

Harmonization of spatial and temporal data and models to advance an Earth Systems Science approach to modeling Climate-Migration

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**Workshop on Climate Change and Human Migration: An Earth Systems Science
Perspective**

National Academy of Sciences, Engineering and Medicine

Tuesday March 19th 2024

Climate Hazards Center

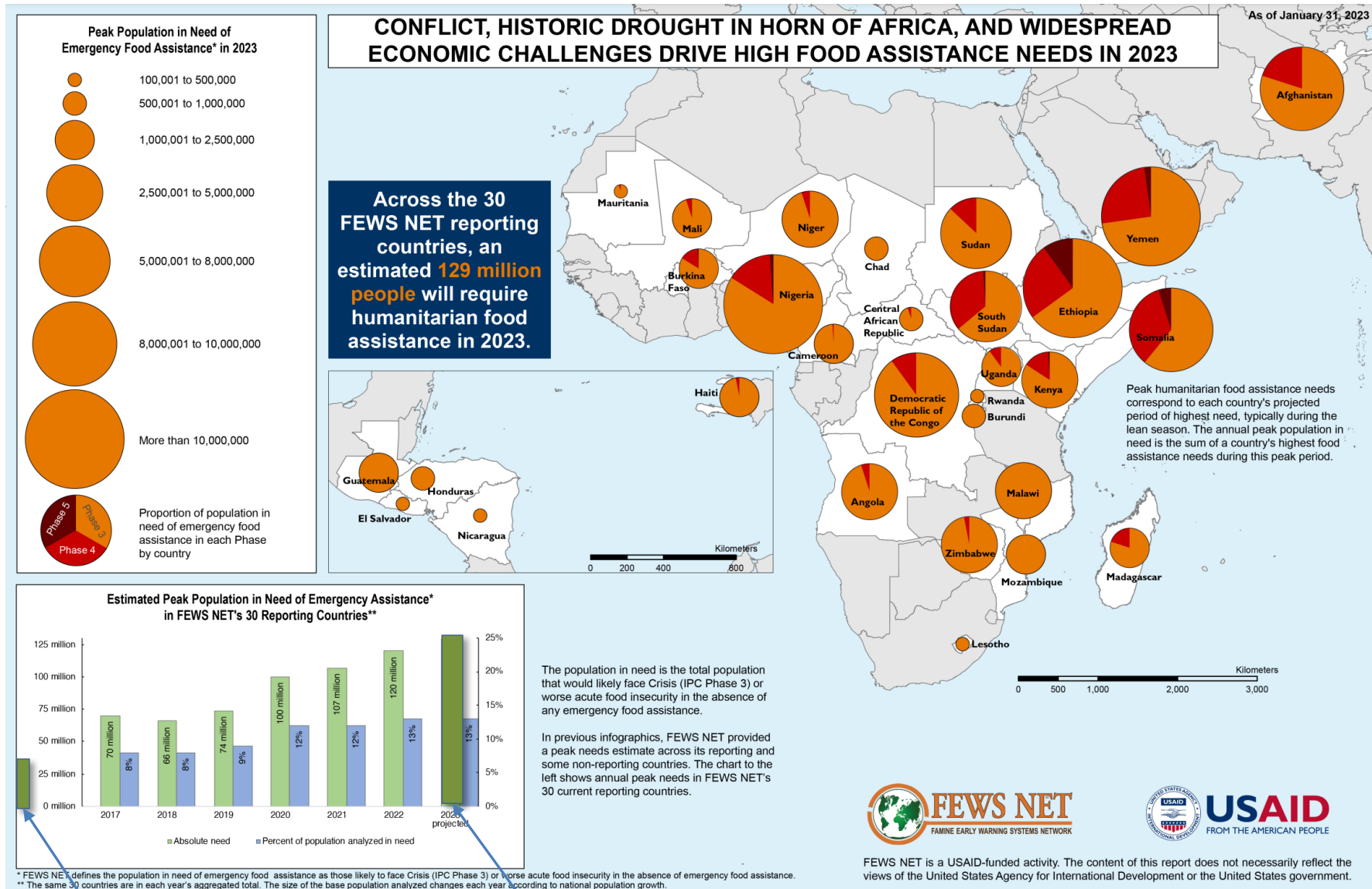
