Estimation of Canopy Height using UAVSAR Data in the Reserve Faunique des Laurentides and Penobscott Forests.

Marc Simard
Jet Propulsion Laboratory, California Institute of Technology

Marco Lavalle, Naiara Pinto, Scott Hensley, Maxim Neumman, Thierry Michel, Ralph Dubayah

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Remote Sens. **2012**, *4*, 975-986; doi:10.3390/rs4040975

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Remote Sensing

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Article

An Empirical Assessment of Temporal Decorrelation Using the Uninhabited Aerial Vehicle Synthetic Aperture Radar over Forested Landscapes

Marc Simard [1,*], Scott Hensley [1], Marco Lavalle [1], Ralph Dubayah [2], Naiara Pinto [2] and Michelle Hofton [2]

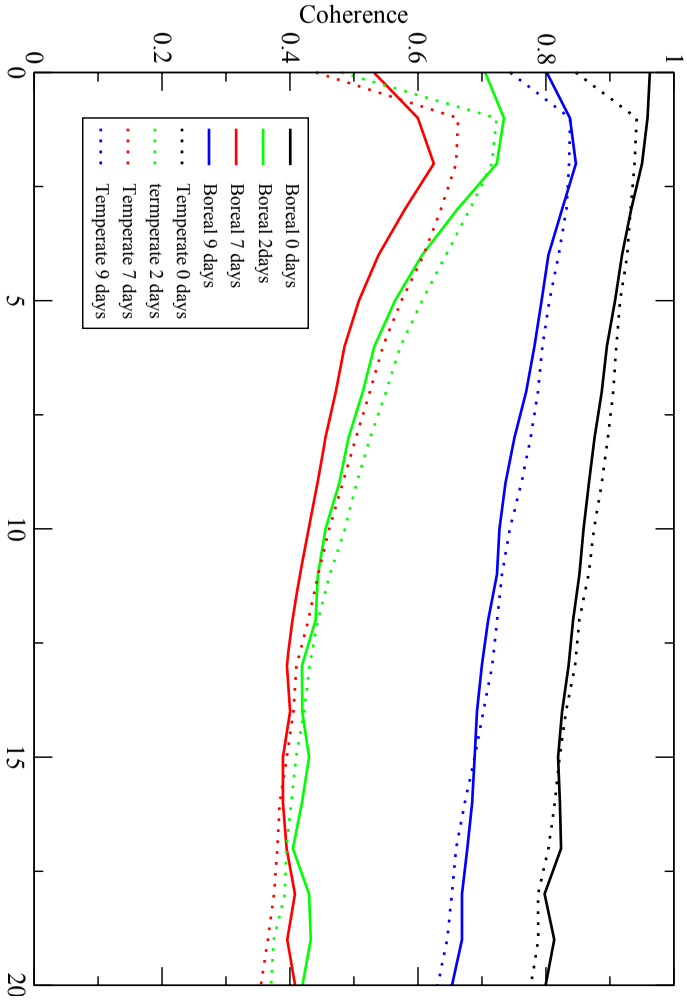

Figure 5. Variation of termporal coherence $\widetilde{\gamma}_t$ with canopy height. (**a**) HH coherence for mixed termperate and boreal coniferous forests at various time intervals and (**b**) for all forest types at various polarizations and two time periods. The vertical bars in (b) give the standard deviations for discrete height intervals and are not shown in (a) for clarity.

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IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING

A Temporal Decorrelation Model for Polarimetric Radar Interferometers

Marco Lavalle, Marc Simard, and Scott Hensley

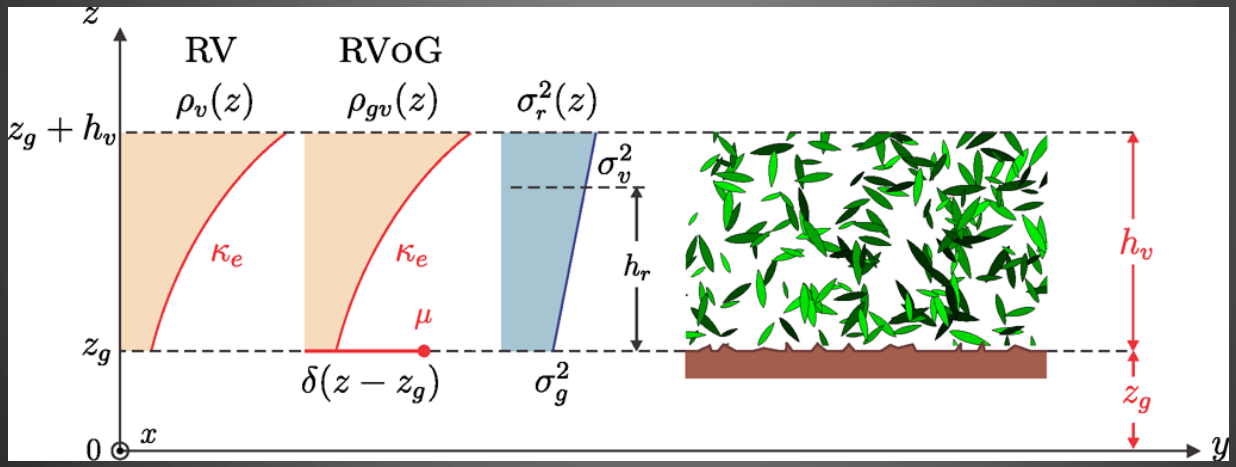

Fig. 2. Structure functions and motion variance of a canopy layer with underlying ground surface. The structure function of the RV model and of the RVoG model corresponds to (11) and (15). The motion variance illustrates the function in (9). The structure functions and the motion variance are used to derive the temporal coherence model in Section III.

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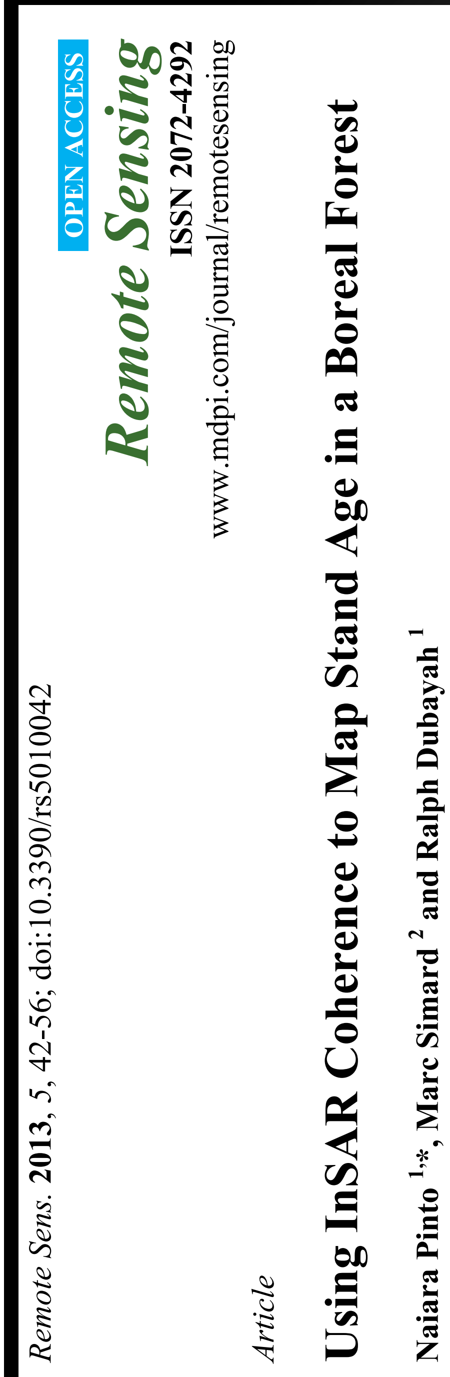
Remote Sens. **2013**, *5*, 42-56; doi:10.3390/rs5010042

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Article

Using InSAR Coherence to Map Stand Age in a Boreal Forest

Naiara Pinto [1,*], Marc Simard [2] and Ralph Dubayah [1]

Figure 8. Actual and modeled patch age from UAVSAR coherence data with zero spatial baseline and 2-day temporal baseline.

R^2=0.7 and RMS~5.5 depending on scale

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PLoS one

Mapping Migratory Bird Prevalence Using Remote Sensing Data Fusion

Anu Swatantran[1]*, Ralph Dubayah[1], Scott Goetz[2], Michelle Hofton[1], Matthew G. Betts[3], Mindy Sun[2], Marc Simard[4], Richard Holmes[5]

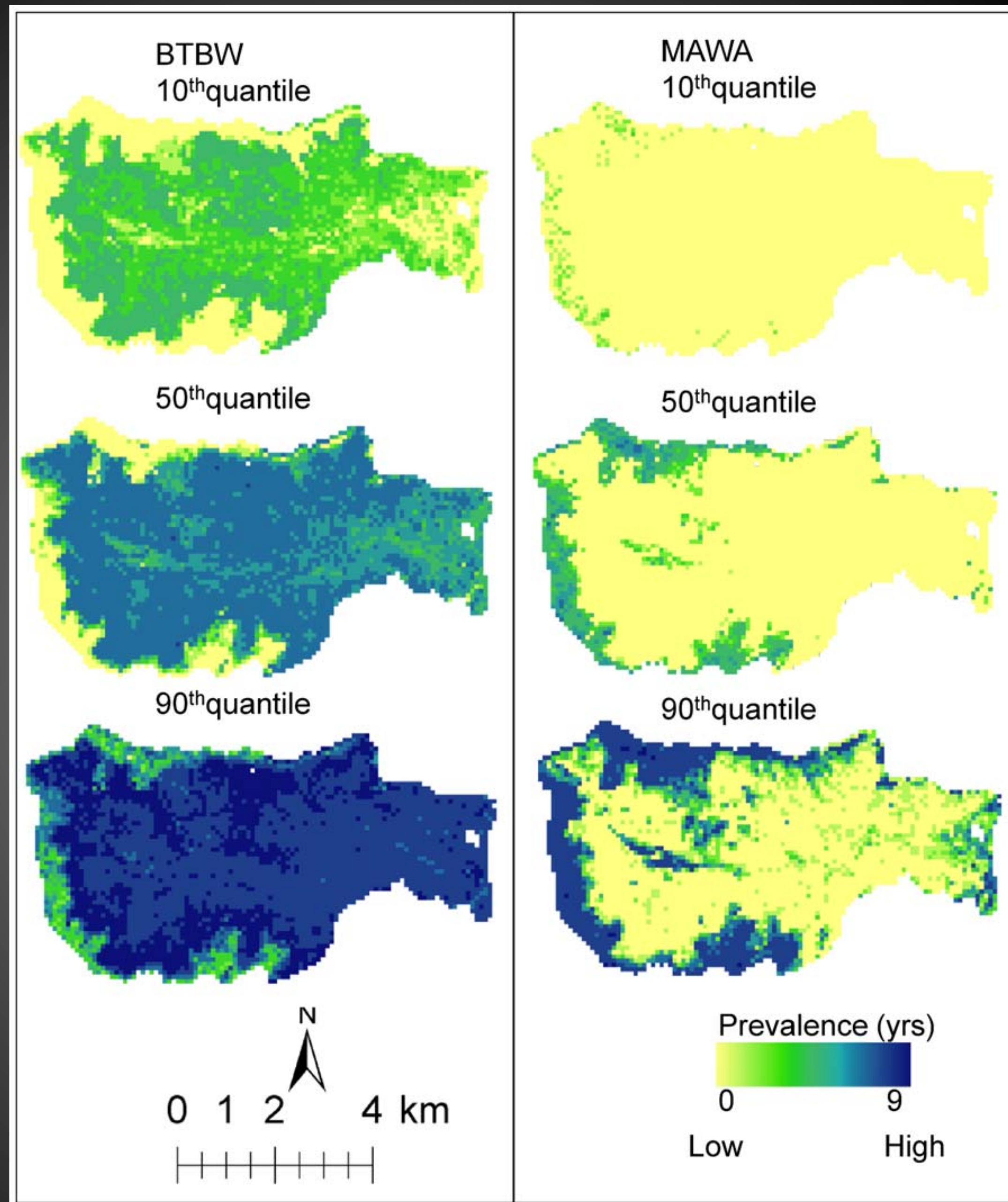

Figure 8. Quantile predictions for black-throated blue warbler [BTBW] and mag...

doi:10.1371/journal.pone.0028922.g008

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Remote Sensing of Environment 130 (2013) 153–170

Contents lists available at SciVerse ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Achieving accuracy requirements for forest biomass mapping: A spaceborne data fusion method for estimating forest biomass and LiDAR sampling error

P.M. Montesano [a,b,c,*], B.D. Cook [b], G. Sun [c], M. Simard [d], R.F. Nelson [b], K.J. Ranson [b], Z. Zhang [c], S. Luthcke [b]

