Living on the Urban Ocean
Planning for the Expected and the Unexpected

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Photo Credit: Eric Goldenberg

The Urban Ocean is Where the Ocean, Land, and People Come Together…

We live in an urban, coastal world. Coastal cities are home to more than 50% of the global population, and to more than 80% of the U.S. population.

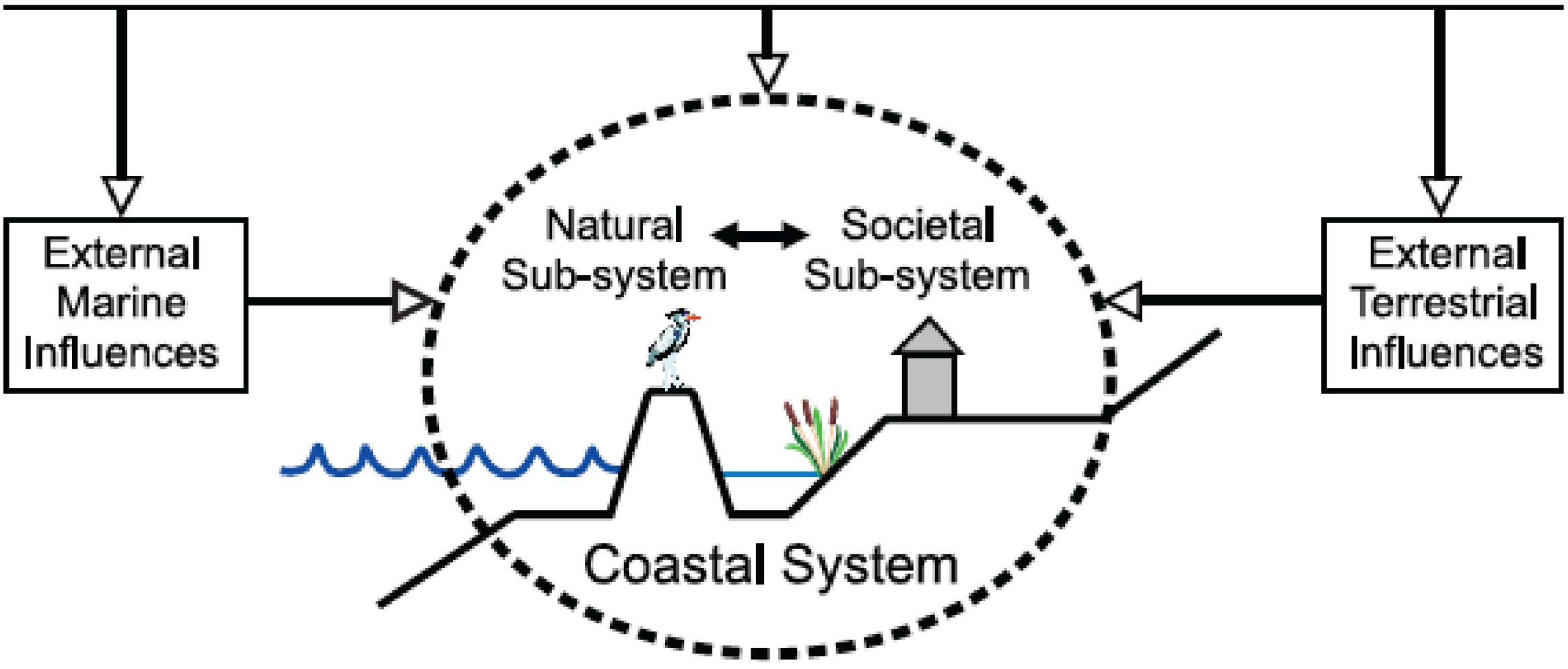
Of the 23 megacities of the world, cities with over 10 million in population, 18 are on the coast.

Urban ocean is the interface between ocean and land, extending seaward to approximately the middle of the continental (50km) and inland to about 100km to include all areas strongly influenced by the proximity to the ocean."

Urban poor at greatest risk

The Urban Ocean

Storms Sea Level Rise Waves Run-off Walls Berms Marshes



Two domains:

Cities => Water – blacktop – people

Beaches => Water – sand - people

What’s Happened?

Photo of flooded streets in Fort Lauderdale, Florida after storm Eta in 2020

JILLIANCAIN/GETTY

Miami

- King Tide or “Sunny-Day” flooding occurs regularly in Miami. Any slightly exaggerated high tide (full moon, weather offshore, etc.) causes severe flooding. The entire city lies at or near sea level. Huge assets (Hotels, Condos, EXPENSIVE Real Estate) are built directly on beach (at Sea Level).

The playground at Little River Pocket Park floods on Monday, Oct. 30, 2023 in Miami, Fla. Monday was the highest king tide of the year for South Florida, flooding streets, driveways and parks. MATIAS J. OCNER *mocner@miamiherald.com*

An aerial view of a vehicle making its way through a flooded street near Little River Pocket Park or Monday, Oct. 30, 2023 in Miami, Fla. Monday was the highest king tide of the year for South Florida, flooding streets, driveways and parks. MATIAS J. OCNER *mocner@miamiherald.com*

'Some of their homes are in danger': Jupiter Inlet Colony closes beach as waves erode sand

Jupiter Inlet Colony beachfront homes have faced damage from erosion since November. Two of the homes belong to Kid Rock and heiress Babe Rizzuto.

Maya Washburn and Kimberly Miller Palm Beach Post

Published 11:59 a.m. ET Feb. 13, 2024 | **Updated 11:26 a.m. ET Feb. 15, 2024**

Hurricane Sandy 2012

The energy of the Hurricane Sandy system created over 30 foot waves and affected an area of ocean covering 1.4 million square miles – nearly half of the area of the United States.

