Comparative Study of Grasslands in the ABCC Countries

Li Zhang[1], Jingfeng Xiao[2] , Bruce Wylie[3]

[1] Center for Earth Observation and Digital Earth, CAS
[2] University of New Hampshire, USA
[3] USGS EROS, USA

Nov. 19-20, 2012, Iguaçu, Brazil

OUTLINE

1、Grassland Ecosystems

2、Climate Change

3、Vegetation Greenness and Climatic Controls

4、 Vegetation Productivity

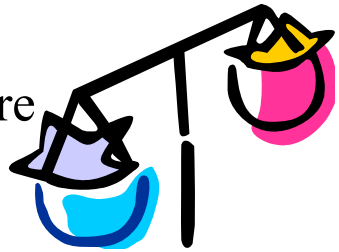
5 、 Impacts of Extreme Climate Events and Disturbance

6、Future Plans

GRASSLAND ECOSYSTEMS

- Grasslands cover nearly 1/5 of the global terrestrial surface (Eswaran et al., 1993) and store most of their carbon below ground (Burke et al., 1997; Connor et al., 2001);
- provide a variety of products and ecosystem services and are important contributors to climate regulation and global carbon balance;
- is the most serious affected area by human activities;
- very sensitive to environment change due to its limitation on moisture and nutrient supplies;
- disturbances from global change may impact its composition and function , which is a very complex process.

GRASSLAND ECOSYSTEMS

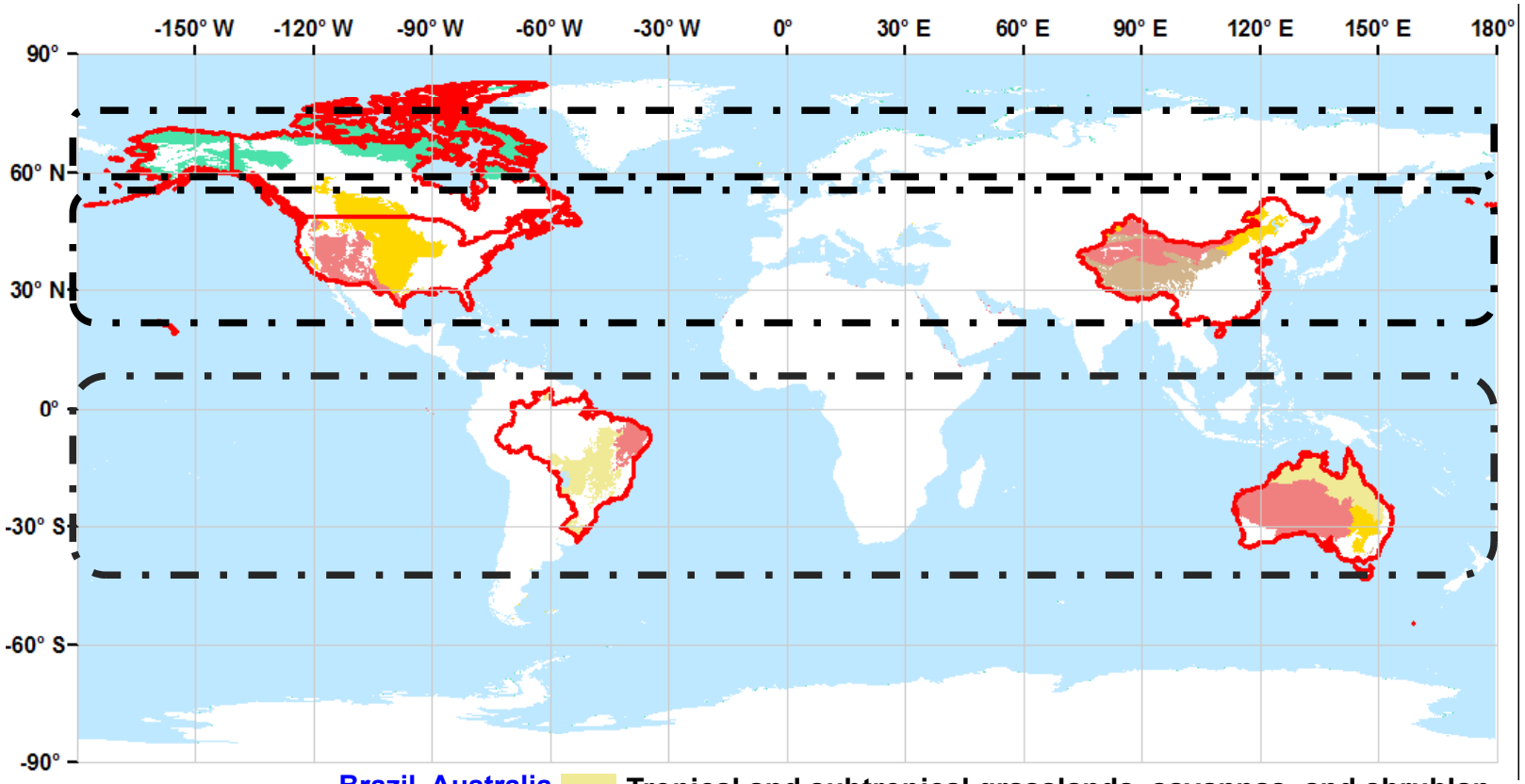


- Grassland ecosystems may function as potential carbon sinks, or are near equilibrium, and could contribute to balancing the global carbon budget.

- However, grassland ecosystems also release carbon into the atmosphere during extreme climate events and disturbance.

- How to guarantee the sustainable development of grassland ecosystems under global climate change? —Subject of IGBP

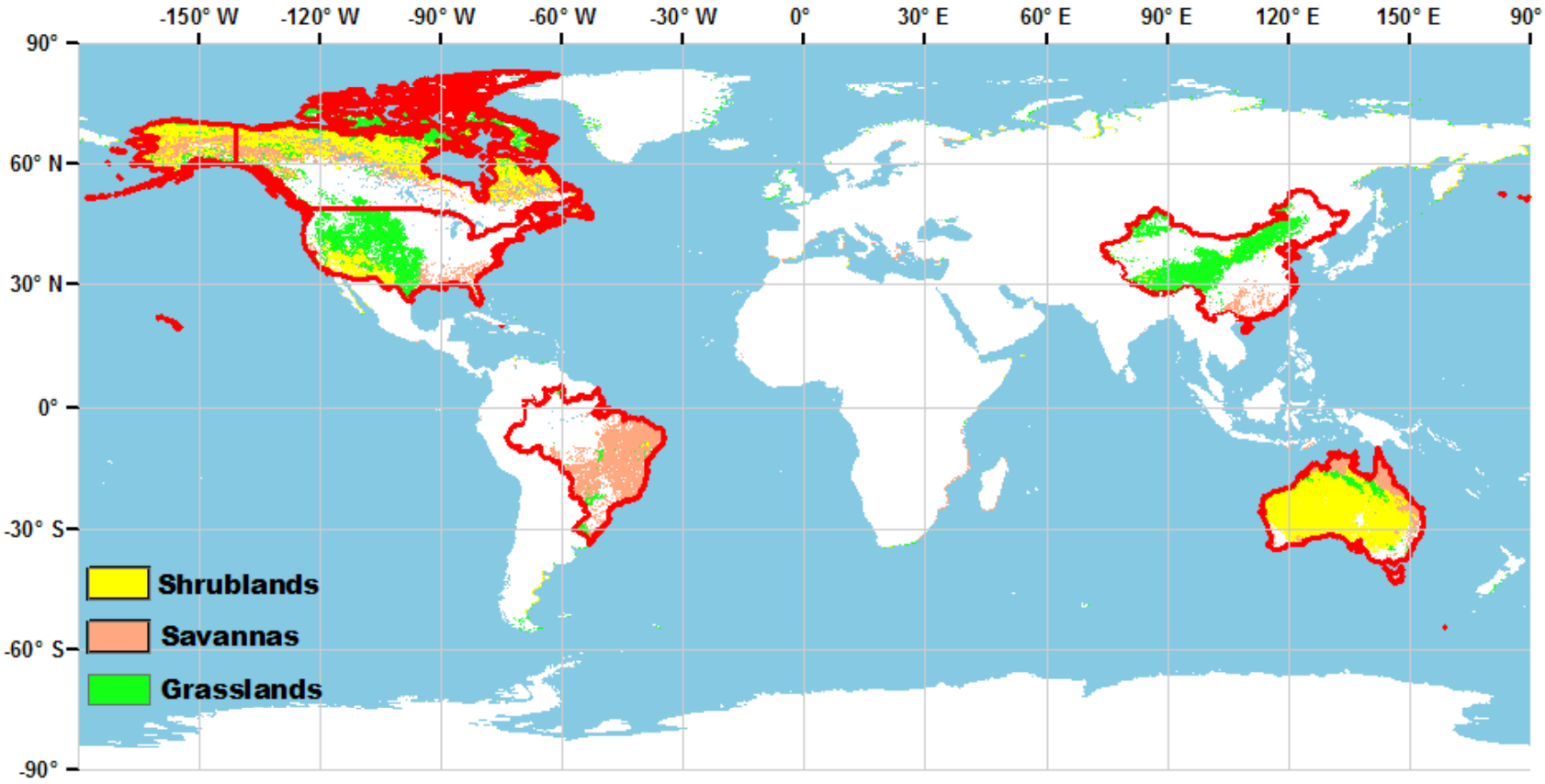
GRASSLAND ECOSYSTEMS



Brazil, Australia	Tropical and subtropical grasslands, savannas, and shrublan
North American China, Australia	Temperate Grasslands, Savannas, and Shrublands
All countries except Canada	Deserts and Xeric Shrublands
China	Montane Grasslands and Shrubland
Canada	Tundra

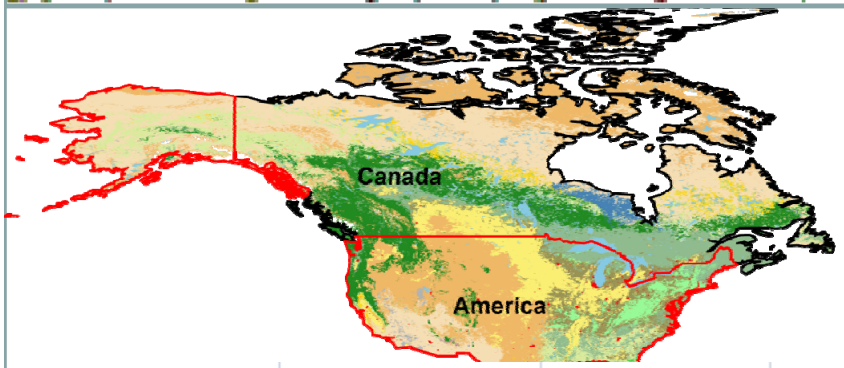
Olson's

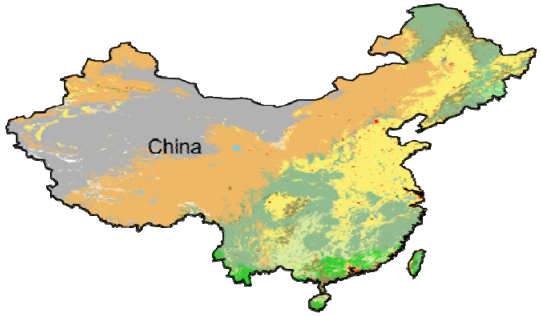
GRASSLAND ECOSYSTEMS



Grasslands in our study include grasslands, shrublands, and savanna.

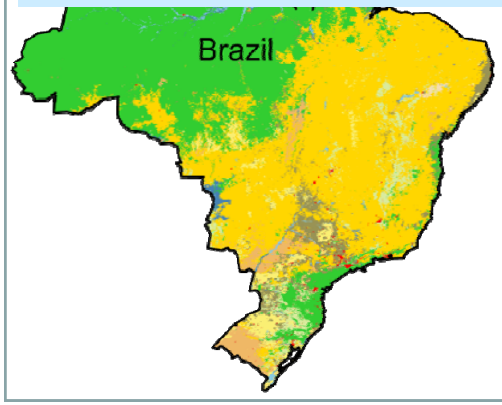
GRASSLAND ECOSYSTEMS

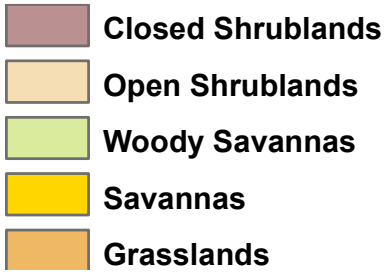


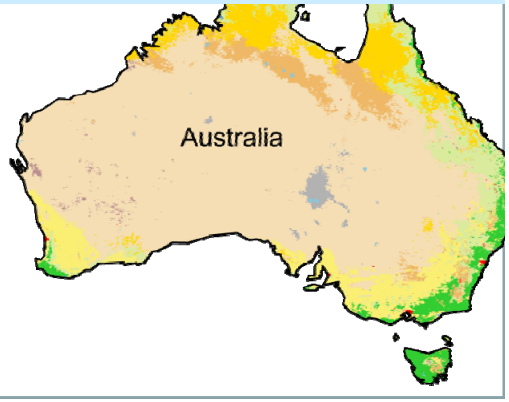


	Australia	Brazil	Cannada	China	America
shrublands	66%	0%	24%	1%	19%
savannas	15%	44%	9%	4%	11%
grasslands	5%	3%	20%	32%	28%

- **Comparative studies** over grasslands (Great Plains and Northern China), shrublands (Australia, Canada, America), Savanna (Australia, Brazil, America).







OUTLINE

1、Grassland Ecosystems

2、Climate Change

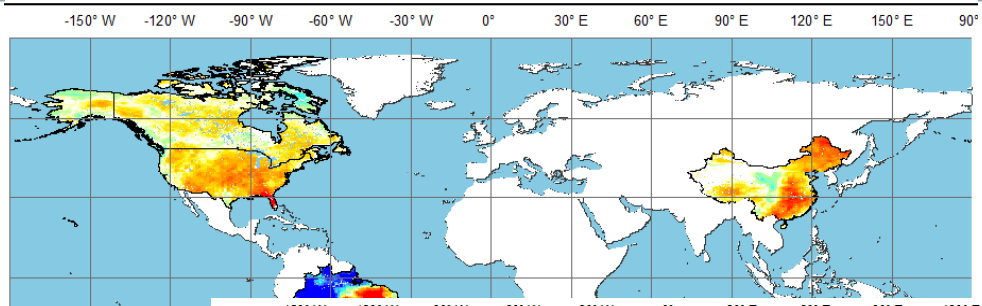
3、Vegetation Greenness and Climatic Controls

4、 Vegetation Productivity

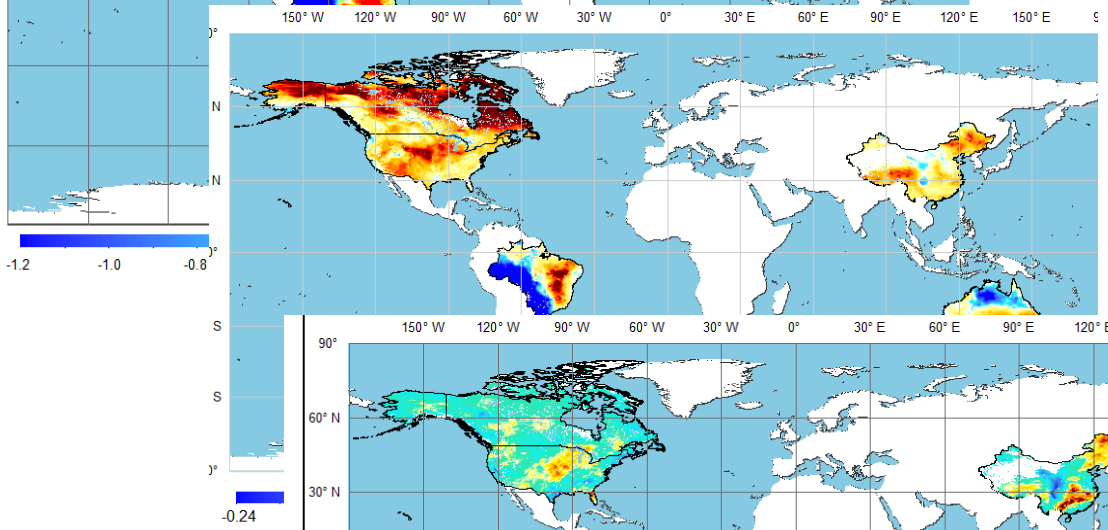
5 、Impacts of Extreme Climate Events and Disturbance

