Regional variability in the dynamics of poleward mangrove range limits

Kyle Cavanaugh

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1999
Image U.S. Geological Survey
50 m


2005
50 m
Google earth


2008
Image U.S. Geological Survey
50 m
Google earth


2010
50 m
Google earth


2013
50 m
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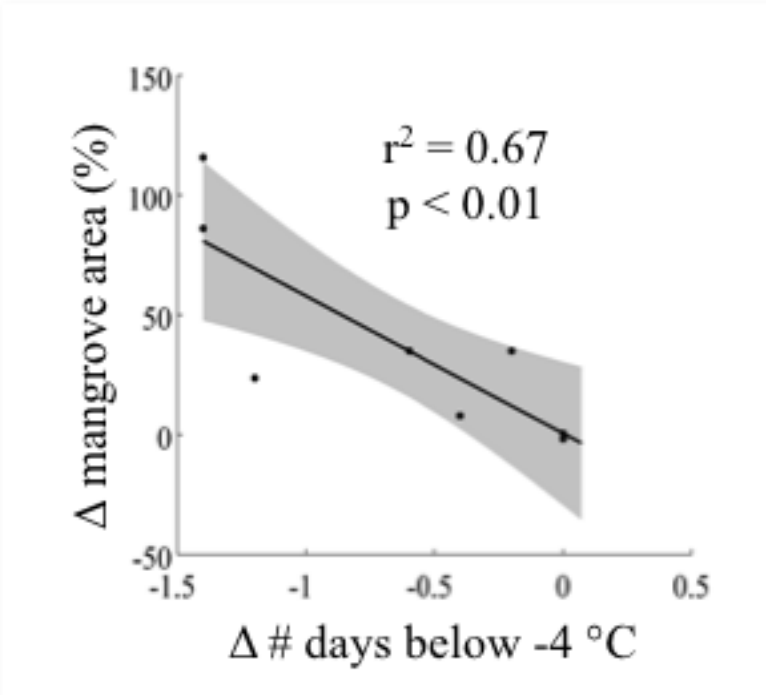
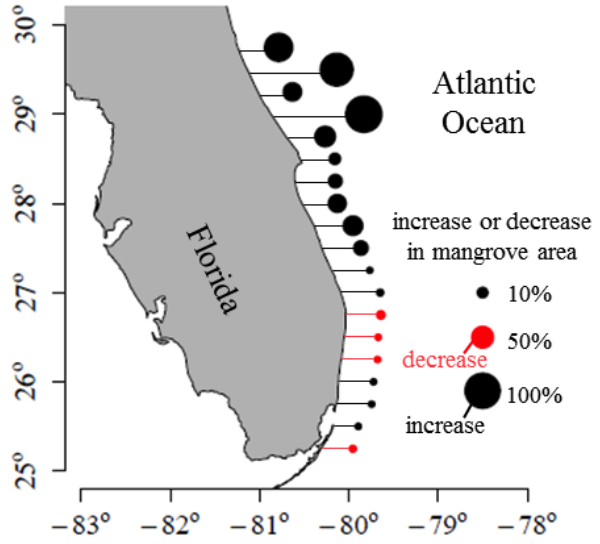
Google earth

On Atlantic coast of Florida, mangrove expansion from 1984 to 2011 correlated with a decrease in the frequency of extreme cold events (days < -4° C)



Long-term Δ in mangrove area (1984-2011)



Cavanaugh et al. (2013)

Mangrove expansion has been observed at poleward limits around the world

Global Change Biology

Global Change Biology (2014) 20, 147–157, doi: 10.1111/gcb.12341

Mangrove expansion and salt marsh decline at mangrove poleward limits

NEIL SAINTILAN*, NICHOLAS C. WILSON†, KERRYLEE ROGERS‡, ANUSHA RAJKARAN§ and KEN W. KRAUSS¶

Ecosystems (2010) 13: 437–451
DOI: 10.1007/s10021-010-9329-2

ECOSYSTEMS
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Mangrove Forest and Soil Development on a Rapidly Accreting Shore in New Zealand

Catherine E. Lovelock,[1,2]* Brian K. Sorrell,[3,4] Nicole Hancock,[3] Quan Hua,[4] and Andrew Swales[3]

PLOS | ONE

RESEARCH ARTICLE

The Contribution of Mangrove Expansion to Salt Marsh Loss on the Texas Gulf Coast

Anna R. Armitage[1☯]*, Wesley E. Highfield[2☯], Samuel D. Brody[2,3‡], Patrick Louchouarn[2,4‡]

Global Ecology and Biogeography (1999) **8**, 117–124

RESEARCH LETTER

Mangrove transgression into saltmarsh environments in south-east Australia

NEIL SAINTILAN and ROBERT J. WILLIAMS *Australian Catholic University, PO Box 968, North Sydney, NSW 2059, Australia, and Fisheries Research Institute, 202 Nicholson Pde, Cronulla, NSW 2230, Australia*
email: N.Saintilan@mackillop.acu.edu.au

IAVS

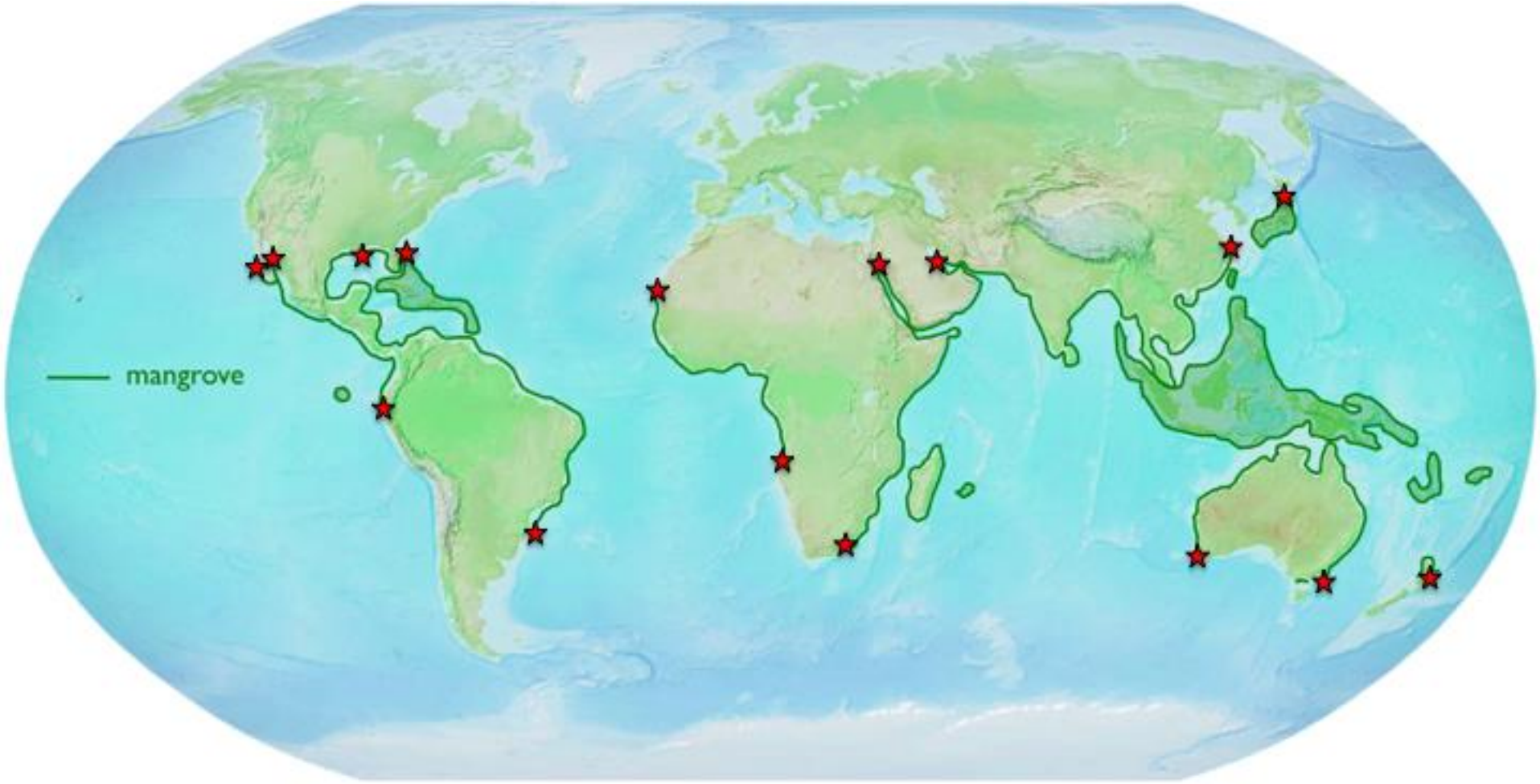
Journal of Vegetation Science **22** (2011) 143–151

Oceanographic anomalies and sea-level rise drive mangroves inland in the Pacific coast of Mexico

