Designing for Urban Sustainability and Resiliency in an Era of Climate Change

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ACKNOWLEDGEMENTS

The CUNY HPC Center acknowledges support from the following:

- NSF Grants 0855217, 0958379,1126113
- NYC Council through the efforts of Staten Island Borough President James Oddo
- New York State Regional Economic Development Grant
- CUNY's Office of the Corporate Information Officer

Agenda

Demonstrate the uses and value of HPC

- Reduce carbon foot print
- Identify the cost-benefits of alternate energy sources
- Identify areas at risk from climate change
- Evaluate alternative strategies for enhancing urban resiliency

CUNY – The Beginning

- The "Free Academy" - City College of New York - 1847
  - Initiated by Townsend Harris
  - Tuition-free
  - Based solely on merit
  - Economically disadvantaged and those precluded from attending the leading universities because of ethnicity or gender.
- Enrollment
  - 269,000 students in degree programs
  - 247,000 students in non-degree programs
  - 170 different languages spoken
- Tuition
  - About $6,000 per year
  - Approx 60% of students pay no tuition
- 68% attended New York City public high schools
- 42% first time college students
- 170 first languages

CUNY

Enrollment statistics

- Enrollment
  - 269,000 students in degree programs
  - 247,000 students in non-degree programs
- Tuition
  - About $6,000 per year
  - Approx 60% of students pay no tuition
- Gender
  - 61% female
  - 39% male
- 170 different languages spoken
- 68% attended New York City public high schools
- 42% first time college students

Alumni

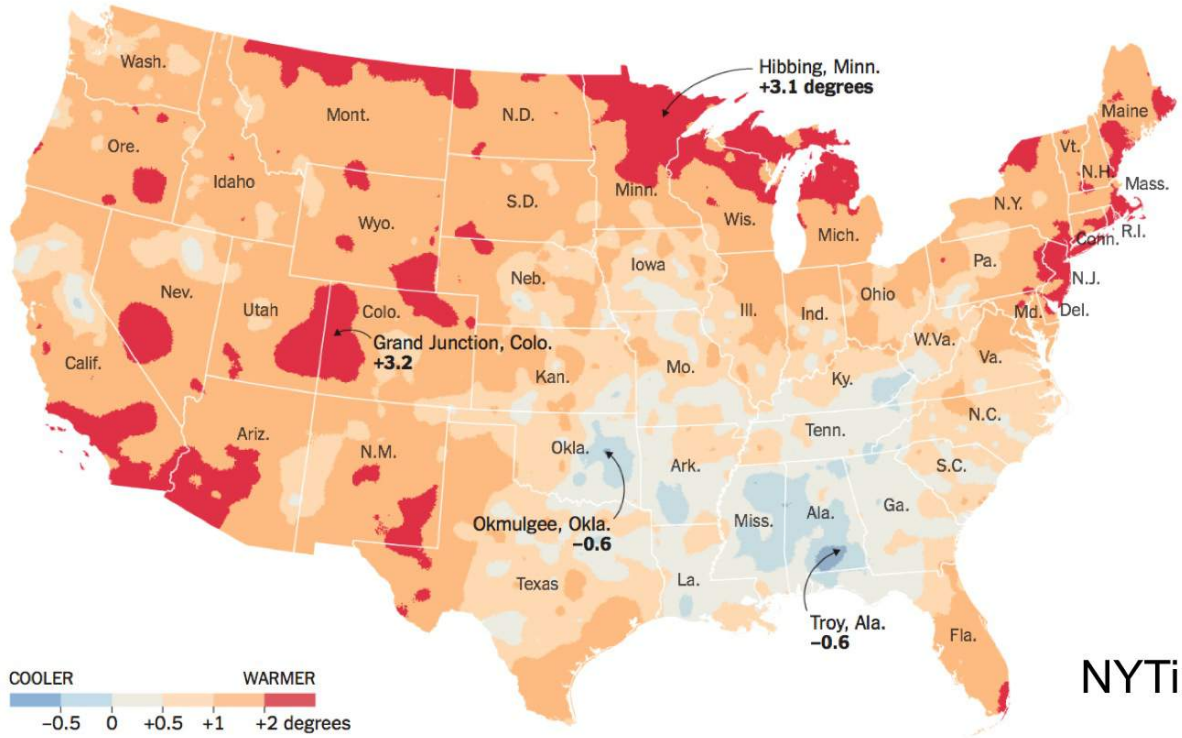
- 12 Nobel prize winners
  - 11 were first in their family to go to college
- 2 Fields Medal winners
- Many Pulitzer Prize Winners
- Dr. Jonas Salk, Polio Vaccine
- Andy Grove, co-founder and former CEO, Intel Corp.
- Robert Kahn, Co-inventor of TCP/IP
- Charles Wang, CEO, Computer Associates
- Bruce Chizen, former CEO, Adobe

ENVIRONMENT

1293 COMMENTS

U.S. Climate Has Already Changed, Study Finds, Citing Heat and Floods

By JUSTIN GILLIS MAY 6, 2014



Rising Temperatures

1991-2012 average temperature compared with 1901-1960 average

NYTimes, 7 May 2014

PlaNYC

- 3% of the world's population lived in cities in 1800
- 60% by 2030

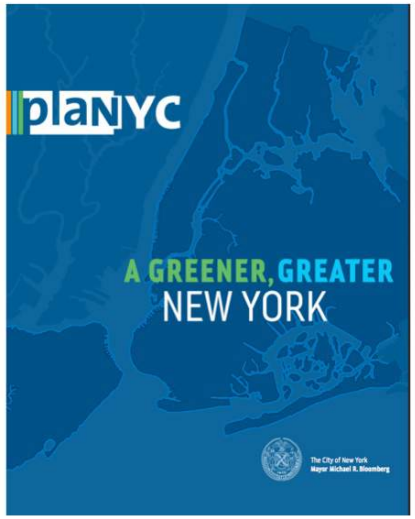
- New York City Metropolitan Area was the first world "megacity" – 1950

- Still largest megacity in the US in 2013 (pop. 21,600,000) , now tenth largest in the world

- Tokyo is the largest (pop. 34,800,000)

