The Assembly and Evolution of the Amazonian Biota and its Environment

Dimensions of Biodiversity US-BIOTA-São Paulo

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www.amazoniabiodiversity.org

FAPESP NSF NASA bioGENESIS
a core project of DIVERSITAS

Scientific challenges and goals

- How is genetic, taxonomic, and ecological diversity distributed within Amazonia?
- What has been the evolutionary history of the Amazonian biota and how was it generated?
- What has been the history of the Amazonian aquatic and terrestrial environments?
- How has the Amazonian environment and its biota evolved together, and what have been the global effects of this evolutionary-ecological system over time?

Requires a new integrated approach

NSF-NASA-FAPESP project: broad-scale collaboration

Brazil

- Universidade de São Paulo
- Universidade Federal de Goiás
- Universidade Federal do Pará
- Universidade Estadual de Campinas
- Museu Paraense Emílio Goeldi
- Instituto Nacional de Pesquisas da Amazônia

Argentina

- CONICET-Instituto Superior de Entomologia, Tucumán

Great Britain

- University of Edinburgh

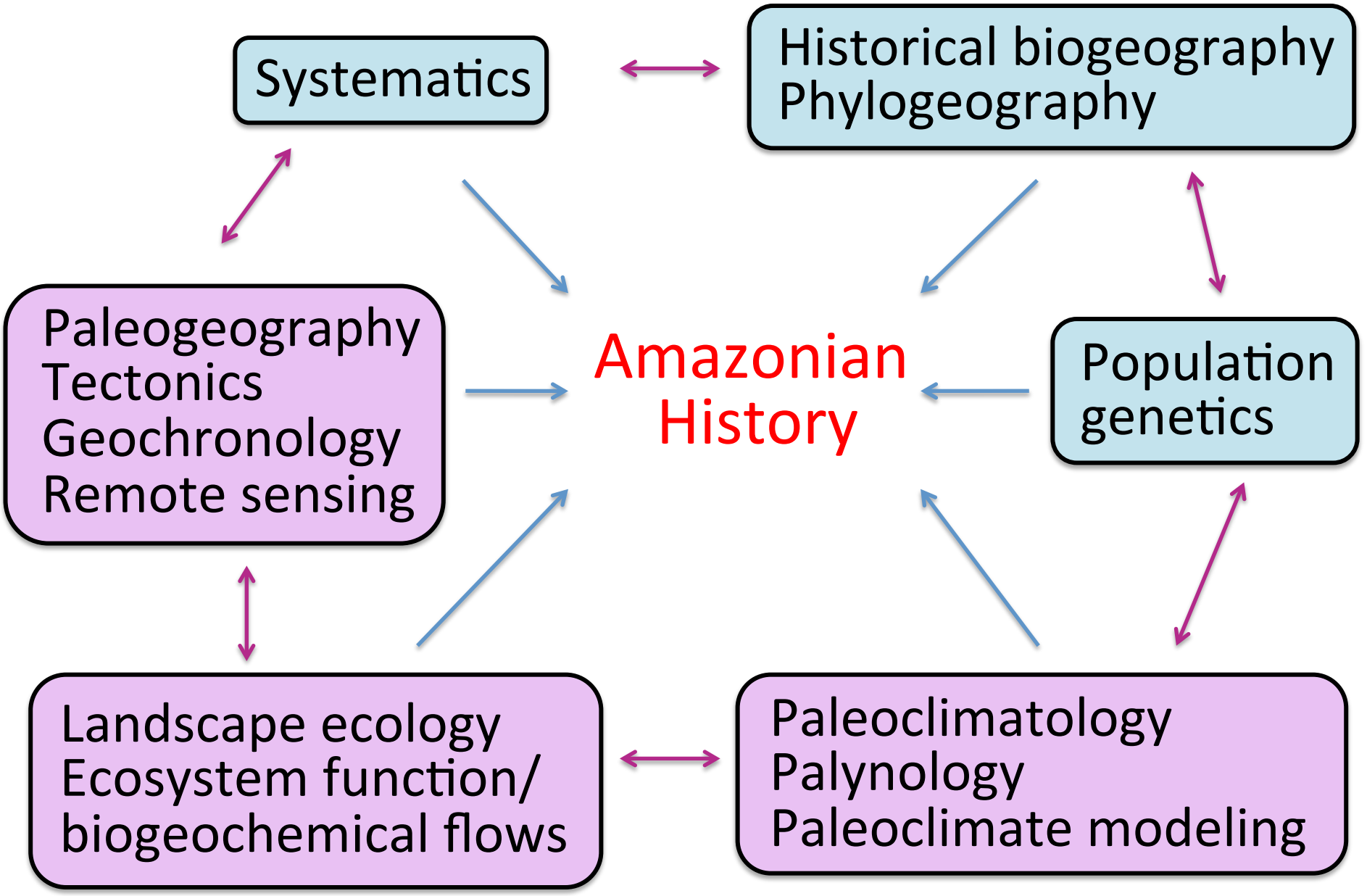
Canada

- University of Toronto

United States

- American Museum of Natural History
- City University New York
- Field Museum of Natural History
- Middle Tennessee State University
- Natural History Museum Los Angeles County
- New York Botanical Garden
- University of Michigan
- University of Colorado

Integration across disciplines

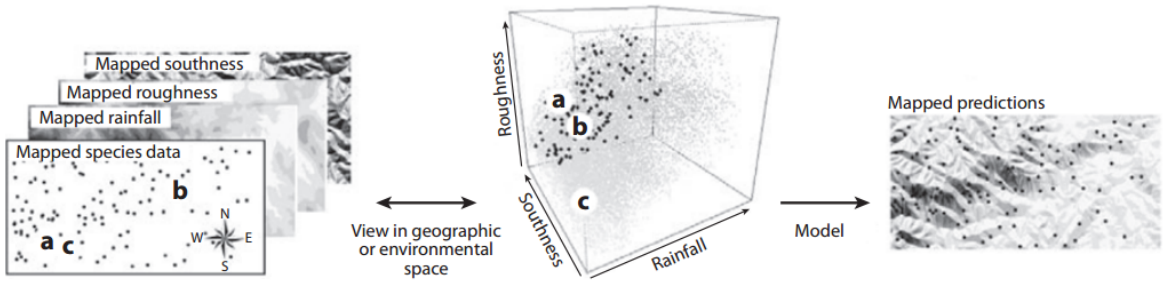


Reconstructing the history of the Amazonian biota and environment: some examples of integration

Bioclimatic Envelopes

Geographic regions with similar environmental conditions.

species distribution modeling (SDM) and environmental niche modeling (ENM)



Source: Elith and Leathwick, 2009

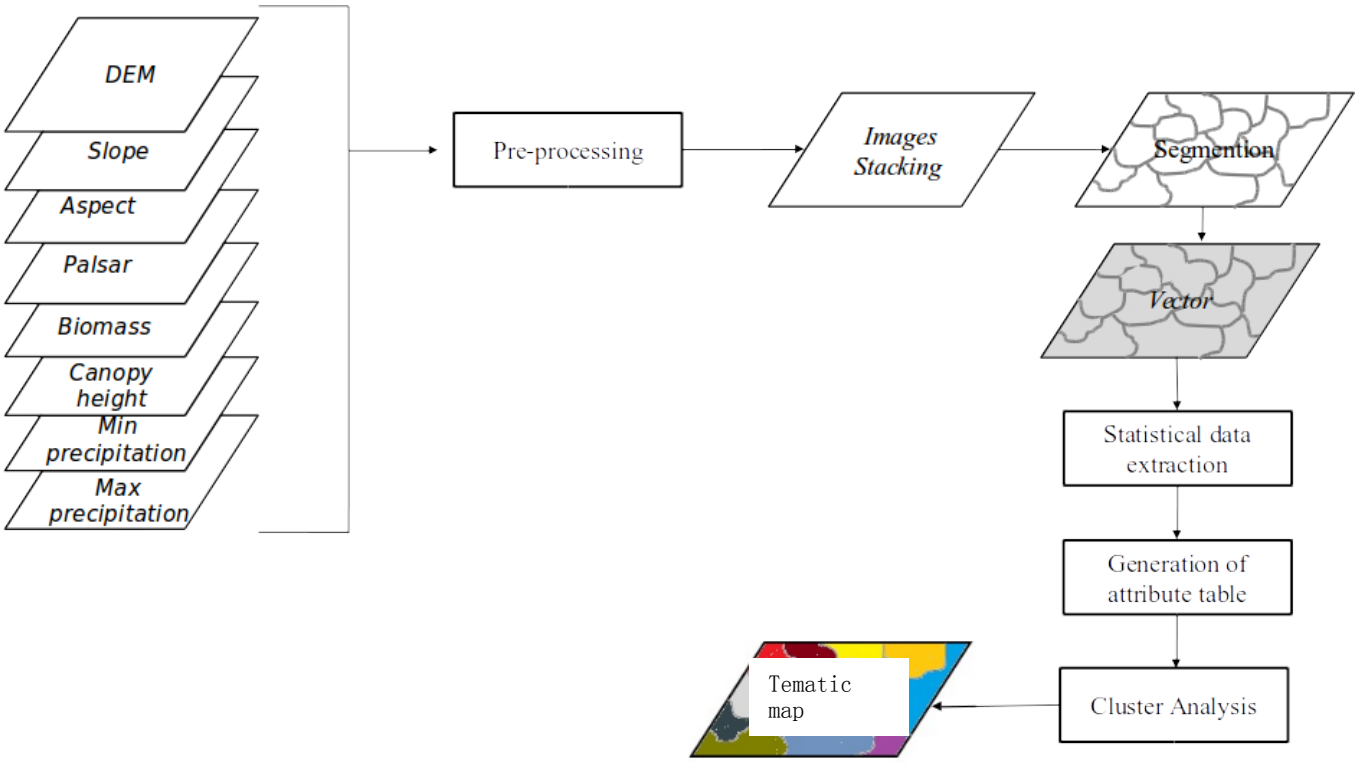
SDM as a model that relates species distribution data (occurrence or abundance at known locations) with information on the environmental and/or spatial characteristics of those locations.

