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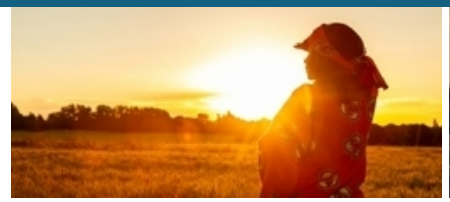
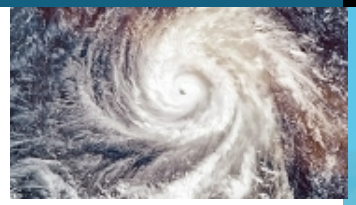
Sandia National Laboratories

Projected climate security risks in the arctic motivate advances in situational awareness





World Conference on Climate Change and Sustainability

Frankfurt, Germany September 1, 2022

PRESENTED BY

Rob Leland, Sandia National Laboratories

Diana Bull, Richard Garrett, Elizabeth Kistin Keller, Daniel Krofcheck, Howard Passell, Natalie Prittinen

Support from Sharon DeLand, Diana Hackenburg, Mary Ann Córdova, and Doug Prout

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SUMMARY MESSAGES

- Climate change is occurring and is significantly concentrated in the Arctic
- Climate change is a global security challenge
- A broad set of activities and advances are required to address these global security challenges
- **Situational awareness will play a foundational role in characterizing the activities and advances needed to respond effectively to climate change in the Arctic and more broadly**

"No nation can find lasting security without addressing the climate crisis"

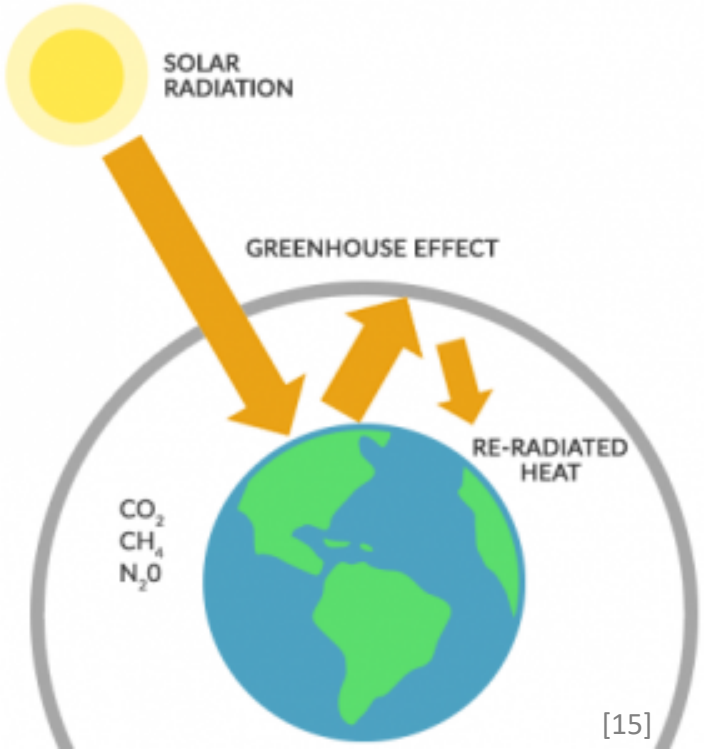
- U.S. Secretary of Defense Austin, April 2021 [2]

IPCC: HUMAN-CAUSED CLIMATE WARMING "ESTABLISHED FACT"

Society's influence on climate change from the IPCC's Assessment Reports (ARs)

"**Consistent**"	"**Discernible**"	[Likely]	"**Very Likely**"	"**Clear**"	"**Established fact**"
1990, AR1[3]	1996, AR2[4]	2001, AR3[5]	2007, AR4[6]	2014, AR5[7]	2021, AR6[8]

