GINIS, URI
DHS COASTAL RESILIENCE CENTER
RESEARCH PROJECT
YEAR 4 PROGRESS REPORT
July 1, 2018 – June 30, 2019

Project Title:
Modeling the combined coastal and inland hazards from high-impact hurricanes

Principal Investigator Name/Institution:
PI: Isaac Ginis, University of Rhode Island, Professor
Co-PIs:

- Tetsu Hara, University of Rhode Island, Professor
- David Ullman, University of Rhode Island, Marine Research Scientist
- Pam Rubinoff, University of Rhode Island, Coastal Resilience Specialist
- Austin Becker, University of Rhode Island, Assistant Professor

Other Research Partners/Institutions:
Wenrui Huang, Florida State University, Professor

Short Project Description ("elevator speech)

This project advances modeling capabilities that assess the potential impacts of landfalling hurricanes on critical infrastructure and communities. The primary focus is on hurricanes in the Northeastern United States, combining multiple hazard impacts, including coastal flooding due to storm surge and inland flooding due to rainfall.

This project will expand outreach to the Northeast region previously not a focus of the models and allow DHS and other agencies to better understand the consequences of coastal and inland hazards associated with extreme high-impact landfalling hurricanes in specific regions and to better prepare coastal communities for future risks.

1. Introduction and project overview:

The major goal of this project is to comprehensively investigate hazards and impacts in the focus regions using the most advanced coupled hurricane, coastal ocean circulation/storm surge, wave, and hydrological models and transition the developed new modeling capabilities to the real-time ADCIRC-Surge Guidance System (ASGS) and Coastal Emergency Risks Assessment (CERA). To attain this goal, the following specific tasks will be accomplished: 1) Advancing the ADCIRC modeling system in the Northeast; 2) Expanding coupled inland and coastal flood modeling to all of Southern New England; 3) Expanding the URI Hurricane Boundary Layer model application to any location in the U.S. coastal region; 4) Implementation of hazard impact modeling into the real-time ASGS and CERA; and 5) Expanding end-user outreach to New England stakeholders.

2. Results:

Our research activities in Year 4 focus on advancing the capabilities and forecast skill of the ADCIRC modeling system in the Northeast and add new capabilities, such as improved surface wind modeling during hurricane landfall, coupling of storm surge and waves, inland flooding from rainfall. Details of the main activities and research findings are provided in Year 4 Report Appendix.

3. End users:

This project will contribute to improving the real-time ADCIRC-Surge Guidance System (ASGS) and Coastal Emergency Risks Assessment (CERA) to meet the requirements of their main users within federal agencies, including users within FEMA, USACE and NOAA NWS, and decision makers at state and municipal levels in New England.

Focus to date has been to engage end-users to define and advise on pilot application in Providence, Rhode Island. The Rhode Island Emergency Management Agency, RI Department of Health Emergency Preparedness Center, and the Providence Emergency Management Agency are our prime partners to help scope and implement the effort, as they are the ones targeted to use the product for real time applications. In efforts to plan and implement focus groups and gather information, there is a Steering Committee, made up of other key state, municipal, and private sector partners. These include: US Coast Guard, RI Department of Environmental Management, RI Department of Transportation, Lifespan Health Care, Narragansett Bay Commission (wastewater), City of Providence Police and Fire, Providence Port Authority and National Grid (energy).

4. Transition:

To date, the primary focus on the end-user transition has been on the Rhode Island emergency management community, with the goal of getting their input and buy-in to 1) develop a pilot project that shows the capability of modeling storms and impacts; 2) gather critical infrastructure information to use in the model; 3) Identify ways to share information for real time use at the Emergency Operations Center; 4) Get feedback on visualizations, platforms, and modeling approaches that will be rolled out to New England stakeholders for the enhanced ADCIRC modeling initiative.

The team has successfully engaged key project partners - Rhode Island Emergency Management Agency, the Rhode Island Department of Health Emergency Preparedness Center and the Providence Emergency Management Agency. Providence is the capital city of Rhode Island, where much of the state leadership is housed as well as the largest population in the state. With these groups, we confirmed that we would target our pilot project for Providence, Rhode Island to develop and demonstrate real time hazard and impact prediction system for hurricanes and

nor'easters in Southern New England. The system includes an assessment of cascading consequences of extreme weather impacting critical infrastructure.