PlaNYC

Planning for urban population growth in an era of climate change

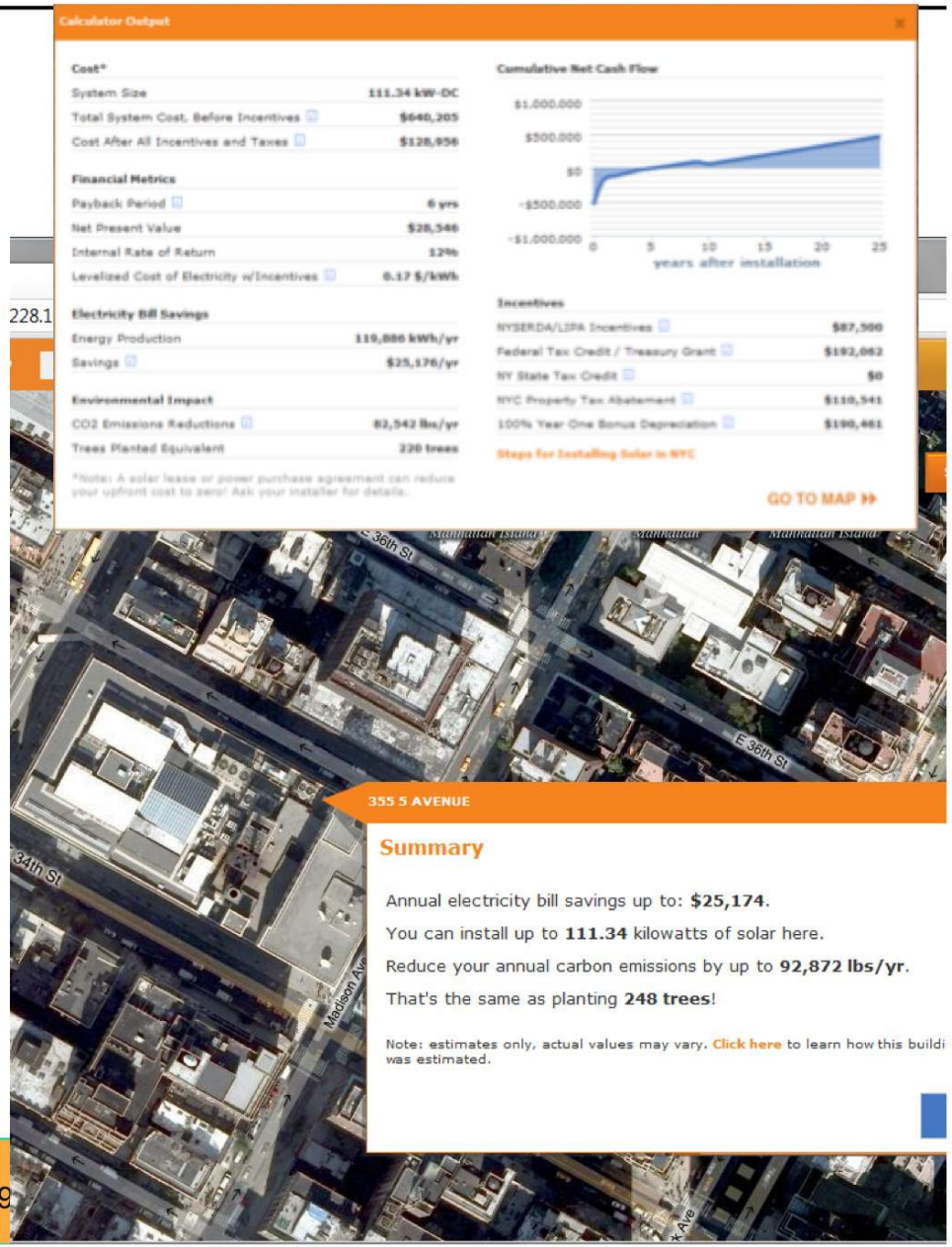


- Comprehensive planning document for NYC
- Provide for 1 million more inhabitants by 2030
- Cut carbon footprint by 30% by 2030
- New York panel on climate change
- Community by community
- 500 pages
- Also available in Chinese and Japanese
- Annual progress reports

The New York Solar Map

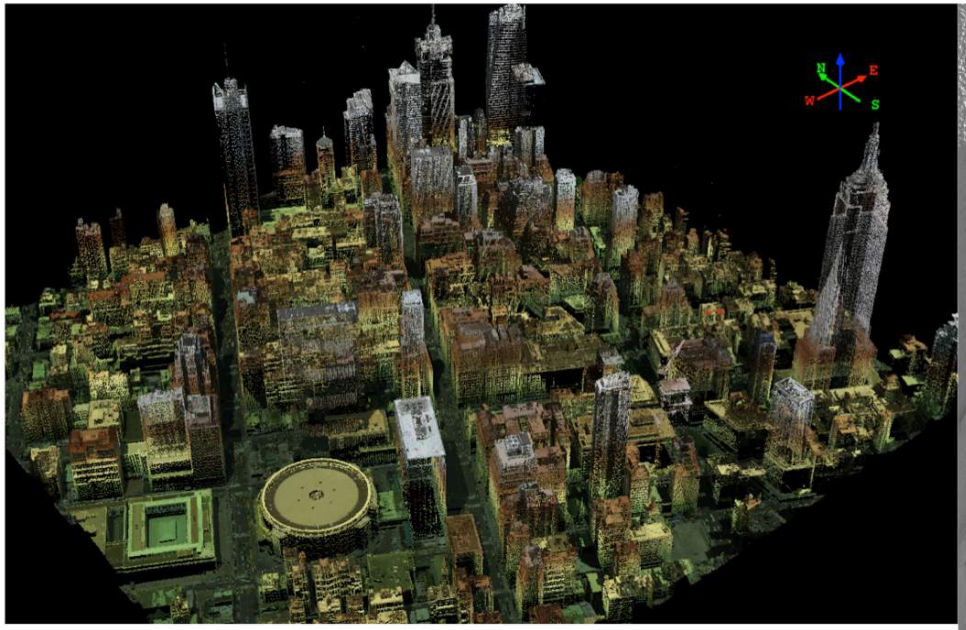
Reduce carbon footprint

- Enable owners of the one million buildings in NYC to assess the value of their solar PV potential
- Reduce the strain on the NYC electric grid during peak periods, lower chances of blackouts
- Create green jobs



Courtesy: S. Ahearn, Hunter College/CUNY

Solar Insolation Calculation



- LiDAR mapping of the City, 30 cm resolution
- Create a digital surface model (DSM) from the LiDAR data
- Calculate solar incidence (MATLAB)

- Determine the area on each rooftop suitable for solar panels
- Calculate cost/benefit

Hydrokinetic Power Generation

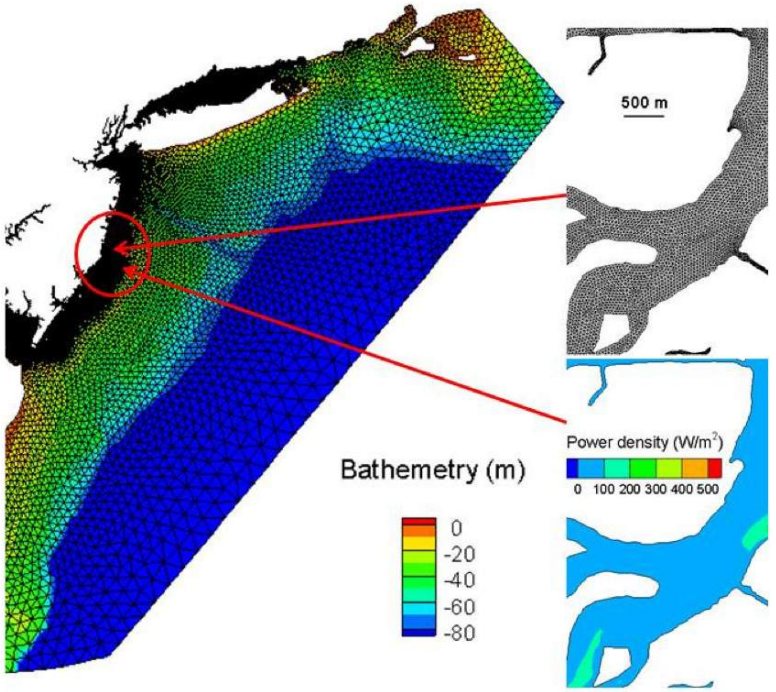
Reduce carbon footprint

- Typical hydrokinetic turbine
  - 5 to 10 meter diameter
  - 50 KW/turbine
  - Usually installed in estuaries
  - Verdant Power, New York's East River

