Notes from WATER HM Barcelona Meeting, July 25, 2007

Date of this document is July 30, 2007 with update on August 16, 2007

Meeting Attendees: Doug Alsdorf (OSU), Shannon Brown (JPL), Anny Cazenave (LEGOS CNES), Daniel Fernandez (JPL), Lee Fu (JPL), Juliette Lambin (CNES), Yves Menard (CNES LEGOS), Nelly Mognard (LEGOS CNES), Baptiste Mourre (ICM), Ernesto Rodriguez (JPL), Jean-Claude Souyris (CNES)

Invited but unable to attend: Kostas Andreadis (UW), Paul Bates (U. Bristol), Bruno Cugny (CNES), Diane Evans (JPL), Bruno Lazard (CNES), Dennis Lettenmaier (UW), Eric Thouvenot (CNES)

The purpose of the Barcelona meeting was to initiate the WATER HM Science Working Group (SWG) and to plan the inaugural meeting of the SWG. Our discussions centered on science questions, technology issues, and organization of the SWG.

Doug Alsdorf will initiate a ~10 page document that presents WATERHM and its science goals, it requirements, an explanation of why the best approach is wide-swath technology, and a description of the instrument, payload, and spacecraft. Essentially, this document will form the foundation of the SWG. The document will be designed for uppermost level managements at CNES and NASA. Lee Fu and Nelly Mognard will further edit the document with subsequent distribution to the group. The document will be used to inform the participants in the science working group and administrations at CNES and NASA. It should be finalized before the mid-September meeting of CNES and NASA HQ.

Action items and results for the Barcelona meeting agenda are as follows:

A. Discussion & Results of Action Items

1. Define the International Joint-Science Working Group

The overall goal of the SWG is to conduct a mission definition study leading to an optimal preliminary design of the mission given science requirements and technology and cost constraints. The SWG will follow the design of the Topex/Poseidon working group. Science questions will drive the mission with scientists and engineers working together to ensure a cost-effective design through studies of the trade-off space.

2. Determine SWG Participants and Workers

The SWG will consist of about 15 people. Doug Alsdorf, Lee Fu, and Nelly Mognard will create an initial list of participants and the list will be refined by the broader group. The list will be completed by mid-August to ensure a timely invitation to named individuals so they might be available for the inaugural SWG meeting.

3. Plan First Full SWG Meeting

Meeting Location: Washington D.C.

Meeting Time: Sometime during late October or early November, 2007.

Meeting Invitees: SWG participants, NASA HQ people, CNES HQ people, and a few key individuals who will help guide WATER HM.

Agenda and Action Items: Will be refined by mid-August, in time for distribution to meeting invitees. These will largely focus on the science drivers for the mission. The meeting will also include technology discussions, particularly those focused on the cost trade-offs. We would like to provide program managers with a set of fundable plans for advancing WATER HM related science and technology. A roadmap for WATER HM, with a timeline for deliverables, is an expected result of the inaugural SWG meeting.

Expected Results: To show that WATER HM is capable of accomplishing the science goals.

B. Discussion & Results of Agenda Items

1. Define Science

The suggested top priority hydrology question is focused on the terrestrial surface water contribution to the global water cycle. The suggested top priority oceanography question is focused on the dynamics of kinetic energy in ocean currents. The prioritization of all WATER HM science questions is a task for the entire SWG. Additional hydrology science questions under consideration include those related to flood hazards, water resource management, carbon evasion, and health issues. Additional oceanographic science questions include those related to coastal zones, contributions to climate data records, improving hurricane forecasts, and operational needs like those related to transportation, pollution, and wasted disposal.

These questions need careful articulation. For example, saying that WATER HM will answer the question of “how much surface water is on the Earth” is not exactly true. Rather, WATER HM will address the question of “what is the spatial and temporal variability of terrestrial surface waters around the globe”. Questions related to sea level also need clarification because WATER HM may not be explicitly designed to address the question of “what is the rate of sea level rise”. Rather, WATER HM will make high-resolution measurements of ocean surface topography and issues related to the mean sea surface. Oceanographic questions will need to carefully consider internal tides, which operate at ~100 km spatial scales and external tides, which are ~1000 km scales. Internal tides are a function of the thermocline and operate on spatial scales similar to meso-scale currents, thus they can be a source of error. Both internal and external tides are a source of error via aliasing.

All questions need to be refined so that the height and spatial accuracies required for answering the question are cost effective (see next section). For example, hydrology is proceeding with a NASA funded study, the Virtual Mission, which will define the accuracy trade-offs associated with coarse vs. fine samplings and how effective these are for constraining the global terrestrial water cycle, improving flood hydraulics, and the other hydrology questions. A key consideration for all questions is the design lifetime of the satellite mission. Costs increase markedly for longer mission lifecycles, e.g., 3 years compared to 5 years. Thus questions should be focused on those that can be answered in a minimal amount of time.

There is a certain degree of "excitement" that needs to be enveloped by the science questions. For example, measuring vector winds does not engage the general public, whereas the entire world is keenly interested in hurricanes. Similarly, floods have a tremendous economic impact, especially in developing countries. While WATER HM is not a flood chasing satellite, it should provide new insights toward understanding how floods evolve. Applications of WATER HM measurements are important, but we should view WATER HM as a demonstrator of science. Essentially, the science questions will need to have some degree of direct applicability while focusing on unanswered science questions of great impact.

