Climate impacts of short-lived climate forcers

Credit: CC0 Public Domain

Maria Sand

NKL workshop 20. november 2019

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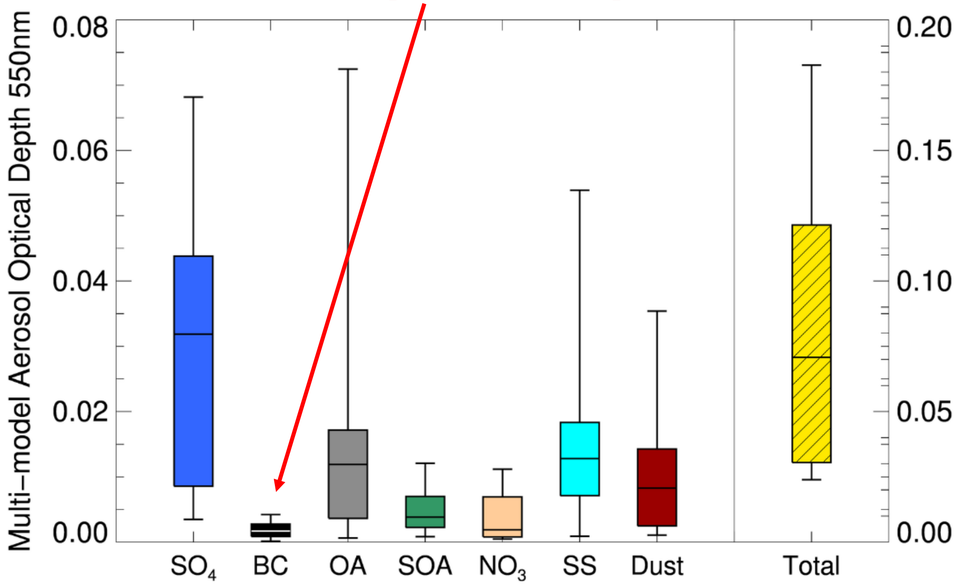
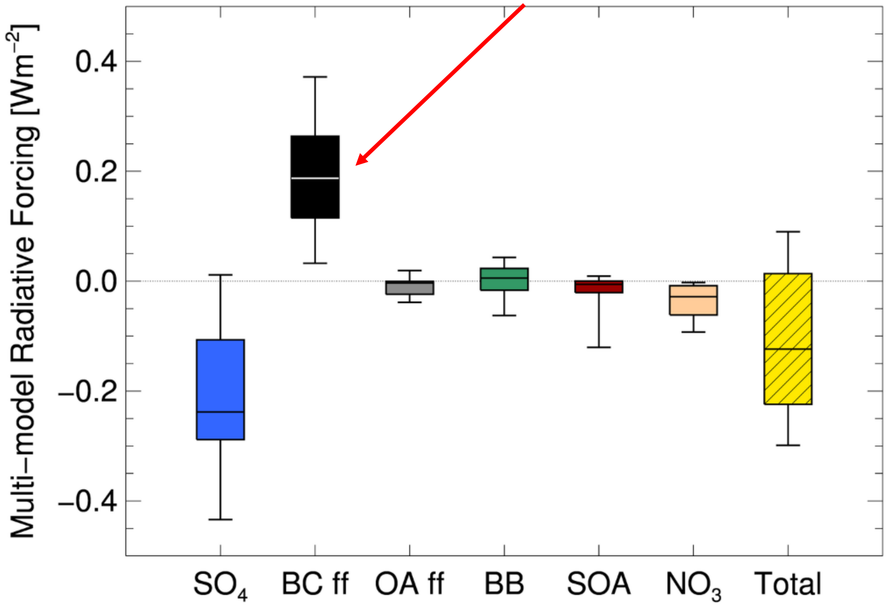
There is not much Black Carbon in the Arctic, but it dominates the radiative forcing during spring

