VIC!

On the road to a pan-Canadian application of a hydrological/simple land surface model

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Integrated Modelling Program for Canada
Global Water Futures

GLOBAL WATER FUTURES
SOLUTIONS TO WATER THREATS IN AN ERA OF GLOBAL CHANGE

UNIVERSITY OF SASKATCHEWAN
Global Institute for Water Security
USASK.CA/WATER

GWF, IMPC and VIC

The Variable Infiltration Capacity (VIC) model was selected as a hydrologically-simple land surface model to be developed as part of GWF modeling efforts along side the more sophisticated models such as MESH.

The IMPC vision is to set up the VIC model for the major Canadian basins.

GWF core modeling: Kai Tsuruta (PCIC, VIC-GL); Juliane Mai (UW, Inter-comparison);

PhD student: Hongren Shen (UW, Inter-comparison);

Jefferson Wong (UofS, GIWS)

What have been done? (1) Assessment/improvement

We have reviewed +50 articles related to VIC

- Routing (reservoir/lakes) are generally not reported.
- Regionalization of the conceptual parameters is not well explored.
- Model parameters uncertainty and sensitivity are not well explored.
- Limited focus on model evaluation or validation.

Dive into the code and formulations

- To find exactly what the model does.

$$e = \frac{b}{1+b}$$

$$A = 1-(1-\frac{S}{S_s})^e$$

$$S_s = \sum_{i=0}^{n-1} D_i \theta_i$$

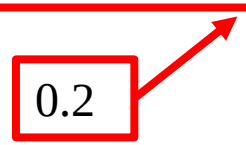
$$i_m = (1+b)S_s$$

$$i_0 = i_m(1-(1-A)^{\frac{1}{b}})$$

What have been done? (1) Assessment/improvement

```
[shg096@platolgn02 VIC-master]$  grep -irw VEG_LAI_WATER_FACTOR
tests/science/vic_parameters_42_compat.txt:VEG_LAI_WATER_FACTOR 0.1
docs/Documentation/Constants.md:| VEG_LAI_WATER_FACTOR           |
|
samples/vic_parameters.txt:VEG_LAI_WATER_FACTOR 0.1
vic/vic_run/include/vic_def.h:    double VEG_LAI_WATER_FACTOR;  /**<
Coefficient multiplied by the LAI to determine the amount of water that can
be stored in the canopy */
vic/vic_run/src/vic_run.c:
param.VEG_LAI_WATER_FACTOR;
vic/drivers/cesm/bld/vic.constants.txt:# VEG_LAI_WATER_FACTOR 0.1
```

- Many hard coded values. $W_{max} = VEG\_LAI\_WATER\_FACTOR * LAI$



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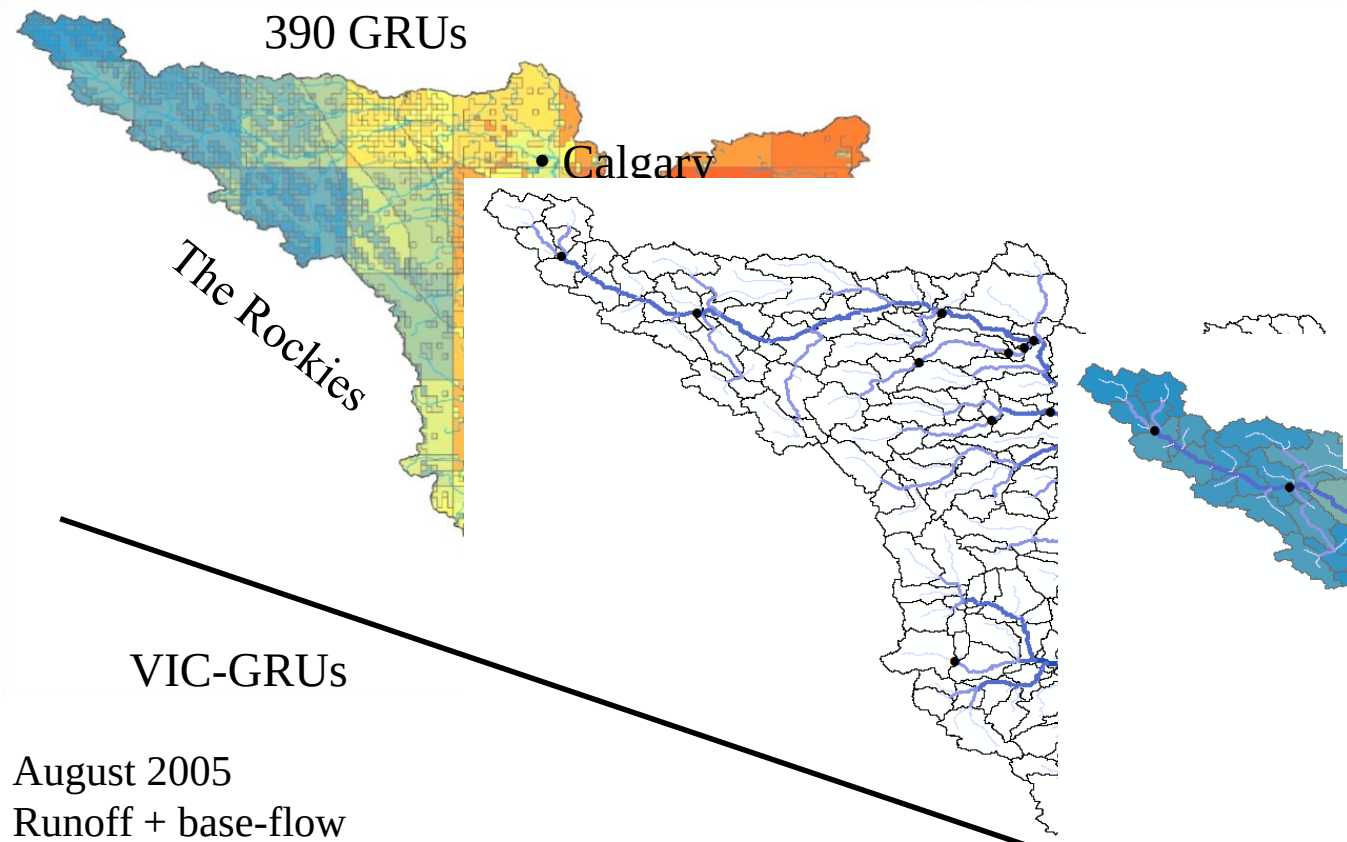
Dive into the code and formulations

