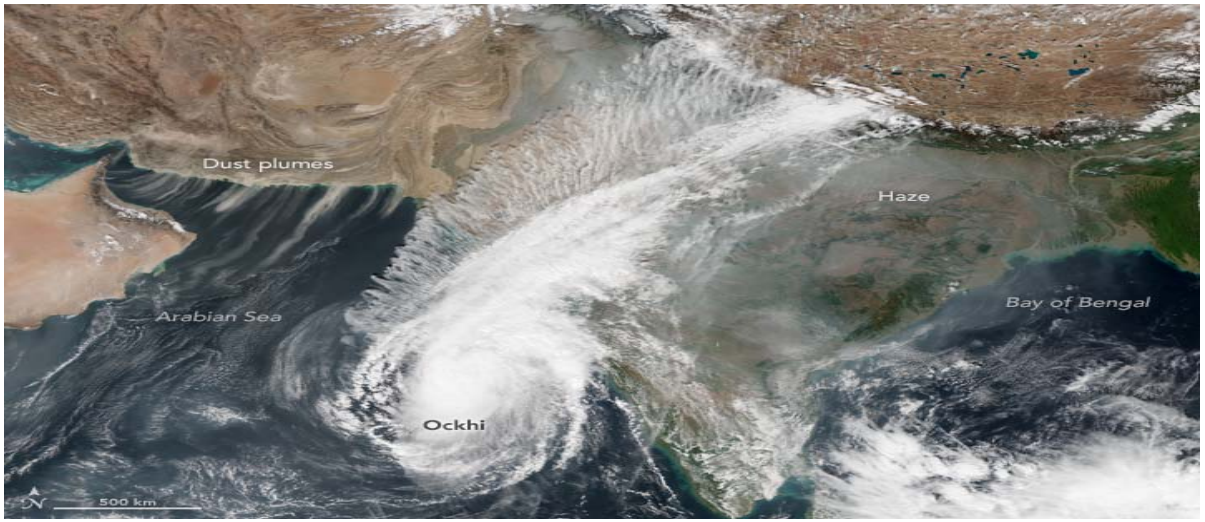
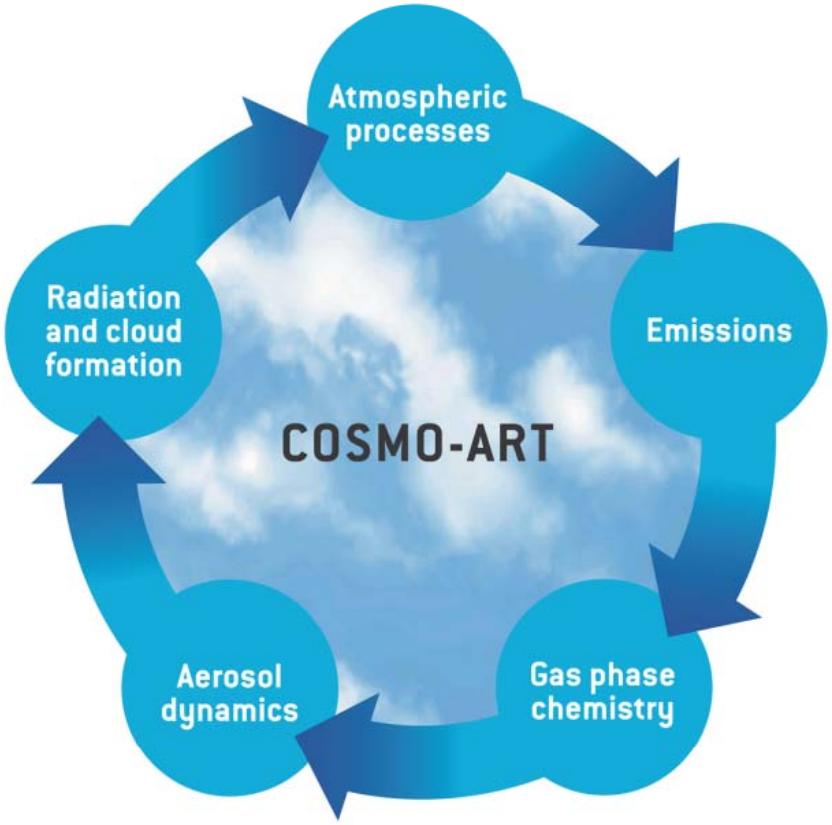
Status of COSMO-ART & ICON-ART