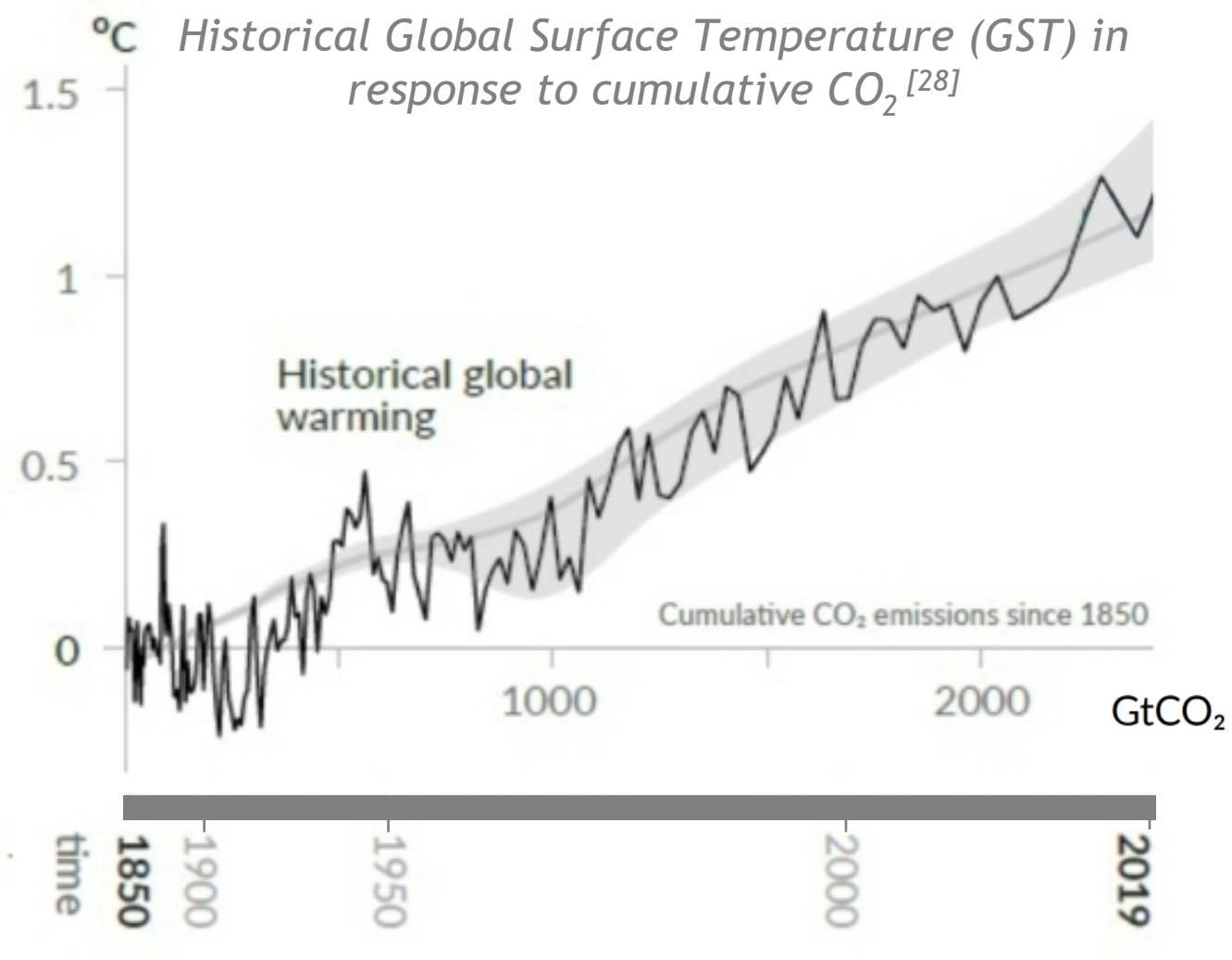
- Global average temperature is **1.09°C** [17] elevated; the ocean has increased by **0.88°C** [18] and land by **1.59°C** [18]
- Cumulative amounts of greenhouse gasses, GHGs, (e.g., CH_4, N_2O, and CO_2) increase global temperatures[11]
- "Human driven warming is nearly irreversible on time frames of 1000 years or more[12, 13] "[14]



Greenhouse effect established in 1896 by Arrhenius[16].

TEMPERATURE ANOMOLY LINEARLY RELATED TO CUMULATIVE CO_2

Historical Global Surface Temperature (GST) in response to cumulative CO_2 [28]



- Paris Accord aspiration: Keep global temperature well below an increase of 2°C[29]
- Arctic now assessed to be warming at 4 times the average rate[87]

CLIMATE ATTRIBUTED IMPACTS ARE ALREADY SIGNIFICANT

2021 Heat waves[22]

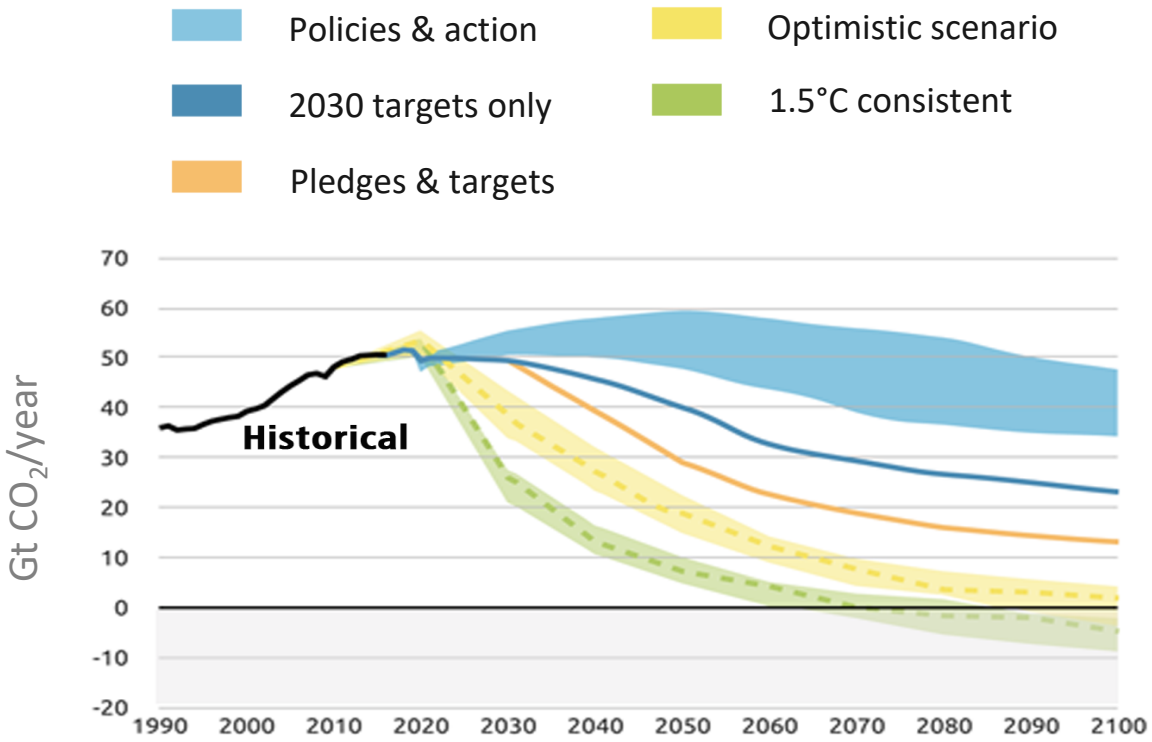
2021 Flooding in Germany[23]