6、Future Plans

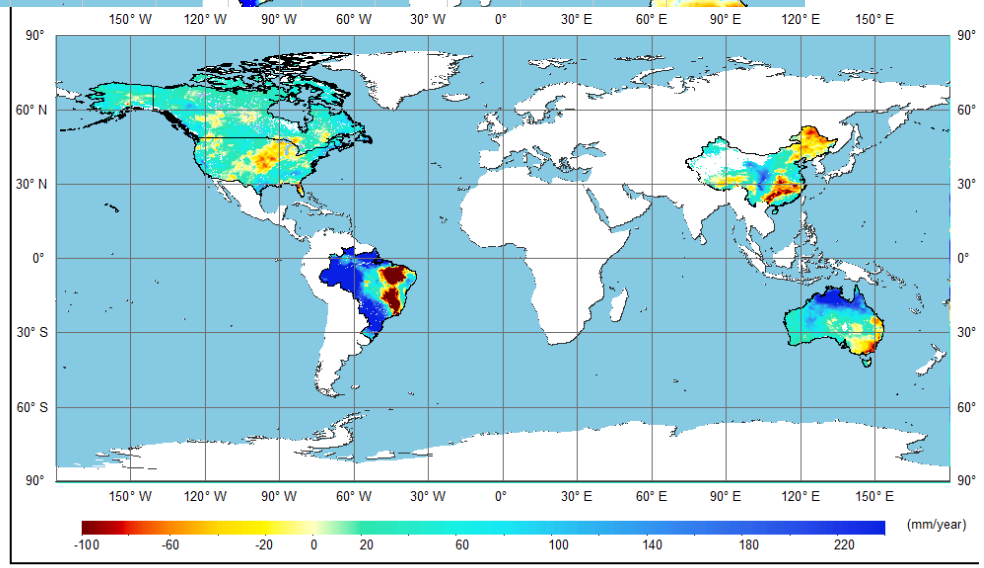
CLIMATE CHANGE



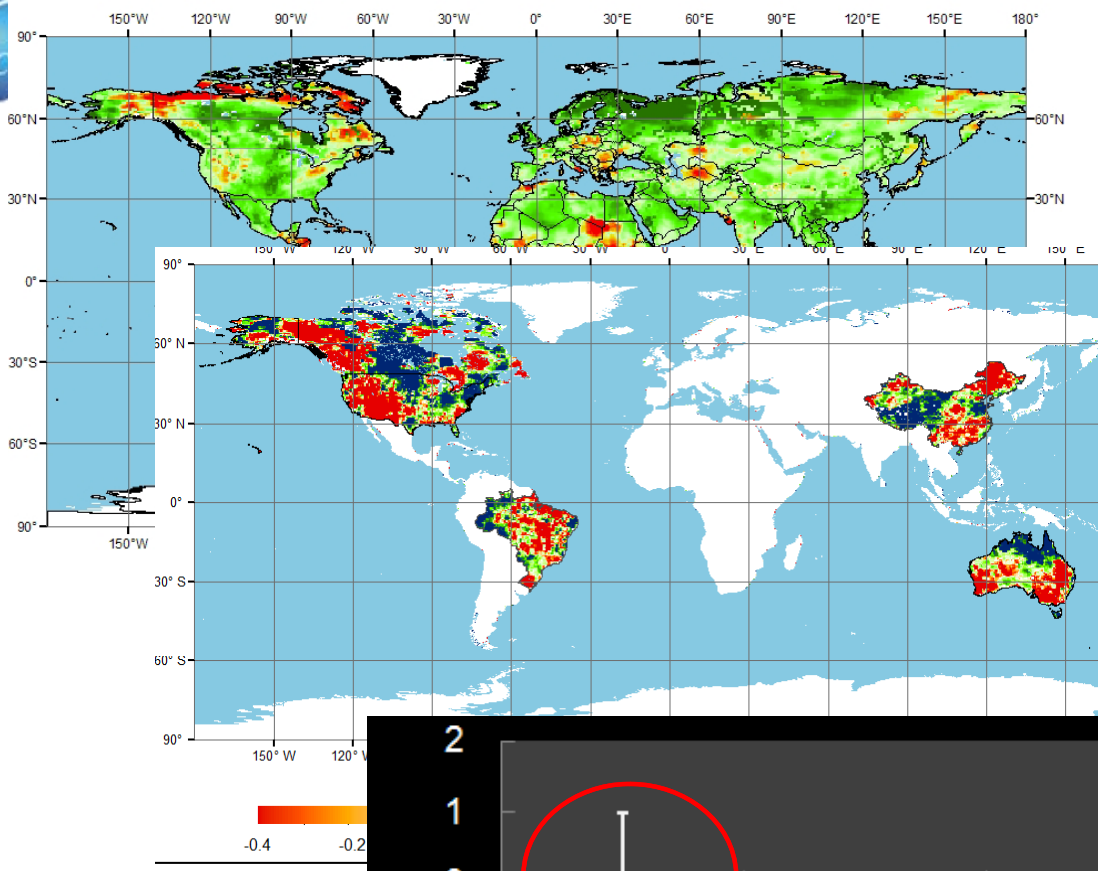
PAR



Temperature

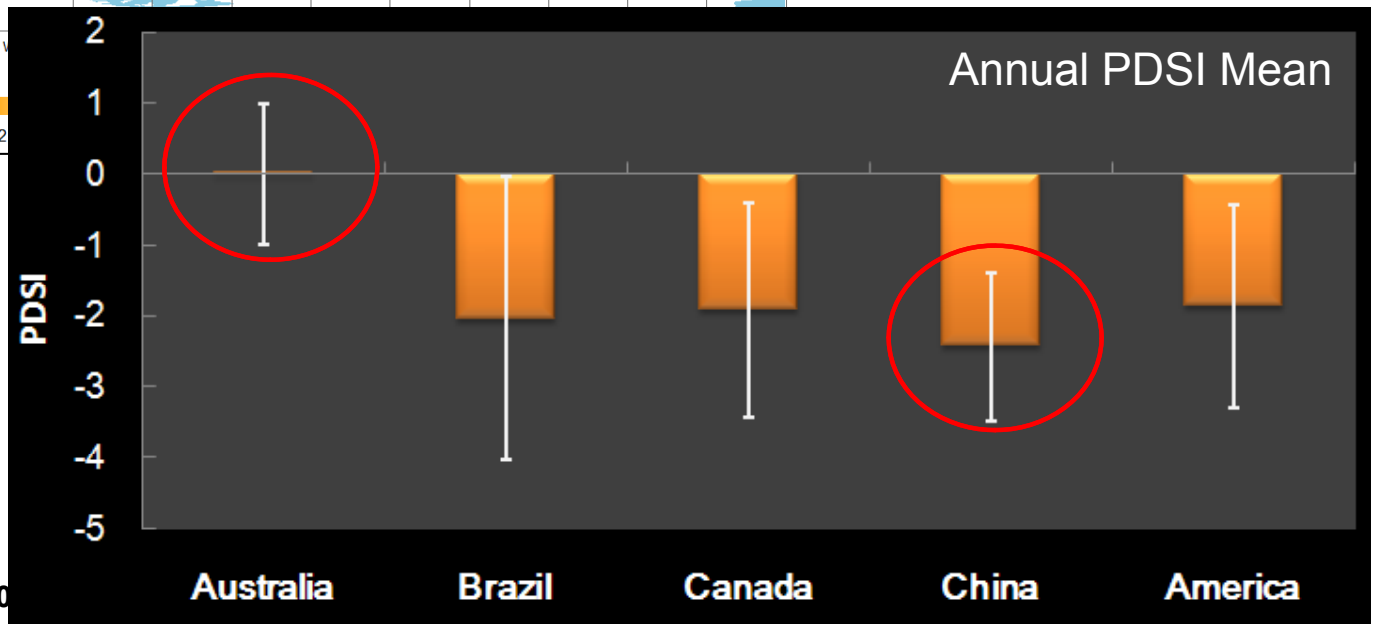


Precipitation



Annual PDSI Mean

Annual PDSI Trend



Data source: Zhao, M et al. 20

OUTLINE

1、Grassland Ecosystems

2、Climate Change

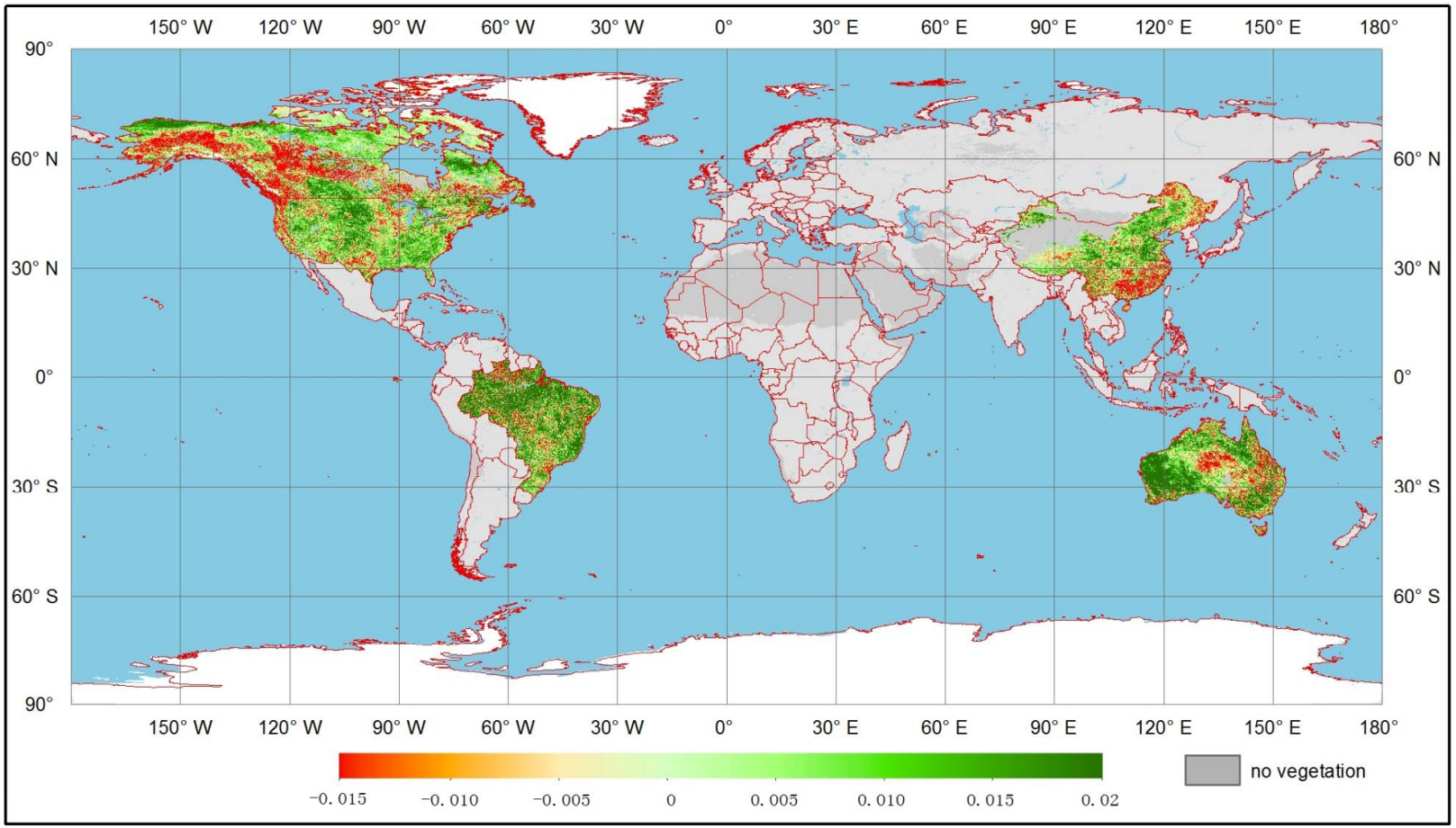
3、Vegetation Greenness and Climatic Controls

