

ClimateBC and its applications

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Dept. of Forest and Conservation Sciences

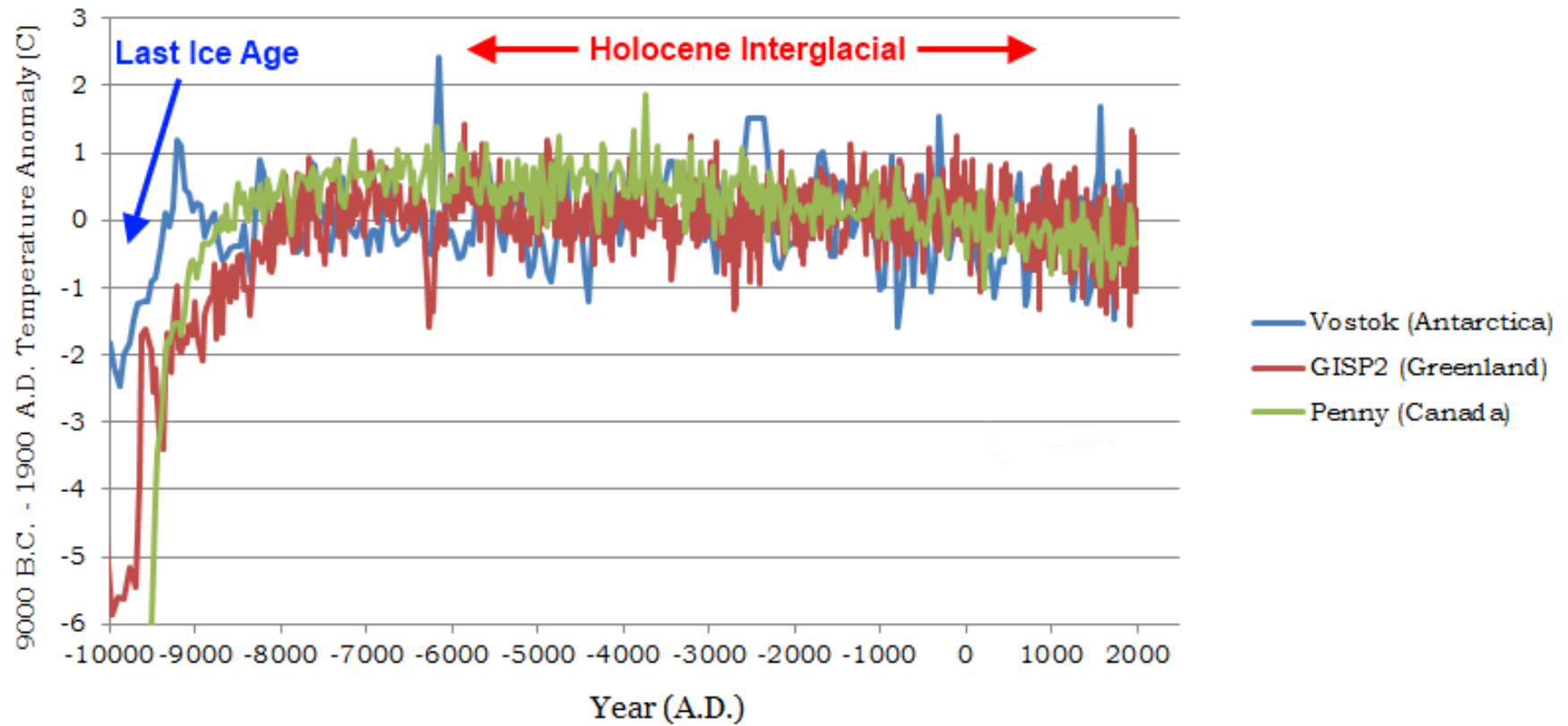
University of British Columbia

October 17, 2018

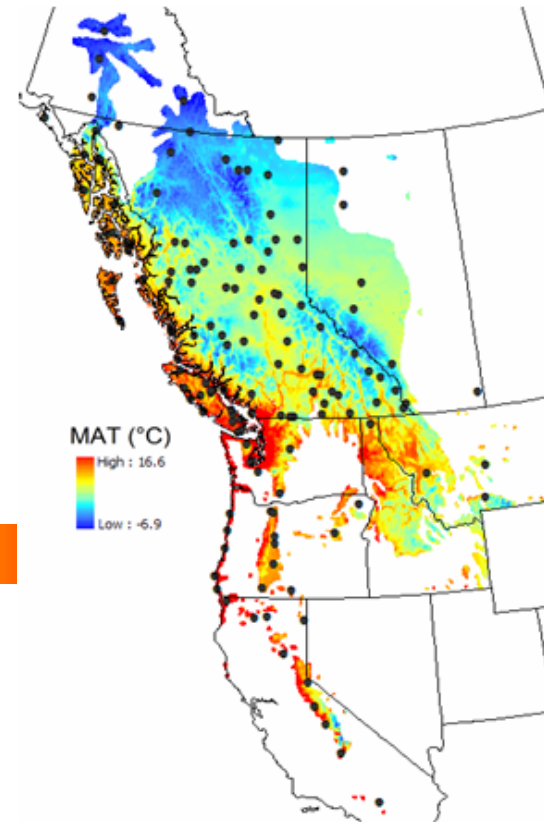
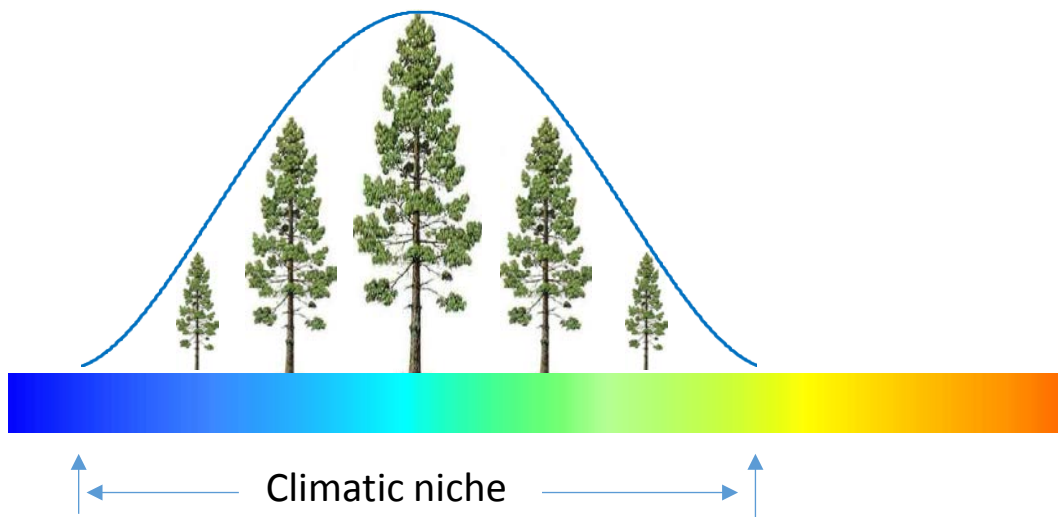


Ice Core Temperature Reconstructions

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

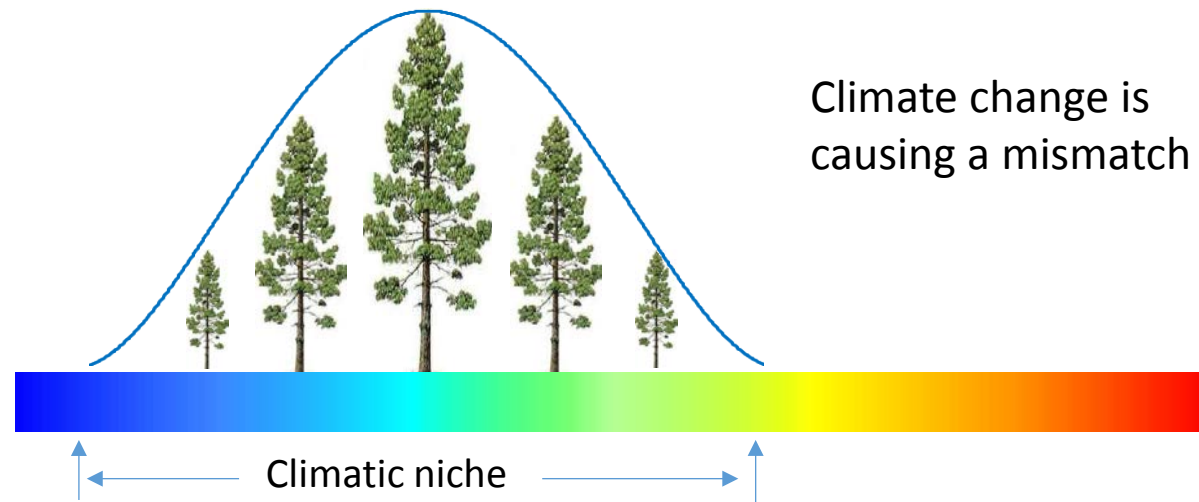
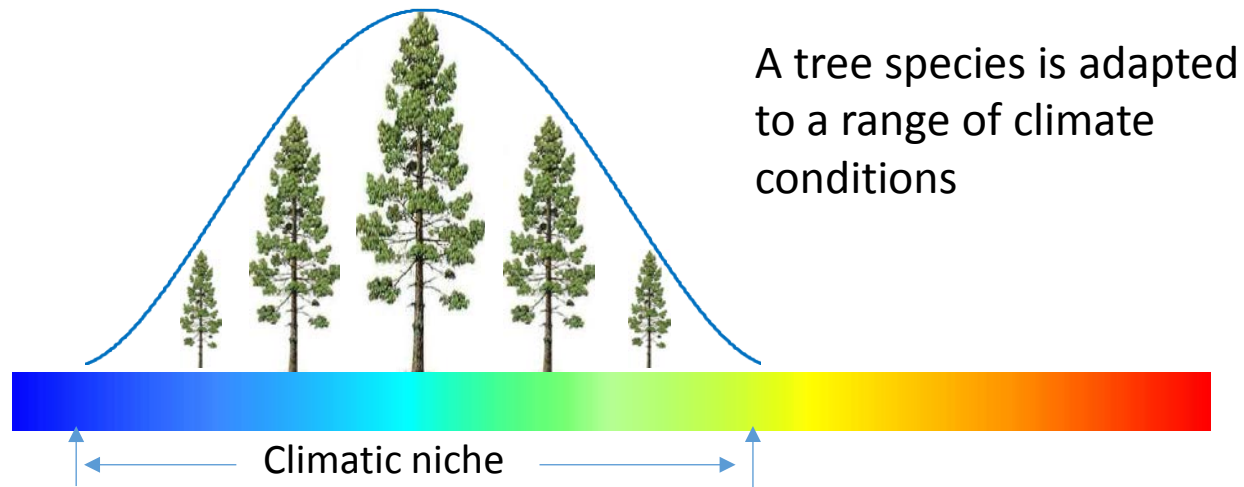


Most plant species are adapted to a range of climatic conditions

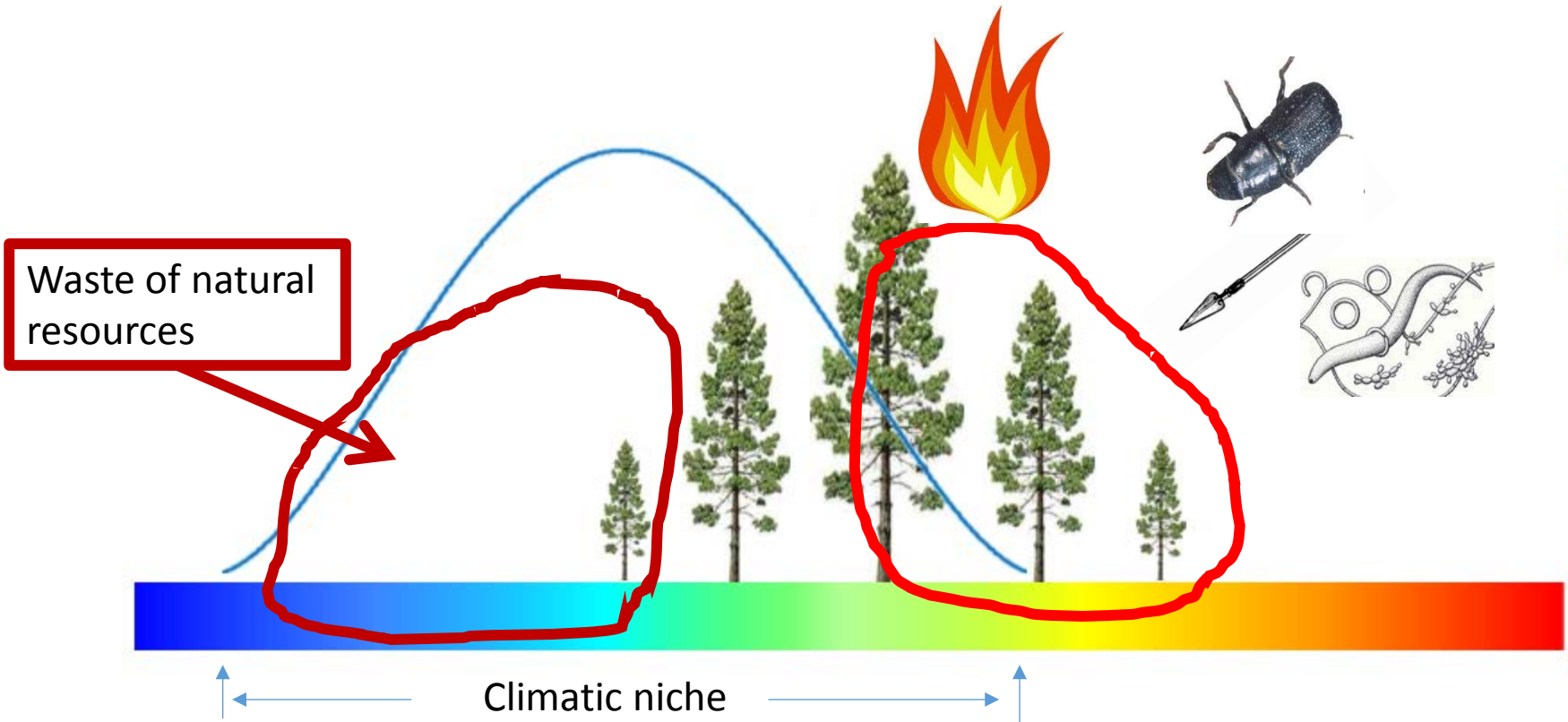


Distribution of lodgepole pine in North America

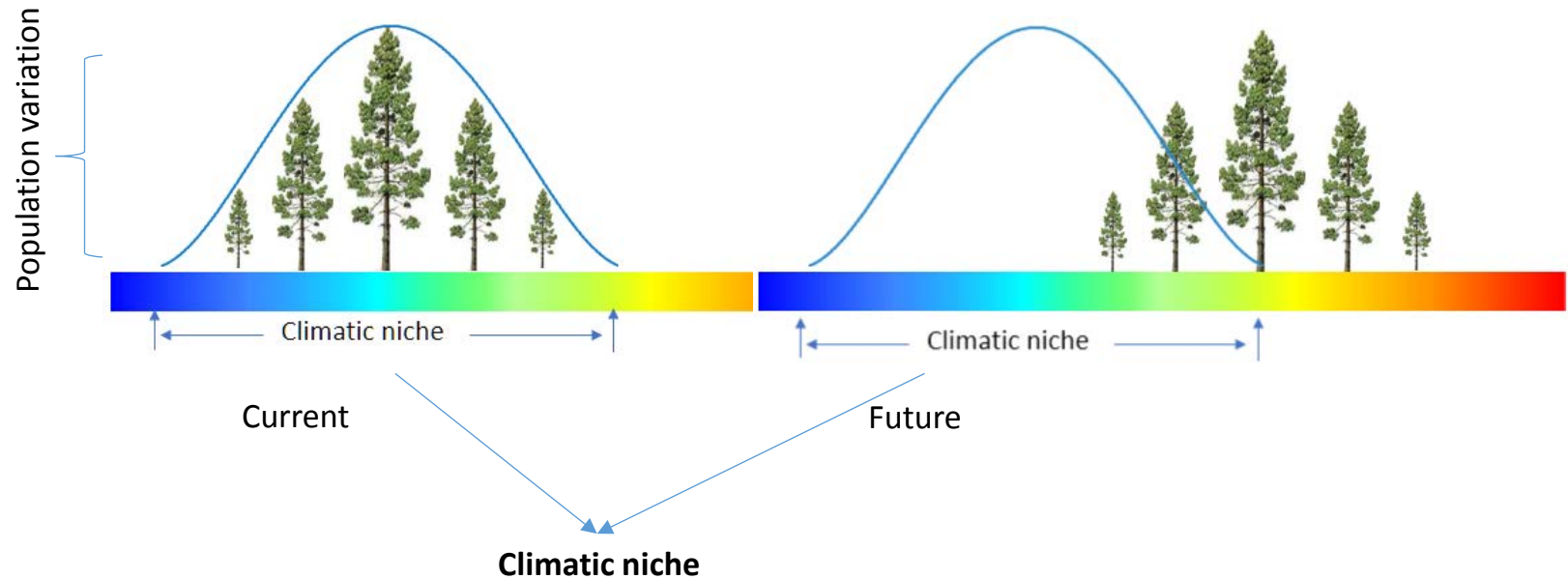
What is the major challenge?



