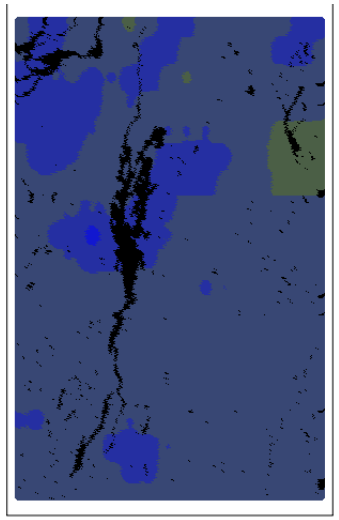
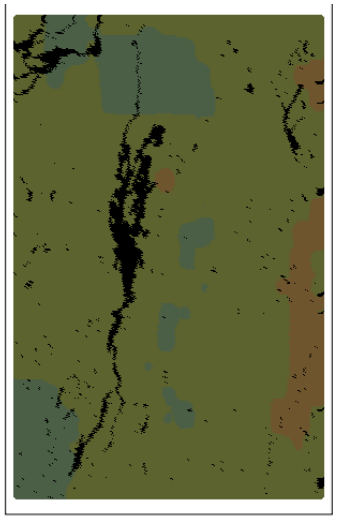
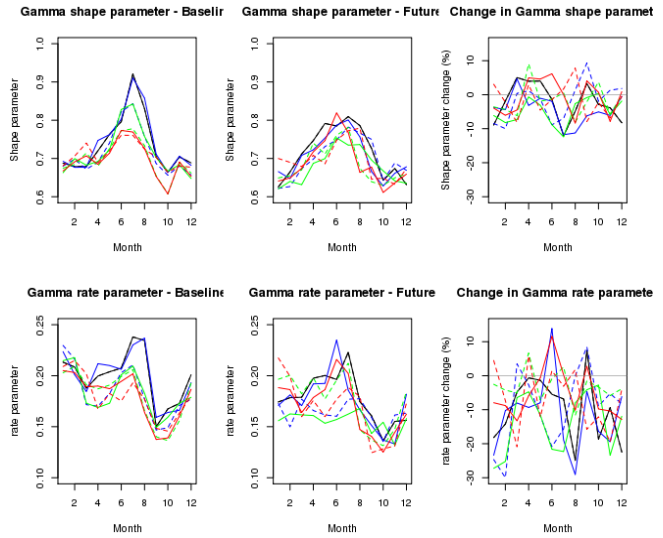
Sensitivity of Missisquoi Bay algal blooms to changes in climate variability and extremes







