

STARSHIP –

Synergy and tradeoff analysis
on the reduction strategies for
climate and health impacts from particulate
matter and greenhouse gases



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE



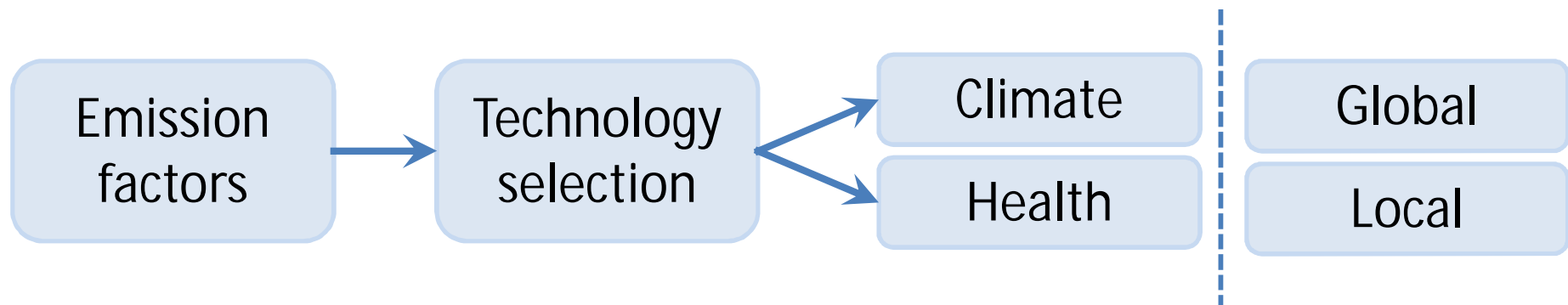
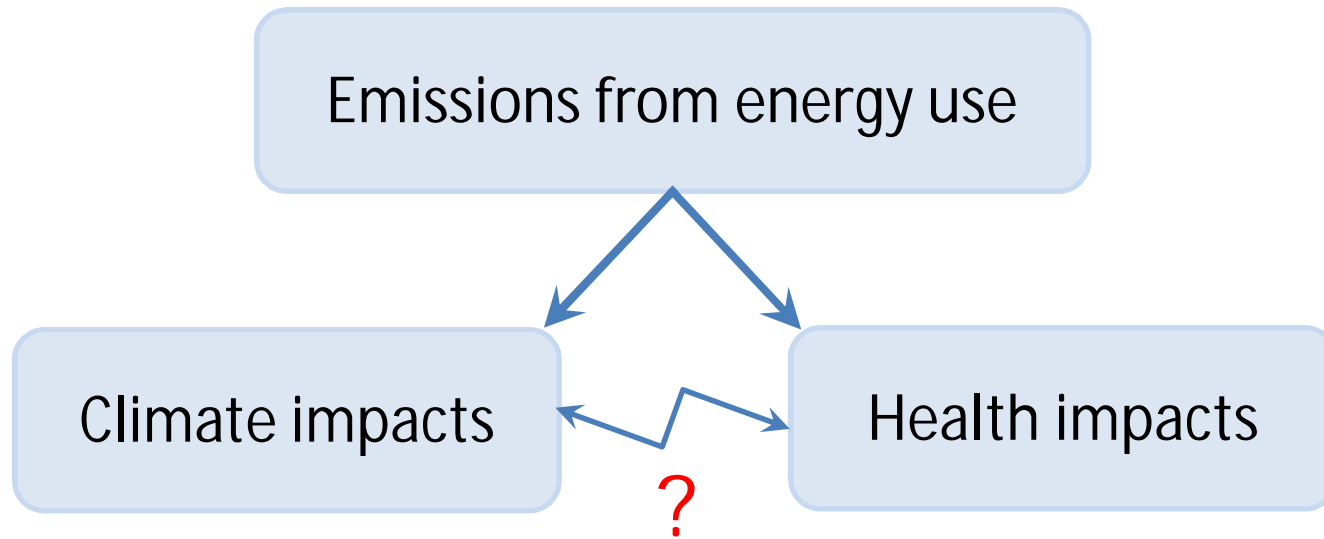
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Research outline

