Regional Mapping and Monitoring Rice Production and Greenhouse Gas Emissions in Asia with PALSAR

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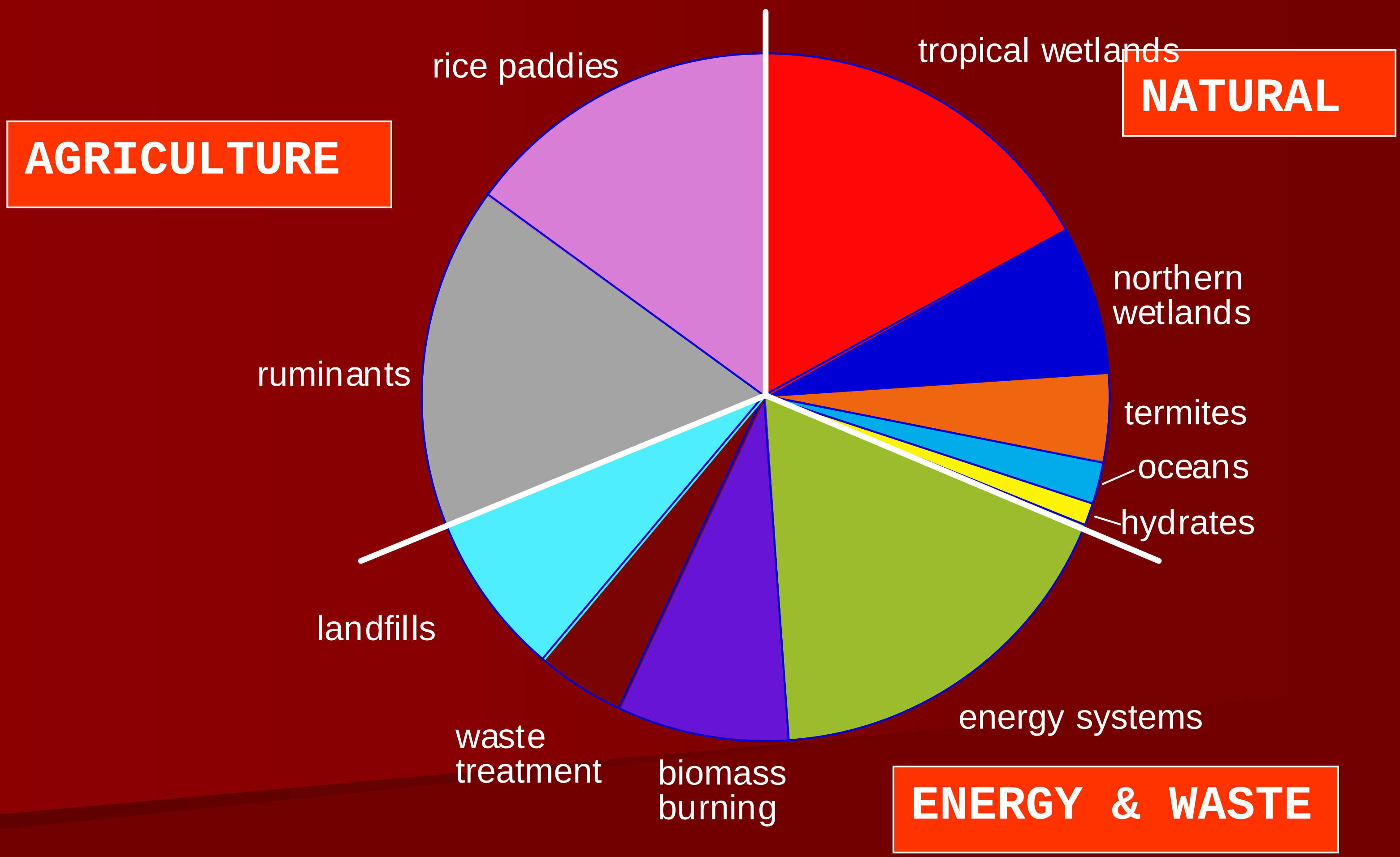
Background: GHG from Rice

- Carbon Dioxide (CO2) - release of stored soil carbon (tillage) and soil carbon sequestration (storage of organic carbon in soils – crop residues).
- Methane (CH4) – produced by fermentation in anaerobic conditions (flooding), GWP_{100yr} = 25 (25 times more potent than CO_2)
- Nitrous Oxide (N2O) – primarily produced by denitrification (nitrate reduction), GWP_{100yr} = 298.

