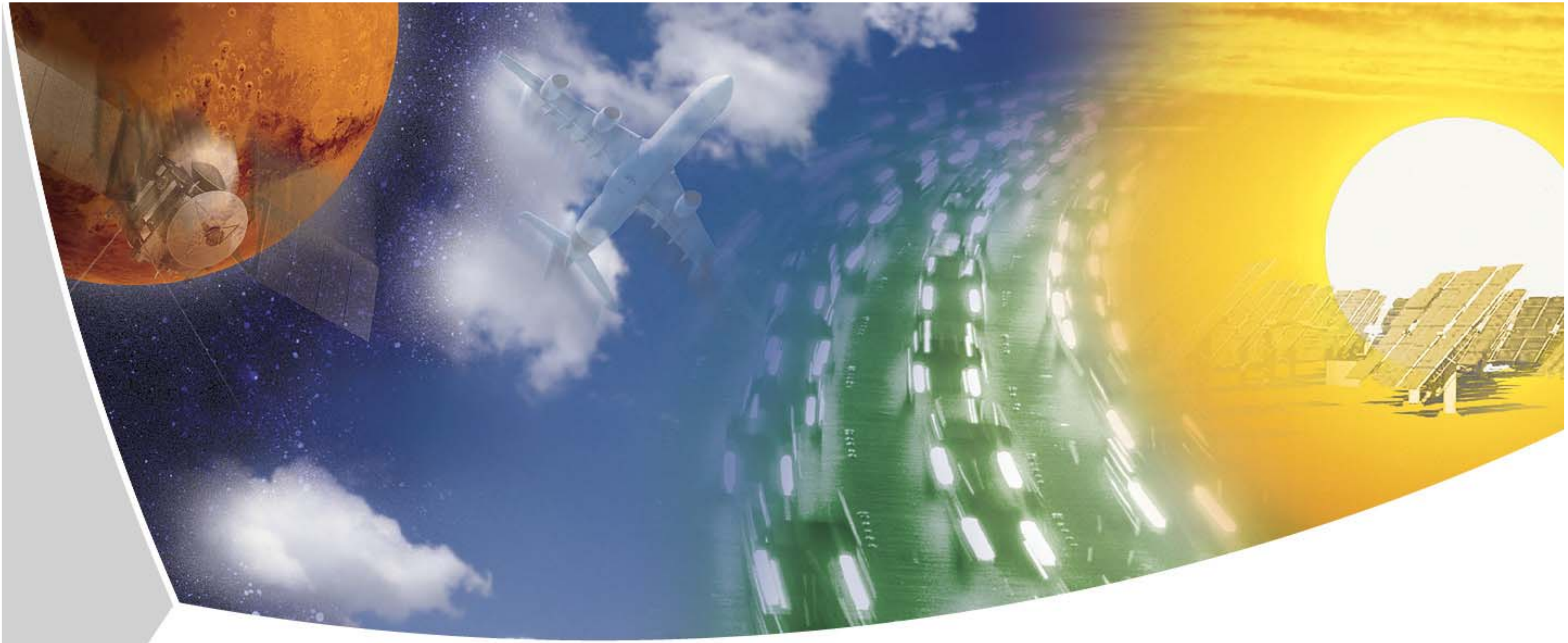

ADM-Aeolus pre-launch campaigns with an airborne instrument demonstrator

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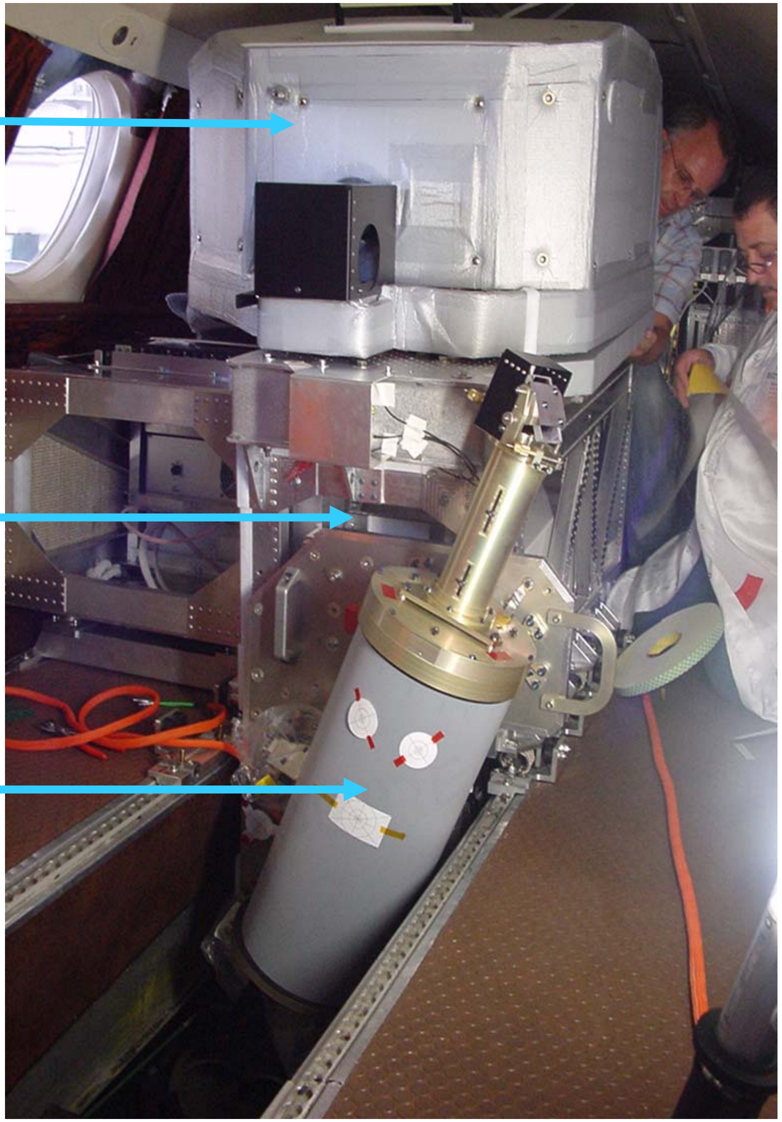
Background

