Updates to Climate Information and CASI Research

Goddard Institute for Space Studies

Cynthia Rosenzweig

Climate Adaptation Science Investigators (CASI) Working Group

15 May 2013

Updates to Climate Information and CASI Research

- What climate projections are available for NASA facilities?
- What is the basis of climate projections?
- What will the next modeling advances bring us?
- What do the initial climate projections using the latest data show?
- What can NASA learn from New York City’s response to Hurricane Sandy?

NASA Climate Adaptation Science Investigators (CASI) Workgroup

September 2009 fires at JPL

Winter 2009-2010 cold event at KSC

Advance and apply NASA's scientific expertise and products to develop climate adaptation strategies that support NASA's overall mission by minimizing risks to each center's operations, physical assets, natural resources, and personnel.

Question

What climate projections are available for NASA facilities?

CASI projections

Table 1. Baseline climate and mean annual climate change projections for Stennis Space Center

Climate variable	Baseline	2020s	2050s	2080s
Average temperature	66.5 °F	+1.5 to 2.0 °F	+2.5 to 4.0 °F	+3.5 to 7.0°F
Average precipitation	63.1 in	-5 to 5%	-10 to 5%	-10 to 5%
Sea level rise	NA	+ 2 to 4 in	+ 6 to 10 in	+11 to 19 in
Sea level rise - Rapid Ice Melt Scenario	NA	~ 5 to 9 in	~ 18 to 27 in	~40 to 51 in

Temperature and precipitation projections reflect a 30-year average centered on the specified decade; sea levels are averages for the specific decade. The baseline for temperature and precipitation is 1971-2000; the baseline for sea level is 2000-2004. Temperature and precipitation data are for Poplarville, MS and sea level data are for Grand Isle, LA. Temperatures are rounded to the nearest half degree, precipitation projections to the nearest 5%, and sea level rise to the nearest inch. Shown are the central range (middle 67% of values from model-based probabilities) across the GCMs and GHG emissions scenarios. Data are from the NOAA National Climatic Data Center.

In addition to changes in mean climate, extreme events are also projected to change in their frequency and/or intensity. For Stennis Space Center, an increase in hot days and decrease in cold days is projected for the future (Table 2). Other climate extremes, such as intense rainfall events and coastal flooding are also projected to change in the future.

Table 2. Extreme temperature event projections for Poplarville, MS[3]

	Baseline	2020s	2050s	2080s
Days with maximum temperature at or above 90 °F	82	93 to 106	106 to 131	120 to 155
Days with minimum temperature at or below 40 °F	62	49 to 54	40 to 50	31 to 45

The baseline data for temperature are for the most complete set of years centered around the 1980s at the weather station. The central range (middle 67% of values from model-based probabilities) across the GCMs and GHG emissions scenarios is shown.

Given the potential impacts of climate and climate change on Stennis Space Center, it is important to incorporate climate risks into planning. This process includes considering both adaptation and mitigation strategies.

All facilities have access to climate data

Sea level rise projections

NASA Center	2050s GCM-based SLR*	2050s Rapid Ice-Melt SLR**
Ames Research Center	6 to 9 inches	18 to 25 inches
Johnson Space Center	5 to 9 inches	17 to 26 inches
Kennedy Space Center	5 to 8 inches	17 to 24 inches
Langley Research Center	7 to 11 inches	19 to 27 inches
Michoud Assembly Facility	*30 to 34 inches****	*42 to 51 inches****
Stennis Space Center	6 to 10 inches	18 to 27inches
Wallops Flight Facility	7 to 11 inches	19 to 28 inches

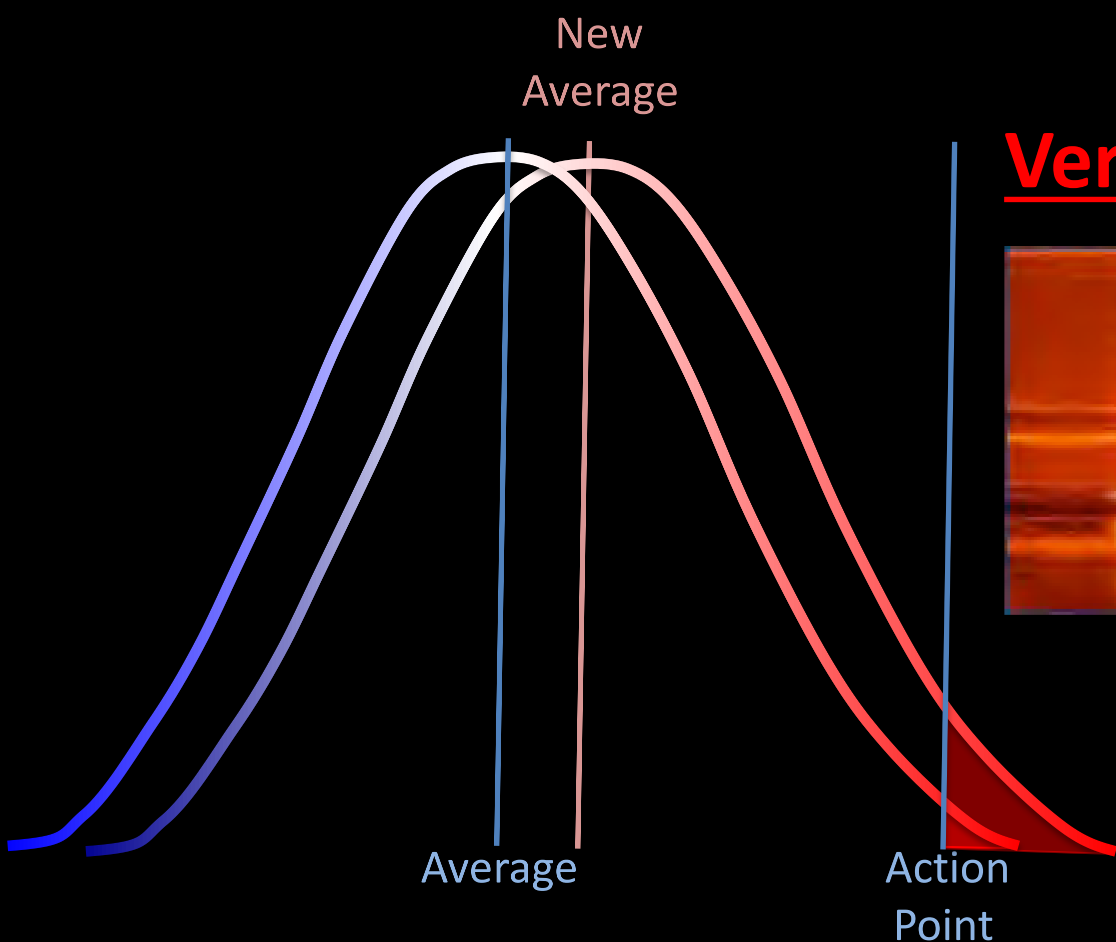
* Projections are based on 7 GCMs and 3 emissions scenarios. Presented are the central range (middle 67%) of values from model-based probabilities. Data are rounded to the nearest inch.