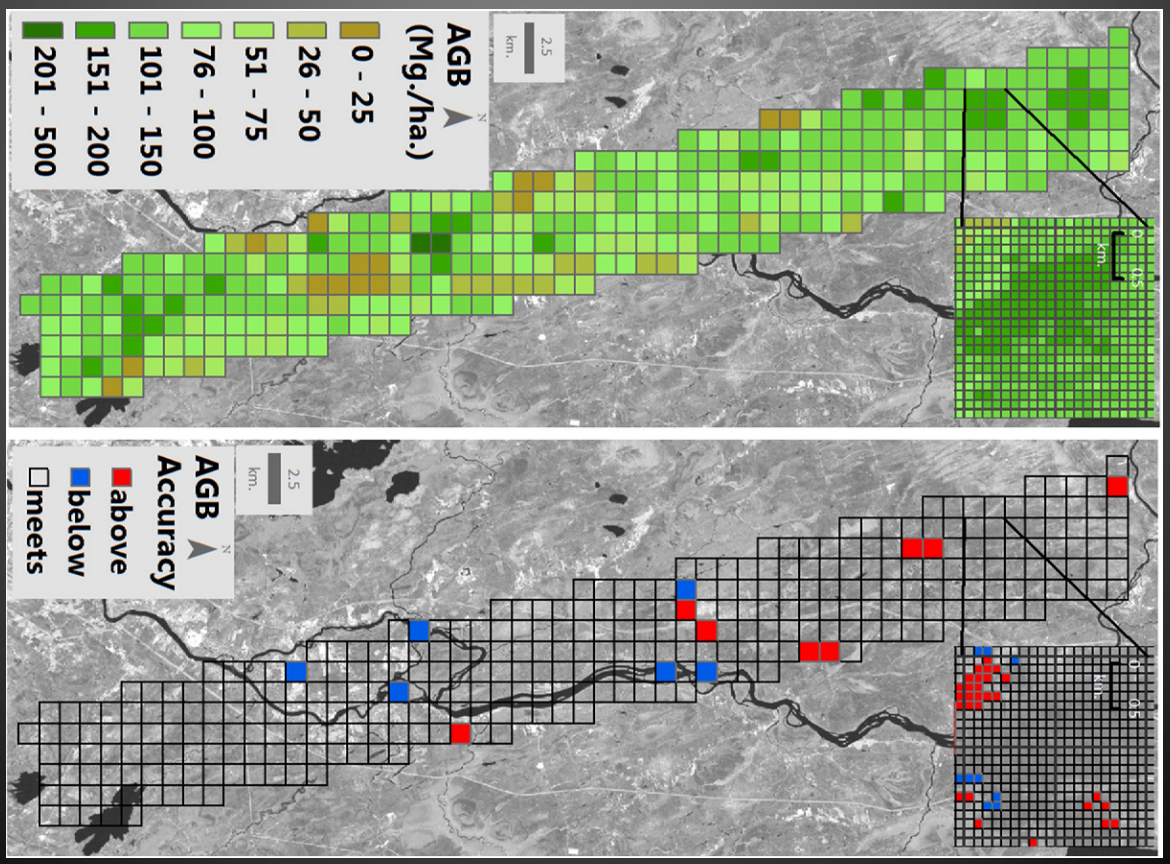

Fig. 11. (a) Gridded (1 km) AGB estimates for the study area derived from SAR/Optical data and NNET predictions. (b) Corresponding accuracy classes of gridded (1 km) AGB estimates, where accuracy is met when estimates are within ±20 Mg ha^{-1} or 20%, whichever is greater. The inset map is a portion of Howland Forest at the 100 m grid scale from the corresponding data combination and prediction method.

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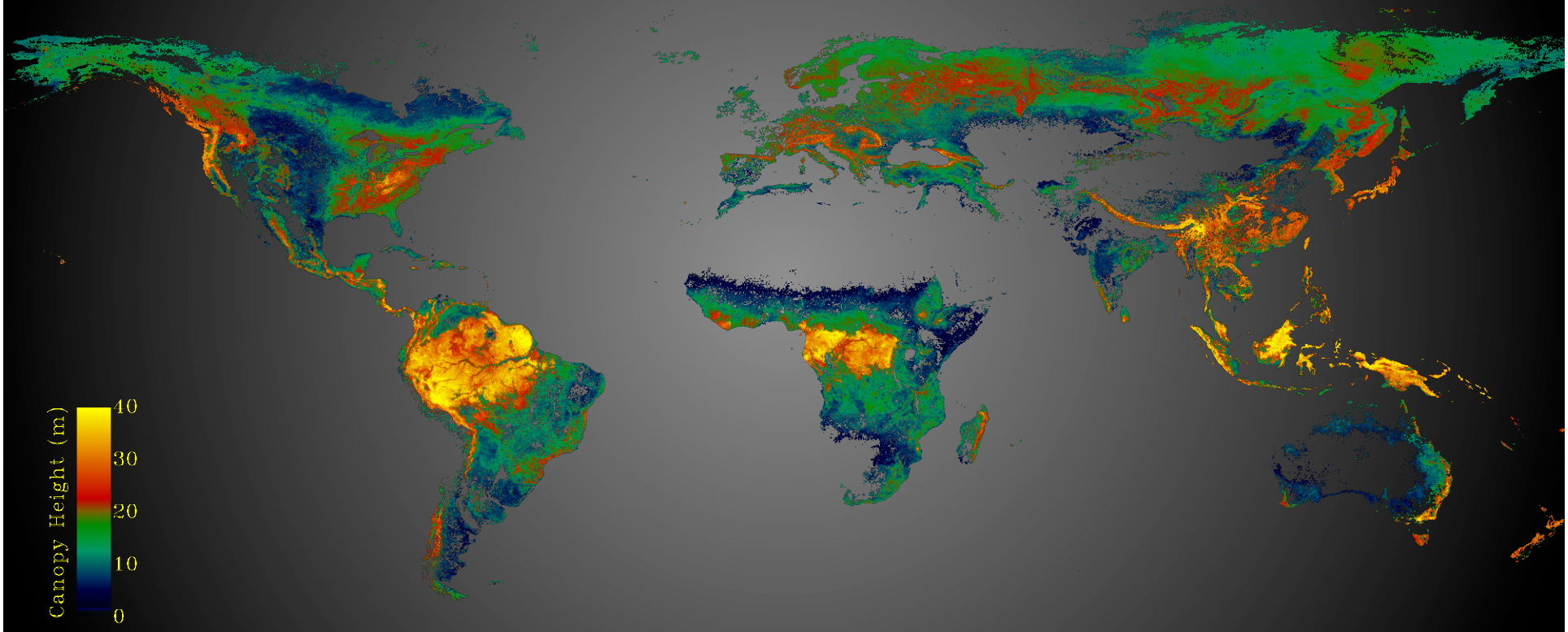
Global Map of Forest Canopy Height (1km resolution)



Simard, Pinto, Baccini and Fisher (Journal of Geophysical Research, 2011)

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IS THE NEW

LeisureArts

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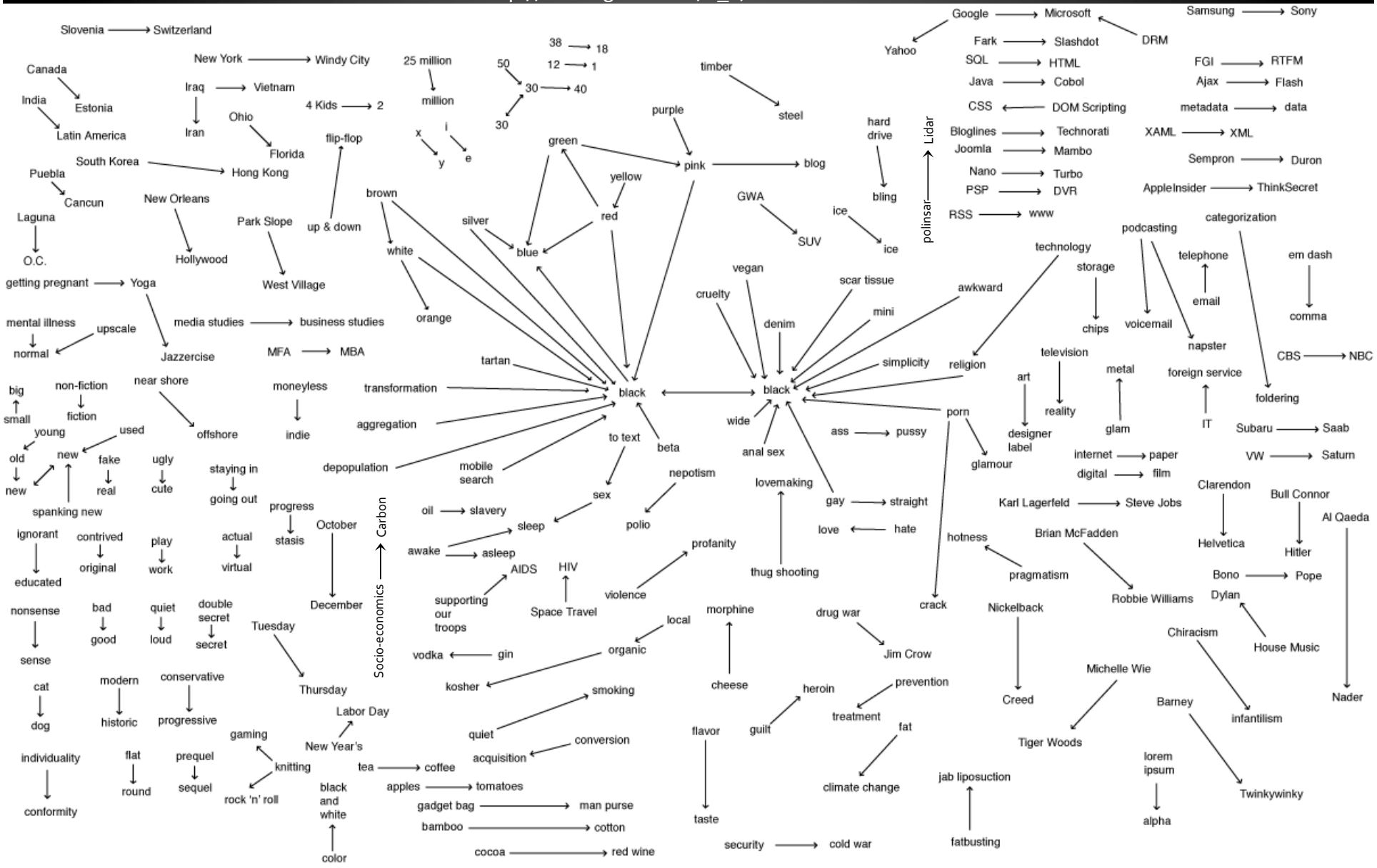
http://thediagram.com/6_3/leisurearts.html



UAVSAR Campaign 2009-2010

- PI: Marc Simard,
  - Co-I's Ralph Dubayah, Scott Hensley
- Objective:
  - To assess, quantify and mitigate the impact of temporal decorrelation on the retrieval of canopy height from polinSAR

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Airborne and Field Data Collection

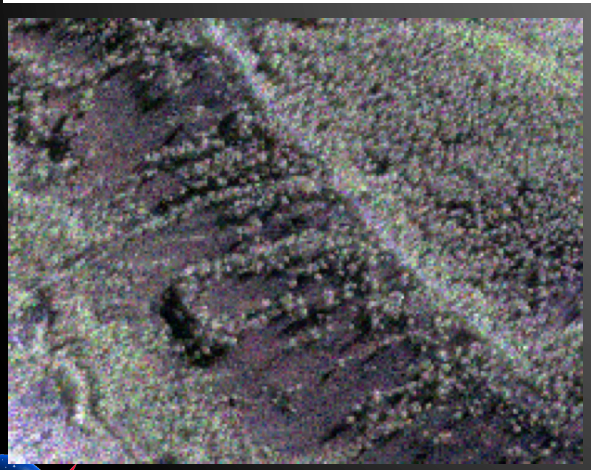
UAVSAR

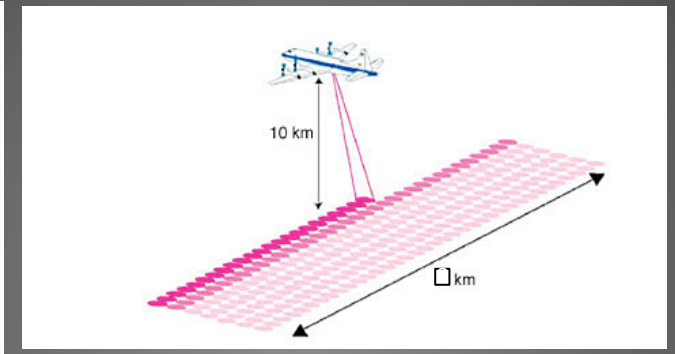
L-band polarimetric radar capable of repeat pass interferometry

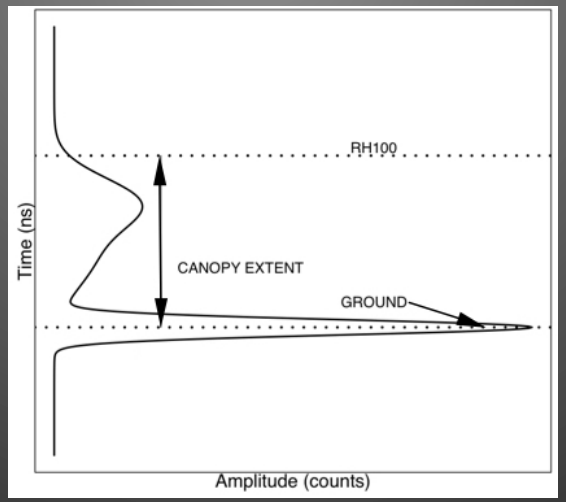
LVIS

Laser Vegetation Imaging System

Full waveform lidar (25m footprint)







- Spatial resolution
  - UAVSAR: ~6m
  - LVIS ~25m

Swaths

- UAVSAR ~20km
- LVIS 2km (based on max of 5^{o} look for vegetation)

Field data (88 forest plots)

- Tree height;
- Trunk diameter DBH
- Tree species
- Crown size
- Terrain Slopes
- Plot height and biomass

