NERGICA Renewable Energy Research and Innovation

How might climate change affect repowering?

Case Study at Rivière-au-Renard

Nigel Swytink-Binnema
Marilys Clément
Charles Godreau
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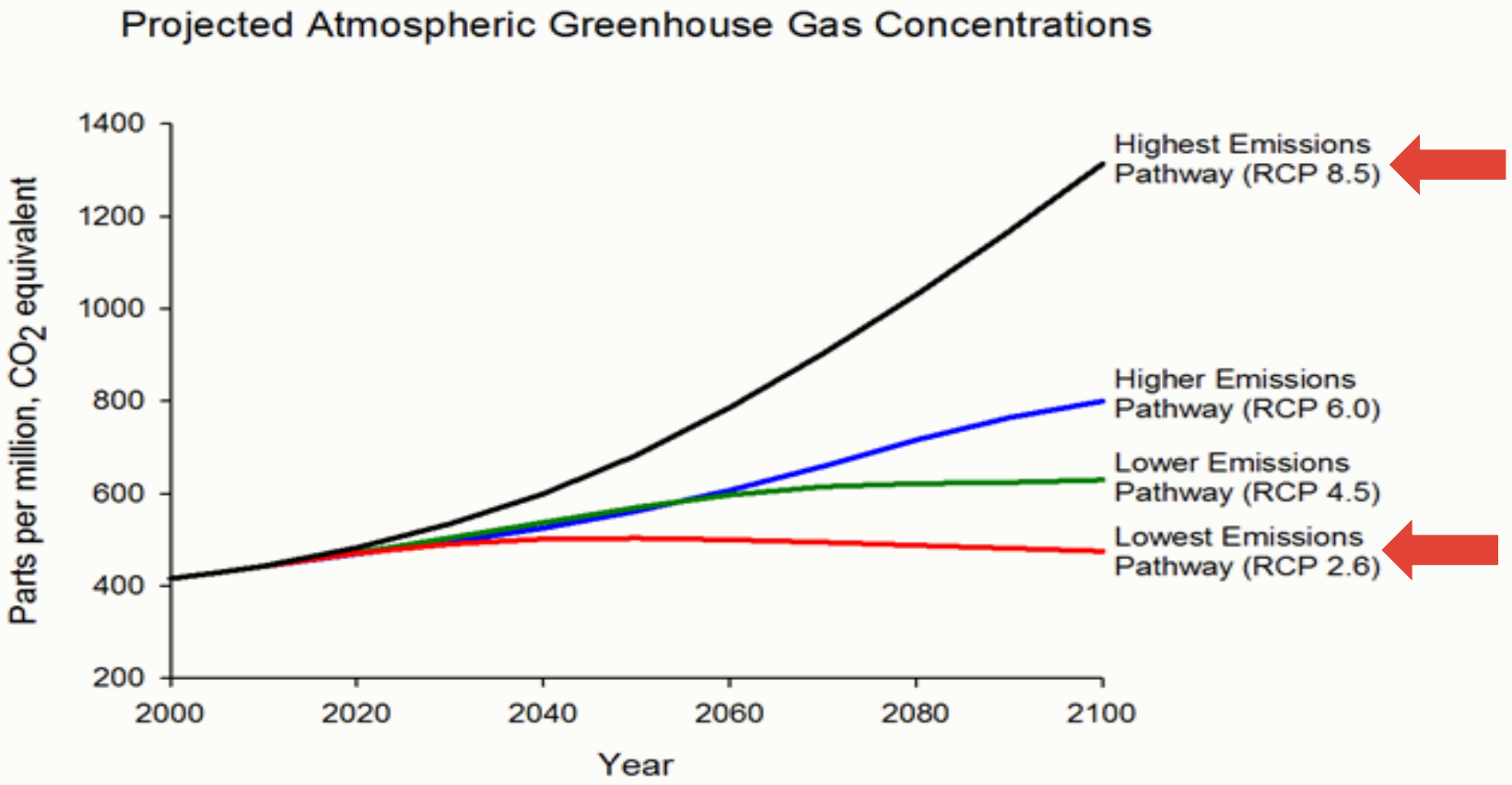
Simulating Climate Change

Representative Concentration Pathways (RCP)



