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Predicting the response of the forage grass timothy to climate change in Canada

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Introduction

- The effect of climate change on crop growth can be predicted by combining stochastic weather generators and crop models.
- The stochastic weather generator AAFC-WG has not been evaluated with a perennial grass model.
- The grass model CATIMO (Canadian Timothy Model) has been validated for eastern and western Canada.
- Timothy performance under future climate conditions in Canada is unclear.

Objectives

- To evaluate synthetic weather data with the grass model CATIMO.
- To explore timothy yield and nutritive value under future climate conditions.

Materials and Methods

- **Sites**

- **Weather**
  a. 1961-90: observed data used to calibrate AAFC-WG, which generated the 300-year data (synthetic) to represent the baseline weather.
  b. 2040-69: synthetic 300-year data by AAFC-WG with two Global Climate Models (CGCM3 and HadGEM1) forced by IPCC SRES emission scenarios (A1B and A2).
- **Grass model**

  CATIMO is a process-based model, simulating the growth and nutritive value of the perennial grass timothy for spring growth and summer regrowth [1-4].
- **Model Scenario Design**
  a. Cultivars: Champ in eastern Canada and Climax in western Canada.
  b. Life span cycle: 5 years.
  c. Harvest: twice annually at heading (700ºC-d above 0ºC) at a stubble height of 5 cm.
  d. Fertilizer N rate: 72 kg ha^{-1} in spring growth and 48 kg ha^{-1} in summer regrowth.
  e. Maximum soil N mineralization: 3.7 kg ha^{-1} d^{-1} in eastern Canada and 2.0 kg ha^{-1} d^{-1} in western Canada.
  f. Rainfed.

Results

- **Synthetic *vs* observed weather data**
  a. Growth onset and harvest dates, dry matter (DM) yield, neutral detergent fiber (NDF) concentration, and digestibility of NDF (dNDF) from synthetic and observed weather data were very close (Fig. 1).

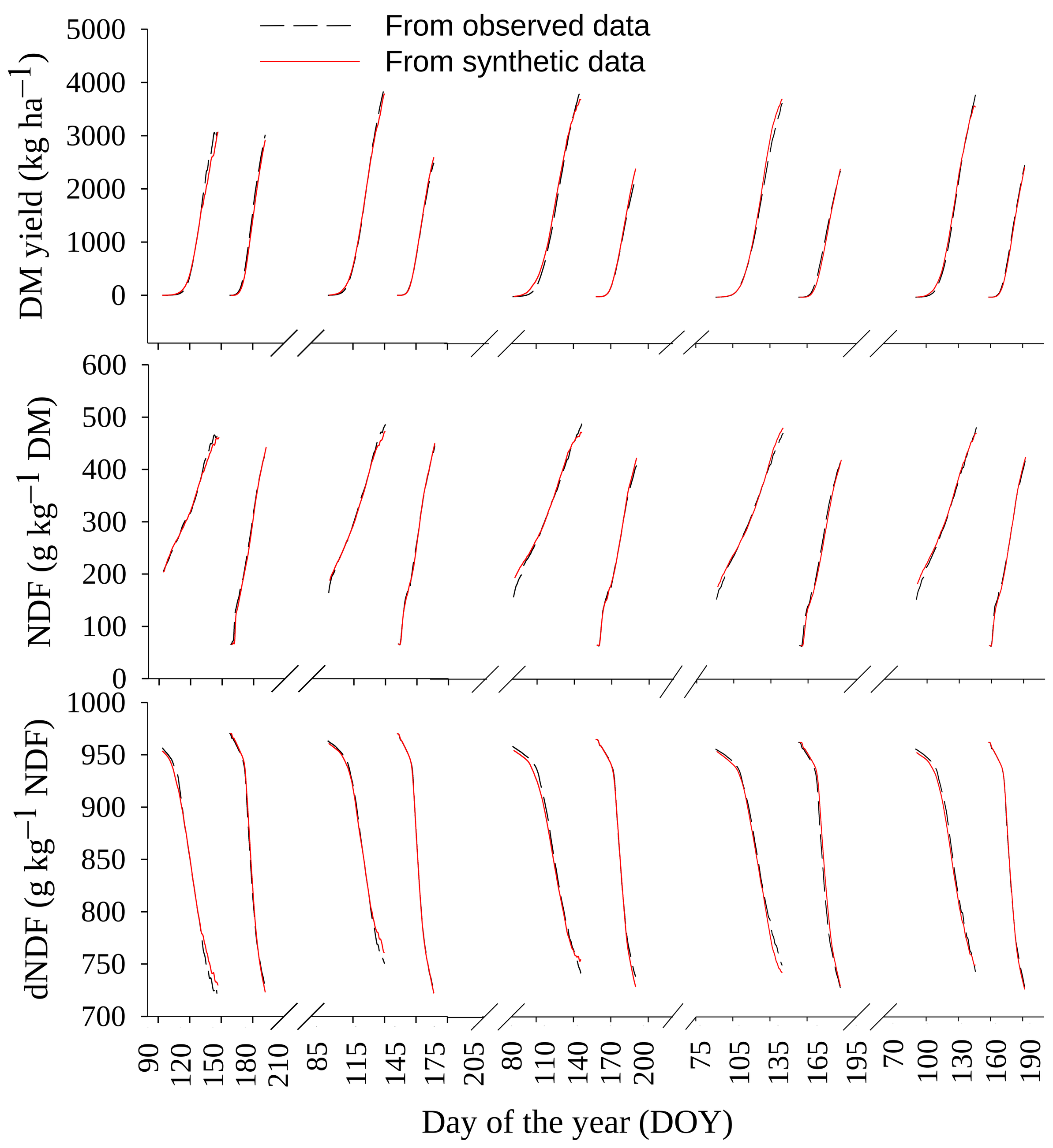

Fig. 1. Crop attributes simulated with synthetic and observed weather data at Montreal [5], similar pattern at other sites.

