Deriving Leaf Area Index (LAI) from Multiple LiDAR Remote Sensing Systems

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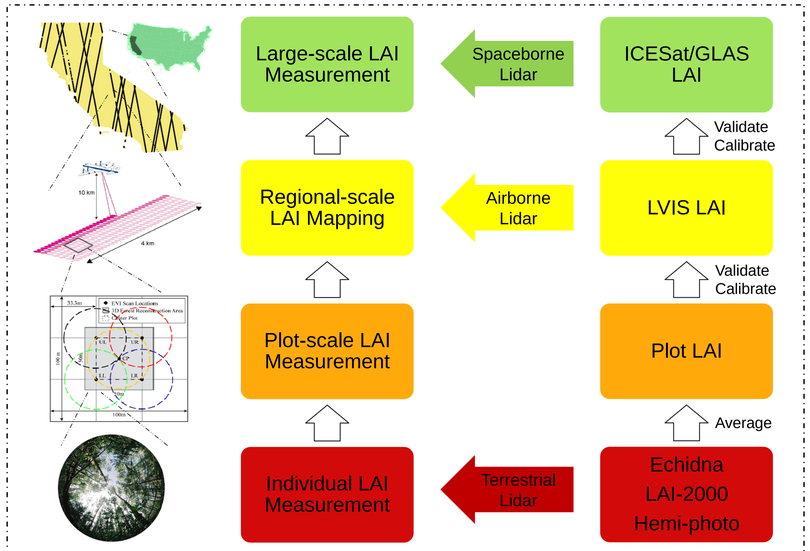
Introduction

In this study, we compare LAI retrievals from three different types of lidar sensors (*Terrestrial, Airborne, Spaceborne*) and validate the results with ground measurements.

Our goal **is to demonstrate a path for deriving LAI products at large scale by providing a link between field observations, ground lidar, aircraft and space-based lidar .**



General framework for deriving and validating multiple lidar LAI products

Study Area & Field Data

Sierra National Forest is located in the Sierra Nevada range of California. This ~60,000 ha area is primarily comprised of conifer forests.

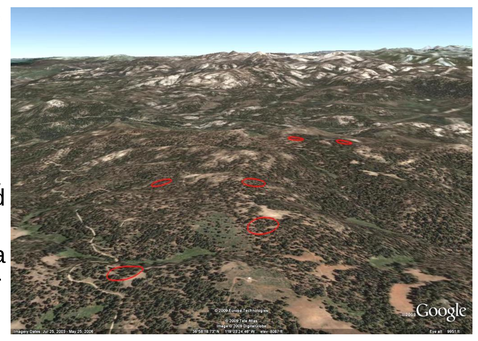
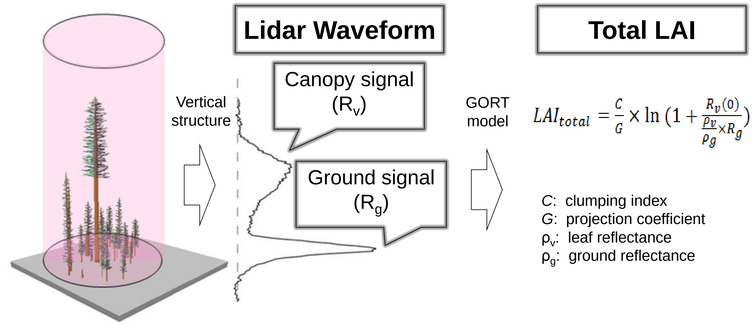


Table 1 Field LAI sites

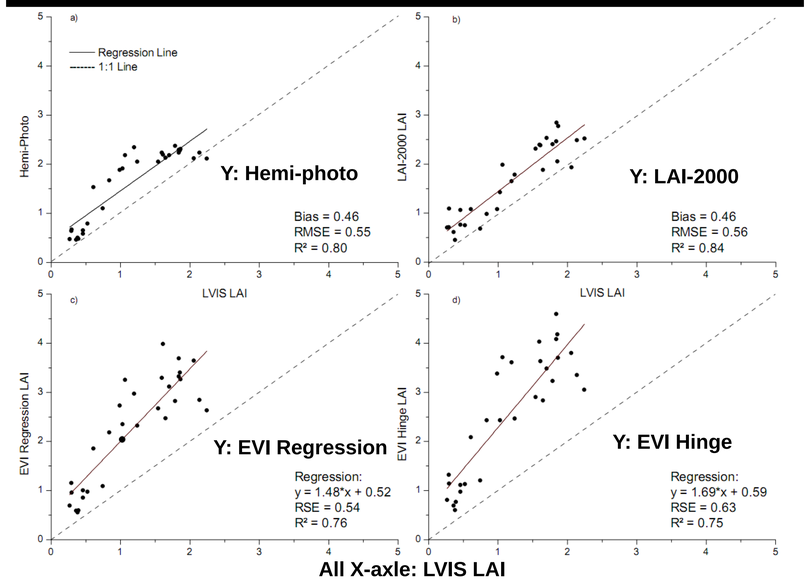
Tree/ha	Dominant species
248± 40	Red Fir
231± 64	Red Fir
125± 12	White fir
256± 27	White fir, Incense cedar, Sugar pine
110± 29	Jeffery pine, Black oak
570 86	Red fir

