DC3: DLR Falcon contribution

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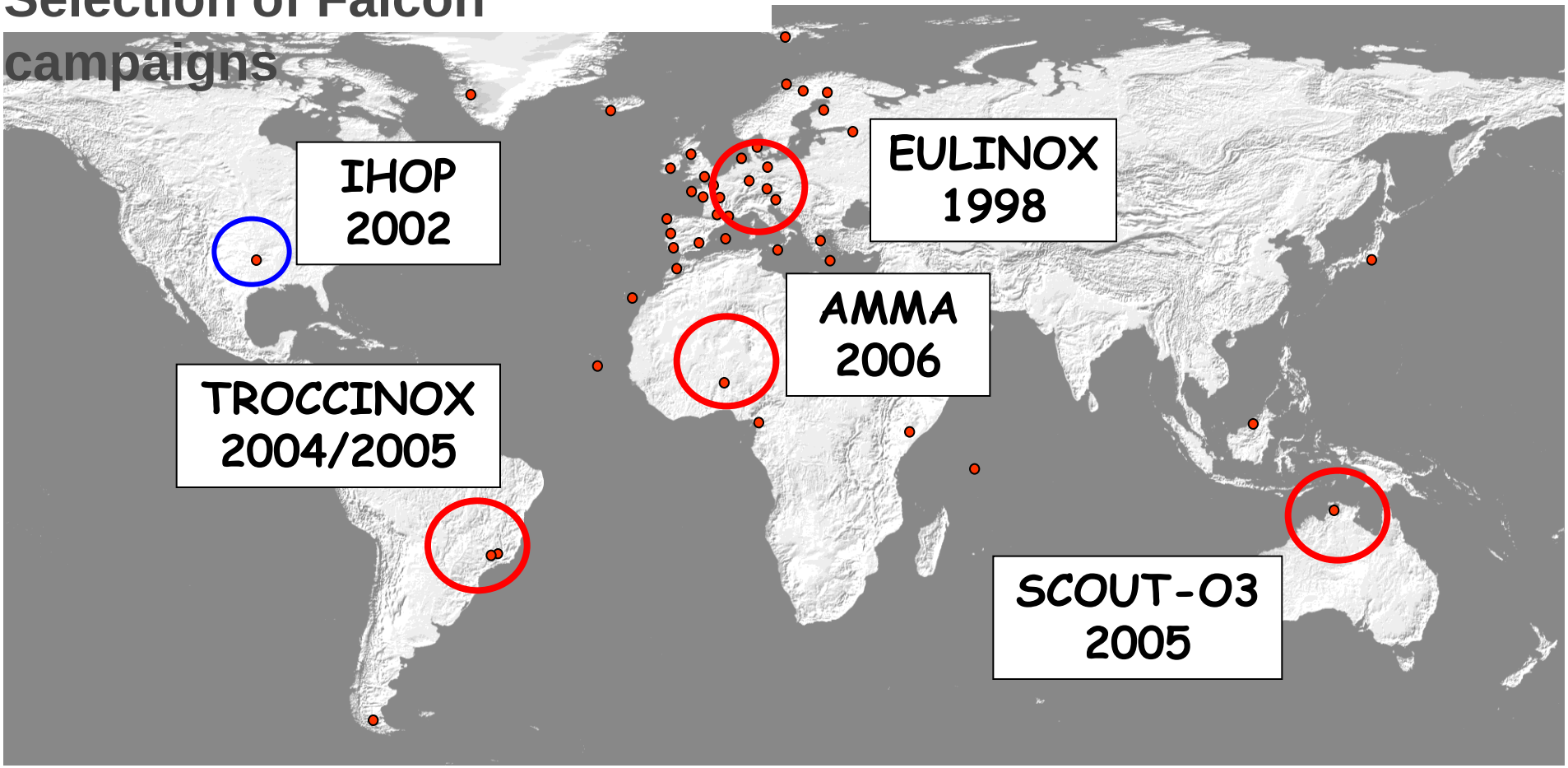
[1]PI trace gases: here at meeting, [2]PI aerosols: represented by B. Weinzierl, [3]logistic

DLR Flight Facility Oberpfaffenhofen (Germany)

Falcon 20-E5 D-CMET	Do228-212 D-CFFU	Cessna C208B D-FDLR	G550 D-ADLR

DLR Flight Experiments are Europes biggest civil operator of research aircraft for atmospheric research and earth observation. Currently at Oberpfaffenhofen a fleet of four highly modified aircraft are being operated worldwide for a number of science organisations, universities, agencies and companies.

Selection of Falcon campaigns



ACSYS, ACSYS II, ADM I + II, AERO-CONTRAIL1-2, AEROIMPACT, AFO 2000, Airbus – Toulouse, **AMMA**, ANASTASIA, APE THESEO, ASTAR, A-TOAST, AWIATOR, ASUR, BASIS, CAATER, CARAMEL, CIRRUS, CIRRUS 94, CLARE, CLEOPATRA, CONTRACE, CONTRAIL 1-10, CONTRAILS, DRAMAC, EFEDA, ELITE, ESCOMPTE, EUCREX, EUCREX 2, **EULINOX**, EUPLEX, EuroSOLVE, Flugzeug Immission, FRAMZY, FETCH, HIMSPEC 1+2, H2O, HRSC / MARS 96, **IHOP**, INCA 1 + 2, ITOP, KORRIDOR, LACE, LOFZY, Luftverkehr und Umwelt, MAP, METEOSAT, METEX, MINOS, PAZI, PAUR 96, POLECAT96+97, , POLARCAT, POLINAT95+97, POLSTAR, POLSTAR 2, SAMUM I + II, Schadstoffe in der Luftfahrt, **SCOUT-O3**, SESAME 1-3, SHIPS, SHIVA, STAAARTE 98, STAAARTE, STAIRSS, SULFUR 1-6, SUMAS, THOMAS, THORPEX-IPY, T-PARC, **TROCCINOX 1 +2**, TROPOSAT/SCAVEX,UFA-EXPORT, VAP / SCIA, Vulkanasche, 500 GHz Arctic Campaign

