ESA - MOST Dragon 2 Programme

2011 DRAGON 2 SYMPOSIUM

中国科技部-欧洲空间局合作 "龙计划"二期

"龙计划"二期2011年学术研讨会

Dragon 2 Project Lidar Cal/Val (ID 5291)

Pre-launch validation of ADM-Aeolus over Greenland using Airborne Lidar´s–

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Team Meeting in May 2010 in Qingdao

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Overview

- ADM-Aeolus - the first wind lidar in space

- Airborne pre-launch validation over Iceland and Greenland

Global Observing System for Weather Prediction

Received observations at ECMWF within 24 h on 13 Feb 2006

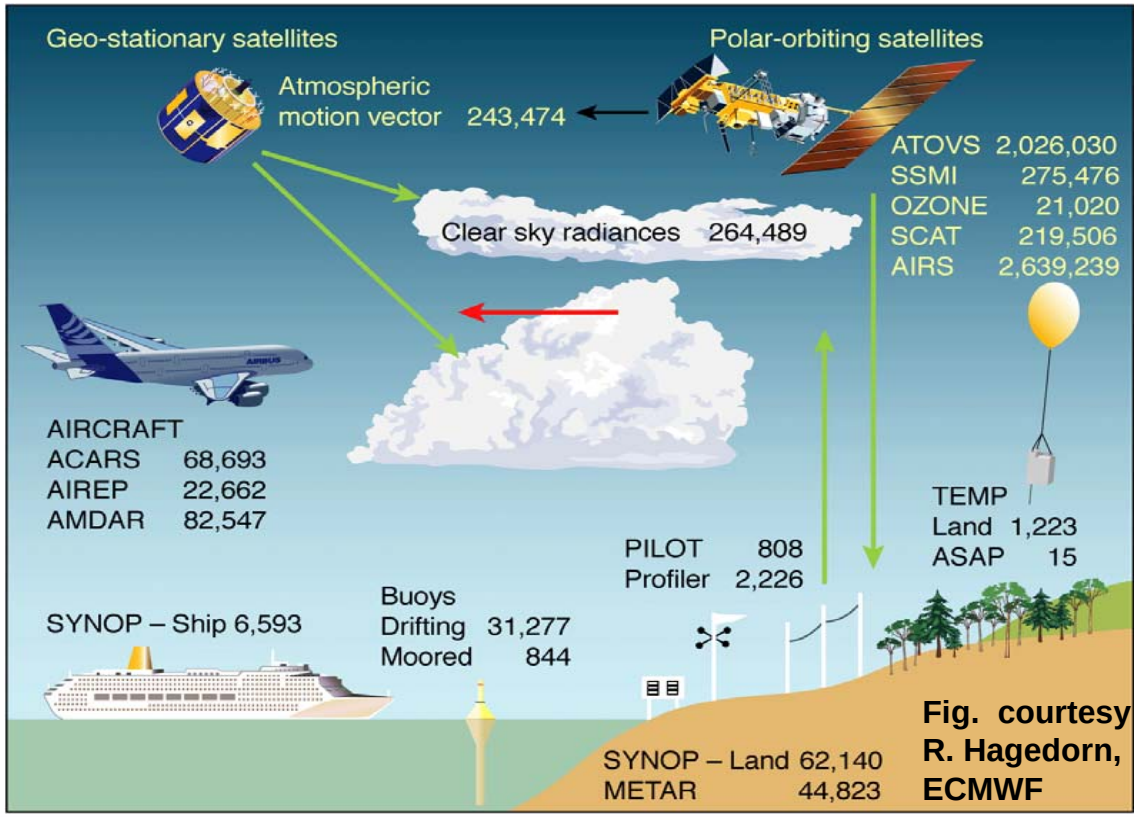


Fig. courtesy R. Hagedorn, ECMWF

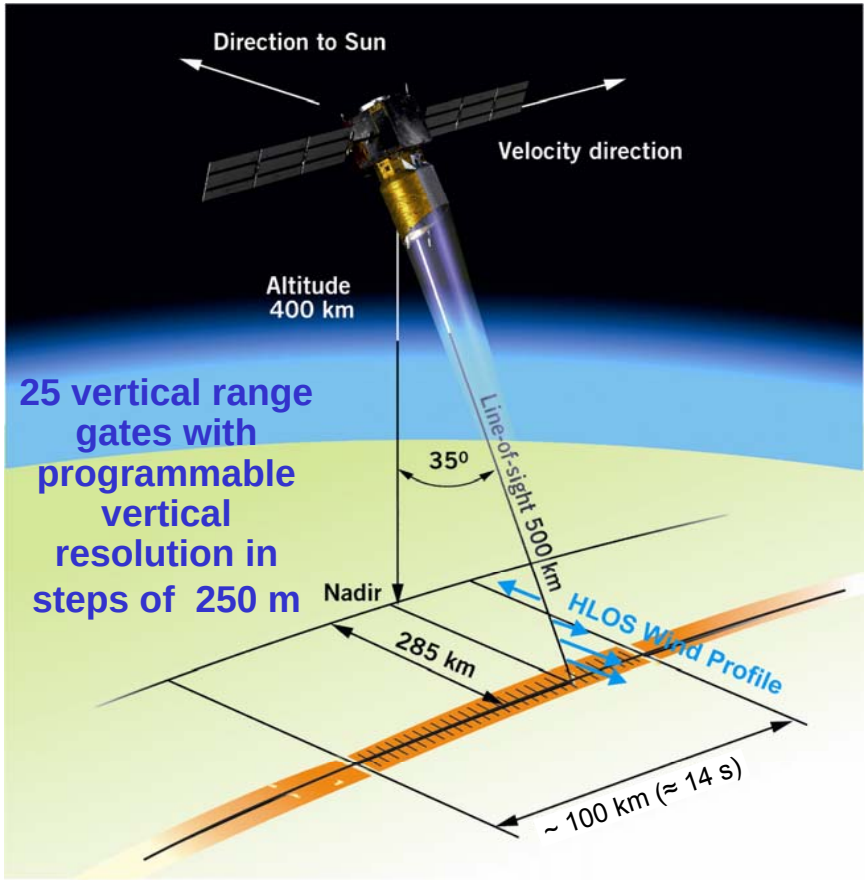
WMO Expert Team on Observational Data Requirements and Redesign of the Global Observing System

Statement of Guidance for Global NWP (Dec 2009) and High-Resolution Numerical Weather Prediction (Feb 2010):

