Hans-Ertel-Zentrum
für Wetterforschung

On the role of complex terrain for aerosol burden

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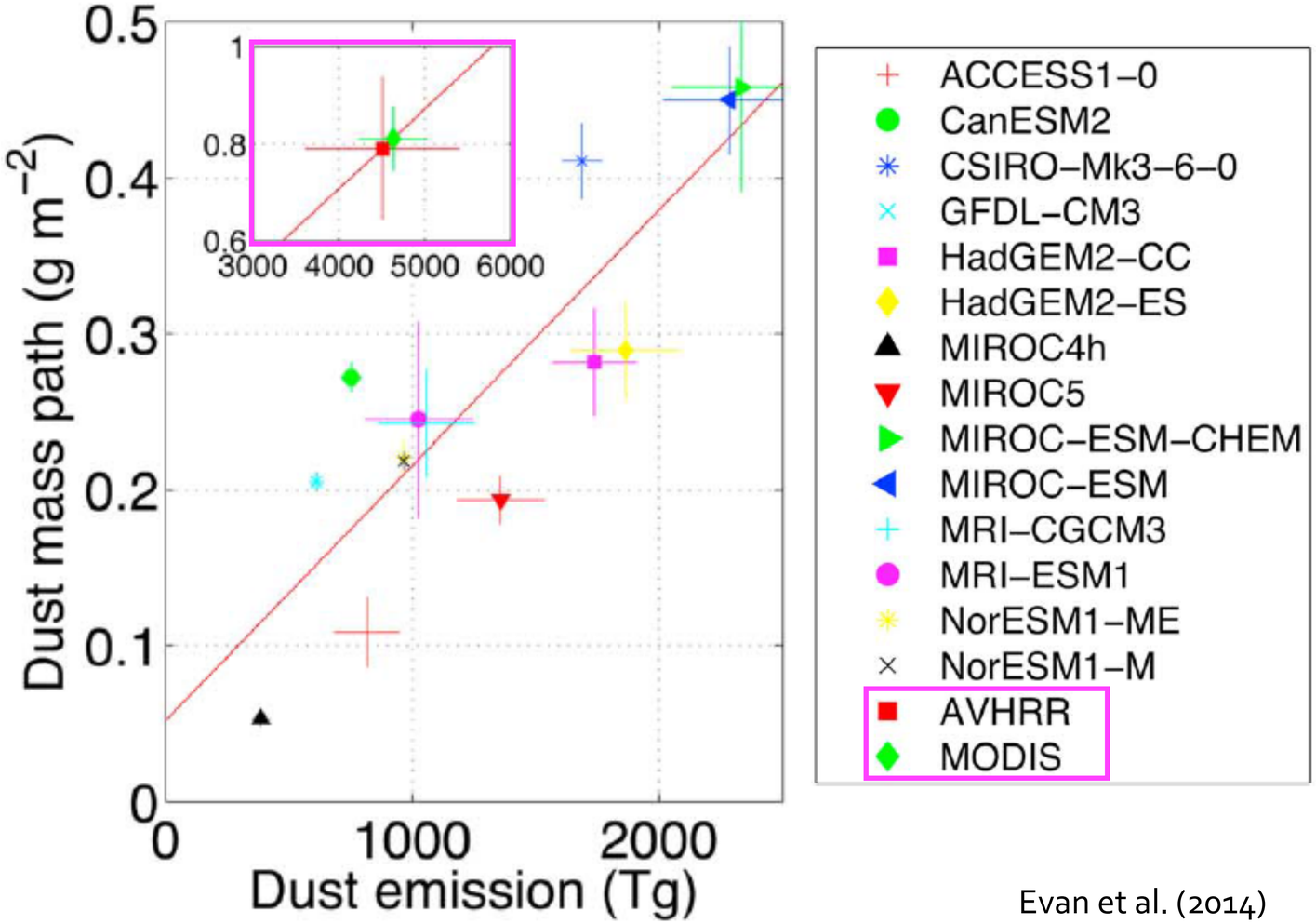
Online EGU splinter meeting of TEAMx
6 May 2020