Methods

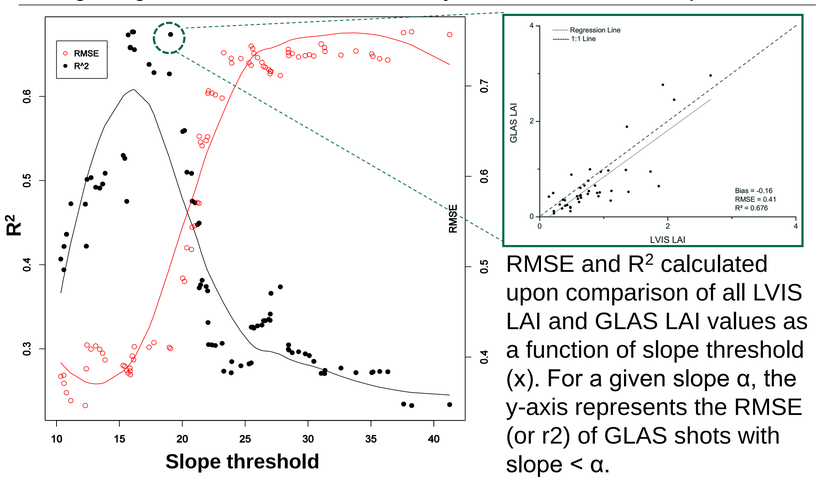


Derive LAI from lidar waveform using a GORT model

Results



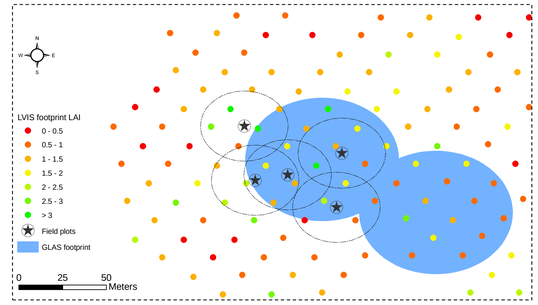
Plot-level averaged LVIS LAI against plot-level LAI estimates from a) Hemi-photos, b) LAI-2000, c) Echidna regression LAI and d) Echidna hinge angle LAI**.** LVIS LAI are relatively underestimated in all plots.



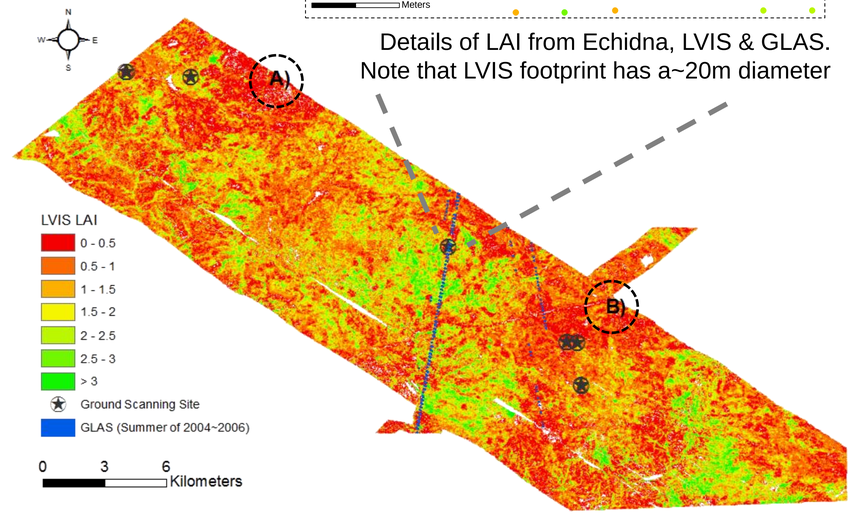
RMSE and R^2 calculated upon comparison of all LVIS LAI and GLAS LAI values as a function of slope threshold (x). For a given slope α, the y-axis represents the RMSE (or r2) of GLAS shots with slope < α.

Results (cont'd)

LVIS could capture the LAI variability at ~20m.
Two low LAI areas:
A) bare ground
B) selectively-logged



Details of LAI from Echidna, LVIS & GLAS.
Note that LVIS footprint has a~20m diameter



Landscape map of effective LAI generated from Echidna, LVIS & GLAS

Table 2 Data Acquisition Time

Data Type	*Acquisition Time*
Field LAI	July, 2008
Echidna	July, 2008
LVIS	July, 2008
GLAS	Summer, 2004 ~ 2006 (Campaign 2C, 3C, 3F)

Conclusion

1. **LAI can be derived from lidar data at different scales.**
2. **Lidar LAI products can be appropriately validated at different scales following a "bottom-up" approach.**
3. **Airborne lidar LAI maps can be used as a validation link between field and spaceborne lidar measurements.**
4. **Our framework is a potential pathway for validating large-scale LAI products from previous and future spaceborne lidar missions (e.g. ICESat-2).**

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