ADM-Aeolus – Progressing Towards Mission Exploitation

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Overview

- Background
- The ADM-Aeolus Mission
  - Cal/Val Announcement of Opportunity
  - Campaigns and Pre-launch validation
  - Other activities
- Conclusions

ADM-Aeolus objectives and requirements

What are the scientific objectives?

Improve understanding of

- Atmospheric dynamics and global atmospheric transport
- Global cycling of energy, water, aerosols, chemicals

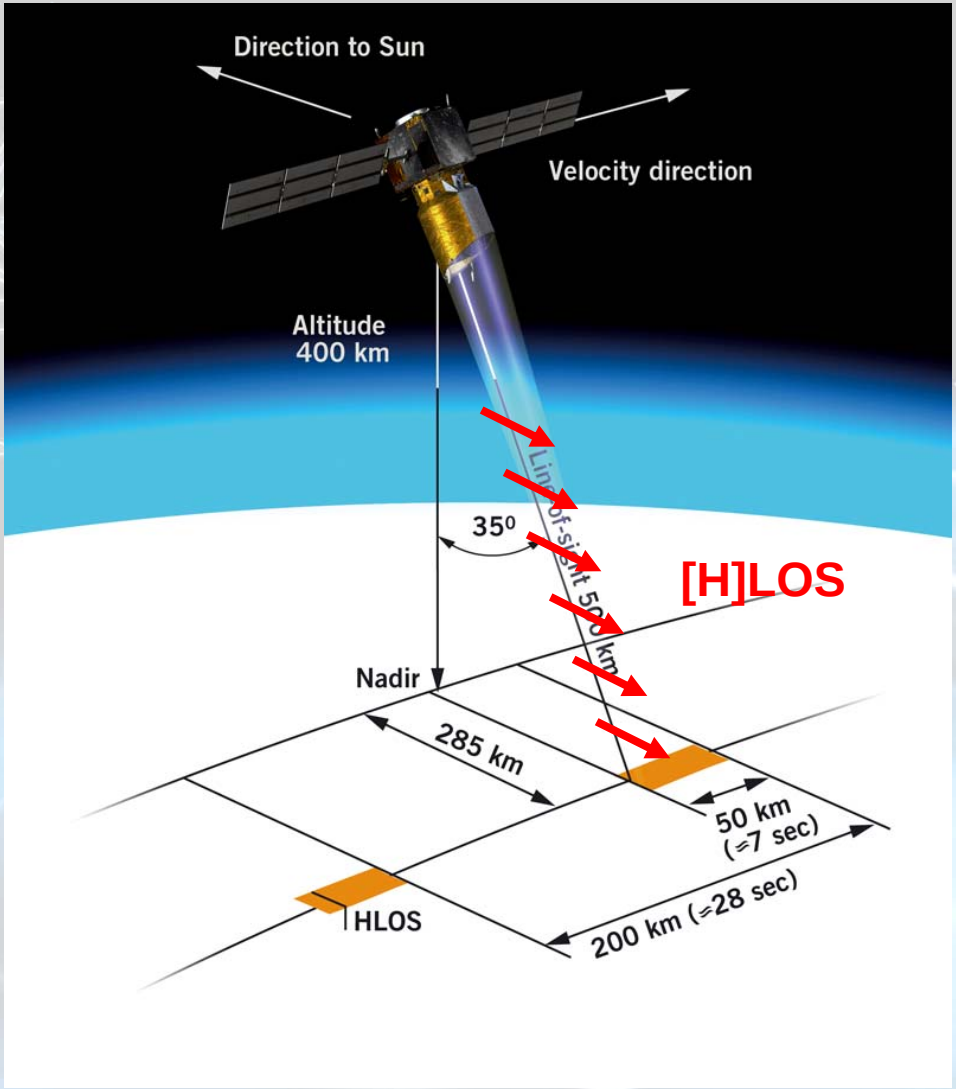
How are they achieved?

- Improved analysis of the atmospheric state to provide a more complete (three-dimensional) picture of the dynamical variables

What are the benefits?

- Better initial conditions for weather forecasting
- Improved parameterisation of atmospheric processes in models
- Advanced climate and atmospheric flow modelling
- Will show ADM-Aeolus' potential for full operational use