** The rapid ice-melt scenario is based on acceleration of recent rates of ice melt in the Greenland and West Antarctic ice sheets and paleoclimate studies.

****** Projections for MAF are high due to rapid rates of land subsidence in the New Orleans region. The subsidence rate is highly site specific and could change in the future.***

Rising sea levels threaten NASA's coastal facilities

What can a few degrees warmer do?



Very Likely Increase:

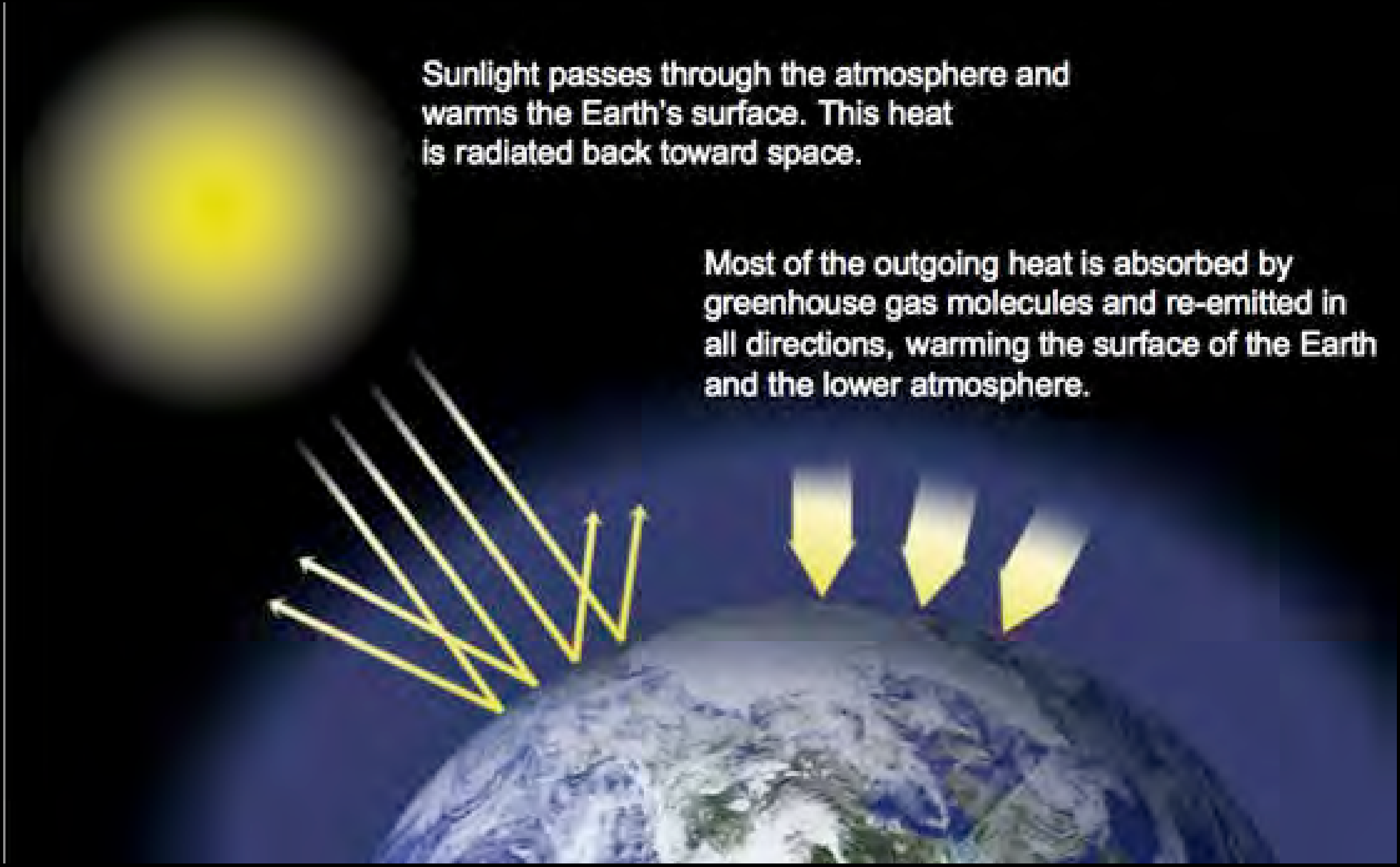
Days with
Extreme
Heat

A small average change can mean a big effect on extremes

Question

What is the basis for climate projections?

