

# “Scene setter: Scientific research enhances DoD’s mission effectiveness in an evolving Arctic”

John Farrell  
US Arctic Research Commission  
[www.arctic.gov](http://www.arctic.gov)



# Bottom line up front

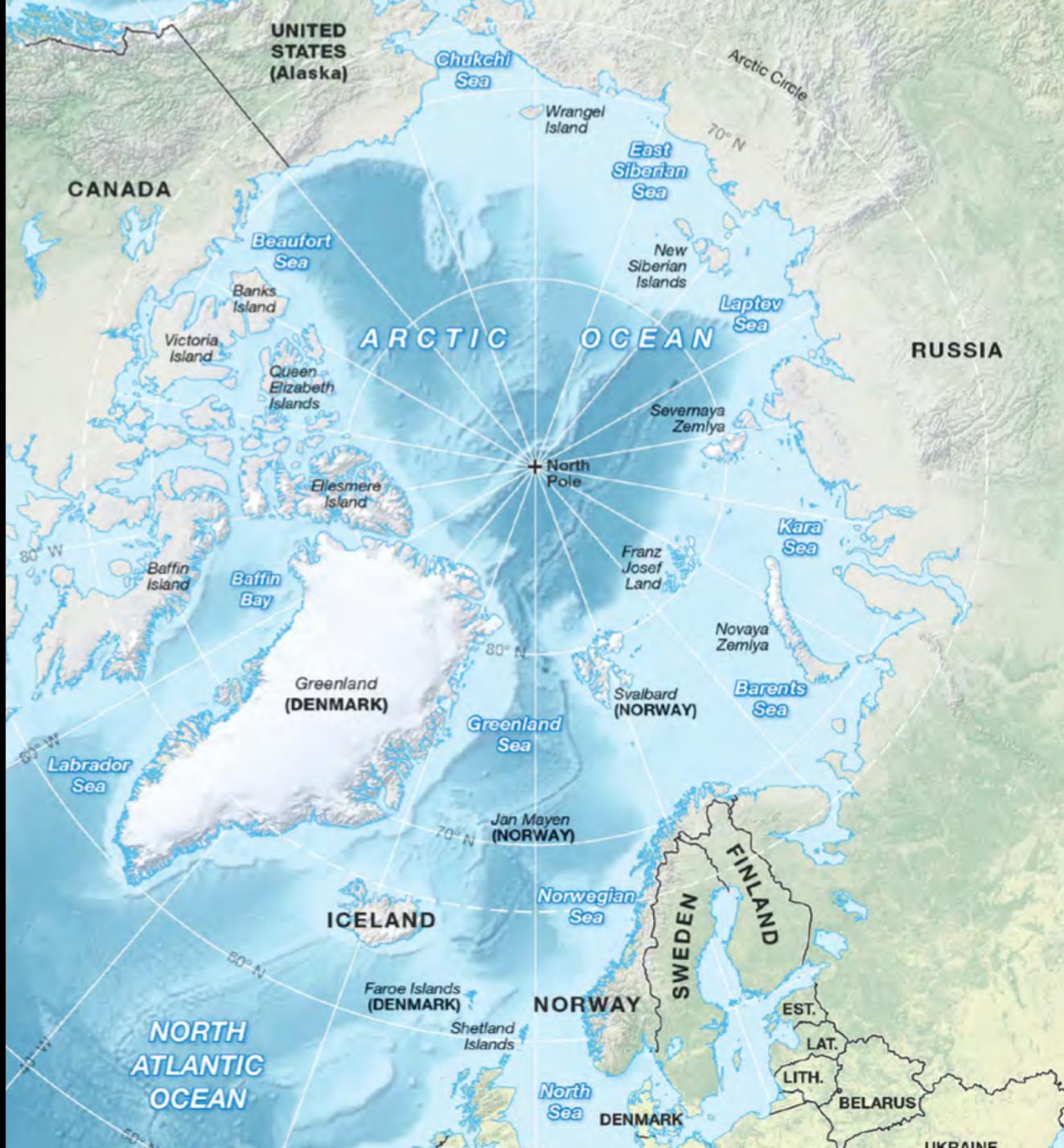
## The DoD needs a new engineering design support system for Arctic infrastructure

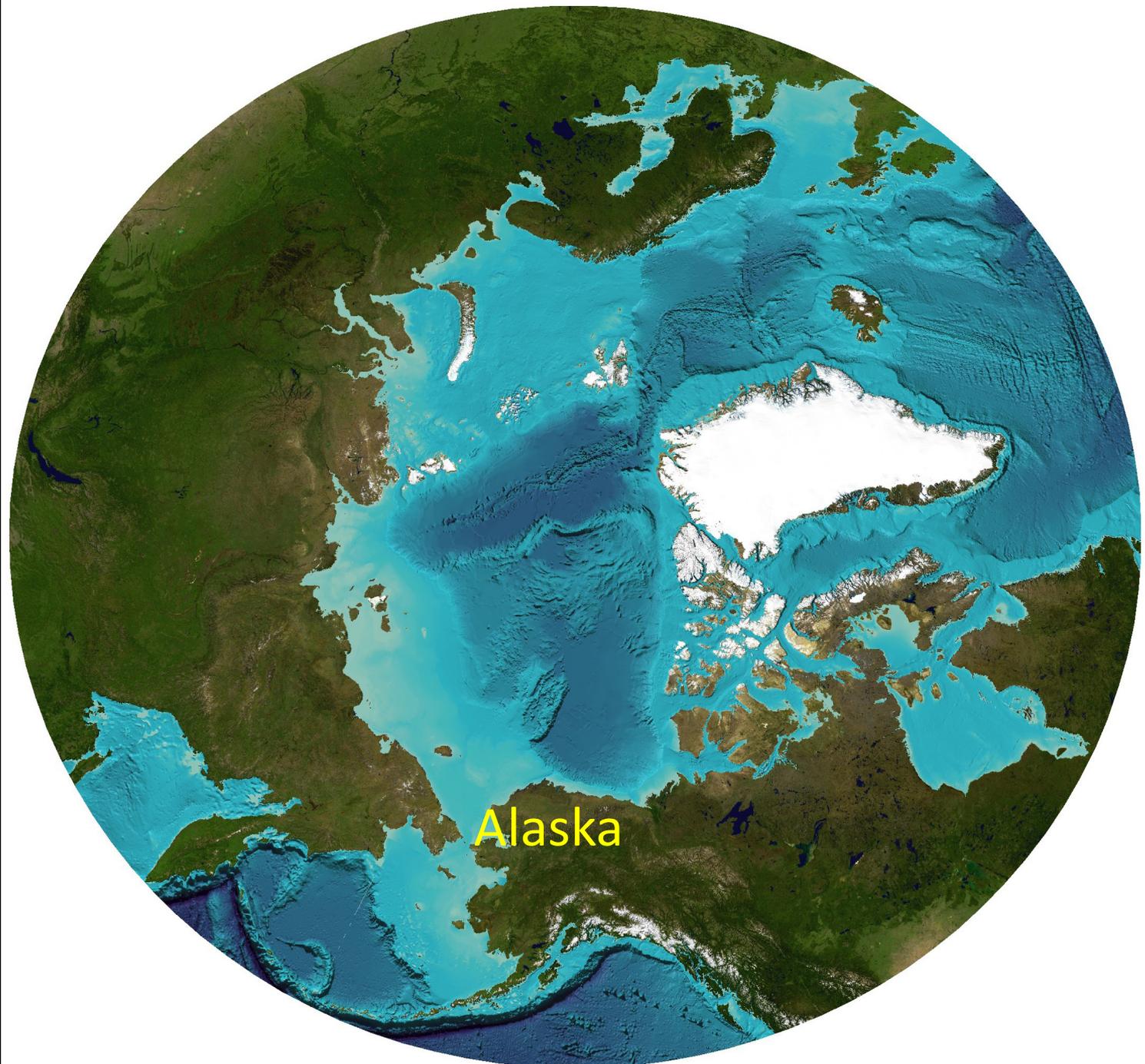
- Demand for DoD Arctic infrastructure is increasing
- Arctic environments are changing dramatically
- Prior guidance (static manuals) outdated



### System should include:

- An environmental database that is regularly updated and validated
- Dynamically downscaled data and projections for current and future Arctic conditions
- Ability to calculate mean, trends, and other statistics for regions
- Scenarios to compare historic and future conditions
- Climate & environmental variables easily integrated into engineering design parameters
- User-friendly web-based interface as the access point





## Arctic Circle compared with continental U.S.



**5.5** million sq. mi.

or

**1.5** times the continental U.S.



Arctic Ocean

Baffin Bay

**Thule Air Base**

Northwestern Passages

Greenland

Iceland

Canada

Hudson Bay

AK

YT

NT

NU

BC

AB

SK

MB

ON

QC

NL

WA

MT

ND

MN

WI

MI

NB

PE

NS

ME

NH

Sea



An aerial photograph of a vast sea of icebergs in the Arctic. The icebergs are of various sizes and shapes, some large and jagged, others smaller and more rounded. They are scattered across a dark, calm body of water. The sky is a pale, hazy blue, suggesting a clear but cool day. The overall scene is desolate and expansive.

