WRF-BASED HINDCAST SIMULATIONS IN THE MENA REGION: MODELING ADVANCES AND CONTRIBUTION TO CORDEX PHASE II

George Zittis[1,*], *Panos Hadjinicolaou*[1], *Jos Lelieveld*

[1]Climate and Atmosphere Research Centre (CARE-C), The Cyprus Institute, Nicosia, Cyprus
[2]Atmospheric Chemistry Department, Max Planck Institute for Chemistry, Mainz, Germany

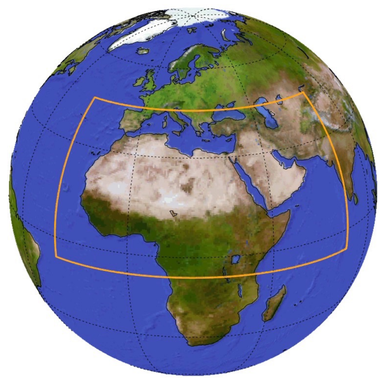
g.zittis@cyi.ac.cy

Introduction

- The Middle East and North Africa is a climate change hotspot that currently warms faster than the average global warming rates [1-2]. Global climate projections suggest a further warming intensification, particularly regarding summertime heat extremes. To assess regional impacts, and underpin mitigation and adaptation measures, robust information is required from climate downscaling studies, which has been lacking for the region. **MENA-CORDEX** (http://mena-cordex.cyi.ac.cy/), a region-focused climate downscaling initiative was established to provide the much-needed regionalized information and is dedicated to the modelling of this extraordinary climate change hotspot.
- During CORDEX Phase I, several studies focused on hindcast and model optimization experiments, while fewer discussed regional future climate projections [3-5]. These studies, on a 50-km domain, were mainly driven by the Representative Concentration Pathways (RCP), most of them considering intermediate and high-emissions scenarios, and contributed to assess regional climate change in the Atlas of the 6th IPCC Assessment Report (AR6) [6].
- Here, we present the first analysis of the ongoing ERA5-driven hindcast simulations of CORDEX Phase II, using WRF as a dynamical downscaling tool. Besides refinements in the horizontal and vertical resolutions, the model advancements since the previous phase experiments include a dynamic-vegetation land surface model [7] and a better treatment of aerosols, including online dust emissions.

