ACT GLOBAL

ICAO: UNITING AVIATION ON CLIMATE CHANGE

ICAO Colloquium on Aviation and Climate Change

# Recent research results on the climate impact of contrail cirrus and mitigation options

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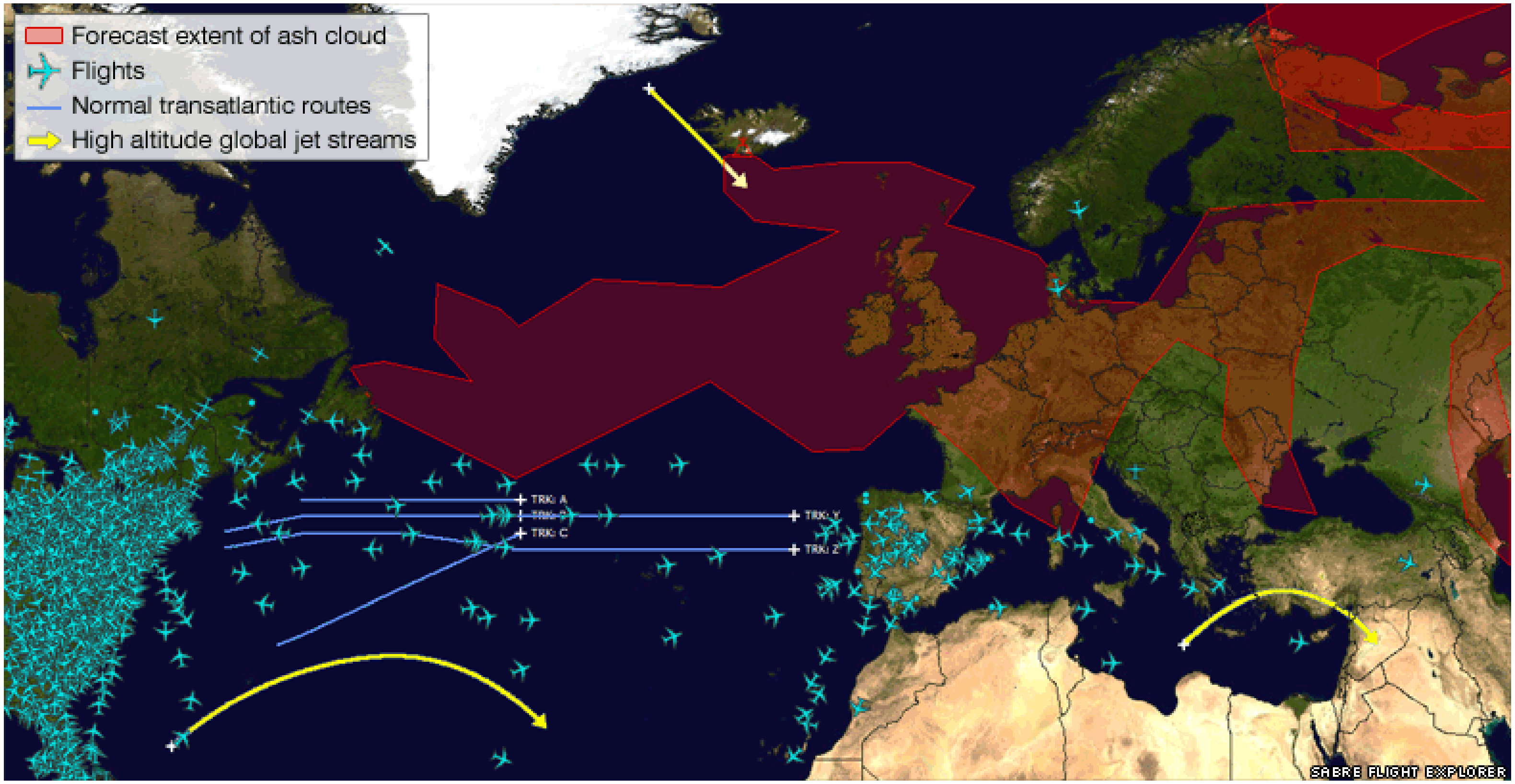
DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

# April 19, 13 UTC: Air space closure justified?




DLR-Falcon started at 14:11 UTC

see http.dlr.de

# May 1: DLR Falcon measures Eyjafjal Volcano Plume

New chance to detect the cloud impact of contrails (for reduced traffic) and to compare with the impact of volcanic aerosol

