Climate Adaptation Science Investigators Workgroup (CASI):

A Partnership between Scientists and Facility Managers to Enhance Climate Resilience at NASA

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Nick Pelaccio
March 27th, 2024

NASA Goddard Institute for Space Studies
Columbia University Center for Climate Systems Research

21st Annual Climate Prediction Applications Science Workshop (CPASW)

NASA Centers are highly vulnerable to climate change

NASA spent $1.6 billion in supplemental funding for climate event repairs from 2003-2022

NASA Office of Strategic Infrastructure

Michoud Assembly Facility damage after Hurricane Zeta Oct 2020

CASI Mission

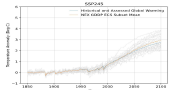
- CASI's mission is to provide the latest scientific research on climate change to help NASA facilities managers adapt to increasing climate risks in timely and effective ways.

- CASI is the only NASA program that creates open channels of communication between the Earth Science Directorate (ESD) and the Office of Strategic Infrastructure (OSI).

CASI Workshop at Langley Research Center, November 1st, 2023

CASI Activities and Workgroups

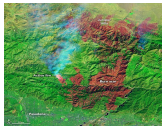
CASI Activities



Downscale center-specific climate hazard risk information using CMIP6 models and updated IPCC methods

Assist with OSI/NREL Center Resilience Assessments

Contribute to NASA Climate Action Plan reporting for EO #14008



Develop CASI Workgroup co-generated products as decision aids

CASI Workgroups and Products

Sea Level Rise
- Sea level rise projections
- Coastal inundation maps

Extreme Weather Events
- High temperatures
- Droughts
- Inland floods

Fires and Air Quality
- Wildfire risk, current & future
- Smoke risk, current & future

Energy
- Energy management tools

Water Budgets
- Water demand
- Surface flooding

CASI Stakeholders

- Primary Stakeholder: Office of Strategic Infrastructure (OSI)
- Top-Down ⟶ OSI HQ Staff, Climate Adaptation Plan
- Bottom-Up ⟶ Center Points of Contact
  Master Planners, Facilities, Energy, Environment

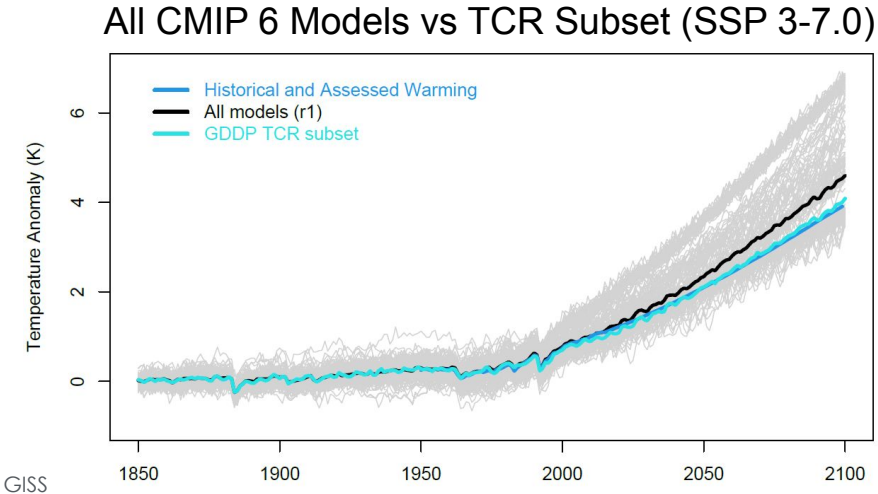
CASI Interacts with nearly all OSI Divisions

CASI Projections for NASA Centers

- NASA Earth Exchange Global Daily Downscaled Projections (NEX GDDP)

