Leaf Area-Climate Interaction as a Functional Constraint Across CMIP5 Models

Community Land Model Workshop

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University of Washington

March 2nd, 2017

Vegetation Interaction: Multilinear Regression

$$\%\Delta LAI = \beta_o + T_{MAT}\,\beta_{Temp} + P_{MAP}\,\beta_{Precip}$$

Vegetation Interaction: Multilinear Regression

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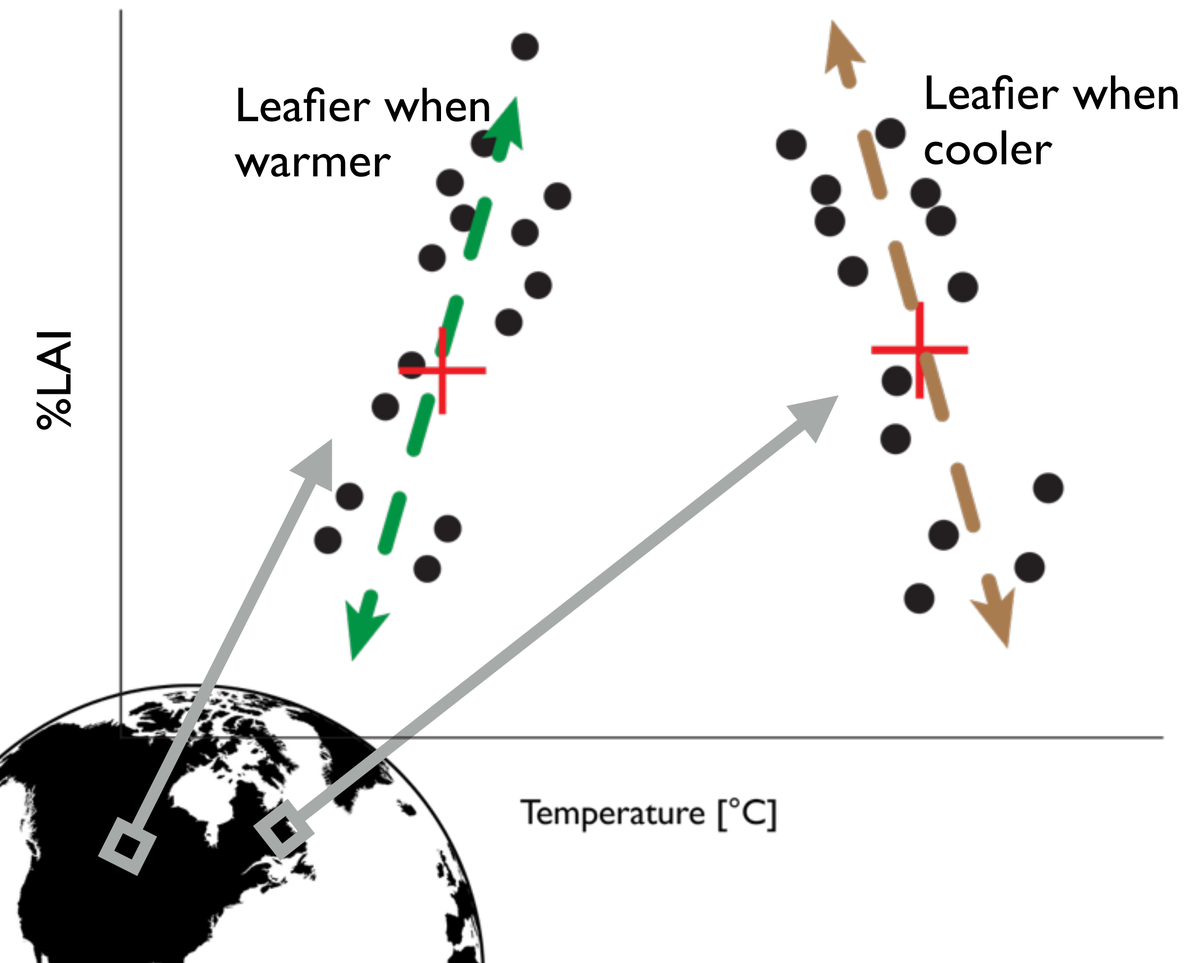

Vegetation Interaction: Multilinear Regression

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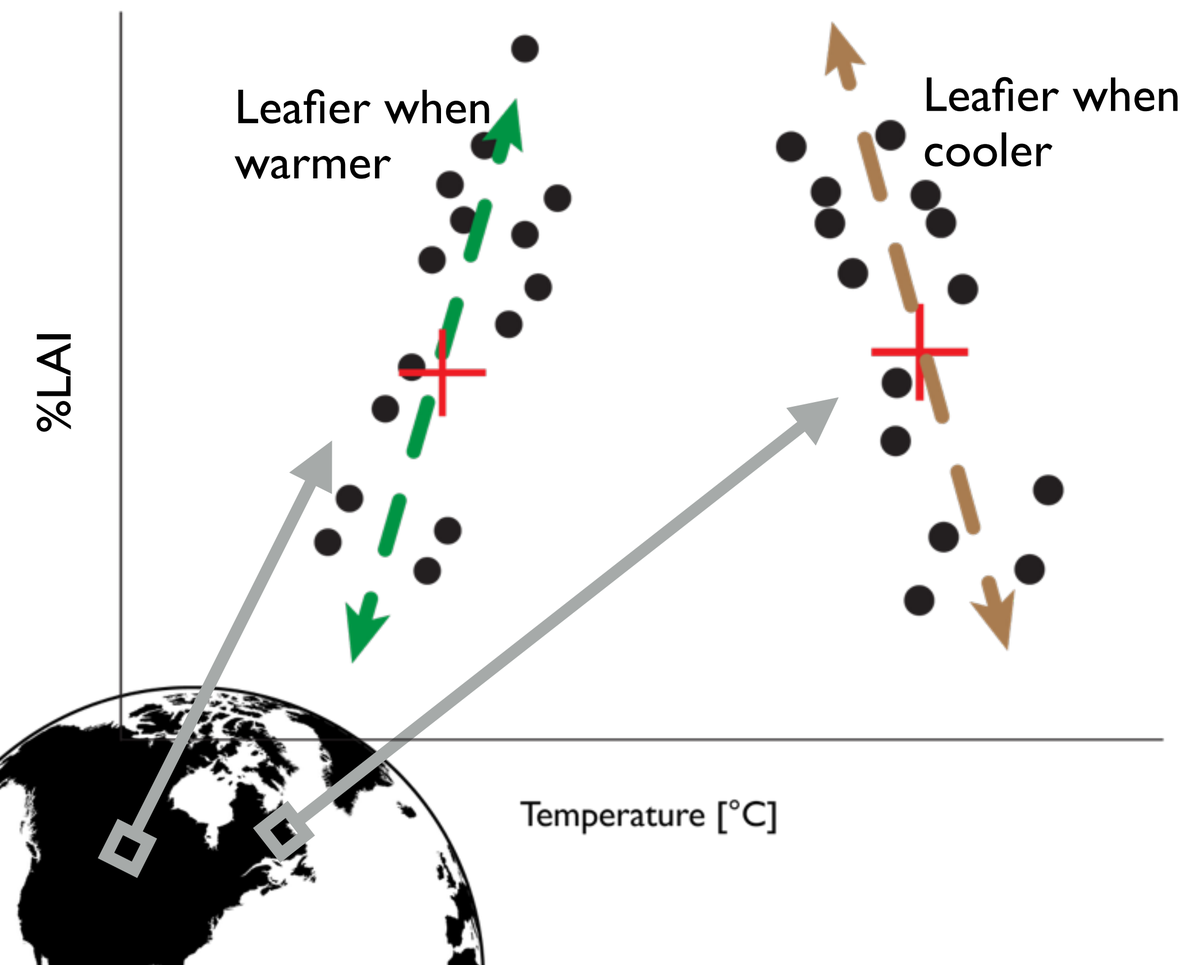


Observations

Leaf Area Index 3g

(Pizon and Tucker, 2014)