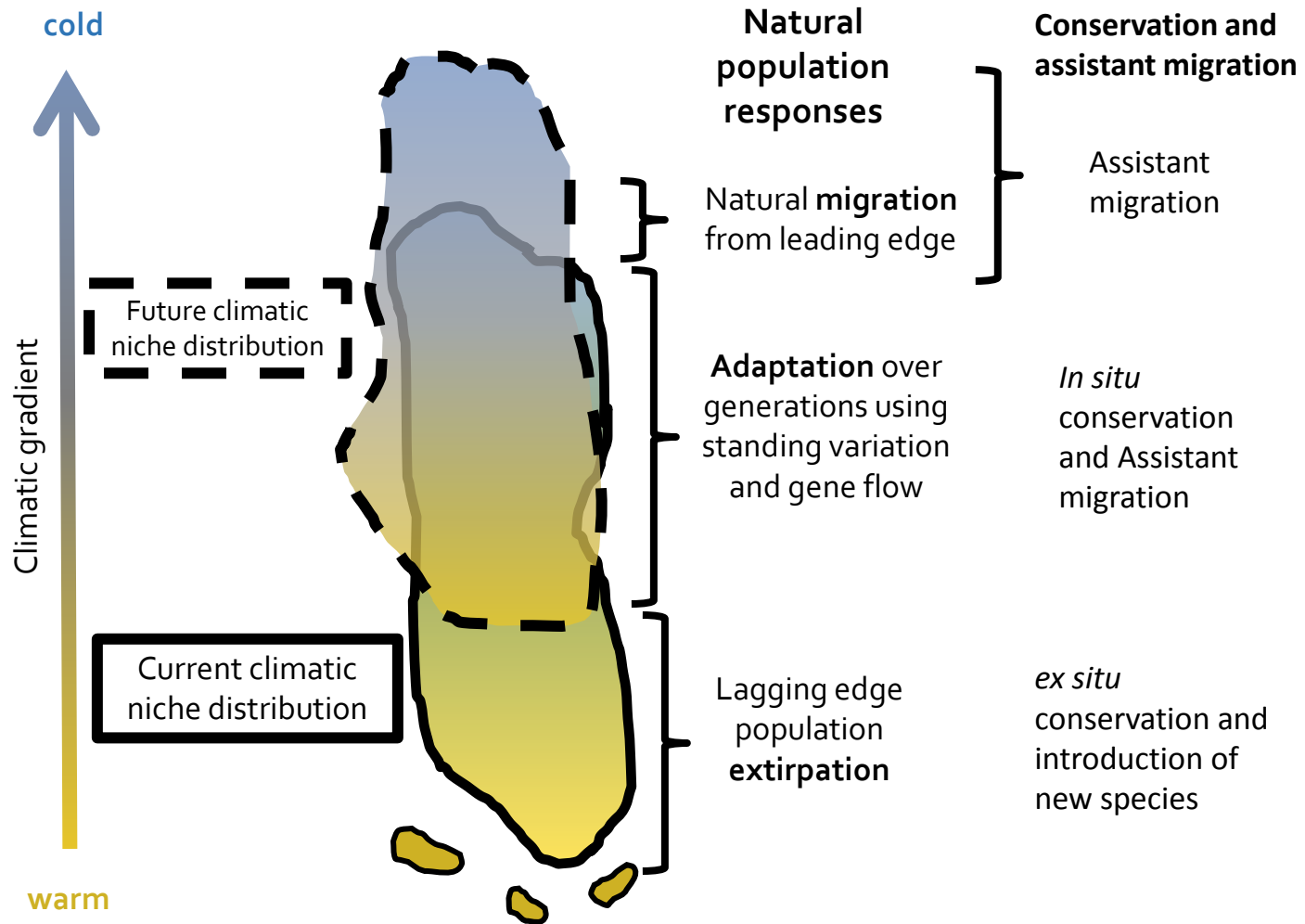
Trees left out their suitable climate habitat will be vulnerable



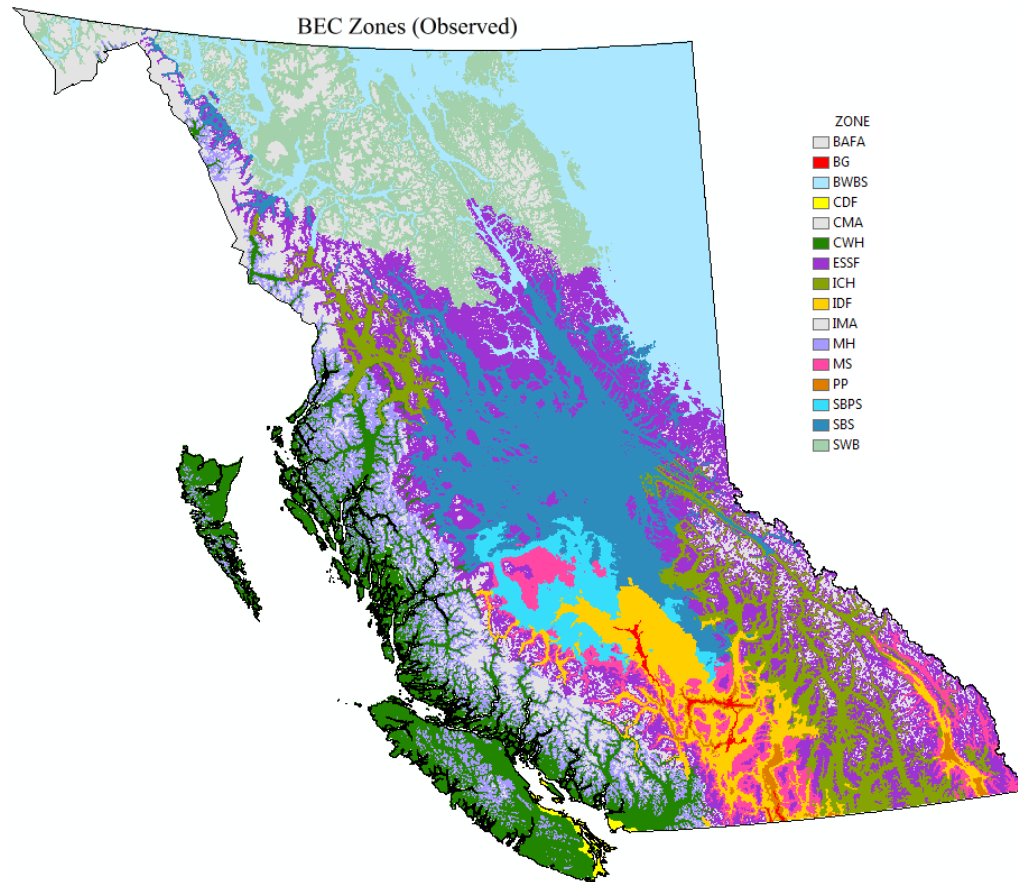
Mismatches will occur in two dimensions



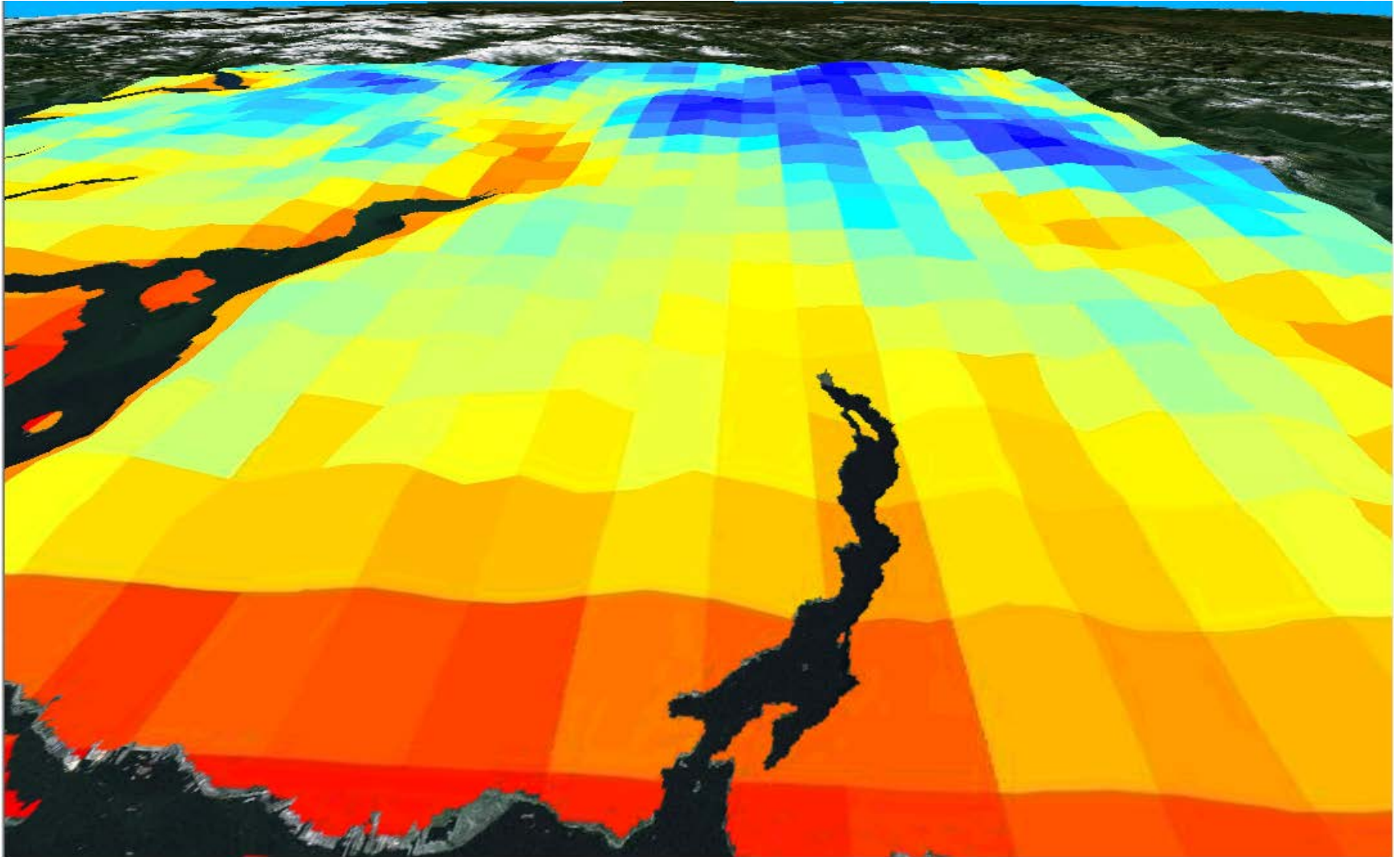
We need to help trees to match their favorable climate conditions in the two dimensions under a changing climate



We started with predicting BEC instead of individual species

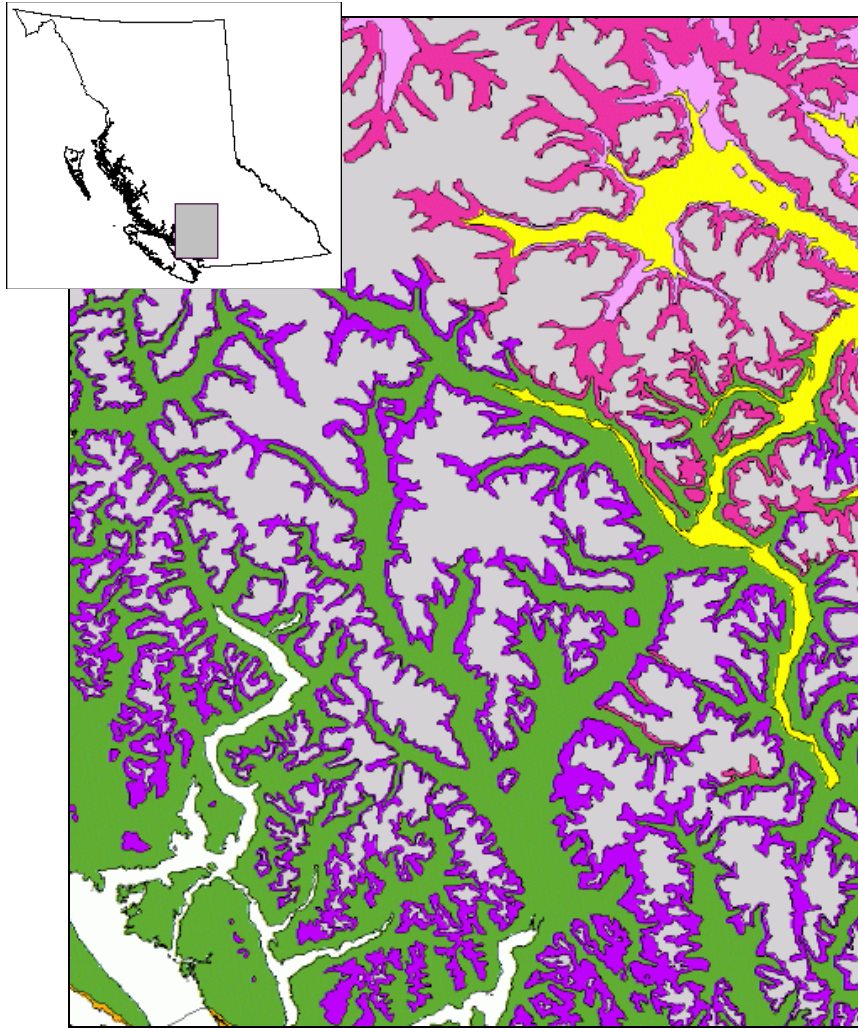


Mean Annual Temperature (MAT) by PRISM (4 x 4 km)