- ~25km x 25km gridbox resolution; finer resolution model coming soon

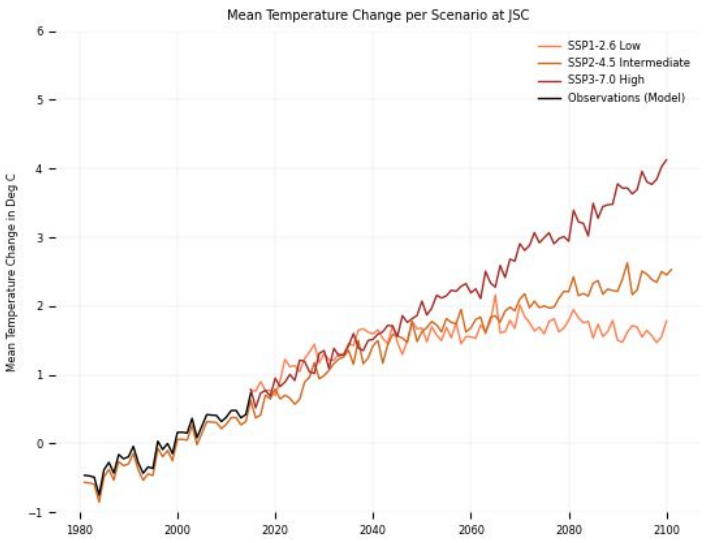
- To avoid 'hot' CMIP6 GCMs, use IPCC AR6 assessed "Very Likely" range of Transient Climate Response (TCR) (1.2 - 2.4°C)

