Project: 105
Title: ANDIVA (Analyse, Diagnose und Validation)
Report for period 01.01.2016-31.12.2016

During the year 2016, different research questions have been processed, leading to a couple of publications in scientific journals (partly based on work started in 2015). In this report, we give a short overview of achieved and ongoing research projects

a) Evaluation of moisture sources for the Central European summer flood in 2013

By means of the regional climate model COSMO-CLM, we evaluated the importance of different moisture sources for the summer flood event particularly along the Danube River in 2013. In a couple of sensitivity model experiments, individual potential moisture sources are analyzed concerning their influence on the heavy precipitation event triggering the flood. In each of the sensitivity experiments, a specific moisture source is uncoupled from the hydrological cycle (e.g. the Mediterranean, the Atlantic Ocean, The Black Sea or the continental areas) and its influence on the accumulated precipitation is considered. Our results show that the most important moisture source for this event was the continental evapotranspiration over Eastern Europe, followed by moisture uptake from the North Atlantic Ocean. In contrast, the evaporation over the Mediterranean and Black Sea has only little or even no impact on the accumulated heavy precipitation triggering the event.

Kelemen, F., Ludwig, P., Reyers, M., Ulbrich, S., & Pinto, J. (2016). Evaluation of moisture sources for the Central European summer flood of May/June 2013 based on regional climate model simulations. Tellus A, 68. *doi:http://dx.doi.org/10.3402/tellusa.v68.29288*

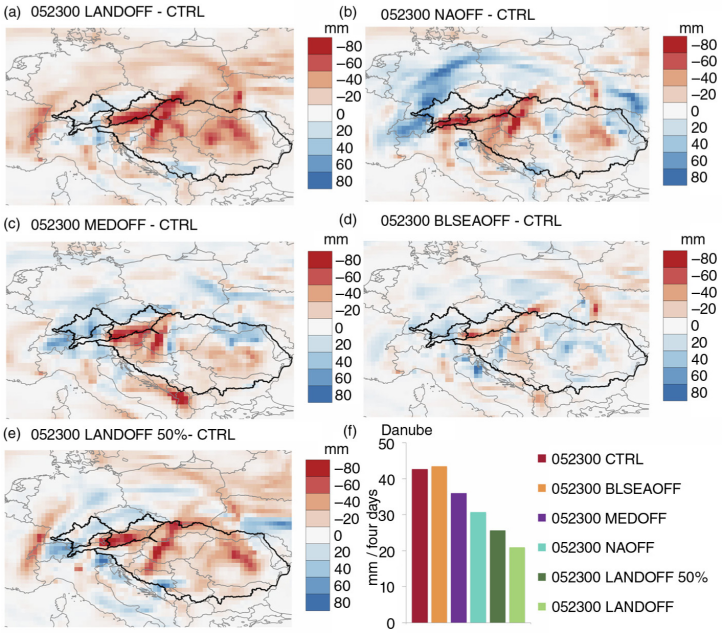

Figure 1: (a–d) Four-day (30.05.2013–02.06.2013) accumulated precipitation differences [mm] between the sensitivity simulations and the control simulation (053200 CTRL). (e) Same as (a–d) but for additional LANDOFF 50 % sensitivity experiment. (f) Four-day (30.05.2013–02.06.2013) accumulated precipitation mean in the Danube basin in the control and in the sensitivity simulations.

b) Influence of a single storm event on design water levels in the German Bight

Simulations of winter storm 'Xaver' (December 2013) with the regional climate model COSMO-CLM have contributed to a study on design water levels for coastal structures. The exceptional influence of such an event, which caused record breaking water levels for large parts of the southwestern German North Sea coastline is demonstrated. It is shown that the water level estimates for a 1 in 200 years event increased by up to 40 cm due to the update after 'Xaver', a value twice as large as the estimated regional sea level rise for the entire 20th century. However, a thorough analysis of different independent meteorological (winds and pressure) and oceanographic components (tides, surges, mean sea level (MSL) anomalies) driving the event reveals that their observed combination does not yet represent the physically possible worst case scenario. Neither tides, nor surges nor MSL anomalies were at their observational maximum, suggesting that there is a realistic risk of a storm like 'Xaver' to cause even higher extreme water levels by a few decimeters under current climate conditions.

Dangendorf S, Arns A, Pinto J G, Ludwig P and Jensen J 2016 The exceptional influence of storm 'Xaver' on design water levels in the German Bight. Environ. Res. Lett. 11 054001 doi: 10.3389/fmars.2016.00056

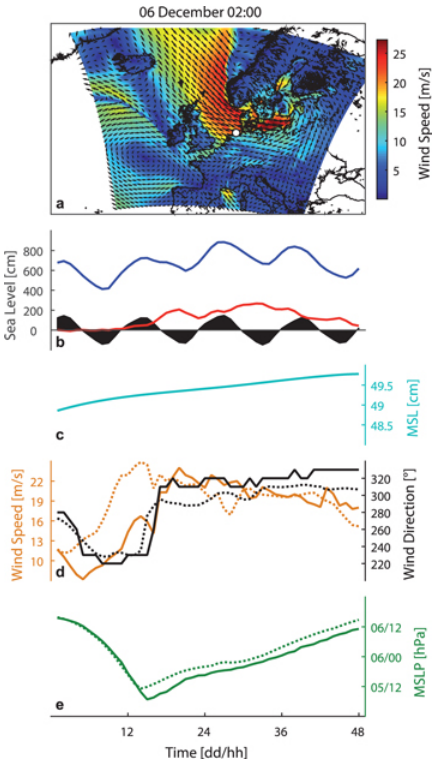

Figure 2. Oceanic and meteorological situation (observed and modelled) during storm Xaver. (a) Wind speeds as modelled by CCLM. The white dot marks the station of Norderney. (b) Water levels (dark blue), surges (red), and tides (black) at Norderney. The MSL component is shown in (c). Also shown are, in (d), the wind speeds and directions observed in 10 m height at Norderney (lines) and as modelled at the closest grid point to the station by CCLM (dotted). (e) as (d) but for observed and modelled MSLP curves.

c) High resolution simulation of the severe convective event during Pentecost in 2014

The COSMO-CLM is used with convection permitting resolution (2.8 km) to analyze the severe convective system crossing North-Western parts of Germany on Pentecost Monday 2014. The high-resolution simulations provide insights into the generation and dynamics of the event. Important features like a rear inflow jet or a mesocyclone connected to strong surface wind gust are reproduced by the simulation and thus provide insight to this rare type of event.

Mathias, L., Ermert, V., Kelemen, F.D., Ludwig, P., and Pinto, J.G.: Synoptic analysis and hindcast of the Pentecost storm above Western Europe on 09 June 2014 (in preparation)