Earth's Greenhouse Effect

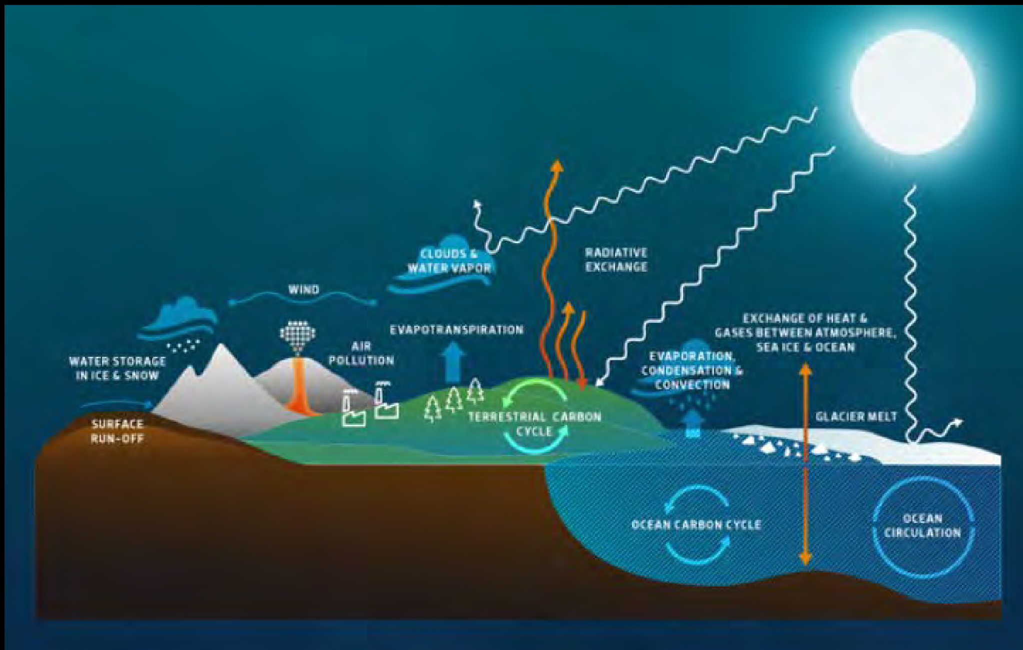


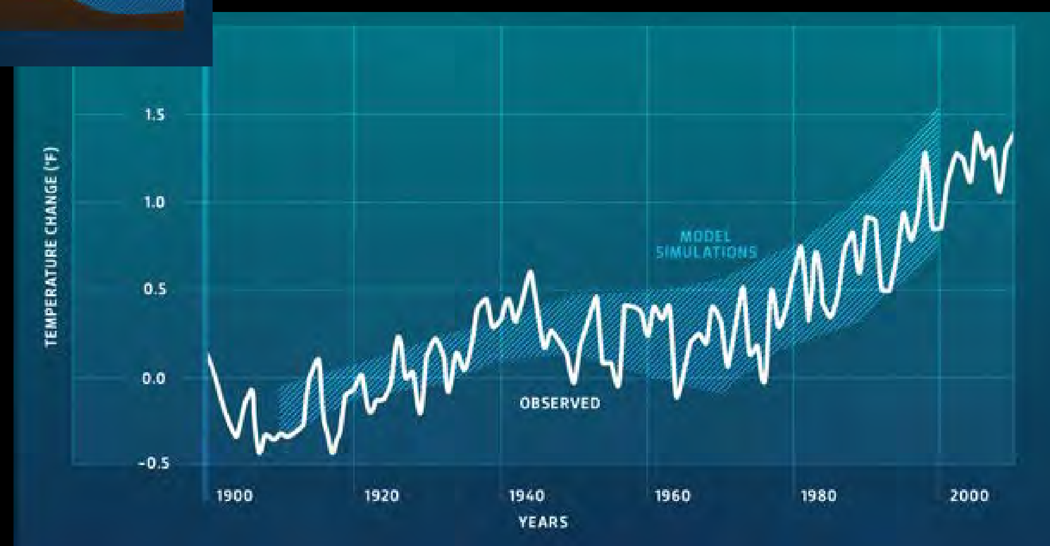
Scientists have understood this pattern for over a century

