

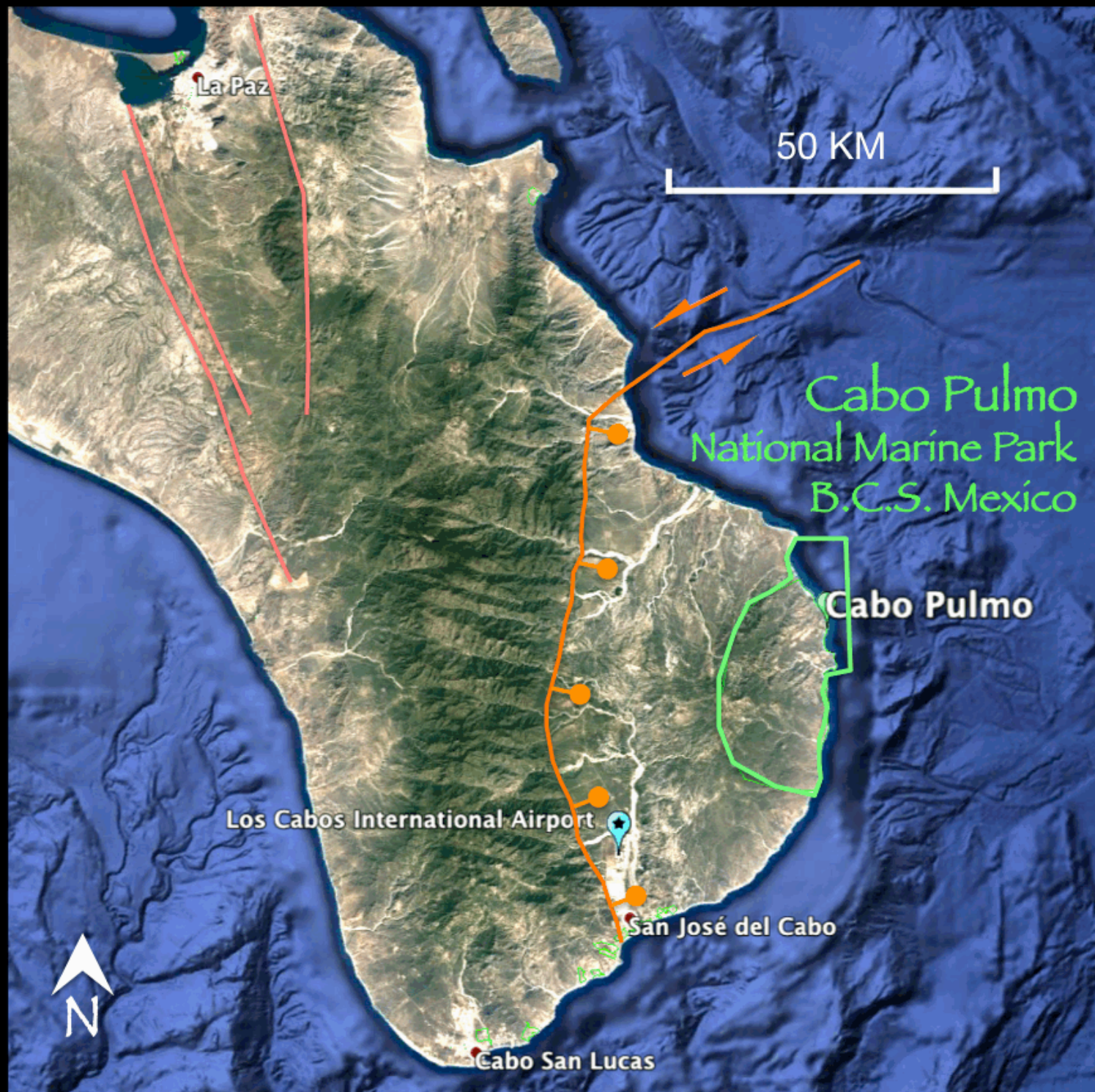
Paper No. 28-6

**Speculations about Beach Erosion, Sea-Level  
Rise, Storm Surge, Hurricane, Earthquake, and  
Tsunami Hazards for Homes in Cabo Pulmo  
National Park, East Cape, Baja California Sur  
Mexico**

by  
**Silvio Pezzopane**  
Independent Researcher, Paisley Oregon









# Sierra La Laguna



San Jose Del Cabo Fault

25 M

50 M

Image Landsat / Copernicus  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Data LDEO-Columbia, NSF, NOAA

Google earth

2006

Imagery Date: 4/3/2018 lat 23.193854° lon -109.771871° elev 129 m eye alt 1.36 km



San Jose Del Cabo

3.5 KM

Los Cabos  
International Airport

Sierra La Laguna

50 M

25 M

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Data IDEO-Columbia, NSF, NOAA  
Image Landsat / Copernicus

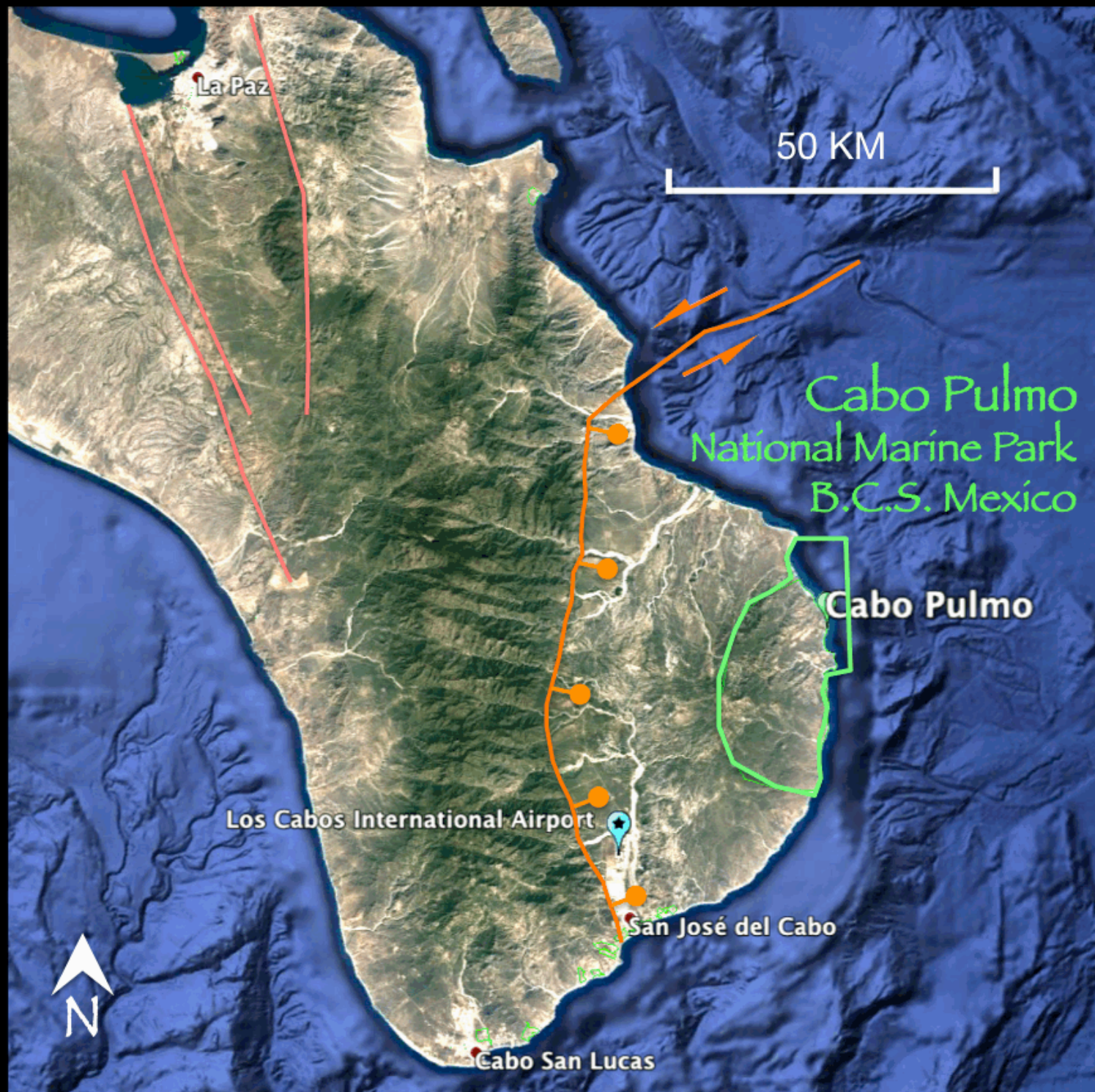
Google earth

753 m

2004

Imagery Date: 3/27/2018 lat 23.191441° lon -109.769835° elev 126 m eye alt 3.17 km







# Cabo Pulmo, México





# Headquarters of Cabo Pulmo National Marine Park

March 2014





# PARQUE NACIONAL CABO PULMO

## BIENVENIDO

Estás en una de las áreas protegidas más exitosas de México y el mundo. Desde 1995 esta comunidad decidió cambiar las redes por el turismo y esta apuesta por la conservación ha rendido frutos. Hoy, gracias a las autoridades, investigadores, organizaciones de la sociedad civil y comunidades vecinas, este parque es uno de los mejores sitios dentro del Golfo de California.

El arrecife de Cabo Pulmo tiene 5 mil años y es el único vivo dentro del Golfo de California. En muchos sentidos, visitar Cabo Pulmo es como un viaje al pasado pues aquí puedes apreciar una gran abundancia y cantidad de especies que son historia en otros sitios.

Aquí podrás observar garropas, cabrillas, tiburones, tortugas y muchas otras especies. Con suerte, puedes encontrar meros de más de 60 años y 2 metros de longitud.

Parque Nacional Cabo Pulmo es Patrimonio de la Humanidad y sitio Ramsar, y lo conservamos también para ti. Te invitamos a disfrutar la belleza de este sitio y respetar las regulaciones.

El pago de tu brazalete hace posible el buen manejo de este sitio. Utilizar los servicios de la comunidad contribuye a seguir haciendo de la conservación una apuesta rentable.

