



COSTA Update

Newsletter from the COSTA project

March 2006

The COSTA project is on schedule. The outlines of the COSTA standard are now fixed and an initial implementation is almost finished. A validation study with RIKZ's surface-flow simulation package WAQUA/ TRIWAQ has shown the validity of the basic concepts with respect to the handling of observations. And a fruitful cooperation has been established with the DATools project by WL|Delft Hydraulics.

The COSTA project is now moving into a new phase, focusing on consolidation, refinement and validation of what has been developed. This phase can only be a success if an active user-community can be established. Plans for this are underway.

In this newsletter you will be updated about the work that has been done and the plans for the near future.

Recent developments

Definition and implementation of the Model component and the Observations component

Broadly speaking, COSTA brings together three distinct parts: a mathematical model, observations and a data-assimilation method. The latter can be provided by COSTA, but the first two must be provided by the COSTA user. To establish interaction between the model, the observations and the data-assimilation method, a definition is needed of the interaction structure.

COSTA defines operations through which it will interact with the model and the observations. For example, the model must be able to deliver a state-vector and accept modified forcings. With respect to the observations, COSTA software must be able to select particular observations and to obtain meta-information about them (units, location, timestamp, uncertainty).

A model(implementation) that provides the required COSTA operations is called a *Model component*. The term component is central in the design of COSTA. Components are the building blocks from which data-assimilation methods are constructed. Components are similar to classes in object-oriented languages. There can be *multiple instances* of a component and all data is hidden inside them. The set of methods that is defined for a component to export and manipulate its internal data is called the *interface*. Note that the object-oriented terminology does not imply that COSTA is restricted to object-oriented languages. In fact, the cur-

rent implementation is available for C and Fortran.

Model components are provided by COSTA users. They write interface operations for their model either directly or through the use of COSTA building blocks. For observations, it will usually not be necessary to explicitly create the necessary components: COSTA comes with a default implementation based upon an observation repository (database) in SQLite. A simple conversion of the observations from their own format to an SQLite format will suffice. However, the user is free to reprogram the observation components if necessary.

A preliminary specification of the Model component and the components involved in handling observations is available from the COSTA website at www.costapse.org.

Collaboration with WL | Delft Hydraulics

A pleasant and fruitful collaboration has been established between COSTA and the developers of the data-assimilation package DATools at WL | Delft Hydraulics. The DATools toolbox will include for example Ensemble Kalman, or Particle filters that can be used in combination with any simulation software package and application by using the standard Published Interface or OpenMI coupling.

The collaboration focuses on sharing concepts and experiences, which is expected to lead to improved design and a more efficient development cycle of both systems. One of the results of this collaboration is the common interface design of the stochastic-observer and observations description component.

A manual that provides guidelines for extending a deterministic model to a stochastic model from the modeling point of view has been written by data assimilation experts of WL | Delft Hydraulics. This manual gives a general description and uses three different models for illustration. This manual will be part of the COSTA documentation.

Implementation of an RRSQRT Kalman filter

The first data-assimilation method that is available in COSTA is the RRSQRT Kalman filter, developed by Martin Verlaan and Arnold Heemink. This choice was obvious as it is also the method now used for WAQUA/TRIWAQ, the first test-case for COSTA.

The filter uses a reduced-rank approximation of the covariance matrix. This saves both a huge amount of computing time and an enormous amount of memory.

Application to WAQUA/TRIWAQ

RIKZ has shown a warm interest in COSTA as it promises to make data-assimilation available for a wide range of models used within Rijkswaterstaat. The Open Source nature of COSTA also fits in well with the current policy of Rijkswaterstaat.

Therefore they have opted for WAQUA/TRIWAQ to be the first application for COSTA. The handling of observations in WAQUA/TRIWAQ has been reconstructed on the basis of the COSTA framework.

This effort has had two very beneficial effects. On the one hand the validity of the basic concepts of COSTA observation components has been established, strongly enhancing the confidence that COSTA will eventually live up to the expectations. Secondly, the implementation has been extended and consolidated in order to make everything work.

Plans for the near future

Now that the first implementation is nearly ready, the time has come to apply COSTA to real-world problems and make it grow by experience.

Continuation of the work on WAQUA/TRIWAQ

The work on WAQUA/TRIWAQ that was started last year will be continued. WAQUA/TRIWAQ will be turned into a COSTA Model component and coupled to the RRSQRT filter that is available in COSTA. This will be the first complete, real-life application for COSTA. Experiences from this effort will be used to improve the design and implementation of COSTA.

The COSTA Website

A new version of the COSTA website has been put online at www.costapse.org. COSTA software will be delivered through this site by the end of 2006. A forum will be established for users to share their experiences.

Further plans for setting up the organization around COSTA as an Open Source project are now being discussed. Common facilities like a bug-database and a CVS repository are considered. One option is to use the sourceforge framework, but other options are still open. You will be informed as soon as any final decisions have been made, but you are also cordially invited to provide your own ideas.



Presentation at CMWR

In June COSTA will be presented to an international audience at the CMWR conference in Denmark. A preprint of the paper is available at the COSTA website.

Improved documentation

Documentation of COSTA is still rudimentary. Definition documents have been created that specify the COSTA interfaces, but they are not yet well suited for users and developers.

A extensive getting-started manual will be written to assist new users in their first dealings with COSTA. This will be supported by a range of example programs to illustrate the concepts. These programs can also be used as a basis for programmers to write their own applications.

Real-world testcases

The COSTA project offers active support for new users who want to start with COSTA. This active involvement in user projects is not only aimed at stimulating the use of COSTA, but also provides us with an opportunity to learn how COSTA can be improved.

We will also be seeking cooperation with developers of data-assimilation methods to write their software in the COSTA framework. Using COSTA should save the developers time (because they can use the COSTA components as a basis) and also enhance the usability of their software for various applications.

Keep in touch

If you have not yet joined the COSTA mailing list, you can do so at www.costapse.org. The site also has a news-page where important events are listed.

Right now, COSTA software is not yet distributed through the website as it is not quite ready for word-wide distribution. If you are interested to experiment with the code as it is now, you can contact the COSTA project through the reaction form on the COSTA website.