Seasonal-Scale Drought Forecasting in Africa and the Middle East

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Computing resources provided by NASA's NCCS

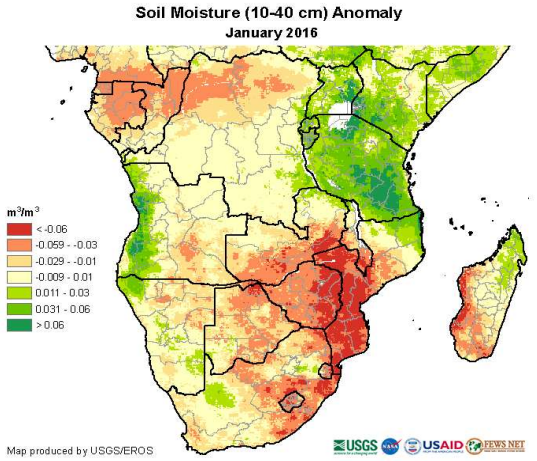
The Problem: Forecasting Drought

Project Summary: To develop a seasonal water deficit forecasting system that is relevant for USAID and USACE activities in the Middle East and Africa based on existing/mature NASA and NOAA Earth science capabilities.

Challenges: Working in regions most affected by droughts, with little in the way of ground observations to verify models and forecasts.

Need: Improved seasonal forecasts, utilizing best available models (land surface, climate forecast), satellite-data, etc., for drought-related crop impacts.

Opportunity: Working with end-users within these regions to help verify and work towards improved forecasts.

