BECC QUARTERLY REPORT, EPA Border 2020 Proposal, RFP SOLTA-C-17-003
Project Sponsor Name: University of California, San Diego

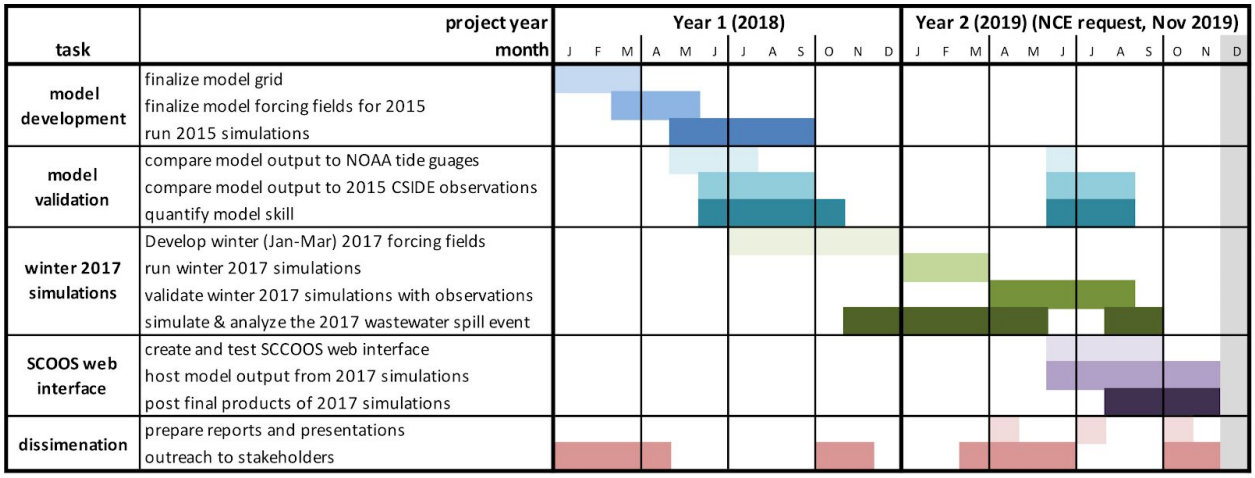
I. **PROJECT TITLE:** Evaluating the 2017 Tijuana River Estuary cross-border wastewater spill sources and coastal impacts

II. **PROJECT PERIOD:** 1 January 2018 - 30 June 2019 (18 months)

III. **PERIOD REPORTED:** 1 April 2019 - 30 June 2019 (~ 80% complete)

IV. **SCHEDULED ACTIVITIES FOR THIS PERIOD:** If the project is delayed, provide an expected completion date.

The project was delayed from the original schedule due to delays in getting the supercomputer time at the San Diego SuperComputer Center. The simulations required would take over a month if ran continuously on the equivalent of 400 desktop computers. This requires special reservations and it only became available to us in early February 2019. Thus our adjusted completion dates have been shifted accordingly, including a request for a no-cost-extension through November 2019 (please see the chart below). Remaining project tasks include finalizing model validations, creating and posting results on the SCCOOS web interface, and writing final analysis report.



V. **PROGRESS REPORT**: explaining work performed during the reported period. The progress report should provide a comparison of actual accomplishments with anticipated outputs/outcomes specified in the work plan, and anticipated next quarter activities and show past, current, and planned activities as well as dates.

During this reporting period we fully completed our simulations of and extractions from the winter 2017 wastewater spill event and have presented the results to coastal managers and stakeholders at the US EPA, IBWC, WildCoast, and the Tijuana National Estuary Research Reserve, and more. Additionally, we have made significant progress on a manuscript outlining

the model configuration and mechanisms that lead to transport pathways along and across teh shoreline. Below we outline our progress in each of the activities originally proposed.

Model Development

Model development and computer simulations for the 2015 test period as well as the winter 2017 spill event have been completed covering the San Diego / Tijuana Border region including the Tijuana River Estuary, San Diego Bay, and the San Antonio de los Buenos outfall 10 km south of the border in Mexico on a new model grid (see Figure 1 below). This included grid completion, compilation of all the realistic model forcing fields (winds, precipitation, waves, solar heating, etc.), and finally running the simulations on the UCSD Triton Cluster supercomputer.

