Climate Program Memo

August 2021

Re: Understanding the Working Group I Contribution to the IPCC Sixth Assessment Report (August 7, 2021) - The Physical Science Basis

What is this report?

- This report summarizes the most updated physical understanding of the climate system and climate change, bringing together the latest advances in climate science, and combining multiple lines of evidence from paleoclimate, weather observations, process understanding, global and regional climate simulations. It shows *how and why climate has changed to date* and improved understanding of human influence on climate change characteristics, including extreme events.
- The IPCC itself does not 'do' research. This report was created with the input of 234 authors and editors, over 14,000 scientific citations, over 75 000 comments from subject matter experts and 3000 comments from international governments.
- *This report is policy neutral.* While it draws links to the 1.5°C and 2°C, it does not advocate for emissions reductions, nor does it comment on which pathway we are most likely to follow.
- It is the first report in the Sixth Assessment Report (AR6) series to use the Shared Socio-Economic Pathways (SSP) which look at a broader range of scenarios than the previous utilized Representative Concentration Pathways (RCP) scenarios.
    - Note – SSP 4.5 is approximately equivalent to RCP 4.5, and SSP 8.5 is approximately equivalent to RCP 8.5 for both the amount of emissions and the magnitude of climate change. (SSP 1-1.9, SSP 2-2.6, SSP 3-4.5, SSP 4-7.0, and SSP 5-8.5 descriptions can be found online). SSP1-1.9 and SSP1-2.6 are scenarios that start in 2015 and have very low and low GHG emissions and CO2 emissions declining to net zero around or after 2050, followed by varying levels of net negative CO2 emissions.
    - The new Calgary Climate Projections report that the climate adaptation team will be producing late fall 2021 is based on RCP 8.5. It is international practice to use this emissions model as a conservative risk approach.
- The IPCC Report is still undergoing copy/edit so the graphics etc. are not yet perfected, although several from the draft report have been included in this Memo for context.
- *Climate adaptation team editorial* – this information is precisely in line with the projections that have been completed for Calgary, with the work that we are already fully engaged in,

and with the aims of our Climate Strategy update. It lends urgency and criticality to what we are doing, both to reduce emissions to reach net-zero, and to adapt to climate change.

The following sentences have been chosen from the document to summarize and highlight what is included, and what is relevant to Calgary, from the IPCC AR 6 WG1 report.

For more information – there is a great set of videos and documents publicly accessible at https://www.ipcc.ch/assessment-report/ar6/

Headline Statement: It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

CO2 and Emissions

Current levels of CO_2 have not been experienced for at least 2 million years (high confidence) with a 47.3% increase over 1750-2019. No precedent in this rate of change has been observed within the past 800 000 years.

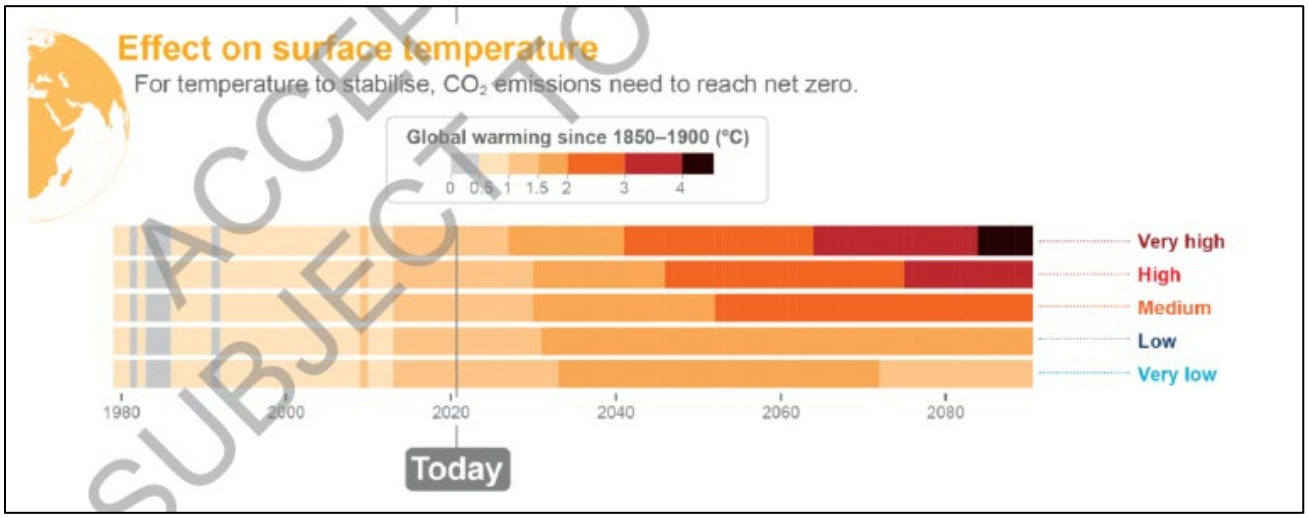
Future emissions cause future additional warming, with total warming **dominated by past and future CO_2 emissions.** Global surface temperatures will continue to increase until at least the 2050s, under all emissions scenarios (as determined by past emissions). **Global warming of** 1.5°C and 2°C will be exceeded during the 21st century unless deep global reductions in CO_2 and other GHG emissions occur in the coming decades.

