



GAW Letter of DWD

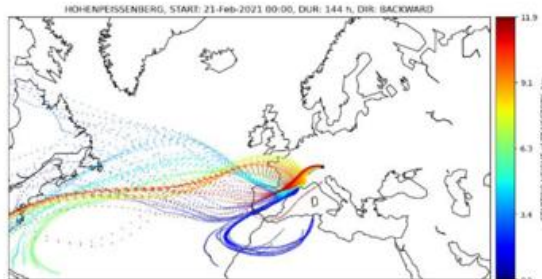
No. 77, March 2021

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Saharan dust climatology from ceilometer measurements

In February 2021, there were again several days with very high Saharan dust concentrations over Germany (transport paths of the low-level air masses from the Sahara in



blue, Figure 1). Saharan dust, or mineral dust, over Germany is a recurring event. Dust has an influence on weather and climate, as well as on electricity generation from photovoltaic systems. Mineral dust is an essential climate variable because it affects scattering and absorption of sunlight and cloud formation in the atmosphere.

Figure 1 Trajectories (paths) of the air particles for 21.02.21

At the Hohenpeißenberg Observatory, frequency and distribution of Sahara dust events are classified and documented in a "climatology". To do this, Saharan dust must be identified from the measurement data of suitable observation instruments using clear criteria. The main tools are the Lufft CHM15k ceilometers operated by the DWD since 2008. In simple terms, these are laser scanners of the vertical structure of the atmosphere (GAW Letters No. 49, 53, 61, 62), of which the DWD operates more than 150 and can thus describe layers spatially well. In addition, there is information from an aerosol LIDAR, solar photometers, and backward trajectories from model calculations.

Dust layers over Germany are first spatially identified in a special visualisation of the Ceilometer data in "quicklooks". Next, backward trajectories are used to check from where the air mass came originates. Specifically, whether really it comes from known source regions for dust events, such as the Sahara. The third step is to check whether the aerosol properties of the layers in question are indicative of dust and not, for example, forest fire or anthropogenic aerosol. For this purpose, LIDAR and AERONET data are used. AERONET is a global network of solar photometers that measure the aerosol optical thickness (AOD) of aerosol particles at different wavelengths. Large particles, such as Saharan dust, show a smaller wavelength dependence of the AOD, while smaller particles, such as continental background aerosol, show a larger wavelength dependence of the AOD. Sun photometers are therefore size-selective. LIDAR instruments, on the other hand, measure vertical profiles of the depolarisation ratio, i.e. the ratio of light in two different oscillation planes. The depolarisation ratio (cf. Groß et al. 2015) allows non-spherical particles in

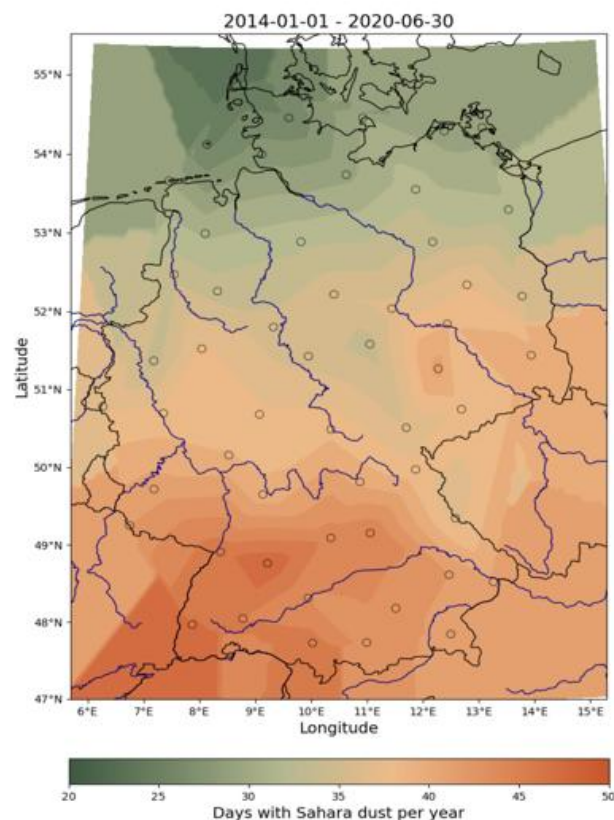


Figure 2 Average number of days with Saharan dust per year over Germany Jan 2014- Jun 2020 (interpolated)

aerosol layers to be distinguished from spherical particles. This can be used to distinguish dust from typically round background aerosol, so it is shape-selective. Thus, Saharan dust is identified with high reliability based on the origin of the air mass, the size and shape of the particles.

