Reducing tropospheric ozone with methane controls:

Impact on Arctic radiative forcing

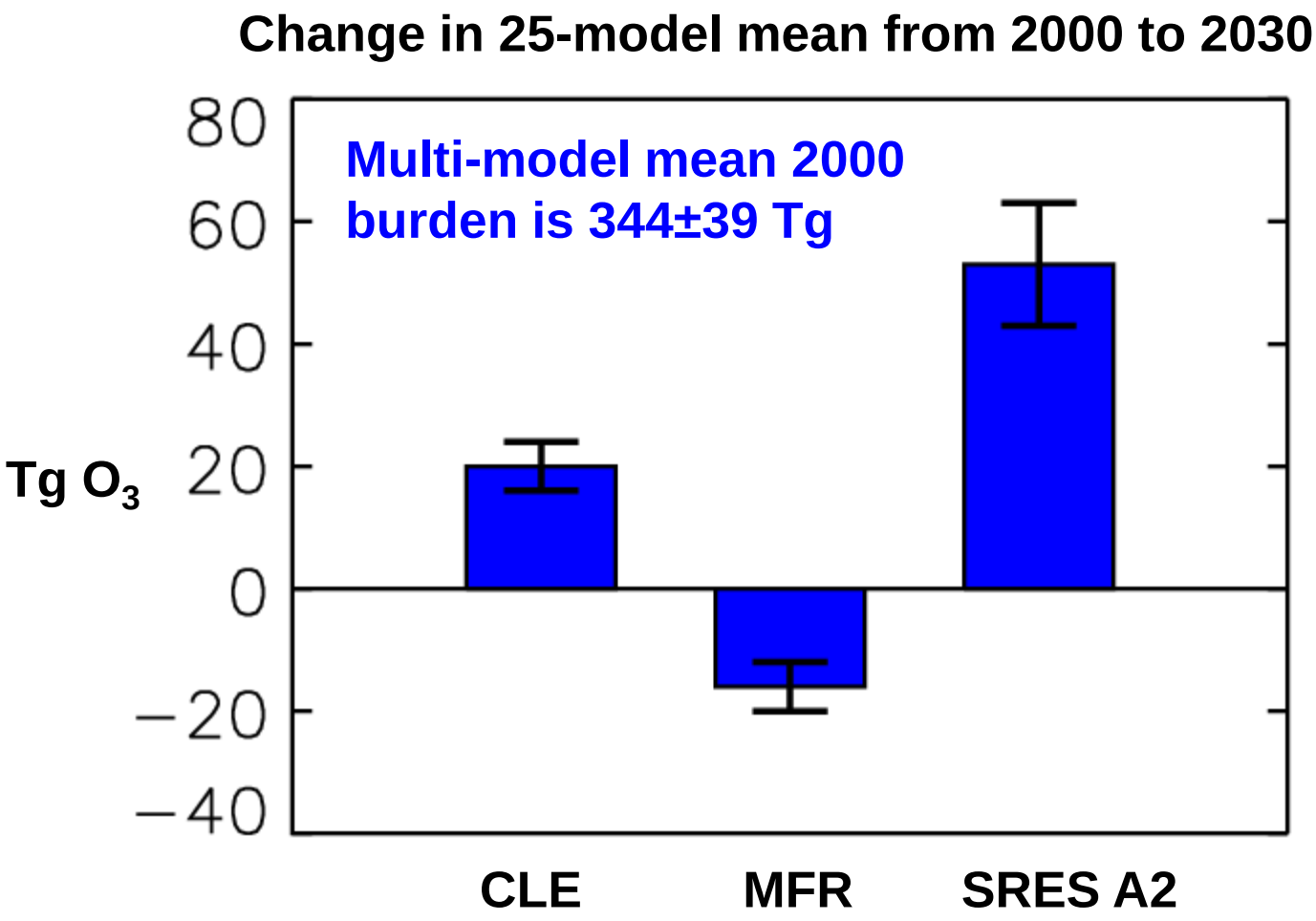
Arlene M. Fiore
(arlene.fiore@noaa.gov)