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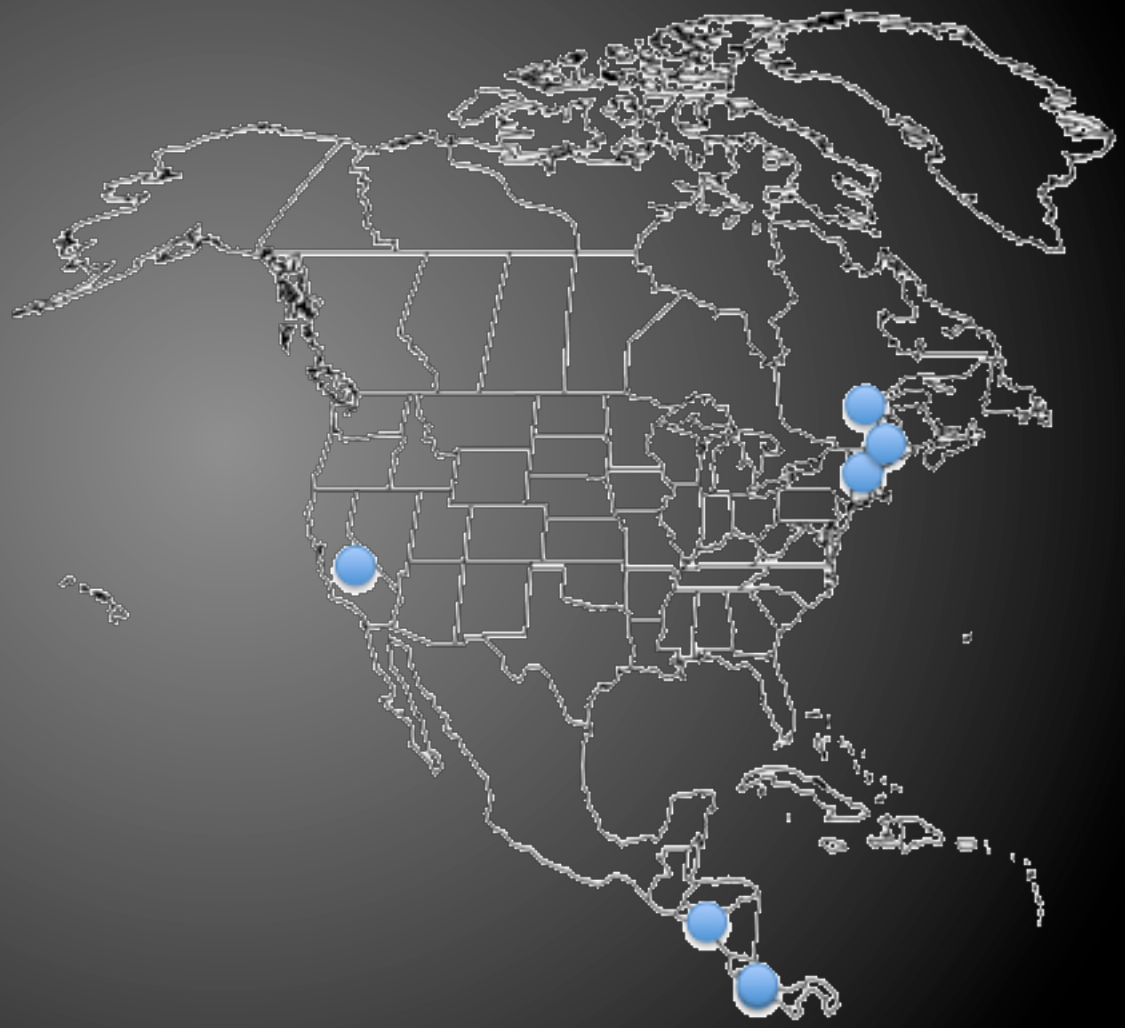
Sites

- Laurentides, Québec
- Penobscott/Howland, Maine
- Bartlett/Hubbard Brook, New Hampshire
- Sierra Nevada, Clifornia
- La Selva, Costa Rica



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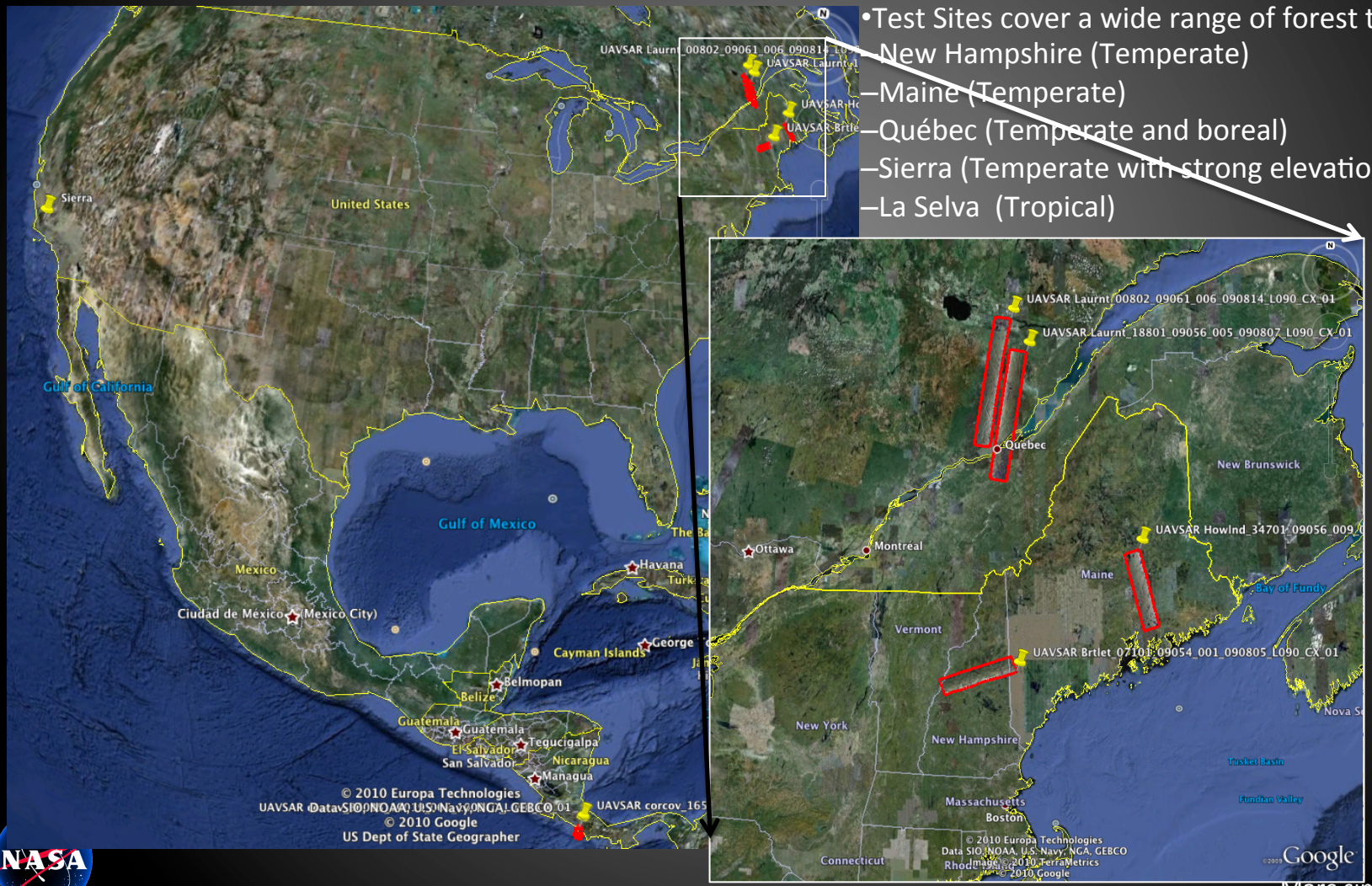
UAVSAR Campaign 2009-2010



- Test Sites cover a wide range of forest types and terrain
  - New Hampshire (Temperate)
  - Maine (Temperate)
  - Québec (Temperate and boreal)
  - Sierra (Temperate with strong elevational gradient)
  - La Selva (Tropical)

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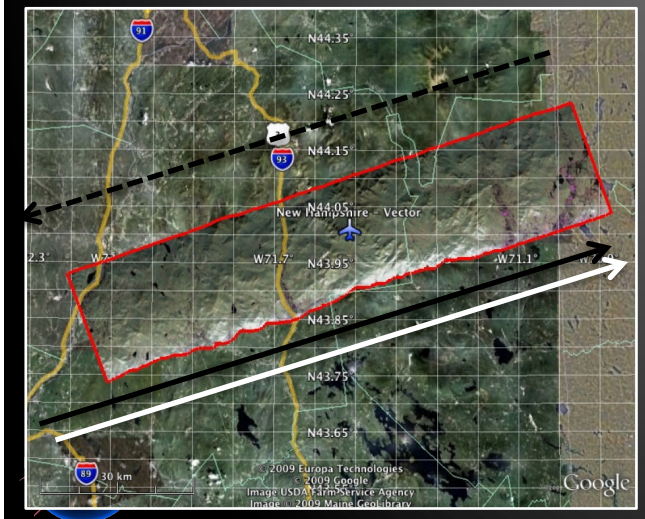
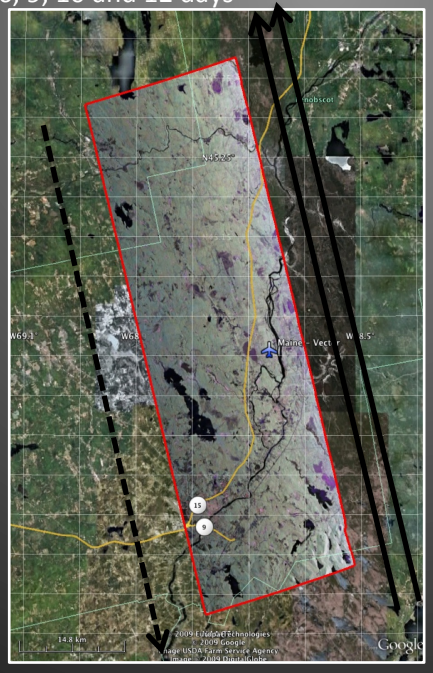
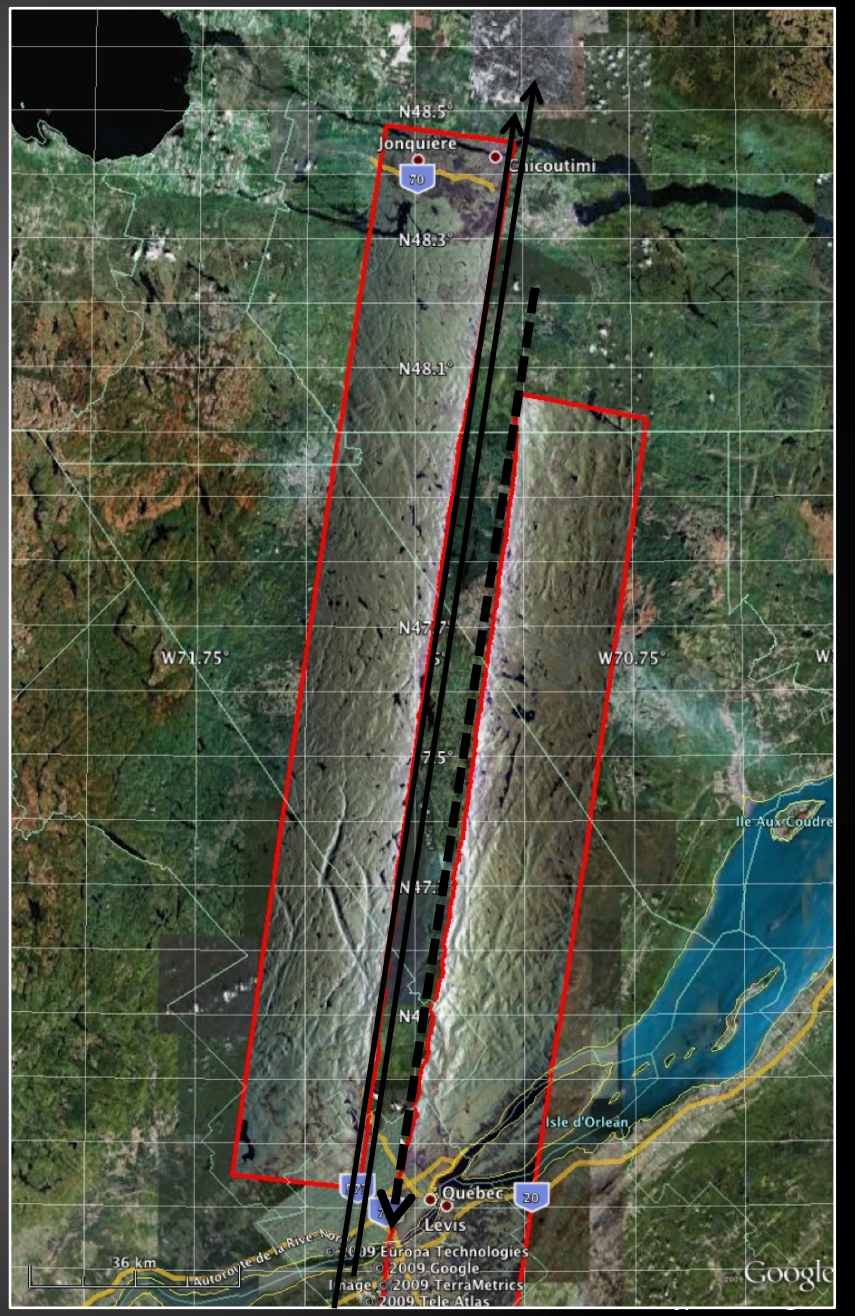
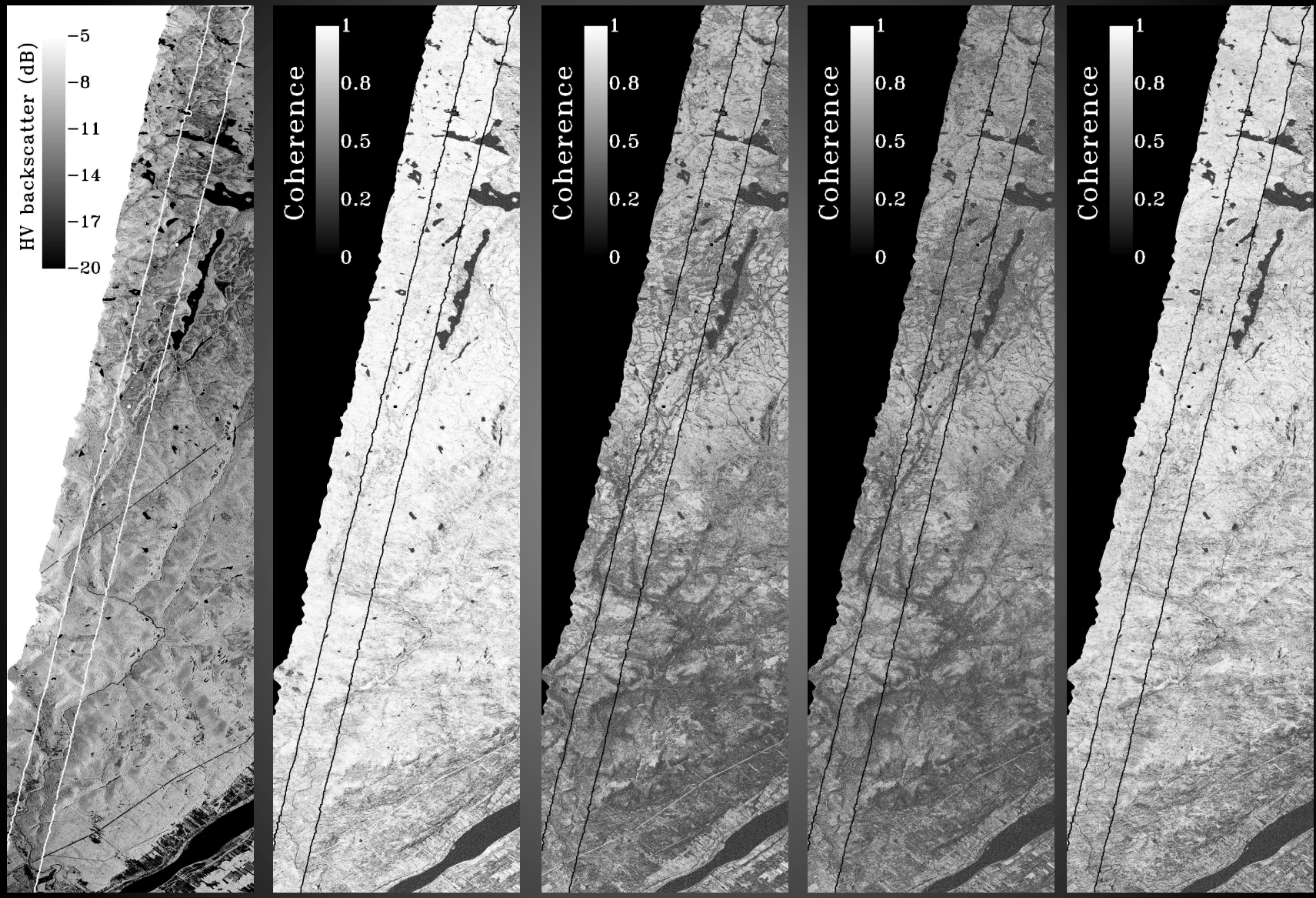
Data collection strategy

