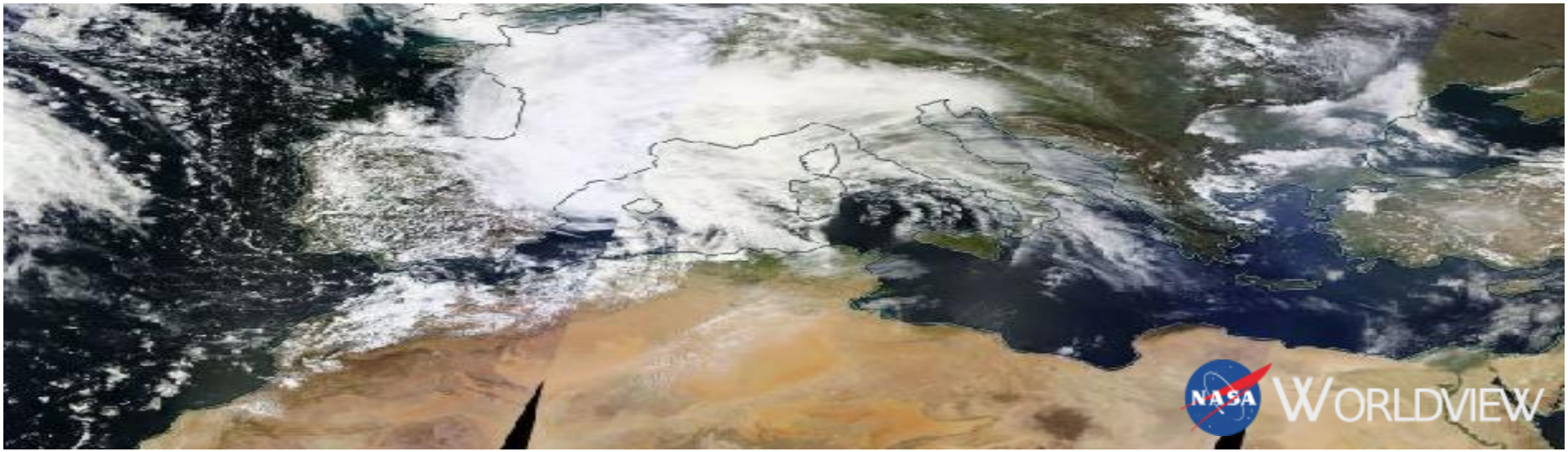
Karlsruhe Institute of Technology

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

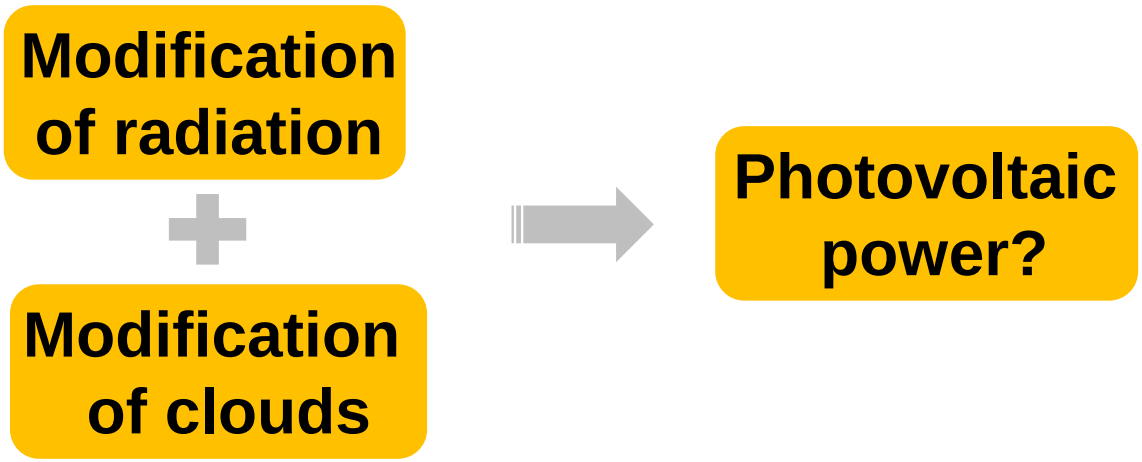


Impact of mineral dust particles on the forecast of temperature and photovoltaic power

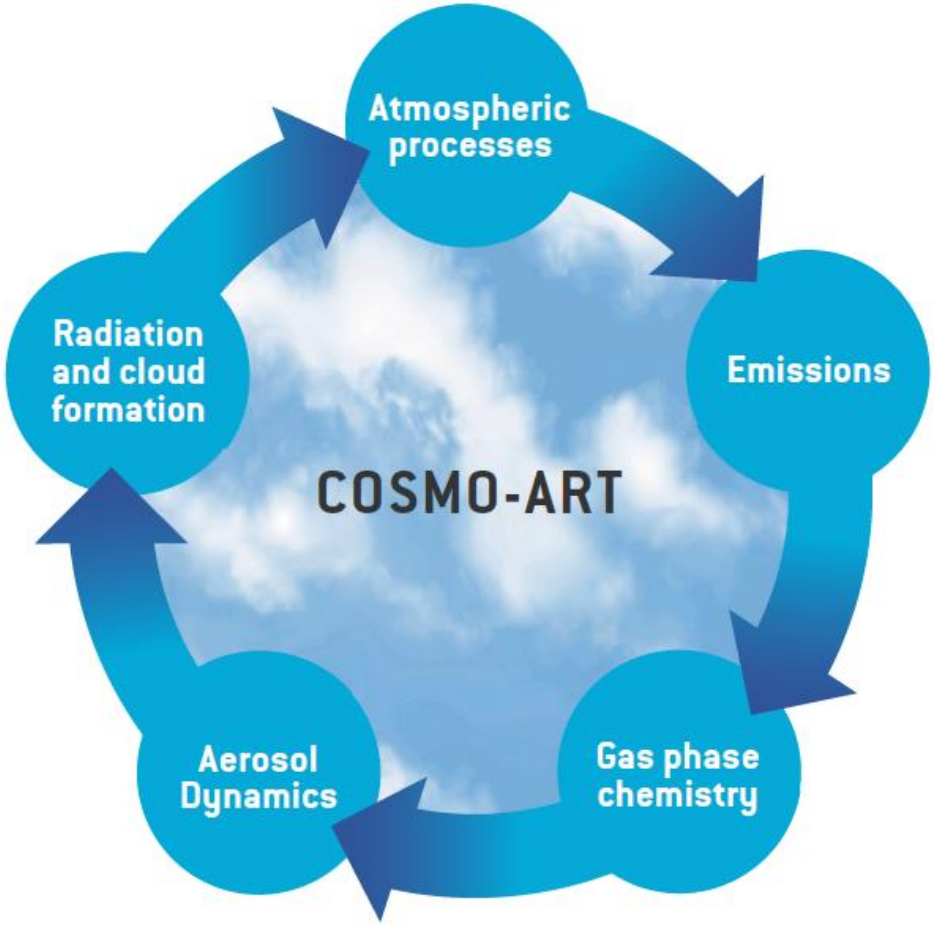
H. Vogel (KIT), Jochen Förstner (DWD), C. Köhler (DWD),
B. Ritter (DWD), D. Rieger (KIT), B. Vogel (KIT)

