BAE

- Contents
- Work Scope

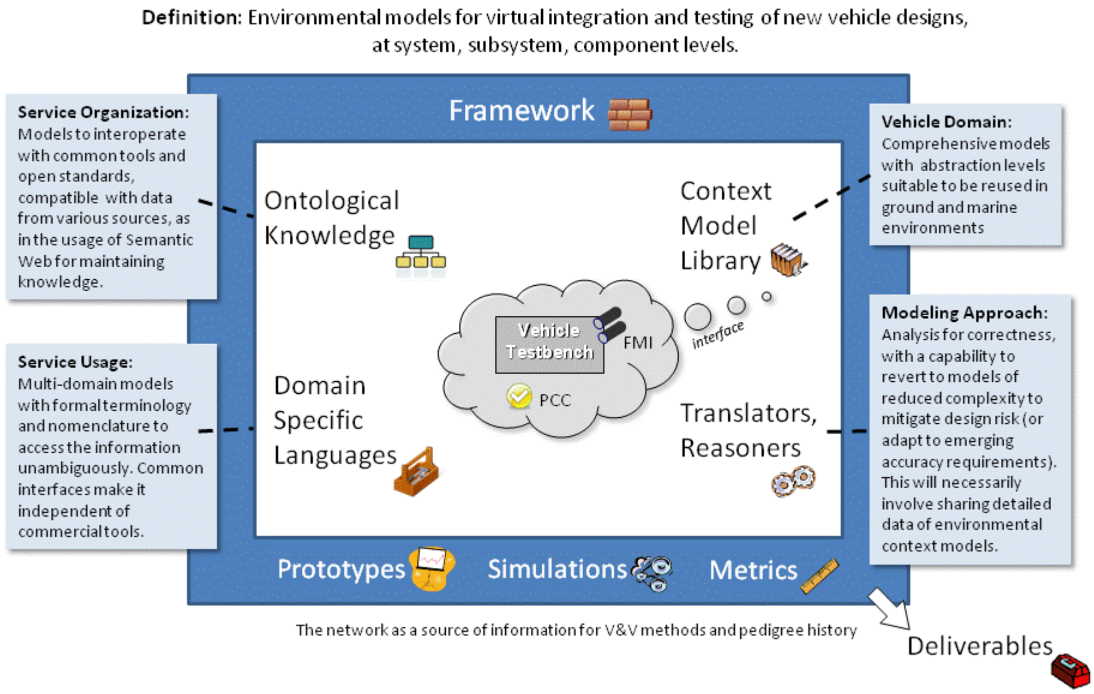
BAE Systems is responsible for context modeling of the vehicle environment.

Contents

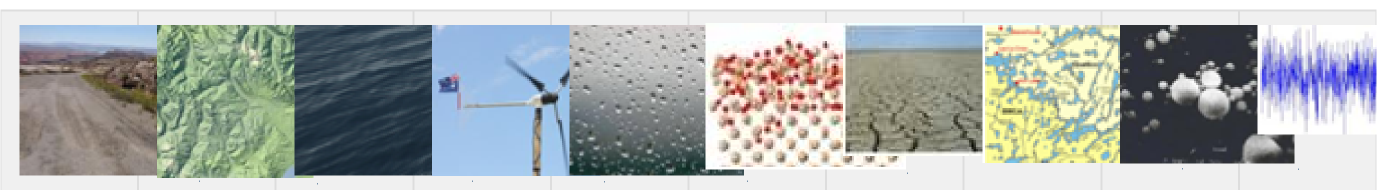
The BAE working area is in Environmental Context Modeling

Work Scope

> ***The principal focus of this technical area is on exogenous contexts applicable at all levels of abstraction to drivetrain and mobility subsystems of an infantry fighting vehicle with amphibious considerations. Of specific interest under this technical area are terrain (to include land and water), atmosphere, thermal, moisture, corrosion, and foreign particulates models.***
>
> - *Terrain models are expected to represent the surface/fluid that an amphibious infantry fighting vehicle would traverse, ranging from paved road surfaces to rocky, mountainous terrain, slope, discrete obstacles (such as step climbs, v-ditches, etc.), mud, sand, snow, and water fording (both salt water in a ship-to-shore deployment typical of a Marine Air-Ground Task Force, as well as fresh or coastal water for river/lake/etc. fording). Additionally, surface curvature and forward- as well as side-sloping should be incorporated. Context models for amphibious locomotion should include overcoming various water-borne mobility elements of drag, hydrostatic and hydrodynamic performance, operations in both calm water and sea states with wave heights up to 3 feet. The models should specify in detail the modality of interaction between the environment and the specific elements of the drivetrain and mobility subsystems which it affects.*
>
> - *Atmosphere and moisture models provide an ambient thermal, photonic, salt water, and humidity environment within which the mobility and drivetrain subsystems must function, and their interaction with the constituent elements of the vehicle subsystems.*
>
> - *Particulates models of interest include atmospherically-borne particulate matter such as dust, sand, snow, ice particles, water-borne particulates (when submerged during amphibious transit), and volcanic ash, and their interaction with the mobility and drivetrain subsystems.*



Environmental Context Modeling



Labeled context pages

SWEET

OpenCRG

Environmental Context

Requirements

Probabilistic formal model checking

Context Model Interfacing

Dispersion Characterization

Terrain Spectroscopy

Probability Elements

SemanticContextArchitectureOscar

TOPS

Stochastic Models

Thermal Dispersion

ContextModelsCSIR

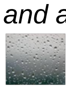
Gross Terrain Features

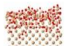
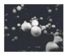
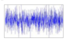
Lake Size Statistics

Showing first 15 of 27 results

Index

- Architecture
  - Ontology - plan / work - *Semantic classification, search, and service composition approaches*
  - Stochastic Patterns - plan / work - *Fundamental probability and statistics models of the environment*
  - Interfaces - plan / work - *Interoperability for testbench configurations*
  - Artifacts - plan / work - *Metrics and modeling artifacts for curation*

- Land
  - Fine Terrain Features - plan / work - *Methods for modeling spatial frequencies for power spectral densities (PSD)*
  - Gross Terrain Features - plan / work - *Simple distribution for sampling likelihood of terrain slopes*
- Aquatic
  - Wave Energy Statistics - plan / work - *Simple approach for generating PSD's and sea-state data*
  - Lake Size Statistics - plan / work - *Maximum entropy estimation for lake size distributions for regions*
- Atmospheric
  - Wind Energy Statistics - plan / work - *General results for modeling wind energy distribution and autocorrelations for persistence*
  - Rainfall Statistics - plan / work - *General model for rainfall distributions within storms using composite process, clouds*

    - Corrosion and Oxidation - plan / work - *Model of oxidation and corrosion growth*
    - Thermal Dispersion - plan / work - *Simplification of thermal diffusion model to account for disorder and variability in the media.*
    - Particle Size Statistics - plan / work - *General method for modeling size distribution of particulates such as ash and ice crystals*
    - Clutter Modeling - plan / work - *Maximum entropy models for E-M signals and noise, lightning*

- Environmental Context Requirements
    - Natural Environment
        - Modality of interaction
            - Fixed models (static, passive)
            - Compliant models (deforming, feedback)
        - Statistical
            - Nominally fluctuating
            - Extreme Values
    - Man-Made
        - Deterministic (Context Fixed Obstacles)
        - semi-Markov (quasi-periodic, see ContextModelsCSIR for examples such as Belgian Block and corrugated tracks)

- Test & Verification
    - Probabilistic formal model checking
    - Test Procedures
    - Testbench examples

Overview

In response to DARPA's drive to develop a radically innovative approach to the development of military vehicles, resulting in significant reductions in the cost and schedule required to do so, a novel approach to the model-based verification of vehicles is required. In support of that goal, and in response to C2M2L-1 Technical Area 2, we propose to build a virtual mobility Test Bed for AVM. The AVM Test Bed will consist of a comprehensive suite of environmental context models necessary to thoroughly test the model-based mobility and drivetrain systems of a land-based or an amphibious Infantry Fighting Vehicle (IFV).

Description of Deliverables

- A comprehensive suite of environmental context models that are necessary to thoroughly test the mobility and drivetrain component models, and subsystems composed of the models, as delivered by the Technical Area 1 performers.
- A comprehensive set of use cases/mobility verification requirements for testing land-based and amphibious mobility systems and drivetrains intended to illustrate use of the models to META performers and users and to test the models provided.
- Information used to formulate each context models, which also will be used to quantify the uncertainty of each model delivered.
- Executable examples illustrating the use of each of the context models the BAE Systems team synthesizes and delivers. The executable examples will be used to verify the context models. The examples will also provide the META development community with detailed information about how to use and verify the context models.
- A semantic web based executable architecture based on the Semantic Web Earth and Environmental (SWEET) ontology populated with translatable representations of the context models, information used to

construct the models, examples of model use, and methods for translating the models.
- Utilities necessary to search and manipulate the ontology of context models and facilitate translation of the models.
- Novel methods for constructing adaptable models.
- A template of a test article, called the Virtual Automotive Test Rig (VATR), that will assist META in performing design verification.

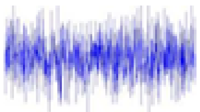
Managing work

- Context Modeling task list 1

References

1. Previous META work here. This has information on modeling and simulation for PCC.

Clutter Modeling



- Intro
- EMI effects

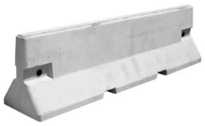
Intro

The foundation for this work is described in the Probability Elements white paper.

EMI effects

(placeholder for further work)

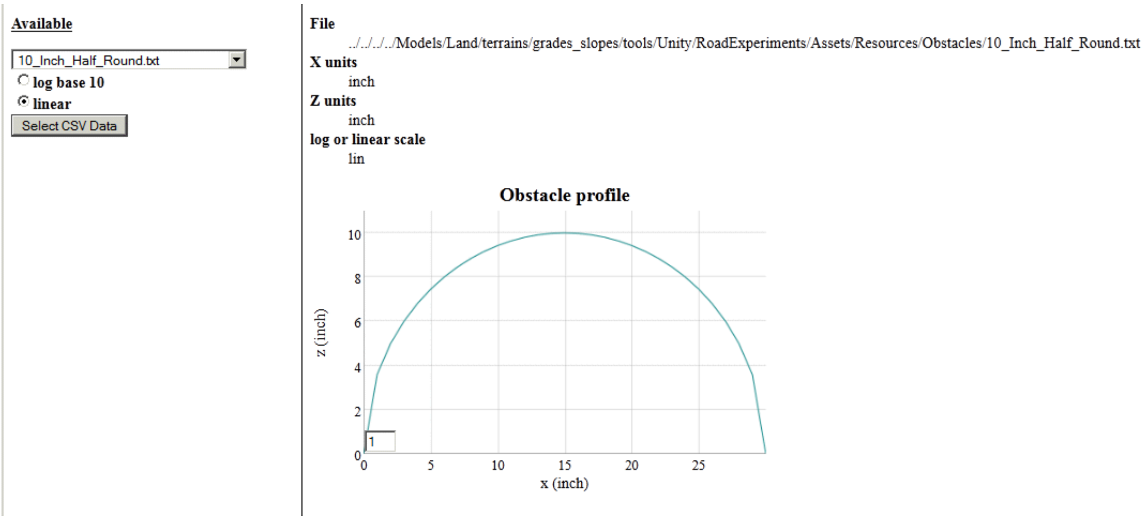
Context Fixed Obstacles



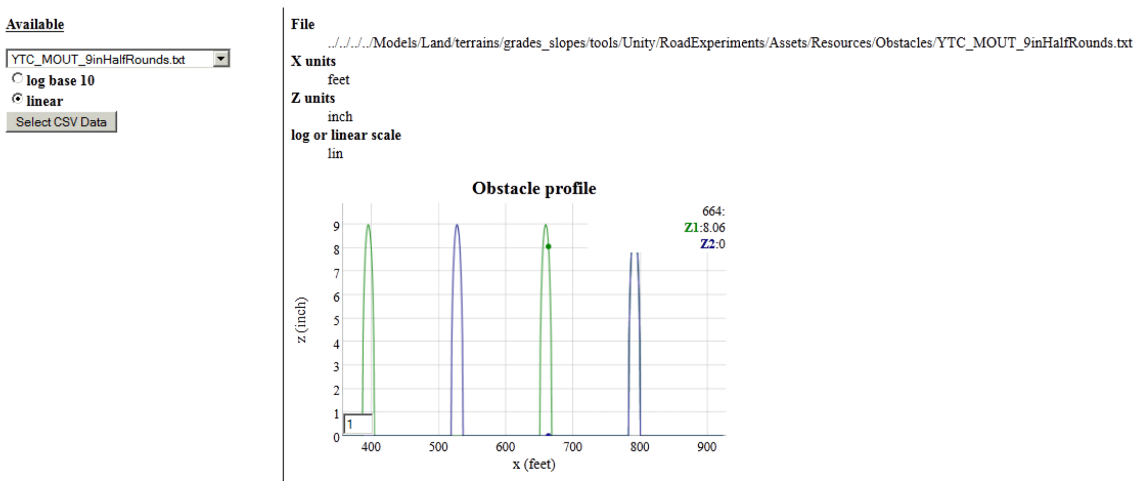
- One dimensional obstacle profile
- A pair of 1D profiles
- 3D Rendering view

Fixed obstacles are specified by either a 1D track profile or a pair of 1D track profiles in the case of cross slopes.

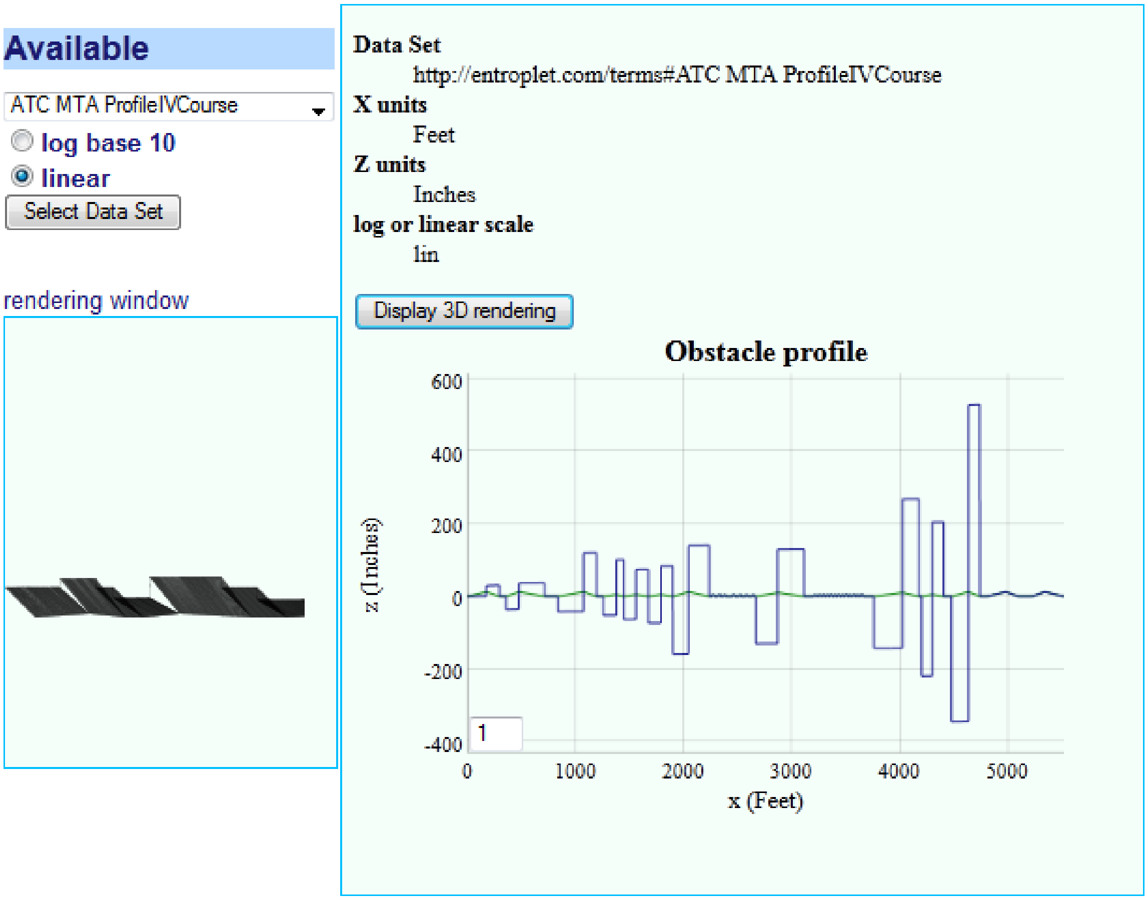
One dimensional obstacle profile



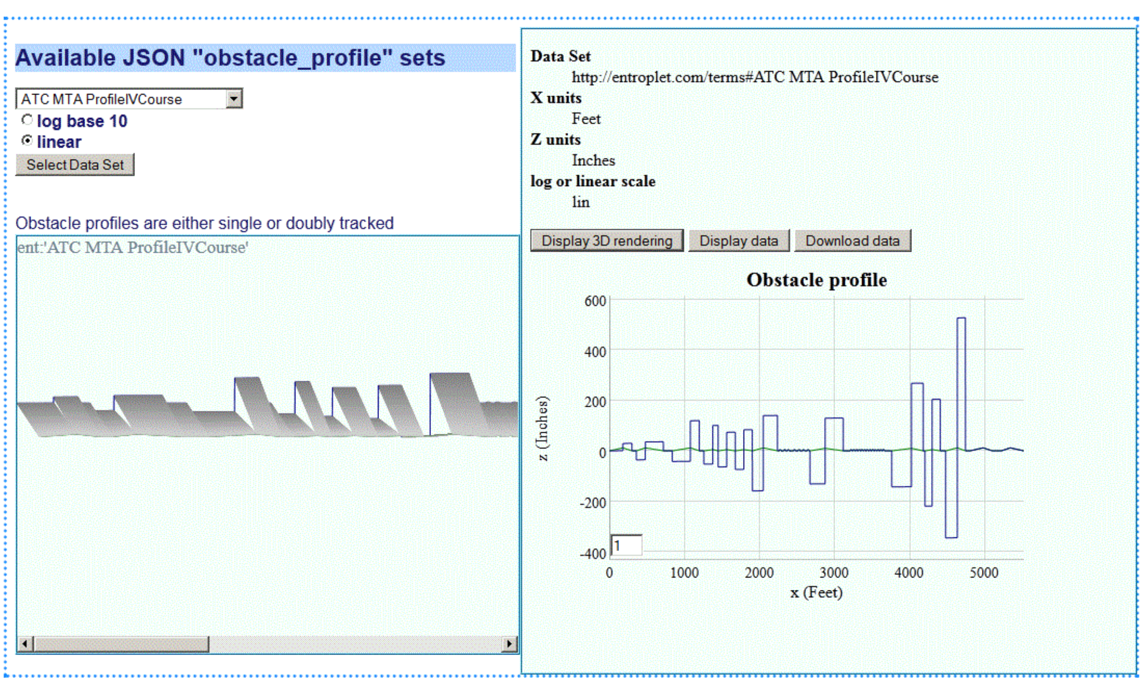
A pair of 1D profiles



3D Rendering view


Available
ATC MTA ProfileIVCourse
log base 10
linear
Select Data Set
rendering window
Data Set
http://entroplet.com/terms#ATC MTA ProfileIVCourse
X units
Feet
Z units
Inches
log or linear scale
lin
Display 3D rendering
Obstacle profile
600
400
200
0
-200
-400
1
0
1000
2000
3000
4000
5000
z (Inches)
x (Feet)

version 2:


Available JSON "obstacle_profile" sets
ATC MTA ProfileIVCourse
log base 10
linear
Select Data Set
Obstacle profiles are either single or doubly tracked
ent:'ATC MTA ProfileIVCourse'
Data Set
http://entroplet.com/terms#ATC MTA ProfileIVCourse
X units
Feet
Z units
Inches
log or linear scale
lin
Display 3D rendering
Display data
Download data
Obstacle profile
600
400
200
0
-200
-400
1
0
1000
2000
3000
4000
5000
z (Inches)
x (Feet)

Context Modeling task list 1

First task list
☐ **Pull TOPS and other requirements documents into citation system, partially complete**
☐ **Add physical constants and properties to the knowledgebase**
☐ **Plan for use of AVM SVN repository, Ontology subdirectory in place, Models need to be updated**
☐ **Integrate smaller models (buoyancy, temperature, etc) into ontology**
☐ **Convert "Terrain PSD metadata.xlsx" into triple-store representation**
☐ **Change file names to not use % or other characters that do not operate well over operating systems**
☐ **Set up a cloud evaluation platform to run the semantic server on, initial evaluation version running, see PP**
☐ **Create synthetic representations of CSIR track data via the superposition of sine approach**
☐ **On cloud server, the R images such as PNG, BMP, JPG don't work. Look for a more recent R package**
☐ **Simple testing infrastructure for semantic web calls**

Context Model Interfacing

Interface Categories

Most of the environmental context models have similar patterns, in that they possess salient characteristics that follow standard representations such as probability density functions (PDF), power spectral densities (PSD), and amplitude profiles. Since these are standard formulations, they can be aggregated and distilled through a common pattern and reuse framework.

