THE CASH PROJECT

Seyler Frédérique [(1)], Bonnet Marie-Paule [(1)], Calmant Stéphane [(2)], Cauhopé Mathilde [(2)], Cazenave Anny [(2)], Cochonneau Gérard [(1)], Divol Jacques [(3)], Do-Minh Kien [(2)], Frappart Frédéric [(2)], Gennero Marie-Claude [(2)], Guyenne-Blin Karine [(3)], Huynh Frédéric [(3)], Leon Juan Gabriel [(1)], Mangeas Morgan [(3)], Mercier Franck [(4)], Mercier Caroline[(2)], Rocquelain Gilles [(5)],Tocqueville Laurent [(5)], Zanifé Ouan-Zan [(4)]

[(1)]LMTG (IRD/CNRS/UPS) 14 av.Edouard Belin 31400 Toulouse, FRANCE
[(2)]LEGOS (CNES/IRD/CNRS/UPS) 14 av.Edouard Belin 31400 Toulouse, FRANCE
[(3)]ESPACE (IRD) Maison de la Télédétection, 500 rue Breton, 34093, Montpellier, FRANCE
[(4)]CLS, 8-10 rue Hermes, Parc Technologique du Canal, 31526, Ramonville St Agne, FRANCE
[(5)]BRL Ingénierie, 1105 rue Pierre Mendes-France, 30001, Nimes cedex 5, FRANCE

ABSTRACT/RESUME

CASH « Contribution of spatial altimetry to hydrology » aims at the definition of a global, standard, fast and long term access to a set of hydrological data concerning the greatest river basins in the world. The key questions to be answered are: what are the conditions for monitoring river water stages from altimetric radar data and how is it possible to combine altimetric data with other spatial sources or/and in-situ data in order to deliver useful parameters for hydrology community, both scientific and end users. The CASH project is ending mid-May of 2006 and there is yet a lot of tasks to be performed for altimetric heigths of continental water bodies becoming part of the scientific and end-users hydrologists day-to-day practice. The project has nethertheless delineated the way this use could be improved in a near future, and opened very interesting perspectives for ungauged or poorly gauged great basins in the world.

1. INTRODUCTION:

CASH « Contribution of spatial altimetry to hydrology » is a project funded by the French Ministry of Research (Réseau Terre et Espace). The coordinator of the project is IRD (Institut Français de Recherche pour le Développement) and the industrial partners are CLS (data supply from satellite-based systems for studying and monitoring the environment) and BRLi (consultant in water and the environment). The scientific teams involved are LEGOS (altimetric and geodesic data processing and interpretation), LMTG (hydrology and geodynamic of the great river basins, in particular the Amazon basin), and ESPACE (remote sensing, reception station network and decision support systems).

2. OBJECTIVE:

The first goal of the project was to assess the ability of radar altimetry to determine the elevation of continental water bodies. It was then to define the scientific and technological environment necessary to use these altimetric elevation in complement of existing in-situ gauging network; in some cases altimetric data could even be used in substitution of some distant gauges, delivering in several months unprecise or irregular data, or of gauges that have swiched off. The target was therefore the definition of a global, standard, fast and long term access to a set of hydrological data concerning the greatest river basins in the world.

The key question to be answered by this project is: Are altimetric radar data able to monitor river water stages; the answer involves the subsequent points:
- The study of the precision of the data and its physical parameter,
- The validation of altimetric data against in-situ measurements,
- What kind of development is necessary to improve the data,
- How is it possible to combine altimetric data with other spatial sources or/and in-situ data in order to deliver useful parameters for hydrology community, both scientific and end users.

3. STAKES:

The first interest at stake is the global monitoring of water resources, which is evidently a major issue for the future. It is worthwhile noting that the context of the global monitoring of water is the reduction of the number of in situ measurement gauges, in particular in developing countries, where are located most of the great rivers in the

world. In these countries are also located most of the major water related risks: drought (example: Africa), floods (example: South-East Asia), over-use of ground water for irrigation (example: India). Very often the political context of the great river basins is that of trans-boundary basins (example: Amazon basin shared by 7 countries), which complicate the management tasks and the information gathering and sharing. This context is therefore calling for the definition of a global, standard, fast and long term access to a set of hydrological data concerning the greatest river basins in the world.

4. CASH PRODUCTS:

4.1. Altimetric elevation database

Two database have been created; they concern the water bodies of eight great basins (Amazon, Congo, Ganges, Yangtse, Parana, Lena, Mekong, and Danube).
- The first one collects water stage time series from T/P GDR (Topex/Poseidon Geophysical Data Records) river crossings (hydroweb at LEGOS, [1]).
- The second one has been built at the same locations from T/P data processed using the four ENVISAT retracking algorithms as well as geophysical/environmental corrections designed specifically for continental waters (CLS).

