Modeling future sea-ice conditions in Hudson Bay

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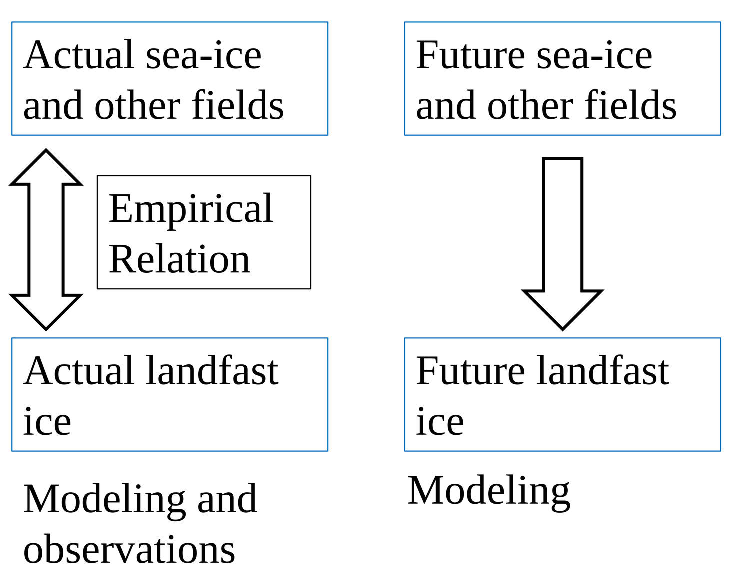
1. Introduction

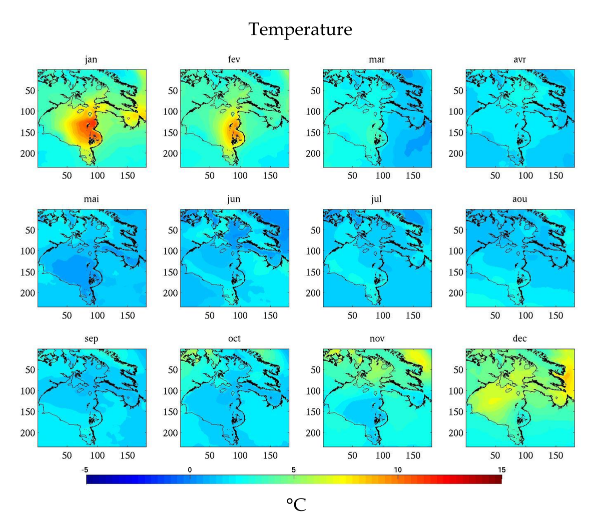


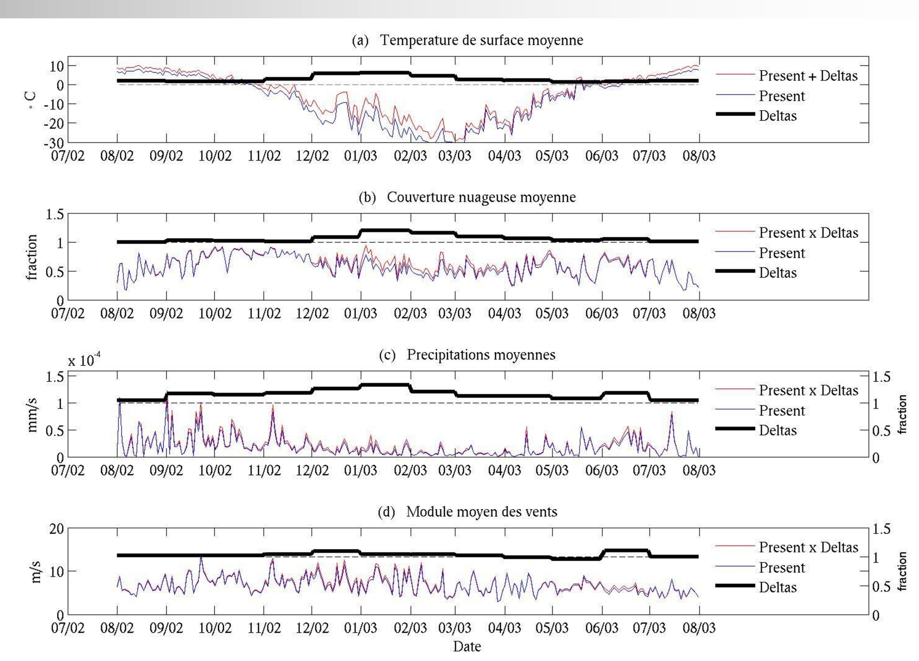
The main purpose of this joint project with Transport Québec is to predict the landfast ice conditions in 2055 in order to evaluate the risk factors to which the Hudson Bay marine infrastructures will be exposed. To achieve this, we will try to find an empirical relation between sea-ice (and other fields) and observed landfast ice. Then, this relation will be applied to sea ice-ocean model results in order to obtain landfast ice conditions in the future.