Global Methane Emissions

~600 Tg CH_4/Yr



Project Overview

➢As part of JAXA’s Kyoto and Carbon Initiative, we are utilizing regional PALSAR acquisitions for routine monitoring of rice agricultures and modeling GHG emissions

Project Objectives

➢ Map rice paddy extent for Southeast Asia, California USA, and other regions

➢ Characterize rice paddy attributes including hydroperiod, biomass, planting/harvest dates, and crop cycles

➢ Develop regional estimates of methane and nitrous oxide emissions from rice agriculture using PALSAR derived rice products and DNDC (DeNitrification-DeComposition) biogeochemical modelling

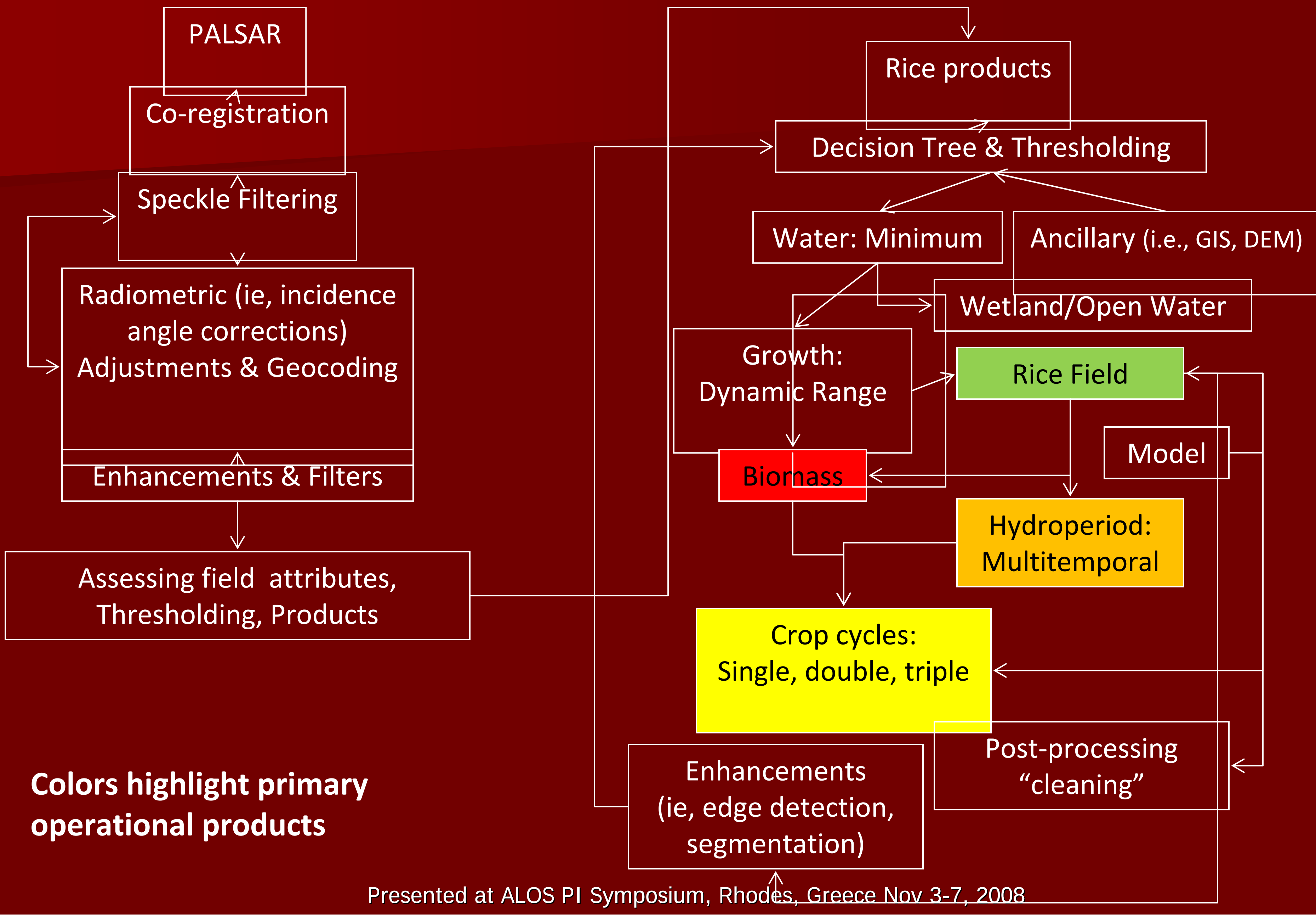
Two methodological divisions of rice analyses

1. Mapping Rice Paddies
   A. Applied to varying geographic regions in need of accurate rice maps (ie, LULC studies)
   B. Some fine-beam PALSAR data required (high spatial precision)
   C. Some field data required for validation & training

2. Operational Monitoring for Large Regions
   A. No a priori data required; “unsupervised”
   B. Utilizes multi-temporal PALSAR for automated mapping and monitoring of rice paddies: biomass/yields, hydroperiod/inundation status, planting dates

