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Data assimilation in forest inventory: First empirical results using ALS data

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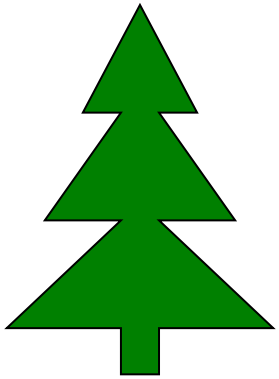
Background

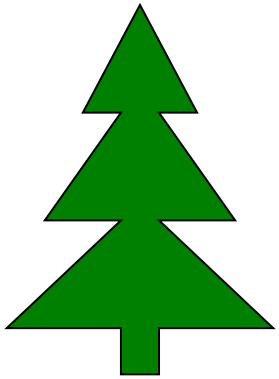
- Remote sensing is now giving a flow of data
  - How do we take care of all that?
- How to combine many data sources?
- How do we maintain accurate and up-to-date data?
- Data assimilation is one possible solution

Data assimilation in forest inventory

Data assimilation in forest inventory

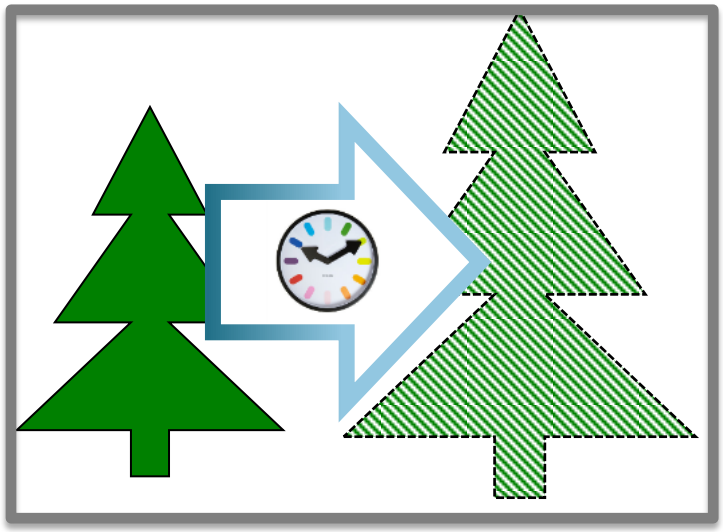


Data assimilation in forest inventory



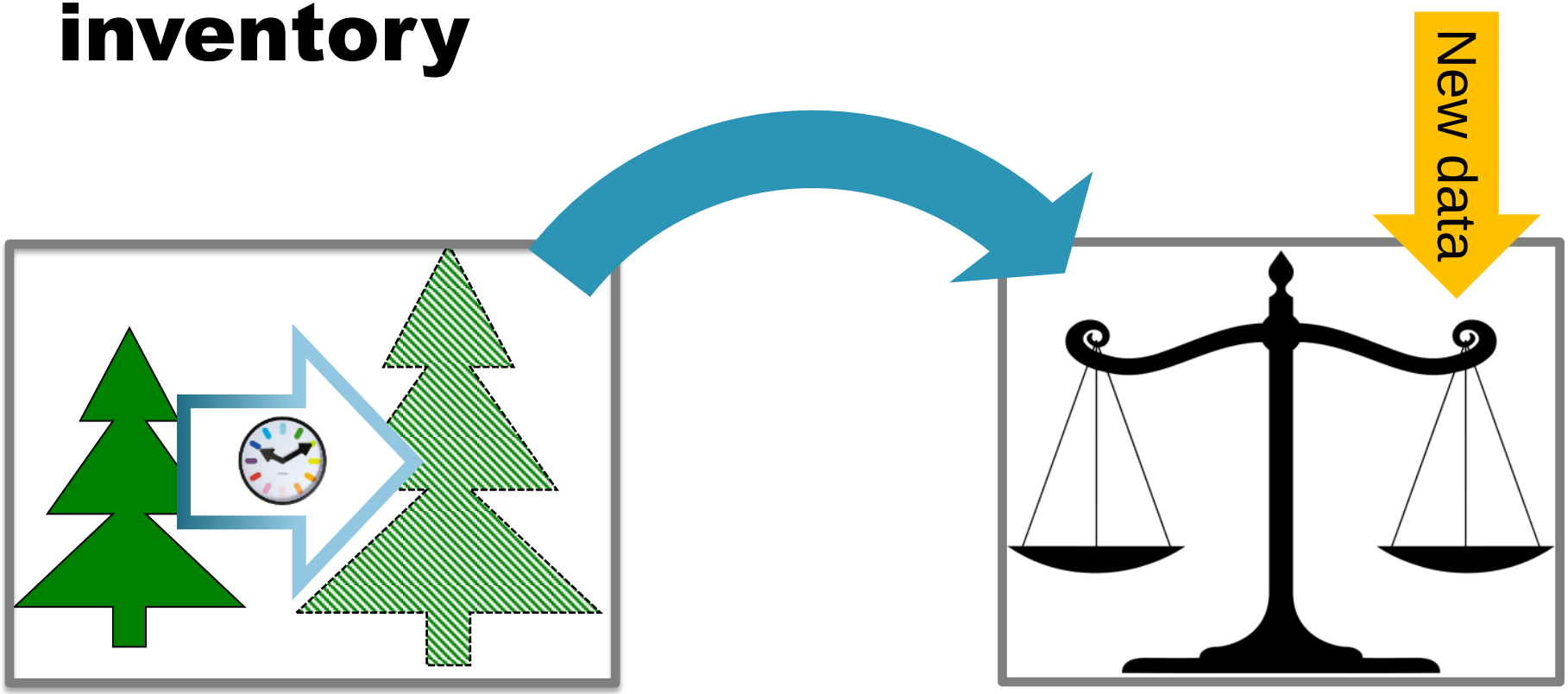
New data