Acknowledgments:
Larry Horowitz, Dan Schwarzkopf (NOAA/GFDL)
Jason West, Vaishali Naik (Princeton University)
Ellen Baum, Joe Chaisson (Clean Air Task Force)

Funding from Luce Foundation via Clean Air Task Force

Arctic Workshop at NASA GISS, January 8, 2006

Projected changes in tropospheric O_3 burden by 2030



Stevenson et al., JGR, 2006

CLE scenario: Changes in emissions and O_3 burden

Anthropogenic emission changes in CLE (2030-2005):

CH_4 +29% (+96 Tg CH_4 yr^{-1}) **NO_x +19% (+5.3 Tg N yr^{-1})**

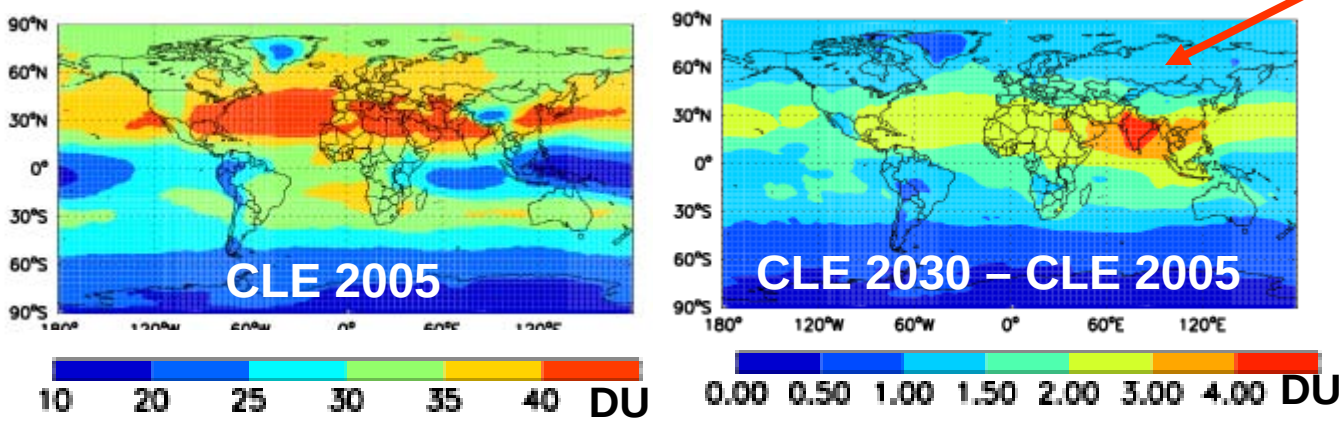
CO -10% (-44 Tg CO yr^{-1}) **VOC +3% (+3 Tg C yr^{-1})**

2005 to 2030 transient simulations in MOZART-2 CTM [*Horowitz et al.*, 2003]
2000-2004 NCEP meteorology; 1.9°x1.9°; 28 vertical levels

ANNUAL MEAN TROPOSPHERIC O_3 COLUMNS (DU)

