Implementation of IMPEx at CCMC

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Outline

- Objective
- SPASE Overview
- IMPEx Overview
- Progress

Objective

- Re-architecture of the CCMC run-on-request database
  - Provide a hub for the community to easily search and obtain simulations data for their own research
  - Interconnect the compare simulations from scientific models with observation data

The Space Physics Archive Search and Extract (SPASE)

- The SPASE effort is a Heliophysics community-based project with the goals of:
  - **Facilitating data search and retrieval** across the Space and Solar Physics data environment with a common metadata language
  - Defining and maintaining a **standard Data Model** for Space and Solar Physics **interoperability**, especially within the Heliophysics Data Environment
  - Using the Data Model to create data set descriptions for all important Heliophysics data sets
  - Providing **tools and services** to assist SPASE data set description creators as well as the researchers/users
  - Working with other groups for other Heliophysics data management and services coordination as needed
- Three products:
  - SPASE Metadata Model
  - Set of Services and protocols to enable the exchange of information
  - Tools for developing and validating resource descriptions
- http://www.spase-group.org/

Problem?

- SPASE data model is used to describe data coming from observations of space physics domain
- What about simulations?

Integrated Medium for Planetary Exploration(IMPEx)

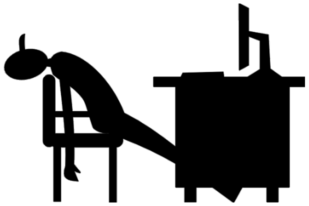
- The SPASE Simulation Extensions developed by the IMPEx project, a European Union (EU) Seventh Framework Programme sponsored project
- Describing simulations and related generated data
- http://impex-fp7.oeaw.ac.at/home.html

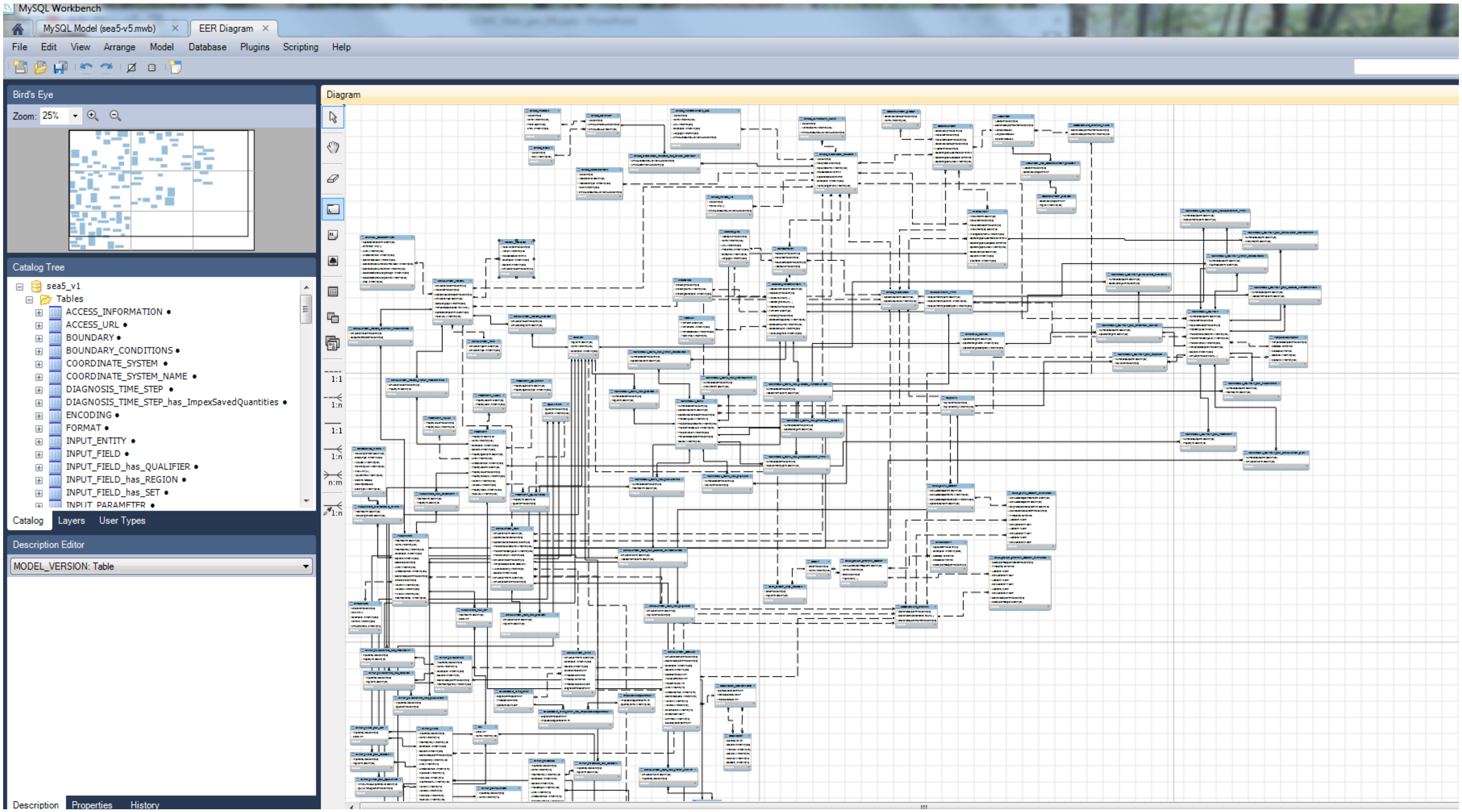
IMPEx Simulation Data Model (v.1.0.3)