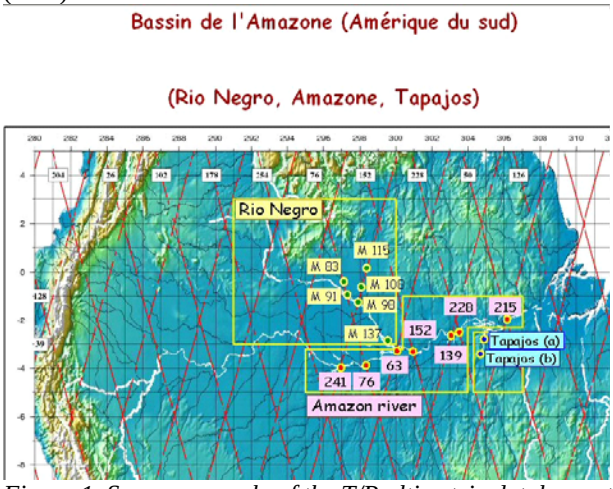

Figure 1. Screen example of the T/P altimetric database at LEGOS; from this screen, it is possible to choose an altimetric time series

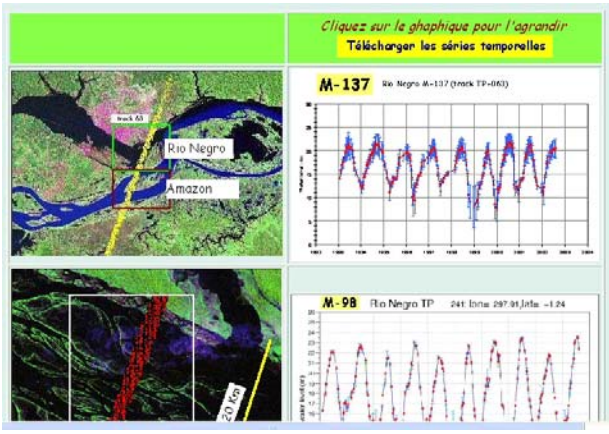

Figure 2. Other screen example of the T/P altimetric database at LEGOS; from this screen, it is possible to retrieve the chosen altimetric time series

4.2. CASH Online Demonstrator:

The CASH online demonstrator has been built for the test site of the Amazon basin. Actually, Amazon basin is a rather propitious area for the test and the development of CASH methods. LMTG is maintaining a Research Observatory of Environment for the Amazon Basin (HYBAM) labelled by the french Ministry of Research [2], thanks to a long term partnership with water institutes in several countries: Brazil, Ecuador, Bolivia, Peru, Venezuela, and Colombia. The greatest basin in the world displays a wide variety of river size and morphology. Furthermore, for a tropical rain forest basin, Amazon basin have a gauging network relatively dense to which we have a full access.

Figure 3: Screen example of the hybam database

The main task of the demonstrator is to retrieve both spatial data and in-situ data from distant database for applying in some key hydrological processing, as flow modeling for a given reach, calculation of the volume of water potentially stored in the inundation plains [3], elevation/discharge conversion at a given “virtual” gauge (or intersection between radar satellite track and river), retrieving of water height value at any point of the hydrological network by spatial interpolation between satelllite tracks including for gauge levelling, spatial interpolation conversion of elevation at virtual gauge measured each ten days (for T/P) in daily water height, design of an optimum in-situ gauge network for a given uncertainty at the virtual gauges.The CASH demonstrator is java implemented and at present the different modules are:

- ProGUM: a flow propagation model; an optimized version runs with one downstream in situ gage only and retrieves discharge corresponding to altimetric stages at each "virtual" stations [4], [5].
- Stadis: stage discharge relationship module; this module enables to retrieve the altitude of the river bed for a given "virtual" station [6].
- Satextra: temporal water elevation series constitution and validation through access to in situ and altimetric database; feeds the virtual gauges database. In the internal altimetric database of the demonstrator, virtual gauges records have exactly the same structure than that of the in situ records (HYBAM database, [7]).
- Heva: Inundation plains transfer flow model
- Altiniv: spatial an temporal interpolation tool coupled with Satextra.

