

# Mapping Global Urban Area from DMSP/OLS Nightlights using a Cluster-based Method

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# Outline

## ❖ **Project background**

- Motivations
- Scientific questions
- Research objectives

## ❖ **Methodology**

## ❖ **Preliminary results**

- Global urban area
- China urbanization dynamics

## ❖ **Summary and future work**

# Motivations

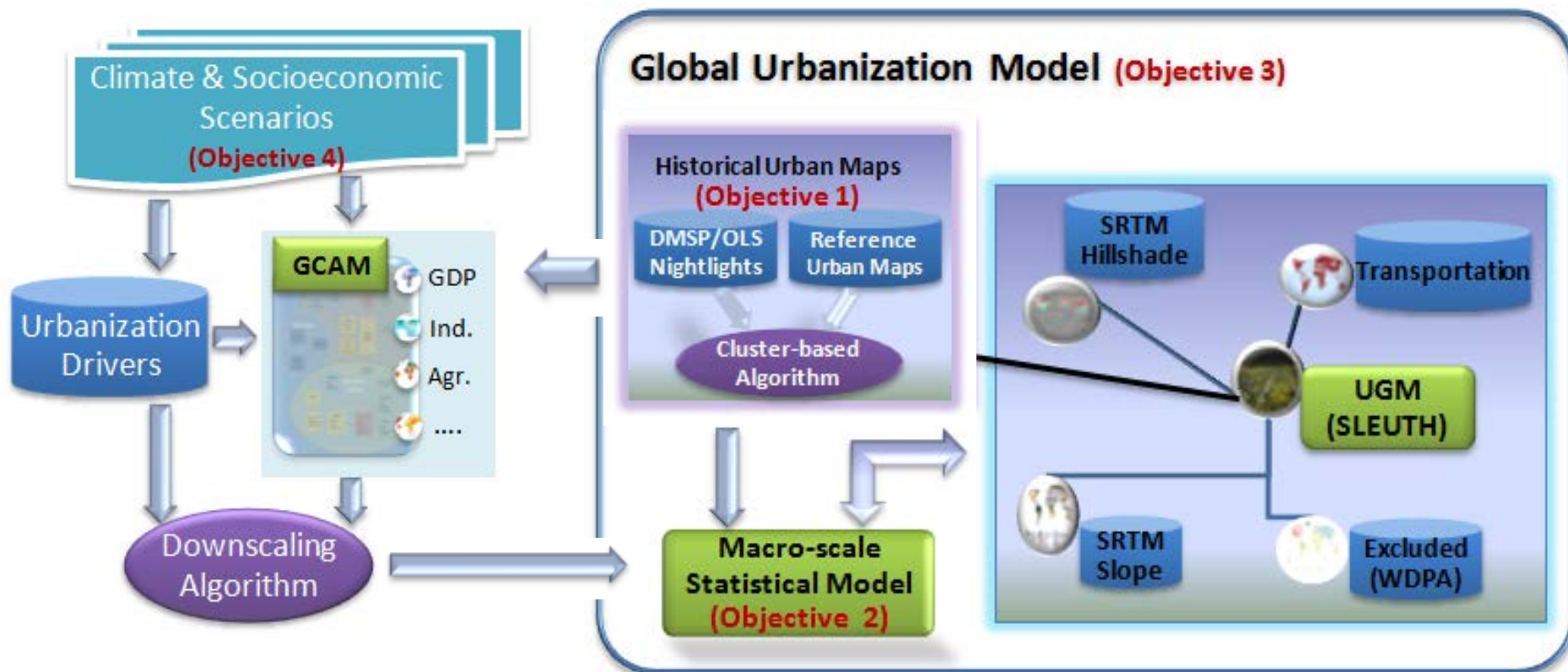
- ❖ **Urban population is projected to 70% by 2050**
- ❖ **Urbanization shows important impacts on environment**
  - Global warming
  - Urban heat island
  - Energy demand
  - Water cycle
  - .....
- ❖ **It is an important parameter in climate and environmental modeling**
- ❖ **A consistent global urban map series is lacking**

# Scientific questions

- ❖ **Where and when did urbanization occur?**
- ❖ **What are the socioeconomic and natural causes of urbanization?**
- ❖ **What are the consequences of urbanization for the sustainability of our earth system?**

# Objectives

- ❖ A consistent global urban map series
- ❖ An integrated framework to project urban expansion
- ❖ Future urbanization scenarios and implications



# Urban Mapping from nightlights

## A cluster-based method

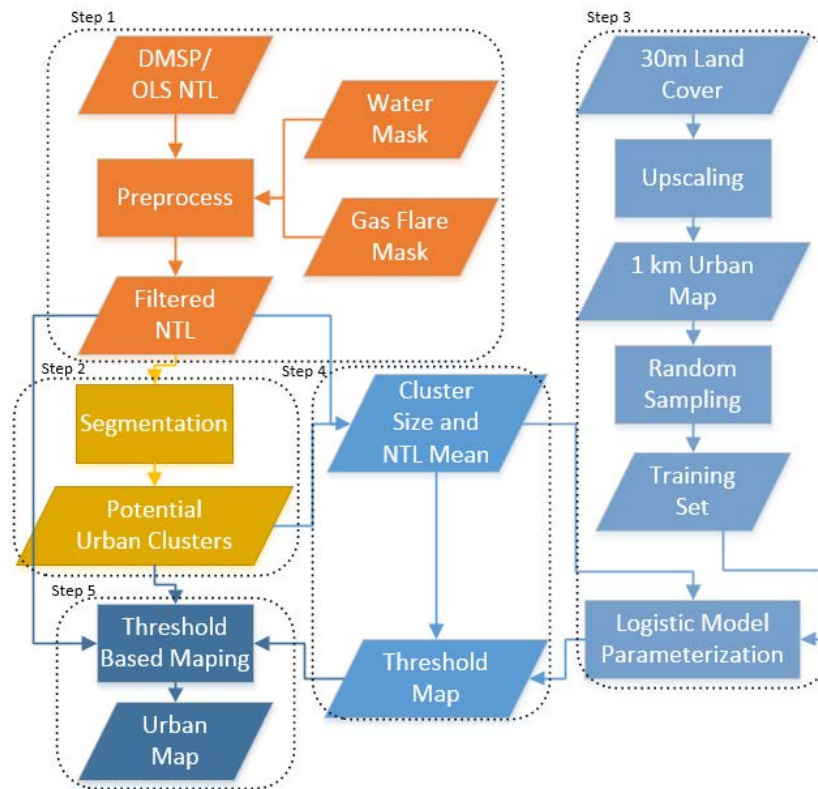
1. Data Preprocess

2. Urban Clusters Segmentation

3. Logistic Model

4. Thresholds Estimation

5. Urban Extent Delineation



Y. Zhou et al, 2014. A cluster-based method to map urban area from DMSP/OLS nightlights, *Remote Sensing of Environment*, 147 (5): 173-185