- Largest Atlantic Hurricane On-Record
- Made Landfall near Brigantine, NJ

  Oct. 29, 2012
- Wind Gusts Above 75 mph
- Water Levels Greater than 8 Feet Above High Tide
- 117 Fatalities in the US
- Over $50 Billion in Damages
- Millions of People Stuck in Their Homes Without Electricity for Days
- Public Transportation System were Delayed or Closed
- Severe Fuel Shortages

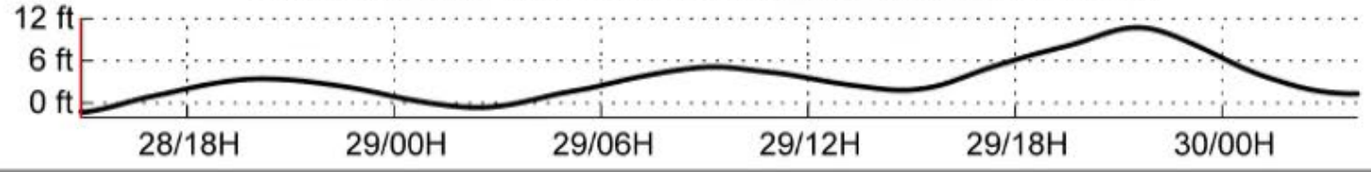
[redacted]

2012-10-28 14:55 EDT

N

HOBOKEN, NJ
Water Depth
Extreme > 9 ft
High 6~9 ft
Moderate 3~6 ft
Low 0~3 ft
Ground

Hudson River Water Elevation above Mean Sea Level



Cities and Water – Building Resilience

What is Resilience?

The ability of a community and its supporting socio-economic and socio-technical systems to respond, learn, and adapt in order to preserve and even enhance functionality under both expected and unexpected conditions.

Is this Resilience?

REUTERS/Eduardo Munoz

How can we, the urban ocean & weather community address the risks & impacts of a changing climate?

- Use **new data & models**
- Understand **the urban ocean's dynamics, chemistry and biology**
- Foster innovation to focus on the **interaction of water and the urban environment**

The Basis of Urban Coast Dynamic Flood Models
Isaac Newton - 1687

$$\frac{Du}{Dt} = -\frac{1}{\rho_0}\frac{\partial p}{\partial x} + fv + A_H\nabla_H^2 u + \frac{\partial}{\partial z}K_M\frac{\partial u}{\partial z}$$

$$\frac{Dv}{Dt} = -\frac{1}{\rho_0}\frac{\partial p}{\partial y} - fu + A_H\nabla_H^2 v + \frac{\partial}{\partial z}K_M\frac{\partial v}{\partial z}$$

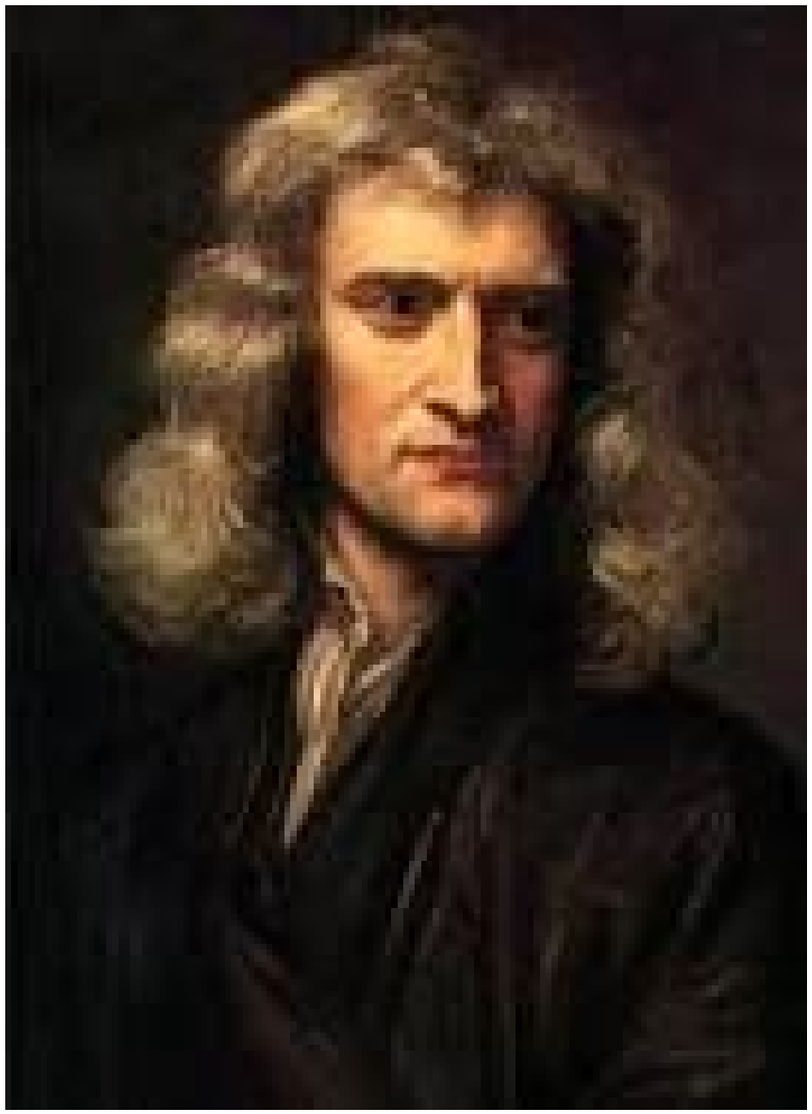
$$0 = -\frac{1}{\rho}\frac{\partial p}{\partial z} - g$$

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

$$\frac{DS}{Dt} = A_H\nabla_H^2 S + \frac{\partial}{\partial z}K_H\frac{\partial S}{\partial z}$$

$$\frac{DT}{Dt} = A_H\nabla_H^2 T + \frac{\partial}{\partial z}K_H\frac{\partial T}{\partial z}$$