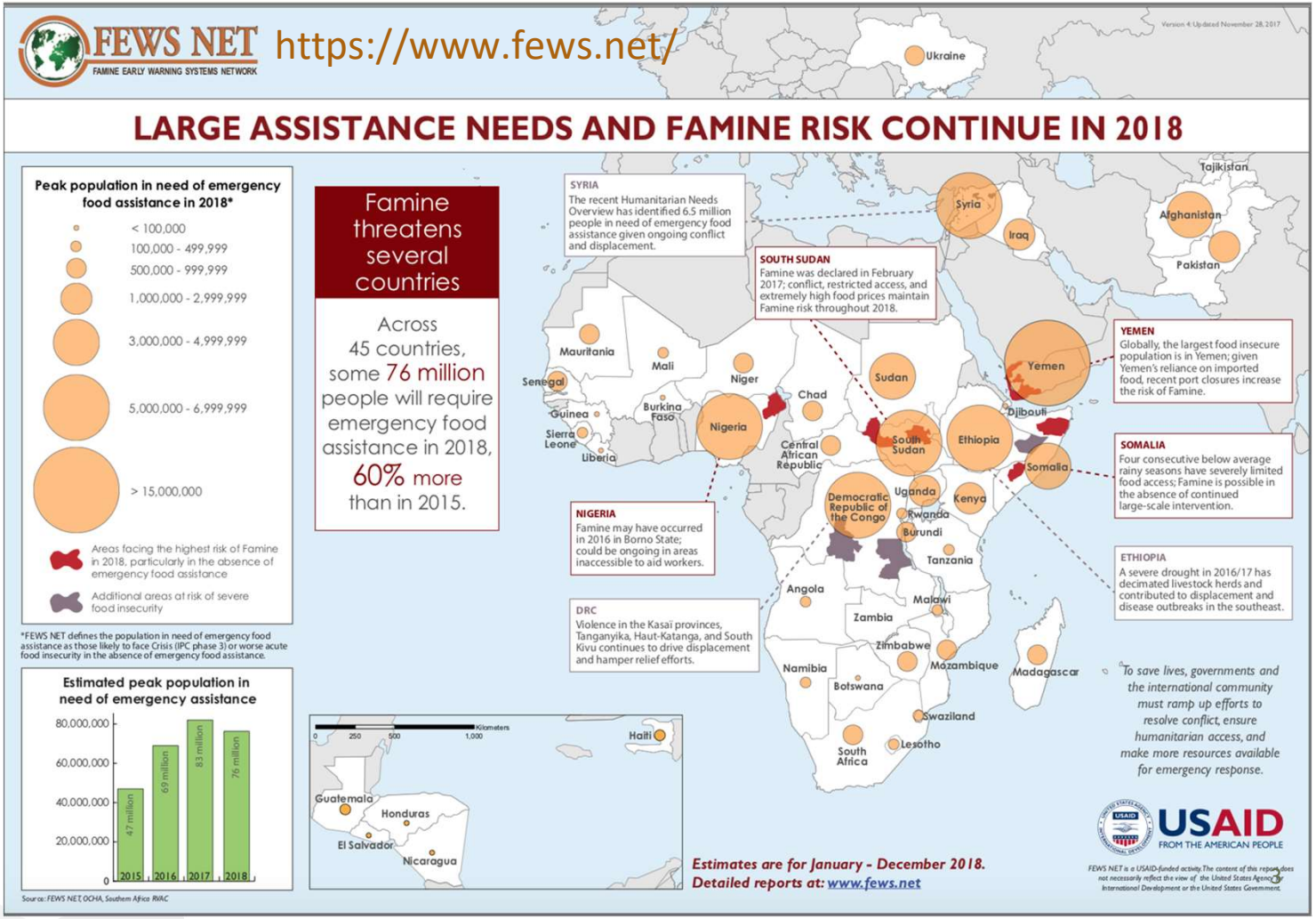


"Zimbabwe declares 'state of disaster' due to drought: More than quarter of population face food shortages as country hit by severe drought, with cattle dying and crops destroyed"

-The Guardian, 5 February 2016

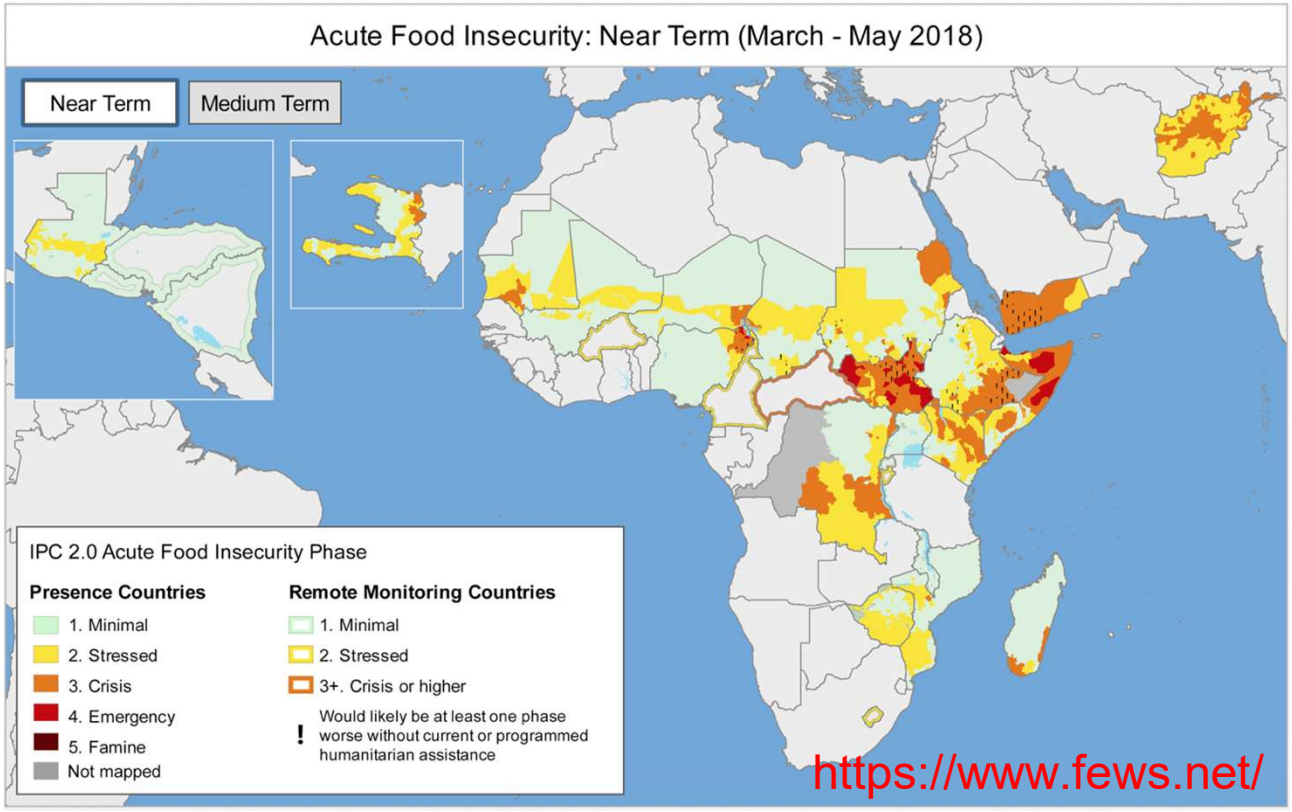
Why Forecast Drought?

