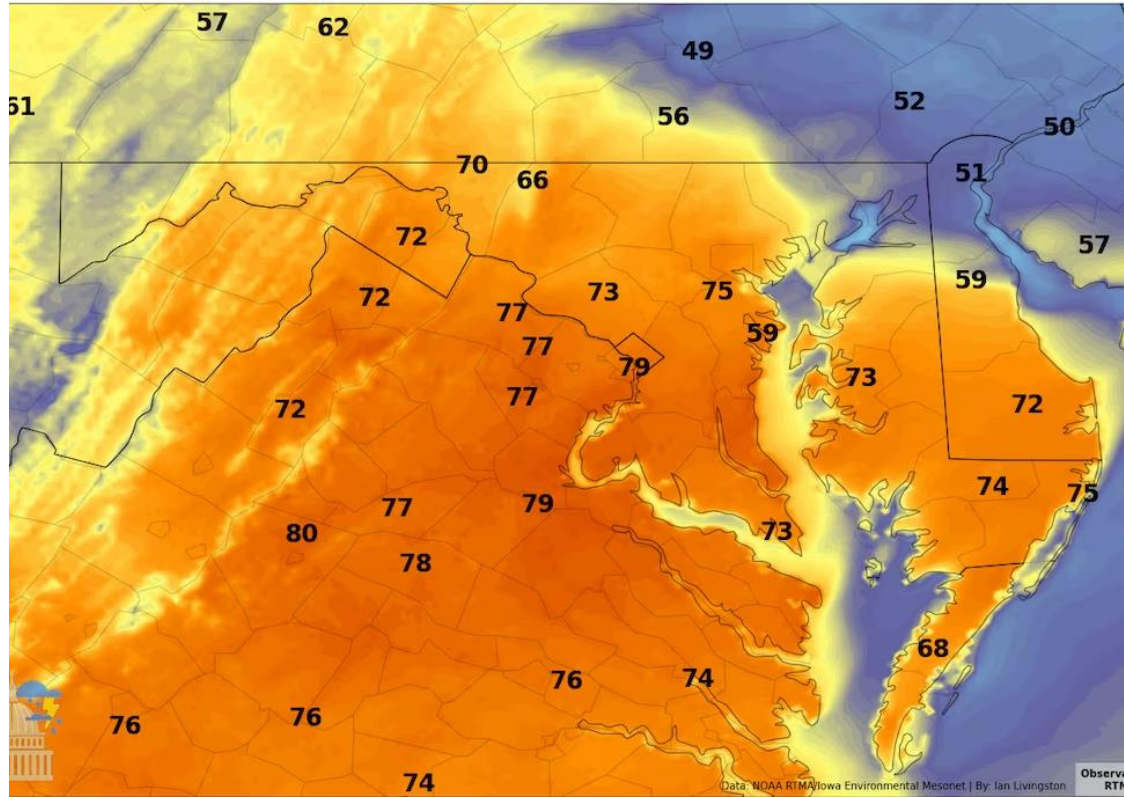


# **Weather Forecasting Challenges, and Efforts to Address Them**

Dan Stillman,  
Co-Founder and Meteorologist  
The Washington Post's Capital Weather Gang

EESI Congressional Briefing  
February 15, 2024

## Washington soars to 80 degrees, its highest January temperature on record



- Jan. 26: Highest January temperature in D.C. since record keeping began in 1872<sup>1</sup>
- Earliest 80-degree day by several weeks; previous earliest was Feb. 21 in 2018<sup>1</sup>
- Occurred during worldwide warm spell with record warmth on nearly every continent<sup>2</sup>
- Just a week after snow and arctic cold blast
- Intense cold snaps still happen in a warming world, but they are becoming less extreme
- Warm spells becoming more extreme
- Warm records outpacing cold records; 31,611 warm records in 2023 compared to 10,493 cold-weather records<sup>3</sup>

1. <https://www.washingtonpost.com/weather/2024/01/26/dc-record-january-temperature-climate/>
2. <https://www.washingtonpost.com/weather/2024/01/25/record-warmth-earth-climate-europe/>
3. <https://www.washingtonpost.com/weather/2024/01/17/climate-change-cold-extremes-arctic/>