Example pre-processing stream

Example rice product stream



Colors highlight primary operational products

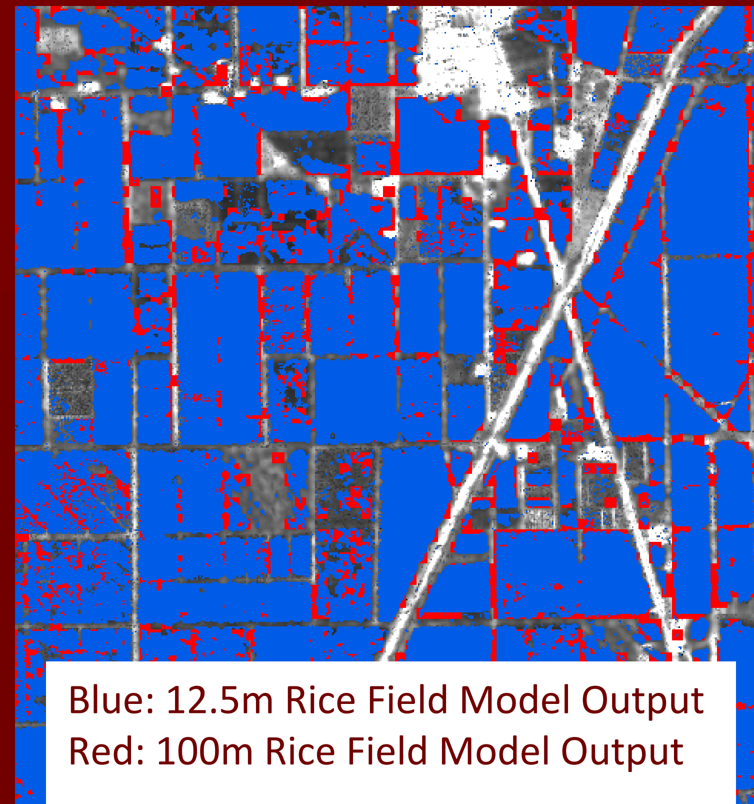
Signal : Noise Scaling Sensitivity

Scaling: increasing number of looks via re-sampling

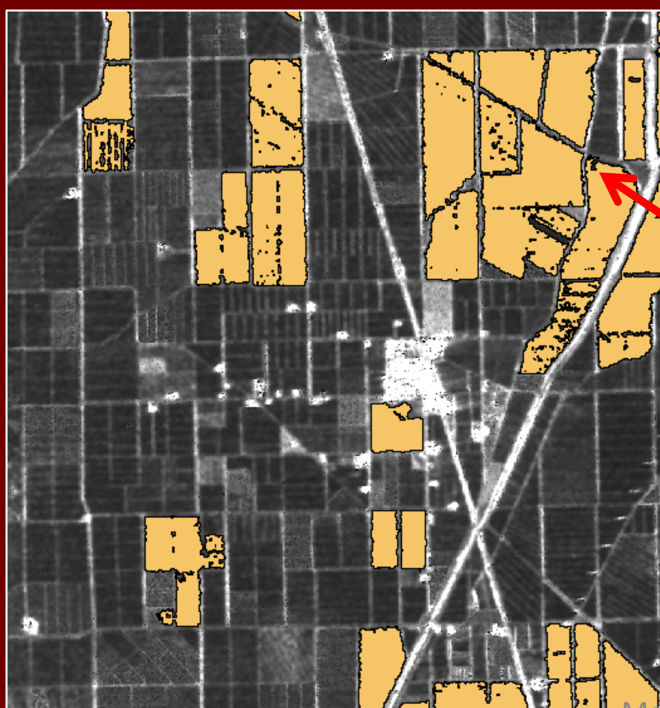
Test Area (Biggs)

Same decision tree rules, different resolutions.

