Jet Propulsion Laboratory
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Neighborhood-Scale Extreme Humid Heat Health Impacts

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Project goal and objectives

al. 2017). **Our project will build capacity for identifying projected heat risk in urban regions that could be used for mitigating morbidity and mortality due to extreme humid heat under climate change. We propose two primary objectives to accomplish this goal:**

Objective 1: Create neighborhood-scale projections of extreme humid heat health impacts in global urban centers.

Objective 2: Guide decision-making activities on extreme humid heat preparedness and mitigation in global urban centers.

overview

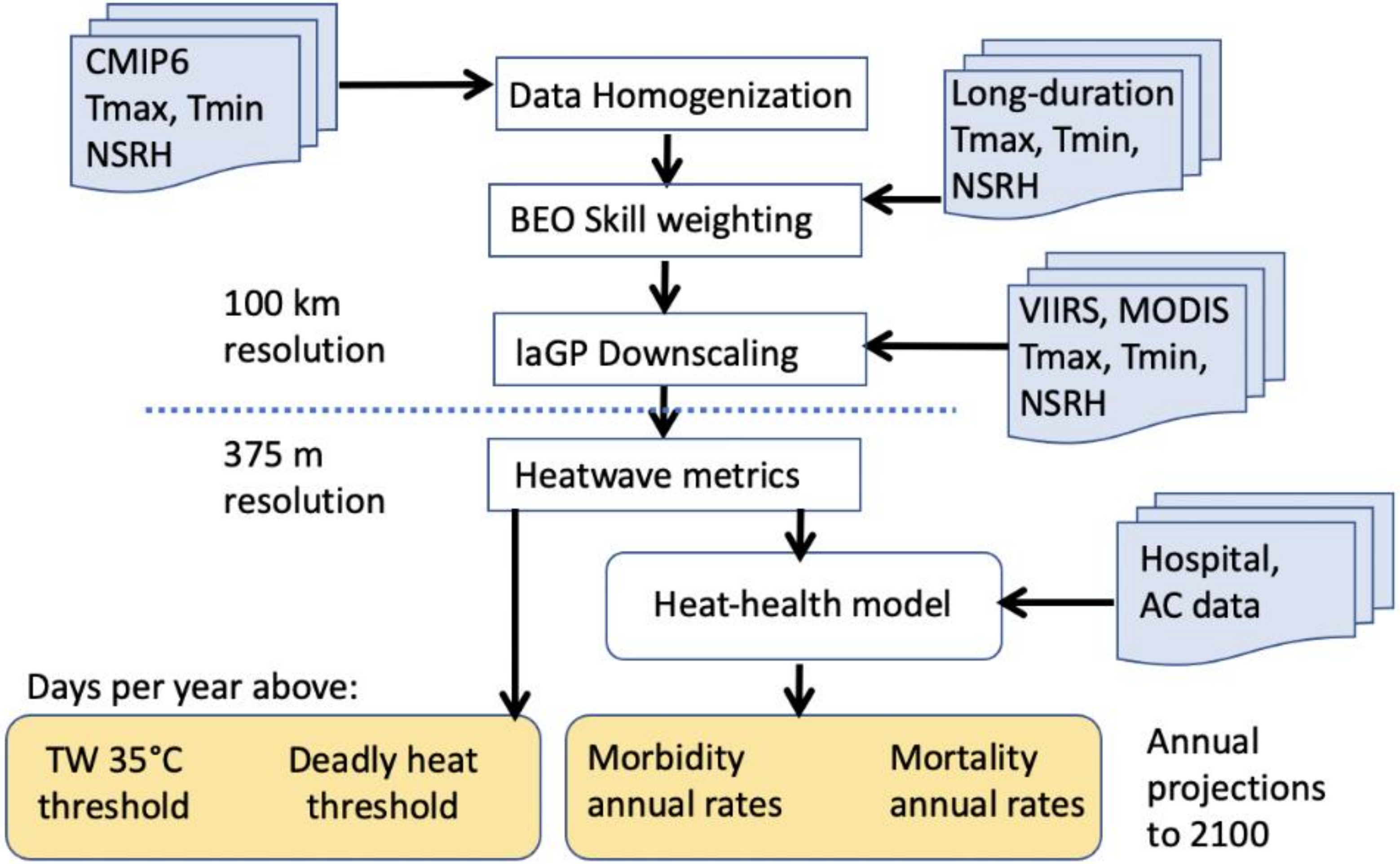

Figure 3-2. Simplified overview of the scientific analysis. Inputs in blue boxes, outputs in yellow.

