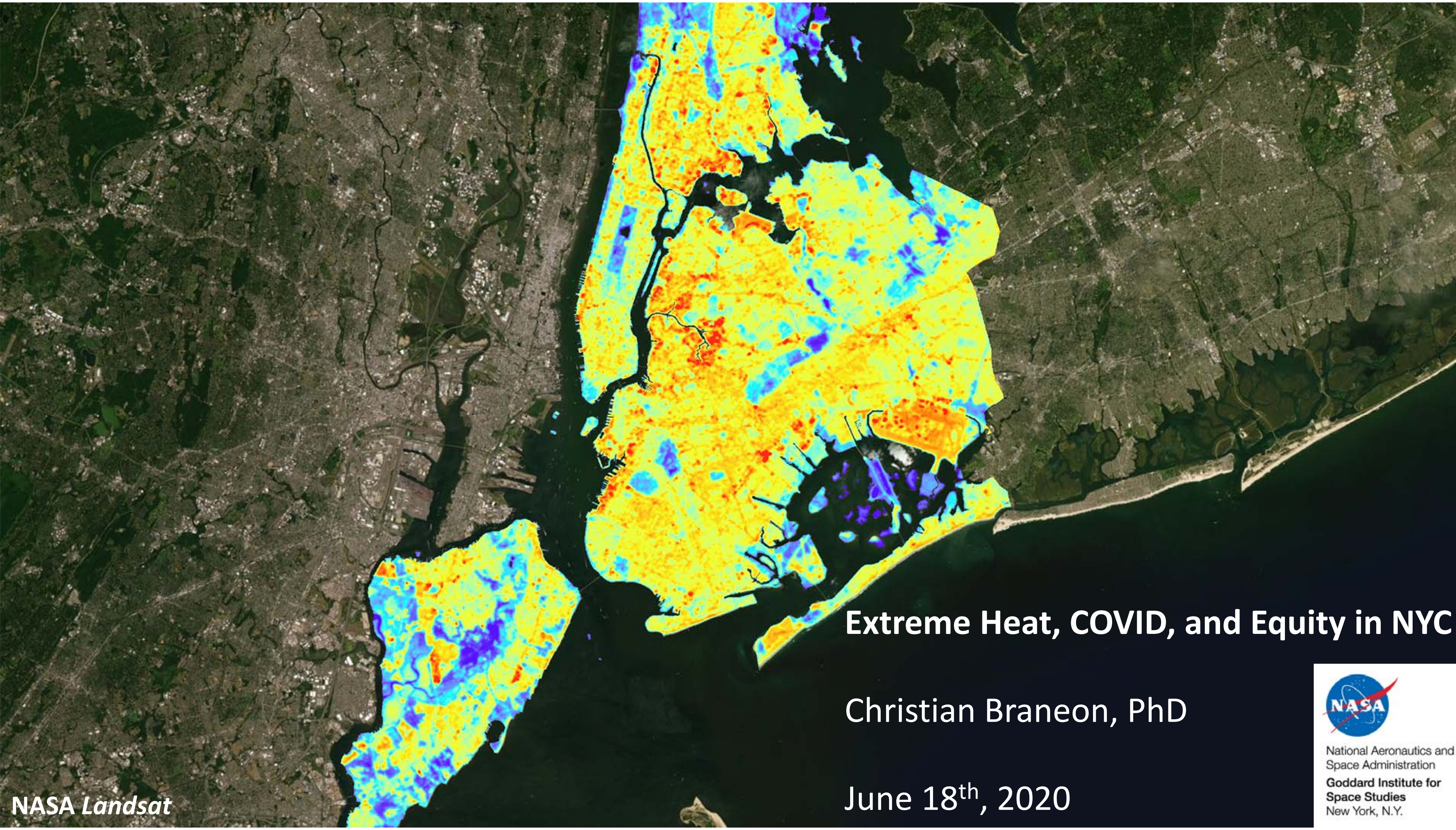
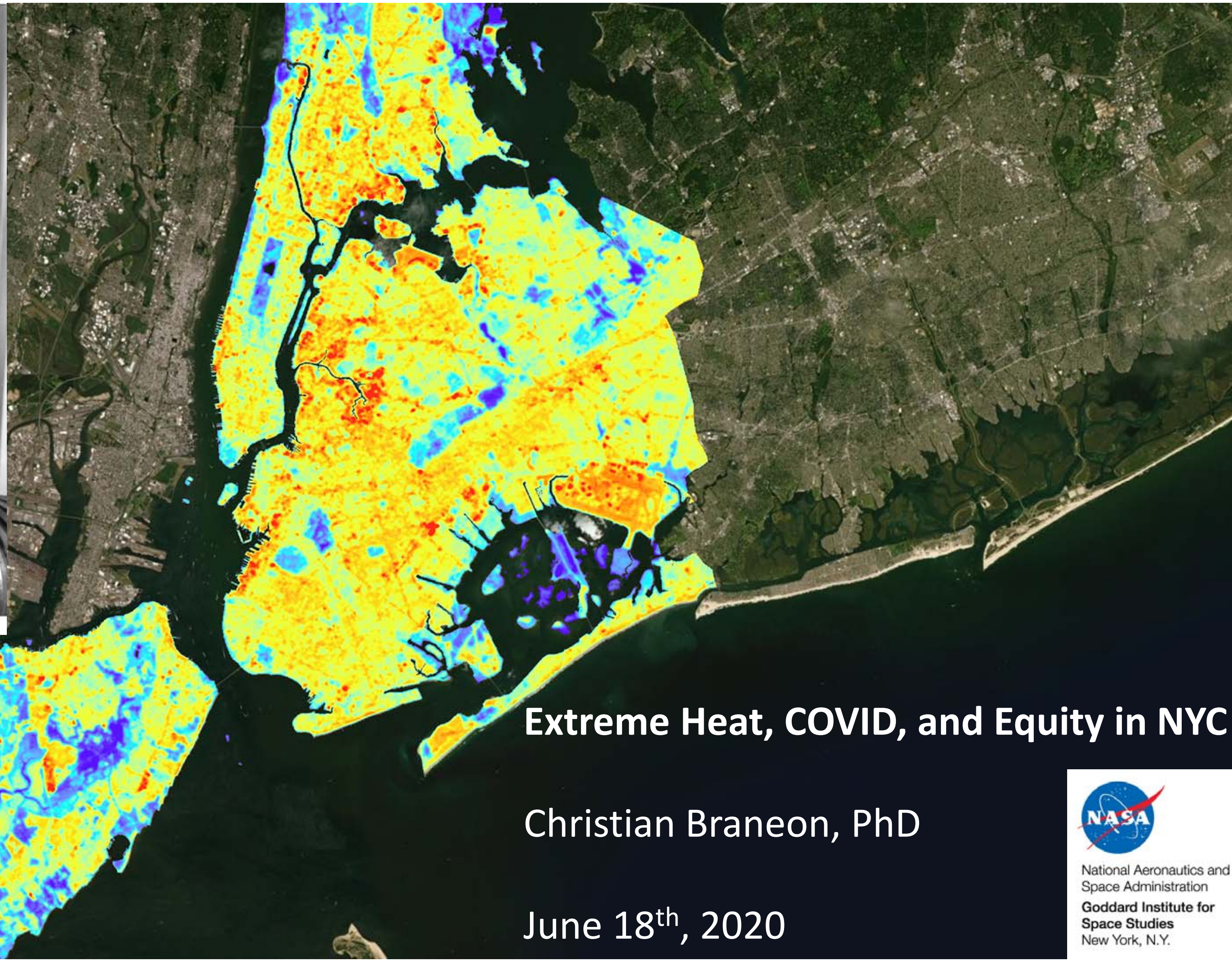