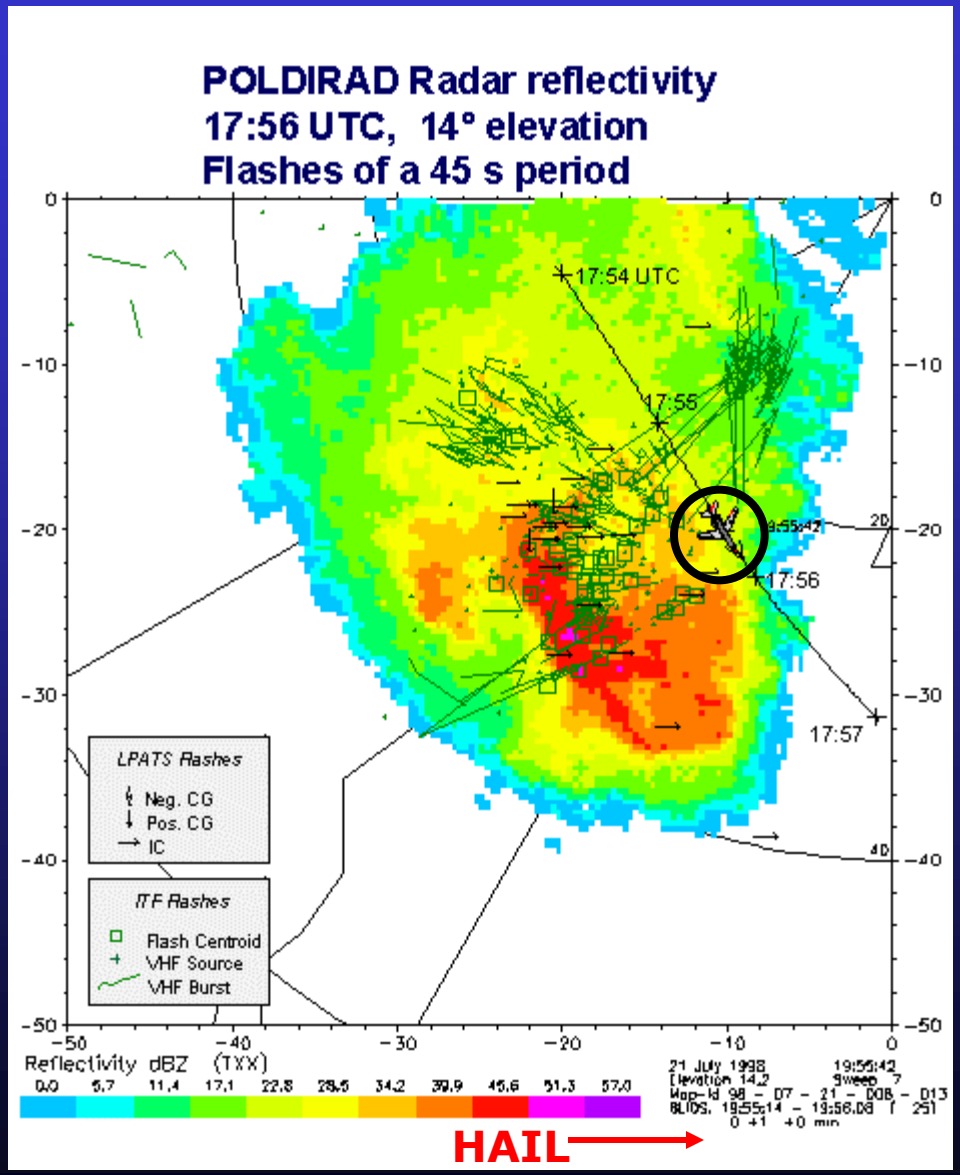

"Challenge to be at the right place at the right time"

EULINOX - 21 July 1998

Supercell close to Munich

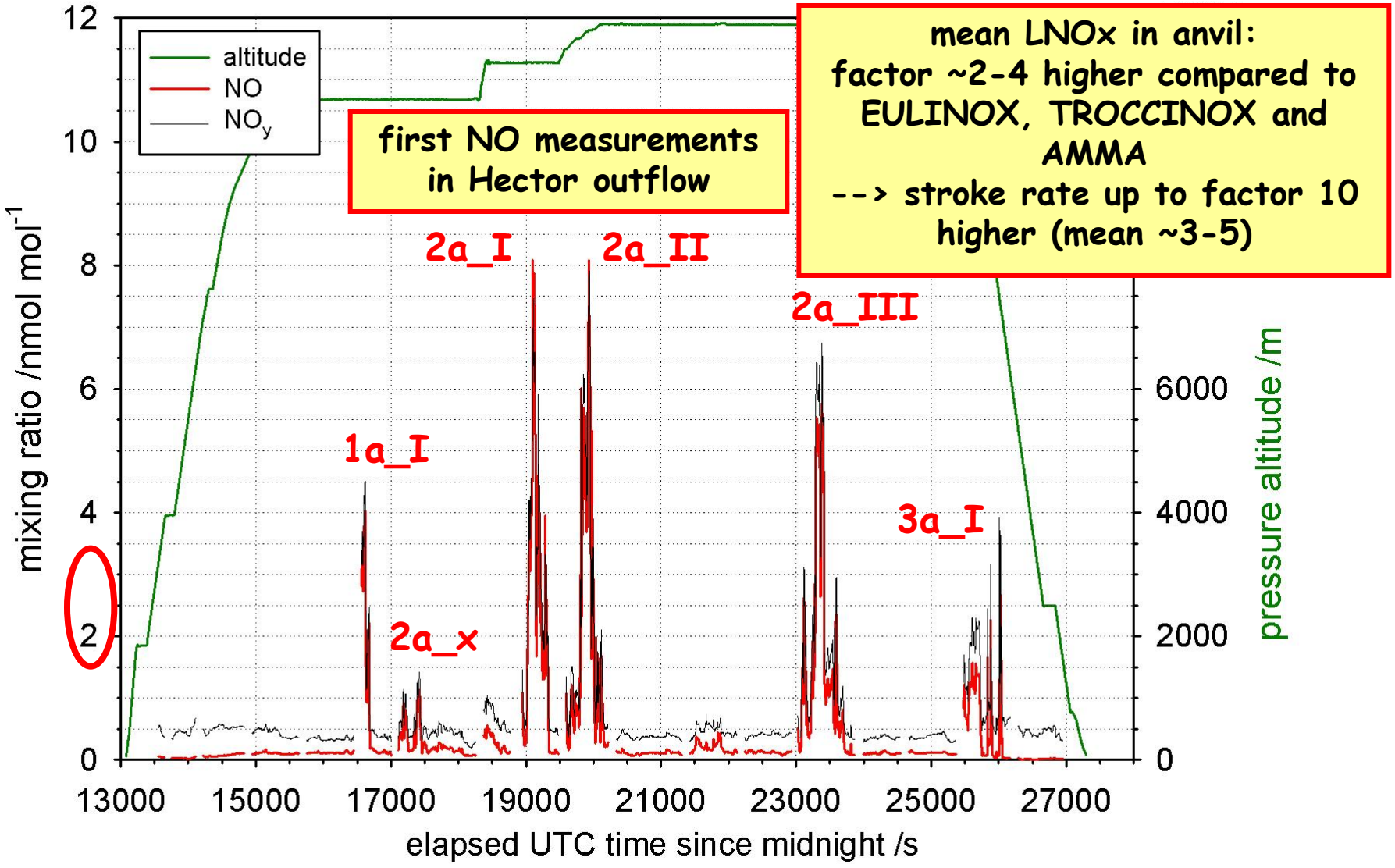
Polarisation Doppler Radar „POLDIRAD“

(DLR-Oberpfaffenhofen)