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Builds on prior work: coral reef projections

- same methods, including statistical downscaling and model weighting
- two predictor variables (heat and humidity) instead of one (SST)
- start with simple health thresholds, develop modeled thresholds

Earth's Future

RESEARCH ARTICLE
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Past the Precipice? Projected Coral Habitability Under Global Heating

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Key Points:

- We project over 91 percent of coral reefs will now experience severe-bleaching-level ocean heat recurring at least once every 10 years
- We project over 99 percent of reefs will experience severe-bleaching-level ocean heat at least twice per 10 years by 2036 under SSP3-7.0
- We find SSP1-2.6 to be the only scenario not consistent with near-complete global severe degradation or

Abstract Coral reefs are rapidly declining due to local environmental degradation and global climate change. In particular, corals are vulnerable to ocean heating. Anomalously hot sea surface temperatures (SSTs) create conditions for severe bleaching or direct thermal death. We use SST observations and CMIP6 model SST to project thermal conditions at reef locations at a resolution of 1 km, a 16-fold improvement over prior studies,

Team

End users and applications

Ms. Julie Arrighi, Co-PI, Red Cross Red Crescent: Co-lead for decision-making applications.

Ms. Roop Singh, Red Cross Red Crescent, Climate Risk Advisor: Decision-making applications.

Ms. Alison Frazzini, LA County CSO, Sustainability Advisor: Decision-making applications.

Ms. Kristen Pawling, LA County CSO, Sustainability Program Director: Decision-making applications.

Dr. Chris Funk, Collaborator, UCSB Climate Hazards Center: Applications and integration.

Dr. Ben Zaitchik, Collaborator, Johns Hopkins, GEO Health Heat Small Group: UHI, community.

Extreme heat: heatwaves and remote sensing and modeling of near-surface air temperature

Dr. Glynn Hulley, Co-I, NASA JPL: VIIRS Tmax, Tmin data production, UHI, analysis.

Dr. Anamika Shreevastava, Postdoc, NASA JPL: UHI, remote sensing, and modeling.

Dr. Bénidicte Dousset, Collaborator, U. Hawaii: Heatwave science and the deadly heat threshold.

Dr. Josh Fisher, Collaborator, Chapman University: MODIS near-surface 5 km products.

Statistical methods

Dr. Emily Kang, Co-I, U. Cincinnati: Statistical downscaling and heat-health modeling.

Ms. Ayesha Ekanayaka, Grad Student, U. Cincinnati: Statistical downscaling and modeling.

Dr. Elias Massoud, Collaborator, UC Berkeley: Model skill weighting with BEO.

Health and medical statistics

Dr. Howard Chang, Co-I, Emory U: Health data collection and modeling.

Dr. Ronita Bardhan, Collaborator, U. Cambridge: Mortality data in the Global South.

Air conditioning modeling

Dr. Kelly Sanders, Co-I, USC: AC data collection and modeling.

Near-surface air temperature

- NSAT from land surface temperature using linear regression model
- VIIRS high- resolution TIR band (375 m)