Scale	: % Identified
100M	: 33.1%
50M	: 33.2%
12.5M	: 33.2%



Blue: 12.5m Rice Field Model Output
Red: 100m Rice Field Model Output

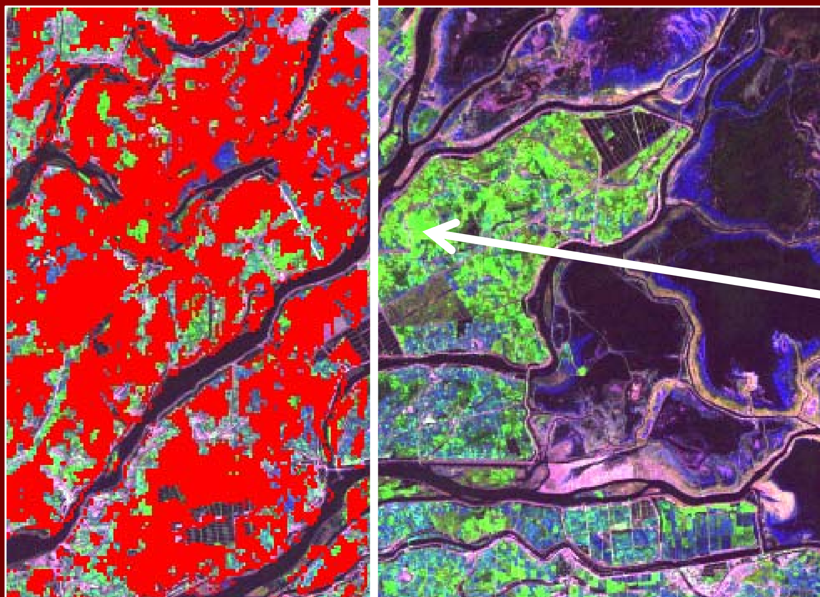


Random 60 Rice Fields selected

Dataset: Multi-temporal HH (12.5 vs. 100m)

- Average- Minimum and- Dynamic Range for fields
- No Significant Difference (two-tailed t-test)

Automated Product: Rice Maps – Poyang Lake, Jiangxi Province, China

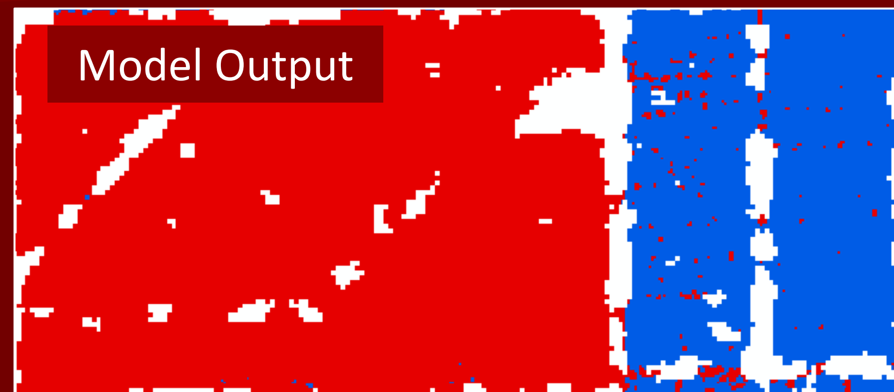


AUIG ScanSAR binary map of rice (red); stacked (hh/hv/difference) fine-beam underneath (8/28/07). Automated binary rice maps threshold minimum HH backscatter values (flooded) and dynamic range (rice growth) to isolate rice paddy locations. AUIG ScanSAR products compared against China NLCD "Rice Layers" (made from Landsat) show moderately strong (R2=.65) fractional cover agreement for Poyang Lake development site (~200x200km).

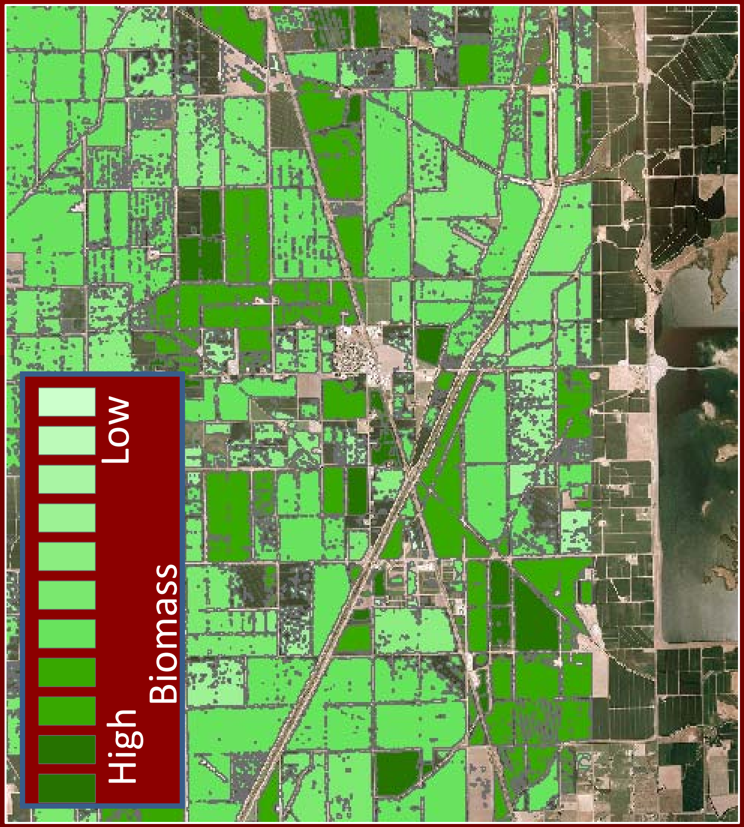
Automated Product: Hydroperiod & Inundation Status