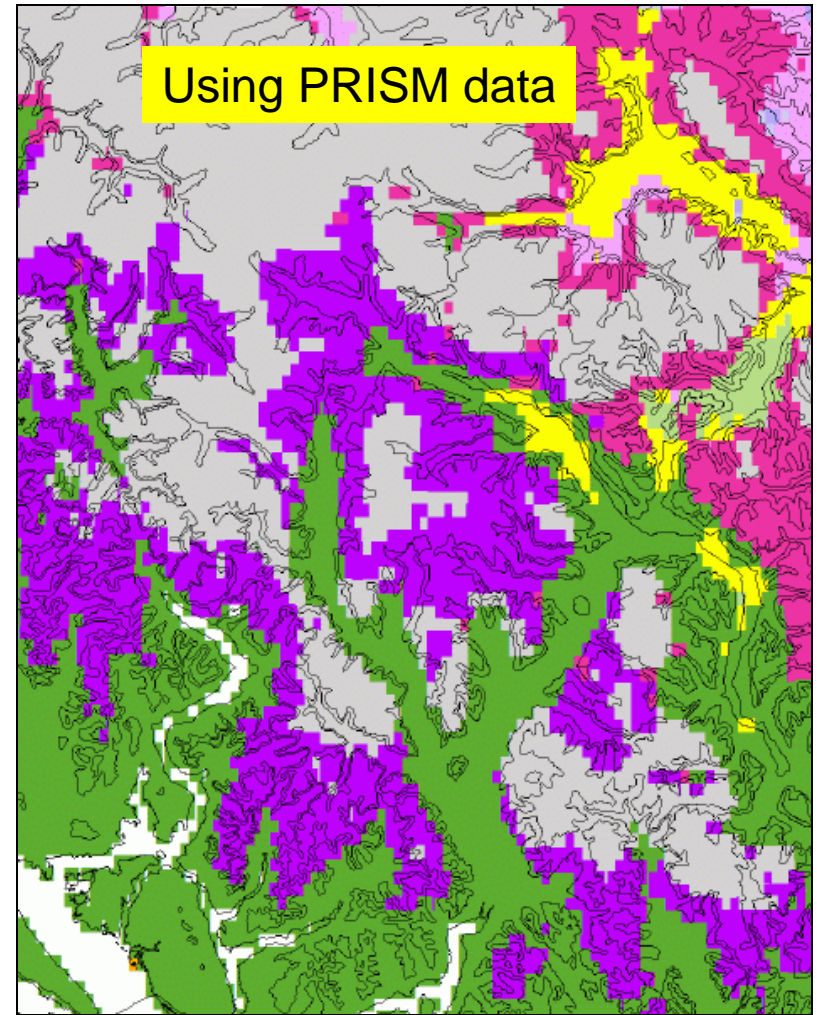


A mountain area near North Vancouver

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



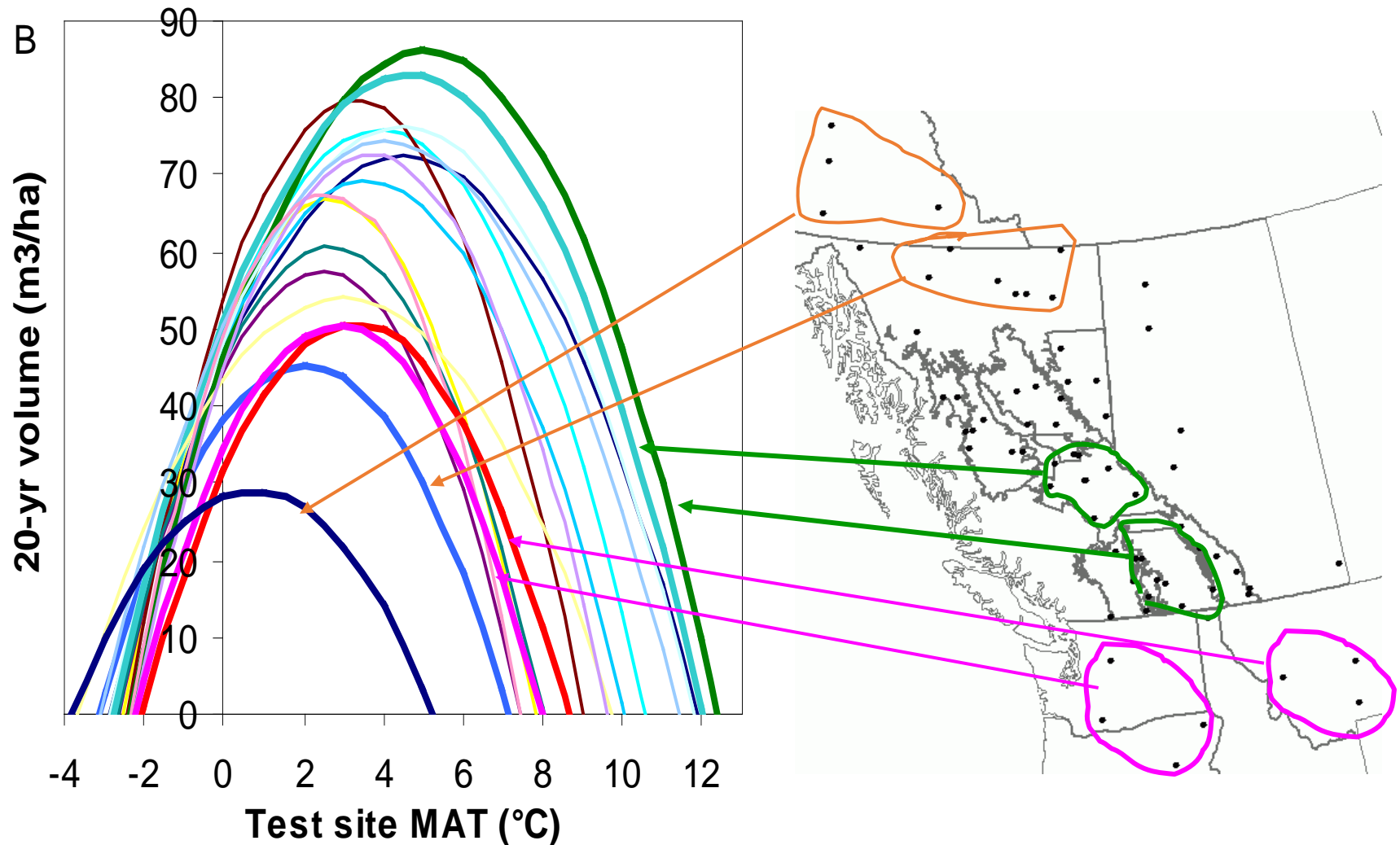
Observed



Predicted

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

Variation in response of lodgepole pine populations to climate change



ClimateBC/WNA/NA

ClimateWNA_v4.70 Copyright (2010) Wang T, Hamann A and Spittlehouse D. All rights reserved.

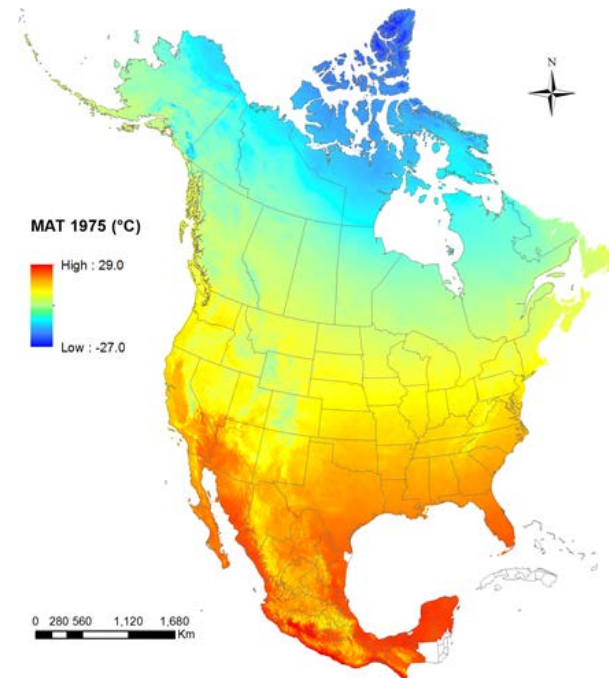
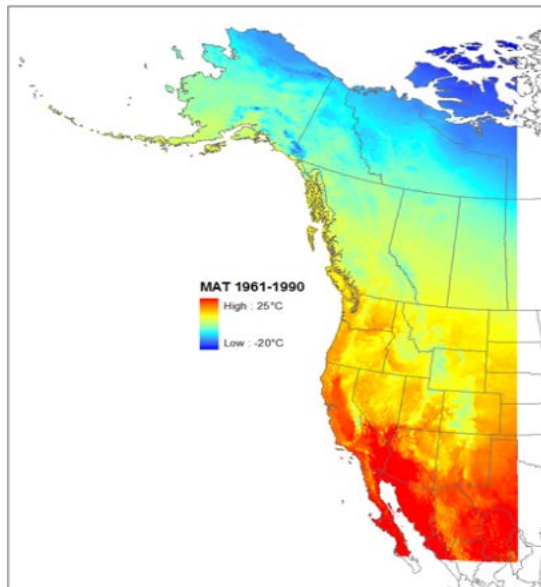
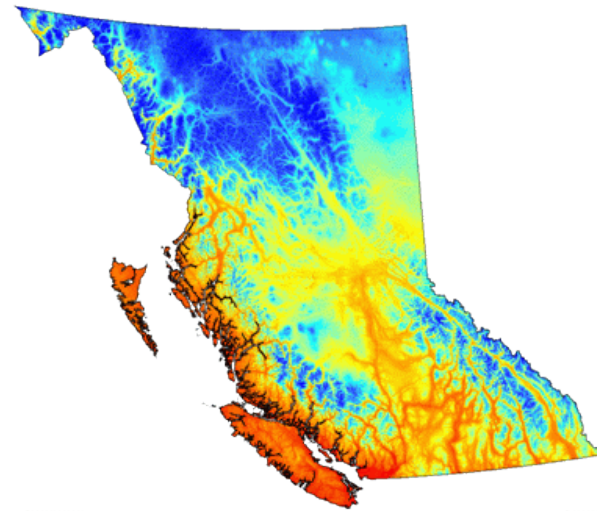
Single location ☒ Decimal ☐ Degree About Help

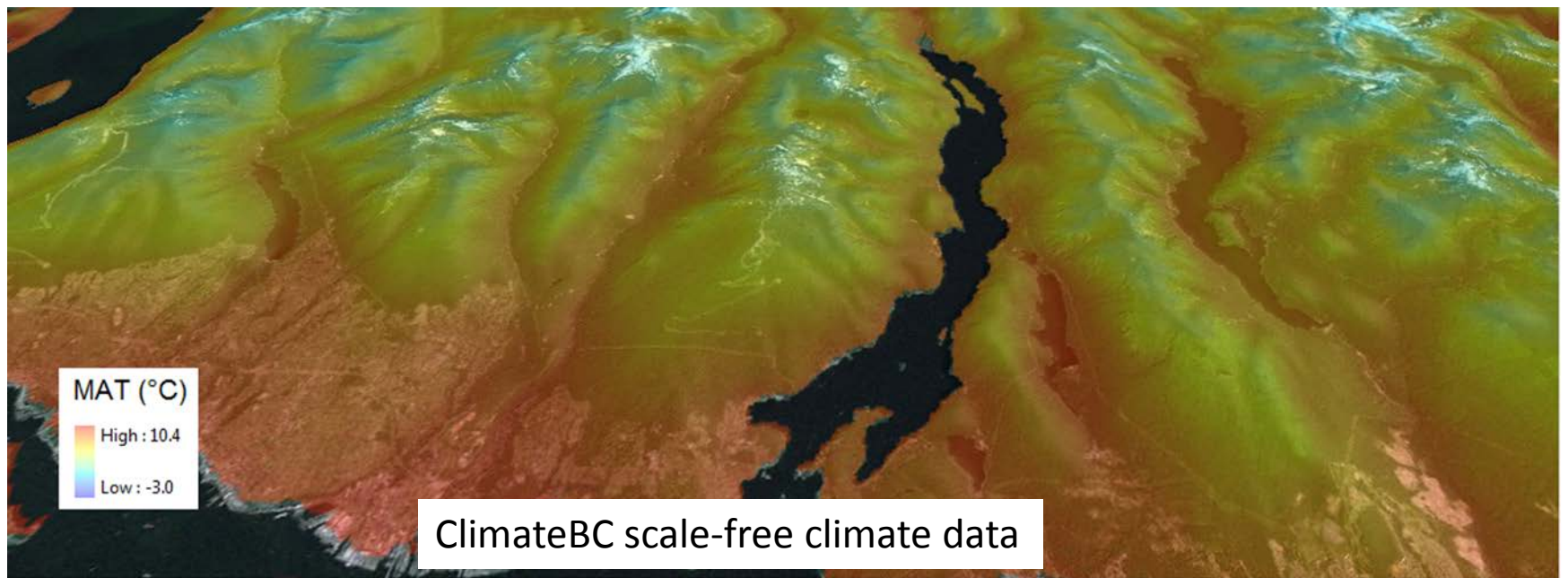
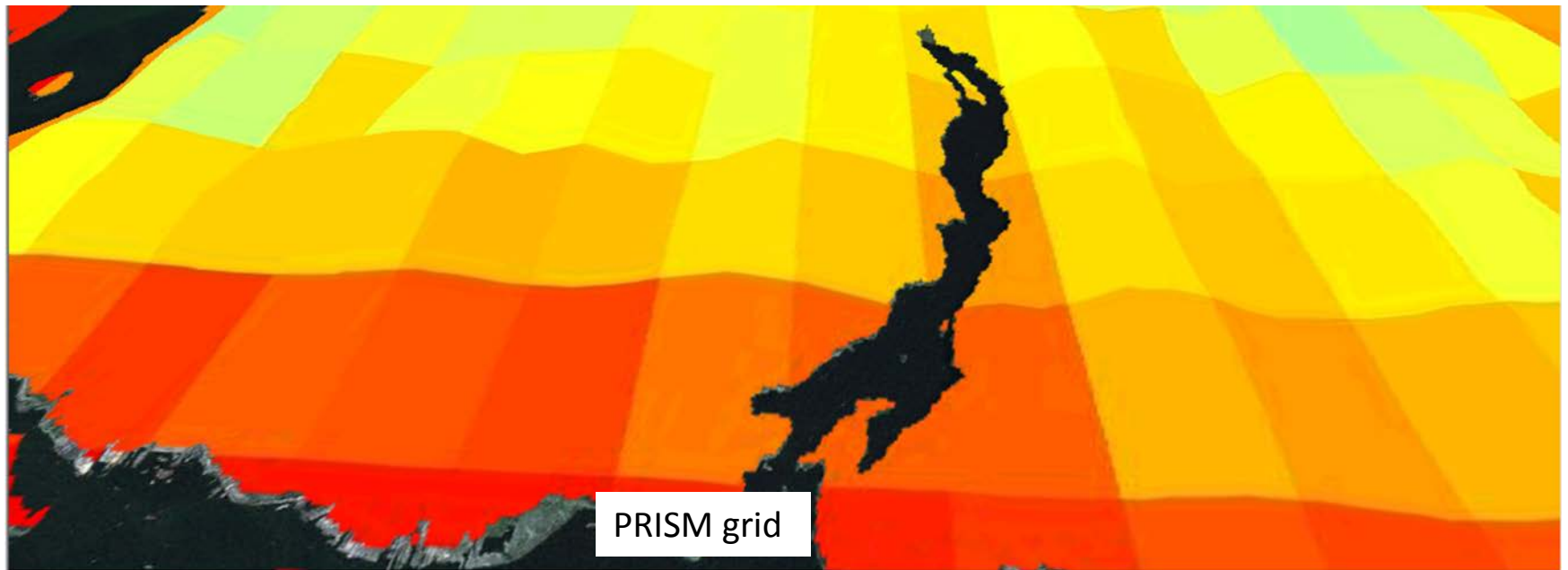
Latitude Elevation (m)
 Longitude

Annual variables	Seasonal variables	Monthly variables
MAT = 5.9	Tmax_wt = 0.6	Tmax01 = -1
MWMT = 17.2	Tmax_sp = 13.2	Tmax02 = 3.4
MCMT = -5.5	Tmax_sm = 26.1	Tmax03 = 7.6
TD = 22.7	Tmax_at = 12.9	Tmax04 = 13.2
MAP = 624	Tmin_wt = -8.8	Tmax05 = 18.7
MSP = 197	Tmin_sp = -1.7	Tmax06 = 23.2
AHM = 25.5	Tmin_sm = 6.3	Tmax07 = 27.6
SHM = 87.5	Tmin_at = -1.4	Tmax08 = 27.5
DD_0 = 587	Tave_wt = -4.1	Tmax09 = 21
DDS = 1572	Tave_sp = 5.8	Tmax10 = 13.5
DD_16 = 4459	Tave_sm = 16.2	Tmax11 = 4.1
DD18 = 63	Tave_at = 5.7	Tmax12 = -0.7
NFFD = 160	PPT_wt = 225	Tmin01 = -9.9
bFFP = 156	PPT_sp = 135	Tmin02 = -7.6