# Potential urban clusters

1. Data Preprocess

2. Urban Clusters Segmentation

3. Logistic Model

4. Thresholds Estimation

5. Urban Extent Delineation

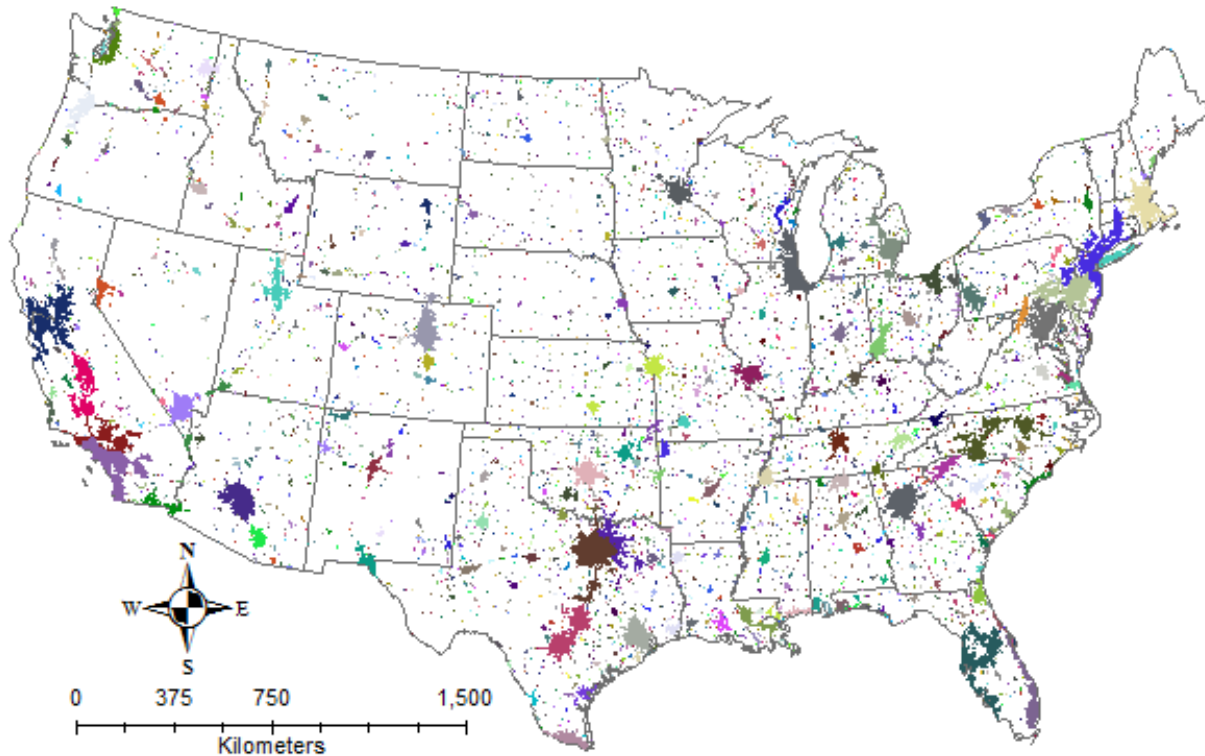
NTL data

Gradient map

Foreground markers

Background markers

Watershed -based segmentation



# A logistic model

1. Data Preprocess

2. Urban Clusters Segmentation

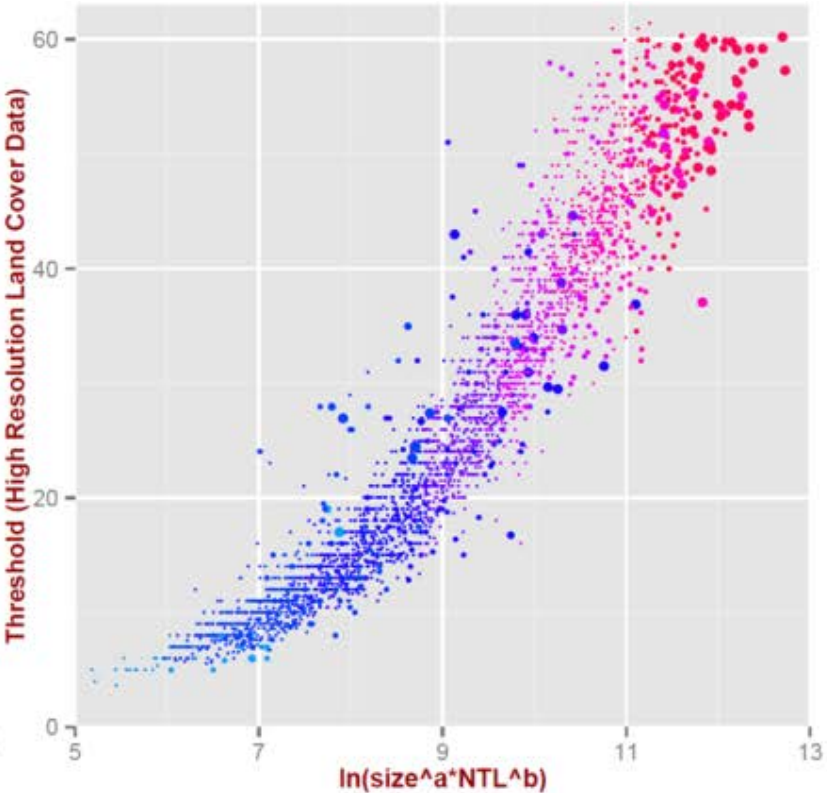
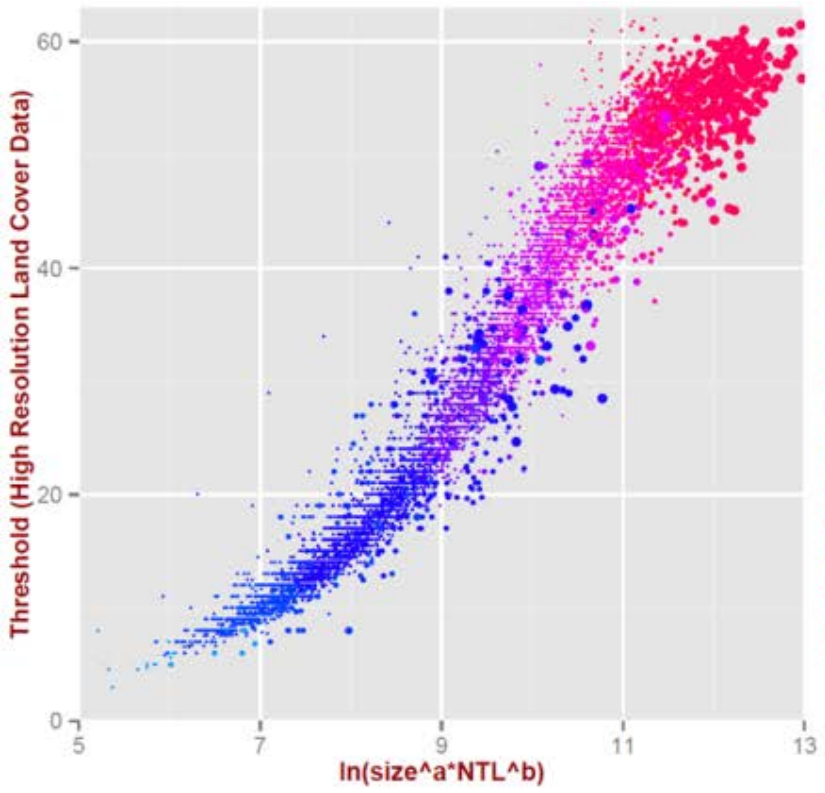
3. Logistic Model