- Characterizing hydroperiod to model biogeochemistry
- Maps of rice paddies & multi-temporal flood status (example: Biggs, USA)

Red	Summer Rice, No Winter Flood
Blue	Summer Rice, Winter Flood

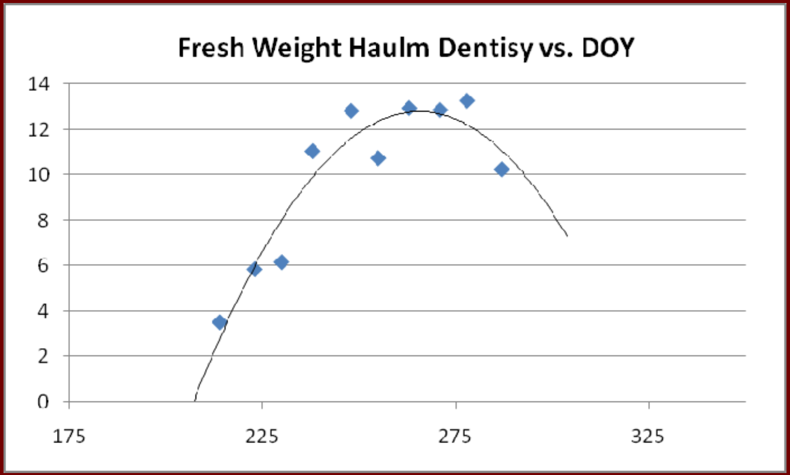


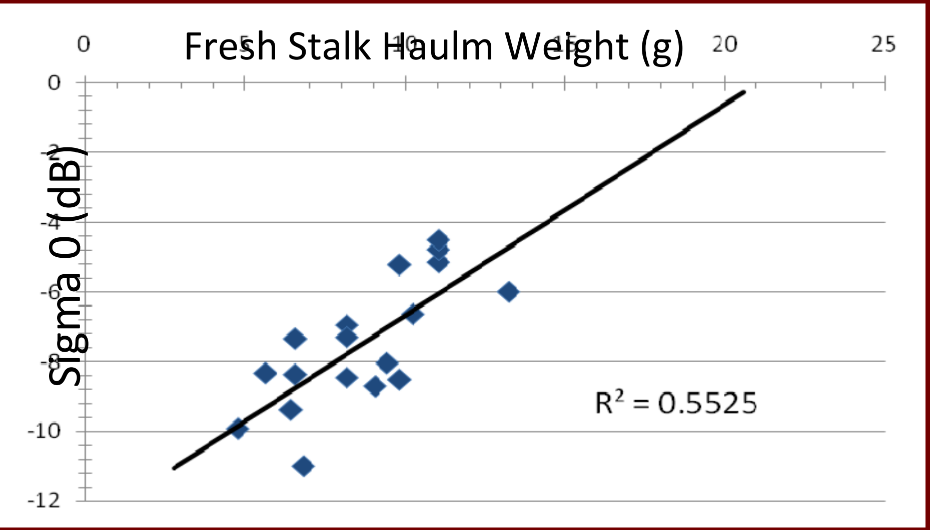
1.5 km



Operational estimates of biomass:

- Using temporal information, field data, and/or empirical models, our system uses proven rice:backscatter relationships to quantify biomass and estimate yields

