Project: **793** Project title: **PEGASOS** Project lead: **Susanne Pfeifer** Report period: **1.1.2014 - 31.12.2015**

The duration of the EU FP7 Project on the Pan-European Gas-AeroSOIs-climate interaction Study (PEGASOS) lasted for 4 years from 1 January 2011 to 31 December 2014. The Consortium is composed of 26 partners from 15 countries including the Climate Service Center Germany (GERICS) and coordinated by Prof. Spyros Pandis (pegasos.iceht.forth.gr).

GERICS participated in two workpackages. WP 12 focused on the impact of aerosols during the present climate. WP 14/15 investigated the impact of aerosols in a climate change scenario. The regional feedbacks due to aerosol-cloud-precipitation interaction in Europe were assessed by including an aerosol module in a regional climate model. In the regional aerosol-climate model REMO-HAM (Pietikäinen et. al., 2012), the aerosol module HAM-M7 has been implemented from the global climate model ECHAM5-HAM to the regional model REMO.

In order to investigate the regional feedbacks due to the aerosol-cloud-precipitation interaction during the present climate, the **REMO-HAM** simulation was driven by the perfect boundary conditions from the global reanalysis data of ERA-Interim (Simmons, et al., 2006) at a horizontal resolution of approx. $0.7^{\circ} \times 0.7^{\circ}$. The experiments used in this study were indicated in Table 1. The simulations were done using the coarse spatial resolution of 0.44 ° (about 50 km) with 27 vertical levels of the CORDEX Europe domain (Jacob et al., 2012).

For the evaluation of REMO-HAM, the simulation was compared with the results from the CRUv3.0 observations **(CRU)** and from the REMO simulation without the aerosol module (**REMO**). The 5-year simulation of REMO-HAM included the Greek forest fires of 2007. As a case study for the inclusion of forest fire emissions, the impact of aerosols on the cloud cover, precipitation and temperature were investigated during the summer of 2007.

Experiment	Description	Emissions, Chemistry	Period
REMO	REMO driven by ERA-Interim for model evaluation, European CORDEX Domain, 0.44 degree resolution	GHG_CTL	1989-2009
REMO-HAM	REMO-HAM driven by ERA-Interim including the Greek forest fires of 2007, European CORDEX Domain, 0.44 degree resolution, AEROCOM2000	AEROCOM2000+GFED3, MOZART	2005-2009

Table 1. Simulations setup used in the study.

To illustrate the impact of aerosols on cloud cover during the summer and winter for the 2005-2009 period, REMO-HAM simulation is compared to REMO by calculating their differences (REMO-HAM – REMO).



Figure 1. Changes (REMO-HAM – REMO) in cloud cover fraction during summer (left) and winter (right) for the 2005-2009 period. Blue (brown) shades indicate positive (negative) differences.

During summer (Figure 1), REMO-HAM has generally less cloud cover fraction in Europe with an exception over the Alpine region. During winter, REMO-HAM has a tendency of higher cloud cover fraction than REMO in northern and southern Europe.

Several experiments (Table 2) were planned to investigate future regional feedbacks due to the aerosol-cloud-precipitation interaction using the **REMO-HAM**. The simulations were done using the coarse spatial resolution (0.44 degree) with 27 vertical levels of the CORDEX Europe domain (Jacob et al., 2012). The model domain and boundary conditions were decided to develop a coordinated effort for future model intercomparison studies.

Experiments	Description	Period
REMO-EITR	REMO without aerosol module using the ERA-Interim for hindcast simulations	1979-2008
REMO-NORESMCLE	REMO without aerosol module driven by NORESM CLE and GHG from RCP4.5	1990-2050
REMOHAM-EITR	REMO-HAM using ERA-Interim, aerosols and emissions boundary conditions from AEROCOM, GFED, and oxidants from MOZART	2005-2009
REMOHAM-NORESM	REMOHAM driven by NORESM CLE, GHG from RCP4.5, aerosols and emissions boundary conditions from AEROCOM, and oxidants from MOZART	2005-2009
REMOHAM- NORESMCLE	REMOHAM driven by NORESM CLE, GHG from RCP4.5, aerosols and emissions boundary conditions from ECLIPSE, and oxidants from TM4	Representative years for 2005-2011, 2040- 2044

Table 2.	List of relevant	REMO and R	EMO-HAM	Experiments fo	or climate cha	nge simulations.
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As a case study, the REMOHAM-NORESMCLE simulation for the mean summer of 2040 was compared to the mean summer of 2005. Concentrations of different aerosol species as percentage difference between years 2040 and 2005 at lowest model level (up to several meters), were analyzed in Figure 2. The analysis was done during the summer season (JJA).



Figure 2 Difference of future and past aerosol concentrations over Europe during summer (2040 – 2005).

- Concentrations of black carbon were increased over Atlantic ocean by about 60 70 % with amplification up to 100% in the North Atlantic. The changes were moderate over the continental area with slight decrease over Northern Europe.
- An increase of sulfate concentration of about 60 % were found over south of France. Sulfate concentration was slightly increased over Italy, Spain and Portugal and slightly decreased over most parts of other European regions.

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