Gathering better data

NASA's orbital perspective is a critical vantage-point

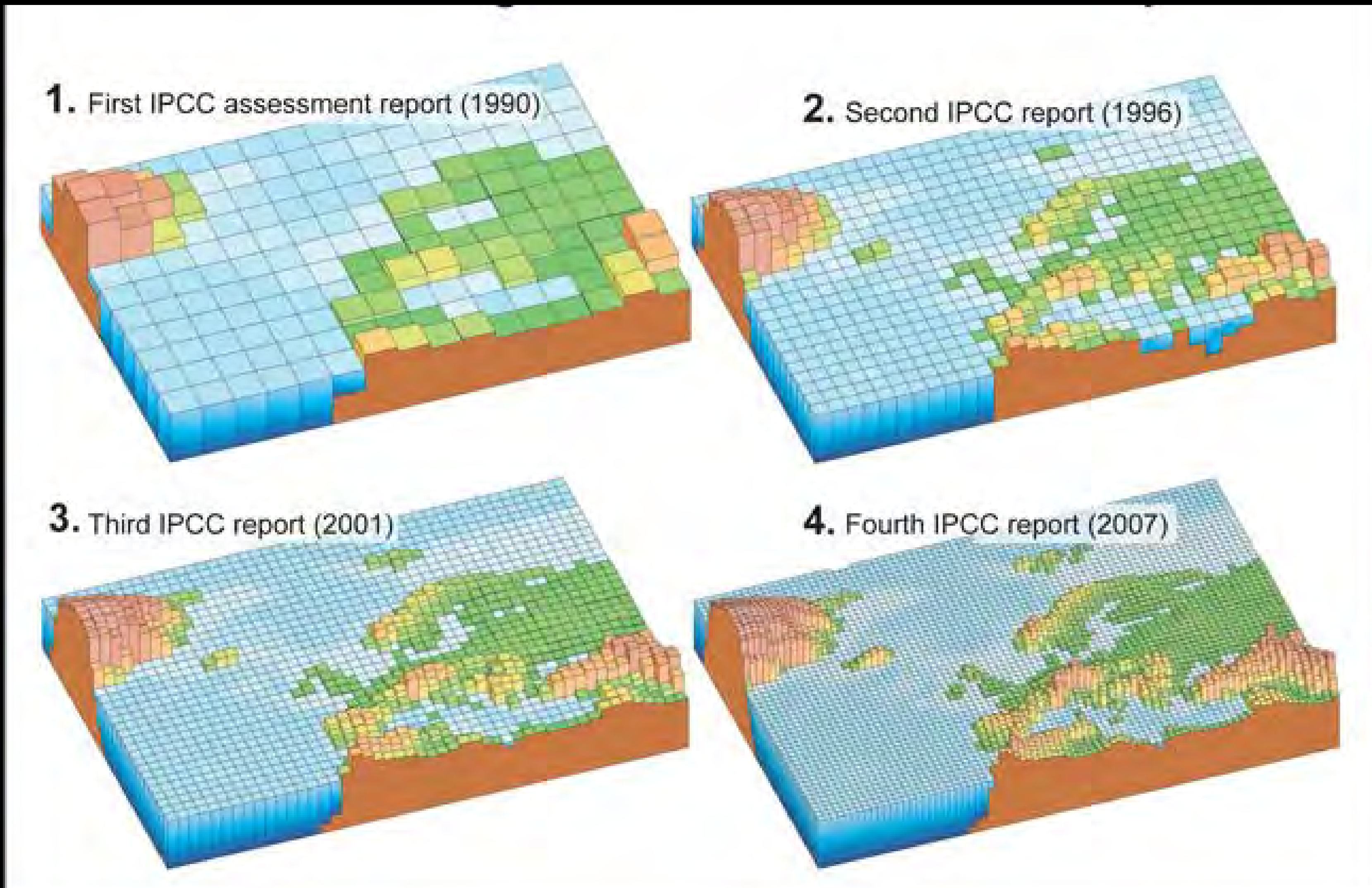
Building on a strong foundation





Powerful computer models let us test and refine hypotheses

Rising precision/resolution over time



New models + better data = more specific projections

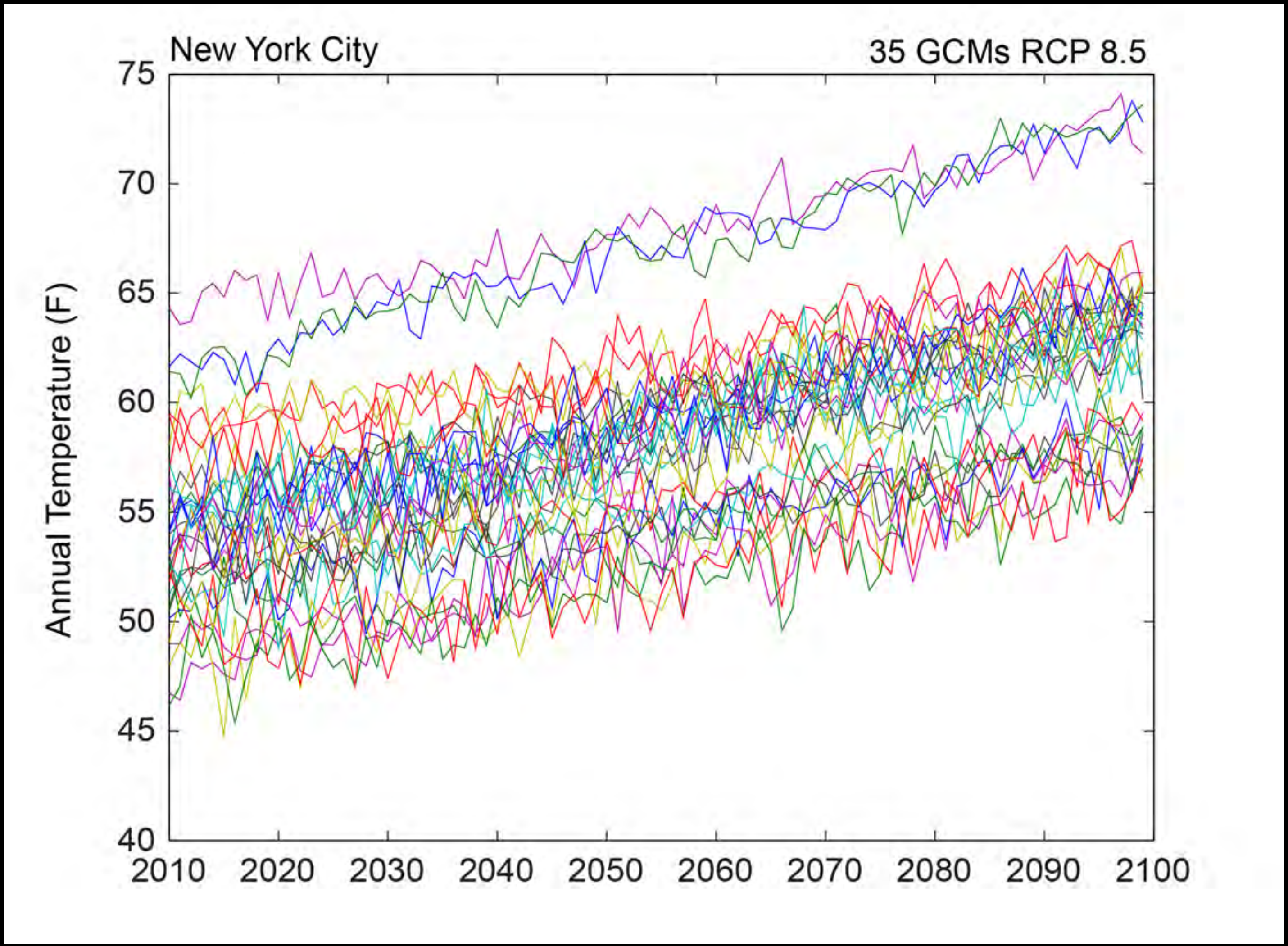
Developing climate projections

A complex and time-consuming process

Question

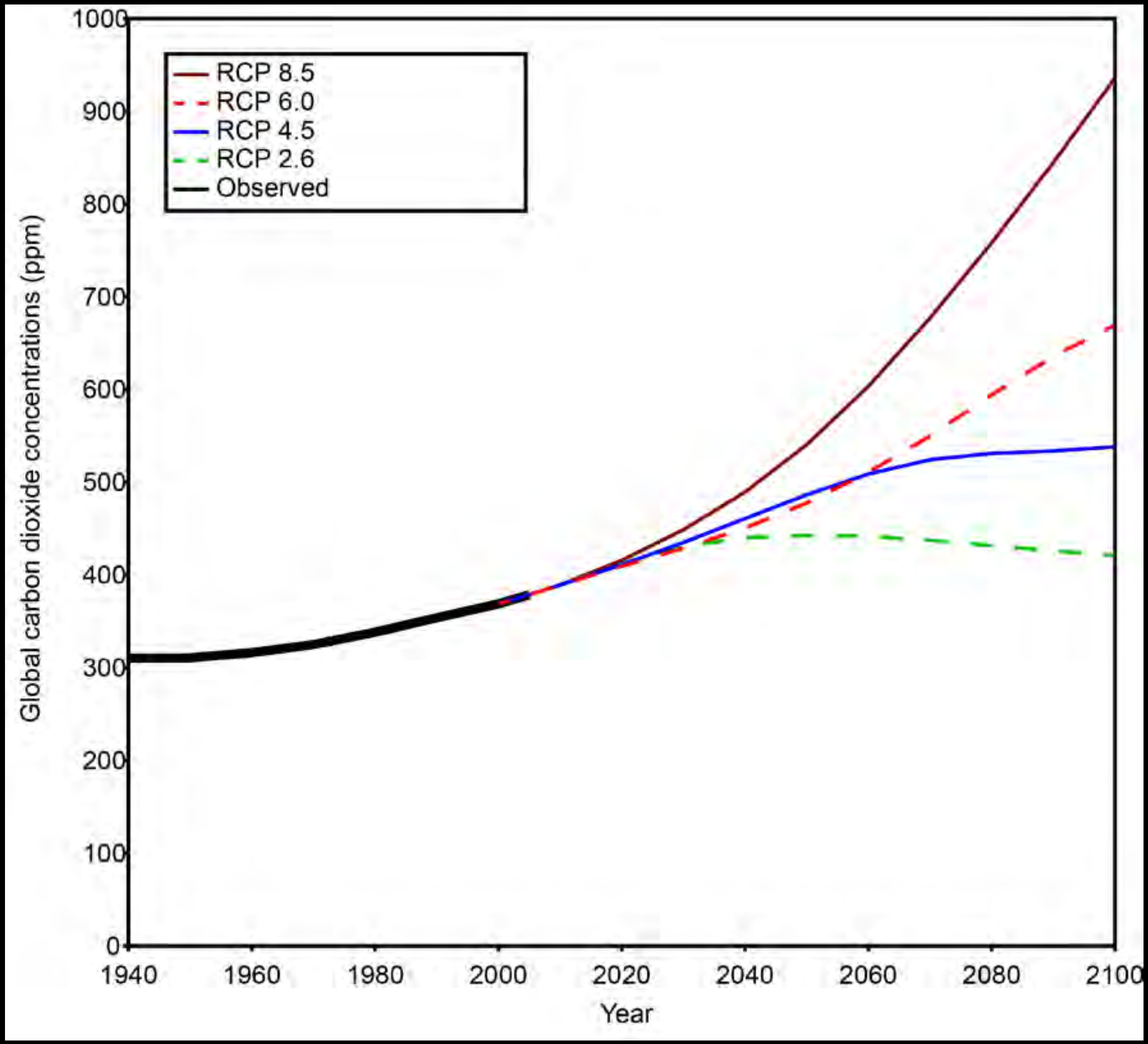
What will the next modeling advances bring us?

New Models – New Projections



CASI climate projections will be updated using new data

Representative Concentration Pathways



Updated emissions that drive global climate models

Revised methodologies

SLR Component	Global or Local	Method	References
Ocean height	Local	CMIP5 data	http://cmip-pcmdi.llnl.gov/cmip5/
Global thermal expansion	Global	CMIP5 data	http://cmip-pcmdi.llnl.gov/cmip5/
Land height	Local	Latest version of Peltier's Glacial Isostatic Adjustment (GIA) model	Peltier, 2012
Meltwater	Global	Based on literature, used updated observations of ice sheets and sea level, paleoclimate studies, and modeling	Bamber and Aspinall, 2013; Radic , 2013; Marzeion, 2012
Gravitational, isostatic, and rotational ('fingerprint')	Local	New terms added based on literature review	Mitrovica et al., 2009; Perrette et al., 2013; Gomez et al., 2010
Land water storage	Global	New terms added based on literature review	Konikow, 2011; Wada et al., 2012; Pokhrel et al., 2012
TOTAL SLR	Local	Devised a probabilistic and risk-based approach that integrates the above terms	

Allow for improved climate projections

Question

What do the initial climate projections using the latest data show?