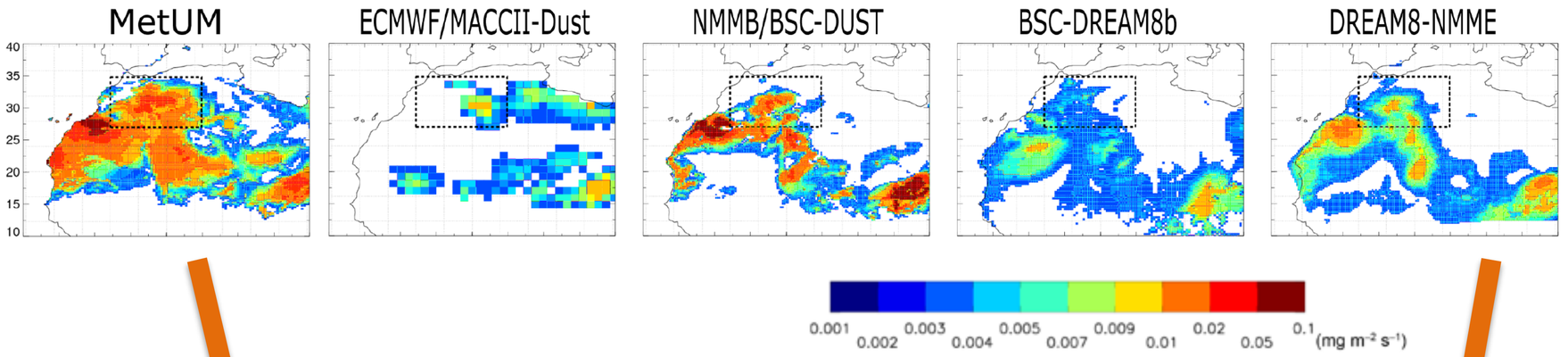
CMIP5 uncertainty in aerosol burden



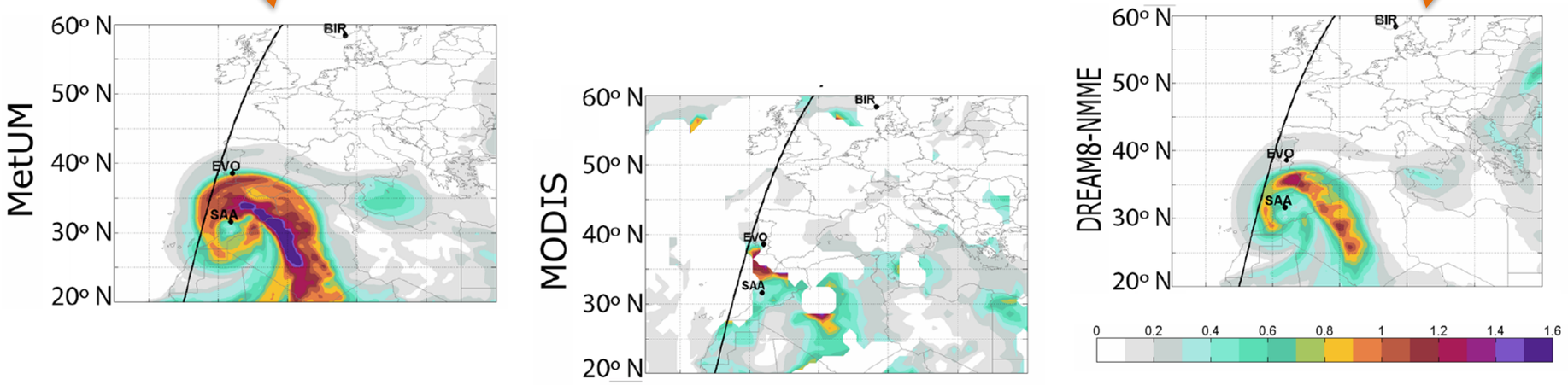
Evan et al. (2014)

Dust forecast uncertainty

Dust emission on 4 April 2011



Aerosol optical depth on 5 April 2011



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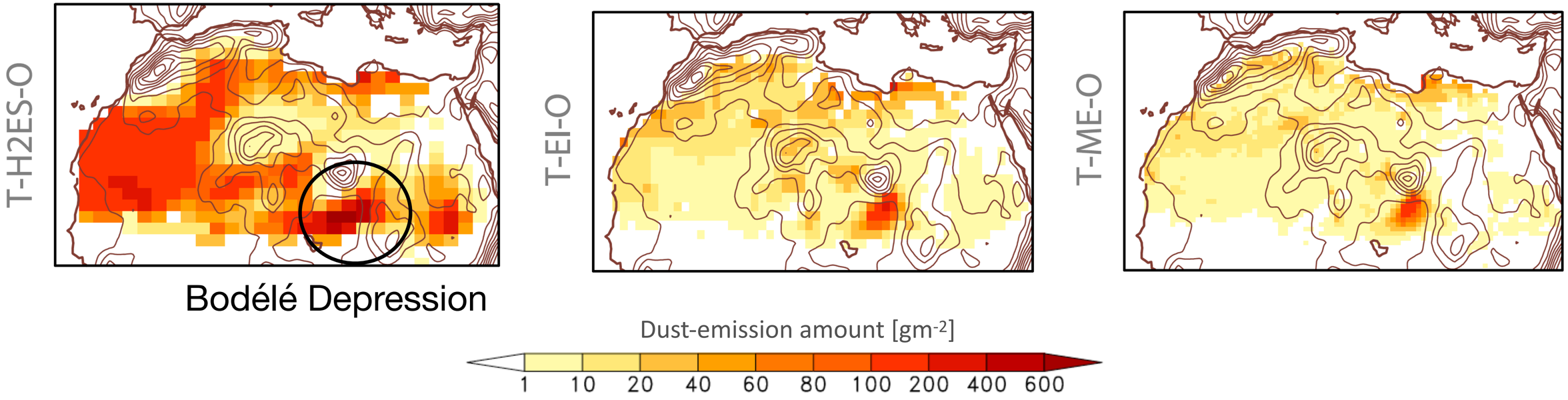
Huneeus et al (2016)

Dust uncertainty associated with near-surface winds

Climatologies for December - February (1980 - 2009)

CMIP5 climate model

European and American re-analysis

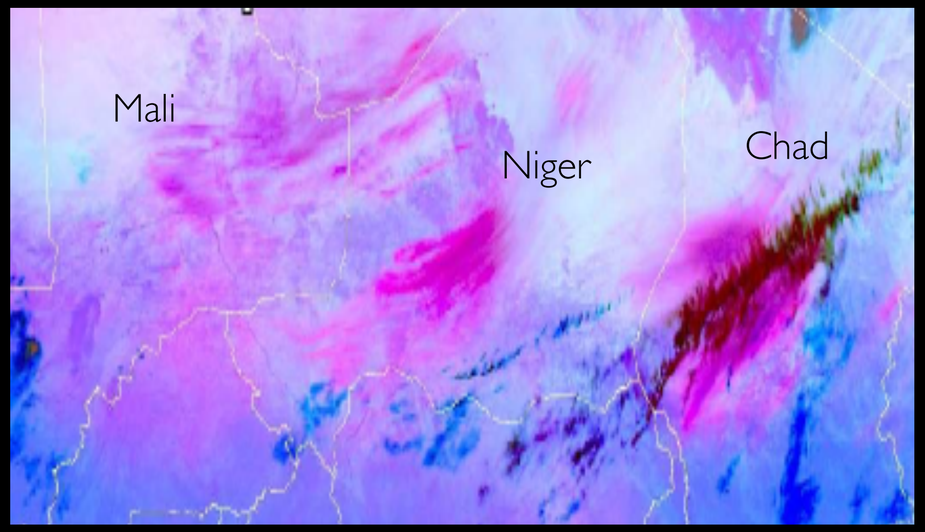


Fiedler et al. (2016)

