

Understanding Juniper Forest Encroachment into Grasslands in Oklahoma and the Impacts on Primary Production, Evapotranspiration, and Climate



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Earth observation and modeling
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Study background

- **Woody plant encroachment into grasslands has been increasing over years and space.**
- **WPE is a gradual process over years.**
- **Juniper forest area is unknown.**



Eastern redcedar forest



Ashe Juniper forest

Affect forage and livestock production, biodiversity , carbon, water , nutrient, and biogeochemical cycles, local climate,

Research objectives

- (1) To **develop an algorithm** to identify and map juniper forest encroachment in Oklahoma at 30-m spatial resolution
- (2) To **quantify the spatial-temporal dynamics** of juniper forest encroachment in Oklahoma over several decades at 30-m spatial resolution



Presentation Topics

- Project 1: Mapping eastern redcedar forest encroachment: **Algorithm development**
- Project 2: Mapping juniper forest encroachment in Oklahoma: **Algorithm application at state scale**

Mapping eastern red cedar forest encroachment: Algorithm development

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Mapping the dynamics of eastern redcedar encroachment into grasslands during 1984–2010 through PALSAR and time series Landsat images



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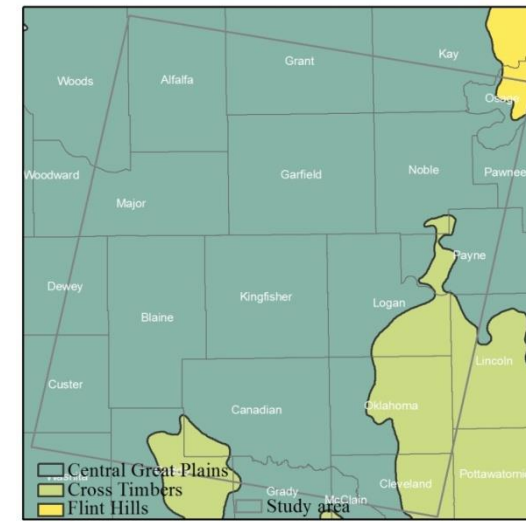
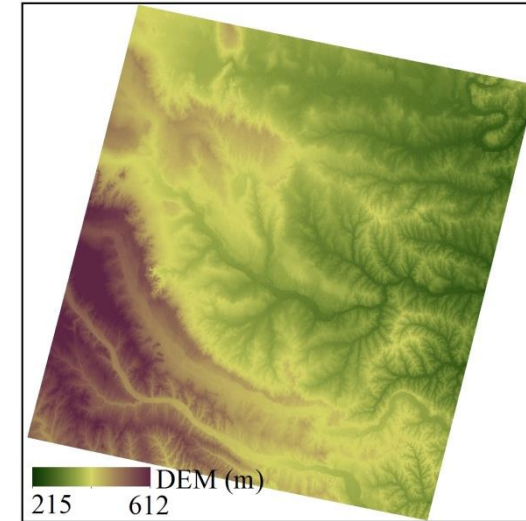
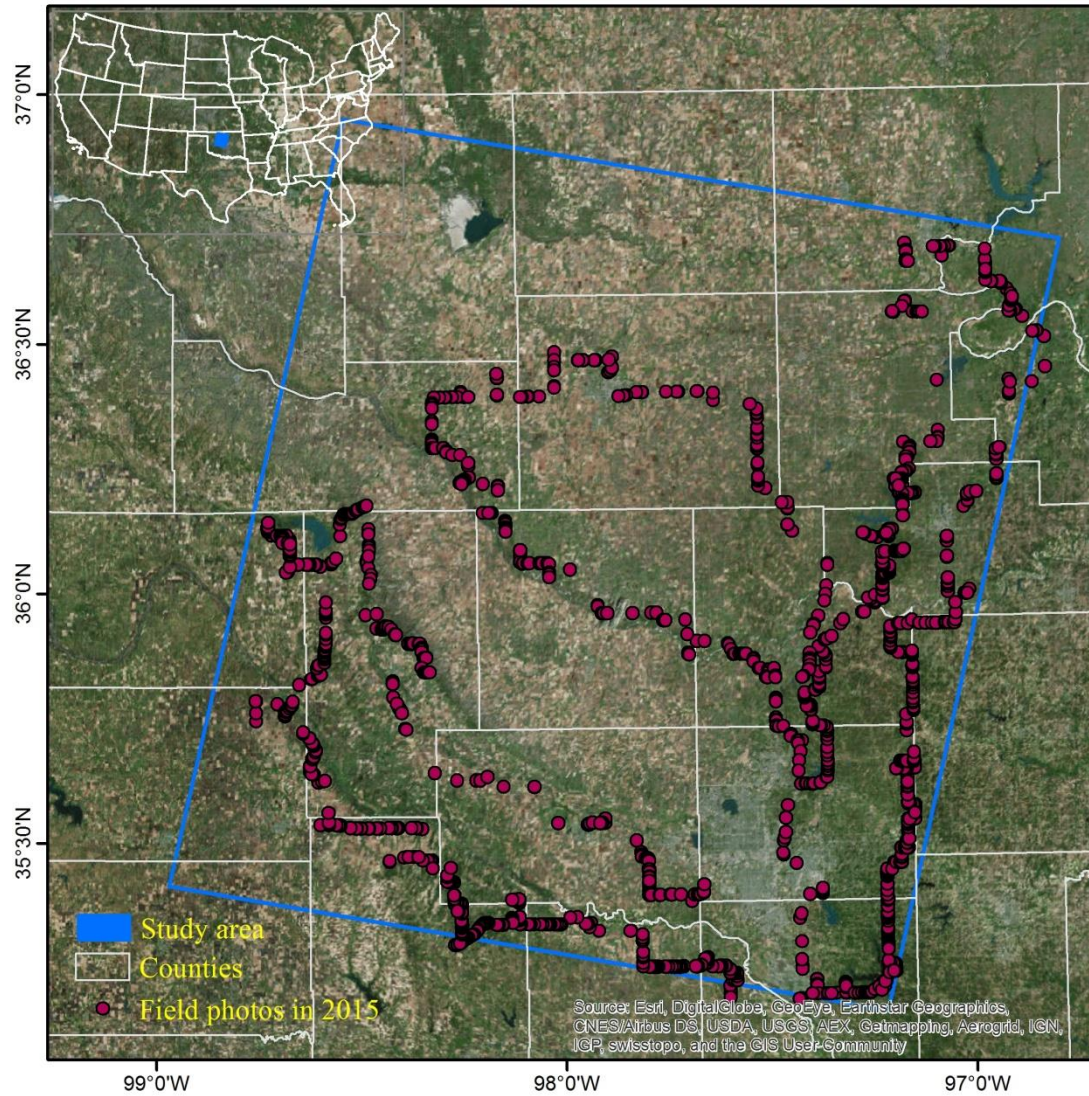
^a Department of Microbiology and Plant Biology, Center for Spatial Analysis, University of Oklahoma, Norman, OK 73019, USA