2021 Hurricane Harvey[24]

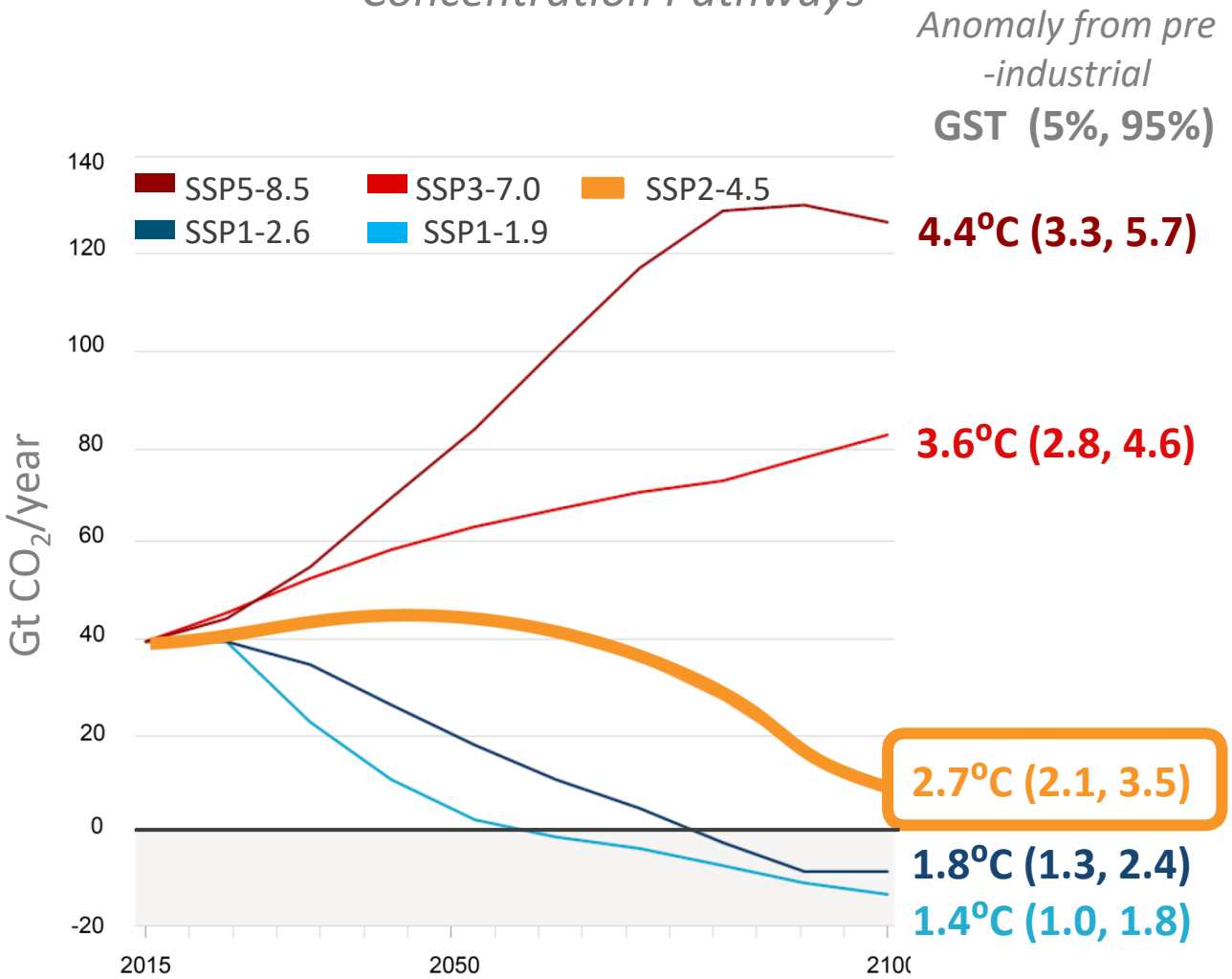
2020 Australian wildfires[25]

LIKELY FUTURES THIS CENTURY WILL EXCEED 2.0°C

Paris Accord relevant yearly emission projections[33]

