

Climate Change Scenarios

Dave Spittlehouse,
Research Branch, BC Min. Forest & Range, Victoria, BC



Outline

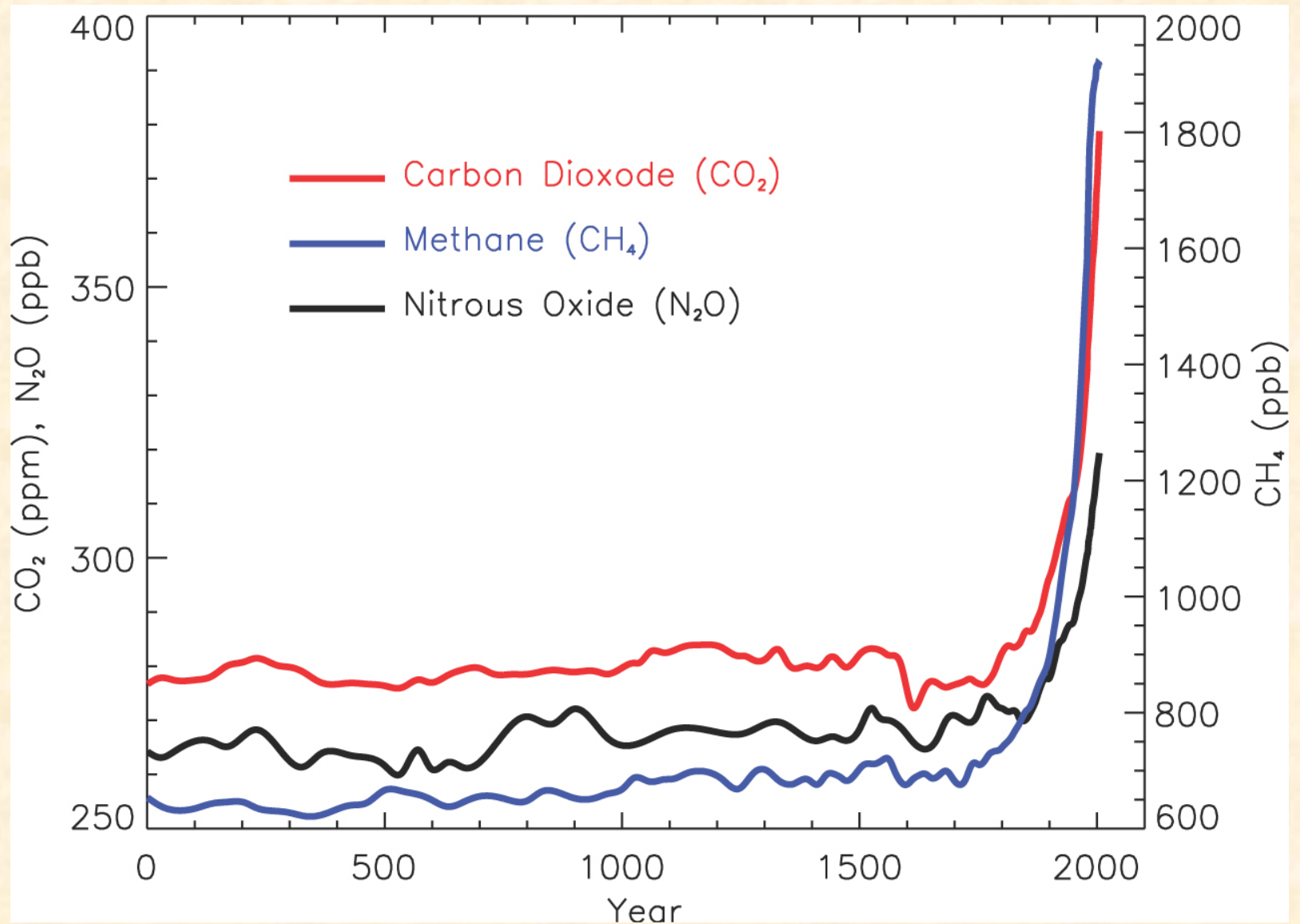
- What we know - recent changes in the Earth's climate, and biological and physical systems
- The "Greenhouse Effect"
- Forecasting the future
- Data availability
- Possible future BC climates

What we know

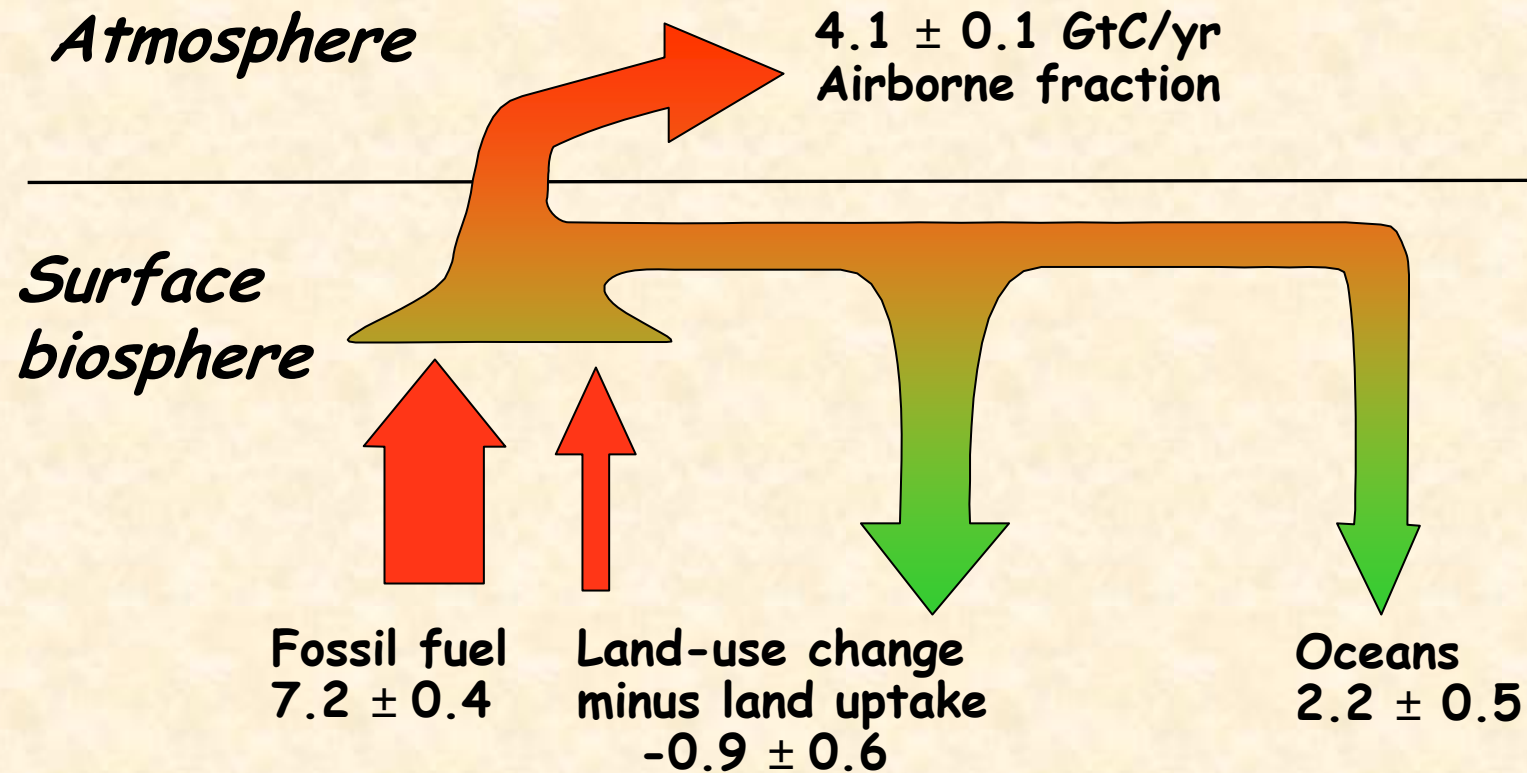
IPCC 4th Assessment

- Atmospheric concentrations of GHGs (CO₂, CH₄, N₂O, SO₂...) and aerosols are increasing
- Main source of the GHGs is human activity
- The atmosphere and oceans are warming
- Changes in precipitation regimes

