Review of “Response of cirrus clouds to idealised perturbations from aviation”, by Gilbert and coauthors, EGUSphere-2024-821

I have carefully gone through the manuscript and am very familiar with aircraft contrails and contrail development, along with the associated properties of contrails. I have given considerable thought to the question of how aircraft passage through a cirrus cloud is affected by the passage and have discussed the effects with researchers at several institutions, using data collected by aircraft and satellite-borne sensors. I appreciate the time and effort taken by the authors of this article, and the LES model used to study the potential effects of the addition of ice nuclei added by the aircraft during its passage. The finding that gravity waves have considerably more effect than warm conveyor belt outflow on the resulting ice water path is interesting.

I have numerous comments in my review of the manuscript by I’m left with a concern that I feel makes the manuscript incomplete in its current form. The exhaust from combustion by the aircraft engines, and the wake turbulence from the aircraft, affects the downstream heat and moisture, along with the dynamics of the air. I note this from the Wikipedia article passage below. The vortices sink at a rate of 3 m/s or more and stabilize at about 150-270 m below the aircraft. As a result, the pre-existing cirrus crystals might sublimate rather at the aircraft level rather than the additional generation of copious ice crystals generated from the combustion products. In fact, for the thinner cirrus, holes (Distrails) may be produced (see below). The article by Marjani et al. (2022) shows this effect clearly at the flight level.

To summarize, I feel that the use of the LES model, without incorporating the effects of the aircraft combustion and wake turbulence makes the study incomplete and in some cases may lead to the opposite effect. I hope the authors can take these effects into account in a revised version of the article.

Wikipedia Wake Turbulence

The vortex circulation is outward, upward, and around the wingtips when viewed from either ahead or behind the aircraft. Tests with large aircraft have shown that vortices remain spaced less than a wingspan apart, drifting with the wind, at altitudes greater than a wingspan from the ground. Tests have also shown that the vortices sink at a rate of several hundred feet per minute, slowing their descent and diminishing in strength with time and distance behind the generating aircraft.[2]

At altitude, vortices sink at a rate of 90–150 m (300–490 ft) per minute and stabilize about 150–270 m (490–890 ft) below the flight level of the generating aircraft. Therefore, aircraft operating at altitudes greater than 600 m (2,000 ft) are considered to be at less risk.[3]

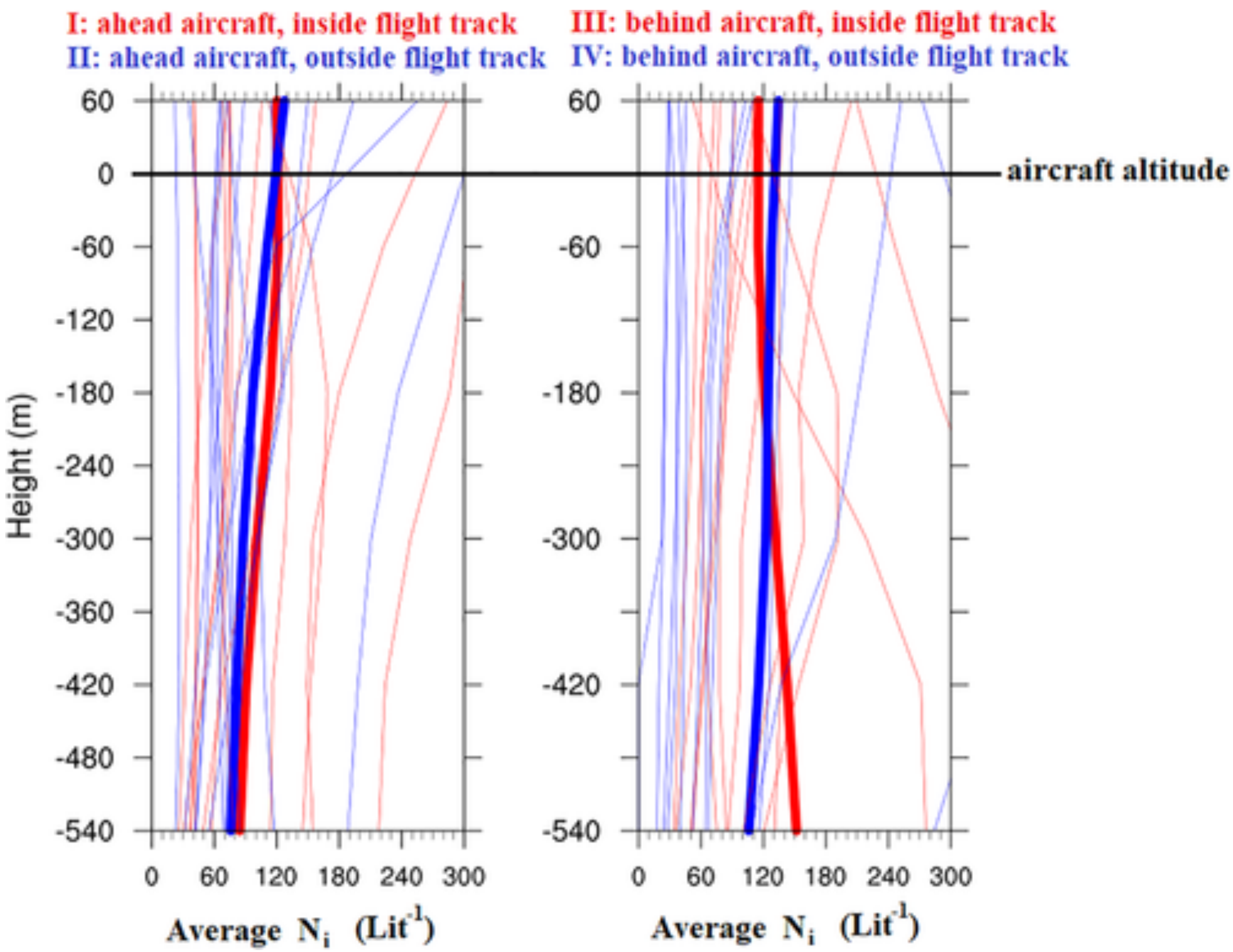

Figure 1, Marjani, S., Tesche, M., Bräuer, P., Sourdeval, O., & Quaas, J. (2022). Satellite observations of the impact of individual aircraft on ice crystal number in thin cirrus clouds. *Geophysical Research Letters*, 49, e2021GL096173

Where an aircraft passes through a cloud, it can disperse the cloud in its path. This is known as a distrail (short for "dissipation trail"). The plane's warm engine exhaust and enhanced vertical mixing in the aircraft's wake can cause existing cloud droplets to evaporate.

Distrails & Rain ~ The path of an aircraft in high cirrus is marked by a dark trail, a distrail or dissipation trail. Its formation is the result of subtle differences between ice and supercooled water. Images taken in Germany by Sebastian Luft.