# Model forecasts for Jan. 26

## 5-day forecast

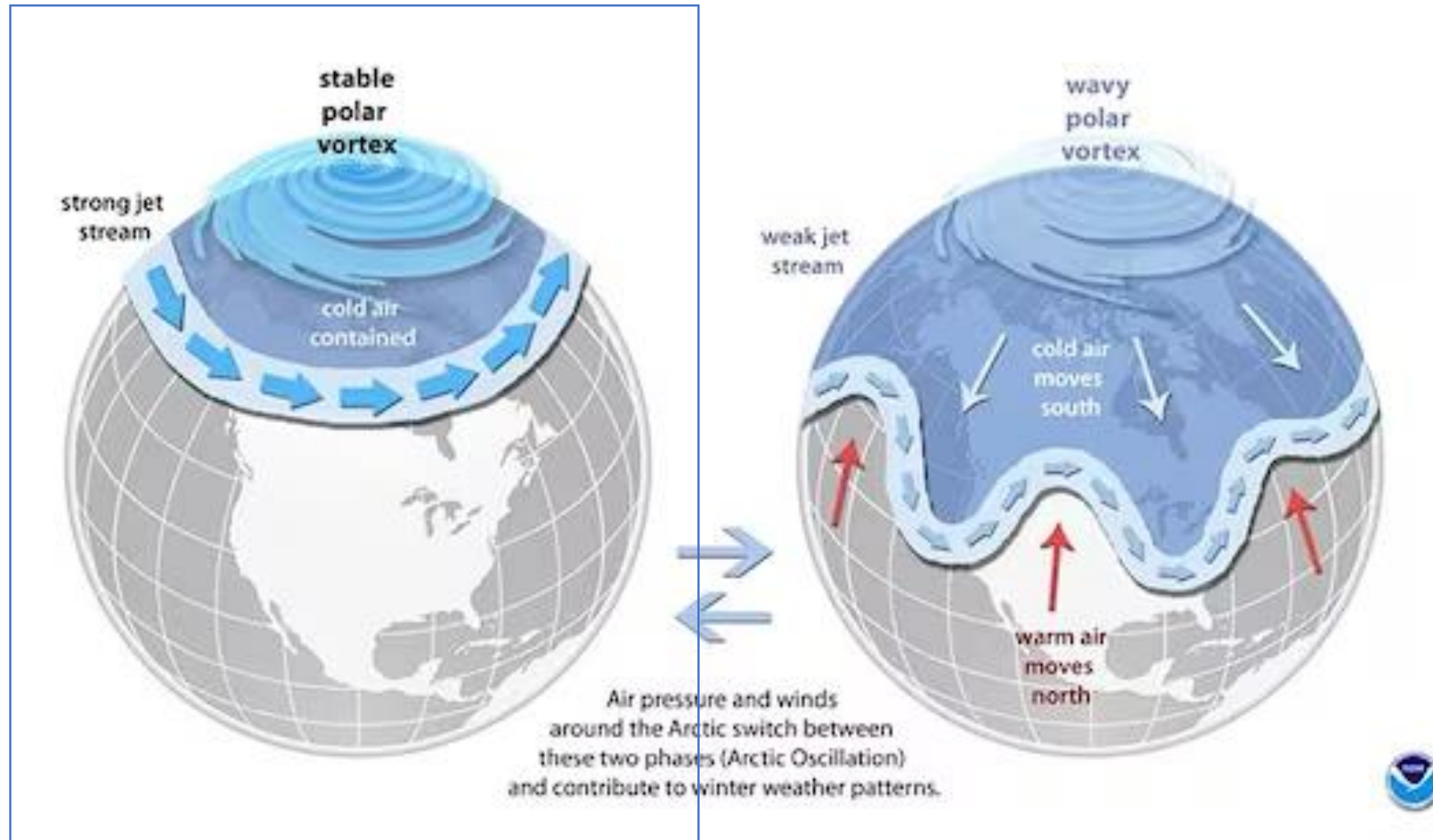
Model	Metric	Day 1 Sun 2024-01-21		Day 2 Mon 2024-01-22		Day 3 Tue 2024-01-23		Day 4 Wed 2024-01-24		Day 5 Thu 2024-01-25		Day 6 Fri 2024-01-26		Day 7 Sat 2024-01-27		Day 8 Sun 2024-01-28	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
ECMWF-EPS	Value	20	32	14	41	25	47	37	49	48	64	53	67	46	54	42	47
GFS-ENS	Value	16	31	18	37	28	41	37	51	50	63	55	65	50	59	41	51
GFS-ENS-BC	Value	17	32	16	37	28	39	35	46	44	60	54	65	50	61	41	53
GFS	Value	18	32	14	40	26	44	37	43	41	52	49	55	42	54	37	47
ECMWF	Value	21	32	12	40	25	48	38	50	51	65	53	71	45	57	42	46
ICON-GLOBAL	Value	17	34	18	41	32	43	38	45	42	47	44	64	39	50		
<b>Ensemble Mean</b>	<b>Value</b>	<b>19</b>	<b>32</b>	<b>15</b>	<b>38</b>	<b>26</b>	<b>43</b>	<b>39</b>	<b>50</b>	<b>50</b>	<b>62</b>	<b>54</b>	<b>65</b>	<b>48</b>	<b>55</b>	<b>43</b>	<b>48</b>
Operational Mean	Value	19	33	15	40	27	45	38	46	45	54	49	63	42	54	40	46
Climo		30	45	30	45	30	45	30	45	30	45	30	45	30	45	30	45
Prior Year		34	44	33	43	39	47	33	52	36	48	40	50	32	47	34	58
Records		-4 1985	70 1959	1 1893	76 1927	0 1936	72 1974	3 1963	73 1950	3 1935	75 1950	5 1948	80 2024	6 1935	75 1974	-2 1935	73 1949

## 1-day forecast

Model	Metric	Day 1 Fri 2024-01-26		Day 2 Sat 2024-01-27		Day 3 Sun 2024-01-28	
		Min	Max	Min	Max	Min	Max
ECMWF-EPS	Value	54	74	49	56	43	46
GFS-ENS	Value	55	73	49	57	43	51
GFS-ENS-BC	Value	53	72	48	57	42	52
GFS	Value	56	74	48	57	41	48
ECMWF	Value	52	74	48	58	40	48
ICON-GLOBAL	Value	53	70	45	56	42	46
<b>Ensemble Mean</b>	<b>Value</b>	<b>56</b>	<b>73</b>	<b>50</b>	<b>57</b>	<b>45</b>	<b>50</b>
Operational Mean	Value	54	73	47	57	41	47
Climo		30	45	30	45	30	45
Prior Year		40	50	32	47	34	58
Records		5 1948	80 2024	6 1935	75 1974	-2 1935	73 1949

