform setup

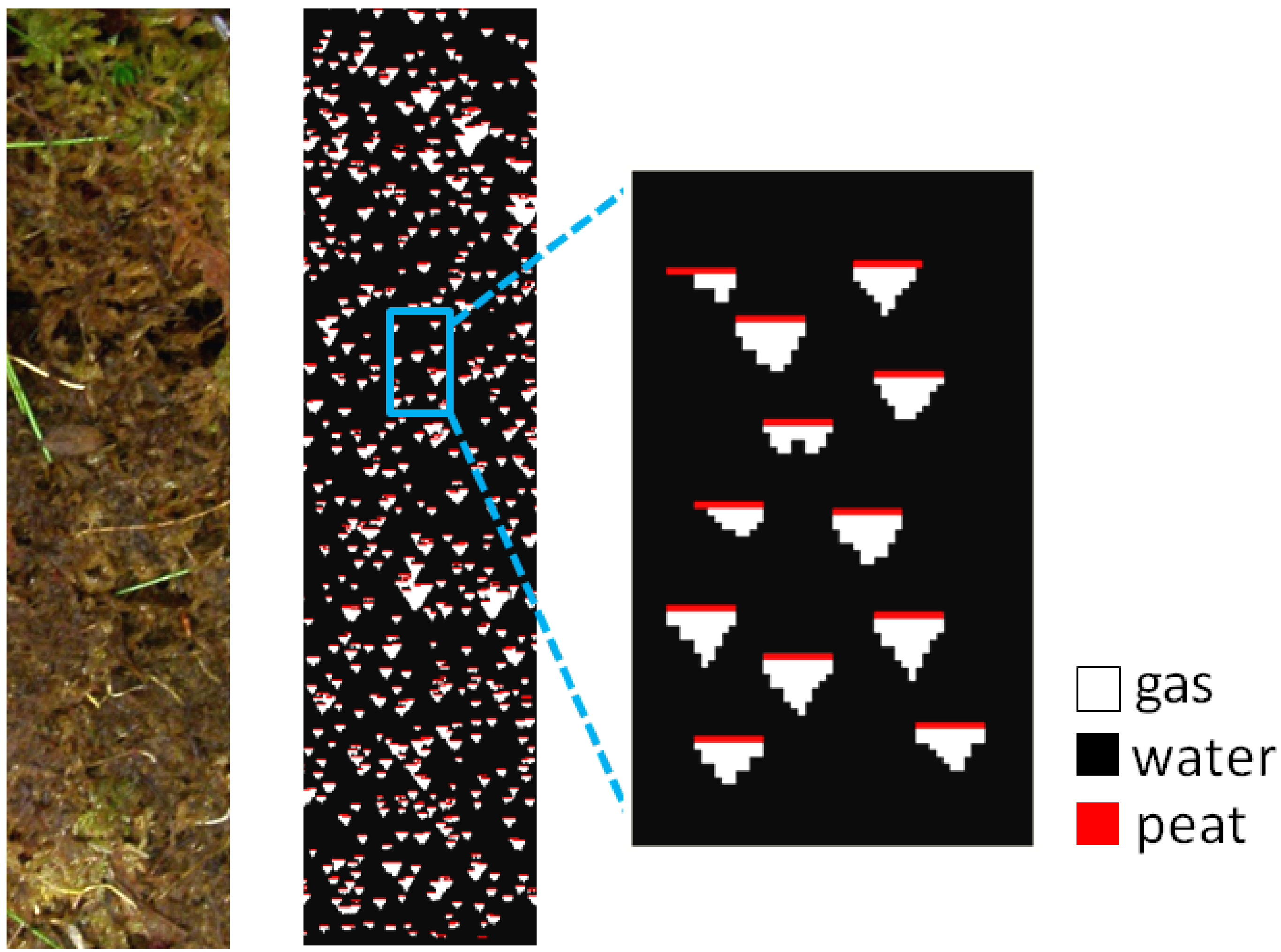


- Gas released
- moisture content
- Temperature
- EC
- water table
- salinity
- surface deformation

