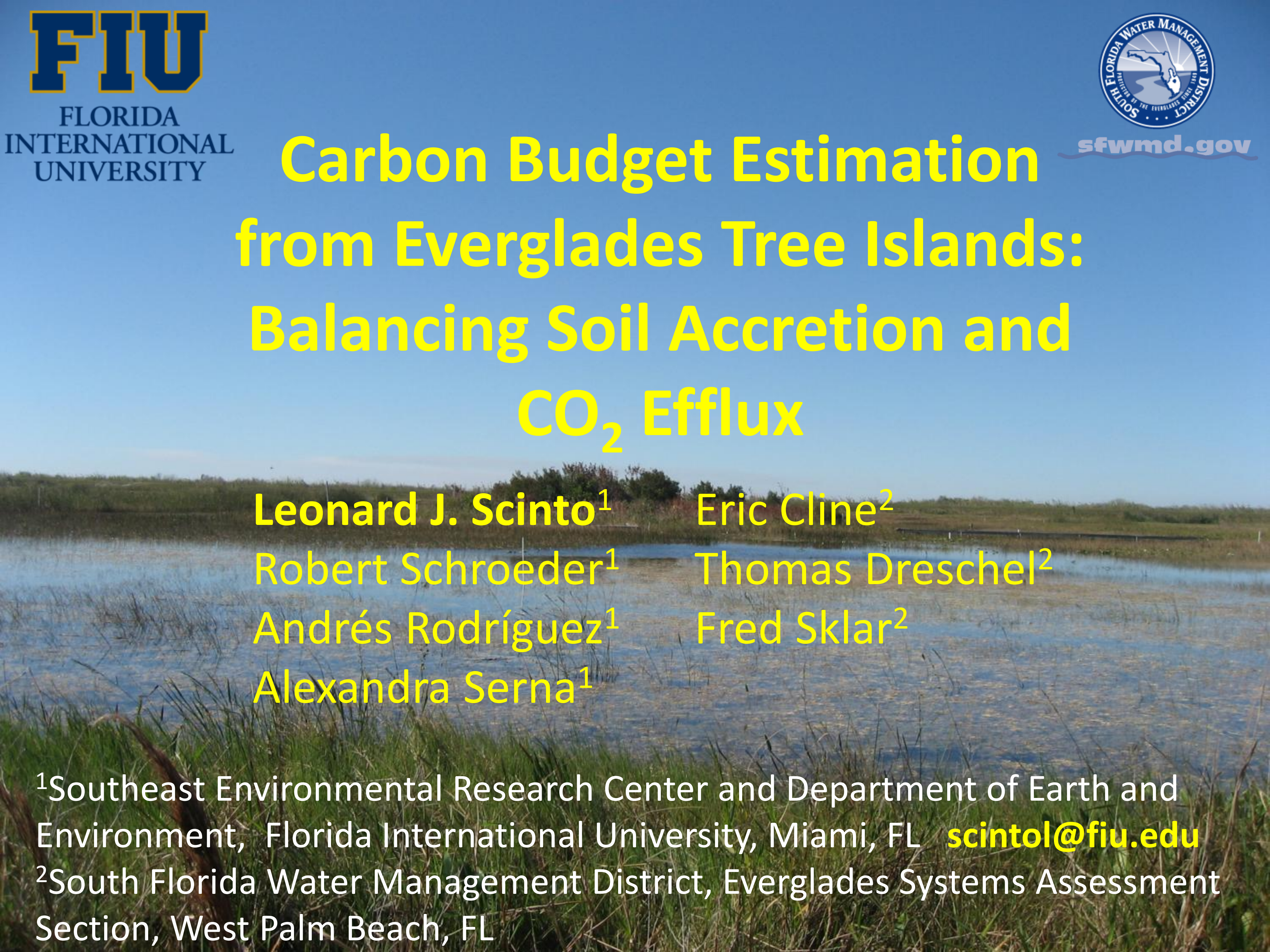

Carbon Budget Estimation from Everglades Tree Islands: Balancing Soil Accretion and CO_2 Efflux

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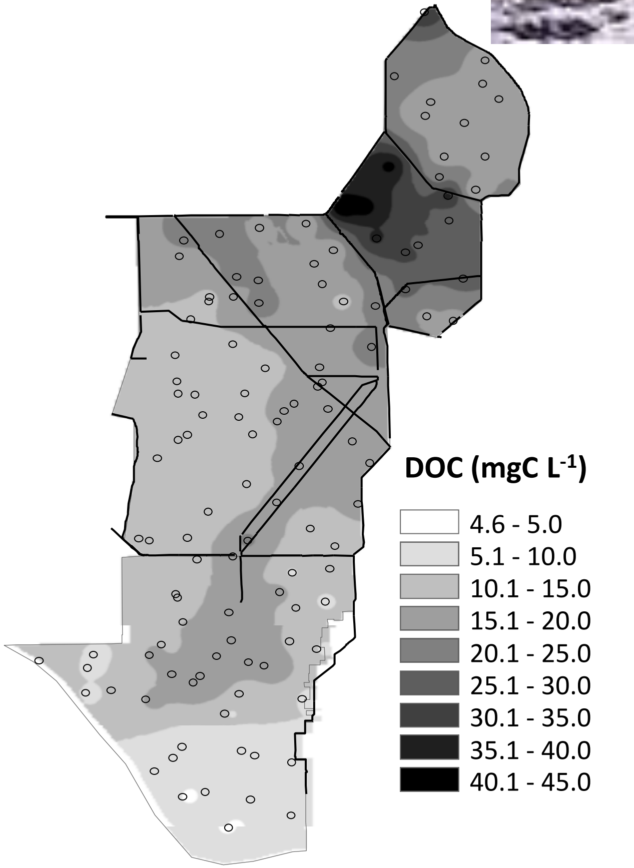
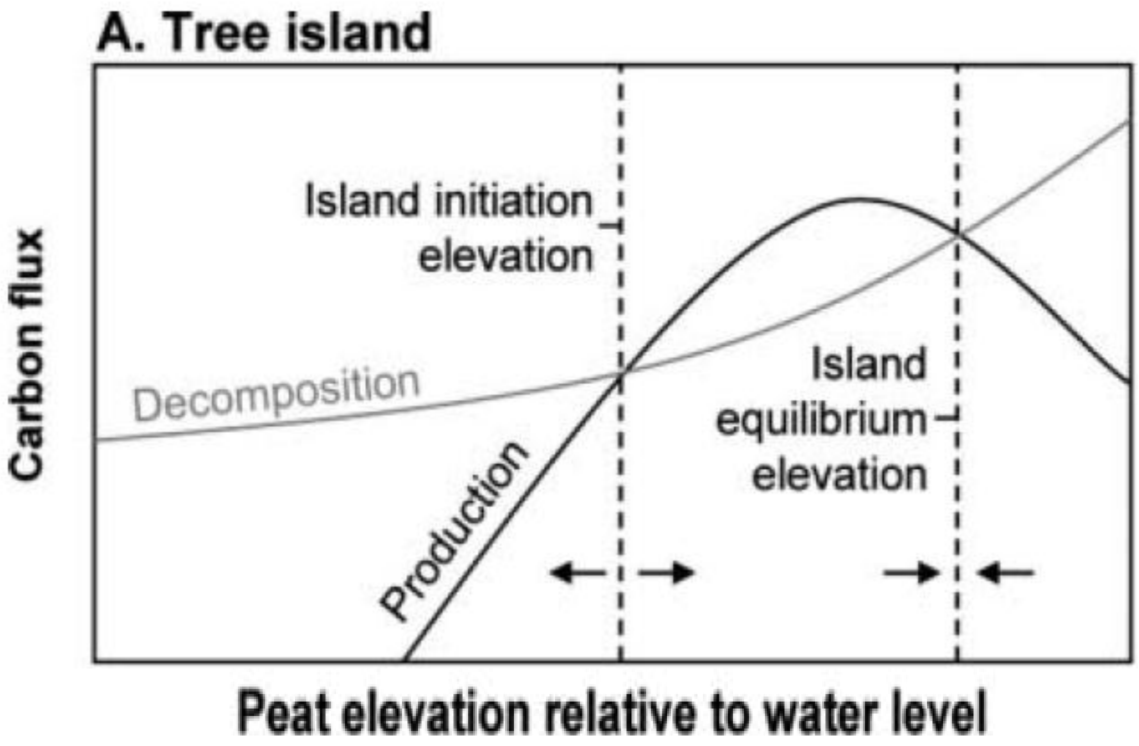
Drainage of the Everglades results in loss of stored Soil Carbon



Yamashita et al., 2010 Ecosystems 13:1006-1019

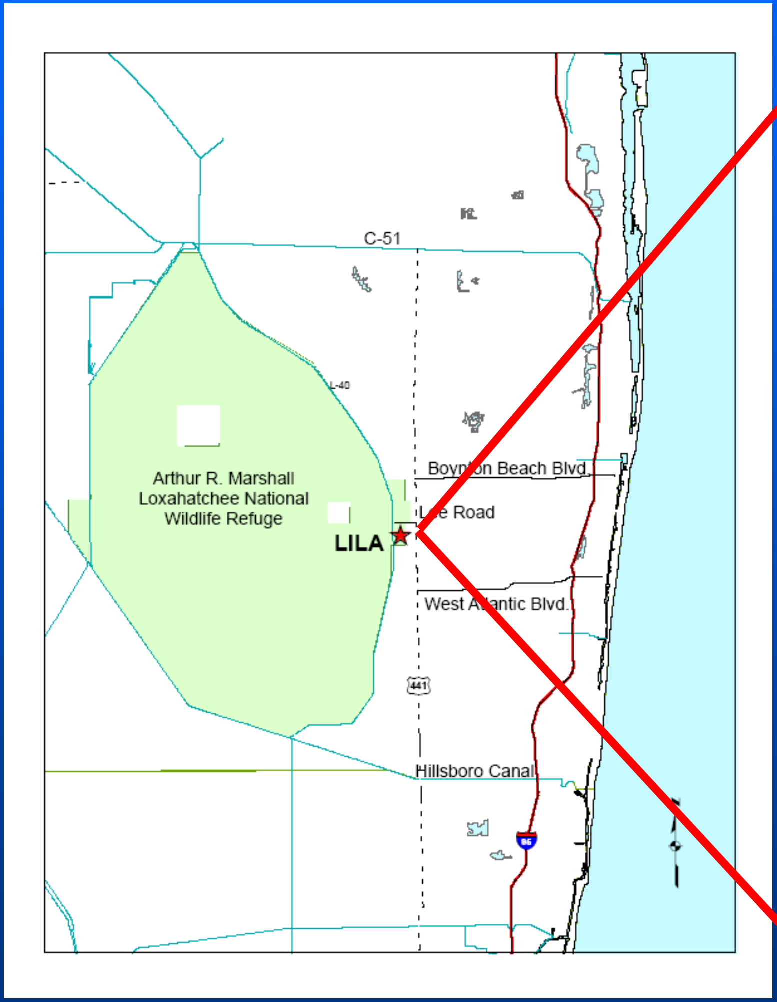
Our objective is to develop a model based on empirical data for tree island soil carbon sequestration/release relative to water depth fluctuations



From Fig. 4 Larsen et al., 2011 Crit Rev Environ Sci Technol. 41 (S1):344-381

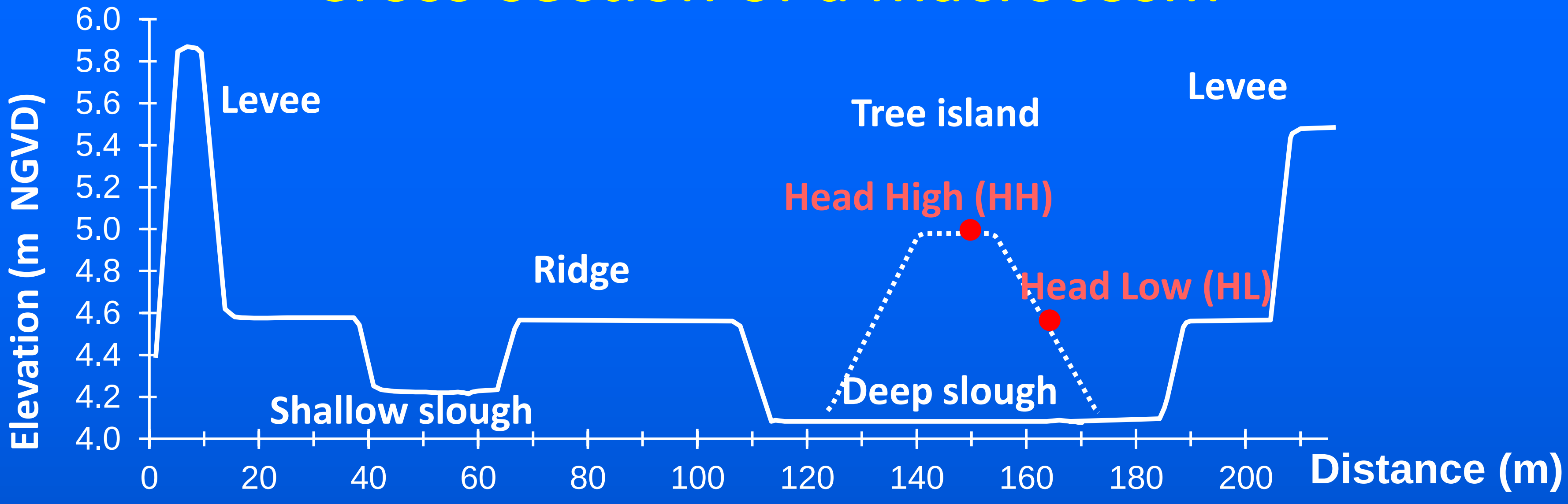
Loxahatchee Impoundment Landscape Assessment