Bernhard Vogel

Institute of Meteorology and Climate Research, KIT, Karlsruhe

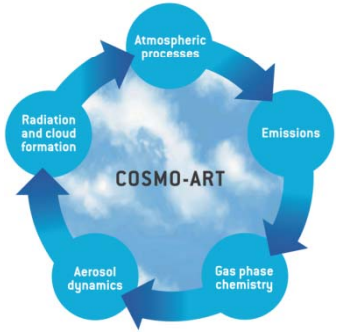


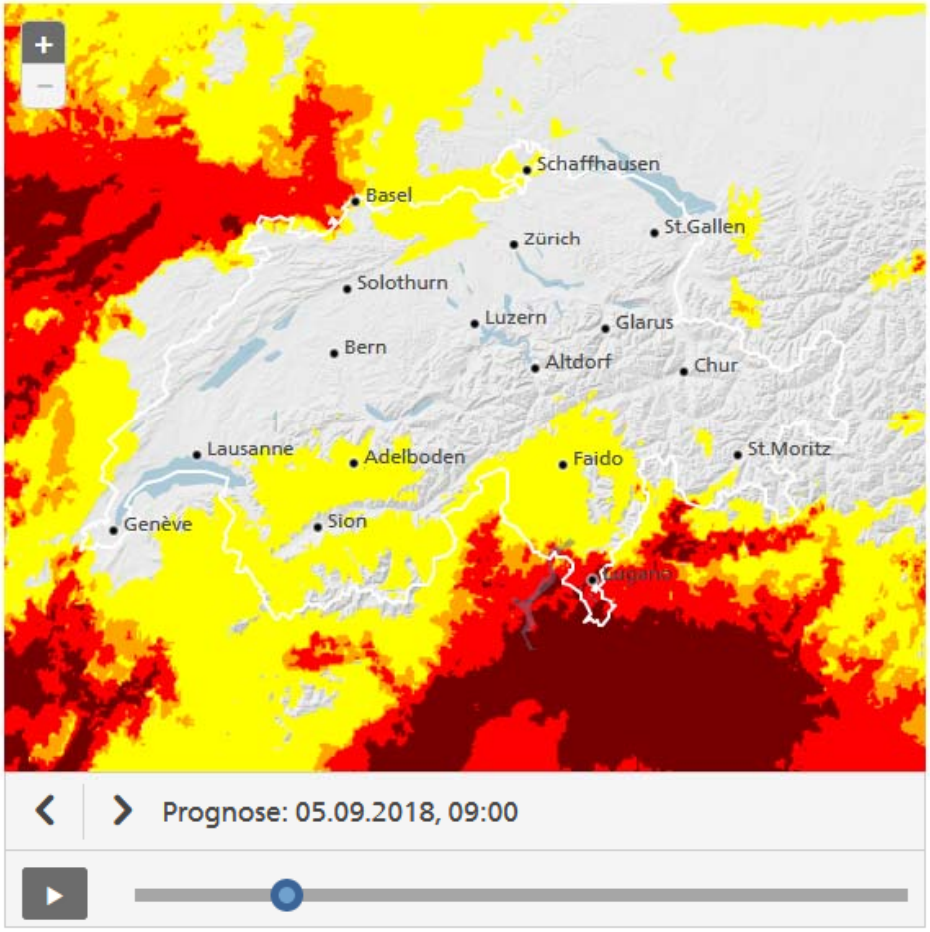
Applications of COSMO-ART



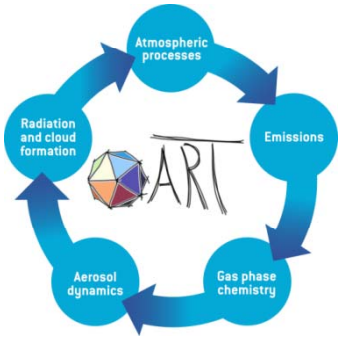
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Karlsruhe Institute of Technology