Hydrokinetic Power Generation

Reduce carbon footprint

- Predict locations where tidal flows in estuaries along the New Jersey coast are conducive for electric power generation
  - Funded by Bureau of Research, New Jersey Department of Transportation
- Finite Volume Coastal Ocean Model
- Typical runs of 1,024 cores
  - 2.6 days/run
  - Linear scaling



Courtesy: H. Tang, CCNY/CUNY

Hydrokinetic Power Generation

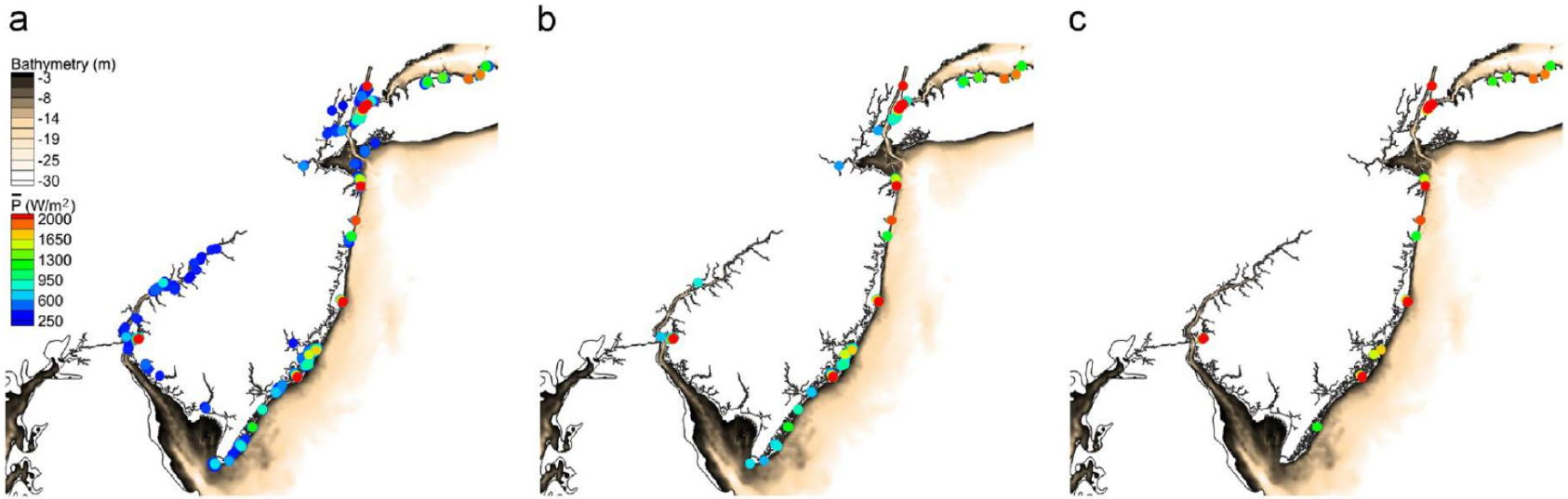
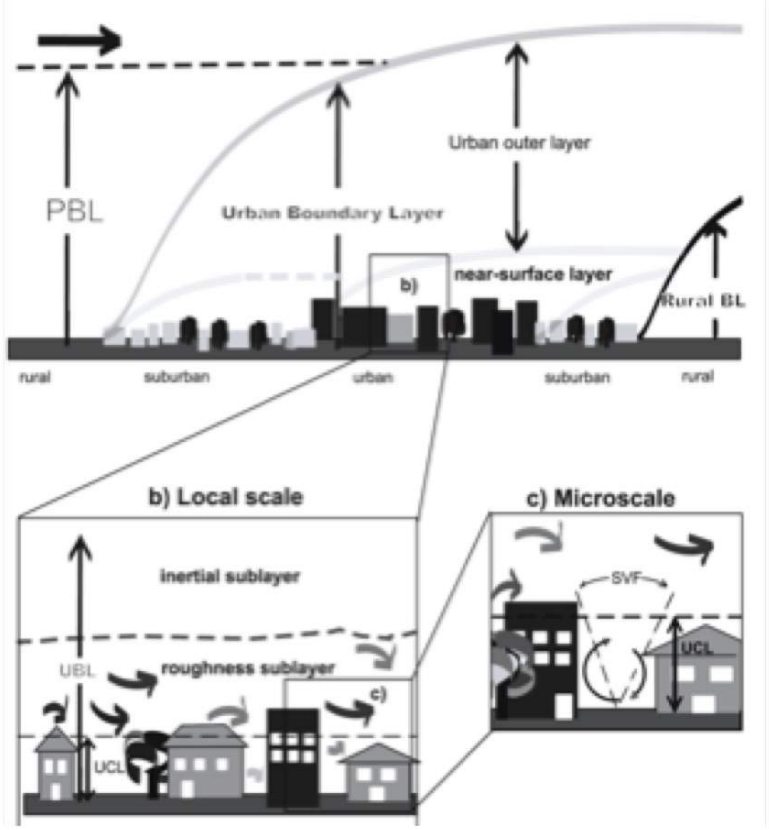


Fig. 14. Top sites with regard to average power density. (a) $\overline{P} \geq 250$ W/m^2, (b) $\overline{P} \geq 500$ W/m^2 and (c) $\overline{P} \geq 1000$ W/m^2.

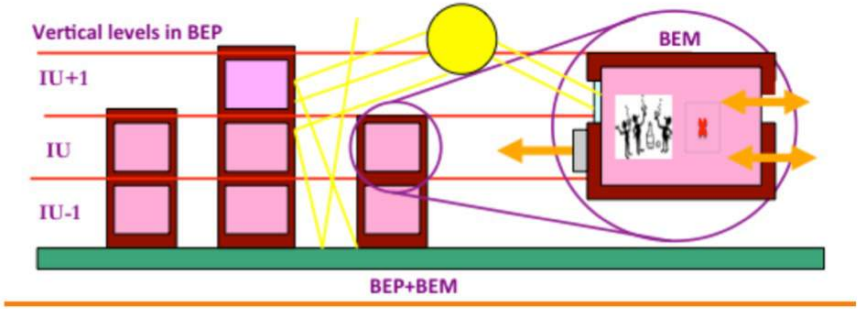
Courtesy: H. Tang, CCNY/CUNY

μ WRF

Understand the interaction between weather/climate and urban development



- Weather prediction model to provide weather forecasting for densely populated urban areas at a fine-scale (1 km)
- Based on WRF
- Building energy parametrization model
- Building energy model

