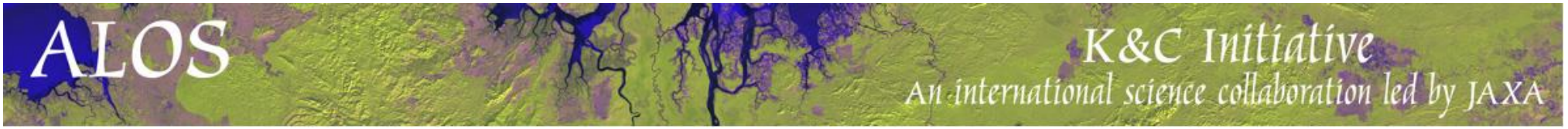


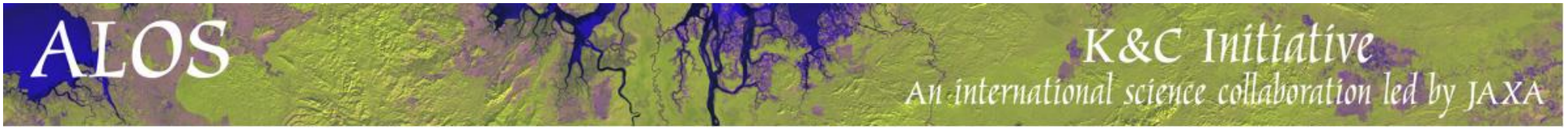
K&C Phase 4 – Final Report

Mapping Wetlands, Surface Structural Attributes, and Boreal Freeze/Thaw at Regional Scales with JAXA SAR Datasets

Kyle C. McDonald

Department of Earth and Atmospheric Sciences
City College of New York
City University of New York
New York, NY, USA

Science Team meeting #25
Tokyo, Japan, February 5-8, 2019



Mapping Wetlands, Surface Structural Attributes, and Boreal Freeze/Thaw at Regional Scales with JAXA SAR Datasets

Collaborators:

Ana Carnaval, Maria Tzortziou (CCNY)
Laura Chavez (Michigan Tech)
Joel Cracraft (American Museum of Natural History)
Bruce Chapman, Erika Podest (JPL/Caltech)
Mahta Moghaddam (USC)
Lisa Rebelo (IWMI), Thiago Silva (UNESP)

CCNY Contributors:

Nicholas Steiner, Kat Jensen, Brian Lamb, Aaron Davit, Jessica Rosenqvist, Rehnuma Islam

Science Team meeting #24
Tokyo, Japan, January 29-31, 2018

Project Objectives

Wetlands

Extension of on-going wetlands work

- 30-year record: JERS, PALSAR, PALSAR2

South America, Alaska, Canada, Africa

Additional Regions

Chesapeake Bay – Estuarine carbon, Land-ocean exchange

New England, **Long Island Sound** – Land-ocean carbon exchange; Built environment and urbanization impacts

River Deltas – Carbon & Conservation (Mekong, Indus, **South Asia**)

Boreal peatlands – Canada, Alaska - Soil organic carbon influence on moisture and temperature controls to carbon flux and fire risk.

Project Objectives

Freeze/Thaw

Alaska, Canada, Northern Europe

– Thermokarst studies

– Permafrost carbon cycle

High Mountain Asia

- Snow and glacier melt links to climate

- Climate change links to economies (hydropower, fisheries)

Biodiversity and Surface Structure

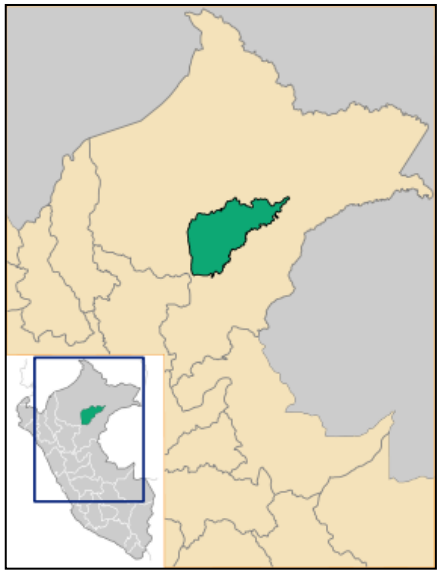
Amazon and Brazilian Atlantic Coastal Forest

– Biodiversity (relevance to Conservation)

– Biome classification, landcover structure

Pacaya-Samiria National Reserve, Peru

- Most extensive tropical flooded forest in the Peruvian Amazon
- Spans area of more than 20,000 km²
- Hosts rich biodiversity
- Home to variety of wetland types, primarily palm swamp

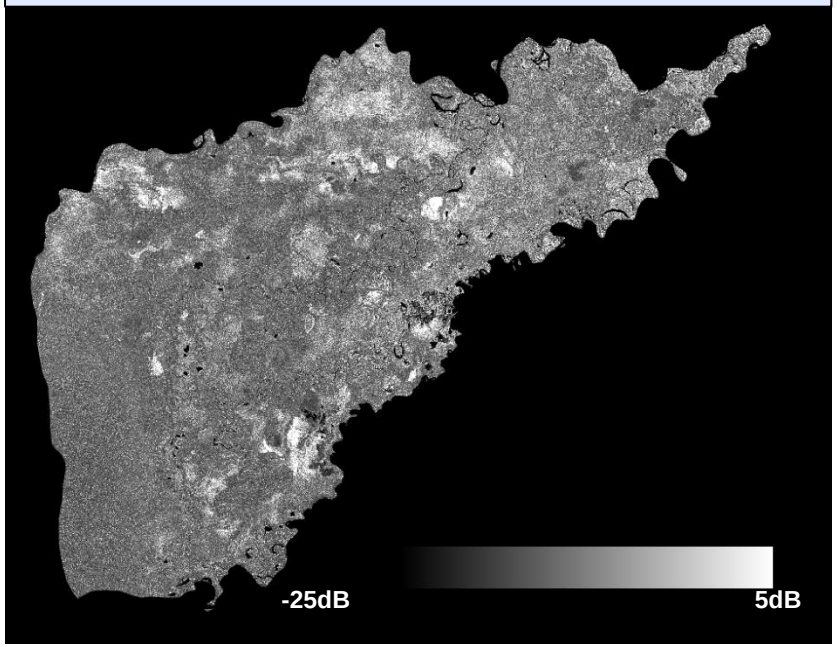


Mapping of wetlands in Pacaya Samiria Reserve, Peru

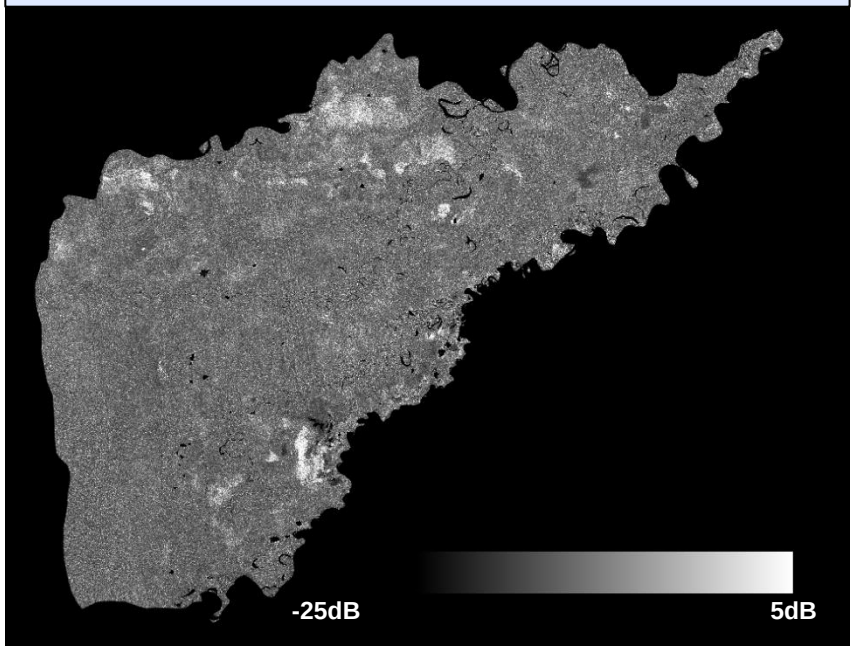
Multi temporal SCANSAR

Seasonality of inundation patterns

Wet Season [Mar-Apr 2009]
HH-polarized ALOS PALSAR Fine-Beam



Dry Season [Jul-Aug 2010]
HH-polarized ALOS PALSAR Fine-Beam



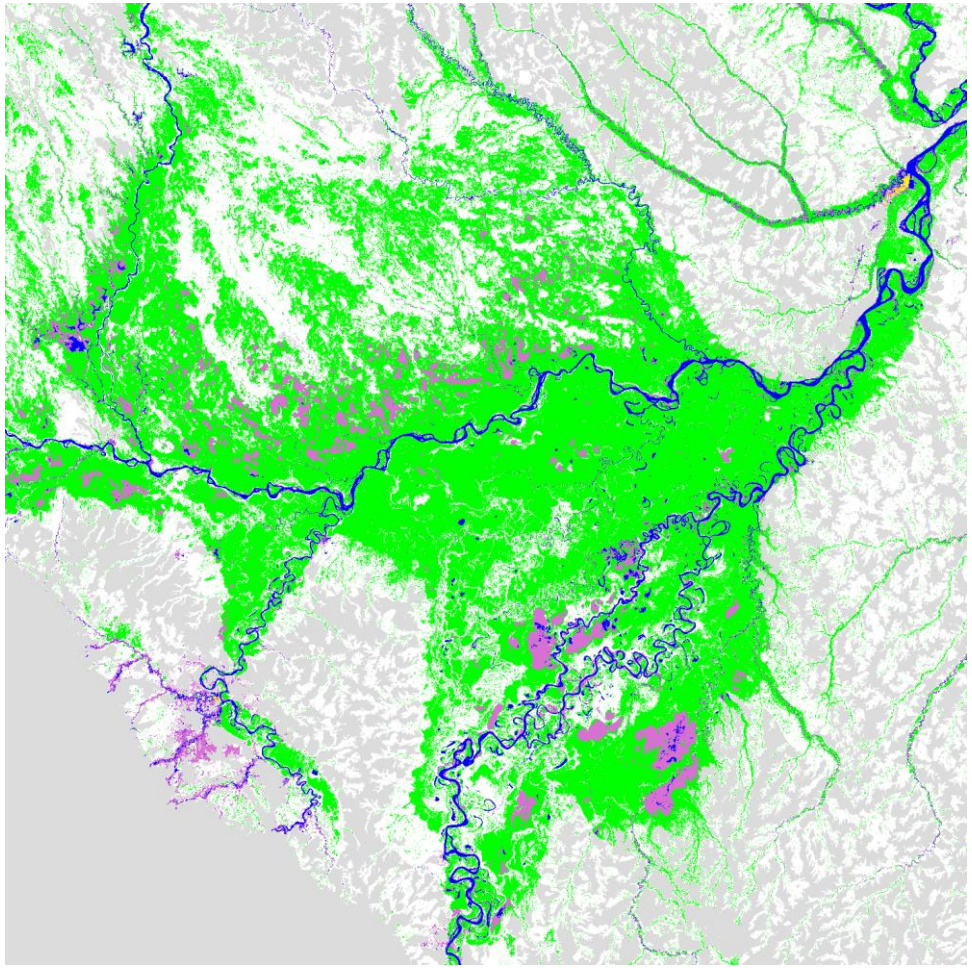
Classification of PALSAR-2 Scansar Mosaics