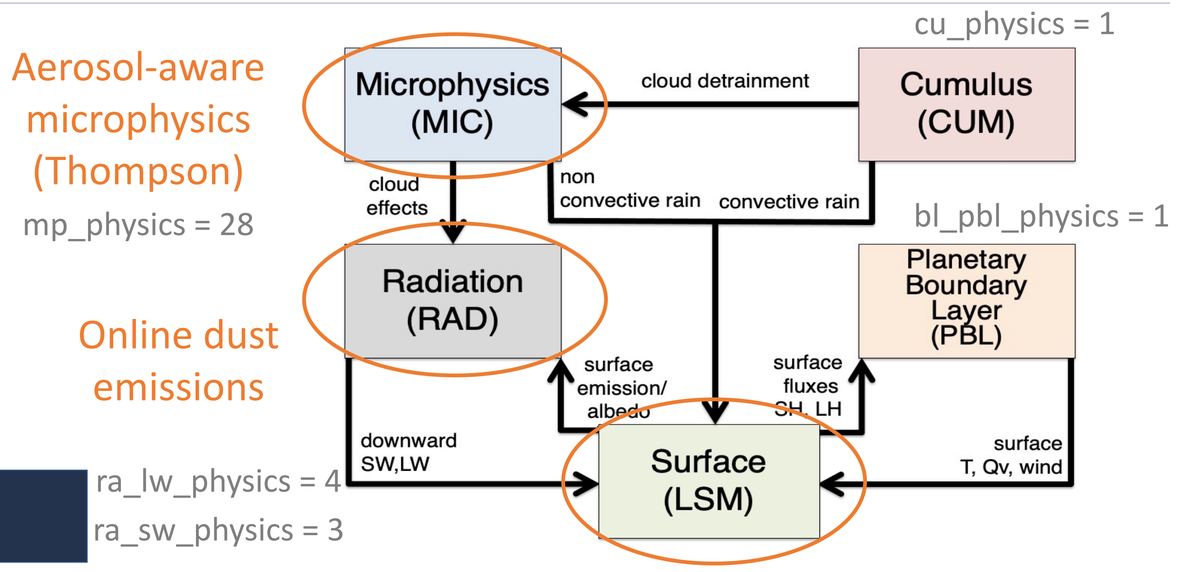
Model Setup

- Model: WRFv4.5 (was v3.5)
- Horizontal resolution: 25×25km (was 50-km)
- Projection: Cylindrical equidistant
- Nx= 464 (was 232)
- Ny= 236 (was 118)
- Vertical resolution: 35 levels (was 30 levels)
- Model top at: 30hPa
- Land use data: IGBP_MODIS (21 categories)
- Boundary conditions: ERA-5 Reanalysis
- Aerosols: Monthly climatology (2001-2007) [8]
- Spin-up period (1 year: 1990)



TLC (333.; 45.0) BLC (333.0; -7)
TRC (76.0; 45) BRC (76.0; -7)

