Airborne wind lidar campaigns for preparation of the Aeolus mission

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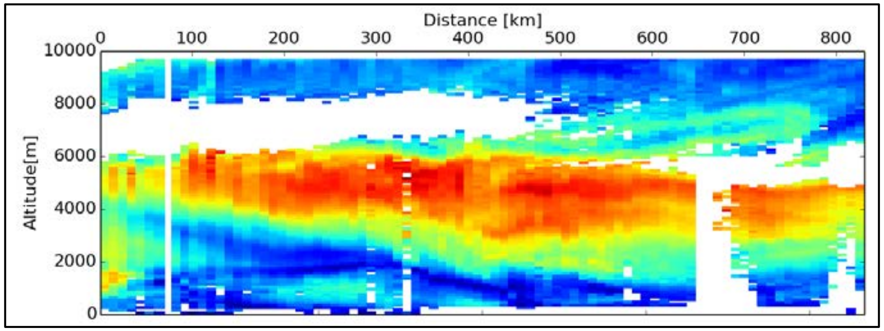
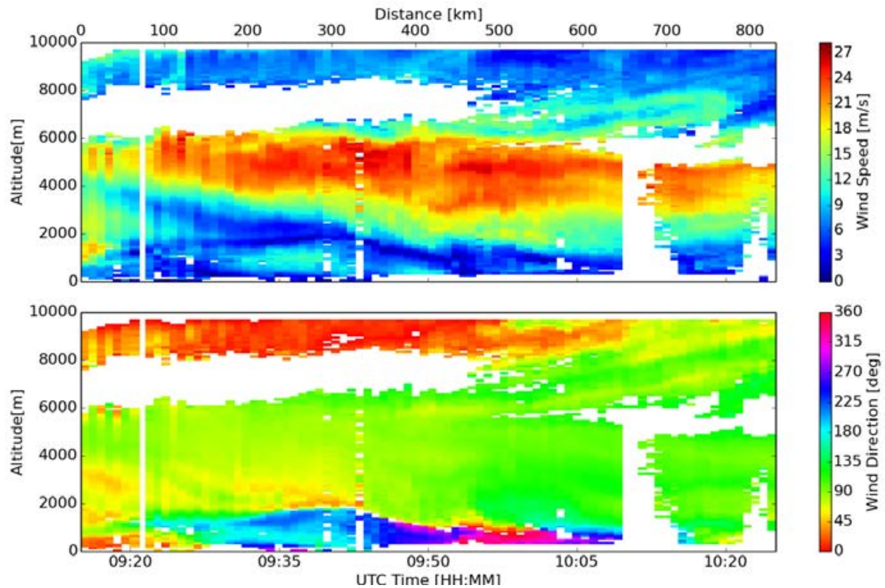
DLR

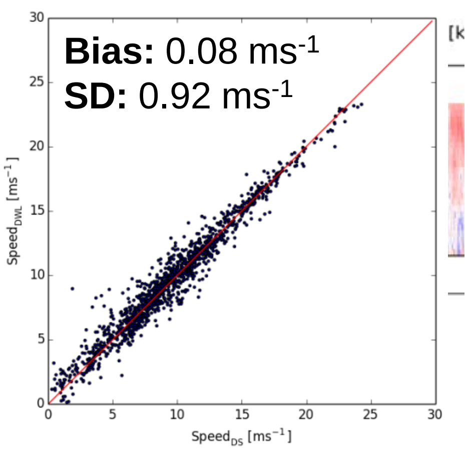


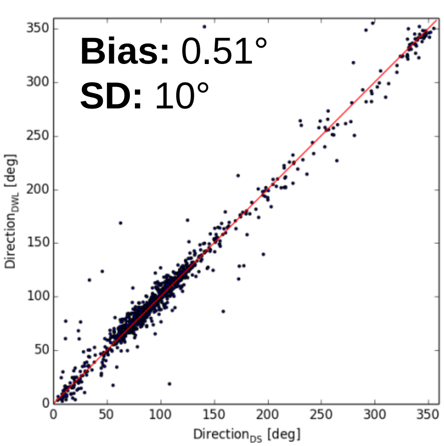
Outline

- Capabilities of airborne wind lidars
- Campaigns for Aeolus preparation
- Observations of wind and aerosol in the Tropics

What can be measured with airborne wind lidars?





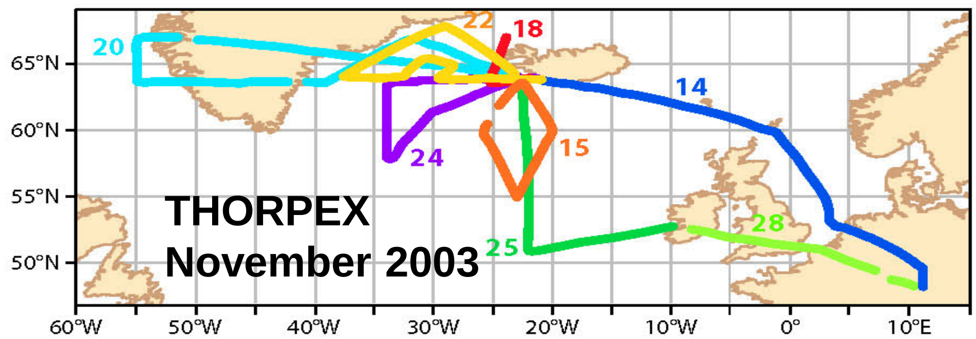


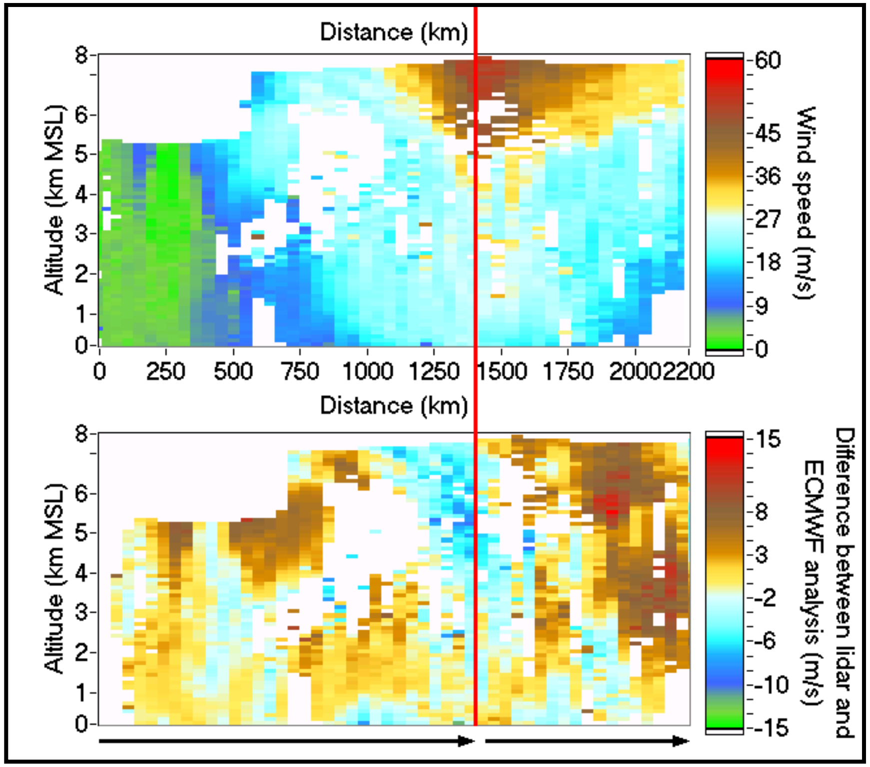
Chouza et al. (2015), **AMT**
Chouza et al. (2016), **ACP**

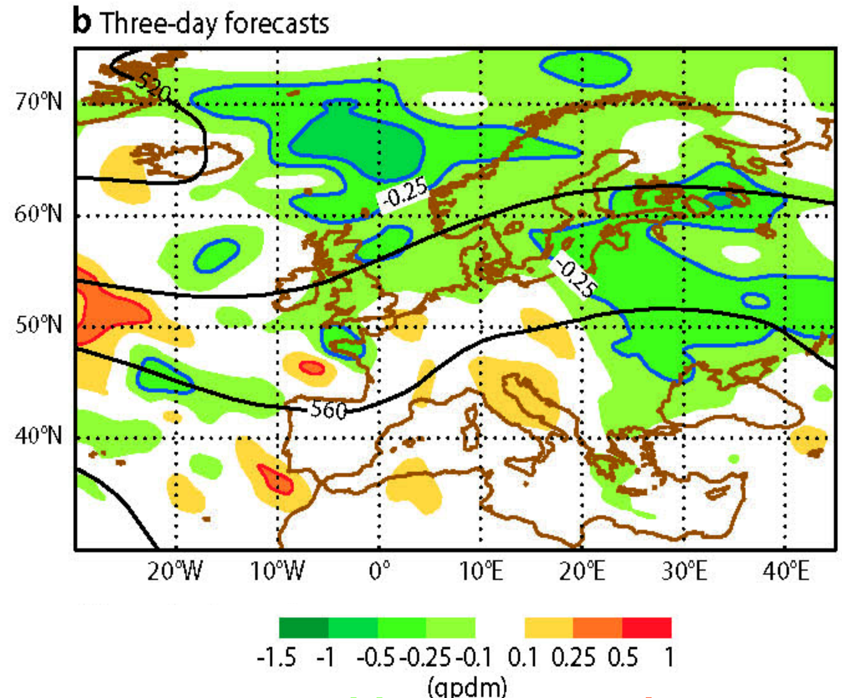
	ADM airborne demonstrator	2-µm wind lidar
wavelength	355 nm (UV)	2.022 µm (IR)
backscatter	molecules, aerosol, clouds	aerosol, clouds
wind	line-of-sight LOS, 20°	LOS, hor. wind vector, vertical wind w
vert. res.	250 m – 2 km	100 m
temp. res.	14 s (+4 s)	1 s LOS 30-40 s vector
hor. res. @ 200 m/s	3.6 km	200 m LOS 6-8 km vector
precision	2 m/s (mol.) 1.5 m/s (aer.)	< 1 m/s vector < 0.3 m/s vertical
accuracy	0.5-1 m/s	< 0.1 m/s

Reitebuch et al. (2009), **JAOT**
Reitebuch (2012): Wind Lidar, in Schumann U. (Ed.)