**The Washington Post**  
*Democracy Dies in Darkness*

National Security

# THE NEW ARCTIC FRONTIER

As the ice melts, U.S. prepares for possible threats from Russia and China

Photos and videos by **Kadir van Lohuizen** and **Yuri Kozyrev** | **NOOR**

Story by **Dan Lamothe**

Nov. 21, 2018



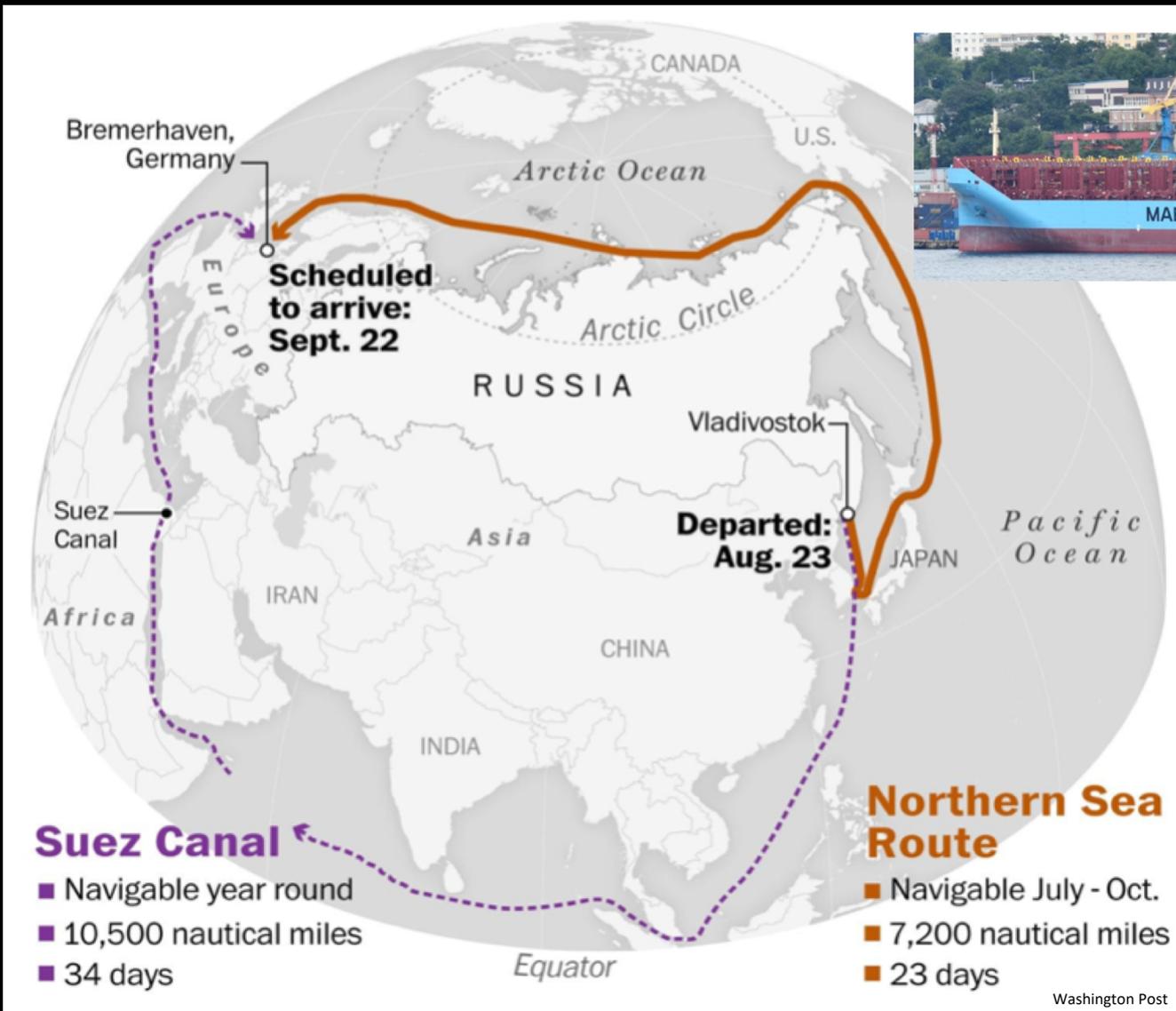






# First large container ship transits Arctic Ocean

Venta Maersk travels from Vladivostok to Bremerhaven



Arctic has much of world's remaining "undiscovered" fossil fuel

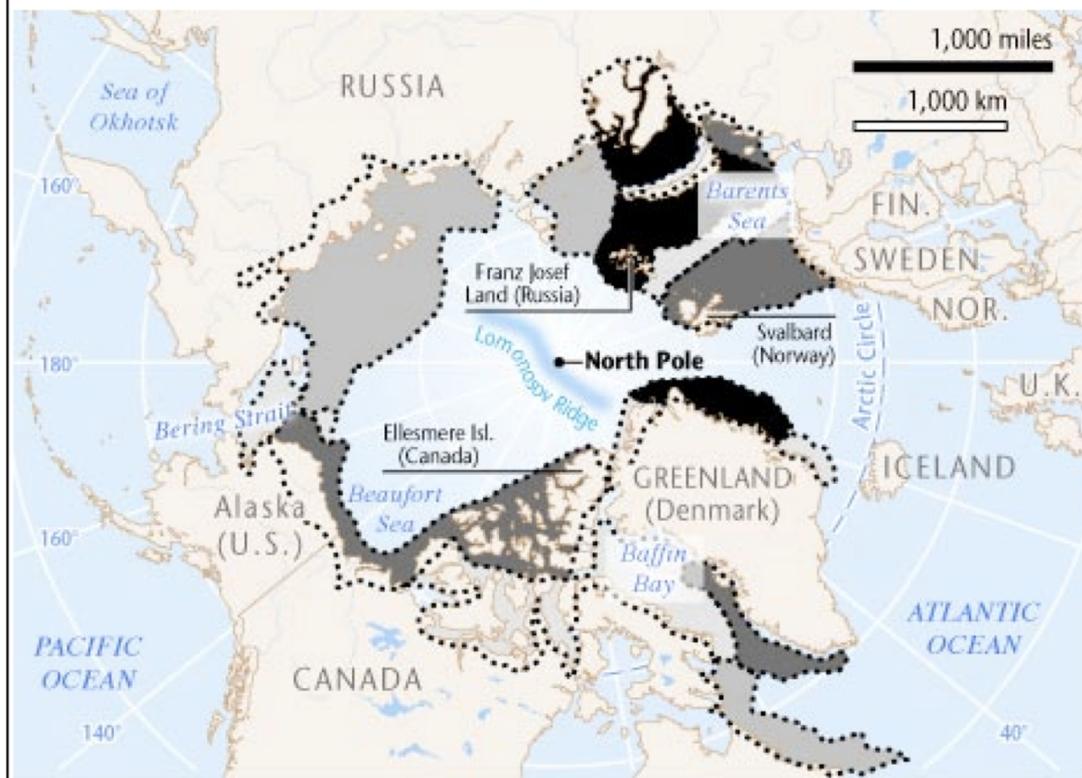
13% oil

30% natural gas

20% natural gas liquids

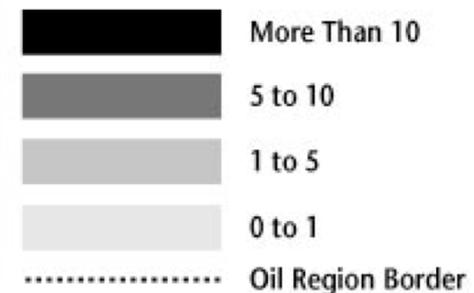
2009 USGS CARA report

# Arctic Oil and Gas Potential



## Estimated Oil, Gas Yet to Be Found

In billions of barrels of oil equivalent



SOURCE: Wood Mackenzie  
Map based on a *Financial Times* graphic

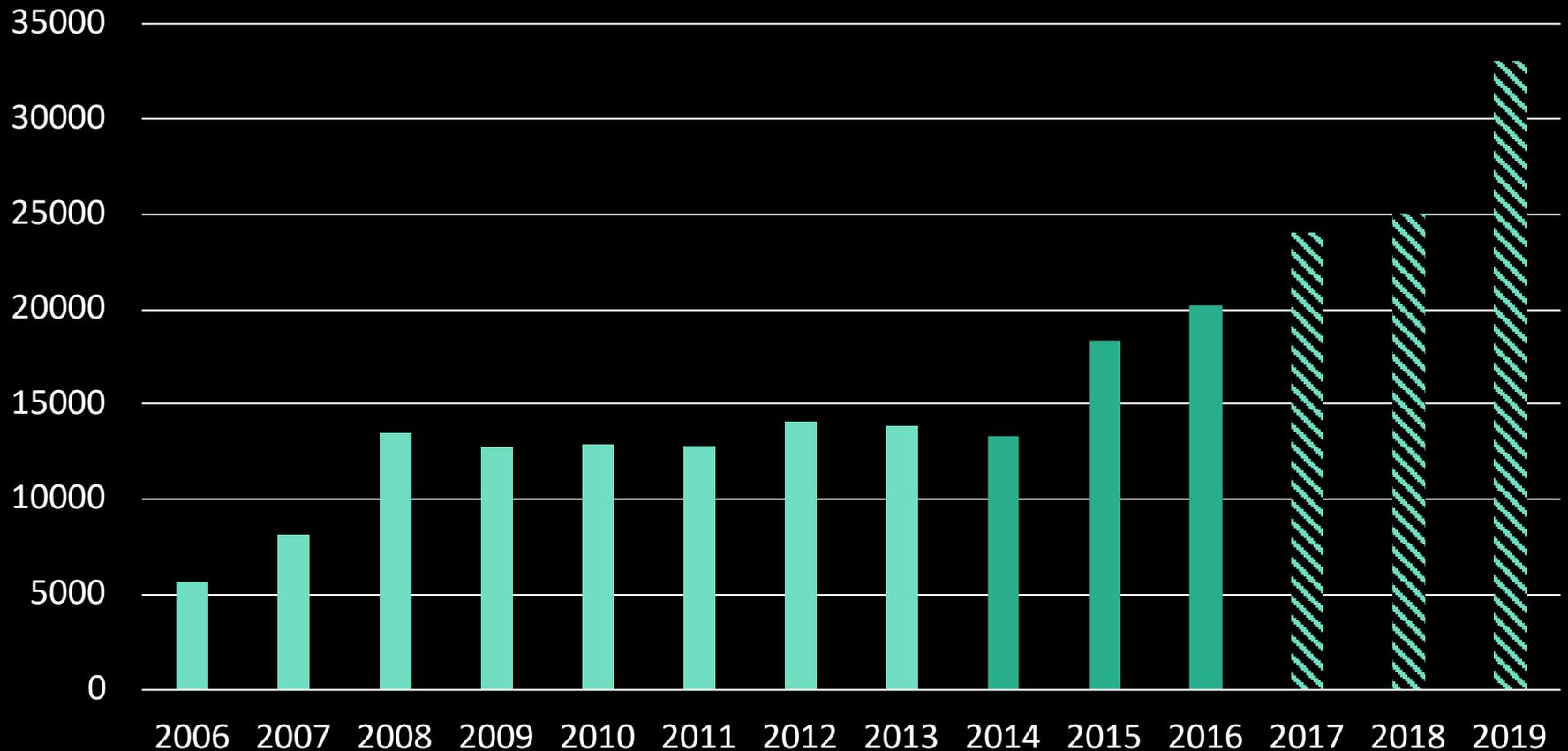


# Arctic Tourism Expanding



# Arctic cruising passengers\*

Svalbard, Greenland, Jan Mayen, Canada & Russia



\*Data from Association of Arctic Expedition Cruise Operators

Aaron Lawton, One Ocean Expeditions

# Motivation for DoD action in the Arctic

“America has got to up its game in the Arctic.”

“The Arctic is an area of concern in our National Security Strategy.”

“We're going to have to deal with the developing Arctic, and it is developing.”



Secretary of Defense James Mattis  
*Press Conference in Anchorage 6/26/18*

# Additional motivation...

“We need to have presence up there.”



Sec. of the Navy, Richard Spencer

4/19/18 to reporters after Senate Armed Services Committee hearing

“Our two peer competitors, Russia and China, have both declared the Arctic a strategic priority and they continue to aggressively develop the capability, capacity, and expertise to exert influence and seize opportunities in the region”



Admiral Charles Ray, Vice Commandant USCG

6/7/18 at House Subcommittee Hearing

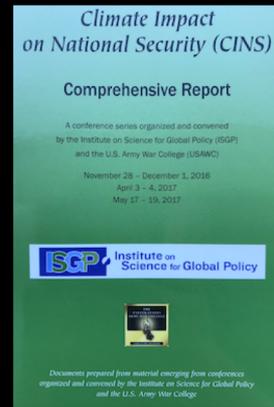
“Our collective efforts must ensure we are ready to operate in and through the Arctic ... in all scenarios ... across all domains ... and against any adversary. The defense of our nations depends upon it.”



General O'Shaughnessy, Commander NORTHCOM and NORAD

8/16/18 at ALCOM/JBER Arctic Maritime Symposium

# Arctic Advice to the DoD



## US Army War College and Inst. on Sci. for Global Policy (2016) “Climate Impact on National Security (CINS) Report”

“The emergence of an increasingly navigable Arctic...presents serious diplomatic and security challenges for the US, especially regarding military operational capabilities and readiness at its Arctic bases, facilities, and installations.

The US military must, under all circumstances, be capable of operating effectively in this ‘new’ and rapidly evolving Arctic.”



