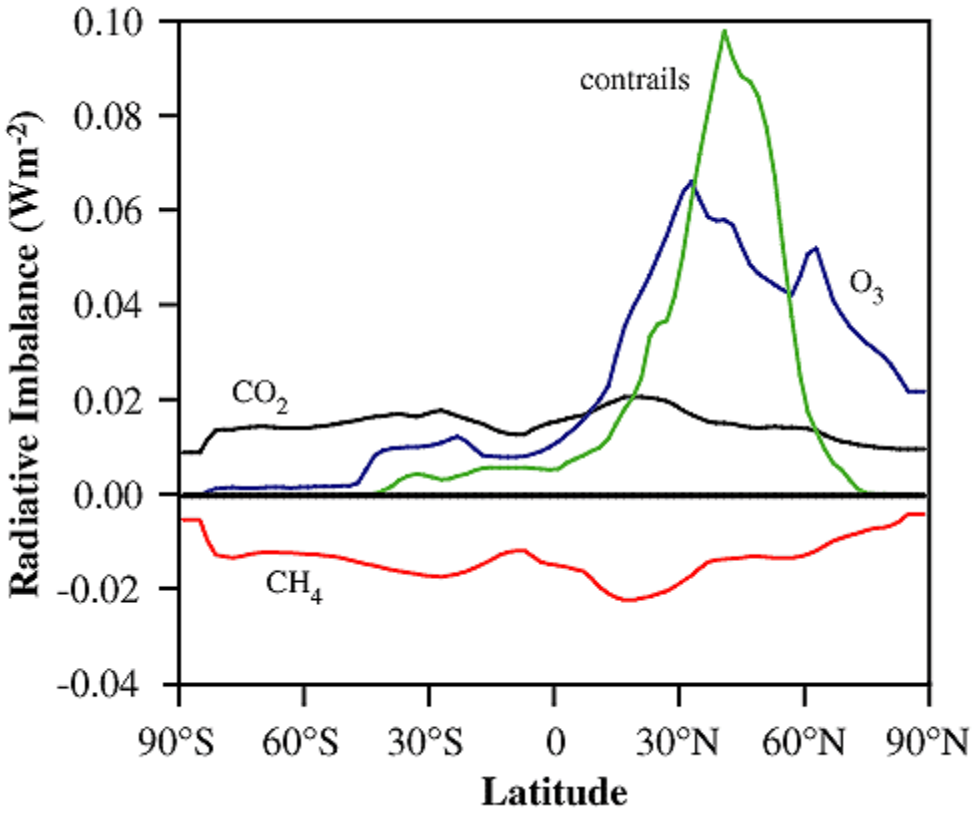
# Implications for Future Climate.

When studying the formation of contrails it is important to put it into the context of the possible implications for future climate. Although here our ability to make predictions about future climate is limited (as there has been no research conducted into the radiative properties of contrails) suggestions can be made.

Contrails, and contrail related cirrus cloud, influence climate in two ways. Firstly, the increased cloudiness acts to reflect solar radiation and insulate terrestrial radiation, and secondly, aerosol particles, that are emitted by aircraft and can become incorporated in contrail and cloud ice crystals, act to scatter and absorb short wave solar and long wave terrestrial radiation and so affect the radiative properties of contrails. For example, if soot becomes incorporated into the cloud ice crystals it will increase the ability of the cloud to absorb solar radiation, locally warming the atmosphere, whereas pure contrails and clouds warm the atmosphere by insulating terrestrial radiation. One of the main problems however of analysing the influence of contrails on climate is combining the effects of the aerosols with the effects of the contrails themselves.

There is much doubt as to just how contrails will influence climate, however due to their similarity to cirrus cloud it is believed that they will affect climate in the same way, and will therefore have a positive radiative forcing, thus warming the atmosphere. This warming effect is not even over the whole globe. Figure 1 shows how the warming effects of contrails is concentrated around 40-50° north, which is where the greatest amount of air travel is.