Forecasts were as much as 10 to 15 degrees too low

## Contributing Factor: Strong, Stable Polar Vortex

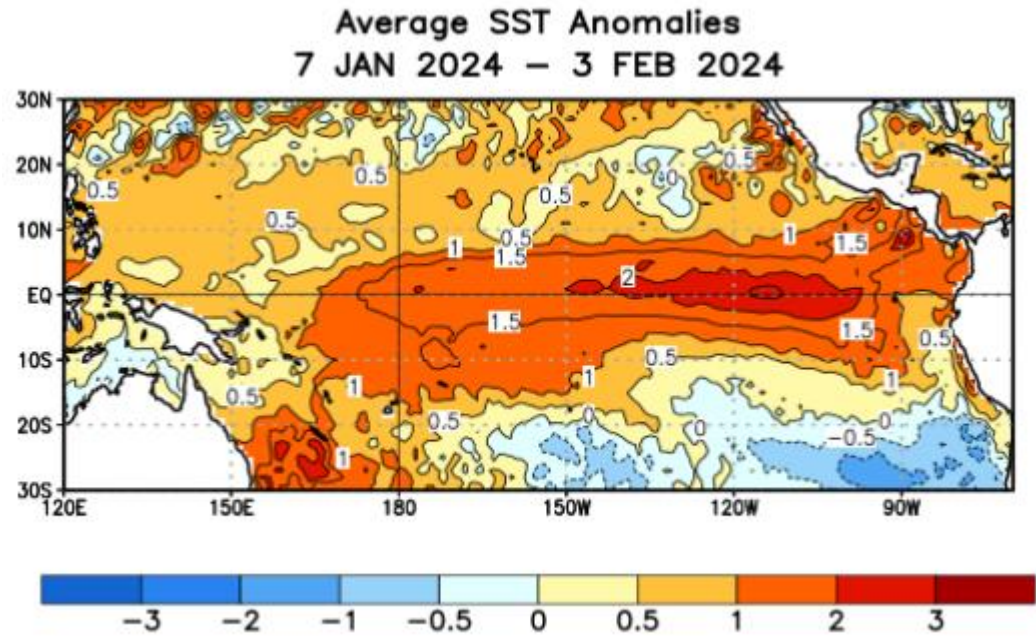


When polar vortex is strong and stable, cold air is locked up near Arctic

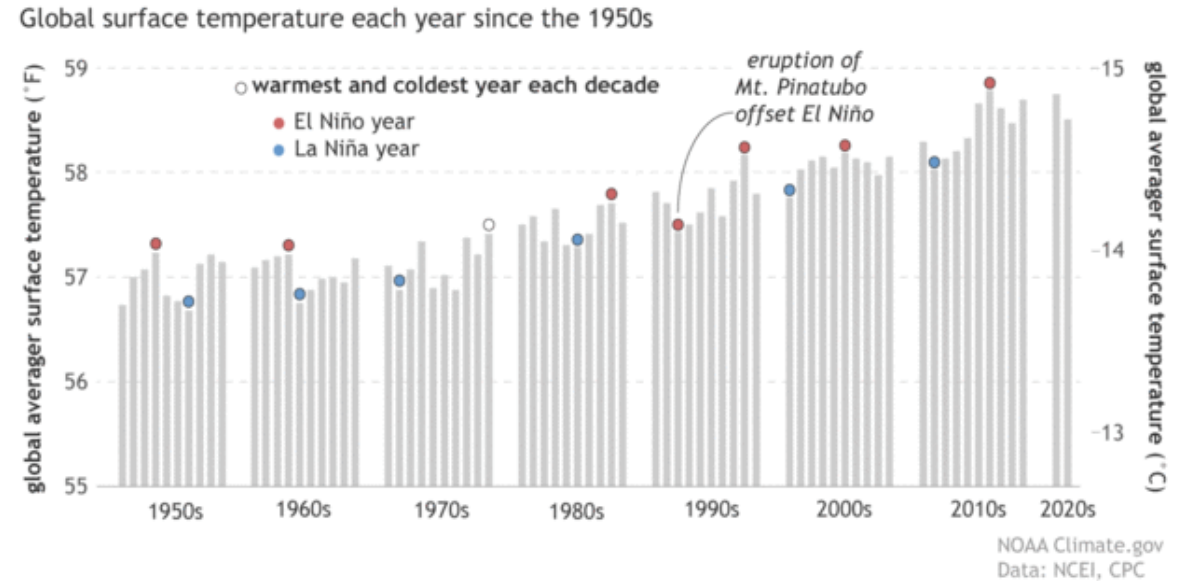


# Contributing Factor: El Niño

## Ongoing Strong El Niño

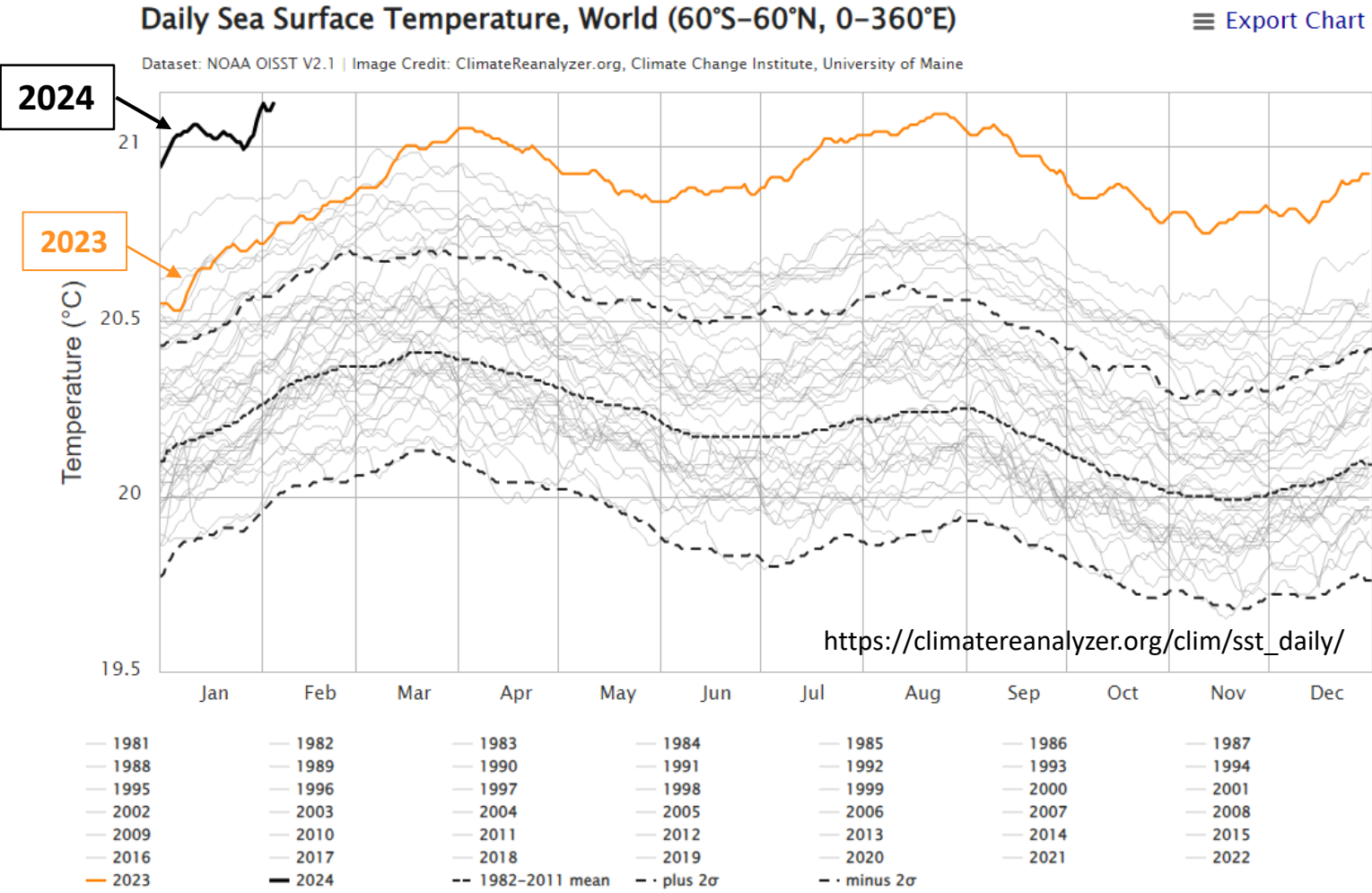