Once a dust cloud has been classified as Saharan dust, the time period and strength of the event are recorded. For this purpose, four classes of low to massive Saharan dust events are formed. Criteria are the intensity of the backscatter signal, the geometric layer thickness, the duration of the event and the temporal and spatial course. The frequency of Saharan dust events (Figure 2) is significantly higher in the south with 40-50 events/year than in the north with 20-30 events/year. Weak events occur significantly more often than strong ones (Figure 3). The number of days with Saharan dust varies from year to year and ranged from 22 days (2019) to 57 days (2017) for the period 2014-2020.

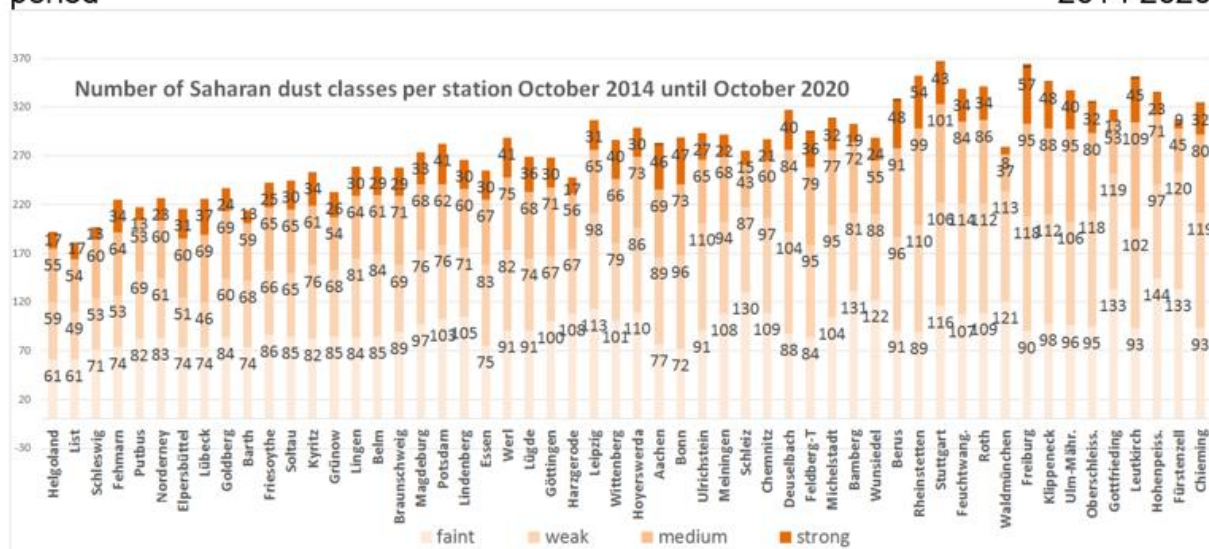


Figure 3 Number of calendar classes that occurred between 2014-10 / 2020 for each documented station (sorted by WMO number)

The seasonal distribution shows that most Saharan dust events occur in spring and early summer (Figure 4).

The Saharan dust calendar is formed from remote sensing data. Additionally, we have ground-based in-situ measurements of dust at Hohenpeißenberg. These data indicate Saharan dust on 10-60 days/year, with a long-term mean contribution of $0.5 \pm 0.1 \mu\text{g}/\text{m}^3$ or 6% to the particulate matter (PM10) (Flentje et al., 2015), individual events can reach over $100 \mu\text{g}/\text{m}^3$. The data of the Saharan dust calendar are available for comparisons, especially with satellite data and model calculations. The DWD is working on improving the modelling of dust transport and the influence of dust particles on energy generation (photovoltaics) and on weather patterns.

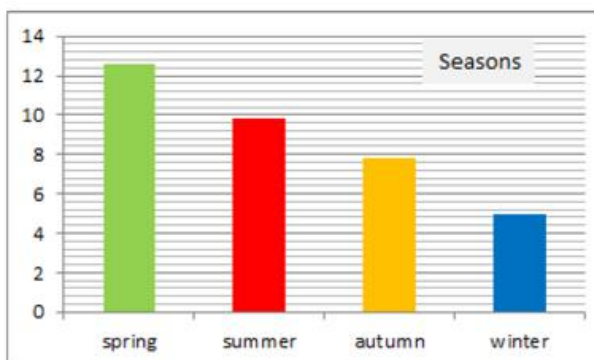


Figure 4 Distribution of the total number of events over the seasons for all 45 stations

References:

GAW-Letters of DWD (49, 53, 61, 62,73)
 Groß et al., Atmos. Chem. Phys. 15, 11067–11080, 2015
 H. Flentje, et al. <https://doi.org/10.1016/j.atmosenv.2015.02.023>.

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