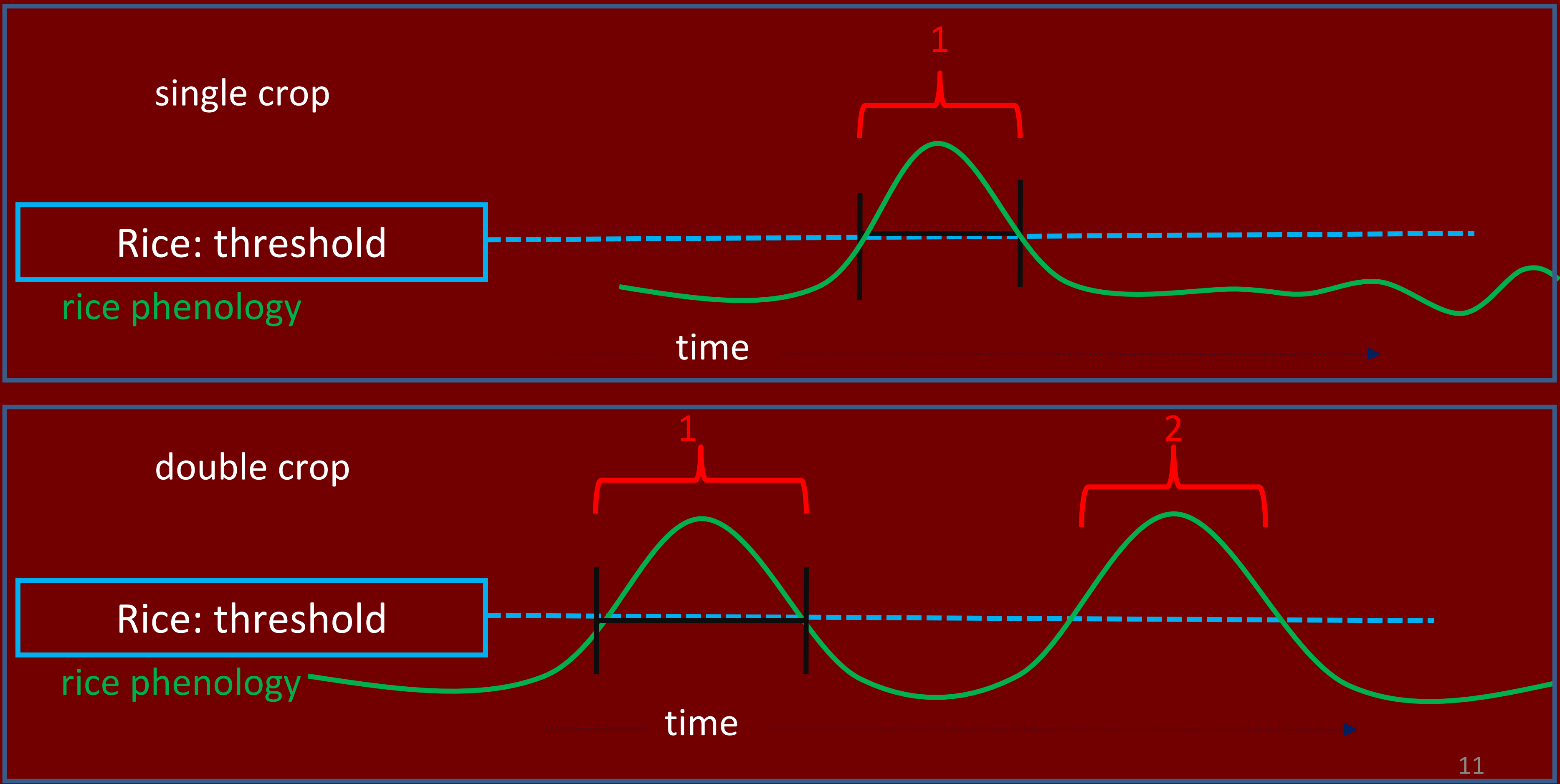




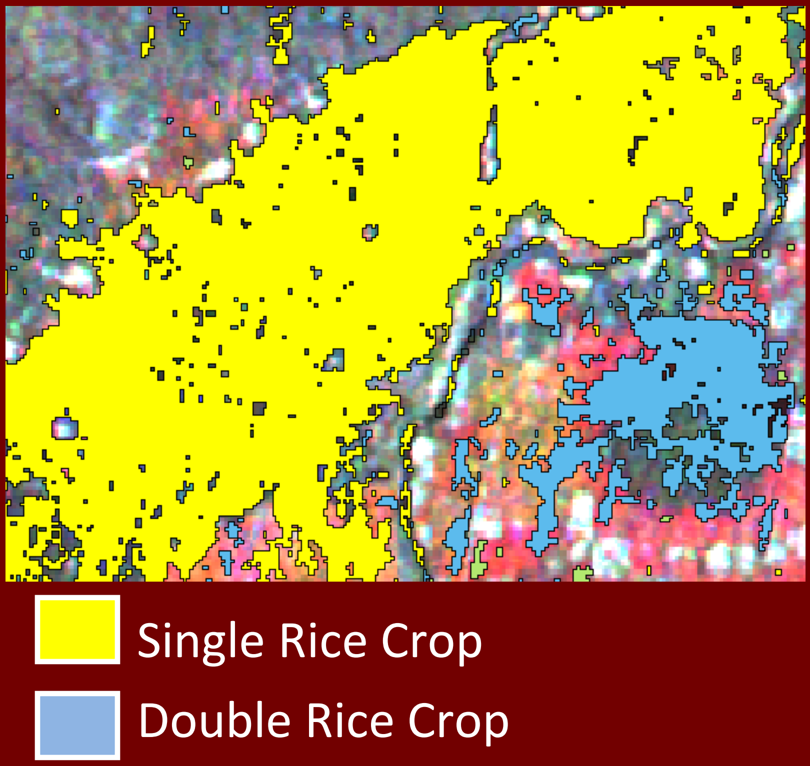
Field-scale rice paddy measurements from Poyang, China algorithm development sites