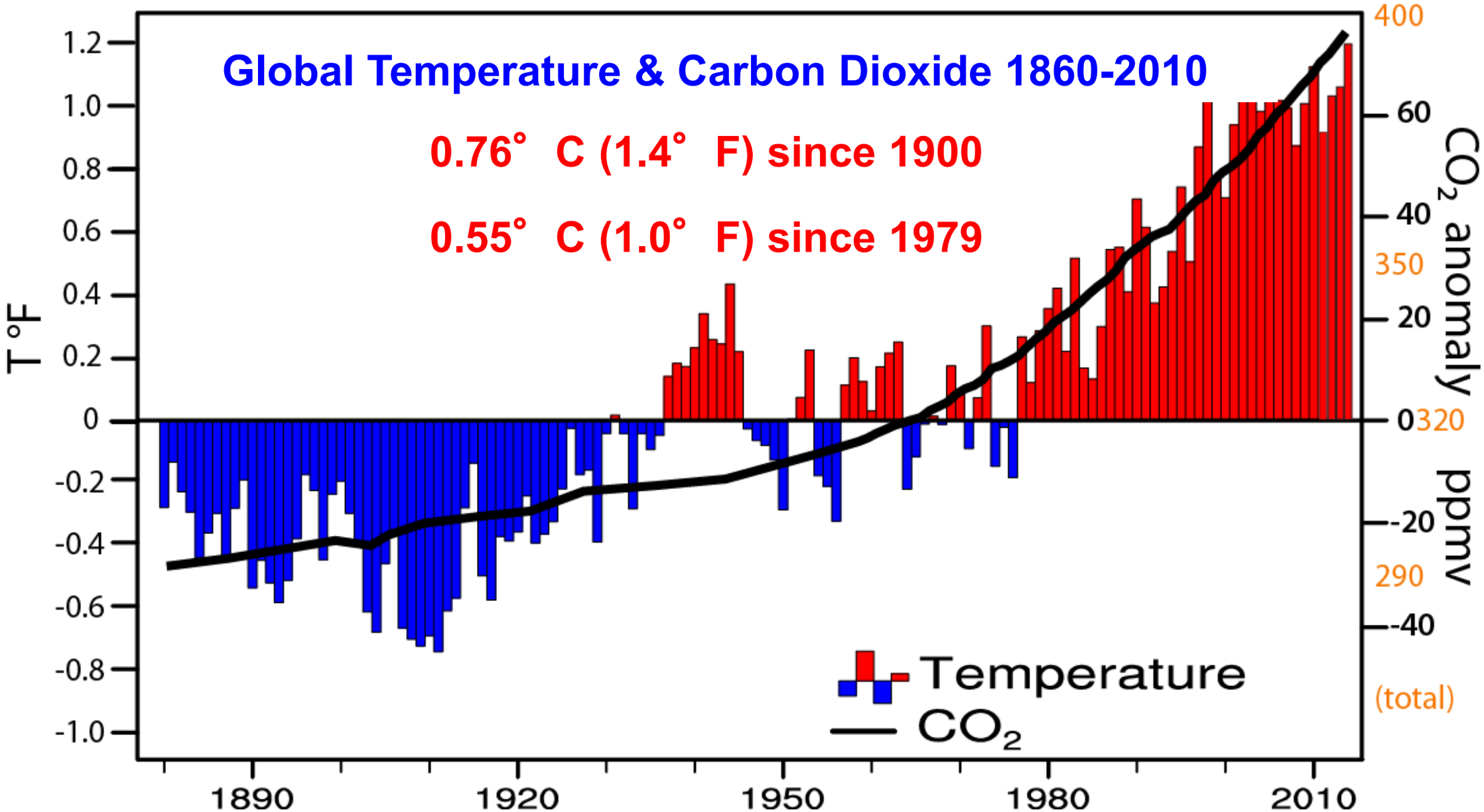
$$\frac{D}{Dt} = u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y} + w\frac{\partial}{\partial z} + \frac{\partial}{\partial t}$$



$$\vec{ma} = \sum \vec{F}$$

An Elegant Scientific Question:

Are increases in greenhouse gases responsible for increase in global mean temperature (global warming)?



Time series of annual values of global mean temperature anomalies (bars) and carbon dioxide concentrations at Mauna Loa, both from NOAA. Data are relative to a baseline of the 20th-century values. (Trenberth and Fasullo, 2013)

“We live in a world designed for an environment that no longer exists.”

