GEOSPATIAL WEB SERVICE CLIENT

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ABSTRACT

This Geospatial Web Service Client (GWSC) provides an interoperable way of accessing geospatial Web service, especially those from Open Geospatial Consortium (OGC), for integrating and analyzing distributed heterogeneous Earth science data. GWSC utilizes the geospatial interoperability and Web service standards developed by OGC, ISO, W3C, and GRID communities to enable in service discovery, invocation, negotiation, selection and composition. GWSC is in conformity with OGC Catalog Service for Web (CSW) specification to play a "directory" role that permits the registry, discovery and access of geospatial information resources that distribute on the Internet, such as services, data sets, data descriptions and their associations. By implementing the latest protocols of OGC Web Feature Service (WFS), Web Map Service (WMS) and Web Coverage Service (WCS), GWSC provides a single point of entry to the access of OGC compliant data services around the world to request any subsets of a multi-dimensional and multi-temporal geospatial data for a specific geographic region. It provides the capabilities to handle all details of different protocols internally so that users don't need to know the low level details of how to find and access these data. GWSC also can access tool-like Web services, such as Web Image Classification Service (WICS) and Web Coordinates Transformation Service (WCTS), to produce value-added data products. Moreover, in order for developing user's own more complex processing workflow that is used for further geospatial visualization and analysis, GWSC supports to build, instantiate, execute and register Web service chain.

INTRODUCTION

In recent years, a growing number of geospatial Web services designed to deal with distributed geospatial information over network have emerged as the maturation of Web service technologies. The Open Geospatial Consortium (OGC) has just finished the Open Web Services initiative phase 2 (OGC, 2004) that addresses geospatial interoperability requirements and standards to enhance the discovery, retrieval and use of geospatial information and geoprocessing services. A series of geospatial Web service specifications have been published, such as Web Coverage Service (WCS) (Evans, 2003), Web Feature Service (WFS) (Vretanos, 2002), Web Map Service (WMS) (Beaujardiere, 2004), Web Image Classification Service (WICS) (Yang et al 2004), Web Coordinate Transformation Service (WCTS) (Müller et al, 2004). Moreover, the true potential of geospatial Web services is to dynamically assemble new web services that provide more functionality compared to existing web services.

To aim to integrate and analyze distributed heterogeneous Earth science data, Geospatial Web Service Client (GWSC) is designed to be a portal that handles all low level details of different protocols internally and allows users to discover, invoke, negotiate, select and composite geospatial Web service around the world, especially those from OGC, based on the geospatial interoperability and Web service standards developed by OGC, ISO, W3C, and GRID communities. It also can 1) request any subset of multi-dimensional and multi-temporal geospatial data for a specific geographic region; 2) reformat the returning dataset in a data format specified by the user; 3) provide robust visualization and analytical tools for geospatial data; 4) support multiple data format: HDF, GeoTiff, GML, JPG, PNG, GIF.

In this paper, we show how to use Catalog Service for Web (CSW) (Nebert, 2003) to discover geospatial data and service, explain and illustrate service composition and dynamic service and data retrieval through GWSC.

GEOSPATIAL WEB SERVICE AND DATA DISCOVERY

Currently CSW as the part of OWS-2 is becoming the de facto standard that supports the registry and discovery of geospatial information resources. It plays a “directory” role in the open, distributed Web service environment: providers register their capabilities using metadata, and users can then query the metadata to discover interesting information. GWSC implements OGC Registry Information model (OGCRIM) and supports CSW “*getRecord*” and “*getResourceByID*” interfaces to allow users to discover distributed service and data by mouse clicking.

As figure 1 shows users can query any known CSW in GWSC to find interesting data based on the spatial, temporal, topic keyword, platform, instrument and process level attributes rather than data name. Once CSW return the query results, GWSC allows users to view the result list and relevant metadata. For retrieving the interesting dataset, the information about which service provides such data is also needed necessarily. GWSC uses “*Association*” relationship between service and data registered in CSW to get the service information at backend for service binding. Moreover, users can discover services directly based on service classification specification, such as ISO19119, OGC, NASA GCMD (Global Change Master Directory). For example, users can do “find all of OGC WCS”.