Data assimilation in forest inventory



New data

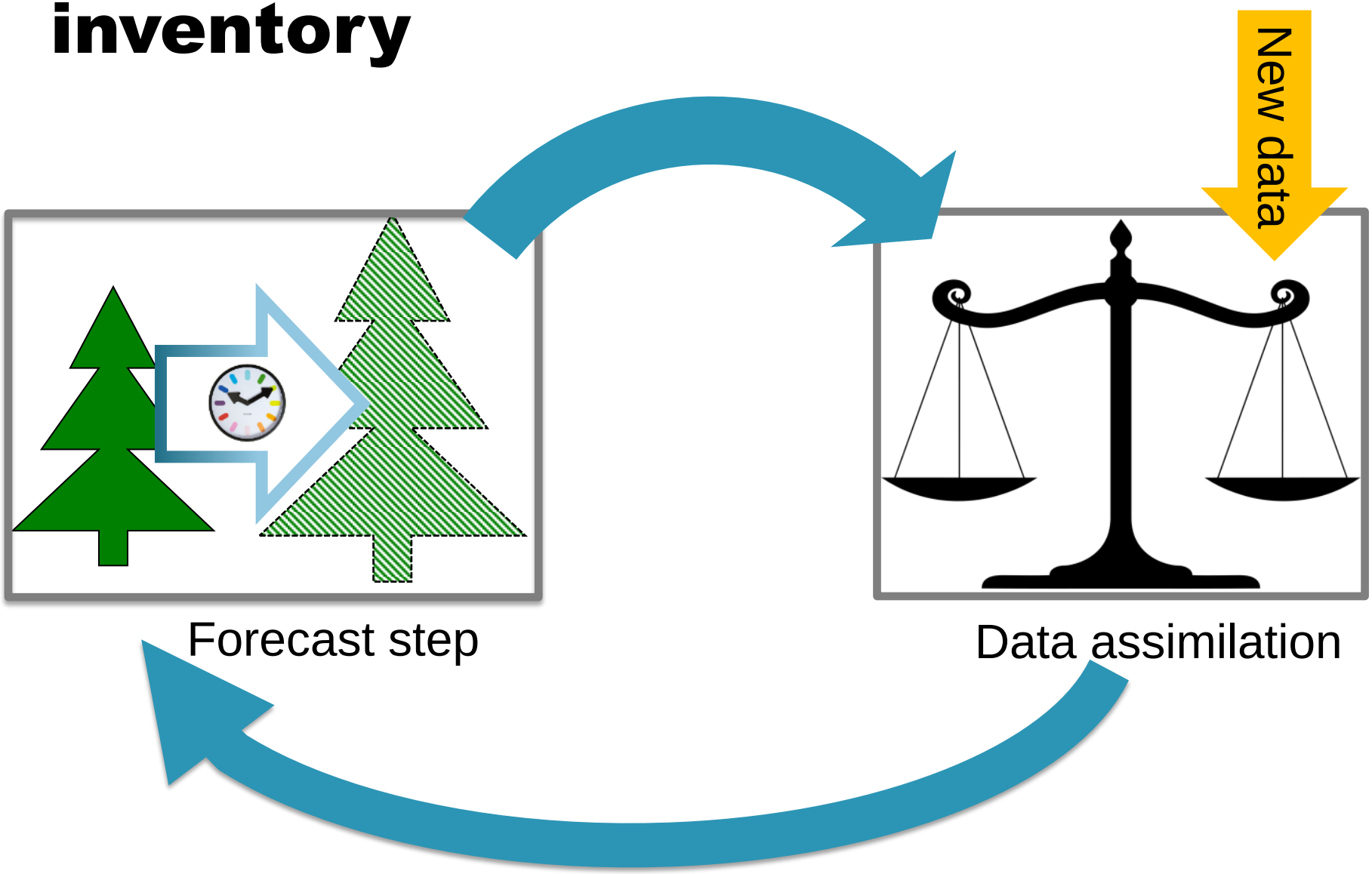
Data assimilation in forest inventory



Forecast step

Data assimilation

Data assimilation in forest inventory



Studies

- This is one of many case studies in a research program about data assimilation
  - Simulation study (published, Ehlers *et al* 2013)
  - Digital photogrammetry (submitted case study)
  - **ALS (presented here)**
  - InSAR (just started)

* Ehlers, S.; Grafström, A.; Nyström, K.; Olsson, H.; Ståhl, G. Data assimilation in stand-level forest inventories. *Can. J. For. Res.* **2013**, *43*, 1104–1113.

Objective

- Apply data assimilation to forest stand data using remote sensing data from ALS

