Facing the scientific challenges of the BIOMASS mission

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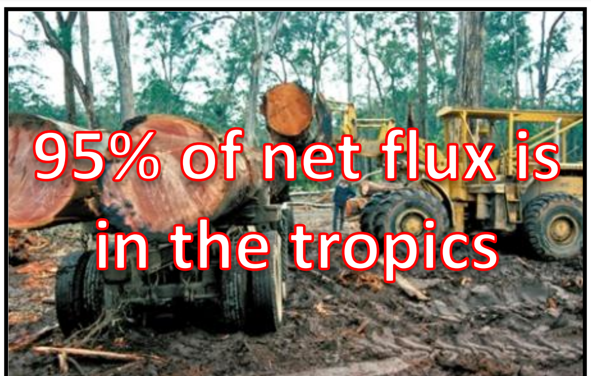
The effects of forest changes on climate

8.3±0.4 GtC/yr

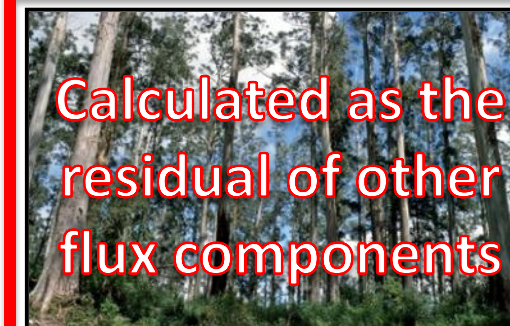
1.0±0.5 GtC/yr net flux



+

4.3±0.1 GtC/yr

2.6±0.9 GtC/yr



2.5±0.5 GtC/yr

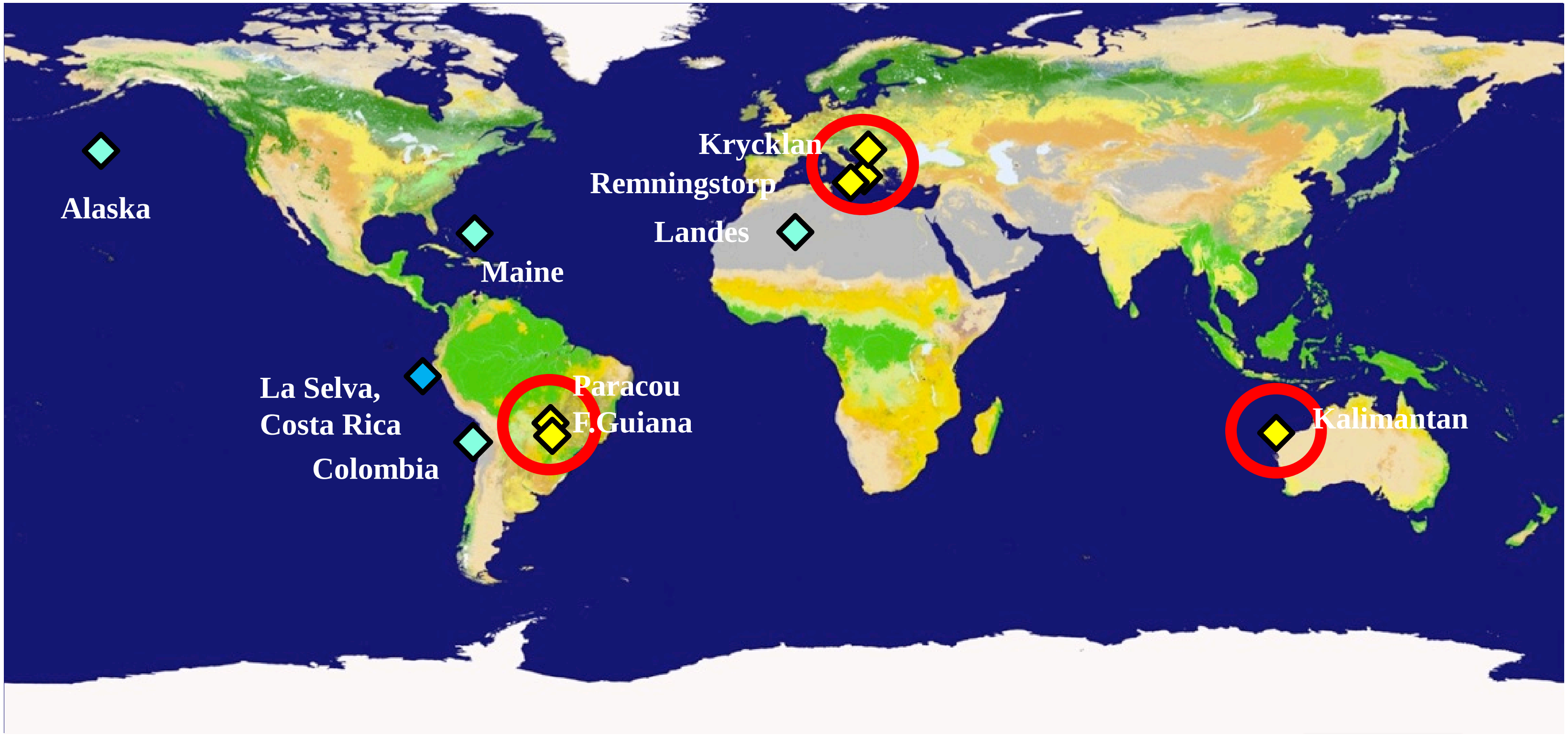
Global Carbon Project, 2012

Biomass will map forest biomass, height and change with unprecedented accuracy

Forest biomass and forest height:
global, 200 m scale, every 6 months for 4 years, 20% accuracy in biomass, 20-30% accuracy in height

