Predictability of Maize(corn) Production in the Great Horn of Africa

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Structure of The Talk

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- Major crop in the region, The majority of farmers in the region grow and consume Maize,
- The cheapest source of calorie intake and highest in terms of productivity (2 - 4 t/ha),
- Produced over various agro-ecological parts, (FAOSTAT, 2016).
- Potential production over the region; up to 12 t/ha;
- While, water-limited potential production, 8 - 12 t/ha, (GYGA, 2005).
- On-farm trials, on average, 6 - 8 t/ha.

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- Population is exponentially growing in the region,
- Drought is inevitable,
- Pressure from climate variability, aggravated by climate change,
- There is an acute lack of effective and real time agro-meteorological information and advisory services,
- Farmers have to make on farm decisions each year without a clear knowledge of how the season will evolve and the yields they are likely to achieve,
- This situation is forcing policy makers, agricultural experts and farmers to make decisions with very limited or no information available to them.
- Hence, a successful seasonal climate and agricultural production forecasting system can be instrumental.

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- The NMAs is providing seasonal climate forecast and agrometeorological outlook, a week prior to the start of the target season,
- This will limit the usability and reduce the value of the forecast product, even if the forecast has high skill.
- The PSNP & LEAP,
- The LEAP allows the PSNP to be scaled-up immediately in case of a climate disaster by triggering contingency funding ahead of disaster,
- No opportunity to act in time to mitigate drought and prevent famine.
- However, impending drought can be predicted, even well in advance before the start of the target season.

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- For managing climate risks, the information must be presented in terms of production outcomes at a scale relevant to their decisions, with uncertainty information,
- One way of achieving this is using GCMs in conjunction with CSM,
- Now days, state-of-the-art GCMs are providing relatively accurate, time and location specific, seasonal forecast and can be directly linked to various applications, such as CSMs.
- The use of CSMs along with GCMs allows decision makers to prepare and pan for the next season through effective planning and management that help reduce risks, increase productivity and early planning of contingency options.

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Research questions

- Are downscaled climate forecasts useful in pre-season maize production planning?
- Can spatial crop simulations provide locally relevant decision support for maize production planning?

- To develop a crop production planning and decision support system using crop simulation models that use downscaled seasonal climate forecasts as inputs.

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- Daily precipitation (CHIRPS),
- Daily solar radiation, maximum and minimum temperature (AgMERRA),
- The 6-hourly retrospective 9-month out reforecasts of of CFSv2,
- The Africa Soil Profiles Database (ISRIC, 2014),
- Elevation, USGS,
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- Rainfed Maize physical area, (SPAM, 2005).

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Table 1. Description of benchmark maize variety

	Melkasa-II
Type	Open pollinated
Year of release	2003
Country/region of release	Eastern and Southern Africa
Maturity Group	Intermediate maturing (130 days)
Maize mega environment	Wet lower mid-altitude/dry mid-altitude/wet and dry lowland (1000 m – 1700 m)

Source: (Tesfaye *et al.*, 2015)

Table 1. Genetic coefficients of the variety calibrated for mega environments

Coefficient	Description	Melkasa-II
P1	Thermal time from seedling emergence to the end of the juvenile stage (degree days above the base temperature of 8°C in the juvenile stage)	220.0
P2	Photoperiod sensitivity associated with delayed growth under unfavorable long day length condition (no unit)	0.10
P5	Thermal time from silking to physiological maturity (degree days above the base temperature of 8°C in the maturity stage)	640.0
G2	Potential maximum number of kernels per plant	920.0
G3	Kernel filling rate under optimum condition (mg/d)	7.1
PHINT	Interval in thermal time between successive leaf appearance (degree days above a base temperature of 8°C)	38.90

Source: (Tesfaye *et al.*, 2015)

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- Three animal-drawn tillage; a day before sowing at a depth of 10 cm; 10 and 20 days before sowing at a depth of 20 cm,
- A rule-based automatic planting, 70% soil moisture within 30-cm soil depth, monthly maximum temperature, 50 ^{0}C & minimum temperature, 8 ^{0}C within a 135 days planting window,
- The crop was sown (broadcast) at a population of 5.33 plants/m^2,
- Fertilizer application (banded on surface); 50 kg/ha DAP and 25 Kg/ha UREA.