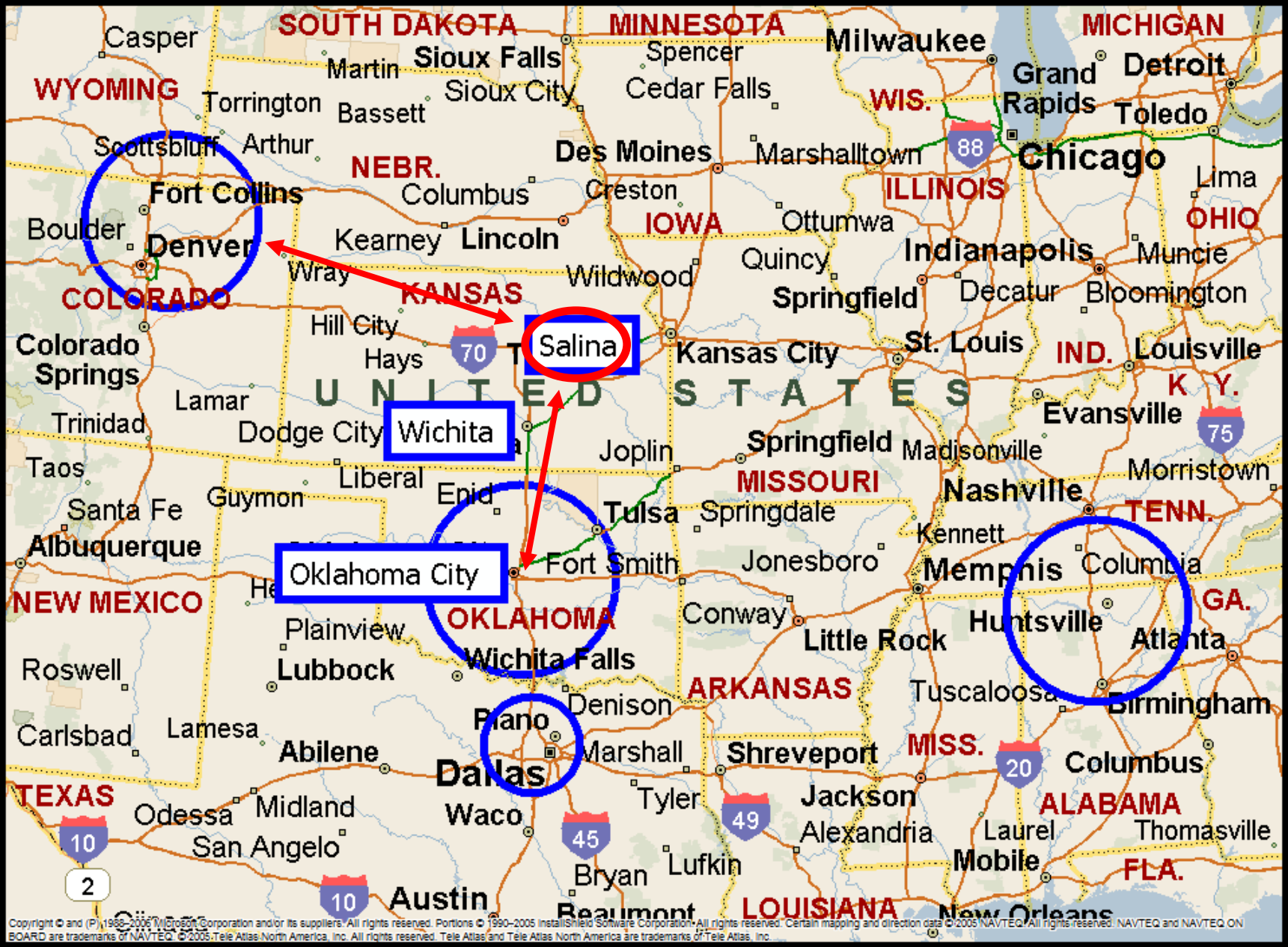
(Huntrieser et al., JGR, 2002)

SCOUT-O3: 19 November 2005 - Falcon flight



(Huntrieser et al., ACP, 2009)

DC3-Falcon flights to Colorado and Oklahoma



DC3-Falcon flights: 28 May - 15 June 2012

1. individual thunderstorm flights: different days /different areas /different storms compared to the DC8 and GV

2. joint flights with the DC8 and GV:

- 1-2 intercomparison flights with at least one of the U.S. aircraft (cloud-free, 3 levels, each level ~15 min)
- at least one joint flight with the DC8 and GV at the same time in a thunderstorm with an extended anvil outflow
- a few flights time-delayed within the same storm as investigated by DC8 and GV (preferable the Falcon would investigate the outflow when its fresh as first aircraft, since it can fly closest to the convective core)

3. refueling at other airports than Salina might be necessary due to the limited flight duration of the Falcon (approx. 3.5 h)

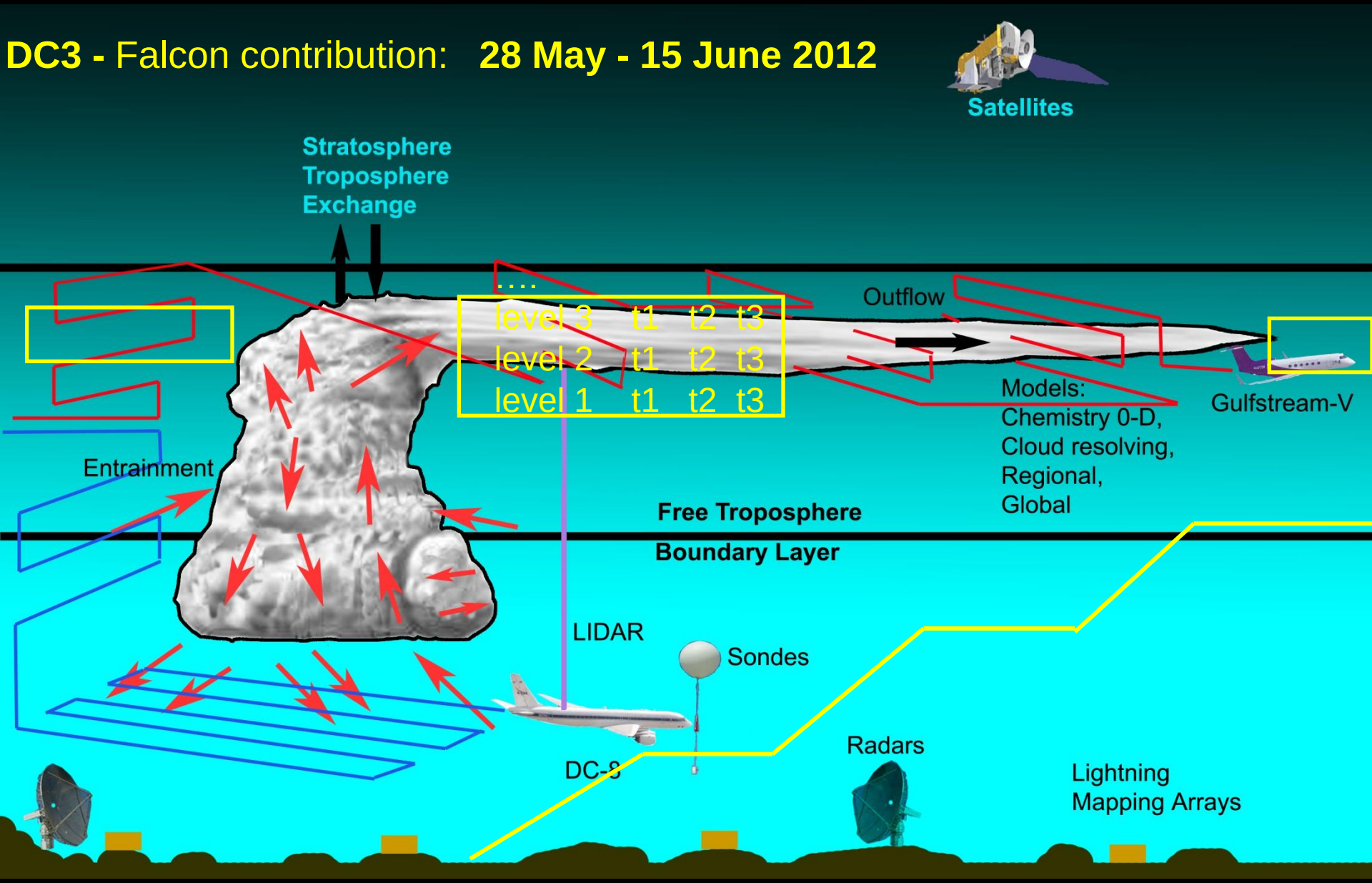
DC3-Falcon flights: Four main thunderstorm target areas

1. cross the fresh outflow at different levels, start close to the convective core and do several cross sections downwind, then climb to the next higher level for the next cross sections, start again close to the core, approx. FL 300 – FL 390

