

SWEN METZGER<sup>1,2</sup> WITH SUPPORT FROM: GREGOR FEIGEL<sup>1</sup>, BENEDIKT STEIL<sup>3</sup>, SAMUEL RÉMY<sup>4</sup>, ANDREAS CHRISTEN<sup>1</sup>, SUE GRIMMOND<sup>5</sup>  
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## RESEARCH QUESTION

To which extent does aerosol hygroscopic growth influence meteorology on global and/or urban scales?

## EXPERIMENTS SET-UP

Only aerosol water is switched on / off. Aerosol number concentrations and composition unchanged. Exp 1+2, sst, stp, div, vor nudging towards ERA interim reanalysis data. No data assimilation. AOD calculation from size resolved N, PM and water.

### EXPERIMENT 1 AND 2 - NUDGED TOWARDS ERAI

Exp1 with aerosol water, Exp2 without aerosol water (both T42L31, daily mean).

### EXPERIMENT 3 AND 4 - ONLY SST FORCING (HADISST)

Exp3 with aerosol water, Exp4 without aerosol water (both T42L31, daily mean).

### IDENTICAL EMAC SETUP OF ALL EXPERIMENTS (1 - 4) W.R.T. EMISSIONS, ETC.

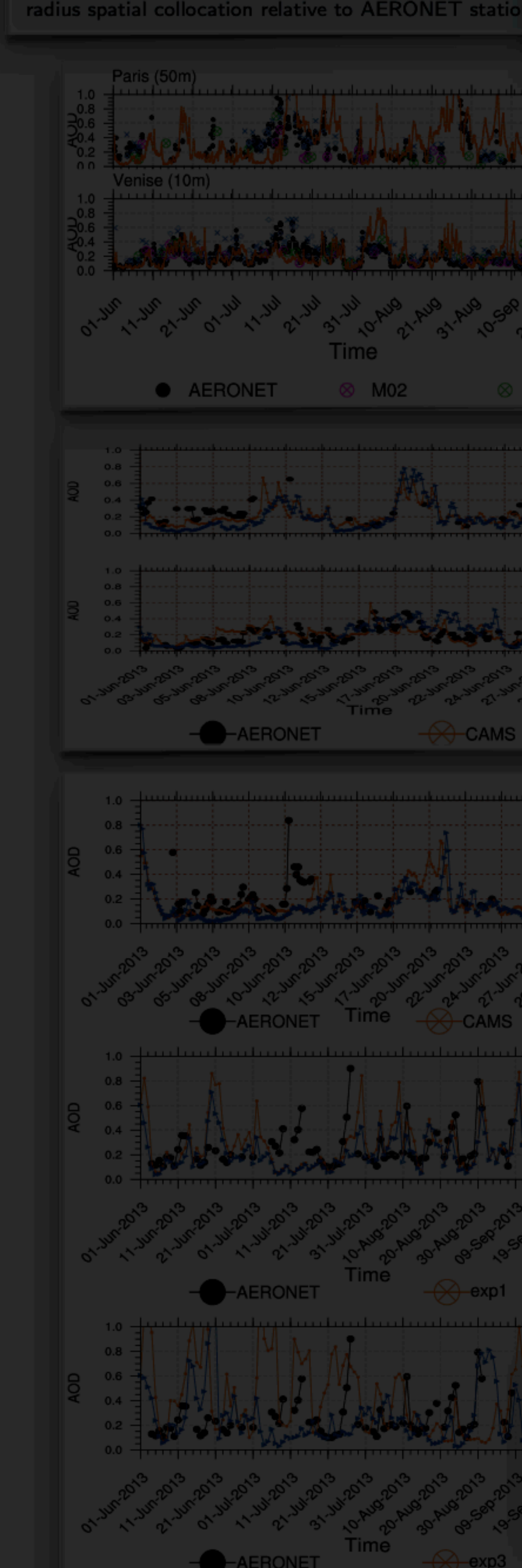
All exp., identical aerosol and gas phase chemistry, emission inventory and model spin-up.

## REFERENCE SIMULATIONS (HIGH RESOLUTION)

EMAC AOD vs CAMS reference simulations (REA) vs AERONET (3hr avg). CAMS REA includes AOD observations (data assimilation). EMAC does not. EMAC output regridded to CAMS grid (0.5 deg) for consistent reference model evaluation.

