Abstract:
More than half the population of Guatemala lives in rural areas and depends on subsistence agriculture for their well being. This region is vulnerable to many climatic events, one of which is El Niño. This study looks at the effects of El Niño on rainfall patterns at regional scales and specifically quantifies the effects on agricultural water balances in Guatemala. Analysis is focused on maize crops during the Primera growing season (May – Aug, May – Oct). The study builds on rainfall and water balance modeling techniques developed by the Famine Early Warning Systems Network (FEWS NET). The results corroborate previous work, showing that there is a negative relationship between El Niño and rainfall, primarily on the Pacific side of the region and mainly during the months of August and September. The study also found that the related rainfall variations influence long-term (May – October) maize growing areas and could affect the start of the short-term Postmera season (August – October) by extending the Cunicula (mid season dry period).

Objectives:
To determine the effects of changes in SST in the El Niño 3.4 region on:
- Rainfall patterns in Central America.
- Agricultural water balance in Guatemala

Problem:
In Guatemala, agriculture is the most important production sector, with 61 % of the population living in rural areas and depending on agriculture for their livelihood. Bad climatic conditions mainly heavy rains and droughts are one of the major problems for agriculture. The most affected products are rice, wheat, maize, coffee, cotton and sugar cane, (Carrera Cruz 2001).

While the effects of El Niño on rainfall patterns have been studied at different scales and are well understood, it is important to know what the effect is on agricultural water balances at the local scale. This information would help determine possible implications on population’s food security.

Background:
The Famine Early Warning System (FEWS NET) is characterized by developing applicable tools for monitoring food security and providing timely information to decision makers. One of these tools is the Water Requirement Satisfaction Index (WRSI) (Verdin, 2002) model for monitoring agricultural food production. The WRSI model uses rainfall estimates as input to evaluate the availability of water for the crop, at any time during the growing period.

Method:
A new monthly rainfall database was developed for the years 1970-2004. A monthly rainfall field is the result of the combination of the FEWS Climatology (FCLM), a 4 km resolution raster dataset, with existing stations for each month (Funk, 2007). The relationships between SST and rainfall, for the entire region (Southern Mexico to Panama), were first established. Gridded monthly rainfall data for each latitude/longitude pixel was correlated with the ONI. Separate statistics were calculated for each month during the rainy season. The value for each of the parameters of the analysis; correlation coefficient, p-value, and slope coefficient was used to create new maps, with the same dimensions as the original gridded rainfall fields, depicting the spatial distribution of the given parameter.

Furthermore, the FEWS NET GeoWRSI tool was used to calculate the seasonal WRSI for Guatemala for every year between 1970 and 2004. Correlation parameters were calculated for each month over the period April – September to determine how the SST during each of these months affected the seasonal water balance for Primera season. Even though there was a mismatch when relating monthly ONI with the seasonal WRSI, the fact that SST is persistent during the period may reduce the error.

Results:
A – Effects of changes in SST on rainfall patterns in Central America.

B – Effects of changes in SST on agricultural water balance in Guatemala

Conclusions:
We corroborated previous work showing that changes in SST in the Pacific Ocean affects rainfall patterns in Central America. The period showing most significant effect is Jul-Oct.

Changes in SST in the El Niño 3.4 region have a negative impact on the agricultural water balance in parts of Guatemala. The area of highest impact is the Altiplano (see Fig. 11). This mountainous region has a long growing season (180 days) and is especially vulnerable to water stress during this period. A strong El Niño can lead to extremely low rainfall during this time, due to the length of the growing season. This scenario can be exacerbated by the high water requirements of crops during this period. The Altiplano region is characterized by high elevation and steep slopes, which can lead to rapid runoff and limited access to water resources.

The effects of El Niño on water availability can be significant for rainfed agriculture in Guatemala. The study found that there was a negative correlation between SST and rainfall during the months of June, July, and August. This correlation was strongest during the months that follow (Figure 11). Based on the length of the growing period, this period would correspond to the flowering stage. The region is particularly vulnerable to water stress during this period, with correlations near 0.6 to 0.8. Persistent El Niño conditions could lead to water deficits in the southern part of the Altiplano, where the impact of El Niño is most severe.

The Gulf of Fonseca region, located in the south of the country, also showed a strong correlation between SST and rainfall (Figure 11). This region is characterized by a short growing season (90 days) and is more vulnerable to drought conditions. The study found that there was a negative correlation between SST and rainfall during the months of July and August, with correlations near 0.5. Persistent El Niño conditions could lead to water deficits in this region as well.

The results of this study confirm previous findings and highlight the importance of monitoring SST and rainfall patterns at regional scales. The study provides useful information for decision makers and policymakers in Guatemala, who can use this information to develop strategies to mitigate the impact of El Niño on agriculture. The study also highlights the need for further research to better understand the long-term effects of El Niño on water availability in Guatemala.