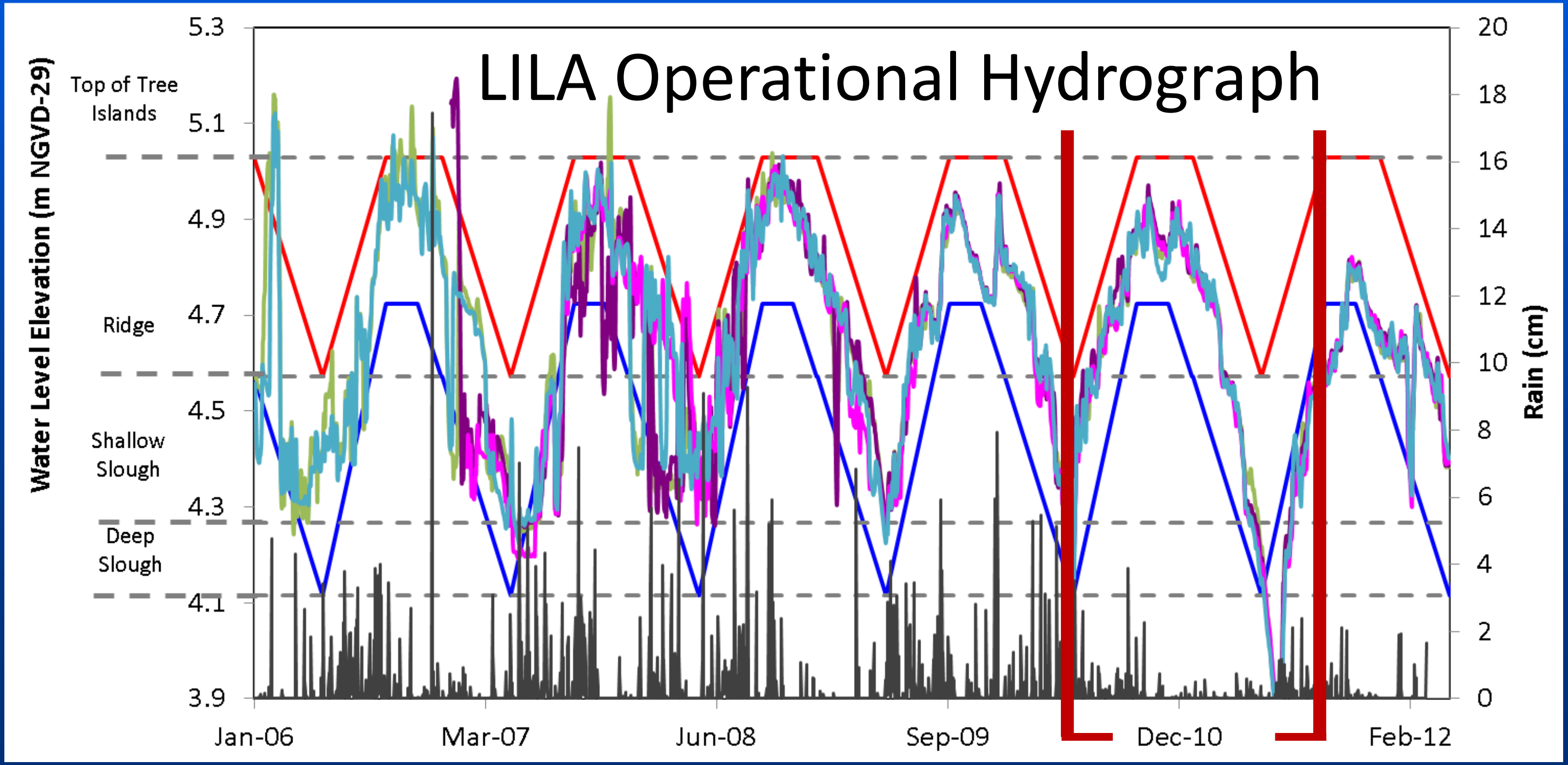
LILA



Aich et al., 2011 J. Environ Sci Engineer 5:289-302

Cross-section of a macrocosm

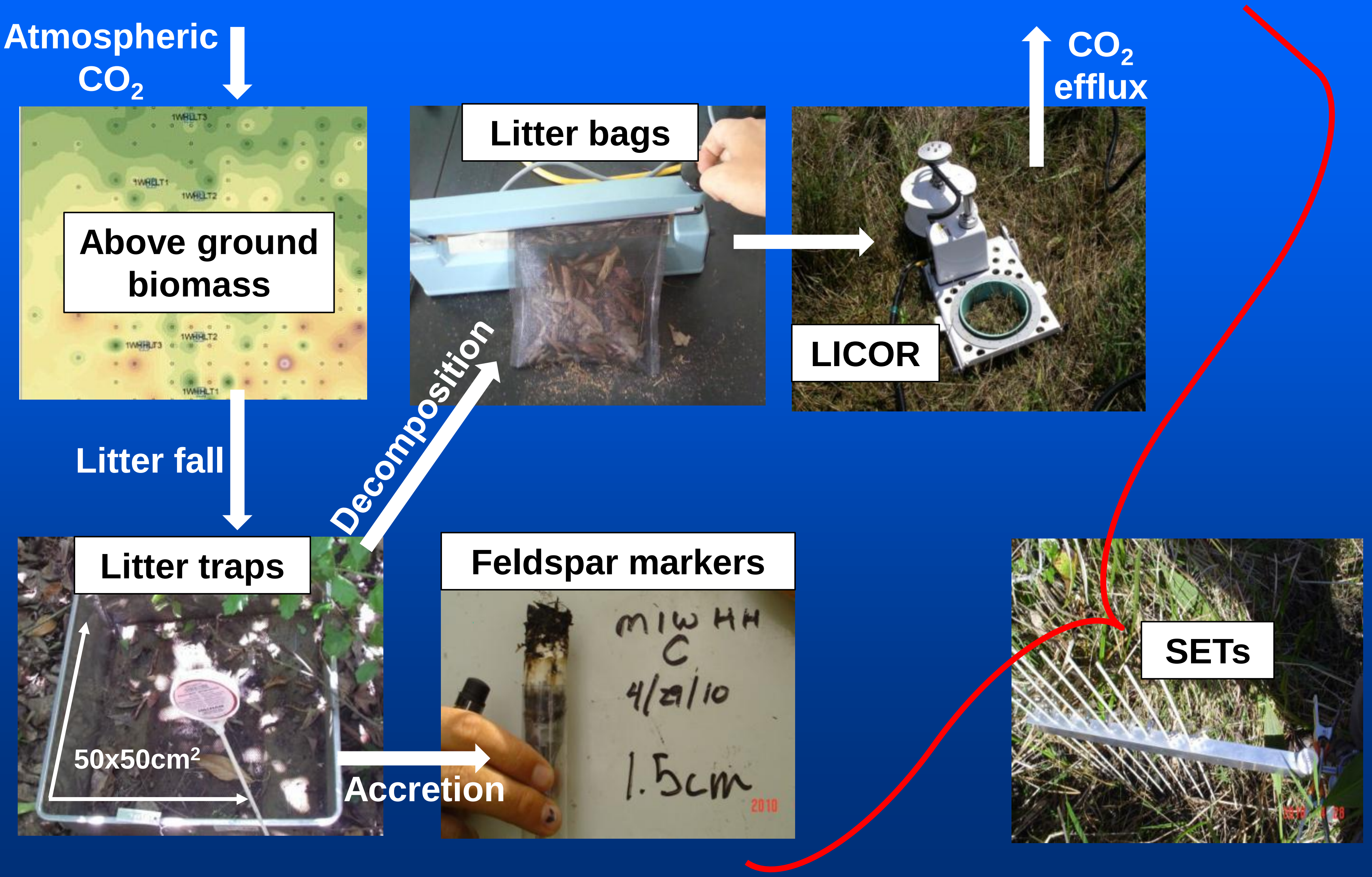




Tree island planting 2006

2010

Net soil C accumulation in tree islands is a balance between production and respiration



Atmospheric CO_2

Above ground biomass

Litter fall

Litter traps

$50 \times 50\,cm^2$

Decomposition

Litter bags

LICOR

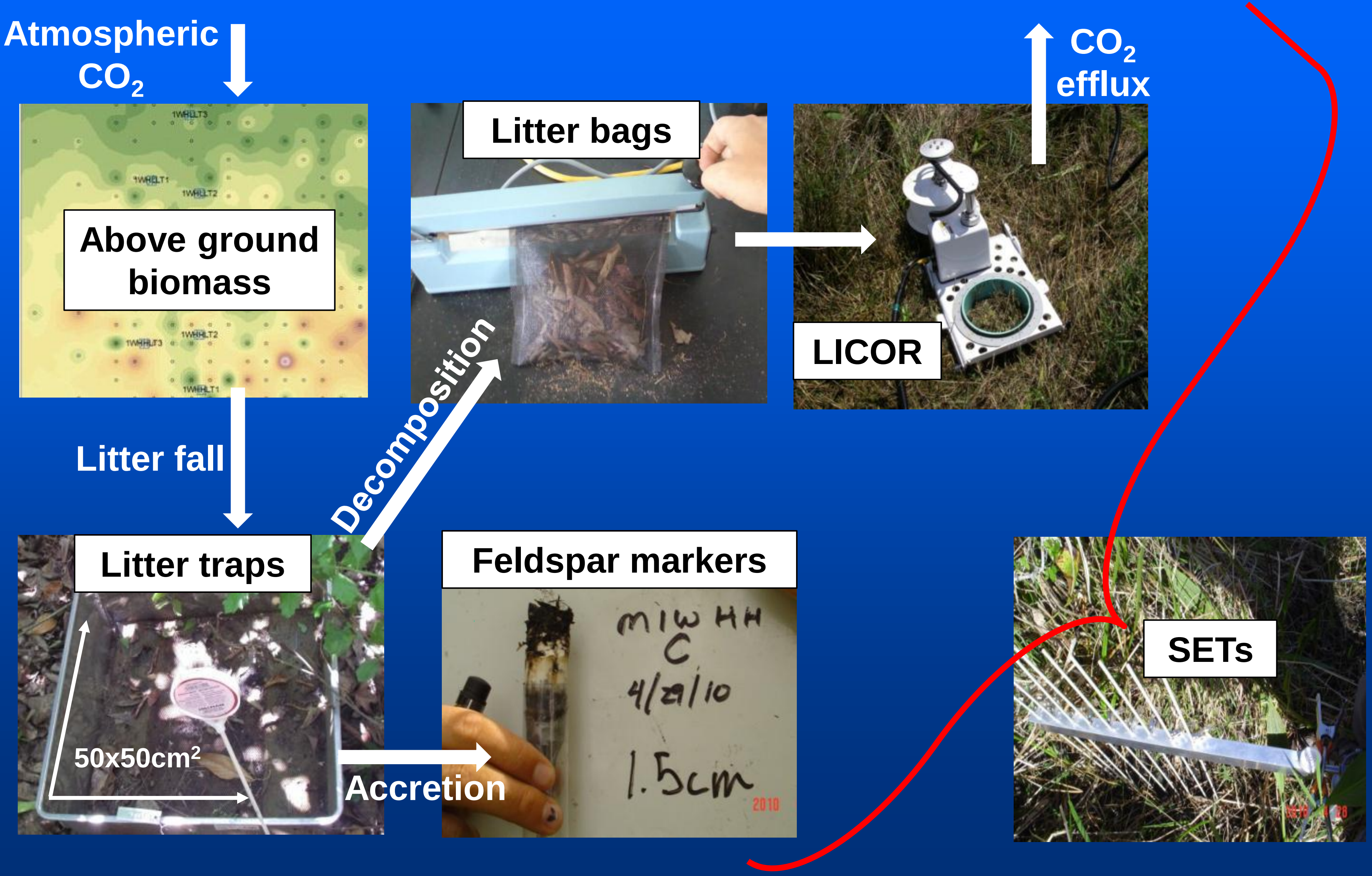
CO_2 efflux

Accretion

Feldspar markers

SETs

Organic matter respiration will be greater at higher elevations because of reduced inundation



Atmospheric CO_2

Above ground biomass

Litter fall

Litter traps

50x50cm^2

Decomposition

Litter bags

LICOR

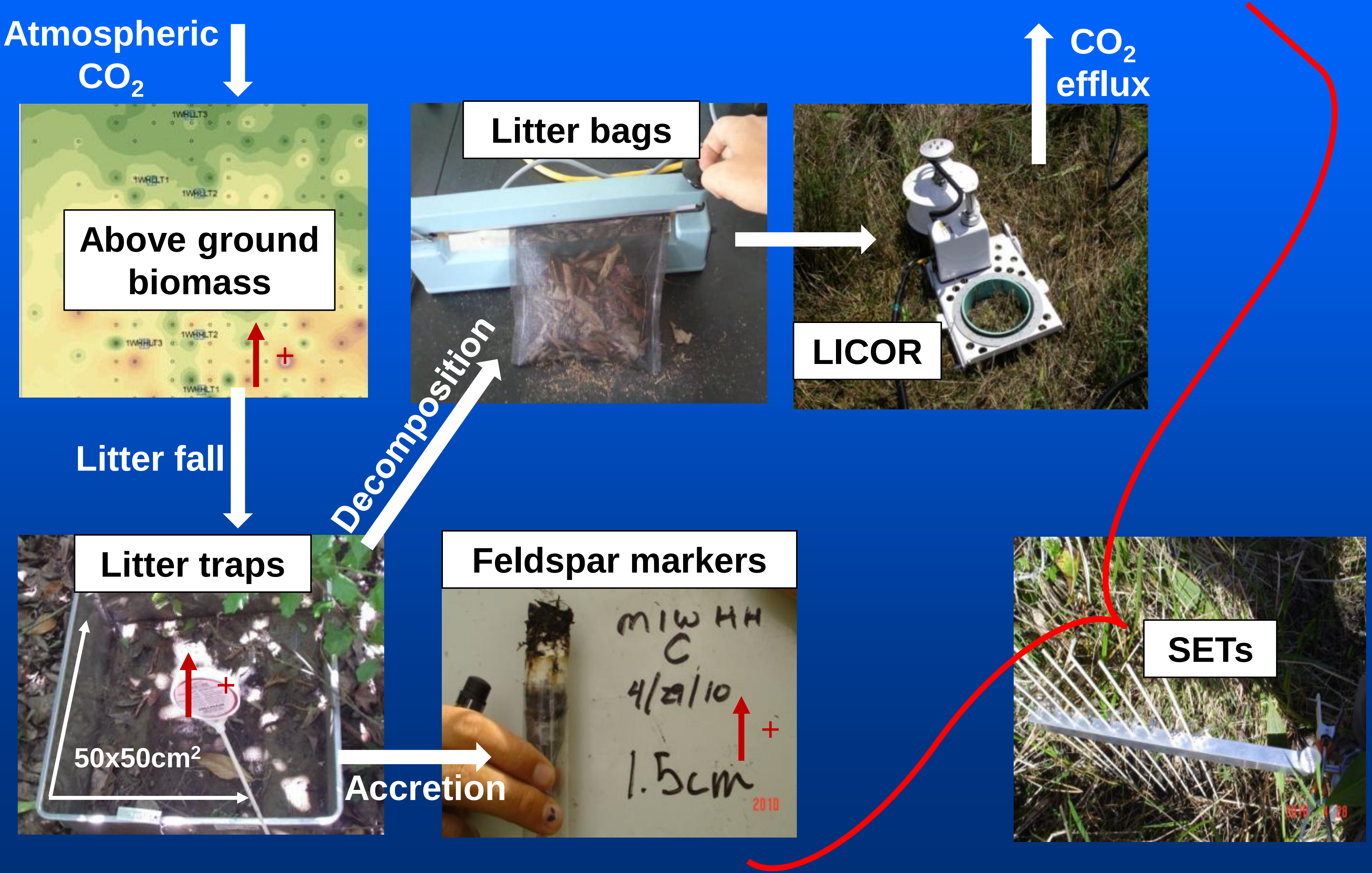
CO_2 efflux

Accretion

Feldspar markers

SETs

Litter production and soil building will be higher at high elevations because of higher biomass growth



