Understanding and Attributing the Severity of Extreme Precipitation Events

Main Supervisor: **Douglas Maraun** [**showcase 1**]
Research field "Physical climate science: extreme events in a warming climate, underlying processes, modelling and uncertainties"
Research question 2 | Cluster 1
Links to showcases Foelsche 1, Foelsche 2, Kirchengast 1, Steiner 1 , Birk 1, Meyer 1, Sass 1, Schulev-Steindl 2

Background: The hydrological cycle has already responded to climate change, and is expected to invigorate under continued global warming. Austria is delicately affected by hydrological extreme events, in particular by so-called Vb cyclones. These summer storms are formed over the gulf of Genoa, travel across the Adriatic, and bring heavy precipitation to the South-East of Austria. These events often cause severe landslides, such as in the summers of 2009 and 2014. It has been shown that recent Mediterranean warming may have amplified the intensity of such precipitation extremes by up to 20 % (Volosciuk et al., 2016). We haves just started to quantify the relationship between heavy precipitation and landslide occurrence in south-eastern Styria, and potential changes in landslide occurrence under climate change.

Goal: The PhD thesis will improve our understanding of (1) the physical mechanisms causing the 2009 and 2014 heavy precipitation events in south-eastern Styria; (2) how these mechanisms have been modified already by climate change; and (3) how these mechanisms may further change in a future climate. The relevant mechanisms include: the moisture sources, in particular over the Mediterranean sea; pre-moistening by a preceeding wet spell; the atmospheric stability; feedbacks due to latent heating (which amplify convection) and latent cooling (in downdrafts, which ultimately shut down convection); and the spatial organization of convection (which may result in a higher affected area). A comparison of the 2009 and 2014 events is planned.

Methods and disciplinary background: The project will combine a suite of state-of-the-art modeling approaches. The events, as they happened, will be analyzed based on operational analysis, reanalysis data, and observations from Wegener Net and ZAMG. Lagrangian modeling will be employed to identify the moisture sources of the event (based on backtracking with the Hysplit model). The physical mechanisms will be analyzsed by very high-resolution storyline simulations of the event (Trenberth et al., 2015; Meredith et al., 2015) with the atmospheric regional climate model CLM. The event based approach will allow for a horizontal resolution of approx. 1 km to resolve deep convection and the complex topography of south-eastern Styria and surrounding regions. The observed boundary conditions will be systematically varied to isolate the different physical mechanisms, and to simulate the response of these mechanisms to past and future climate change.

References:

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