Hirzel e Lay, 2008; Elith and Leathwick, 2009; He et al. 2015; Mod et al., 2016

Source, layer of representation environmental (Layer), spatial resolution (Resolution) and attribute type (Attribute) used to map bioclimatic envelopes to Amazon Basin.

Source	Layer	Resolution	Attribute
SRTM (Shuttle Radar Topography Mission)	Elevation	90 m	Abiotic
SRTM (Shuttle Radar Topography Mission)	Slope	90 m	Abiotic
SRTM (Shuttle Radar Topography Mission)	Aspect	90 m	Abiotic
CHIRPS (Climate Hazards group InfraRed Precipitation with Station data)	Maximum precipitation	5,5 km	Abiotic
CHIRPS (Climate Hazards group InfraRed Precipitation with Station data)	Minimum precipitation	5,5 km	Abiotic
PALSAR (Phased Array type L band Synthetic Aperture Radar)	HH polarization	100 m	Abiotic/Biotic
MODIS (Moderate Resolution Imaging Spectroradiometer)	NDVI	250 m	Biotic
Avitabile et al., 2016	Canopy height	1km	Biotic
MODIS (Moderate Resolution Imaging Spectroradiometer)	Isothermality	1km	Abiotic

Methods



Open Source GIS

Segmentation

- RSGISLib

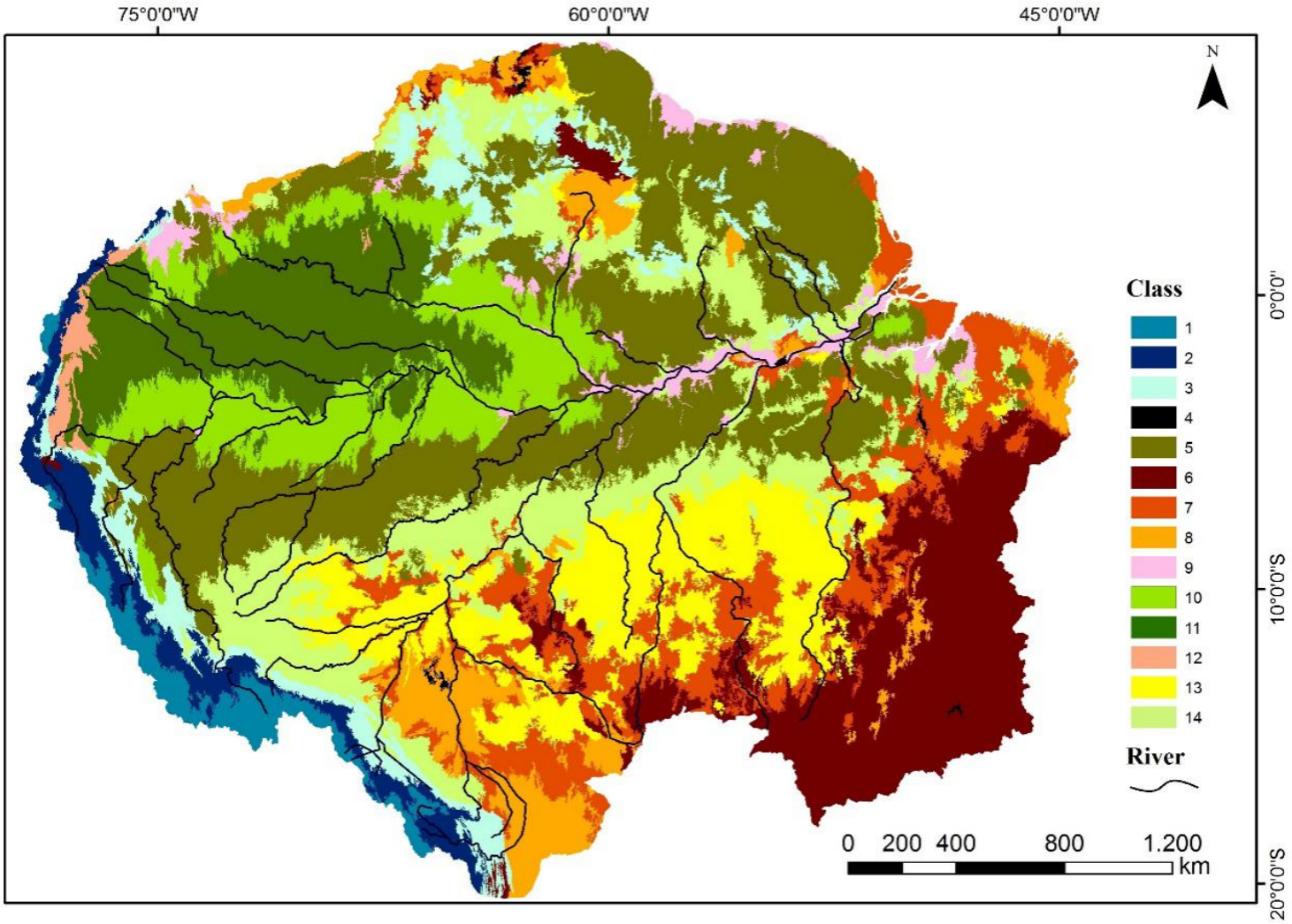
Cluster analisys

- UPGMA

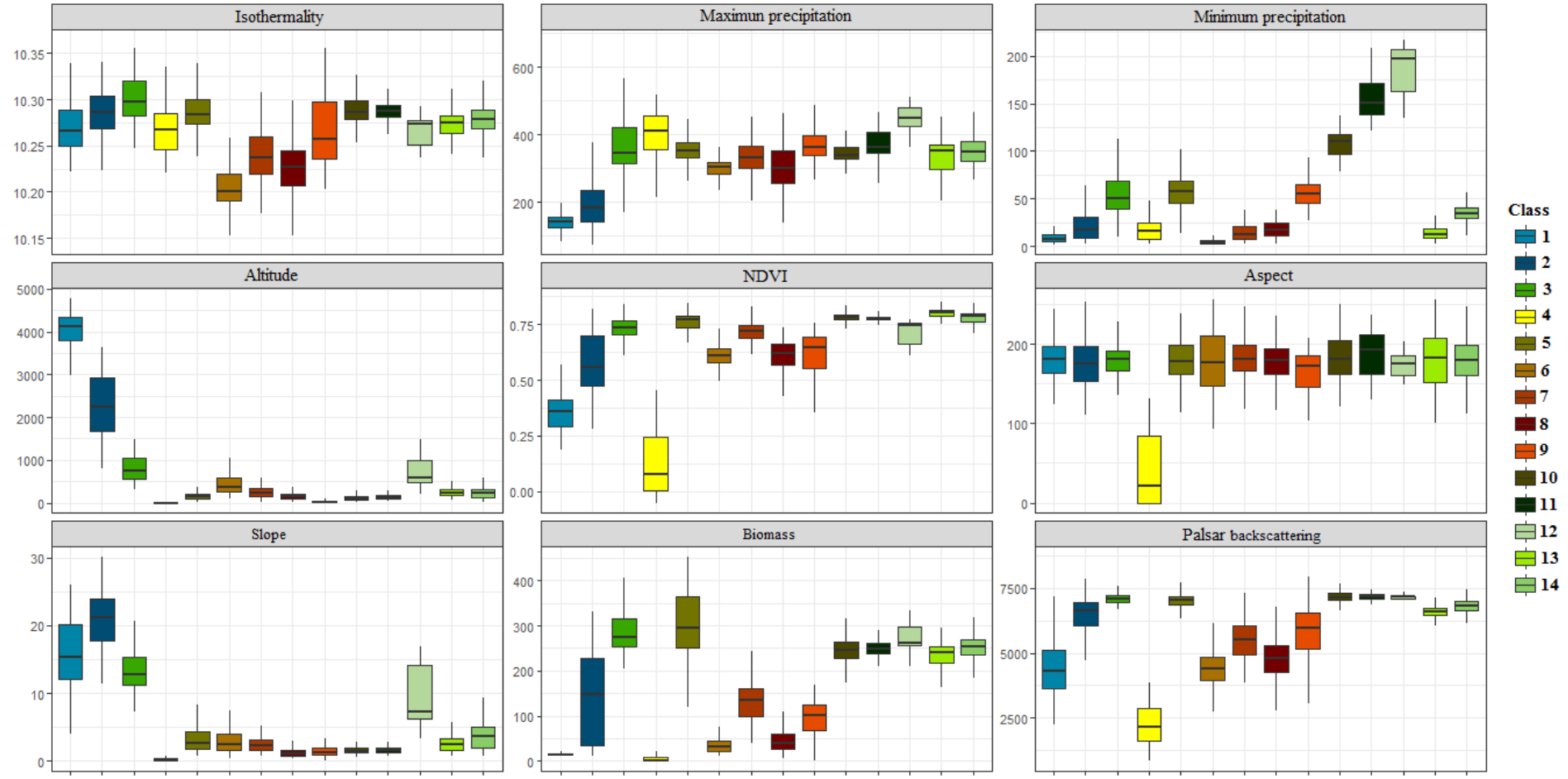
Flowchart with the steps of the data analysis for the classification of geographic spaces in Amazon basin, using the method of segmentation and clustering.

Bunting & Clewley, 2013

Results



Final map of the distribution from bioclimatic envelopes in the Amazon basin with 14 classes.



Variation of the environmental layer values used for the mapping of environmental envelopes in the Amazon region. The layers used were isothermality (%), maximum and minimum temperature (mm), altitude (m), NDVI, aspect (º), slope (%), biomass (Mg ha−1) and backscattering coefficient HH polarization - PALSAR (digital number). Variations are shown for the 14 class in bioclimatic envelopes of the final map.

