

Airborne direct-detection and coherent wind lidar measurements over the North Atlantic Region during the WindVal campaign in 2015 supporting ESA's Aeolus mission

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The launch of the Aeolus mission by the European Space Agency (ESA) is planned for early 2018. The satellite will carry the first wind lidar in space, ALADIN (Atmospheric Laser Doppler INstrument). Its prototype instrument, the ALADIN Airborne Demonstrator (A2D), was deployed during several airborne campaigns aiming at the validation of the measurement principle and optimization of algorithms. In 2015, flights of two aircraft from DLR & NASA provided the chance to compare parallel wind measurements from four airborne wind lidars for the first time.

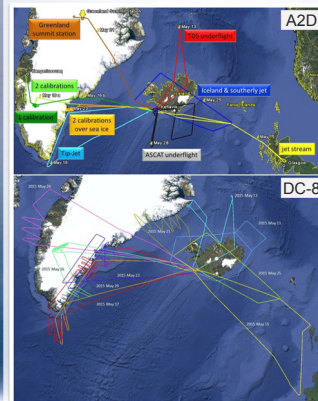
DLR-ESA-NASA WindVal Flight Campaign 2015

- 1st time worldwide with 4 wind lidar instruments flown on 2 aircraft in parallel
- Rehearsal of airborne Cal/Val activities after launch of Aeolus
- Datasets for testing calibration and wind retrieval algorithms



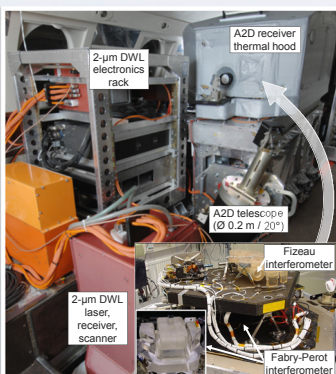
- **A2D:** DLR, Falcon direct-detection (Reitebuch et al. 2009)
- **2- μ m:** DLR, Falcon coherent (Witschas et al. 2017)
- **TWILite:** NASA, DC-8 direct-detection (Gentry et al. 2011)
- **DAWN:** NASA, DC-8 coherent (Kavaya et al. 2014)
- **Yankee dropsondes** (Yankee Environmental System, 2016: <http://www.yankee.com/news/research.html>)

Flight Tracks



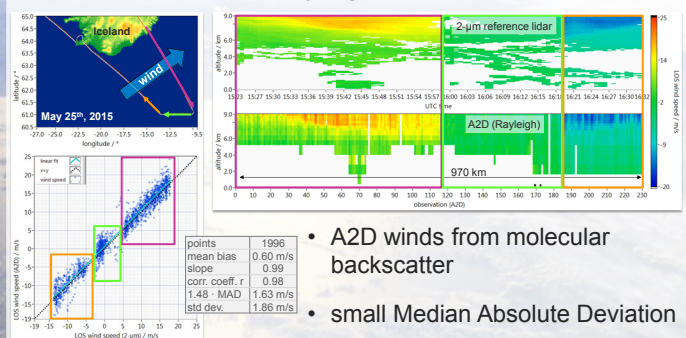
- A2D: 9 scientific and 4 transfer flights between May 11th and May 29th, 2015
- ≈ 12 h of A2D wind measurements (21 scenes between 10 – 88 min)
- 5 in-flight instrument response calibrations (≈ 2.5 h)
- Coordinated wind measurements performed during 7 flights
- Flight hours:
 - NASA DC-8 = 51 h (excl. transfer)
 - DLR Falcon = 48 h (incl. transfer)
- 101 dropsondes released from DC-8
- Ground based lidar at Greenland summit station (Shupe et al. 2013)

Payload of the DLR Falcon



parameter	A2D	2- μ m
detection principle	direct	coherent
wavelength / nm	354.9	2022.5
pulse repetition rate / Hz	50	500
pulse energy / mJ	50 - 60	1 - 2
pulse length / ns	20	400
telescope diameter / m	0.2	0.11
resolution vertical / m	300 - 2400	100
resolution temporal / s	0.4 \rightarrow 18	1 \rightarrow 40
line-of-sight	20° off-nadir (fixed)	vertical (fixed) or 20° off-nadir (scanning)

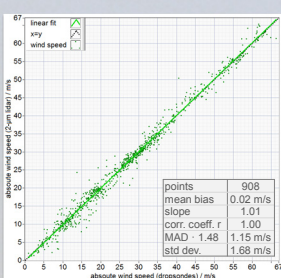
A2D Rayleigh channel



- A2D winds from molecular backscatter
- small Median Absolute Deviation
- comparison to 2- μ m coherent detection lidar: precision < 1 m/s, bias < 0.1 m/s (Witschas et al. 2017, Chouza et al. 2016, Weissmann et al. 2005)

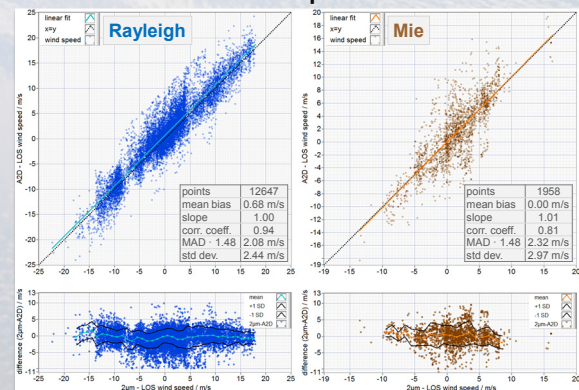
Comparison of 2- μ m lidar to dropsondes

- Dropsonde data from DC-8 available for 10 collocated flights with Falcon
- Valid measurement within < 3 min and < 5 km difference



- Measurements with differences > 5 m/s or > 25° (direction) are considered to be gross outliers and removed from comparison
- Std. dev. is higher than for previous comparisons:
 - 0.92 m/s (Chouza et al. 2016)
 - 1.2 m/s (Weissmann et al. 2005)

Overall wind speed comparison of WindVal campaign: A2D vs. 2- μ m lidar



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