The change factors (CF) method is commonly use to predict the effects of climate change on a particular system. The main results presented here are a comparison of this method with long term simulations (LTS).

2. Methods

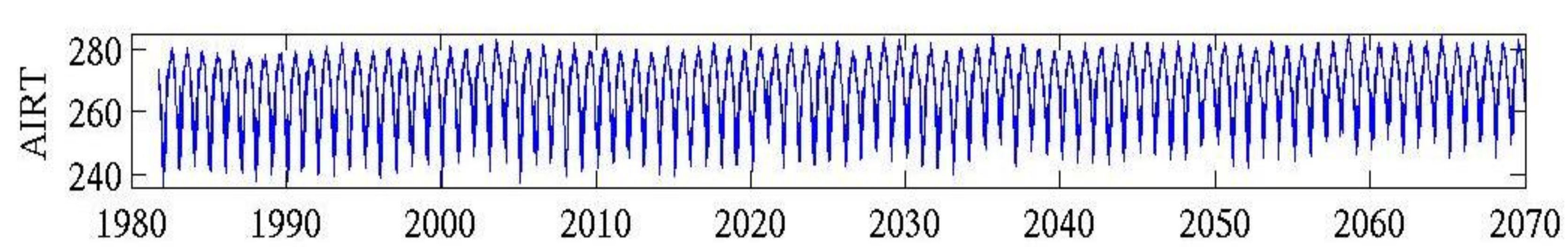
Change Factor (CF) method





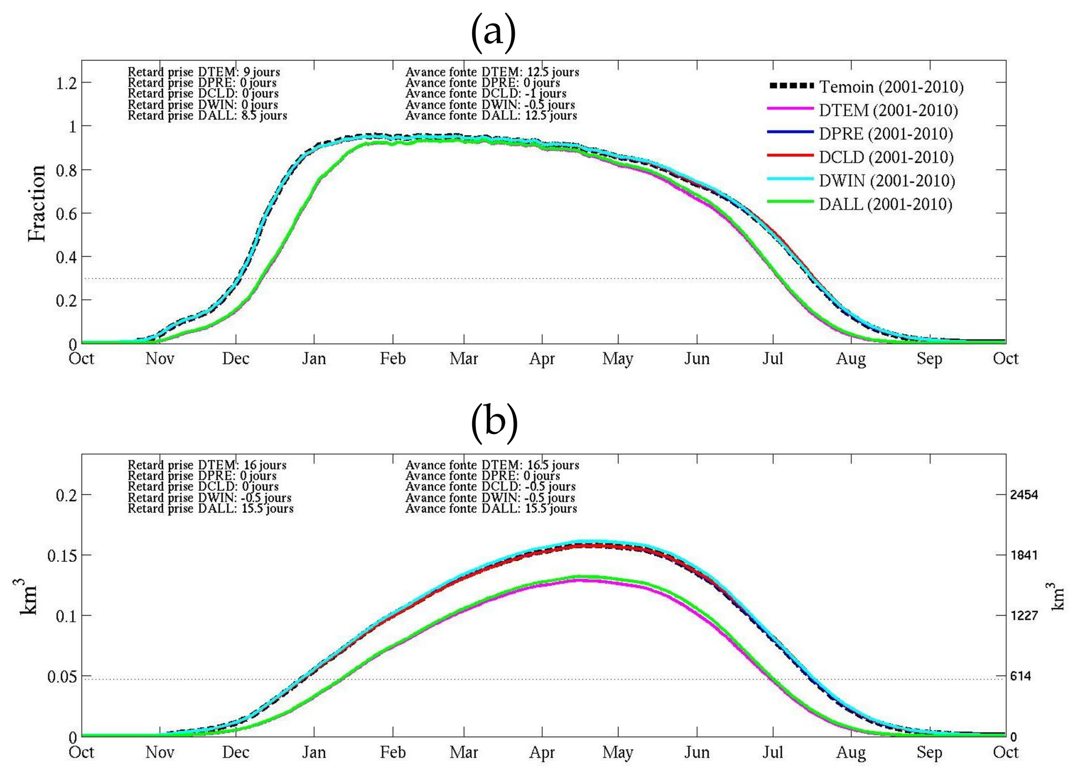
Using the Canadian Regional Climate Model outputs, we computed a recent 30-years monthly mean dataset (1981-2010) and a future 30-year monthly mean dataset (2041-2070). These datasets were used to modify the atmospheric fields of the sea ice-ocean model in order to take into account the effects of climate change. This method has been used with 4 different atmospheric fields: temperature; precipitation; cloud cover and wind speed. These changes have been applied individually as well as all together.

