



The NASA Surface Water Working Group

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Dear Drs. Komar and Hartley,

We would like to formally introduce you to the NASA Surface Water Working Group which is funded by the Terrestrial Hydrology Program (THP) of NASA's Earth Science Enterprise (ESE). This letter summarizes our scientific goals with a purpose of encouraging the development of spaceborne technology suitable for measuring surface water hydraulics. We specifically hope that you will join us in this exciting opportunity by placing these concerns within future technology related NRAs, such as those of the Instrument Incubator Program.

Water issues, at the global, regional, and local scale, receive a great deal of attention and are high on the lists of public concerns. The annual cost of floods and droughts in the U.S. greatly exceeds those of other major natural hazards, such as earthquakes. NASA has, for over a decade, addressed global research issues related to land surface hydrology through its Terrestrial Hydrology Program, whereas a U.S. focus has been conducted by the U.S. Geological Survey for over a century. Nonetheless, the temporal distribution of the Earth's fresh water is poorly known, especially outside of industrialized nations. Lacking these measurements, climate and water cycle models are not well constrained. The capability of measuring the flux of water through vast wetland areas is quite limited using *in-situ* methods, despite the global importance of nutrient and biogeochemical fluxes that are dependant upon wetland hydraulics. Coupled with these science concerns are the societal issues of growing populations needing management of their basin's water resources. All of these concerns fit well within ESE's roadmap of activities for answering science questions regarding water cycle variability, response, consequences, and predictability.

The Surface Water Working Group has identified and explored various spaceborne methods that would facilitate measuring the storage and the movement of water across the earth's land surface. Some of these techniques, such as altimetry, are feasible for some applications using existing sensors. Others, however, require the development of new technology, and these are areas in which ESTO could play an important role. In particular, we hope that ESTO will place a high priority on technology development activities applicable to surface water problems and make funding opportunities available through various NRAs. While the attached articles deal primarily with the scientific underpinnings of surface water issues, they also highlight three different technology avenues that could be pursued, but require additional development. These include:

- Radar altimetric measurements of the elevation of the water surface across inland water bodies. Various exploratory projects using existing ocean radar altimeters have demonstrated the feasibility of observing water levels (stage) of large lakes, reservoirs, and rivers, but the potential is greatly constrained by the onboard processing of the data, which assumes ocean returns. Moreover, in the case of river discharge measurements, the capability to coincidentally measure channel widths and surface velocities (or water slope) is needed. Based on efforts of working group members, there appear to be options for improving the performance of radar altimeters for the estimation of these parameters. *Thus, the measurement of these surface water hydraulic variables is an area where technology development is a paramount need.*
- SAR has a demonstrated capability to provide estimates of the extent of inundation associated with lakes, wetlands, and rivers. Yet, there remain issues in the processing of the large volumes of SAR data that would be required to provide such estimates in near-real time, and in combining SAR with altimetry data to provide estimates of changes in surface water storage, one of the largest terms in the surface water budget. Interferometric processing of conventional off-nadir SAR is a possible alternate to radar (or lidar) altimetry that has provided centimeter-scale changes in water levels, but its interpretation is complicated by requiring flooded vegetation (a frequent occurrence in wetland applications, but not in open-channel environments). A near-nadir instrument may overcome this vegetation restriction. Furthermore, interferometric SARs having antennae offset to provide both along and cross-track measurements could also provide a measure of surface velocity on sufficiently wide streams. *Thus, the real-time processing of image data mapping inundation combined with altimetric and interferometric measures of flow hydraulics is a considerable need.*
- Gravity data from the ongoing GRACE mission and its possible follow-on are expected to provide measurements of the changes in total stored water volumes (i.e., atmospheric, surface, soil, and ground water), yet the spatial resolution is on the order of 200,000 km². While gravimetric data has the potential to address important science issues at the continental and large river basin scale, it most likely will not be applicable for directly measuring the smaller scale hydraulics of individual channels, lakes, and wetlands. *Nevertheless, such missions provide hydrologic constraints on integrated basin storage changes, thus follow-on gravimetric opportunities provide unique remotely sensed measurements for understanding the water cycle.*

The ideal instrument for surface water measurements would provide surface water stage, extent, slope, and surface velocity. Such an instrument clearly does not exist, but could be designed and built based upon lessons learned from existing SAR, GRACE, and altimetry missions. For this reason, the working group has a strong interest in ESTO, and very much encourages the inclusion of technology funding opportunities for the design and construction of instruments that are targeted to measure terrestrial surface waters.

We are very enthusiastic about the science and societal values of better understanding the global distribution of fresh water. The technology for such measurements is well-founded and within near-term development. Thus, we are strongly optimistic that NASA will lead this exciting opportunity to measure surface water hydraulics. The attached publications further detail these thoughts and our web page provides additional background information (www.swa.com/hydrawg). We would be pleased to discuss these thoughts with you in more

detail at your convenience. One possible venue would be this Fall's AGU meeting, the second week of December, or perhaps you might suggest a more convenient date and location. For your information, the working group is holding a brief informational meeting on Sunday, December 7th at 7:00 PM in the San Francisco Marriott's Pacific Room J. We would be pleased to have you attend. Please feel free to contact us if you have any questions.

Sincerely,



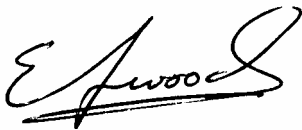
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Publications noted in the letter:

Alsdorf, D.E. and D.P. Lettenmaier, Tracking fresh water from space, *Science*, 301, 1485-1488,
2003. [Note: A senior editor invited this “Perspective”]

Alsdorf, D., D. Lettenmaier, C. Vörösmarty, and The NASA Surface Water Working Group, The
need for global, satellite-based observations of terrestrial surface waters, *EOS*
Transactions AGU, 84, 269-276, 2003. [Note: this was the lead, top-front page article of
the issue.]