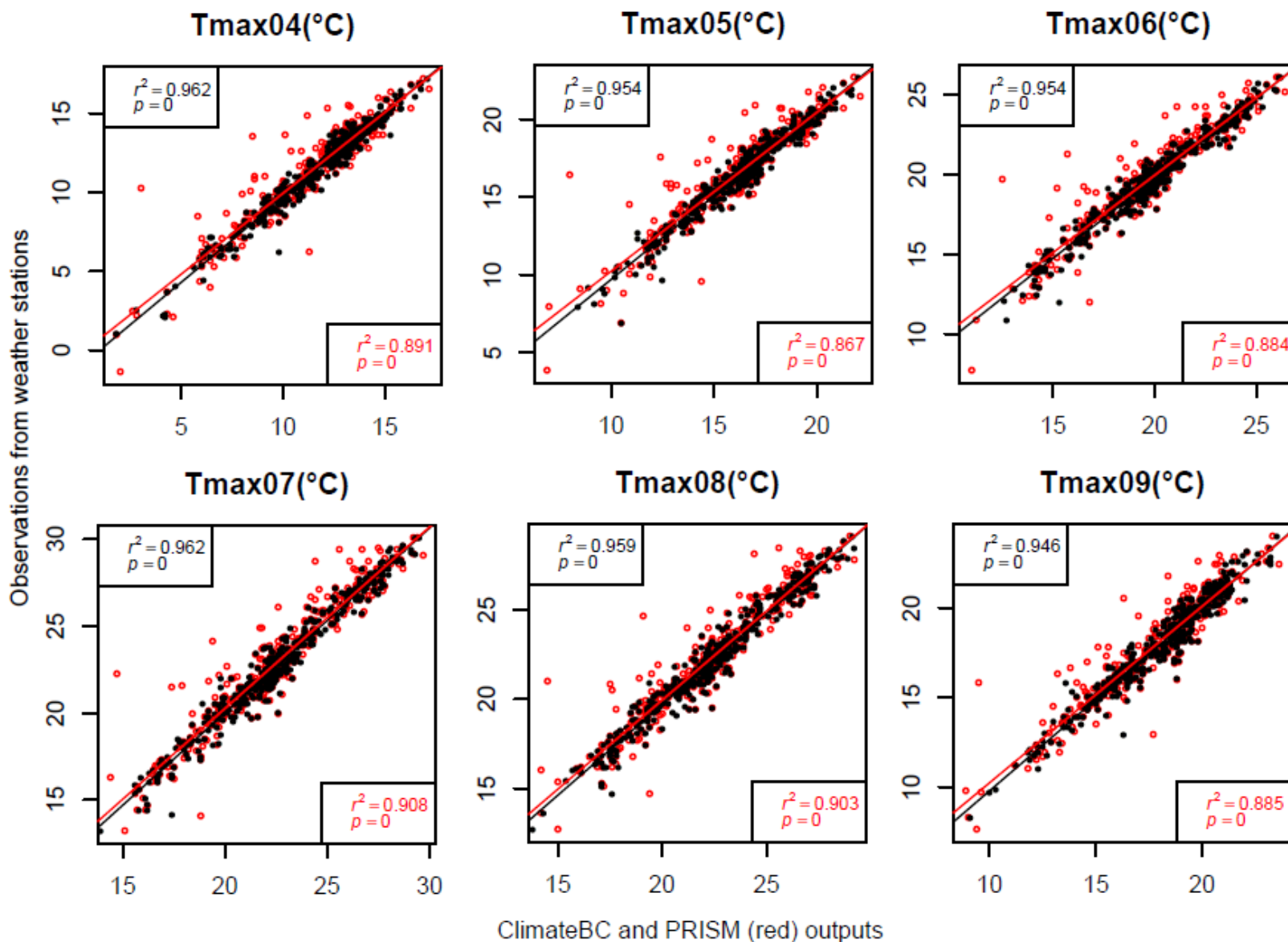
Multiple locations

Status

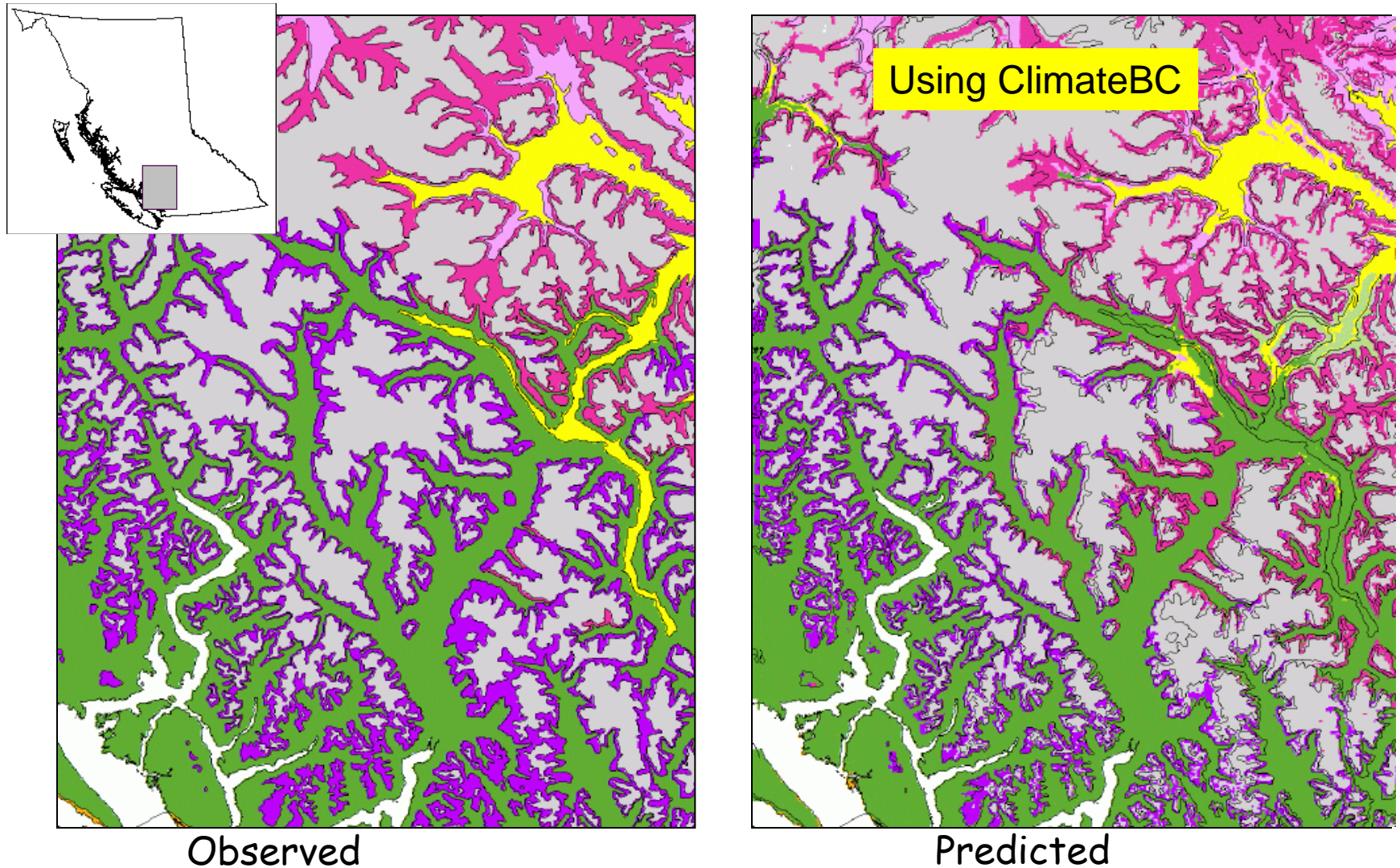




PRISM (800m) vs. ClimateBC (scale-free)



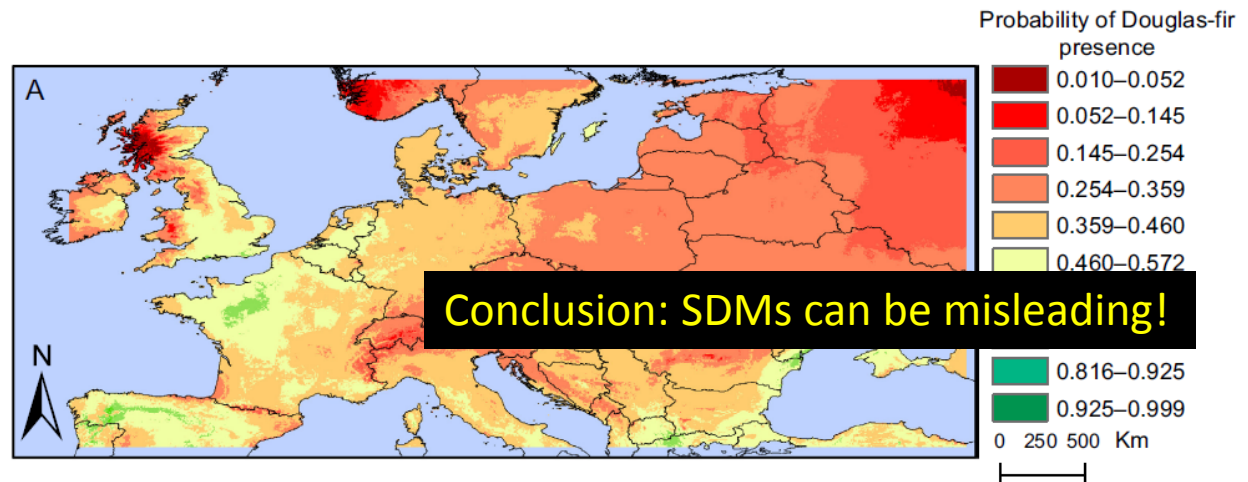
ClimateBC improves climatic mapping of the BEC zones



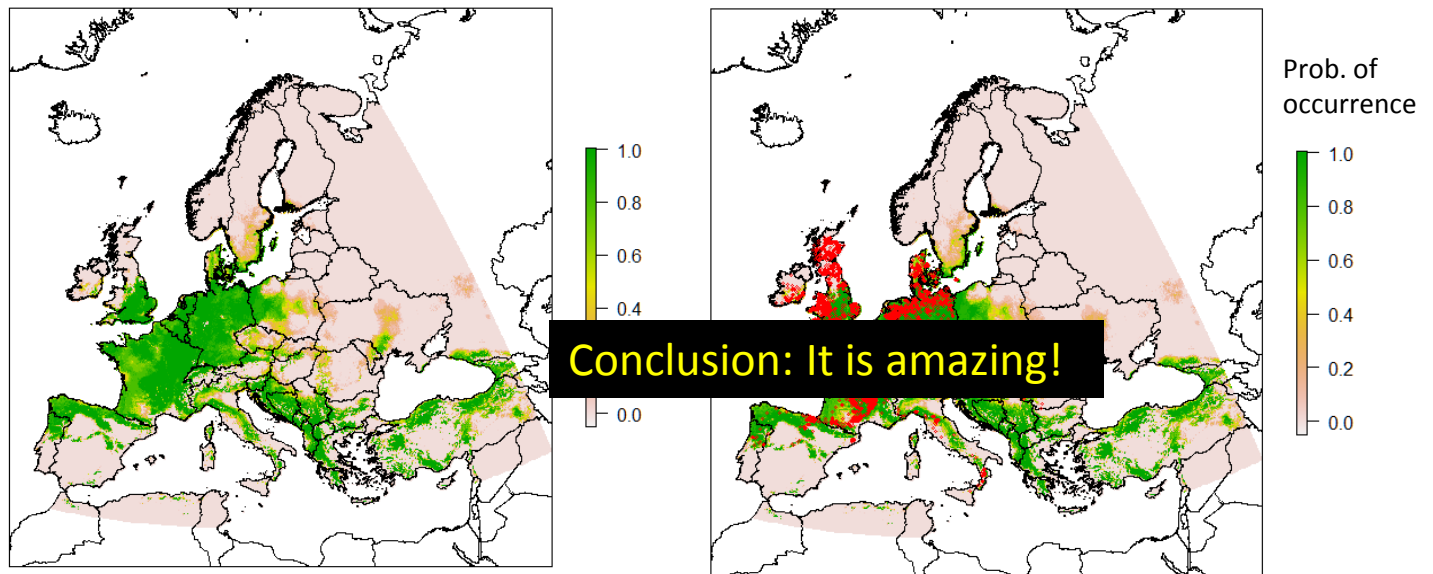
Source: Hamann & Wang. 2005. *Agricultural and Forest Meteorology* **128**: 211-221

Predictions based on poor climate data can be misleading

Boiffin et al.
(2017)

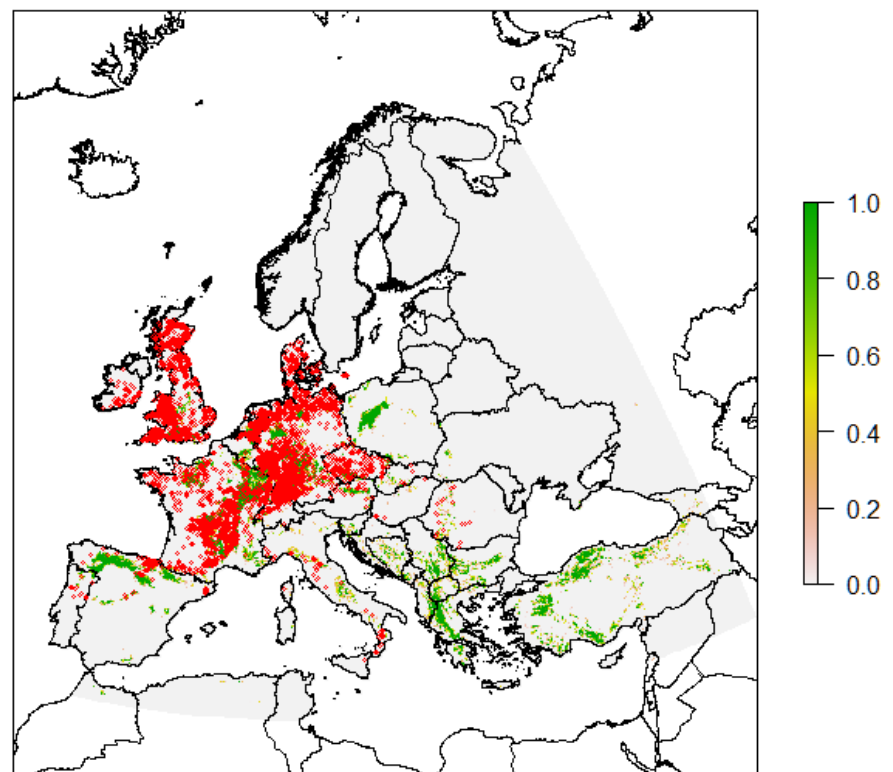
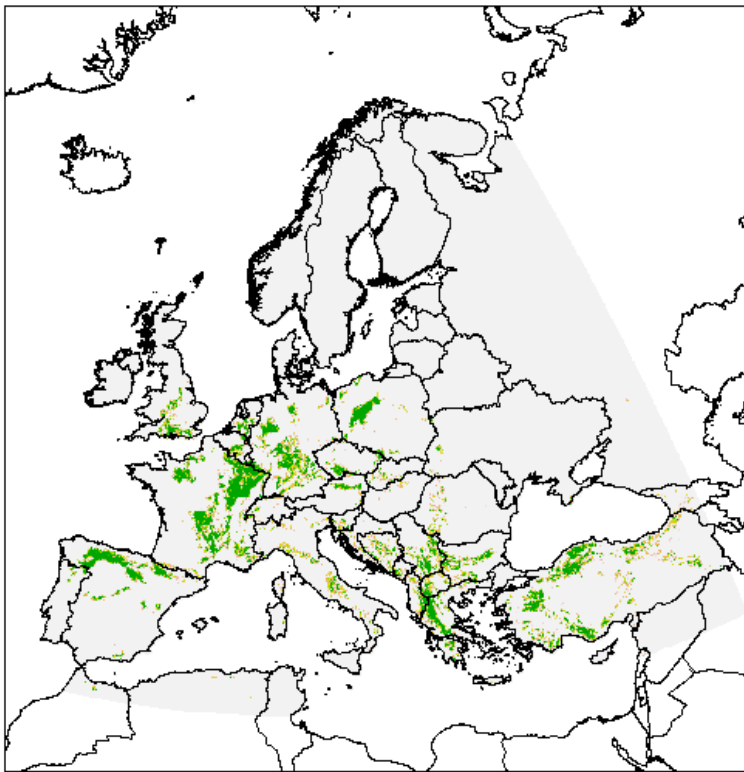


Our results



Accuracy = 88%

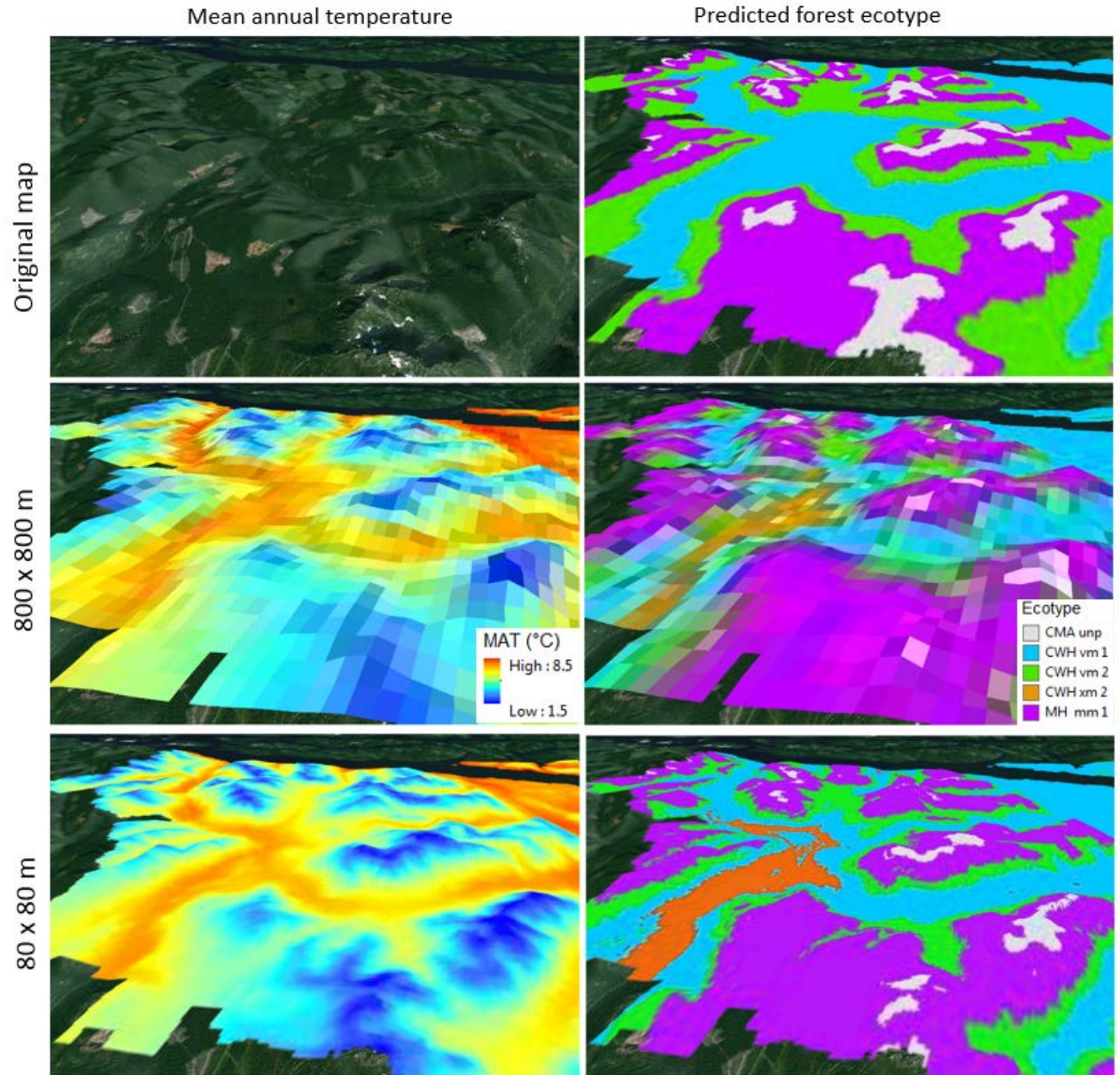
Climate data:
scale-free → 4x4 gridded as used in Boiffin (2017)