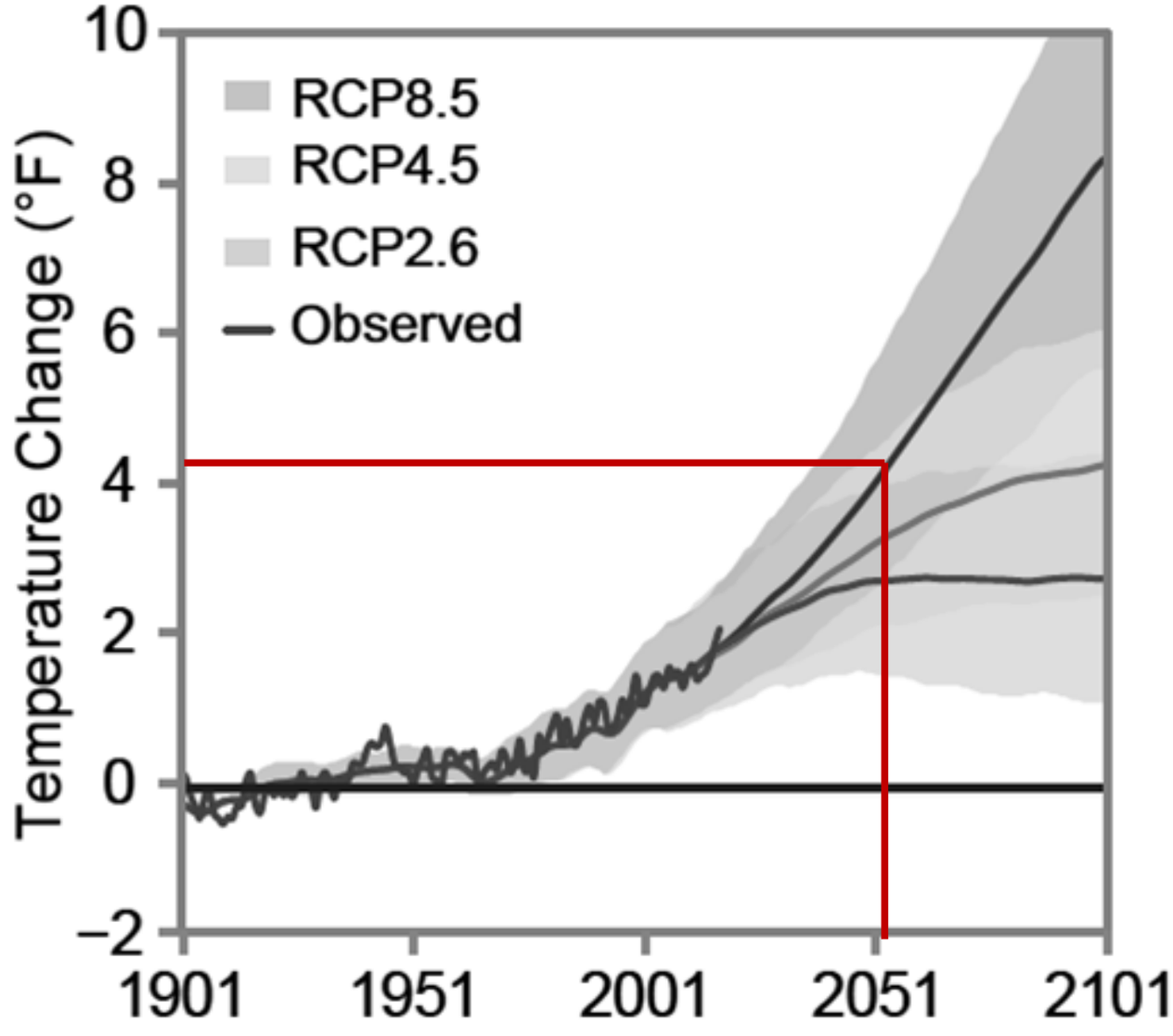
A Changing Climate

- Use calibrated models to make "projections" of the future

  -With greenhouse gas emissions

- Emissions scenarios (RCP) of the future depend upon
  - Energy technologies
  - Economic growth
  - Population

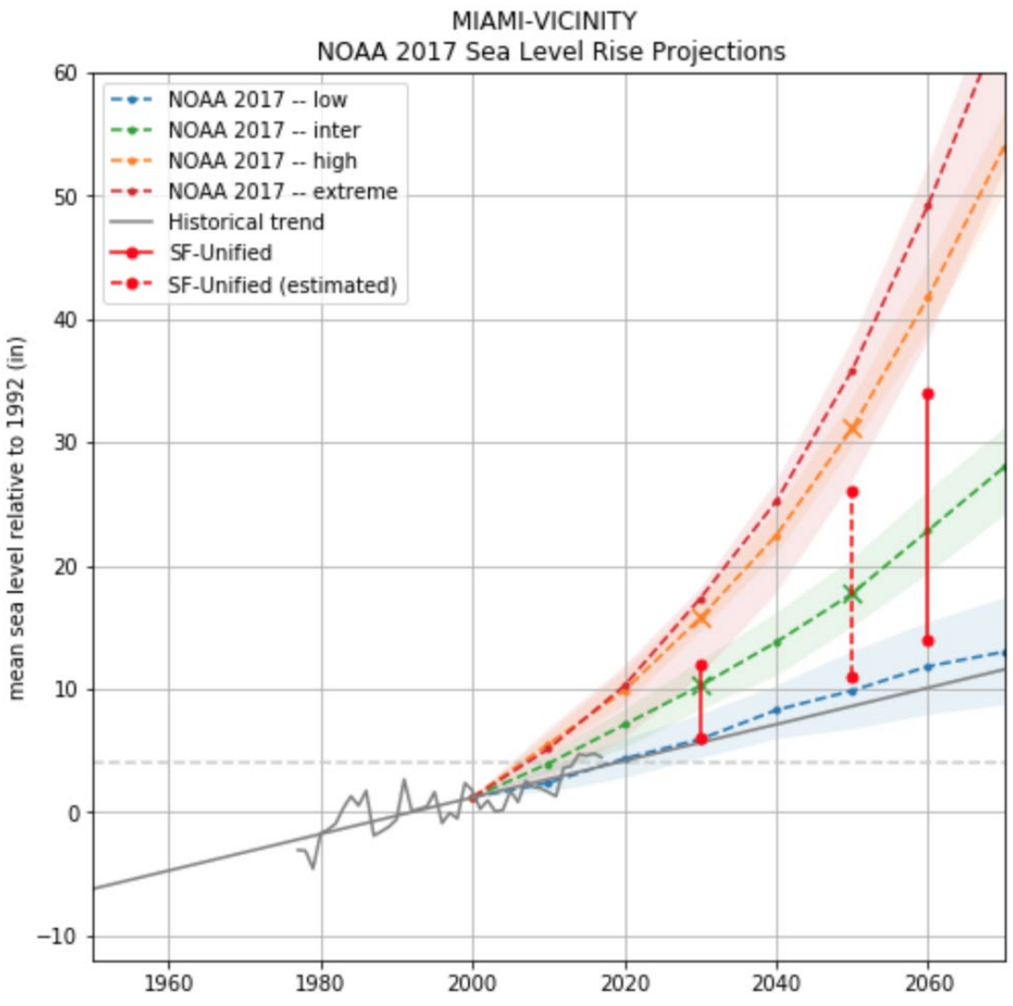
- If we stop all greenhouse gas emissions now we still get warming



4F by 2050 – 25 years.

Multimodel simulated time series from 1900 to 2100 for the change in global annual mean surface temperature relative to 1901–1960 for a range of the Representative Concentration Pathways. The mean (solid lines) and associated uncertainties (shading, showing ±2 standard deviations [5%–95%] across the distribution of individual models based on the average over 2081–2100) are given for all the RCP scenarios.

Projected changes in sea level



- **Regional sea level rise projections are based on the NOAA 2017 Interagency Report [1]**
  - Jupiter uses "Intermediate" and "High" scenarios for the Shorecrest analysis
  - The presentation today focuses on the results for the "Intermediate" SLR scenario
- **NOAA 2017 are incorporated into the 4th National Climate Assessment**
- **The new NOAA 2017 "high" sea level projections exceed older values used by the Southeast Florida Regional Compact**
  - ...due to more recent evidence of rapidly melting ice sheets in Greenland and West Antarctica

[1] Sweet et al, 2017: Global and Regional Sea Level Rise Scenarios for the United States. NOAA Technical Report NOS CO-OPS 083. NOAA/NOS

Florida 1" every 3 years. So in 25 years we have 8"!