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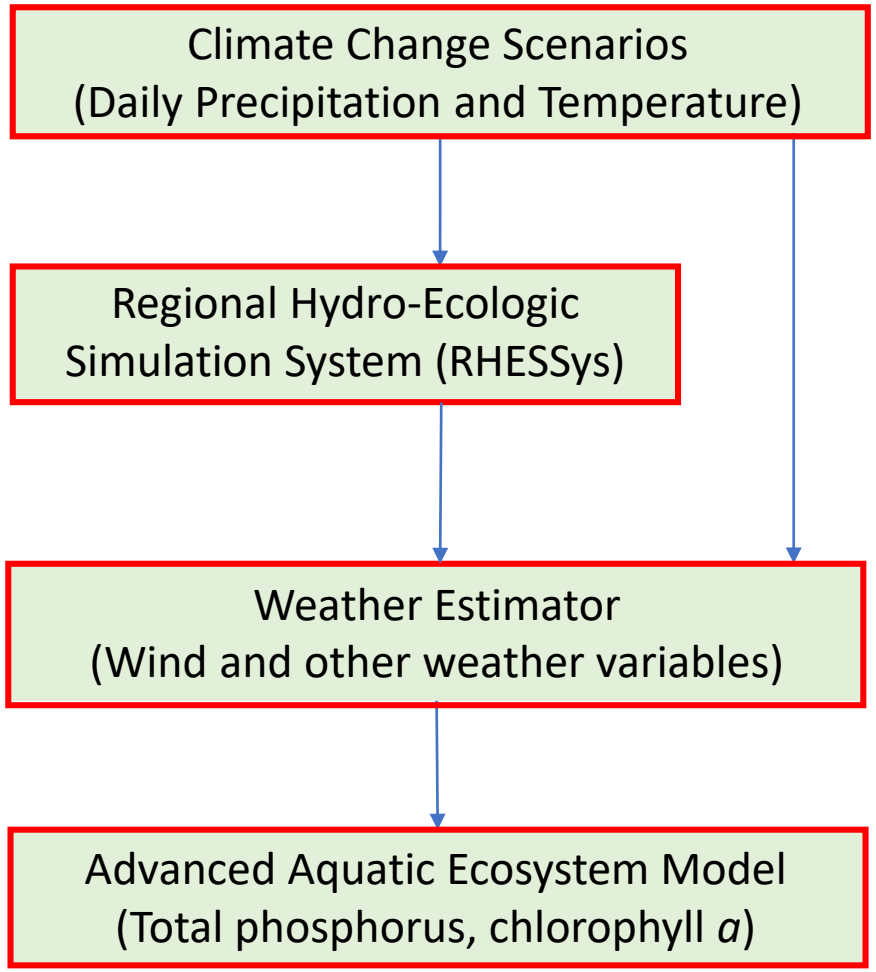
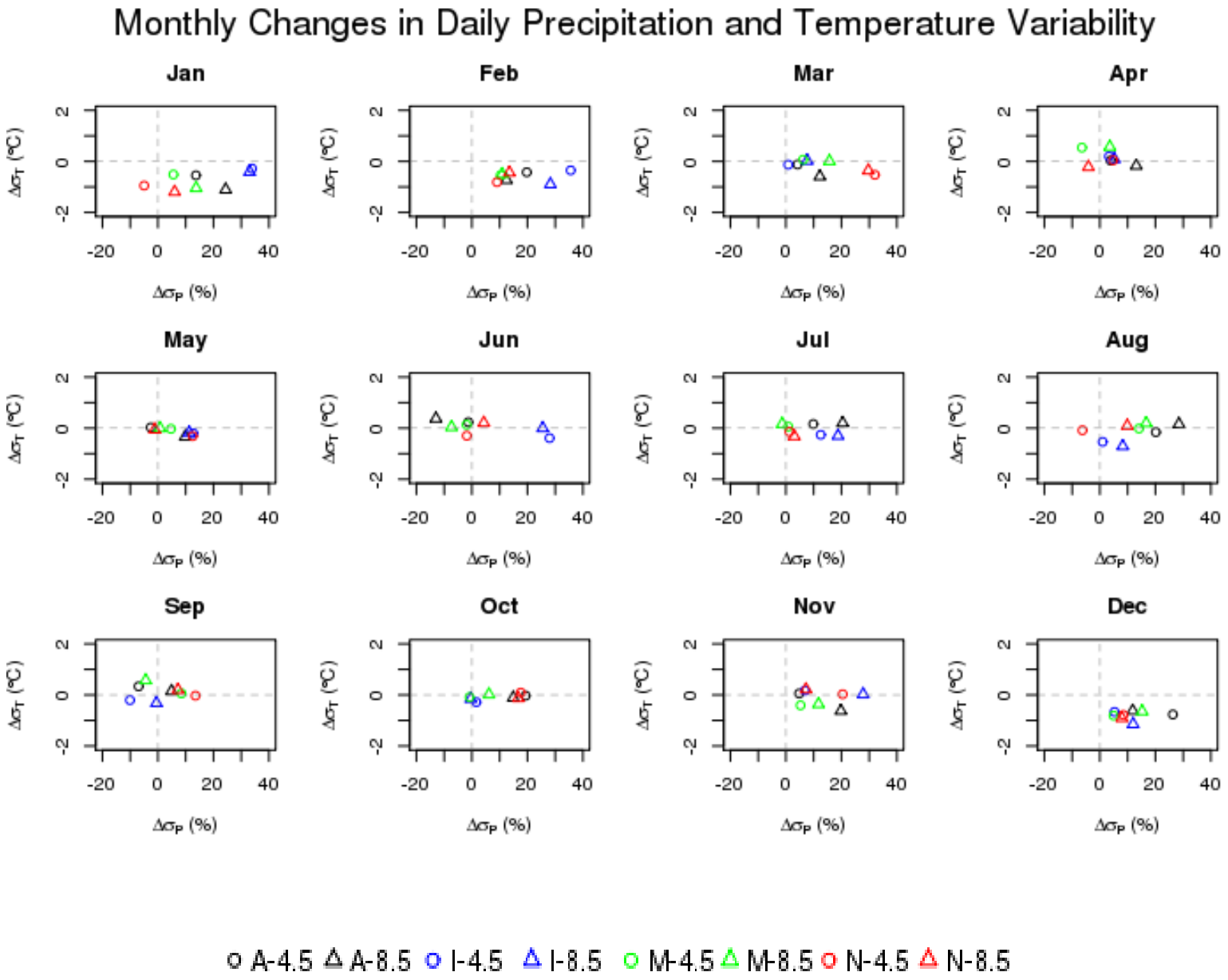
