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science for a changing world

Climate Change Impacts to the Los Angeles Shoreline

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lacurbed.com

What is the problem?

- Climate change, including sea level rise, changing wave climates, and storms will place additional stresses on coastal systems worldwide
- Coastal flooding from SLR alone could displace ~200 million people by 2100
- Nationally, $1.4 trillion of coastal property could be at risk at high tide by the end of the century
- 500,000 people, one million jobs, and $100 billion in property are threatened by climate change along the California coast over the next century
- In Los Angeles County: 4,000 people and $4 billion in property at risk per Pacific Institute Report (not inclu. river discharge, waves, coastal change, changes in storms, etc.)
- 1982-83 El Niño storms caused ~$2.2 billion in storm damage to California, $1.1 billion in 1997-98

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Projections for Southern California

SLR for Los Angeles (NRC, 2012)

-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 (e.g., wind and circulation patterns, sea level fingerprint, glacial isostatic adjustment, tectonics)

Storms for Southern California (Bromirski et al., 2012; USGS)

-No significant changes in wave height

-Extreme events approach from ~10-15 degrees further south

El Niño for 21st Century (Cai et al., 2015, Barnard et al., 2015)

-More frequent extreme events

-Doubling of winter erosion

-Wave energy increase by 30%

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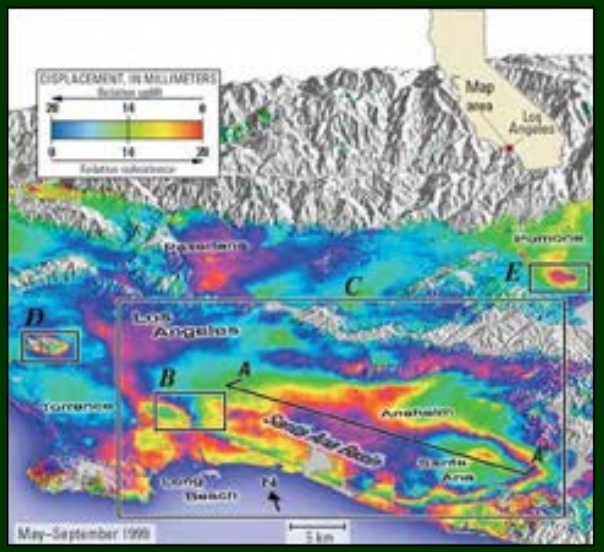
Coastal Vulnerability Considerations

- **Global factors:**
  - **Eustatic sea level**

- **Regional factors:**
  - **Ocean circulation patterns**
  - **Glacial fingerprinting**
  - **Tectonics (large-scale)**
  - **Isostasy**

- **Local factors:**
  - **Subsidence**
  - **Local tectonic deformation**
  - **Fluvial discharge AND sediment supply changes**
  - **Development and restoration**

- **Seasonal and storm impacts:**
  - **Steric effects**
  - **Waves and storm surge**
  - **River discharge**



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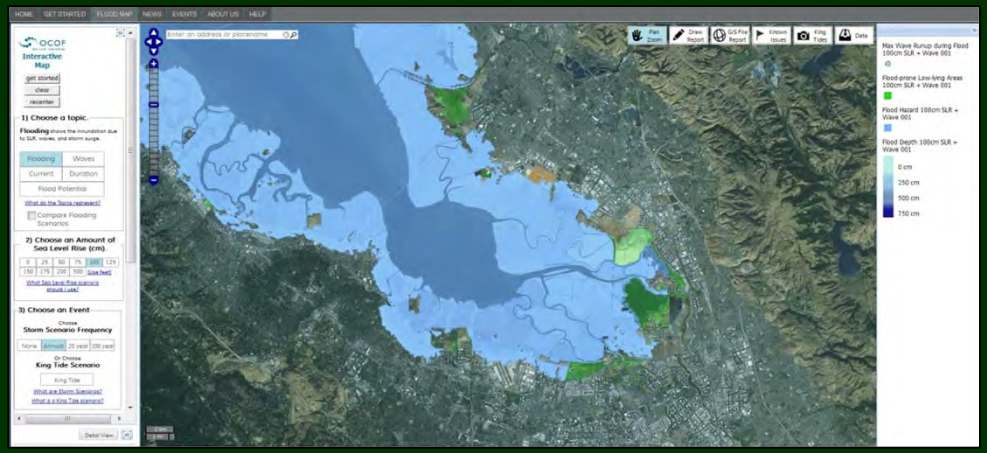
Coastal Vulnerability Approaches

- **STATIC: NOAA SLR Viewer**
  - –Passive model, hydrological connectivity
  - –Tides only (MHHW)
  - –Excellent elevation data, datum control
  - –Wetland migration model, socioeconomic impacts
  - –'1st order screening tool'

http://www.coast.noaa.gov/slr/

- **DYNAMIC: CoSMoS**
  - –GCM ensemble forcing
  - –Includes wind, waves, sediment transport, fluvial discharge, and vertical land movement rates
  - –Range of SLR and storm scenarios
  - –Flooding extent explicitly modeled, hydrological connectivity



Our Coast Our Future: *www.prbo.org/ocof*

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CoSMoS: A Tool for Coastal Resilience

- Physics-based numerical modeling system for assessing coastal hazards due to climate change
- 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
- Developing coastal vulnerability tools in collaboration with federal, state, and city governments to meet their planning and adaptation needs


Gary Griggs, UCSC

Brad Graverson, January 2010

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CoSMoS Version Summary

CoSMoS 1.0

- So Cal, 470 km coastline (Pt. Conception -> Mexico border)
- Historical storms, 2 SLRs
- Global & regional parts continue to run operationally

CoSMoS 2.0

- North-Central CA coast, 170 km, (Bodega Head to Half Moon Bay)
- 21st century winds & waves
- High resolution grids of lagoons and protected areas
- Annual, 1 yr, 20 yr, 100 yr storm events in combination with SLR 0 m to 5 m at 0.25 m increments +5 m
- Web-based tool

CoSMoS 2.1

- San Francisco Bay
- Spatial- & time-downscaled climate scenario winds
- Fluvial discharges
- Vertical land motion
- Marsh accretion