+1DU increase in Arctic

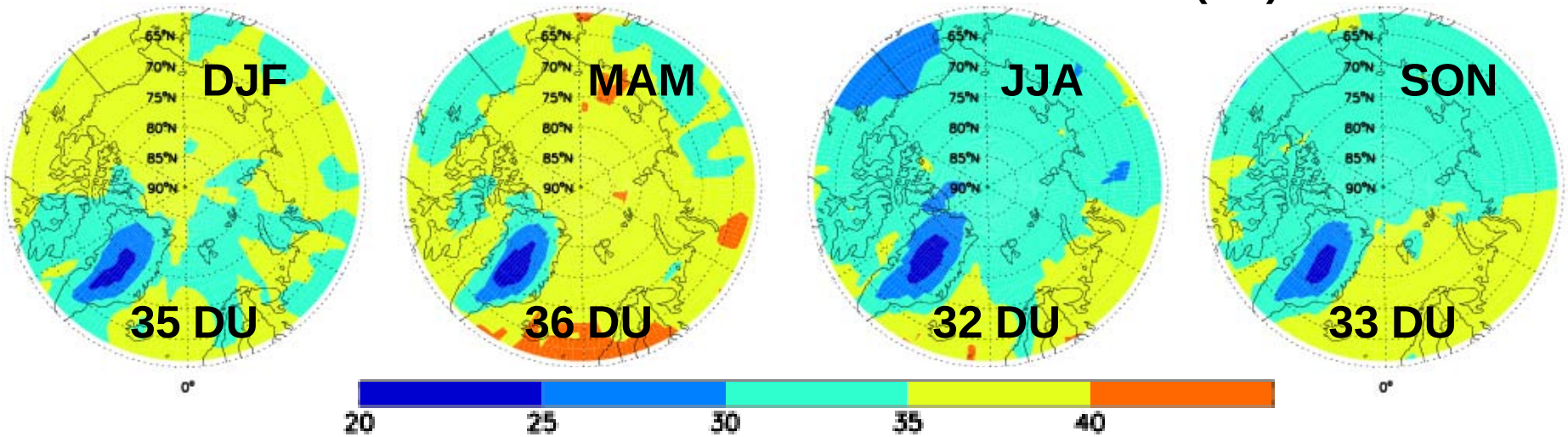
31 DU
340 Tg O_3 global burden



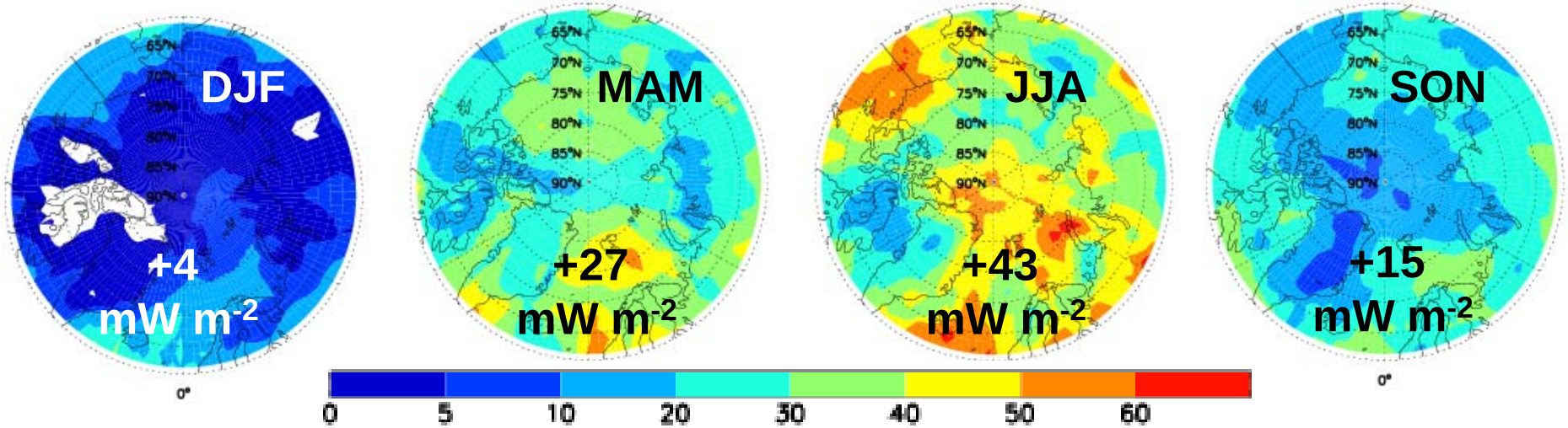
increase from 2005 to 2030:
+1.6 DU
+18 Tg O_3

Arctic O_3 columns highest in winter and spring; Radiative forcing largest spring and summer

CLE 2030 TROPOSPHERIC OZONE COLUMNS (DU)