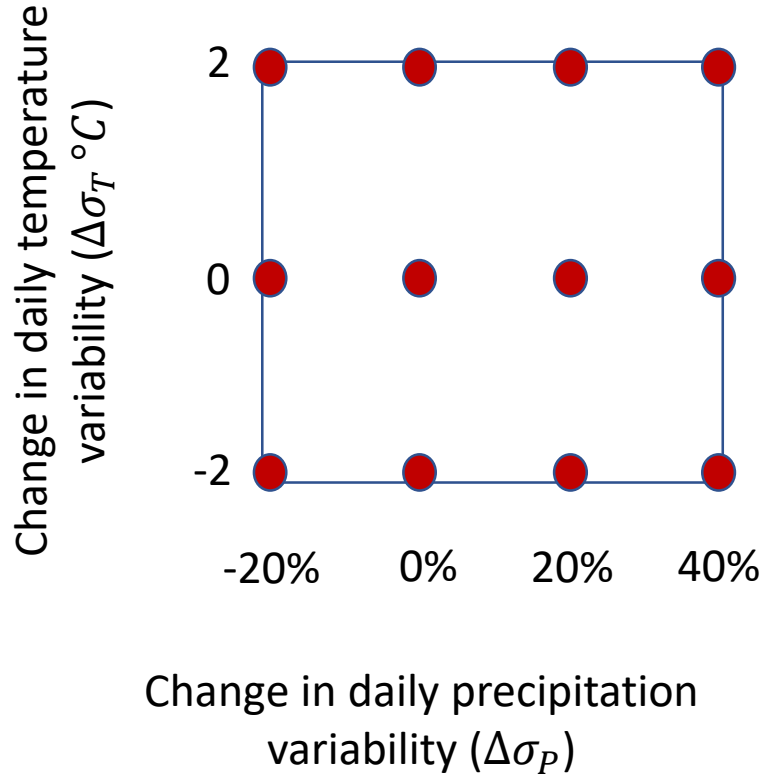
Examining sensitivity of algal blooms to changes in climate variability and extreme events

