REFLECTIONS ON THE IRIS EFFECT

HOT TAKES

1 The 'iris effect' describes how a decrease in heat-trapping clouds can offset rising temperatures.

2 It provides an explanation for the remarkable stability of Earth's climate throughout its long history.

3 If the iris effect counters warming from increasing carbon dioxide, then there is no 'climate emergency'.

In Chapter 13 of Climate Change the Facts 2020, Professor Richard Lindzen described the discovery of an atmospheric process called the 'iris effect'. It deals with the response of upper-level cirrus clouds[1] to temperature. These clouds are extremely important contributors to climate – their presence makes it warmer. In fact, night-time temperatures beneath cirrus clouds can be up to 10°C warmer. They easily transmit the incoming sunlight that warms the Earth, but retard the escape of heat that cools it. According to the iris effect, these thin wispy clouds diminish in response to warming, allowing more heat to escape.

The term 'iris effect' derives from the way the iris in an eye expands and contracts in response to light, regulating the amount which enters the eye. Similarly, cirrus clouds may act like an 'iris' – contracting in response to warming – so that more heat can escape to space and keep the climate stable.

This self-limiting cycle is called a 'negative feedback'. Negative feedbacks are important processes in the climate system because they operate to keep things stable. In contrast, positive feedbacks foster instability.

The iris effect provides a long-sought-after explanation for the remarkable stability of the Earth's multi-billion-year-old climate system, where there has been virtually no correlation between climate and carbon dioxide (CO_2). Its stability is consistent with the general expectation that long-surviving complex systems are intrinsically self-stabilising because the net feedbacks are negative. Destabilising positive feedbacks *cannot* dominate.

Clouds 101

To understand why the iris effect is so important it is first necessary to understand the broader critical role that clouds play in Earth's climate. In Fact Sheet 11, it is revealed that clouds cover 65% to 70% of the Earth and have a major impact on its energy budget. Lower-level thick clouds have a *cooling* effect by reflecting as much as 30% of incoming solar radiation back to space. But upper-level thin clouds have a *warming* effect by reflecting some of the outgoing infrared radiation (IR) continually leaving the Earth's surface back down again, retarding its escape.

It only requires tiny natural changes in cloudiness averaged over time to make a big difference to the climate. Changes might include small variations in cloud cover, changes in the distribution of lower- versus upper-level clouds, or changes in cloud opacity and brightness. Long term changes in any of these properties could account for the roughly 1°C of global warming over the last century.

Carbon Dioxide & Climate 'Feedbacks'

CO_2 has long been looked at as a possible source of human influence on climate but, until the early 1970s, it was dismissed as only a minor factor.

However, a paper by Manabe and Wetherald in 1975[2] offered a possibility that could double the warming impacts of an initial increase in CO_2 – a positive feedback. The idea was that the small warming due to the CO_2 would lead to an increase in water vapour, the most important greenhouse gas. Since then, climate modellers believe they have identified further positive feedbacks that create an even more dramatic amplification of the initial CO_2 effect. The main ones are an increase in the height of climate-warming high clouds, a reduction in the coverage of climate-cooling low clouds, and a poleward shift of storms toward higher latitudes where there is less sunlight for them to reflect. Combined, it is postulated these feedbacks amplify the effect of the CO_2 by at least 3-4 times so that a hypothetical future doubling of CO_2 above pre-industrial levels eventually results in a global warming response of between 1.5°C and 4.5°C over the next few centuries. But the strength and direction of the feedbacks that dominate this result depend entirely on the assumptions made in the configuration of the models.

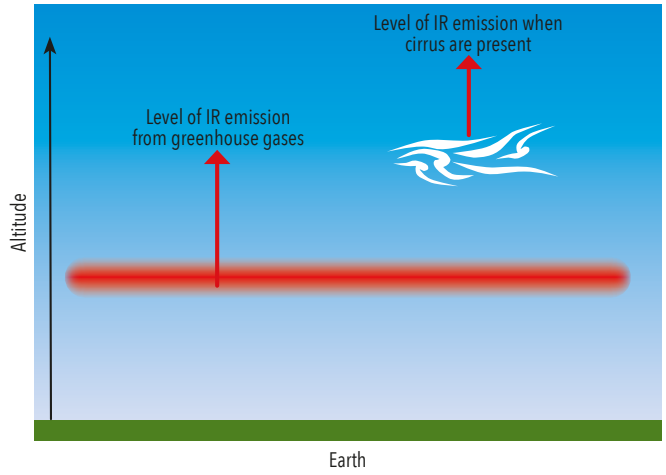
It is curious that this result remained stubbornly persistent for *more than 40 years*. It first appeared in the Charney Report from the US Academy of Sciences in 1979[3]. Since then, after spending many billions of dollars developing ever more complex and expensive computer models, this wide sensitivity range was finally 'narrowed' in 2021 to between 2.5°C and 4°C[4].