Humanitarian Earth Scientists



Climate
Hazards
Center
UC SANTA BARBARA



Context: Increasing Food Insecurity

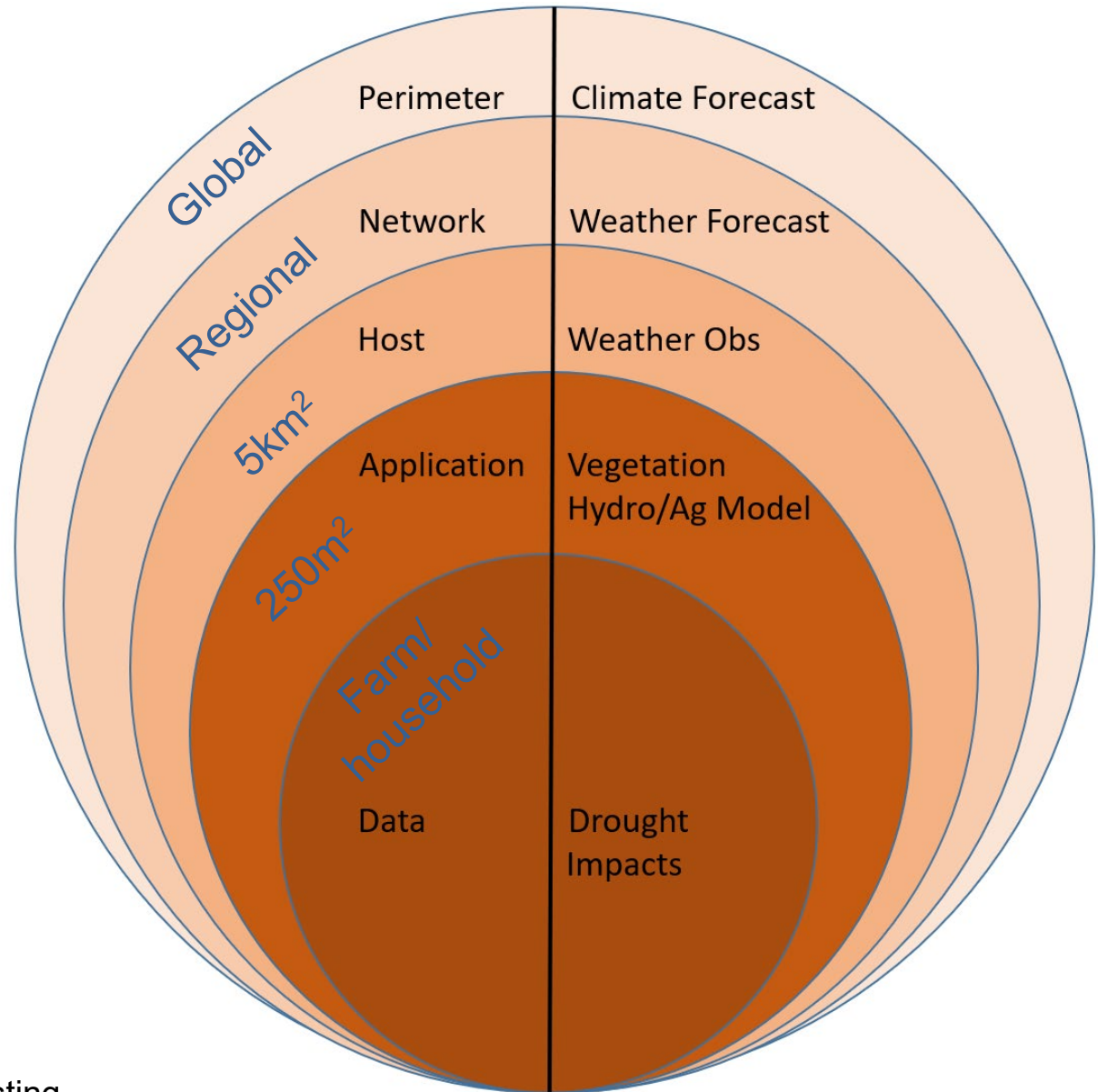


2015=35 million

2023=134 million

Humanitarian Earth System Science

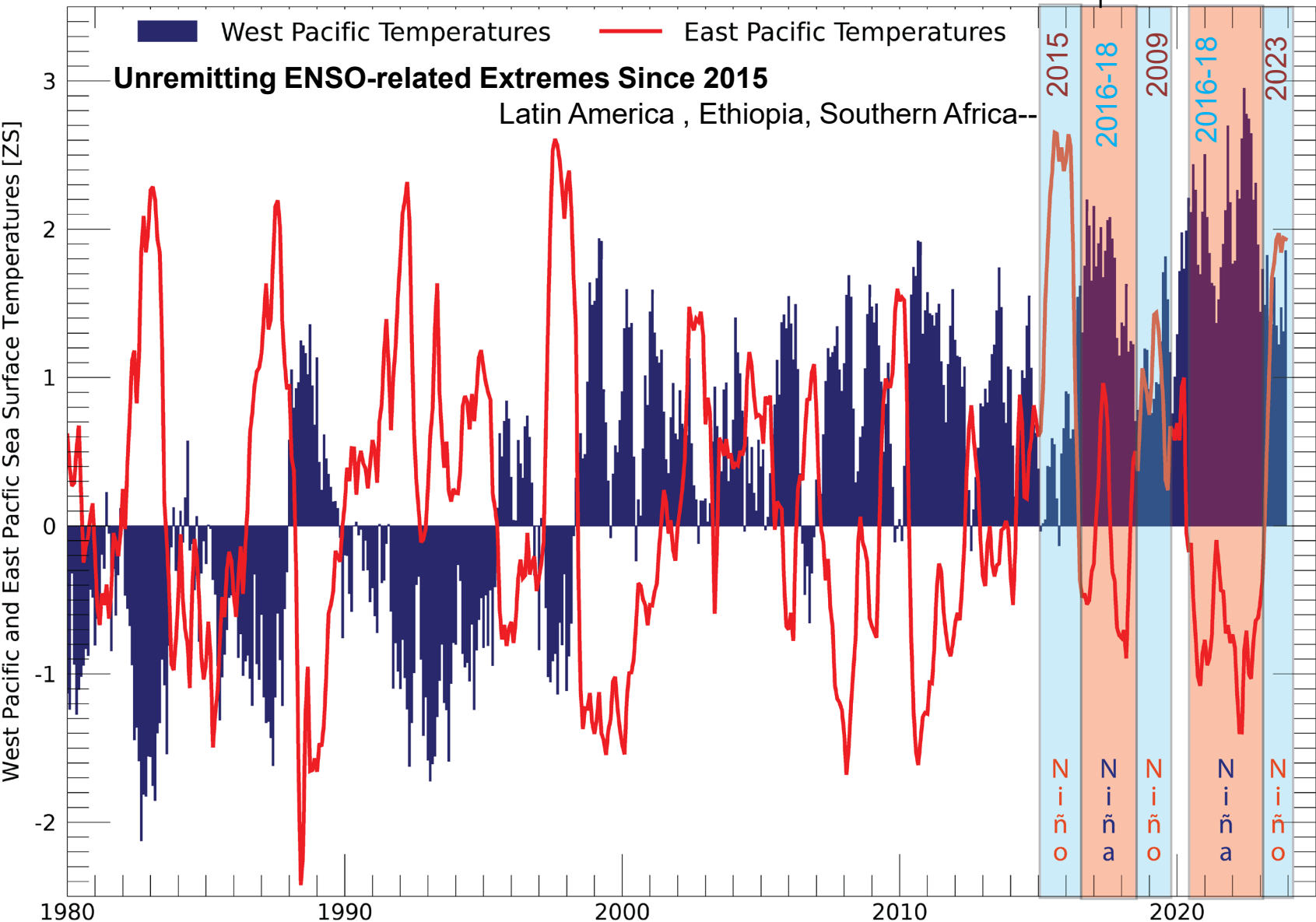
Defense In Depth/Staged Early Warning Systems



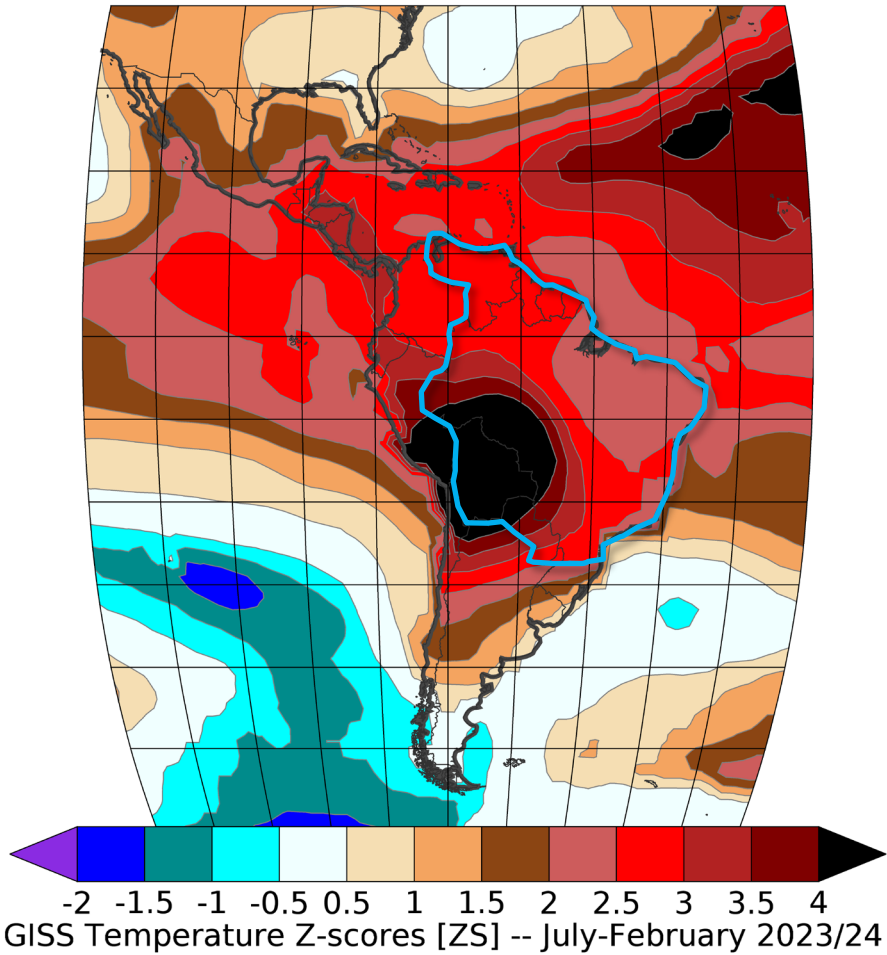
East and West Pacific Sea Surface Temperatures