Accuracy: 88% → 20%

Features of ClimateBC

1. Generate climate data at any spatial resolution



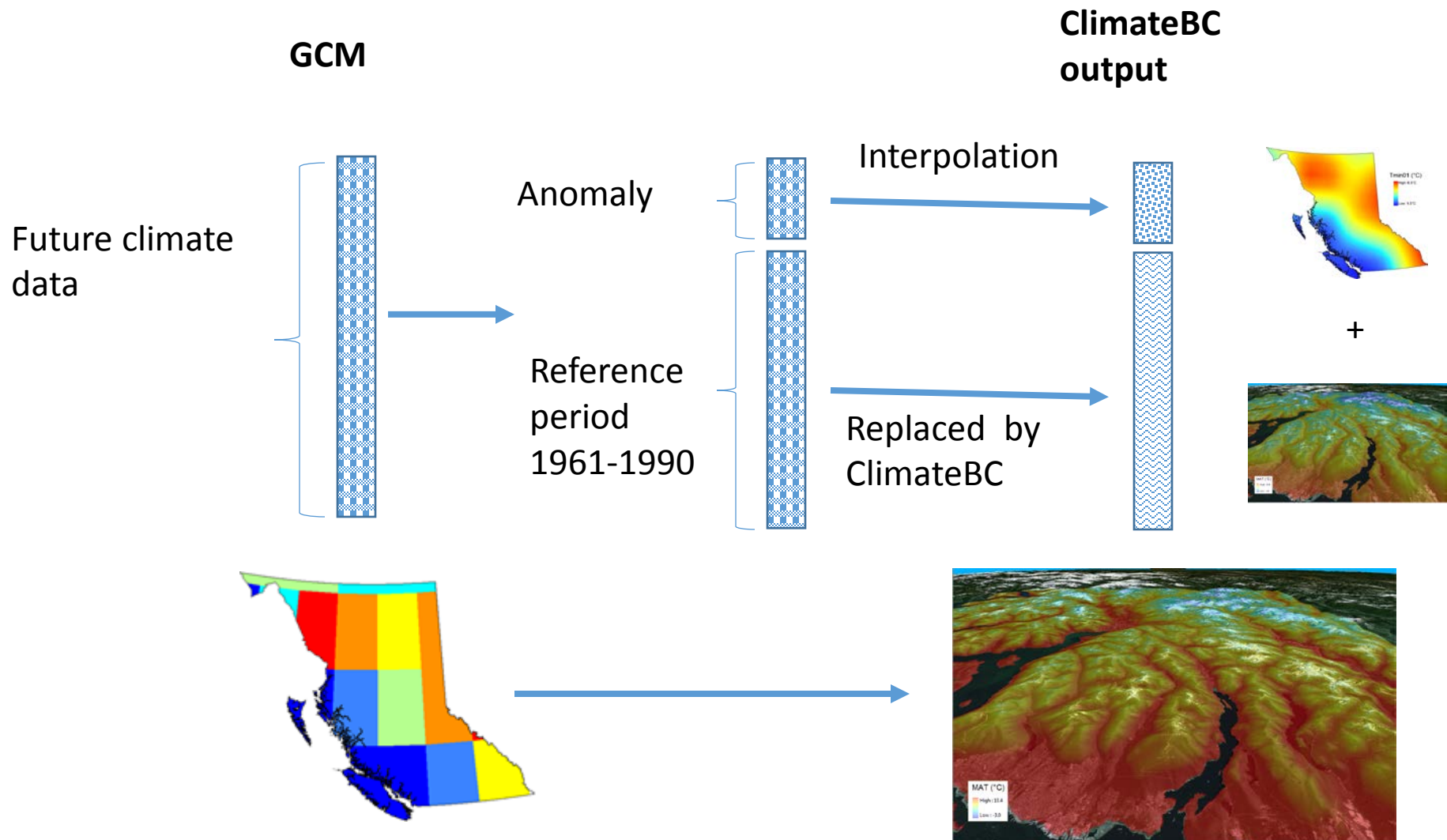
2. Produce many calculated and derived climate variables

- 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

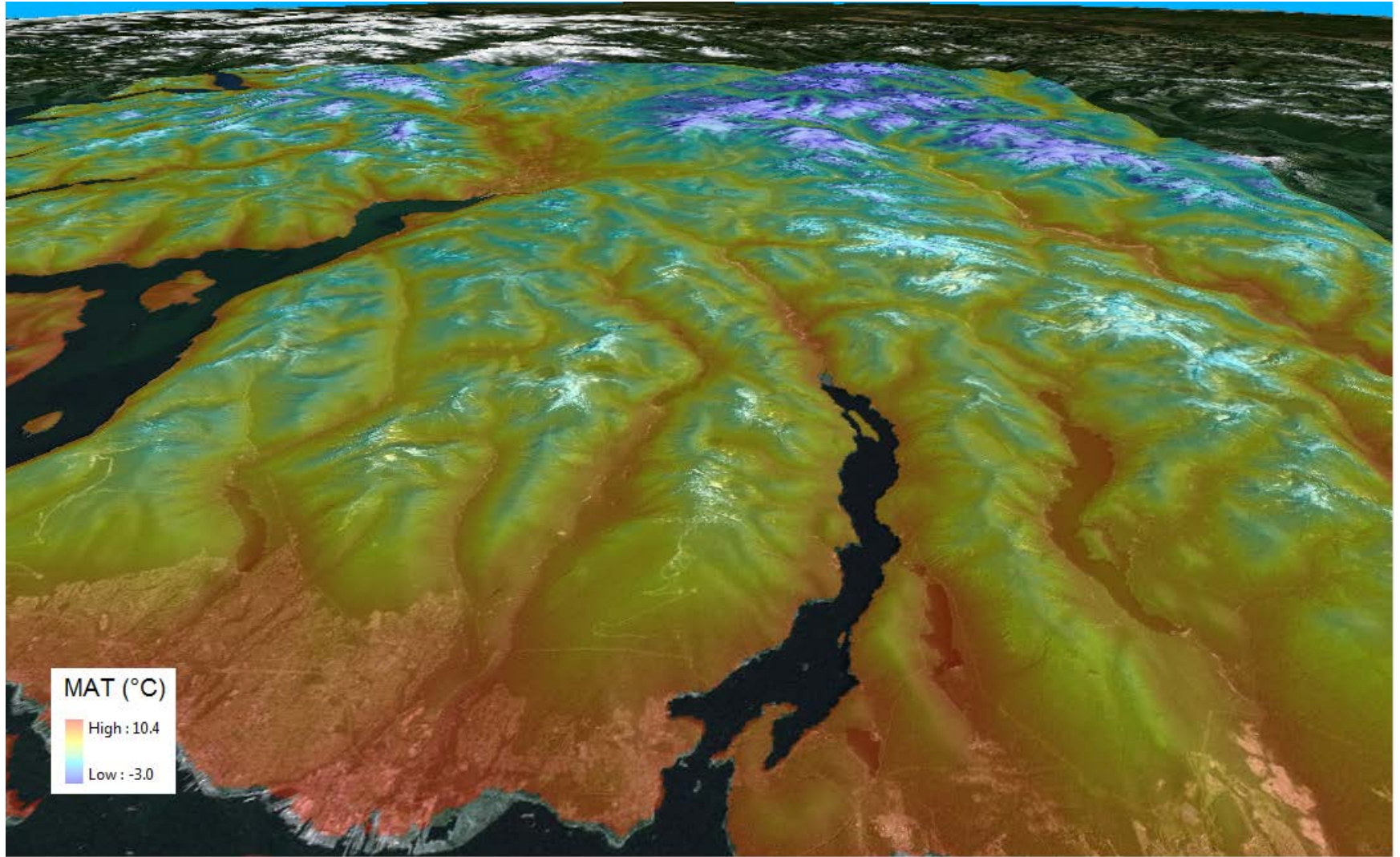
3. Integrate and downscale historical and future climate data

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

Downscaling future climate data to scale-free

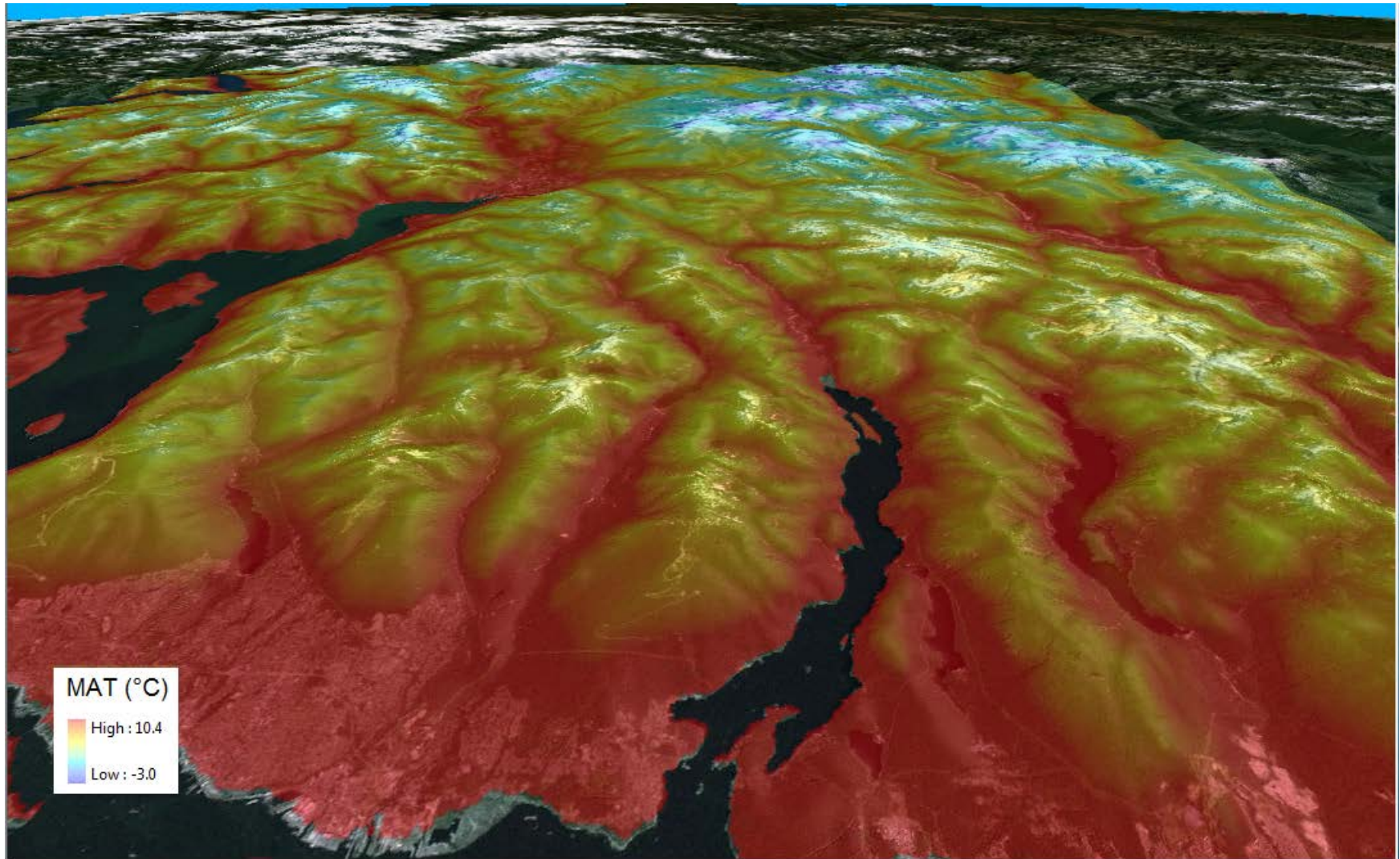


Scale-free MAT by ClimateWNA



A mountain area near North Vancouver

GCM changes added onto the baseline data



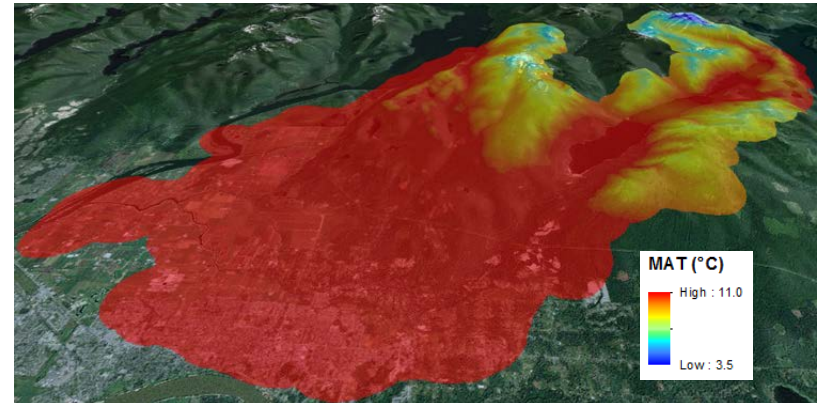
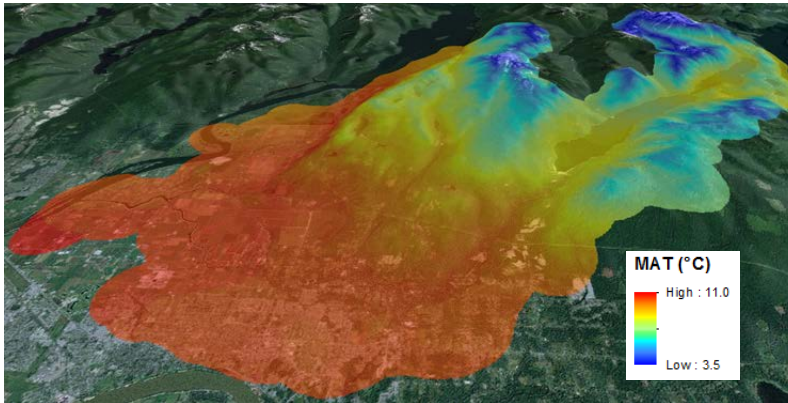
ClimateWNA output (90m) overlaid on a satellite image (CGCM2 A2_2050s)

It facilitates predictions for management unit

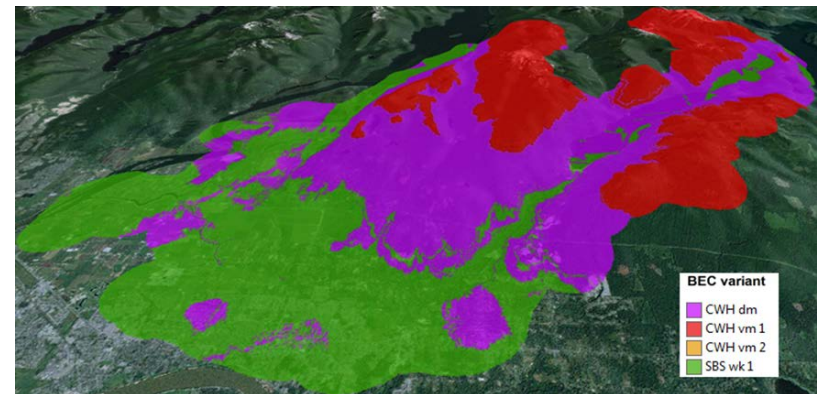
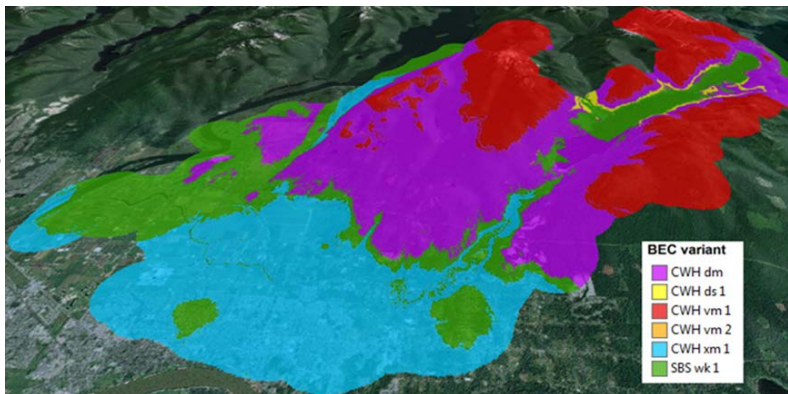
Current

Future (2050s)

Climate

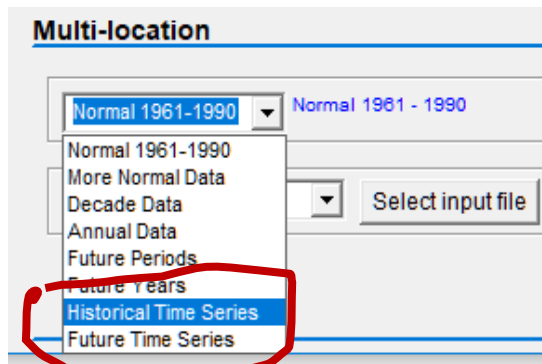


Ecosystems

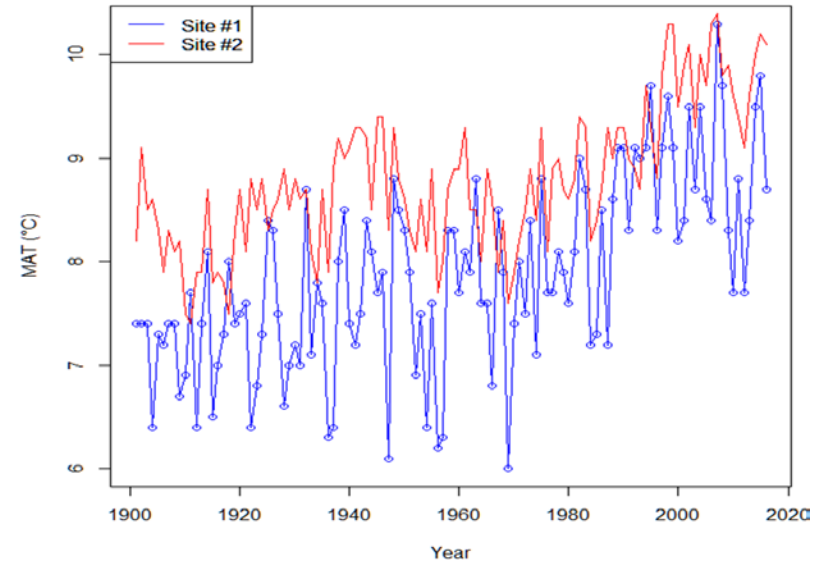


UBC Research Forest (25 x 25 m)

