

DOCKETED

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Coastal Vulnerability in Ventura County using CoSMoS

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U.S. Department of the Interior
U.S. Geological Survey



Collaborators and funders:



State of California
Ocean Protection Council



What is CoSMoS?

- Physics-based numerical modeling system for assessing coastal hazards due to climate change
- Ongoing development for the last decade
- Utilizes models that have been developed over the past several decades
- Predicts coastal hazards for the full range of sea level rise (0-2, 5 m) and storm possibilities (up to 100 yr storm) using sophisticated global climate and ocean modeling tools
- Emphasis on directly supporting federal and state-supported climate change guidance (e.g., Coastal Commission) and vulnerability assessments (e.g., LCP updates, OPC/Coastal Conservancy grants)
- Designed for community-scale planning

Ventura Pier, December 2015
(Ricky Staub)

What makes CoSMoS unique?

- **Explicit, high-resolution, dynamic modeling of waves, currents, storm surge, flooding, and beach change**
- **Considers the future evolution of storm patterns based on the latest Global Climate Models**
- **Uses state-of-the-art projections of (dynamically-downscaled) winds and waves to calculate surge and seas**
- **Extensively tested, calibrated, and validated with local, historic data on waves, water levels and coastal change**
- **Flood projections are based on dynamic wave set-up, i.e., any area that is wet for at least 1 minute during a storm scenario**
- **Flooding is determined by the dynamic interaction of the evolving profile and ocean conditions during the storm event, including dune erosion and overtopping, and also the preceding long-term evolution of the coast**
- **Coastal change projections are based on a series of strenuously tested, peer-reviewed models, and calibrated by the local behavior of the coast**
- **Predicts the horizontal and vertical evolution of the entire beach profile through time**

The CoSMoS Team* - who are we?

Research Director

Patrick Barnard, Ph.D.



Cliff Modeling

Pat Limber, Ph.D.

Modeling Director

Li Erikson, Ph.D.

Shoreline Modeling

Sean Vitousek, Ph.D.

CoSMoS Manager

Andy O'Neill, M.S.

Field Work

Dan Hoover, Ph.D.

Alex Snyder, M.S.

Hydrodynamic Modeling

Liv Herdman, Ph.D.

Rose Martyr, Ph.D.

Jessica Lovering, Ph.D.

Director of Outreach

Juliette Hart, Ph.D.

Global Wave Modeling

Christie Hegermiller, Ph.D.

candidate

GIS

Amy Foxgrover, M.S.

*collectively over 150 years of experience in numerical modeling, oceanography, civil engineering, atmospheric science, and coastal geology

The CoSMoS Team- who are we?

DEMs

Jeff Danielson, Dean Tyler (USGS EROS Data Center)

Socioeconomics

Nate Wood, Jeanne Jones, Matt Jamieson (USGS Western Geographic Science Center)

Our Coast – Our Future Web Tool

Michael Fitzgibbon, Maya Haden, Sam Veloz, Grant Ballard, Julian Wood (Point Blue)

Modeling Support

Maarten van Ormondt, Edwin Elias (Deltares)

Dynamical Downscaling

Dan Cayan, David Pierce (Scripps)

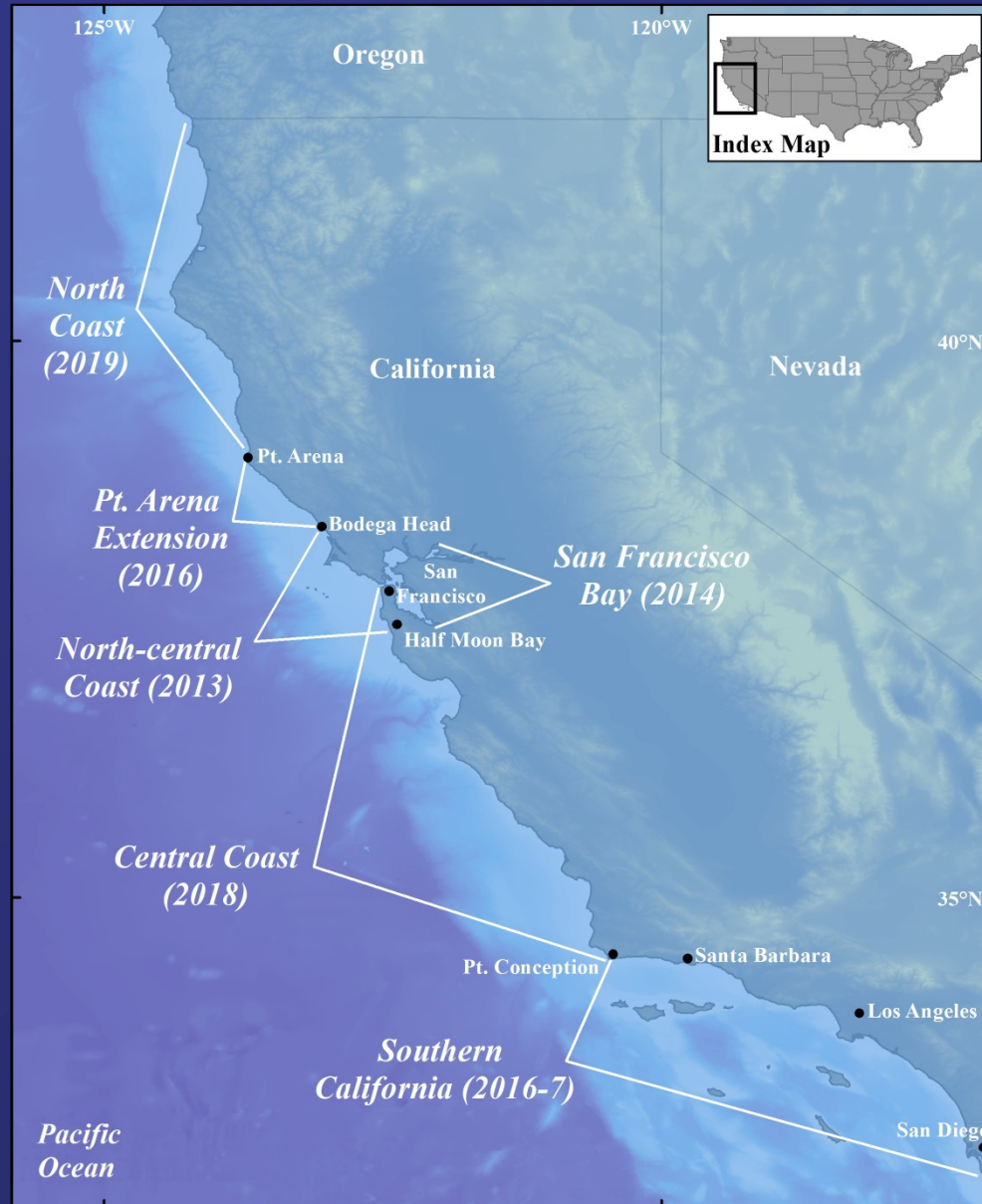
Statistical Downscaling

Fernando Mendez (U. of Cantabria)

Additional Collaborations

Oregon State University (Ruggiero), U. of Hawaii (Fletcher), UC Berkeley (Stacey)

Where has CoSMoS been applied?



Who uses CoSMoS?

