

Savanna-Bio: Biomass estimation with new spaceborne missions for MRV in Dry Forests and Savannas

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Introduction

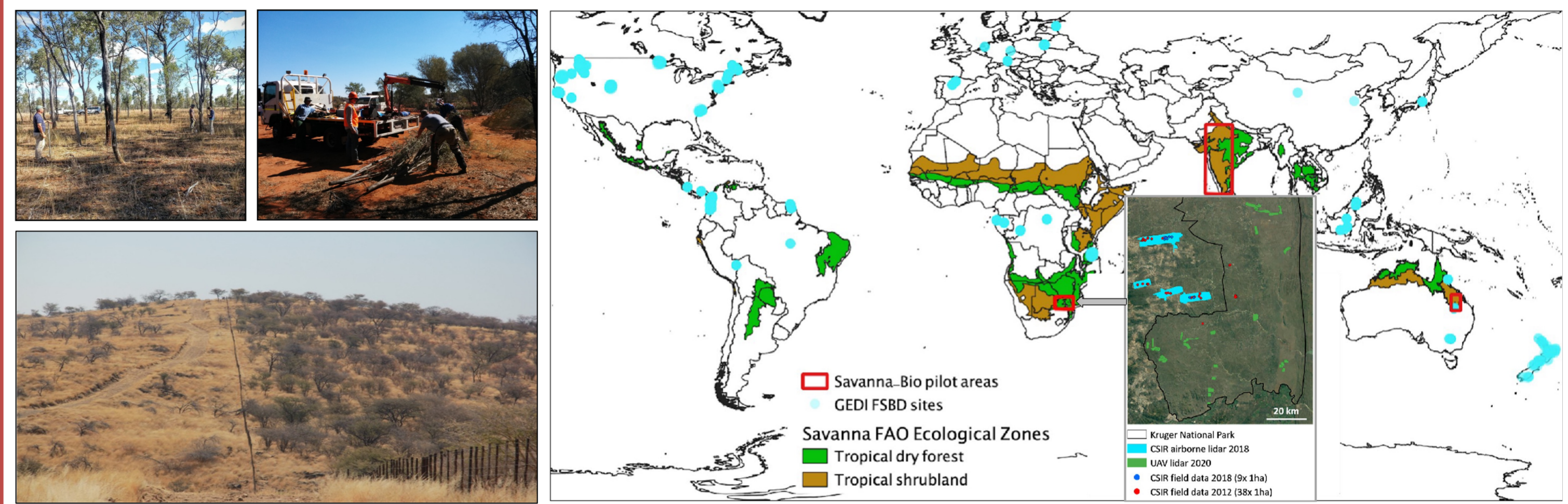
The aim of our CMS research is to develop prototype aboveground biomass and change products for selected tropical savanna regions (South Africa, Australia, India), using NASA's GEDI and ICESat-2 spaceborne lidar data to reduce the uncertainty of SAR-based models and map products (Sentinel-1A/1B, ALOS PALSAR-1/2, NASA/ISRO NISAR)

The specific objectives of this research are:

1. Develop prototype height and aboveground biomass products for international pilot sites using satellite lidar and SAR time-series (Sentinel-1A/1B and ALOS PALSAR-2) datasets.
2. Use independent field and airborne data to validate the products and evaluate the uncertainty of aboveground biomass estimates from 0.25 ha to 1 km² scales following the CEOS Land Production Validation good practices protocol.
3. Quantify the impacts of woody degradation and regrowth on aboveground biomass and carbon stock change with reference to existing MRV activity data employed by selected international stakeholders in India, South Africa and Australia.