Radiative forcing = 8.5 W/m^2

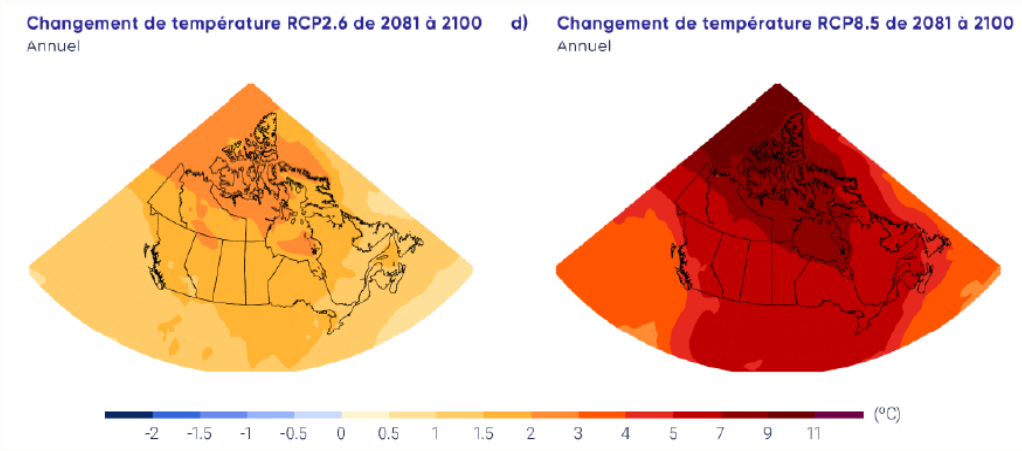
2.6 W/m^2

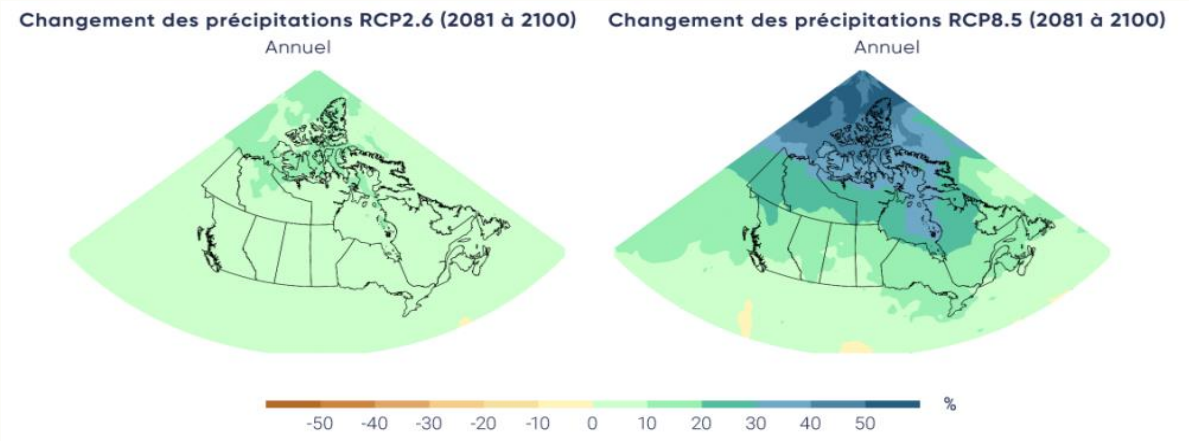
Source: *Climate Change 2014 – Synthesis Report*, iPCC, [Online], 2015. [https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf]