4. Thresholds Estimation

5. Urban Extent Delineation

USA

China





# Estimation of optimal thresholds

1. Data Preprocess

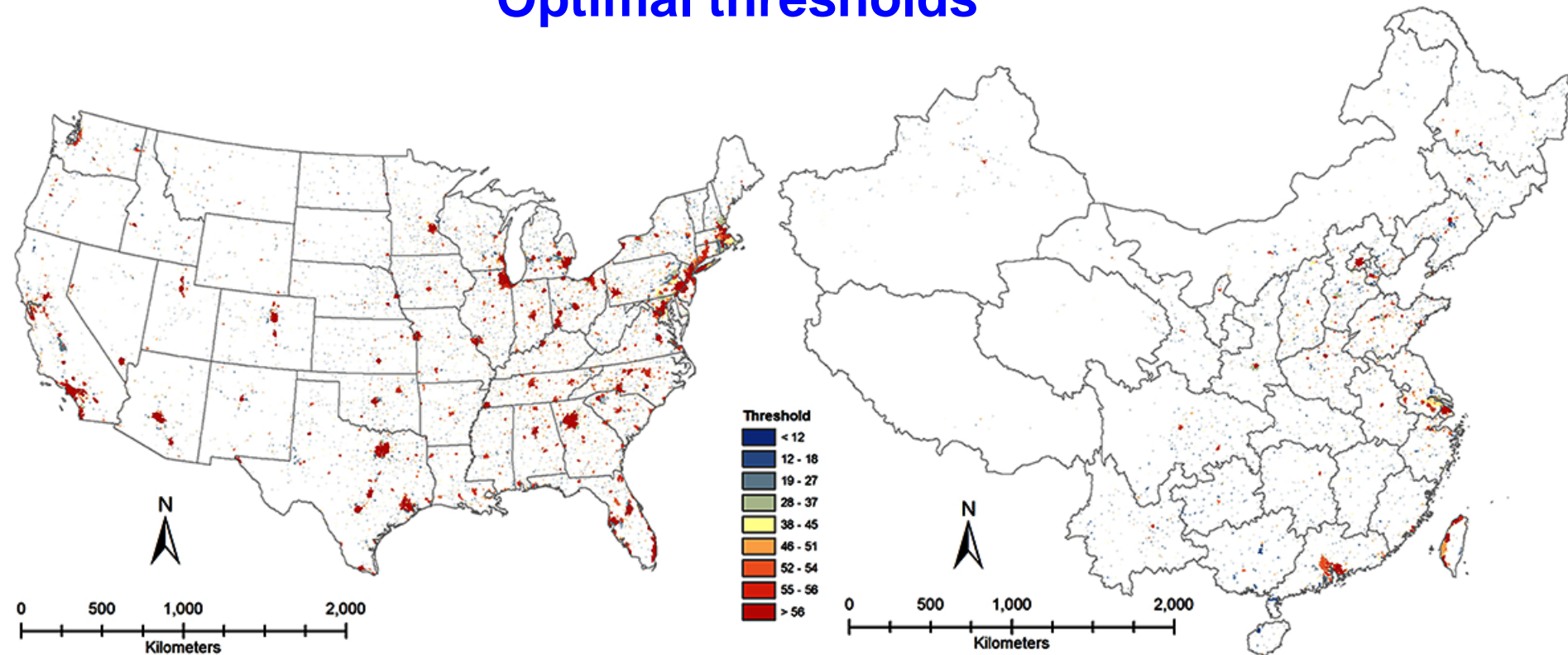
2. Urban Clusters Segmentation

3. Logistic Model

4. Thresholds Estimation

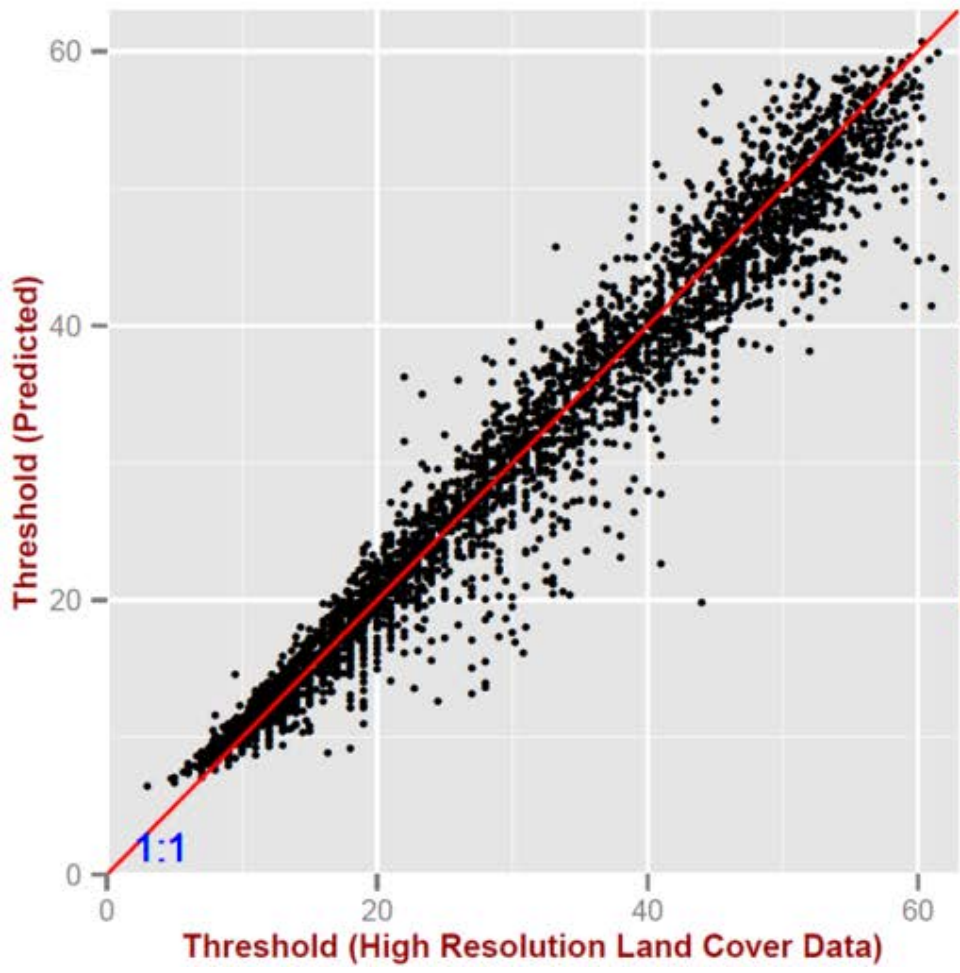
5. Urban Extent Delineation

## Optimal thresholds

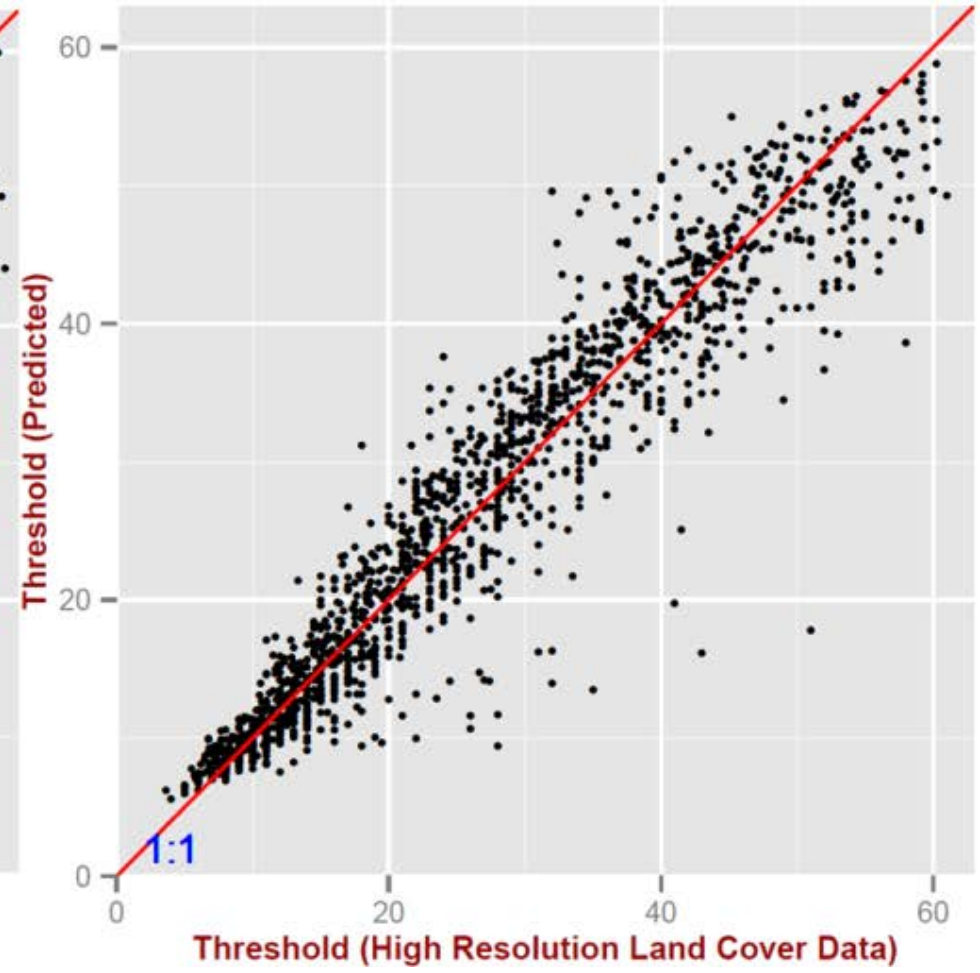