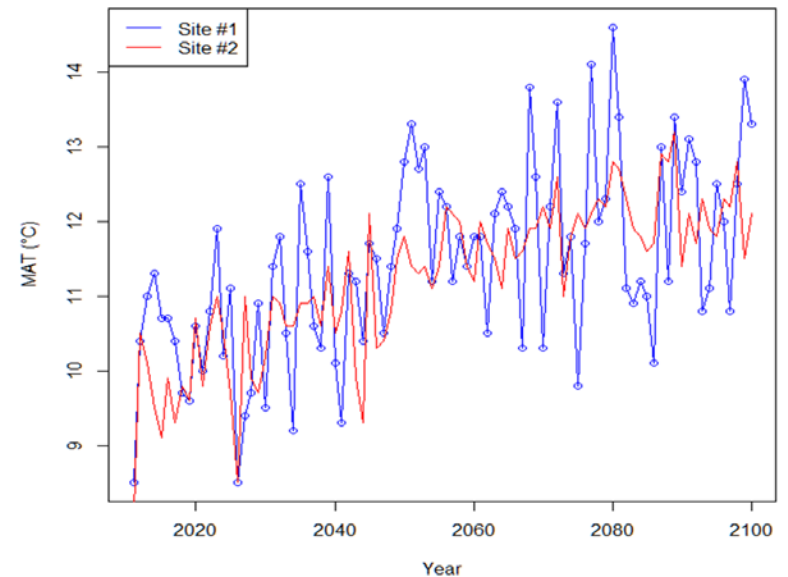
4. Time-series functions



Climate time-series for a historical period




Climate time-series for a future period



5. A platform for data spatial visualization and download

→ [Browser](#)



Centre for Forest Conservation Genetics
•CFGC•

ClimateBC_Map

— An Interactive Platform for Visualization and Data Access

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

Latitude Longitude

Elev (m) Historical

Future

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 Count

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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:

Transparen

overlays/c

Map

Climate maps

MAT 1961-1990 normal

MAP 1961-1990 normal

MCMT 1961-1990 normal

DD>5 1961-1990 normal

AHM 1961-1990 normal

SHM 1961-1990 normal

FFP 1961-1990 normal

EMT 1961-1990 normal

PAS 1961-1990 normal

Eref 1961-1990 normal

CMD 1961-1990 normal

MAT changed (2001-2009)

MAP changed (2001-2009)

CGCM3a2r4_MAT 2020s

CGCM3a2r4_MAT 2050s

CGCM3a2r4_MAT 2080s

CGCM3a2r4_MAP 2020s

CGCM3a2r4_MAP 2050s

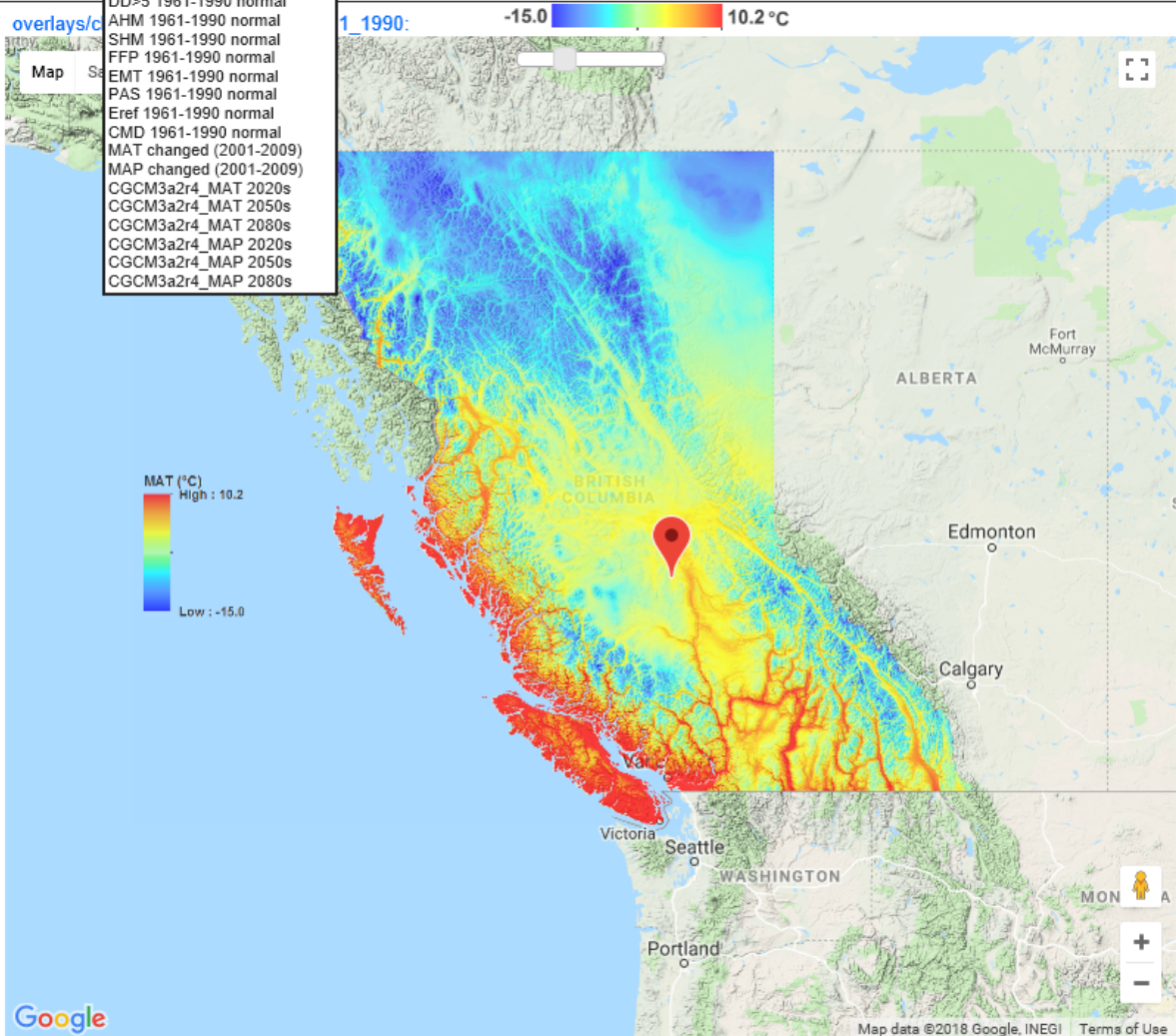
CGCM3a2r4_MAP 2080s

BEC zones - currently ma

Species ranges

SPU maps

1990: -15.0 10.2 °C



Google

Map data ©2018 Google, INEGI Terms of Use

Note: Mismatches between overlays and the map may occur if your browser is outdated. More spatial raster layers of climate variables are available for [download](#).



ClimateBC_Map

— A Interactive Platform for Visualization
and Data Access

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

Latitude Longitude

Elev (m) Historical

Future

Quick Tutorial

Help

Calculate

Annual Variables

MAT = 2.5
MWMt = 13.8
MCMT = -10.1
TD = 23.9
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MSP = 271
AHM = 23.4
SHM = 51
DD<0 = 1097
DD>5 = 1016
DD<18 = 5645
DD>18 = 16
NFFD = 142
bFFP = 164
eFFP = 248
FFP = 84

Seasonal Variables

Tmax_wt = -3.5
Tmax_sp = 9.3
Tmax_sm = 19.7
Tmax_at = 8.4
Tmin_wt = -13.5
Tmin_sp = -3.7
Tmin_sm = 5.8
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Tave_sm = 12.8
Tave_at = 2.9
PPT_wt = 133
PPT_sp = 85
PPT_sm = 187
PPT_at = 127

Monthly Variables

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Tmax(08) = 20.2
Tmax(09) = 16
Tmax(10) = 9.4
Tmax(11) = -0.1
Tmax(12) = -5
Tmin(01) = -14.9
Tmin(02) = -11.6
Tmin(03) = -8.1
Tmin(04) = -3.6

Append to

ClimateData.csv

Count 0

Save

Clear

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Overlays: Climate maps

Transparency(%):

overlays/climateBC//bec/BEC_zone:

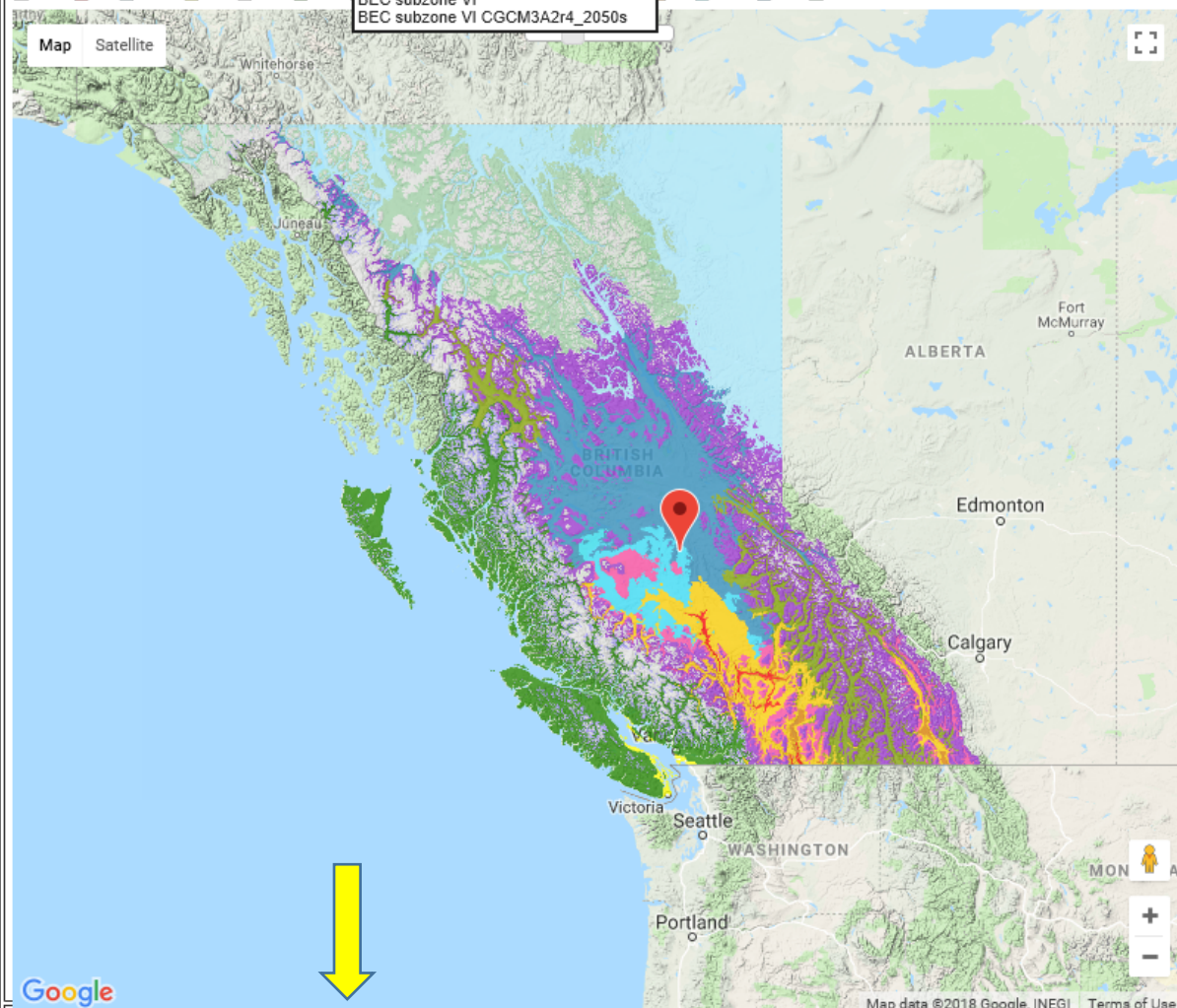
☐ BAFA ☐ BG ☐ BWBS ☐ CDF ☐ CMA ☐ CWB

Map Satellite

BEC zones
BEC zones - currently mapped
BEC zone - climate_2010s
BEC zone - climate_2020s
BEC zone - climate_2050s
BEC zone - climate_2080s
BEC subzone VI
BEC subzone VI CGCM3A2r4_2050s

Changes

SPU maps



Google

Remove Overlays

Download Overlay raster files

Desktop version

ClimateNA_Map

ClimateWNA_Map

Note: Mismatches between overlays and the map may occur if your browser is outdated. More spatial raster layers of climate variables are available for [download](#).



ClimateBC_Map

-- A Interactive Platform for Visualization
and Data Access

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

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Elev (m) Historical

Future

[Quick Tutorial](#)
[Help](#)
[Calculate](#)

Annual Variables

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MWM = 13.8
MCM = -10.1
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AHM = 23.4
SHM = 51
DD<0 = 1097
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DD<18 = 5645
DD>18 = 16
NFFD = 142
bFFP = 164
eFFP = 248
FFP = 84

Seasonal Variables

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Tmax_sp = 9.3
Tmax_sm = 19.7
Tmax_at = 8.4
Tmin_wt = -13.5
Tmin_sp = -3.7
Tmin_sm = 5.8
Tmin_at = -2.6
Tave_wt = -8.5
Tave_sp = 2.8
Tave_sm = 12.8
Tave_at = 2.9
PPT_wt = 133
PPT_sp = 85
PPT_sm = 187
PPT_at = 127

Monthly Variables

Tmax(01) = -5.3
Tmax(02) = -0.3
Tmax(03) = 3.8
Tmax(04) = 9.4
Tmax(05) = 14.6
Tmax(06) = 18.1
Tmax(07) = 20.7
Tmax(08) = 20.2
Tmax(09) = 16
Tmax(10) = 9.4
Tmax(11) = -0.1
Tmax(12) = -5
Tmin(01) = -14.9
Tmin(02) = -11.6
Tmin(03) = -8.1
Tmin(04) = -3.6

[Append to](#)

[Count](#)

[Save](#)
[Clear](#)

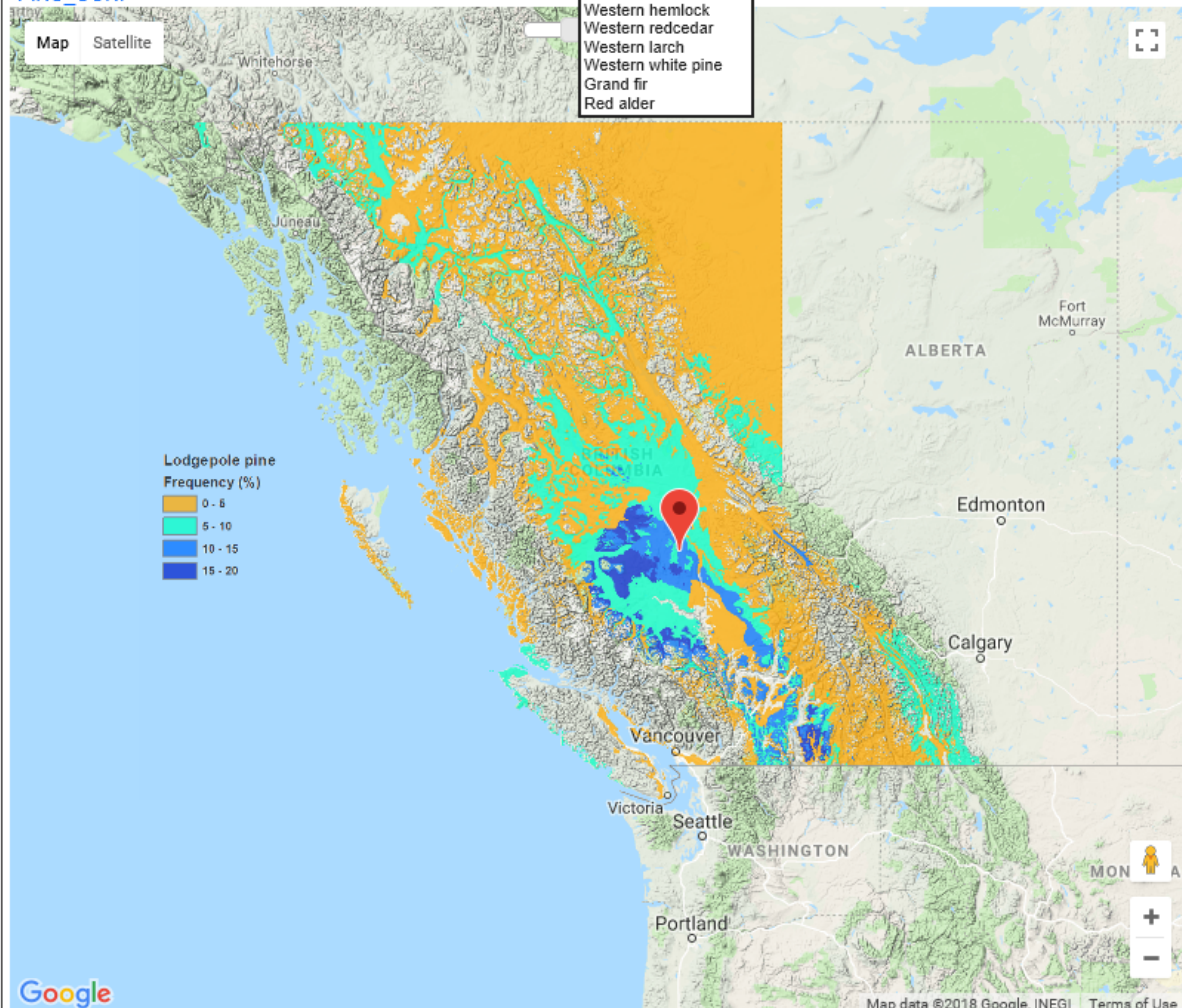
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Overlays: MAT 1961-1990 normal BEC zones - currently ma

Transparency(%):

PINU_CON: Frequency (%):



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

SPU maps

Forestry

[Remove Overlays](#)
[Download Overlay raster files](#)
[Desktop version](#)
[ClimateNA_Map](#)
[ClimateWNA_Map](#)

Note: Mismatches between overlays and the map may occur if your browser is outdated. More spatial raster layers of climate variables are available for [download](#).