Potential Impacts in Canada: 2081 to 2100

Increase of annual average temperature

- RCP 2.6 : 1.8 °C
- RCP 8.5 : 6.3 °C
- RCP 8.5 (Arctic) : 12 °C





Increase of annual average precipitation

- RCP 2.6 : 6.8 %
- RCP 8.5 : 24.2 %

The Project

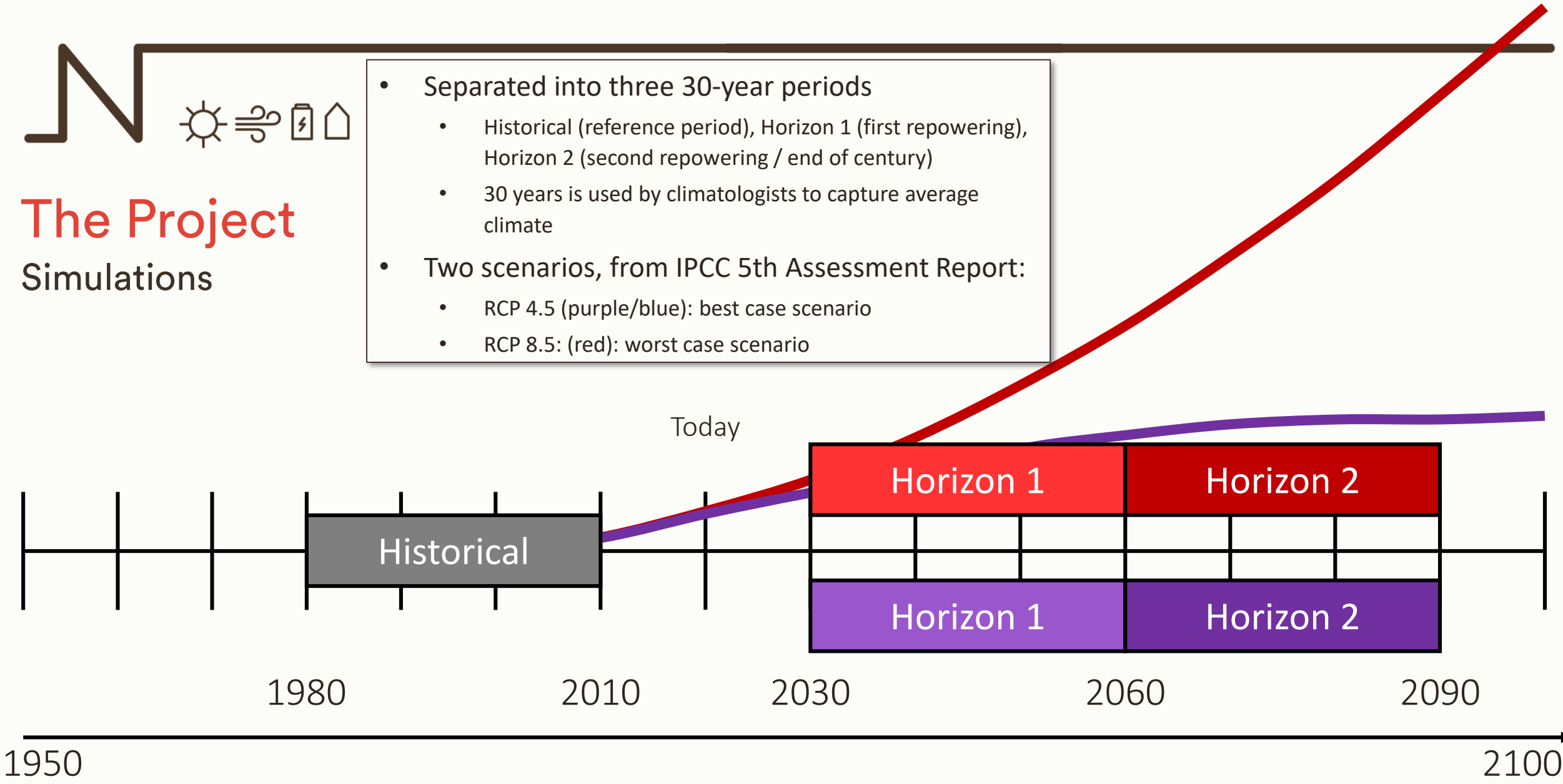
Partners

- Hydro Québec, Ontario Power, Manitoba Hydro: utility perspective
- Nergica: wind energy and icing expertise
- Ouranos: climatologists

The Project

Simulations

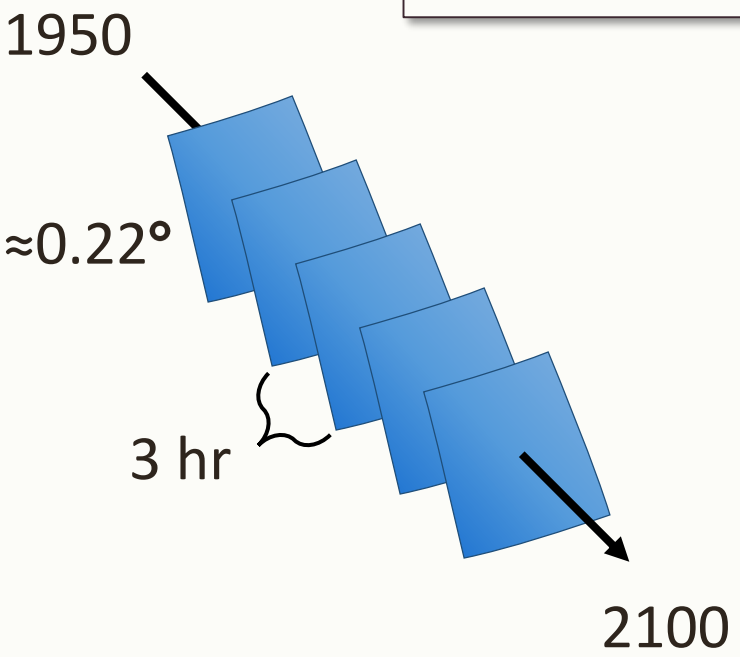
- Separated into three 30-year periods
  - Historical (reference period), Horizon 1 (first repowering), Horizon 2 (second repowering / end of century)
  - 30 years is used by climatologists to capture average climate
- Two scenarios, from IPCC 5th Assessment Report:
  - RCP 4.5 (purple/blue): best case scenario
  - RCP 8.5: (red): worst case scenario