Aerosol Optical Depth 550nm



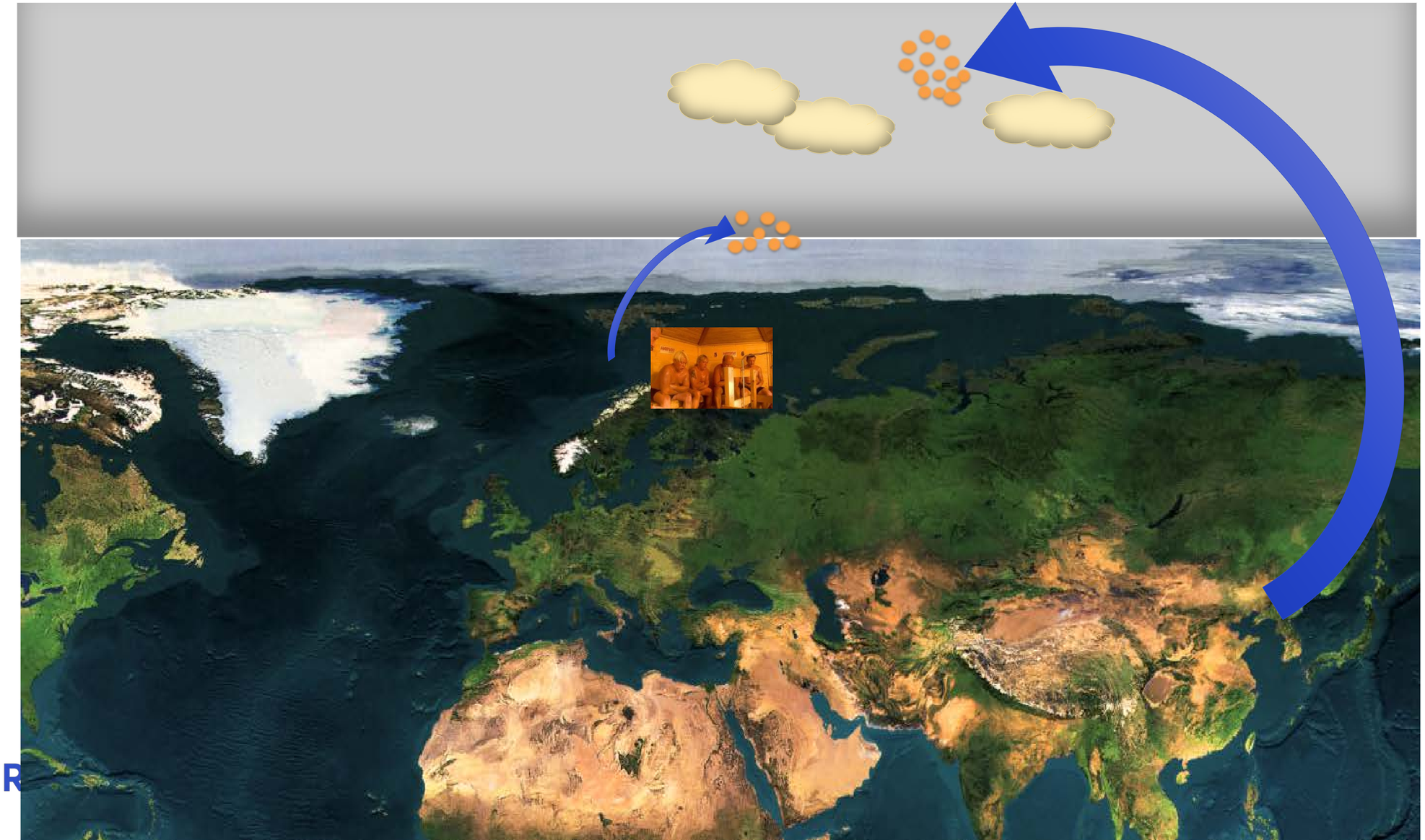
Direct radiative forcing



Aerocom phase II model intercomparison

°CICERO Sand et al, ACP, 2018

Emissions close to the Arctic are transported into the Arctic at lower altitudes



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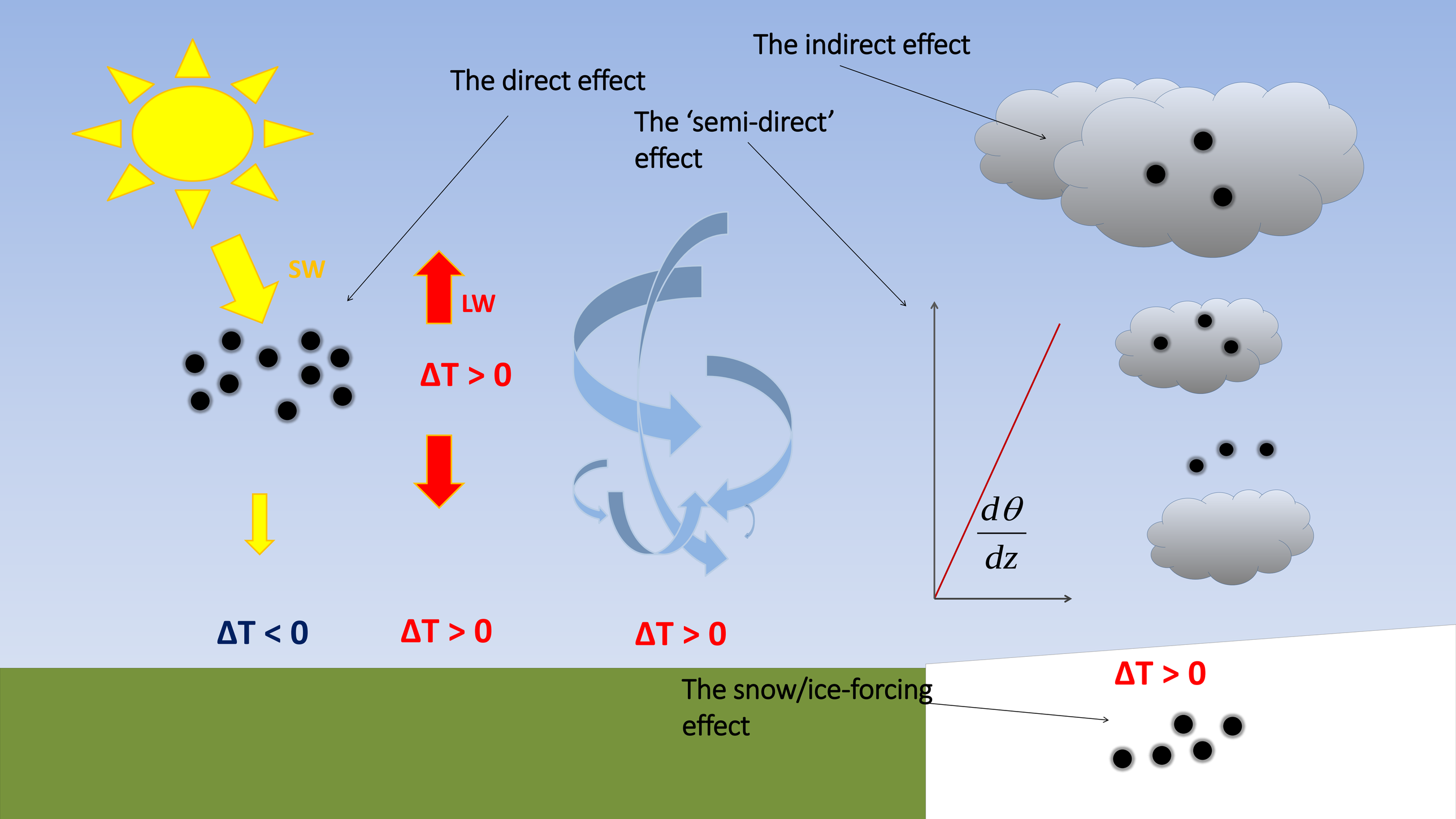
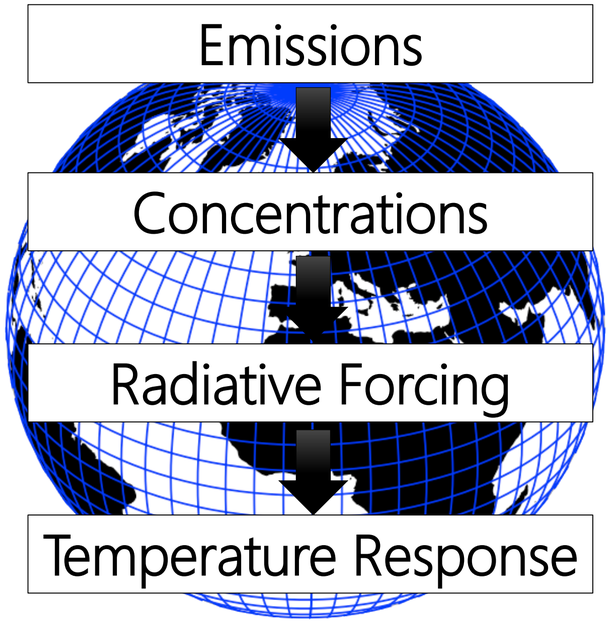
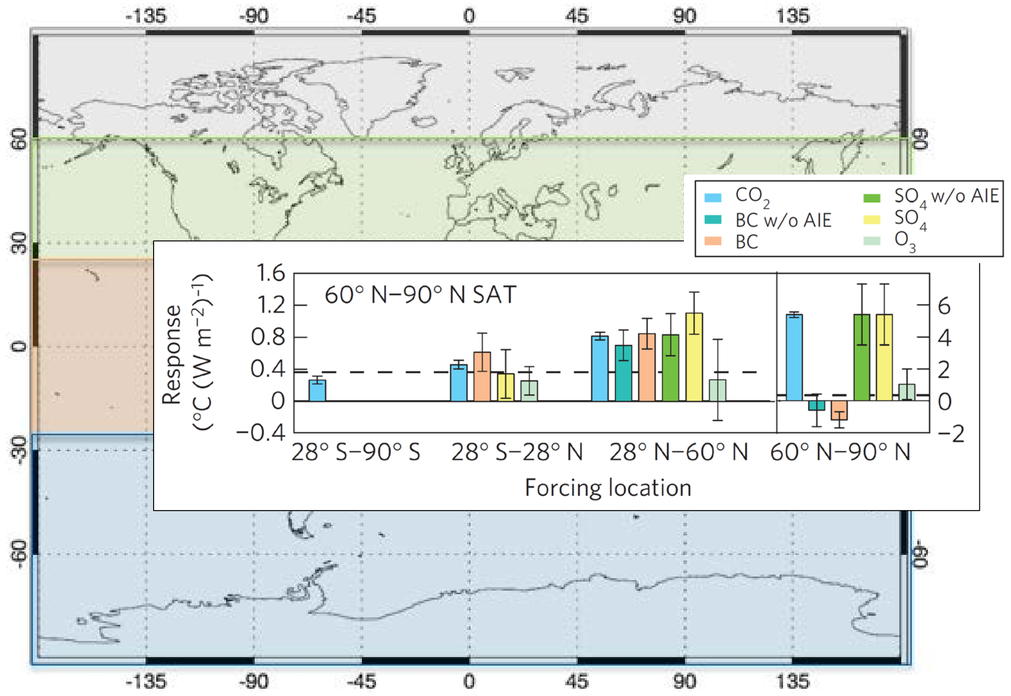