Drought contributes to food insecurity!



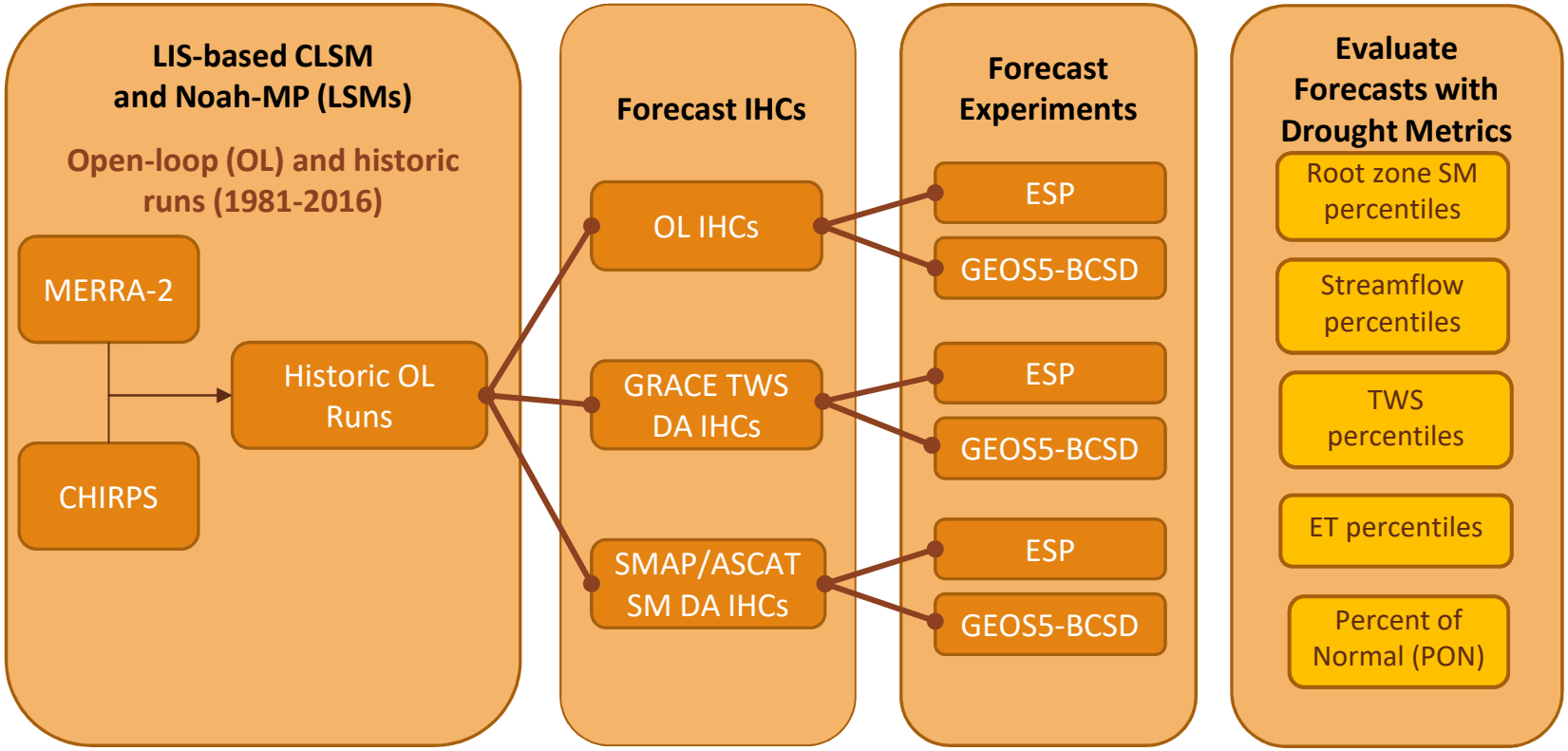
A drought forecasting system will support