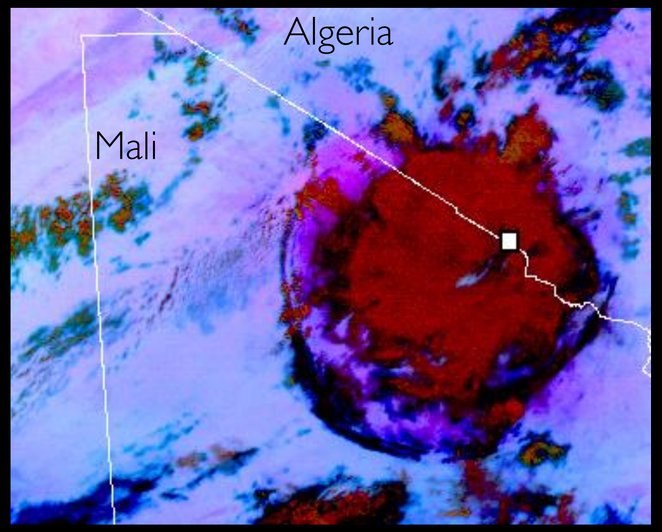
Meteorological processes for dust storms

First climatological assessments of the relative importance of different types

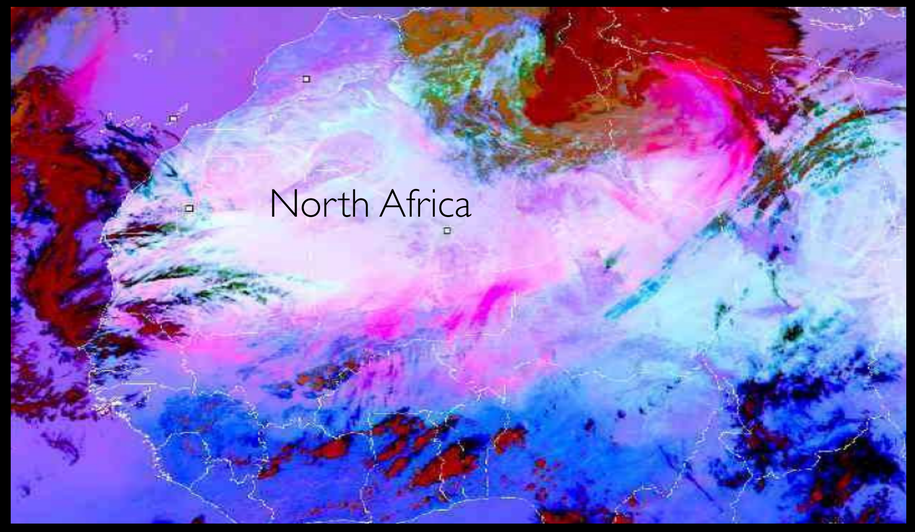
Nocturnal low-level jets
(Fiedler et al.,2013; 2016)



Convective cold pools
(Heinold et al.,2013)