Concentrations of Greenhouse Gases, 0 to 2005

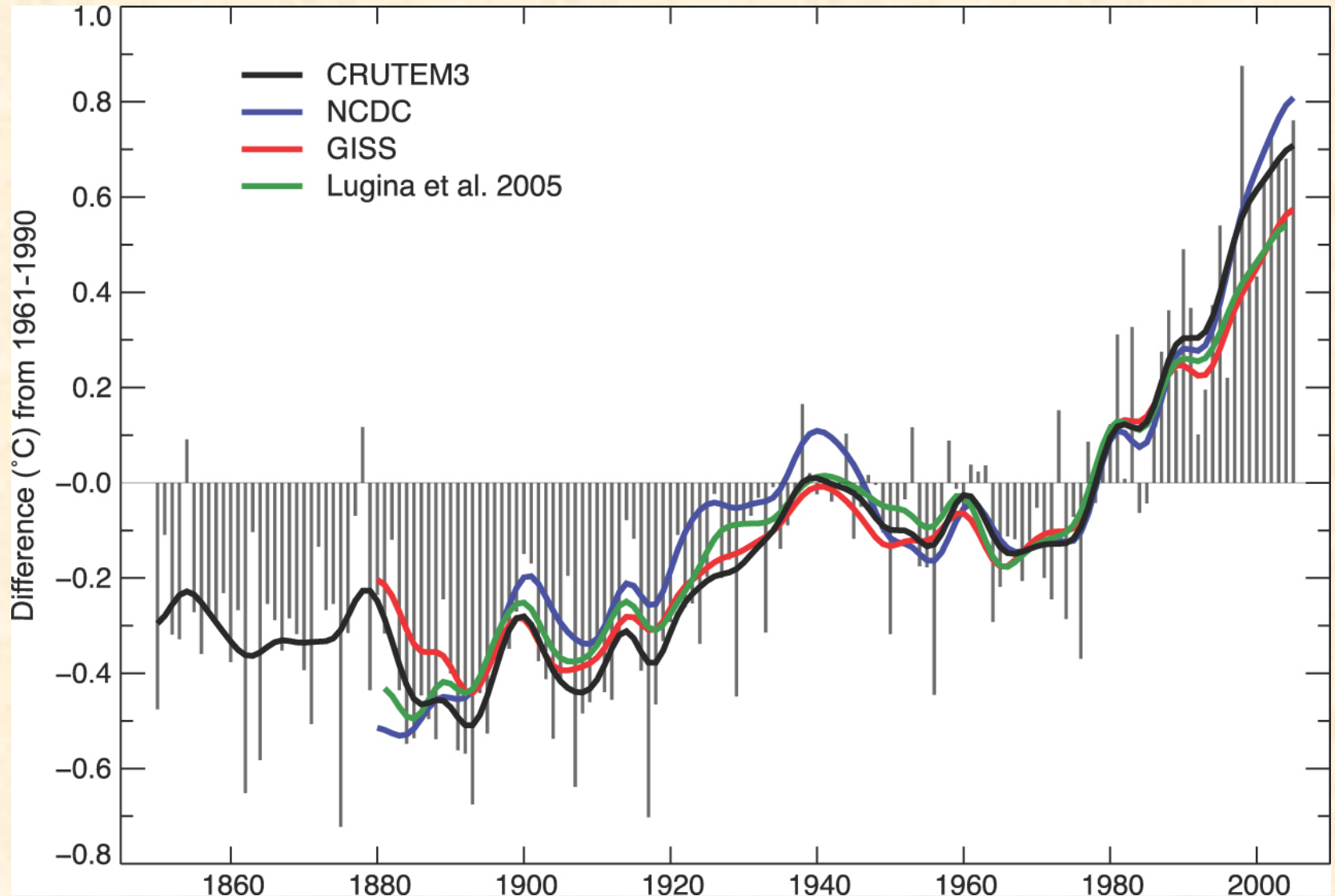


Sources and Sinks of Anthropogenic Carbon 2000-2005



(IPCC 2007)

Change in Global Surface Air Temperature



(IPCC 2007)

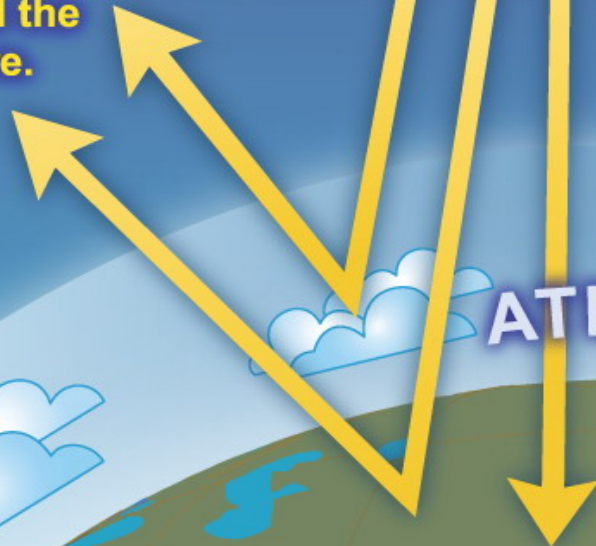
The Greenhouse Effect

Some of the infrared radiation passes through the atmosphere but most is absorbed and re-emitted in all directions by greenhouse gas molecules and clouds. The effect of this is to warm the Earth's surface and the lower atmosphere.

Solar radiation powers the climate system.



Some solar radiation is reflected by the Earth and the atmosphere.

