Past, Present & Future Climate

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Past Climate

Temperature of Planet Earth
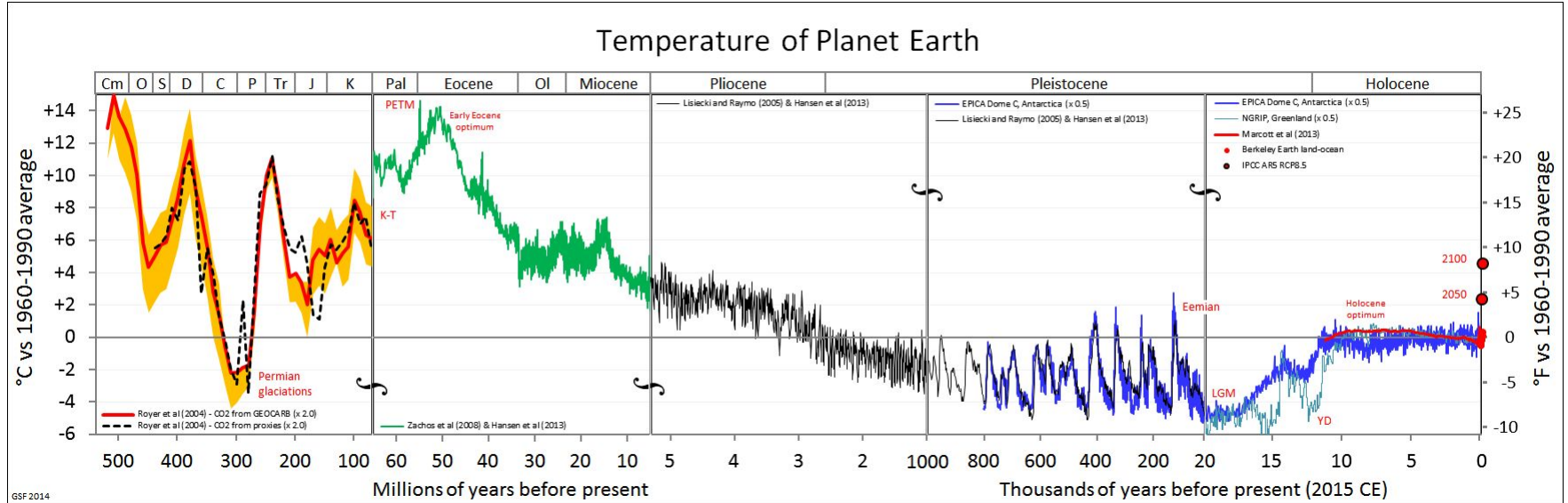
(Glen Fergus, CC-BY-SA 3.0)

Present Climate

FAQ 2.1: How is this global warming different to before?

Climate has always changed, but warming like that of recent decades has not been seen for millennia or longer.

It is warming almost everywhere
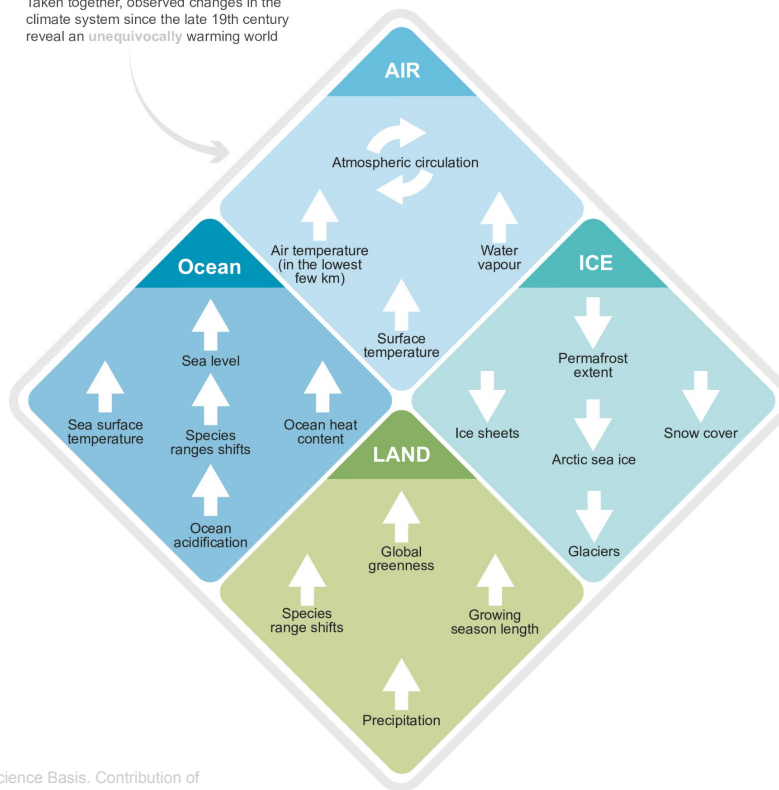
It is warming rapidly