- The ADM-Aeolus instrument ALADIN uses several novel techniques, like
  - **Fizeau** interferometer for aerosol return
  - **Sequential** Fabry-Perot interferometer for molecular return
  - **Accumulation** CCD as detectors
- Characterization of ALADIN is done by industry with "artificial" signals and no "real" signals from the atmosphere
- No direct-detection Doppler lidar was operated in downward looking scheme as from space
- Need for validation of ALADIN with real atmospheric signals identified by DLR, ESA and ADMAG
- Development of ALADIN Airborne Demonstrator A2D started in 2003 in order to perform ground and airborne campaigns, which is funded by ESA and DLR

Objectives of pre-launch campaigns

- Validate the predicted instrument performance:
  - radiometric performance
  - wind measurement performance
- Optimize and test algorithms for ground segment (L1B, L2A, L2B) with real atmospheric signals:
  - homogenous and heterogeneous conditions (clouds, horizontal and vertical gradients in backscatter and wind)
  - corrections and quality control
  - derivation of aerosol and cloud products; ALADIN as a High-Spectral-Resolution-Lidar
  - assess calibration schemes
- Definition of objectives for a ground campaign and two airborne campaigns by team from DLR, Meteo-France, KNMI, IPSL

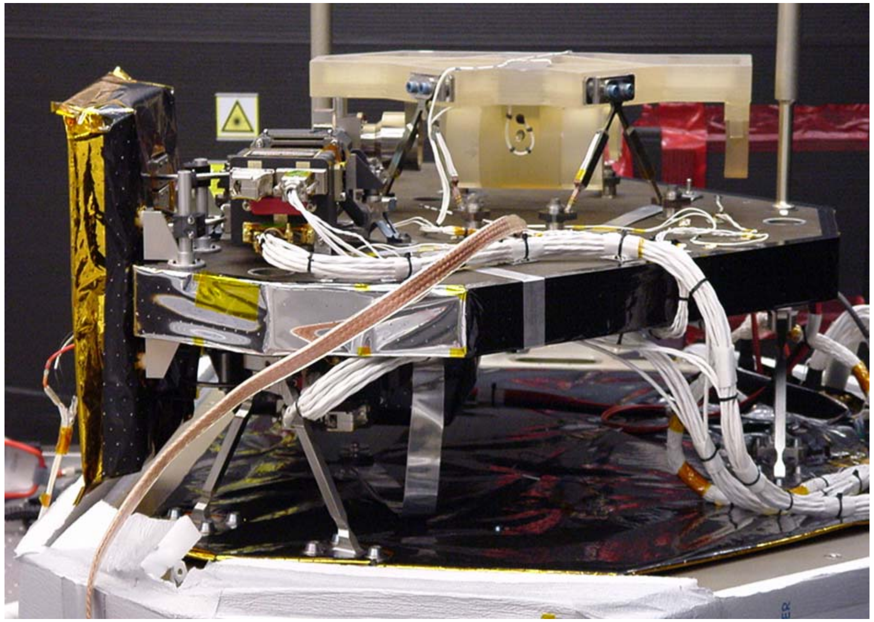
A2D in DLR Falcon in October 2005



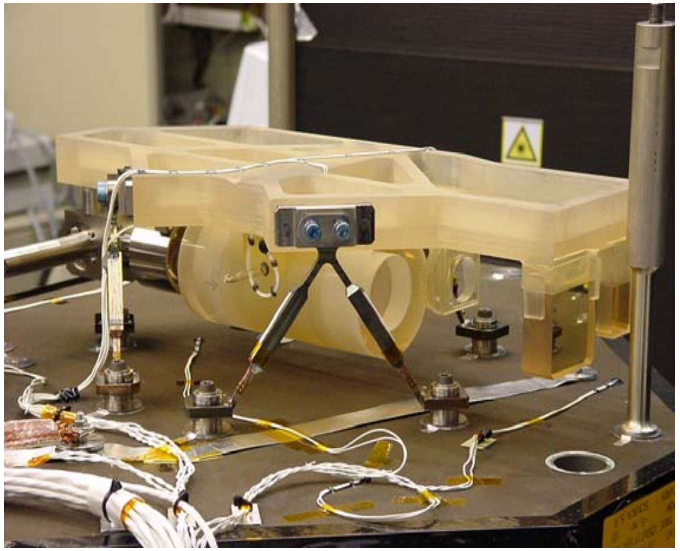
Development of the A2D from 2003-2006 by

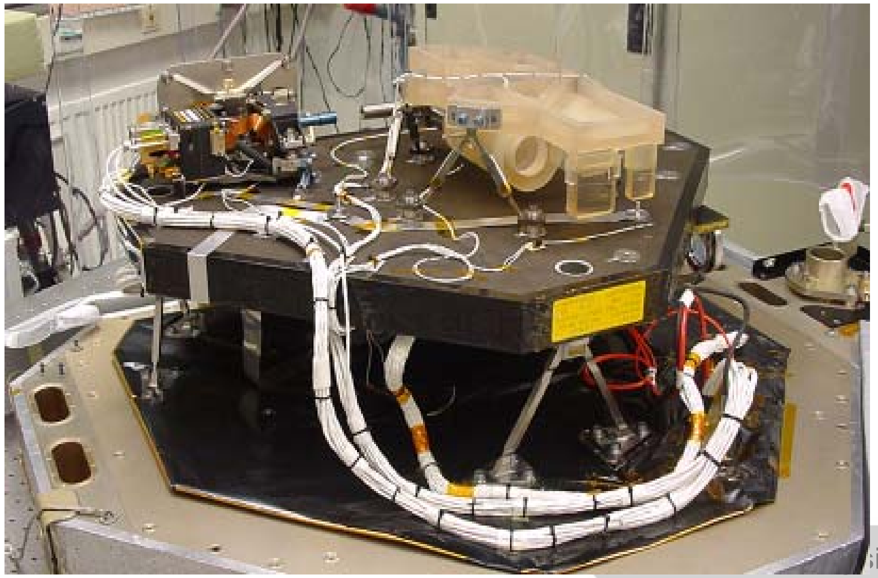
- EADS-Astrium France: design, telescope,receiver
- EADS-Astrium Germany: laser
- DLR: aircraft, flight testing