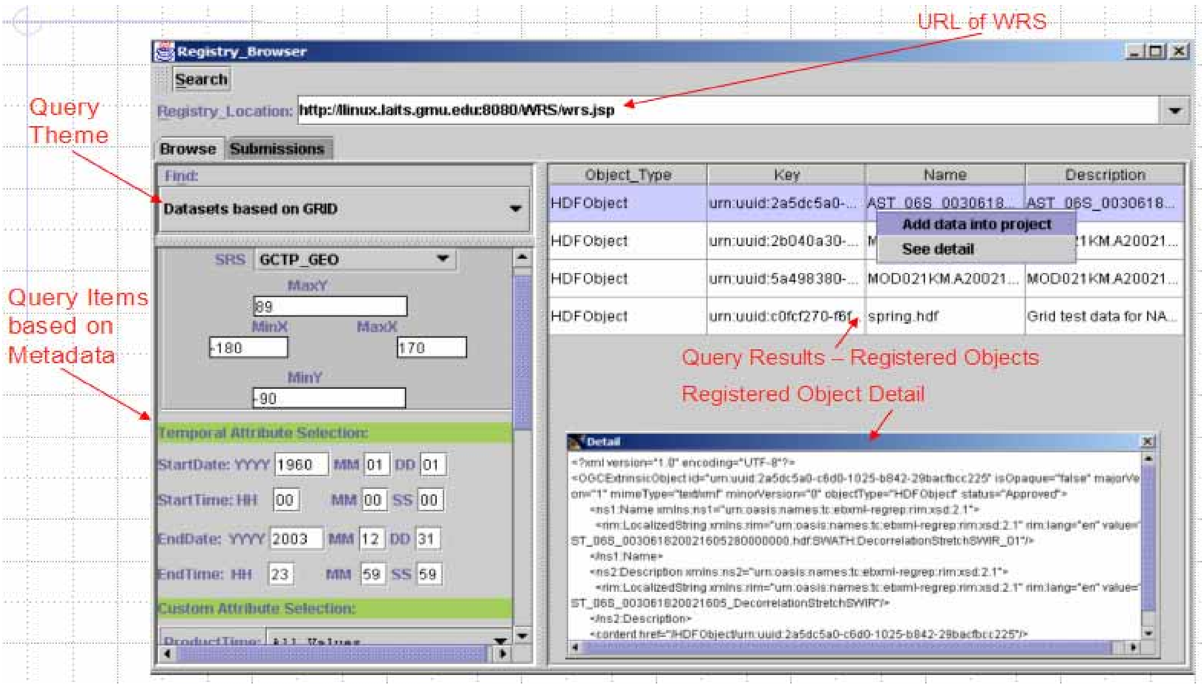

Figure 1. Screenshot of data discovery through CSW in GSWC.

GEOSPATIAL WEB SERVICE AND DATA ACCESS

By implementing the latest protocols of OGC WFS, WMS WCS, GWSC provides a single point of entry to the access of OGC geospatial Web services around the world to facilitate requesting, analyzing and visualizing any subsets of multi-source geospatial data for a specific geographic region.

WCS Acess

WCS supports the networked interchange of multi-dimensional and multi-temporal geospatial data as "coverage" through “*getCapabilities*”, “*describeCoverage*” and “*getCoverage*” interfaces. WCS provides intact geospatial data products encoded in HDF-EOS, NITF and GeoTIFF to meet the requirements of client-side rendering, multi-valued coverages, and input of scientific models and other clients beyond simple viewers. Figure 2 shows the WCS “*getCoverage*” user interface in GWSC:

- Server URLs come either from CSW service query or from user inputs.
- Data layer list for each service derives from “*getCapabilites*” response.