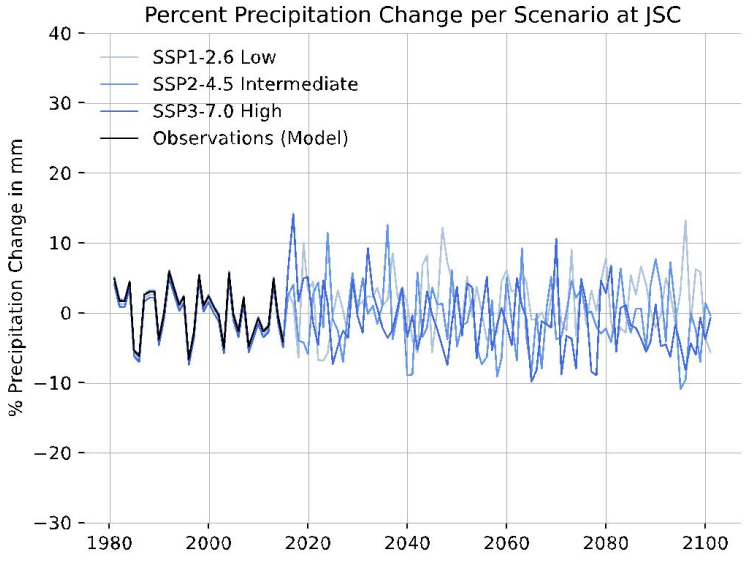


Credit: Gavin Schmidt, NASA GISS

Temperature and Precipitation Projections at Johnson Space Center

Baseline 1981-2020



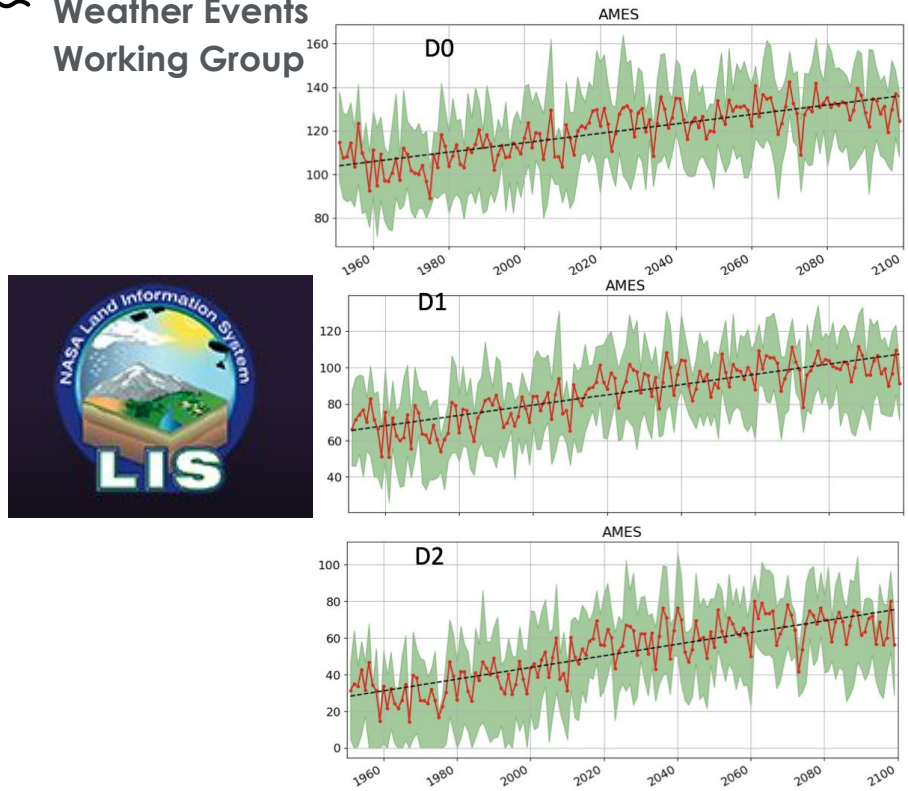


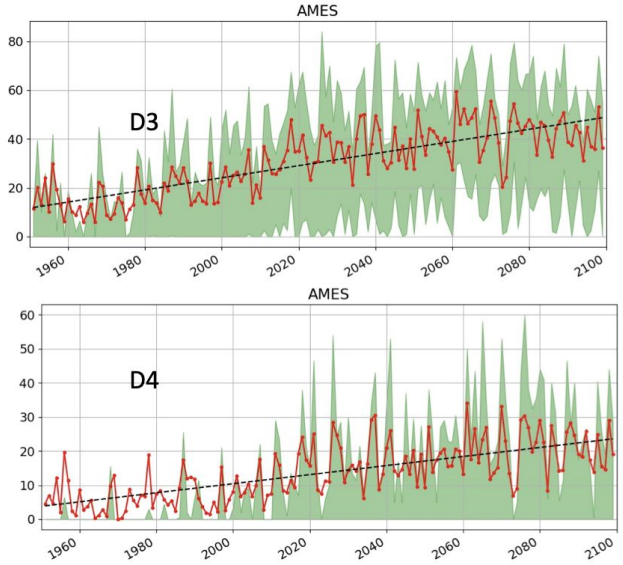
Temperature projected to increase at JSC
Precipitation shows greater variability

Nick Pelaccio

Root Zone Soil Moisture at Ames

CASI Extreme Weather Events Working Group





Category	Description
D0	Abnormally Dry
D1	Moderate Drought
D2	Severe Drought
D3	Extreme Drought
D4	Exceptional Drought

Root zone soil moisture Drought estimates (USDM)