Targeted wind lidar observations in 2003 and assimilation experiments at ECMWF





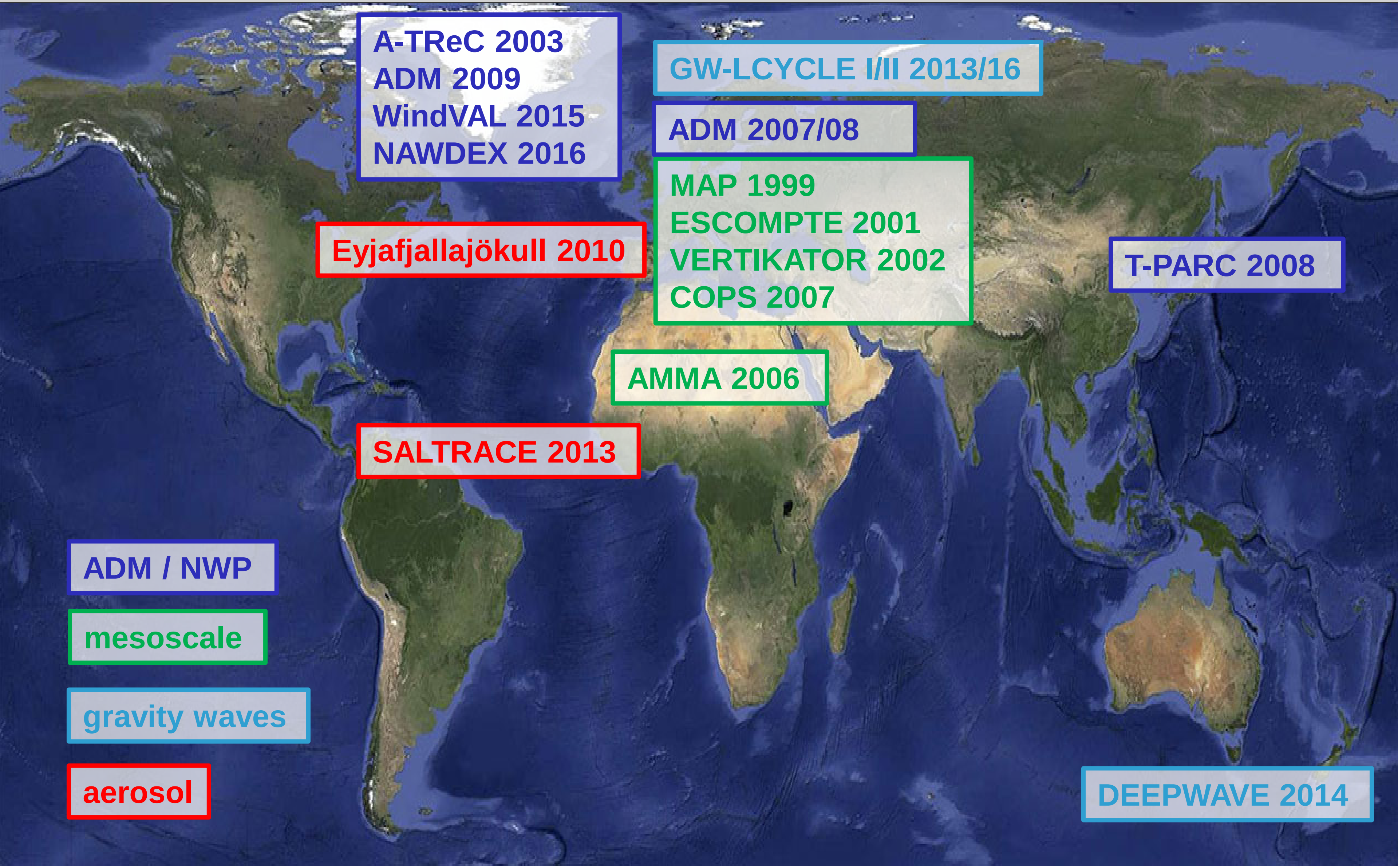


positive **negative**
impact on forecast

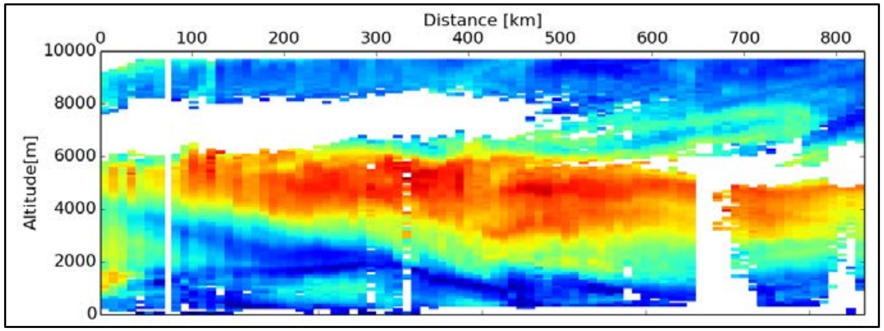
Lidar observations over North Atlantic show clear positive impact on ECMWF forecast skills for 2-4 days, despite increase of amount of total observations by only 0.005%

Weissmann et al. (2005), **JAOT**
Weissmann and Cardinali (2007), **QJRMS**

Airborne Wind Lidar Campaigns by DLR



Outline



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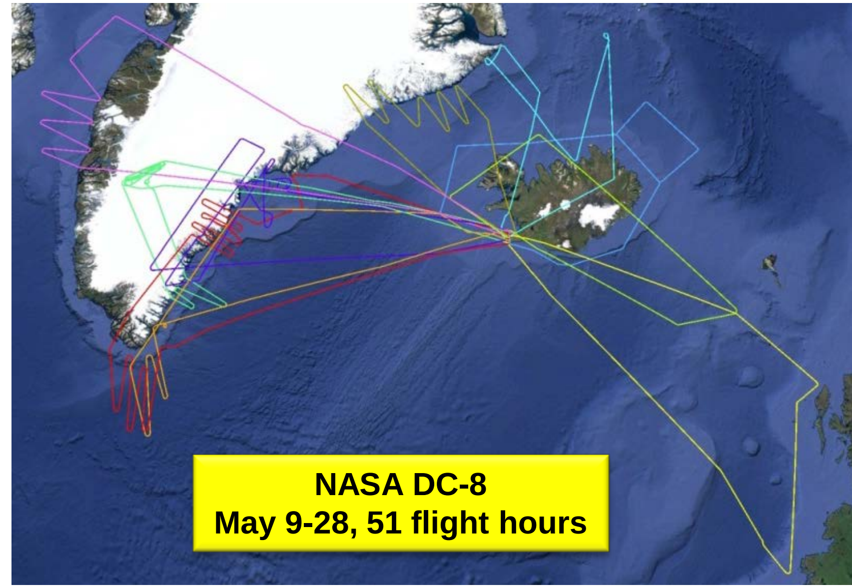
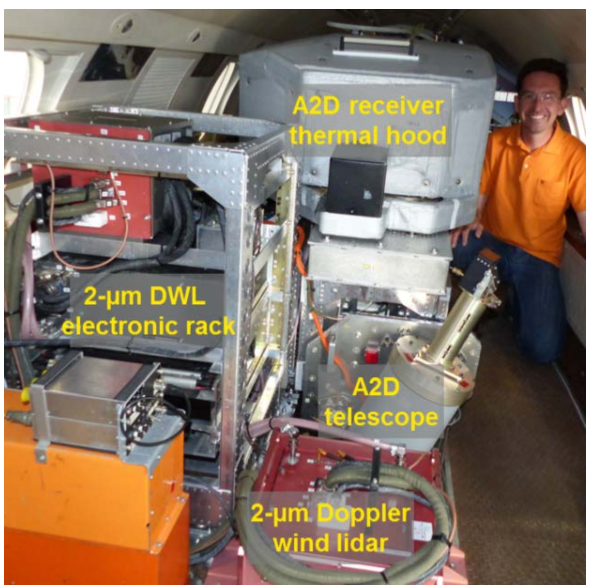
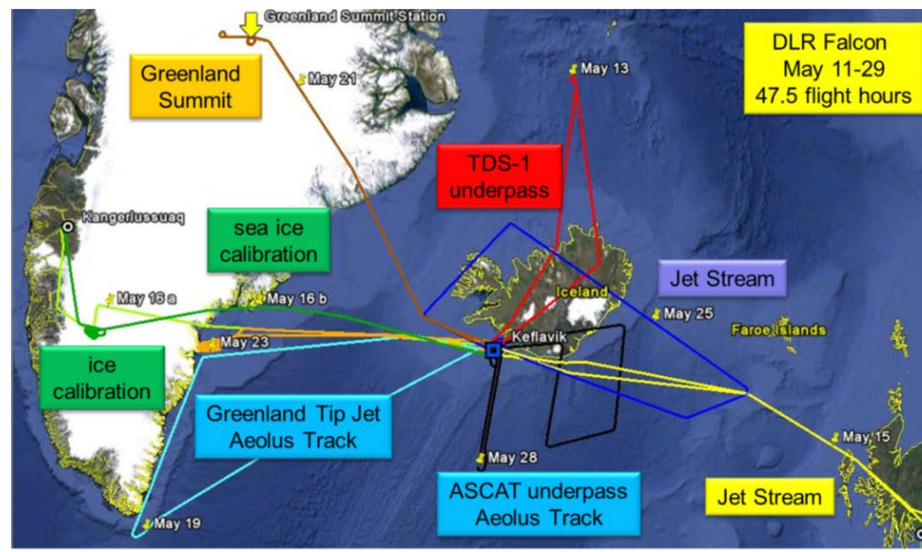
Joint ESA–NASA–DLR campaign for Aeolus in 2015

