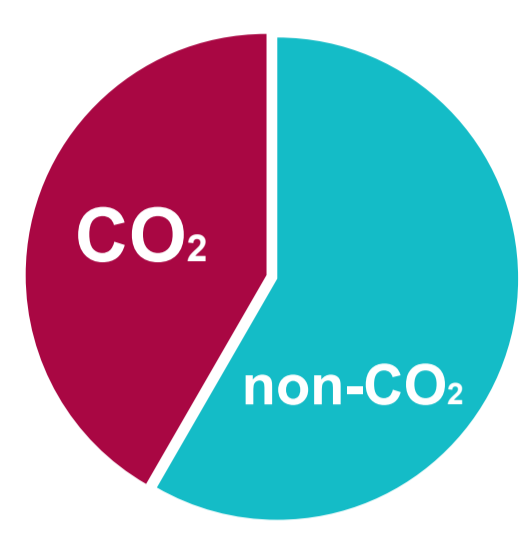


Big-Hit flight identification

Part of the **CONCERTO SESAR** project

Problem Statement



Aviation contributes to 3.5% of global warming. Major non-CO₂ effects are contrails, NO_x-induced O₃ increase and CH₄ depletion [1].

- Non-CO₂ effects are a local phenomena [2].
- Rerouting can reduce total climate impact [3].
- **However: rerouting is a trade-off.**

Research Objective

Can we identify and reroute the flights with a significant climate impact first?



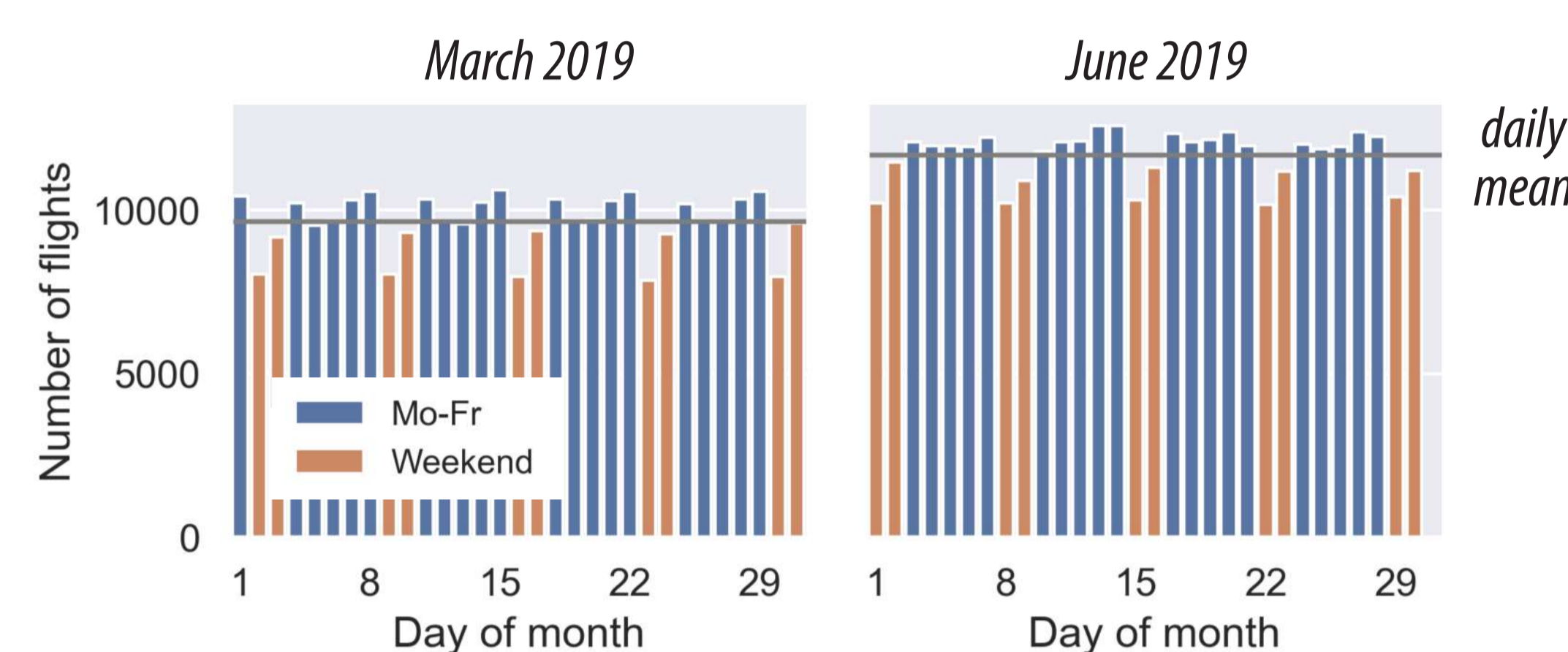
This causes minimal disruption to:

- fuel consumption + CO₂ emissions
- airspace capacity flight time

Here, big-hit flights are the subset of daily flights accounting for 80% of the total climate impact, including CO₂ and non-CO₂ effects.

Study Area: Borealis

The airspace of the Borealis alliance is a free route airspace over nine North-Western European countries. About 10.000 flights traverse Borealis on a daily basis.

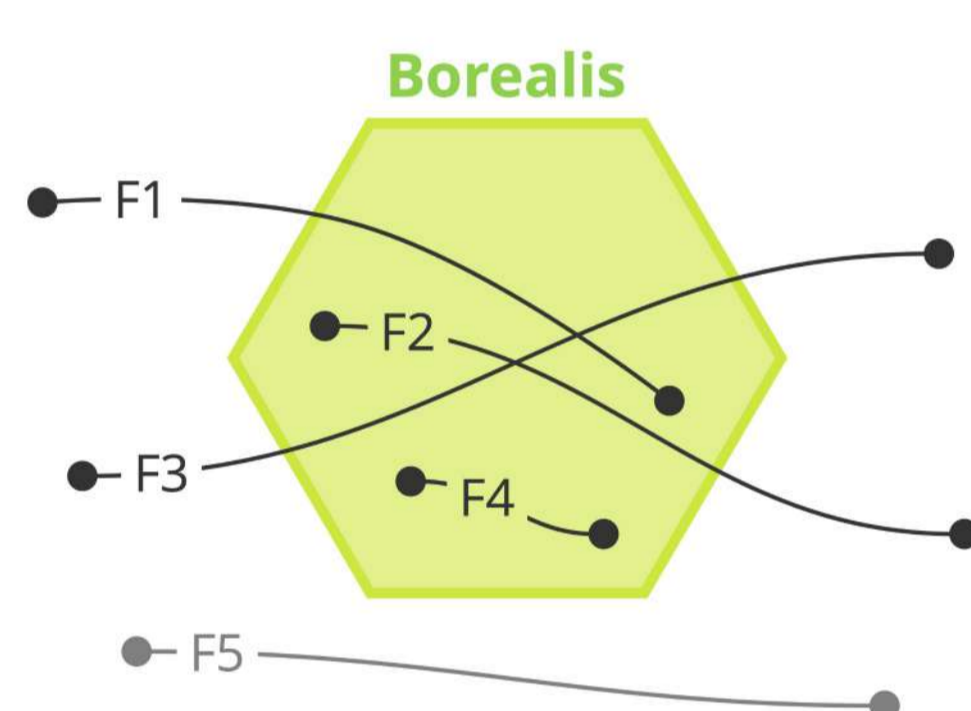


Daily Borealis flights in winter and summer.