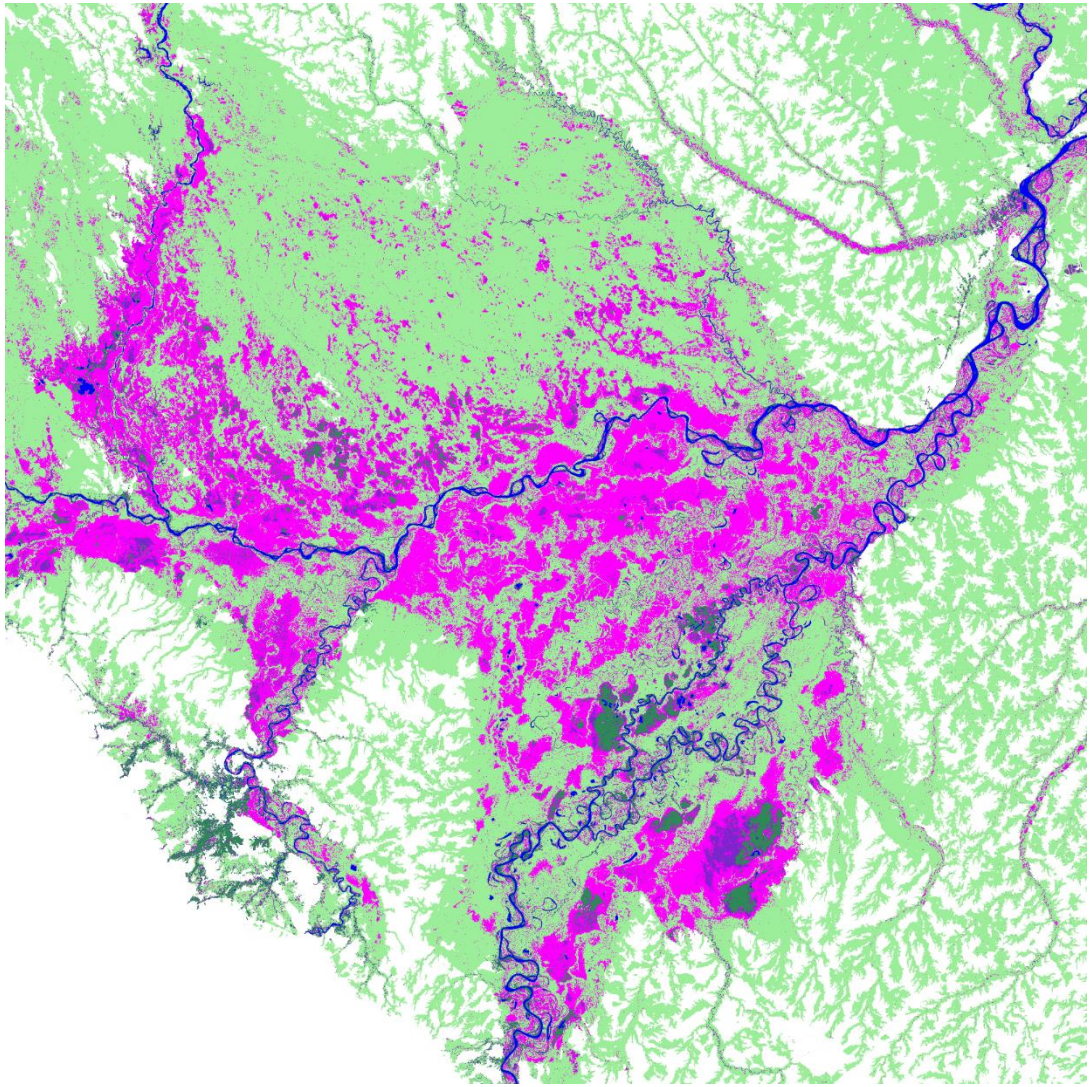
Maximum Extent Classification

This classification delineates the maximum extent of inundatable areas observed in our PALSAR-2 time series

- **Open Water**
- **Flooded Low Biomass Vegetation**
- **Flooded High Biomass Vegetation**
- **Never/rarely inundates**
- **Masked**

→ Can use this as a mask to classify individual mosaics



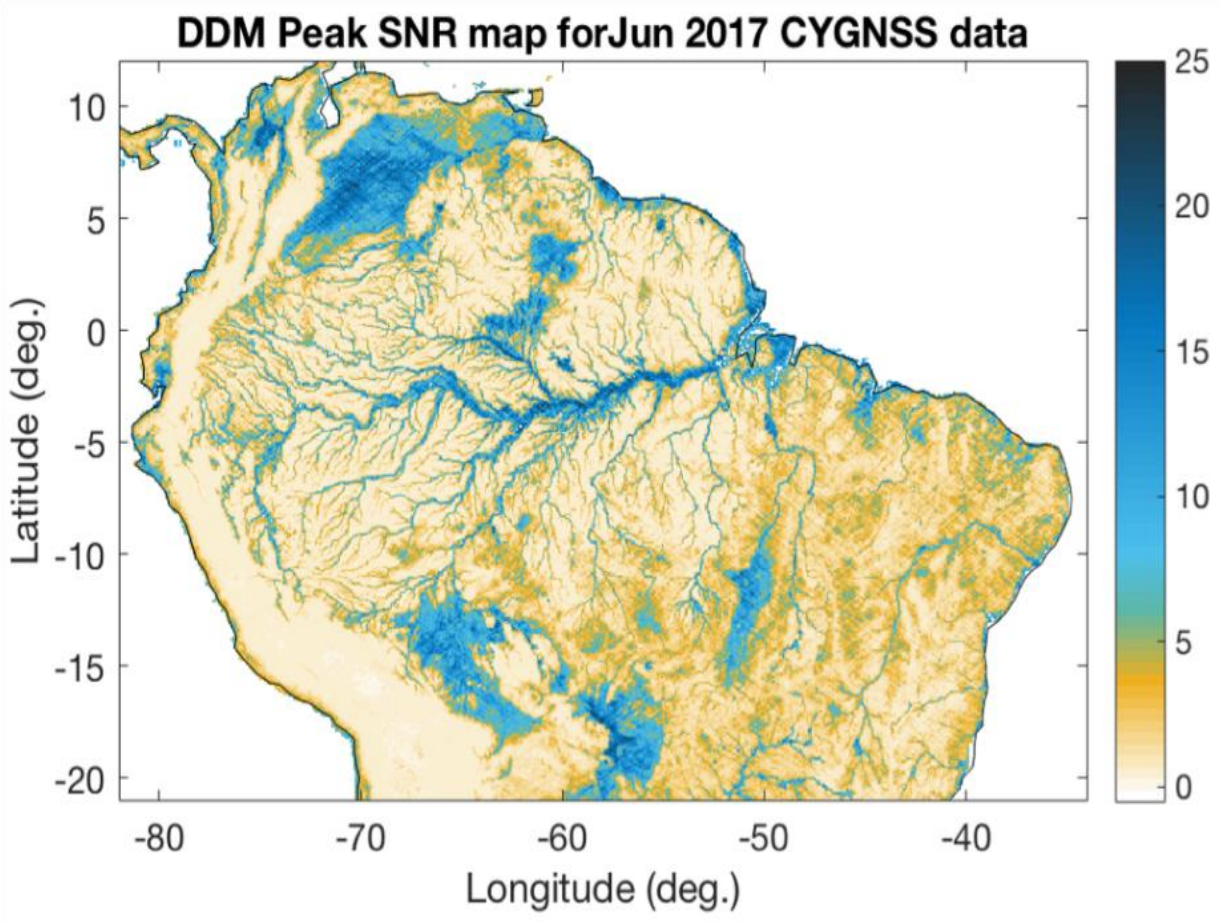


Land Cover Classification Based on Multi-temporal PALSAR 2 Pacaya Samiria National Reserve, Peru

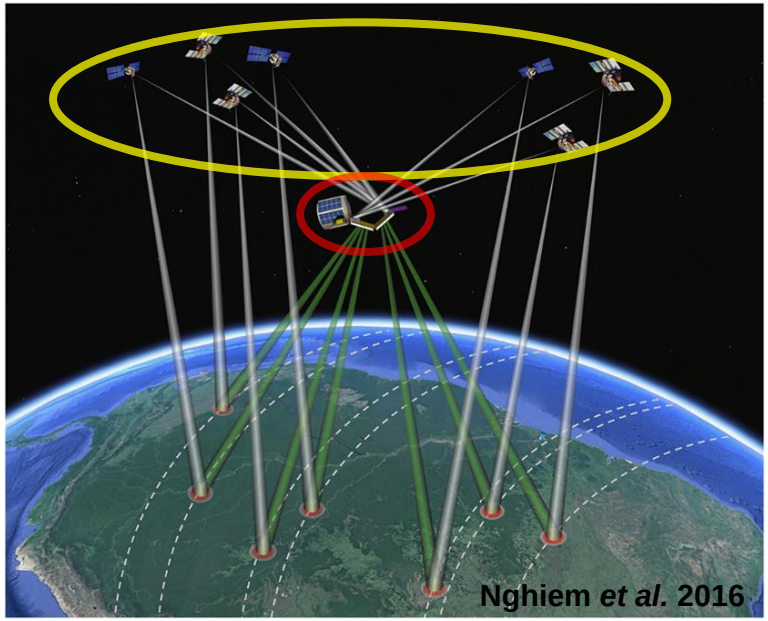
- **Permanent Open Water**
- **Intermittent Open Water / Flooded Low Vegetation**
- **Seasonally Flooded Forest**
- **Permanent Flooded Forest**
- **Never Flooded**

Regions where Height Above Nearest Drainage (HAND) index > 20m masked out in white

GNSS Reflections: CYGNSS



GNSS-Reflectometry



- Operates at L-band
  - Penetrates 'all weather' and some vegetation canopies over wetlands

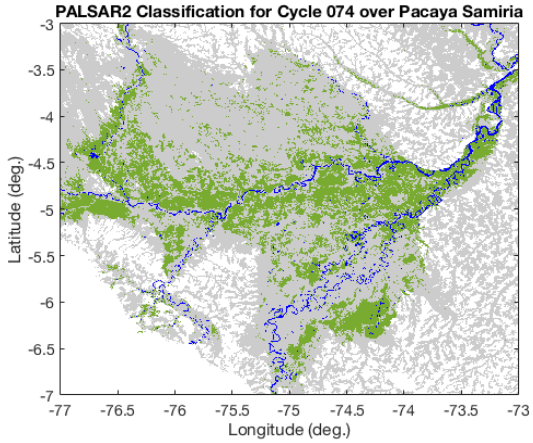
- **Bistatic radar** concept takes advantage of GNSS transmitting satellites
- GNSS receivers receive surface-reflected **signals of opportunity**
- A GNSS-based sensor does not need to transmit signal
  - "Passive", smaller, cheaper
  - This enables small platforms, **constellations**