- Metadata for simulation run and output dataset
- 4 level of metadata related to simulation results:
  - File: basic information about a data file that is part of a dataset
  - Dataset: what do the data represent? Under which form?
  - Simulation Run: Description of the run including the inputs
  - Simulation Model: description of the model
- Simulation data maybe searched in 2 ways:
  - From the simulation inputs
  - By the simulation outputs

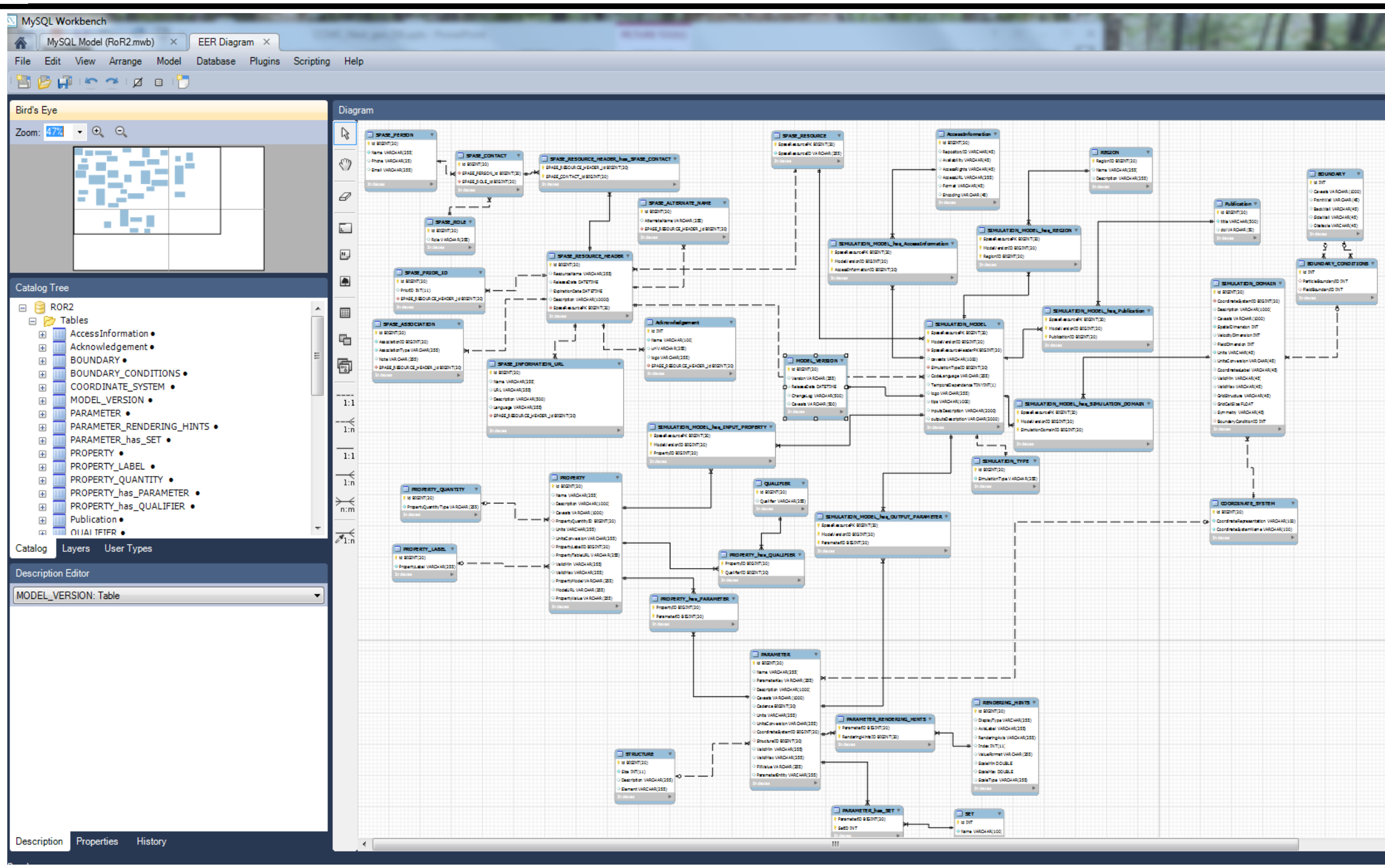
IMPEx Simulation Data Model (v.1.0.3)