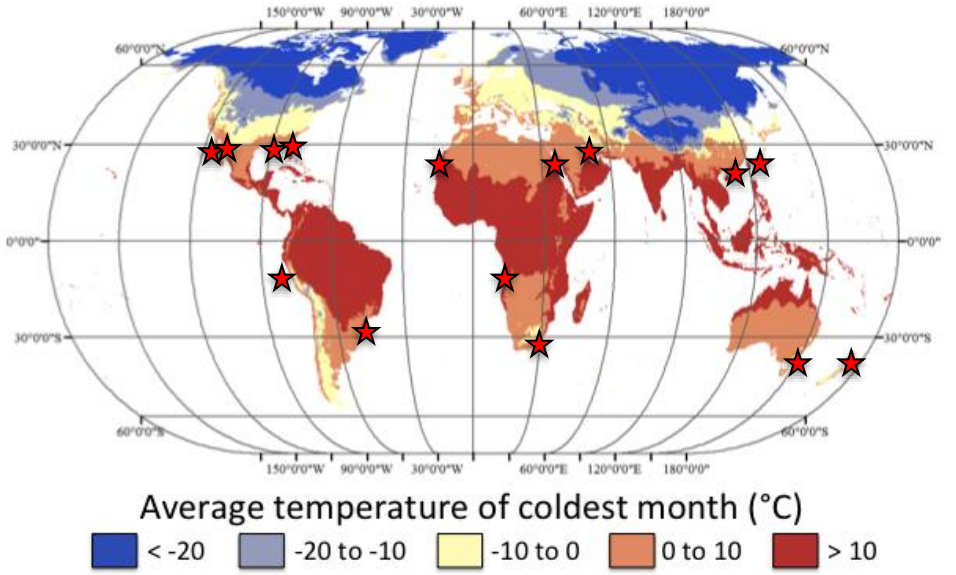
Xavier López-Medellín, Exequiel Ezcurra, Charlotte González-Abraham, Jon Hak, Louis S. Santiago & James O. Sickman

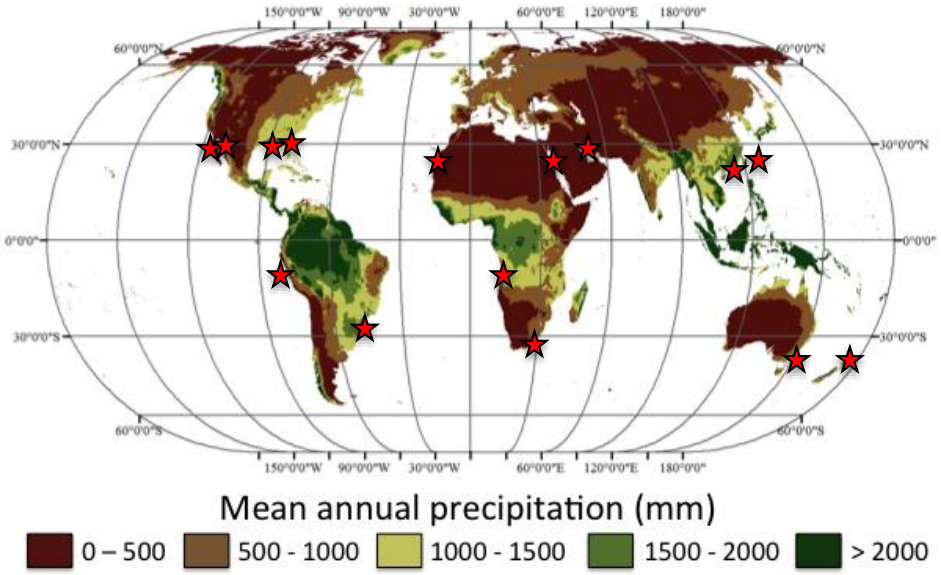
What are the global patterns of poleward mangrove expansion?

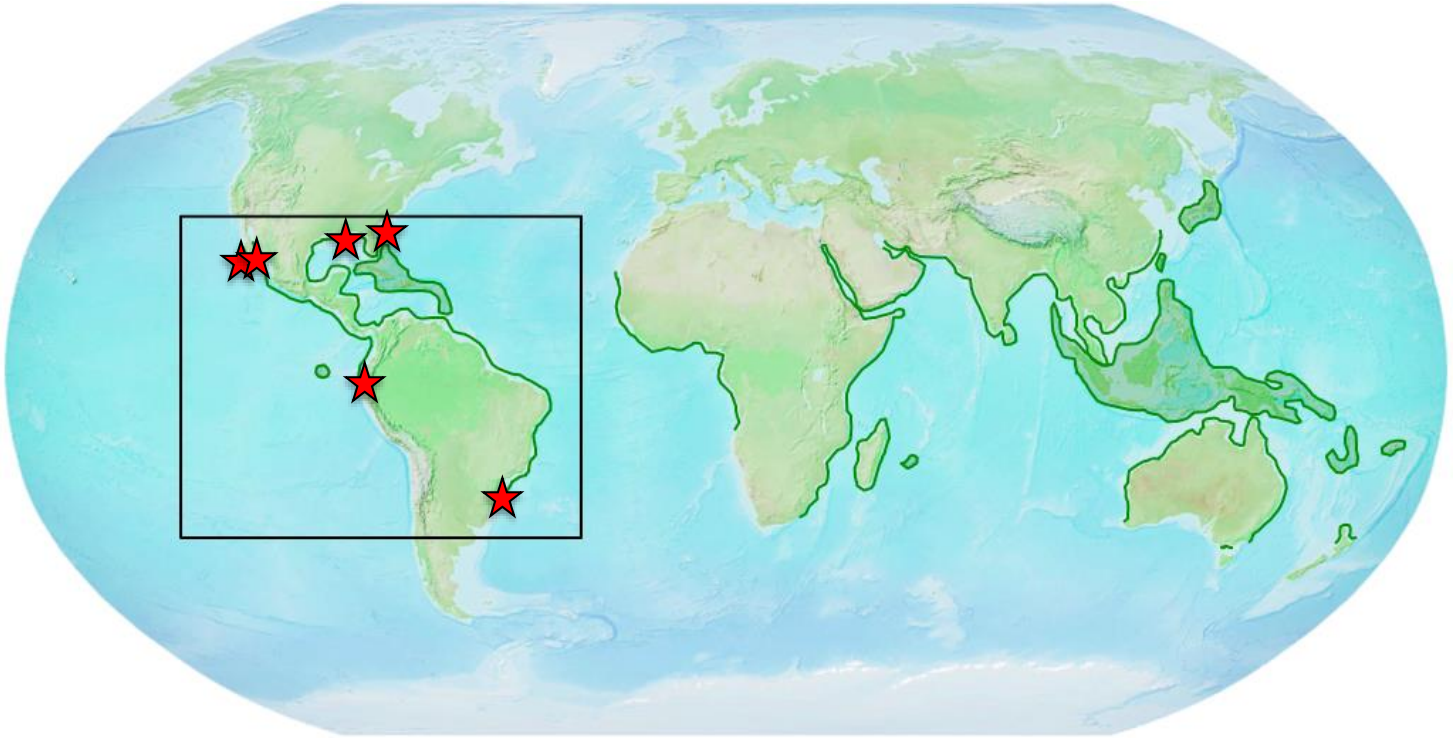
What are the macroclimatic drivers of this expansion?



Climatic conditions vary across range limits







- What are the **patterns and trends** in mangrove abundance at range limits in North and South America?

  H1: Mangrove abundance has increased at all range limits

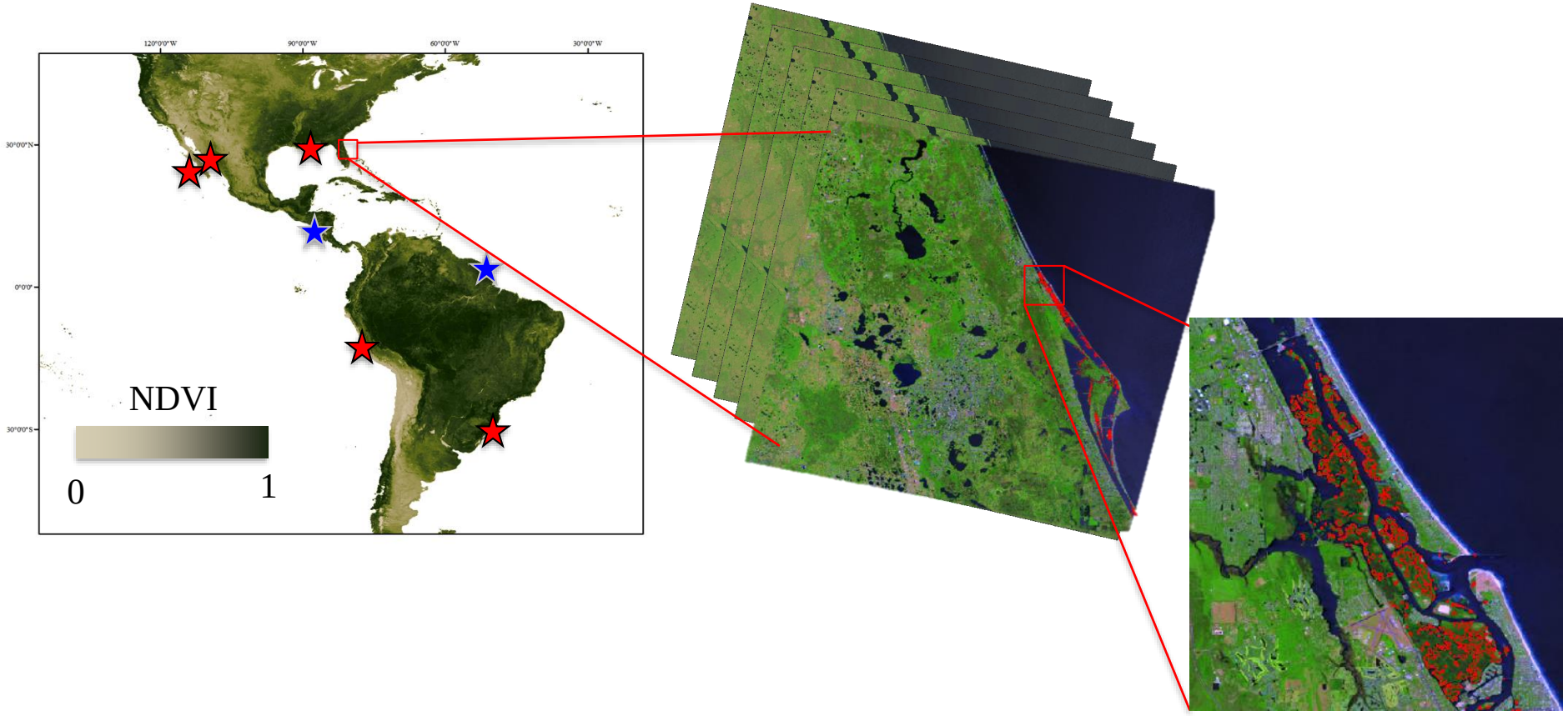
  H2: Abundance will be more variable at range limits as compared to center populations

- **What controls variability** in mangrove abundance at these range limits?