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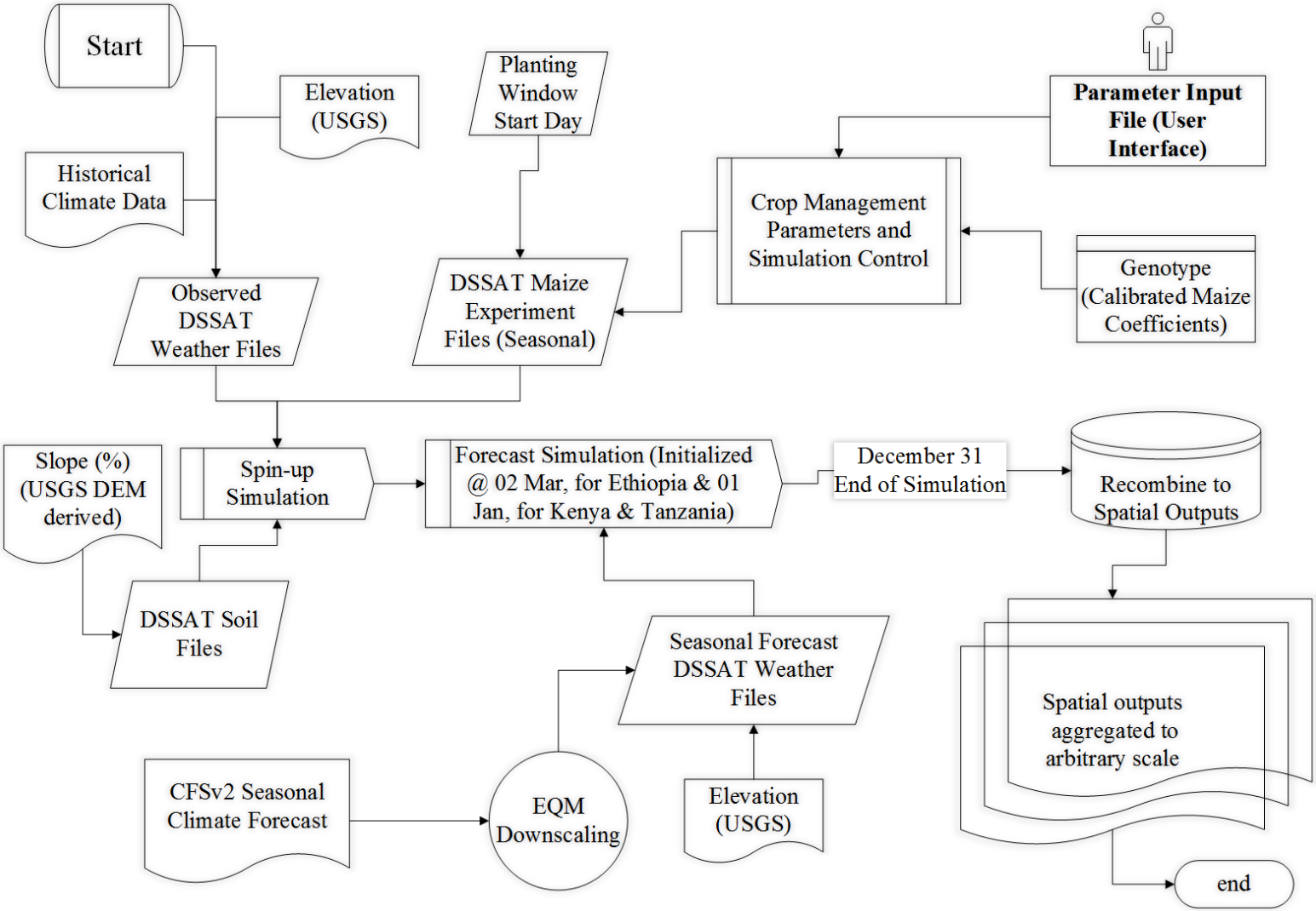

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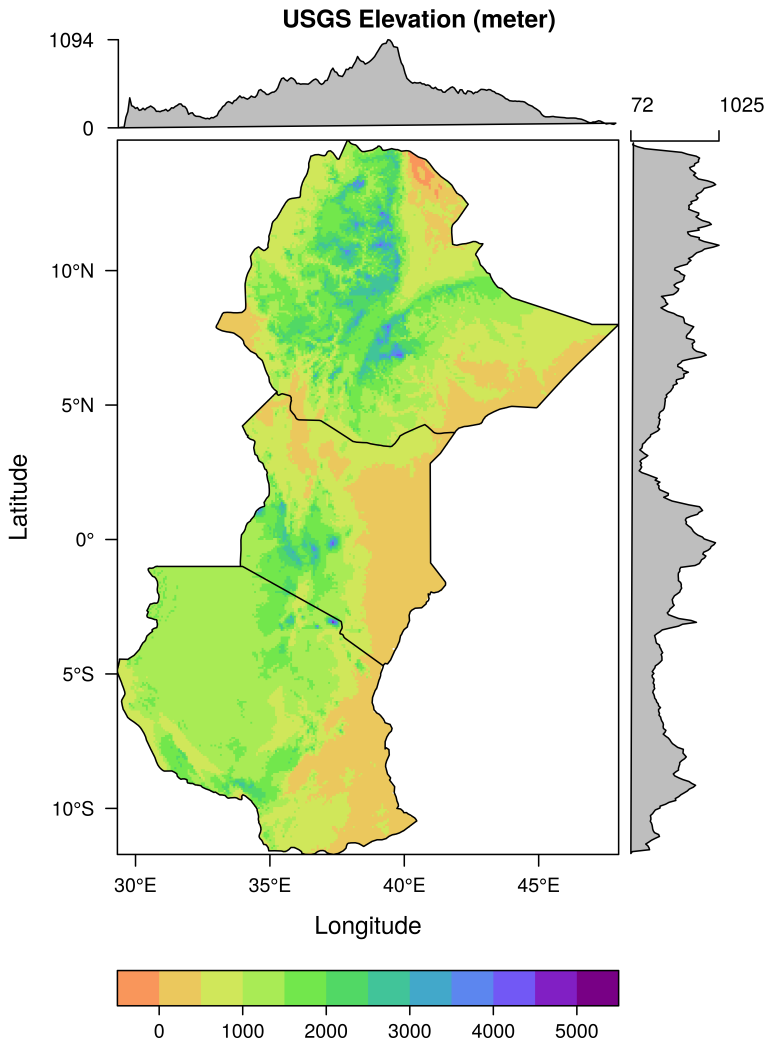