## Center for Naval Analyses Military Advisory Board (2014) “National Security and the Accelerating Risks of Climate Change”

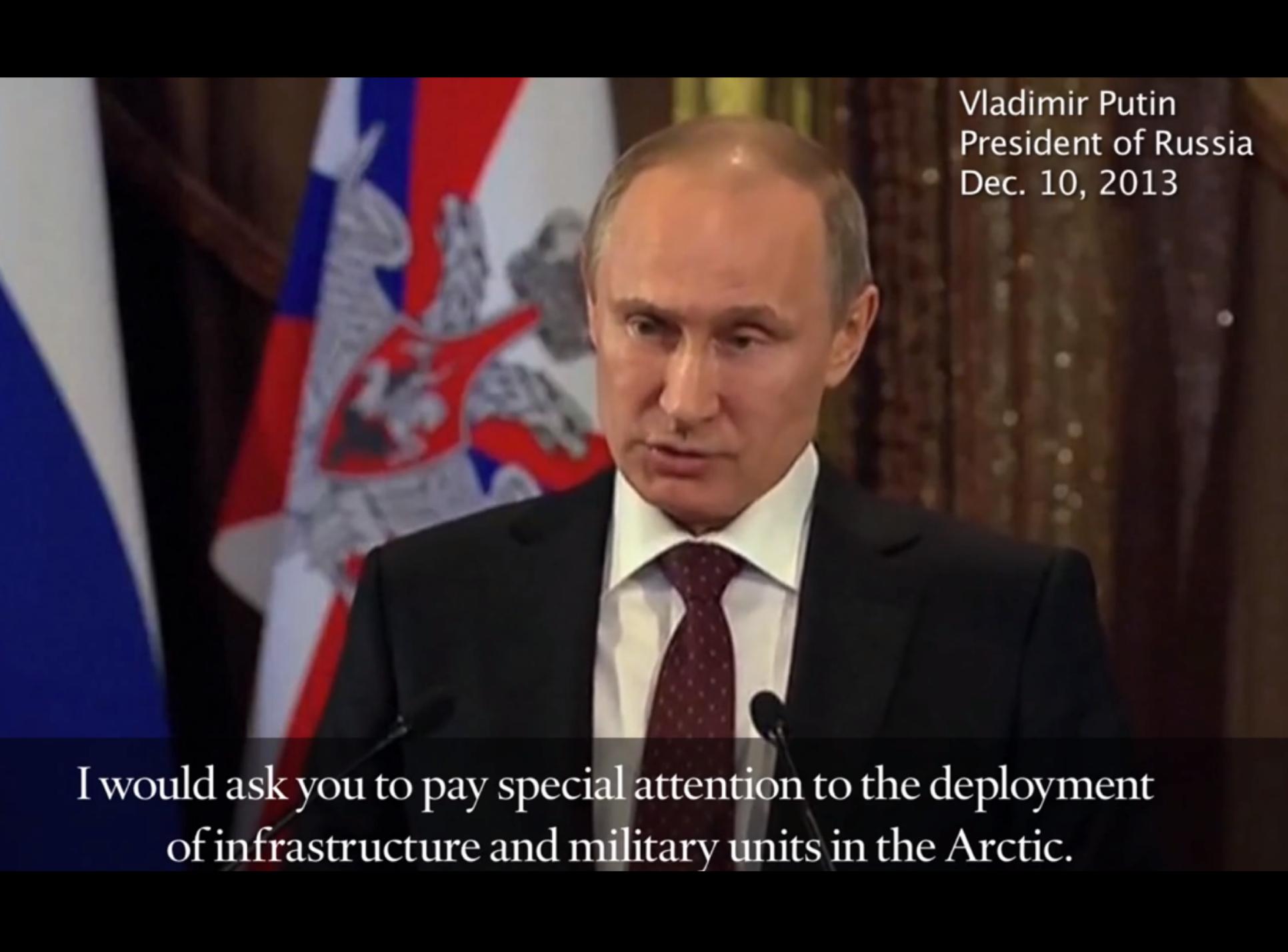
“The US should accelerate and consolidate its efforts to prepare for increased access and military operations in the Arctic”

# DoD in the Arctic 2018

- National Defense Strategy makes countering Russia and China a priority (Jan.)
- More fighter jets stationed in Alaska
- Expanding partnerships with Nordic militaries
- Navy submarine “Ice Camp SKATE” (March)
- “Arctic Edge” 1500 troops trained in Alaska (March)
- Increasing cold-weather training and exercises (“Arctic Shield”)
- New USCG icebreakers, possibly armed
- Navy, Airforce, DHS, and USCG developing new Arctic “strategies”
- New sensors on several Aleutian island radars, “Northern Warning System”
- More missile defense, Ft. Greely
- Army Corps of Engineers considers deepening Nome’s port, for large vessels.
- USS Harry S. Truman aircraft carrier ventured above Arctic Circle (October)

# “Great-power competition in the Arctic”



A medium shot of Vladimir Putin, President of Russia, speaking at a podium. He is wearing a dark suit, a white shirt, and a dark red tie with small white dots. He is looking slightly to his left. In the background, the Russian flag and the coat of arms of Russia are visible. The setting appears to be a formal event or press conference.

Vladimir Putin  
President of Russia  
Dec. 10, 2013

I would ask you to pay special attention to the deployment of infrastructure and military units in the Arctic.

# Russia builds Arctic air defense shield

## Россия развернет новую дивизию ПВО в Арктике



Подразделение закрывает Москву и Урал от удара со стороны Северного полюса



Фото: РИА НОВОСТИ/Михаил Воскресенский

- Covers from Novaya Zemlya to Chukotka
- Can discover and destroy enemy aircrafts, cruise missiles and drones.
- Russia sent the S-400 Triumph anti-aircraft weapon to the Arctic.
- Russia deployed Bastion mobile coastal missile systems

# Russian submarine fleet expands Arctic presence



And don't forget their 40+ icebreakers...



“America has no permanent friends or enemies, only interests”  
- Henry Kissinger



ALASKA  
SIBERIA  
WWII

The work of one nation rests on the shoulders of the world.



# China: We are a 'Near-Arctic State' and we want a 'Polar Silk Road'



- New Arctic Policy released in January 2018
- Describes how China thinks the Arctic should be governed and used
- Involved in research, resources, shipping, and security
- China is impacted by climate change linked to Arctic
- Wants to be included in economic benefits, even if not an Arctic nation (UNCLOS)
- PRIC predicts that 5 to 15% of China's trade could traverse the Arctic by 2020
- *Xue Long 1*, *Xue Long 2*, & a tender released 6/18 for a nuclear-powered icebreaker

**“The Arctic belongs to all the people around the world as no nation has sovereignty over it.”**



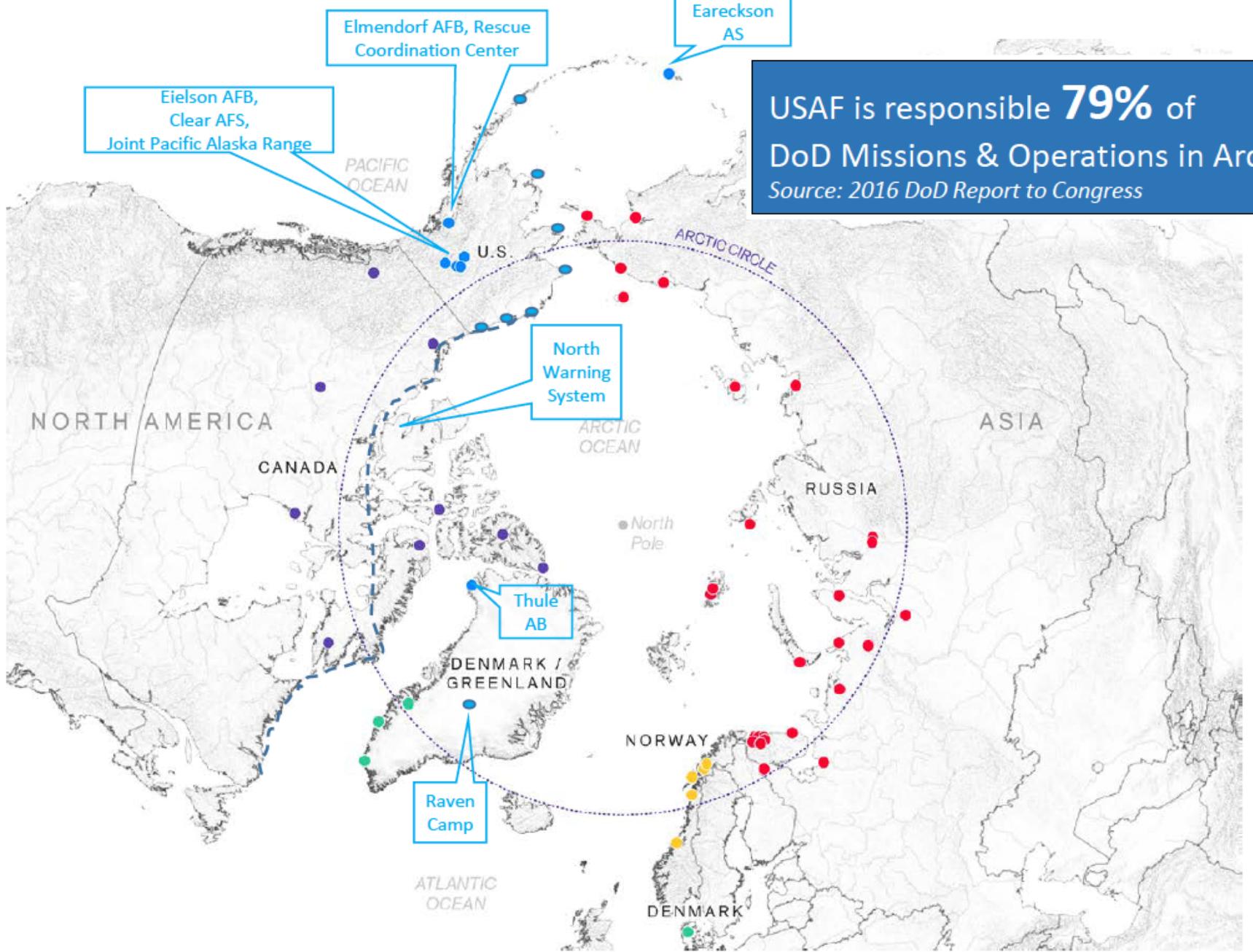
Kadir van Lohuizen and Yuri Kozyrev | NOOR

# Recent changes in Alaska/Arctic military assets

- >100 5<sup>th</sup>-generation fighter jets in Alaska, highest concentration in US
  - 47 F-22 Raptor fighter jets now in JBER. Two squadrons
  - 54 F-35A Lightning II fighter jets will be at Eielson AFB by 2020
    - ...and >5,000 people to support the two squadrons
    - ...will bring \$1.3B/yr revenue for the Fairbanks North Star Borough
  - \$1.4B for military construction. \$900M to install the F-35s  
\$47M to repair runway erosion at Cape Lisburn
- Missile Defense Agency paid Boeing \$6.6B as part of 6-yr contract to build a new underground silo field of 20 more anti-ballistic missiles at Ft. Greely
- USCGC Comm. Zukunft: “We need to reserve space, weight and power if we need to strap a cruise missile package on it” (new icebreaker)



USAF is responsible **79%** of DoD Missions & Operations in Arctic  
 Source: 2016 DoD Report to Congress



Arctic Military Facilities

- U.S.
- Canada
- Denmark/Greenland
- Norway
- Russia

Iris Ferguson, USAF

Map Source: Bloomberg & NGA

# Climate change recognized as a security threat

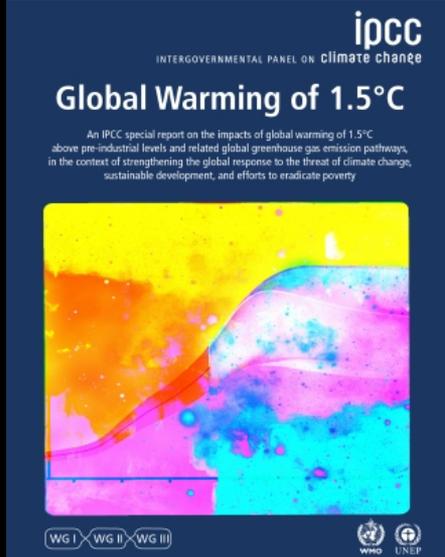
“Climate change is impacting stability in areas of the world where our troops are operating today. It is appropriate for the Combatant Commands to incorporate drivers of instability that impact the security environment in their areas into their planning.”