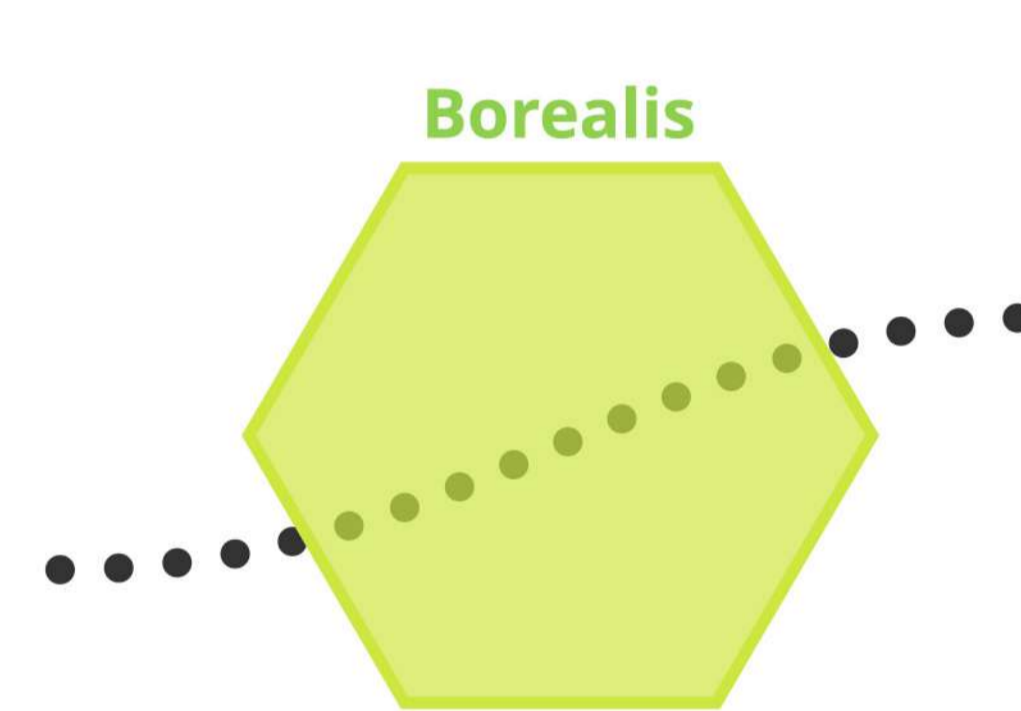


Borealis area.