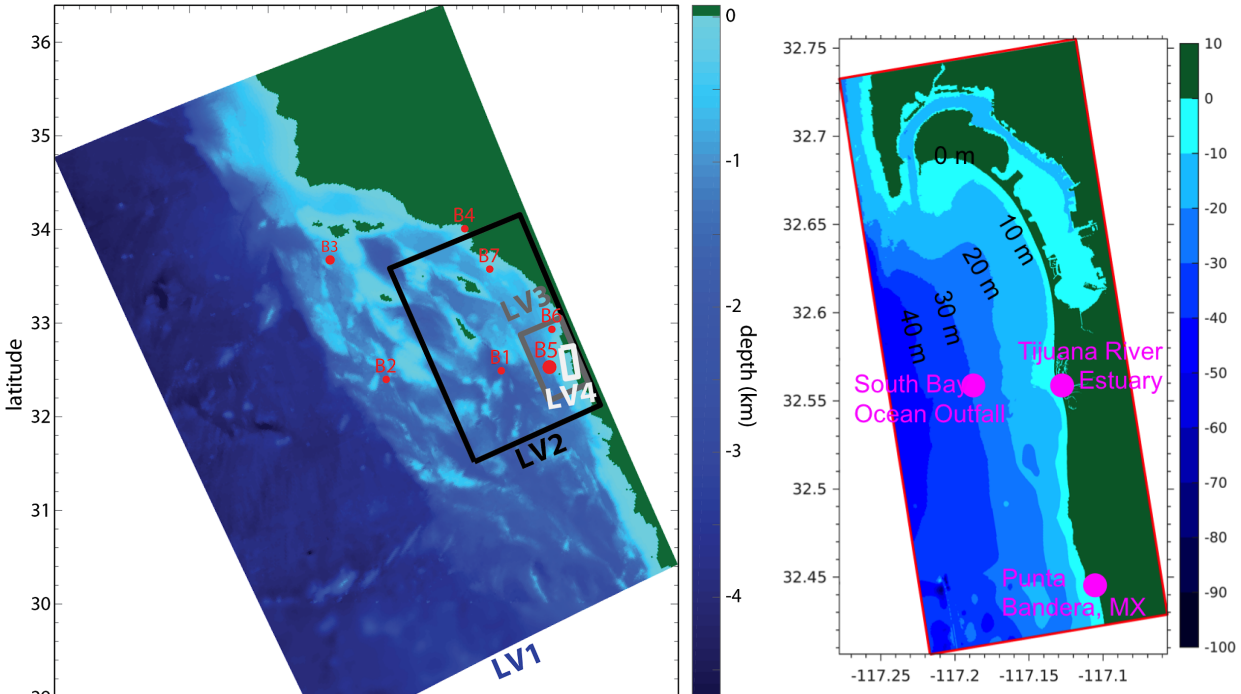


Figure 1. Model grids for the Level 1-4 (LV1-LV4) nests scaling from the Southern California Bight (LV1) down to the SDTJ Region in the LV4 grid (right). LV4 has horizontal resolution of 100 m at the outer boundaries down to 7 m along the coastline resolving San Diego Bay, the TJRE, the SBOO and Pt. Bandera. Bathymetry is shown in color, LV1-3 validation buoys (left) and point sources (right) are labeled.

The model domains (see Figure 1 above) encompass a series of 1-way nested rectangular grids starting at the coarsest resolution (LV1) telescoping in to the newest, highest resolution (LV4). The high LV4 grid covers the region from Pt. Loma, San Diego Bay, down the coast to Baja Malibu, MX at variable horizontal grid resolution from 100 to 7 m with 15 vertical levels.

Forcing for all domains is realistic. LV1 is initialized with and forced at the open ocean boundary using solutions from the data assimilative, realistic, MITgcm California State Estimate (CASE, http://www.ecco.ucsd.edu/case.html), which has 7 km resolution and covers most of the CA Current System. Open boundary conditions for each subsequent level is then applied from the coarser resolution (i.e., LV1 solutions are used to force LV2). Surface atmospheric forcing for all

grids use the NOAA North American Mesoscale Forecast System Hindcast (NAM) with data gaps interpolated with U.S. Navy Fleet Numerical high resolution Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS) atmospheric variables. Tidal constituent amplitude and phase are extracted from ADCIRC (http://adcirc.org/products/adcirc-tidal-databases/) and imposed at the LV1 boundary. Wave information from the CDIP Monitoring and Prediction system (MOP - which uses CDIP buoys and a linear model) have been extracted at the LV4 boundary and are used as boundary conditions for the LV4 wave model. During the prior review period, we worked closely with scientists and managers at the US Environmental Protection Agency (EPA), International Boundary Water Commission (IBWC), WildCoast, and Proyecto Fronterizo de Educación Ambiental (PFEA) to calculate the appropriate freshwater as well as contaminated flow rates in each of the sources. Wetting and drying is enabled to allow for the extensive estuarine intertidal regions to wet and dry and to realistically model tidal variation in surfzone location and extent.

