Confronting Climate Change Over the Next Three Decades

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Climate change is a super-hard problem for two simple reasons.
1. Climate change is a *collective action* problem that is truly *global*. 
2. Almost all aspects of climate change have long timescales.
The spatial pattern of climate change

Average temperature (2011-2015) minus average temperature (1911-1915)
GRACE Observations of Greenland Ice Mass Changes

Average Mass Loss: 281 Gigatons/year

Greenland Ice Loss (meters water equivalent relative to 2002)
Four categories of investment risks and opportunities:

- Infrastructure related to decarbonization
- Disruptions related to climate change impacts
- Infrastructure needed to prepare and/or respond to climate change impacts
- Interactions with social/political systems
Cartoon from an 1861 Vanity Fair: "Grand ball given by the whales in honor of the discovery of the oil wells in Pennsylvania."
Technology is critical to any solution. Global demand for electric vehicles (for example) will happen when electric vehicles are a better choice than internal combustion engine vehicles. Global demand for wind and solar power will happen when wind and solar power are better choices than coal power.
“It is very hard to predict, especially the future.”

(attributed to Niels Bohr but apparently an old Danish proverb)
Phase 1 (until 2030 to 2050): Increasing penetration of wind and solar (backed by natural gas); substitution of natural gas for coal; efficiency in all sectors.

Phase 2 (2040 to 2070): Continued expansion of renewables; deployment of storage to manage intermittency of renewables; electrification of passenger vehicles, heating, industry.

Phase 3: (post-2070?) Carbon capture and storage for natural gas plants, industrial sources; biofuels or synthetic fuels; advanced nuclear.
If global decarbonization takes longer than current rhetoric among the U.N. climate discussions, then people’s experience of climate impacts will grow substantially over the coming decades.
The graph shows the change in mean sea level (Δ MSL) over time. The data is represented by different colors for different satellite missions: TOPEX, Jason-1, Jason-2, and Jason-3. The black line represents a 60-day smoothed trend with a trend of 3.1 ± 0.4 mm/yr.

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**Tide Gauges**

Rate = 2.3 mm/yr

**Satellites**

Rate = 3.4 mm/yr

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**Figure 1**

Observed global mean sea level (from tide gauges) between 1900 and 2001. Red dots are from Church et al. (2004). Blue dots are from Jevrejeva et al. (2006).

**Figure 2**

Global mean sea level from satellite altimetry between January 1993 and December 2008. Annual cycle has been removed. Blue dots are raw 10-day data. Red line corresponds to a 90-day smoothing of the raw data. The ~0.3 mm year$^{-1}$ GIA correction has been removed.
Sandy's 9-foot storm surge in New York City coincided with the approximate time of high astronomical tide creating a record shattering tidal maximum the evening of October 29 of 13.88 feet at The Battery in New York City Harbor. The previous high tide record of 11.20 feet was set during the great hurricane of 1821.
The elevated house that the owners call the Sand Palace, on 36th Street in Mexico Beach, Fla., came through Hurricane Michael almost unscathed. Credit: Johnny Milano for The New York Times
“We are kept keen on the grindstone of pain and necessity.”
— H.G. Wells, *The Time Machine*

“It is not the strongest of the species that survives, not the most intelligent that survives. It is the one that is the most adaptable to change.”
— Charles Darwin
Are we on the verge of a new age of innovation?

Energy?
Architecture?
Agriculture?
Transportation?
Government?
What is the relationship between technology, economics, and social and political attitudes?

How will our perception of the climate problem change as new technologies are developed?

How will the politics of climate change shift as the experience of climate impacts grows?