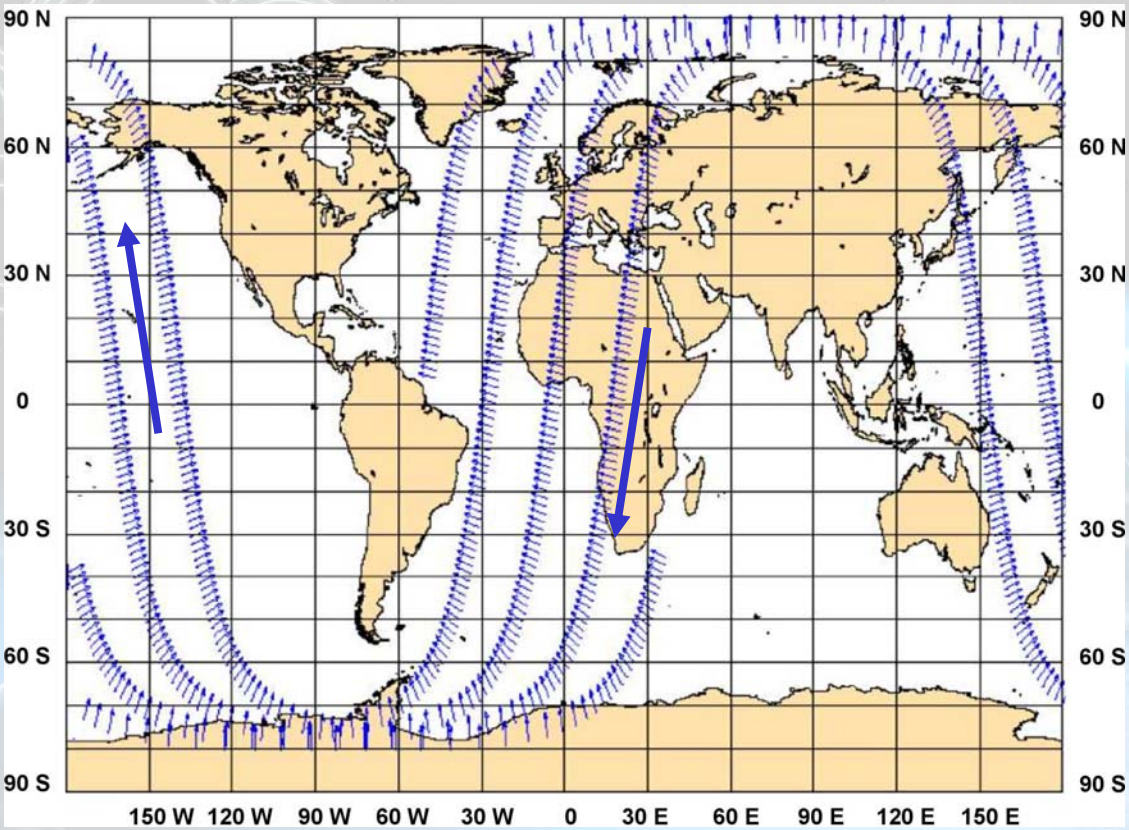
Atmospheric Dynamics Mission ADM-Aeolus



ADM-Aeolus with single payload Atmospheric LAser Doppler Instrument [ALADIN]

- Observations of Line-of-Sight LOS wind profiles in **troposphere to lower stratosphere up to 30 km** with **vertical resolution from 250 m - 2 km** horizontally averaged over **50 km every 200 km**
- High requirement on **random error** of HLOS
  <1 m/s (z=0-2 km, for Δz=0.5 km)
  <2 m/s (z=2-16 km, for Δz= 1 km),
  unknown bias <0.4 m/s and linearity error <0.7 % of actual wind speed; HLOS: projection on horizontal of LOS => LOS accuracy = 0.6*HLOS
- Operating @ **355 nm** with spectrometers for **molecular Rayleigh** and **aerosol/cloud Mie backscatter**

ADM-Aeolus Coverage and Data Availability



- **> 3000 wind profiles per day**: about factor 3 more than radiosondes
- **3 hour data availability** after observation (NRT-Service) => 1 data-downlink per orbit; 30 minutes data availability for parts of orbit (Quasi-NRT-Service with late start of downlink)
- **launch date late 2009**
- **mission lifetime 39 months**: observations from 2010-2012

Overview paper about ADM-Aeolus
Stoffelen et al. 2005, Bull. Am. Met. Soc.

Ongoing ADM-Aeolus Scientific Activities

Title	Team
Consolidation of ADM-Aeolus Ground Processing including L2A Products	**DLR** Germany & IPSL, Météo-France, KNMI
Development and Production of Aeolus Wind Data Products (Level 1B to L2B/C)	**ECMWF** UK & Météo-France, KNMI
Optimisation of spatial and temporal sampling	**KNMI**, the Netherlands & Met.No, MISU
A spontaneous Rayleigh-Brillouin Scattering Experiment	**University of Amsterdam,** the Netherlands & Univ of Nijmegen, KNMI
ADM-Aeolus Campaigns	**DLR** Germany & Météo-France, KNMI, IPSL, DWD, MIM

Tan et al

Stoffelen et al

ADM-Aeolus AO Calls

- Considerations for **CAL/VAL**
  - Validation requirements for co-location in time and space
  - Limitations when comparing datasets with different measurement characteristics
  - Inter-product dependencies, mission optimization, etc.

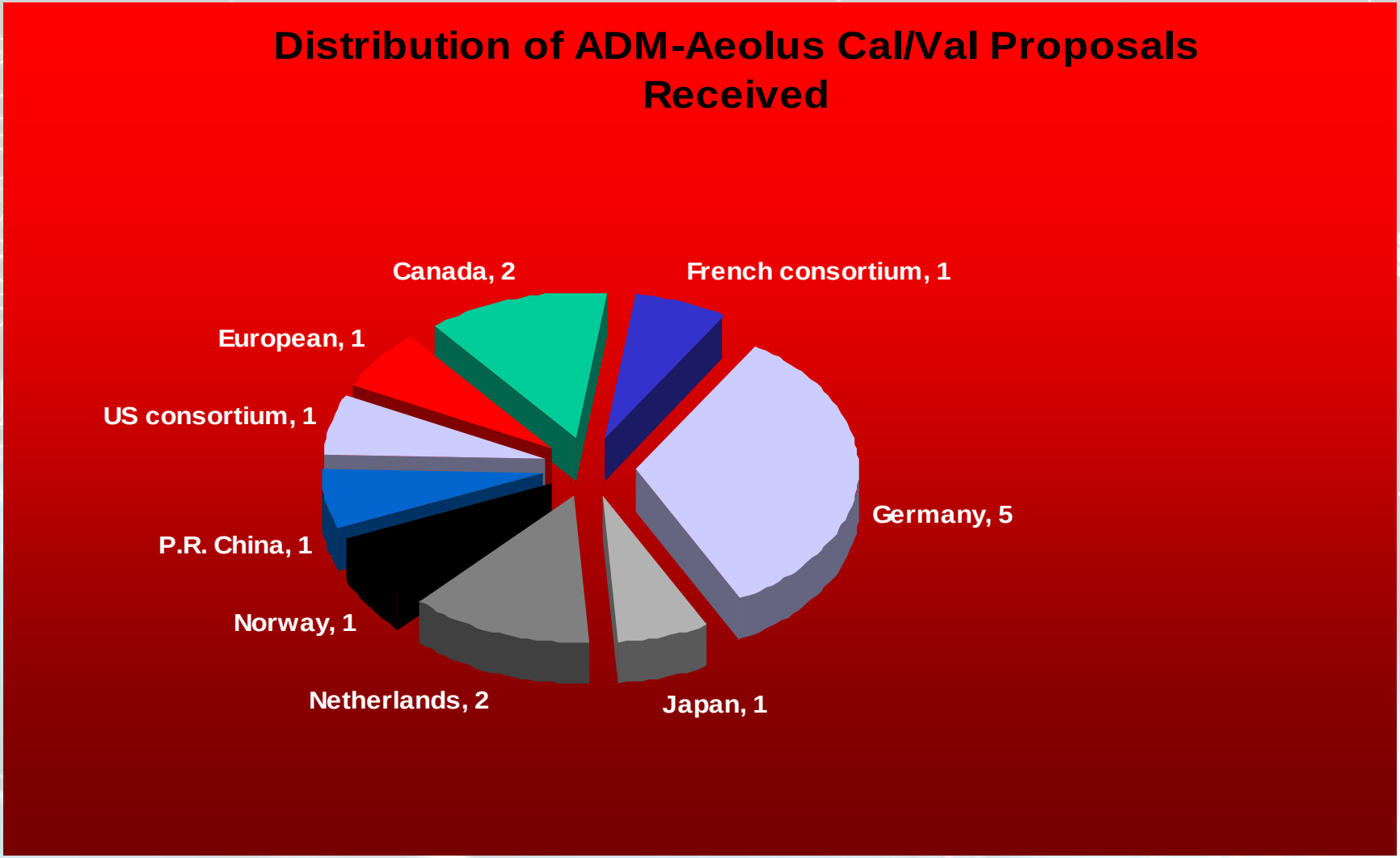
ESA plans an Announcement of Opportunity AO for ADM-Aeolus scientific use of data for early 2009 in addition to the AO for Cal/Val