# Validations of estimated optimal thresholds

## USA

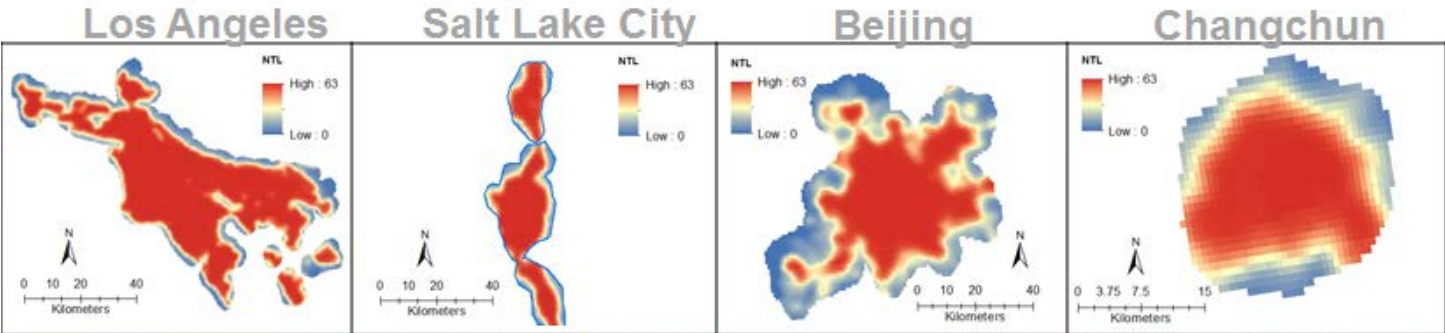


## China

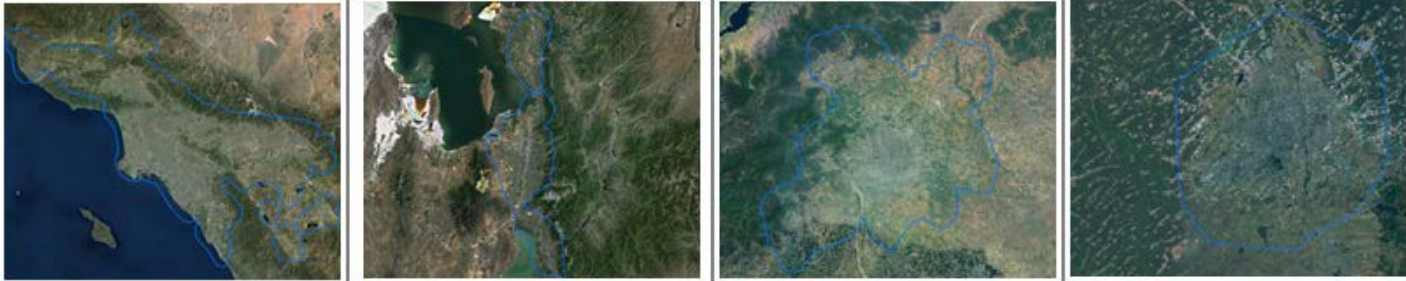


# Urban extent from nightlights

NTL



Google map



High-Res Urban

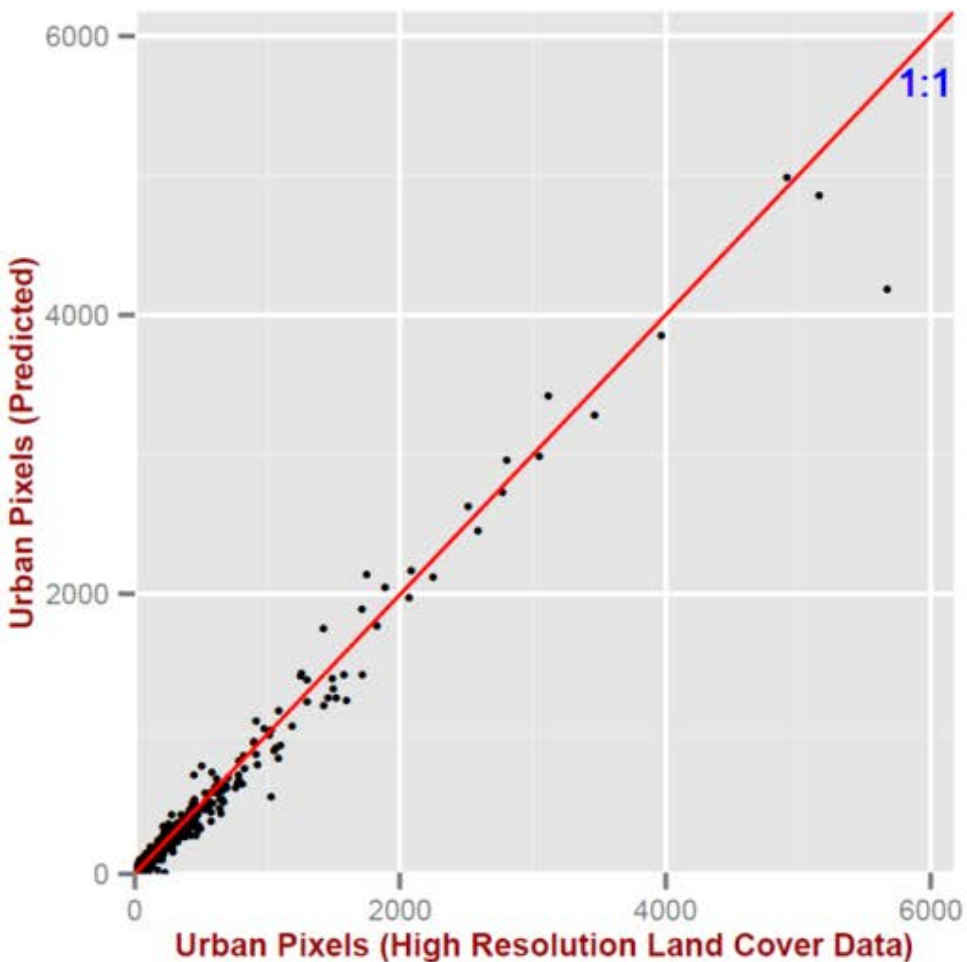


Urban from NTL

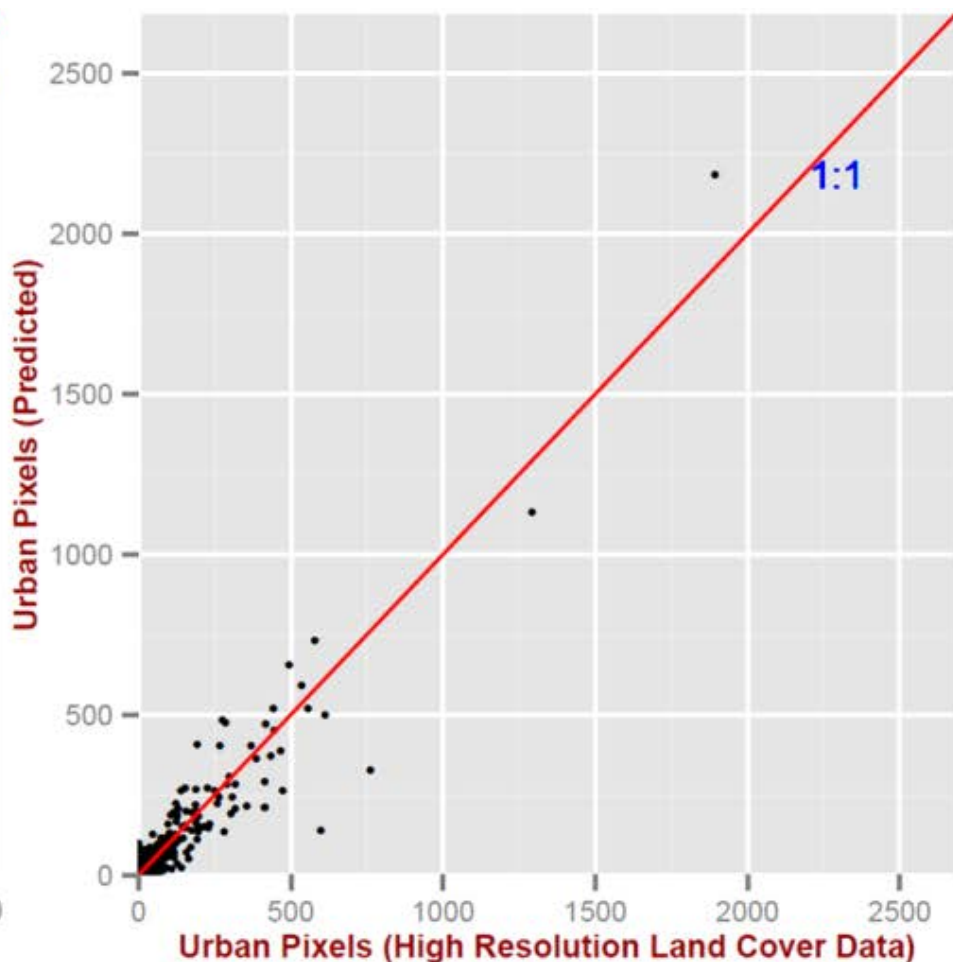