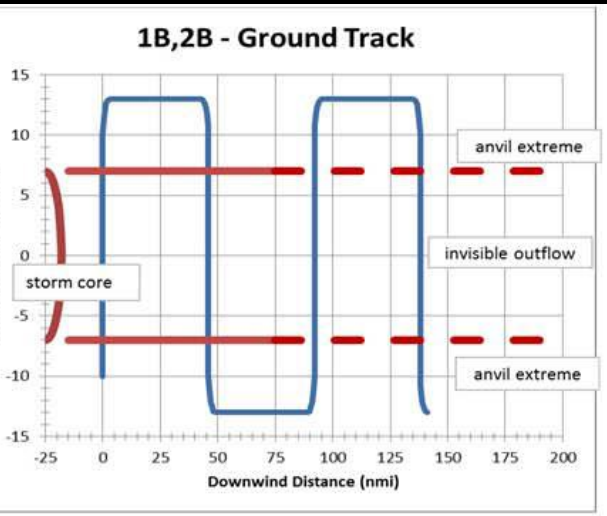
2. in the cloud-free area outside of the fresh anvil outflow (up- and downwind)

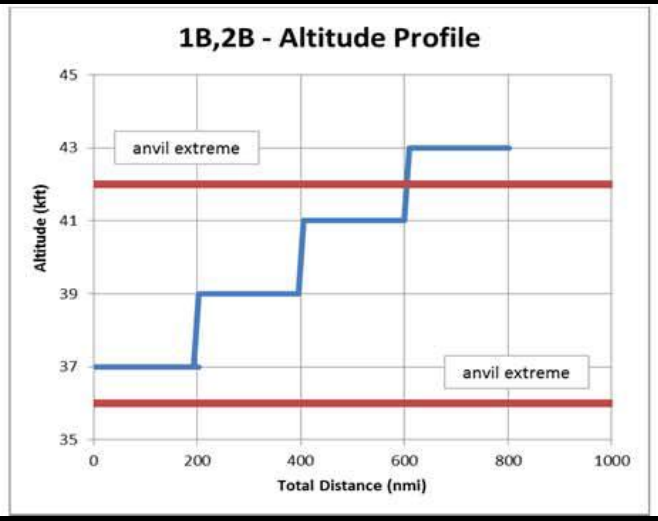
3. in the boundary layer ahead of the thunderstorm (may be combined with the refueling stop, step descent at several levels maintained for some minutes each)

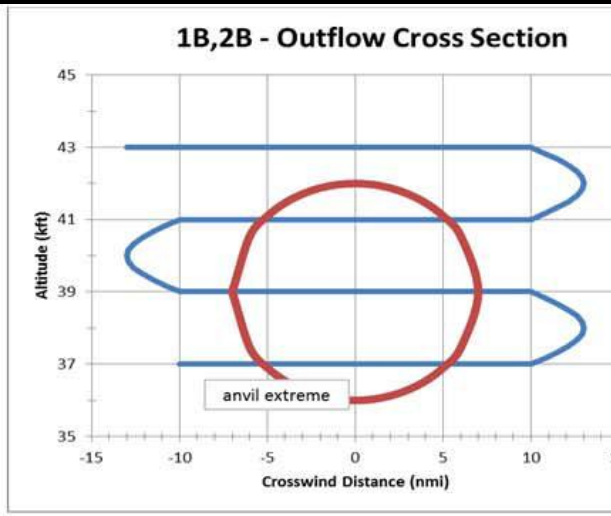
4. in the aged anvil outflow 12-48 h after the thunderstorm activity (e.g. sample released tracer)


DC3 - Falcon contribution: 28 May - 15 June 2012
Satellites
Stratosphere
Troposphere
Exchange
....
level 3 t1 t2 t3
level 2 t1 t2 t3
level 1 t1 t2 t3
Outflow
Models:
Chemistry 0-D,
Cloud resolving,
Regional,
Global
Gulfstream-V
Entrainment
Free Troposphere
Boundary Layer
LIDAR
Sondes
DC-8
Radars
Lightning
Mapping Arrays

DLR Falcon flight patterns (design: Chris Cantrell)





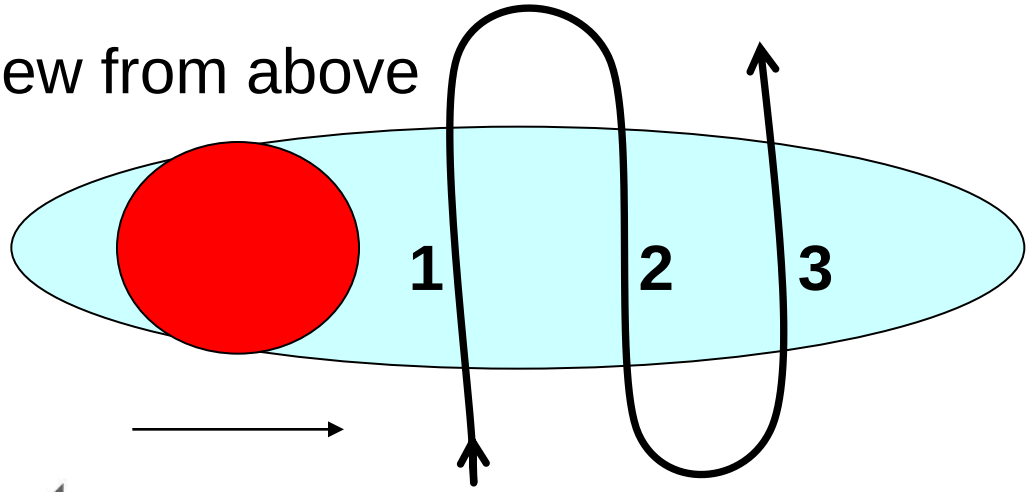


F2a: Falcon fresh anvil cross-wind constant altitude legs

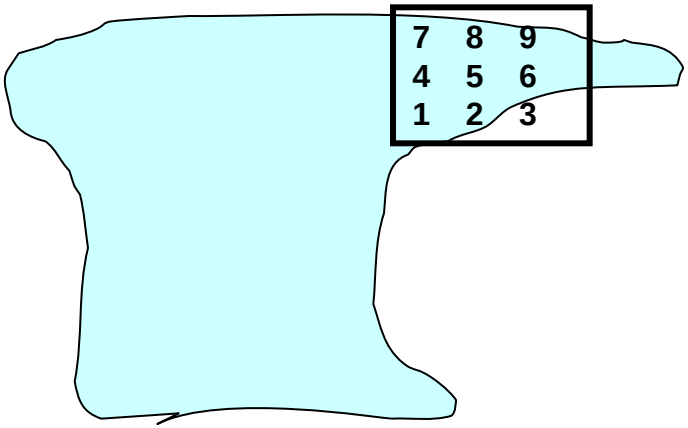
Task: fresh LNOx, dilution of fresh outflow, chemical aging

