Surface Water and Ocean Topography (SWOT) Mission

1st Science Team Meeting

13-16 June 2016

SWOT Applications Working Group (SAWG)

Leads:

Margaret Srinivasan, Craig Peterson: NASA

Alice Andral, Michel Dejus: CNES

Faisal Hossain, Ed Beighley: ST

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SWOT Applications Working Group (SAWG)

1. Margaret Srinivasan, Craig Peterson, **NASA Applications Leads**
2. Alice Andral, Michel Dejus, **CNES Applications Leads**
3. Faisal Hossain, U. Washington, **U.S. SWOT Applications Scientist**
4. Ed Beighley, Northeastern University, **U.S. SWOT Applications Scientist**
5. Rosemary Morrow, LEGOS, **CNES Ocean Science Lead**
6. Jean-Francois Cretaux, LEGOS, **CNES Hydrology Science Lead**
7. Kostas Andreadis, JPL
8. Bob Arnone, U. Southern Mississippi at Stennis SC
9. Sylvain Biancamaria, LEGOS
10. Matt Bonnema, U. Washington
11. Emilie Bronner, CNES
12. Phil Callahan, JPL
13. Jennifer Cruz, JPL
14. Annette deCharon, U. Maine
15. Guy Schumann, RSS, Google
16. Jessica Hausman, PODAAC JPL
17. Nicolas Picot, CNES
18. Gregg Jacobs, Naval Research Laboratory
19. Alexander Kurapov, U. Oregon
20. Robert Leben, U. Colorado
21. Pierre-Yves Le Traon, Ifremer & Mercator Ocean
22. Dennis Lettenmaier, U. Washington
23. Steve Nerem, U. Colorado
24. Tamlin Pavelsky, University of North Carolina
25. Vinca Rosmorduc, CLS
26. Robert Saint-Jean, Canadian Space Agency
27. Guy Schumann, RSS, Google

Quarterly telecons
ST meetings
Email listserve

Wednesday, ~6 pm,
Westin San Gabriel Room

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Applications: Key Publications

Co-authored papers, articles, conference talks/posters to disseminate info about

1. **Paper submitted** to *Remote Sensing Applications: Society & Environment* journal, under review
2. **Springer Book** "Earth Science Satellite Applications: Current and Future Prospects", F. Hossain, ed.; SWOT in EA chapter, April 2016.
3. **BAMS article** in support of Decadal Survey, Societal benefits of RS, accepted.

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Applications: Phase B presentations

18 Joint NASA, Stennis, CNES, SDT, SAWG presentations

2013

- OSTST; SWOT Applications poster, Srinivasan, Peterson
- 3rd Texas Water Forum: Austin, Oct.; "*Hydrology from Space: NASA's Satellites Supporting Water Resources Applications*"
- GODAE Ocean 2013; Jacobs et al.
- AGU Fall; Dec., SF; Poster, SWOT Applications

2014

- AGU Oceans: Feb., Hawaii; SWOT poster, Applications session
- SDT; June, Toulouse; Plenary, SAWG meeting, Poster
- SRR-MDR; May, Pasadena; SWOT presentation
- OSTST; Oct., Germany, SWOT Applications poster, GLOBE activites at OSTST Outreach/ Education splinter
- AGU; Dec., SF, SWOT coastal application poster, SWOT-GLOBE poster

2015

- 1st Applications Working Group meeting, LA Jolla, Jan.
- 5th SWOT Science Definition Team Meeting, January, La Jolla, CA
- Climate Predictions Applications Science Workshop (CPASW), Las Cruces, Mar., "Water Resource Applications Of The SWOT And GRACE Missions",
- ISRSE, May, Berlin; "Engaging the Applications Community of the SWOT Mission",
- 6th SWOT SDT, Jul., Toulouse; SAWG meeting, Applications plenary,
- Marine Technology Society (MTS) Oceans In Action; Aug., Stennis; SWOT Early Adopter Program,
- OSTST, Oct., Reston, SWOT Applications poster, SWOT-GLOBE presentation,
- AWRA; Oct., Denver, CO; SWOT & GRACE Applicaitons & Early Adopter plans
- Fall AGU; Dec., SF; *"Pre-Launch Assessment of User Needs for SWOT Mission Data Products"*