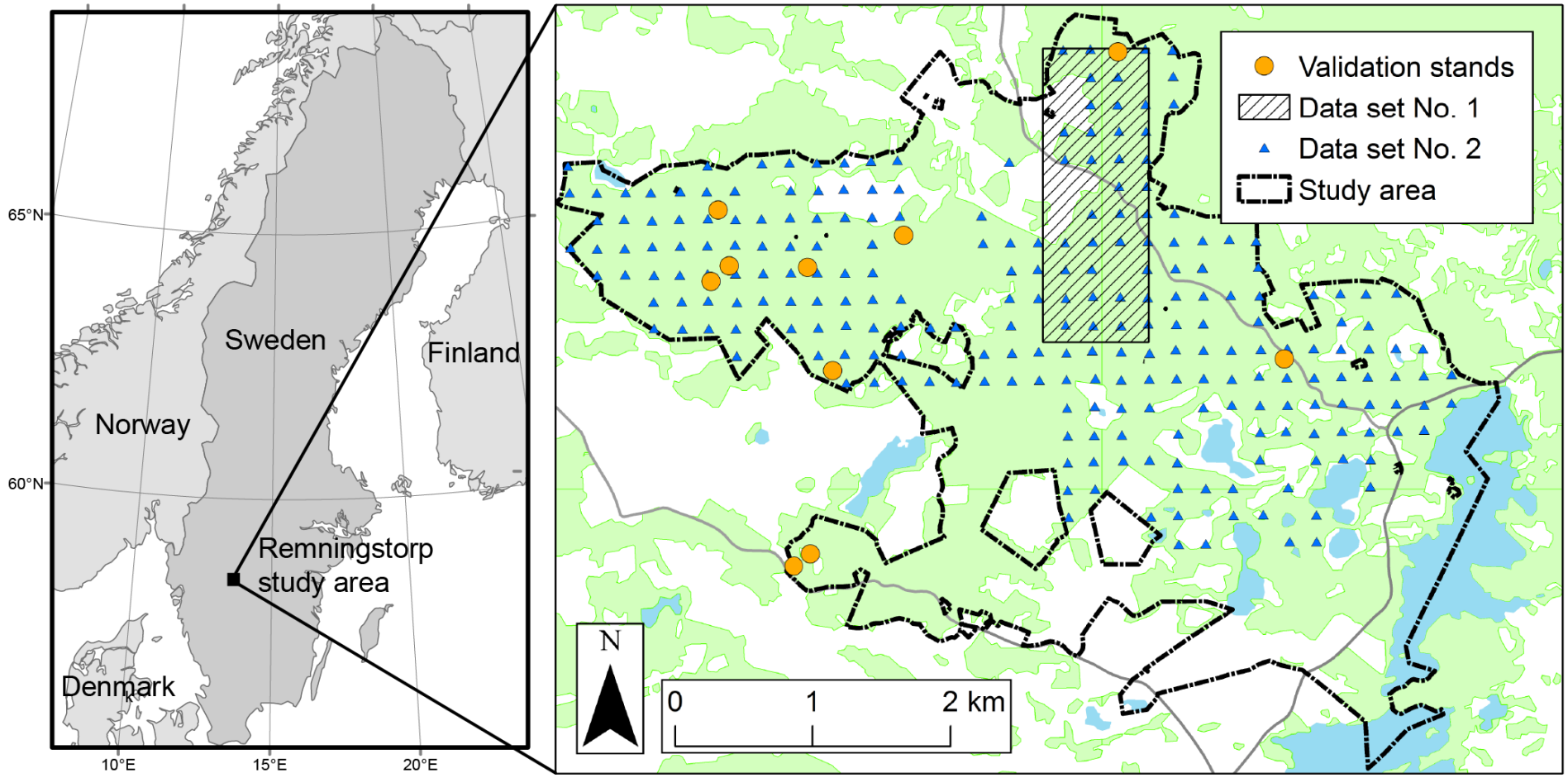
- Studied variables:
  - Stem volume
  - Basal area
  - Lorey´s mean height

The case study

- Using the extended Kalman Filter for assimilation

- ALS data from 2003, 2004, 2007, 2008, 2010, 2011
  - But all validation plots are not covered every year (on average 3.7 acquisitions/plot)