## Warmest Years Are El Niño Years



El Niño increases the chance of breaking warm temperature records

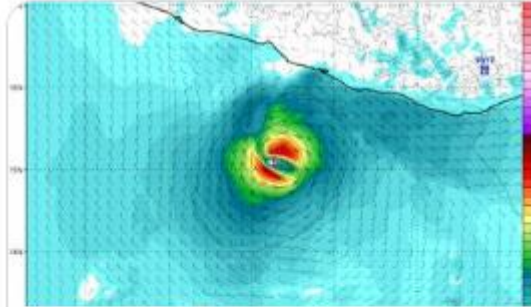
# Contributing Factor: Record-Warm Oceans



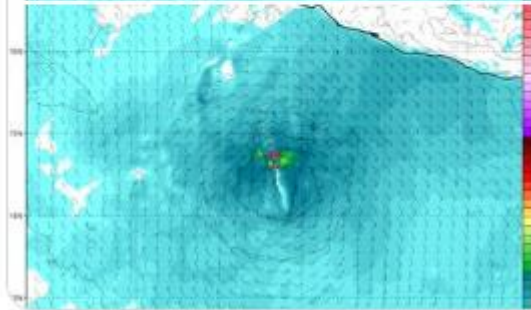
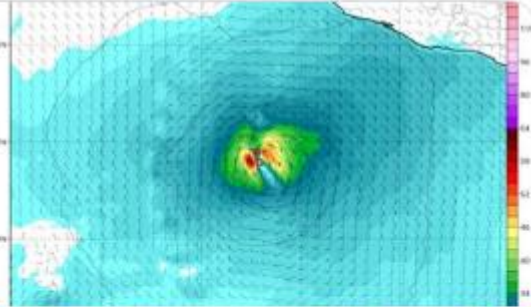
Last year was warmest on record, even warmer to start 2024