ClimateWNA_MAP

-- An Interactive Platform for Visualization and Data Access

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

Latitude Longitude

Elev (m) Historical

Future

[Quick Tutorial](#)
[Help](#)
[Calculate](#)

Annual Variables

Seasonal Variables

Monthly Variables

[Append to](#)

Count
[Save](#)
[Clear](#)

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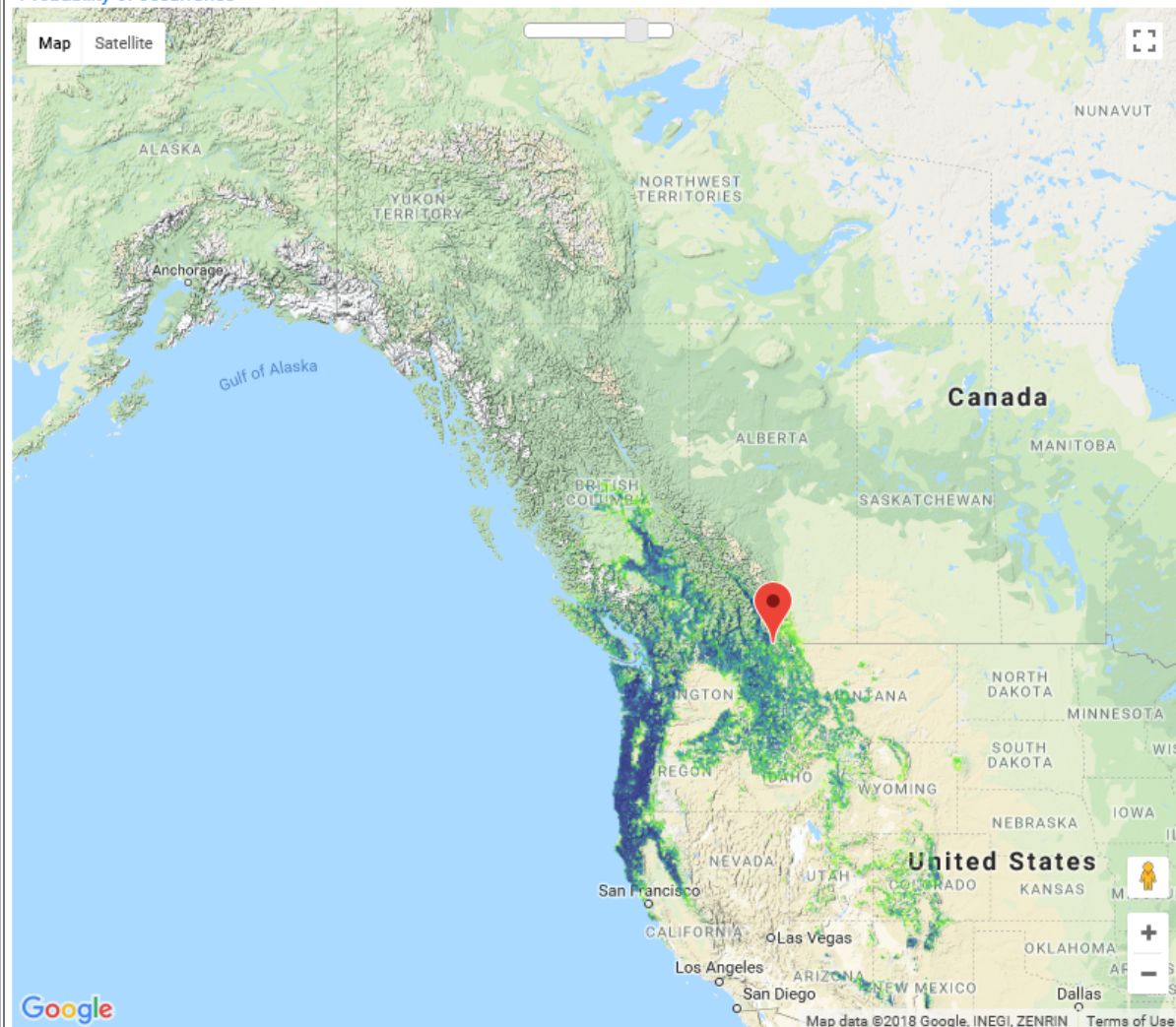
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Species ranges
Lodgepole pine
Lodgepole pine 2050s
Douglas-fir
Douglas-fir 2050s

Overlays:

Transparency(%):

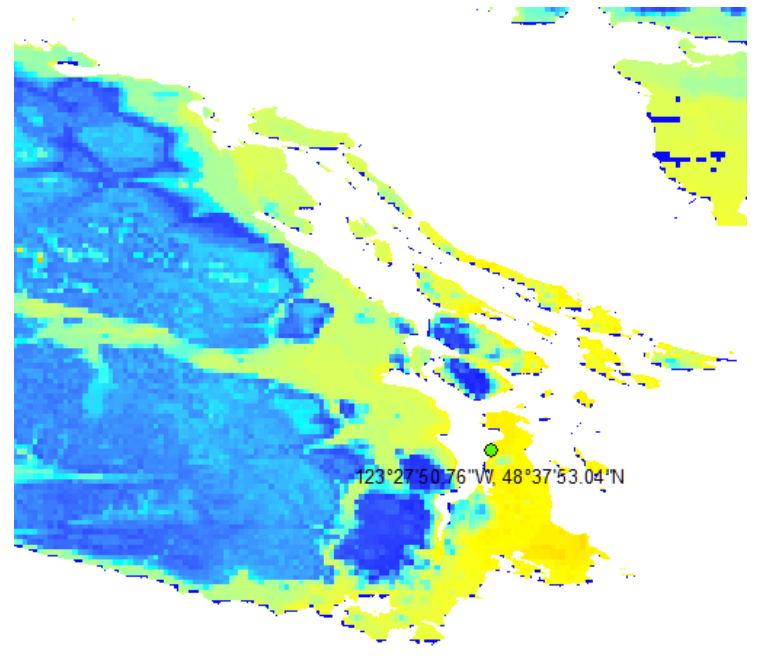
Probability of occurrence


[Remove Overlays](#)
[Download Overlay raster files](#)
[Desktop version](#)
[ClimateNA_Map](#)
[ClimateBC_Map](#)

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



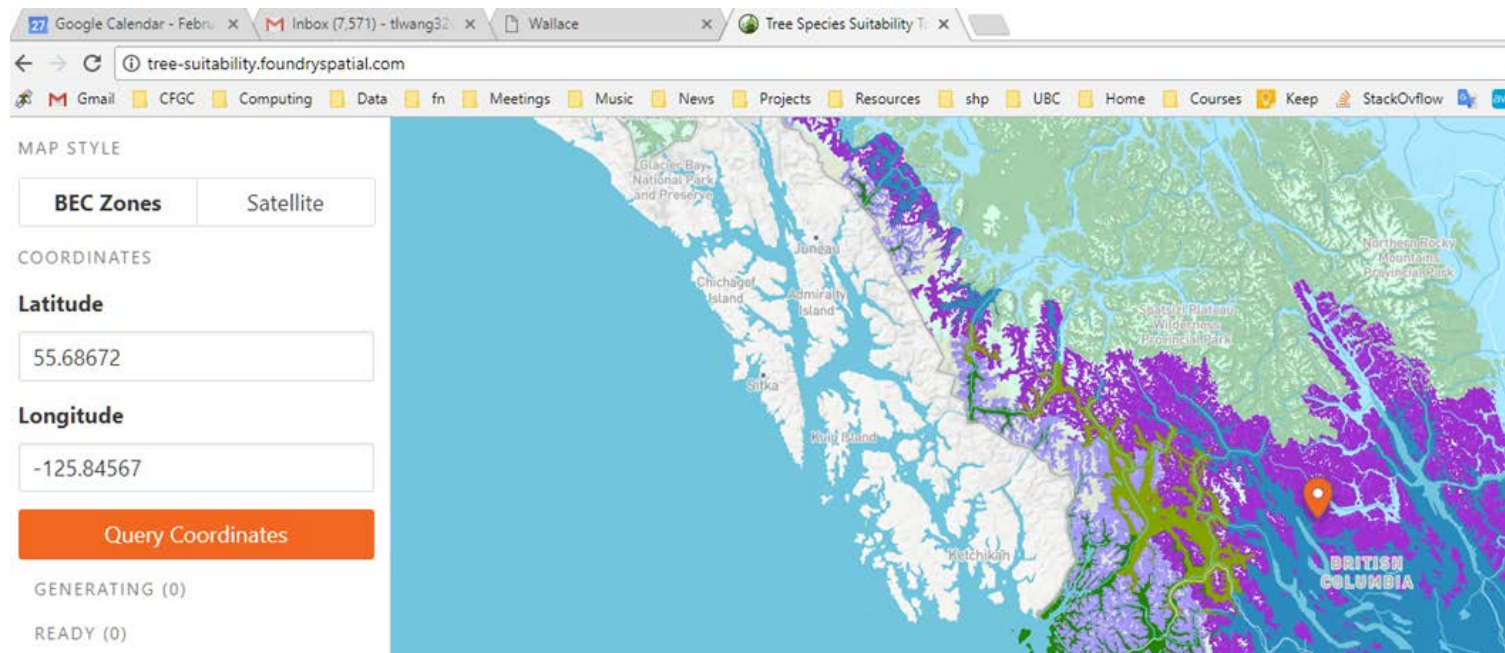
1961-1990 (PO=0.83)



2020s (PO=0.32)

New developments - ClimateBC API

- To facilitate integration to other web-based applications

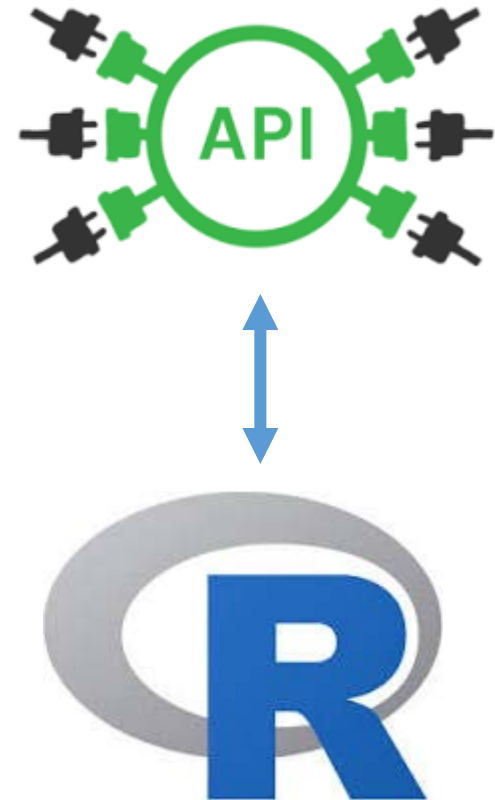


New developments - ClimateBC API

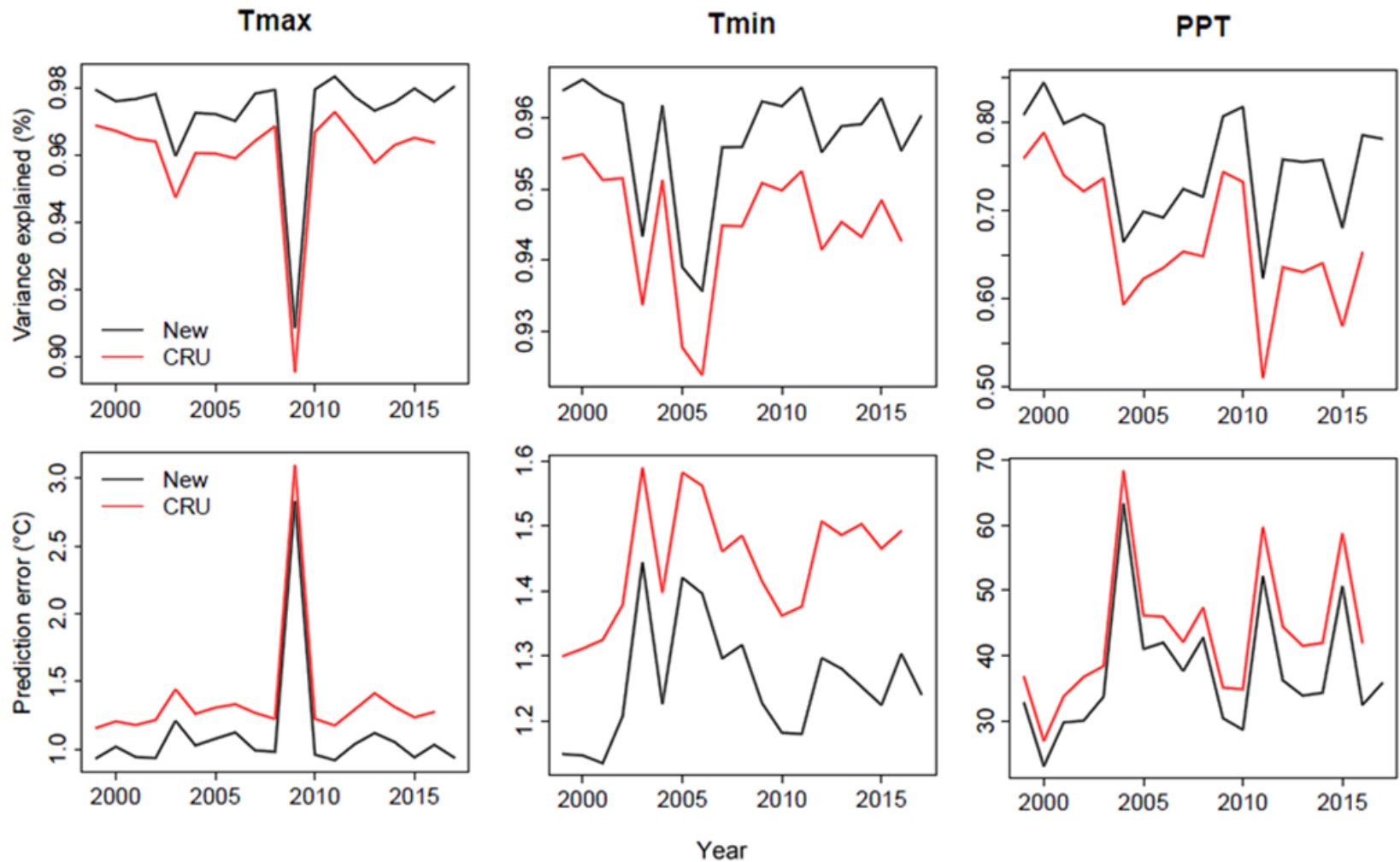
- To enable interactive integration with R environment

Almost all modeling works are using R!

