Project: 105
Project title: ANDIVA (Analyse, Diagnose und Validation)
Principal investigator: Joaquim G. Pinto
Report for period 01.01.2020 - 31.12.2020

During the year 2020, different aspects of regional modelling of extreme events have been tackled. In this report, we give a short overview of achieved and ongoing research projects.

Research on compound-Events:

Weather events associated with concurrent wind and precipitation extremes, so-called compound events, can lead to severe damage. As continuation from last year, we finalized work on compound events on the Iberian Peninsula as a stand-alone chapter of a PhD-Thesis from Riccardo Henin. Summary of the work (partly described in 2019): An objective ranking of concurrent events is produced for the period 1979-2018 and the top100 ranked events are analyzed in detail. Subsequently, three of these events, namely the 5th Nov 1997 storm, Storm Emma on 28th Feb 2018 and Storm Ana on 10th Dec 2017 were simulated @DKRZ with the regional WRF model. The WRF model is used with a horizontal resolution of 3km. Several spin-up times have been considered (up to 3 days prior the day of maximum intensification of the cyclone) so that the best agreement (in terms of trajectory and time evolution of the cyclone intensity) with ECMWF-ERA5 reanalysis estimates is reached. It is observed that short spin-up time is preferable: larger time intervals lead to weaker and East-shifted cyclones than observed. Current research focuses on the analysis of possible drivers for the intensification of the cyclones and the observed impacts.

Transition COSMO-CLM → ICON-CLM

This topic is still ongoing in 2020 and will continue in the next years. The ICON code is now running on mistral @DKRZ utilizing resources in this computing time project and the Starter Package for ICON-CLM Experiments (SPICE-Environment) has been setup up successfully. First sensitivity experiments considering namelist setting are expected until the end of this year. Within this project KIT contributes to the ICON-CLM model development with partners at DWD, HZG, FU-Berlin and BTU-Cottbus. As new member of the project group ICON-core, KIT is a key partner now for the development and testing of the ICON-CLM runtime environment and namelist parameter sensitivity testing.

Two-Way nesting with ICON-LAM

The European windstorms Kyrill (2007), Xynthia (2010), Klaus (2009) and Christian (2013) are modelled with the ICON model in limited-area mode driven by ERA5 data. Simulations are conducted on a horizontal resolution of 10 km with nested domain of 5 km and 2.5 km horizontal resolution. The nested domains are either placed over the development area of the winstorms (North-Atlantic) or over the impact region (Europe). Several sensitivity experiments are conducted with different nesting areas, 1-way vs. 2-way nesting, and parameterized convection on/off. A special focus is on the sensitivity of the modelled European windstorms with 1-way vs. 2-way nesting. It is seen that there is a high case-to-case variability. For e.g. Windstorm Kyrill, which was mainly synoptically driven, the differences between 1-way and 2-way nesting are small. For Windstorm Xynthia, on the other hand, diabatic processes play an important role. Differences in the dynamics in an early stage lead to a slightly different storm development 24 hours later. However, all simulations perform quite well when maximum wind gusts are compared to observations (Fig. 1). Further, the the dynamics of windstorms under several environmental conditions, using sensitivity experiments and trajectories analysis will be considered. This work is part of a new MSc-Thesis and no results can be shown yet.
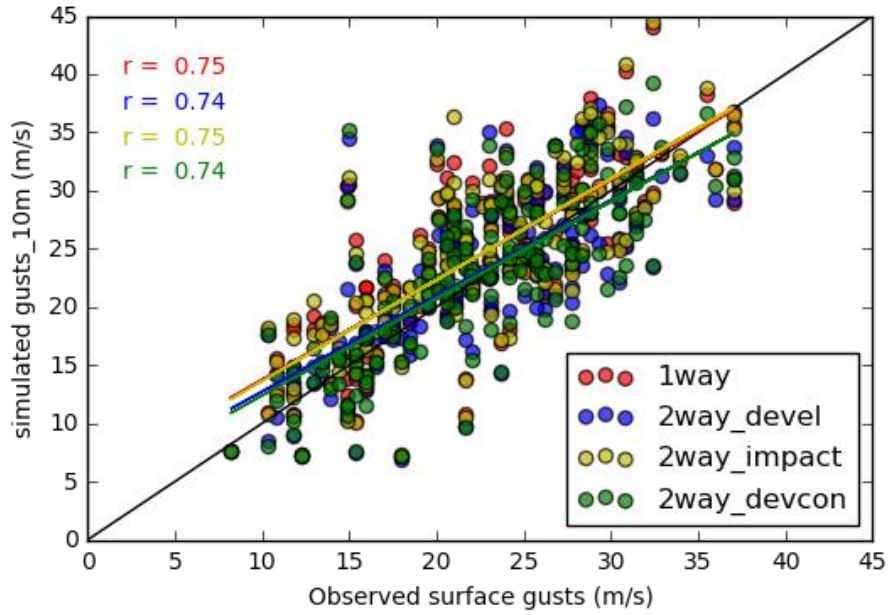
Figure 1: Correlation between observed and simulated maximum surface (10m) wind gusts for windstorm Xynthia (2010) based on the simulations using 1- way nesting (red), a 2-way nested domain over the development area of Xynthia with either boundary layer convection parameterized (blue) or all convection explicitly computed (green), and a 2-way nested domain over the impact area of Xynthia (yellow). Observations are obtained from the NOAA GSOD catalog. (https://catalog.data.gov/dataset/ global-surface-summary-of-the-day-gsod).

Tornado outbreak in Luxemburg

On 9 August 2019, a supercell thunderstorm crossed over the south-western part of Luxembourg during the evening hours and produced a significant tornado along its path. Roughly 400 trees and a total of 310 houses were damaged, 50 of which lost their roofs Moreover, the tornado was associated with 17 minor casualties and 2 seriously injured persons. The vortex lasted for about 10 to 15 minutes and travelled a distance of 18 to 20 km. The tornado was rated as IF2+ based on the scale currently in development by a steering group lead by the European Severe Storms Laboratory which corresponds to estimated maximum wind speeds of approximately 241 km h^{-1}. We used the DKRZ capacities to analyze this event in more detail with a focus on predictability and uncertainties in ensemble forecast products (COSMO-DE ensemble). A publication of this rare event is currently in preparation.