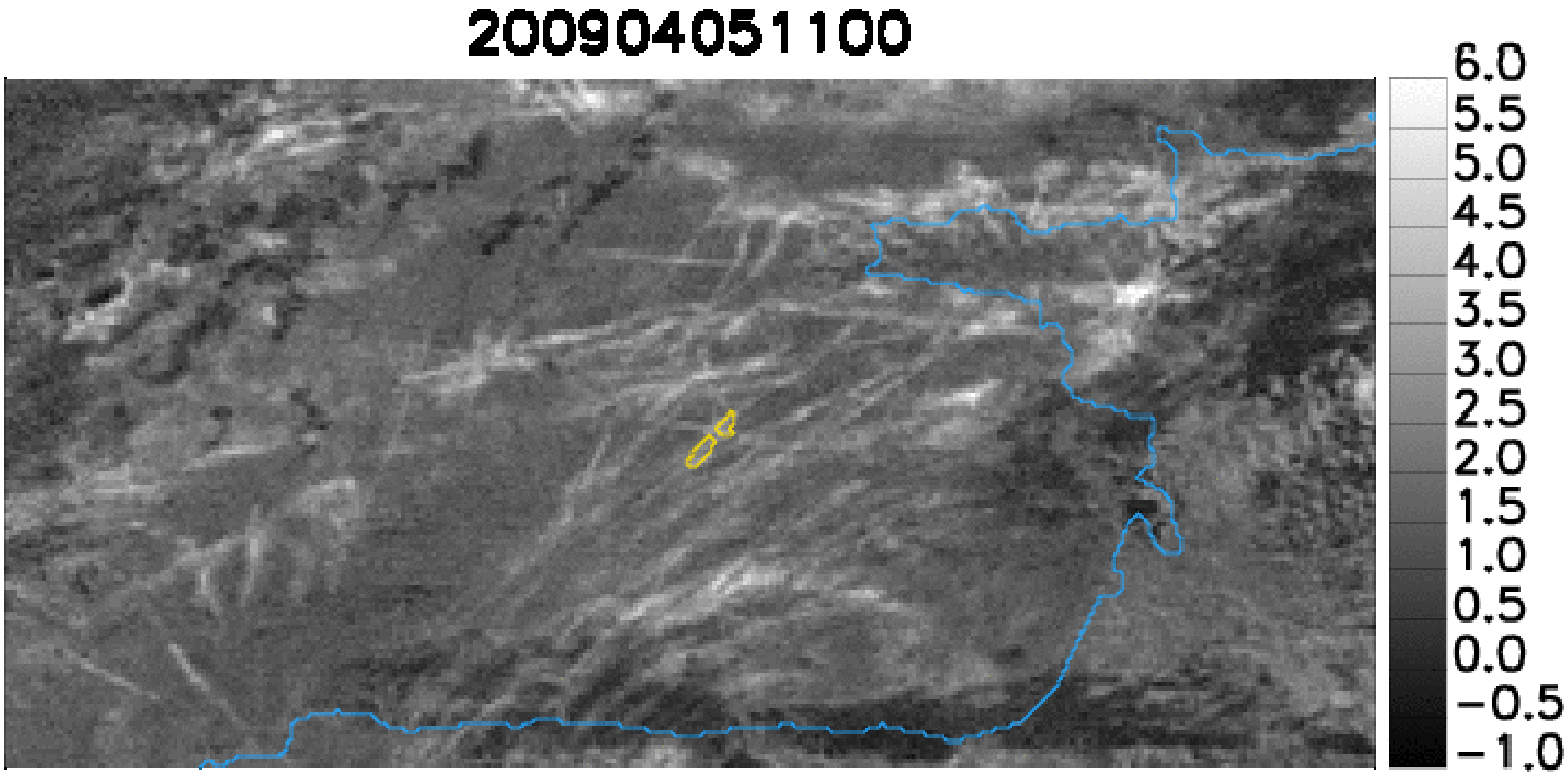
Similar to or better than the 9/11/2001-case

Requires access to European air traffic data for research

Aged (7h) particulate mass flux measured: 3000 kg/s

(Schumann, Weinzierl, Reitebuch et al.)

# Results from DLR CATS-Project: "Climate-Compatible Air-Transport System", e.g.: Contrails traced in Meteosat scene




***An automatic contrail tracking algorithm**, M. Vazquez-Navarro, B. Mayer, H. Mannstein, 2010, Atmos. Meas. Tech. Discuss., 3, 1439-1494, 2010*

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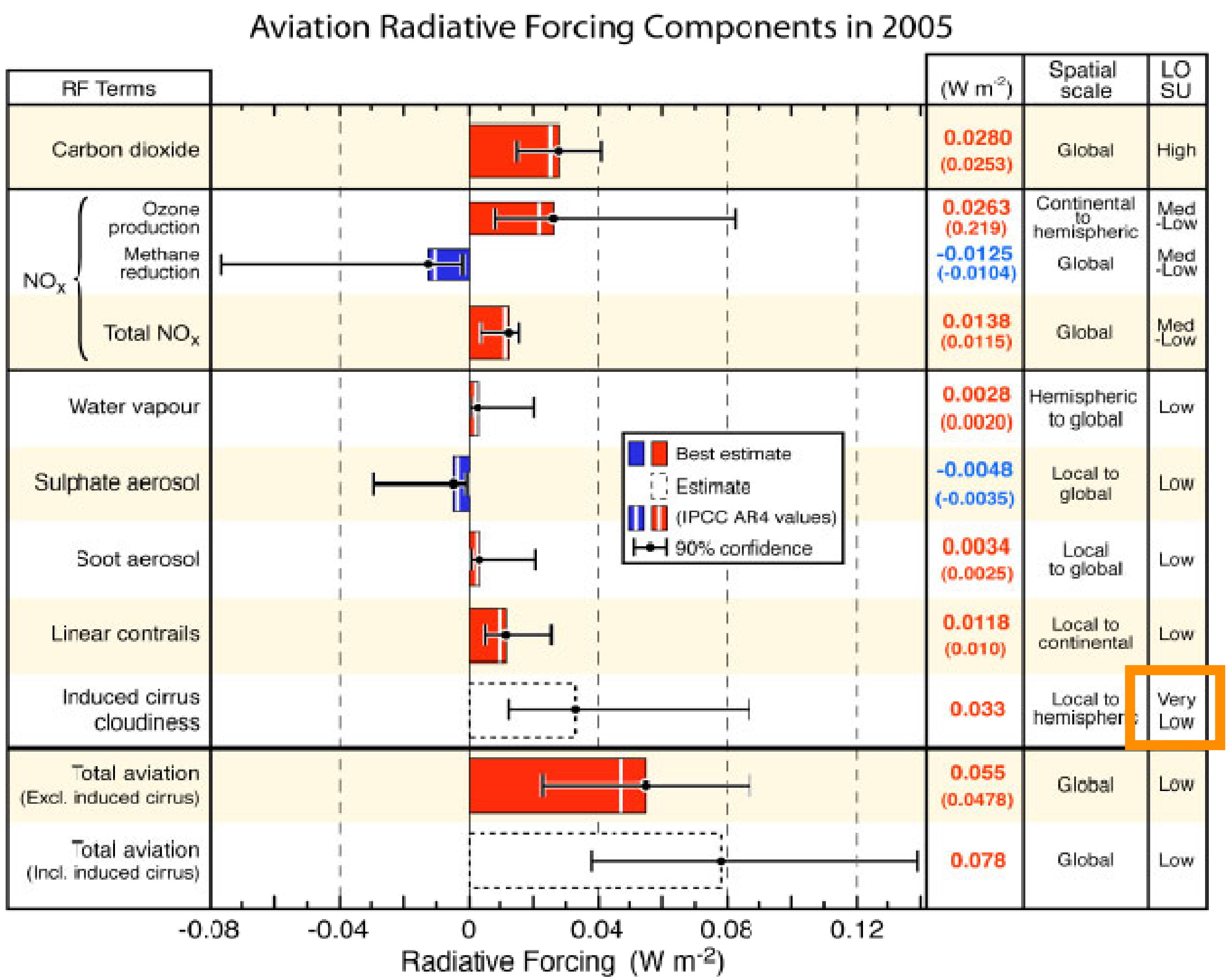
# Induced Cirrus Cloudiness still not IPCC-assessed