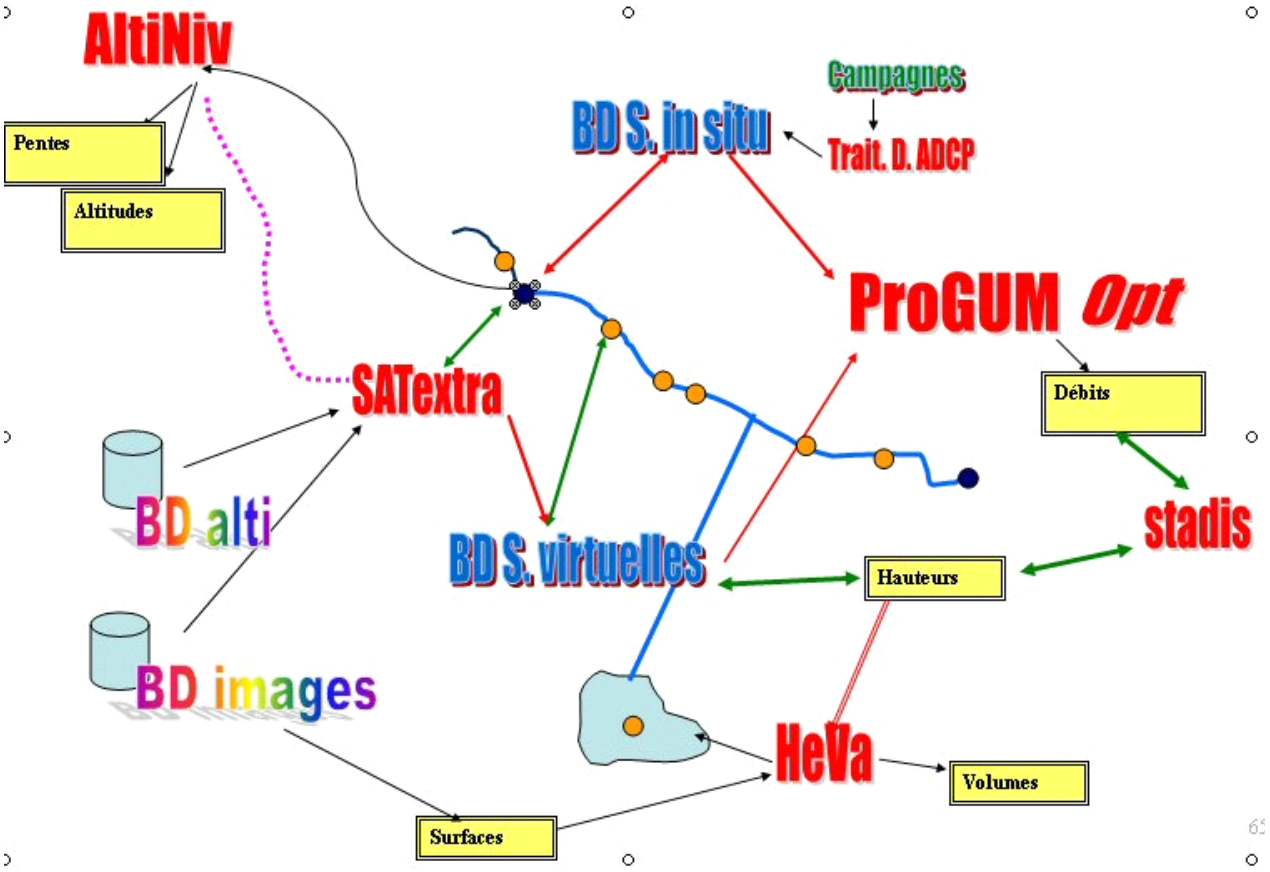

Figure 4: Database access and the different modules of the demonstator; their interactions and their products: slopes and altitude of in situ gauges (blue dots) for Altiniv, discharges from ProGUM, stage/discharge relationship and river depth from stadis, inundation zones volumes from HeVa. In situ information from the in situ database, altimetric heigths from the alti database of virtual stations (yellow dots), spatial informations from the image database.

These modules are implemented to be used from a platform built as a geographic information system (U-DIG based). The platform has online access to the in-situ database for Amazon basin. At present it performs request on an internal altimetric database whose structure is exactly copied from that of the in situ database. The access to CASH database of either LEGOS or CLS is made via ftp, as can be made access to other global database as the “river and lakes project” database at ESA.

5. CONCLUSION:

The CASH project is ending mid-May of 2006. But there is yet a lot of tasks to be performed for altimetric heigths of continental water bodies becoming part of the scientific and end-users hydrologists day-to-day practice. The project has nethertheless delineated the way this use could be improved in a near future, and opened very interesting perspectives for ungauged or poorly gauged great basins in the world.

6. REFERENCES:

1. http://www.legos.obs-mip.fr/soa/hydrologie/hydroweb/
2. http://www.ore-hybam.org/
3. Frappart F., et al. Floodplain Water Storage in the Negro River Basin Estimated from Microwave Remote Sensing of Inundation Area and Water Levels. *Remote Sensing of Environment*, Vol. 99**,** 387 – 399, 2005.
4. Leon J.G., et al. Preliminary estimations of discharges in the Rio Negro basin by the flow routing model proGUM using altimetric spatial data. *Journal of hydrology*, in revision.
5. Leon J.G., et al. Hydrological parameter estimation for ungauged basin based on satellite altimeter data and discharge modelling. A simulation for the Caqueta River (Amazonian Basin, Colombia). *Hydrology and Earth System Sciences*, in press.
6. Leon J.G., et al. Rating curves and average water depth estimation at the upper Rio Negro from altimetric spatial data and calculated remote discharges. *Journal of Hydrology*, in press.
7. http://www.mpl.ird.fr/hybam/

Acknowledgements

The CASH project was funded from the "Réseau Terre & Espace" of the French Ministry of Research and Technology (MR decision n° 04 T 131).