The critical atmospheric variables that are not adequately measured by the current or planned observing systems are (in order of priority):

1. wind profiles at all levels

Atmospheric Dynamics Mission ADM-Aeolus

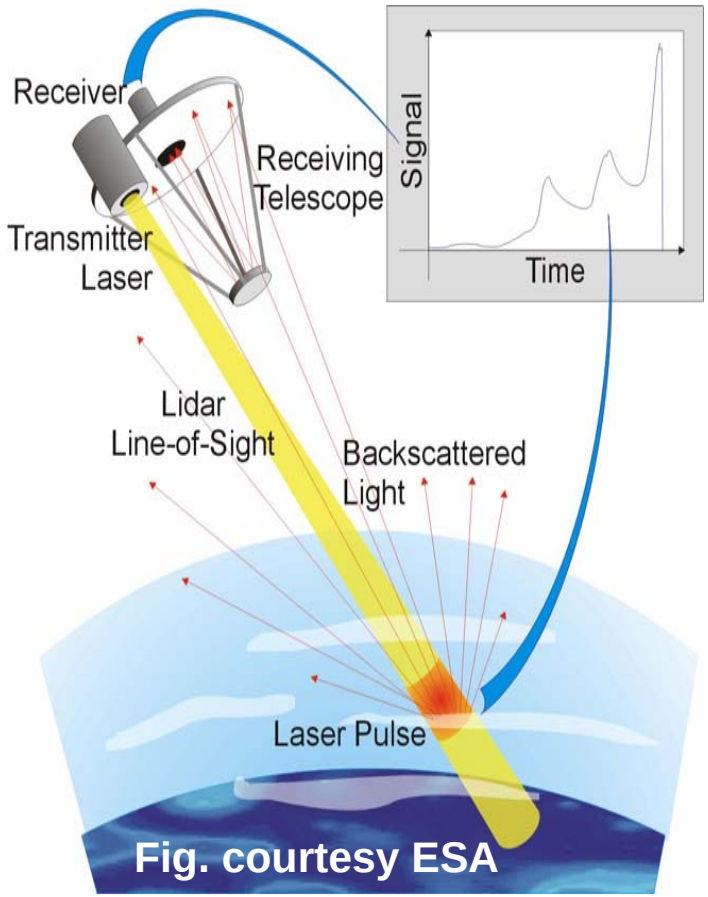


on-board averaging over 3-5 km horizontally
on-ground processing to 100 km

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 100 km
- Precision and accuracy rather than quantity:
  HLOS random error requirement
  <1 m/s (z = 0 - 2 km, for Δz = 500 m)
  <2 m/s (z = 2 - 16 km, for Δz = 1000 m),
  unknown bias <0.4 m/s, slope error <0.7 %
- First wind lidar and first High Spectral Resolution Lidar HSRL in space → vertical profiles of wind speed and aerosol and cloud properties (extinction, optical depth)
- Launch planned for end 2013

