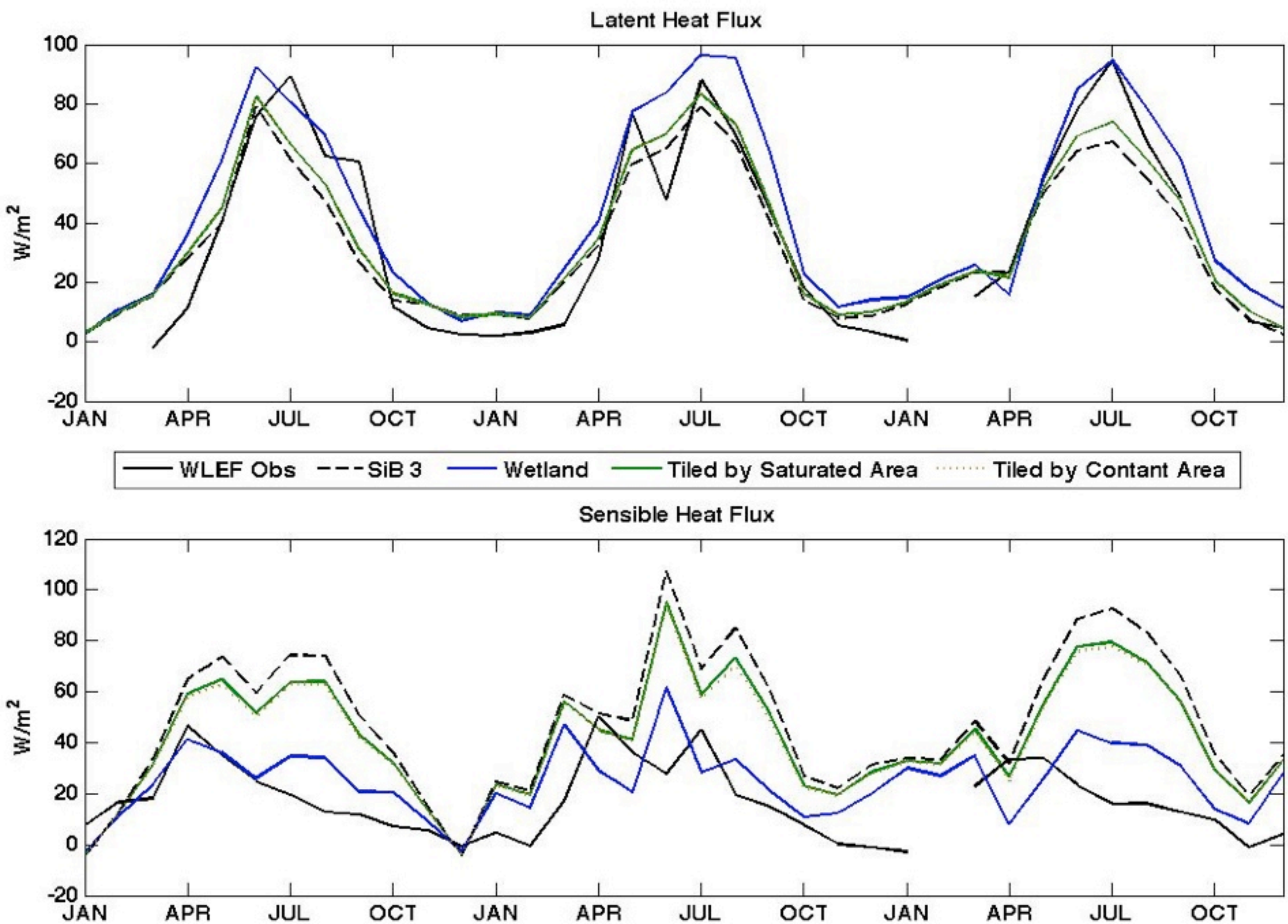
On the use of topographic information in the delineation of sub-grid scale wetland area, modeling wetlands in land surface models, impacts of wetlands on modeled heat fluxes, atmospheric methane, the implicit seasonality of methane emissions from the scaling of Arrhenius-type equations for methanogenic and methanotrophic respiration, and modeled and observed emissions of methane from a natural wetland in northern Wisconsin.