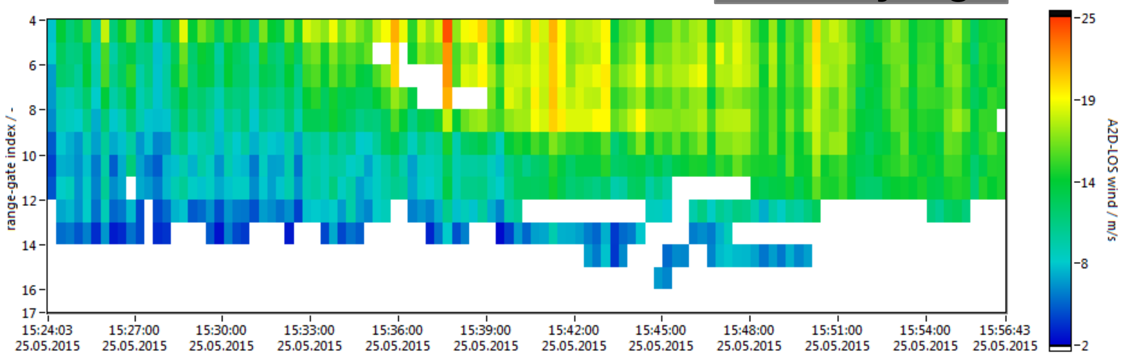




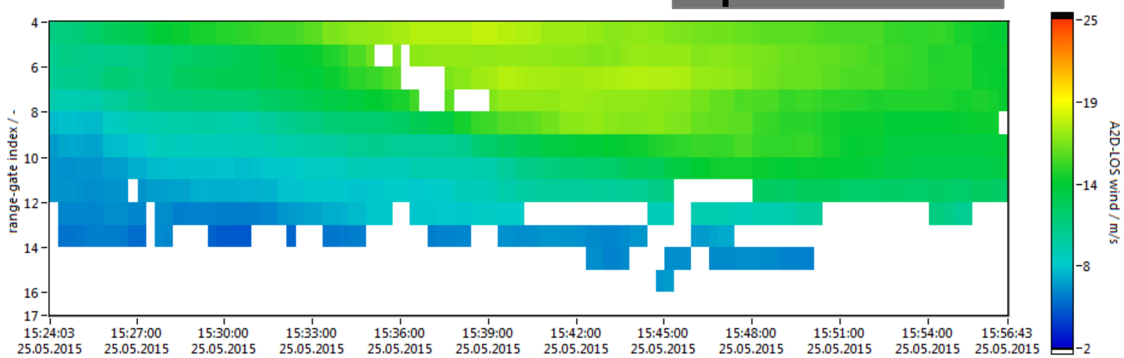


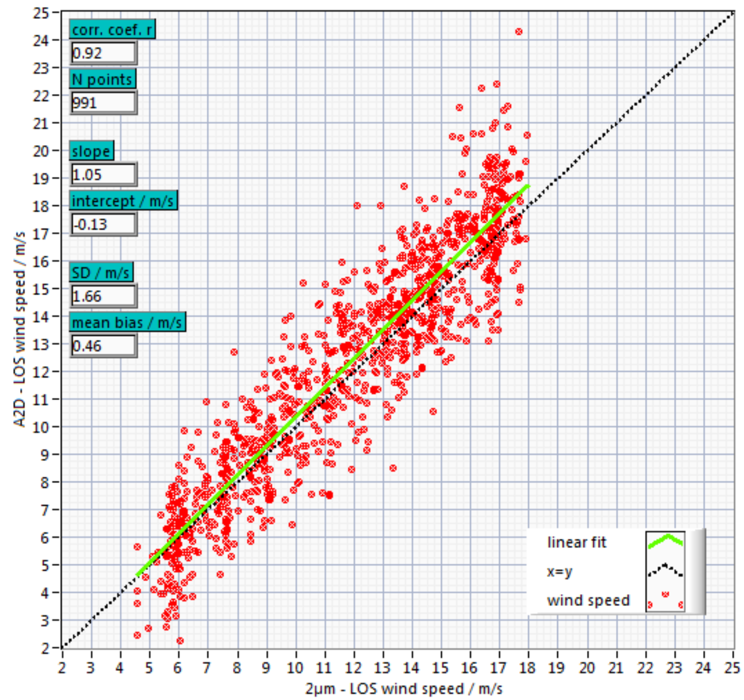
Performance of the airborne demonstrator for Aeolus

A2D Rayleigh



2-µm wind lidar

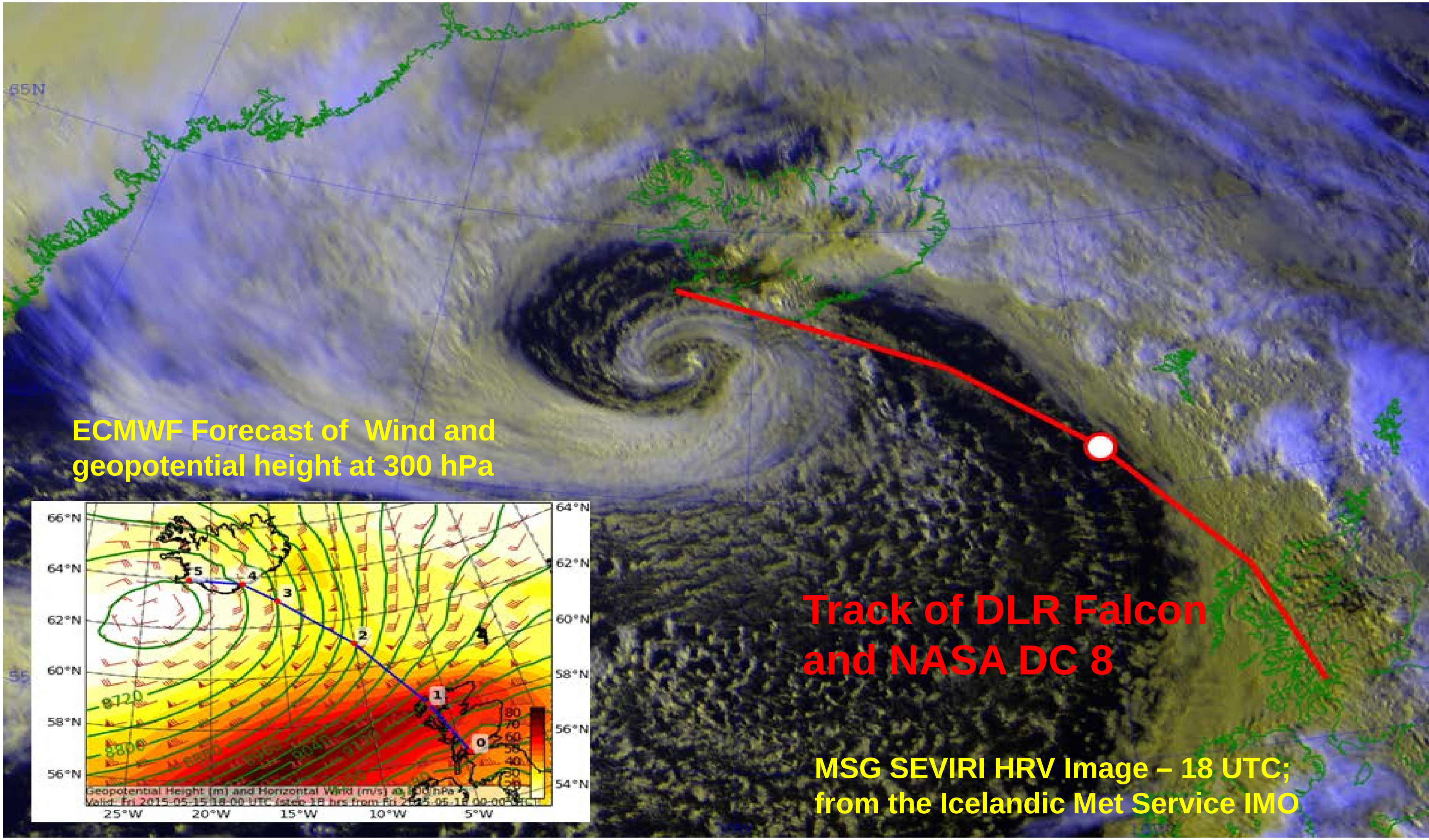




More than 100 recommendations for Aeolus space mission derived from pre-launch campaigns with airborne demonstrator

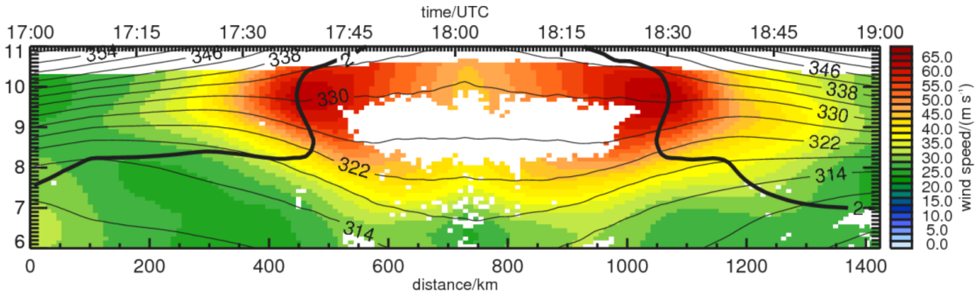
good comparison with corr. coeff. r=0.92,
1.7 m/s std. and 0.5 m/s systematic difference
for flight on May 25, 2015