2 meter Temperature
ERA-Interim Reanalysis

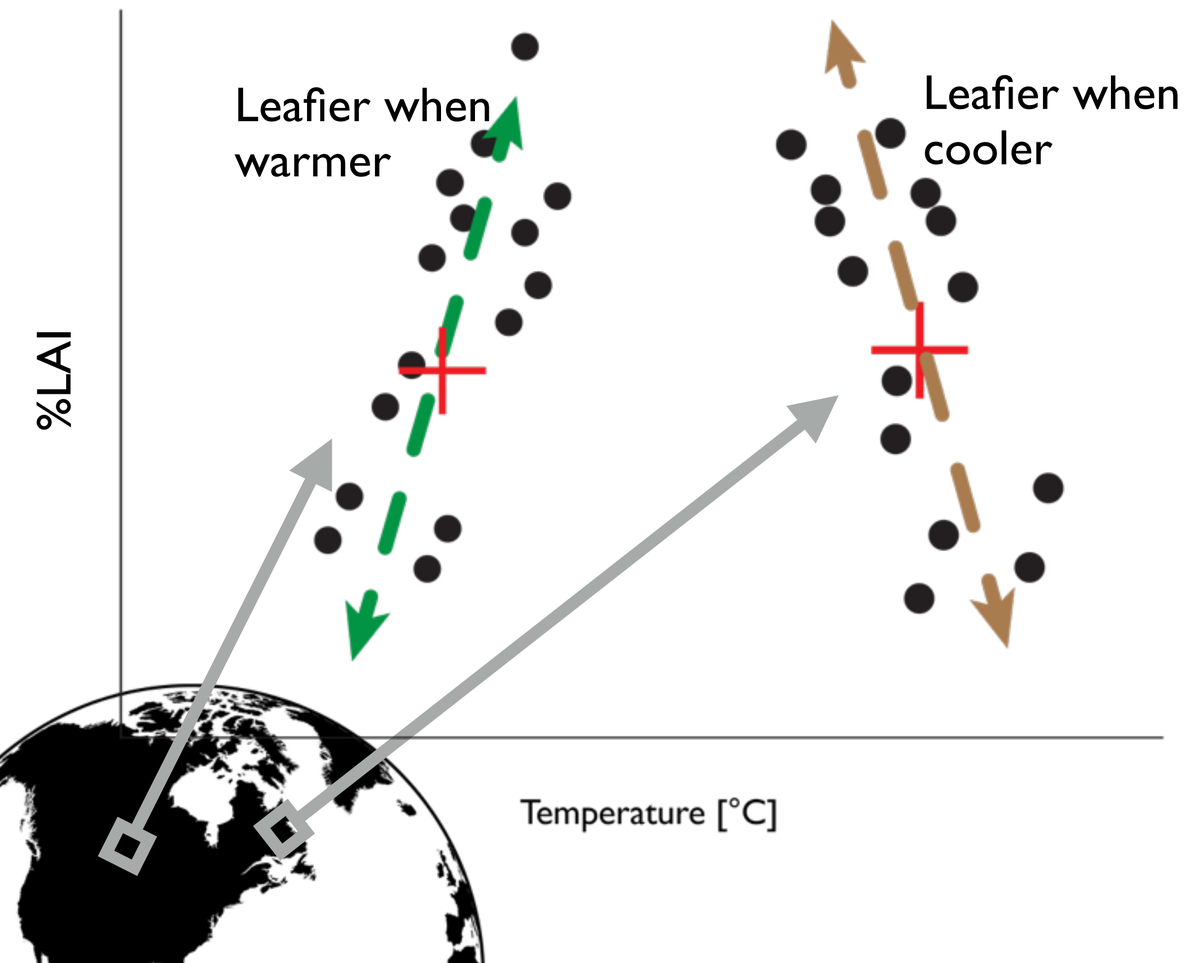
(Dee et al, 2011)

Global Precipitation
Climatology Project (Rain)

(Adler et al, 2003)

Vegetation Interaction: Multilinear Regression

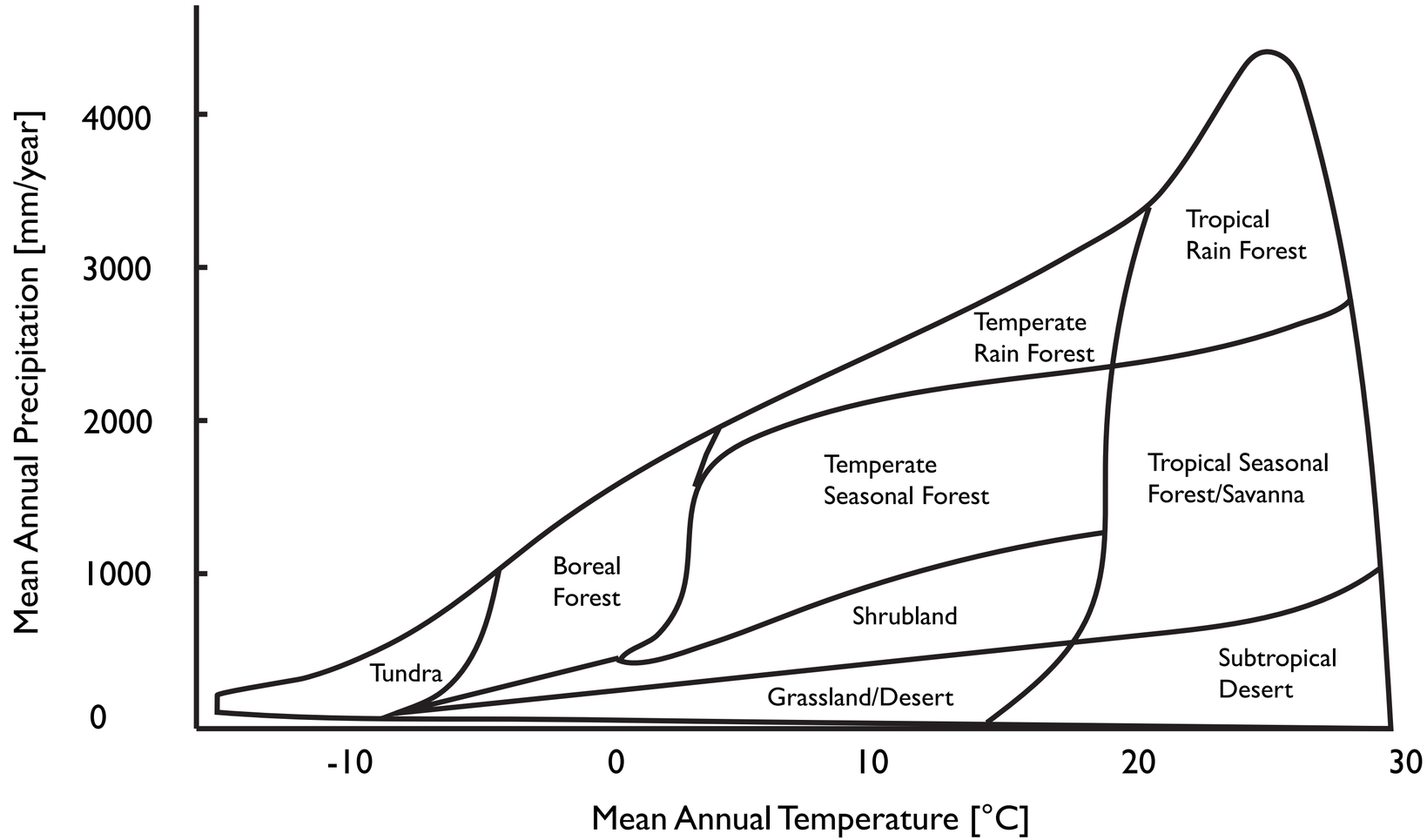
$$\%\Delta LAI = \beta_o + T_{MAT}\,\beta_{Temp} + P_{MAP}\,\beta_{Precip}$$



Models - CMIP5

CESM1-BGC	**CLM4**
NorESM1-ME	**CLM4**
CanESM2	
GFDL-ESM2M	
HadGEM2-ES	
IPSL-CM5A-LR	
MIROC-ESM	
MPI-ESM-LR	
BNU-ESM	
bcc-csm1-1	

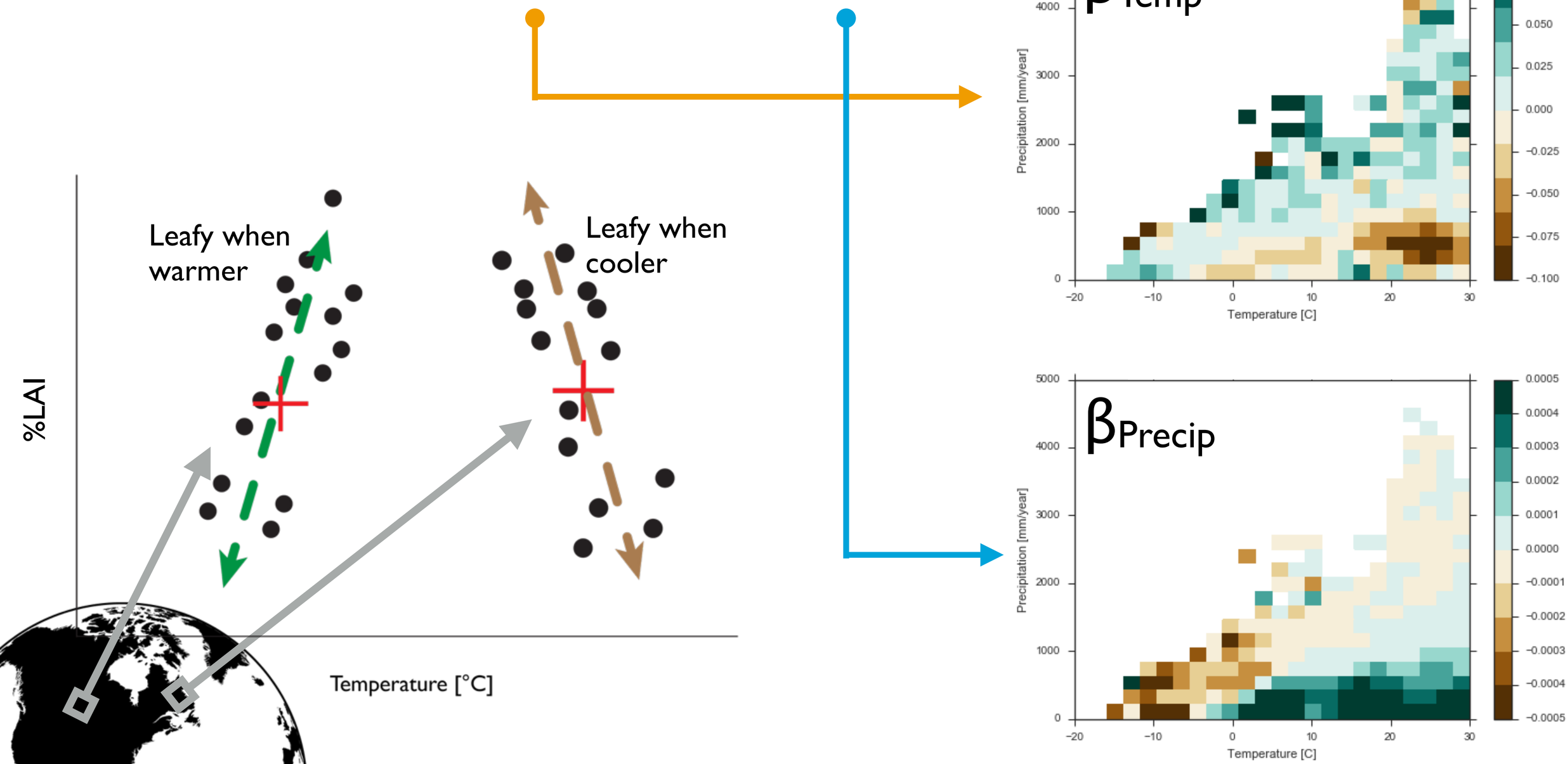
Aggregate in Whittaker style climate space