“The **Arctic** is key strategic terrain. Russia is taking aggressive steps to increase its presence there. I will prioritize the development of an integrated strategy for the Arctic.”



Sec. Def. James Mattis

*in written responses after confirmation hearing, 1/20/17*



# IPCC special report, 10/8/18

## 1.5°C vs. 2°C in Paris agreement

### Arctic



Impacts and risks for selected natural, managed and human systems

**Purple** indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

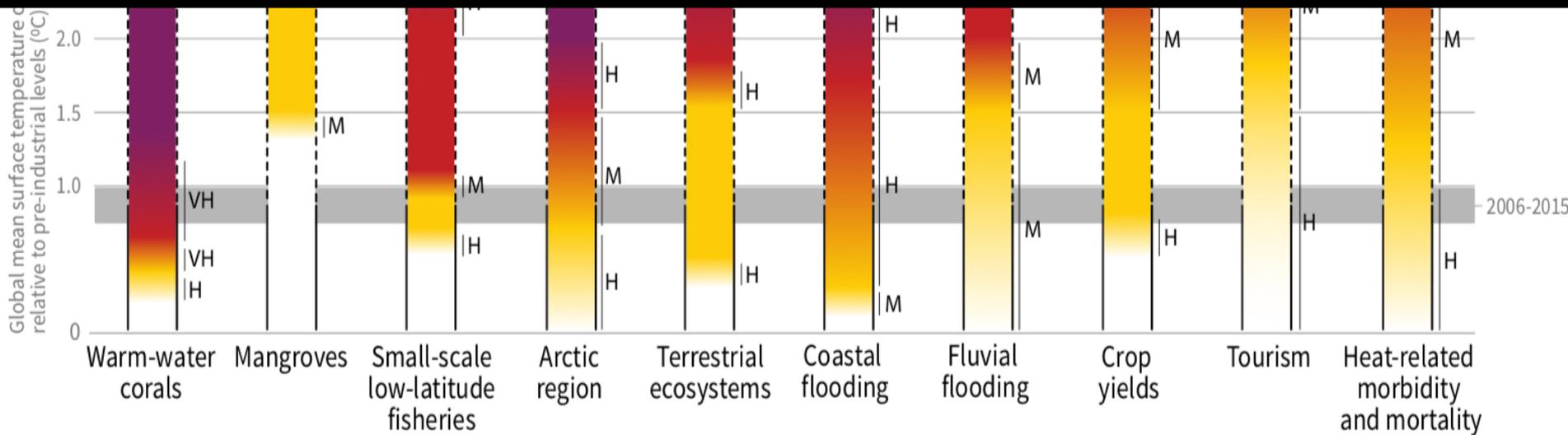
**Red** indicates severe and widespread impacts/risks.

**Yellow** indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

**White** indicates that no impacts are detectable and attributable to climate change.

Level of additional impact/risk due to climate change

- Very high
- High
- Moderate
- Undetectable



Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high

# White House climate report released 11/23/18

- 1,656-page National Climate Assessment IV
- Conclusion: human-induced climate change poses major threat to US
- Directly contradicts Administration's climate change policies

*The Atlantic*

**SCIENCE**

## **The Three Most Chilling Conclusions From the Climate Report**

Thirteen federal agencies agree: Climate change has already wreaked havoc on the United States, and the worst is likely yet to come.

# 4<sup>th</sup> National Climate Assessment

## Volume II\*

### Impacts, Risks, and Adaptation in the US

## Rapid Arctic Change

“Arctic annual average temperatures have increased more than twice as fast as the global average, accompanied by thawing permafrost & loss of sea ice & glacier mass.

Arctic-wide glacial and sea ice loss is expected to continue; by mid-century, it is very likely that the Arctic will be nearly free of sea ice in late summer.

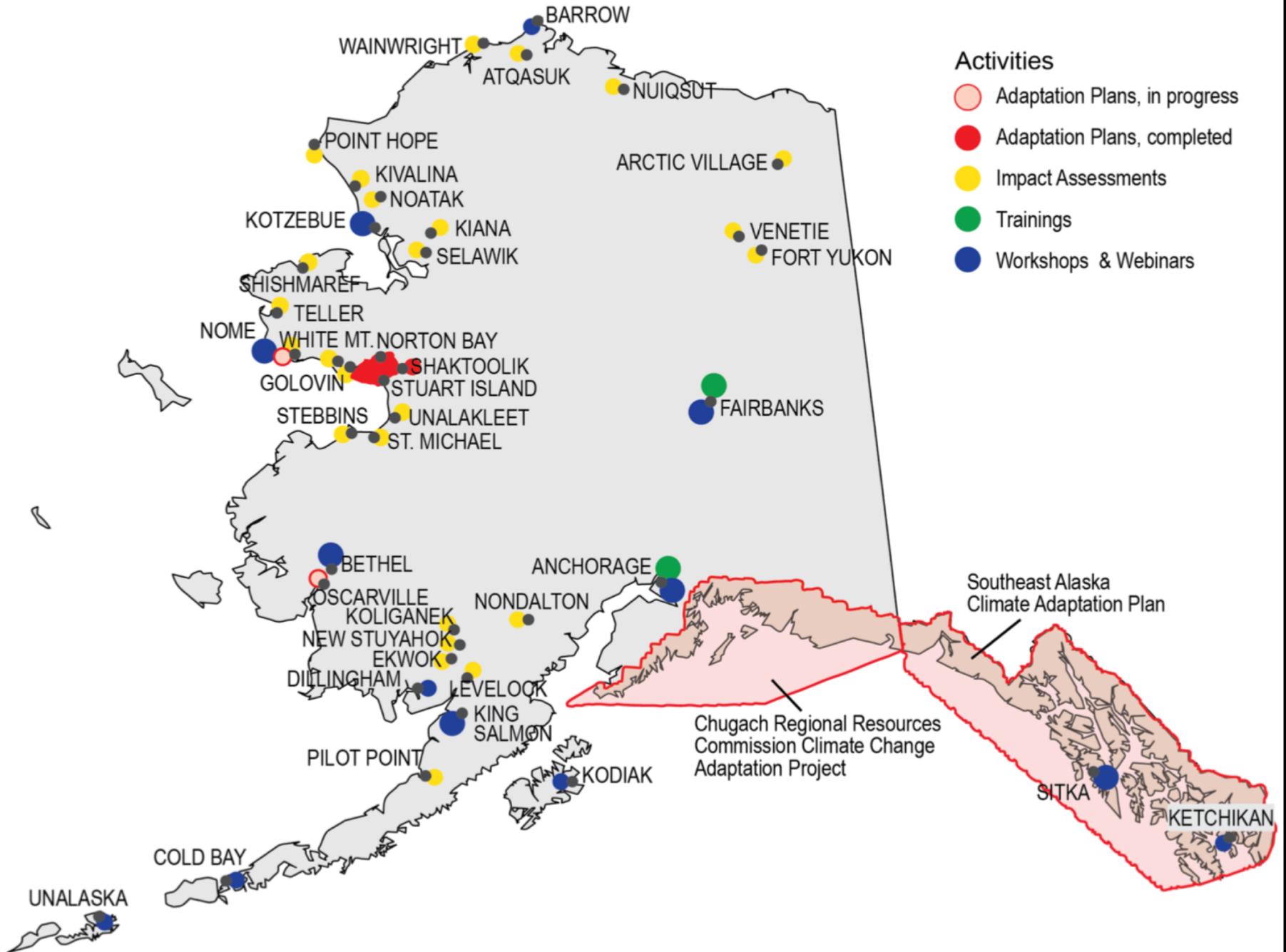
Permafrost is expected to continue to thaw over the coming century, and the carbon dioxide and methane released from thawing permafrost has the potential to amplify human-induced warming, possibly significantly.”

Fixing Alaska’s climate-related damage could cost \$110 to \$270 million per year

# Highlights from the Alaska Chapter of the NCA

- Compromised winter travel linked to higher temperatures and shorter ice seasons, leading to increased risk of hunters falling through the ice or other injuries or fatal incidents
- Fisheries affected by warmer water and ocean acidification
- Longer sea ice-free seasons, higher temperature and sea level rise leading to coastal erosion necessitating the relocation of all or parts of coastal villages and communities
- Rise in the incidence of climate-associated disease associated with the consumption of shellfish from warmer waters
- **Damage to buildings, pipelines, roads and reservoirs due to thawing permafrost**
- Increased frequency of big wildland fires: Three of the top four fire years in terms of acres burn have occurred since 2000
- Limits on subsistence hunting and fishing activities, but also potential new opportunities such as fall whaling on St. Lawrence Island.