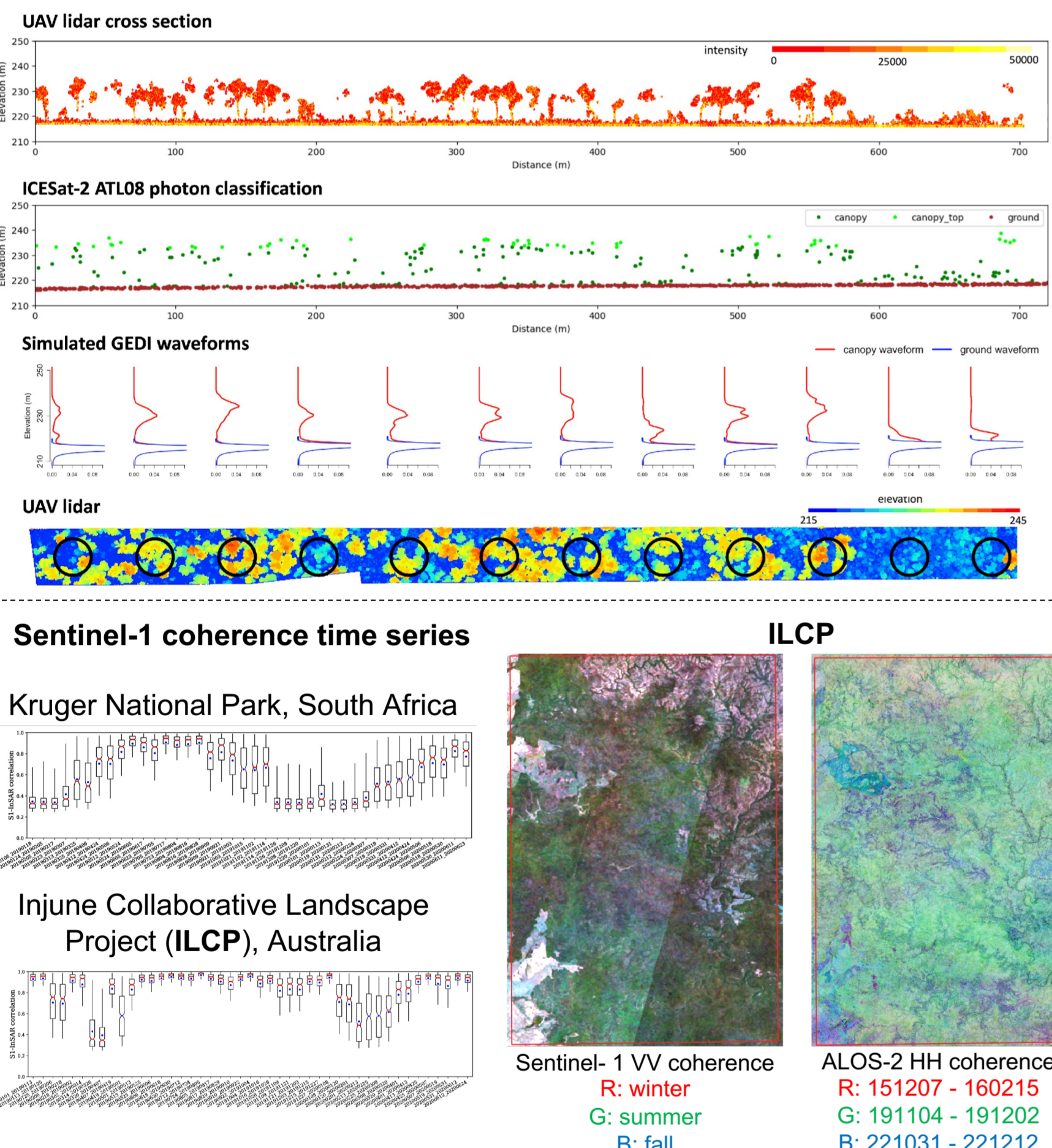
Study Sites

Three international sites (red squares) are located within global Savannas (FAO Tropical Dry Forests and Shrubland) in Australia, India, and South Africa. They include Committee on Earth Observation Satellites (CEOS) Biomass Reference Measurement (BRM) sites (Duncanson *et al.*, 2021). The inset shows the location and extent of existing airborne lidar flights in South Africa and those being targeted for repeat field and airborne campaigns.