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The Path Towards Resiliency

Understand physical vulnerabilities

Quantify costs and damageability

Identify adaptation options (operational, capital, financial)

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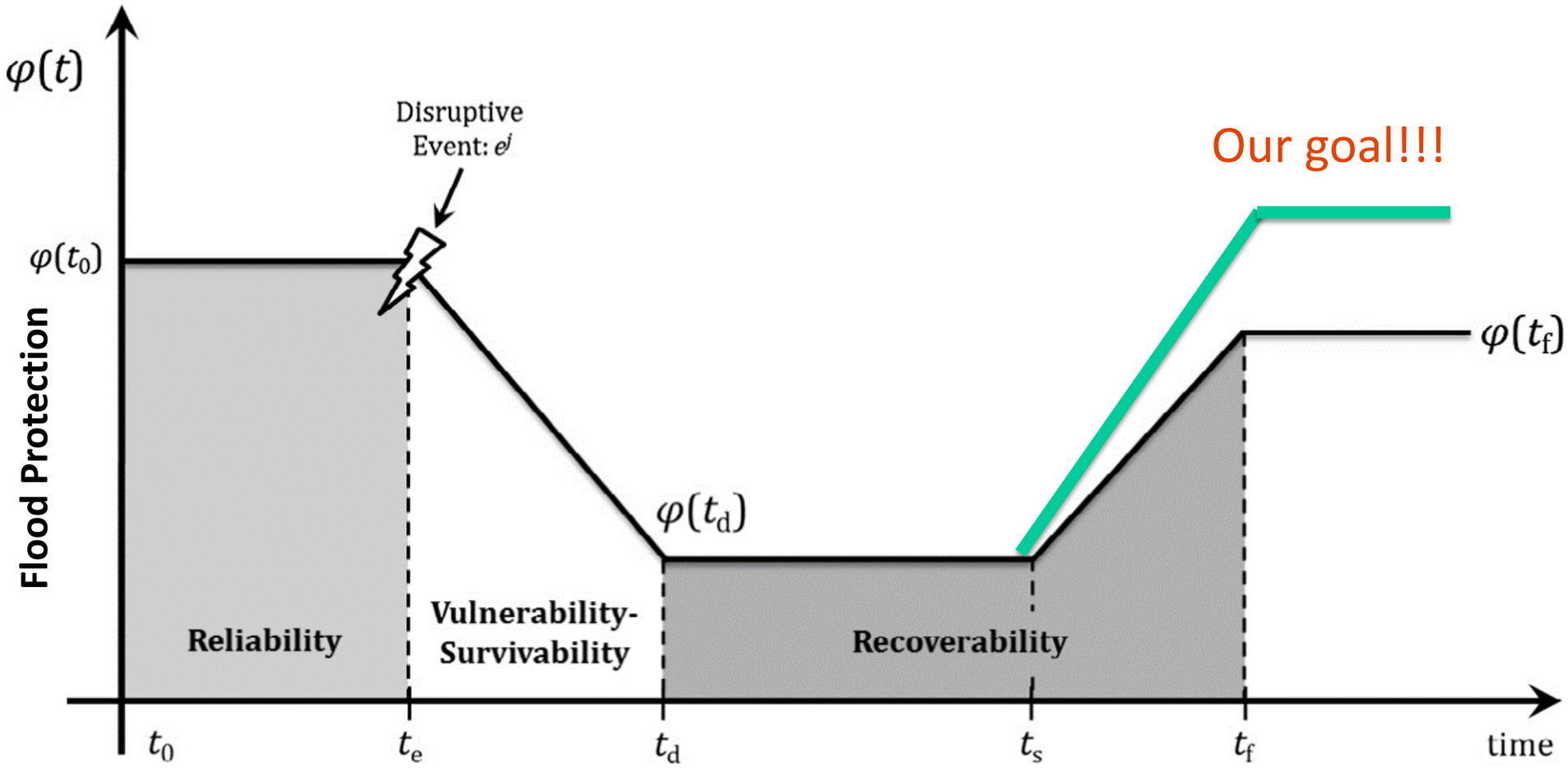
Prepare For Events
Achieve Higher Final State than Otherwise



Life history of a system - prior to disruption, the system's ability to meet performance expectations is described by its *reliability*. The ability to impact system performance is an adverse function of the system's *vulnerability.* Recoverability research is related to understanding the ability and speed of systems to recover after a disruptive event. Recovery is typically to a lower state than prior to event.

Gama Dessavre, D., Ramirez-Marquez, J.E. and Kash B. (2016) "Multidimensional Approach to Complex System Resilience Analysis" Reliability Engineering and System Safety, Vol. 149, pp. 34–43.

Future Flooding in South Florida

Extreme rainfall is expected to increase

Coastal surge
resulting from tropical cyclones
expected to be greater due stronger cyclones.

Sea-level rise will increase storm surge for a given storm intensity.

Seasonal ('king-tide') flooding is expected to occur more frequently and at higher levels due to sea level rise

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Miami Herald

ENVIRONMENT

Miami-Dade wants mangroves and islands as storm protection instead of 10-foot walls