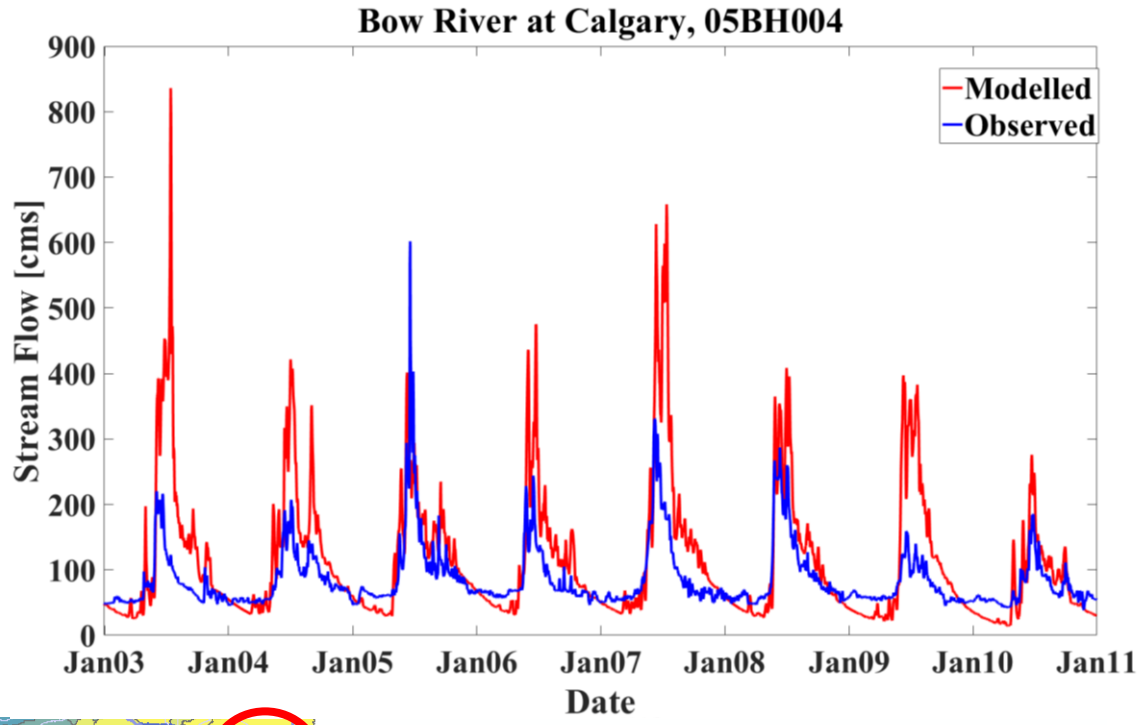
- To find exactly what the model does.
- Many hard coded values.
- Many assumptions.

