ClimateBC and its applications

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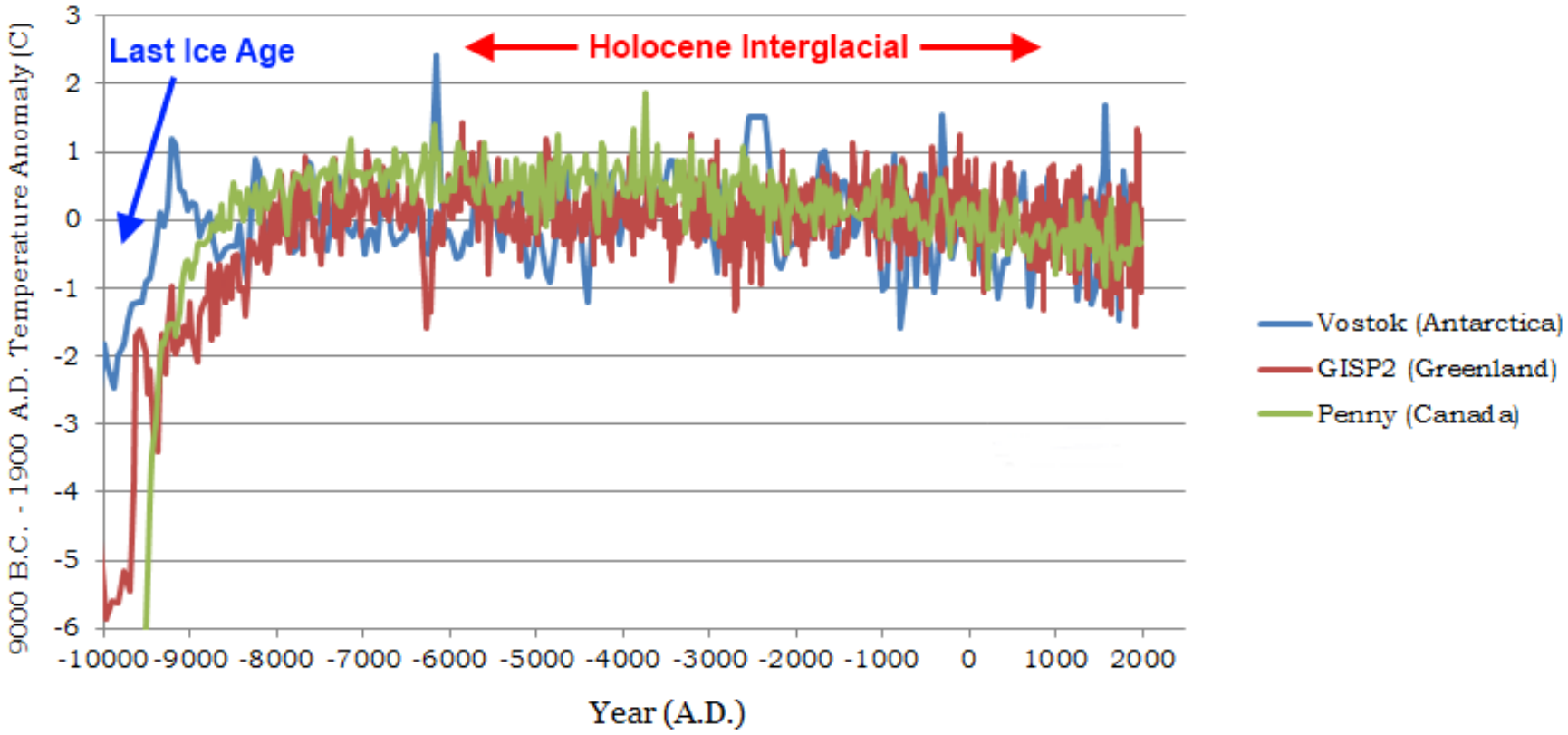
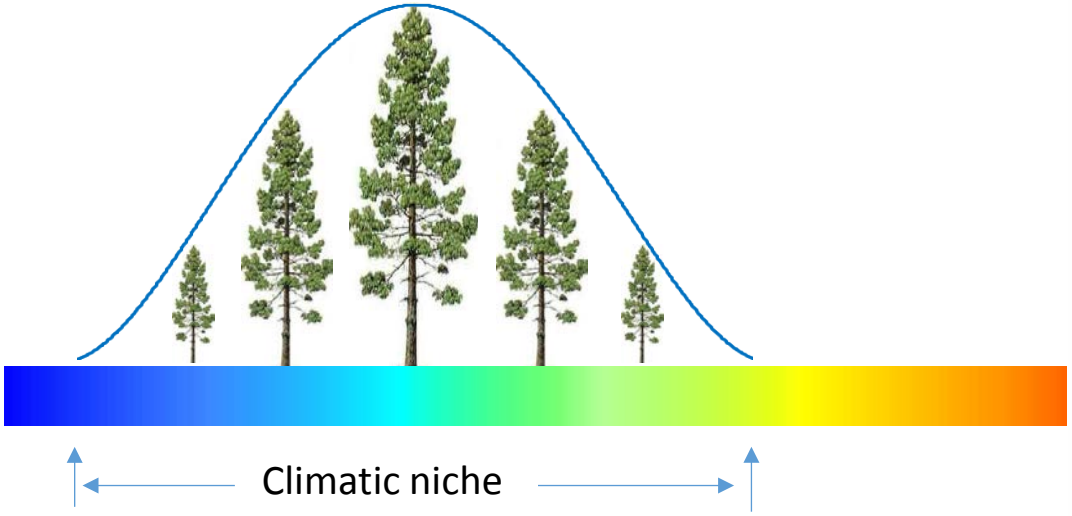
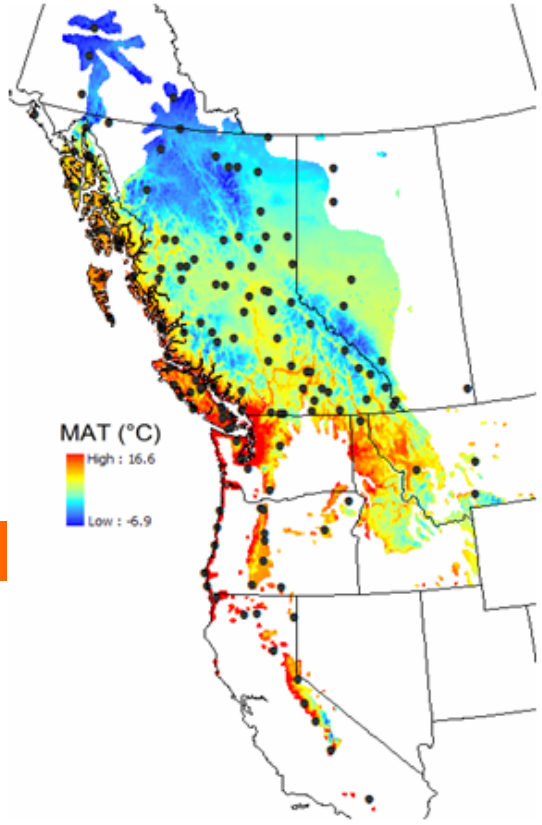
Ice Core Temperature Reconstructions

Data retrieved from the NCDC at ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/



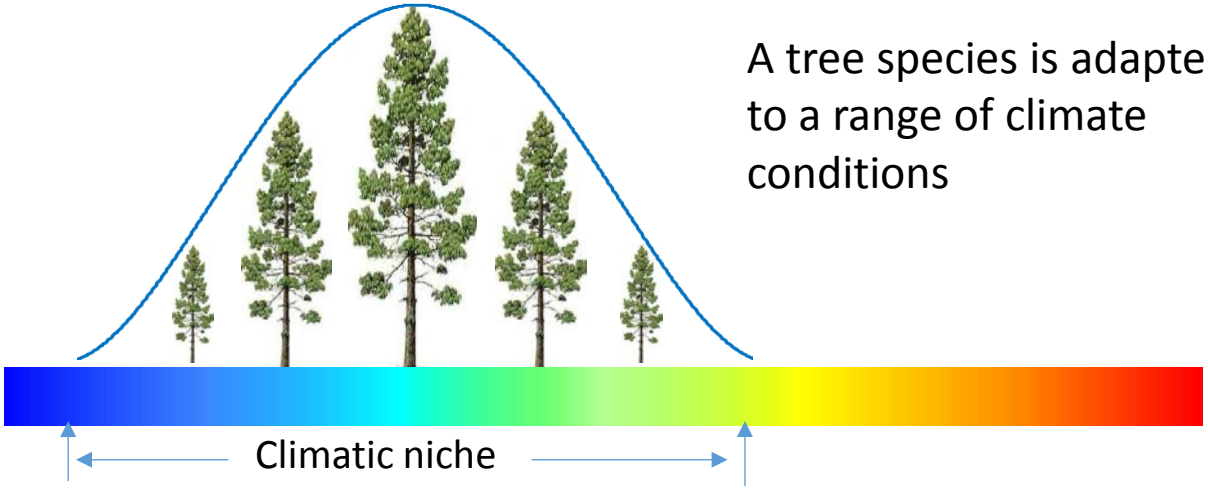
Most plant species are adapted to a range of climatic conditions



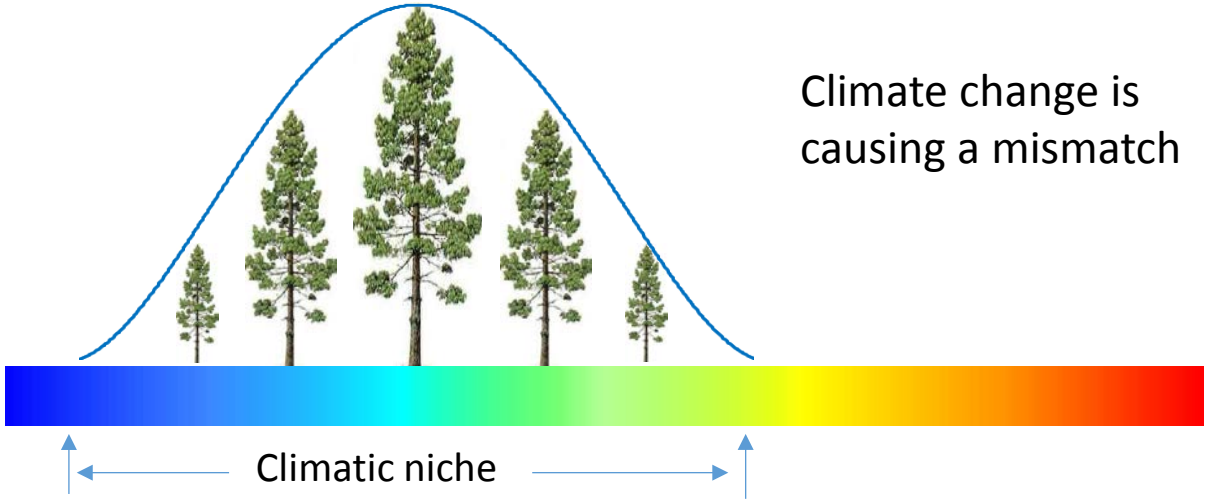


Distribution of lodgepole pine in North America

What is the major challenge?