Standalone or embedded models

The model is delivered inside executable code that is linked to a vehicle simulation testbench. The agreed upon standard is the Functional Mockup Interface, although other approaches include S-functions in Matlab, and general compiled C-code or interpreted embedded Python.

Served models

The model resides on a web server hosted on a cloud computing environment. Information is served for Monte

Carlo simulations run by clients that can interface through a web service. Organization is provided by the Environ mental Context Modeling Ontology semantic web back-end which keeps track of the models available.

The standalone/embedded models can be potentially generated from a reasoner which uses information on algorithms and data to construct the necessary code.

Data file models

Data files are either delivered through a web service or file server, with the semantic web service again providing organization above that a file server will provide.

Model artifacts (graphs, visuals, etc)

Artifacts for models can include interactive PSD and PDF charts, and generated Monte Carlo profiles. These are useful for the user to understand the ranges, extreme values, and severity of the various models.

More elaborate are context model visualizations which can include 3D rendering of terrains and sea-scapes.

Model metrics

Similar to artifacts, metrics contain auxiliary meta-information on models such as maturity and potentially complexity, which will be useful for model curation activities.

Context Model Test Procedures

- Functional Mockup Interfaces

Functional Mockup Interfaces

In preparation for using the FMU the BAE Systems Context Model installer must be run to install the needed files on the target machine.To import the FMUs into OpenModelica you must do the following:

1. If the install program required administrator access rights that are not available in the current ID you must copy the FMUs from C:\BAE Systems\ContextModelExamples\Modelica\Fmu into another directory such as C:\fmu.
2. Start OpenModelica Connection Editor.
3. Select the menu item FMI>>Import FMI
   See Figure 1 to the right
4. Click the Browse button and browse to the FMU you wish to import (i.e. C:\fmu\ SpectralTerrain.fmu).
5. Click the Output Directory Browse button and select a directory to expand the FMU such as C:\fmu\import.

   See Figure 2 to the right
6. Click the Import Button.
7. Change the Working Directory in the Tool>>Options menu item to the resources directory of the expanded FMU(i.e. C:\Fmu\import\resources)
8. Open the example that matches the imported FMU such as C:\BAE Systems\ContextModelExamples\Modelica\Models\TerrainCrawler.mo
9. Select the example model in the Modelica Files panel.
10. Click the green simulate arrow. This will cause the OMEdit – Simulation dialog to appear.
11. Click the Simulate button in the OMEdit – Simulation dialog.
12. In the resulting plot you can see the generated in the fmublock1.Zed variable.

See Figure 3 to the right

Figure 1

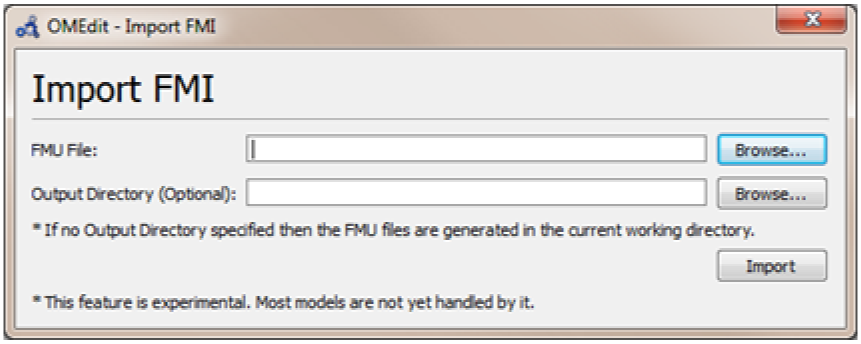


Figure 2

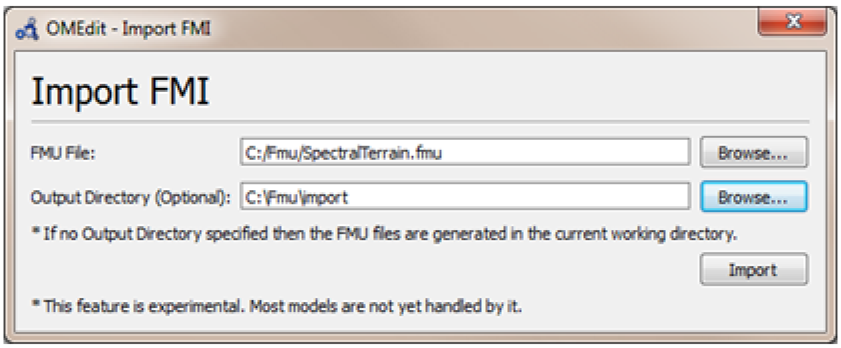
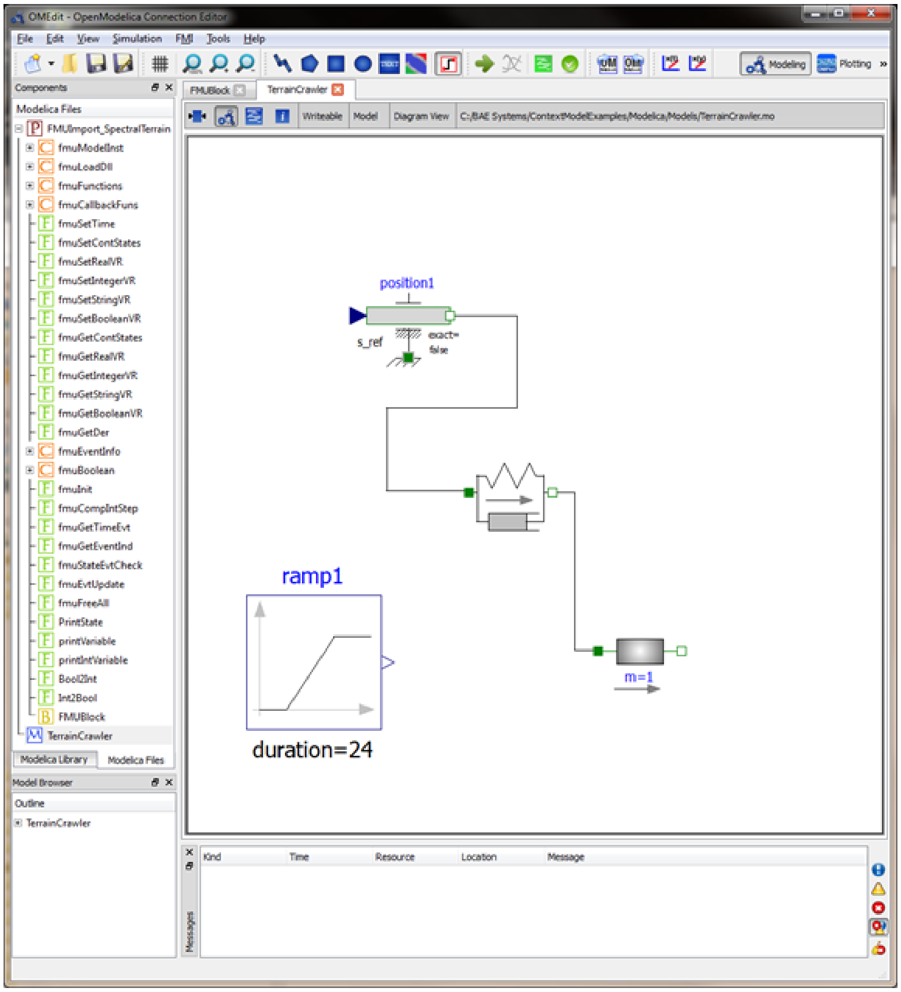
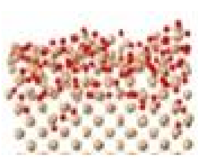


Figure 3



Corrosion and Oxidation



Intro

The foundation for this work is described in the [Dispersion Characterization] white paper.

Environmental Context Modeling Ontology

We are working out the organizational strategy for the context model ontology. The main categories are for environmental descriptions (SWEET), geospatial coordinates, and meta reference material (which can include citations, requirements, etc).

Information Sources

- Physical constants such as water density, gravitational constant

- Lookup tables such as soil types, sea-states
- Dimensional units such as SI
- Geospatial definitions and schema – Environmental Context Geospatial
- Context data sources
    1. Verification & Requirements documents such as TOPS (Test Operating Procedures)
    2. Earth sciences archives such as NASA JPL PO.DAC, US Army Corps of Engineers WIS, etc
- Meta-information: Citations and references for models, algorithms, requirements

Ontology and Vocabulary Candidates

- SWEET 2.3: http://sweet.jpl.nasa.gov/2.3/ [cross-walk analysis of sweet layers : xlsx]
- Instance data http://example.org
- Biblio http://purl.org/net/biblio
- FOAF (Friend of a Friend) http://xmlns.com/foaf/spec/index.rdf
- SKOS (Simple Knowledge Organization System) http://www.w3.org/2004/02/skos/core RDF http://www.w3.org/2009/08/skos-reference/skos.rdf
- Open GIS http://www.opengis.net/def/
- Geospatial Query http://schemas.opengis.net/geosparql/1.0/geosparql_vocab_all.rdf
- CommonTag http://commontag.org/ns
- Bibliographic Ontology http://purl.org/ontology/bibo/ OWL http://bibotools.googlecode.com/svn/bibo-ontology/tags/1.3/bibo.xml.owl#
- Vocabulary http://purl.org/vocab/
- SWORE (Semantic Web Ontology for Requirements Engineering) http://ns.softwiki.de/req/?format=html RDF http://ns.softwiki.de/req/?format=rdfxml
- SIOC (Semantically-Interlinked Online Communities) http://sioc-project.org/ontology/
- PRISM (Publishing Requirements for Standard Industry Metadata) http://prismstandard.org/namespaces/1.2/basic/
- Platform Ontology work: http://marinemetadata.org/community/teams/ontplatforms OWL http://mmi.svn.sourceforge.net/svnroot/mmi/mmisw/platform.owl
- Device Ontology work: http://marinemetadata.org/community/teams/ontdevices
- W3C Semantic Sensor Incubator: http://www.w3.org/2005/Incubator/ssn/
- VSTO Ontologies: http://vsto.org/forward.htm?forward=ontology
- Sindice - Data Web Services: http://sindice.com/

Ontology Terms

- GCMD instruments: http://gcmd.nasa.gov/KeywordSearch/Keywords.do?KeywordPath=Instruments
- GCMD platforms: http://gcmd.nasa.gov/KeywordSearch/Keywords.do?KeywordPath=Platforms
- NASA Taxonomy of Instruments: http://nasataxonomy.jpl.nasa.gov/2.0/instruments/
- NASA Taxonomy of Missions/Projects: http://nasataxonomy.jpl.nasa.gov/2.0/missionsprojects/

Ontology Architectures

- Semantic Context Architecture
- Semantic Context Language Requirements
- Zotero Reference Management system

Ontology References

- Watson ontology search engine: http://watson.kmi.open.ac.uk/WatsonWUI/
- Swoogle ontology search engine: http://swoogle.umbc.edu
- MMI Overview of controlled vocabularies: http://marinemetadata.org/guides
- MMI Ontology Registry: http://mmisw.org/or
- MMI Overview of ontology tools: http://marinemetadata.org/guides/vocabs/ontologies/ontsoftware
- OOSTethys: http://www.oostethys.org

- Open Geospatial Consortium : http://www.opengeospatial.org/
- GMU Geospatial : http://www.laits.gmu.edu/geo/nga/index.html

Ontology Tools

- RDF converter http://www.mindswap.org/2002/rdfconvert/
- Google Refine data translator: http://code.google.com/p/google-refine/
- Google Refine RDF extension: http://refine.deri.ie/

Ontology Elements

We will need to start collecting key terms that we can use to semantically link artifacts with.

Subject	Predicate	Object
dcterms:isRequiredBy	rdfs:comment	"A related resource that requires the described resource to support its function, delivery, or coherence."@en-US
dcterms:requires	rdfs:label	"Requires"@en-US
dc:subject	dcterms:description	"Typically, the subject will be represented using keywords, key phrases, or classification codes. Recommended best practice is to use a controlled vocabulary. To describe the spatial or temporal topic of the resource, use the Coverage element."@en-US
dcterms:hasVersion	rdfs:comment	"A related resource that is a version, edition, or adaptation of the described resource."@en-US
dcterms:hasFormat	rdfs:comment	"A related resource that is substantially the same as the pre-existing described resource, but in another format."@en-US
dcterms:source	rdfs:comment	"A related resource from which the described resource is derived."@en-US
dcterms:hasPart	rdfs:comment	"A related resource that is included either physically or logically in the described resource."@en-US
dcterms:description	dcterms:description	"Description may include but is not limited to: an abstract, a table of contents, a graphical representation, or a free-text account of the resource."@en-US

dcterms:provenance	dcterms:description	"The statement may include a description of any changes successive custodians made to the resource."@en-US
rdfs:comment	rdfs:comment	"A description of the subject resource."
rdfs:label	rdfs:label	"label"
reprMathStatistics:StatisticalDistribution	rdf:type	owl:Class
dc:contributor	dcterms:description	"Examples of a Contributor include a person, an organization, or a service. Typically, the name of a Contributor should be used to indicate the entity."@en-US
skos:definition	rdfs:label	"definition"@en
bibo:ReferenceSource	rdfs:comment	"A document that presents authoritative reference information, such as a dictionary or encylopedia ."@en

Raw Subject (from FANG_reqts_to_BAE.xlsx)	**Predicate**	**Object**
max ambient temperature		
-XX degrees C to +XX degrees C		
level, hard surfaced road		
cross-country		
level, hard surface		
level, clean, clay surface		USCS Soil Classification System
USCS Soil Classification System		
XX mm rainfall per hour		
German dry conditions		NRMM
German wet conditions		NRMM
German snow conditions		NRMM
Jordan dry conditions		NRMM
Jordan sand conditions		NRMM
North Korea dry conditions		NRMM

North Korea wet conditions		NRMM
Root Mean Square (RMS) ride courses		
non-deformable, half-round obstacle of XX inches		
Obstacle Height (in.): WW XX YY ZZ		
all Grade & Slope		
XX% side slope		
slope operations up to and including XX% (T)		
XX% grade		
XX% hard-dry grade		
dry hard surface road that is free of loose material		
slopes up to and including the maximum grade		
dry hard surface, XX% grade (XX degrees)		
Sea State characterized by a XX meter SWH		
calm water		
sea state conditions		
Significant Wave Height (SWH) of XX meters		
river line operations		
XX meter (XX feet) plunging surf		
fresh water		
ambient air temperatures		
temperatures ranging between -XX° F and XX° F		
humid storage conditions		IAW AR 70-38 table 2-1
salt-fog conditions		MCO 4790.18B 16 Jul 04 / TM 4795-34-2 / TM4795-12-1

hard surface road with a coefficient of friction of XX		
distance of XX km		
XX nautical miles of water operation in sea state XX		
stepping up and down a vertical step of XX inches		
a gap no less than XX ft		
a ditch of no less than XX ft deep and no less than XX ft across		
hard surface ingress and egress walls sloped at an angle no less thanXX degrees		
ford a XX" (T)		
fording operations		
flat secondary roads (T)		
max ambient water temperature of XX deg C		
ambient relative humidity of up to XX percent		
-XX ft to +XX ft elevation		
XX inch tree		
lightning strikes		Lightning Indirect Effects environment specified in Paragraph 5.4 of MIL-STD-464A
salt atmosphere		

References

1. https://pods.iplantcollaborative.org/wiki/download/attachments/4528119/Geospatial%2BCI.pdf

EnvironmentalContextGeospatial

- Specification
- Prototype
    - Geographical Location

- Local Coordinates
- Detailed View

Specification

From SWEET, we can use reprSpaceCoordinate.owl or reprSpaceReferenceSystem.owl

UTM	**reprSpaceReferenceSystem.owl#UniversalTransverseMercator**
Cartesian	**reprSpaceReferenceSystem.owl#Cartesian"**

Local view for "http://sweet.jpl.nasa.gov/2.3/reprSpaceReferenceSystem.owl#Cartesian"

Predicate	Value
rdf:type	reprSpaceReferenceSystem:SpatialReferenceSystem
relaMath:coordinate_1	reprSpaceCoordinate:X
relaMath:coordinate_2	reprSpaceCoordinate:Y
relaMath:coordinate_3	reprSpaceCoordinate:Z

All properties reside in the graph http://sweet.jpl.nasa.gov/2.3/reprSpaceReferenceSystem.owl

This might be enough if we want to use Lat/Lon or UTM to specify the location, and a set of finer coordinate triples to represent lateral and elevation changes.