- downwind, as close as possible to the convective core (20-30 dBZ)
- 2-3 constant flight levels between FL ~300-390
- start close to the storm with the lowest level and move downwind
- 2-3 anvil cross-wind legs at constant altitude
- horizontal distance between the legs ~10 to 25 NM
- vertical distance between the legs ~1500-3000 ft

view from above



view from the side

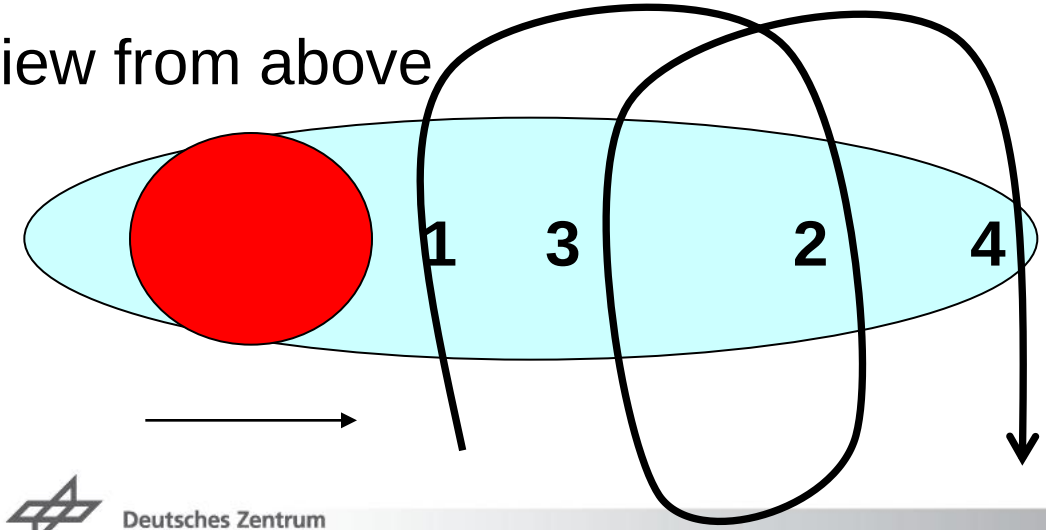


F2b: Falcon fresh anvil cross-wind constant altitude legs

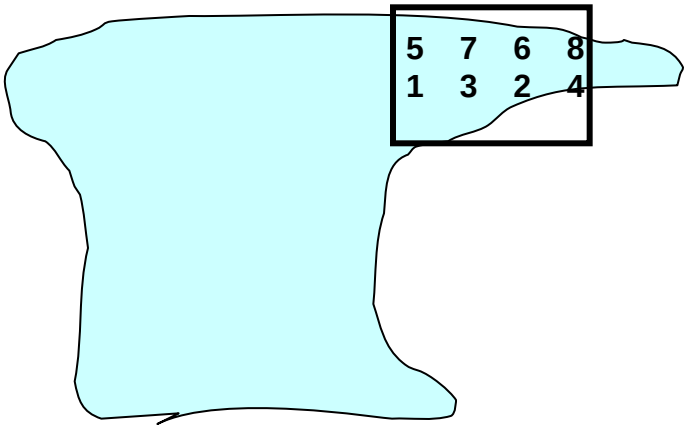
Task: fresh LNOx, dilution of fresh outflow, chemical aging, "Lagrangian"

- downwind, as close as possible to the convective core (20-30 dBZ)
- 2 constant flight levels between FL ~300-390
- start close to the storm with the lowest level and move downwind
- 4 anvil cross-wind legs at constant altitude
- horizontal distance between the legs ~10 NM (depending on wind)
- vertical distance between the legs ~1500-3000 ft

view from above



view from the side

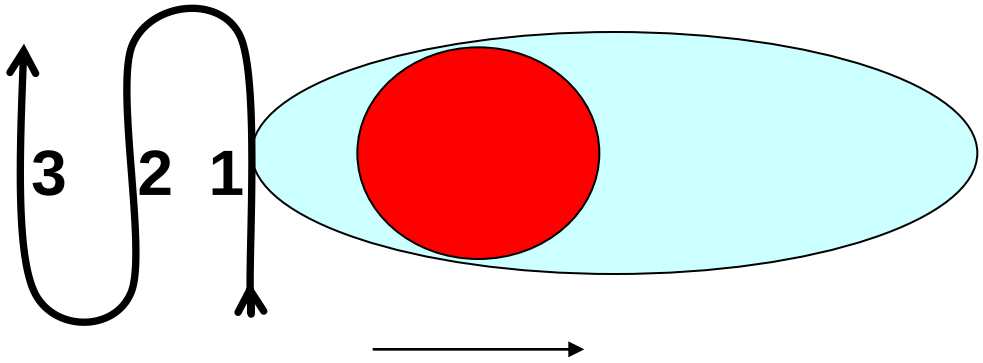


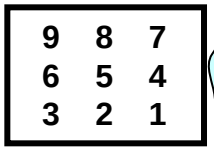
F3a: Falcon outside anvil cross-wind constant altitude legs

Task: change in trace species composition in slightly aged outflow (cloud-free!)

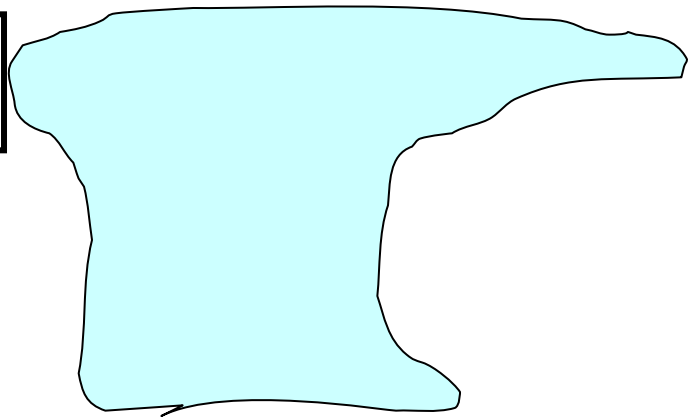
- upwind, as close as possible to the anvil cloud
- 2-3 constant flight levels between FL ~300-390
- start close to the storm with the lowest level and move upwind
- 2-3 anvil cross-wind legs at constant altitude
- horizontal distance between the legs ~10 to 25 NM
- vertical distance between the legs ~1500-3000 ft

view from above





view from the side

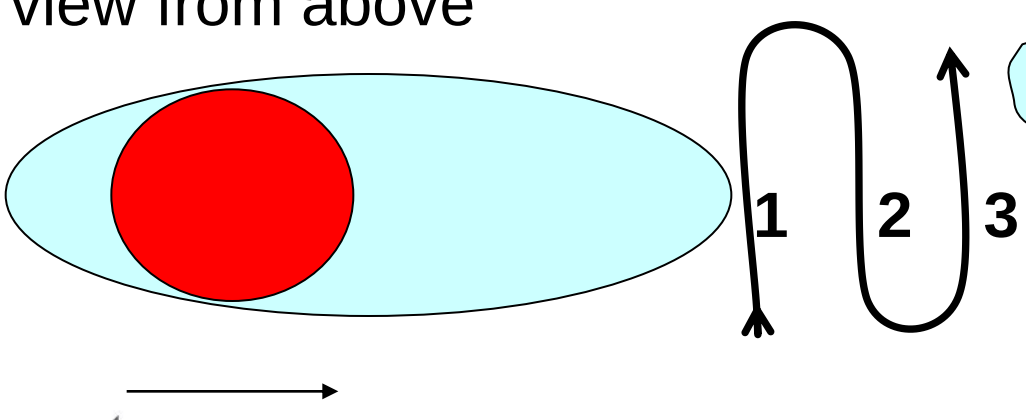


F3b: Falcon outside anvil cross-wind constant altitude legs

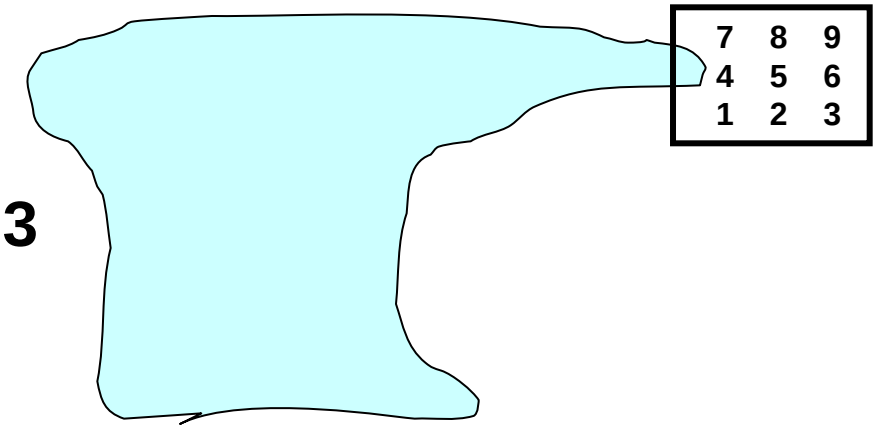
Task: change in trace species composition in slightly aged outflow (cloud-free!)

