THREATS TO GREENLAND ICECAP, SHORT-LIVED CLIMATE FORCERS AND ARCTIC COUNCIL MEETING: WHAT CAN THE U.S. DO?

Armond Cohen
Clean Air Task Force
armond@catf.us

The Arctic Council

Member states

- Canada;
- Denmark; representing also the dependencies of
  - Greenland
  - Faroe Islands
- Finland
- Iceland
- Norway
- Russia
- Sweden
- United States;

Permanent Observer States

- France
- Germany
- Netherlands
- Poland
- Spain
- United Kingdom

Ad-hoc Observer States

- China
- European Union [2]
- Italy
- Japan [2]
- South Korea

The stakes at Nuuk on May 12

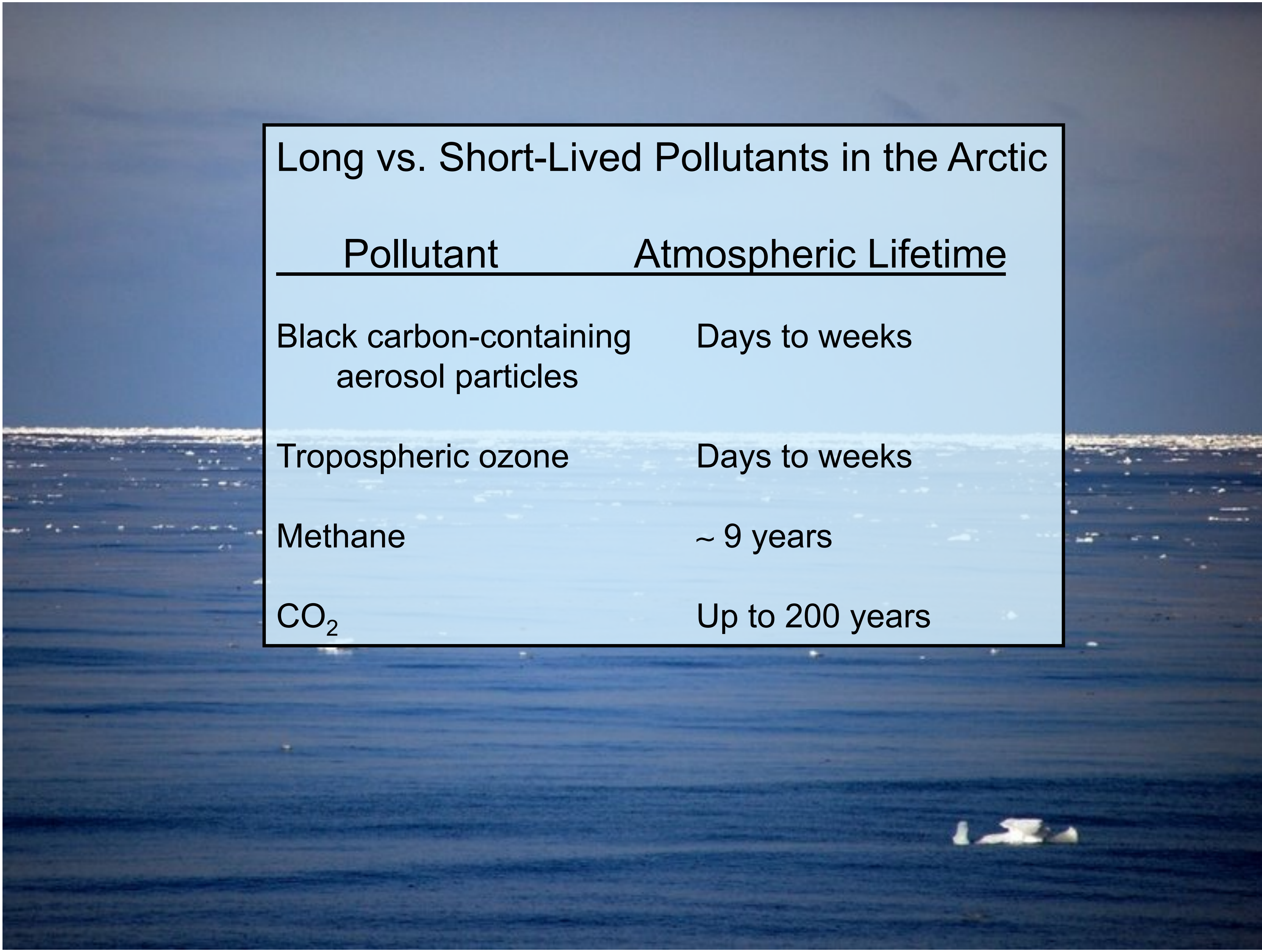
- Arctic Council at its last Ministerial meeting in 2009 created a Short-Lived Climate Forcers Task Force, to identify existing and new measures to reduce SLCF emissions.
- Choosing as its first focus black carbon, the Task Force will present an initial suite of recommendations in Nuuk.
- ***We are strongly urging the Council to collectively support these recommendations and for each nation to commit to immediately undertake domestic implementation.***
- ***We are also urging the Arctic nations and others to address other SLCFs such as methane and ozone.***

Today's speakers

- Dr. Gordon Hamilton, Associate Professor at the University of Maine.
- Dr. Patricia Quinn, a research chemist with the Ocean Climate Research Division of NOAA's Pacific Marine Environmental Lab in Seattle.
- Rafe Pomerance, former President and now Senior Advisor and Fellow of Clean Air-Cool Planet. Former Deputy Assistant Secretary of State for Environment and Development during the Clinton Administration.


