1. Background and Motivation

Dynamical downscaling is emerging as the best climate downscaling approach in bridging the gap between Global Circulation Model (GCM) resolutions and finer resolutions required for climate impact analysis. Dynamical downscaling uses a regional climate model (RCM) into the GCM to represent the atmospheric physics with a higher grid box resolution within a limited area of interest. Sub-grid scale climate information are critical to understand and forecast incidences of extreme hydro-meteorological events such as floods, droughts and daily minimum and maximum temperatures. Moreover understanding the spatial and temporal variability of surface water resource on a basin level is a key step to water resource planning and management.

This ongoing research attempts to explore the potential impacts of climate change and variability on the surface water resource potential of Blue Nile basin using the Weather Research and Forecasting (WRF) model for dynamical downscaling under RCP4.5 and RCP 8.5 greenhouse gas emission scenarios.

2. Research Objectives

1. Determine the skill of dynamically downscaled GCM outputs in detecting trends of climate change and variability over the central high lands of Ethiopia using precipitation and temperature anomalies under the RCP4.5 and RCP8.5 emission scenarios.
2. Determine the spatial and temporal variability and sensitivity of the surface water resource over the central high lands of Blue Nile basin using physical based distributed hydrological models coupled with the dynamically downscaled GCM outputs.
3. Research Methods and Models

3.1 Study area

Blue Nile basin, locally known as “Abaya” basin, covers a catchment area of 395,812 km², contributes about 51% share to the total annual runoff in Ethiopia with 54.852.6 km³ annual runoff. It supports for 25% of the population and over 40% of agricultural production. Together with “Baro – Mekong” and “Talise rivers”, the Blue Nile contributes between 80 and 90 per cent of the Nile’s flow.

3.2 WRF Model set up and physics options

Advanced Weather Research and Forecasting (WRFV3.6.1) is used for the dynamical downscaling using initial and boundary conditions from the Community Climate System Model version-4 (CCSM4) and the ERA-Interim Global Reanalysis data set of the European Centre for Medium range Weather Forecasting (ECMWF). WRF is designed for both research and operational applications in two dynamical (computational) cores, the Advanced Research WRF (ARW) and Non-hydrostatic Mesoscale Model (NHM).

The Non-hydrostatic ARW core or solver ( \( \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + \frac{\partial^2 v}{\partial z^2} - g \frac{\partial h}{\partial y} = 0 \)) is in use for this dynamical downscaling experiment for the domain configurations depicted below under the different physics options.

For the ERA-Interim (2001-2010) simulations the USGS 24 classification category of land-use data is used for interpolating topography and land use with spatial resolution of 15m, 2m and 30m’s. One-way nesting, with 30 vertical levels in the atmosphere and 10 soil layers are used in downscaling the ERA-Interim reanalysis to the desired resolutions.

3.3 Preliminary Results

3.3.1 Time series plots

Time series plots for 36-Km outer domain and 4-Km inner domain

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References