Textbook example of “Iceland” Low on 15 May 2015

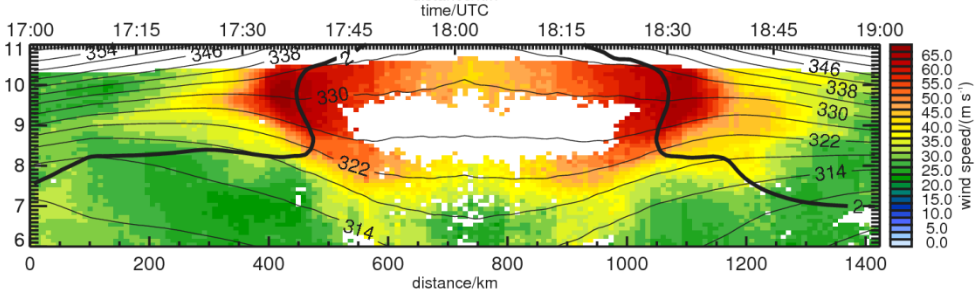


Comparison Winds from ECMWF and Wind Lidar

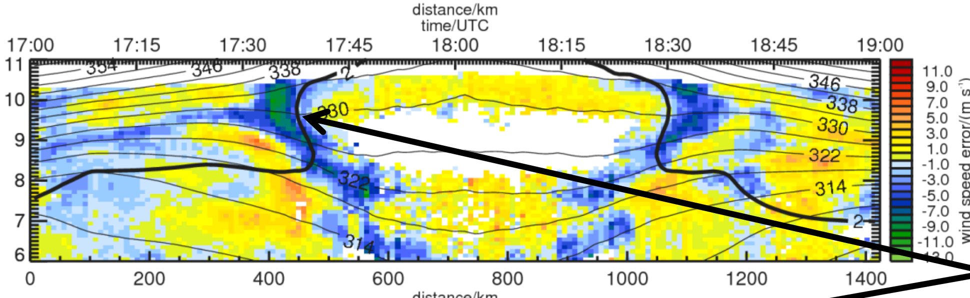
WSP_{ECMWF}



WSP_{Lidar}



$WSP_{ECMWF} - WSP_{Lidar}$



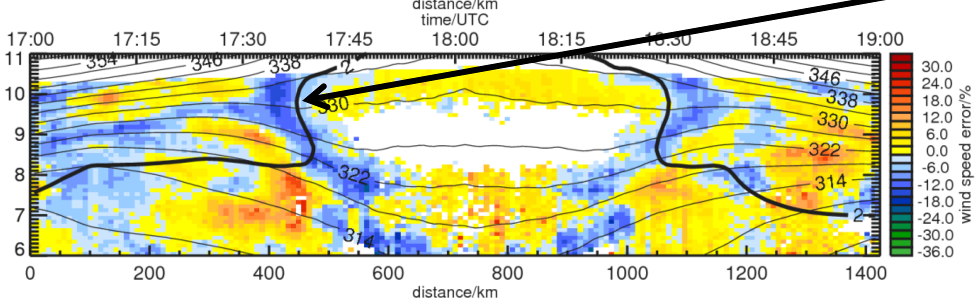
$MAX(WSP_{ECMWF} - WSP_{Lidar})$

= - 9.2 m s⁻¹

$MAX\left(\frac{WSP_{ECMWF} - WSP_{Lidar}}{WSP_{Lidar}}\right)$

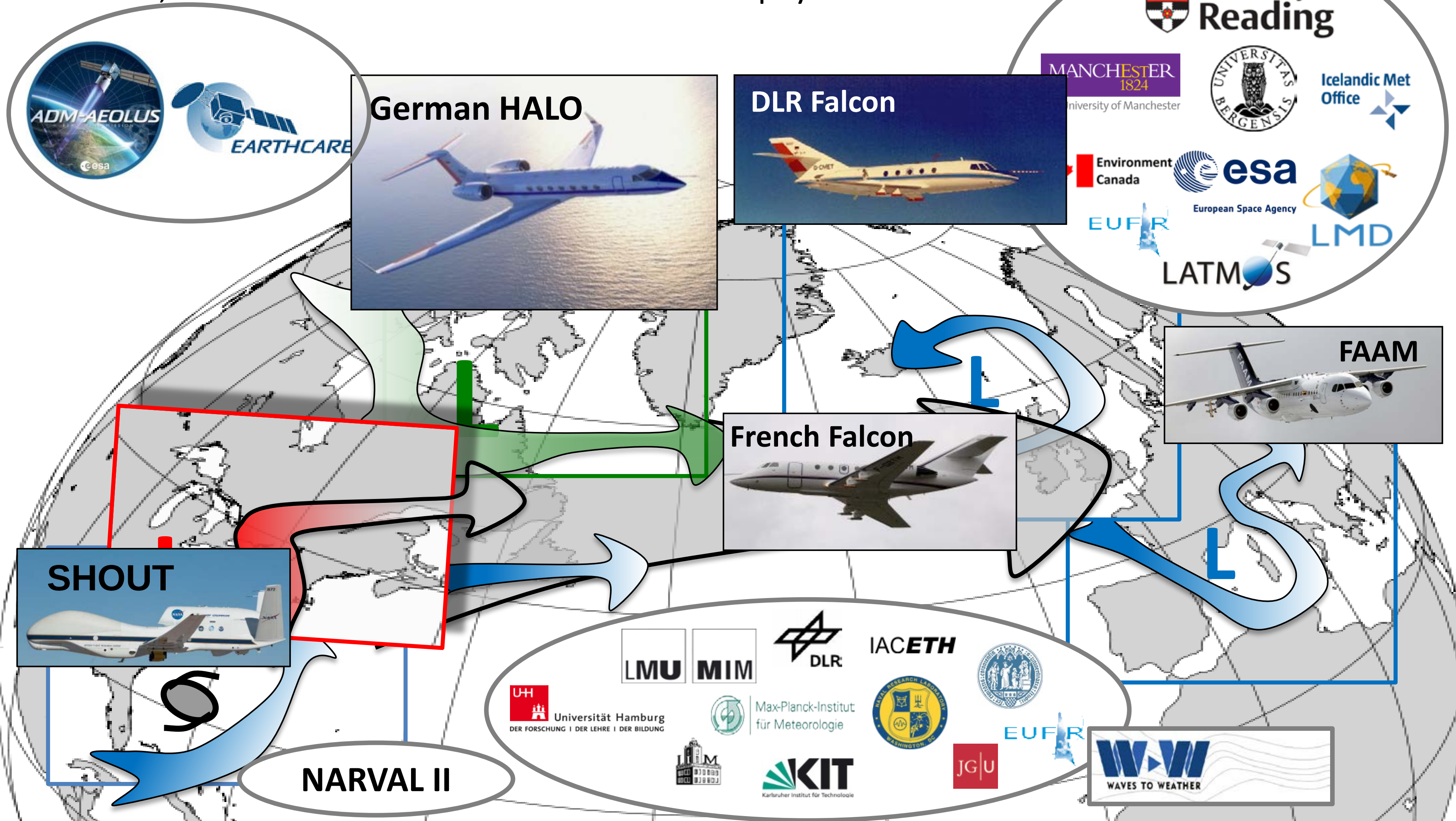
= -13.5 %

$$\frac{WSP_{ECMWF} - WSP_{Lidar}}{WSP_{Lidar}}$$

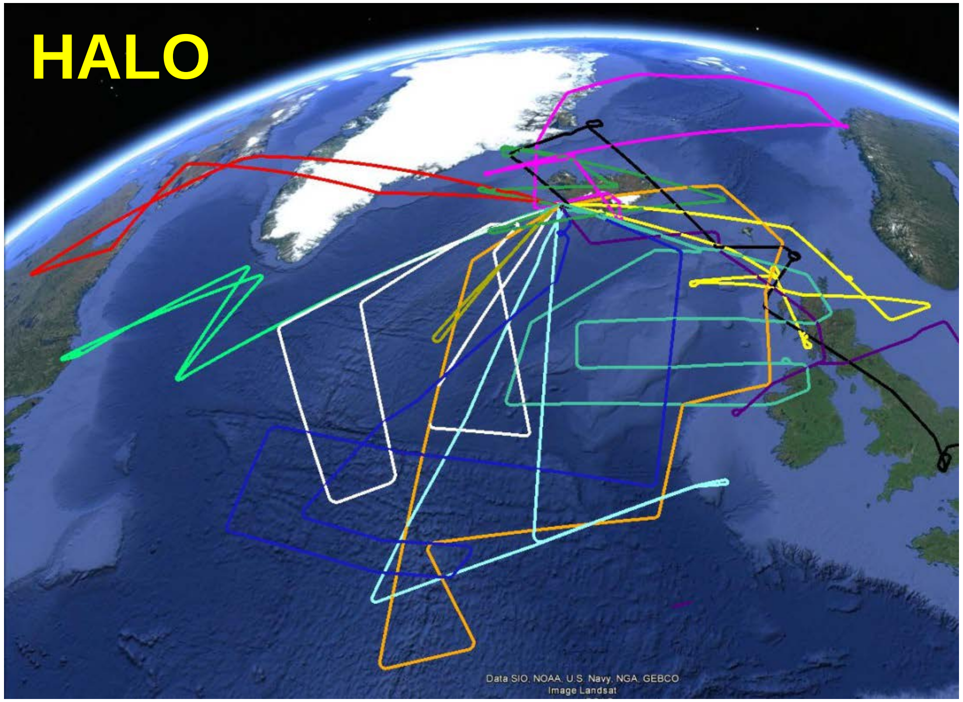


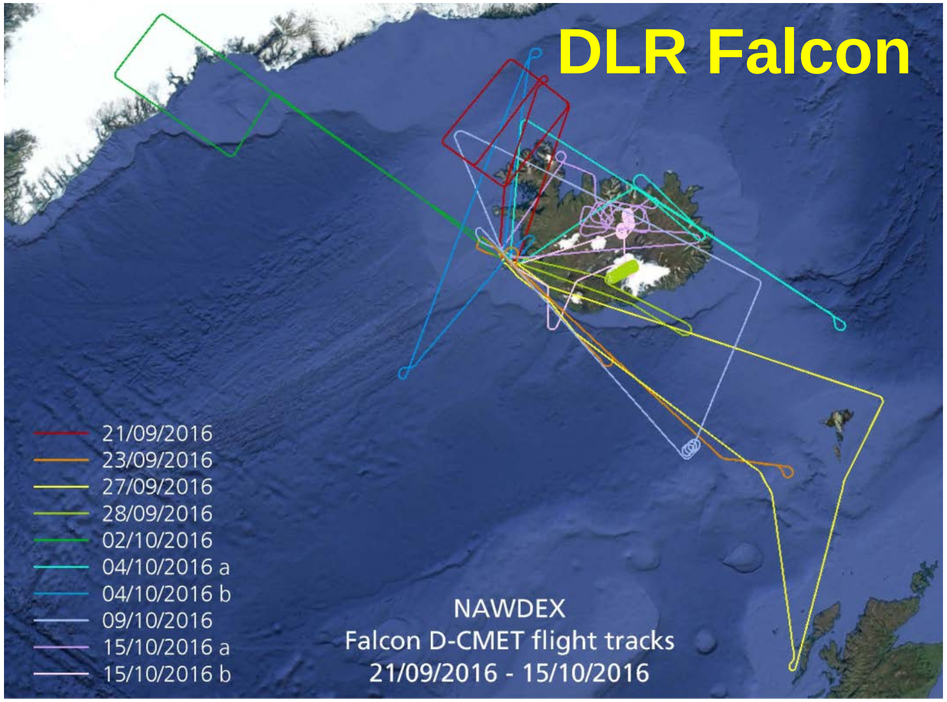
NAWDEX North Atlantic Waveguide and Downstream Impact Experiment

from 17 September – 18 October 2016 in Iceland with deployment of HALO, DLR and French Falcon with lidar-radar payload