The positive feedbacks that greatly amplify CO_2-linked warming are a pivotal feature of the current climate models used in the latest reports by the Intergovernmental Panel on Climate Change (IPCC)[4]. However the failure of the models to identify negative feedbacks such as the iris effect might explain the *persistent warming bias* that is found when the model results are compared against warming estimates made independently using real-world data.

The Iris Effect – Countering CO_2

The term was introduced by Lindzen et al. in 2001[5] to describe a proposed negative feedback mechanism where the extent of cirrus clouds is linked to temperatures. When cirrus clouds are present, it is the clouds and not the greenhouse gasses that dominate the inhibition of IR radiation into space, and hence the rate of heat escape from the atmosphere (Figure 1).

Figure 1: The effect of upper-level cirrus clouds on emission of IR radiation[5]



The greenhouse effect from very high cirrus clouds is particularly strong because temperature decreases with altitude. Cirrus clouds generally lie at higher altitudes than the average level of greenhouse gas IR emissions (the 'emission level')[6], which mostly takes place from mid and upper altitudes. (Also see Fact Sheet 12.) Cirrus clouds effectively raise the altitude and lower the rate of IR emissions (they are colder), which means the atmosphere beneath stays warmer than otherwise.

If cirrus clouds do not form as readily at higher temperatures, then heat is able to escape the atmosphere more easily than otherwise, and this limits the extent of warming. This is the essence of the negative feedback that could counter CO_2 warming.

Lindzen & Choi in 2009[7] believed a reduction in the area of the cirrus clouds was enough to cancel, or even exceed, any positive feedbacks that may amplify the initial very slight direct warming effects of increasing CO_2.

Concluding Observations

Although the idea of an 'iris effect' is not without its detractors, its possibility remains compelling because the behaviour of clouds, and the climate feedbacks linked to them, remains one of the greatest sources of uncertainty in climate models[8].

Given that many of the heat-flow pathways within the climate system are still poorly constrained, there remains the possibility that not all the natural feedbacks impacting long term climate change have been identified. It is important to contemplate the possibility of still-undetected feedbacks because of their impact on the planet's heat budget, and their potential role in natural climate change.

The current obsession with CO_2 in climate science has precluded serious investigations into the many other ways in which the climate can change. In mainstream climate models, the intensely positive water vapour and cloud feedbacks are given prominence. These greatly amplify climate model sensitivity to increasing CO_2. In fact, these postulated positive feedbacks are the amplifying link essential for climate alarm. Without them, there would be no *'climate emergency'!*

The failure of current models to identify negative feedbacks might explain why they run too hot and fail to reproduce the past. Even the most recent models done for the IPCC significantly overpredict warming compared to observations[9]. Perhaps the warming impact of increasing CO_2 is being greatly overstated and, by reconfiguring climate models to take into account negative feedbacks like the iris effect, the oversensitivity of the models to increasing CO_2 could greatly diminish, or even vanish. Another negative feedback was also described in Fact Sheet 12.

Until the response of clouds to our changing climate is resolved, properly distinguishing modest human impacts from ongoing natural climate variability will remain elusive.

SEE ALSO
FACT SHEET #11: THE IMPORTANT ROLE OF WATER AND WATER VAPOUR
FACT SHEET #12: TROPICAL CONVECTION: COOLING THE ATMOSPHERE

Information in this fact sheet has been drawn from Climate Change: The Facts 2020 (IPA 2020), Chapter 13, by Professor Richard S. Lindzen. Fact Sheet series general editor: Dr Arthur Day

1. Cirrus clouds are the distinctive thin wispy hair-like clouds found at extremely high altitudes. They are composed of microscopic ice crystals.
2. Manabe, S & Wetherald, RT 1975, 'The effects of doubling the CO2 concentration on the climate of a general circulation model', *Journal of the Atmospheric Sciences*, vol. 32, pp. 3–15.
3. *U.S. National Academy of Sciences 1979*, 'Carbon Dioxide and Climate. A Scientific Assessment', Washington D C, p. 22.
4. Masson-Delmotte et al. 2021, *IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report:* https://www.ipcc.ch
5. Lindzen, RS, Chou, M-D, Hou, A-Y 2001, 'Does the Earth have an adaptive infrared iris', *Bulletin of the American Meteorological Society,* vol. 82, no. 3.
6. The emission level is a crude measure of the level above the ground from which IR radiation is emitted to space. In reality, emission of IR to space occurs from all levels in the atmosphere but, on average, it is dominantly from the mid and upper levels.
7. Lindzen, RS, & Choi, Y-S 2009, 'On the determination of climate feedbacks from ERBE data', *Geophysical Research Letters*, vol. 36, no. 16.
8. Boucher et al. 2013, *Clouds and Aerosols*: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter07_FINAL.pdf
9. McKitrick, R, & Christy, J 2020, 'Pervasive Warming Bias in CMIP6 Tropospheric Layers', *Earth and Space Science*, 7, e2020EA001281. https://doi.org/10.1029/2020EA001281

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