Optimization of flight routes for reduced climate impact (OP-FLYKLIM) project

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INTRODUCTION

The objective of the project 'Optimization of flight routes for reduced climate impact (OP-FLYKLIM) is to study the potential for mitigation of climate effects of aviation contrails and Short-Lived Climate Pollutants (SLCP) through alternative 3D routes for flights operating in Swedish controlled airspace compared to today's nominal operation where direct routing dominates.

Avoidance of operating in ice-saturated, cloud-free areas with maintained climate benefit is be studied through simulation of day-to-day flight route planning with and without climate optimization in combination with atmospheric modelling. The route optimization has been done by Novair, using their flight planning system on the city pair Stockholm – Kiruna through support of SMHI, providing forecasts of ice-supersaturated regions (Fig. 1) for climate optimized routes which is calculated and used as an alternative to the conventional route optimization typically done by airlines. Impact of the climate optimization on the routes selected will then be analyzed with support of atmospheric models.

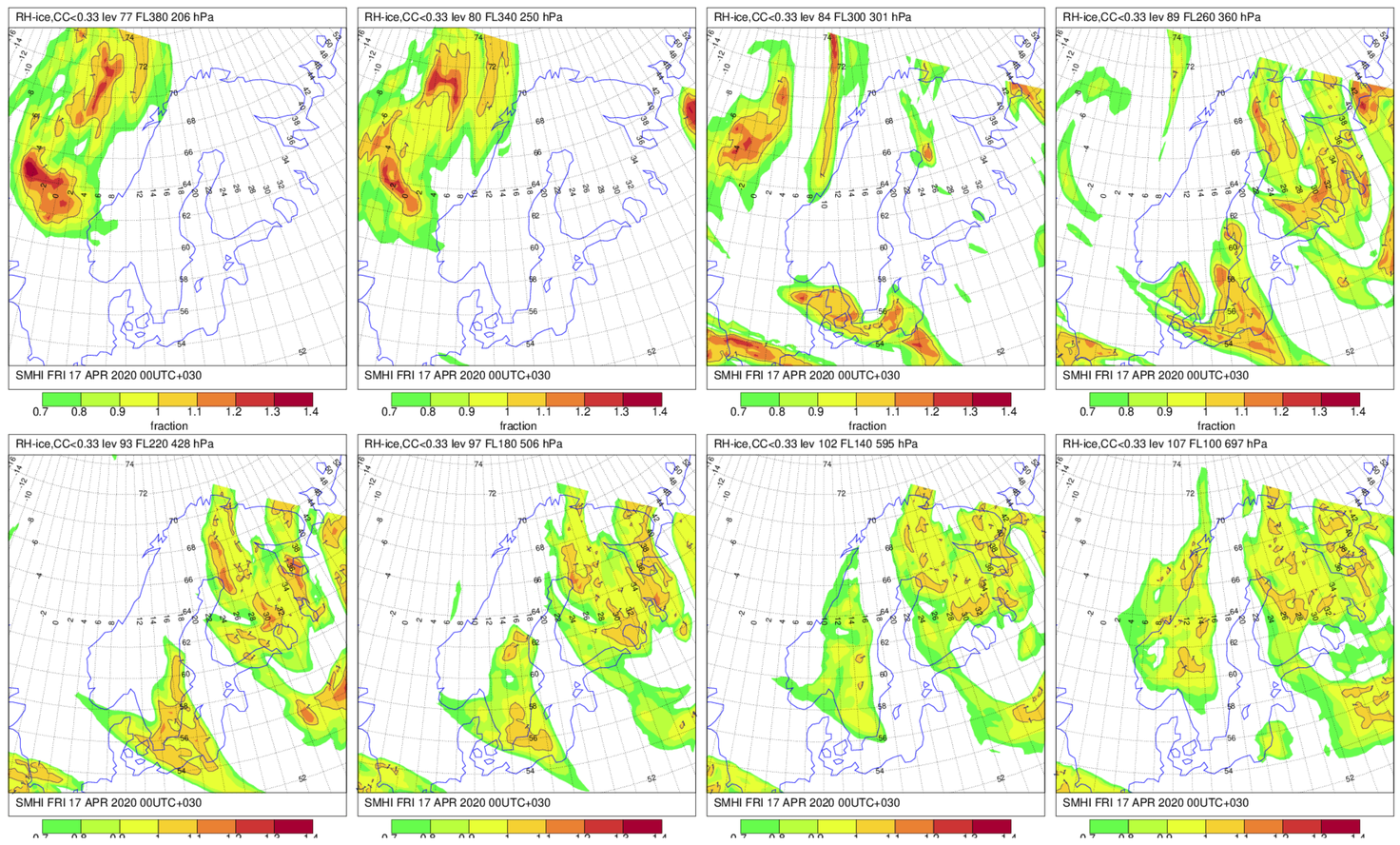
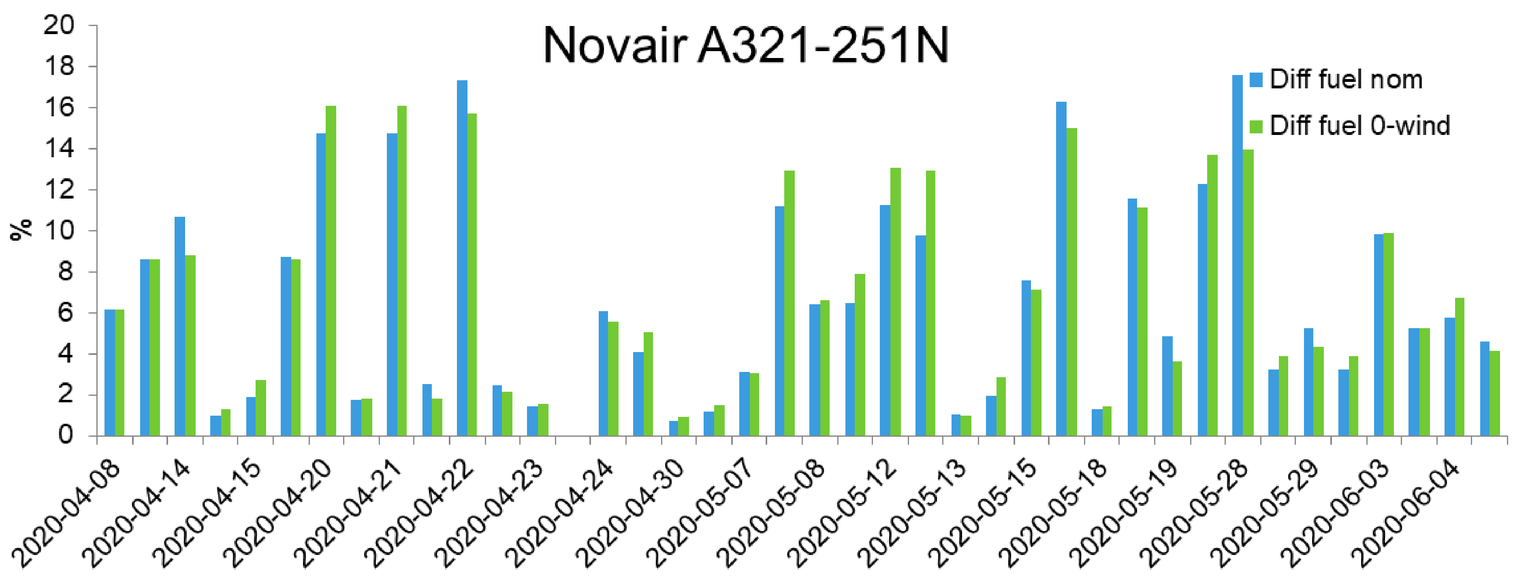