Gordon Hamilton
University of Maine
gordon.hamilton@maine.edu

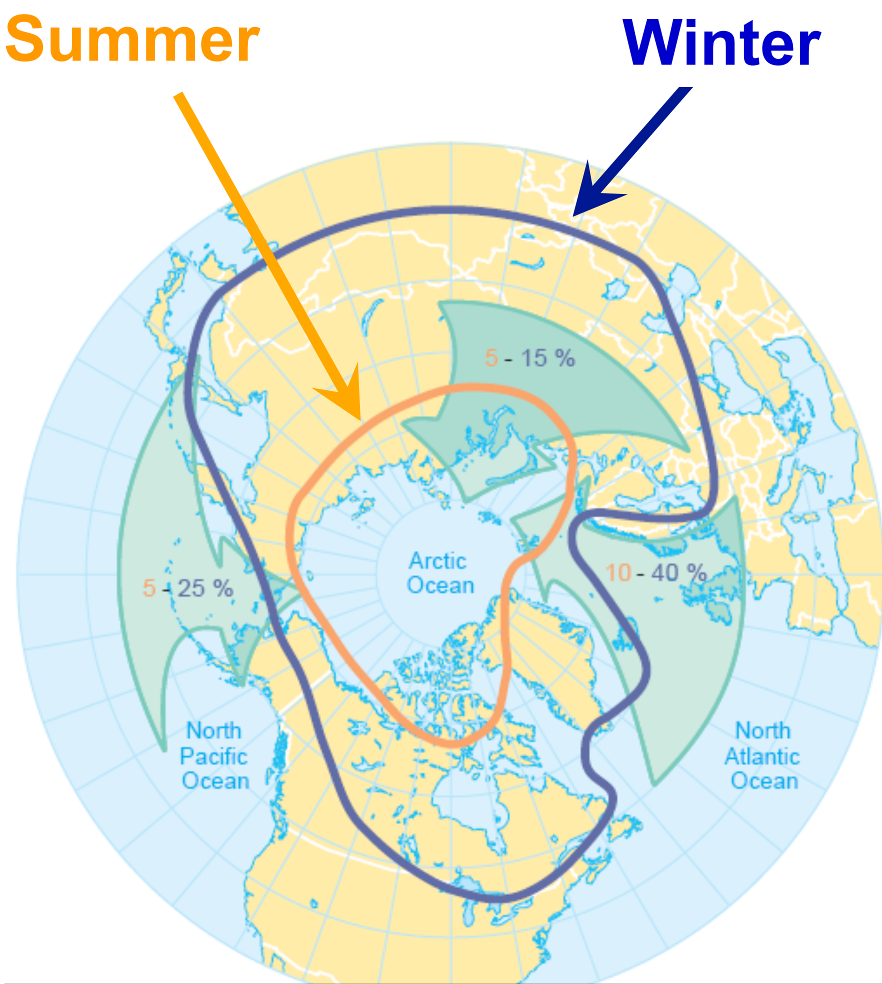

Trish Quinn
NOAA/PMEL
patricia.k.quinn@noaa.gov



Long vs. Short-Lived Pollutants in the Arctic

Pollutant	Atmospheric Lifetime
Black carbon-containing aerosol particles	Days to weeks
Tropospheric ozone	Days to weeks
Methane	~ 9 years
CO_2	Up to 200 years

Long-Range Transport of Pollutants to the Arctic



Mean position of the Arctic Front in Winter and Summer

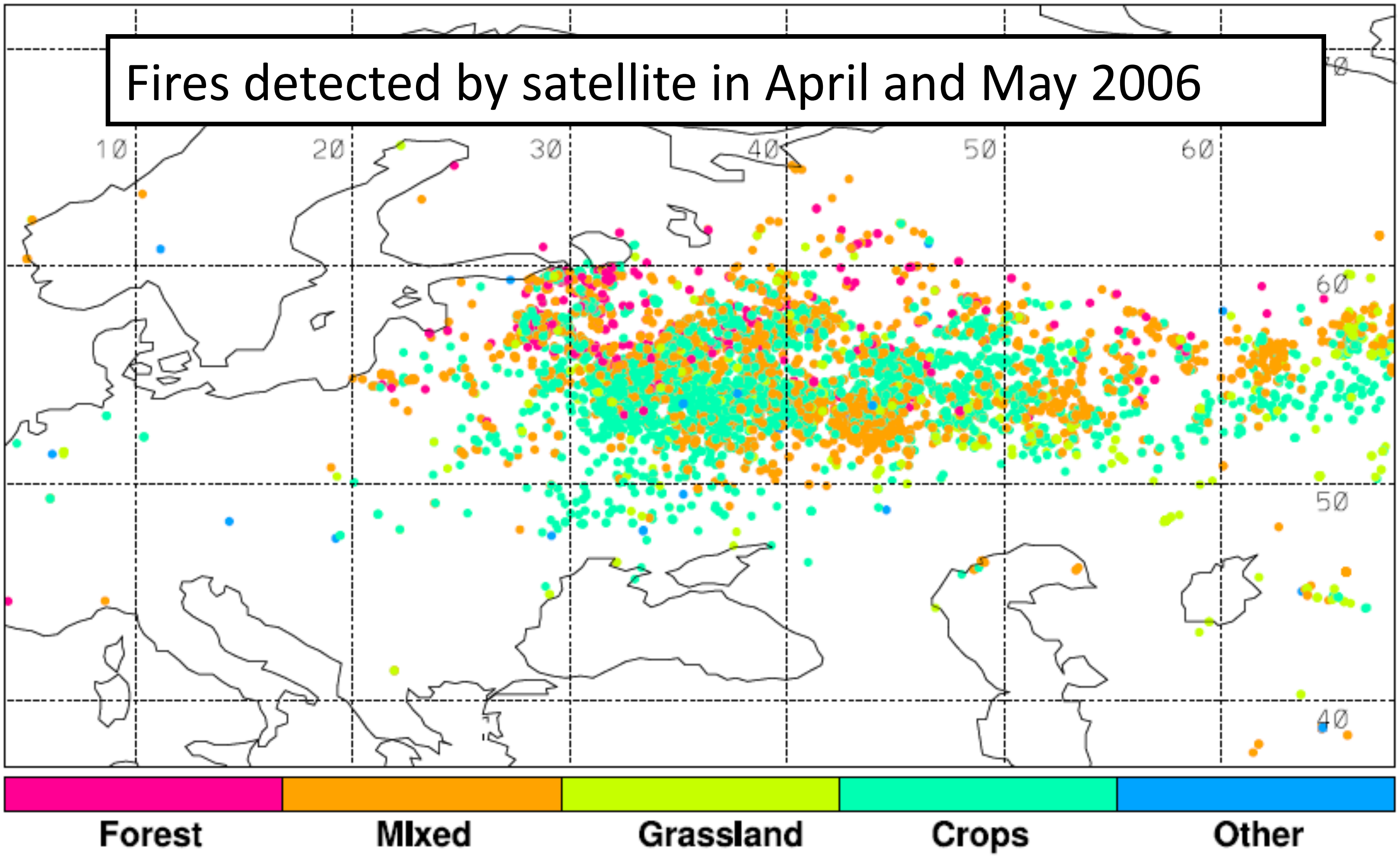
- The Arctic Front forms a barrier to transport.