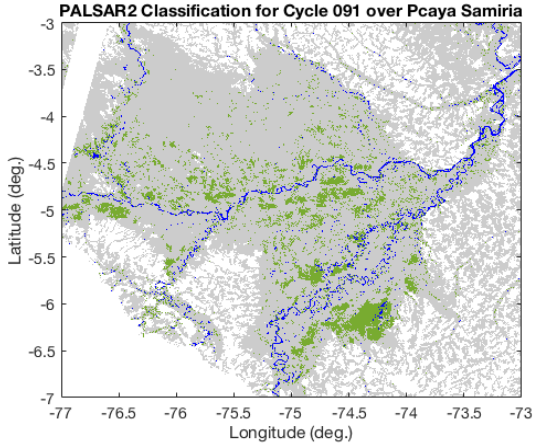
→ Which increases spatio-temporal sampling at reasonable cost

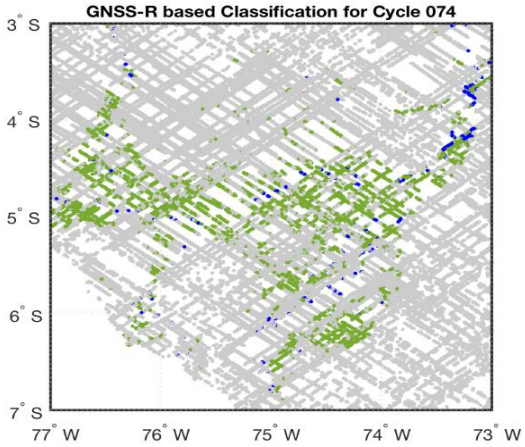
Pacaya Samiria Classifications

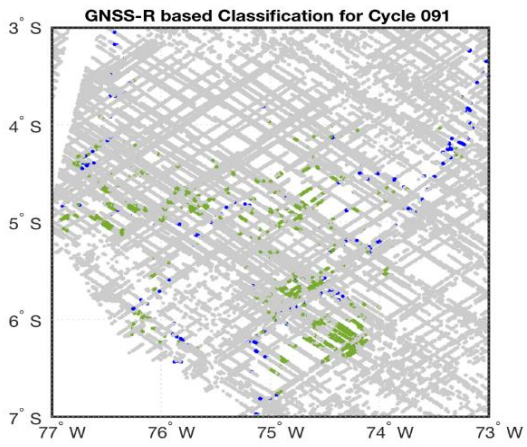
PALSAR2 ScanSAR

GNSS Reflections









ALOS

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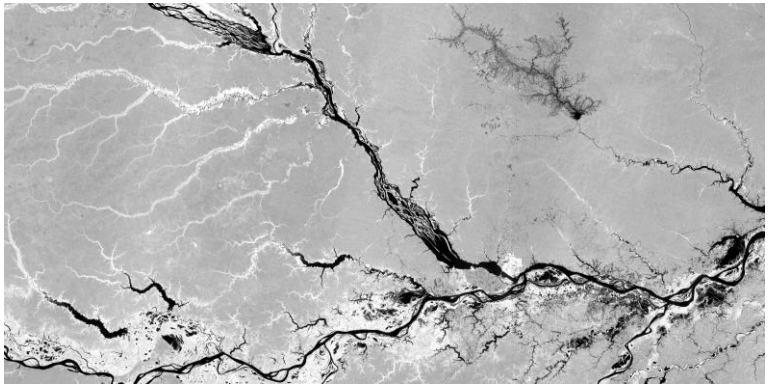
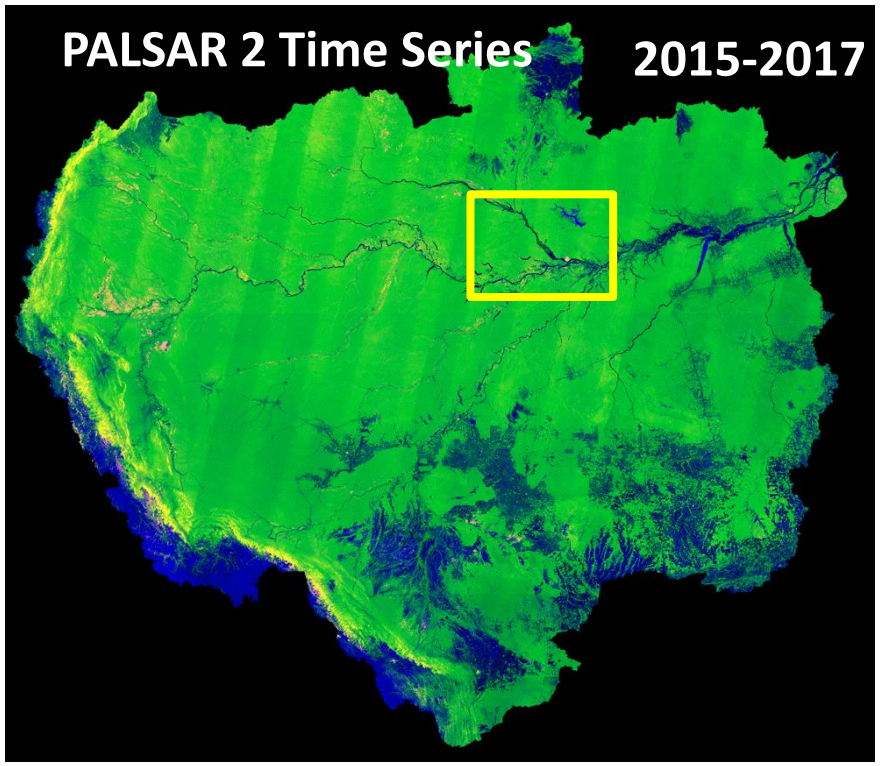
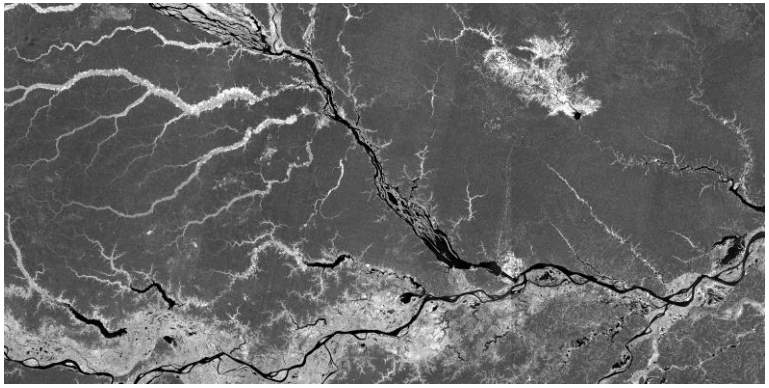
Amazon Inundation Monitoring
ALOS-2 PALSAR-2 ScanSAR