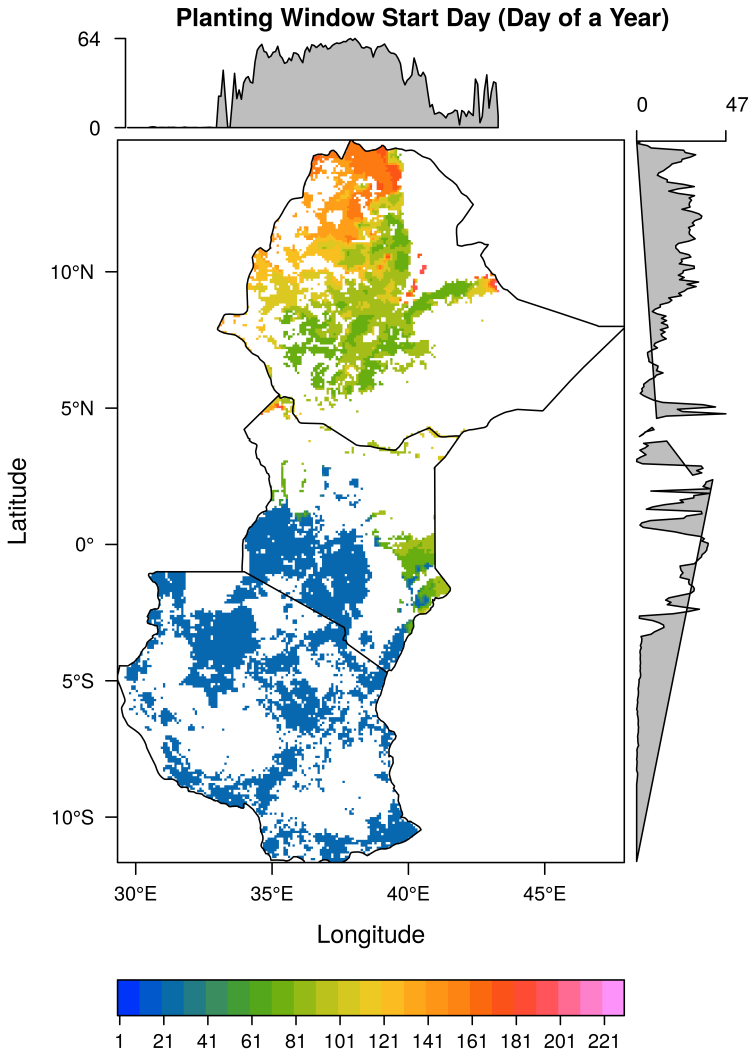

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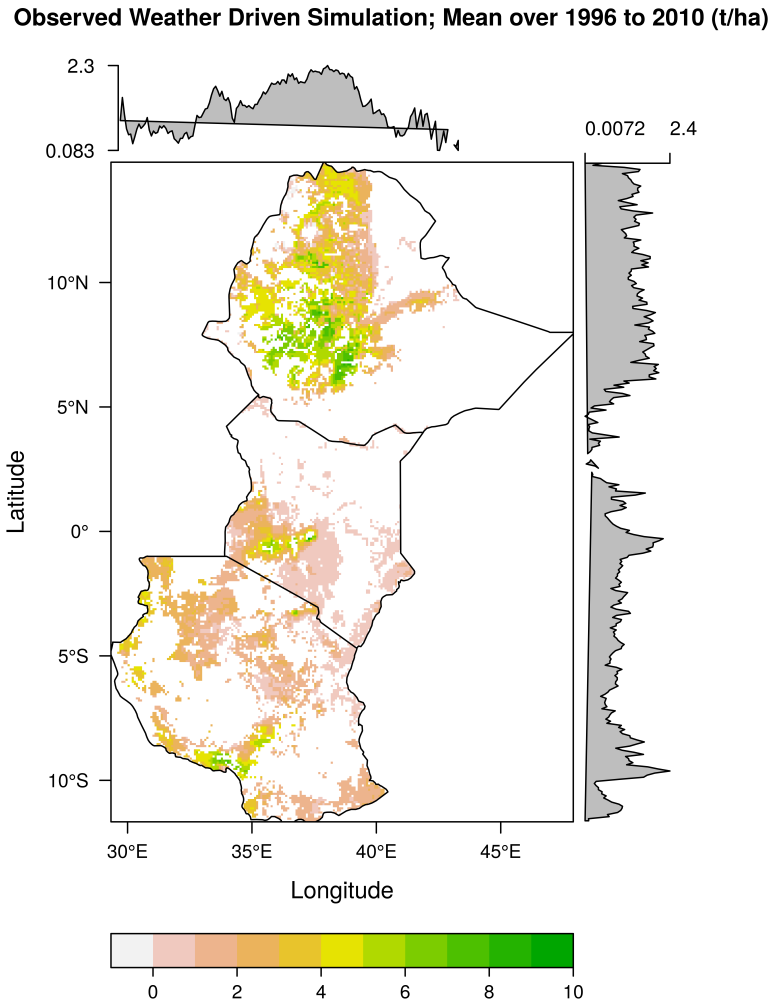