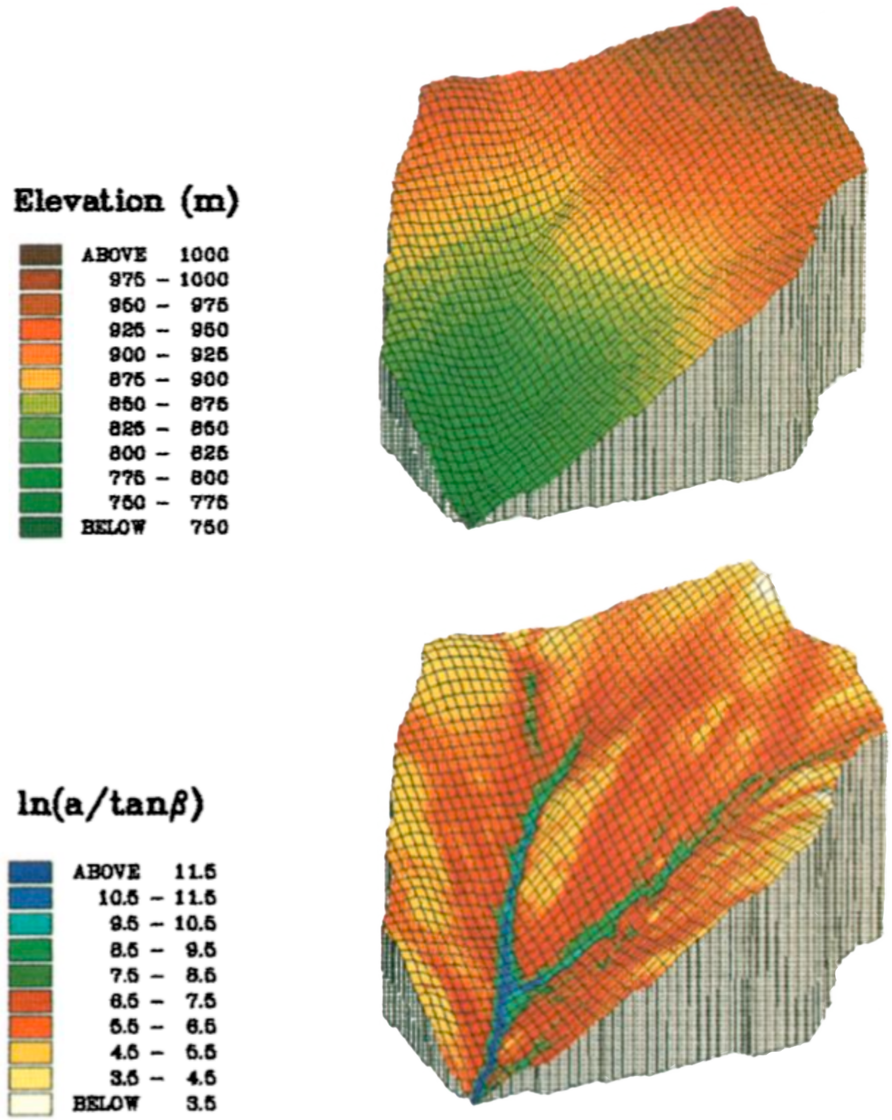
Parker Kraus

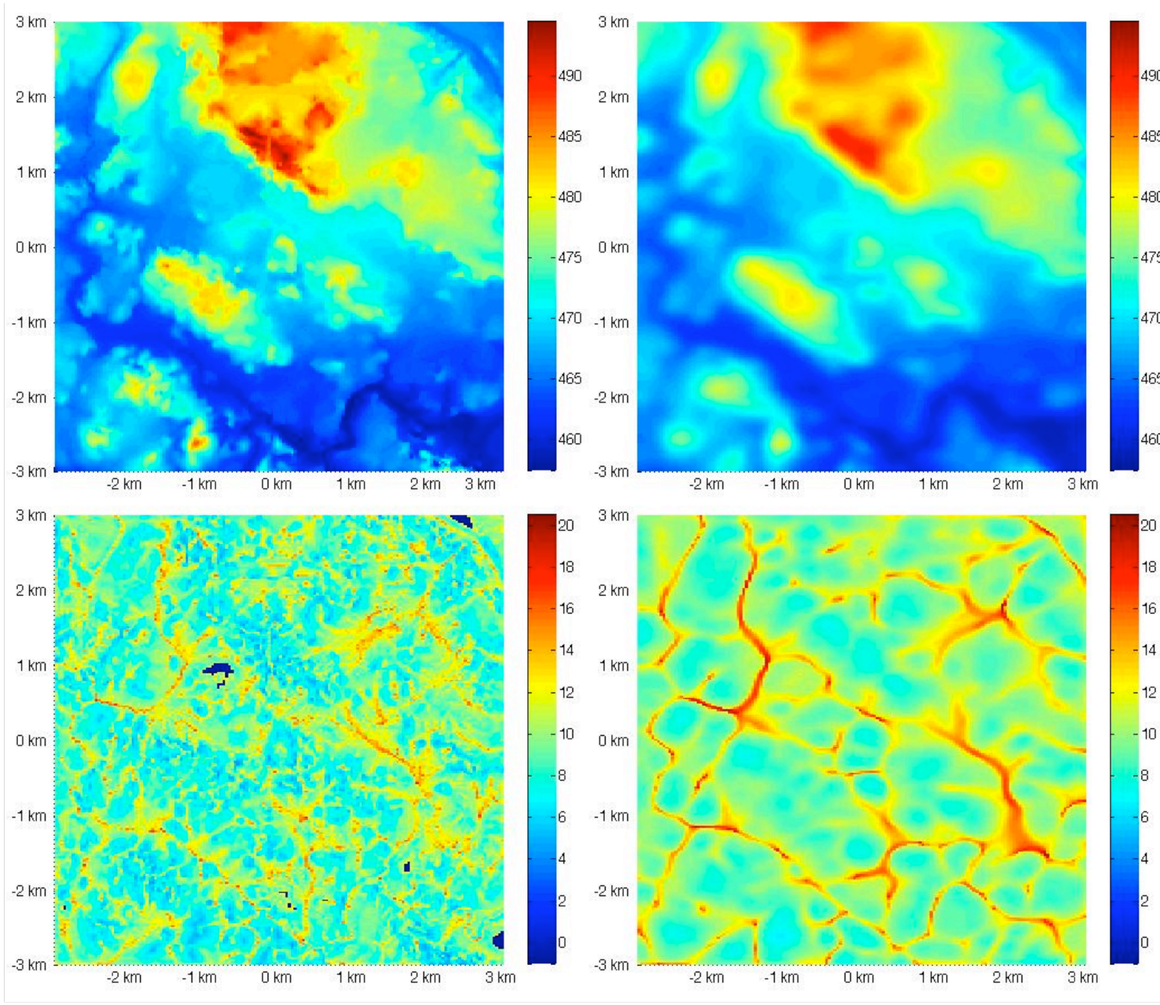
Wetlands


© Doug Wechsler

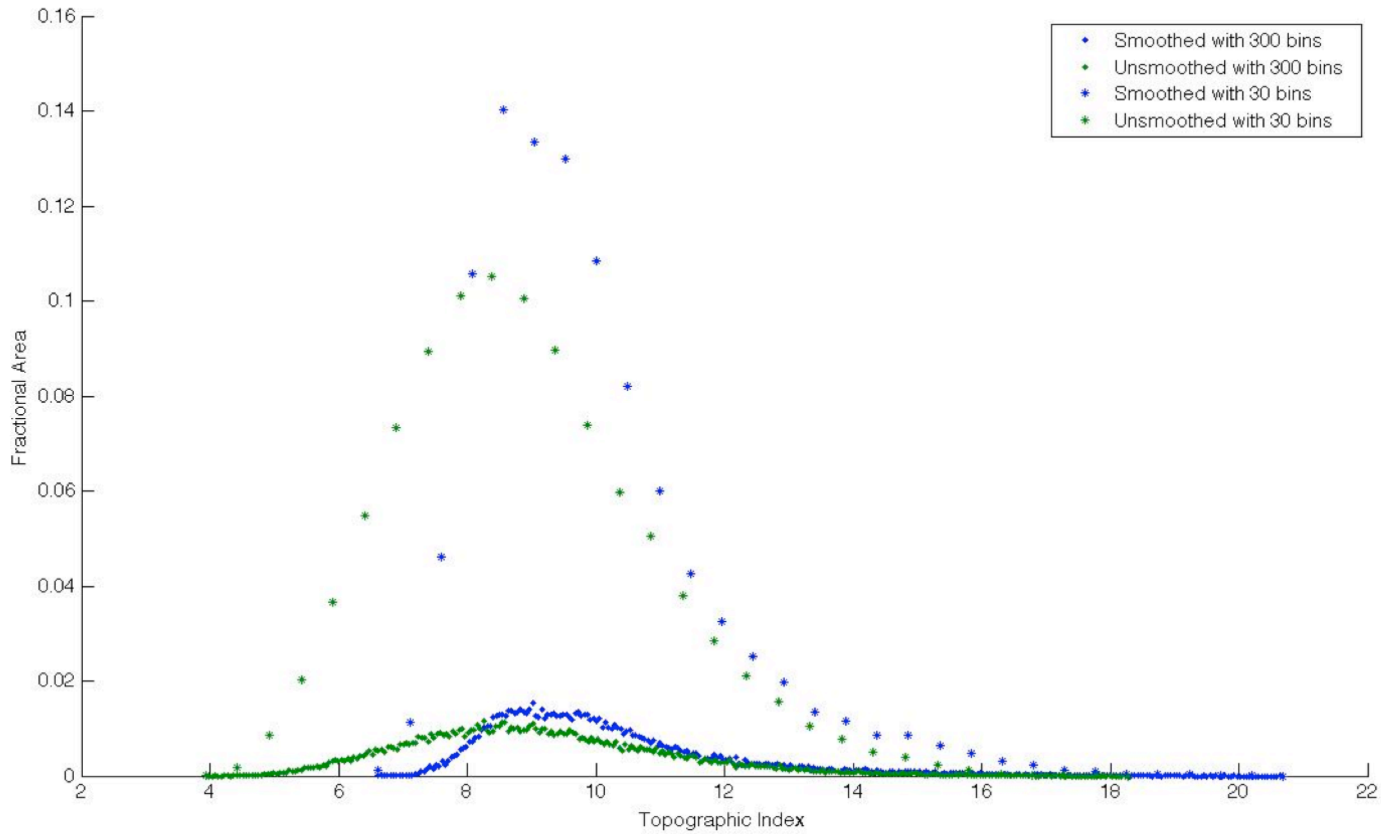

© Doug Wechsler

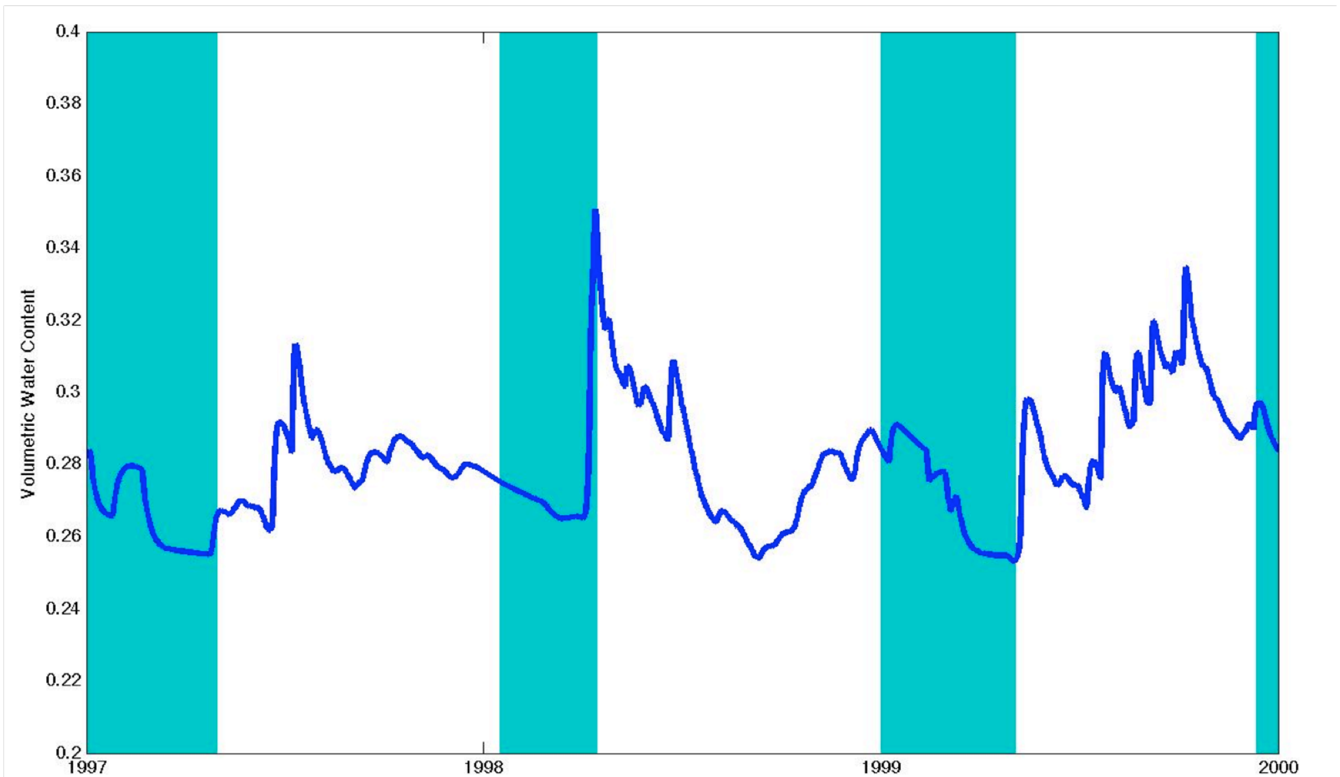

Latent Heat Flux
W/m^2
100
80
60
40
20
0
-20
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT