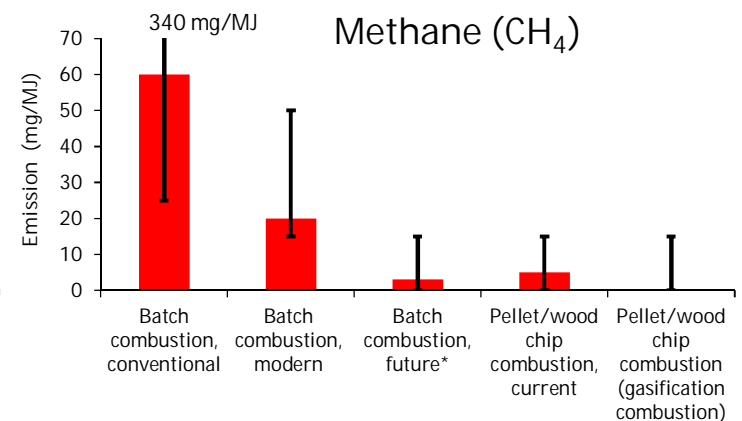
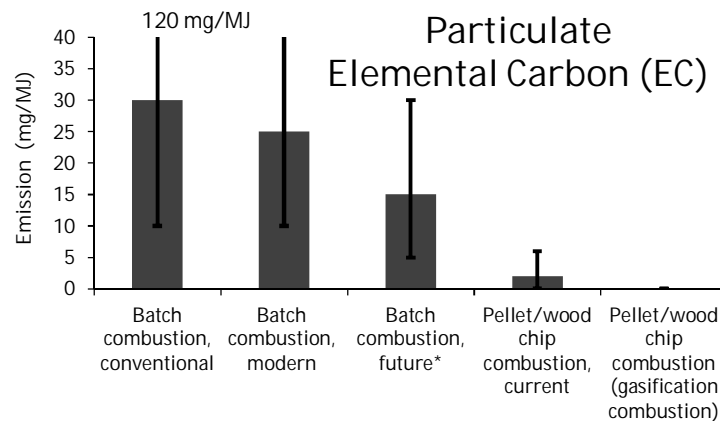
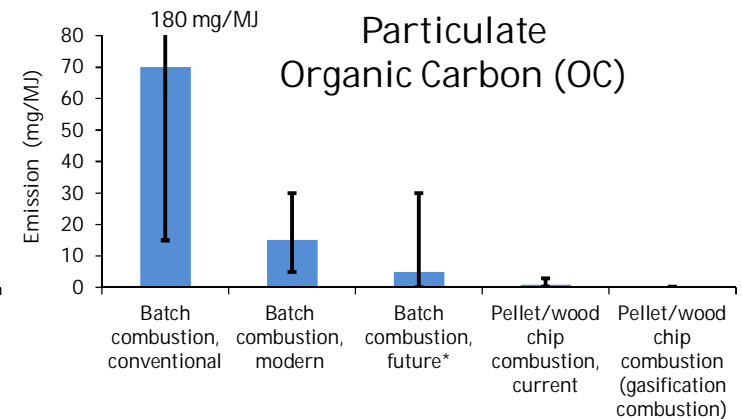
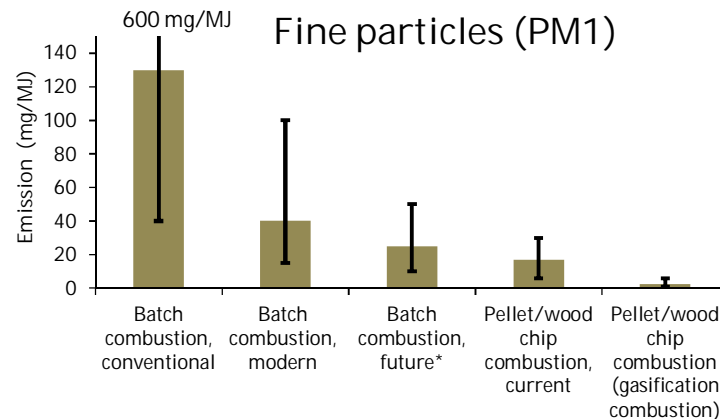