  H3: Temperature is key driver at limits on east coasts of North and South America, precipitation more important on west coasts

Landast 5, 7, and 8 imagery

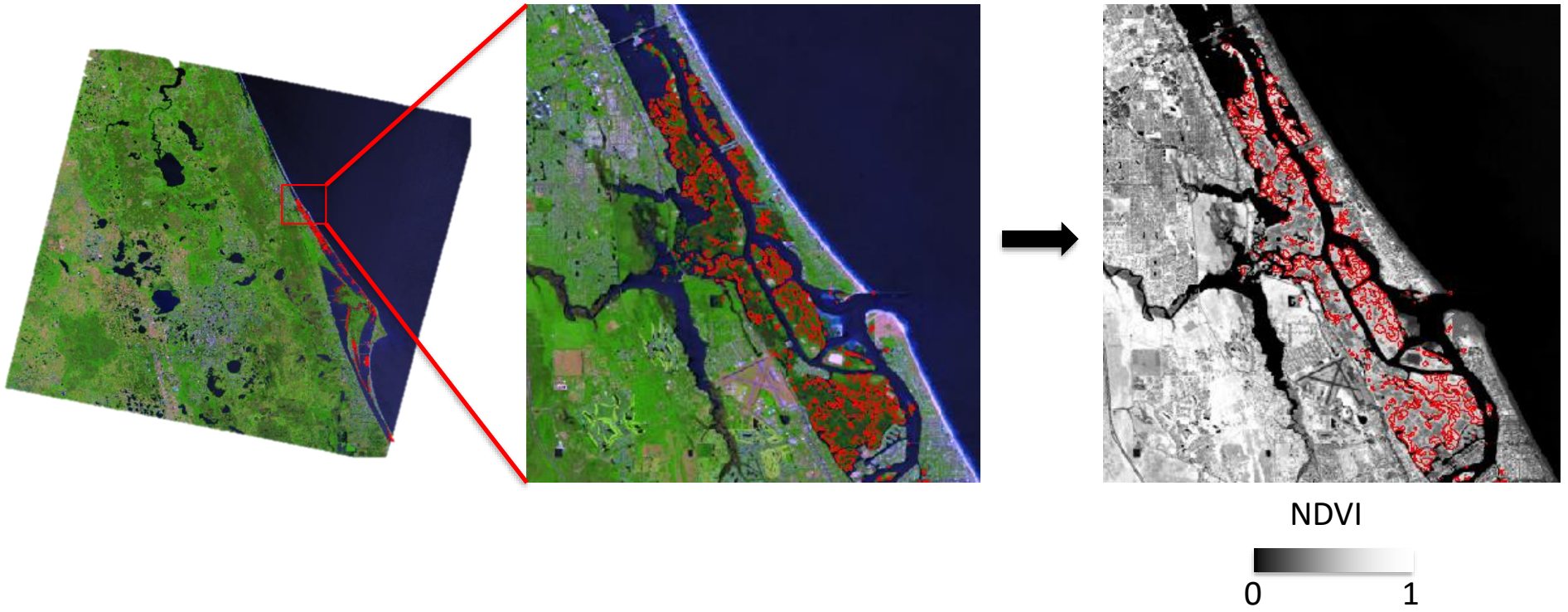
- 30 m resolution
- Coverage from 1984-2015 w/ 16 day repeat time
- Identified mangrove stands within 1° of latitude of each range limit using dataset developed by Giri et al. (2011)