Mineral dust particles

- Increasing usage of solar energy
- Forecast of solar energy yield necessary
- Small errors cause high costs



COSMO-ART: Aerosols and Reactive Trace gases



Vogel et al., 2009
Bangert et al., 2012
Rieger et al., 2014

Coupling of aerosols and cloud microphysics

Two moment cloud microphysics

Six hydrometeor classes (size and mass)

(Seifert and Beheng, 2006)

Ice Nucleation

(Barahona and Nenes 2009)

Aerosol Activation

(Kumar et al. 2009, Barahona et al. 2010)

Parameterization of cloud optical properties

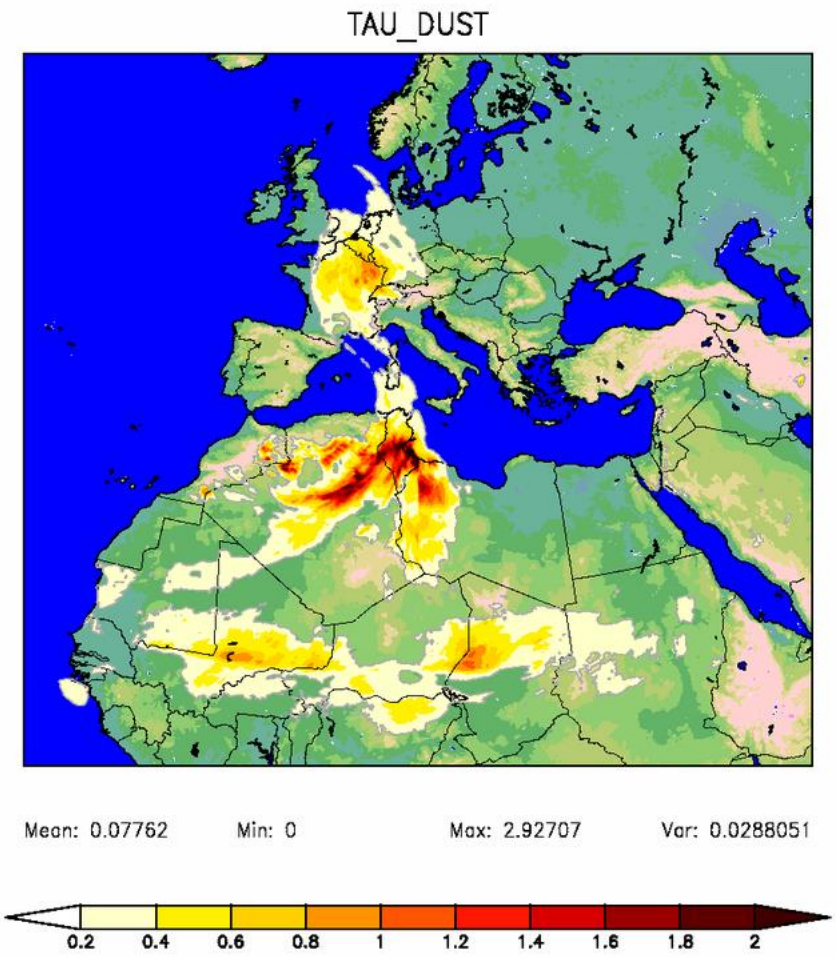
(Hu & Stamnes 1993, Edwards et al. 2007)

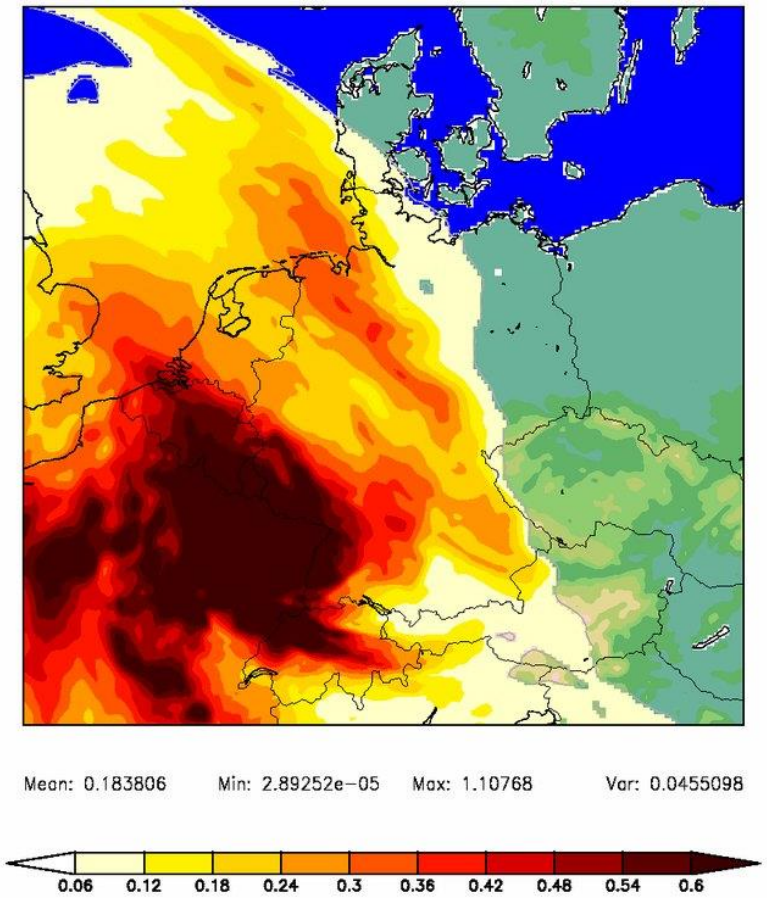
Bangert et al. 2010, 2012

$$I(\lambda) = I_0 e^{-\tau(\lambda)} \quad \text{for } \lambda = 550\ \text{nm}$$