Kennedy Space Center projections

NASA Center	2020s 10th percentile	2020s 25th percentile	2020s 75th percentile	2020s 90th percentile
Kennedy Space Center	2 inches	3 inches	7 inches	9 inches

NASA Center	2050s 10th percentile	2050s 25th percentile	2050s 75th percentile	2050s 90th percentile
Kennedy Space Center	5 inches	9 inches	21 inches	28 inches

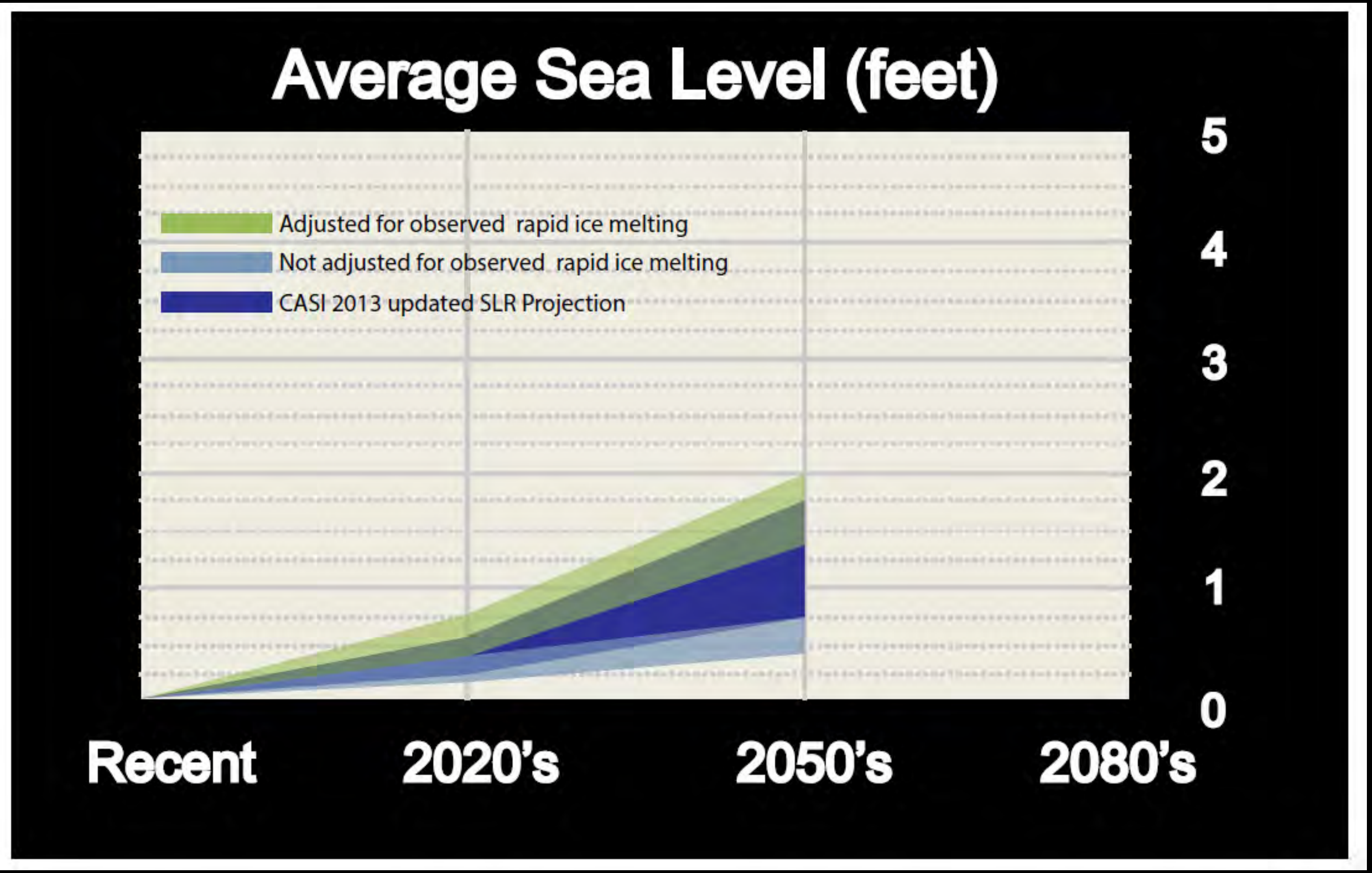
10th and 90th Percentiles chosen based on expert scientific judgment
25th and 75th Percentiles chosen based on stakeholder feedback

*** Projections do not include 'fingerprint' component**

In statistics, a percentile is the value of a variable below which a certain percent of observations fall.