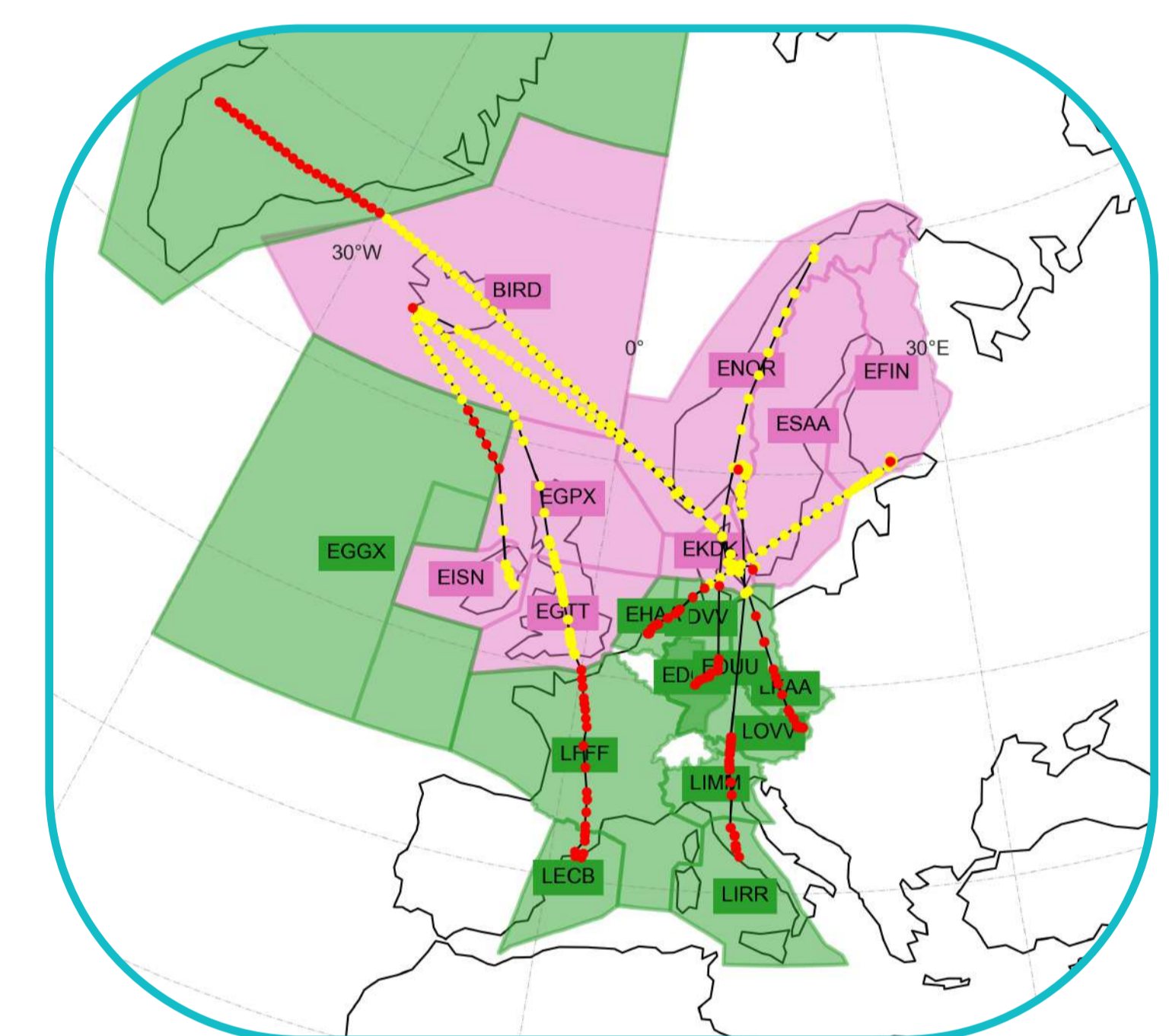
Methodology



1. Identify flights that traverse Borealis by analyzing their entered airspaces.



