

Attribution of temperature and hydrological extreme events to human-induced climate change

Main Supervisor: **Andrea K. Steiner** [showcase 2]

Research field “Physical climate science: Uncertainties in atmospheric processes in a changing climate”

Research question 2 | Cluster 1

Links to showcases Bednar-Friedl 2, Birk 1, Foelsche, Maraun, Meyer 1

Background: The attribution of extreme events to human-induced climate change is of particular interest and has been demonstrated for record hot seasons (e.g., King et al., 2016). It is challenging since changes in circulation are uncertain. Forced circulation changes are not well established in current climate models, and it is difficult to detect changes in circulation-related extremes in observations because of small signal-to-noise ratios. Sensitivity experiments show a decrease in blocking occurrence and shifts eastward over Europe due to a projected eastward extension of the jet and storm track (Kennedy et al., 2016), whereas Arctic sea ice observations point to an increase of blocking occurrence (e.g., Francis and Skific, 2015). A robust approach to climate extreme-event attribution is needed.

Goal: The attribution of temperature and hydrological extreme events to human-induced climate change, in particular of heat waves and drought in Europe (with the DK focus region South East Styria), as well as in drought prone region in Africa. Given a disruption in atmospheric circulation, such as blocking, that caused an event, how did climate change alter its impacts? Why and what kind of changes can be expected in the future? This will be investigated using high quality observations and selected climate models with good blocking representation (Davini and D’Andrea, 2016; Mitchell et al., 2016).

Methods and disciplinary background: For investigating the influence of anthropogenic forcings on extreme heat events, we will use the fractional attributable risk framework (Hegerl et al., 1996; Stott et al., 2004; King et al., 2016). It compares the probability of such events between climate model simulations with both natural and anthropogenic forcings and those with natural forcings only. We further consider the approach of Trenberth et al. (2015) to climate extreme-event attribution. They regard the circulation regime or weather event as a conditional state and ask whether the impact of the particular event was affected by known changes in the climate system’s thermodynamic state (e.g., temperature or atmospheric moisture content).

References:

- Davini, P., and F. D’Andrea (2016), Northern Hemisphere atmos. blocking representation in global climate models: Twenty years of improvements? *J. Climate*, 29(24), 8823–8840, DOI:10.1175/JCLI-D-16-0242.1.
- Francis, J., and N. Skific (2015), Evidence linking rapid Arctic warming to mid-latitude weather patterns, *Phil. Trans. R. Soc. A*, 373(2045), DOI:10.1098/rsta.2014.0170.
- Hegerl GC, von Storch H, Hasselmann K et al. (1996) Detecting greenhouse-gas-induced climate change with an optimal fingerprint method. *J. Climate*, 9(10): 2281-2306.
- Kennedy, D., et al. (2016), The response of high-impact blocking weather systems to climate change, *Geophys. Res. Lett.*, 2016GL069725, DOI:10.1002/2016GL069725.
- King, A. D., et al. (2016), Emergence of heat extremes attributable to anthropogenic influences, *Geophys. Res. Lett.*, 2015GL067448, DOI:10.1002/2015GL067448.
- Mitchell, D., et al. (2016), Assessing mid-latitude dynamics in extreme event attribution systems, *Clim. Dyn.*, 48, 3889–3901, DOI:10.1007/s00382-016-3308-z.
- Stott, P. A., D. A. Stone, and M. R. Allen (2004), Human contribution to the European heatwave of 2003, *Nature*, 432(7017), 610–614, DOI:10.1038/nature03089.
- Trenberth, K. E., J. T. Fasullo, and T. G. Shepherd (2015), Attribution of climate extreme events, *Nature Clim. Change*, 5(8), 725–730, DOI:10.1038/nclimate2657.