## WELCOME

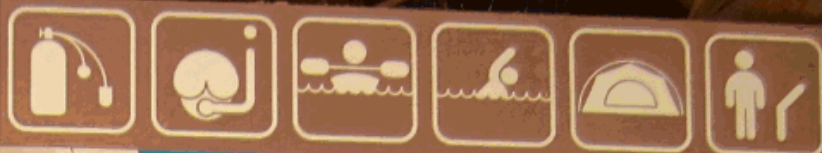
You are in one of the most successful protected areas of Mexico and the world. In 1995, this community decided to trade its fishing nets for tourism and this commitment to conservation has paid off. Today, thanks to the authorities, researchers, civil society organizations and neighboring communities, this Park is one of the best preserved sites in the Gulf of California.

The Cabo Pulmo reef is 5,000 years old and is the only living coral reef in the Gulf of California. In many ways, visiting Cabo Pulmo is like diving into the past. Here you can observe several species that belong to history in other sites.

Here you can see groupers, sea bass, sharks, turtles and many other species. If you are lucky, you can find groupers that are over 60 years old and 2 meters in length.

National Park Cabo Pulmo is recognized by UNESCO as World Heritage and Ramsar site. We invite you to enjoy the beauty of this place and respect the regulations.

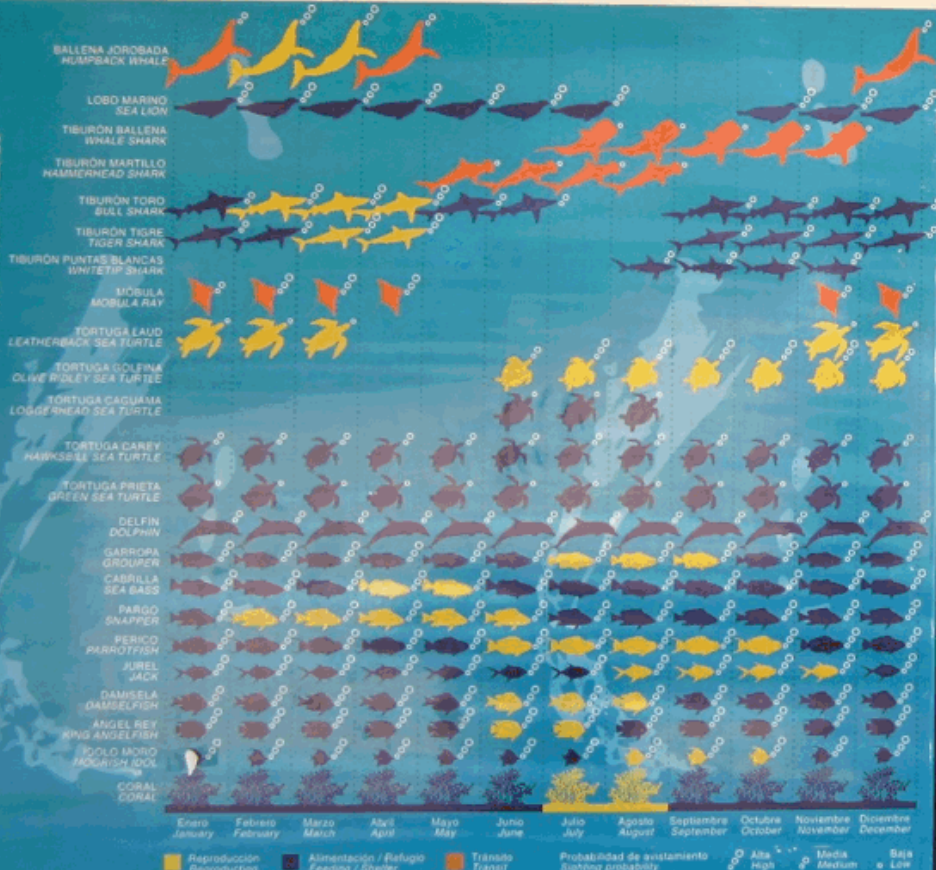
The payment of your bracelet funds the proper management of this site. Patronizing local community businesses helps make conservation a viable livelihood option.



## CALENDARIO DE AVISTAMIENTO SIGHTING CALENDAR

### ESPECIES MIGRATORIAS MIGRATORY SPECIES

### ESPECIES PRESENTES TODO EL AÑO ALL YEAR ROUND SPECIES



## MAPA DEL SITIO SITE MAP

### SÍMBOLOS SYMBOLS

- Camino de terracería (Main dirt road)
- Calle de terracería (Dirt road street)
- Arroyo (Stream)
- Ruta de sendero (Trail track)
- Pueblo (Town)
- Información (Information point)
- Buceo (Scuba dive)
- Snorkel
- Kayak
- Playa (Beach)
- Campismo (Camping)
- Sendero (Trail)
- Sitio (Site)
- Limite del ANP (NPA limits)
- Limite Zona núcleo (Core zone limits)



## BIENVENIDOS WELCOME





# Cabo Pulmo National Marine Park, B.C.S. México

- One of only 3 coral reefs on the west coast of North America
- Whales, dolphins, sea turtles, coral, and 6000 species of fish
- In 1980, fisherman realized the reefs were getting over-fished
- 200 townspeople volunteered to stop fishing and do studies
- In 1995, Mexico declared 27.5 sq miles a National Marine Park
- In 2005, UNESCO designated CPNP as a World Heritage Site
- In 2008, designated a Wetlands of International Importance
- In 2011, study found biomass has increased 463% in 10 years
- Developers have targeted Cabo Pulmo, given tourism potential