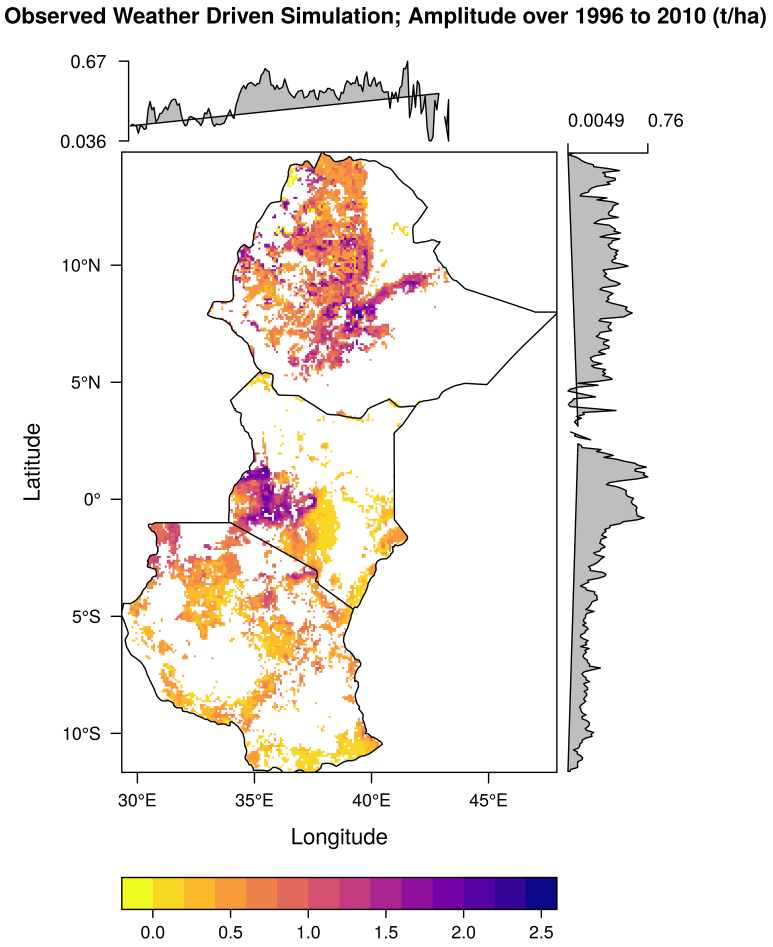

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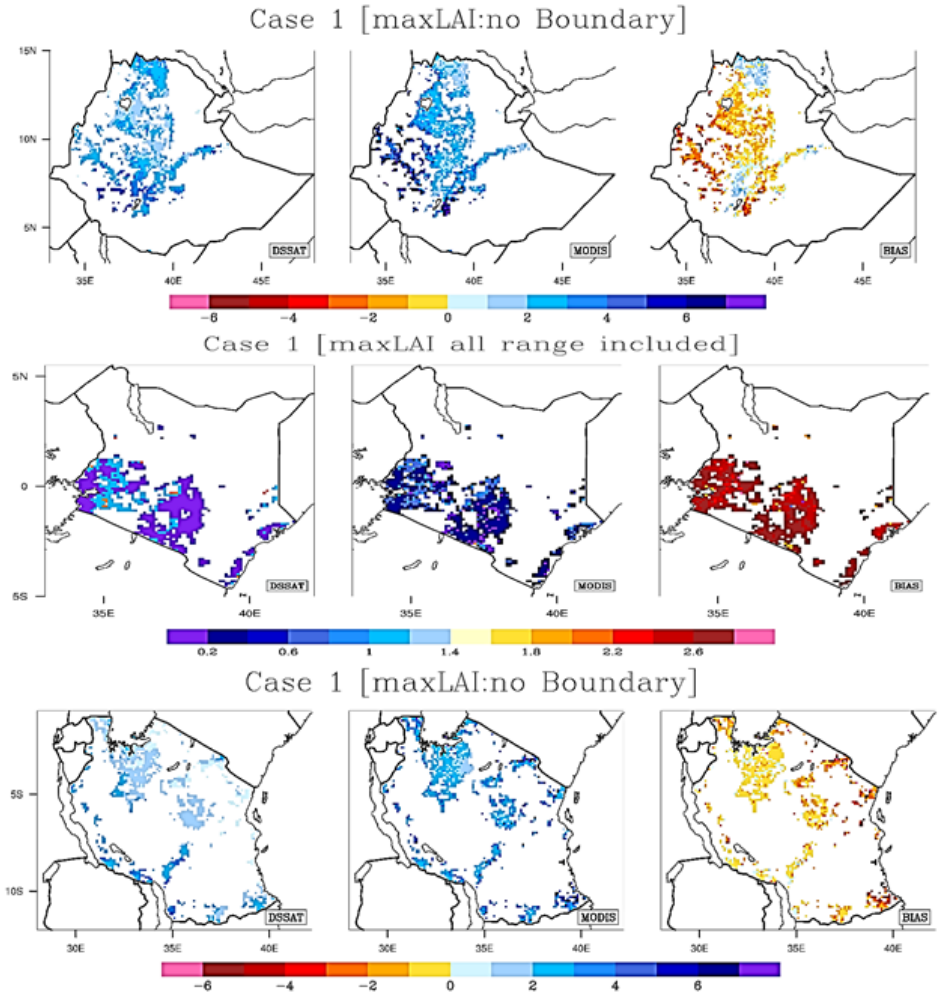