- UAVSAR images covered transects of ~100km with ~20km swath (Laurentides is 185km long)
- Covered boreal, temperate and tropical forests
- Large diversity of management practices:
  - sites are characterized by experimental forests, national parks and managed forests (e.g. lumber)
- UAVSAR flew 3 days(5 in tropics) over a period of about 2 weeks.
  - Each day, UAVSAR flew 4 times over each site.
  - Collected both zero and 65m baselines.
- Example:
  - North East sites flown on 5th, 7th and 14th of August 2009.
  - Providing 4 temporal baslines of 45', 2, 7 and 9 days
  - Costa Rica: January 29th, 31st, February 4th, 6th, 10th 2010
  - Temporal baselines: 30' and 2, 4, 6, 9, 10 and 12 days









σ_{HV} 45’ 2 days 7 days 9 days

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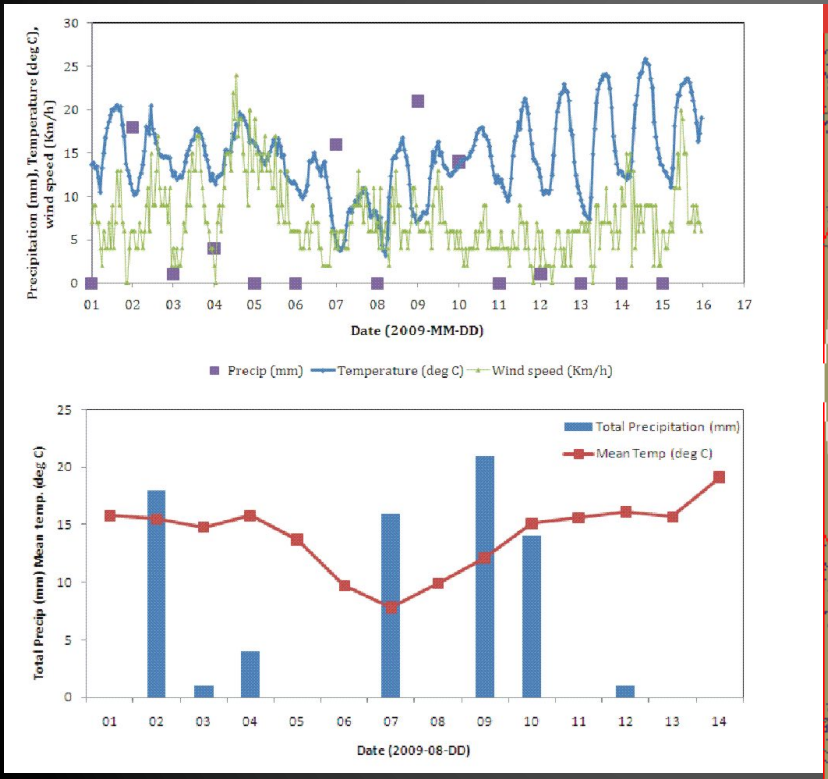
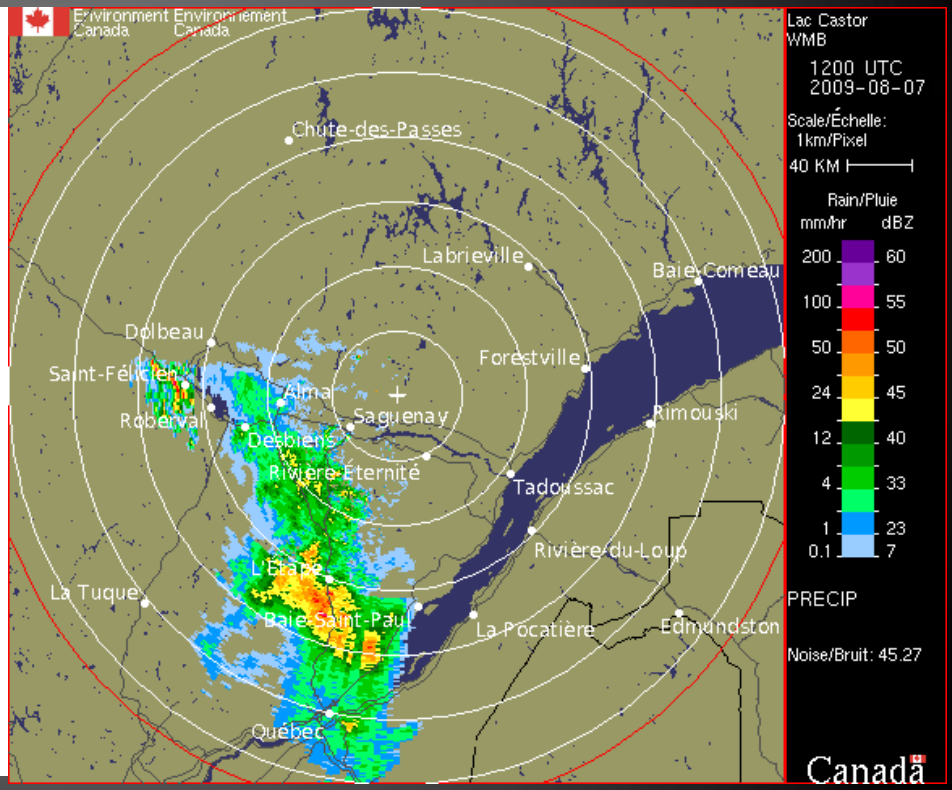
It is precipitation and change in moisture rather than “time” that most impacts temporal decorrelation on temporal scales of days.





- A large rain storm on the acquisition date of the 7th causes a decrease of the inSAR correlation with pairs including other days.
- Wind is nearly stable between 5 and 10km/h.

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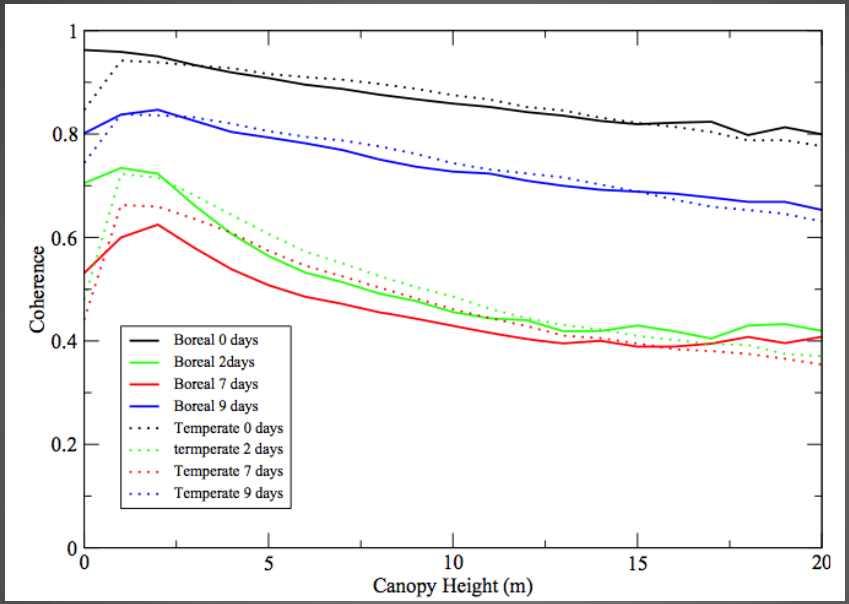
Temporal Decorrelation Experiment Summary and Conclusion



- Simard, M.; Hensley, S.; Lavalle, M.; Dubayah, R.; Pinto, N.; Hofton, M. An Empirical Assessment of Temporal Decorrelation Using the Uninhabited Aerial Vehicle Synthetic Aperture Radar over Forested Landscapes. *Remote Sens.* **2012**, *4*, 975-986.
- M. Lavalle, M. Simard, and S. Hensley, "A temporal decorrelation model for polarimetric radar interferometers," *IEEE Transactions on Geoscience and Remote Sensing*, 2011 (online), DOI: 10.1109/TGRS.2011.2174367.
- Pinto, N.; Simard, M.; Dubayah, R. Using InSAR Coherence to Map Stand Age in a Boreal Forest. *Remote Sens.* **2013**, *5*, 42-56.

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3D Land Mapping – Lidar and Radar Mapping of Land Surfaces

3D Land Mapping – Lidar and R...

lidarradar.jpl.nasa.gov

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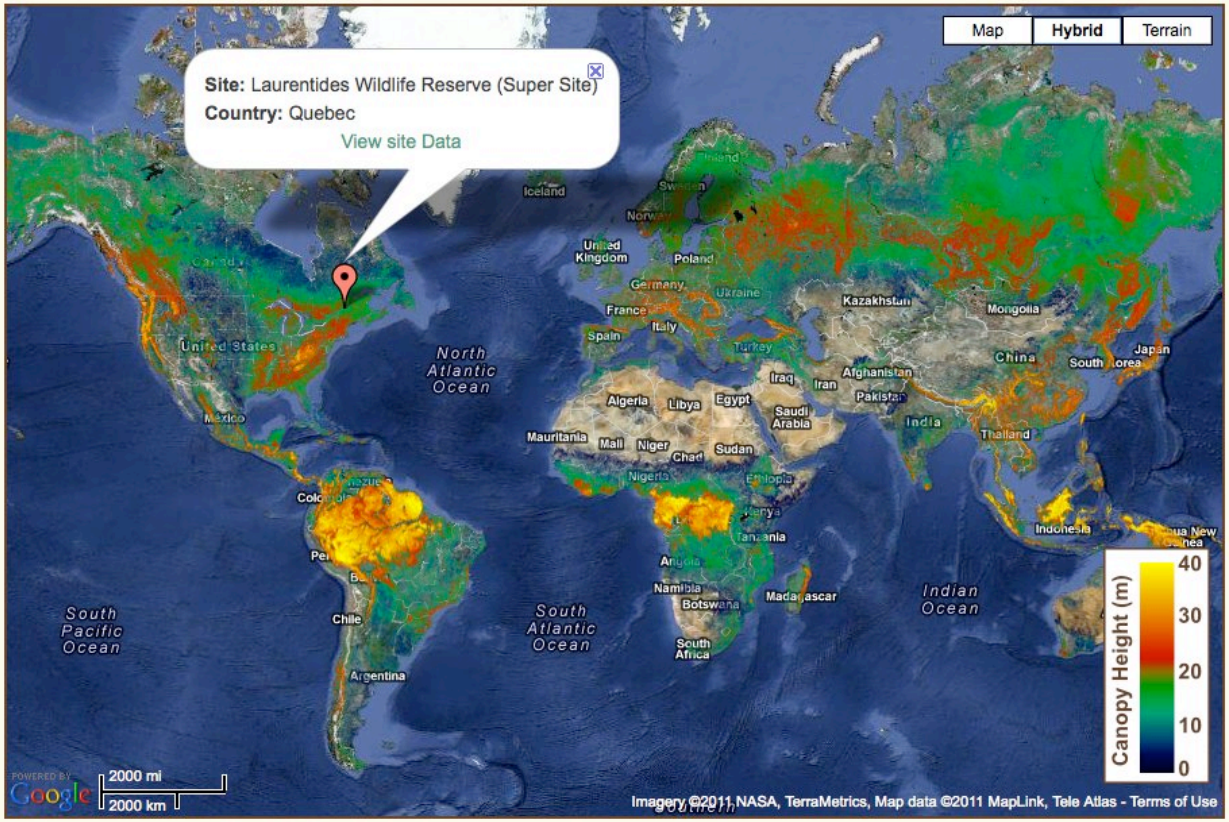
3D Land Mapping

Combining Lidar and Radar for Remote Sensing of Land Surfaces

Click on a marker to find out more information about your favorite site.



☑ Show low resolution (10km) 3D Global Vegetation Map derived from ICESat/GLAS and environmental modeling
Download the full resolution (1km) map here [TIF] and map legend here. An error map can be downloaded here.