- First, examine changes in precipitation (P) and temperature (T) for different scenarios:
  - Baseline period (1980-2009)
  - Future period (2036-2065)
- Scenarios defined by:
  - Downscaled GCMs
  - Emissions (RCP 4.5, RCP 8.5)
- For each scenario, assess changes in distributions of precipitation and temperature
  - Central tendency, variability and extremes
- These changes inform the range of perturbations we apply to Daymet gridded baseline data
- Control for wind impacts



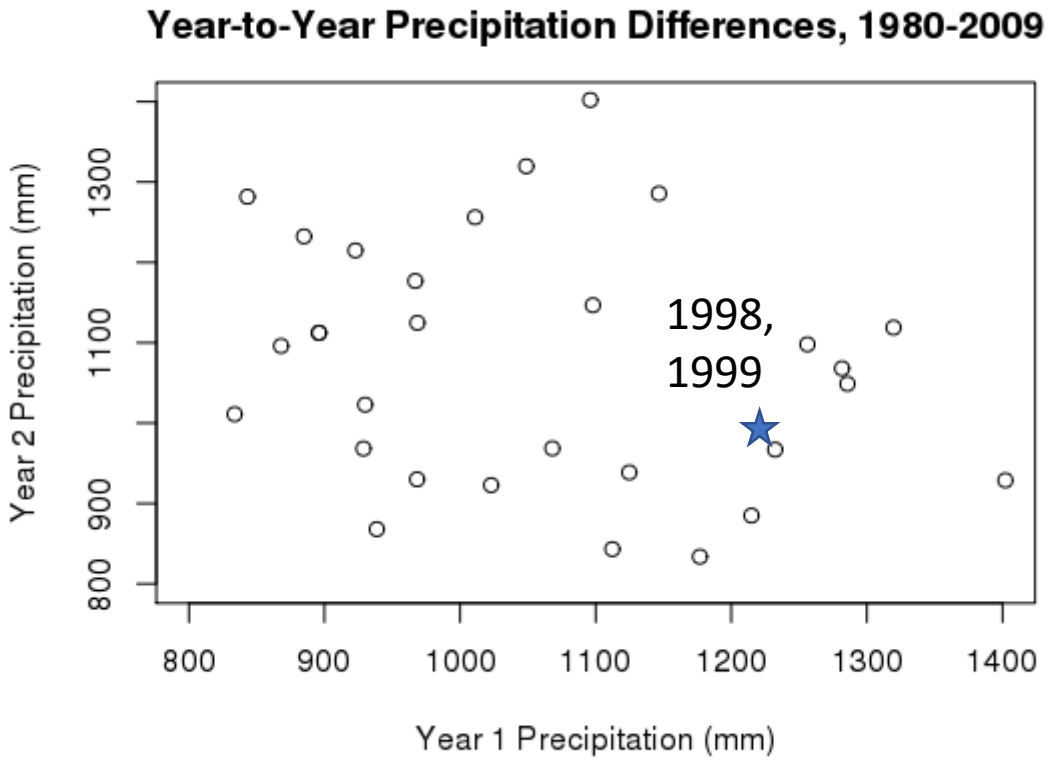


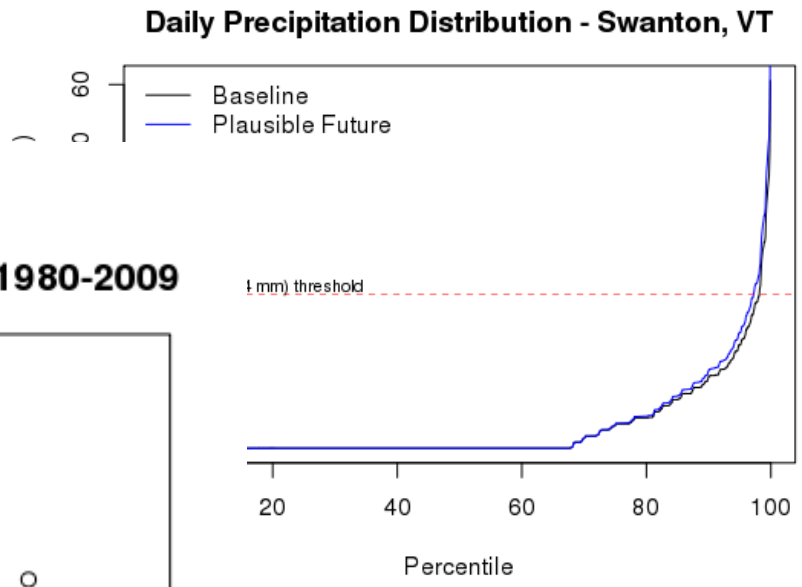
Perform this analysis for different changes in mean P and T:

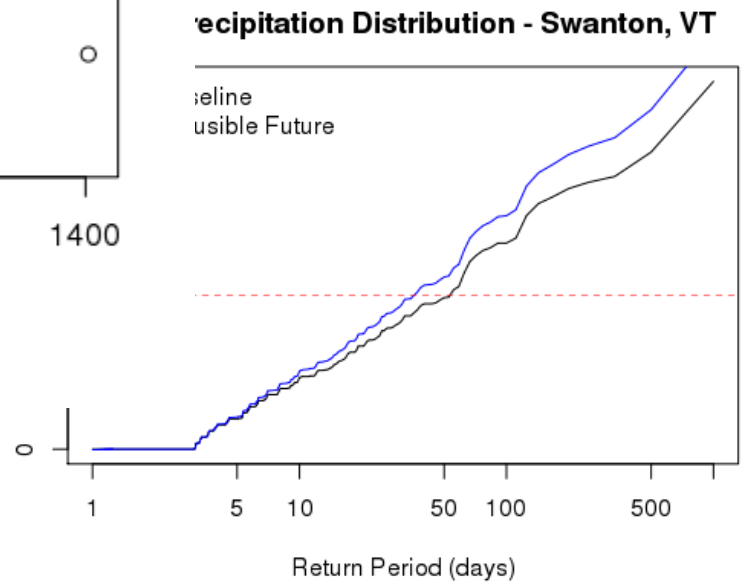


Characterizing extreme events

Variable	Duration			
99th percentile precipitation (all days)	1 day			
Maximum 30-day summer precipitation	30 days			
Maximum 7-day September temperature	7 days			
Wet year, dry year sequences	1 year, 1 year			
Wet month, warm month sequence	1 month, 1 month	?	?	?