## SATELLITE OBSERVATIONS AND GROUND

AOD of PM<sub>2.5</sub> (M01, M02) and MODIS (Aqua / Terra) spatial collocation relative to AERONET station

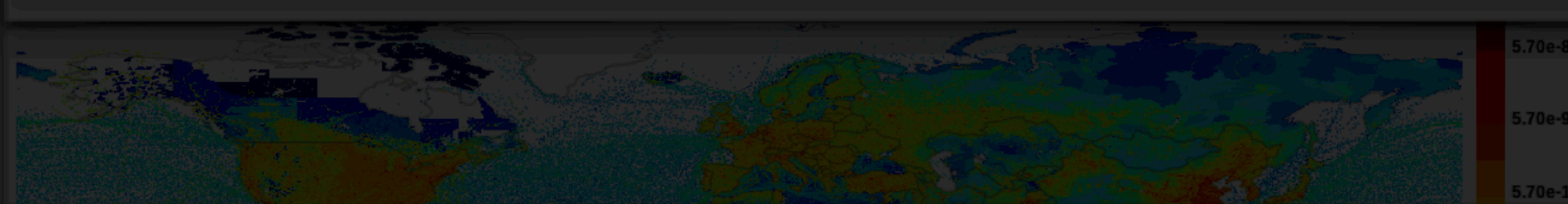


## HIGH RESOLUTION RUNS – EMAC T106 / T255 + ICON

The ICON modelling framework is a joint project between the German Weather Service and the Max Planck Institute for Meteorology for developing a unified next-generation global numerical weather prediction and climate modelling system. The ICON model has been introduced into DWD's operational forecast system in January 2015 (<https://code.mpimet.mpg.de/projects/iconpublic>).

## UPDATE OF EMAC EMISSION INVENTORY

Update of EMAC emission inventory based on CAMS-GLOB-ANT V4.2:  
<https://eccad.aeris-data.fr/2020/04/10/cams-glob-ant-v4-2-and-v4-2-r1-1-now-available>.



## SELECTION OF AERONET SITES WITHIN URBAN AREAS IN THE EUROPEAN UNION

Sensitivity study, first focus on AERONET sites located in urban areas in the European Union. Note, not all sites have data available throughout our simulation period (Jun–Sep year 2013). Results for an urban site are shown in the lower left Figure in comparison to a remote location (i.e. Hamburg vs Helsinki Lighthouse). [https://aeronet.gsfc.nasa.gov/cgi-bin/draw\\_map\\_display\\_aod\\_v3](https://aeronet.gsfc.nasa.gov/cgi-bin/draw_map_display_aod_v3) and [https://en.wikipedia.org/wiki/List\\_of\\_urban\\_areas\\_in\\_the\\_European\\_Union](https://en.wikipedia.org/wiki/List_of_urban_areas_in_the_European_Union).

## LOCATION OF AERONET SITES WITHIN URBAN AREAS IN THE EUROPEAN UNION

Location of AERONET sites within the top 20 and top 30 urban areas by population. Note, not all sites have data available throughout our simulation period (Jun–Sep 2013). [https://en.wikipedia.org/wiki/List\\_of\\_urban\\_areas\\_in\\_the\\_European\\_Union](https://en.wikipedia.org/wiki/List_of_urban_areas_in_the_European_Union).