# Adaptation Planning in Alaska

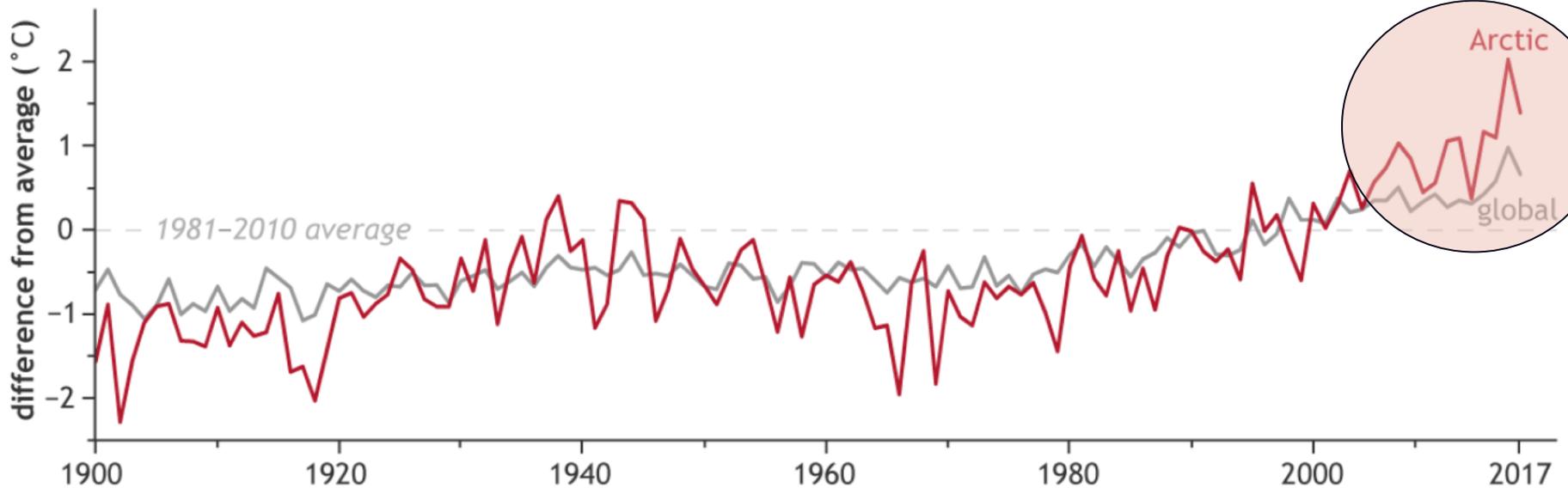


# “The damn thing melted”

Sec. of the Navy, Richard Spencer

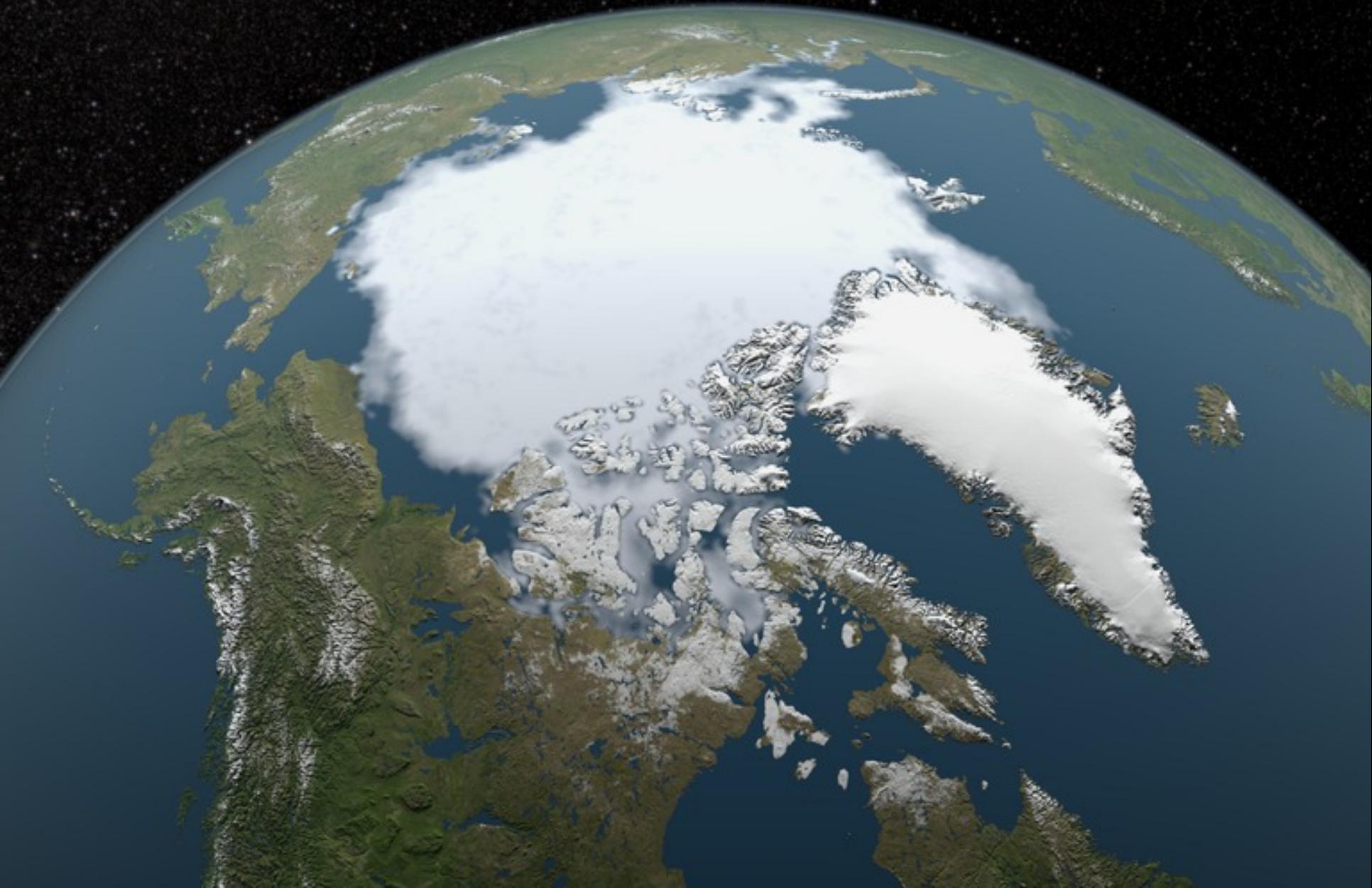
4/19/18 to reporters after Senate Armed Services Committee hearing