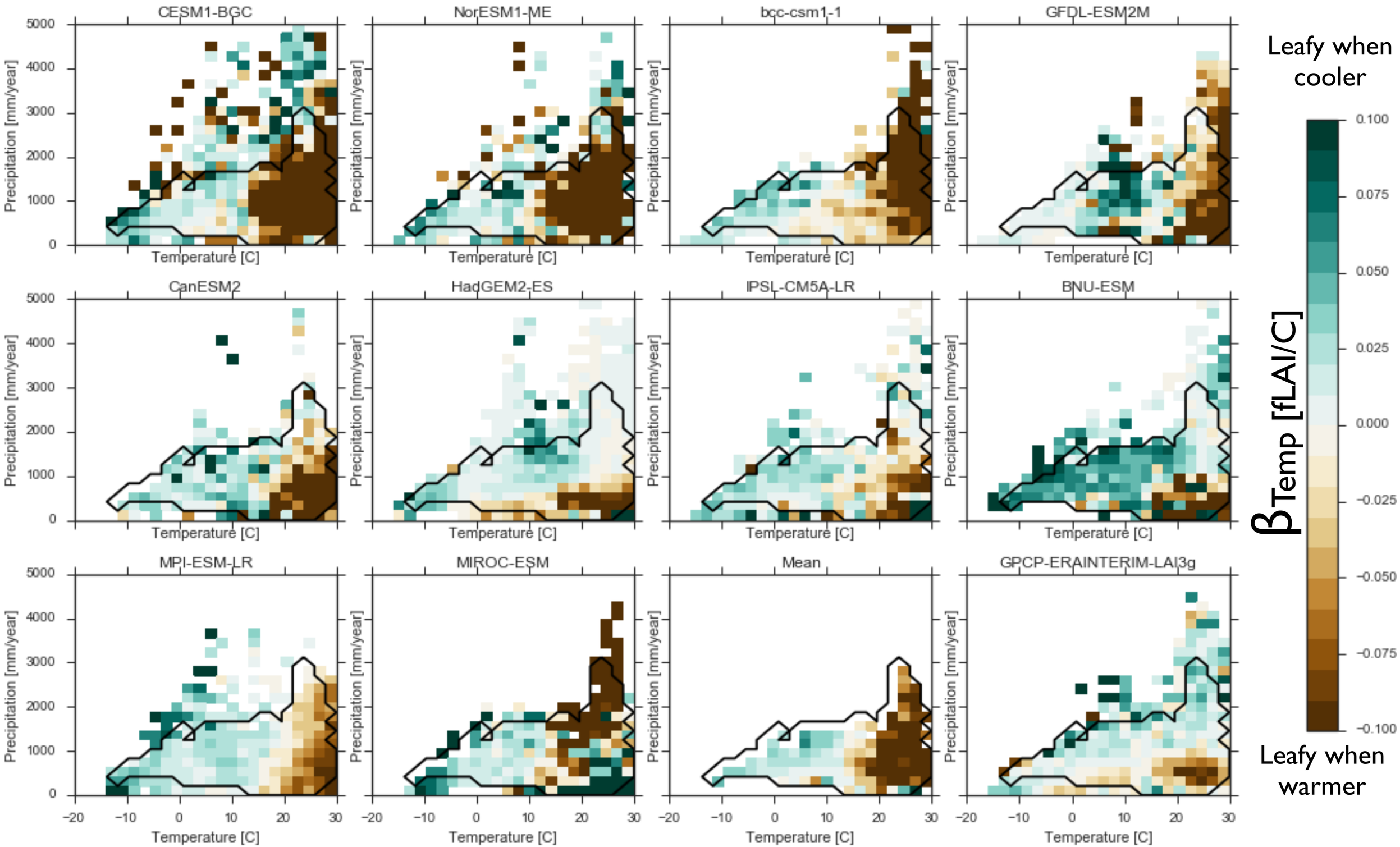


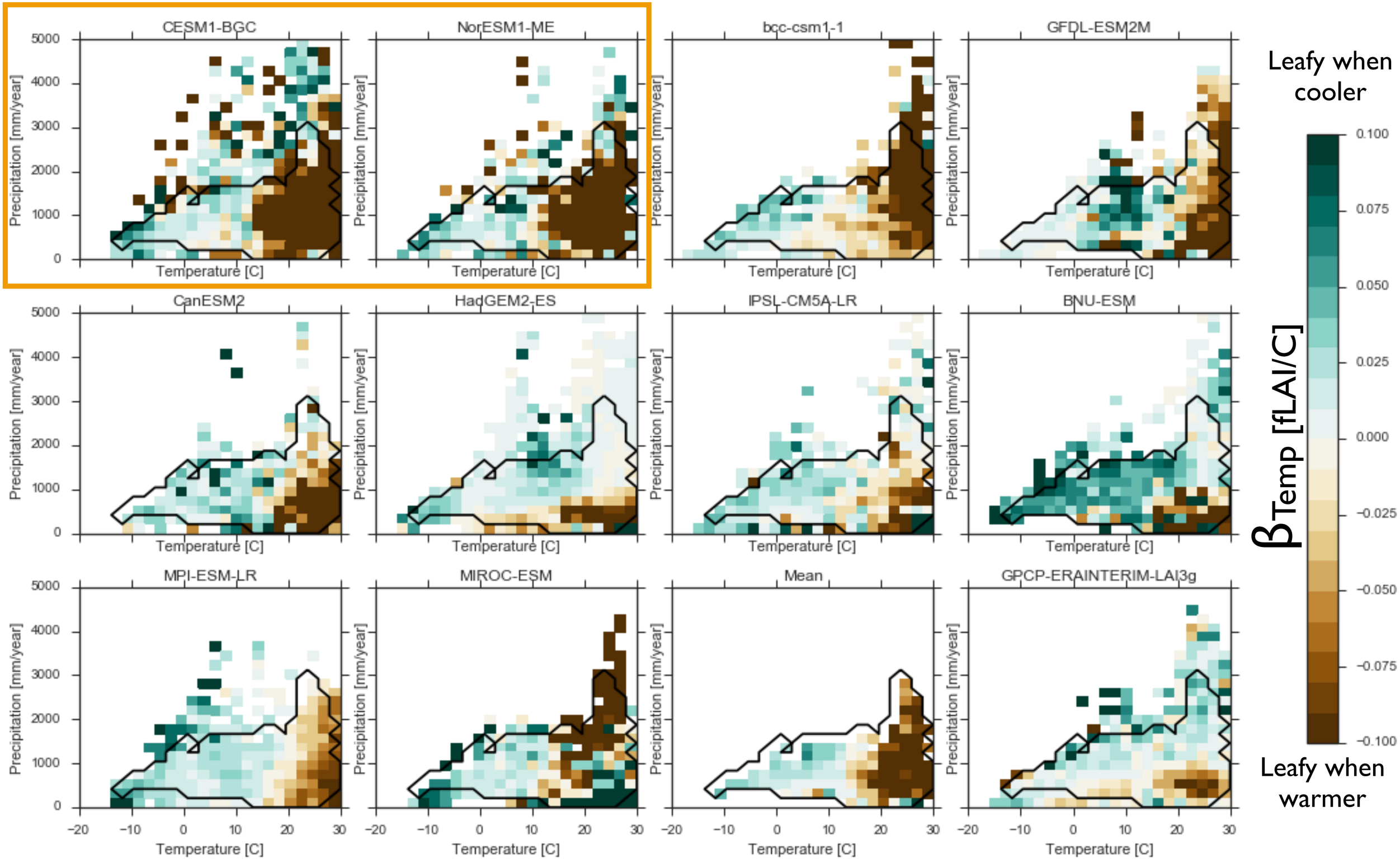
Whittaker 1970

Vegetation Interaction: Multilinear Regression

$$\%\Delta LAI = \beta_o + T_{MAT}\,\beta_{Temp} + P_{MAP}\,\beta_{Precip}$$




CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
CanESM2
HadGEM2-ES
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
MIROC-ESM
Mean
GPCP-ERAINTERIM-LAI3g
Precipitation [mm/year]
Temperature [C]
Leafy when cooler
Leafy when warmer
βTemp [fLAI/C]
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100


CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
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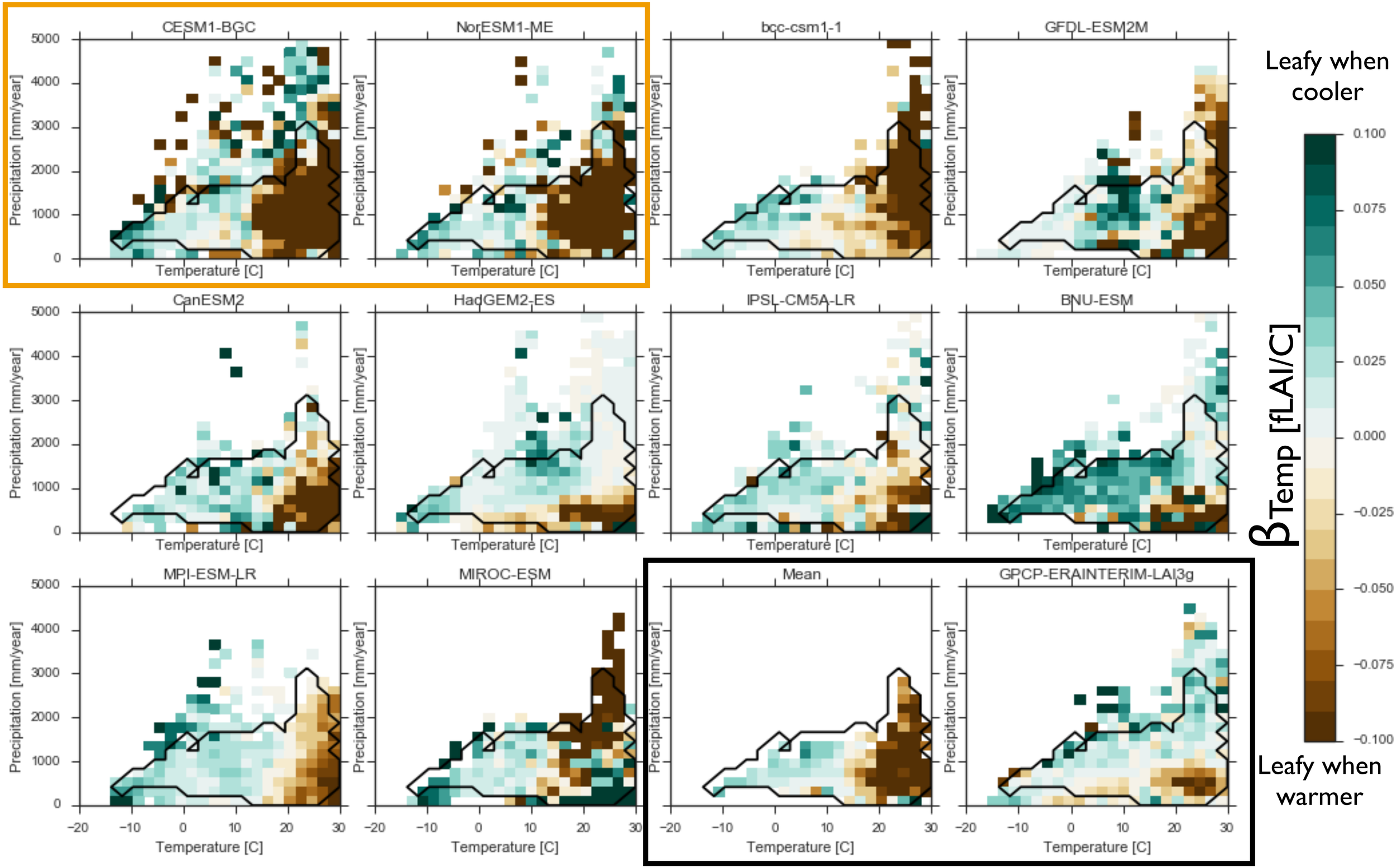
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
MIROC-ESM
Mean
GPCP-ERAINTERIM-LAI3g
Precipitation [mm/year]
Temperature [C]
Leafy when cooler
Leafy when warmer
βTemp [fLAI/C]
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100


CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
CanESM2
HadGEM2-ES
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
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Mean
GPCP-ERAINTERIM-LAI3g
Precipitation [mm/year]
Temperature [C]
Leafy when cooler
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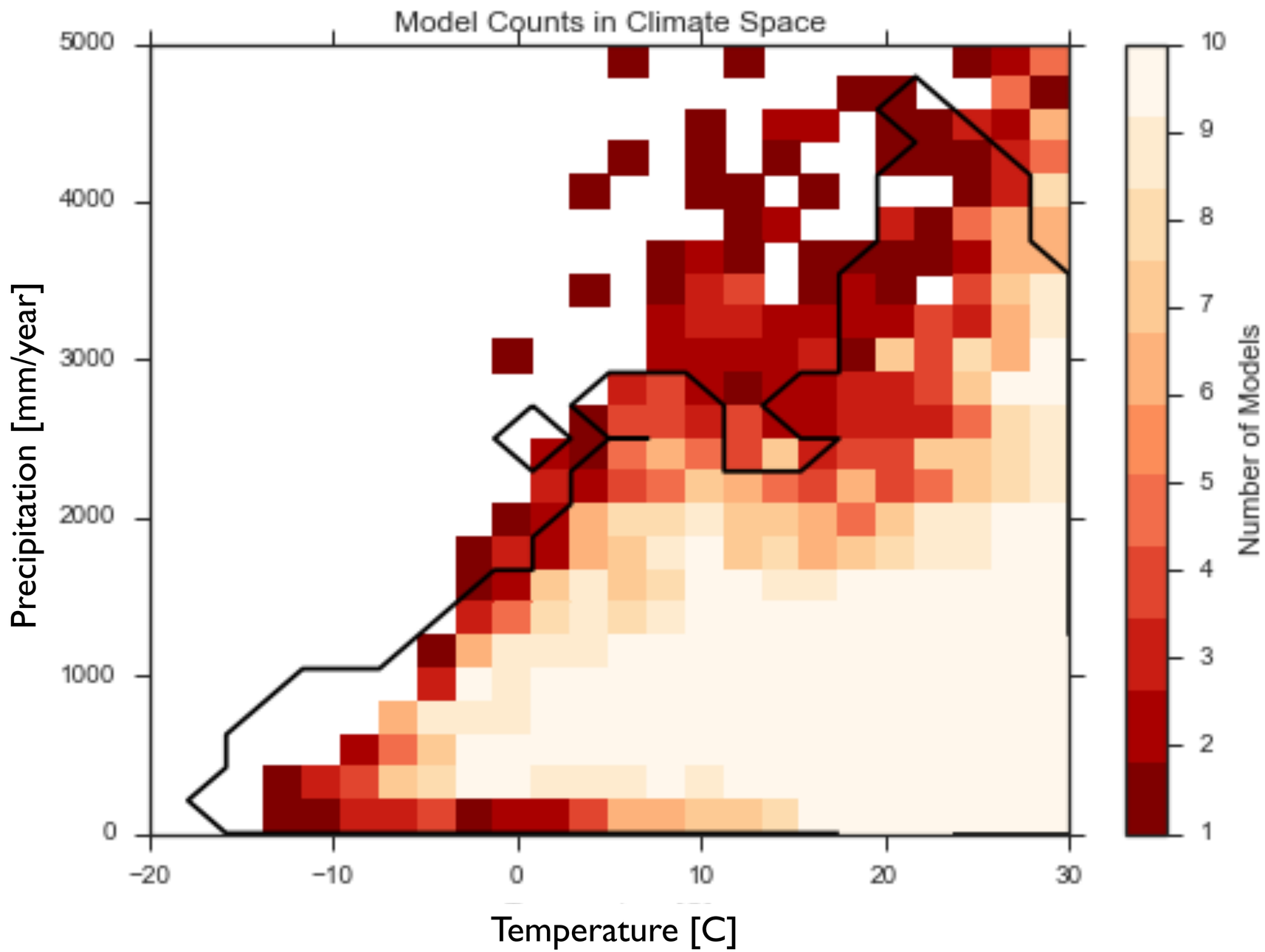
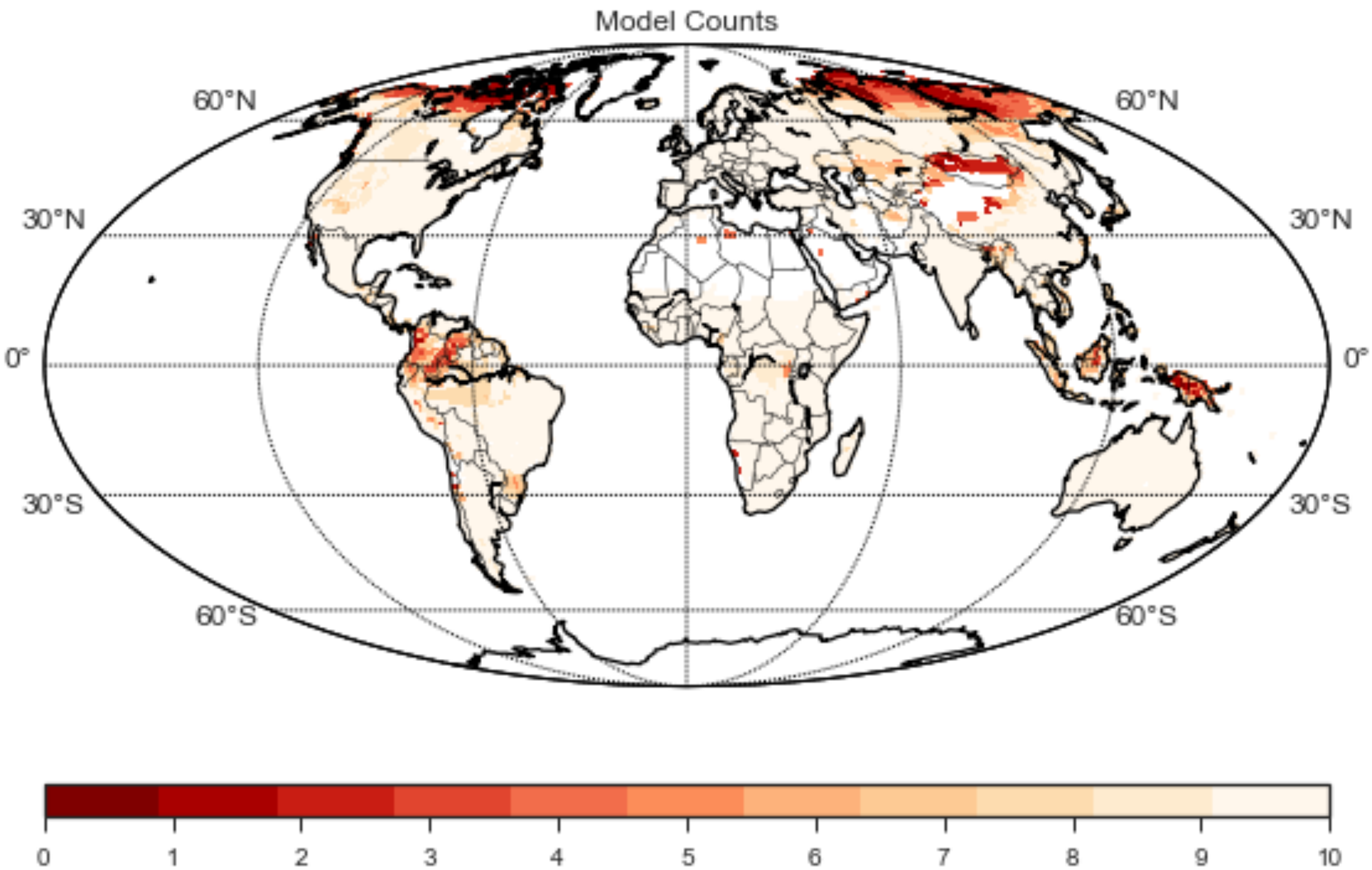
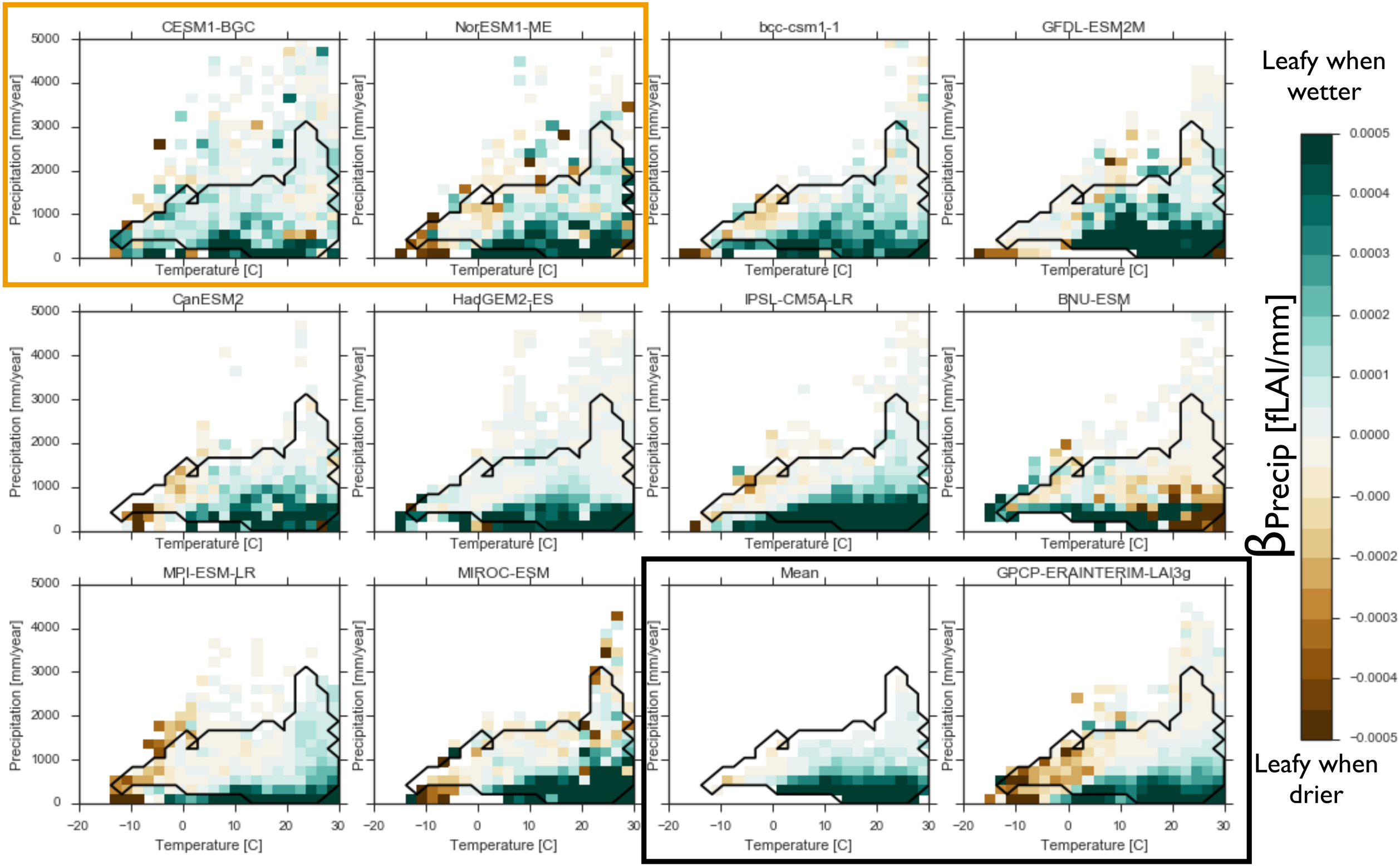
βTemp [fLAI/C]
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100

