Impacts of precipitation variability on agricultural vegetation in sub-Saharan Africa

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P.O. Box 60 12 03, D-14412, Potsdam, Germany

Event: International Geographic Congress (IGU) Commissions C08.04 Climatology
Session: Potential Impacts of Climate Variability and Change on Agriculture
Chair: Julie A. Winkler

Projections from global circulation models (GCMs) are widely used to assess the impact of climate change on the agricultural sector in sub-Saharan Africa (Jones & Thornton, 2003; Liu et al., 2008; Müller et al., 2011; Schlenker & Lobell, 2010). Although GCM projections agree in the level of median temperature increase of 3 to 4°C in 2090s compared to 1990s in the A1B projections (Christensen et al., 2007) they project very different precipitation patterns in various regions of sub-Saharan Africa due to a large variety in model setting, originating from models' resolution and model physics, affecting e.g. the occurrence of convection or the vertical transport of moisture in the tropics (Lin, 2007). There is some consistency between GCMs with respect to projected increase of annual precipitation amount in East Africa and a drying in southern Africa. As farming in many regions of sub-Saharan Africa is closely linked to the occurrence of sufficient rainfall, the length and precipitation of the rainy season very much influence the crop productivity and reachable harvest in a region. Crop failure frequently occurs due to high water stress leading to low grain yield in case of an unusual delayed onset or early break of the rainy season if farmers' cultivation methods are not adapted to these variable conditions. This study focuses on the impact of changing precipitation variability on crop productivity by analysing

changes in the wet season length and the precipitation amount in the wet season projected from 14 GCMs for the SRES A1b and transferred to three stylized precipitation experiments. We analyse the stress potential of these changes for growth and productivity of ten food crops grown in sub-Saharan Africa using the global dynamic vegetation model LPJmL (Bondeau et al., 2007; Gerten et al., 2004). The aim is to identify their magnitude and importance for future food production in sub-Saharan Africa. Results show that most parts of sub-Saharan Africa will experience decreases in both, the length of the rainy season and the amount of precipitation in the rainy season of up to 20 % (Figure 3). The precipitation sum and the length of the rainy season will decrease most severely in parts of the Sahel, Southern Africa and Central Africa. Overall average crop production in sub-Saharan Africa decreases whereas an increase in the mean annual surface temperature of one Kelvin has a stronger effect on the average crop production than a decrease in the wet season length of 30 days and a decrease in the wet season precipitation of 100 mm. The precipitation effect in a precipitation experiment with decreasing wet season precipitation is stronger than in a precipitation experiments with a shorter rainy season and increased rainfall per rain day. In the latter precipitation experiment crop production decrease to a lesser extent and some regions even gain crop production increases like e.g. parts of Nigeria, Uganda or South Africa.

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