What have been done? (2) Model set up

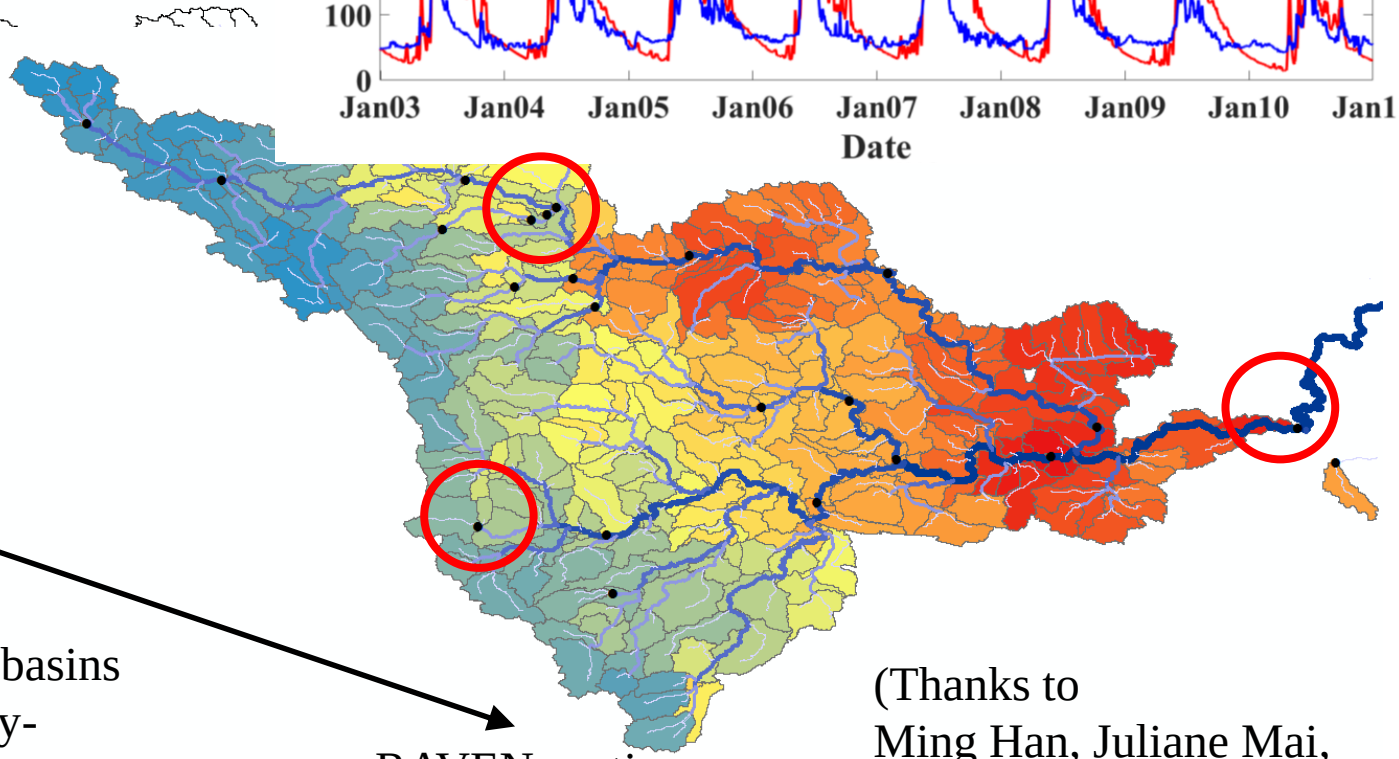
- Data is documented, metadata (collective efforts of Elvis Asong, Mohamed Elshamy, Amin Haghnegahdar, Kuljeet Keshav, Daniel Princz, Jefferson Wong)
- Many utilities have been developed.

What have been done? (2) Model s





August 2005
Runoff + base-flow
[mm/month]



RAVEN routing
River network and sub-basins
based on Hydrologically-
conditioned DEM (90 meters)

RAVEN routing

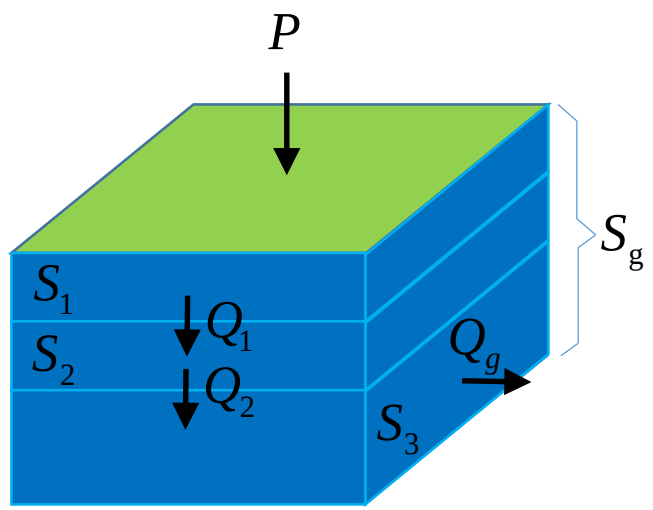
(Thanks to
Ming Han, Juliane Mai,
James Craig, Bryan Tolson)