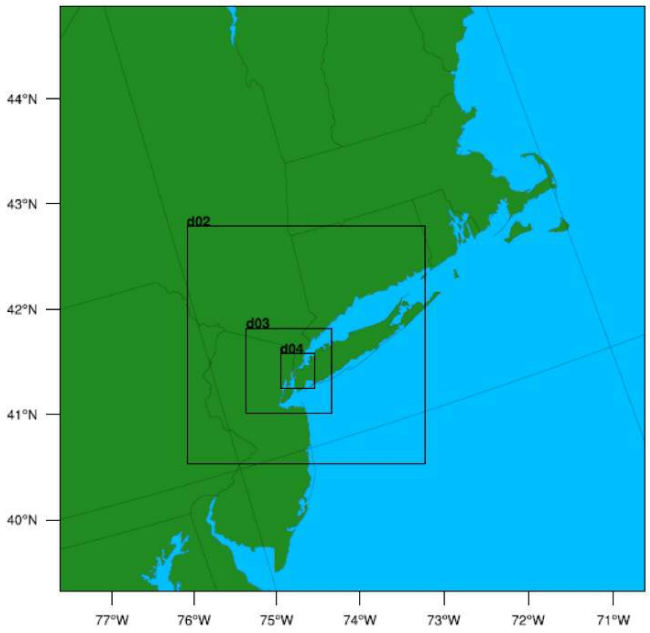


Courtesy: J. Gonzalez & M. Arend, CCNY/CUNY

μ WRF

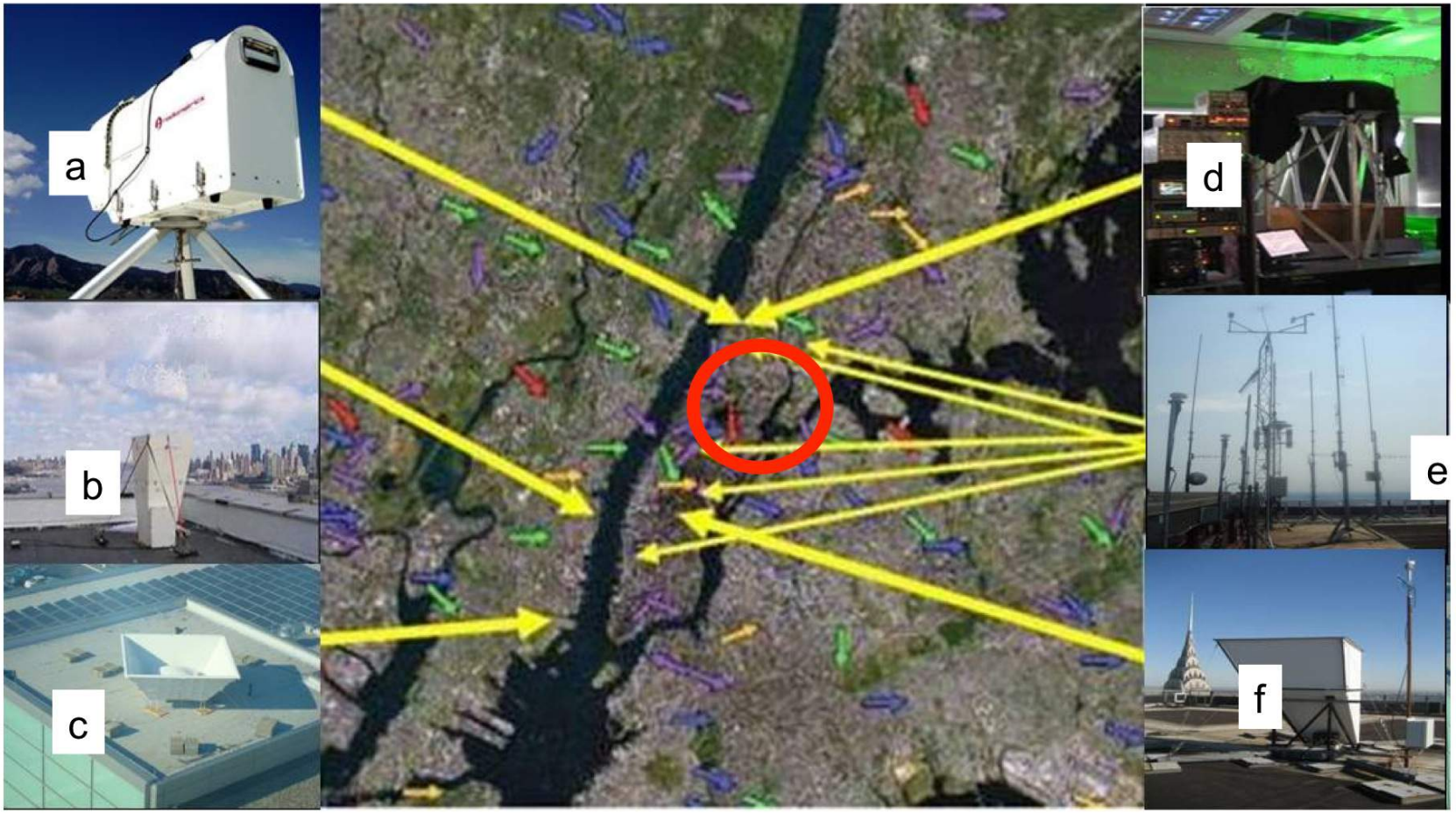
Model Set-up

- Three two-way nested domains with a grid spacing of 9, 3 and 1 km are defined. Initial and boundary conditions from North American Regional Reanalysis (resolution: 32 km). NCEP/MMAB data at 0.5 degree will update the sea surface temperature every 24-h.
- Vertical resolution of 51 terrain following sigma levels
  (33 levels in the lowest 1.5 km, first level ~10m).
- PBL Parameterization: Bougeault and Lacarrère (BouLac).
- Radiation Schemes: RRTM long term radiation and Dudhia short term radiation.
- Cumulus Scheme: Kain Fritsch
- Microphysics: WMD6
- Urban classes were derived from the National Land Cover Data (NLCD).
- Urban canopy parameters from National Urban Database and Access Portal Tool (NUDAPT) are assimilated in WRF on a GRIDDED basis.