A2D receiver optics

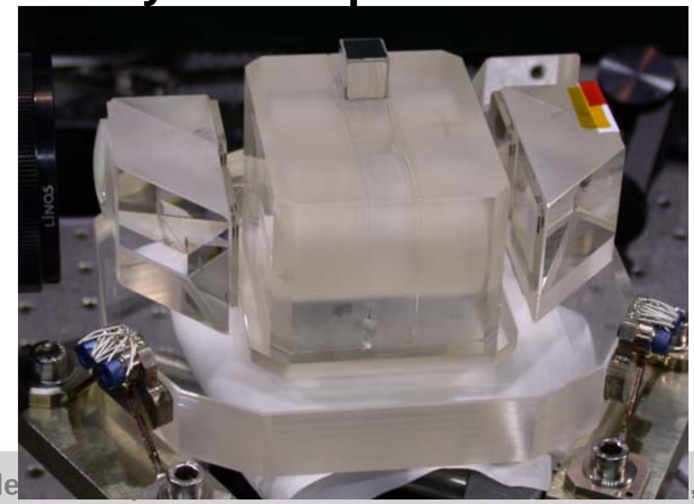


Fizeau spectrometer

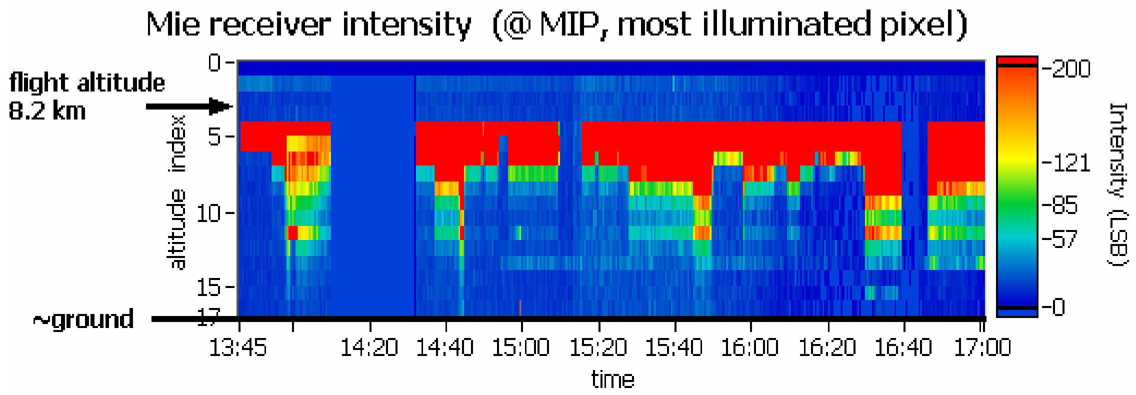


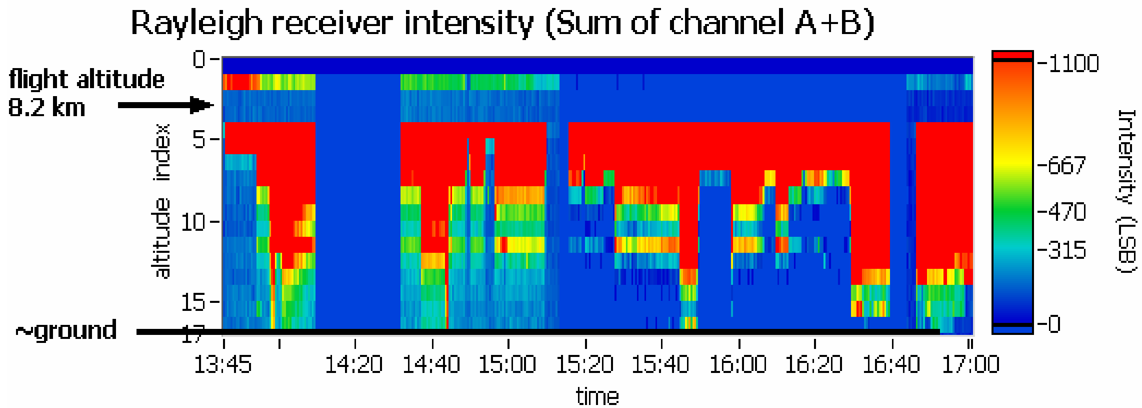


Fabry-Perot spectrometer



First flight of a direct-detection Doppler lidar in 2005



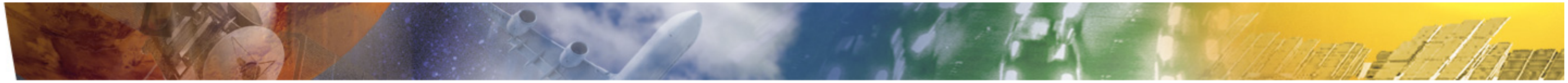


A2D instrument parameters during flights on October 18 and 20, 2005

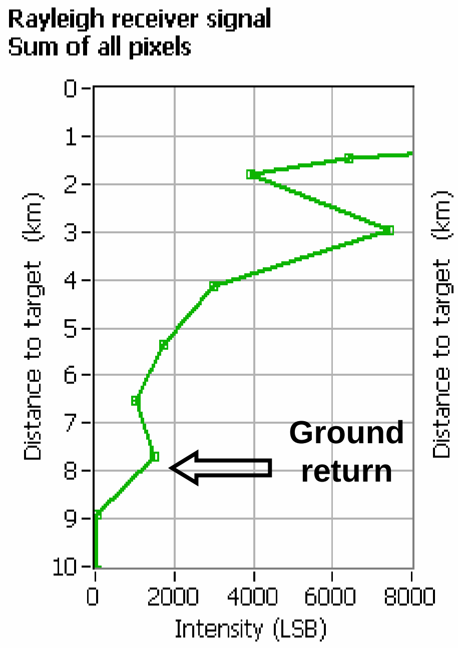
- **8.2 km flight altitude**
- **20 mJ laser energy**
- **700 laser pulses per observation**
- **Vertical resolution and distance:**
  - **300 m for 0-2 km**
  - **1200 m for 2-8 km**

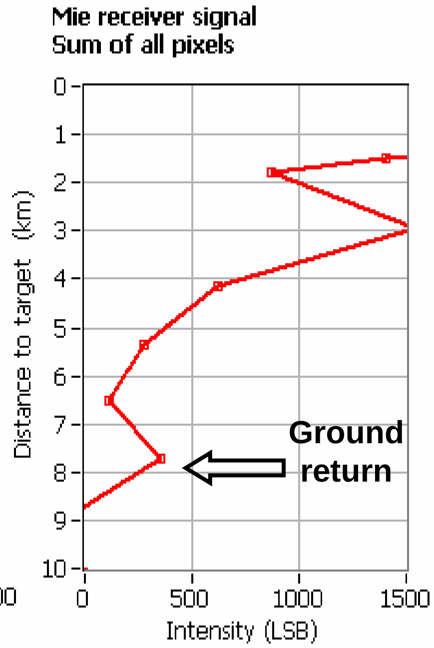
- atmospheric signals from Mie and Rayleigh backscatter
- return from clouds and ground detected
- first flight of a direct-detection Doppler lidar worldwide in nadir pointing geometry