Number of models representing climate

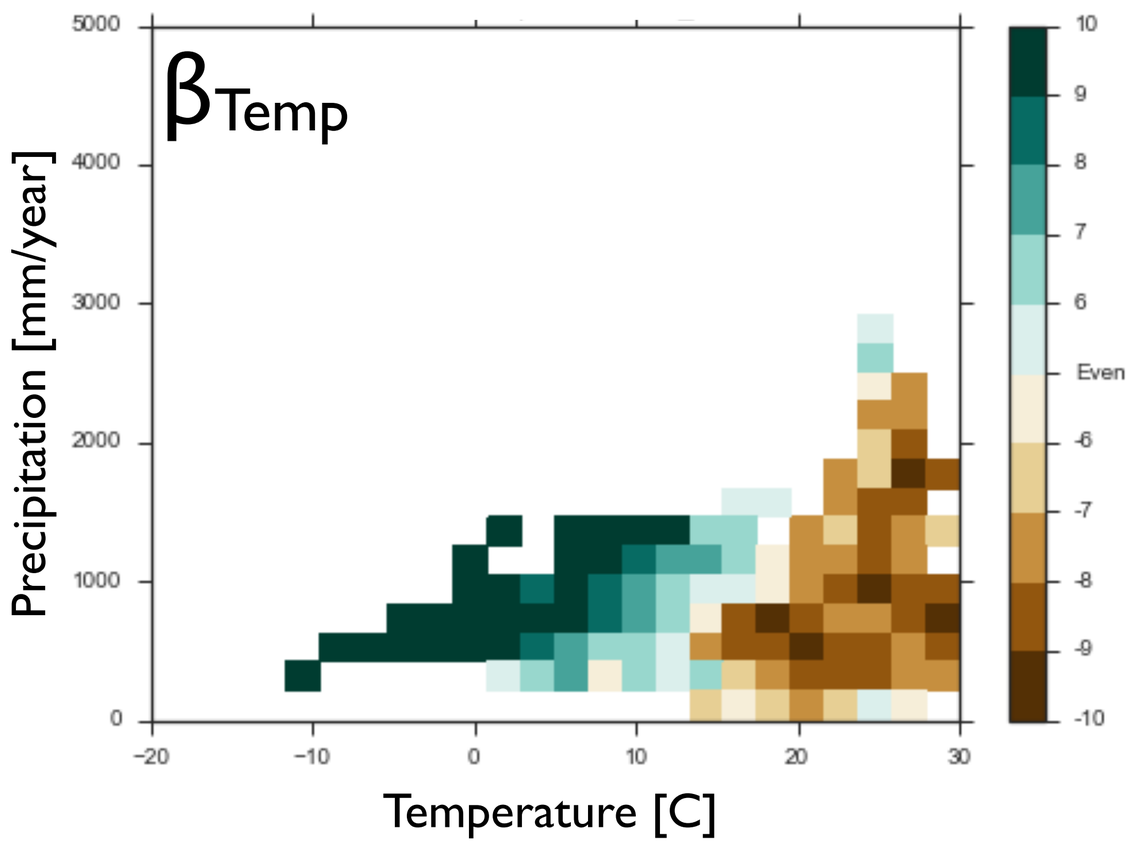


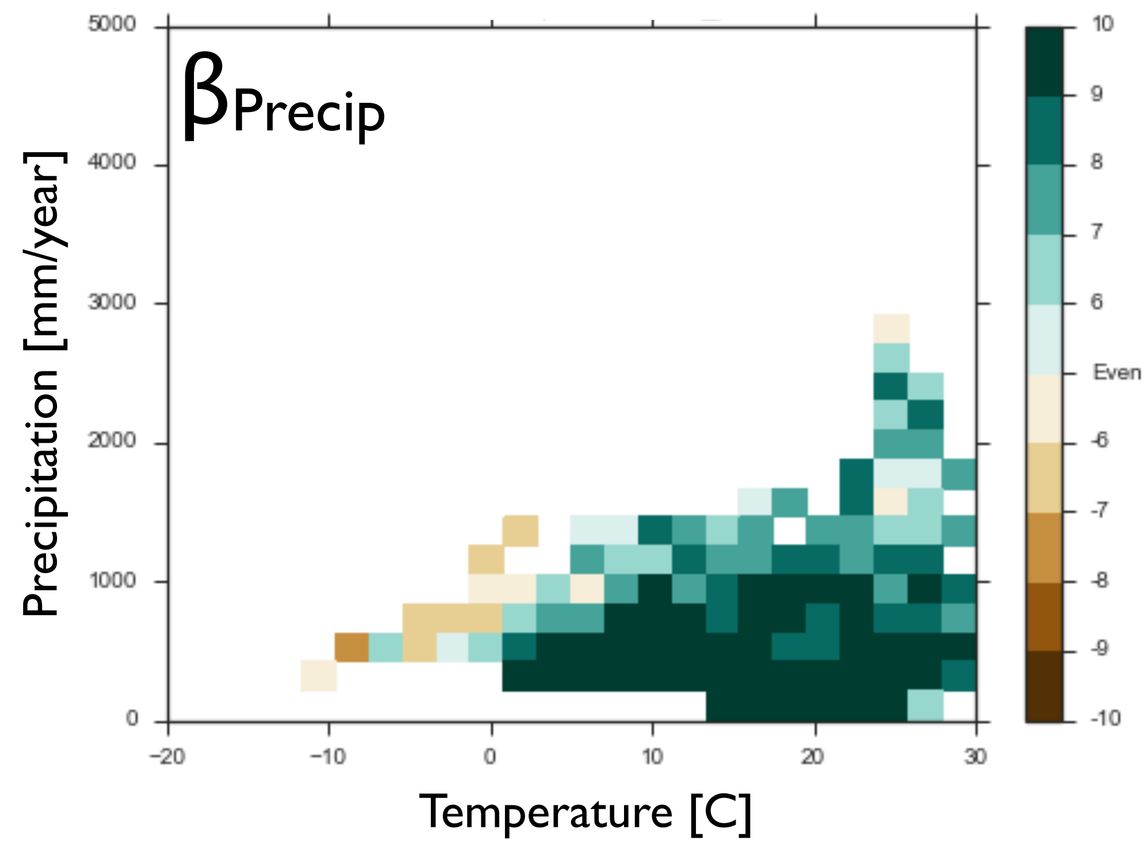
Number of models representing climate




CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
CanESM2
HadGEM2-ES
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
MIROC-ESM
Mean
GPCP-ERAINTERIM-LAI3g
Precipitation [mm/year]
Temperature [C]
Leafy when wetter
Leafy when drier
βPrecip [fLAI/mm]
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
−0.000
−0.0002
−0.0003
−0.0004
−0.0005