Project Description

This website presents the research projects of Dr. Marc Simard, Senior Scientist at the Jet Propulsion Laboratory. **The overall objective is to combine radar and lidar remote sensing to characterize the forested landscapes in 3D.** The science products generated by Simard and

a.gov

3D Land Mapping – Laurentides Wildlife Reserve, Quebec

3D Land Mapping – Laurentides...

lidarradar.jpl.nasa.gov/sites/laurentides.html

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3D Land Mapping Home

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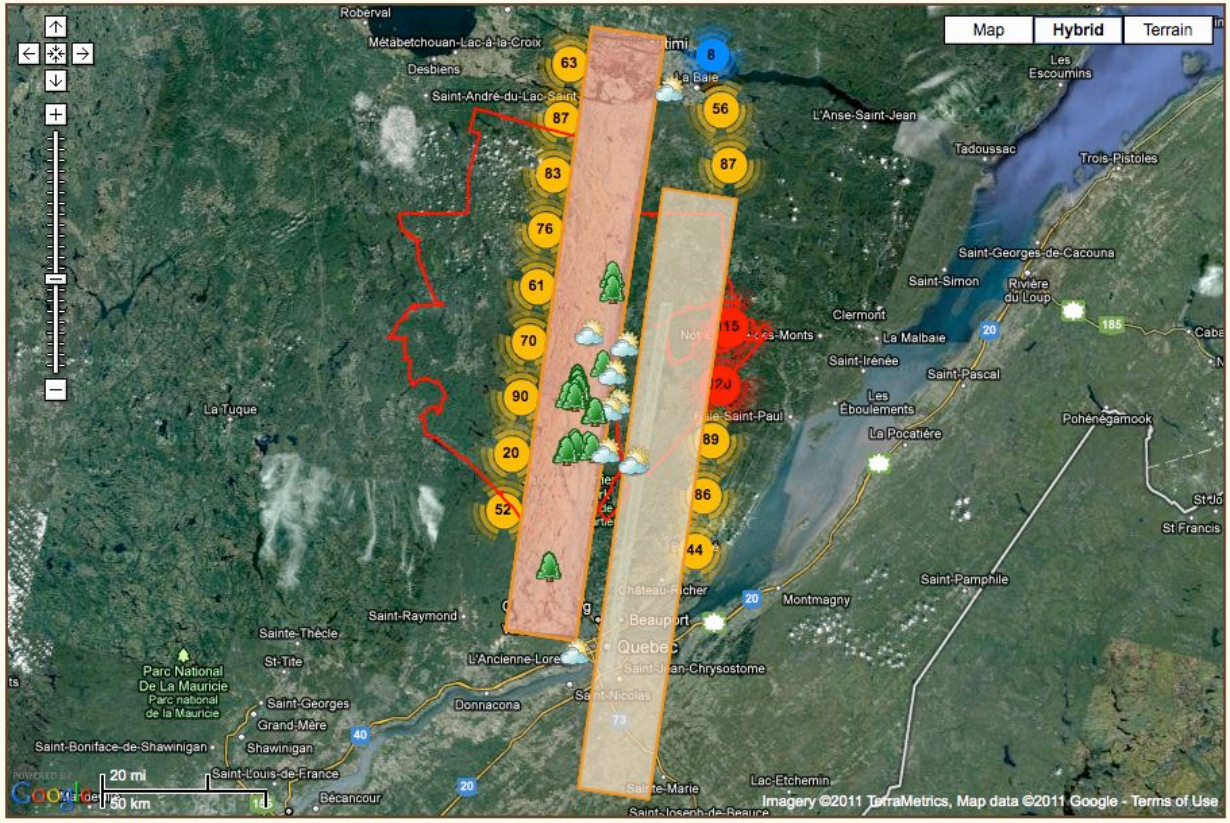
Super Site: Laurentides Wildlife Reserve, Quebec

Click a checkbox to show a specific dataset in the map. Then click the objects (markers, swaths, etc) in the map for more information.

☑ Super Site [KML] ☑ UAVSAR ☑ LVIS ☑ ICESat [TXT] ☐ SRTM [KMZ] ☑ Field Data [CSV] ☑ Weather Data [KML]



Lat: Lng:

UAVSAR Swath Details: Laurnt_00802

Radiometrically Calibrated Backscatter (View a high-resolution map here)

◉ Low-resolution: [KML], GeoTIFF files by polarization: [HH] [HV] [VV]

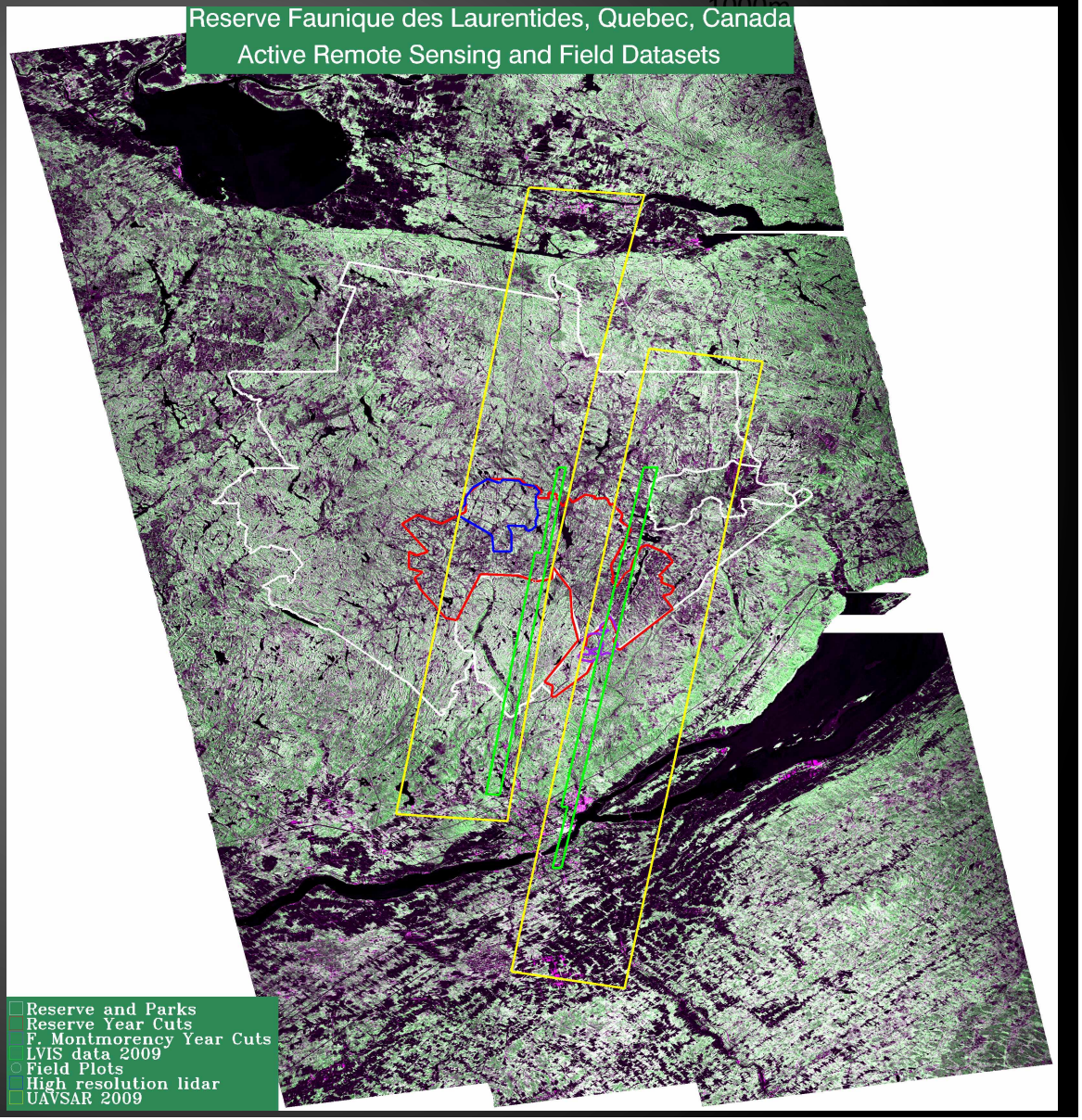
Incidence Angle

nasa.gov

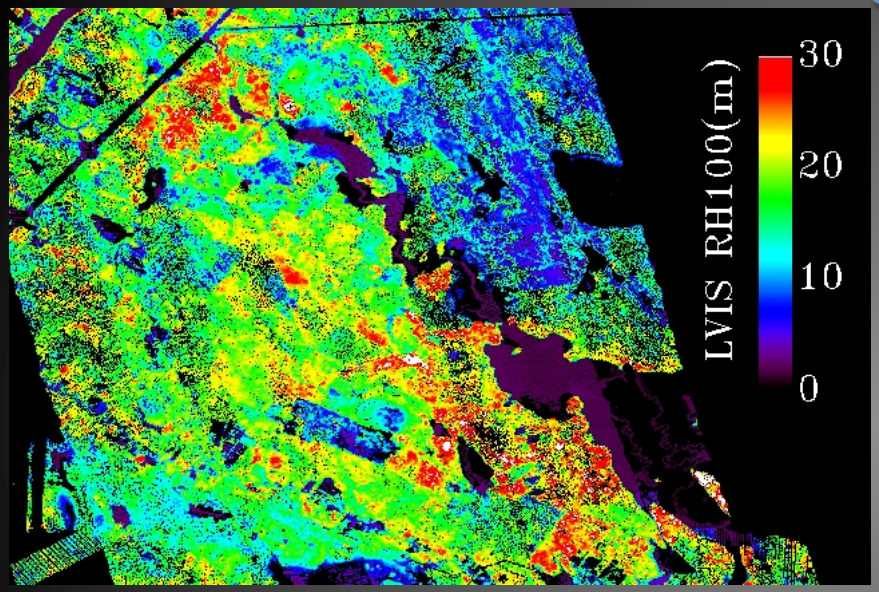
A Cal/Val Super Site for Active Remote Sensing Platforms

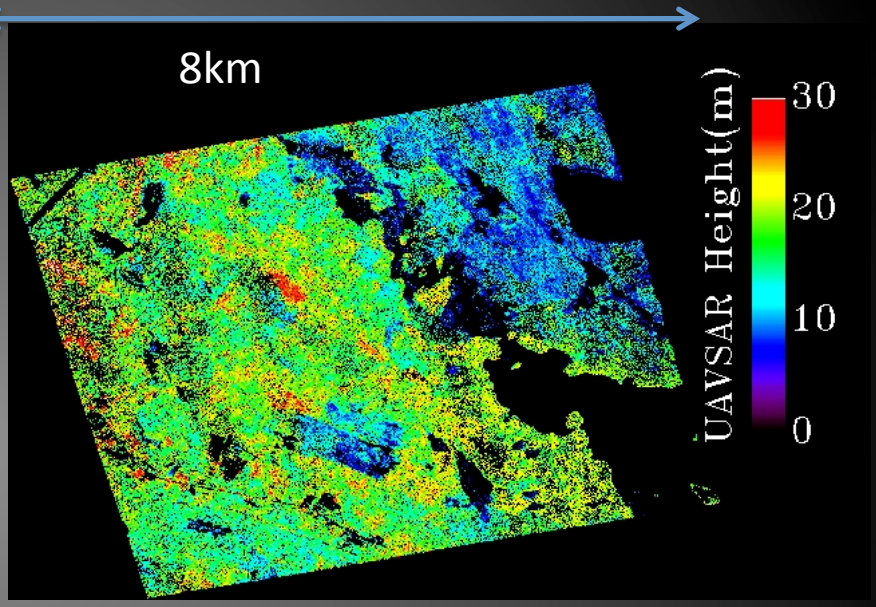
Réserve Faunique des Laurentides (Québec, Canada) proposed at CEOS 2010

- Laurentides
  - 1000m elevation range
  - Temperate and boreal forests
  - National Parks
  - Experimental forests
  - Large scale (Governmental) lumber management
  - Public access to all sites
- Data
  - UAVSAR, ALOS/PALSAR
  - repeat-pass UAVSAR (Multi-temporal)
  - MODIS, LANDSAT
  - Lidars : LVIS, ICESat/GLAS, high res.
  - **TanDEM-X**
  - Field
    - Canopy structure
    - Weather data
    - Government/industry participation
    - Stand age
  - Real Time Weather data
  - Accurate knowledge of terrain slope
- Missing
  - Radarsat (requested)
  - ENVISAT
  - TerraSAR-X