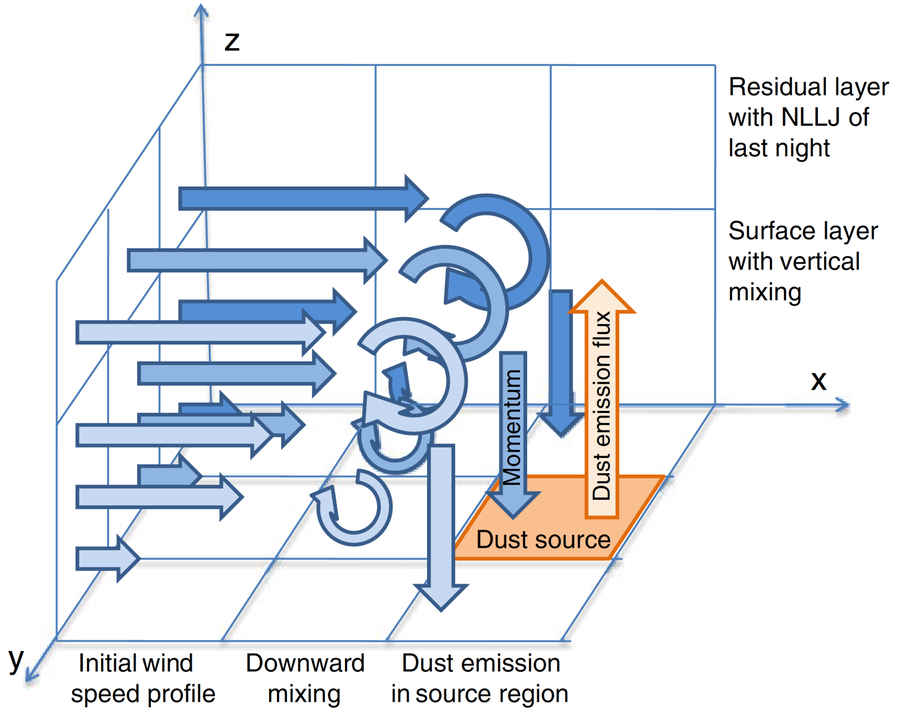


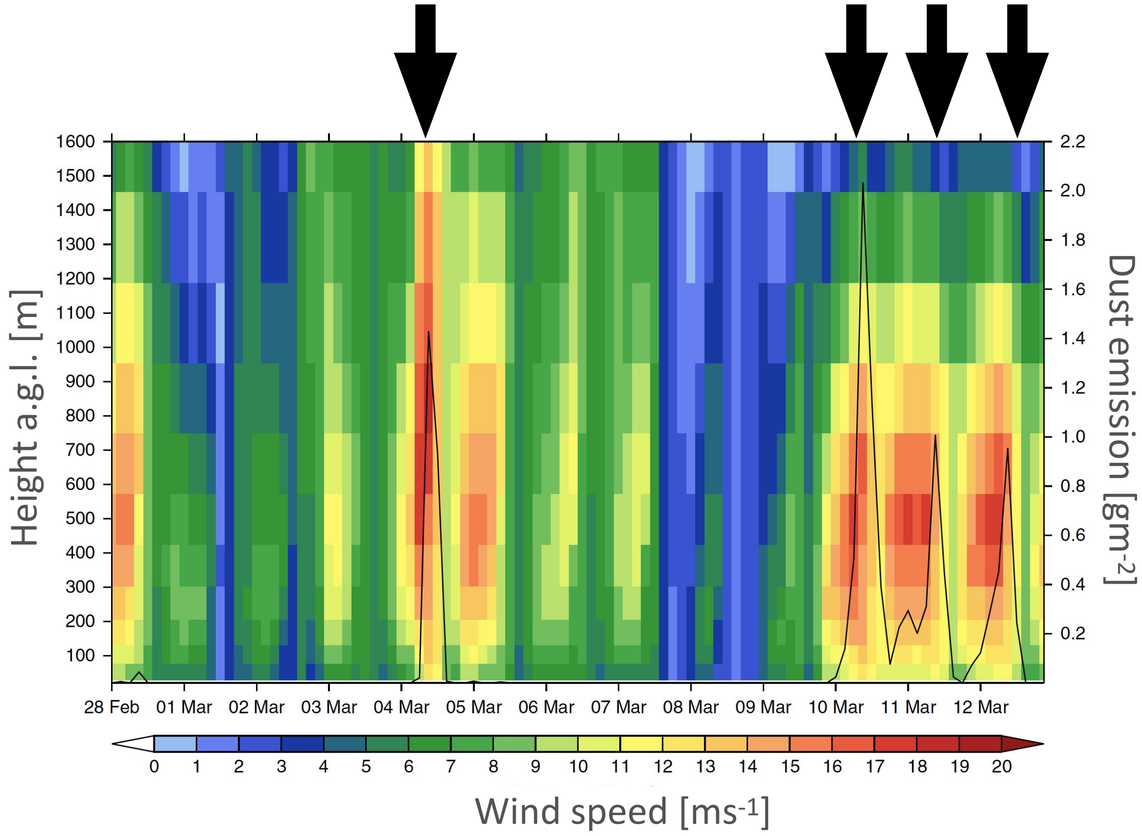
Synoptic disturbances
(e.g., Fiedler et al., 2014; 2015)



Dust emission associated with nocturnal low-level jets

Climatology from automated detection in ERA-Interim re-analysis

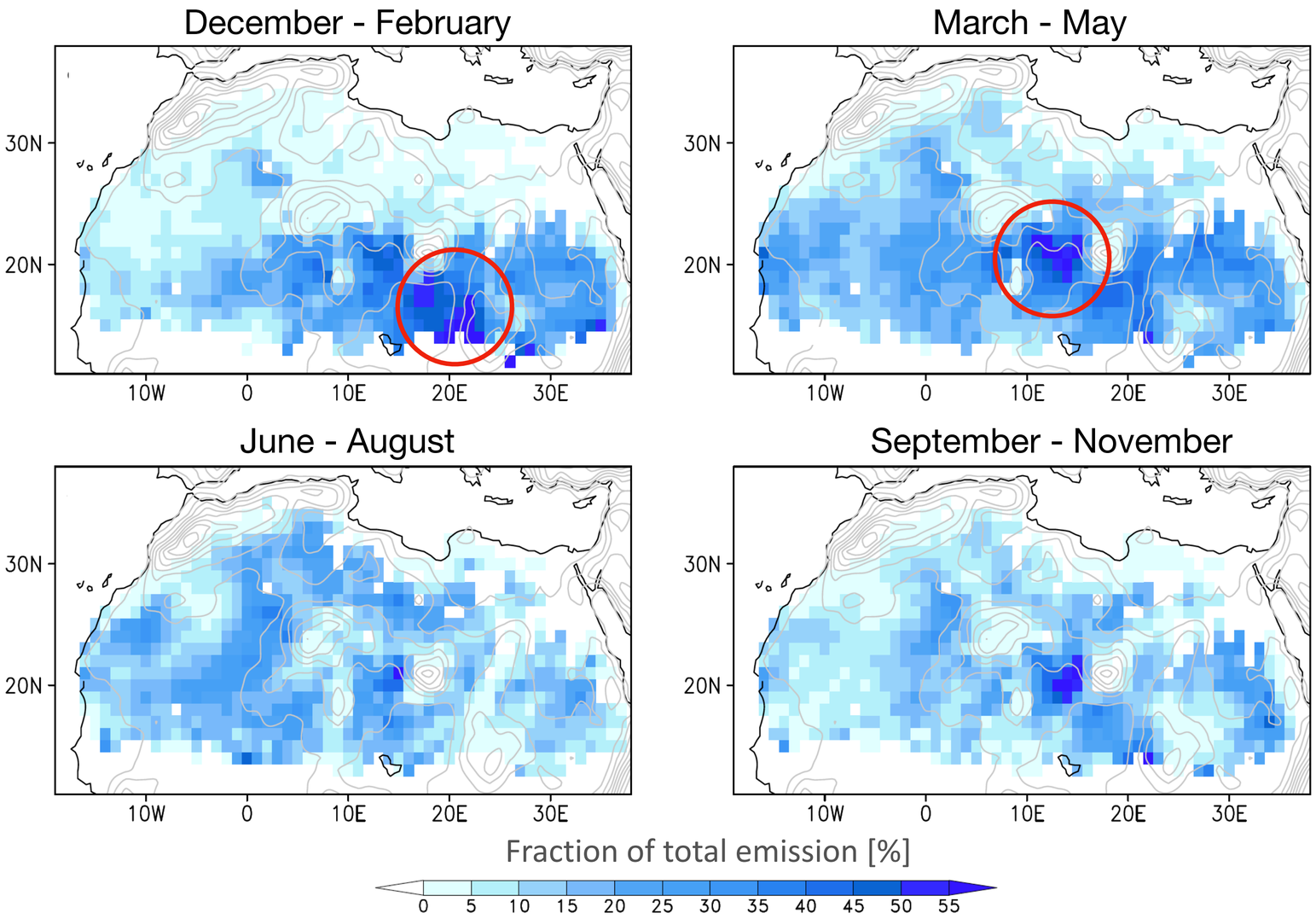




Fiedler et al. (2013)