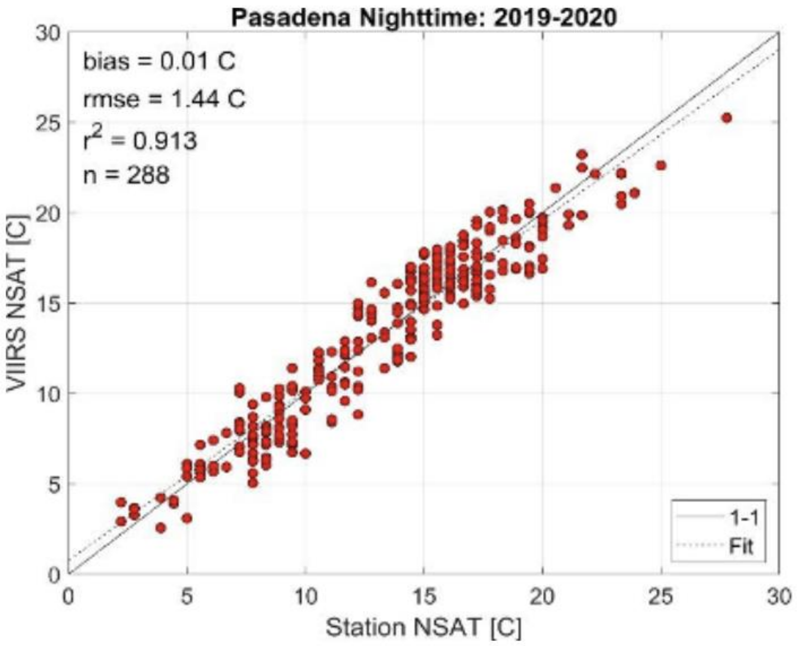
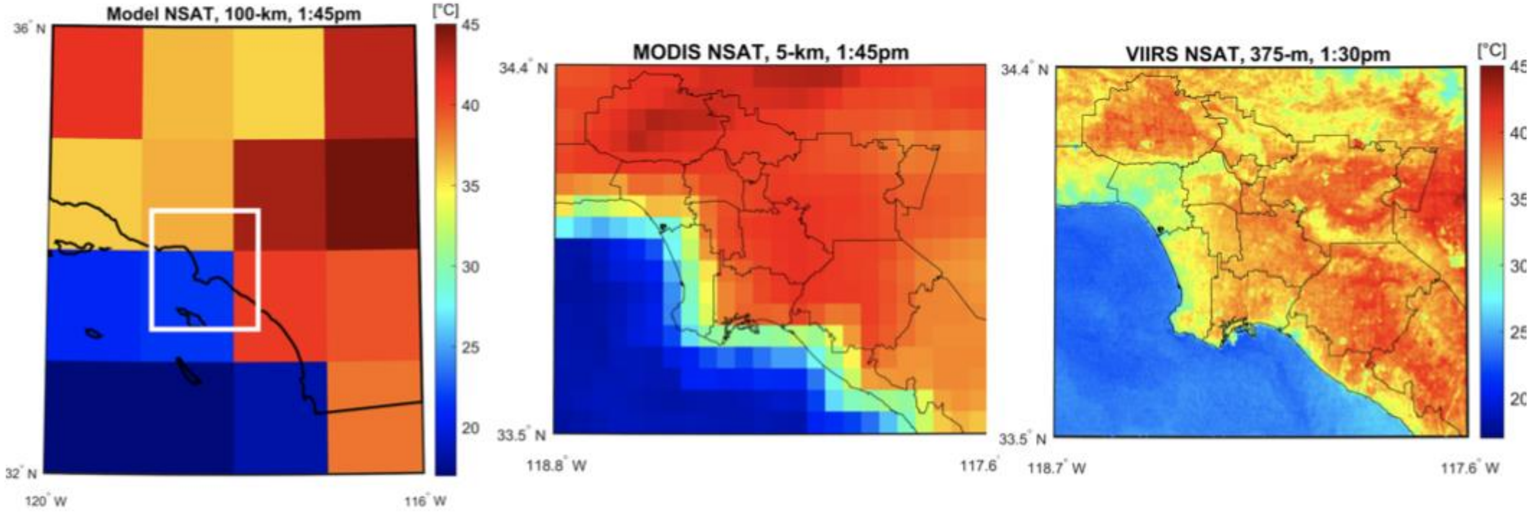


Figure 3-4. VIIRS derived NSAT versus station measured NSAT for two years of data from 2019-2020 at the Pasadena, CA NCDC station.



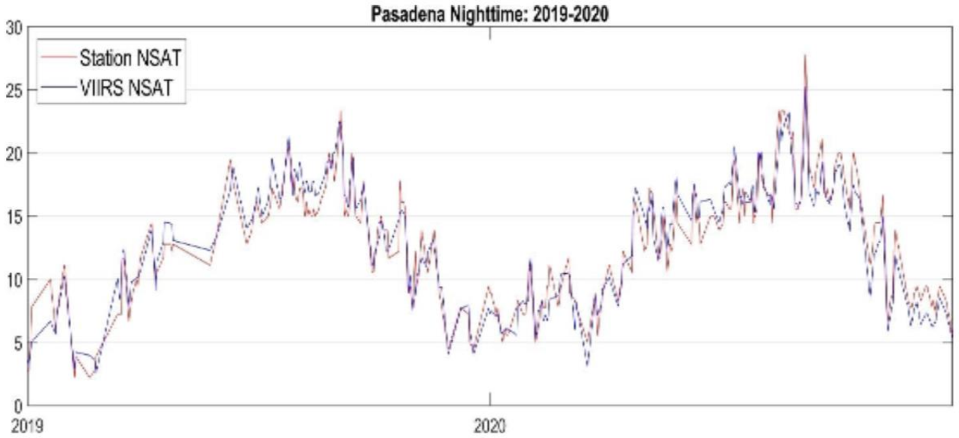


Figure 3-1. Sample NSAT estimates over Los Angeles during the heatwave of 14 August 2020; 400 km region on the left, smaller regions (boxed in white) on center and right. Aqua MODIS NSAT averaged to 100 km resolution (left); Aqua MODIS at native 5 km resolution (center); VIIRS on Suomi-NPP at 375 m resolution (right), demonstrating capability of resolving UHI variation. Note that prior projection studies are closest to the 100 km sample on the left.