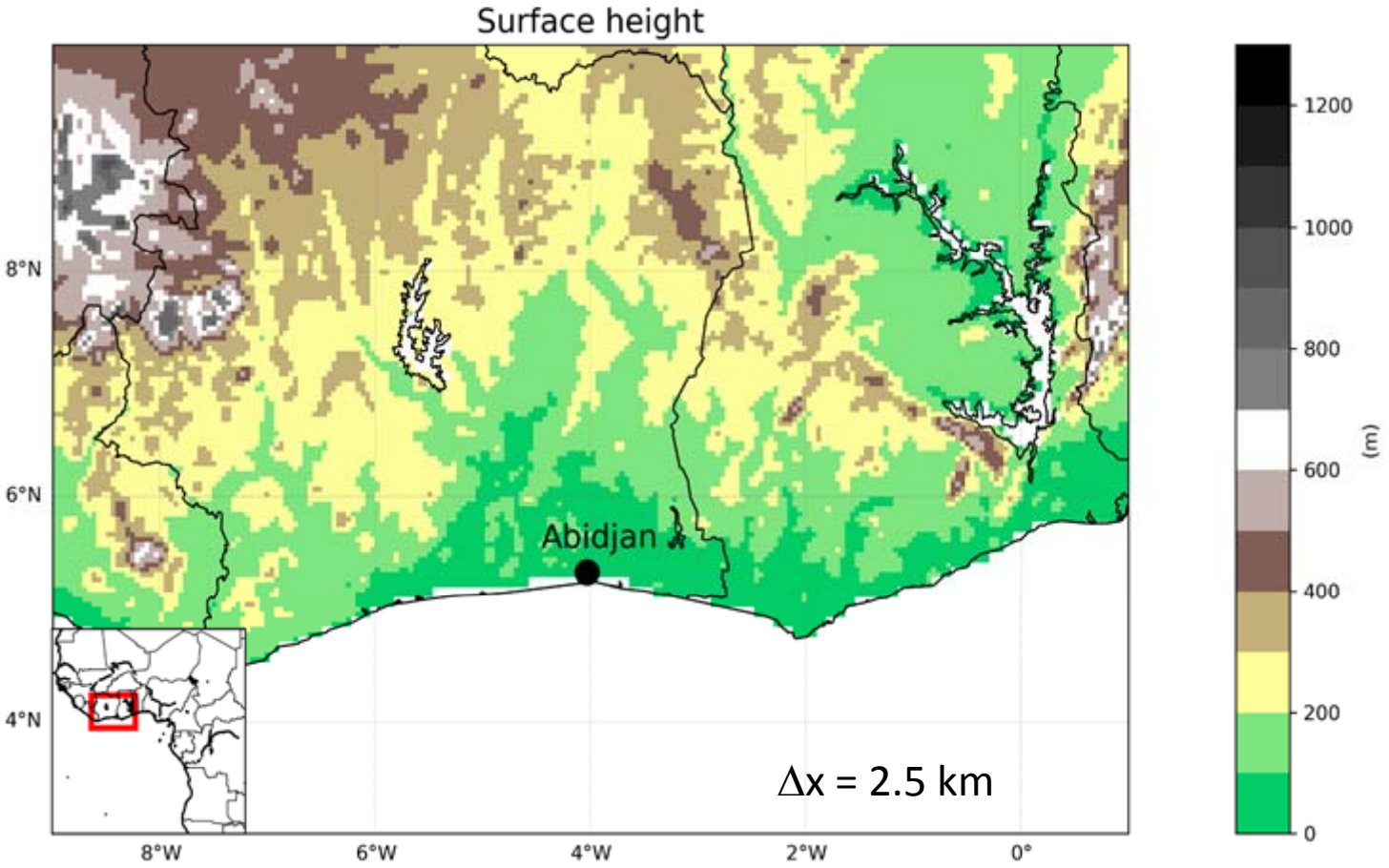




Prognose zuletzt aktualisiert: 05.09.2018, 06:46



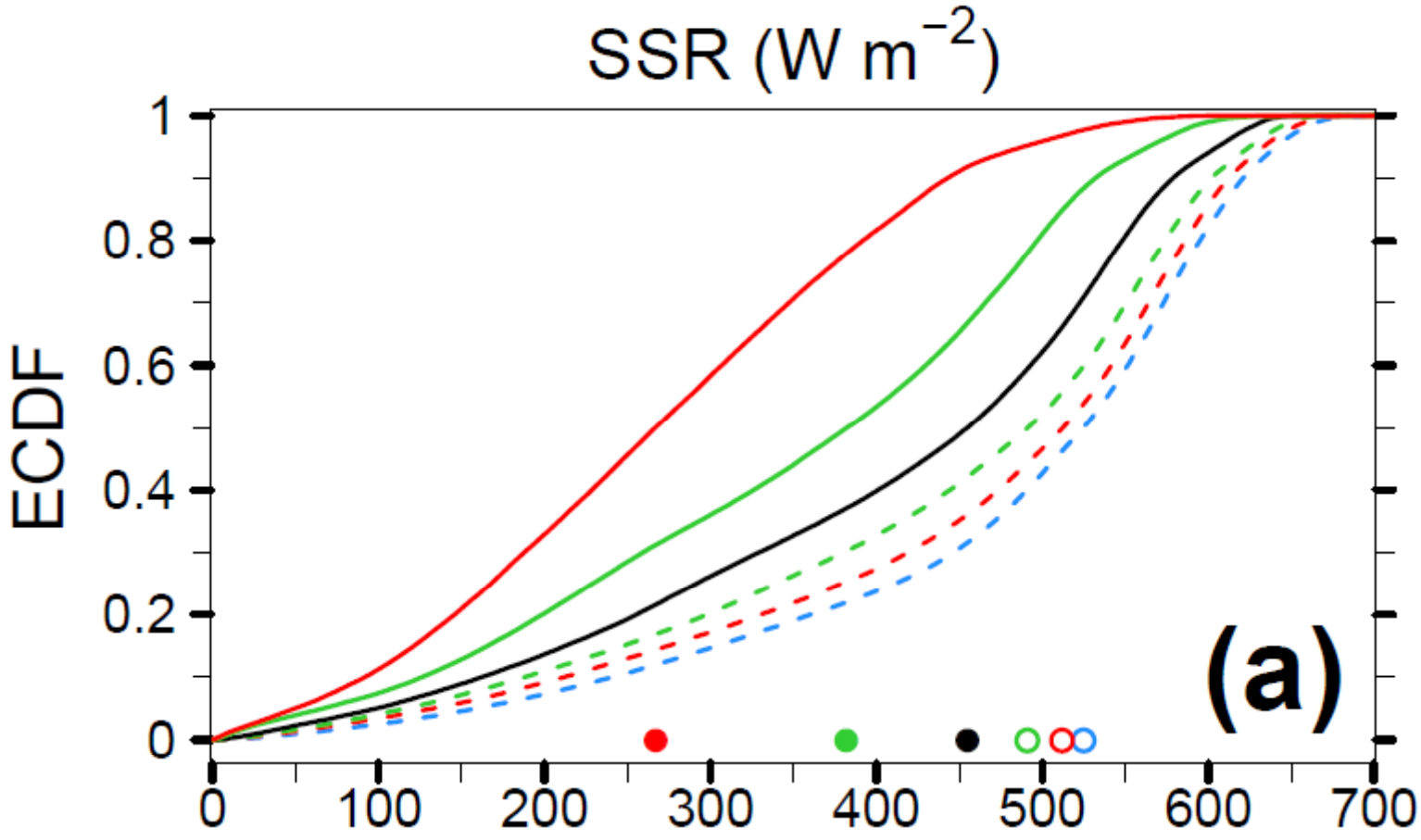
Impact of aerosols on clouds and atmospheric dynamics over southern West Africa



Δx = 5 km

Deetz et al., 2018

Impact on shortwave radiation at surface



Deetz et al., 2018 ACP

COSMO-Ru7-ART

Small domain since June 2017

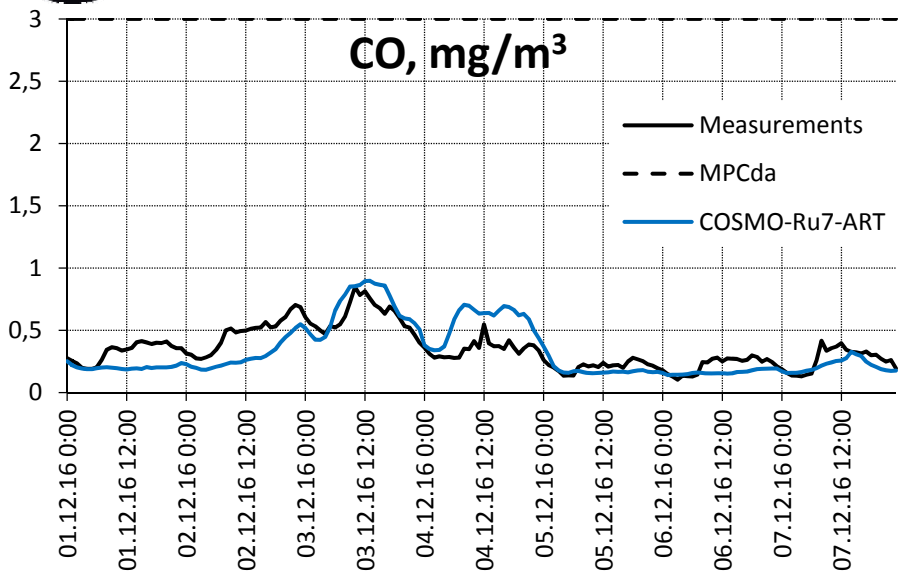
- 60 hour forecast from 12 UTC
- 135x150x40 grid
- ~30-45°E, 50-60°N
- spatial resolution 7 km
- Δt = 40 s
- initial and boundary conditions