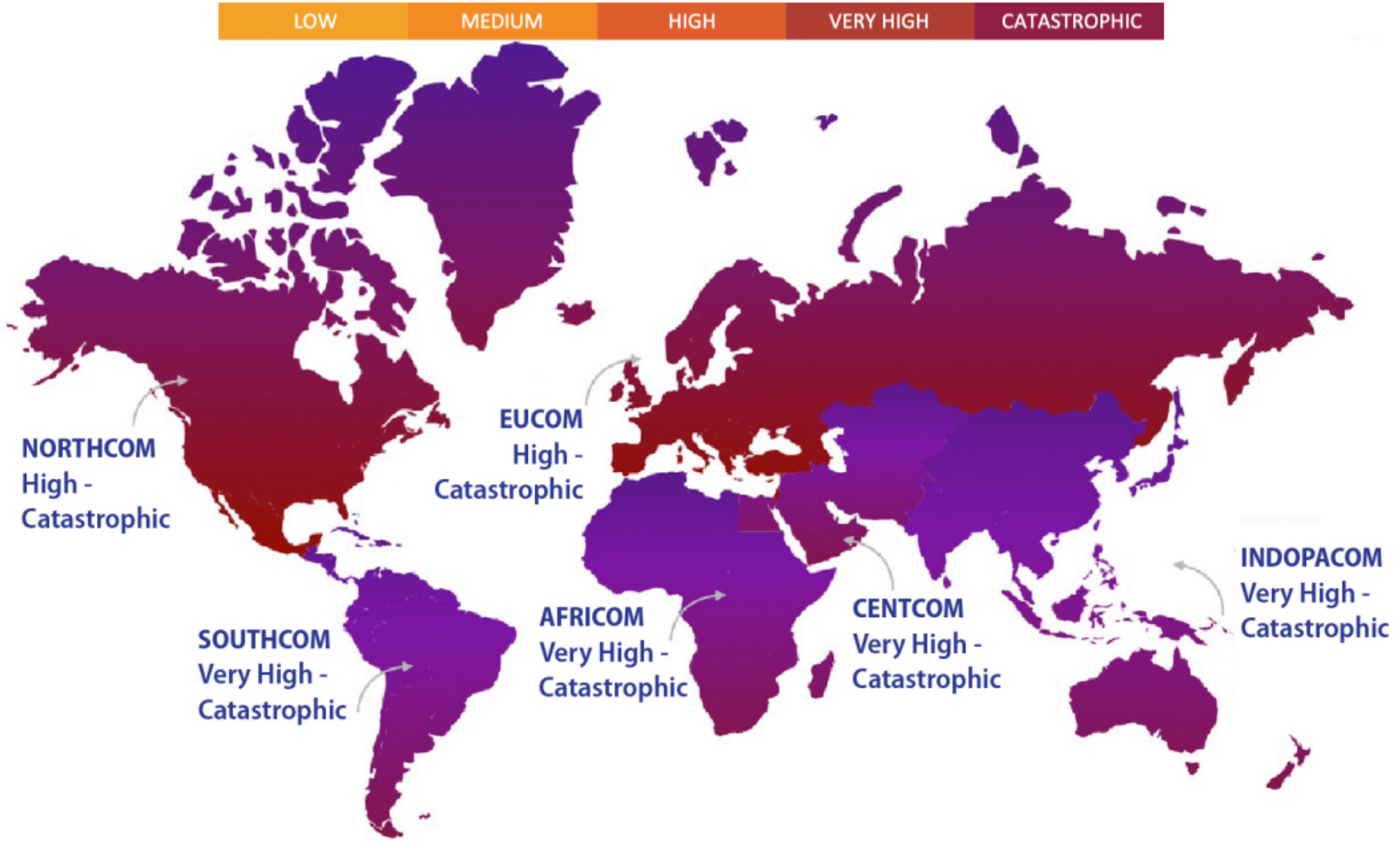


Emission Scenarios: Projections of the Representative Concentration Pathways[34]



CLIMATE CHANGE IS A GLOBAL SECURITY CHALLENGE

Climate Security Threat Profile in 2050–2100 under 2–4°C of Warming [27]



Source: U.S. National Security, Military and Intelligence Panel on Climate Change/Center for Climate and Security

DIMENSIONS OF THE CLIMATE SECURITY CHALLENGE

Awareness

Establish environmental and socio/political situational awareness to support risk analysis and prioritization of efforts

Adaptation

Reduce climate impacts affecting both human and natural systems

Mitigation

Decrease the anthropogenic sources contributing to climate change

Intervention

Undertake deliberate, large-scale actions to modify the Earth's climate system

CLIMATE RISK ARISES FROM SYSTEM INTERACTIONS

- Non-climate stressors are as important, dynamic, and regionally varied as climatic ones in defining climate risk

- With little adaptive capacity, climatic risks fall disproportionately on the most vulnerable populations

IPCC Risk Analysis Framework[26]