Study area / field data

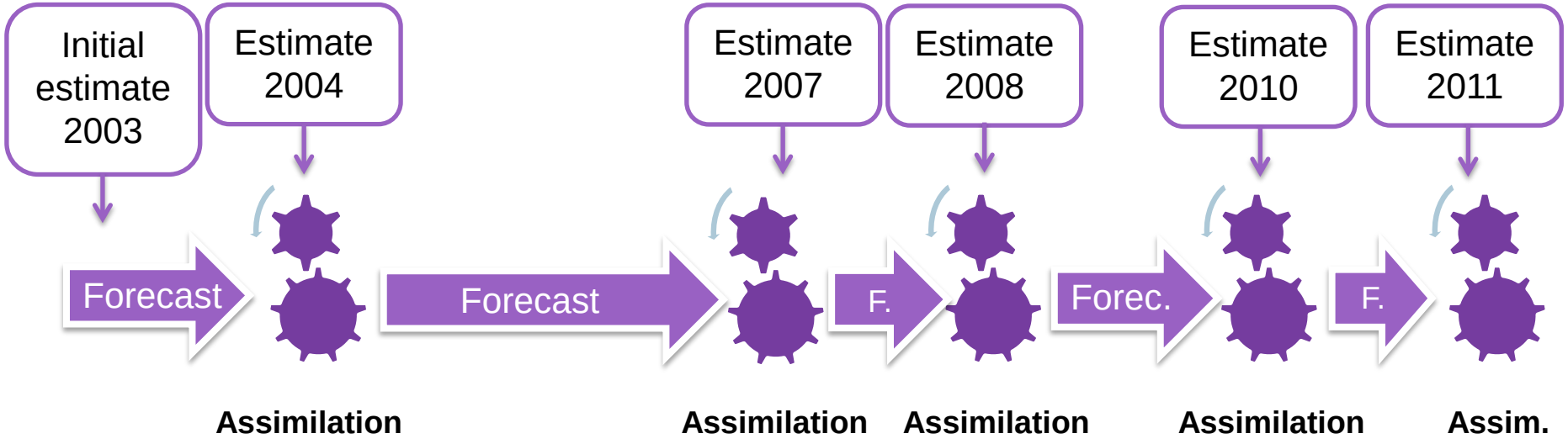


Study area

- Productive forest. Spruce, pine, deciduous (mainly birch)