Penobscott, Maine





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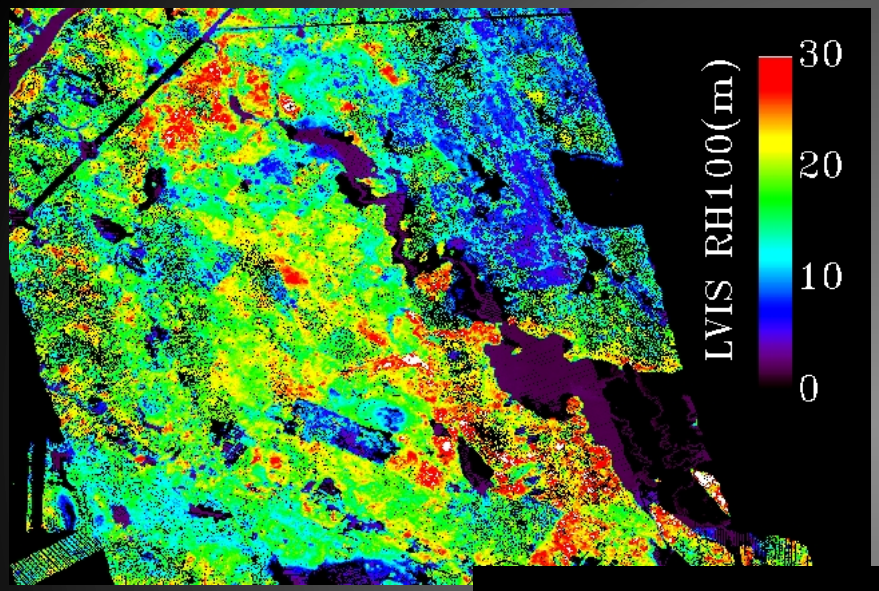
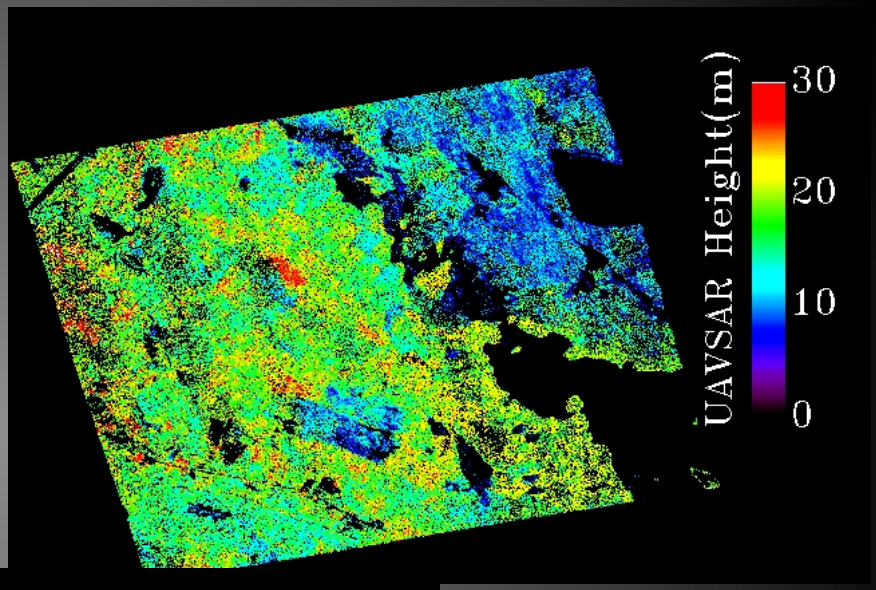
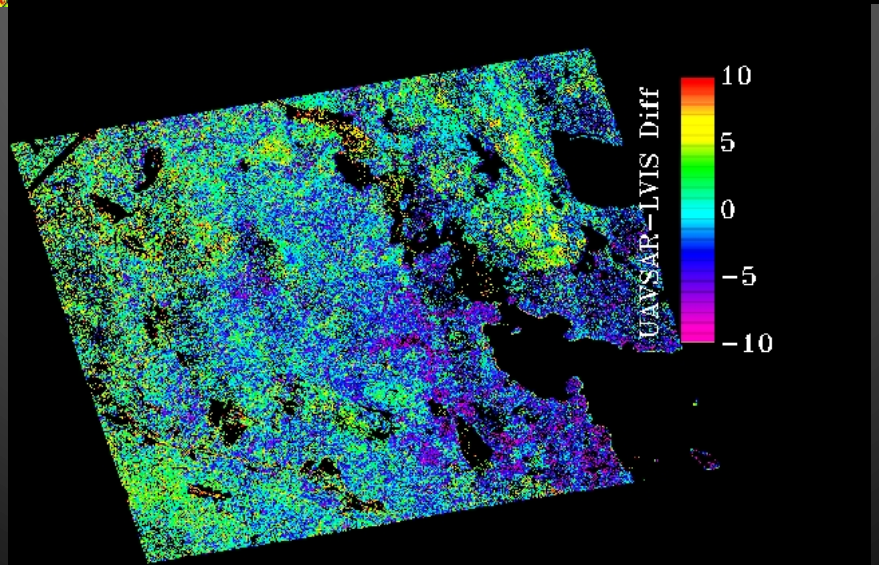
Penobscott, Maine







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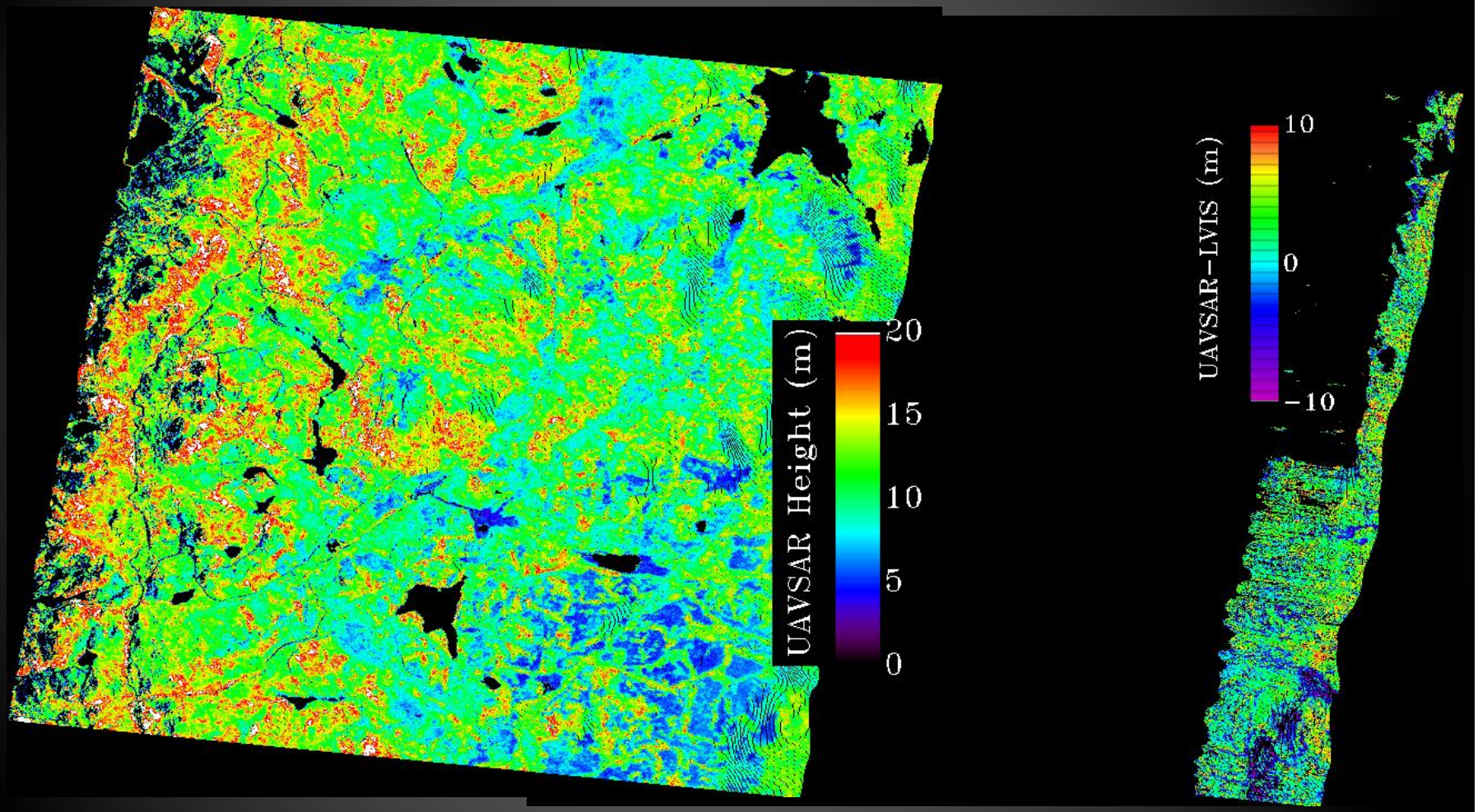
Laurentides, Québec



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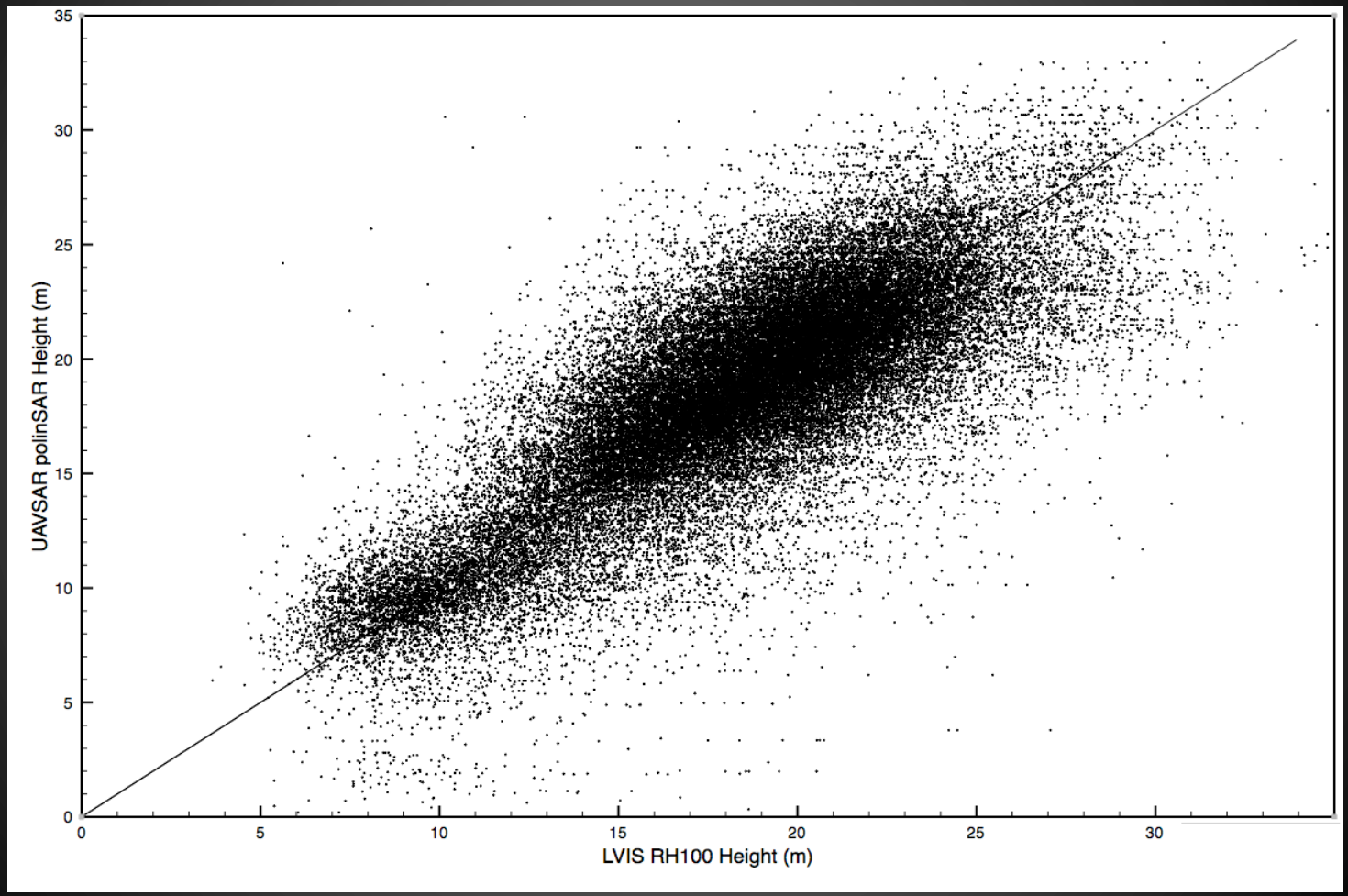
PolinSAR inversion of canopy Height



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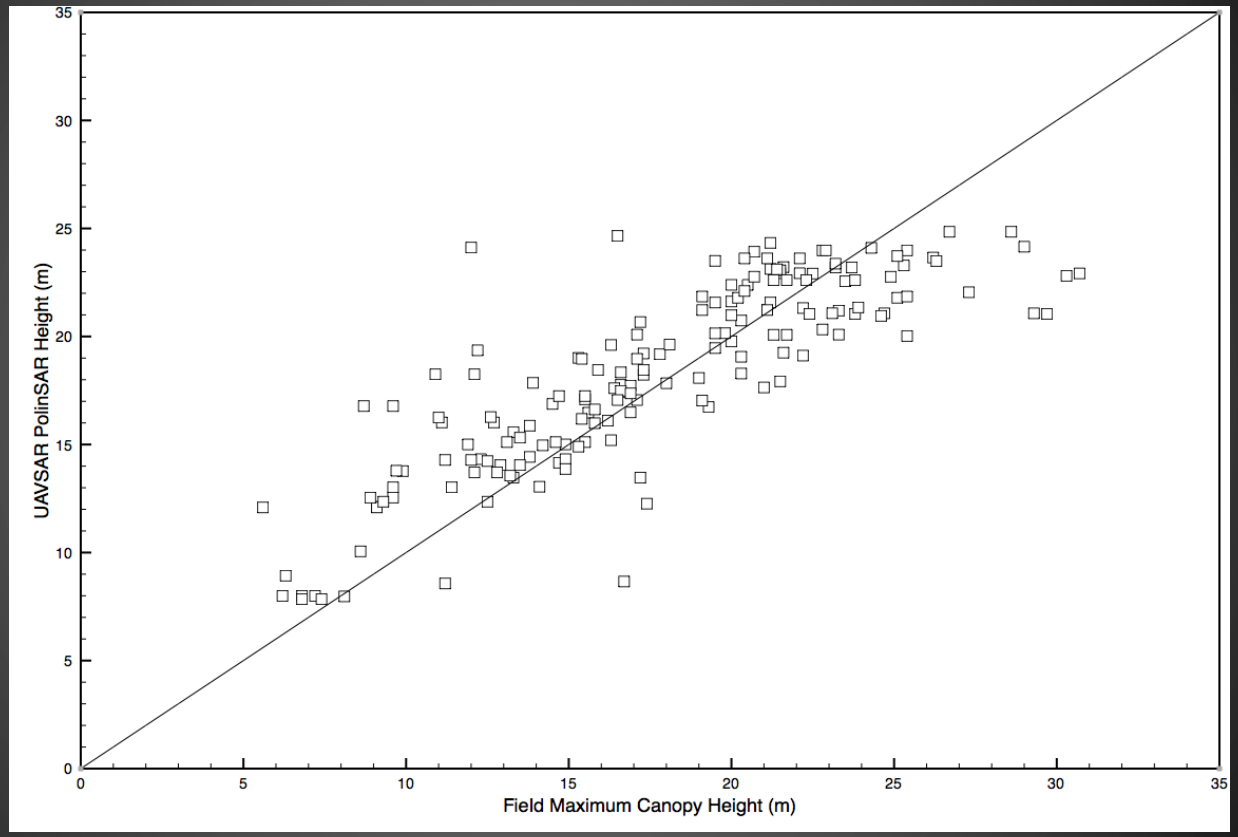
UAVSAR polinSAR vs Field Height