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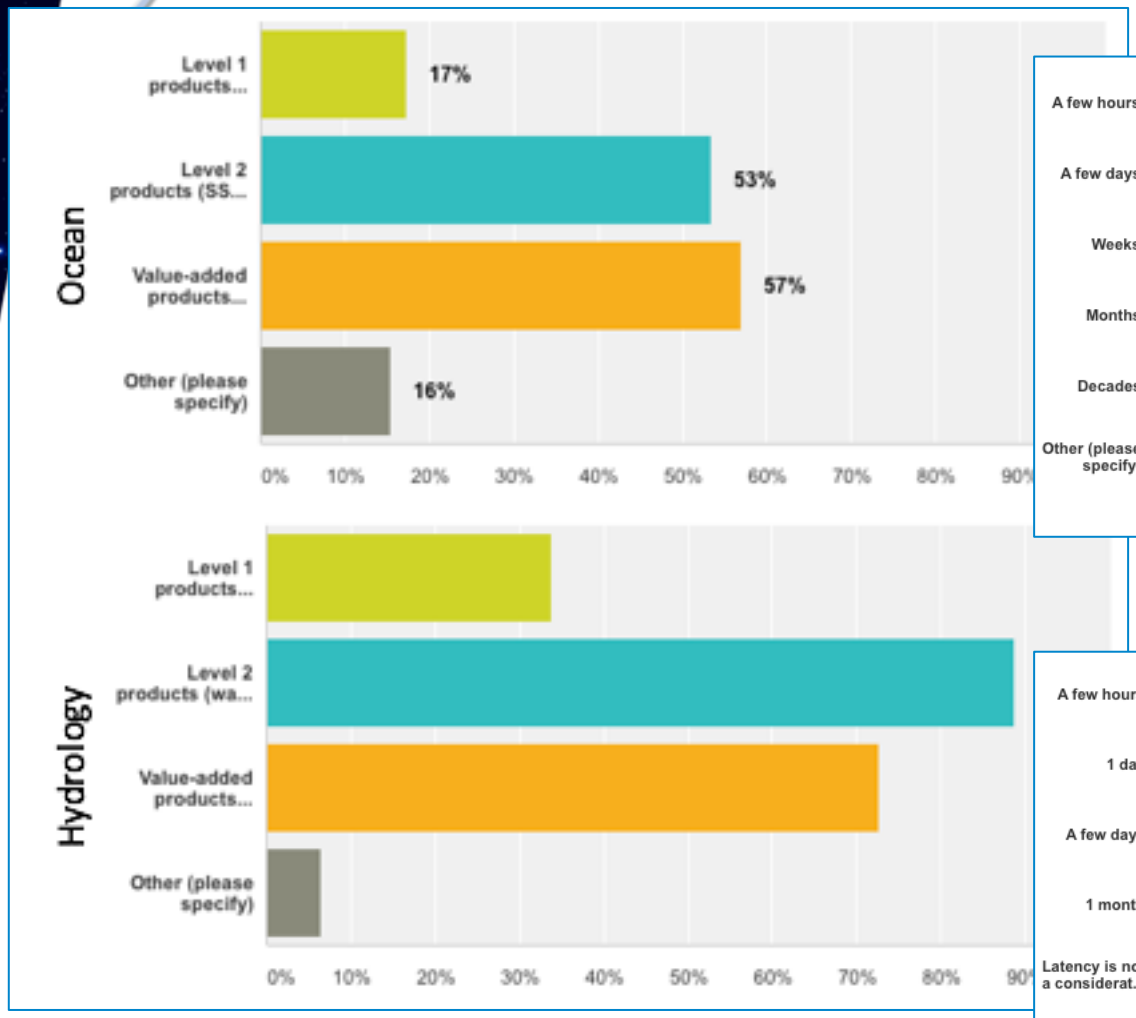
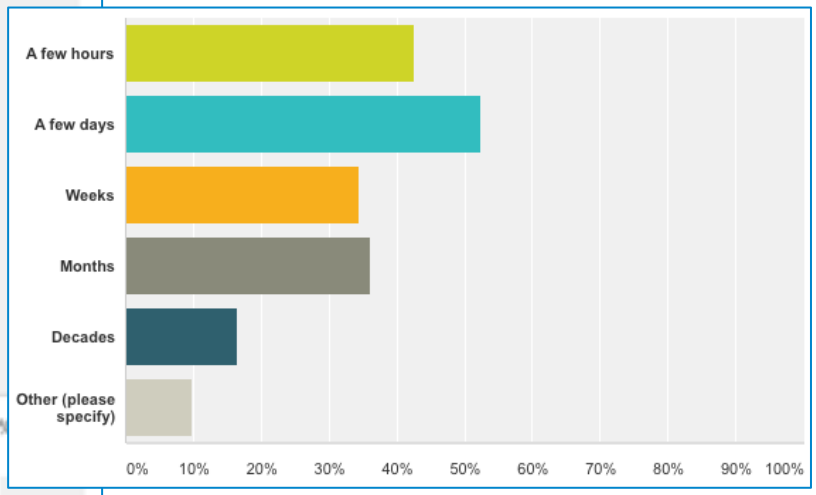
SWOT User Survey