County

- Sonoma County
- Marin County
- Santa Mateo County
- Santa Clara County
- Santa Barbara County
- Los Angeles County
 - Office of Emergency Management
 - Department of Beaches and Harbors
- San Diego County

Federal

- National Park Service
- NOAA Gulf of Farallones National Marine Sanctuary
- NOAA Office for Coastal Management
- National Estuarine Research Reserve (NOAA)

State

- California Coastal Commission
- California Coastal Conservancy
- California Department of Emergency Services (CalOES)
- California Department of Fish & Wildlife
- California Department of Transportation (CalTrans)
- California Energy Commission
- California Natural Resources Agency
- California Ocean Protection Council

Who uses CoSMoS?

City

- City of San Francisco
- City of Pacifica
- City of San Jose
- City of Santa Barbara
- City of Los Angeles
- City of Santa Monica
- City of Hermosa Beach
- City of Long Beach
- City of Huntington Beach
- City of Imperial Beach
- City of Oceanside
- City of Encinitas
- City of Carlsbad
- City of San Diego
- City of Imperial Beach

Regional Scale

- AdaptLA: Coastal Impacts Planning for the LA Region
- California Climate Science Alliance
- Coastal Ecosystem Vulnerability Assessment (CEVA, Santa Barbara)
- LA Regional Collaborative on Climate Action and Sustainability (LARC)
- Regional Water Quality Control Board for LA and Ventura Counties
- San Diego Regional Climate Collaborative
- Southern California Coastal Water Research Project (SCCWRP)
- Wetlands Recovery Projects (San Diego - Orange County region & LA - Ventura - Santa Barbara region)

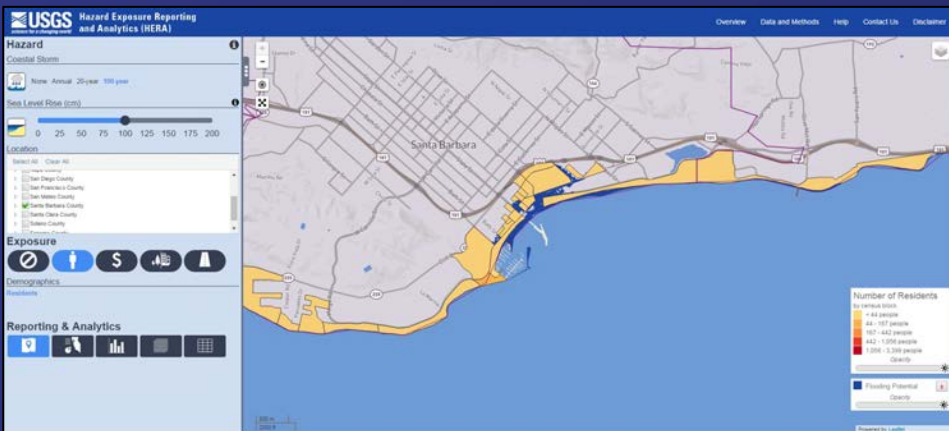
Where can I get more information?

USGS CoSMoS website: http://walrus.wr.usgs.gov/coastal_processes/cosmos/

Data and detailed technical report: <https://www.sciencebase.gov/catalog/item/5633fea2e4b048076347f1cf>

Our Coast - Our Future tool: www.ourcoastourfuture.org, <http://beta.ourcoastourfuture.org>

HERA Tool: www.usgs.gov/apps/hera



Supporting References

(peer-reviewed)

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- Thatcher, C.A., Brock, J.C., Danielson, J.J., Poppenga, S.K., Gesch, D.B., Palaseanu-Lovejoy, M.E., Barras, J.A., Evans, G.A., and Gibbs, A.E., 2016, Creating a Coastal National Elevation Database (CoNED) for science and conservation applications: *Journal of Coastal Research*, SI no. 76, p. 64–74, at <http://dx.doi.org/10.2112/SI76-007>
- Vitousek, S., Barnard, P.L., Limber, P., Erikson, L.H. and Cole, B., in press. A model integrating longshore and cross-shore processes for predicting long-term shoreline response to climate change. *Journal of Geophysical Research-Earth Surface*, <http://dx.doi.org/10.1002/2016JF004065>

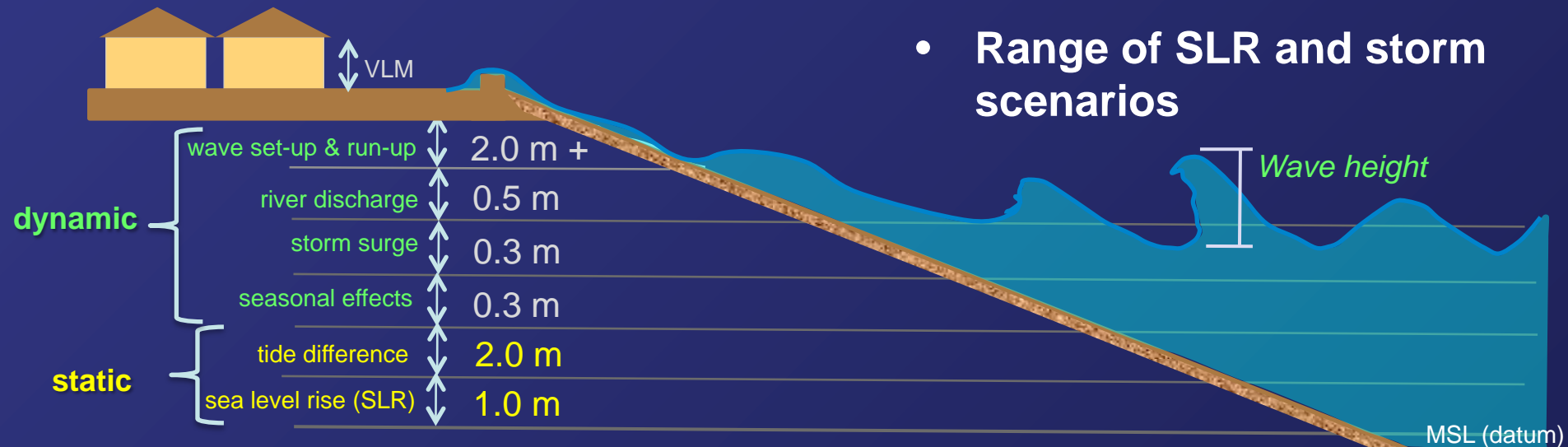
What's included in CoSMoS approach?