In the most recent quarter, the focus was on completing the 2017 spill simulations and extracting output from them including movies and quantities to compare to obdservations. \

Model Validation

We have compared model tides, waves and sea surface temperature at several locations across our domains with a good comparison. See for example a time series of near surface temperature from LV2 and LV3 as compared to a buoy (Figure 2).

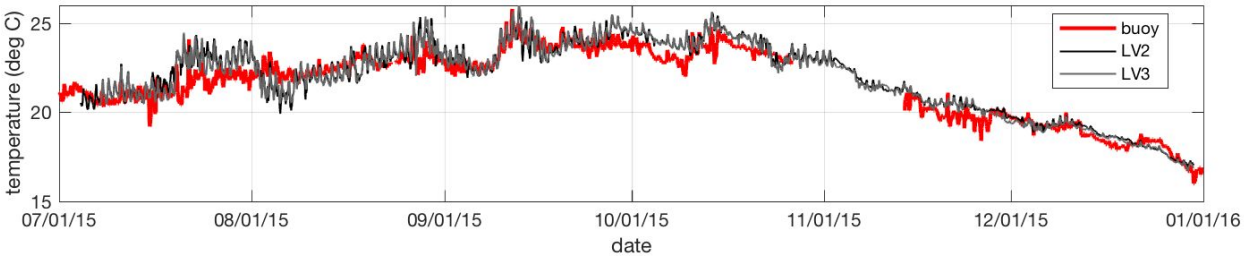


Figure 2: LV1-3 validation. The above time series shows 6 months of observations and simulation output of near surface temperature from LV2 (black) and LV3 (gray) as compared to the B5 buoy, NDBC Station 46232 - Point Loma South, CA (red). The B5 buoy location is indicated on Figure 1..

Additional validations that were started this quarter that need to continue next quarter include:

- Compare model tides to more coastal TJNERR tide gauges
- Compare model waves and currents to CSIDE, SBOO, and the City of San Diego (Tim Stebbins) existing observations
- Quantify model skill

Winter 2017 Simulation

During the last reporting period, we completed the winter 2017 simulation incorporating a realistic spill from the known sources. As stated above, this included grid completion, compilation of all the realistic model forcing fields (winds, precipitation, waves, solar heating, etc.), analysis and determination of the freshwater and contaminated inflow rates, and finally running the simulations on the UCSD Triton Cluster supercomputer. The details of the model setup are described above in the model development section. Figure 3 (below) shows a snapshot from LV4 simulations exemplifying model capabilities. Simulation movies from older runs are

available here: scripps.ucsd.edu/projects/cside/cside-lv4-simulations/. Figure 3i shows the results from the freshwater and contaminated flow rate analysis that is critical for this winter 2017 simulation. Movies from the BECC 2017 simulations are available at https://www.youtube.com/watch?v=91Cc1U9t1DI and https://youtu.be/J3sol2J0_zo.