The indirect effect
The direct effect
The ‘semi-direct’ effect
SW
LW
ΔT > 0
$\frac{d\theta}{dz}$
ΔT < 0
ΔT > 0
ΔT > 0
ΔT > 0
The snow/ice-forcing effect

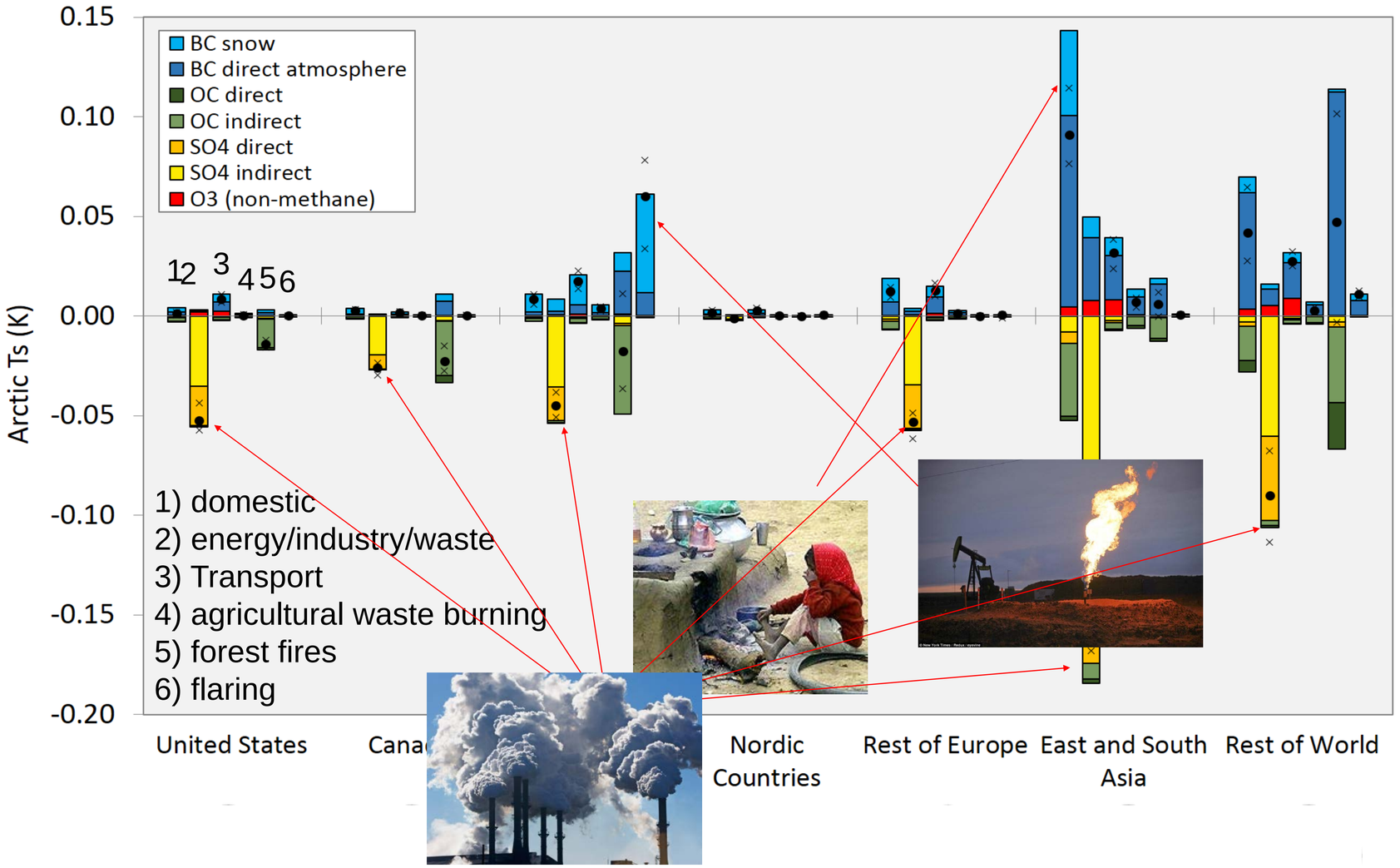
We have used regional temperature sensitivity factors to calculate the surface temperature response





(Shindell and Faluvegi, Nature Geoscience, 2009)

SLCFs from Asian domestic and Russian flaring emissions warm the Arctic, while the energy sector cools the Arctic