Critical validation points

- Validation of wind profiles and assimilated wind fields (L2B/C) and atmospheric optical properties products (L2A)
  - Atmospheric heterogeneities – co-location, slant versus vertical column, etc.
    - Only the wind products can be directly evaluated by the ECMWF assimilation system
  - Wind and aerosol products from space-based lidars or passive instruments, ground-base instrumentation, air-borne instrumentation, etc.
    - instrument properties and error characteristics (Aeolus is a HSRL)
    - in-situ (e.g. radiosonde) vs. layer averaged products (averaging kernels)
    - measured at different wavelengths (approximate conversion laws from e.g. 2 µm and/or 522 nm to 355 nm – if possible, measurements at 355 nm)
    - different viewing geometry, etc.
- The impact of atmospheric heterogeneities (e.g. clouds) on the Mie and Rayleigh wind product accuracies (the importance of scene classification and validation of the cross-talk corrections)
- Vertical sampling strategy w.r.t.
  - Troposphere research
  - Stratosphere research
  - Regional effects

Would like to draw from the Experience with validation of other satellite missions

ADM-Aeolus Cal/Val AO



Cal/Val and Mission Phases

- Commissioning Phase (phase E1) – First Three months of Mission:
  - Specific campaigns designed to verify that data products are suitable for release to User Community
  - Processing changes likely to evolve rapidly
  - Access to data restricted to active participants (AO PIs)
- Routine operations (phase E2) – rest of mission (3 years)
  - Ongoing improvements to data products
  - Emphasis on product stability. Slow changes only to the processing
  - Novel scientific uses of data
    - Access open to all proposals accepted as result of an up-coming Science AO

Cal/Val AO Time Table

- Updates required from PIs: 18 April 2008
- Notification of the evaluation results to PIs: 25 April 2008
- Start of ESA data delivery to accepted PIs: TBD (expected about 6 weeks after launch)
- Projects completion (Final reports): 2012 (TBC)
- AVRT (ADM-Aeolus Validation and Retrieval Team) Symposia or Workshops: First workshop early in 2009

Expected Outcome and Data Access

- The AO PIs are expected to play an active role in the validation of the data products
- Members of the AVRT will have access to ADM-Aeolus data products starting at Level 1b up to Level 2b
- During the commissioning phase of the satellite, data access will be limited to the AVRT members

ADM-Aeolus Science AO

- Release planned for 2009
- Objectives
  - Novel scientific use of the Aeolus data, e.g.:
    - Foster research and application development in the field of atmospheric dynamics and climate research
      - Impact of Aeolus wind and/or clouds and aerosols in NWP and climate research (including atmospheric transport and radiation budget)
      - Contribute to long-term databases of wind and optical properties
      - Support high-impact weather response through the improvement of forecasts
      - ENSO?
    - In the frame of GMES, exploit the synergy with other satellite based, ground-based, or air-borne measurement product

ADM-Aeolus Pre-Launch Campaigns

First ground campaign in October 2006

Second ground campaign in July 2007

Objective

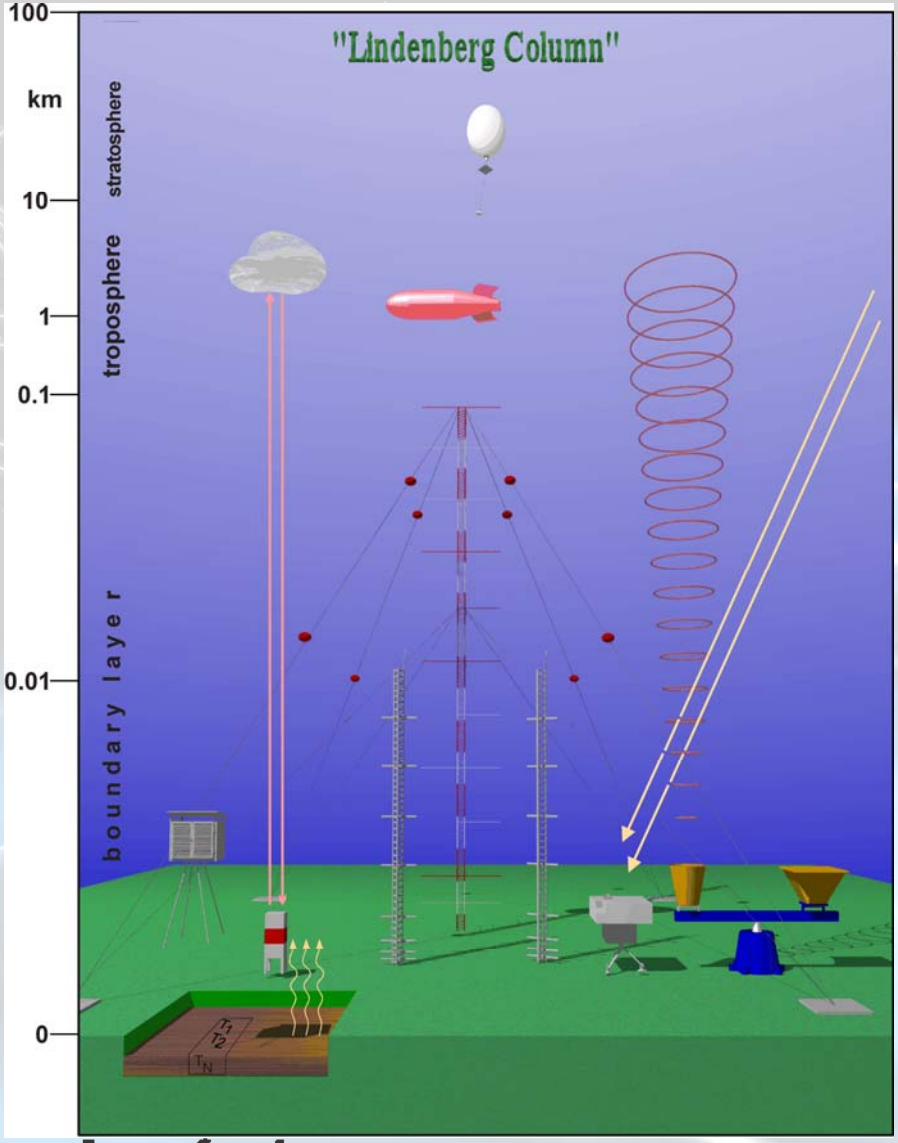
- **Validate ALADIN instrument before launch with atmospheric signal** and derive conclusions for retrieval algorithms and for on-ground and in-orbit test, verification and calibration of satellite instrument
- Specific topics are: **radiometric and wind measurement performance, calibration procedures for Mie and Rayleigh spectrometers, quality-control, Rayleigh wind correction schemes (T, p),** ground detection and zero-wind calibration