- XML Schema:
  - http://impex-fp7.oeaw.ac.at/xsd/doc/1_0_3/index.html
  - http://impex-fp7.oeaw.ac.at/xsd/doc/1_0_3/impex-1_0_3.pdf (300+pages)
- Challenge:
  - No easy task to translate the schema to an actual database design
  - Very comprehensive schema but will it work for us?

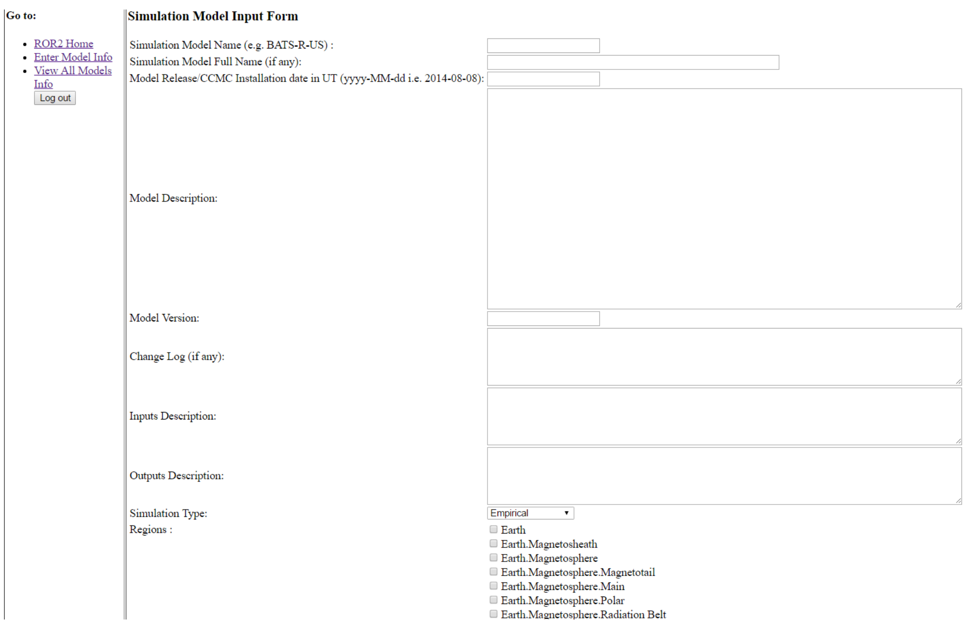



MySQL Workbench
MySQL Model (sea5-v5.mwb)
EER Diagram
File
Edit
View
Arrange
Model
Database
Plugins
Scripting
Help
Bird's Eye
Zoom: 25%
Diagram
Catalog Tree
sea5_v1
Tables
ACCESS_INFORMATION
ACCESS_URL
BOUNDARY
BOUNDARY_CONDITIONS
COORDINATE_SYSTEM
COORDINATE_SYSTEM_NAME
DIAGNOSIS_TIME_STEP
DIAGNOSIS_TIME_STEP_has_ImpexSavedQuantities
ENCODING
FORMAT
INPUT_ENTITY
INPUT_FIELD
INPUT_FIELD_has_QUALIFIER
INPUT_FIELD_has_REGION
INPUT_FIELD_has_SET
INPUT_PARAMETER
Catalog
Layers
User Types
Description Editor
MODEL_VERSION: Table
Description
Properties
History

Simulation Model: Description of the model



User Interface to Enter Simulation Model



- UI to enter simulation model info into the database
- Unique resource ID generated using model name and version (ex: ccmc://Model/AMOS/v1/Info)

User Interface to View Simulation Model

DBM (cdbm_201510) [Add New Version]

drag-based model with constant solar wind speed

Model Description (Edit)

The Drag-Based Model (DBM) tool provides prediction of the interplanetary coronal mass ejection (ICME) expansion and its prediction of arrival at arbitrary location (or preselected planet or satellite) in the ecliptic plane. The calculation is based on the assumption that the dominant magnetohydrodynamical force exerted upon ICME in interplanetary space is equivalent to the aerodynamic drag (for details see Vršnak et al., 2013, and references therein). The model is based on the additional assumption that the background solar wind is approximately stationary and isotropic, where its speed w is always constant (Vršnak et al., 2007). In that case, immediately follows that the drag-parameter γ is constant as well. Finally, for a given set of input parameters the model provides the ICME Sun-"target" transit time, the arrival time, and the impact speed (Vršnak et al., 2007).