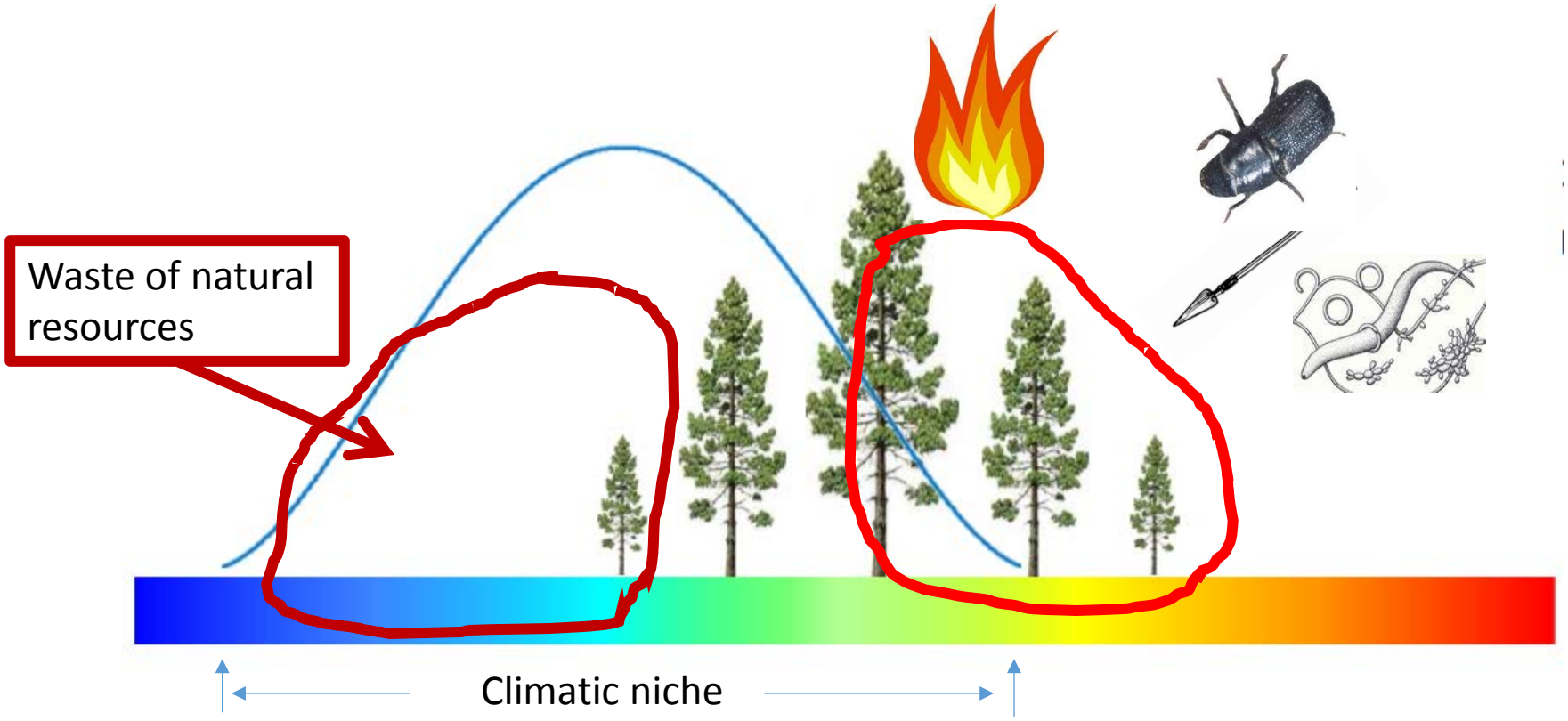


A tree species is adapted to a range of climate conditions

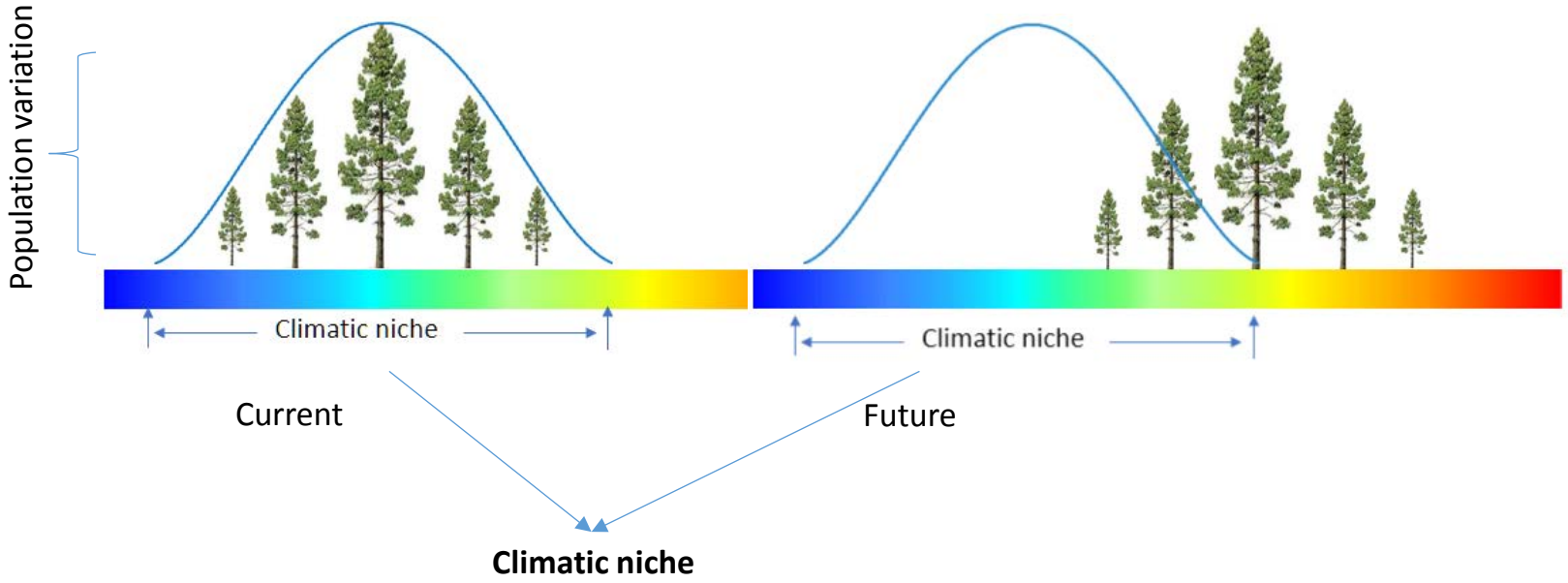


Climate change is causing a mismatch

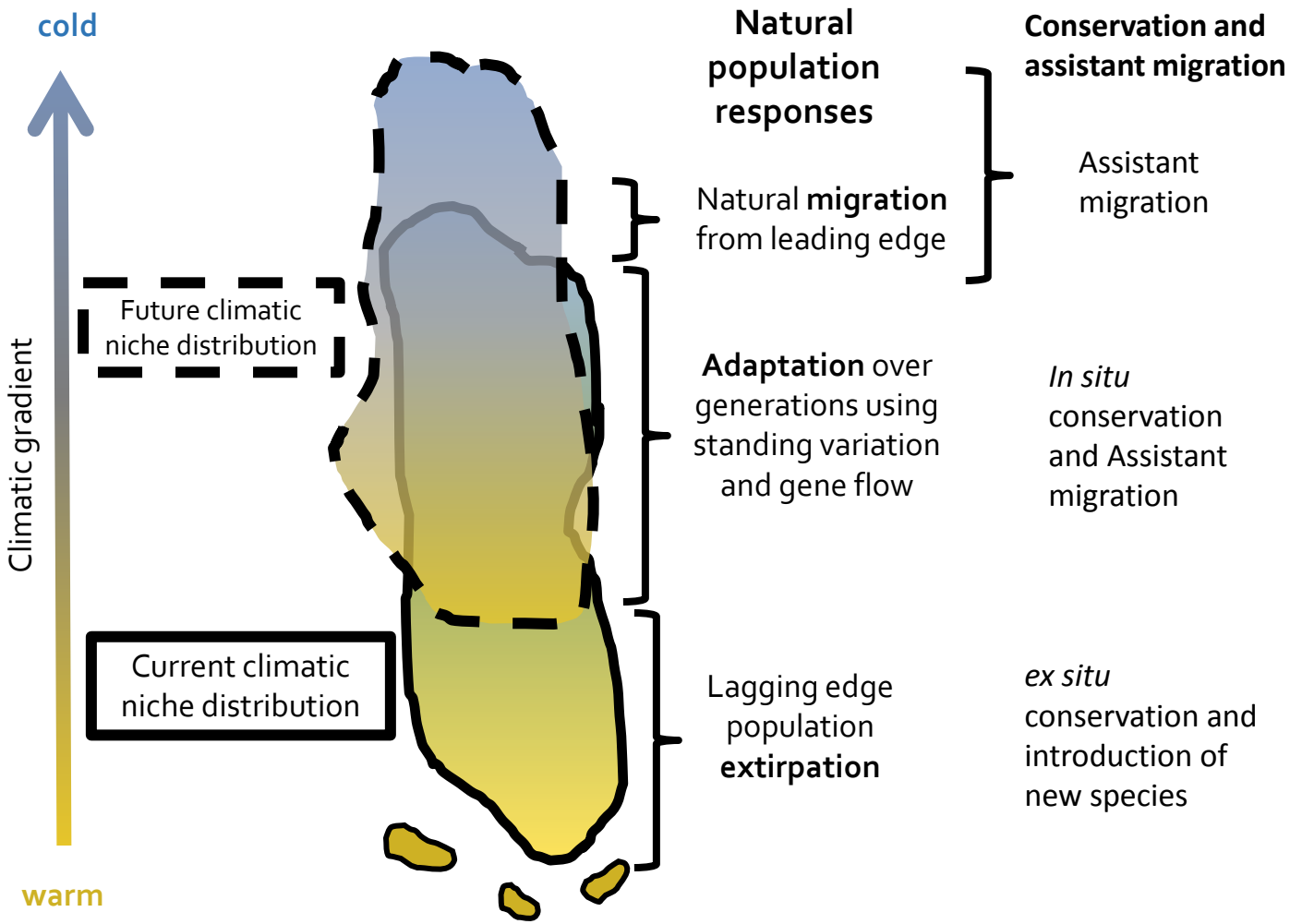
Trees left out their suitable climate habitat will be vulnerable



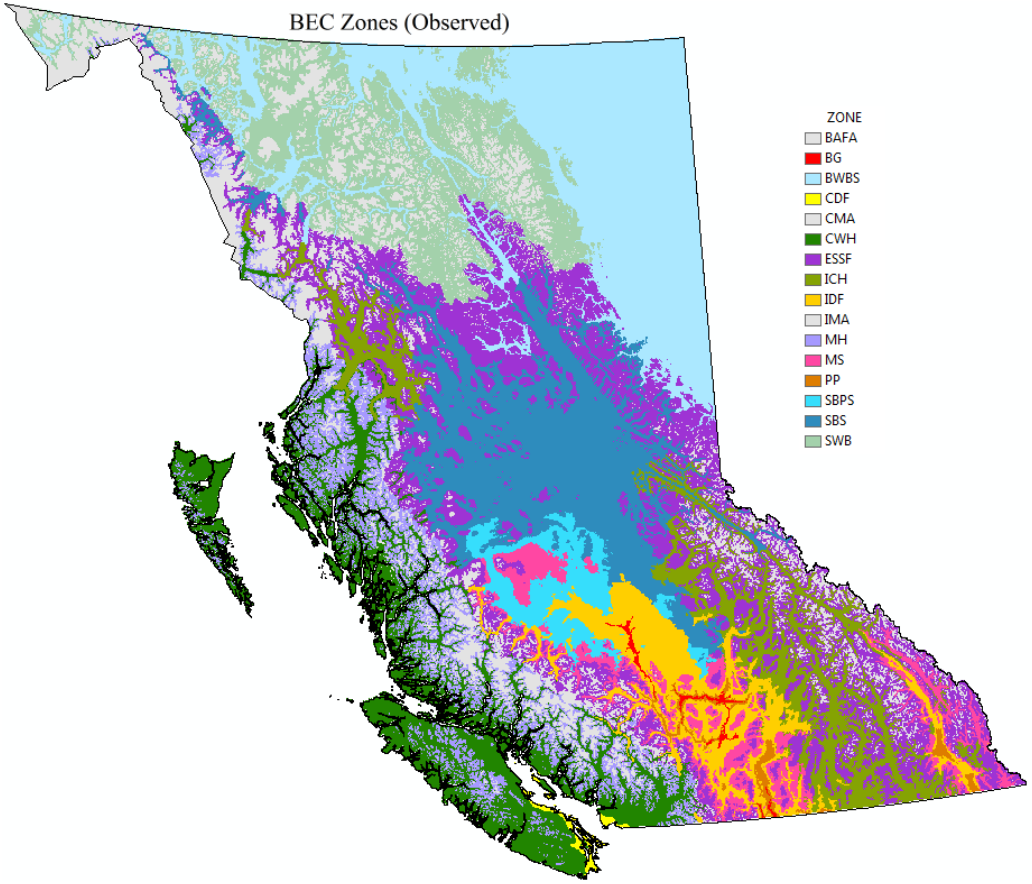
Mismatches will occur in two dimensions



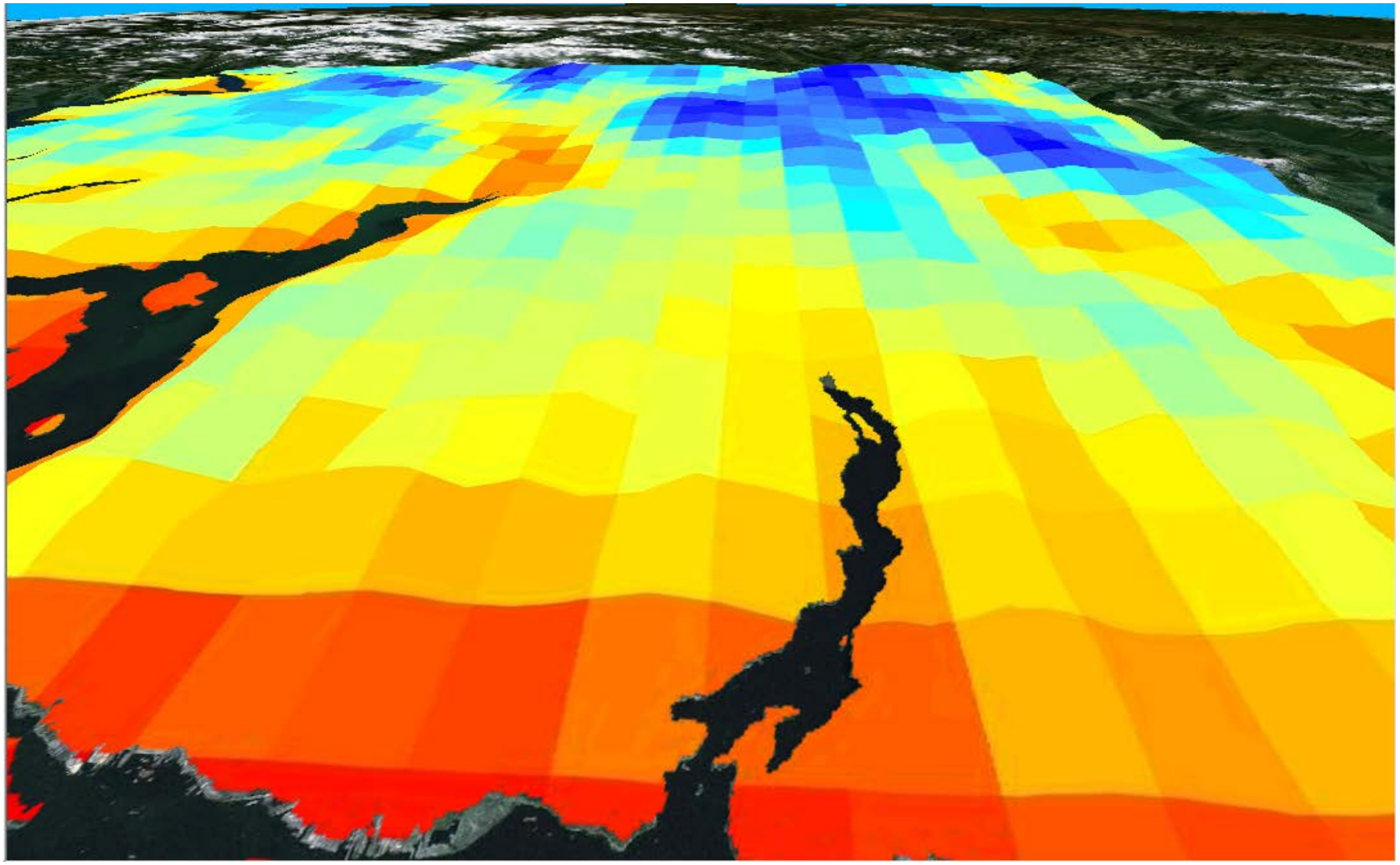
We need to help trees to match their favorable climate conditions in the two dimensions under a changing climate


cold
Climatic gradient
warm
Future climatic niche distribution
Current climatic niche distribution
Natural population responses
Natural migration from leading edge
Adaptation over generations using standing variation and gene flow
Lagging edge population extirpation
Conservation and assistant migration
Assistant migration
In situ conservation and Assistant migration
ex situ conservation and introduction of new species

We started with predicting BEC instead of individual species

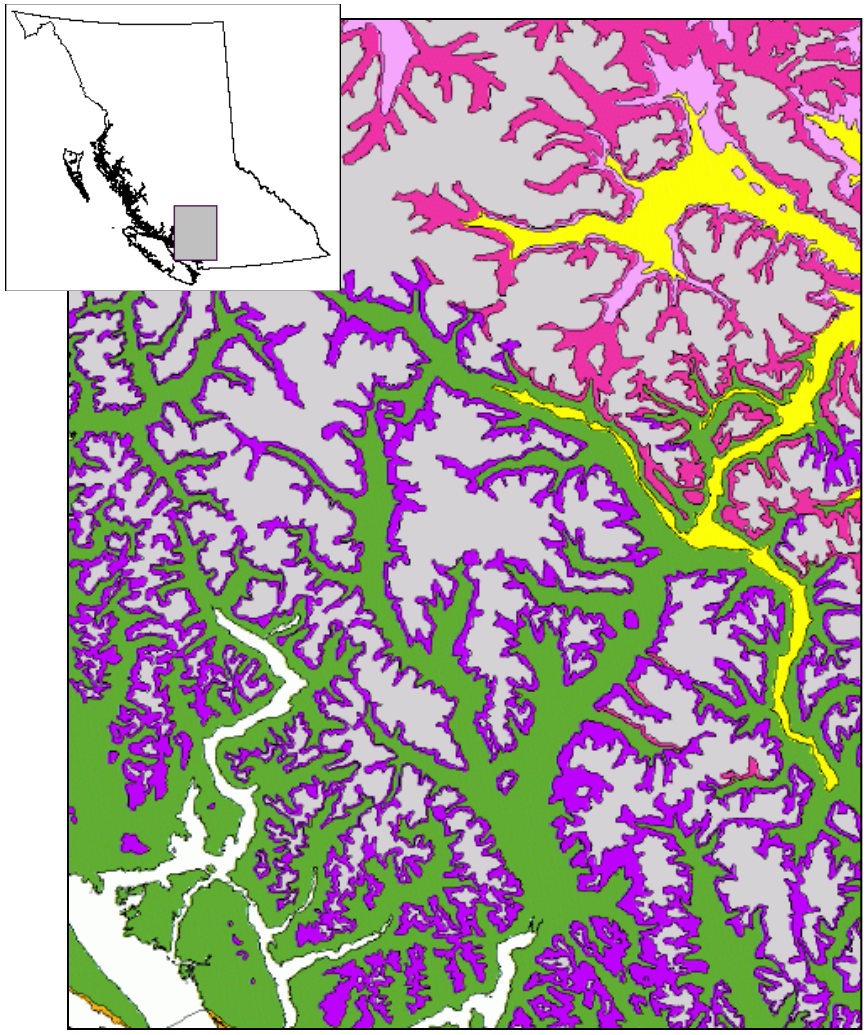


Mean Annual Temperature (MAT) by PRISM (4 x 4 km)

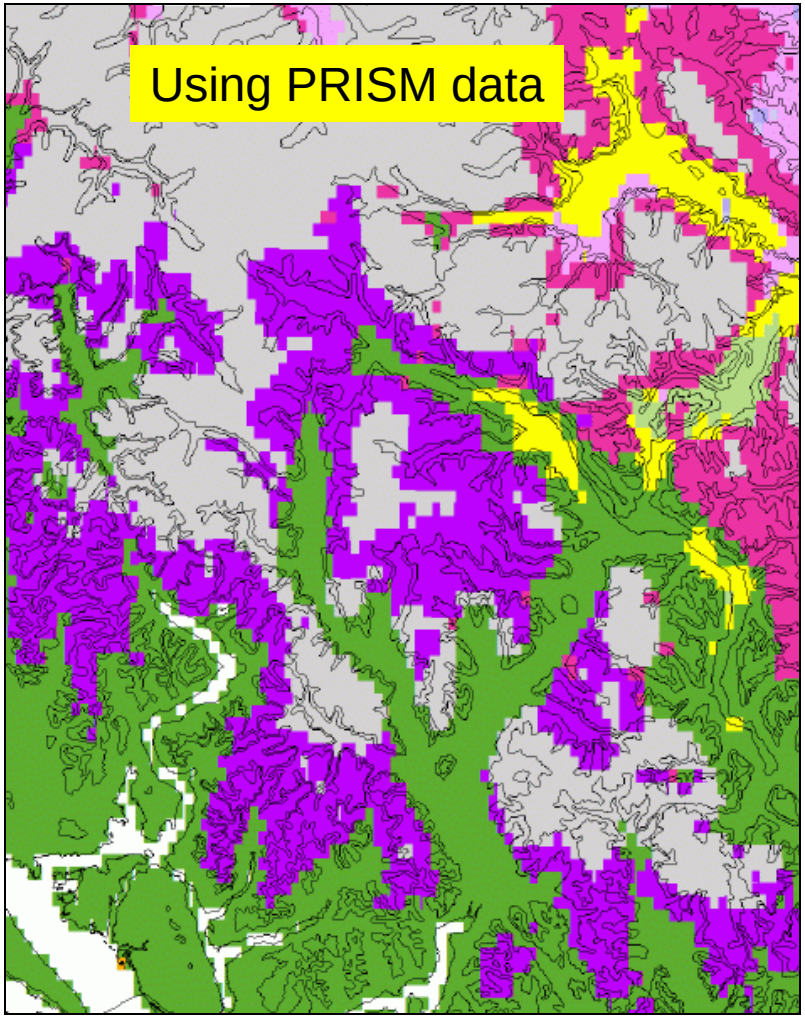


A mountain area near North Vancouver

PRISM climate data was used for climatic mapping of Biogeoclimatic Ecological Classification (BEC) zones



