# Linking Climate, NEE and NDVI across semi-arid biomes in the Southwestern US using the NMEG cluster of flux towers

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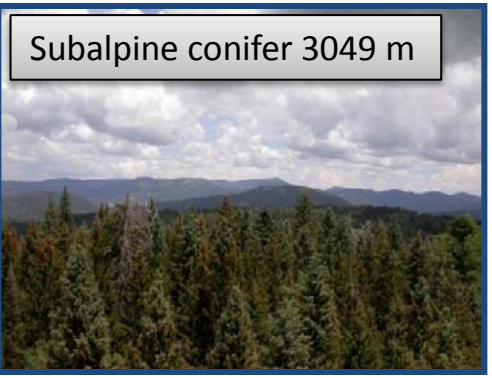
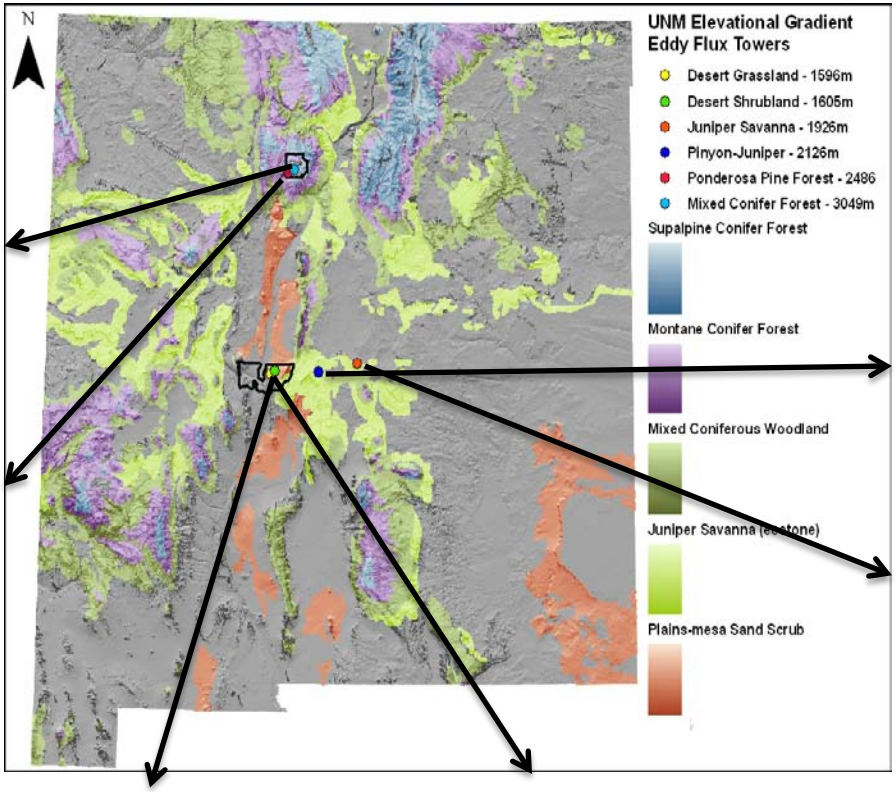
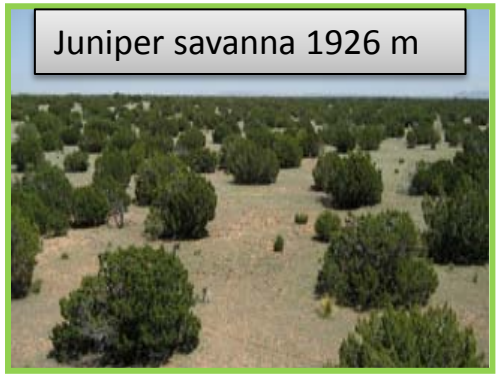
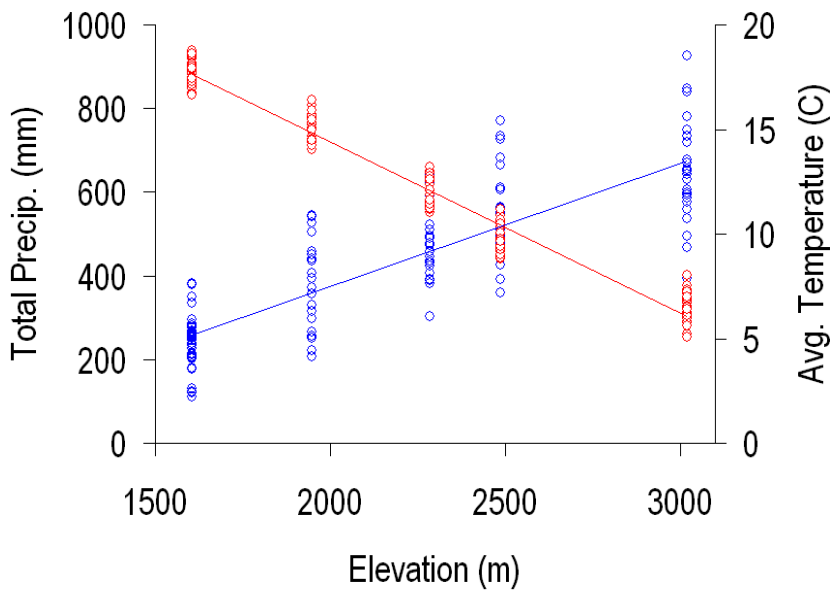
# New Mexico Elevation Gradient