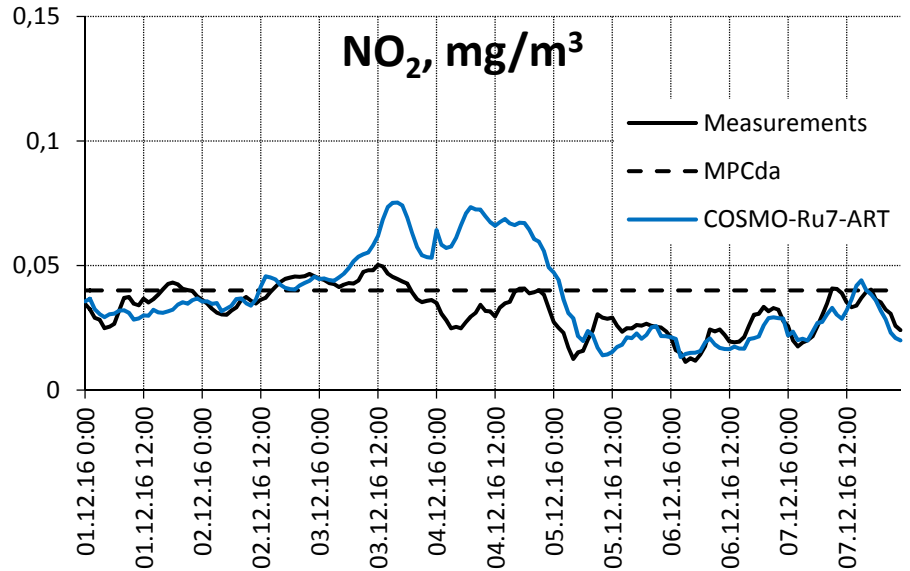
COSMO-RU7

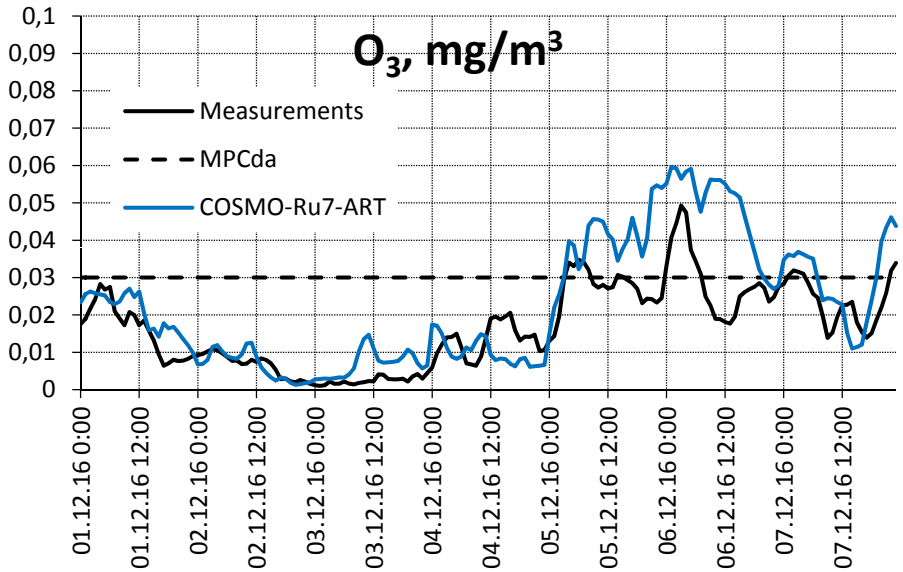
- anthropogenic emissions TNO
- Landuse Data GLC 2000
- CO, NO, NO_2, O_3, SO_2, PM_{10}