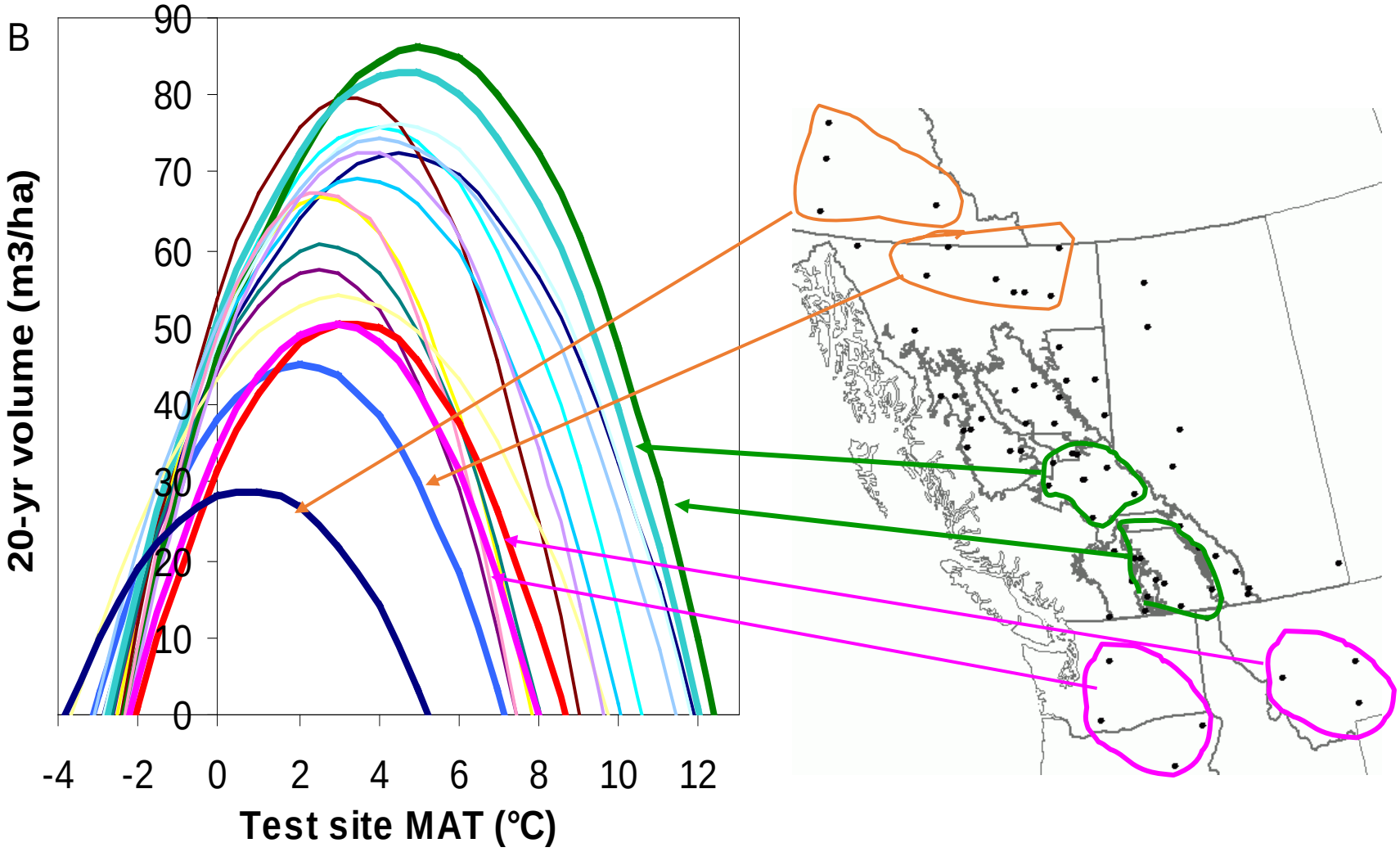
Observed



Predicted

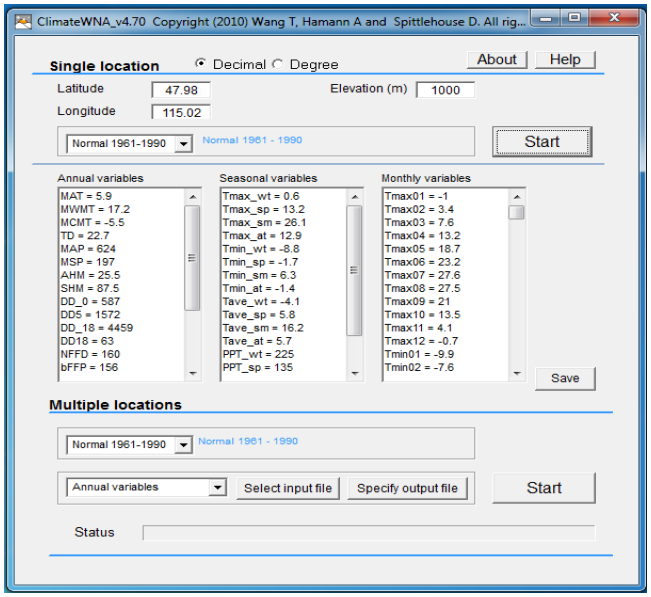
Source: Hamann & Wang. 2005. *Agricultural and Forest Meteorology* **128**: 211-221

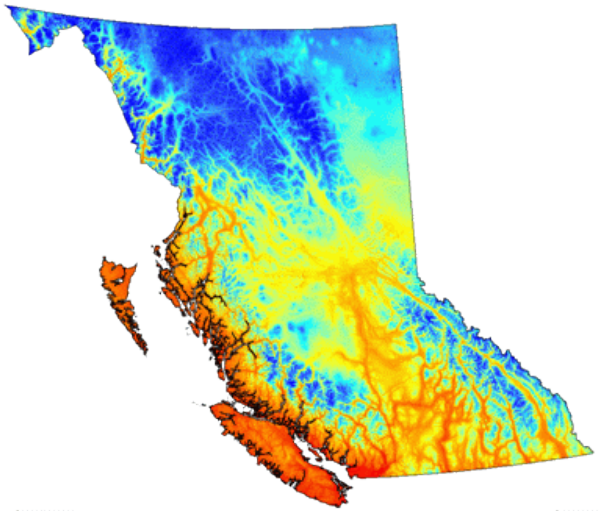
Variation in response of lodgepole pine populations to climate change