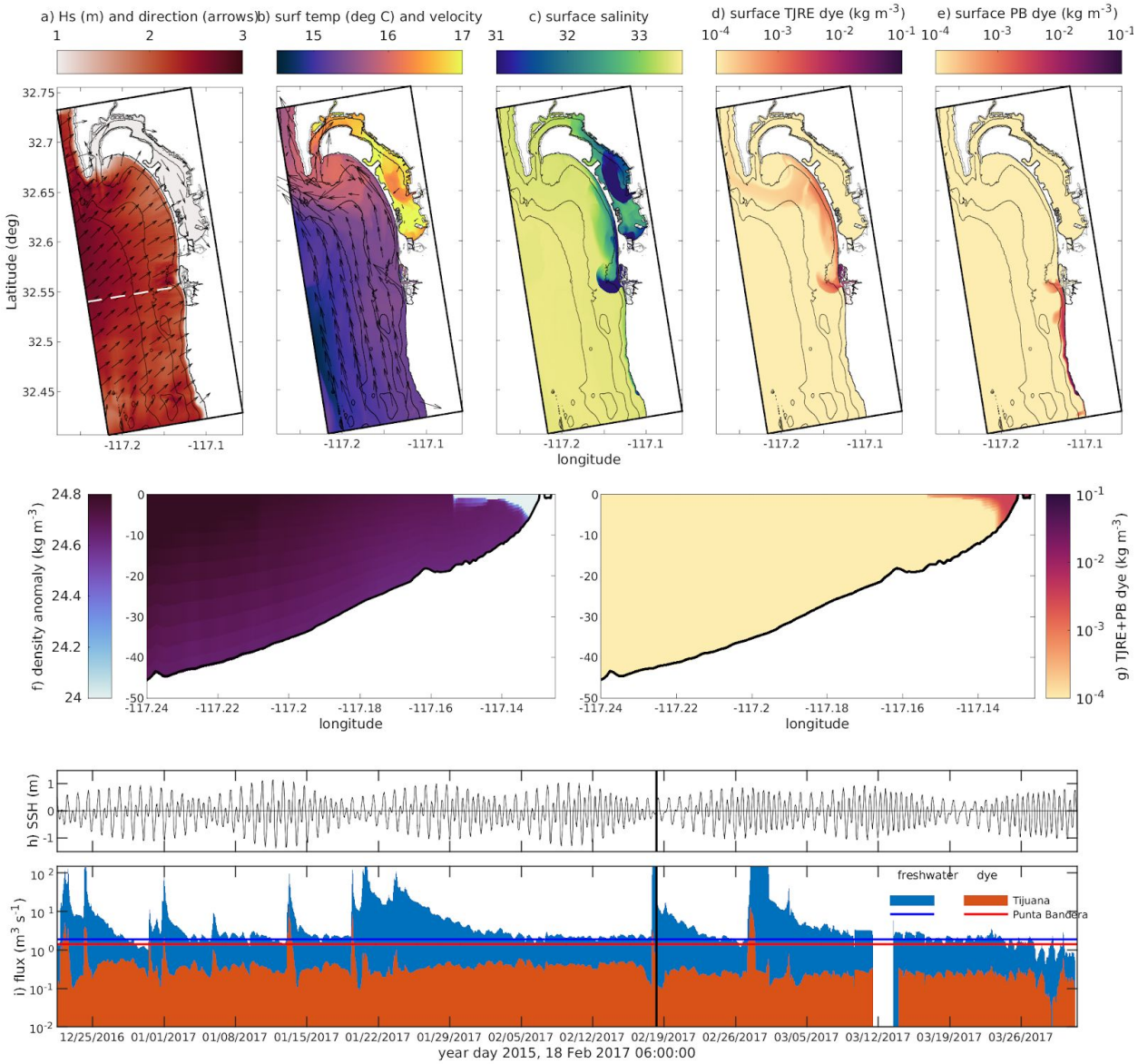


Figure 3. LV4 simulation snapshot. Snapshot from the 2017 spill event LV4 wave-hydrodynamic coupled simulations with passive tracers at sources on 18 February 2017. a) wave height (color) with direction (arrows), b) sea surface temperature with velocity vectors, c) sea surface salinity, d) sea surface concentrations of TJRE and e) Pt. Bandera tracer, cross sections of f) density anomaly and g) both dye tracers at the location indicated in a) with a dashed white line. Note that the tracers enter with a concentration of 1, such that 10^{-2} indicates 1% of the input concentration remains. Time series of h) sea surface height and i) freshwater and tracer discharge with a black line marking the snapshot time. Freshwater discharge (blue) and tracer flux (red) which is a proxy for the discharge of contaminated water for the Tijuana (filled curves) and for Pt. Bandera (lines).

Remaining aspects of this task include final model validation (see above and Figure 2) and analysis of the results to be hosted on the SCCOOS website (see below).

SCCOOS Web Interface Development

This part of the project remains to be completed and will be completed in the coming project months. It includes:

- creating and testing a SCCOOS web interface for visualizing the extent of the modeled wastewater plume
- hosting model output from the 2017 simulations on a public web interface
- post final products of the 2017 simulation

Stakeholders Engagement

We have been engaged with stakeholders throughout the project, particularly in the last 2 quarters. Outreach meetings with stakeholders have included meeting with the EPA, TRNERR, City of Imperial Beach, City of Coronado, the Regional Water Quality Control Board, International Boundary Water Commission, Proyecto Fronterizo de Educación Ambiental, City of San Diego, and other governmental and non-governmental organizations about our work. These meetings have included gathering information and data to help guide model runs, obtaining feedback, and presenting the results to the public. Specific events include the following (note that those marked with a * are during this review period):