Static: SLR Viewer (“bathtub”)

- Passive model, hydrological connectivity
- Tides only
- ‘1st order screening tool’

Dynamic: USGS CoSMoS

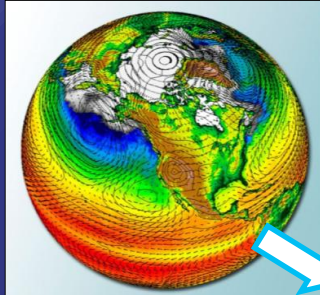
- All physics modeled
- Forced by Global Climate Models
- Includes wind, waves, atmospheric pressure, shoreline change
- Range of SLR and storm scenarios



CoSMoS 3.0 Southern California

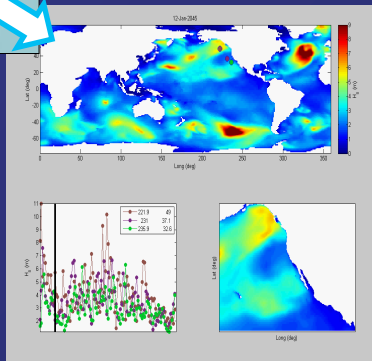
Global

Global climate models (GCMs)



GCM winds

WW3 wave model



SIO downscaled winds and SLPs

Regional

Tides, water levels, and regional forcing
Delft3D FLOW model

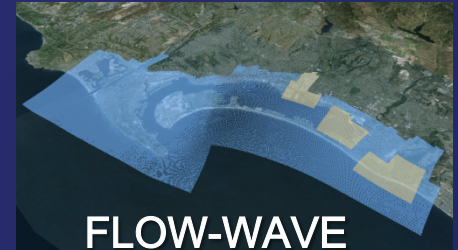


SWAN wave model

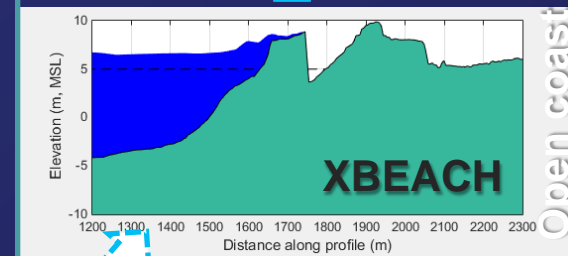
Long-term cliff recession and shoreline change

Local

High resolution hydrodynamics, waves, & fluvial discharge



FLOW-WAVE



results projected onto hi-res DEM

CoSMoS Validation

CoSMoS model components and performance validated:

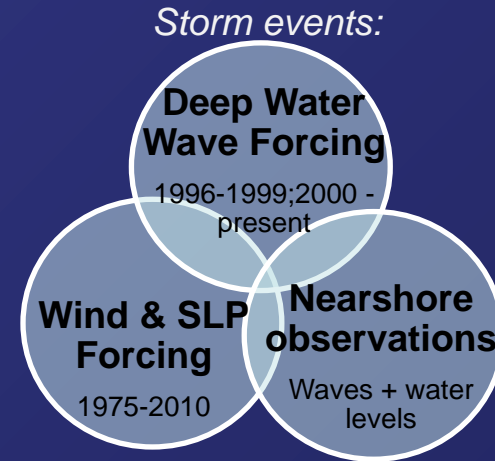
- Extensive historical data including storms

Nov/Dec 1982

Dec 2005

Jan 2010

- Water levels – across the Bight
- Waves – buoys
- Wave runup
- Storm-driven morphodynamic change – XBeach
- Long-term shoreline change – CoSMoS Coast



CoSMoS validation

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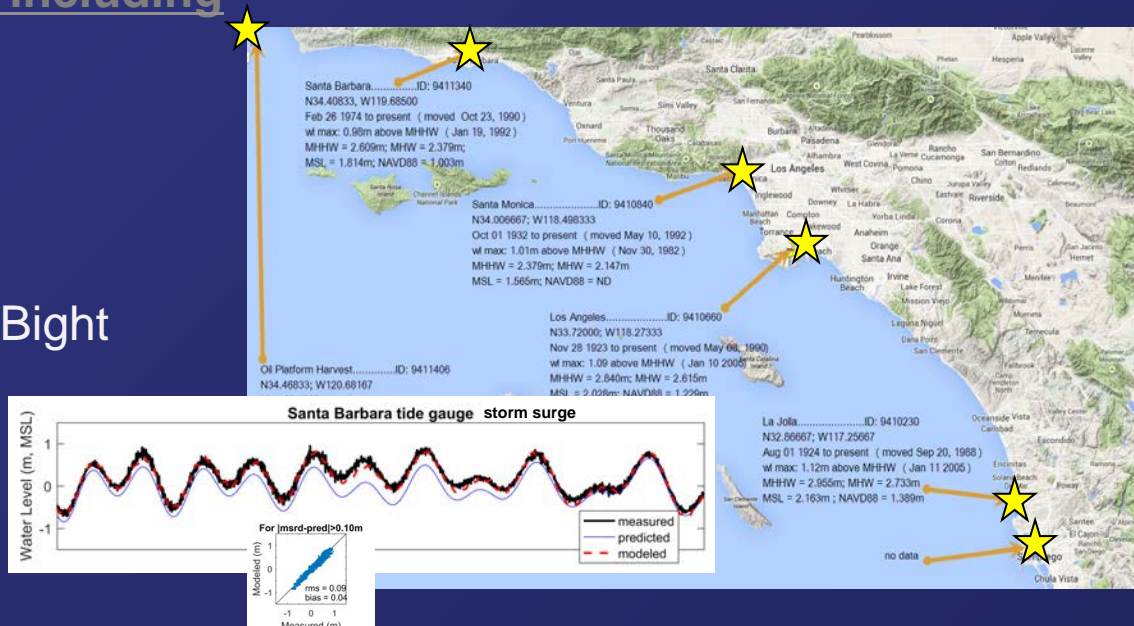
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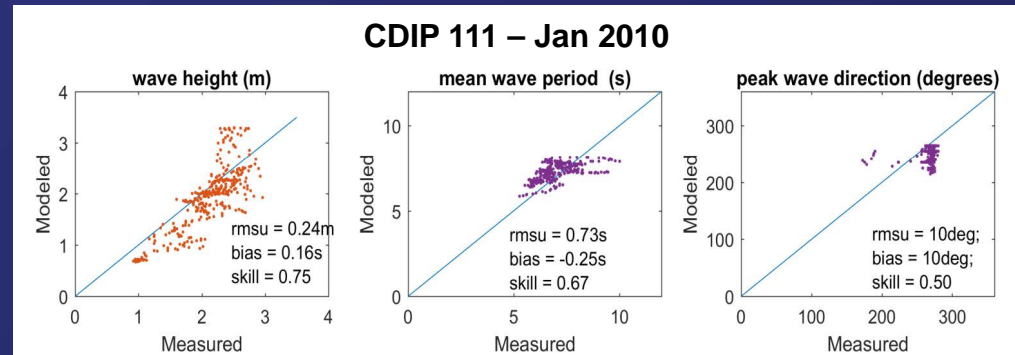
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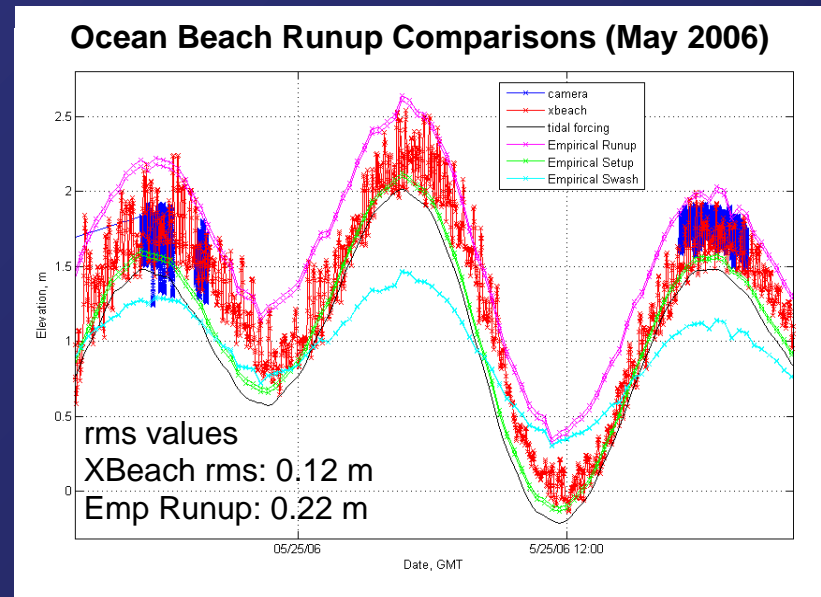
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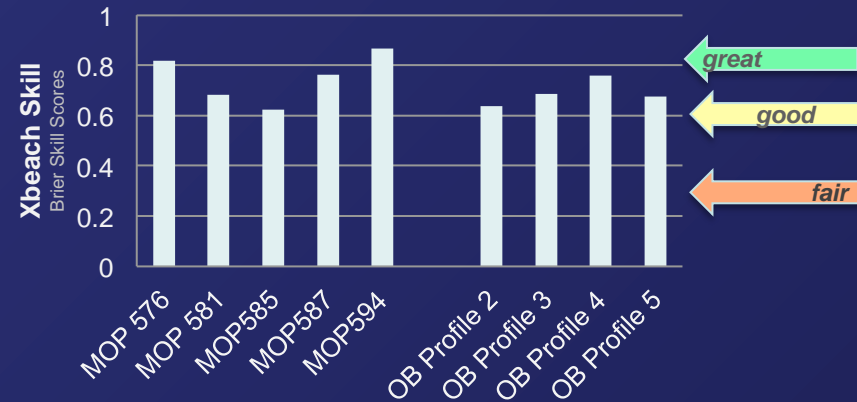
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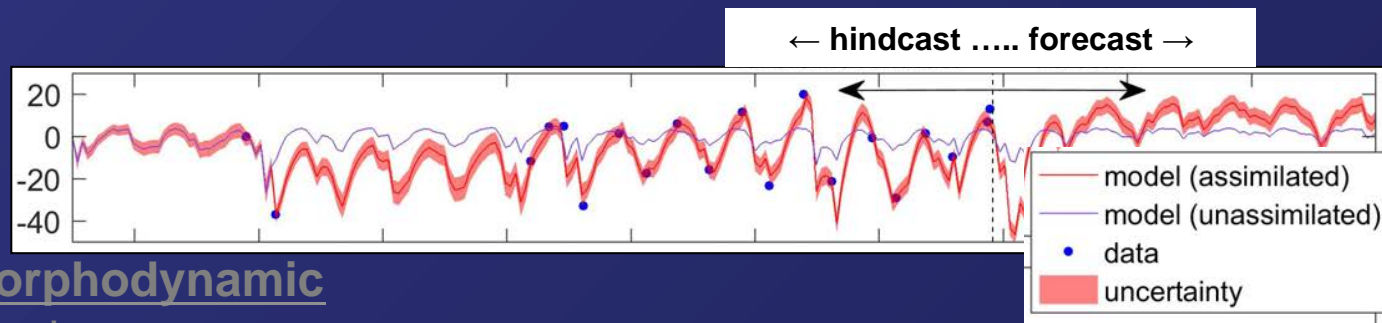
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- Long-term shoreline change – CoSMoS-COAST