WLEF Obs
SiB 3
Wetland
Tiled by Saturated Area
Tiled by Contant Area
Sensible Heat Flux
W/m^2
120
100
80
60
40
20
0
-20
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT


Elevation (m)
ABOVE 1000
975 – 1000
950 – 975
925 – 950
900 – 925
875 – 900
850 – 875
825 – 850
800 – 825
775 – 800
750 – 775
BELOW 750
ln(a/tanβ)
ABOVE 11.5
10.5 – 11.5
9.5 – 10.5
8.5 – 9.5
7.5 – 8.5
6.5 – 7.5
5.5 – 6.5
4.5 – 5.5
3.5 – 4.5
BELOW 3.5

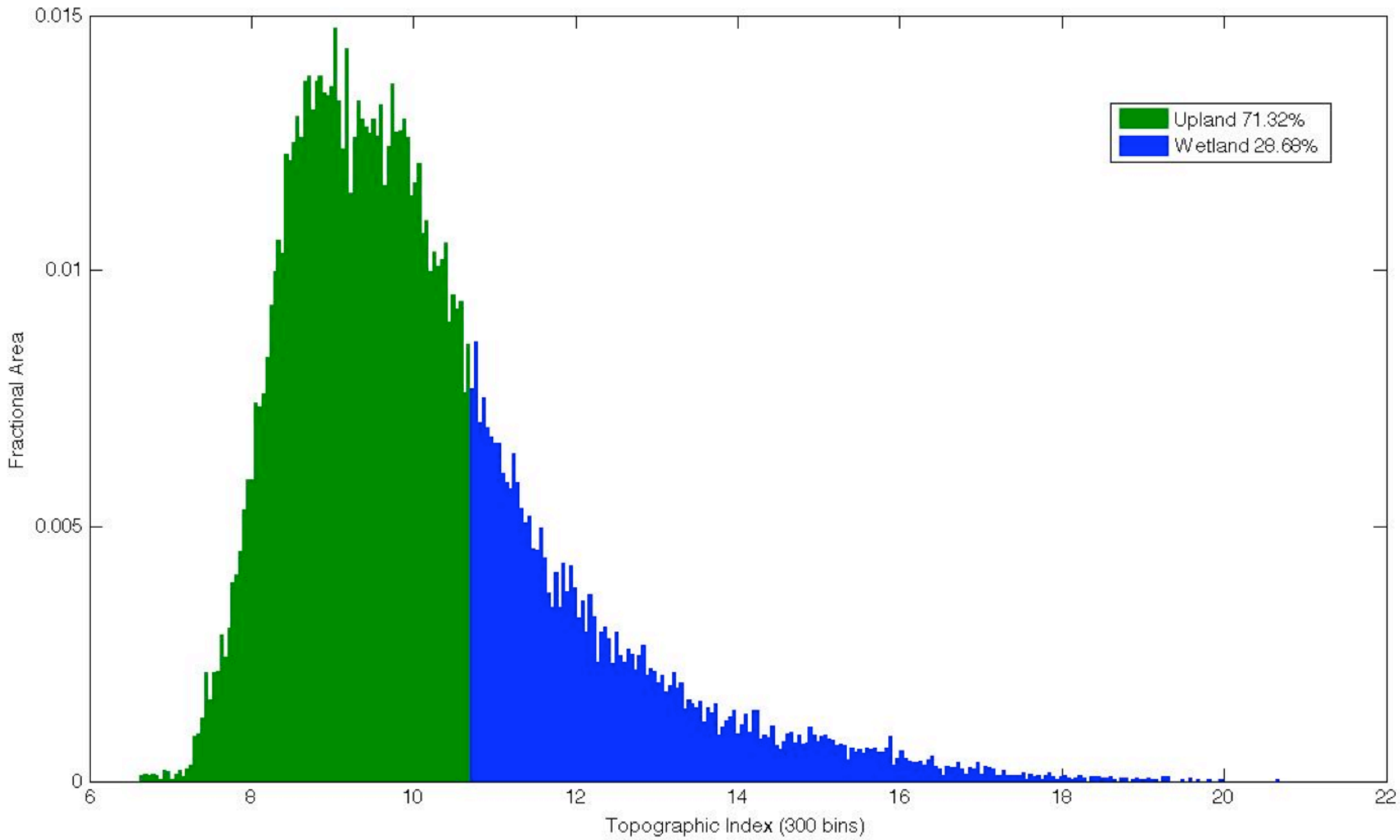


3 km
2 km
1 km
0 km
-1 km
-2 km
-3 km
-2 km
-1 km
0 km
1 km
2 km
3 km
490
485
480
475
470
465
460
20
18
16
14
12
10
8
6
4
2
0