## Hurricane Otis forecast an 'epic fail'

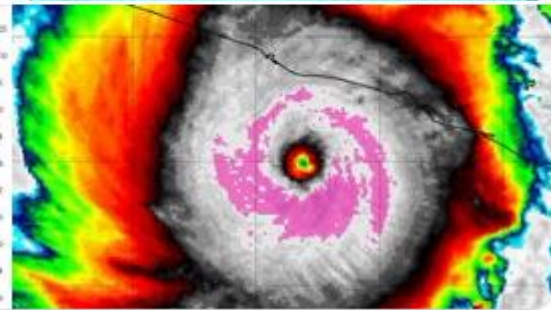
24-hour HWRF forecast



24-hour HMON forecast



24-hour HAFS-A forecast

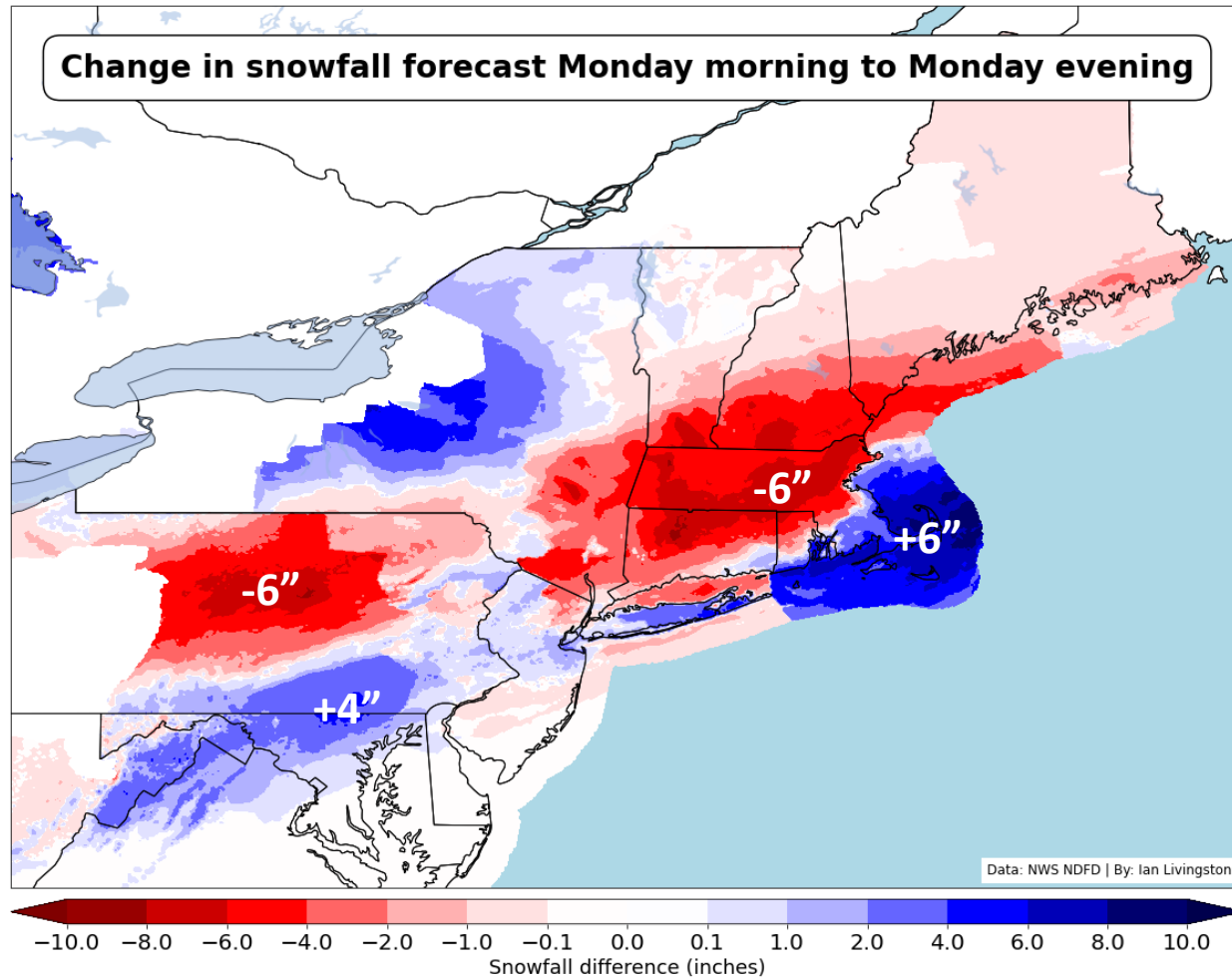


Actual

Most models kept Otis below hurricane strength.  
A day later it catapulted to a Category 5.