Surface temperature from Passive Microwave Radiometry

- AMSR-E (2002-2011)
- Data collected twice a day (1:30 AM/PM)
- > 6600 files
- 16 day repeat cycle

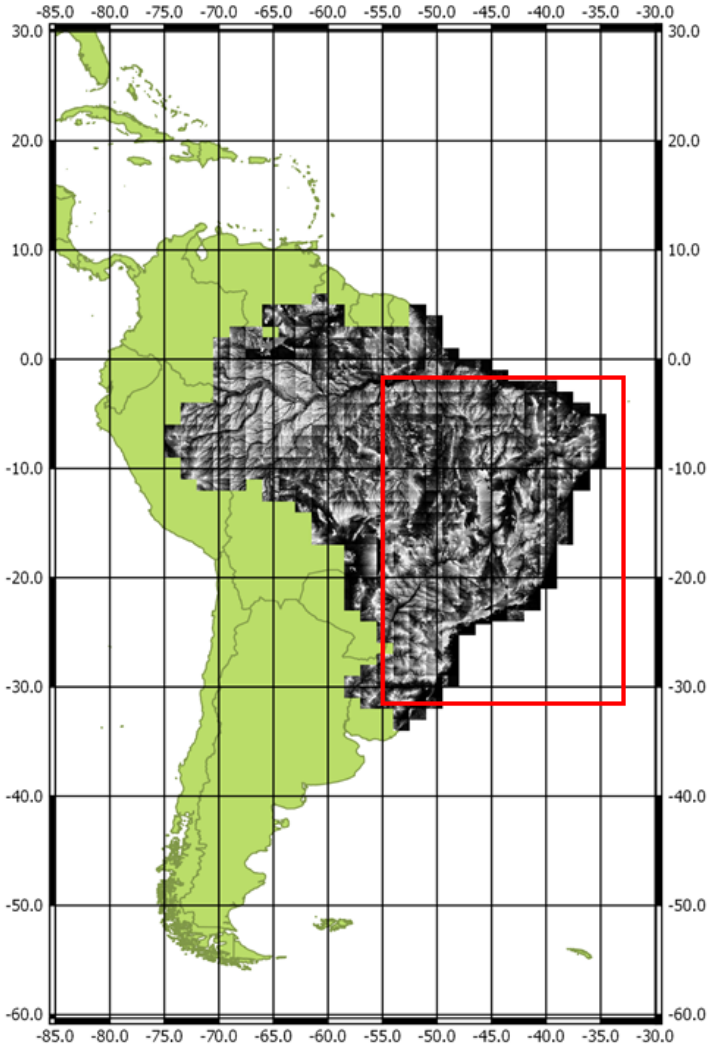
Jan 1, 2007 Day

Jan 2, 2007 Day

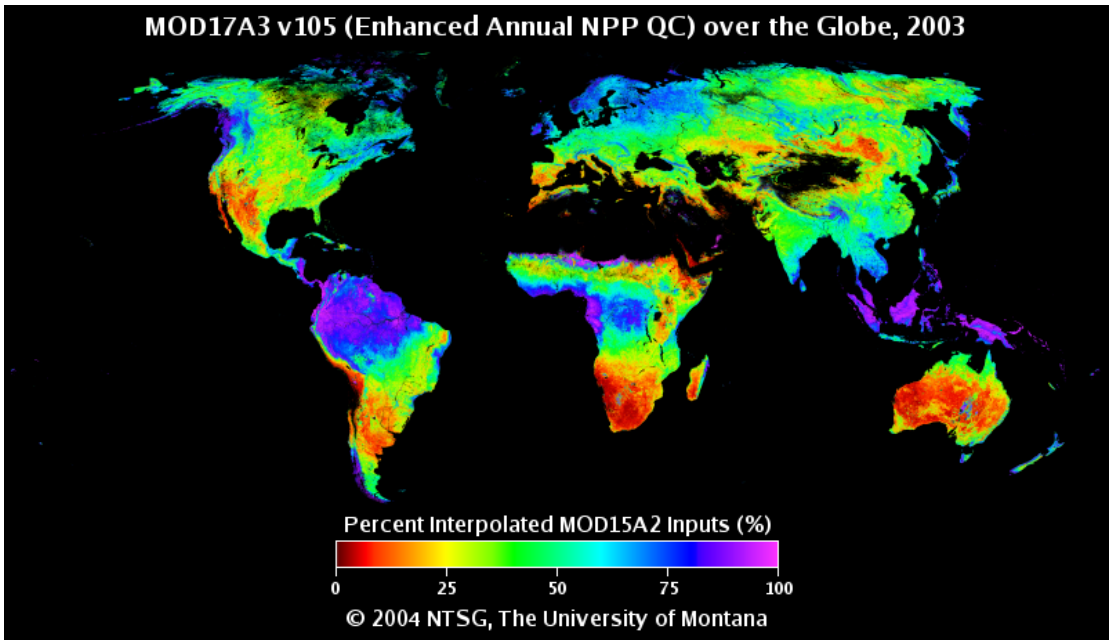
Jan 1-2, 2007 Day

*white is where there is coverage

MODIS Datasets

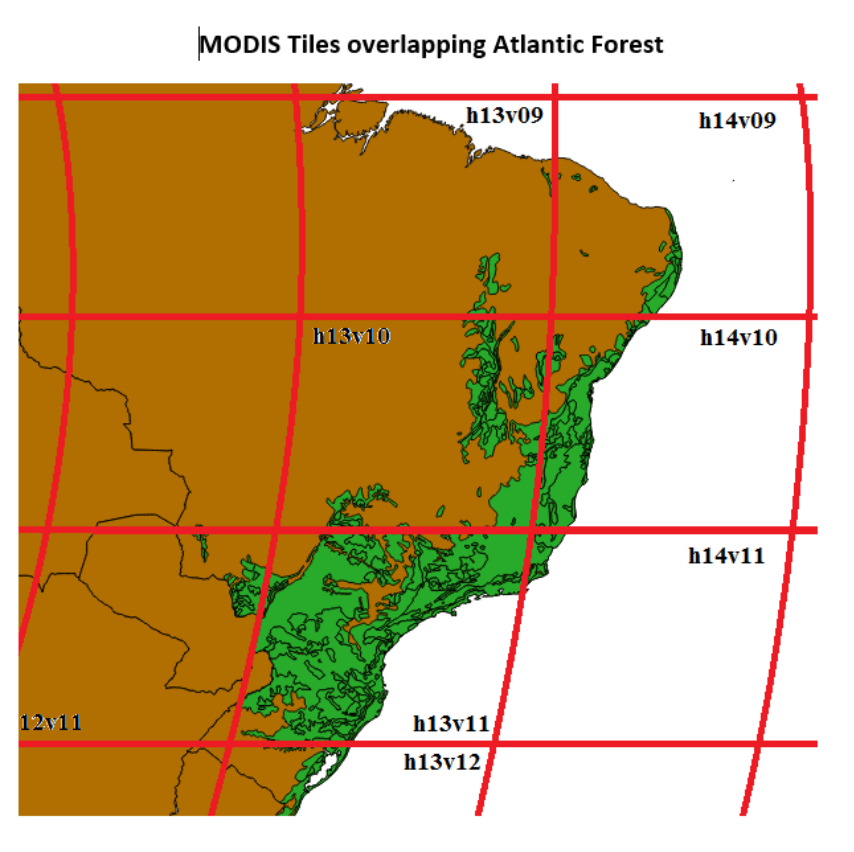


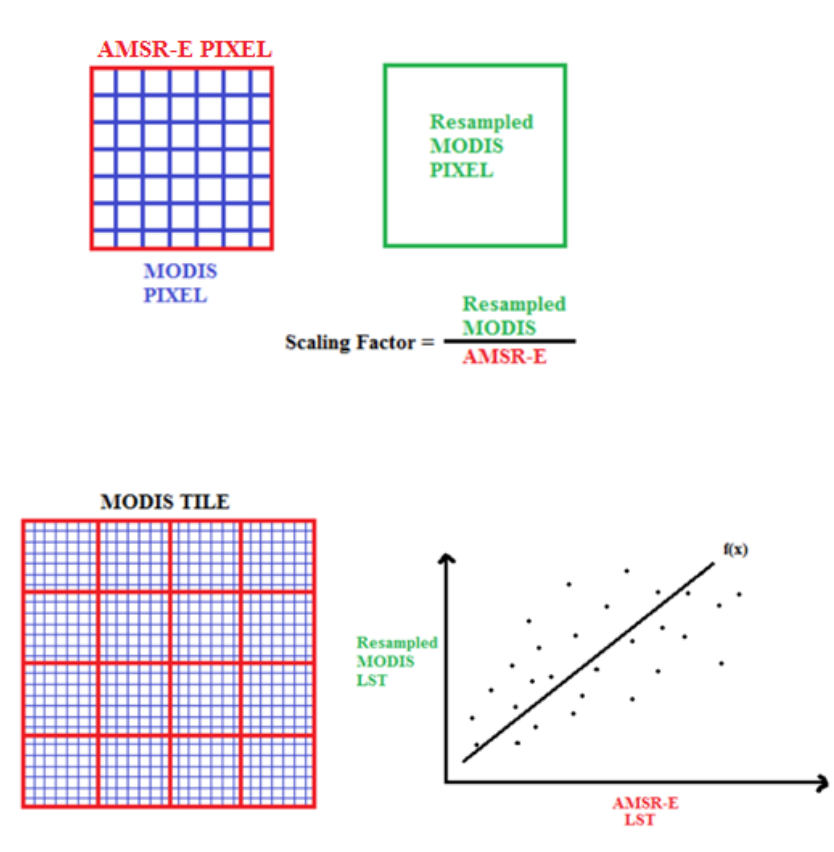
Aggregated LST (25km)