Site: Meteorological Observatory of DWD in Lindenberg (southeast of Berlin, Northeast Germany); flat terrain

Campaign Team: 20 participants from DWD, University Munich, and DLR

=> www.pa.op.dlr.de/aeolus

Instruments at DWD Lindenberg for Ground Campaigns



Windprofiler site

- ALADIN Airborne Demonstrator A2D (LOS winds) 355 nm
- DLR 2-µm Doppler Lidar (wind up to 2-3 km); only Oct. 06
- University Munich aerosol lidar MULIS (backscatter, extinction coefficient up to 10 km) 355 nm, 532 nm, Raman
- 482 MHz windprofiler with RASS (wind up to 16 km, temperature up to 4 km)
- 1290 MHz windprofiler (wind up to 1.5 km)
- ceilometer (clouds up to 12 km, aerosol backscatter in boundary layer)

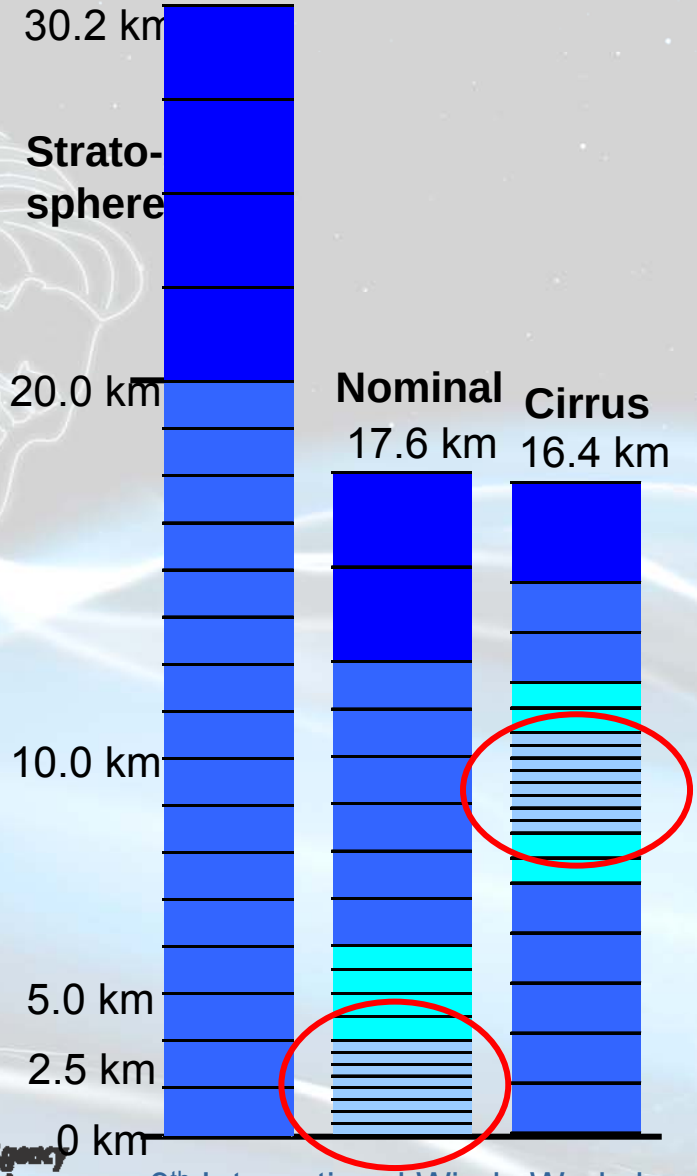
Optic laboratory (distance 500 m)

- 355 nm Raman-lidar RAMSES (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, linear depolarisation ratio)
- Ceilometer (clouds up to 12 km, aerosol backscatter in boundary layer)

Radiosondes (Vaisälä RS 92)

- 4 routine radiosondes per day (0, 6, 12, 18 UTC) and additional radiosondes on request (3, 9, 15, 21 UTC)

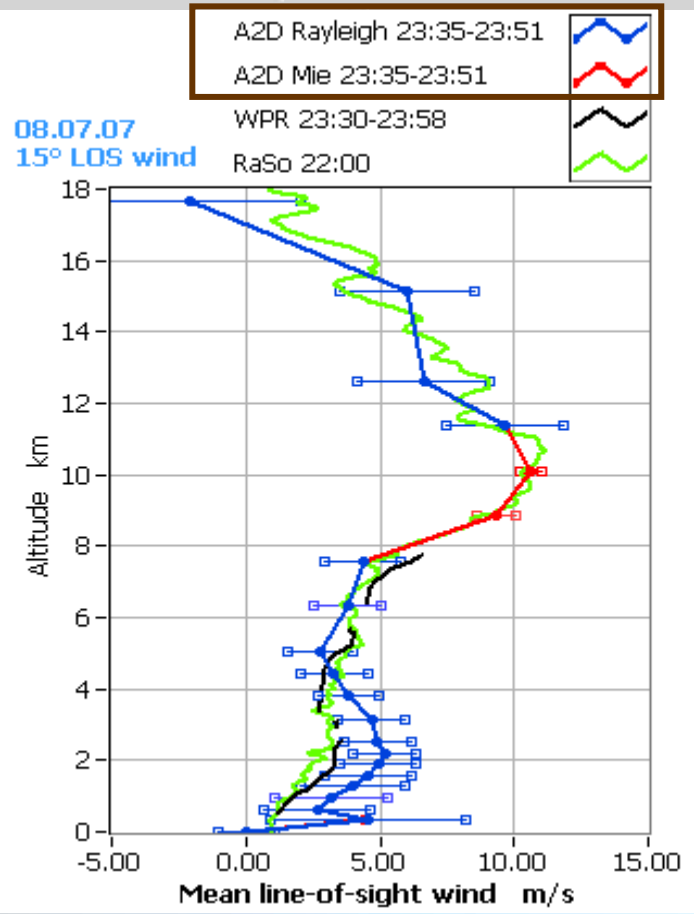
A2D vertical sampling schemes during second ground campaign