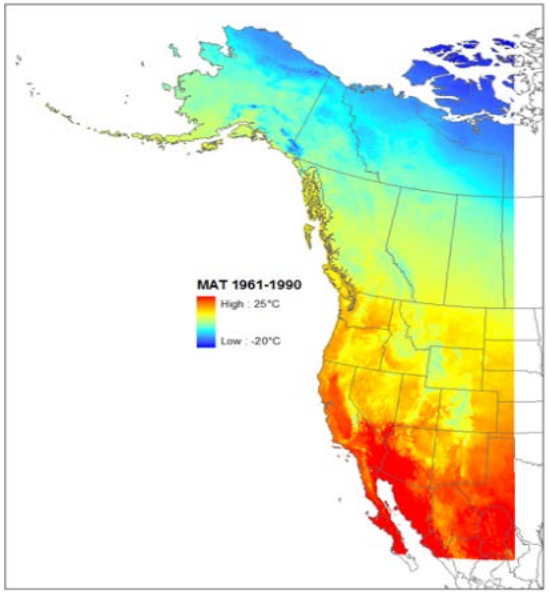


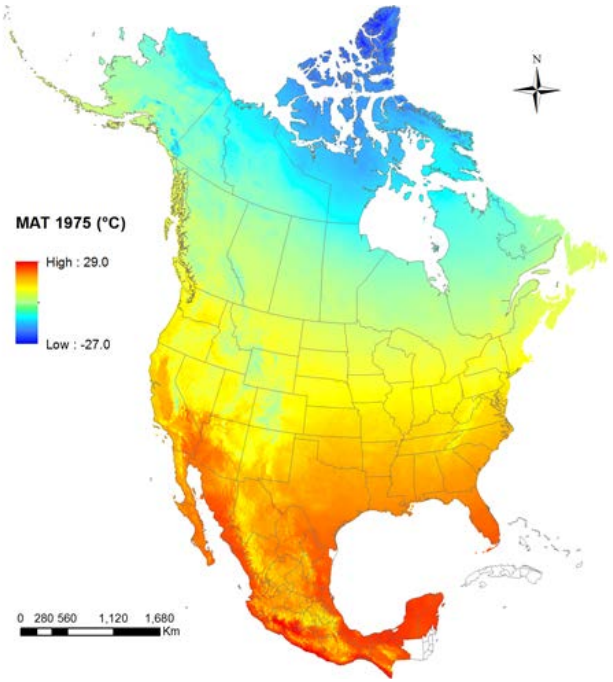
Wang et al. 2006. Global change Biology

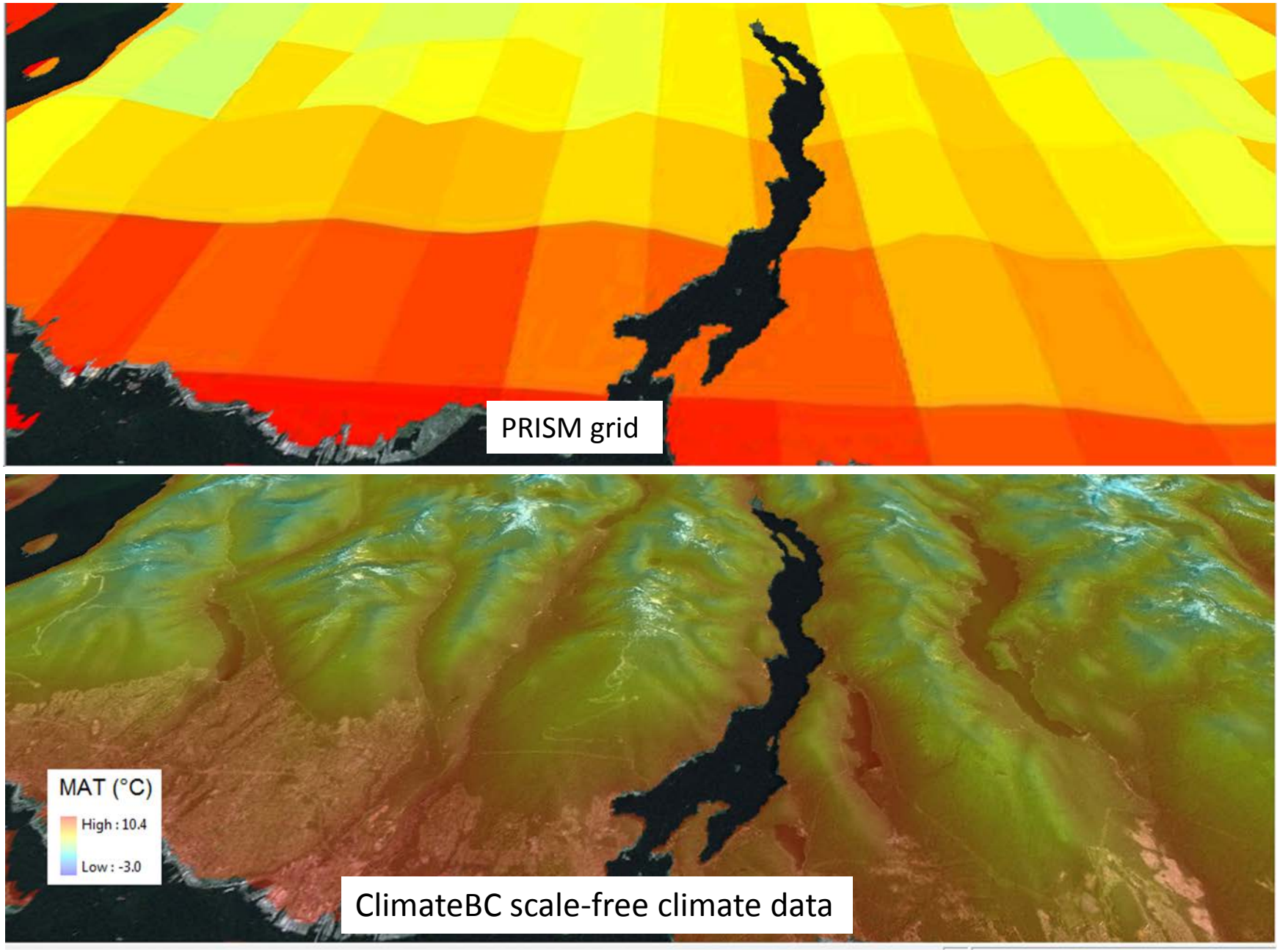
ClimateBC/WNA/NA



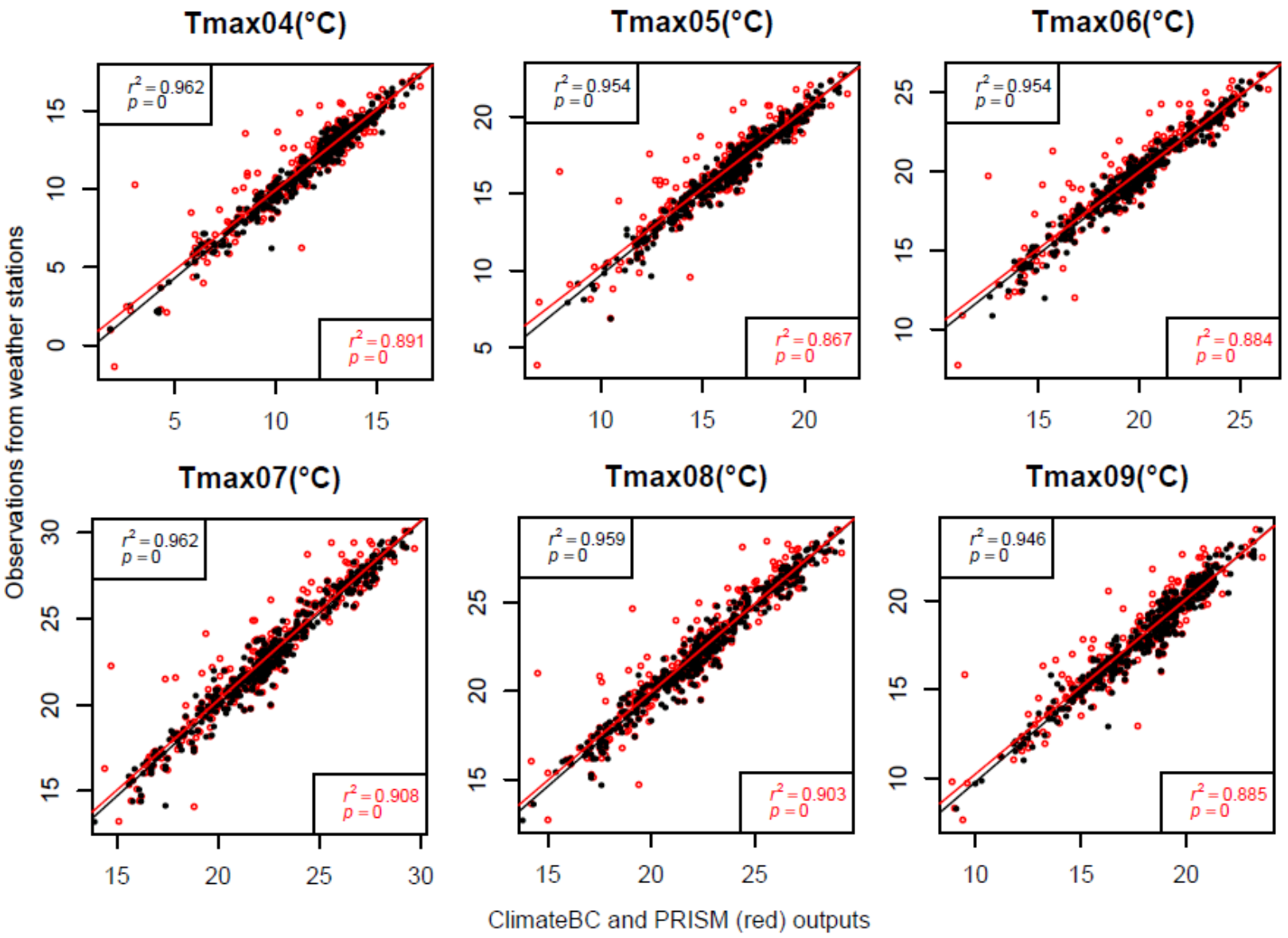




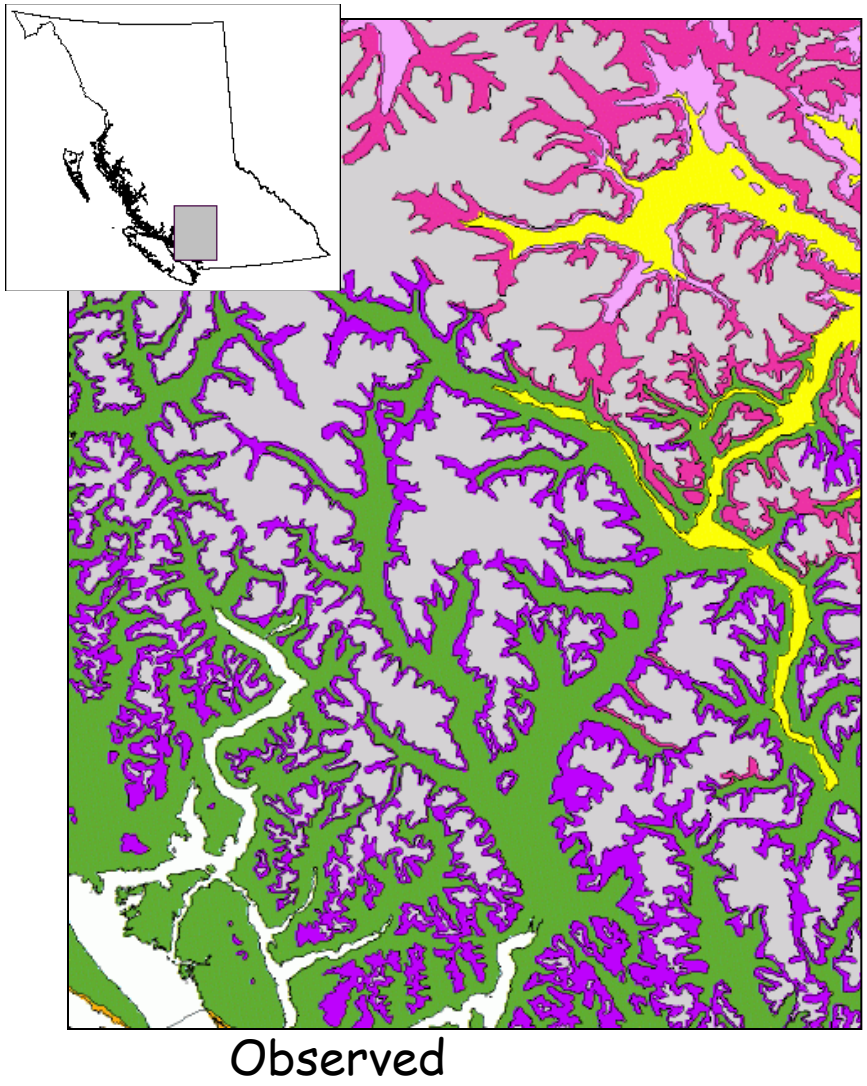



PRISM grid
MAT (°C)
High : 10.4
Low : -3.0
ClimateBC scale-free climate data

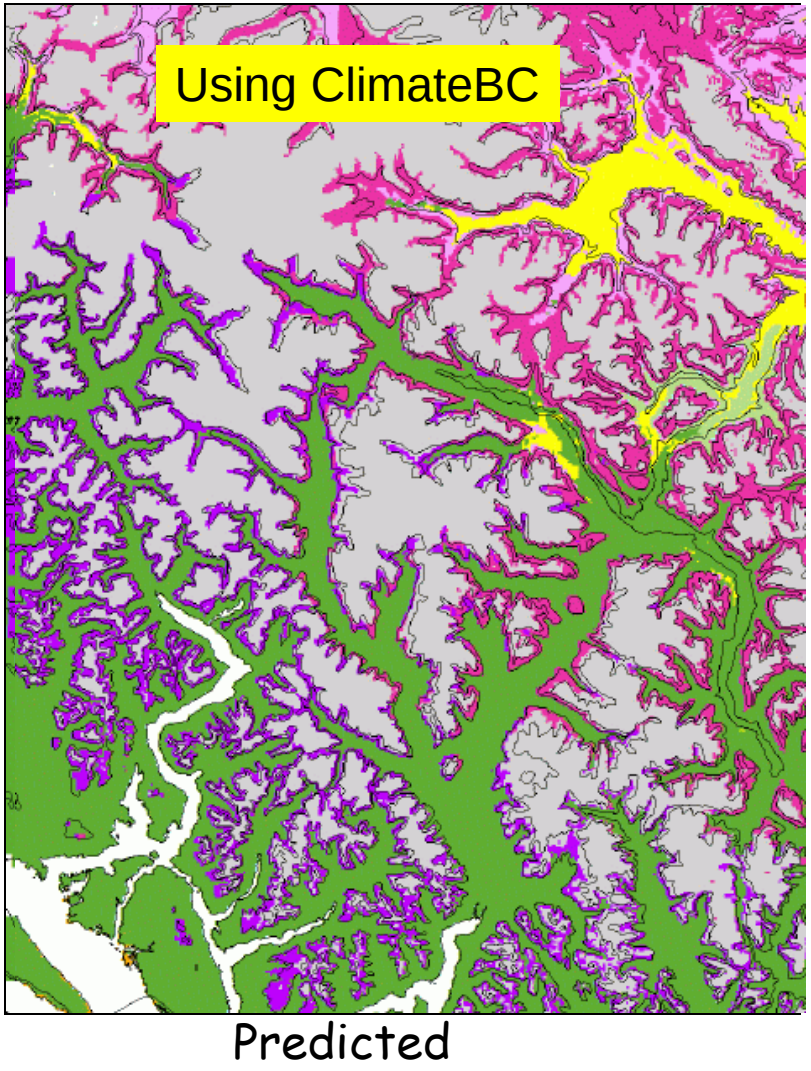
PRISM (800m) vs. ClimateBC (scale-free)



ClimateBC improves climatic mapping of the BEC zones



Observed

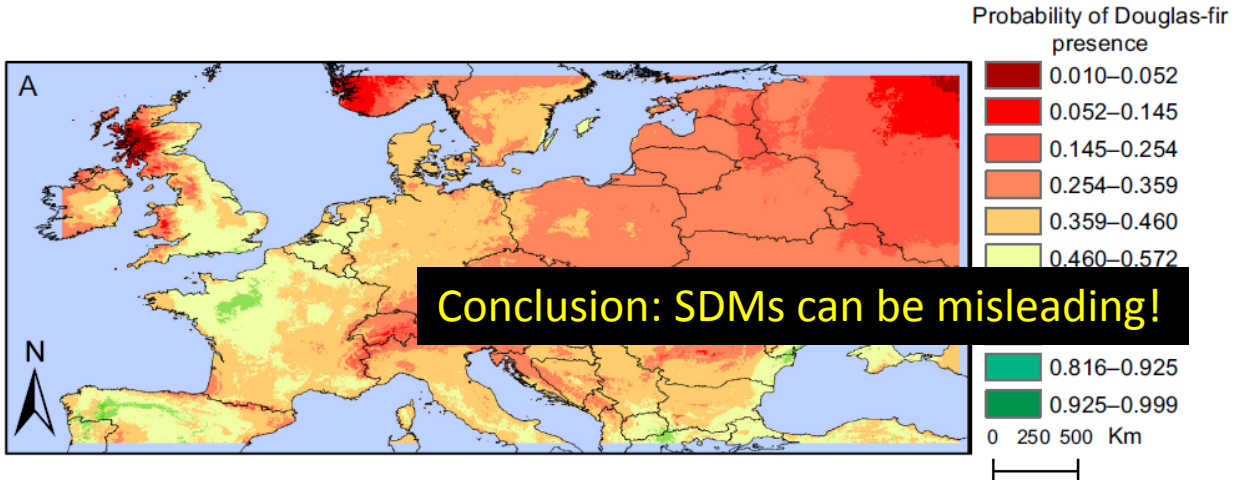


Predicted

Source: Hamann & Wang. 2005. *Agricultural and Forest Meteorology* **128**: 211-221

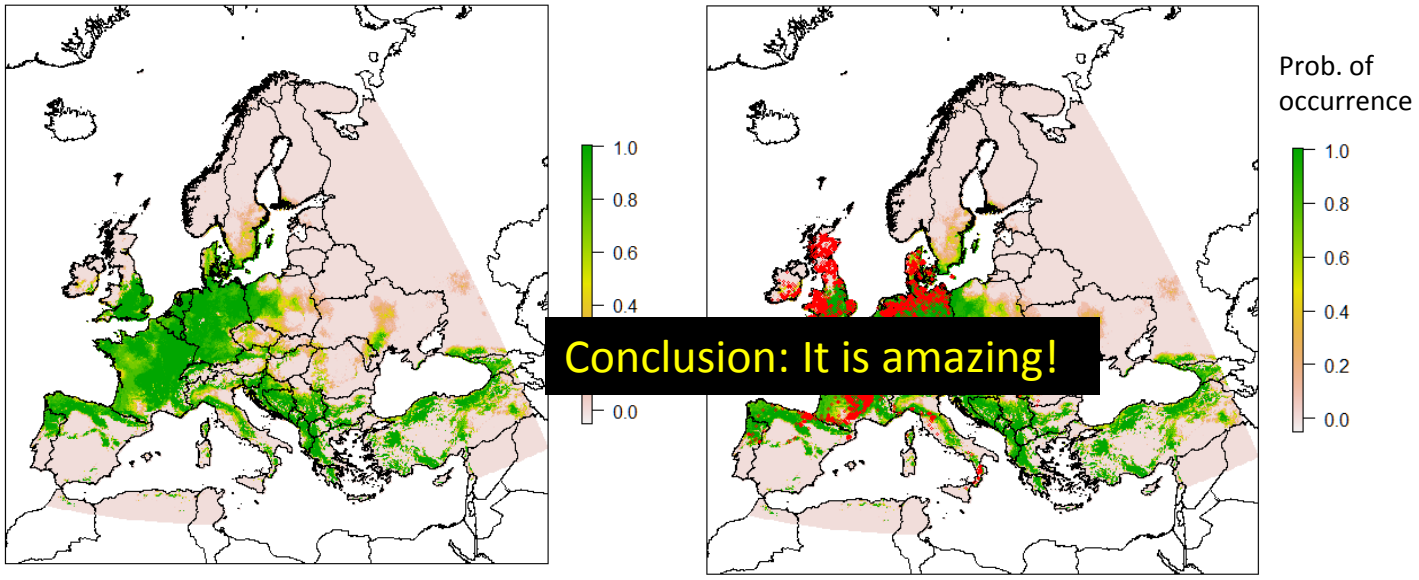
Predictions based on poor climate data can be misleading

Boiffin et al. (2017)



Conclusion: SDMs can be misleading!

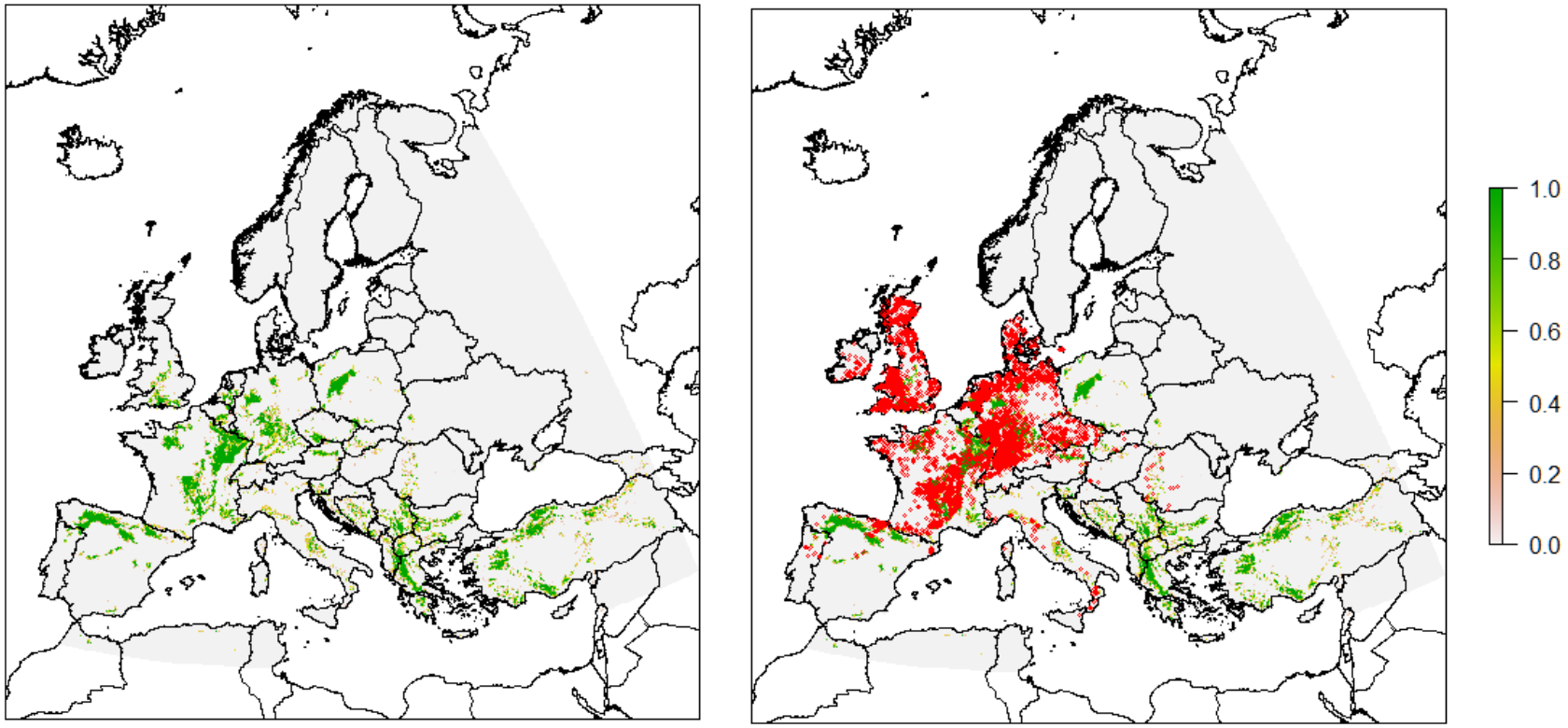
Our results



Conclusion: It is amazing!

Accuracy = 88%

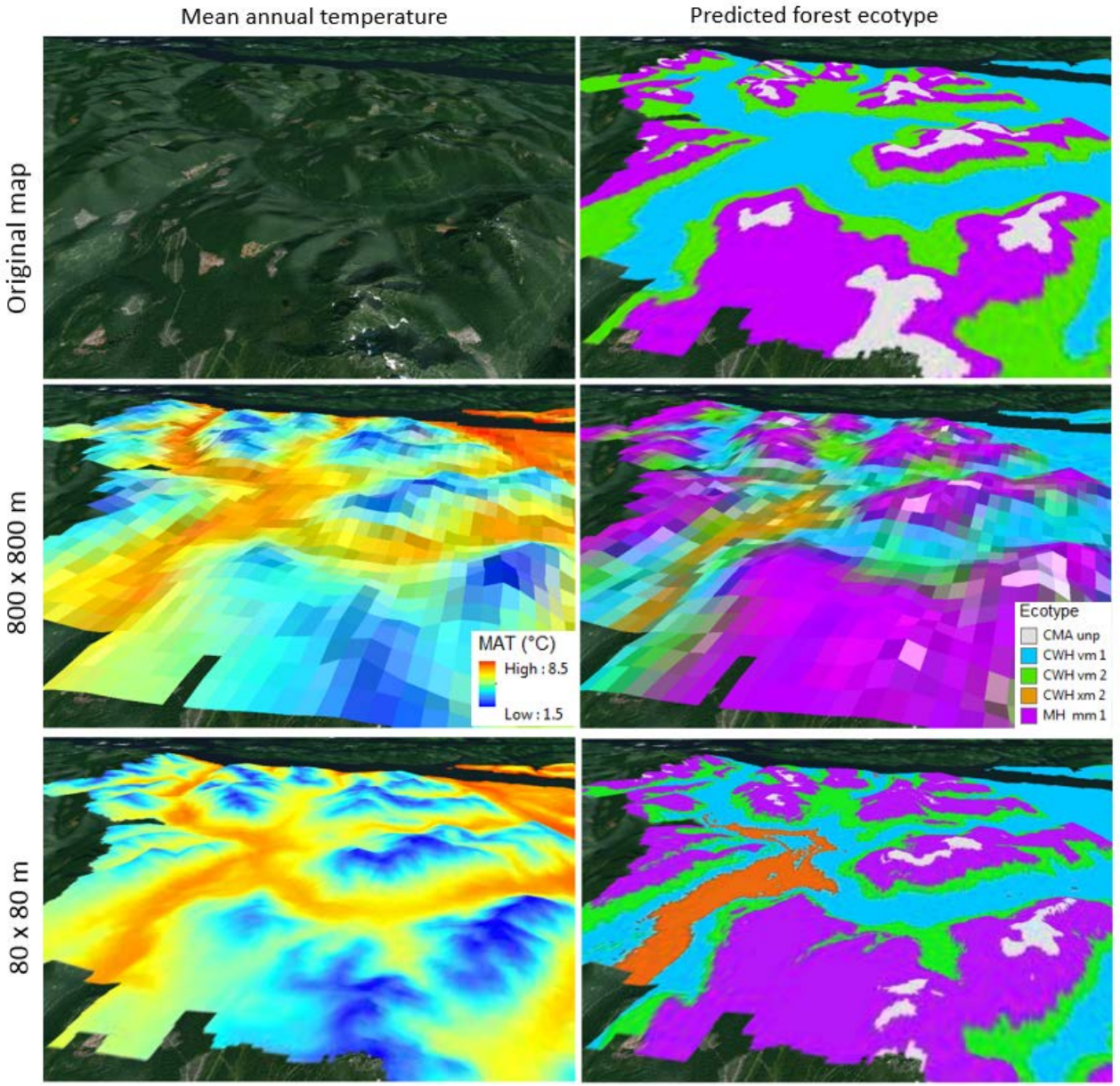
Climate data:
scale-free → 4x4 gridded as used in Boiffin (2017)