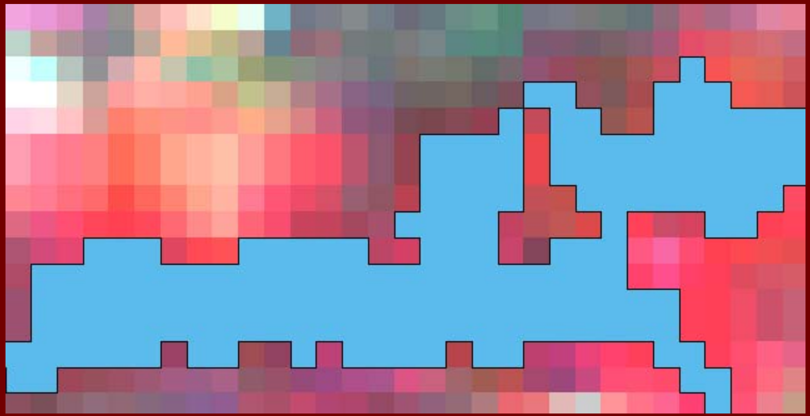
Operational mapping of crop cycles.

- characterize number of peaks and temporal windows
- rules to utilize PALSAR overpasses and temporal windows of rice growth (i.e., example crop 90-120 days)



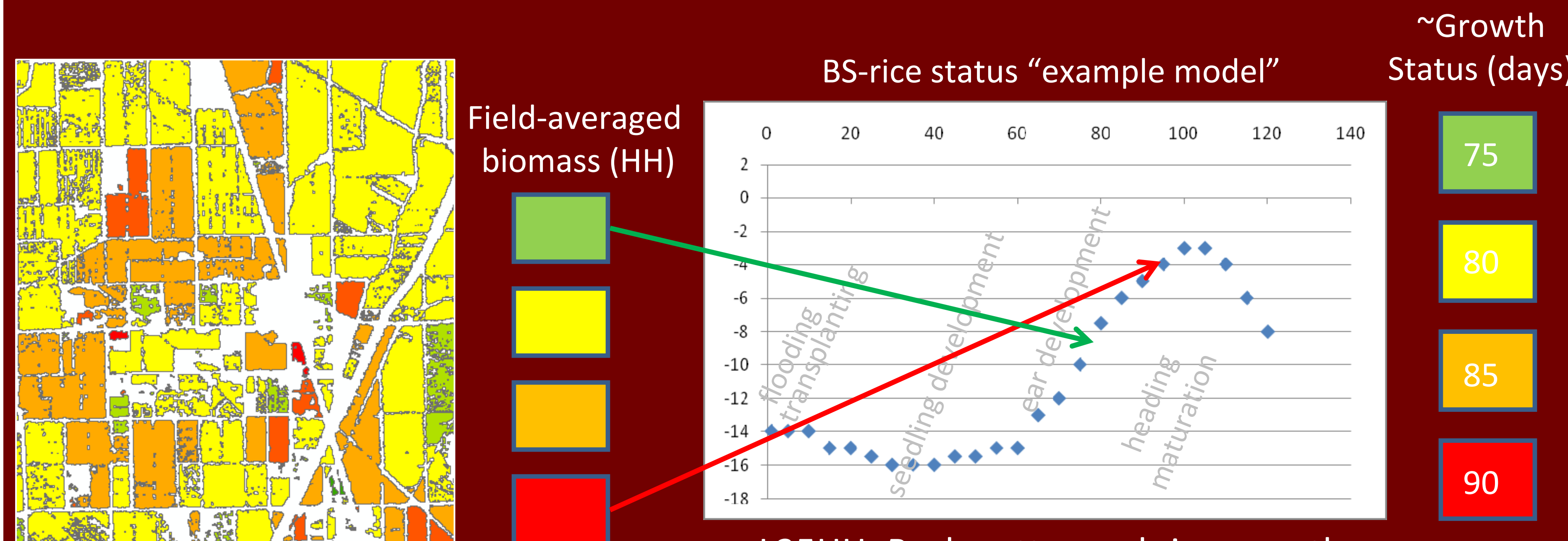
Java Products: Crop cycles





Operational mapping of planting and harvest dates.