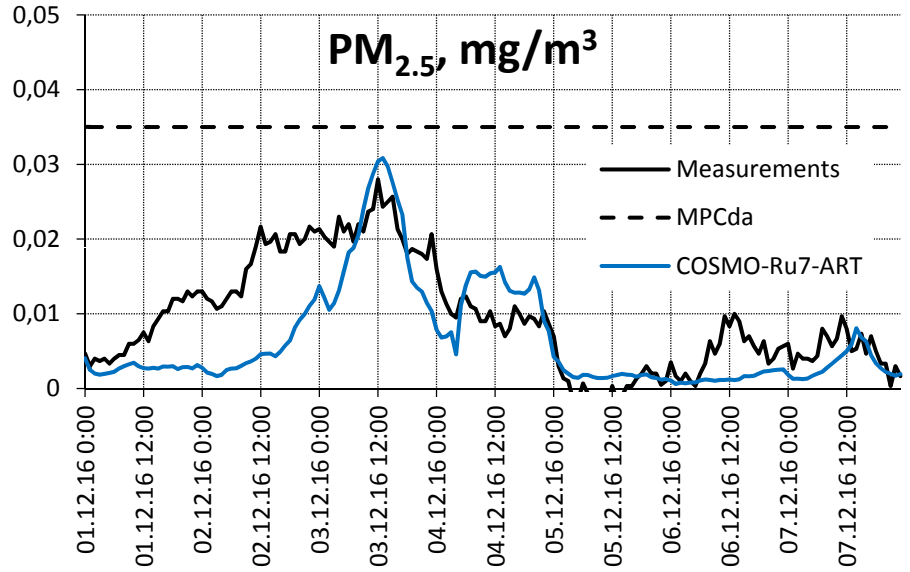
COMPARISON WITH MEASUREMENTS

Pollutant concentrations forecasted on 01.12.2016 – 07.12.2016





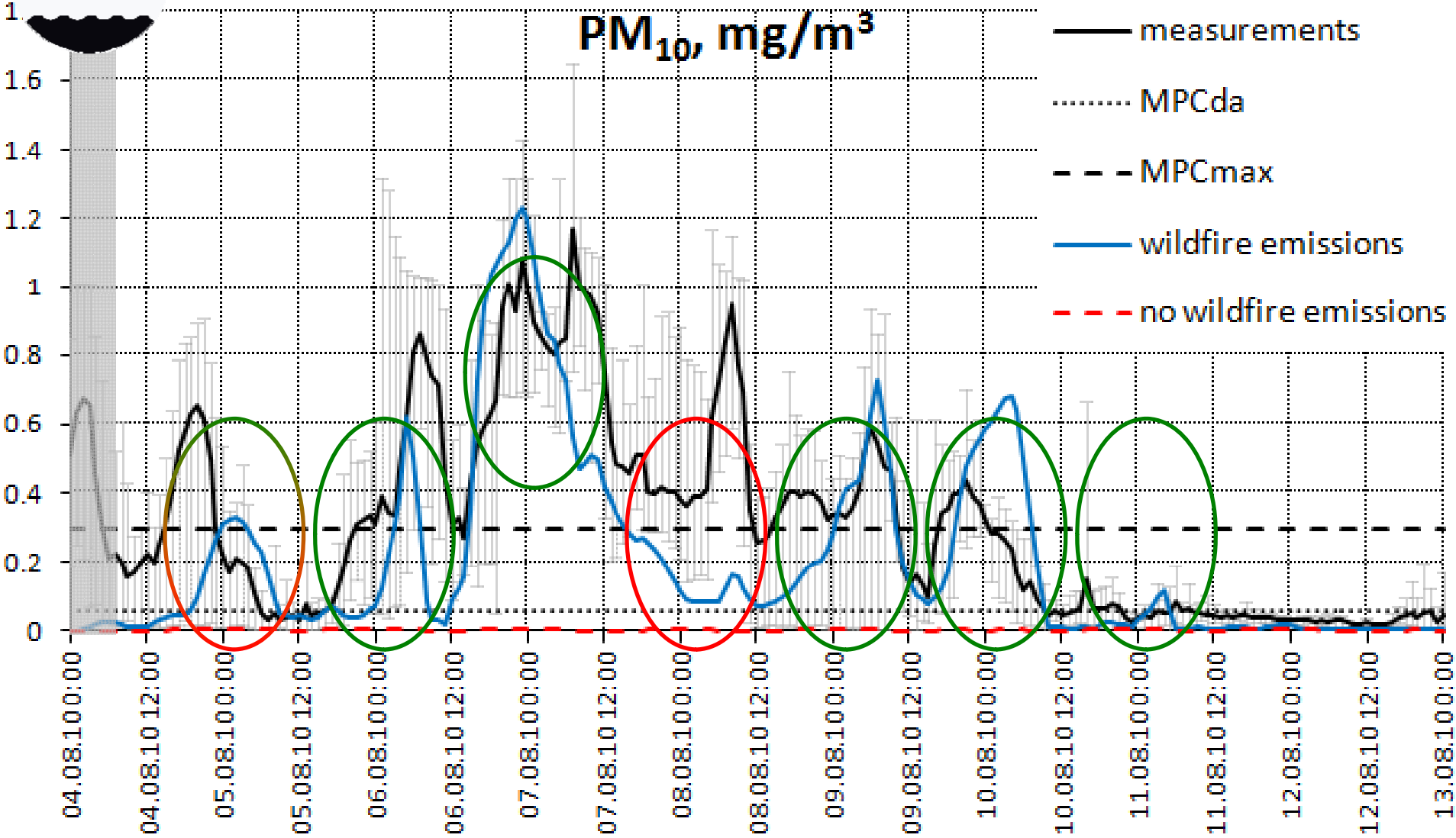




FOREST FIRES OF SUMMER 2010

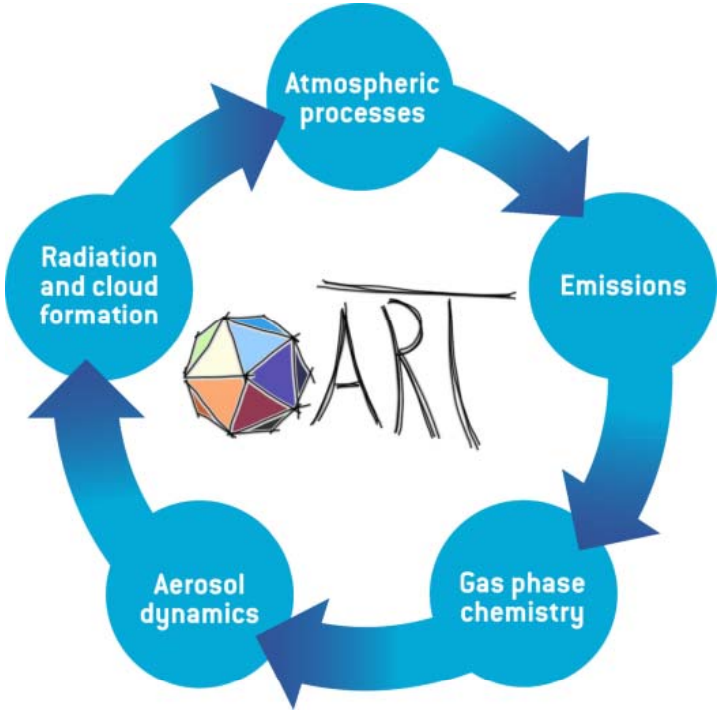
Moscow, Aivazovsky Street,
17.06.2010 (left) and 07.08.2010 (right)