4、 Vegetation Productivity

5 、Impacts of Extreme Climate Events and Disturbance

6、Future Plans

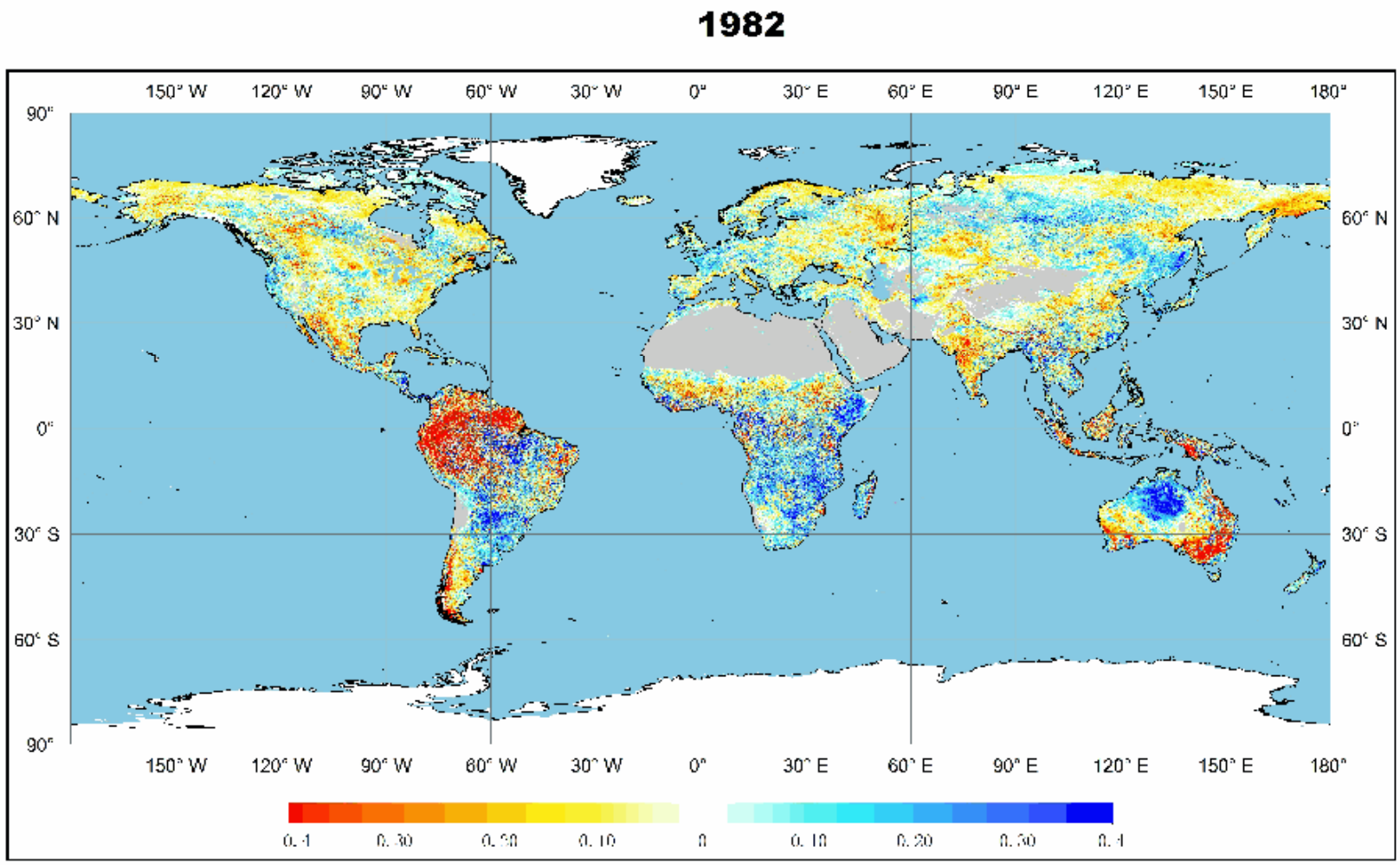
VEGETATION GREENNESS AND CLIMATE CONTRO



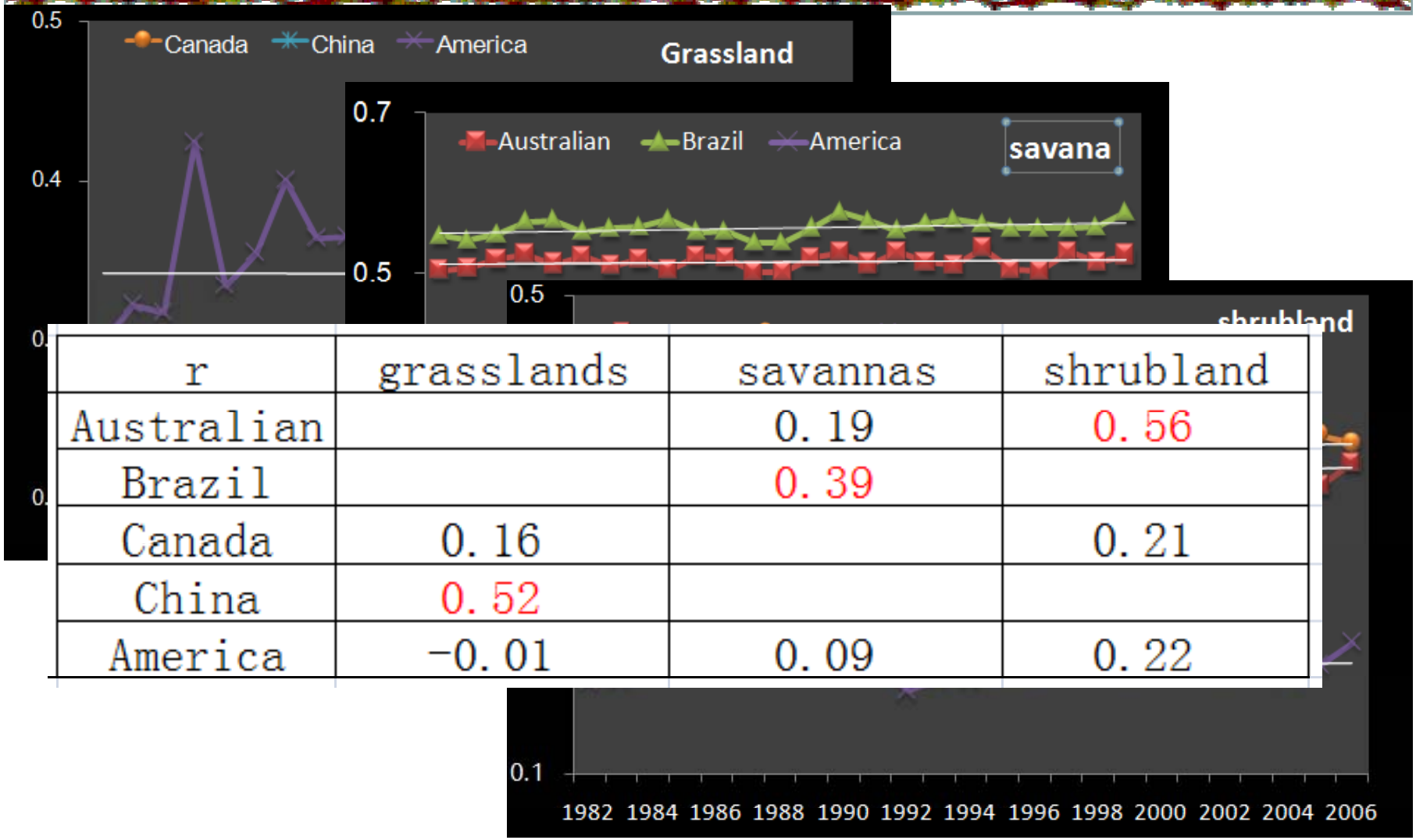
AVHRR NDVI Trend (1982-2006)

VEGETATION GREENNESS AND CLIMATE CONTROLS

AVHRR NDVI Anomaly (1982-2006)



VEGETATION GREENNESS AND CLIMATE CONTROLS

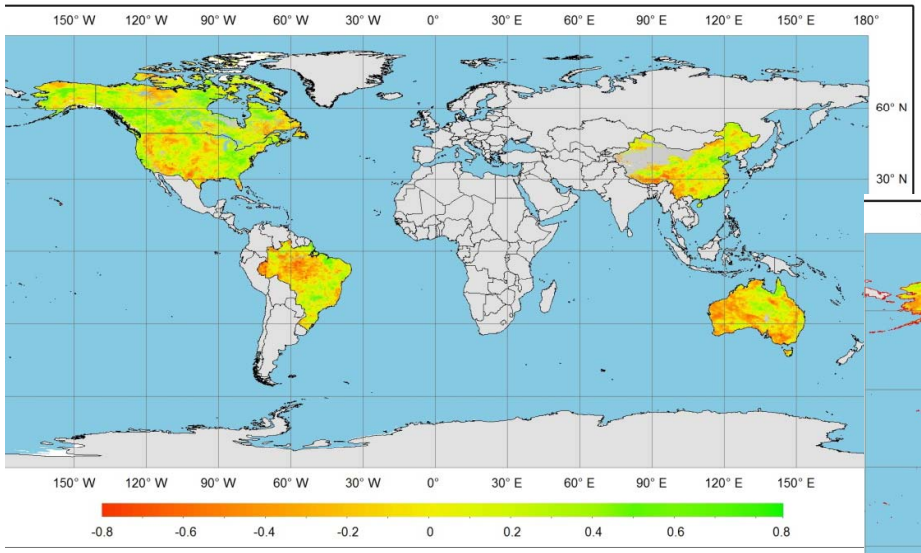


r	grasslands	savannas	shrubland
Australian		0.19	0.56
Brazil		0.39	
Canada	0.16		0.21
China	0.52		
America	-0.01	0.09	0.22