Atmospheric CO_2

Above ground biomass

Litter fall

Litter traps

50x50cm^2

Decomposition

Litter bags

LICOR

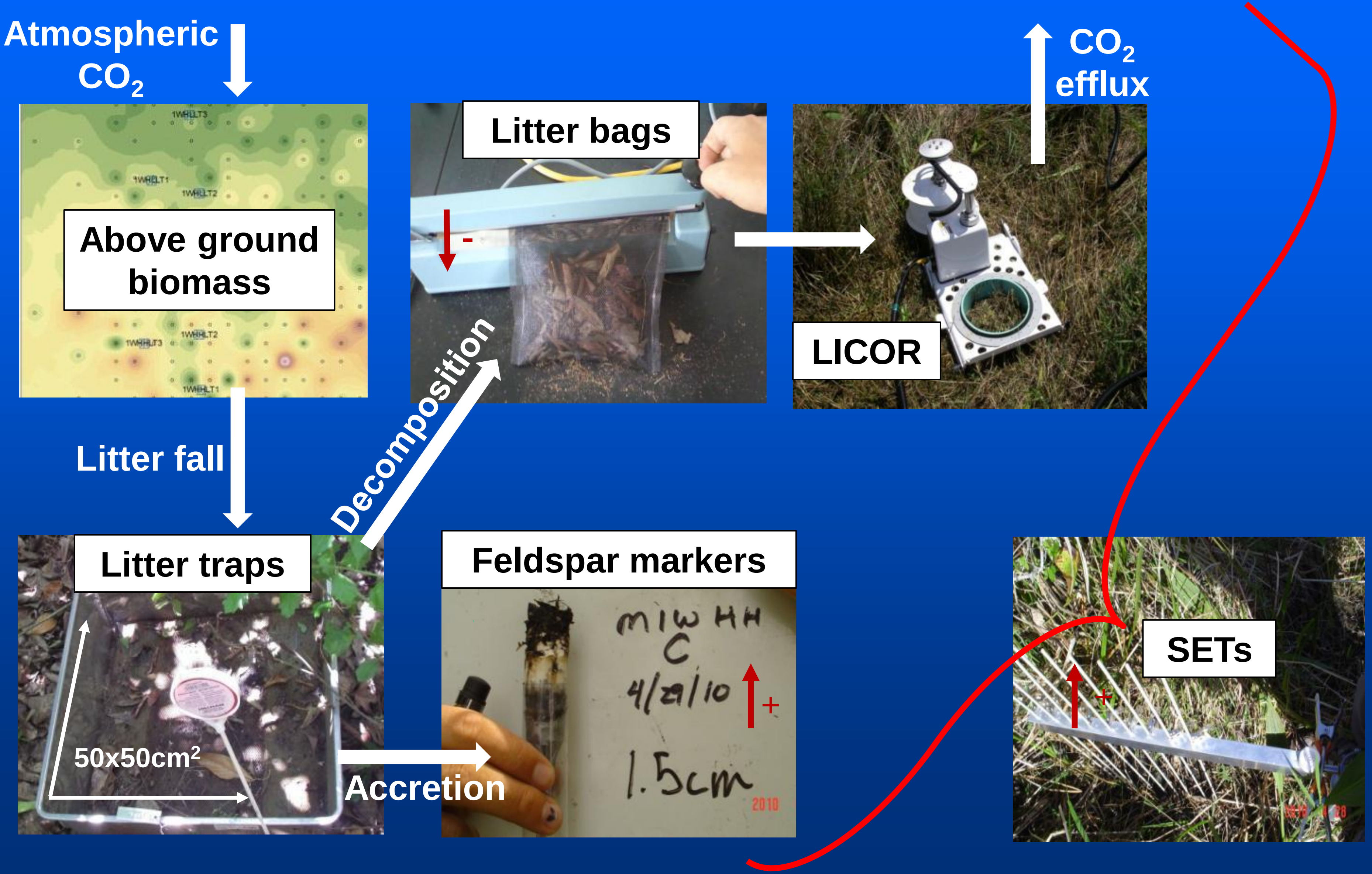
CO_2 efflux

Accretion

Feldspar markers

SETs

Tree island will increase in elevation if soil building occurs at a rate greater than decomposition