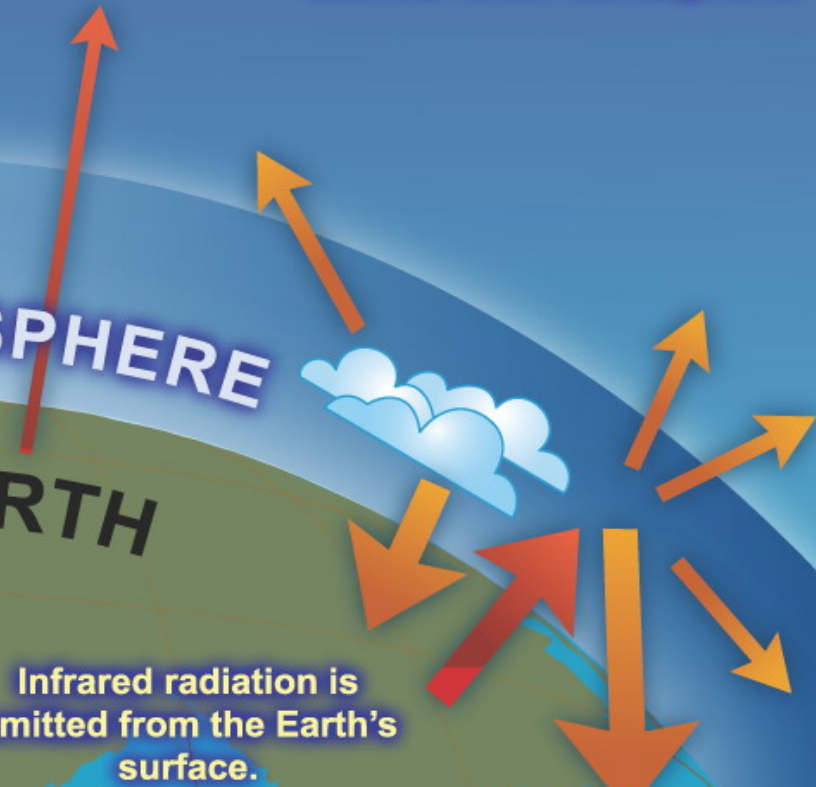


ATMOSPHERE

EARTH

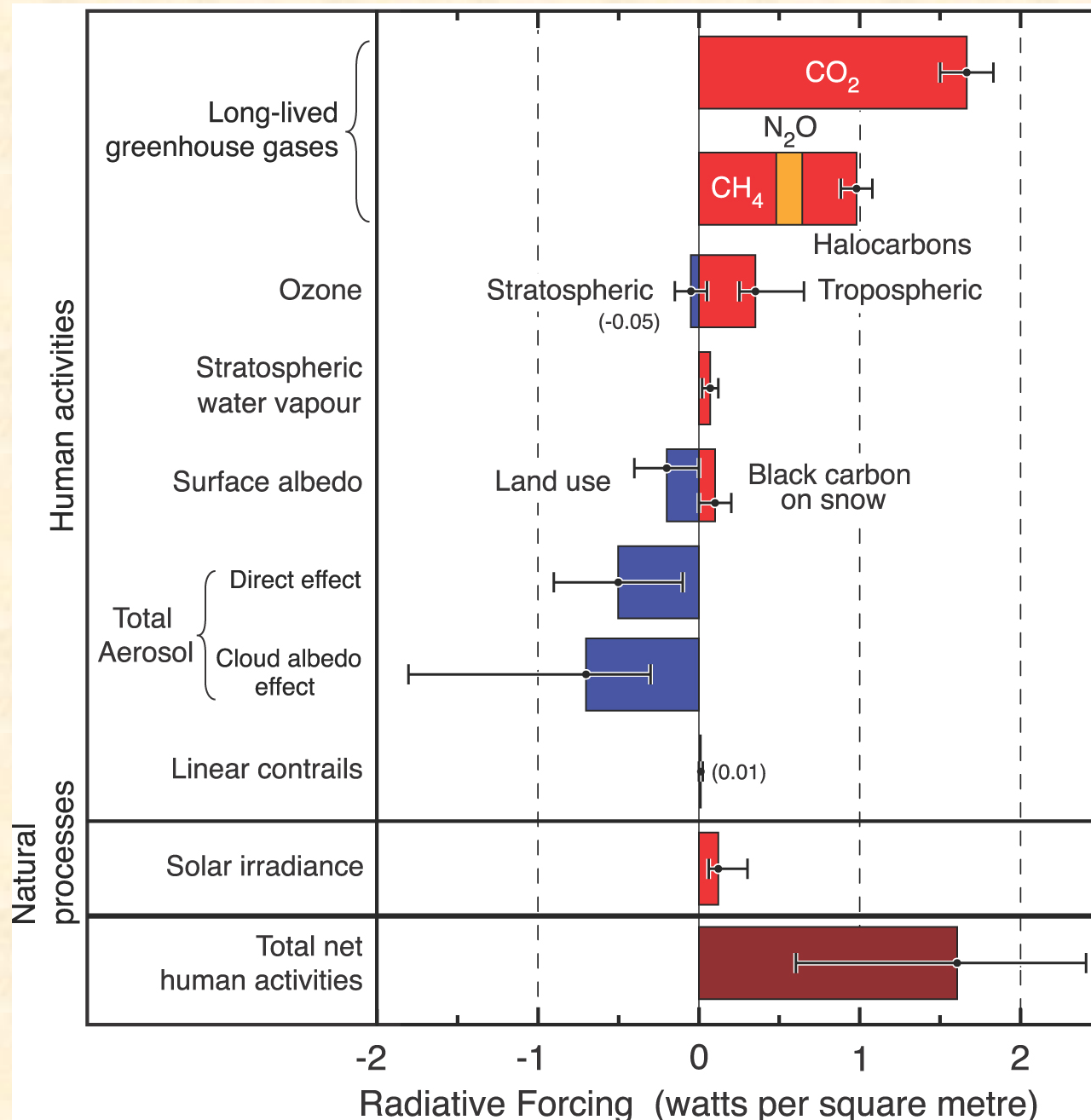
About half the solar radiation is absorbed by the Earth's surface and warms it.

Infrared radiation is emitted from the Earth's surface.



(IPCC 2007)

Radiative forcing of the climate, 1750 to 2005



Responses to the change in climate

- Glaciers, ice caps, arctic sea ice and permafrost are melting
- Sea level is rising
- Oceans are acidifying
- Range extensions of plants and animals
- Advance in timing of leaf out and arrival of migrant animals
- Excess mortality due to high temperature

The Climate Change Issue

- It's all about US
- Values
- Lifestyle
- Inequities in resource use and impacts of climate change

Forecasting the Future

- Emission scenarios and global climate models
- Continued release of greenhouse gases at or above current rates will exacerbate the warming.
- This will have significant social, physical and biological consequences.

Future Greenhouse Gas Emissions (SRES)