BY ALEX HARRIS

AUGUST 21, 2020 06:00 AM ,


USACE BACKBAY TSP PROPOSED at Miami River
Rendering 7

A New Idea …
Reducing the Intensity of Hurricanes

A Hurricane Slayer

Hurricanes get all of there energy from warm water at the surface

so

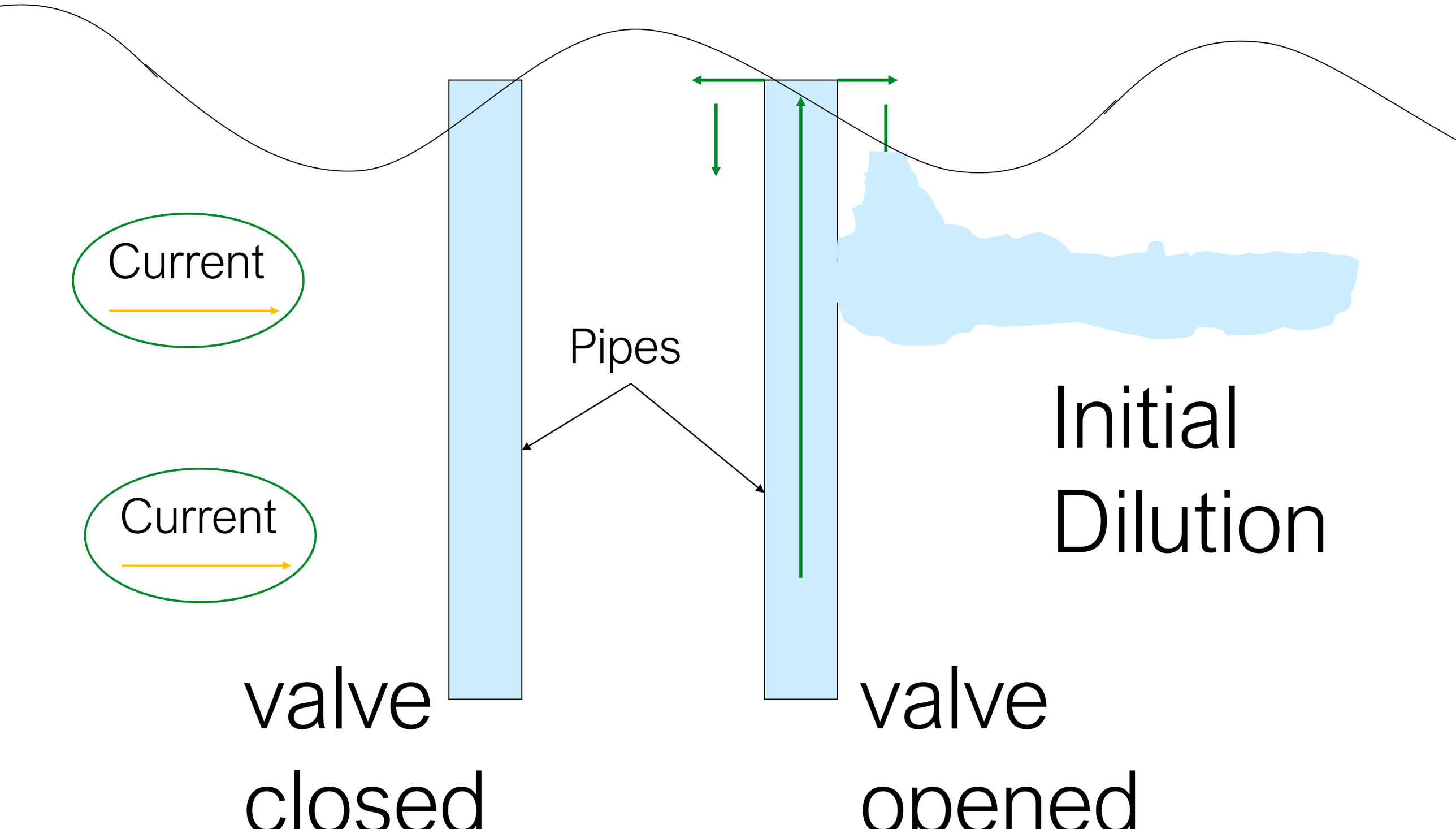
lets reduce the SST

How??

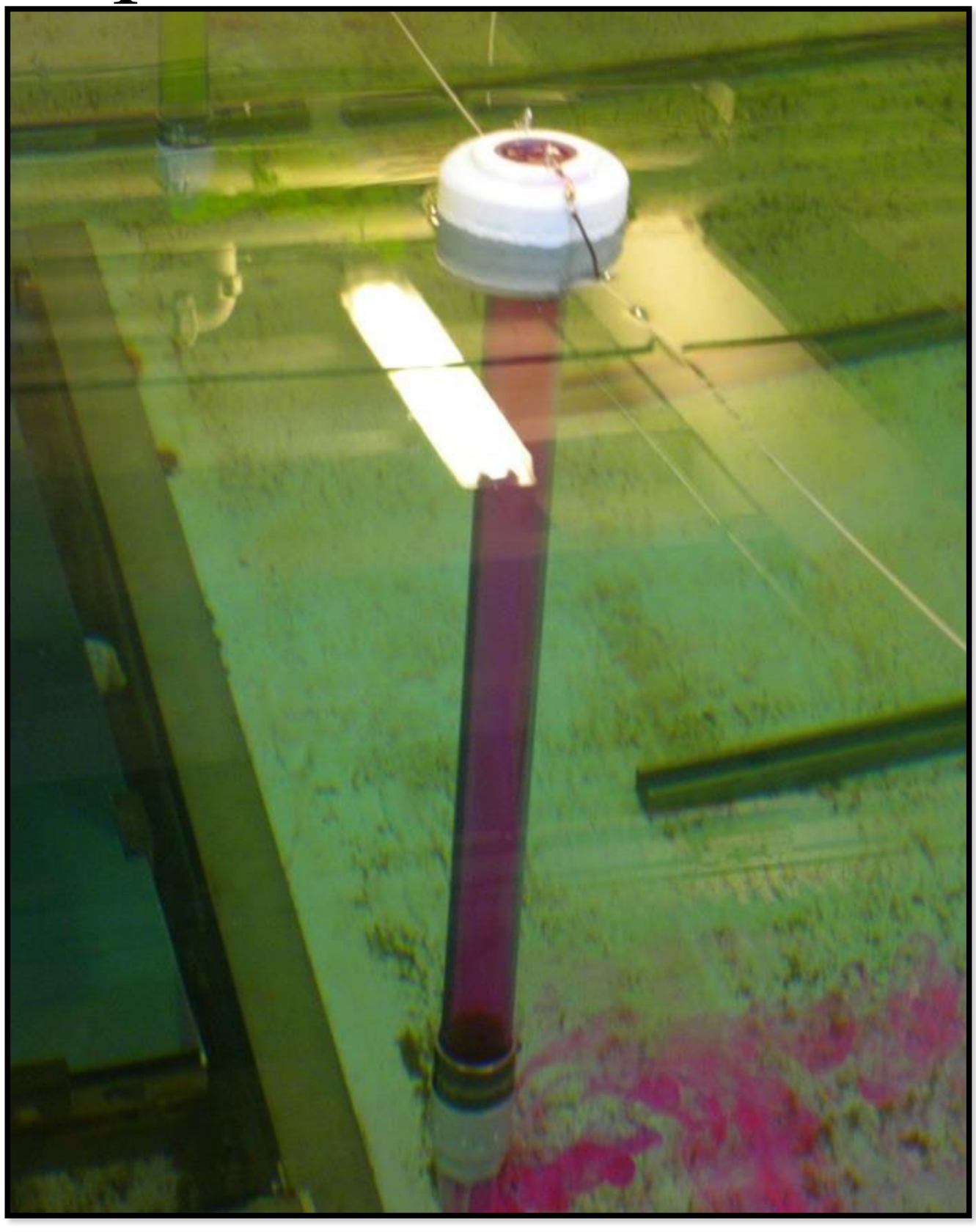
Cool it!