Long Term Simulations (LTS): 1981-2070



Results from the Canadian Regional Climate Model serve directly as atmospheric forcing in the sea ice-ocean numerical model. Two different climatic simulations are used: AHJ and AEV.

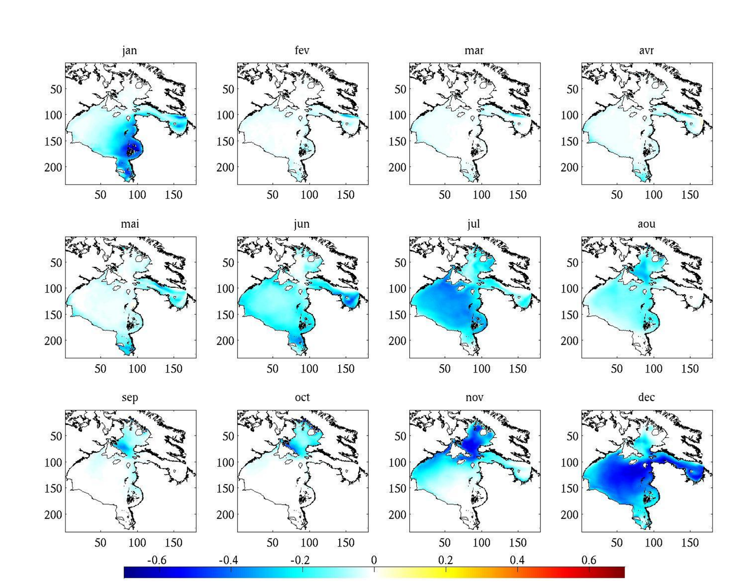
3. Results CF

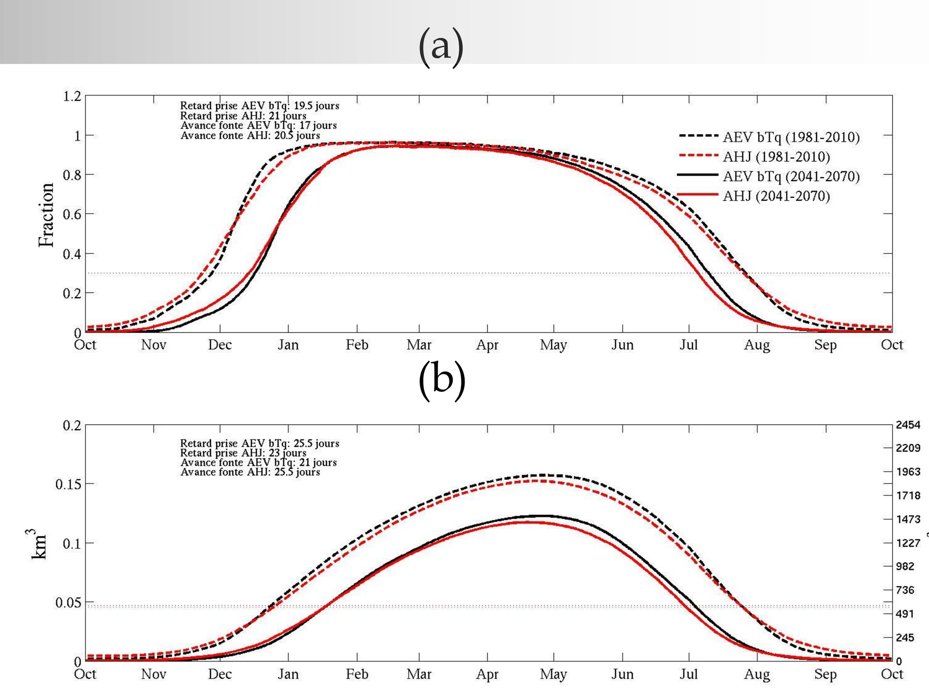


Mean (10 years) sea ice concentration (a) and sea ice volume (b) for 6 simulations. Different CF have been applied to five of those simulations. The reference simulation is represented by the dotted black line.

Air temperature is definitely the most determinant factor.