Extreme Heat, COVID, and Equity in NYC

Christian Braneon, PhD

June 18th, 2020

National Aeronautics and Space Administration
Goddard Institute for Space Studies
New York, N.Y.



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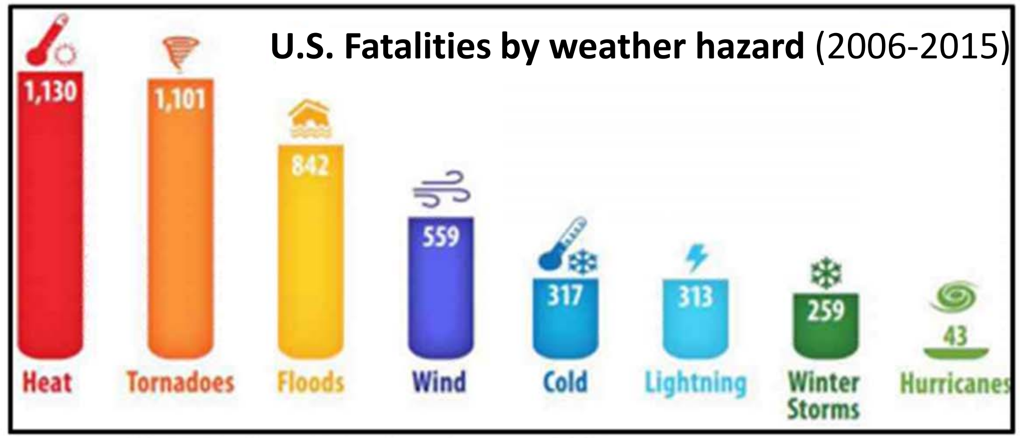
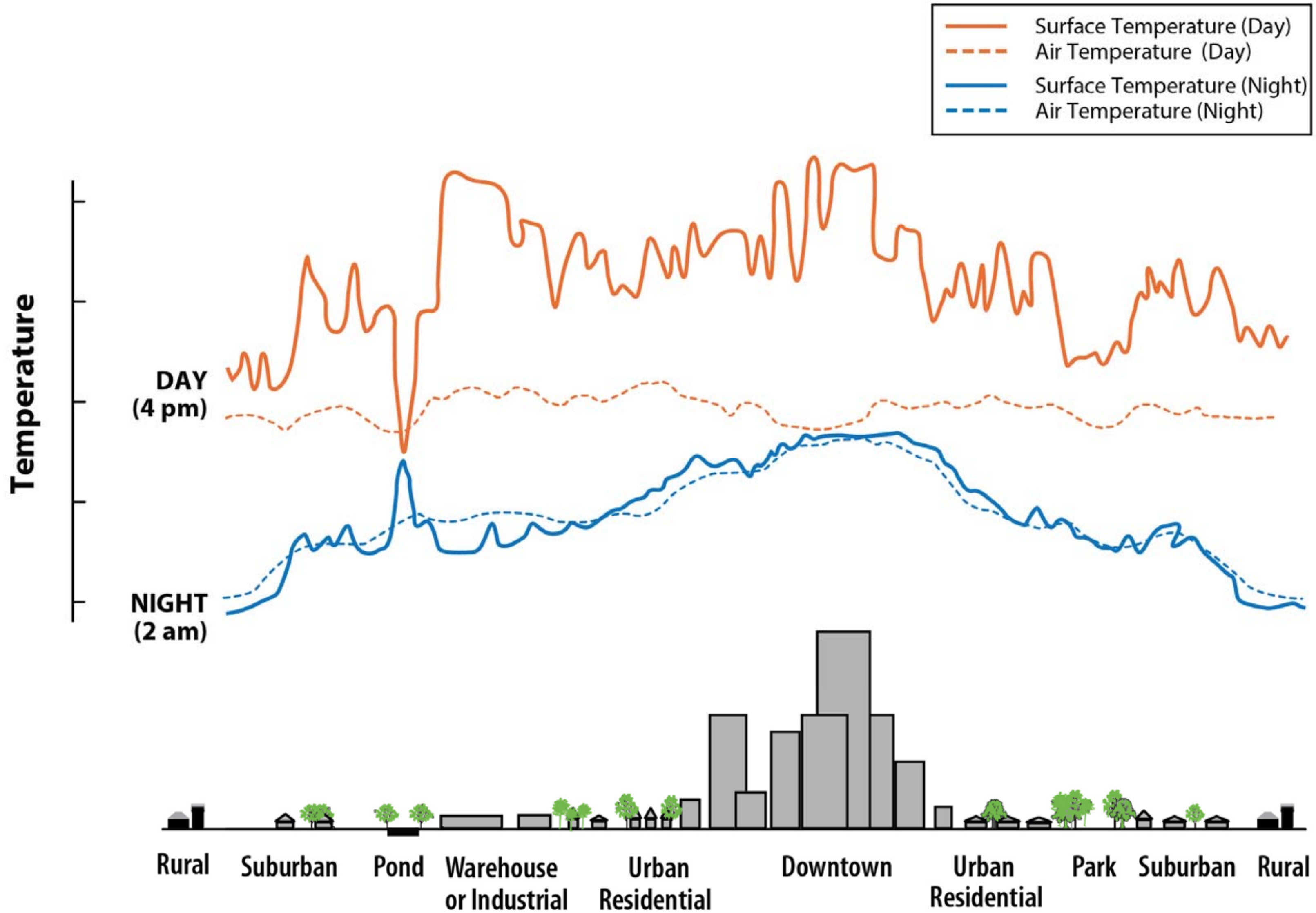
COMMUNITY CONCERN