Other options not a part of SWEET include

- The spatial reference system according to FGDC definition http://www.fgdc.gov/metadata/csdgm/04.html
- Or http://www.w3.org/2003/01/geo/

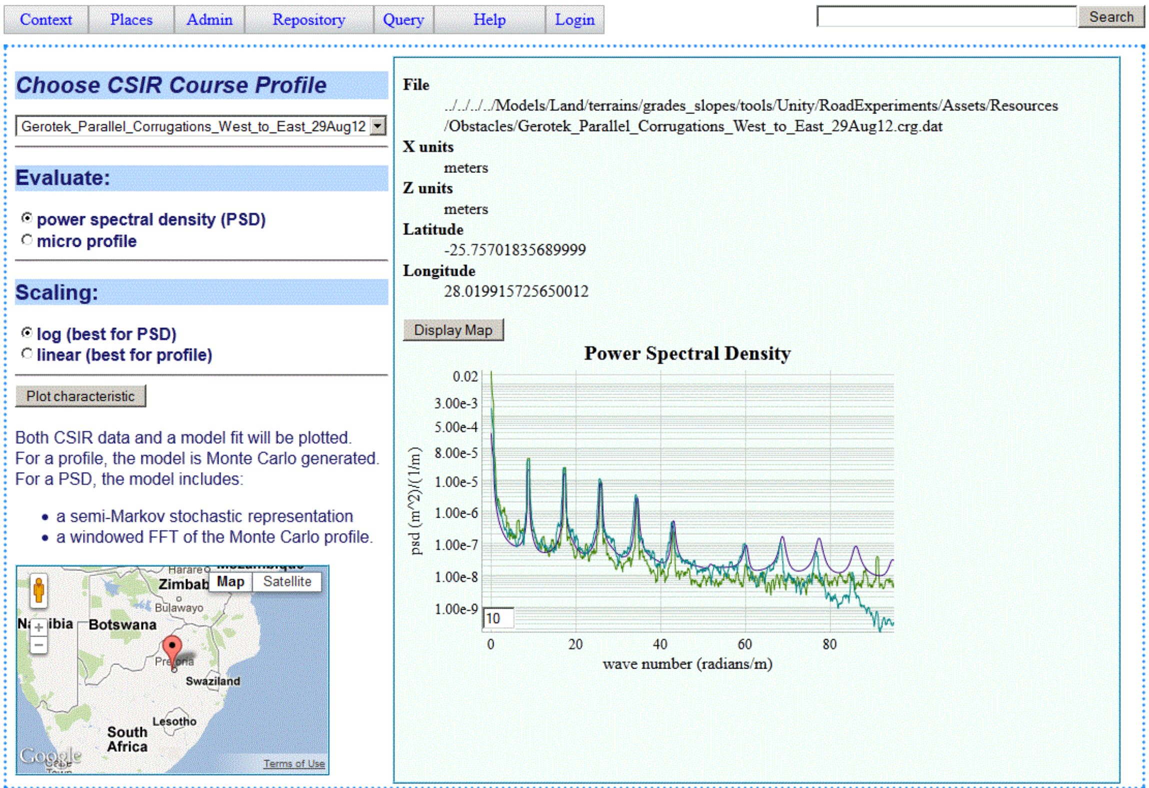
Predicates in graph http://www.w3.org/2003/01/geo/wgs84_pos

Predicate	#Triples	#Distinct subjects	#Distinct objects	Domain(s)	Range(s)
rdfs:comment	9	8	9	3	rdfs:Literal
dc:date	1	wgs84:	"$Date: 2009/04/20 15:00:30 $"	rdfs:Resource	rdfs:Literal
dc:description	1	wgs84:	"A vocabulary for representing latitude, longitude and altitude information in the WGS84 geodetic reference datum. Version $Id: wgs84_pos.rdf,v 1.22 2009/04/20 15:00:30 timbl Exp $. See http://www.w3.org/2003/01/geo/ for more details."	rdfs:Resource	rdfs:Literal
rdfs:domain	3	3	wgs84:SpatialThing	rdf:Property	rdfs:Class
rdfs:label	8	8	8	3	rdfs:Literal
rdfs:range	1	wgs84:location	wgs84:SpatialThing	rdf:Property	rdfs:Class
rdfs:subClassOf	1	wgs84:Point	wgs84:SpatialThing	rdfs:Class	rdfs:Class
rdfs:subPropertyOf	1	wgs84:location	foaf:based_near	rdf:Property	rdfs:Resource
dc:title	1	wgs84:	"WGS84 Geo Positioning: an RDF vocabulary"	rdfs:Resource	rdfs:Literal
rdf:type	7	7	2	2	rdfs:Resource

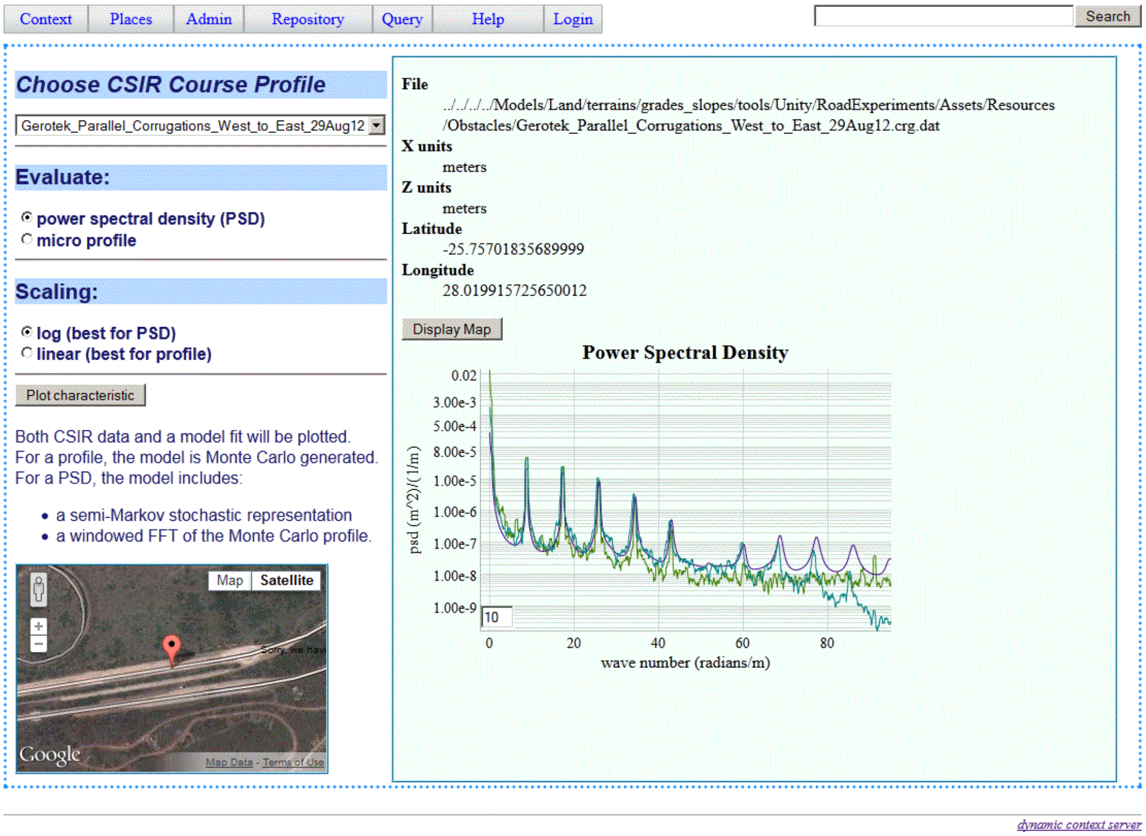
Prototype

Using the geospatial coordinates, we can add artifacts, such as a map to the user interface

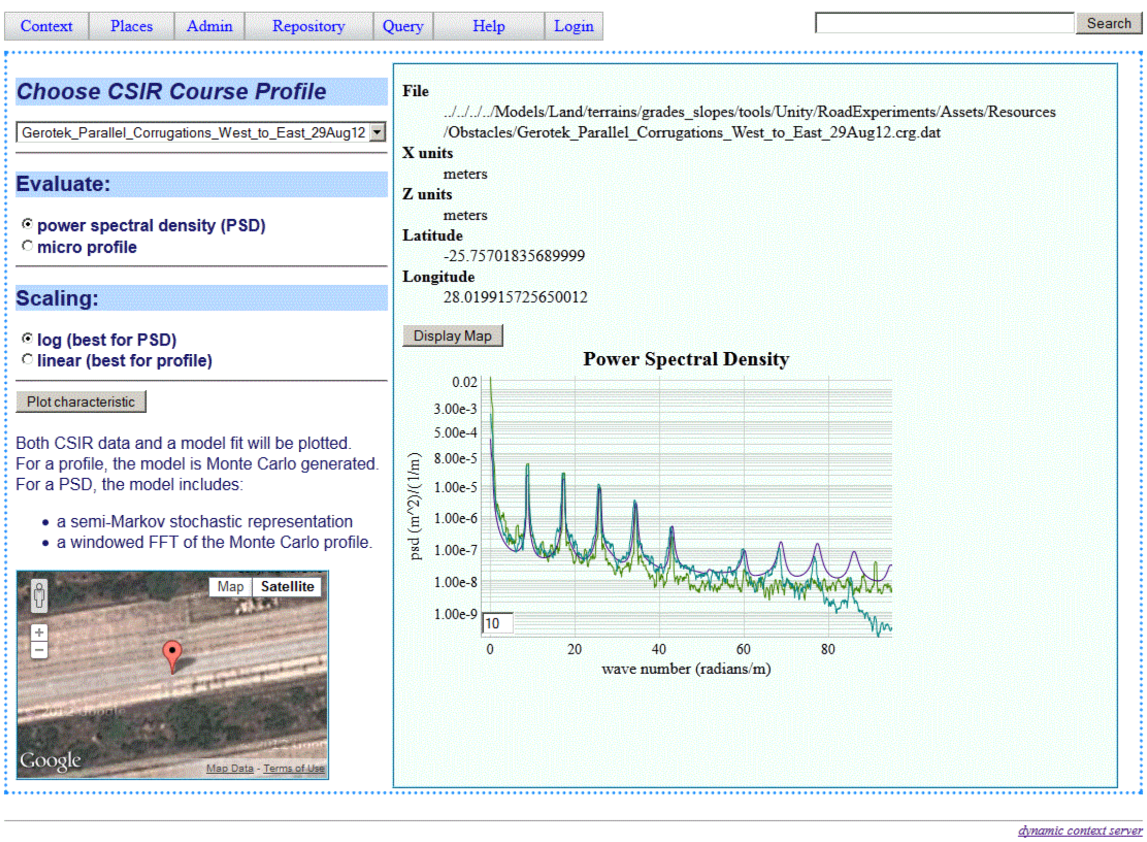
Geographical Location



Local Coordinates



Detailed View

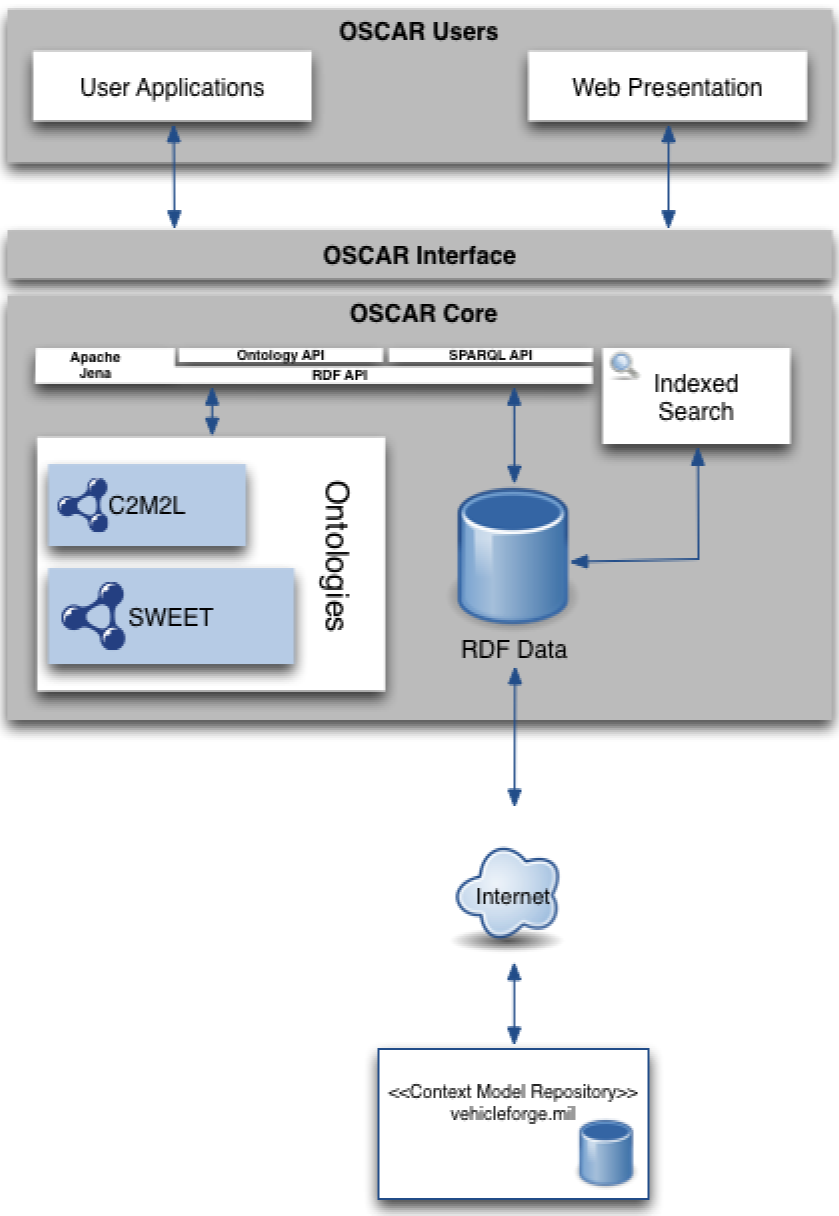


Semantic Context Architecture

- OSCAR
- Additional Knowledge Base Capability

The knowledge-based system we are to implement will provide semantic web discovery capability according to the C2M2L-1 ontology and instance data. OSCAR is short of Ontological System for Context Artifacts and Resources. The goal is to provide guide discovery for users to find context models and associated metadata to enable their simulation. The context models can include collections of PDFs and PSDs.

OSCAR

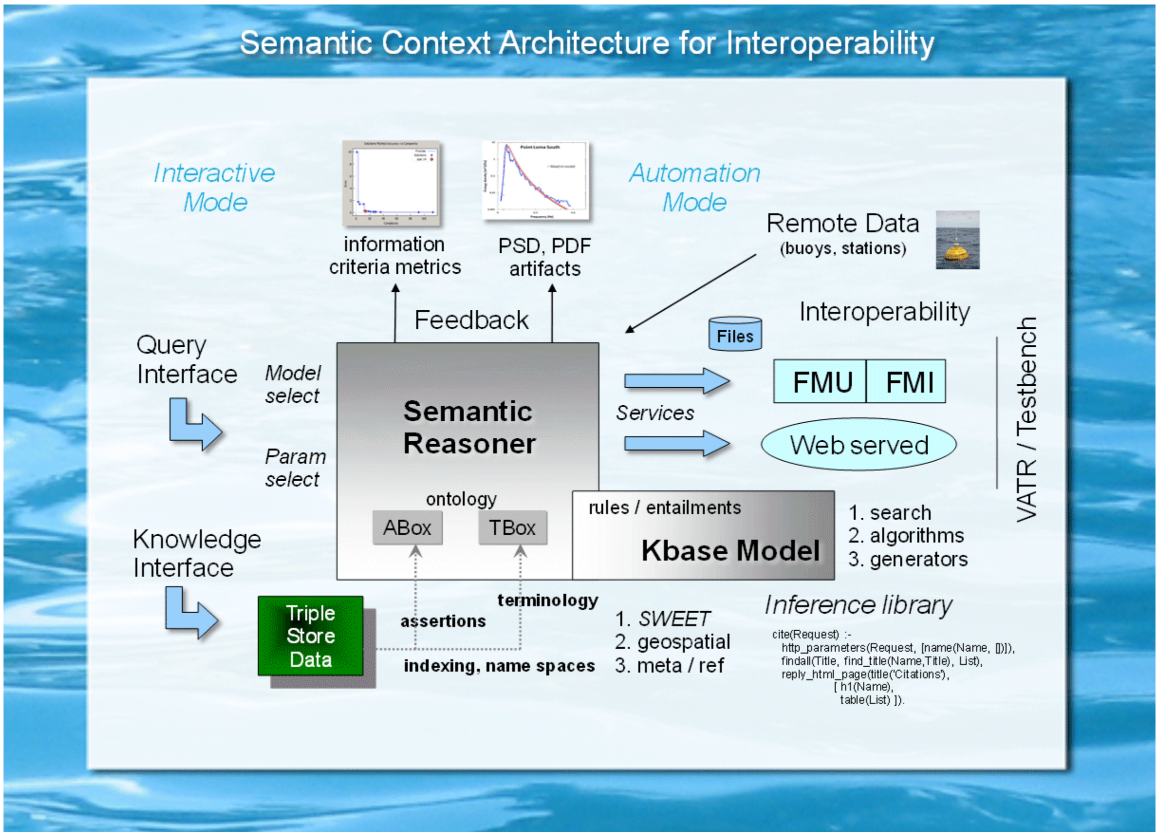


More prototype and design information is here :

SemanticContextArchitectureOscar

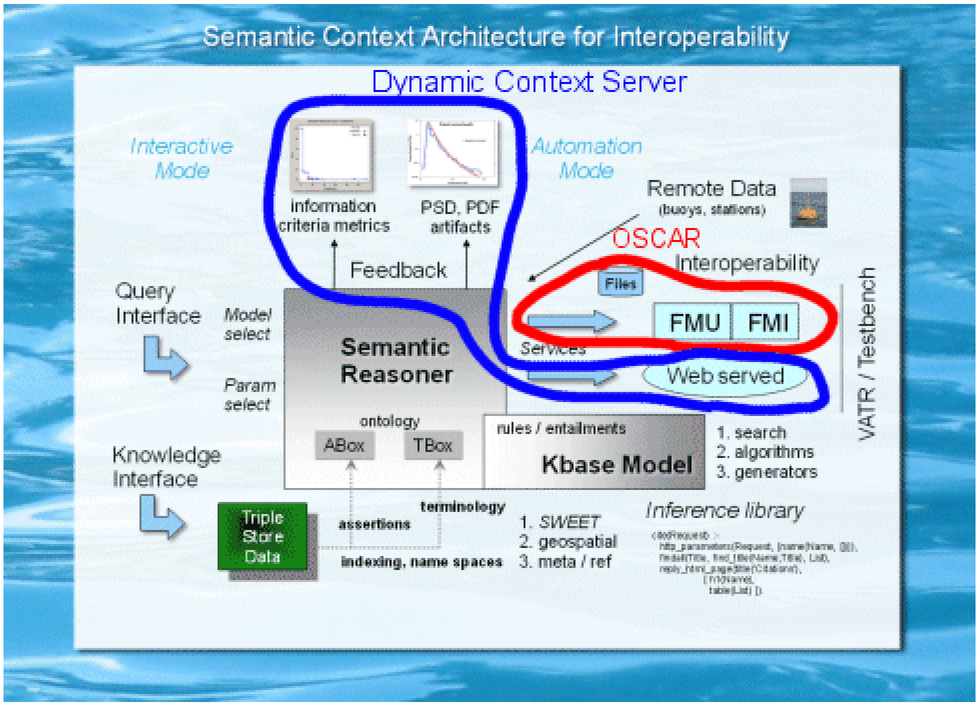
Additional Knowledge Base Capability

To give the user some capability to evaluate and explore the artifacts of the model library, we provide an additional interface that has the capability to serve up artifacts such as PDF and PSD charts, information metrics, and simple visualizations of stochastic and deterministic profiles. This capability is shown running along the top of the following figure. We require a flexible semantic language to support dynamic artifact generation.



Splicing this additional capability into OSCAR is based on conventional web server technology and practices. This allows independent development of the core library mechanisms of OSCAR from the dynamic artifact generation and reasoning capabilities.

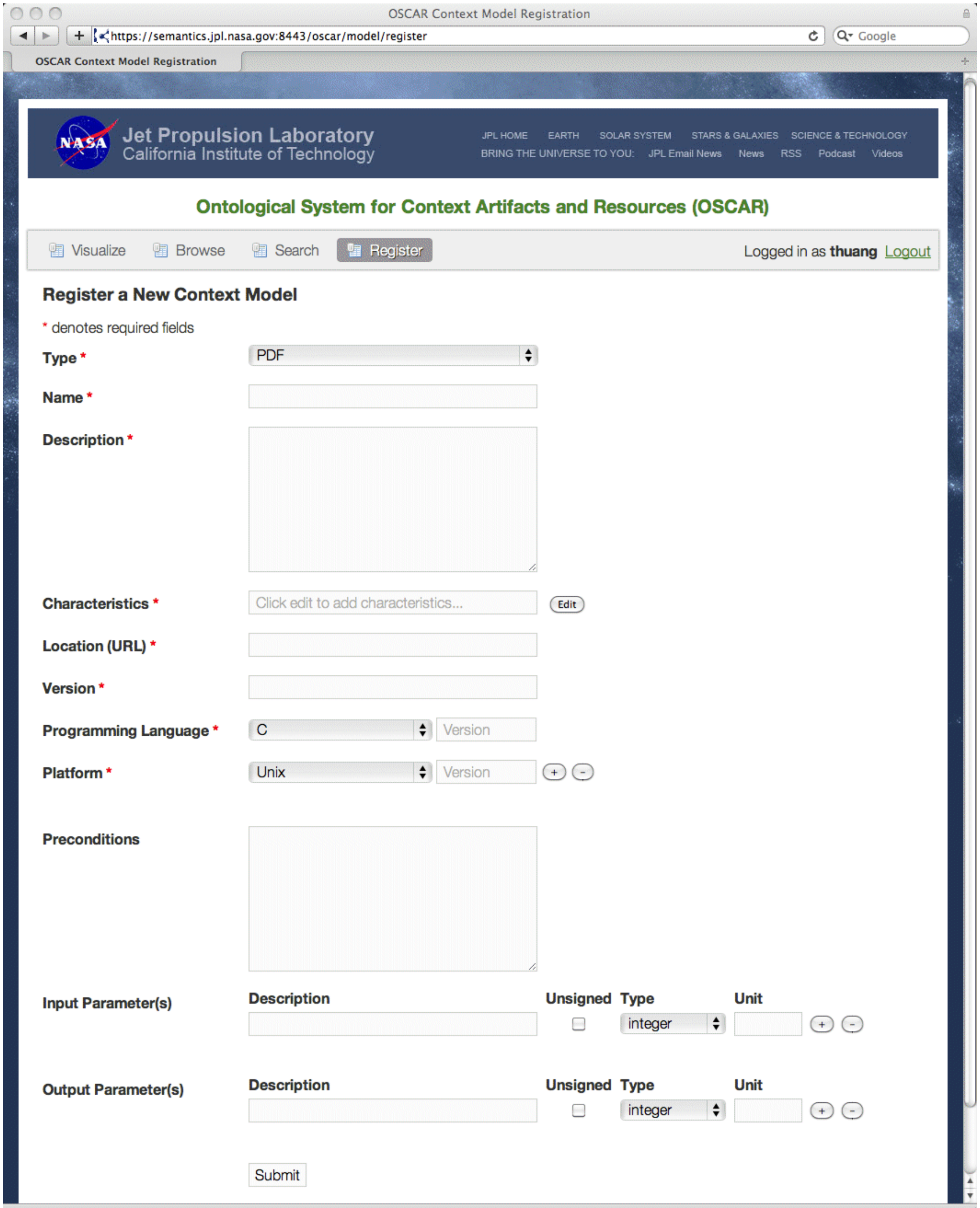
The figure below sketches the boundary between the OSCAR (in red) and the supplemental dynamic context (in blue) roles. The triple store ontology is shared along with the semantic web foundation.