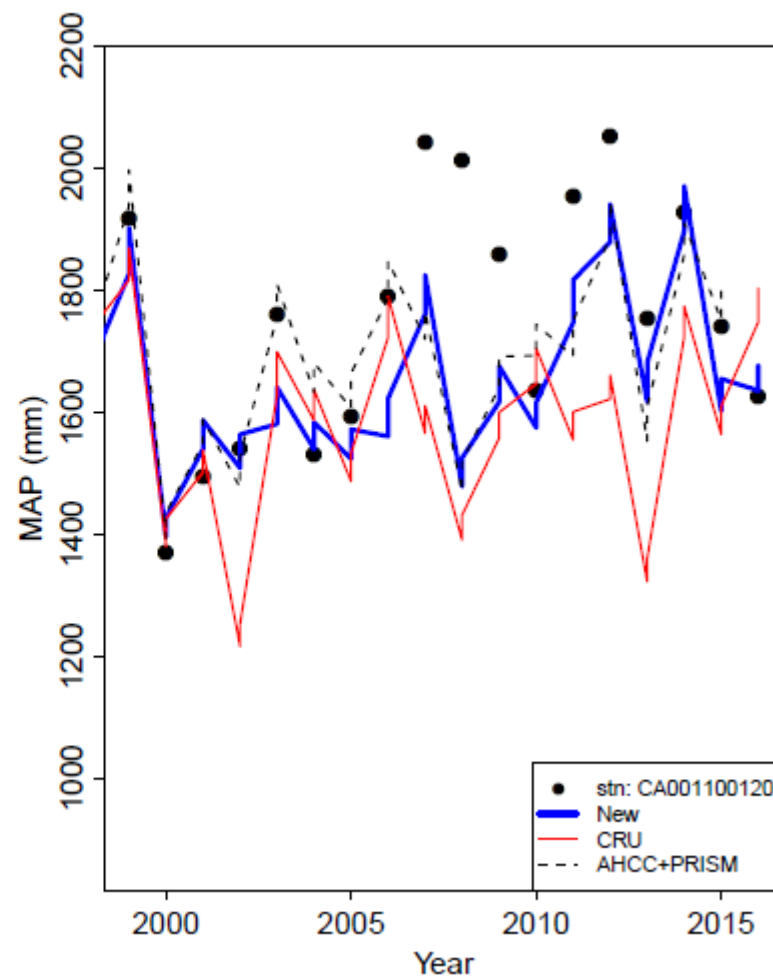
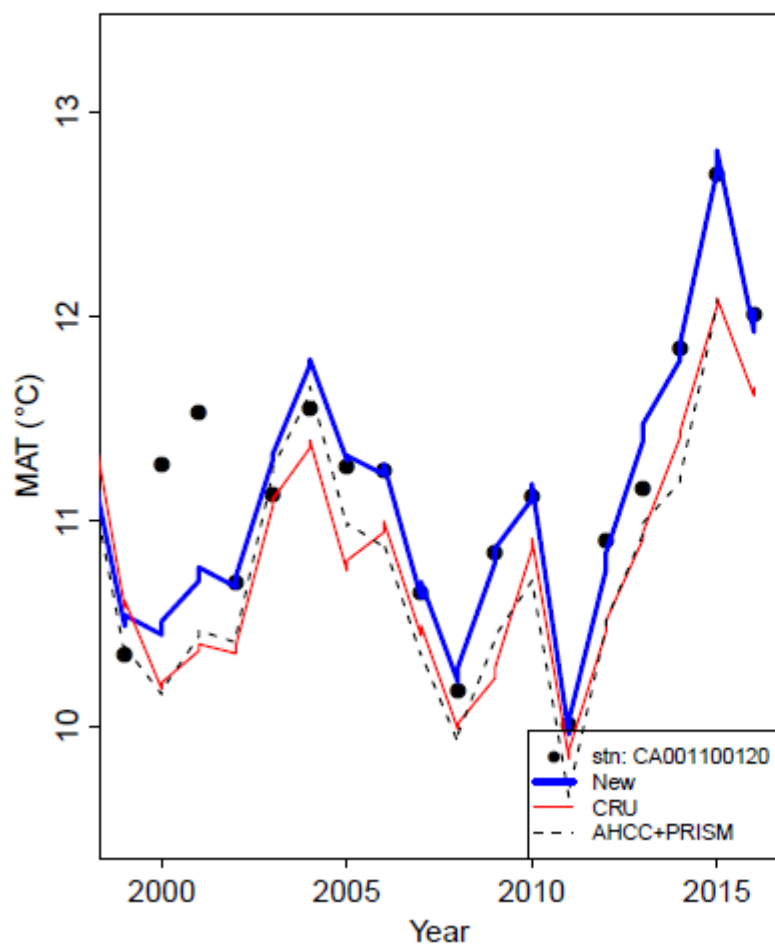
```
library(climatebcAPI)  
clm <- climatebcAPI(x, ysm='Y', period="1996")
```

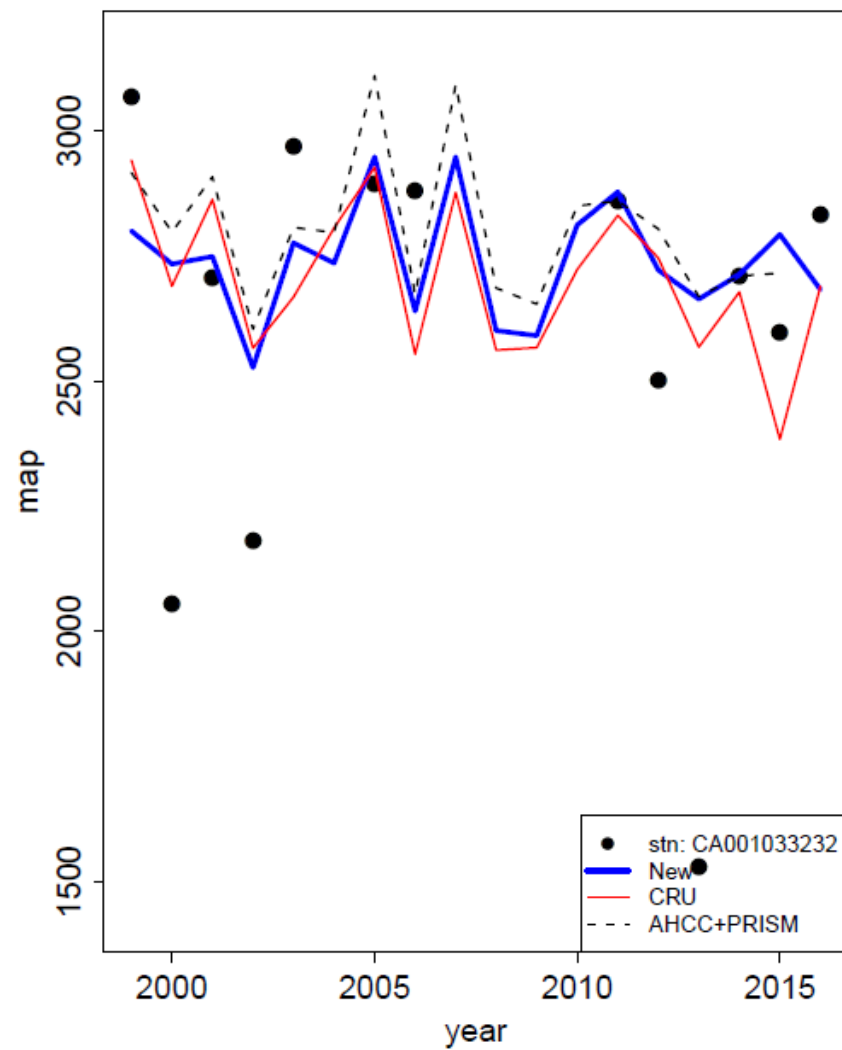
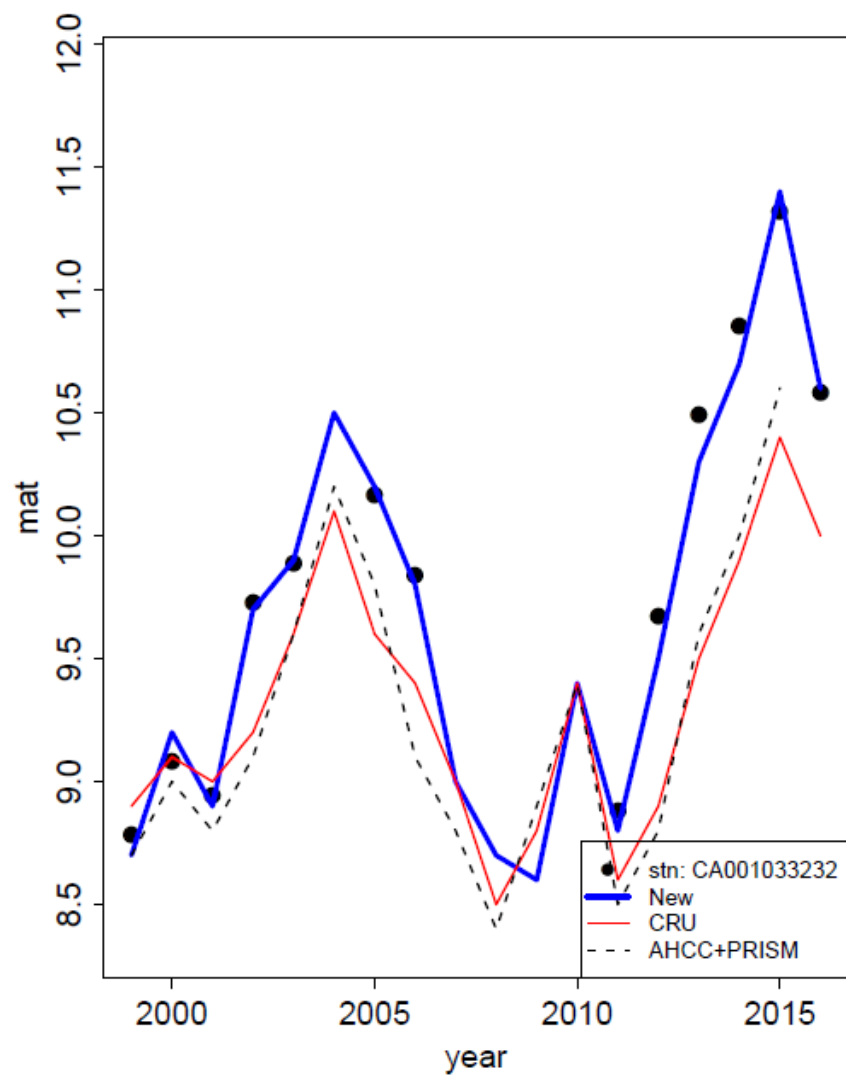


New developments – Replacing CRU monthly data for 1999 – 2017

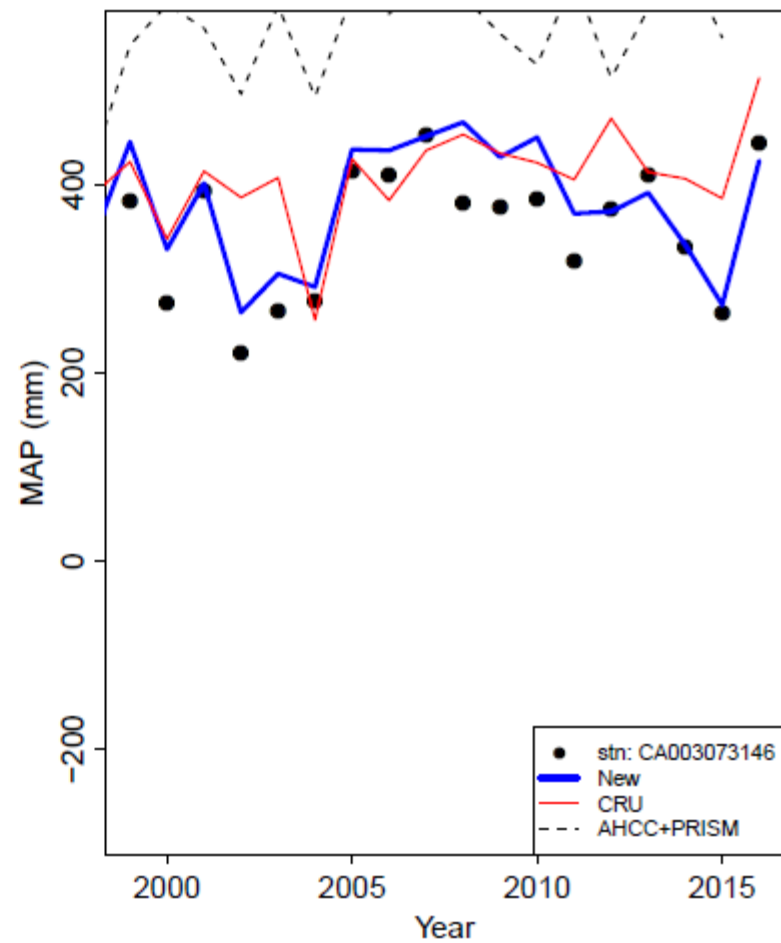
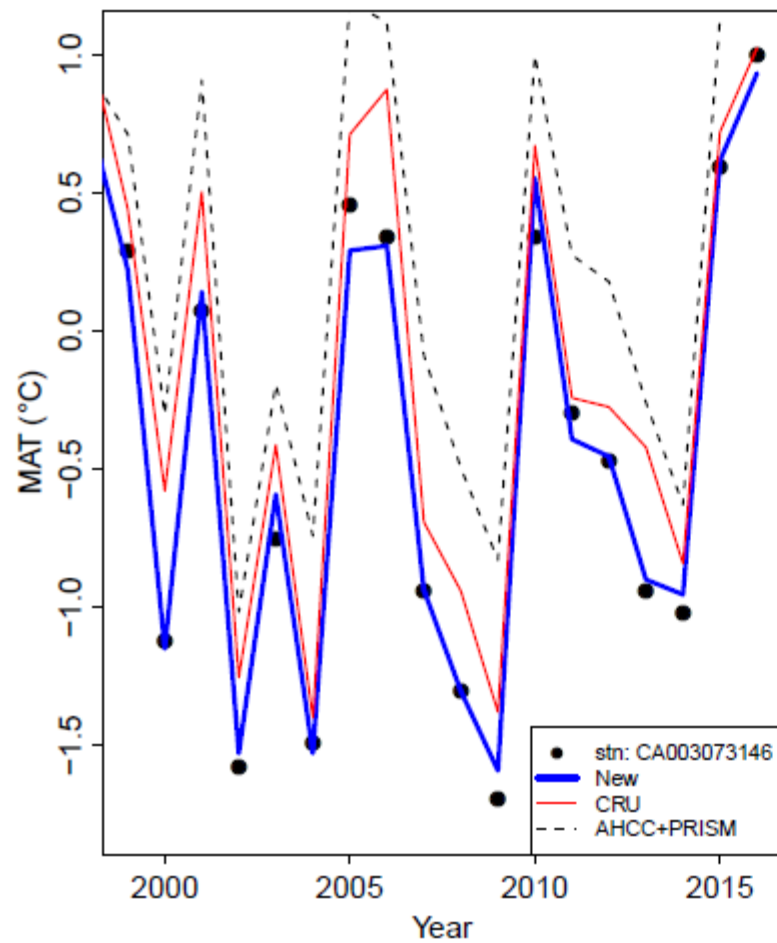


Comparisons in MAT and MAP by station and year



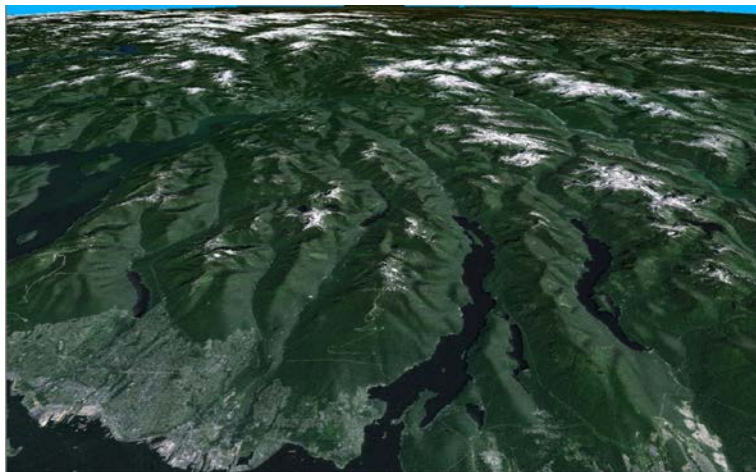


Comparisons in MAT and MAP by station and year

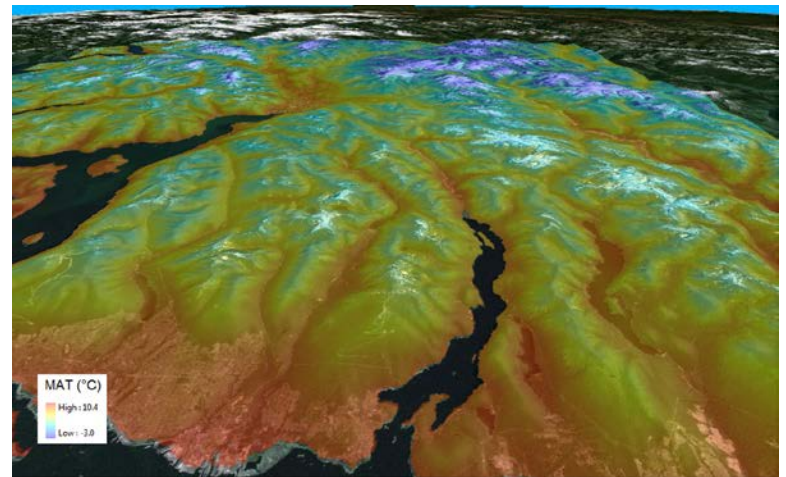


Future developments

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



ClimateBC



Where to get ClimateBC?

- Google: climatebc

Thanks!