Level of Scientific Understanding (LOSU):

very low??

(Lee et al., 2009a)

# Content

The presentation will be summarizing results from recent research studies on contrail cirrus and its climate impact.

- Satellite observations of aviation induced cirrus changes,
- In-situ measurements of contrail properties behind a series of aircraft,
- Contrail and contrail cirrus modeling with a global climate model ECHAM,
- Contrail cirrus properties based on microphysics and LES simulations,
- Contrail prediction with a contrail cirrus prediction tool CoCiP.

# Message

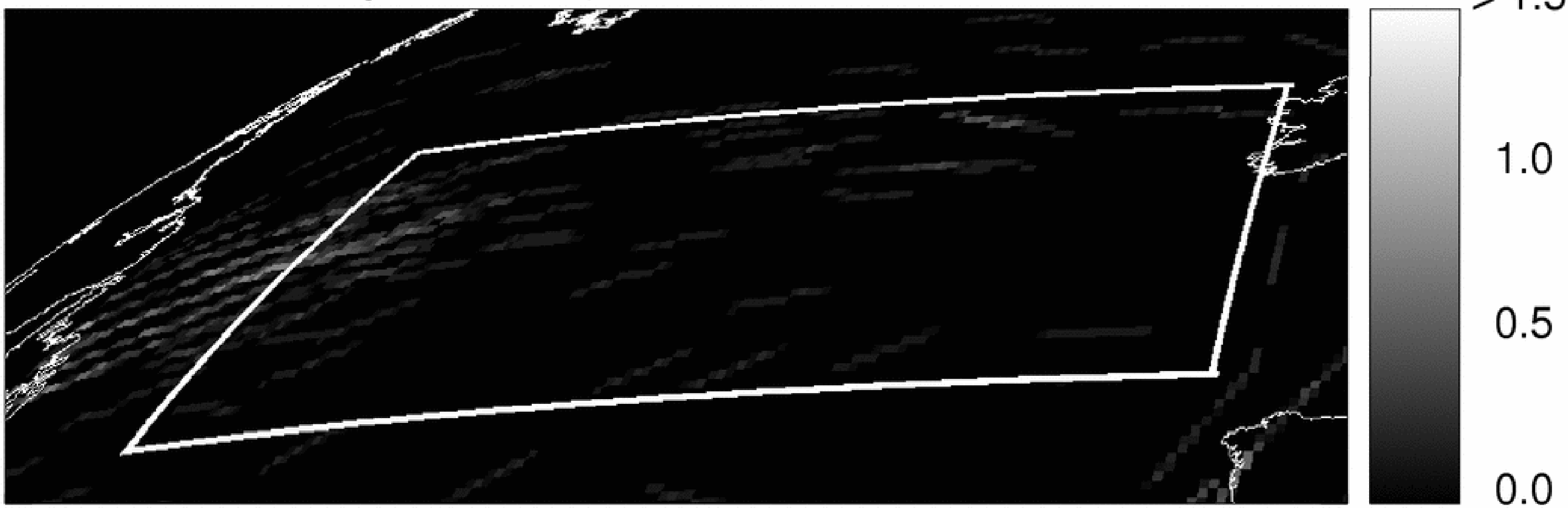
Contrail cirrus contributes a large fraction to the aviation induced climate impact.

Satellite data analyses suggest observable impact of aviation on cirrus cover and radiation fluxes.

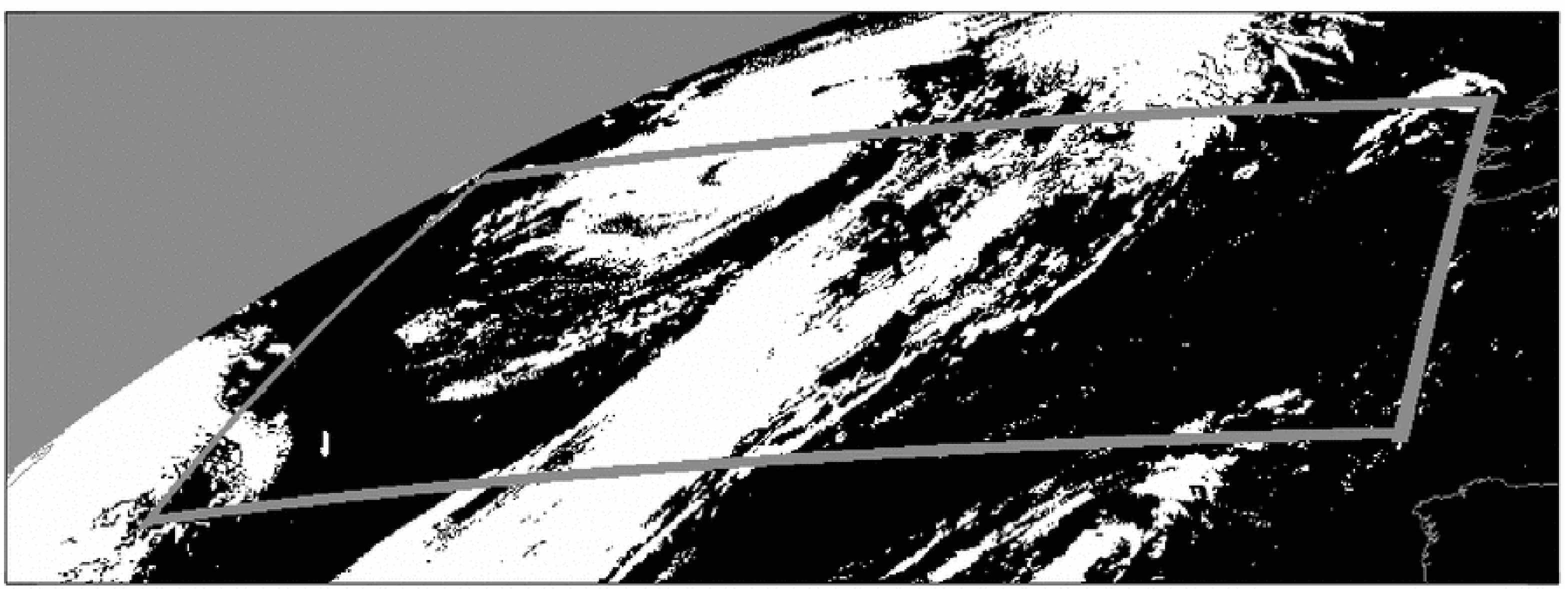
The climate impact of aviation induced contrail cirrus depends on aircraft properties and routing