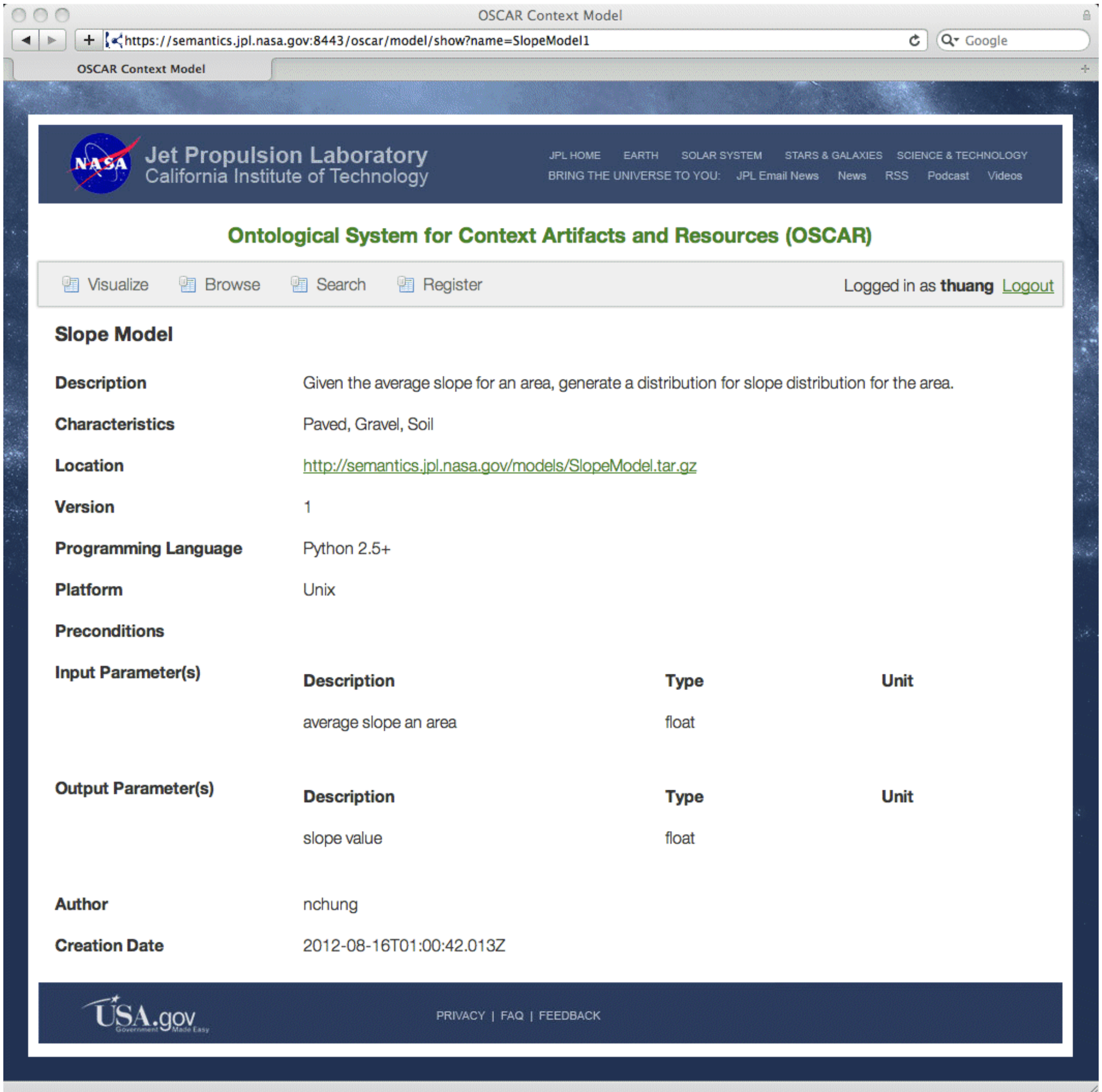


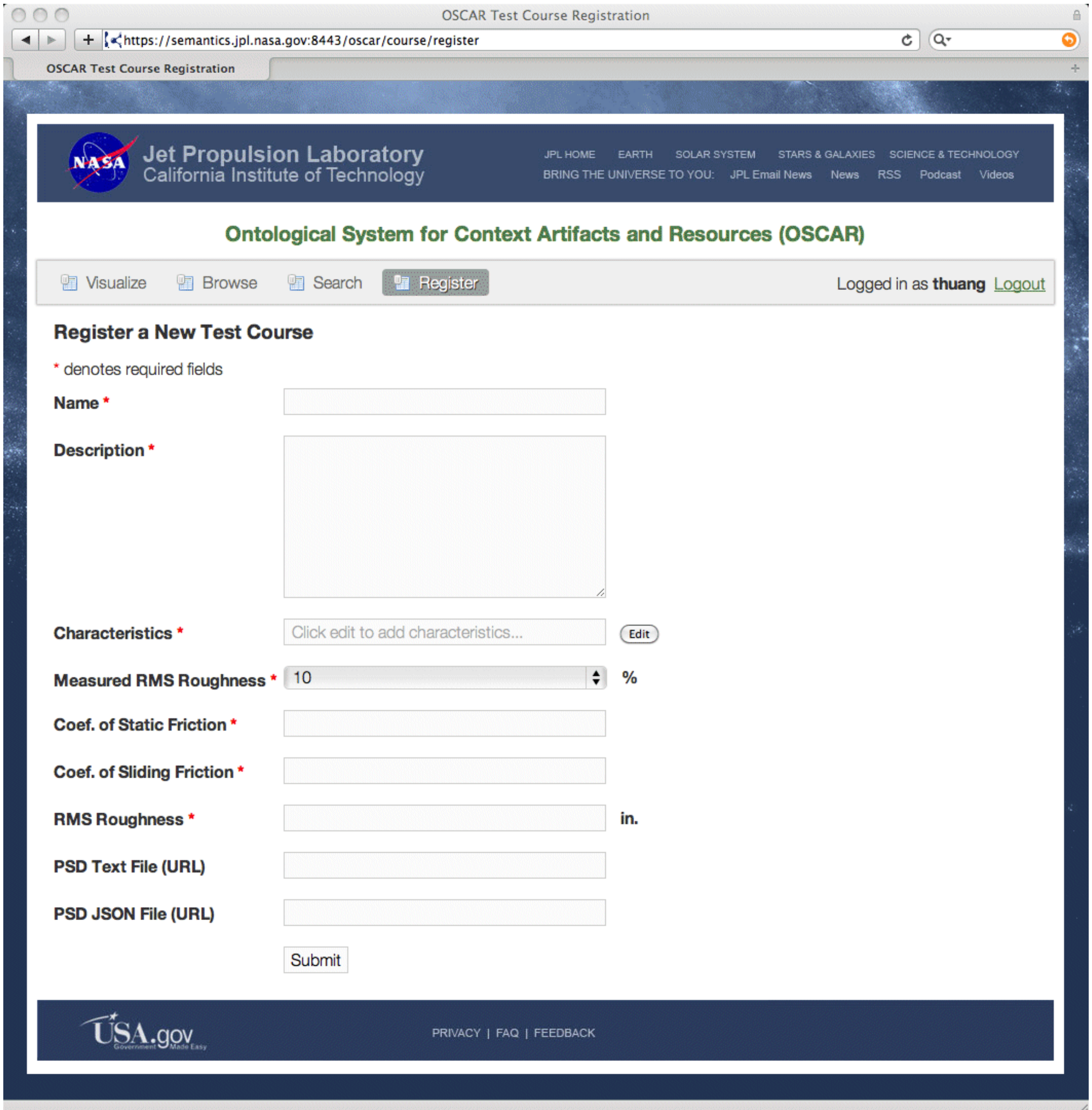
See further on the [Dynamic Context Server]

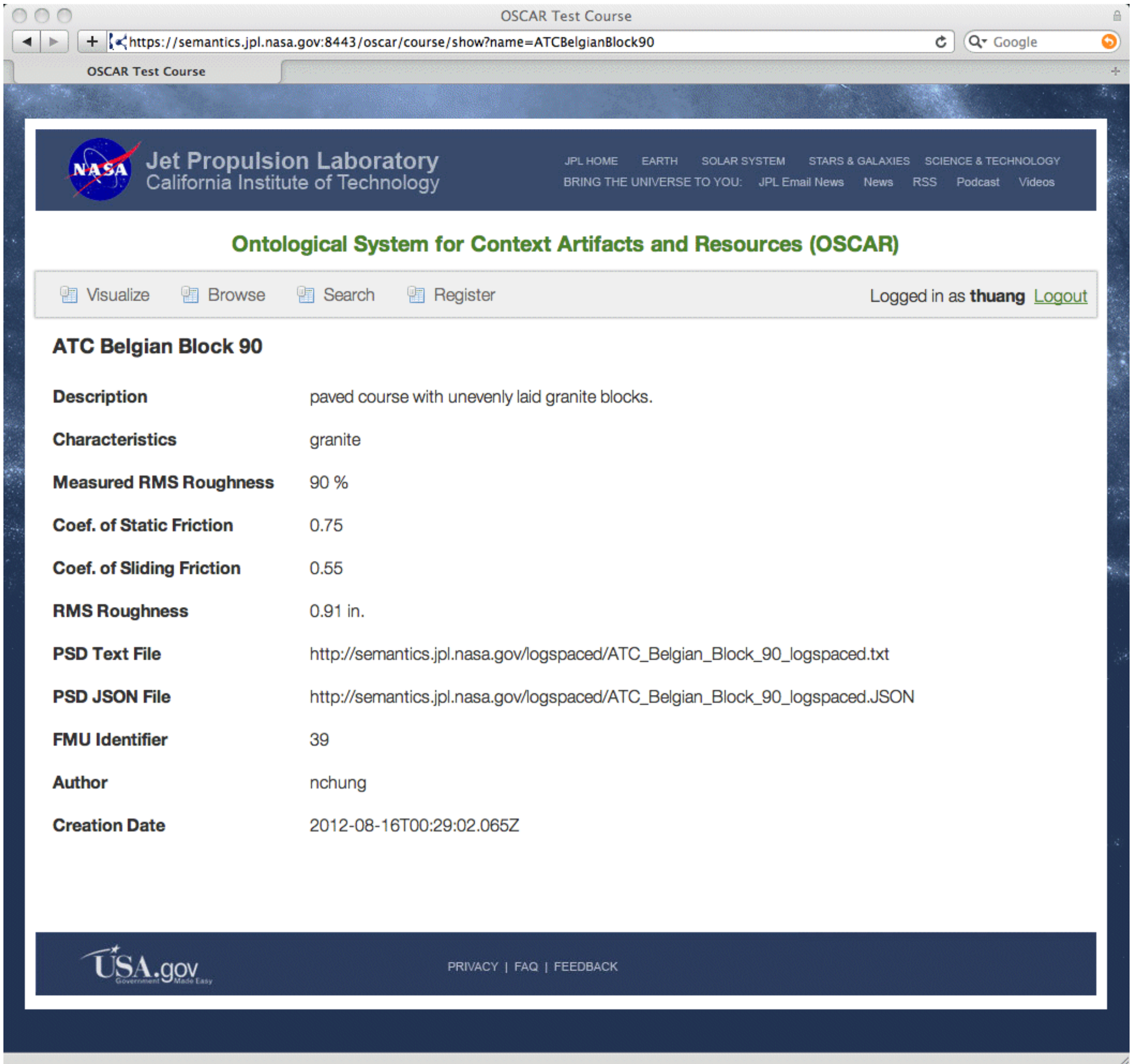
SemanticContextArchitectureOscar

Examples of Oscar model registration used for building the library, and general curation.


OSCAR Context Model Registration
https://semantics.jpl.nasa.gov:8443/oscar/model/register
Google
OSCAR Context Model Registration
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME EARTH SOLAR SYSTEM STARS & GALAXIES SCIENCE & TECHNOLOGY
BRING THE UNIVERSE TO YOU: JPL Email News News RSS Podcast Videos
Ontological System for Context Artifacts and Resources (OSCAR)
Visualize Browse Search Register
Logged in as thuang Logout
Register a New Context Model
* denotes required fields
Type *
PDF
Name *
Description *
Characteristics *
Click edit to add characteristics...
Edit
Location (URL) *
Version *
Programming Language *
C
Version
Platform *
Unix
Version
Preconditions
Input Parameter(s)
Description
Unsigned
Type
Unit
integer
Output Parameter(s)
Description
Unsigned
Type
Unit
integer
Submit


OSCAR Context Model
https://semantics.jpl.nasa.gov:8443/oscar/model/show?name=SlopeModel1
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME EARTH SOLAR SYSTEM STARS & GALAXIES SCIENCE & TECHNOLOGY
BRING THE UNIVERSE TO YOU: JPL Email News News RSS Podcast Videos
Ontological System for Context Artifacts and Resources (OSCAR)
Visualize Browse Search Register
Logged in as thuang Logout
Slope Model
Description
Given the average slope for an area, generate a distribution for slope distribution for the area.
Characteristics
Paved, Gravel, Soil
Location
http://semantics.jpl.nasa.gov/models/SlopeModel.tar.gz
Version
1
Programming Language
Python 2.5+
Platform
Unix
Preconditions
Input Parameter(s)
Description Type Unit
average slope an area float
Output Parameter(s)
Description Type Unit
slope value float
Author
nchung
Creation Date
2012-08-16T01:00:42.013Z
USA.gov
PRIVACY | FAQ | FEEDBACK

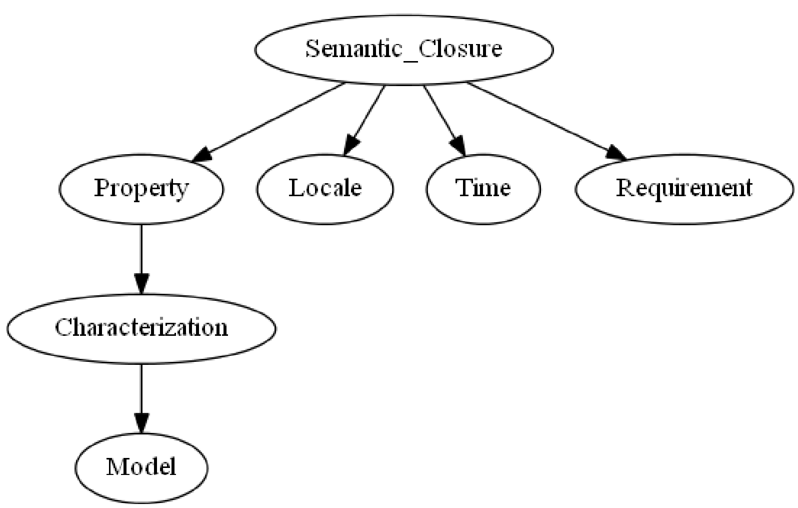

OSCAR Test Course Registration
https://semantics.jpl.nasa.gov:8443/oscar/course/register
OSCAR Test Course Registration
Jet Propulsion Laboratory
California Institute of Technology
JPL HOME EARTH SOLAR SYSTEM STARS & GALAXIES SCIENCE & TECHNOLOGY
BRING THE UNIVERSE TO YOU: JPL Email News News RSS Podcast Videos
Ontological System for Context Artifacts and Resources (OSCAR)
Visualize Browse Search Register
Logged in as thuang Logout
Register a New Test Course
* denotes required fields
Name *
Description *
Characteristics *
Click edit to add characteristics...
Edit
Measured RMS Roughness *
10
%
Coef. of Static Friction *
Coef. of Sliding Friction *
RMS Roughness *
in.
PSD Text File (URL)
PSD JSON File (URL)
Submit
USA.gov
PRIVACY | FAQ | FEEDBACK



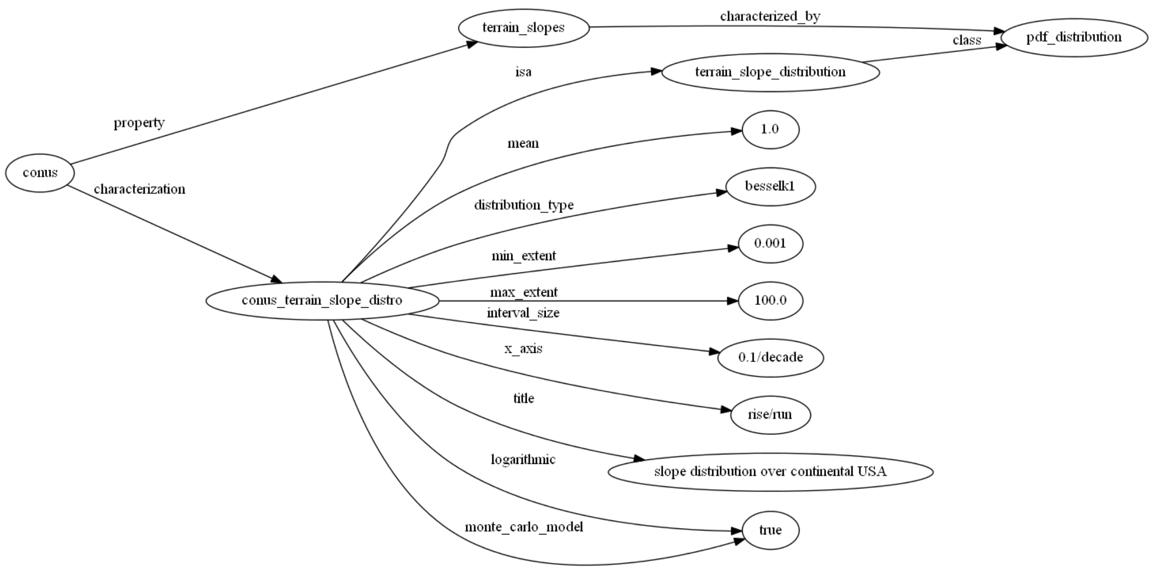
Semantic Context Language Requirements

Language Requirements

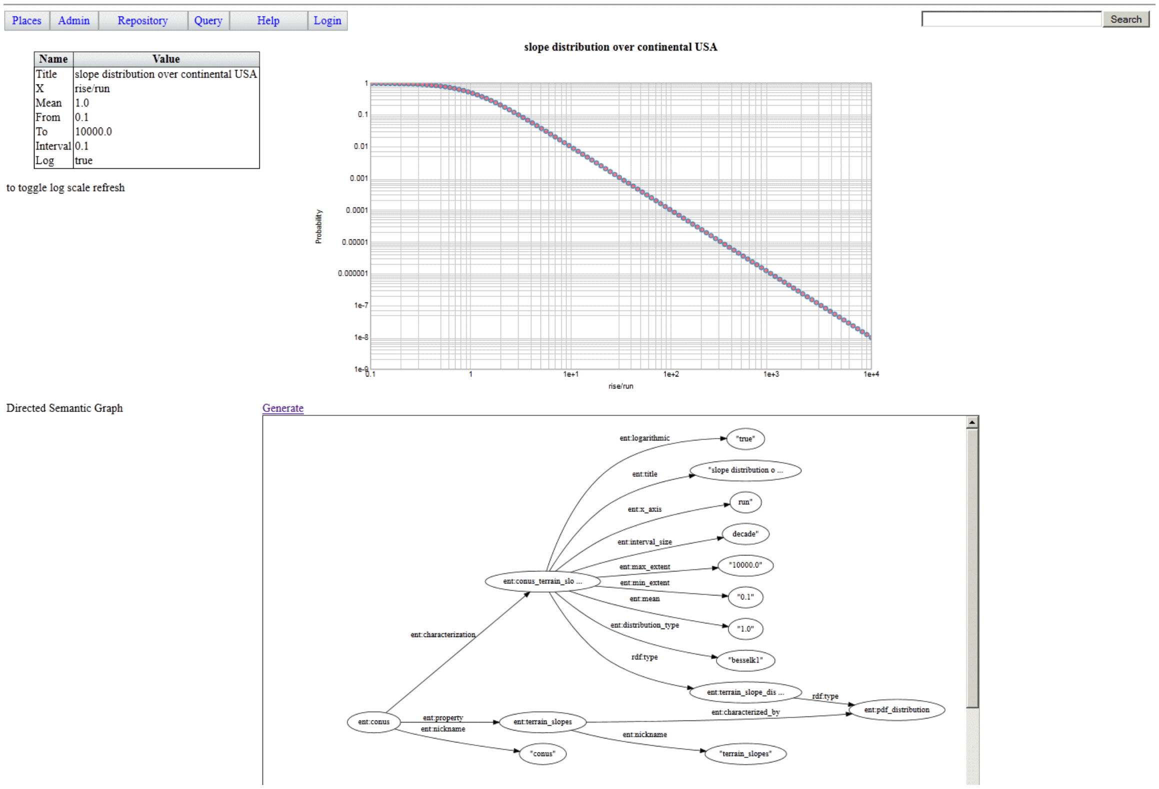
1. Integration with triple-store (RDF, OWL)
2. Integration with statistics framework such as R
3. Knowledge base and logic formulation
4. Search and query
5. XML processing
6. JSON processing
7. Semantic Web servicing – integration of queries as services
8. Ontology graphing
9. Entailment – creating rules that abstractly appear as triple store
10. Generators for code production and data
11. Math and complex math
12. Array and list processing
13. Artifact generation such as graphs for PDF and PSD



Subject/Predicate/Object Closure Graph of a terrain slope PDF for the USA. This gives the logical path of matching up a locale (CONUS) with a feature property (Terrain Slopes) and how to characterize and model that (via probability distribution functions). This was the original closure that was sketched out:



The following screenshot is an example of most of the language requirements pieced together. Two keywords, **locale** and **property**, guide the search to this artifact screen. The **locale** in this example is "conus" which represents the continental USA. The **property** is "terrain_slopes", which indicates the semantic ontology to look up. In this case the linked characterization model is a Probability Density Function (PDF) which contains the information on terrain slope probabilities.