# Validations of mapped urban area

## USA

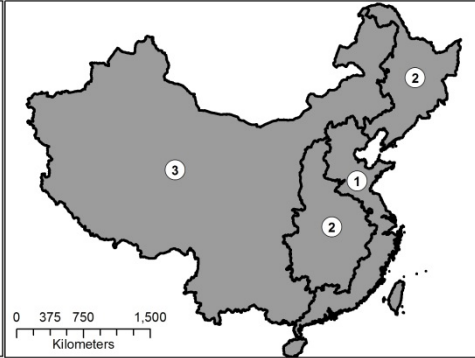
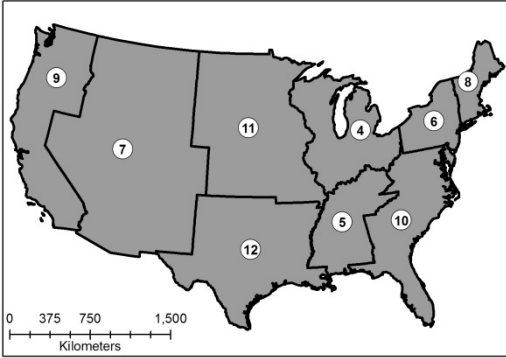
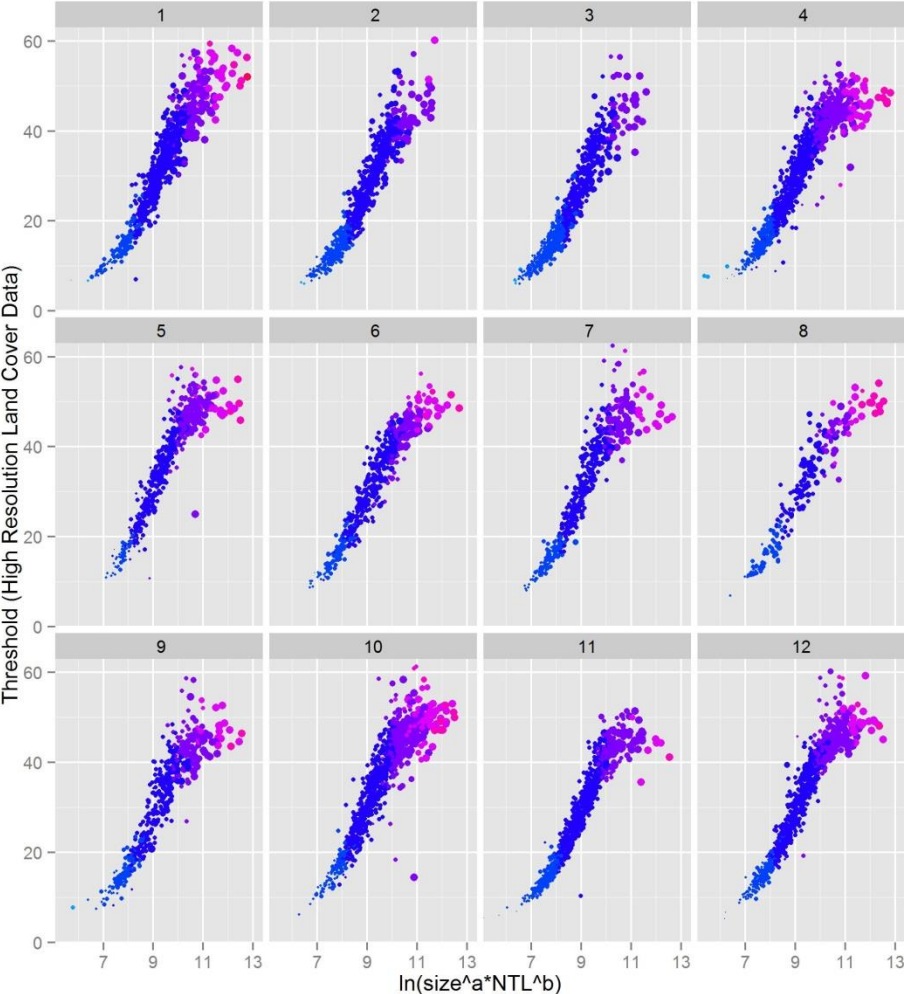


## China



# Global urban areas mapping

## Parameter in the logistic model

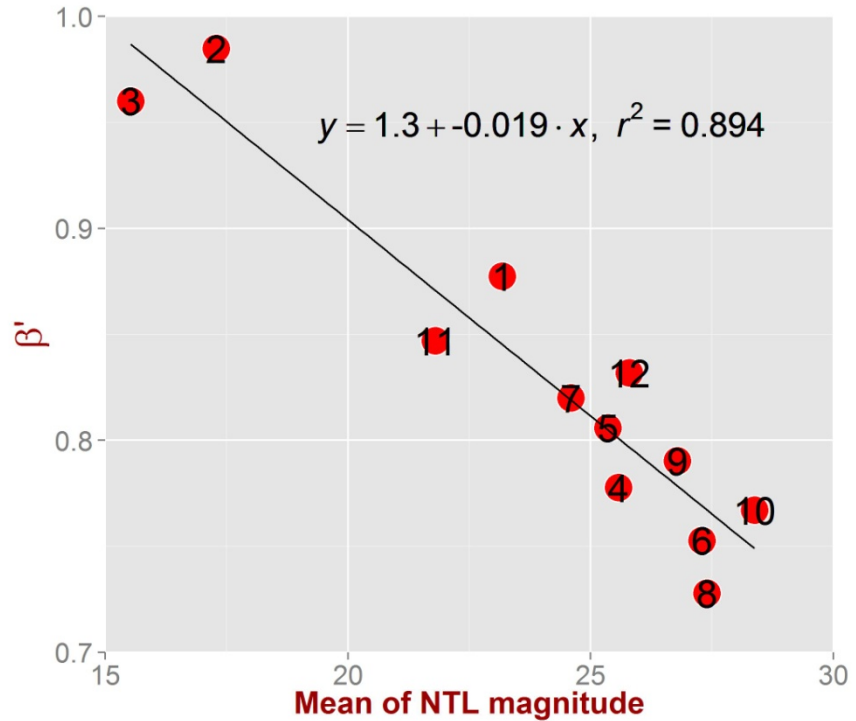


### Cluster Size (Pixels)

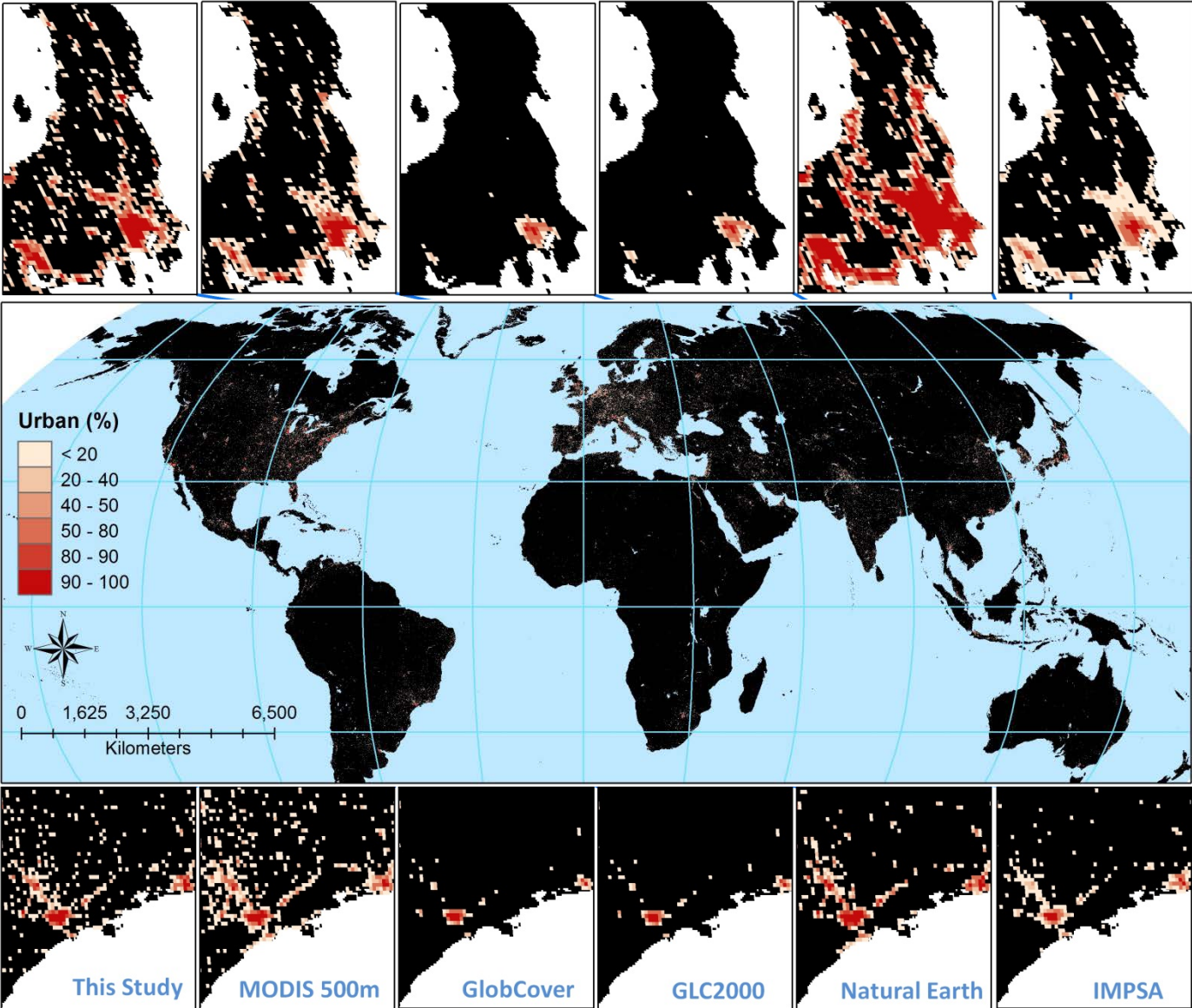
- (1,10]
- (10,50]
- (50,250]
- (250,500]
- (500,500]