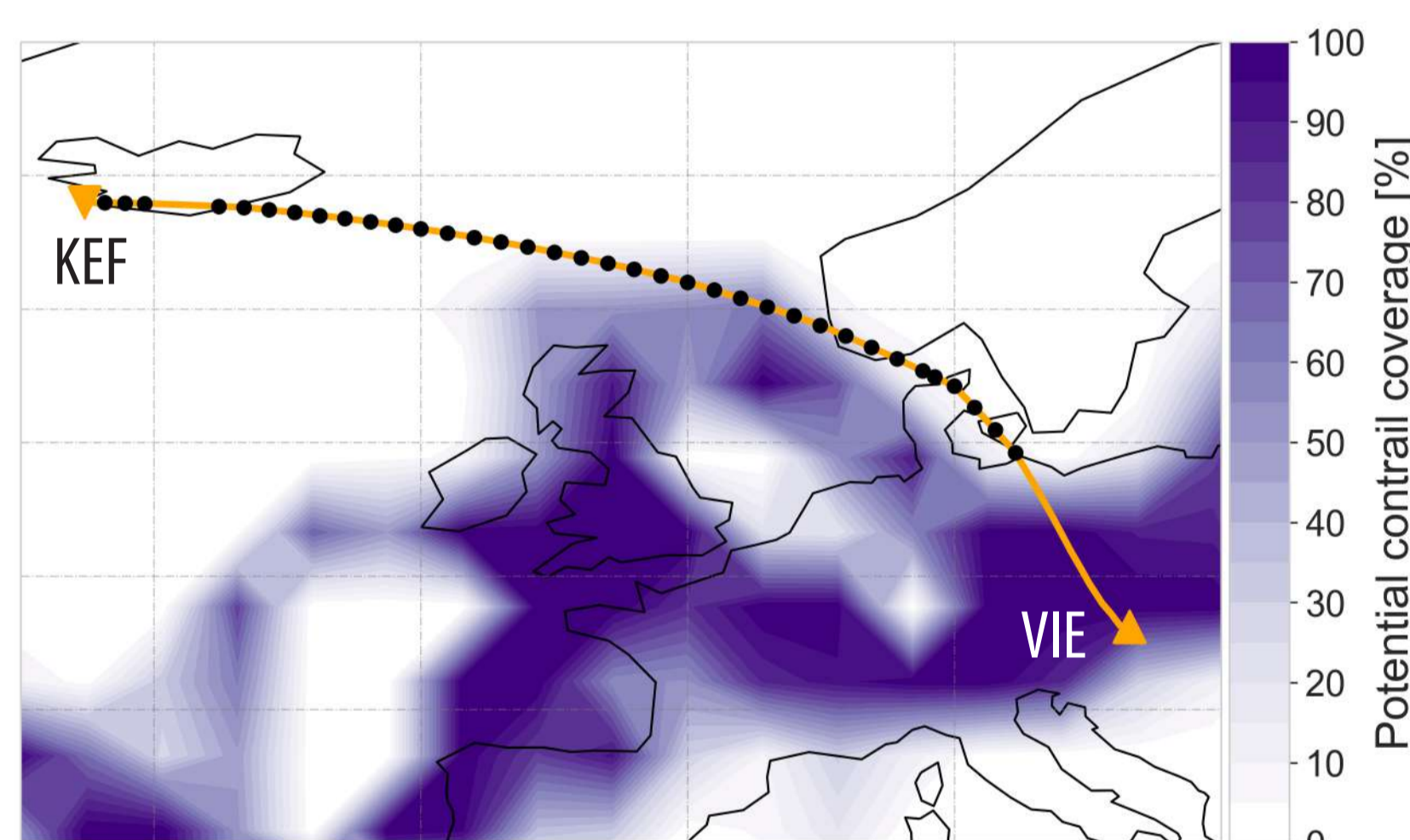
2. Determine waypoints within Borealis to evaluate the climate impact.



