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Climate impact of aircraft-induced cirrus assessed from satellite observations before and during COVID-19

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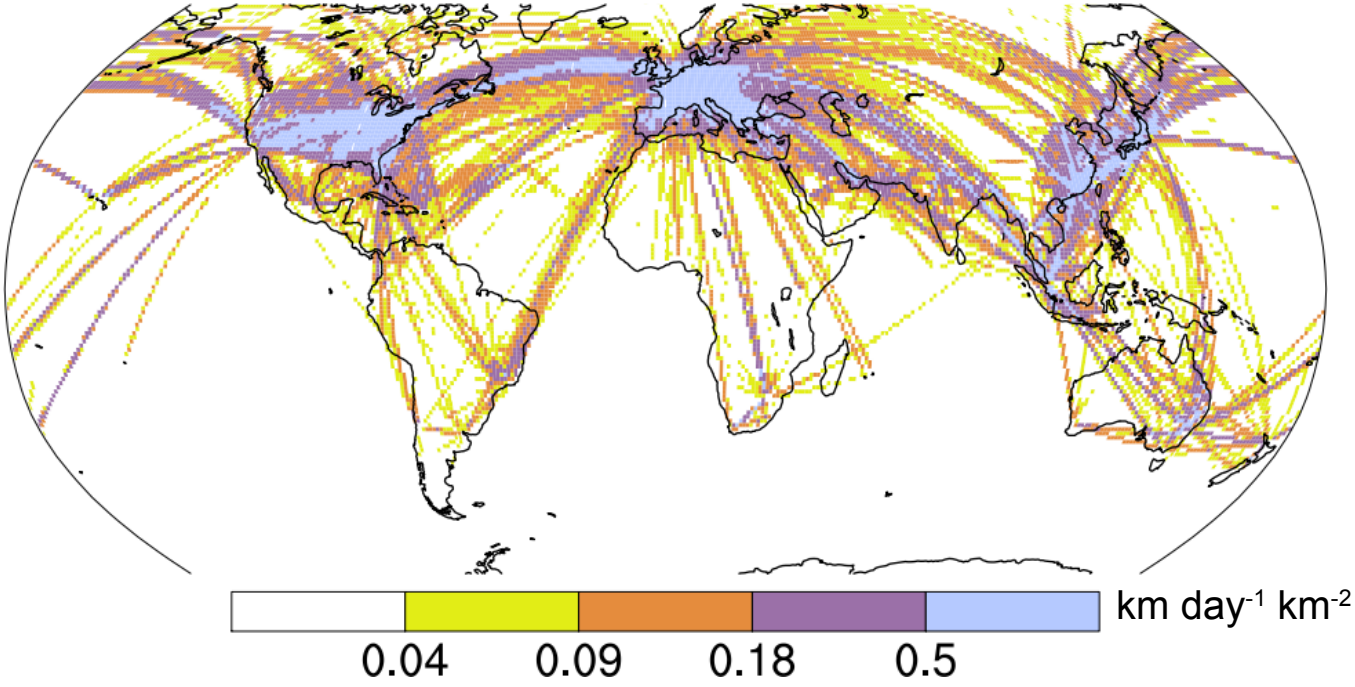
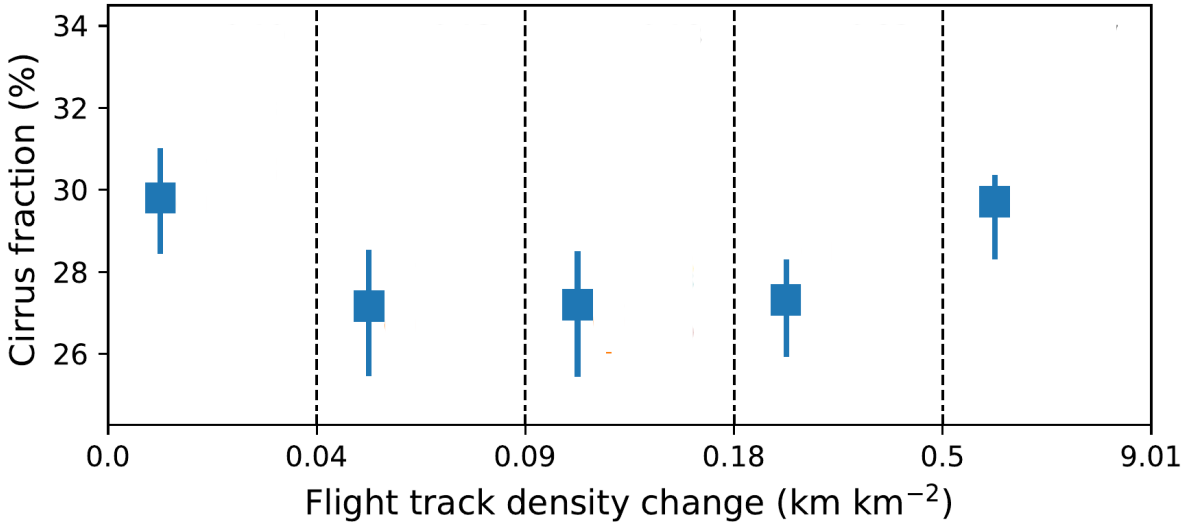