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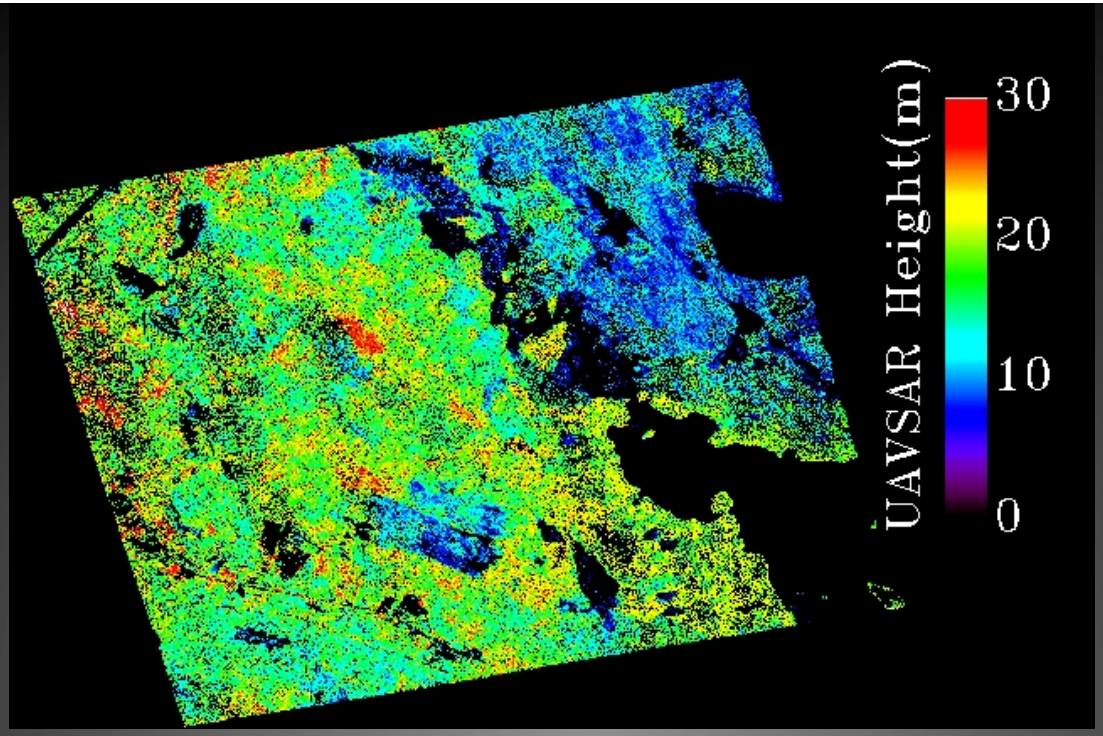

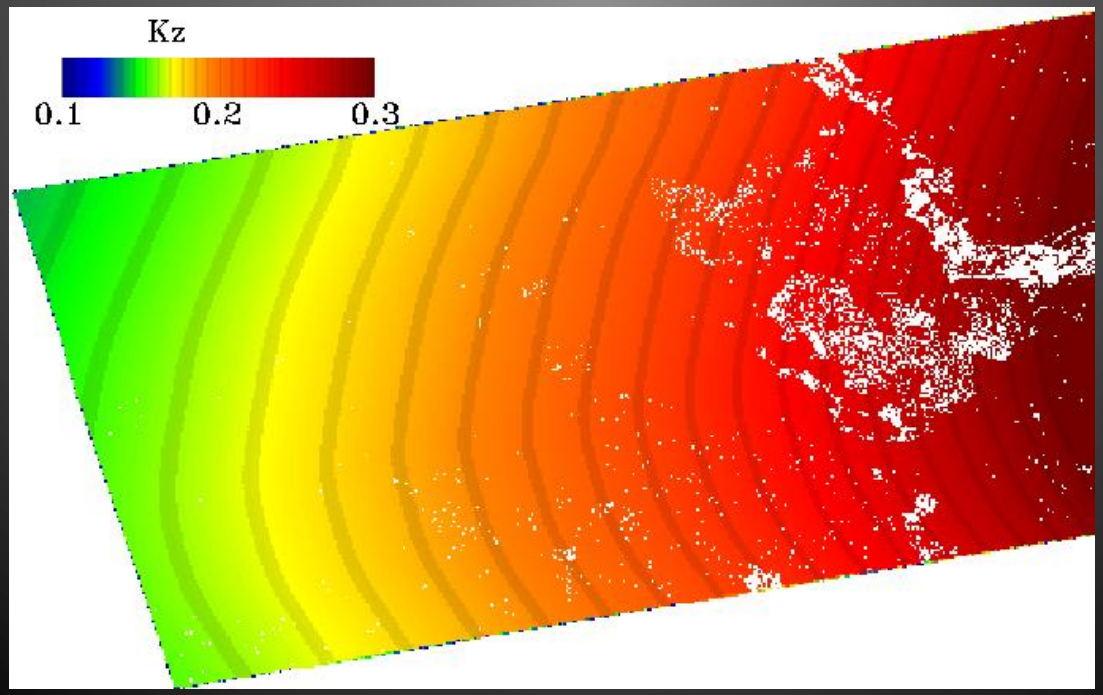

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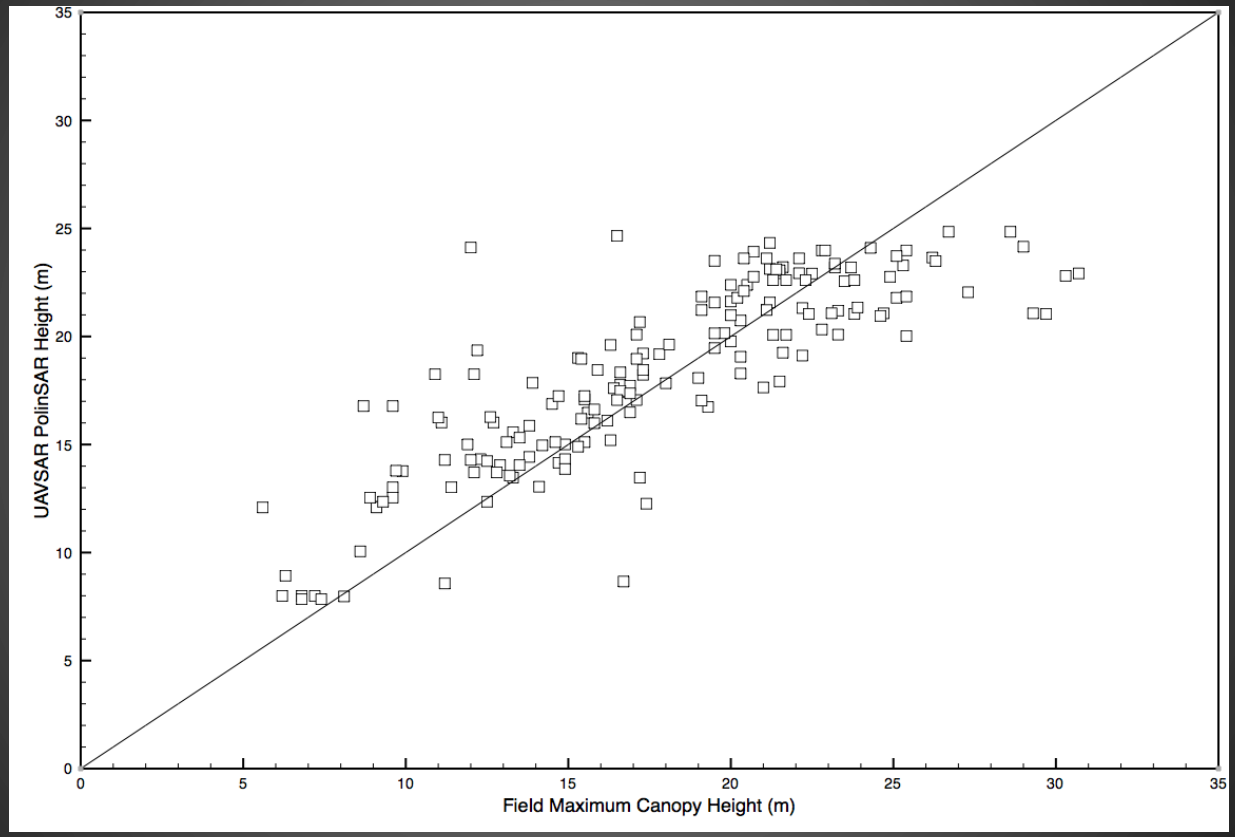
UAVSAR polinSAR vs Field Height



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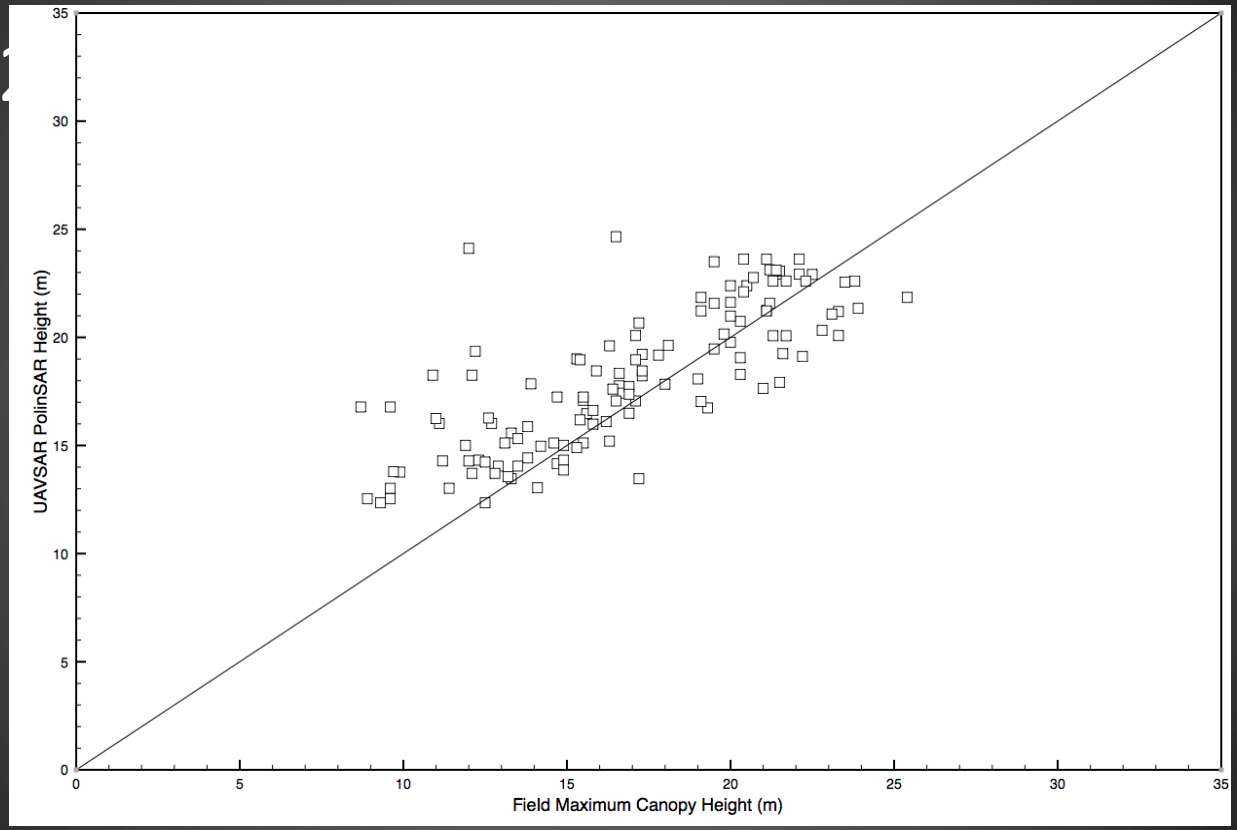
UAVSAR polinSAR vs Field Height