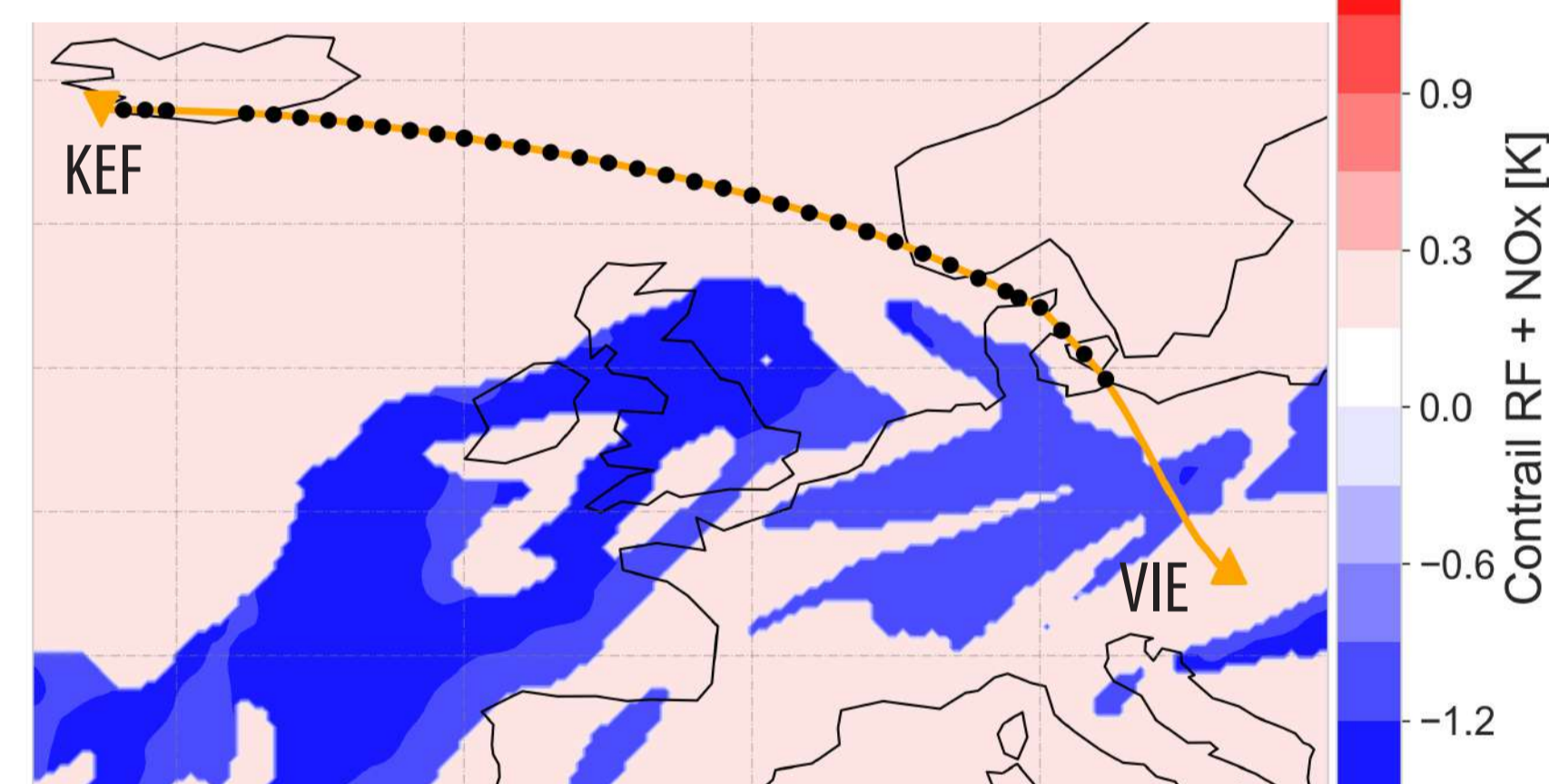
Sample of flights traversing Borealis (pink airspaces) on June 1st, 2019.