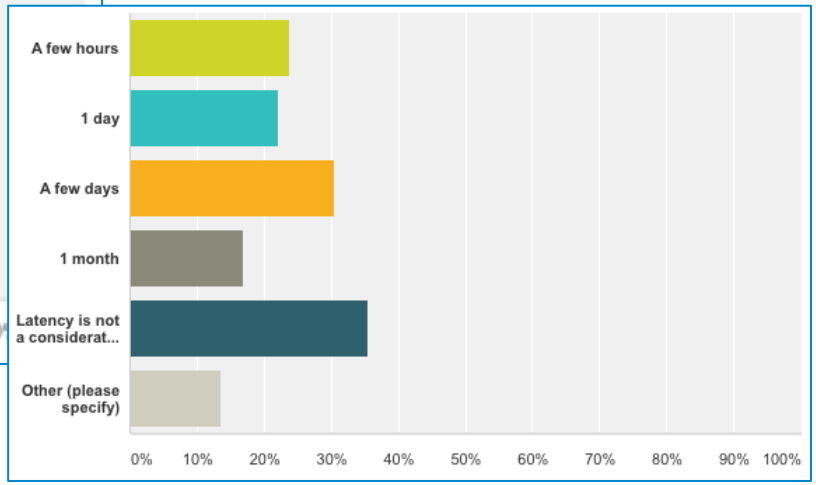
Data Products:



Temporal Scale:



Latency:



Submesoscale Prediction of Eddies through Altimeter Retrieval (SPEAR)

Gregg Jacobs

Naval Research Laboratory, Ocean Dynamics and Prediction

Research Objectives

- Enable ocean forecasting into the submesoscale eddy domain
- Prepare to utilize SWOT high resolution satellite altimeter sea surface height
- Quantify SWOT submesoscale prediction skill

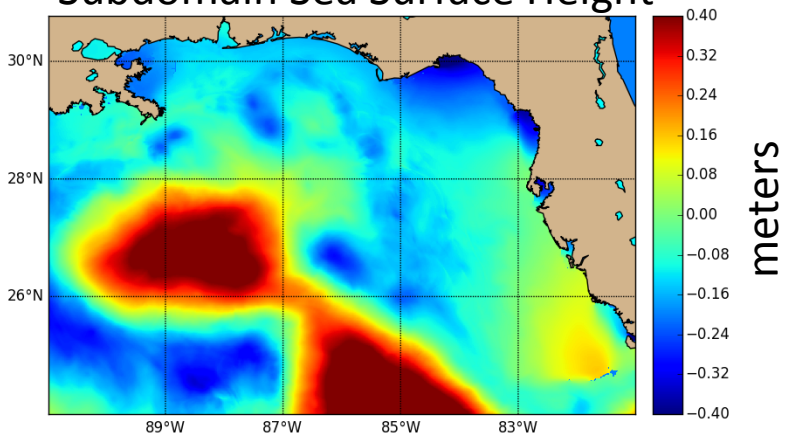
Team Membership (Naval Research Laboratory)