### Mean NTL

- (1,5]
- (5,10]
- (10,20]
- (20,30]
- (30,40]
- (40,50]
- (50,63]

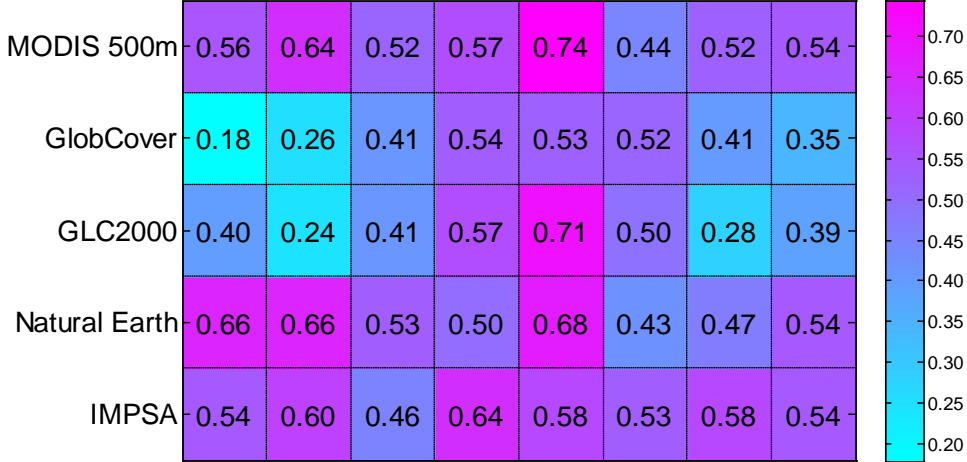


# Global urban areas in 2000

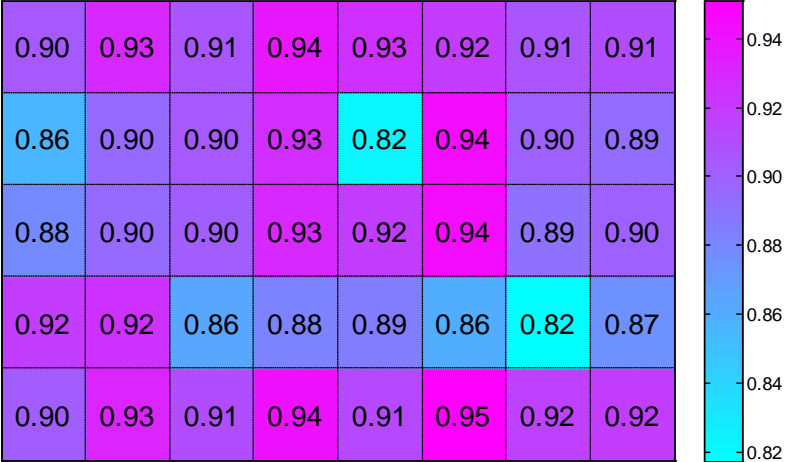


# Global urban areas (evaluation)

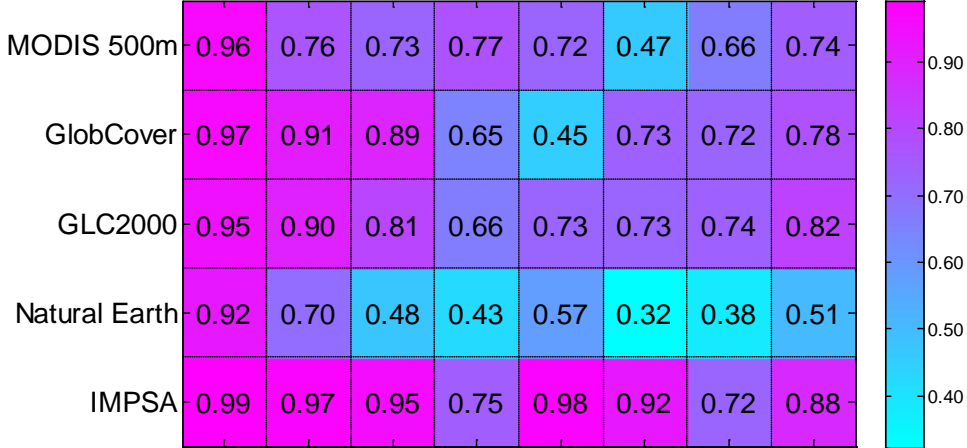
Kappa Coef.



Overall Accuracy



Producer Accuracy (1-Omission)



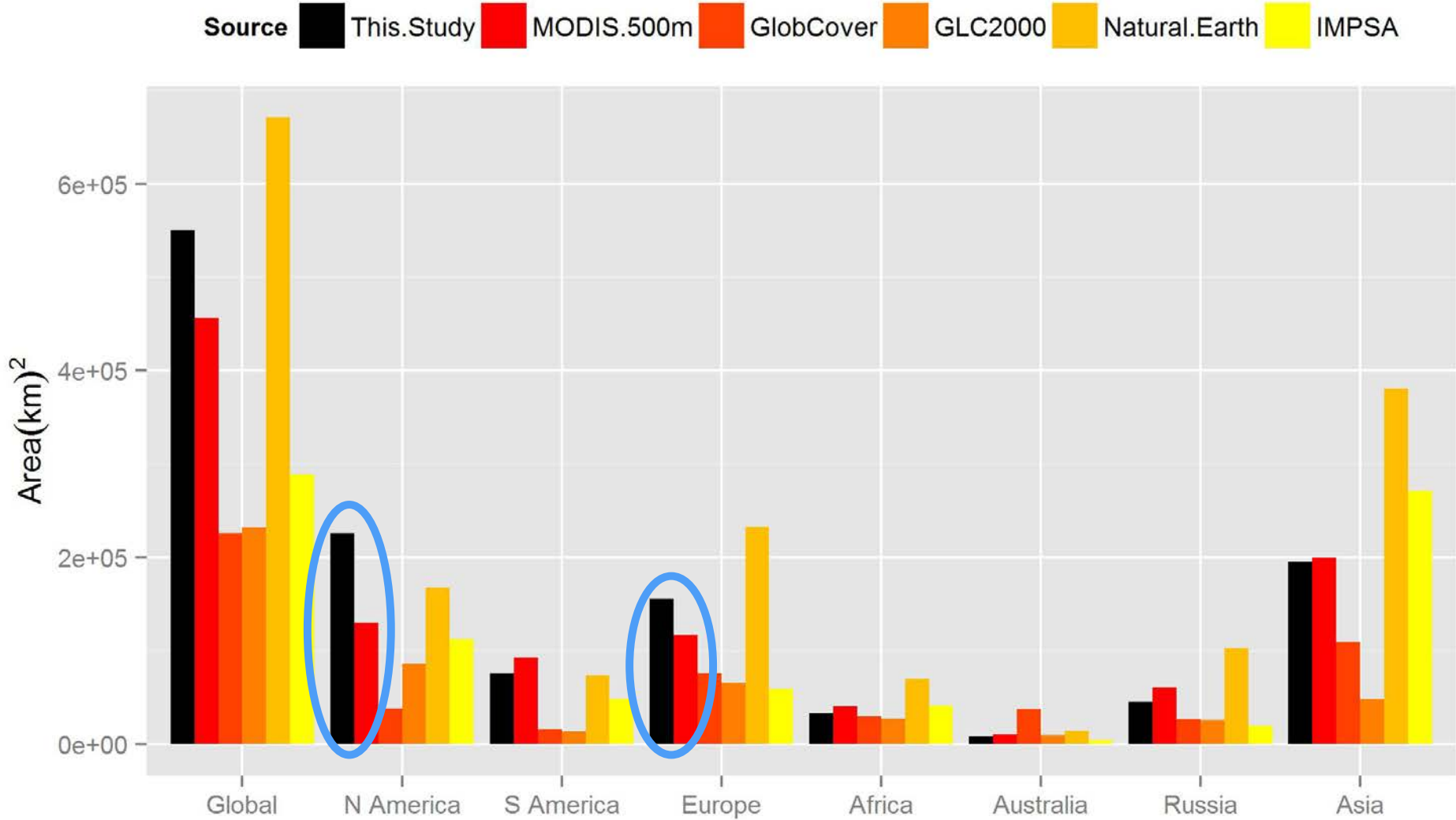
User Accuracy (1-Commission)