Landast 5, 7, and 8 imagery

- Calculated mean NDVI across region for each image date

$$NDVI = \frac{R_{NIR} - R_{red}}{R_{NIR} + R_{red}}$$



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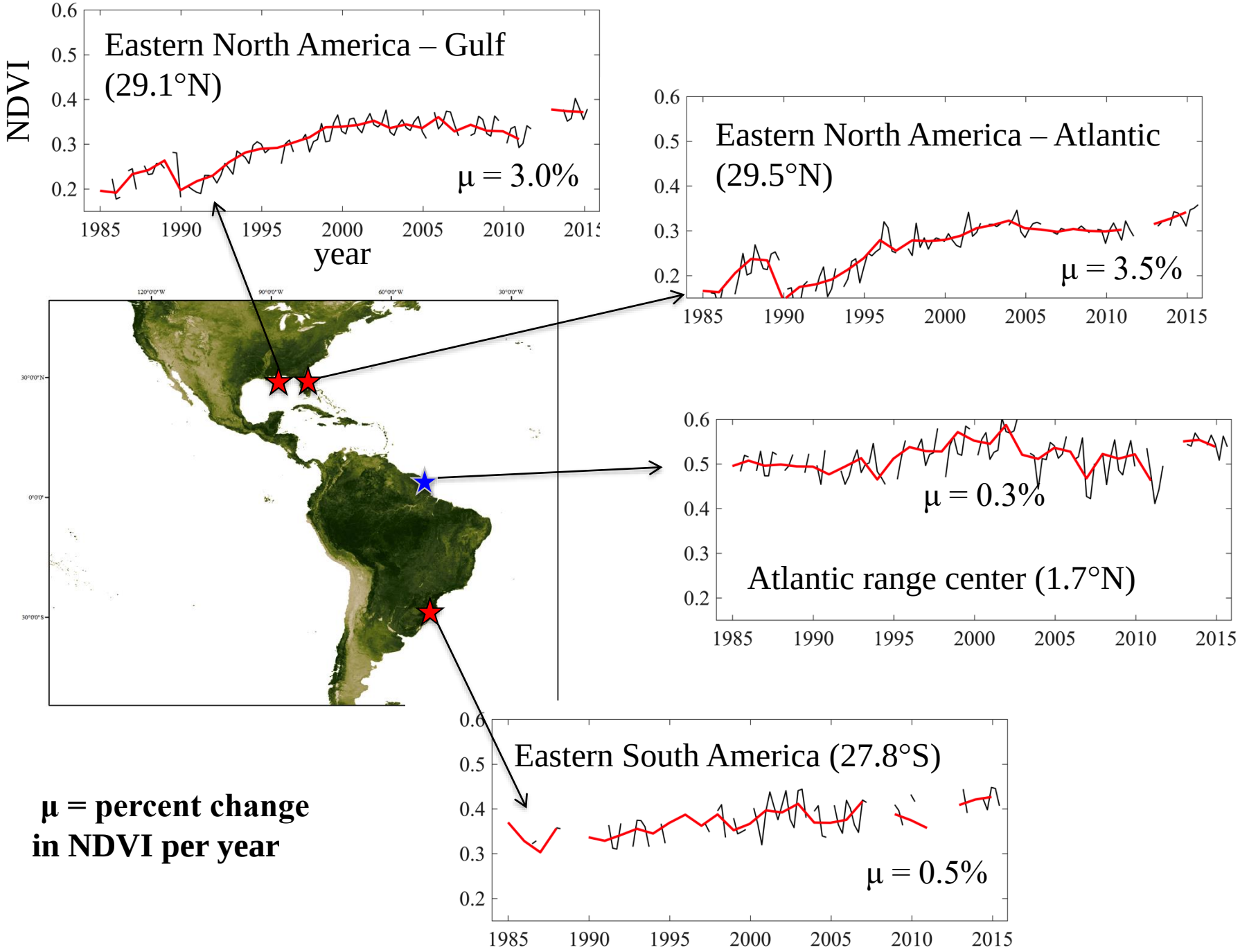
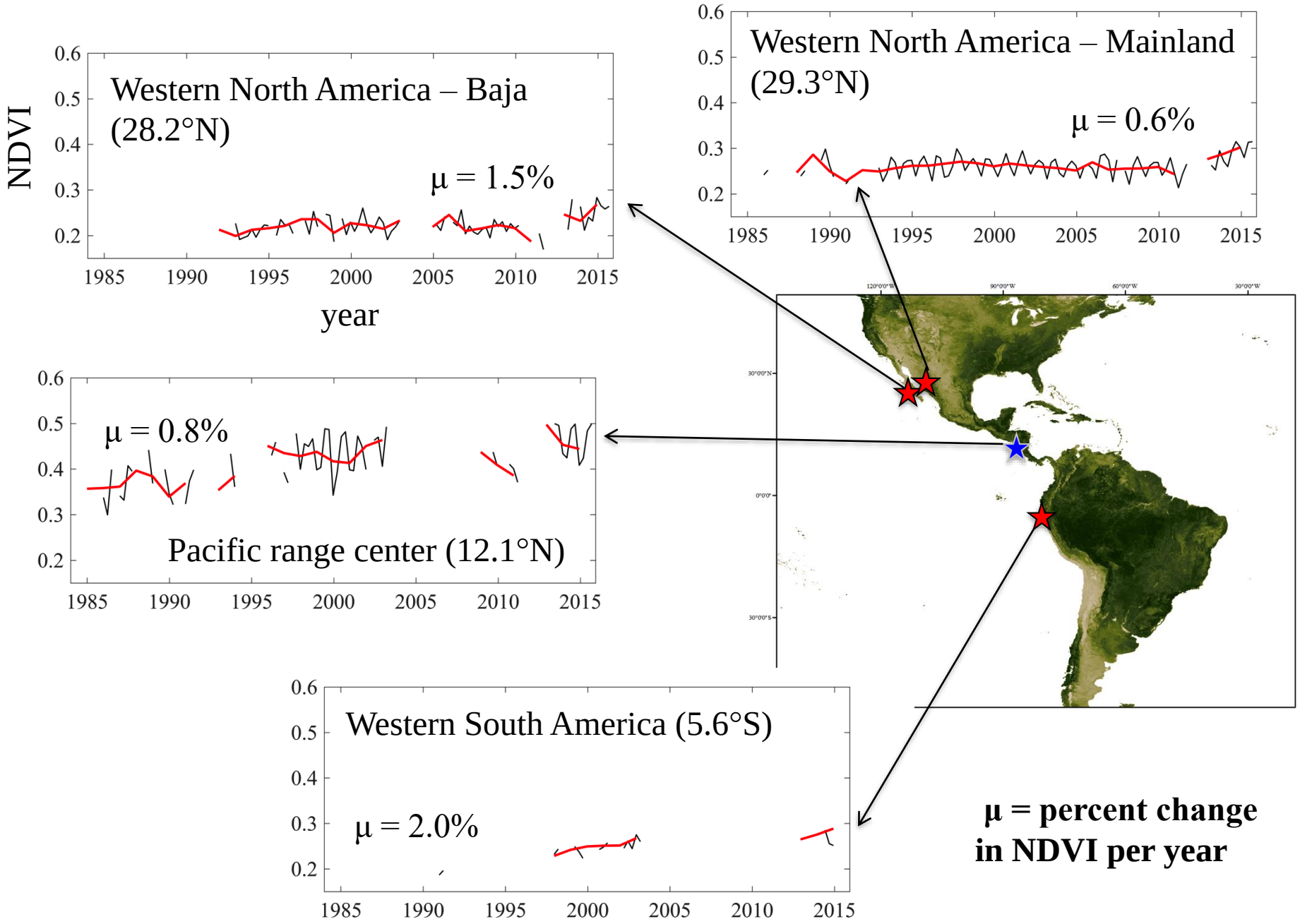
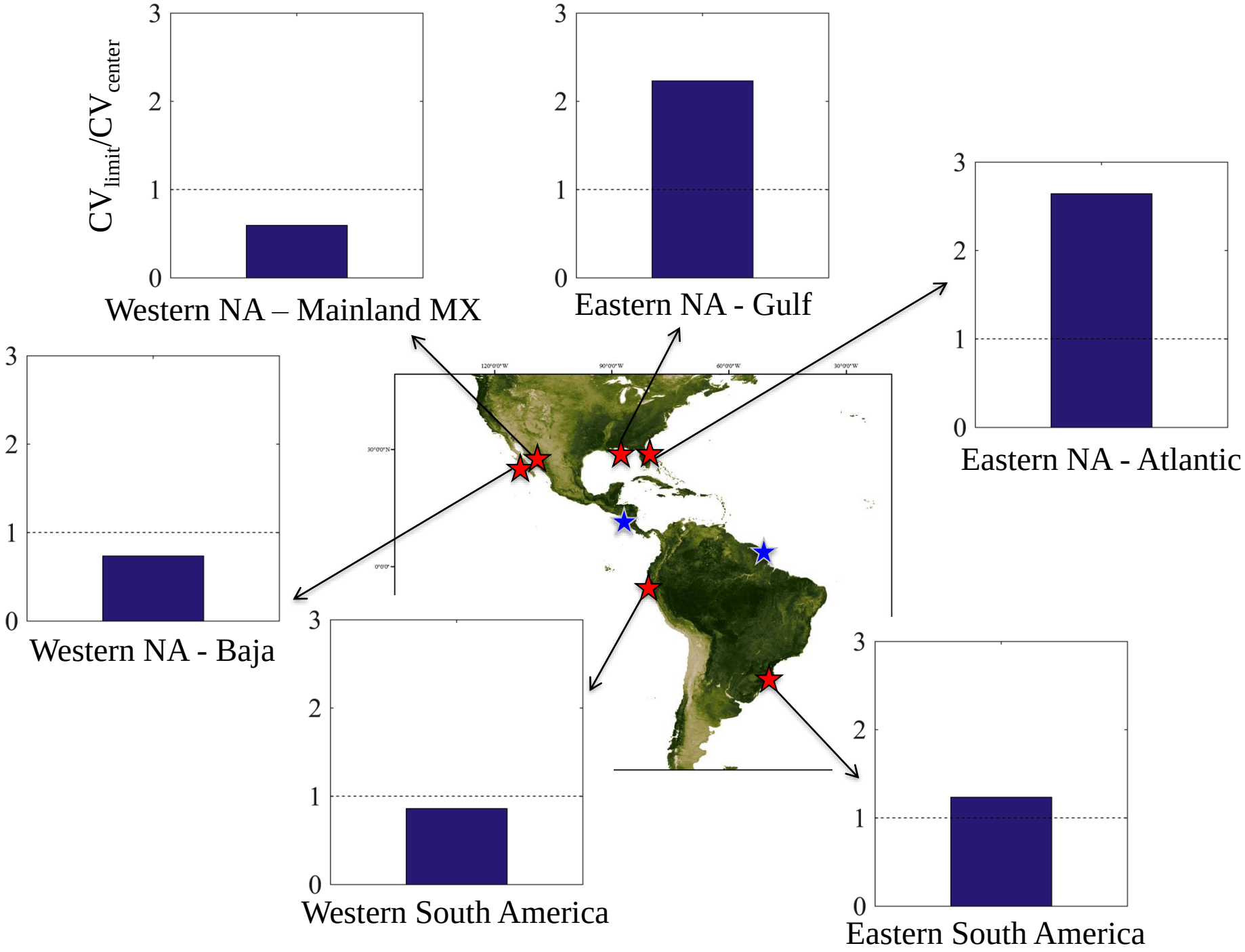

Eastern North America – Gulf (29.1°N)
μ = 3.0%
NDVI
year
Eastern North America – Atlantic (29.5°N)
μ = 3.5%
μ = 0.3%
Atlantic range center (1.7°N)
Eastern South America (27.8°S)
μ = 0.5%
μ = percent change in NDVI per year


Western North America – Baja
(28.2°N)
μ = 1.5%
NDVI
year
Western North America – Mainland
(29.3°N)
μ = 0.6%
μ = 0.8%
Pacific range center (12.1°N)
Western South America (5.6°S)
μ = 2.0%
μ = percent change
in NDVI per year


CV_{limit}/CV_{center}
0
1
2
3
Western NA – Mainland MX
Eastern NA - Gulf
Eastern NA - Atlantic
Western NA - Baja
Western South America
Eastern South America
120°0'0"W
90°0'0"W
60°0'0"W
30°0'0"W
30°0'0"N
0°0'0"

- What are the **patterns and trends** in mangrove abundance at range limits in North and South America?

