Web Geoprocessing Services for Disseminating and Analyzing SMAP Derived Soil Moisture Data Products

Chen Zhang[1], Zhengwei Yang[2], Liping Di[1], Eugene Yu[1], Li Lin[1], and Haoteng Zhao[1]

[1]George Mason University
[2]USDA National Agricultural Statistics Service

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Abstract

Soil moisture is an essential metric to understand crop condition throughout the growing season. Collecting soil moisture data by field observation is time-consuming and labor-intensive, especially for a CONUS geographic coverage. NASA's SMAP Mission has been providing global mapping of soil moisture and freeze/thaw state at high spatial and temporal resolutions since 2015. However, handling SMAP data could be difficult for users who do not have technical background. Creating a soil moisture map with SMAP data contains a series of steps, including data retrieval, reformatting, reprojection, mosaicking, and clipping. Moreover, users need to install special software and configure the system environment to further perform geospatial analysis for SMAP data. To facilitate using of SMAP data, this paper presents a cloud-based web geoprocessing service system for disseminating and analyzing SMAP data products. This web service system serves a variety of data products, including 9-km SMAP Level-4 data, 1-km SMAP Hybrid data, and MODIS-based vegetation index data. The development of the geoprocessing services is based on the three-layer system architecture composed of an infrastructure layer, a data layer, and a service layer. The infrastructure layer manages the fundamental computing resources and offers the Platform as a Service (PaaS) to the data layer and service layer. The data layer stores all raw raster and vector data offered by the web service. The service layer handles all geospatial web services including map services and geoprocessing services. Both the data layer and service layer are deployed as instances of virtual machines on the top of the infrastructure layer. The system offers a variety of geoprocessing operations in the OGC Web Processing Service (WPS) interface standard. These operations are grouped into get file processes, geospatial statistics processes, map production processes, time-series profile processes, image composite processes, and miscellaneous processes. The proposed geoprocessing services have been implemented as a part of the Crop Condition and Soil Moisture Analytics (Crop-CAMSA) web service system and are interoperable with other web applications. The experiment result shows the geoprocessing service can significantly simplify the procedures of dissemination and analysis of SMAP data.

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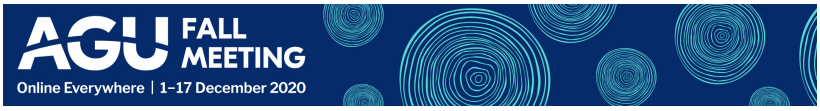
Chen Zhang (a), Zhengwei Yang (b), Liping Di (a), Eugene G. Yu (a), Li Lin (a), Haoteng Zhao (a)

(a) Center for Spatial Information Science and Systems, George Mason University, Fairfax, VA 22030, USA
(b) U.S. Department of Agriculture National Agricultural Statistics Service, Washington, DC 20250, USA

PRESENTED AT:



INTRODUCTION

Soil moisture is an essential metric to understand crop condition throughout the growing season. NASA's SMAP Mission has been providing global mapping of soil moisture and freeze/thaw state at high spatial and temporal resolutions since 2015. However, handling SMAP data could be difficult for users who do not have technical background. To facilitate the use of SMAP data, we present a cloud-based web geoprocessing service system for disseminating and analyzing SMAP derived soil moisture data products.