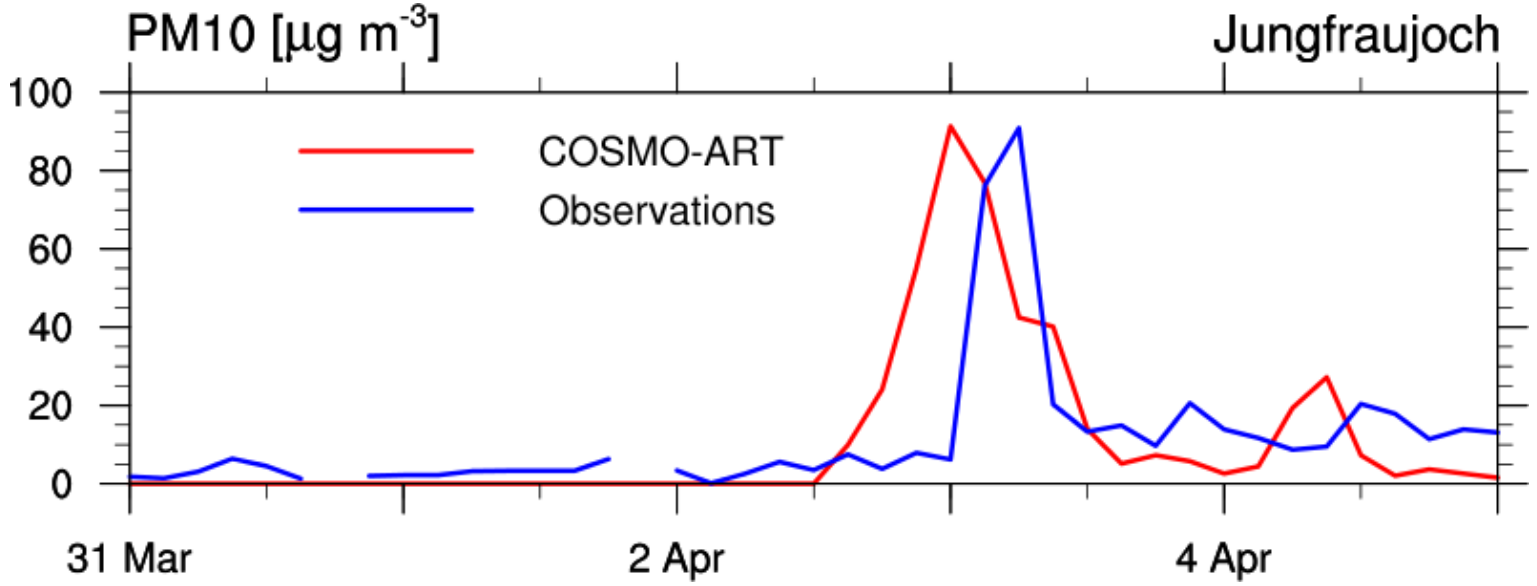
Dust event over Europe

03.04.2014 12 UTC





Comparison with observations



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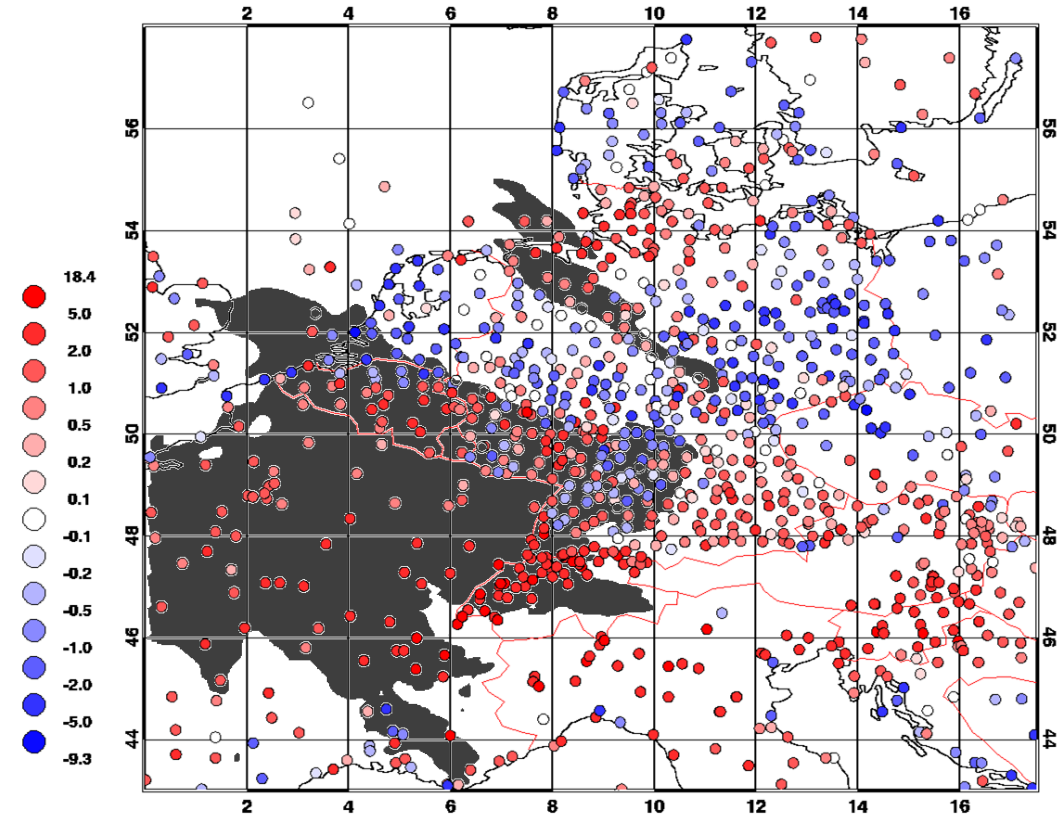
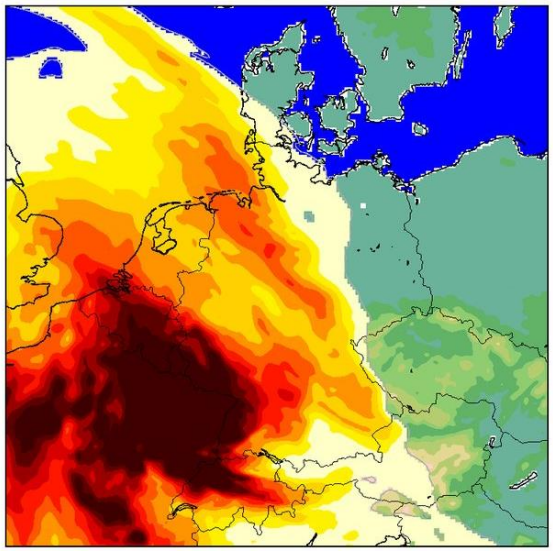
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