What will be done? (3) Optimization, Sensitivity and Uncertainty Analysis

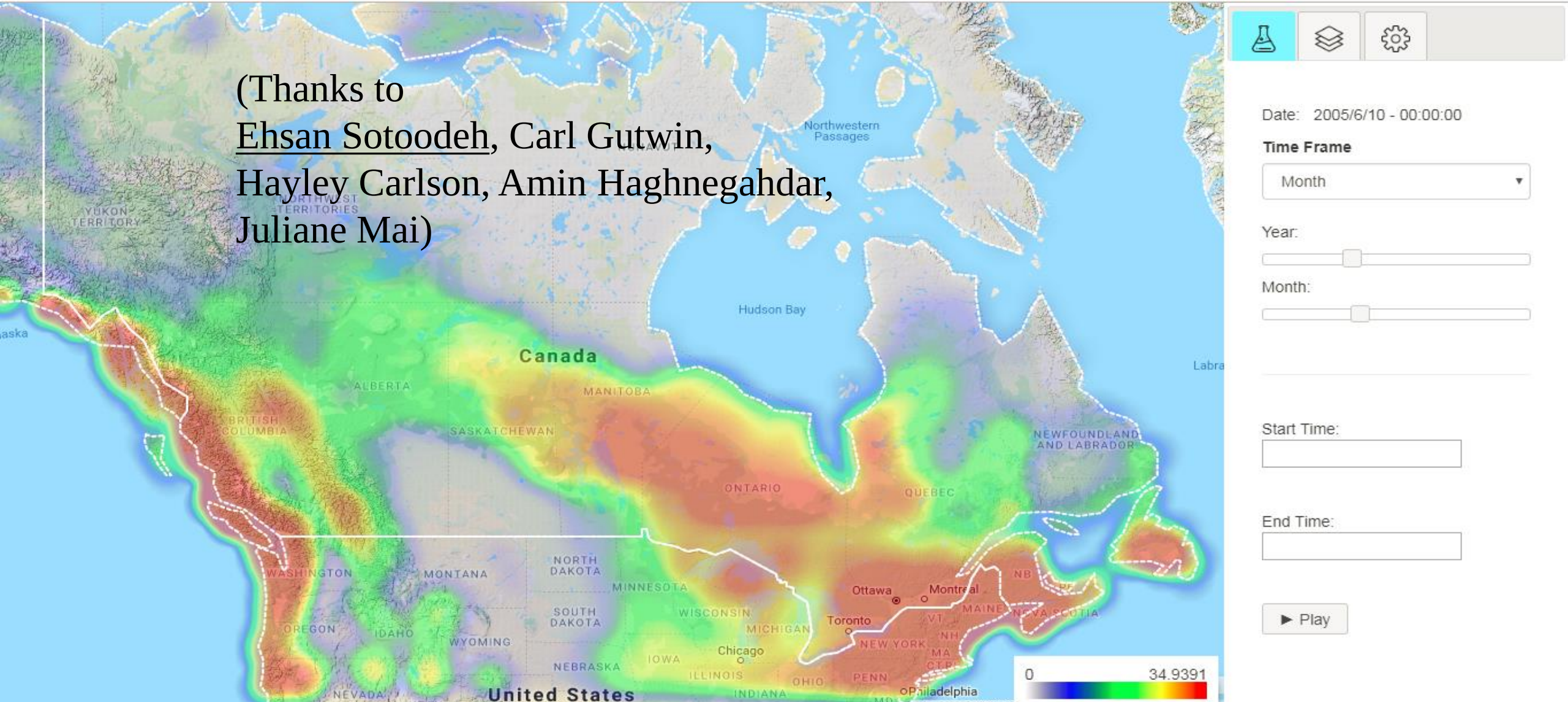
- Constraint-based calibration/optimization
- OSTRICH
- VARS

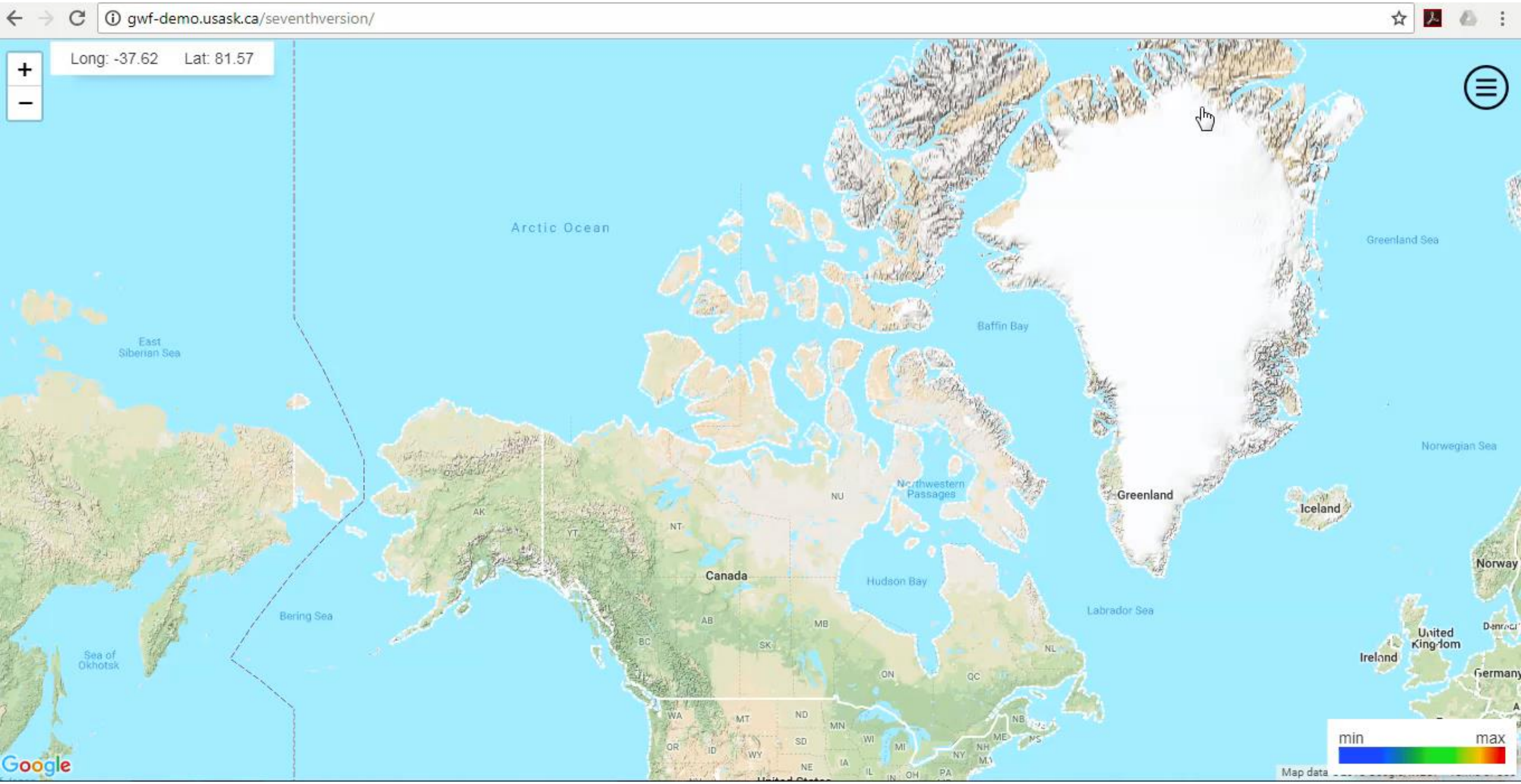
What will be done? (4) Scenarios of Change