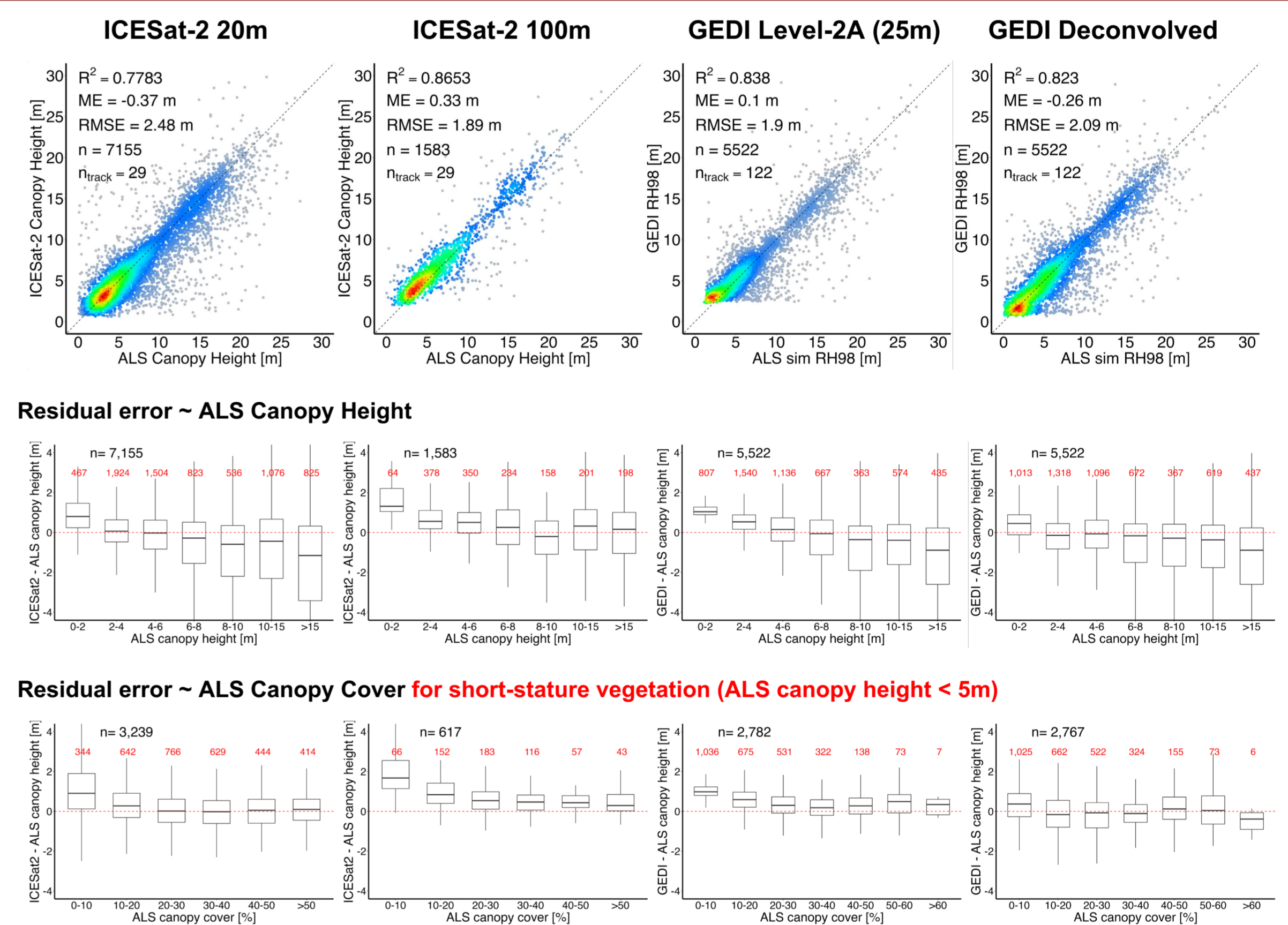
Spaceborne SAR and Lidar Datasets

Transect of vegetation height in Litchfield site (tropical savanna), Australia



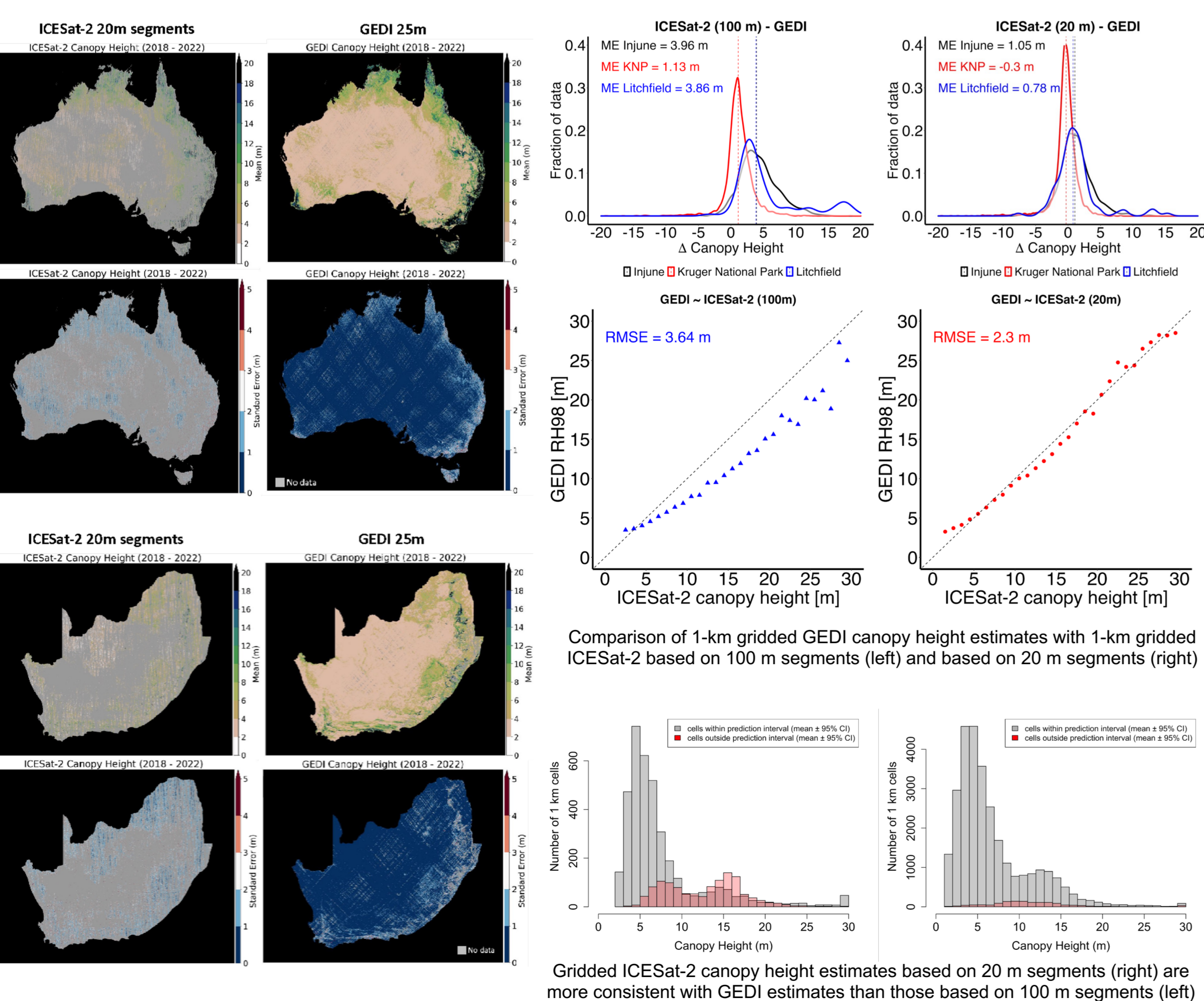
- For large area mapping we develop a tiled processing framework on the NASA Multi-Mission Algorithm and Analysis Platform (MAAP).
- The framework standardizes ICESat-2 ATL03 photon metrics, GEDI Level-2A and -2B footprint metrics, and Sentinel-1 coherence and radar cross-section (RCS), and ALOS-2 PALSAR-2 RCS into a common reference frame based on the Military Grid Reference System (MGRS).
- These datasets improve and localise the calibration of the height and biomass estimation algorithms currently being investigated.

Validation of GEDI and ICESat-2 footprint canopy height estimates (South Africa + Australia)