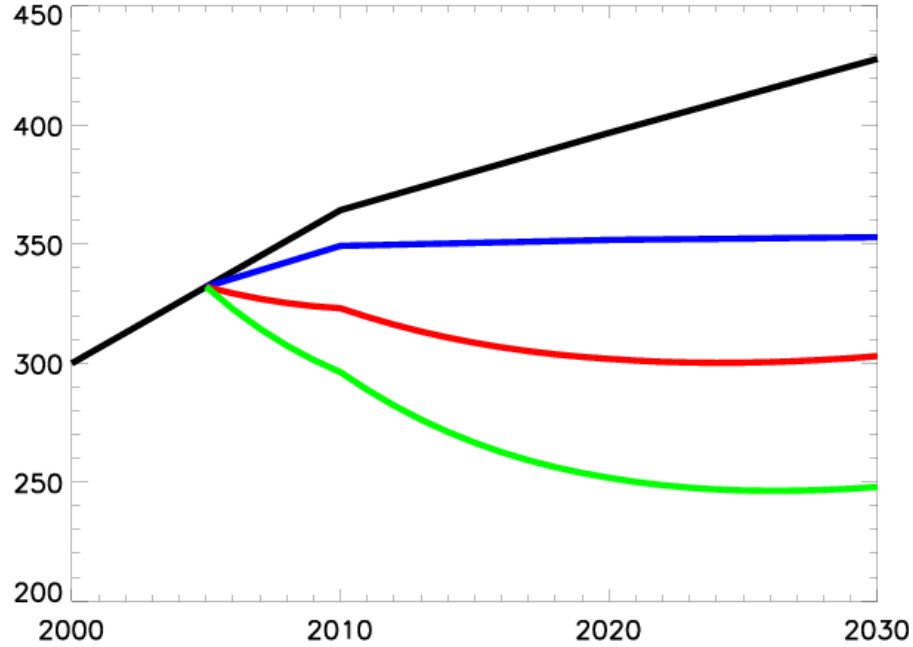


OZONE RADIATIVE FORCING (mW m^{-2}) 2005 TO 2030 UNDER CLE SCENARIO



Apply methane controls relative to CLE baseline scenario

Anthropogenic CH_4 Emissions (Tg yr^{-1})



Control scenarios reduce 2030 emissions relative to CLE by:

A) -75 Tg (18%)

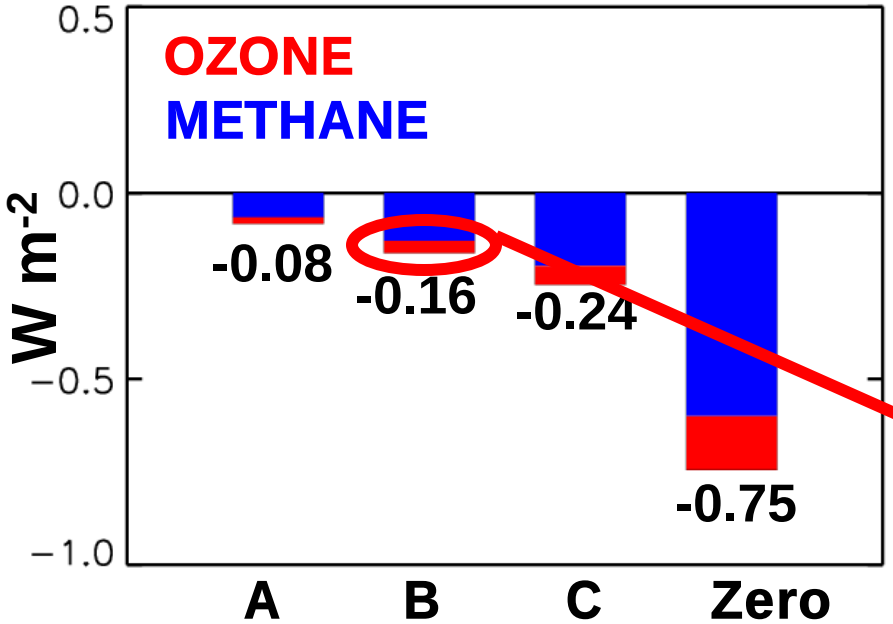
B) -125 Tg (29%)