- downwind, as close as possible to the anvil cloud
- 2-3 constant flight levels between FL ~300-390
- start close to the storm with the lowest level and move downwind
- 2-3 anvil cross-wind legs at constant altitude
- horizontal distance between the legs ~10 to 25 NM
- vertical distance between the legs ~1500-3000 ft

view from above



view from the side

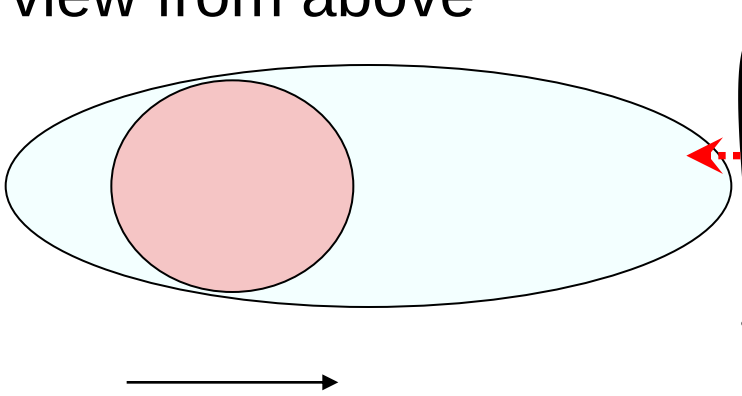


F4: Falcon outside anvil cross-wind constant altitude legs

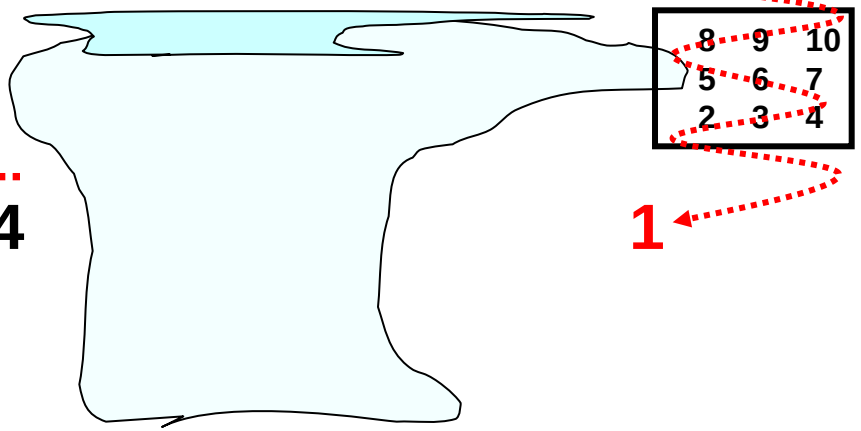
Task: sample released PFC tracer in aged outflow (mainly cloud-free)

- downwind, ~24 h after convection
- start with descending profile through aged outflow region (Nr. 1)
- 2-3 constant flight levels between FL ~300-390
- start closest to the outflow with the lowest level and move downwind
- 2-3 anvil cross-wind legs at constant altitude
- horizontal distance between the legs ~30 NM
- vertical distance between the legs ~500-1500 ft
- finish with axial constant altitude leg moving upwind (Nr. 11)

view from above



view from the side



Miscellaneous:

- **During the Falcon mission flights, sometimes also different flight segments will be combined (e.g. 2a+3b) during one flight, depending on the flight time available (total 3-4 hours per flight).**

- **The suggested flight segments can be performed by the Falcon alone or be combined with flight segments from the GV and DC8.**

- **PFC tracer release (from ground/mountain) for later detection with Falcon.**

  FLUTEC TG PMCP™: Perfluoromethylcyclopentane,
  CAS number 1805-22-7
  Not hazardous according to Chemicals (Hazard Information and Packaging for Supply) Regulations 2002, data sheet available.

Radiation | $NO_{(y)}$ | CO | O_3 | CO_2 | CH_4

Falcon instrumentation for DC3

SO_2 | PAN | HNO_3 | PFC-Tracer | Aerosol

UT composition and chemistry:
NO_x and O_3 budget

conv. 0 - 12 hours

LINET

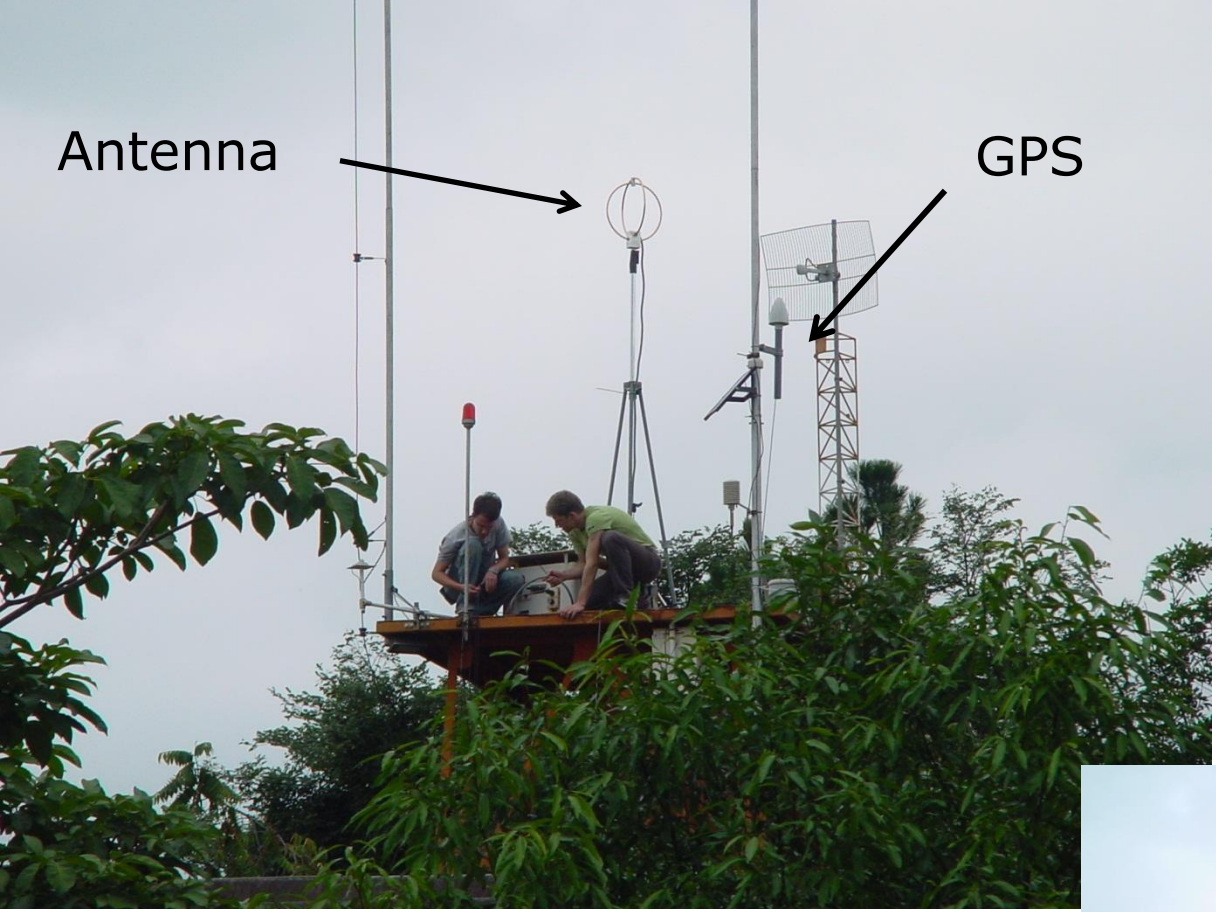
Different storm types/ BL conditions

conv. 12 - 48 hours

DC3 Aircraft Payloads_HH.pdf

Thank you for your attention!