ΔT_{2m} (COSMO-EU – observation)





grey: AOD ≥ 0.3

Setup of Simulations

FB: COSMO-ART with all feedbacks

Dust: Simulated emissions

Radiation: Prognostic dust, climatology for dust is lower limit

Microphysics: Dust activation, ice nucleation of Barahona & Nenes

CTRL: COSMO-ART no feedback with radiation

Dust: Very low emissions

Radiation: Climatology for aerosols

Microphysics: Dust activation, ice nucleation of Barahona & Nenes

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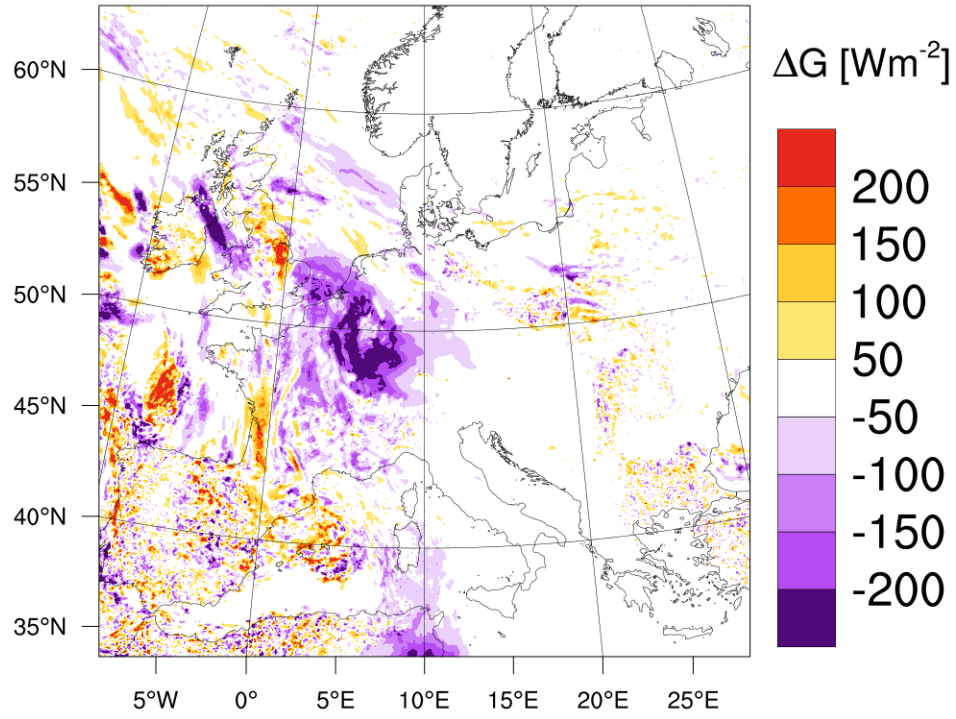
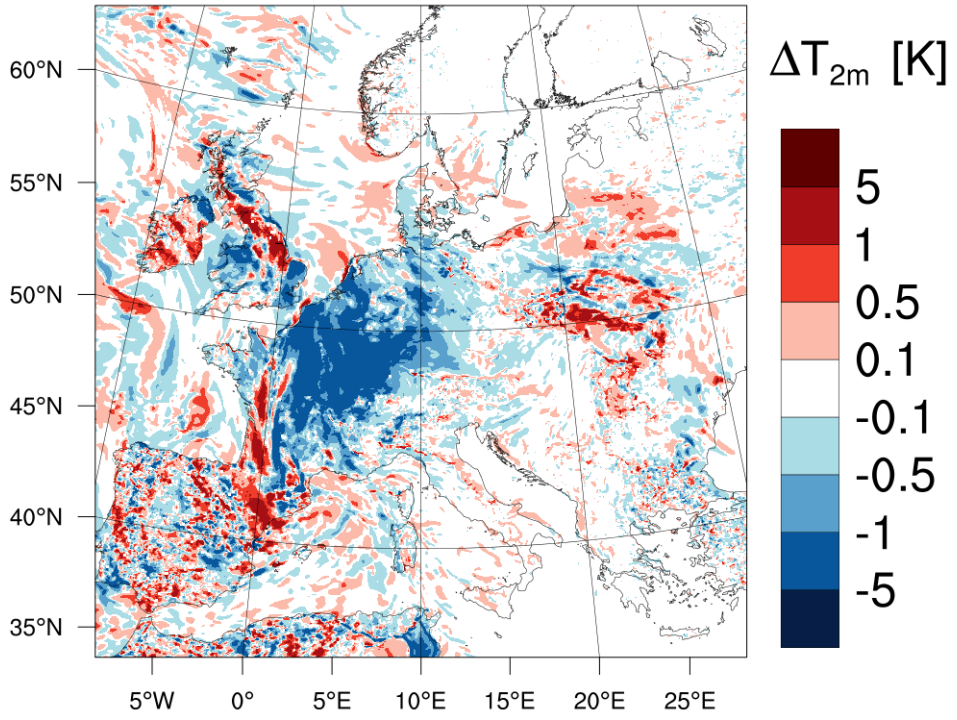
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Impact on radiation and temperature