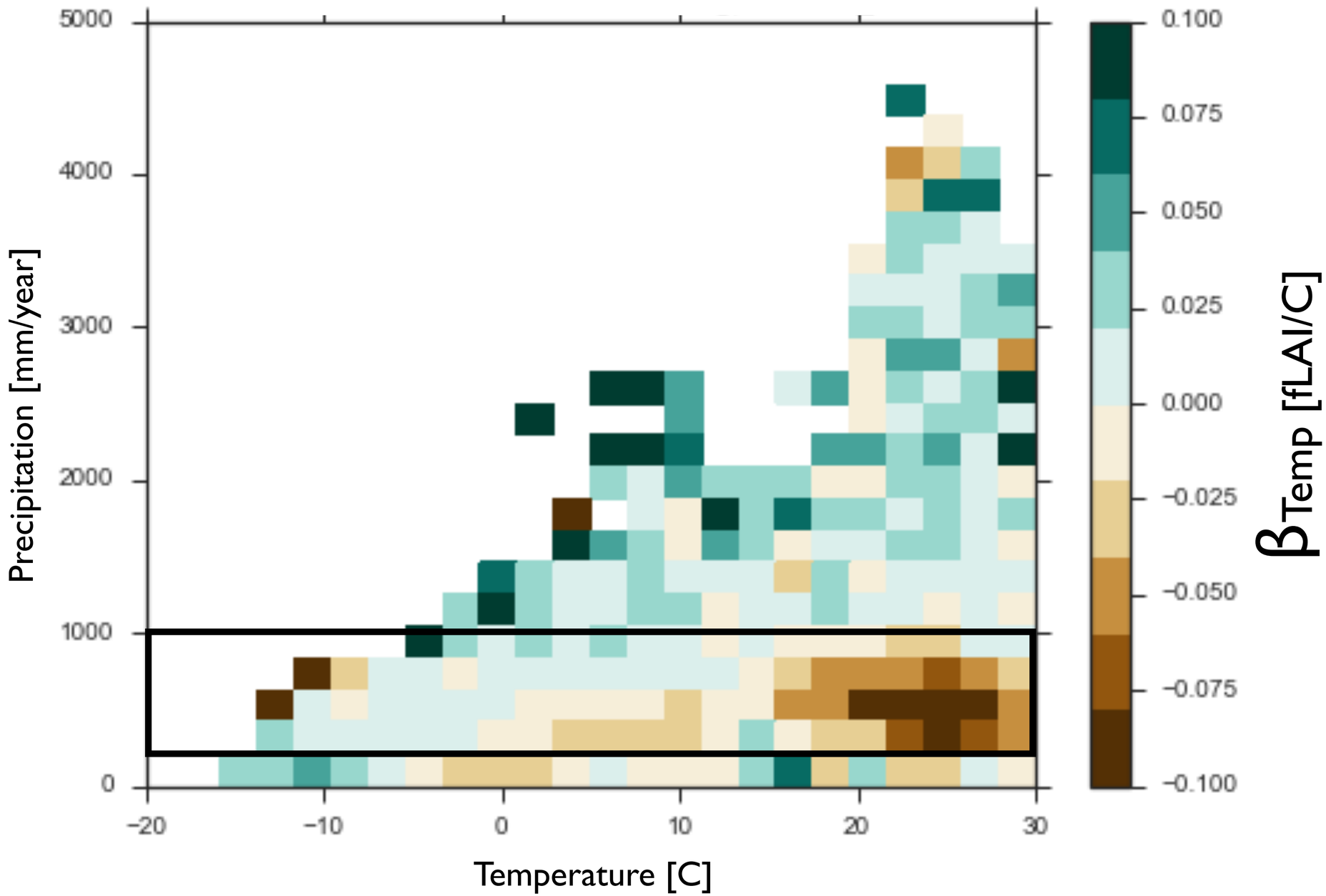
Model Consensus in sign

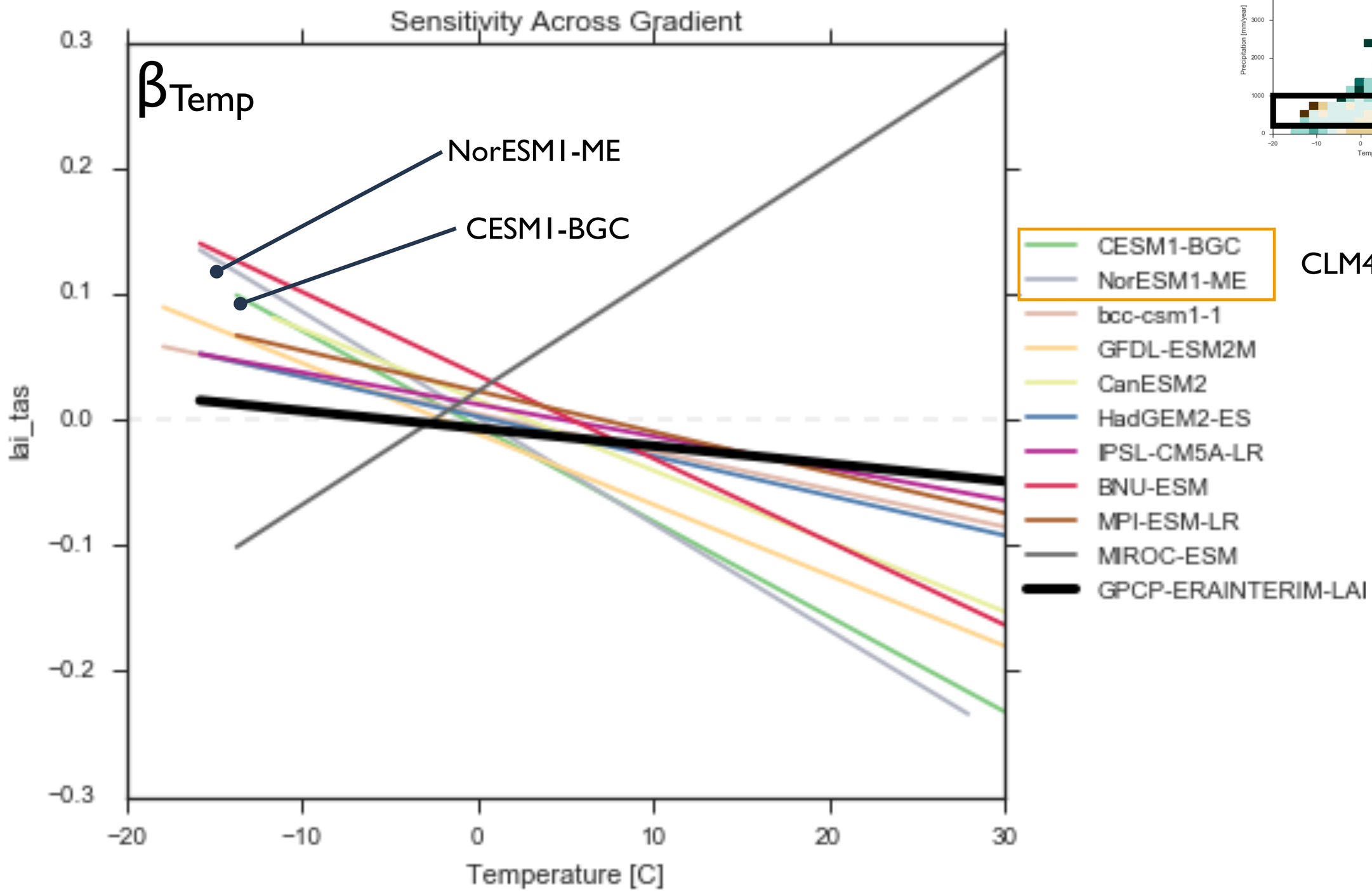


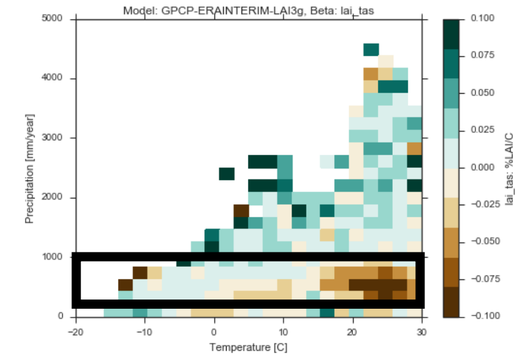


Questions?