Tab. 1: AERONET sites in urban areas in the European Union

| Urban area          | State          | elevation [m] | lat      | lon       |
|---------------------|----------------|---------------|----------|-----------|
| Aachen HOPS RWTH    | Germany        | 230           | 50.7777  | 6.0806    |
| Barcelona           | Spain          | 125           | 41.3850  | 2.1730    |
| Bari University     | Italy          | 12            | 41.1883  | 16.8308   |
| Berlin FDB          | Germany        | 80            | 52.4875  | 13.3103   |
| Brno Airport        | Czech Republic | 238           | 49.1547  | 16.6333   |
| Brussels            | Belgium        | 130           | 50.8333  | 4.35      |
| Bucharest Ince      | Romania        | 85            | 44.3453  | 26.0903   |
| Coruna              | Spain          | 67            | 43.363   | -8.4208   |
| Granada             | Spain          | 680           | 37.184   | -3.615    |
| Hamburg             | Germany        | 120           | 53.5833  | 9.97333   |
| Helsinki            | Finland        | 52.8          | 60.2078  | 24.9005   |
| Karlsruhe           | Germany        | 140           | 49.053   | 8.475     |
| Leipzig             | Germany        | 125           | 51.3525  | 12.4328   |
| Lille               | France         | 60            | 50.6187  | 2.14167   |
| Madrid              | Spain          | 680           | 40.4158  | -3.70385  |
| Malaga              | Spain          | 56            | 36.71524 | -4.478152 |
| Marseille           | France         | 34            | 43.2824  | 5.36817   |
| Munich Maastrich    | Germany        | 520           | 48.209   | 11.258    |
| Munich University   | Germany        | 555           | 48.148   | 11.573    |
| Napoli              | Italy          | 69            | 40.831   | 14.1917   |
| Paris               | France         | 50            | 48.8468  | 2.35068   |
| Rome La Sapienza    | Italy          | 75            | 41.9017  | 12.51377  |
| Roma Ter Vergata    | Italy          | 130           | 41.8955  | 12.6473   |
| Santa Cruz Tenerife | Spain          | 52            | 28.47253 | -16.24736 |
| Chemnitz            | Germany        | 80            | 50.83    | 12.85     |
| Toulon              | France         | 50            | 43.1858  | 6.09444   |
| Toulouse            | France         | 150           | 43.61472 | 1.37489   |
| Toulouse MIP        | France         | 150           | 43.61472 | 1.37489   |
| Valdeltia           | Spain          | 795           | 41.4626  | -4.79583  |
| Valdeltia Rd        | Spain          | 795           | 41.4622  | -4.7448   |
| Vienne BOKU         | Austria        | 366           | 48.25788 | 16.3101   |
| Vienne UNIVIE       | Austria        | 225           | 48.2107  | 16.3585   |
| Zaragoza            | Spain          | 117           | 41.6505  | -0.85954  |
| Zaragoza            | Spain          | 250           | 41.6334  | -0.85233  |

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| $\Delta$ [%] | -8.75       | 16.63       | 23.34       | 19.26       | -37.90      | -22.73      |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Europe       | Urban/City  | Urban/City  | Urban/City  | Rural/Coast | Rural/Coast | Rural/Coast |
| Exp          | Exp1 – Exp2 | Exp1 – Exp3 | Exp1 – Exp4 | Exp1 – Exp2 | Exp1 – Exp3 | Exp1 – Exp4 |
| Npoints      | 773         | 773         | 773         | 303         | 303         | 303         |
| $\Delta$ [%] | -31.57      | 30.59       | 9.47        | -31.95      | 29.10       | 0.98        |

## TAKE HOME MESSAGE

Aerosols can affect AOD, even with unchanged aerosol composition and number concentrations.

## EMAC vs CAMS – REFERENCE SIMULATIONS

CAMS REA closer to AERONET globally, but EMAC superior for some dust locations.

## MODIS vs AERONET – REFERENCE OBSERVATIONS

AERONET station SEDE BOKER (Israel), MODIS AOD – CAMS REA issue? Dust aging issue?

## EMAC vs SATELLITE AOD

EMAC AOD within the range of satellite AOD of MODIS (Aqua/Terra) and of PMAp v2.2.2, i.e., recent version of the Polar Multi-sensor Aerosol product of the Meteorological Operational Satellites (MetOp) on MetOp-B platform number 1 (M01), MetOp-A platform number 2 (M02).



## EXP2 VS EXP1 AND EXP4 VS EXP3

Aerosol water effect on AOD noticable for nudged and free running EMAC versions.

## EXP4 VS EXP1 RELATIVE TO EXP3 VS EXP1

Aerosol water effect on AOD larger for free running EMAC versions (Exp4 vs Exp1). Effect is evident for several AERONET sites, e.g., Hamburg, Karlsruhe, Thessaloniki, Zaragoza.

## REMOTE VS URBAN REGIONS

Aerosol water effect on AOD larger for urban regions due to moisture feedback with air pollution. This effect is most pronounced for the free running EMAC model. Exp1 – Exp4:  $\Delta(\text{urban})=9.47$  [%] vs  $\Delta(\text{rural})=0.98$  [%].