- FEWS NET's food insecurity early warning efforts
- USACE stability operations



"Across 45 countries, some 76 million people will require emergency food assistance in 2018": USAID's Famine Early Warning System Network Team

Approach


LIS-based CLSM and Noah-MP (LSMs)
Open-loop (OL) and historic runs (1981-2016)
MERRA-2
CHIRPS
Historic OL Runs
Forecast IHCs
OL IHCs
GRACE TWS DA IHCs
SMAP/ASCAT SM DA IHCs
Forecast Experiments
ESP
GEOS5-BCSD
ESP
GEOS5-BCSD
ESP
GEOS5-BCSD
Evaluate Forecasts with Drought Metrics
Root zone SM percentiles
Streamflow percentiles
TWS percentiles
ET percentiles
Percent of Normal (PON)

Does historical simulated CLSM & Noah-MP Terrestrial Water Storage (TWS) identify major drought events?

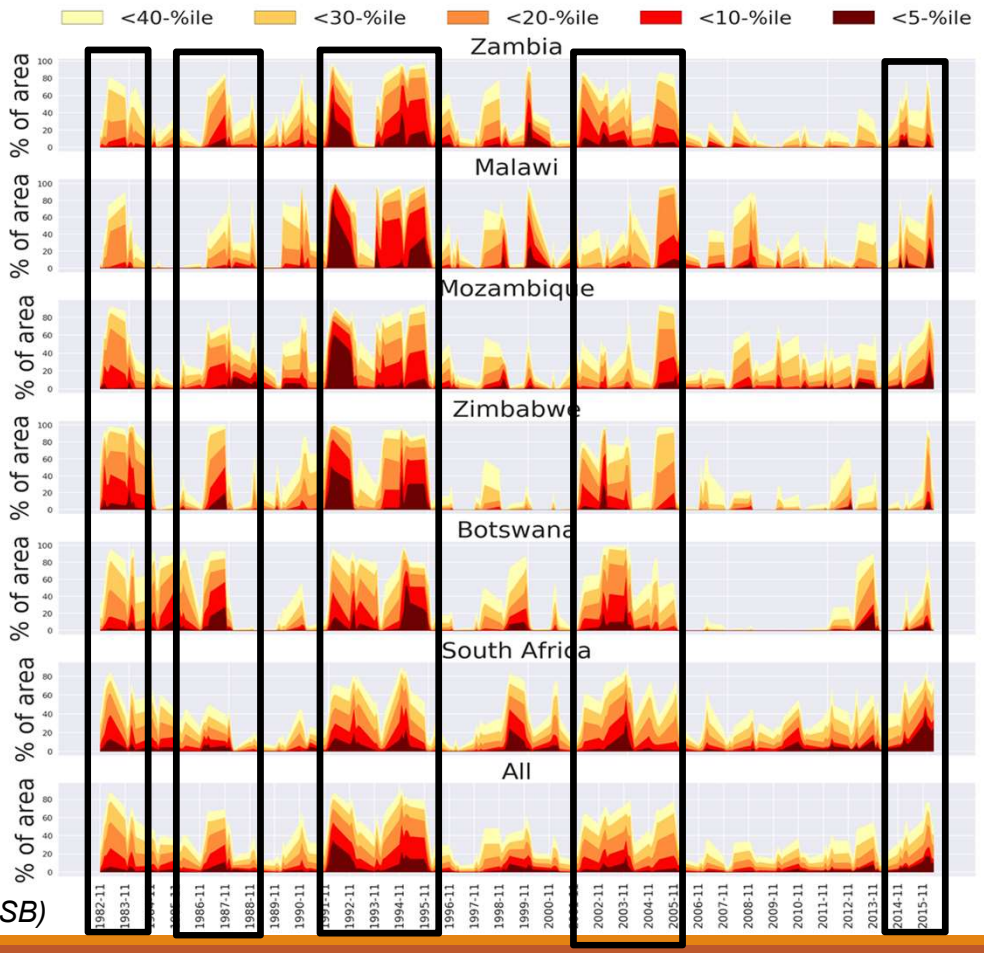
YES!