## ARCTIC WARMING TWICE AS FAST AS GLOBAL AVERAGE

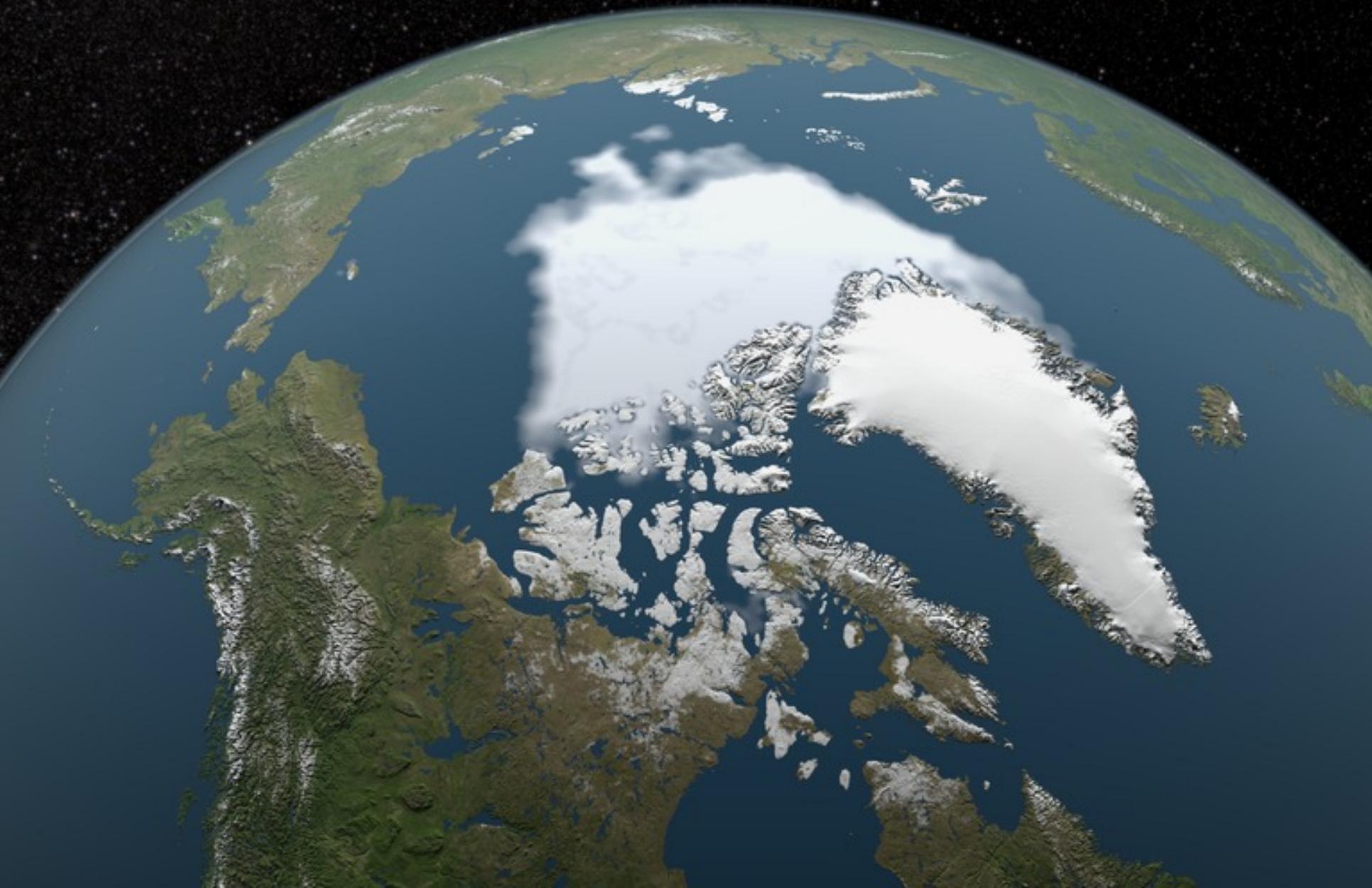


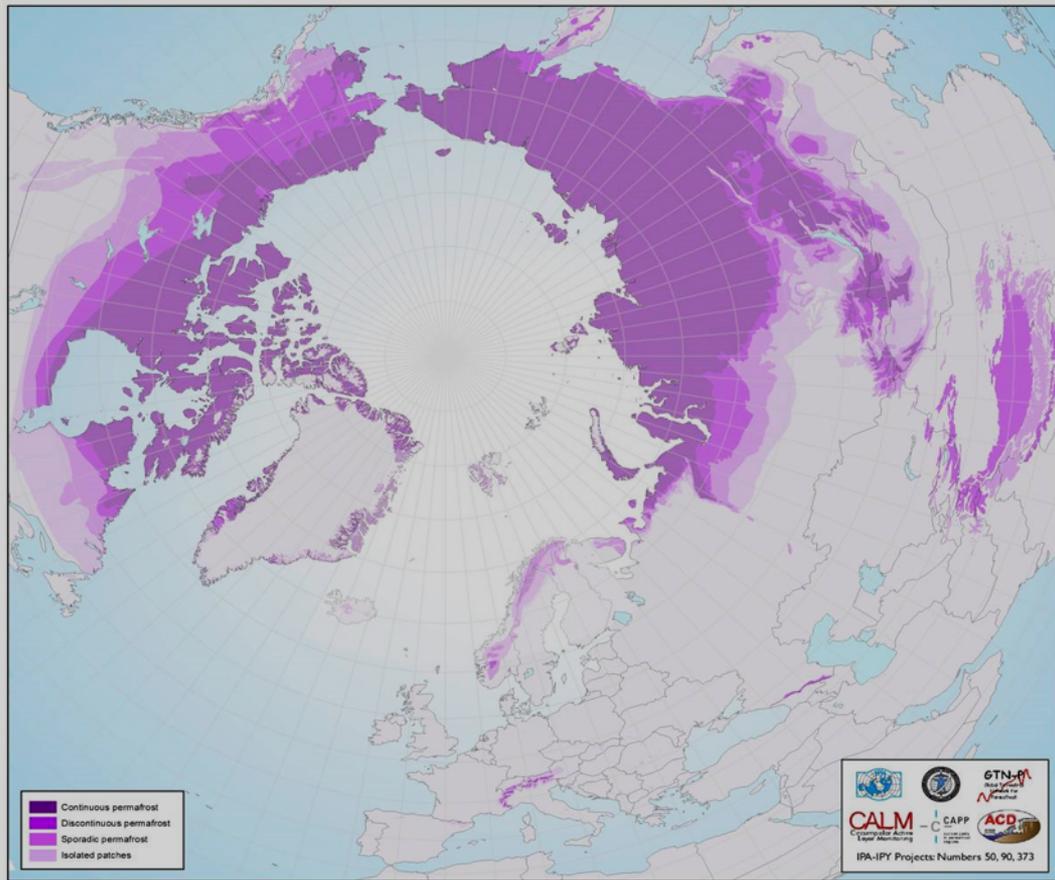
NOAA Climate.gov  
Data: ARC 2017

# 1980 September Sea Ice Extent



# 2012 September Sea Ice Extent





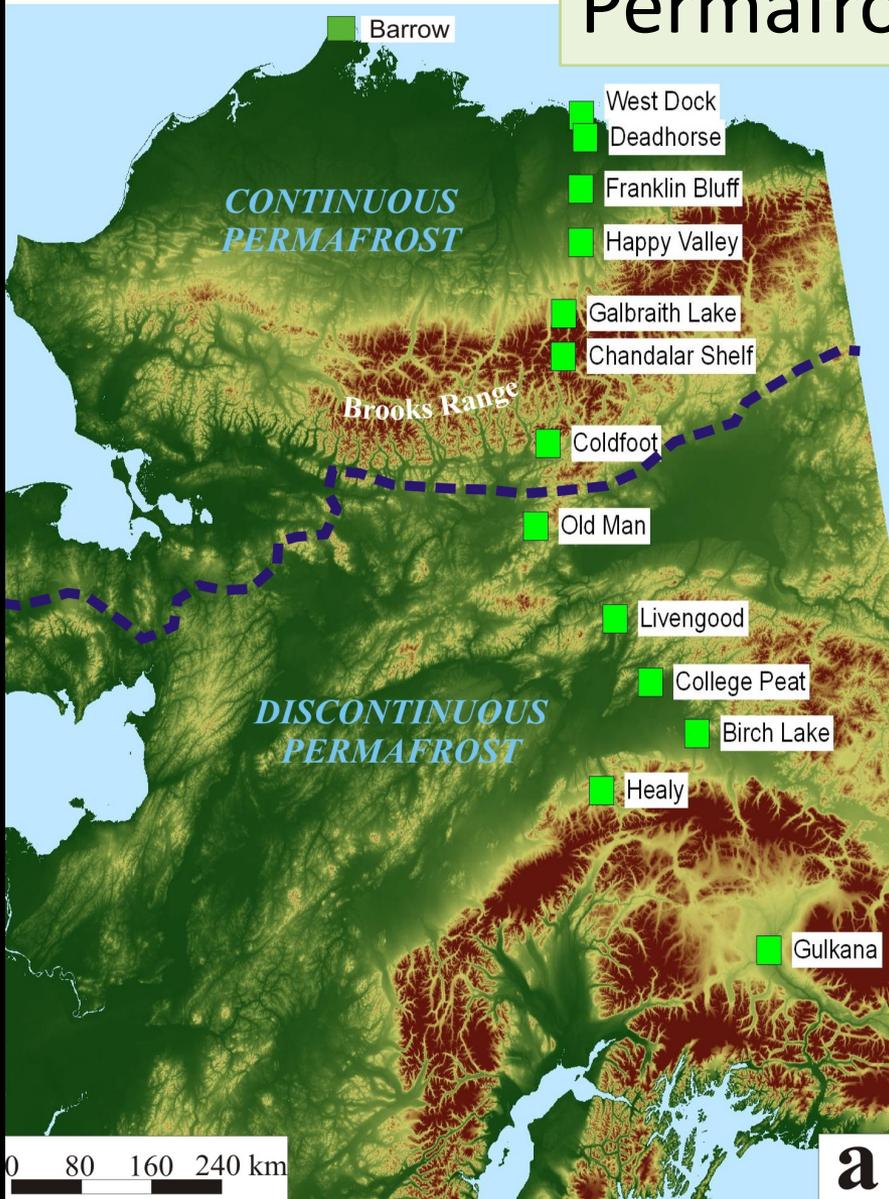
Permafrost is warming.  
Thawing impacts  
coastlines, communities,  
people's safety & health

24% of land in N. Hemisphere  
contains permafrost.

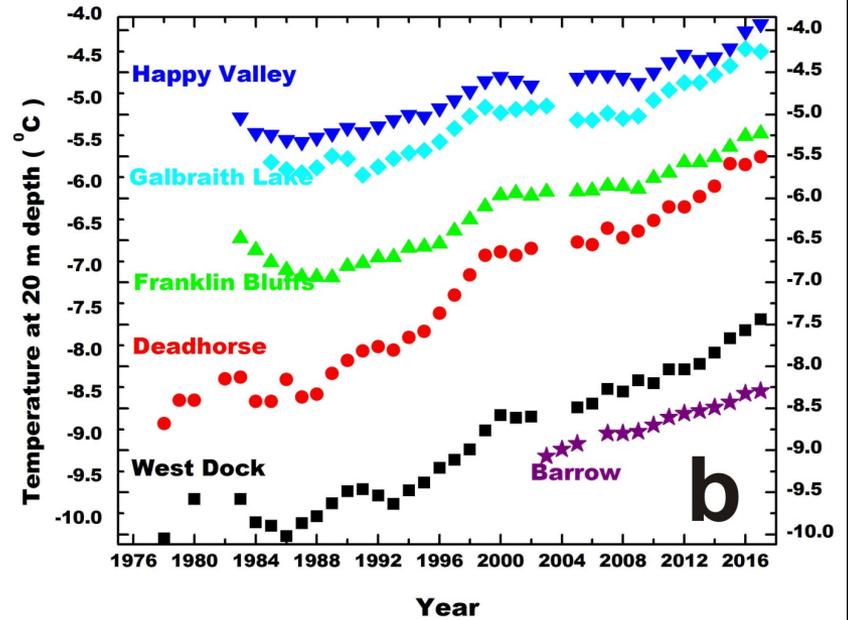
Potential climate impact from  
methane & CO<sub>2</sub> release uncertain.



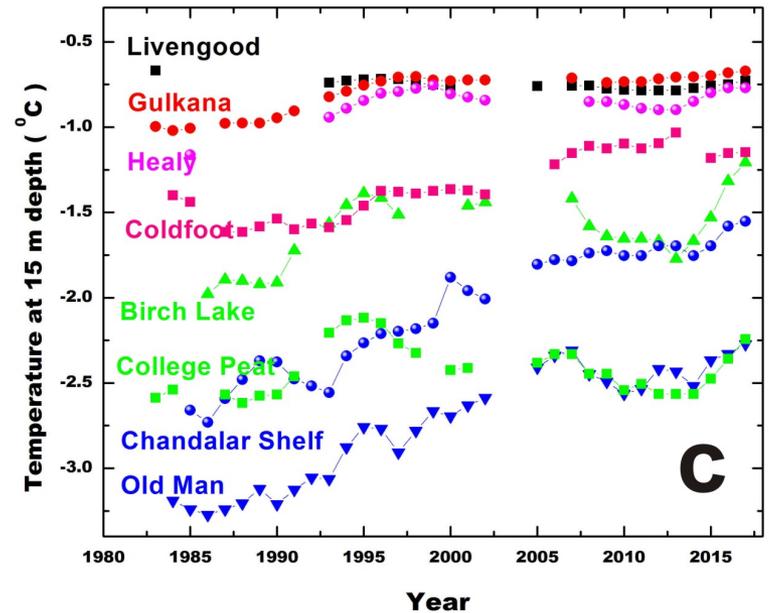
# Permafrost



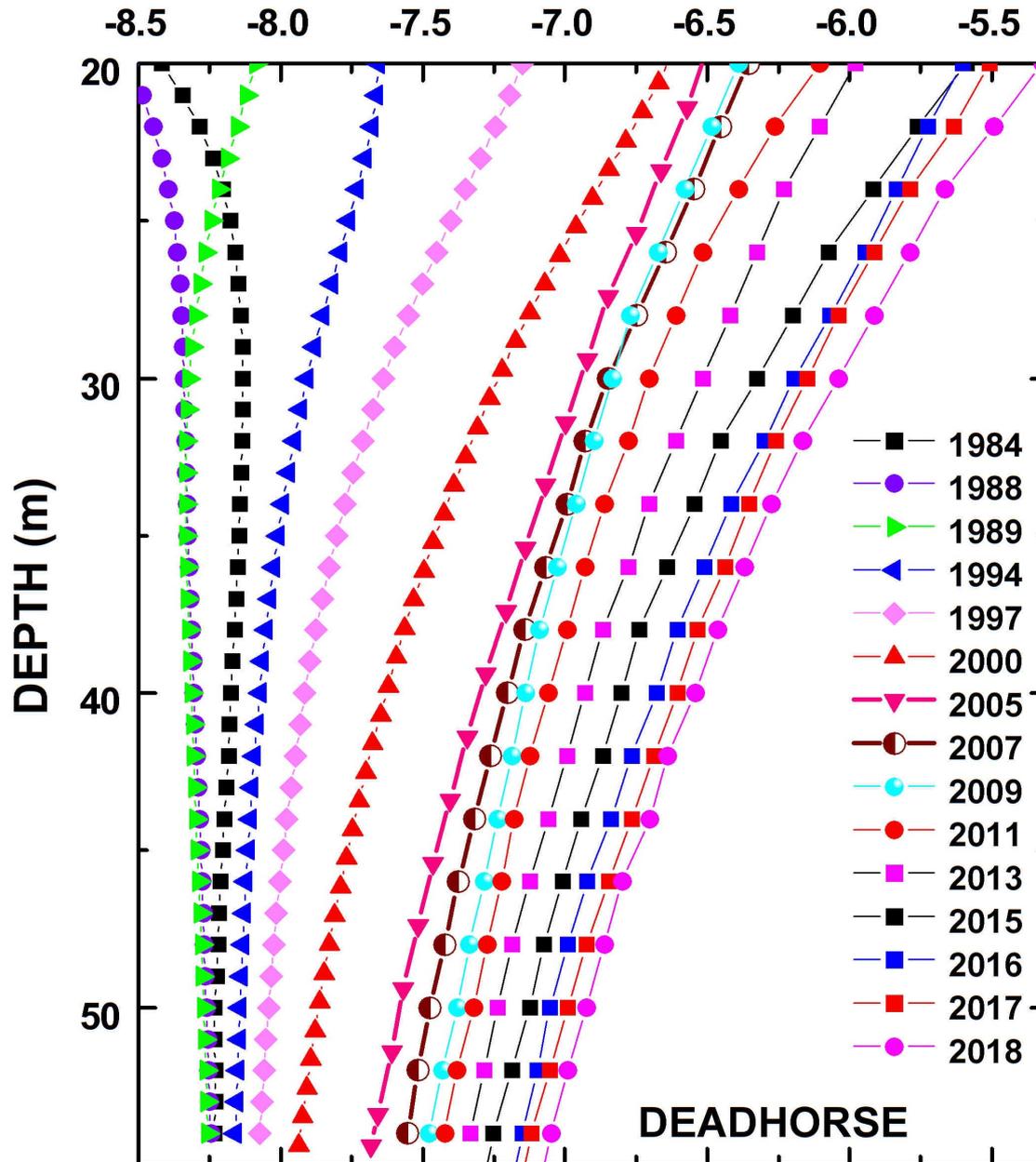
## Northern Alaska



## Interior Alaska



# TEMPERATURE (°C)



Permafrost  
warming  
at depth







# Flood, Sag River Road, Prudhoe Bay, Alaska

Fall 2014



# Repair work begins

May 28, 2015



# Thule Air Base, Greenland









Camp Centry



Arctic skyline is pierced by 1,212-ft radio tower at Thule Air Force Base. Guyed at three levels, tower has maximum width of 15 ft, and stands on cast-steel insulator dome.

