Projected climate change impacts on hydroelectric energy
Lake Victoria, East Africa
Kara A. Smith and Fredrick H. M. Semazzi
North Carolina State University, Climate Modeling Laboratory (climlab.meas.ncsu.edu)

Background
The flow of the White Nile over Eastern Africa and the productivity of its hydroelectric power dams is primarily determined by the level of Lake Victoria. The only outlet from the lake is at Nalubaale and Kiira dams. The lake level has been slowly decreasing since 1964, with a sharp decrease starting in 2003.

Sharp 2003-2006 decrease:
- half drought/half over-release
- more water released for same amount of electricity.

Supply < Demand = Load Shedding

Objectives
- Determine when the lake levels will switch from current decreasing trend to the projecting increasing trend.
- Project annual lake levels under climate change conditions.
- Plan for climate change adaptation for hydroelectric power industry over the Nile Basin in Uganda.

IPCC ensemble A2-Ref OND Precipitation
Lake Victoria levels calculated using IPCC A2 scenario precipitation.

IPCC AR4 model ensemble predicts an increase in precipitation over the lake basin. This increase in precipitation could increase Lake Victoria levels from the current level to 14 meters. However, it is unknown when the increase in precipitation will take place.

Methods
- Interpolate model output precipitation to 6 stations surrounding Lake Victoria
- Use interpolated precipitation in water balance model based on the equation:

$$\Delta L = P - E + \left(\text{Outflow} - \text{Inflow}\right)$$

- Annual evaporation (E) relatively constant.
- Tributary inflow (Qin) calculated from precipitation over lake.
- Outflow (Qout) calculated from current lake level. Agreed Curve release rule approximates natural flow without hydroelectric dam.

Ensemble modeled lake levels (black) with confidence intervals (blue) plotted with actual lake levels (red) and lake levels modeled using CRU gridded station data (green).

Conclusions
- PRECIS precipitation output in water balance model simulates Lake Victoria levels well.
- No huge increase in levels from 1969-2049.
- Signs of levels bottoming out ~ 2019.
- Potential way to determine over-release from Nalubaale and Kiira dams.