Frequent but Predictable Droughts in East Africa
Driven by a Walker Circulation Intensification

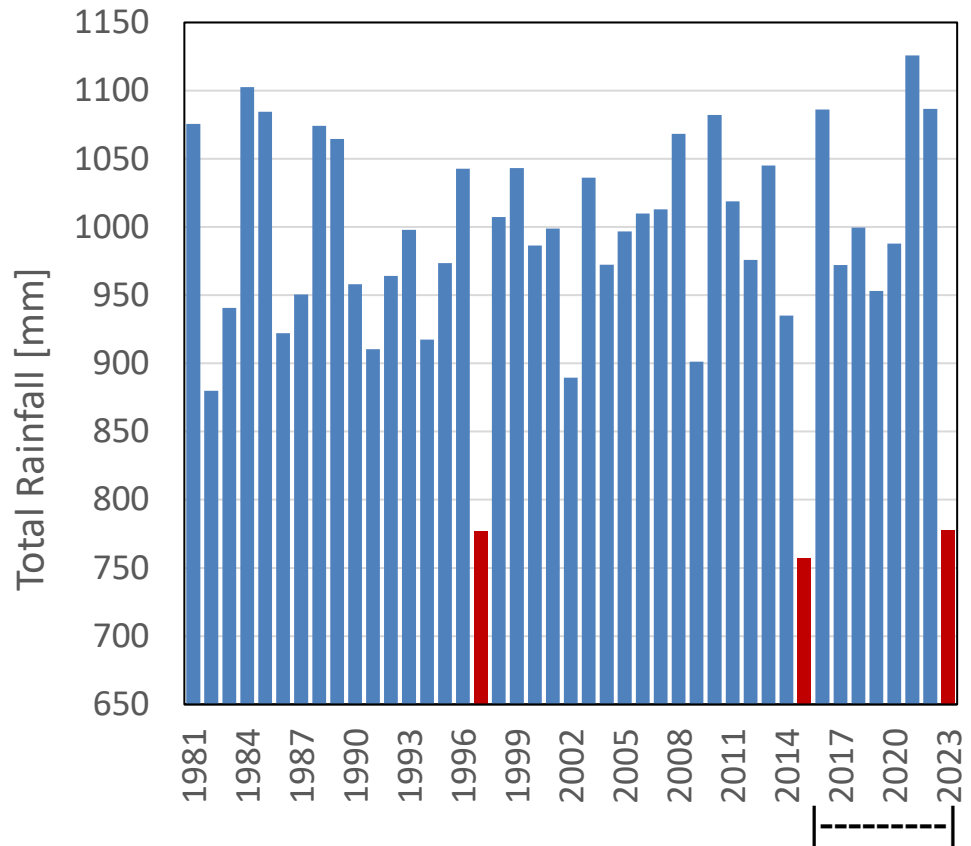
Afghanistan/East Africa/Western US



Exceptional July-February Drought and Heat



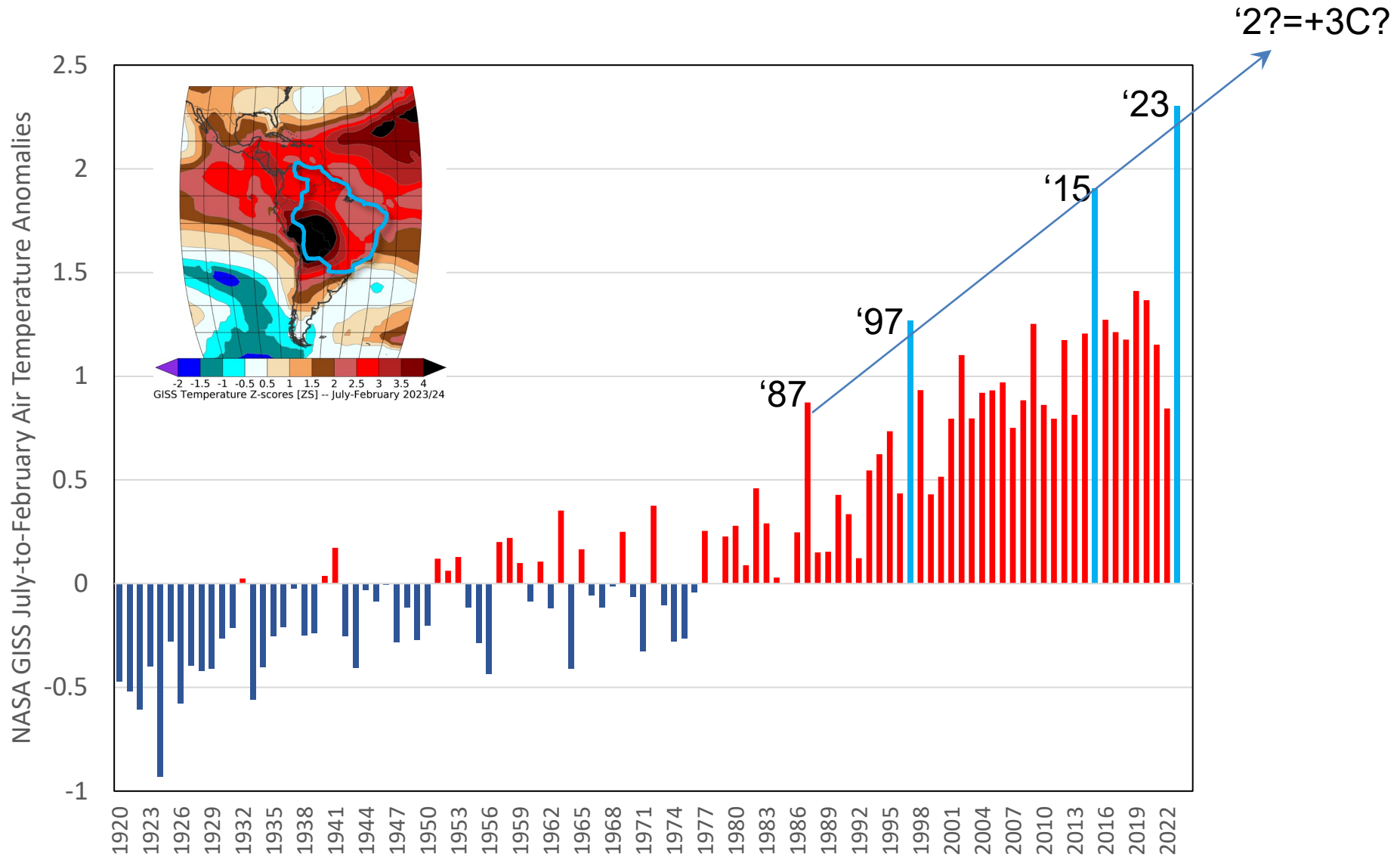
NE South America July-February CHIRPS Rainfall