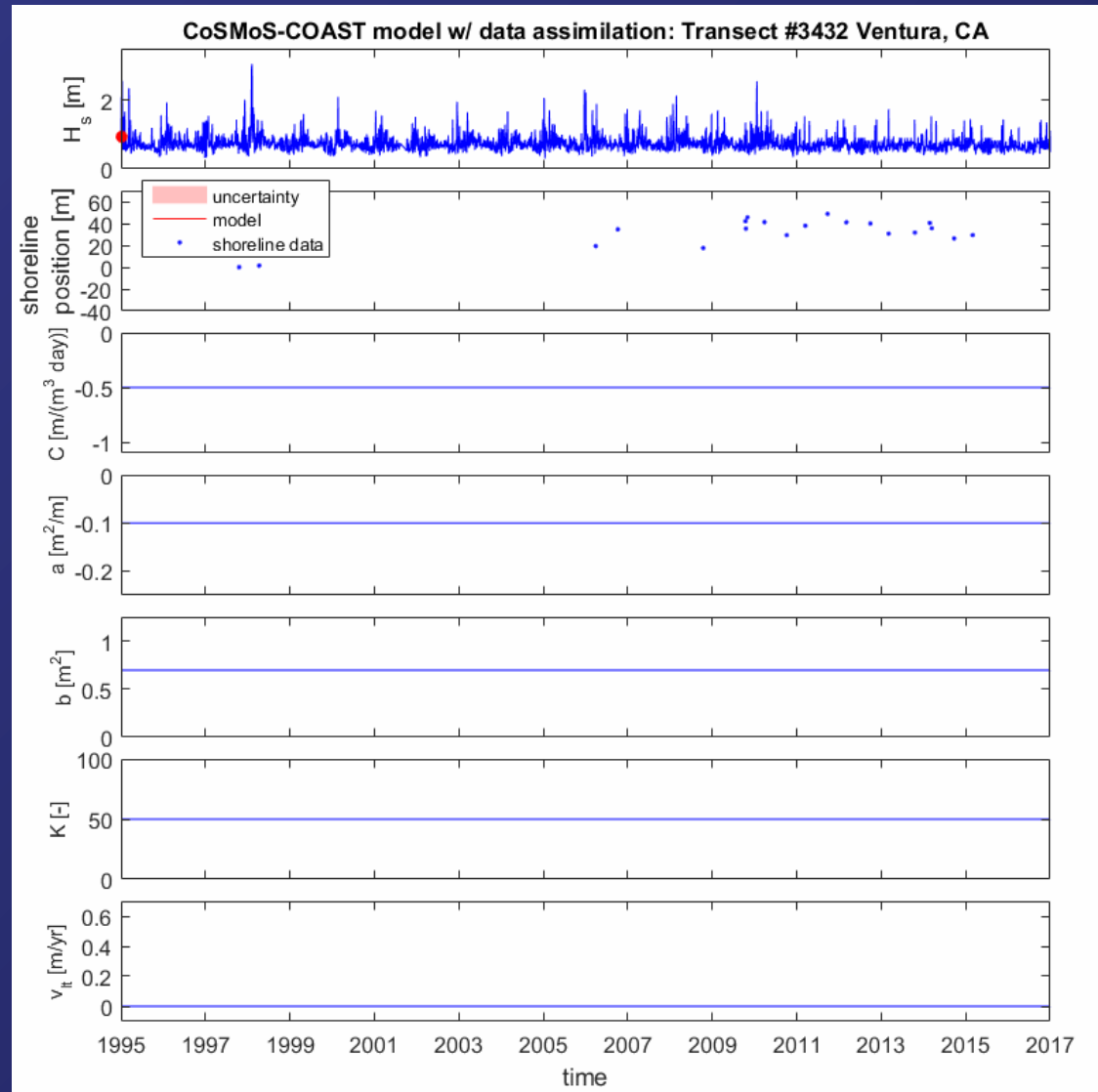
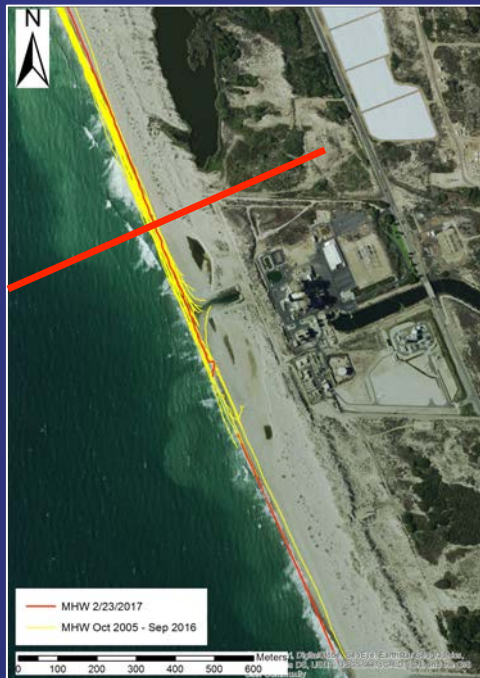


