Intercomparison of models for simulating timothy yield in northern countries

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Background

- Forage-based livestock and dairy production are the economic backbone of agriculture in many northern countries.
- In northern Europe and eastern Canada, forage grasses for silage are commonly grown for 2-4 years or longer in rotations with cereal crops and harvested 2-3 times per year.
- In those regions, timothy (*Phleum pratense* L.) is one of the most widely grown forage grass species.
- Models that simulate the growth and nutritive value have been developed for timothy, but the performance of different models has not been compared so far.

Timothy
(*Phleum pratense* L.)

Research questions

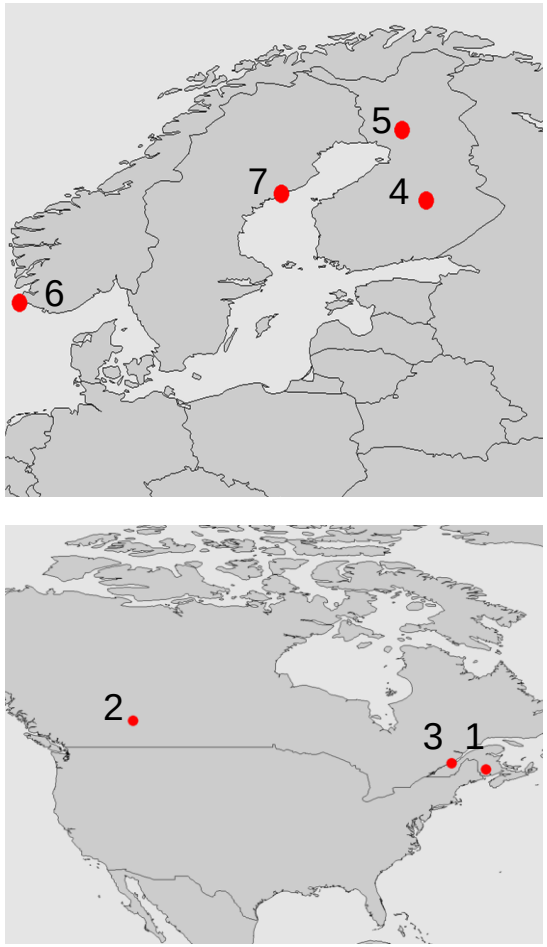
- How can current timothy models predict timothy yields of the first and second cut in northern areas of Europe and Canada where timothy is widely grown?
- Are the models able to predict the timothy yield response to climatic factors and changes in management (e.g. changes in cutting times or N application rates)?
- How do models perform with cultivar-specific vs. non-cultivar specific (generic) calibrations?
- What is the magnitude of uncertainty associated to the yield predictions by different models?

Model comparison setup

- Three models:
  - BASGRA (The BASic GRAssland model, based on LINGRA)
  - CATIMO (CAnadian TImothy MOdel)
  - STICS (Simulateur mulTIdisciplinaire pour les Cultures Standard)

- 7 study sites

Country and site name	Treatments (calibration+test)	
Canada		
1. Fredericton	6 (4+2)	(different N levels)
2. Lacombe	2 (2+0)	
3. Quebec	9 (6+3)	(different N levels)
Finland		
4. Maaninka	2 (2+0)	
5. Rovaniemi	6 (4+2)	(different N levels)
Norway		
6. Saerheim	6 (4+2)	(early and late cut)
Sweden		
7. Umeå	2 (2+0)	



Altogether ~1500 observations of dry-matter yield (also for leaf and stem fractions), crop height, leaf area index and specific leaf area.

Calibrations

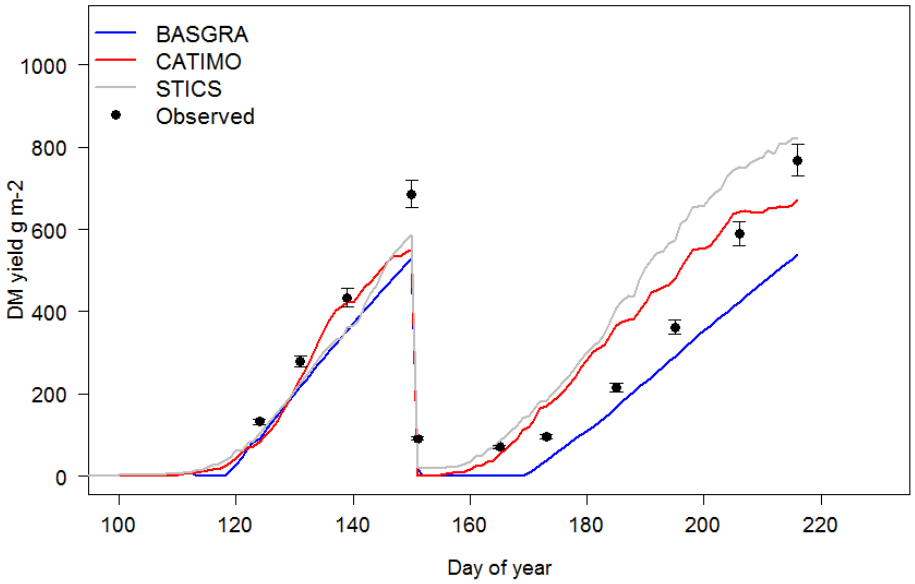
- Model users were free to use preferred calibration method
  - BASGRA and CATIMO applied Bayesian calibration
  - STICS was calibrated using the integrated optimization tool (simplex algorithm)
- Data from 24 treatments were used for calibration and the remaining 9 treatments were used to assess model performance
- Two different calibrations
  - Cultivar-specific calibration
  - Generic calibration applying data from all sites and cultivars