Optical Remote Sensing with LIDAR



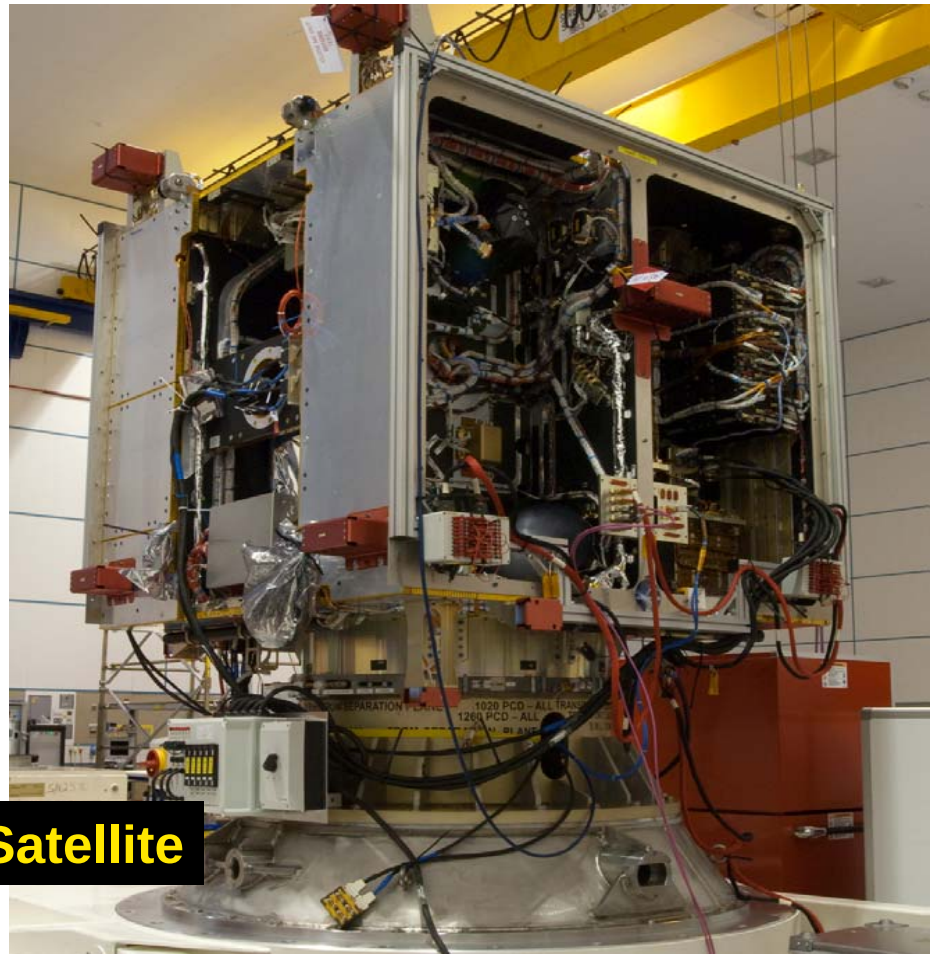
LIDAR (Light detection and ranging)

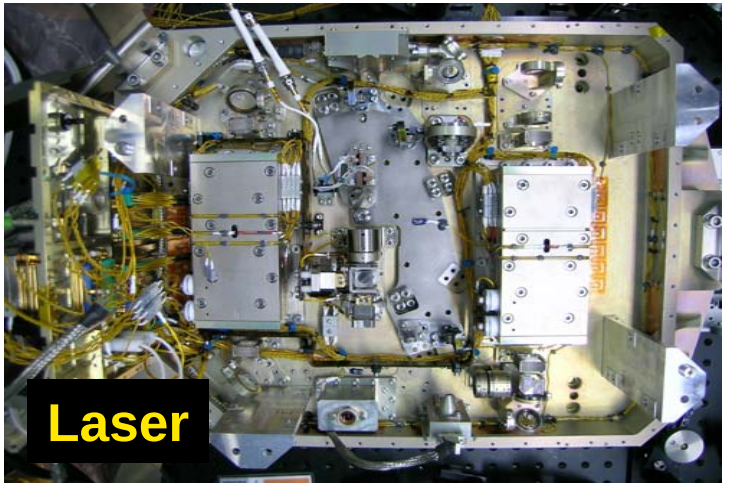
- Laser pulses are transmitted into the atmosphere where they are partly scattered on molecules, aerosols, clouds and ice particles.
- Scattered light is collected by a telescope and analyzed
- Depending on the state of the scatterer (T, p, aerosol content and type,…) the properties of the scattered light are changed. → atmospheric quantities can be derived.

