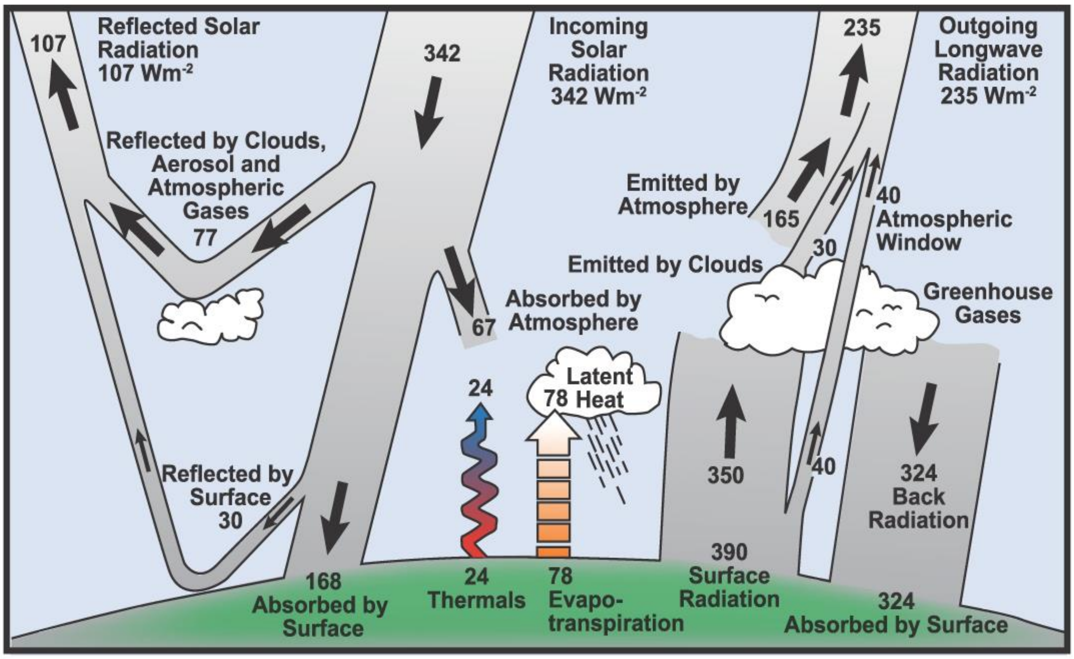
Climate change, Oceans and Atmosphere and Numerical Toolkit (GL1401)

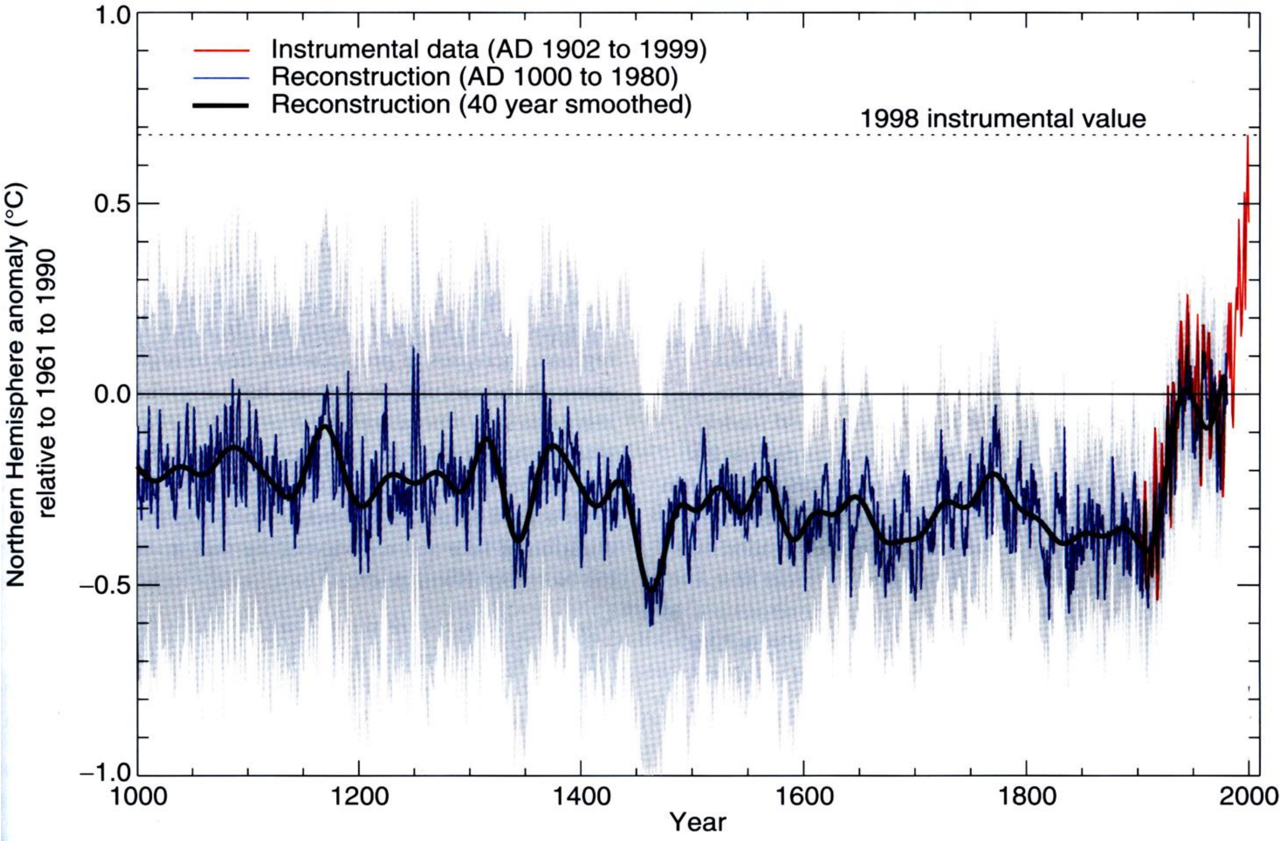
A module introducing the climate, oceans and atmospheres and the numerical toolkit to study them.