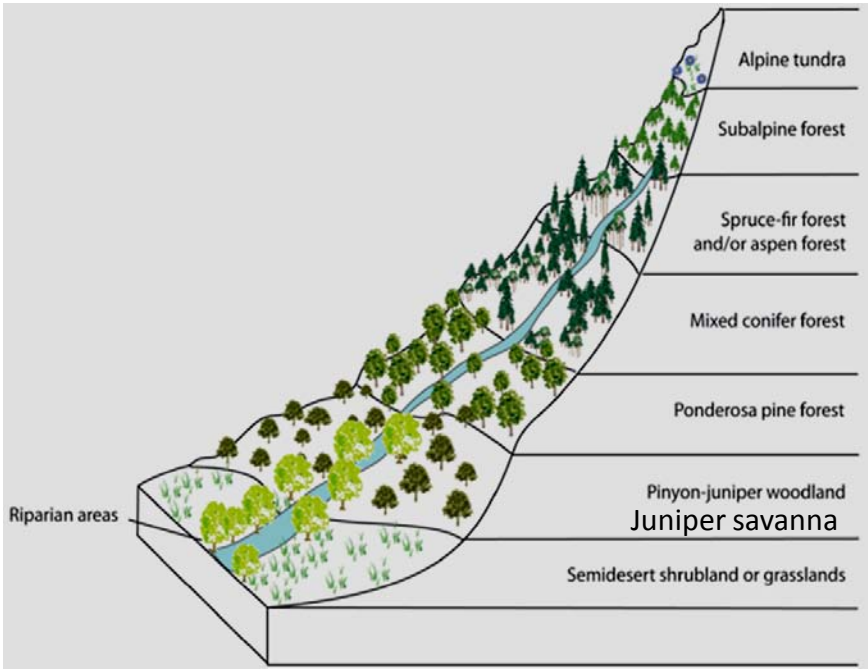




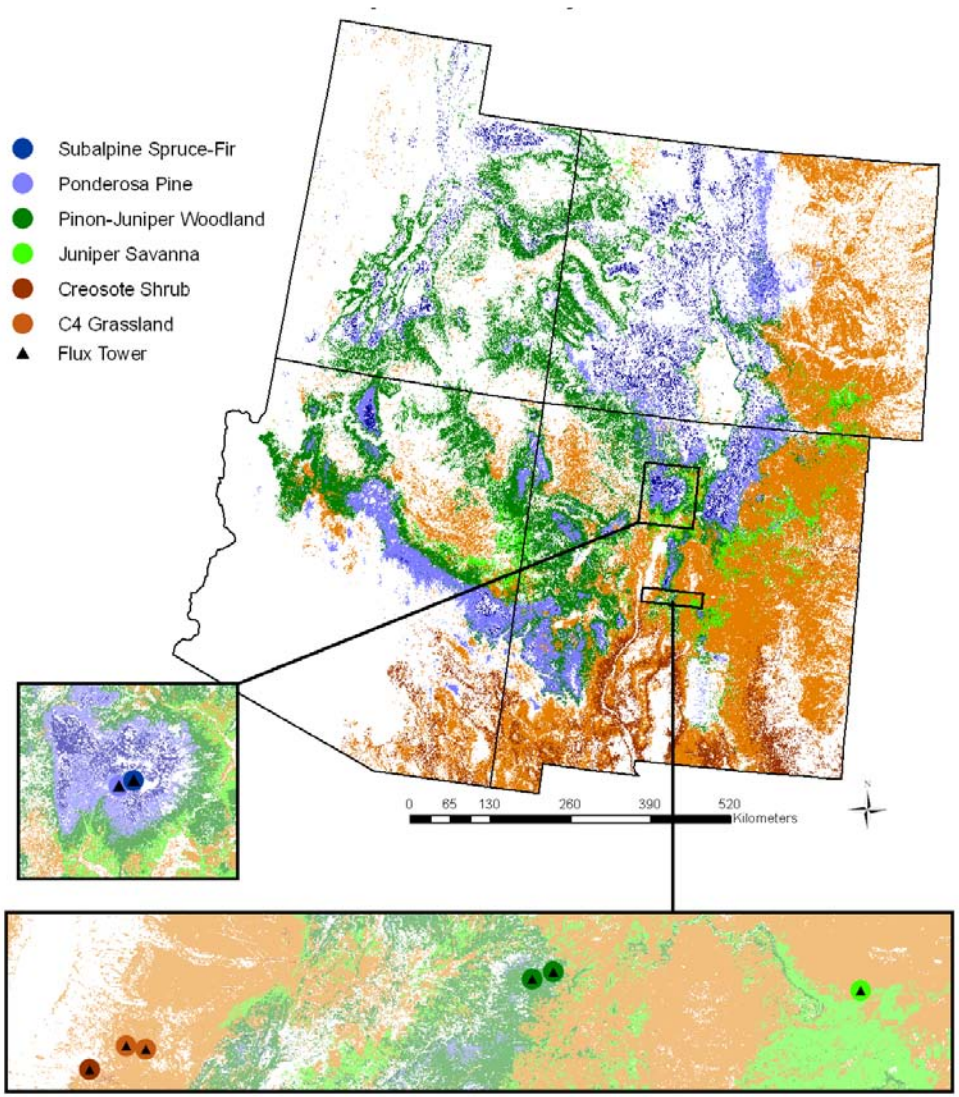


# Spatial heterogeneity in SW



# Biomes represented by the NMEG

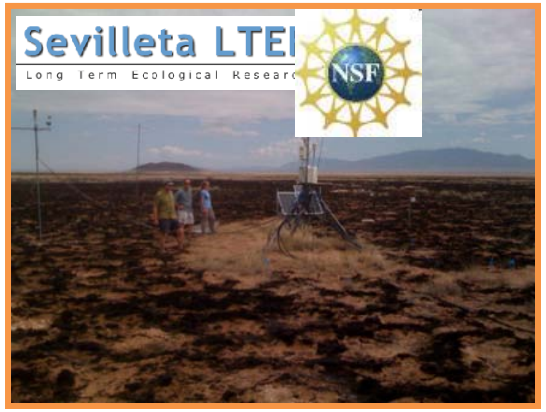



Tower sites and biomes represented in the NMEG network over a landcover map using data from the Southwest Regional Gap Analysis Project (SWReGAP)(http://earth.gis.usu.edu/swgap).

# Disturbance in NMEG

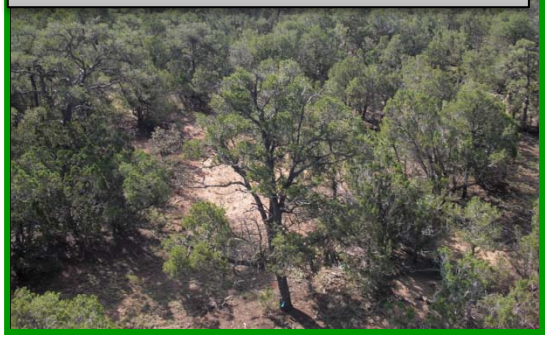
## Fire

Desert grassland 1596 m



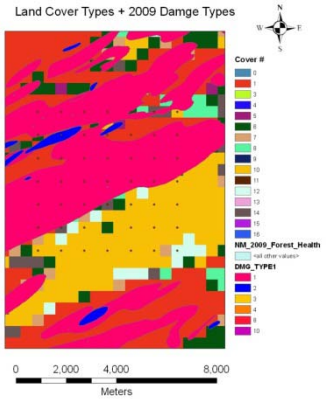

## Bark beetle

Piñon-juniper 2126 m

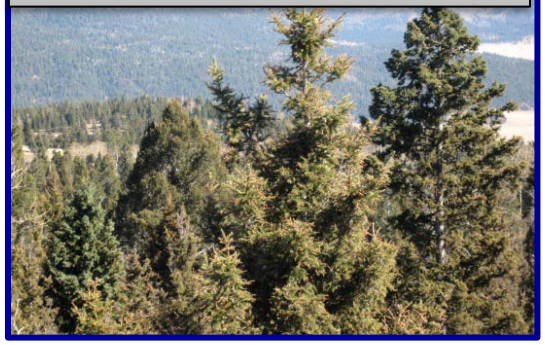


piñon girdled Sept 2009

## Spruce budworm

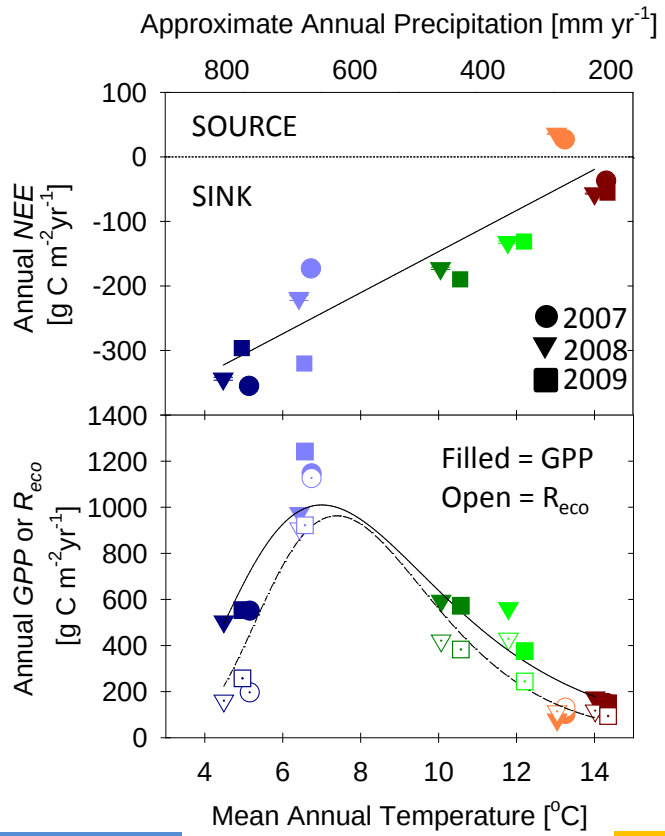


Subalpine conifer 3049 m



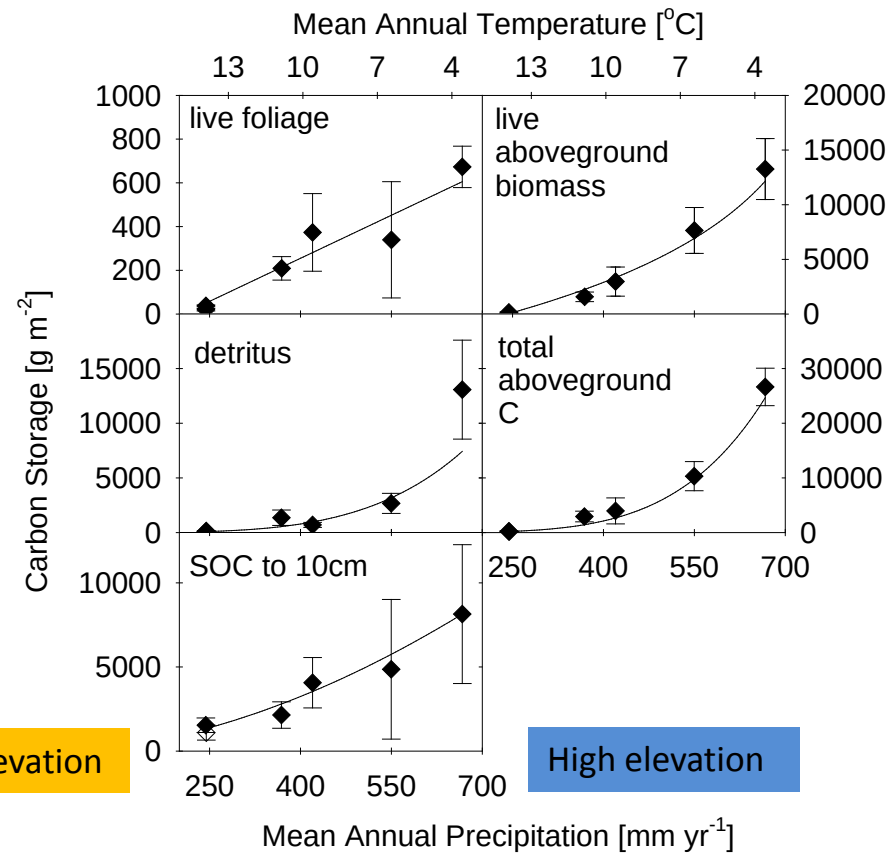
# Climate dependence of carbon fluxes and storage