In efforts to collect critical infrastructure information, thresholds, and concerns, we received Internal Review Board approval to conduct key informant interviews and focus groups of key infrastructure sector experts. We had a project kickoff meeting (25 stakeholders), and established a Steering Committee with 15 end-user organization/agency participants. The Steering Committee helped to refine the list of ten critical infrastructure and key resources (CIKR) sectors for which we will conduct focus group and/or key informant interviews. The CIKR was preferred by the emergency managers, as opposed to critical infrastructure communities, as it would be more functional within the Emergency Operations Center, with the Emergency Support Functions already functioning in Rhode Island. Efforts are underway to plan for 7-10 focus groups during the summer 2019.

Additional details on the transition activities are provided in Year 4 Report Appendix.

5. Project Impact:

By establishing a partnership with statewide emergency managers, and the capital city's emergency management agency in the development and implementation of the pilot project, it helps to ensure that the project, framework, information, and the technologies will build upon existing knowledge and be applicable to them as the products are rolled out. It provides the team with a real-world application, and a committed end user, who will be able to use this for real world applications, in addition to training exercises. This real time critical infrastructure impact information will build upon and enhance their knowledge base and strategies for preparation, response and recovery.

We further advanced the capabilities the ADCIRC modeling system in the Northeast and added new capabilities, such as improved surface wind modeling during hurricane landfall, highly refined its computational grid in Southern New England, improved wave coupling physics and the coupling with hydrological models. Specific examples are provided in the Year4ProjectAppendix.

6. Unanticipated Problems:

This project received 50% of annual budget in Year 4. As a result, some of the tasks have partially completed. The graduate students involved in the projects received partial support through a Dean's pledge provided by the URI's Graduate School of Oceanography.

7. Student Involvement and Awards:

1) Xuanyu Chen, a PhD student at the Graduate School of Oceanography, focused her work on evaluation and improvements of the wave models WW3 and SWAN in hurricane conditions

and investigated the sea state dependent drag coefficient in shallow waters during hurricane landfall.

2) Mansur Ali Jisan, a PhD student at the Graduate School of Oceanography, focused his work on advancing modeling of surface winds during hurricane landfall for predicting storm impacts.
3) Robert Witkop, a MS student at the Department of Marine Affairs, developed a methodology to collect qualitative data from emergency managers in a format that could then be integrated with the drivers that can be modeled (e.g., wind, wave, surge, flooding). He served as an intern in RIEMA's critical infrastructure program intern and conducted storm vulnerability analysis for 11 critical facilities in Westerly, RI.
4) For the transition component, three students have been hired to work 20 hours per week, two at URI, Noah Hallisey and Samantha Radov. One of the graduate students, Joyce Park, has been leveraged through our partnership with the RI Department of Health and Brown Public Health program. The primary responsibility of these students is to work with PIs and end-user partners to collect data on critical infrastructure.

Student demographics: Three female, and two males. Four graduate students and one undergraduate.

Degrees attained

- Bobby Witkop, Master's thesis in Marine Affairs
- Peter Stempel, Ph.D. Dissertation in Marine Affairs

8. Interactions with education projects:

N/A

9. Publications:

Publications (Student authors are marked with an asterisk)

- *Liu, Q.*, L. M. Rothstein, and Y. Luo, 2017. A periodic freshwater patch detachment process from the Block Island Sound estuarine plume. J. Geophys. Res. Oceans, 122, 570–586, DOI:10.1002/2015JC011546
- Gao, K., I. Ginis, J.D. Doyle, Y. Jin, 2017: Effect of boundary layer roll vortices on the development of the axisymmetric tropical cyclone *J. Atmos. Sci*. DOI: 10.1175/JAS-D-16-0222.1
- Whitney, M. M., D. S. Ullman, and D. L. Codiga, 2016. Subtidal Exchange in Eastern Long Island Sound, . *J. Phys. Oceanogr*. 46, 2351-2371. DOI: 1175/JPO-D-15-0107.1
- Gao, K. and I. Ginis, 2016: On the equilibrium-state roll vortices and their effect in the hurricane boundary layer. *J. Atmos. Sci.*, 1205- 1222. https://doi.org/10.1175/JAS-D-15-0089.1
- Liu, Q., L. M. Rothstein, Y. Luo, D. S. Ullman, and D. L. Codiga, 2016. Dynamics of the periphery current in Rhode Island Sound, *Ocean Modelling*, 105, 13-24. DOI: 10.1016/j.ocemod.2016.07.001
- Liu, Q., L. Rothstein, and Y. Luo, 2016. Dynamics of the Block Island Sound estuarine plume. J. Phys. Ocean., Accepted for publication. DOI: 10.1175/JPO-D-15-0099.1