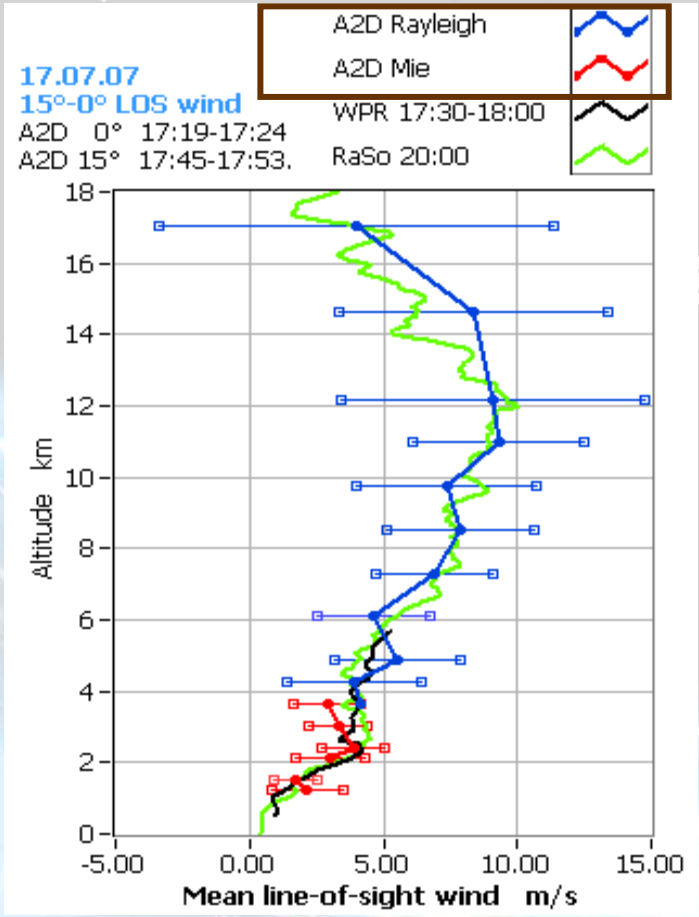


3 different vertical sampling schemes used during second ground campaign

- **nominal mode** up to 17.6 km with highest vertical resolution (315 m) close to ground
- **cirrus mode** up to 16.4 km with highest vertical resolution between 8 km - 10 km => adapted in real-time with measurements from aerosol lidar MULIS
- **stratosphere mode** up to 30.2 km with resolution of 1.26 km and 2.52 km

Ground Campaign July 2007





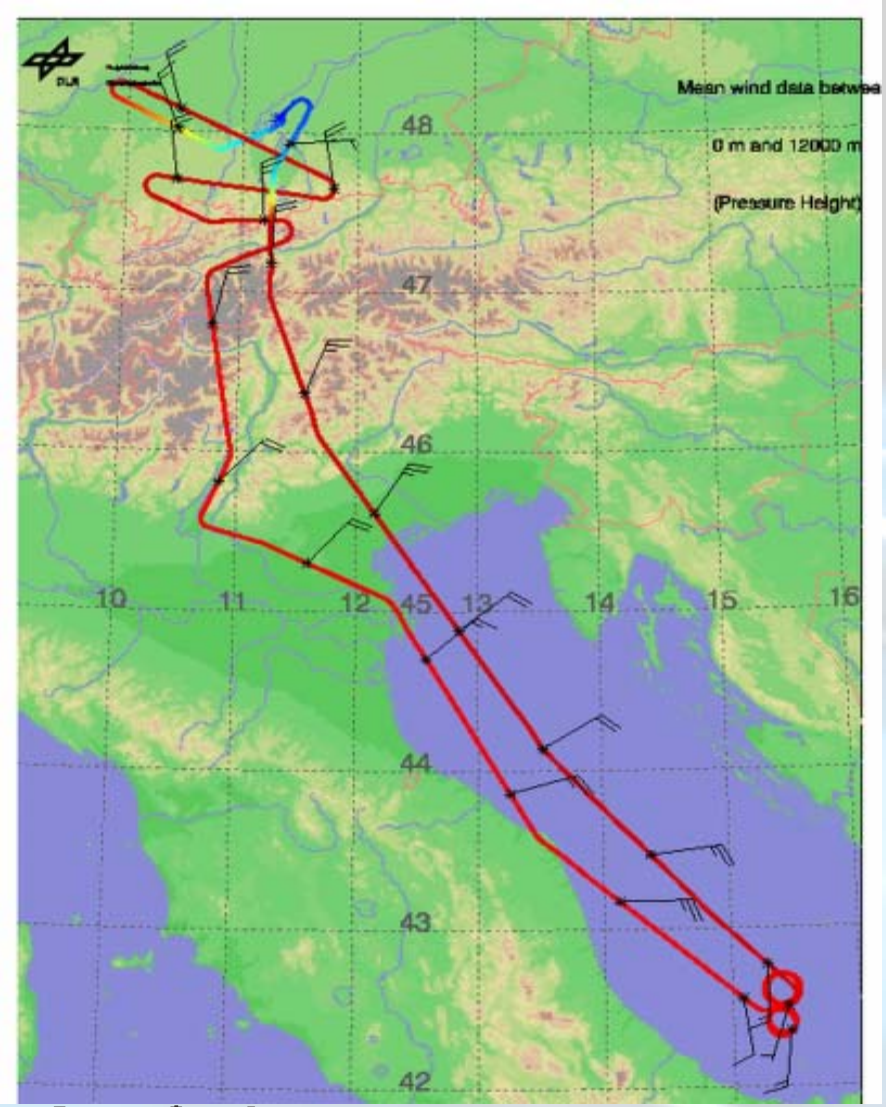
Observations from ALADIN Airborne Demonstrator A2D (DLR: U. Paffrath, O. Reitebuch), Windprofiler Radar WPR and Radiosonde RaSo (DWD: D. Engelbart, V. Lehmann)

