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Workflows for Propagation Models in Heliophysics

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The Sun is responsible for Coronal Mass Ejections: events that can be damaging to our technological infrastructure, therefore there is an effort to understand the cause of these eruptive events and how they propagate from Sun to Earth. As the physics governing their behaviour is still not well understood, there is a need to develop a theoretical description of their propagation, these are known as a Propagation Models.

It is often difficult to define a single propagation model capable of correctly describing the physics of these events, and it is even harder to implement it in a reliably and precisely, finally the validation using real observational data is often challenging on its own.

We envisage that workflows can offer viable solutions to overcome the theoretical and practical difficulties in studying, designing, implementing and validating propagation models. Accordingly, in the ER-FLOW project, we have developed workflows that can be used by the users as "building blocks"to implement models that accommodate their research requirements.

Wider impact and conclusions

The "building block"workflows developed in the TAVERNA language offer a user-friendly approach to invoking the HELIO web services and to filter and sort the data they returned.

The workflow-based approach to propagation models has proven very effective and the building blocks have already been used to implement real science cases. We expect an even wider impact by offering easy-to-use and intuitive GUIS to the workflows within the SCI-BUS project.

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URL(s) for further info

HELIO - http://www.helio-vo.eu
ER-FLOW - https://www.sci-bus.eu
SCI-BUS - https://www.erflow.eu
TAVERNA - http://www.taverna.org.uk
myExperiment - http://www.myexperiment.org/
SHIWA - https://www.shiwa-workflow.eu
SHIWA Repository –http://shiwa-repo.cpc.wmin.ac.uk

Description of work

First, we identified 4 main usage scenarios for propagation models:
(1) Manual: where users are in charge of selecting parameters and to validate the results of the model.
(2) Assisted: where part or all the execution parameters are automatically extracted from existing catalogues of solar events.
(3) Validated: where the execution is performed in a parameter sweep fashion and the results are validated by querying existing catalogues of events at the target locations.
(4) Iterative: where the model is iteratively executed until a certain condition is obtained.
Based on these scenarios, we have defined a mathematical framework capable of encompassing them and designed workflows for execution and testing.
To design the workflows, we took into account that a previous FP7 project (HELIO) left a rich legacy of web services and workflows written in the TAVERNA language; we analysed what was already available in TAVERNA and developed new workflows of the following types:
(a) Building blocks. Simple operations that invoke one or two HELIO Web Services.
(b) Propagation Models. Meta workflows that implement the different usage scenarios of propagation models, and
(c) Science Cases. Real science use cases to test the usability of the building blocks.

To achieve workflow interoperability and to support users that may want to adopt languages other than TAVERNA, we are using another workflow language and an Interoperability platform (SHIWA).

We develop the building blocks both in TAVERNA (publishing them in myExperiment) and in WS-PGRADE (publishing them in the SHIWA repository), then we developed the different use cases of the Propagation Models as Meta Workflows made of two layers: a WS-PGrade layer that orchestrates the execution of smaller TAVERNA workflows (Building Blocks). We have also developed 1 Science Case for testing with TAVERNA and we are currently completing two more Science Cases.

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