Disturbances: global, at 50 m scale

Scientific challenge 1: environmental changes

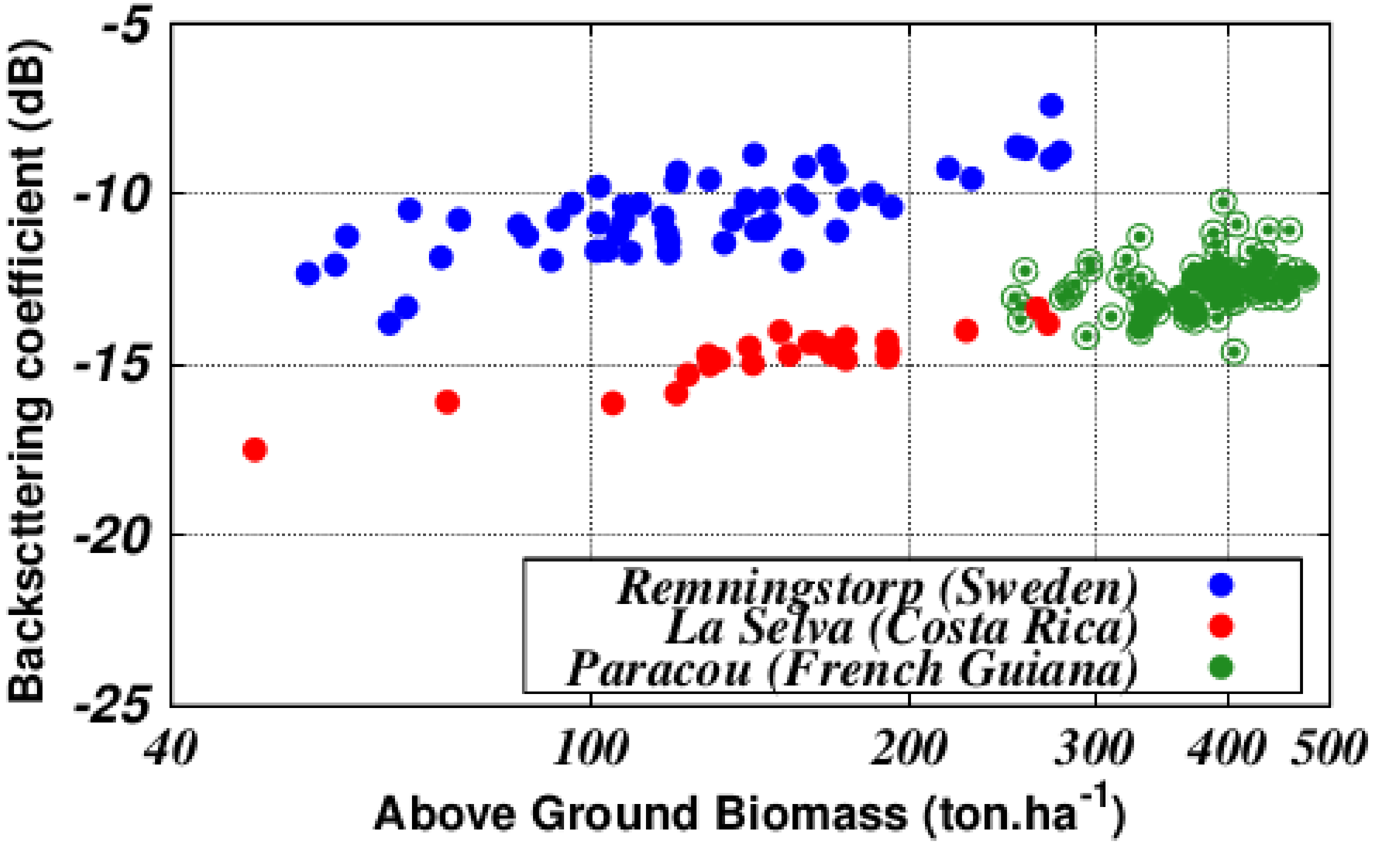


Major recent ESA campaigns:

1. Kalimantan 2004 (Indrex)
2. Remningstorp 2007 (BioSAR 1), 2010 (BioSAR 3)
3. Krycklan 2008 (BioSAR 2)
4. F. Guiana 2009 (TropiSAR), 2011-13 (TropiScat)

◆ ESA campaigns
◆ non-ESA campaigns

Scientific challenge 1: environmental changes (2)

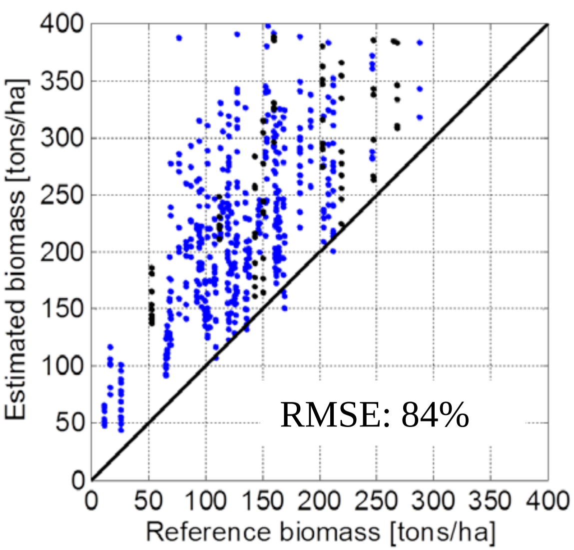


Inversion techniques must deal with data dispersion and differences between different types of forest.