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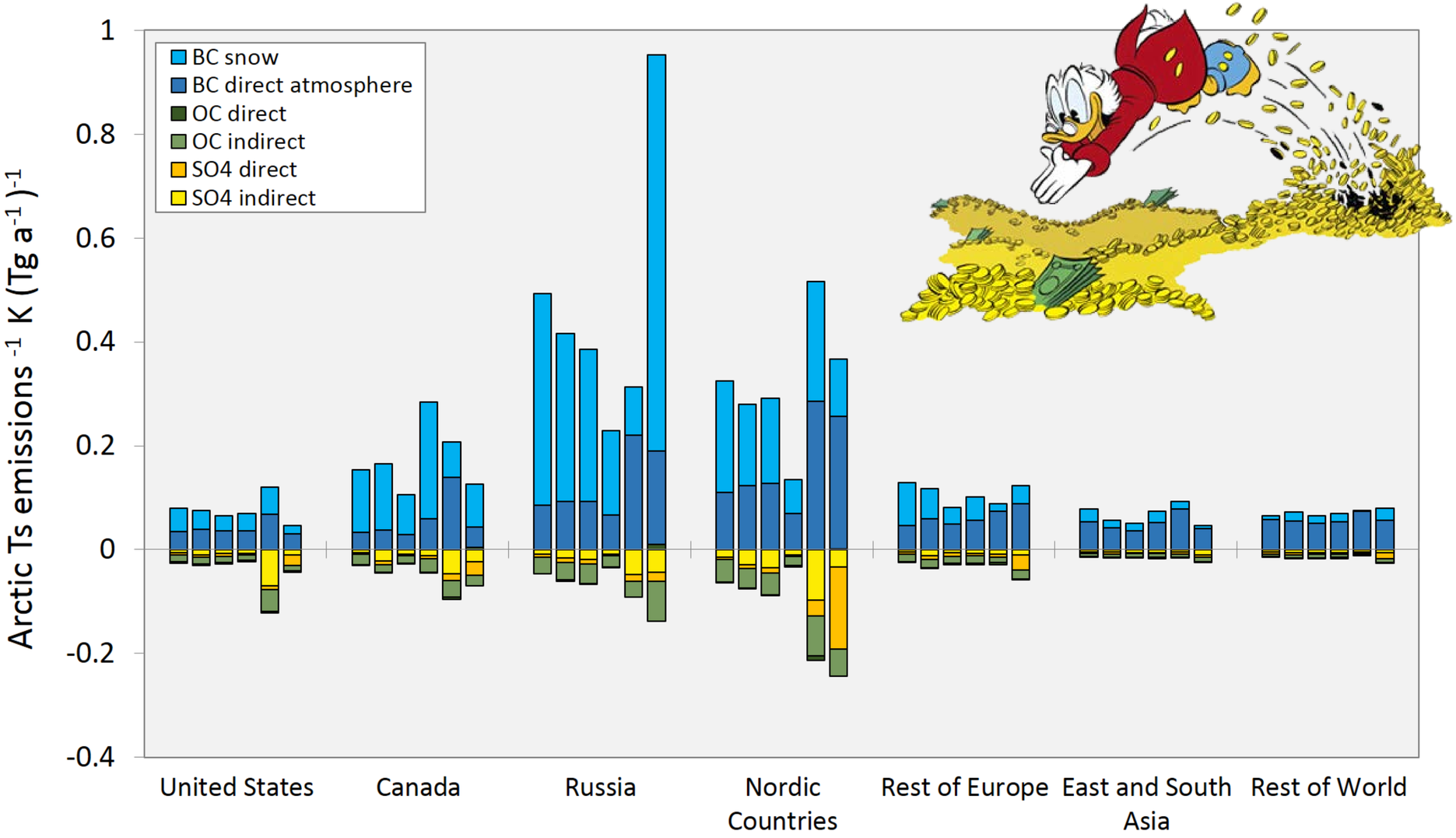
Sand et al., Nature Clim. Change, 2015

‘Bang for the gram’



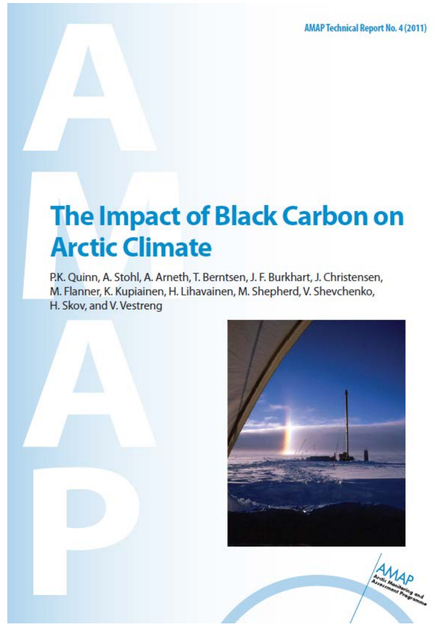
°CICERO

Sand et al., Nature Clim. Change, 2015

AMAP scientific assessments

https://www.amap.no/about/the-amap-programme/amap-assessment-reports

- Scientific assessment with a direct policy connection within the Arctic Council
- Review of scientific literature and own modelling work (SLCF)
- Arctic (Council) focus (source regions, climate impacts)
- Scientific peer review process organized by AMAP secretariat
- 3rd Short-lived climate forcers (black carbon etc.) assessment in 2021



Slide from Kaarle Kupiainen

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AMAP Arctic Monitoring and Assessment Programme

AMAP SLCF 2021 assessment

- Group of ~60 scientists from 15 countries (AC and observers)
- Emission inventory/scenario analyses, multi-pollutant approach
  - Anthropogenic and natural emissions; review of emission inventories;
  - Scenarios: SLCFs in the context of GHG policies, costs of mitigation
- Arctic observations - trends and concentrations: atmosphere, snow samples, ice cores, lake sediments
- Modelling of atmospheric concentrations, depositions and climate impacts (CMIP6, own modellings)
- Co-effects of emissions reductions on human health and ecosystems
- Uncertainties; model-observation comparisons; gaps identified in/after AMAP (2015) BC/O_3 and CH_4 assessments;
- etc.

ARCTIC MONITORING AND ASSESSMENT PROGRAMME

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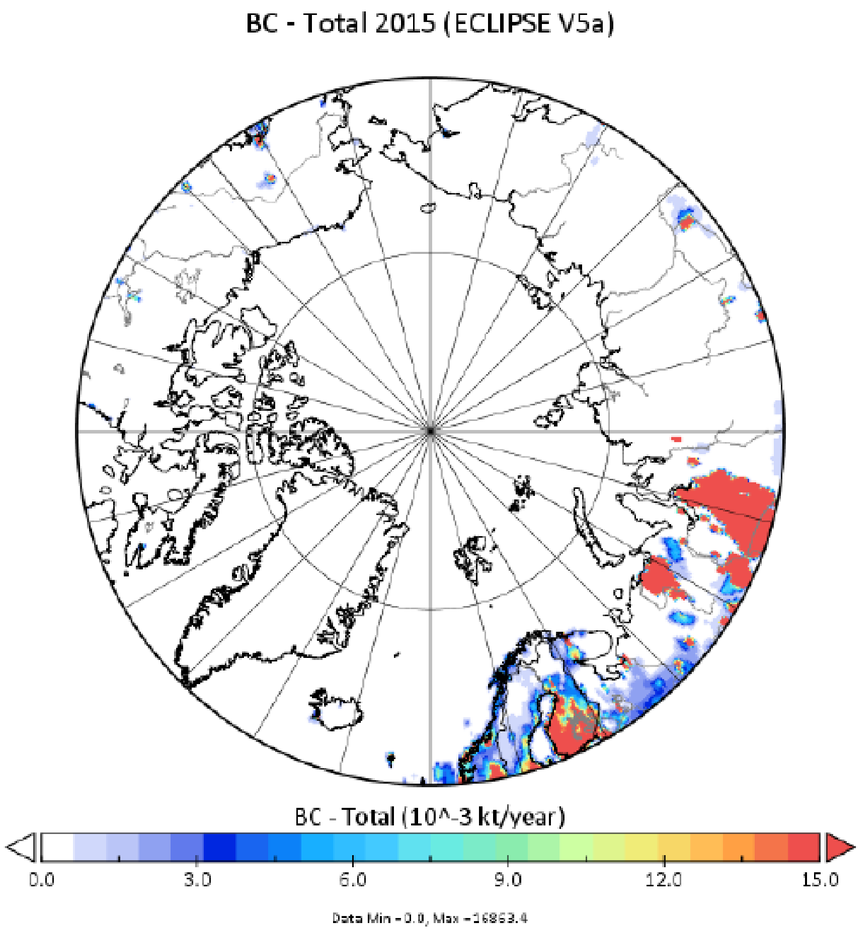
Slide from Kaarle Kupiainen

