High-resolution climate information for Southeast Asia for climate impact modelers

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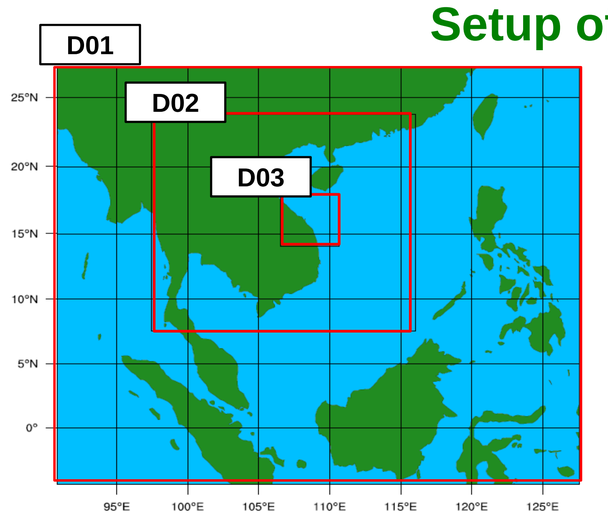
Introduction

High-resolution hydrometeorological information is crucial for regional and local impact studies, especially for data sparse regions such as Vietnam (Souvignet et al., 2013). Regional Climate Models (RCMs) are suitable to dynamically downscale large-scale climate information to regional and even local scales. Transient (1961-2050) ***Weather Research and Forecast*** **(WRF)** simulations are forced by **ECHAM5** and the **A1B and B1 SRES scenarios** using a nested approach, finally resulting in **climate information of 45 km, 15 km and 5 km**, respectively (Fig. 1). After appropriate bias correction, the data can be used for climate impact studies such as future estimations of water availability, crop yield, renewable wind and solar energy productivity.

Setup of WRF



Domain 1:
- horizontal: **45 km (**99x99 grid cells)
- vertical: 50 layers up to 50 hPa
- time step: 180 s

Domain 2
horizontal: **15 km** (142x145 grid cells)
vertical: 50 layers up to 50 hPa
time step: 120 s

Domain 3
- horizontal: **5 km** (66x75 grid cells)
- vertical: 50 layers up to 5000 Pa
- time step: 30 s

Fig. 1: WRF simulation domains (red boxes) as used for the transient climate simulations.

Parameterization experiments (Table 1) are conducted using reanalysis data (NCEP/NCAR, ERA40) to identify a suitable set of physical schemes for **Microphysics**, **Planetary Boundary Layer**, and **Cumulus Convection**. The spatial patterns of WRF rainfall and temperature (D02) are compared to the gridded APHRODITE and CRU data for rainfall and temperature, respectively (Fig. 2). See Laux et al. (2012) for more information.