**DG** **desert grassland**
**DS** **desert shrubland**
**JS** **juniper savanna**
**PJ** **piñon-juniper**
**PP** **ponderosa pine**
**SC** **subalpine conifer**




High elevation

Low elevation

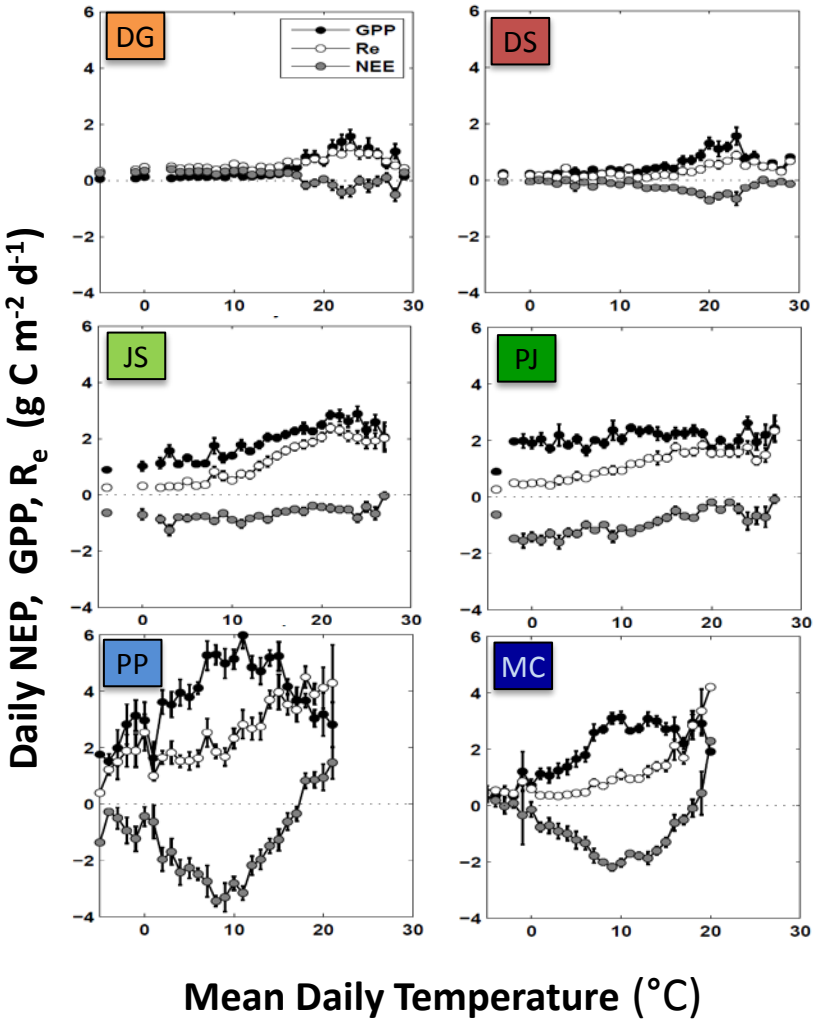


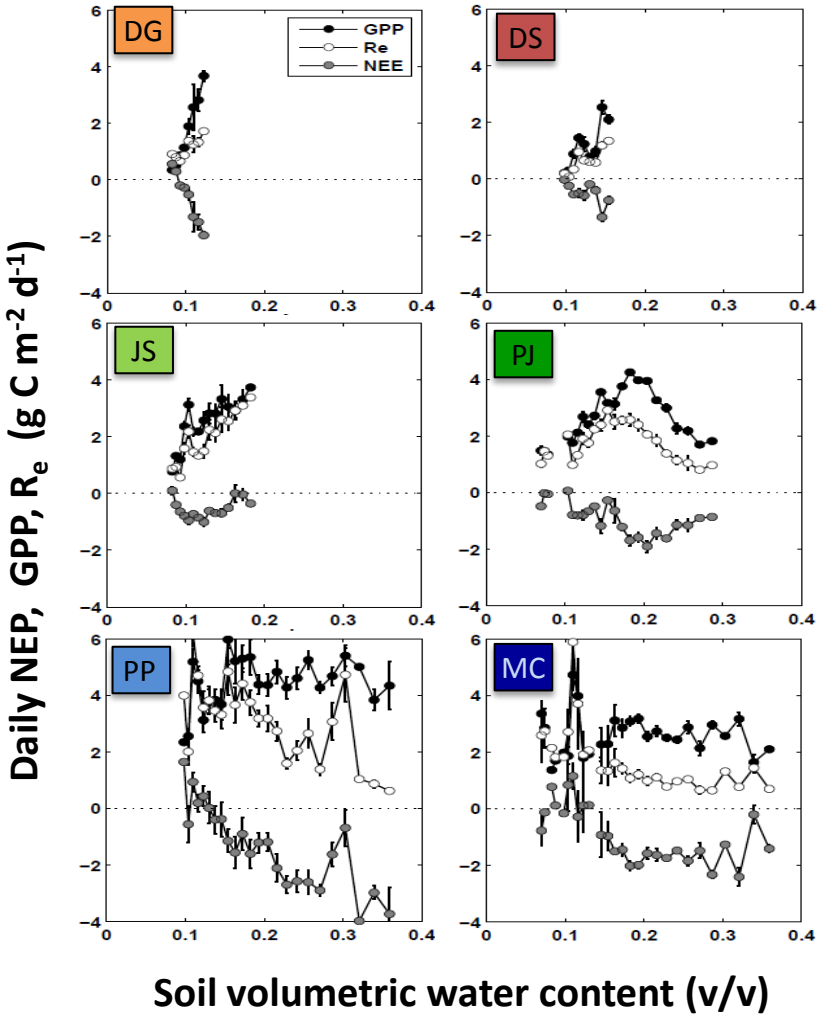

Low elevation

High elevation

**Anderson-Teixeira** et al. (*GCB; 2010*)

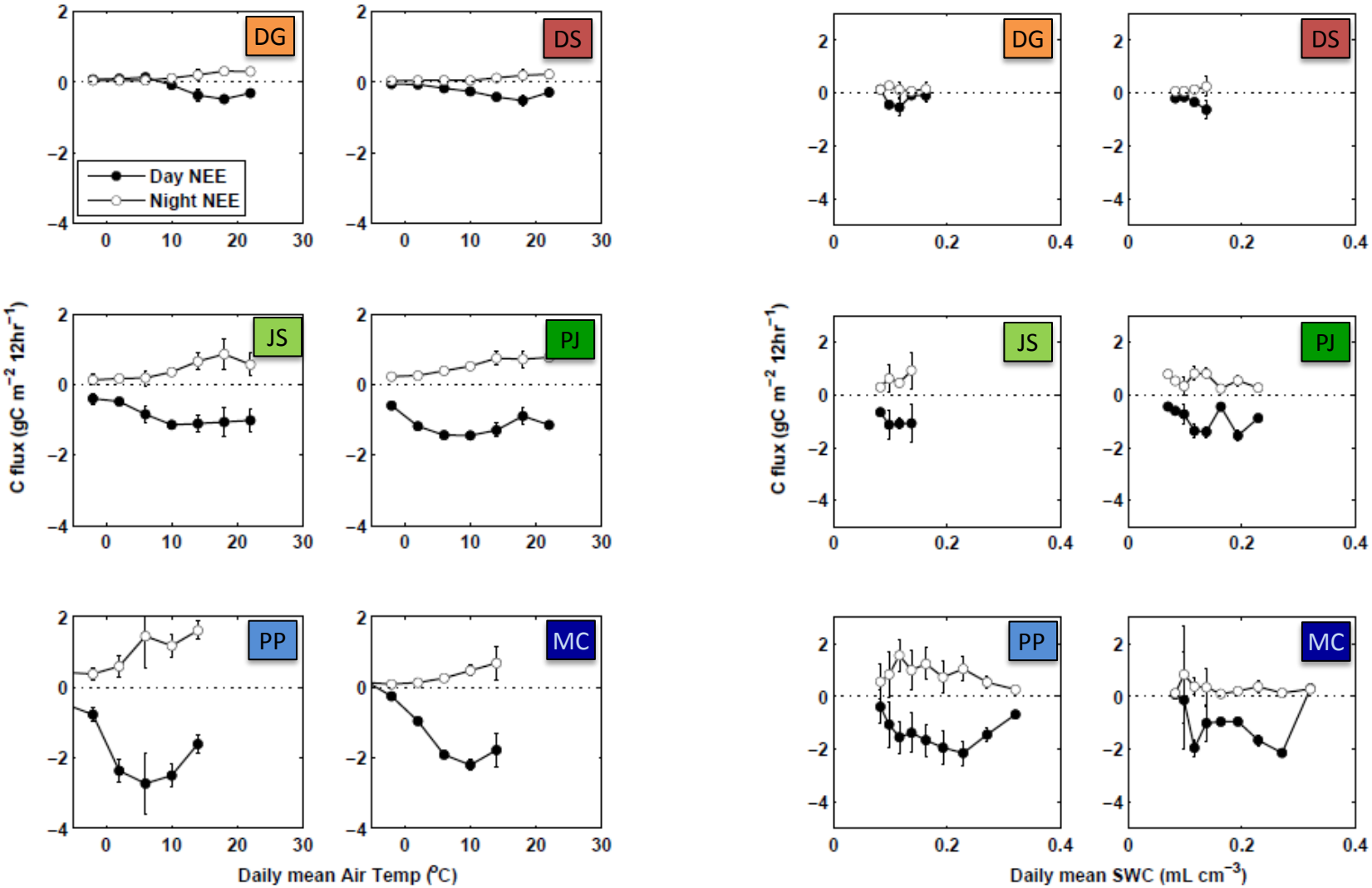
# Response curves to temperature, soil water content




