Review of „Synoptic and microphysical lifetime constraints for contrails“ by Sina Hofer and Klaus Greens submitted to EGUsphere

The submitted paper by Hofer and Gierens analyses the spatial and temporal development of ice-supersaturated regions (ISSRs) in connection with large-scale weather patterns over Central Europe. The aim is to derive lifetimes for contrails. Therefore, two different lifetimes are considered, which are based on different processes. First, the microphysical lifetime, which is primarily determined by the sedimentation of the ice crystals. The second lifetime approach focusses on the synoptic time scale, whereby the degradation of ice supersaturation through synoptic processes and the departure of air parcels from the ISSR are considered.

The paper addresses an important issue for reducing the negative effect of aviation. However, in my opinion, the paper could be written more precisely and thus more briefly, as I will suggest below. I therefore recommend publishing the paper after the major revisions.

Case studies
The choice of the three case studies is not clear to me. I understand that they are supposed to describe three different synoptic situations. However, these are situations within a period of 5 weeks in 2024 during the transition from spring to summer over continental Europe. This raises the question what results could be expected for other seasons?

The description of the case studies in text form compared to the number of images seems lopsided to me. This means that the reader has to leaf through a lot, but learns little new. Perhaps it would make more sense to discuss one case study in more detail and only draw attention to clear differences for the other case studies with fewer illustrations and text?

The synoptic charts (Figs, 3,.6,9) are very small but full of detailed information, which does not always differ from time to time. I would therefore suggest greatly reducing the number of subplots. To describe the weather situation, only one figure might be sufficient.

Fig. 5,8,11 could be summarised as a triple plot and discussed together. Make sure that the y-axis is always identical. Currently, all y-axes are slightly different.

Fig. 5: It is mentioned in the text that the „fit only deviates slightly towards […] large values of T […] due to noise“. Why does noise play a role for large values of T? Also: what is meant by noise here in the first place?

Finally, the conclusions drawn relate, among other things, to the three case studies, which were only conducted over Europe in April and May 2024. The conclusions drawn therefore seem a little too generalised to me. Shouldn't other time scales be expected over the Atlantic or Pacific with stronger links to the tropics? Perhaps the authors could discuss this in more detail.

Other remarks
L20: Perhaps splitting hairs, but can „water vapor“ be subsaturated

L24f: Three very short sentences in a row. Maybe connect the last two sentences into one?

L45: „…it is not yet known which pathway dominates.“ Why should one process dominate?

L62: how robust are the results on the ISSR definition of RHi>93%?

L65f: What is the vertical resolution of the underlying model?

Eq (6): Parenthesis in equation is missing.
Also, here you refer to ln, later in Fig. 5,8,11 you refer to log? Do you mean the same? Please clarify.

Sec. 3.2.1: I find it misleading to denote the time with a capital „T“ and would suggest a small „t“

Sec. 3.2.3: Regarding Z*. It would help the reader if the brief description of Z* is provided already here and not in Sec. 4.3

L130: what is „high altitudes“?

L165: what is meant with „exclusively“?

Fig. 10: labeling missing ((a) to (f))

Sec 4.1 feels out of place here. The discussion about the difference between lifetime and time-scales would be better placed in the introduction. The discussion of trajectory calculation, on the other hand, would also be useful in the methods section. Also: why are methods and results combined in one section?

L 284f: what does „mainly“ and „rarely“ quantitative mean?

L 286: Will the prediction be easier if the normalised geopotential is calculated first in order to narrow down the calculation of the ISSR? This introduces a further work step.

Generally, please refrain from using statements such as ‘we think’ or ‘eplains probably’ as this leaves a lot of room for speculation.