PALSAR Backscatter Statistics: Central Amazon

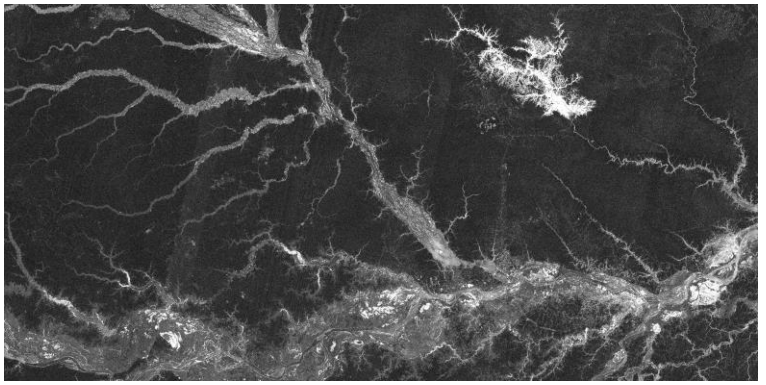


HH Mean



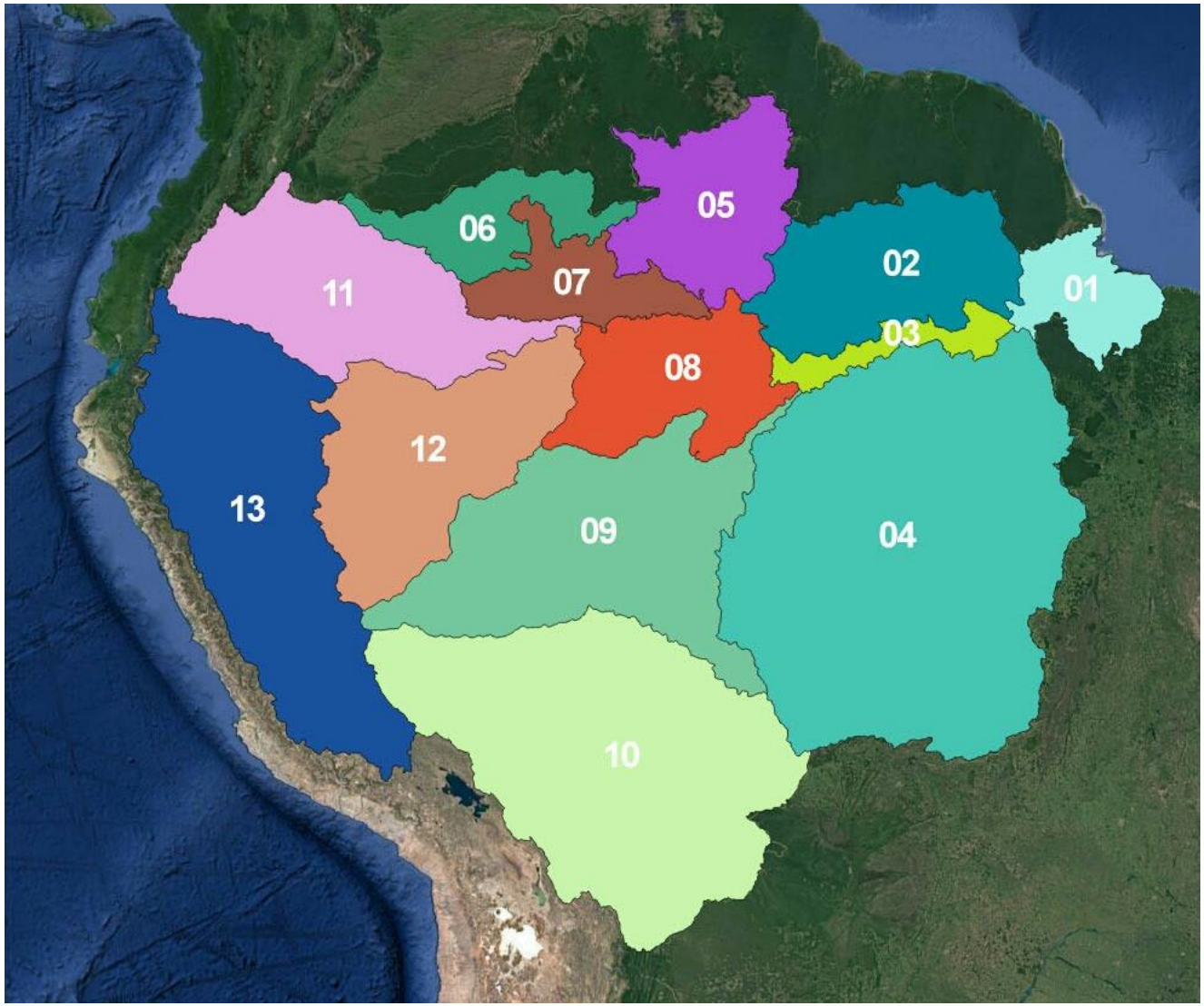


HH St Dev



HH Max – Min: Dynamic Range in dB

Amazon Sub-Basins



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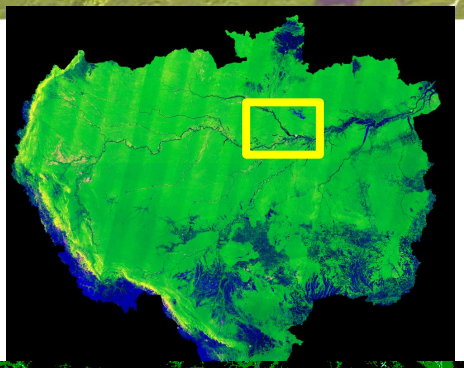
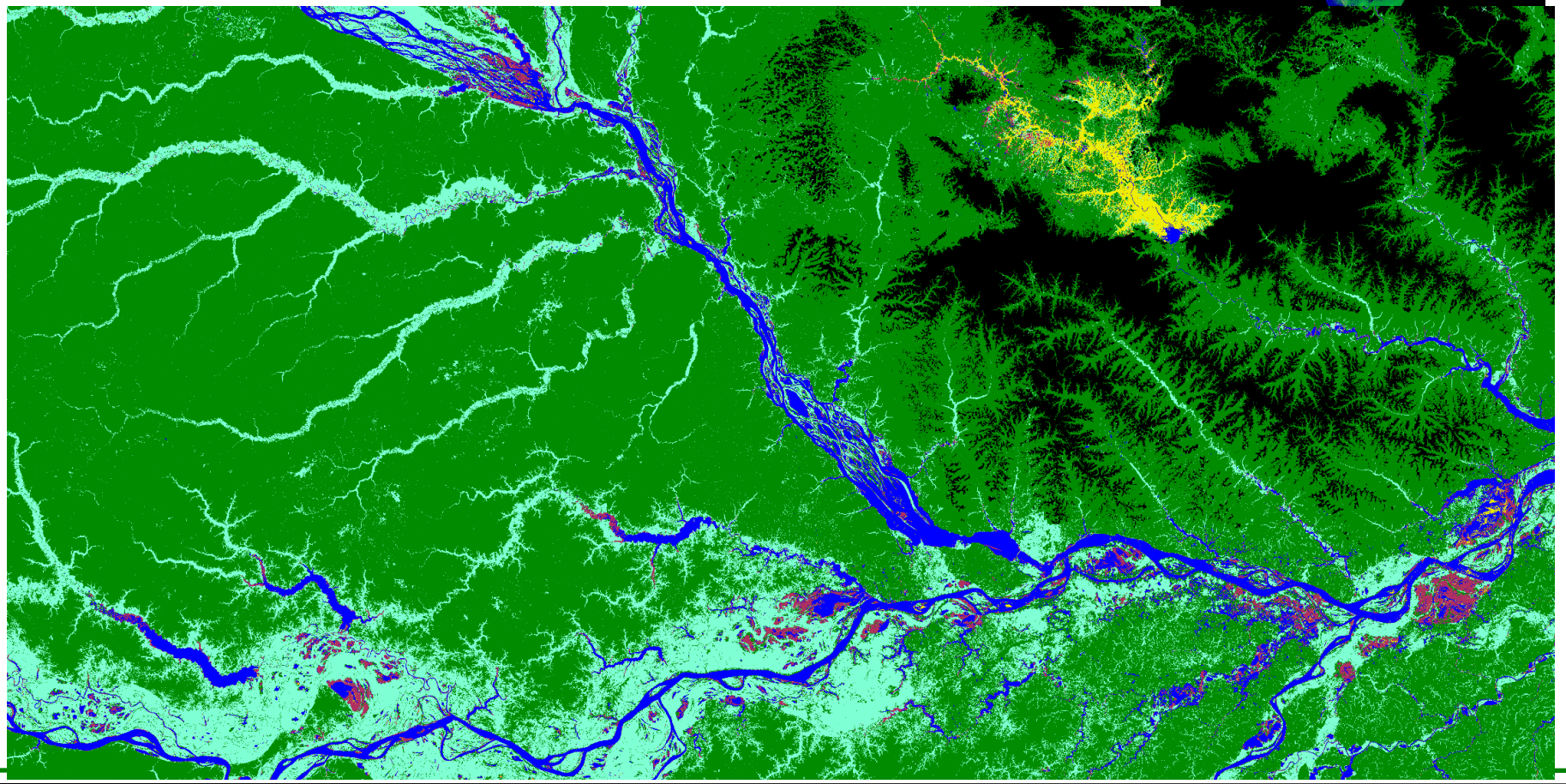
Dark Blue: Open water
Light Blue: Inundated Forest
Green: Never Flooded Forest/Vegetation
Yellow: Balbina Dam region
Maroon: Seasonally submerged forest
Black: Masked areas