# Cabo Pulmo, México





Feb 2019







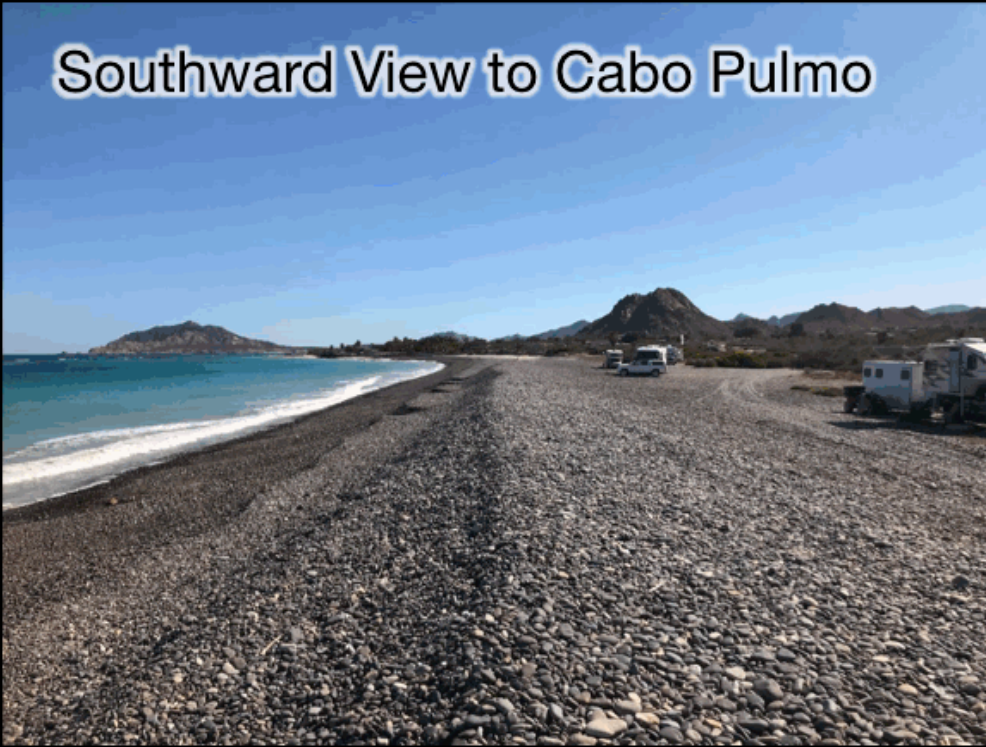




JOHN, H2, Sept 2006, 8 km



Southward View to Cabo Pulmo

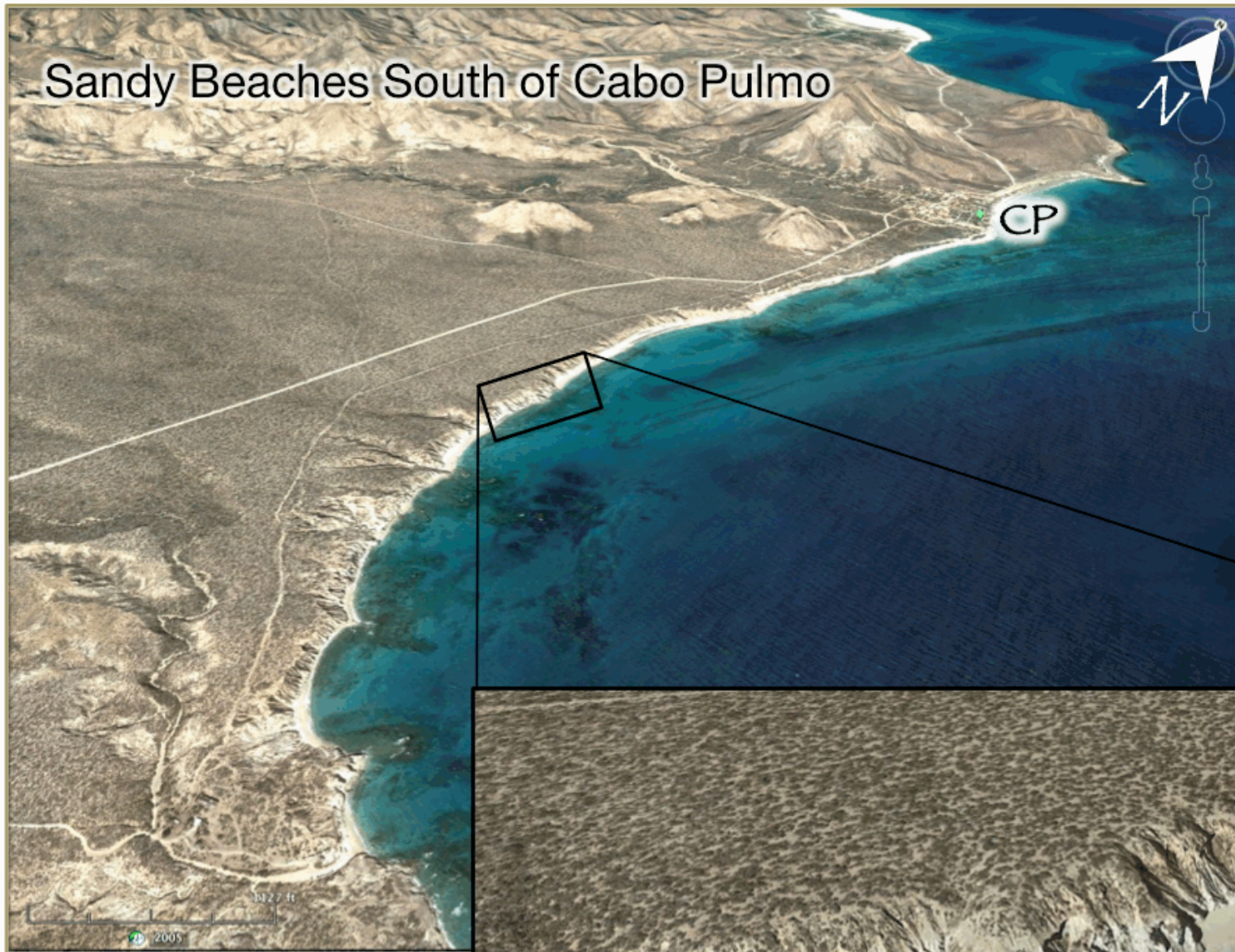


Northward View





# Sandy Beaches South of Cabo Pulmo





March 2014



March 2014



March 2019



March 2019





Spring 1999



March 2014



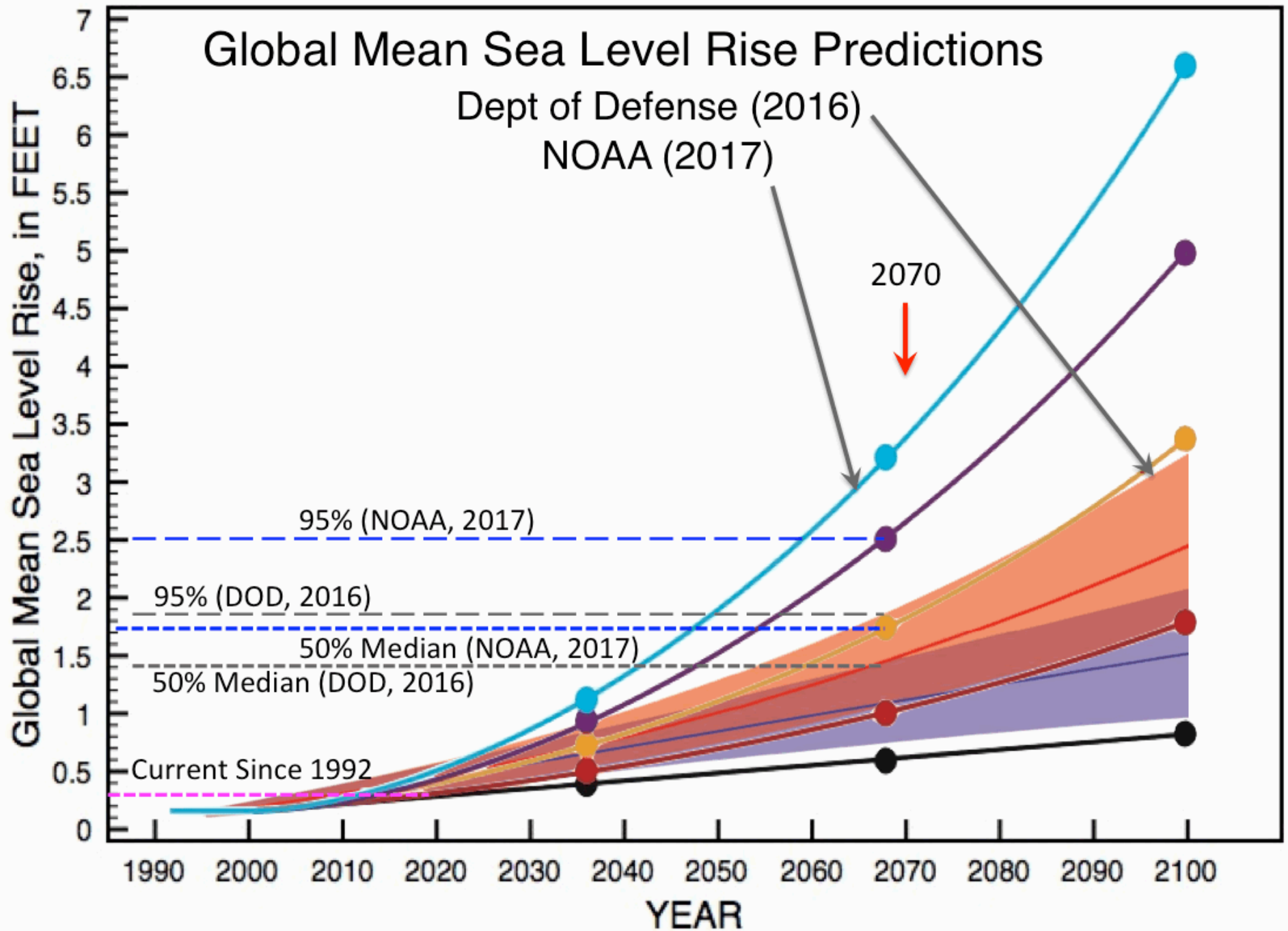
Feb 2019



March 2019









# Katrina, 2005, H3 at Landfall, 4-m Surge

Wave run-up