Dust emission associated with nocturnal low-level jets

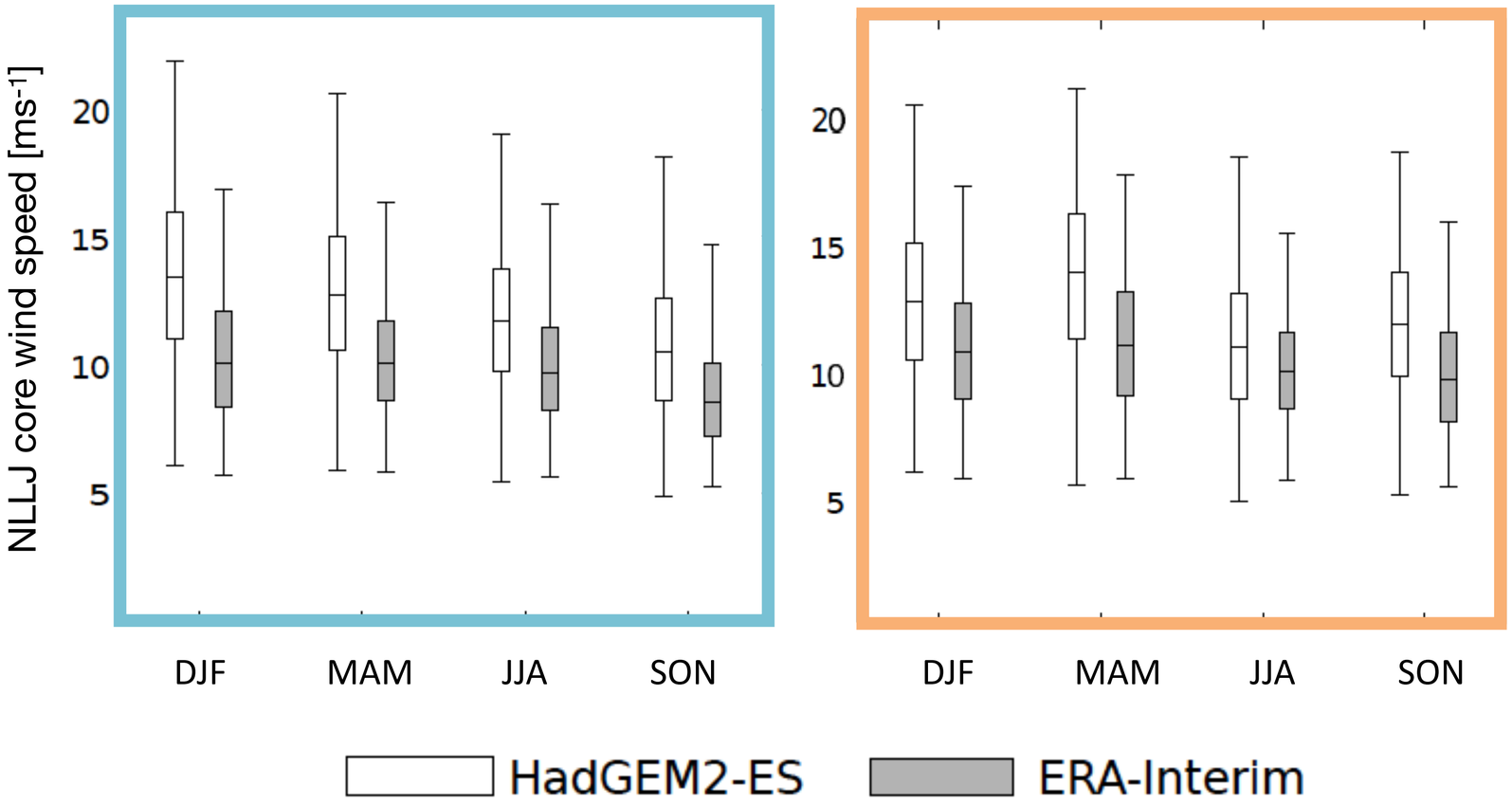
1979-2010 ERA-Interim climatology

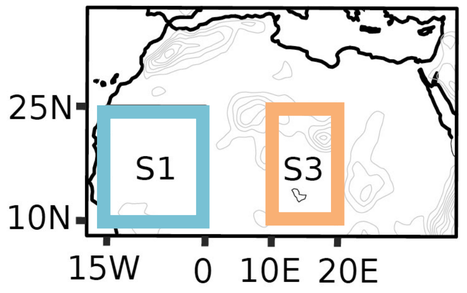


Fiedler et al. (2013)