Major historical drought events include:

1982–1993, 1986-1987,

1991–1992, 1994–1995,

2001–2003, 2004-2005, 2015-2016



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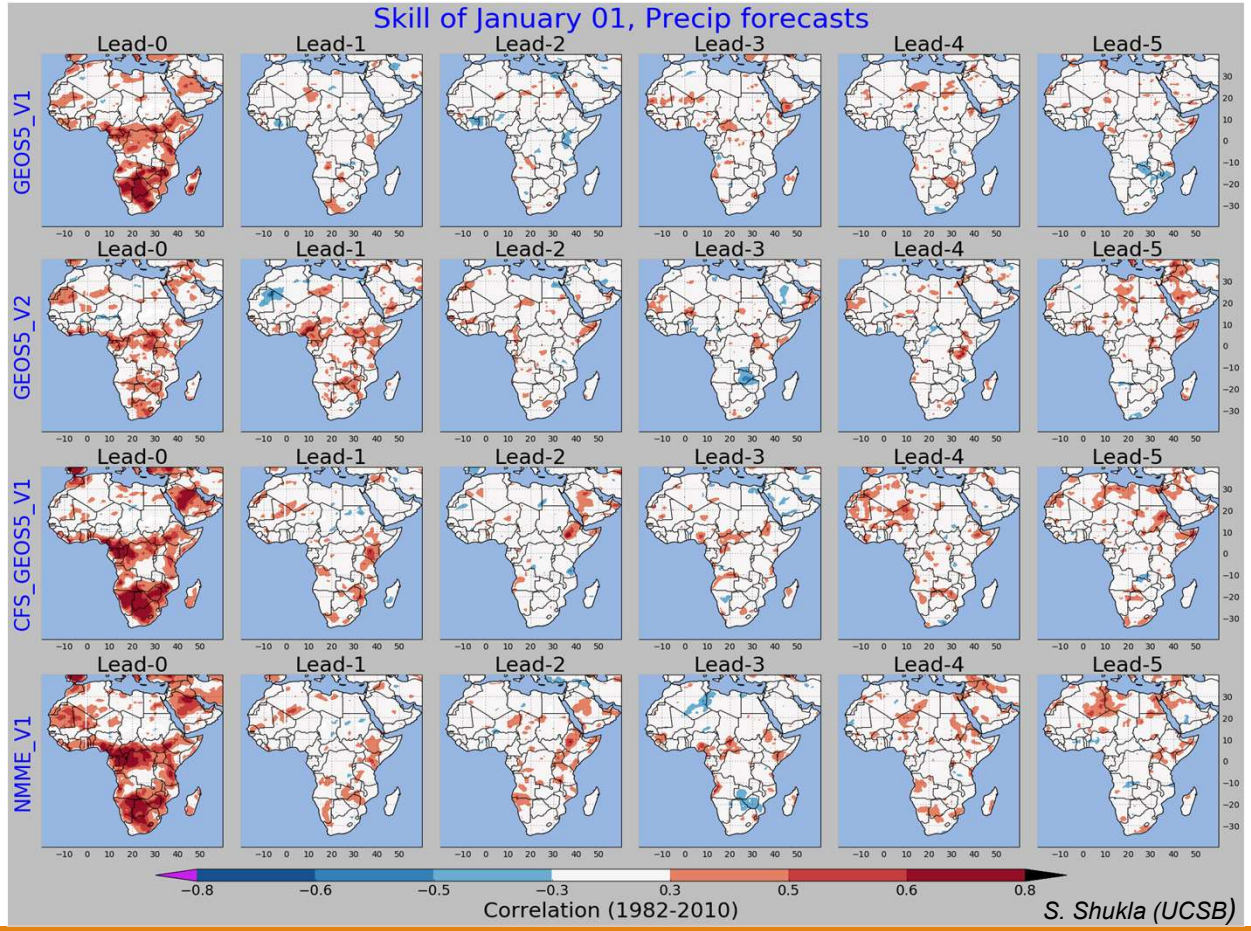
How skillful are GEOS-5 seasonal P forecasts compared to NMME ensemble skill?