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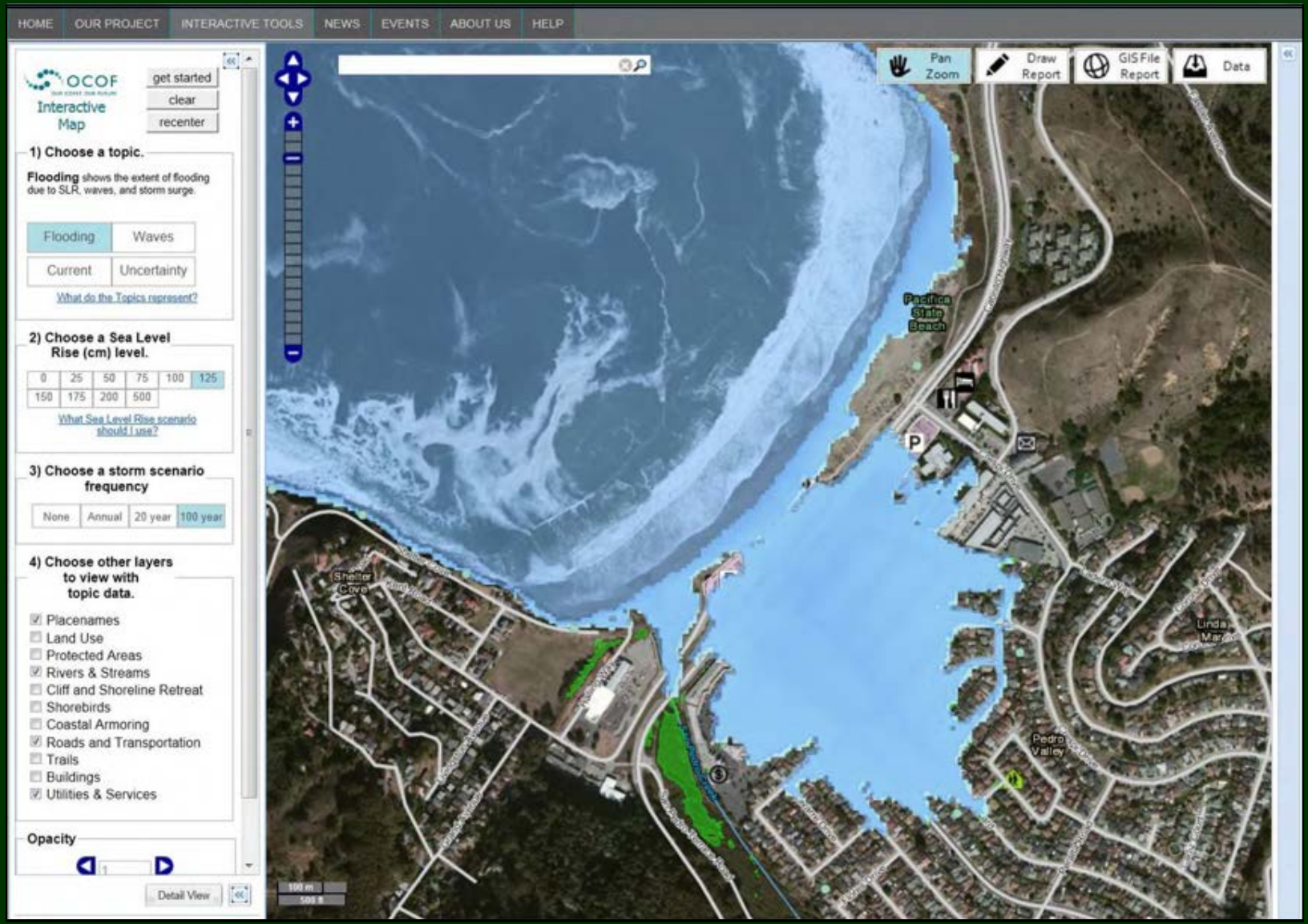
CoSMoS 2.0- CenCal/NorCal



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www.prbo.org/ocof **(Our Coast - Our Future)**

SoCal CoSMoS Version Differences

CoSMoS 1.0

- So Cal, 470 km coastline (Pt. Conception -> Mexico border)
- Historical storms, 2 SLRs
- Global & regional parts continue to run operationally

CoSMoS 3.0 (updated SoCal)

- So Cal, 470 km coastline (Pt. Conception -> Mexico border)
- Future waves downscaled within the Pacific Basin using global climate model (GCM) winds
- Space- & time- downscaled local winds and sea level pressures
- High resolution grids of lagoons and protected areas
- Fluvial discharges
- 100 yr storm events in combination with SLR 0 m to 1.5 m in 0.5 m increments
- Shoreline change: both cliffs and sandy coast

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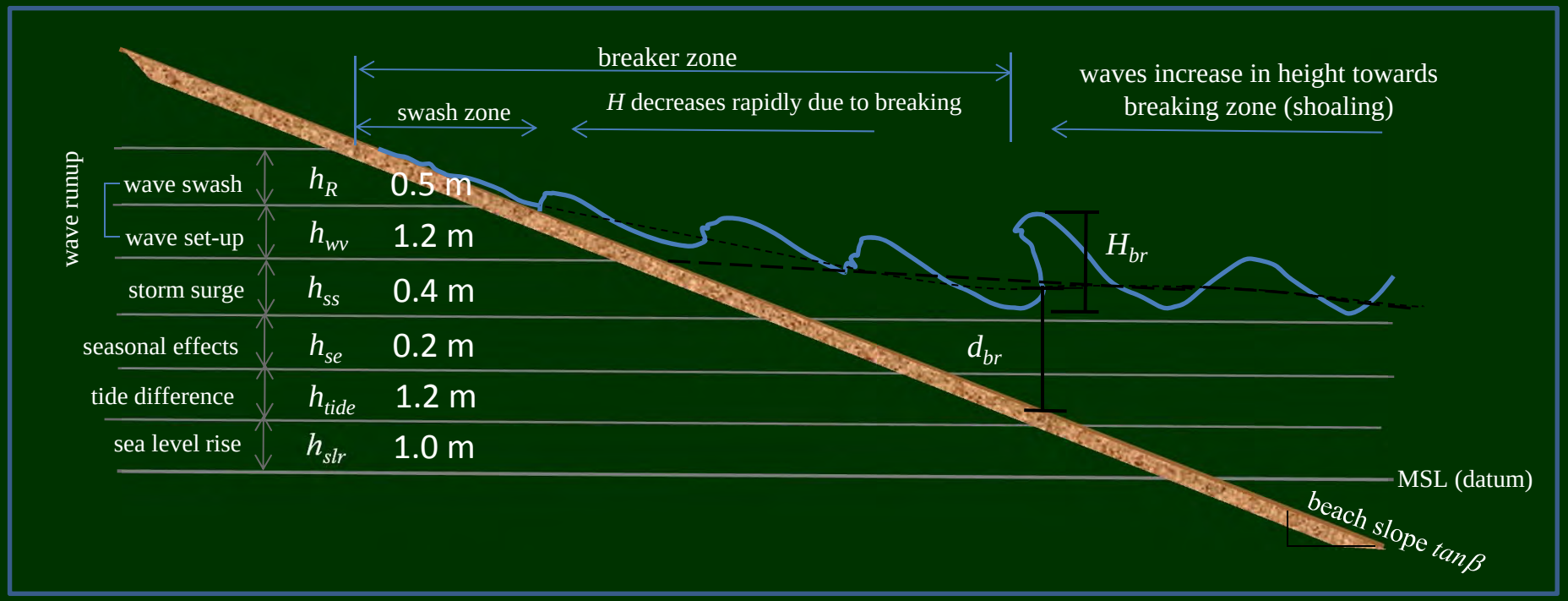
Overview of Processes Included in CoSMoS