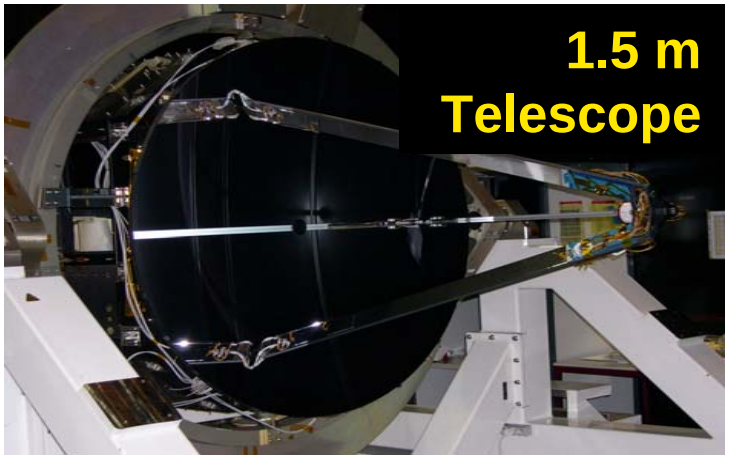
Characteristics of lidar observations

- Measurement of vertical profiles with adjustable vertical resolution
- Random error can be determined for every observation; low systematic error and error correlations
- Data retrieval in clear air and partly cloudy conditions possible

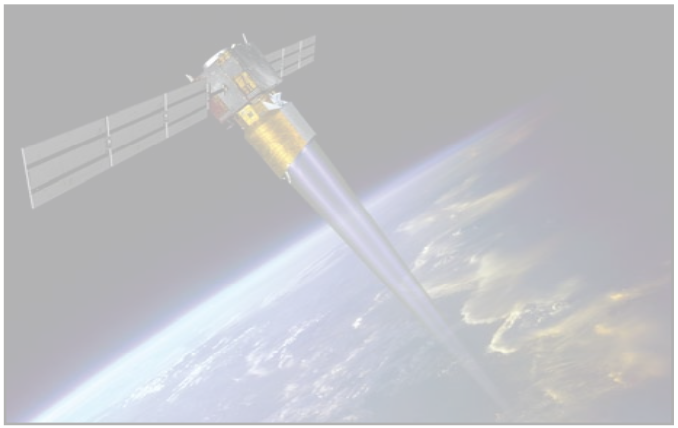
ADM-Aeolus: Some impressions of flight hardware