^b Institute of Biodiversity Science, Fudan University, Shanghai 200433, China

^c Oklahoma Forestry Services, Oklahoma Department of Agriculture, Food and Forestry, Oklahoma City, OK 73105, USA

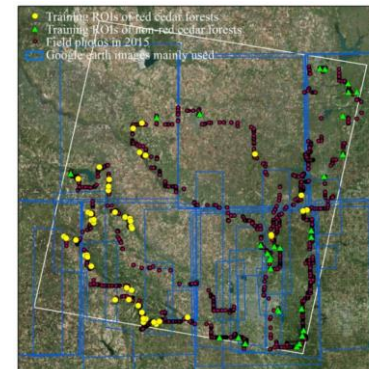
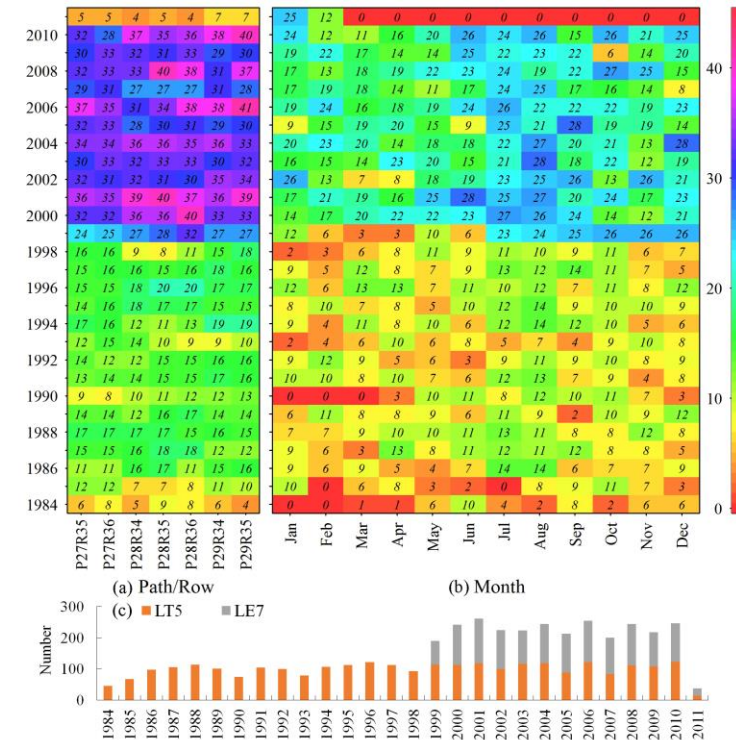


Study area



Data source

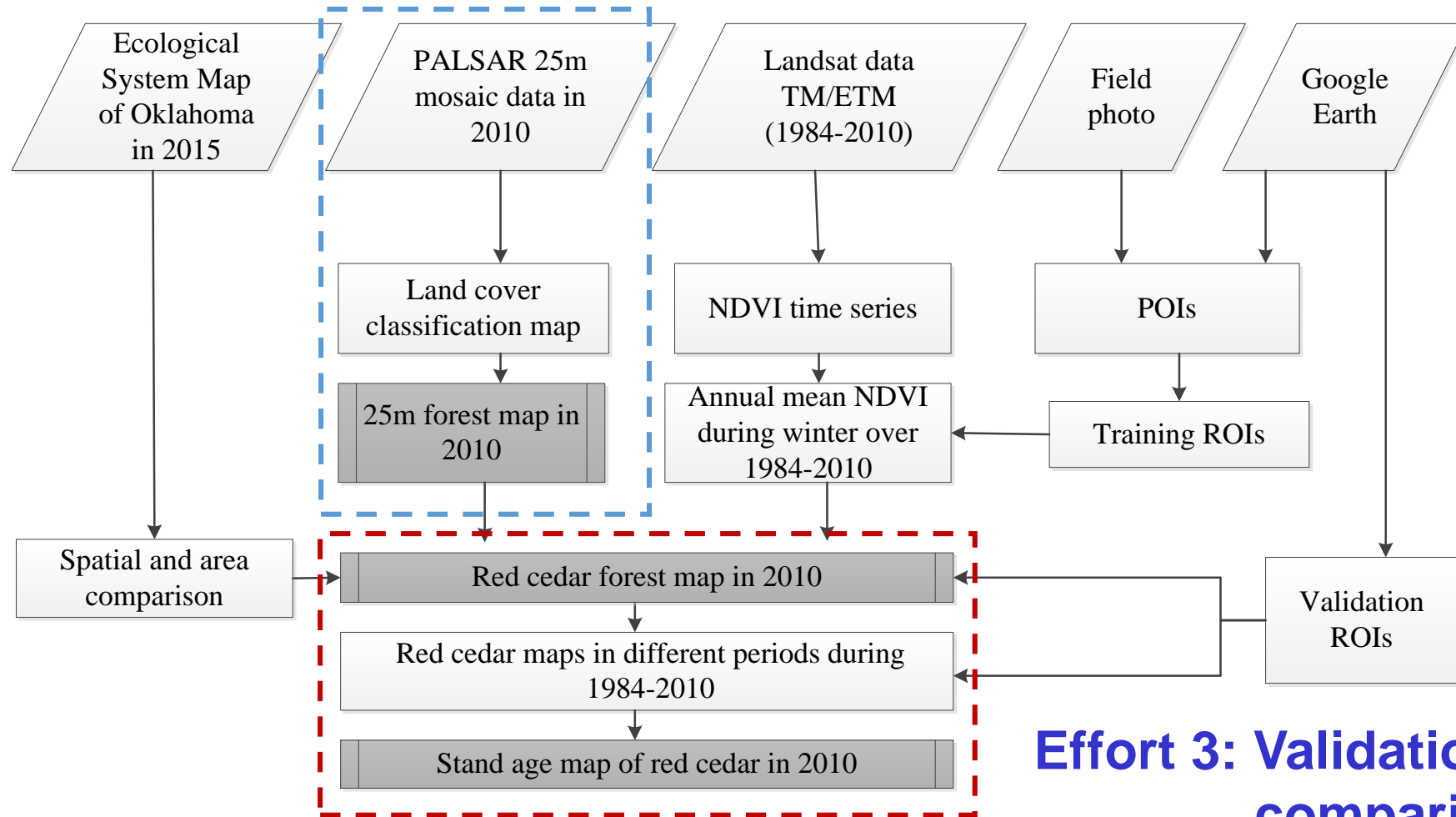
- Microwave remote sensing
25-m L-band ALOS PALSAR, 2010
- Optical remote sensing in time series
30-m Landsat 5/7 images, 1984-2010,
4,233 images
- Field photos
- Google Earth images
- Oklahoma ecological system mapping