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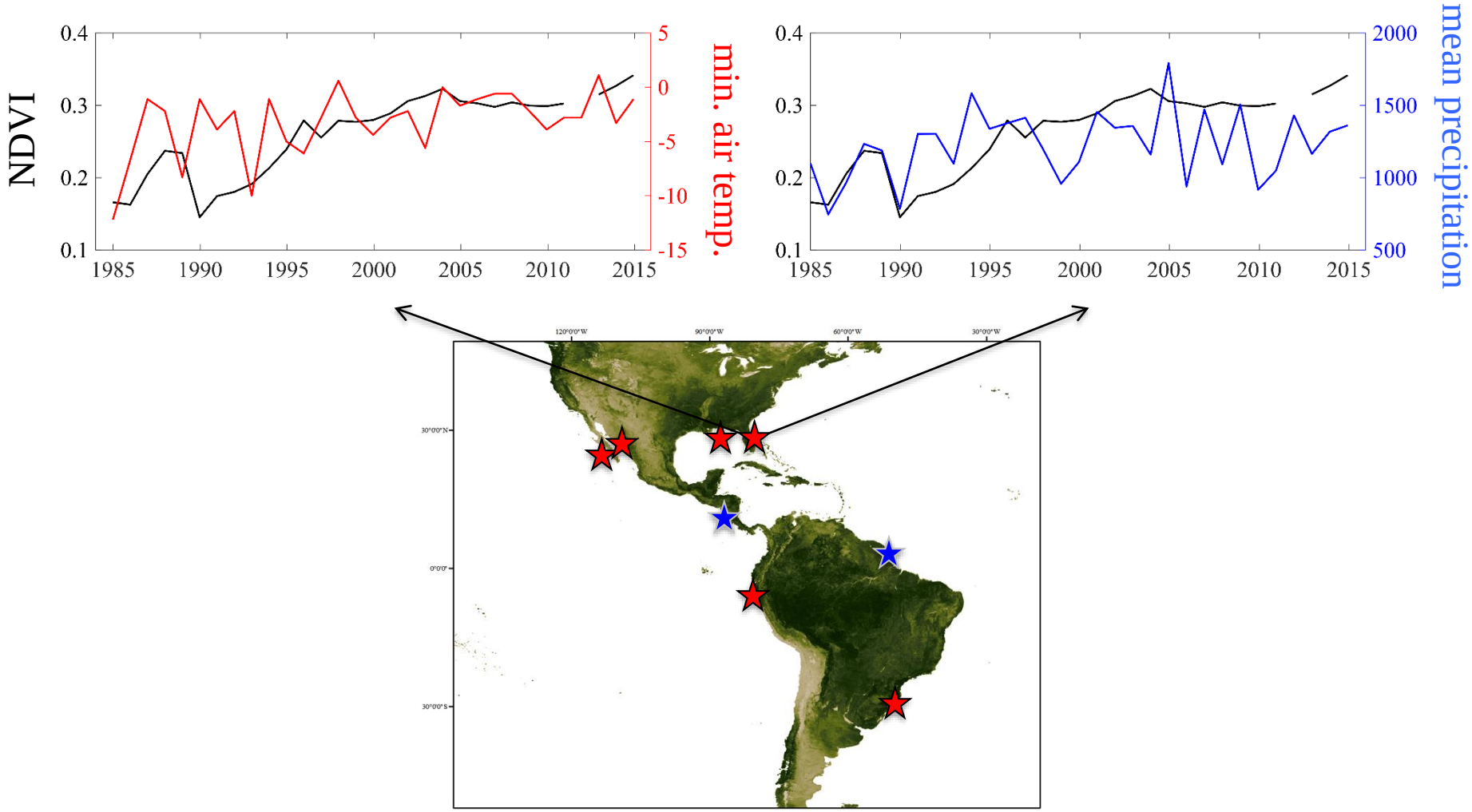
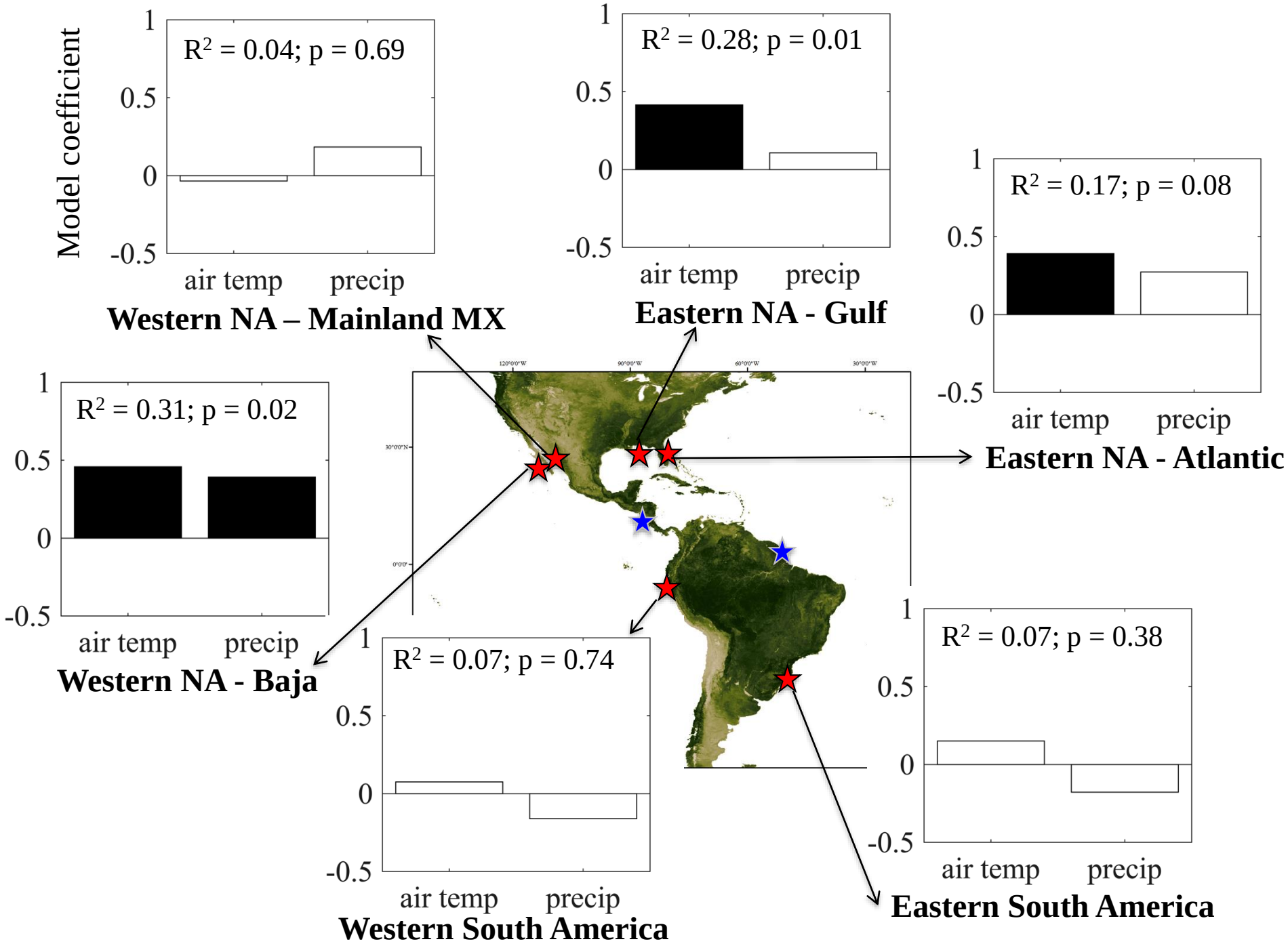
Eastern NA - Atlantic



- Performed multiple linear regression on annual NDVI data
- Identified overall model R^2 and standardized regression coefficients for air temperature and precipitation


Model coefficient
1
0.5
0
-0.5
air temp
precip
R² = 0.04; p = 0.69
Western NA – Mainland MX
R² = 0.28; p = 0.01
Eastern NA - Gulf
R² = 0.17; p = 0.08
Eastern NA - Atlantic
R² = 0.31; p = 0.02
Western NA - Baja
R² = 0.07; p = 0.74
Western South America
R² = 0.07; p = 0.38
Eastern South America

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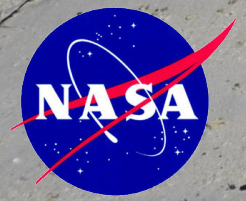
Conclusions

- Mangrove abundance in **eastern North America**: highly variable, correlated with air temperature, and has exhibited increases over the past 30 years
- Mangrove abundance in **western North America**: less variable, correlated with air temperature and precipitation
- Mangrove abundance in **South America**: less variable and not as strongly linked to air temperature and precipitation

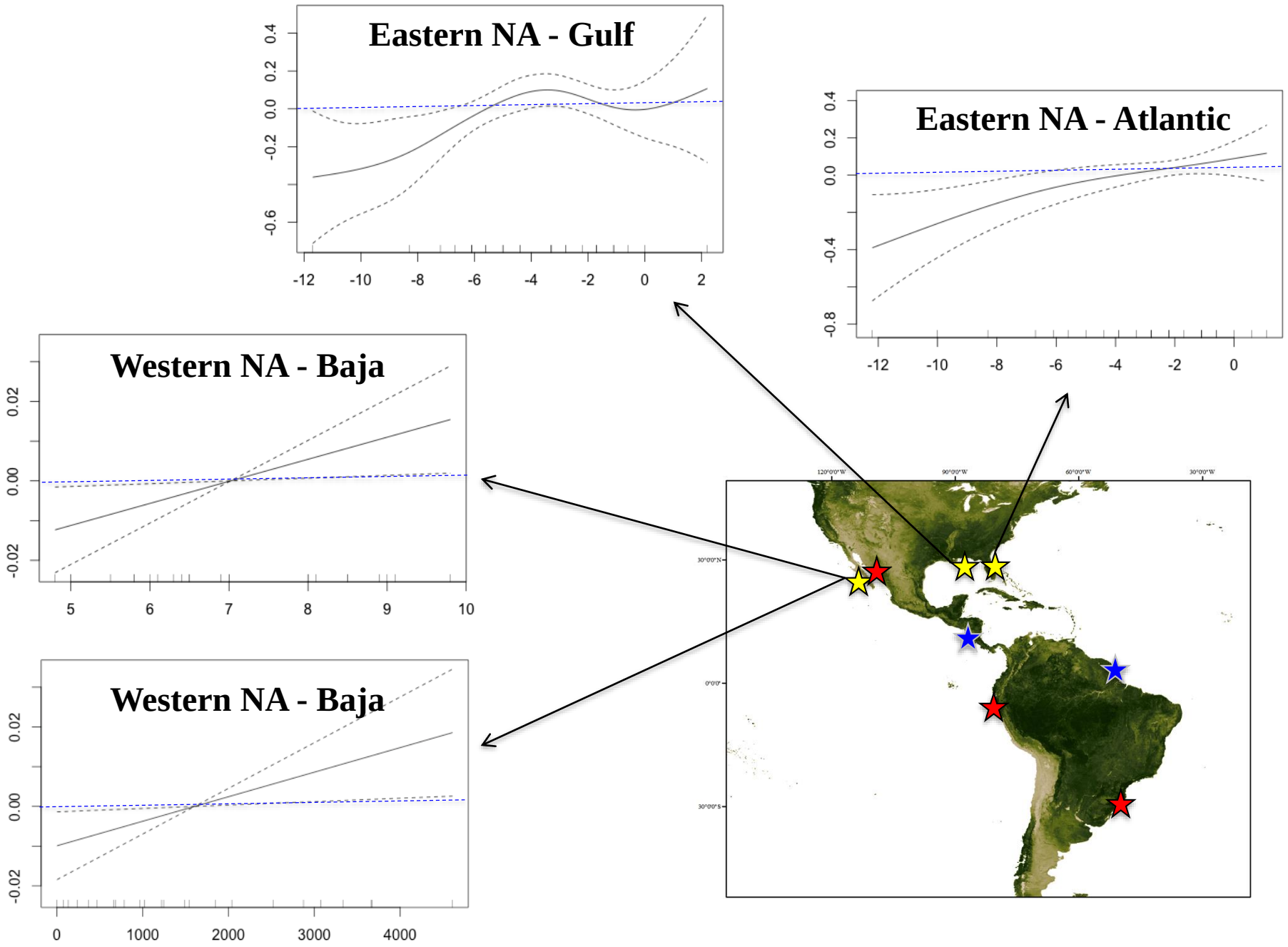
Thank you!