2 extreme droughts in 9 years

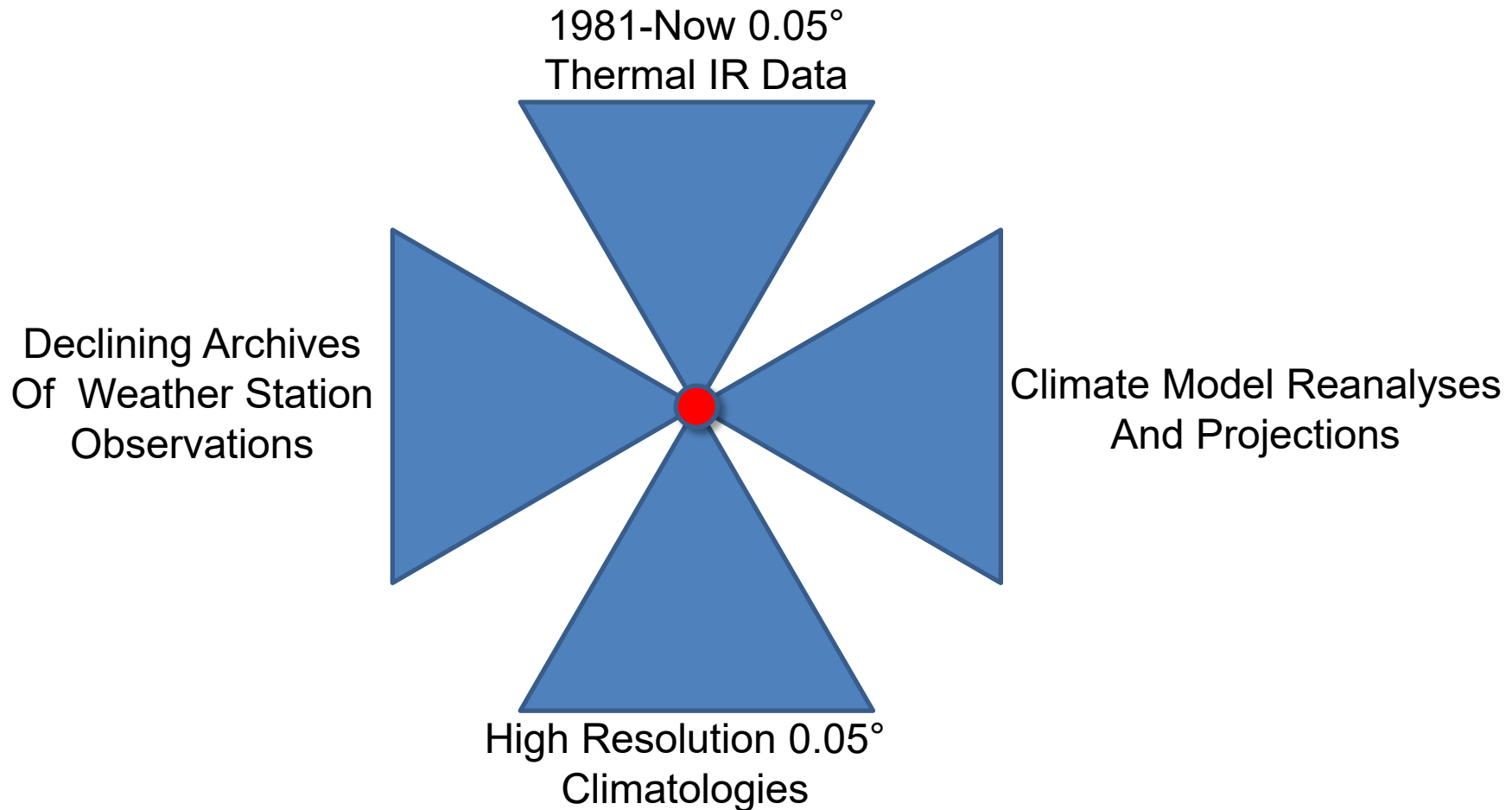
1 extreme drought in 34 years

Exceptional July-February Air Temperatures



Opportunities For Earth Science Data Harmonization

('stacking' can help overcome data poverty)