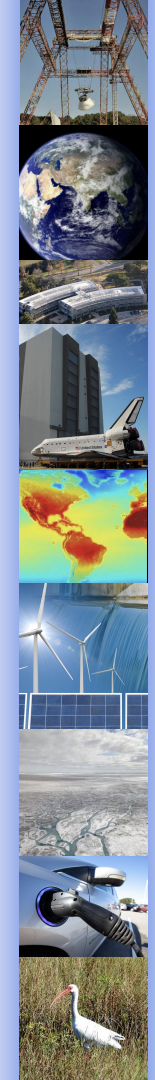
Percentile < 30%

Percentile < 20%

Percentile < 10%

Percentile < 5%

Percentile < 2%



CASI Energy Working Group

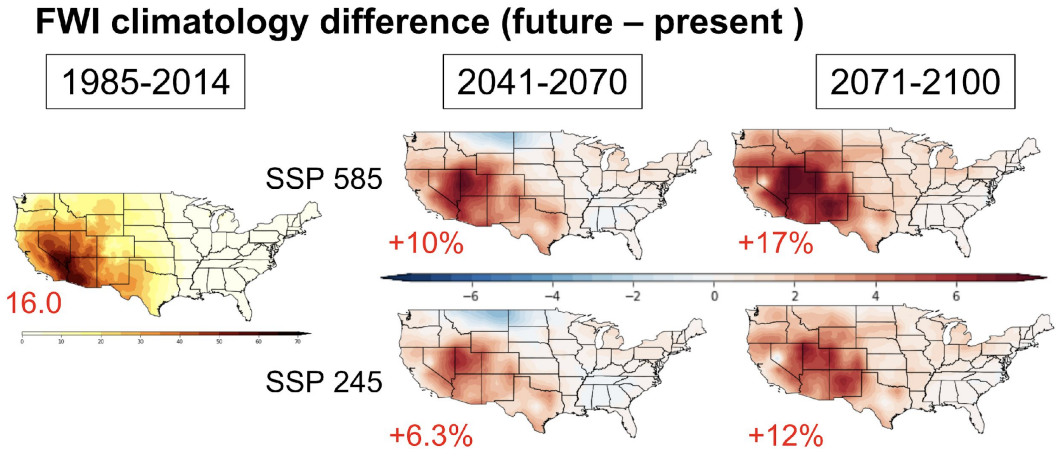
ASHRAE Climate Zone Changes

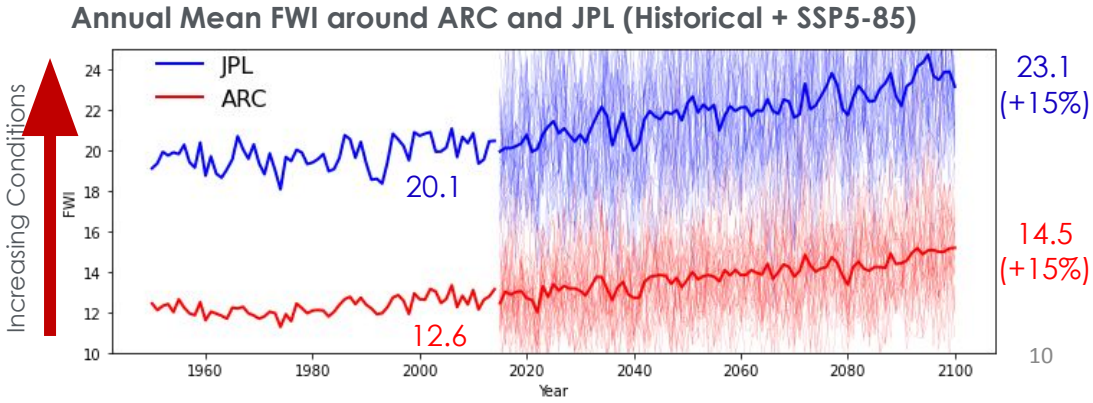
Center	Thermal Zone Change?	Moisture Zone Change?	Thermal Zone Change	Moisture Zone Change	When in SSP3?	When in SSP2?	When in SSP1?
Ames	No	No	3	3A	No change	No change	No change
Armstrong	Yes	Yes	3-->2	3A/3B-->2A/2B	after 2080	No change	No change
GISS	Yes	Yes	4-->3	4A-->3A	after 2070	after 2097	No change
Glenn	**Yes**	**Yes**	**5-->4**	**5A-->4A**	**After 2030**	**After 2030**	**After 2030**
Goddard	**Yes**	**Yes**	**4-->2**	**4A-->2A**	**After 2028 (to 3) After 2085 (to 2)**	**After 2028 (to 3)**	**After 2028 (to 3)**
Johnson	Yes	Yes	2-->1	2A-->1A	After 2045	After 2091	No change
JPL	Yes	Yes	3-->2	3A-->2A	after 2090	No change	No change
Kennedy	Yes	Yes	1-->0	1A-->0A	after 2068	No change	No change
Langley	Yes	Yes	3-->2	3A-->2A	after 2060	No change	No change
Marshall	Yes	Yes	3-->2	3A-->2A	after 2068	After 2088	No change
Michoud	Yes	Yes	2-->1	2A-->1A	after 2068	No change	No change
Stennis	Yes	Yes	2-->1	2A-->1A	after 2073	No change	No change
White Sands	Yes	Yes	3-->2	3B-->2B	after 2070	No change	No change