FlightRadar24 flight track density 2019 minus 2020 (March – May)

Colour bar selects five quintiles of area in Northern hemisphere mid-latitudes
→ will be used for sampling in following plots

Cirrus fraction & emissivity in regions with air traffic change; 2020 vs. past



March – May

2020

Range spanned by four satellite overpasses

MODIS cirrus fraction

- from MOD08_D3 and MYD08_D3 (Terra / 10.30 and MODIS Aqua / 1.30)
- joint histogram, cloud-top pressure < 320 hPa, emissivity < 0.95
- Northern hemisphere mid-latitudes, 27°N - 68°N
- Boreal spring, March – May
- grid-boxes that contain cirrus

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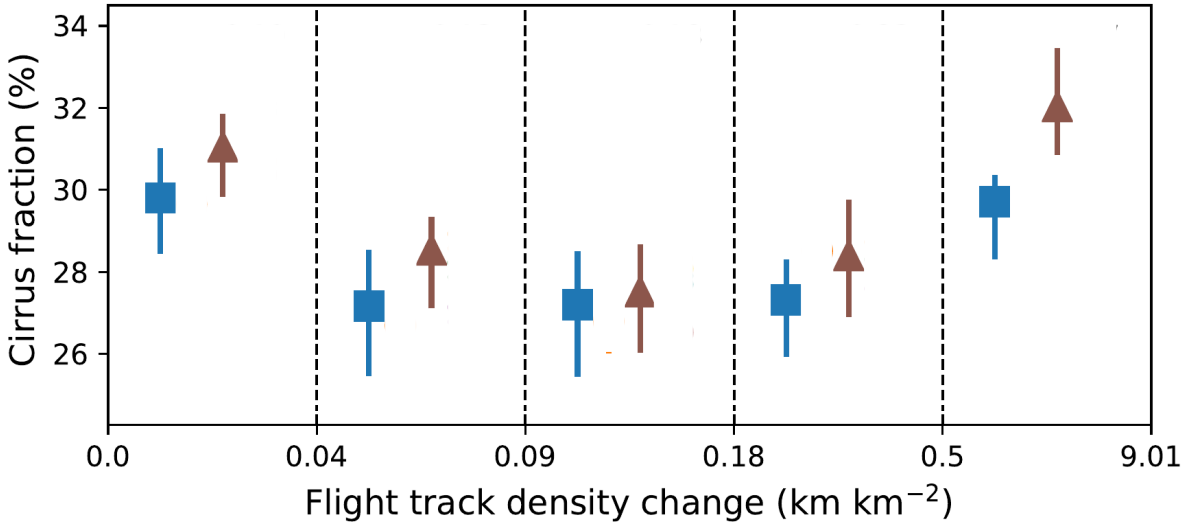