The web-tool is divided into the basic and advanced form. The purpose of the basic form is to predict the radial heliocentric ICME propagation, the arrival time at and the impact speed on preselected "target" in the ecliptic plane (the position R(t) and velocity v(t) in time plots are coupled together with the numeric results). Additionally, the advanced form of DBM produces the similar output for the selected target in the ecliptic plane, however the shape of ICME is taken into account and employed to, so-called, the cone-geometry (see example in Appendix of Žic et al., 2015).

In this option the CME geometry is preserved and the CME propagates in self-similar manner, i.e. the CME leading edge expands proportionally with the radial distance.

Model Inputs Description

CME take-off date: The date of CME take-off (when CME tip is located at radial distance R0)
CME take-off time: The time of CME take-off in UTC (when CME tip is located at radial distance R0).
γ: The constant drag-parameter value γ (in ×10-7 km-1). The valid values for the drag parameter are in between: 0.1 ≤ γ ≤ 100.
w: The constant solar wind speed w (in km/s) could be determined by expected solar wind speed at 1 AU. The valid values for solar wind speed are in between: 200 km/s ≤ w ≤ 800 km/s.
R0: Starting radial distance of CME (in solar radii units, rSun) is the distance of CME tip in coronagraph image on today's date or arbitrary selected date. Valid values are: 1 rSun ≤ R0 ≤ 214 rSun.
v0: The speed v0 = v(R0) in km/s is the speed of CME tip located at R0. Valid values are: 50 km/s ≤ v0 ≤ 5000 km/s.
ω (advanced): CME's angular half-width ω (in deg) is based on coronagraphic observation. Valid values are: 0° < ω < 90°.
φCME (advanced): Longitude of source region is CME propagation direction determined on observation of eruptive phenomena on the solar disc at low-heliographic latitudes (in deg). Valid values are between -180° < φCME < 180°.
Target: The target can be selected from the given list (Mercury, Venus, Earth, Mars, STEREO-A or STEREO-B satellite) or target position could be entered manually, providing the distance Rtarget (in astronomical units, AU) and the Earth-target heliocentric angular separation φtarget (in deg). Valid values are: R0 ≤ Rtarget ≤ 50 AU and -180° < φtarget < 180° .

Model Outputs Description

The general DBM tool is basically focused on the ICME arrival forecasting to Earth position (Žic et al., 2015, see Appendix), although it can be generally used for the estimation of the ICME propagation in the complete ecliptic plane. Therefore, from the input values the basic option calculates: the date and time of the CME arrival at preselected (or entered) target position, transit time (i.e. the ICME travel-time to target position) and the ICME impact speed on preselected target. Furthermore, the heliocentric R(t) and v(t) plots are created from the DBM calculation.

On the other hand, the advanced option, using additional ω and φCME parameters and the cone-geometry, estimates the same ICME impact parameters and the kinematic R(t) and v(t) plots as the basic option, however in addition animates the time-dependent ecliptic ICME expansion in the form of schematic movie.

Model Caveats

A constant drag parameter (γ) and asymptotic solar wind speed (w) is used. Model is 2D (ecliptic plane). CME is symmetric.

Change Log

speed up in calculations and minor graphics changes

Simulation Type: ***Physics-based***

Temporal Dependence: ***true***

Regions:

Heliosphere
Heliosphere.Inner
Heliosphere.Near Earth
Heliosphere.Outer

Contacts (Add Contact) :

M. Leila Mays, CCMC Contact (Edit)
Tomislav Žic , Developer Contact (Edit)
Bojan Vršnak, Model Developer (Edit)
Tomislav Žic , Model Developer (Edit)

User Interface to View Simulation Model

Acknowledgement (Add Acknowledgment) :

List of Model Inputs (Add Input) :