CASI Fire and Air Quality Working Group

Fire Weather Index (FWI)

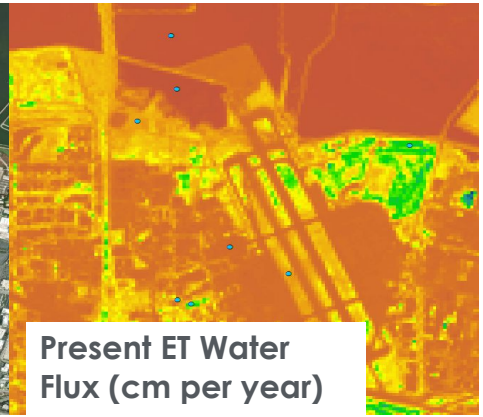
- Fire Weather Index (FWI) calculated using meteorological variables from CASI climate projections
- Conditions around JPL significantly more conducive to fire than at Ames
- Under high emissions scenario (SSP5-8.5), both Ames and JPL expected to increase FWI by ~15%





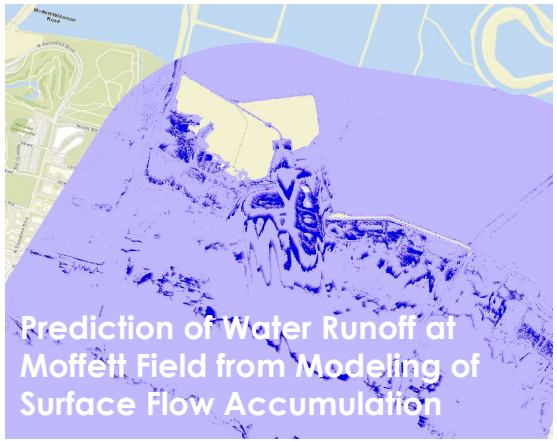
Hydrology at Ames Research Center

CASI Water Budgets Working Group



Present ET Water Flux (cm per year)

Surface Inundation (blue shades) after Heavy Rainfall Event of 2.7 inches/24-hours (October 24, 2021):
(Based on Sentinel-1 SAR)