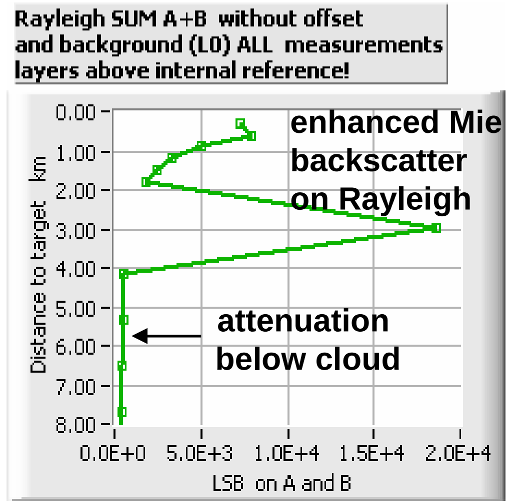
Signal in units of 1 LSB
(least significant bit)
= 3 electrons
for October 20, 2005

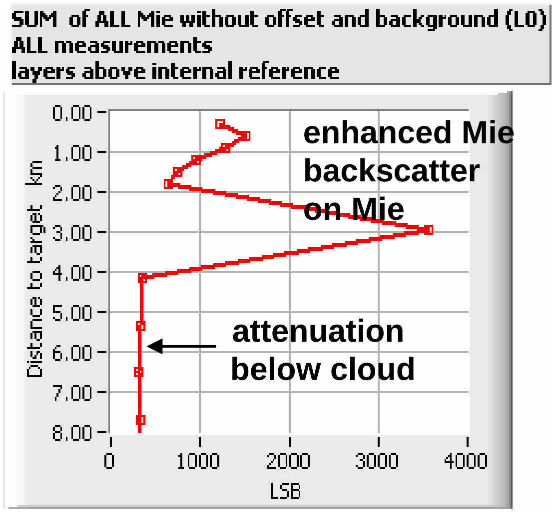


Ground and cloud signals during flight





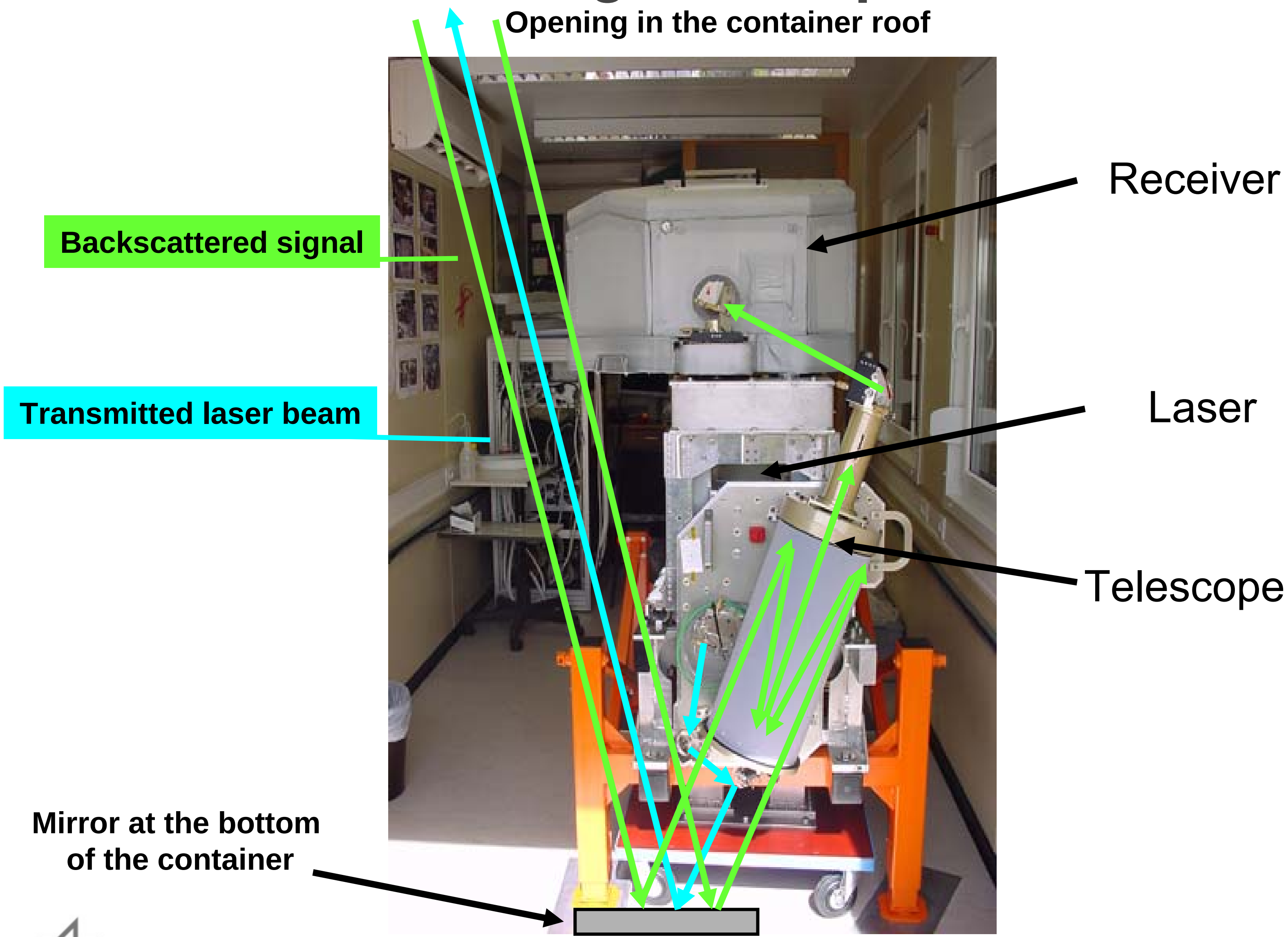




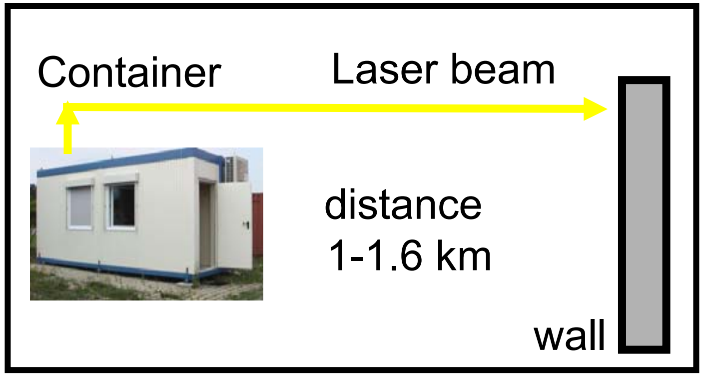
Ground signal on Mie and Rayleigh receiver detected in range bin as expected from elevation