The DLR-Falcon team look forward to join DC3!



LINET

3-D Lightning Detection System
of DLR/LMU:


"Challenge to be at the right place at the right time"

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Quis nostrud exerci

DLR

Falcon 20-E5, D-CMET

- fully IFR-equipped
- RVSM approved
- max. range: 2000 NM
- max. payload (with max. fuel): 1.1 t
- max. speed (TAS): 917 km/h / 495 NM/h / 0.865 Mach
- min. clean speed (TAS): 296 km/h / 160 KIAS)
- max. altitude (ISA): 45000 ft

<u>configuration for DC3:</u>

2 (?) PMS sondes under each wing

max. flight time for measurement flights: approx. 3.5 hrs

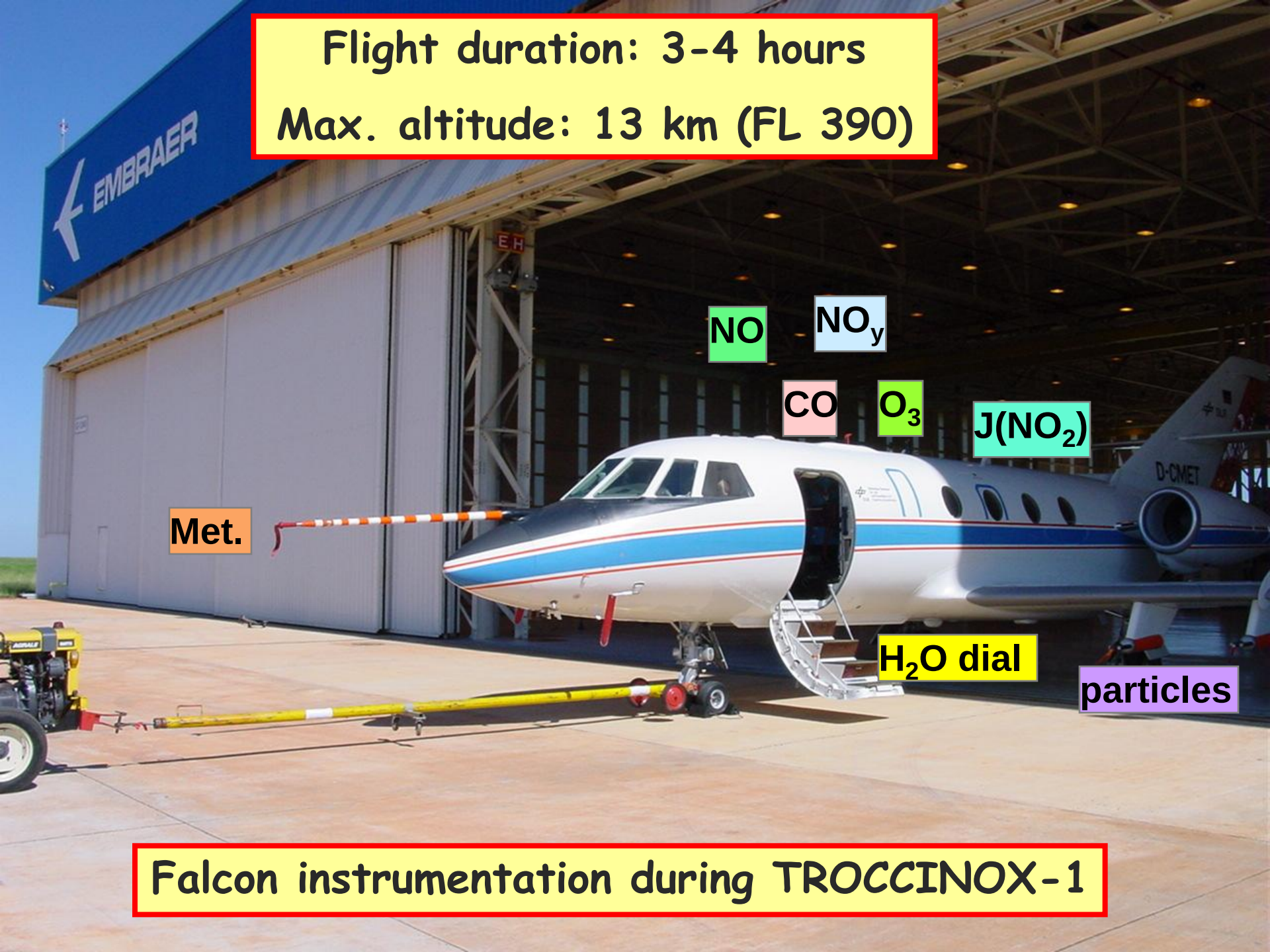
No laser.

No dropsondes (so far, final decision expected until end of February)

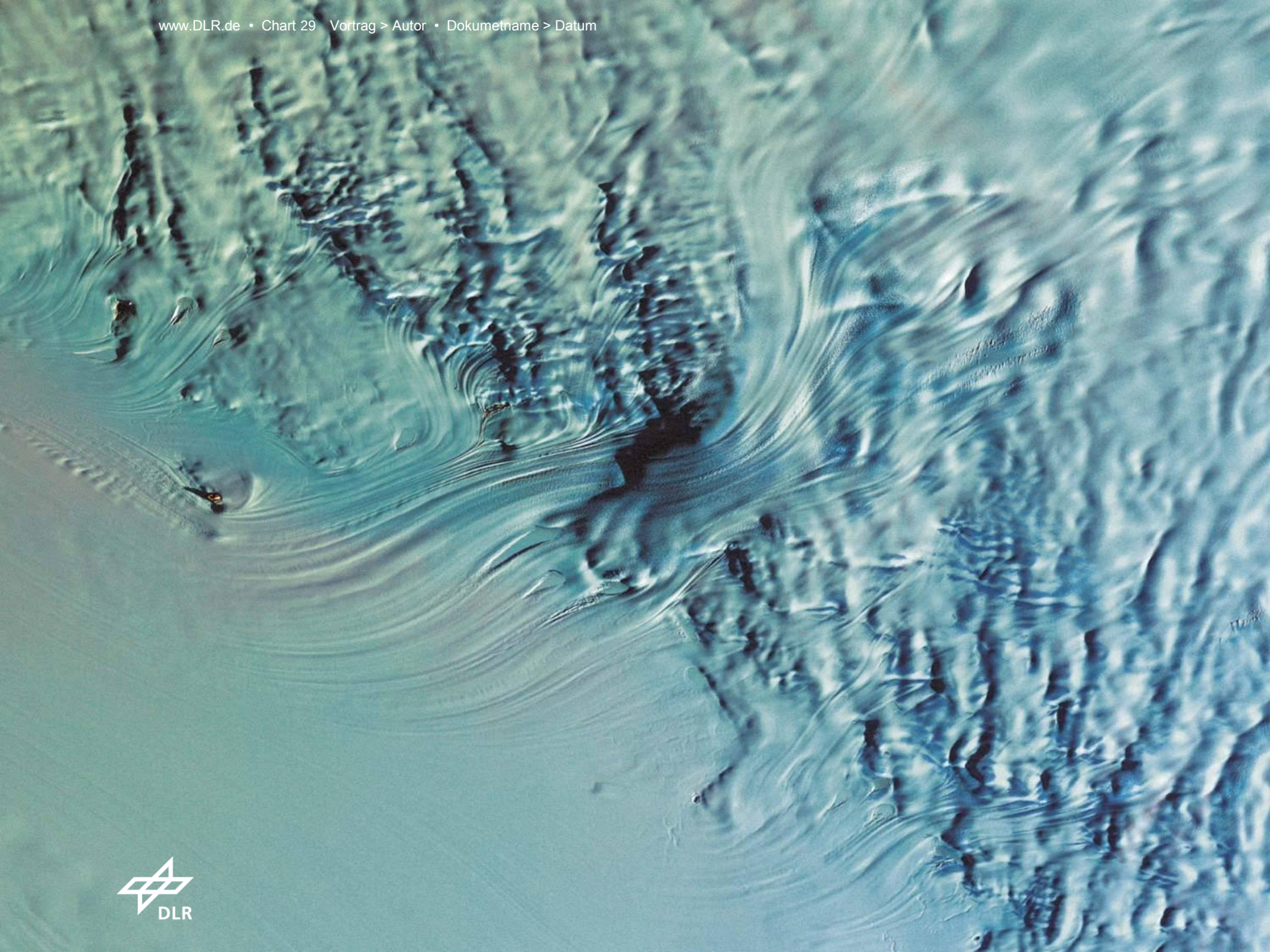
-DC3 – May/June 2012 – Falcon contribution