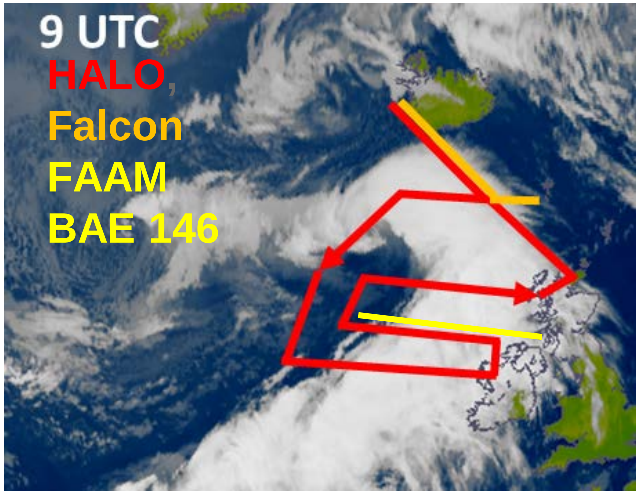


NAWDEX Team and aircrafts Sept-Oct 2016

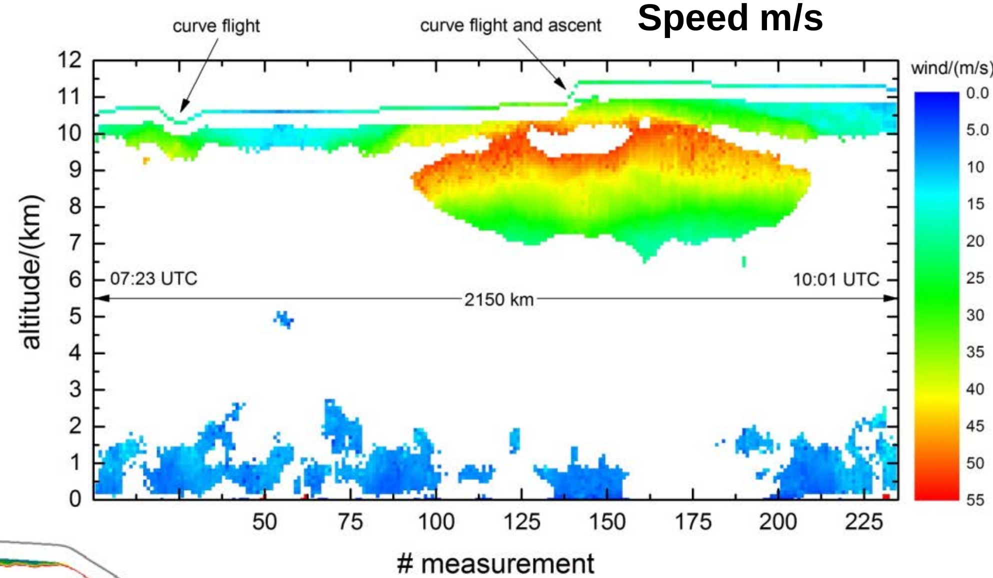


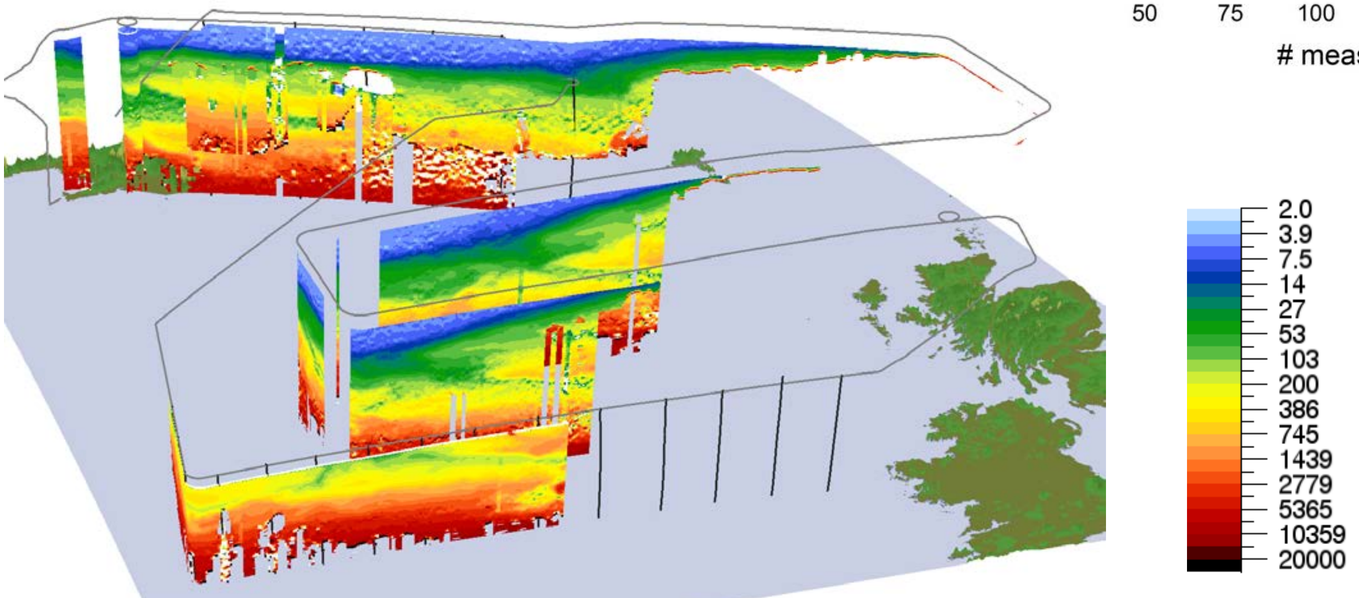


Warm Conveyor Belt WCB Flight on 23 September 2016

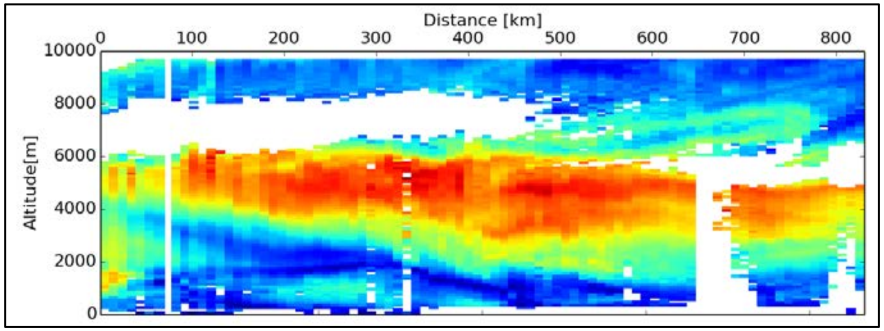


Horizontal Wind Speed m/s





Water Vapor Mixing Ratio /10^{-6}
Fig. M. Wirth (DLR)



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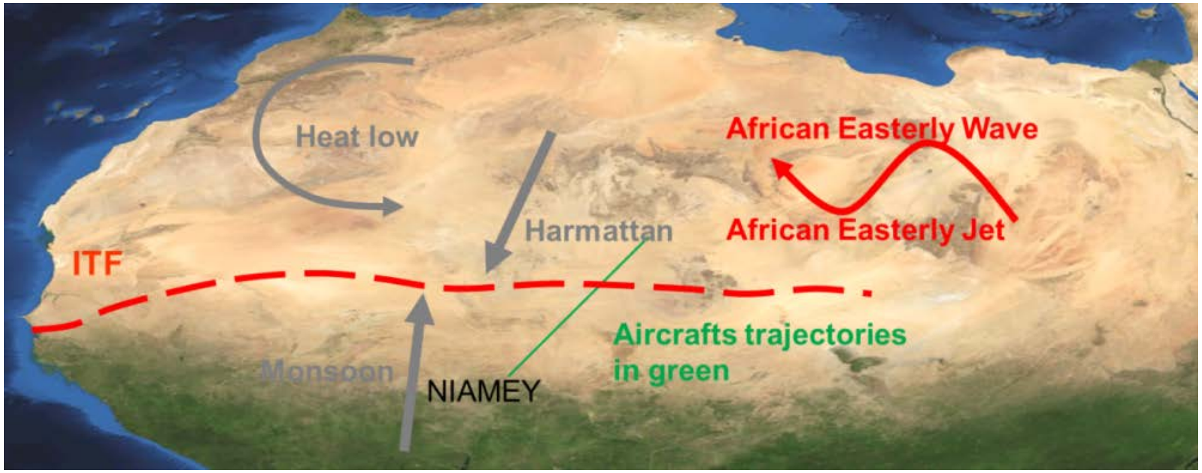
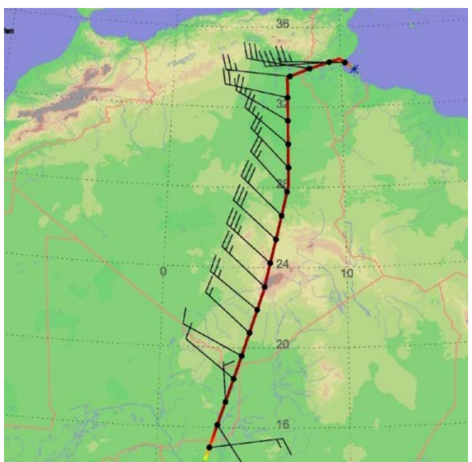
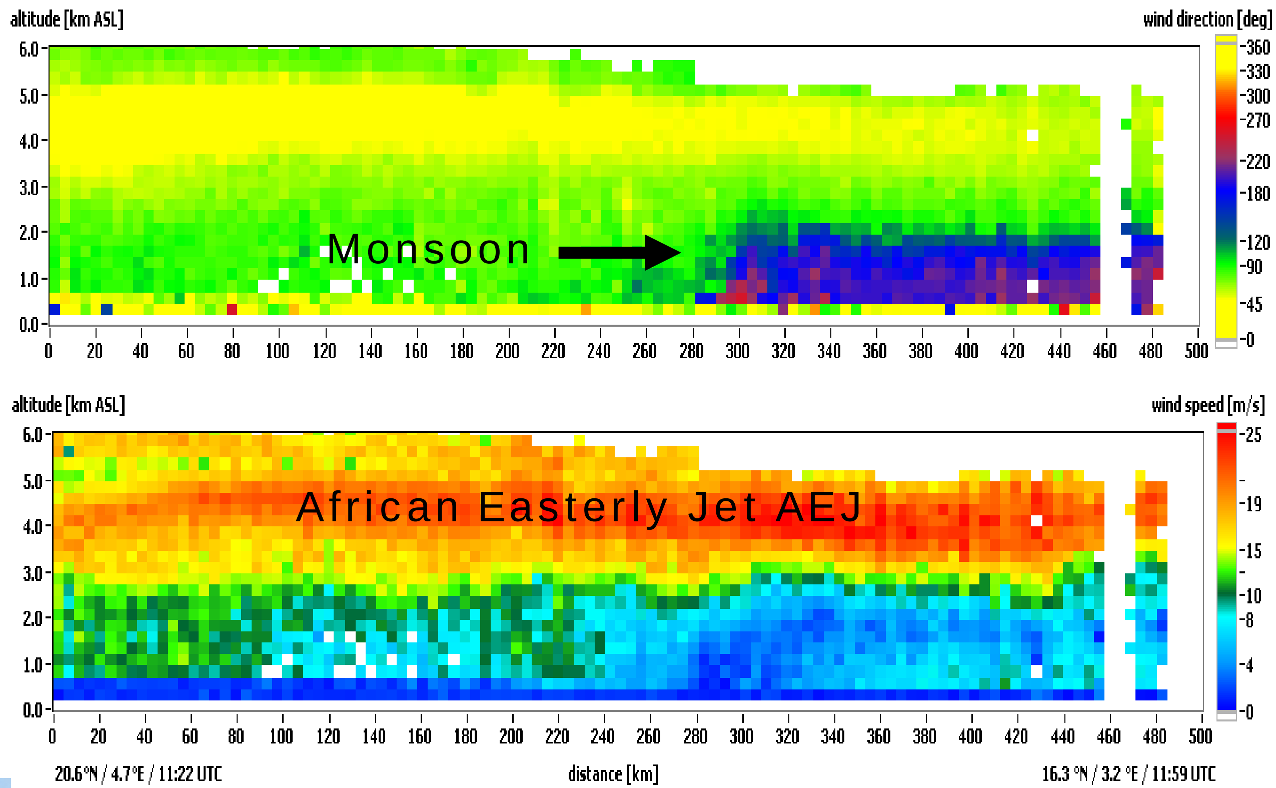
African Monsoon June/July 2006