- Attributes for each data, such as bounding box, range set, resolution and spatial reference system, derives from "*describeCoverage*" response.

Based on the user's subsetting of each data attributes, GWSC automatically generates WCS "*getCoverage*" request as figure 3 and send this request to the selected server to get coverage data. For coverage is intact data, users can do analysis on the original information included in the coverage, such as color composite and histogram. Figure 4 is an example of visualization of "coverage" data.

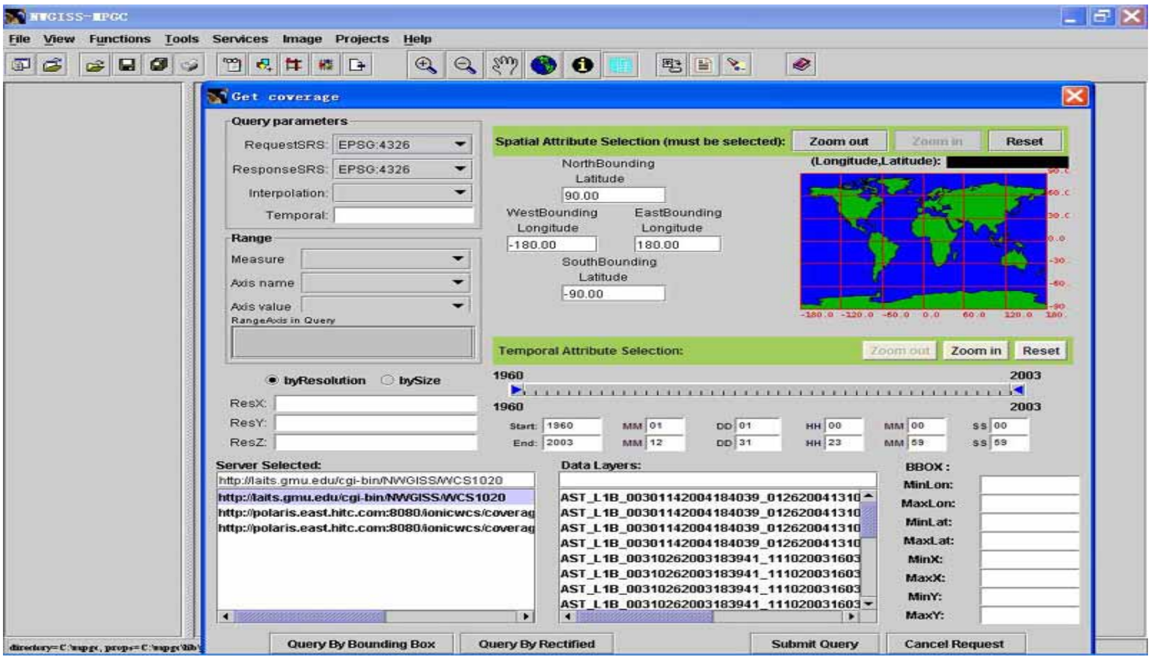

Figure 2. Screenshot of WCS "getCoverage" user interface in GWSC


```
<GetCoverage Version="1.0.2" Service="WCS" >
  <sourceCoverage> MOD021KM </sourceCoverage>
   <DomainSubset> <spatialSubset>
      <gml:Envelop srsName="EPSG:4326">  <gml:pos dimension="2"> -70 40 </gml:pos>
        <gml:pos dimension="2"> -60 50 </gml:pos> </gml:Envelop>
      <gml:Grid dimention="2"> <gml:limits> <gml:GridEnvelope>
              <gml:low> 0 0 </gml:low> <gml:high> 940 940 </gml:high><gml:GridEnvelope></gml:limits>
        <axisName>aaaaa1</axisName> <axisName>bbbbb1</axisName> </gml:Grid>
    </spatialSubset></DomainSubset>
  <rangeSubset>
    <measureSubset measureName="EV_1KM_RefSB"><axisSubset axisName="Band_1KM_RefSB">
      <interval><min>1</min><max>3</max><res>1</res></interval>
    </axisSubset> </measureSubset>
   <measureSubset measureName="EV_1KM_Emissive">  <axisSubset axisName="Band_1KM_Emissive">
      <singleValue>1</singleValue> <singleValue>2</singleValue> <singleValue>3</singleValue>
    </axisSubset> </measureSubset>  </rangeSubset>
  <interpolationMethod> nearest neighbor </interpolationMethod>
  <Output remoteURL="true">  <crs>EPSG:4326</crs>  <format>HDFEOS</format> </Output>
</GetCoverage >
```