International cooperation, economy, population, governance, technology

Global
development
focus

A1

A2

Regional
emphasis

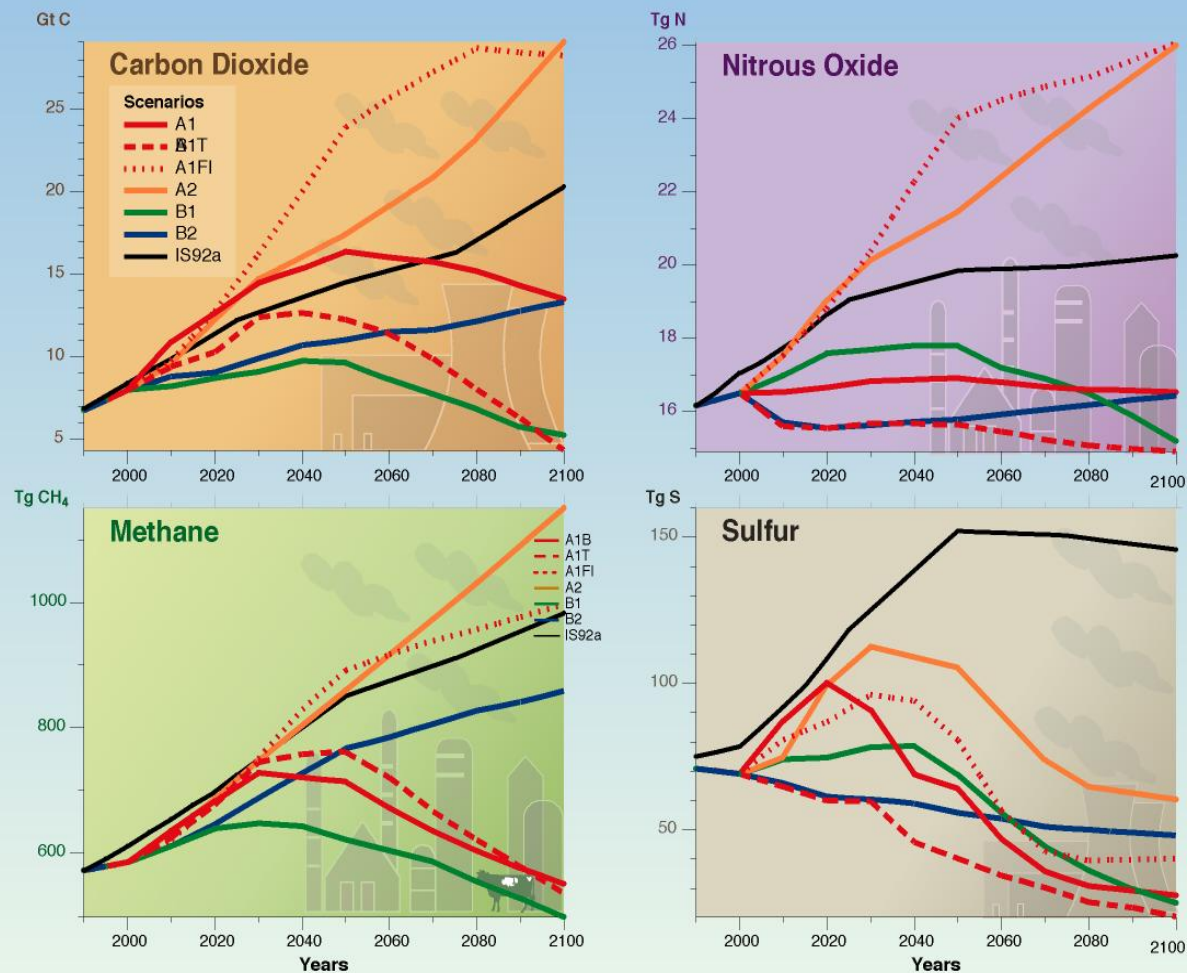
B1

B2

Environmental
emphasis

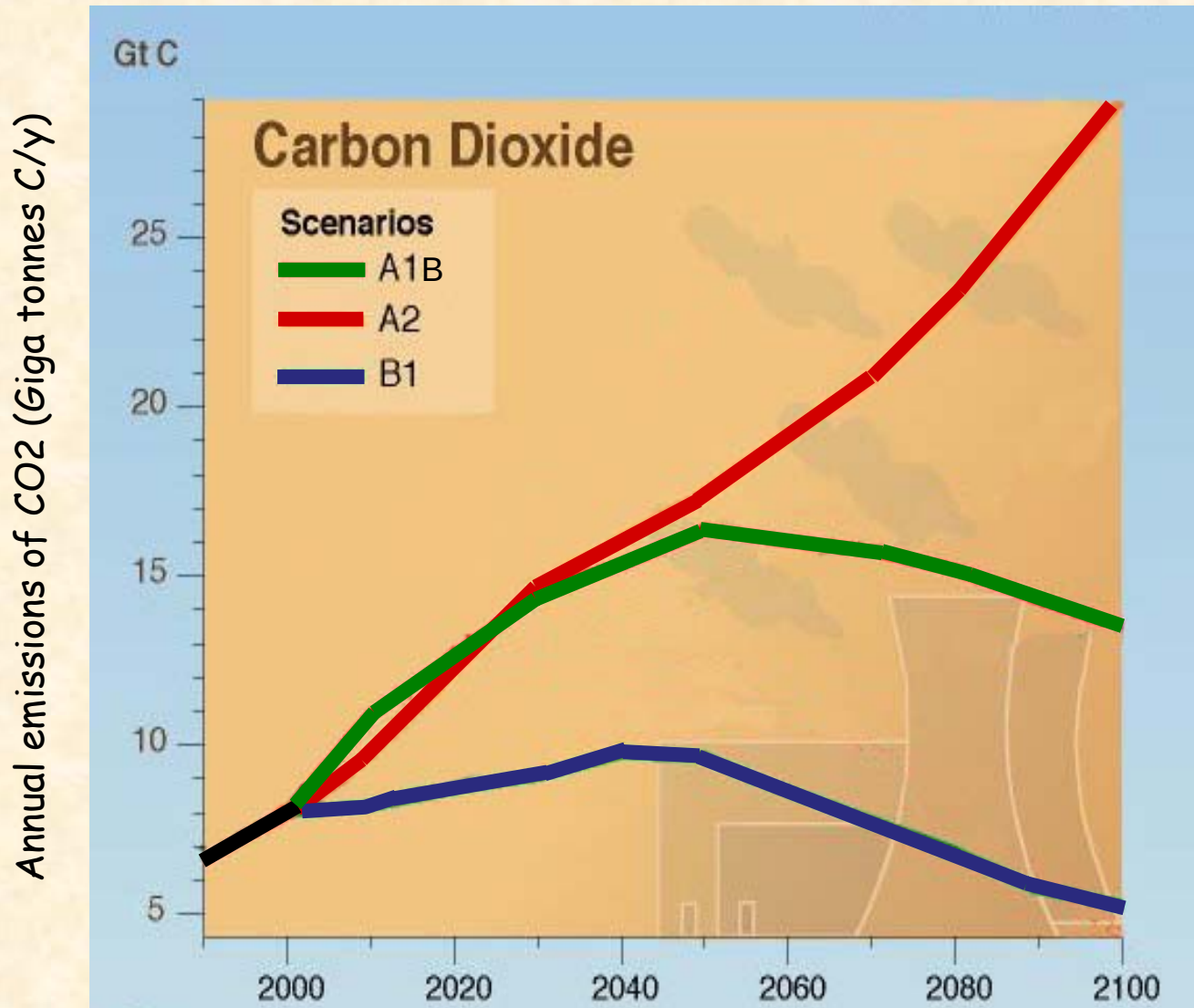
Economic
emphasis

Anthropogenic emissions of CO₂, CH₄, N₂O and SO₂ for the six SRES scenarios



WG1 TS FIGURE 17

CO₂ emissions scenarios



(IPCC - Climate Change 2007: The Physical Science Basis)

Forecasting Future Climates

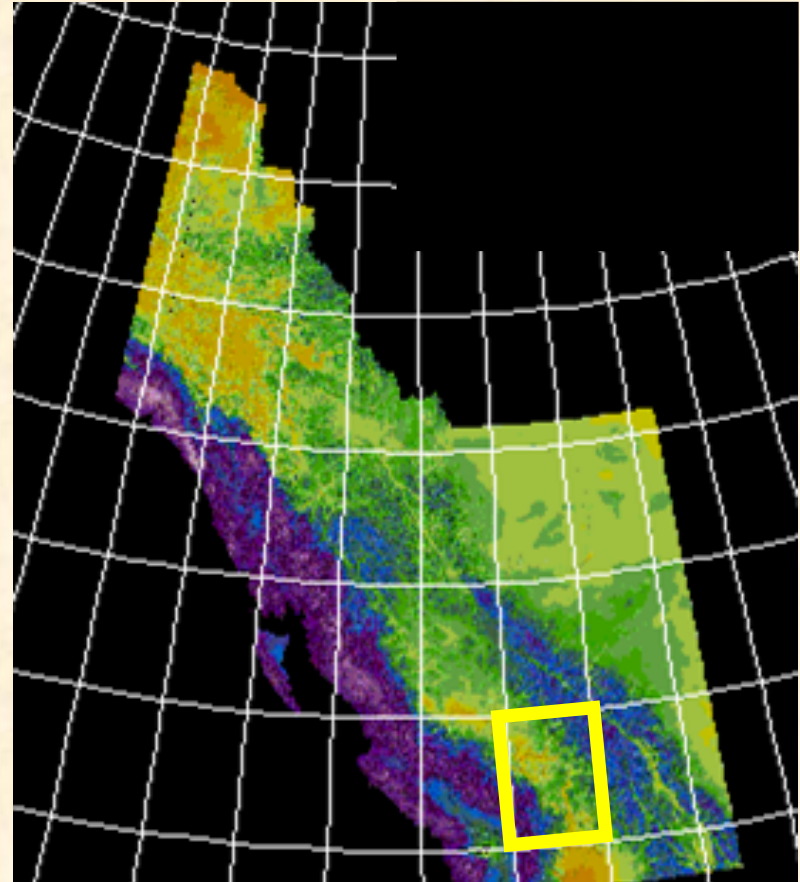
Limitations

- Resolution
- Representation of physical processes
- Representation of surface

Assessment

- Reproduce observed features of recent climate
- Credible quantitative estimates at a continental scale
- Confidence higher for temperature than precipitation
- Inter-model variability

Global Climate Models

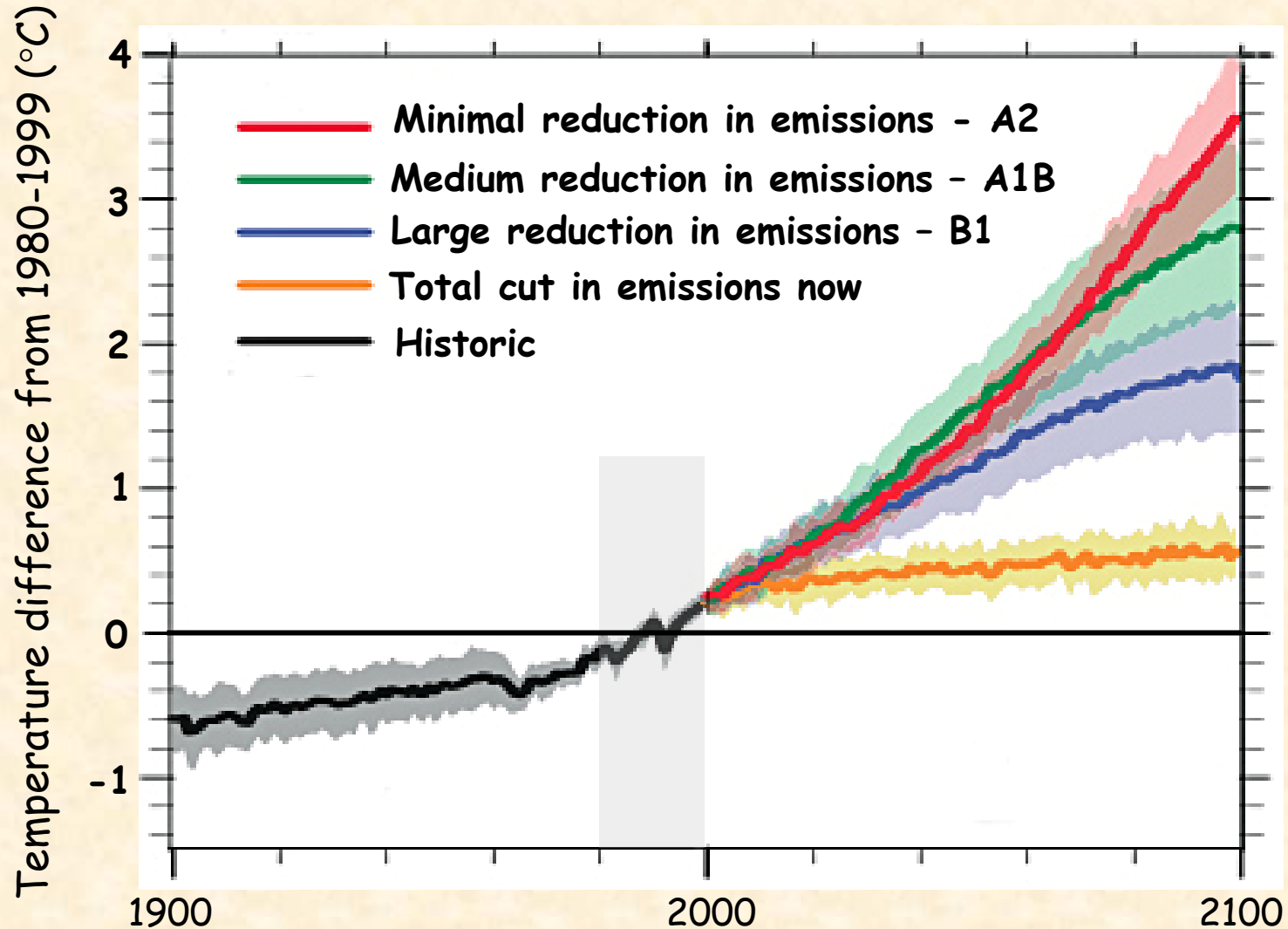


Many Possible Futures

- Emission scenarios
- Variability between global climate models
- Variation between runs for the same model and the same emission scenario