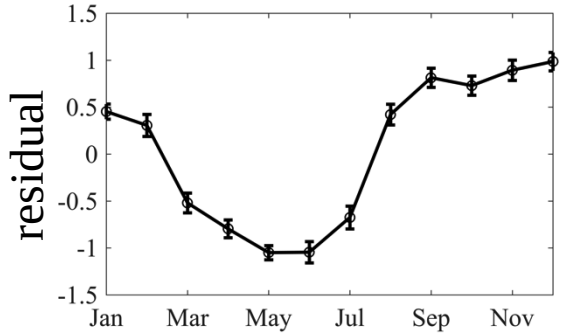
Rémi Bardou - University of California, Los Angeles
Jeff Gorder – University of California, Los Angeles
Rafael Ríosmena Rodriguez – Universidad Autónoma de Baja California Sur

NASA New Investigator Program
NASA Climate and Biological Respons Program (NNX11AO94G)
NSF Macrosystems Biology Program (EF 1065821 and 1065098)

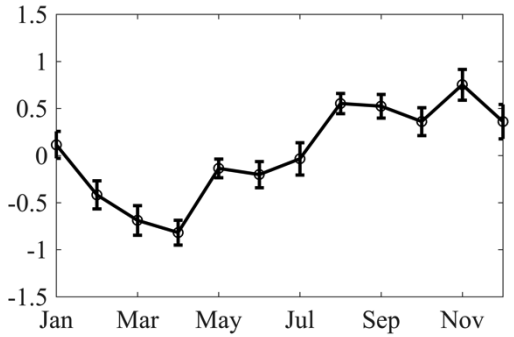


Smithsonian
Institution

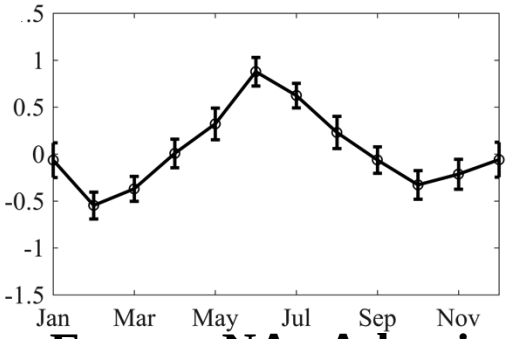

Eastern NA - Gulf
Eastern NA - Atlantic
Western NA - Baja
Western NA - Baja



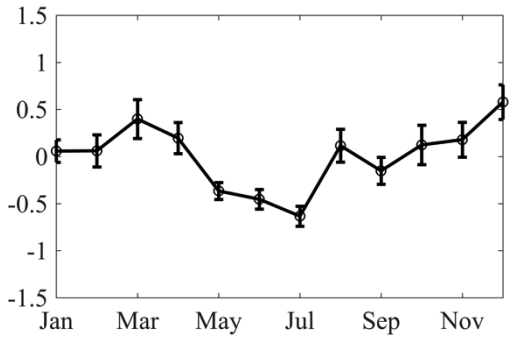
Western NA – Mainland MX



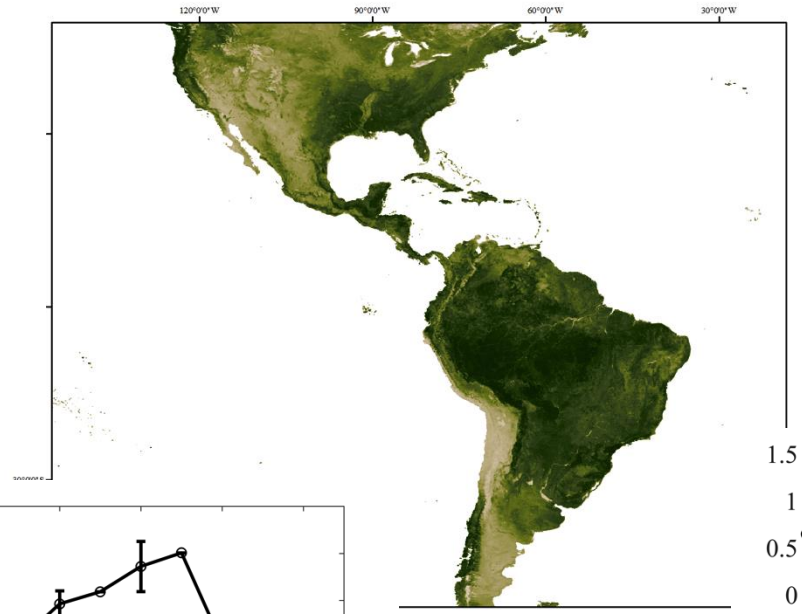
Eastern NA - Gulf