## CIVIL ENGINEERING



1212 FT. RADIO TRANSMISSION TOWER  
THULE AIR BASE — MAJ. GEN. S. D. STURGIS

## World's third tallest structure erected in Greenland

*Radio transmission tower rises 1,212 ft at Thule Air Force Base*

S. D. STURGIS, JR.

Major General  
U.S. Army

Chief of Engineers  
Washington, D.C.

The third tallest structure in the world now stands at one of the most remote corners of civilization, Thule Air Force Base in Greenland. Standing on two tiers of base insulators, the Thule radio transmission tower rises to a height of 1,212 ft 8 in. The two tiers of insulators are a temporary installation, to increase the gap between the tower and the ground. At a later date it is planned to replace them with possibly one large insula-

tor, of the same or slightly greater height than that of the two tiers.

This tower, constructed under the supervision of the Corps of Engineers, U.S. Army, for the U.S. Air Force, is exceeded in height only by the Empire State Building in New York, N.Y. (1,472 ft), and a similar radio tower at Forestport, N.Y., which is 1,218 ft tall. Work on the Thule tower base and anchor blocks was begun in April 1952, and the

actual job of tower erection was completed before the end of the short arctic summer.

In plan, the tower has the typical shape of an equilateral triangle, the vertices of which are the main structural members, or legs, spaced at 15 ft. The lower 50-ft length tapers to a bottom spacing of the members of 2 ft 3 in., and the members are bolt-connected through flanges to a steel casting, shaped to take and transmit









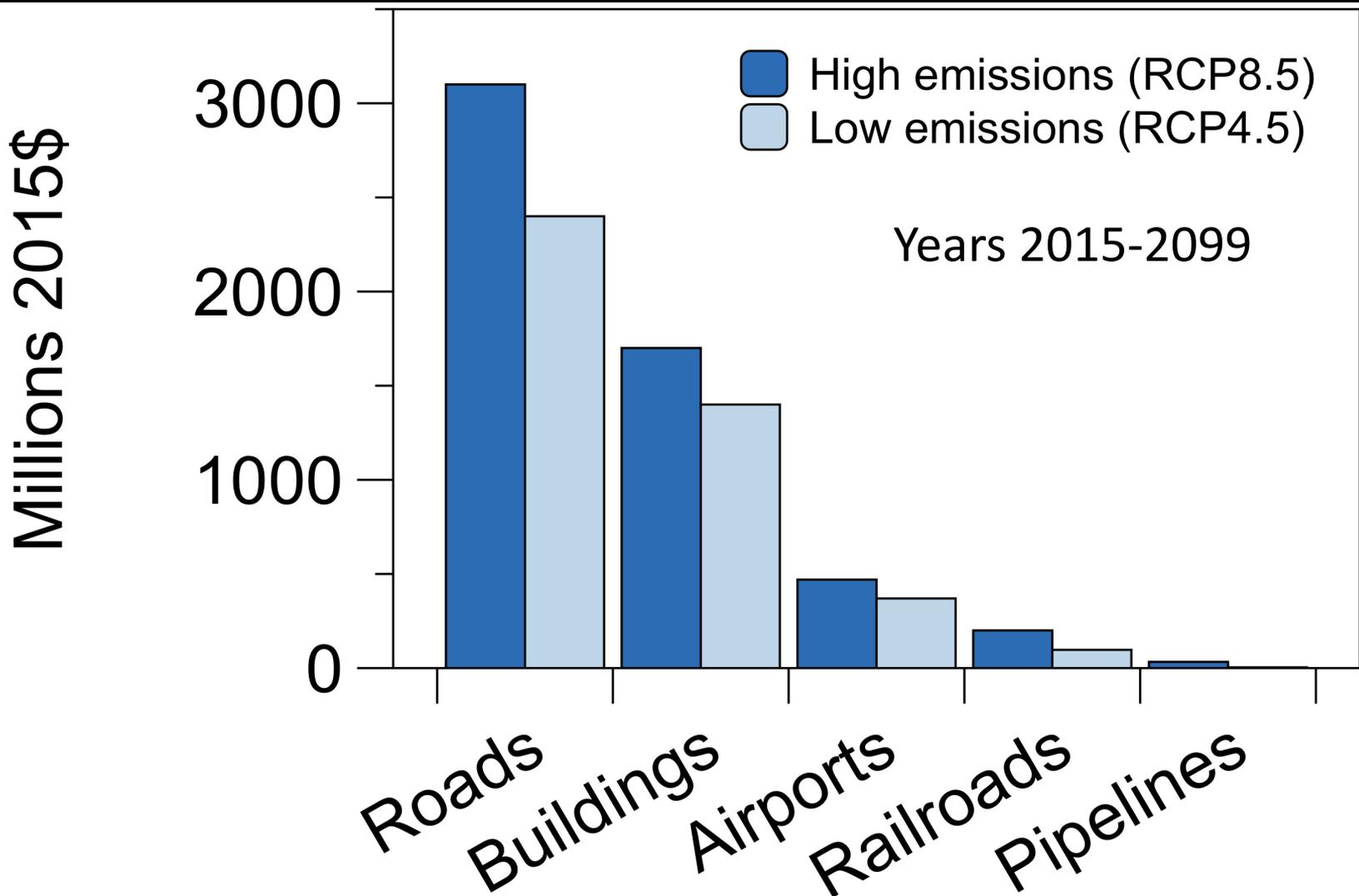
So what are we looking at?

On a broader scale, what's the impact on infrastructure?

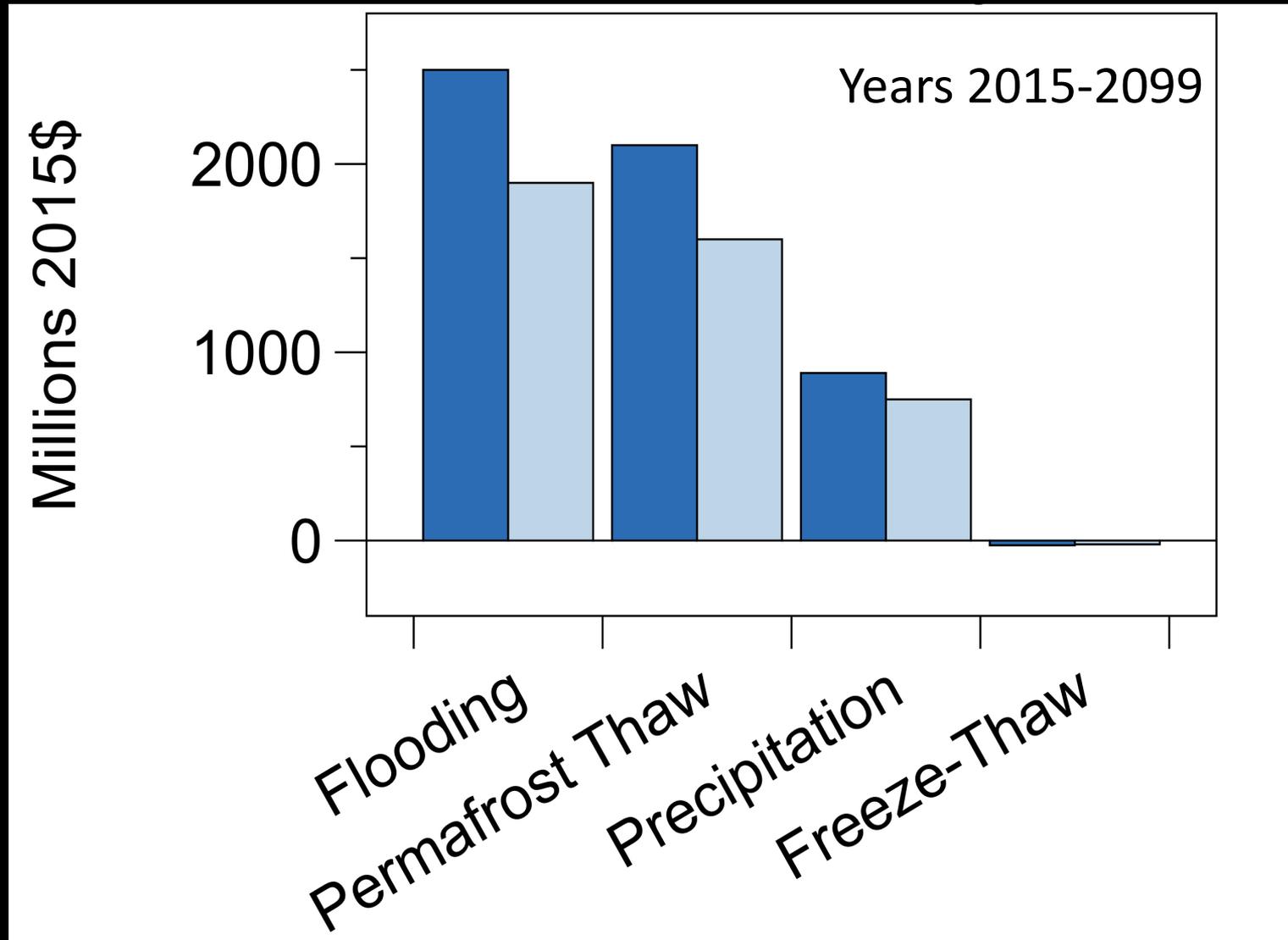
# Climate change damages to Alaska public infrastructure & the economics of proactive adaptation