Typical emission factors of residential-scale biomass combustion

Typical emission factors of PM₁, EC, OC, CH₄ for small-scale appliances

Error bars show the variation with each type

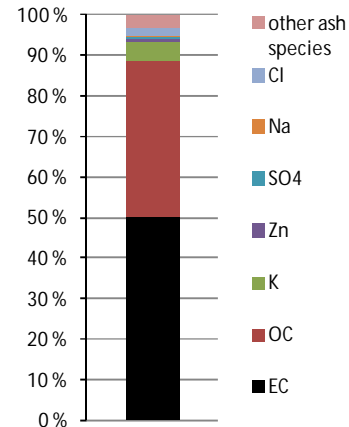
Future emission levels for low-emission technologies



Increasing combustion efficiency →

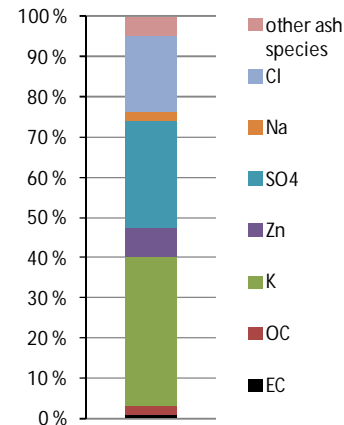
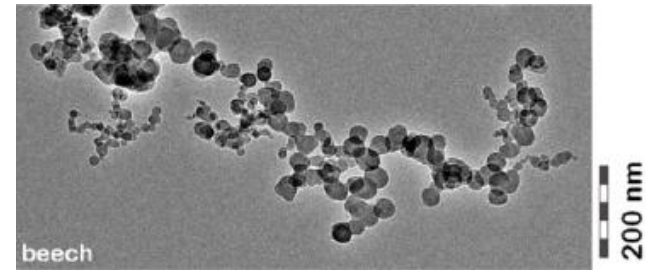
Physico-chemical properties of particulate emissions:

Chemical composition and morphology:

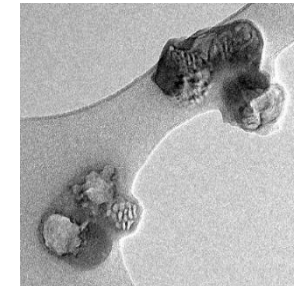
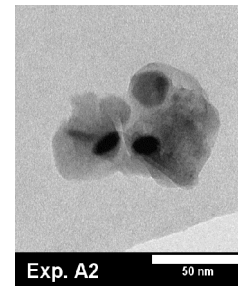


Batch-wise operated stove:

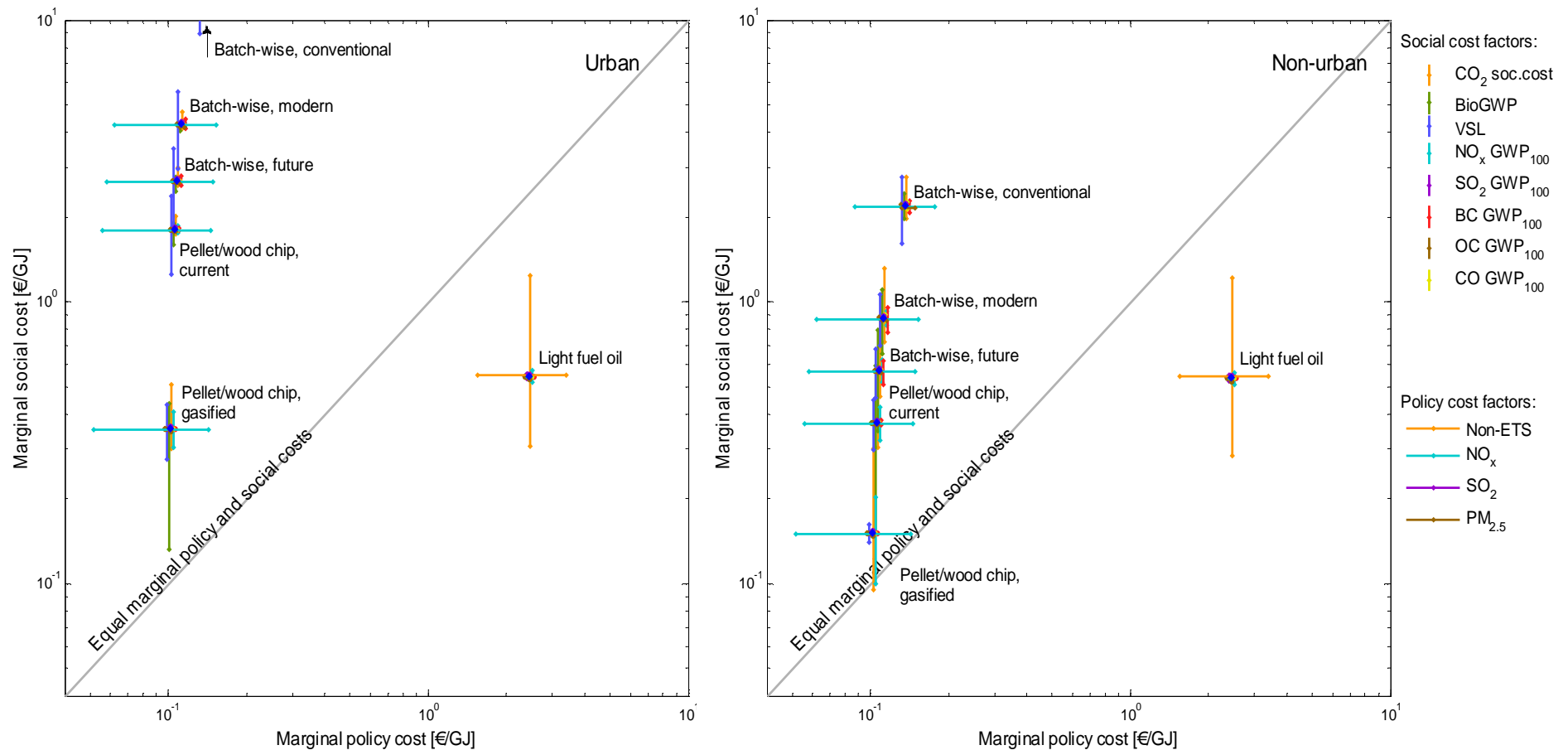
- Chainlike agglomerates consisting of EC particles with a layer of organic material.
- Morphology similar to diesel soot!



Continuously operated wood chip/pellet boiler: Sintered alkali salt particles. Zn is often found as ZnO nucleus inside the particle