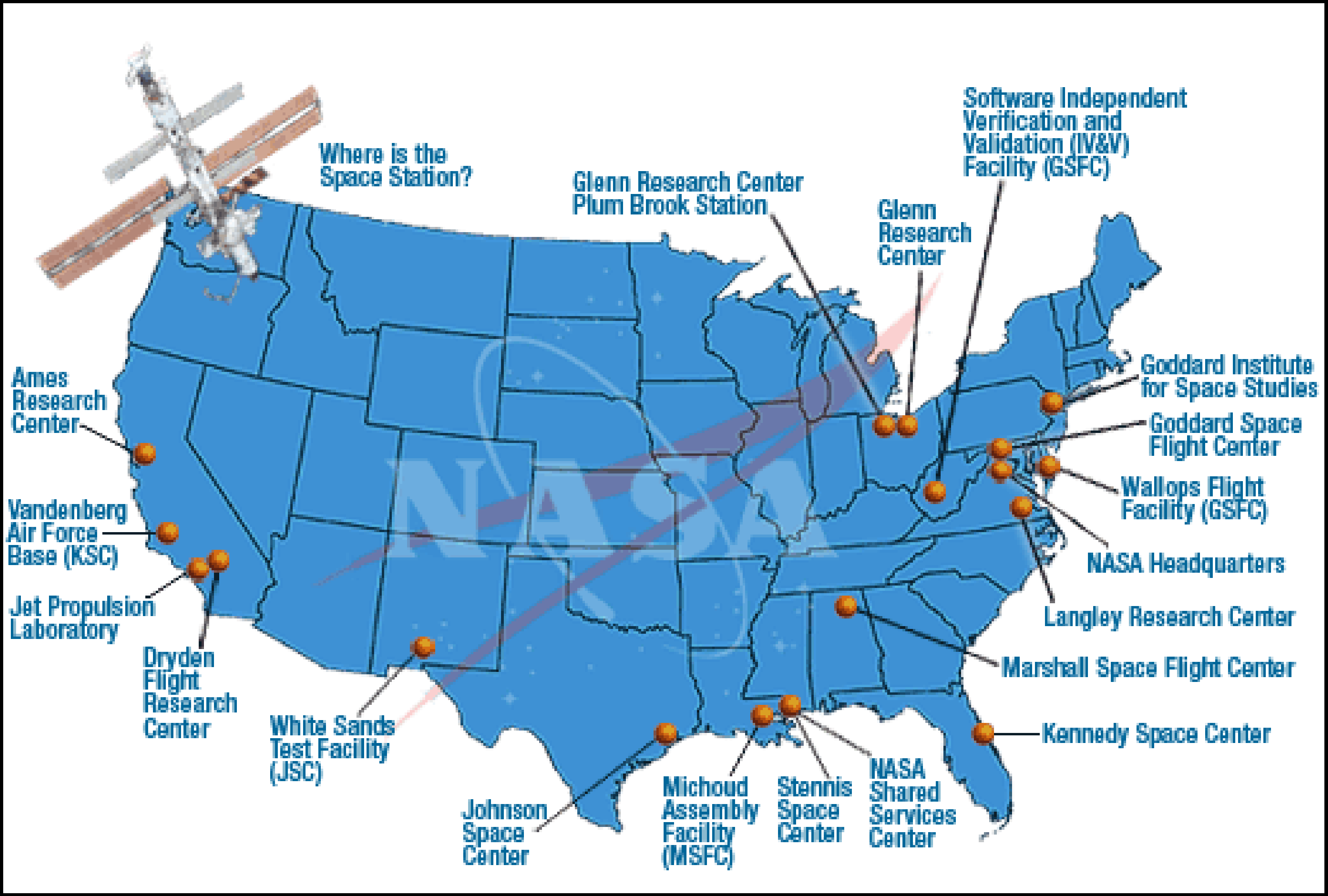
Sea level rise is projected to accelerate this century

How may the new projections differ?



Direction and magnitude of change consistent with past model results

Future CASI work

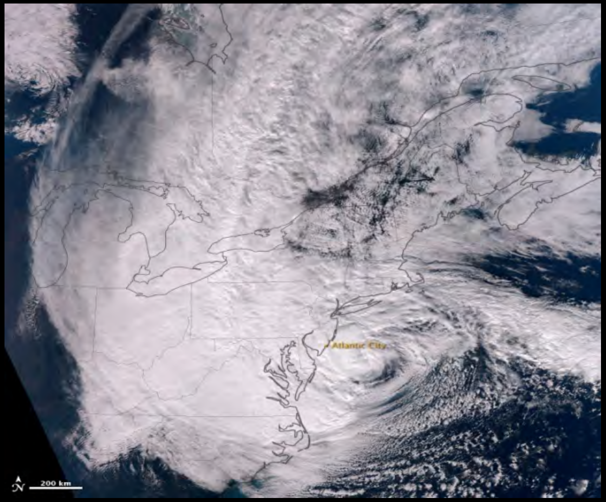


Feedback from NASA facilities will help guide the development of new projections

Question

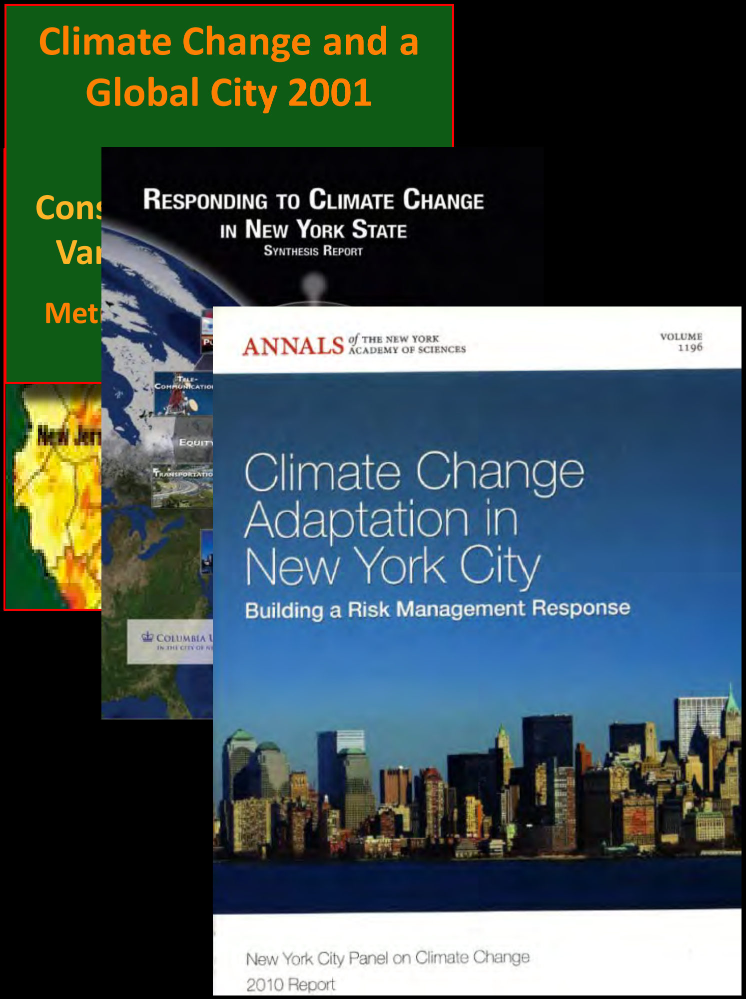
What can NASA learn from New York City's response to Hurricane Sandy?