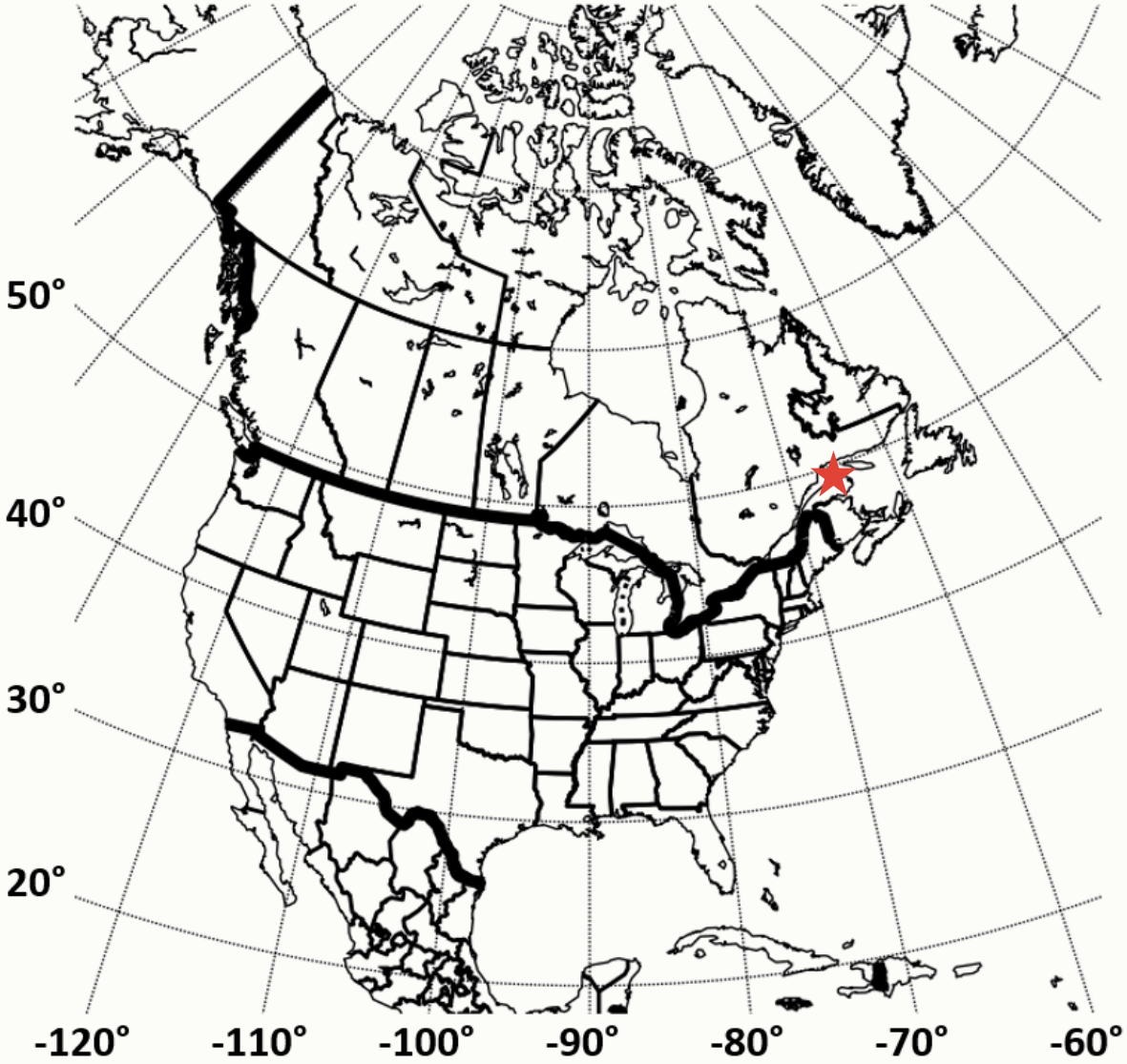


The Project

Scope

- All of North america
- From 1950 to 2100
- 3 hr timestep
- Average 0.22° grid resolution





- Only RCP 8.5 (worst-case) scenario
- Only a single simulation: CRCM5 model, driven by CNRM-CM5