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Climatology

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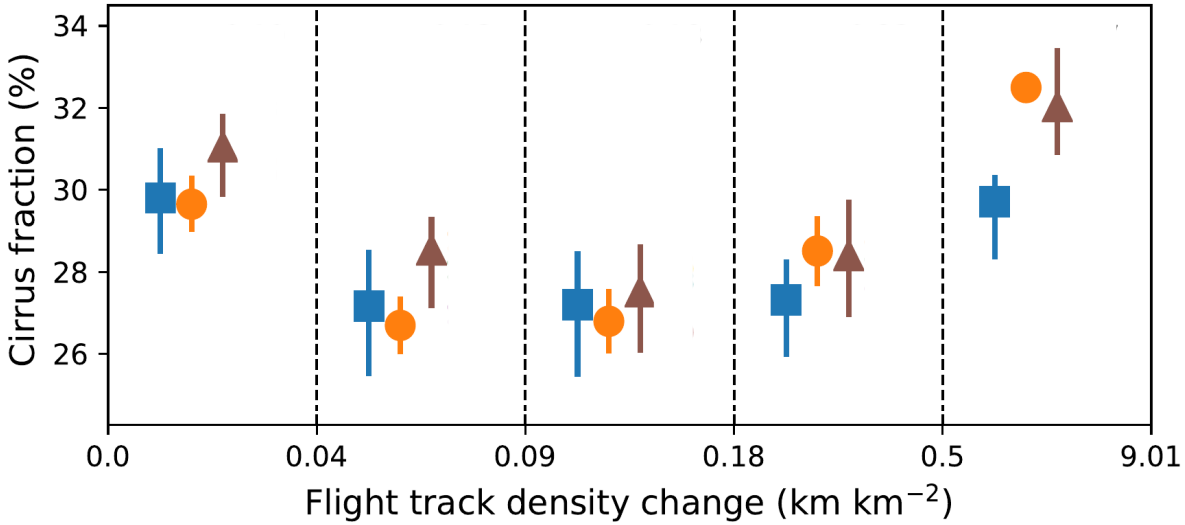

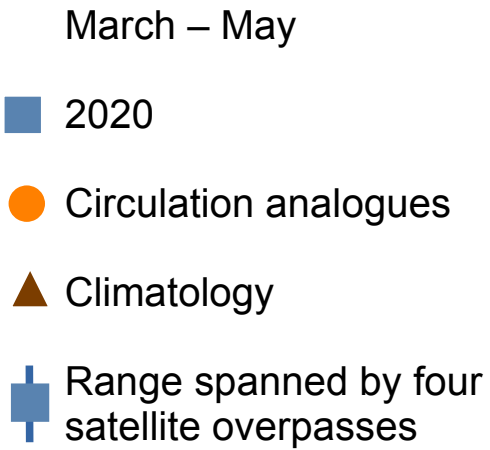

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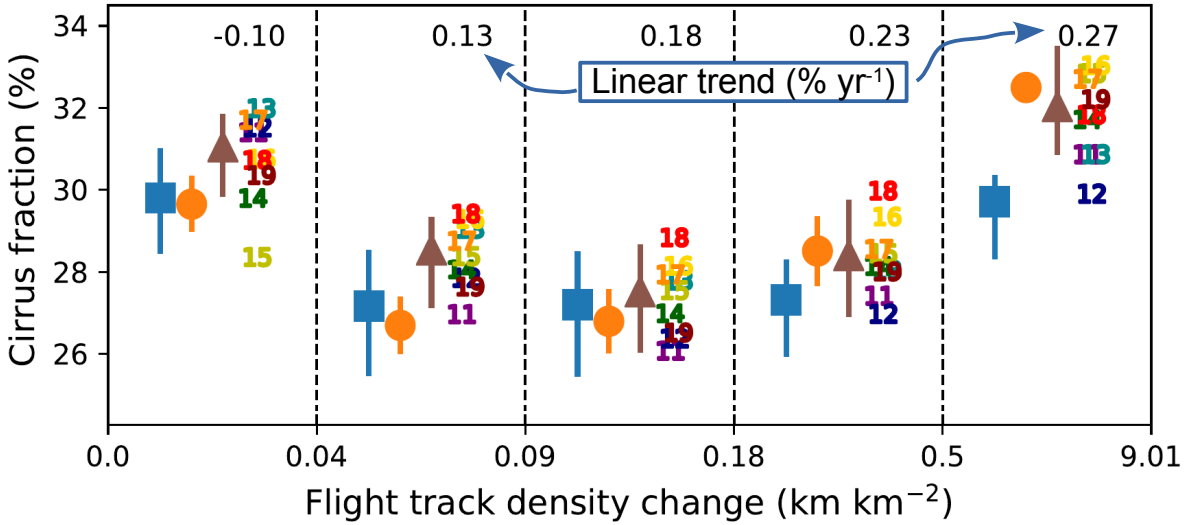
Circulation analogues