The warming reversed a long-term cooling

It has been a long time since it has been this warm

(FAQ 2.1, Figure 1 in IPCC, 2021: Chapter 2. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Gulev, S.K., et al.)

FAQ 2.2: What is the evidence for climate change?

Taken together, observed changes in the climate system since the late 19th century reveal an **unequivocally** warming world

AIR
Atmospheric circulation
Air temperature (in the lowest few km)
Water vapour
Surface temperature

Ocean
Sea level
Sea surface temperature
Species ranges shifts
Ocean heat content
Ocean acidification

ICE
Permafrost extent
Ice sheets
Arctic sea ice
Snow cover
Glaciers

LAND
Global greenness
Species range shifts
Growing season length
Precipitation

FAQ 2.1, Figure 1 | Evidence for the unusualness of recent warming.

FAQ 2.1, Figure 1 in IPCC, 2021: Chapter 2. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Gulev, S.K., P.W. Thorne, J. Ahn, F.J. Dentener, C.M. Domingues, S. Gerland, D. Gong, D.S. Kaufman, H.C. Nnamchi, J. Quaas, J.A. Rivera, S. Sathyendranath, S.L. Smith, B. Trewin, K. von Schuckmann, and R.S. Vose, 2021: Changing State of the Climate System. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 287–422, doi: 10.1017/9781009157896.004 .]

Future Climate

Recent and future change of four key indicators of the climate system
Atmospheric temperature, ocean heat content, Arctic summer sea ice, and land precipitation
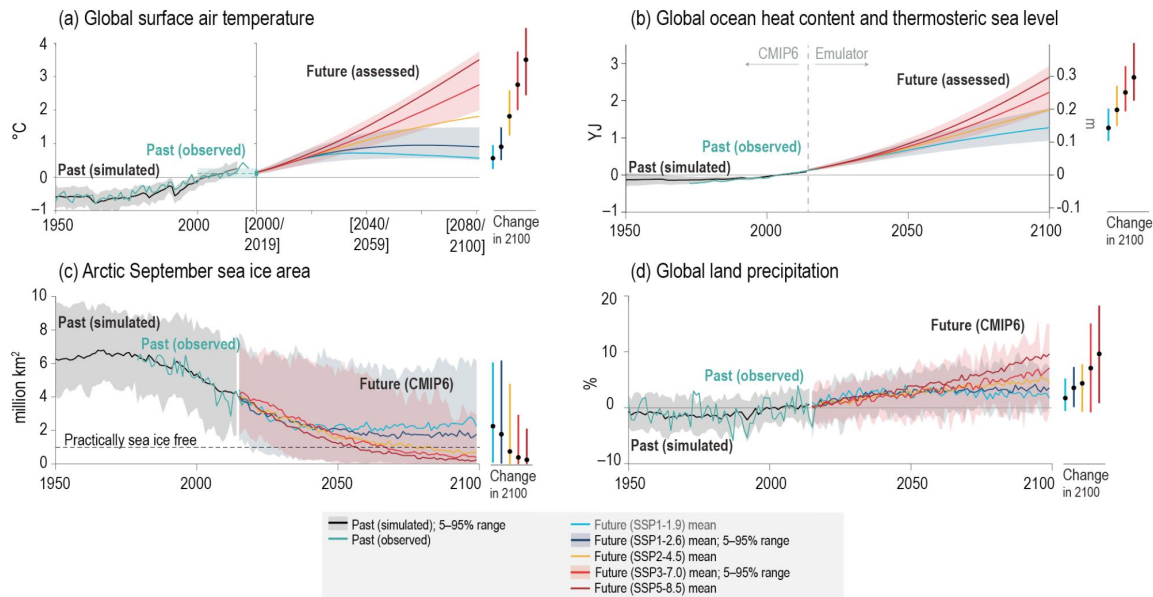
(a) Global surface air temperature