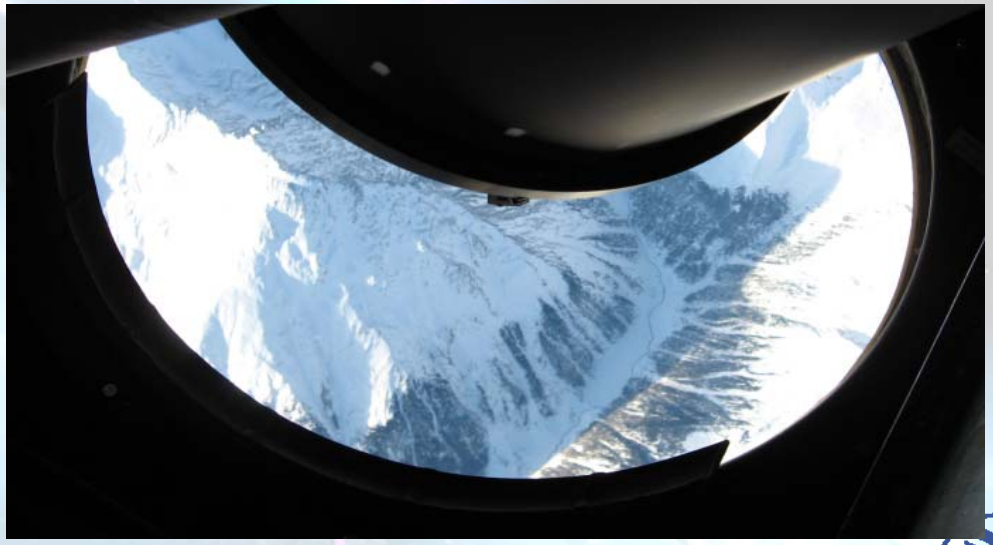
The DLR Falcon 20 Aircraft

Falcon jet just before take-off for first A2D flight in October 2005

pressurized, twin-engine jet, max. altitude 10-12 km, max. endurance 4.5 h, payload 1 t
2 bottom and 1 top optical aperture in fuselage (Ø 515 mm) for lidar payloads