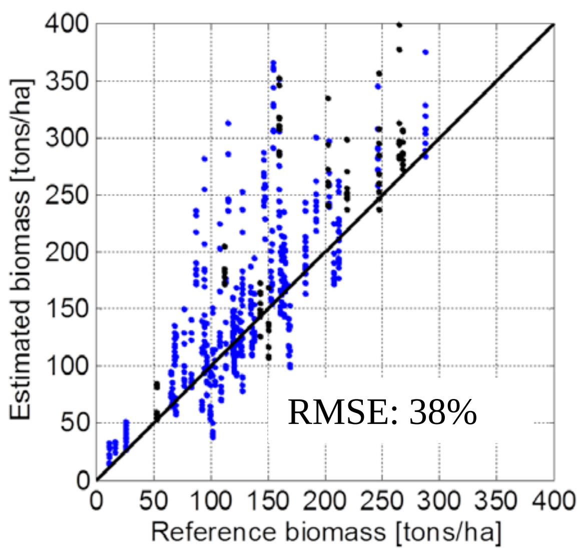
Scientific challenge 1: environmental changes (3)

Remningstorp 70 MHz data: varying environmental conditions over 3 months

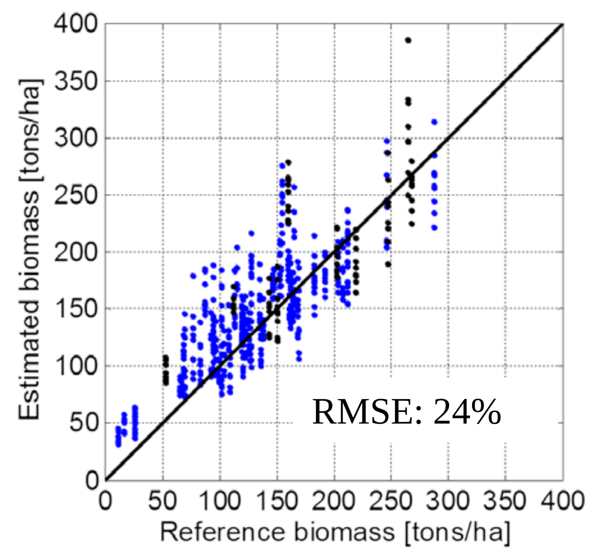
HV only



HV, HH & VV



HV, HH, VV & DEM

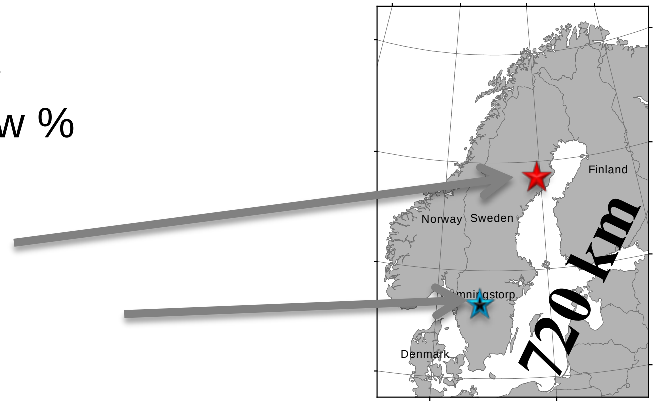


Blue - from airborne lidar map, std. error = 25 ton/ha

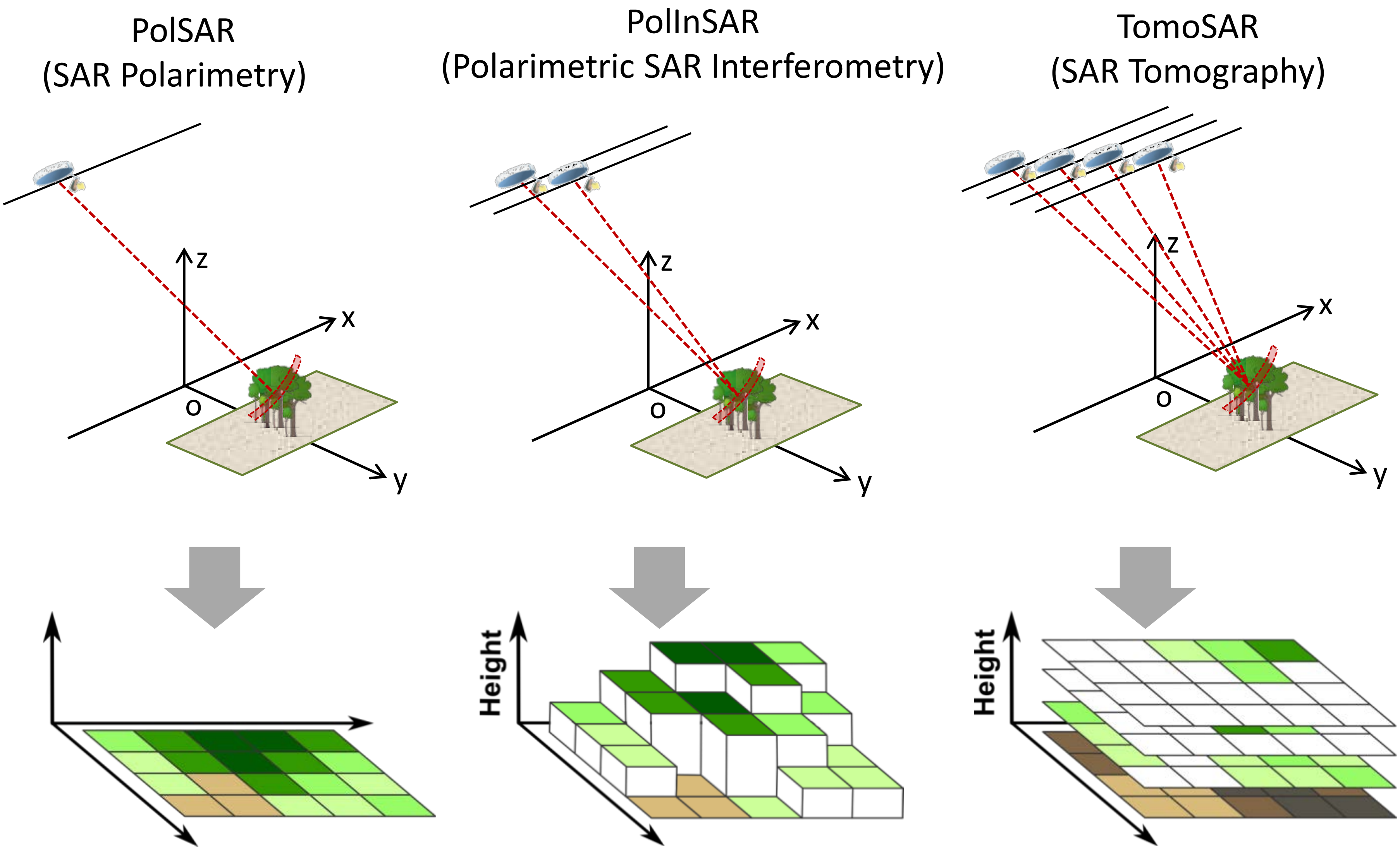
Black - from 80 m x 80 m *in situ* plots, std. error = few %

Training on stratified subset of Krycklan data.

Performance assessed on data from Remningstorp.