- In winter, the front can extend as far south as 40°N over northern Europe and Asia due to cold temperatures in that region.

- Northern Eurasia is the major source region of pollutants to the Arctic boundary layer due to:
  - extension of Arctic Front to near 40°N at this longitude
  - pollution sources
  - snow-covered surfaces allow for isentropic transport into the Arctic

- Warmer source regions can impact higher altitudes within the Arctic

Springtime transport of smoke from agricultural fires in Eastern Europe to the Arctic



Stohl et al., 2006 (ACP)

Visibility degradation at Zeppelin

Pictures courtesy: Ann-Christine Engvall

Visibility degradation at Zeppelin

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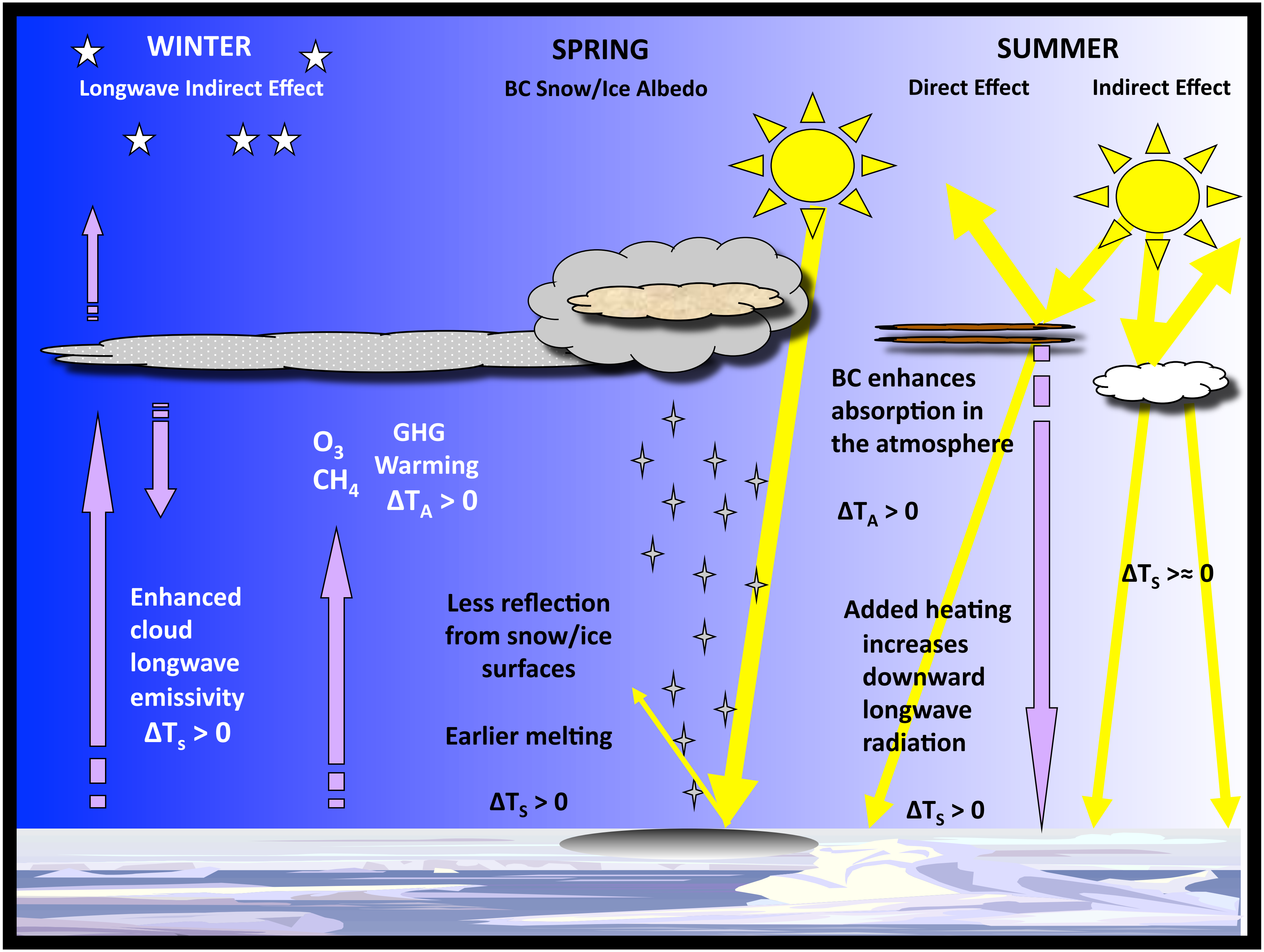
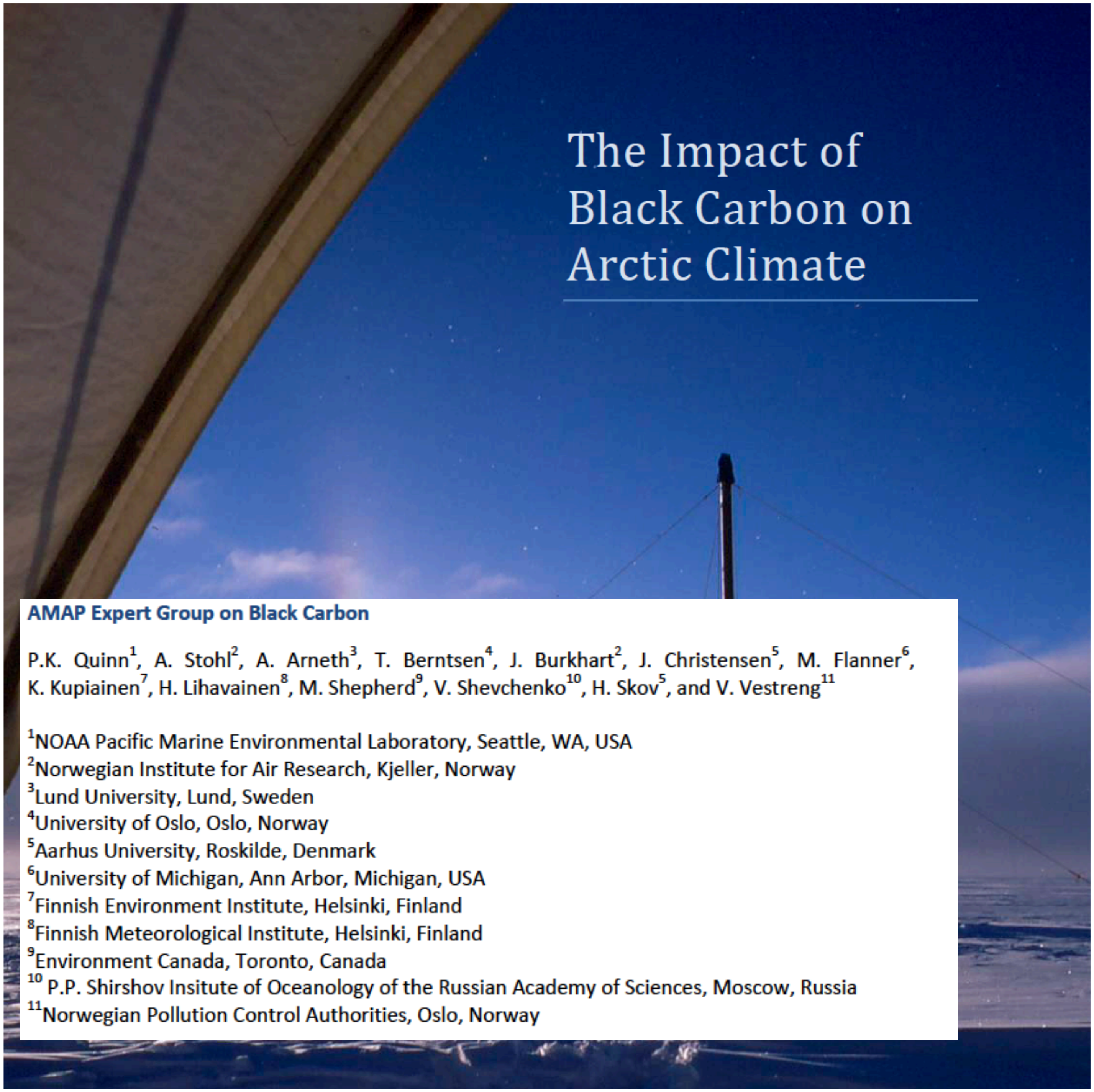