Name	Description	Caveats	Units	Property Table URL	Valid Min	Valid Max	Default Value	From Model	Model Info URL	
CME angular half-width, omega (ω)	CME's angular half-width in degrees (?). Valid between 0 and 90 degrees.		degrees		0	90	30			Edit
CME longitude, phi (φ)	CME/source region central meridian distance, phi (?) (CME longitude). Valid between -180 to 180 degrees. 0 degrees is the Sun-Earth line. DBM using cone-geometry estimates ICME impact parameters, kinematic plots and produces the time dependent cone-geometry animated plot based on phi together with the half angular width (omega).		degrees		-180	180	0			Edit
CME take-off date and time	CME start date, allowed format: DD-MM-YYYY (DD - days from 01 to 31, MM - months from 01 to 12, YYYY - years from 1900 to 2049). CME start time (UTC), allowed format: hh:mm (hh - hours from 00 to 23, mm - minutes from 00 to 59).		UT date time		01-01-1900	01-01-2049				Edit
Constant asymptotic solar wind speed (w)	Constant value of asymptotic solar wind speed, w. Unit: km/s, allowed format: number in range from 200 to 800.		km/s		200	800	450			Edit
Constant drag parameter gamma (γ)	constant value of drag parameter gamma (?) units: 10-7 km-1 number in range from 0.1 to 100.		1e-7 km-1		0.1	100	0.2			Edit
Starting radial distance of CME (R0)	R0 - starting radial distance of CME, unit: Rs (Solar radius), allowed format: number in range from 1 to 214.		Rs (Solar radius)		1	215	20			Edit
Starting radial speed of CME (v0) at starting radial distance (R0)	v0 - speed of CME at R0, unit: km/s, allowed format: number in range from 50 to 5000.		km/s		50	5000	1000			Edit
Target	Target from preselected list: Mercury, Venus, Earth, STEREO A, STEREO B, Mars. DBM calculates the date and time of CME arrival, its transit time and impact speed for the selected target, and also gives heliocentric v(R) and R(t) plots.						Earth			Edit
target heliocentric distance (Rtarget)	Rtarget - target heliocentric distance, unit: AU, allowed format: number in range from 0.01 to 50. DBM calculates the date and time of CME arrival, its transit time and impact speed for this target distance, and also gives heliocentric v(R) and R(t) plots.		AU		0.01	50	1			Edit
target heliocentric distance (Rtarget)	Rtarget - target heliocentric distance, unit: AU, allowed format: number in range from 0.01 to 50.		AU		0.01	50	1			Edit

List of Model Outputs (Add Output)

Name	Description	Caveats	Units	Valid Min	Valid Max	Fill Value	
CME arrival time at target/distance	CME arrival time at selected target or heliocentric distance in UT date time.		UT date time				Edit
CME distance vs. time plot	CME distance vs. time plot						Edit
CME geometry animated plot	Time dependent CME cone-geometry animated plot in the ecliptic plane.						Edit
CME impact speed	CME impact speed at selected target or heliocentric distance in km/s.		km/s				Edit
CME speed vs. heliocentric distance plot	CME speed v vs. heliocentric distance R plot - v(R)						Edit
CME transit time	CME transit time to selected target or heliocentric distance in hours.		hours				Edit

Relevant Links (Add link) :

Development Site: http://www.geof.unizg.hr/~tzic/dbm.html (Edit)
Official site: http://oh.geof.unizg.hr/DBM/dbm.php (Edit)
Detailed Description of Model: http://ccmc.gsfc.nasa.gov/models/CDBM_info.pdf (Edit)

Publications (Add Publication) :

CCMC Service Available (Add Access) :

Web Service Interface

- **Web service** call to get a **SimulationModel** Object with all the info about a simulation model: ***http://kauai.ccmc.gsfc.nasa.gov/ROR2/WS/get/ModelInfo?SpaseResourceID=(the unique SpaseResourceID for the model info)***
  *note: the parameter **'SpaseResourceID'** is required. All simulation models have a unique ID assigned to them, and this ID is needed to get info about it.*
  example: ***http://kauai.ccmc.gsfc.nasa.gov/ROR2/WS/get/ModelInfo?SpaseResourceID=ccmc://Model/DBM/cdbm_201510/Info***
- **JSON object** returned by the call:
  long spaseResourcePK, long modelVersionID, String caveats, String codeLanguage, String logo, Boolean temporalDependence, String tips, String inputsDescription, String outputDescription, SpaseResourceHeader spaseResourceHeader, SpaseResource spaseResource, ModelVersion modelVersion, SimulationType simulationType, List<SimulationDomain> simulationDomains, List<Publication> publications, List<Region> regions, List<Accessinformation> accessinformations, List<Property> inputProperties, List<Parameter> outputParameters

What's Next?

- Continue testing and modifying our current database design based on user feedback and needs
- New Instant-Run interface utilizing the simulation model info (list of all inputs) and the web service API
- Continue adding to the database model to support simulation runs and simulation results
- Expending web service API depending on user feedback and needs