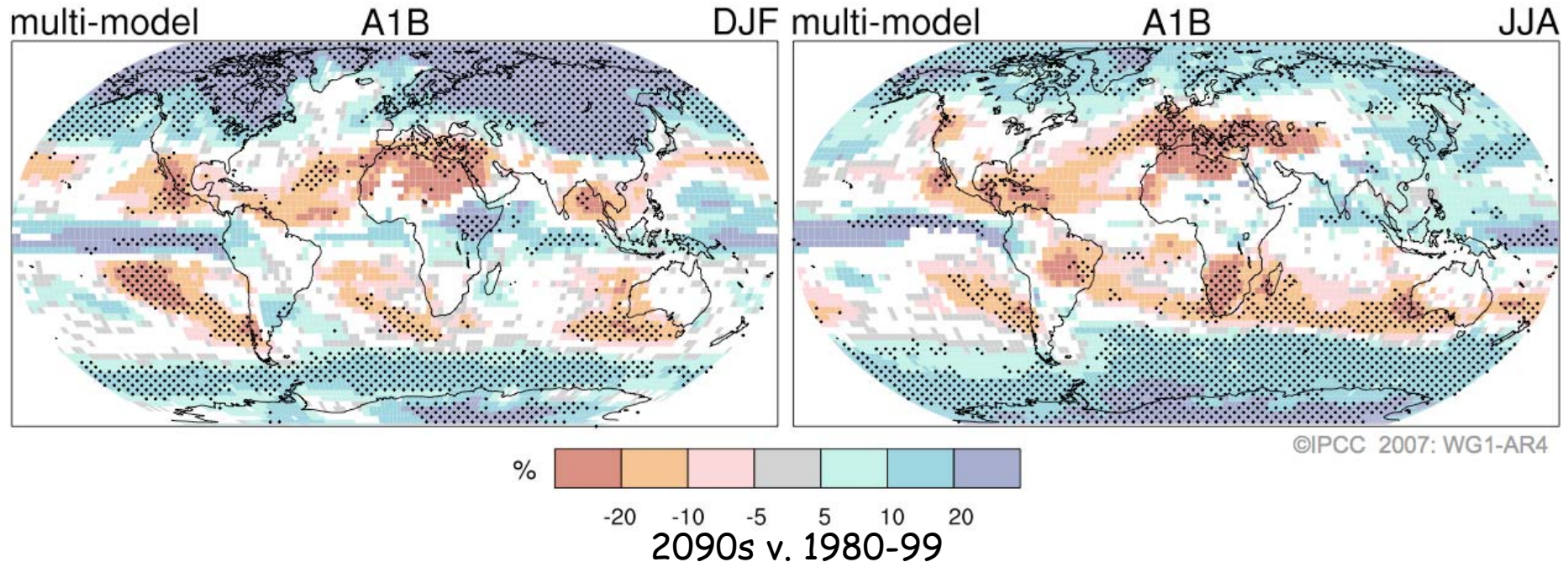
Future Climates

Increase in Global Mean Temperature



(Adapted from IPCC - Climate Change 2007: The Physical Science Basis)

Projected Patterns of Precipitation Changes



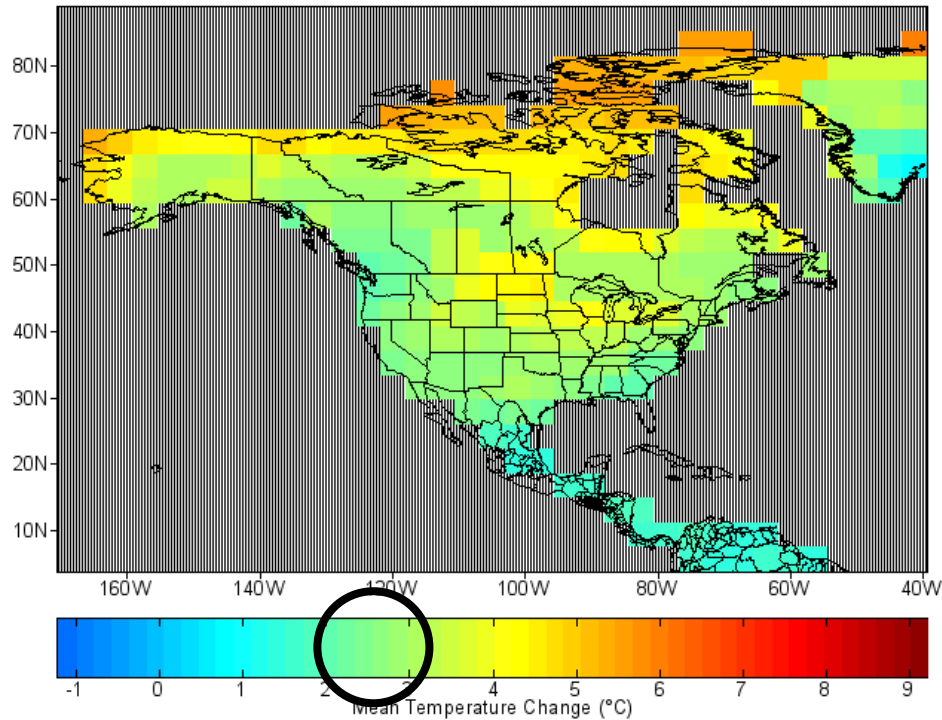
Percentage change in the annual precipitation in 2090s relative to 1980-1999.

Data availability

- IPCC www.ipcc.ch
- Summaries of future climates
Pacific Climate Impacts Consortium
www.pacificclimate.org

ClimateBC $\Rightarrow$ ClimateWNA
genetics.forestry.ubc.ca/cfgc/climate-models.html
- Range changes of plants
Eastern US Tree Atlas www.nrs.fs.fed.us/atlas/
BC www.ales2.ualberta.ca/RR/people/hamann/climate

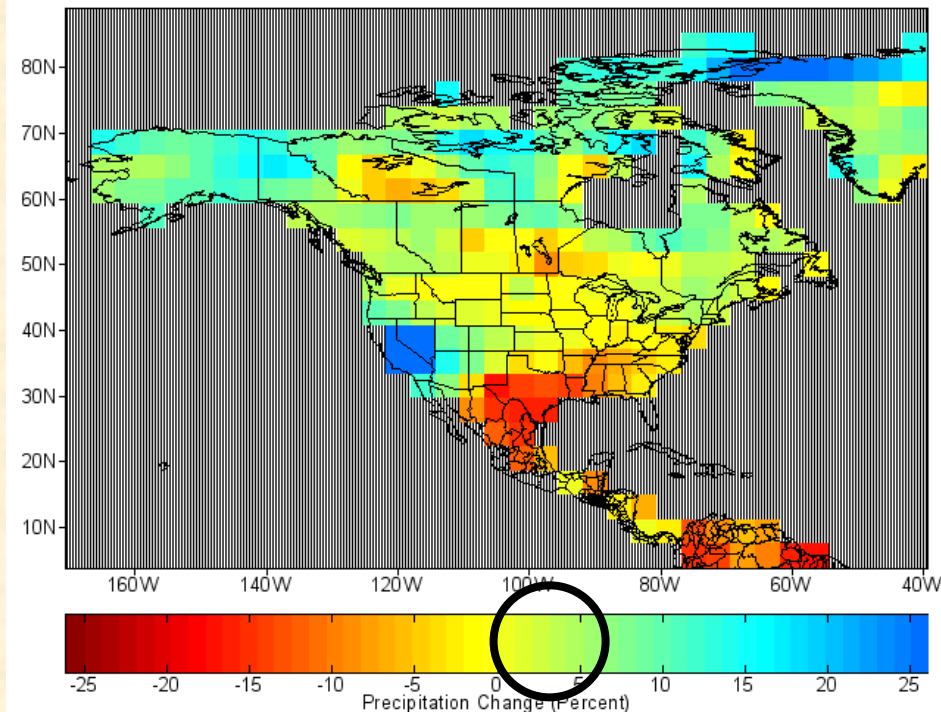
Pacific Climate Impacts Consortium - Regional Analysis Tool



