Clouds save Earth from runaway greenhouse hell

- Updated 18:19 29 July 2013 by **Stephen Battersby**
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Look to Venus, and gulp. On our planet's twin, the atmosphere is toxic and at 460 °C, the temperature is high enough to melt zinc. Earth was thought to be immune from such a fevered state, but a new study suggests we shouldn't be quite so complacent – if it wasn't for clouds we would already be in trouble

A phenomenon known as the runaway greenhouse effect may be responsible for the Venus we see today. This occurs when a critical rise in temperature increases the amount of water evaporated from a planet's oceans, loading its atmosphere with water vapour. Water vapour is a potent greenhouse gas, meaning it hungrily absorbs thermal radiation from the sun-warmed surface, making things even hotter and completing the vicious cycle.

Within a few thousand years, any life on such a planet will end. "If you boil the planet, everything dies," says Colin Goldblatt at the University of Victoria in British Columbia, Canada.

Models created in the 1990s suggested that Earth was far enough away from the sun that the runaway could not happen on Earth today. At our distance, the sun's heat is much less intense than it is for Venus, and calculations of the energy balance predicted that a steamy atmosphere on Earth would actually radiate more heat into space than it would take in.

But since then, our measurements of how water and carbon dioxide absorb different wavelengths of light have improved. To get an up-to-date picture, Goldblatt and his colleagues ran a new model and found that these subtle corrections have changed the balance. Now it seems a steamy atmosphere on Earth would absorb more heat than it emits, so the runaway greenhouse could indeed happen.

Steamy atmosphere

In fact, the model suggests that if we did not have clouds, which reduce the temperature by scattering sunlight and reflecting much of it back into space, we could already be done for. "Clouds save the day," says Goldblatt.

Even though we are now offsetting the cooling effect of clouds by emitting greenhouse gases, we can probably breathe easily. Goldblatt calculates that it would be possible for us to push Earth into a runaway greenhouse, but only by raising the concentration of CO_2 in the atmosphere to around 30,000 parts per million – vastly more than it would reach if we burned all the available fossil fuel reserves.

Some uncertainty remains, however, because it is hard to be sure how clouds would behave if we did get close to runaway. Modern three-dimensional climate models cannot simulate such extreme climates. "It would be like taking a Ford Fiesta and trying to drive it up a mountain," says Goldblatt.

Max Popp at the Max Planck Institute for Meteorology in Hamburg, Germany is trying to

make more rugged models that can deal with temperatures up to 120 °C – well beyond the threshold temperature for a runaway greenhouse. However, he points out that having no observations of such a hot climate makes it very difficult.

Updating the energy balance is a valuable piece of work, says Raymond Pierrehumbert at the University of Chicago, Illinois, "but I think we are still safe against the Venus syndrome."

Journal reference: *Nature Geoscience*, DOI: 10.1038/ngeo1892