TM 5

Optimizing Black Carbon emissions with TM5MP-CTDAS

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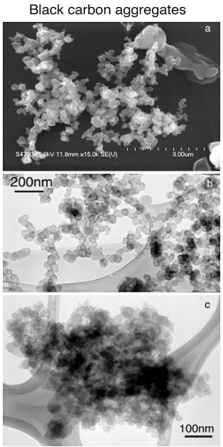
EYE-CLIMA
Verifying emissions of climate forcers

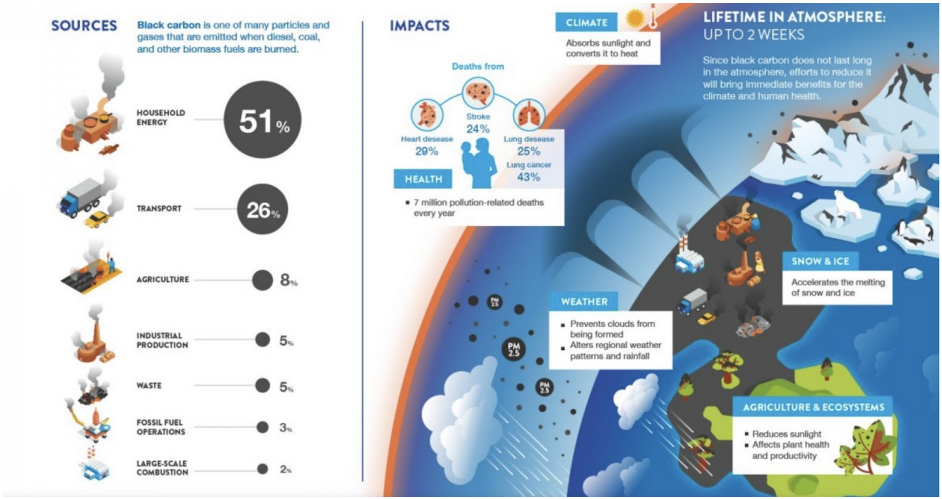
Black Carbon

- Climate forcer (warms the atmosphere)
- Affecting Health (emerging pollutant)
- Produced by incomplete combustion



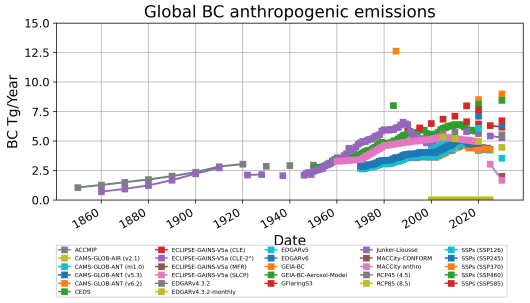
Bond et al.,2013

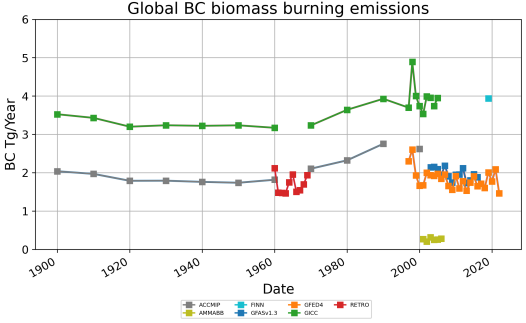
Sources and Impacts



ccacoalition.org

Emission Inventories (data from eccad.aeris-data.fr)