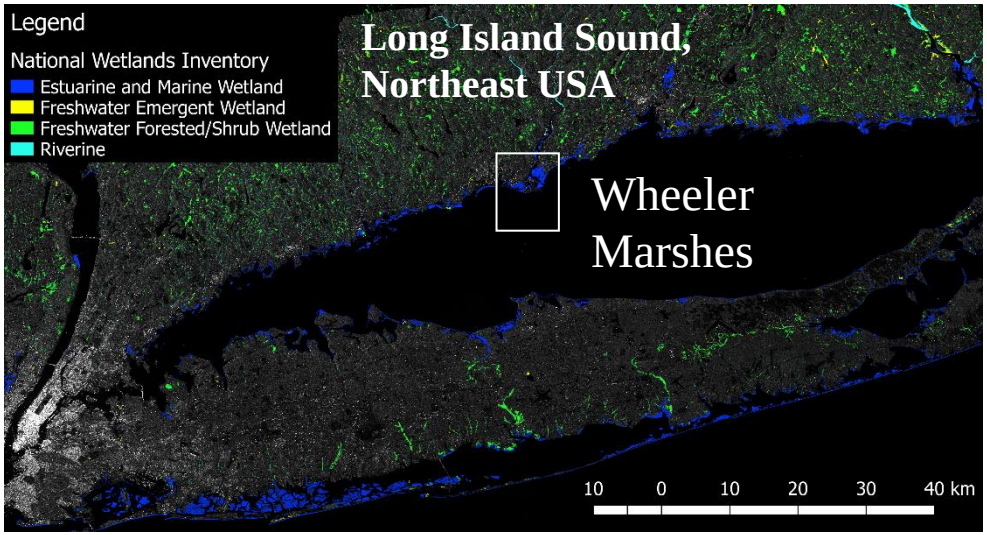
PALSAR Classification: Central Amazon

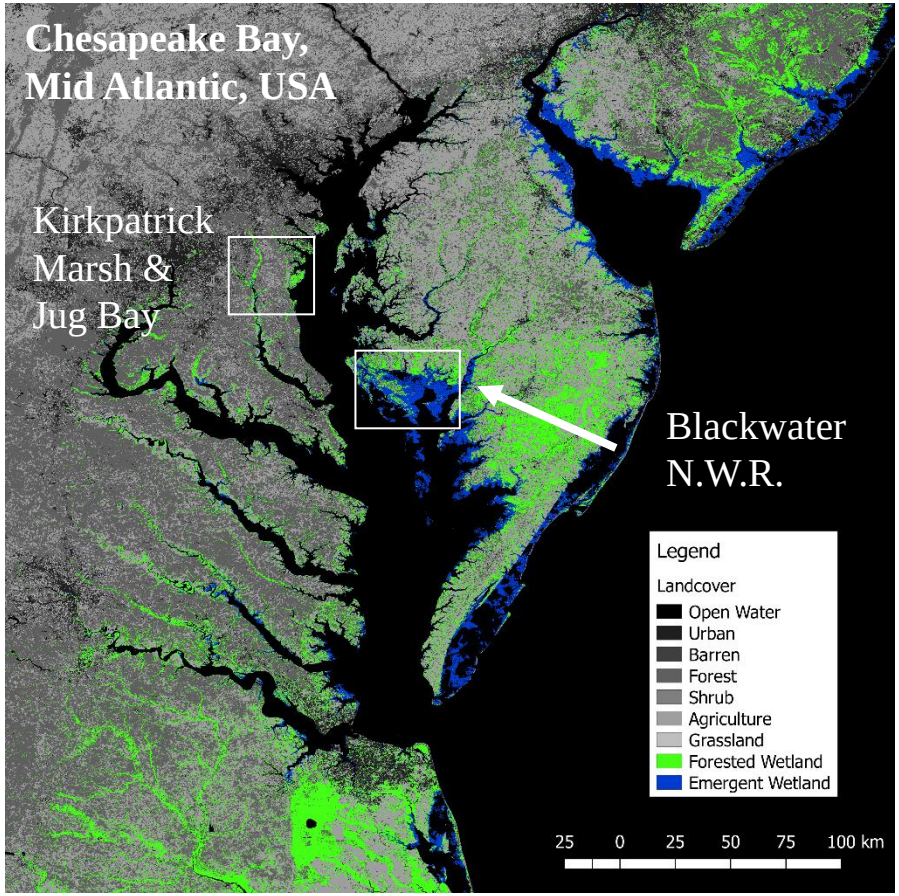




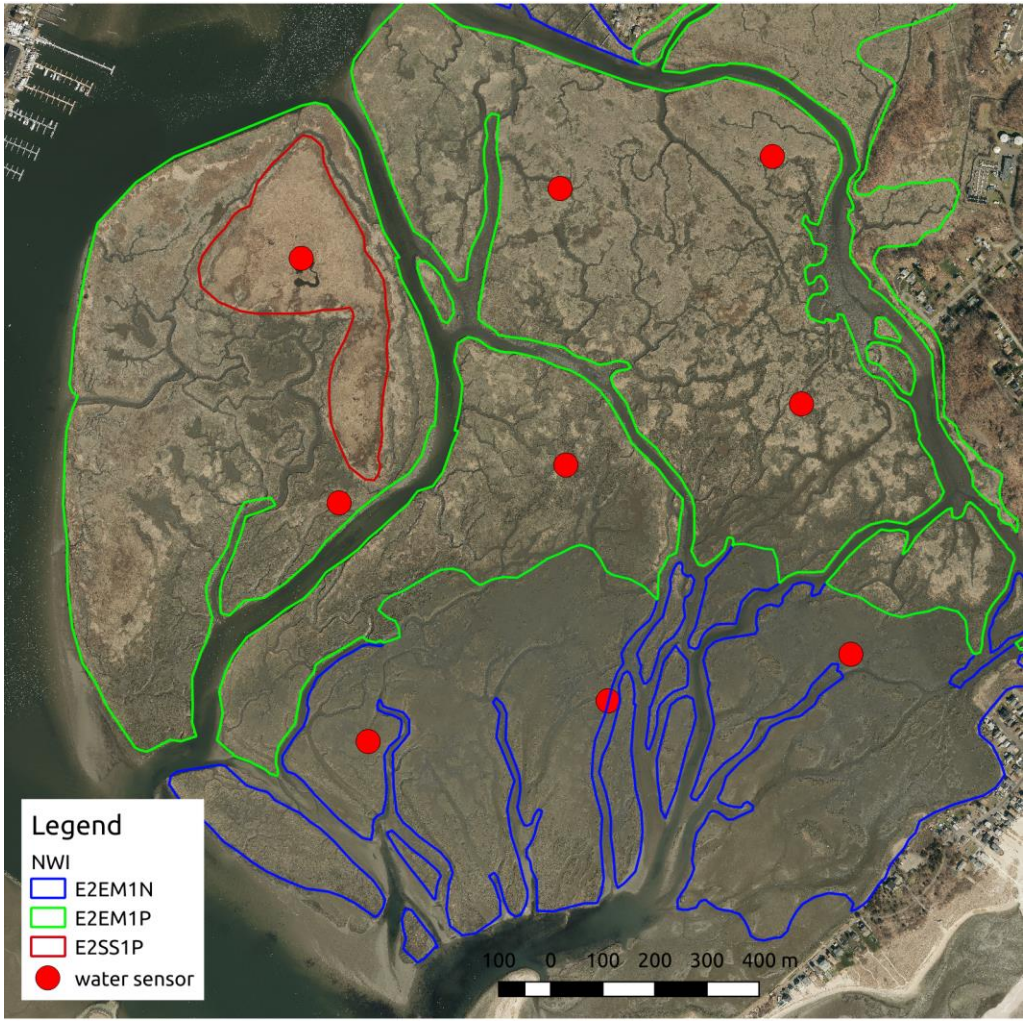
Coastal Wetlands

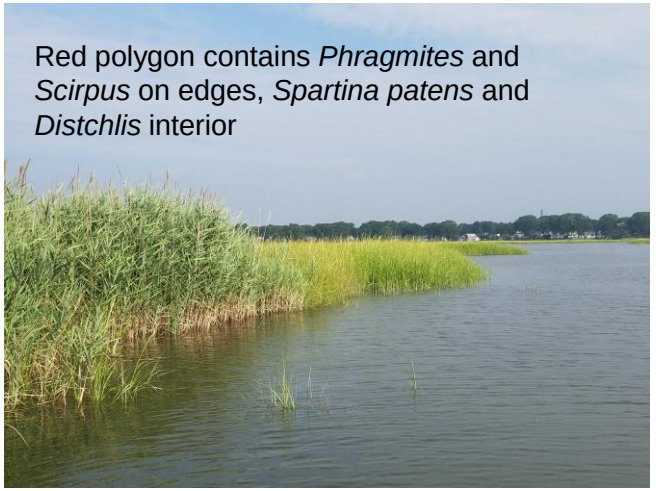
- Regional wetlands processes driven by tides and river discharge
- Colored regions on maps depict wetland locations

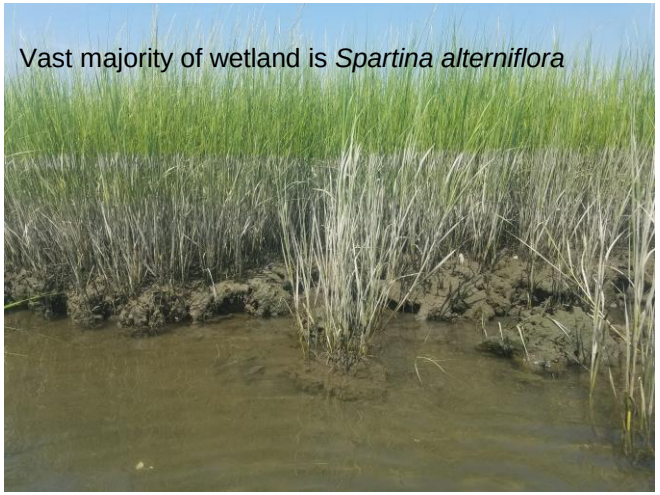




Target Study Sites: Wheeler Marshes (low marsh end-member)

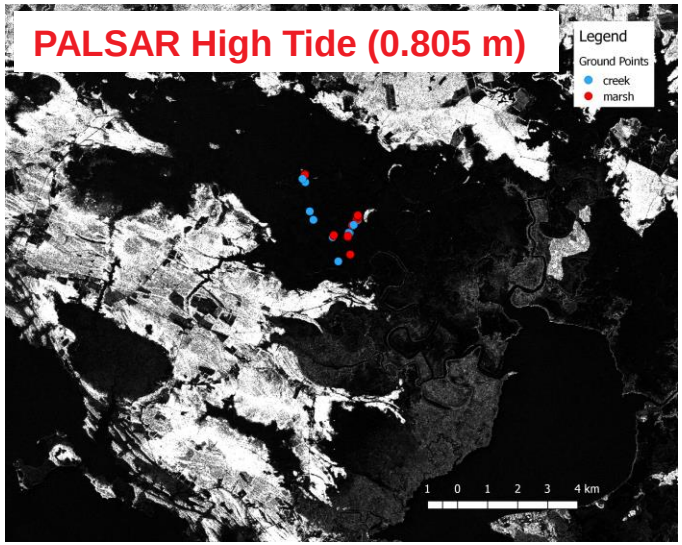




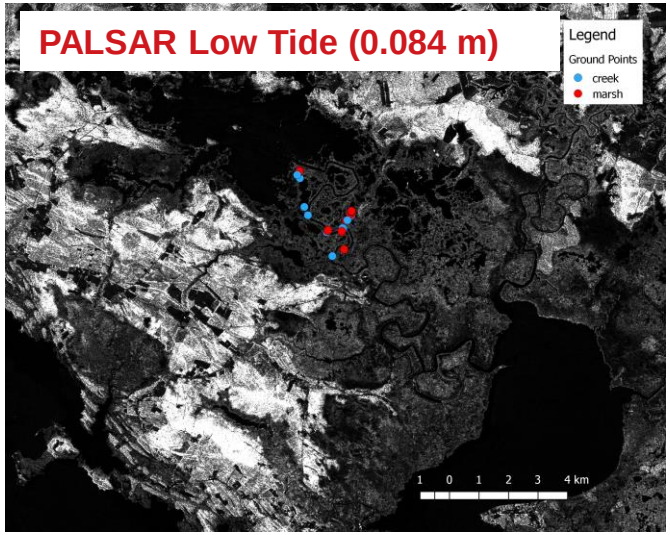


Inundation mapping with PALSAR HH imagery over Blackwater NWR

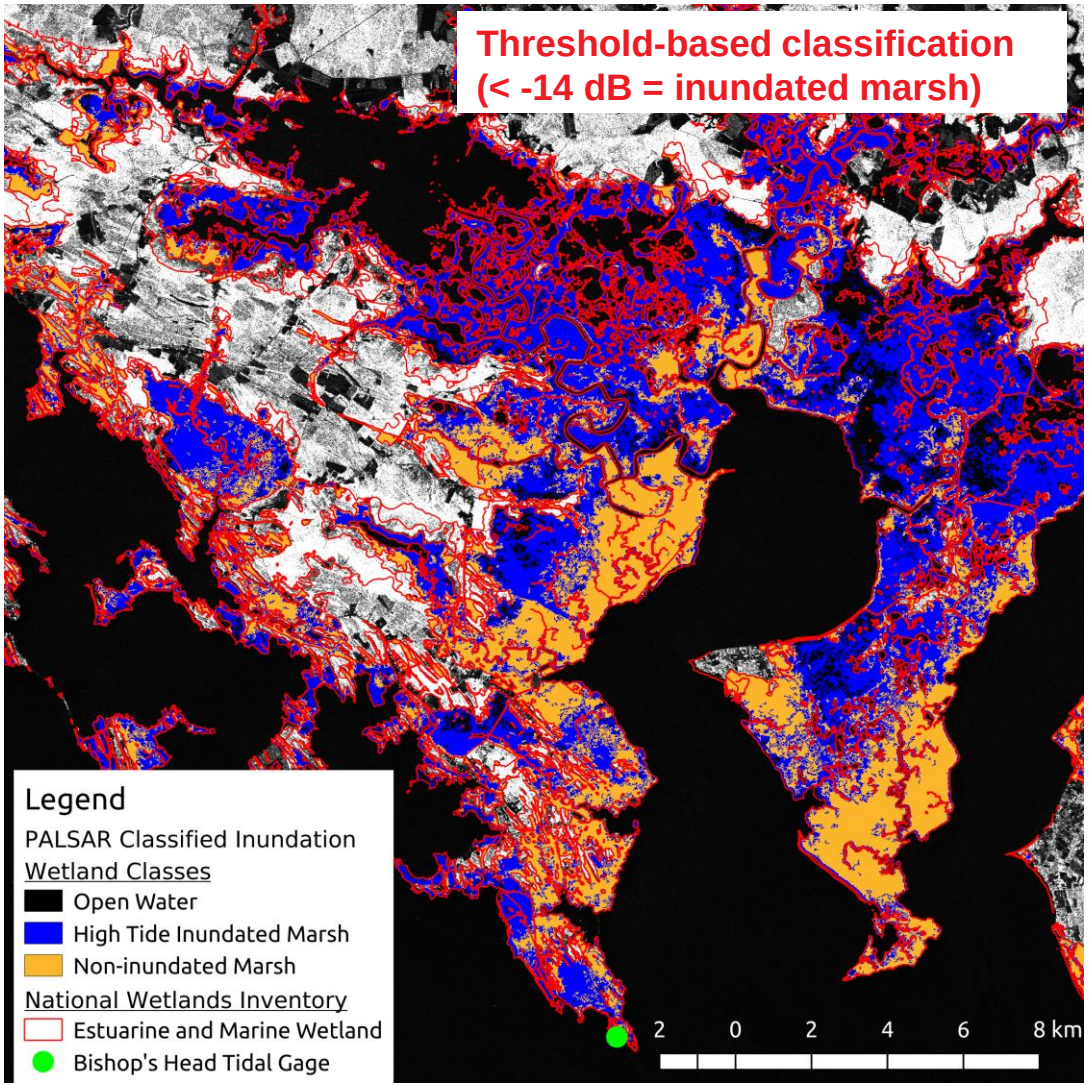
PALSAR High Tide (0.805 m)



PALSAR Low Tide (0.084 m)