- Hurricane Otis made landfall on Acapulco Oct. 25, 2023
- First Pacific hurricane to make landfall at Category 5 intensity
- Winds increased by 90 mph, from a tropical storm to Category 5 hurricane, in 12 hours
- More hurricanes are rapidly intensifying due in part to warmer ocean waters and slower-moving storms
- Harder to predict, harder to prepare for

## Feb. 13, 2024, Nor'easter confounds meteorologists

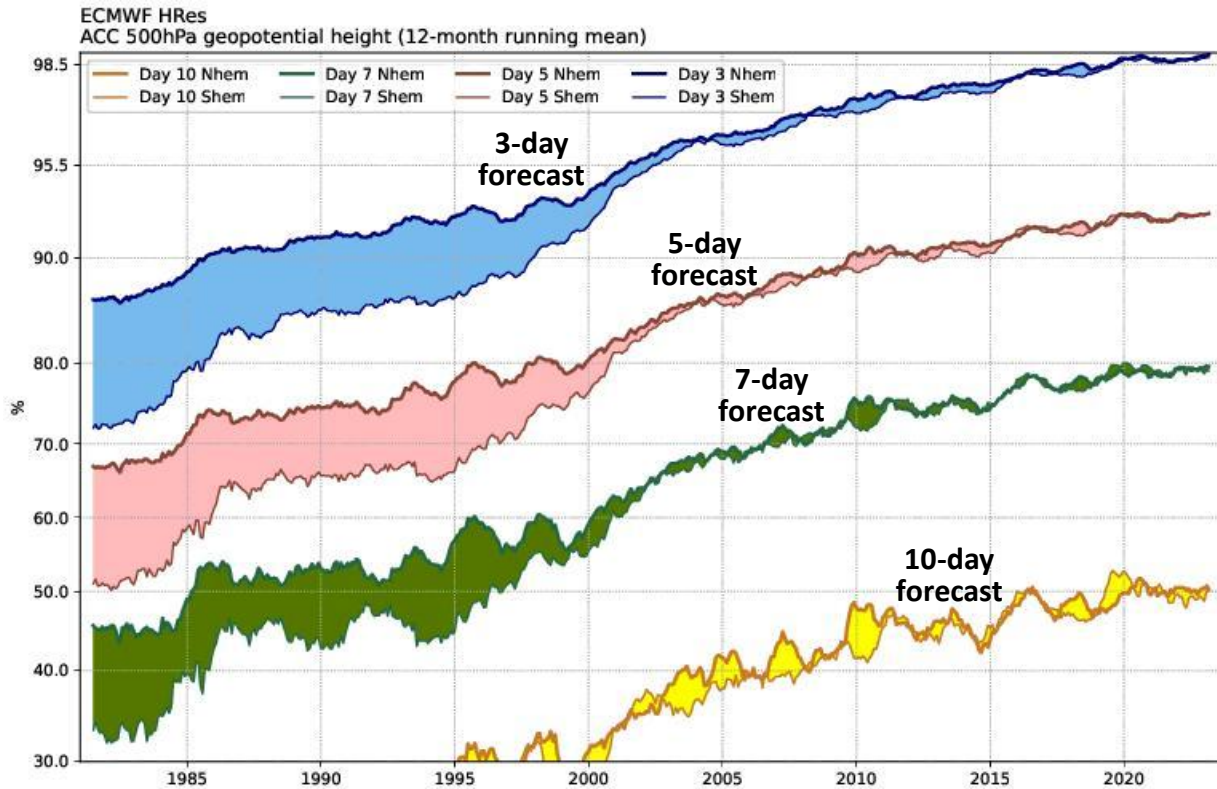


- Huge shift in snowfall forecasts the day before storm as models abruptly shifted storm significantly southward
- Boston forecast dropped from 7-13" to 4-8"; final total at Logan Airport was 0.1"
- Albany forecast dropped from 8-12" to 1-2"; final total: no accumulation
- Hartford forecast dropped from 8-12" to 4-8"; final total was 15"
- Forecast for portions of SE Mass jumped from 1-3" to 6-8"; final total was 4-6"