Reaching net-zero anthropogenic CO_2 emissions is a requirement to stabilize human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO_2 emissions to within a carbon budget.

Global warming between 1850–1900 and 2010–2019 *(°C)*	Historical cumulative CO_2 emissions from 1850 to 2019 *($GtCO_2$)*
1.07 (0.8–1.3; *likely* range)	2390 (± 240; *likely* range)

Approximate global warming relative to 1850–1900 until temperature limit *(°C)**(1)	Additional global warming relative to 2010–2019 until temperature limit *(°C)*	Estimated remaining carbon budgets from the beginning of 2020 *($GtCO_2$)* — *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

*(1) Values at each 0.1°C increment of warming are available in Tables TS.3 and 5.8.
*(2) This likelihood is based on the uncertainty in transient climate response to cumulative CO_2 emissions (TCRE) and additional Earth system feedbacks, and provides the probability that global warming will not exceed the temperature levels provided in the two left columns. Uncertainties related to historical warming (±550 $GtCO_2$) and non-CO_2 forcing and response (±220 $GtCO_2$) are partially addressed by the assessed uncertainty in TCRE, but uncertainties in recent emissions since 2015 (±20 $GtCO_2$) and the climate response after net zero CO_2 emissions are reached (±420 $GtCO_2$) are separate.
*(3) Remaining carbon budget estimates consider the warming from non-CO_2 drivers as implied by the scenarios assessed in SR1.5. The Working Group III Contribution to AR6 will assess mitigation of non-CO_2 emissions.



The Evidence for and Impacts of Climate Change

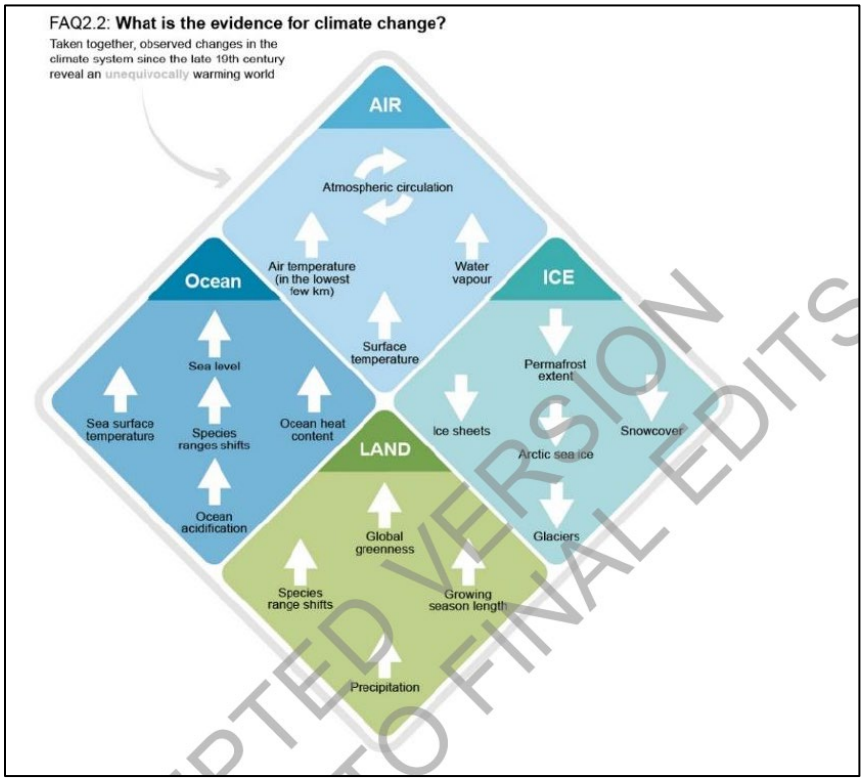
Author: J. Curley
Review: D. Smith
Date: August 18, 2021
Version: 1

Observed temperatures over land have increase by 1.6°C between 1850-1900 and 2011-2020. The increase in land surface temperatures is about 45% larger than for global surface temperature and about 80% larger than for warming of the ocean surface.

It is virtually certain that the frequency and intensity of hot extremes, and the intensity and duration of heat waves have increased since 1950 and will further increase in the future, even if global surface temperature is stabilized at 1.5°C. Very rare extremes and compound or concurrent events are often associated with large impacts. Compound events will become more frequent with increasing global warming. Higher levels of warming increase the likelihood of events unprecedented in the observational record.

Climate zones have shifted poleward and the upslope and the growing season length in the Extratropical Northern Hemisphere has increased (high confidence). The warming pattern will likely vary seasonally, with northern high latitudes warming more during winter than summer. It is virtually certain that further warming will lead to further reductions of Northern hemisphere snow cover. Glaciers have retreated since 1850, unprecedented in the last 2000 years (medium confidence), and glaciers will continue to lose mass at least for several decades even if global temp is stabilized (very high confidence). The land area affected by increasing drought frequency and severity will expand. Ecosystems will become increasingly exposed to climates beyond those that they are currently adapted to, and will increasingly be disturbed by fire, drought, aridity leading to tree mortality (medium confidence).

Frequency and intensity of heavy precipitation events have increased over a majority of land regions with good observational coverage and will increase (extremely likely) over most continents with additional warming. This translates to an increase in the frequency and magnitude of pluvial floods (high confidence).



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