Climate Generated Risks

Human Health

Ecosystem Health

Infrastructure

Operations

Economy

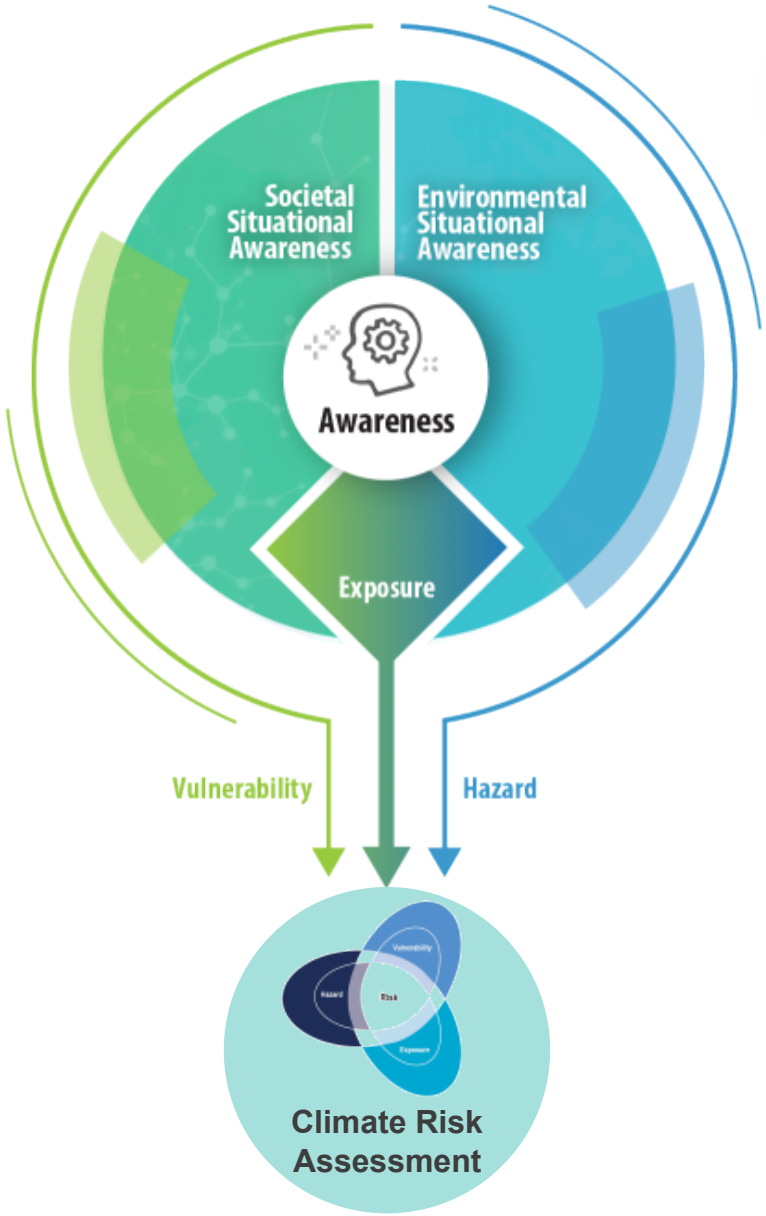
Equality

Governance

Migration

Conflict

AWARENESS: EVALUATE THE COUPLED CLIMATE-HUMAN SYSTEM TO SUPPORT RISK ANALYSES & PRIORITIZE EFFORTS



Awareness is achieved by accomplishing these three tasks:

Monitor – collect observations to enhance knowledge of and projection accuracy for climate and human conditions

- Data-fusion frameworks
- Observational relationships

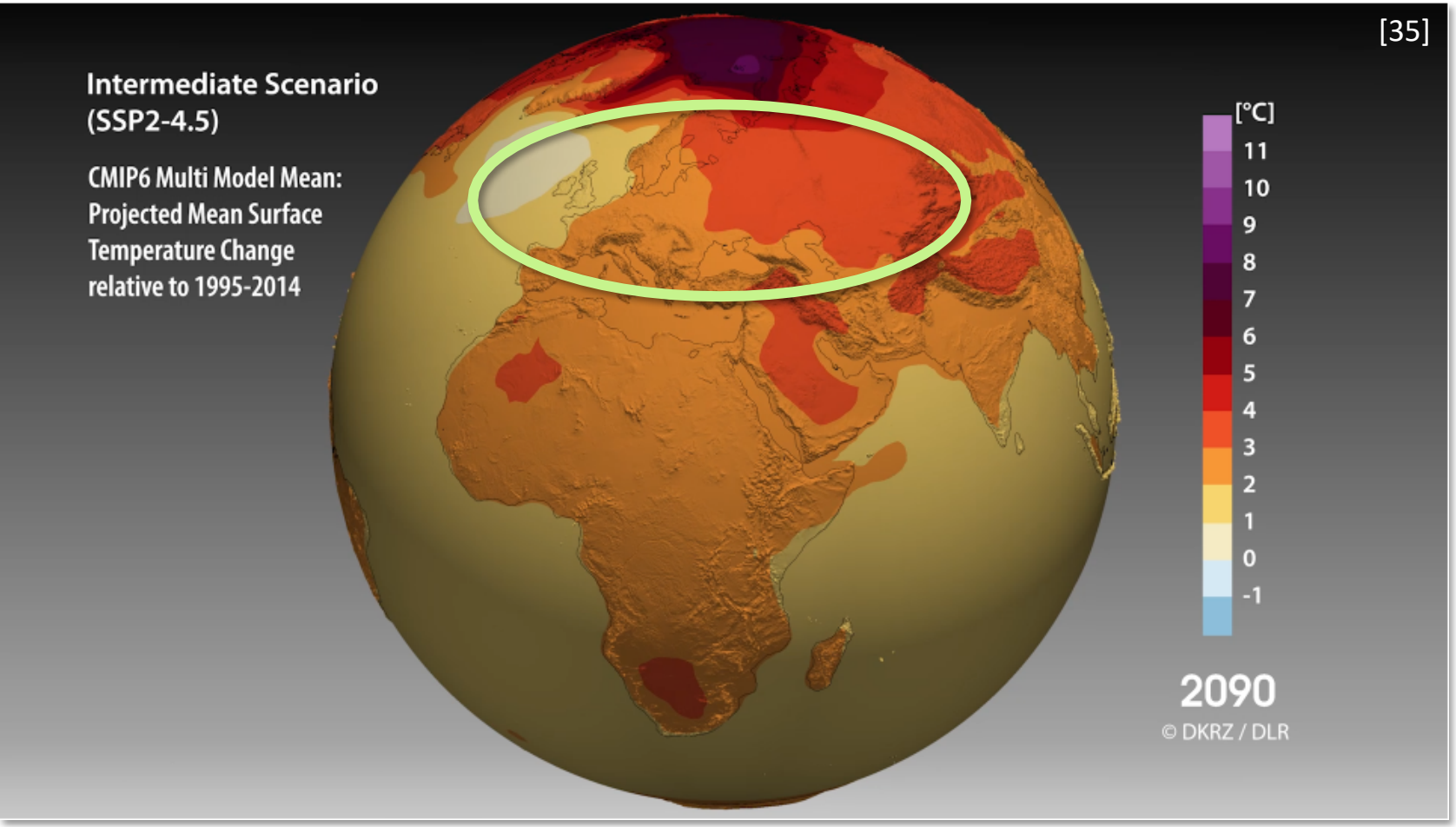
Project – model climate and human systems to anticipate future impacts and response efficacy

- Predictive accuracy
- Intelligible outcomes

Assess – establish climate risk and empower decision-makers with response options

- Multisector tools coupled with climate models[47]
- Multi-objective system analyses