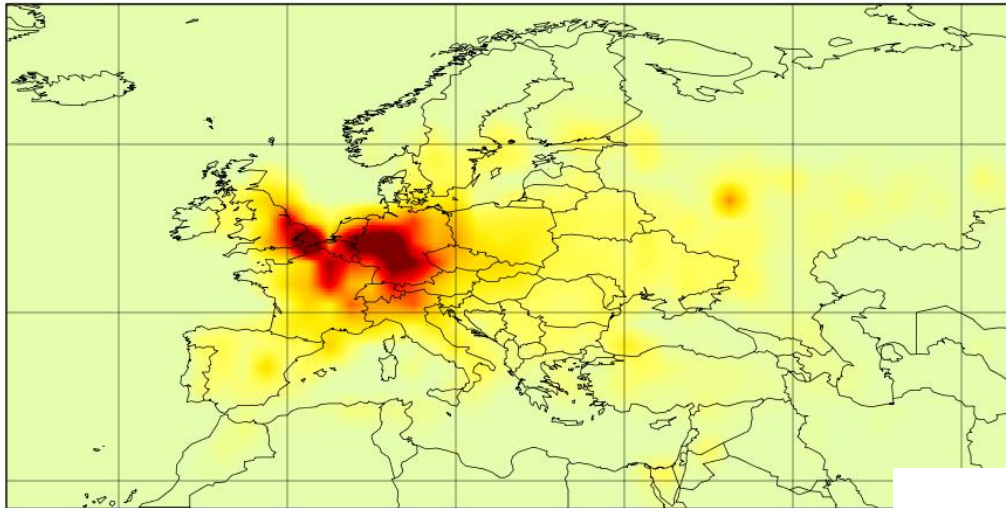


Policy incentives vs. social cost of climate and health for residential heating



Replacing nuclear power with coal power – health and climate effects

The expected number of deaths per km²



The expected number of deaths per km² due to outdoor air pollution ()
-0.08210 -0.04926 -0.01642 0.01642 0.04926 0.08210
Data Min = -0.00369, Max = 0.16053

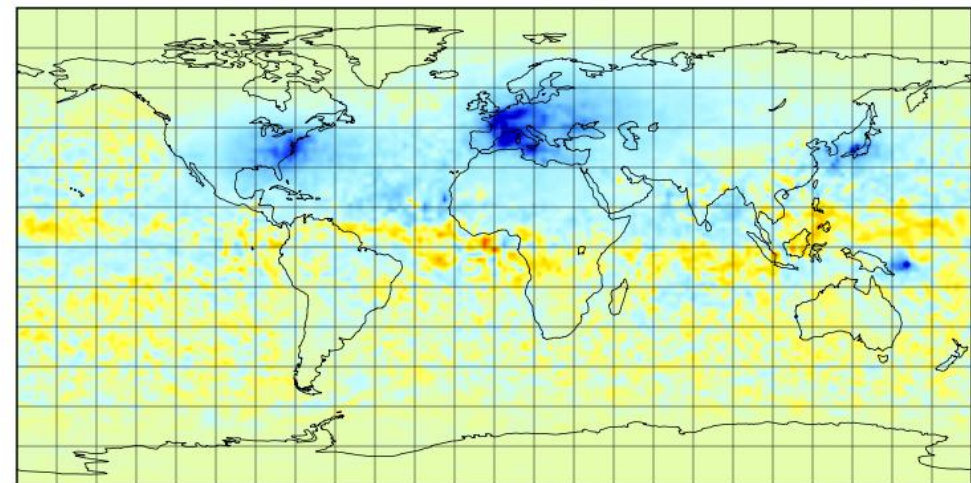
Premature deaths per year:

- 160 000 globally
- 82 000 in EU25 countries
- 900 in Finland

Mean radiative forcing due to particles is -0.021 W/m^2

Change in radiative forcing due to CO₂ emissions is $0.0017 \text{ W/m}^2/\text{year}$

Radiative forcing



Radiative forcing (W/m²)
-0,3480 -0,2088 -0,0696 0,0696 0,2088 0,3480
Data Min = -0,4568, Max = 0,2392, Mean = -0,0207



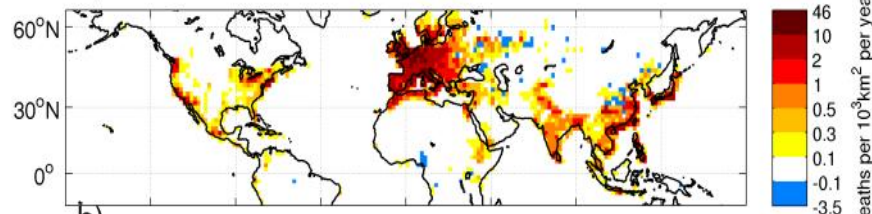
Atmos. Chem. Phys., 13, 12059–12071, 2013