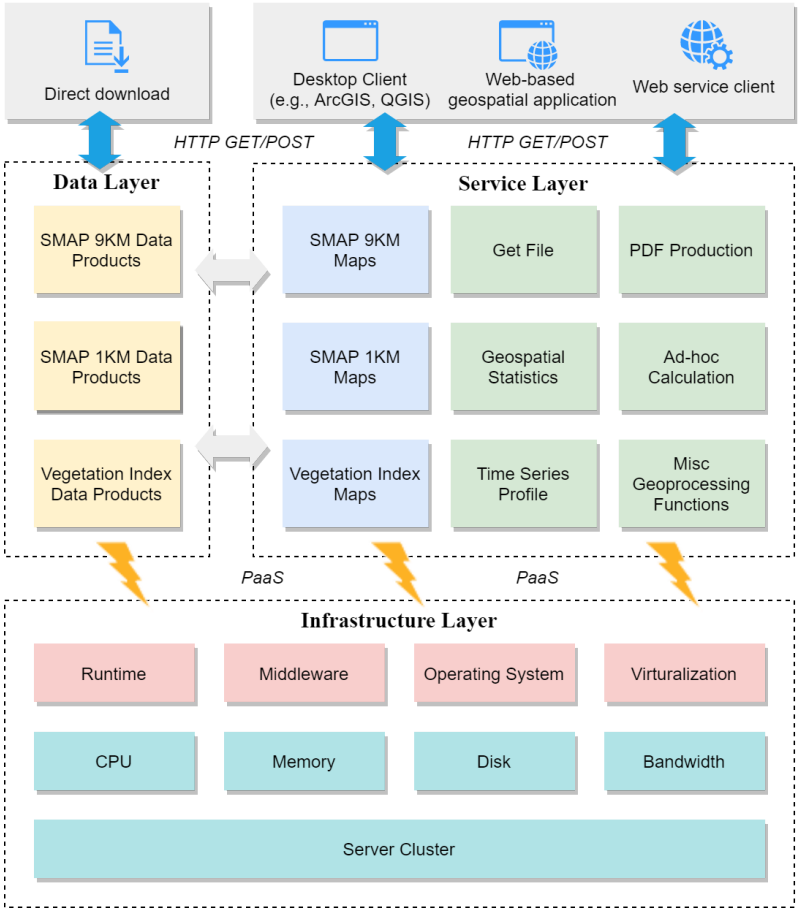
DATA

The proposed system serves a variety of data products over the Conterminous United States (CONUS). According to the type of data source, the available data products can be divided into 9-km SMAP data products that derived from the SMAP Level-4 Soil Moisture (L4_SM) data, 1-km SMAP data products that derived from the SMAP Hybrid 1KM data, and vegetation index data products that derived from Moderate Resolution Imaging Spectroradiometer (MODIS) data.

All data products are disseminated through the OGC Web Map Service (WMS) interface standard. According to the user's need, the image of a map can be returned via GetMap request with parameters including map path, layer name, projection, bounding box, and width/height of the map. For example, the WMS of 9-km SMAP data can be requested via: https://cloud.csiss.gmu.edu/smap_server/cgi-bin/mapserv?SERVICE=WMS&VERSION=1.1.1&REQUEST=GetMap&MAP=/SMAP_DATA/SMAP-9KM-DAILY/2020/SMAP-9KM-DAILY-TOP_2020.03.01_AVERAGE.map&LAYERS=SMAP-9KM-DAILY-TOP_2020.03.01_AVERAGE&SRS=EPSG:5070&FORMAT=image/png&TRANSPARENT=true&BBOX=-2354935.721,311822.402,2256319.225,3165592.366 (https://cloud.csiss.gmu.edu/smap_server/cgi-bin/mapserv?SERVICE=WMS&VERSION=1.1.1&REQUEST=GetMap&MAP=/SMAP_DATA/SMAP-9KM-DAILY/2020/SMAP-9KM-DAILY-TOP_2020.03.01_AVERAGE.map&LAYERS=SMAP-9KM-DAILY-TOP_2020.03.01_AVERAGE&SRS=EPSG:5070&FORMAT=image/png&TRANSPARENT=true&BBOX=-2354935.721,311822.402,2256319.225,3165592.366

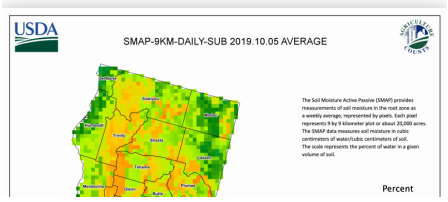
SYSTEM DESIGN

The development of the geoprocessing services is based on the three-layer system architecture composed of an infrastructure layer, a data layer, and a service layer. The infrastructure layer manages the fundamental computing resources and offers the Platform as a Service (PaaS) to the data layer and service layer. The data layer stores all raw raster and vector data offered by the web service. The service layer handles all geospatial web services including map services and geoprocessing services. Both the data layer and service layer are deployed as instances of virtual machines on the top of the infrastructure layer.