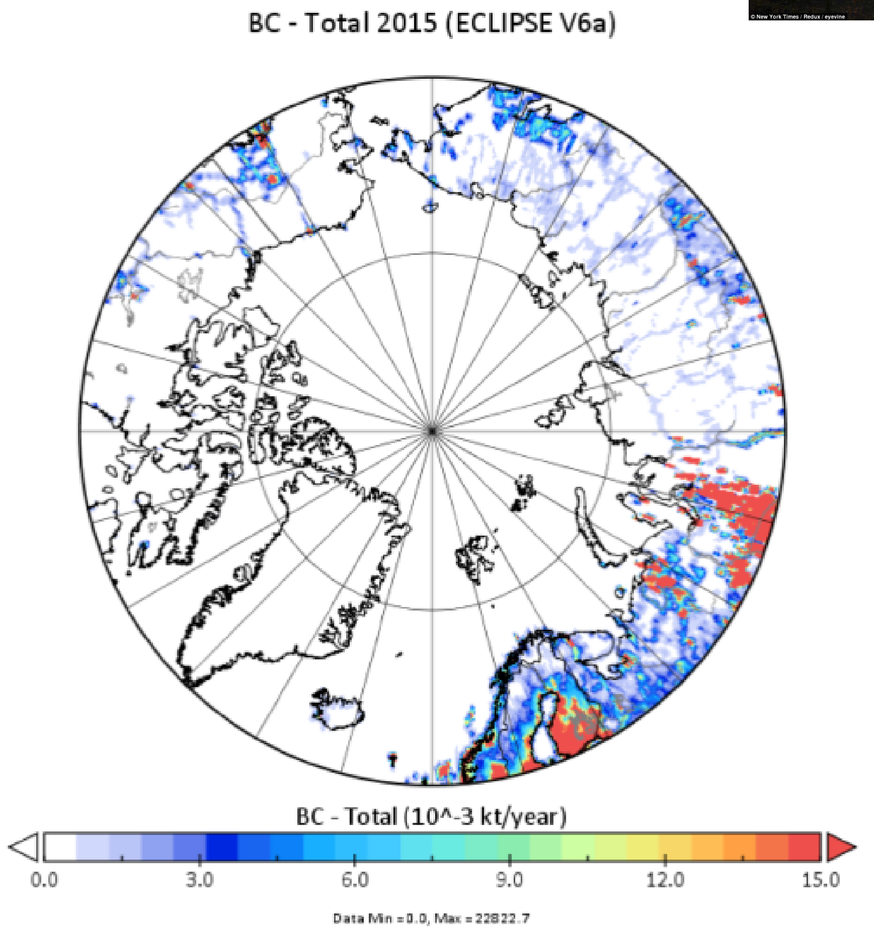
AMAP Arctic Monitoring and Assessment Programme

ECLIPSE v6 scenarios (multipollutant, including harmonized methane)

- ✓ Baseline - IEA/WEO 2018 New Policies scenario (incl. NDCs)
- Mitigation cases
  - ✓ Maximum technical reduction (MFR),
  - Sustainable Development Goals (SDGs),
  - SLCF mitigation;
  - Also specific regional or sectoral focus
- Frozen legislation 2015