Study site	Cultivar	Years
Fredericton, Canada	Champ	1991-1993
Lacombe, Canada	Climax	2004-2005
Quebec, Canada	Champ	1999-2001
Maaninka, Finland	Tammisto II	2006-2007
Rovaniemi, Finland	Iki	1999-2001
Særheim, Norway	Grinstad	2000-2002
Umeå, Sweden	Jonatan	1995-1996

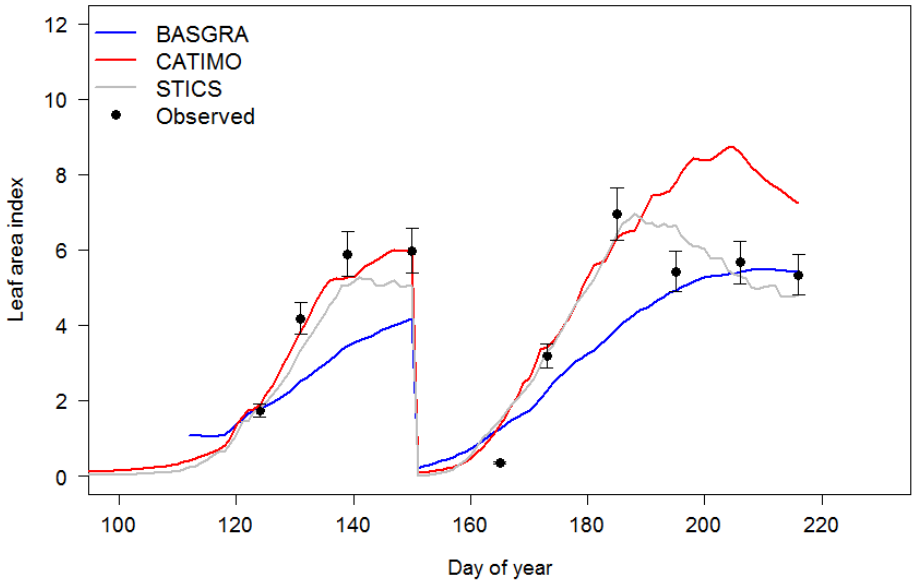
Simulated and observed time course of dry-matter accumulation and leaf area index