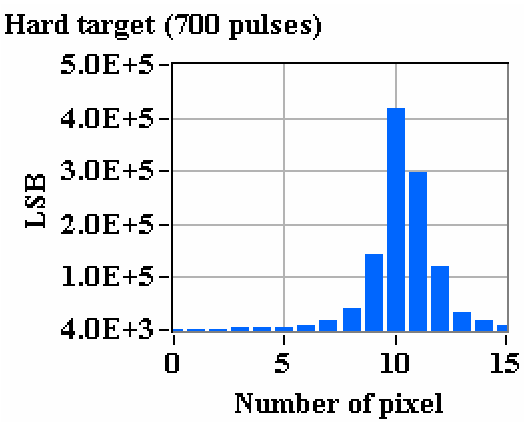
Cloud signal detected in 3 km distance

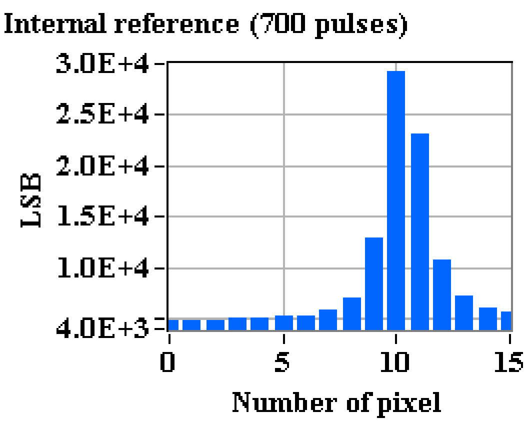
A2D for ground operation

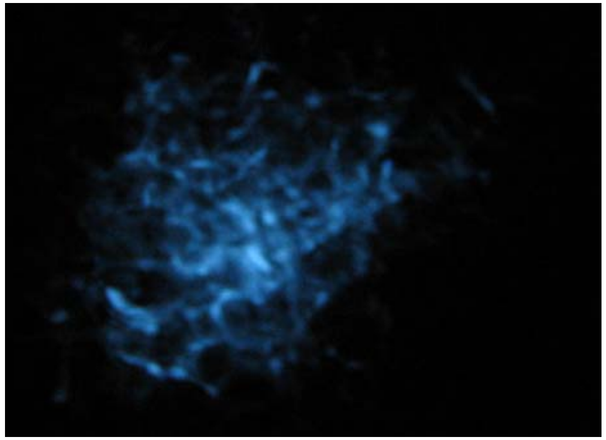


Hard target test at DLR







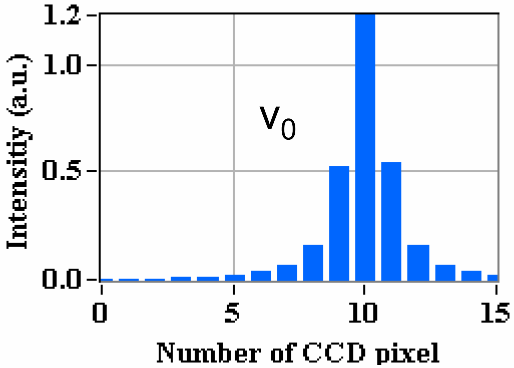


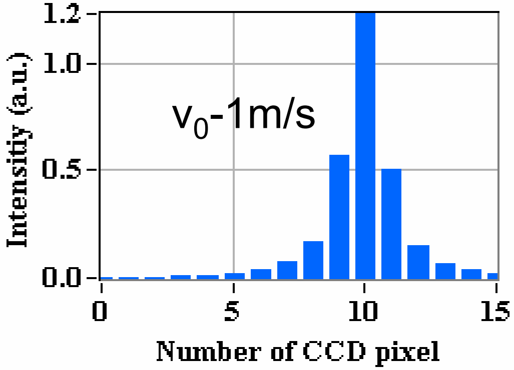
fluorescence of laser on target in 1.6 km horizontal distance (Ø20 cm)

Mie random error of below 1 m/s can be achieved

Analysis of Mie algorithms

Simulations of Mie signal without noise





frequency

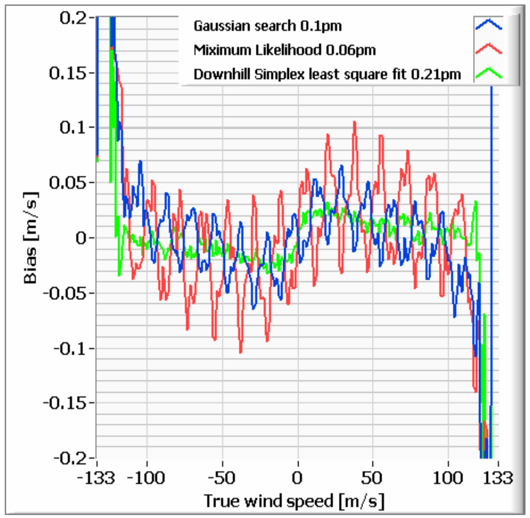
1 Pixel ≈ 100 Mhz

wind

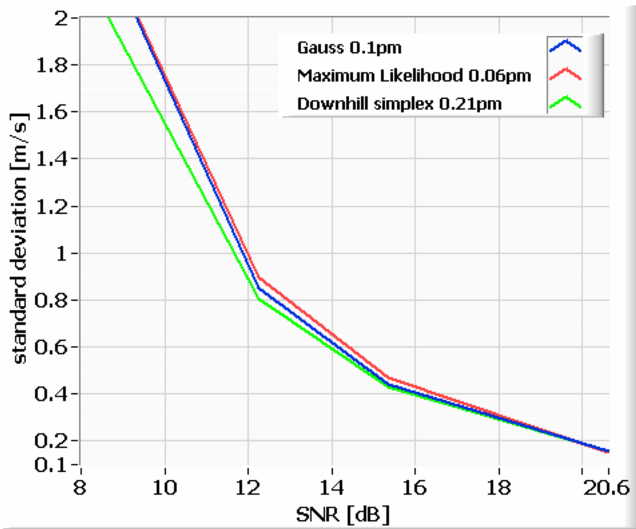
1 Pixel ≈ 18 m/s

Investigation of several Mie algorithms in parallel study at DLR for L1B products (Dorit Huber, Jürgen Streicher, Ines Leike)