- Reichl, B. G, D. Wang, T. Hara, I. Ginis, T. Kukulka, 2016: Langmuir turbulence parameterization in tropical cyclone conditions. *J. Phys. Oceanogr.*, 46, 863-886. DOI: 10.1175/JPO-D-15-0106.1
- Reichl, B. G., I. Ginis, T. Hara, B, Thomas, T. Kukulka, and D. Wang, 2016: Impact of sea-state dependent Langmuir turbulence of the ocean response to a tropical cyclone, *Mon. Wea. Rev*. DOI: 10.1175/MWR-D-16-0074.1
- Sun, Y., C. Chen, R. C. Beardsley, D. Ullman, B. Butman, and H. Lin, 2016. Surface Circulation in Block Island Sound and Adjacent Coastal and Shelf Regions: A FVCOM-CODAR comparison, *Progress in Oceanography*, 143, 26-45. DOI: 10.1016/j.pocean.2016.02.005
- Spaulding, M. L., Grilli, A., Damon, C., Crean, T., Fugate, G., Oakley, B., & Stempel, P.*, (2016). "Stormtools: Coastal Environmental Risk Index (CERI)." *Journal of Marine Science and Engineering*, 4(3). DOI: 10.3390/jmse4030054
- Fei, T., W. Huang, I. Ginis, Y. Cai, 2016. Characteristics of River Flood and Storm Surge Interactions in a Tidal River in Rhode Island, USA. Proceeding of IUTAM Symposium on Storm Surge Modelling and Forecasting, Oct 17-19, 2016, Shanghai, China

New Publications:

- Gao K, and I. Ginis, 2018: On the characteristics of roll vortices under a moving hurricane boundary layer, *J. Atmos. Sci*., 75, 2589-2598. https://doi.org/10.1175/JAS-D-17-0363.1
- Chen*, X., I. Ginis, and T. Hara, 2018: Sensitivity of offshore tropical cyclone wave simulations to spatial resolution in wave models. J. Mar. Sci. Eng., 6, 116. http://www.mdpi.com/2077-1312/6/4/116/
- Jisan, M. A. *, Bao, S., & Pietrafesa, L. J. (2018). Ensemble projection of the sea level rise impact on storm surge and inundation at the coast of Bangladesh. Natural Hazards and Earth System Sciences, 18(1), 351. https://doi.org/10.5194/nhess-18-351-2018
- Stempel, P.*, Ginis, I., Ullman, D., Becker, A., Witkop, R. (2018). Real-Time Chronological Hazard Impact Modeling. Journal of Marine Science and Engineering, Vol. 6, no. 134. doi:10.3390/jmse6040134.
- Teng, F., W. Huang, and I. Ginis, 2018. Hydrological modeling of storm-induced runoff and snowmelt in Taunton River Basin. Journal of Natural Hazards, 91, 179-199, https://doi.org/10.1007/s11069-017-3121-y
- Ullman D.S., I. Ginis, W. Huang, C. Nowakowski*, X. Chen*, and P. Stempel, 2019: Assessing the Multiple Impacts of Extreme Hurricanes in Southern New England, USA, Geosciences 2019, 9(6), 265; https://doi.org/10.3390/geosciences9060265
- Witkop, R., Becker, A., Stempel, P.*, Ginis, I. (2019). Developing Consequence Thresholds for Storm Models through Participatory Processes: Case Study of Westerly Rhode Island. Frontiers in Earth Science: Geohazards and Georisks.Vol. 7. Doi: 10.3389/feart.2019.00133.