Coastal Flooding at Ames Research Center

Sea Level Rise Working Group

Tools available at sealevel.nasa.gov

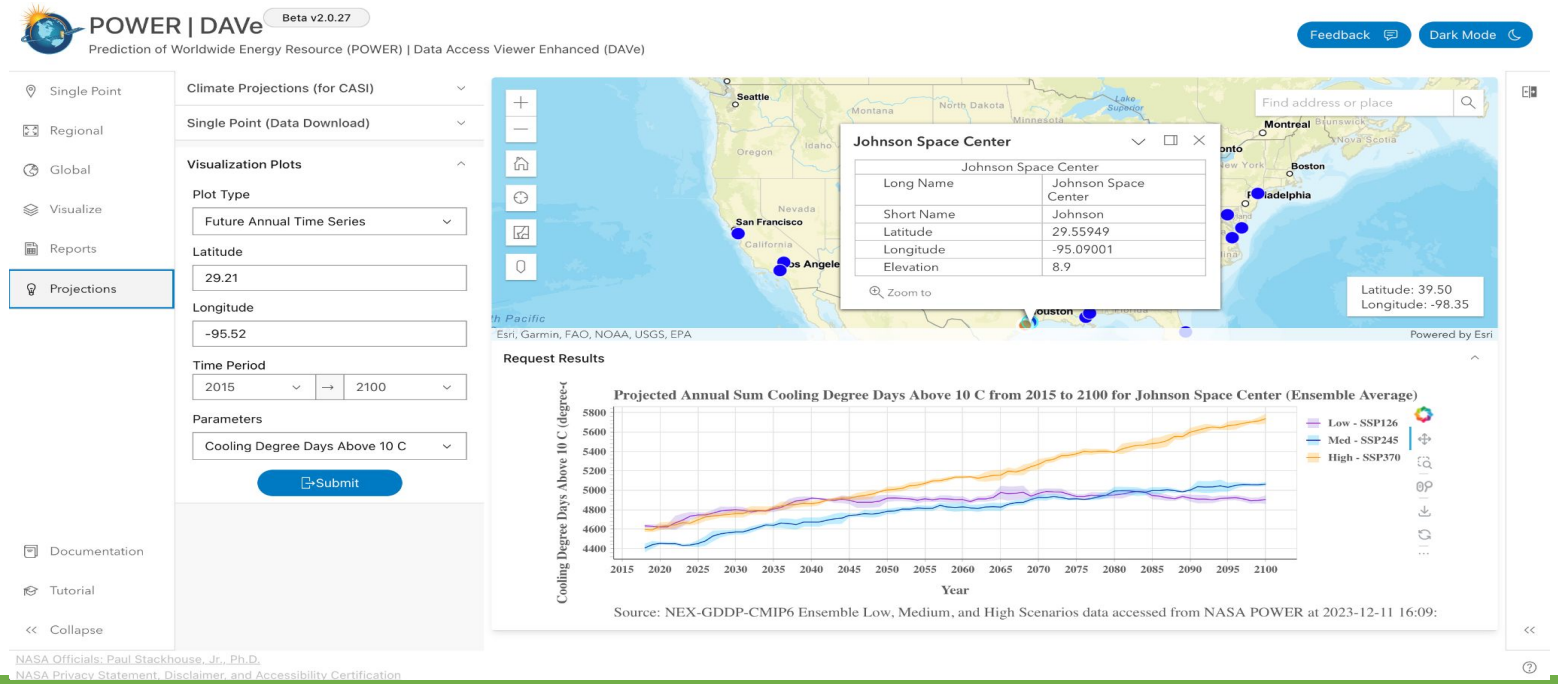
Ben Hamlington

Serving CASI Projections

- In progress: CASI projections publicly available for NASA Centers and surrounding regions

- Access on CASI Energy Workgroups POWER DAVe Tool

  https://power.larc.nasa.gov/beta/data-access-viewer/



CASI Partners

Department of Energy's National Renewable Energy Laboratory (NREL) conducts regular assessments of vulnerability and exposure as part of NASA Agency-wide risk assessment.

- **CASI provides climate projections for the resilience assessment report**
- Rotates through detailed assessments at ~2 centers each year (2024 Centers: GRC and MSFC)
- NREL makes recommendations for risk reduction investments

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NASA's Office of the Chief Health and Medical Officer (OCHMO) is collaborating with CASI with the goal of protecting worker health amid challenges posed by climate change.

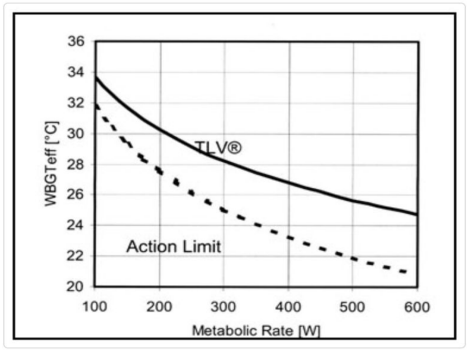
- This includes **heat stress, wildfire smoke, and indoor and outdoor air quality** for each NASA Center
- OCHMO will transform CASI data into actionable insights for the formulation of effective policies, guidelines, studies, operational costs projections, and educational initiatives and purposes