Model differences in nocturnal low-level jets

1979-2010 climatology of ERA-Interim and a CMIP5 model

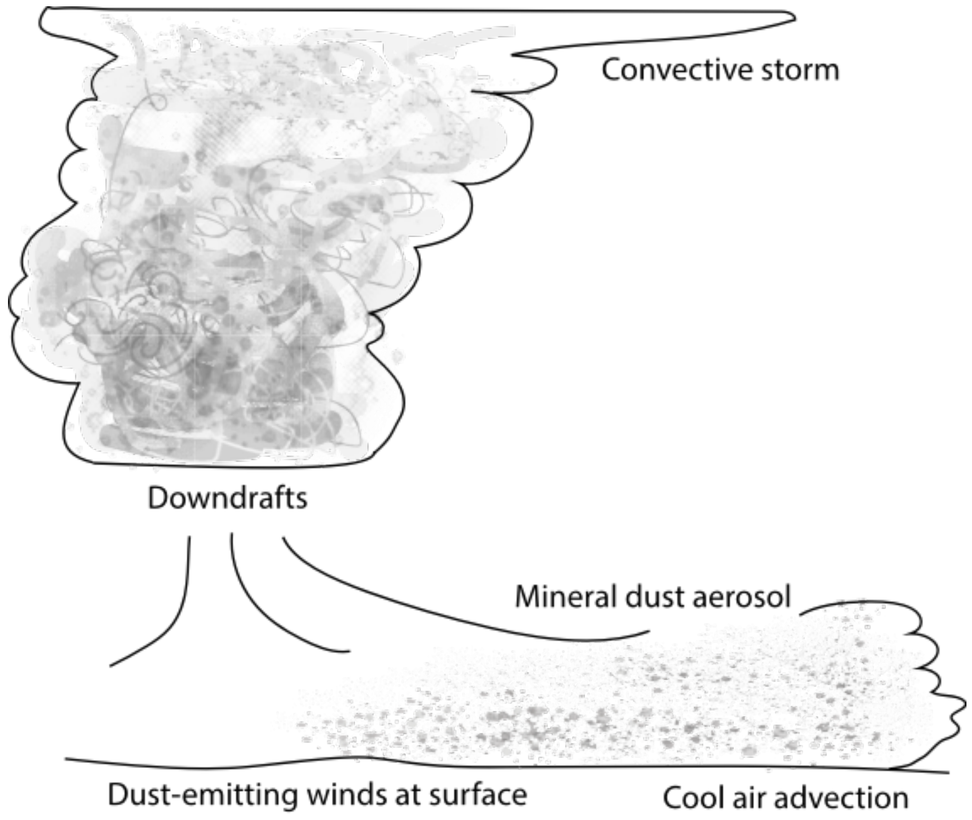


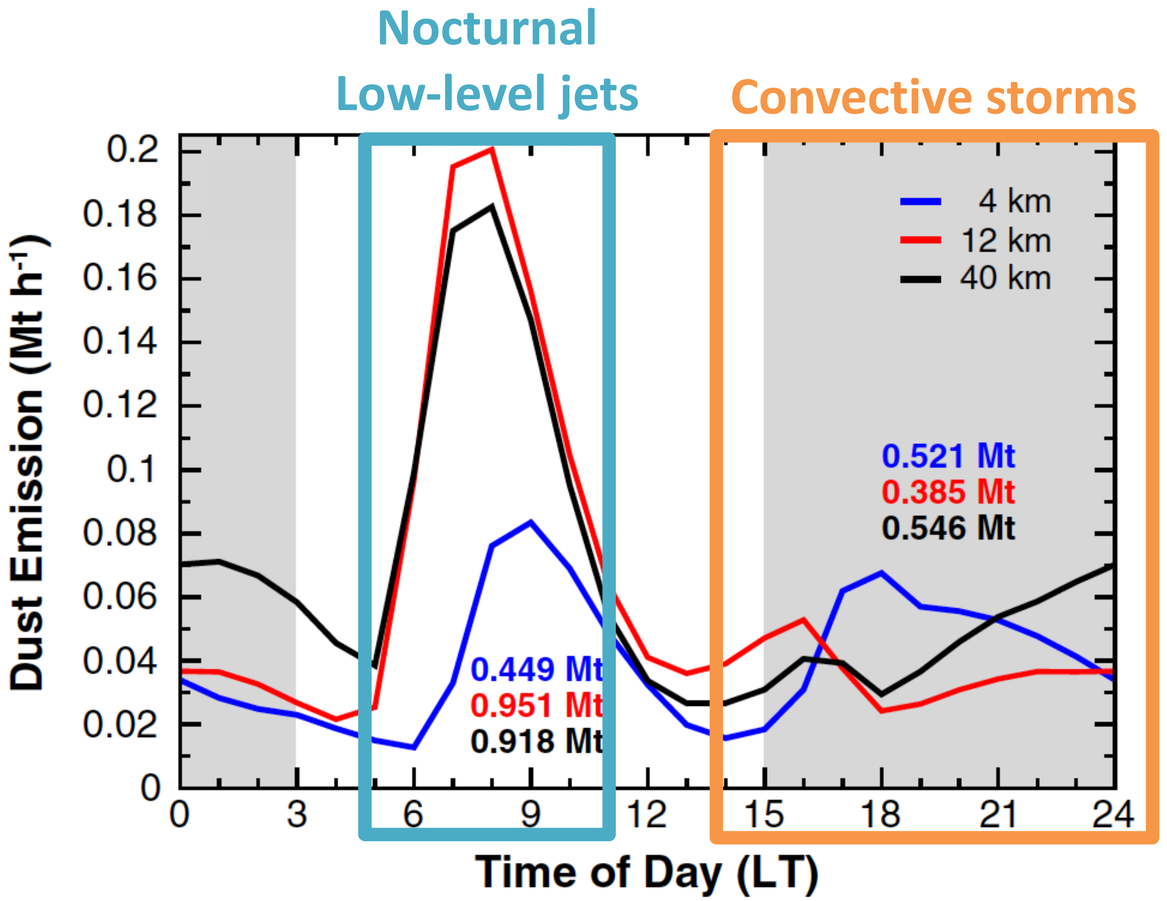


Fiedler et al. (2016)