- NYC is the **most densely** populated city in the United States
- Every year, ~**600** New Yorkers encounter heat-related illness with ~**128 deaths**
- Nine million inhabitants in NYC by **2050**
- Estimated warming of +**5.7°F** by **2050**



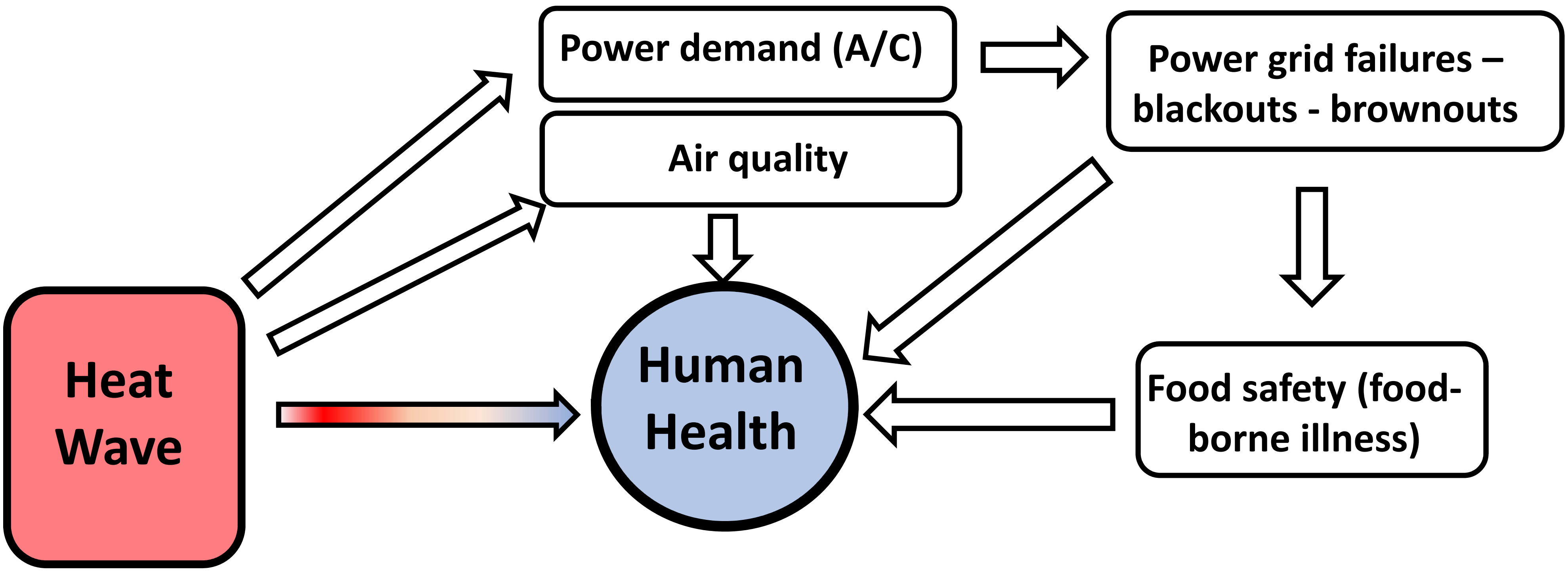
Source: NOAA National Weather Service, 2016.