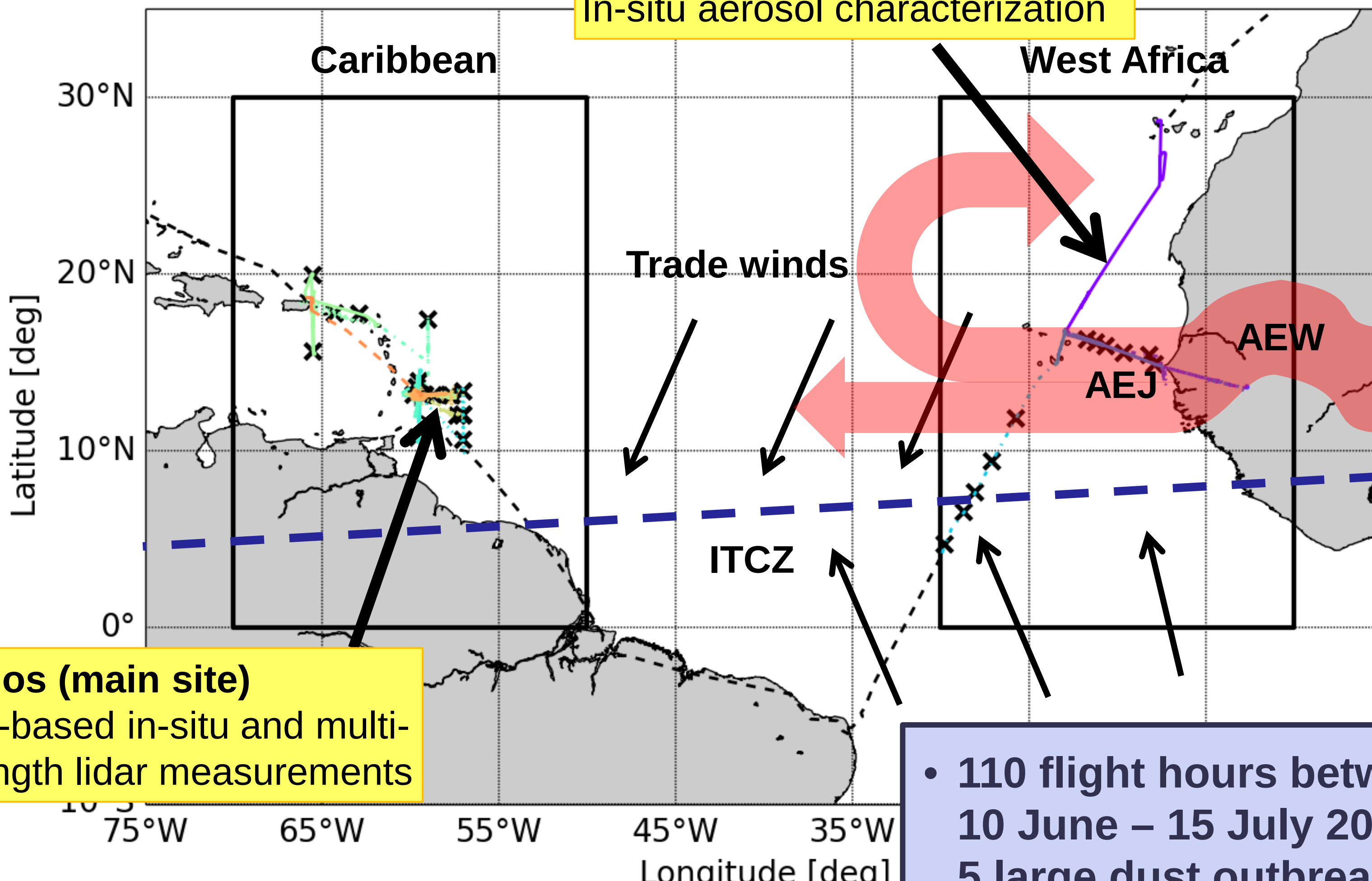
Track Djerba-Niamey on 30. June 2006



Bou Karam et al. (2008), **QJRMS**
Drobinski et al. (2009), **JGR**
Messager et al. (2010), **QJRMS**

Airborne and ground-based measurements during SALTRACE 2013
PI: B. Weinzierl

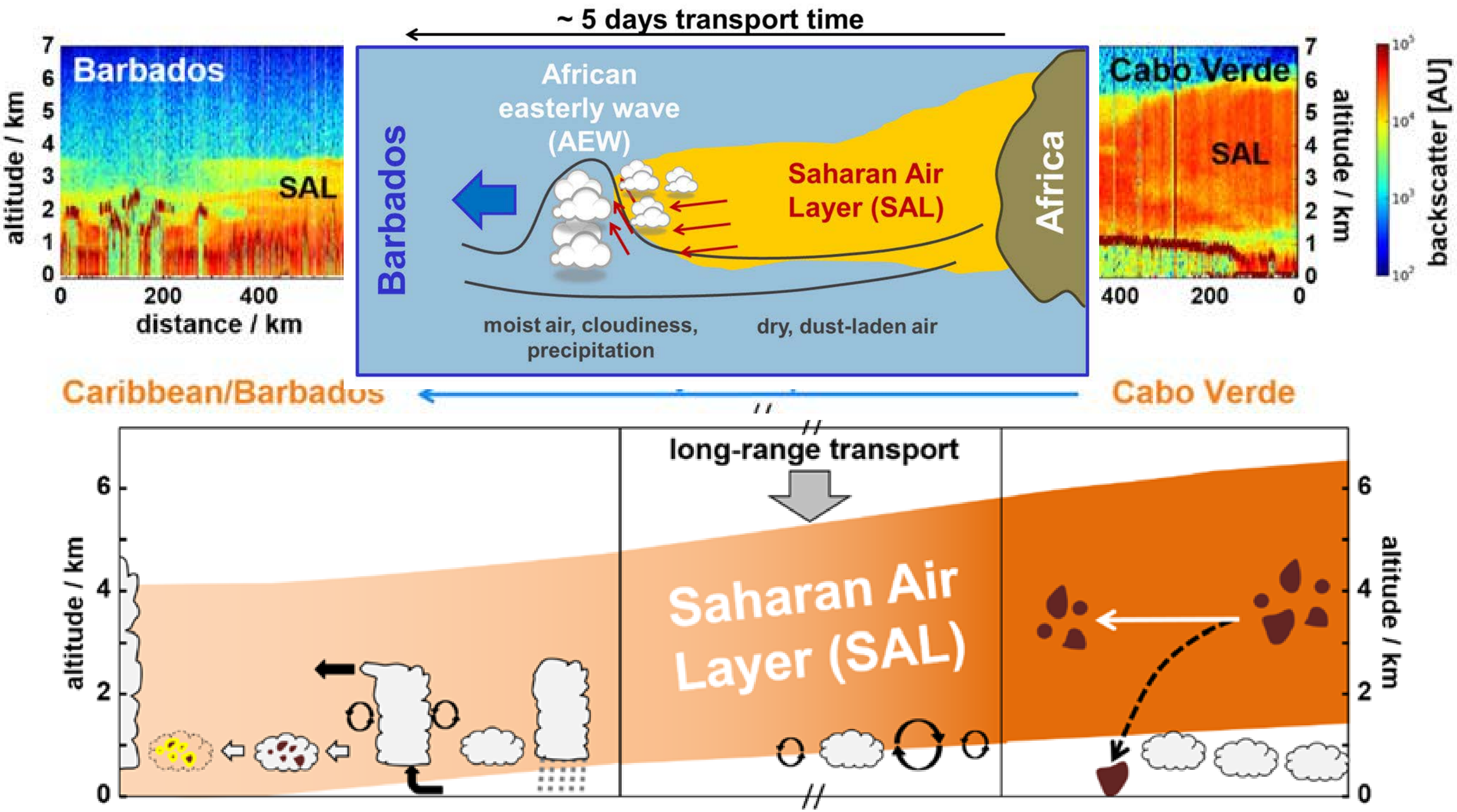
DLR Falcon 20
Doppler wind lidar @ 2µm
Dropsondes
In-situ aerosol characterization



Barbados (main site)
Ground-based in-situ and multi-wavelength lidar measurements

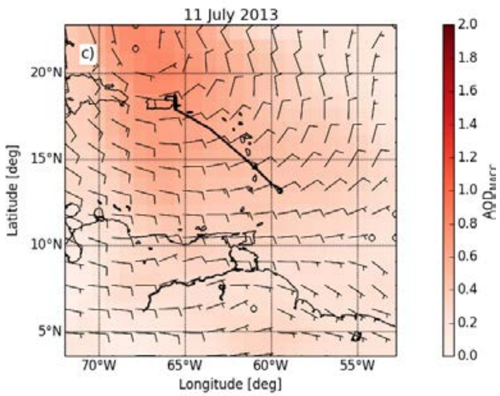
- **110 flight hours between 10 June – 15 July 2013**
  5 large dust outbreaks

How do dust properties change during long-range transport and are processed in the Carribean?

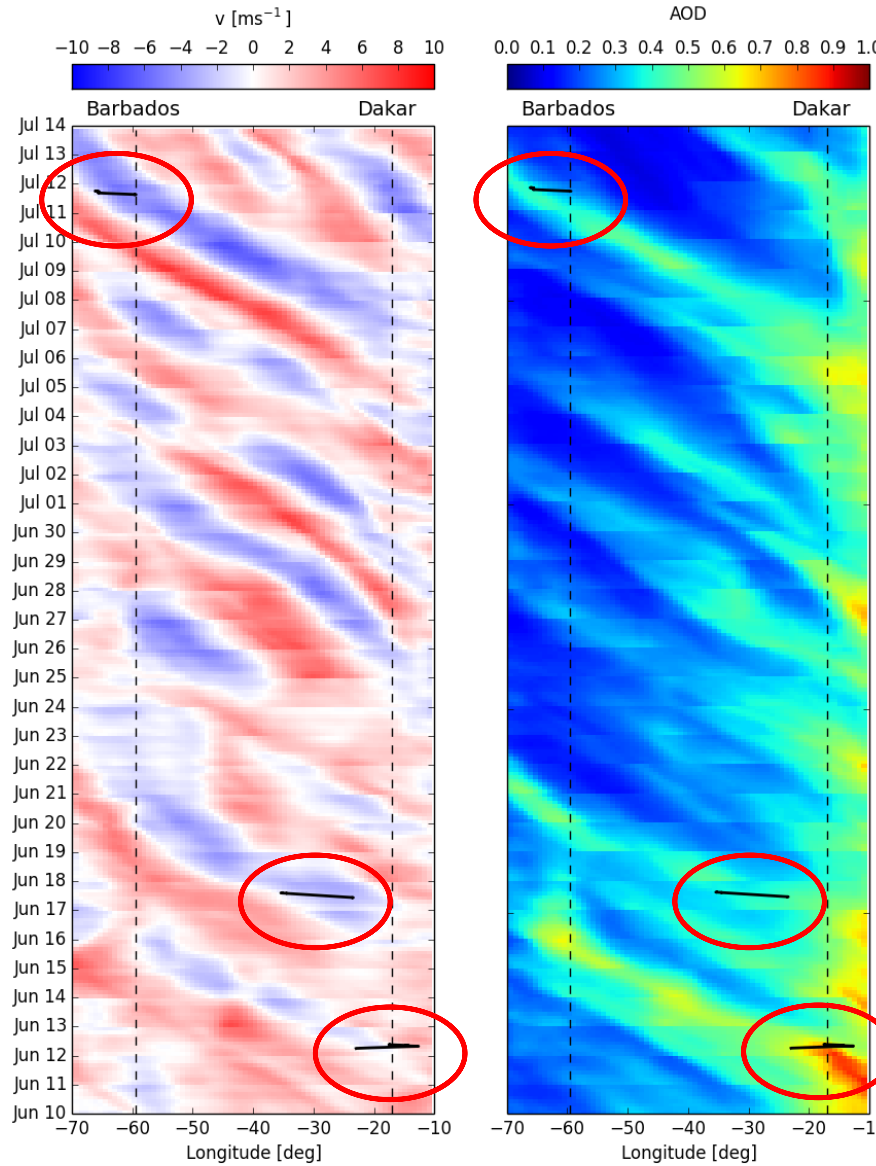


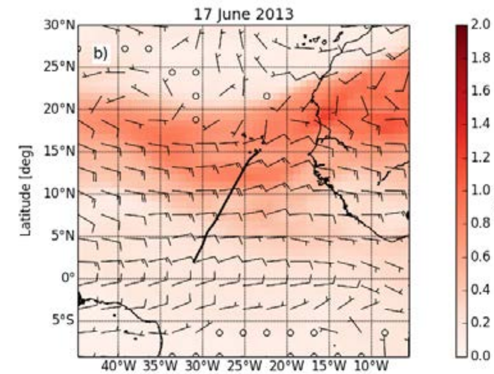
Weinzierl et al. (2016), **BAMS**, revised