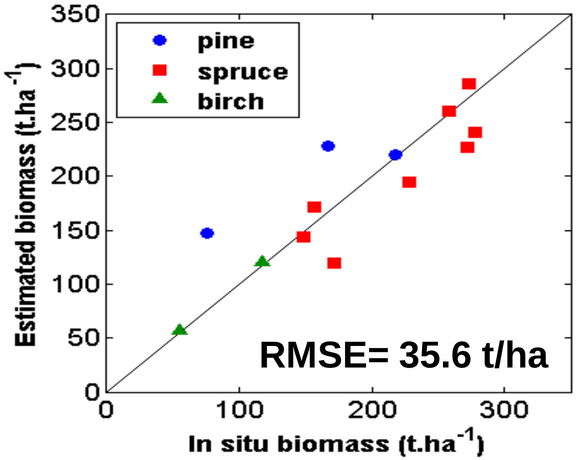


Scientific challenge 2: combining measurement modes

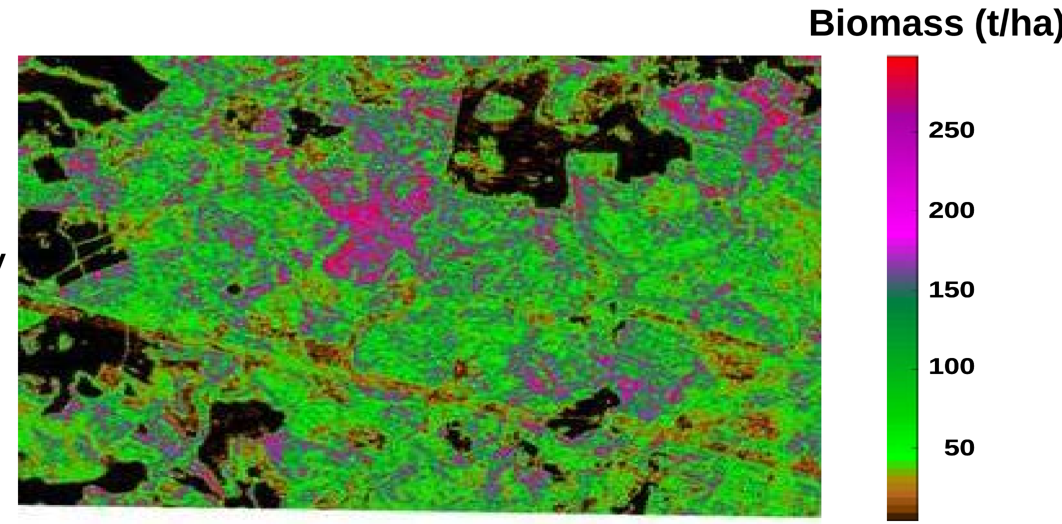


Challenge 2: combining measurement modes