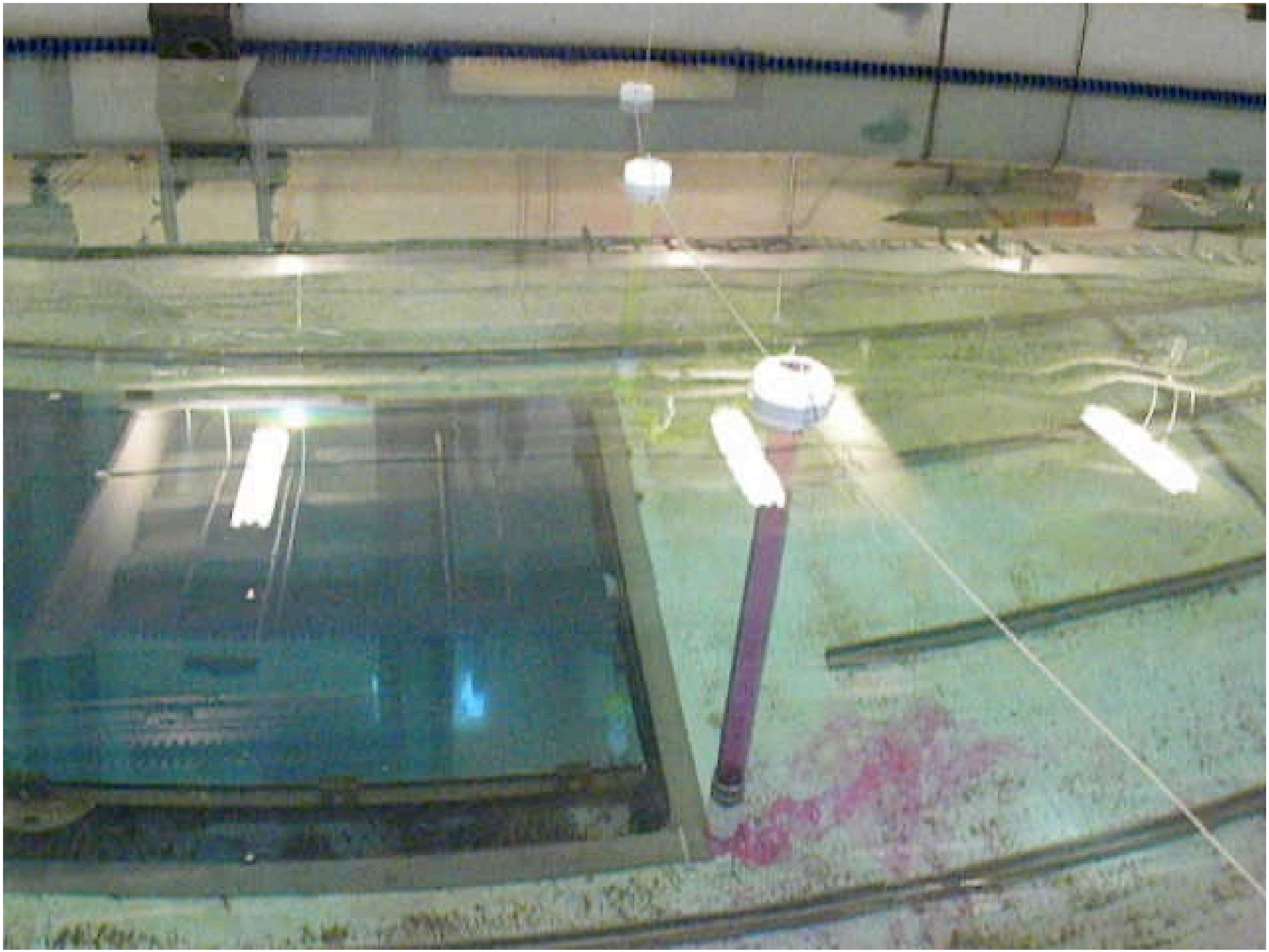
Can we pump up water from deep in the ocean to the surface?