Climate and air quality trade-offs in altering ship fuel sulfur content

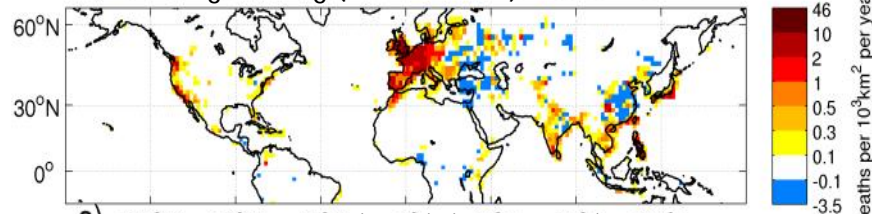
A. I. Partanen¹, A. Laakso¹, A. Schmidt², H. Kokkola¹, T. Kuokkanen³, J.-P. Pietikäinen⁴, V.-M. Kerminen⁵, K. E. J. Lehtinen^{1,6}, L. Laakso^{4,7}, and H. Korhonen¹

Mortality due to shipping (PM)

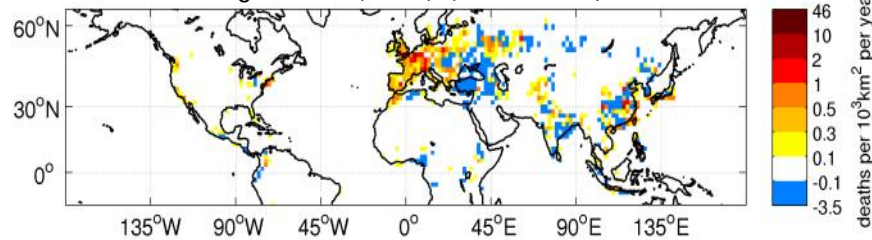
a) Current legislation (total: 50 200)



b) Geoengineering (total: 15 400)

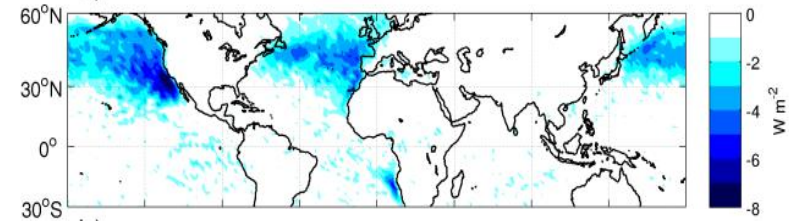


c) Future legislation (2020) (total: 2000)

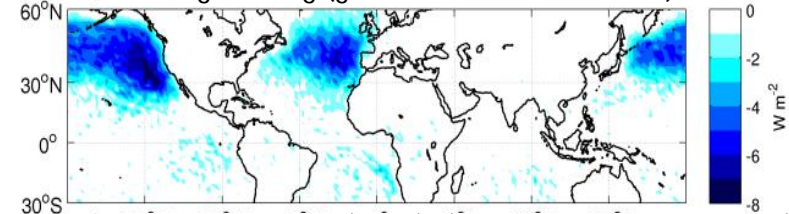


Radiative forcing from shipping

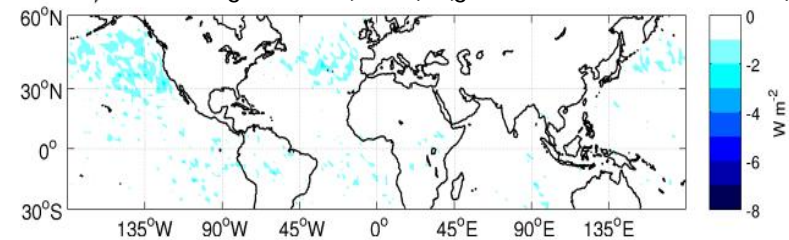
a) Current legislation (global mean: -0.39 W/m^2)