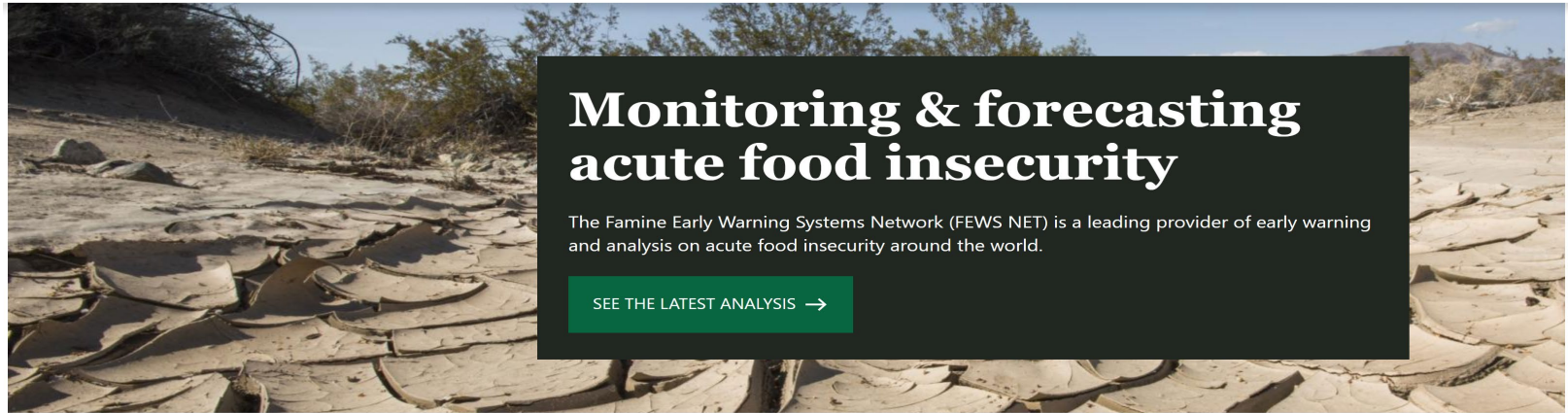


Precipitation: [CHIRPS](#), [CHIRPS-GEFS](#)
>4,500 citations

Temperature: CHIRTS [monthly](#), [daily](#)
~150 citations

We are much better at tracking impacts of precipitation deficits

Example of Effective Harmonization: FEWS NET



Markets and Trade



Agroclimatology



Livelihoods

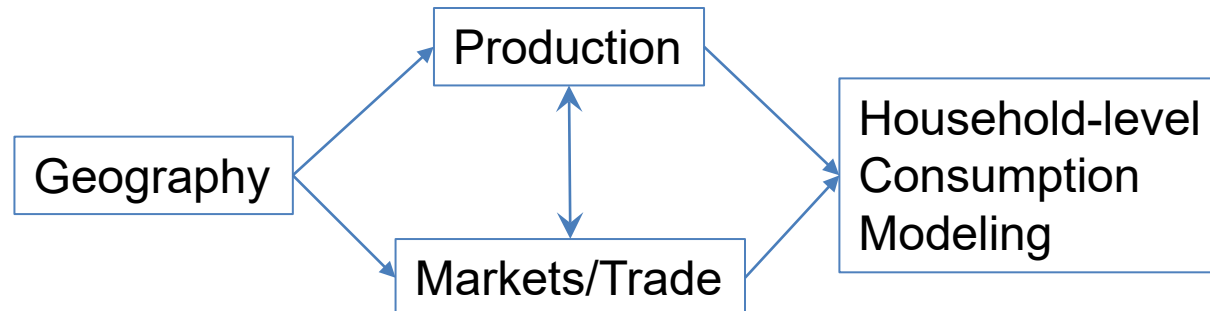


Nutrition



Conflict

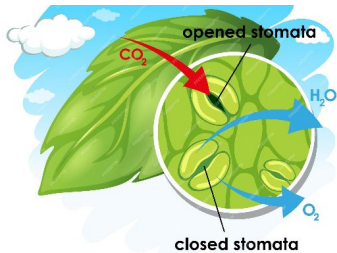
Livelihoods Zone Diamond – Household Level Food Economics



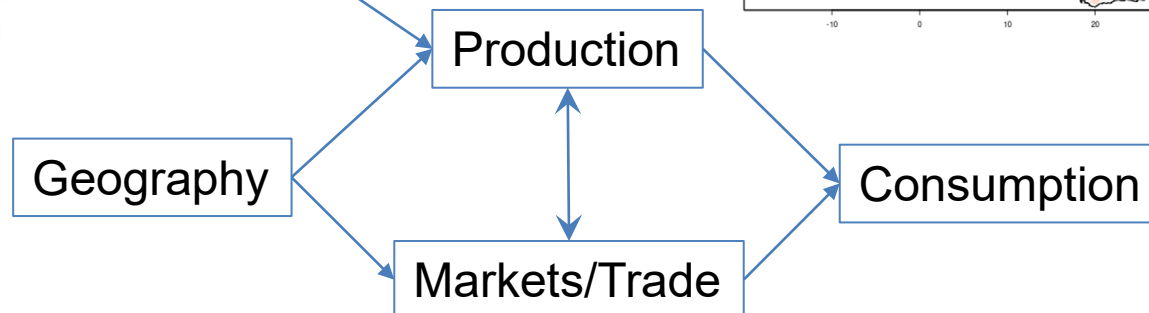
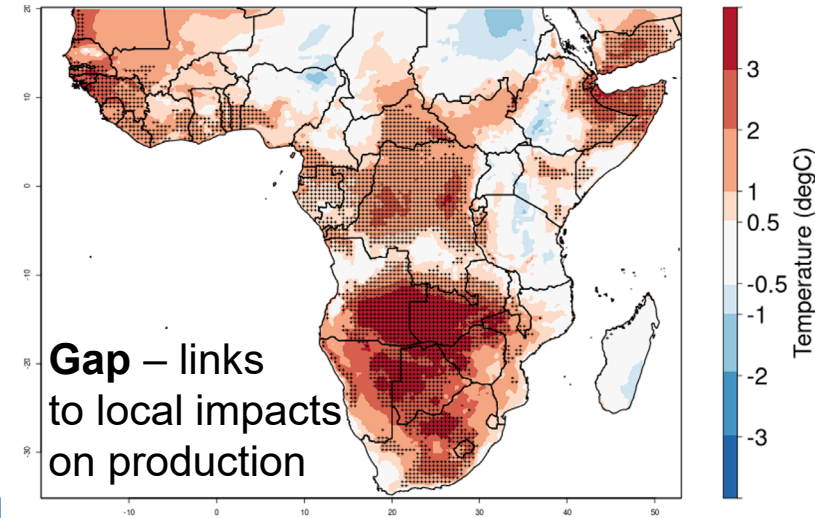
An Earth System Science Framework For Temperature-related Shocks in a Warming World?

Increasing Climate Volatility + Warming Temperatures
Increasing Saturation Vapor Pressure

Rainfall Deficits +
Increasing Evaporative Demand =
More Intense Droughts



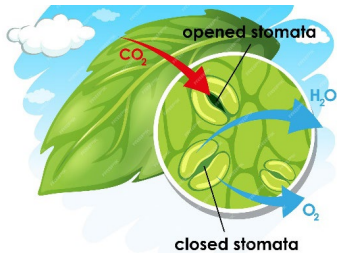
2024 average Tmax anomaly and locations > 95th percentile



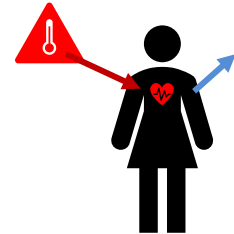
An Earth System Science Framework For Monsoon Shocks in a Warming World?

Increasing Climate Volatility + Warming Temperatures
Increasing Saturation Vapor Pressure

Rainfall Deficits +
Increasing Evaporative Demand =
More Intense Droughts



Humid Heat Shocks Impact
Labor and Health



Geography

Production

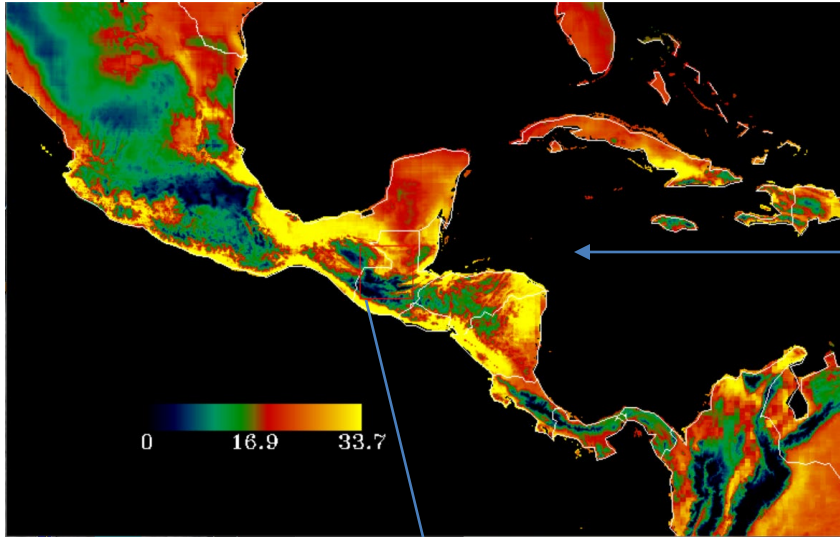
Markets/Trade

Stunting, Wasting, Low Birthweight,
Labor Productivity, Energy Costs, ...