Temperature

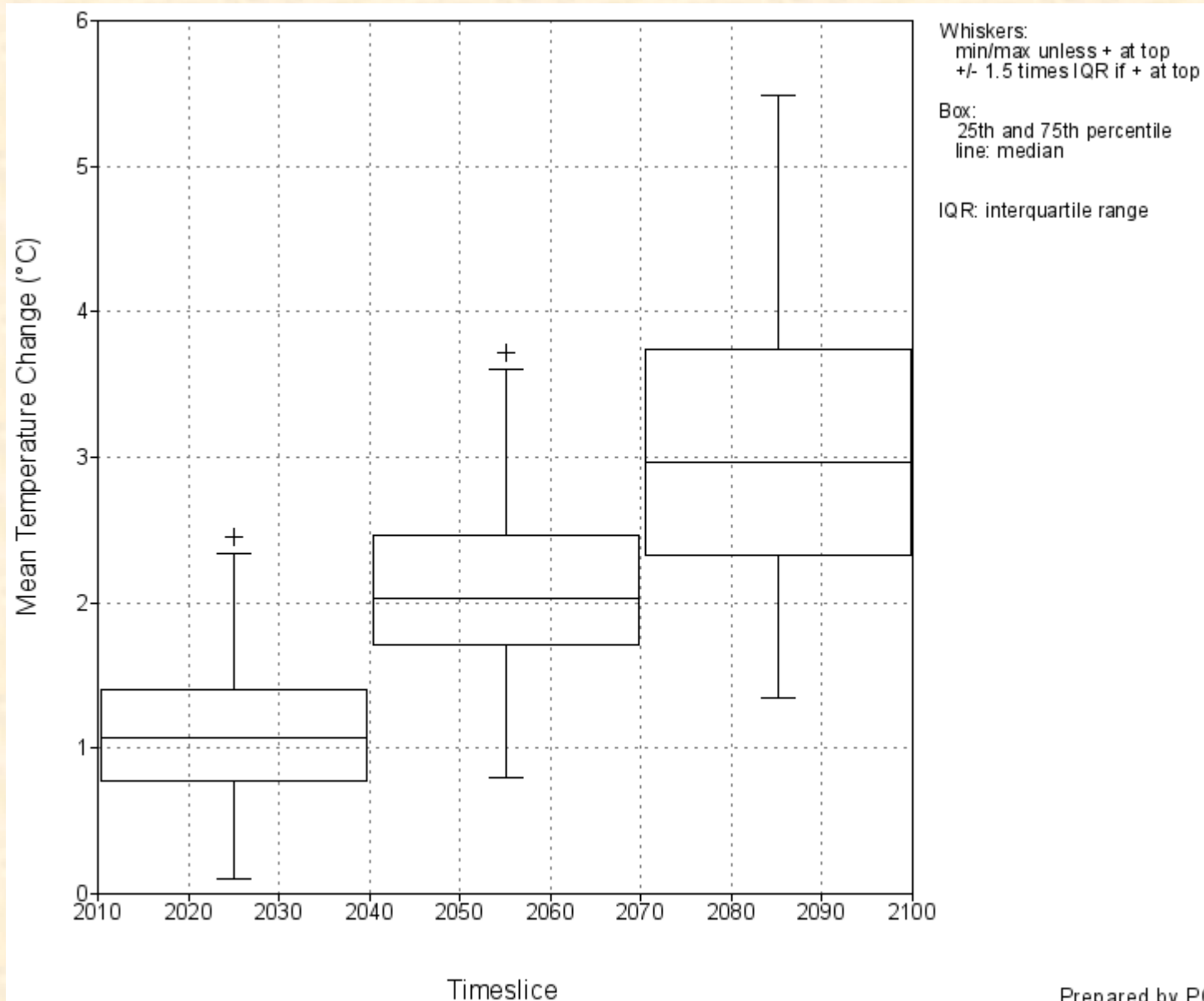
Precipitation

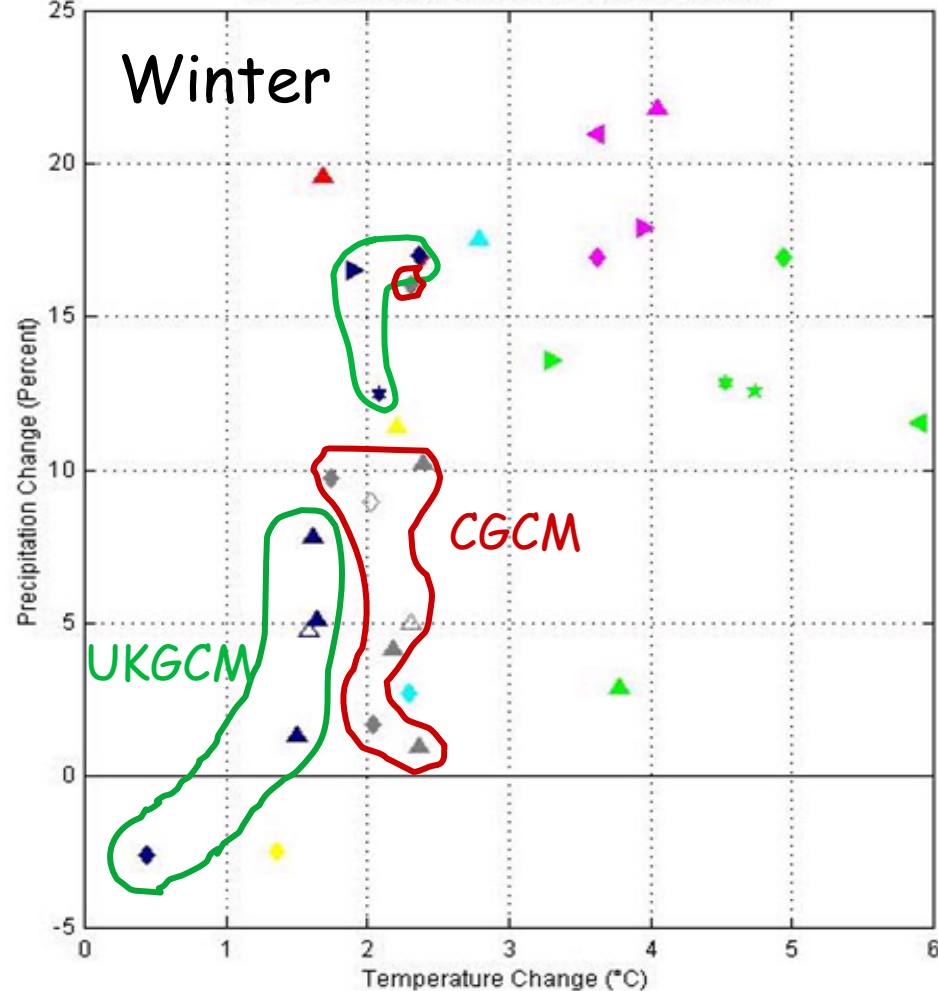
Change in Mean Annual Temperature and Mean Annual Precipitation by 2050s for the A2 Scenario



(<http://www.pacificclimate.org>)

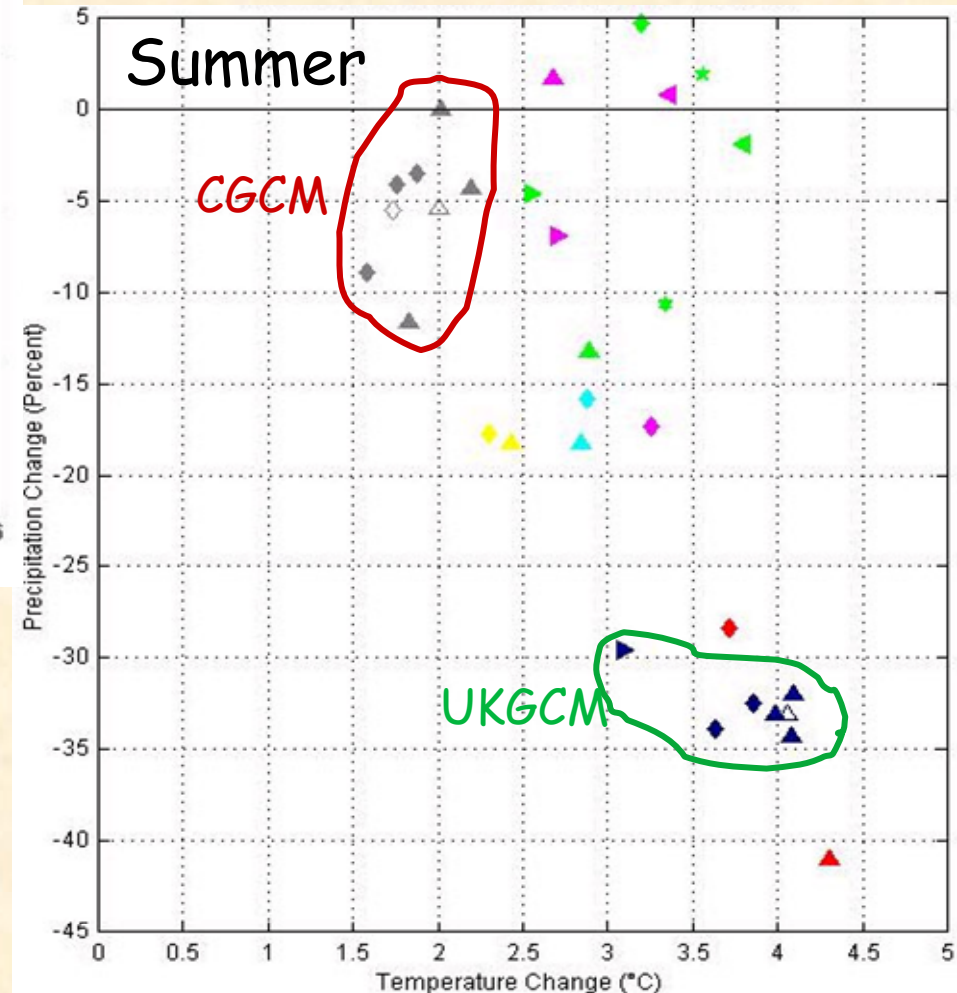
Change in mean annual temperature, southern BC, 2020s, 2050s, 2080s, all SRES and models





Change in mean winter and summer temperature and precipitation for 2050s, Southern BC. (Seven global climate models and eight emission scenarios.