GEOPROCESSING SERIVICE

The system offers a variety of geoprocessing operations in the OGC Web Processing Service (WPS) interface standard. These operations are grouped into get file processes, geospatial statistics processes, map production processes, time-series profile processes, image composite processes, and miscellaneous processes. Using geoprocessing services significantly simplifies the procedures of dissemination and analysis of SMAP data. For example, a request of getting PDF map of California state via HTTP GET method is like http://cloud.csiss.gmu.edu/smap_service?service=WPS&version=1.0.0&request=Execute&identifier=GetSMAPPdfCA&DataInputs=layer=SMAP-9KM-DAILY-SUB_2019.10.05_AVERAGE;title=SMAP-9KM-DAILY-SUB_2019.10.05_AVERAGE;boundary={%22county%22:1} (http://cloud.csiss.gmu.edu/smap_service?service=WPS&version=1.0.0&request=Execute&identifier=GetSMAPPdfCA&DataInputs=layer=SMAP-9KM-DAILY-SUB_2019.10.05_AVERAGE;title=SMAP-9KM-DAILY-SUB_2019.10.05_AVERAGE;boundary={%22county%22:1}).



SOFTWARE AVAILABILITY

The proposed geoprocessing services have been implemented as a part of the Crop Condition and Soil Moisture Analytics (Crop-CAMSA) web service system.

Crop-CASMA Web Client: https://cloud.csiss.gmu.edu/Crop-CASMA/ (https://cloud.csiss.gmu.edu/Crop-CASMA/)

Crop-CASMA WPS Endpoint: https://cloud.csiss.gmu.edu/smap_service (https://cloud.csiss.gmu.edu/smap_service)

Crop-CASMA WPS Capabilities: https://cloud.csiss.gmu.edu/smap_service?service=WPS&version=1.0.0&request=GetCapabilities (https://cloud.csiss.gmu.edu/smap_service?service=WPS&version=1.0.0&request=GetCapabilities)

Developer's Documentation: https://cloud.csiss.gmu.edu/Crop-CASMA-Developer/ (https://cloud.csiss.gmu.edu/Crop-CASMA-Developer/)

User's Documentation: https://cloud.csiss.gmu.edu/Crop-CASMA-User/ (https://cloud.csiss.gmu.edu/Crop-CASMA-User/)

ABSTRACT

Soil moisture is an essential metric to understand crop condition throughout the growing season. Collecting soil moisture data by field observation is time-consuming and labor-intensive, especially for a CONUS geographic coverage. NASA's SMAP Mission has been providing global mapping of soil moisture and freeze/thaw state at high spatial and temporal resolutions since 2015. However, handling SMAP data could be difficult for users who do not have technical background. Creating a soil moisture map with SMAP data contains a series of steps, including data retrieval, reformatting, reprojection, mosaicking, and clipping. Moreover, users need to install special software and configure the system environment to further perform geospatial analysis for SMAP data. To facilitate using of SMAP data, this paper presents a cloud-based web geoprocessing service system for disseminating and analyzing SMAP data products. This web service system serves a variety of data products, including 9-km SMAP Level-4 data, 1-km SMAP Hybrid data, and MODIS-based vegetation index data. The development of the geoprocessing services is based on the three-layer system architecture composed of an infrastructure layer, a data layer, and a service layer. The infrastructure layer manages the fundamental computing resources and offers the Platform as a Service (PaaS) to the data layer and service layer. The data layer stores all raw raster and vector data offered by the web service. The service layer handles all geospatial web services including map services and geoprocessing services. Both the data layer and service layer are deployed as instances of virtual machines on the top of the infrastructure layer. The system offers a variety of geoprocessing operations in the OGC Web Processing Service (WPS) interface standard. These operations are grouped into get file processes, geospatial statistics processes, map production processes, time-series profile processes, image composite processes, and miscellaneous processes. The proposed geoprocessing services have been implemented as a part of the Crop Condition and Soil Moisture Analytics (Crop-CAMSA) web service system and are interoperable with other web applications. The experiment result shows the geoprocessing service can significantly simplify the procedures of dissemination and analysis of SMAP data.