flood level is the combination of

$$rSLR + tides + seasonal\ effects + storm\ surge + wave\ setup + wave\ runup + fluvial\ discharge\ backflow$$

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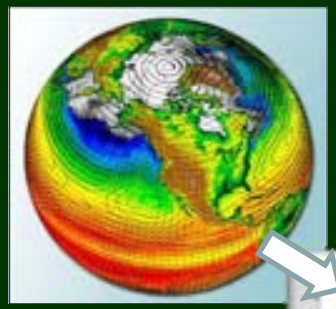
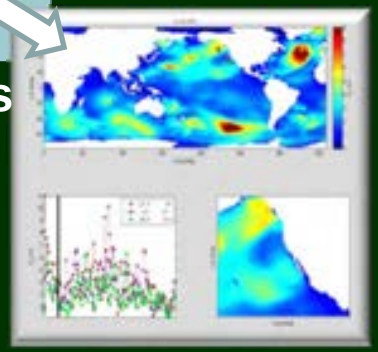
CoSMoS 3.0 Southern California

Global

Global conditions of future climate scenarios



GCM winds



WW3 wave model

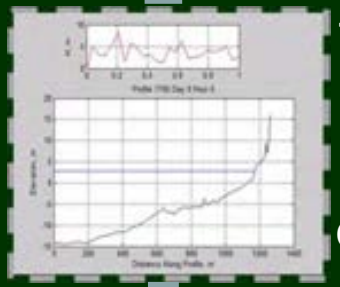
Regional

Tides, water levels, and regional forcing

Local

High resolution hydrodynamics and

XBEACH



Open coast

Fluvial discharge
VLM
Coastal change

results projected onto hi-res DEM

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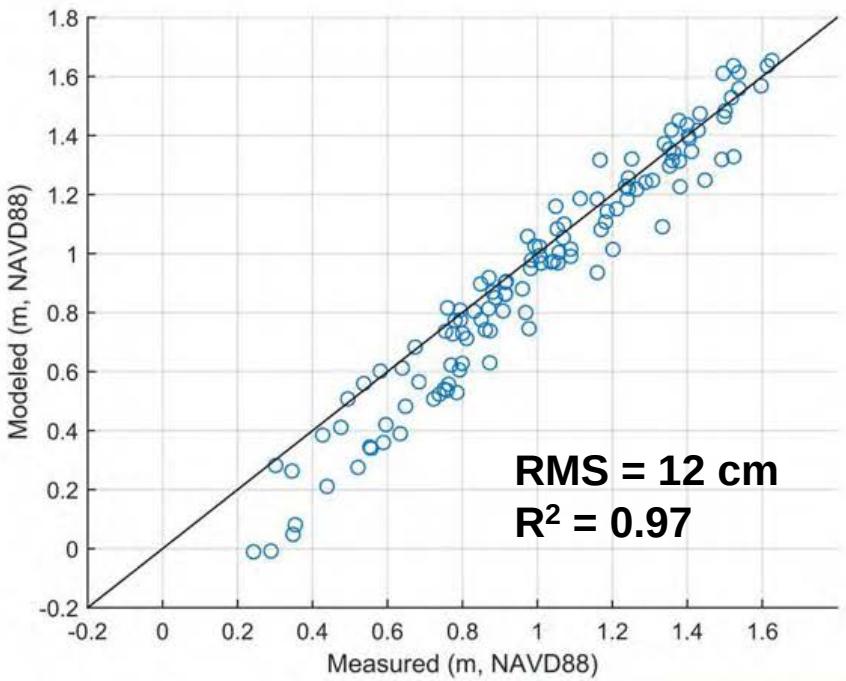
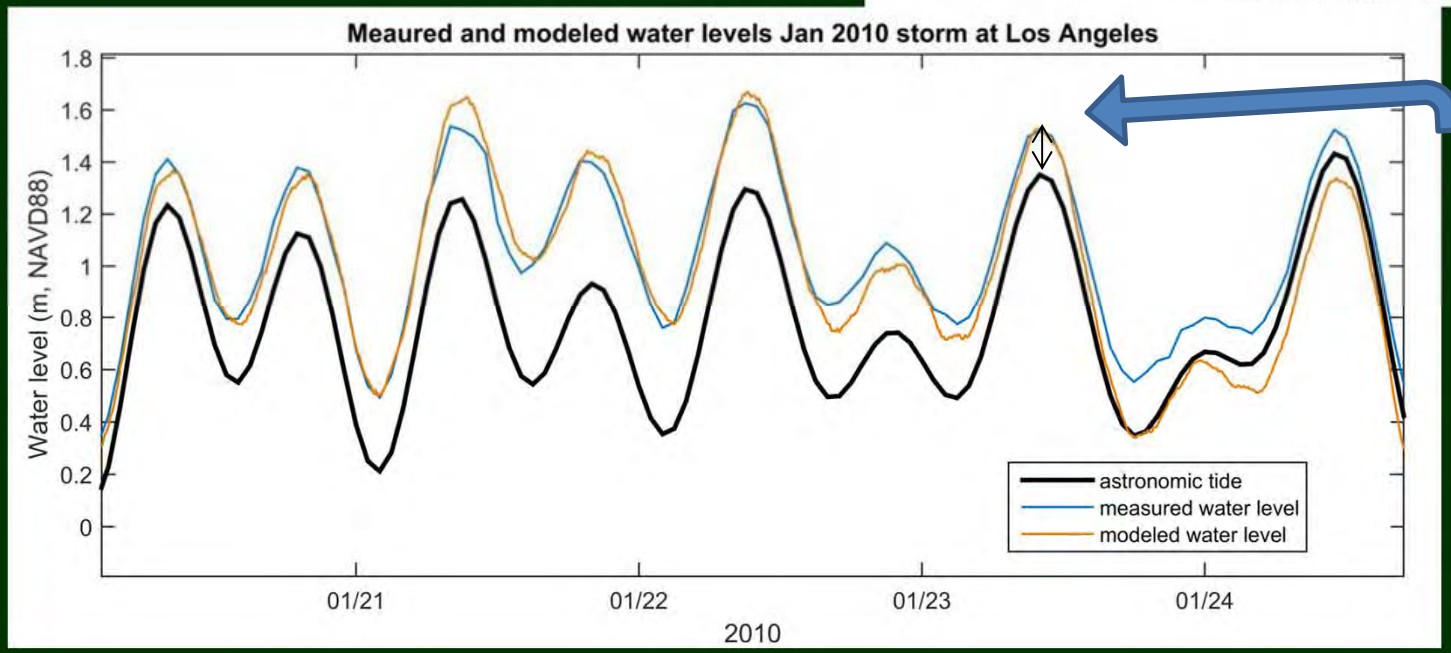
CoSMoS Coastal Storm Modeling System USGS