The following table evaluates how many of the language requirements are involved with generating the features in the application above.

Requirement	Feature and Usage

1. Integration with triple-store (RDF, OWL) 2. Integration with statistics framework such as R 3. Knowledge base and logic formulation 4. Search and query 5. XML processing 6. JSON processing 7. Semantic Web servicing – integration of queries as services 8. Ontology graphing 9. Entailment – creating rules that abstractly appear as triple store 10. Generators for code production and data 11. Math and complex math 12. Array and list processing 13. Artifact generation such as graphs for PDF and PSD	All parametric data is stored in RDF and will use OWL and SWEET to specify terminology Used R to generate the BesselK function Logical rules were used to guide the user and design the interface and tie to the back-end triple store data Used an available search and query framework to integrate RDF is an example of XML processing. Integrated into the PDF graphing as the plotting interface requires JSON data format All main web queries are services, extracting the parameters from the input The closure of the triple-store data needed for generating a PDF is transferred to a directed graph as shown. Overloaded the triple store to capture the closure trace for the graph. This will get linked to a Monte Carlo generation tool Part of the language, the complex number math will get used on PSD Concise list array processing was used to represent and generate the data elements. See the above PDF, both linear and log scales are available.

This leads into the features developed for the dynamic context server prototype

SemanticContextArchitectureDynamic

- **General Architecture of a Dynamic Context Server**
  - Integration with triple-store semantic data
  - Knowledge-based logic formulation
  - Semantic Web servicing
  - Workflows
- **Architecture Features**
  - Pattern architecture
  - Graphing of artifacts
  - Domain-specific language for list processing
  - Domain-specific language for complex-number processing
  - Integration with

    - general statistical functions
    - Random number generation
    - Reference and citation knowledge capture
    - Rules for searching and presenting knowledge
    - Diagramming
    - Generators for code production and data
    - GUI development
    - Portability
    - Maintenance of library
- **Physical Domains**
    - List of physical domains
    - Deterministic and stochastic representations

The plan is to provide two views for context modeling services. The view handled by JPL is called Ontological System for Context Artifacts and Resources (OSCAR) and this will register and deliver well-defined models encapsulated as FMU components (and potentially others).

The supplemental view is a dynamic context server (DCS) which provides an environment for handling interactive applications such as guided workflows, artifact viewing, and reusable web services. OSCAR's capabilities will not overlap with the dynamic server's capabilities and in fact the two complement each other. The two views can be integrated through a conventional web-service front-end.

The DCS has been prototyped with a breadth-first view first to make sure that we have all the semantic, ontological, logical, and mathematical capabilities in place.

General Architecture of a Dynamic Context Server

- **Integration with triple-store semantic data**
    - RDF and simple formats such as Turtle used as input files for data and knowledge
    - SWEET provides ontological classification where possible
- **Knowledge-based logic formulation**
    - Rules interact with the triple-store description logic
    - Entailment – creating rules that abstractly appear as triple store
- **Semantic Web servicing**
    - Queries as model services
    - Queries to generate algorithms and code
    - Queries to generate artifacts and metrics
- **Workflows**
    - Query-based search and navigation
    - Guided workflow starting from requirements

Architecture Features

- **Pattern architecture**
  - Many context models have similar representation or archetypes
    - e.g. PDF patterns use functional mapping on lists
    - Similar format allows reusable artifacts, such as graphs
  - Models calibrated via parameters for different locales
  - Declarative programming facilitates pattern-matching
- **Graphing of artifacts**
  - From models or data
    - PDF and CDF
    - Power Spectral Density
    - Expected value plots
      - Annual, diurnal
      - Growth curves
  - Linear or log scales
  - Noise filtering
  - Inspection of data points
  - Panning and scaling
- **Domain-specific language for list processing**
  - List of X-Y pairs
  - List of X-Y1,Y2,.. n-tuples
  - Math operations on lists
    - Constructors
      - Linear range
      - Log range
  - Dot product
  - Mapping on lists
    - Functions
    - Scaling
  - Convolution
  - Pair Correlation / Auto-correlation
  - Z-difference
  - Integral / Derivative
  - Histogram
  - Direct translation of tuple-lists to graphs
- **Domain-specific language for complex-number processing**
  - Arithmetic
    - Infix operators for multiply, addition, division, power, etc
    - Used for concise semi-Markov terrain profile modeling
  - Built-in FFT for PSD calculation
- **Integration with general statistical functions**
  - R statistics package
    - Uses similar format for mapping against data lists
    - i.e. Statistical operators act on the entire list
  - Provides access to less common functions such as Bessel
- **Random number generation**
  - PDF generators for
    - Uniform
    - Exponential
    - Bessel
    - Rayleigh
    - Fat-tail

- Profile generators
    - Random walk based
        - Markov
        - Semi-markov
    - Superposition of sines
- **Reference and citation knowledge capture**
  - Integration with Zotero citation management system
    - SWEET keyword categorization
    - Generation of RDF stores
- **Rules for searching and presenting knowledge**
  - Based on ontological terms
  - General content search
  - Custom input and output data processing
    - XML and HTML
    - JSON
    - CSV
- **Diagramming**
  - AT&T Graphviz compatibility with SVG
  - Closure of rules as a directed graph.
  - Hierarchy and cloud diagrams
- **Generators for code production and data**
  - Tabulation of data, i.e. connectors for spreadsheet
  - Symbolic representations of algorithms
    - Used for on-line calculation
    - Translated to C-code, Python, etc
- **GUI development**
  - Uses definite clause grammars (DCG) to generate valid HTML
  - Declarative style of programming, similar but much more concise and powerful than XSLT
- **Portability**
  - Windows
  - Linux
  - Cloud environment
- **Maintenance of library**
  - Browsing
  - Site roadmap
  - Documentation
  - Statistical usage
  - Password control for administration of repository

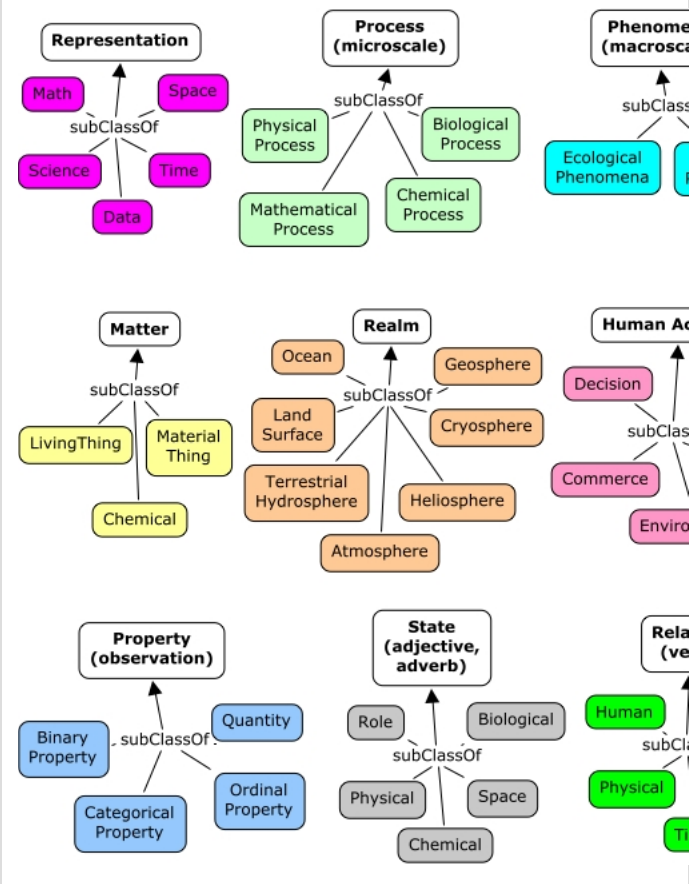
Physical Domains

- **List of physical domains**
  - Land
  - Atmosphere
  - Aquatic
- **Deterministic and stochastic representations**
  - Stochastic terrains characterized by PSD’s
  - Deterministic obstacles

SWEET

Semantic Web for Earth and Environmental Terminology (SWEET)

Official Site : http://sweet.jpl.nasa.gov/



Usage

Start by loading sweetAll into ontology.

http://sweet.jpl.nasa.gov/2.3/sweetAll.owl

Then it is a matter of following the owl:imports to recursively import the various SWEET domains.

SWEET depends on the following namespaces:
http://www.w3.org/2002/07/owl#
http://www.w3.org/1999/02/22-rdf-syntax-ns#
http://www.w3.org/2000/01/rdf-schema#
http://www.w3.org/2001/XMLSchema#

Namespace prefixes

We want to use shortened prefixes to refer to the SWEET terminology

e.g. **wind** for http://sweet.jpl.nasa.gov/2.3/phenAtmoWind.owl

prefix	SWEET
wind	http://sweet.jpl.nasa.gov/2.3/phenAtmoWind.owl

land	http://sweet.jpl.nasa.gov/2.3/realmLandform.owl
scimodel	http://sweet.jpl.nasa.gov/2.3/reprSciModel.owl
res	http://sweet.jpl.nasa.gov/2.3/humanResearch.owl
wave	http://sweet.jpl.nasa.gov/2.3/phenWave.owl
precip	http://sweet.jpl.nasa.gov/2.3/phenAtmoPrecipitation.owl
pollutant	http://sweet.jpl.nasa.gov/2.3/phenAtmoTransport.owl
chemprop	http://sweet.jpl.nasa.gov/2.3/propChemical.owl
chemproc	http://sweet.jpl.nasa.gov/2.3/procChemical.owl
energy	http://sweet.jpl.nasa.gov/2.3/propEnergyFlux.owl
coastal	http://sweet.jpl.nasa.gov/2.3/realmLandCoastal.owl
fluid	http://sweet.jpl.nasa.gov/2.3/phenFluidTransport.owl
emi	http://sweet.jpl.nasa.gov/2.3/phenElecMag.owl
bio	http://sweet.jpl.nasa.gov/2.3/phenBiol.owl
phys	http://sweet.jpl.nasa.gov/2.3/relaPhysical.owl
knowl	http://sweet.jpl.nasa.gov/2.3/humanKnowledgeDomain.owl
systemstate	http://sweet.jpl.nasa.gov/2.3/stateSystem.owl
repr	http://sweet.jpl.nasa.gov/2.3/repr.owl
units	http://sweet.jpl.nasa.gov/2.3/reprSciUnits.owl
prov	http://sweet.jpl.nasa.gov/2.3/reprSciProvenance.owl
method	http://sweet.jpl.nasa.gov/2.3/reprSciMethodology.owl
component	http://sweet.jpl.nasa.gov/2.3/reprSciComponent.owl
ocean	http://sweet.jpl.nasa.gov/2.3/realmOcean.owl
solid	http://sweet.jpl.nasa.gov/2.3/phenSolid.owl
sci	http://sweet.jpl.nasa.gov/2.3/relaSci.owl
state	http://sweet.jpl.nasa.gov/2.3/statePhysical.owl
distance	http://sweet.jpl.nasa.gov/2.3/propSpaceDistance.owl
time	
massprop	http://sweet.jpl.nasa.gov/2.3/propMass.owl
soil	http://sweet.jpl.nasa.gov/2.3/realmSoil.owl
hydro	
speed	http://sweet.jpl.nasa.gov/2.3/propSpeed.owl

ratio	http://sweet.jpl.nasa.gov/2.3/propDimensionlessRatio.owl
quant	http://sweet.jpl.nasa.gov/2.3/propQuantity.owl
datum	http://sweet.jpl.nasa.gov/2.3/reprDataModel.owl
coord	http://sweet.jpl.nasa.gov/2.3/reprSpaceCoordinate.owl
scale	http://sweet.jpl.nasa.gov/2.3/stateSpaceScale.owl
tod	http://sweet.jpl.nasa.gov/2.3/reprTimeDay.owl
format	http://sweet.jpl.nasa.gov/2.3/reprDataFormat.owl
loc	http://sweet.jpl.nasa.gov/2.3/propSpaceLocation.owl
noise	http://sweet.jpl.nasa.gov/2.3/phenWaveNoise.owl
service	
lightning	http://sweet.jpl.nasa.gov/2.3/phenAtmoLightning.owl
thermo	http://sweet.jpl.nasa.gov/2.3/stateThermodynamic.owl
vis	http://sweet.jpl.nasa.gov/2.3/stateVisibility.owl
impact	http://sweet.jpl.nasa.gov/2.3/stateRoleImpact.owl
stats	http://sweet.jpl.nasa.gov/2.3/reprMathStatistics.owl
diffusion	http://sweet.jpl.nasa.gov/2.3/propDiffusivity.owl
freq	
realm	http://sweet.jpl.nasa.gov/2.3/stateRealm.owl
cloud	http://sweet.jpl.nasa.gov/2.3/phenAtmoCloud.owl
particle	http://sweet.jpl.nasa.gov/2.3/matrParticle.owl

Some of these are spread out into phenomena, properties, process, realm so we want to retain those concepts.

The following table lays out the namespace organization as 9 top-level concept ontologies. Certain terms, such as "Chemical" have multiple conceptual meanings; in this case Chemical has meanings in the Process, Property, Relational, and State concepts. So this corresponds to the namespace identifiers procChemical, propChemical, relaChemical, and stateChemical. The table is organized sparsely to get a feel for how terminology spans the various concept namespaces. Highlighted terms span columns. Cells that we won't use will eventually get deleted to reduce complexity.

human (Human Activities)	**matr (Matter)**	**phen (Phenomenon) macroscale**	**proc (Process) microscale**	**prop (Property) observation**	**realm**	**rela (Relational) verb**	**repr (Representation)**	**state adjective, adverb**
								~~Biological~~
~~Agriculture~~	*Aerosol*	***Atmo***		*Binary*	***Atmo***			
~~Commerce~~	~~Animal~~	*AtmoCloud*		*Capacity*	~~AtmoBoundaryLayer~~		*DataFormat*	
Decision		*AtmoFog*		*Categorical*	*AtmoWeather*		*DataModel*	
		~~AtmoFront~~		*Charge*			*DataProduct*	
		AtmoLightning	***Chemical***	***Chemical***		***Chemical***	*DataService*	***Chemical***
		AtmoPrecipitation		*Conductivity*			*DataServiceAnalysis*	
		AtmoPressure		*Count*			*DataServiceGeospatial*	
		~~AtmoTransport~~		*Difference*			*DataServiceReduction*	
		AtmoWind		*Diffusivity*			**~~DataServiceValidation~~**	***DataProcessing***
		AtmoWindMesoscale		*DimensionlessRatio*				
	~~Biomass~~	~~Biol~~			*BiolBiome*			
	Element	~~Cryo~~			***ClimateZone***	***Climate***		
	Elemental Molecule	*Cycle*			*Cryo*	*Human*		
		~~CycleMaterial~~			~~EarthReference~~			
		~~Ecology~~				***Math***	***Math***	

		ElecMag					*MathFunction*	
	~~**Energy**~~	***Energy***		***Energy***			*MathFunctionOrthogonal*	
~~EnvirAssessment~~	*Equipment*	~~EnvirImpact~~		***EnergyFlux***			*MathGraph*	~~***EnergyFlux***~~ **solar flare**
~~EnvirConservation~~	~~Facility~~	*FluidDynamics*		*Fraction*			*MathOperation*	
~~EnvirControl~~	~~Industrial~~	***FluidInstability***		*Function*			*MathSolution*	***Fluid***
~~EnvirStandards~~	*Instrument*	*FluidTransport*		*Index*			*MathStatistics*	
~~Jurisdiction~~	*Ion*	~~**Geol**~~		*Mass*	~~**Geol**~~			
KnowledgeDomain	~~Isotope~~	~~GeolFault~~		~~MassFlux~~	~~GeolBasin~~			
Research	~~Microbiota~~	~~GeolGeomorphology~~		***Ordinal***	~~GeolConstituent~~			***Ordinal***
TechReadiness	~~Mineral~~	~~GeolSeismicity~~		*Pressure*	*GeolContinental*			
~~Transportation~~	~~NaturalResource~~	~~GeolTectonic~~		*Quantity*	~~GeolOrogen~~			
	~~OrganicCompound~~	*GeolVolcano*						
	~~Particle~~ atomic	~~Helio~~	***Physical***			**Physical**		***Physical***
	Plant	***Hydro***		~~Rotation~~	***Hydro***			
	Rock	*Mixing*	*StateChange*		*HydroBody*	*Provenance*		*Realm*
	~~RockIgneous~~				*LandAeolian*			*Role*
	Sediment				*LandCoastal*	***Sci***	***SciComponent***	~~RoleBiological~~
	Water				*LandFluvial*		SciFunction	*RoleChemical*
					Landform		*SciLaw*	*RoleGeographic*