WINTER
Longwave Indirect Effect
SPRING
BC Snow/Ice Albedo
SUMMER
Direct Effect
Indirect Effect
Enhanced cloud longwave emissivity
$\Delta T_S > 0$
O_3
CH_4
GHG Warming
$\Delta T_A > 0$
Less reflection from snow/ice surfaces
Earlier melting
$\Delta T_S > 0$
BC enhances absorption in the atmosphere
$\Delta T_A > 0$
Added heating increases downward longwave radiation
$\Delta T_S > 0$
$\Delta T_S >\approx 0$



The Impact of Black Carbon on Arctic Climate

AMAP Expert Group on Black Carbon

P.K. Quinn[1], A. Stohl[2], A. Arneth[3], T. Berntsen[4], J. Burkhart[2], J. Christensen[5], M. Flanner[6], K. Kupiainen[7], H. Lihavainen[8], M. Shepherd[9], V. Shevchenko[10], H. Skov[5], and V. Vestreng[11]

[1]NOAA Pacific Marine Environmental Laboratory, Seattle, WA, USA
[2]Norwegian Institute for Air Research, Kjeller, Norway
[3]Lund University, Lund, Sweden
[4]University of Oslo, Oslo, Norway
[5]Aarhus University, Roskilde, Denmark
[6]University of Michigan, Ann Arbor, Michigan, USA
[7]Finnish Environment Institute, Helsinki, Finland
[8]Finnish Meteorological Institute, Helsinki, Finland
[9]Environment Canada, Toronto, Canada
[10] P.P. Shirshov Insitute of Oceanology of the Russian Academy of Sciences, Moscow, Russia
[11]Norwegian Pollution Control Authorities, Oslo, Norway

AMAP Expert Group on Short-Lived Climate Forcers:

1st Assessment Report

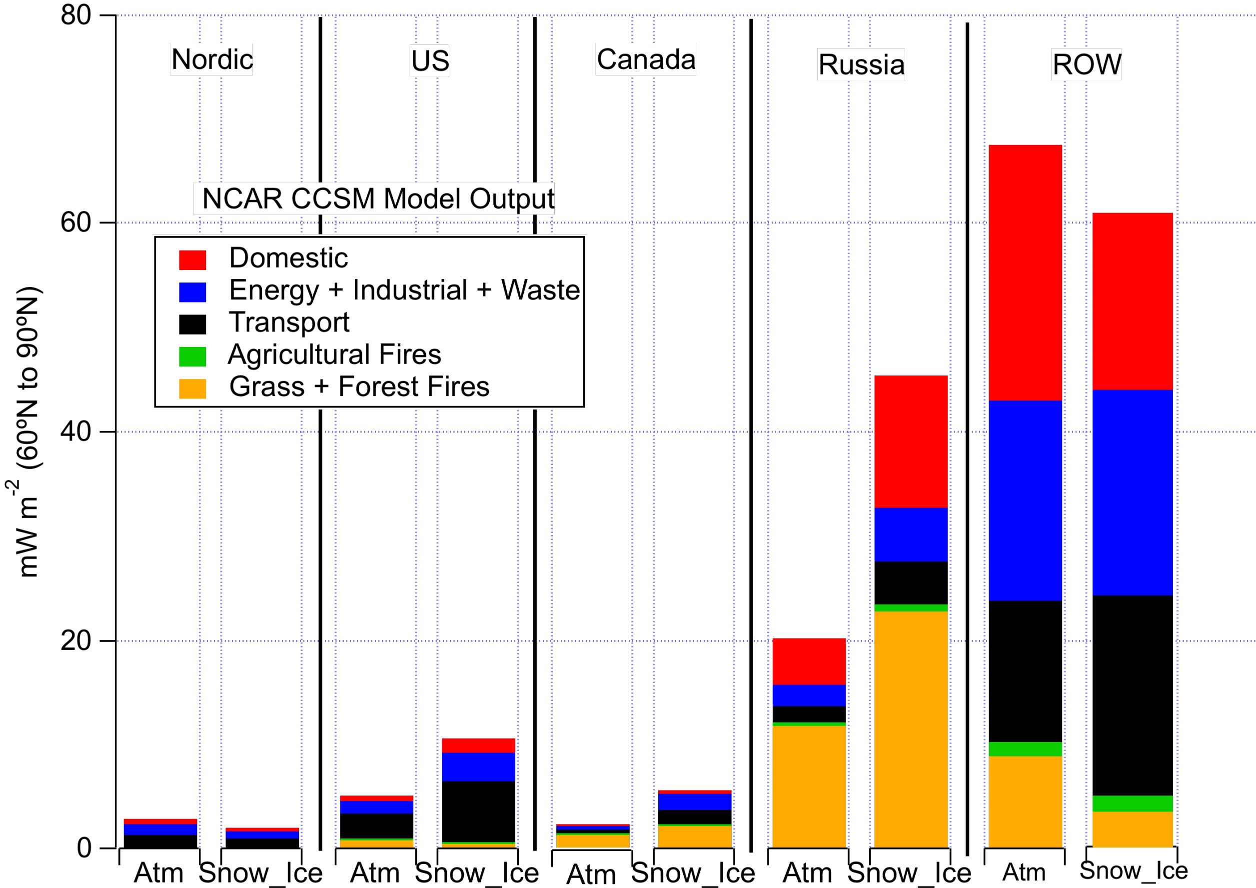
Parameters used to identify regions and sectors for mitigation of BC-containing aerosols:

- Absolute level of impact (Radiative Forcing in Wm^{-2})
- Impact normalized to emission (Radiative Forcing per unit emission in $Wm^{-2}/Tg(yr)^{-1}$) ← Degree of "Bang for the buck"

Factors not discussed here:

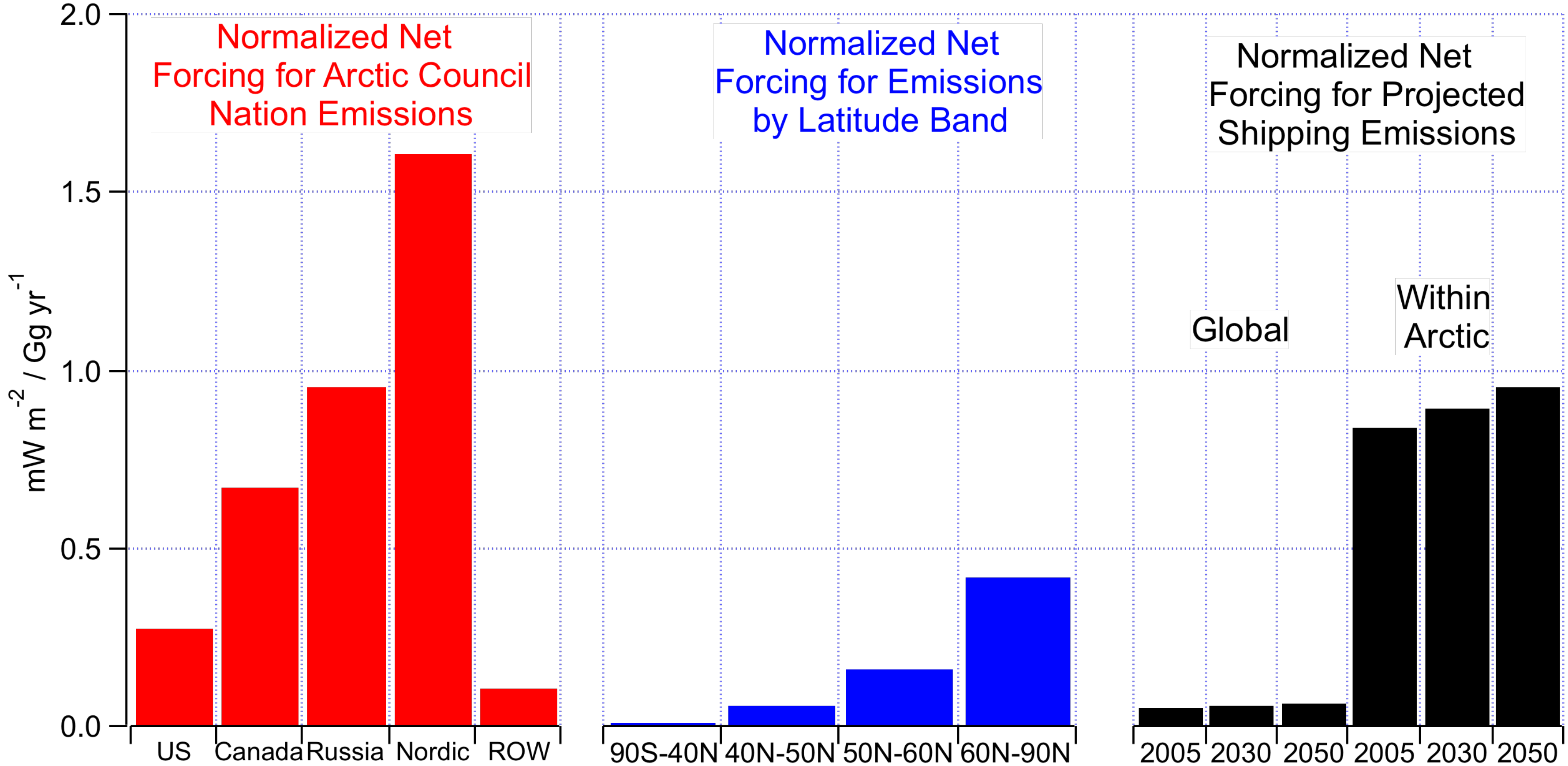
- Mitigation costs
- Feasibility (Technical and Political)

Absolute Level of Impact: Forcing due to BC + OC Mixture by Source Sector and Region within the Arctic Council Nations compared to ROW



- Rest of World dominates absolute forcing because of magnitude of emissions
- Forcing from Nordic countries and the U.S. is dominated by transport emissions
- Forcing from Canada and Russia is dominated by Grass + Forest Fires

Summary of Normalized Net Forcing (Atmospheric Direct RF (BC) and BC-Snow/Ice RF) due to Emissions from Arctic Council Nations, Considered Latitude Bands, and Global and Within-Arctic Shipping (NCAR CCSM)



Near Arctic and within Arctic sources have large forcings per unit emission due to their likelihood of being transported to the Arctic and being deposited at the surface.