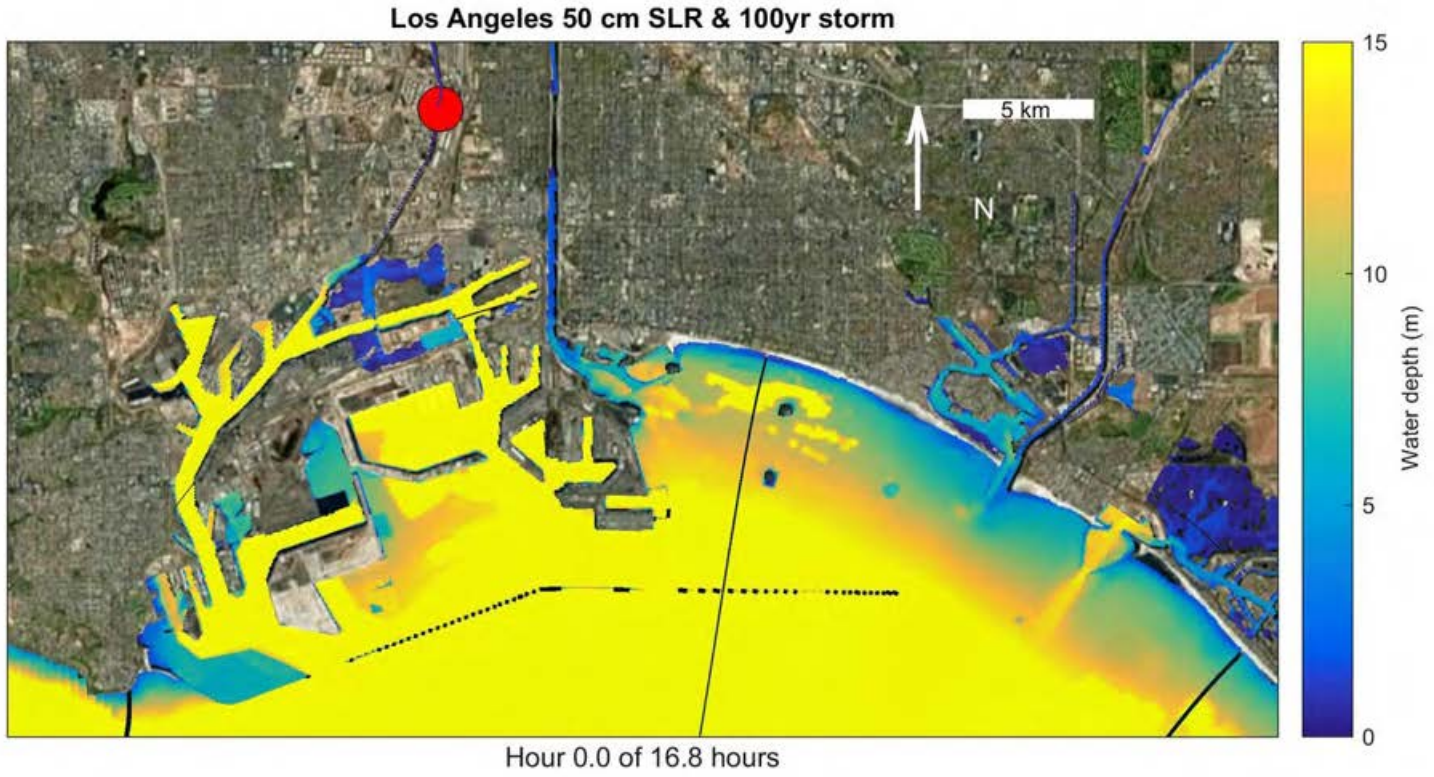
CoSMoS validated with January 2010 Storm