Example: Særheim, Norway, year 2000

Dry matter yield



Leaf area index



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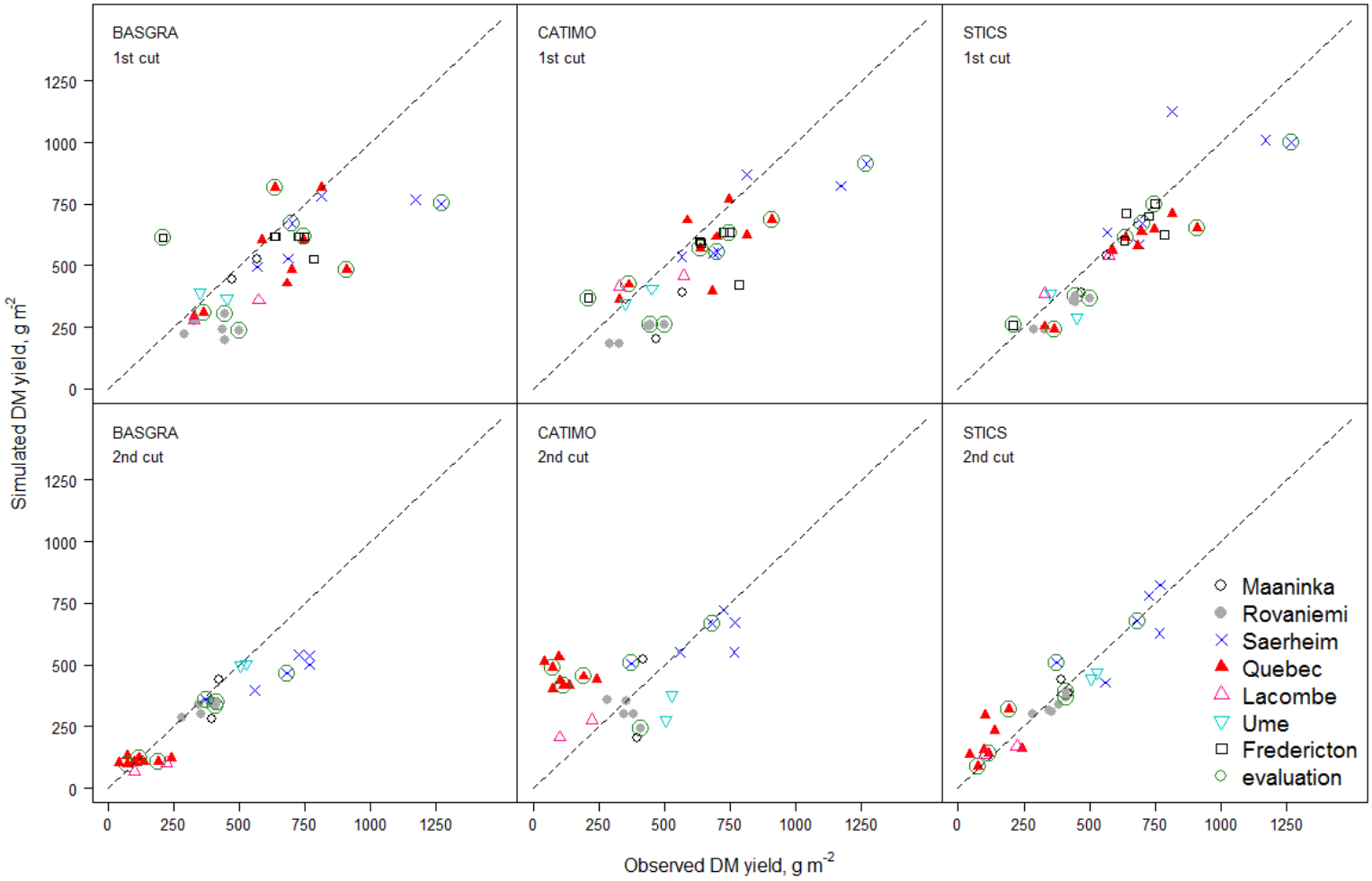
Model performance for the 1st and 2nd cuts

Simulated and observed maximum yields of the 1st and 2nd cut of each treatment using cultivar-specific calibration