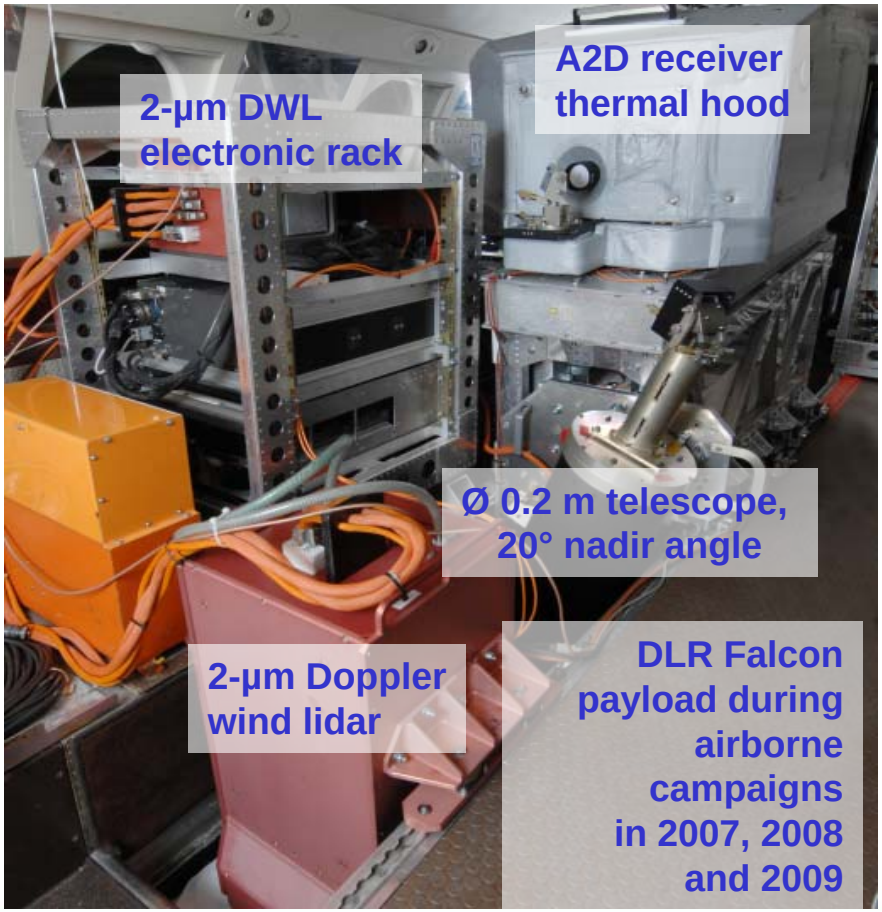
Overview



- ADM-Aeolus - the first wind lidar in space

- Airborne pre-launch validation over Iceland and Greenland

ADM-Aeolus Pre-Launch Validation
The ALADIN airborne demonstrator A2D at DLR



- 3 Flight Campaigns performed to validate instrument and support of algorithm development in 2007, 2008, and **2009 over mid-Europe and Greenland-Iceland**
- **Investigation of Rayleigh-Brillouin scattering in air** from mountain observatory "Schneeferner-haus" (2650 m) in 2009 → Experiments on Rayleigh-Brillouin scattering in air
- About 100 recommendations for ESA satellite ALADIN derived
- Activities funded by DLR and ESA

- Reitebuch et al. (2009): A2D design, JAOT
- Paffrath et al. (2009): Radiometric performance, JAOT
- Li et al. (2010): Sea surface reflectance in UV, JAOT
- Witschas et al (2010): Rayleigh-Brillouin scattering, Appl. Opt.
- Witschas (2011): Analytical Model for Rayleigh-Brillouin line-shape, Appl. Opt.

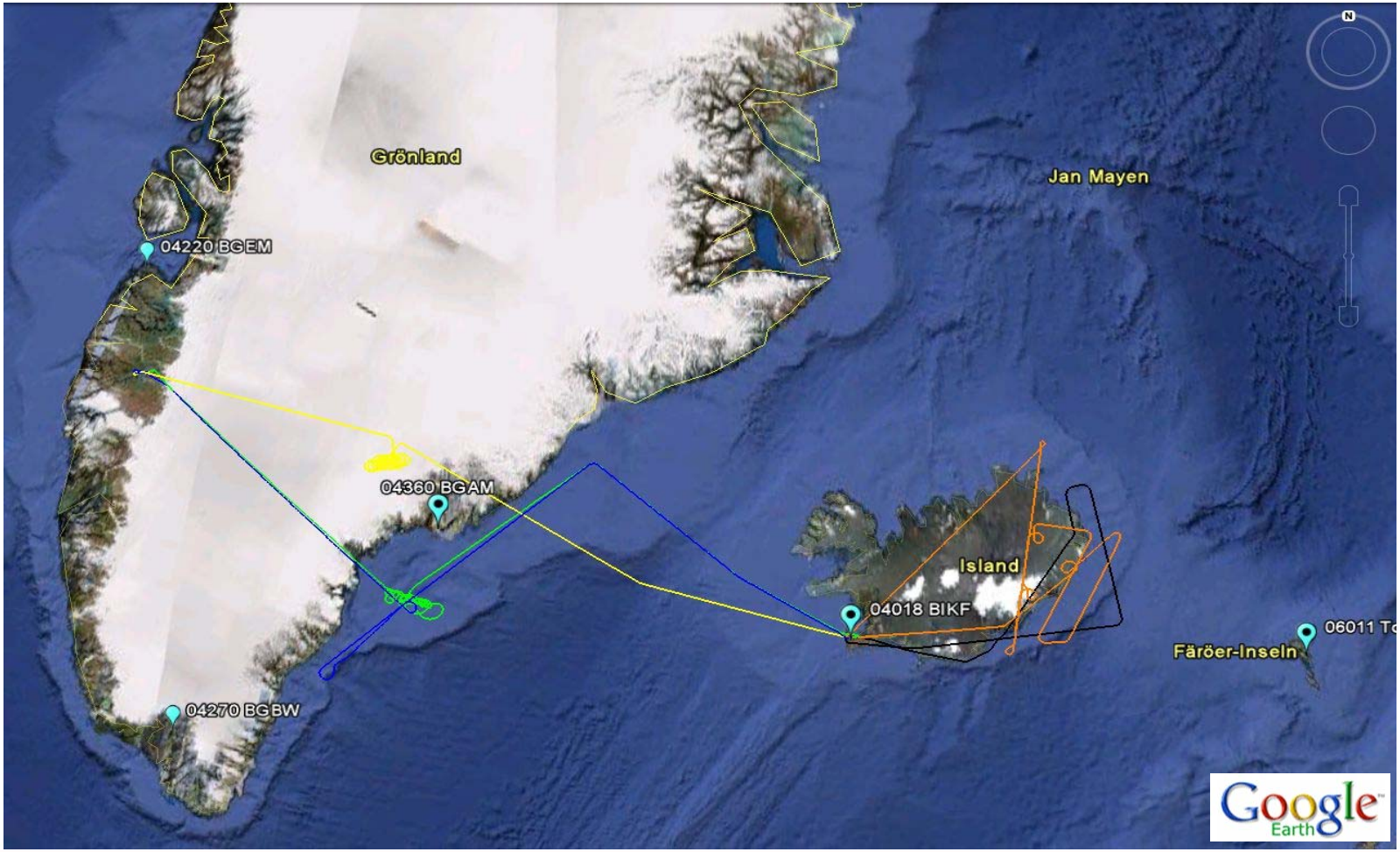
Main objectives of ADM-Aeolus airborne campaign over Iceland and Greenland in September 2009