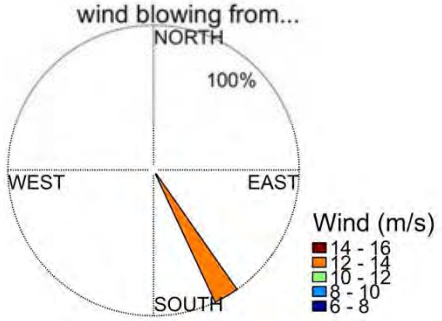
Los Angeles tide gauge

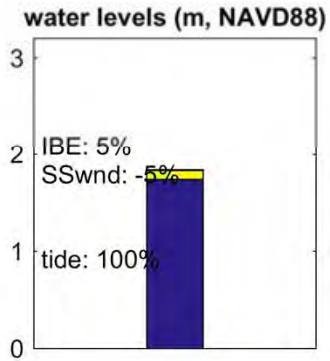


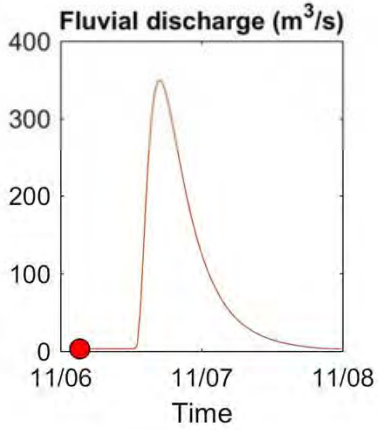


Predicted and observed/modeled water levels differ by 6 to 52 cm


Los Angeles 50 cm SLR & 100yr storm
5 km
N
15
10
5
0
Water depth (m)
Hour 0.0 of 16.8 hours


wind blowing from...
NORTH
100%
WEST
EAST
SOUTH
Wind (m/s)
14 - 16
12 - 14
10 - 12
8 - 10
6 - 8

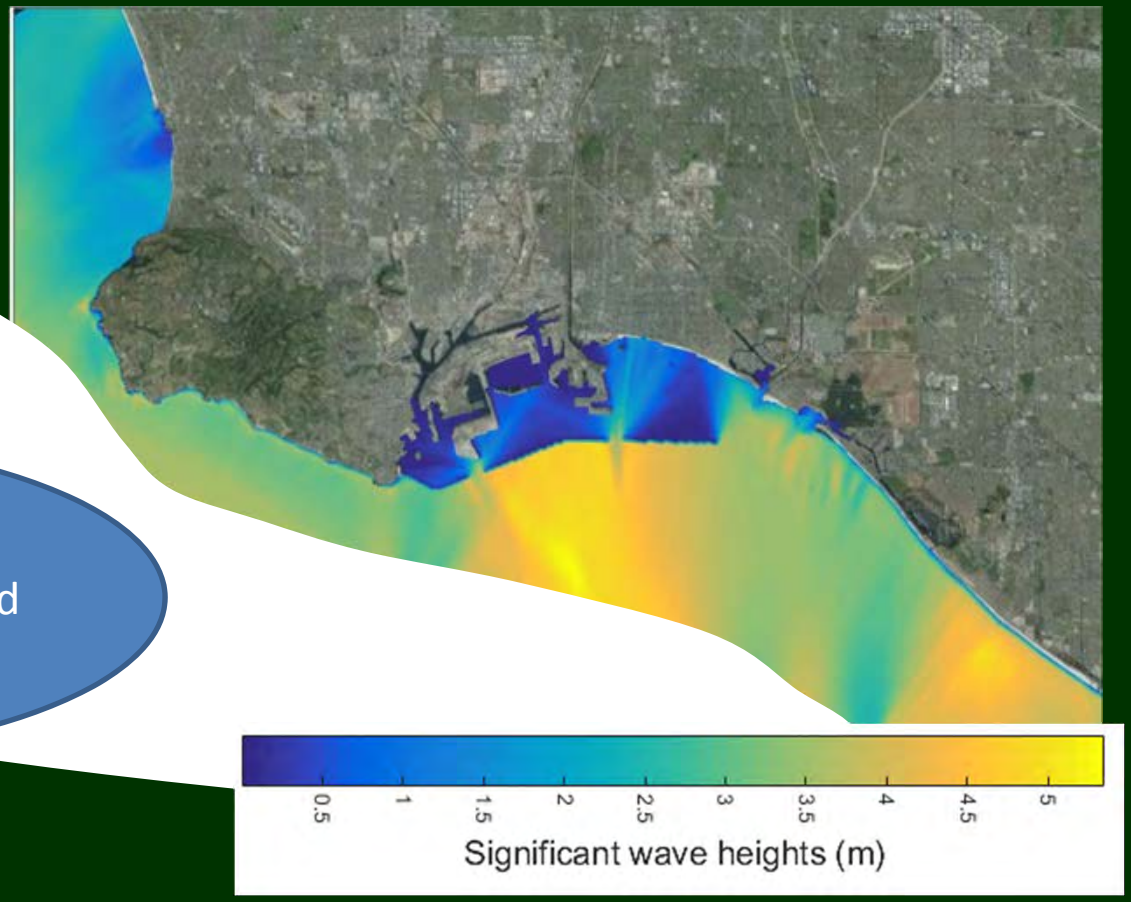

water levels (m, NAVD88)
3
2
1
0
IBE: 5%
SSwnd: -5%
tide: 100%


Fluvial discharge (m3/s)
400
300
200
100
0
11/06
11/07
11/08
Time

Products- Wave and Currents

- Delft3D model results from all local SWAN and FLOW runs are used to…

To generate maps of maximum wave heights and maximum currents



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Products- Flood Maps

- Delft3D model results from high resolution grids (inlets, harbors, etc.)
- Combined with open coast XBeach results
- Overlain and differenced from the 2 m resolution DEM