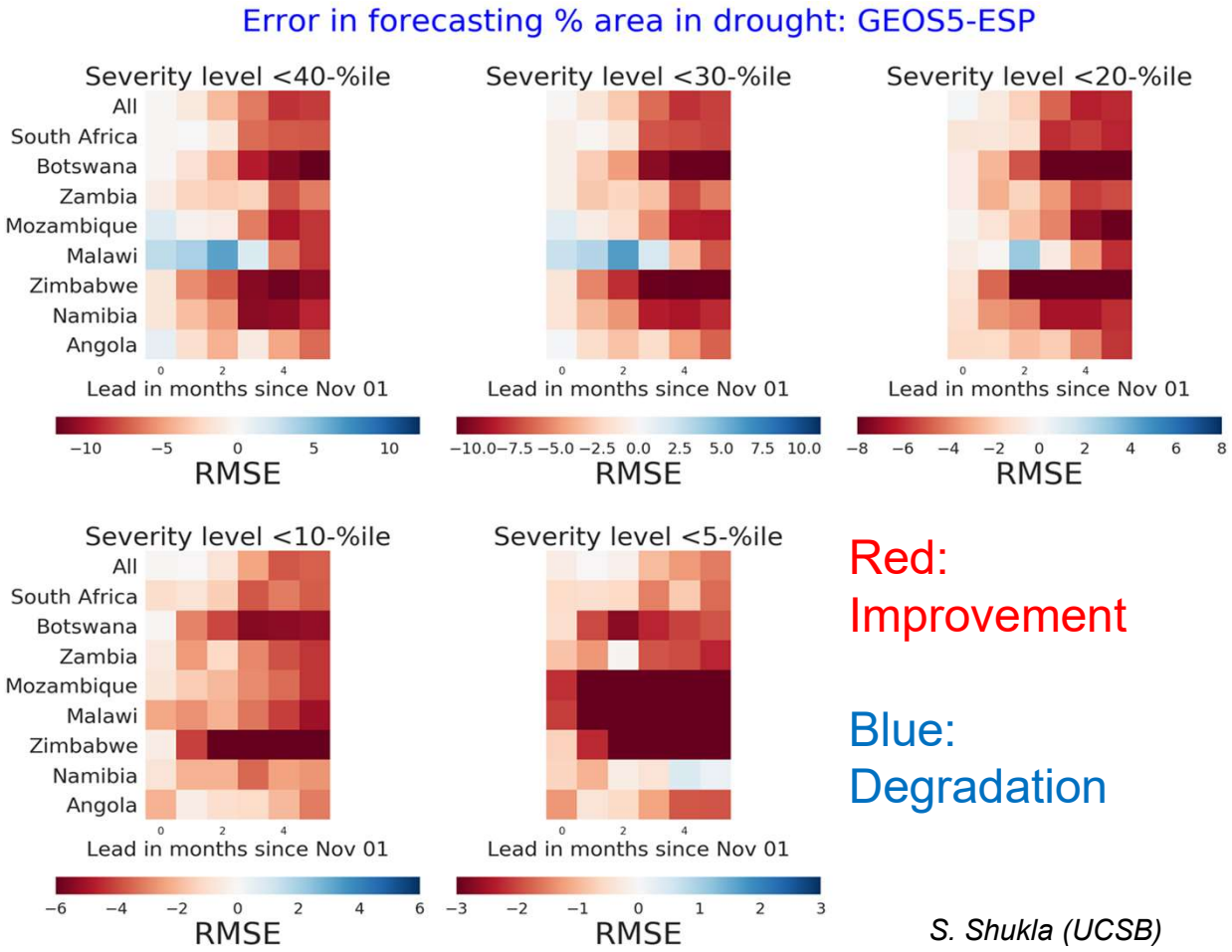
- When CFSv2 and GEOS5 are combined (3rd row), precipitation skill is close to that of the NMME ensemble for most of the domain.
- Limited precipitation forecast skill, especially after lead-0, for all cases.
- GEOS5-V2 shows more skill at lead 1 than V1.



Does GEOS5 improves the skill of forecasting % area in drought relative to ESP?

Yes!

The skill is the highest in Botswana, Zimbabwe and South Africa at higher lead times.