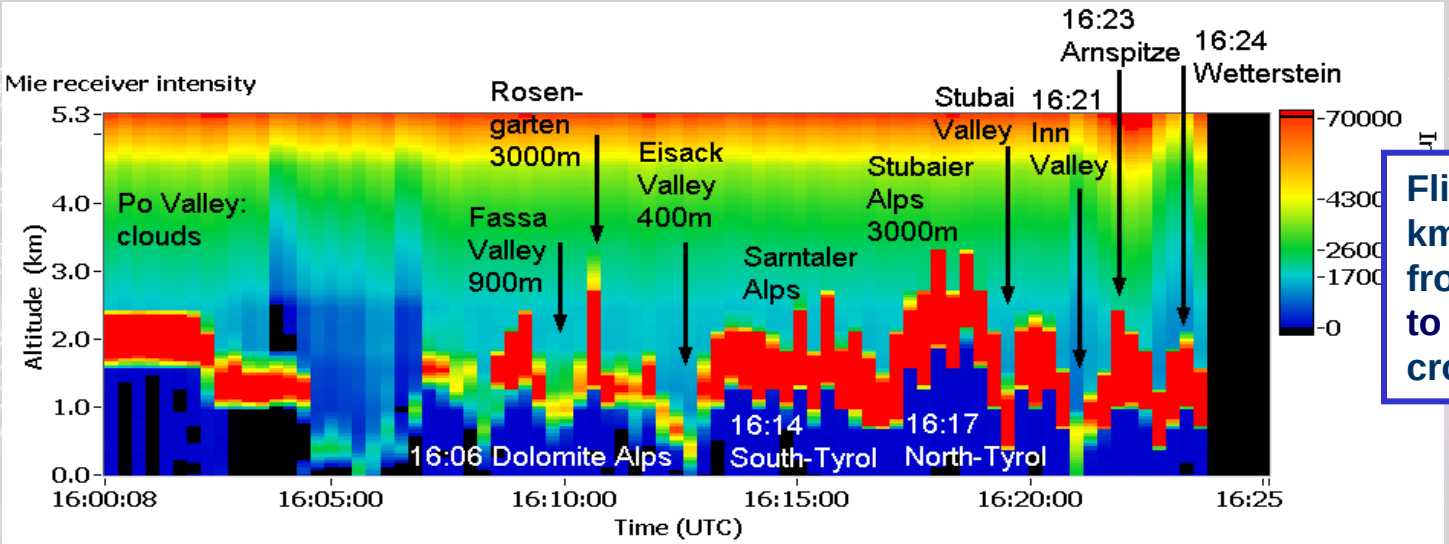
A2D and 2-µm flight on Nov 28, 2007



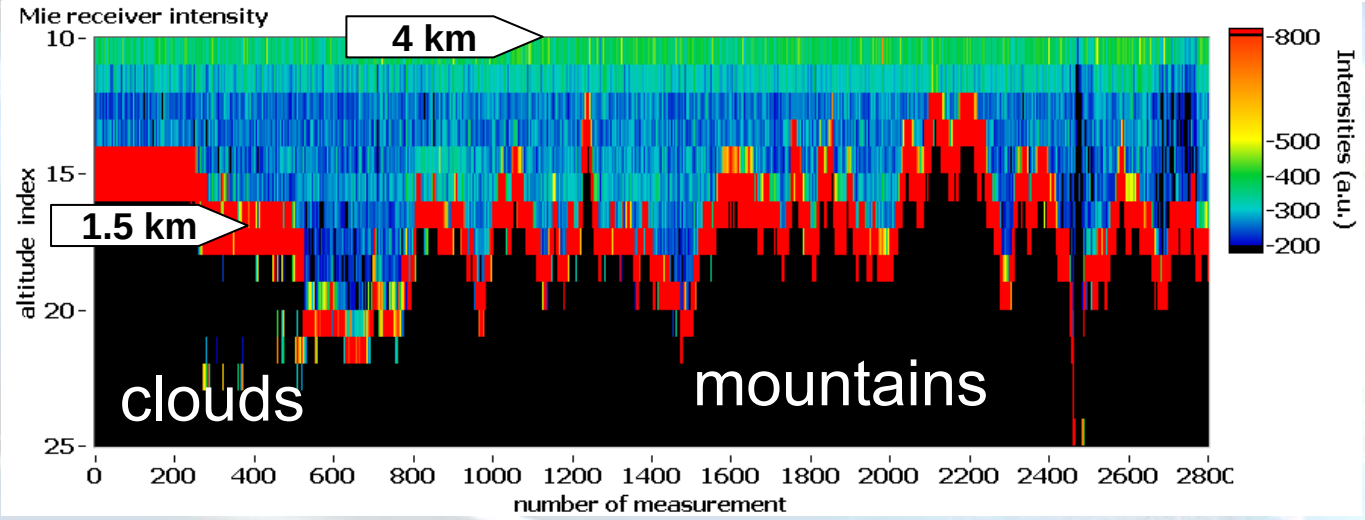


Surface Returns on A2D Mie Receiver

per observation (630 accumulated laser pulses)



per measurement (18 accumulated laser pulses)

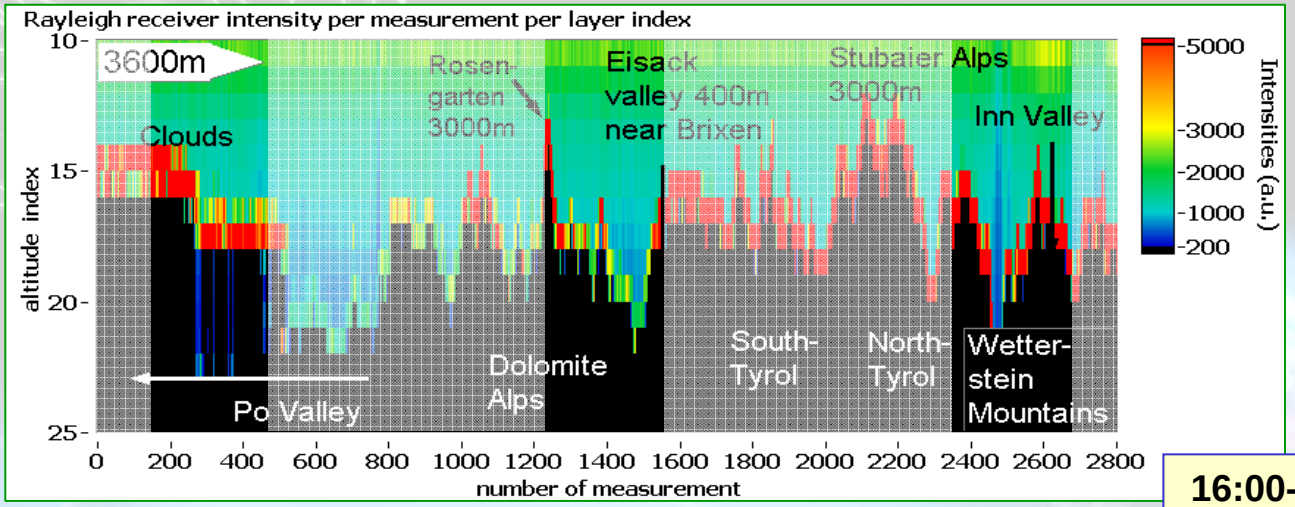


Flight on 28.11.07, (9.2 km flight altitude) from Italy (Po-valley) to Oberpfaffenhofen crossing the Alpes

A2D resolution:
- **315 m vertical resolution (2.1 µs)**
- **one measurement: 18 accumulated laser pulses (P=20)**
- **one observation: 630 accumulated laser pulses (N=35)**

Surface Returns on A2D Rayleigh Receiver

A2D: 616 km, 140 observations = 2800 measurements (à 20 pulses)



16:00-16:30

obs — obs — obs

Satellite: 616 km, 3 observations over 200 km à 50 km (7sec)

Flight on 28.11.07, (9.2 km flight altitude) from Italy (Po-valley) to Oberpfaffenhofen crossing the Alpes

A2D resolution:
- **315 m vertical resolution (2.1 µs)**
- **one measurement: 18 accumulated laser pulses (P=20)**
- **one observation: 630 accumulated laser pulses (N=35)**

Outlook on ADM-Aeolus Campaign Activities

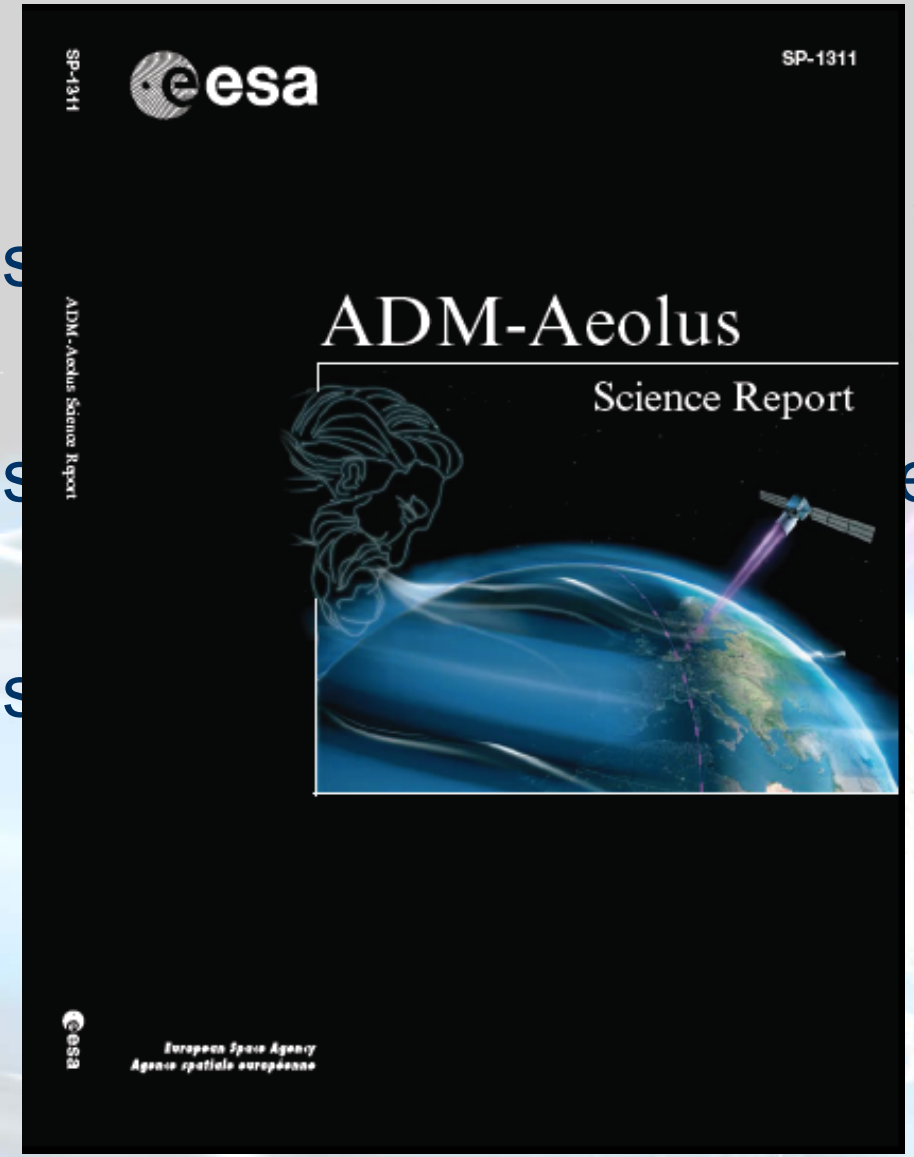
DLR Falcon 20 and HALO (High Altitude and Long Range Research Aircraft, modified Gulfstream G550) in April 2006