Conference papers, presentations:

New presentations:

- Stempel, P.*, Becker, A. (2018), "Effects of localization on perceptions of storm surge risk depicted in model driven semi-realistic visualizations." International Conference on Sustainable Development, NY, NY. September 26-28, 2018.
- Ginis, I., D. Ullman, T. Hara, W. Huang, A. Becker, and R. Luettich (2018): Developing a Coastal and Inland Hazard and Impact Prediction System for Extreme Weather Events in the Northeastern United States, AGU Fall Meeting, December 14, https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/409069
- Ginis I. (2019): Advancing modeling capabilities to improve prediction of extreme weather events in the Northeastern United States, NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ, April 11.
- Ginis I. (2019): Improving Prediction of Extreme Weather and Its Impact in New England, RI Emergency Management Agency, Cranston RI, March 7.
- Ginis I. (2019): Modeling Combined Coastal and Inland Impacts from Extreme Storms, RI Department of Health, Providence RI, March 8.
- Ginis I. (2018): Advances in Predicting Hurricane Path and Intensity, Jamestown Philomenian Library, Jamestown RI, September 24.
- Ginis I. (2018): The 1938 Great New England Hurricane Looking to the Past to Understand Today's Risk, East Greenwich Historic Preservation Society, East Greenwich, RI, September 15.
- Becker, A, (2019). "Overcoming Barriers to Long-term Climate Adaptation," Lecture of Opportunity, US Naval War College, Newport, RI, April 29.
- Becker, A., (2019). "Climate risk adaptation for ports: Research for transformational thinking." UNCTAD Ad Hoc Expert Meeting on Climate Change Adaptation for International Transport: Preparing for the Future , Geneva, Switzerland, April 16-17.
- Stempel, P., Becker., A., Ginis, I., Ullman, D., Rubinoff., P., Overstrom, N. (2019). "Rethinking model-driven realistic storm-surge graphics." Rhode Island Coastal Ecology, Assessment, Innovation, and Modeling (RI C-AIM) Research Symposium 2019, Kingston RI. April 10.
- Becker, A, Stempel, P., Menendez, J. (2019). "Visualizing Risk: Dynamic 3d Models of Storm Impacts on Coastal Structures In Rhode Island." Poster presentation at the Infrastructure Climate Network Meeting, Portsmouth, NH, April 4-5.
- Becker, A. (2018). "Stimulating Transformational Thinking for Long-Term Climate Resilience." University of Rhode Island Coastal Resiliency Symposium, Oct. 16, Narragansett, RI. (I)
- Huang, W., F Teng, I. Ginis, and D. Ullman. 2019. Rainfall Runoff and Flood Simulations for Hurricane Impacts on Woonasquatucket River, USA. ICCEN 2019. Accepted by 8th International Conference on Civil Engineering (ICCEN 2019), November 19-20, Paris, France, 2019

Previous publications

- Chen, X. *, I. Ginis and T. Hara (2018). "Sea-State Dependent Drag Coefficient in Shallow Waters Under Tropical Cyclones", 21st Conference on Air-Sea Interaction, June 18 https://ams.confex.com/ams/23BLT21ASI/meetingapp.cgi/Paper/345222