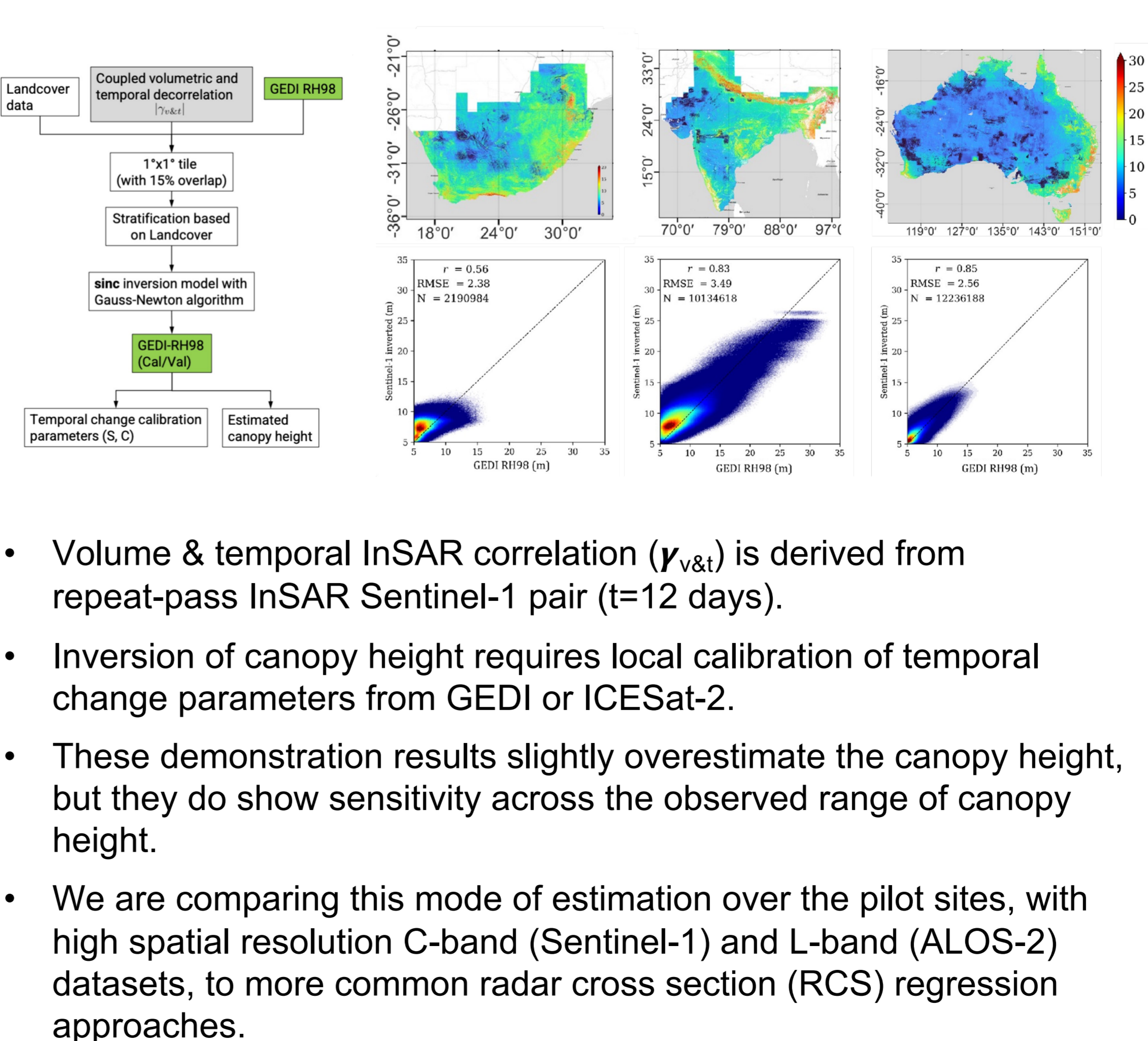


Due to GEDI pulse width (15.6 ns) minimum expected height of retrieval is around 2.4 m, i.e., the return signal from short-stature vegetation is blurred with ground signal. Waveform deconvolution of GEDI data helps to extend the limit of detection for short stature vegetation. Similarly, ICESat-2 at 20m shows a higher accuracies of canopy height retrieval than those from ICESat-2 at 100m.

Comparing the efficacy of GEDI and ICESat-2 for estimating canopy height



Demonstration of InSAR based canopy height estimation on the NASA MAAP



Next steps

1. Benchmarking of biomass estimators in savannas using new training samples (GEDI & ICESat-2) and auxiliary image datasets (RCS & InSAR)
2. Generation of high-resolution canopy height and biomass change maps using Sentinel-1 and ALOS-2 time-series over each of the pilot sites
3. Implementation of Generalized Hierarchical Model Based inference (GHMB) for biomass change uncertainty with GEDI and USFS collaborators
4. Completion of field and airborne campaigns in South Africa (Lowveld) and central Queensland (ILCP) for the generation of reference canopy height and biomass change validation datasets