3. Apply three models to determine the:

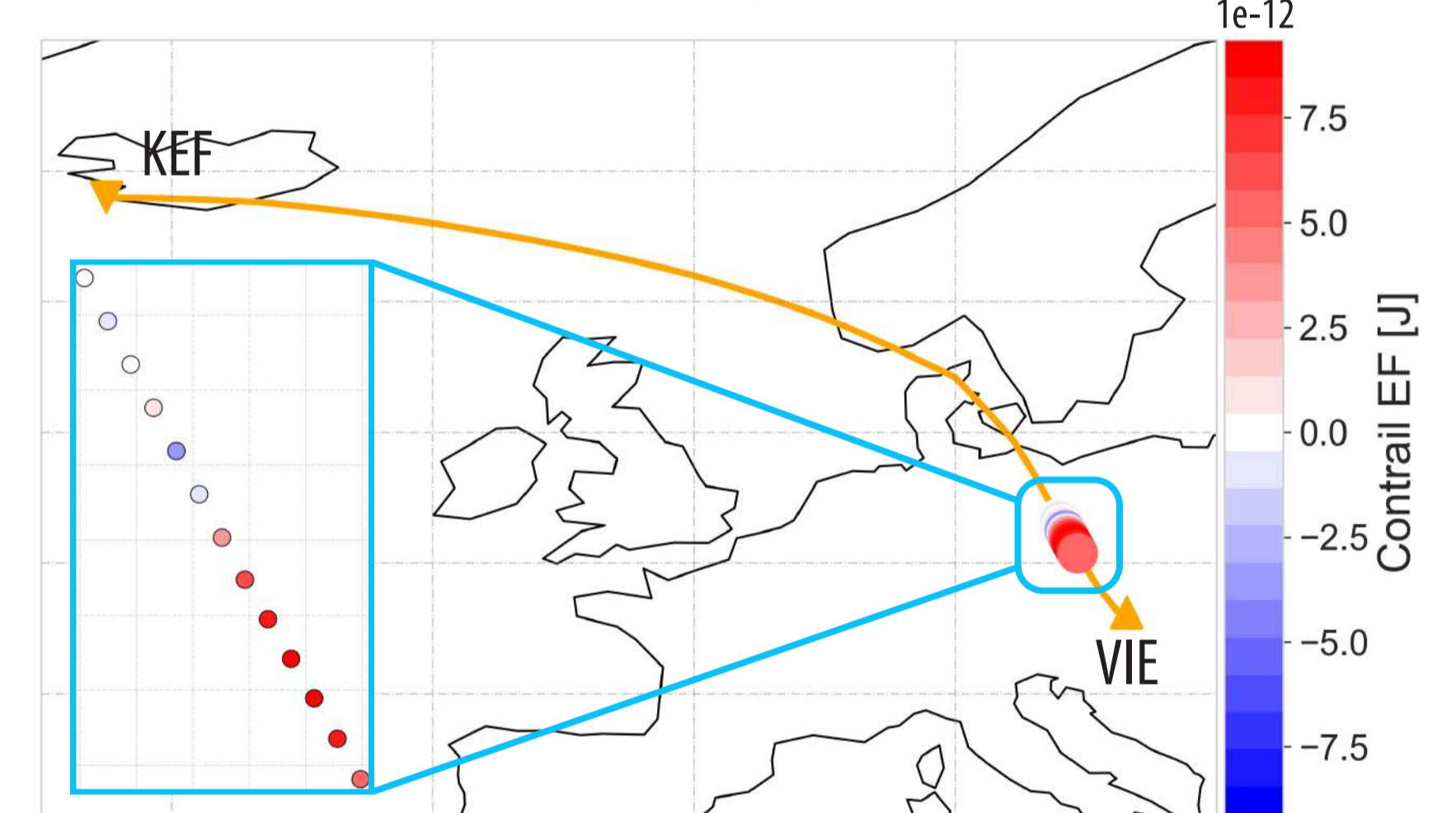
(1) potential contrail coverage



(2) contrail radiative forcing (RF) and NO_x effects



(3) contrail energy forcing (EF)



