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Editorial: Modelling, simulating and forecasting regional climate and weather Volume 2

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Editorial on the Research Topic
Modelling, simulating and forecasting regional climate and weather Volume 2

The volume

Call for contributions

The call for papers was announced with this rationale (cf. https://www.frontiersin.org/research-topics/39396/modelling-simulating-and-forecasting-regional-climate-and-weather—volume-ii). The atmospheric dynamics is essentially the manifestation of a global machinery, within which larger scales are mostly conditioning smaller scales (the downscaling concept), and local processes feedback on the global scale in a statistical sense, often described by parameterizations.

However, the regional and local scales matter in terms of the impact of climate and weather on people and ecosystems. Therefore, the scientific development in the last years was mostly in two directions–towards global Earth system models, and towards the description of regional and local dynamics, and more and more so on the regional and local impact of climate and climate change. The present Research Topic deals with the latter.

Models describing the regional dynamics, and the links to supra-regional conditioning states, usually serve one of the following purposes: description of climate and its change; description of air quality and its change; reconstruction and analysis of past conditions, both in historical times and in Earth history; forecasting short term development; ensemble experiments; and process studies. Also, the issue what climate and climate events mean for social and economic life as well as ecosystem functioning comes to the fore. We ask for contributions in all these fields. A significant issue could be the challenge of detection of regional climate change and attribution of such change to a most plausible cause.

We ask for regional studies, covering several hundred kilometers of diameters but also “local studies,” in particular of urban conglomerates. Most approaches make use of limitedarea models, but some studies are making use of variable-resolution models and

high-resolution global models, which are however constrained on the large scales so that they complement a global forcing (available from analysis systems) with regional or even local detail. On the other end of resolution are convection-permitting models of interest.

While some studies are mostly focusing on dynamical aspects, such as the conditioning of regional and local processes by large-scale conditions and forcing (e.g., changing land-use), other concentrate on impacts, both on geophysical conditions (e.g., ocean waves and storm surges), components of the ecological systems (e.g., vegetation, algae blooms), but also on societal aspects (such as hazards related to extreme events).

The planning and managing of volume II was carried out by the same researchers as volume I (see von Storch et al., 2020), namely, Hans von Storch, Frauke Feser, Martin Stendel, Yinlong Xu, Izuru Takayabu, and Philippe Lucas-Picher (who replaced René Laprise).

Spectrum of regional issues

In most cases, the global studies of climate, climate variability, and the impact of external drivers, in particular a change of the atmospheric composition or the amount of incoming solar radiation, receive most attention, while in the context of the large atmospheric scales, the regional scales has only a subordinate role, and are mostly parameterized in climate models. As such, these global studies are of central relevance for designing and managing climate policy through reductions of greenhouse gas emissions.

However, the significance of regional studies is related to the examination of regional extreme events (e.g., Zhao et al.; Aue et al.), to allow to determine regional specifics through downscaling (e.g., Ishizaki et al.), to document past changes, to detect current non-natural changes and attribute these to most plausible causes (e.g., Zuo et al.), to project expected future climate changes and their regional and local impacts (e.g., Naka and Nakakita; Ozturk et al. All this may be of minor significance for *issues involving mitigation of possible future climate change*, but of major significance for the challenges of responding regionally and locally to these multifaceted changes, i.e., for *regional and local adaptation*.

Obviously, such a volume can only touch upon the some various issues, but our six papers certainly contribute to the, unavoidably slow, progress the field is confronted with.

The contributions

A total of six papers was successfully submitted to the publication process.

