Enhancing the USDA Crop Assessment Decision Support System Using NASA SMAP Soil Moisture Observations

John D. Bolten¹, Iliana E. Mladenova², Nazmus Sazib¹, Wade Crow², and Curt Reynolds³

¹National Aeronautics and Space Administration, GSFC, Greenbelt, MD; ²United States Department of Agriculture, HRSL, Beltsville, MD; ³United States Department of Agriculture, FAS, Washington, DC.

I. ABSTRACT

One of the U. S. Department of Agriculture-Foreign Agricultural Services (USDA-FAS) mission objectives is to provide current information on global crop supply and demand estimates. Crop growth and development is especially susceptible to the amount of water present in the root-zone portion of the soil profile. Therefore, accurate knowledge of the root-zone soil moisture (RZSM) is an essential for USDA-FAS global crop assessments. This paper focusses on the possibility of enhancing the USDA-FAS’s RZSM estimates through the integration of passive-based soil moisture observations derived from the Soil Moisture Active Passive (SMAP) mission into the USDA-FAS Palmer model. Lag-correlation analysis, which explores the agreement between changes in RZSM and crop status indicated that the satellite-based observations can enhance the model-only estimates.

II. BACKGROUND

Crop Condition Data Retrieval and Evaluation (CADRE) Database Management System (DBMS)

WMO Station Data

• Relative yield reductions for corn, wheat, and soybeans;
• Crop stage and crop stress for wheat and corn;
• Normal;
• Percent normal of precipitation;
• Average, minimum, and maximum temperatures;
• Actual and cumulative precipitation;
• Snow depth.

NASA Soil Moisture Data Advances Global Crop Forecasts

Figure 3: Drought monitoring using soil moisture anomalies over the Western Cape, South Africa. The maps show the average soil moisture conditions for the 2017 growing season.

Data represent standardized anomalies, where negative values indicate that the soil moisture conditions are below average and positive values indicate surplus of water.

According to the USDA FAS Crop Intelligence Report reported severe drought in the Western Cape province of South Africa during the 2017 growing season. The Western Cape is the country’s largest wheat producing area, where wheat is typically planted in May and harvested in October. Rainfall this period is essential for crop production. The decline in soil moisture availability as shown in Figure 3 during the 2017 have resulted in poor crop growth and decline in potential end of season yield.

III. SYSTEM SET UP

Improving the USDA-FAS soil moisture information developed using the Palmer Model by integrating SMAP soil moisture observations.

IV. RESULTS

Global Lag Soil Moisture-NDVI Correlation Analysis

Model alone

Satellite Enhanced Model

PM + SMAP

Data Distribution

Crop Explorer

Google Earth Engine

Change in soil moisture conditions is typically preceded by the change in vegetation health as crops have several coping mechanisms to deal with the environmental stresses associated with drought. Maps show the lag correlation agreement between the sub-surface soil moisture values estimated using the SMAP-enhanced Palmer model and NDVI, used here as an indicator of vegetation status. Overall SMAP improves the model.

V. SUMMARY

- USDA-FAS PM+SMAP soil moisture observation system:
  - System is fully set up and operational
  - Positive feedback
  - Data publicly available through Crop Explorer and Google Earth Engine
  - Several papers in progress