PM_{10} CONCENTRATION FORECAST

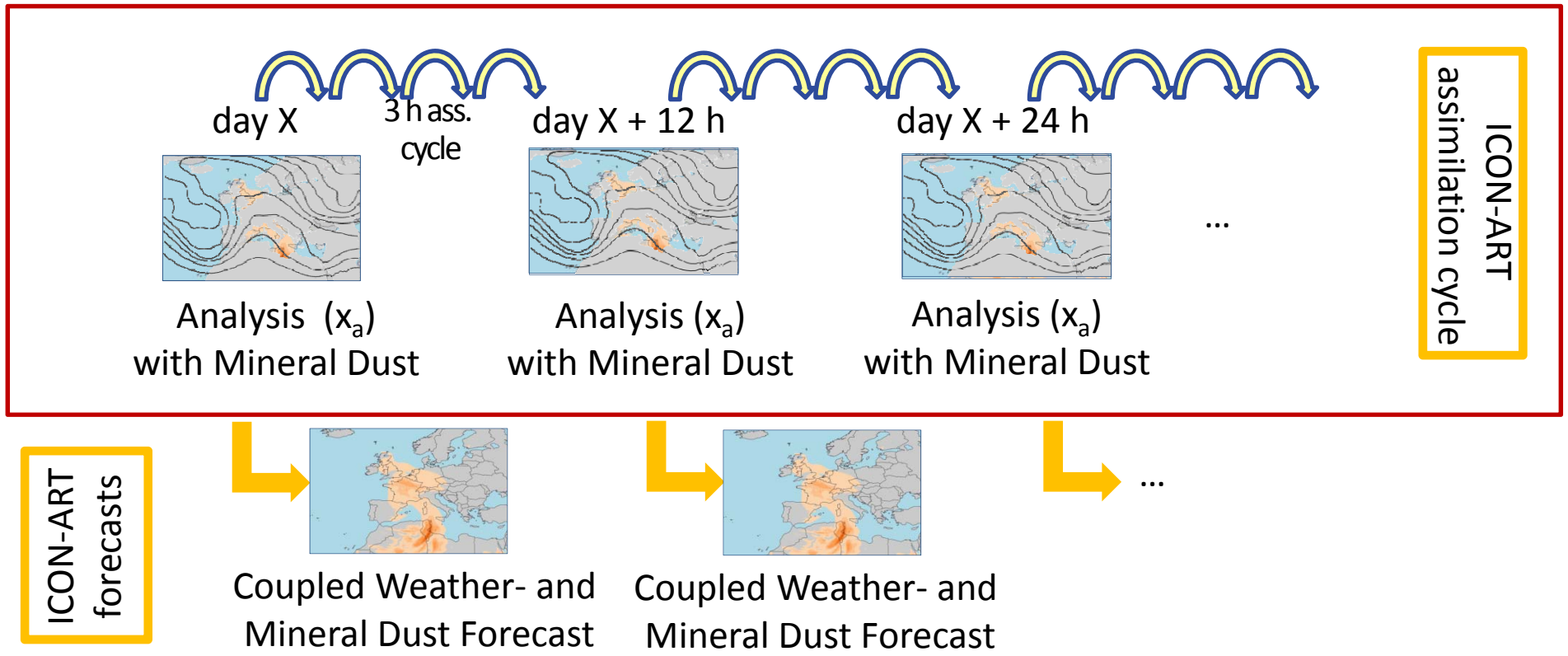


- MPCda – maximum permissible concentration daily averaged = 0.06 mg/m^3
- MPCmax – maximum permissible concentration 20 min. averaged = 0.3 mg/m^3

Development and applications of ICON-ART



ICON-ART in EnVar mode

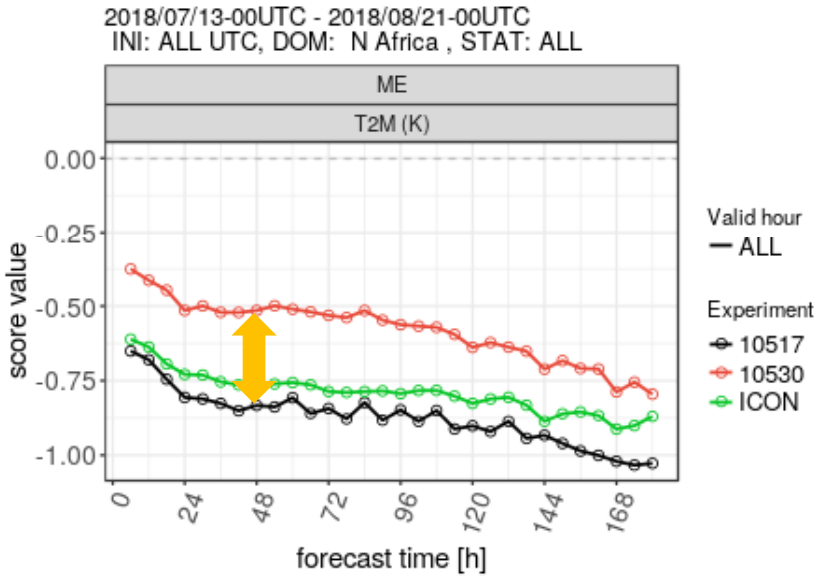


Take home message: First guess forecasts (x_b) in assimilation cycle are ICON-ART forecasts with mineral dust, including aerosol radiation interactions

ICON-ART: Verification of the EnVar mode, N-African biases and runtime optimizations

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- ICON-ART runtime optimizations (280% → 178%) of mineral dust forecast
- Bug in SMA has been recognized and is being fixed
- ReSQME – T-Bias in N-Africa:
  - **Modified longwave emissivity reduces negative Temperature Bias in N-Africa** (ICON vs. exp_10530)