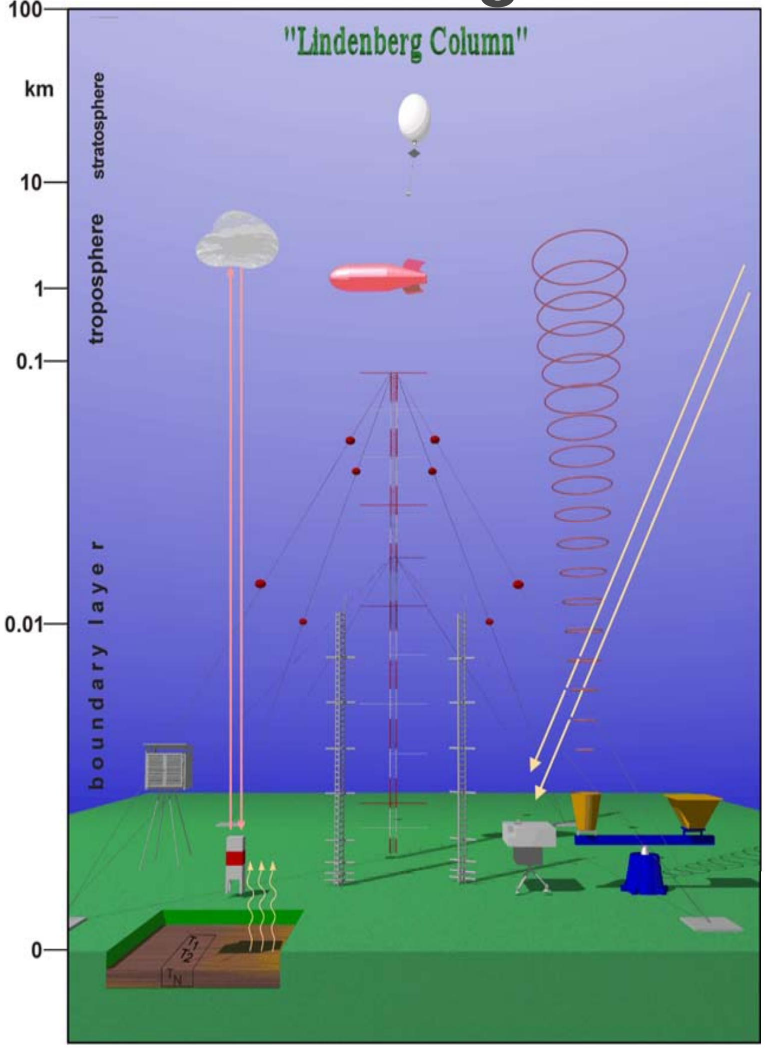
Systematic Error



Random Error



ADM-Aeolus ground campaign at DWD Lindenberg



Meteorological Observatory
of DWD in Lindenberg (Fig. DWD)

Instrumentation from DLR

- ALADIN Airborne Demonstrator A2D
- 2-µm Doppler Lidar (wind up to 2-3 km)

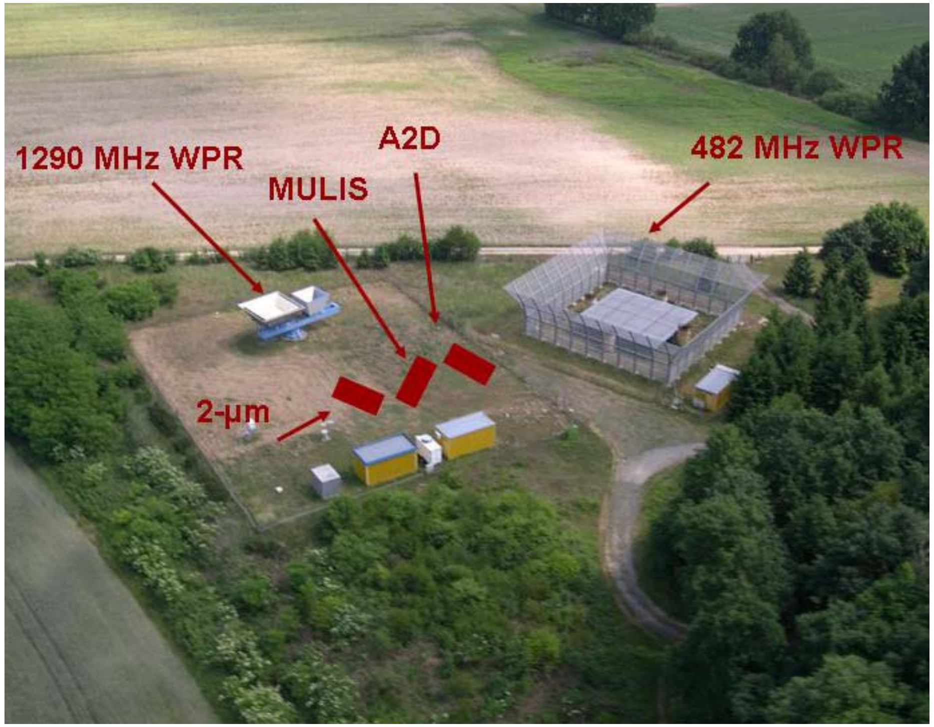
Instrumentation from University Munich

- Aerosol lidar MULIS (backscatter, extinction coefficient up to 10 km, depolarisation) 355 nm, 532 nm, 1064 nm, Raman channels