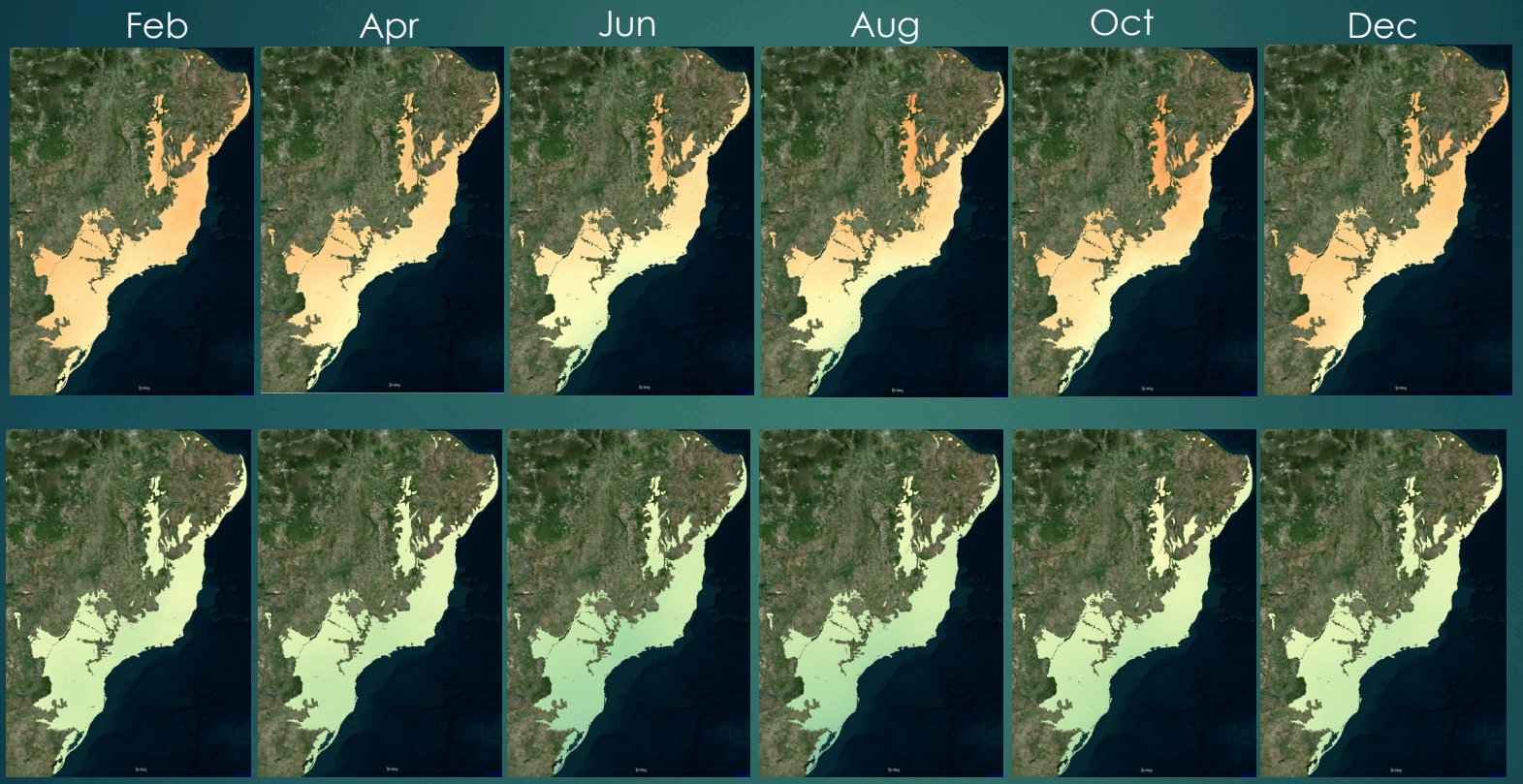
Percent interpolated data, 2003

Scaling Methodology





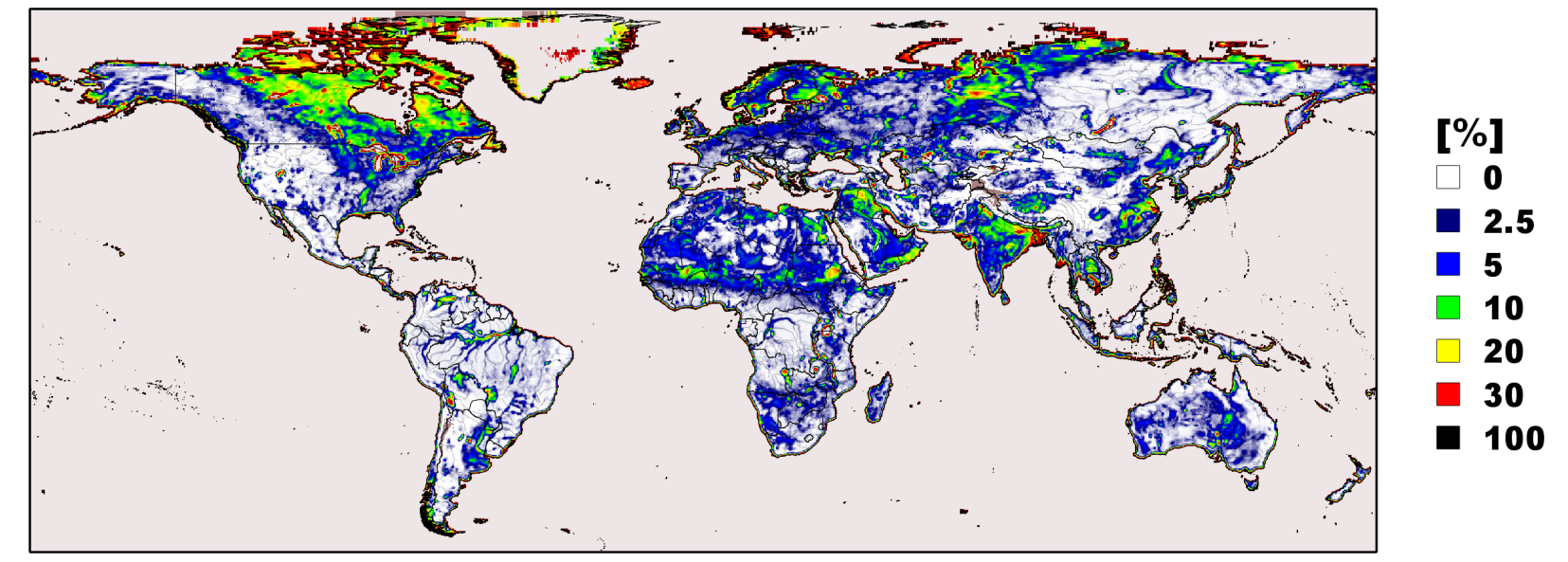
AMSR-E Climatology: LST Mean (2003-2011) Scaled to 1km



Additional data layers under consideration:

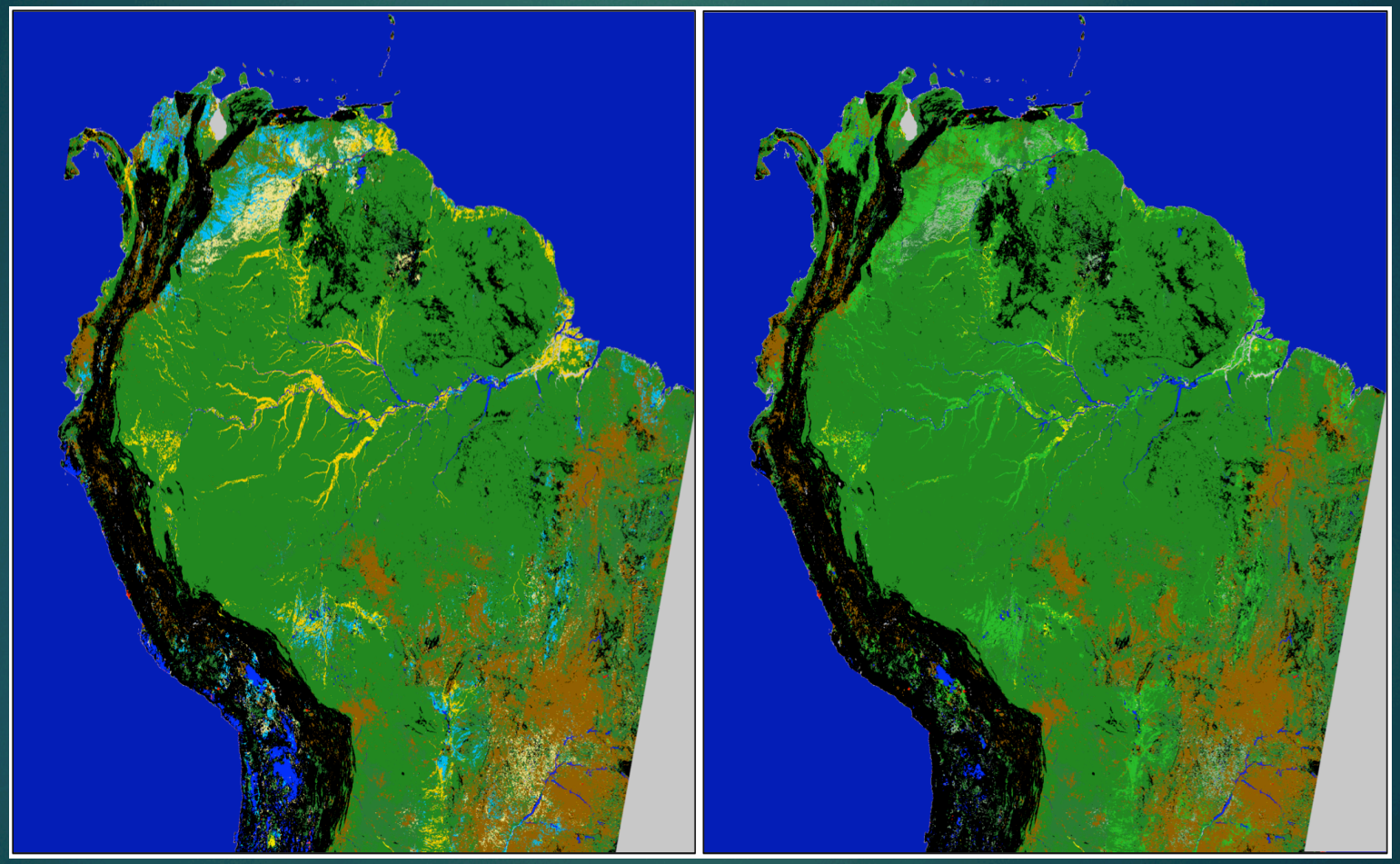
Surface Water Microwave Product Series (SWAMPS)