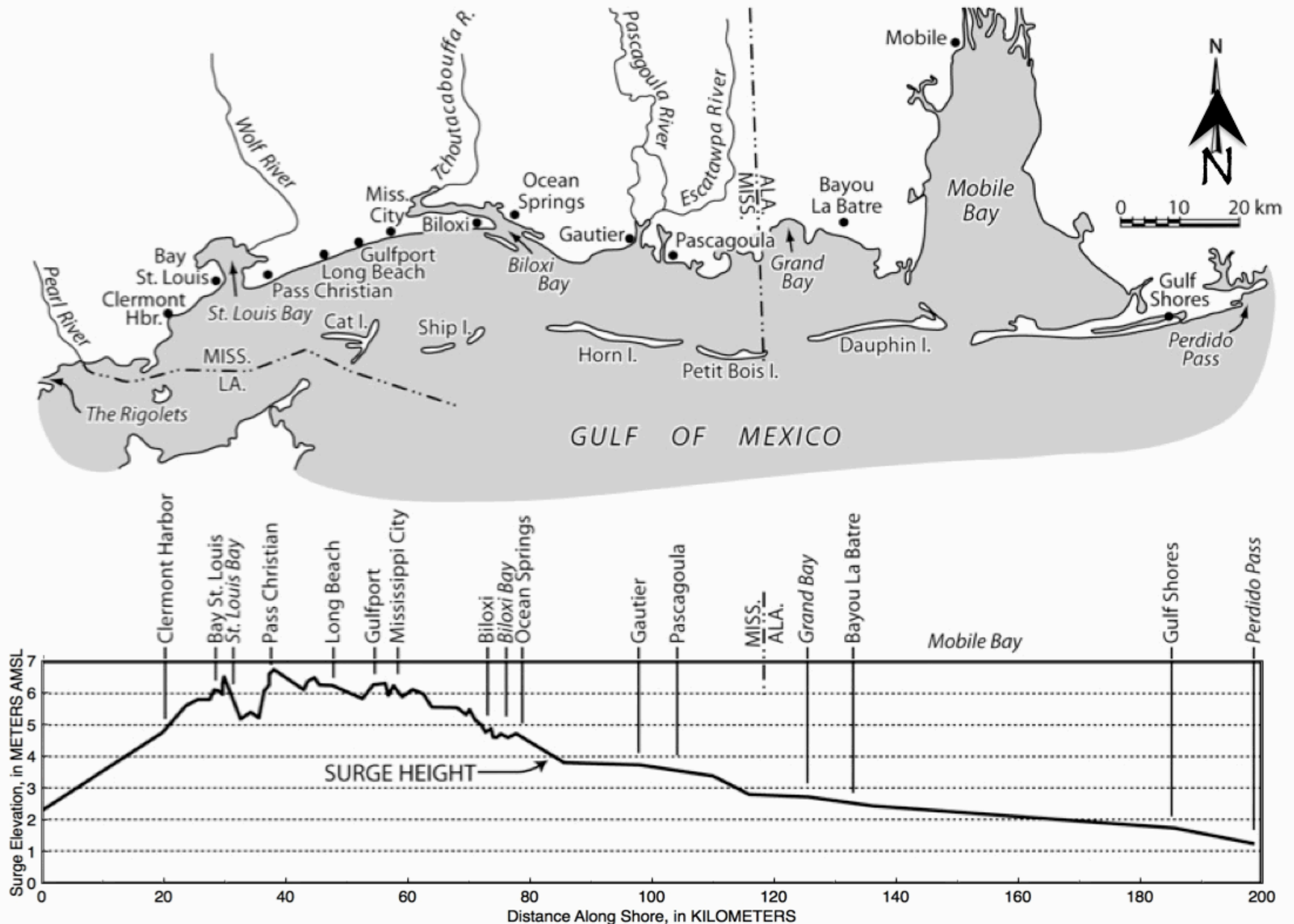
Surge

Photo From: CNBC News, 2005



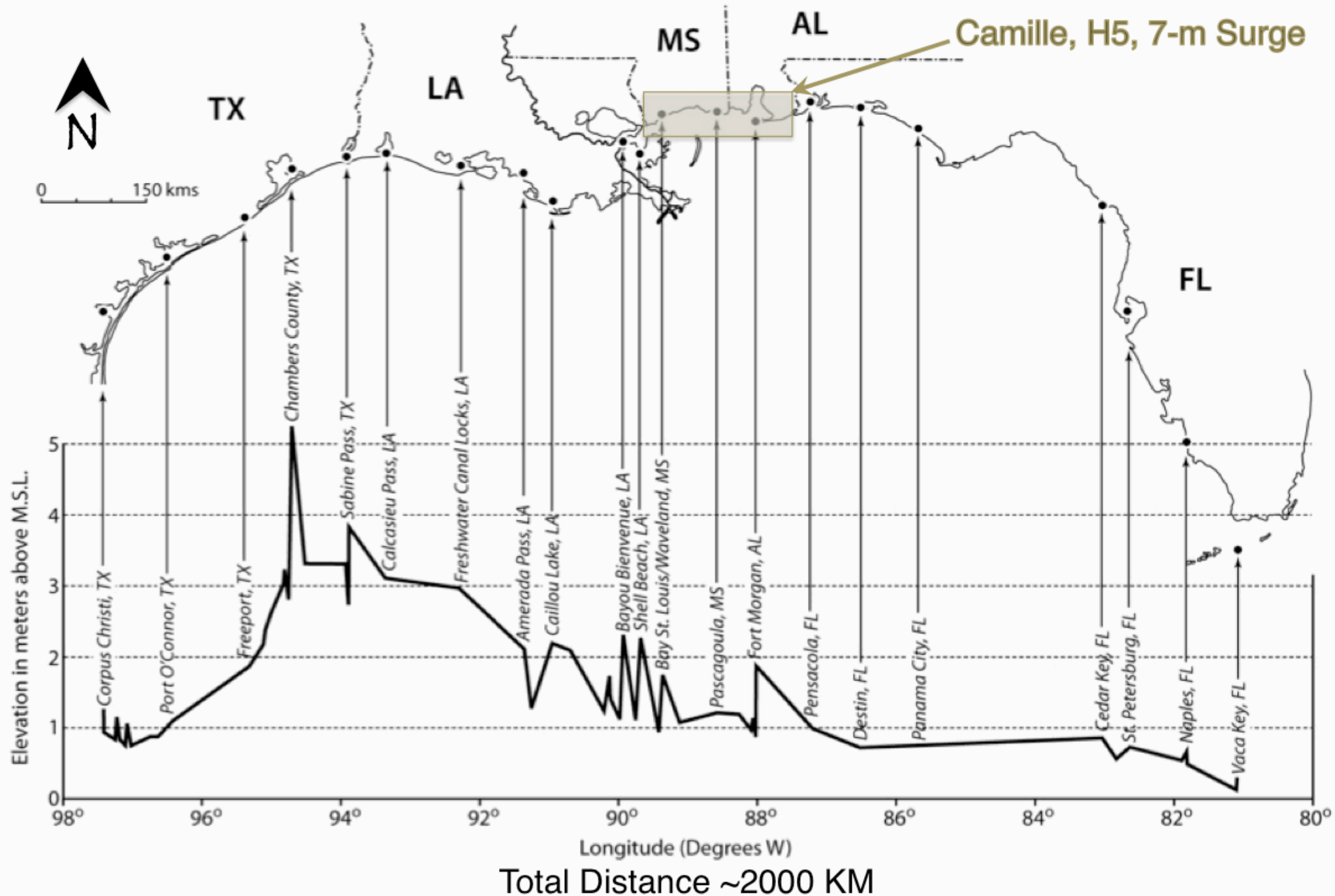


# Camille, H5 at Landfall, 7-m Surge (U.S. Army Corps)

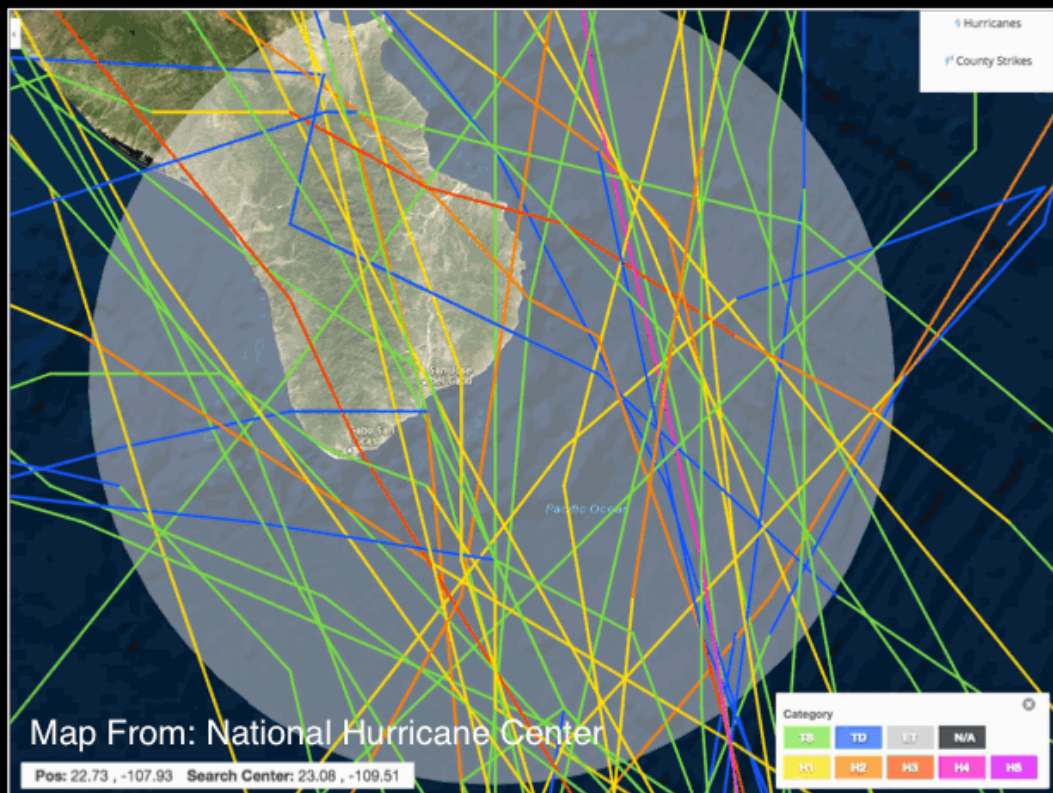




# Ike, H2 at Landfall, 5-m Surge (Berg, 2009)





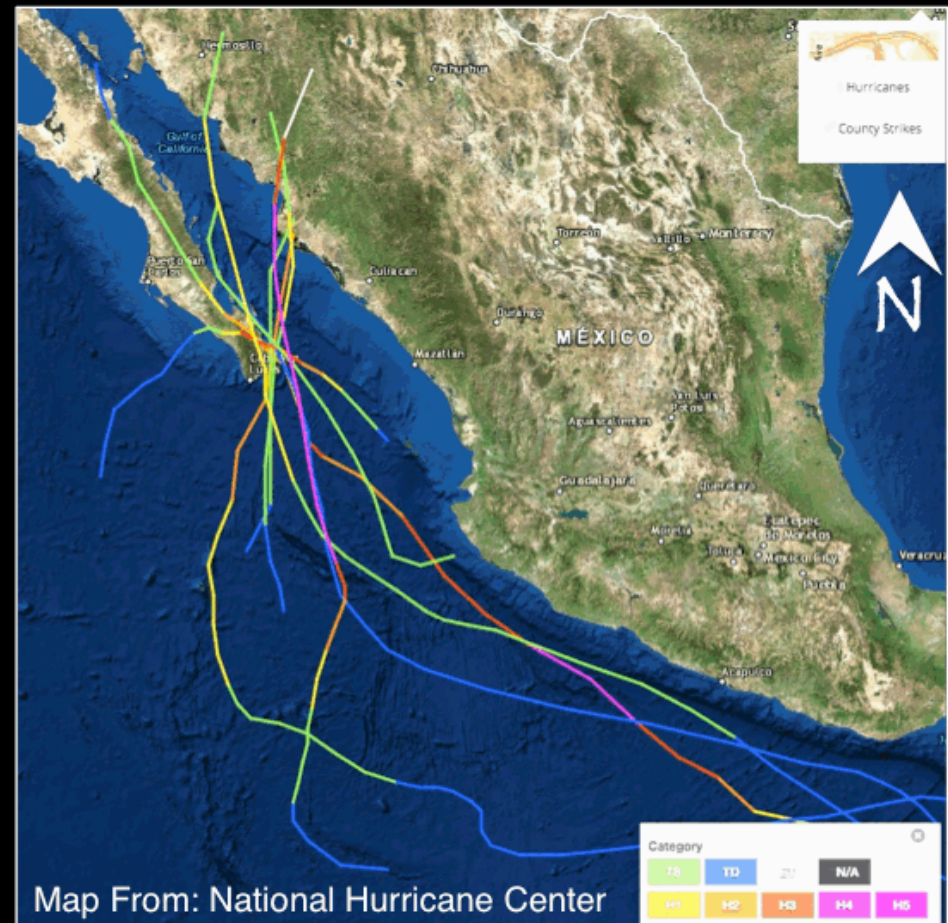


Hurricane Category	Max Wind Speeds, in MPH	Max Storm Surge, in METERS
1	74 to 95	1 to 1.5
2	96 to 110	1.5 to 2.5
3	111 to 130	2.5 to 4
4	131 to 155	4 to 5.5
5	> 155	> 5.5