- Further 2 airborne campaigns in 2008/09 planned with the A2D and 2-µm wind lidar
- DLR intends to support ADM-Aeolus Cal/Val activities in 2009/2010 with
  - ground-based campaign with the A2D, other lidars, windprofiler radar and radiosonde at DWD Lindenberg
  - airborne campaigns with Falcon or HALO aircraft with A2D, 2-µm wind lidar and other additional payloads

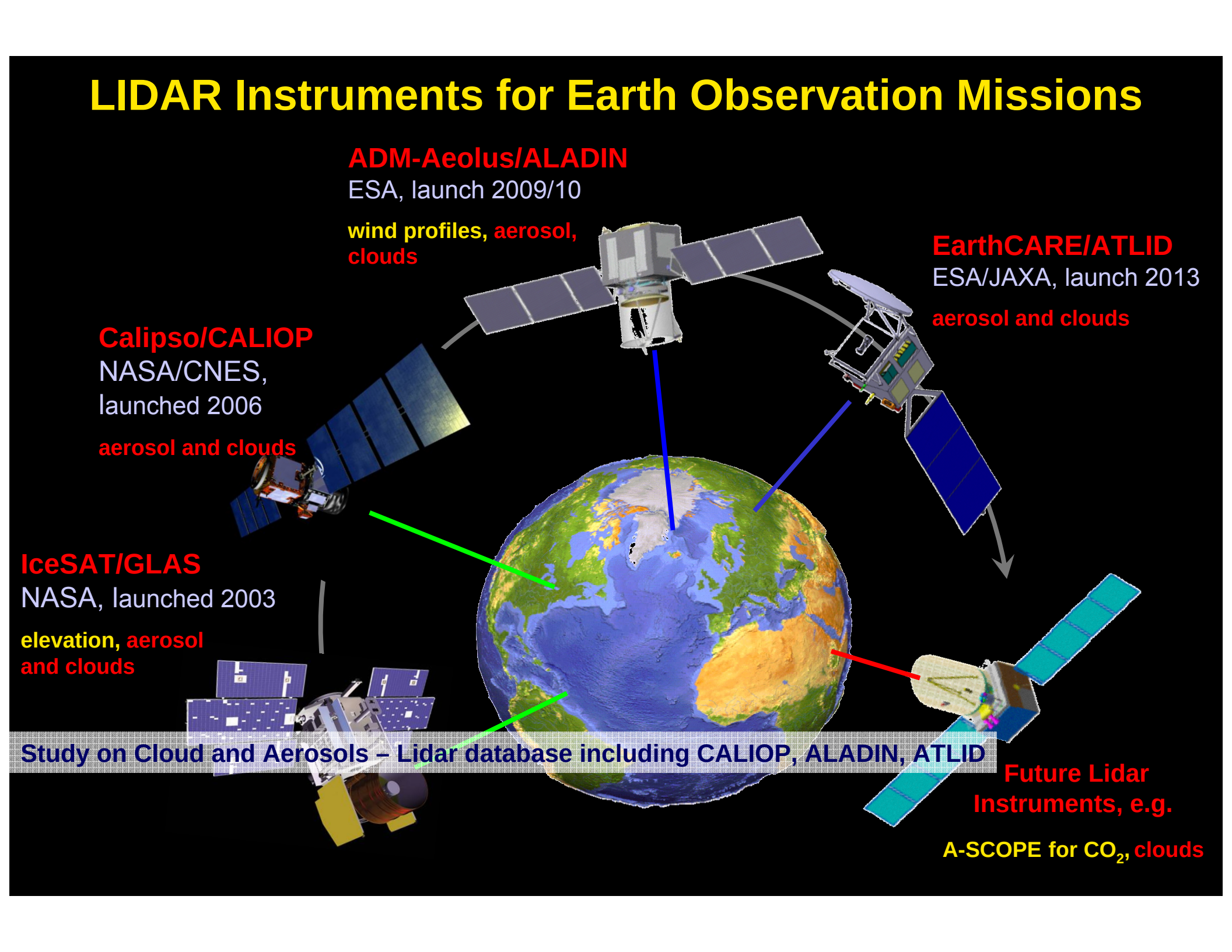
HALO aircraft delivery to DLR in November 2008
www.halo.dlr.de

Other Issues…

- ADM-Aeolus
- ADM-Aeolus eration
- ADM-Aeolus in preparation



LIDAR Instruments for Earth Observation Missions



Conclusions

- Accurate wind profile observations are needed to improve NWP and climate analysis
- A feasible concept for a demonstrator has been developed and is being implemented as the second Earth Explorer Core Mission
- Cal/Val Announcement of Opportunity (and science AO later)
- Various scientific and campaign activities are on going in parallel to the technical activities
- ADM-Aeolus launch: late 2009
- Adaptation of ADM-Aeolus for operational use is being studied
- Listening to the workshop presentations it seems everybody is waiting for ADM-Aeolus appearing…

http: www.esa.int/livingplanet


ADM-AEOLUS
ESA's WIND MISSION
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