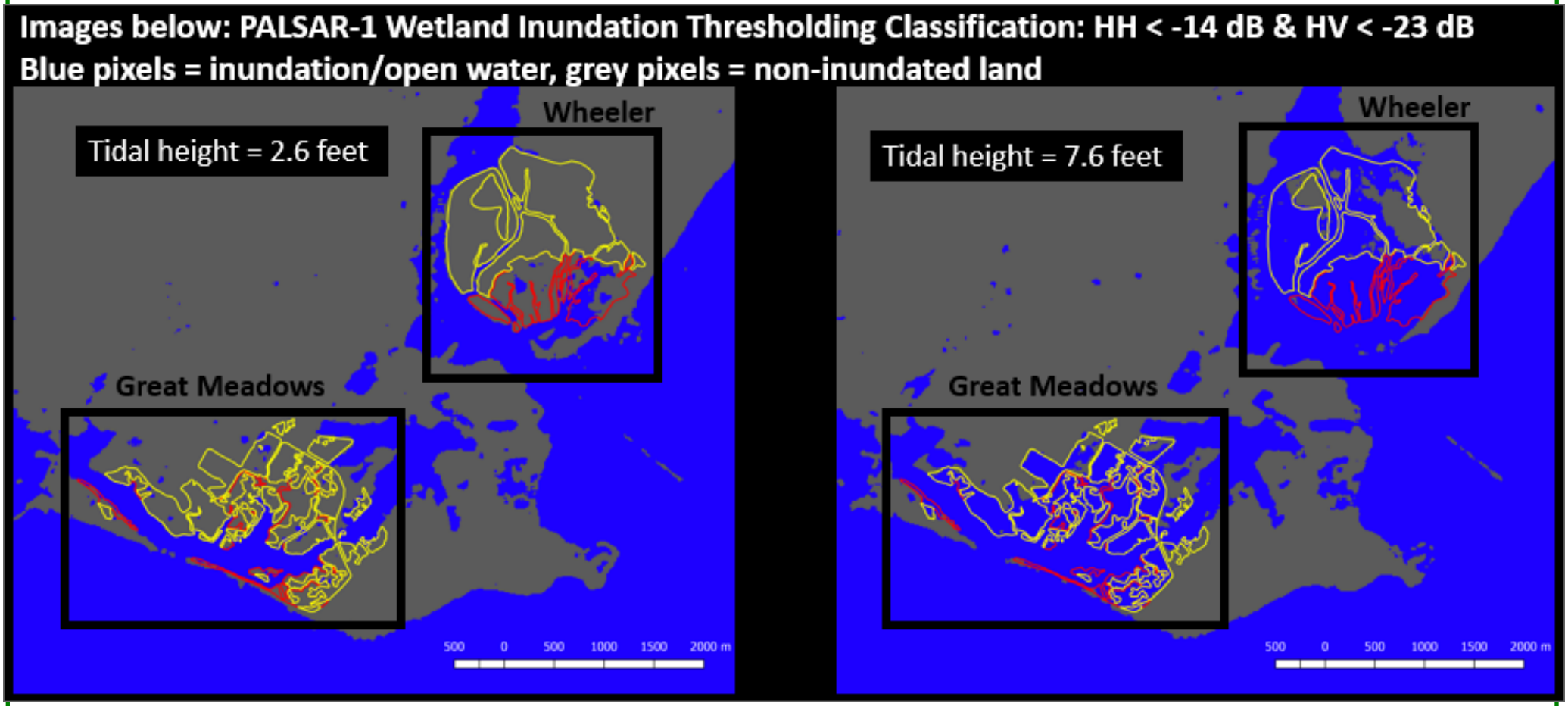
Threshold-based classification (< -14 dB = inundated marsh)



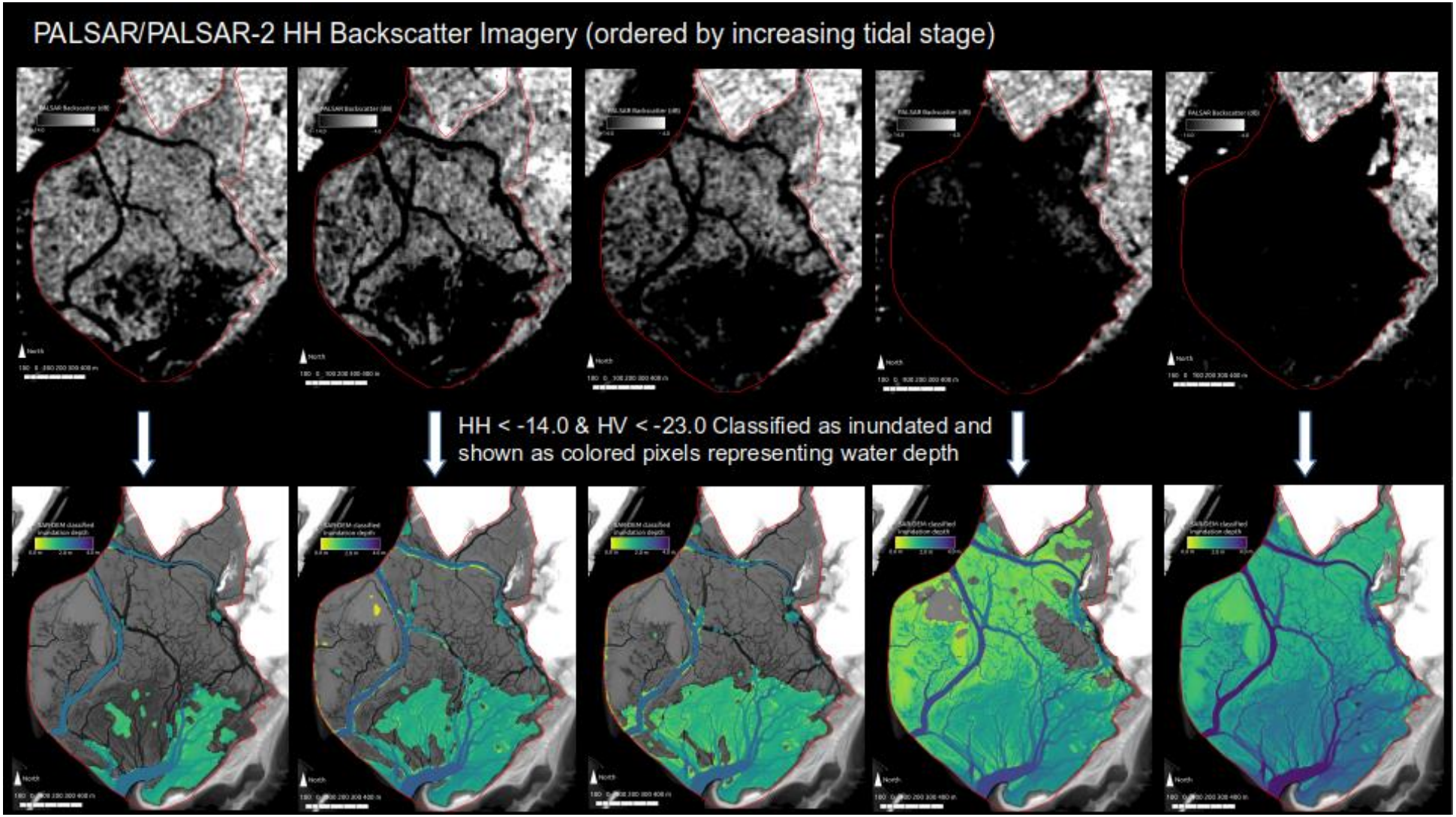
Inundation mapping with L-band PALSAR over Wheeler

- Using same thresholds from Blackwater NWR and integrating HV channel

Images below: PALSAR-1 Wetland Inundation Thresholding Classification: HH < -14 dB & HV < -23 dB
Blue pixels = inundation/open water, grey pixels = non-inundated land



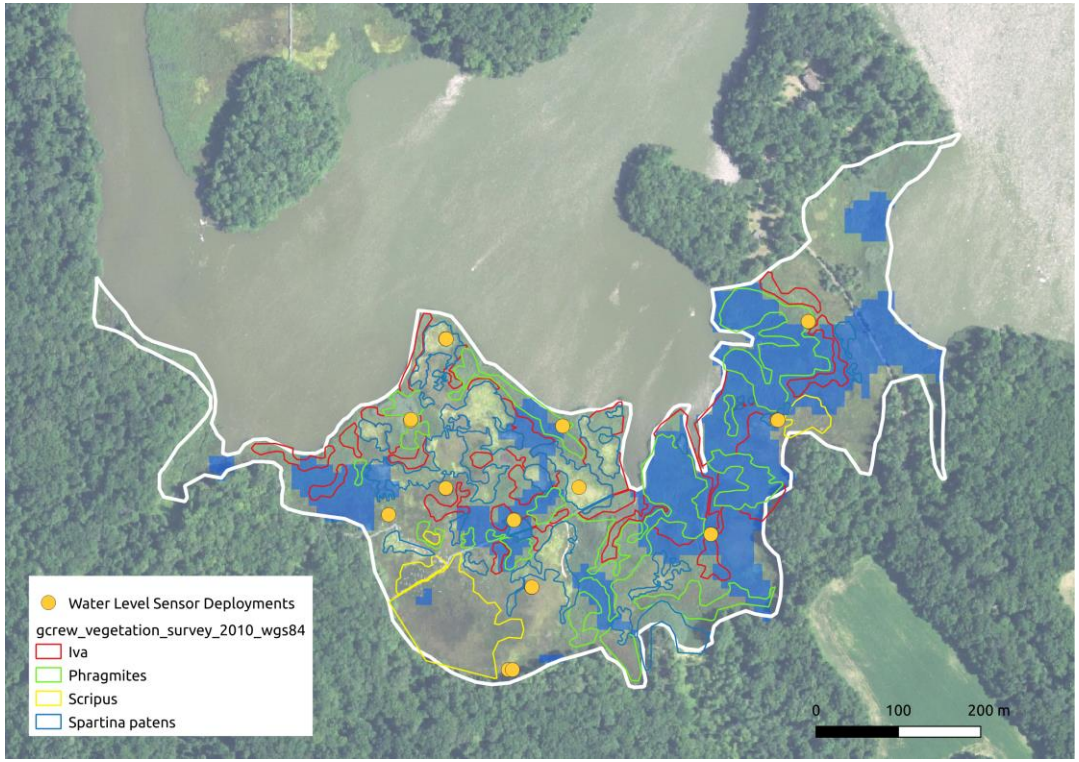
Inundation mapping with PALSAR linking with DEM for volume estimates



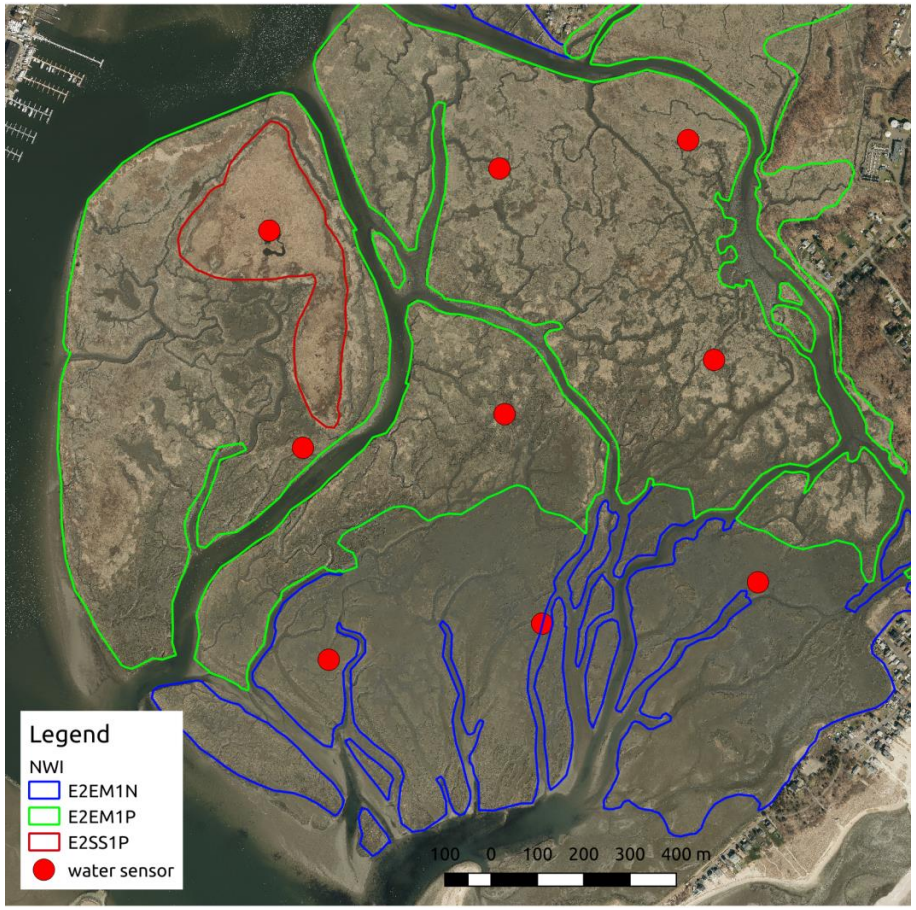
Inundation Product Validation

- Proposed validation with water level sensor grids

Kirkpatrick Marsh (high marsh end-member)