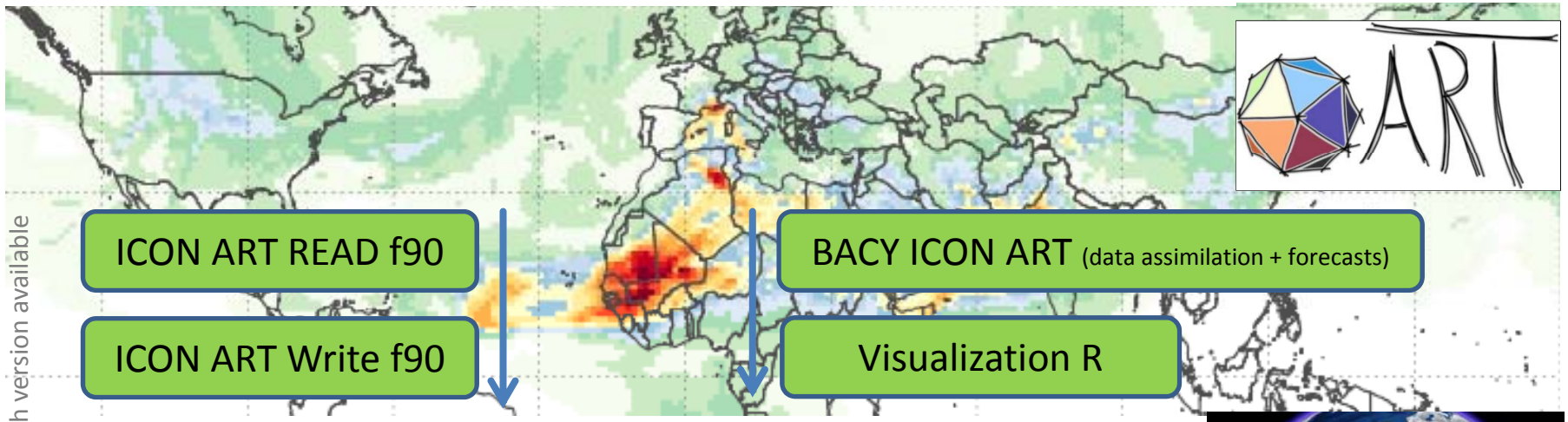


T-Bias in N-Africa in ICON-ART exp_10517 with prognostic mineral dust:

- Problem of large temperature bias in dust source region prevails despite improved longwave emissivity!

ICON ART Data Assimilation

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Green background : research version available

ICON ART READ f90

ICON ART Write f90

2D VAR Octave

2D VAR f90 basic

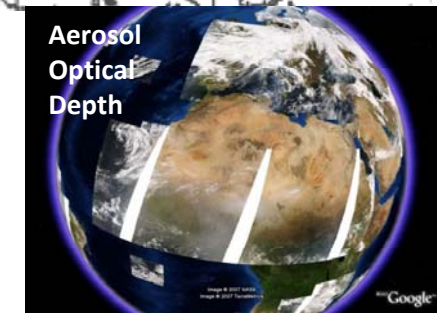
3D VAR f90 basic

BACY ICON ART (data assimilation + forecasts)