Both aspects offer the potential for aviation to reduce the climate impact of aviation

Air traffic density in km / ( km² h ), 25.04.2004, 00:00 UTC



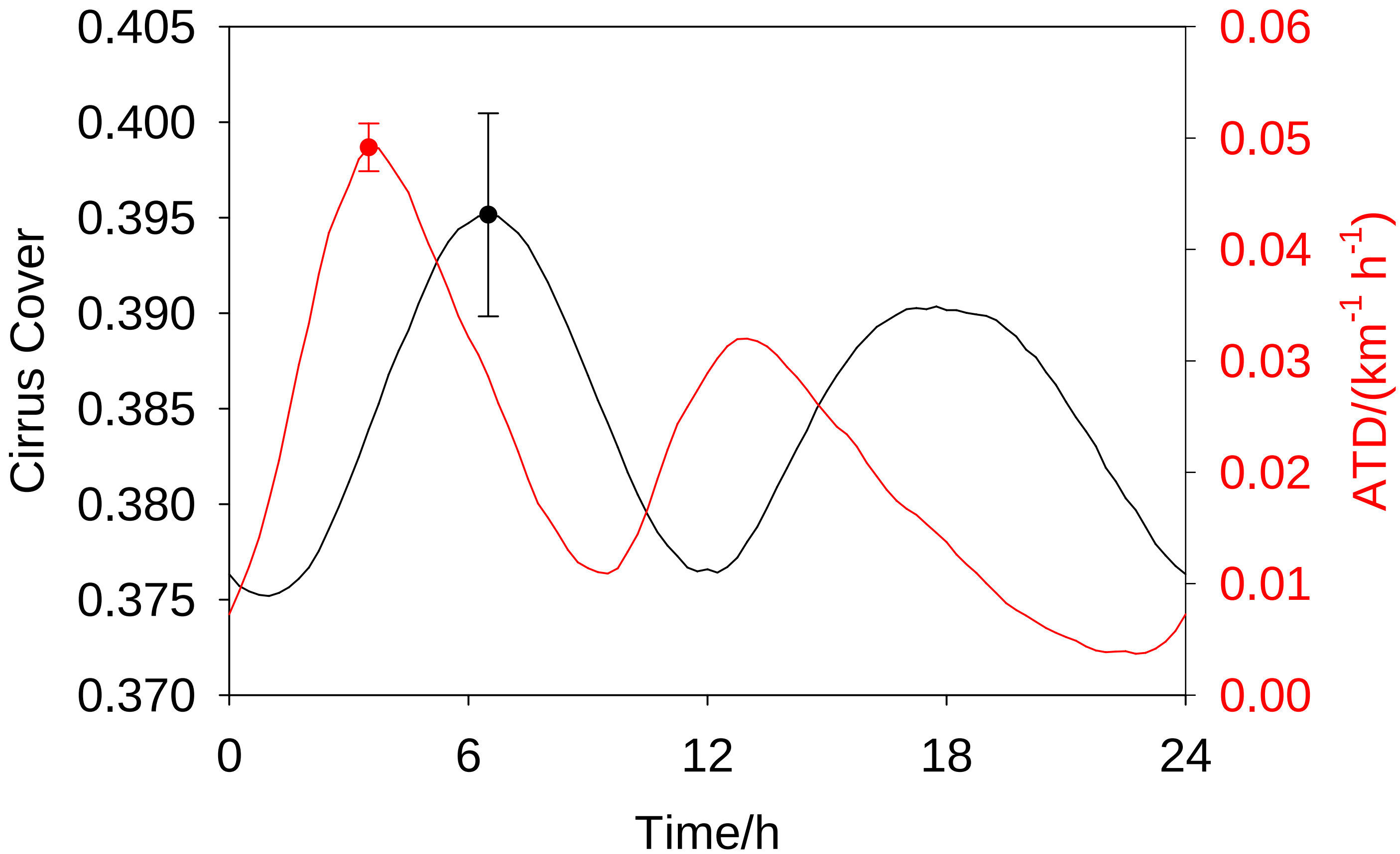

MeCiDA cirrus classification, 25.04.2004, 00:00 UTC



from Meteosat IR data, MeCiDa

Graf et al. (2009)

# Annual mean traffic and cirrus cover in NAR




Contrail Cirrus Aviation Fingerprint!