*Figure 1. Zonal and annual mean radiative imbalance (W m-2) at the tropopause (after adjustment of stratospheric temperature) as a function of latitude as a result of air traffic for 1992.*




*From: Aviation and the Global Atmosphere. IPCC (1999)*

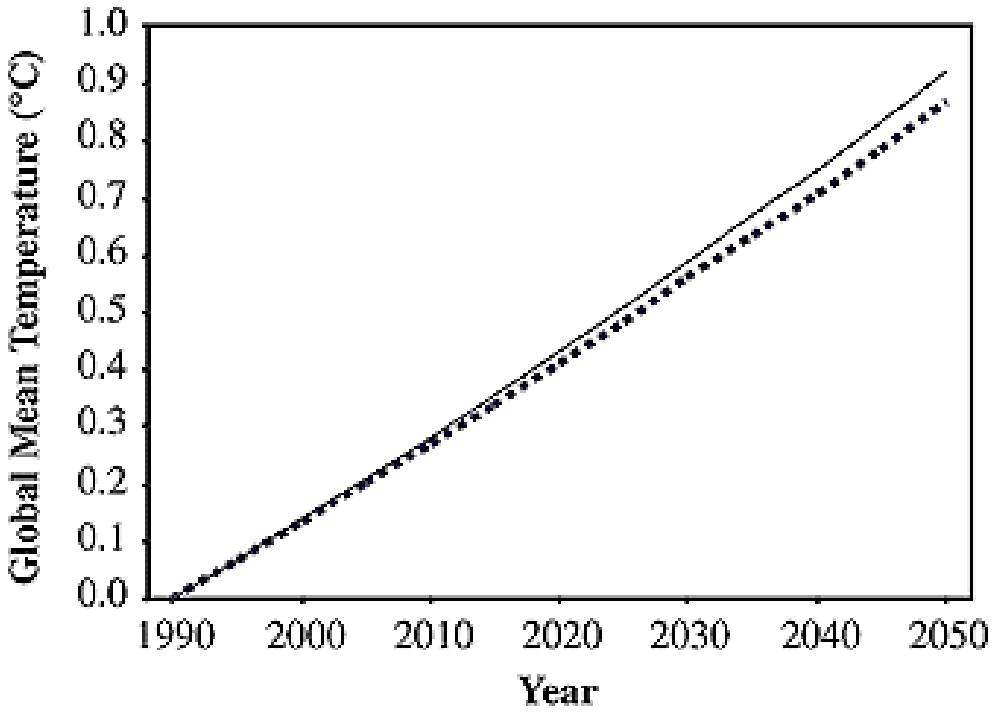
The future aviation industry is expected to continue to grow in the future, it is also expected that there will be technological advances and that fuel use efficiency will increase and the size of planes and the distances flown will also increase. This will have several implications for contrail formation:

> Larger size planes and greater flight distances will mean that planes will need to carry greater volumes of fuel and so the weight of the planes will increase. This weight will increase the amount of fuel burn and will therefore increase the emissions from the plane and so will also increase the number of contrails.
>
> Greater fuel use efficiency means that the engine is better able to obtain energy from the fuel it burns. This will mean that for the same volume of fuel there are greater emissions of substances such as carbon dioxide, soot and water vapour. This will in turn lead to the formation of more contrails for the same volume of fuel that in the past would have produced fewer contrails.
>
> More efficient engines can trigger the formation of contrails at higher atmospheric temperatures (IPCC 1999) and therefore contrails can form at a greater range of altitudes which will increase the number of contrails formed.

Therefore not only will the increase in the number of planes increase the number of contrails but technological advances will also influence the formation of contrails.

When considering the impact of the aviation industry on climate we are not simply referring to the formation of contrails and contrail related cloud but also to other emissions from aircraft and in particular carbon dioxide which is one of the major contributing factors to anthropogenic climate change. Human induced climate change occurs from many factors, not just from the aviation industry, it is therefore important to assess how much aircraft affect climate.

*Figure 2. Predicted change in global mean surface temperature (K) from 1990 to 2050 for scenario IS92a (solid line) and for the same scenario without aircraft (dotted line).*




*From: Aviation and the Global Atmosphere. IPCC (1999)*

Figure 2 shows the increase in climate for the scenario IS92a and the same scenario without the influence of aviation. It can be seen that although aviation does contribute to climate warming it is a relatively small factor (although its contribution will increase as the industry increases) and as contrails are only a part of the concern over the aviation industry this means that the contribution contrails have is small and this is probably why there has been limited research into this area in the past. However the aviation industry will continue to grow in the future and

thus the impact that contrails have on climate will also continue to grow. Therefore the influence of contrails may not always be small, and as there is so much uncertainty in this area it is important that more research be done in the future and that the work done by the National Contrail Network continues.

Suggestions for Further Study.

The National Contrail Network. Discussion and Conclusions.

Links

References

Acknowledgements

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