Workflow and general approach

Effort 1: Forest mapping

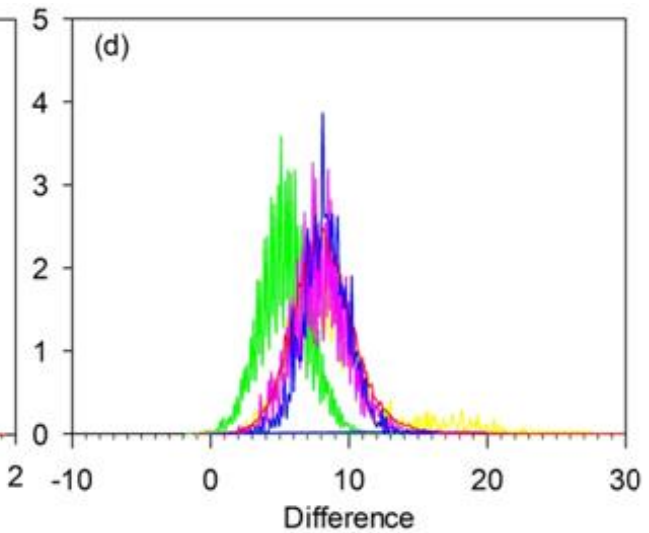
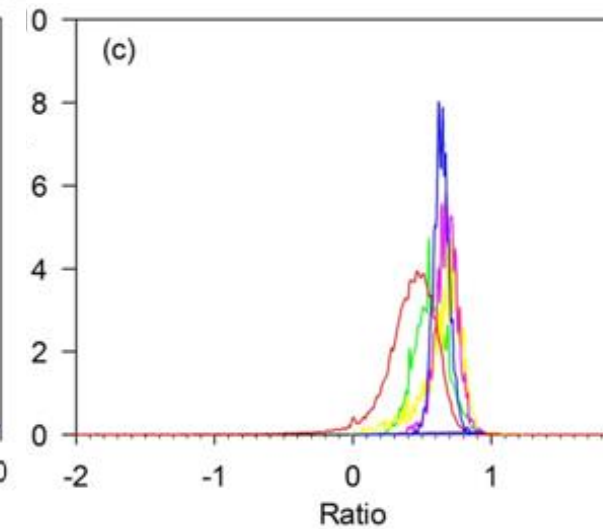
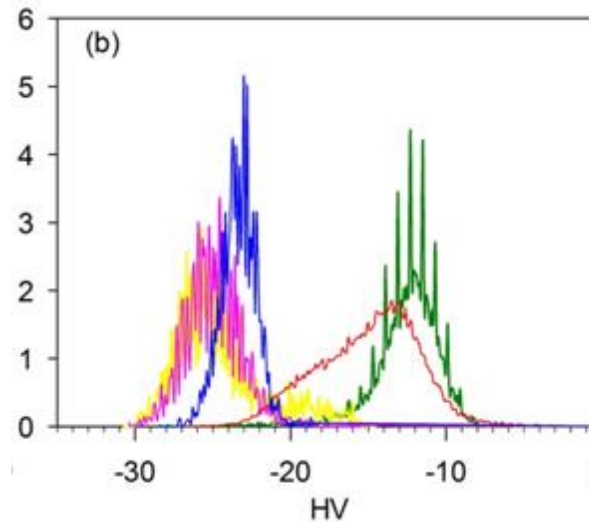
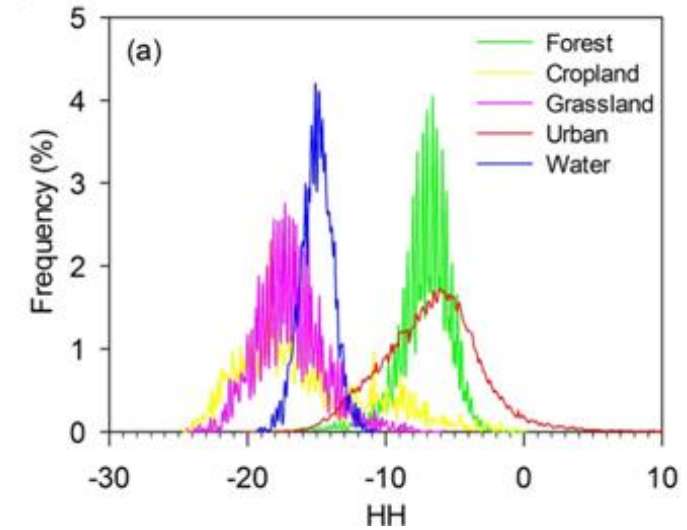
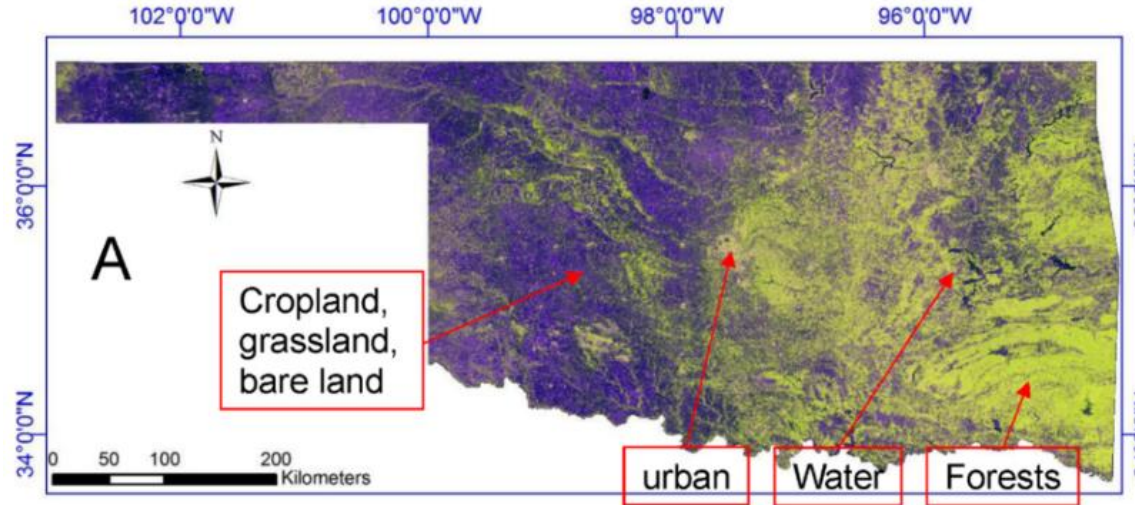
Effort 2: Eastern redcedar forest mapping