<http://www.pacficclimate.org>)



ClimateBC - High spatial resolution climate data

ClimateBC_v3.0 Copyright (2005) Wang,T., Hamann,A., Spittlehouse,D.L. and Aitken,...

Select Time Scale
☒ Annual ☐ Season ☐ Monthly

Select Period
 Normal 1961-1990 Period: Normal 1961-1990

Coordinate Input ☐ Decimal ☒ DMS

Latitude 48° 38' 00" N
 Longitude 123° 26' 05" W
 Elevation (m) 20

Output of annual variables

MAT	MWMT	MCMT	TD	MAP	MSP	AH:M	SH:M	EMT	PAS
9.8	16.4	3.6	12.8	887	149	22.3	110.3	-14	46

DD<0	DD>5	DD5_100	DD<18	DD>18	NFFD	FFP	bFFP	eFFP
56	1983	90	2850	45	318	217	92	309

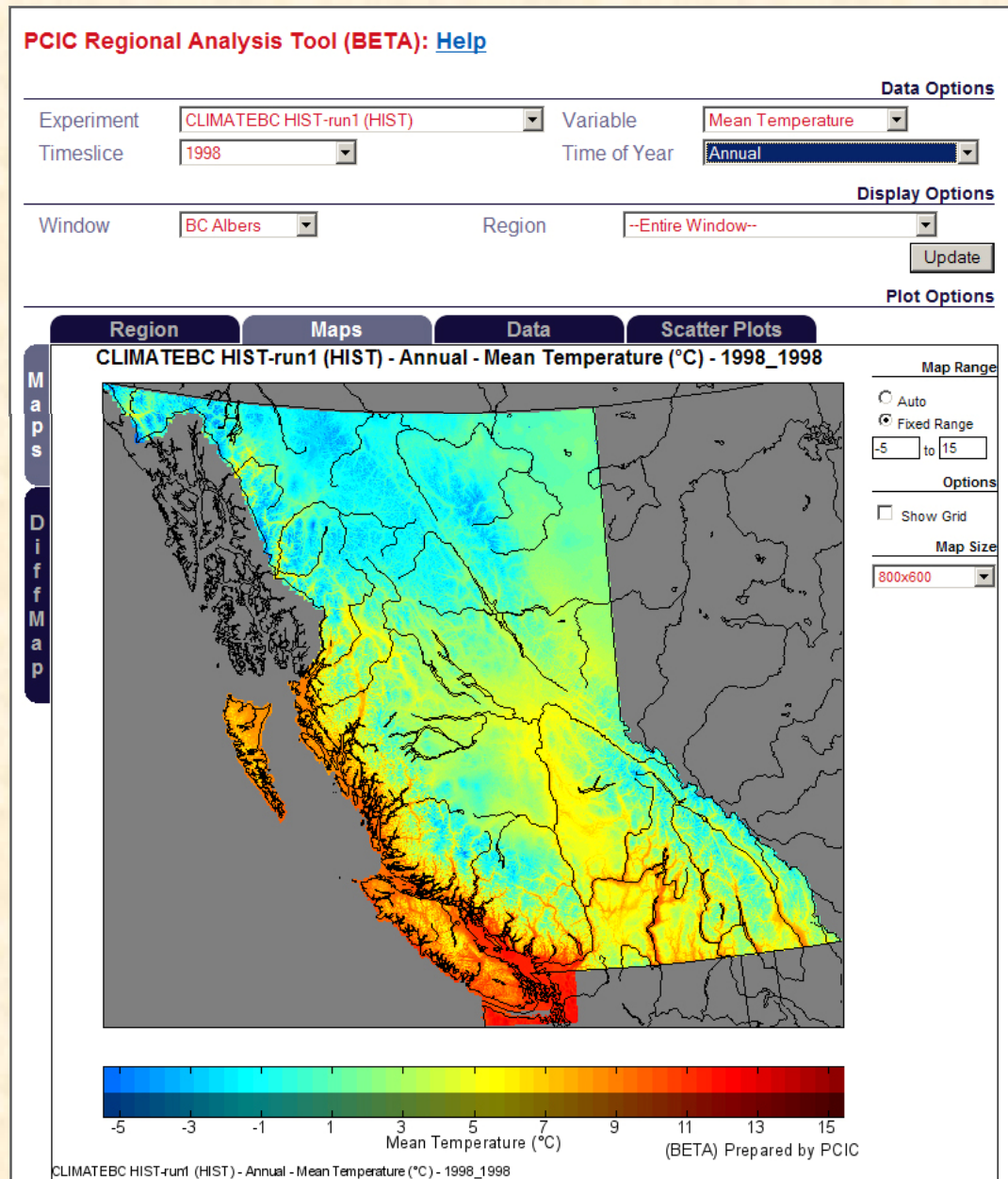
Multi-location

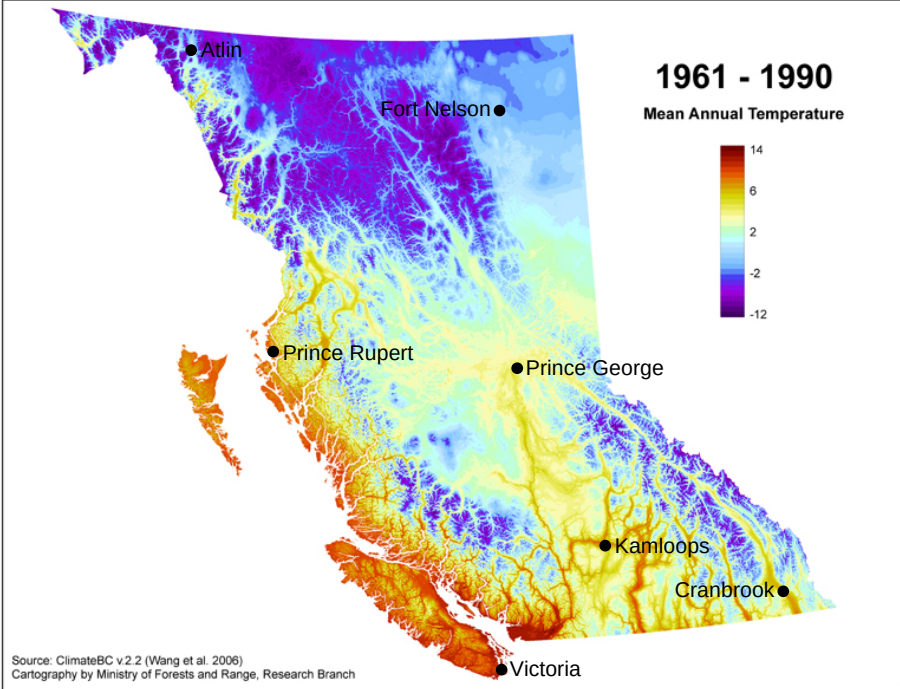
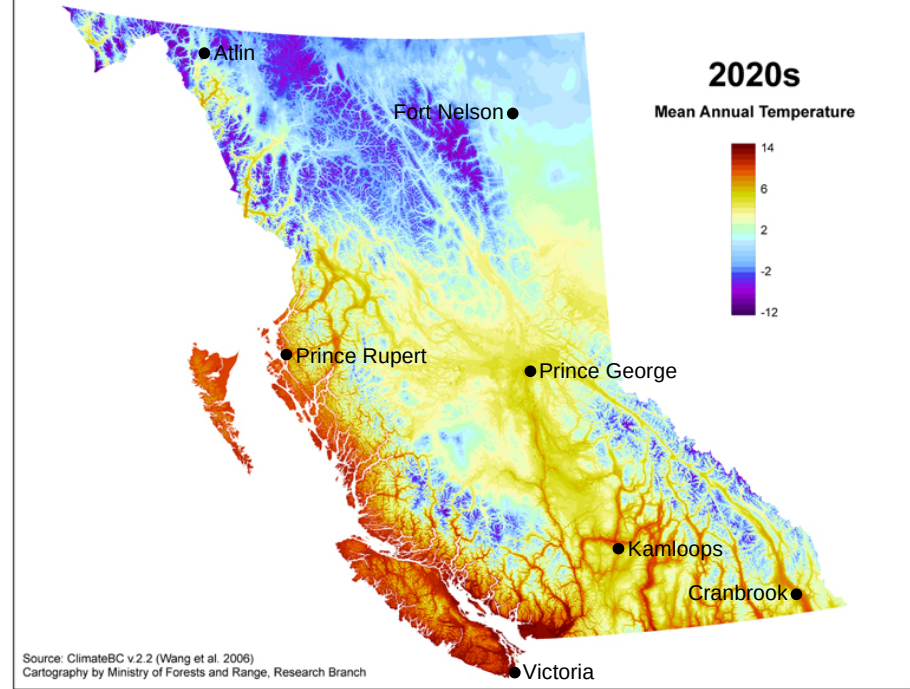
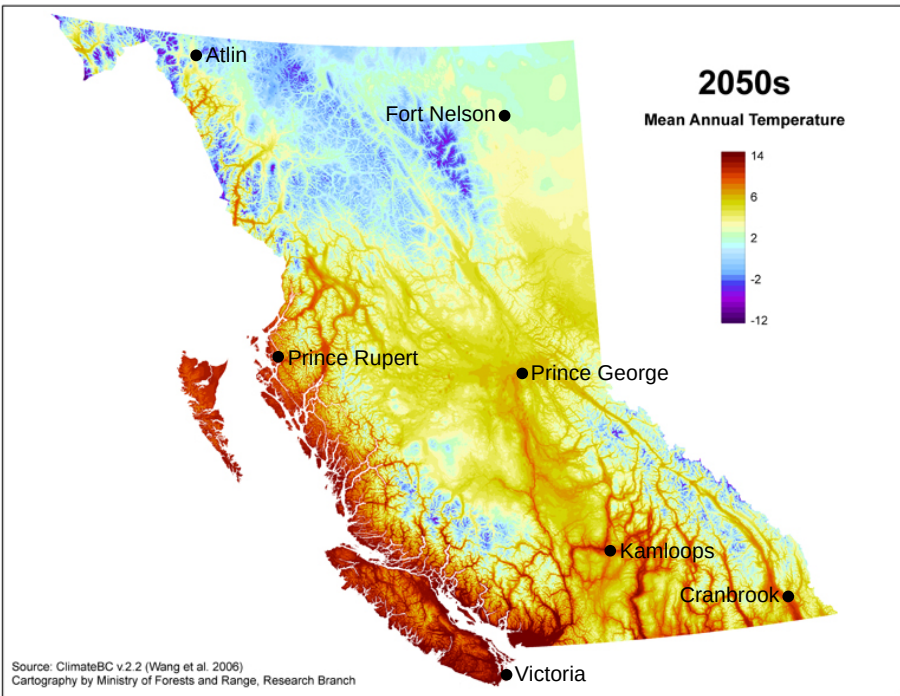
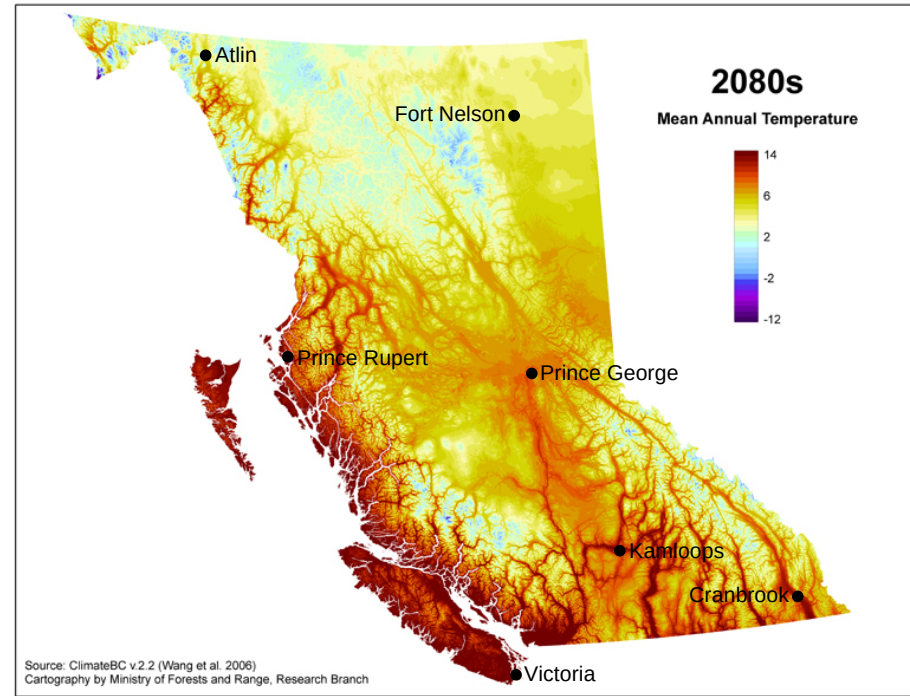
Select input file Specify output file Calculate

Status

Select Period
 Future Periods
 CGCM1_gax_2020s.g
 CGCM1_gax_2050s.g
 CGCM1_gax_2080s.g
 CGCM2_A1FI_2000s.s
 CGCM2_A1FI_2010s.s
 CGCM2_A1FI_2020s.s
 CGCM2_A1FI_2030s.s
 CGCM2_A1FI_2040s.s
 CGCM2_A1FI_2050s.s
 CGCM2_A1FI_2060s.s
 CGCM2_A1FI_2070s.s
 CGCM2_A1FI_2080s.s
 CGCM2_A1FI_2090s.s
 CGCM2_A2_2020s.gc
 CGCM2_A2_2050s.gc
 CGCM2_A2_2080s.gc
 CGCM2_A2x_2020s.g
 CGCM2_A2x_2050s.g
 CGCM2_A2x_2080s.g
 CGCM2_B1_2020s.gc
 CGCM2_B1_2050s.gc
 CGCM2_B1_2080s.gc
 CGCM2_B2_2000s.gc
 CGCM2_B2_2010s.gc
 CGCM2_B2_2020s.gc
 CGCM2_B2_2030s.gc
 CGCM2_B2_2040s.gc
 CGCM2_B2_2050s.gc
 CGCM2_B2_2060s.gc
 CGCM2_B2_2070s.gc

Historic and climate change data visualization and access