CoSMoS-COAST

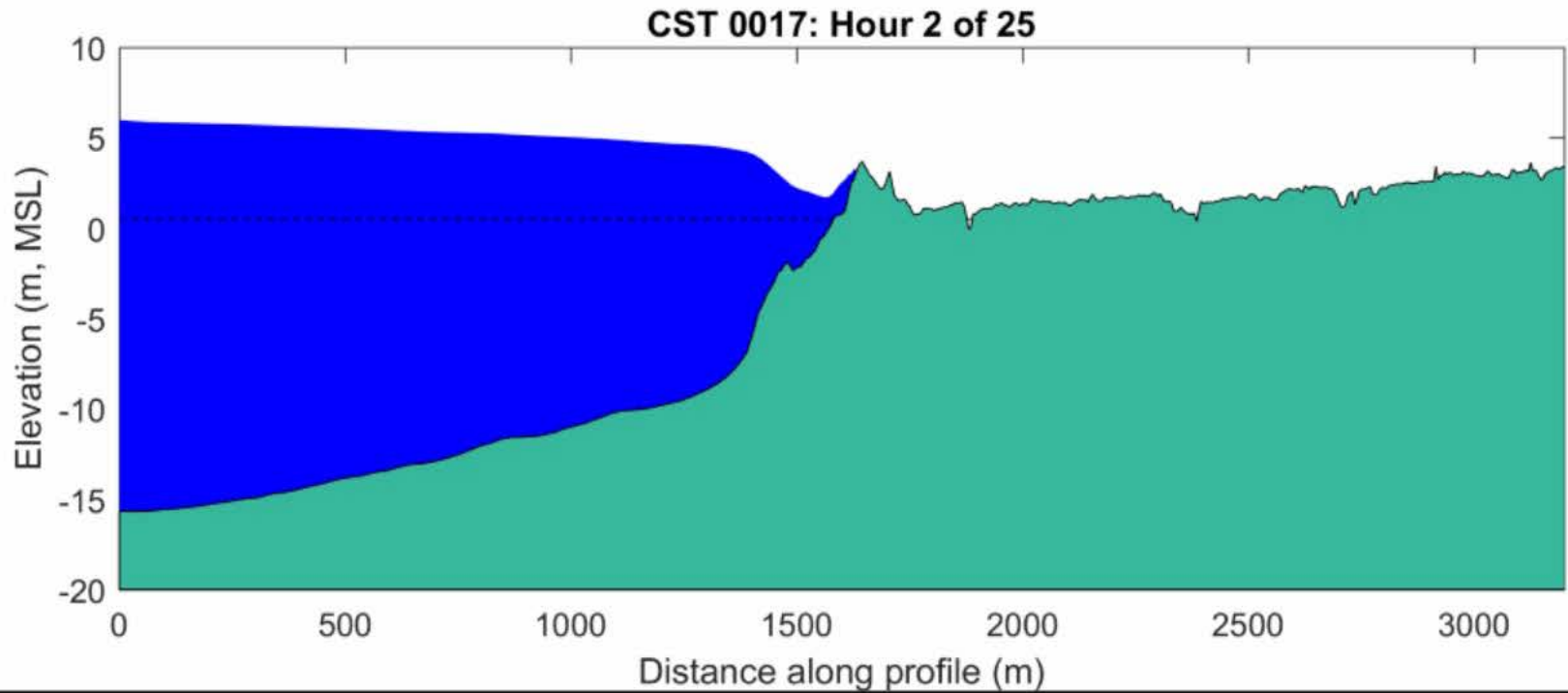
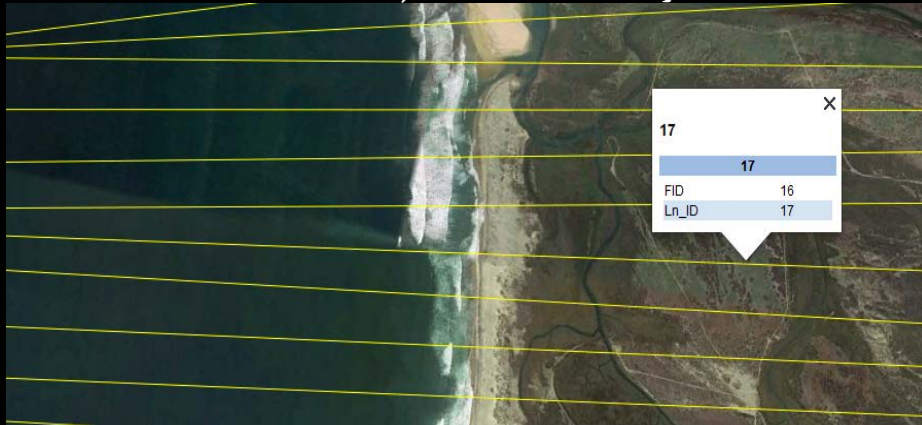
We use the *extended Kalman filter method* of Long & Plant 2012

- Auto-tunes model parameters for each transect to best fit the historical shoreline data
- We improved the method to handle sparse shoreline data and ensure that parameters are positive or negative.

Simulation output for a single transect at study site:

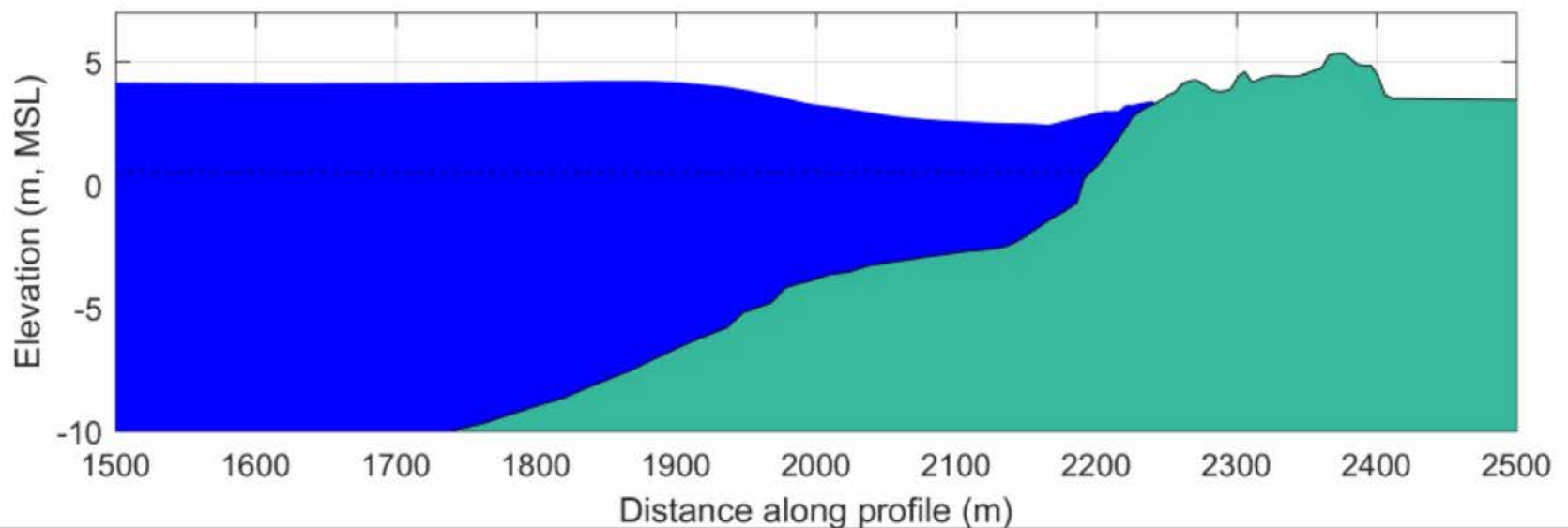
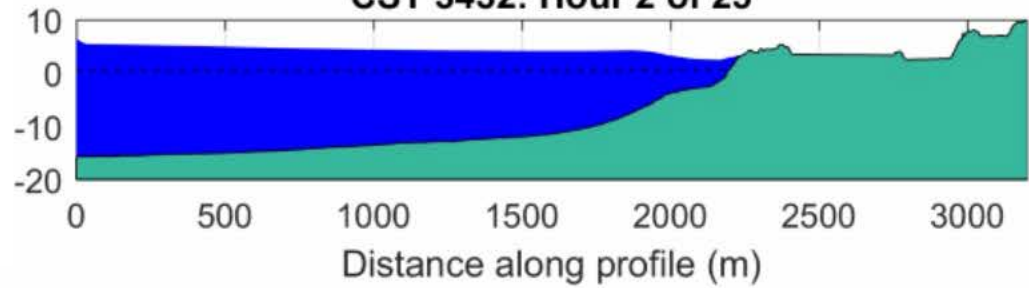


Dune field near Tijuana Estuary - XBeach simulation

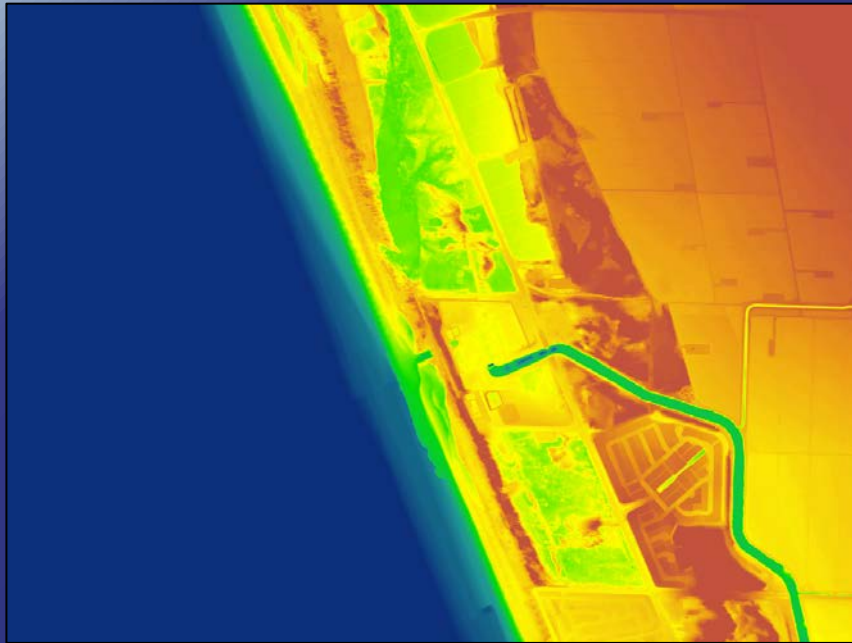




CST 3432: Hour 2 of 25



DEM and Computational Grids



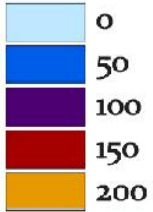
DEM: 2 m horizontal resolution

Hydrodynamic grids: 20 x 40 m



Flooding Projections for 100 year storm- Phase 1

100-year storm
flood extent
SLR scenario (cm)



2050 = ~50 cm SLR






Google

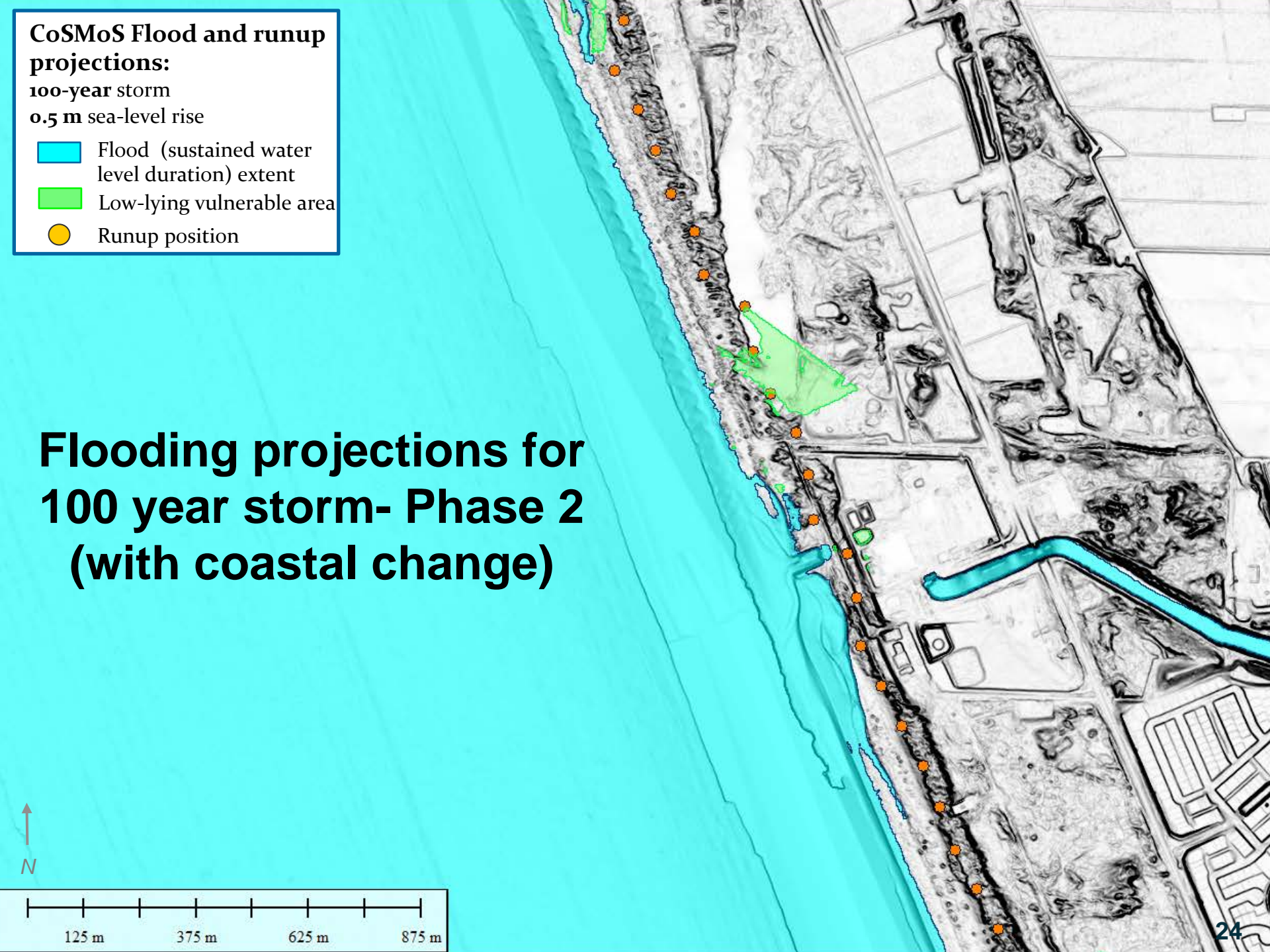
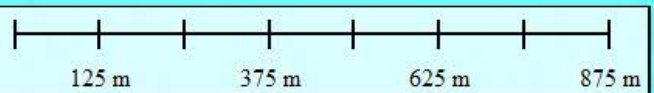
CoSMoS Flood and runup projections:

100-year storm

0.5 m sea-level rise




-  Flood (sustained water level duration) extent
-  Low-lying vulnerable area
-  Runup position

Flooding projections for 100 year storm- Phase 2 (with coastal change)

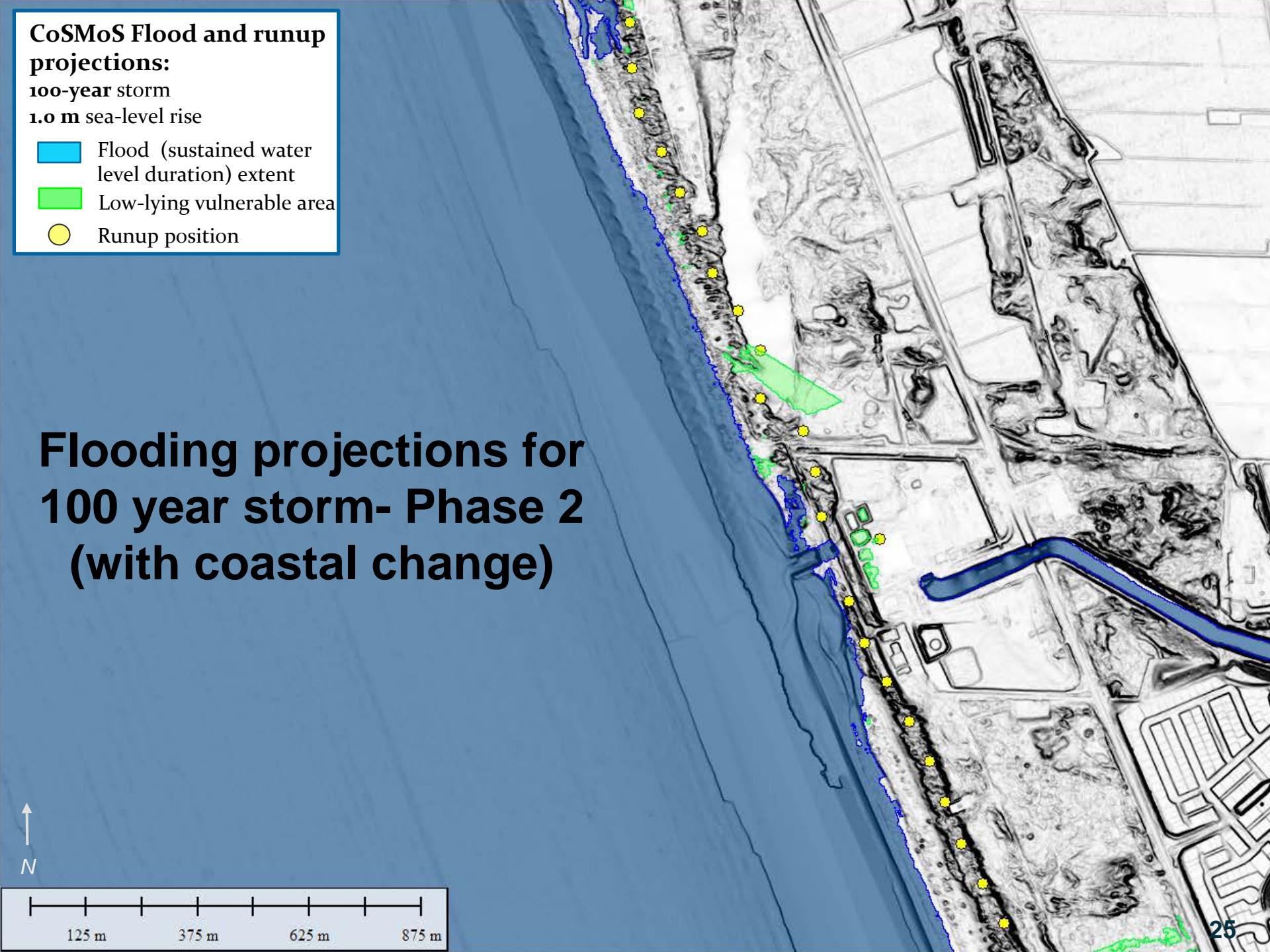
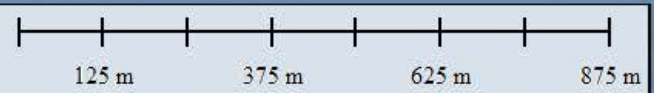


CoSMoS Flood and runup projections:

100-year storm
1.0 m sea-level rise

-  Flood (sustained water level duration) extent
-  Low-lying vulnerable area
-  Runup position

Flooding projections for 100 year storm- Phase 2 (with coastal change)