Atmospheric CO_2

Above ground biomass

Litter fall

Litter traps

$50x50cm^2$

Decomposition

Litter bags

CO_2 efflux

LICOR

Accretion

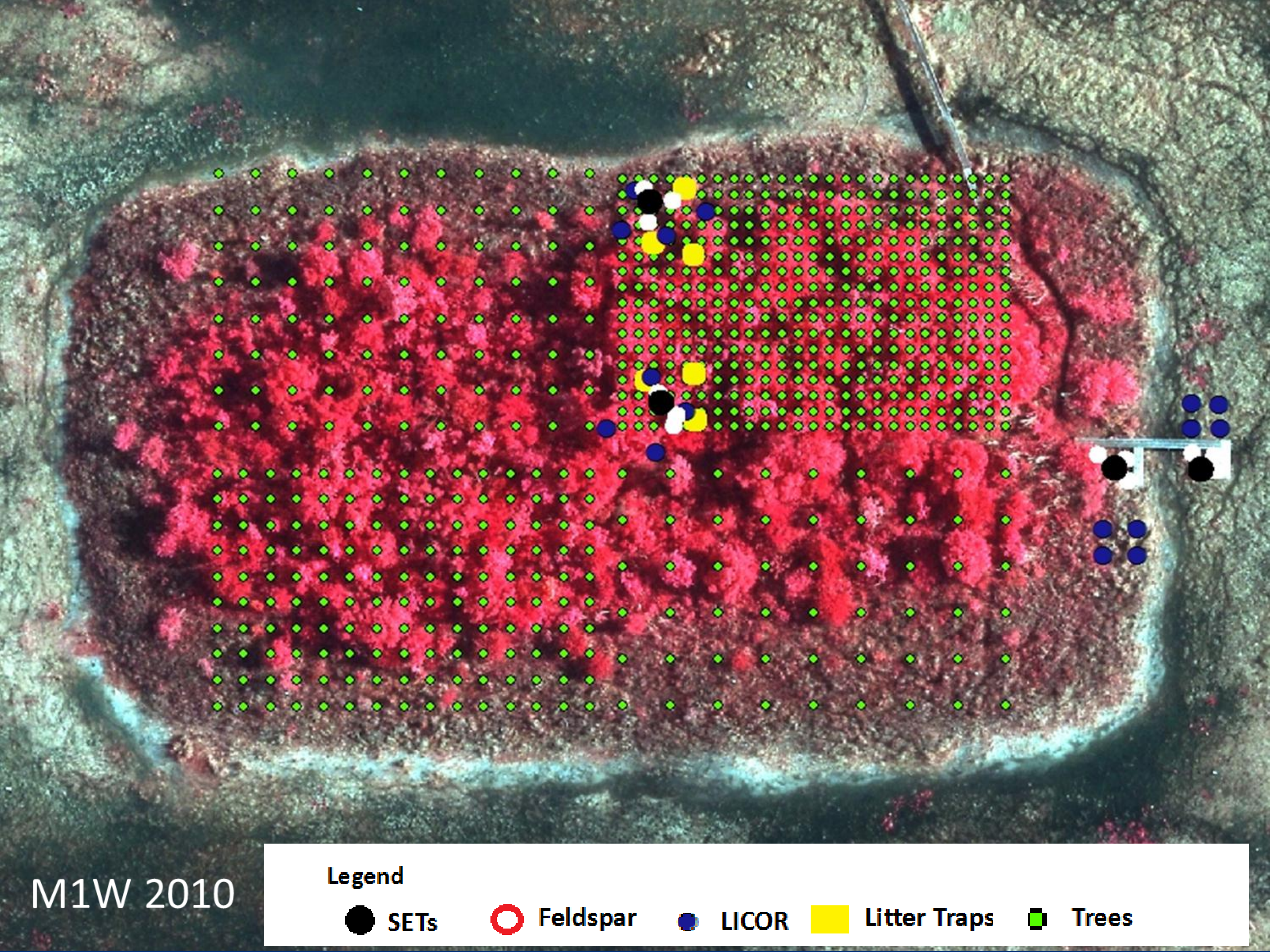
Feldspar markers

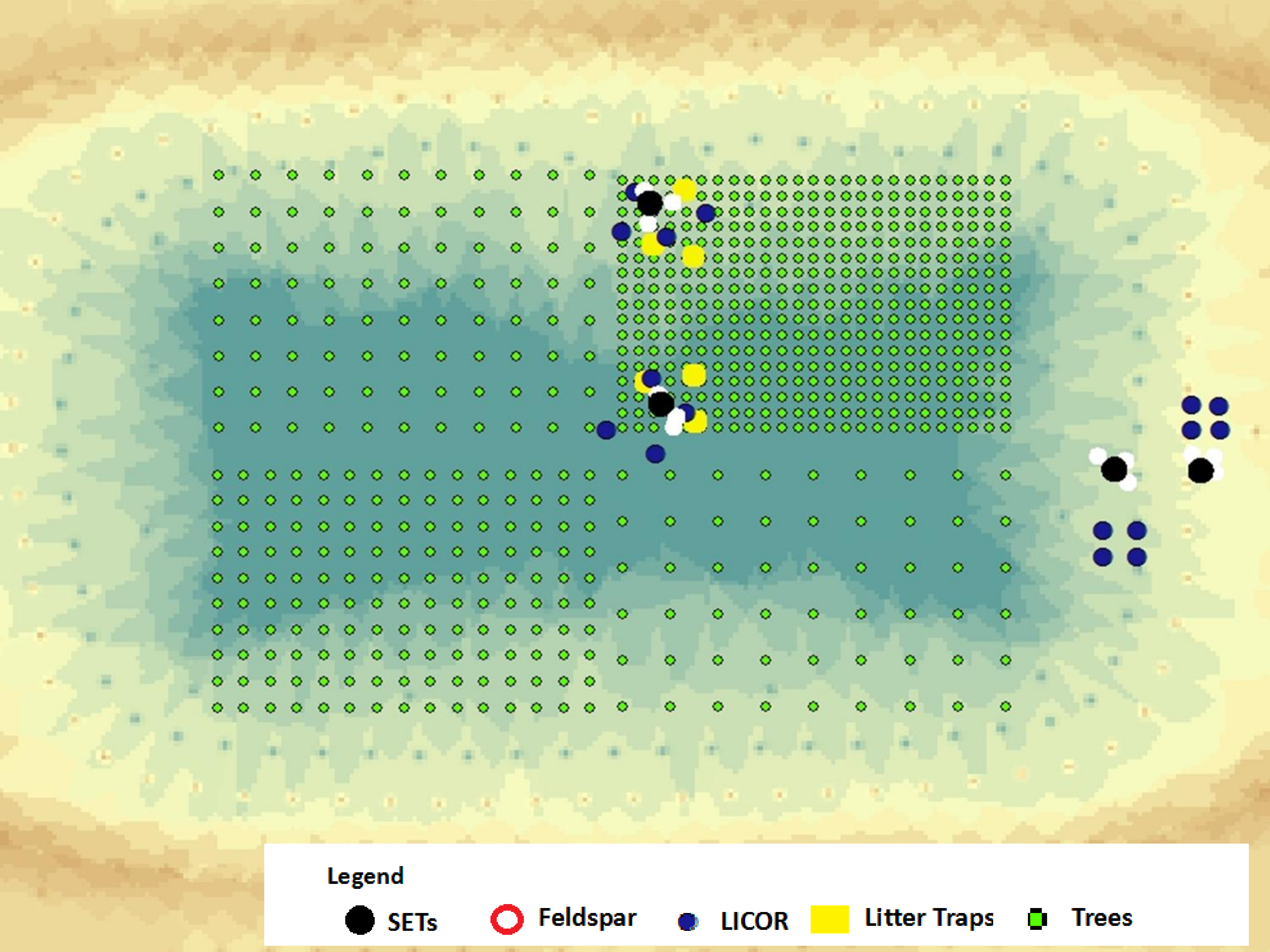
SETs

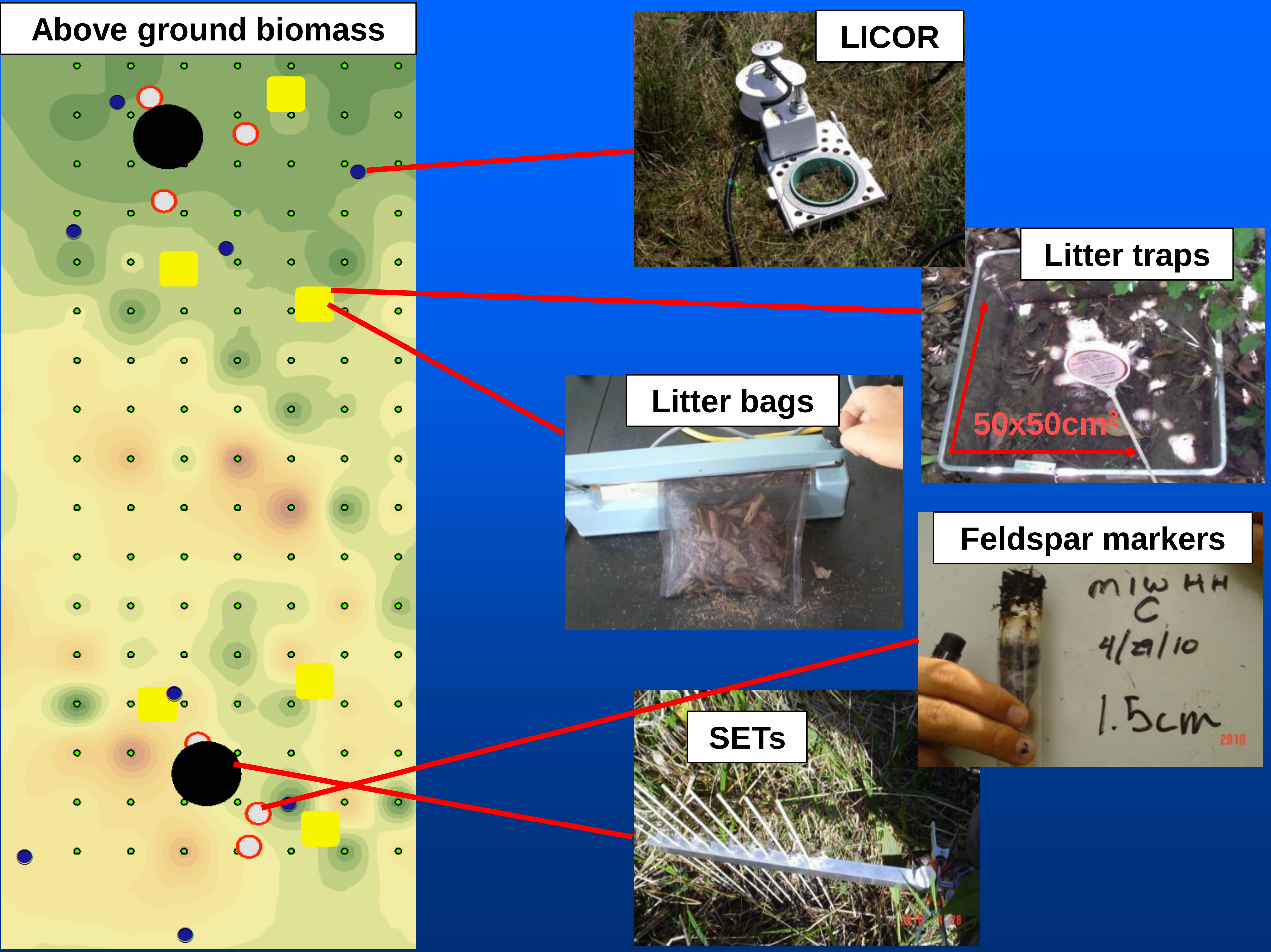
M1W 2006

M1W 2006

M1W 2010


M1W 2010


Legend
SETs
Feldspar
LICOR
Litter Traps
Trees



Above ground biomass

LICOR

Litter traps

Litter bags

Feldspar markers

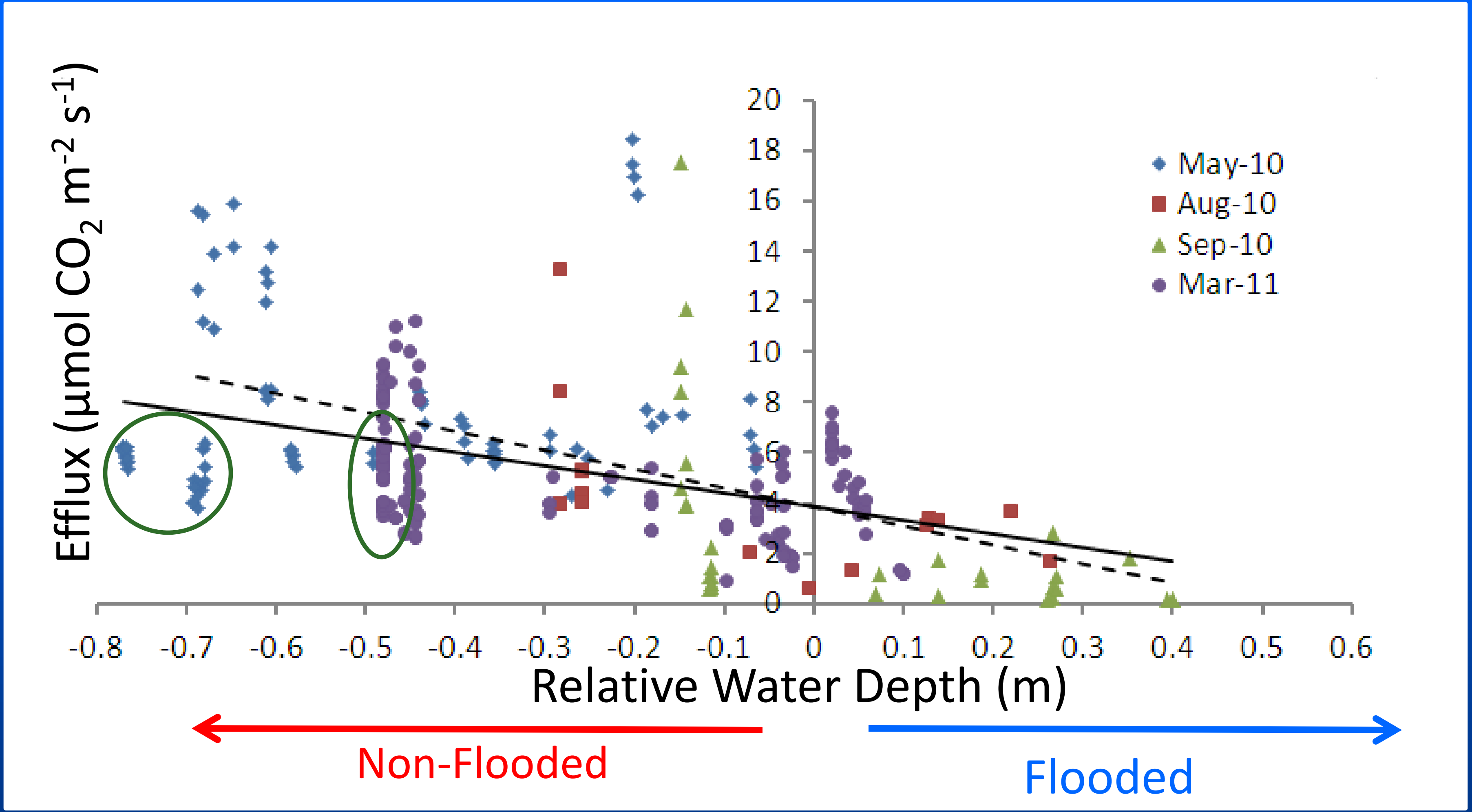
SETs

Soil CO_2 Efflux measured using a LICOR LI-8100 Infra-red Gas Analyzer (IRGA) with Multiplexer and Long-term automated chambers (4 - model 104 chambers) with 20 cm diameter collars.

Collars georectified in x, y, and z at each location. Soil elevation at each collar was determined and combined with daily stage to calculate relative water depth (RWD).

Collars sampled once quarterly for approximately 24 h.

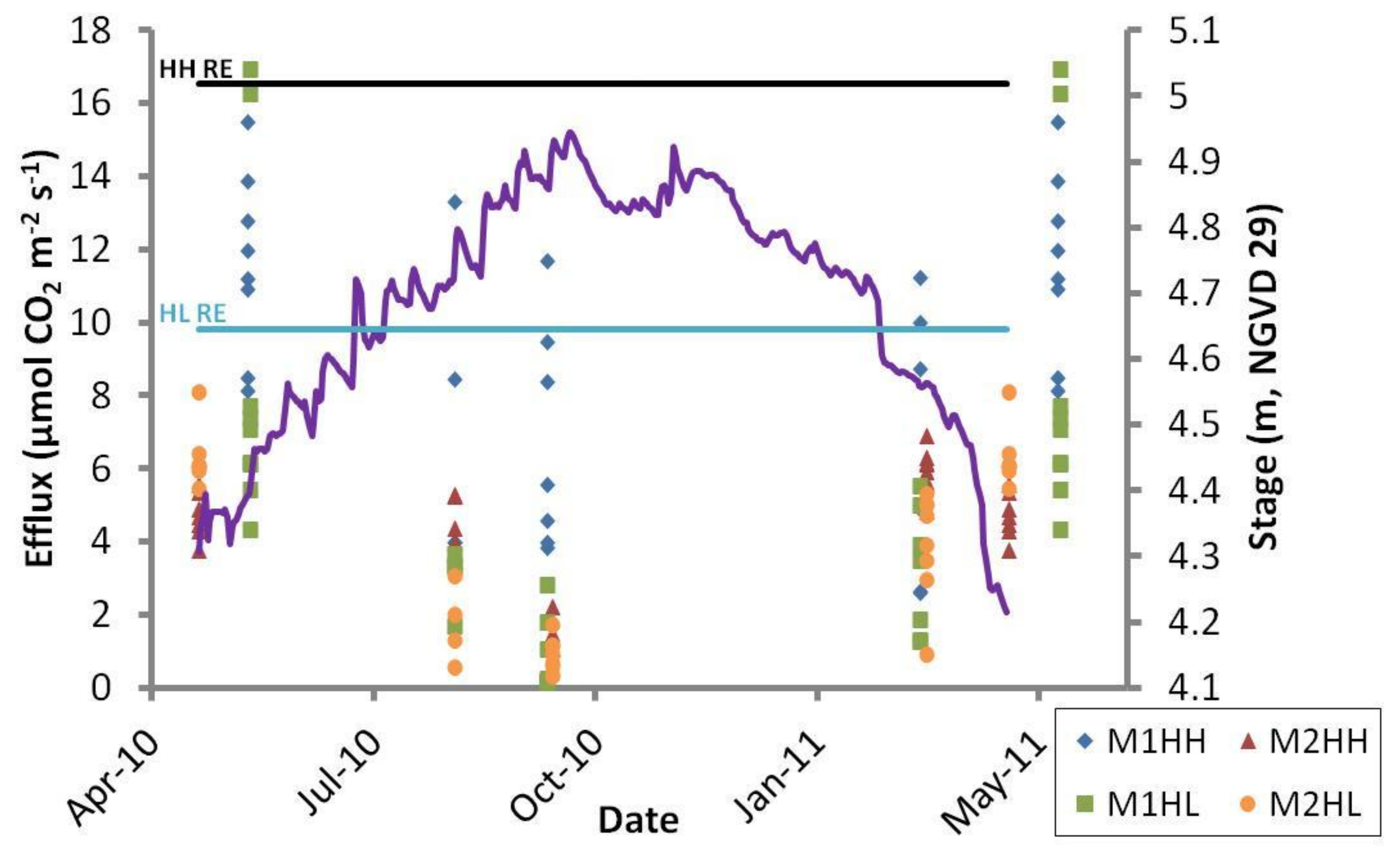
CO_2 efflux was significantly and negatively correlated to Relative Water Depth (RWD)



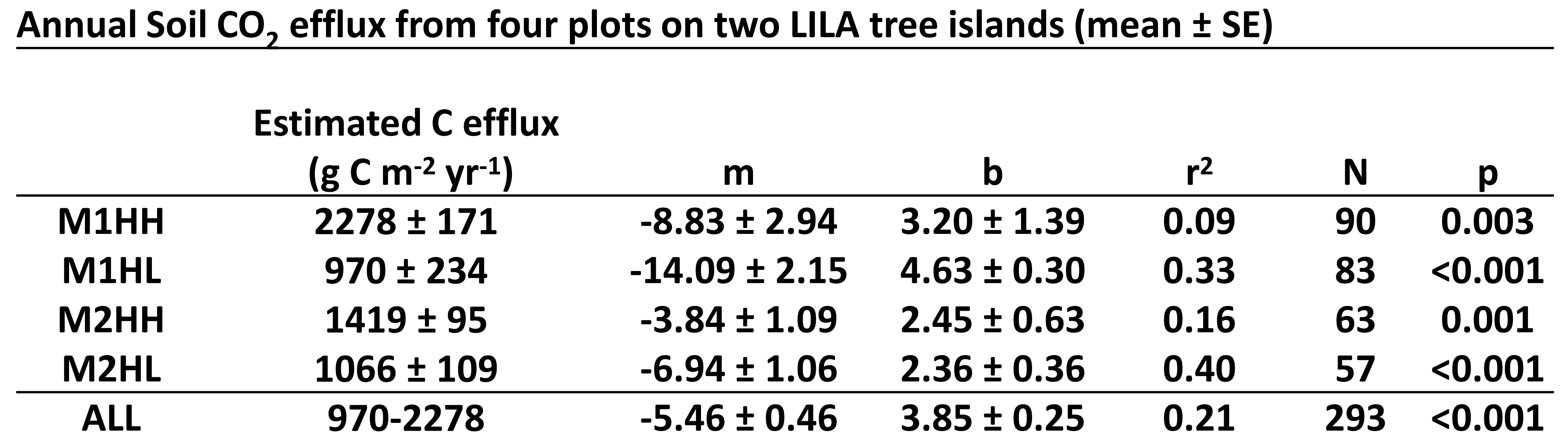
ALL: $y = -5.46x + 3.85$, $r^2 = 0.21$, $n = 293$, $p < 0.001$ (solid)

W/O Limestone: $y = -7.54x + 3.86$, $r^2 = 0.30$, $n = 225$, $p < 0.001$ (dashed)

Efflux varied seasonally with RWD. Lower elevations saturated or flooded approximately 50% of the year while High elevations were not inundated.