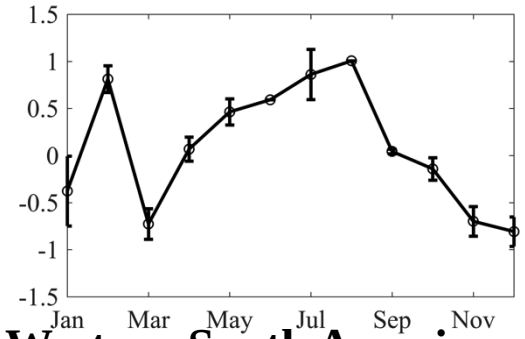


Eastern NA - Atlantic

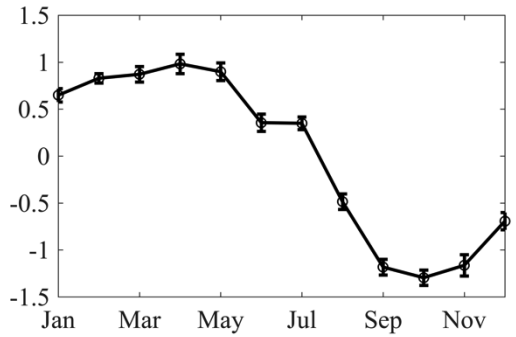


Western NA - Baja

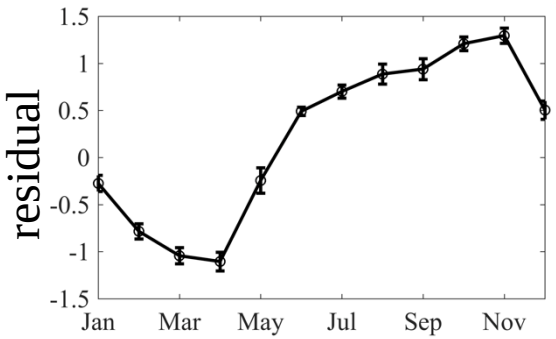




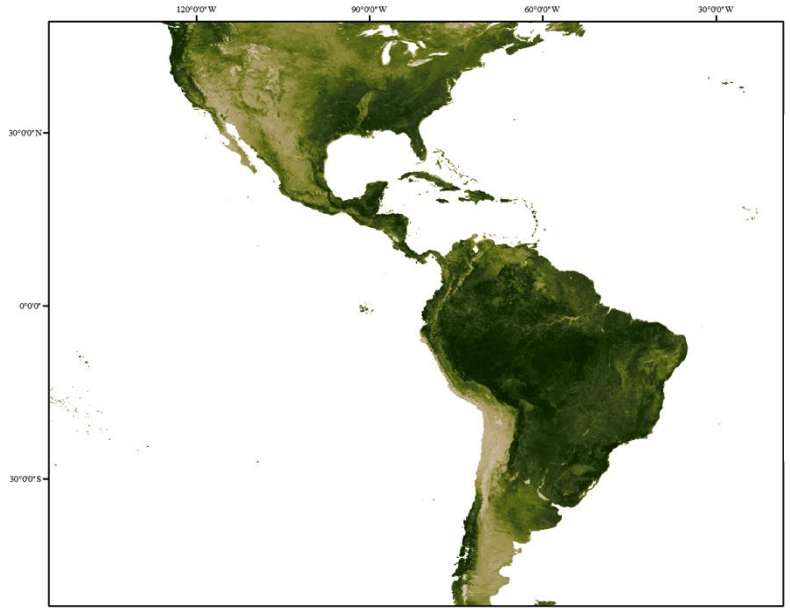
Western South America

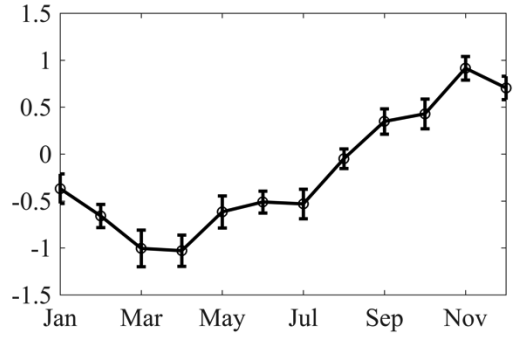


Eastern South America



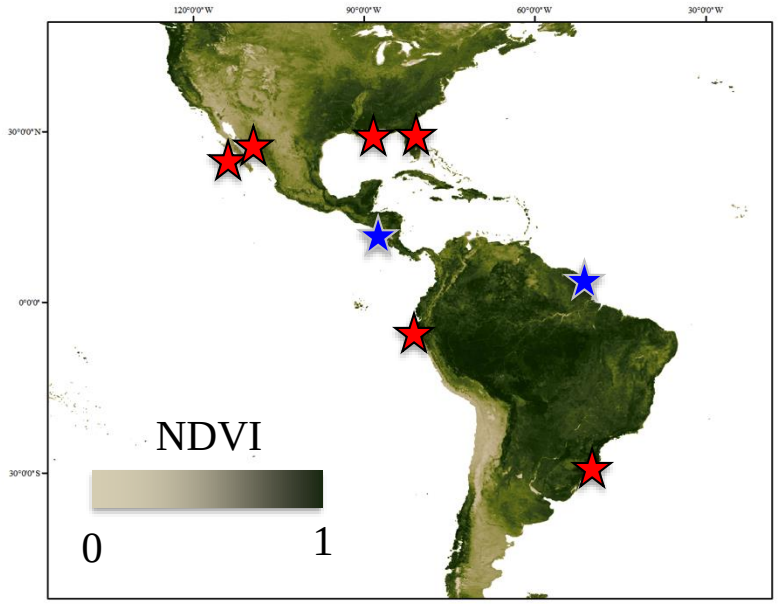
Central Pacific

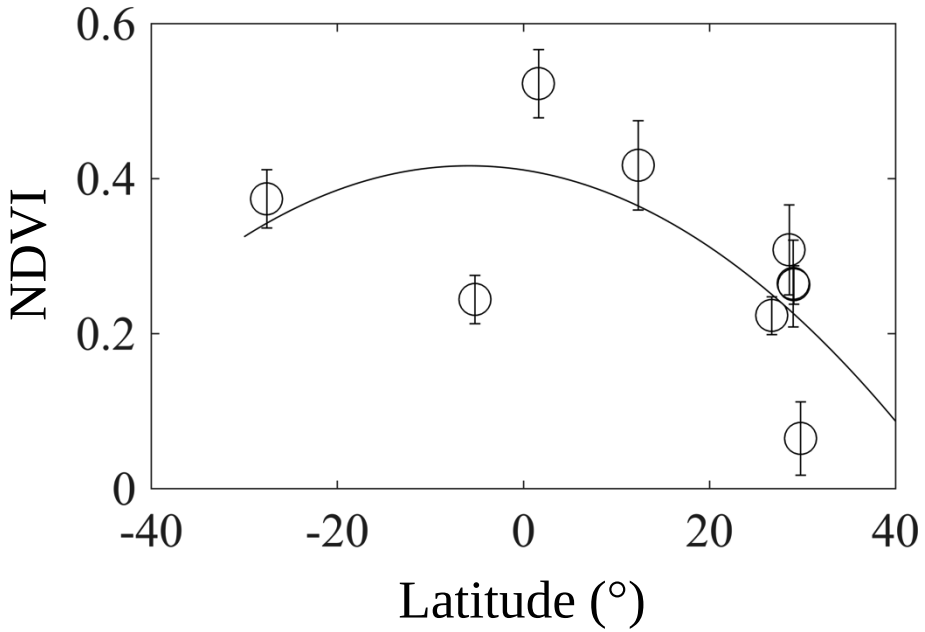




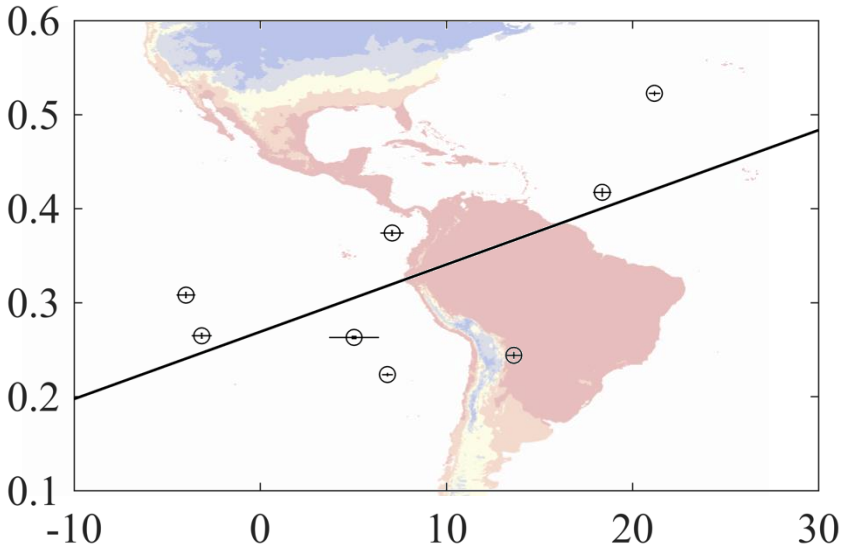
Central Atlantic

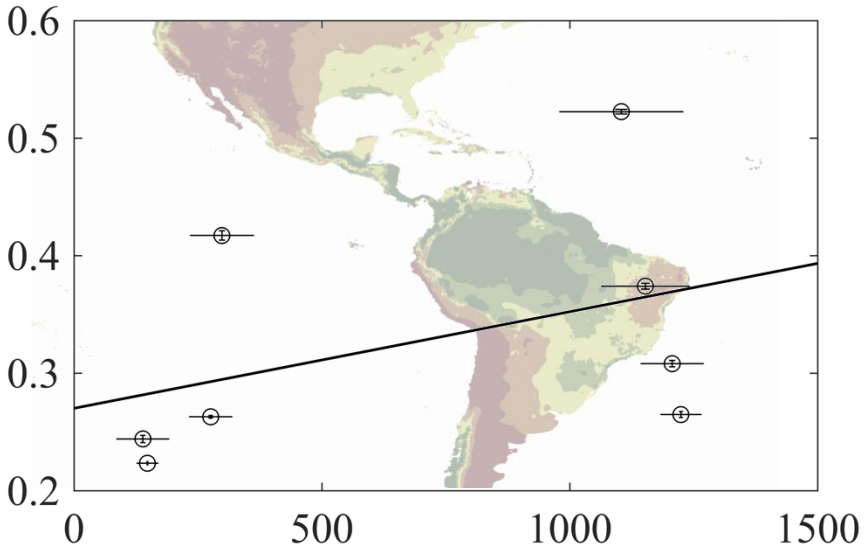
Abundance (mean NDVI) declines from range center to range edges



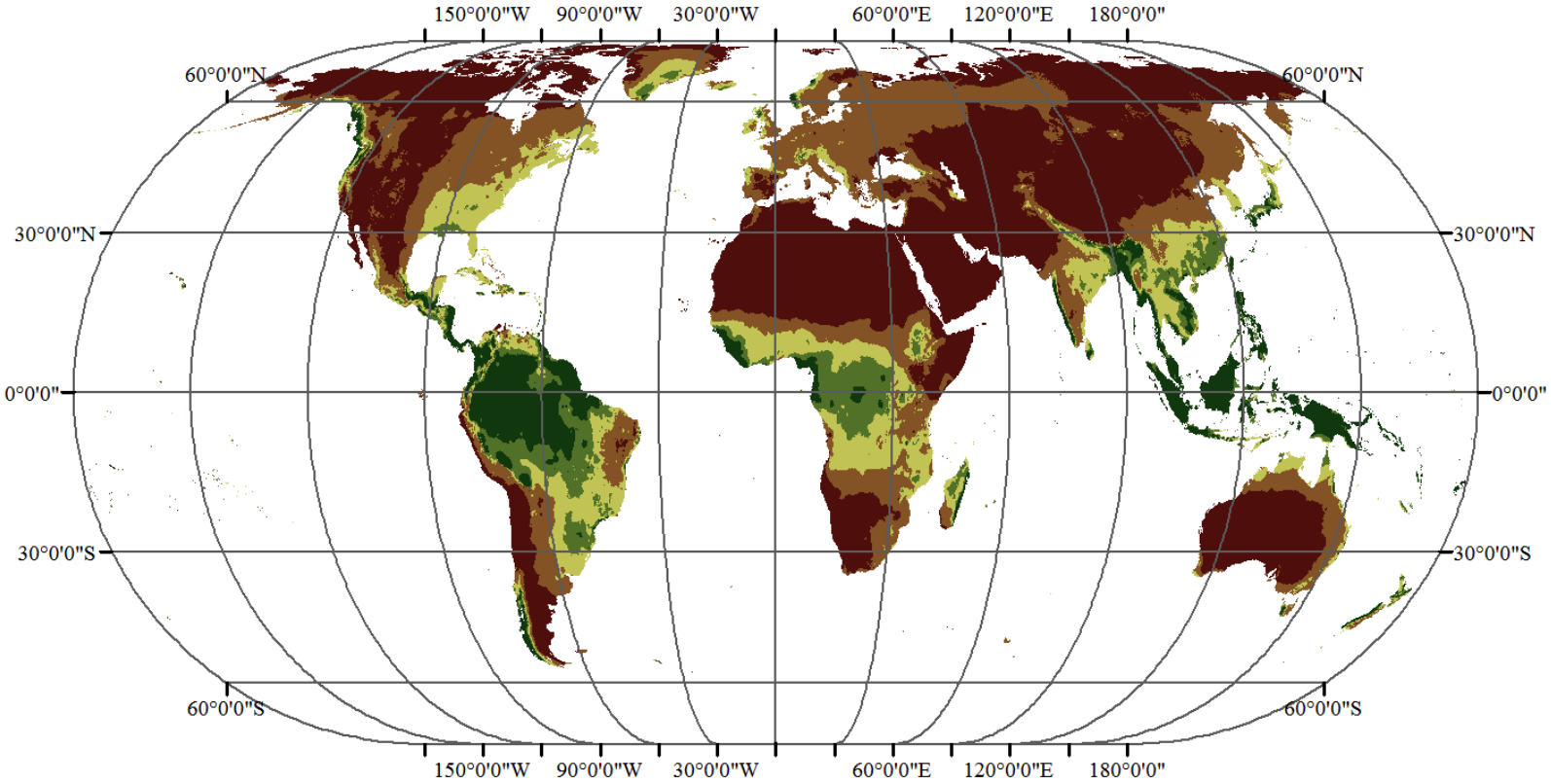


Abundance (mean NDVI) correlated with mean minimum annual air temperature and mean annual precipitation