Heat-health modeling

- Conditional logistic regression for comorbidities and age
- We will link AC prevalence at census-tract level to ED data
  - Understand protection that AC affords urban dwellers in different climates, and the potential public health impacts of power outages during periods of high heat
  - Hourly smart meter data: diverse populations, housing stocks, and climate variability for modeling purposes
- Three phases:
  - 1. California (best data)
  - 2. US (good data)
  - 3. Global cities (poor data, mortality only)

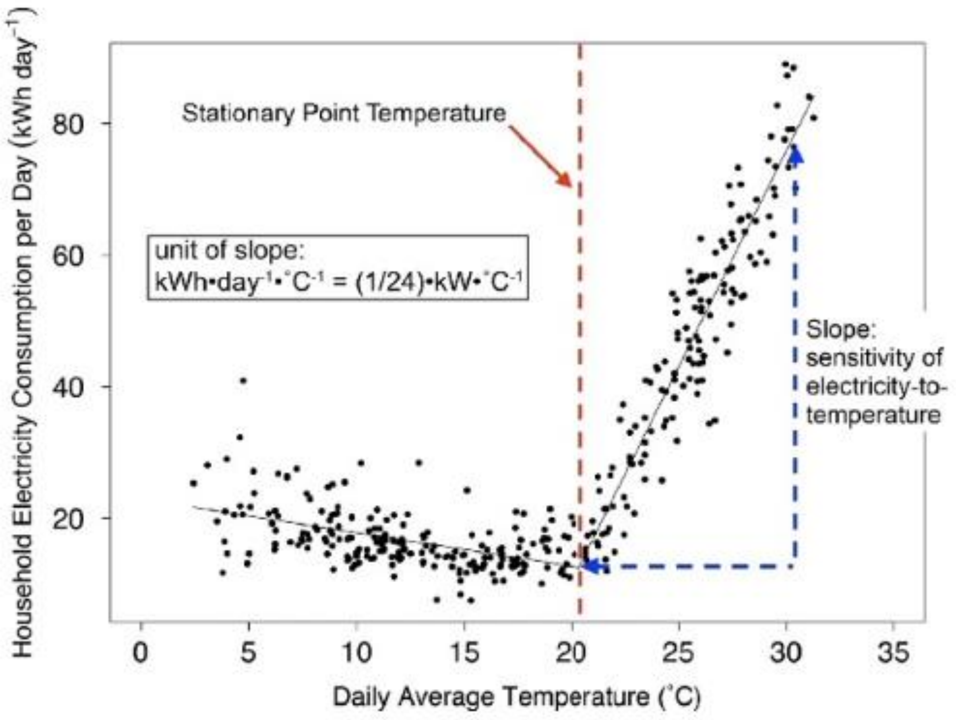


Figure 3-6. A piecewise linear regression method was developed to identify whether a household has access to AC based on E-T sensitivity in units kW per °C and SPT in units of °C (from Chen, Sanders & Ban-Weiss 2018).

Potential Applications

- 5-year timescale
  - Improve heat early warning systems
  - Prevent / direct resources for extreme heat humanitarian crises
- 20-year timescale
  - Urban heat mitigation and planning
    - municipal, national heat action plans
    - Siting, prioritization decisions
    - Cool pavements and roofs, urban greening, cooling centers
- 50-year timescale
  - Insight into deepest risks
  - Inform long-term planning of humanitarian systems and decision making