Total BC emissions beyond 60°N





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Slide from Zig Klimont

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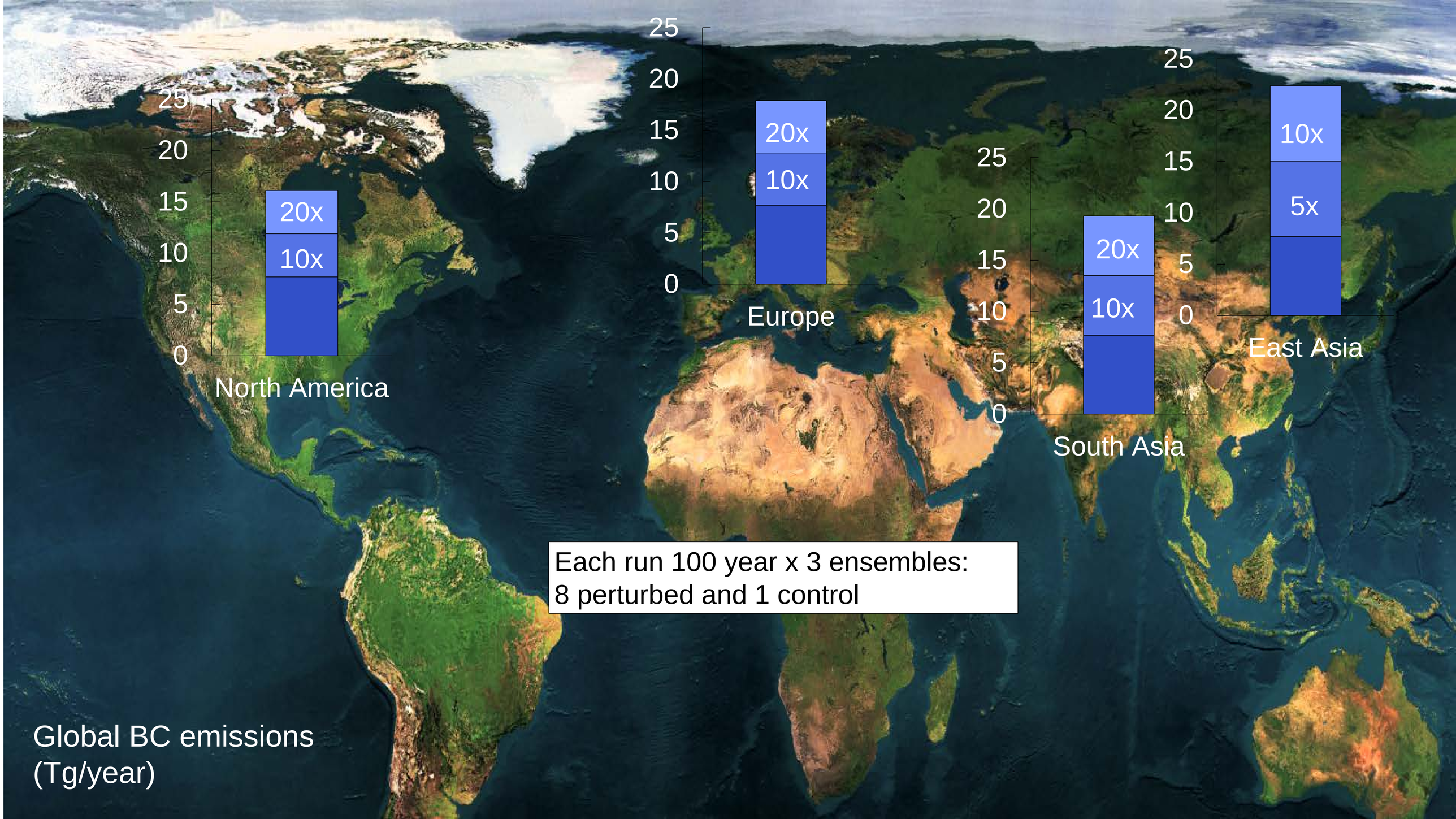
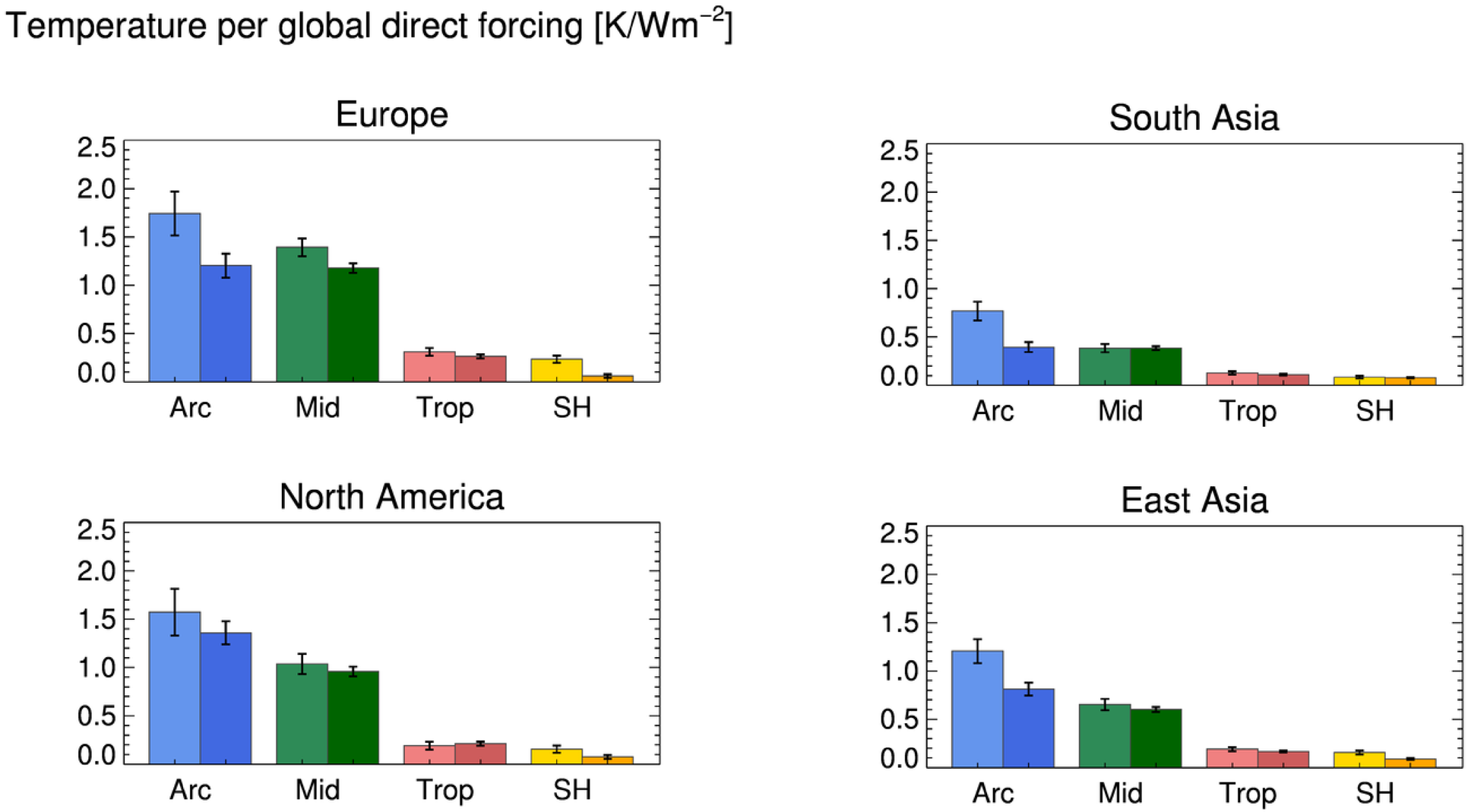
Surface temperature response to regional Black Carbon emissions: Do location and magnitude matter?

Maria Sand[1], Terje K. Berntsen[1,2], Annica Ekman[3,4], Hans-Christen Hansson[4,5], and Anna Lewinschal[3,4]

[1]CICERO Center for International Climate Research, Oslo, Norway
[2]Department of Geosciences, University of Oslo, Oslo, Norway
[3]Department of Meteorology, Stockholm University, Stockholm, Sweden
[4]Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden
[5]Department of Environmental Science and Analytical Chemistry, Stockholm University, Stockholm, Sweden


25
20
15
10
5
0
20x
10x
North America
Europe
South Asia
East Asia
5x
Each run 100 year x 3 ensembles:
8 perturbed and 1 control
Global BC emissions
(Tg/year)