25+ Years of Daily Global Mappings of Inundation Extent at ~25 km Resolution for the Period 1992-2017



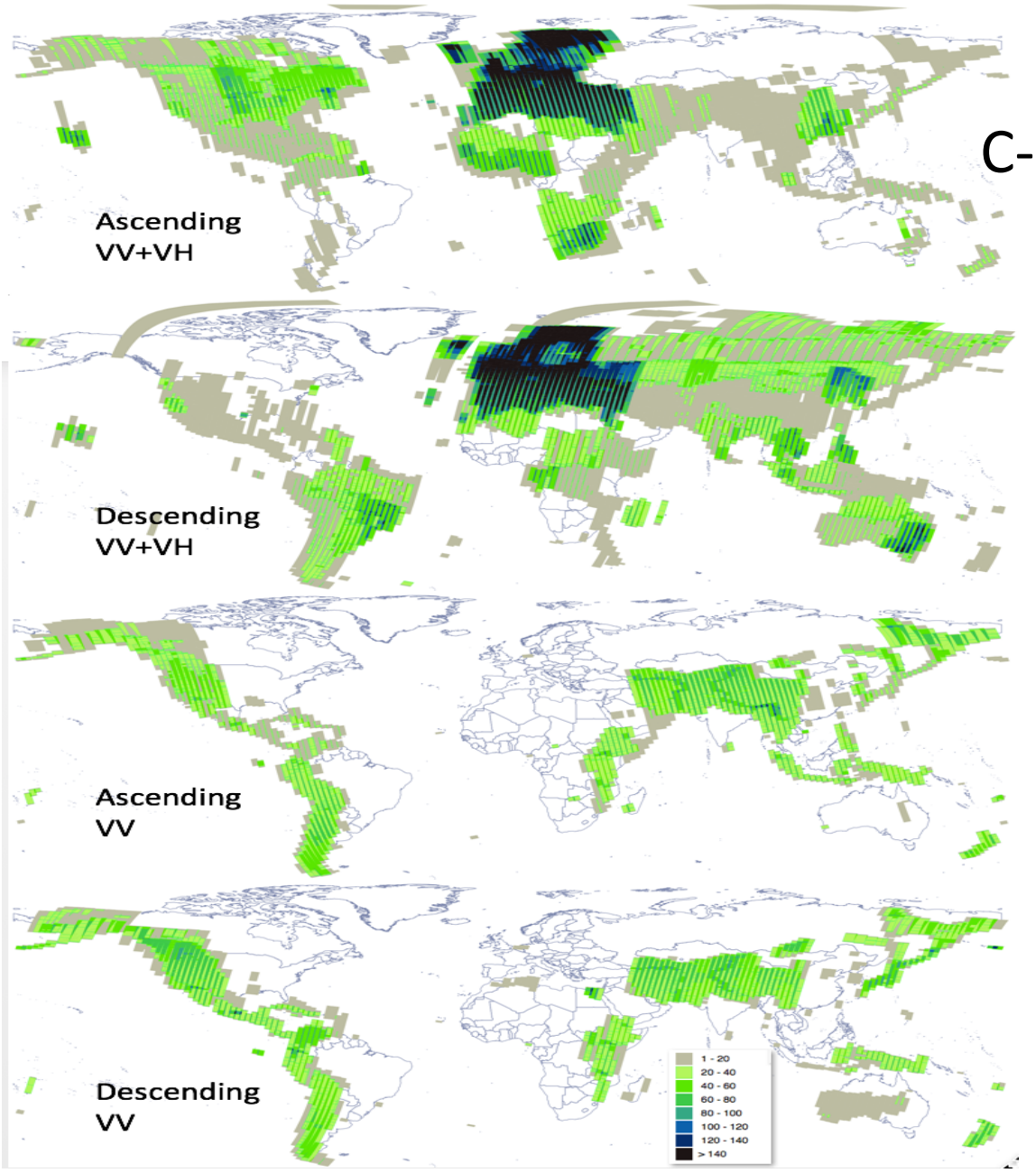
Schroeder et al 2015

Seasonal Maximum/Minimum Inundation from ALOS PALSAR ScanSAR

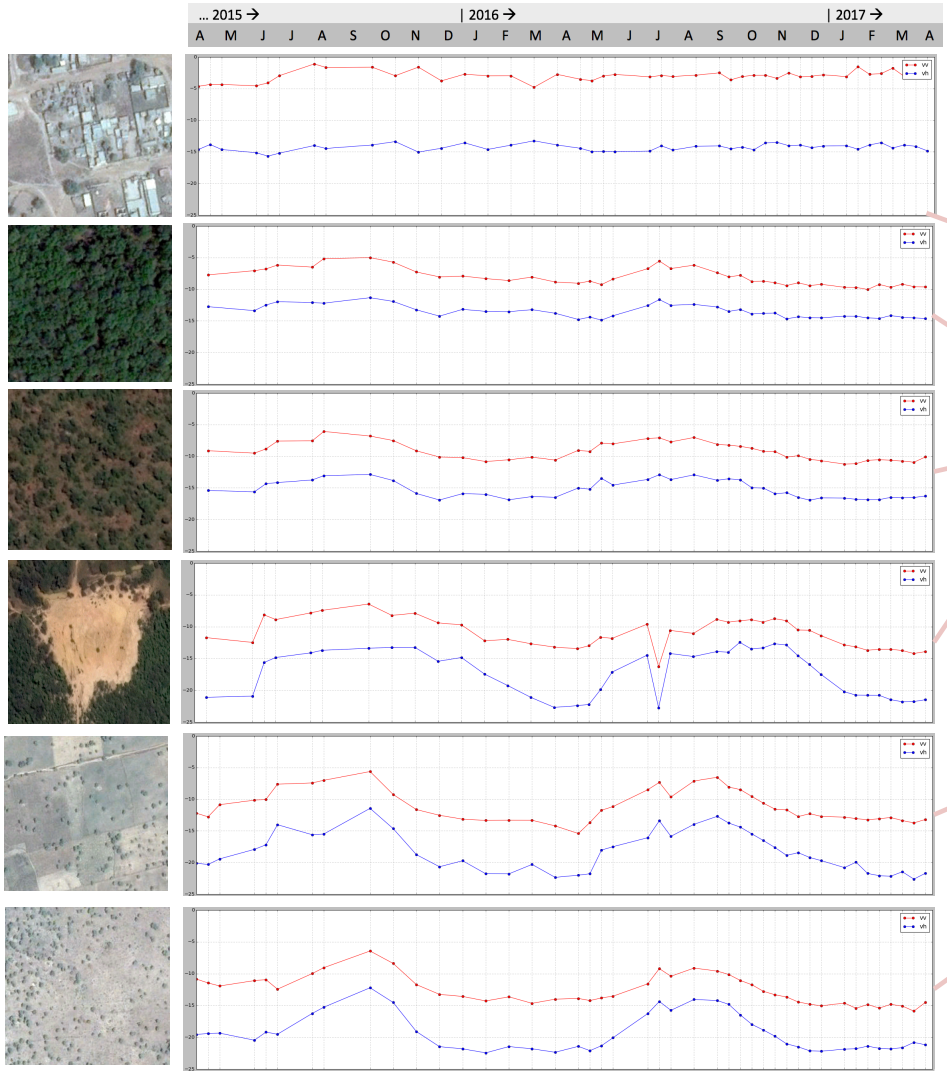


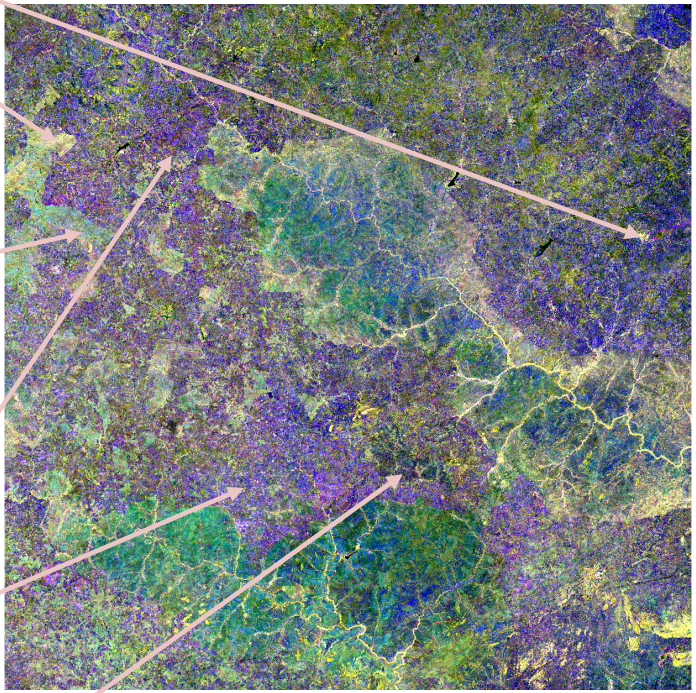
Chapman et al, 2015

Sentinel-1 A/B
C-band SAR coverage



Sub-Saharan Africa Study: Burkina Faso





Multi-temporal composite

R 2016-02-02 Dry

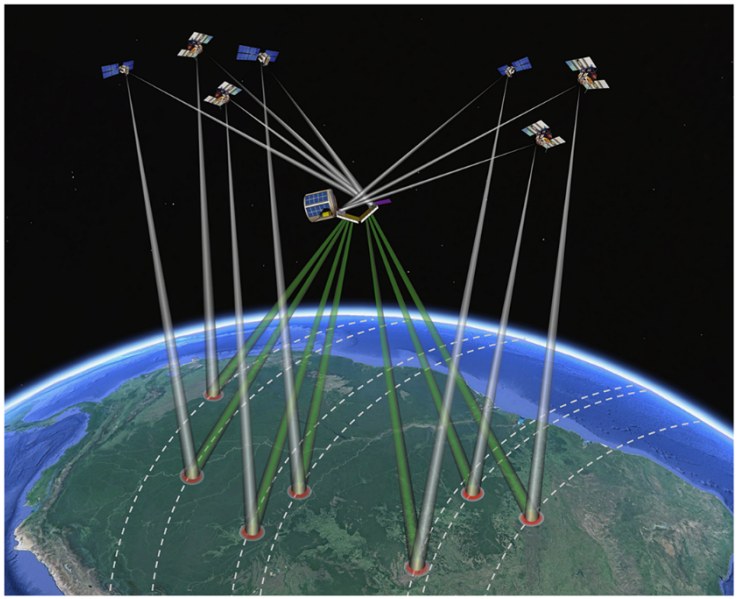
G 2016-04-07 Medium

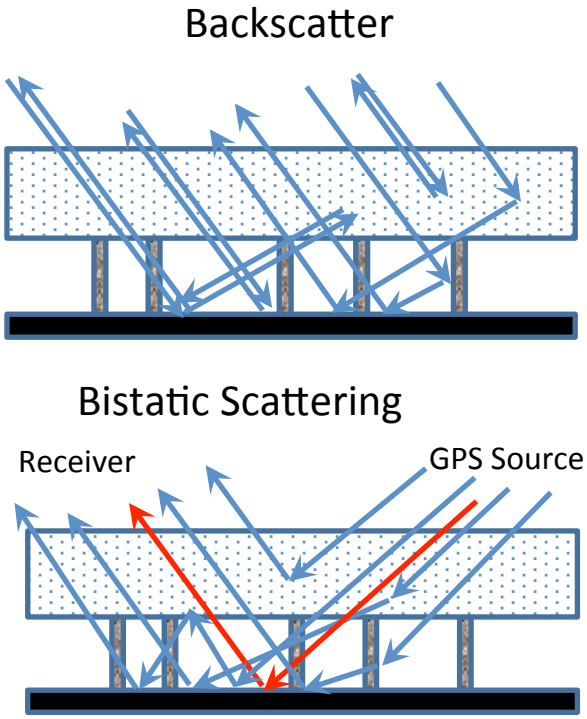
B 2016-08-29 Wet

Burkina Faso
N11 W002 (lower left)
1x1 degree tile

Sentinel-1 Time Series