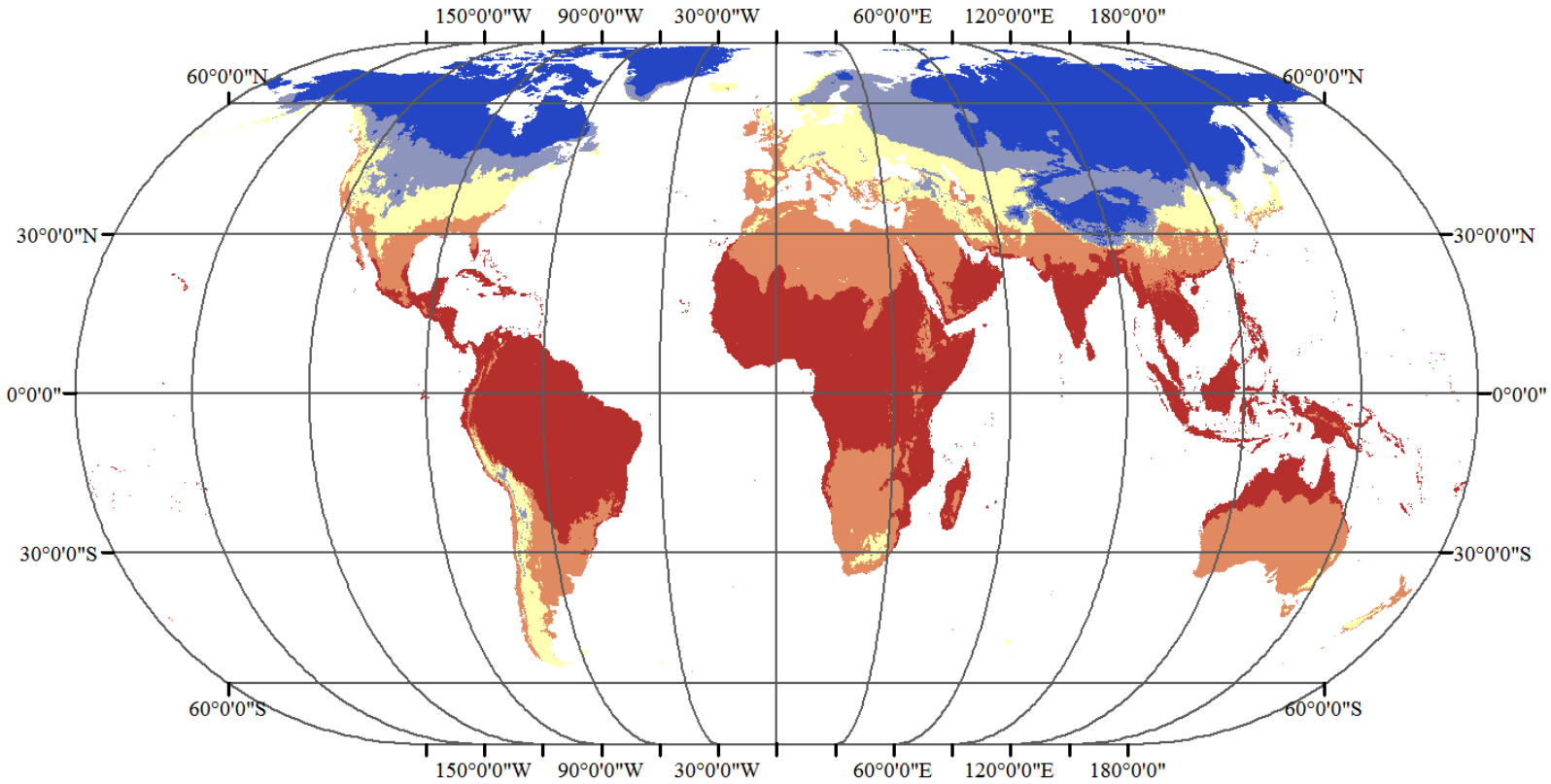


Predictor variable	β	std. error	*p*	adjusted R^2
Intercept	-0.17	0.14		0.85
Min. Temperature	0.83	0.14	< 0.01	
Precipitation	0.72	0.15	< 0.01	



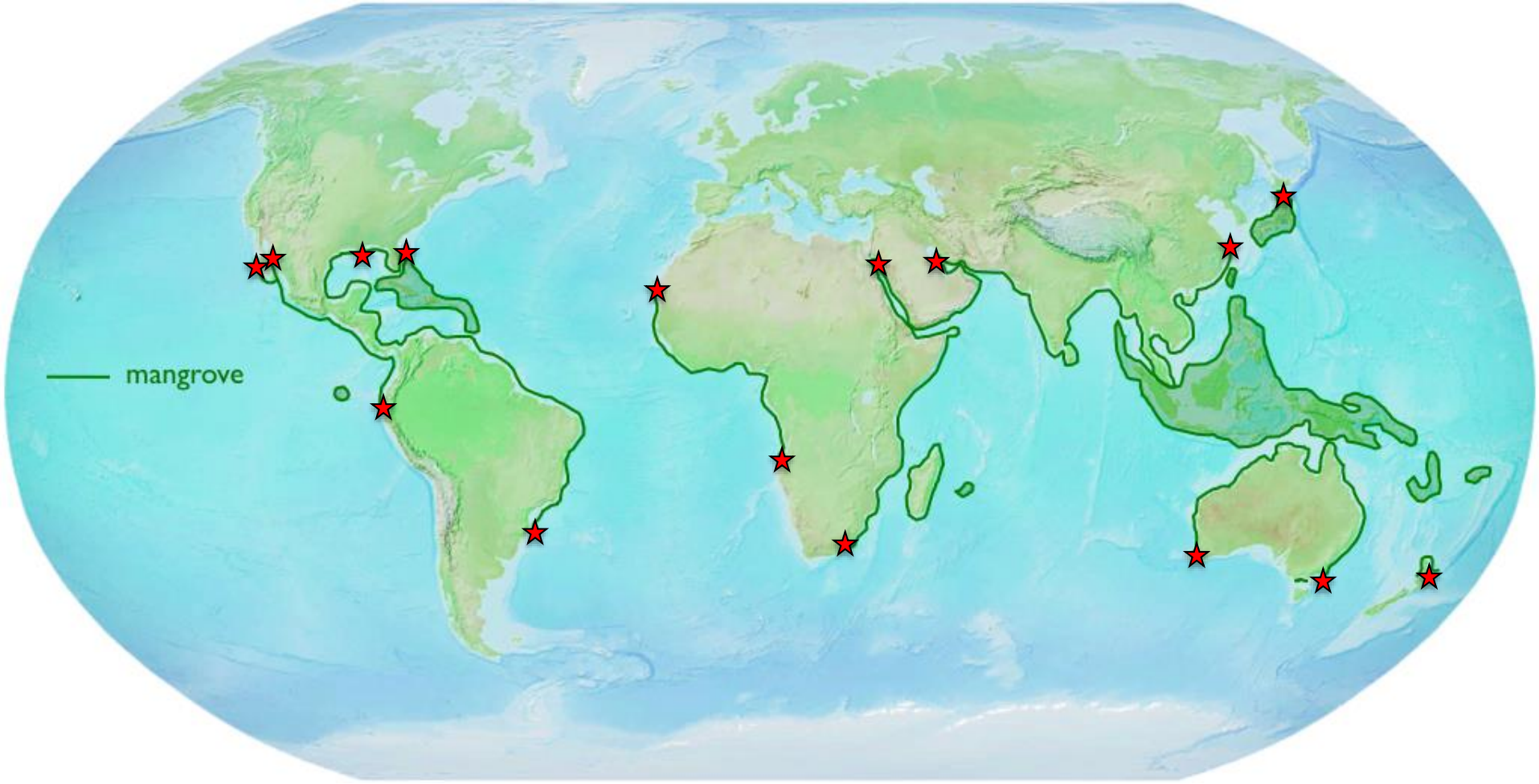
Mean annual precipitation (mm)

0 – 500 | 500 - 1000 | 1000 - 1500 | 1500 - 2000 | > 2000



Average temperature of coldest month (°C)

< -20 | -20 to -10 | -10 to 0 | 0 to 10 | > 10


mangrove