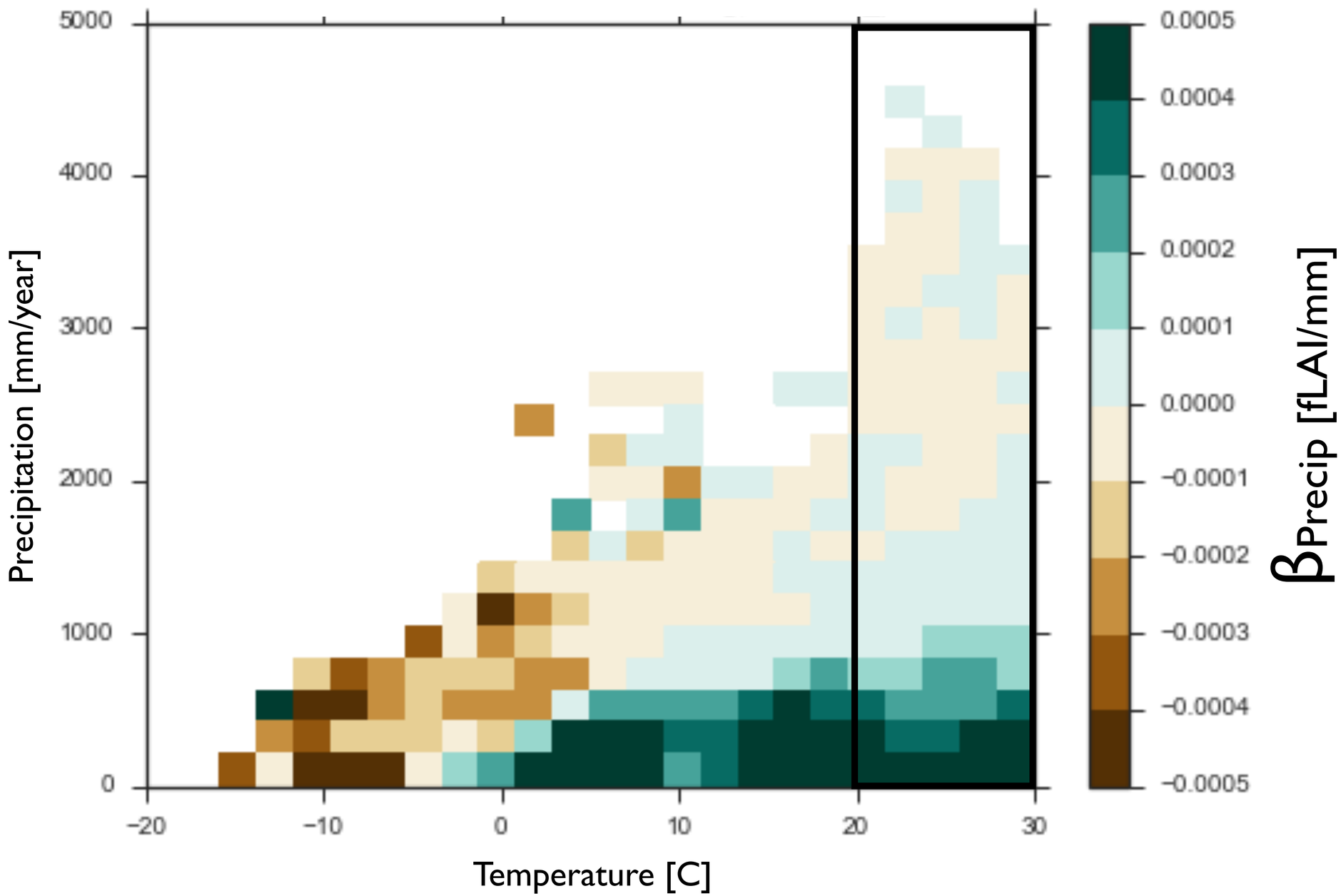
Change across temperature gradient

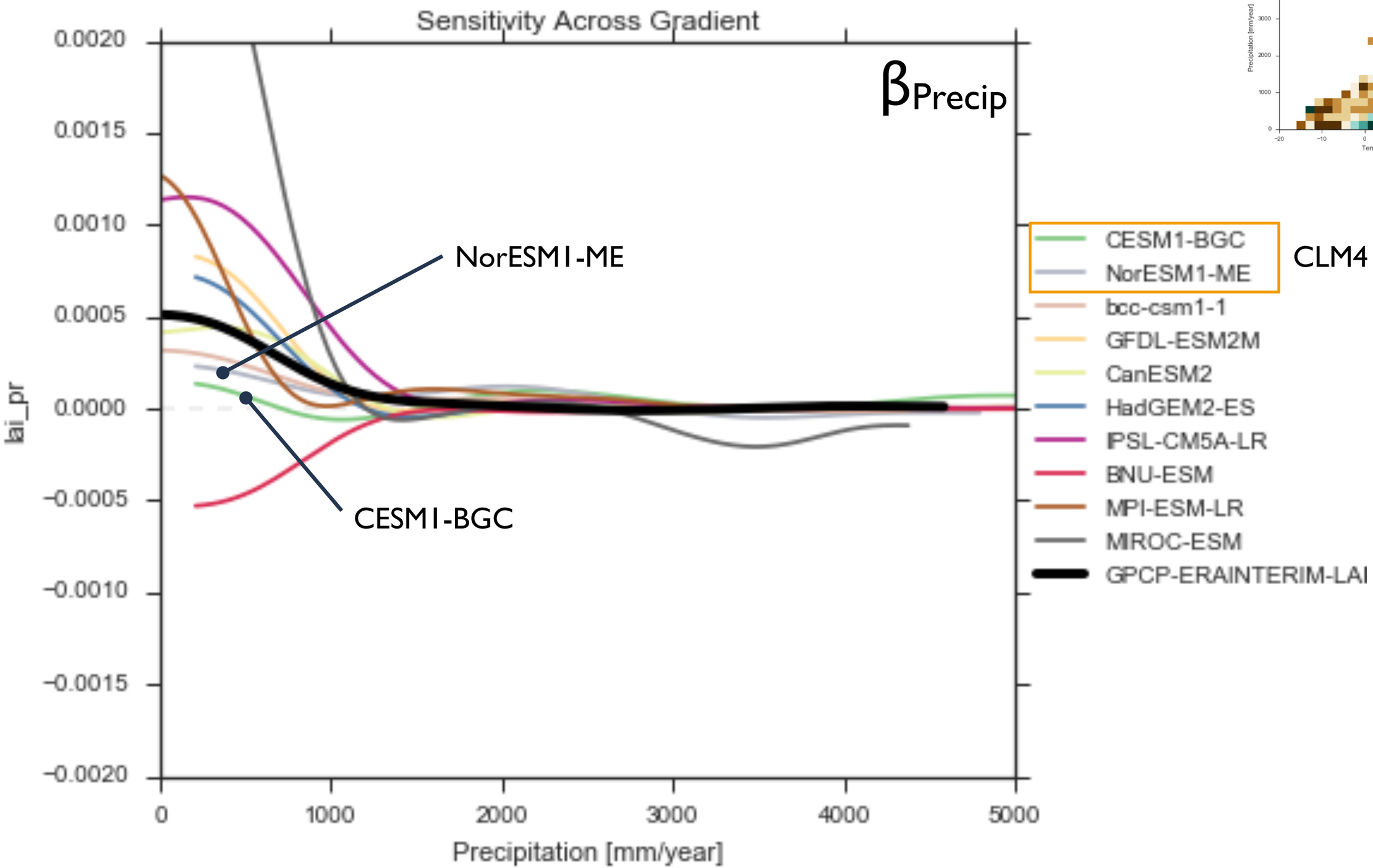


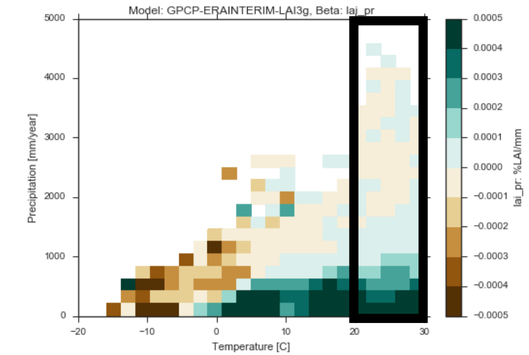

Sensitivity Across Gradient
βTemp
NorESM1-ME
CESM1-BGC
lai_tas
Temperature [C]
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−20
−10
0
10
20
30
CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
CanESM2
HadGEM2-ES
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
MIROC-ESM
GPCP-ERAINTERIM-LAI
CLM4

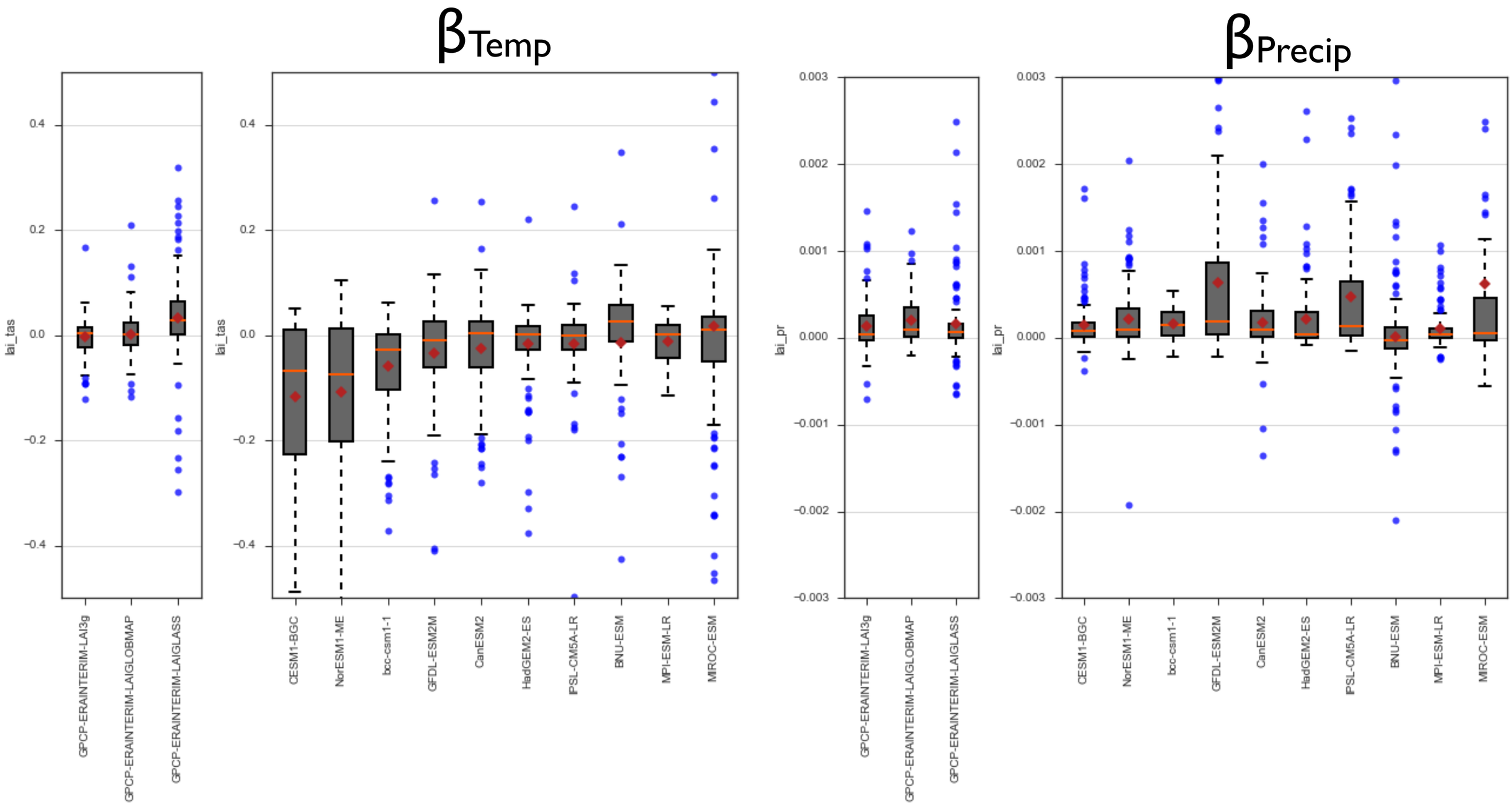

Model: GPCP-ERAINTERIM-LAI3g, Beta: lai_tas
Precipitation [mm/year]
Temperature [C]
lai_tas: %LAI/C

Change across precipitation gradient




Sensitivity Across Gradient
βPrecip
NorESM1-ME
CESM1-BGC
CLM4
CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
CanESM2
HadGEM2-ES
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
MIROC-ESM
GPCP-ERAINTERIM-LAI
lai_pr
0.0020
0.0015
0.0010
0.0005
0.0000
−0.0005
−0.0010
−0.0015
−0.0020
0
1000
2000
3000
4000
5000
Precipitation [mm/year]


Model: GPCP-ERAINTERIM-LAI3g, Beta: lai_pr
Precipitation [mm/year]
Temperature [C]
lai_pr, %LAI/mm


βTemp
βPrecip
lai_tas
lai_pr
0.4
0.2
0.0
−0.2
−0.4
0.003
0.002
0.001
0.000
−0.001
−0.002
−0.003
GPCP-ERAINTERIM-LAI3g
GPCP-ERAINTERIM-LAIGLOBMAP
GPCP-ERAINTERIM-LAIGLASS
CESM1-BGC
NorESM1-ME
bcc-csm1-1
GFDL-ESM2M
CanESM2
HadGEM2-ES
IPSL-CM5A-LR
BNU-ESM
MPI-ESM-LR
MIROC-ESM