WMO
Aeronautical Meteorology Scientific Conference
Toulouse – France
6th - 10th November 2017

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Aircraft measurements of Saharan mineral dust over Germany - preparation for airborne volcanic ash measurements

D. Ebert[1], V. Bachmann[1], A. Diehl[1], C. Fischer[4], H. Flentje[2], J. Förstner[1], I. Mattis[2], G. Müller[2], S. Müller[5], T. Pohl[4], D. Schell[5], A. Steiner[1], W. Thomas[2], F. Wagner[1,3], K. Weber[4] and T. Steinkopff[1]

[1]Deutscher Wetterdienst (DWD), D-63067 Offenbach; [2]DWD, Meteorologisches Observatorium, D-82383 Hohenpeißenberg; [3]Karlsruhe Institute of Technology (KIT), D-76344 Eggenstein-Leopoldshafen; [4]Hochschule Düsseldorf (HSD), D-40476 Düsseldorf; [5]enviscope GmbH, D-60489 Frankfurt/M.

The Deutscher Wetterdienst (DWD) is responsible for the detection of volcanic ash contaminations within the German airspace by national rules and the regulations of the International Civil Aviation Organization (ICAO).
For this task DWD has implemented several procedures including airborne measurements, in order to determine atmospheric ash concentrations and their spatial extension (Weber et al., 2012; Weinzierl & Diehl, 2014).
The aircraft measurements are used for verification of the volcanic ash model forecasts as well as for comparison with data from the DWD ceilometer network.
Final goal of these collaborative efforts is an improved and distinguished designation of the flight restriction zones in case of an intense volcanic ash plume over Germany (Schumann et al., 2011).

Operational procedure

To guarantee the operational readiness of airborne measuring systems, DWD performs flights on a regular basis. During these measurement flights technical and organizational steps are practiced and optimized under realistic conditions.
Airborne volcanic ash concentrations are determined by aerosol spectrometer (1.129 Sky-OPC, GRIMM Aerosol Technik) which measure the particle size distribution.
For data evaluation it is crucial to consider that the scattering properties of volcanic ash particles strongly differ from a typical European background aerosol. Because of the lack of intense volcanic ash plumes over Central Europe Saharan dust events were chosen as a realistic test scenario. Saharan dust and volcanic ash are both dominated by larger and irregular shaped particles having comparable optical properties.
DWD uses the ICON-ART model (Rieger et al., 2015) to predict the occurrence of Saharan Dust over Germany with a lead time of 4 days (Fig.1). Pilots, aeronautical weather forecaster and scientist analyse the current dust event at briefings on a daily basis. Route, time and pattern of the flight will be specified by this expert team. On the day of the measuring flight ceilometer measurements of the DWD Ceilometer network help to identify the mineral dust layers and provide details of their altitude, thickness and structure.
All of these operational steps of planning and performing measurement flights are basically similar in case of a mineral dust event and at a volcanic ash case.

References:

Rieger, D. et al:, ICON-ART 1.0 – a new online-coupled model system from the global to regional scale, Geosci. Model Dev., 8, 1659-1676, 2015.

Schumann U., Weinzierl B. et al., Airborne observations of the Eyjafjalla volcano ash cloud over Europe during air space closure in April and May 2010, Atmos. Chem. Phys., 11, 2245-2279, 2011.

Weber, K., et al., Airborne in-situ investigations of the Eyjafjallajökull volcanic ash plume on Iceland and over north-western Germany with light aircrafts and optical particle counters. *Atmospheric Environment* 48, 9–21, 2012.

Weinzierl B. and Diehl A., Warnung vor Vulkanasche: Was haben wir aus den isländischen Vulkanausbrüchen 2010 und 2011 gelernt, promet, 39, 91- 103, 2014.