Figure 3. An example of WCS "getCoverage" request generated by GWSC.

WFS Access

Through "*getCapabilities*", "*describeFeatureType*" and "*getFeature*" interfaces, WFS supports the networked interchange of geographical vector data as "feature" which is described by a set of properties where each property can be thought of as a {name, type, value} tuple and at least one property is geometry-valued. The name and type of each feature property is determined by its type definition in its schema file. All feature data are encoded in Geographic Markup Language (GML) which is a kind of extensible markup language for support and storage of geographic vector data to meet the requirements of complex spatial analysis. Currently, GWSC only supports GML 2.0 in which topology is not included. Figure 5 shows an example of visualization of feature data in GWSC. The process of user's request of feature data would proceed in GWSC as following:

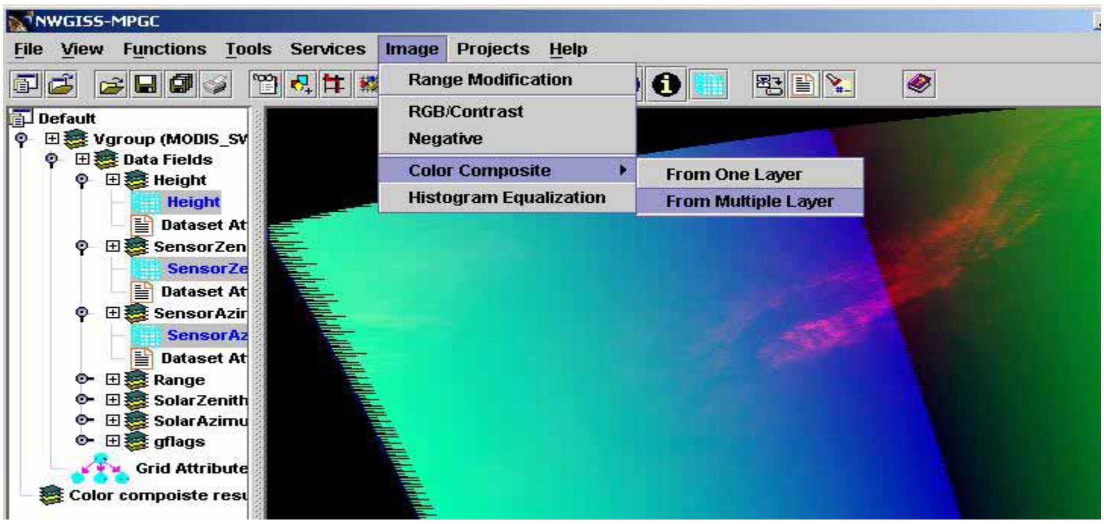

Figure 4. Screenshot of coverage data visualization in GWSC.

1. GWSC gets a description of all the operations and a list of all feature types that the WFS can support through "*getCapabilities*" request.
2. GWSC gets the definition of one or more of the feature types that the WFS can service through "*decribeFeatureType*" request.
3. Based on the definition of the feature type(s), GWSC generates a "*getFeaure*" request.
4. GWSC parses the responses from the WFS and generates a result view for users.