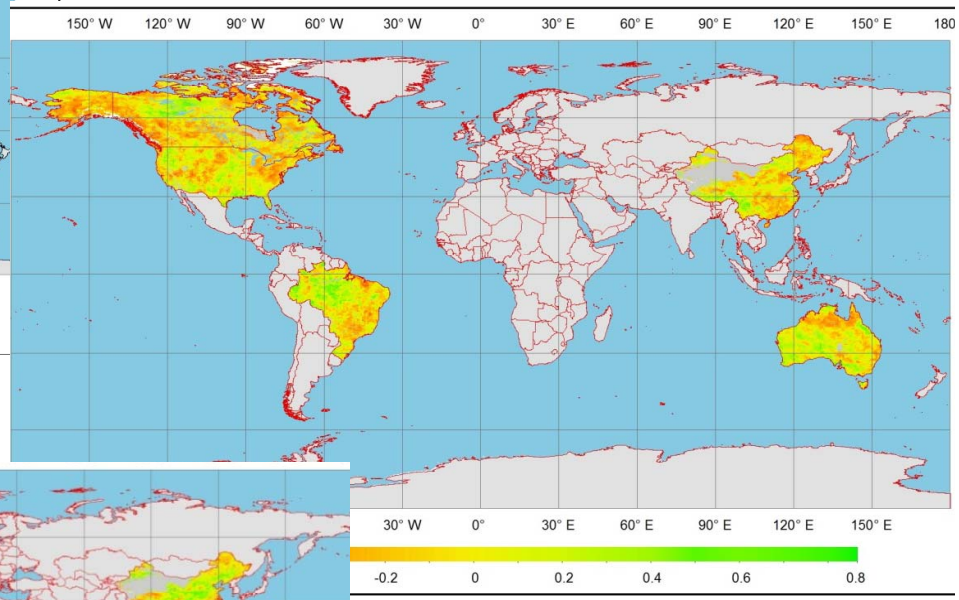
Zhang L., et al. unpublished

VEGETATION GREENNESS AND CLIMATE CONTROLS

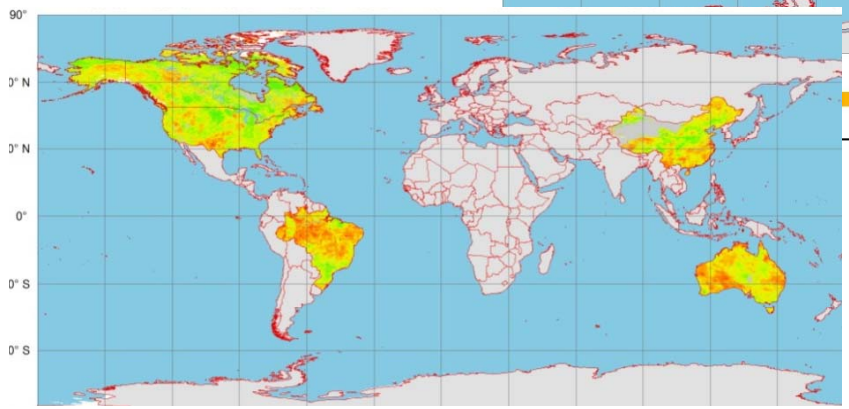
PAR-AVHRR



PRCP-AVHRR



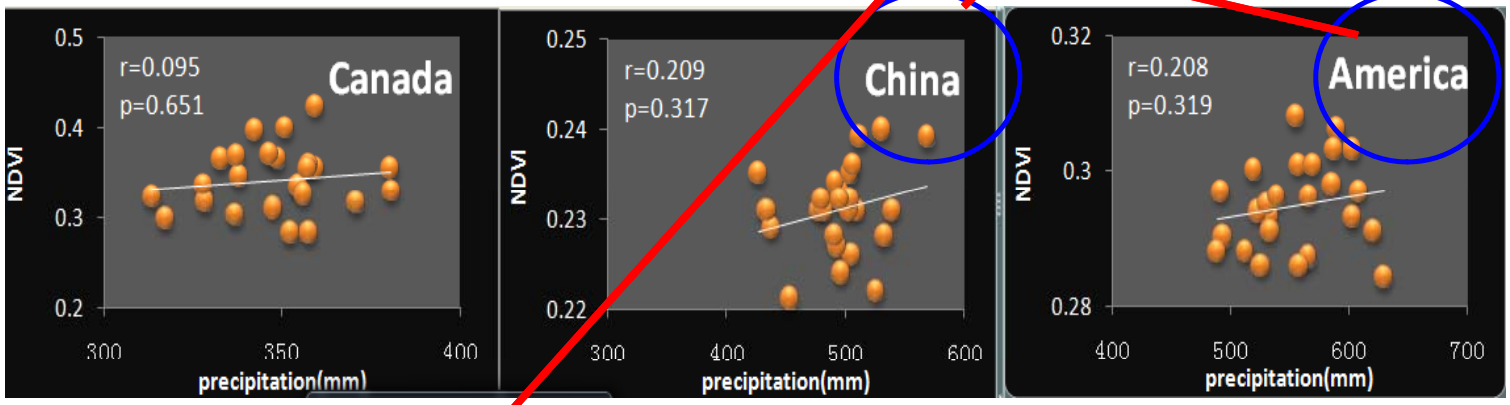
TEMP-AVHRR



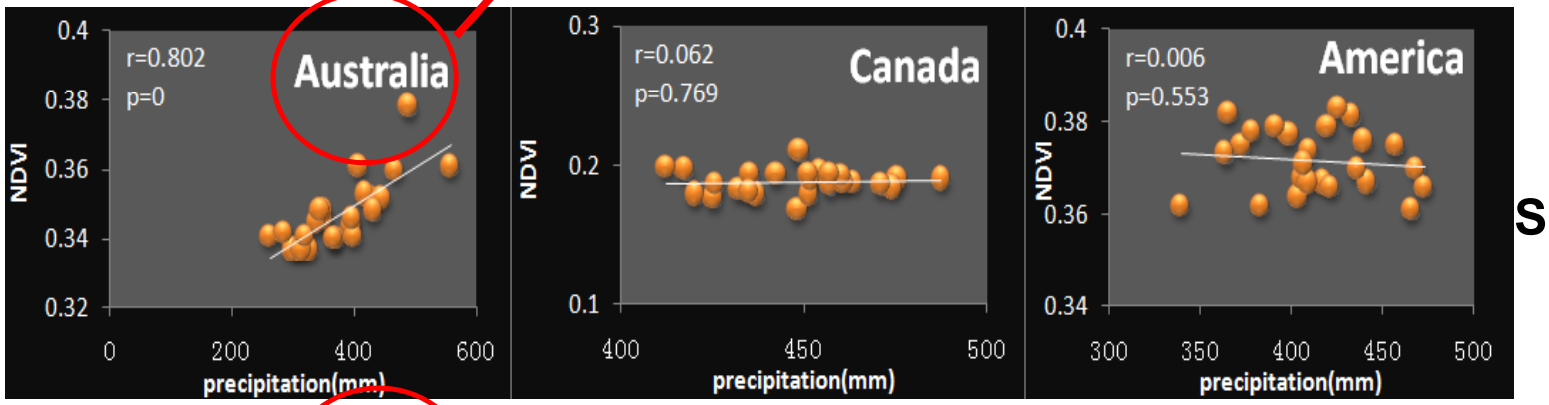
Zhang L., et al. unpublished

Precipitation-NDVI

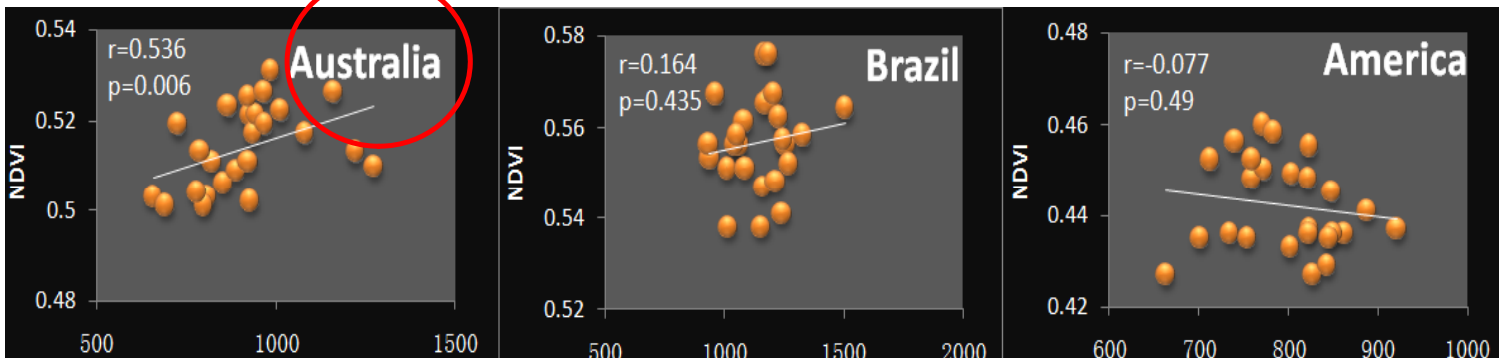
Water limited



Grassland



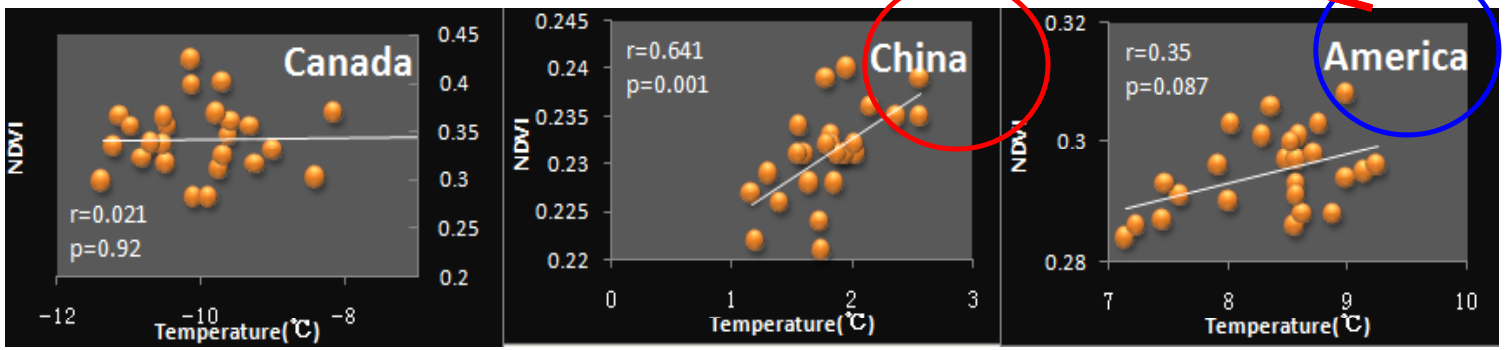
Shrubland



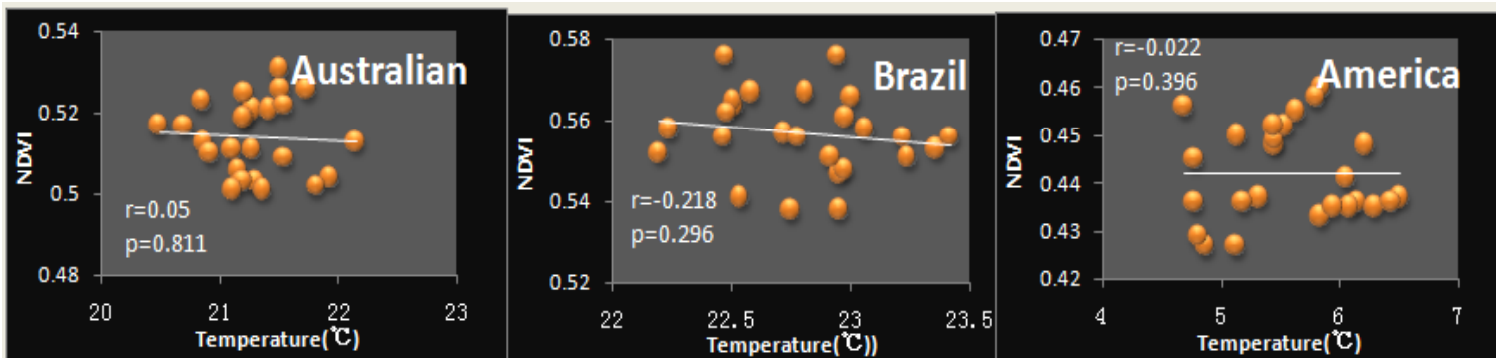
Savanna

Temperature-NDVI

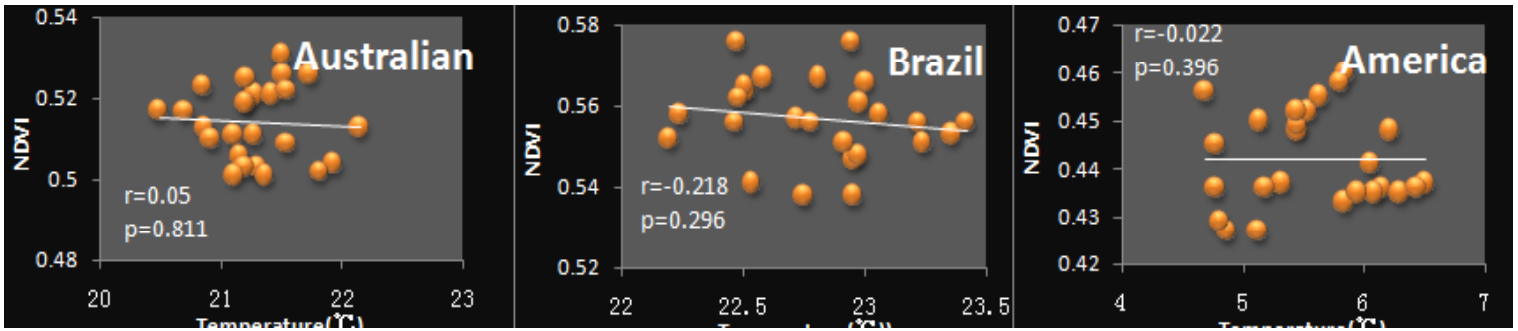
Temperature limited



Grassland



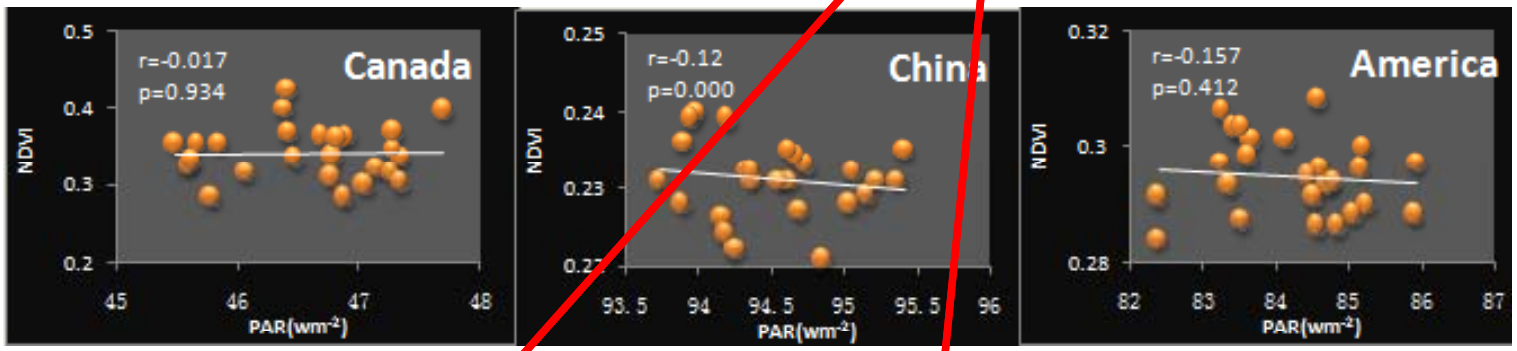
Shrubland



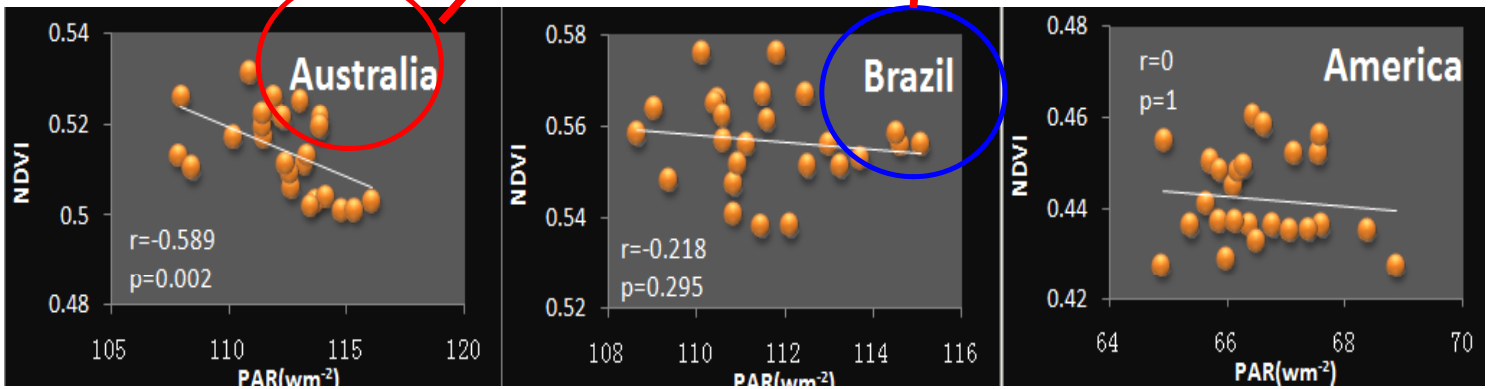
Savanna

PAR-NDVI

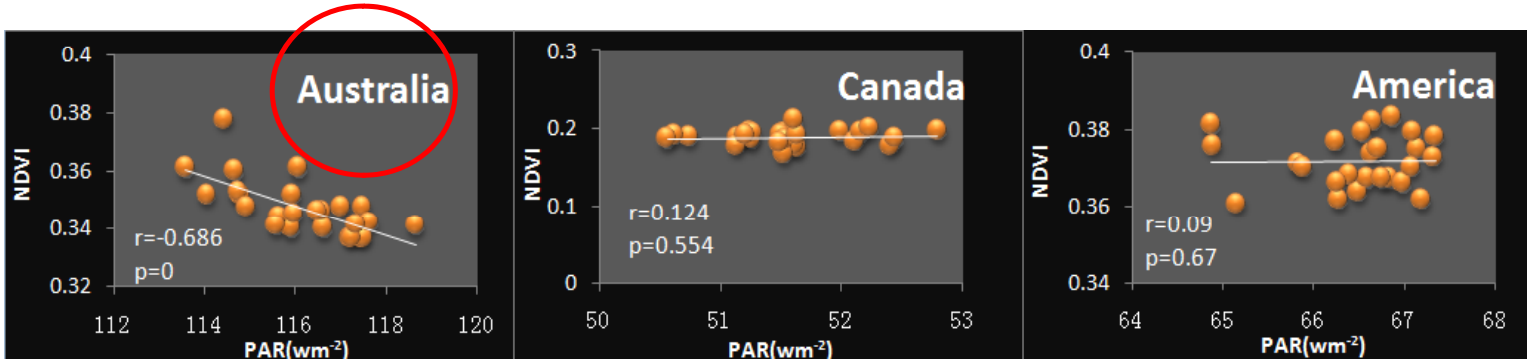
Radiation limited



Grassland

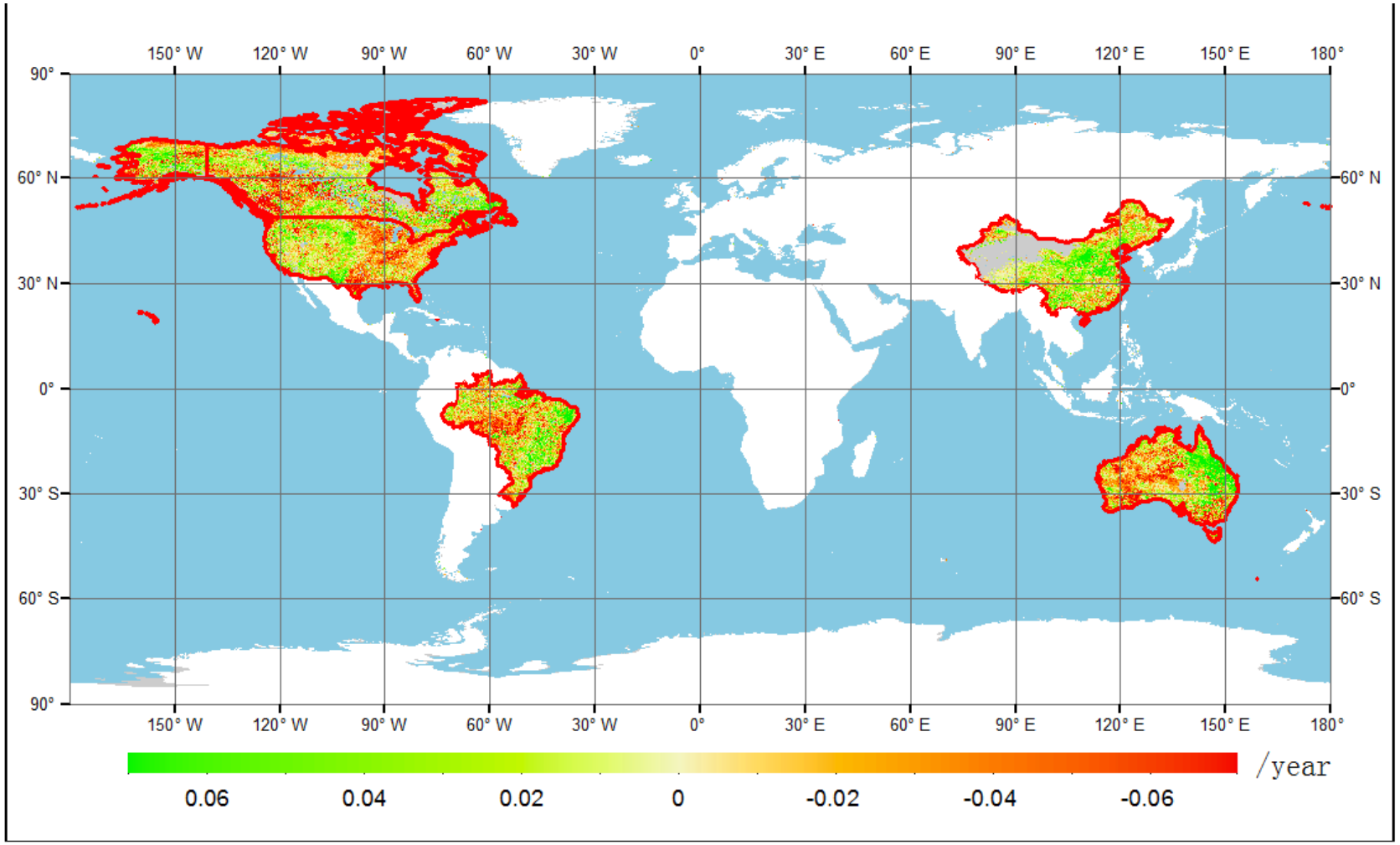


Shrubland



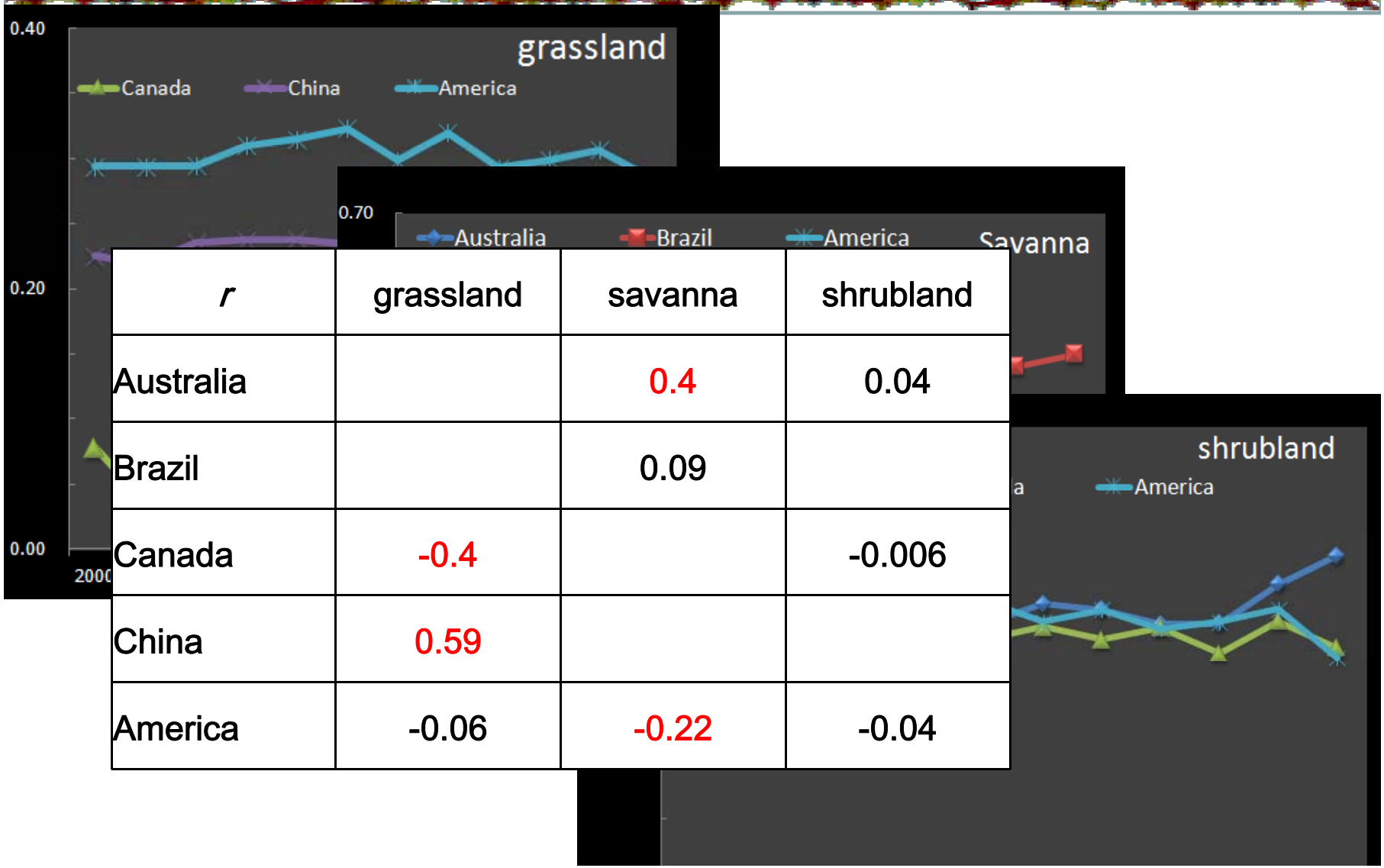
Savanna

VEGETATION GREENNESS AND CLIMATE CONTROLS



MODIS NDVI Trend (2000-2011)

VEGETATION GREENNESS AND CLIMATE CONTROLS



r	grassland	savanna	shrubland
Australia		0.4	0.04
Brazil		0.09	
Canada	-0.4		-0.006
China	0.59		
America	-0.06	-0.22	-0.04