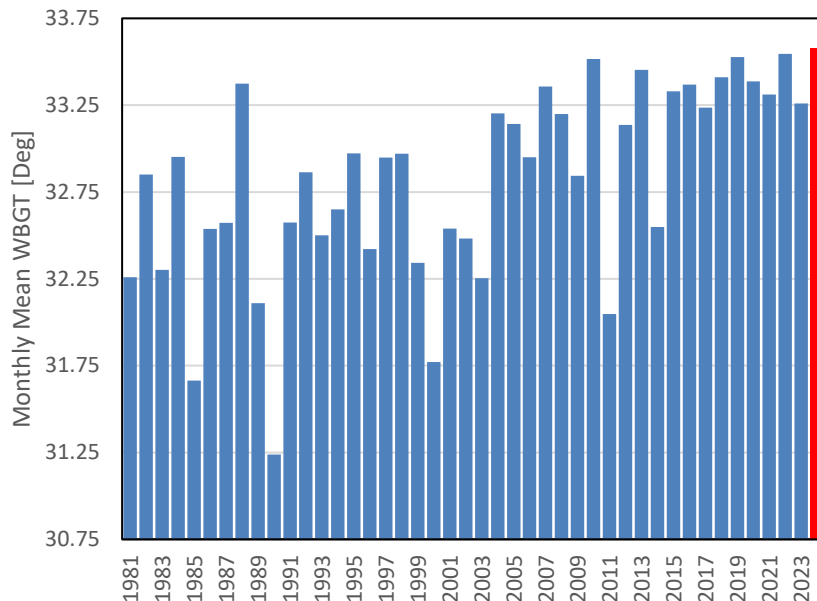
Consumption

Under-represented Risk Modality: Humid Heat

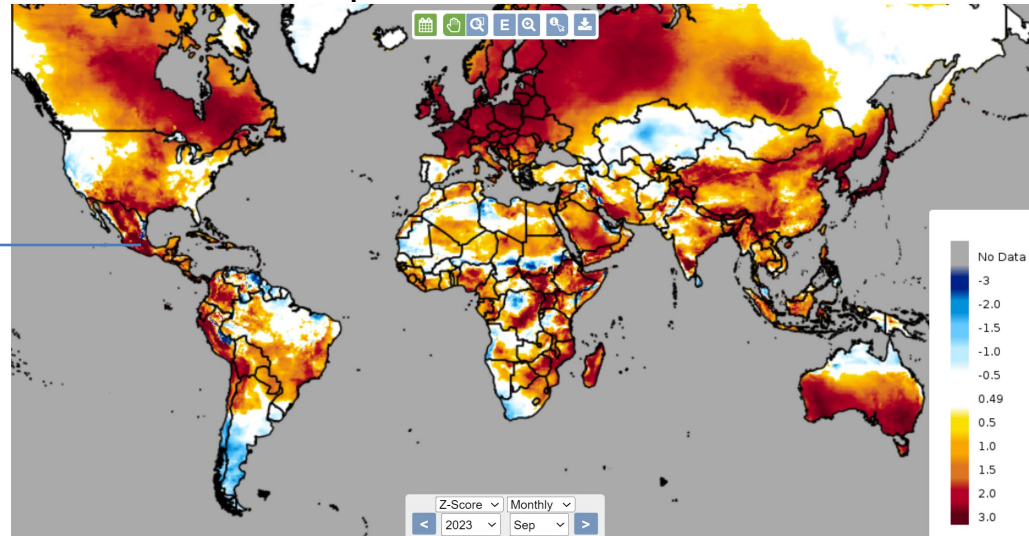
September 2023 WBGT



Coastal Guatemala September WBGT



September 2023 CHIRTS-ERA5 Standardized Wet Bulb Globe Temperature Anomalies



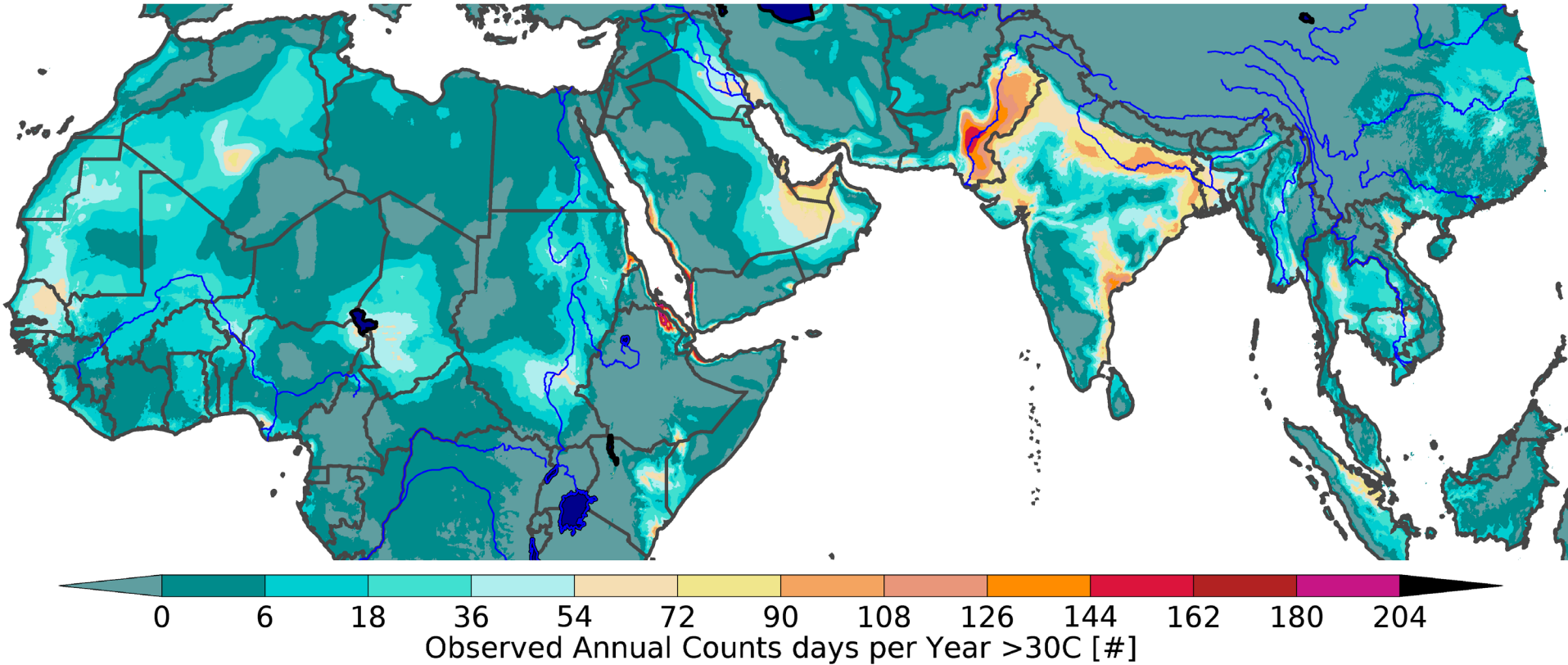
Gap: Stunting, Wasting, Low Birthweight, Labor Productivity, Energy Costs, ...