Effort 3: Validation & comparison

Forest mapping from PALSAR images

Statistical analysis of land cover types

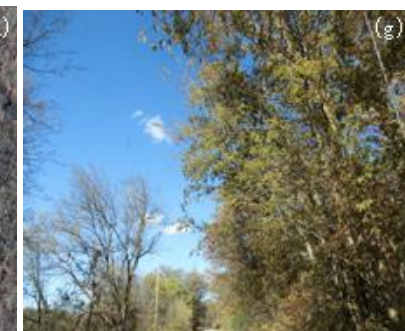
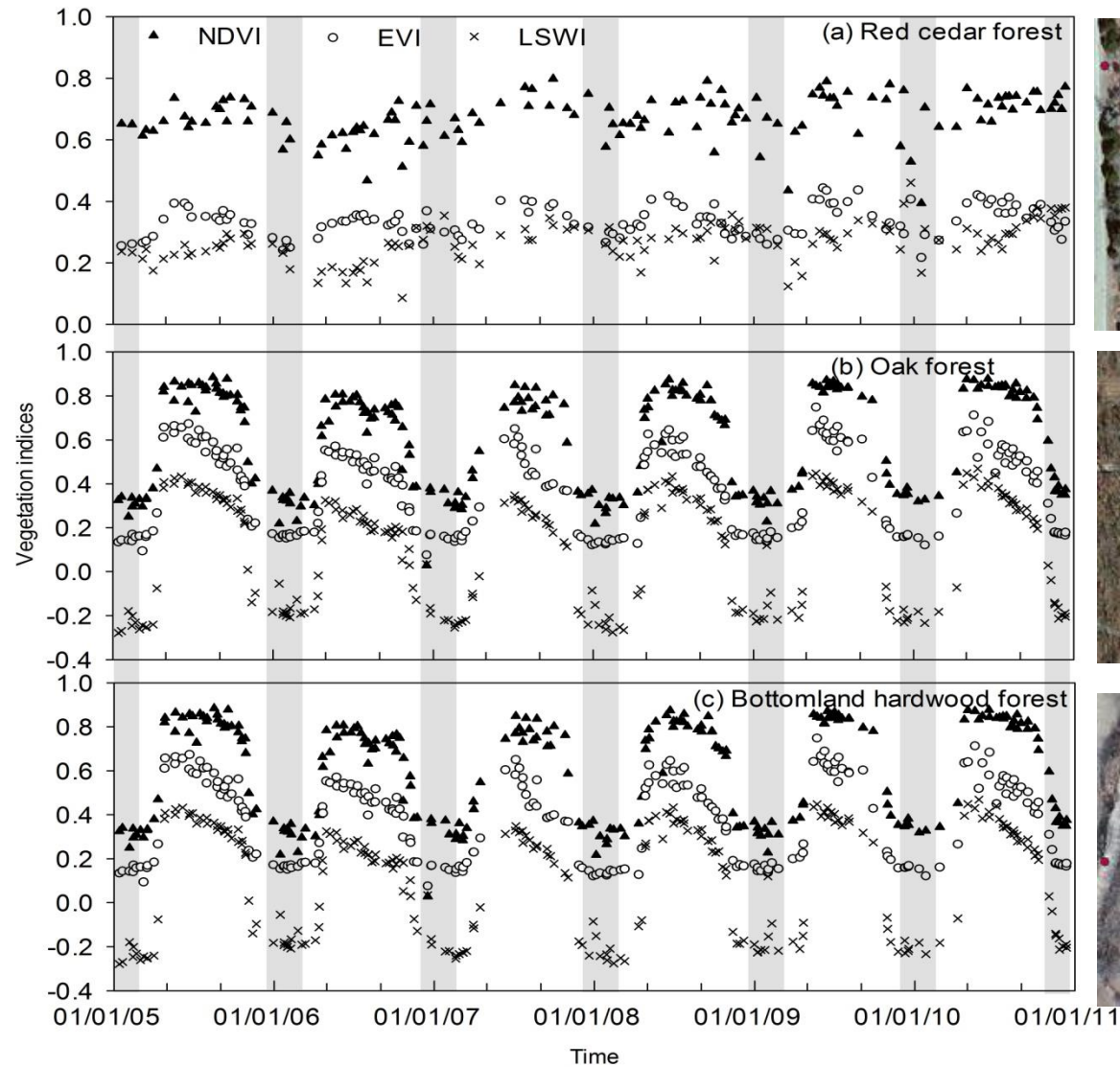


-16 < HV < -8 & 2 < Difference < 8 & 0.3 < Ratio < 0.85

(Wang *et al.*, RSE, 2017)

(Qin *et al.*, Remote Sensing, 2016)

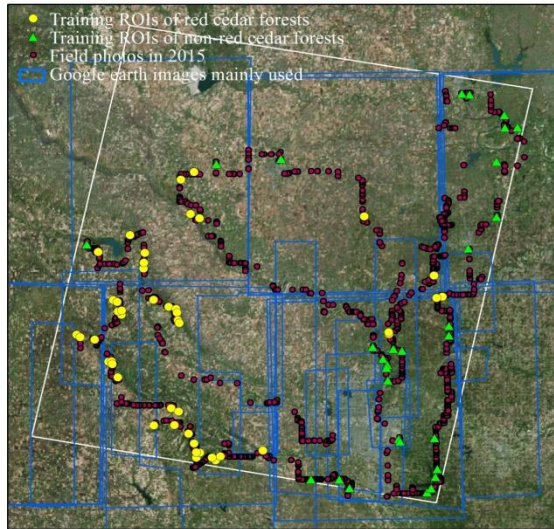
Eastern redcedar mapping from Landsat images