Shoreline Projections for 2050

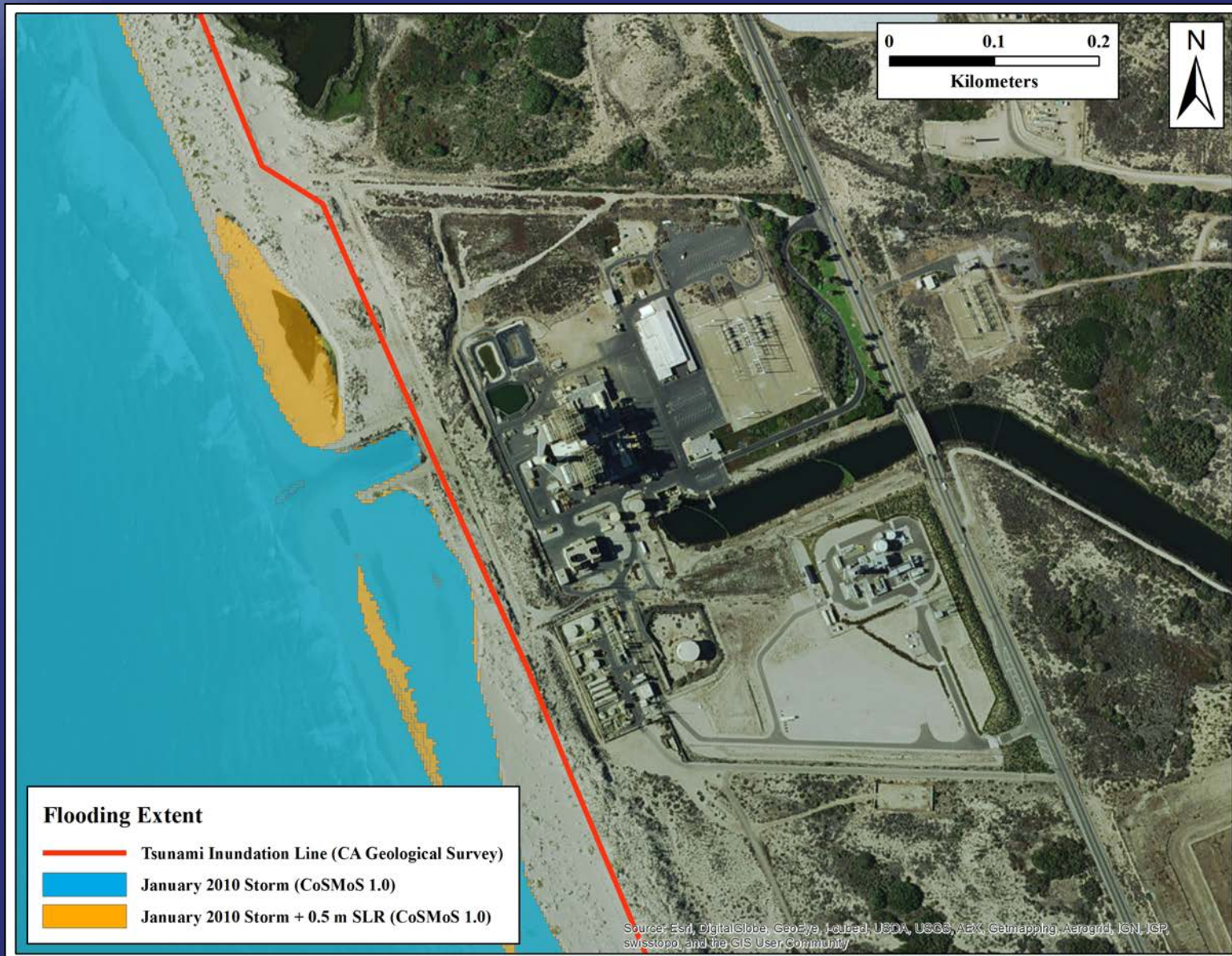
2100 shoreline position

SLR scenario (m)

- 0
- 0.5
- 1.0
- 1.5
- 2.0
- 5.0



Tsunami Risk



Future Conditions

SLR for Los Angeles (National Research Council)

- 28 cm of sea level rise by 2050 (range 13-61 cm)
- 93 cm of sea level rise by 2100 (range 44-167 cm)
- includes global and regional effects

Pending State SLR Guidance for 2100

- 20 cm to 52 cm of sea level rise by 2050
- 74 cm to 287 cm of sea level rise by 2100

Waves

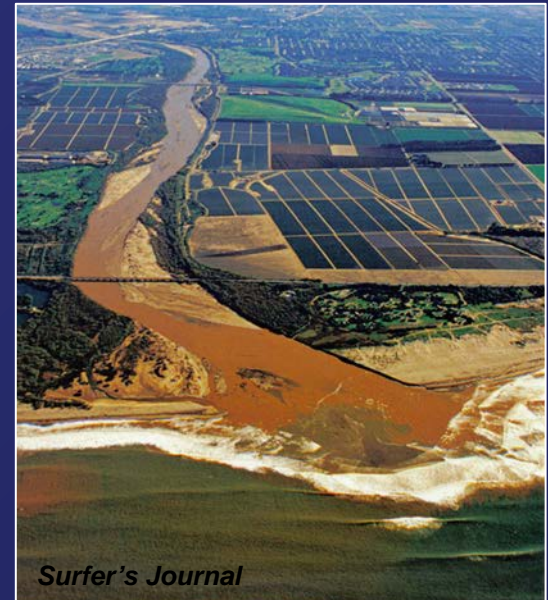
- No significant changes in wave height, possible decrease
- More south swell influence

Atmospheric Patterns

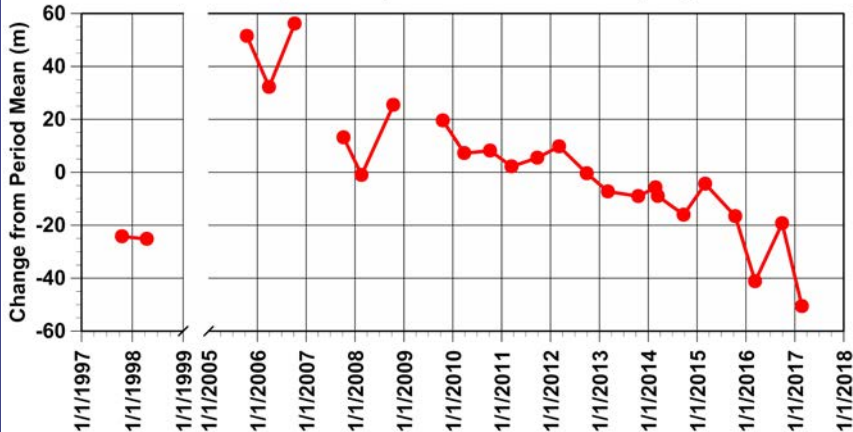
- Potential for more extreme El Niño events
- Storm tracks possibly moving north

Sediment Inputs

- Episodic (normal)
- Longer droughts but higher intensity rainfall events



South Ventura Mean High Water Contour Position, 1997 - 2017
Includes preliminary data for Fall 2016 and Spring 2017



CoSMoS Highlights

- **Extensively tested and validated** for waves, extreme water levels and coastal change, including with local historic storm events
- **40 plausible future scenarios**
- **Downscaled winds** from Global Climate Models (GCMs) (SIO)
- **Downscaled waves** from GCMs (dynamically, not statistically downscaled)
- **High resolution grids** of lagoons, protected areas, and high-interest areas
- **Long-term coastal evolution** (CoSMoS-COAST)
- **Short-term beach and dune response** (XBeach)
- **Long- and short-term coastal change** (i.e., beaches, dunes and cliffs) **integrated into coastal flooding projections**
- **Discharge from rivers** for event response
- **Vertical land motion** factored into flood potential layer
- **Web-based tool** that includes data visualization and download and socio-economic summaries

Conclusions

- All phases of CoSMoS results show no significant risk of flooding to project site for 100 yr storm event at ~2050 (50 cm SLR) or for decades after
- Models developed are state-of-the-art
- Dune fields are dynamic
- Multiple lines of evidence from models and observations should be considered to assess risk
- CoSMoS final results for Ventura County to be released end of April

*For more information, contact Patrick Barnard: pbarnard@usgs.gov

USGS CoSMoS data: http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Our Coast - Our Future tool: www.ourcoastourfuture.org, <http://beta.ourcoastourfuture.org>

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