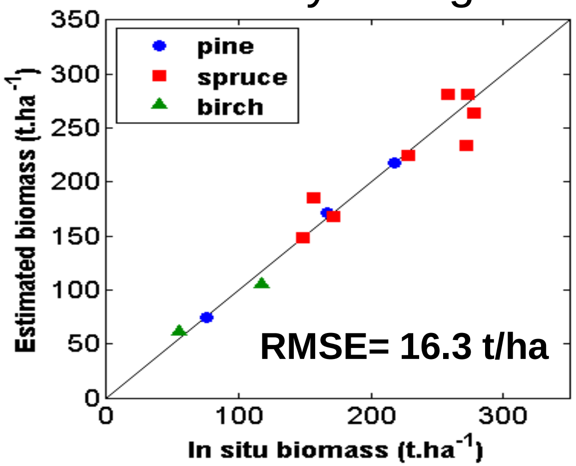
Polarised intensities only



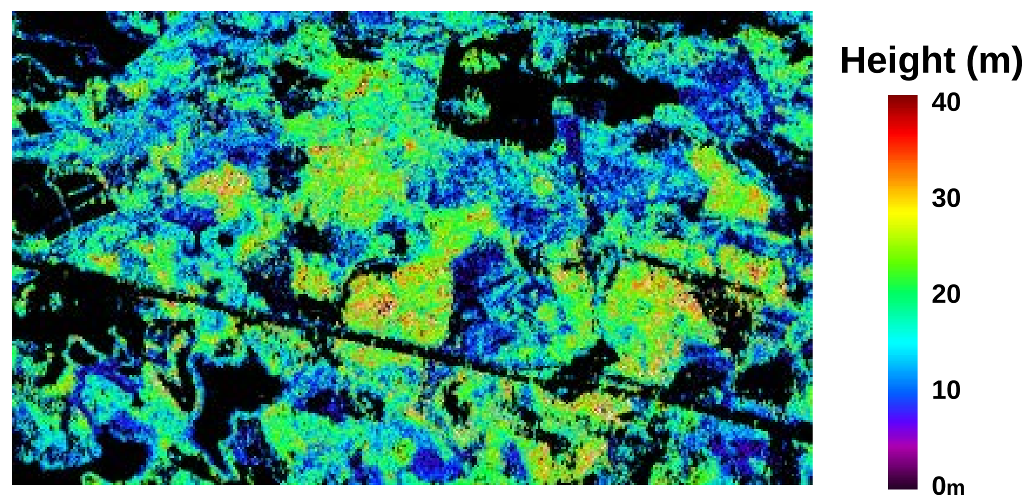
Intensity retrieval