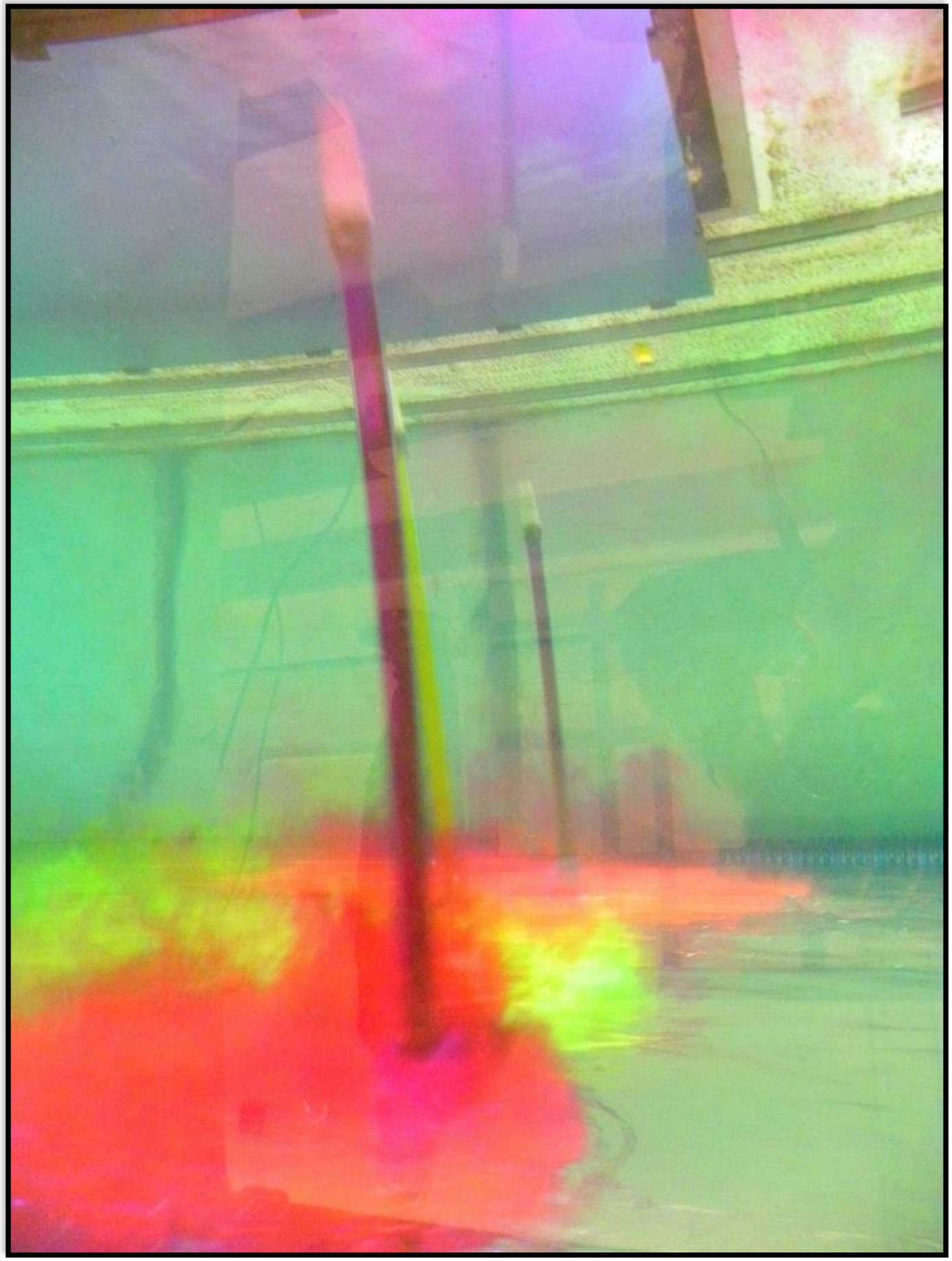
Consider first: wave driven pumps



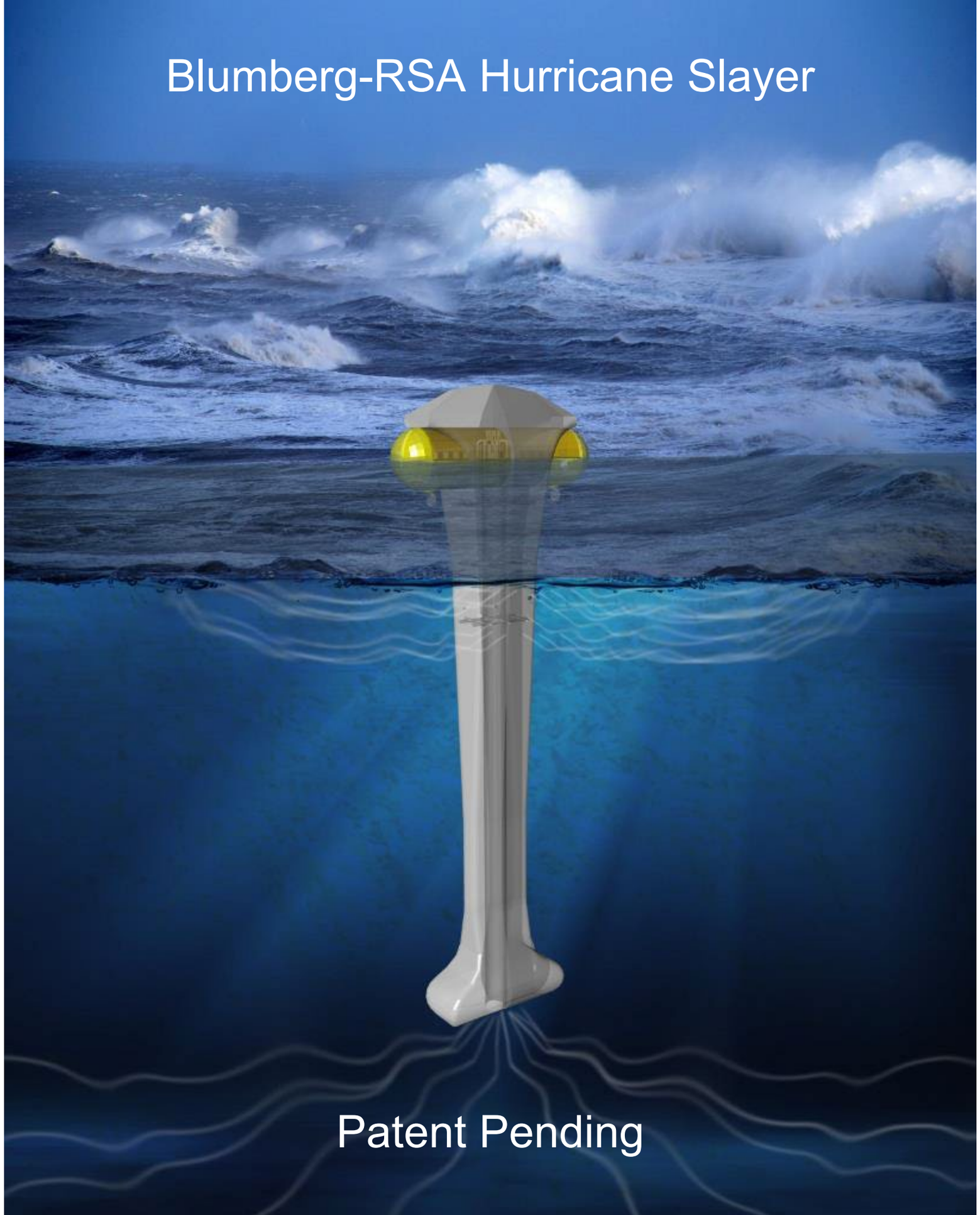
Experimental Validation







Blumberg-RSA Hurricane Slayer



Patent Pending

Number of Slayers

- Number of pumps = N_p

$$N_p = \text{(Volume to be pumped)/(Pump rate x Time)}$$

1. Assume a hurricane eye diameter of 50km
2. A lead time of 2 days
3. Pumping rate from commercially available pumps of 2 million gallons/min

So…

N_p = 300 slayers

(at a cost of $100 million each event)

Groups of Hurricane Slayers drive into the eye and follow the hurricane pumping up cold water from 1,000’ depths to reduce the surface temperature of the warm sea water that fuels the violent hurricane

WHITE HOUSE

WHERE IS EYE IN TWO DAYS

WHAT HAPPENS IF SLAYERS TURN H. DIRECTION…

Groups of Hurricane Slayers drive into the eye and follow the hurricane pumping up cold water from 1,000’ depths to reduce the surface temperature of the warm sea water that fuels the violent hurricane

Takeaways

- **Socio-Technical Systems: "The future will be intensely technological and intensely human"**
- **Prepare, Respond, Recover, *and Adapt***
- **Build back better. Focus on what goes RIGHT… this will require data & analytics**
- **Key abilities: monitor, respond, learn, anticipate**
- **It is all about people and how they respond.**

Alan F. Blumberg Michael S. Bruno

THE URBAN OCEAN

The Interaction of Cities with Water

better not miss the boat…

Timing can be of Essence !

Thank you

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