AWARENESS IN THE ARCTIC

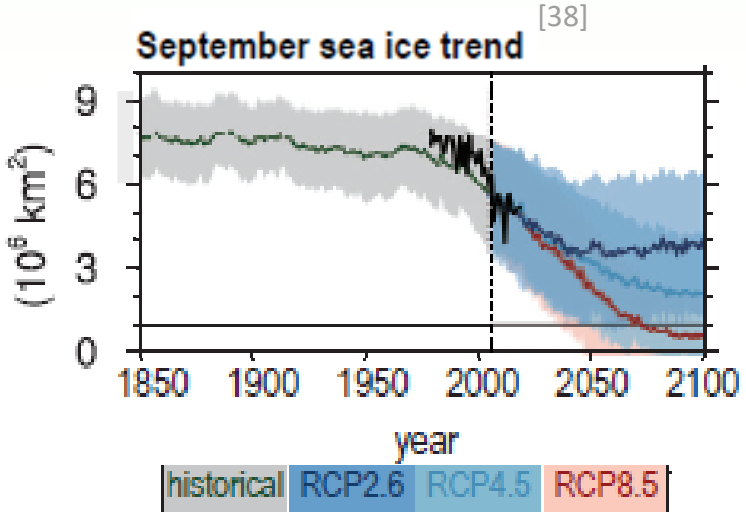


ARCTIC CONDITIONS IN AN +2.7°C WORLD IN 2100

Climate Conditions

- +5.8°C average surface temperature[36]
- Permafrost degradation over an area larger than China[47, 88,91]
- By 2100 more than one length of soccer field eroding per yr. into the ocean along entire Arctic coastline[48]
- **~75% reduction in summer sea ice [38]**

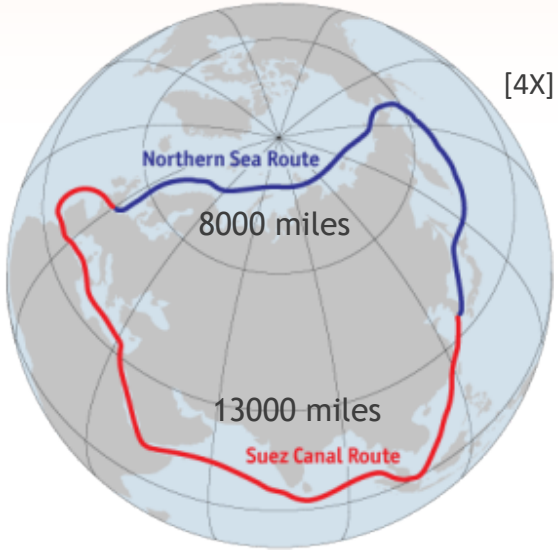
[38]



Societal Conditions

- ~50% indigenous population[39]
- Over $20 trillion in natural resources[40,41]
- **New trade routes (40% shorter) to connect 90% of world's international trade [42,43]**
- Competing capability development across Arctic region [44,45]
- $4.2 billion in projected cumulative expense for climate-related damage to AK public infrastructure[37]

[4X]



AWARENESS OF ARCTIC CLIMATE

Needed Advances in Awareness

Monitor: Terrestrial & submarine permafrost, Greenland ice sheet & sea ice, Atlantic deep water formation, etc.

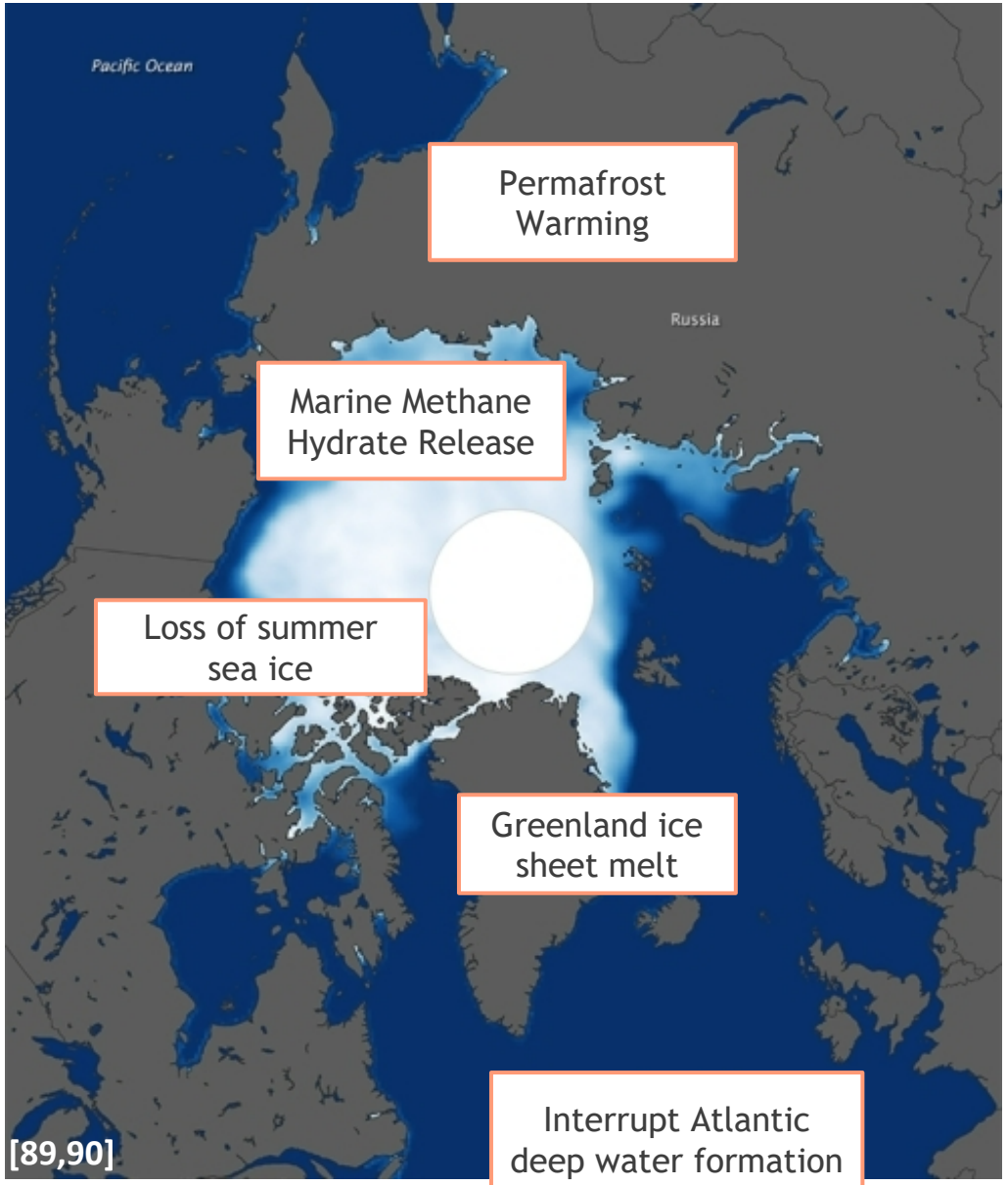
Project: Permafrost carbon dynamics, soil thermal dynamics, wetting between land & ocean, etc. in models