Long range dust transport seen by MACC/CAMS model

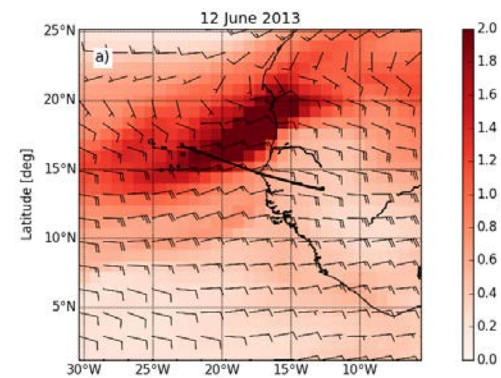


Long-range
dust transport





ITCZ, AEJ and TEJ

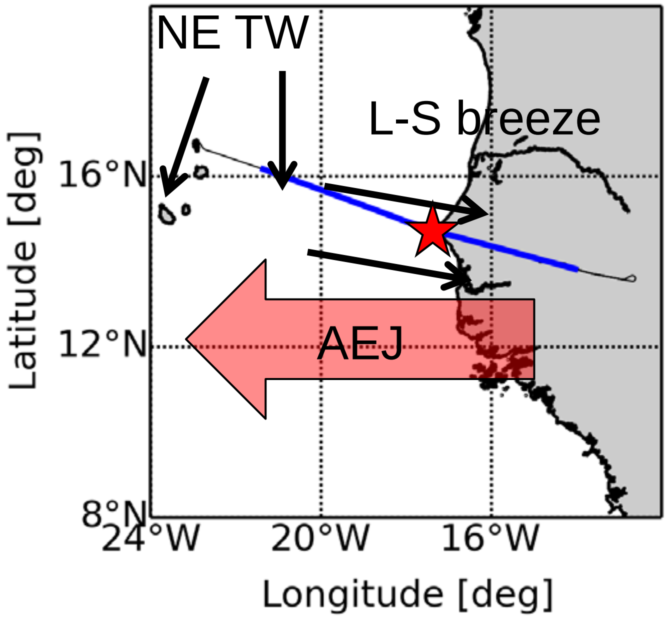


AEW and AEJ

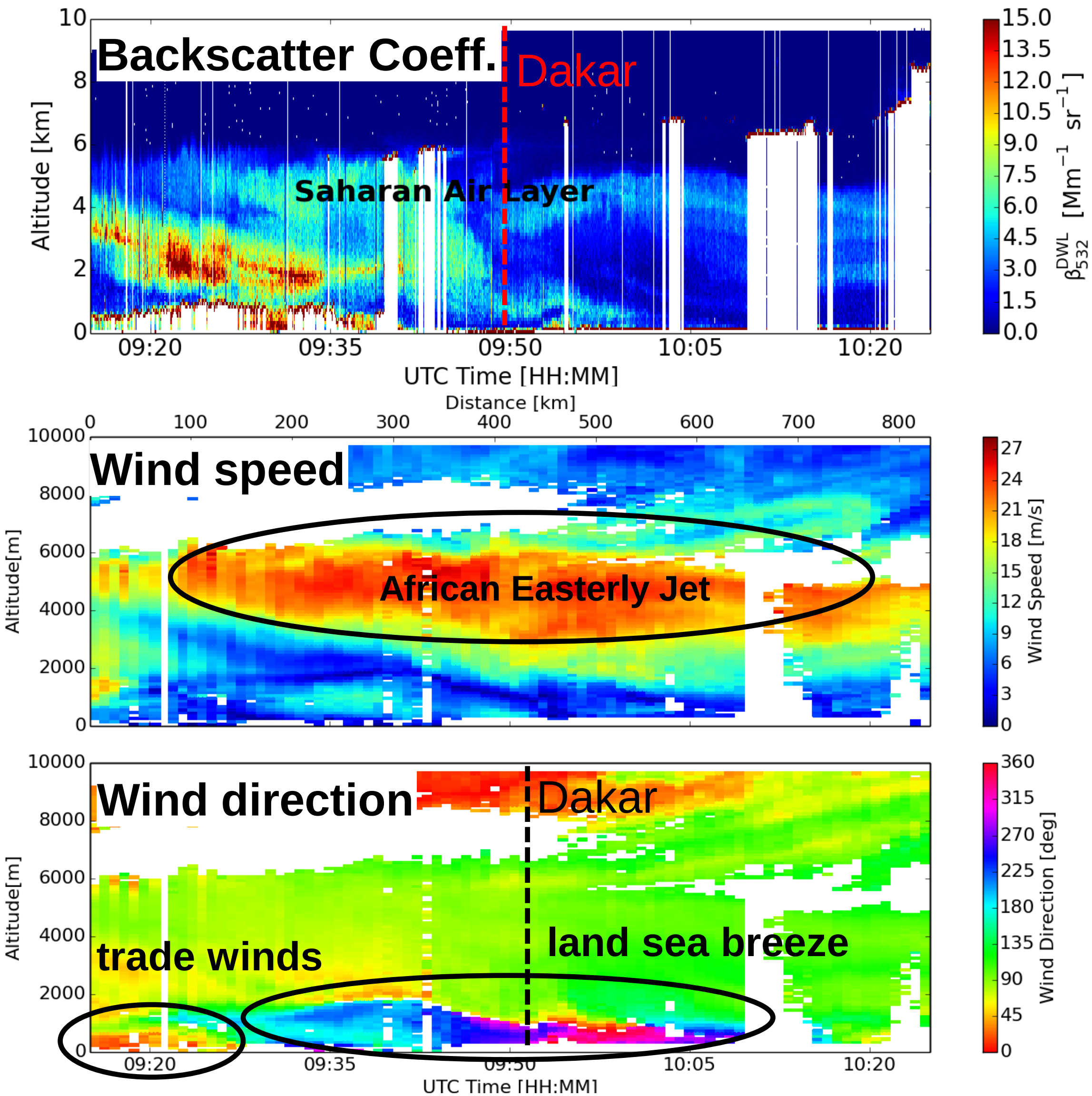
in cooperation
with A. Benedetti
(ECMWF)

Chouza, Reitebuch, Benedetti, Weinzierl (2016), **ACP**

Saharan Air Layer SAL and African Easterly Jet AEJ



Flight between Cap Verde and Dakar on June 12, 2013



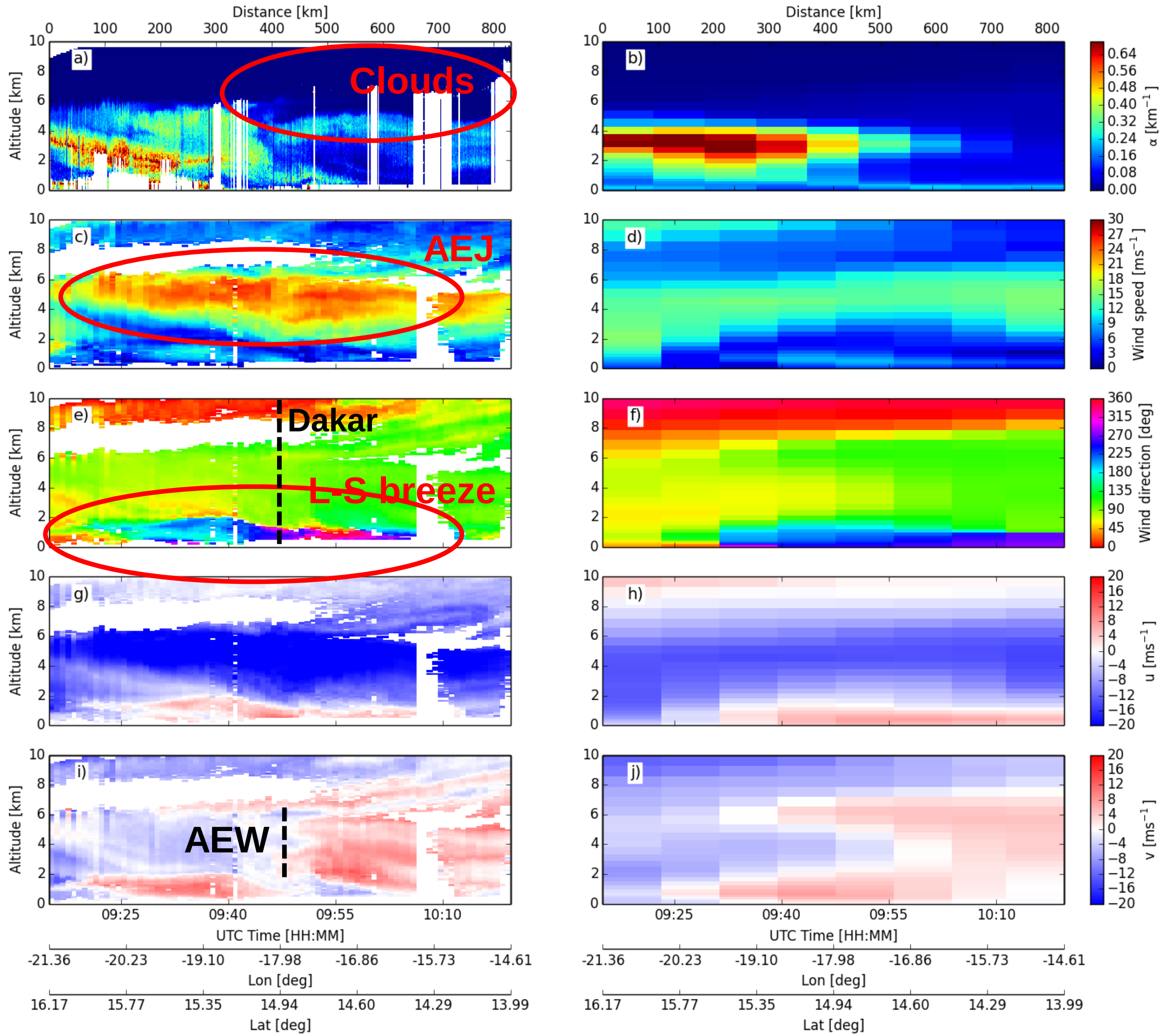
MACC model validation – The African Easterly Jet