Smoothed with 300 bins
Unsmoothed with 300 bins
Smoothed with 30 bins
Unsmoothed with 30 bins
Fractional Area
Topographic Index
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2
4
6
8
10
12
14
16
18
20
22

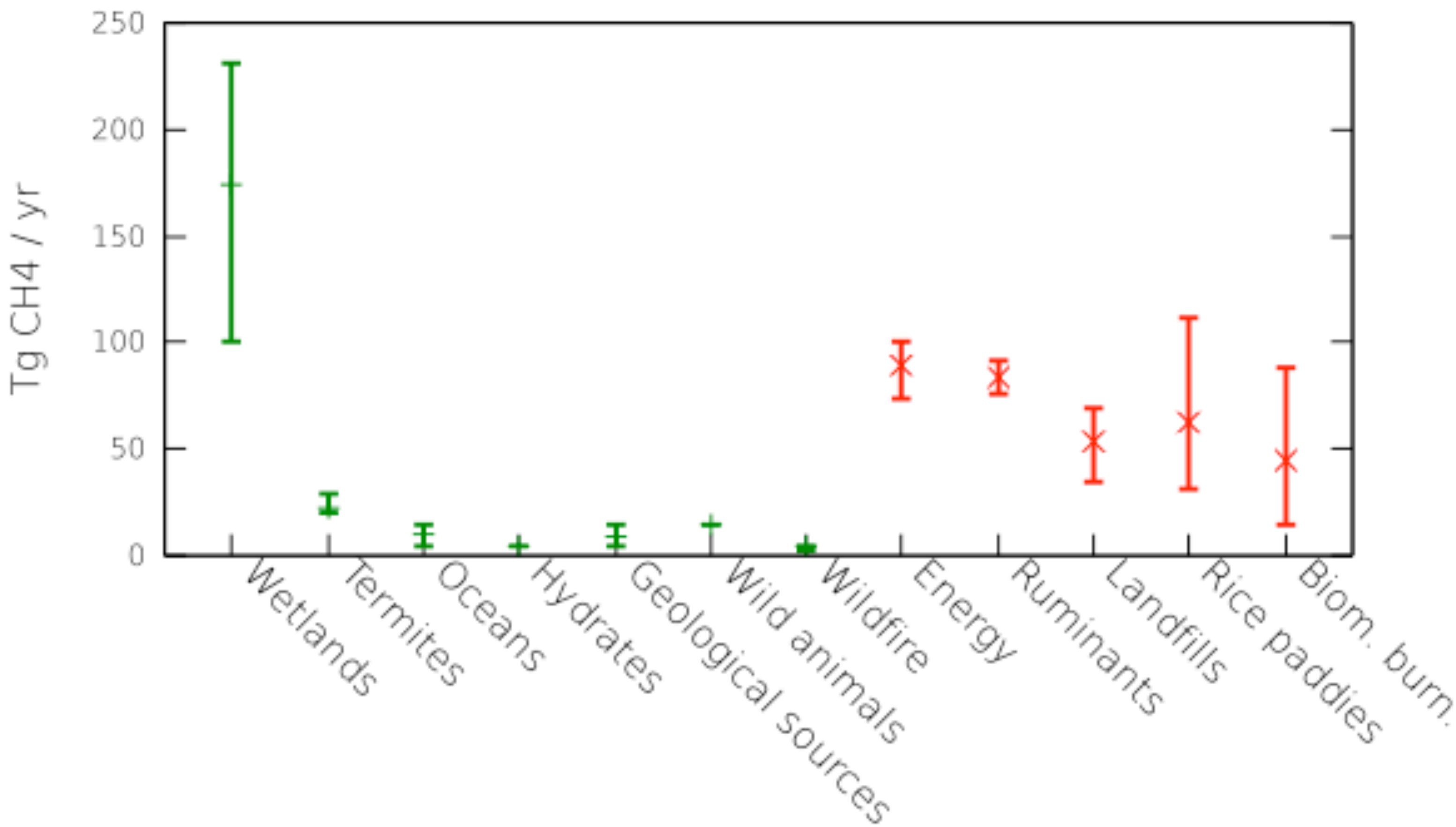


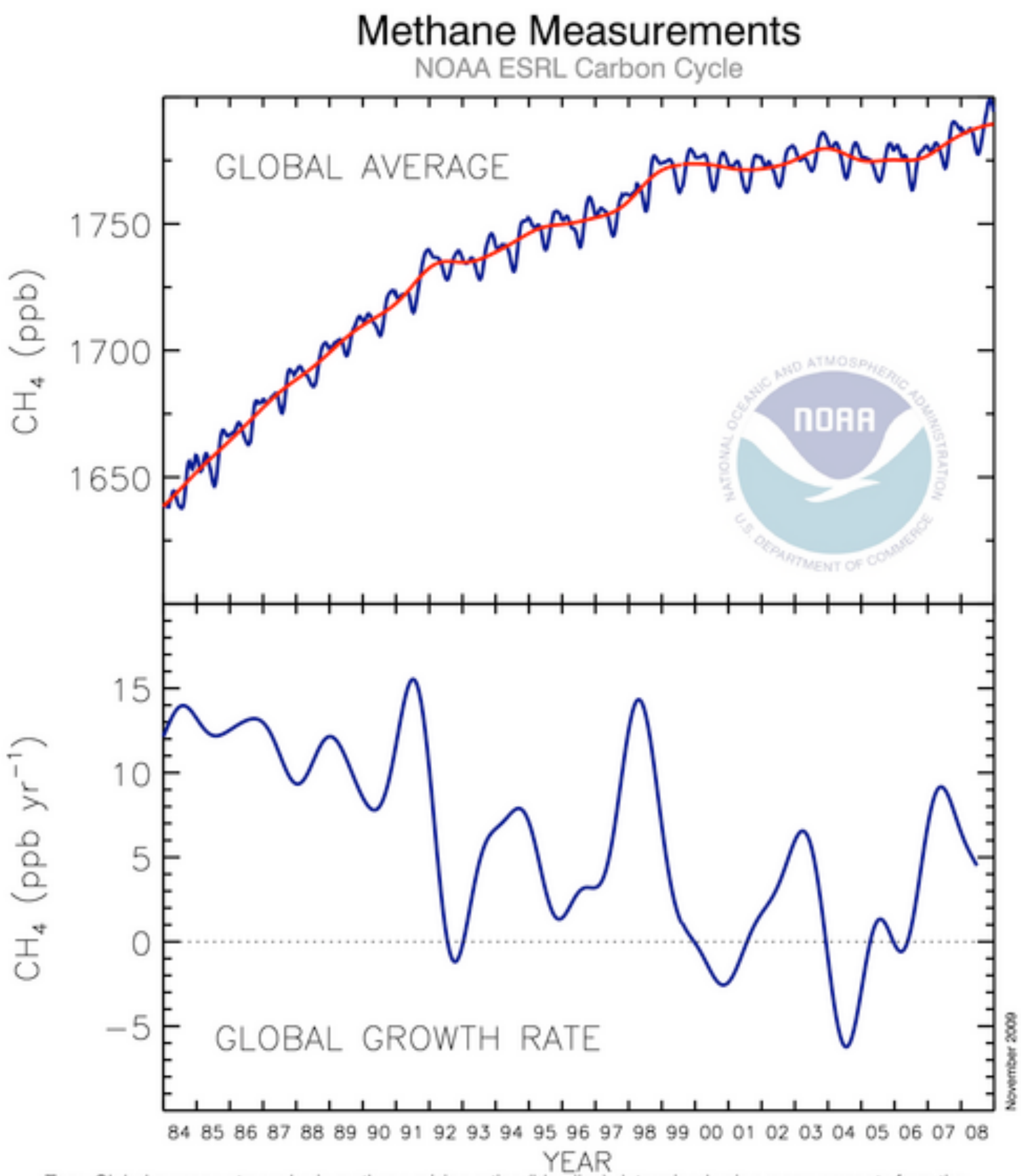
Volumetric Water Content
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
1997
1998
1999
2000



0.015
0.01
0.005
0
Fractional Area
6
8
10
12
14
16
18
20
22
Topographic Index (300 bins)
Upland 71.32%
Wetland 28.68%

