ELVIC - Climate Extremes in the Lake Victoria Basin

a CORDEX-Africa & GEWEX initiative

Report 3: 25/03/2021

1. Introduction

The ELVIC project is an internationally COordinated Regional climate Downscaling EXperiment (CORDEX) - Flagship Pilot Study (FPS) initiative, bringing together different research groups that perform simulations with multiple high-resolution, convection-permitting regional climate models. All models share a similar set-up and are centered at Lake Victoria (East Africa). For more information, see https://ees.kuleuven.be/elvic/.

Extreme weather events, like heavy precipitation, heat waves, droughts and wind storms have a detrimental impact on East African societies. The Lake Victoria Basin (LVB) is especially vulnerable, since nightly storms on the lake catch fishermen by surprise. As the frequency and intensity of climate extremes is projected to further increase substantially with climate change, so do the risks, with potentially major consequences for livelihoods and policy in the LVB. ELVIC aims at answering four questions:

- What is the added value of high resolution climate modelling; do convection permitting models (CPMs) better represent deep convective systems in Equatorial Africa compared to models that rely on a convection parameterization?
- How can CMIP and CORDEX-Africa information best be combined with CPM (climate change) integrations?
- How will extreme weather events evolve in the future in the Lake Victoria basin?
- How can the impact community make use of the improved probabilistic information on convective extremes?

2. Progress

Milestone 1: Decisions are made on guidelines for simulations concerning the spatial domain, simulation period, settings, experiments and output variables. The consolidated protocols can be found on: https://ees.kuleuven.be/elvic/protocols/

Milestone 2: A list of data available for evaluation has been compiled and is used for model evaluation.

Milestone 3: The added value of convection-permitting simulations for the LVB under present-day climate conditions is assessed, based on multi-model ensemble. The latter consists of existing and new simulations at <- 5 km horizontal resolution.

Similarly to other regions in the world, there is no unanimous improvement or deterioration in the representation of the spatial distribution of total rainfall and the seasonal cycle when going to the convection-permitting scale (CPS). Moreover, substantial biases in the multi-annual averages (up to 30 W m^{-2}) and seasonal cycle in Top-Of-Atmosphere (TOA) upward radiative fluxes remain, both in models with parameterized and with explicitly resolved convection. Most substantial systematic improvements were found in the representation of the diurnal cycle in precipitation, the diurnal cycle in TOA radiation, some metrics for precipitation intensity and number of rain events. More specifically, the timing of the daily maximum in precipitation is systematically delayed when going to the CPS, thereby improving the agreement with observations. In particular, the peaktime of precipitation strongly improves over land, especially at the shores of the lake, indicative of a better representation of the impact of the lake-land-mountain circulations on the convection at CPS. The underestimation in the 90^{th} rainfall quantile of three-hourly precipitation in the parameterized models is alleviated. For the 95^{th} and 99^{th} percentile of precipitation, no clear improvement or deterioration is found, which might be related to poor observational constraints on extreme precipitation. The large overestimation in the total number of rainy events is alleviated when going to the CPS. The diurnal range in the radiative fluxes at the TOA strongly improves when going to CPS, especially for the longwave. All this indicates that the representation of the convective systems is strongly improved when going to CPS, giving confidence that the models are a valuable tool for studying how extreme precipitation events evolve in the future in the LVB. A consortium paper summarizing the evaluation is close to being ready for submission and will be presented at vEGU2021.

Milestone 4: Originally, a mid-term workshop with stakeholders and decision makers in the region was planned. However, due to COVID-19 regulations, this workshop was delayed and might need to be canceled or changed into a virtual meeting. Fortunately, there is also a workshop planned at the end of the project.

Milestone 6: Concerning climate change assessment in the LVB (with focus on changes in weather events, like heavy precipitation, heat waves, droughts and wind storms, and the water balance of the lake), the team already decided the methodology, agreeing to apply the Pseudo Global Warming approach, in which a run is driven with re-analyses that are perturbed with a multi-member ensemble mean from the recent CMIP6 global dataset. Yet, also a discussion on multi-member traditional downscaling is on the table, and will possibly be applied at a later stage.

Tab 1. Overview of the ensemble models with some specifications.

Group	Coarse-res model	High-res model	Timing	Driver	Coarse resolution	High resolution	Lake Model
KU Leuven	COSMO-CLM 5.0	COSMO-CLM 5.0	2005-2016	ERA 5	12 km	2.8 km direct from E5	FLake (1D)
SMHI	HCLIM-ALADIN	HCLIM_AROME	2005-2016	ERA Interim	12 km	2.5 km	FLake (1D)
Met Office	Pre-HadGEM3-A-N512	MO-UKV	1997-2007	SST: Obs; LBC: pre-HadGEM3-A-N512	12 km	4.4 km	ARC-Lake-v3
ICTP	RegCM 4.7.0	RegCM 4.7.0	2005-2016	ERA Interim	25 km	3.0 km	Hostetler et al.
KIT	WRF v3.9.1.1	WRF v3.9.1.1	2005-2016	ERA Interim	12 km	2.8 km	CLM 4.5 Lake Model (1D)

3. Planning

Milestone 5: Guideline on best practices for using climate information from different sources, including GCMs, CORDEX-Africa and CPM data. This includes the potential of tales of present and future weather simulations (TALES). [M36]

This milestone has not started and it is currently under investigation which partner would be interested to take up this task.

Milestone 6: Future projections are planned applying the Pseudo Global Warming approach, driving with a multi-member ensemble mean from the recent CMIP6 global dataset. In a second step, a multi-member traditional downscaling will be discussed. [M54]

Milestone 7: End workshop with stakeholders and decision makers in the region. [<= M60]

4. Publications

van Lipzig, Nicole , Jonas Van de Walle, Wim Thiery, Matthias Demuzere, Grigory Nikulin, Russell Glazer, Erika Coppola, Joaquim G. Pinto, Andreas H. Fink, Patrick Ludwig, Dave Rowell, Ségolène Berthou, Declan Finney, and John Marsham, 2021. Representation of precipitation and top-of-atmosphere radiation in a multi-model convection-permitting ensemble for the Lake Victoria Basin (East-Africa). To be submitted to climate dynamics.

Conference contributions:

J. Van de Walle and complete ELVIC team (September 2019) CORDEX-FPS ELVIC: a convection-permitting model ensemble over the Lake Victoria region. COSMO-CLM Assembly, Paestum, Italy

J. Van de Walle, G. Nikulin (presenting author) and complete ELVIC team (October 2019) ELVIC: a convection permitting model ensemble over the Lake Victoria region. AFRICAN CLIMATE RISKS CONFERENCE, Addis Ababa, Ethiopia

N. van Lipzig, J. Van de Walle (presenting author), W. Thiery, G. Nikulin, M. Wu, R. Glazer, E. Coppola, J. Pinto, A. Fink, P. Ludwig, D. Rowell, S. Berthou, D. Finney, and J. Marsham: Climate Extremes in the Lake Victoria Basin: The ELVIC CORDEX Flagship Pilot Study, EGU General Assembly 2020, Online, https://doi.org/10.5194/egusphere-egu2020-17466

van Lipzig, Nicole , Jonas Van de Walle, Wim Thiery, Matthias Demuzere, Grigory Nikulin, Russell Glazer, Erika Coppola, Joaquim G. Pinto, Andreas H. Fink, Patrick Ludwig, Dave Rowell, Ségolène Berthou, Declan Finney, and John Marsham, 2021. Representation of precipitation and top-of-atmosphere radiation in a multi-model convection-permitting ensemble for the Lake Victoria Basin (East-Africa). EGU General Assembly 2021.