Graf et al. (2009)

# A new model
# Contrail Cirrus Simulation and Prediction (CoCiP)

***Input:***

**<u>Aircraft</u>**

**(BADA)**

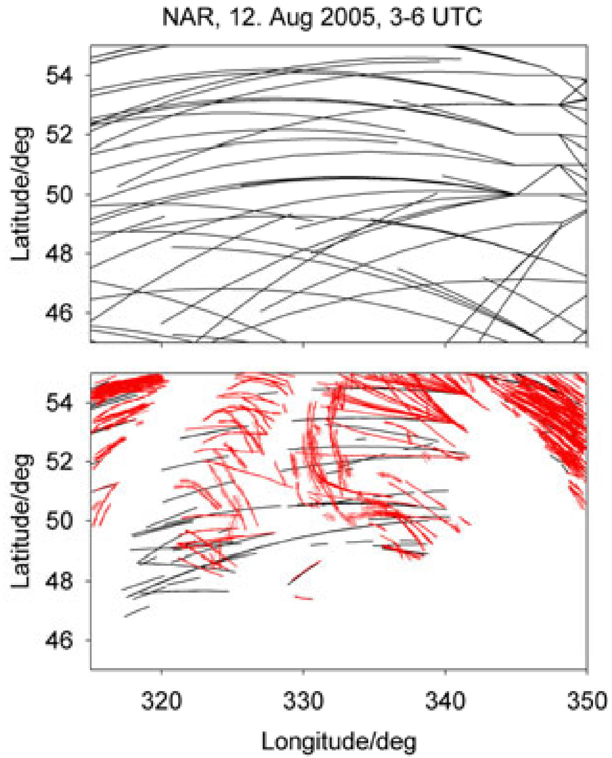
**<u>Movements</u>**

**(Eurocontrol, OAD, DFS)**


**<u>Meteorology</u>**

**(NWP results, ECMWF, DWD)**

**Contrail Cirrus Prediction Tool**




- From regional to global
- Comparable to observations

***Output:***

**<u>Contrail</u>, life cycle, cover, radiation**

**<u>Cirrus</u>**

**<u>Simulation</u>**

**insitu, Lidar, Satellite**

**<u>Sensitivity studies</u>**

**<u>Prediction</u>**

**<u>Climate impact</u>**

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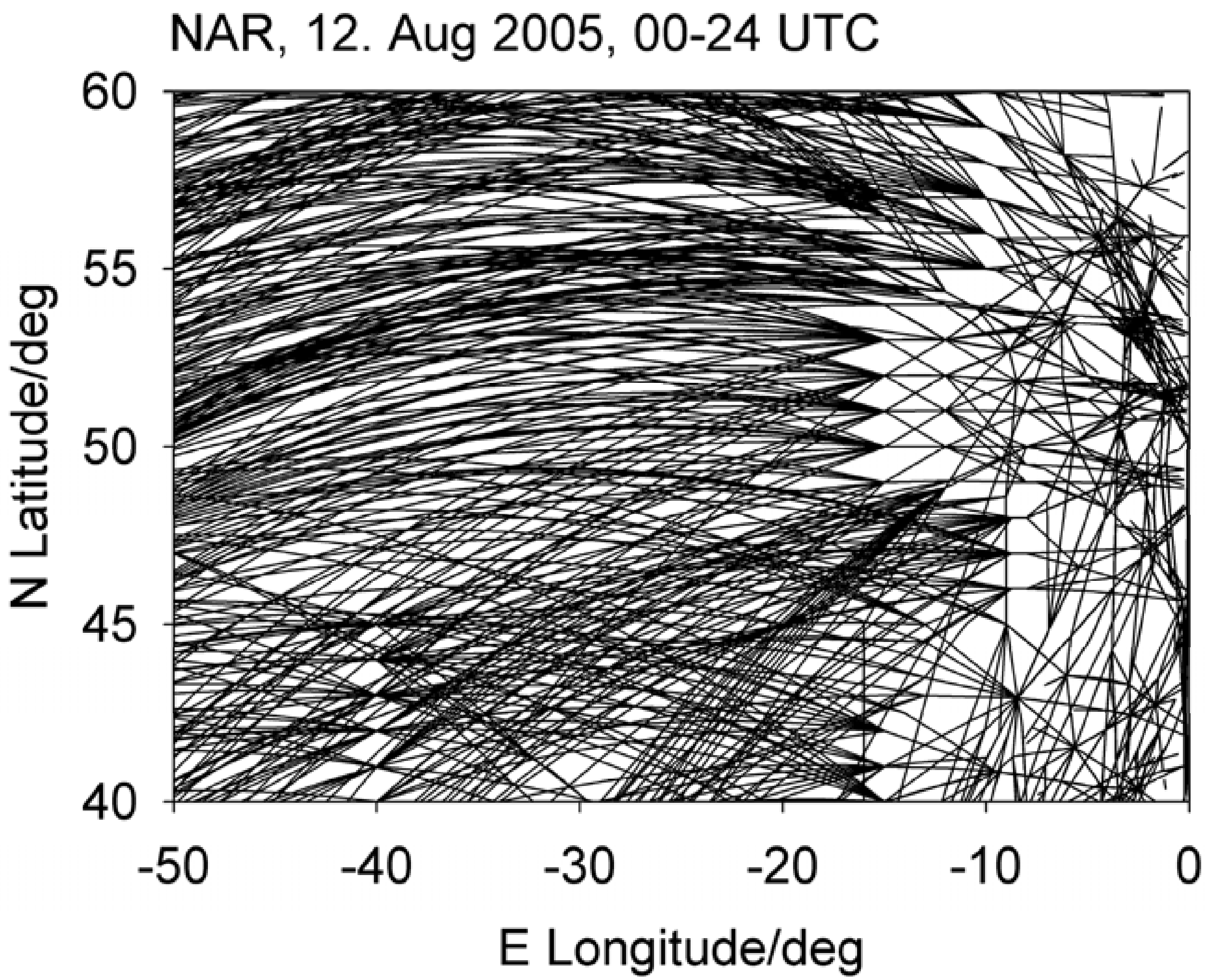
(Schumann, 2009)