(b) Global ocean heat content and thermosteric sea level

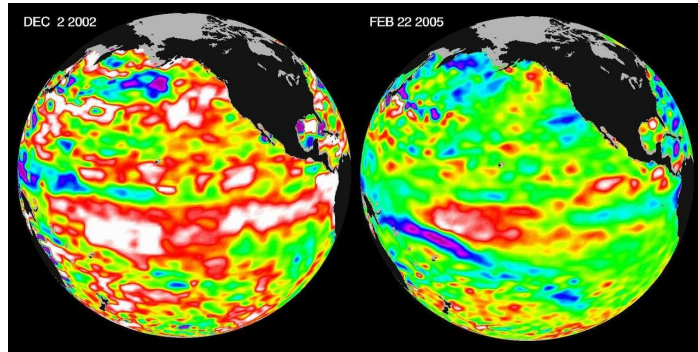(c) Arctic September sea ice area

(d) Global land precipitation

Figure TS.8 | Observed, simulated and projected changes compared to the 1995–2014 average in four key indicators of the climate system through to 2100 differentiated by Shared Socio-economic Pathway (SSP) scenario. *The intent of this figure is to show how future emissions choices impact key, iconic large-scale indicators and to highlight that our collective choices matter.* Past simulations are based on the Coupled Model Intercomparison Project Phase 6 (CMIP6) multi-model ensemble. Future projections are based on the assessed ranges based upon multiple lines of evidence for (a) global surface temperature (Cross-Section Box TS.1) and (b) global ocean heat content and the associated thermosteric sea level contribution to global mean sea level change (right-hand axis) using a climate model emulator (Cross-Chapter Box 7.1), and CMIP6 simulations for (c) Arctic September sea ice and (d) global land precipitation. Projections for SSP1-1.9 and SSP1-2.6 show that reduced greenhouse gas emissions lead to a stabilization of global surface temperature, Arctic sea ice area and global land precipitation over the 21st century. Projections for SSP1-2.6 show that emissions reductions have the potential to substantially reduce the increase in ocean heat content and thermosteric sea level rise over the 21st century but that some increase is unavoidable. The brackets in the x axis in panel (a) indicate assessed 20-year-mean periods. {4.3, Figure 4.2, 9.3, 9.6, Figure 9.6}

(Figure TS.8 in IPCC, 2021: Technical Summary. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Chen, D., M, et al.)
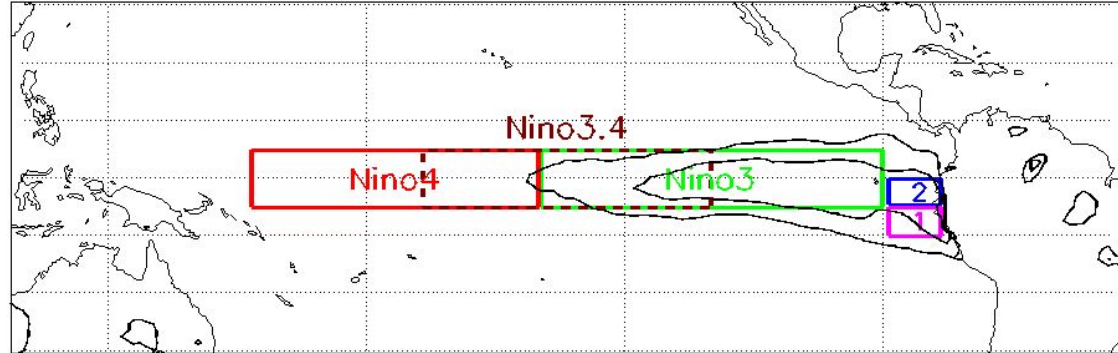
Tutorial 9: Masking with Multiple Conditions

- One climate process that is expected to vary in response to future climate change is El Niño Southern Oscillation (ENSO)

- In this tutorial, we'll use masking in Xarray to explore tropical Pacific SST changes related to ENSO

El Niño   La Niña