					LandGlacial		*SciMethodology*	*RoleImpact*
					LandOrographic		SciModel	*RoleRepresentative*
					~~LandProtected~~		*SciProvenance*	*RoleTrust*
					~~LandTectonic~~		*SciUnits*	
					~~LandVolcanic~~			
		Ocean			***Ocean***			
		OceanCoastal			~~OceanFeature~~ names			
		~~OceanDynamics~~			~~OceanFloor~~ reef			
		PlanetClimate			*Region*			
		~~Reaction~~			*Soil*			
		Solid						***Solid***
		~~Star~~		***Space***		***Space***	~~**Space**~~	***Space***
				SpaceDirection			*SpaceCoordinate*	*SpaceConfiguration*
				SpaceDistance			*SpaceDirection*	*SpaceScale*
				SpaceHeight			*SpaceGeometry*	*SpectralBand*
				SpaceLocation			*SpaceGeometry3D*	~~SpectralLine~~
				SpaceMultidimensional			*SpaceReferenceSystem*	*Storm*
		System		*SpaceThickness*				***System***
		SystemComplexity		*Speed*				*Thermodynamic*
		Wave	***Wave***	*Temperature*				

		WaveNoise		*TemperatureGradient*				
				Time		***Time***	***Time***	***Time***
				TimeFrequency			*TimeDay*	~~TimeCycle~~
							TimeSeason	*TimeFrequency*
								~~TimeGeologic~~
								Visibility

Examples

humanDecision	Objective	**realm**	Land
humanKnowledgeDomain	Rheology	**realmAtmo**	Troposphere
humanResearch	Publication	**realmAtmoWeather**	CloudBase
humanTechReadiness	TRL	**realmBiolBiome**	Grassland, Terrain
		realmClimateZone	MarineClimate
		realmCryo	AlpineTundra
matr	Medium	**realmHydro**	SurfaceWater
matrAerosol	Particulate	**realmHydroBody**	Lake
matrElement	Iron	**realmLandAeolian**	SandDune
matrElementalMolecule	O2	**realmLandCoastal**	Shoreline
matrEquipment	Vehicle	**realmLandFluvial**	Wash
matrInstrument	Buoy	**realmLandform**	Land
matrPlant	Tree	**realmLandGlacial**	Esker
matrRock	SedimentaryRock	**realmLandOrographic**	Hill
matrSediment	Sand	**realmOcean**	OpenOcean
matrWater	SeaWater	**realmRegion**	Polar
		realmSoil	Ground
phen	StochasticProcess		
phenAtmo	Sunlight	**rela**	hasRealm

phenAtmoCloud	Cloud	**relaChemical**	hasMedium
phenAtmoFog	SaltHaze	**relaClimate**	hasAverageAnnualTemperature
phenAtmoLightning	Lightning	**relaHuman**	produces
phenAtmoPrecipitation	Rainfall	**relaMath**	hasScale
phenAtmoPressure	Barometric	**relaPhysical**	hasSpectralBand
phenAtmoTransport	AcidFog	**relaProvenance**	hasInferenceRule
phenAtmoWind	SandStorm	**relaSci**	hasMagnitude
phenAtmoWindMesoscale	CanyonWind	**relaSpace**	hasSpatialScale
phenCycle	DiurnalCycle	**relaTime**	halfLife
phenElecMag	ElectricField		
phenEnergy	WindEnergy		
phenFluidDynamics	Eddy	**repr**	LogarithmicScale
phenFluidInstability	Wake	**reprDataFormat**	ASCII
phenFluidTransport	Buoyancy	**reprDataModel**	DataStructure
phenGeolVolcano	VolcanicPlume	**reprDataProduct**	Curate
phenHydro	Streamflow	**reprDataService**	FormatConversion
phenMixing	FickianDiffusion	**reprDataServiceAnalysis**	FourierTransform, SpectralAnalysis
phenOcean	OceanPhenomena	**reprDataServiceGeospatial**	Map
phenOceanCoastal	BreakingWave	**reprDataServiceReduction**	Normalize
phenPlanetClimate	LocalClimate	**reprDataServiceValidation**	Calibrate
phenSolid	Ablation	**reprMath**	Equation
phenSystem	Growth	**reprMathFunction**	ProbabilityDensityFunction
phenSystemComplexity	Pattern	**reprMathFunctionOrthogonal**	Harmonic
phenWave	ShallowWaterWave	**reprMathGraph**	Digraph
phenWaveNoise	WhiteNoise	**reprMathOperation**	Slope
		reprMathSolution	Simulation
		reprMathStatistics	Statisticalsample

proc	Force	**reprSciComponent**	Input
procChemical	Corrosion	**reprSciFunction**	Invariant
procPhysical	Cooling	**reprSciLaw**	EmpiricalLaw
procStateChange	Freezing	**reprSciMethodology**	RemoteSensing
procWave	RayleighScattering	**reprSciModel**	Spectral
		reprSciProvenance	Workflow
		reprSciUnits	hertz
prop	Precision	**reprSpace**	Space
propBinary	BinaryProperty	**reprSpaceCoordinate**	Pitch
propCapacity	HeatCapacity	**reprSpaceDirection**	Uphill
propCategorical	StandardIndustrialClassification	**reprSpaceGeometry**	Point
propCharge	ElectricFieldStrength	**reprSpaceGeometry3D**	Dome
propChemical	pH	**reprSpaceReferenceSystem**	UniversalTransverseMercator
propConductivity	ThermalConductivity	**reprTime**	UniversalTime
propCount	NumberDensity	**reprTimeDay**	Sunrise
propDifference	Deviation	**reprTimeSeason**	Winter
propDiffusivity	ThermalDiffusivity		
propDimensionlessRatio	DragCoefficient		
propEnergy	Entropy	**state**	BinaryState
propEnergyFlux	Insolation	**stateChemical**	Acid
propFraction	Correlation	**stateDataProcessing**	Scaled
propFunction	StandardDeviation	**stateFluid**	Buoyant
propIndex	Turbidity	**stateOrdinal**	Medium
propMass	Density	**statePhysical**	WaveState
propOrdinal	SpectralBand	**stateRealm**	Aquatic
propPressure	BarometricPressure	**stateRole**	Provider
propQuantity	PhysicalConstant	**stateRoleChemical**	Oxidizer
propSpace	Curvature	**stateRoleGeographic**	Highway
propSpaceDirection	Angle	**stateRoleImpact**	Rough
propSpaceDistance	Wavelength	**stateRoleRepresentative**	Sample

propSpaceHeight	Topography	**stateRoleTrust**	Unknown
propSpaceLocation	Position	**stateSolid**	Rigid
propSpaceMultidimensional	Area	**stateSpace**	Point
propSpaceThickness	Precipitation	**stateSpaceConfiguration**	Ridged
propSpeed	WindSpeed	**stateSpaceScale**	Continental
propTemperature	DewPoint	**stateSpectralBand**	RadioWave
propTemperatureGradient	ThermalGradient	**stateStorm**	WindScale
propTime	Latency	**stateSystem**	Stochastic
propTimeFrequency	Rate	**stateThermodynamic**	MaximumEntropy
		stateTime	1hour
		stateTimeFrequency	Diurnal
		stateVisibility	Cloudy

List of possible terms for SWEET

- sea wave / wind wave (choppy waves caused by wind)
- prop:Fideltiy spelled wrong
- stateRoleBiological:Poision spelling
- Bessel function (math function)
- convolution (math operation)
- ambient temperature (temperature, reprSciComponent:Ambient?)
- requirement (alias for humanDecision:Objective)
- slope/grade for terrain (alias for reprSpaceCoordinate:pitch ? or reprMathOperation:Slope)
- moguls (terrain)

Environmental Context Requirements

The context model applied to a simulation typically derives from a requirements or text document

The ontology should allow the description of the path from a source (requirements) to a target (model)

Possibilities of describing the source text include:

1. Short phrases indicating the environmental context, such as ***"level, hard-surface road"***
    - Linked to a document they appear in.

    - Defined in some other reference, possibly a standard.
    - Target models and documents are easily linked to phrases via semantic descriptions
2. Description of specific vehicle requirements or tests,
   such as ***"6 watt absorbed power"***
    - Linked to a document that contains the complete description.
    - All target models applicable are linked to the named requirement
3. Long description of the requirement
    - Same as 2 but description maintained in knowledge base
4. Requirements for passing specific tests,
   such as ***"Churchville A course"***
    - Specific target models applicable to the test are linked to the test case.

The generality is highest at #1 and least in #4.

The chart below shows a concordance between a short-phrase requirement, a link to the source it was derived from, and then a step in the workflow path. If the phrase has further meaning, it can also be linked to another document.

> *from : " The vehicle shall be capable of being placed outdoor in long term storage, up to XX months, at temperatures ranging between -XX° F and XX° F (-XX° C to XX° C) , in **humid storage conditions** IAW **AR 70-38 table 2-1** and in salt-fog conditions per MCO 4790.18B 16 Jul 04 / TM 4795-34-2 / TM4795-12-1 without degradation. "*

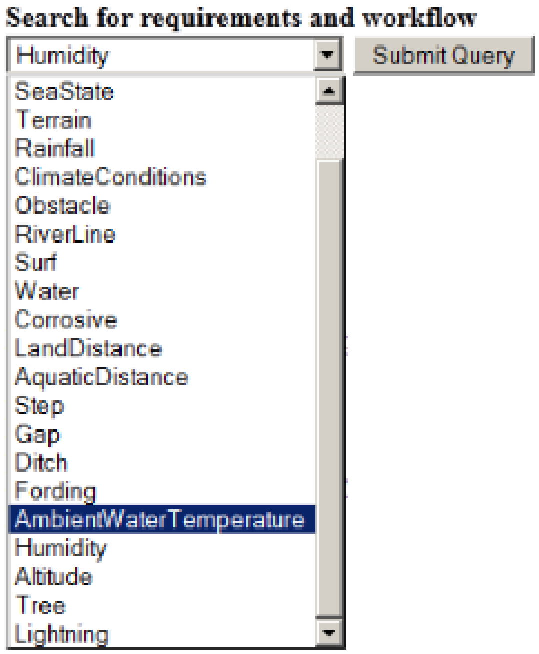
The phrase "**humid storage conditions**" is pulled from the text and linked to a specific model as one triple. The same phrase is also registered as an "in accordance with" to a specific Army Regulation standard "**AR 70-38**" and at a specific location "**table 2-1**".

https://babelfish.arc.nasa.gov/confluence/display/AVMPROJ/BAE#

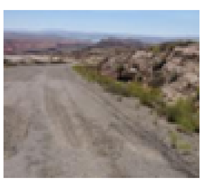
Humidity

requirement	source	workflow path
ambient relative humidity of up to XX percent	doc	model index
humid storage conditions	doc	model index
humid storage conditions	AR-70-38	table 2.1

The procedure then follows to parse the text for the rest of the phrases, and add each to the semantic knowledge base, using the SWEET ontology to categorize the environmental contexts. The user can then browse through the categories to establish the workflow.

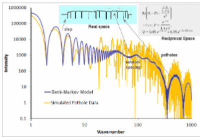


Fine Terrain Features



- Data Sources
- Power Spectral Densities of Terrain
  - Models
  - Data
  - Python Terrain Generator

Data Sources

- OpenCRG
  Mercedes-Benz test track data and data translation code : http://www.vires.com/opencrg/download.htm
- CSIR C2M2L partner
  Pothole examples attached: (1) OpenCRG format, (2) Matlab format zipped
  

- TOPS
  Open military test course data

Power Spectral Densities of Terrain

Models

Two approaches to generating terrain profiles based on power spectral densities (PSD)

1. Superposition of randomly phased sine waves to accomplish a pseudo inverse Fourier transform of the PSD
2. Fitting a semi-Markov autocorrelation model of random walk to the PSD (via the Weiner-Khinchin theorem), see Terrain Spectroscopy

Each approach has benefits and drawbacks

Benefits

- The superposition approach is fast and automatic as it works as a rough heuristic
- The semi-Markov autocorrelation function approach is based on stochastic properties of the terrain so can model phase and skew

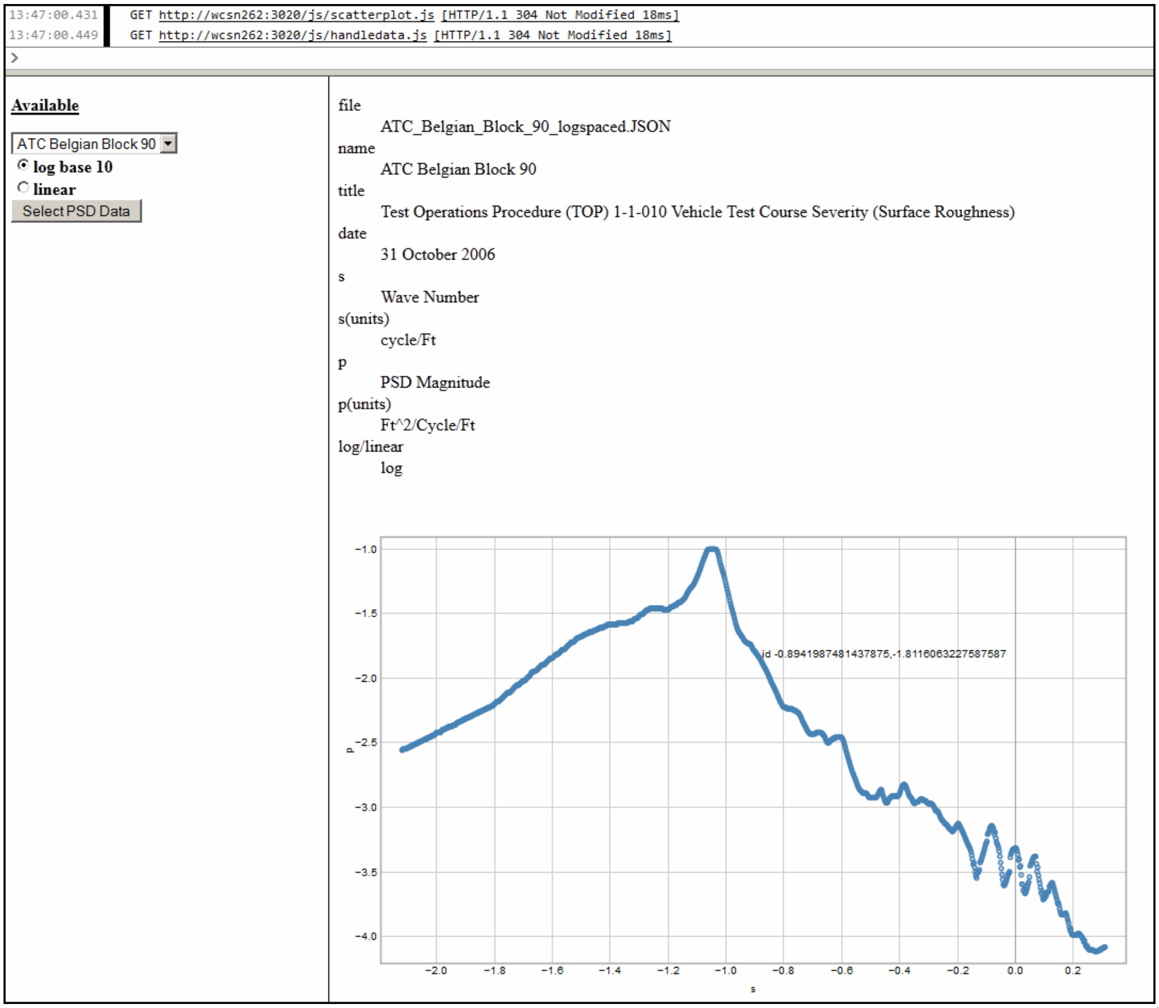
Drawbacks

- The superposition approach will show a repeat sequence based on the lowest spatial frequency and needs to approximate phase (no asymmetries possible)
- The semi-Markov autocorrelation function approach requires a fitting process, and gets the most benefit from prior knowledge in addition to that provided by the PSD. However, once the models are created, new models can easily be composed from the old ones.

The terrain profile context models will include both variants.

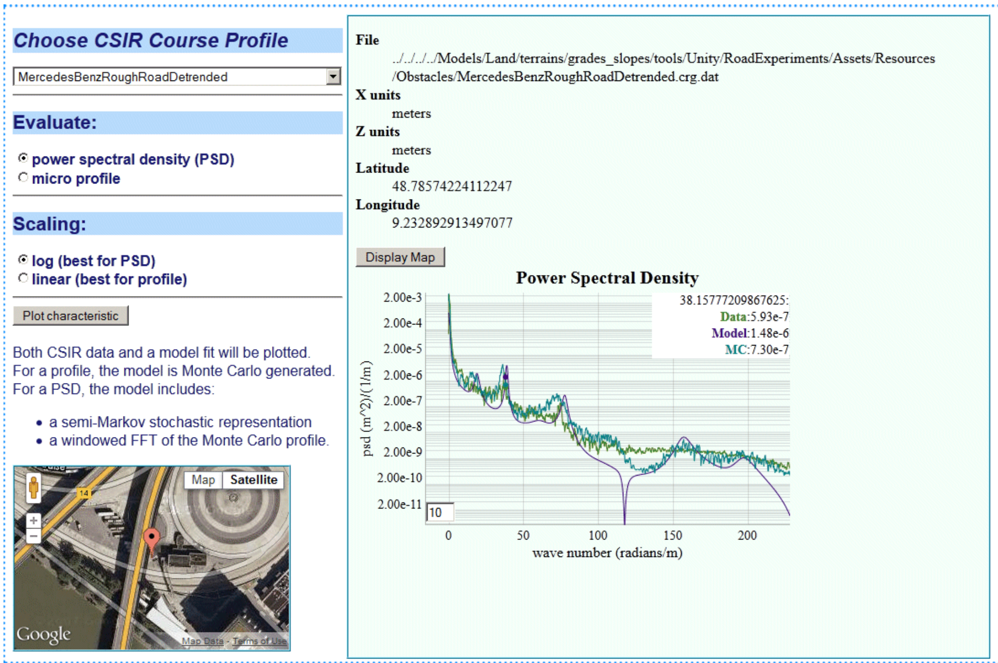
Data

The figure below shows a prototype of a semantic web indexing renderer. This will index against an ontologically categorized set of terrain PSD data cataloged from Test Operating Procedures (TOPS). The data file will contain header information necessary to calibrate the scales.



We now have data from CSIR and a few examples are shown in ContextModelsCSIR.

One example that CSIR provided is a Belgian Block track. As a benefit to the detailed analysis that went into fitting to a semi-Markov moded, we can use the same model fit to the CSIR Belgian Block course to fit to Mercedes Benz test track data. From a OpenCRG data file called "RoughRoad", the following model reused the exact dimensions and weighting of the CSIR fit.



Python Terrain Generator

Python version of the core from Roger Polston's terrain generator (based on approach 1 above). It takes a JSON file containing PSD terrain data, and generates vertical offset data using the specified step size and distance. Get it here: terrain_gen.py .

OpenCRG

OpenCRG Home Page

OpenCRG recommendations

email 4/1/2012

After doing some prototyping with the OpenCRG format that you suggested, we find that it is very acceptable for processing. It has very good resolution and it appears very efficient in memory and speed.

For the format of raw terrain data we propose the following specification.

Specification

		Description
Source	OpenCRG (http://www.opencrg.org/)	Fixed (non-deforming) terrain format
Input	File name	

Input	U (meters)	Distance along the path
Input	V (meters)	Distance perpendicular to the path
Output	Z (meters)	Elevation at (U,V) point along path
Output	UTM	Location of starting point of path

Table 1: Path based interface

		Description
Source	OpenCRG (http://www.opencrg.org/)	Fixed (non-deforming) terrain format
Input	File name	
Input	X (meters)	Distance Easting in grid
Input	Y (meters)	Distance Northing in grid
Output	Z (meters)	Elevation at (X,Y) point in grid
Output	UTM	Location of lower left corner of grid

Table 2: Grid based interface

Notes:

A combination of path and grid interface is possible via the OpenCRG API.

The UTM can be replaced with a latitude and longitude available from the CRG file header

This is only a proposal so if you can suggest alternatives, we will be open. We will likely produce other formats for other applications (such as those using XML) but to store the original data in, the OpenCRG should work.