Assess: Reduce uncertainty in characterization of climatic hazard and high-latitude transitions

To Better Characterize Climate Risk

Natural feedback loops have potential to shift climate trajectory far beyond anthropogenic-only estimates

- Releasing GHGs pushes mitigation efforts off track
- Melting Greenland ice sheet raising global sea levels
- Weakening of Atlantic Meridional Overturning (AMO) Circulation altering N. American and European weather



AWARENESS OF THE GEOPOLITICAL LANDSCAPE

Needed Advances in Awareness

Monitor: Infrastructure development, transportation, population movement, etc.

Project: Economic dynamics, needed technological advances, resource demand, etc.

Assess: Develop multi-sector tools capable of capturing the system dynamics that influence geopolitical relationships

To Better Characterize Geopolitical Risks

Increased protection of sovereign borders:

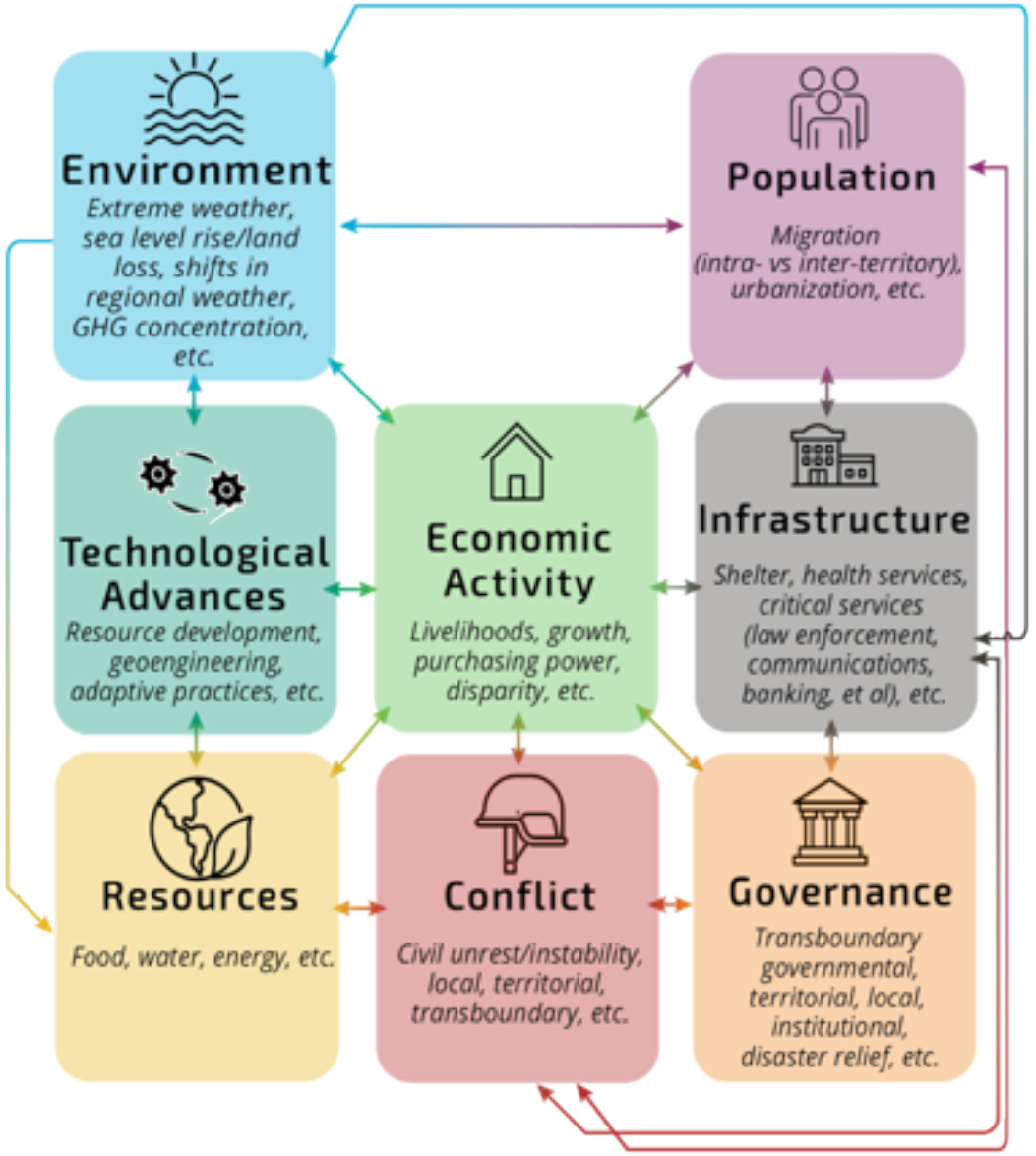
- Active ports of entry and centers of trade
- Expanded economic and military activity