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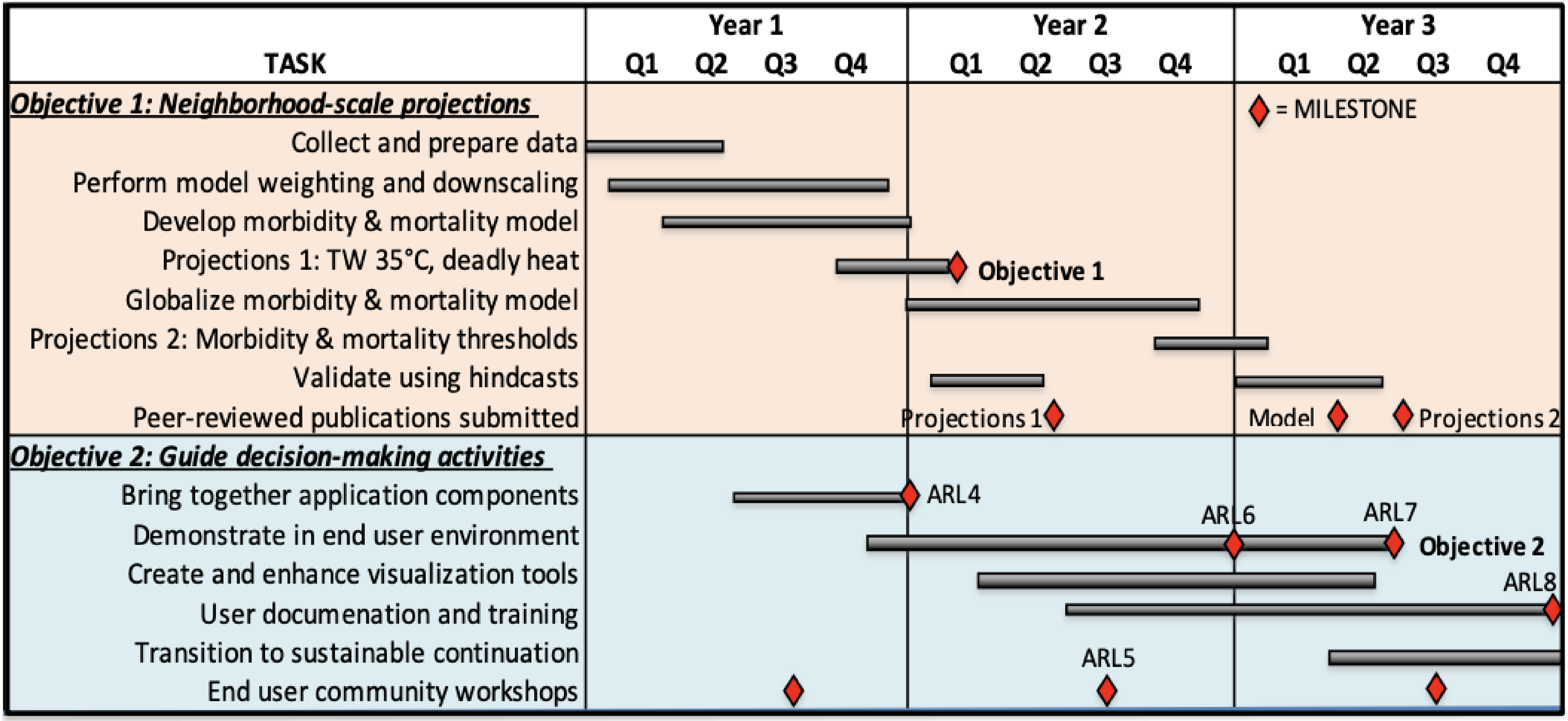
Work plan



ARLs

- Start-of-Project: ARL3 (viability established by the coral reef project)
- ARL4 (initial integration and verification) will depend on infusing initial projections into end user networks, which will occur first in Los Angeles.
- ARL6 (potential demonstrated) will depend on assessing application systems before and after enhancement using our projections.
- Anticipated End-of-Project: ARL7 (functionality demonstrated) for urban heat mitigation and planning in LA County

Risks

- Computational speed. Downscaling one GCM, one SSP to 10 km resolution over global land surface requires 6 days on 48 CPUs. Limit geographical extent of study e.g. to urban cores.
- Developing a community of practice around our project's objectives within the rich ecosystem of heat-health research and decision-making already in place. Connect with this community early and often, soliciting their feedback in a two-way communications process involving planned, dedicated workshops.
- Globalizing the heat-health model. Developing and validating the model for application in LA County and CA first, where we have high-resolution hospital and AC data. We will validate the model in varying climates within the United States and will also work to leverage the Red Cross Red Crescent network and sphere of influence to access mortality records in other locations. We note that the project can obtain its objectives based on the humid heat thresholds, TW35 and Deadly Humid Heat.