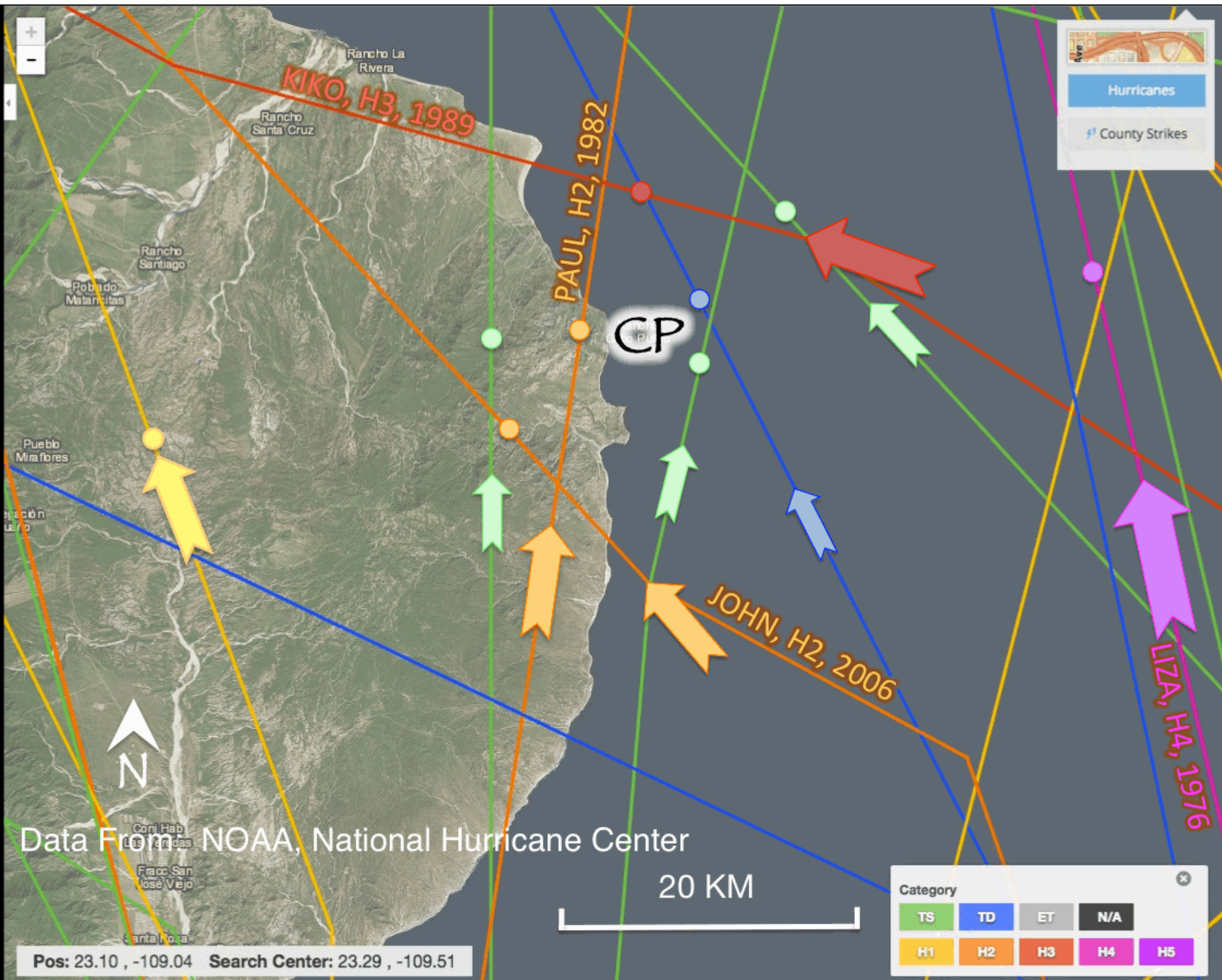
From: National Hurricane Center

Hurricanes near Cabo Pulmo	Date	Category	Closest Approach, in KM
UNNAMED	June 1993	TD	7
ISIS	Sept 1998	TS	6.8
LIDIA	Oct 1981	TS	7.5
UNNAMED	Oct 1955	TS	15
HENRIETTE	Aug 1998	1	29
PAUL	Sept 1982	2	1.7
JOHN	Sept 2006	2	8
KIKO	Aug 1989	3	11
LIZA	Oct 1976	4	33