Annual Soil efflux was determined for individual sites, all of which showed significant, negative linear relationships with RWD. Efflux estimates were in the range of other published values.

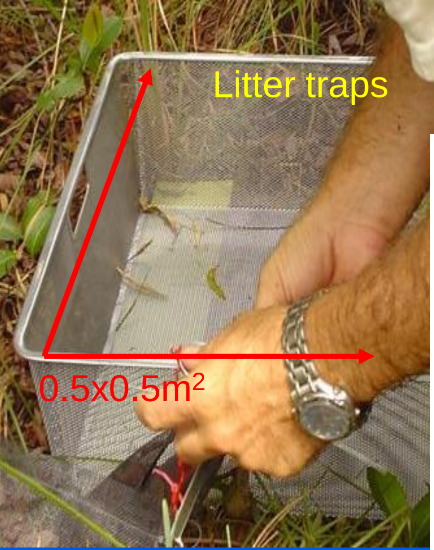


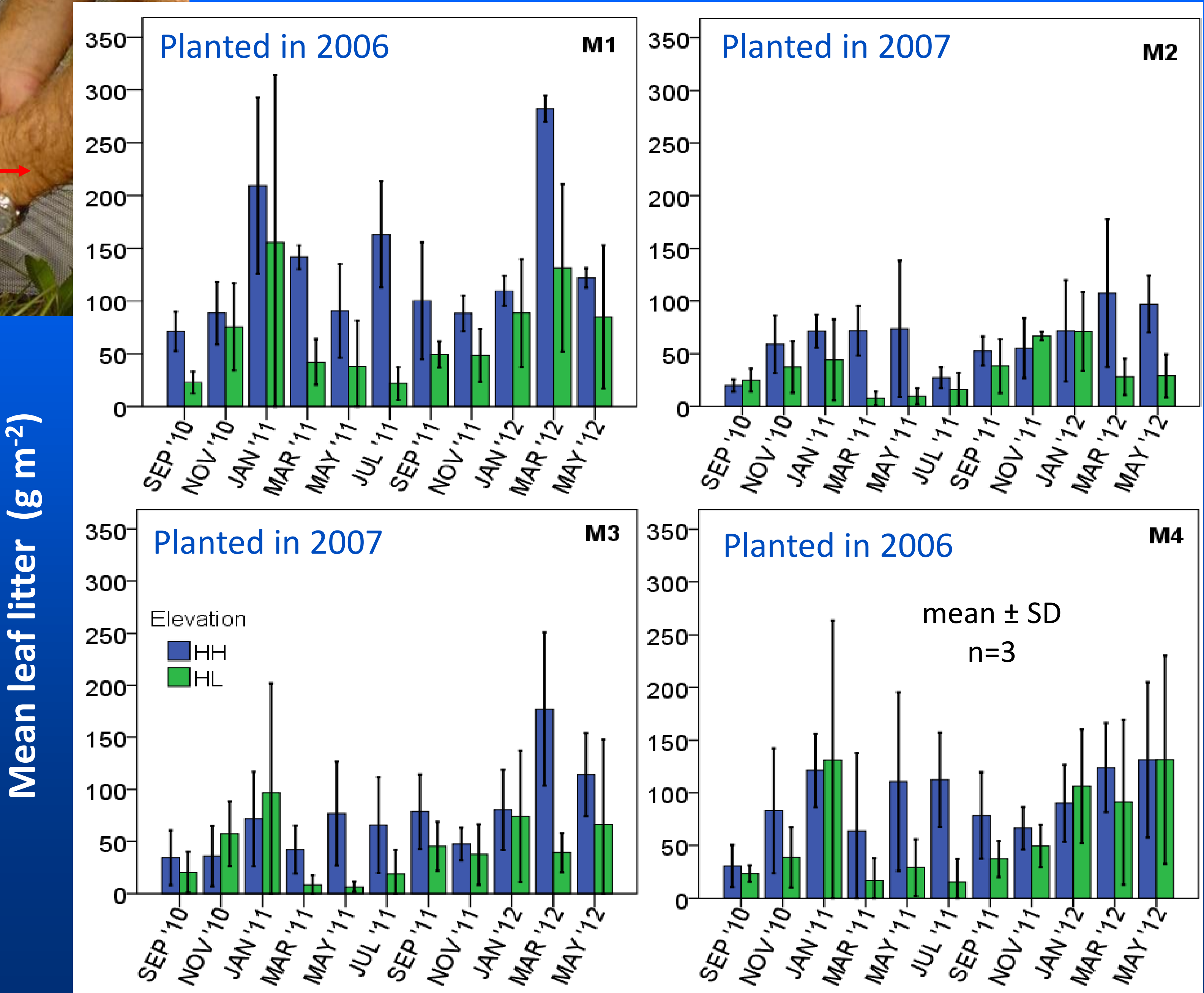
Annual Soil CO_2 efflux from four plots on two LILA tree islands (mean ± SE)

	Estimated C efflux (g C m^{-2} yr^{-1})	m	b	r^2	N	p
M1HH	2278 ± 171	-8.83 ± 2.94	3.20 ± 1.39	0.09	90	0.003
M1HL	970 ± 234	-14.09 ± 2.15	4.63 ± 0.30	0.33	83	<0.001
M2HH	1419 ± 95	-3.84 ± 1.09	2.45 ± 0.63	0.16	63	0.001
M2HL	1066 ± 109	-6.94 ± 1.06	2.36 ± 0.36	0.40	57	<0.001
ALL	970-2278	-5.46 ± 0.46	3.85 ± 0.25	0.21	293	<0.001

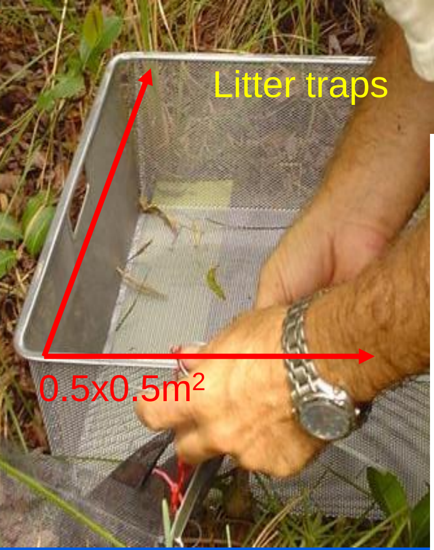
Hirano et al., 2009:	2592 – 4794 g C m^{-2} y^{-1}
Savage and Davidson, 2003:	1636 g C m^{-2} y^{-1}

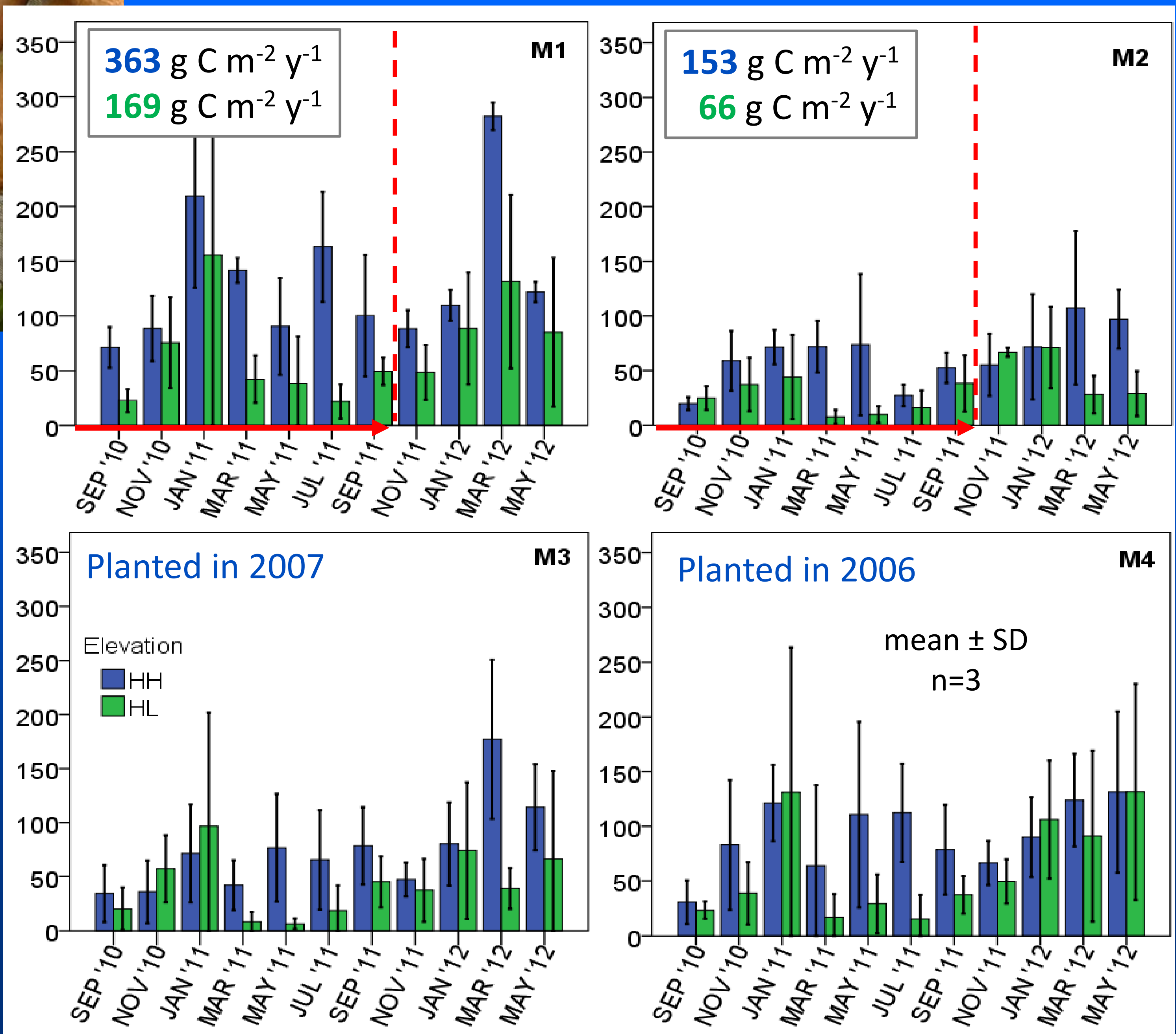
Litter fall adds material to surface soil



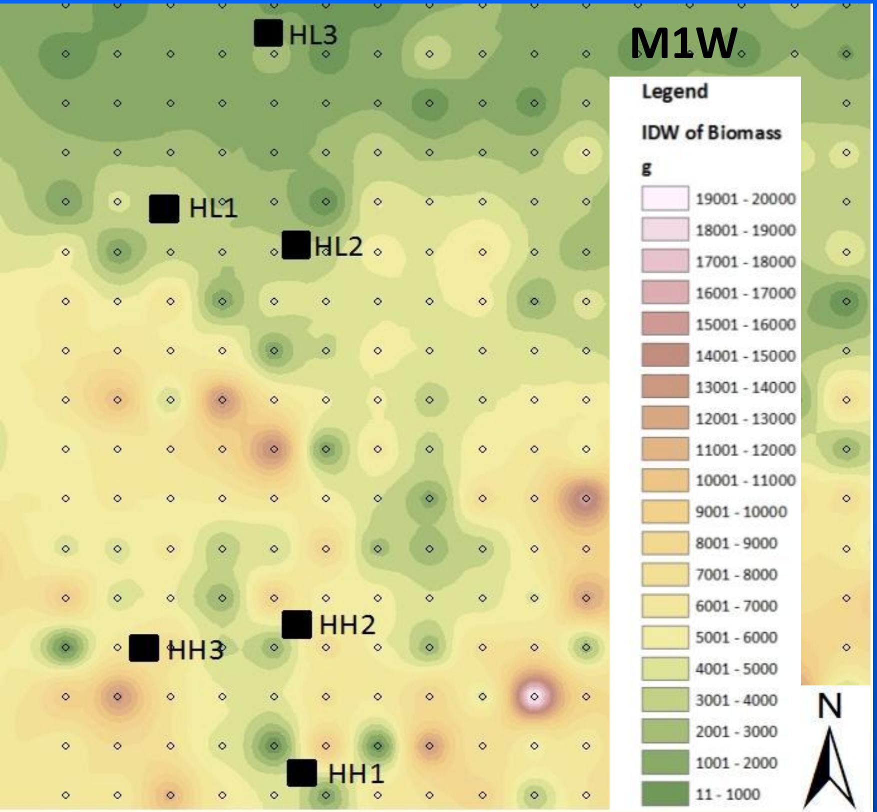


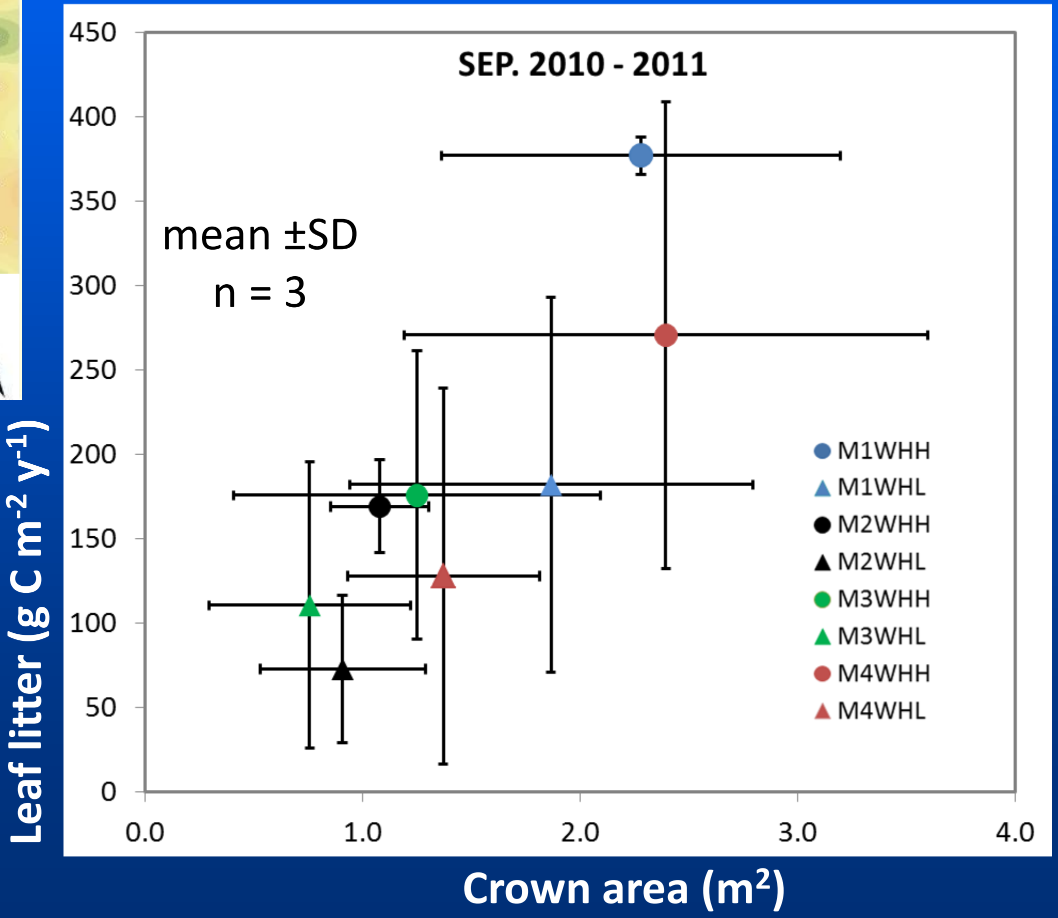
Litter fall adds material to surface soil