C) -180 Tg (42%)

+ 2030 simulation with CH_4 set to 700 ppb pre-industrial level

Methane controls reduce global radiative forcing

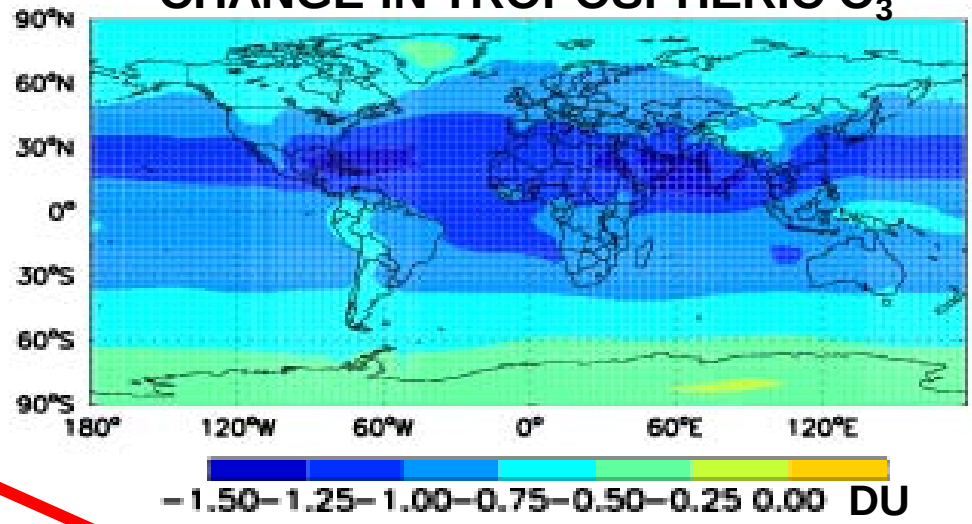
Radiative Forcing in 2030 relative to CLE 2030