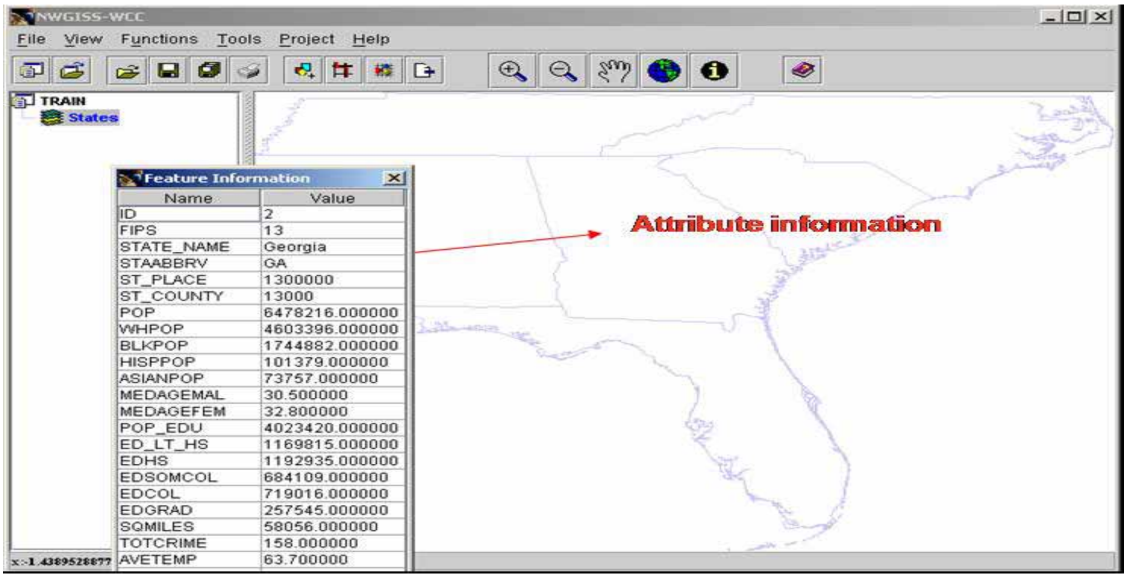

Figure 5. Screenshot of feature data visualization in GWSC.

WMS Access

WMS supports the networked interchange of geospatial data as "map" which is generally rendered in a spatially referenced pictorial image, such as PNG, GIF or JPEG, dynamically from real geographical data. For digital image map suitable for display on computer, lots of organizations including USGS, NASA and FGDC are using WMS to publish data. GWSC provides users an easy way to access thousands of WMS around the world. Figure 6 shows WMS “getMap” user interface in GWSC where users can specify interesting map data and relevant parameters, such as spatial reference system, bounding box, image size, image format, feature styles in map and image transparent. Since image data may be transparent, the map can be overlaid with other data. In figure 7 the map “coastlines” represented in black line is overlaid above the coverage “Vgroup”.