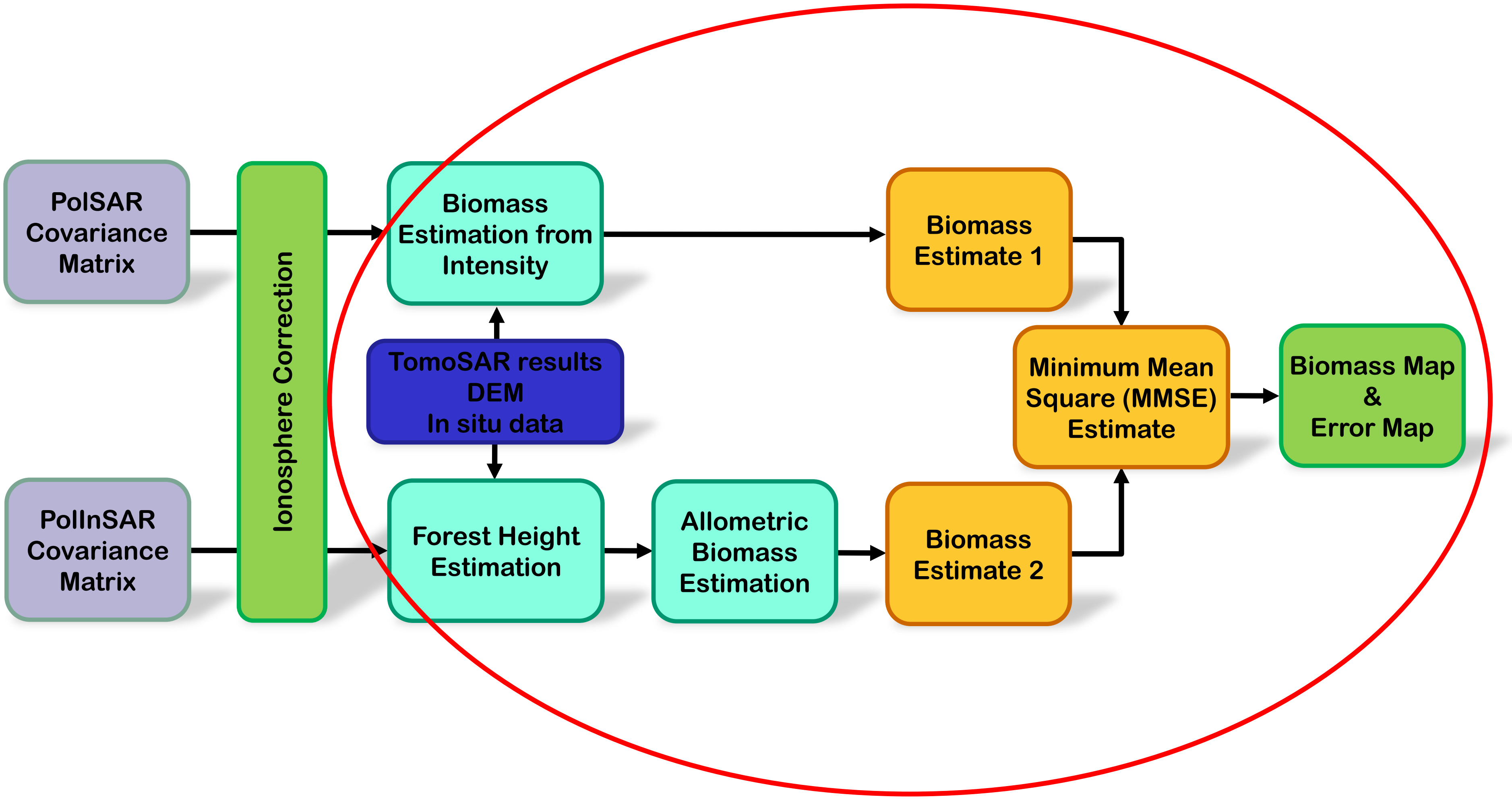
Intensity + height



Height retrieval



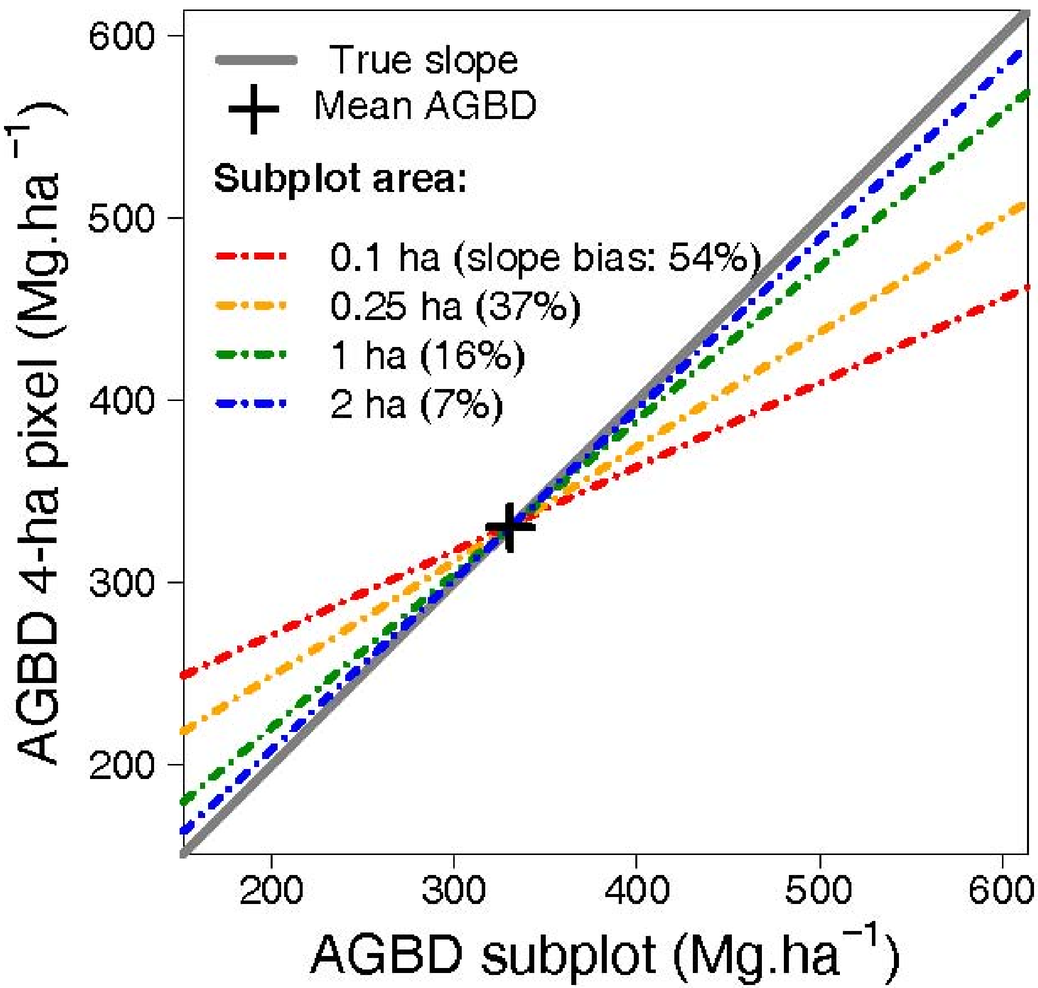
Challenge 2: combining measurement modes