Select Findings from the AMAP Expert Group Assessment on "The Impact of Black Carbon Arctic Climate"

- Reductions in the emissions of CO_2 are the backbone of any meaningful effort to mitigate climate change. The limited focus of this assessment on BC is not meant to distract from primary efforts on CO_2 reductions or mislead mitigation action toward a sole focus on BC.

- That said, immediate reductions in short-lived climate forcers (BC and CH_4) will have a larger near-term impact on global temperature than immediate reductions in CO_2.

Impact on global average temperature of immediate reductions in CH_4, BC, and CO_2

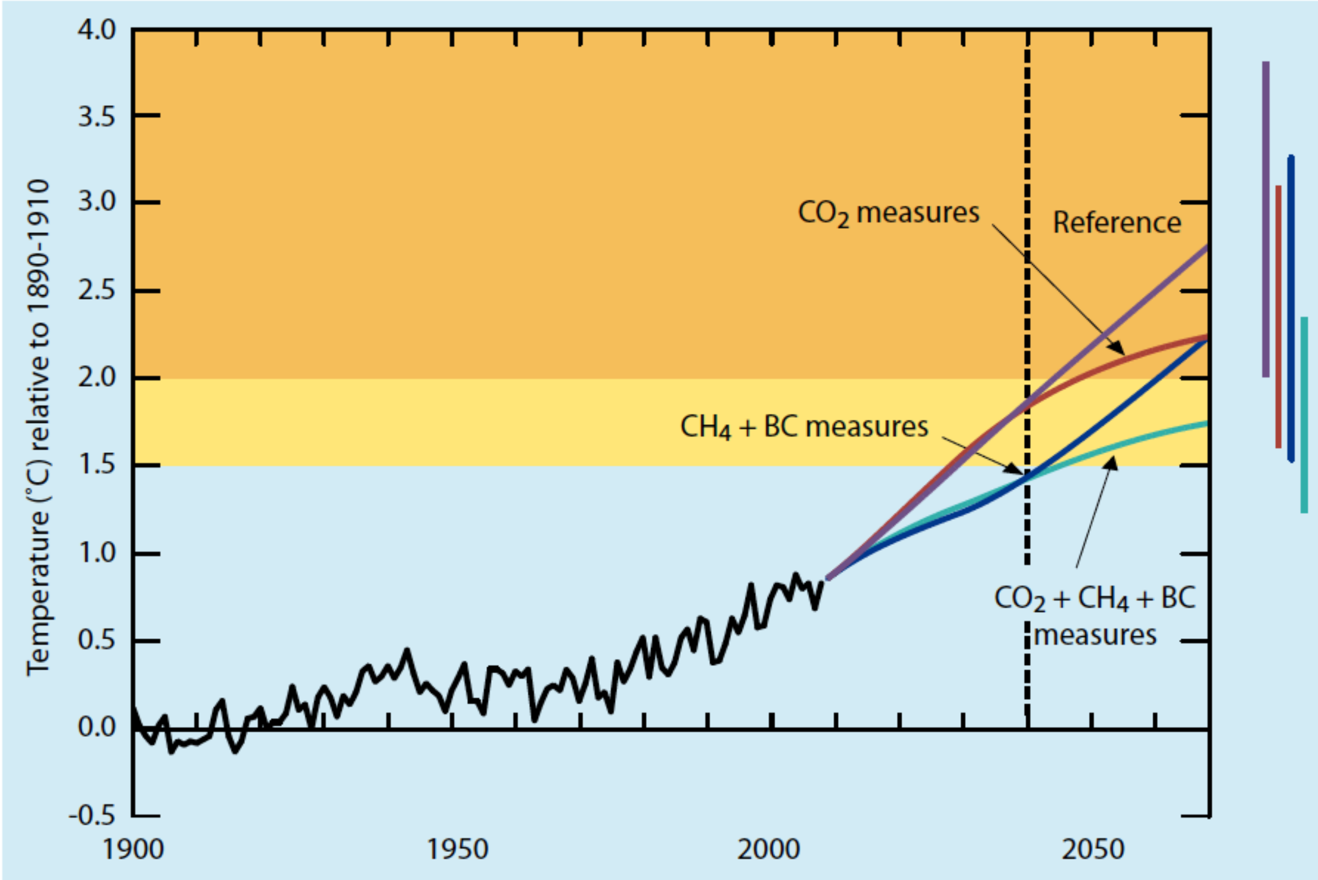


Figure 3. Observed deviation of temperature to 2009 and projections under various scenarios. Immediate implementation of the identified BC and CH_4 measures, together with measures to reduce CO_2 emissions, would greatly improve the chances of keeping Earth's temperature increase to less than 2°C relative to pre-industrial levels. The bulk of the benefits of CH_4 and BC measure are realized by 2040 (dashed line).

Explanatory notes: Actual mean temperature observations through 2009, and projected under various scenarios thereafter, are shown relative to the 1890–1910 mean temperature. Estimated ranges for 2070 are shown in the bars on the right. A portion of the uncertainty is common to all scenarios, so that overlapping ranges do not mean there is no difference, for example, if climate sensitivity is large, it is large regardless of the scenario, so temperatures in all scenarios would be towards the high-end of their ranges.