Uncertainty in dust emission from NLLJs and convective storms

Summertime West Africa





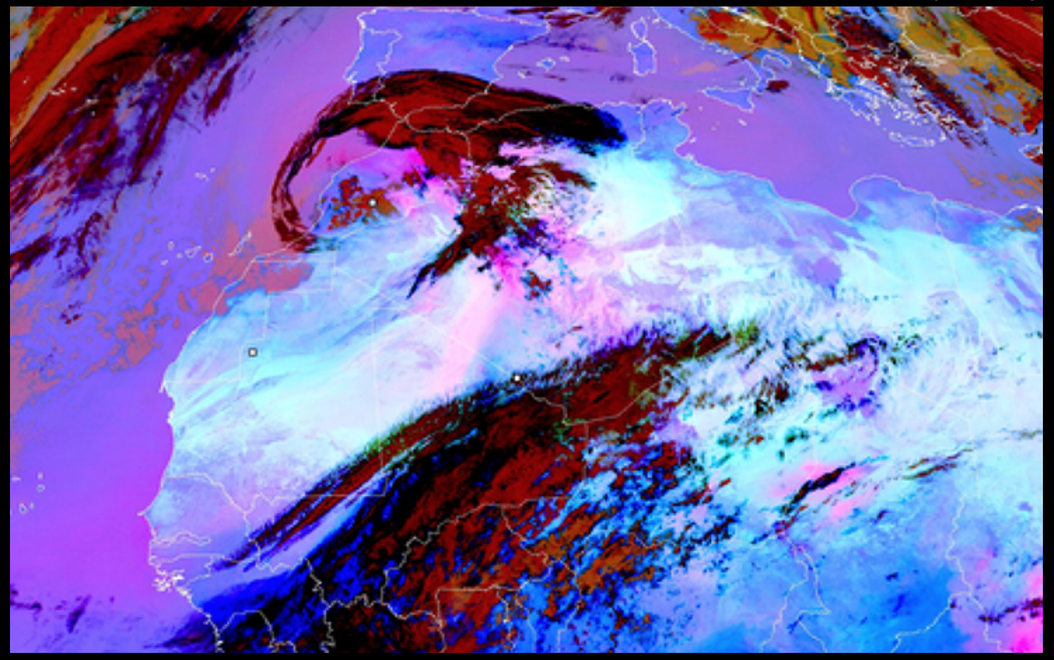
Heinold et al. (2013)

Continental-scale dust outbreaks

Dust transport towards Europe

4 April 2011

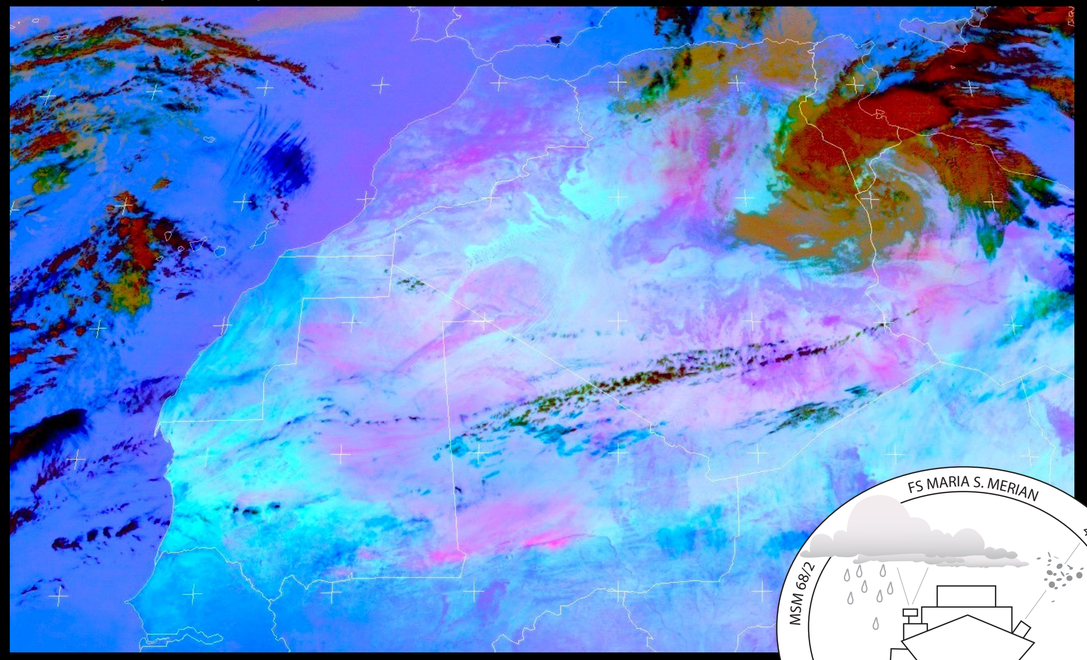
Huneeus et al. (2016)



Dust transport towards North Atlantic

Fiedler (2018)

11 November 2017



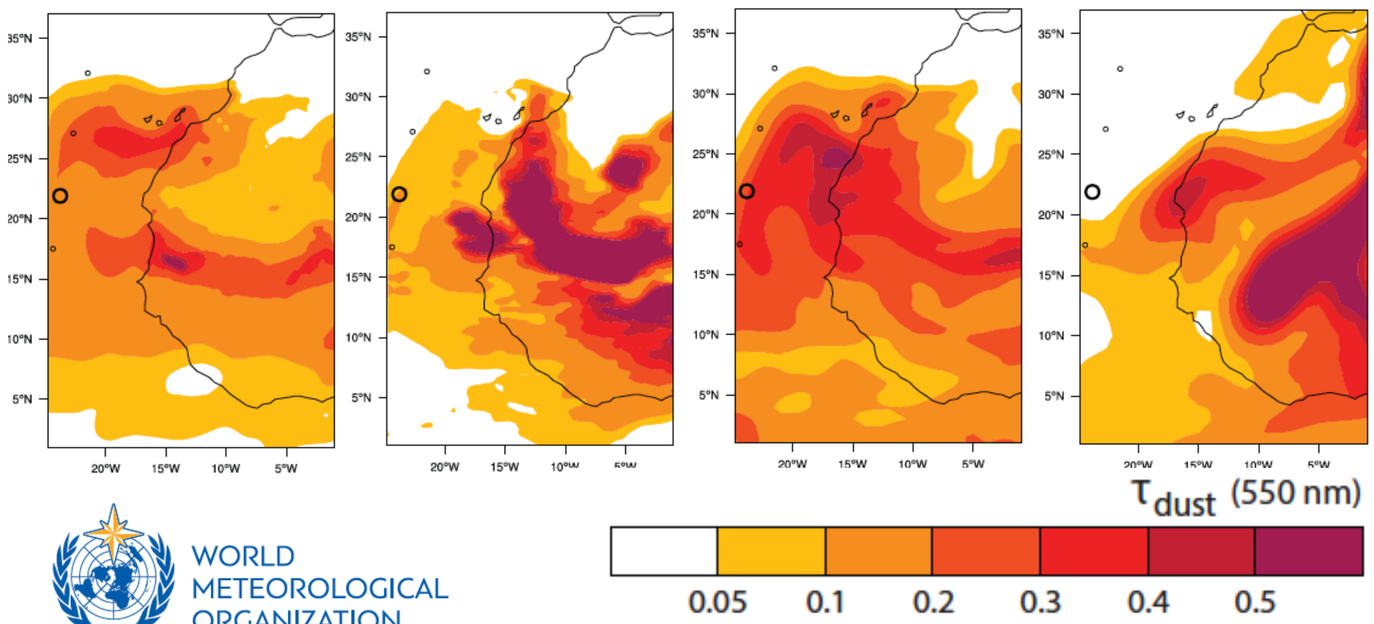
Synoptic-scale disturbances cause most dust emission in winter and spring
(Fiedler et al., 2014, 2015)