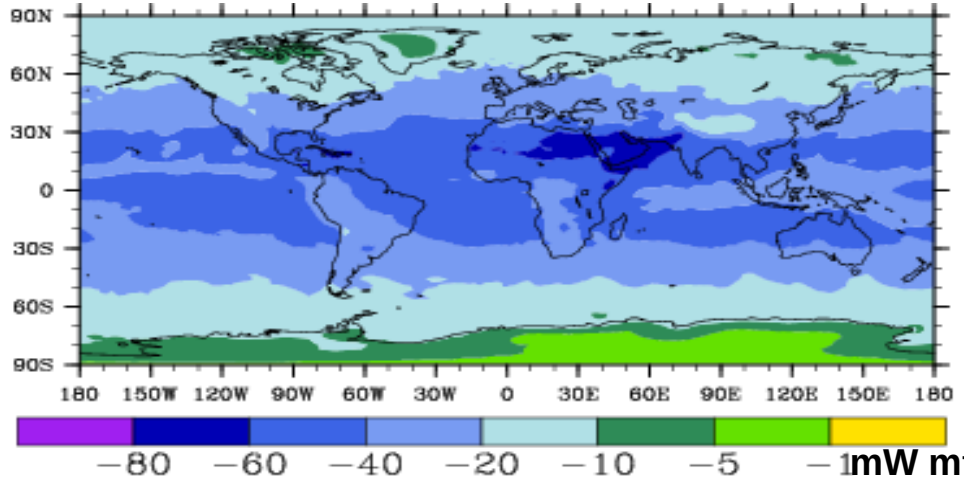
Methane control scenario

SCENARIO B – CLE BASE 2030

CHANGE IN TROPOSPHERIC O_3



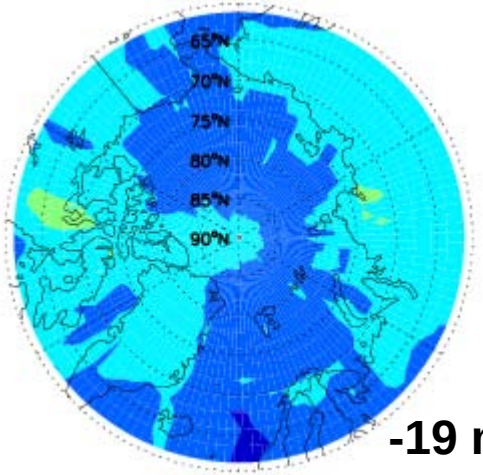
TROPOSPHERIC OZONE FORCING



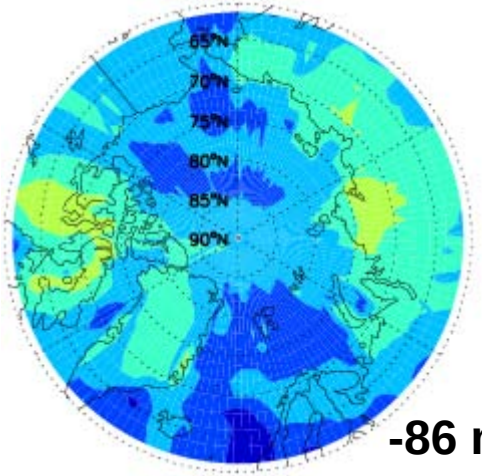
Methane Controls: Impact on Arctic radiative forcing