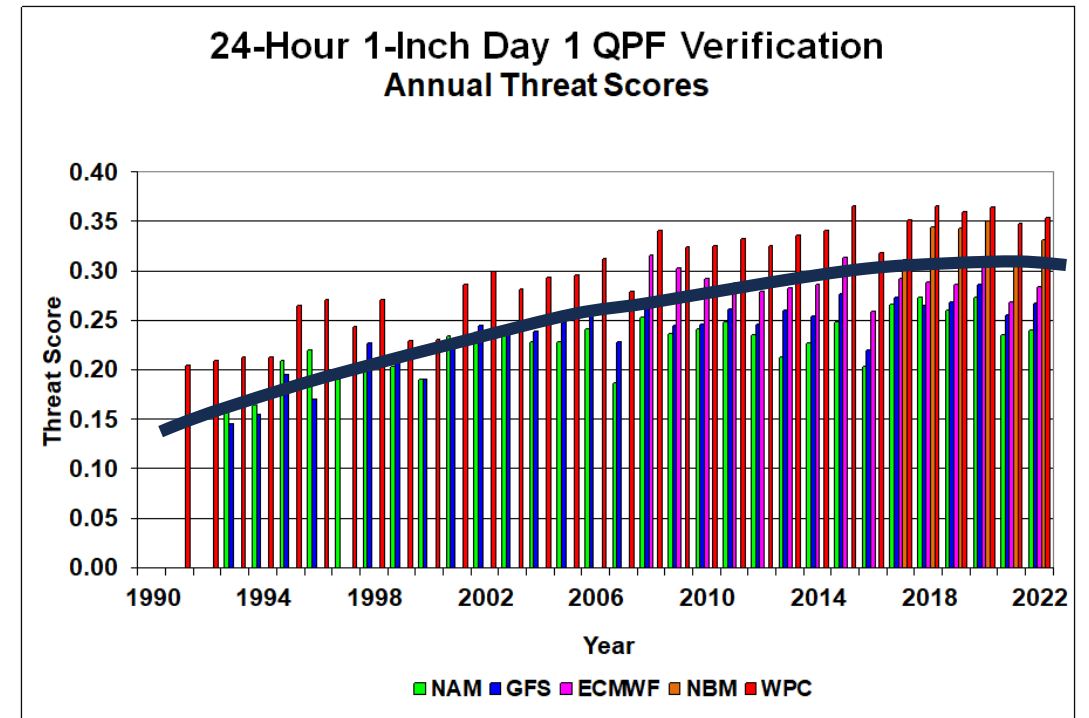


# Flattening Rate of Forecast Improvement

## Large-scale weather pattern accuracy

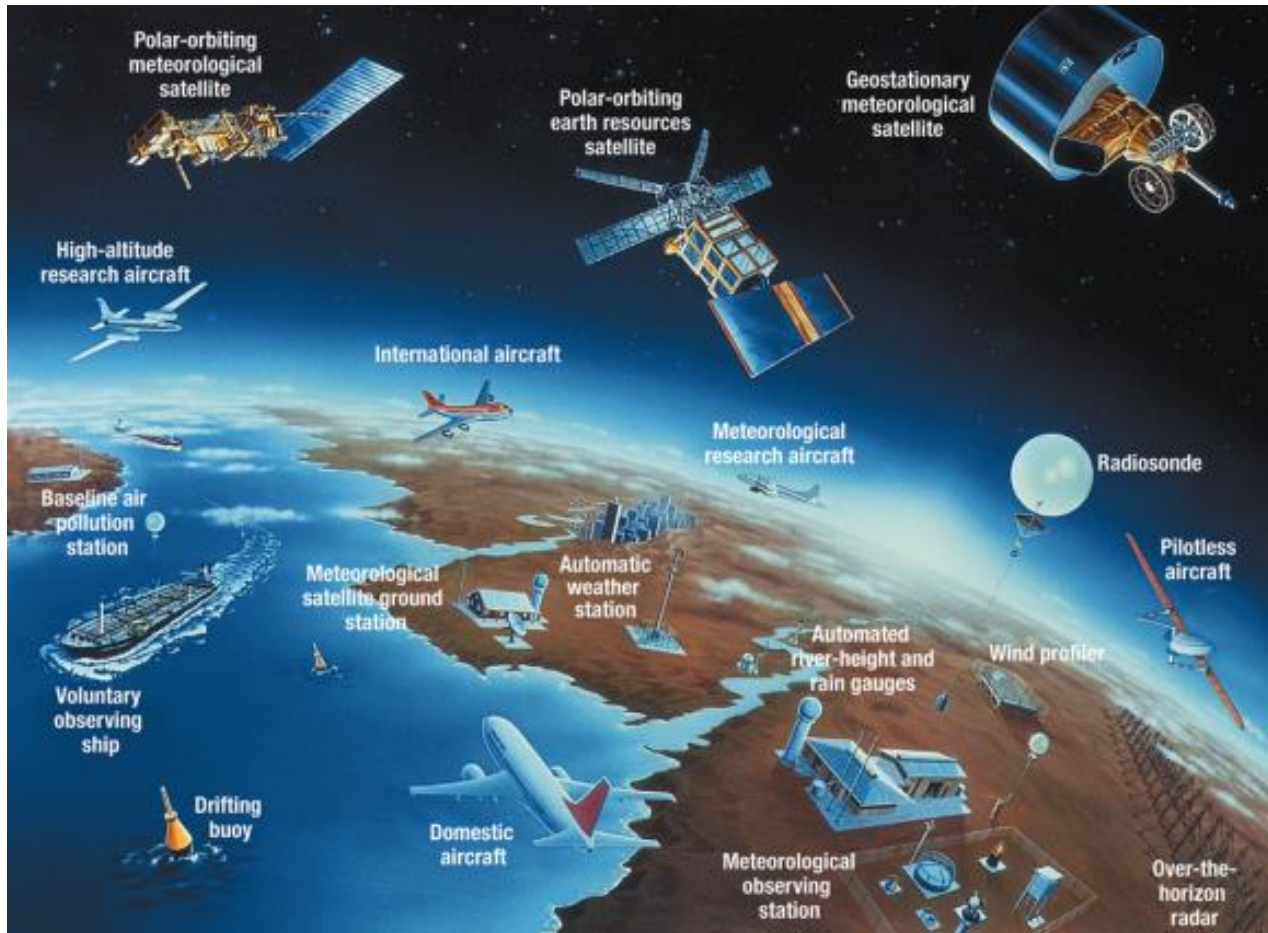


## Precipitation forecast accuracy



Rate of forecast improvement has slowed, especially for precipitation, but efforts to improve models continue