Dr. Gregg Jacobs
Dr. Robert Helber
Dr. Clark Rowley
Dr. Scott Smith
Dr. Innocent Souopgui
Dr. Max Yaremchuk

Status

- Project extends FY17-FY19
- Experiments under way with CARTHE researchers

Subdomain Sea Surface Height



Data product/Methodology

- Primitive equation numerical ocean models assimilating available satellite and in situ observations forcing by weather prediction systems
- 1 km resolution and finer to resolve submesoscale ageostrophic dynamics
- SWOT simulator to sample model sea surface height
- 1 km Gulf of Mexico 2012 to present
- 250 m northeastern Gulf of Mexico Jan 2016 – April 2016
- Other areas at 1 km and finer resolution planned for coming year
- Use SWOT simulator with multi-dynamic assimilation methods through 3DVar and 4DVar

Schedule and Issues

- FY17: Build ageostrophic submesoscale covariances through semigeostrophic dynamics, verify against full model fields, generalize the assimilation process
- FY18: Incorporate submesoscale covariances into generalized assimilation, begin multi-dynamic assimilation with mesoscale geostrophic dynamics in first analysis and submesoscale ageostrophic dynamics in second analysis
- FY19: SWOT Observation System Simulation Experiments (OSSEs) to quantify the predictive capabilities of the submesoscale ageostrophic eddies

SWOT FOR IMPROVING HYDRAULIC MODEL CALIBRATION FOR OPERATIONAL NOWCAST OF TRANSBOUNDARY RIVER FLOW -

Faisal Hossain

Research Objectives

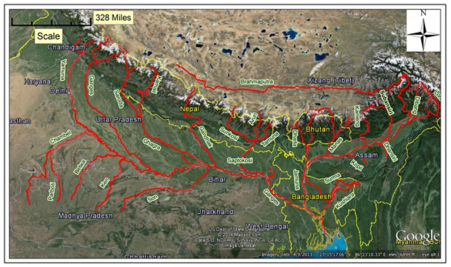
- Assess the value of SWOT data (distributed water elevation and inundated area) for improving hydraulic model calibration and set up.

Assess the skill of the continental-scale hydraulic model in operational nowcast of transboundary streamflow, flood forecast and river heights

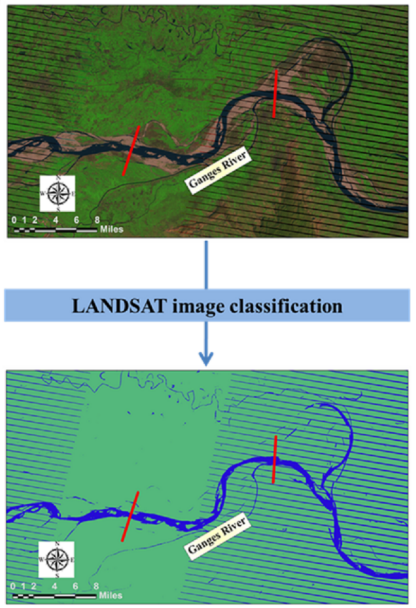
Team Membership

- Faisal Hossain (UW),
- Safat Sikder (UW)
- Nishan Biswas (UW)
- Stakeholder – Institute of Water Modeling and FFWC, Bangladesh

Methodology



.Maswood*, M., F. **Hossain** (2016). Advancing River Modeling in Ungauged River Basins using Remote Sensing: The Case of Ganges-Brahmaputra-Meghna Basins. *Journal of River Basin Management*,vol. 14(1), pp. 103-117, (doi:10.1080/15715124.2015.1089250).



Status

- Current state: HEC RAS is set up over Ganges-Brahmaputra river basin. But stage-width relationship available at few places using altimeter and non—sync Landsat/MODIS
- Region: South Asia
- How available for sharing? – Model and Ensuing data will be available
- Qualifiers: SWOT Simulator with Rivwidth is needed
- We will test how the simultaneous availability of height and width (to set up stage-width and Q relationship improves our HEC RAS model).
- Eventually – we want to apply ALL platforms, SWOT and others (Landsat, MODIS, altimeters)