Accuracy: 88% → 20%

Features of ClimateBC

1. Generate climate data at any spatial resolution



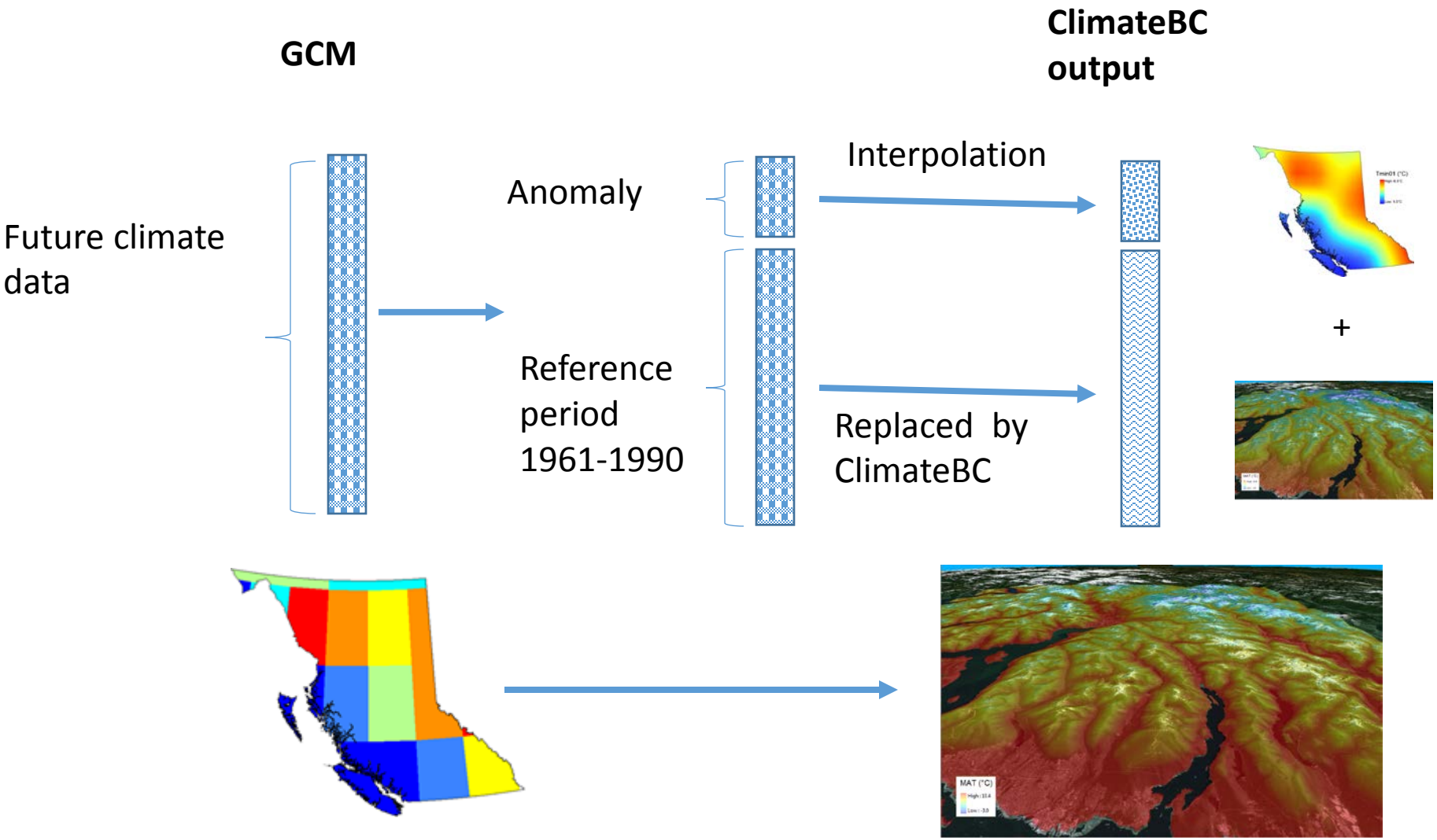
2. Produce many calculated and derived climate variables

- Primary climate variables
  - Monthly Tmax, Tmin and Prec
- Calculate climate variables
  - Temperatures: MAT, MWMT, MCMT, TD,
  - Precipitation: MAP and MSP
  - Dryness: AHM and SHM
- Derived climate variables
  - Degree-days: DD<0°C, DD>5°C, DD<18°C and DD>18°C
  - Frost: NFFD, FFP, bFFP, eFFP
  - Dryness: Eref, CMD, RH
  - Snow: PAS

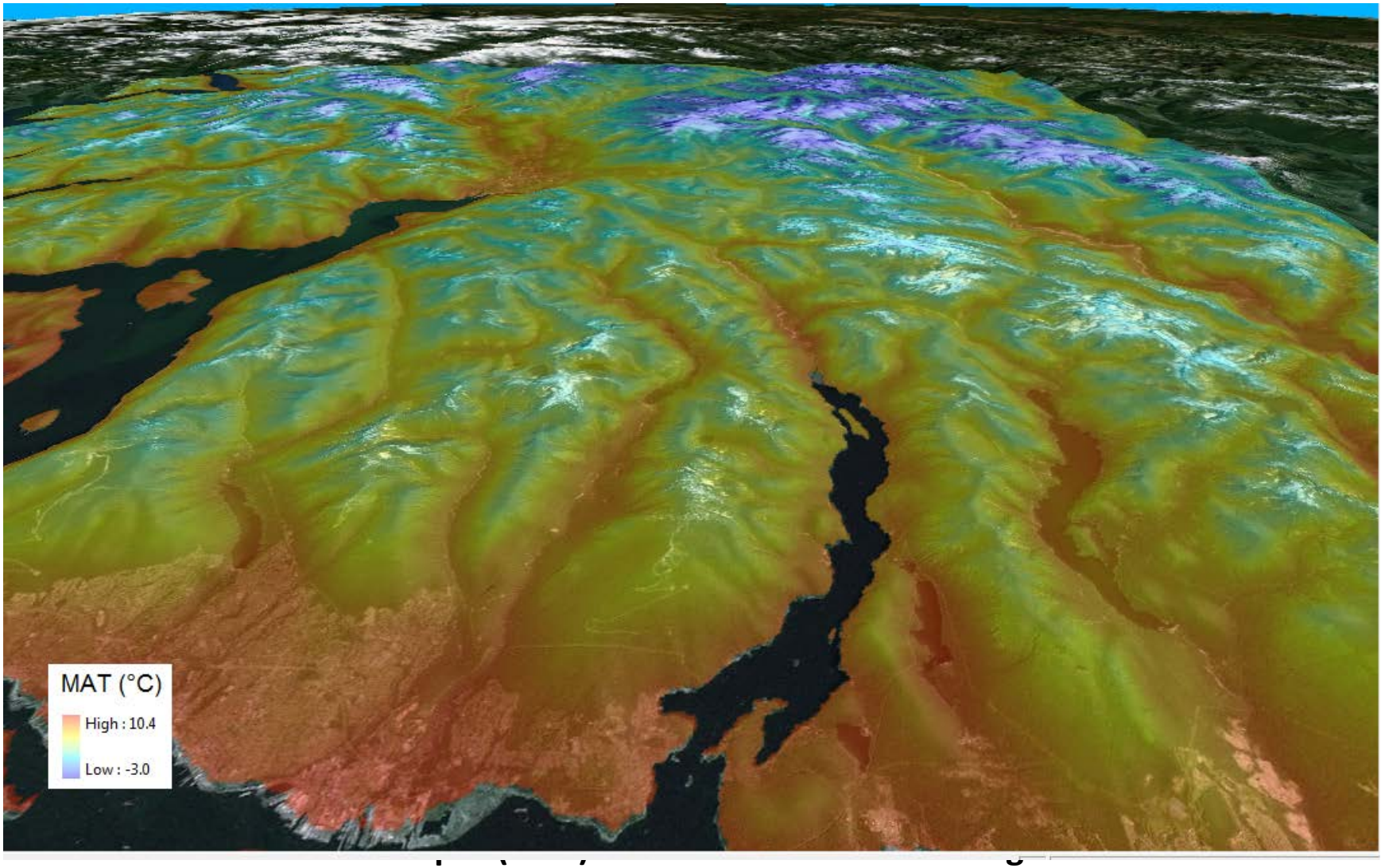
3. Integrate and downscale historical and future climate data

- Historical: 1901 – 2017
- Future: 2011 – 2100
- Paleo: down to 21,000 years ago

Downscaling future climate data to scale-free

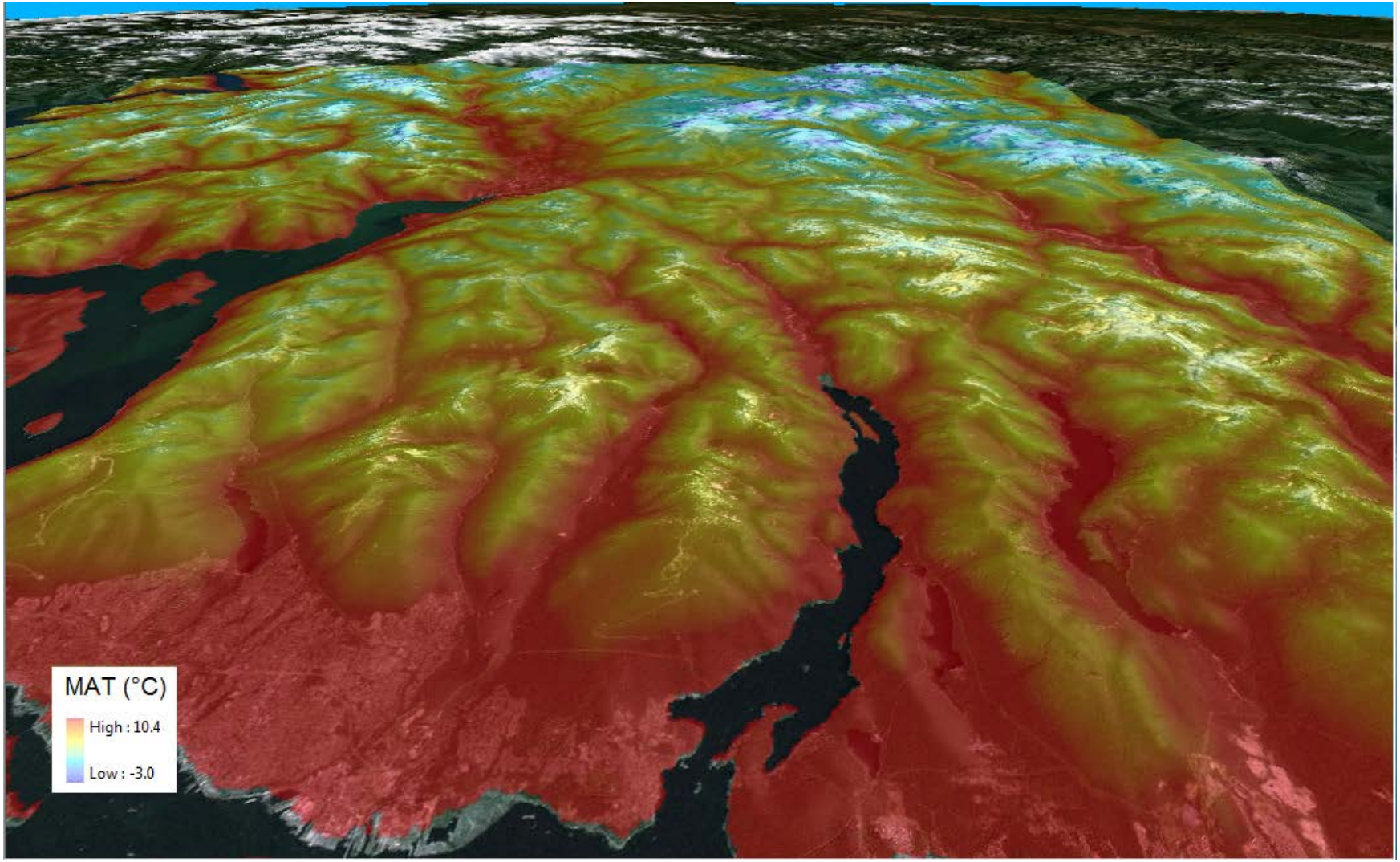


Scale-free MAT by ClimateWNA



A mountain area near North Vancouver

GCM changes added onto the baseline data



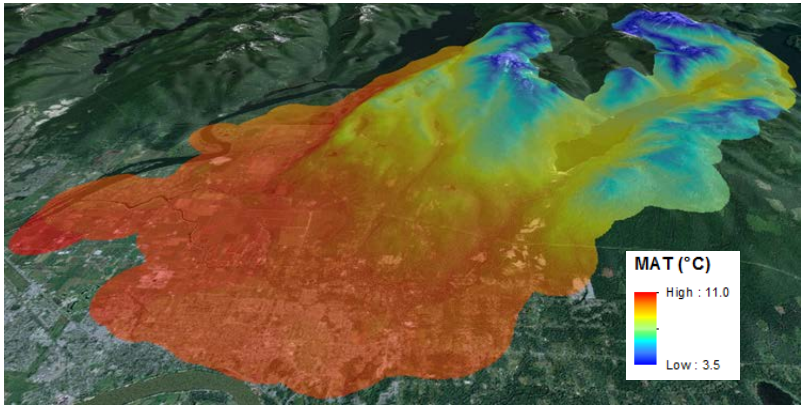
ClimateWNA output (90m) overlaid on a satellite image (CGCM2 A2_2050s)

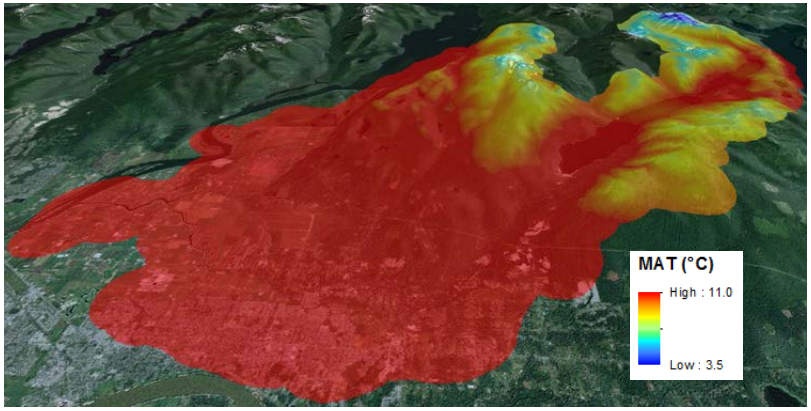
It facilitates predictions for management unit

Current

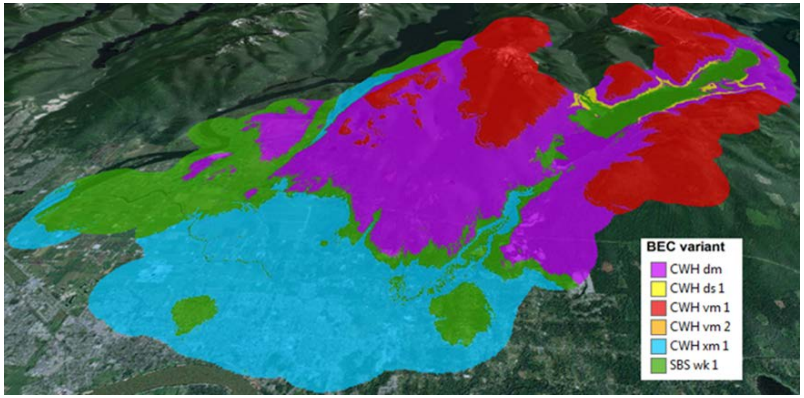
Future (2050s)