Methane emissions





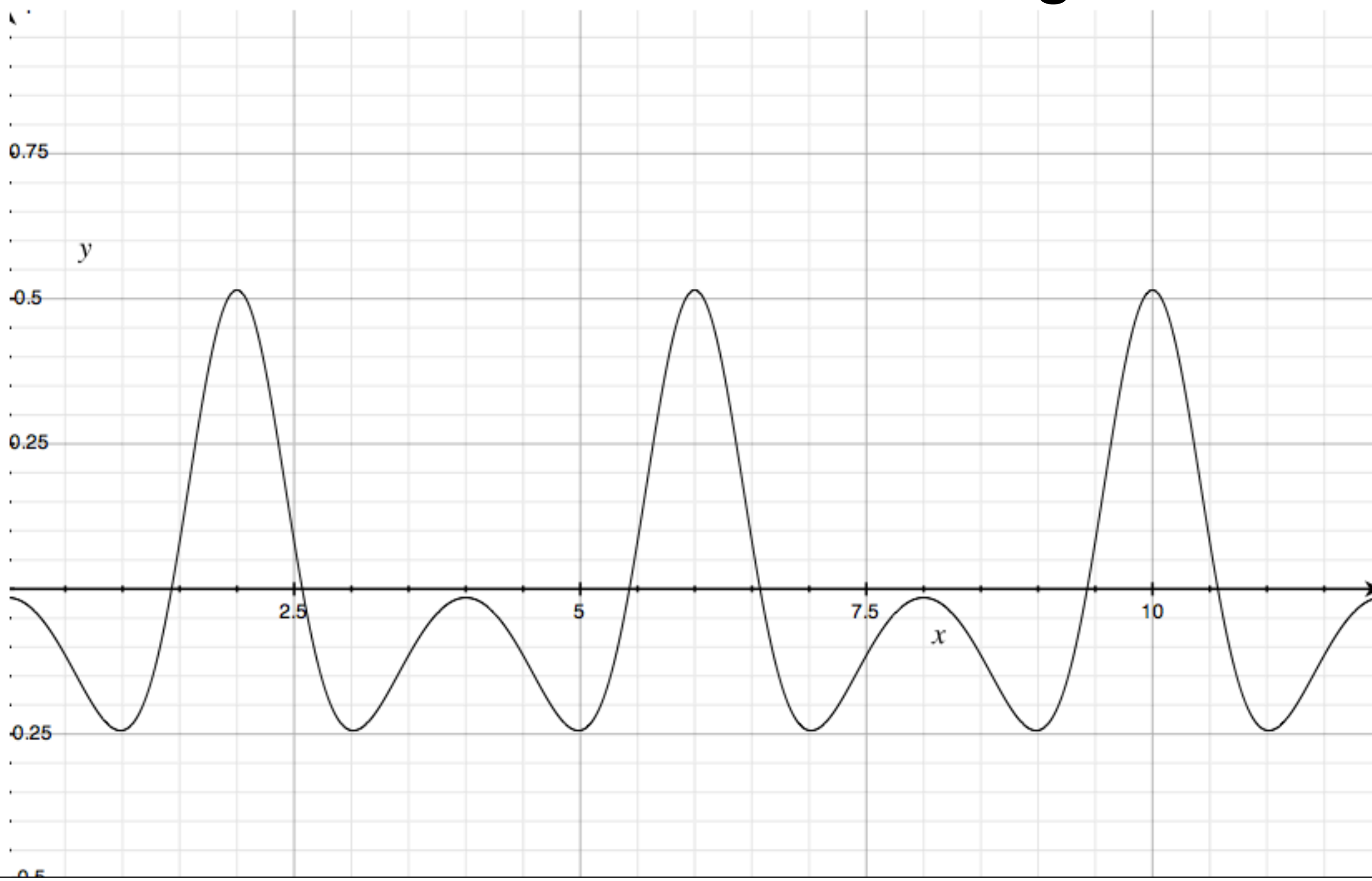
Top: Global average atmospheric methane mixing ratios (blue line) determined using measurements from the Carbon Cycle cooperative air sampling network. The red line represents the long-term trend. Bottom: Global average growth rate for methane. Contact: Dr. Ed Dlugokencky, NOAA ESRL Carbon Cycle, Boulder, Colorado, (303) 497-6228, ed.dlugokencky@noaa.gov, http://www.esrl.noaa.gov/gmd/ccgg/.