- To be continued…



What have been done? (5) Communication http://gwf-demo.usask.ca/seventhversion/

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East Siberian Sea
Northwestern Passages
Greenland
Iceland
Norwegian Sea
Canada
Hudson Bay
Labrador Sea
Bering Sea
Sea of Okhotsk
Norway
United Kingdom
Ireland
Germany
AK
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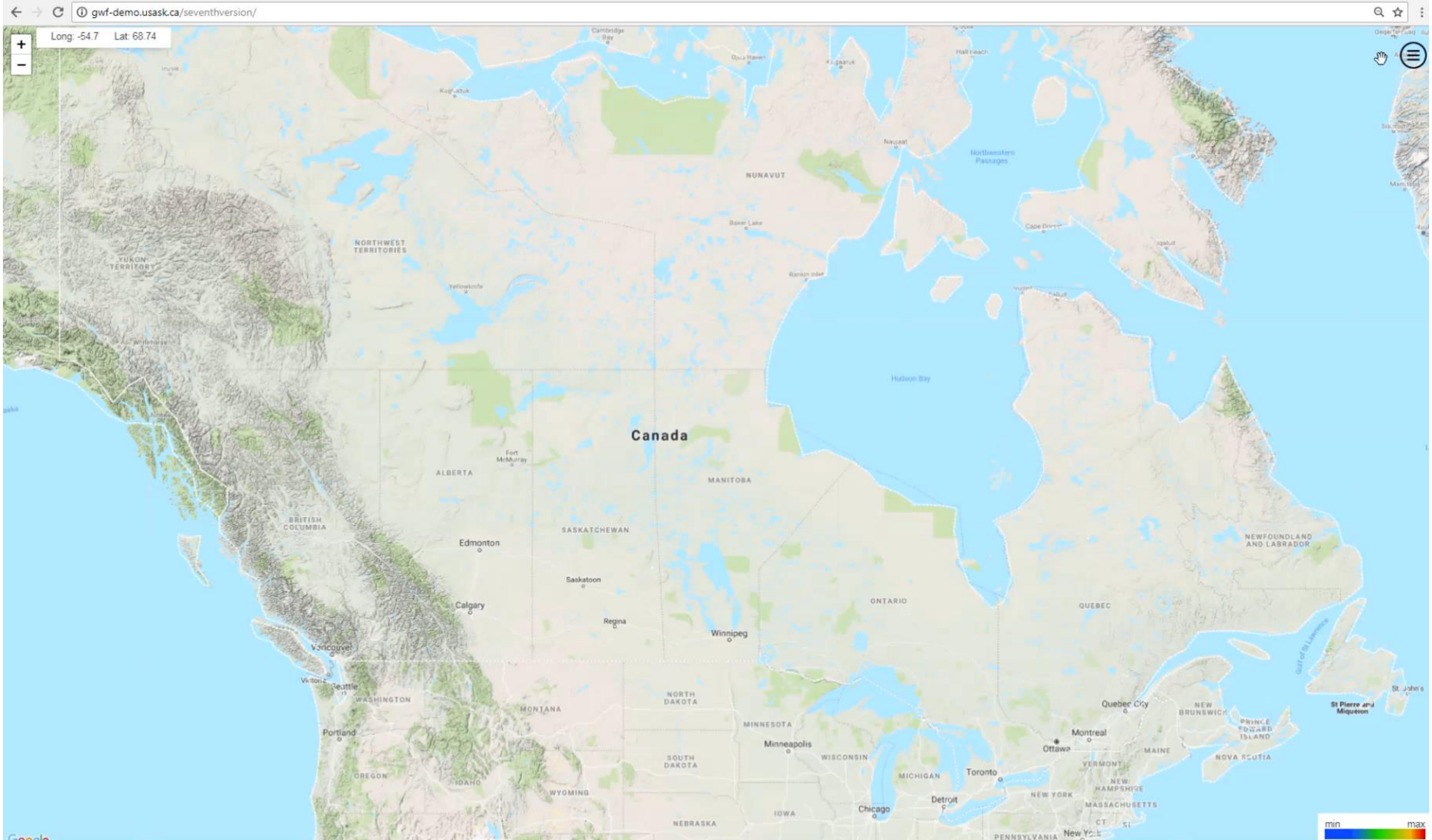
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YUKON TERRITORY
Canada
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
BRITISH COLUMBIA
NEWFOUNDLAND AND LABRADOR
Edmonton
Saskatoon
Calgary
Regina
Winnipeg
Vancouver
Seattle
Portland
Minneapolis
Toronto
Montreal