FB - CTRL

03.04.2014 12 UTC

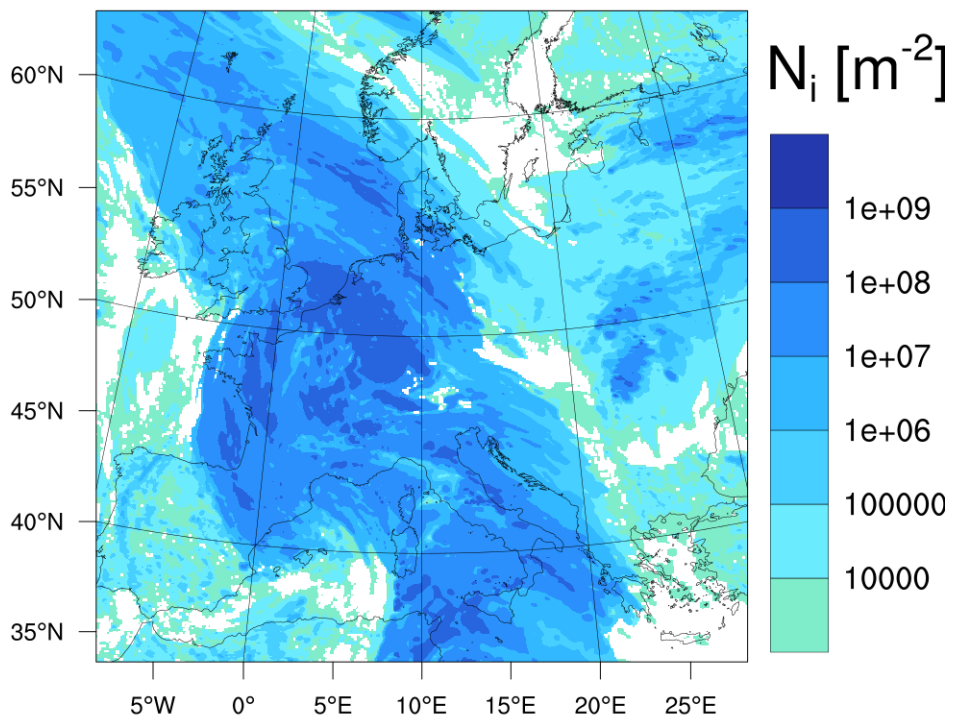


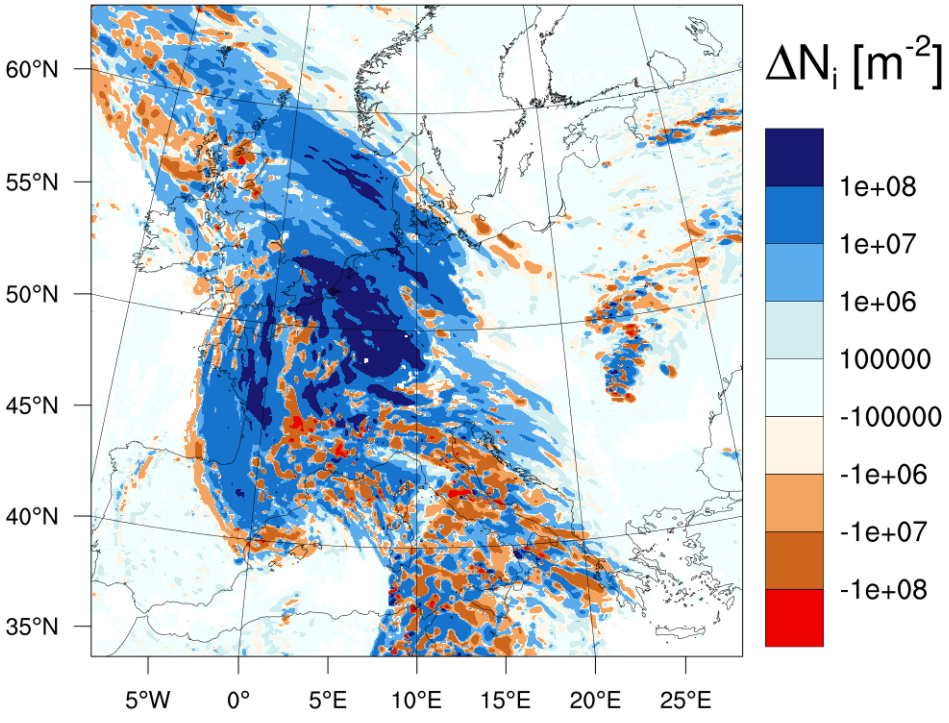


Impact on clouds

FB **FB - CTRL**

03.04.2014 12 UTC





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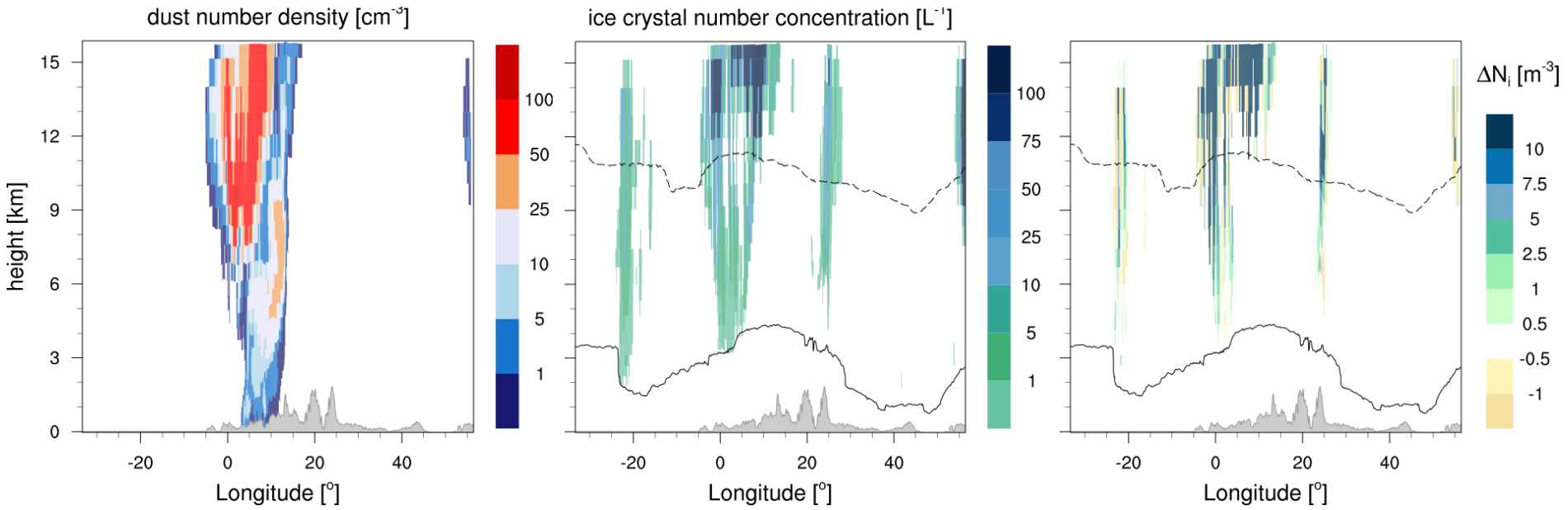
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