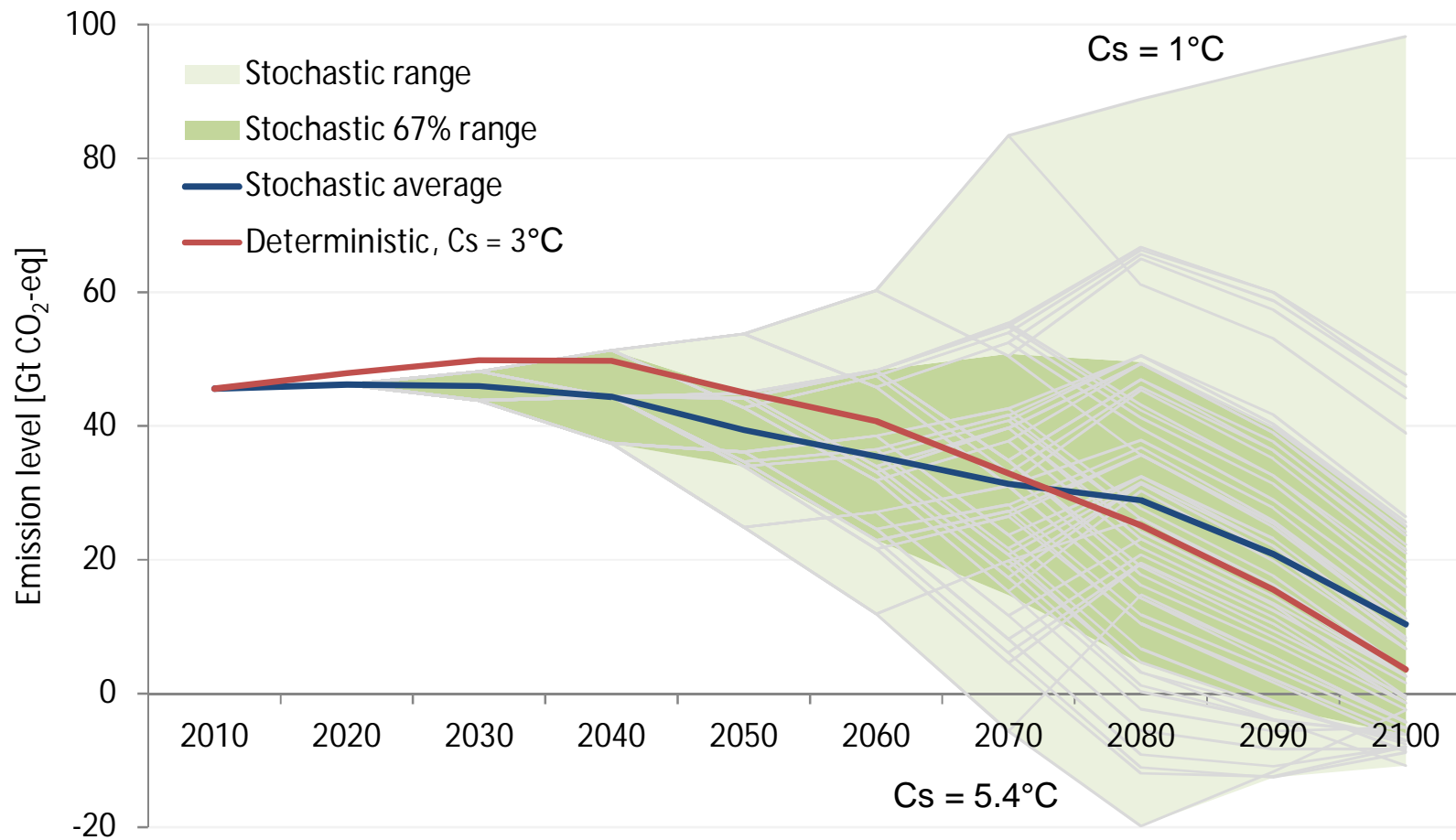
b) Geoengineering (global mean: -0.43 W/m^2)



c) Future legislation (2020): (global mean: -0.06 W/m^2)