1.) In-flight response calibration with nadir pointing over ice

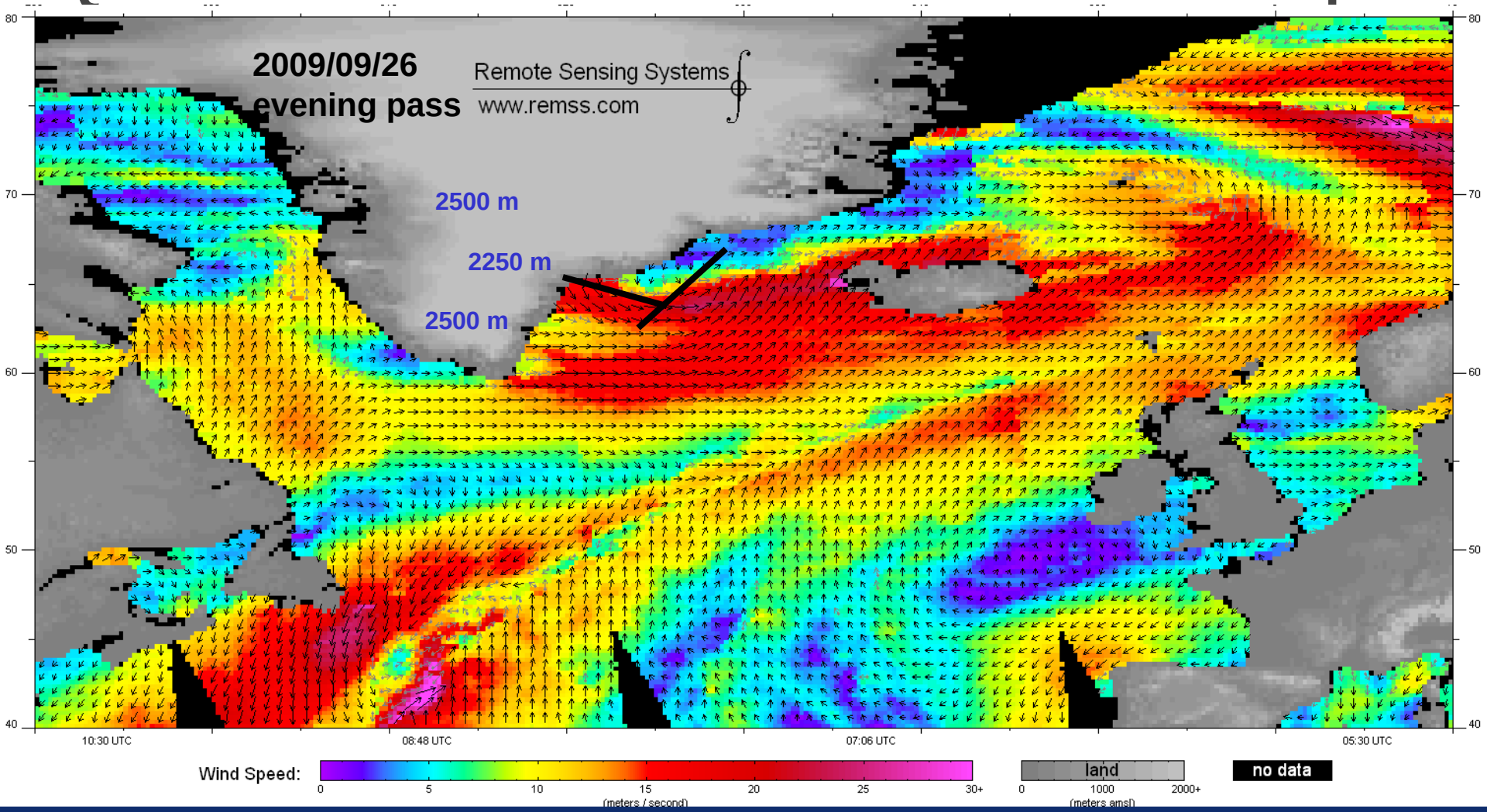
2.) Observations of high wind speeds in combination with high vertical and horizontal shear