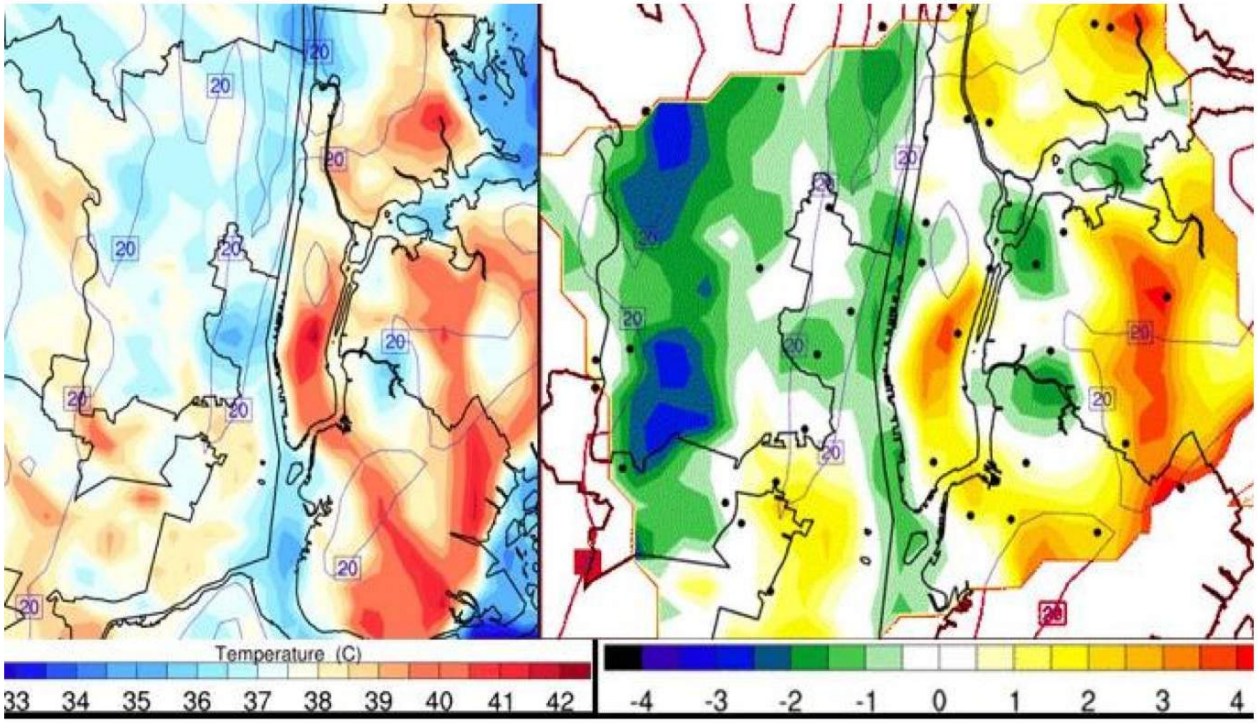
Model Domains

μ WRF NYCMetNet



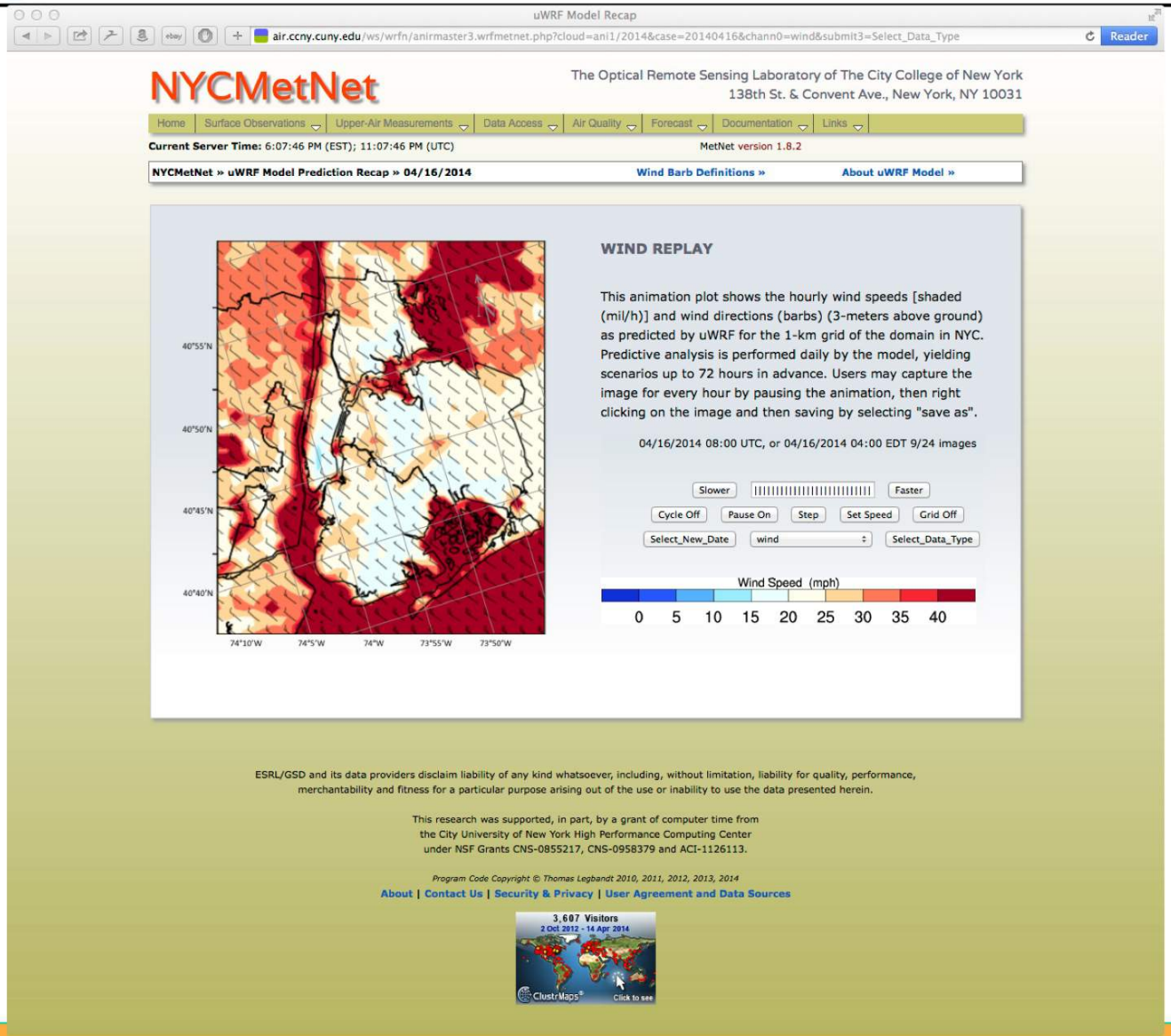
a) Hyper spectral radiometer
b) Sodar to 300 m
c) Radar Wind Proifiler to 2 km
d) Backscatter aerosol Lidar
e) Building top Met Tower
f) Sodar to 400 m

μ WRF vs NYCMetNet observations



Surface temperature distribution (left) and differences between modeling and observation (right) at 1500 LST July 6th during the heat wave event that took place July 5th-7th, 2010 in NYC Metro Area. The small errors between model and observations in mid and downtown areas represent a significant improvement over existing modeling capabilities.

