CNRM, UMR 3589

SOUTENANCE DE THESE CNRM

jeudi 6 octobre 2022 à 14h

RÉPONSE DES FORTES PRÉCIPITATIONS ET DES SÉCHERESSES MÉTÉOROLOGIQUES À UN ACCROISSEMENT DU CO2 ATMOSPHÉRIQUE ET AU RÉCHAUFFEMENT GLOBAL ASSOCIÉ

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Abstract :

Climate change is a challenging and yet a humbling insight provided by science. While the global warming train has left the station with a more than 1K rise in the global mean temperature, we need to ask ourselves the question of what kind of future is up ahead, and what climate “surprises” we have in store? This thesis is a contribution to better quantifying and understanding the global response of extreme daily precipitation intensities to anthropogenic climate change. The words droughts and floods resonate across our disastrous history and our uncertain collective future. Anticipating, mitigating and adapting to such disasters remains a challenge to our shared humanity. In this thesis, I assess future changes in meteorological dry and mostly wet extremes on regional and global scales. The investigation is primarily based on global projections and more idealised climate change experiments conducted in phase 6 of the Coupled Model Intercomparison Project (CMIP6). The future changes described in the thesis are mostly based on the highest emission scenarios (SSP5-8.5), which maximises the signal-to-noise ratio, but presumably, provides an unfavourably bleak picture of our future climate (although large model uncertainties can lead to a strong overlap between projections derived from moderate to high-emissions scenarios). In the lead of the 6th Assessment Report of IPCC, future changes in extremes are also investigated at different global warming levels. The extremes considered include the annual maximum daily precipitation intensities (RX1DAY) and meteorological droughts described as consecutive dry days and their annual maximum numbers (CDD). Using some idealised atmosphere-only experiments with the CNRM-CM6-1 and a few other climate models which participated in a CMIP subproject, I first distinguish the various timescales of the

annual mean and daily precipitation responses to an abrupt quadrupling of the atmospheric CO2 concentration, especially the fast response to CO2 increase from the slower response to the gradual and uniform versus non-uniform components of the global ocean warming. The response of the dry meteorological extremes is particularly complex and involves multiple timescales and processes which can be highly model-dependent. Even though most CMIP6 models qualitatively agree on the idealized response of RX1DAY to a CO2 increase, I quantify the related uncertainties in a high-emission scenario using a large subset of CMIP6 models and a large ensemble of a single model. The study pays particular attention to both model uncertainties, and the irreducible uncertainties related to internal climate variability. The results illustrate an upper bound of the inter-model spread and estimate a large spread. However, there is a robust enhancement of extreme precipitation with more than 90% of models simulating an increase in the precipitation extremes. I also provide a 5--95% confidence range for projected RX1DAY values at the end of the 21st century and highlight the regions (only 17% of the globe surface) where the changes may not be consistent with the widely used assumption of a Clausius–Clapeyron (CC) rate of ~%/K when scaled by concomitant changes in global mean surface temperature. Finally, I investigate the changes in the seasonality of precipitation extremes, focusing on Europe and the potential contribution of regional changes in atmospheric circulation. My analysis documents a sharper seasonal cycle of extreme precipitation and a shift in its seasonality. To better understand the mechanisms that cause the change in seasonality, I analyse the possible role of different synoptic circulation types (CTs) in regulating the frequency of extremes across different seasons. By using a simple decomposition technique, I further explore the role of the projected changes in the CT frequencies to the previously assessed changes in the RX1DAY seasonality and the associated inter-model spread.

La composition du jury :
Directeurs: Hervé Douville (CNRM/GMGEC/CLIMSTAT) et Pascal Yiou (CEA/LSCE)
Rapporteurs: Sophie Bastin (CNRS/LATMOS) et Yves Tramblay (IRD/HydroSciences Montpellier)
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