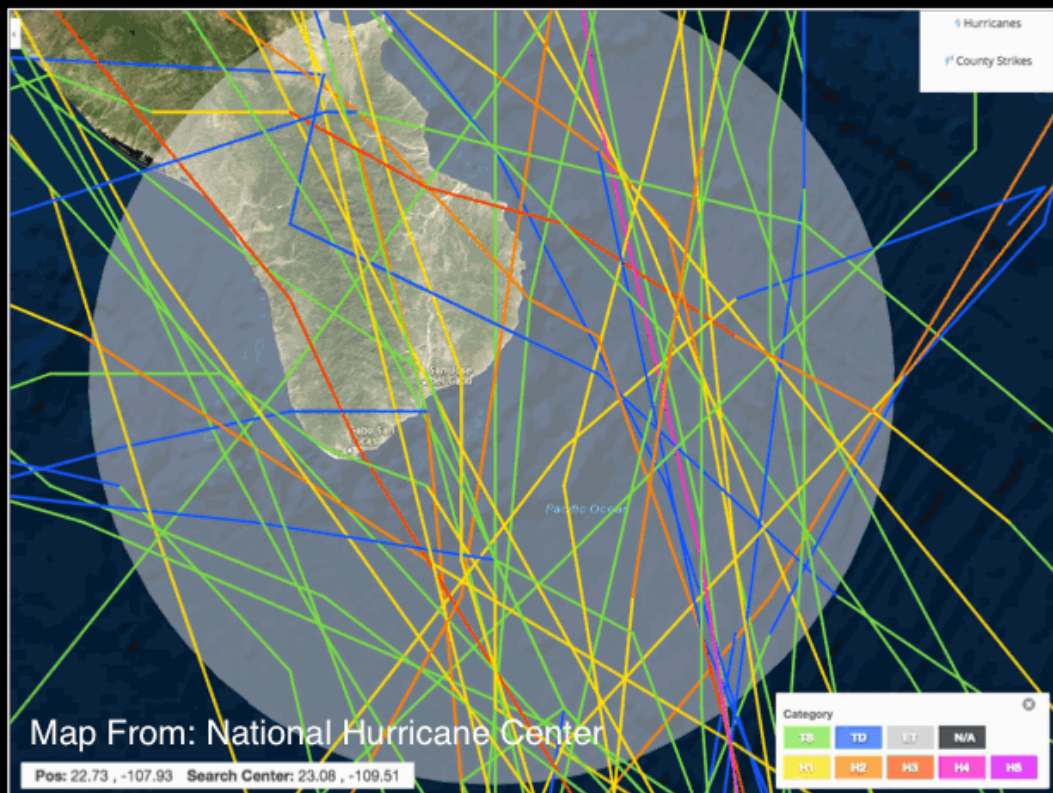
From: National Hurricane Center









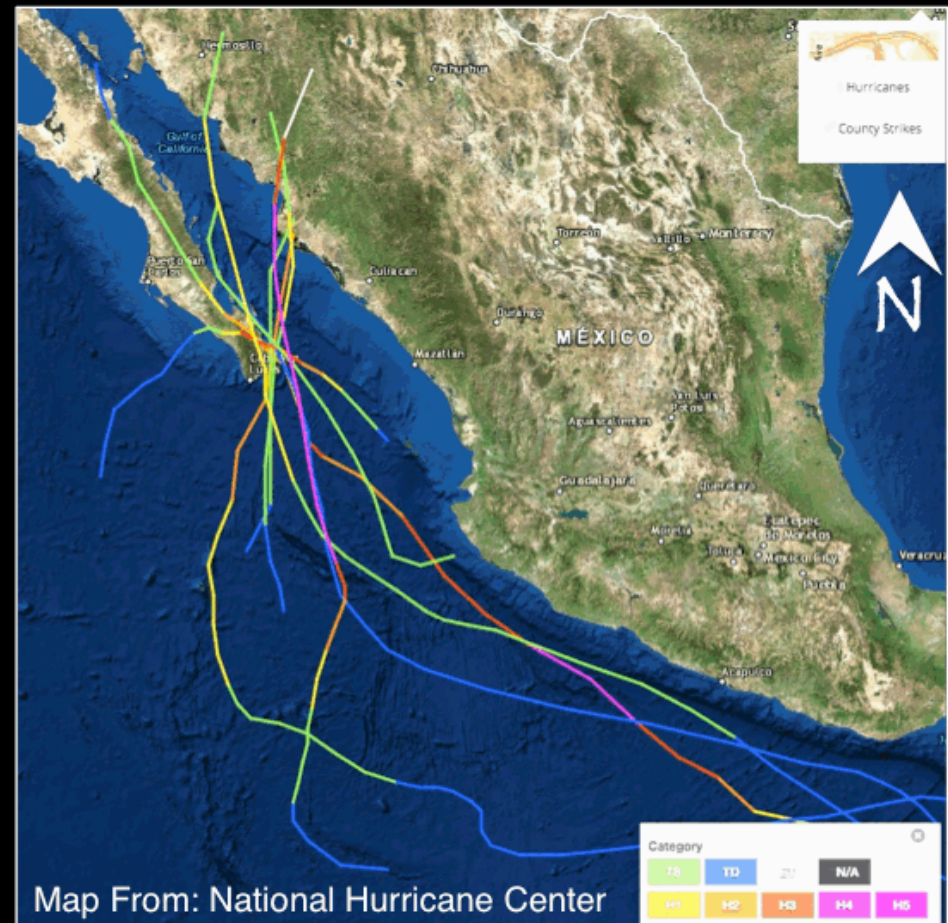


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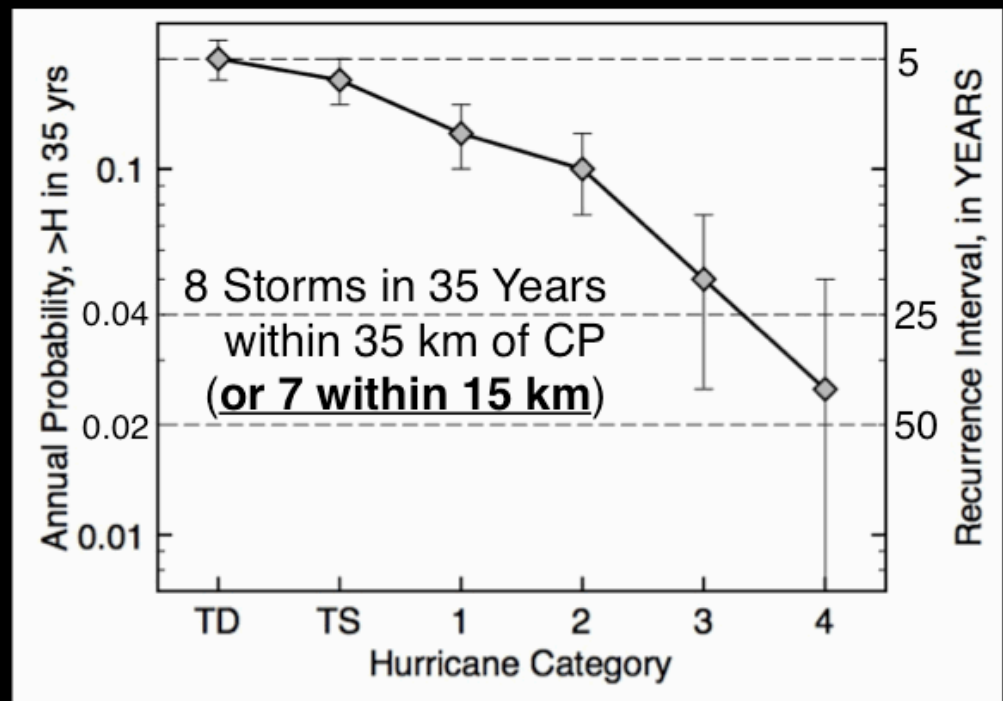
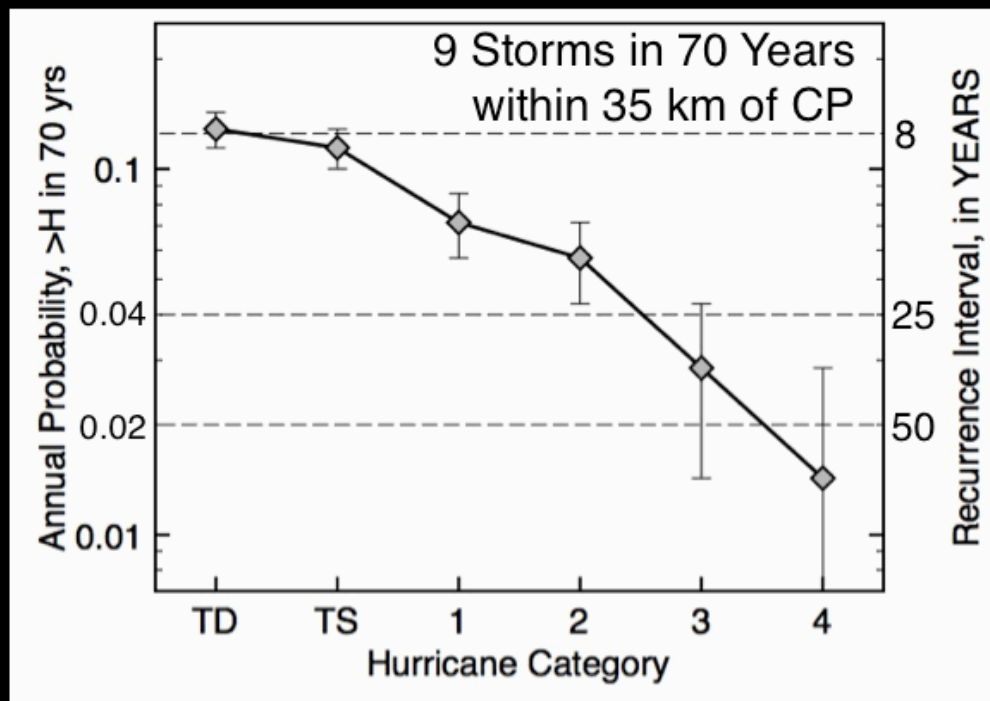
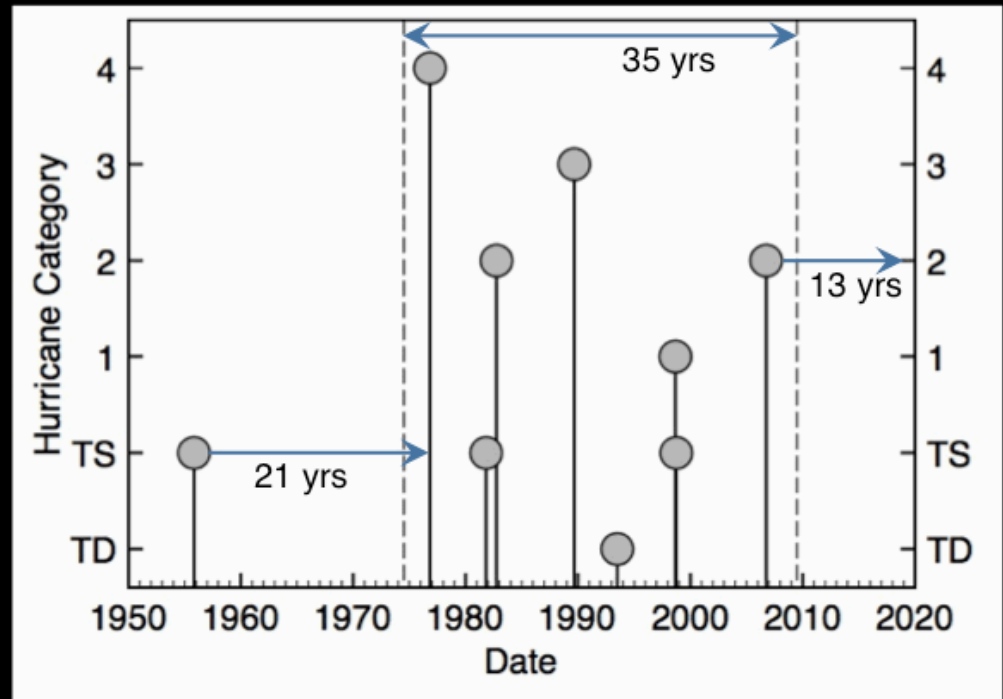
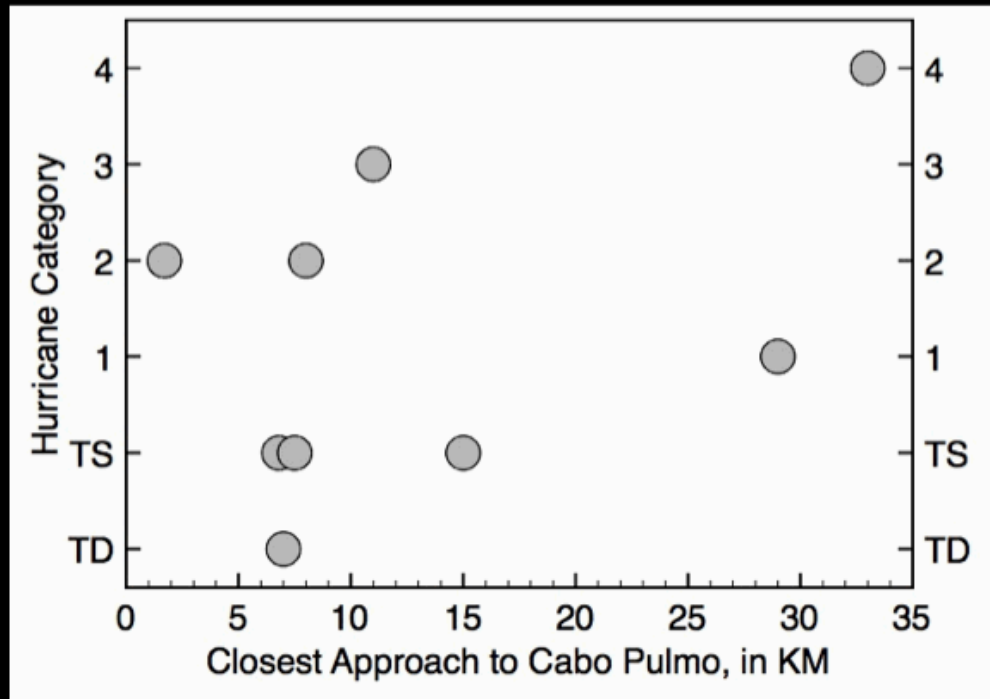
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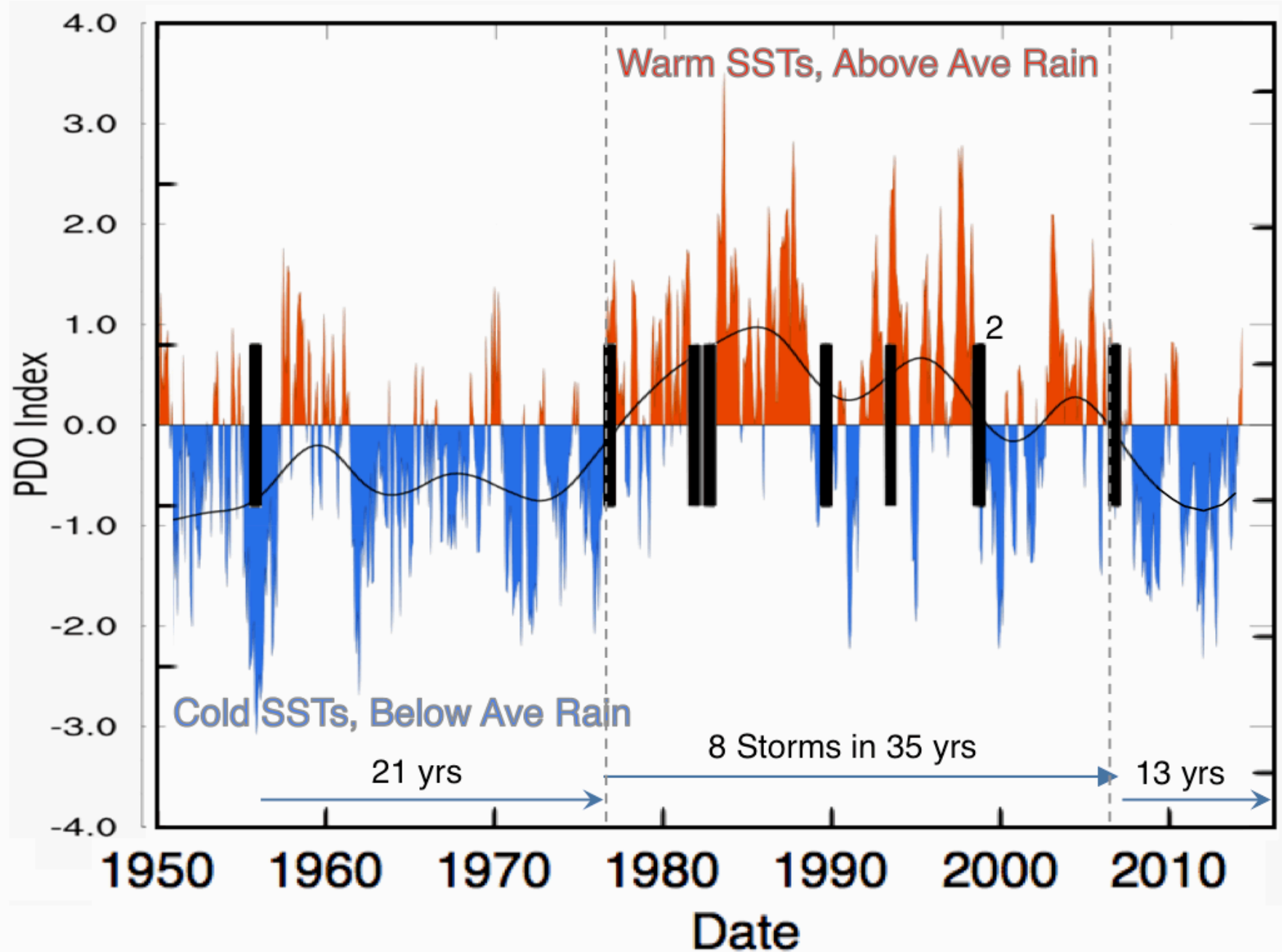