3.) Obtain data set for sea-surface reflectance for high sea surface winds and measurements with anisotropic reflectance

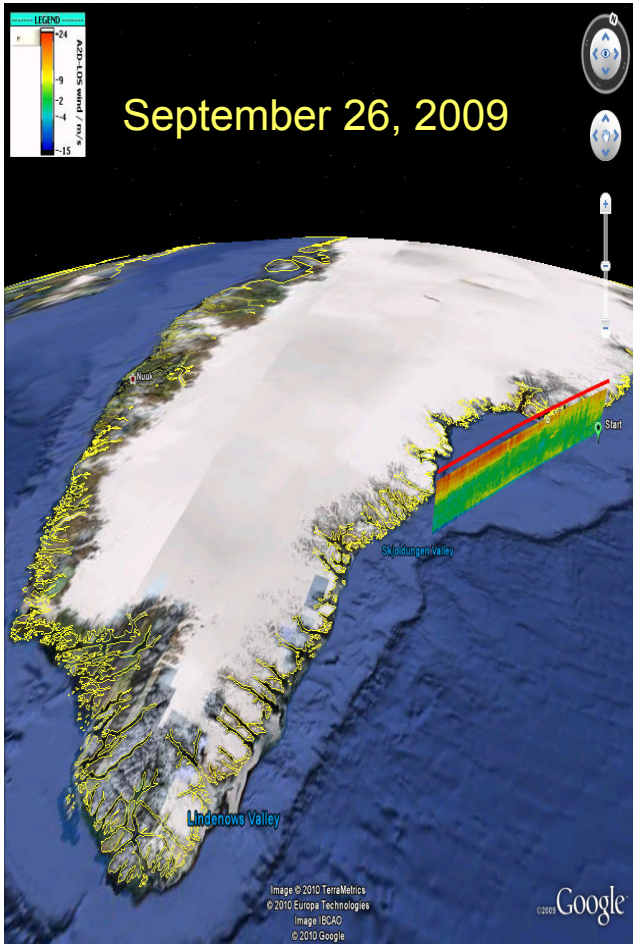
Flight Tracks in September 2009

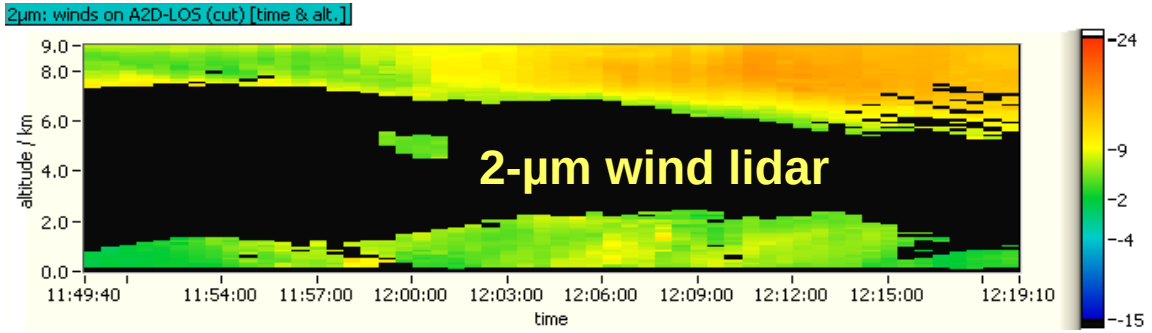


QuikSCAT observations of sea surface wind speed



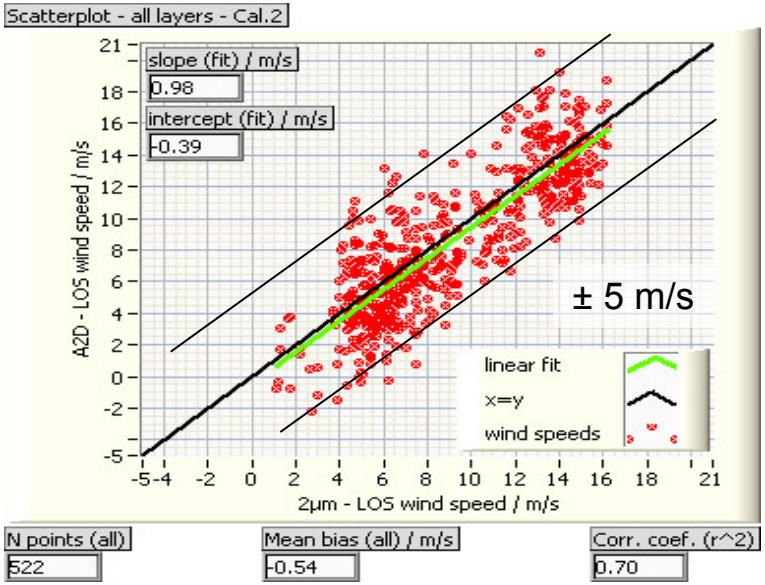
Wind lidar comparison: ADM-prototype A2D vs. 2-µm lidar

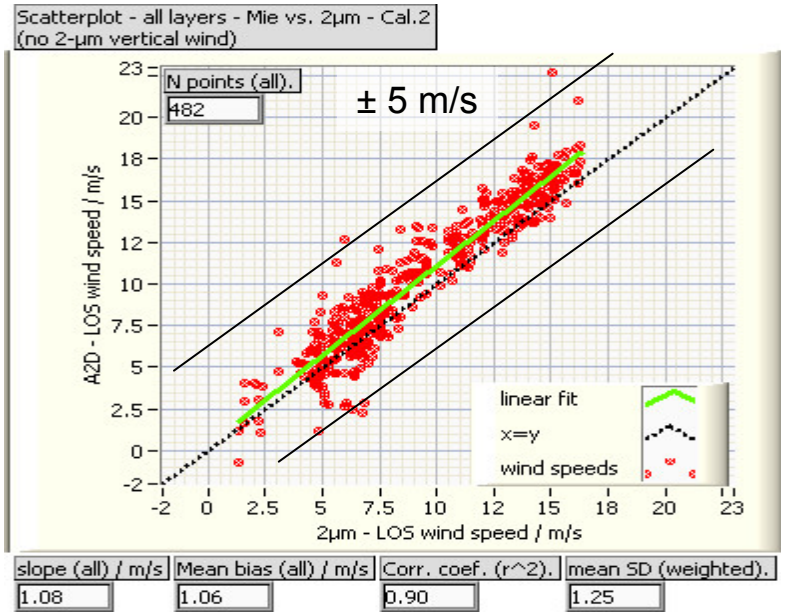




Wind lidar comparison: ADM-prototype A2D vs. 2-µm lidar
Statistical comparison

statistical comparison of 2-µm and A2D Rayleigh/MIE channel line-of-sight (LOS) wind speed (97 vertical profiles)





Rayleigh winds	**STD 2 m/s** **bias = - 0.5 m/s** **corr. coeff. R = 0.84**

Mie winds	**STD 1.3 m/s** **bias = 1.1 m/s** **corr. coeff. R = 0.95**

Summary and Conclusion

- Wind profiles are still missing observation with highest priority for global and regional numerical weather prediction.
- ADM-Aeolus will sense the vertical profile of wind with a vertical resolution of 250-1000 m up to the lower stratosphere (20-30 km) with high accuracy of 1-2 m/s.
- Principle of calibration over Ice and wind retrieval for ADM-Aeolus was validated with an airborne demonstrator (by DLR) during an airborne campaign at Iceland and Greenland.
- Dragon 2 activities are used to prepare and coordinate a Chinese-European effort to validate ADM-Aeolus mission after launch with ground and airborne campaigns in 2014.


Xièxie!
谢谢!
Thank you
very much!