Forecast uncertainty for dust storm

Forecast model results from the WMO's Sand and Dust Storm Warning Advisory and Assessment System

Dust aerosol optical depth forecasts

12 November 2017, 12 UTC



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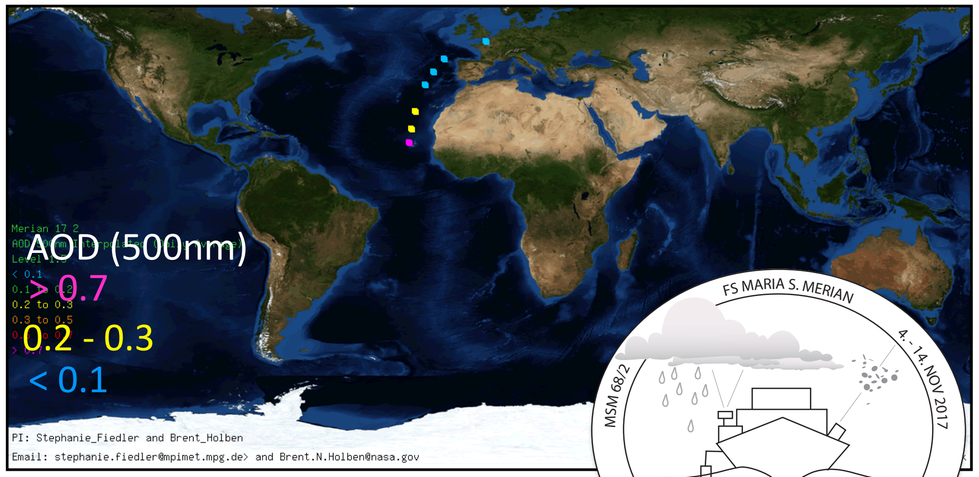
Expedition MSM68/2



NASA's Maritime Aerosol Network

Fiedler (2018)

On the role of complex terrain for aerosol burden

Summary:

Near-surface **peak winds** important for dust aerosol emission and subsequent transport with substantial **model diversity**
(e.g., Fiedler et al., 2013, 2016)

Mountains affect:

- Initiation and development of **dust storms**
  (e.g., Pokharel et al., 2018, Dhital et al., in review)
- Dust **transport** from North Africa
  (e.g., Huneeus et al., 2016, Fiedler, 2018)
- Dust **burden** with implications, e.g., for photovoltaic power production

TEAMx ideas:

- understand **vertical mixing of momentum** in lower troposphere in complex terrain under different synoptic conditions
- e.g., stable stratification that affect momentum transport to the surface during the following morning (NLLJs)

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Publications

- Evan, A., Flamant, C., Fiedler, S., Doherty, O, 2014: An analysis of aeolian dust in climate models. *Geophys. Res. Lett.*, 41, doi:10.1002/2014GL060545.
- Fiedler, S., Schepanski, K., Heinold, B., Knippertz, P., Tegen, I., 2013: Climatology of nocturnal low-level jets over North Africa and implications for modeling mineral dust emission, *J. Geophys. Res.*, 118, 6100–6121, doi:10.1002/jgrd.50394.
- Fiedler, S., Schepanski, K., Knippertz, P., Heinold, B., Tegen, I., 2014: How important are cyclones for emitting mineral dust aerosol in North Africa?, *Atmos. Chem. Phys.*, 14, 8983-9000, doi:10.5194/acp-14-8983-2014.
- Fiedler, S., Kaplan, M., Knippertz, P., 2015: The importance of Harmattan surges for the emission of North African dust aerosol, 2015, *Geophys. Res. Let.,* 42, 9495-9504, doi:10.1002/2015GL065925.
- Fiedler, S., Knippertz, P., Woodward, S., Martin, G., Bellouin, N., Ross, A., Heinold, B., Schepanski, K., Brich, C., Tegen, I., 2016: A process-based analysis of dust-emitting winds in the CMIP5 simulation of HadGEM2-ES, Clim. Dyn., 46: 1107. doi:10.1007/s00382-015-2635-9.
- Fiedler, S., 2018. Expedition to the North Atlantic with RV MARIA S. MERIAN. Berichte zur Erdsystemforschung, 211, doi: 10.17617/2.3006588.
- Heinold, B., Knippertz, P., Marsham, J. H., Fiedler, S., Dixon, N. S., Schepanski, K., Laurent, B., Tegen, I., 2013: The role of deep convection and low-level jets for dust emissions in West Africa, *J. Geophys. Res.*, 118, 4385–4400, doi:10.1002/jgrd.50402.
- Huneeus, N., Basart, S., Fiedler, S., Morcrette, J.-J., Benedetti, A., Mulcahy, J., Terradellas, E., Pérez García-Pando, C., Pejanovic, G., Nickovic, S., Arsenovic, P., Schulz, M., Cuevas, E., Baldasano, J.M., Pey, J., Remy, S., and Cvetkovic, B., 2016: Forecasting the North African dust outbreak towards Europe in April 2011: a model intercomparison, *Atmos. Chem. Phys.*, 16, 4967-4986, doi:10.5194/acp-16-4967-2016.

https://geomet.uni-koeln.de/forschung/ag-fiedler

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