Methodology, Schedule and Issues

- We'll corrupt a 'reference' HEC RAS water level with SWOT simulator and then derive stage-width and Q relationships. Next, we will insert into reference HEC RAS the 'SWOT' based river bathymetry data. We will repeat the same for reference HEC RAS using altimeter-Landsat based bathymetry (non-sync). Simulation of water level downstream in delta region (stakeholder agencies are interested in this) will be compared for the 3 options (reference, SWOT and altimeter-Landsat non-sync)
- Fall 2016 – start applying simulator on HEC RAS water DEM
- Fall 2017 – assessment of performance after replacing river bathymetry
- Fall 2018 – Report results and share with IWM/FFWC

SWOT FOR IMPROVING RESERVOIR MANAGEMENT

Faisal Hossain, Bangladesh-IWM, Pakistan-PCRWR, Vietnam-NUCE

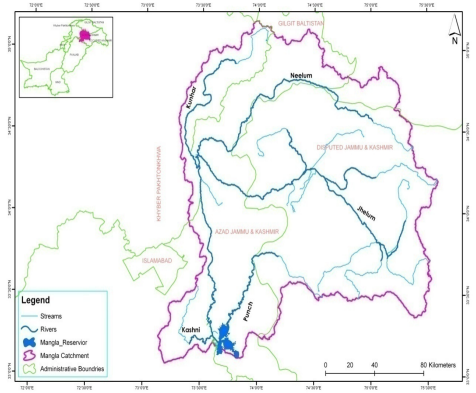
Research Objectives

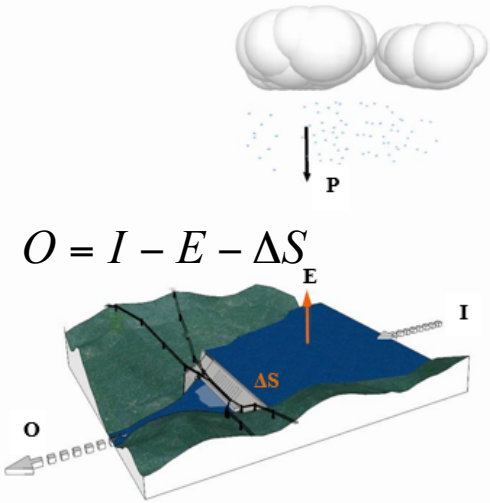
- Assess the value of SWOT data (distributed water elevation and inundated area) for improving reservoir operations (outflow estimation, storage change and inferring rule curves

Team Membership

- Faisal Hossain (UW),
- Matthew Bonnema (UW)
- Stakeholder – Institute of Water Modeling (Bangladesh),
- PCRWR (Pakistan) and NUCE (Vietnam)

Status





Data product/Methodology

- We will apply the following mass-balance approach using SWOT simulator data outlined in Bonnema et al. (2016) –
- Bonnema*, M., S. Sikder, Y. Mao, X. Chen and F. Hossain, I.A. Pervin, S.M. M. Rahman and H. Lee. (2016). Understanding Satellite-based Monthly-to-Seasonal Reservoir Outflow Estimation as a function of Hydrologic controls *Water Resources Res.* , (In revision) (doi: 10.1002/2015WR017830).
- SWOT simulator will be applied on reservoir surface area and height data (derived from altimeter, SRTM, MODIS/ Landsat). Three reservoirs are selected – Mangla or Tarbela (Pakistan), Kaptai (Bangladesh) and a reservoir on Red river (Vietnam)

Schedule and Issues

- Fall 2016 –Spring 2017– start applying simulator on selected resevoirs after reservoir bathymetry is derived from in-situ or non-SWOT data
- Summer 2017-Spiring 2018– assessment of performance of SWOT data in reservoir outflow and storage changes.
- Summer 2018-Spring 2019 – rule curve inference.
- Data and results will all be made available freely

Fusion of SWOT with Coastal Ocean Weather and Ecological Processes

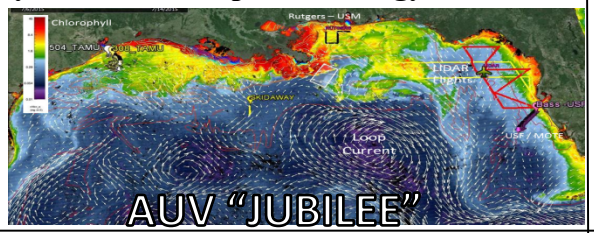
Robert Arnone
University of Southern MS, Dept Marine Science, Stennis Space Center

Research Objectives

1. Integrate and fuse SWOT with ocean weather products for satellites and models in coastal regions.
2. Define if SWOT can be used for adaptive sampling with the Ocean Weather Laboratory .
3. Examine applications of SWOT to support coastal marine ecology.
4. Define SWOT detection of river plumes and estuary processes impact the ecosystem and bio-optical ecology.