Regional surface temperature response normalized to DRF

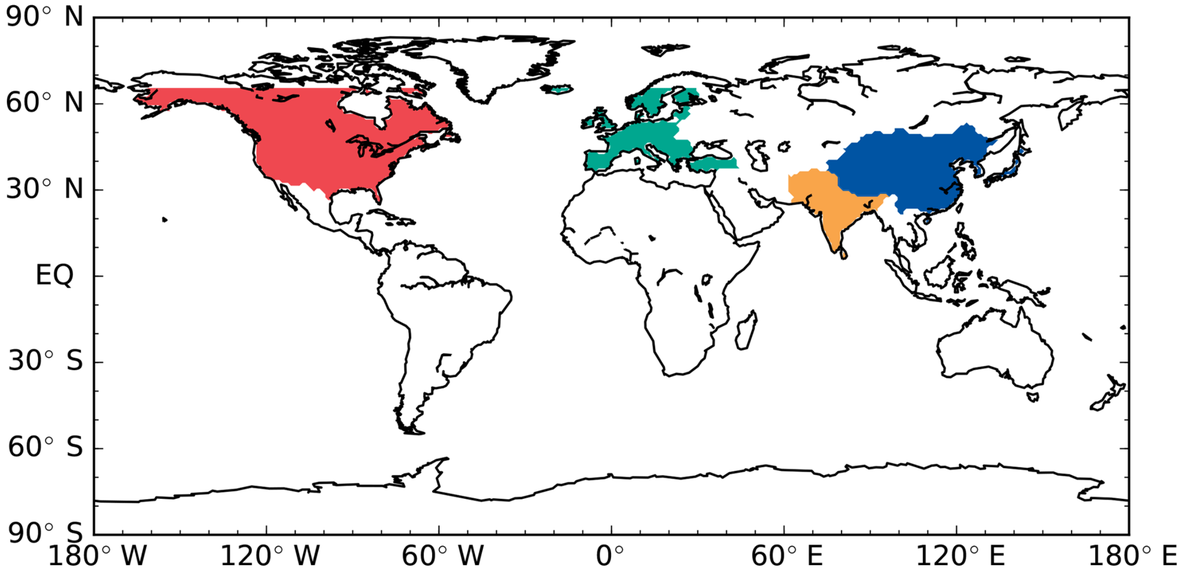


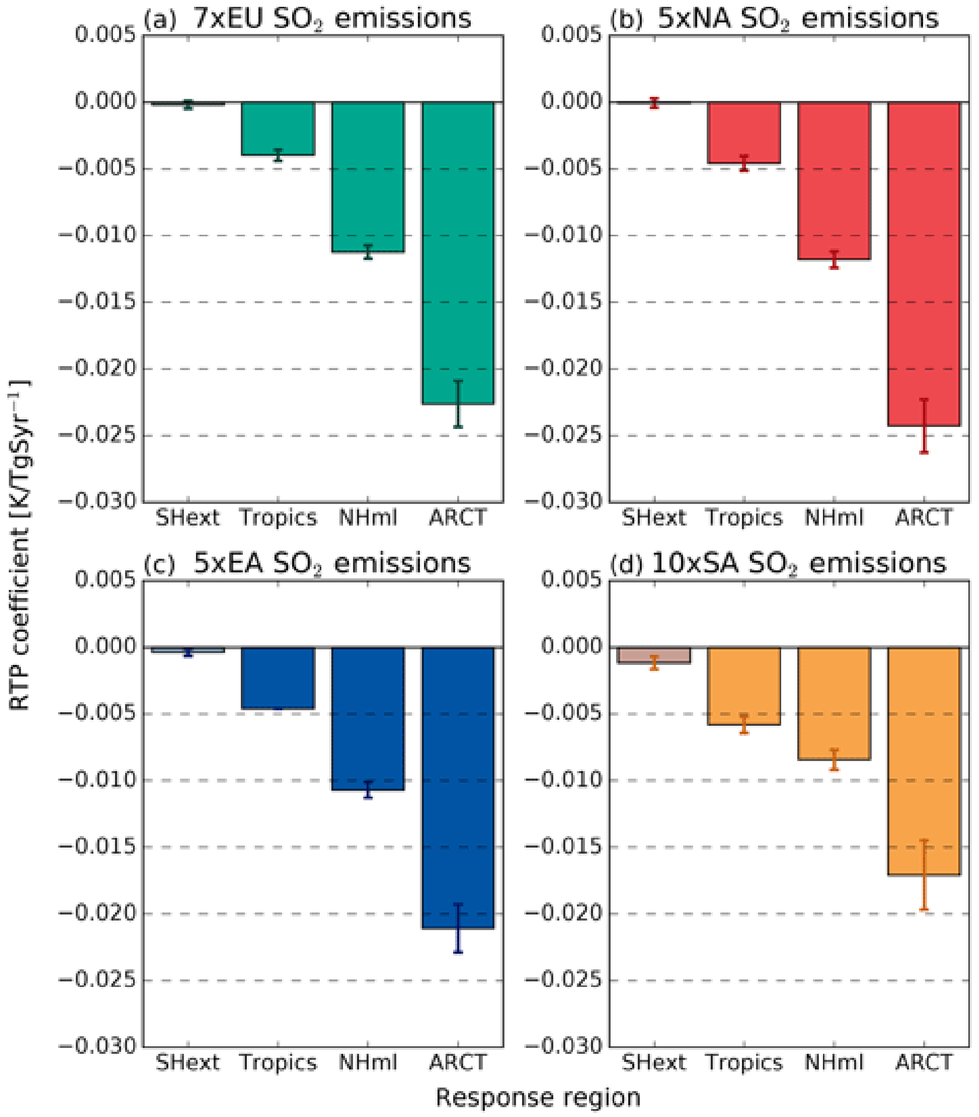
Local and remote temperature response of regional SO_2 emissions

Anna Lewinschal[1,2], Annica M. L. Ekman[1,2], Hans-Christen Hansson[2,3], Maria Sand[4], Terje K. Berntsen[4,5], and Joakim Langner[6]

[1]Department of Meteorology, Stockholm University, Stockholm, Sweden
[2]Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden
[3]Department of Environmental Science and Analytical Chemistry, Stockholm University, St
[4]CICERO Center for International Climate and Environmental Research, Oslo, Norway
[5]Department of Geosciences, University of Oslo, Oslo, Norway
[6]Swedish Meteorological and Hydrological Institute, Air Quality Research Unit, Norrköping,

Correspondence: Anna Lewinschal (anna@misu.su.se)