## Backbone of Weather Forecasts: Observations



- NOAA and other government satellites, radars, weather balloons, aircraft, ground sensors, buoys, serve as backbone of global observation network
- International collaboration because local forecasts depend on global data
- Forecast models limited by incomplete, relatively scarce observations of surface and lower atmosphere
- NOAA continuing to explore and/or operationalize use of private-sector satellite, radar, buoy, and other data

## How Big Tech AI models nailed forecast for Hurricane Lee a week in advance

U.S. and European weather agencies are escalating their engagement with artificial intelligence as the technology rapidly advances

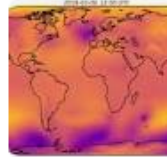


wp Washington Post

### Google's AI weather forecast model is surprisingly accurate, study finds

Google has produced a weather forecasting model using artificial intelligence with better accuracy, faster speed and lower costs,...

Nov 14, 2023



wp Washington Post

### Should we trust artificial intelligence to predict natural disasters?

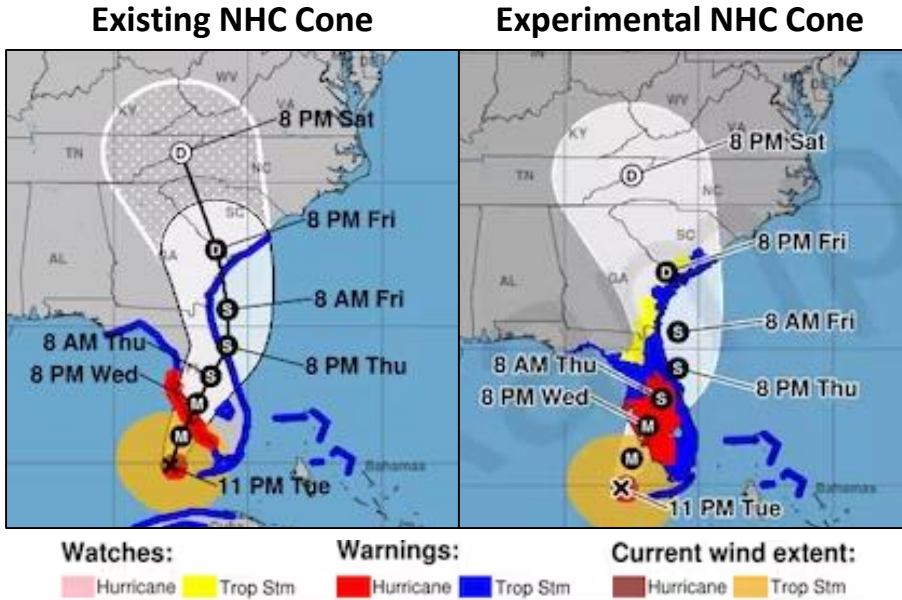
Count weather forecasting among the numerous industries AI has the potential to transform. Artificial intelligence is already helping...

Jul 4, 2023

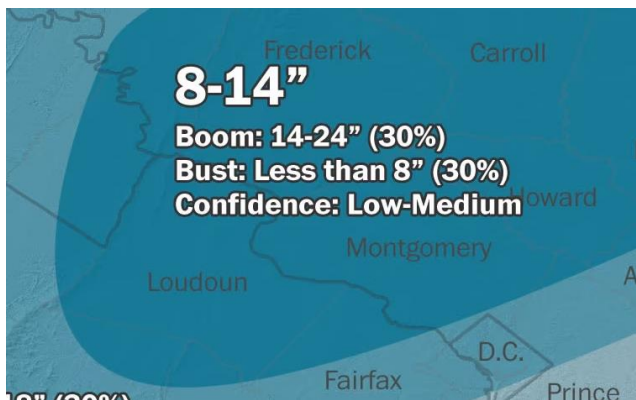


- Big Tech, including Google, Microsoft and Nvidia, have made rapid advances in AI weather modeling in the last 2 years
- AI models now as accurate, in some cases even more accurate, than traditional models
- AI models are less expensive and much faster to run than traditional models; could enable more confident forecasts and better capture extreme conditions
- But it's a symbiotic relationship. AI models are trained on traditional models and use their data as starting point to make forecasts
- Government weather agencies, including NOAA, accelerating AI modeling activities and collaborating with private sector

# To Be Effective, Accurate Forecasts Must Be Effectively Communicated



- Social science is key to turning forecasts into well informed decisions
- Forecasts for low-probability, high-impact events especially challenging
- Experimental National Hurricane Center forecast cone this coming season; will highlight inland threats, not just on the coast



**Capital Weather Gang's  
'Boom-Bust' Snow Map**

- NWS emphasis on better communication with, and embedding forecasters with, emergency managers
- NOAA Weather Program Office projects looking at how people understand probabilities, interpret weather risk graphics, and respond to severe weather



## Messages to Congress

- More accurate forecasts, earlier warnings, better characterization of extreme scenarios, and more effective communication will save thousands more lives and provide millions to billions of dollars in economic benefit
- When you properly fund weather and climate agencies, you are investing in the entire U.S. weather and climate enterprise—the public, private, and academic sectors
- When you underfund any one component of forecasting, you undercut the end-user forecast and potential for personal, organizational, and economic benefit