Instrumentation from DWD

- 482 MHz windprofiler with RASS (wind up to 16 km, temperature up to 3 km)
- 1290 MHz windprofiler (wind up to 1.5 km)
- Ceilometer (clouds 12 km, aerosol backscatter in boundary layer)
- Microwave radiometer (profiles of water vapour and temperature up to 10 km)
- 355 nm Raman-lidar (profiles of water vapour mixing ratio and backscatter ratio during night)
- Sun photometer (aerosol optical depth during day)
- 35.5 GHz cloud radar (reflectivity, vertical velocity)
- 4 routine radiosondes per day (0, 6, 12, 18 UTC) additional 10 radiosondes (3, 9, 15, 21 UTC)

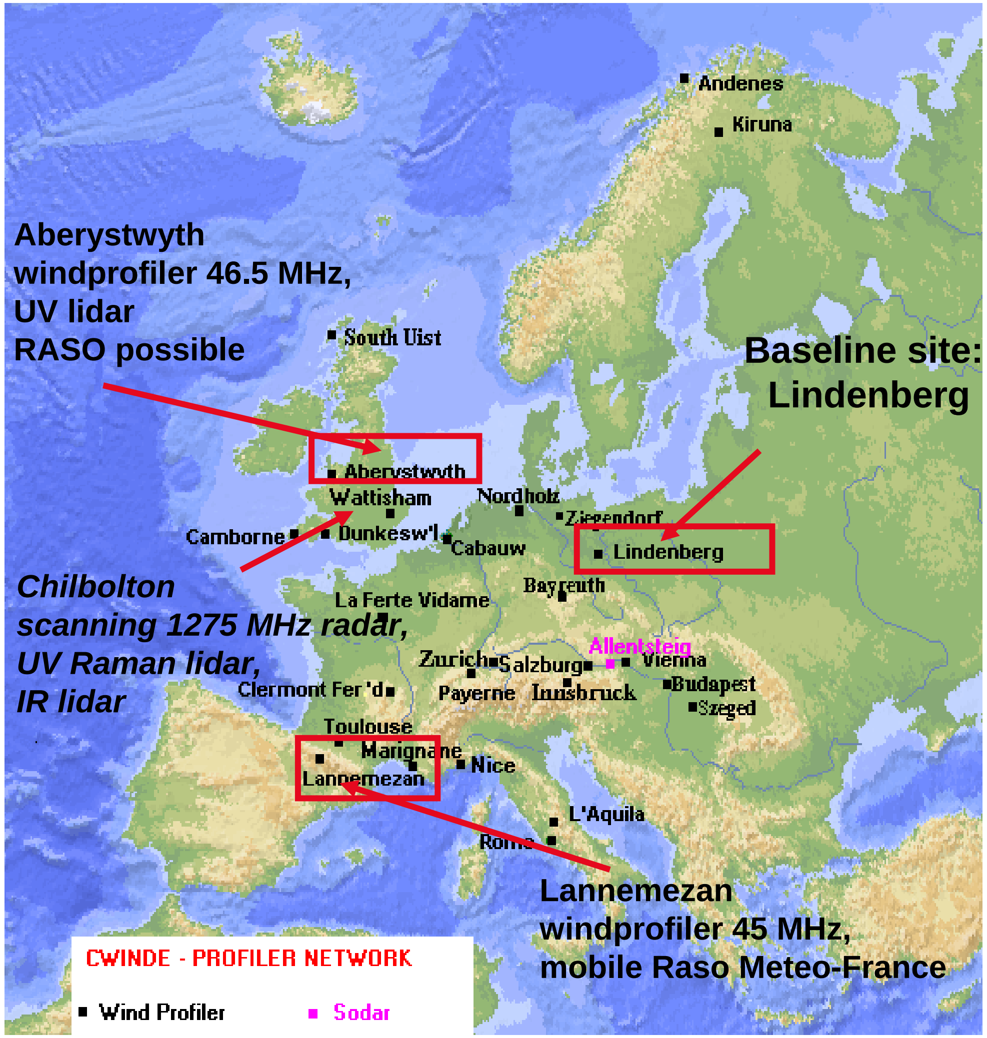
ADM-Aeolus ground campaign in October 2006



Windprofiler Site at DWD Lindenberg (photo DWD)

A2D container at Lindenberg
on September 19, 2006

1st airborne campaign in April-May 2007



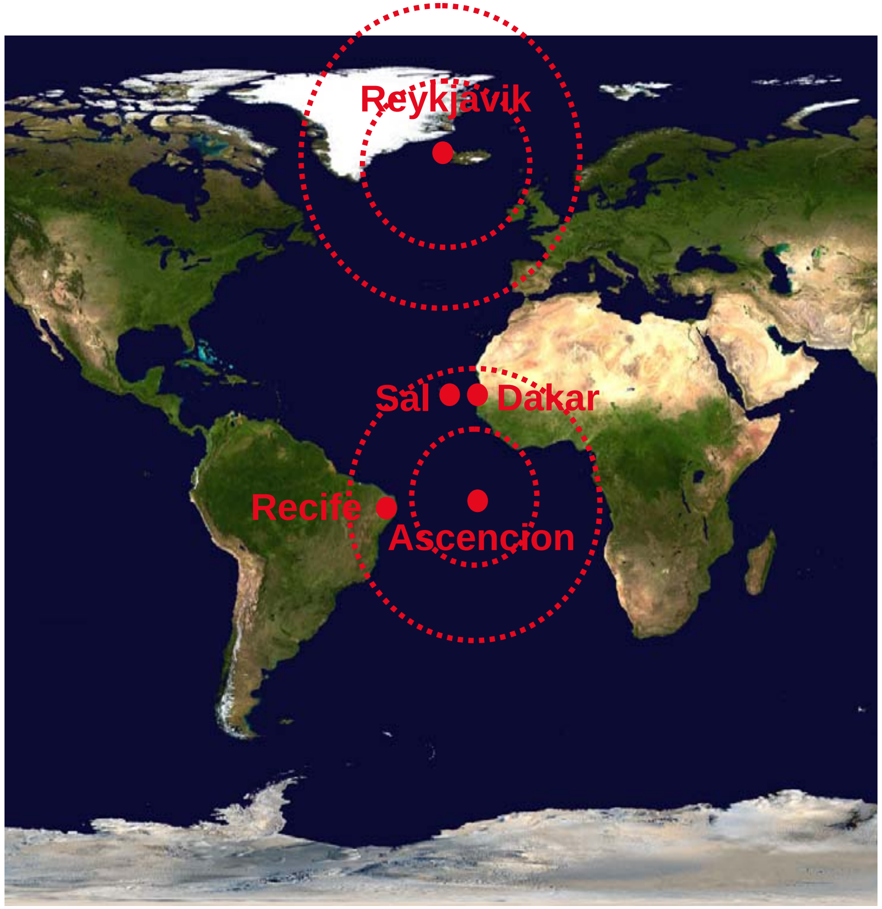
Objectives:

- Validate A2D under mainly homogenous atmospheric conditions
- Test of Level-1B and Level-2A algorithms

Implementation

- ALADIN Airborne Demonstrator and DLR 2-µm Doppler lidar on Falcon aircraft
- Overflights of observatory Lindenberg with 482 MHz windprofiler radar or backup sites with windprofiler radars in Lannemezan, Aberystwyth, or Chilbolton

2nd airborne campaign in fall 2007



Objectives:

- Validate A2D under mainly heterogenous atmospheric conditions (clouds, wind shear)
- Test of Level-2 algorithms

Implementation

- ALADIN Airborne Demonstrator and DLR 2-µm Doppler lidar on Falcon aircraft
- Operating site in North-Atlantic or Tropics

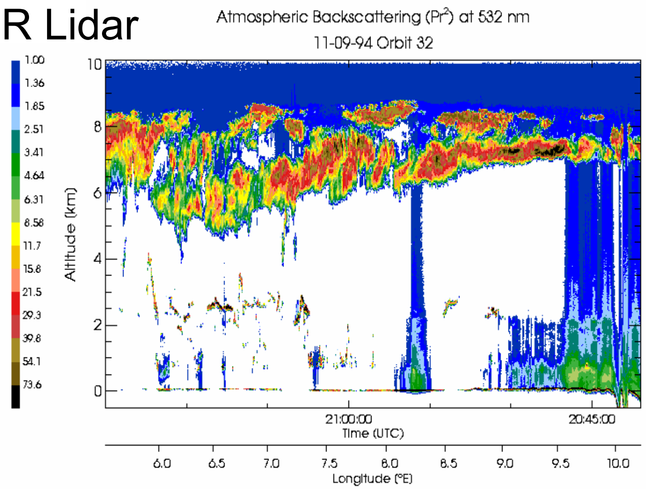
approximate transfer times from DLR-OP:
Reykjavik (4 h), Dakar/Sal (6.5h), Ascencion (10 h), Recife (10 h),
circles approximate one-way/two-way endurance of Falcon (2500-3500 km)

Airborne in-orbit validations with DLR lidars

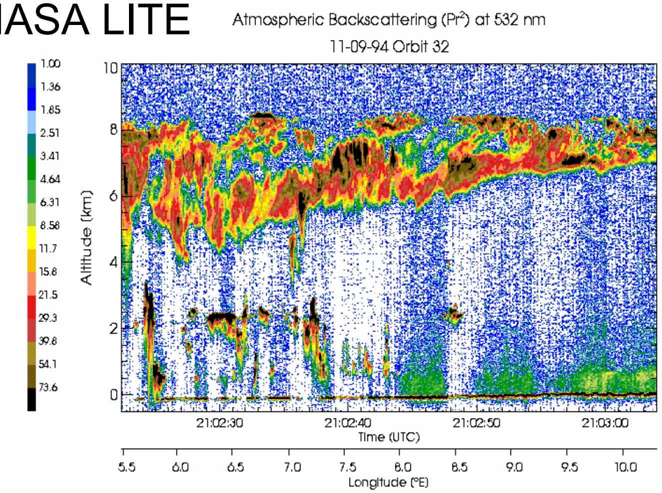
Orbit 32

- Airborne validation of LITE performed in 1994
- Several airborne campaigns performed for validation of ENVISAT instruments, e.g. SCIAMACHY, MIPAS

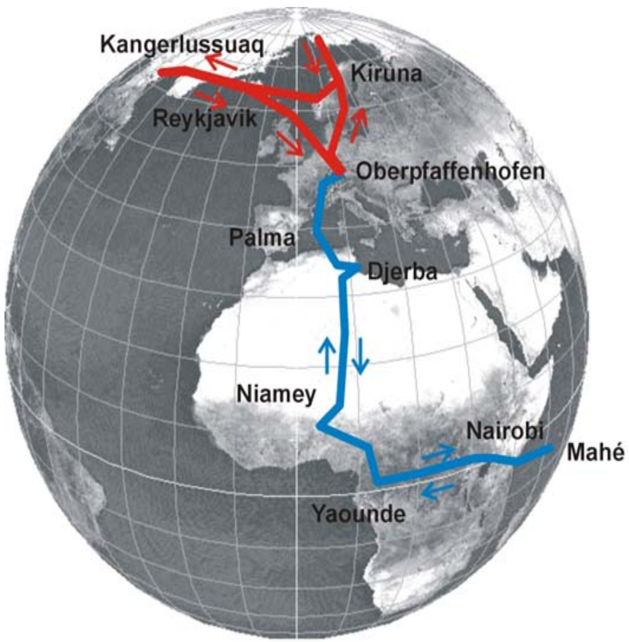
DLR Lidar



NASA LITE



Fligth track
DLR Falcon
for SCIAMACHY
validation with
ozone lidar



Conclusion and Outlook

- First atmospheric signal with ALADIN instrument detected from ground in October 2005
- First direct-detection Doppler lidar in nadir pointing geometry flown on aircraft in October 2005 with molecular, aerosol, cloud and ground signal
- End-to-end simulators for airborne and satellite instrument developed at DLR
- Setup of ALADIN Airborne Demonstrator for ground campaign at Meteorological Observatory Lindenberg of DWD started last week for a 3-weeks ground campaign in October 2006
- First airborne campaign with overflights over Lindenberg in April 2007, second campaign with flights in Tropics or North Atlantic in fall 2007
- DLR proposes to use ALADIN Airborne Demonstrator for in-orbit validation of ADM-Aeolus

Acknowledgements

A2D-Development

- Eric Chinal, Marc Chaloupy, Didier Morancais (EADS Astrium Toulouse)
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- Yannig Durand, Roland Meynart, Martin Endemann (ESA)

Definition of Campaign Objectives and Ground Campaign Implementation

- Alain Dabas (Meteo-France), Ad Stoffelen, Gert-Jan Marseille (KNMI)
- Dirk Engelbart, Volker Lehmann (DWD)
- Volker Freudenthaler (University Munich)

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