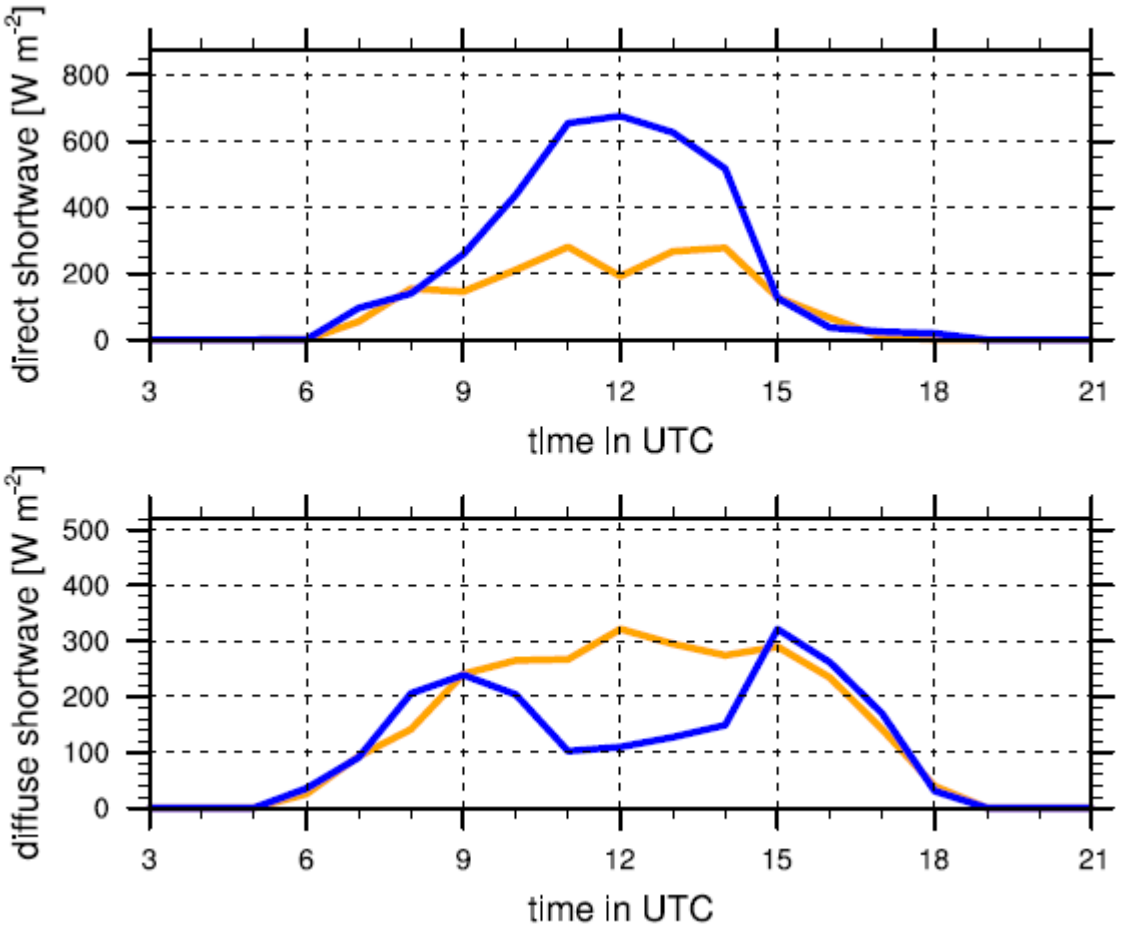
Impact on clouds

FB **FB - CTRL**

03.04.2014 12 UTC



Impact on photovoltaic power

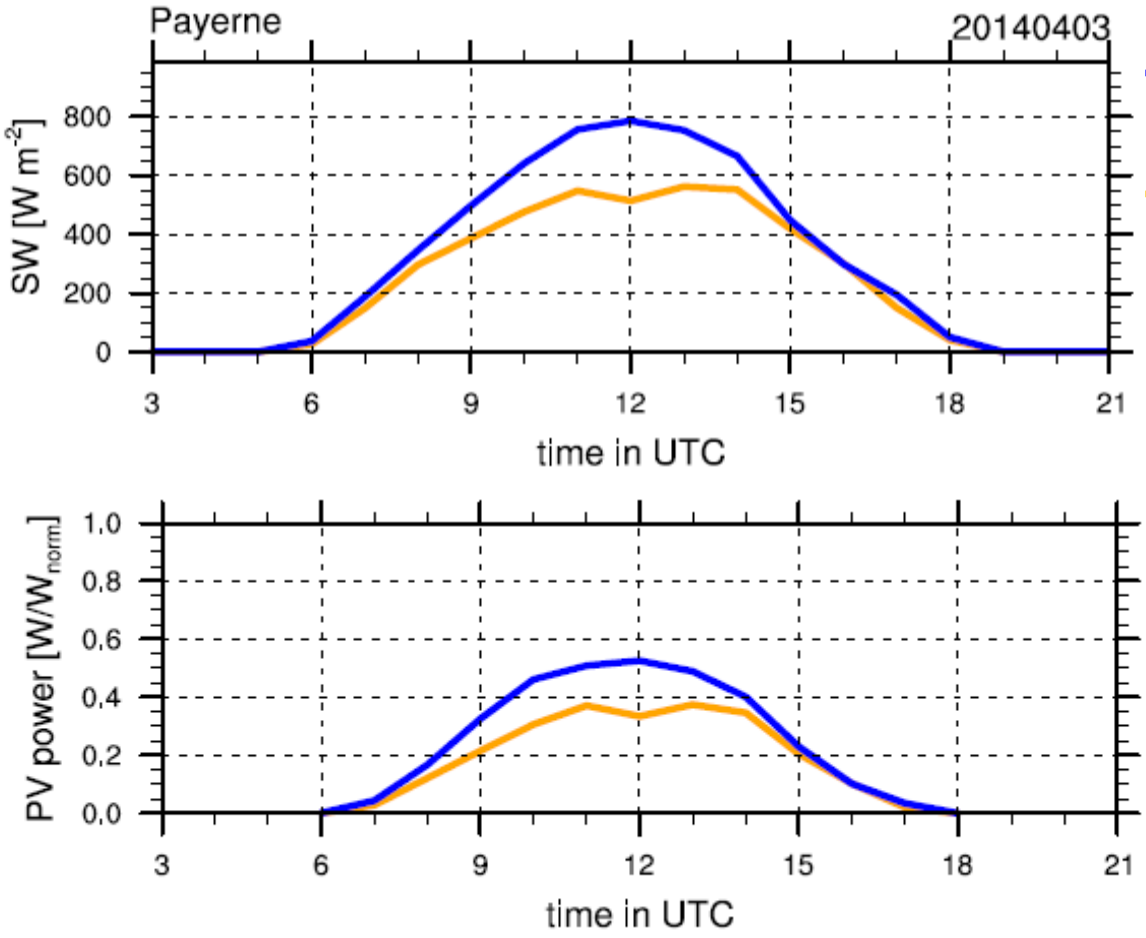


CTRL

Feedback

Payerne

Impact on photovoltaic power



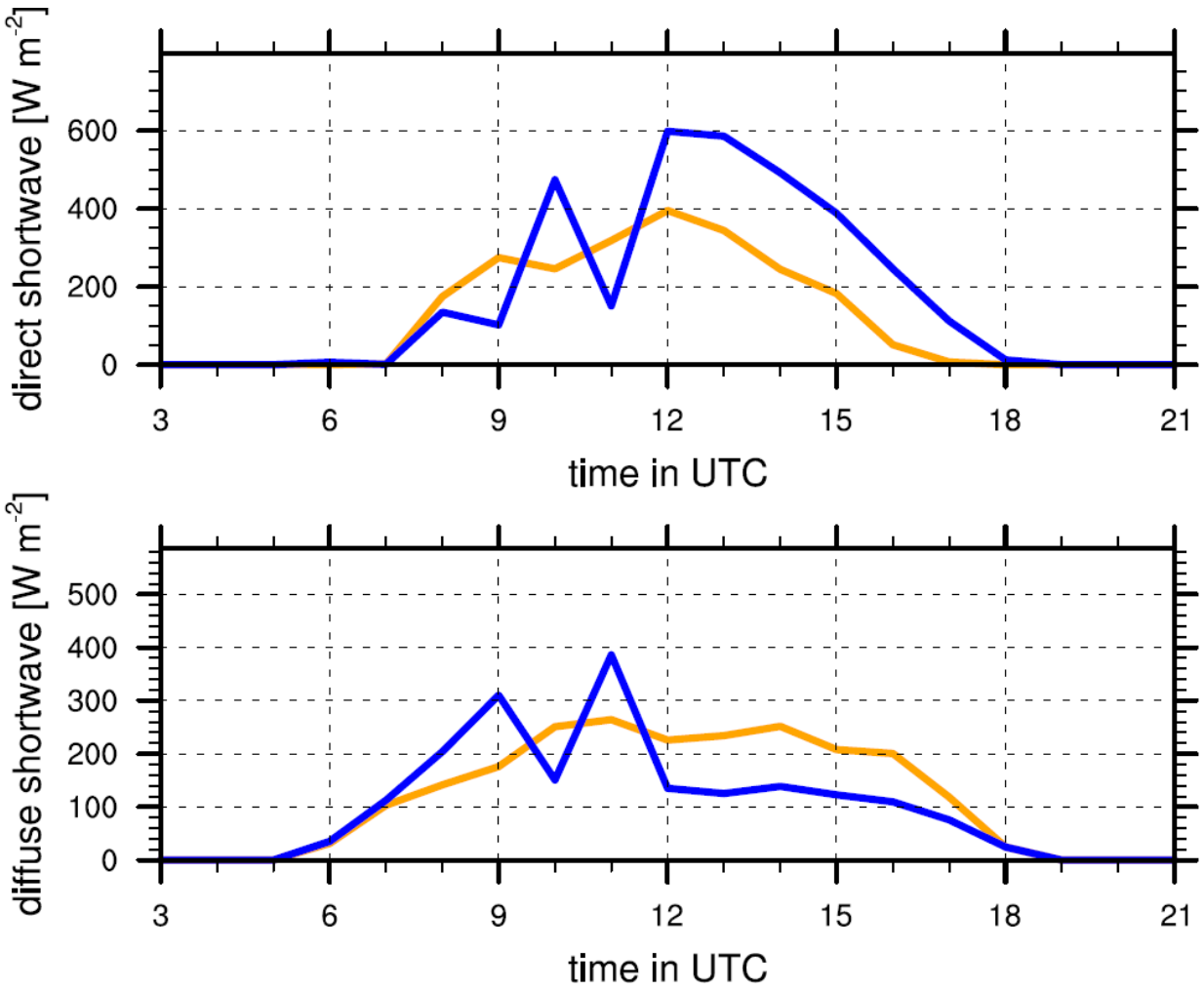
CTRL

Feedback

Payerne