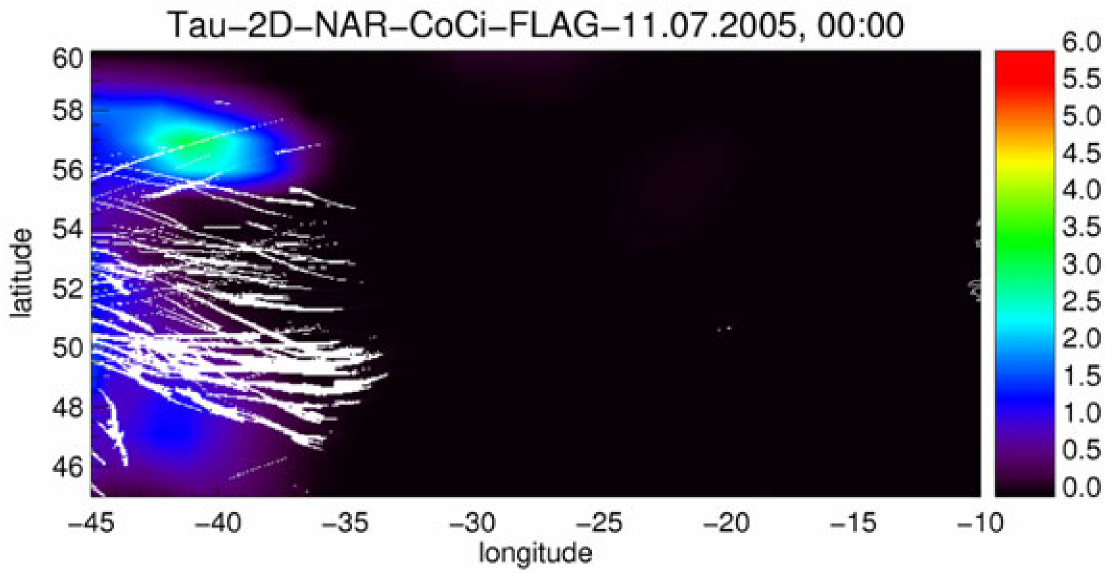
# Essential Input: Waypoint data

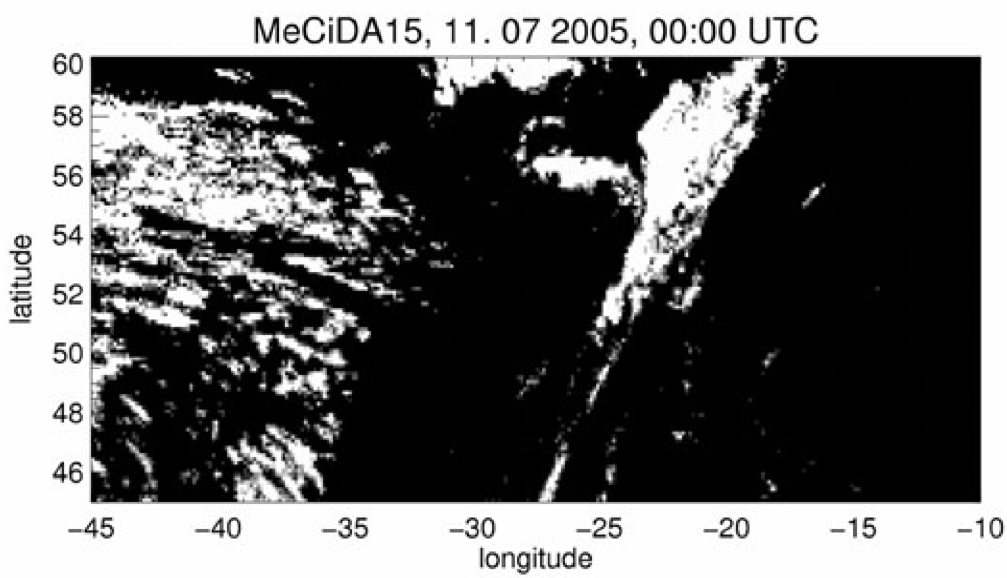



provided by EUROCONTROL, including FL, ac type, destination, origin.

More data are needed for contrail cirrus and volcano effect analysis (impact of reduced traffic, but increased aerosol load since April14 2010)

# North Atlantic Region: CoCiP simulation & MSG observation




**Top:**

**Color scale:** **cirrus cloud optical thickness** $\tau$

**white:** $\tau_{Contrail}>0.1$

**Bottom:**

**Meteosat (MSG)-MeCiDa observation derived cirrus cover (white)**

# Measurements with DLR Falcon of A319, A340, A380, B737, CRJ2 aircraft


**Contrails of larger aircraft are thicker and stay longer than for smaller ones**

**More soot causes smaller ice particles which sediment later and cause longer contrails therefore**

(C. Voigt, U. Schumann et al., 2010)

# ACCRI-Contributions, DLR in 2 out of 8 projects

Aviation induced cloudiness climate impacts derived from a new MODIS contrail climatology and contrail cirrus model simulations:
*Pat Minnis (PI, NASA LaRC), David Duda (NIA), Andy Heymsfield (NCAR), Ulrike Burkhardt, Bernd Kärcher, Hermann Mannstein and Ulrich Schumann (DLR)*

Influence of aviation aerosols and contrails on cirrus clouds and anthropogenic forcing:
*Joyce Penner (PI, Univ. Michigan) and Ulrich Schumann (DLR)*