- **Effects of climate change**
  a. Dates of growth onset in spring will be 13~31 days earlier and harvest dates 10~25 days earlier (Table 1).
  b. DM yield will be increased by 339 to 687 kg ha^{-1} at the first harvest but decreased by 248 to 453 kg ha^{-1} at the second harvest.
  c. The dNDF will be reduced mostly at the second harvest from 17 to 24 g kg^{-1} NDF.
  d. The increasing temperatures will extend the growing season of timothy, and this may cause an additional harvest (Fig. 2).

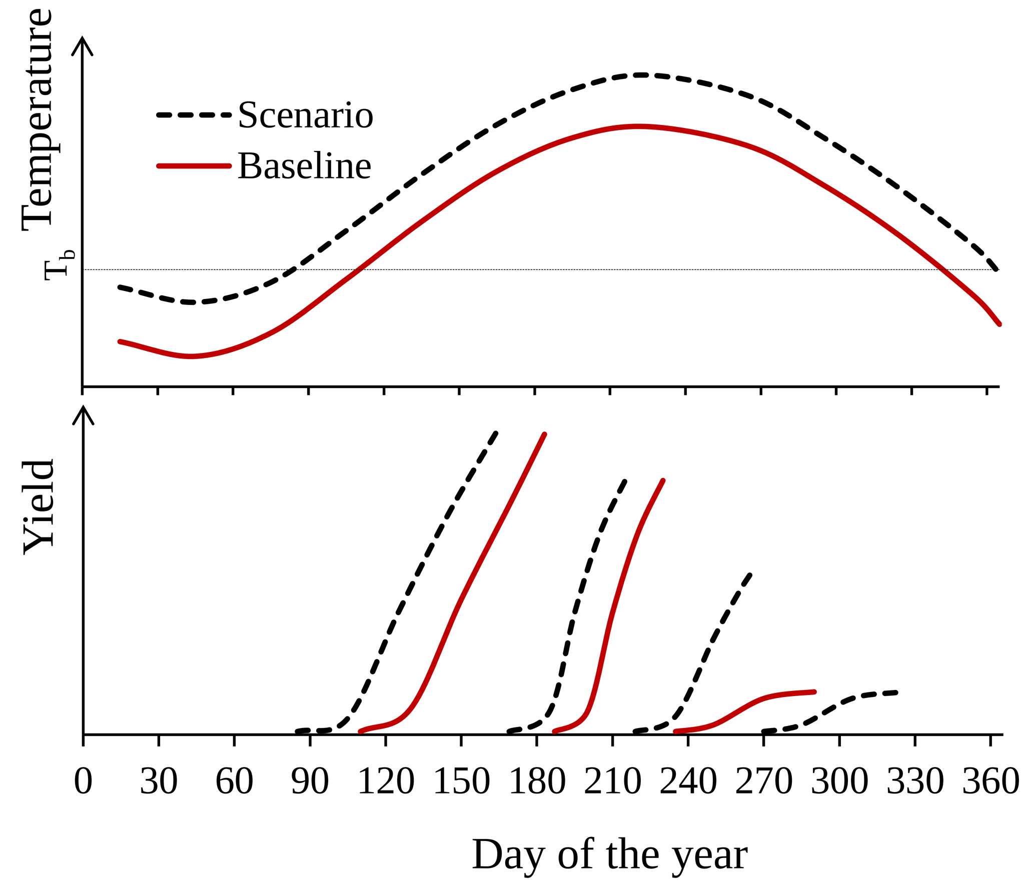

Fig. 2. Growth pattern changes in response to future climate conditions. T_b, base temperature.

Table 1. Climate change effects on dates of growth onset and harvests, DM yield, neutral detergent fiber (NDF) concentration, and digestibility of NDF (dNDF). Data are the average of five sites.

Scenario	Onset (DOY)	1st Harvest (DOY)	2nd Harvest (DOY)	Yield (kg DM ha^{-1}) 1st harvest	Yield (kg DM ha^{-1}) 2nd harvest	NDF (g kg^{-1} DM) 1st harvest	NDF (g kg^{-1} DM) 2nd harvest	dNDF ((g kg^{-1} NDF) 1st harvest	dNDF ((g kg^{-1} NDF) 2nd harvest
Baseline	100	166	216	3908	3431	536	561	699	684
CGCM-A1B	74	151	197	4247	3178	546	562	694	667
CGCM-A2	73	150	196	4317	3183	546	565	694	667
Had-A1B	69	146	191	4595	2978	547	570	693	660
Had-A2	87	156	201	4341	3071	547	563	693	663

Conclusions

- **Synthetic weather data by AAFC-WG can represent the observed data to simulate timothy growth in Canada.**
- **Climate change will extend the timothy growing season and an additional harvest will be possible in future.**
- **Climate change will affect timothy DM yield and nutritive value differently in spring and summer.**

References

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