Visualization R

MODIS AOD read f90

AOD Obs-Op f90



Variational Assimilation 2D VAR/3D VAR/EnVAR

$$x^a = x^b + B\,H^T\,(R + H\,B\,H^T)^{-1}(y - Hx^b)$$

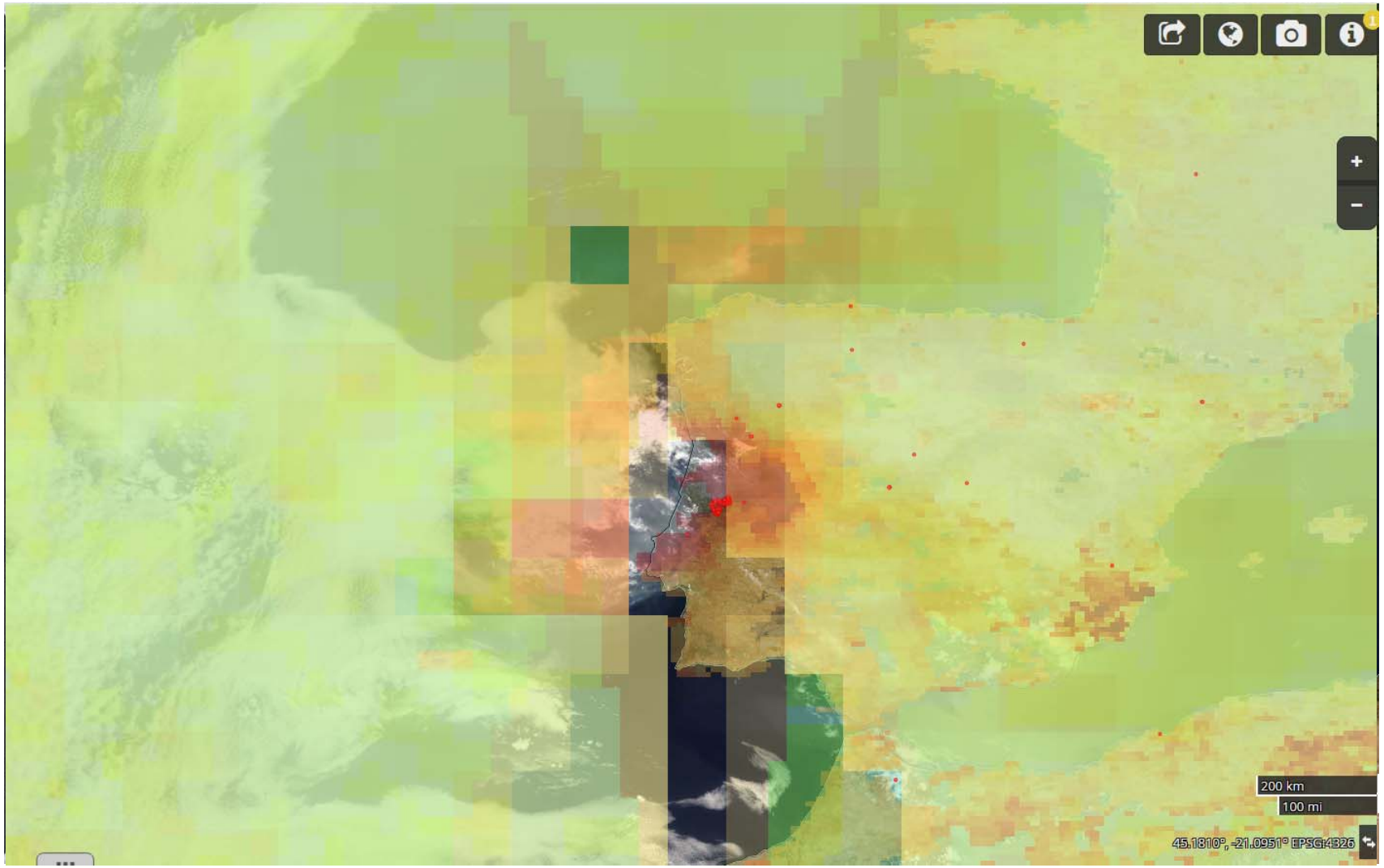
Experiments

Consolidation

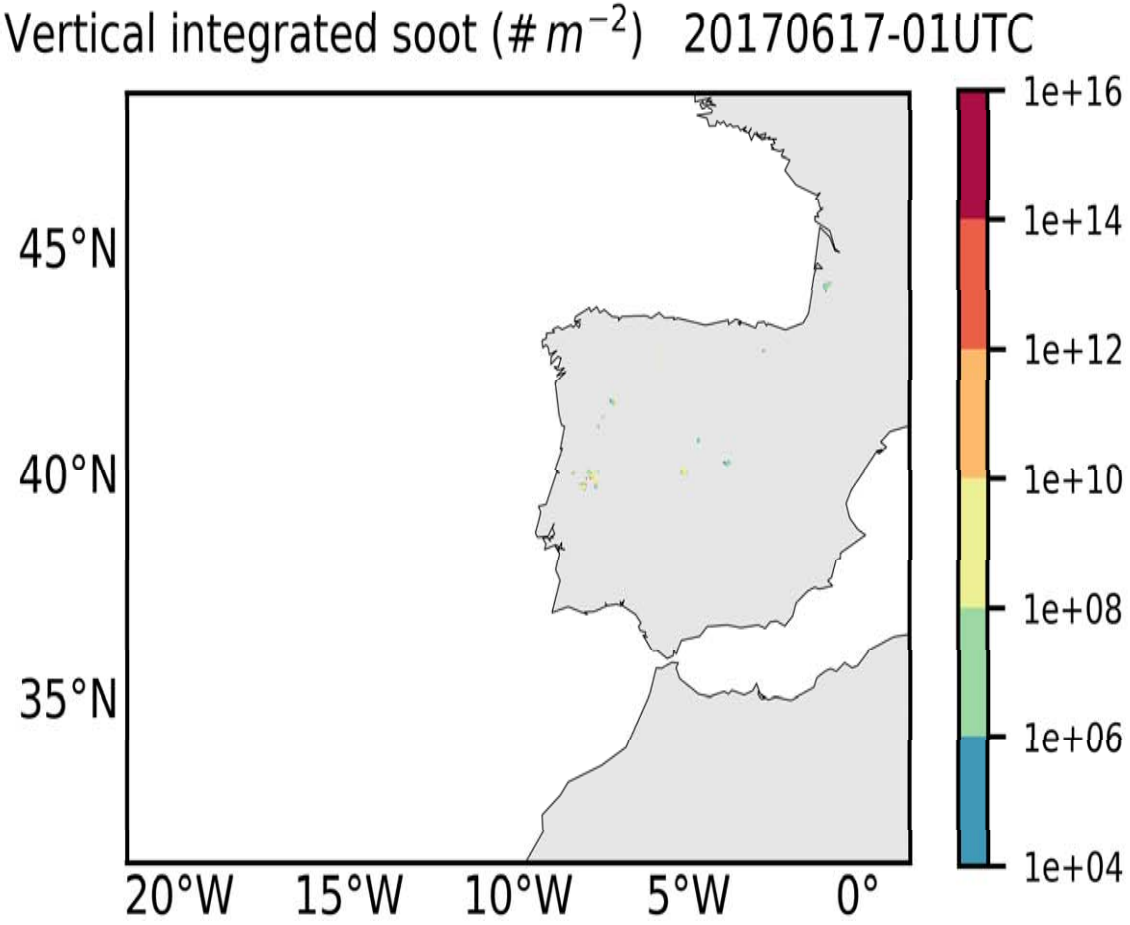
Documentation

Operationalization

Vegetation fires, 17.06.17 Portugal



Vegetation fires, 17.06.17 Portugal



Publications

Baklanov et al.: *Key issues for seamless integrated chemistry-meteorology modeling.* Bull. Amer. Meteor. Soc., Nov., 2285-2292, 2017.

Deetz et al.: *Numerical simulations of aerosol radiative effects and their impact on clouds and atmospheric dynamics over southern West Africa,* Atmos. Chem. Phys., 18, 9767-9788, 2018.

Deetz et al.: *Aerosol liquid water content in the moist southern West African monsoon layer and its radiative impact, A*tmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-420, 2018.

Gruber et al.: *Contrails and their impact on shortwave radiation and photovoltaic power production - a regional model study,* Atmos. Chem. Phys., 18, 6393-6411, 2018.

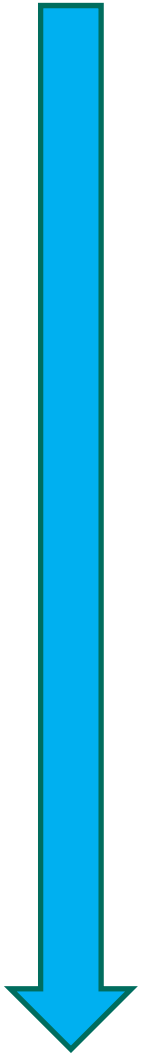
Schröter et al.: *ICON-ART 2.1 – A flexible tracer framework and its application for composition studies in numerical weather forecasting and climate simulations*, Geosci. Model Dev., 2018.

Barrett et al.: *One step at a time: How model timestep significantly affects convection-permitting simulations*, submitted to JAMES, 2018.

Hoshyaripour et al.: *Accounting for particle non-sphericity in a dust forecast system: Impacts on model-observation comparison*, submitted to JGR, 2018.

Gruber et al.: *A process study on thinning of Arctic winter cirrus clouds with high-resolved ICON-ART simulations*, in preparation.

Aerosols in operational forecasts



Pollen grains: **health issues**

Volcanic ash: **aviation**

Mineral dust: **visibility**

Vegetation fires: **health, aviation**

Sea salt, mineral dust: **cloud formation**

Primary and secondary aerosols:

visibility, fog, icing, flooding, …