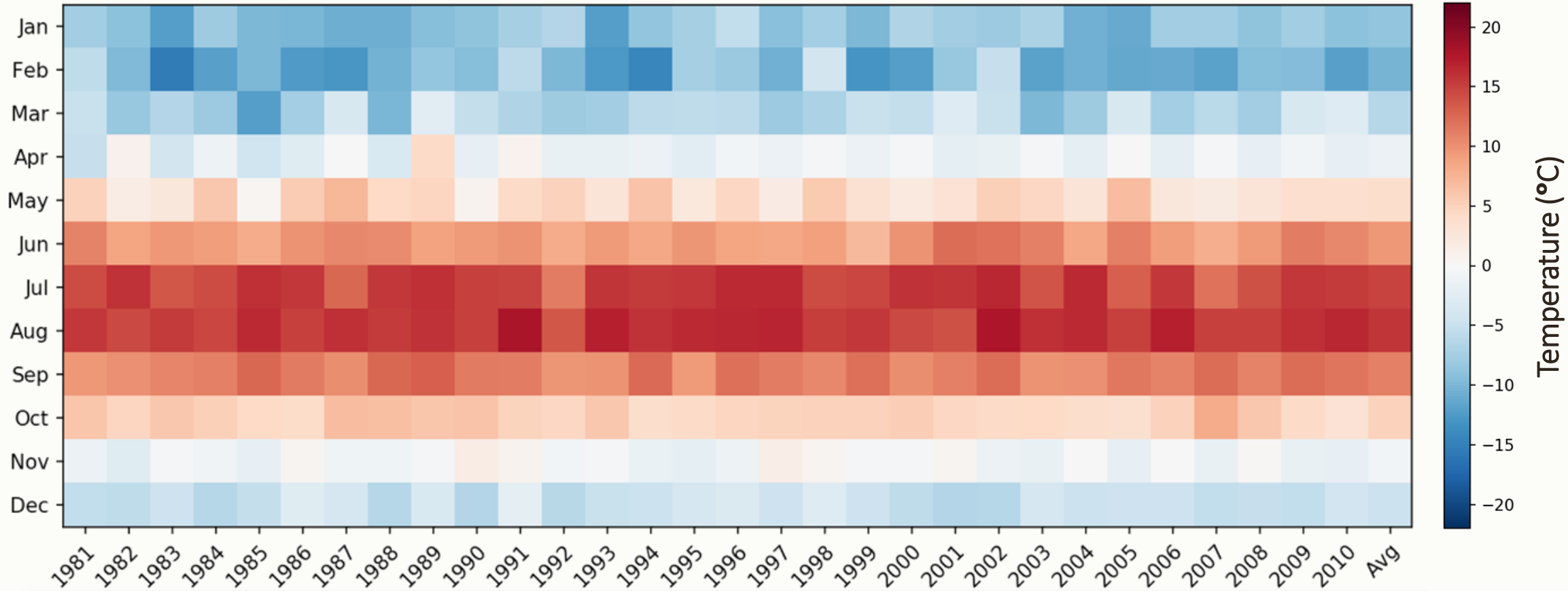
Case Study – Rivière-au-Renard

Preliminary Results

Temperature – Modeled Historical

Average – Worst-Case Scenario (RCP 8.5)

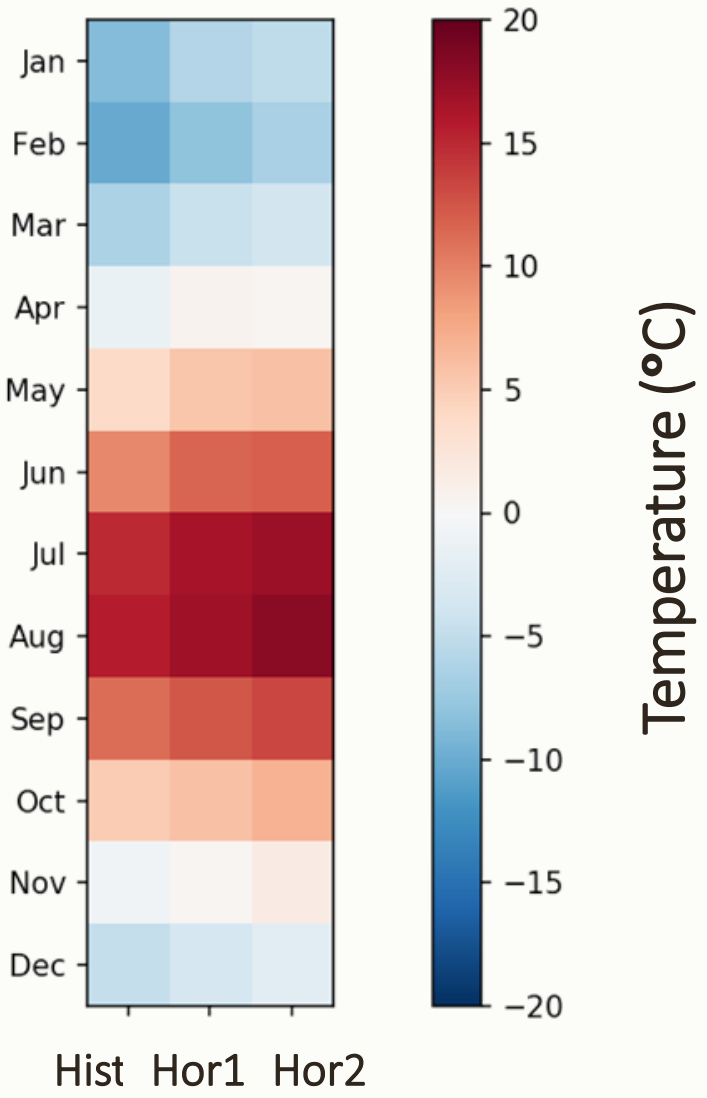
Represents **climate**
(not events)