SCENARIO B | **ZERO ANTHROP. CH_4**

MAM

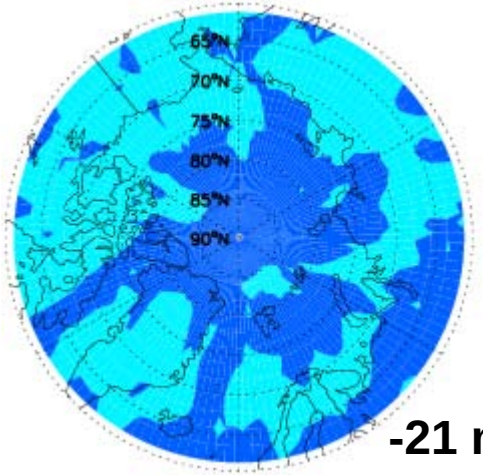


-19 mW m^{-2}

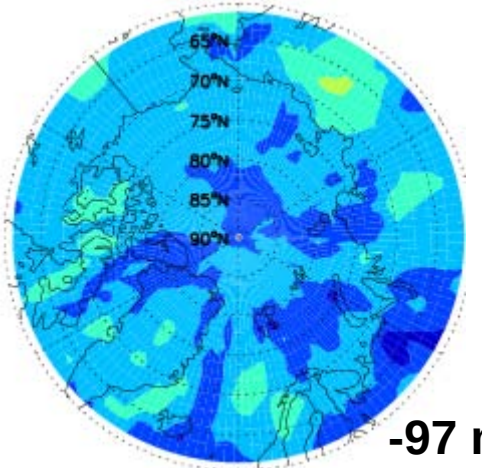


-86 mW m^{-2}

JJA



-21 mW m^{-2}



-97 mW m^{-2}

-40 -30 -20 -10 -5

mW m^{-2}

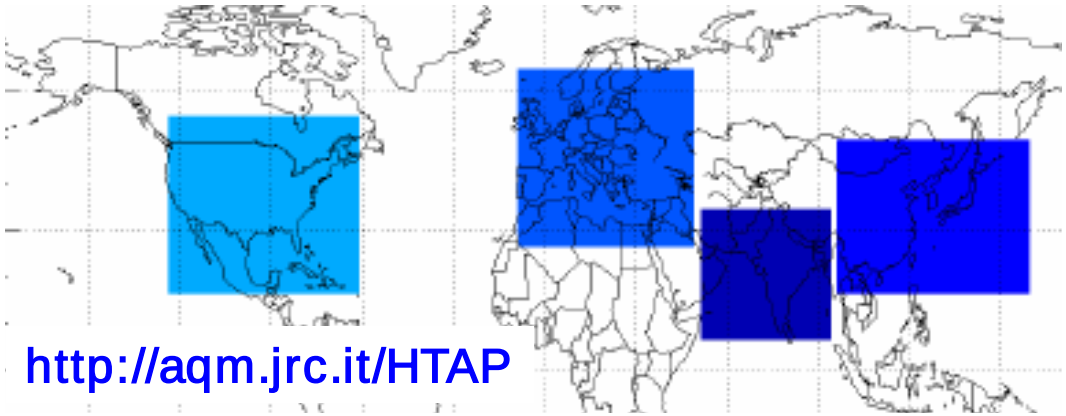
-150 -125 -100 -75 -50 -25

TF HTAP multi-model assessment: The Arctic as a receptor region?

Task Force on Hemispheric Transport of Air Pollution

Co-Chairs: Terry Keating (U.S. EPA), Andre Zuber (EC)
www.htap.org

Intercontinental Source-Receptor Regions



http://aqm.jrc.it/HTAP

20% decreases in anthrop. emissions in HTAP regions:

- NO_x, CO, NMVOC
- aerosols and precursors
- mercury
- POPs

Also 20% decrease in global CH_4 concentration

~ 13 modeling groups have already delivered results for Experiment 1

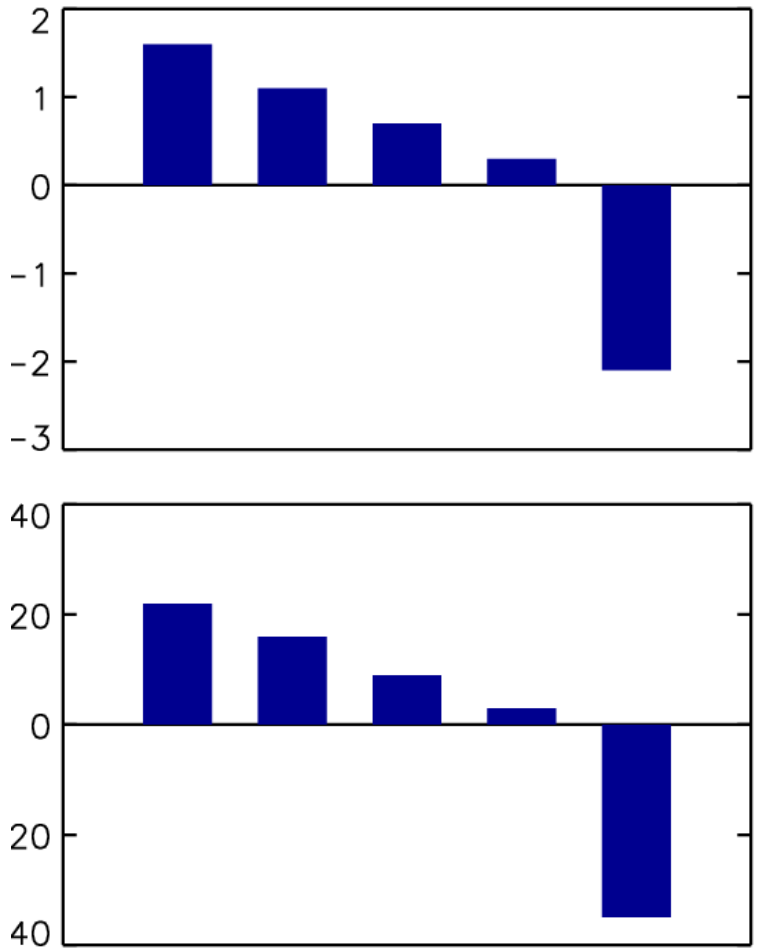
→ Opportunity to assess impact of several species from major NH source regions on the Arctic in a consistent way across models

Summary:
Impact of methane controls on Arctic radiative forcing

Annual mean changes in the Arctic from 2005 to 2030

TROPOSPHERIC OZONE COLUMN (DU)

OZONE RADIATIVE FORCING (mW m^{-2})



CLE A B C Zero Anth. CH_4

INCREASING METHANE CONTROL →

Additional decrease in radiative forcing from lower CH_4 abundances