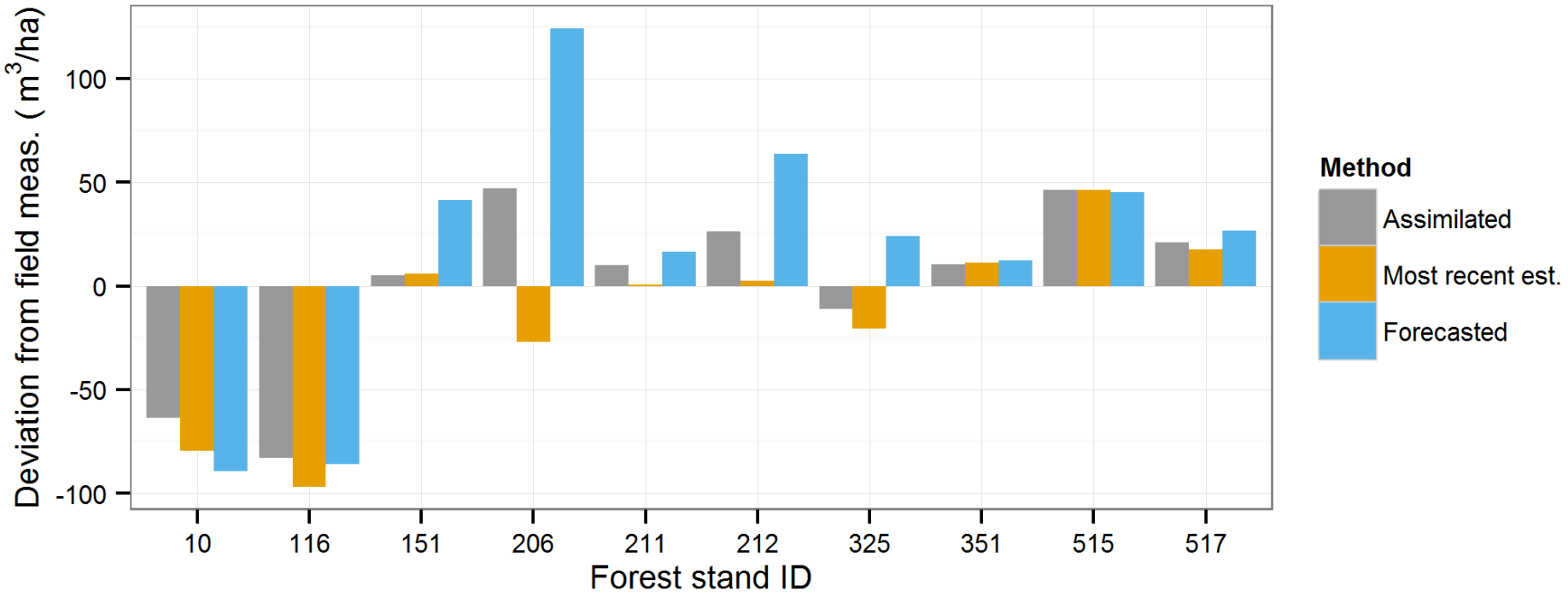
Method

- Area based approach to create estimates
- Assimilation performed on ten 40m radius sample plots
- Comparing assimilation to:
  - Forecasting from the initial estimate (2003)
  - Only using the most recent ALS acquisition (2011)