- Simulated model data, not actual historical values (i.e. represents climate, not actual events)
- Statistics (average and variance) are similar to the true historical values for this period (1981-2010)

Temperature

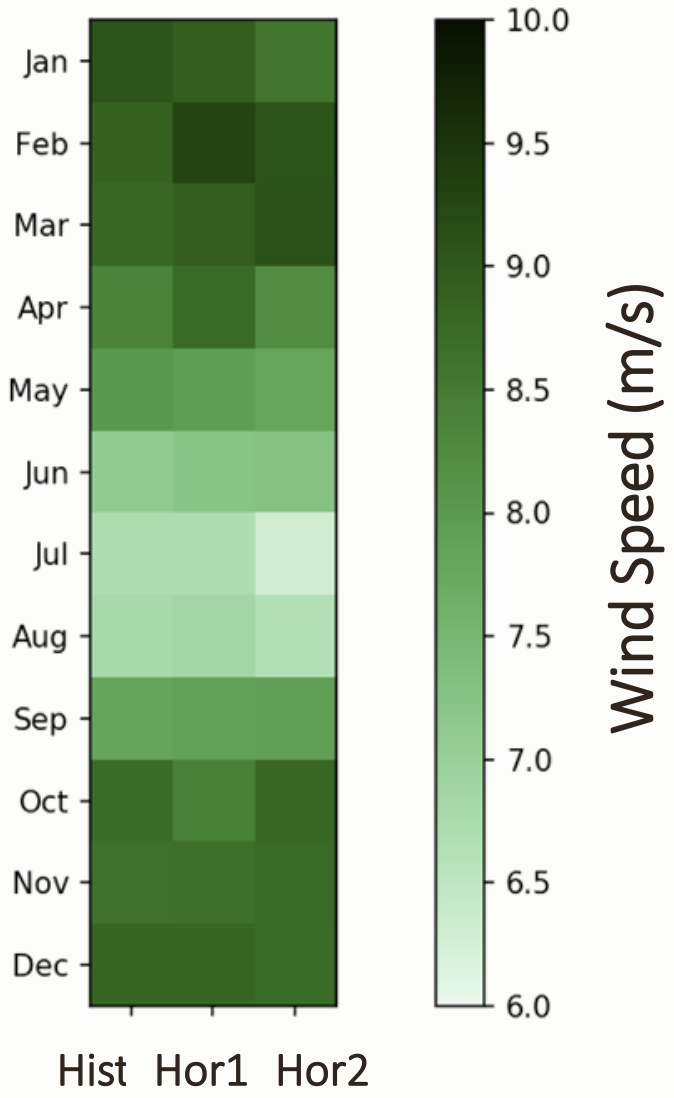
Averages



- Warming trend as we progress into the future (as predicted by climatologists – global warming)
- Warmer temperatures mean lower density air, and lower power production. However, shouldn't be a very significant difference.

Wind Speed

Averages

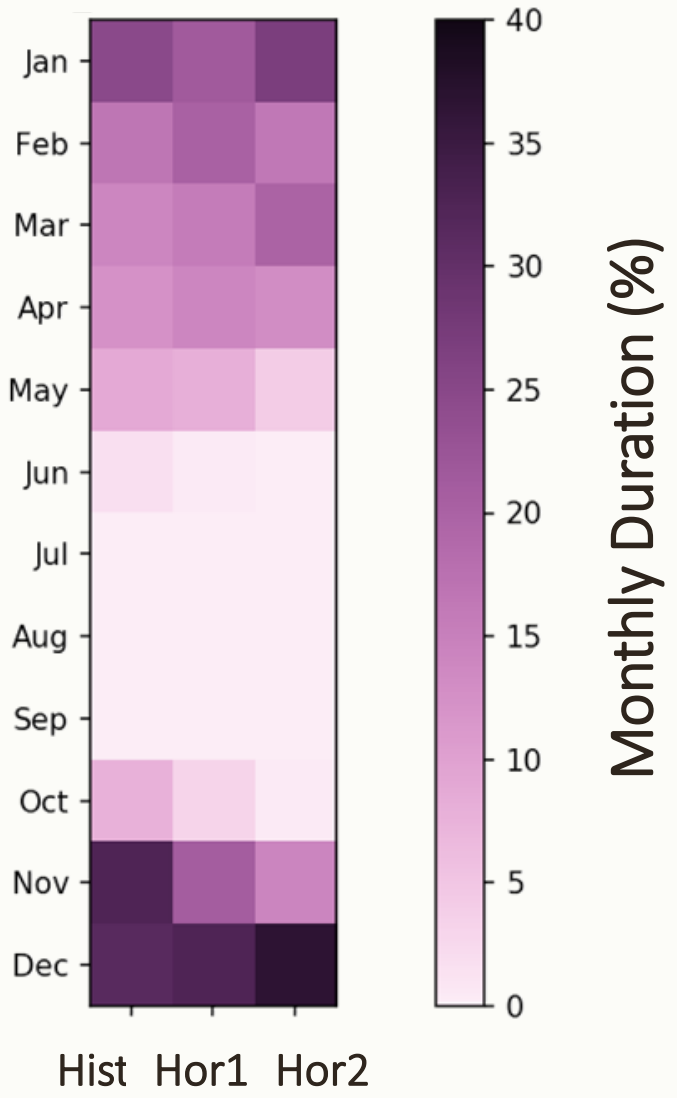


- No significant trend in wind speed
- Consistent with what climatologists see in their models: there's no clear signal.