To generate maps of flood extents, duration, and depth

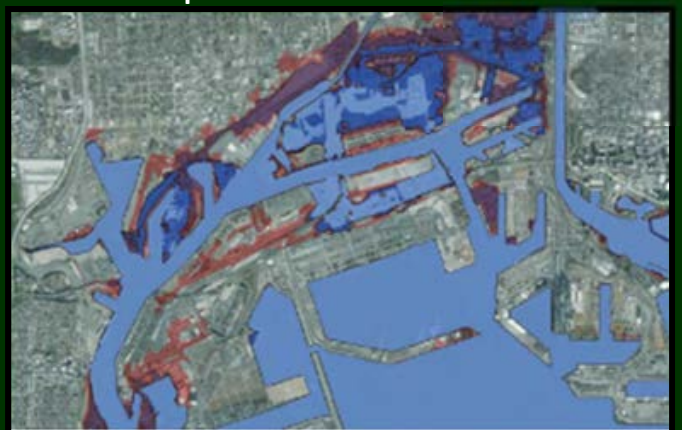
High resolution model results

+

XBeach results along open coast

=

Flood map



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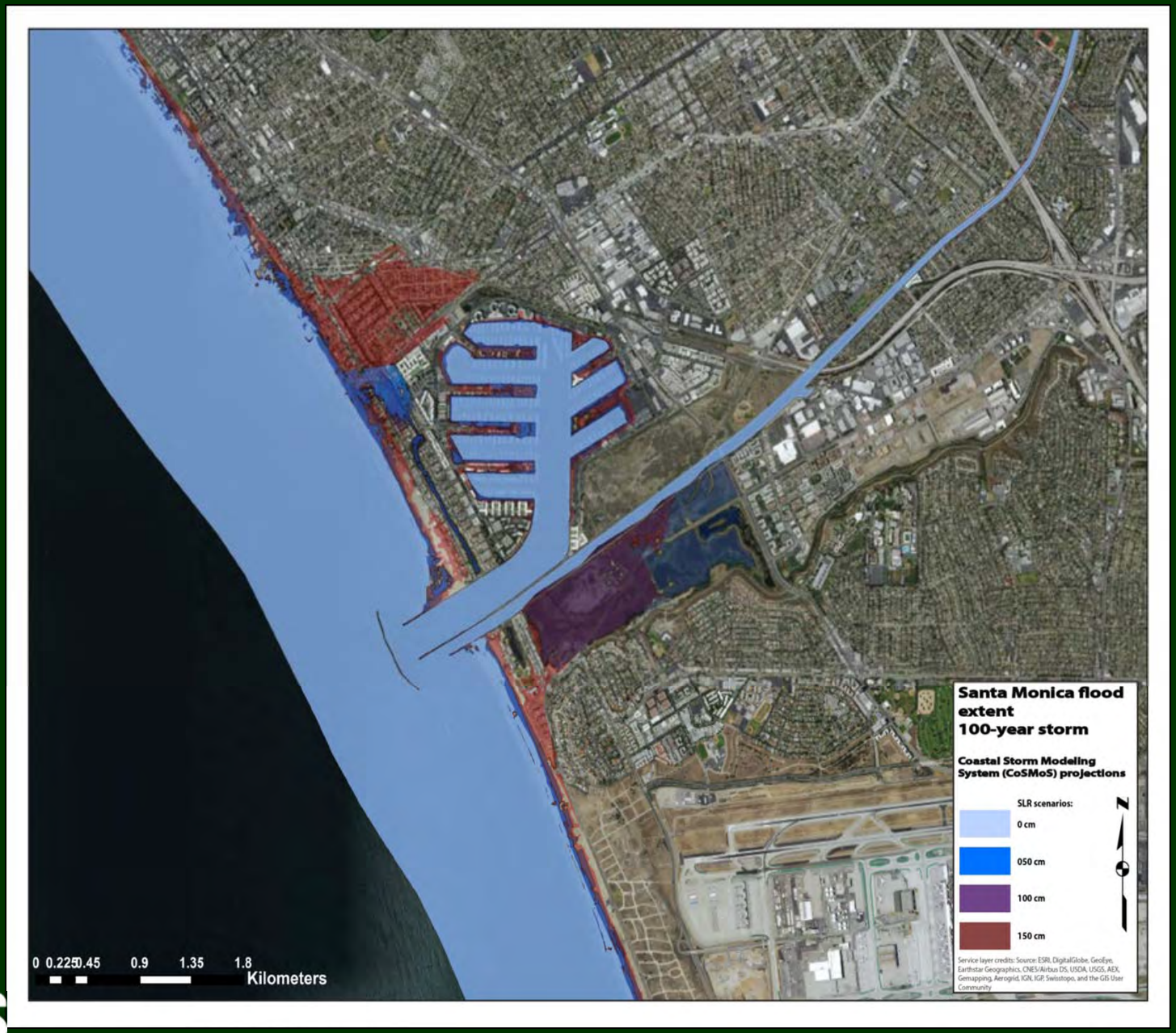
SLR 0 cm


SLR 50 cm


SLR 100 cm


SLR 150 cm

Venice / Marina Del Rey



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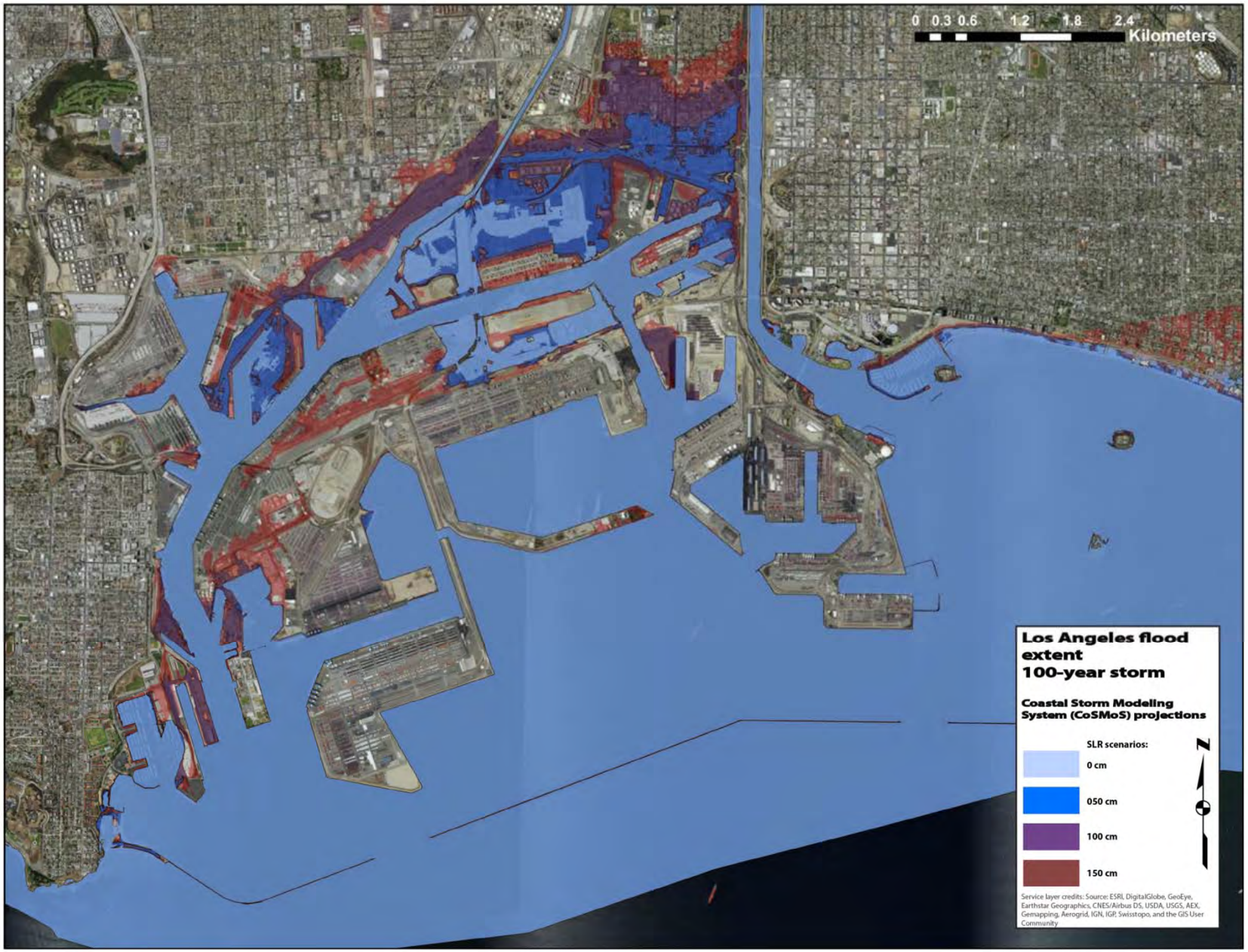
L.A. Harbor