**Anderson-Teixeira** et al. (*GCB; 2011*)

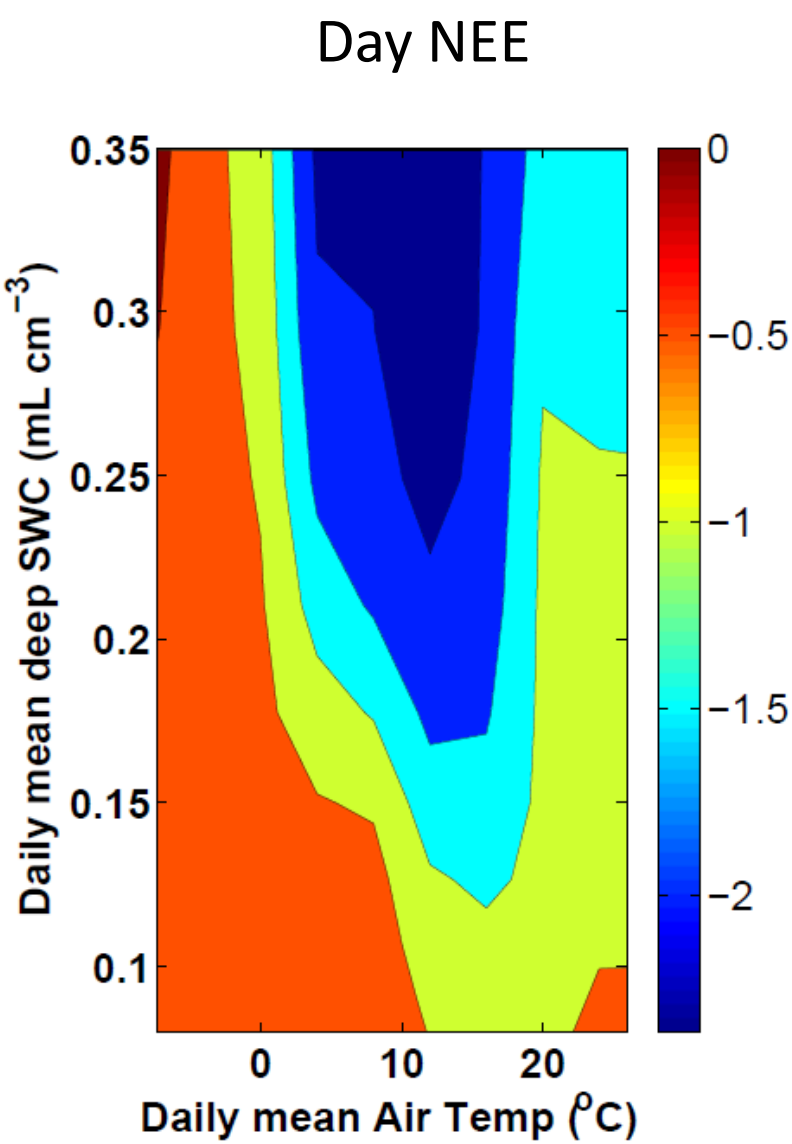
# Day vs. night NEE response curves

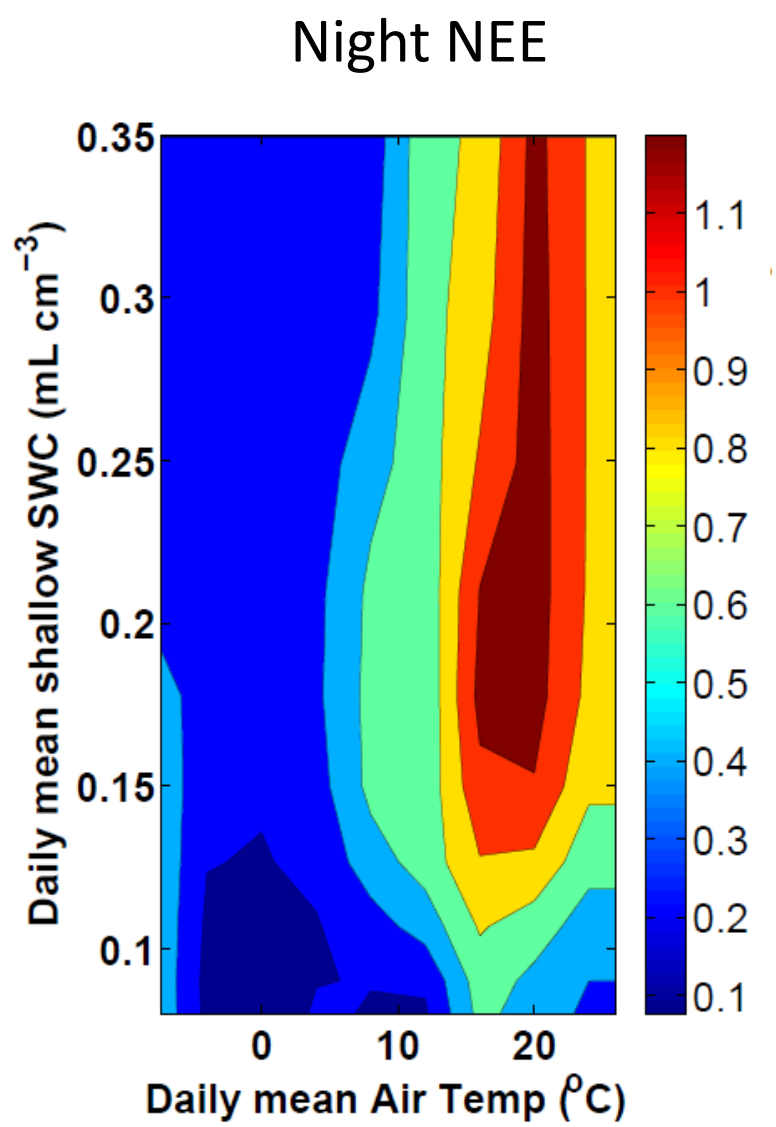


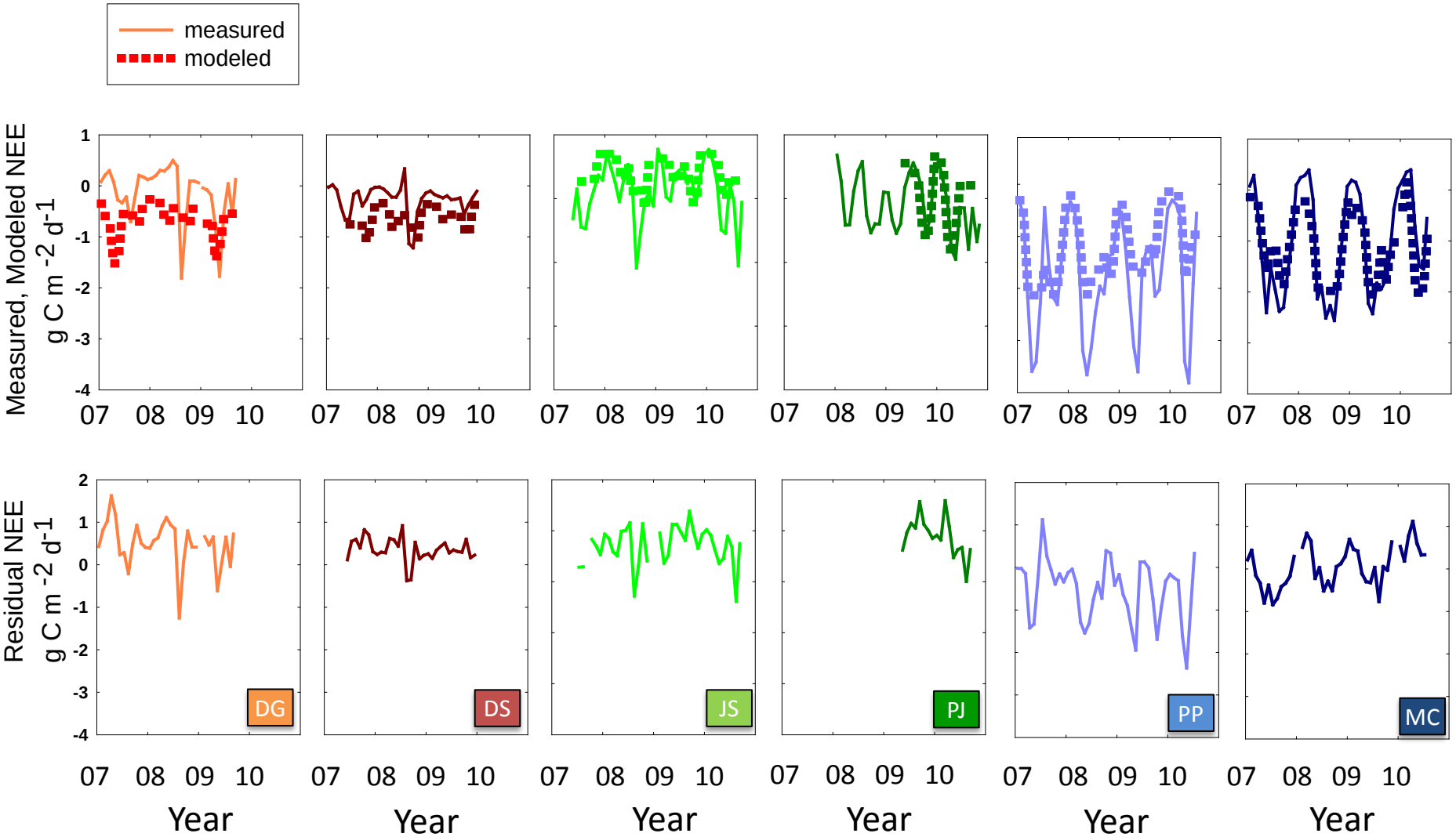
# First step

Is there broad geographic coherence in terms of the control of temperature and soil water content on NEE?

Or…does the heterogeneity matter and require site-specific surfaces?


Day NEE
Daily mean deep SWC (mL cm$^{-3}$)
0.35
0.3
0.25
0.2
0.15
0.1
0
10
20
Daily mean Air Temp ($^{o}$C)
0
−0.5
−1
−1.5
−2


Night NEE
Daily mean shallow SWC (mL cm$^{-3}$)
0.35
0.3
0.25
0.2
0.15
0.1
0
10
20
Daily mean Air Temp ($^{o}$C)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

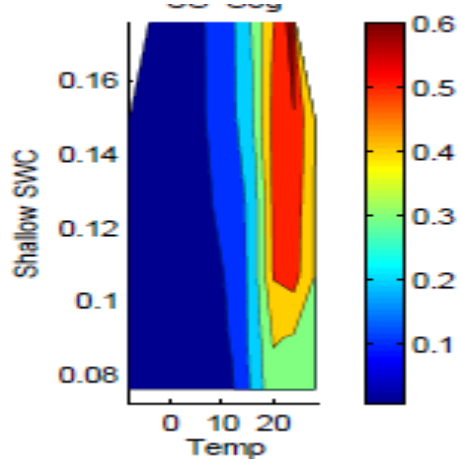


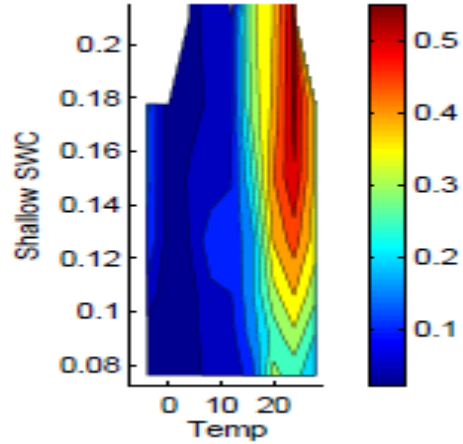