Team

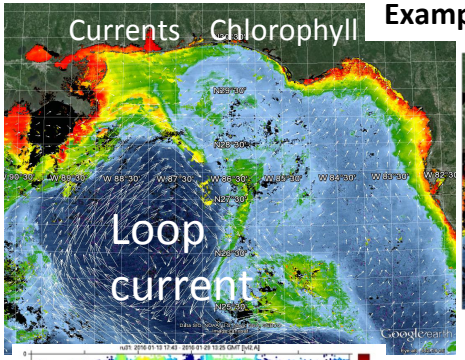
- Pro Robert Arnone
- Dr. Inia Soto
- Dr. K. Cambazoglu
- Dr. Jerry Wiggert
- Dr. Brook Jones

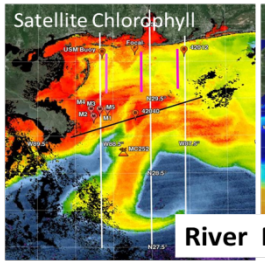


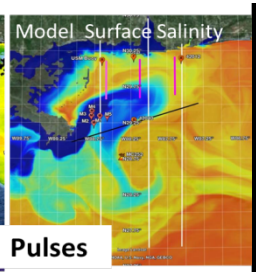
Status - OWX Lab

https://www.usm.edu/marine/research-owx

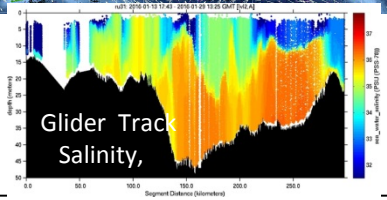
Example OWX products in Gulf of Mexico

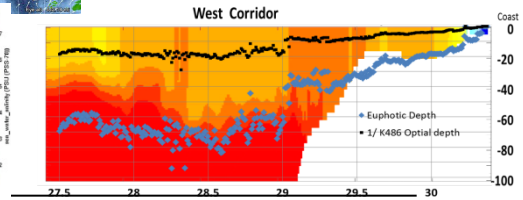






River Pulses





Data product/Methodology

- Ocean Weather Laboratory (OWX) products of models and satellites SST and color and bio-optics (VIIRS)
- Defining Uncertainity with different products (3 Circulation models and satellite bio-optical and observations)
- Gulf of Mexico and coastal estuaries
- Periodic data products available

Ocean Weather Laboratory

Ocean Weather

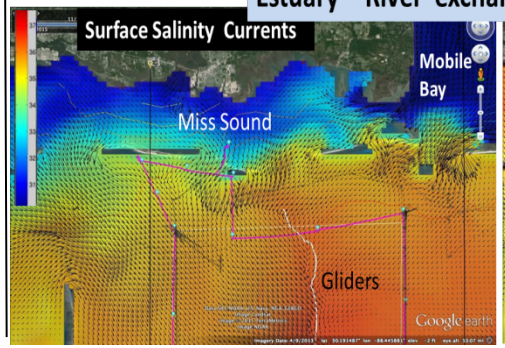
Satellite Products	Model Products
Biology – Chlorophyll	*Sea Surface Temperature*
Light attenuation	*Sea Surface Salinity*
Particles – Backscatter	*Mixed Layer Depth*
Absorption	*Intensity of Mixed Layer*
CDOM	*Sea Surface Height*
Detritus	*Current Vectors*
Phytoplankton	*Current Magnitude*
Sea surface Temperature	*Model Differences*
Sea surface Salinity	*Regional Cross Sections*