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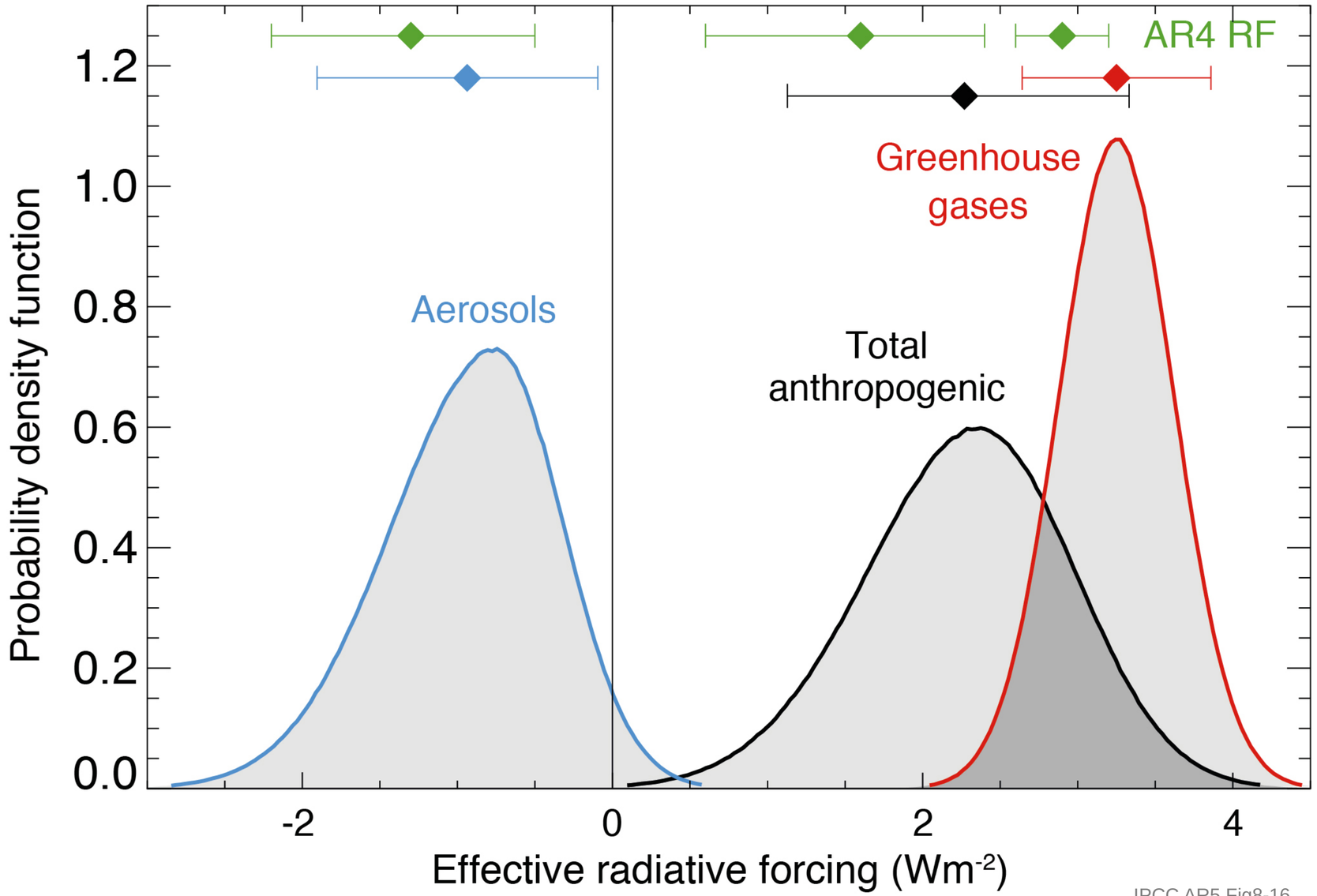
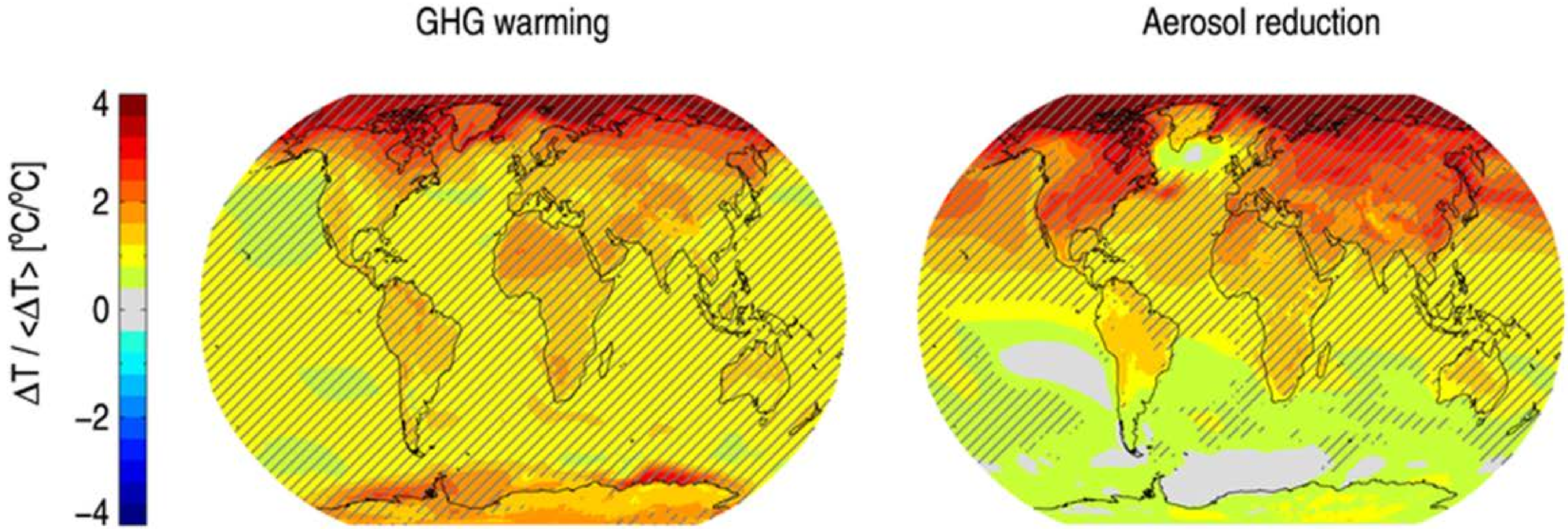
Drakamp mellom partikler og drivhusgasser



IPCC AR5 Fig8-16

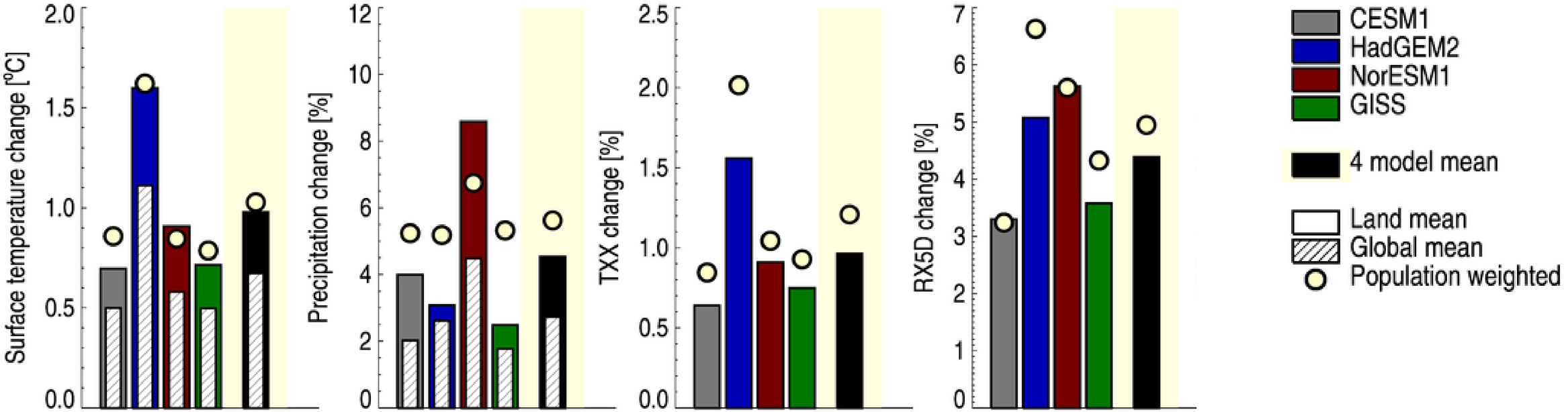
Hva om vi fjernet alle partiklene?

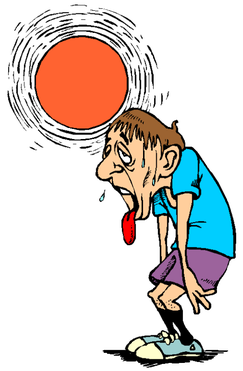


Climate Impacts From a Removal of Anthropogenic Aerosol Emissions

B. H. Samset[1], M. Sand[1], C. J. Smith[2], S. E. Bauer[3], P. M. Forster[2], J. S. Fuglestvedt[1], S. Osprey[4], and C.-F. Schleussner[5]

Hva om vi fjernet alle partiklene? Effekter på nedbør og ekstremvær





FEBRUARY 8, 2018 6:28PM ET

Devil's Bargain: Why Aerosols Pose a Deadly Climate Change Threat

We already have planet-cooling technology – the problem is, it's killing us

By ERIC HOLTHAUS

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Thanks!

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Maria Sand

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