- pattern correlation of 500 hPa geopotential (NCEP reanalysis) within 5°x5° grid-boxes
- select up to 50 cases ($r^2 > 0.5$) from 2011 – 2019 reference period

Cirrus fraction & emissivity in regions with air traffic change; 2020 vs. past



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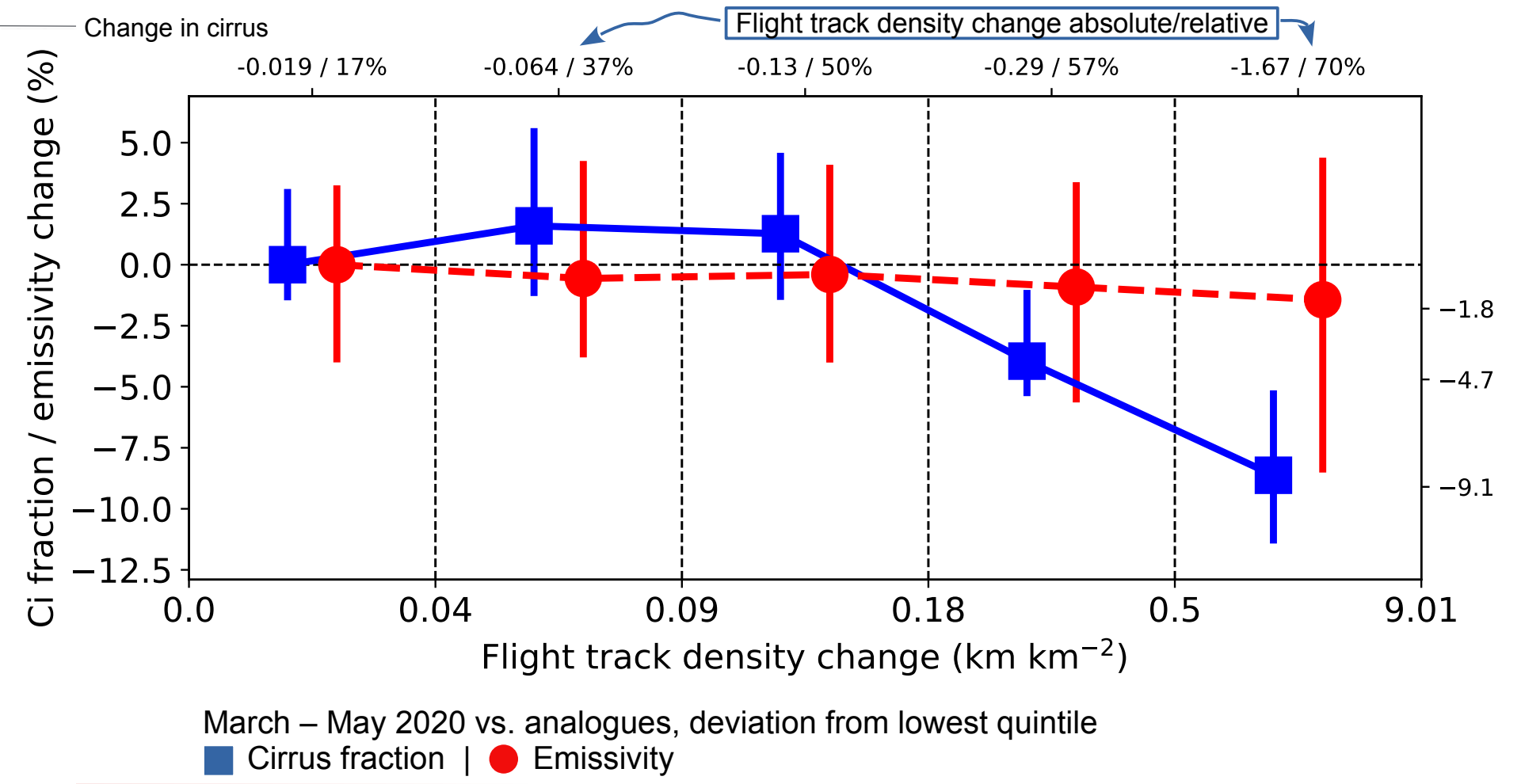
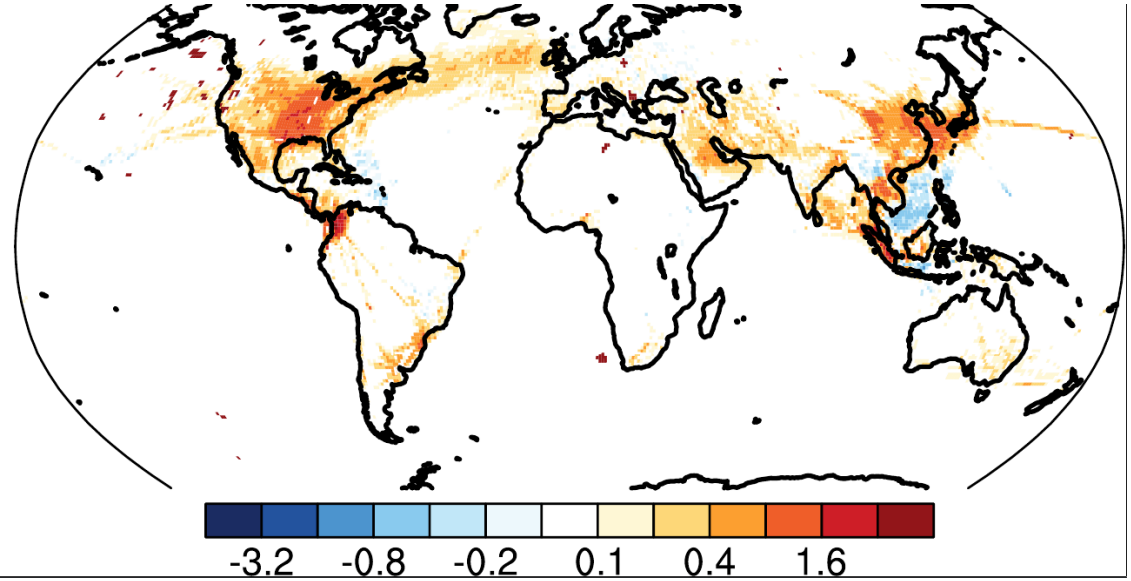
Quaas, Gryspeerdt, Vautard, Boucher, Environ. Res. Lett. in press


Change in cirrus
Flight track density change absolute/relative
-0.019 / 17%
-0.064 / 37%
-0.13 / 50%
-0.29 / 57%
-1.67 / 70%
Ci fraction / emissivity change (%)
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−12.5
−1.8
−4.7
−9.1
0.0
0.04
0.09
0.18
0.5
9.01
Flight track density change (km km^{-2})
March – May 2020 vs. analogues, deviation from lowest quintile
Cirrus fraction | Emissivity



Net radiative forcing (W m^{-2})

Radiative forcing
- ECHAM off-line radiation transfer
- driven by ERA5 re-analysis
- accounts for change in aviation during reference period
  & not-complete reduction in 2020

Radiative forcing: 61 ±39 mW m^{-2} (2019)
Lee et al. (AR 2020)
57 (17 to 98) mW m^{-2} for 2018

IPCC AR5: 50 mW m^{-2} for 2014
→ 74 mW m^{-2} for 2019 / 5% annual increase