Instrumental Icing Duration

Averages

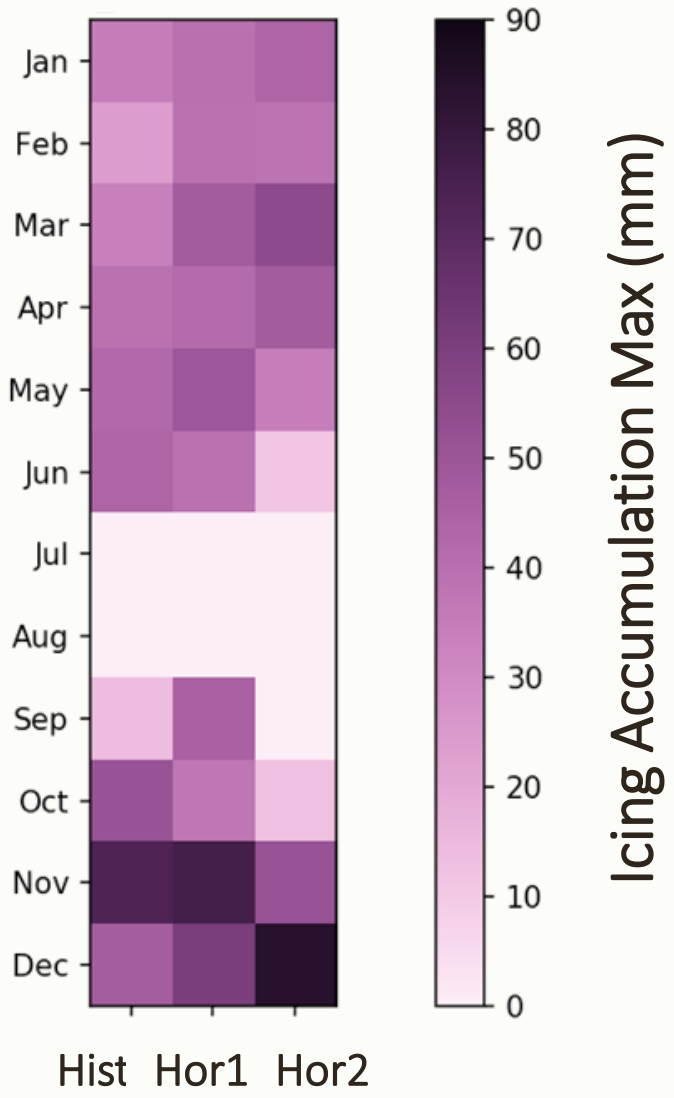
- Icing season will likely be shorter in the future at our site