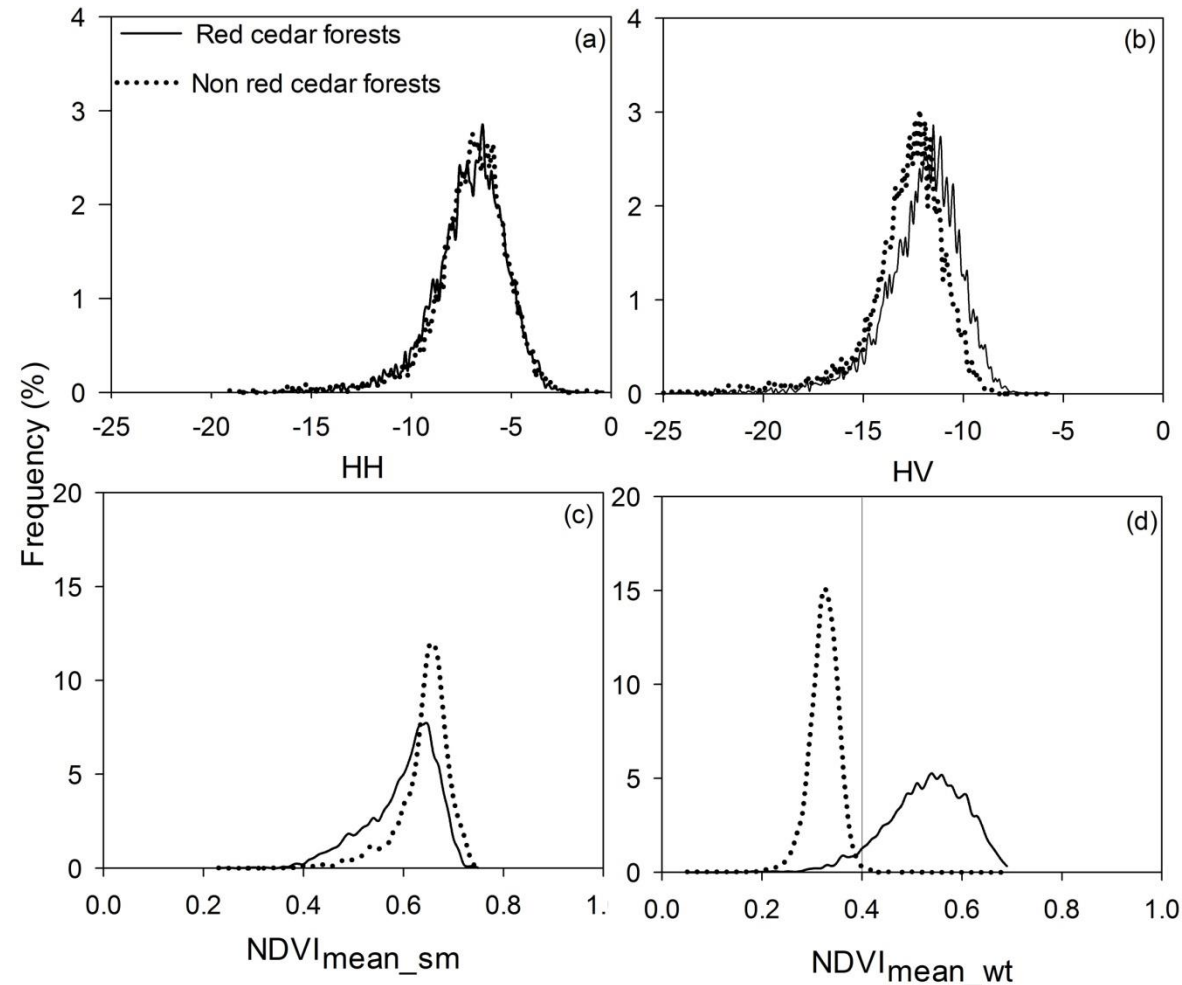
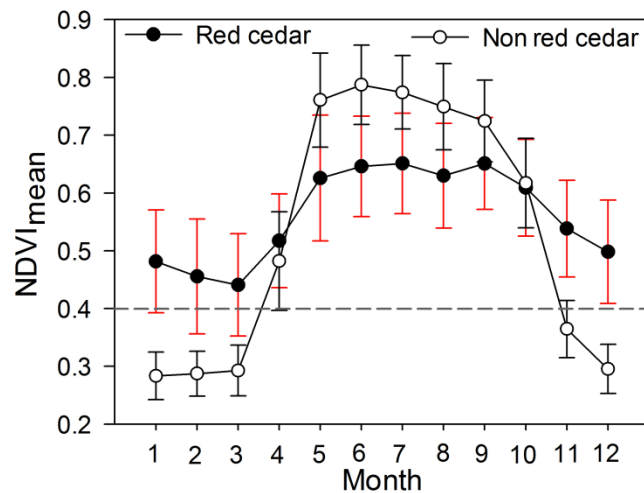
Phenology analysis of land cover types

Different seasonal dynamics

Eastern redcedar mapping from Landsat images



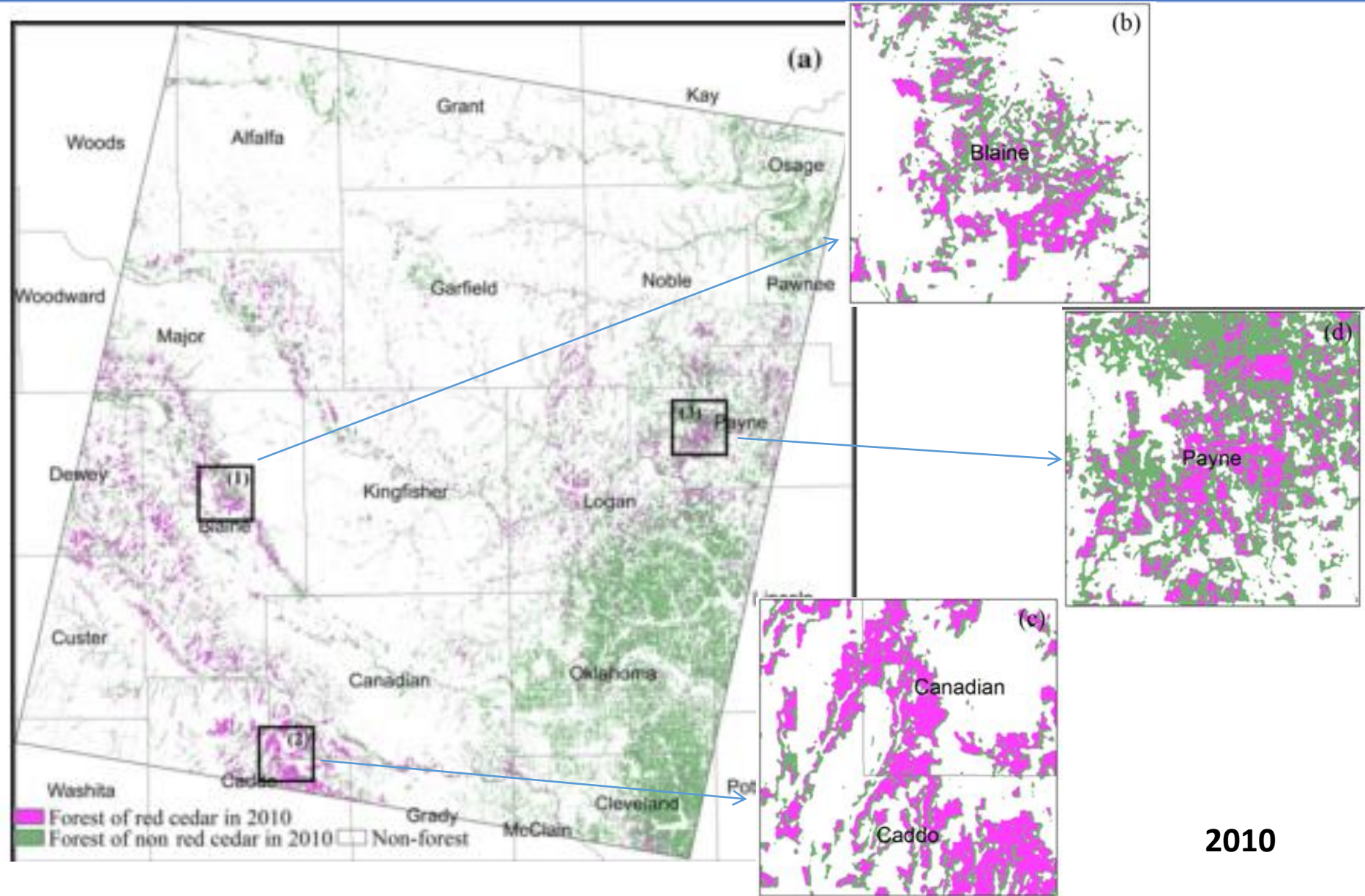
Training samples: 11,712 pixels for red cedar and 10,698 pixels for other trees