Saharan dust event: 2017, Aug., 29th-31st

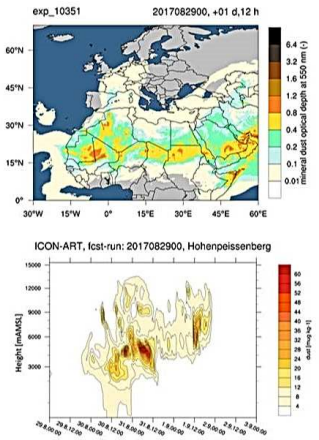

Figure 1: (upper) ICON-ART forecasts of dust aerosol optical depth (AOD) and (lower) profiles of Saharan dust mass concentrations provide basic parameters to perform measurement flights.

Conclusions

Our training flights have shown that Saharan Dust events are well suited to act as test scenario for the evaluation of airborne volcanic ash measurements over Germany.
The established operational procedure guarantees that DWD may rely on high-quality aircraft based aerosol particle measurements, even under challenging conditions.

Saharan dust measurements

During a Saharan dust event on December 17th 2015 (Fig.2) a flight over North-western Germany was conducted with two measuring aircrafts. This campaign was successfully performed even under challenging winterly conditions.
The focus of this training flight was the field intercomparison of two different airborne volcanic ash measuring systems. The Hochschule Düsseldorf operated a Diamond Twin Star DA42 D-GOMH and the company enviscope performed measurements onboard a Partenavia P68B D-GERY (Fig.3). In the area between the German-Dutch border and Mönchengladbach/Germany both aircraft successfully performed side-by-side flights within the Saharan dust layer at altitudes between 500m and 3000m (Fig.4).

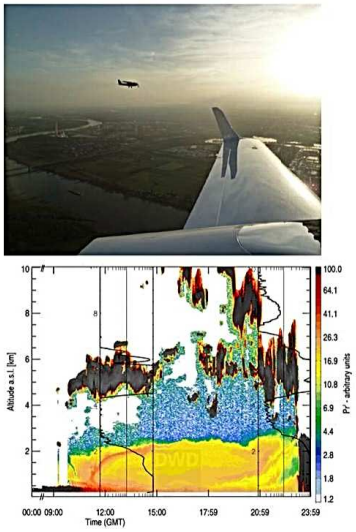

Figure 3: (upper) The two aircraft within the Saharan dust layer. (lower) Ceilometer measurements at Lingen show Saharan dust up to 2.5 km (yellow/red areas), black areas correspond to clouds.

Flight in Saharan dust: 2015, Dec., 17th

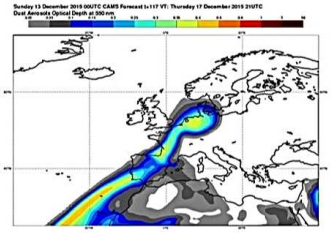

Figure 2: 4-days CAMS forecast of dust aerosol optical depth at 550nm on 17th of Dec. 2015. Values > 0.1 (dark blue) are attractive to perform comparing measurement flights of dust aerosol particles.

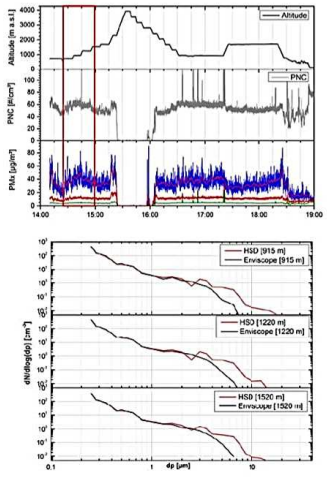

Figure 4: (upper) Flight pattern and time resolved PNC, PM10, PM2.5 and PM1 values measured by DA42 D-GOMH and (lower) size distribution of Saharan dust over northwestern Germany at three altitudes (915m, 1220m, 1520m) determined by DA42 D-GOMH (red) an Partenavia D-GERY (black) on 17th of Dec., 2015.

Contact: Dörthe Ebert - DWD - Observing networks and data - doerthe.ebert@dwd.de