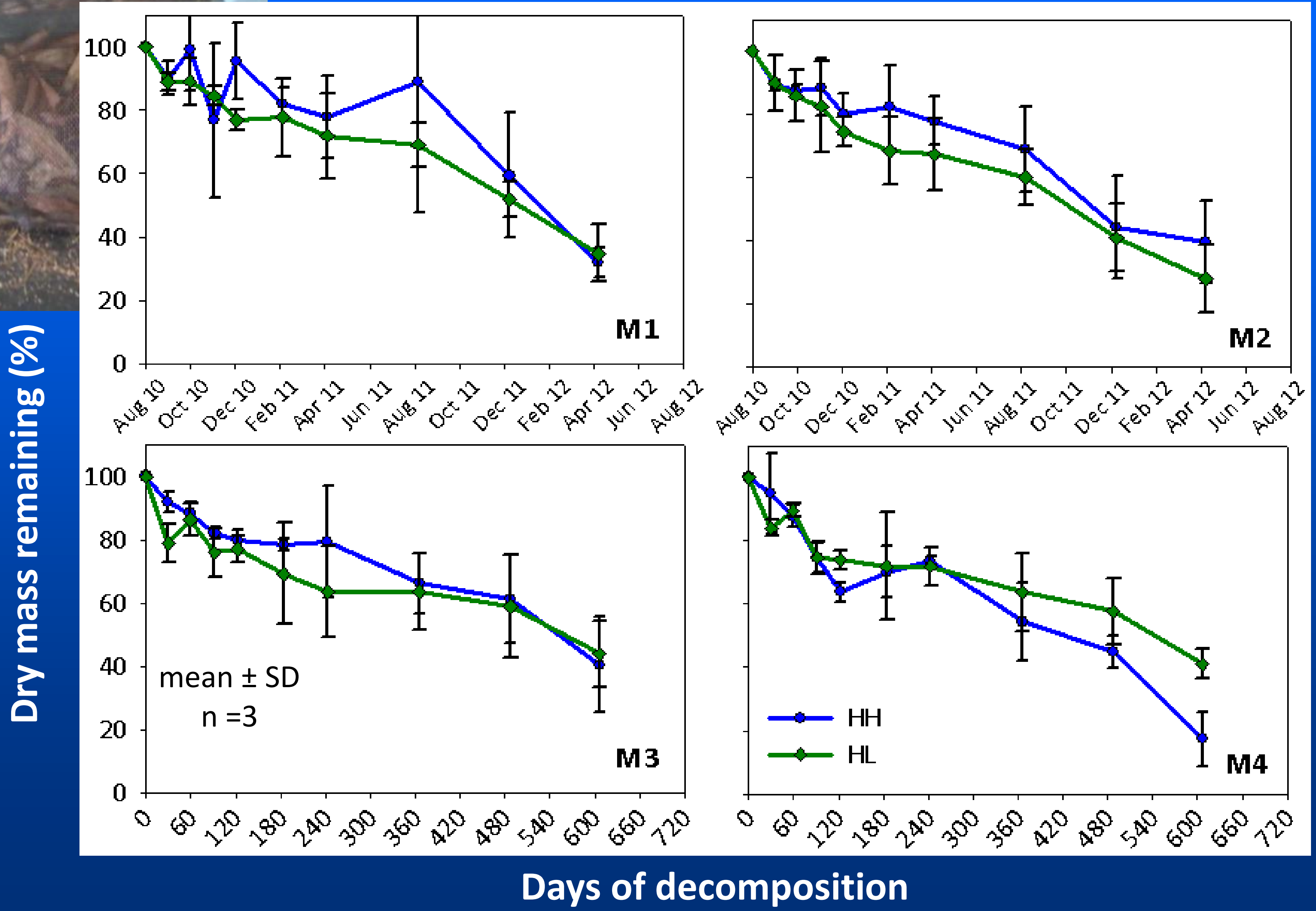
Litter production increases with increase in biomass