Icing Accumulation Maximum

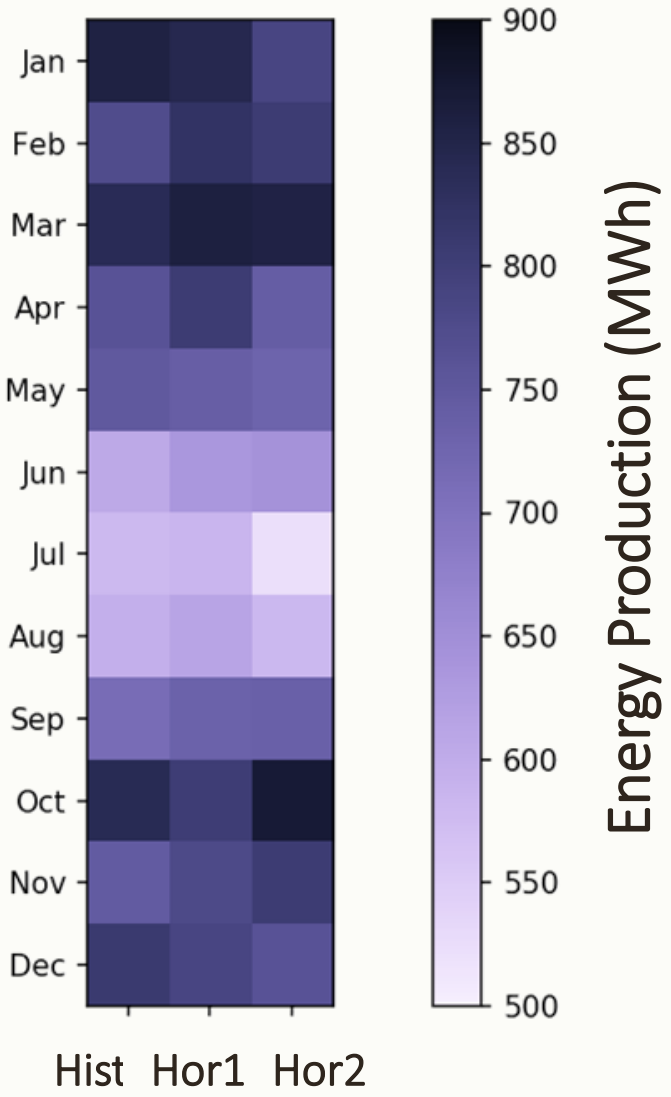
Averages

- Average of monthly maximum shows a less evident trend:
- For each month in which there is no reduction in the **duration** of ice (December to April), there is an **increase** in the maximum
- I interpret this as follows: while the icing season may become **shorter**, it may also become more **intense**.



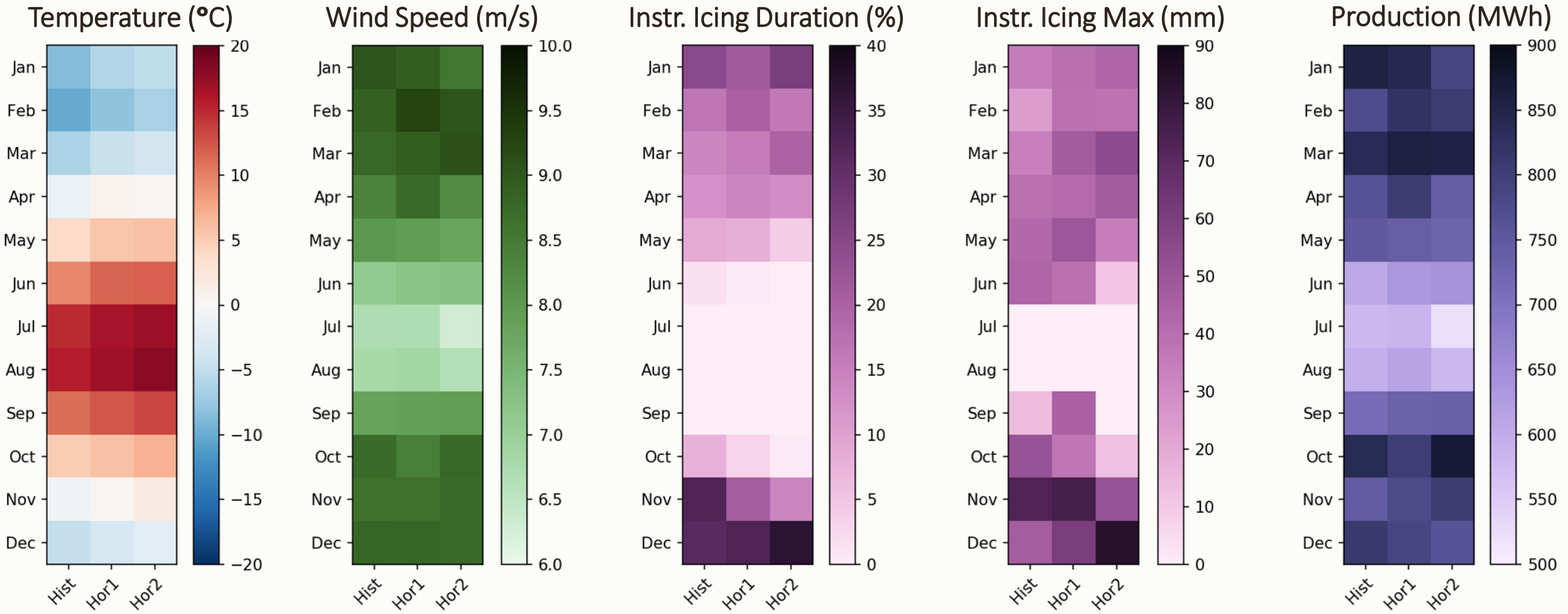
Production

Averages



- Similar to wind speed heatmap: no clear trend

Climate Averages at Rivière-au-Renard



- One additional note: can see the effect of icing on the production values. For example, December is modeled as having increased icing but same average winds. So production decreases.

Production

Impact on repowering

- Later fall and earlier spring means probably more production, since ice has more impact than temperature.
- But with potentially more extreme ice events, there is the possibility of reduced production in winter at our site.
- Other sites will likely have different conclusions

One Final Note

Preliminary results…

…from single simulation

→ More analyses under way
(other simulations, uncertainty)

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Other project partners

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NERGICA

70, rue Bolduc, Gaspé, QC G4X 1A6
nergica.com

T +1 418 368-6162 | info@nergica.com

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