Wheeler Marshes (low marsh end-member)



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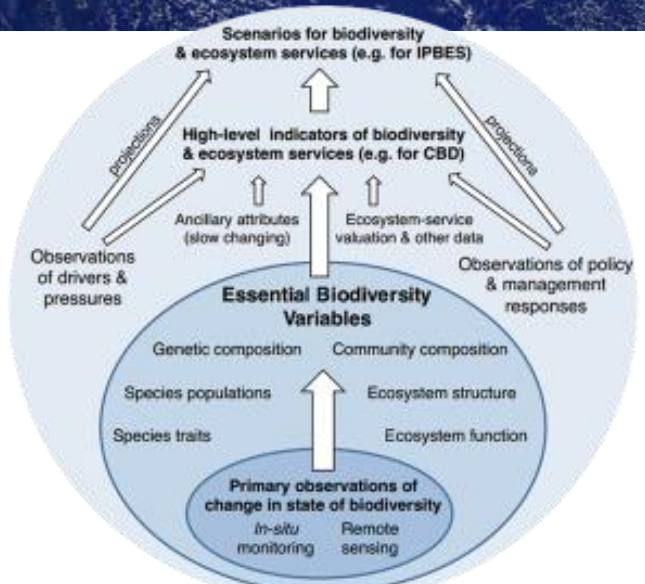
Essential Biodiversity Variables

EBVs are defined as the derived measurements required to study, report, and manage biodiversity change, focusing on status and trend in elements of biodiversity.



derived measurements required to study, report, and manage biodiversity change,

focusing on status and trend in elements of biodiversity

provide the first level of abstraction between low–level primary observations and high–level indicators of biodiversity

EBV classes and candidates

There are 6 EBV classes and 22 EBV candidates.

Click on each EBV class to get more detailed information about the candidates for each class.

show all EBV classes & candidates

EBV class	EBV candidate
Ecosystem structure	Habitat structure
	Ecosystem extent and fragmentation
	Ecosystem composition by functional type

ALOS

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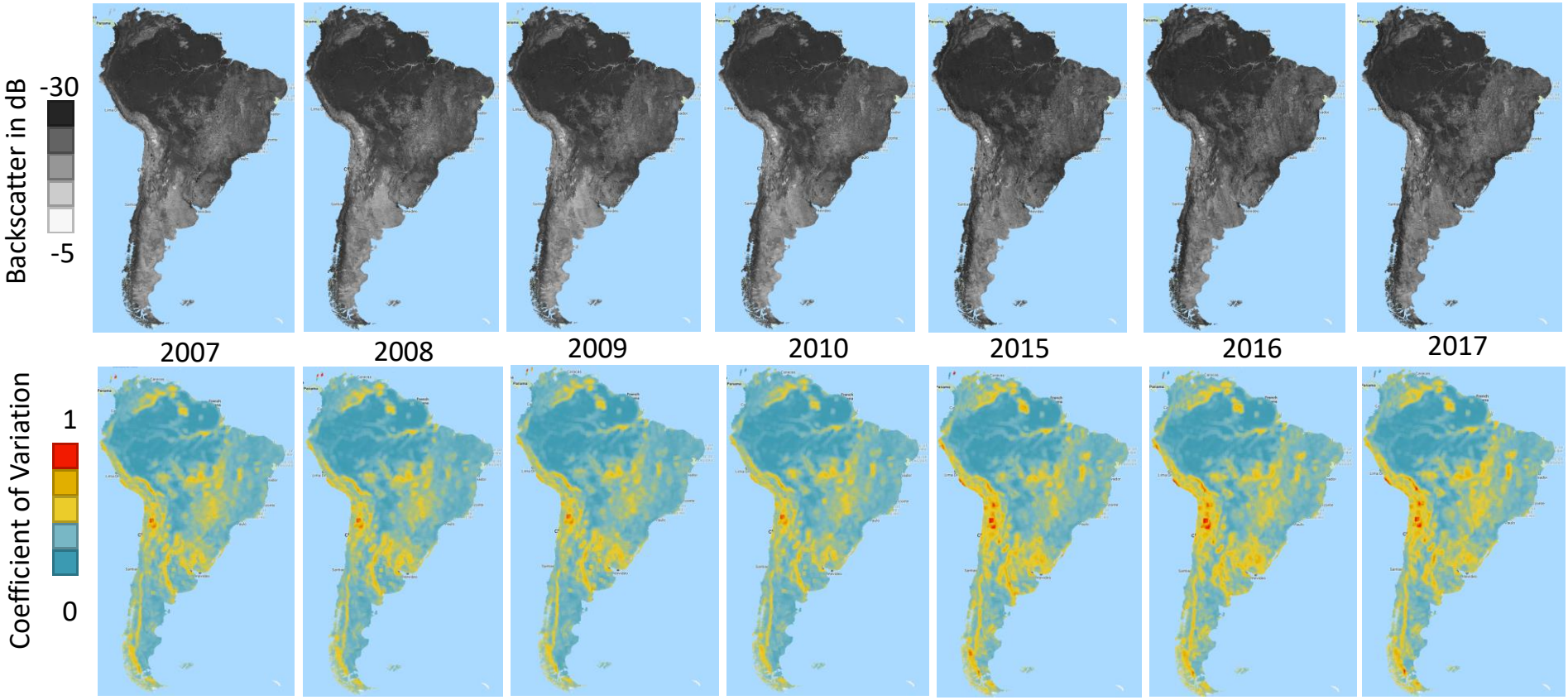
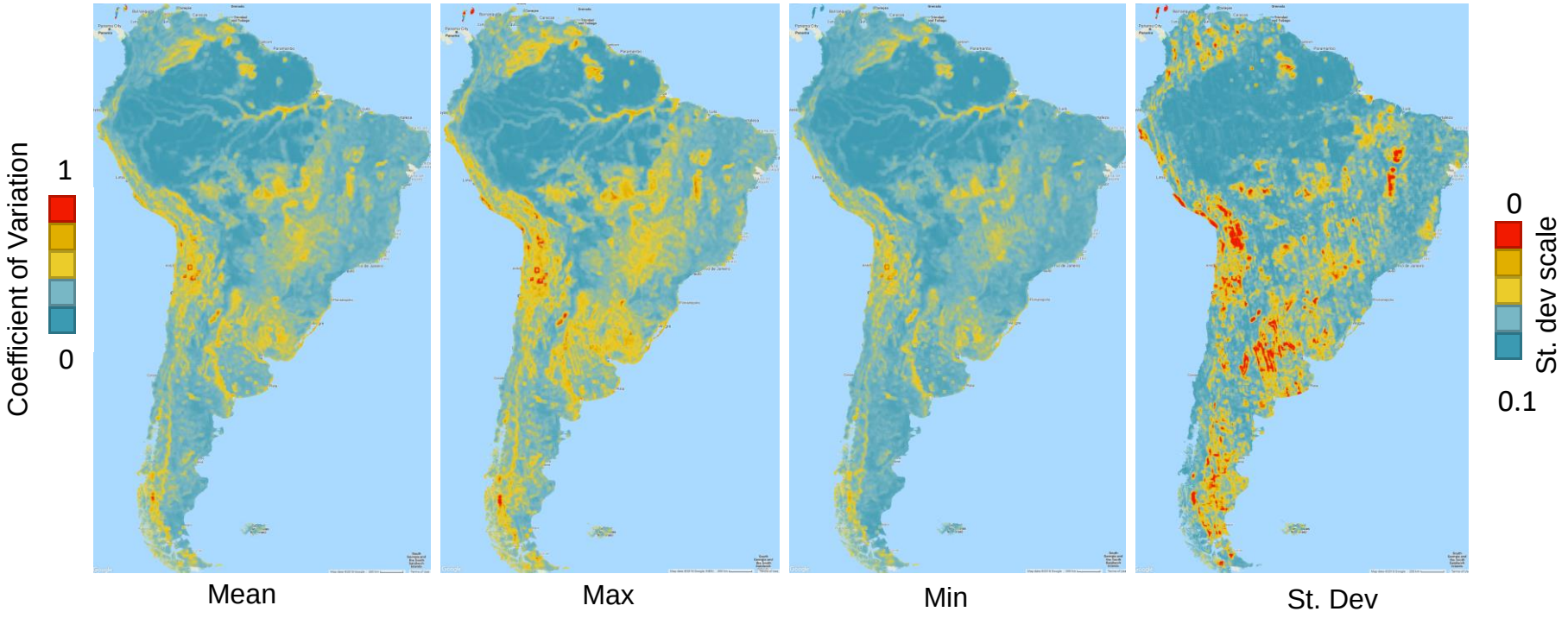
Assessing Structural Variability with Imaging Radar Remote Sensing



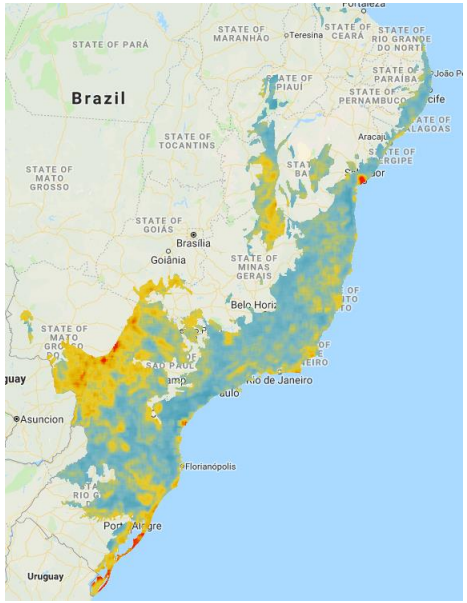
PALSAR and PALSAR2 Yearly Backscatter Mosaics

PALSAR Coefficient of Variation Statistics

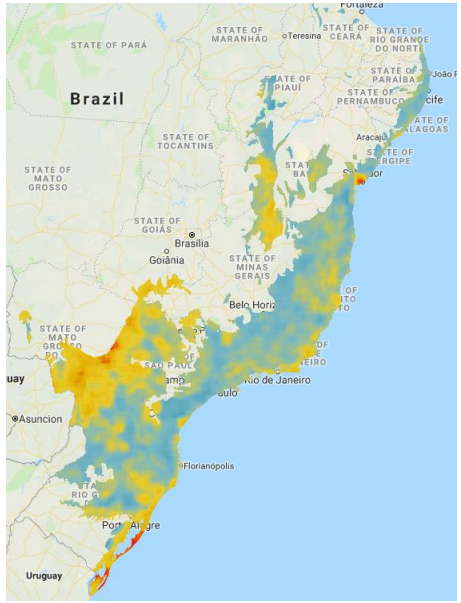


Using the annual coefficient of variation, summary statistics were calculated. The color scale on the left (used for mean, max, and min coeff. of var.) indicates that a low covariance value is closer to blue, whereas, a high value is closer to red in color. The color scale on the right is for the standard deviation of the coeff. of var.