GNSS-Reflectometry

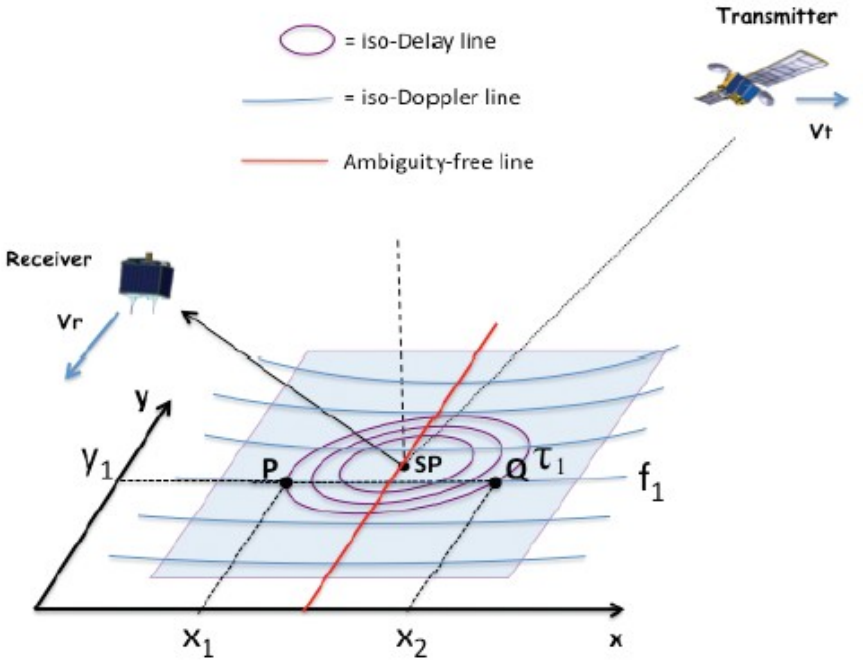


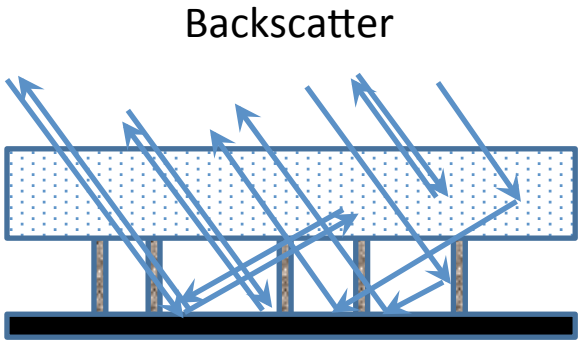


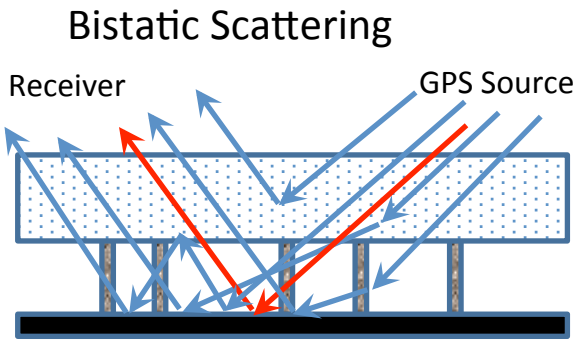
GNSS-R: Bistatic Radar Scattering Physics

- Increasing inundation gives rise to increased coherent forward scattering and hence **increases GNSS-R**
- Associated **backscatter will decrease**, indicating diffuse or surface scattering physics, **or will increase**, indicting double-bounce scattering.

GNSS-Reflectometry







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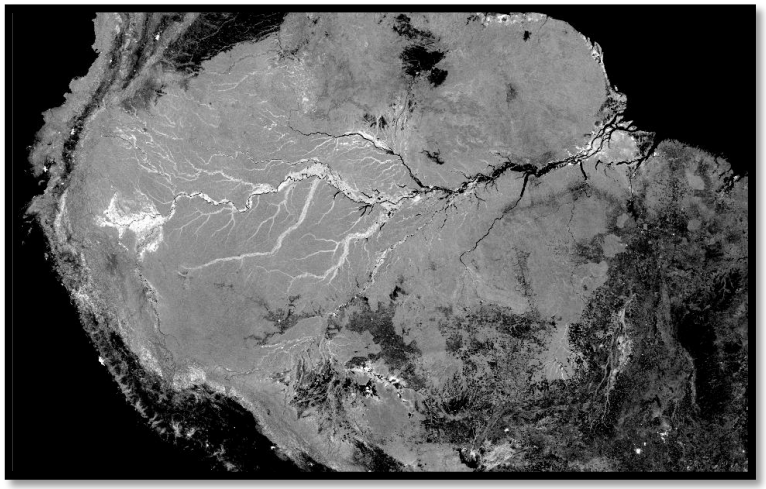
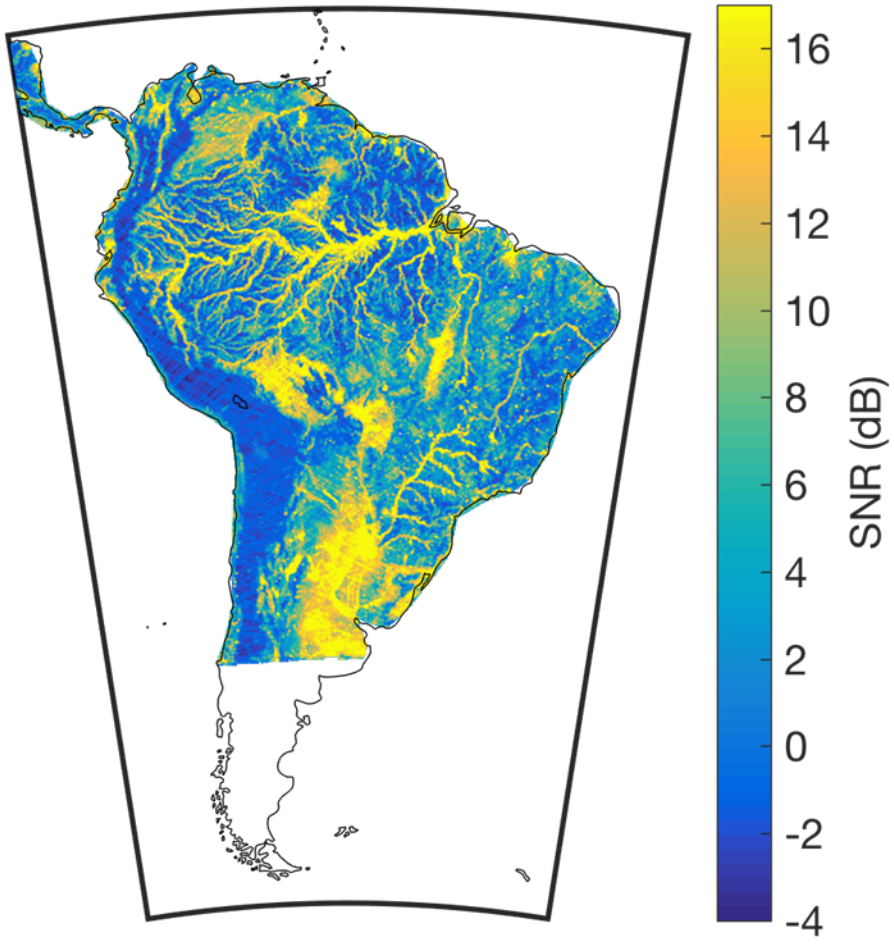
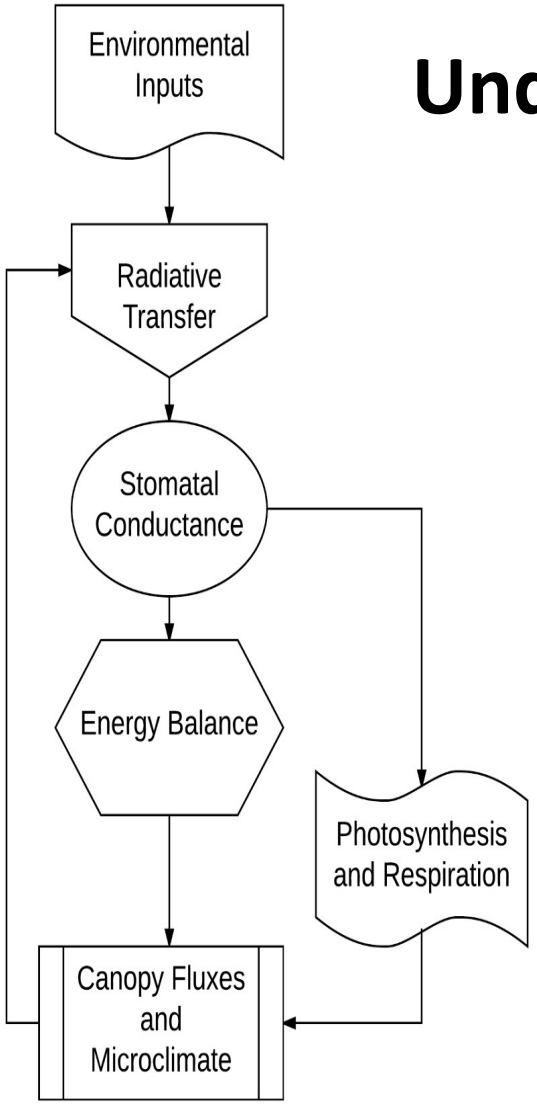