Red: Improvement

Blue: Degradation

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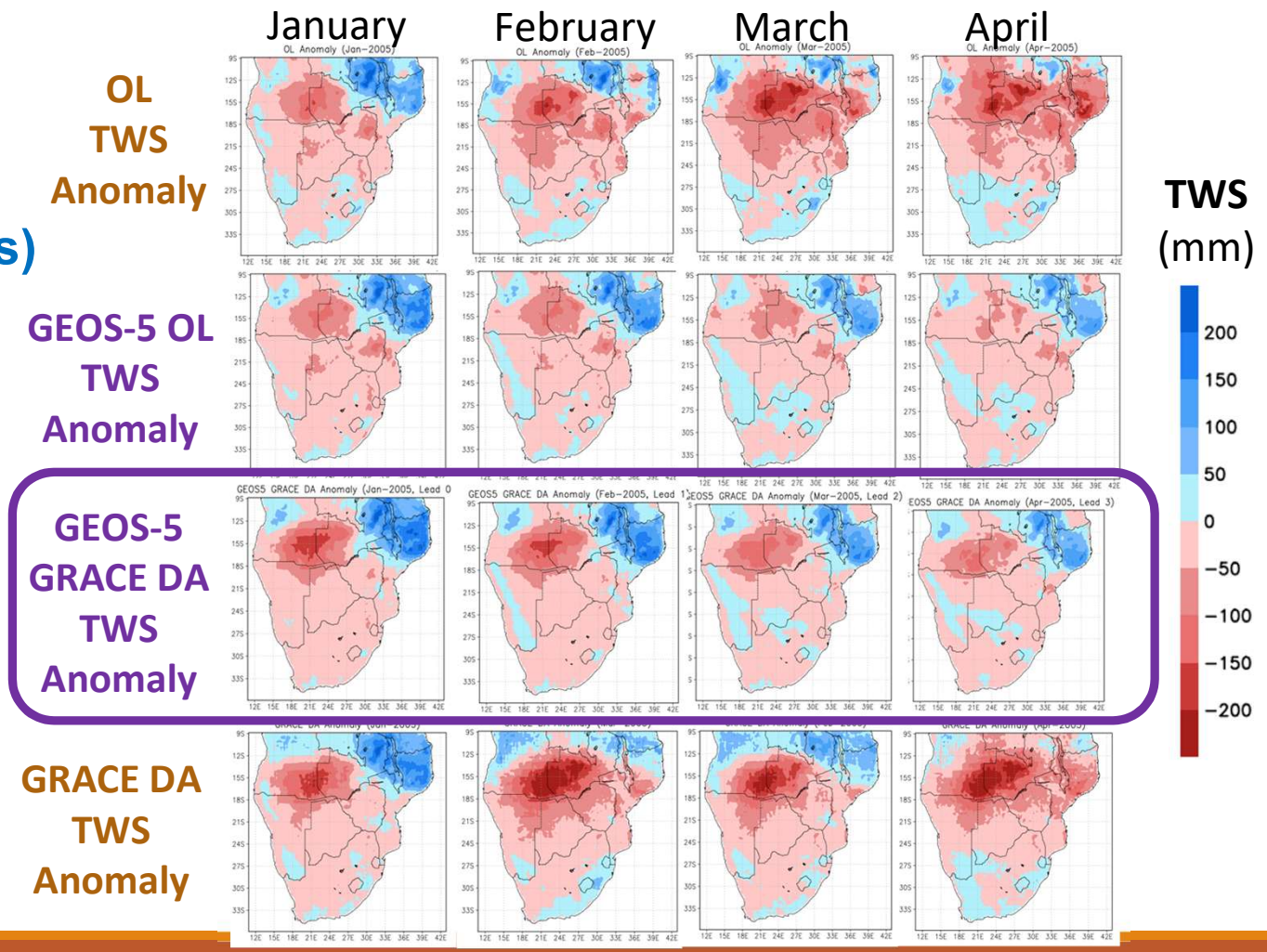
Does GRACE DA improve drought forecasts?

Yes (sometimes)

- Forecasts initialized with GRACE DA based IHC were able to better simulate the severity of the drought than the IHC without GRACE DA.

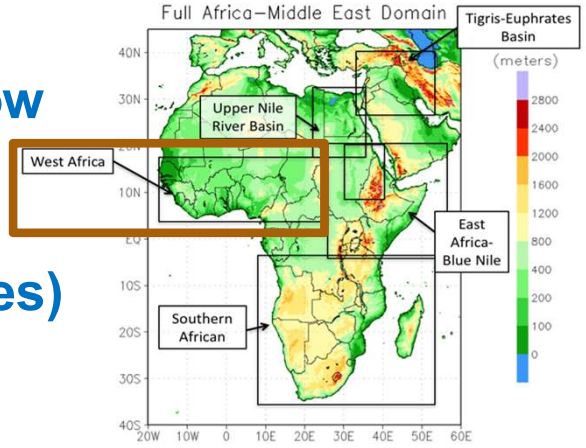
2005 Drought



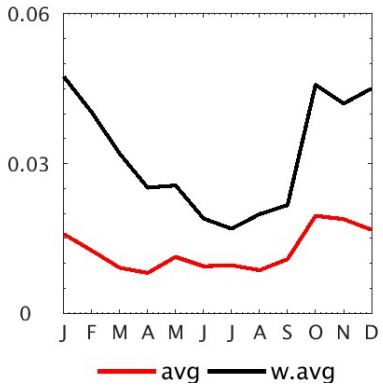
Does GRACE DA improve streamflow forecasts?