NDVI mean in winter > 0.4

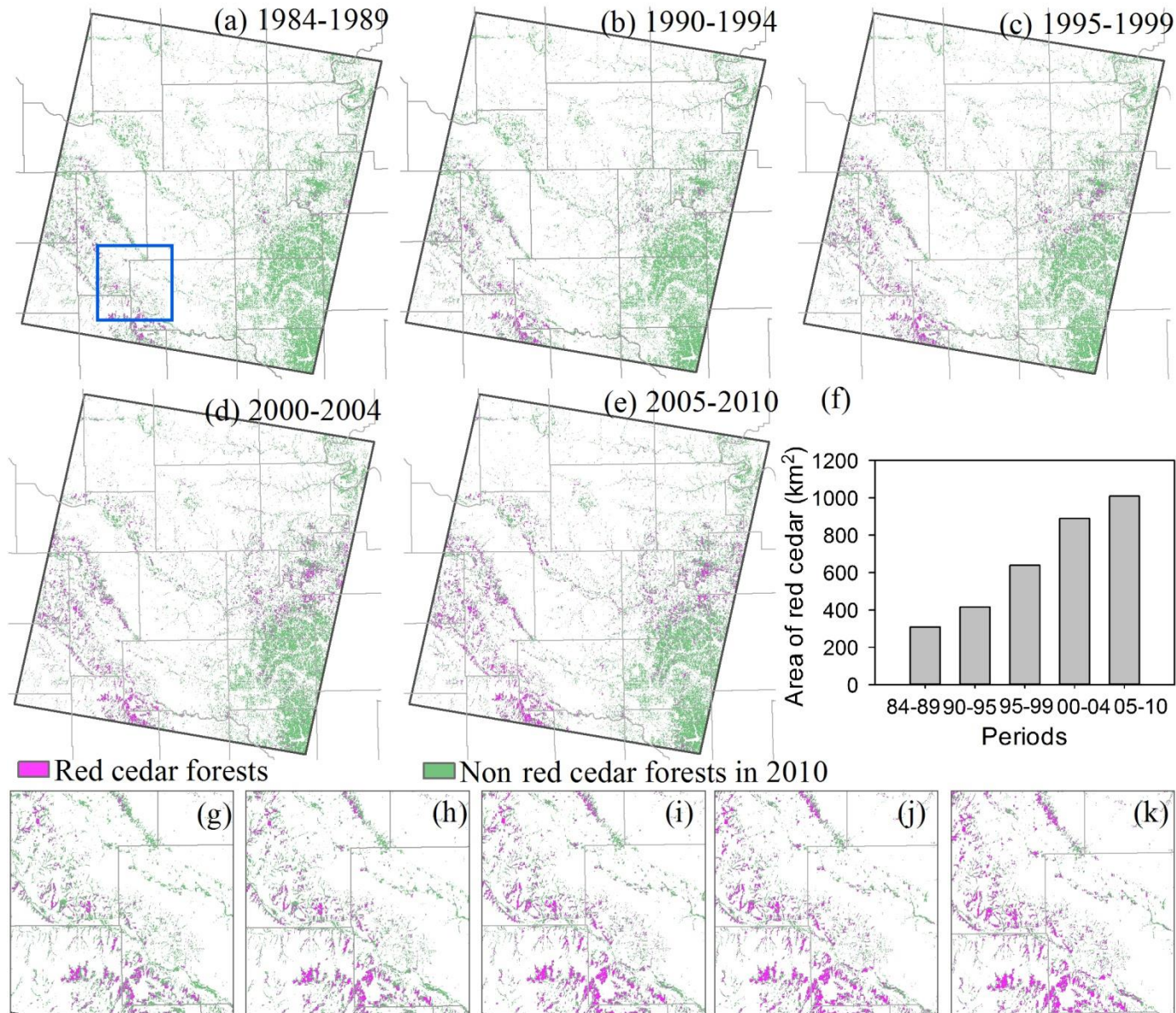
Phenology analysis of land cover types

The map of eastern redcedar forests in 2010



185 km by 185 km

The maps of eastern redcedar forests



2010:
PA = 0.93
OA = 0.96

2005-2010:
PA = 0.90
OA = 0.95

2000-2004:
PA = 0.88
OA = 0.94

1995-1999:
PA = 0.90
OA = 0.95

Mapping juniper forest encroachment in Oklahoma: Algorithm application at the state scale

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Characterizing the encroachment of juniper forests into sub-humid and semi-arid prairies from 1984 to 2010 using PALSAR and Landsat data

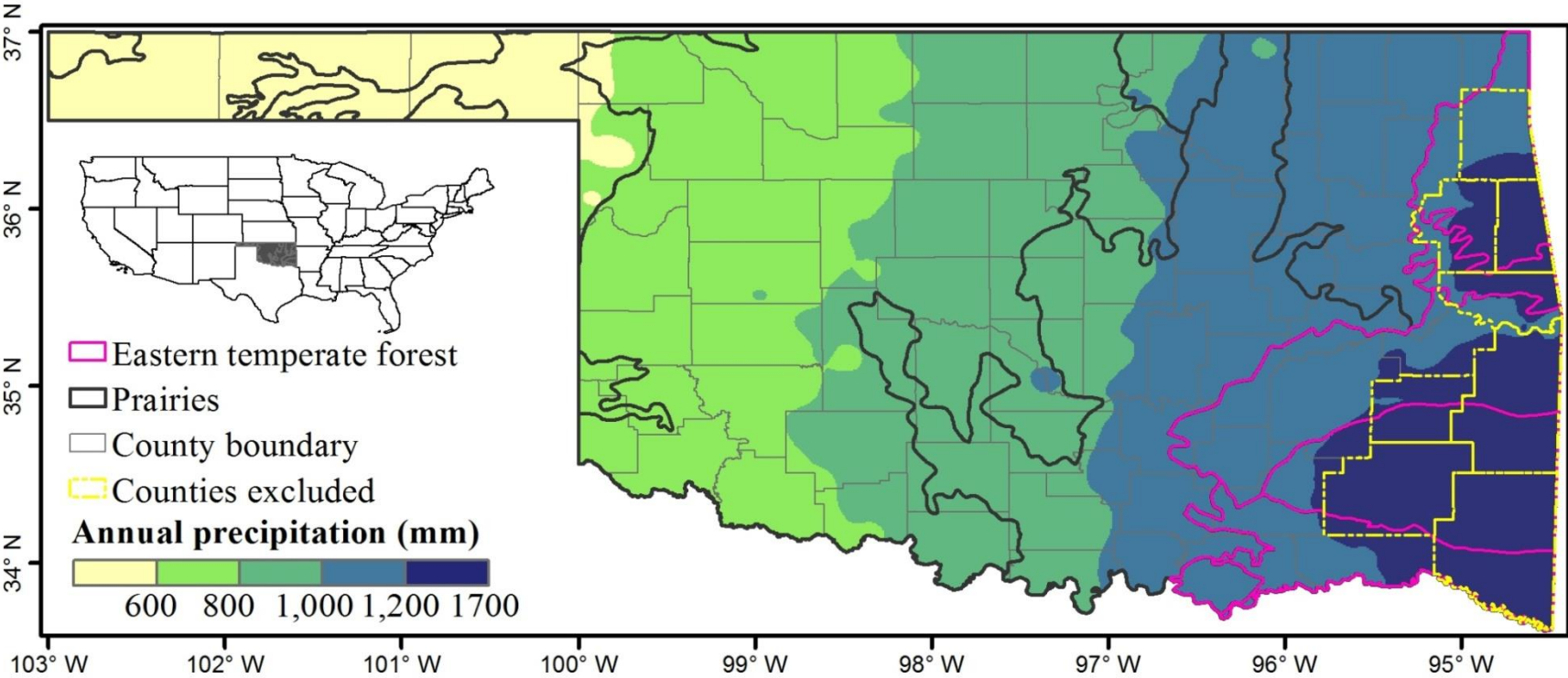
Jie Wang^a, Xiangming Xiao^{a,b,*}, Yuanwei Qin^a, Russell B. Doughty^a, Jinwei Dong^a, Zhenhua Zou^a