4. Results LTS





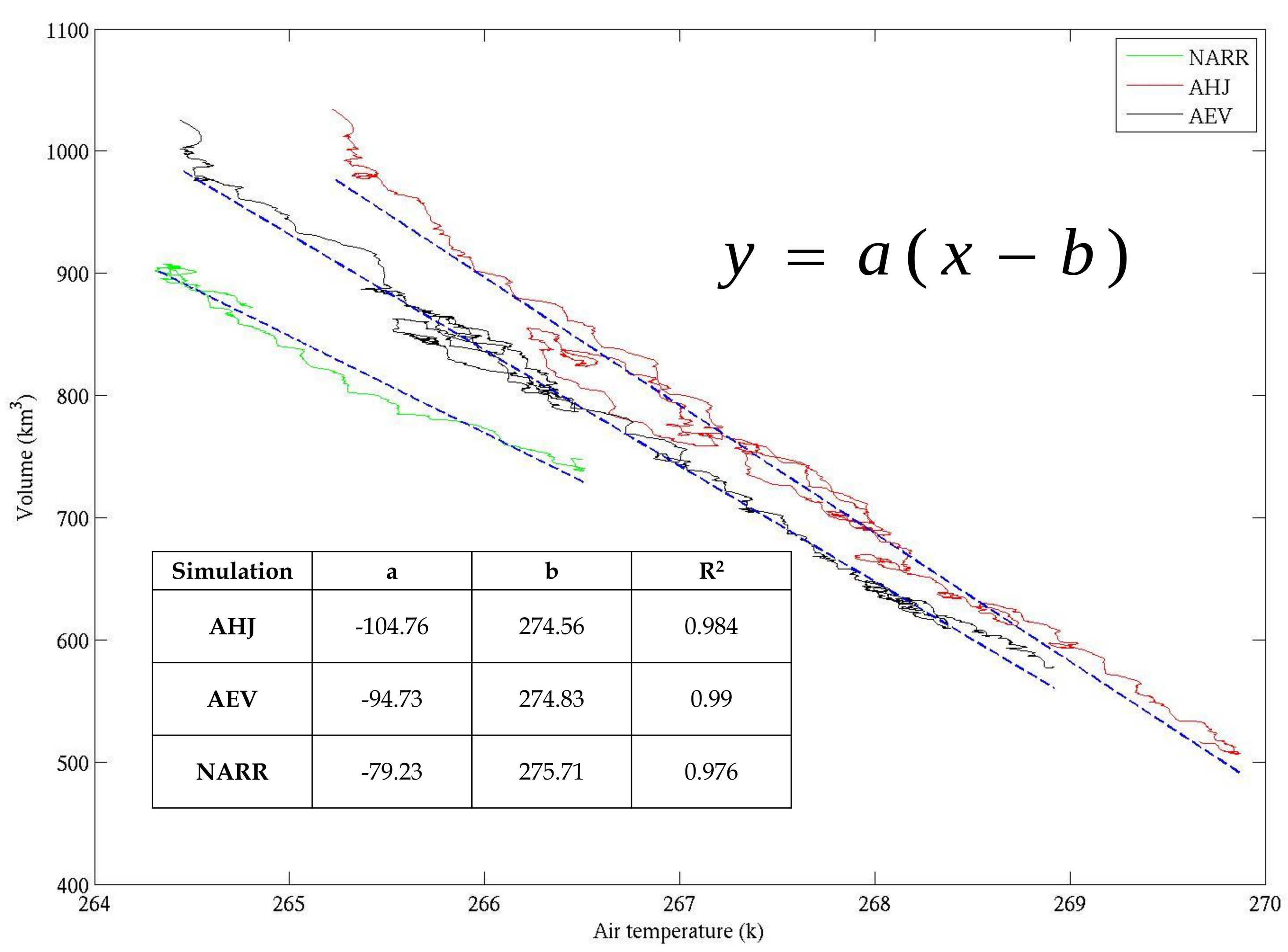
Left: Climatological monthly mean sea ice concentration anomaly (1981-2010 vs 2041-2070).
Right: 30 year mean sea ice concentration (a) and sea ice volume for the recent past (1981-2010, solid lines) and the future (2041-2070, dotted lines).

5. CF vs LTS

Simulation	ΔT Ice concentration > 30% (days)	Δ Maximum Ice Volume (%)
LTS AHJ	-41.5	-23%
LTS AEV	-36.5	-21%
CF Wind	+0.5	+2%
CF Temperature	-21.5	-18%
CF All (temperature., wind, precipitations, cloud cover)	-21.0	-16%

The anomaly of the 30% sea ice coverage period is twice as long for LTS compared to CF method.

6. Air Temperature and Sea Ice Volume



$$y = a(x - b)$$

Simulation	a	b	R²
AHJ	-104.76	274.56	0.984
AEV	-94.73	274.83	0.99
NARR	-79.23	275.71	0.976

There is a linear relation between the moving average of sea ice volume and the moving average of air temperature.

7. Perspectives

- Investigate CF method with quantile computed CF;
- Check the effect of a spin-up on CF method;
- Look at the relationship between air temperature and sea ice volume using real observations.

Coordinates

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