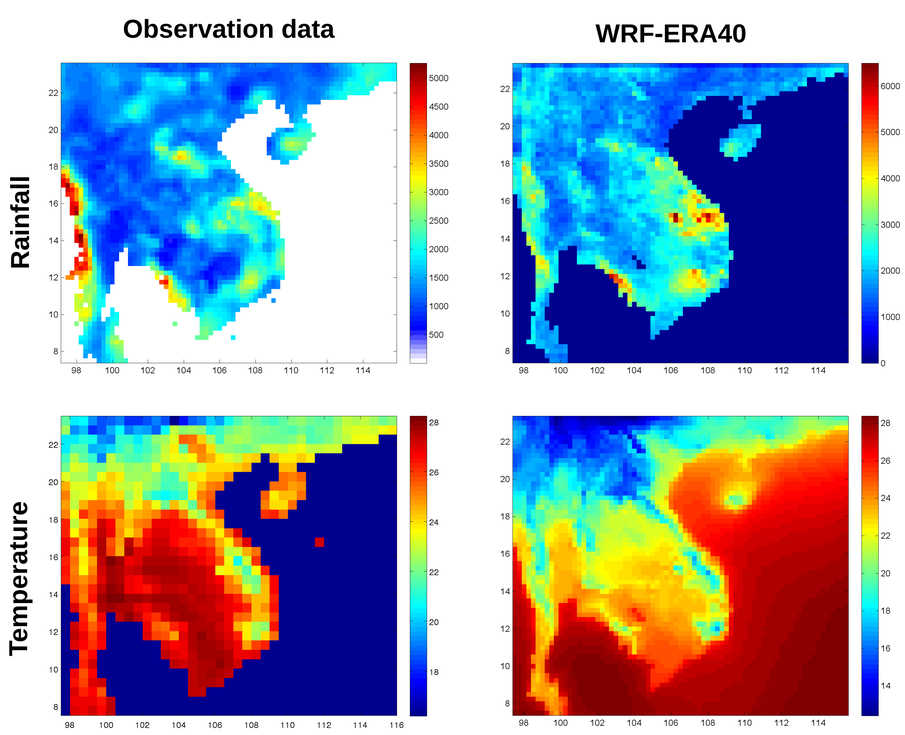


Fig. 2: Rainfall amount and mean temperature for 2000 of observations (left column) and WRF simulations using ERA40 reanalysis data and parameter combination of **run G** (see Table 1).

- **Precipitation:** patterns well captured
- **Temperature**: patterns very well captured, low sensitivity of parameterization runs (not shown here)

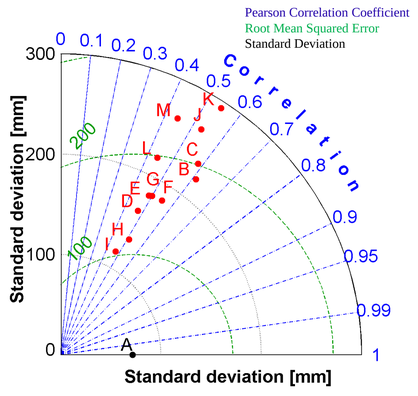


Fig. 3: Taylor diagram showing performance of WRF to simulate precipitation (run B to M) compared to Aphrodite (A).

Table 1: 12 combinations of parameterization schemes used for both NCEP/NCAR and ERA40 reanalysis data:

Run	Microphysic schemes	PBL physic schemes	Cumulus physic schemes
B	Lin et al.	Hong et al.	Betts-Miller-Janjic
C	Lin et al.	Nakanishi and Niino	Betts-Miller-Janjic
D	Lin et al.	Nakanishi and Niino	New SAS
E	Lin et al.	Hong et al.	New SAS
F	WRF Single-Moment 3-class	Hong et al.	Betts-Miller-Janjic
G	WRF Single-Moment 3-class	Nakanishi and Niino	Betts-Miller-Janjic
H	WRF Single-Moment 3-class	Hong et al.	New SAS
I	WRF Single-Moment 3-class	Nakanishi and Niino	New SAS
J	WRF Double-Moment 6-class	Hong et al.	Betts-Miller-Janjic
K	WRF Double-Moment 6-class	Nakanishi and Niino	Betts-Miller-Janjic
L	WRF Double-Moment 6-class	Nakanishi and Niino	New SAS
M	WRF Double-Moment 6-class	Hong et al.	New SAS

➡ Parameterization of run G for long-term simulations based on multiple criteria

Past Climate Trends

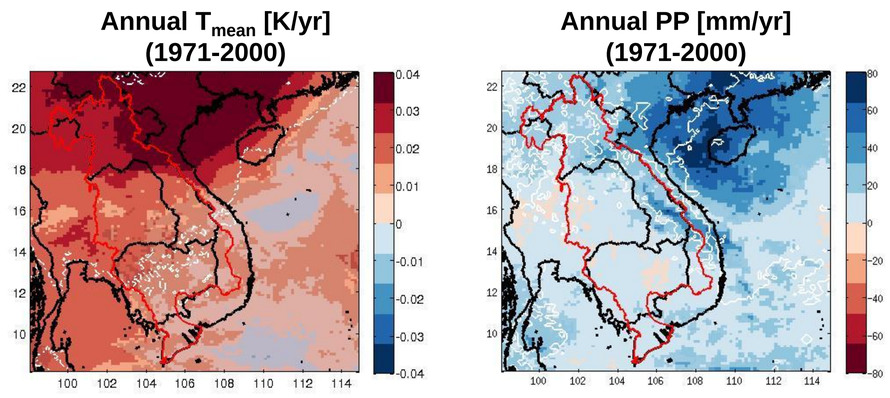


Fig. 4: Temperature (left) and rainfall (right) trends as obtained by WRF simulations for D02 driven by ERA40 Reanalysis data. White dashed (solid) line.indicates significance at α = 0.01 (0.05).