Aviation Climate Change Research Initiative

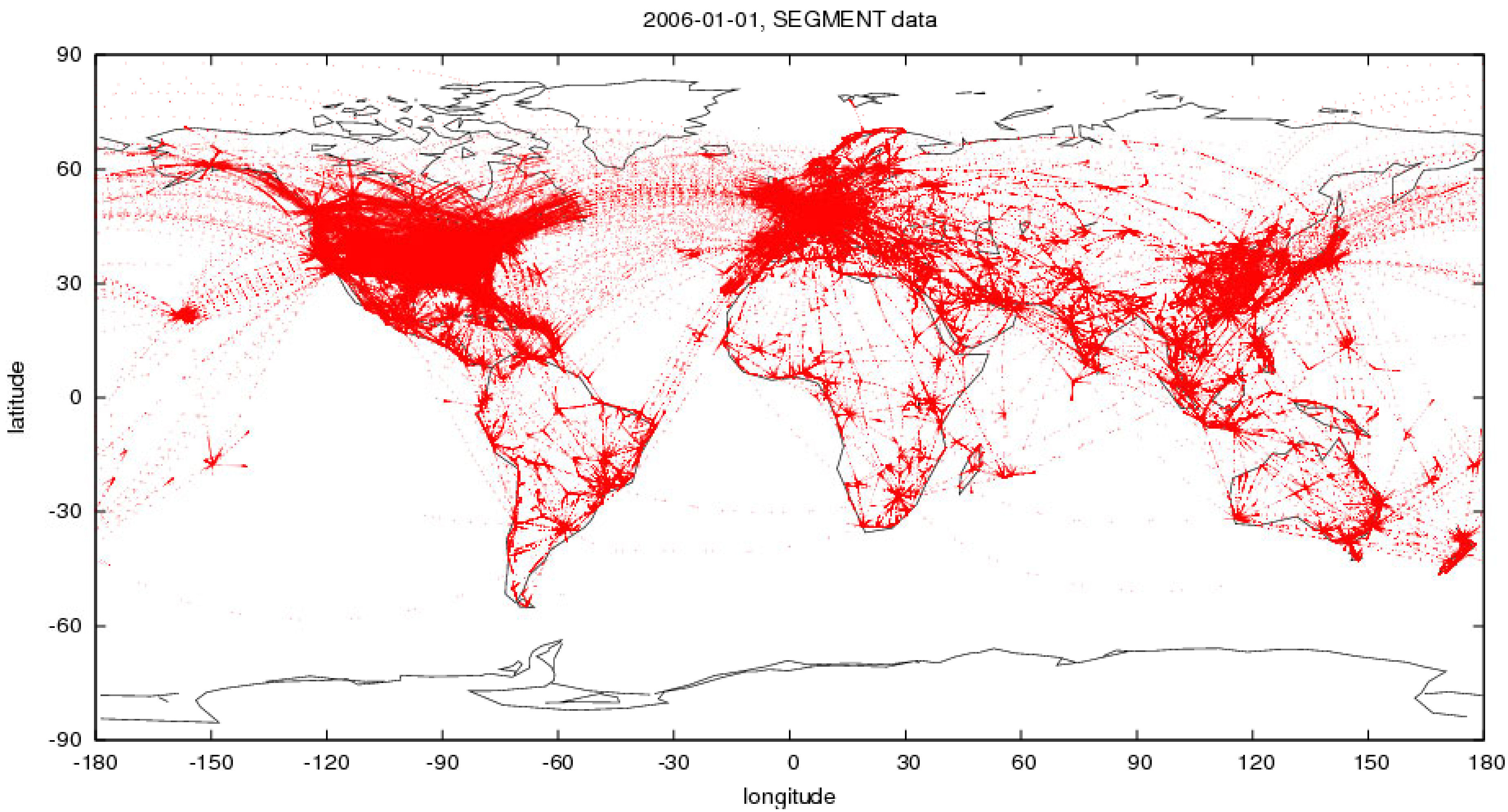
ACCRI

- chorded waypoint data 2006

- **Guidance on Particulate Aircraft Emissions**

**Mohan Gupta, FAA**

# Flight routes, January 1, 2006

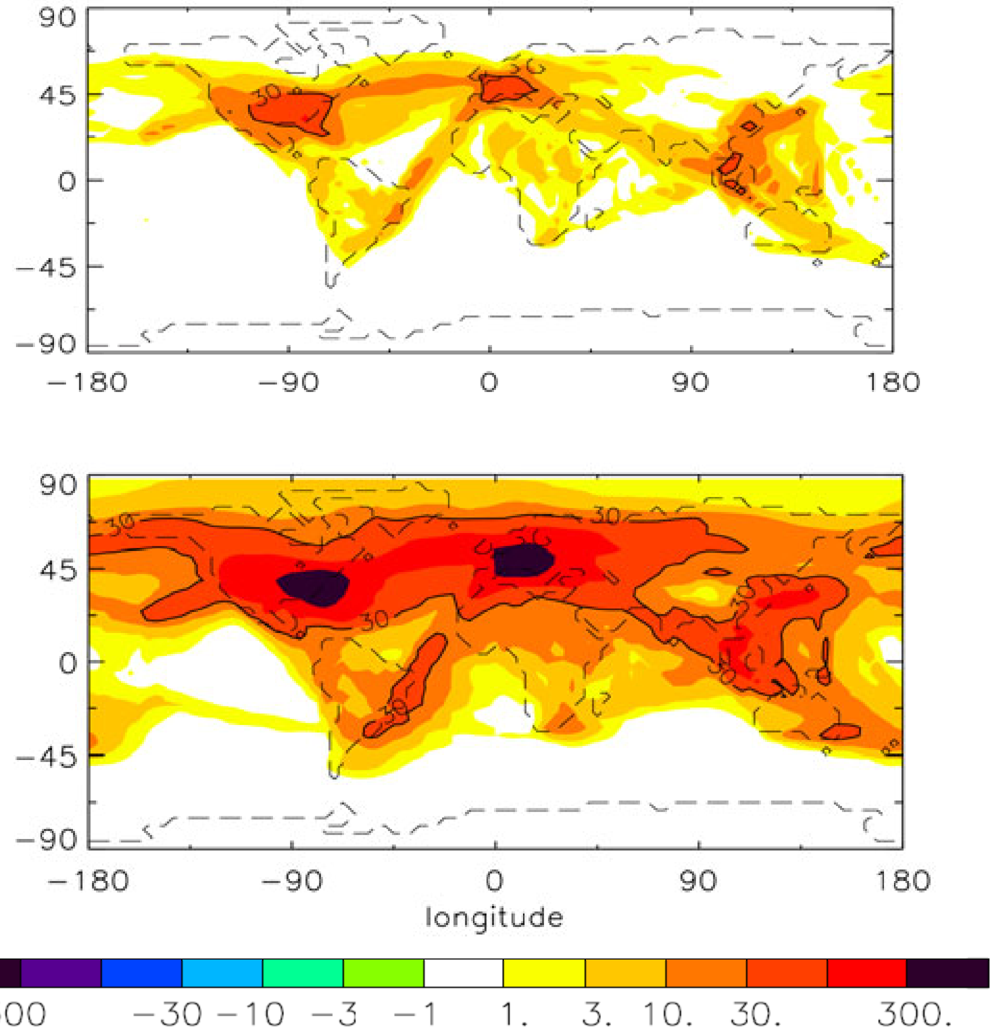



**ACCRI/FAA data, plotted by DLR, 2010**

# Radiative forcing by Contrail Cirrus from ECHAM GCM

net RF young contrails

net RF contrail cirrus




Burkhardt and Kärcher, in preparation

RF from contrail cirrus:

~ 40 mW/m²

Joint (ECHAM/CoCiP) best estimate range:

**20-70 mW/m²**

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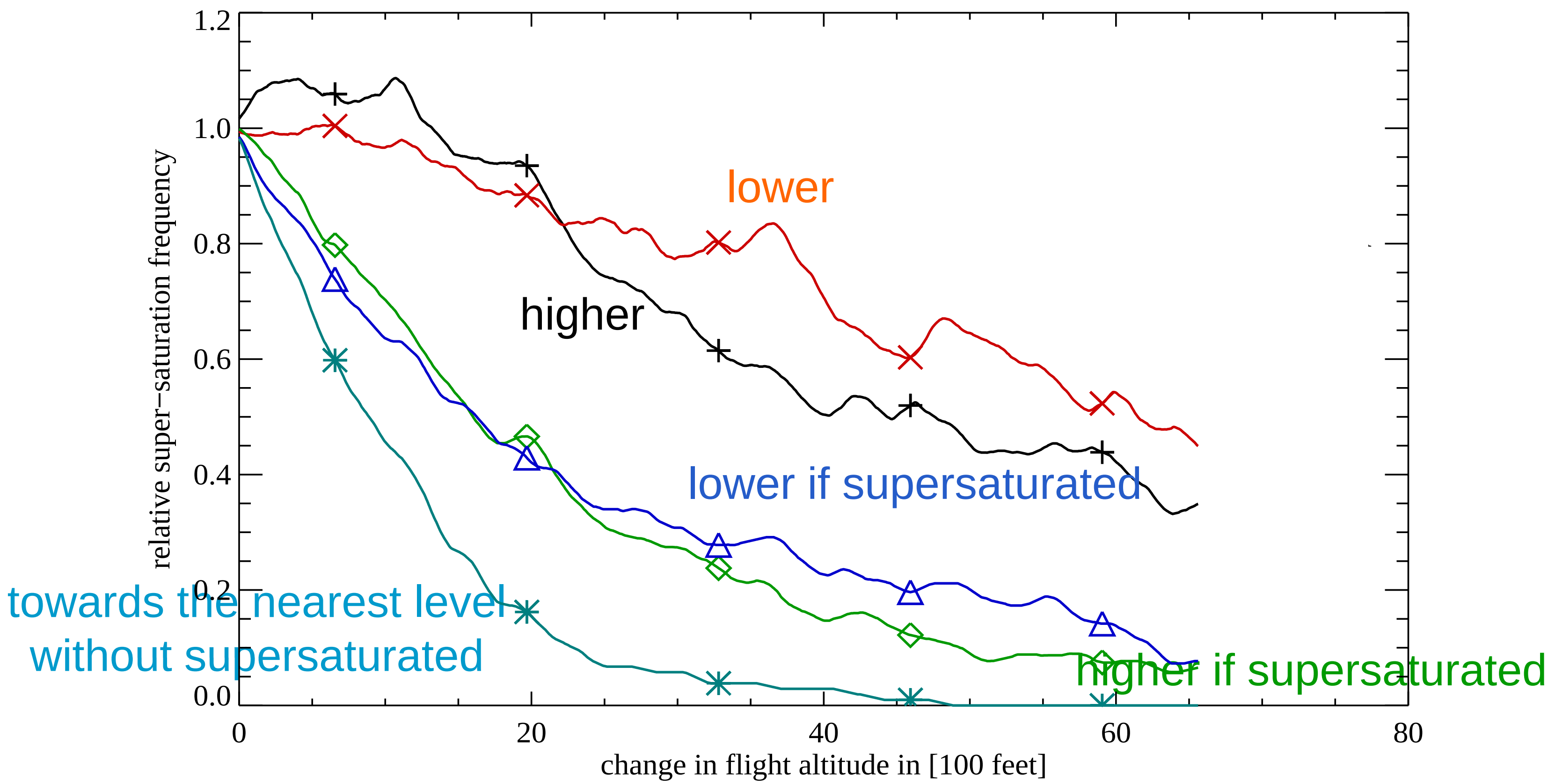
# Avoiding ice supersaturation: fly higher or lower




(Mannstein et al., 2005)

# Message

Contrail cirrus contributes a large fraction to the aviation induced climate impact (comparable to 50 years of aviation $CO_2$)

Satellite data analyses suggest observable impact of aviation on cirrus cover and radiation fluxes

The climate impact of aviation induced contrail cirrus depends on aircraft properties (e.g. soot emissions) and routing (avoid cirrus forming regions)

Both aspects offer the potential for aviation to reduce the climate impact of aviation (less soot emissions, less warming and more cooling contrails; predictable for operational planning)