d) Modeling

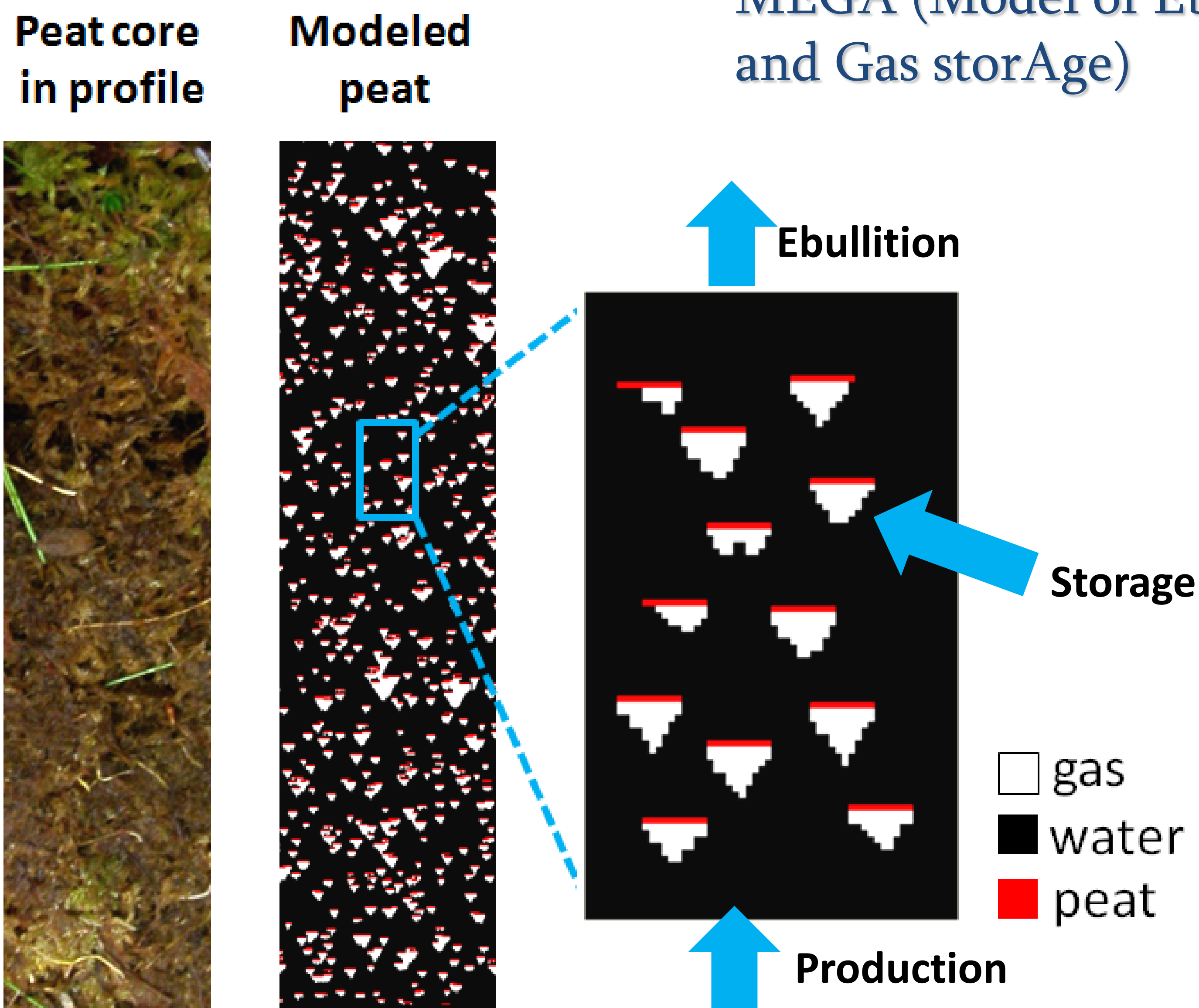
MEGA (Model of Ebullition and Gas storAge)