Fig. 1. Forcast of ice supersaturated areas over Scandinavia predicted by SMHI model and used for alternative route planning

Route planning experiment

- In total 42 sets of route plans for flights Stockholm Arlanda – Kiruna were prepared during spring 2020. For each route 4 alternative plans were prepared: plan with and without consideration of winds and alternative plans avoiding flying in ice-supersaturated air masses for both alternatives. Example of alternative route plan is shown in Fig. 2
- During the experimental period additional 18 occasions without occurrence of ice supersaturated layers (ISSL) along the route were registered. The ISSL thus occurred in more than 60% of the studied cases.
- The alternative routs avoiding ice-supersaturated areas had on average 6.5% and 6.6% increased fuel consumption for the nominal route and the route without consideration of winds (0-winf route) respectively (Fig. 3)



- Restrictions for Arlanda – Kiruna 2020-06-18 10:00

RESNA -
OSK –
RASEN -
64000N019008E FL<240
REKMI FL<240
OSKIR FL<240
ITVAV FL<240
VAGAS FL<240

Example of an alternative route plan: at points followed by FL<240 the flight altitude is restricted to bellow flight level 240.

Plume modelling

The modelling part of the project employs a plume model for calculation of the formation of contrails and the short-term effects linked to the aircraft NOx emissions under the entire flight mission, taking into account conditions in the atmosphere where the emissions take place. The model is following the plume in a 3-d trajectory.

The model will calculate the routes prepared during the experimental part of the project to evaluate impact of the route optimisation with respect to avoidance of ice supersaturated areas on climate by coupling the modelled contrail occurrence and impacts on short-lived climate forcers with results of climate model sensitivity smulations and climate cost functions from Grewe et al. (2017).

Regional-scale modelling

The chemistry-transport model MATCH will calculate impact of emissions on selected flight routs during 1 year to scale-up the study to national aviation in Sweden. The flight emissions for modelling are calculated with FOI3 aircraft emission model and validated with fuel consumption data provided by Novair and SAS.

Acknowledgements:

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Grewe, V., Matthes, S., Frömming, C., Brinkop, S., Jöckel, P., Gierens, K., Champougny, T., Fuglestvedt, J., Haslerud, A., Irvine, E., Shine, K., 2017. Feasibility of climate-optimized air traffic routing for trans-Atlantic flights. Environmental Research Letters, Vol. 12, 034003.

CONCLUSIONS

- The route planning experiment has demonstrated possibility of climate optimisation of flight routes in practice by combining the flight operator's route planning system with enhanced meteorological forecast.
- During the study the ISSL occurred in more than 60% of the studied cases; this is in line with available observations and model data which indicate occurrence of ISSL of c.a. 50%
- In the next step the climate impact of the regular and ISSL-avoiding routes will be evaluated with help of plume and chemistry-transport models and climate cost functions in order to evaluate the climate benefit of the ISSL avoiding routing and to estimate potential of climate optimisation of flight routes in Swedish air space.

13 CLIMATE ACTION

Swedavia Airports

FOI

SMHI

ivl Swedish Environmental Research Institute