- identify max (biomass) date for rice field peaks (phenology)
- average max (HH: biomass) for rice field
- back-cast using BS(HH):rice growth relationships
- use max date and back-cast model to identify planting dates

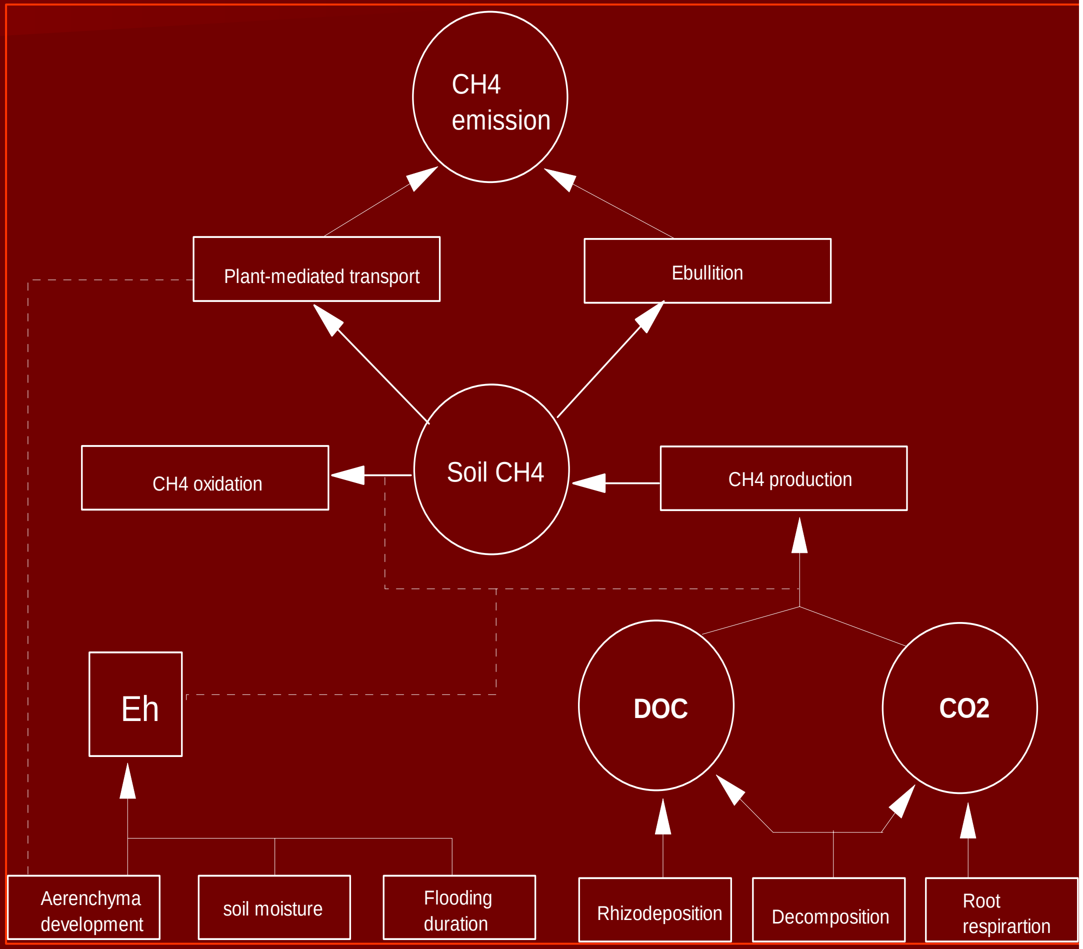


L35HH: Backscatter and rice growth

GHG Modeling with PALSAR Products

- DNDC Model
  - Well validated for rice systems worldwide
- PALSAR products used to drive model
- Regional Outcomes
  - CH4, N2O and CO2 flux estimates
  - Rice crop yield

DNDC: DeNitrification-DeComposition



Summary Current Results

- Algorithm development using AUIG and K&C data; multi-temporal ALOS L-band successfully captures hydroperiod and dynamic range; enabling characterization of paddy status and rice development

- Decision-tree models of flood status, dynamic range, and phenology allow large-area rice mapping with little to no a priori data; Regional products for Java and China created

- Operational ScanSAR-based rice models moderately agree (R2=.65 aggregated fractional rice cover) with China NLCD rice layers; however, PALSAR provides more detail such as cropping cycles and intensity

Challenges and Next Steps

Data Issues

- Some “Raw” K&C Strips have some spatial/geocode discrepancies, radiometric discontinuities across ScanSAR strips.
- Need more detailed metadata, consistent formats, and formalized raw data process regimes

Rice Mapping Challenges

- Every ~46 days *might* miss a flood stage or key phenology period
- Smaller-sized, isolated fields across the landscape can be beyond the spatial limits of ScanSAR (~100m) and K&C (~50-70m) products

Next Steps

- Validation for Java and China products in progress
- Continue model development and data collection
- Expand operational mapping to more regions

The End.
Thank you.

Questions?

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