courtesy of
Yves-Marie Saint-Drenan (IWES)
Annika Schomburg (DWD)

Impact on photovoltaic power

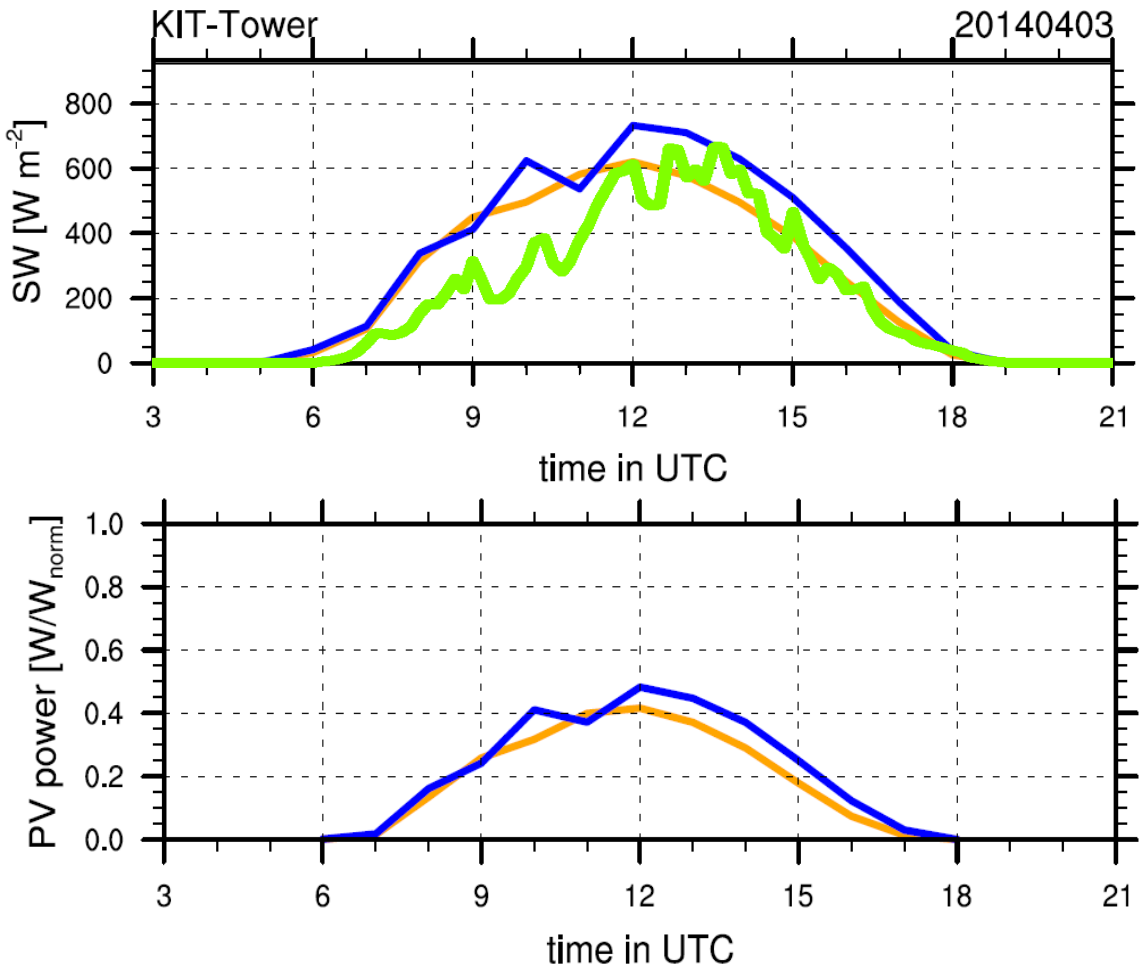


CTRL

Feedback

KIT-Tower

Impact on photovoltaic power



CTRL

Feedback

KIT-Tower

courtesy of
Yves-Marie Saint-Drenan (IWES)
Annika Schomburg (DWD)