μ WRF


uWRF Model Recap
air.ccny.cuny.edu/ws/wrfn/anirmaster3.wrfmetnet.php?cloud=ani1/2014&case=20140416&chann0=wind&submit3=Select_Data_Type
Reader
NYCMetNet
The Optical Remote Sensing Laboratory of The City College of New York
138th St. & Convent Ave., New York, NY 10031
Home
Surface Observations
Upper-Air Measurements
Data Access
Air Quality
Forecast
Documentation
Links
Current Server Time: 6:07:46 PM (EST); 11:07:46 PM (UTC)
MetNet version 1.8.2
NYCMetNet » uWRF Model Prediction Recap » 04/16/2014
Wind Barb Definitions »
About uWRF Model »
40°55'N
40°50'N
40°45'N
40°40'N
74°10'W
74°5'W
74°W
73°55'W
73°50'W
WIND REPLAY
This animation plot shows the hourly wind speeds [shaded (mil/h)] and wind directions (barbs) (3-meters above ground) as predicted by uWRF for the 1-km grid of the domain in NYC. Predictive analysis is performed daily by the model, yielding scenarios up to 72 hours in advance. Users may capture the image for every hour by pausing the animation, then right clicking on the image and then saving by selecting "save as".
04/16/2014 08:00 UTC, or 04/16/2014 04:00 EDT 9/24 images
Slower
Faster
Cycle Off
Pause On
Step
Set Speed
Grid Off
Select_New_Date
wind
Select_Data_Type
Wind Speed (mph)
0 5 10 15 20 25 30 35 40
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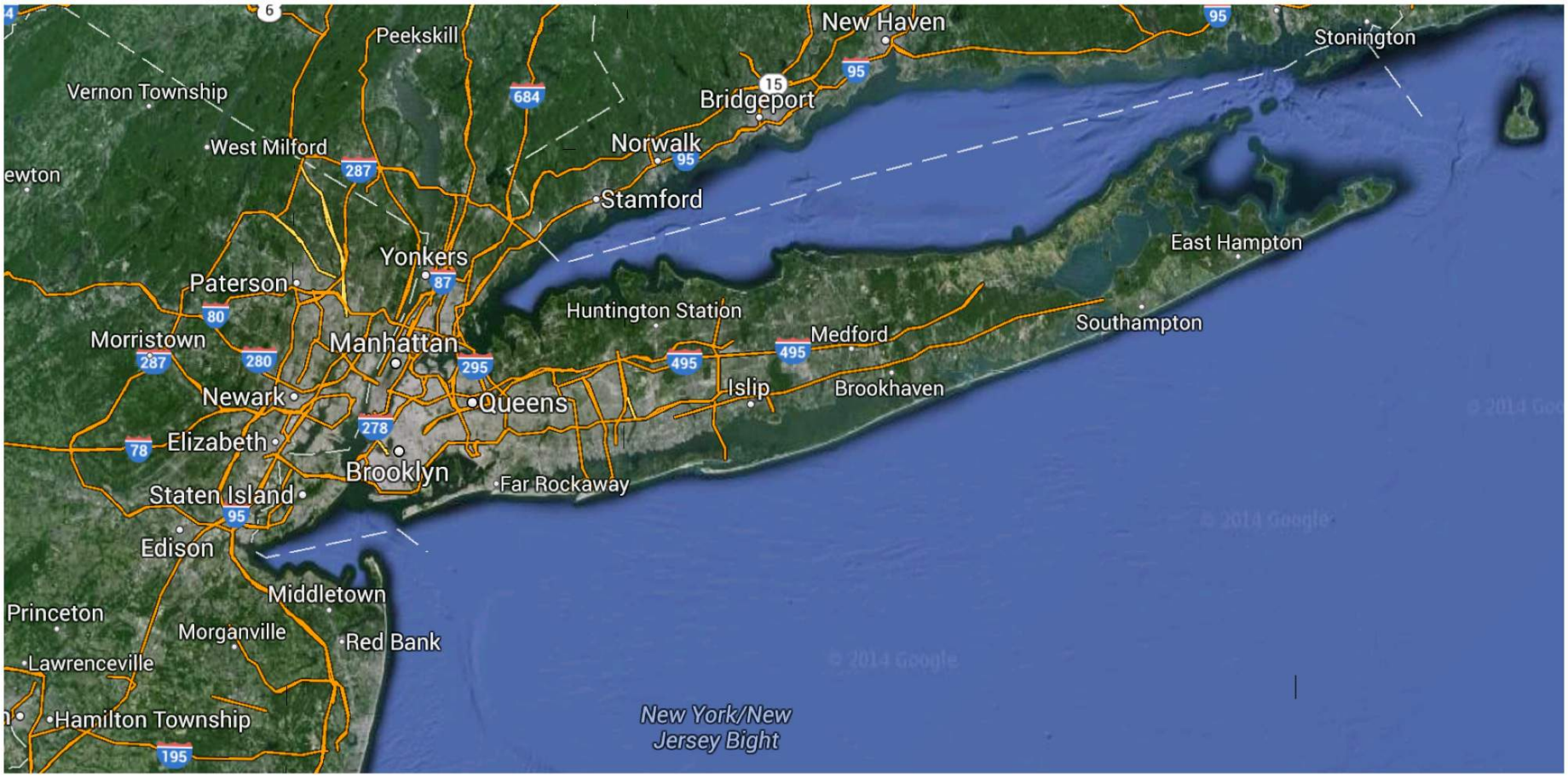
This research was supported, in part, by a grant of computer time from the City University of New York High Performance Computing Center under NSF Grants CNS-0855217, CNS-0958379 and ACI-1126113.
Program Code Copyright © Thomas Legbandt 2010, 2011, 2012, 2013, 2014
About | Contact Us | Security & Privacy | User Agreement and Data Sources
3,607 Visitors
2 Oct 2012 - 14 Apr 2014
ClustrMaps
Click to see

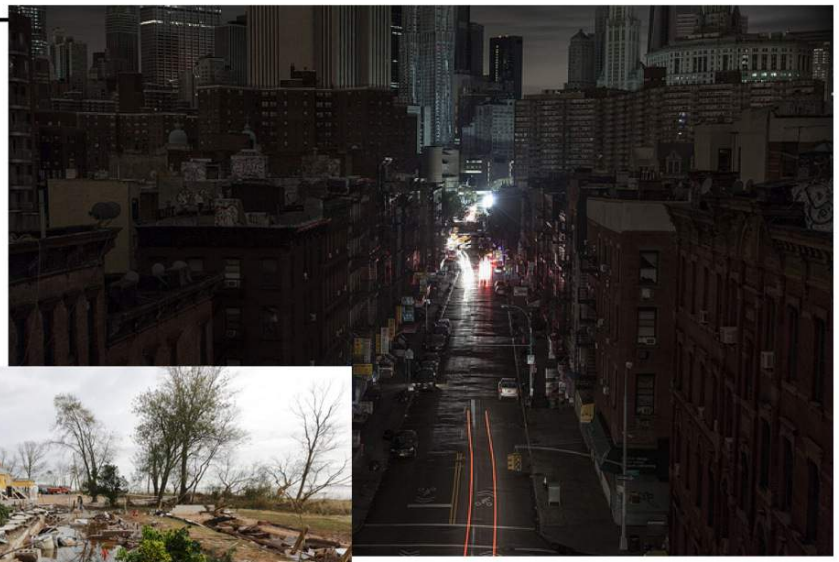
Hurricane Sandy 2012

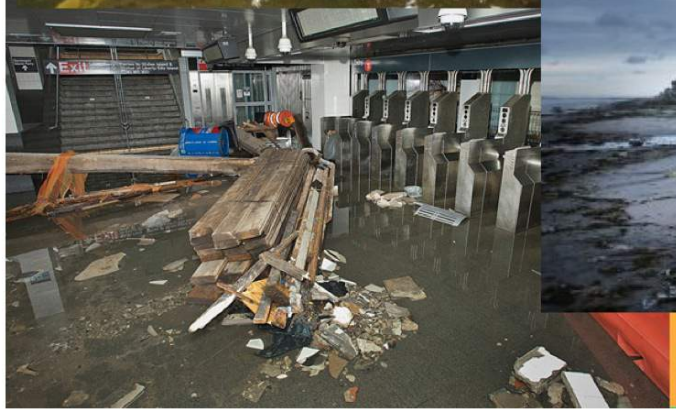


Population statistics:

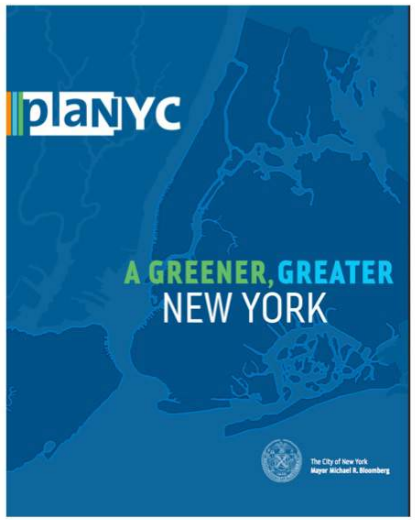
New York City	8,330,000
Brooklyn & Queens	4,740,000
Long Island (including Brooklyn and Queens)	7,570,000

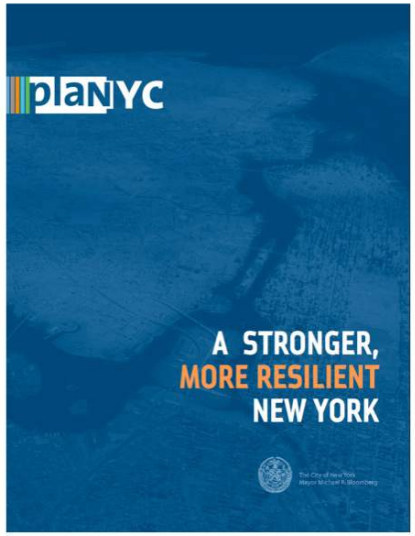
Hurricane Sandy - 2012

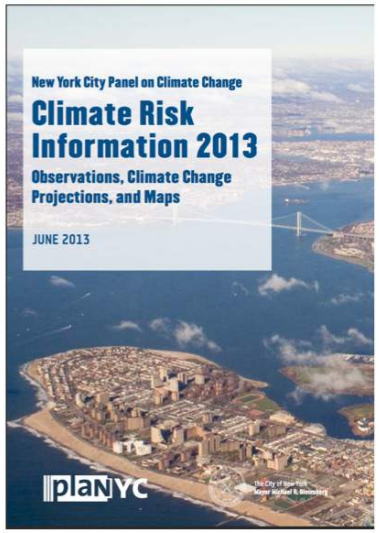




PlaNYC



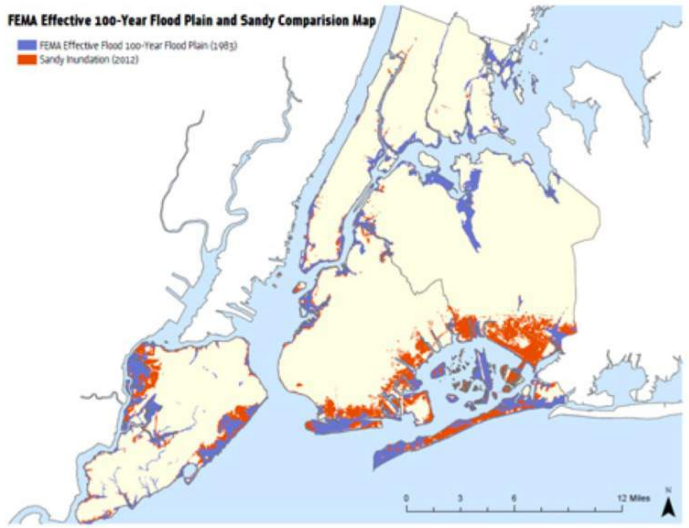




What could happen in the future?

Understanding the Risk: Prior to Sandy, FEMA's maps had not been updated since 1983 and understated the risk in many areas

- Approximately 1/2 of all impacted residential units were outside 100-year floodplain
- More than 1/2 of all impacted buildings were outside 100-year floodplain

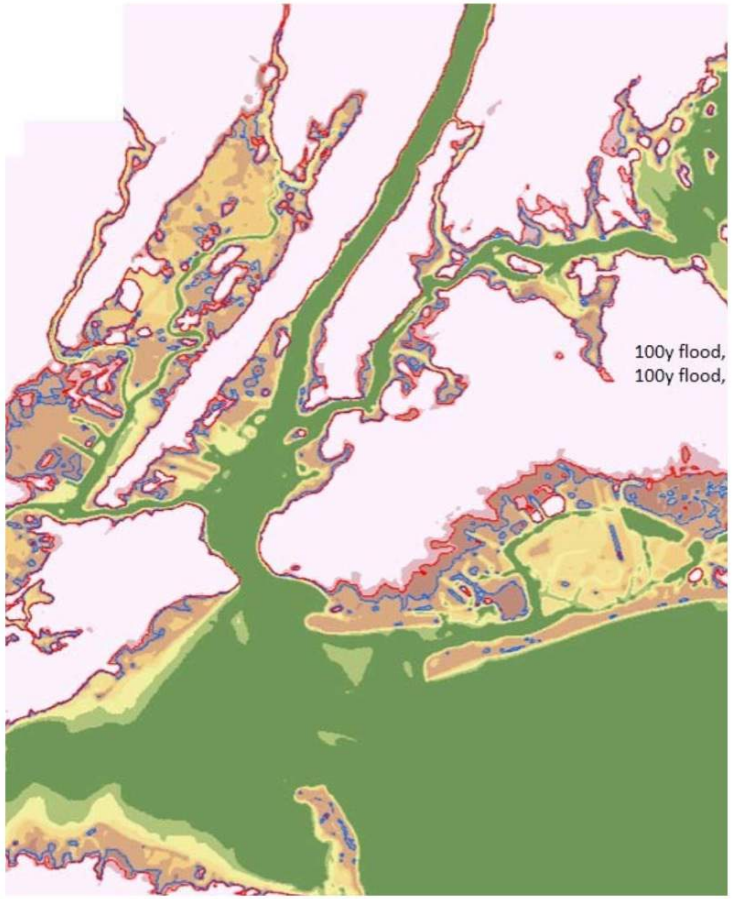


Source: FEMA and SIRR

Hydrodynamic Mapping

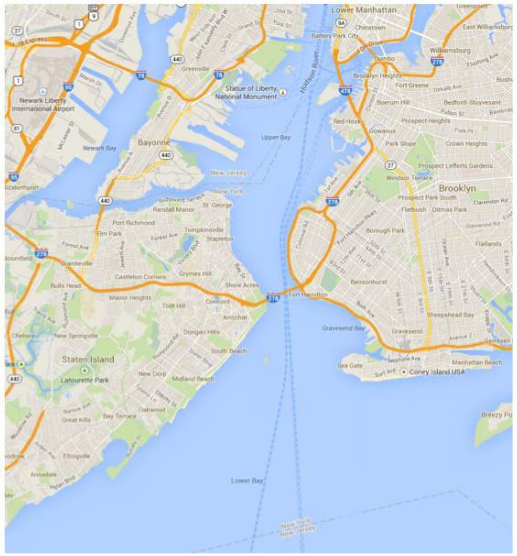
Recalibrate the 100-year/500-year flood maps

- Prepared for PlaNYC-SIRR by Stevens Inst of Tech
- Factors sea level rise (SLR) into Flood Maps (2050/2080)
- Used ADCIRC/SWAN, FEMA R2 maps, FEMA procedures, but includes SLR
- Chart
  - Blue = 100y flood, present
  - Red = 100y flood for 2080 with 90th percentile SLR scenario