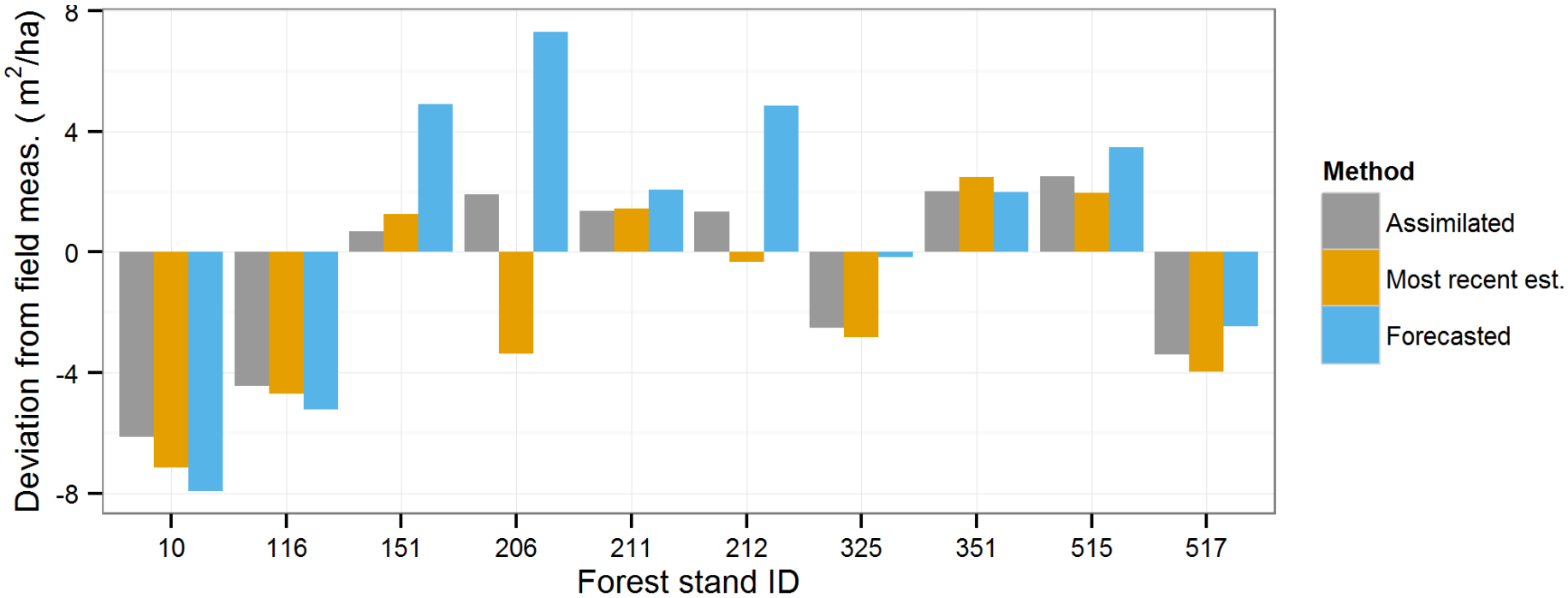
Results

- Deviation from field-measured **stem volume**, plot wise



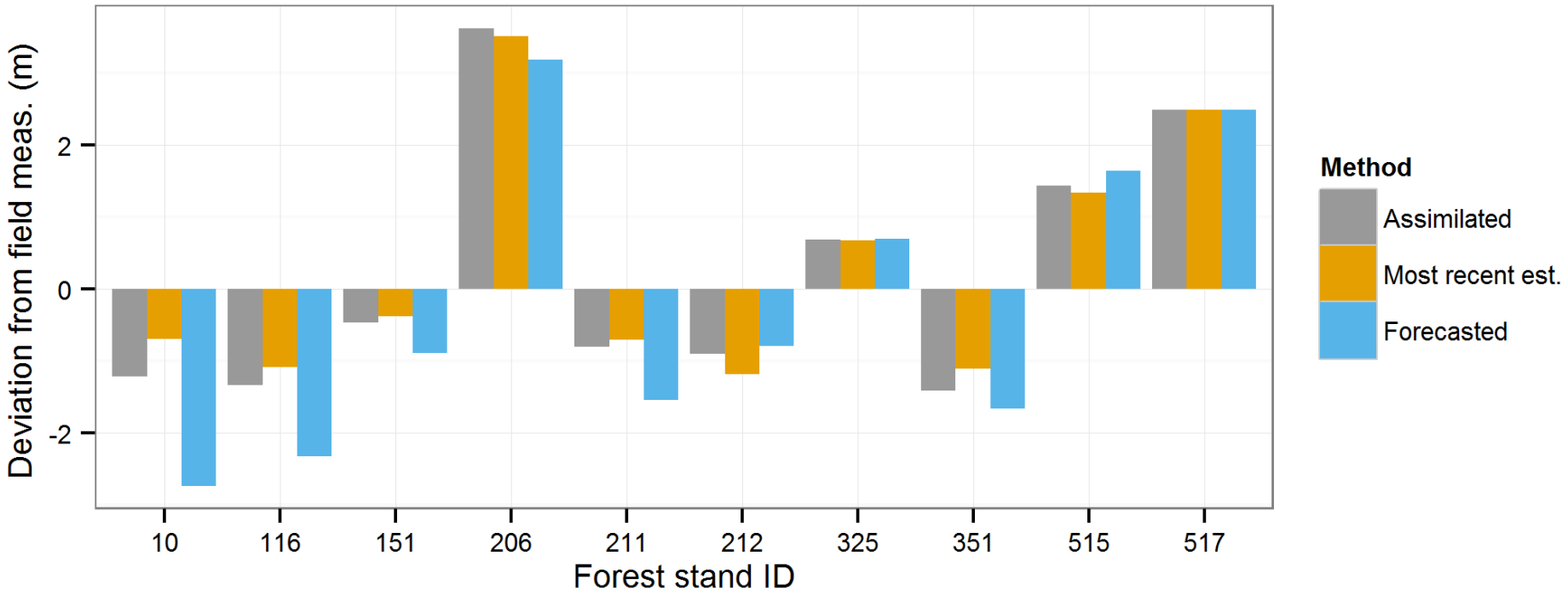
Results

- Deviation from field measured **basal area**, plot by plot



Results

- Deviation from field measured **Lorey´s mean height**, plot by plot



Results

- Relative RMSE of the ten assimilated plots

Target variable	Assimilated	Last ALS	Forecast from first ALS
Lorey's mean height	8.5%	8.0%	9.9%
Basal area	9.5%	10.8%	14.5%
Stem volume	13.3%	14.3%	20.6%

The comparison is to the field measured values for the plots

Discussion / conclusions

- Successfully developed a data assimilation framework for forestry data

- The case study with image matching resulted in higher RMSE

- Similar RMSE as using only the most recent remote sensing data

- 9 years is a short time-period in Swedish forestry

Future

- Combination of data sources, e.g. ALS, aerial images, satellite data

- At which unit should we perform the assimilation? Pixels? Stands?

- Comments from the audience?

Thank you for your attention!