# Pacific Decadal Oscillation and Hurricanes near Cabo Pulmo





# Storm High Water Level = Tide + Surge + Wave-Run up

## Depiction of Category 4 Hurricane (From: NOAA)

Occurs at high tide 2 feet above MSL, with a 15-foot hurricane storm surge  
Wave-run up places 10-foot waves on top of the 17-foot storm tide,  
Highest water level could be 27 feet or higher above MSL

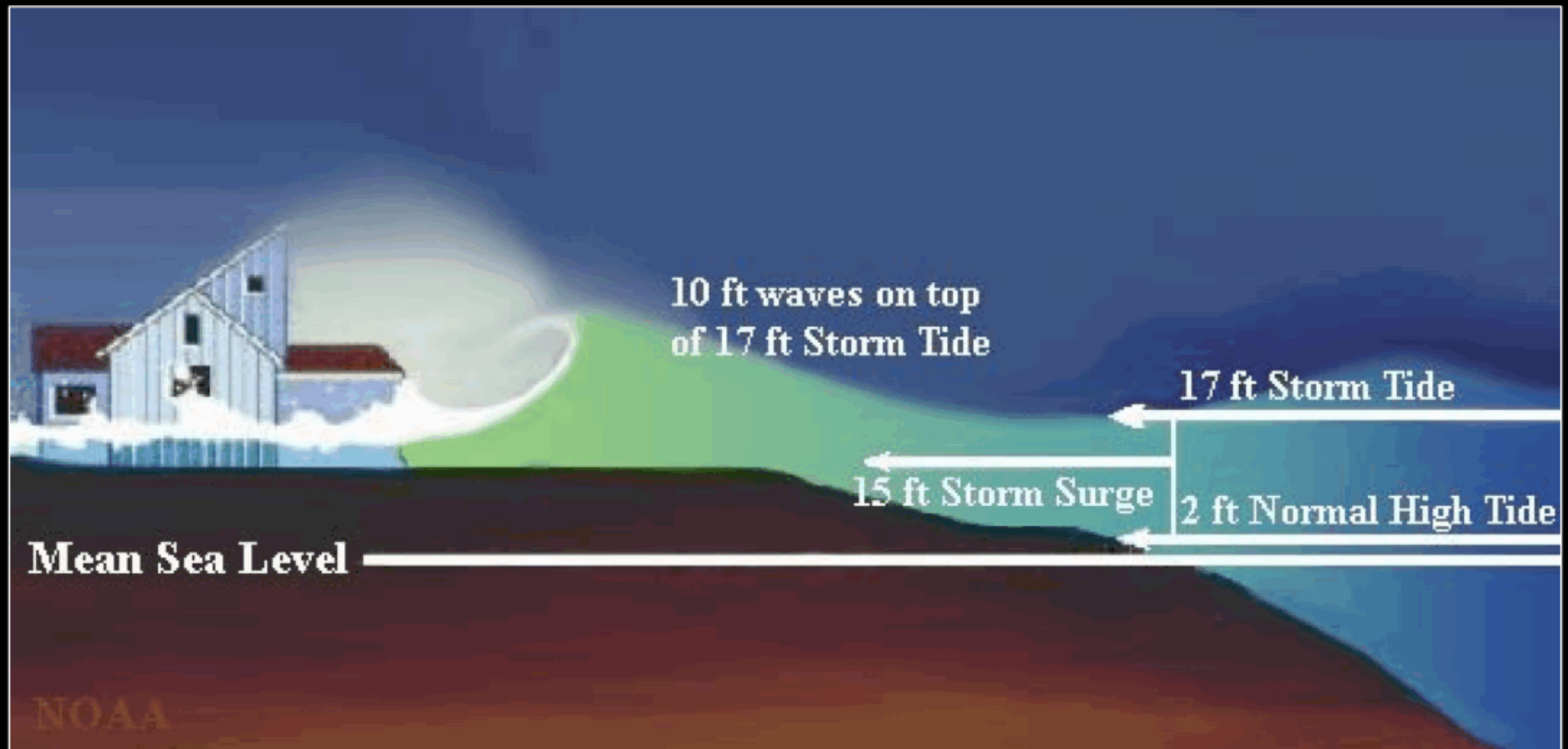


Diagram From: NOAA, National Hurricane Center



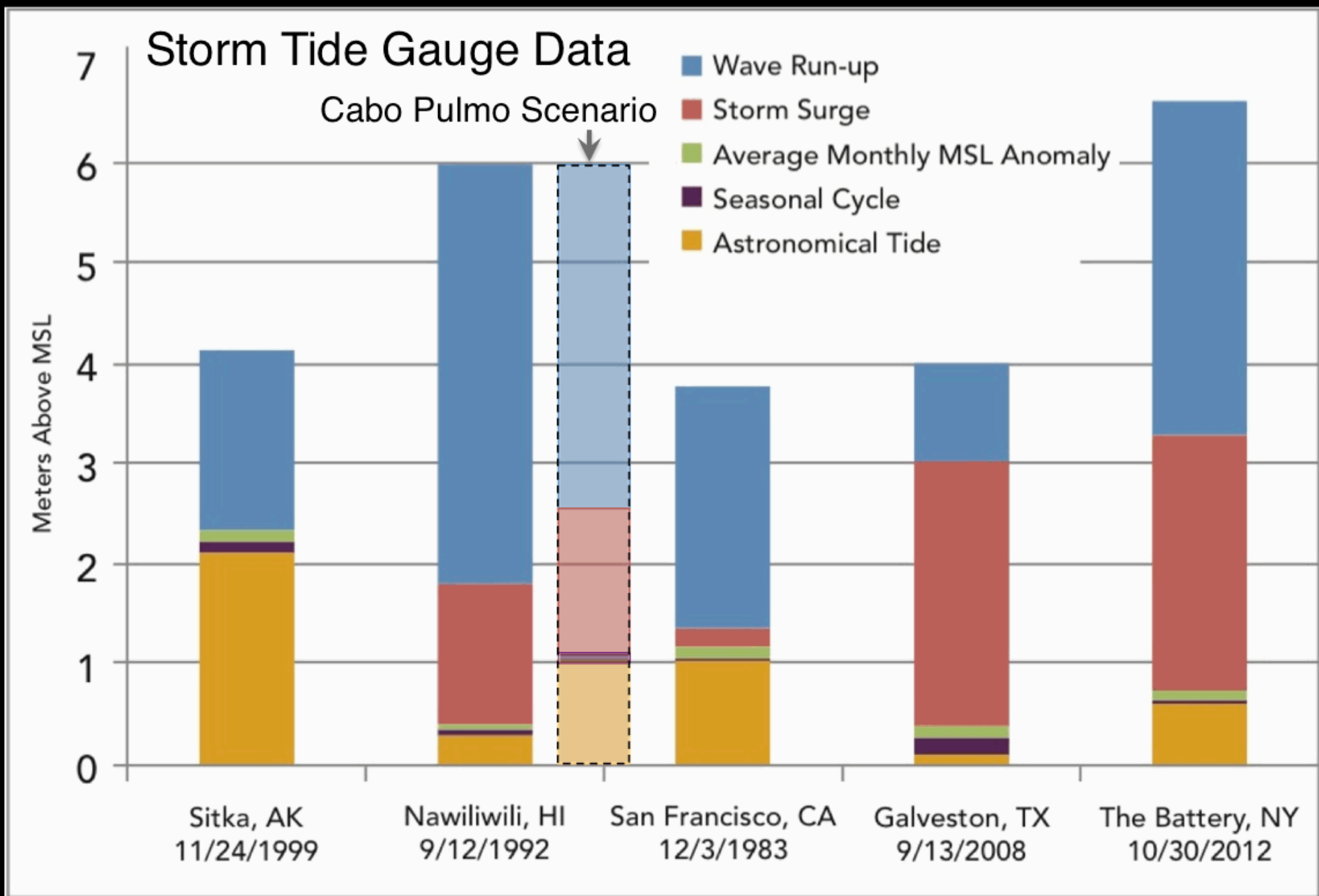


Diagram Modified From: Hall, et al., 2016, U.S. Department of Defense



Coastal Boulder Deposit on Marine Terrace, Isla del Carmen, MX  
Boulders lifted and transported 25 m from sea cliff = Hurricane!  
(Johnson and others, 2018)