tentative schedule (+/- some days, details to be discussed):

7 - 21 May:	aircraft installation, ground and flight test
22 - 24 May:	transfer flights EDMO (D) – Salina (KS)
28 May – 15 June:	**DC3 measurement flights**
17 – 20 **June**:	transfer flights Salina (KS) – EDMO (D)



Falcon instrumentation during TROCCINOX-1



DLR

Headline lorem ipsum
2nd line lorem ipsum dorum

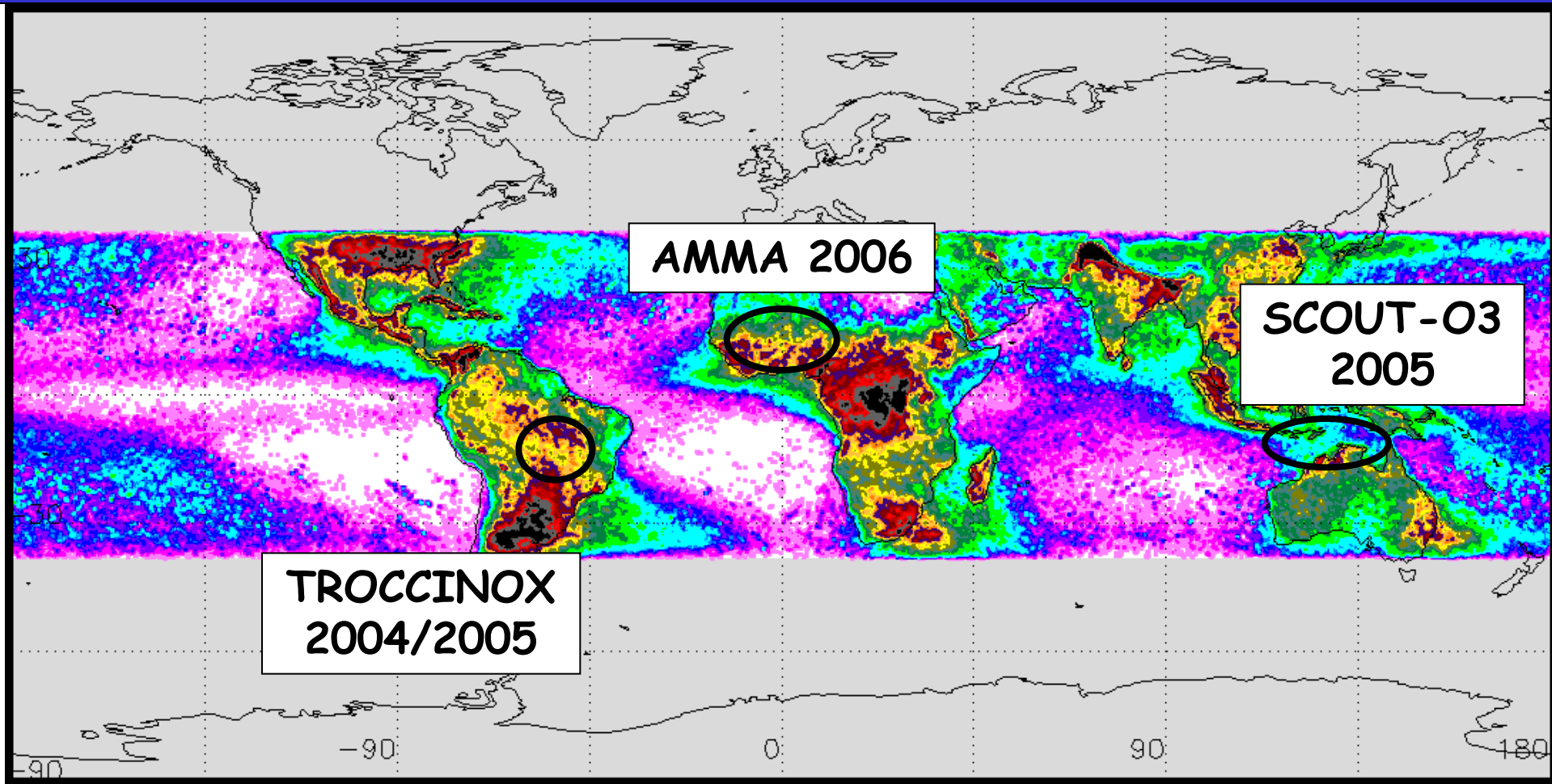
- Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean commodo ligula eget dolor
- Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean
- Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean commodo ligula eget dolor

Headline lorem ipsum
2nd line lorem ipsum dorum

- Listing
  - Second Level
    - Third Level
      - Fourth Level
        - Fifth Level

Global lightning distribution observed by LIS

Lightning Imaging Sensor



Orbits	54389
Areas	2584015
Flashes	12435841
Groups	146500597
Events	691198532

08/31/2007 Version 04.1

January 1998 - July 2007

Lightning Imaging Sensor

NASA/MSFC

1. Introduction
2.
3. Quantification of Global-LNOx
4. Do tropical thunderstorms produce the same amount of LNOx per flash as thunderstorms in the subtropics or midlatitudes?

DC3 – May/June 2012 – questions

• minimum vertical and lateral separation between Falcon and the other aircraft during joint flights

• is it sufficient to send FAA a 3-dimensional box of expected flight area the day before the flight and final flight plan the day of the flight?

• TSA waivers:
- one for the transfer EDMO – Salina ?
- one for the transfer Salina – EDMO ?
- one for all measurement flights ?

• tracer release from ground/building or small aircraft permitted?

DC3 – May/June 2012 – questions

- tracer release from ground/building or small aircraft permitted?
- Suitable aircraft available for rent (including crew), for example spraying aircraft or aircraft used for hail suppression?