- Kz<0.1



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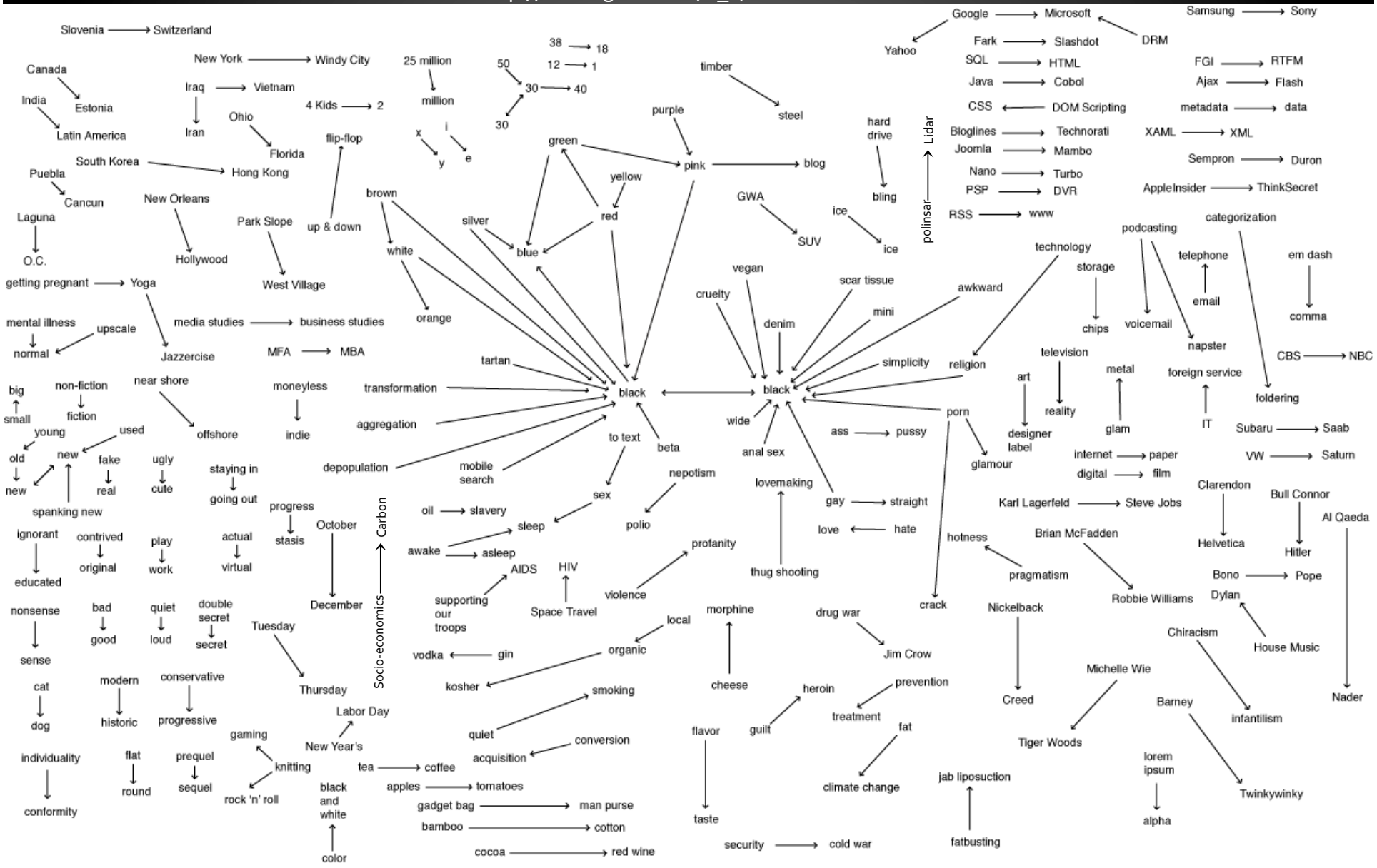
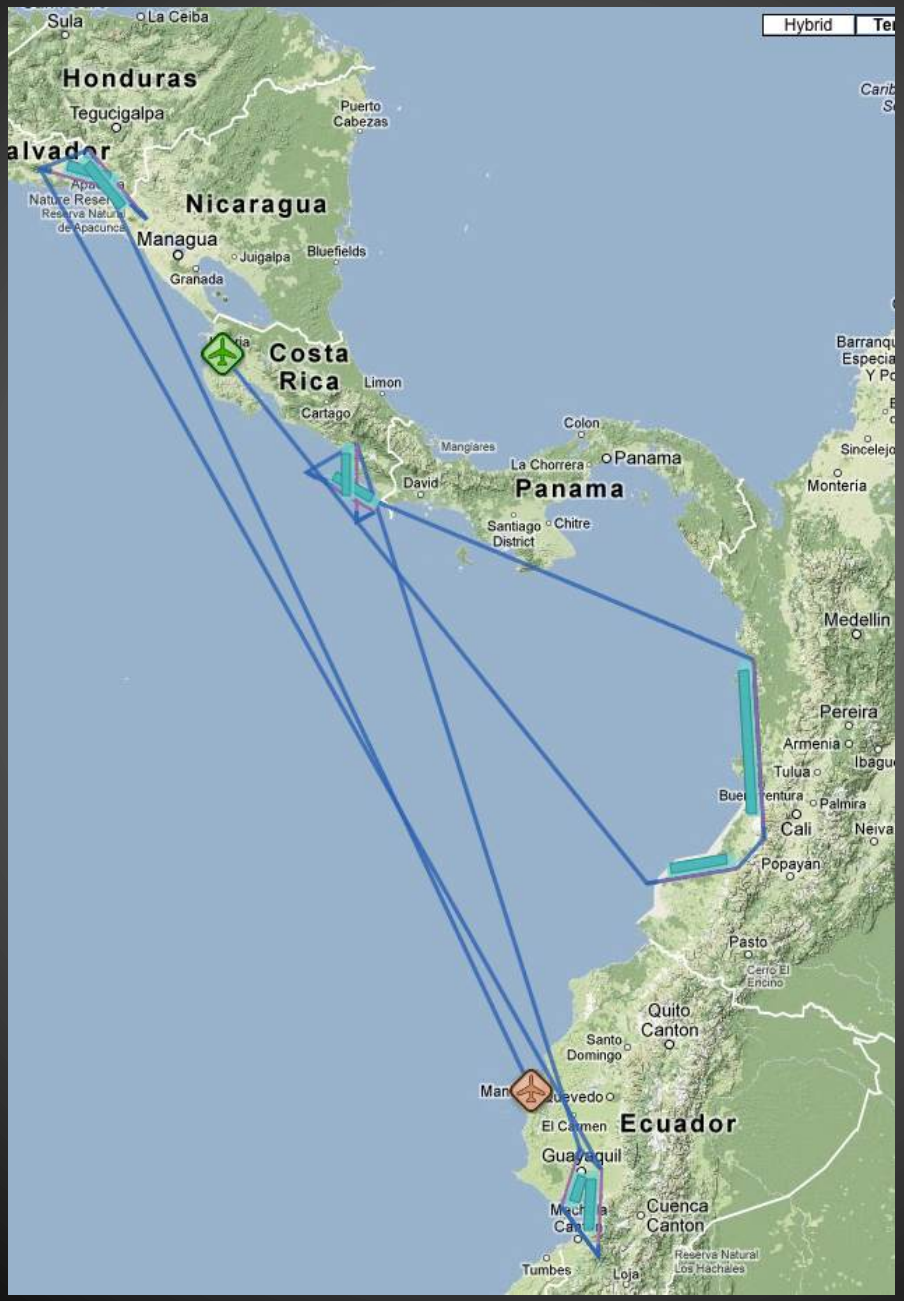
http://thediagram.com/6_3/leisurearts.html



UAVSAR mangrove monitoring campaign in Central and South America



Térraba-Sierpe, Costa Rica

Gulf of Fonseca, Honduras

Chocó, Colombia

Guayas, Ecuador

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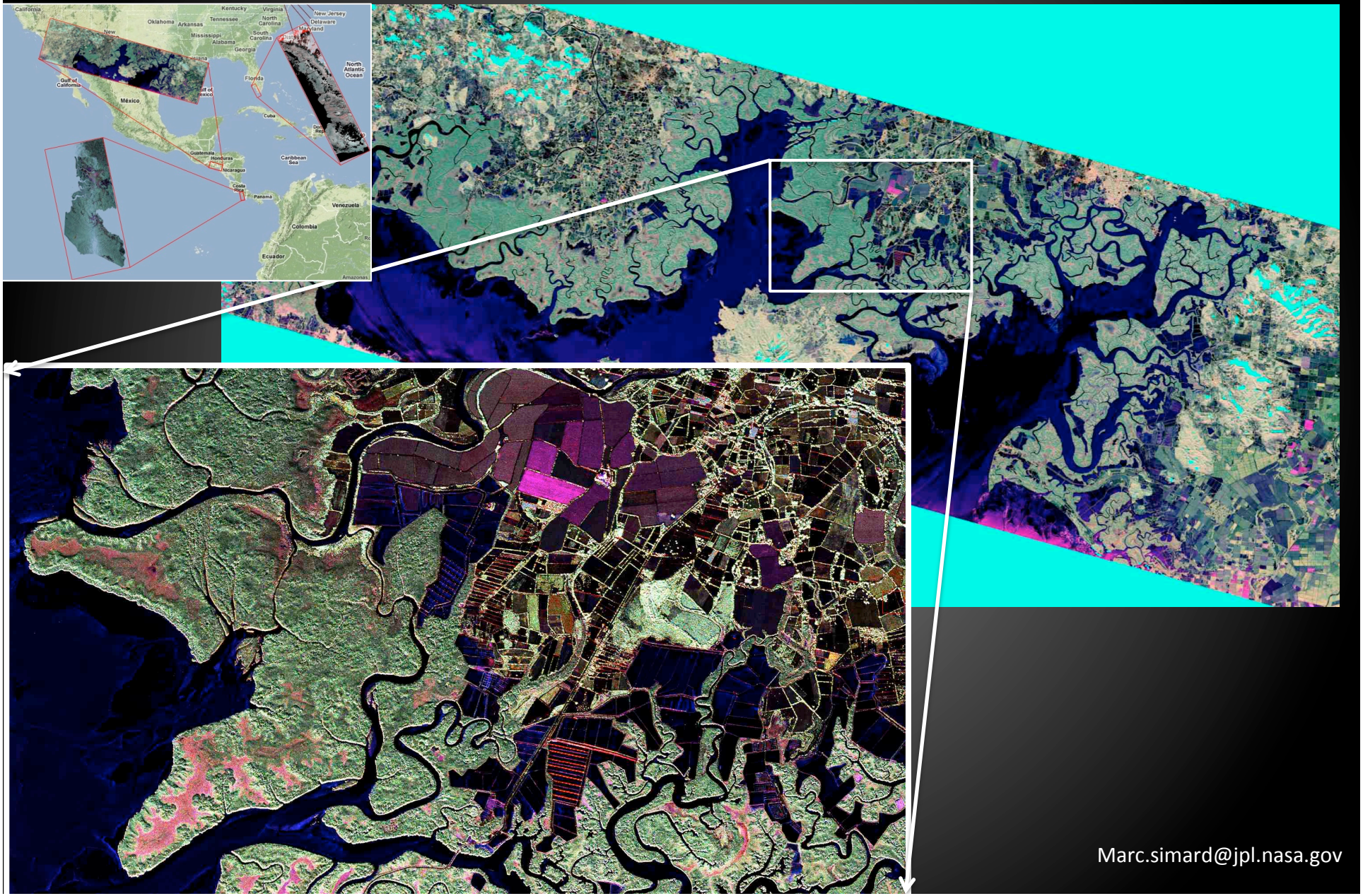
Mangrove Vulnerability Assessment to Climate Change and Socio-Economic Pressure.



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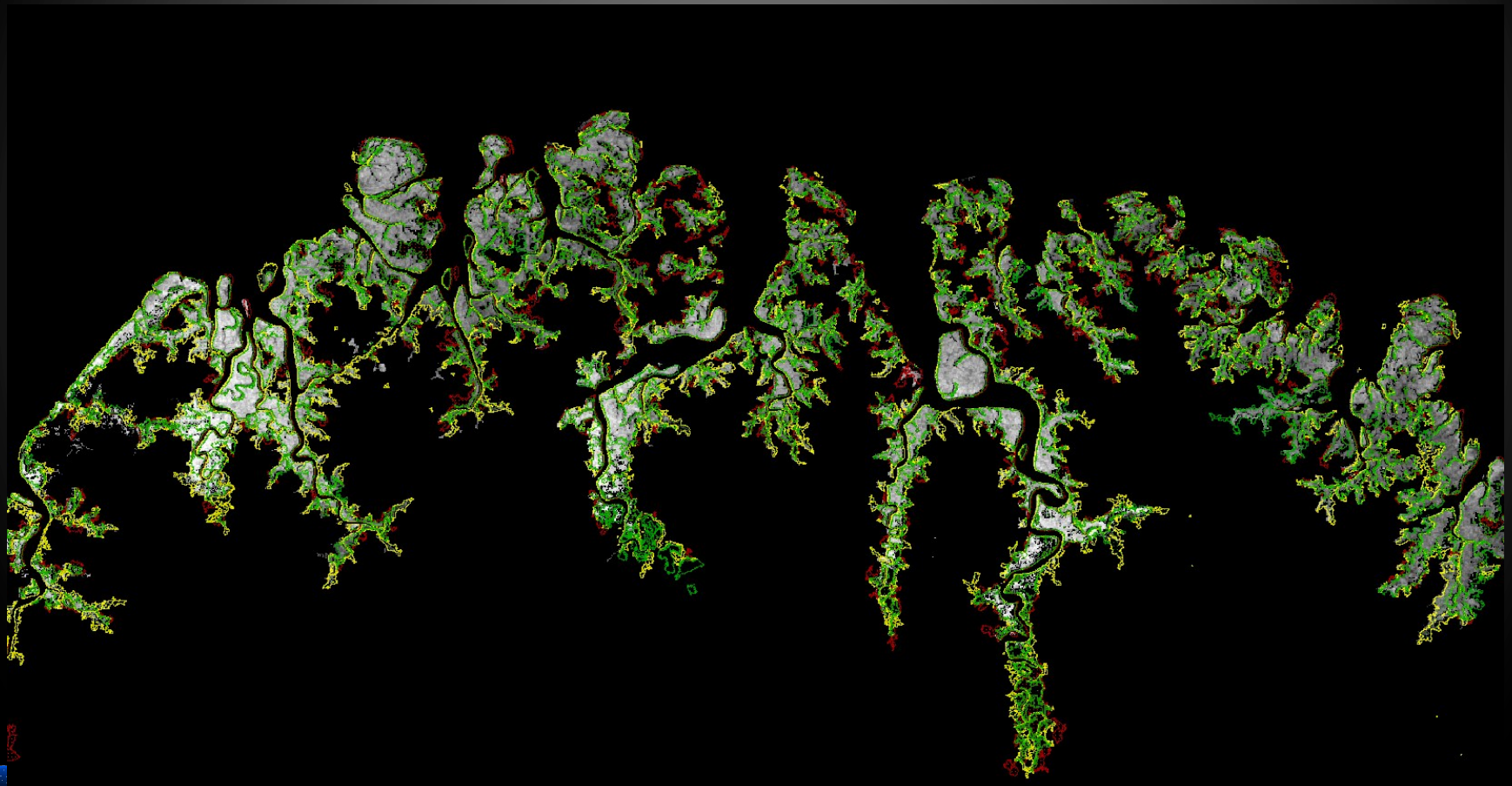
Time-series analysis with JAXA's ALOS/PALSAR dataset (K&C initiative and Mangrove Watch)

- Launched in 2006, worked until April 2011
- Programmed for repeat data acquisition over global wetland sites through the Kyoto and Carbon Initiative in support of the Ramsar convention.
- Current research on using ALOS/PALSAR for mapping of land cover, degradation and biomass in mangroves



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Conclusion

- We empirically estimated the impact of temporal decorrelation on interferometric coherence and identified a few causes
- We successfully performed polinSAR inversion of canopy height using repeat-pass UAVSAR data
- Future: Continue analysis of the impact of Kz, extinction, temporal decorrelation and spatial resolution
- Process other sites

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