N American  
S American  
Europe  
Africa  
Austria  
Russian  
Asian  
Global

N American  
S American  
Europe  
Africa  
Austria  
Russian  
Asian  
Global

# Global urban areas (6 products)



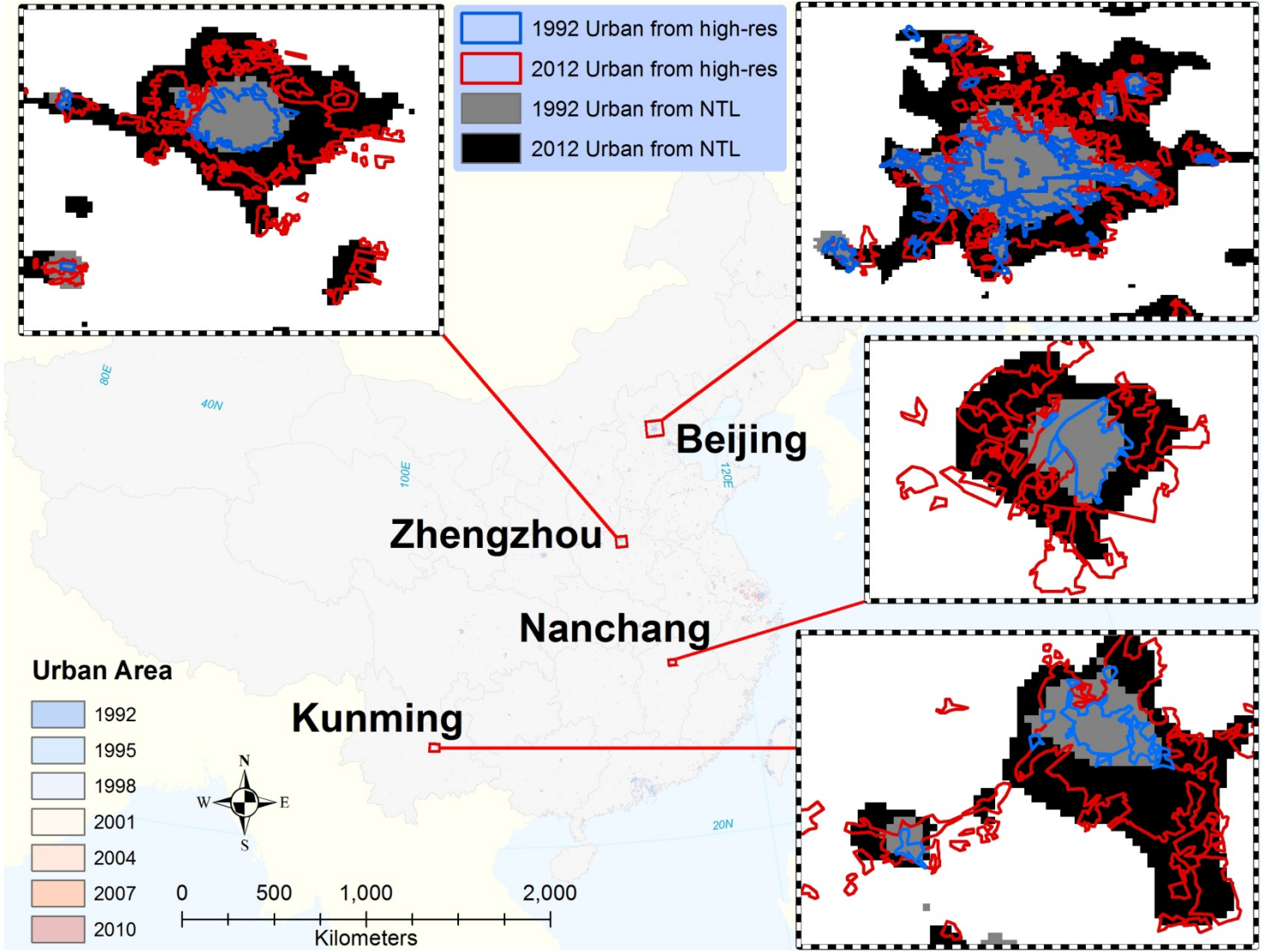


# Urban dynamics mapping

- ❖ **Inter-calibration of the annual nighttime lights products**
- ❖ **Parameterization of the logistic model**
- ❖ **Urban dynamics mapping using the cluster based method**

Zhao, N., Y. Zhou, 2014. Correcting incompatible DN values and geometric errors in nighttime lights time series images. *IEEE transactions on Geoscience and Remote Sensing*. In review.

# Urbanization in China (evaluation)



# Urbanization in China (1992-2012)

Percentage

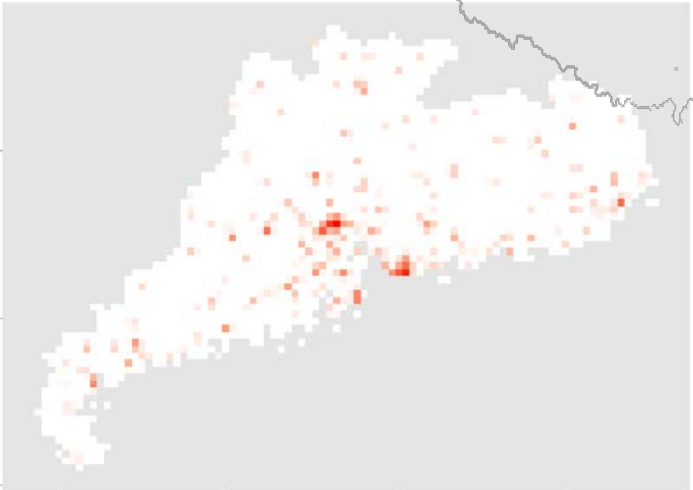
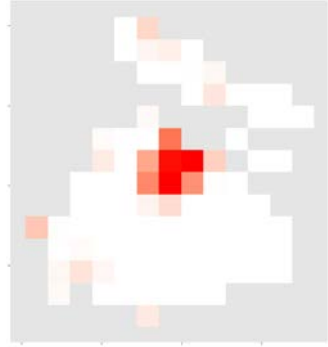
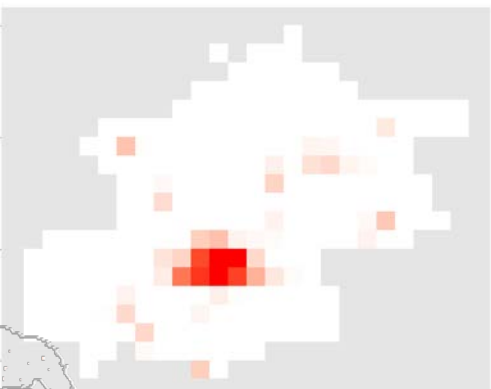
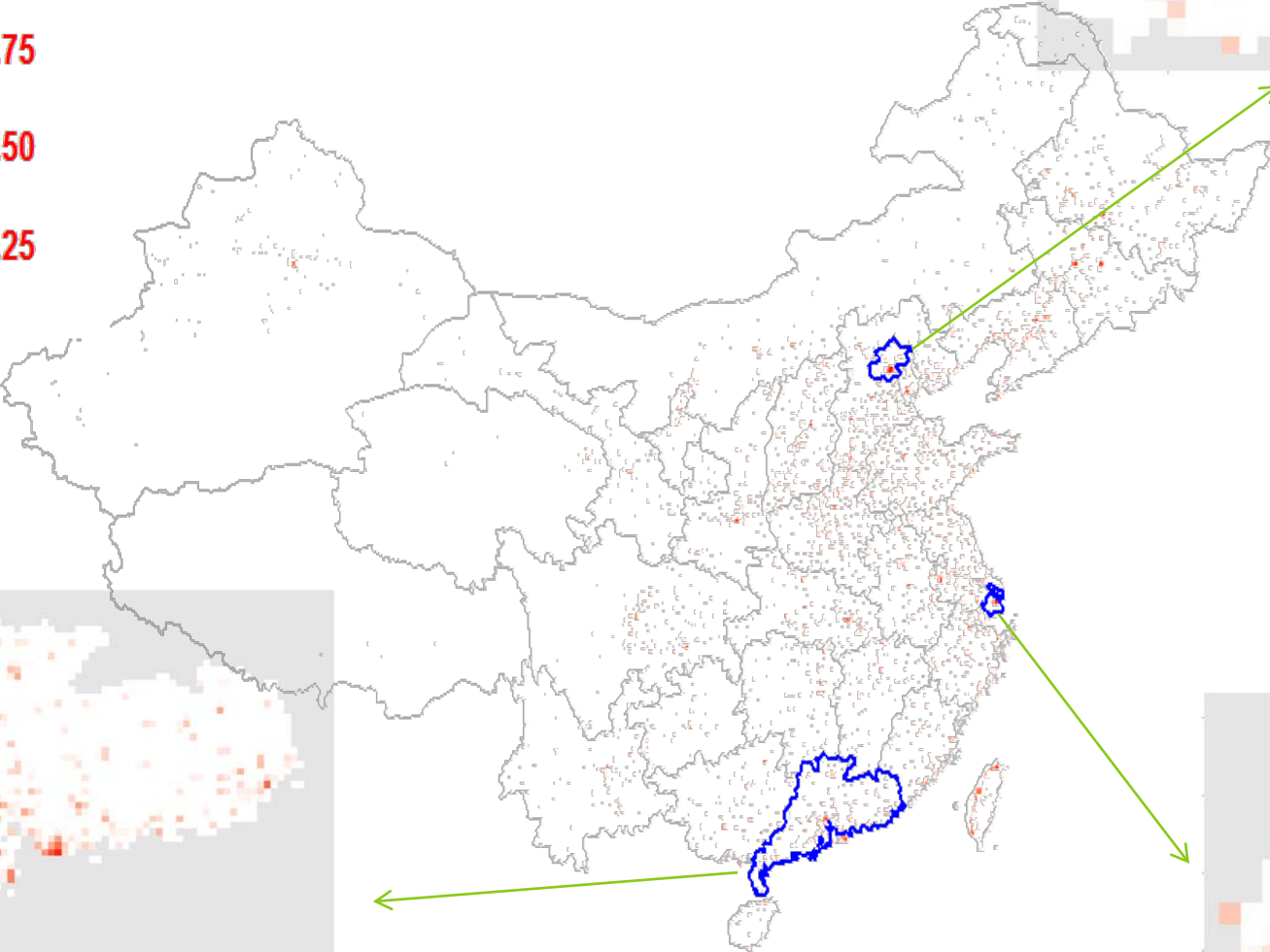