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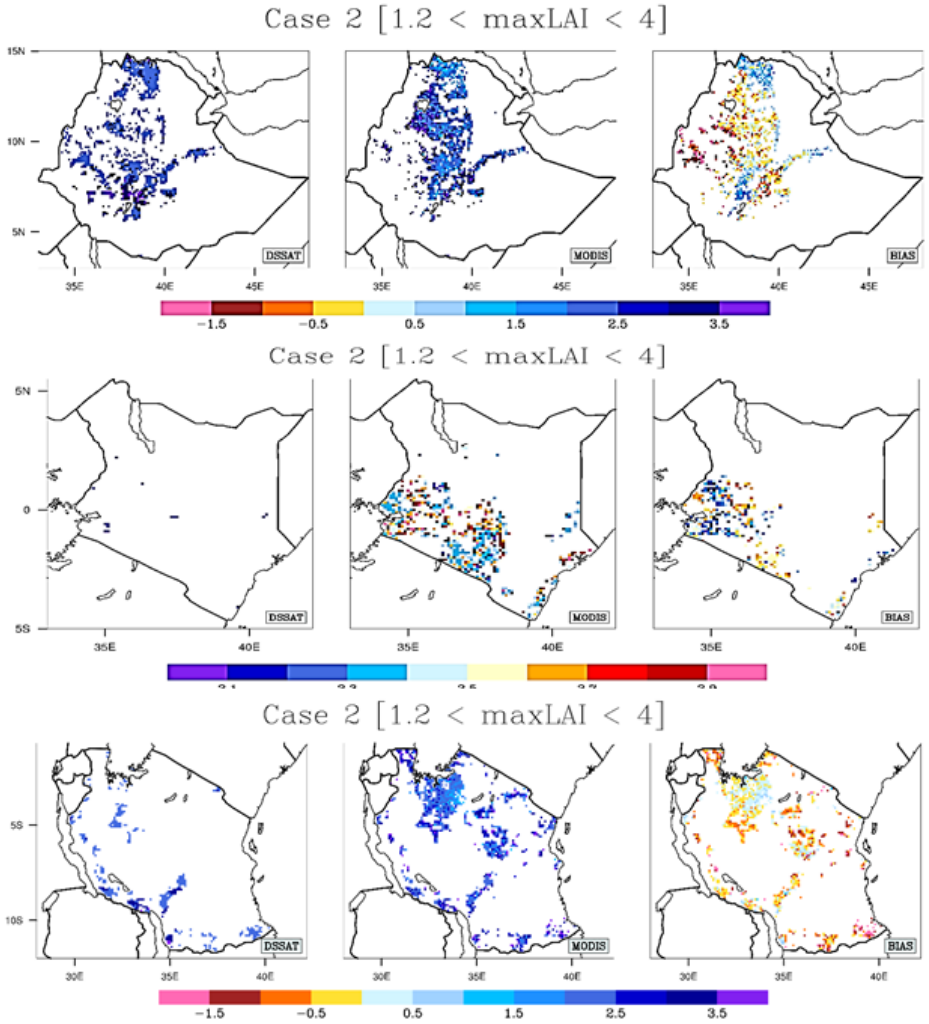