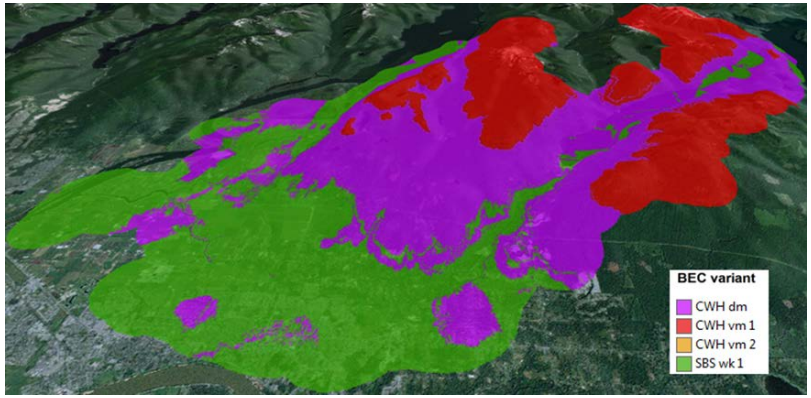
Climate





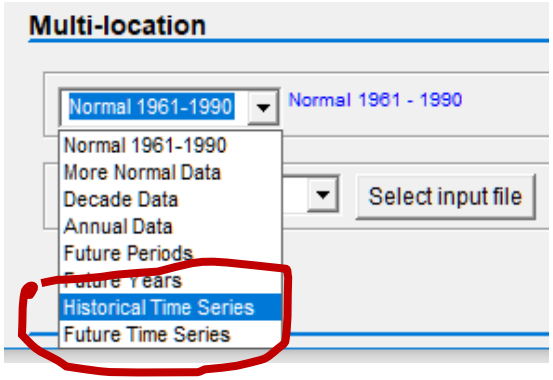
Ecosystems

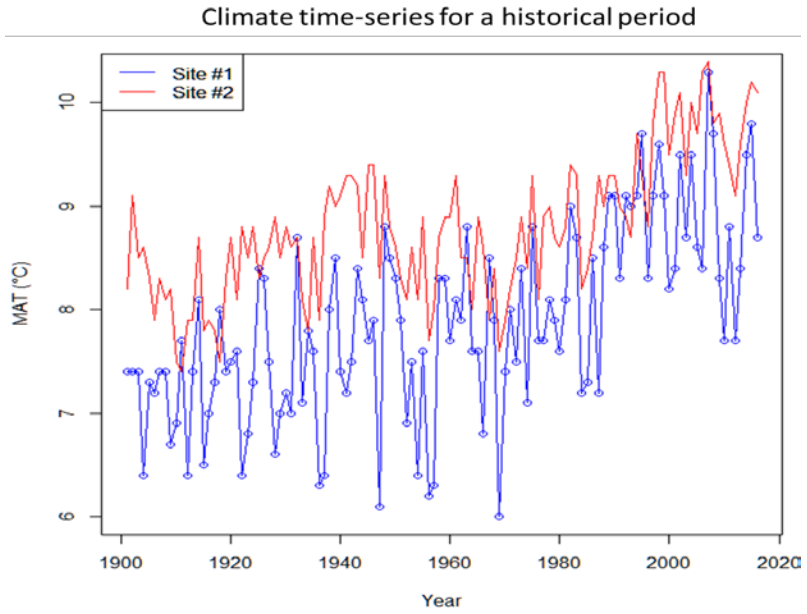


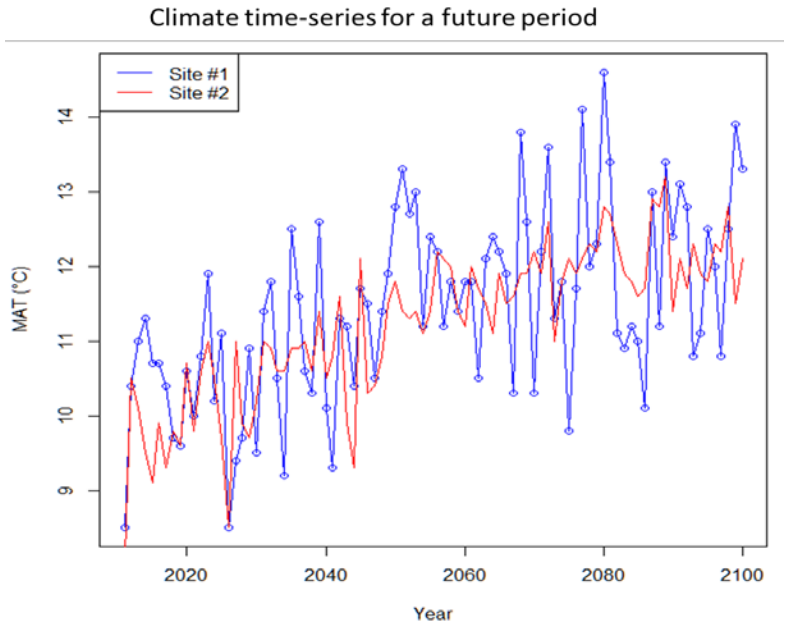


UBC Research Forest (25 x 25 m)

4. Time-series functions

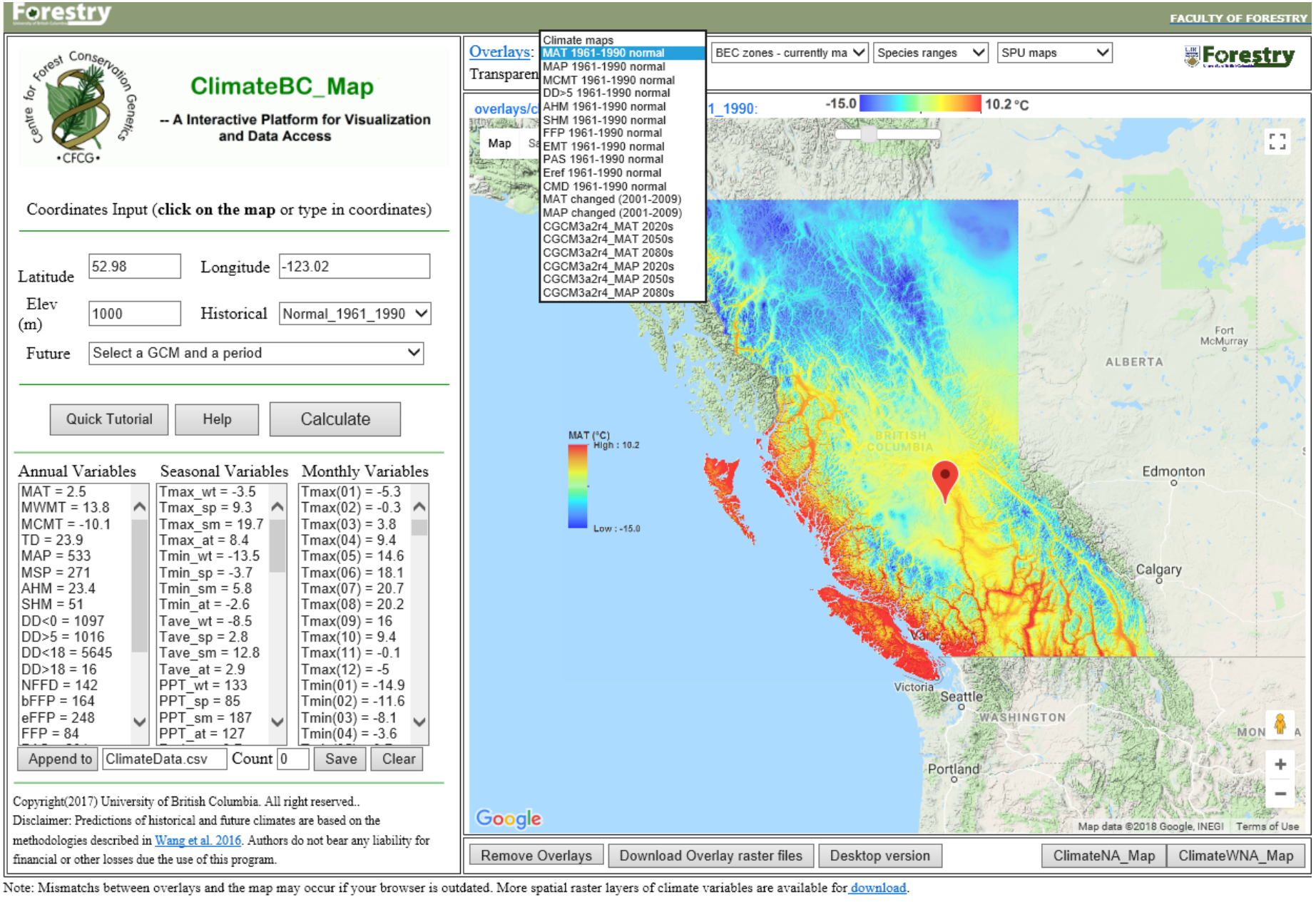




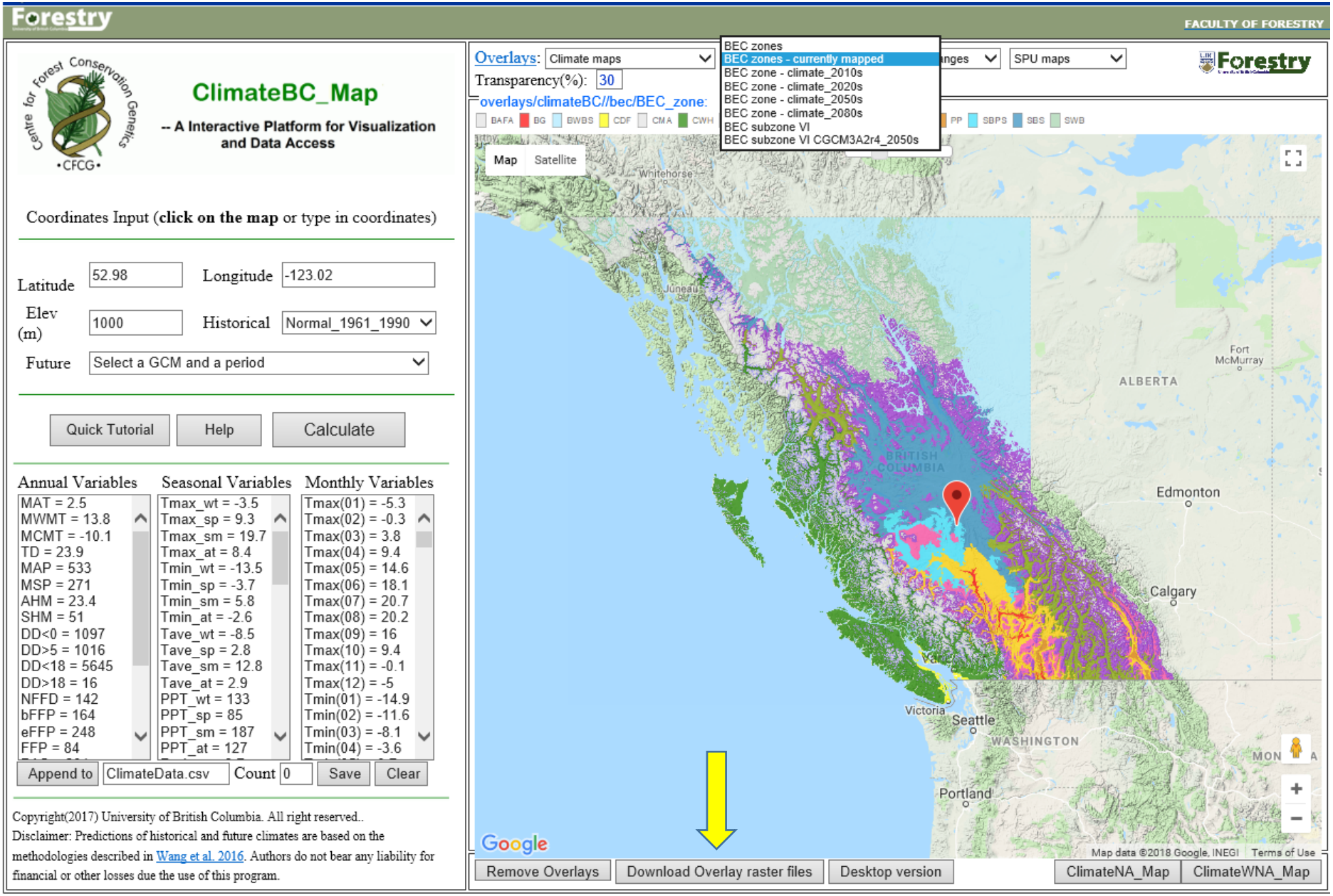


5. A platform for data spatial visualization and download

→ Browser



Note: Mismatchs between overlays and the map may occur if your browser is outdated. More spatial raster layers of climate variables are available for download.



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Forestry

FACULTY OF FORESTRY

Centre for Forest Conservation Genetics •CFCG•

ClimateBC_Map

-- A Interactive Platform for Visualization and Data Access

Coordinates Input (**click on the map** or type in coordinates)

Latitude 52.98 Longitude -123.02

Elev (m) 1000 Historical Normal_1961_1990

Future Select a GCM and a period

Quick Tutorial | Help | Calculate

Annual Variables	Seasonal Variables	Monthly Variables
MAT = 2.5	Tmax_wt = -3.5	Tmax(01) = -5.3
MWMT = 13.8	Tmax_sp = 9.3	Tmax(02) = -0.3
MCMT = -10.1	Tmax_sm = 19.7	Tmax(03) = 3.8
TD = 23.9	Tmax_at = 8.4	Tmax(04) = 9.4
MAP = 533	Tmin_wt = -13.5	Tmax(05) = 14.6
MSP = 271	Tmin_sp = -3.7	Tmax(06) = 18.1
AHM = 23.4	Tmin_sm = 5.8	Tmax(07) = 20.7
SHM = 51	Tmin_at = -2.6	Tmax(08) = 20.2
DD<0 = 1097	Tave_wt = -8.5	Tmax(09) = 16
DD>5 = 1016	Tave_sp = 2.8	Tmax(10) = 9.4
DD<18 = 5645	Tave_sm = 12.8	Tmax(11) = -0.1
DD>18 = 16	Tave_at = 2.9	Tmax(12) = -5
NFFD = 142	PPT_wt = 133	Tmin(01) = -14.9
bFFP = 164	PPT_sp = 85	Tmin(02) = -11.6
eFFP = 248	PPT_sm = 187	Tmin(03) = -8.1
FFP = 84	PPT_at = 127	Tmin(04) = -3.6

Append to ClimateData.csv Count 0 Save Clear

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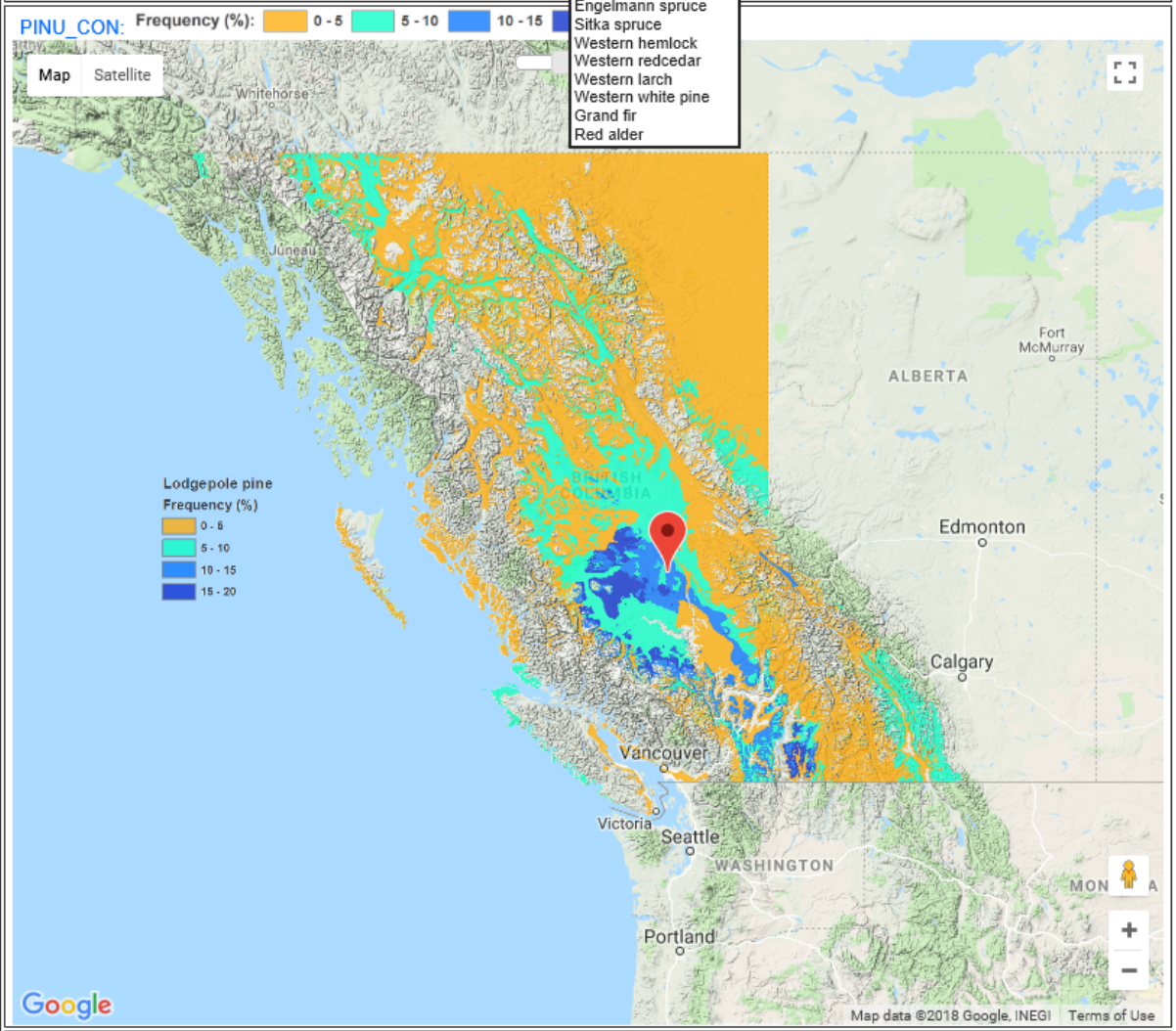
Disclaimer: Predictions of historical and future climates are based on the methodologies described in Wang et al. 2016. Authors do not bear any liability for financial or other losses due the use of this program.