$$CH_4 flux = WF \cdot Q10_P^{\left(\frac{td(6)-273}{10}\right)} - (1-WF) \cdot Q10_C^{\left(\frac{td(6)-273}{10}\right)} + k$$

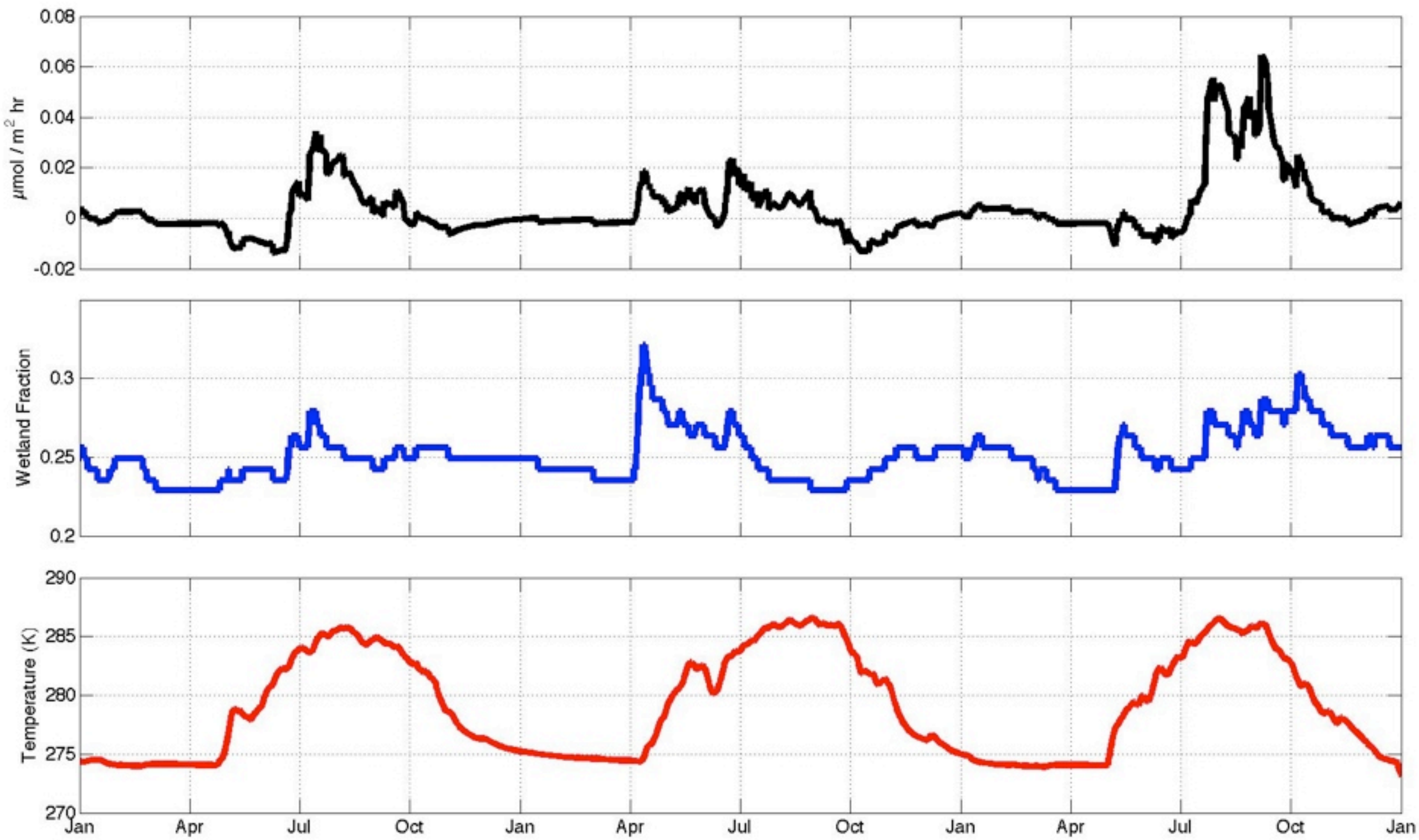
- The production term will dominate above a certain critical wetland fraction.
- By adding a constant baseline production, the equilibrium fraction may be varied.
- I've assumed the site is near equilibrium by picking k so that the equilibrium fraction is the average observed wetland fraction.