Scientific challenge 3: training and validation

In situ **network led by Smithsonian, including Centre for Tropical Forest Science**

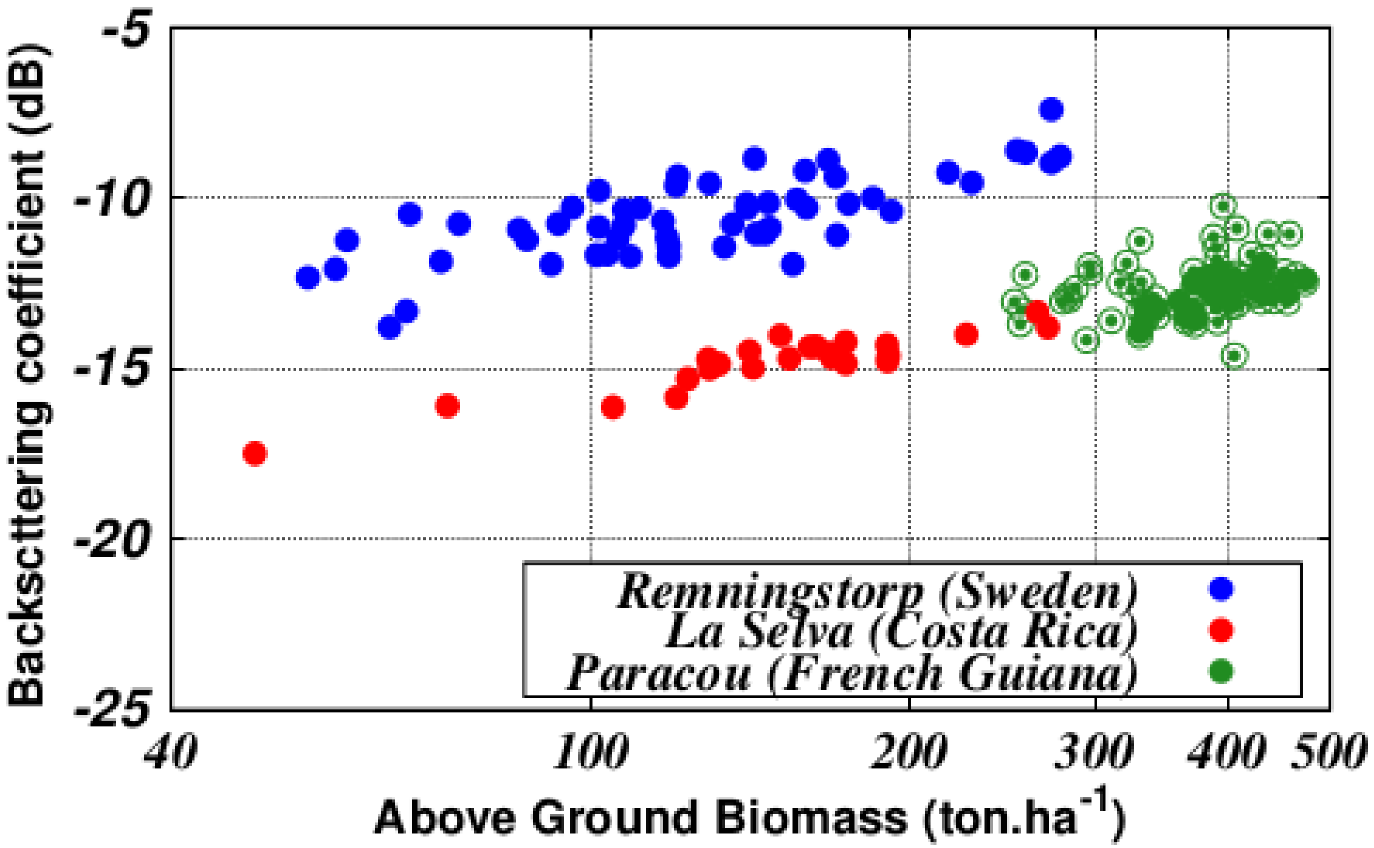
Scientific challenge 3: training and validation (2)



Rejou-Mechain et al.(2014)

Key message: Training inversion algorithms at 4 ha resolution (the Biomass estimation scale) with in situ data at smaller scales leads to an estimation bias.

Scientific challenge 4: the physics of P-band scattering



Inversion techniques need to deal with data dispersion and differences between different types of forest.

Scientific challenge 4 (2)

Site	Intercept=a	Slope=q	R^2	p-value
Paracou	-3.3 ± 0.46	0.79 ± 0.17	0.46	< 0.001
La Selva	-2.8 ± 0.07	0.60 ± 0.03	0.92	< 0.001
Remningstorp, March 9th	-2.1 ± 0.08	0.47 ± 0.04	0.71	< 0.001
Remningstorp, April 2nd	-2.1 ± 0.07	0.44 ± 0. 03	0.71	< 0.001
Remningstorp, May 2nd	-2.1 ± 0.07	0.42 ± 0. 03	0.73	< 0.001
Landes	-3.4 ± 0.16	1.01 ± 0. 03	0.88	< 0.001
Maine	-2.2 ± 0.08	0.41 ± 0.04	0.75	< 0.001

Power-law relationships between HV backscatter and biomass are found for all forests where we have data. What determines the exponent?