- The planet Earth is illuminated by sun and conditions on the planet are due to the fluxes of radiation (mainly visible light) in and radiation out (some visible and some near IR radiation) being in balance. There is a natural Greenhouse effect owing to our planet being shrouded in a ~80 km thick atmosphere containing water vapour, methane, carbon dioxide and other gases.
- If there were no atmosphere on our planet then you could calculate the temperature of the planet as $T^4 = \frac{(1-\alpha)S}{4\sigma}$ where T is the temperature, and using the planet's reflectivity, α = 0.3, the solar flux of light, S=1370 W m^{-2}, and the Steffan-Boltzman Constant, σ = 5.67×10^{-8} W m^{-2} °K^{-4}. Try it – its too cold – remember water freezes at 273 K. Thus, we need a natural greenhouse effect to keep our planet warm.
- The atmosphere and oceans on our planet keep the temperature extremes between the equator and the poles quite small as the oceans and atmosphere "pump" heat polewards and cause our planet's weather.

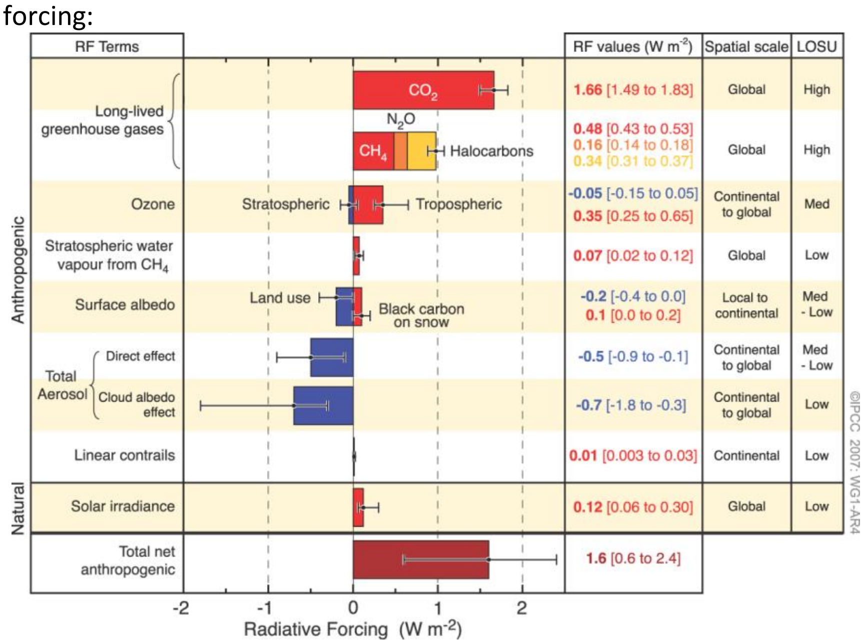


- Some of the predictions of the modern climate change from the IPCC are a loss of glaciers and sea-ice, increased number and severity of storms, increased number and severity of floods and droughts, and warmer nights.

- Humankind’s perturbation of the Earth’s atmosphere and surface is changing that balance and the temperature is increasing.



- As the concentrations of greenhouse gases increase, fluxes of aerosol change, clouds are perturbed, land surface is changed, and the Sun’s output changes so too will the climate change.
- Understanding how the oceans and atmosphere work are crucial to this climatic prediction
- Understanding basic statistics, how to handle uncertainty in science and simple box modelling is also crucial. We can apply these to different mechanisms of modern climate change and assign them a radiative forcing:



- Such as calculating radiative forcing, the uncertainty in the radiative forcing and the level of scientific understanding from greenhouse gases, clouds, or land use change as above.
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Consideration of environments where climate change may be occurring quickly, such as the cryosphere provide a useful natural laboratory. Below are some Antarctic Adele penguins examining a member of the teaching team's equipment for studying the reflectivity of sea ice.

Assessment

- The basic statistics, how to handle uncertainty in science and simple box modelling is crucial is typically assessed in class with your colleagues.
- A typical Example exam question might be:
  a) Explain the term “Radiative forcing”. (5%)
  b) What are the limitations of radiative forcings for modern climate change? (10%)
  c) The second figure on page 2 is from the IPCC latest report quantifying the radiative forcing for warming or cooling processes. For each process, i.e. for each row of the table, explain the physical mechanism by which the planet is warmed or cooled. (65%)
  d) If you were a policy maker which radiative forcing mechanism would you focus on to combat modern climate change? Use the data in the figure to inform your decision. (20%)

Want to know more? We recommend ‘Chapter 21; Earth: An Introduction to Physical Geology, Global Edition, Tarbuck et al.’