Overlays: MAT 1961-1990 normal | BEC zones - currently ma | SPU maps

Transparency(%): 30

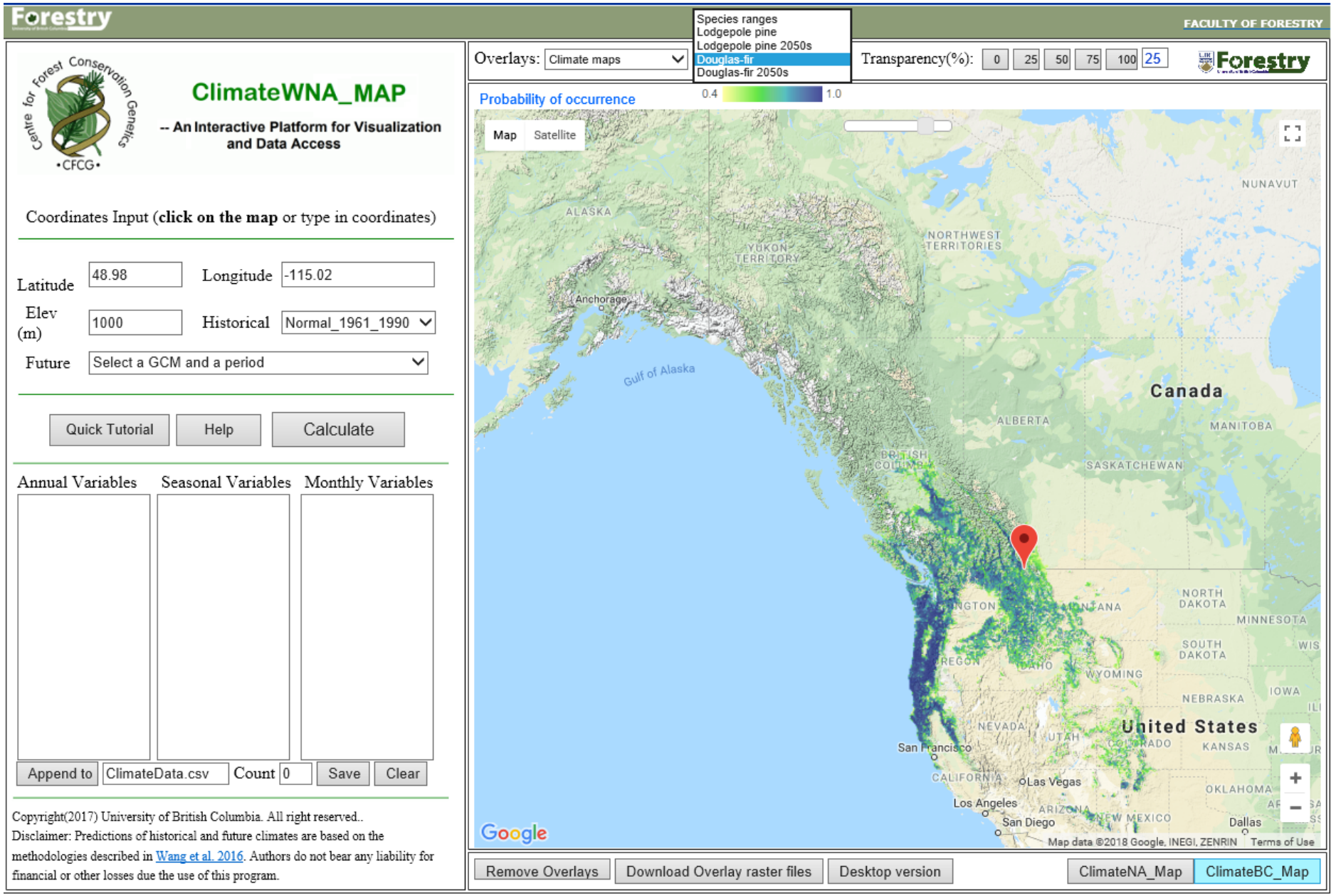
Species ranges
Lodgepole pine
Douglas-fir
White spruce
Engelmann spruce
Sitka spruce
Western hemlock
Western redcedar
Western larch
Western white pine
Grand fir
Red alder

PINU_CON: Frequency (%): 0 - 5 | 5 - 10 | 10 - 15



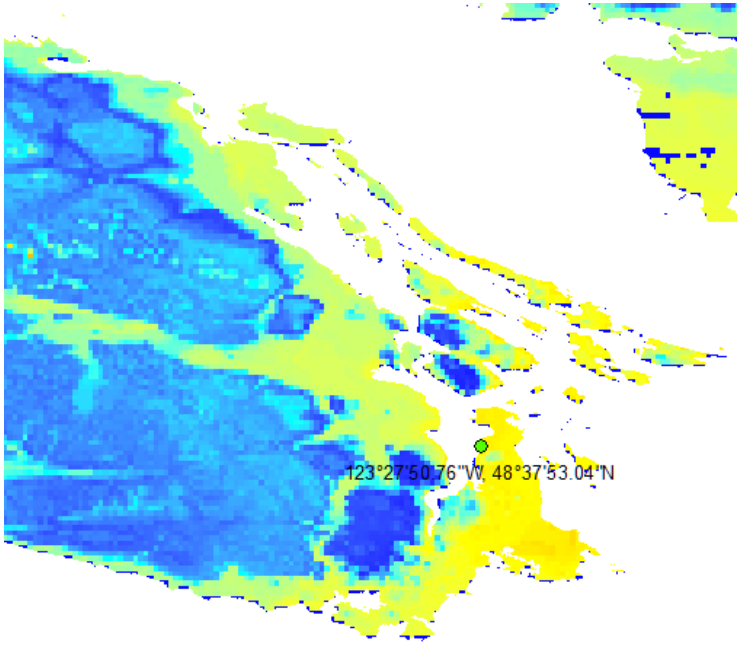
Remove Overlays | Download Overlay raster files | Desktop version | ClimateNA_Map | ClimateWNA_Map

Note: Mismatchs between overlays and the map may occur if your browser is outdated. More spatial raster layers of climate variables are available for download.



Note: Mismatchs between overlays and the map may occur if your browser is outdated.

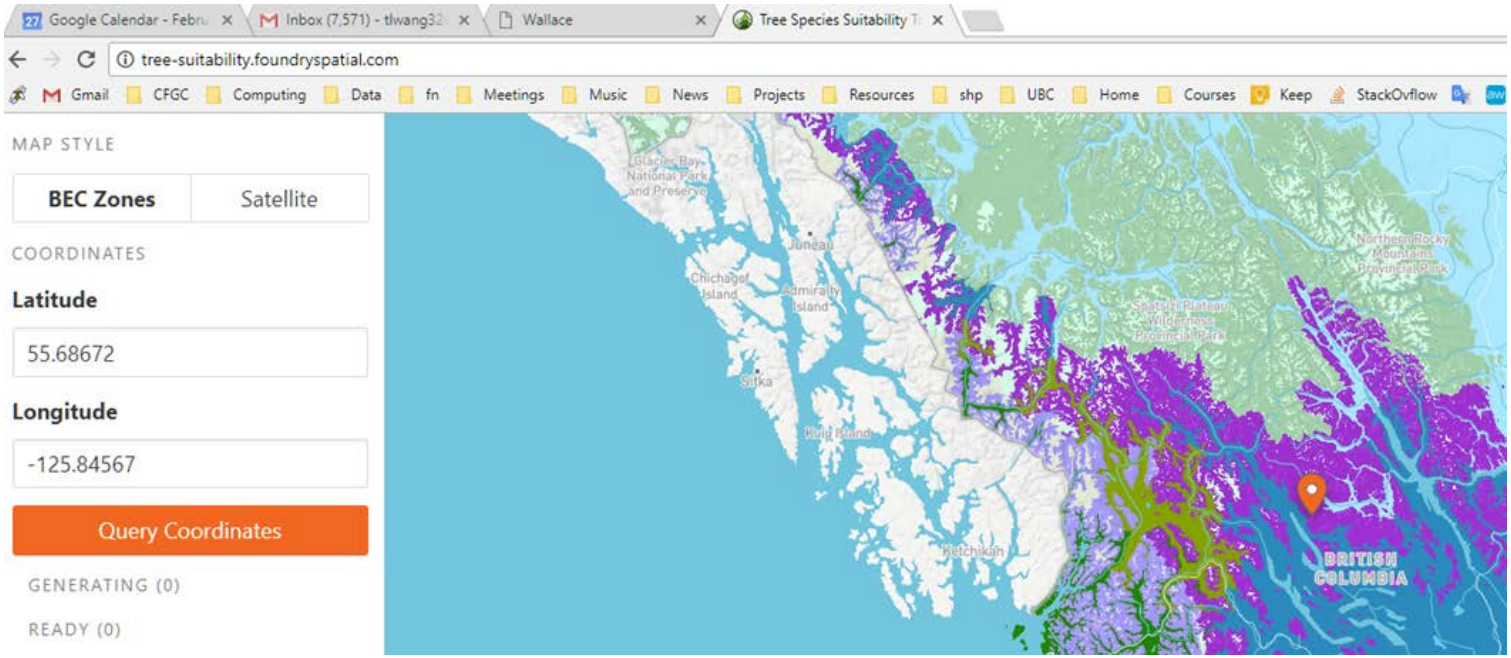
1961-1990 (PO=0.83)



2020s (PO=0.32)

New developments - ClimateBC API

- To facilitate integration to other web-based applications

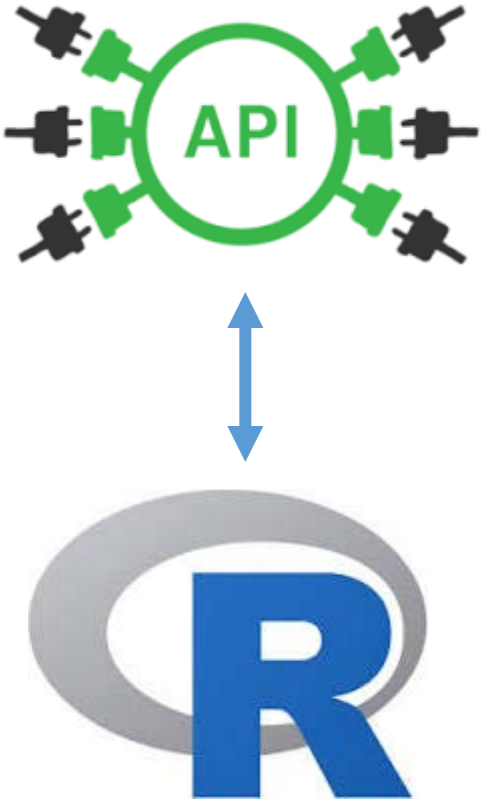


New developments - ClimateBC API

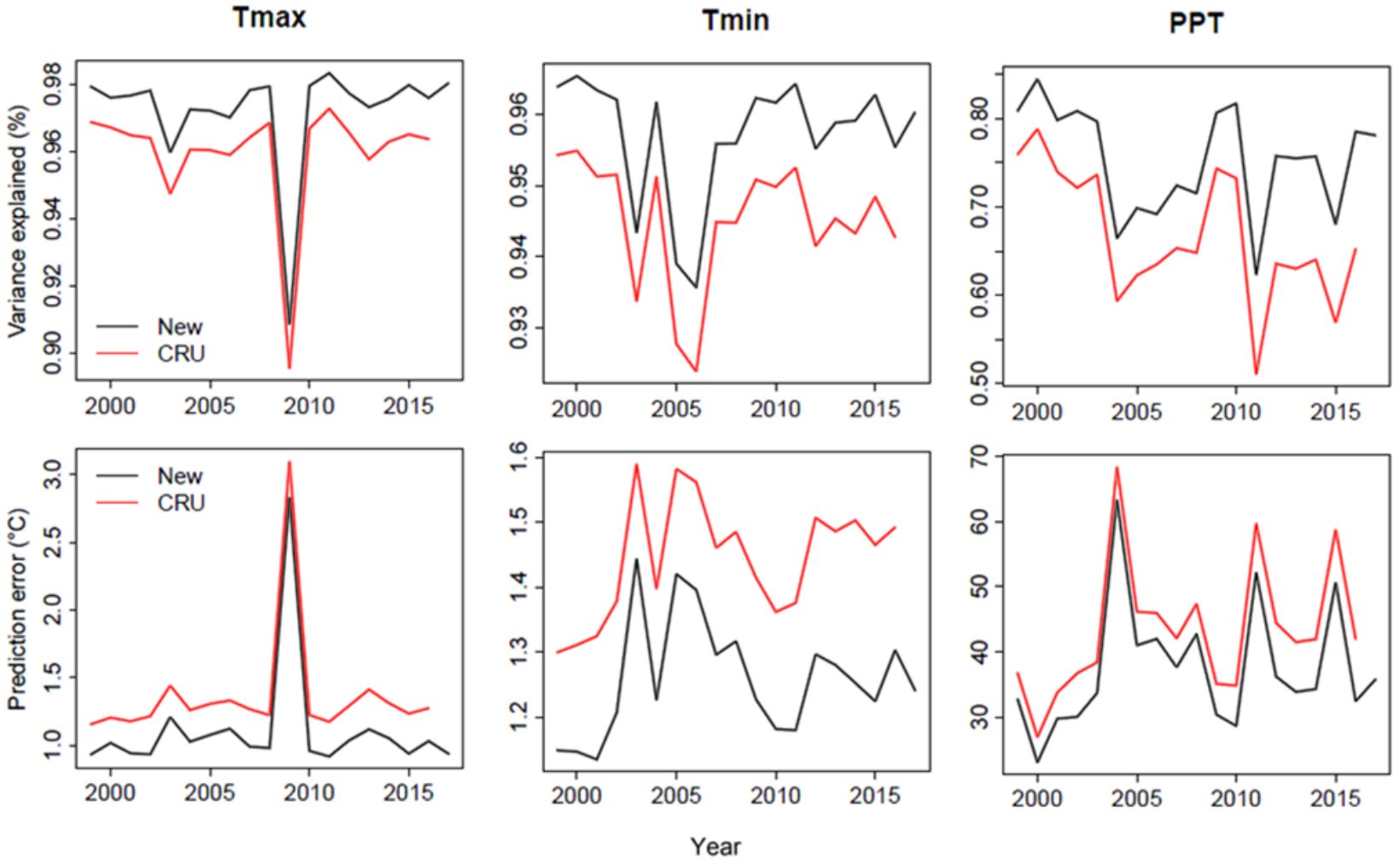
- To enable interactive integration with R environment

Almost all modeling works are using R!