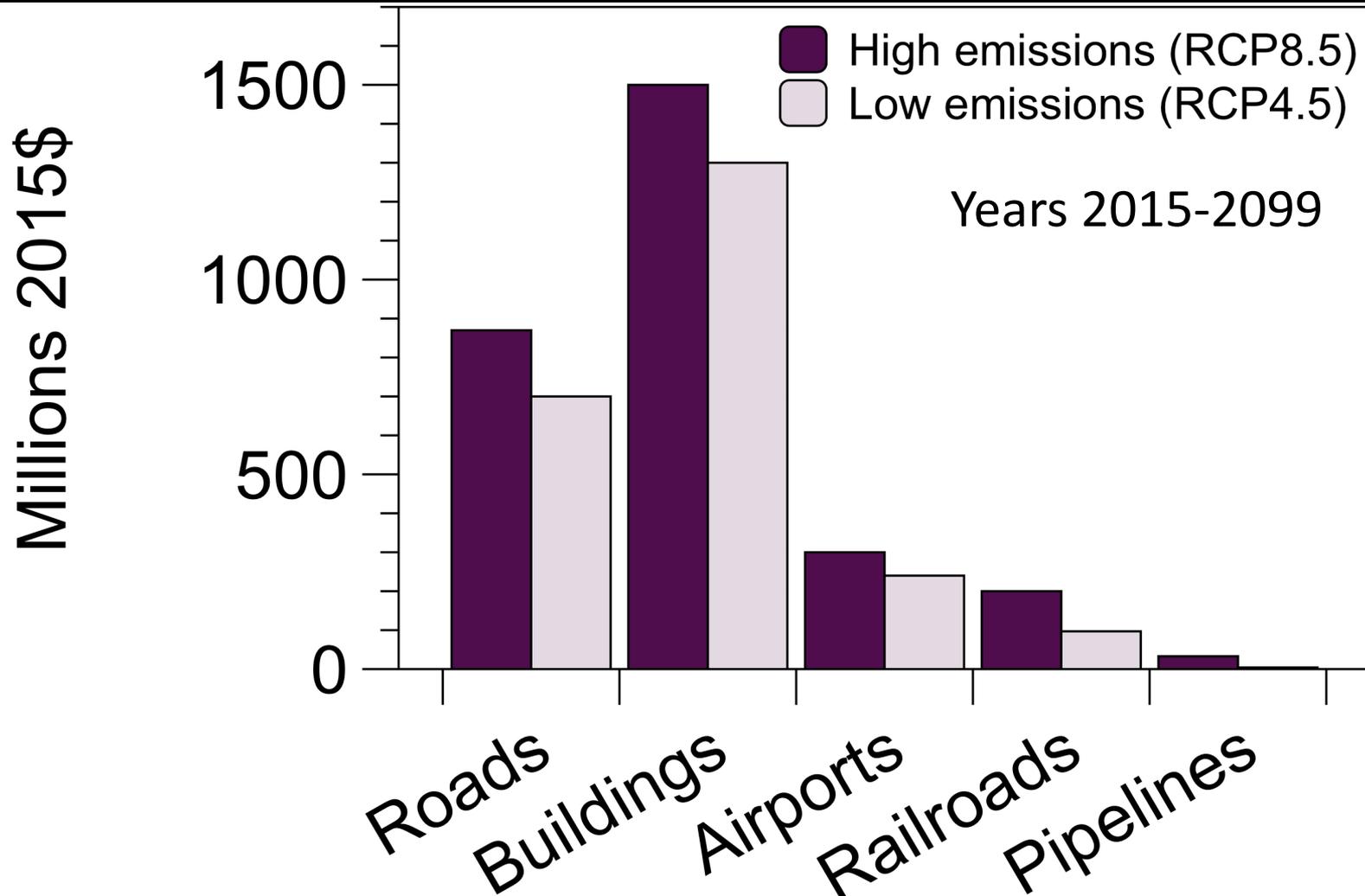
# Cumulative damages statewide



# Cumulative damages statewide



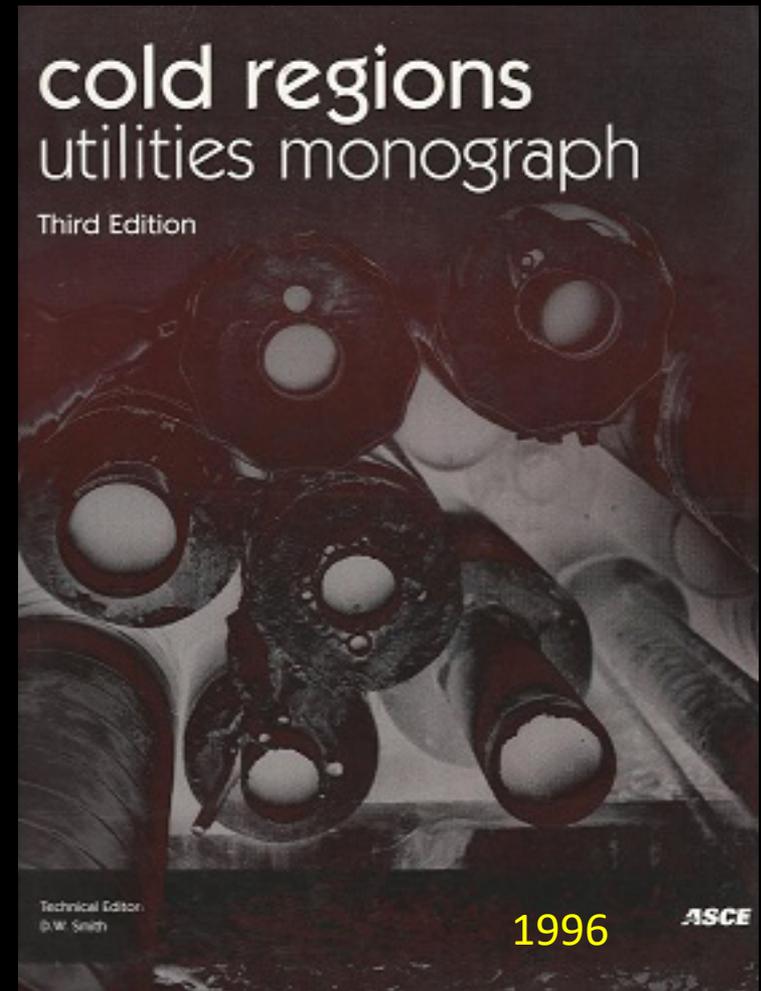
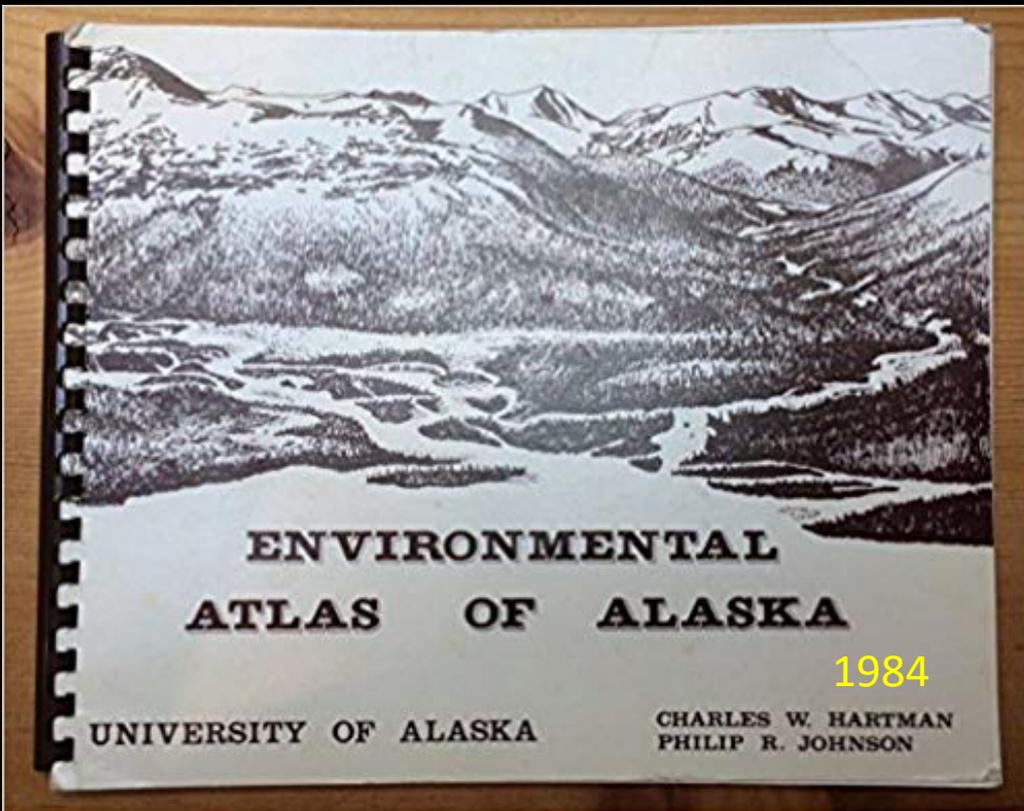
# Proactive Adaptation



# Conclusions

- Largest damages projected for roads from flooding, followed by permafrost damage to buildings
- Estimated damages are not evenly distributed across the state
- Damages were consistently lower under the low emissions future
- Proactive adaptation, especially for roads in the near-term, could provide large savings for Alaska

# Current guidance for engineers



# PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS

Edited by

W.M. SACKINGER, Ph. D., P.E.

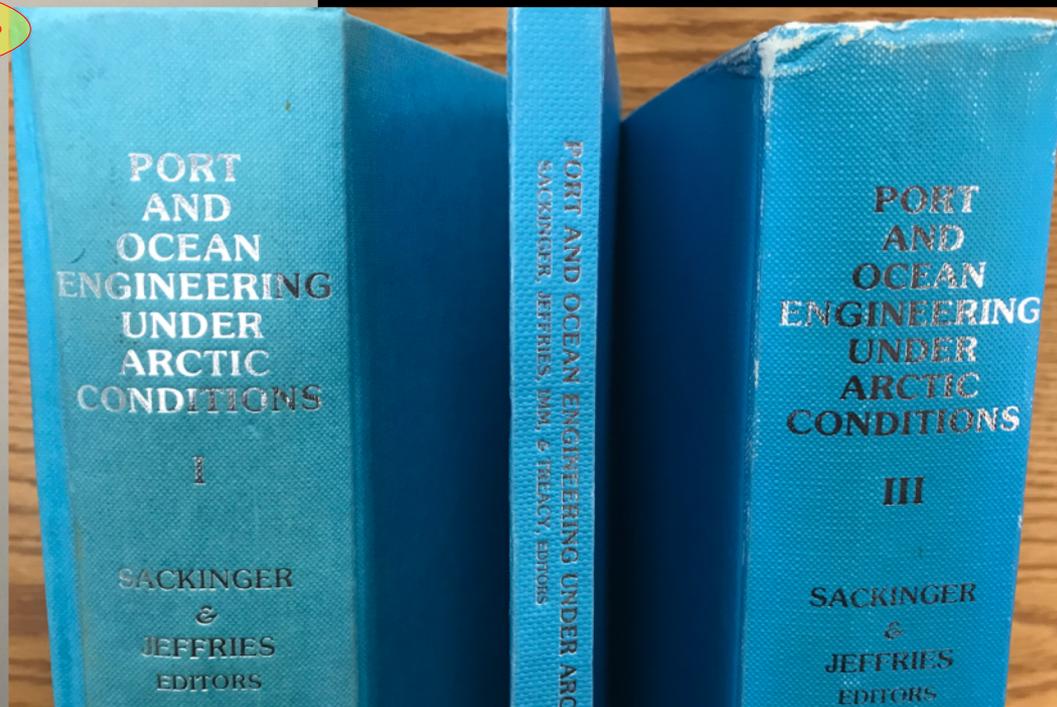
M.O. JEFFRIES, Ph. D.

The Geophysical Institute  
University of Alaska Fairbanks

VOLUME III  
1988



The Geophysical Institute  
University of Alaska Fairbanks  
Fairbanks, Alaska



# Alaska Engineering Design Information System



- Engineering support tool developed in the early 2000's (CRREL, UA)
- Used by planners, designers, builders and operators of infrastructure
- AEDIS used a GIS toolkit of intelligent display methods to access a broad range array of geospatial terrestrial and atmospheric environmental data to derive engineering parameters
- AEDIS provided info to select building sites, and transportation routes/corridors, to design constructed works, and to program facility maintenance, repair and replacement
- No longer supported/used. **An updated version is needed!**

# Bottom line

## The DoD needs a new engineering design support system for Arctic infrastructure

- Demand for DoD Arctic infrastructure is increasing
- Arctic environments are changing dramatically
- Prior guidance (static manuals) outdated



### System should include:

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