Precipitation Change (FUT *minus* CTR)

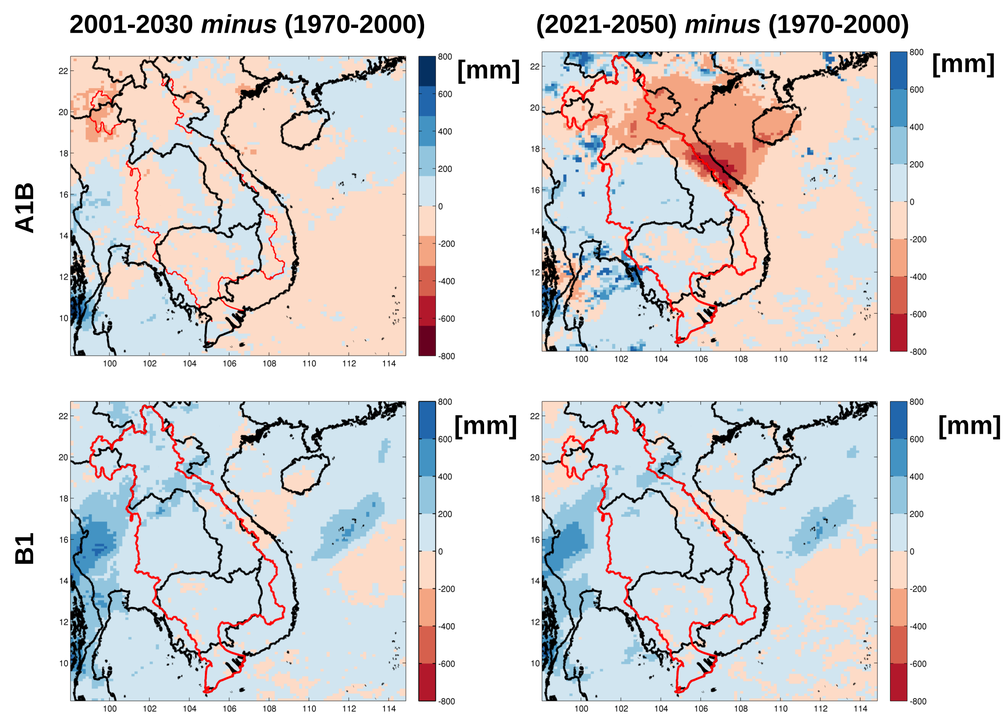


Fig. 5: Expected precipitation change obtained by the transient WRF simulations for D02 driven by ECHAM5 data and A1B and B1 SRES emission scenarios.

Outlook: Opportunities tailor-made Impact Studies?

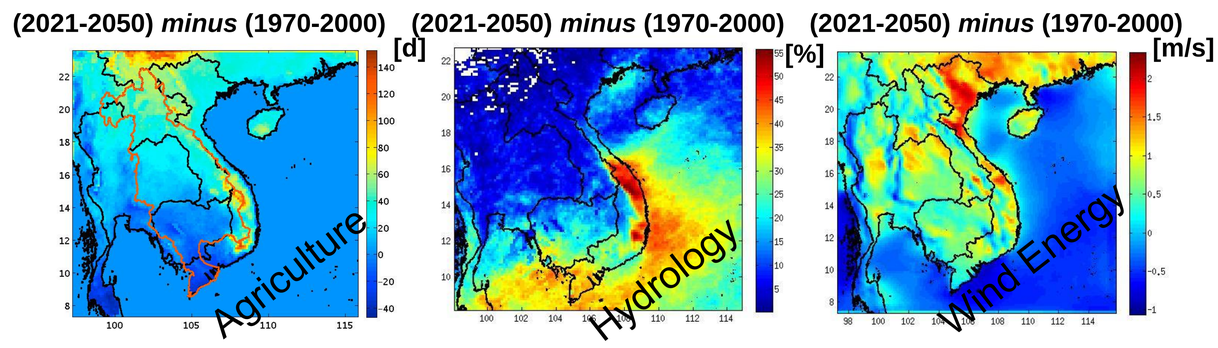


Fig. 6: Expected change in growing season length index for rice (left), change of precipitation extremes (95th quantile) (middle), and wind speed (10m) using ECHAM5 data and A1B SRES emission scenario. Expert knowledge from local stakeholders required for those studies.

Laux, P., Phan, V.T., Lorenz, Ch., Thuc, T., Ribbe, L., Kunstmann, H. (2012), Setting up Regional Climate Simulations for Southeast Asia. High Performance Computing in Science and Engineering ' 12, Conference Proceedings, Wolfgang E. Nagel, Dietmar B. Kröner, Michael M. Resch (Eds.), Springer

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