- * 22 June 2019: provided input to US Congress Representative Vargas office on ocean monitoring needs for understanding border water quality.
- * 20 June 2019: Poster presented at the Gordon Research Conference
- * 05 June 2019: Doug Liden from the San Diego EPA office, presented our results at the EPA co-sponsored “Tijuana River and New River Transboundary Sewage Stakeholder Meeting” in Coronado CA. We attended as well.
- * 15 May 2019: This work was part of a presentation to the Wednesday Club, a group of local women that meet regularly to discuss important issues
- * 25 April 2019: Briefed US Congression Representative Michael Levin on border water quality issues and our research.
- * 20 April 2019: Presented an invited talk at the Tijuana River National Estuarine Research Reserve speaker series
- 26 March 2019: Presented some of this work at the San Diego Climate Summit
- 13 February 2019: Presented at the Imperial Beach Water Quality Workshop
- 08 November 2018: CSIDE experiment: Cross Inner-shelf/Surfzone Dye Exchange - preliminary findings, presentation for the Surfrider Foundation, San Diego chapter
- 18 October 2018: Attended San Diego/Tijuana Transboundary Pollution Stakeholder Meeting
- 17 September 2018: South San Diego REgion pollutant tracking - preliminary results - presentation for the San Diego Chamber of Commerce, stakeholder meeting
- 10 September 2018: Modeling update presentation for the Surfrider Foundation and City of Imperial Beach stakeholders
- 13 June 2018: BECC kick-off meeting for ocean modeling/monitoring studies in Imperial Beach, stakeholder meeting

What remains to be completed is the presentation of the results on a public website (see above) and analyzing/preparing final reports and presentations summarizing the project results.

Project Outputs

Original project outputs are listed below and their status.

1. Hindcast simulations of the 2017 wastewater spill event testing the point source location(s) and duration. 100% complete.
2. Maps of likely extent of impact derived from the hindcast simulations of wastewater concentration using a model dye. 80% complete.

   Dye has been incorporated and movies have been made, however final movies will be determined with stakeholder feedback. Recent discussions with EPA representatives have led to some new products we are working on now including new model analysis. While not a specific output for this project, we have also made significant progress on a manuscript which outlines the model setup and discusses mechanisms that transport waters along and across-shore from a coastal source.
3. These outputs will be delivered via a SCCOOS real-time web interface. 0% complete.

   This will be a big focus of the remaining project months.
4. Presentations and reports to the Border 2020 Task Force, regional water quality control board, the IBWC, the EPA, and other stakeholders on both sides of the border such as City of Imperial Beach, State Parks, TRNERR, International Boundary Water Commission, Tijuana River Action Network, WiLDCOAST, Projecto Fronterizo de Educación Ambiental. See the full list above, 95% complete.

Project Outcomes

Original project outcomes are listed below, several of them are jumping off points not anticipated to be completed with this project alone. Strong progress has been made on all fronts:

1. Better understanding of the 2017 spill event, including its magnitude, and extent of influence:

   Our model results have already contributed substantially to an improved understanding of the 2017 event, and will be even more successful at this once the information is posted publicly on SCCOOS.
2. Improved prediction capability of wastewater spill events in the region leading to deeper understanding of the extent and impacts of these events on both sides of the border:

   This has already started to occur as a result of this model and its use as a visualization tool. Moreover, the development of the model is a critical step towards a long-term improved prediction system.
3. Improved management tools.

   The model finalized during this project will soon be available as a tool for managers to study historical spill impacts. In addition, the existence of 2017 model simulation outputs will allow for future meta-analysis of varying wind/wave/oceanographic conditions to be

tested, quantified, and summarized as to their impact on plume spreading to allow for rapid response management to particular situations (not part of this project).

VI. Additional Comments (incidents, problems encountered, any other project relevant issue)

The biggest issue that arose was the slow down in getting the simulations going on the supercomputer as described above. Beyond that, the most difficult part of the project has been the analysis of freshwater and contaminated water flow rates. We are pointing this out as it represents a lack of data critical to better understanding these local pollution issues.

VII. Proposed Tasks for Next Reporting Period

During the next reporting period we plan to in parallel to continue model validation analysis and work on the SCCOOS web interface.

VIII. Reporting Schedule to NADB/EPA

Quarterly reports will be due and we have already requested an official no-cost-extension to complete our work.