- Two of these papers deal with case studies. One, by Zhao et al., investigates the synoptic development in the Japan region during the Meiyu-Baiu 2020. Through a numerical experiment, they examined the actual impact of moisture from the subtropical West Pacific region on the regional atmospheric river. By reducing the moisture supply, they confirmed the importance of moisture in the atmospheric river and the resulting precipitation over Japan during the exceptional Meiyu-Baiu season.
- The case study by Aue et al. examines the influence of a series of three intense cyclones on the sea ice cover in the Barents and Kara Seas in February 2020. They utilized a numerical experiment to analyze the changes in sea ice concentration and thickness, distinguishing between their dynamic and thermodynamic contributions. The study reveals that the significance of these contributions depends on the time interval between the arrival of subsequent storms.
- Ishizaki et al. explored the potential of downscaling by focusing on the Upper Chagres River Basin, which has a significant impact on the stable functioning of the Panama Canal. The researchers conducted dynamical downscaling experiments using a convection-permitting model with horizontal grid spacings of 5 and 2 km. Their findings indicate that this modeling approach successfully replicates the diurnal characteristics of the orographic effect, specifically the morning rainfall on the Caribbean seaside coastal region in the western Caribbean Sea, as well as an early afternoon precipitation peak in the landside coastal regime.
- The research conducted by Zuo et al. focuses on the recent climate developments in China. They utilized a coupled atmosphere-ocean-sea ice model, as well as a stand-alone atmospheric model, to examine the historical variations in surface air temperature. Both models successfully reproduce the observed variations in surface air temperature.

  The coupled model particularly captures the cooling trend observed during the period 1941–1970, while the uncoupled model fails to replicate it effectively. Moreover, the coupled simulations exhibit stronger long-term trends compared to the uncoupled simulations when considering the full interaction among the atmosphere, ocean, and sea ice during the period 1870–2014.

  Conversely, the uncoupled simulations better replicate the decadal and multi-decadal surface air temperature variations, thanks to the constraints imposed by observed sea surface temperatures. The research findings suggest that the warming experienced in the early 20th century and the recent 50 years can be primarily attributed to natural forcings and greenhouse gases. On the other hand, the cooling observed during the period 1941–1970 is predominantly influenced by natural factors and anthropogenic aerosols.
- In their study, Naka and Nakakita investigated climate change projections regarding local extreme rainfall associated with the Baiu front, specifically focusing on the period from June to August in Japan. The researchers examined two representative concentration pathway scenarios to assess the potential impacts.

  To conduct their analysis, they utilized high-resolution regional climate model simulations with a 5-km-mesh resolution. The findings indicate that under the RCP2.6 scenario, a is projected 20% increase in the frequency of Baiu extreme rainfall events compared to the current climate. Furthermore, under the more severe RCP8.5 scenario, the frequency of Baiu extreme rainfall is projected to increase by at least 1.5 times compared to the current climate.

  Overall, the study highlights the potential future changes in the occurrence of localized extreme rainfall associated with the

Baiu front in Japan, indicating an increased frequency of such events under both considered scenarios.

- Ozturk et al. examined the scalability of extreme temperatures across the European region. They utilized an ensemble of regional climate models embedded in different GCM projections. The researchers scaled the regional changes in daily minimum and maximum temperatures based on the corresponding global warming levels obtained from the driving GCMs. This approach allowed them to provide insights into climate change projections for specific periods or emission scenarios, even in the absence of dedicated simulations.

  According to this study, the annual minimum temperature of the lowest temperature recorded in a day exhibits a greater increase compared to the annual maximum temperature of the highest temperature recorded in a day across Europe. The multi-model mean of the changes in scaled patterns of extreme temperatures becomes apparent early, around 2020, even before reaching robustness. On the other hand, individual scaled patterns of the minimum and maximum temperatures emerge from around 2040.

  According to the last IPCC (2023), co-working with local stakeholdefrs is strongly recommended. when dealing with climate change. For that purpose, it becomes more and more important to discuss local climate change in detail, what is the focus of this collection of papers- The articles presented here show the potential of regional climate and weather studies in advancing scientific knowledge at the local scale, both for historical and future climate states. Such research is key and a prerequisite for more applied, impact-oriented studies addresing stakeholders and decision makers. It would be recommendable to discuss local-scale climate change which is out of reach from standard global earth system models. We hope that this Research Topic will be a valuable contribution to further develop this field of research.

Author contributions

HS: Conceptualization, Writing-original draft.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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