Integrated Assessment of Black Carbon and Tropospheric Ozone

UNEP Summary for Decision Makers (2010)

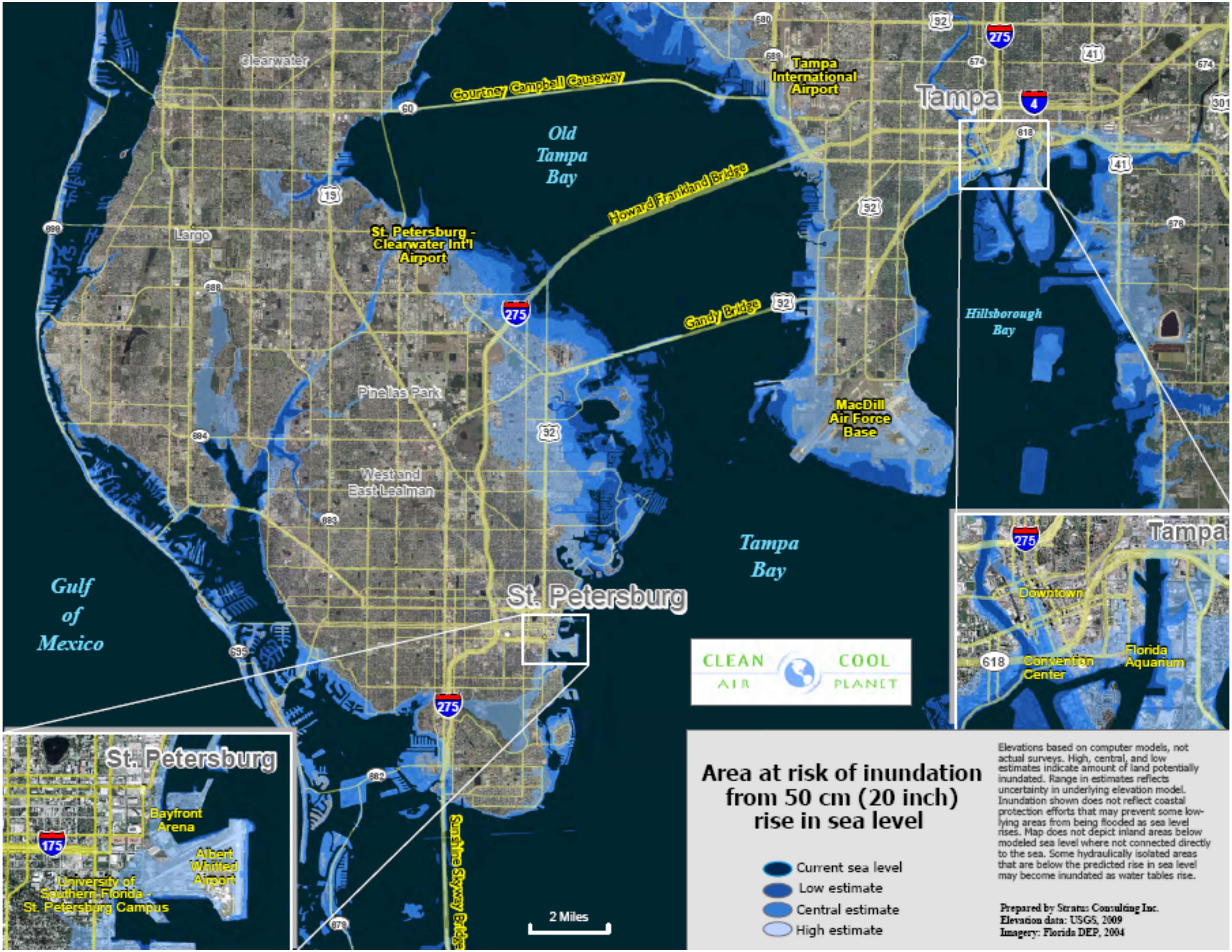
Select Findings from the AMAP Expert Group Assessment on "The Impact of Black Carbon Arctic Climate"

• Carbonaceous aerosol (both black carbon and organic carbon) emitted near or within the Arctic will have the greatest impact on Arctic climate. Emissions in close proximity to or within the Arctic are more likely to cause surface warming and to be deposited to snow and ice surfaces than emissions further south.

• The BC snow/ice *radiative forcing per unit of BC emitted* is larger for the Arctic Council nations or high latitude regions (> 40°N) of Arctic Council nations than for the Rest of the World. As a result, the Nordic countries are associated with the largest *forcing per unit of BC emission* due to emissions occurring at the highest latitudes.

• Forest, grassland and agricultural fires are the source types in Canada and Russia that dominate BC+OC radiative forcing in the Arctic. Fossil fuel combustion (e.g., diesel engines) is the dominant source in the U.S., Nordic countries and ROW.