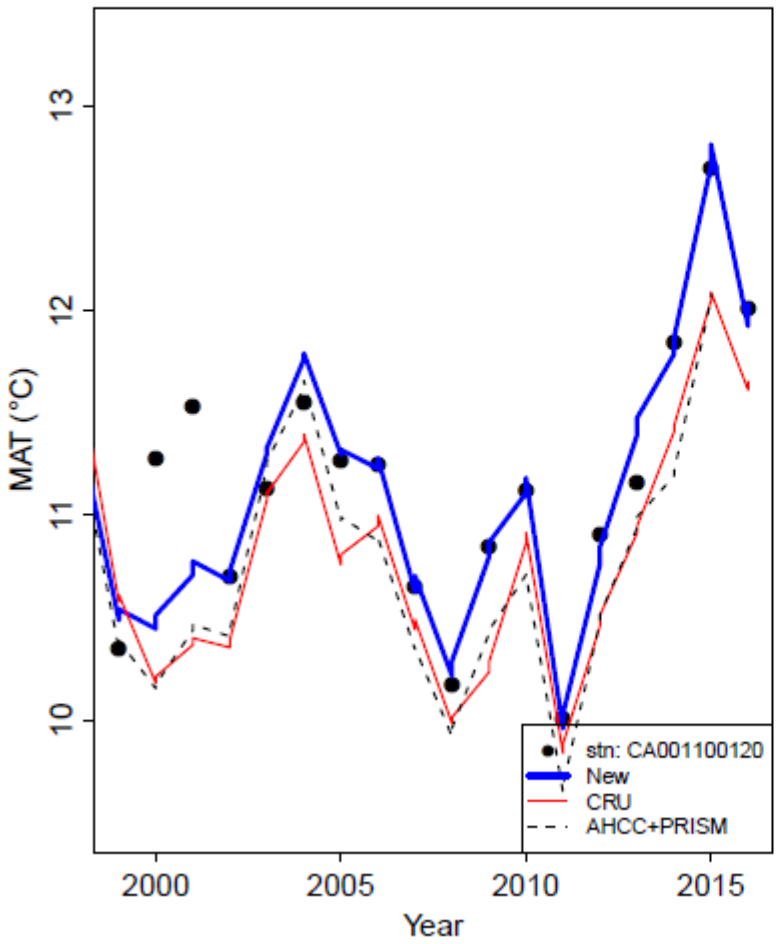
```
library(climatebcAPI)
clm <- climatebcAPI(x, ysm='Y', period="1996")
```

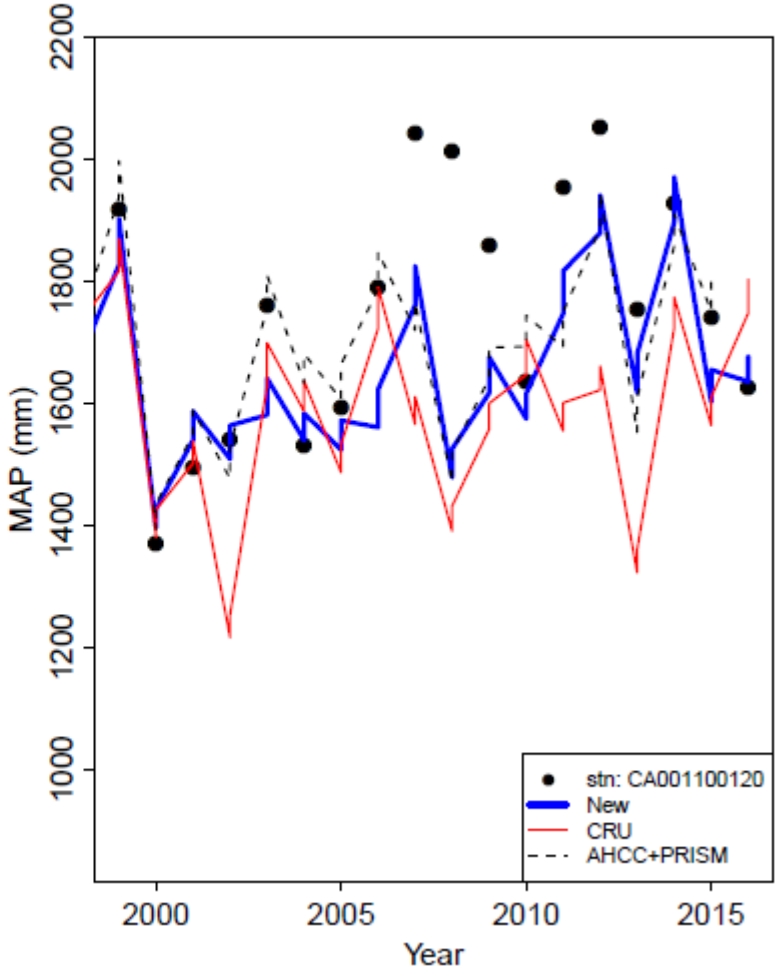


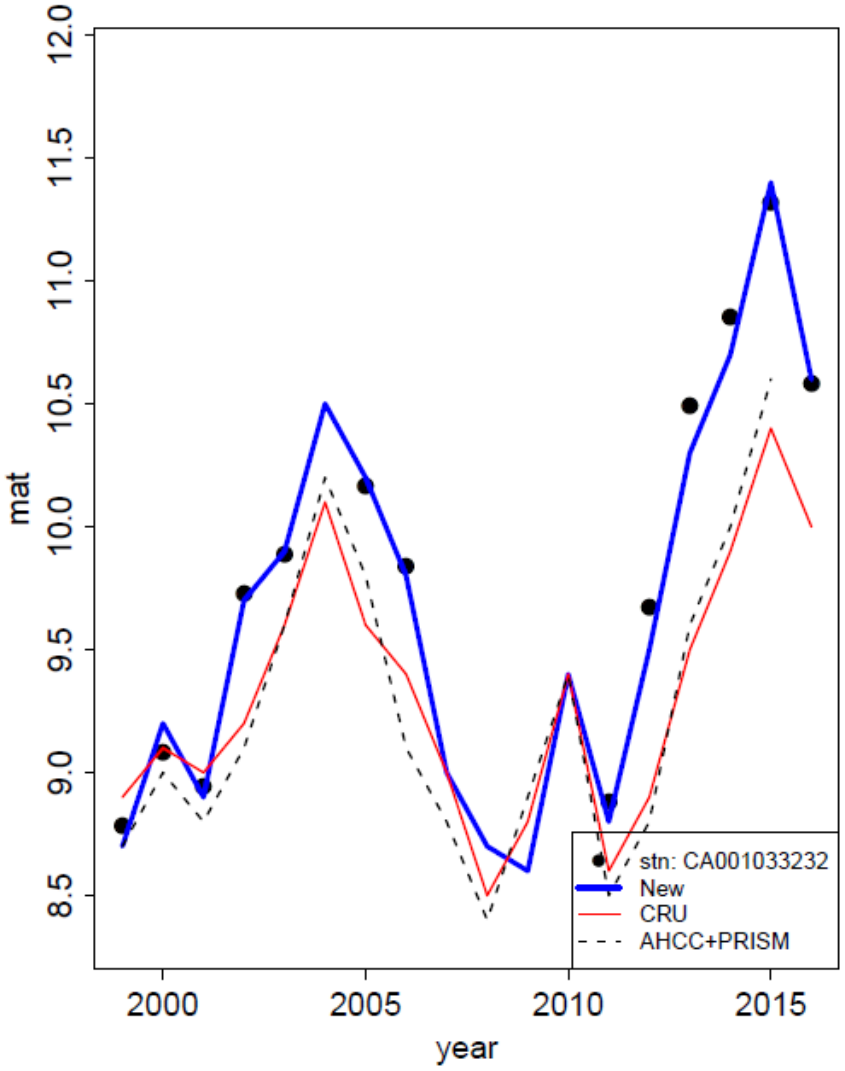
New developments – Replacing CRU monthly data for 1999 – 2017

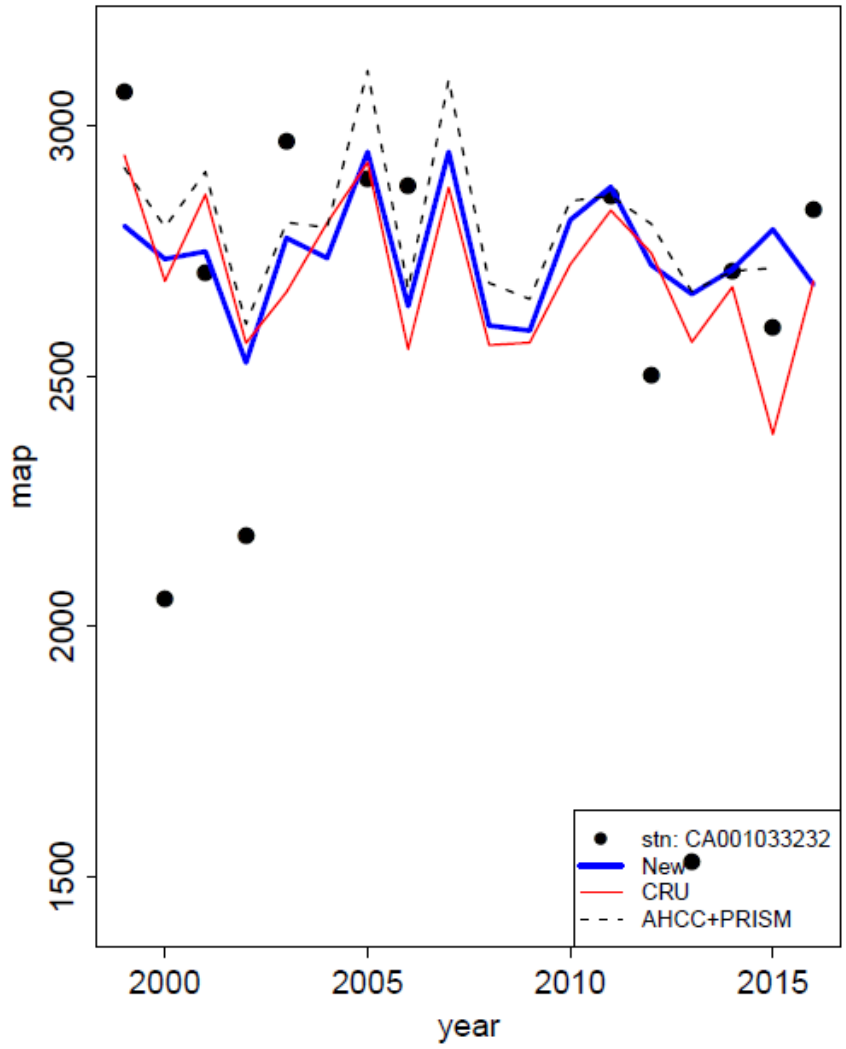


Comparisons in MAT and MAP by station and year






mat
year
stn: CA001033232
New
CRU
AHCC+PRISM


map
year
stn: CA001033232
New
CRU
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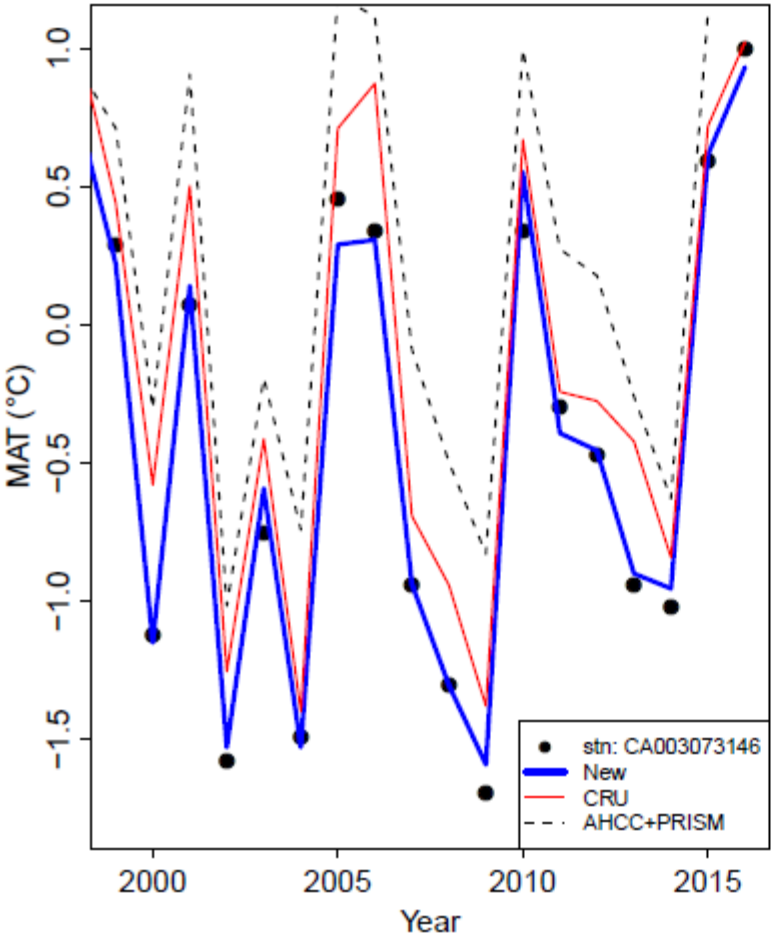
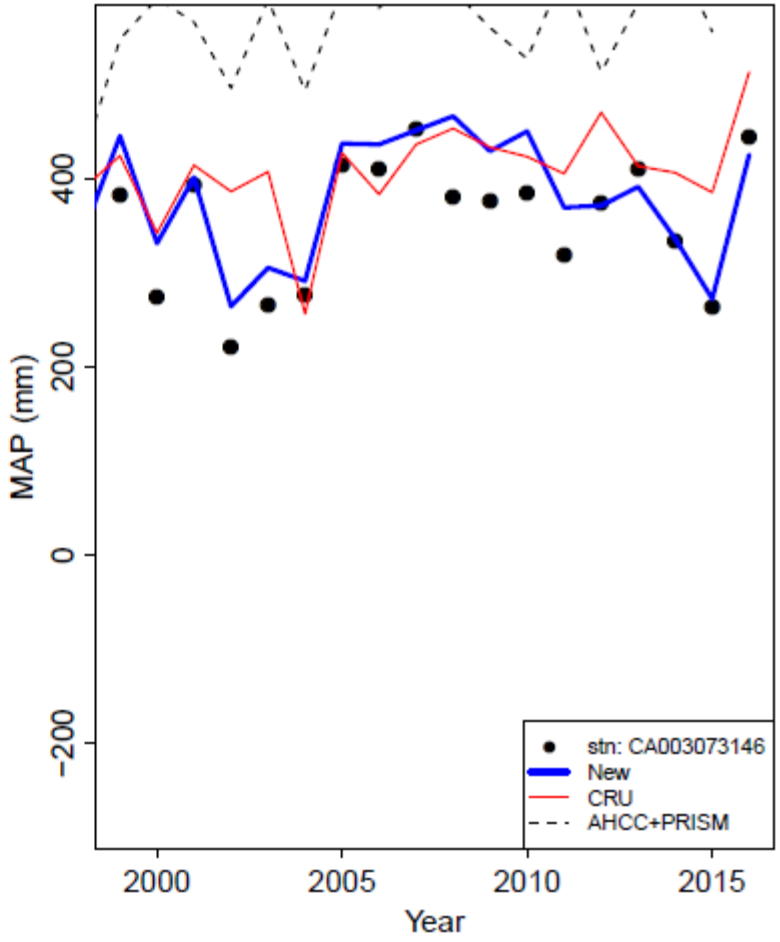
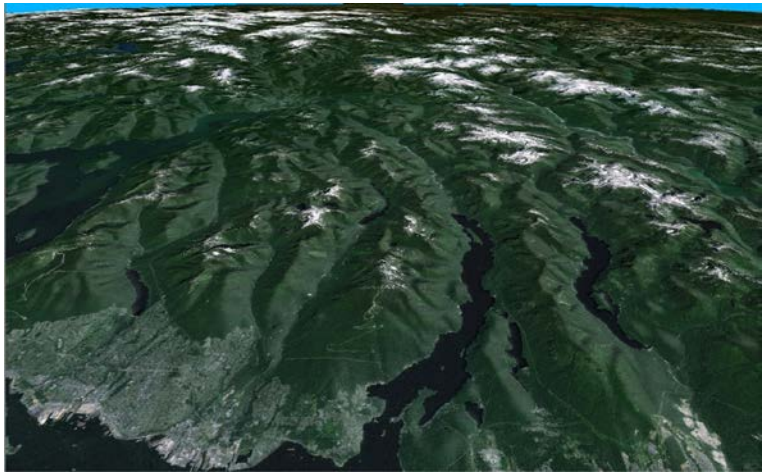
Comparisons in MAT and MAP by station and year



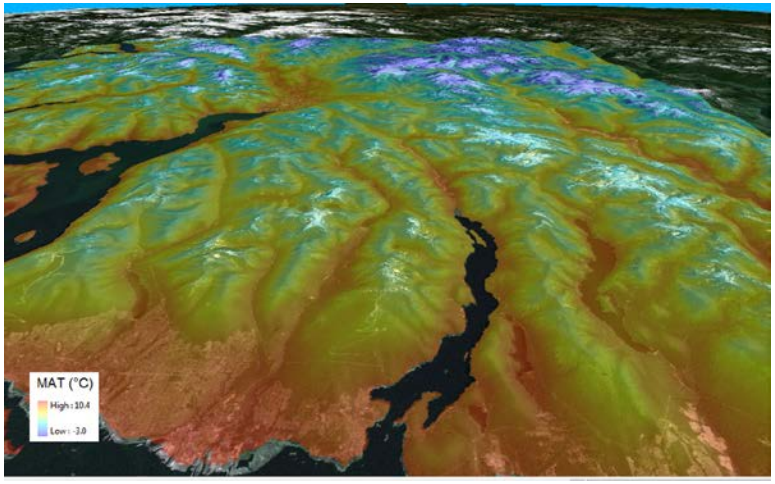


Future developments

- Replace CRU for 1901 – 1998
- API R commends
- Enable ClimateBC to input and output maps directly



ClimateBC



Where to get ClimateBC?

- Google: climatebc

Thanks!