Increased geopolitical tensions:

- Access to natural resources (e.g., minerals, food)
- Newly defined borders

New diplomatic considerations

Arctic System Interconnection Diagram [92]



AWARENESS FOR LIFESTYLE AND EQUITY IMPACTS

Needed Advances in Awareness

Monitor: Integration of local measurements and accessibility of data

Project: Relevant scales and for culturally relevant measures

Assess: Incorporate and prioritize local objectives in system analyses to ensure equitable treatment of risk

To Better Characterize Lifestyle & Equity Risks

Threats to traditional lifestyles:

- Food security
- Transportation and infrastructure
- Cultural heritage

Equity concerns:

- Local interests highly susceptible to global preferences

Eight tribal representatives testified in 2019 about the importance of protecting the Arctic National Wildlife Refuge

ARCTIC METHANE SITUATIONAL AWARENESS, ASSESSMENT, & POLICY DIRECTIONS[36]

Key Takeaways

Arctic methane *underestimated* in current carbon budgets, yet it has significant potential to drive accelerated warming

- **Major scientific/technical gaps in measurement, monitoring & modeling capabilities**
  - Limited capability for modeling permafrost thaw & associated methane emissions
  - No integrated, strategic approach to track/predict emissions from thawing permafrost
- **Need integrated focus for science assessments, policy decisions at pan-Arctic scale**
- **Pan-Arctic collaboration is critical**
- **No direct technical solutions for mitigating permafrost methane release**
- **War in Ukraine has reduced access to critical data, information and scientific collaborations for both Russian permafrost and oil and gas operations**

Contact: Rob Leland, SNL, leland@sandia.gov

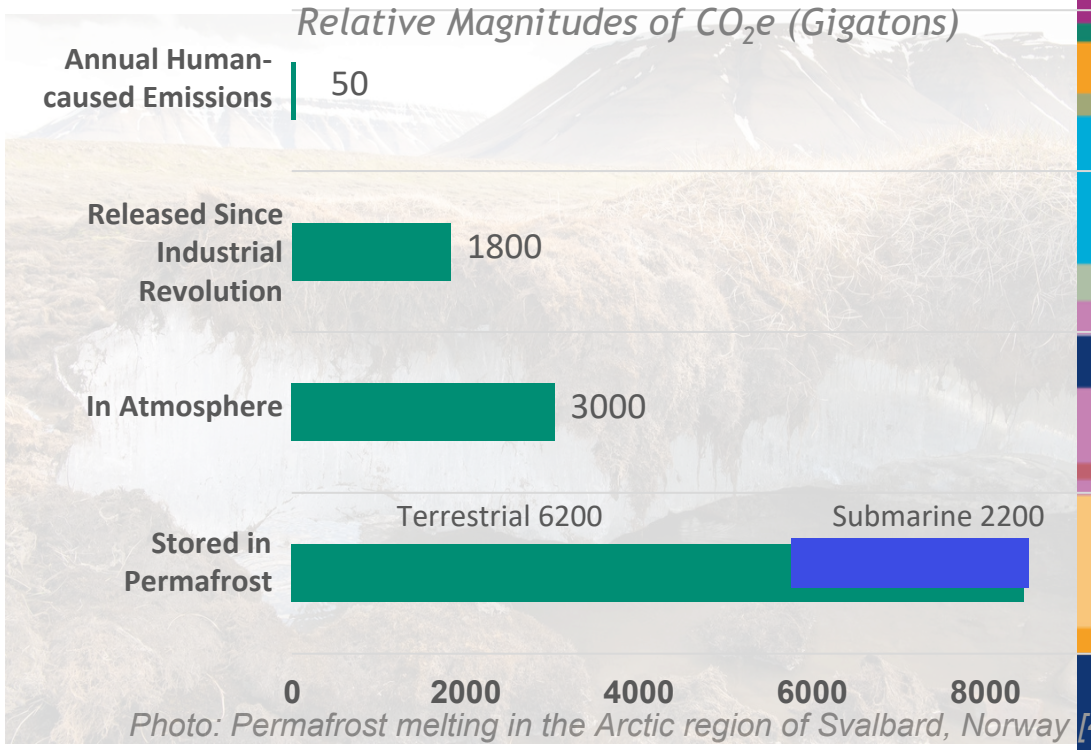


Photo: Permafrost melting in the Arctic region of Svalbard, Norway [

Wilson Center/Sandia Workshop Speakers & Participants:

- **John Holdren,** *President's former Science Advisor*
- **Rick Duke**, *Deputy Special Envoy for Climate Change*
- **David Balton,** *Executive Director, White House Arctic Executive Steering Committee*
- **Mike Sfraga,** *Chair, U.S. Arctic Research Commission*
- Indigenous communities
- International representatives from Canada, Iceland, & Norway
- Universities
- US Federal Agencies – DOE, NASA, NOAA, NSF, State, USGS
- US Intelligence Community
- Woodwell Climate Research Center

THANK YOU, QUESTIONS.

“No nation can find lasting security without addressing the climate crisis”

- U.S. Secretary of Defense Austin, April 2021[2]

[1]

Energy &
Homeland Security

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Will need to update.

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