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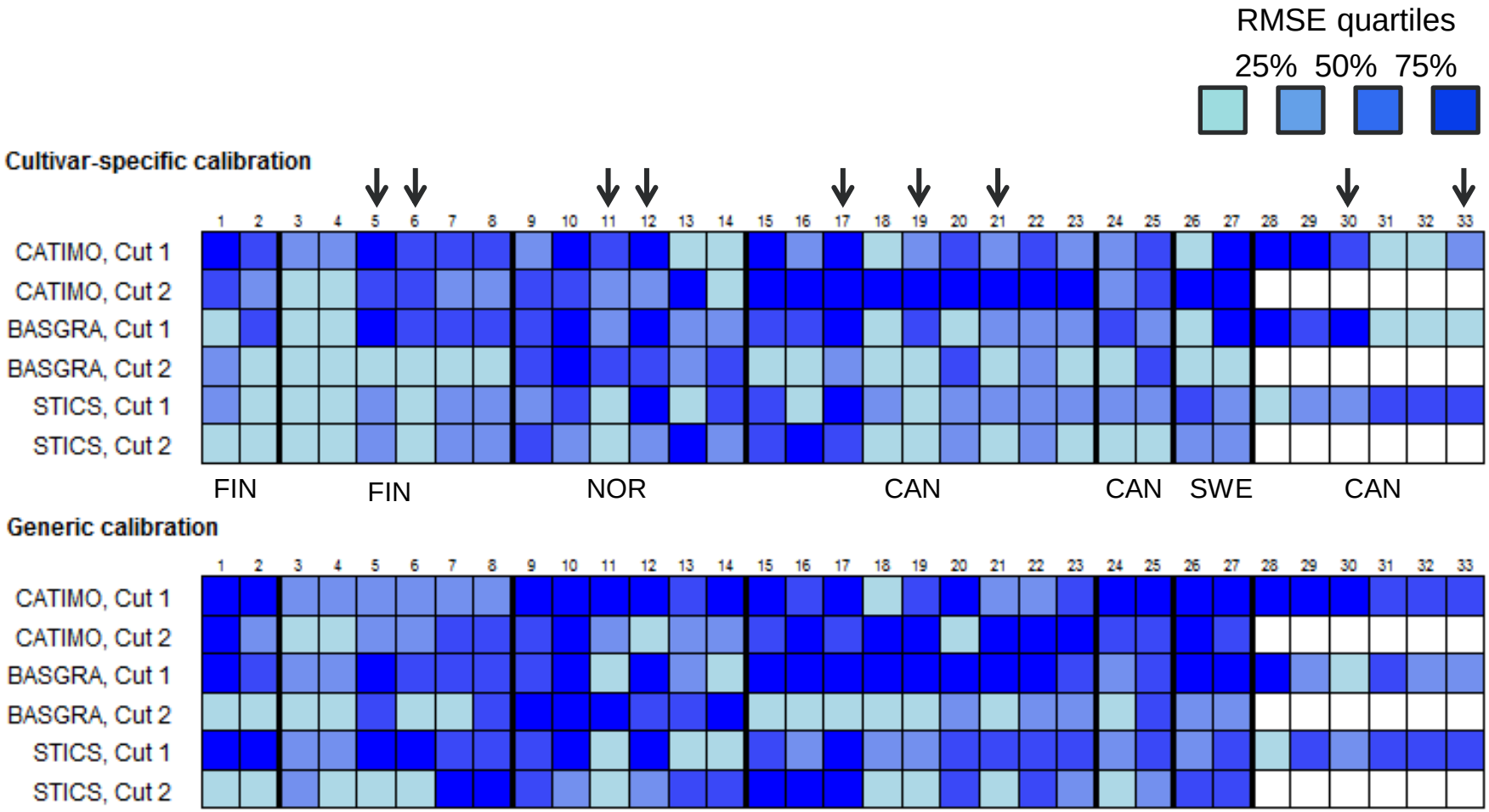
Cultivar-specific vs. generic calibration



Arrows depict treatments used to assess model performance (not included in calibration).