Rafe Pomerance
Clean Air-Cool Planet
rpomerance@cleanair-coolplanet.org

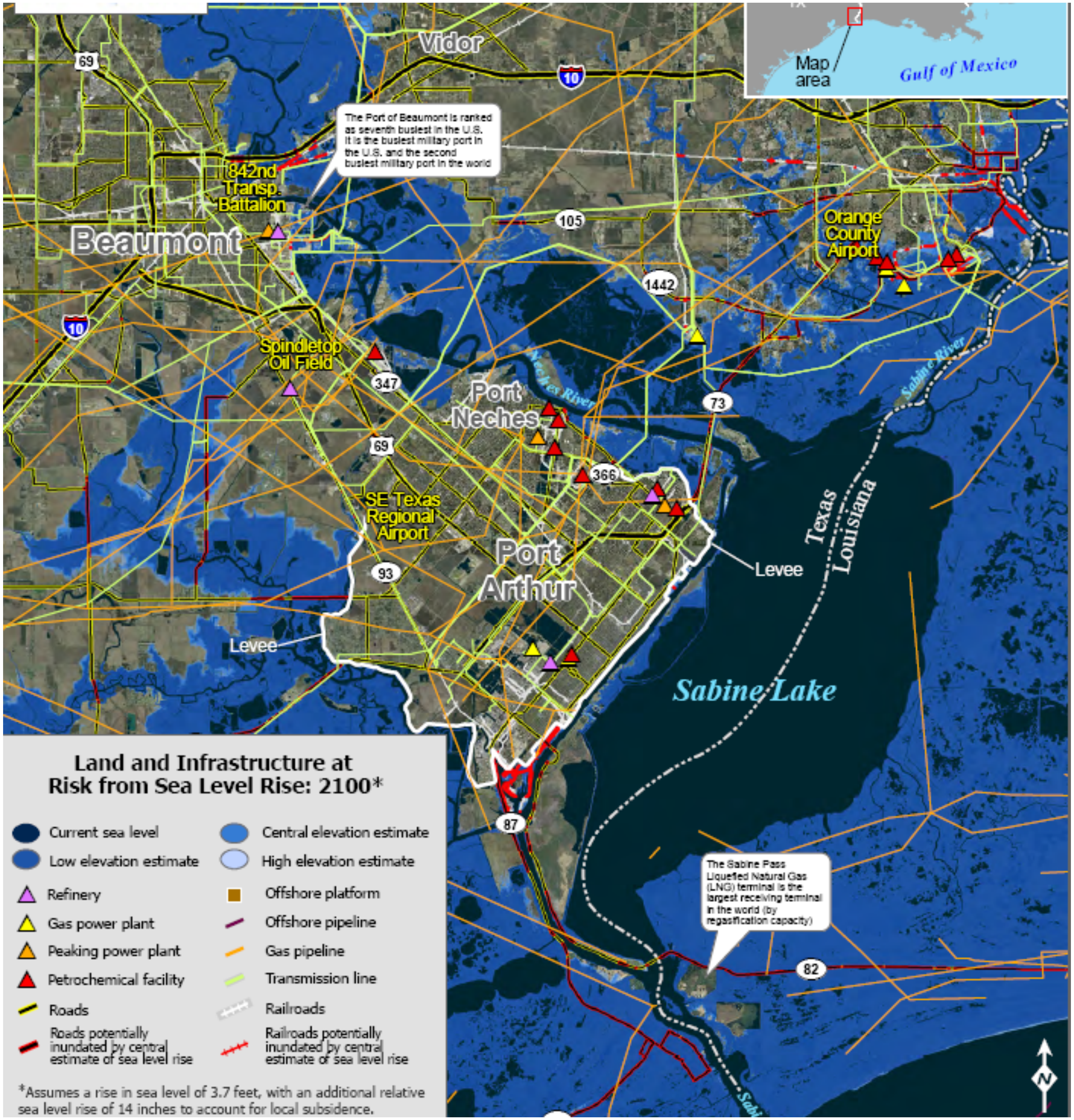


Clearwater
Courtney Campbell Causeway
Old Tampa Bay
Tampa International Airport
Tampa
Howard Frankland Bridge
Largo
St. Petersburg - Clearwater Int'l Airport
Gandy Bridge
Hillsborough Bay
Pinellas Park
MacDill Air Force Base
West and East Lealman
Tampa Bay
Gulf of Mexico
St. Petersburg
CLEAN AIR COOL PLANET
Downtown
Convention Center
Florida Aquarium
Bayfront Arena
Albert Whitted Airport
University of Southern Florida - St. Petersburg Campus
Sunshine Skyway Bridge
2 Miles
Area at risk of inundation from 50 cm (20 inch) rise in sea level
Current sea level
Low estimate
Central estimate
High estimate
Elevations based on computer models, not actual surveys. High, central, and low estimates indicate amount of land potentially inundated. Range in estimates reflects uncertainty in underlying elevation model. Inundation shown does not reflect coastal protection efforts that may prevent some low-lying areas from being flooded as sea level rises. Map does not depict inland areas below modeled sea level where not connected directly to the sea. Some hydraulically isolated areas that are below the predicted rise in sea level may become inundated as water tables rise.
Prepared by Stratus Consulting Inc.
Elevation data: USGS, 2009
Imagery: Florida DEP, 2004


Area at risk of inundation from
3.3 ft. (1-meter) rise in sea level
Current sea level
Low estimate
Central estimate
High estimate
CLEAN AIR COOL PLANET
Prepared by Stratus Consulting Inc.
Elevation data: NOAA, 2007;
SC DNR, 2006
Imagery: USDA, 2009
Elevations based on computer models, not actual surveys. High, central, and low estimates indicate amount of land potentially inundated. Range in estimates reflects uncertainty in underlying elevation model. Inundation shown does not reflect coastal protection efforts that may prevent some low-lying areas from being flooded as sea level rises. Map does not depict inland areas below modeled sea level where not connected directly to the sea. Some hydraulically isolated areas that are below the predicted rise in sea level may become inundated as water tables rise.
North Charleston Terminal
Charleston AFB/Int'l Airport
North Charleston
Cooper River
Veterans Terminal
Ashley River
Daniel Island
Wando River
Wando Welch Terminal
Drum Island
Ravenel Bridge
The Citadel
Columbus St. Term.
Charleston
Med. Univ. of S.C.
College of Charleston
Union Pier Term.
Patriots Point
Mt. Pleasant
Savannah Highway
Stono River
Charleston Harbor
Fort Sumter Nat'l Mon

Thank you—Contact Info:

sross@catf.us
dhrizza@gmail.com
armond@catf.us
gordon.hamilton@maine.edu
patricia.k.quinn@noaa.gov
rpomerance@cleanair-coolplanet.org


Vidor
69
10
Map area
Gulf of Mexico
The Port of Beaumont is ranked as seventh busiest in the U.S. It is the busiest military port in the U.S. and the second busiest military port in the world
842nd Transp. Battalion
Beaumont
105
1442
Orange County Airport
10
Spindletop Oil Field
347
Neches River
Port Neches
73
Sabine River
69
366
SE Texas Regional Airport
Port Arthur
93
Levee
Texas
Louisiana
Levee
Sabine Lake
87
The Sabine Pass Liquefied Natural Gas (LNG) terminal is the largest receiving terminal in the world (by regasification capacity)
82
Land and Infrastructure at Risk from Sea Level Rise: 2100*
Current sea level
Low elevation estimate
Central elevation estimate
High elevation estimate
Refinery
Gas power plant
Peaking power plant
Petrochemical facility
Roads
Roads potentially inundated by central estimate of sea level rise
Offshore platform
Offshore pipeline
Gas pipeline
Transmission line
Railroads
Railroads potentially inundated by central estimate of sea level rise
*Assumes a rise in sea level of 3.7 feet, with an additional relative sea level rise of 14 inches to account for local subsidence.
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