US NATIONAL CROPLAND SOIL MOISTURE MONITORING USING SMAP

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INTRODUCTION

Crop condition information is critical to decision making in both public and private sectors that concern agricultural policy, production, food security, and food prices. Crop growing conditions, such as temperature, soil moisture, fertilization, or disease, etc., change quickly. The National Agriculture Statistics Services (NASS) of the United States Department of Agricultural (USDA) publishes weekly topsoil and subsoil moisture conditions for 45 states by field observation in crop condition report. The soil moisture data are observed by volunteers. These data are subjective, qualitative, inconsistent, unreliable, and not fully geospatially covered. The survey operation is a burden to farmers and NASS field officers. To improve NASS cropland soil moisture monitoring, this study proposes to use the remote sensing results from NASA Soil Moisture Active and Passive (SMAP) mission[1] for US national cropland soil moisture monitoring.

OBJECTIVES

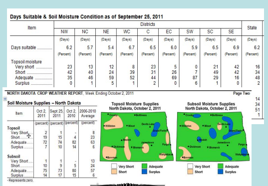
- To study study the feasibility of early adapting of SMAP products at the pre-launch stage to support US national crop condition monitoring and other NASS operational data needs, such as crop yield modeling;
- To explore a technical route to build a remote sensing based soil moisture monitoring system prototype based on the feasibility of application of SMAP data products.
- To improve NASS soil moisture condition monitoring in high spatial and temporal resolution.

DATA AND STUDY AREA

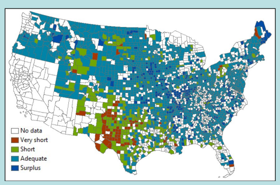
•Simulated SMAP data: L3SM_A/P, L4_SM, or L1C-S0_HiRes.

•A crop mask derived from NASS Cropland Data Layer [2].

•Study area: CONUS 48 states.

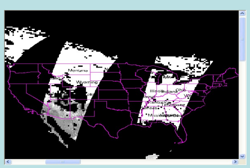


NASS soil Moisture Report



NASS soil Moisture Map

Global SMAP simulated data



US SMAP soil moisture data

Requirements

•Objective, consistent, reliable and quantitative soil moisture measurement;
•High resolution national geospatial coverage, and georeferenced monitoring;
•At least Sub-county resolution monitoring;
•Automatic data collection, processing and publishing;
•Online visualization and dissemination;
•Efficient and low cost.

METHODOLOGY

•***SMAP Data Downscaling***

• Fuse SMAP data with the soil moisture estimates from higher resolution visible/infrared (VIS/IR) satellite data using "universal triangle" concept, which correlates NDVI, and Land Surface Temperature (Ts), to the soil moisture [3].

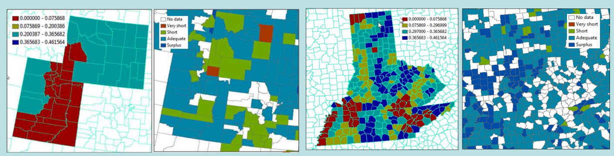
•***Validation and Calibration***

•Validate the SMAP data and their derivative products using existing NASS soil moisture survey data.

•Use controlled ground truth measurements with soil moisture sensors. With SMAP data and ground truth measurement data at hand, an empirical look-up table or mapping equation will be derived.

•***SMAP Data Assessment***

•Correlate the SMAP soil moisture with NDVI and evapotranspiration data derived from other sensors.

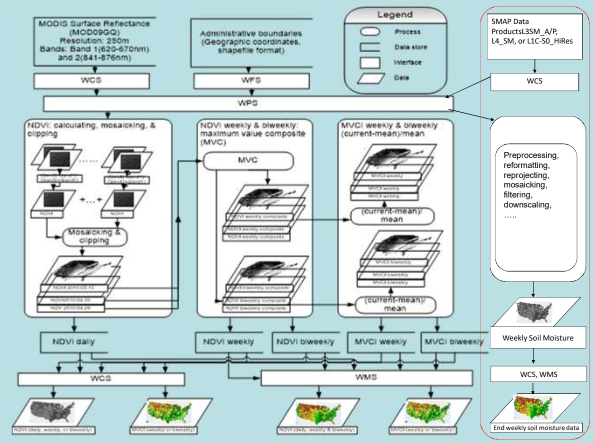


L3-AP soil moisture(left) vs. NASS Surveyed topsoil moisture(right) – different metrics.

SYSTEM DESIGN

- The derived SMAP soil moisture products need to be published, visualized, accessed, analyzed, and disseminated to end users via online application.
- A web service based online geospatial system will be developed.
- The existing crop vegetation condition monitoring system-VegScape [4] is to be reused:
  - A SMOP processing component is to be added to the VegScape framework.
  - Most of the VegScape browser based client user interface components can be reused.
  - New additions include SMAP data layers, SMAP map legends, and SMAP product selection options.
  - VegScape's query, visualizing, dissemination, and online analysis functions are to be reused for SMAP soil moisture.
- The system features:
  - A service-oriented architecture (SOA).
  - MapServer configured as the server of WCS, WFS, and WMS to support retrieval and rendering of soil moisture data.
  - OpenLayers and JavaScript libraries are used to develop common internet browser-based client application.
  - The W3C Web service is adopted in implementing the Web geoprocessing service and Web processing services for SMAP data reformatting, reprojection, downscaling and quantification

SMAP DATA FLOW ON VegScape FRAMEWORK



CONCLUSIONS

•SMAP data allows sub-county level soil moisture monitoring while downscaled data may allow field level monitoring.
•The service oriented architecture allows scalability and reusability.
•Interactive mapping enabled online geospatial data equal accessing, data exploring, navigation, querying, visualization, and dissemination, and greatly improved user experiences.
•Web-based interactive mapping enabled online geospatial data equal accessing, data exploring, navigation, querying, visualization, and dissemination, and greatly improved user experiences.

FUTURE WORKS

•Find the vegetation impact on SMAP data results;
•Assess errors caused by low 9km resolution;
•Establish the mapping relation between SMAP's soil moisture measurement and the qualitative assessment of NASS soil moisture survey result once the real SMAP data are available

REFERENCE

[1] Entekhabi, D. et al. "The Soil Moisture Active Passive (SMAP) Mission." Proceedings of the IEEE 98.5: pp.704-716, 2010. ©Copyright 2010 IEEE.
[2] C. Boryan, Z. Yang, L. Di, "Deriving 2011 Cultivated Land Cover Data Sets Using USDA National Agricultural Statistics Service Historic Cropland Data Layers", Proc. of 2012 IEEE International Geoscience & Remote Sensing Symposium, Munich, Germany, July 2012.
[3] Piles, M. et al., "Downscaling SMOS-Derived Soil Moisture Using MODIS Visible/Infrared Data," IEEE Transactions on Geoscience and Remote Sensing, Vol. 49, Issue 9, Sept. 2011.
[4] Z. Yang, G. Yu, L. Di, B. Zhang, W. Han, R. Mueller, "Web Service-based Vegetation Condition Monitoring System – VegScape", Proc. of IEEE IGARSS 2013, Melbourne, Australia, August 2013

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