## Urban Area in Year: 1992

Guangdong

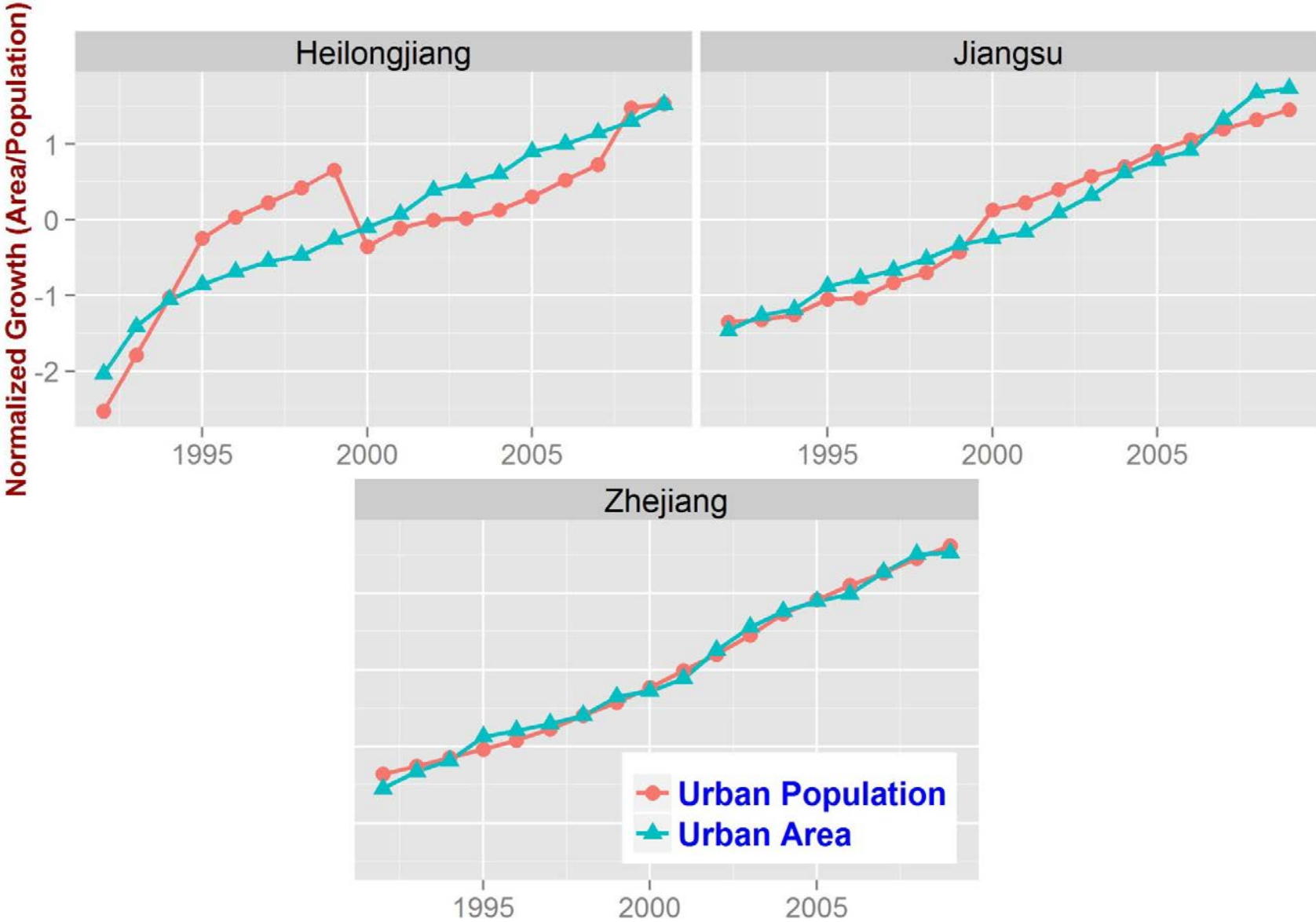
Beijing

Shanghai



# Urbanization in each province (1992-2012)

# Urban area & population



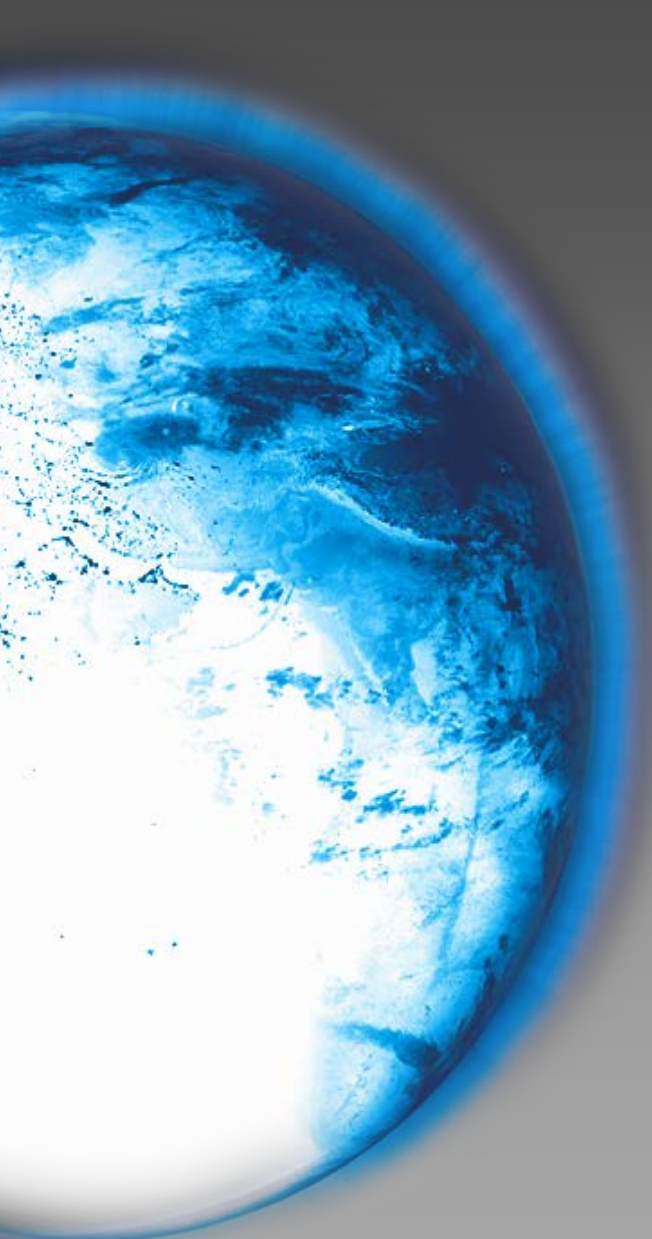
# Summary and future work

## ❖ Summary

- The cluster-based method performs well in mapping urban extents from nightlights over large areas
- The method shows its potential to map global urban areas and temporal dynamics
- The preliminary results indicate that urbanization shows large spatial and temporal heterogeneity

## ❖ Future work

- Refine global urbanization mapping
- Predict future global urbanization
- Evaluate the environmental impacts of global urbanization



# Acknowledgements

- NASA ROSES LCLUC Program
- Collaborators
  - S. Smith
  - A. Thomson
  - B. Bond-Lamberty
  - M. Imhoff
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