^a Department of Microbiology and Plant Biology, Center for Spatial Analysis, University of Oklahoma, Norman, OK 73019, USA

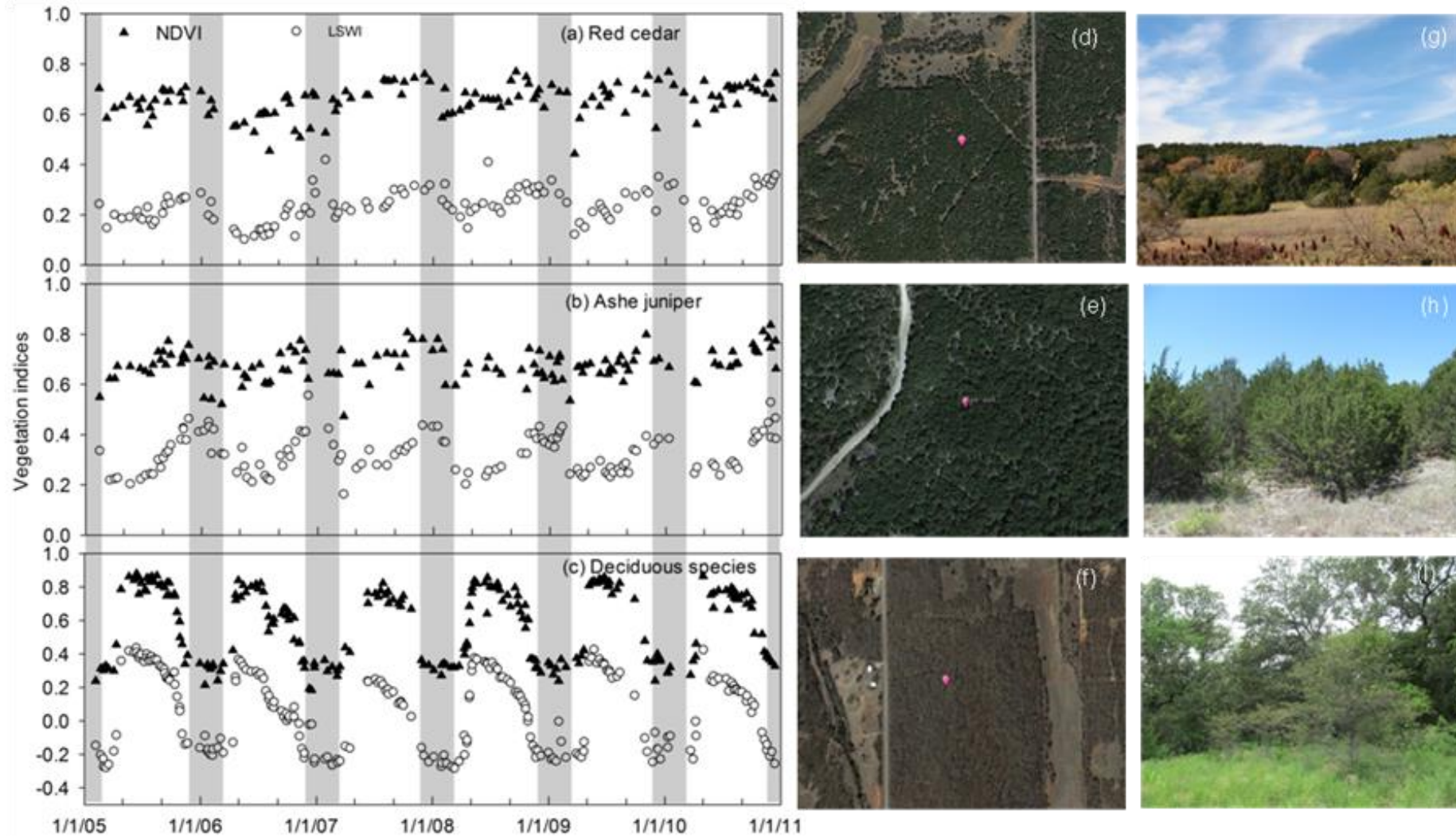
^b Ministry of Education Key Laboratory of Biodiversity Science and Ecological Engineering, Institute of Biodiversity Science, Fudan University, Shanghai 200433, China