Examining water quality impact thresholds

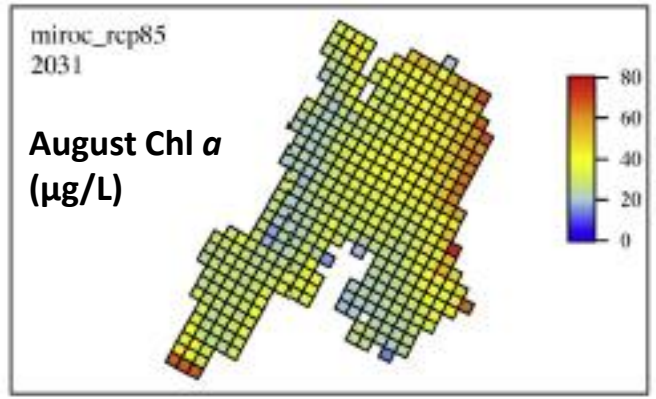
- IAM produces estimates of TP and chlorophyll *a* concentrations in Missisquoi Bay

- How can we translate these estimates into meaningful societal and ecological impacts?

- WHO provisional recreational exposure guidelines:
  - Short-term health impacts (> 20,000 cells/mL ~ 10 µg/L)
  - Long-term health impacts (> 100,000 cells/mL ~ 50 µg/L)

- Drinking water guidelines:
  - In US, < 1.6 µg/L for adults, 0.3 µg/L for young children
  - In Canada, < 1.5 µg/L for adults

- Other key tipping points? Useful metrics?



Zia et al. (2016)

www.lakechamplaincommittee.org

Discussion questions

- To which extreme events are algal blooms most sensitive?
  - Can you describe them in terms of their magnitude and duration?
  - Are there any specific thresholds above which they cause notable WQ impairment?
  - Which ones might change the most over time?
  - Are there any specific sequences or combinations of extremes we should consider?

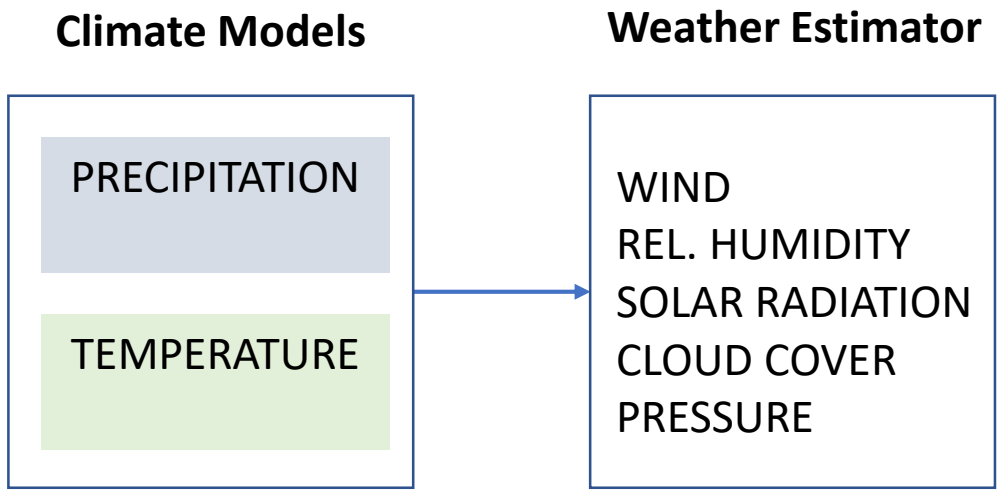
- What are key algal bloom tipping points? How can we measure them best?
  - For recreation?
  - For lake ecosystems?
  - For drinking water?

- Any other suggestions?

QUESTION SLIDES

Disentangling climatic drivers of algal blooms

- Many algal blooms in Missisquoi happen when weather is hot, dry and calm
- Isles *et al.* (2017) shows that wind speed controls blooms in Missisquoi Bay
- Future work will test alternative sequences of meteorological variables



SIMULATION SET 1	Perturb Precipitation Perturb Temperature Perturb Wind
SIMULATION SET 2	Perturb Precipitation Perturb Temperature Keep Baseline Wind

Characterizing extreme events

- Numerous extreme events drive algal blooms in Missisquoi Bay:
  - Storms
  - Wet seasons/years
  - Heat waves
- Examining changes in frequency and magnitude of extreme events using probability distributions
- Must also consider sequences and combinations of events
- Will compare GCM and station-based estimates of extremes