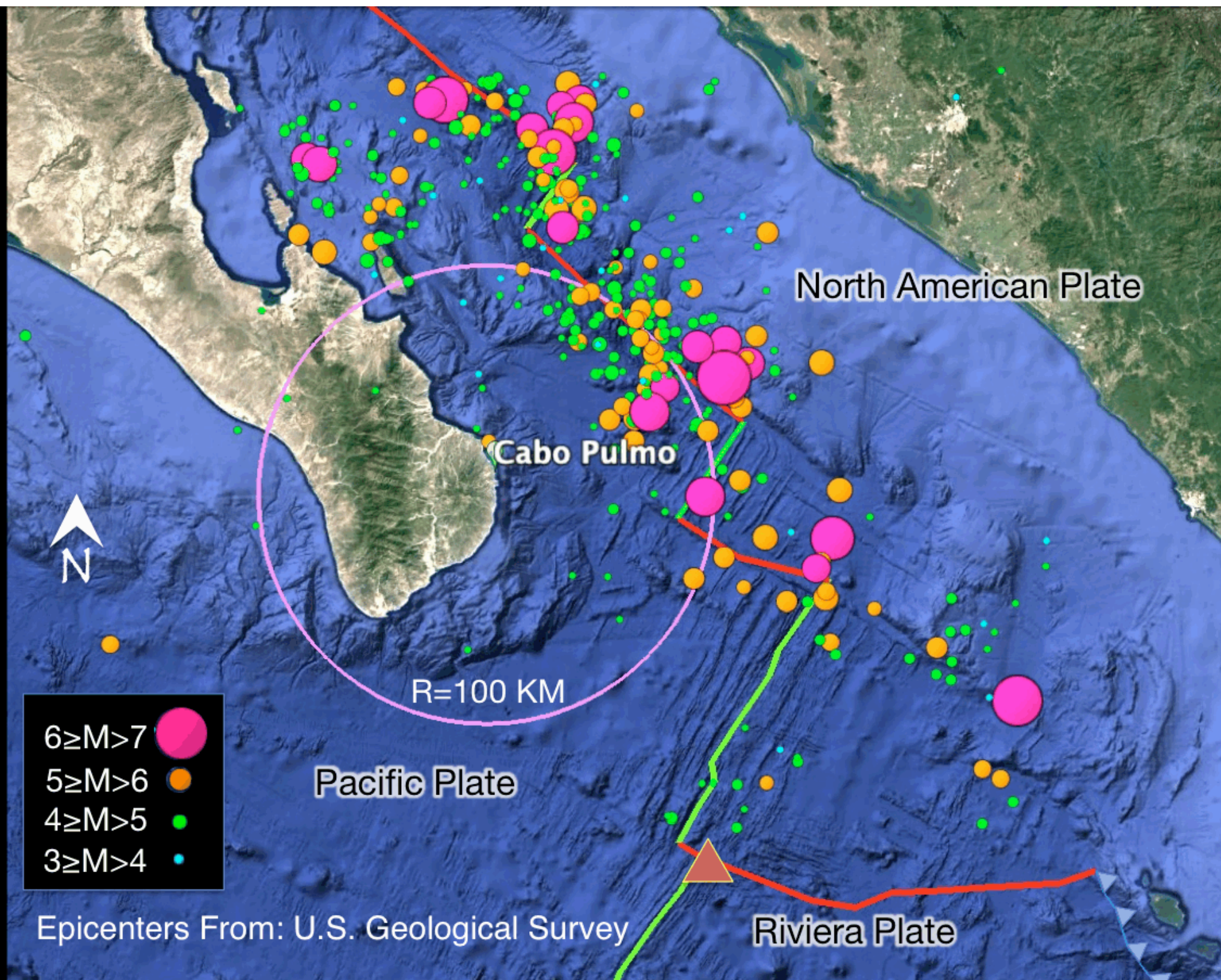




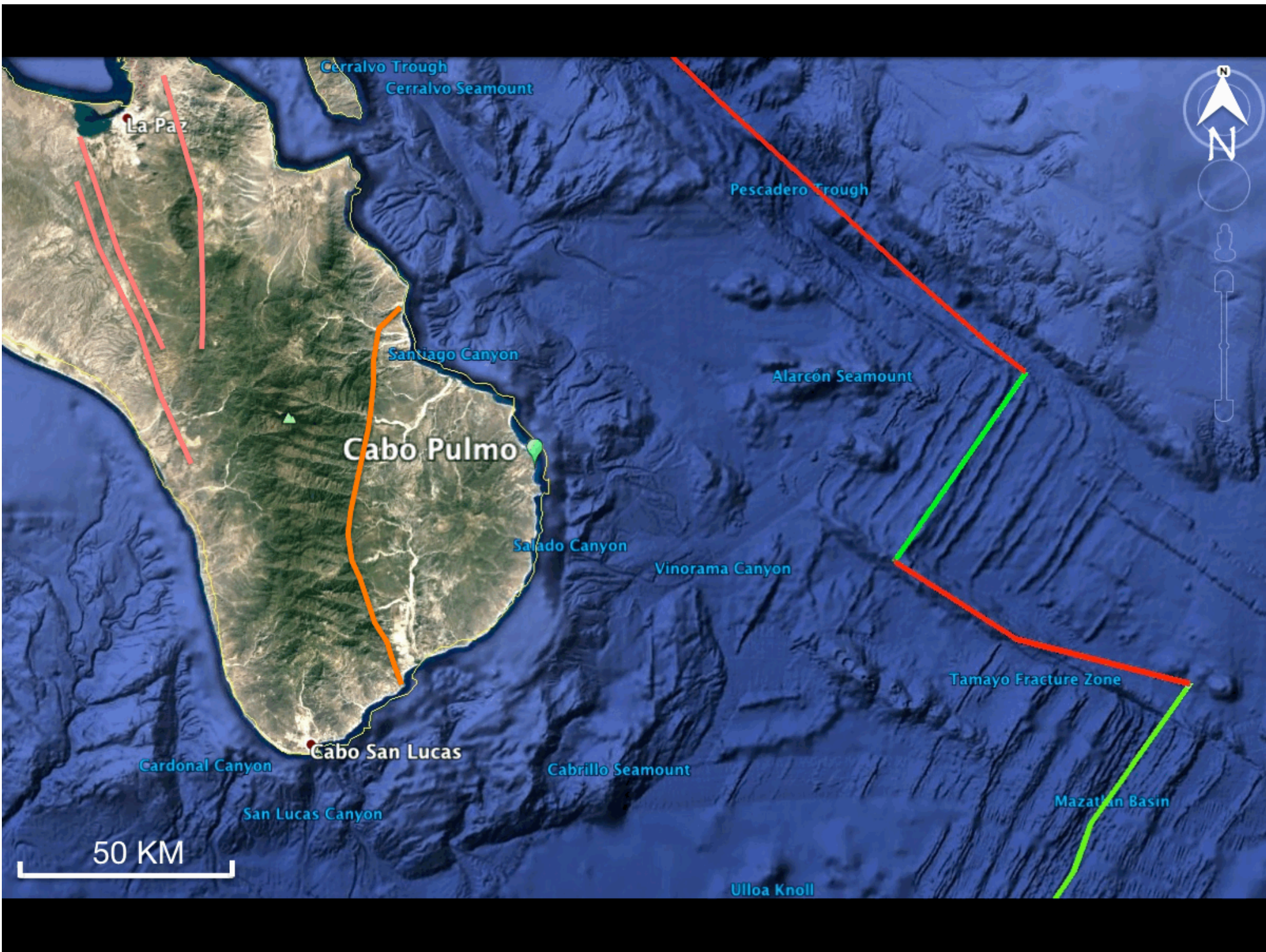
# Boulders = Hurricane Deposit?



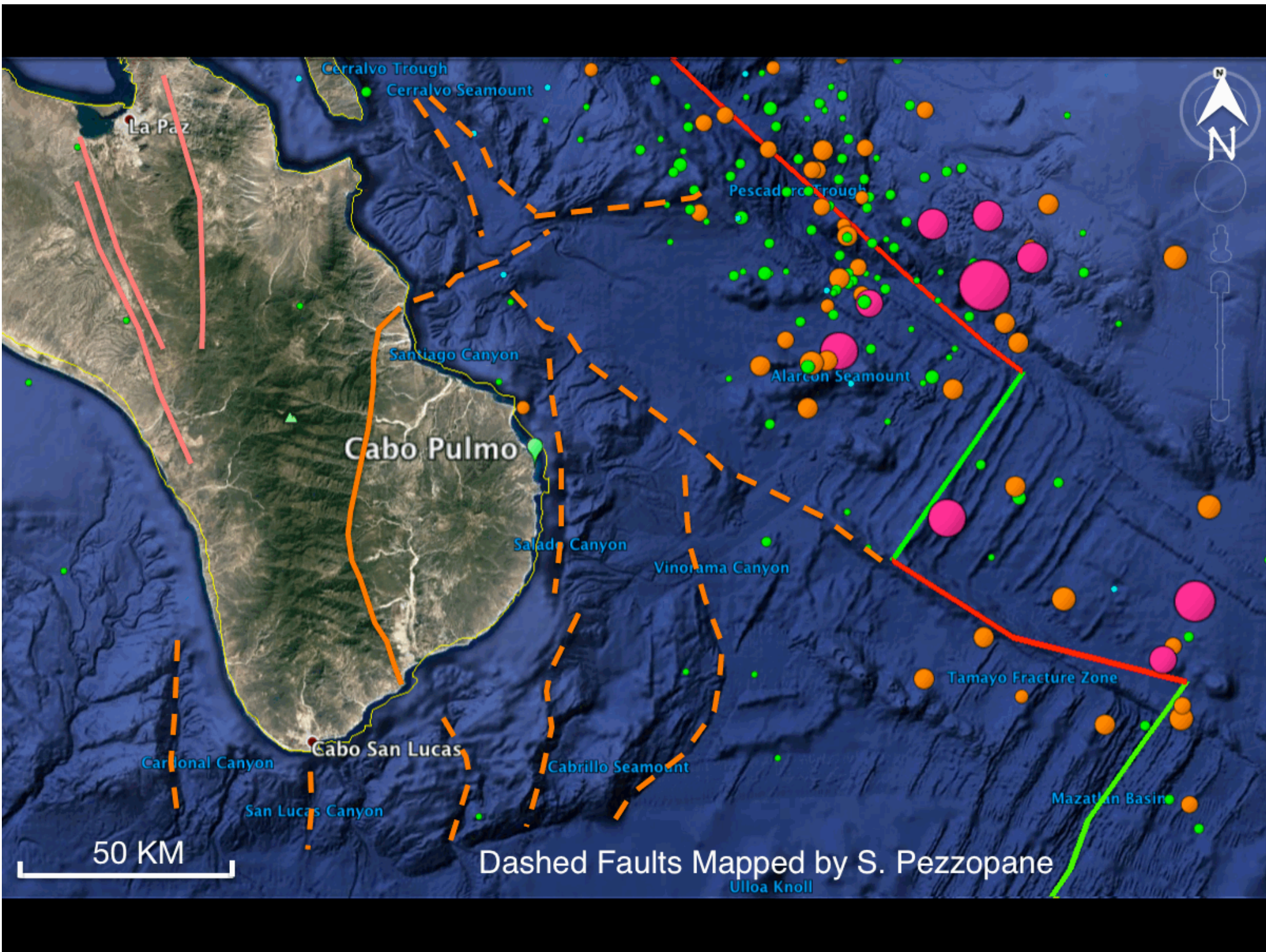














# Conclusions

- Accelerated Beach erosion and Shoreline transgression
- Sea-Level rise 0.5 to 0.8 m (50-yr PE, 50% & 95%)
- Hurricane H3 to H4 (w/in 35 km, 50-yr PE, 50% & 95%)
  - Hurricanes are temporally clustered
    - PDO Warm = 5 to 10 yrs; PDO Cold = 20 to 35 yrs?
- H3 @ Cabo Pulmo: Surge = 1.5 m, Run-up = 3.5 m
- Rounded Boulders in CP beach = Paleohurricane?
- Max  $M_w$  7 Earthquake on SAF (50-yr PE), 100 km
- Local Mapped Faults, Onshore and Offshore, Active?
- Minimal risk of Tsunami waves