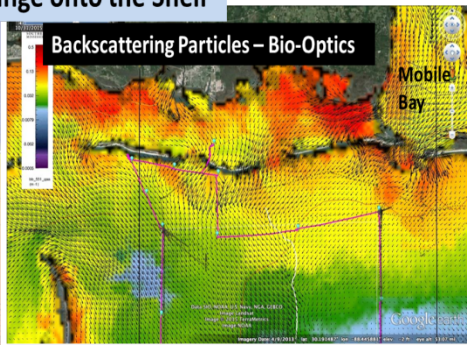
Add SWOT

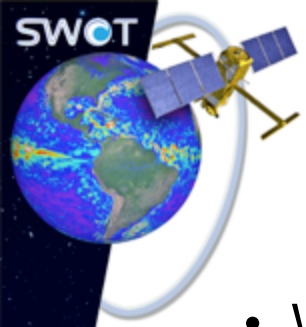
Schedule and Issues

a. Leveraging GOMRI – Concorde and Restore.
b. 2017 Daily Nowcast of ocean weather Products for Gulf of Mexico
c. Integrate SWOT into OWX requires address data availability and format

Estuary – River exchange onto the Shelf







16 Jun, Wednesday, nlt 6 pm SAWG agenda

- Welcome
- Data sets/data access
- Research Early Adopter summaries
- Workshop planning; “Exploring the Utility of Satellite Observations for Water Management Needs of the US”

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Broad Issues

- Where does Applications fit within overall SWOT mission?
- What tools do we have to provide for an effective and relevant SWOT applied science program pre- and post-launch?
- What are some effective (optimal) ways to involve applications and operational agencies?
- How do we promote private industry participation?
- Who is funding this effort? And who is not funding it?
- What are the available and future funding opportunities and programs?
- What synergies and collaborations with other missions (GRACE, Jason-class, GPM, SMAP, etc) will benefit SWOT mission & applications development?

Open Questions & Issues

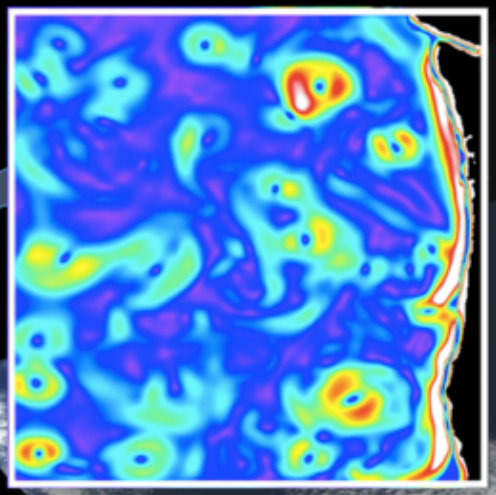
- What applications do users and operational agencies want from SWOT?
- We don’t want to oversell SWOT
- What applications are viable (temporally, spatially, economically)?
  - Solutions must be tailored to local and regional needs and circumstances
  - Real-time data will not be available, but does one- or three-month old data have value?
  - Does the entire time series of the mission data have value for some applications?
- Does global data have applied uses? What are they?

Open Questions & Issues

- What is the role of observations in adaptation/mitigation studies and/or preparations (climate, global change)?
- Will SWOT be useful for observing rapid changes & feedbacks?
- What about sea level trends from SWOT?
- Are there SWOT applications for human health studies (i.e., SREX, 2012)?
- Can we use existing architecture (inputs and data distribution), i.e., IOOS?
- Is there a SWOT role in
  - -- Comprehensive, coordinated observing systems (i.e., IOOS)?
  - -- Long term risk reduction studies?
  - -- Observations coupled with adaptation?

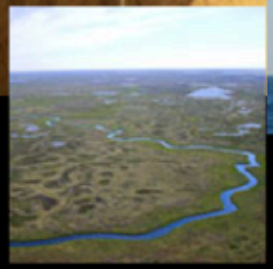
*SREX, 2012 – Special Report on Extremes; http://ipcc-wg2.gov/SREX/images/uploads/IPCC_SREX_slide_deck.pdf

High resolution products



Advanced wide swath technology

Ocean and surface water topography measurements



Supporting societal need

SWOT
SURFACE WATER & OCEAN TOPOGRAPHY

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