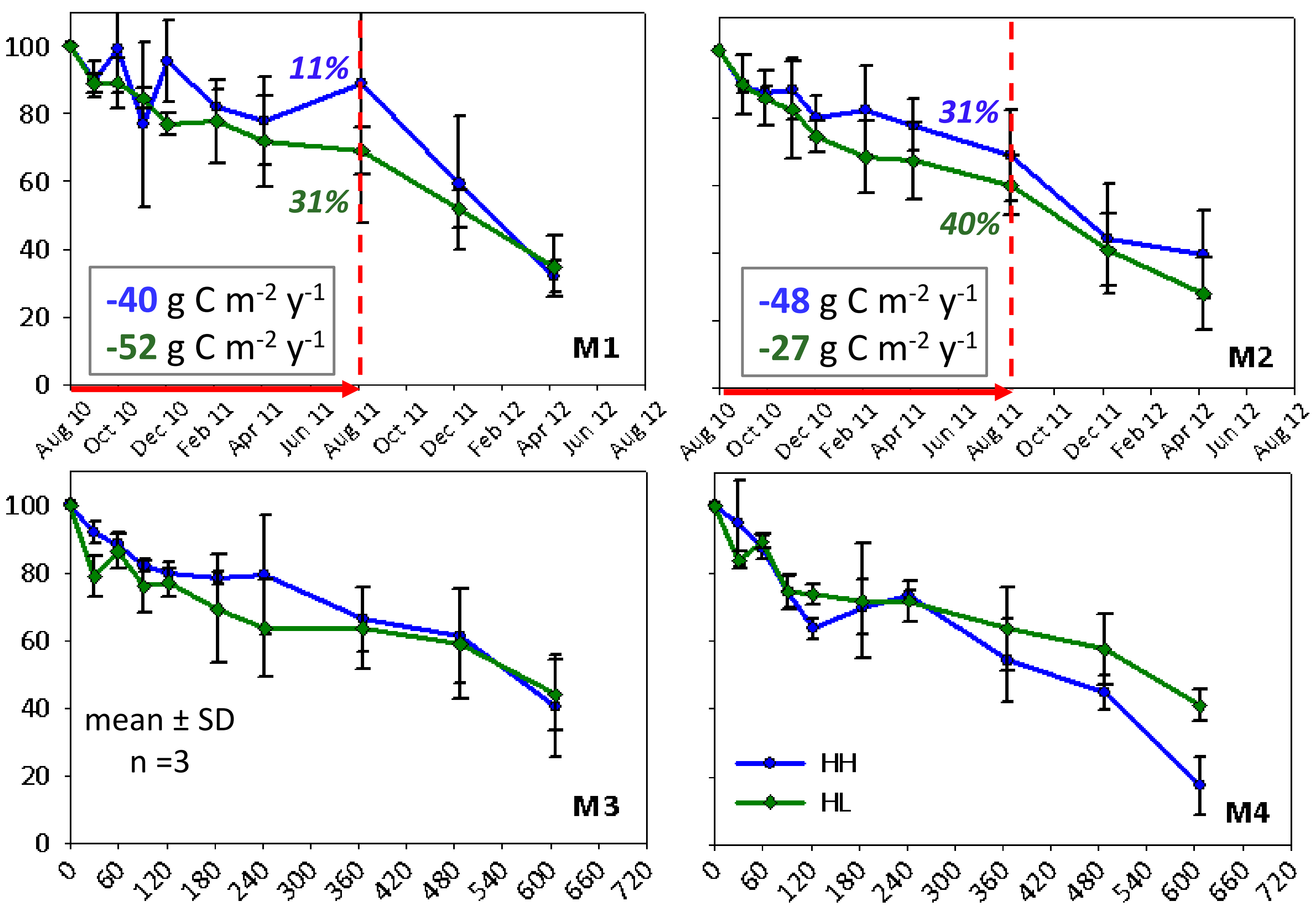


Litter production and biomass were greater at higher elevations

Litter decomposition was similar for all tree islands and elevations



Litter decomposition was similar for all tree islands and elevations

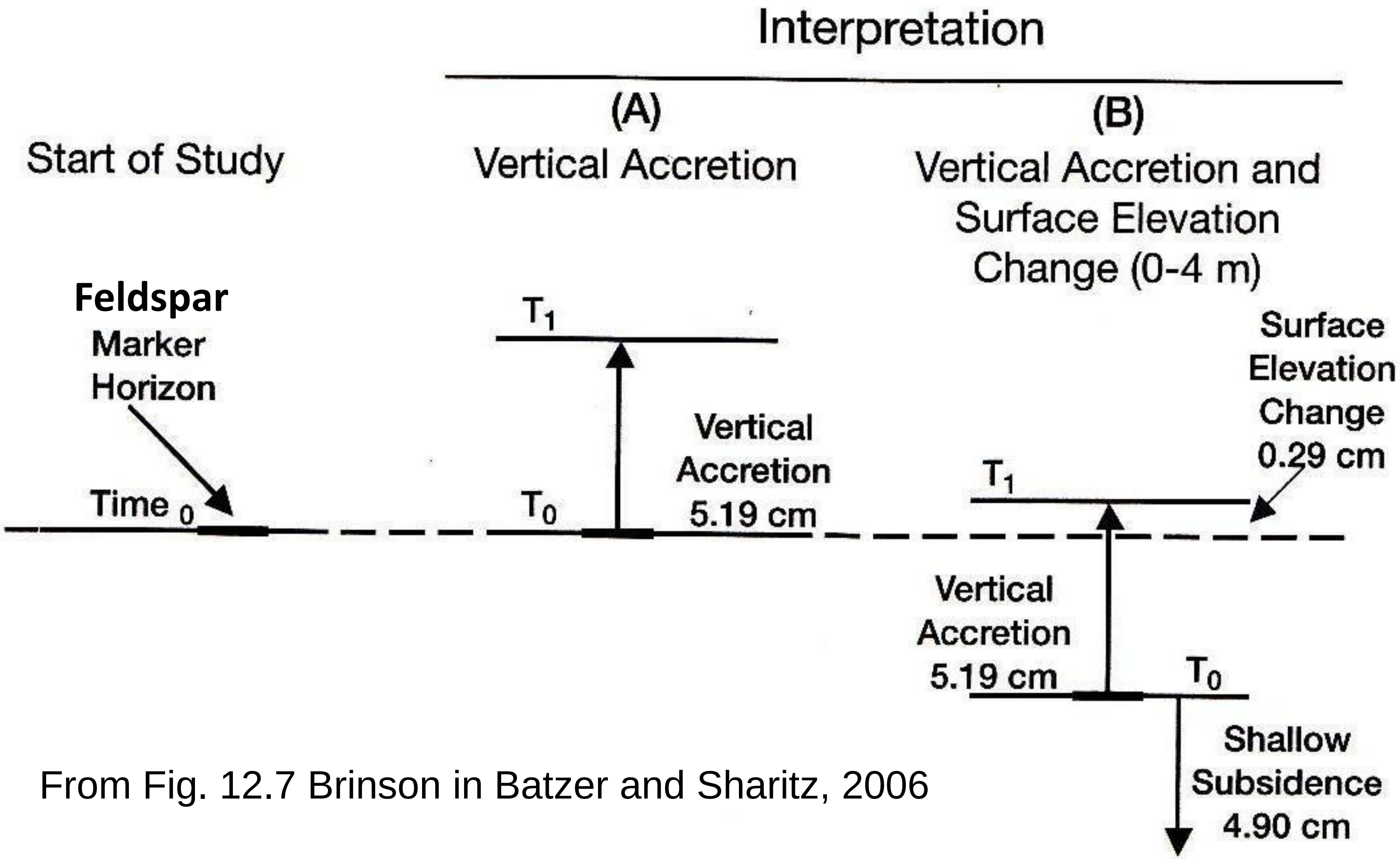


Balance between litter production and litter decomposition results in a net gain

Sum of leaf litter input and litter bag mass loss of C per year

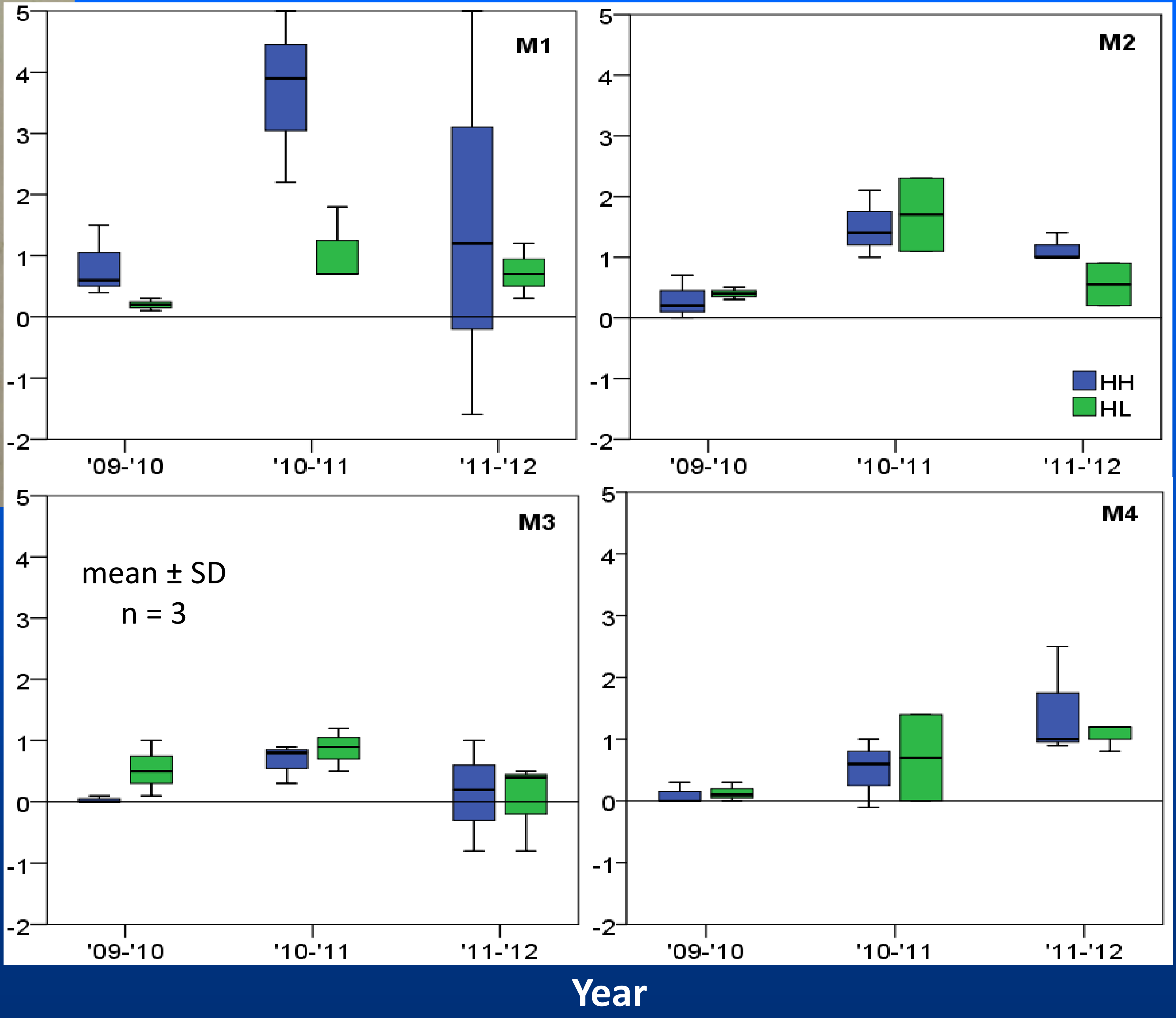
Parameter	M1WHH	M1WHL	M2WHH	M2WHL
	---------------------g C m^{-2} y^{-1}			--------------------
Leaf litter input	363	169	153	66
Litter bag mass loss	- 40	- 52	- 48	- 27
Net Gain	323	117	106	40

Feldspar markers determine surface accretion and SETs show overall changes in elevation



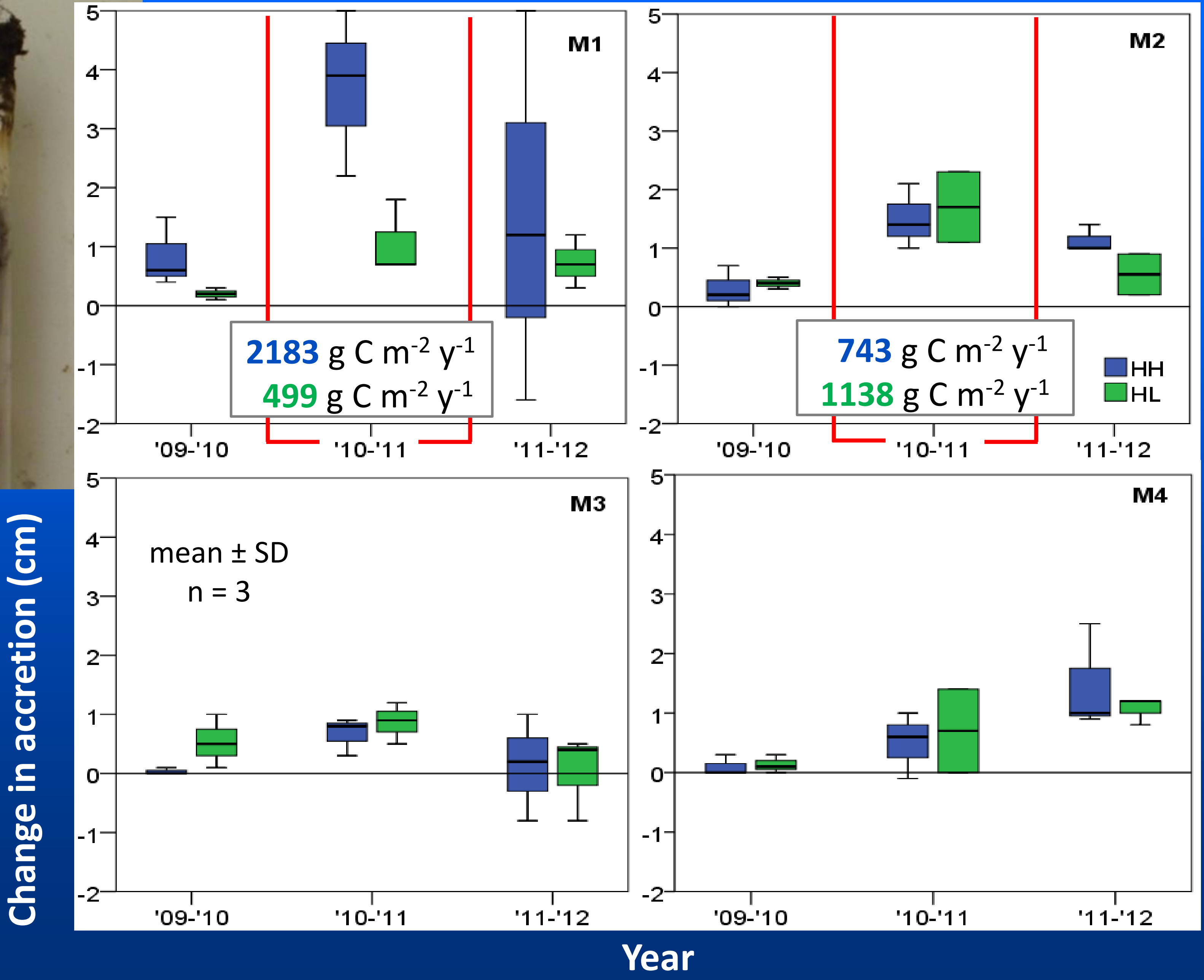
From Fig. 12.7 Brinson in Batzer and Sharitz, 2006