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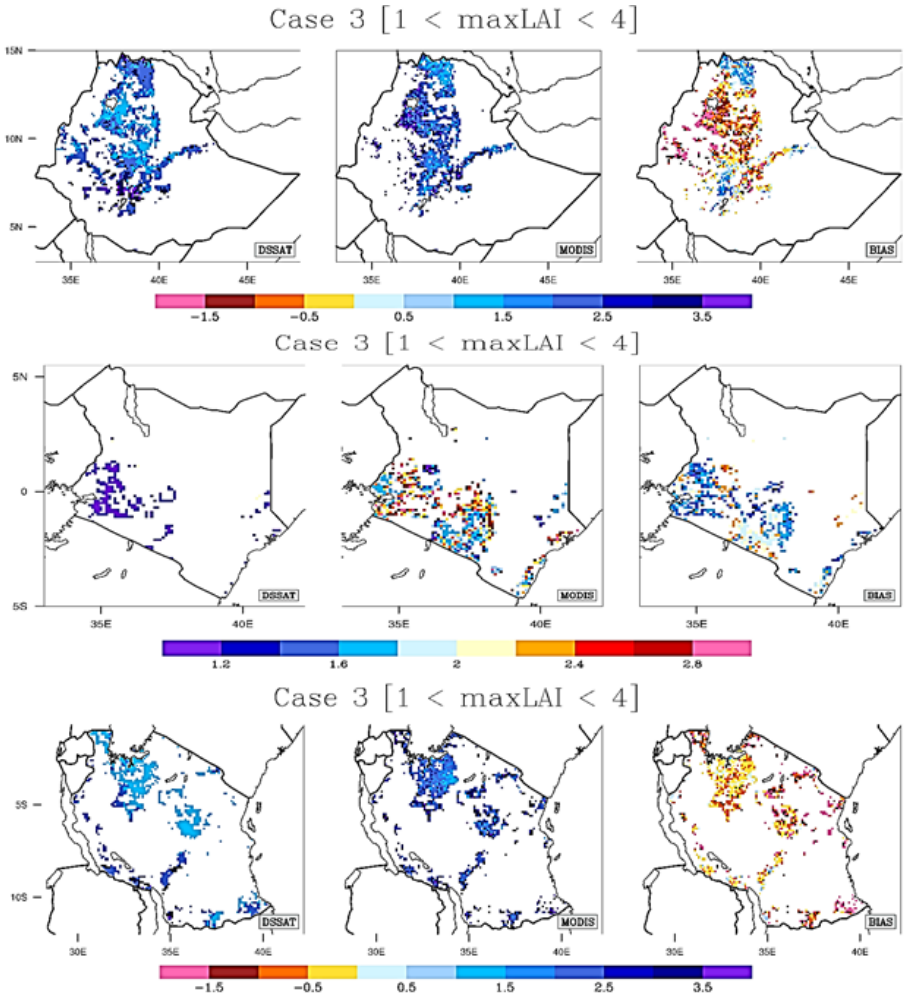

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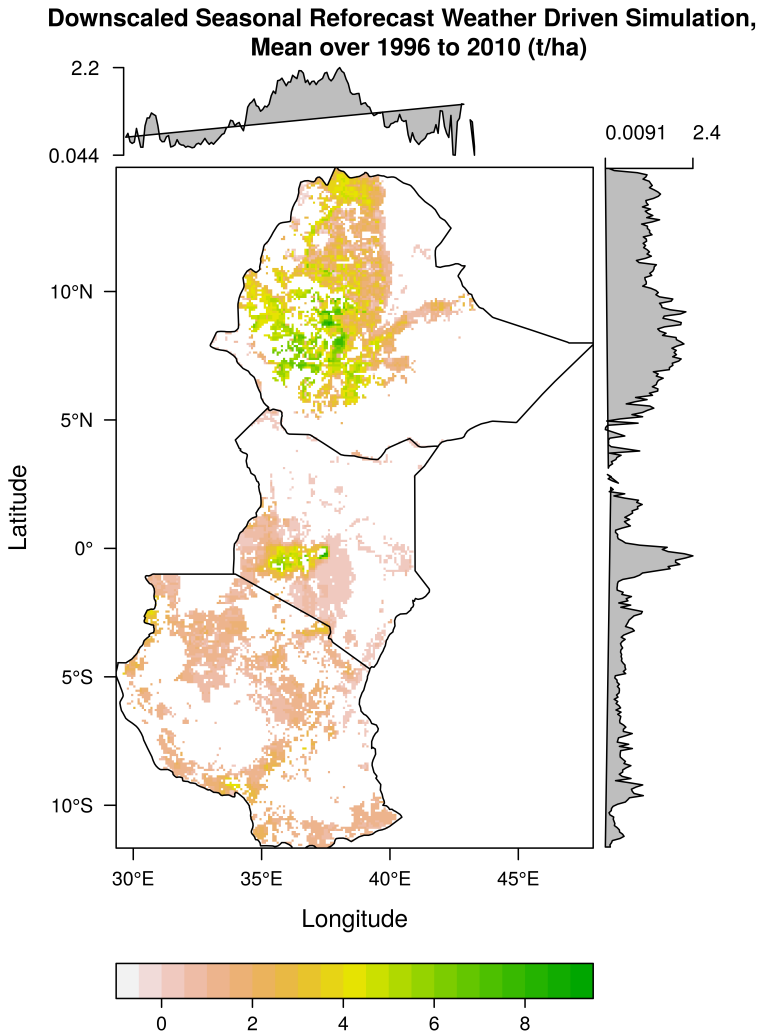