The incidences of heat related illness are sure to rise.


Surface Temperature (Day)
Air Temperature (Day)
Surface Temperature (Night)
Air Temperature (Night)
Temperature
DAY
(4 pm)
NIGHT
(2 am)
Rural
Suburban
Pond
Warehouse or Industrial
Urban Residential
Downtown
Urban Residential
Park
Suburban
Rural

USEPA

There are complex direct and indirect effects of heat on health



Adapted from Augustin Vintzileos / Univ. of Maryland

Heat Projections

		Baseline	10th Percentile	25th Percentile	75th Percentile	90th Percentile
Heat waves per year **Average # events per year**	2020s	1.1	1	2	4	5
	2050s	1.1	2	3	5	6
	2080s	1.1	2	3	5	7
Mean heat wave duration **Average heat wave length in days**	2020s	4	3	4	6	8
	2050s	4	4	5	9	13
	2080s	4	4	6	15	27
LONGER + MORE FREQUENT HEAT WAVES						
Days above 90°F **Average # days per year**	2020s	9.6	6	11	25	34
	2050s	9.6	15	24	46	56
	2080s	9.6	23	34	62	74
Days above 100°F **Average # days per year**	2020s	0.27	0	0	0	2
	2050s	0.27	0	0	4	8
	2080s	0.27	0	1	13	27

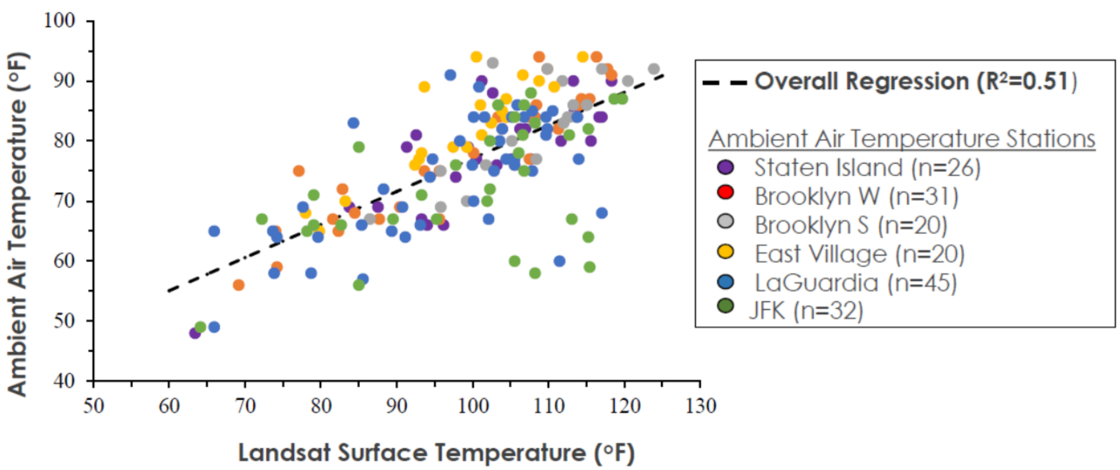
Results from new projection methods for future assessments of heat wave across 52-member ensemble (26 models, 2 projections) for New York City. Baseline refers to 1971-2000 average characteristics. See Appendix 2.B for comparison to NPCC 2015 projected values.

Note: NPCC3 confirms the temperature projections of NPCC2 as those of record that should be used for planning. Based on new and emerging science, NPCC3 introduces a new methodology for analyzing heat extremes that could be used for developing future projections of record in NPCC4.