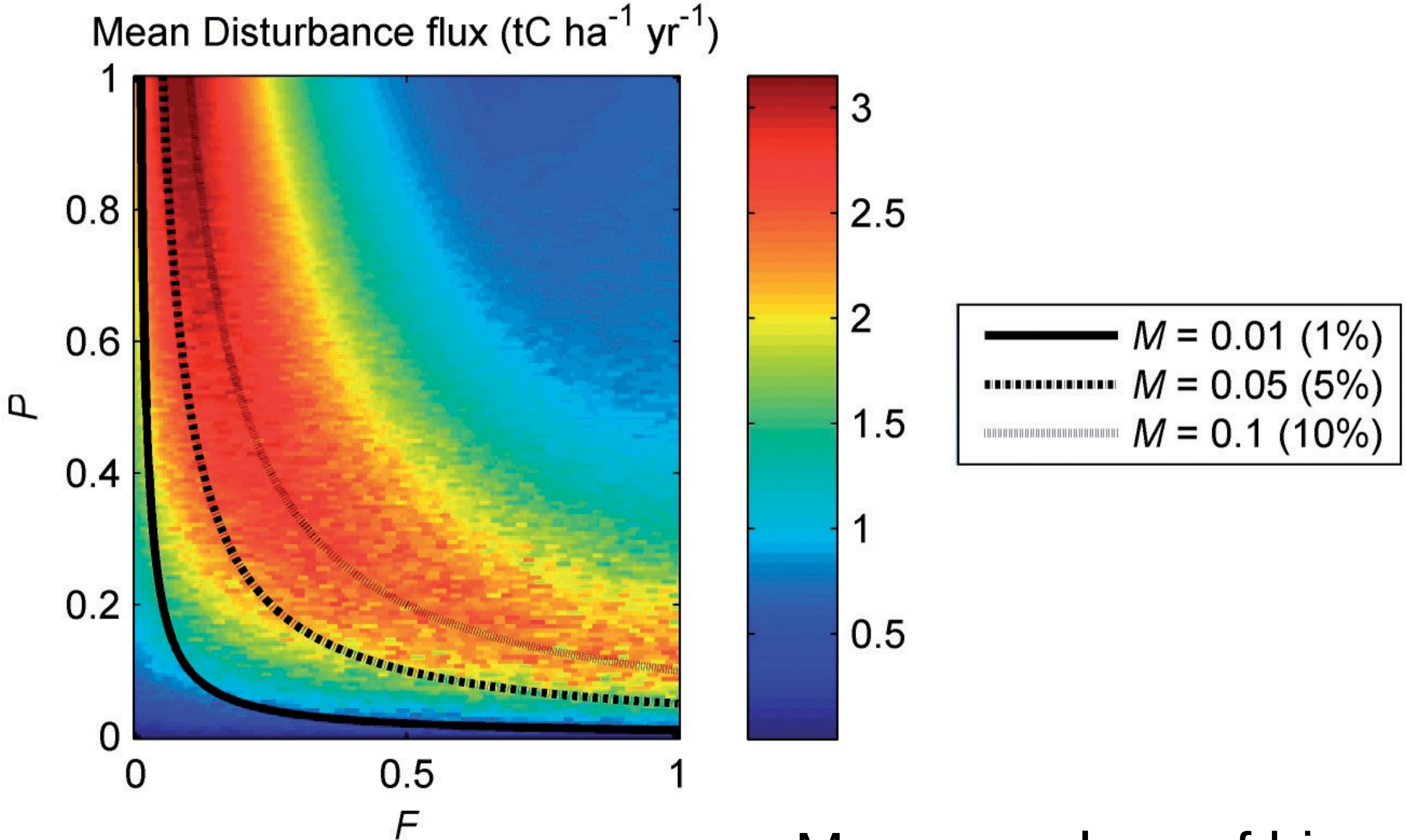
Scientific challenge 5: getting BIOMASS data into carbon cycle estimates (& IPCC & REDD+)

AGU 2014: **Informing carbon dynamics in the Community Land Model with observations from across timescales**
(Andy Fox [NEON] & Tim Hoar [NCAR])

Conclusions

- Annual AGB biomass observations are a powerful constraint on many large C and N pools
- Annual Net Primary Production estimates are less helpful than we expected

Carbon flux depends on the disturbance regime



M = mean loss of biomass
F = severity of disturbance
P = probability of disturbance

Summary

1. BIOMASS is the first P-band radar in space, the first space mission exploiting Pol-InSAR for global forest height mapping, and the first space radar tomographic mission.
2. The experimental data supporting BIOMASS is heavily under-sampled in time and space.
3. 1 & 2 imply that
   1. We have to make as much use as possible of physical, modelling and statistical reasoning in preparing for BIOMASS
   2. In practice many aspects of using the data will only become clear after launch
4. The BIOMASS mission already has significant buy-in from the ecological and carbon science communities.
5. More needs to be done to make sure that BIOMASS meets the needs of its non-science users