We currently have a limited ability to assess **local** impacts on people and households



Mario – “It’s been really hot in Guatemala”

Observed 1981-2016 Annual Days warmer than 30C

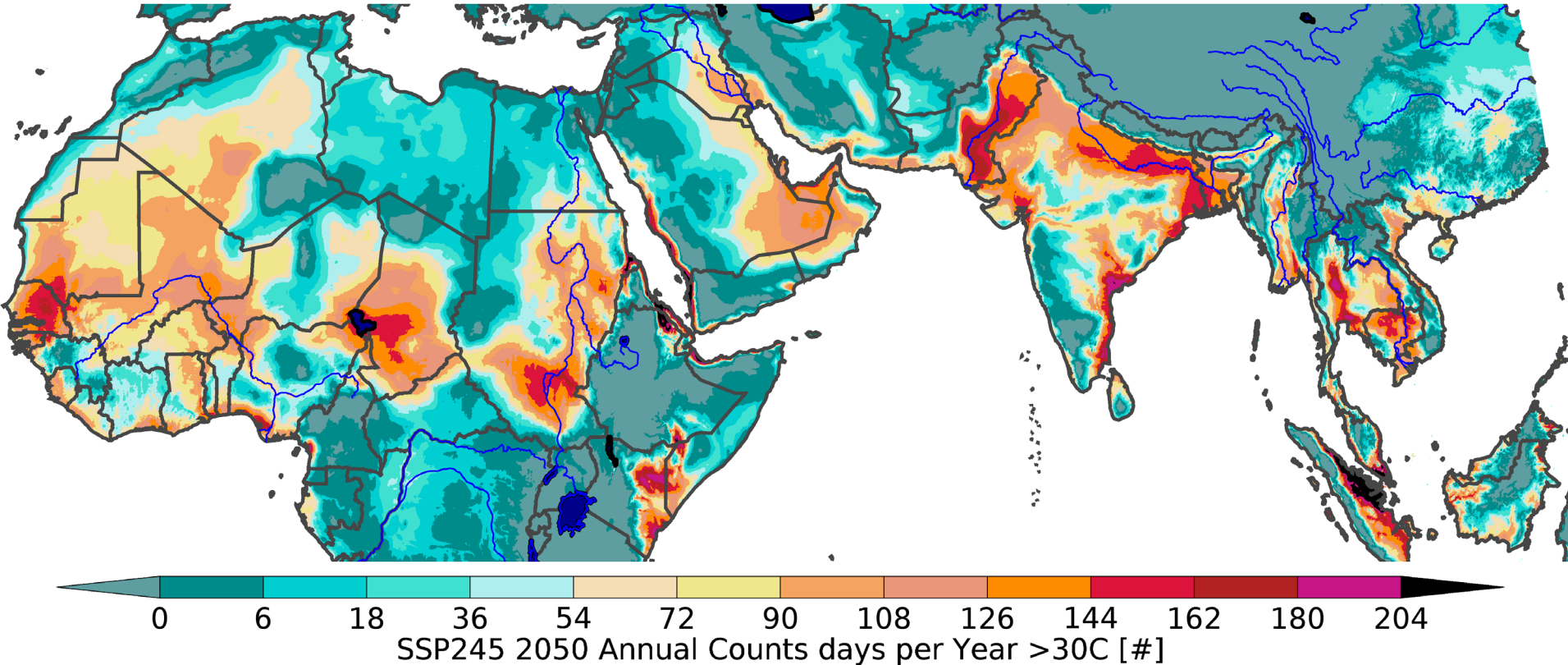


Data Descriptor | [Open access](#) | [Published: 01 March 2024](#)

High resolution climate change observations and projections for the evaluation of heat-related extremes

[Emily Williams](#) , [Chris Funk](#) , [Pete Peterson](#) & [Cascade Tuholske](#)

SSP245 2050 Annual Days warmer than 30C



Large Impacts on Stunting, Wasting, Low Birthweight, Labor Productivity, Energy Costs, ...

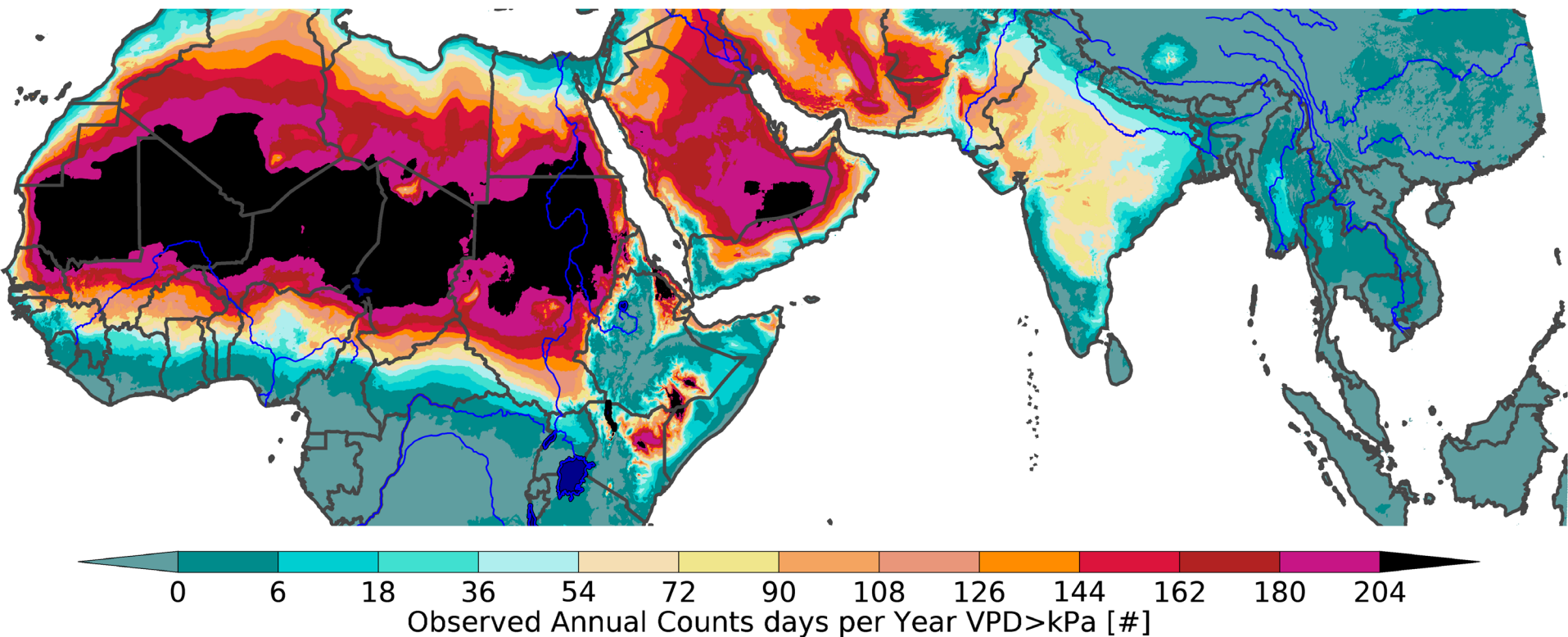
Coastlines and major rivers Senegal, Niger, Nile, Tigris, Euphrates, Indus, Ganges, Brahmaputra, Irrawaddy, Salween, Mekong