0 0.3 0.6 1.2 1.8 2.4
Kilometers
Los Angeles flood extent
100-year storm
Coastal Storm Modeling System (CoSMoS) projections
SLR scenarios:
0 cm
050 cm
100 cm
150 cm
N
Service layer credits: Source: ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Gemapping, Aerogrid, IGN, IGP, Swisstopo, and the GIS User Community

Shoreline Projections

What's Coming Summer 2016

- 40 scenarios of SLR + storms
- Long-term coastal evolution integrated into flood mapping
- Socioeconomic impacts
- Groundwater, hurricane impact pilots
- Our Coast Our Future (OCOF) web tool

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

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

Our Coast- Our Future tool: *www.prbo.org/ocof*

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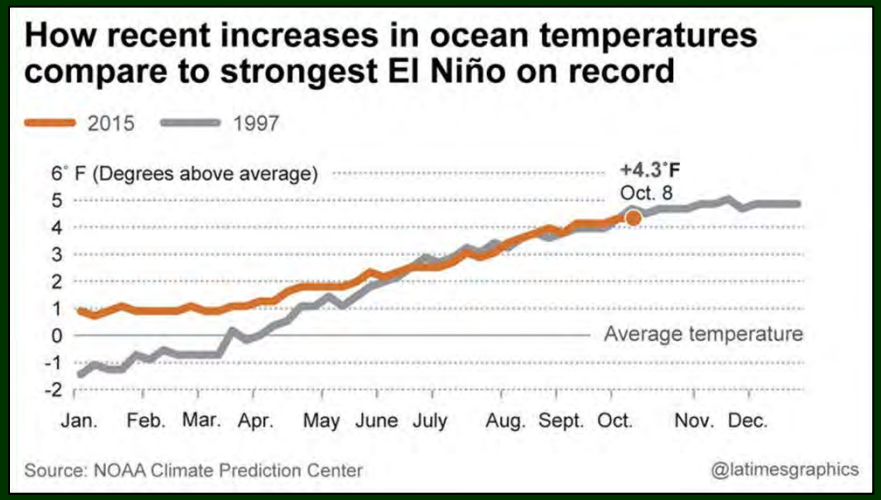
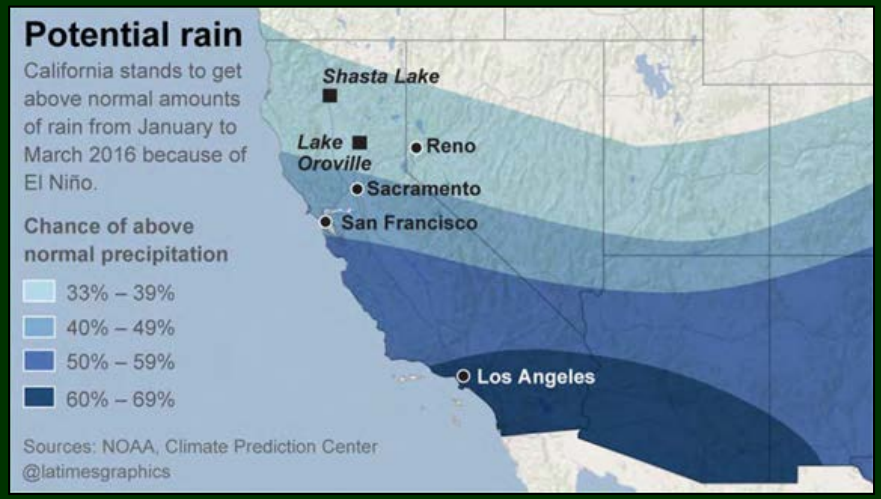
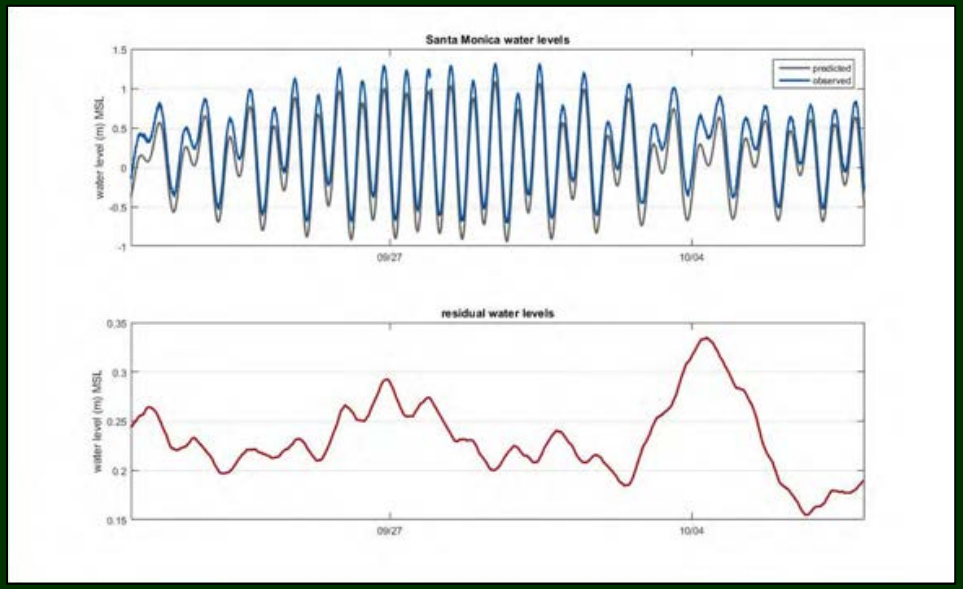
2015-2016 El Nino