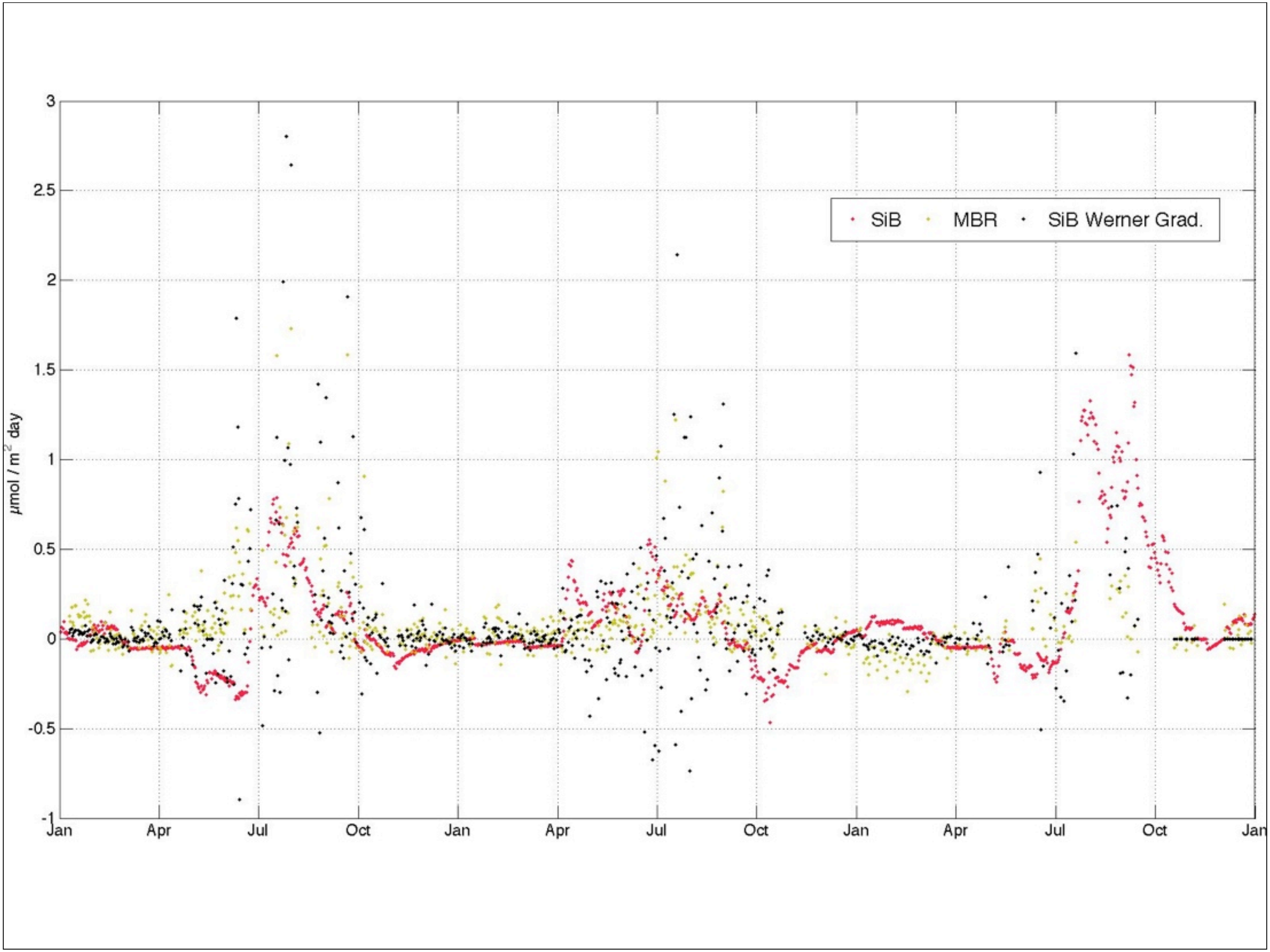
A Prediction

- Since summers at the WLEF are wet, while Spring and Fall are warm, but dry; we might expect a pattern in the methane flux something like this:



$$CH_4\,flux = WF \cdot Q10_P^{\left(\frac{td(6)-273}{10}\right)} - (1 - WF) \cdot Q10_C^{\left(\frac{td(6)-273}{10}\right)}$$





3
2.5
2
1.5
1
0.5
0
-0.5
-1
μmol / m2 day
SiB
MBR
SiB Werner Grad.
Jan
Apr
Jul
Oct
Jan
Apr
Jul
Oct
Jan
Apr
Jul
Oct
Jan