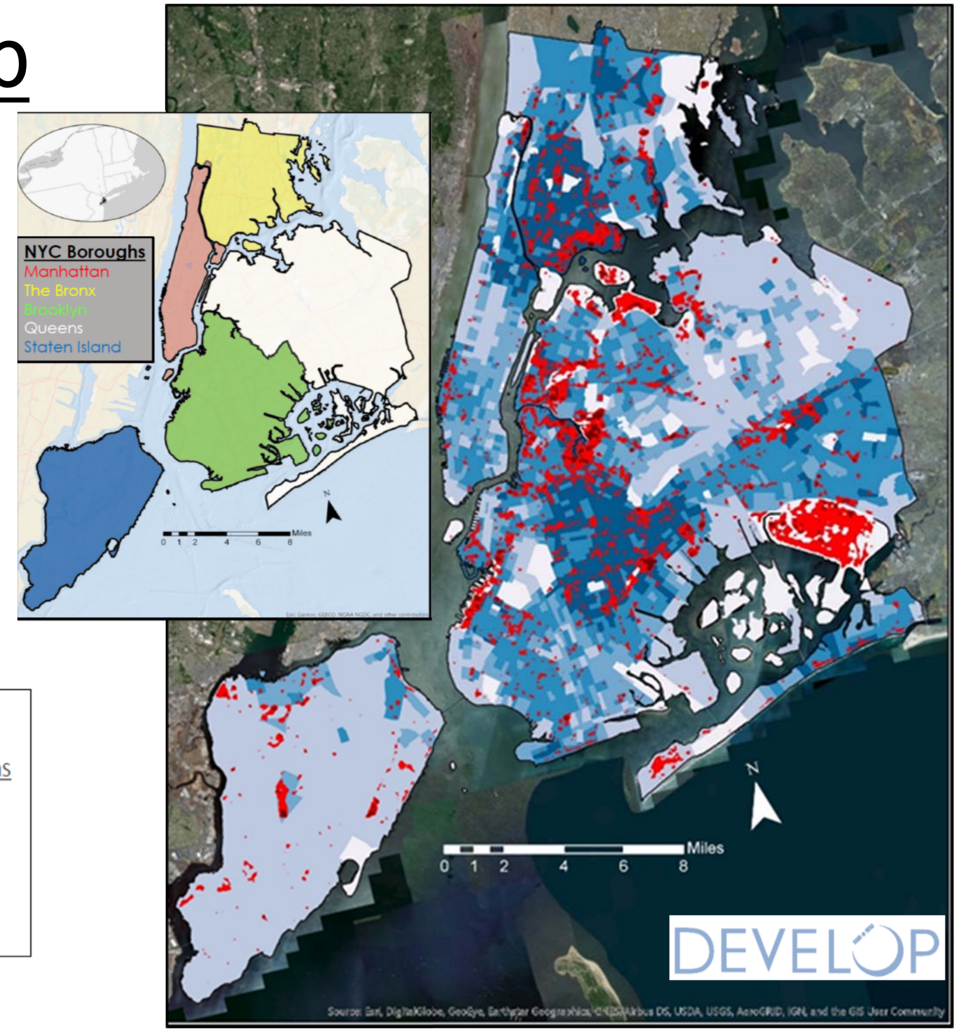
NPCC, 2019

Air Temp + Land Surface Temp

- Location of NYC land surface temperature (LST) hotspots overlaps with neighborhoods identified as heat vulnerable (areas w/ heat vulnerability index HVI > 4) by the City
- At right, red represents areas with elevated surface temperature (Landsat ARD 1990-2019) while darker blue areas represent neighborhoods with increased heat vulnerability.