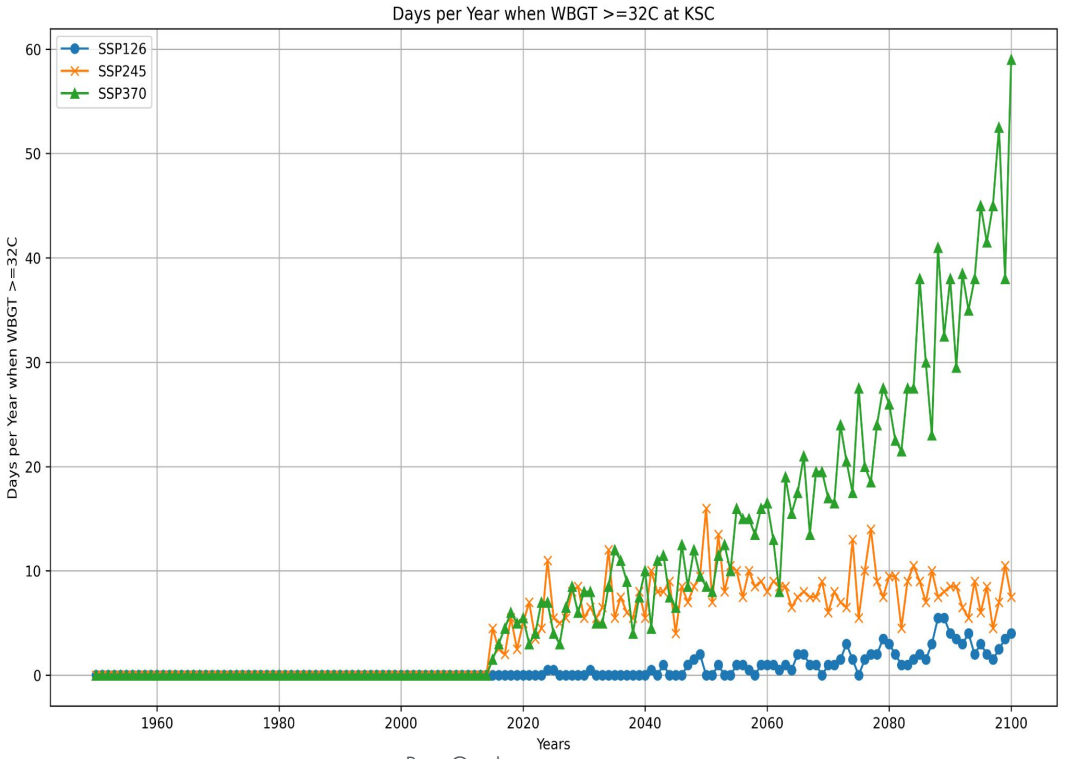
NASA Office of Chief Health and Medical Officer

Wet Bulb Globe Temperature at KSC

CASI Extremes Working Group

OSHA has published Threshold Limit Values (TLVs) for heat hazard based on WBGT and workload intensity (OSHA Technical Manual Section III: Chapter 4)





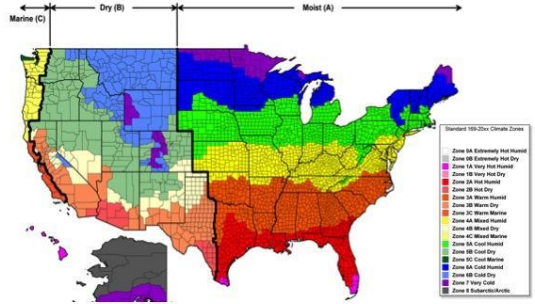
Ben Cook

CASI Projections in Action

- CASI projections are used in the NREL Resilience Assessment for each Center. These assessments help inform Center master planners of key vulnerabilities and climate risks at their center, in addition to mitigation and adaptation opportunities

- At Glenn Research Center, we have projected a shift in their ASHRAE Climate Zone around 2030 under all SSP scenarios. This information was used to inform the Chief Facility Manager Engineer to start designing HVAC systems for the new, projected climate zone.

Climate Zones – ASHRAE Standard 169-2013



Thank you very much!

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