

How does predicting climate differ from forecasting weather?

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We can predict the climate next summer, but not the day-to-day weather.

With global models we can forecast the day-to-day weather for about a week – generally forecast skill lasts longer in winter than in summer. Further into the future we can only predict the general climate.

For example, we can predict with certainty that next July will be warmer than it was in January – because the sun heats the Earth more when it is high in the sky - but we can't forecast whether it will rain on the 4th of July. Furthermore, although the sun follows the same path in the sky every year, some summers are drier and warmer, or wetter and cooler than 'usual', because the internal oscillations of the climate system are large.

Similarly as CO₂ rises in the atmosphere, we know this will push the Earth towards a warmer climate, because CO₂ is a greenhouse gas that traps the Earth's heat. And as the Earth warms, more water evaporates. Water vapor is a strong greenhouse gas, and this more than doubles the warming. And as the Earth warms, ice and snow cover are reduced, so less sunlight is reflected, and this too further amplifies the warming. So we can predict that the Arctic (and northern winters) will warm faster as the reflective snow and sea-ice decrease there - while in Antarctica the ice-sheets are thousands of feet thick, so melting there will take far longer, hundreds to thousands of years.

We can also predict that the continents will warm faster than the oceans, because as the climate warms, heat is only conducted down a short distance over land, but the oceans circulate heat down to the ocean depths, so the oceans warm much more slowly.

So although we can predict a broad warming climate trend into the future as atmospheric greenhouse gases rise, we cannot predict the detailed future weather; and we must expect the large variability from year to year to continue – in fact it may increase.