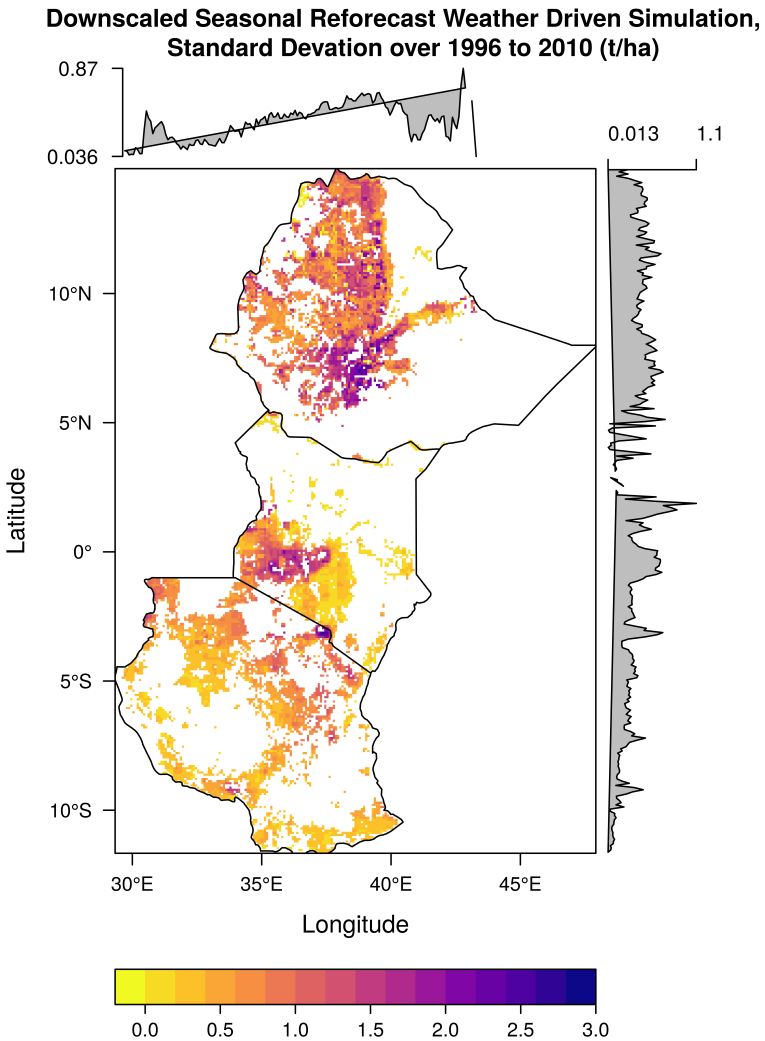

Predictive Error

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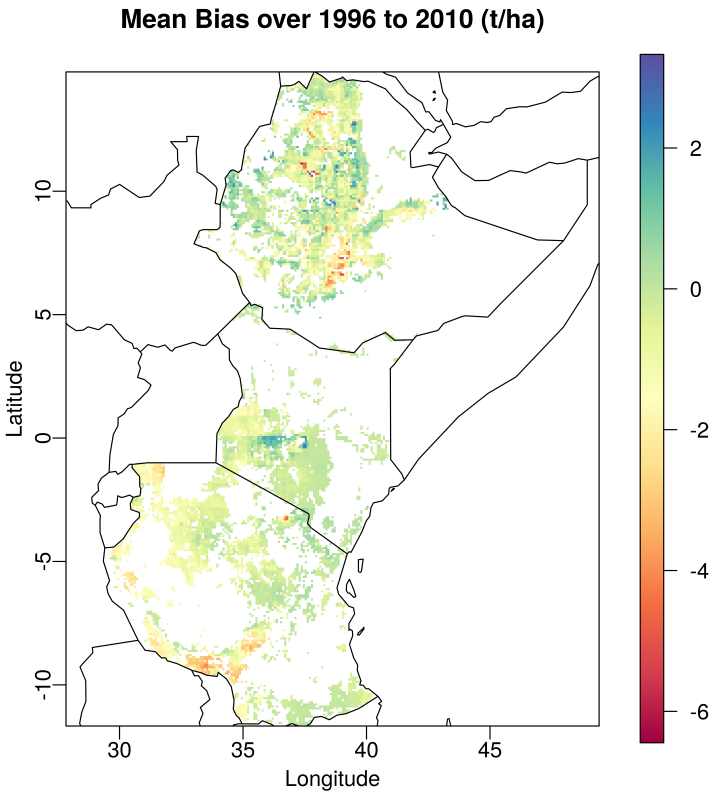