RMSE

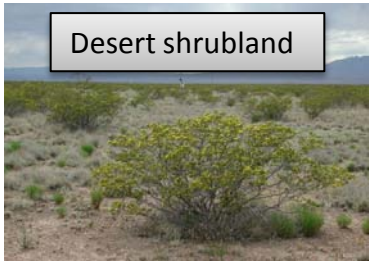
| | DG | DS | JS | PJ | PP | MC |
|---|---|---|---|---|---|---|
| Day | 0.73 | 0.46 | 0.48 | 0.39 | 0.89 | 0.49 |
| Night | 0.20 | 0.24 | 0.18 | 0.15 | 0.63 | 0.31 |

# Night NEE

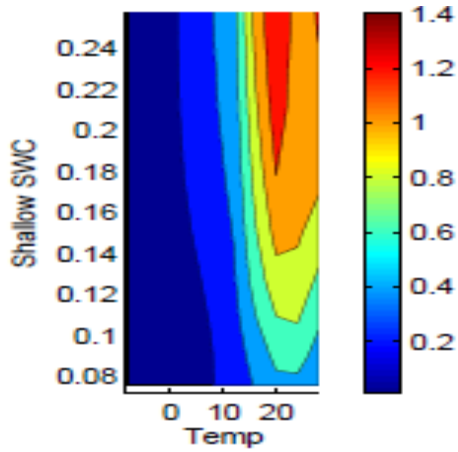
Desert grassland

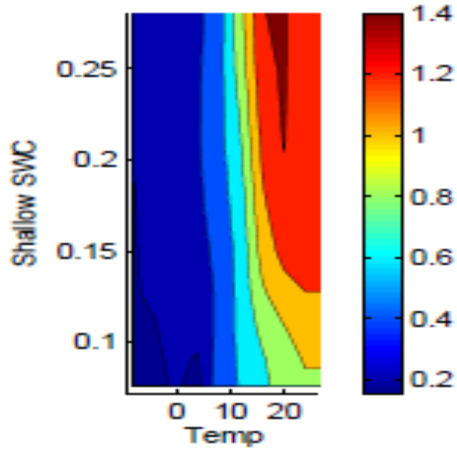

Shallow SWC
0.16
0.14
0.12
0.1
0.08
0 10 20
Temp
0.6
0.5
0.4
0.3
0.2
0.1


Shallow SWC
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0 10 20
Temp
0.5
0.4
0.3
0.2
0.1

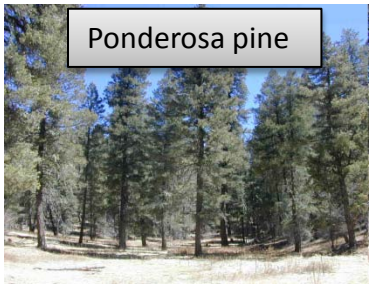

Desert shrubland

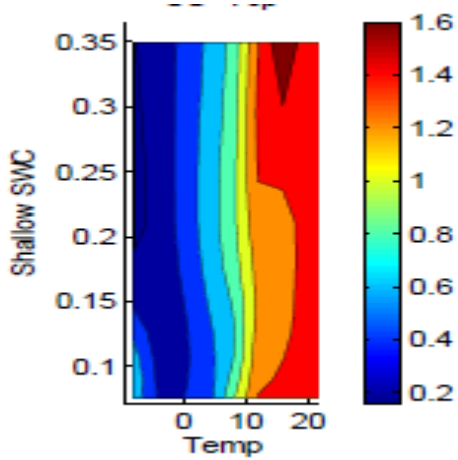
Juniper savanna

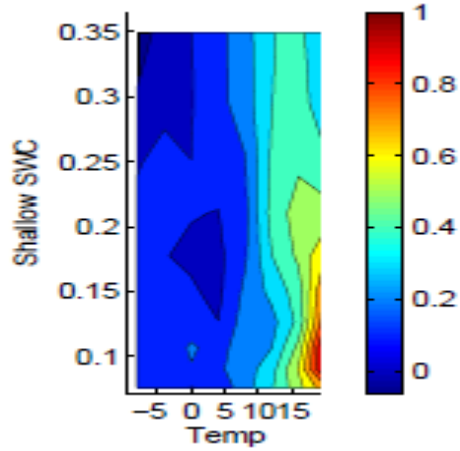

Shallow SWC
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0 10 20
Temp
1.4
1.2
1
0.8
0.6
0.4
0.2