Ottawa
Quebec City
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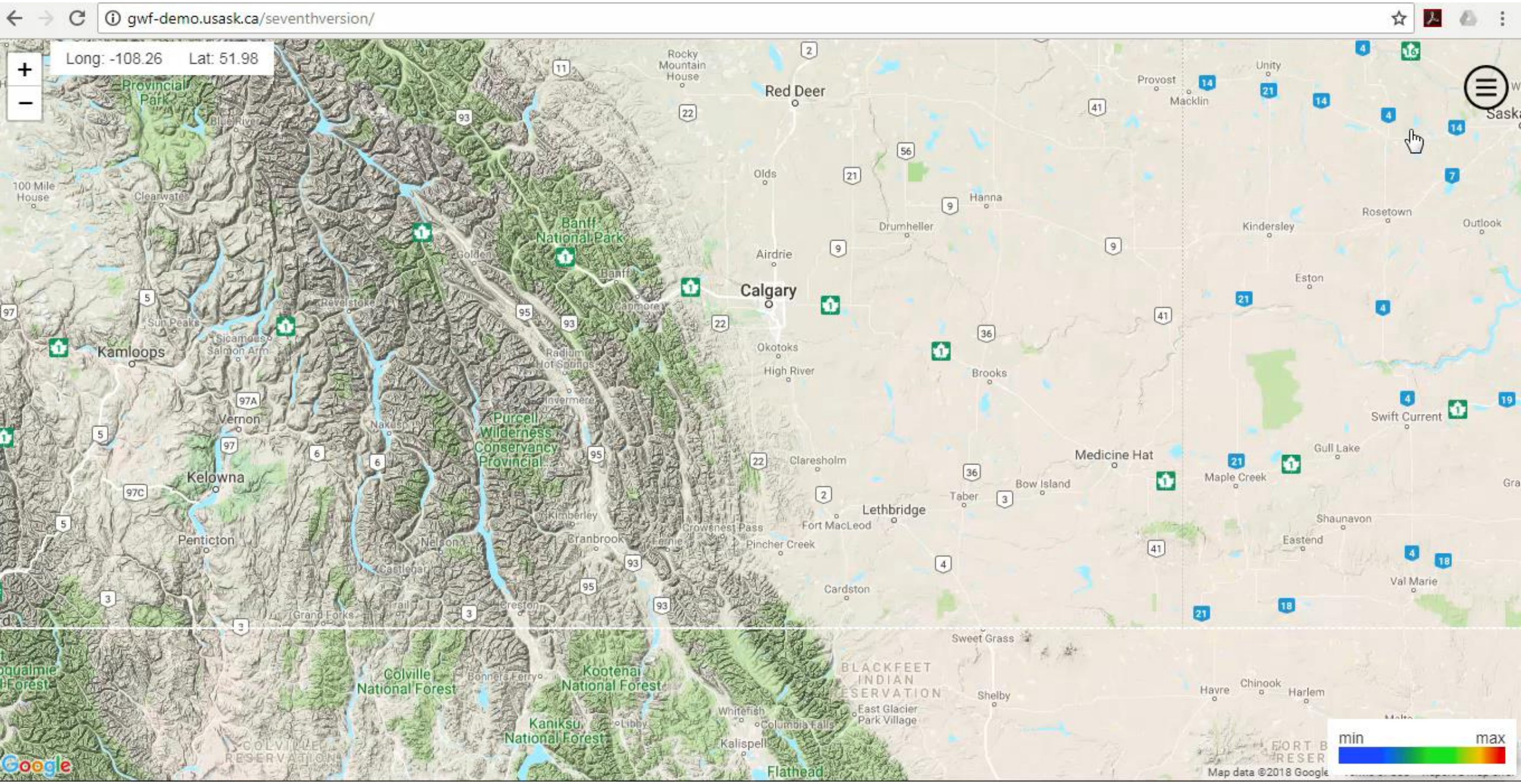
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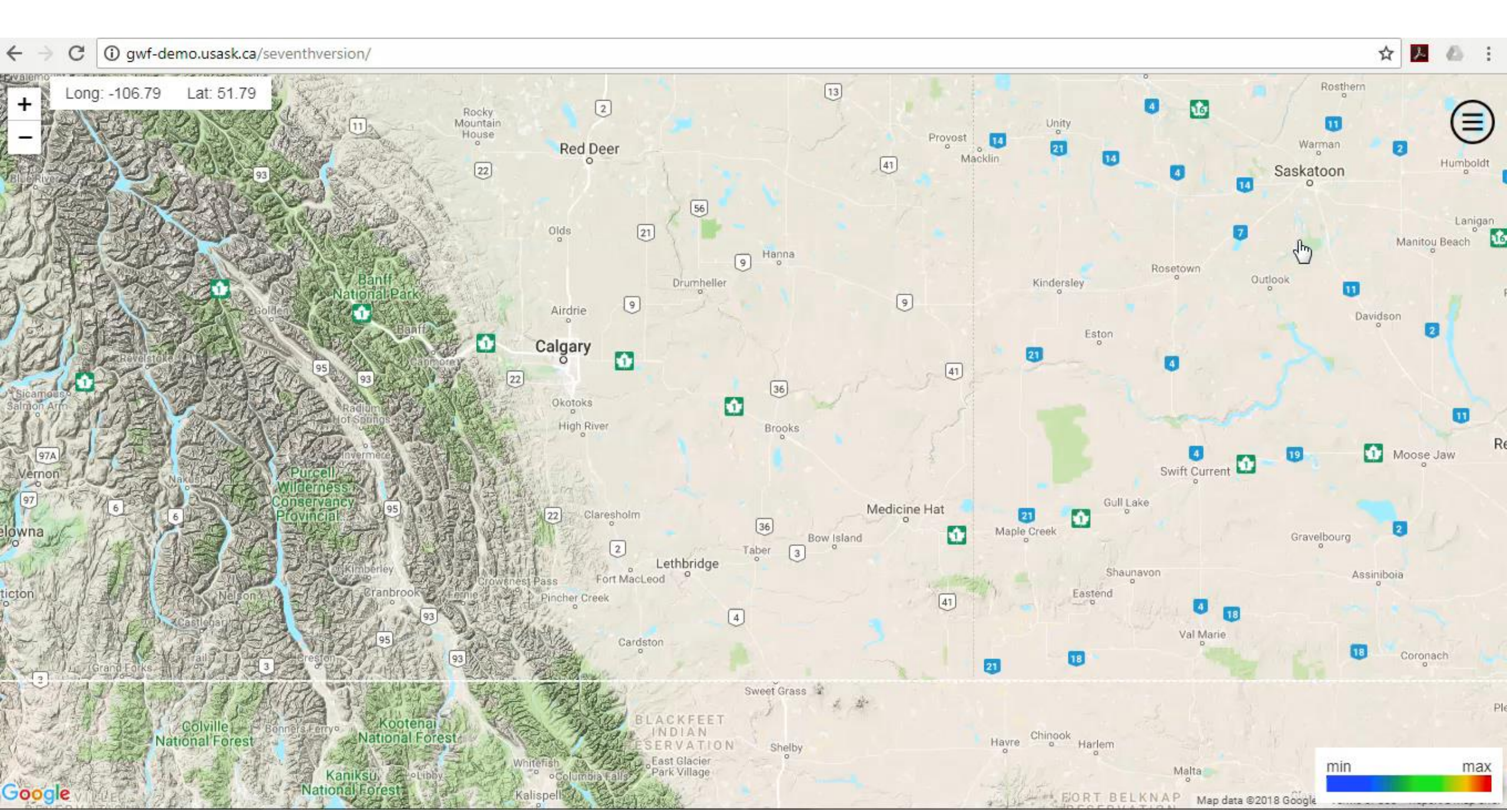
Red Deer
Calgary
Airdrie
Banff National Park
Banff
Canmore
Golden
Revelstoke
Kamloops
Sun Peaks
Sicamous
Salmon Arm
Vernon
Kelowna
Penticton
Okotoks
High River
Olds
Drumheller
Hanna
Brooks
Medicine Hat
Lethbridge
Fort MacLeod
Claresholm
Bow Island
Taber
Cardston
Pincher Creek
Crowsnest Pass
Fernie
Cranbrook
Kimberley
Nelson
Castlegar
Grand Forks
Trail
Purcell Wilderness Conservancy Provincial
Invermere
Radium Hot Springs
Rocky Mountain House
Provost
Macklin
Unity
Kindersley