Summary

Reduction of shortwave radiation up to 200 W m^{-2}

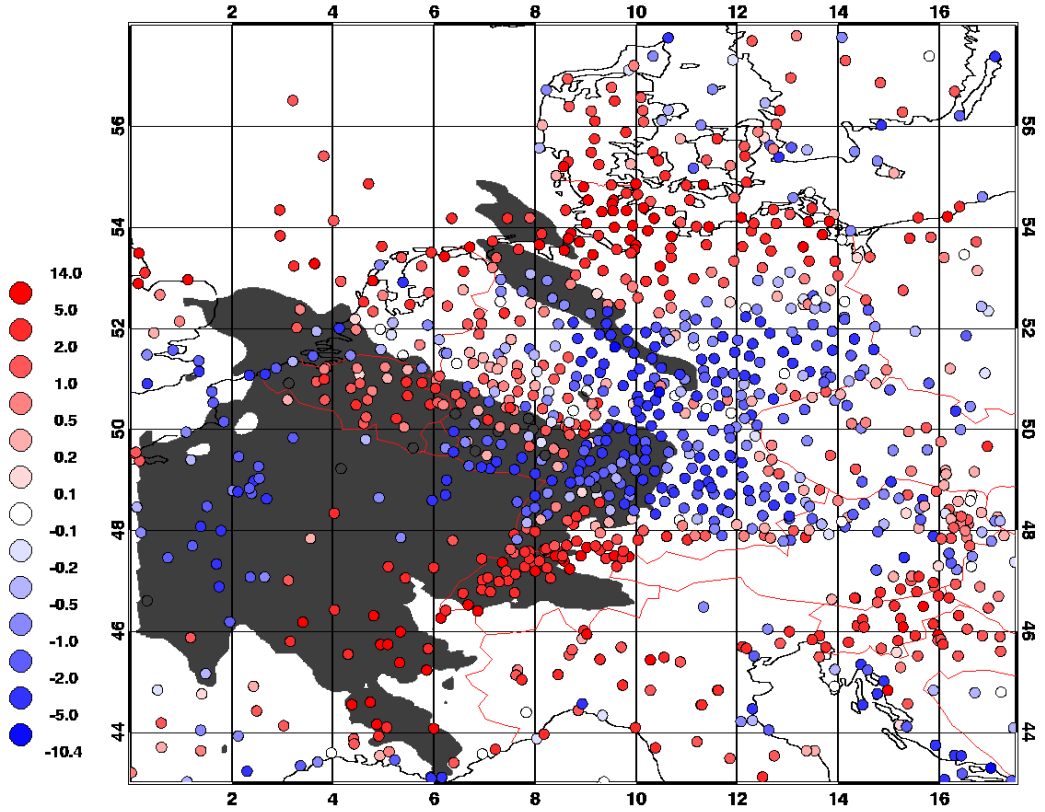
Reduction of temperature up to 5 K

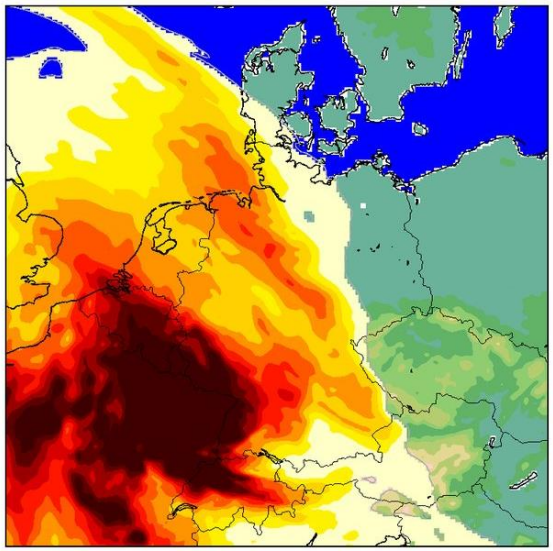
Increase of ice particles

Decrease of photovoltaic power up to 20%

Coupled dust radiation forecast is needed

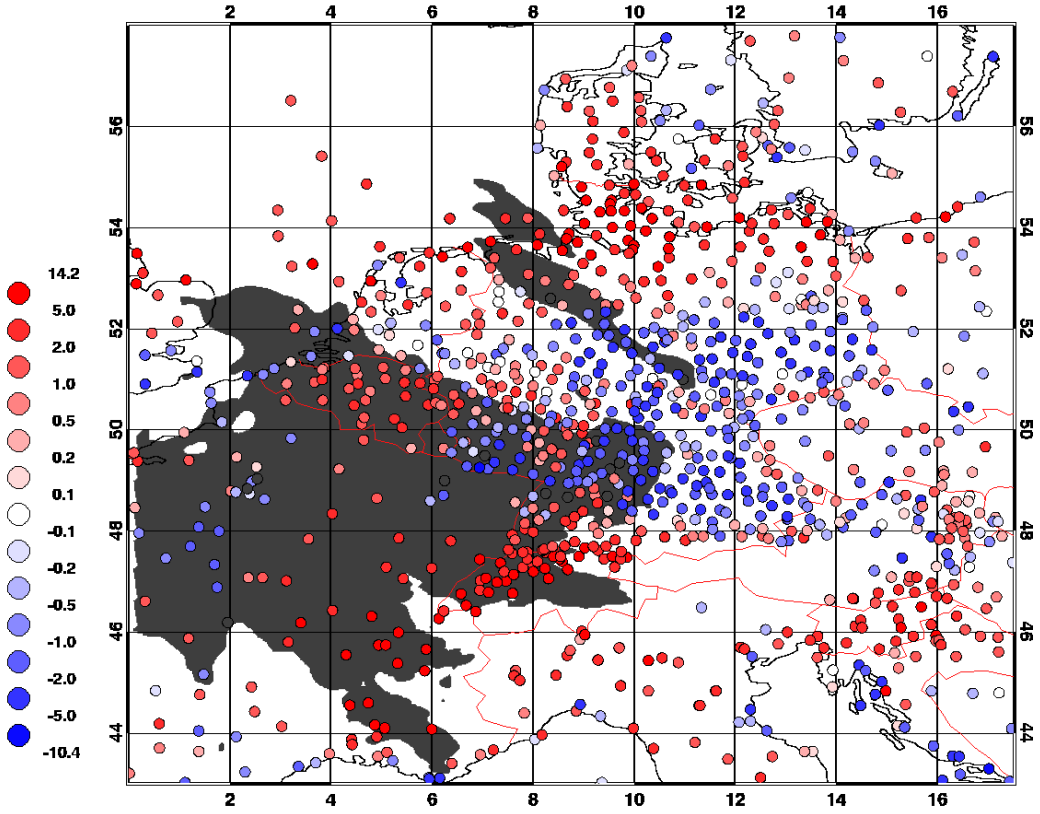
ΔT_{2m} (COSMO-ART (FB) – observation)

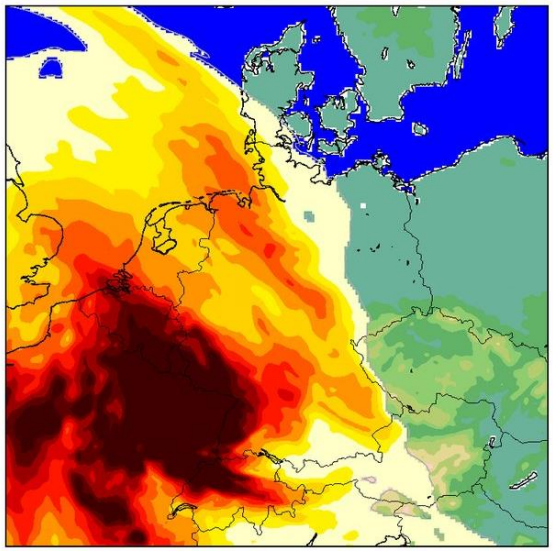




grey: AOD ≥ 0.3

ΔT_{2m} (COSMO-ART (CTRL) – observation)





grey: AOD ≥ 0.3