Zhang L., et al. unpublished

OUTLINE

1、Grassland Ecosystems

2、Climate Change

3、Vegetation Greenness and climatic controls

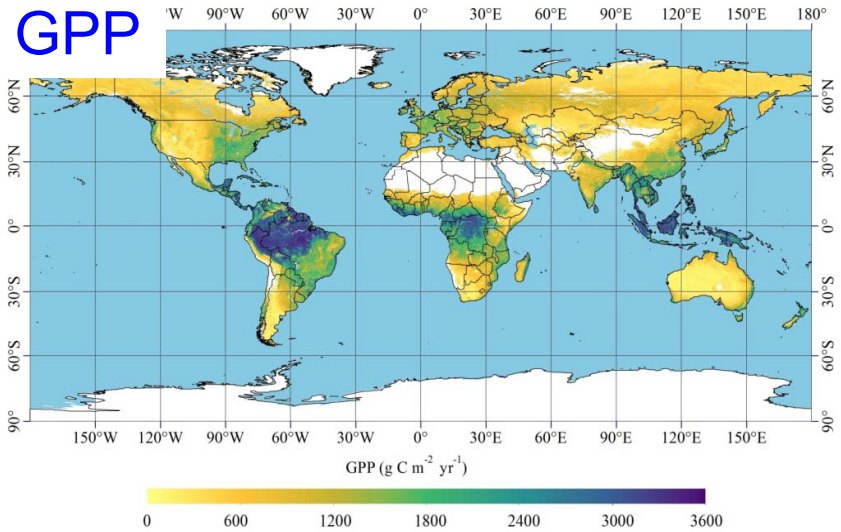
4、Vegetation Productivity

5、Impacts of Extreme Climate Events and Disturbance

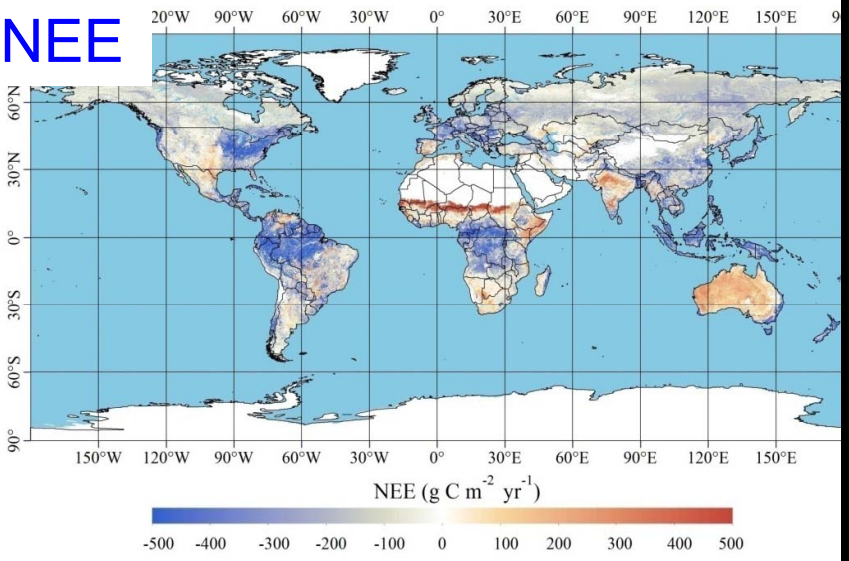
6、Future Plans

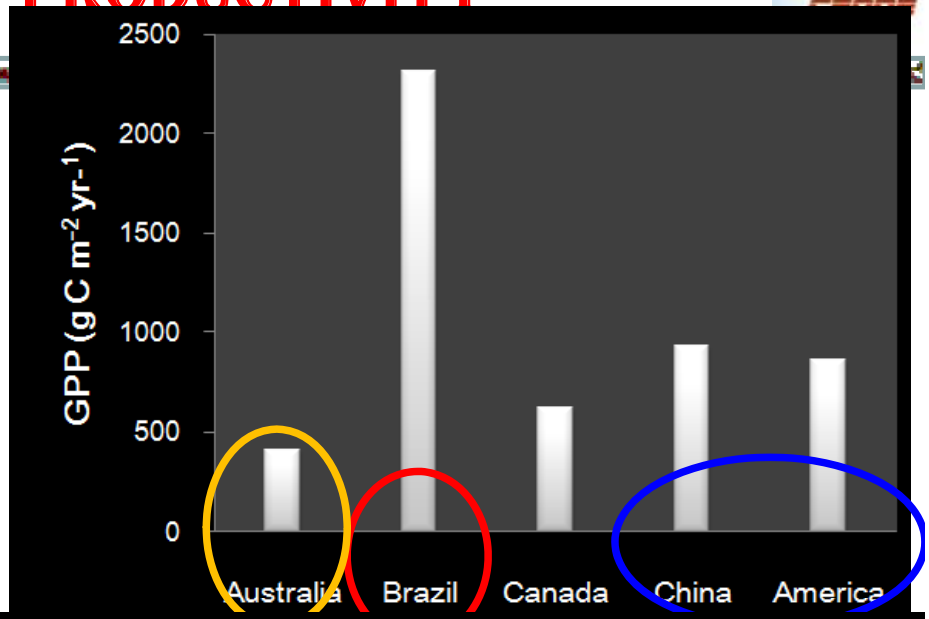
VEGETATION PRODUCTIVITY

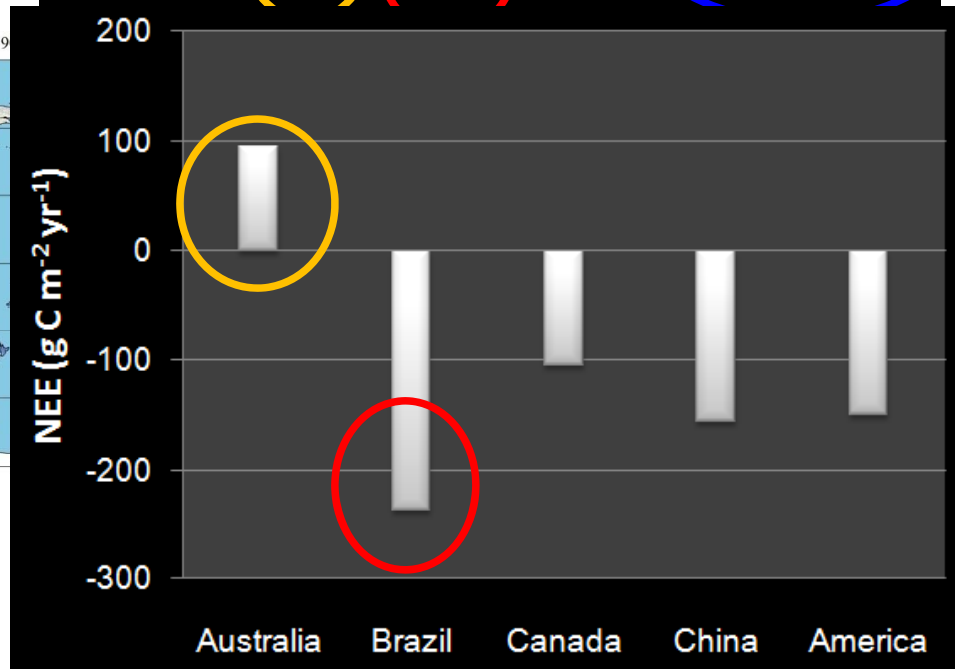
GPP



NEE

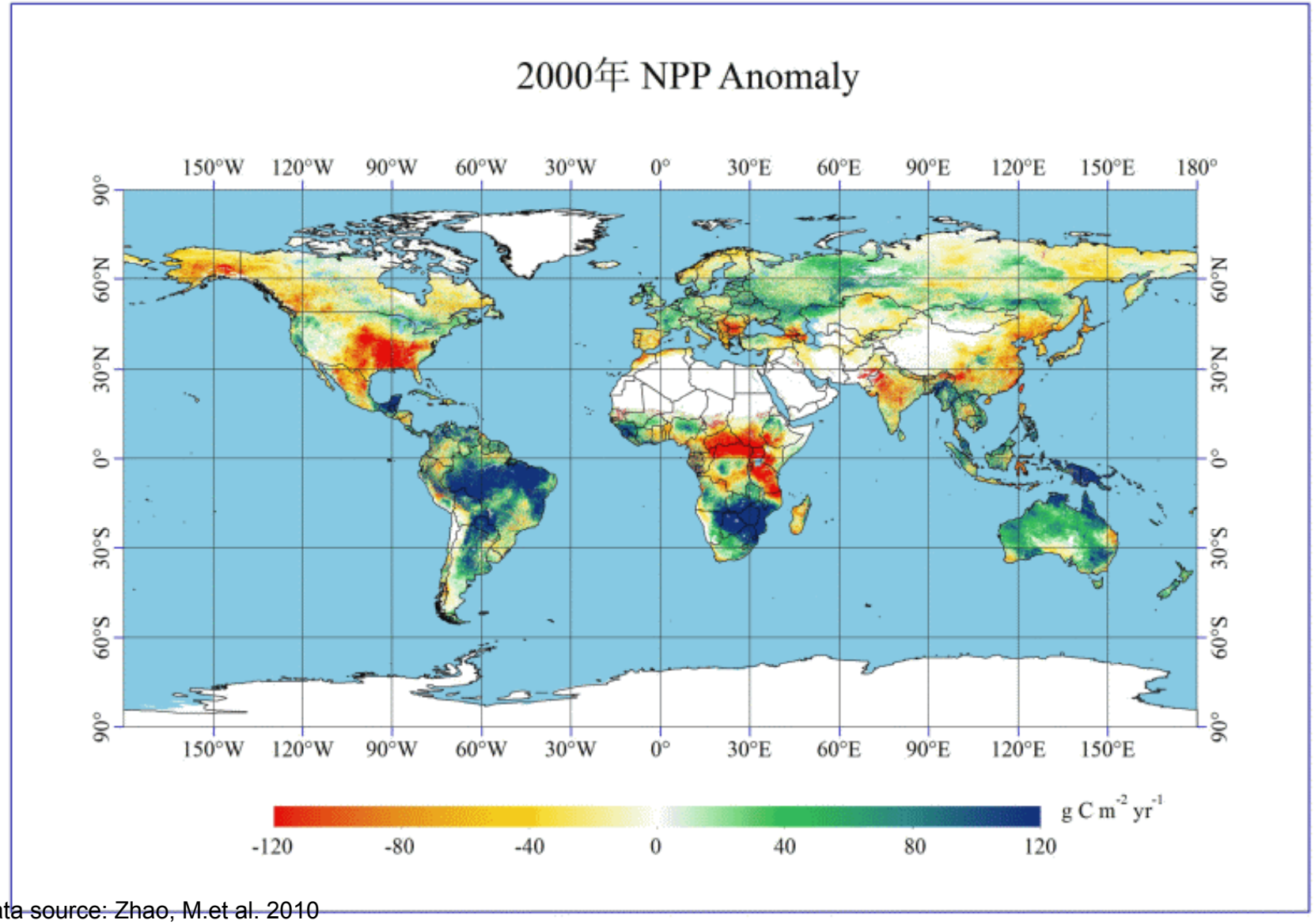






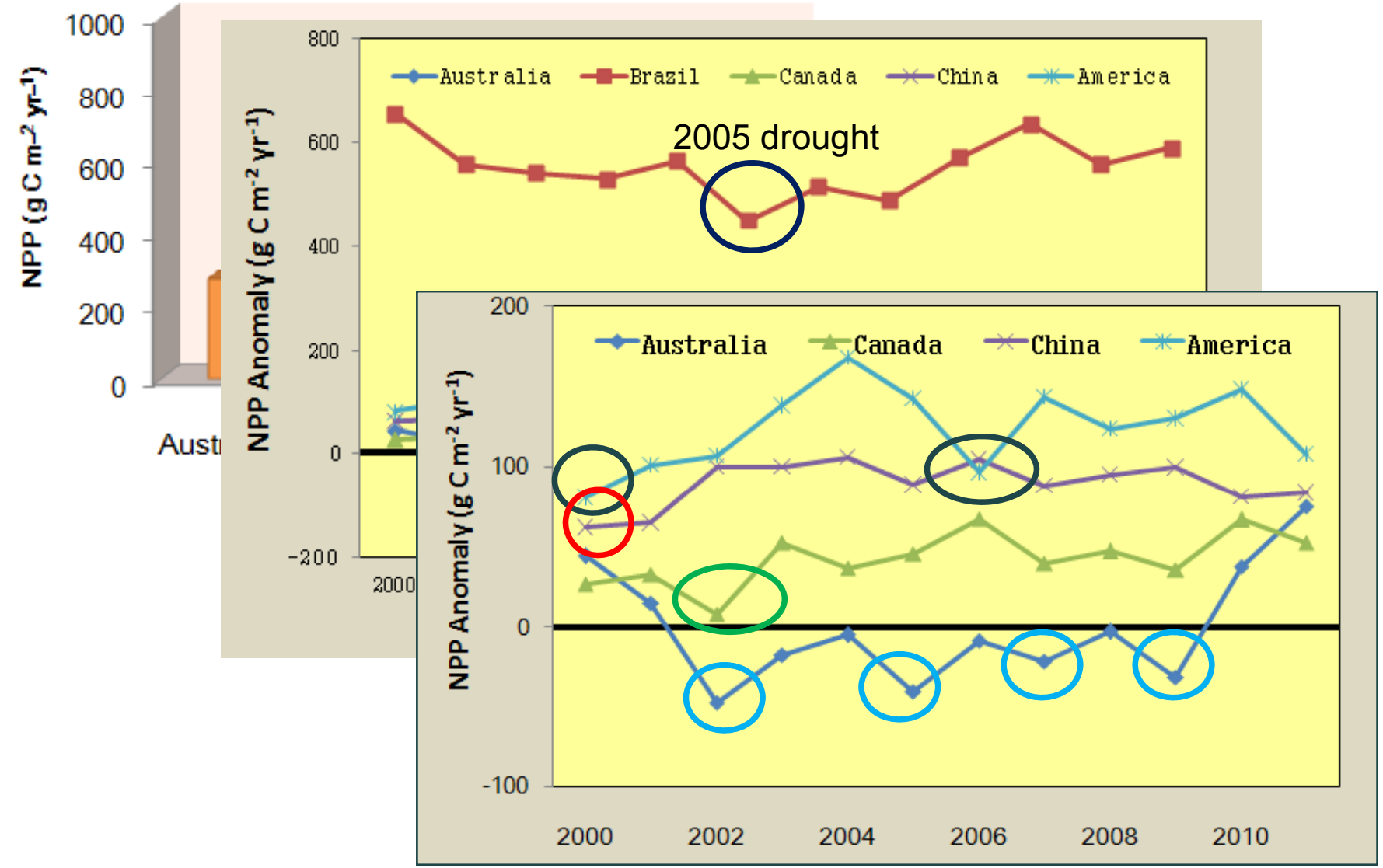
Data source: Xiao, J. et al. unpublished

VEGETATION PRODUCTIVITY



Data source: Zhao, M.et al. 2010

VEGETATION PRODUCTIVITY



OUTLINE

1、Grassland Ecosystems

2、Climate Change

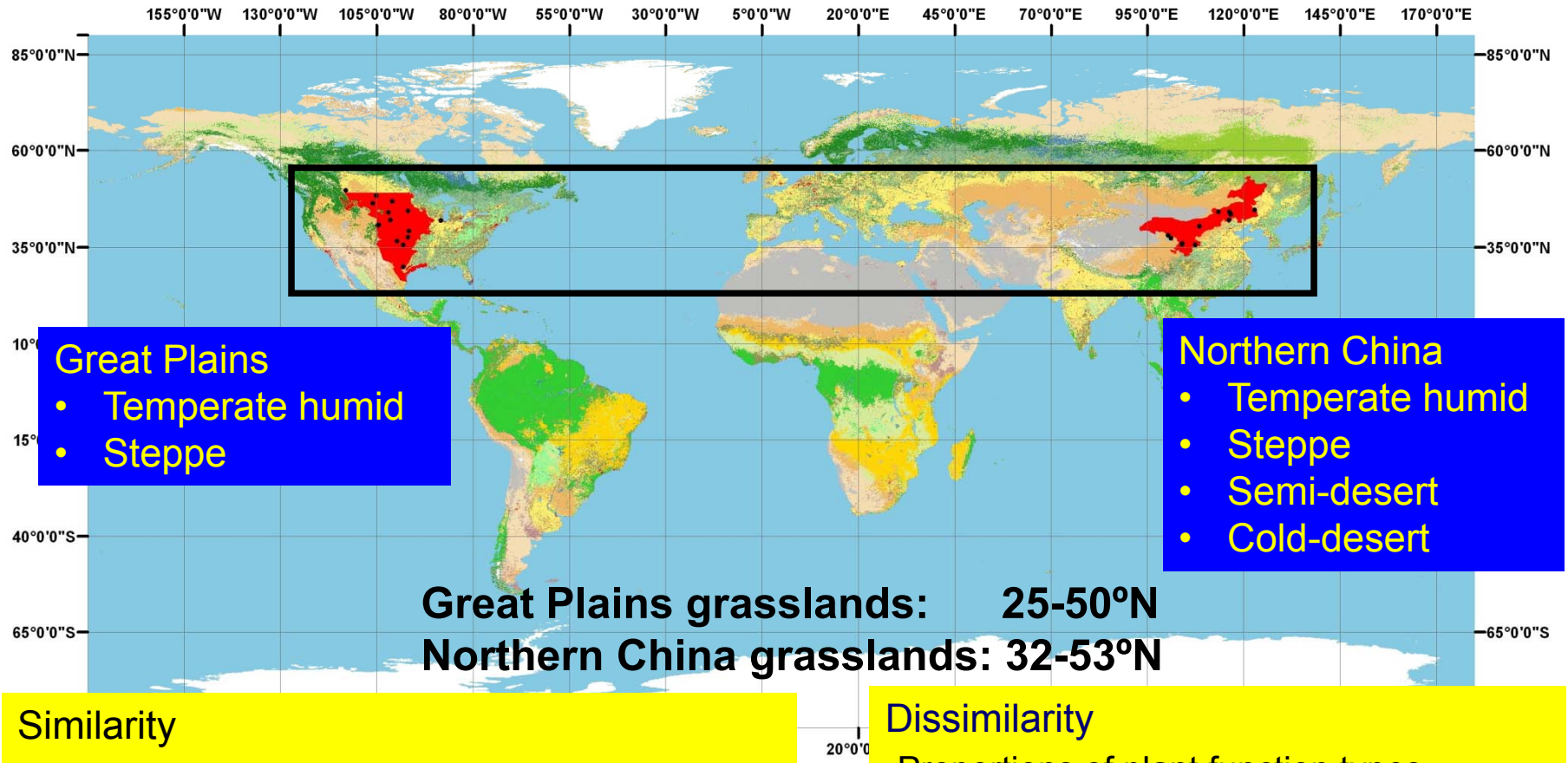
3、Vegetation Greenness and climatic controls