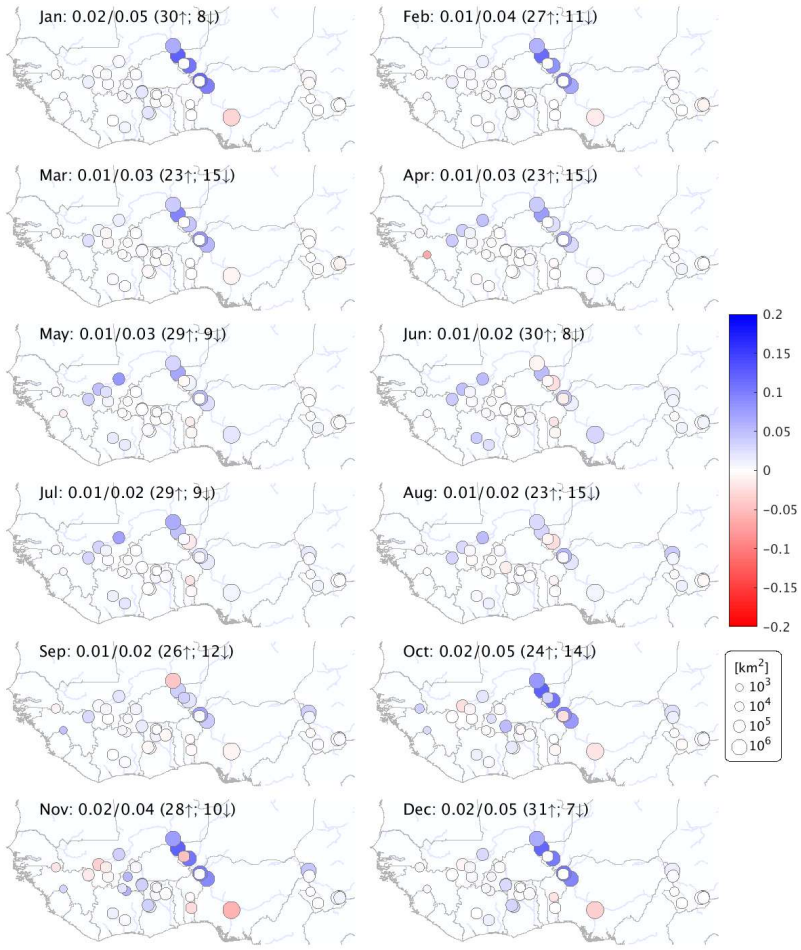
Yes (sometimes)

- For West Africa, some improvement (blue shaded circles) is shown with assimilated GRACE for some streamflow gages (*far right*) for different GEOS5-V1-based initialization months.
- (*Bottom-left*) Station-averaged, normalized RMSE values for each initial month. Black line shows basin-area weighted averages.



Normalized RMSE Improvement





A. Getirana (ESSIC), H. Jung (SSAI)

Achieved Results

- LIS+MERRA2/CHIRPS is able to reconstruct major drought events in Southern Africa.
- Despite limited precipitation forecast skill, GEOS5 adds to skill of drought forecasting beyond ESP. Additional climate models (e.g. CFS or NMME) can add to skill.
- Drought severity detection can be improved by assimilating GRACE (potentially more useful for real-time forecasts)

Anticipated Results and Impacts

- Producing near real-time soil moisture/TWS/streamflow forecasts for all of FAME domain, including bias-correction and assimilated GRACE TWS and SMAP soil moisture.
- Delivering these products prior to monthly FEWS NET Seasonal Forecast Review Technical Discussions
- Improved drought forecasts lead to improved agroclimatological assumptions, situational awareness, food insecurity projections, and food assistance decisions.