TOPS

Test Operating Procedures

Aerial view of Munson test area at
Aberdeen Test Center

- Test Operating Procedures
- Working Test Operating Procedure List
    - Ontological Knowledge

Working Test Operating Procedure List

- 1-1-010 Vehicle Test Course Severity (Surface Roughness
- TARADCOM_SignalAnalProg
- TOP 01-1-010 VEHICLE TEST COURSE SEVERITY (31 Oct 06)
- TOP 01-1-011A VEHICLE TEST FACILITIES AT ABERDEEN TEST CENTER AND YUMA TEST CENTER (27 Feb 12)
- TOP 1-1-014 Ride Dynamics
- TOP 1-1-015 Human Systems Integration
- TOP 2-2-603 Vehicle Fuel Consumption (12 Feb 1980)
- TOP_1_1_011

These will be indexed semantically and added to the knowledge base

Table of test courses with descriptions

Test Course	Description
ATC_Belgian_Block_10	"Test Operations Procedure (TOP) 1-1-010 Vehicle Test Course Severity (Surface Roughness)"
ATC_Belgian_Block_90	etc.
ATC_Belgian_Block	
ATC_Churchville_B_10	
ATC_Churchville_B_90	
ATC_Churchville_B	

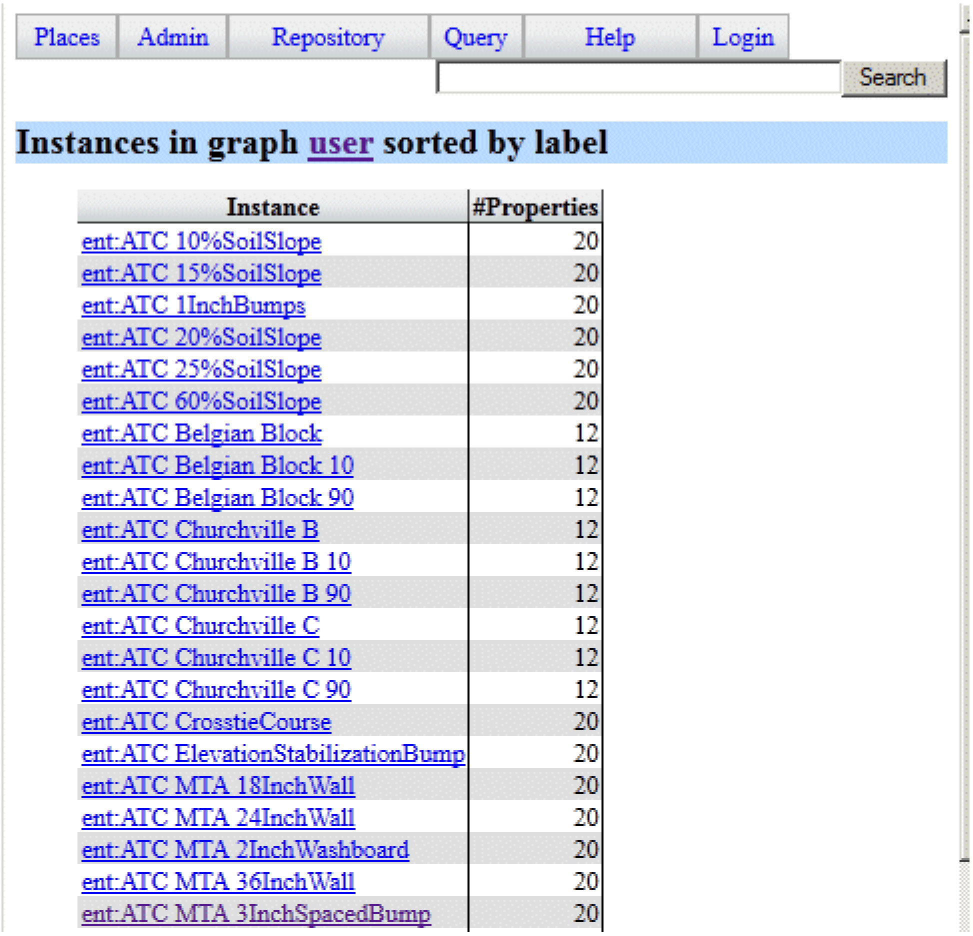
ATC_Churchville_C_10	
ATC_Churchville_C_90	
ATC_Churchville_C	
ATC_Munson_Gravel_10	
ATC_Munson_Gravel_90	
ATC_Munson_Gravel	
ATC_Perryman_1_10	
ATC_Perryman_1_90	
ATC_Perryman_1	
ATC_Perryman_2_10	
ATC_Perryman_2_90	
ATC_Perryman_2	
ATC_Perryman_3_10	
ATC_Perryman_3_90	
ATC_Perryman_3	
ATC_Perryman_A_10	
ATC_Perryman_A_90	
ATC_Perryman_A	
YTC_Desert_March	
YTC_KOFA_Level_Gravel	
YTC_Laguna_Hilly_Trails	
YTC_Laguna_Levels_Trails_West	
YTC_Laguna_Level	
YTC_Laguna_Level_Trails_East	
YTC_Laguna_Paved	
YTC_Mid-East_Sec_B	
YTC_Mid-East_Start	
YTC_Mid-East_WashEnd	
YTC_MidEast_Sec_A	
YTC_Patton_Hilly_Gravel	
YTC_Patton_Hilly_Trails	
YTC_Patton_Level_Gravel	

YTC_Patton_Level_Trails	

Ontological Knowledge

The data was compiled into JSON files, and initially stored on a file directory.

We prototyped the incorporation of PSD data from stochastic test course terrains and deterministic obstacle profiles into the knowledgebase repository.


Places | Admin | Repository | Query | Help | Login

Search

Instances in graph user sorted by label

Instance	#Properties
ent:ATC 10%SoilSlope	20
ent:ATC 15%SoilSlope	20
ent:ATC 1InchBumps	20
ent:ATC 20%SoilSlope	20
ent:ATC 25%SoilSlope	20
ent:ATC 60%SoilSlope	20
ent:ATC Belgian Block	12
ent:ATC Belgian Block 10	12
ent:ATC Belgian Block 90	12
ent:ATC Churchville B	12
ent:ATC Churchville B 10	12
ent:ATC Churchville B 90	12
ent:ATC Churchville C	12
ent:ATC Churchville C 10	12
ent:ATC Churchville C 90	12
ent:ATC CrosstieCourse	20
ent:ATC ElevationStabilizationBump	20
ent:ATC MTA 18InchWall	20
ent:ATC MTA 24InchWall	20
ent:ATC MTA 2InchWashboard	20
ent:ATC MTA 36InchWall	20
ent:ATC MTA 3InchSpacedBump	20

The data can be viewed from a triple-stored graph browser.

ent:data_y	[0.001192851],[0.0011796972],[0.0011667125],[0.0011546925],[0.001143178],[0.0011316794],[0.0011201491],[0.0011077672],[0.001095257],[0.0010844636],[0.0010742011],[0.001063155],[0.0010517921],[0.0010404846],[0.0010293798],[0.0010190494],[0.0010088689],[0.00099793769],[0.00098700328],[0.00097684167],[0.00096690713],[0.00095691289],[0.00094695256],[0.00093452514],[0.00092815],[0.00092815],[0.00092791632],[0.00091951202],[0.00090808895],[0.00089571846],[0.00089074],[0.00089074],[0.00089074],[0.00089074],[0.00089074],[0.00089074],[0.00089074],[0.00089074],[0.00088925235],[0.00087735787],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.0008726],[0.00087004435],[0.00085732476],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00085483],[0.00084922127],[0.00083814065],[0.00083743],[0.00083743],[0.00083743],[0.00083743],[0.00083261265],[0.00082146982],[0.00081303926],[0.00080486891],[0.00079671453],[0.00078852194],[0.0007782143],[0.00077128131],[0.00077128],[0.00077128],[0.00076392849],[0.00075558009],[0.00075558],[0.00075558],[0.00075558],[0.00075546237],[0.0007465332],[0.0007402],[0.0007402],[0.00074009565],[0.00072968544],[0.00071576815],[0.00070476404],[0.0006938661],[0.00068171414],[0.00067367378],[0.00066915911],[0.00066785],[0.00066785],[0.00066785],[0.00066785],[0.00066677378],[0.00065755059],[0.00065425],[0.00065425],[0.00065425],[0.00065425],[0.00065550136],[0.00066424436],[0.00066995839],[0.00067325942],[0.00067649168],[0.00067966029],[0.00068465252],[0.0006925433],[0.00070027221],[0.00070793232],[0.00071561553],[0.00072299952],[0.0007279098],[0.00073151935],[0.00073507758],[0.00073874488],[0.00074452003],[0.00075291577],[0.00076300734],[0.00077580739],[0.00079325336],[0.0008151775],[0.00083777745],[0.00086064274],[0.00088053815],[0.00089825025],[0.00091188749],[0.00092589328],[0.00095022817],[0.00098365566],[0.0010254818],[0.0010692566],[0.0011018532],[0.0011280198],[0.0011461931],[0.001163489],[0.0011858998],[0.0012133474],[0.0012516219],[0.0012927181],[0.0013344846],[0.0013597521],[0.0013690828],[0.001372],[0.001372],[0.001372],[0.001372],[0.0013731213],[0.0013915453],[0.0014005],[0.0014005],[0.0014002675],[0.0013953959],[0.0013811936],[0.0013242686],[0.0012758984],[0.0012423143],[0.0012173689],[0.0011996583],[0.0011796906],[0.0011559134],[0.0011265796],[0.0010893837],[0.0010560023],[0.0010259966],[0.001013861],[0.0010083474],[0.0010077],[0.0010077],[0.0010077],[0.0010077],[0.0010030285],[0.00098915494],[0.00098723],[0.00099786956],[0.0010077],[0.0010077],[0.0010077],[0.0010077],[0.0010075489],[0.00099770752],[0.00098653173],[0.00098115103],[0.00097634701],[0.00097168006],[0.00096561227],[0.00095545627],[0.00094487418],[0.00093552369],[0.00092446342],[0.00091007081],[0.00089586075],[0.00088337849],[0.00086644923],[0.0008397516],[0.00080881095],[0.00077240467],[0.0007469998],[0.00072889708],[0.00072513],[0.00072513],[0.00072368546],[0.00071490452],[0.00070605489],[0.00069734204],[0.0006959],[0.0006959],[0.00069289146],[0.00068334752],[0.00068173],[0.00068173],[0.00067941738],[0.00067053559],[0.00066346535],[0.00065681907],[0.00064879921],[0.00063835674],[0.00061666782],[0.00058148633],[0.00054697921],[0.00051275841],[0.00048567087],[0.000464014],[0.00044988941],[0.00043952708],[0.00043193131],[0.00042565181],[0.00041899718],[0.00041241713],[0.00040454207],[0.00039935267],[0.00039934],[0.00039934],[0.00039634966],[0.00039122212],[0.00038615106],[0.00038324],[0.00038324],[0.00038322393],[0.00037985986],[0.00037498931],[0.00037106602],[0.00036719611],[0.00036338287],[0.00035961768],[0.00035590267],[0.00035218638],[0.00034817371],[0.00034521393],[0.0003434395],[0.0003417634],[0.00034009213],[0.00033779533],[0.00033420214],[0.00033041787],[0.00032621124],[0.00032553526],[0.00032939186],[0.00033328368],[0.00033677659],[0.00034057397],[0.0003448793],[0.00034469244],[0.0003382021],[0.00033268903],[0.00032798218],[0.00032075017],[0.00030999615],[0.00030048083],[0.00029213202],[0.00028894478],[0.0002874695],[0.00028734],[0.00028734],[0.00028777284],[0.00028963081],[0.00029343921],[0.00030050082],[0.00030847875],[0.0003170645],[0.00032277927],[0.00032744407],[0.00033276309],[0.0003379682],[0.00034186774],[0.00034526257],[0.00034912677],[0.00035266085],[0.00035519652],[0.00035663269],[0.00035426504],[0.00034962227],[0.00034573222],[0.00034113775],[0.00033386805],[0.00032670871],[0.00032295981],[0.00031825609],[0.00030268752],[0.00028297804],[0.0002659825],[0.00024971992],[0.00023442442],[0.00022009117],[0.00020649143],[0.00019446875],[0.00018398149],[0.00017551799],[0.00016887262],[0.00016356988],[0.00015931273],[0.00015560077],[0.00015207678],[0.00014974201],[0.00014814836],[0.00014804548],[0.00015097598],[0.00015537279],[0.00016233224],[0.00017004679],[0.00017852489],[0.00018581821],[0.00019205122],[0.00019638331],[0.00019953384],[0.00020128945],[0.00020240116],[0.00020255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ent:file	"ATC_Perryman_1_logspaced.JSON"
ent:file_path	"../../../../Models/Land/terrains/grades_slopes/data/WaveNumberSpectra/LogSpaced/ATC_Perryman_1_logspaced.JSON"
ent:label_x	"Wave Number"
ent:label_y	"PSD Magnitude"
ent:name	"ATC Perryman 1 "
ent:title	"Test Operations Procedure (TOP) 1-1-010 Vehicle Test Course Severity (Surface Roughness)"
ent:type	"terrain_psd"
ent:units_x	"cycle/Ft"
ent:units_y	"Ft^2/Cycle/Ft"

All properties reside in the graph user

The resource does not appear as an object

By adding a few query rules, we can access the data and present as a graphical artifact.

Available

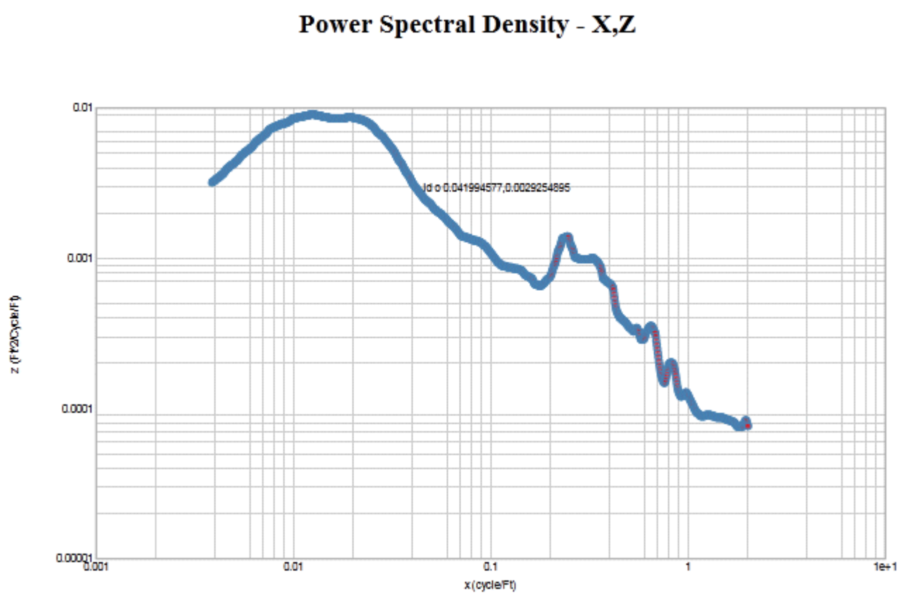
ATC Perryman 1

- log base 10
- linear

- static plot
- dynamic plot

Select Data Set

Data Set
http://entroplet.com/terms#ATC Perryman 1
X units
cycle/Ft
Z units
Ft^2/Cycle/Ft
log or linear scale
log



Gross Terrain Features

- Data Sources
- Prototype

Data Sources

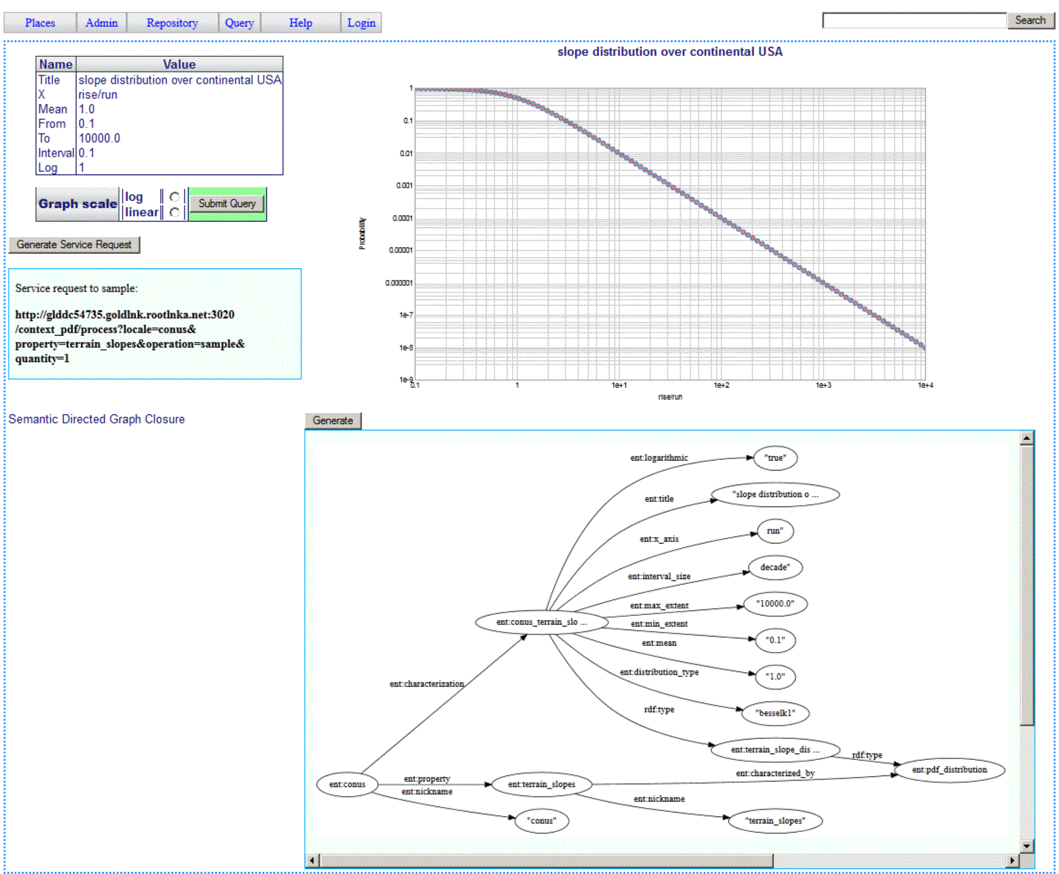
- USGS DEM
  A list of USA Lower 48 DEM 250 files suitable for wget download : wg.txt

Prototype

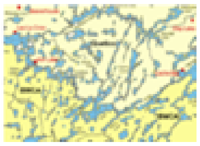
We used the distributions described here to prototype the service.

This is a general search interface to select the locale.

Once locale is selected, then services and artifacts become available.



Lake Size Statistics



Intro

The foundation for this work is described in the [Probability Elements] white paper.

Particle Size Statistics

- 
- Intro
- Data Sources
- Characteristics

Intro

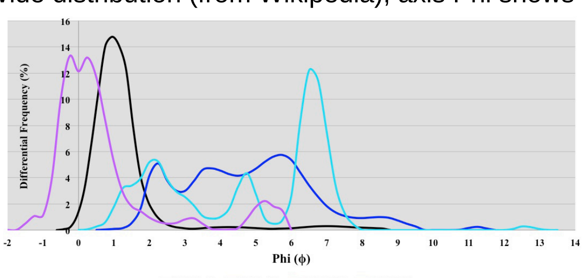
The foundation for this work is described in the Probability Elements white paper.

Data Sources

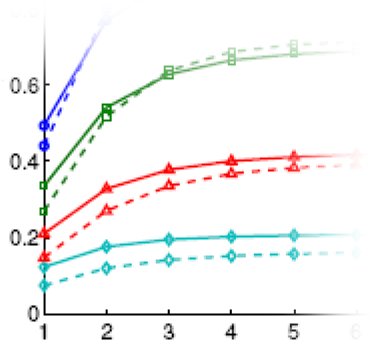
- Cloud particulates at JPL, ice
  http://mls.jpl.nasa.gov/dwu/cloud/index.html
- Volcanic ash
  Particle size distribution

Characteristics

- Wide distribution (from Wikipedia), axis Phi shows size in powers of 2



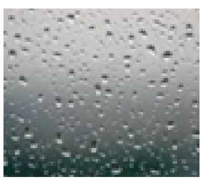
Probabilistic formal model checking



Intro

Strategy

Rainfall Statistics



Intro

The foundation for this work is described in the Probability Elements white paper.

Stochastic Models

We propose to use patterns to model the stochastic characteristics of the environmental contexts.