Markers showed cumulative Accretion over time



mean ± SD
n = 3

Markers showed cumulative Accretion over time

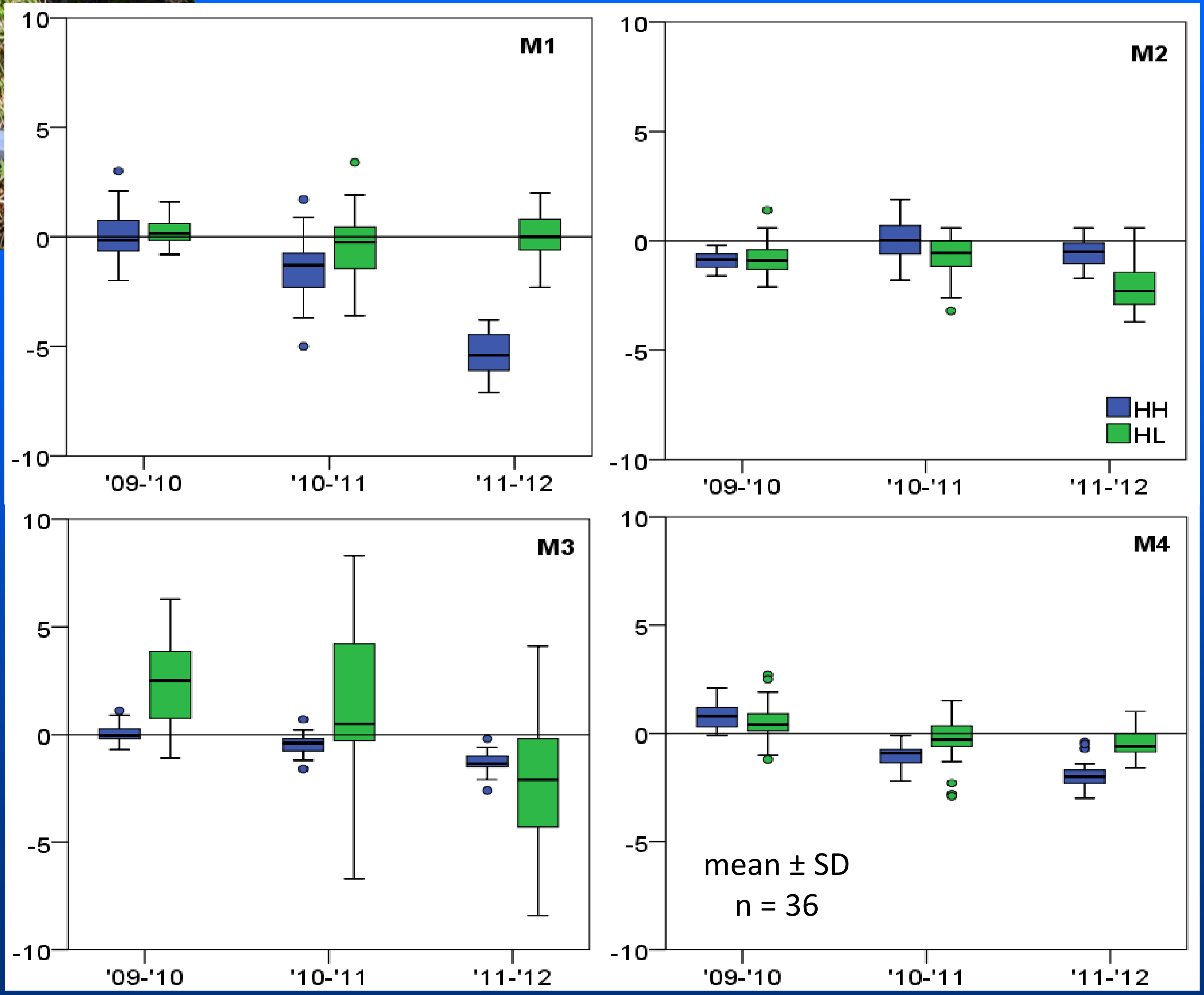


2183 g C m^{-2} y^{-1}
499 g C m^{-2} y^{-1}

743 g C m^{-2} y^{-1}
1138 g C m^{-2} y^{-1}

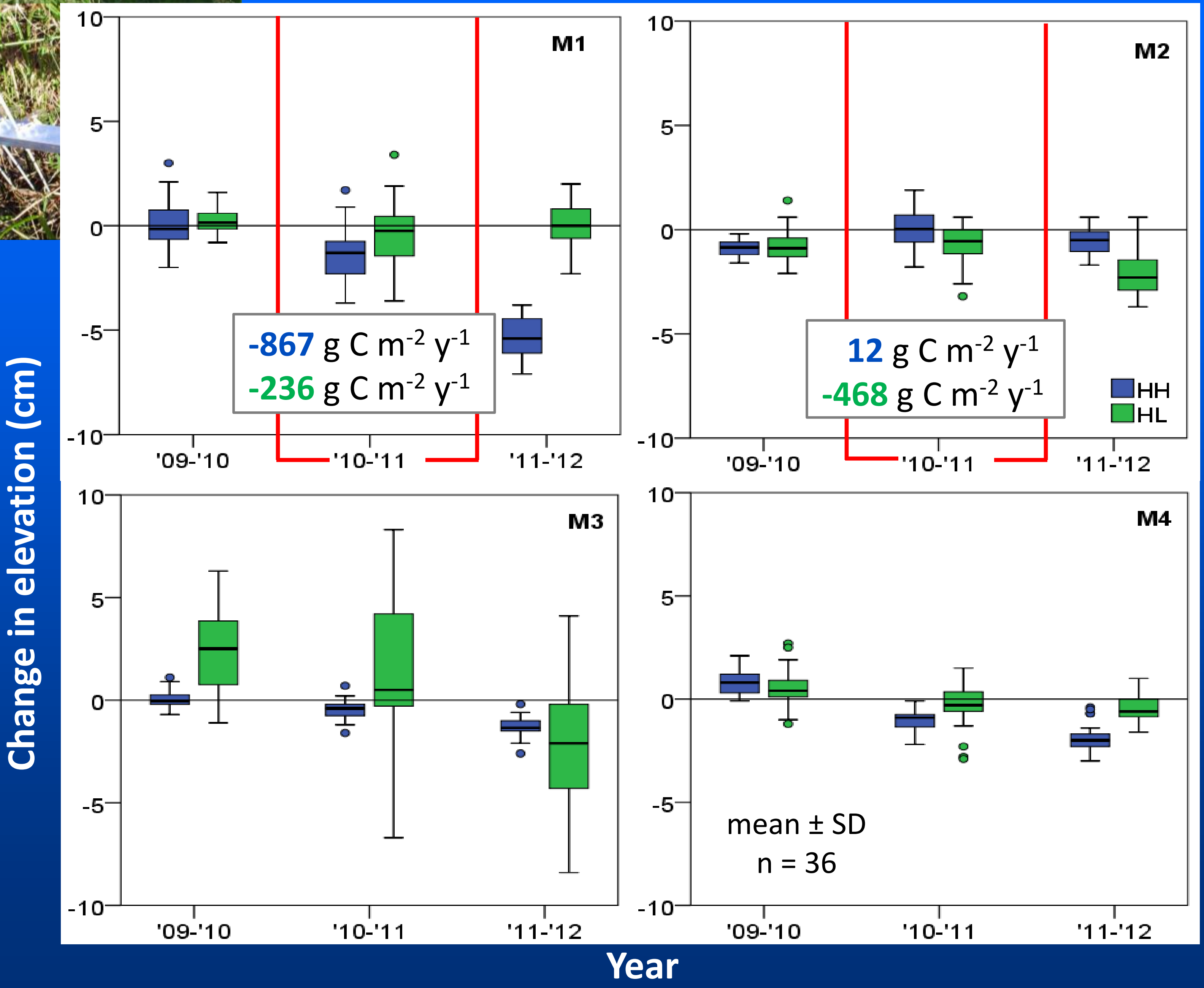
mean ± SD
n = 3

SETs generally show negative elevation change



mean ± SD
n = 36

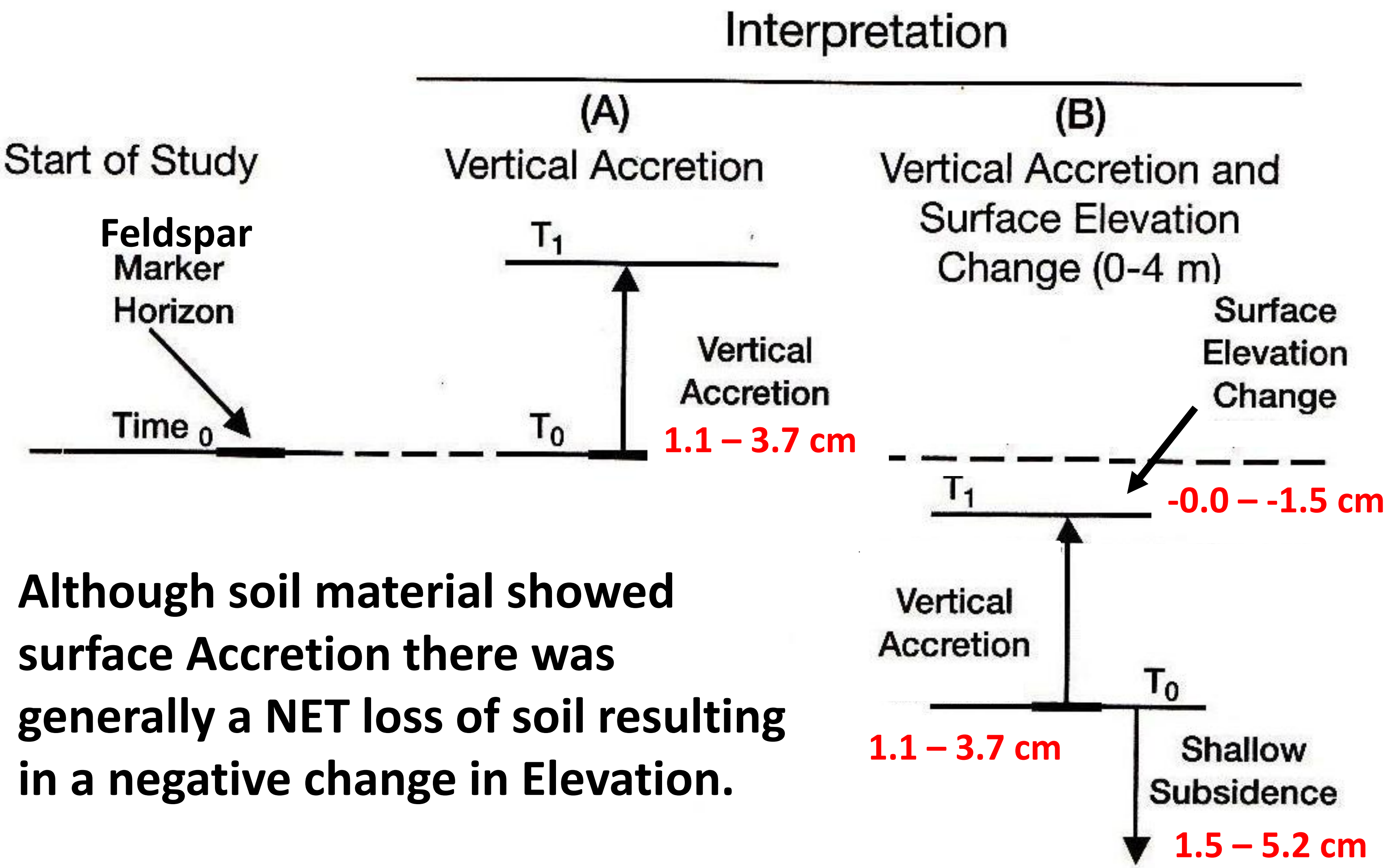
Net elevation change suggests a loss in net carbon



-867 g C m^{-2} y^{-1}
-236 g C m^{-2} y^{-1}

12 g C m^{-2} y^{-1}
-468 g C m^{-2} y^{-1}

mean ± SD
n = 36



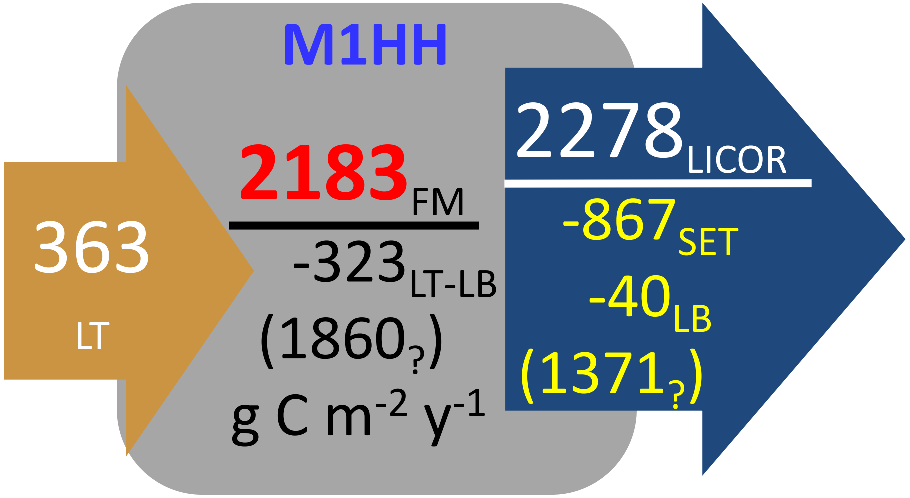
Although soil material showed surface Accretion there was generally a NET loss of soil resulting in a negative change in Elevation.

Loss of soil elevation suggests NET loss of soil Carbon. Loss of soil C estimated from change in elevation, soil bulk density, and soil total C content

Field bulk density, total carbon content, feldspar accumulation, variation in elevation and net gain/loss (mean ± SD)

	Soil field bulk density (g dw cm^{-3})	Soil total carbon (mg g^{-1} dw)	SET gain/loss (cm)	Feldspar accumulation (cm)	Calculated gain/loss (cm)	NET gain/loss (g C m^{-2} y^{-1})
M1HH	0.39 ± 0.05	151.7 ± 54.5	-1.5 ± 1.3^{a}	3.7 ± 1.4^{a}	-5.2 ± 1.4	-867 ± 753
M1HL	0.47 ± 0.08	99.2 ± 24.6	-0.5 ± 1.5^{b}	1.1 ± 0.6^{b}	-1.6 ± 0.6	-236 ± 706
M2HH	0.52 ± 0.01	95.5 ± 36.4	0.0 ± 0.8^{c}	1.5 ± 0.6^{b}	-1.5 ± 0.6	12 ± 420
M2HL	0.46 ± 0.23	145.4 ± 74.1	-0.7 ± 0.9^{b}	1.7 ± 0.8^{b}	-2.4 ± 0.8	-468 ± 612

Carbon budget estimation



M1HH

363 LT

$\frac{2183_{FM}}{-323_{LT-LB}}$

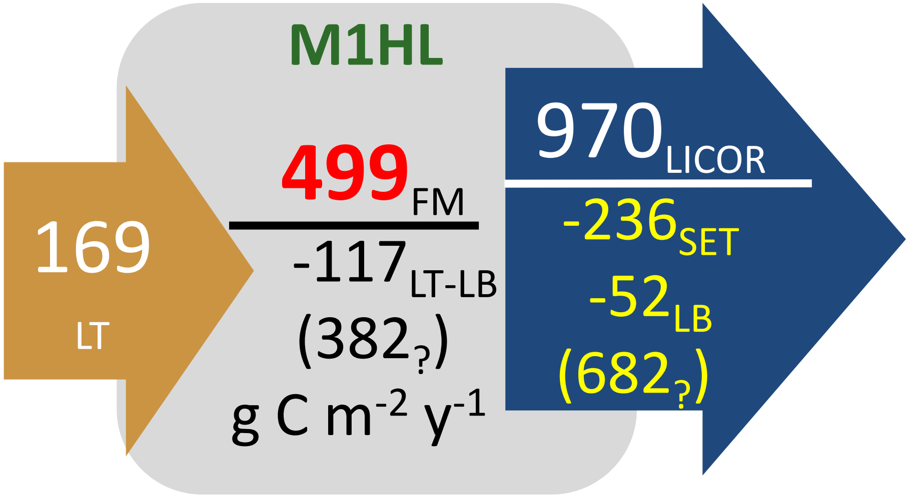
$(1860_?)$

g C m^{-2} y^{-1}

$\frac{2278_{LICOR}}{-867_{SET}}$

-40_{LB}

$(1371_?)$



M1HL

169 LT

$\frac{499_{FM}}{-117_{LT-LB}}$

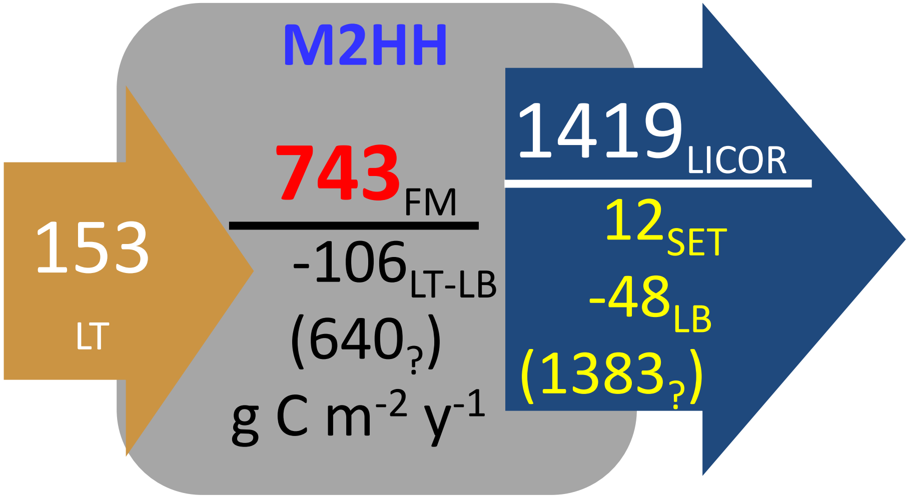
$(382_?)$

g C m^{-2} y^{-1}

$\frac{970_{LICOR}}{-236_{SET}}$

-52_{LB}

$(682_?)$



M2HH

153 LT

$\frac{743_{FM}}{-106_{LT-LB}}$

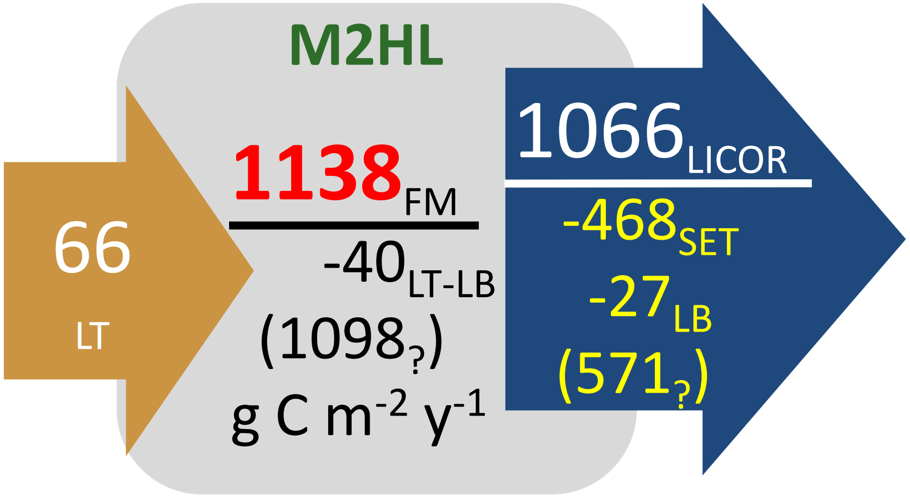
$(640_?)$

g C m^{-2} y^{-1}

$\frac{1419_{LICOR}}{12_{SET}}$

-48_{LB}

$(1383_?)$



M2HL

66 LT

$\frac{1138_{FM}}{-40_{LT-LB}}$

$(1098_?)$

g C m^{-2} y^{-1}

$\frac{1066_{LICOR}}{-468_{SET}}$

-27_{LB}

$(571_?)$

LT: litter traps, FM: feldspar markers, LB: litter bags

Conclusions

- CO_2 efflux was significantly and negatively correlated to Relative Water Depth at all locations.
- Annual efflux from LILA tree island soils are comparable to other studies conducted in similar ecosystems (Savage and Davidson, 2003; Hirano et al. , 2009).
- Within a Tree Island the higher elevations generally had higher Respiration, Biomass, Litter Fall, and NET Litter inputs.
- Accretion is less than Subsidence resulting in NET elevation loss on “young” LILA Tree Islands.

Conclusions

- Respiration, Litter inputs, Accretion and Subsidence were “Balanced” for a one-year period 2010 to 2011.
- At this point, outputs are greater than inputs.
- Currently, 77-96% of inputs and 54-97% of outflows are unaccounted.
- To improve our estimates:
  - A laboratory core study is being conducted to determine effects of Live Root Respiration.
  - Fine scale soil sampling and nutrient analysis.
  - Evaluate over a longer time-frame.

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