Peat core in profile | **Modeled peat**

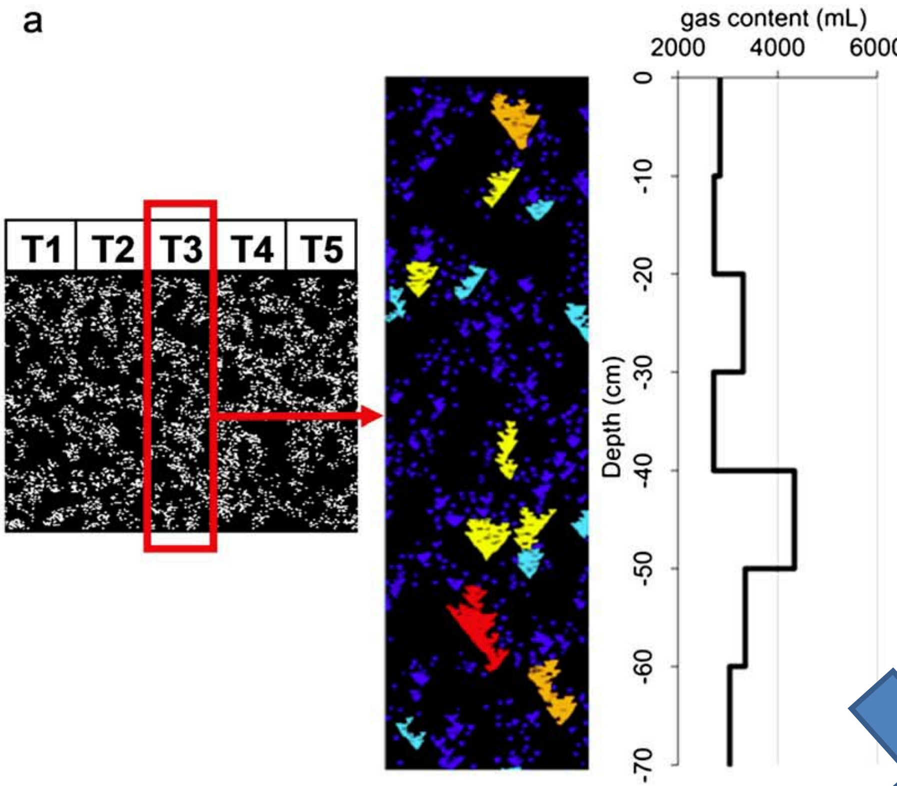


d) Modeling

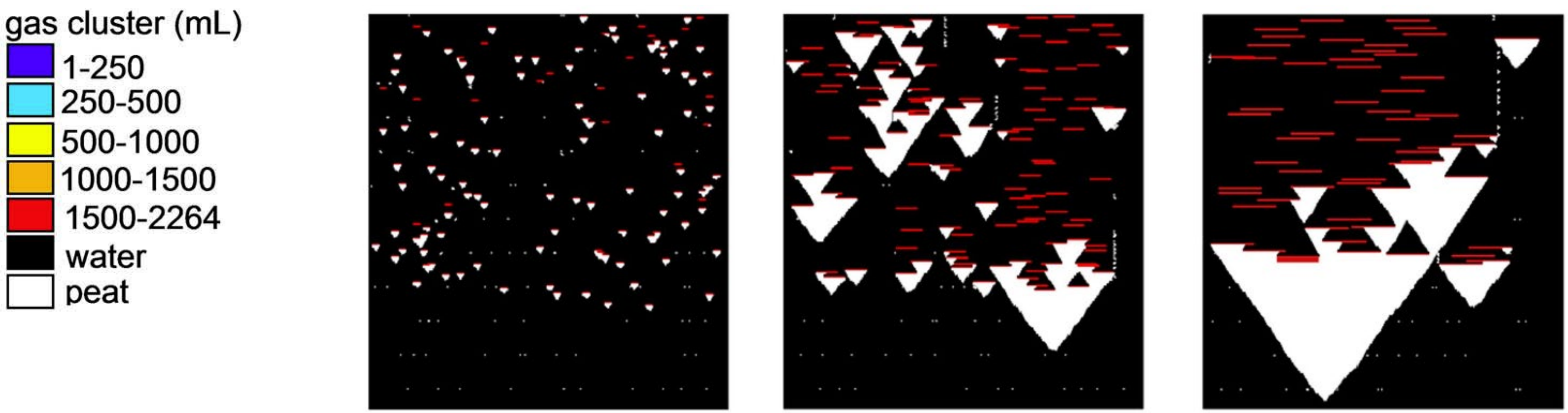
MEGA (Model of Ebullition and Gas storAge)



Modified from Ramirez et al, 2015



from Wright, Comas et al, 2018



Open peat

Dense peat

6. Conclusions

- **Physical properties:**
  - *Increased salinization induces progressive peat pore dilation resulting in increased hydraulic conductivity. Threshold at around 0.2-0.3 S m^{-1} with a change in dynamics*
  - *Strikingly similar pore dilation dynamics between boreal and subtropical soils*
  - *At the field scale, pond initiation is characterized by a contrast in electrical conductivity with no apparent lithological control from underlying limestone*

- **Biogenic gas dynamics:**
  - *Progressive decreased in production, accumulation, and release of biogenic gas with increased conductivity. Consistent threshold showing change in dynamics (sudden release)*

7. Acknowledgements:

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