4、 Vegetation Productivity

5 、Impacts of Extreme Climate Events and Disturbance

6、Future Plans

IMPACTS OF DISTURBANCE



Great Plains
- Temperate humid
- Steppe

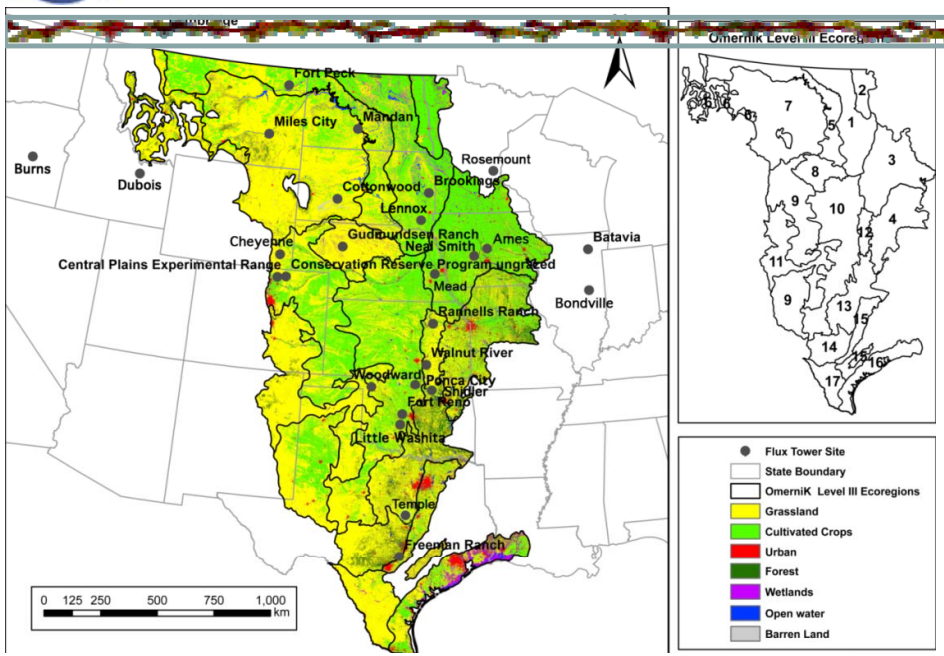
Northern China
- Temperate humid
- Steppe
- Semi-desert
- Cold-desert

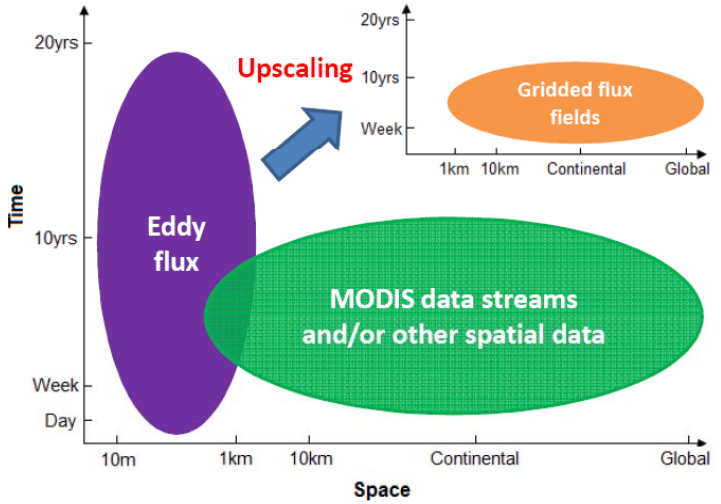
Great Plains grasslands: 25-50ºN
Northern China grasslands: 32-53ºN

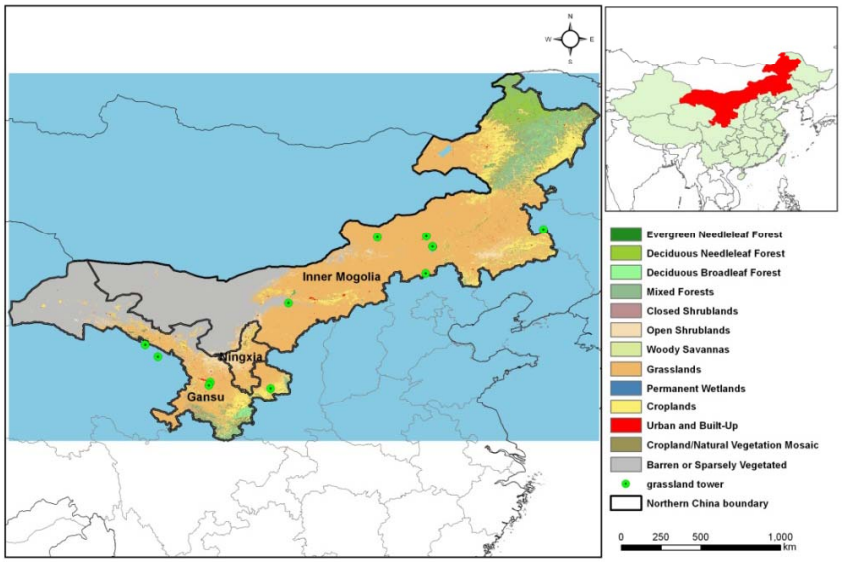
Similarity
- Inland grassland in the northern Hemisphere
- Temperate grasslands with C3/C4
- Precipitation decrease from east to south

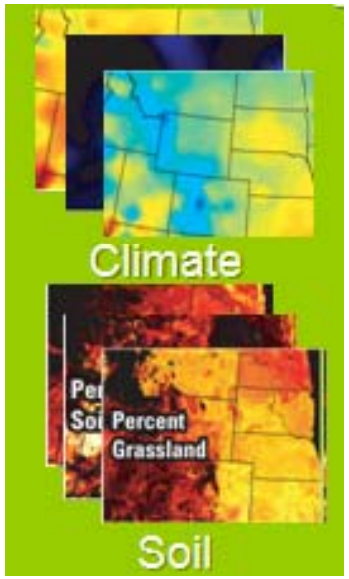
Dissimilarity
- Proportions of plant function types
- Precipitation gradient from east to west
  - 500-150mm in northern China
  - 1000mm-300mm in Great Plains
- Different human activities

IMPACTS OF DISTURBANCE









IMPACTS OF DISTURBANCE

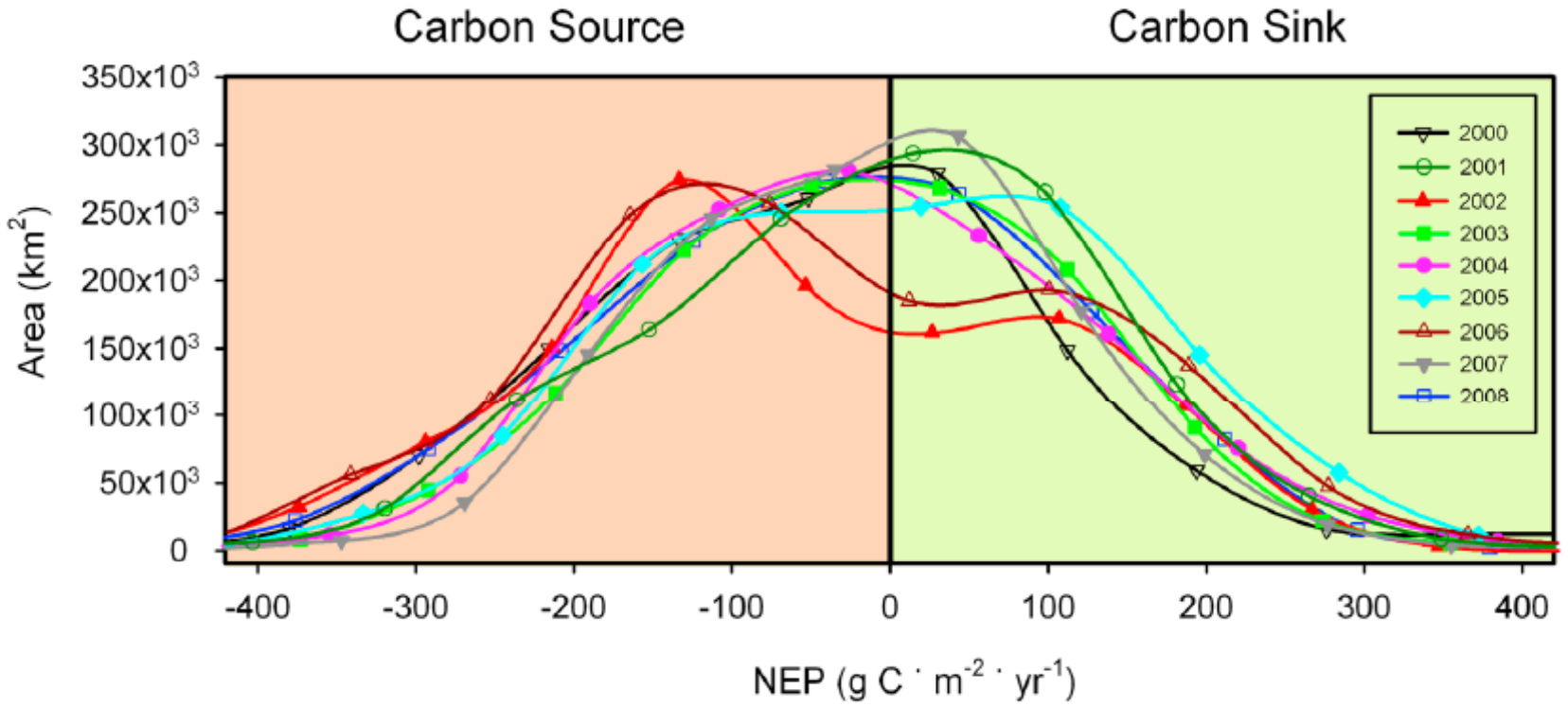
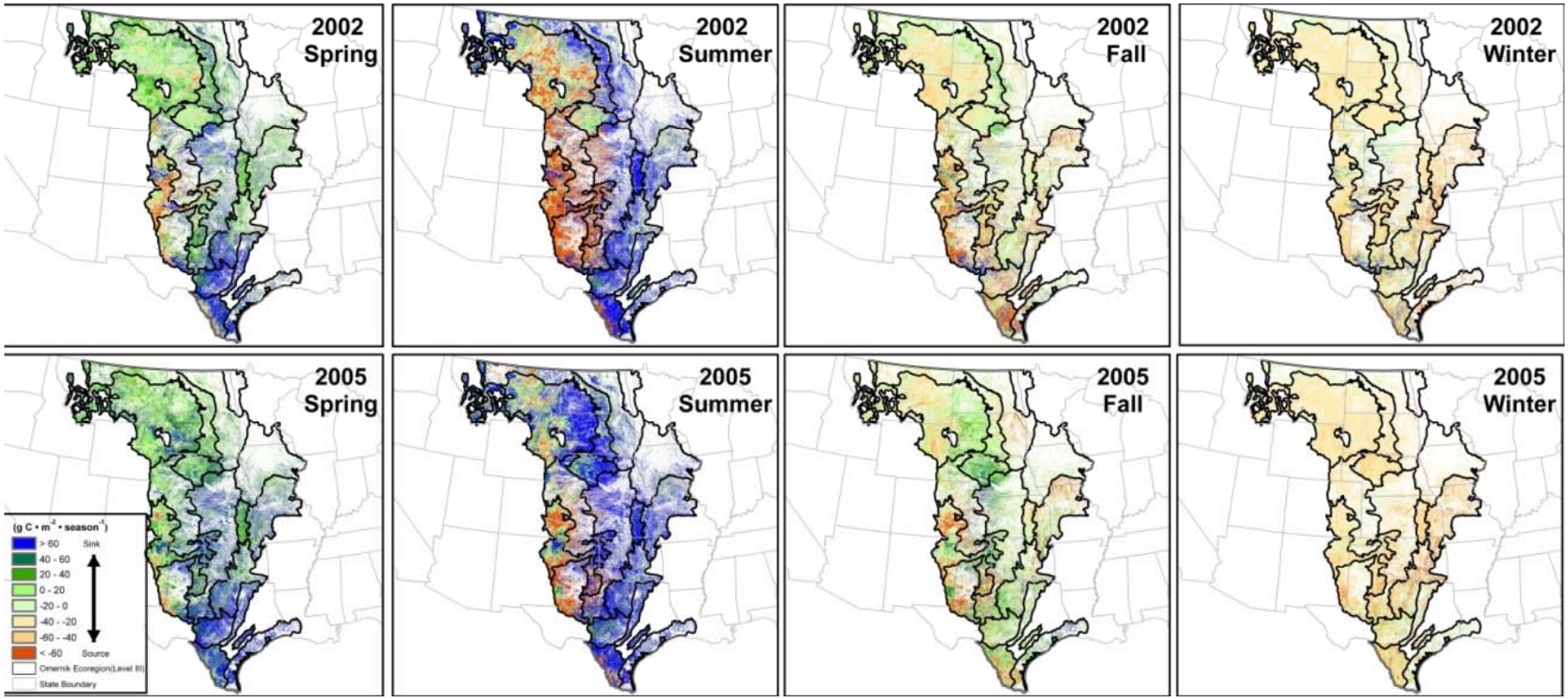


Figure 5. Areal distribution of annual NEP in the Great Plains grasslands during 2000–2008.