We also welcome other science questions, particularly those related to ocean bathymetry and sea ice. Synergies with these questions need to be developed so that new science questions do not lead to costly technology creep. For example, if the optimal WATER HM orbit configuration does not extend well into Arctic ocean, then is the additional cost to cover the ice pack too prohibitive?

Modeling is increasingly important for understanding the global water cycle and oceanic circulation issues. Satellite measurements are never sufficiently frequent enough to measure the full dynamics of water movement (e.g., every second), however the spatial density of wide-swath samples allows a high-resolution and broad-scale application in modeling. We need to determine the requirements of models and ensure that our colleagues from the various hydrologic, ocean circulation and climate modeling communities are involved in WATER HM planning and its eventual measurements.

In summary, hydrology science questions to be directly addressed by WATER HM are at the zero-order level, i.e., highly important and with immediate impact. The great achievements resulting from Topex/Poseidon and its successors allow oceanography to ask higher-order questions on the kinetic energy of the ocean that is of great importance to both climate science and practical applications.

2. Prioritize Trade Studies

Presentations were made regarding the various activities designed to address the trade-offs between science questions, technology required to address the questions, and the involved costs.

Hydrology is conducting a series of "Virtual Mission" (VM) studies which include data assimilation. A VM consists of a water balance model which supplies rainfall generated runoff at a coarse grid scale (e.g., 0.5 degree) to a fine-scale (~100 m) hydrodynamic model which routes water through a channel and across a floodplain. The routing results in water surfaces which are then sampled with an instrument simulator designed with various error characteristics (e.g., layover, thermal noise, etc.). These measurements represent the KaRIN instrument and are subsequently used in a data assimilation scheme designed to assess the importance of the errors in constraining discharge estimates and storage change measurements. Published first-results are promising and represent a new avenue for working with spaceborne surface water measurements.

Hydrology is also using SRTM elevation measurements as a proxy for KaRIN. Although SRTM is at least an order of magnitude lower in accuracy than the design of KaRIN, published first-results using a simple Manning's n approach suggest that SRTM is capable of supplying discharge estimates from large rivers such as the Amazon, Ohio, and Missouri.

Ka-band radar has now been tested from several bridges over terrestrial water bodies. A reservoir and two rivers in Ohio were chosen as targets representing surface water characteristics of wind advected wave action across a standing body of water and different turbulent conditions for moderate and large rivers (i.e., the Muskingum River at ~300 m^3/s and Ohio River at ~3000 m^3/s). Results demonstrate that Ka-band will provide significant backscatter energy at the look-angles proposed for KaRIN, including angles beyond 6 degrees off-nadir. As a general characterization of all surface conditions, the change in dB is only ~10 dB or less from peak at nadir to the returns registered at 6 degrees off-nadir.

Radiometer studies are needed that will characterize height errors related to atmospheric water vapor over coastal and terrestrial areas. Both CNES and JPL have made preliminary studies with somewhat similar conclusions. Options suggest a large antenna to acquire sufficient km-scale resolutions or a smaller, multi-frequency antenna. This Fall, a coastal altimetry workshop is being held and it is suggested that WATER HM be represented at this meeting to further our collaborations with this important community.

CNES is advancing their previous studies which were based on WSOA and the WatER concept (a sun-synchronous orbit with the KaRIN wide-swath instrument and the AltiKa nadir altimeter). CNES is now conducting a Phase Zero study to investigate the power requirements and fit with the Pleiades platform (i.e., the PASO study). This would be an upgrade from the WatER design using the PRIMA platform. Initial power studies suggest that solar panels on a non-sun-synchronous platform would require 21 square-meters for 1000 watts and 33 sq-m for 1600 watts. These studies need to verify the number of articulation points used in the design of the solar panels. The new generation of platforms may not accommodate such large solar panel arrays, thus it is suggested to decrease the solar panel sizes, hence decrease the power requirements. The SWG will need to determine if it is acceptable to decrease the power requirements, hence decrease the height accuracy of KaRIN's measurements. A broader scope of spacecraft study involving US aerospace industries should be conducted to fully evaluate the options for flying the mission in a non-sun-synchronous orbit to meet the oceanographic objectives.

CNES has developed a tool capable of simulating multi-mission configurations (e.g., WATER HM and Jason) and the related orbit and tidal aliasing issues. The tool is designed to understand how variance can be reduced through multiple altimeters.

CNES is also working on an intriguing idea of using the ONERA powered glider toward understanding Ka-band radar and interferometric altimetry. This work is in the planning stage and is not yet implemented.

In summary, its clear that key studies are being advanced at JPL, CNES, and various universities, principally OSU and UW. The SWG will facilitate the organization and cooperation of these studies, especially as WATER HM heads toward implementation of Phase A. A key issue is to integrate these studies so that spatial, temporal, and height accuracies implied by the science studies are fit into the technology studies to determine related costs.

3. Data Processing, Applications, and Synergies

While science and technology issues are of an immediate concern, in the near future we will need to determine how data will be processed and its processing level; who are the potential end users and what are their requirements; and synergies that should be developed with other satellite missions or in-situ sampling groups. Of these, the SWG should focus initially on synergies with other research communities and other satellite missions, particularly those missions concerned with the global water cycle.