Main advancements since set-up used in CORDEX Phase I

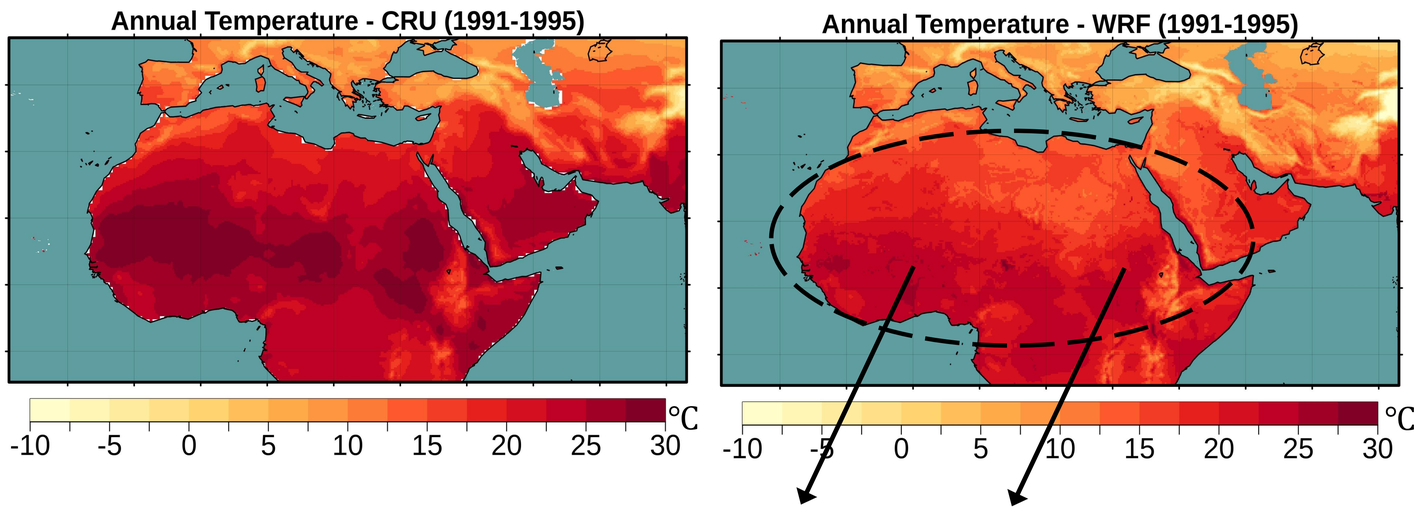


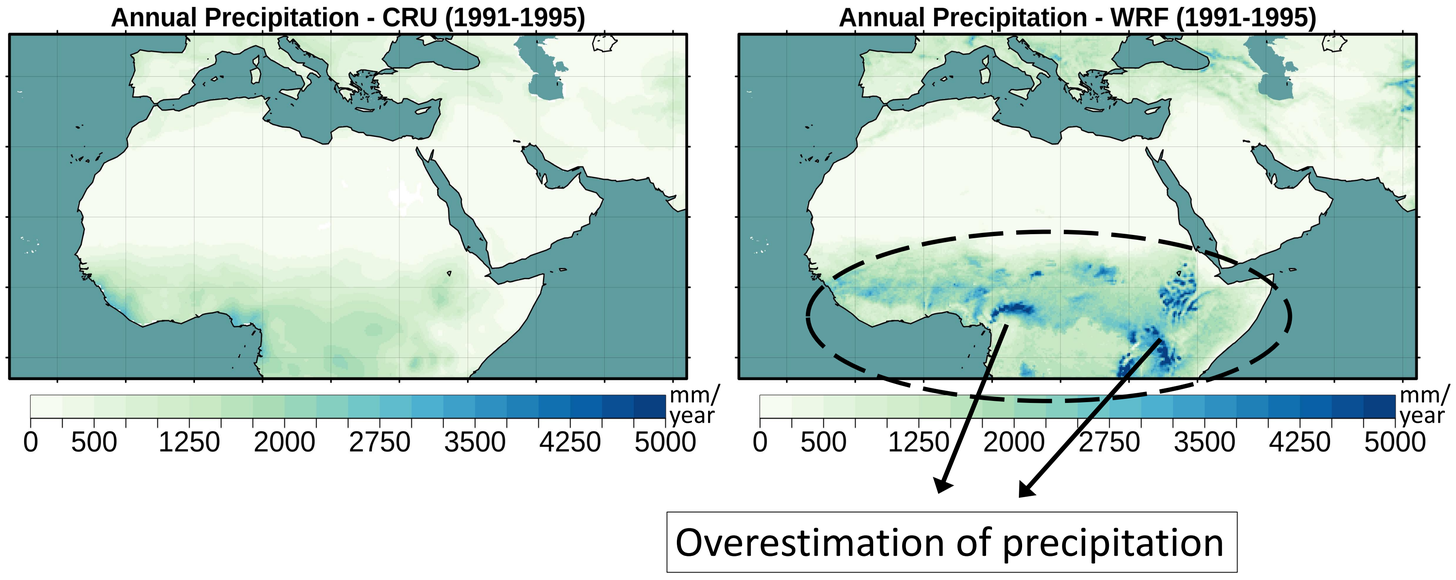
Dynamic vegetation LSM (Noah-MP)

sf_surface_physics = 4

Preliminary Results

Period: 1991-1995; Reference dataset: CRU-TS-v4.07





Next steps – Future work

- Sensitivity experiments (switch on/off new components) – simulation duration: 5-10 years
- Complete the full hindcast (ERA5: 1979-2020)
- Select ESMs for historical runs 1950-2014 (priority to OptimESM project models, e.g., EC-EARTH, UKESM)
- Future scenarios: Priority to SSP3-7.0 and SSP1-2.6
- Incorporate future land-use scenarios (static MODIS information at the moment)

Scan for more information about the MENA-CORDEX initiative

References

[1] G. Zittis, and P. Hadjinicolaou, Int. J. Climatol. 37, 3847–3862 (2017).

[2] G. Zittis, M. Almazroui, et al., Rev. Geophys. 60, e2021RG000762 (2022).

[3] F. Driouech, K. El Rhaz, et al., Earth Syst. Environ. 4, 477-492 (2020).

[4] T. Ozturk, F.S. Saygili-Araci, M.L. Kurnaz, Atmosphere, 16, 622 (2021).

[5] G. Zittis, P. Hadjinicolaou, et al., NPJ Clim. Atmos. 4, 20 (2021).

[6] J. Diez-Sierra, Iturbide M., J.M. Gutiérrez et al., Bull Am Meteorol Soc. 103, 12 (2022).

[7] K. Constantinidou, P. Hadjinicolaou, et al., Earth Syst. Environ. 4, 647-665 (2020).

[8] G. Thompson and and T.Eidhammer, J. Atmos. Sciences, 71, 10 (2014).

The Cyprus Institute — Research • Technology • Innovation
CARE-C — Climate and Atmosphere Research Center
EMME-CARE — Eastern Mediterranean Middle East – Climate & Atmosphere Research Centre
This project has received funding rom the European Union's Horizon 2020 research and innovation programme under grant agreement No. 856612 and the Cyprus Government.
OptimESM — Optimal high resolution Earth System Models for exploring future climate change
This research is supported by the the European Union's Horizon Europe research and innovation programme under grant agreement No 101081193.