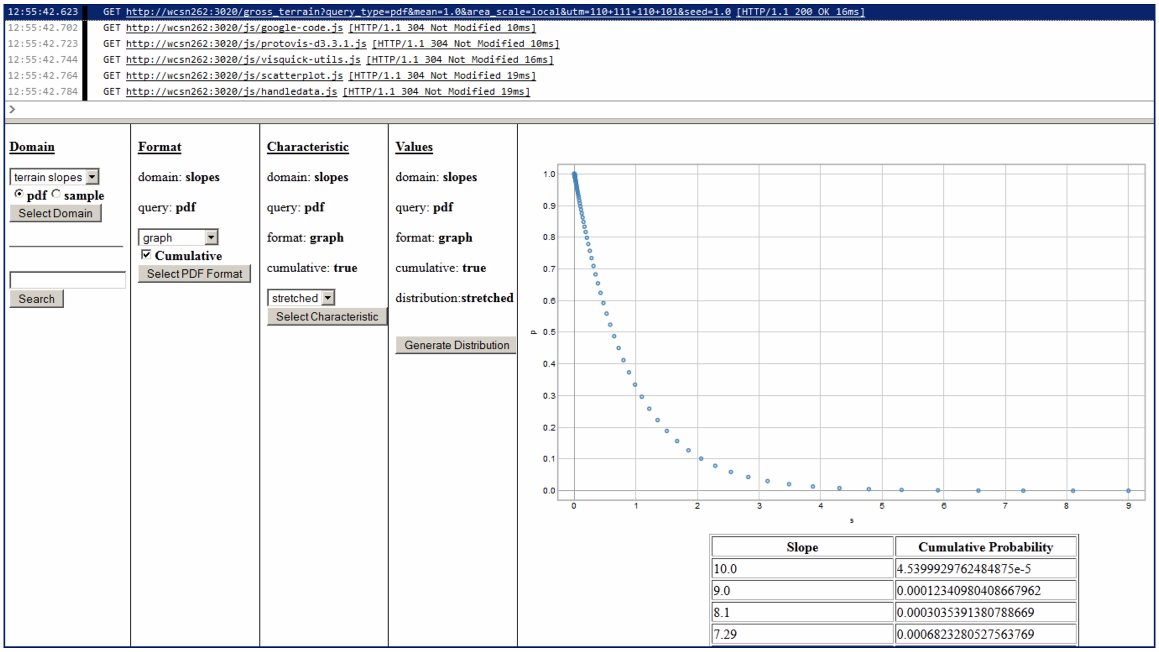
Patterns:

- Probability Elements
  Stochastic Analysis for Context Modeling
- Terrain Spectroscopy
  Unified characterization of surface topography for vehicle dynamics applications
- Dispersion Characterization
  Characterizing diffusive growth by uncertainty quantification :

These models will get tied together via a semantic web architecture, which will link to the earth sciences ontology of SWEET.

The following figure is a snapshot of a prototype that guides the generation of an environmental model or environmental model artifacts.

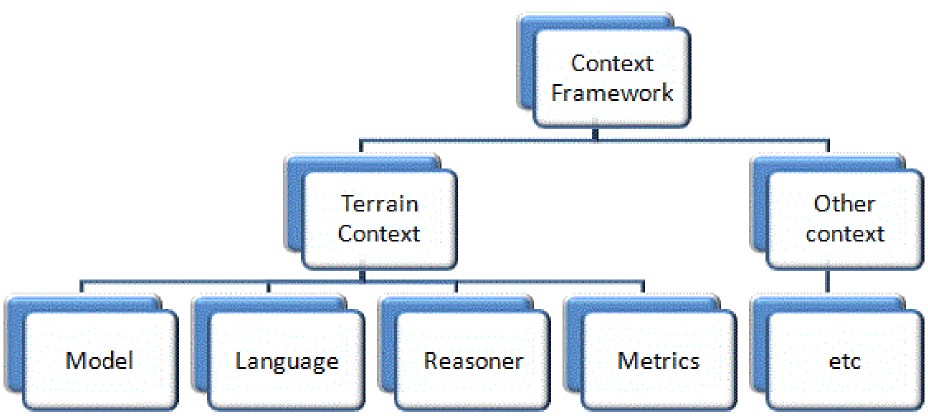
Probability Elements :: Domain Format Characteristic Values Results



1. **Domain:** select the context modeling domain and the main feature to model from that domain
2. **Format :** depending on the domain context select a specific format to express that model in, i.e. graph, table, FMU code, etc.
3. **Characteristic :** narrow down on the probability or stochastic characteristic of that model
4. **Values :** depending on the nature of the model, select range constraints, parametric values, or semantic relationships to existing geo-spatial knowledge (options not shown)

This meta-pattern for generating models will be repeated for other context modeling categories.

Organization



Dispersion Characterization

A white paper is in the works called "Characterizing diffusive growth by uncertainty quantification".

Attached is a draft version: diffusive_growth.pdf

Environmental Model Artifacts

- Metrics
- Charts and Graphs
- Diagrams

Metrics

...

Charts and Graphs

...

Diagrams

...

Probability Elements

A white paper is in the works called "Stochastic Analysis for Context Modeling".

Attached is a draft version: stochastic_analysis.pdf

Terrain Spectroscopy

A white paper is in the works called "Unified characterization of surface topography for vehicle dynamics applications".

Attached is a draft version: terrain_characterization.pdf

Thermal Dispersion

Thermal models are divided into localized effects featuring conduction and convection behaviors and nominal climate models which create a passive environment. See Dispersion Characterization for the former.

Design Example

The attached PDF file XV-Thermal-Manag-forMETA-v4b-11.Aug.11.pdf and forwarded email gives an example of a vehicle cooling system model sugegsted for our context work. So in this case we will likely provide an external environment context (nominal/extreme ambient temperatures, solar insolation, etc) for the vehicle.

Temperature Records

For Camp Lejuene, the Wilmington site and the Morehead City site are equally close from the NWS records.

http://www.erh.noaa.gov/

The historical data at the Wilmington location is in a PDF file, so we have to dig the parameters out manually. The Morehead City page had a slot but no data. Baltimore had a text file. This is called “unique local data”.

See the attachments for the difference between Baltimore (for Aberdeen Proving Ground) and Wilmington (for Camp Lajeune). These are expected value models taken from National Weather Service records. I would describe it as a nominal model, and will give the “normal” temperature that a weather forecaster would provide for any calendar date and time-of-day. It doesn’t provide statistical moments. This includes a prototyped function on the last sheet. The input is in days since the first of the year, so noon on January 1st would be input as 0.5. Noon on the last day of the year would be 364.5.

Some of the non-uniformity in reporting is being addressed by NOAA, and they have recently deployed the U.S. Climate Reference Network to streamline the reporting:

http://www.ncdc.noaa.gov/crn/

On our team we have the maintainer of a uniform oceanography data set, Thomas Huang, and he has some good ideas on how to pull this data together.

http://podaac.jpl.nasa.gov/dataaccess

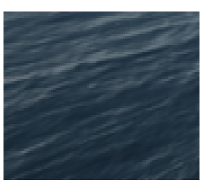
We are set to create a semantic architecture that uses geospatial reasoning to pull in appropriate data. The geospatial functionality is very useful for inferring information. For example, say that temperature statistics are not known for a particular area, but data from nearby locations is available. A geospatial engine can aggregate and select data from weather stations in close proximity and use that to interpolate the statistics.

daily_temperature_baltimore.xlsx

Prototype

This is a screenshot of a prototype for generating artifacts and code.

Wave Energy Statistics



Data Sources

- [Coastal Data Information Program](http://cdip.ucsd.edu/)
  This has information for coastal engineers and scientists. An example of a query
  Main Menu: http://cdip.ucsd.edu/?nav=historic&sub=data&units=metric&tz=UTC&pub=public&map_stati=1,2,3
  Around San Diago: http://cdip.ucsd.edu/?nav=historic&sub=map&units=metric&tz=UTC&pub=public&map_stati=1,2,3&xmap_id=9
  Santa Cruz Island: http://cdip.ucsd.edu/?nav=historic&sub=data&units=metric&tz=UTC&pub=public&map_stati=1,2,3&stn=182&stream=p1
  Select Interactive Spectral / Energy Spectrum from the selector box, this gives a PSD
  http://cdip.ucsd.edu/?nav=historic&sub=data&units=metric&tz=UTC&pub=public&map_stati=1,2,3&stn=182&stream=p1&xitem=product25&xyrmo=201206&xwait=2

- US Army Corps of Engineers Wave Information Studies

This data consists of flat files for the coastal USA and the Great Lakes

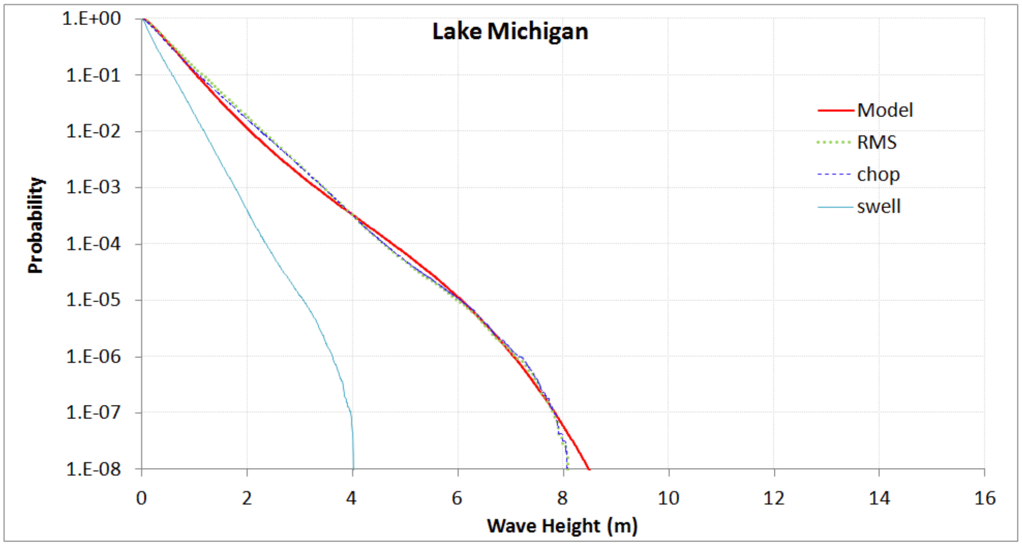
Properties

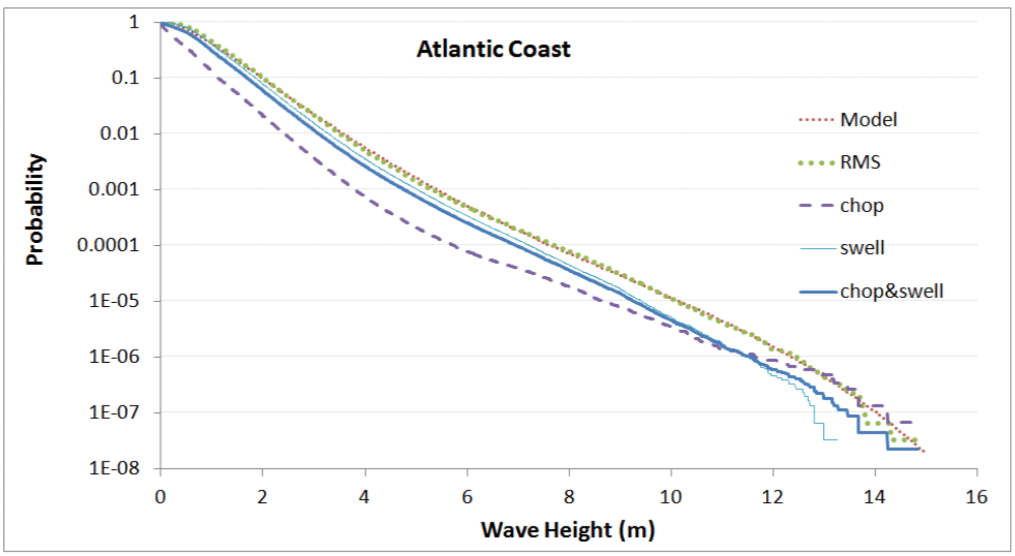
This is a sea-state classification table. The grayed column is dependent on the distribution of the wave height for a particular location. Lakes will be less rough than oceans, in general, so will have different probability transitions.

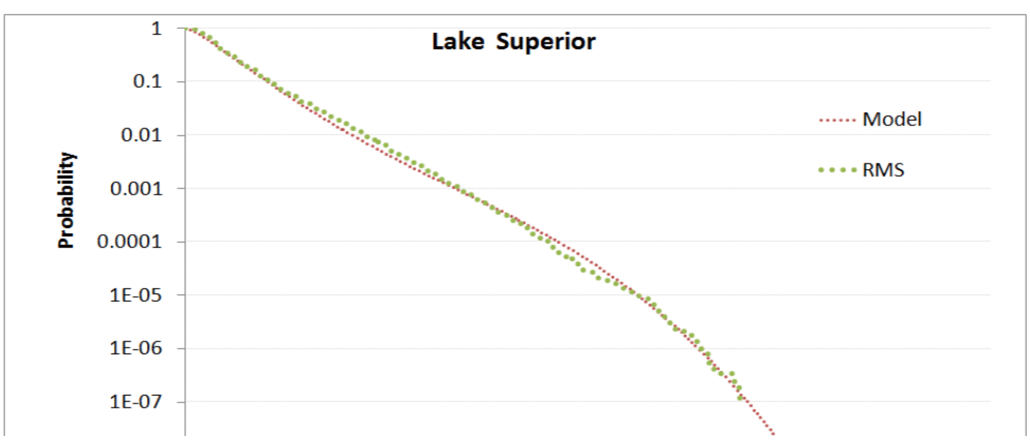
WMO Sea State Code	Wave Height (meters)	Probability	Characteristics
0	0	**0**	Calm (glassy)
1	0 to 0.1	**0.7**	Calm (rippled)
2	0.1 to 0.5	**6.8**	Smooth (wavelets)
3	0.5 to 1.25	**23.7**	Slight
4	1.25 to 2.5	**27.8**	Moderate
5	2.5 to 4	**20.64**	Rough
6	4 to 6	**13.15**	Very rough
7	6 to 9	**6.05**	High
8	9 to 14	**1.11**	Very high
9	Over 14	**.05**	Phenomenal

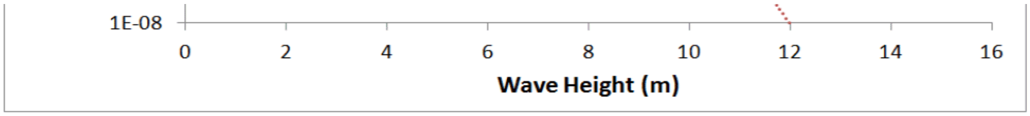
Analysis

We took a deep analysis of three regions from the Army's wave information data source, the eastern seaboard of the Atlantic coast, along with Lake Michigan and Lake Superior. These all fit a model following a BesselK distribution subject to crest height and ocean depth interactions. (See the white paper on stochastic modeling)

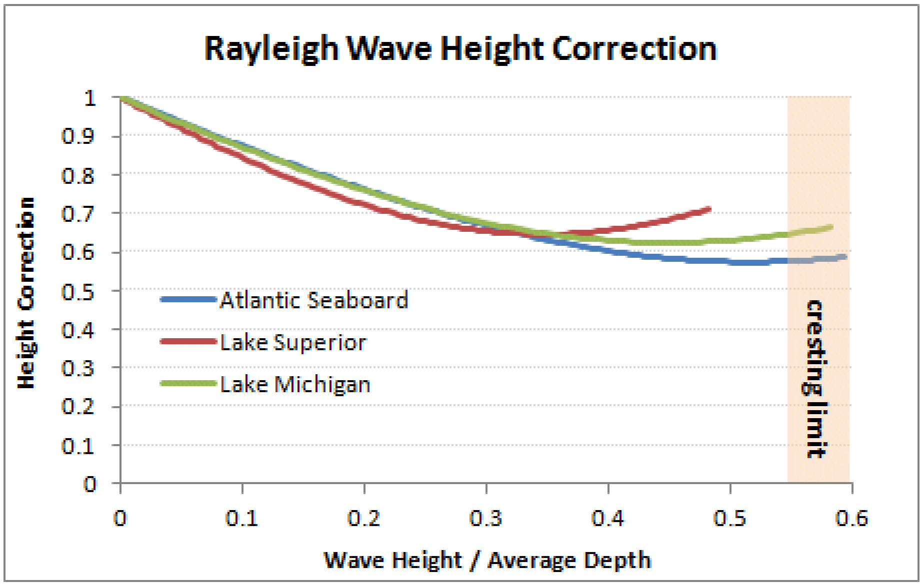

Lake Michigan
Model
RMS
chop
swell
Probability
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
0
2
4
6
8
10
12
14
16
Wave Height (m)


Atlantic Coast
Model
RMS
chop
swell
chop&swell
Probability
1
0.1
0.01
0.001
0.0001
1E-05
1E-06
1E-07
1E-08
0
2
4
6
8
10
12
14
16
Wave Height (m)

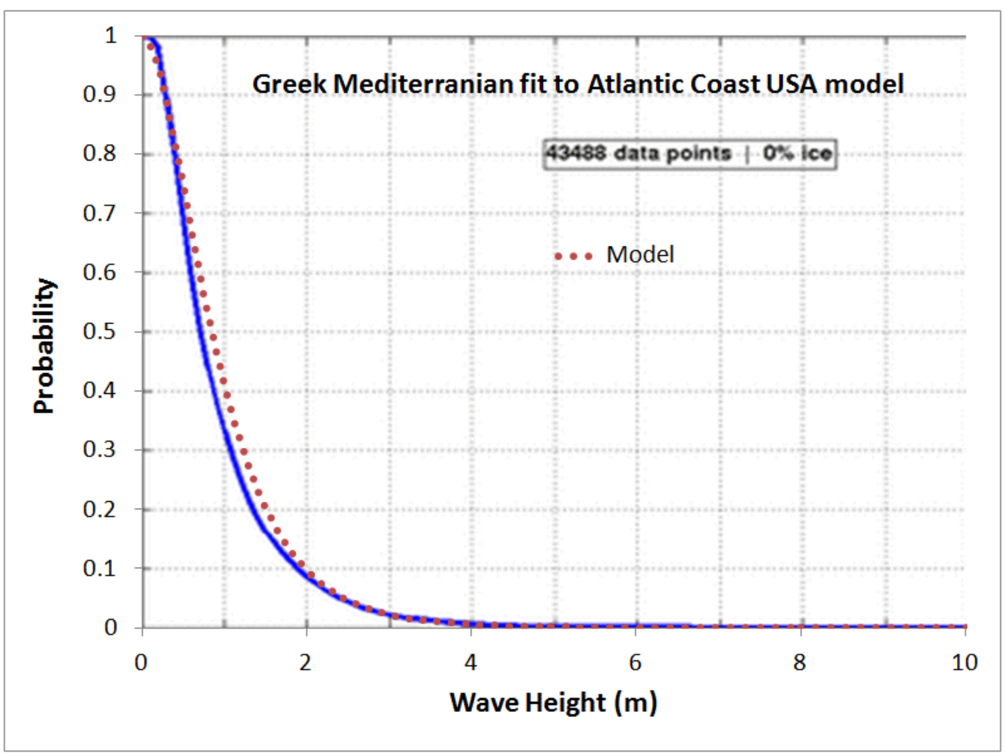

Lake Superior
Model
RMS
Probability
1
0.1
0.01
0.001
0.0001
1E-05
1E-06
1E-07



The correction factor appears universal across the regions as plotted below.



We can thus extrapolate the model to other regions across the earth and find a reasonable fit. The plot below is a fit of sea state distribution off the coast of Greece using the Atlantic seaboard model



Wind Energy Statistics

Intro

The foundation for this work is described in the Probability Elements white paper.

Data Sources

- Bonneville Power Administration
  This contains several sites spread around Oregon and Washington state.
- Ontario IESO
  Hourly wind generator output spreadsheet, latest : http://www.ieso.ca/imoweb/pubs/marketReports/download/HourlyWindFarmGen_20120615.csv
  Historical CSV file, 04/30/2010
- German Wind Farm Data
  Hourly data which substantiates the Ontario set, spreadsheet