Zhang, L., et al., 2011, *J. Geophys. Res*.
Zhang, L., et al., 2010, *Rangeland Ecology & Management*

IMPACTS OF DISTURBANCE



2002 NEP: 0.30 g C m^{-2} yr^{-1}

2005 NEP: 47.7 g C m^{-2} yr^{-1}

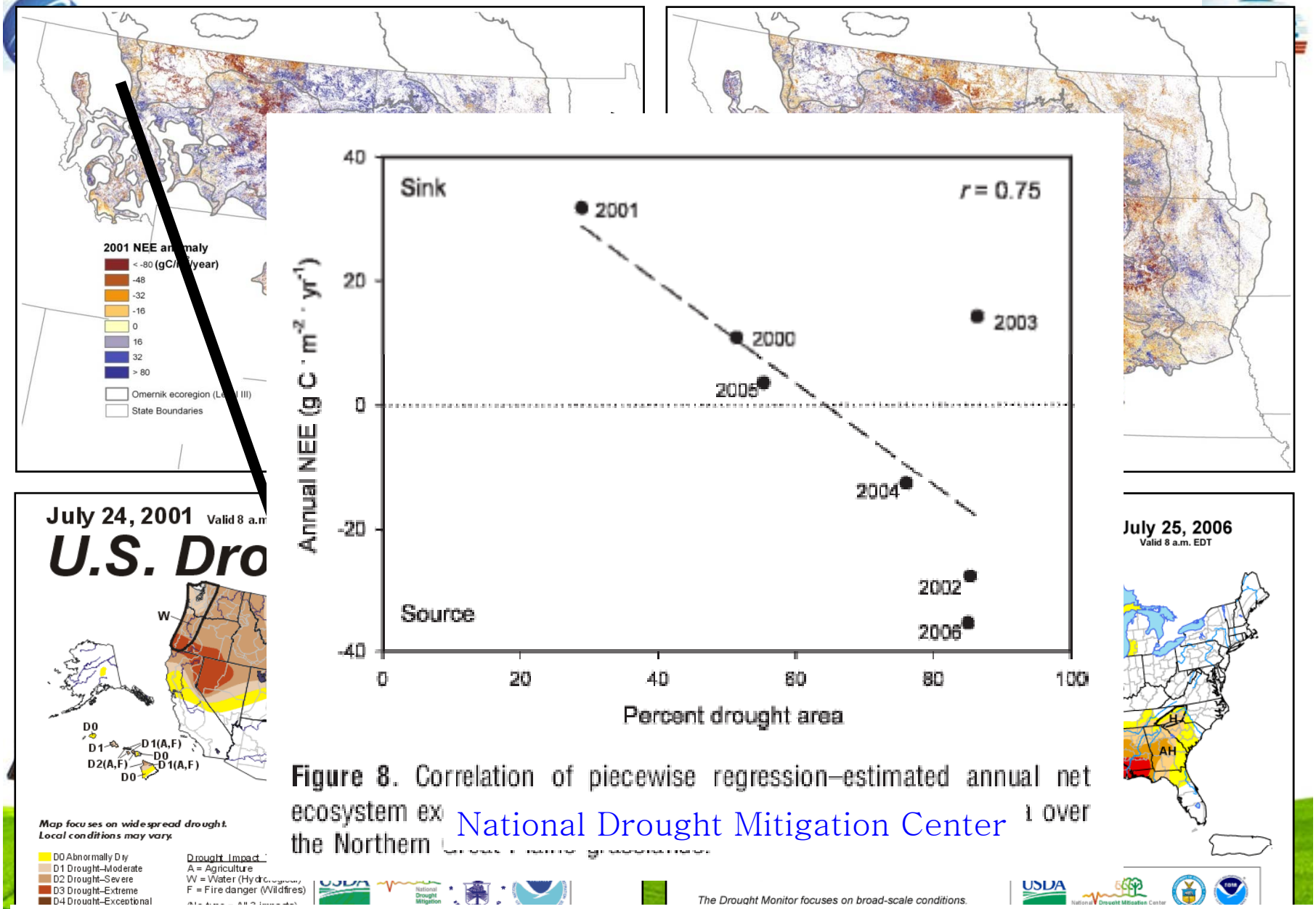
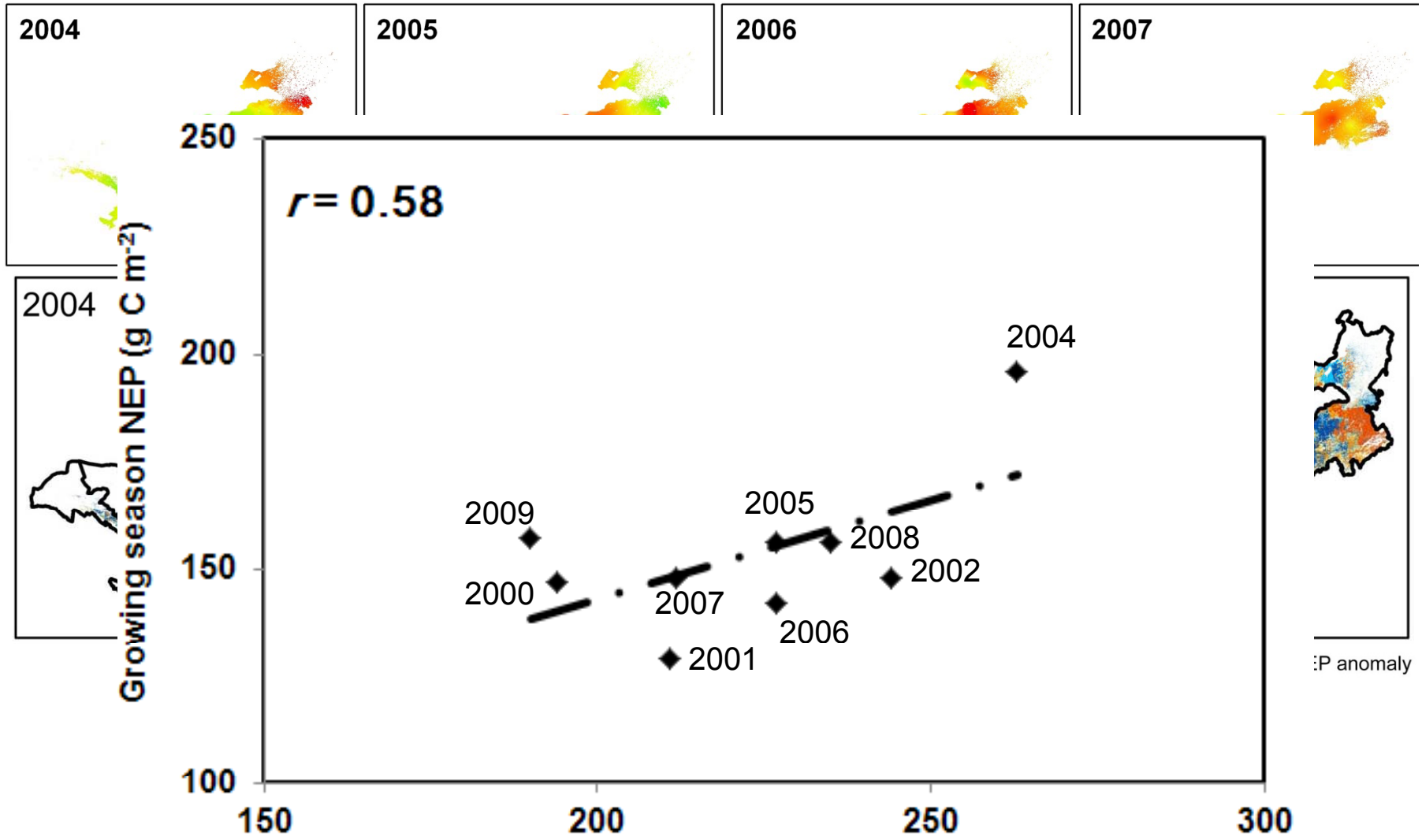


Figure 8. Correlation of piecewise regression–estimated annual net ecosystem ex … over the Northern …

National Drought Mitigation Center

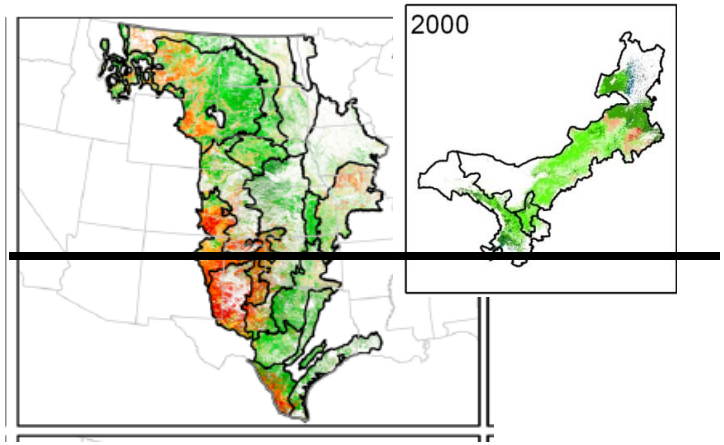
Zhang L., et al. 2010. Rangeland Ecol Manage.

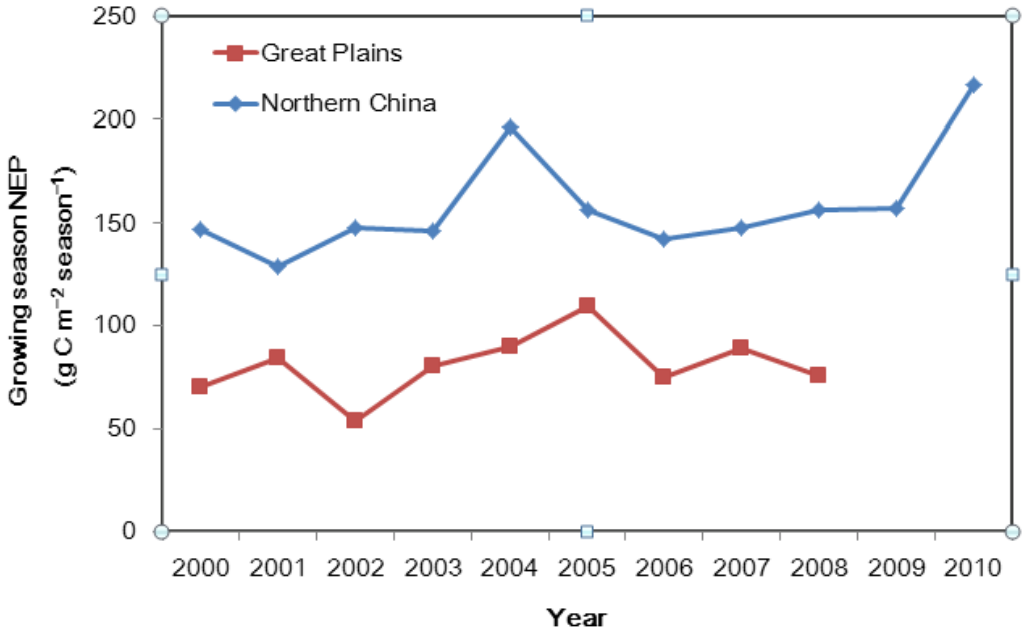
IMPACTS OF DISTURBANCE



Zhang L., et al. unpublished

IMPACTS OF DISTURBANCE



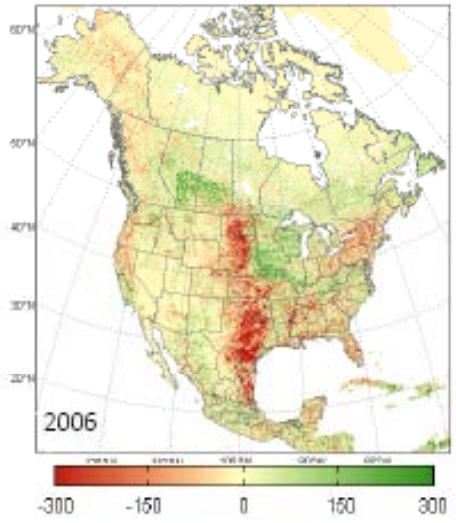


Great Plains (2000-2008) was a net carbon uptake with an averaged NEP of 81 ± 15 g C m^{-2} growing season $^{-1}$, ranging from a low value of 54 in 2002 to a high value of 109 g C m^{-2} growing season $^{-1}$ in 2005.

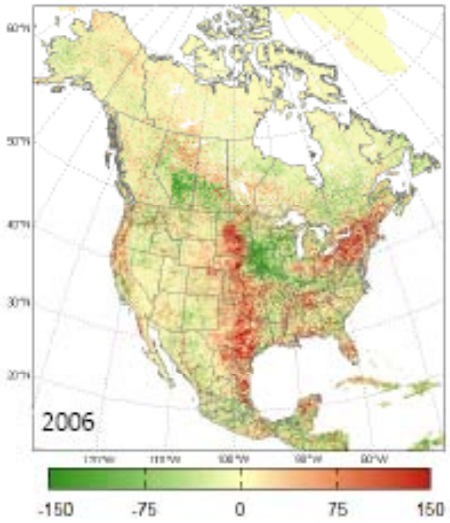
Northern China (2000-2010) was a net carbon uptake with an averaged NEP of 158 ± 25 g C m^{-2} growing season^{-1}, ranging from a low value of 129 in 2001 to a high value of 217 g C m^{-2} growing season $^{-1}$ in 2010.

Zhang L., et al. unpublished

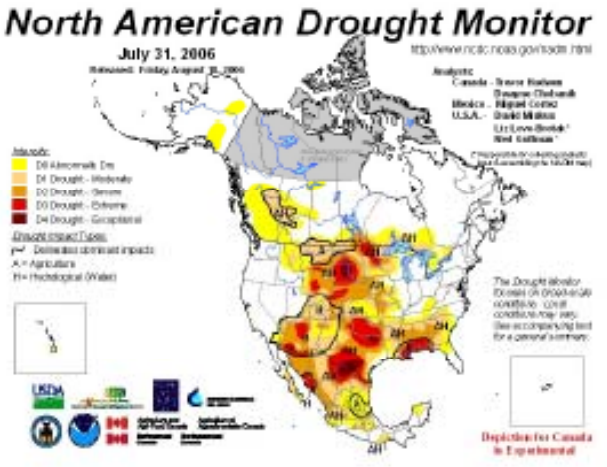
Impacts of drought on ecosystem carbon fluxes