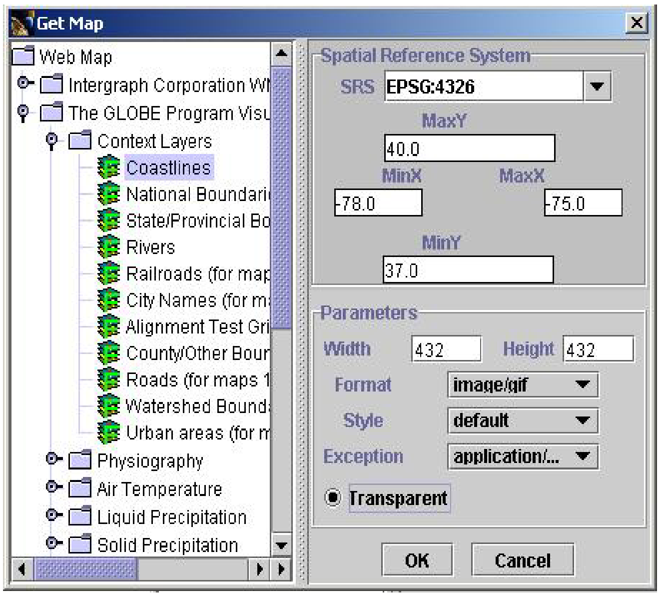

Figure 6. Screenshot of WMS “getMap” user interface in GWSC

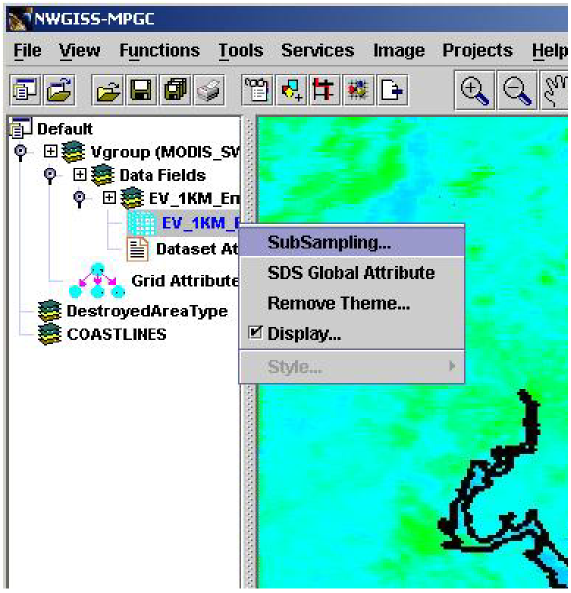

Figure 7. Screenshot of overlay of “coverage” and “map” in GWSC

GEOSPATIAL WEB SERVICE COMPOSITION

Assembling individual geospatial web services into more complex and more useful web processes to achieve desired results proves to be essential for complex geospatial applications. Service composition has great potential to reduce the development time and effort for new applications. GWSC provides a toolset that allows service developers to quickly compose existing services into a new composite service in “*Composition Editor*” and easily execute the new composite service in “BPEL Engine”. The key idea behind GWSC for service composition is as following:

1. Individual service is described in terms of its inputs, outputs, operations and bindings based on its WSDL definition. Given individual service for composition, there must be a relevant WSDL file.
2. The process of composite service is described in terms of not only inputs, outputs and operations encoded in WSDL, but partner links, variables and sequence encoded BPEL. Given a composite service, it can be executed by “BPEL Engine” based on its WSDL and BPEL descriptions.

Figure 8 shows how to use “Composition Editor” to composite a new service including WCS and WICS. In the left pane, there shows available services: WCS and WICS. Users can drag and drop them into right pane using “Sequence” button to link them together. “Partner Link” allows users to specify which operation for each individual service will be executed in sequence. All these operations would result in generating WSDL and BPEL descriptions for composite service automatically.

Figure 9 shows the execution of composite service. The left pane indicates the input variables of composite service derived from its BPEL description. Users can assign values to these variables for execution. The right pane prints out the execution outputs of the whole process of composite service based on its WSDL description.

CONCLUSION

GWSC provides a friendly integrated environment which enables user in service discovery, invocation, negotiation, selection and composition easily. It brings us a new interoperable way of integrating and analyzing distributed heterogeneous Earth science data. The adoption of this easy-to-install and easy-to-use GWSC thus greatly enhances the productivity of geospatial community. GWSC is still under continuous development. We intend to evolve the more complex process of composite service and ontology-driven service discovery.