Rosetown
Outlook
Eston
Swift Current
Gull Lake
Maple Creek
Shaunavon
Eastend
Val Marie
Sweet Grass
Shelby
Havre
Chinook
Harlem
East Glacier Park Village
Columbia Falls
Whitefish
Kalispell
Libby
Bonners Ferry
Colville National Forest
Kootenai National Forest
Kaniksu National Forest
BLACKFEET INDIAN RESERVATION
COLVILLE RESERVATION
min
max
Map data ©2018 Google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Red Deer
Saskatoon
Calgary
Lethbridge
Medicine Hat
Moose Jaw
Swift Current
Banff National Park
Purcell Wilderness Conservancy Provincial
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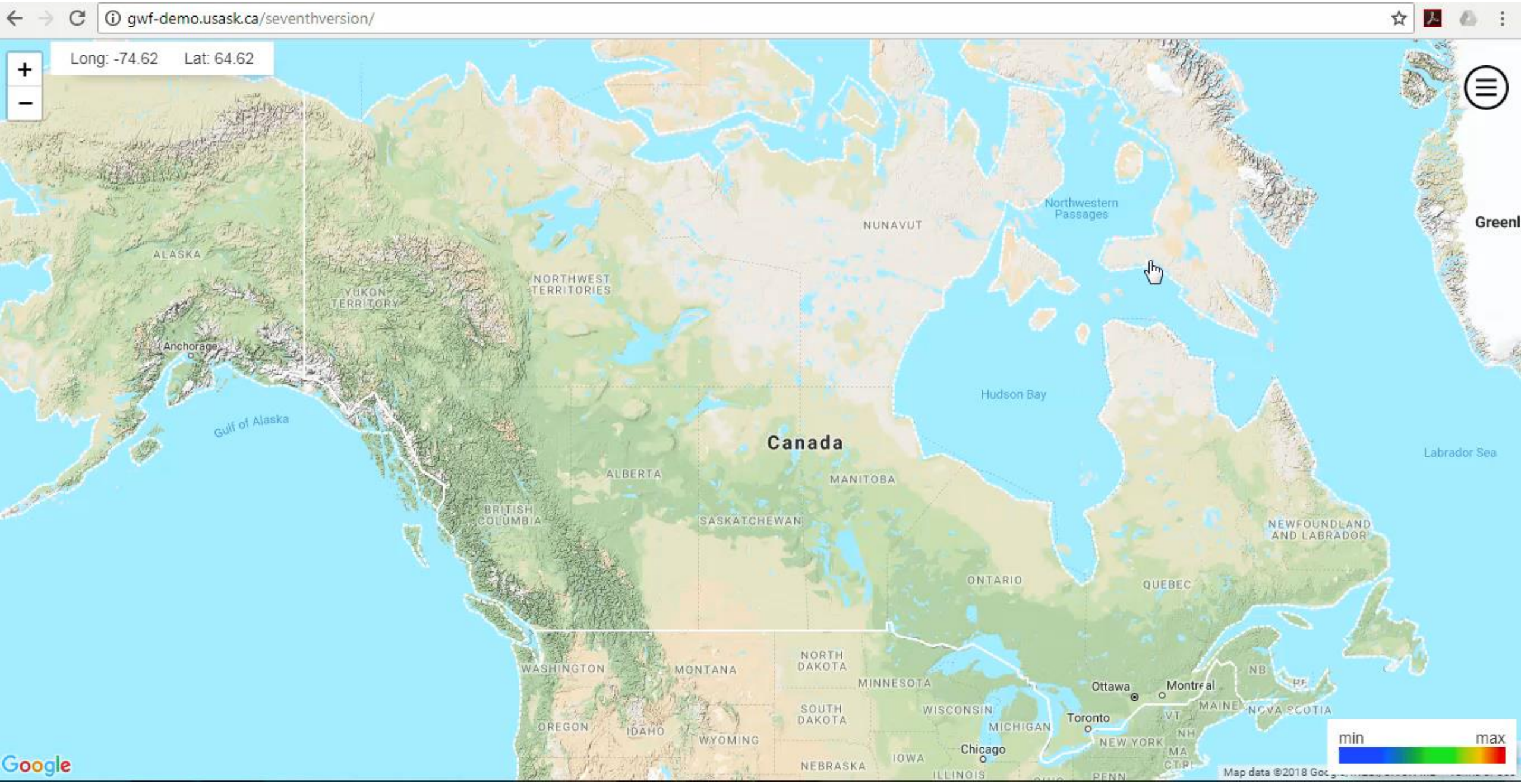
Kootenai National Forest
Kaniksu National Forest
BLACKFEET INDIAN RESERVATION
FORT BELKNAP
min
max
Map data ©2018 Google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Northwestern Passages
NUNAVUT
Greenl
ALASKA
NORTHWEST TERRITORIES
YUKON TERRITORY
Anchorage
Hudson Bay
Gulf of Alaska
Canada
Labrador Sea
ALBERTA
MANITOBA
BRITISH COLUMBIA
SASKATCHEWAN
NEWFOUNDLAND AND LABRADOR
ONTARIO
QUEBEC
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
Ottawa
Montreal
NB
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WISCONSIN
MAINE
NOVA SCOTIA
OREGON
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Chicago
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ILLINOIS
PENN
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