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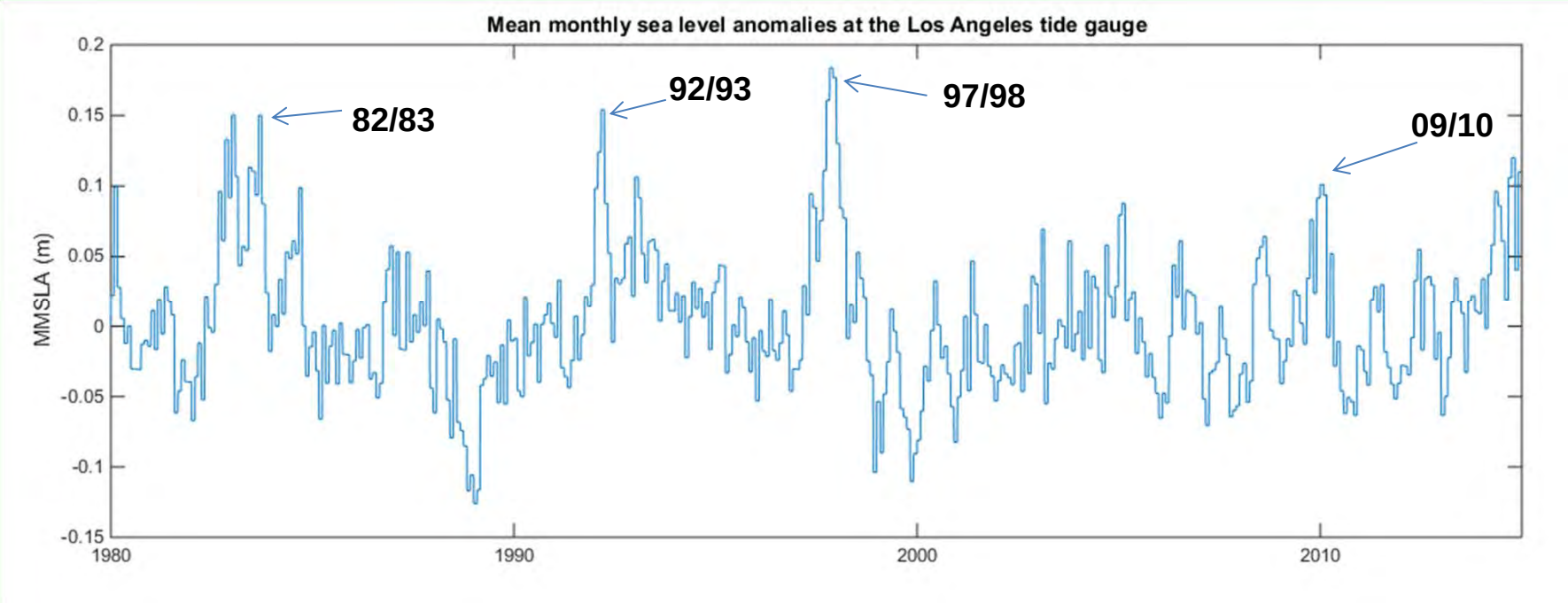
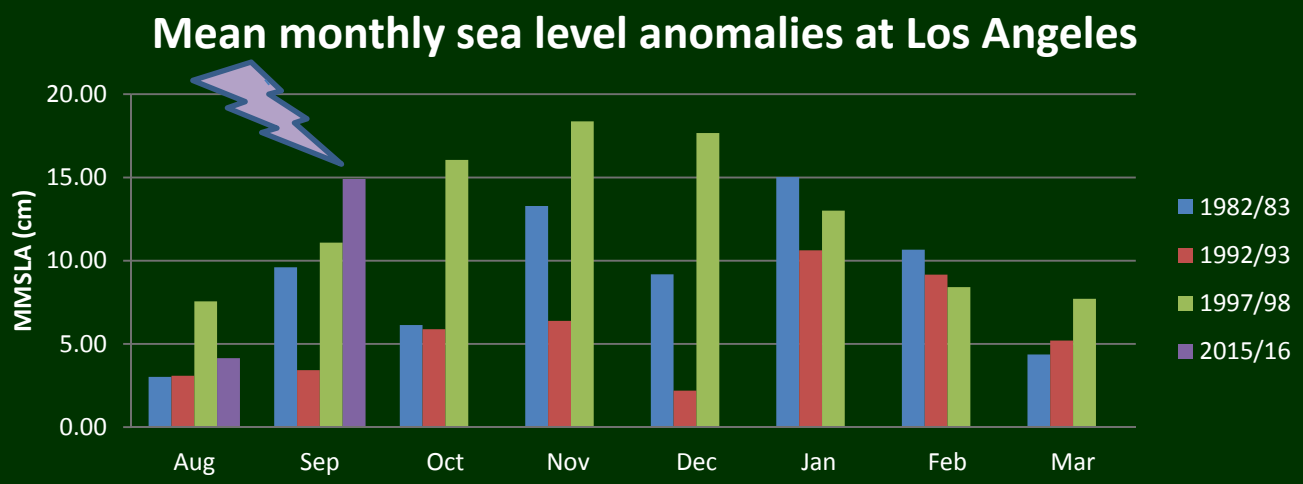
2015-2016 El Nino





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