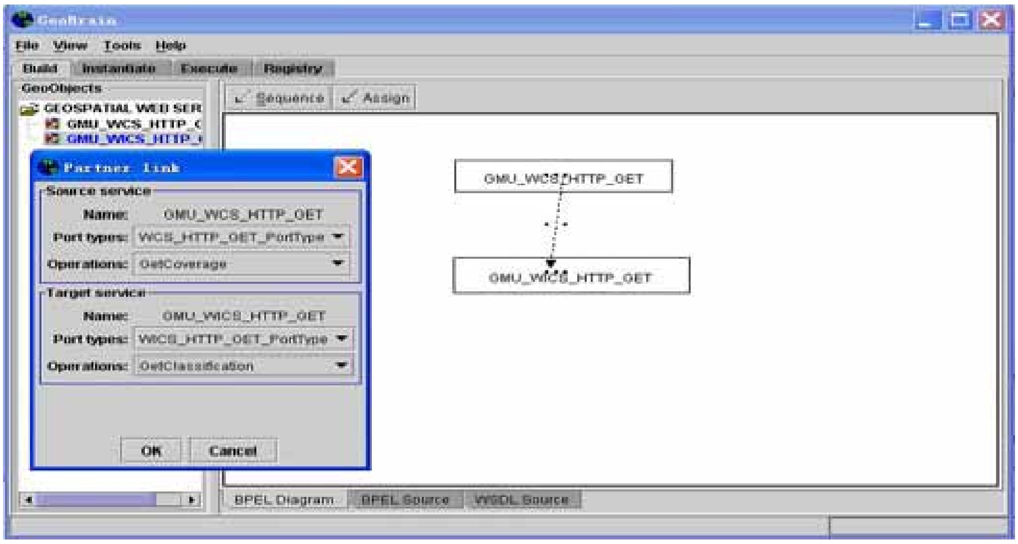

Figure 8. Screenshot of “Composition Editor” in GWSC

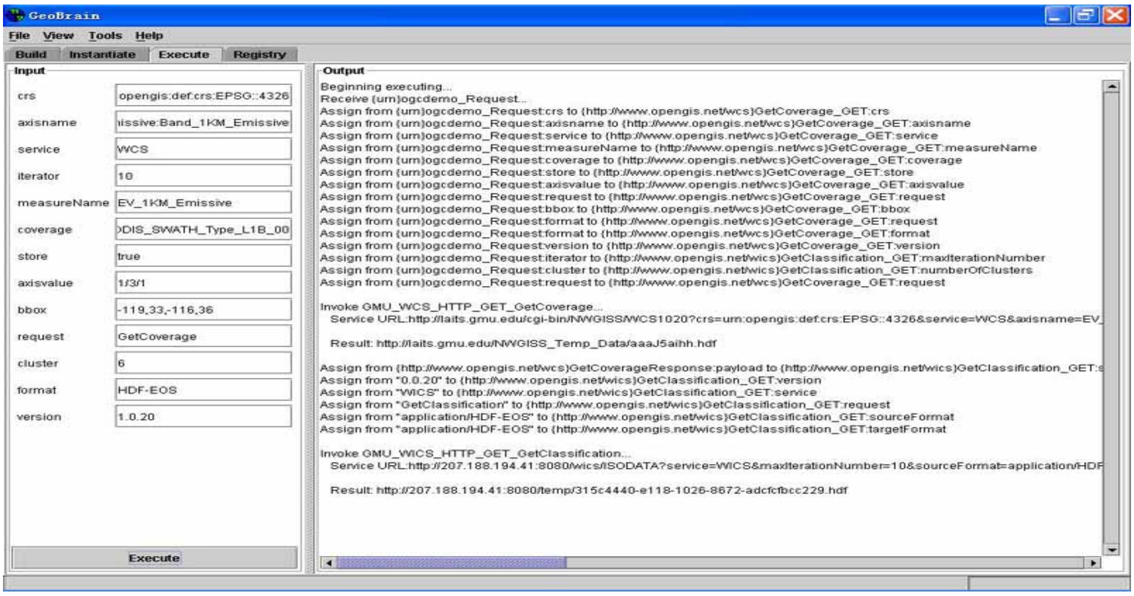

Figure 9. Screenshot of service execution in GWSC.

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