Hurricane Sandy



Lowest recorded central pressure at landfall north of Cape Hatteras

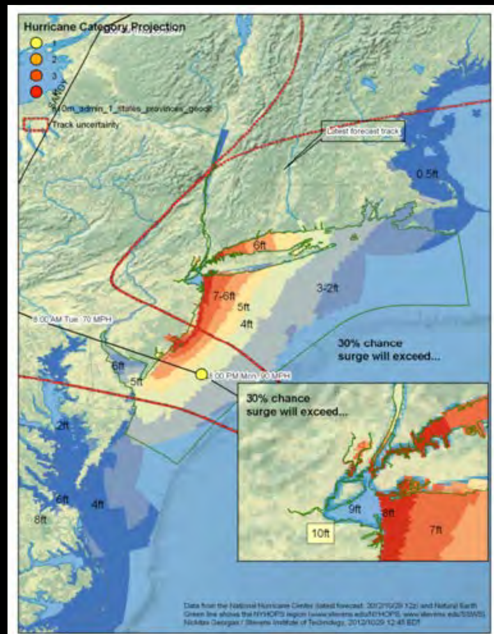
MTA closed down operations and boarded and placed sandbags at subway entrances to protect against flooding



Storm track and impacts forecast well in advance

Documenting and studying the impacts

New York Harbor Observing and Prediction System (NYHOPS Model), Stevens Institute of Technology Storm surge forecast

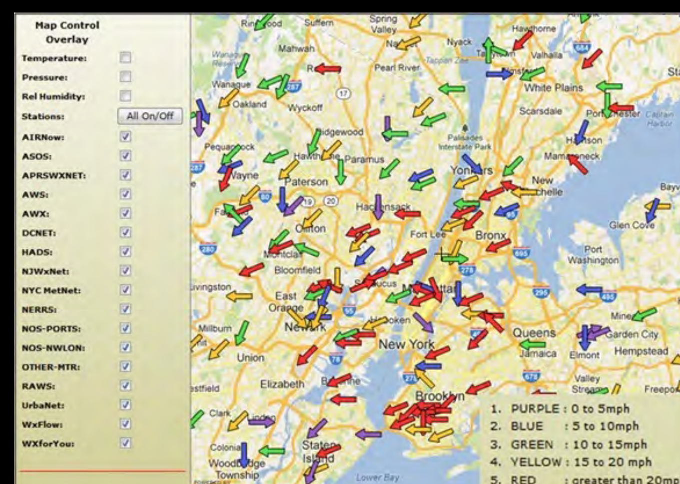


Damaged Home in Staten Island

Somayya Ali, Columbia University

Boardwalk and Beach Damage in Rockaway Park, Queens, NY

Gary Monitz, Columbia University



Wind speed observations from NYCMetNet CUNY/ NOAA Cooperative Remote Sensing Science and Technology Center (CREST)

Using Hurricane Sandy as a tipping point

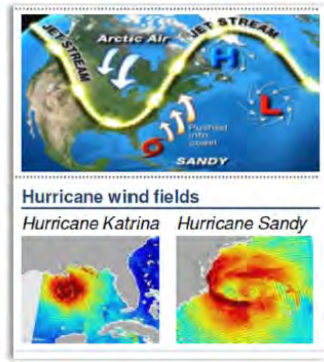
Special Initiative for Rebuilding and Resiliency

> "…the single most important piece of unfinished business that lies ahead of us in 2013: rebuilding the communities hit hardest by Hurricane Sandy - and creating a more resilient and sustainable city."
>
> – Mayor Michael Bloomberg in his State of the City address, February 14, 2013

NYC has a legacy of thinking long-term, but Sandy was a wake-up call. The Special Initiative for Rebuilding and Resiliency (SIRR) addresses how we rebuild New York City to be more resilient in the wake of Sandy but with a long-term focus on:

1) how to rebuild locally; and

2) how to improve citywide infrastructure and building resilience



We are producing a comprehensive report in May 2013 that will address these challenges by investigating three key questions:

- What happened during and after Sandy and why?
- What is the likely risk to NYC as the climate changes and the threat of future storms and severe weather increases?
- So what do we do?
  - In our coastal neighborhoods
  - With citywide infrastructure

SIRR is focused on areas directly impacted by Sandy, but will use this investigation to inform a citywide view of how to plan and rebuild better.

SIRR's May report will present policy recommendations, infrastructure priorities, and community plans and will assess sources of long-term funding.

Response activities in New York City can help guide NASA's process

CASI Team

NASA Center	Team Members
Ames	Max Loewenstein
Dryden	Edward Teets
Glenn	Larry Liou
Goddard	Molly Brown
Jet Propulsion Lab	William Patzert
Johnson	William Stefanov
Kennedy	Carlton Hall
Langley	Russell De Young
Marshall	Gary Jedlovec
Stennis	William Graham
Wallops	Tiffany Moisan