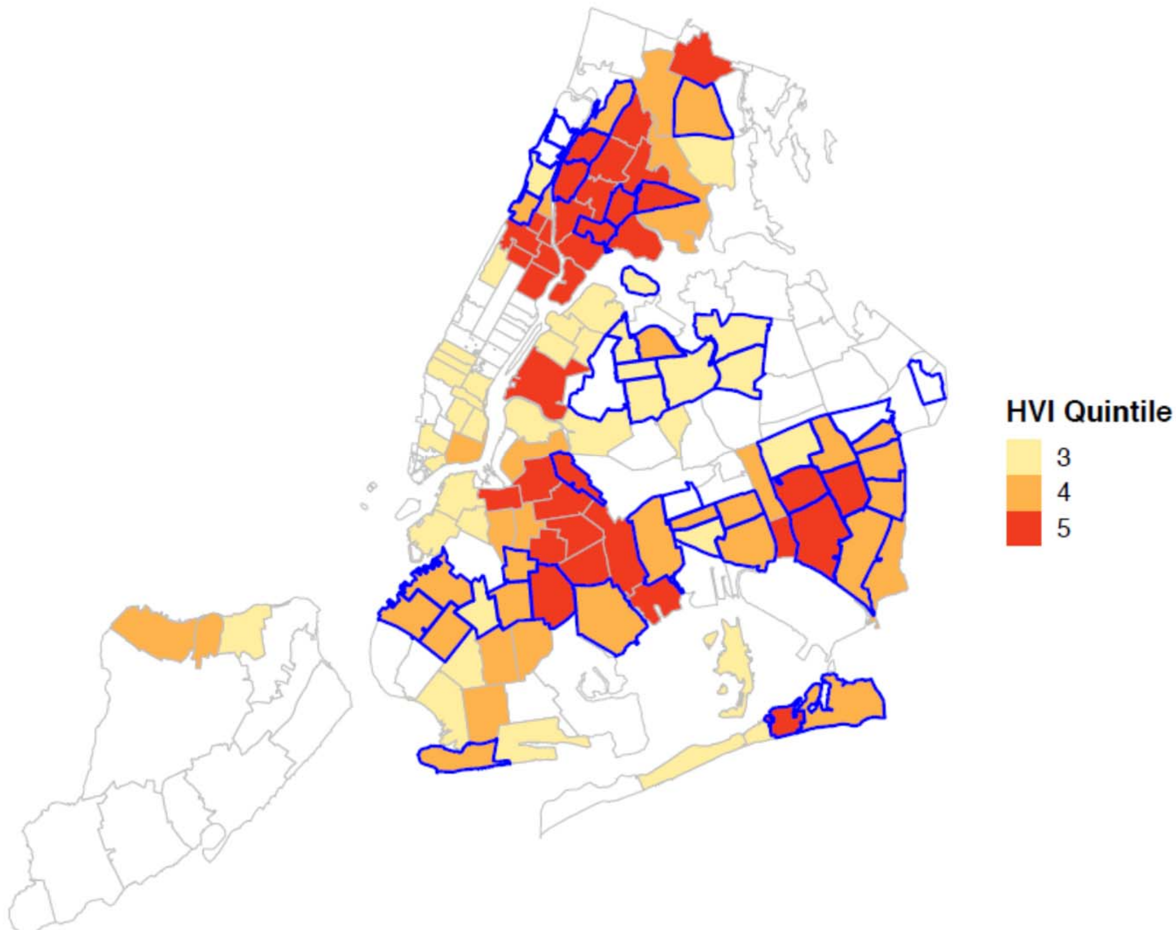
Sources: NASA DEVELOP, NYC MOR, Landsat Level-2 analysis-ready data



Average thermal hotspot location (1990-2019) in NYC compared to location of heat vulnerable neighborhoods (Heat Vulnerability Index; NYCDOHM, 2015; NASA DEVELOP)

Medium–High Heat Vulnerability and Percent Positive COVID–19 Cases

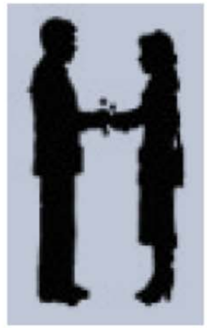
>53% positive COVID–19 cases highlighted in blue (4/27)



Source: NYC DOHMH HVI and COVID–19 percent positive– ZCTA level

SARS-CoV-2

Modes of Transmission

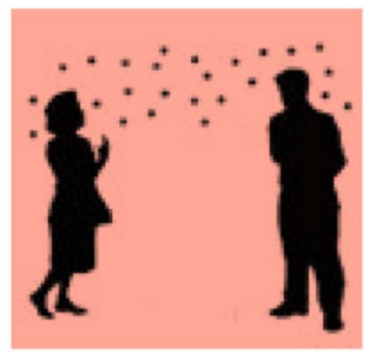


direct contact

indirect contact

Defined by medical community as >5 µm and happening at close-range only (<2 m)

large droplets



aerosols

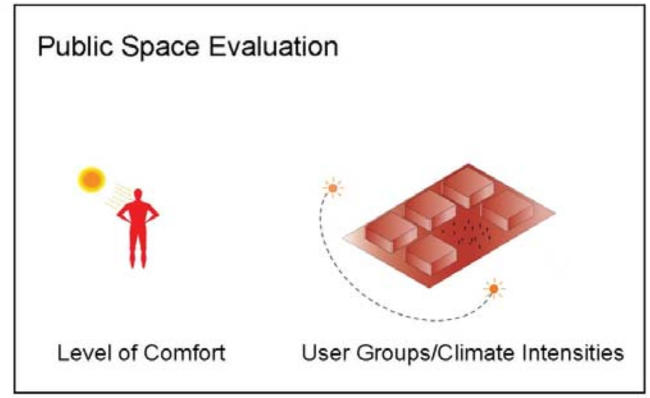
Defined by medical community as <5 µm and happening at long-range only (>2 m)