Shallow SWC
0.25
0.2
0.15
0.1
0 10 20
Temp
1.4
1.2
1
0.8
0.6
0.4
0.2

Piñon-juniper


Ponderosa pine

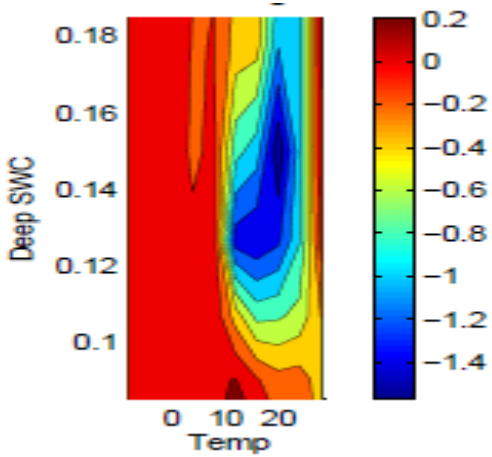

Shallow SWC
0.35
0.3
0.25
0.2
0.15
0.1
0 10 20
Temp
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2

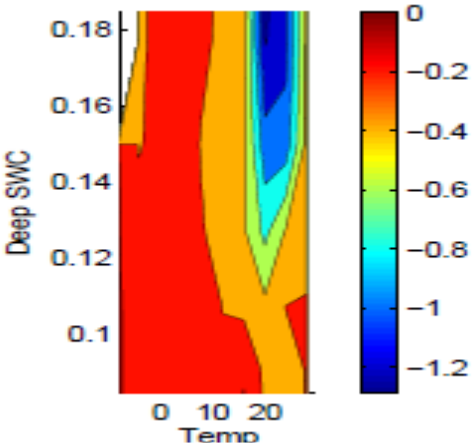

Shallow SWC
0.35
0.3
0.25
0.2
0.15
0.1
−5 0 5 1015
Temp
1
0.8
0.6
0.4
0.2
0

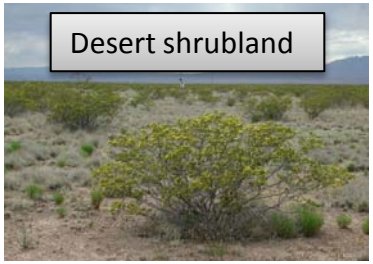
Subalpine conifer

# Day NEE

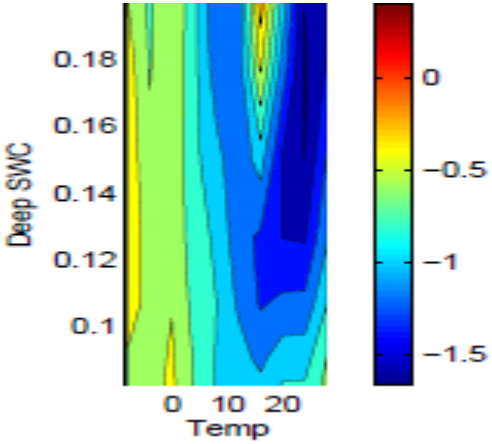
Desert grassland

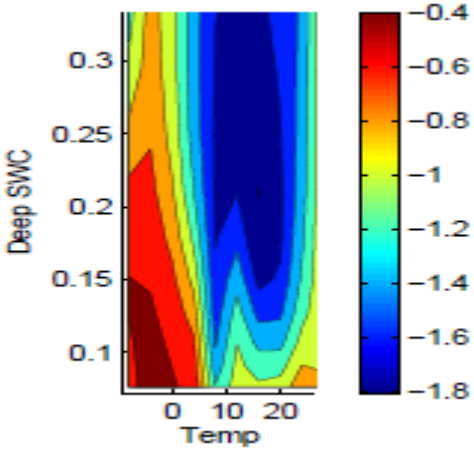

Deep SWC
0.18
0.16
0.14
0.12
0.1
0 10 20
Temp
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4


Deep SWC
0.18
0.16
0.14
0.12
0.1
0 10 20
Temp
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2


Desert shrubland

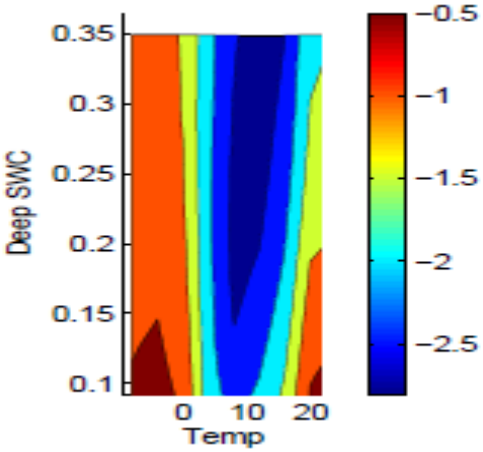
Juniper savanna

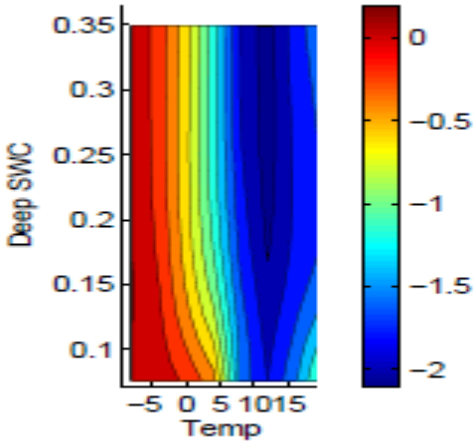

Deep SWC
0.18
0.16
0.14
0.12
0.1
0 10 20
Temp
0
−0.5
−1
−1.5


Deep SWC
0.3
0.25
0.2
0.15
0.1
0 10 20
Temp
−0.4
−0.6
−0.8
−1
−1.2
−1.4
−1.6
−1.8