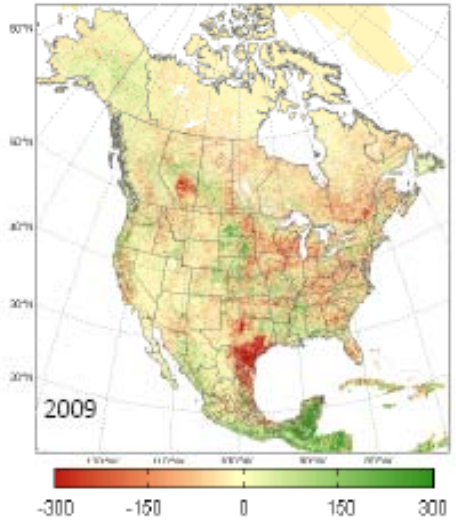


GPP

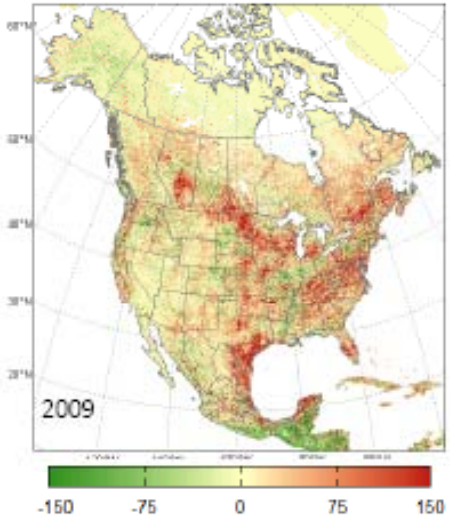


NEE

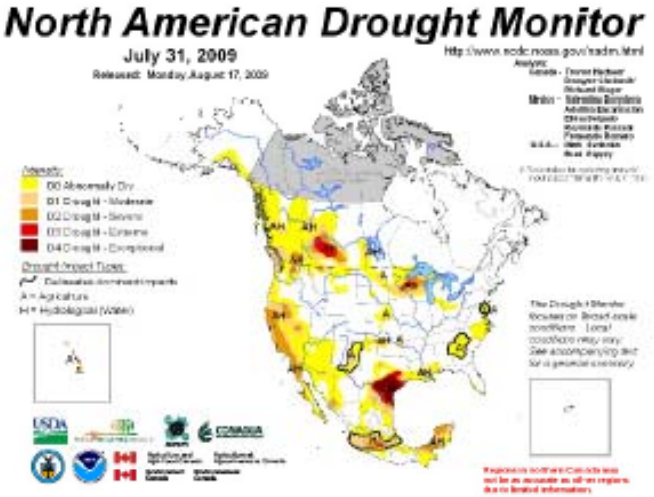




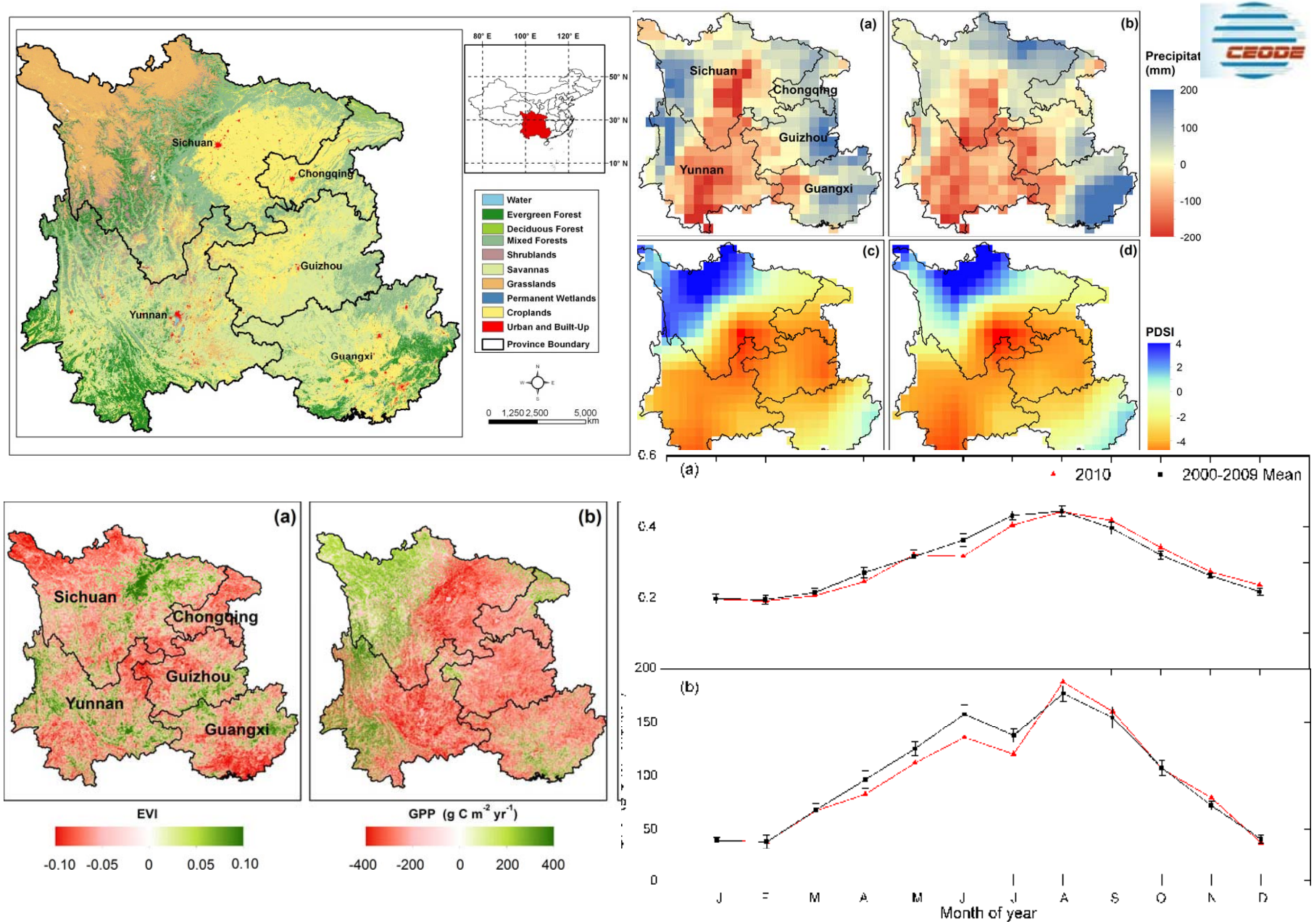
GPP



NEE



Xiao, J. et al. unpublished



Zhang, L. et al. *Environ Res Letters*, in press

OUTLINE

1、Grassland Ecosystems

2、Climate Change

3、Vegetation Greenness and climatic controls

4、 Vegetation Productivity

5 、Impacts of Extreme Climate Events and Disturbance

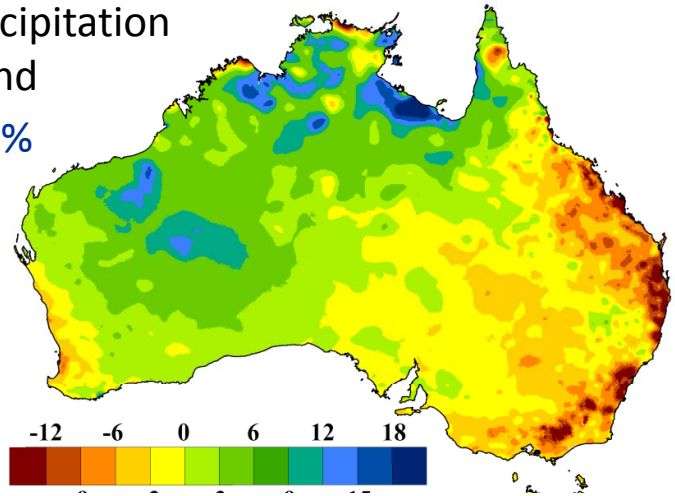
6、Future Plans

FUTURE PLANS

Australia-wide trends in P and AVHRR fPAR 1981-2006
Donohue et al., (2009) Global Change Biology

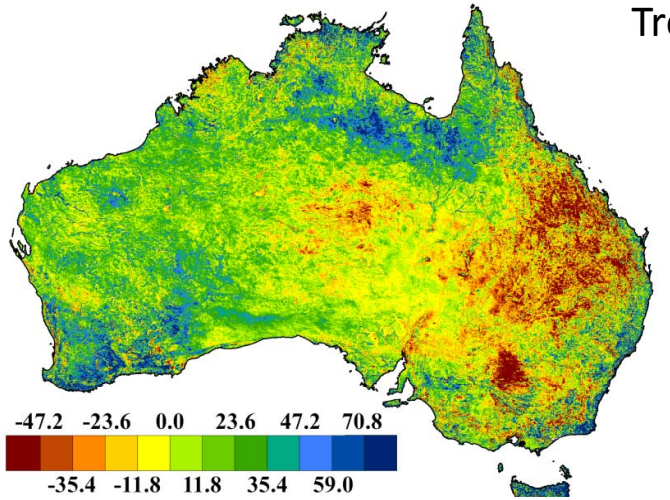
Precipitation trend

+7%



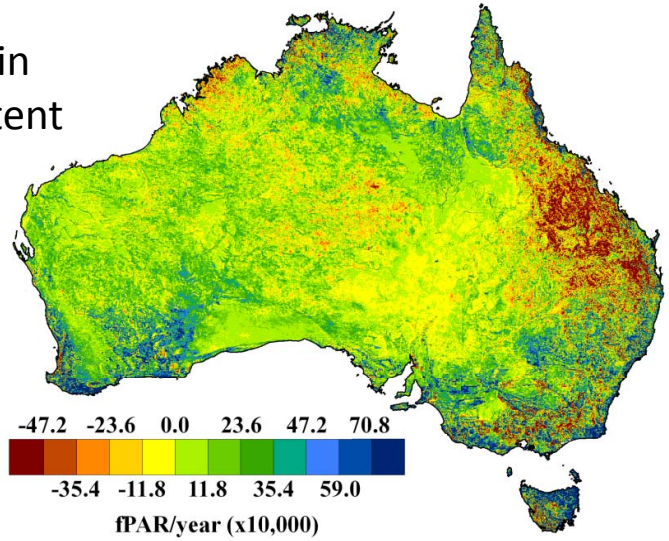
Trend in total fPAR

+8%



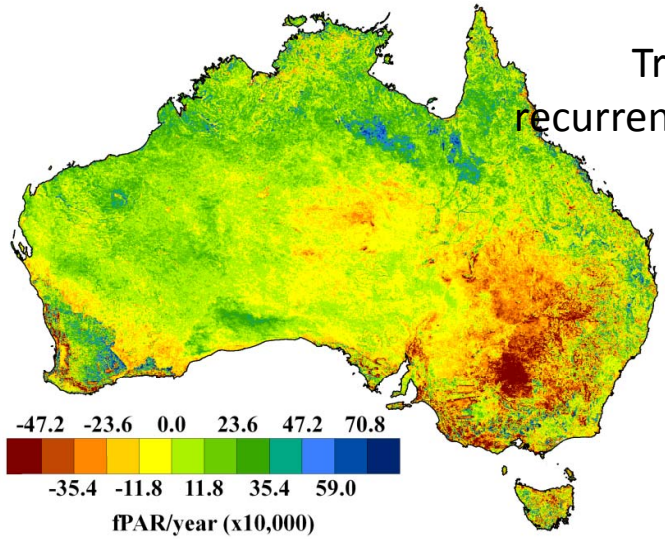
Trend in persistent fPAR

+21%



Trend in recurrent fPAR

-7%

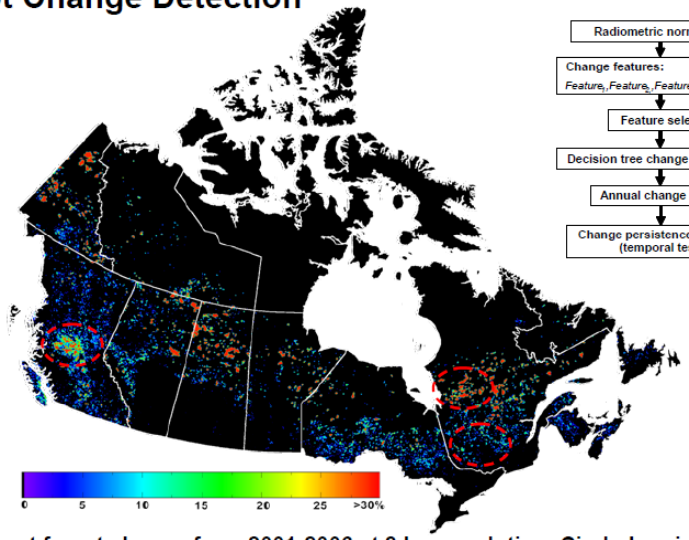


FUTURE PLANS

Canada

Long-term Satellite Data Records

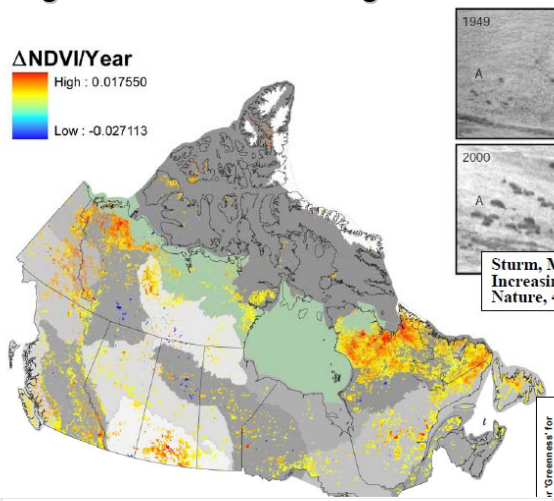
Abrupt Change Detection

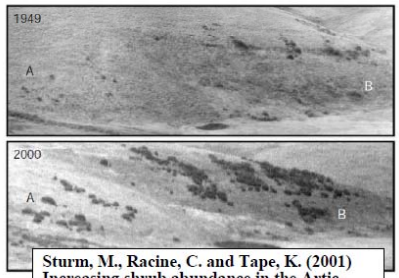


Percent forest change from 2001-2006 at 8 km resolution. Circled regions correspond to examples shown on next slide.

Pouliot, D., R. Latifovic, R. Fernandes, and I. Olthof. (2009). Evaluation of annual forest disturbance monitoring using a static decision tree approach and 250 m MODIS data. Remote Sensing of Environment, 113:1749-1759.

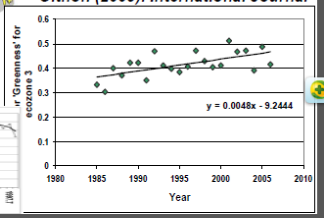
Progressive\Gradual Change Detection





Sturm, M., Racine, C. and Tape, K. (2001) Increasing shrub abundance in the Artic. Nature, 411, 546-547.

Pouliot, D., R. Latifovic, and I. Olthof. (2009). International Journal



FUTURE PLANS

Scientific questions for comparison studies with space technology：

<u>Similarity and Dissimilarity on:</u>

Feedback to climate change and human activities?

Interactions?

Balance?

Projections?

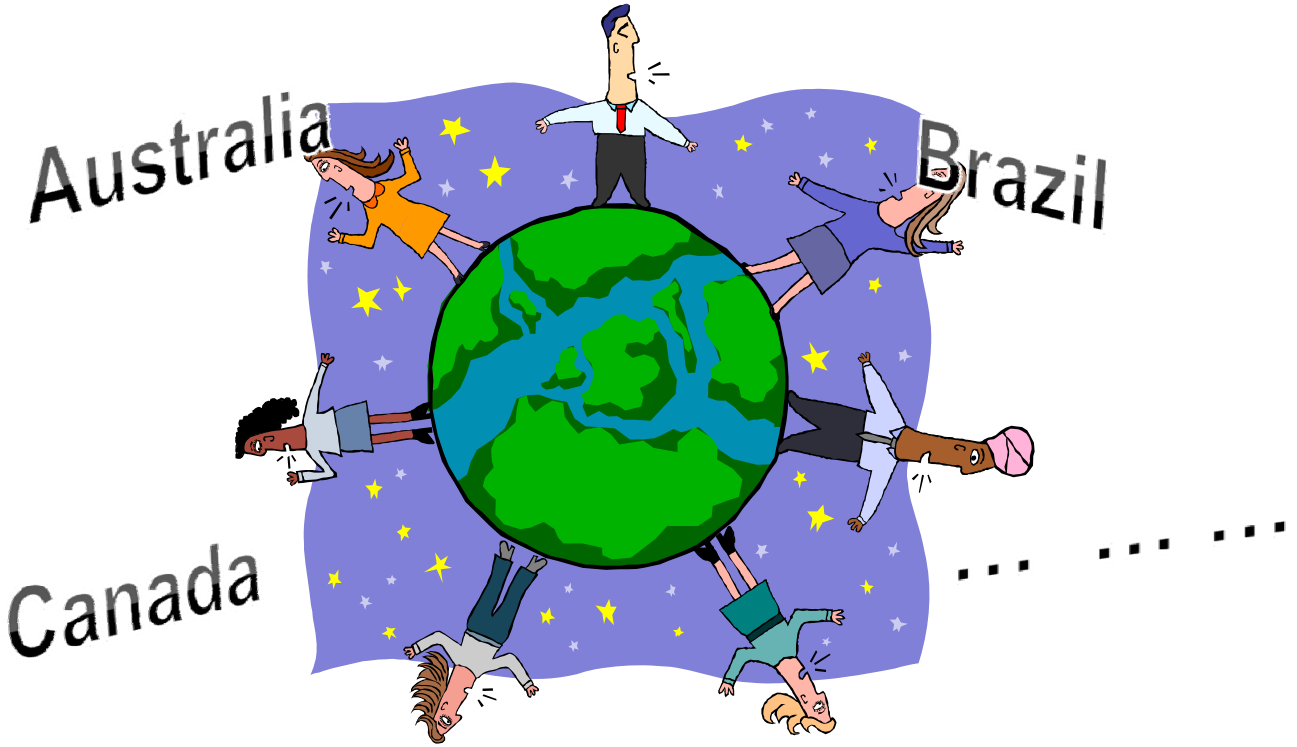
..

FUTURE PLANS

China: Zhang Li et al.

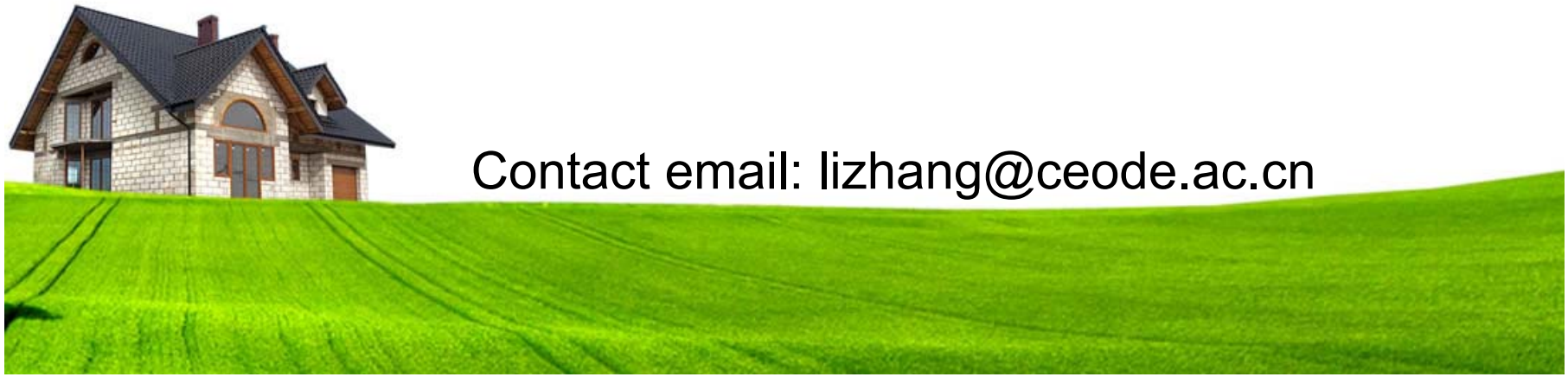
U.S.: Xiao, Jingfeng; Wylie, Bruce

Call for Partners from



Special thanks for the data providers and my graduate students.

THANK YOU !



Contact email: lizhang@ceode.ac.cn