- Chen, X.*, T. Hara, and I. Ginis (2018). "Sea-state dependent air-sea momentum flux in a shallow water under a tropical cyclone", Ocean Sciences Meeting, February 14 https://agu.confex.com/agu/os18/meetingapp.cgi/Paper/303041
- Ginis, I., C. Nowakowski*, and K. Gao (2018). "A Hurricane Boundary Layer Model for Simulating Surface Winds during Hurricane Landfall", 33rd Conference on Hurricanes and Tropical Meteorology, April 18, https://ams.confex.com/ams/33HURRICANE/webprogram/Paper339799.html
- Ginis, I., D. Ullman, T. Hara, C. Kincaid, K. Rosa*, X. Chen*, B. Thomas, A. Becker, P. Stempel*, R. Witkop*, P. Rubinoff, W. Huang, M. Orr, R. Thomas, R. Thompson, M. Belk, P. Morey, and S. Conard (2018). "Advancing Modeling Capabilities and Impact Analysis Tools to Improve Preparedness for Major Hurricane Hazard Events", 98th AMS Annual Meeting, January 11, https://ams.confex.com/ams/98Annual/webprogram/Paper336049.html
- Nowakowski, C.* and Ginis I. (2018): Advancing modeling of surface winds during hurricane landfall for predicting storm impacts, DHS Centers of Excellence Summit, May 30-31, 2018 https://cina.gmu.edu/coe-summit-2018/
- Witkop, R.*, Becker, A., Stempel, P.*, (2018). "Incorporating facility manager knowledge into storm impact models: A case study of critical facilities in Westerly, Rhode Island," Rhode Island Floodplain Managers Association, Smithfield, RI, April 5.
- Rosa, K.*, Kincaid, **C.** (2018). "Transporting Nutrients Northward from Rhode Island Sound Bottom Water to the Upper Narragansett Bay Euphotic Zone", RI C-AIM/RI NSF EPSCoR Symposium. Kingston, RI, April 9.
- Rosa, K., Kincaid, C., Ullman, D., and Ginis, I. (2017). Hurricane Rhody: How does Rhode Island Fare Against Hypothetical Superstorm? URI Graduate Conference. Kingston, RI. 8 April.
- Rosa, K. *, Kincaid, C., Ullman, D., and Ginis, I. (2017). "Baroclinic Model of Narragansett Bay Post-Storm Shelf-Estuary Exchange", Estuary Research Workshop: Limiting Factors Beyond Nitrogen. Narragansett, RI. September 13.
- Ginis, I., D. Ullman, T. Hara, C. Kincaid, L. Rothstein, W. Hwang, B. Thomas, X. Chen*, K. Rosa*, A. Becker, P. Stempel*, R. Witkop*, P. Rubinoff (2017). "Developing a mul.-model ensemble system for assessing hurricane hazards and impacts", URI Coastal Resilience Science and Engineering Workshop, December 4.
- Ullman, D., I. Ginis, W. Hwang, P. Stempel*, T. Hara, C. Kincaid, L. Rothstein, P. Rubinoff, B. Thomas, X. Chen*, K. Rosa* (2017). "Assessing the Mul-ple Impacts of Extreme Hurricanes in Southern New England", URI Coastal Resilience Science and Engineering Workshop, December 4.
- Witkop, R.*, Stempel, P.*, **Becker, A.**, (2017). "Coupling local scale, high resolution, qualitative data to interface with numerical storm models", American Geophysical Union Annual Conference, New Orleans, LA. Dec. 12.
- Stempel, P.* (2016). "Data Driven Visualization", Estuarine and Coastal Modeling Conference 2016, Narragansett, RI, June 14-15.

Student Theses/Dissertations

- Bobby Witkop Master's thesis in Marine Affairs "Developing Consequence Thresholds for Storm Impact Models: Case Study of Westerly, Rhode Island", 2018, Primary advisor: Dr. Austin Becker, Committee member: Dr. Isaac Ginis

- Peter Stempel Ph.D. Dissertation in Marine Affairs: “Depicting consequences of storm surge, opportunities and ethics.” 2018, Primary advisor: Dr. Austin Becker, Committee member: Dr. Isaac Ginis

10. Year 4 Research Activities and Milestone Achievements:

Year 4 Research Activities and Milestones: Status as of 6/30/2019

Reporting Period 7/1/2018 – 6/30/2019			
Research Activity	Proposed Completion Date	% Complete	Explanation of why activity/milestone was not completed
Modify the ADCIRC mesh to provide higher spatial resolution in the open ocean region south of New England in order to enable more accurate wave forecasts near the coast during hurricanes.	12/31/2018	100%	
Modify the ADCIRC mesh to increase the spatial resolution to approximately 30 m along the entire southern New England coast from western Connecticut to northern Massachusetts.	06/30/2019	100%	
Modify the ADCIRC mesh to facilitate the implementation of riverine inflows from the major New England rivers at the upland boundary of the mesh.	06/30/2019	80%	Delay due to receipt of funding.
Evaluate and implement the sea state dependent drag coefficient into ADCIRC.	06/30/2019	80%	Delay due to receipt of funding.
Implement the Precipitation-Runoff Modeling System (PRMS) to simulate rainfall runoff in Connecticut.	06/30/2019	60%	Delay due to receipt of funding.
Expand the operation of the hurricane boundary layer model to more locations in the U.S. coastal region and develop a more efficient and user-friendly software to run the HBL model.	06/30/2019	100%	
Integrate hazard impact tools into the real-time ADCIRC-Surge Guidance System (ASGS). Besides the storm surge prediction, this new capability will provide information on disaster consequence thresholds for critical facilities such as wastewater treatment facilities, seaports, substations, roads and communication facilities.	06/30/2019	10%	Delay due to receipt of funding.
Configure inputs and outputs of the hazard impact tools to conform to the existing ASGS formats and computational framework.	06/30/2019	40%	Delay due to receipt of funding.
Research Milestone			
Complete the modification of a high resolution ADCIRC mesh along the entire southern New England coast from western Connecticut to northern Massachusetts including the implementation of riverine inflows from the major New England rivers at the upland boundary of the mesh.	06/30/2019	80%	Delay due to receipt of funding.