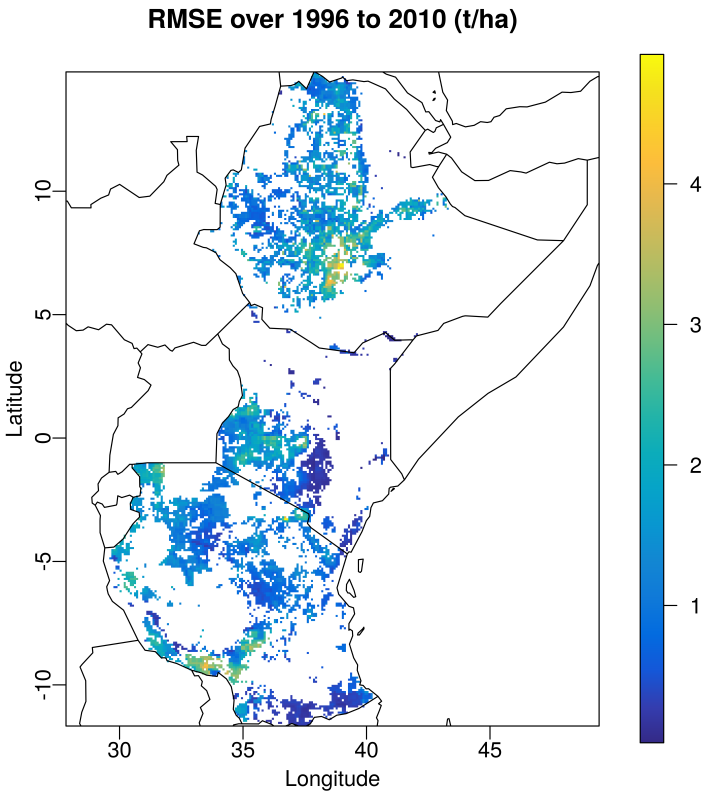

Predictive Success

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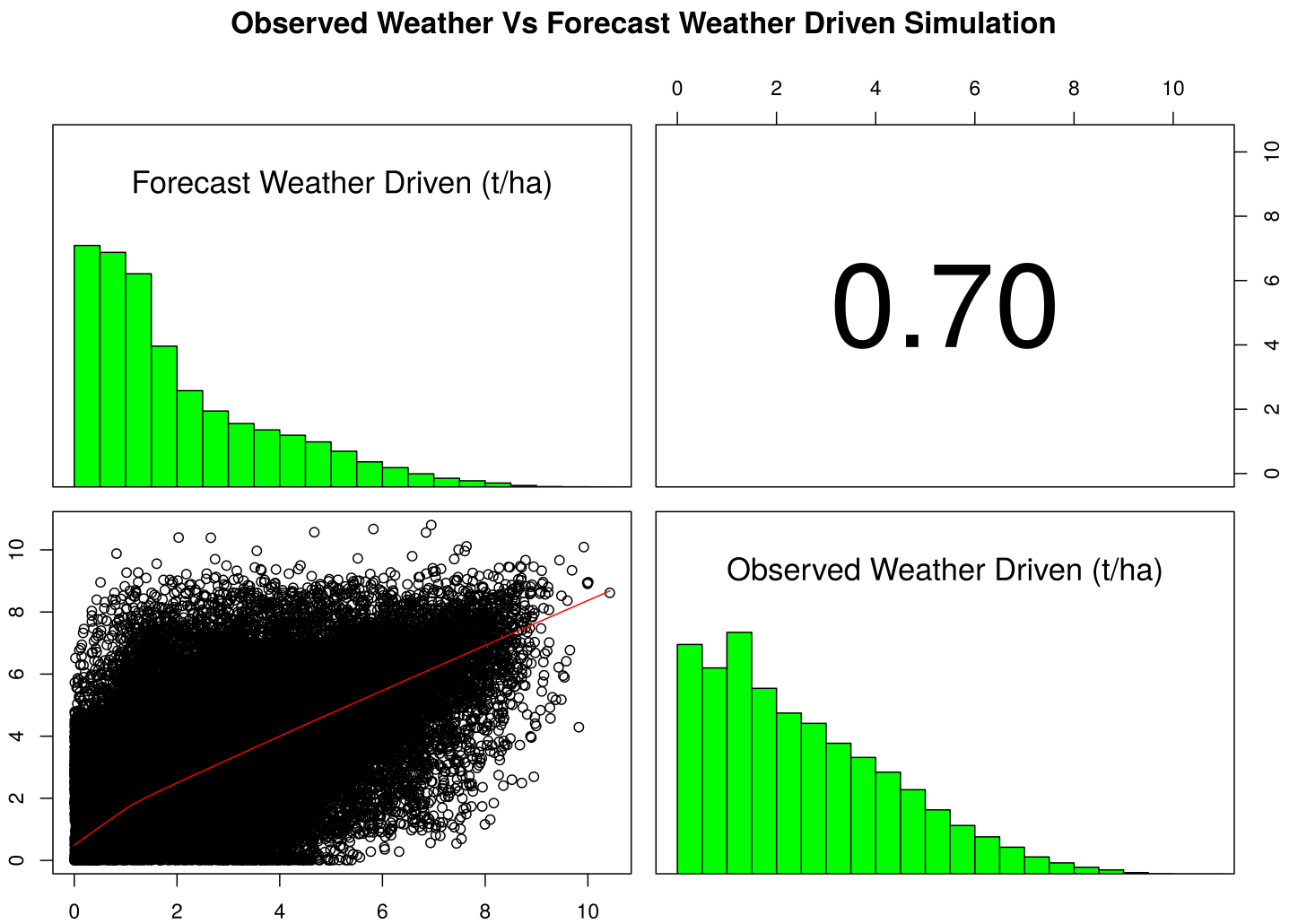

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- The spatial variation of, the year to year, yield variability was well reproduced by the simulation, which indicates a potential for predictability.
- The maize forecast does well predict the observed maize simulation. but, the prediction is not precise, with incorrect model form.
- The methodology can now used to study the mesoscale nature of spatial and temporal maize yield variability, as well as, can serve as a decision support for maize production planing and strategy development.

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- Grid-based calibration of the genetic coefficients,
- Lateral exchange of information between neighboring grids,
- Dynamically integrating climate models with detailed crop simulation models; 2-way feedback between crops and climate within a growing season,
- Bias-correction (MOS) and uncertainty estimates,
- This methodology is in its early stages, but has a wide applicability and the limitations should be understood.

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Insanity: Doing the same thing over and over and expect a deferent outcome! ***Albert Enstine***

Thank You!