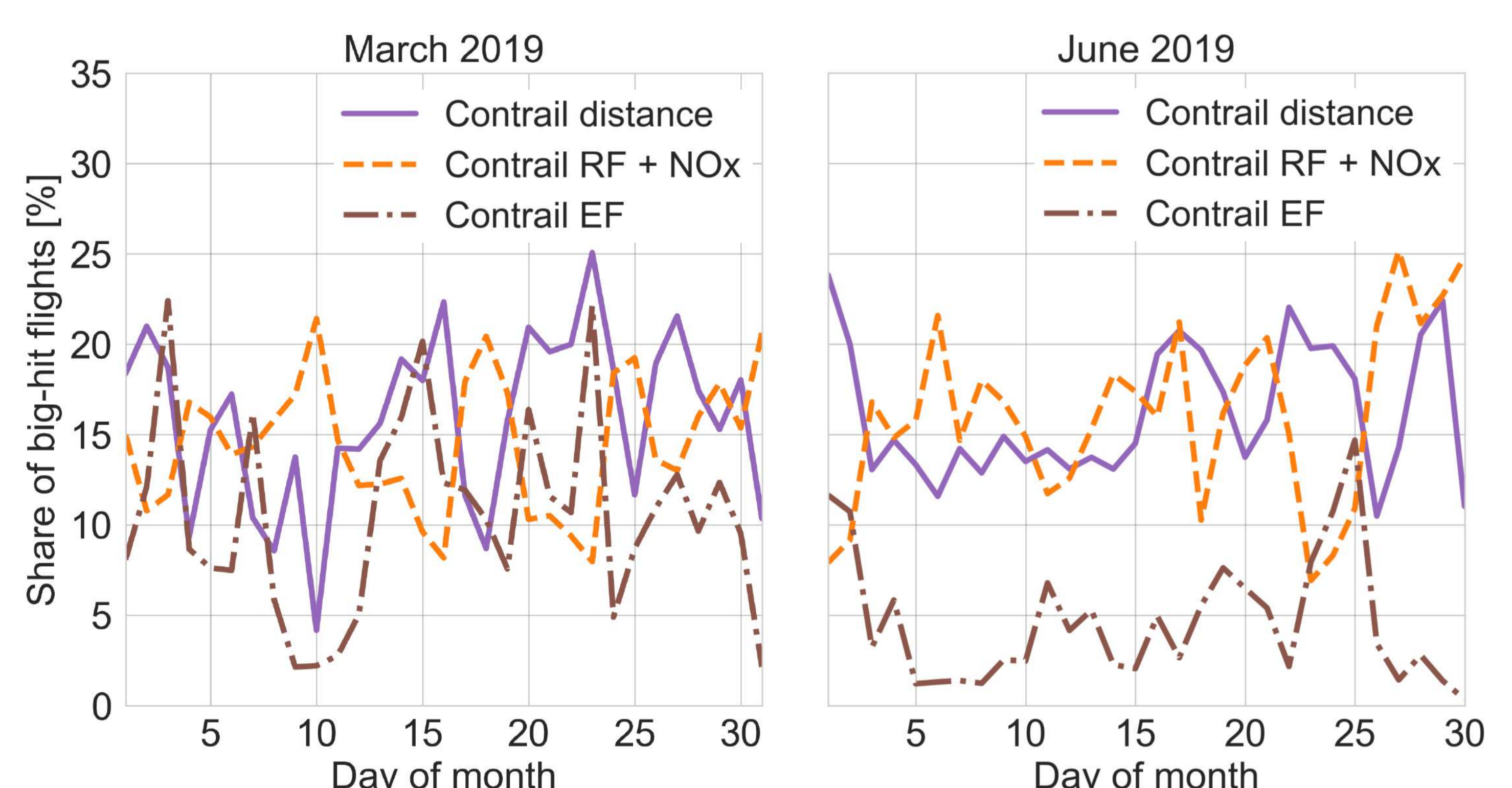
The three models are the (1) contrail submodel in EMAC [4], the (2) algorithmic climate change functions (aCCFs) [5], and (3) the contrail cirrus prediction model (CoCIP) [6].

4. Select the flights that account for 80% of the total (1) contrail distance, (2) contrail RF + NO_x effects, (3) contrail EF.

Results

The Big-Hits are aligned.

Climate Indicator	Big-hits [%]
Contrail distance	16.2 [4.2 to 25.8]
Contrail RF + NO _x effects	16.1 [6.9 to 25.2]
Contrail EF	10.0 [0.3 to 31.6]
	14.1% on average



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[1] Lee et al. (2021): "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018."
[2] Grewe et al. (2017): "Feasibility of climate-optimized air traffic routing for trans-Atlantic flights."
[3] Matthes et al. (2020): "Climate-optimized trajectories and robust mitigation potential: Flying ATM4E"
[4] Frömming et al. (2014): "Documentation of the EMAC submodels AIRTRAC 1.0 and CONTRAIL 1.0."
[5] Yin et al. (2023): "Predicting the climate impact of aviation for en-route emissions: The algorithmic climate change function submodel ACCF 1.0 of EMAC 2.53."
[6] U. Schumann. (2012): "A contrail cirrus prediction model."

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This project is funded by CONCERTO as part of the SESAR 3 Joint Undertaking Grant managed through EU Funding & Tenders. Project number: 101114785.