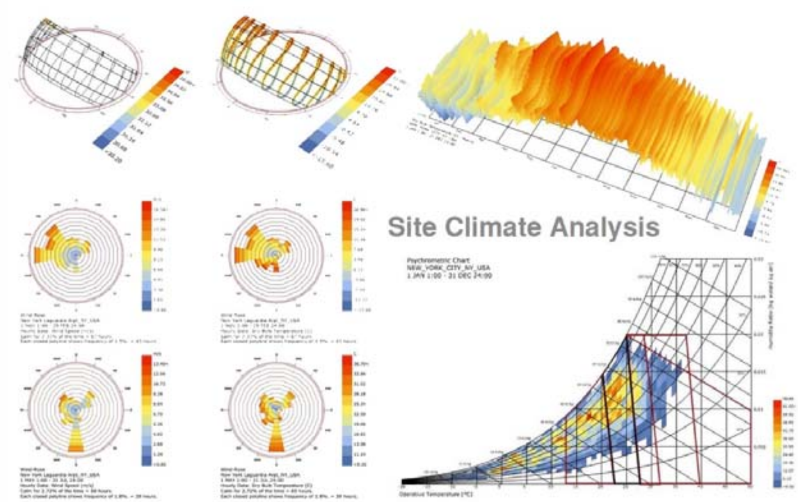
Adapted from Marr, 2020

http://www.phac-aspc.gc.ca/cpip-pclcpi/annf/v2-eng.php

Public Space Evaluation

Urban Design Climate Lab, NYIT Urban Design 2018



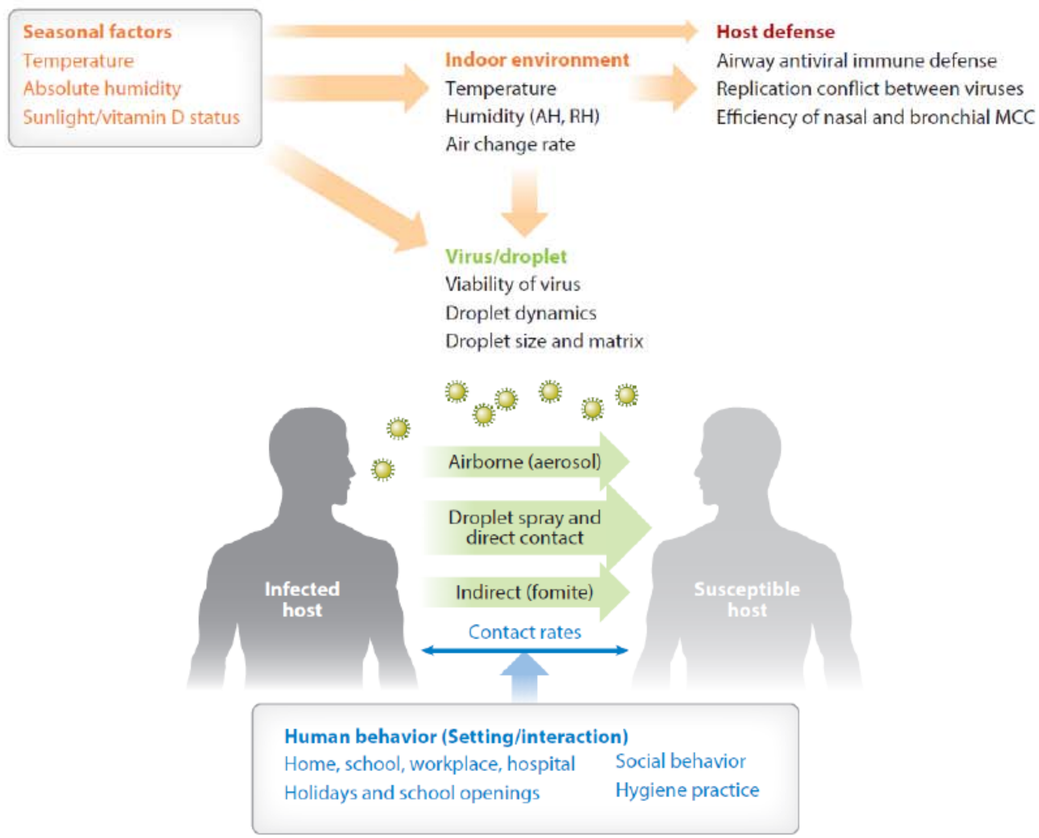


Urban Design Climate Lab, NYIT Urban Design 2018

Courtesy of Jeffrey Raven / NYIT

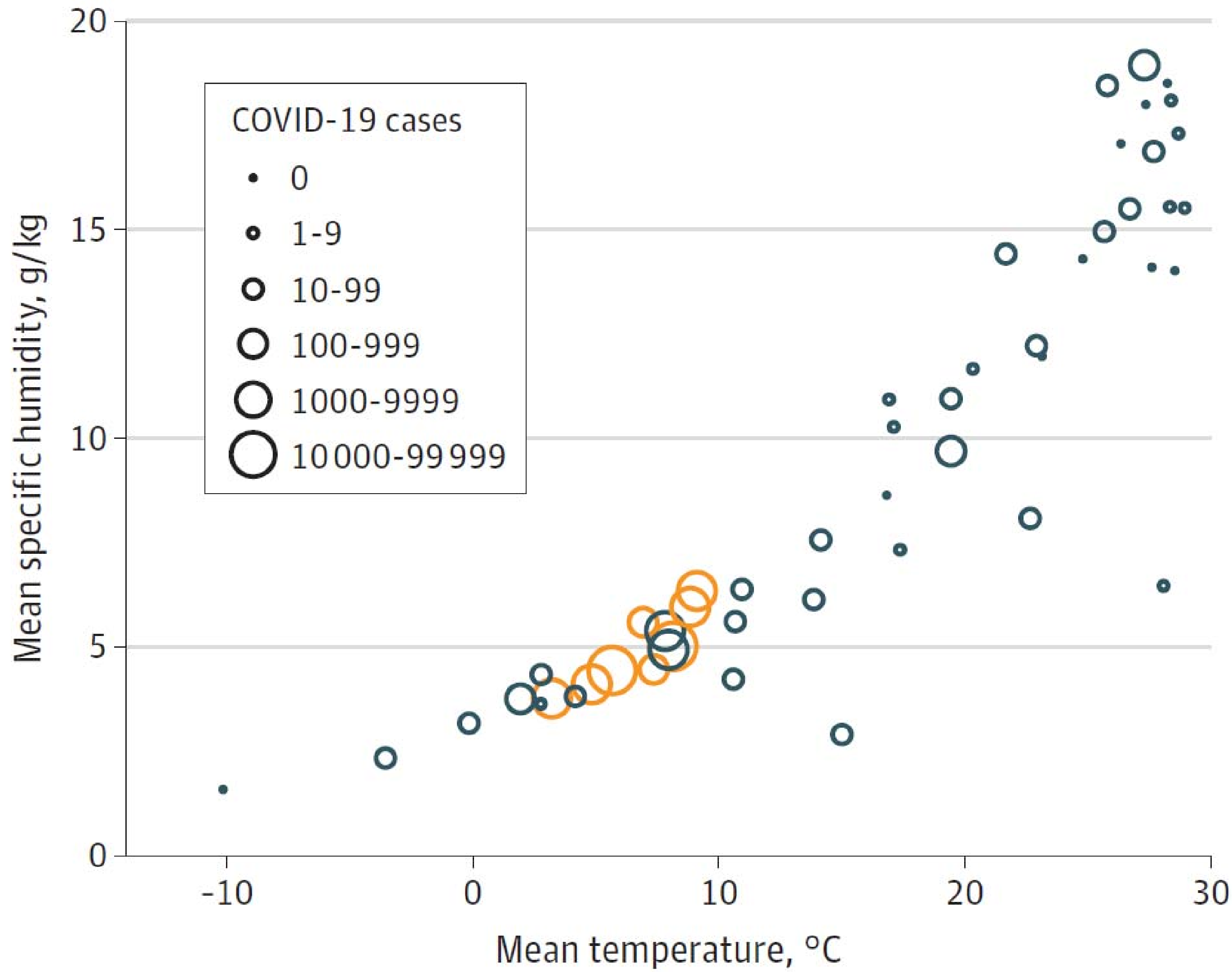
Why might hydrometeorology matter?

Most, though not all, **human respiratory pathogens exhibit seasonality in temperate regions**, with a winter peak.



Moriyama et al. (2020)

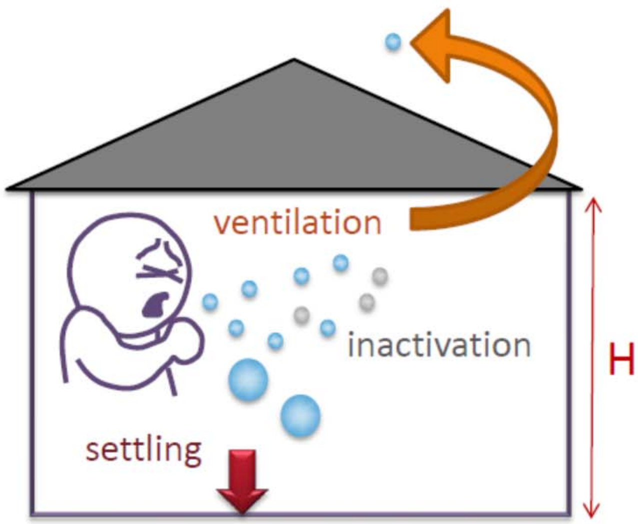
Adapted from Zaitchik, 2020



Orange circles represent countries with substantial community transmission (10 deaths as of March 10, 2020), and circle size represents total cases in each country

Sajadi et al, 2020

Virus Dynamics in Indoor Air



settling / ventilation (air-exchange) / inactivation

$$\frac{dC_d}{dt} = -\left(\frac{v}{H} + \lambda + k\right)C_d$$

concentration of infectious virus in aerosols of diameter *d*

- Settling velocity *v* depends on diameter *d*
- Diameter depends on RH
- Inactivation rate *k* depends on RH

relative humidity (RH)

Yang and Marr, 2011, *PLoS One*, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3123350/

Which hydromet variables matter?

For COVID-19: **we don't know for sure**

But for influenza and some other viruses:

- Temperature
- Absolute and relative humidity
- UV radiation

Adapted from Zaitchik, 2020

What can the EO community do?

- Make our data accessible, usable and **understood**
- **Collaborate** with disease transmission experts and holders of non-EO data
- Communicate and **think creatively**

Earth Observations for Impact (**#EO4Impact**)

Adapted from Zaitchik, 2020