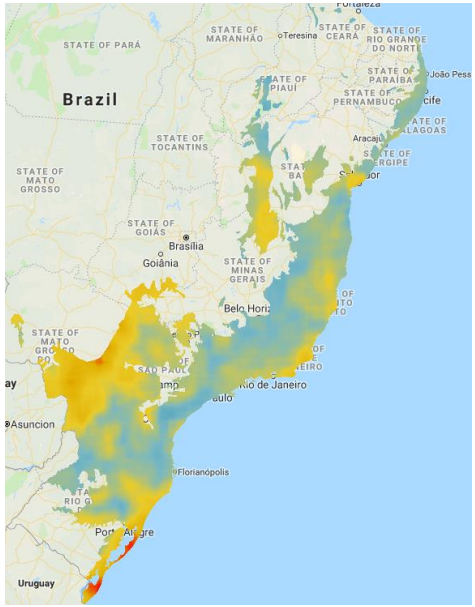
Coefficient of Variation with Different Window Sizes



3x3



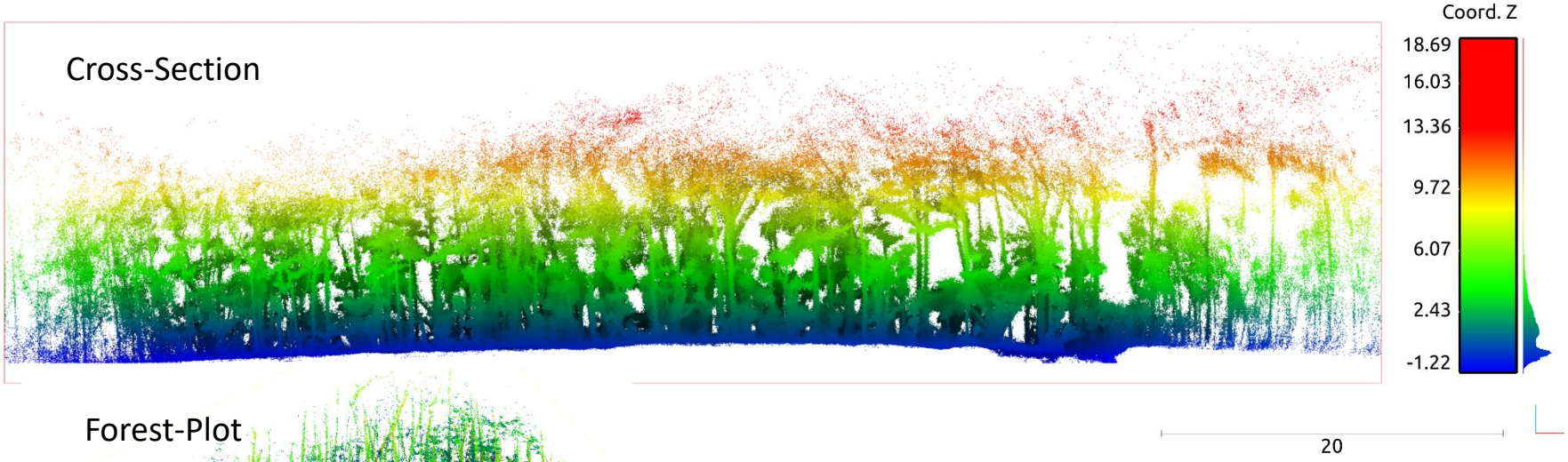
5x5

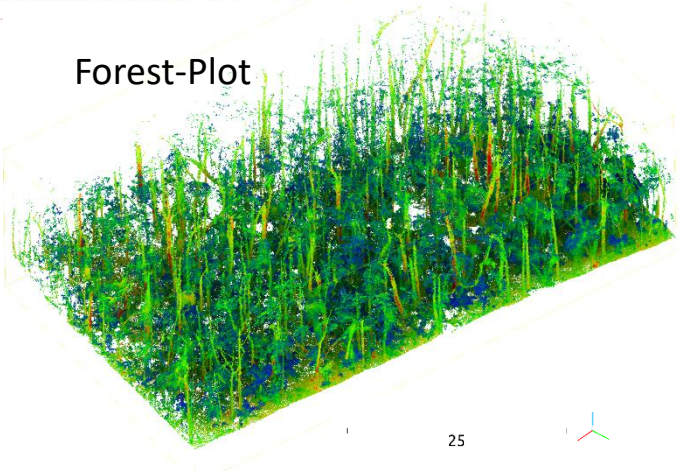


10x10

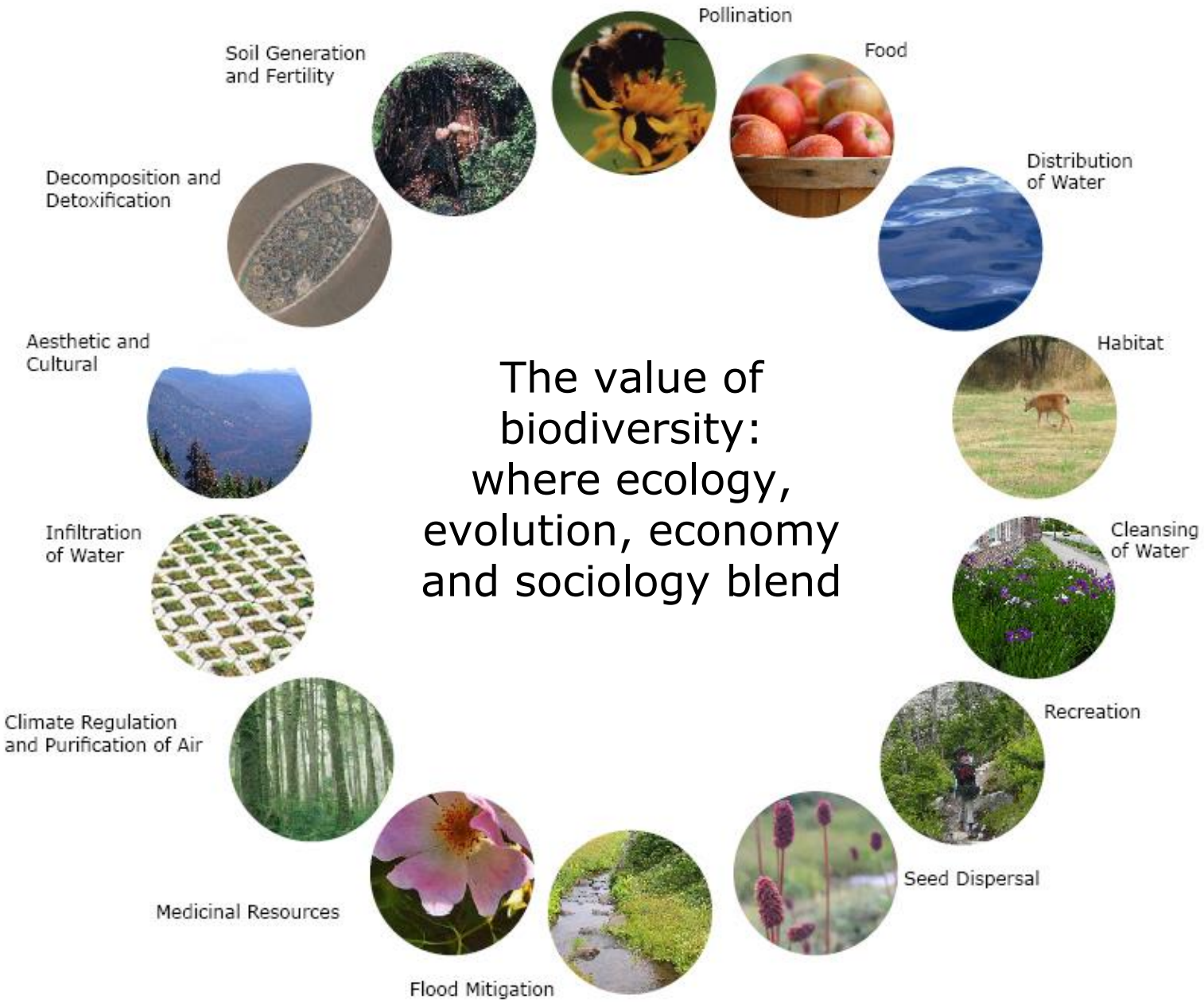
Above are the coefficient of variation of PALSAR HV resampled 1km data for the year 2017, calculated at different neighborhood sizes over the Atlantic Forest region. Note the upper limit of the color scale is 0.75, instead of the previous 1.0, this to better illustrate coeff. of var. in this specific region.

Structural Mapping of White Sands Forest





- Lidar point-clouds from forest plots of white sands vegetation
- Detailed measurements of sub-canopy vegetation
- Collection contains traditional biometry measurements for comparative analysis


Pollination
Soil Generation and Fertility
Food
Decomposition and Detoxification
Distribution of Water
Aesthetic and Cultural
Habitat
The value of biodiversity: where ecology, evolution, economy and sociology blend
Infiltration of Water
Cleansing of Water
Climate Regulation and Purification of Air
Recreation
Seed Dispersal
Medicinal Resources
Flood Mitigation

The City College of New York

BIODIVERSITY

The Center for Biodiversity Under Environmental Change (C-BEC) at The City College of New York

Global reach of CCNY Biodiversity research

(Ryukyu subtropical forest　Photo Credit: Justin Moat)

WELCOME TO
BIODIVERSITY AND **C**ONSERVATION **B**IOGEOGRAPHY **JAPAN**

UNIVERSITY OF THE RYUKYUS

Post-KC Efforts

Spatio-temporal heterogeneity in seasonal landscape processes controlling terrestrial carbon flux

- **Carbon functional groups in Tropical forests**
- **Rangelands and Grassland Savannas**
- **Frost dynamics in cold soils**
- **Glacial landscape melt/thaw/freeze processes: Climate and Carbon in High Mountain Asia**

Characterization of wetland distribution and inundation dynamics in coastal regions

- **Eastern USA Coastal Wetlands**
- **South Asia Coastal Wetlands**

Application of ALOS-2 datasets to assess seasonal wetlands inundation and vegetation structure of endemic ecosystems for the tropics and south Asia

- **Biodiversity Monitoring**
- **Seasonally Inundated Tropical Wetlands and South Asia**
- **White Sands Vegetation Systems, South America**