Piñon-juniper

Ponderosa pine


Deep SWC
0.35
0.3
0.25
0.2
0.15
0.1
0 10 20
Temp
−0.5
−1
−1.5
−2
−2.5

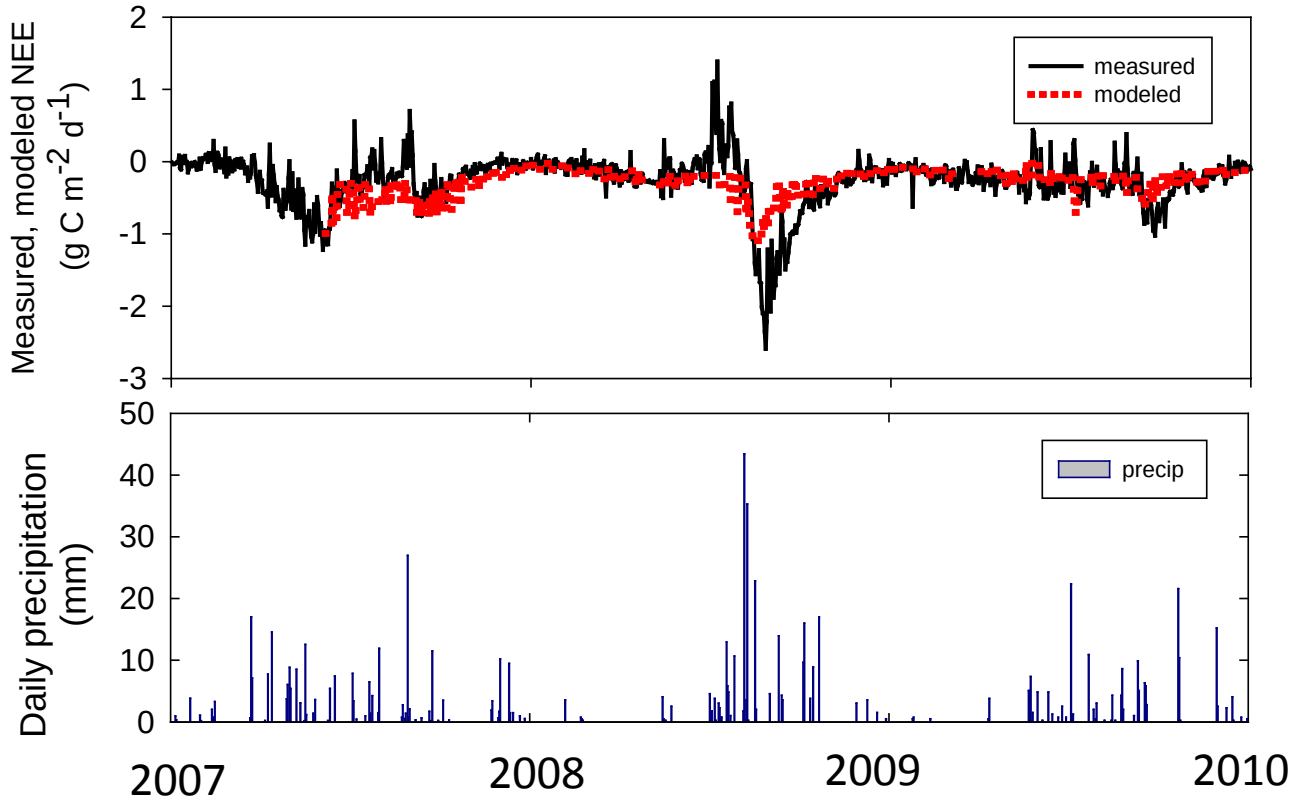

Deep SWC
0.35
0.3
0.25
0.2
0.15
0.1
−5 0 5 1015
Temp
0
−0.5
−1
−1.5
−2

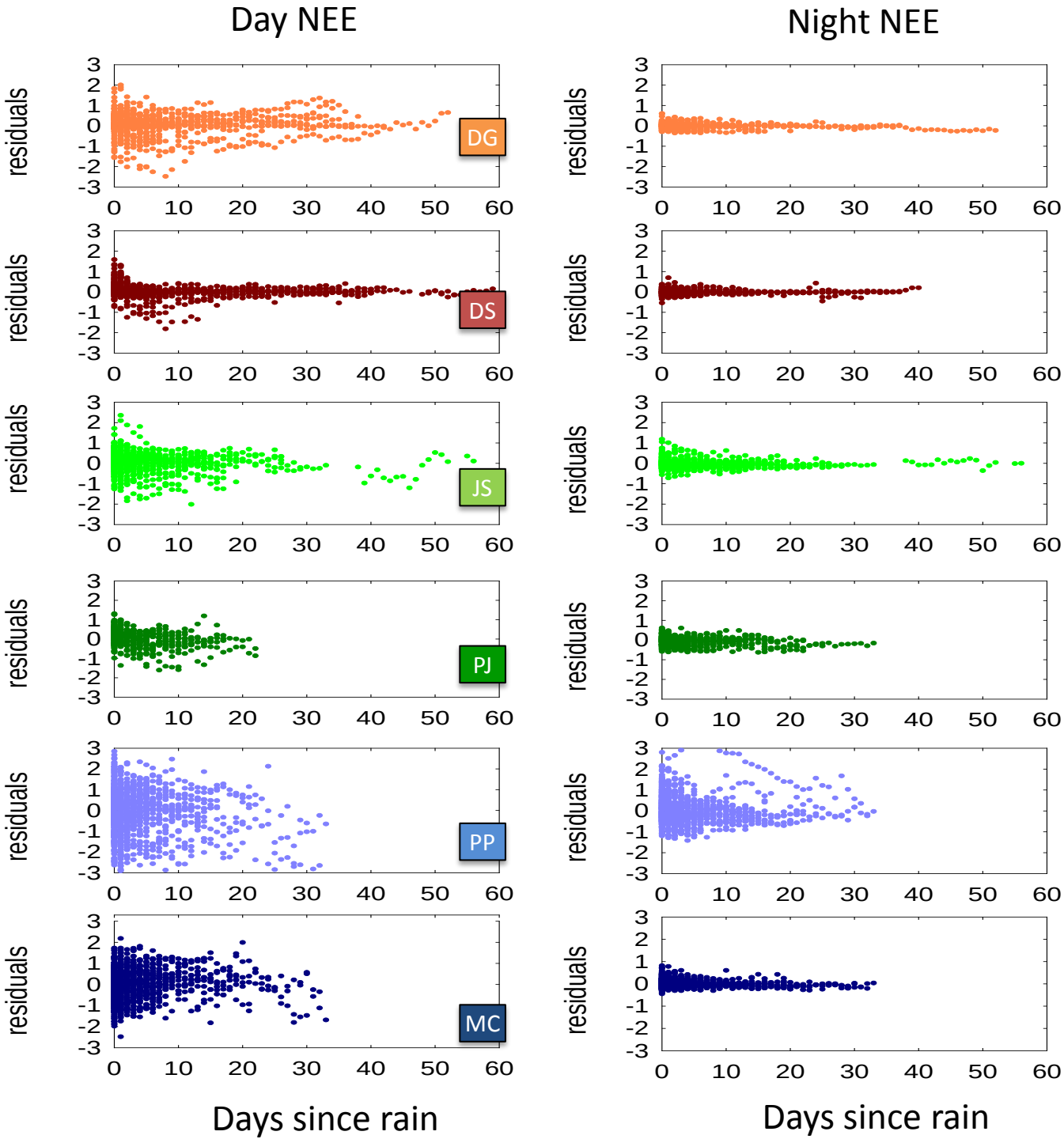
Subalpine conifer

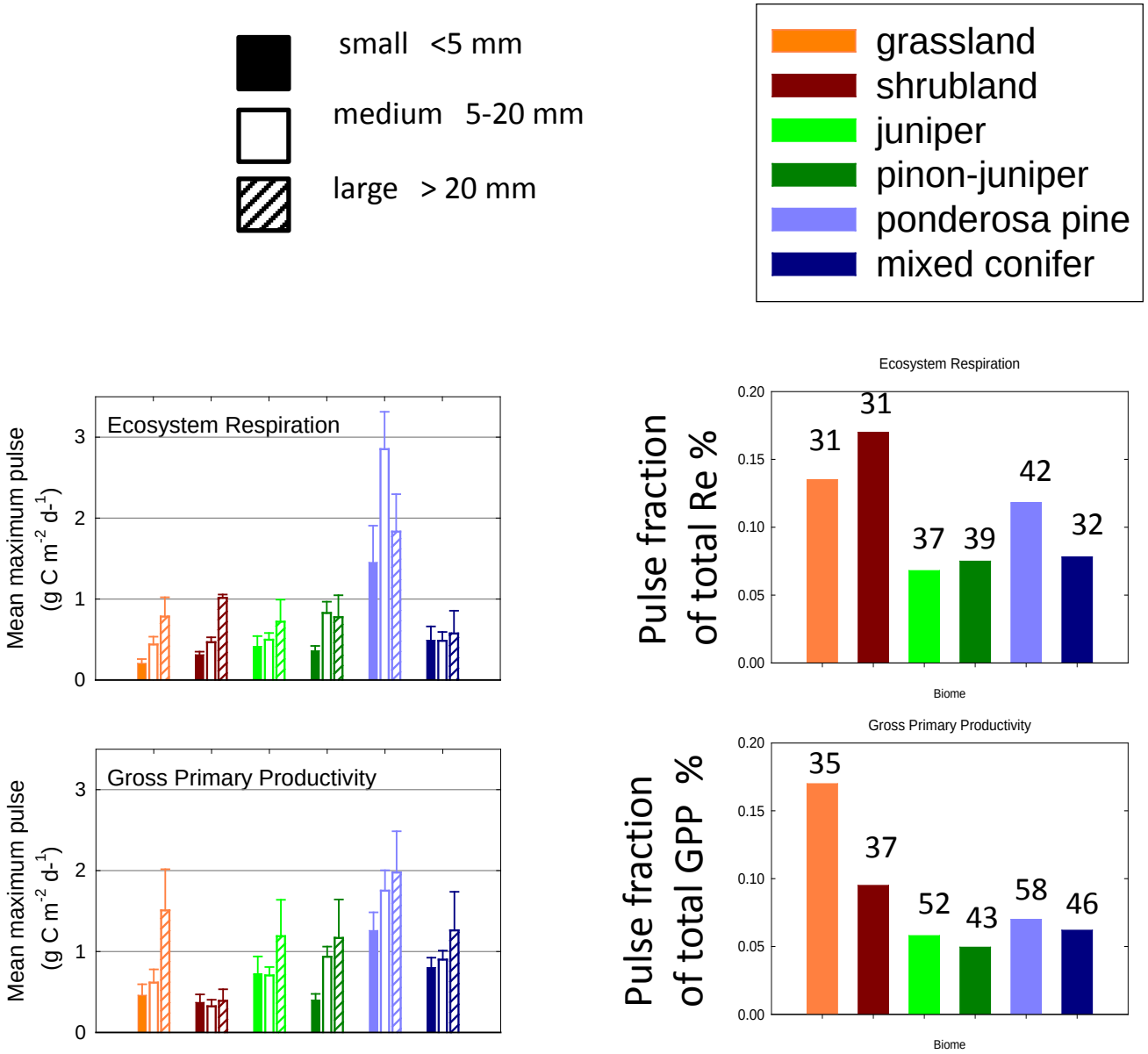
RMSE daily surfaces vs. observations

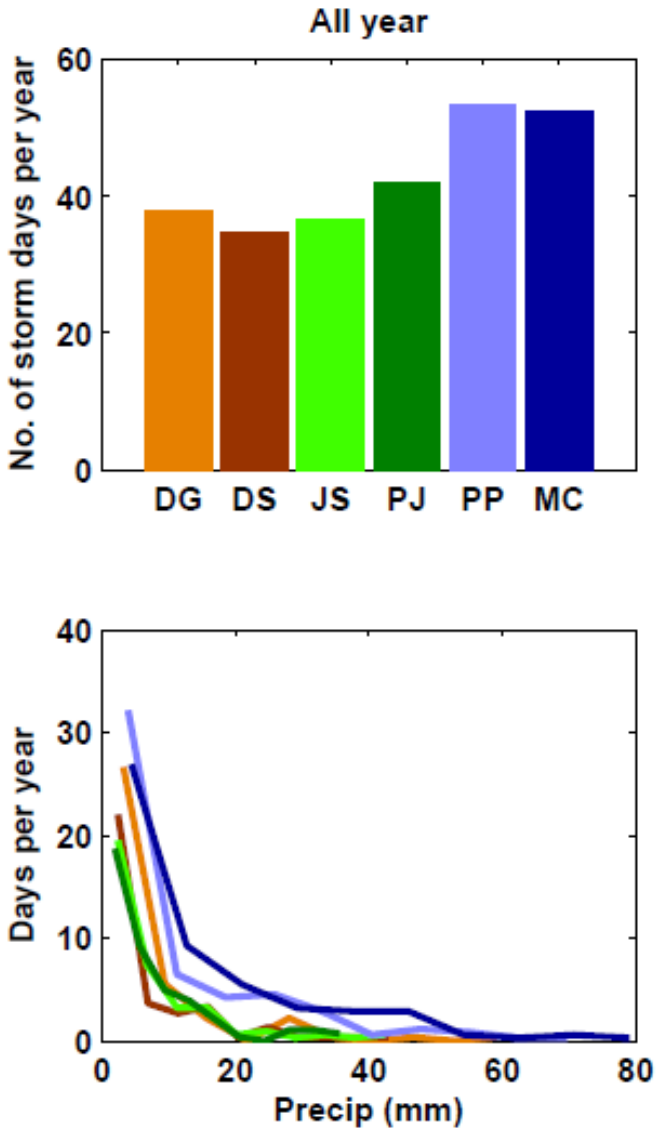
| | DG | DS | JS | PJ | PP | MC |
|---|---|---|---|---|---|---|
| Day | 0.56 | 0.32 | 0.49 | 0.45 | 1.09 | 0.70 |
| Night | 0.13 | 0.12 | 0.21 | 0.25 | 0.66 | 0.16 |

# Desert shrubland

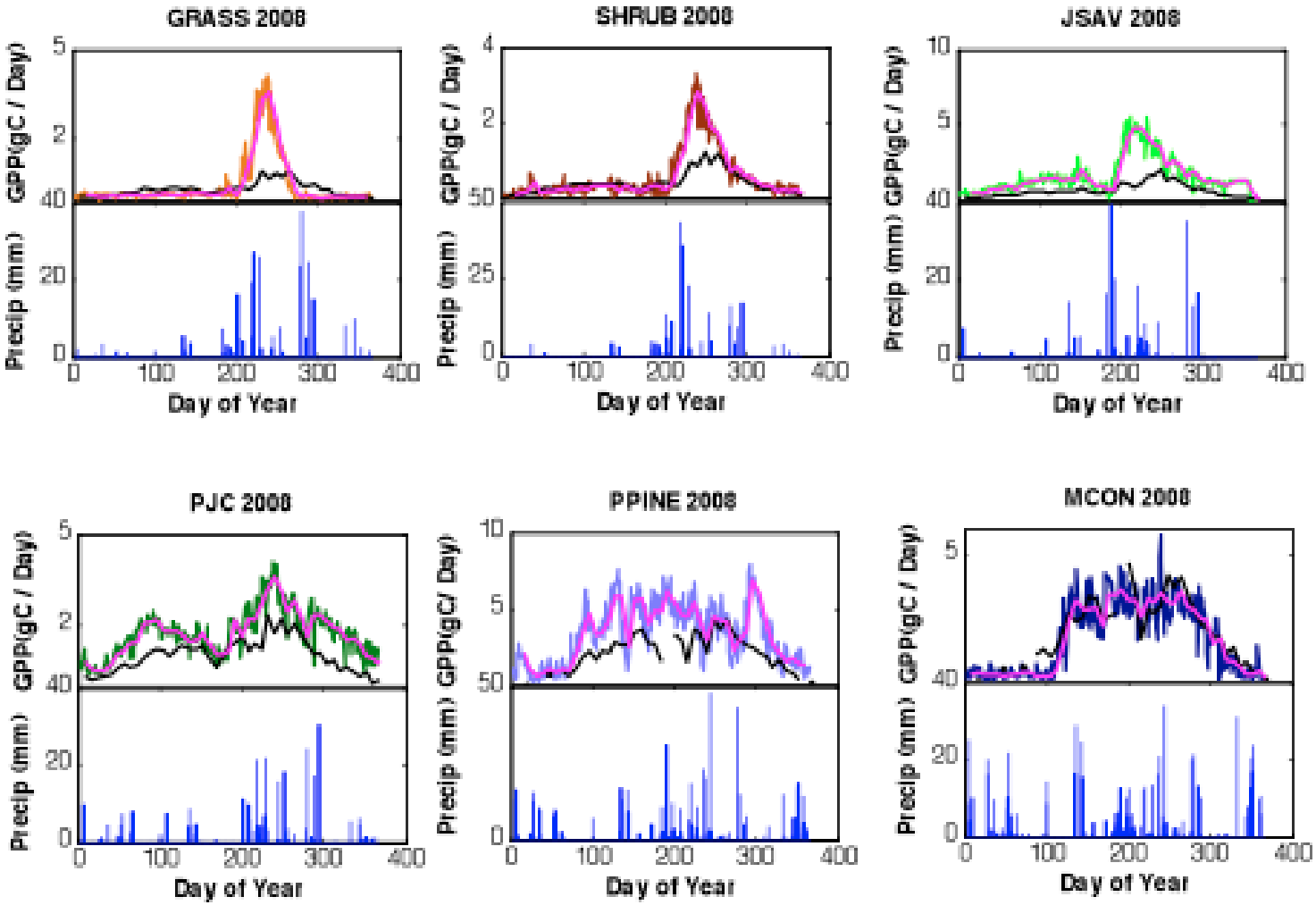



Day NEE
Night NEE
residuals
DG
DS
JS
PJ
PP
MC
Days since rain
Days since rain


small <5 mm
medium 5-20 mm
large > 20 mm
grassland
shrubland
juniper
pinon-juniper
ponderosa pine
mixed conifer
Ecosystem Respiration
Mean maximum pulse
(g C m-2 d-1)
0
1
2
3
Gross Primary Productivity
Mean maximum pulse
(g C m-2 d-1)
0
1
2
3
Ecosystem Respiration
Pulse fraction
of total Re %
0.00
0.05
0.10
0.15
0.20
31
31
37
39
42
32
Biome