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Observed 1981-2016 Annual Days with VPD > 3kPa

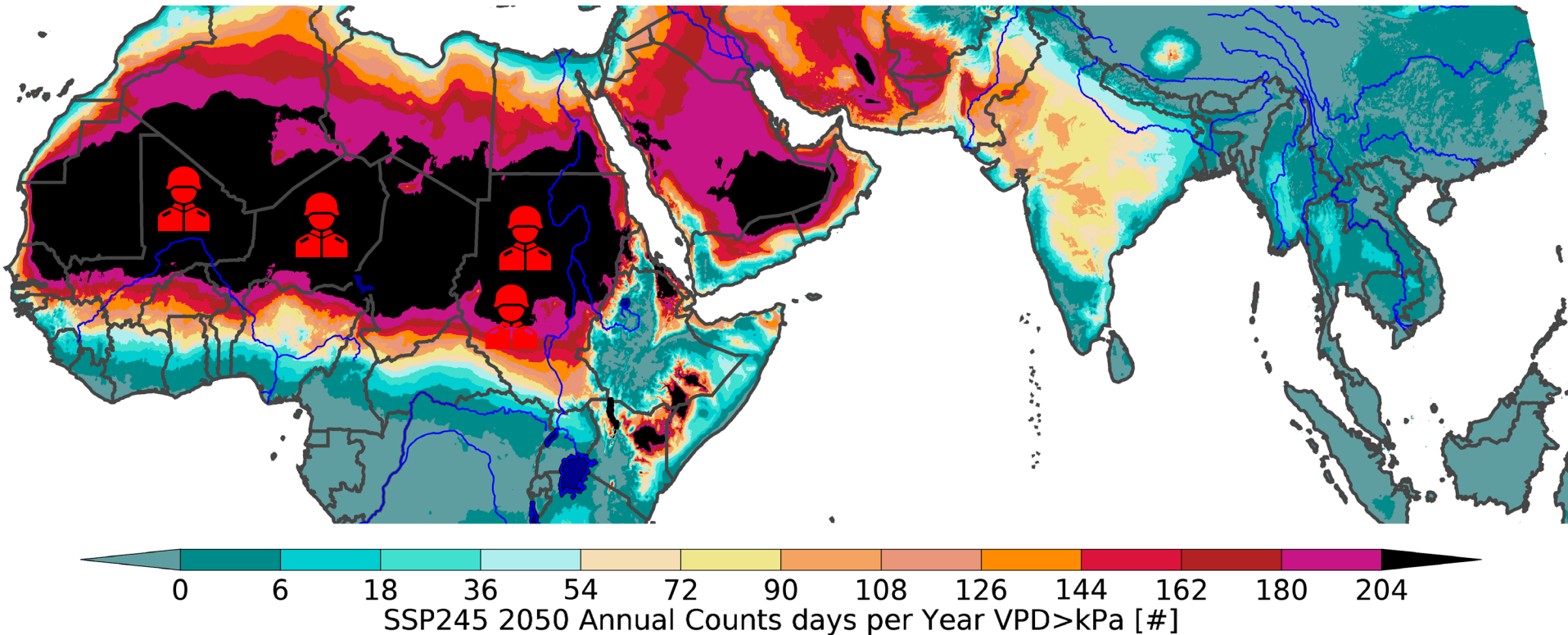


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SSP245 2050 Annual Days with VPD > 3kPa



Desiccated rangelands – More Rapid Senescence → longer dry seasons

Decreased crop production – Increased VPD early in the season,
more intense dry spells

Reduced water availability

Semi-arid regions and seasons hit very hard, many failing states

Data Descriptor | [Open access](#) | [Published: 01 March 2024](#)

**High resolution climate change observations and
projections for the evaluation of heat-related extremes**

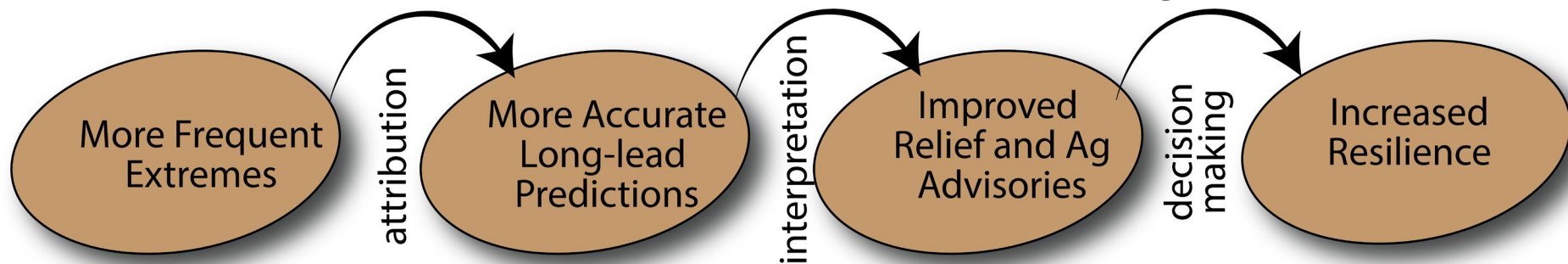
[Emily Williams](#) ✉, [Chris Funk](#) ✉, [Pete Peterson](#) & [Cascade Tuholske](#)

Conclusions

- Carefully stacking multiple sources of information can help overcome data scarcity.
- Groups like FEWS NET demonstrate that effective cross-disciplinary, cross-scale harmonization is possible.
- More work needs to be done to monitor, anticipate, understand and mitigate temperature related shocks.
- An effective Earth Science/Climate Hazard assessment of climate change sees more energy moving through the system, not just a slow change in mean temperatures.

Extra Slides

BUT ... Climate Extremes Offer Opportunities for Prediction and Proactive Intervention ... If we work together



Thanks!

Attribution Informs Prediction

Trust and Understanding Empowers Early Action



This is the comparison for the progress; 28th Feb to 29 March 2023 · 172 KB · [View full-size](#) · [Download](#)

Example of Effective Harmonization: Crop Monitor