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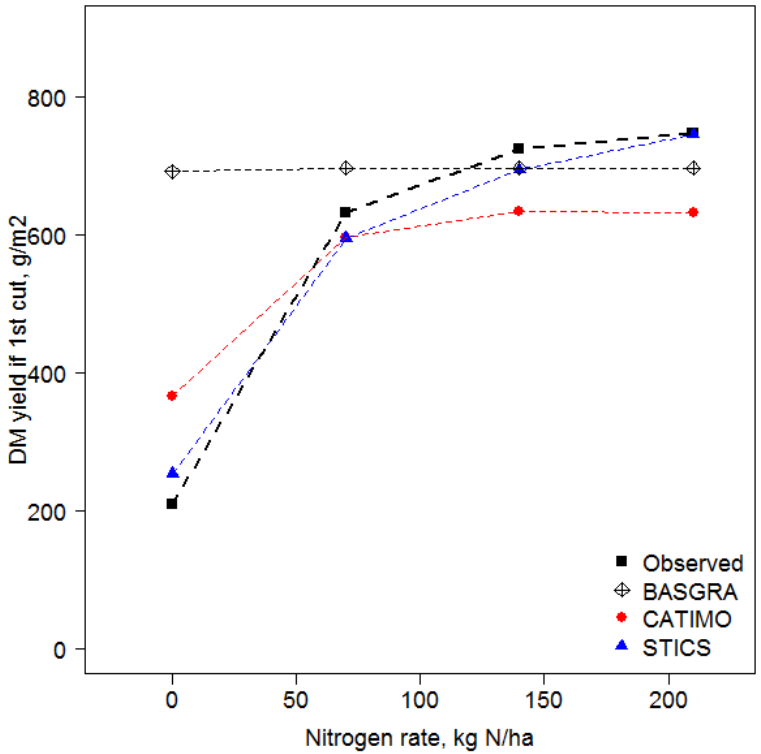
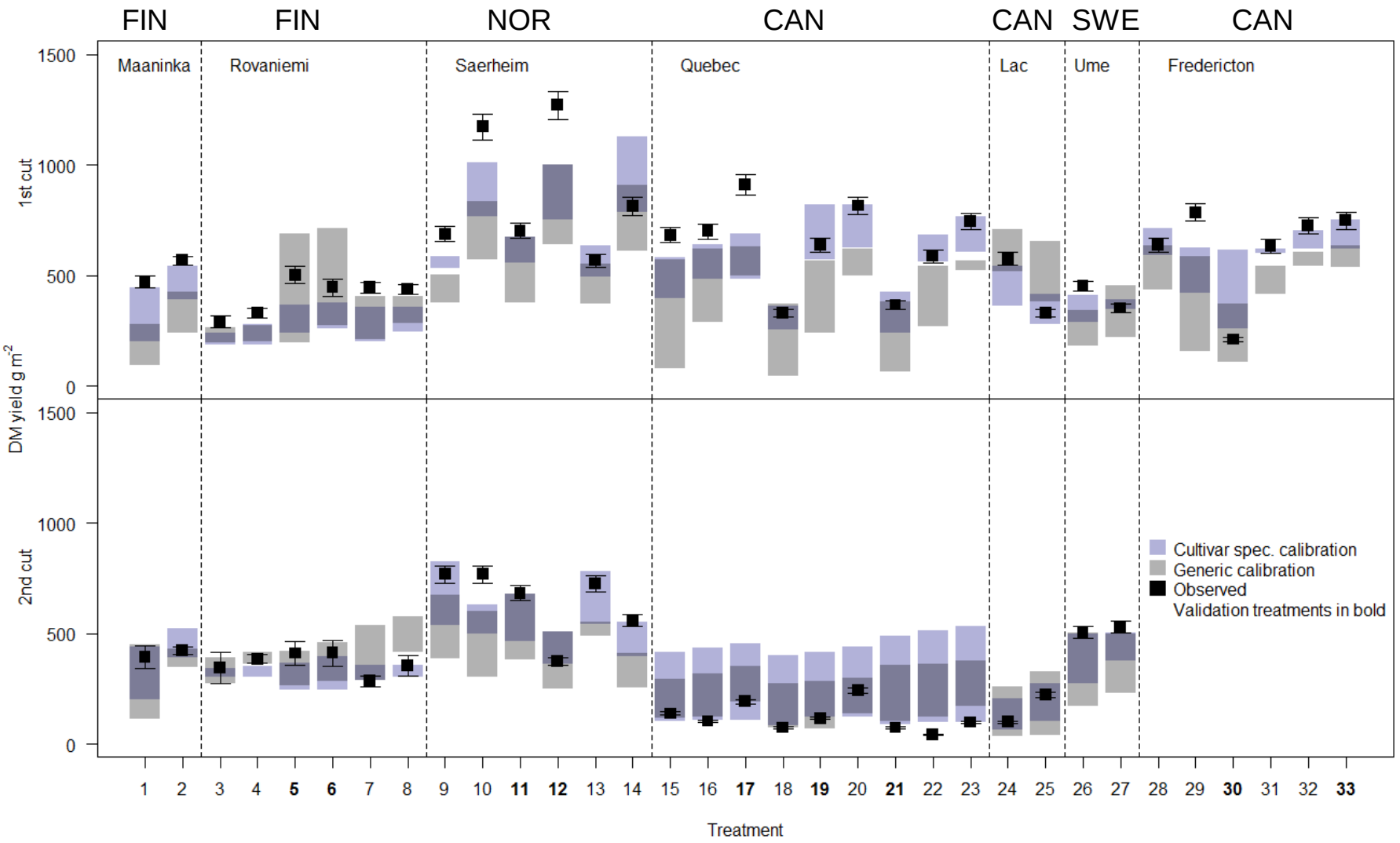
Yield responses to N levels

Fredericton, year 1993, Cultivar-specific calibration



Uncertainty related to model predictions



Discussion

- All models generally managed to estimate the DM yields satisfactorily and none of them worked clearly better than the others at all sites.
- Cultivar-specific calibration provided better simulation accuracy than the generic calibration. Calibration effect on simulated yields varied among sites and treatments.
- Models differed in their ability to simulate a response to nitrogen fertilization.
- Uncertainties in simulated yield estimates in models are still quite wide and they are related to deficiencies in models process descriptions, uncertainties in model parameters and input data.

Next steps

- MACSUR2 LiveM task 1.2 - grassland quality modelling
  - Model survey of how current grass growth models simulate the nutritive value of forage grasses is currently going on
    - Related workshop to be held in connection with EGF 2016 in Trondheim (Norway) in September
  - Contact panu.korhonen@luke.fi if you want to join in or need more information!
  - Hopefully leads to model comparison paper

- Results will be used to improve models:
  - CATIMO: Regrowth functions will be updated soon
  - BASGRA: Ongoing work to improve N responses
  - STICS: Planned upgrades to better simulation of plant reserve dynamics for improved regrowth and multiannual simulations

Thank you!

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