Gross Primary Productivity
Pulse fraction
of total GPP %
0.00
0.05
0.10
0.15
0.20
35
37
52
43
58
46
Biome


All year
No. of storm days per year
60
40
20
0
DG
DS
JS
PJ
PP
MC
Days per year
40
30
20
10
0
0
20
40
60
80
Precip (mm)

grassland
shrubland
juniper
pinon-juniper
ponderosa pine
mixed conifer


GRASS 2008
SHRUB 2008
JSAV 2008
PJC 2008
PPINE 2008
MCON 2008
GPP(gC / Day)
Precip (mm)
Day of Year

# Conclusions

1. NMEG valuable network for examining C dynamics in semi-arid ecosystems in the SW US

2. Single response surface better at explaining variability in nighttime NEE as a function of temperature and soil water content than daytime NEE

3. Distinct site-specific patterns in daytime NEE
   - Lower sites more water limited
   - Upper sites more temperature limited

4. Short term carbon dynamics following precipitation events not well represented by this simple model or MODIS products

Sevilleta LTER
Long Term Ecological Research
SAHRA
UNM BIOLOGY
THE UNIVERSITY of NEW MEXICO
NSF
EPSCoR
New Mexico
FOREST SERVICE
U S
EPSCoR
DEPARTMENT of ENERGY