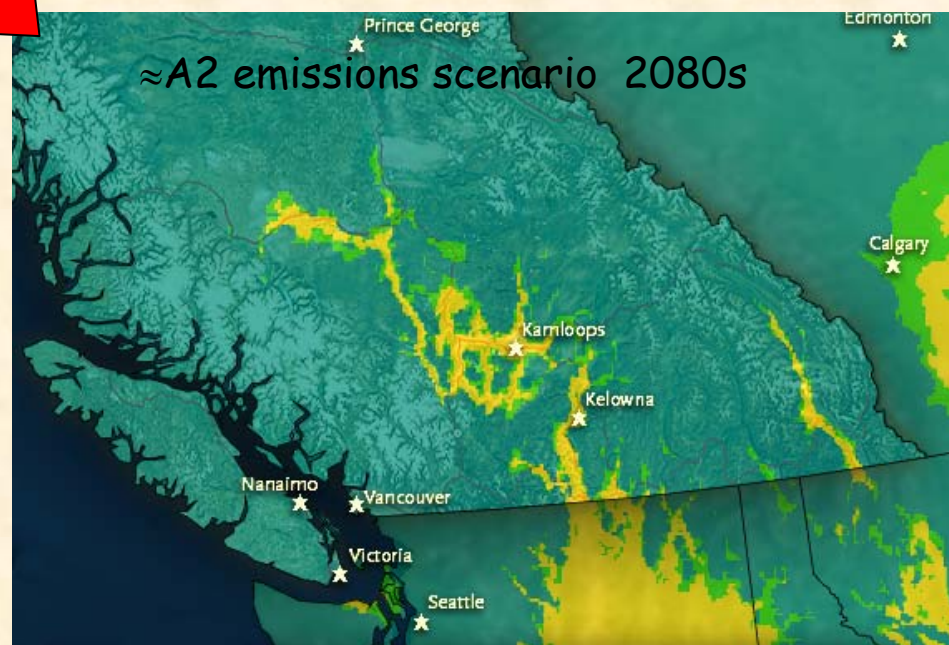




Grassland/forest biome climates



(Royal BC Museum, 2006)



Future BC Climates - Temperature, 2080s

- A2 - 3 to 5°C MAT warming
- B1 - 2 to 3°C MAT warming
- Winter minimum: Northern BC 4 to 9°C warming (range of B1 to A2)
Southern BC 3 to 7°C
- Summer maximum: 2 to 4 °C warming
- Increase in temperature extremes
- Increased evaporative demand

Future BC Climates - Precipitation, 2080s

- A2 greater change than B1
- Winter: All of BC 5-20% wetter
- Summer: North 5-10% wetter
South and Central 5-35% drier
- Volume change is relatively small
except on coast in winter
- Increase in precipitation intensity
- Inter-annual variability dominates

Implications

- Species and ecosystems adapted to current not future conditions
- Vegetation change will lag climate
- Increase in disturbances
- Hydrologic changes
- Change migration patterns
- Change priorities for resource use

Summary - IPCC 4th Assessment

- Warming of the Earth's climate is unequivocal.
- Most of the warming is very likely due to the increase in greenhouse gases from anthropogenic activity.
- Natural systems are being affected by the warming.
- Continued release of greenhouse gases at or above current rates will exacerbate the warming.
- This will have significant social, physical and biological consequences.

Next steps

- FFEI
- Awareness & capacity building
- Vulnerability assessments
- Improved data availability
- Research on potential impacts
- Adaptation - risk management