SMAP Radar Mosaic- Amazon
(HH- Apr. 2015)



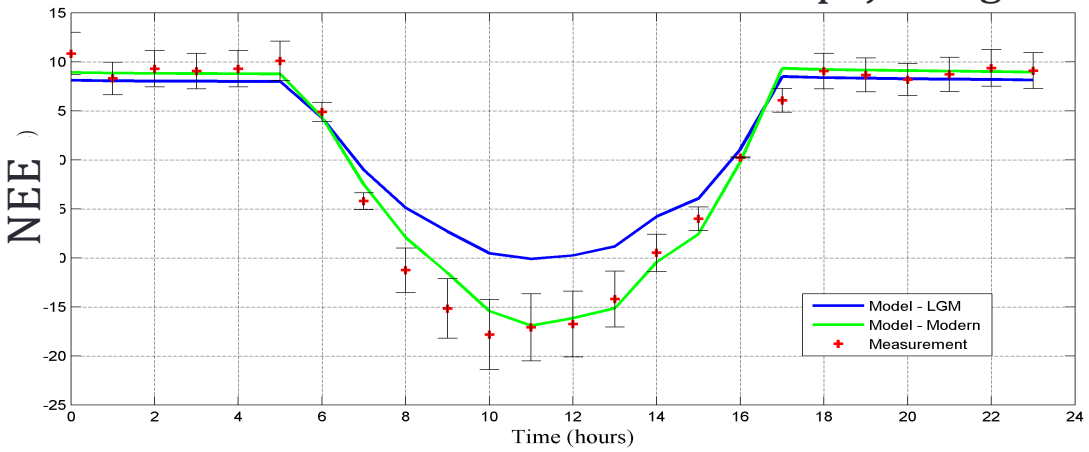
CYGNSS Reflections

Understanding Canopy Microclimate



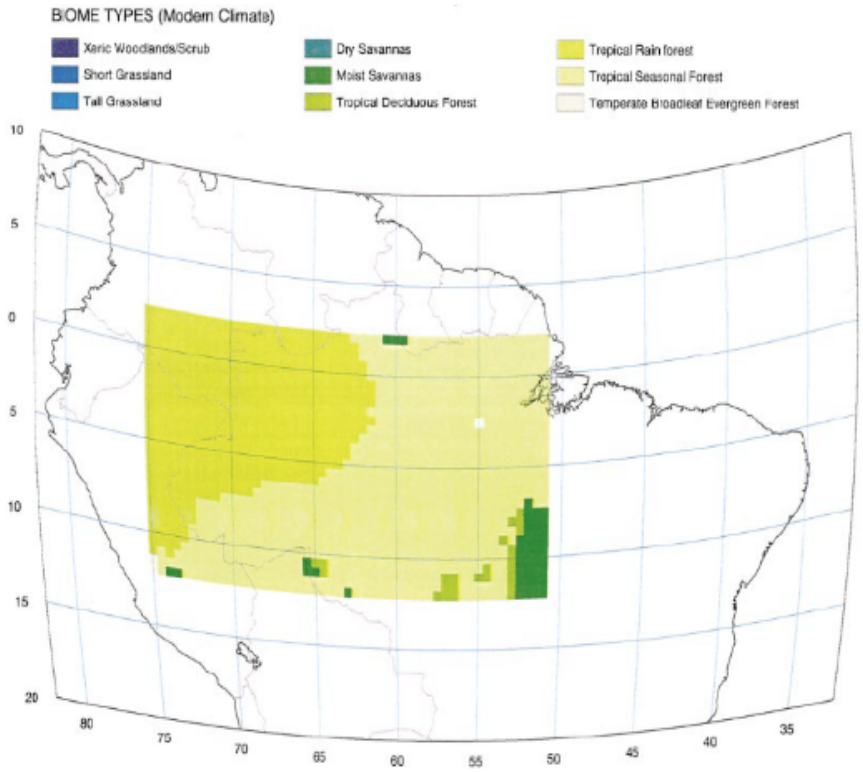
Simplified flowchart of CANOAK microclimate and flux model (Baldocchi, 1995).