Good qualitative dust spatial distribution agreement

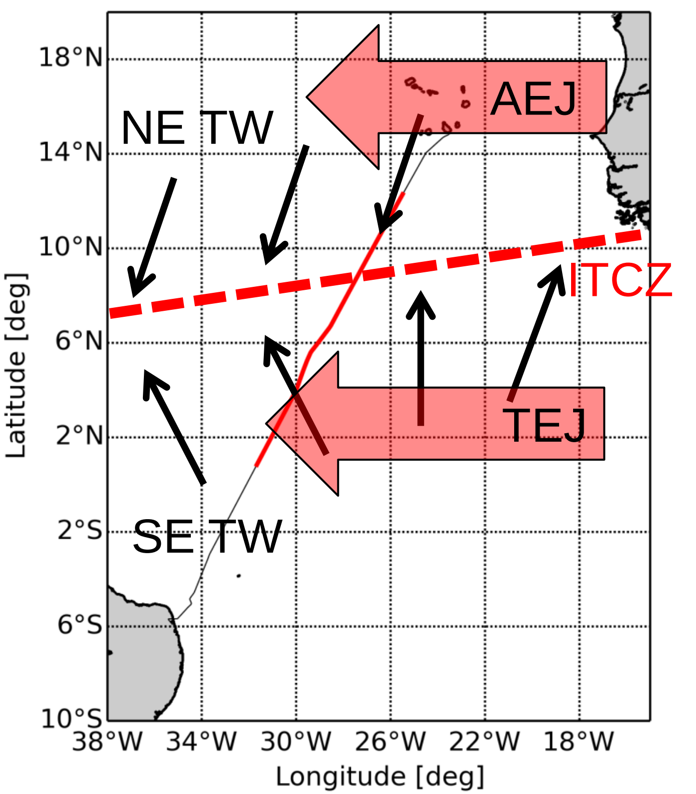
AEJ intenstiy is strongly underestimated by MACC

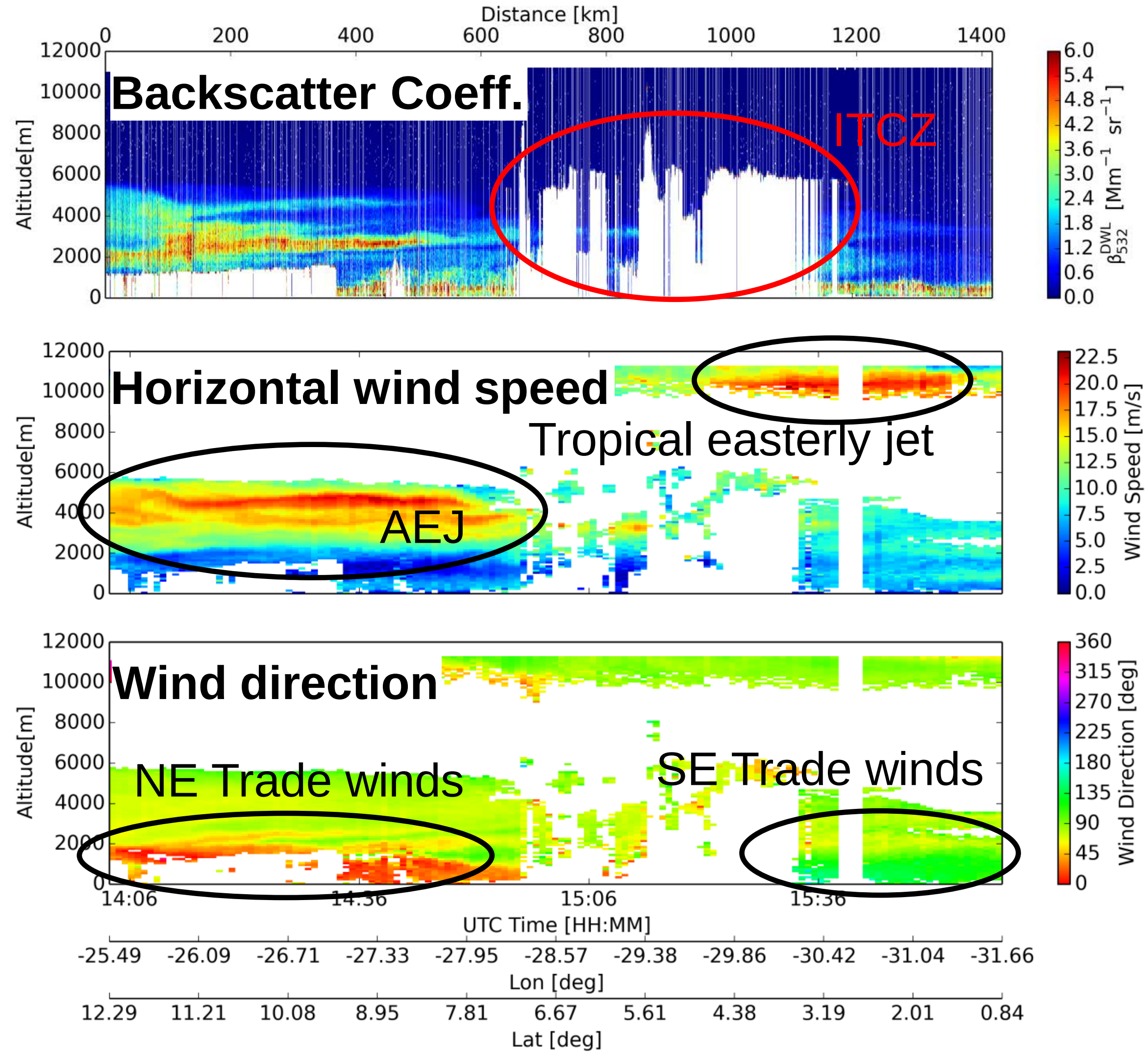
Land-sea breeze over Dakar is in good agreement

AEW trough position is well reproduced



Aerosol and wind south/north of the ITCZ





Flight between Cape Verde and Brazil on June , 2013

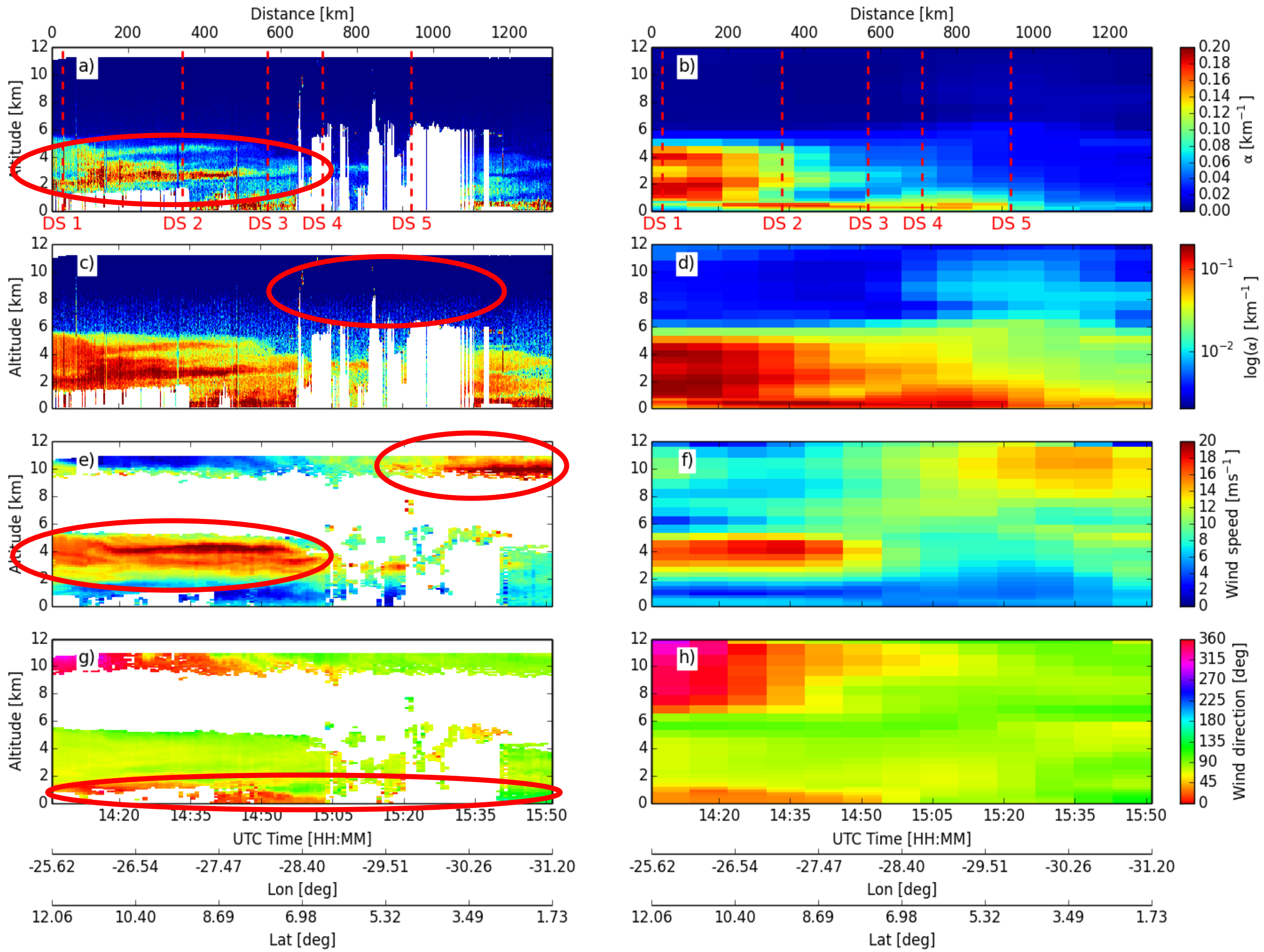
MACC model validation – The ITCZ

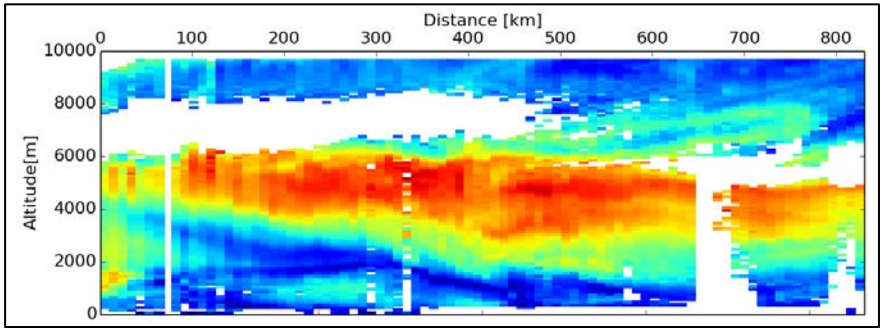
Good qualitative dust spatial distribution agreement. ABL too low.

Overestimation of the dust above the SAL

AEJ and TEJ position is well reproduced, but the speed underestimated-

Good estimation of the trade winds





Summary

- Airborne wind lidars allow observation of horizontal wind vector and vertical wind speed
- Case studies show significant underestimation of jet winds (ET, AEJ) in models by up to 10 m/s
- Validation of Aeolus with airborne demonstrator and pre-launch campaigns is well prepared
- First wind lidar and aerosol observations in Tropics used for MACC/CAMS model evaluation