Implemented of the sea state dependent drag coefficient into ADCIRC.	06/30/2019	80%	Delay due to receipt of funding.
Implemented the Precipitation-Runoff Modeling System (PRMS) to simulate rainfall runoff in Connecticut.	06/30/2019	60%	Delay due to receipt of funding.
Extend the URI hurricane boundary layer model to additional locations in the U.S. coastal region with a more efficient and user-friendly software to run the HBL model.	06/30/2019	100%	
Completed integration of the URI hazard impact model into the real-time ADCIRC-Surge Guidance System (ASGS).	06/30/2019	10%	Delay due to receipt of funding.
Publish research results in peer-reviewed journal and conduct presentations at national and regional conferences and workshops. We anticipate delivering 14-15 presentations each year.	06/30/2019	90%	Delay due to receipt of funding.

11. Year 4 Transition Activities and Milestone Achievements:

Year 4 Transition Activities and Milestones: Status as of 6/30/2019

Reporting Period 7/1/2018 – 6/30/2019			
Transition Activity	Proposed Completion Date	% Complete	Explanation of why activity/milestone was not completed
Coordinate transition efforts with UNC/CRC on ADCIRC/CERA.	6/30/2019	30%	Delay due to receipt of funding.
Identify, contact, and meet with core end-users, Federal and State Emergency Managers in the five states of NE, to discuss the project and strategy for engagement and outreach.	6/30/2019	60%	Given the delay in ADCIRC team funding, this has been initiated in RI, but not in the other states.
Assist the model developers in their efforts to enlist local emergency managers in the development a database that includes the concerns of specific facility managers as quantifiable thresholds that tie these concerns back to the hazard models.	6/30/2019	30%	Delay due to receipt of funding.
Develop and/or adapt ADCIRC and CERA outreach materials for Northeast users.	6/30/2019	30%	Delay due to receipt of funding.

Participate and contribute to annual ADCIRC training courses for end users.	6/30/2019	20%	Delay due to receipt of funding.
Conduct questionnaires at the end of each training and workshop activity to determine progress and assess effectiveness of the developed hazard model improvements and impact output capabilities in improving risk assessment and emergency response.	6/30/2019	30%	Delay due to receipt of funding.
Transition Milestone			
Transition the URI hazard impact analysis tools into the ADCIRC-Surge Guidance System (ASGS).	6/30/2019	10%	Delay due to receipt of funding.
Disseminate ADCIRC and CERA outreach materials to-Northeast end-users.	6/30/2019	60%	Delay due to receipt of funding.

12. Tables:

Table 1: Research Project Product Delivery

N/A

Table 2:

GINIS – HUANG Performance Metrics

Metric	Year 1 (1/1/16 – 6/30/16)	Year 2 (7/1/16 – 6/30/17)	Year 3 (7/1/17-6/30/18)	Year 4 (7/1/18-6/30/19)
HS-related internships (number)	0	0	0	0
Undergraduates provided tuition/fee support (number)	0	0	0	0
Undergraduate students provided stipends (number)	0	0	0	1
Graduate students provided tuition/fee support (number)	2	3	3	3
Graduate students provided stipends (number)	2	3	3	3
Undergraduates who received HS-related degrees (number)	0	0	0	0
Graduate students who received HS-related degrees (number)	0	0	0	0
Graduates who obtained HS-related employment (number)	0	0	0	0
SUMREX program students hosted (number)	0	2	2	0
Lectures/presentations/seminars at Center partners (number)	1	3	2	1
DHS MSI Summer Research Teams hosted (number)	0	0	0	0
Journal articles submitted (number)	2	7	6	3
Journal articles published (number)	7	8	9	7
Conference presentations made (number)	15	14	15	8
Other presentations, interviews, etc. (number)	12	22	17	23
Patent applications filed (number)	0	0	0	0
Patents awarded (number)	0	0	0	0
Trademarks/copyrights filed (number)	0	0	0	0
Requests for assistance/advice from DHS agencies (number)	0	3	5	3
Requests for assistance/advice from other agencies or governments (number)	5	13	12	11
Dollar amount of external funding	$3,921,000	$3,660,000	$3,660,000	
Total milestones for reporting period (number)	11	21	19	8
Accomplished fully (number)	9	17	19	1
Accomplished partially (number)	2	4	0	7
Not accomplished (number)	0	0	0	0