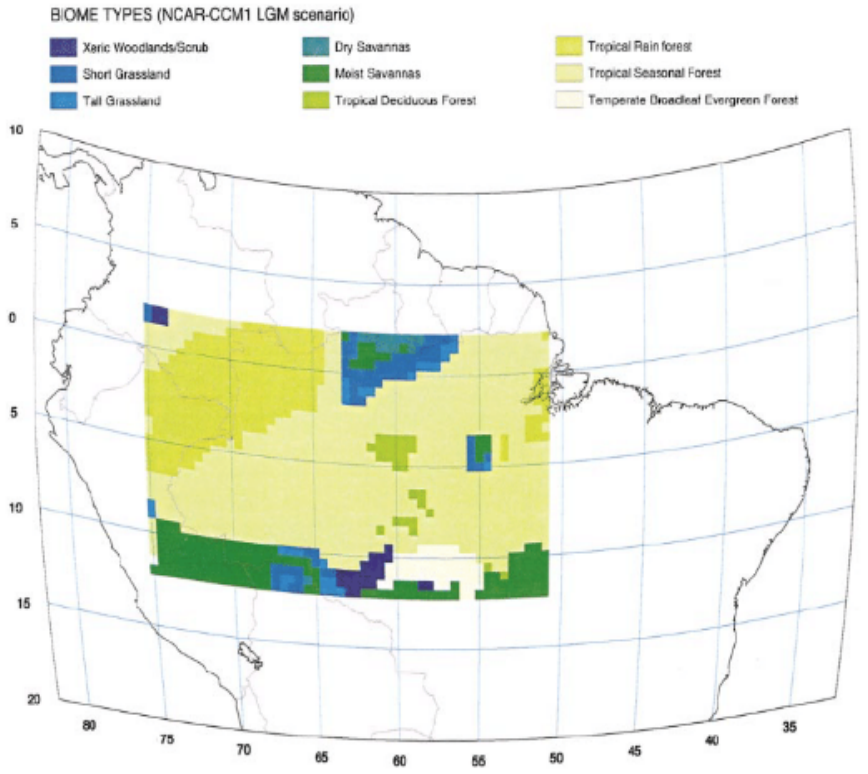
Tapajos region



Modern carbon flux data against modern and LGM estimates from CANOAK

Biome Distribution: Modern and LGM



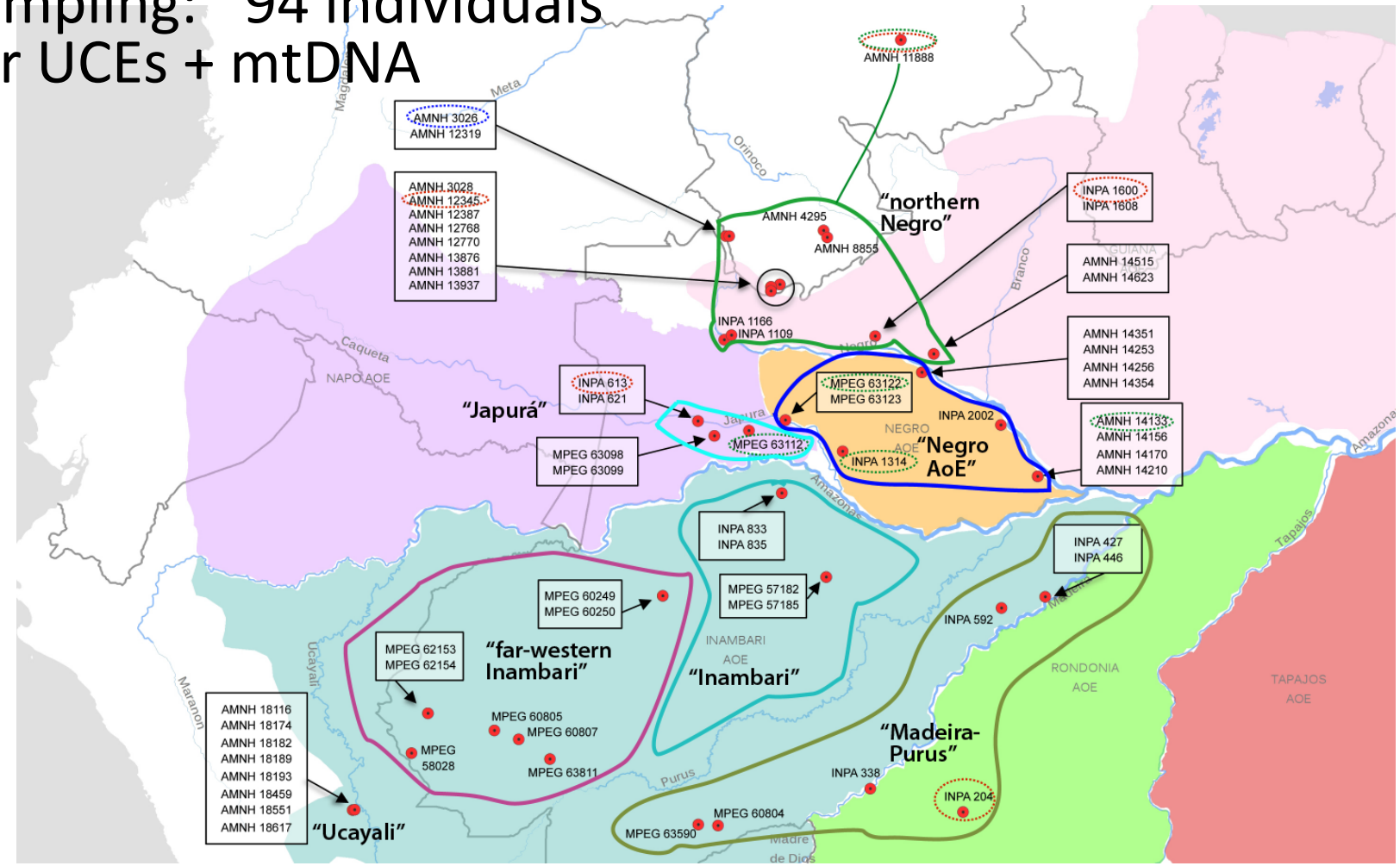


Dynamic Global Vegetation Models (DGVMs) estimate biome distributions in response to climate, show a somewhat substantially continuous forest at LGM

Lepidothrix coronata phylogeography: the spatial setting

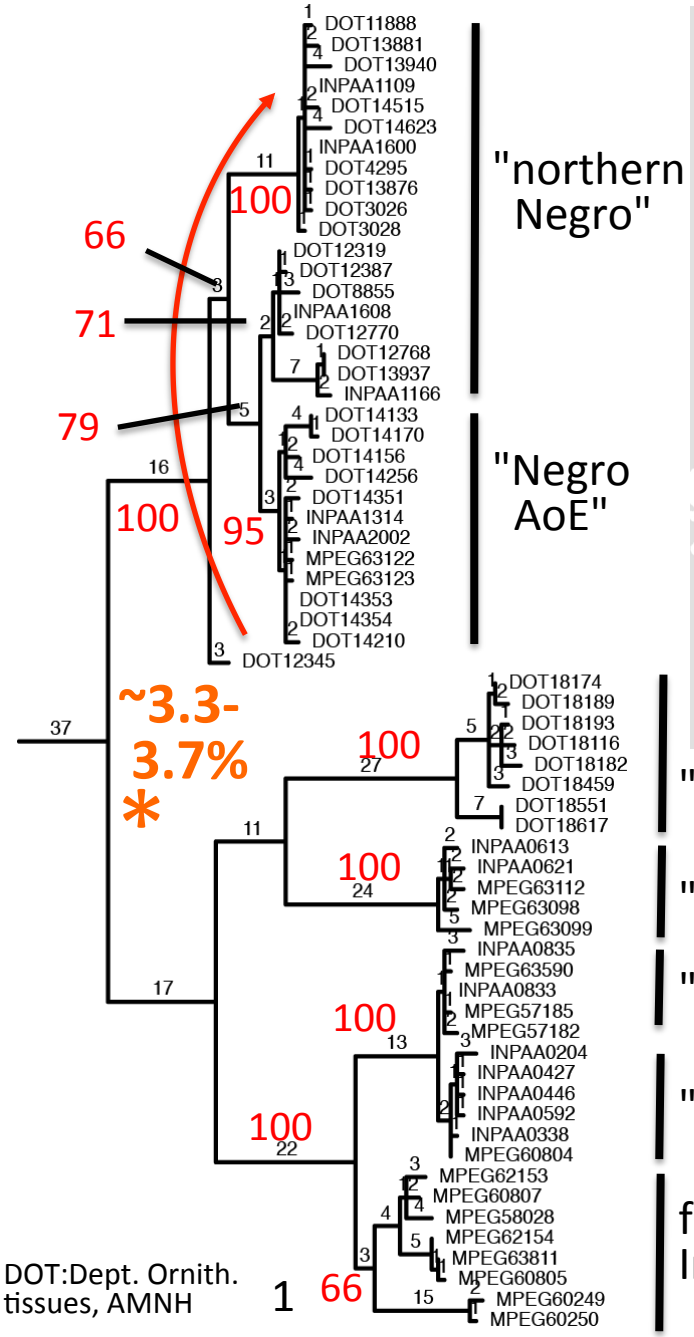
Stress: preliminary, incomplete sampling, etc.

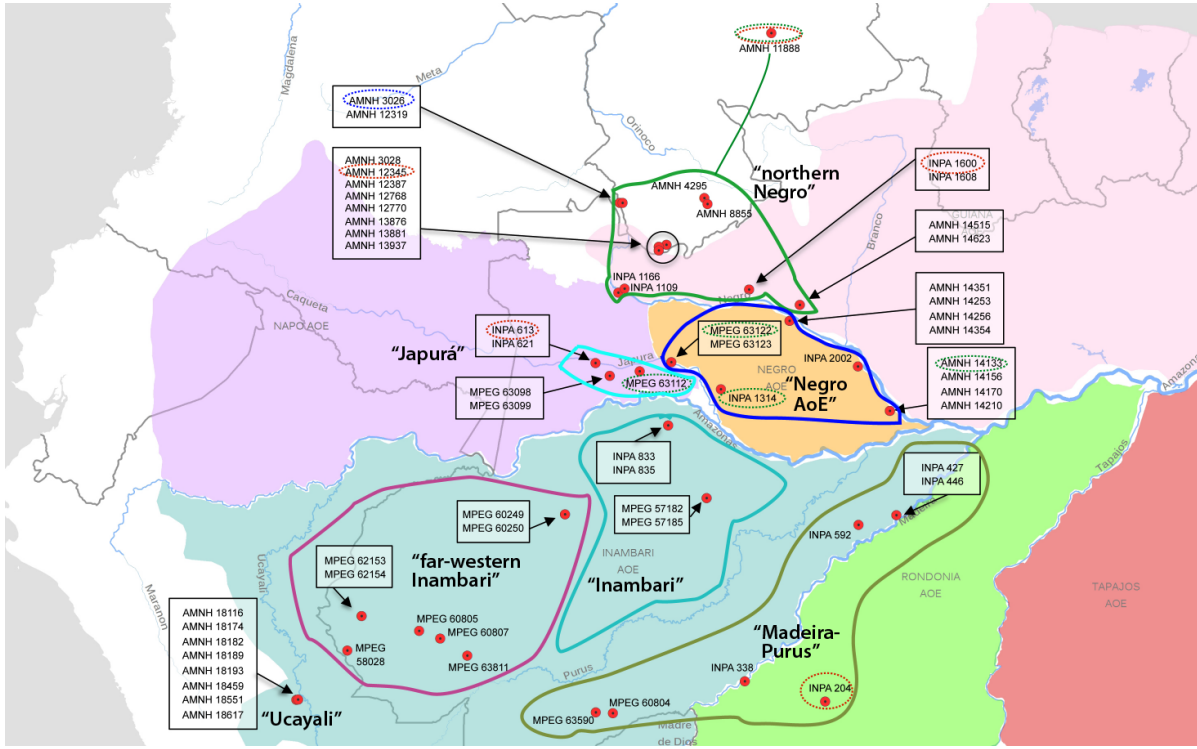
sampling: ~94 individuals for UCEs + mtDNA



phylogeographic studies: Blue-crowned Manakin—demonstrates a high level of genetic and spatial structuring indicating patterns of microendemism.

Lepidothrix coronata phylogeography: ND2 + cytb (2184 bp)





- North-south split
- Ucayali + Japurá ?
- Moderate-good BS

DOT:Dept. Ornith. tissues, AMNH

1 66 100 bootstrap support

Working groups, São Paulo Dimensions meeting, 31 October-2 November 2016

- Biotic and environmental history of western Amazonia
- Spatial analysis of Amazonian biodiversity
- LGM paleoenvironmental and biogeographic change in eastern Amazonia
- Connections between Amazonia and Atlantic Forest
- Landscape of eastern Amazonia prior to origin of major river system
- River dynamics and biotic diversification