Study area

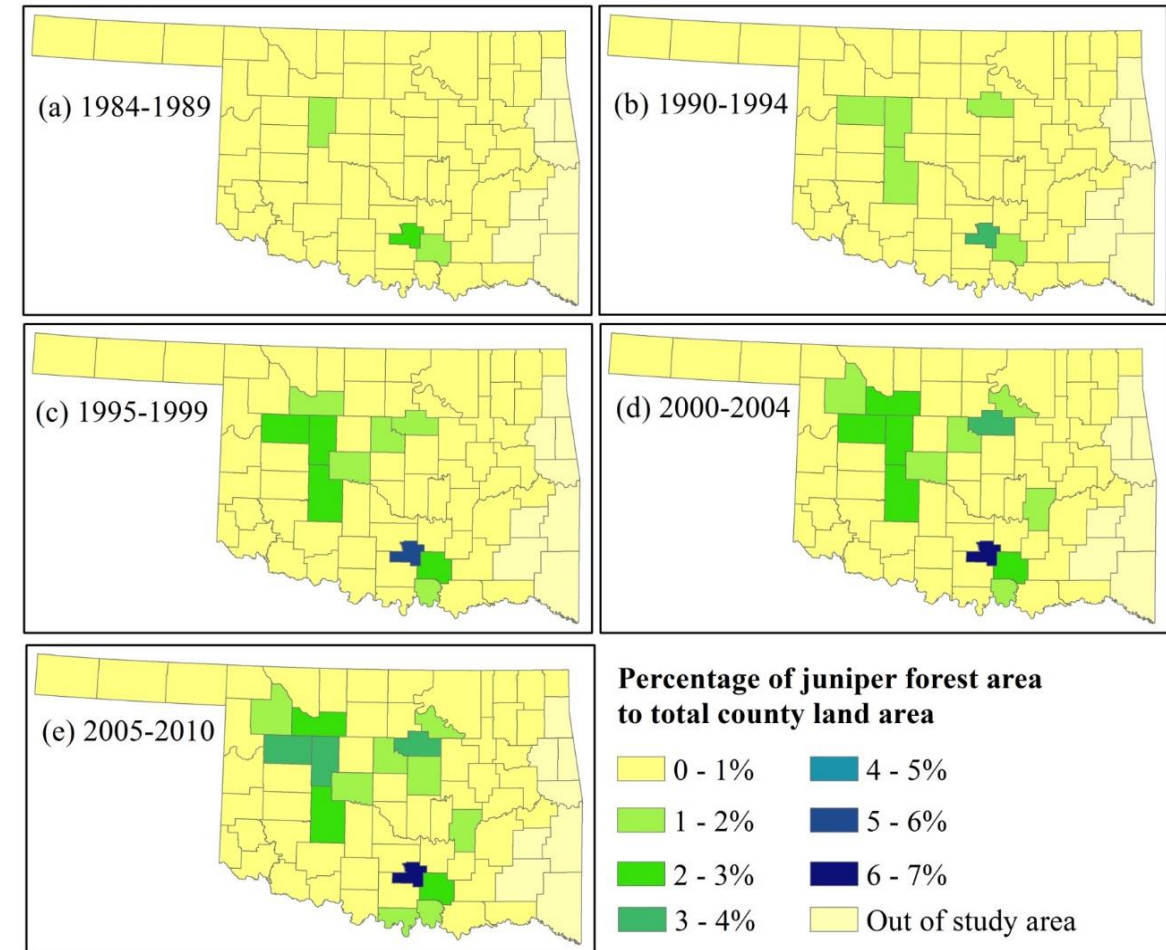
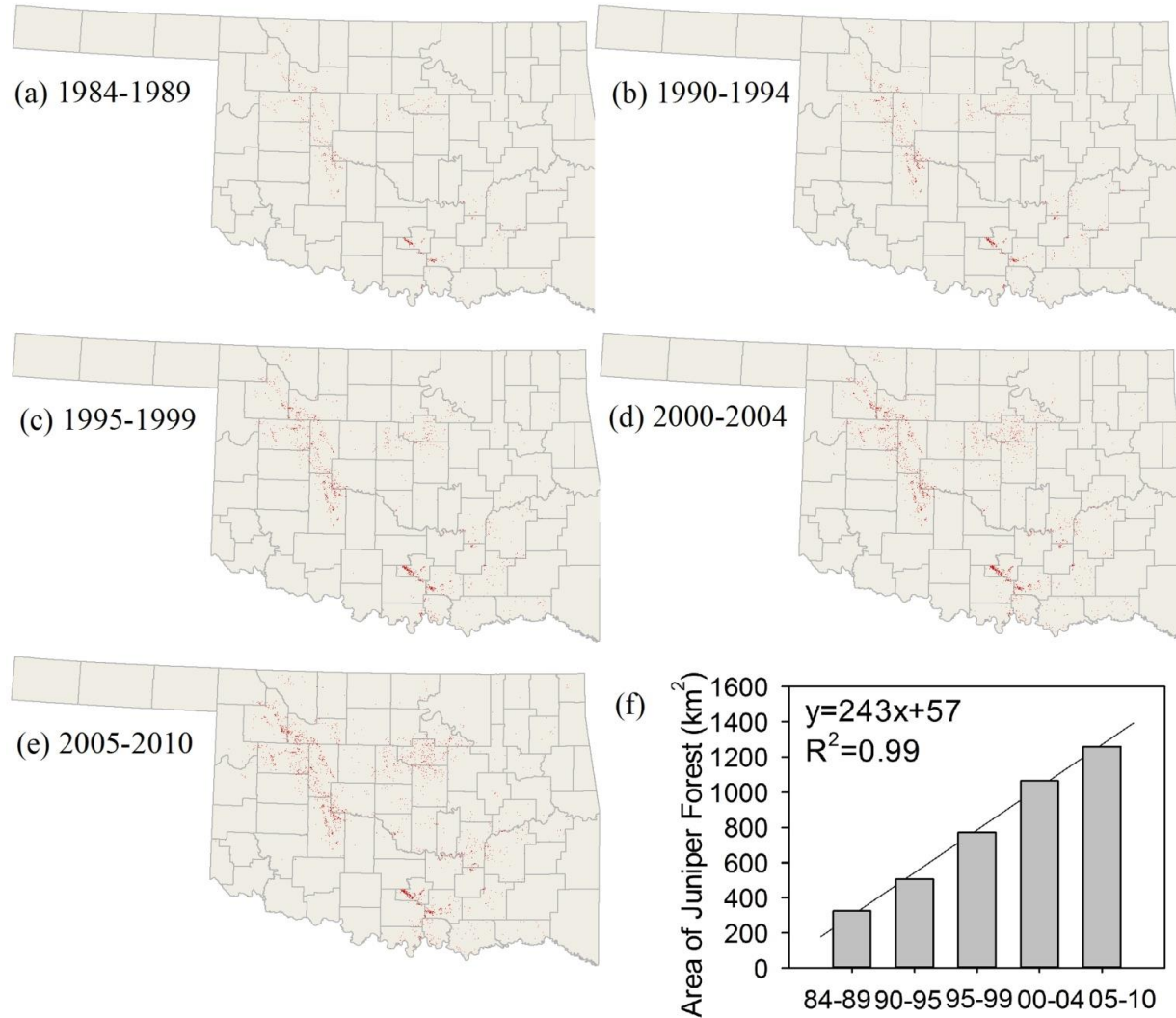


Method: Phenology of juniper species from Landsat images



Similar signals from Landsat images for juniper species

Results: The juniper forest encroachment maps



producer's accuracy (PA) of 0.95 ± 0.01

Northwestern counties in Oklahoma experienced the most juniper encroachment

Summary

- Cloud-free **PALSAR** data and **long term Landsat** data provide the potential to track the history of woody plant encroachment into grasslands.
- The **pixel and phenology-based algorithms** through combined PALSAR/Landsat is simple, robust and accurate for juniper forest mapping.
- **Juniper forests in Oklahoma** have **expanded** linearly **during 1984-2010** with notable spatial clusters in its expansion process.



Acknowledgements

- The US National Science Foundation EPSCoR program (IIA-1301789)
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Thank you !