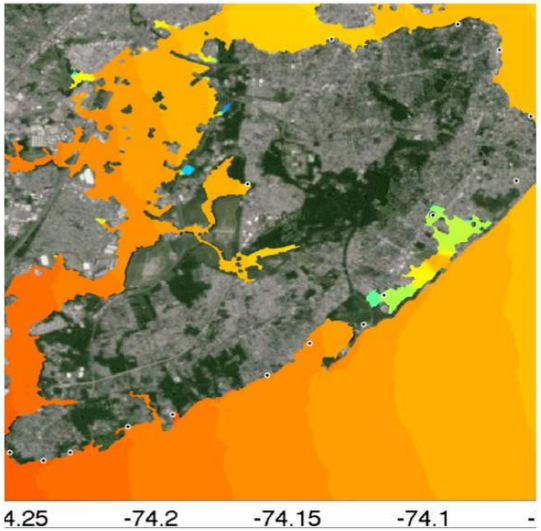
Courtesy: Orton, Vinogradov, Georgas, Blumberg, Stevens Inst. Of Tech

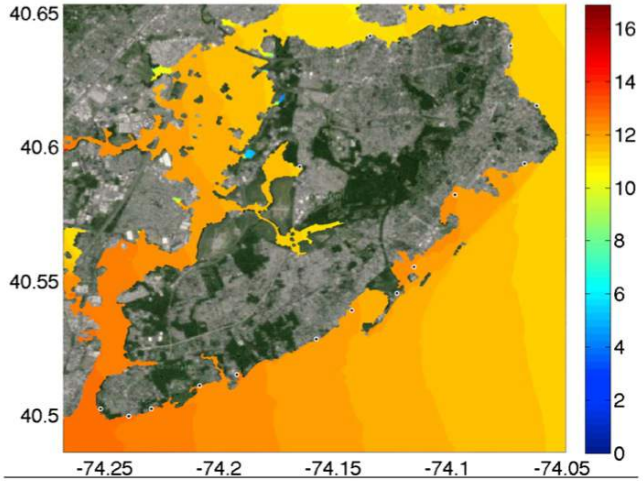
Analysis of quick dune repairs on Staten Island

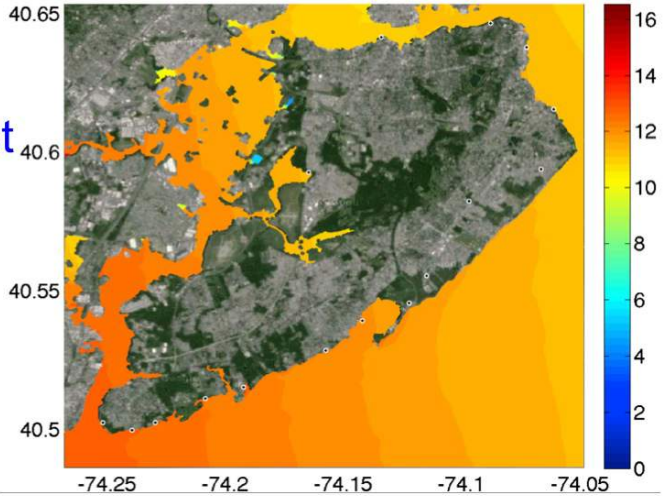


Assess quick fixes

- LL: Showing areas of flooding
- UR: Hindcast with quick dune fix except area adjacent to Federal property
- LR: Sandy hindcast with full dune restoration



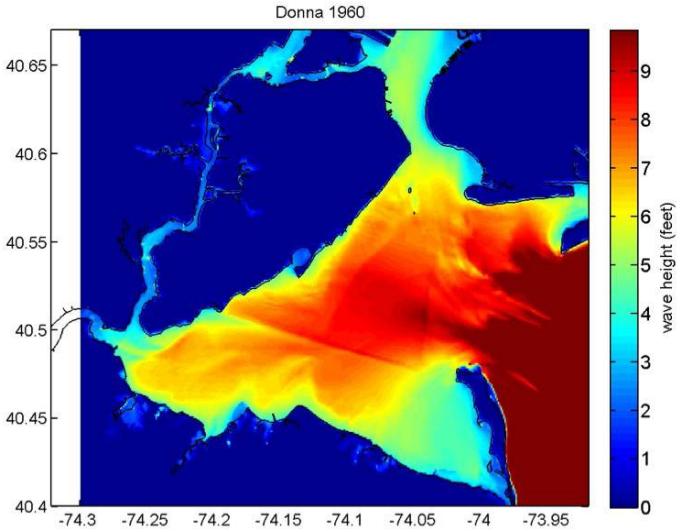


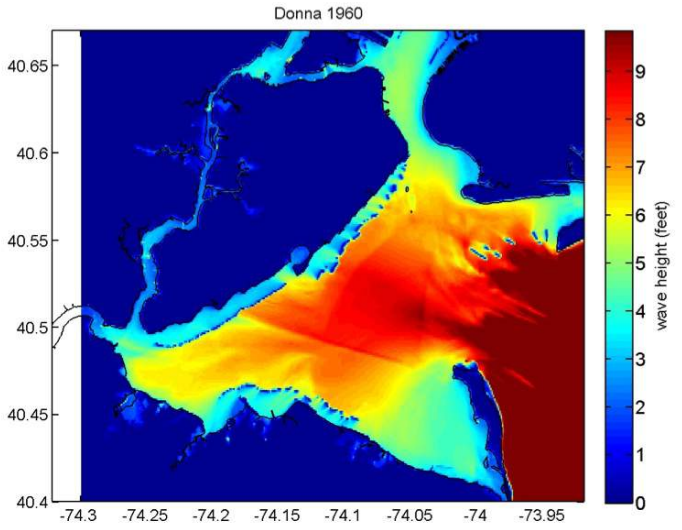


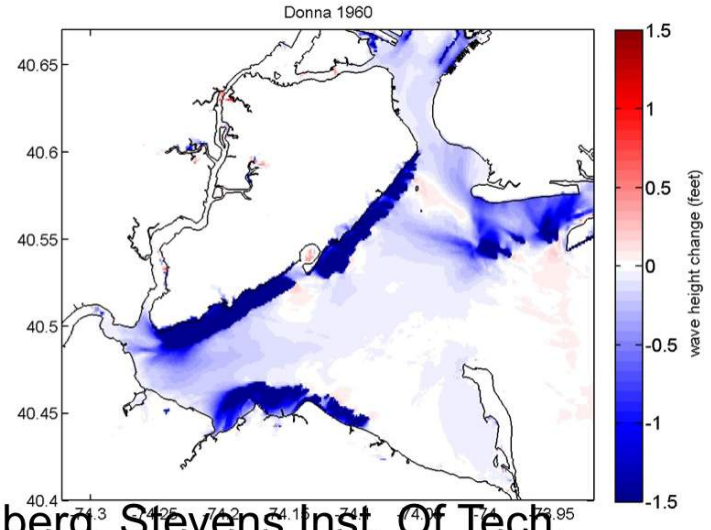
Courtesy: Dzedzits, Kress, Benimoff, CSI/CUNY

Oyster bed reefs

Evaluate the longer-term solutions







- UL – No reefs
- UR – With reefs
- LR – Estimate of wave height reduction

Stevens: Orton, Vinogradov, Georgas, Blumberg, Stevens Inst. Of Tech.

Concluding comments

HPC is playing a critical role in evaluating options for ameliorating the impact of climate change on urban areas