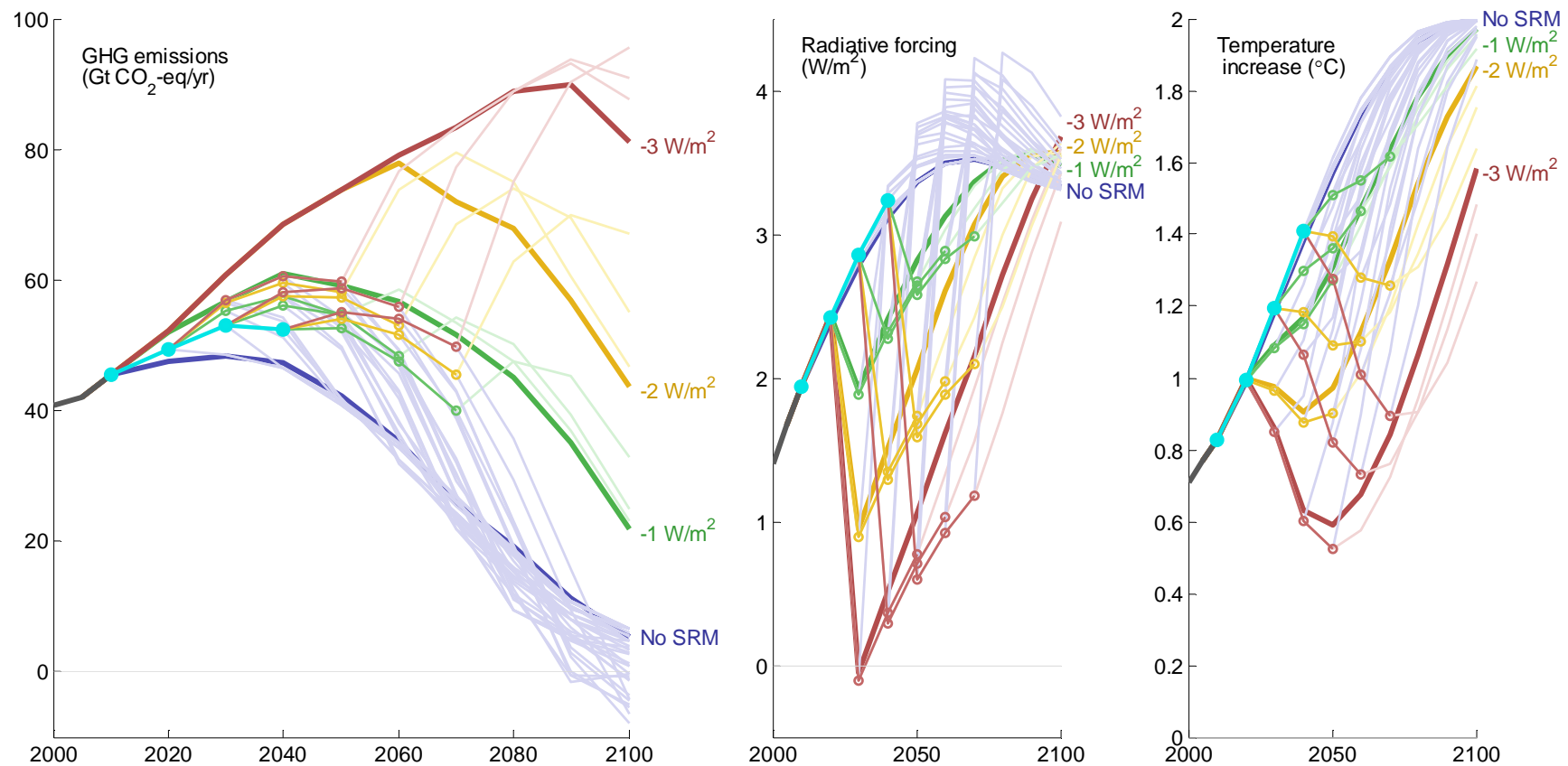


Meeting the 2°C target under uncertainty and learning on climate sensitivity



Paper: Ekholm, 2014: Hedging the climate sensitivity risks of a temperature target, *Climatic Change* 127, pp. 153-167.

Meeting the 2°C target under an uncertain SRM possibility



Paper: Ekholm & Korhonen, 2014: Climate change mitigation strategy with an uncertain Solar Radiation Management possibility, under review.

Summary of outcomes

- 13 peer-reviewed articles
- 3 PhD theses
- 1 citation in IPCC AR5 (perhaps more in AR6?)



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Thank you!



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