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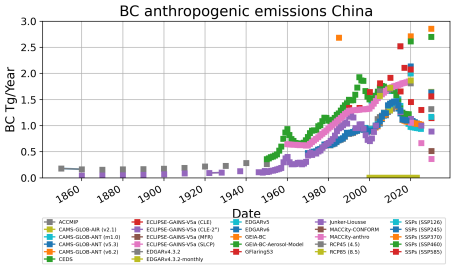
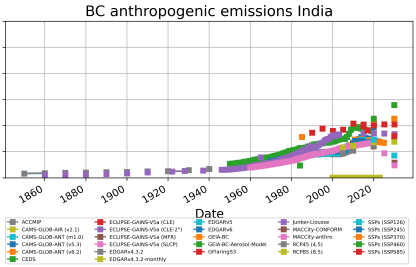
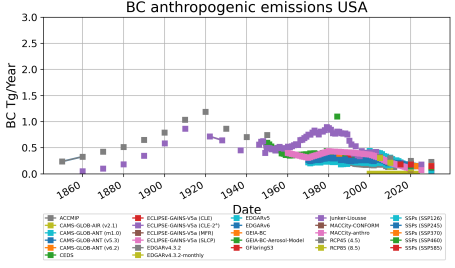




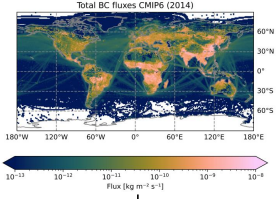


Aim

This study aims to improve inventory estimates using ground based measurements

Methodology

Initial flux estimate (prior)

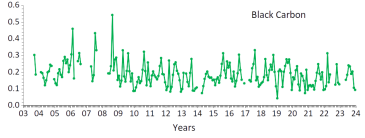


TM 5

CTDAS
Ensemble
Kalman
Filter

Optimized fluxes
(posterior)

Observations



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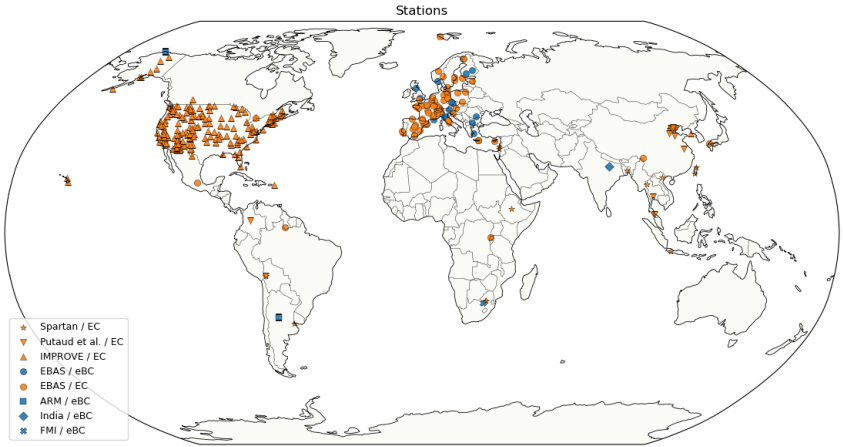
Observations

Measurements used are filter based and from aethalometers (EC,eBC)



Observations

- Observations hard to obtain
- Non homogeneous geographical distribution
- Often poor temporal resolution

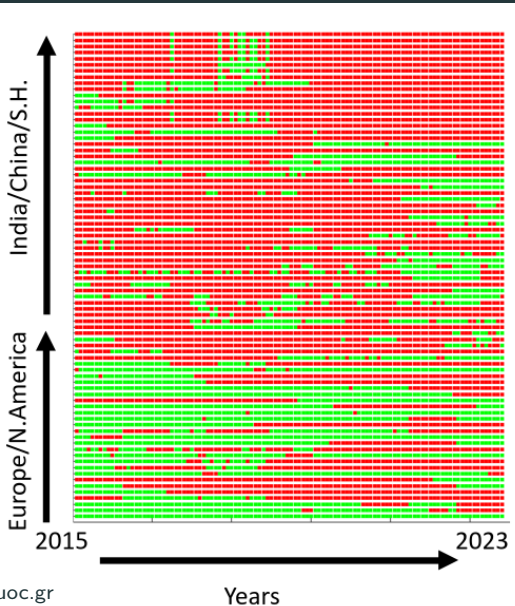


Figure by Dr. Sabine Eckhardt

Simulation Setup

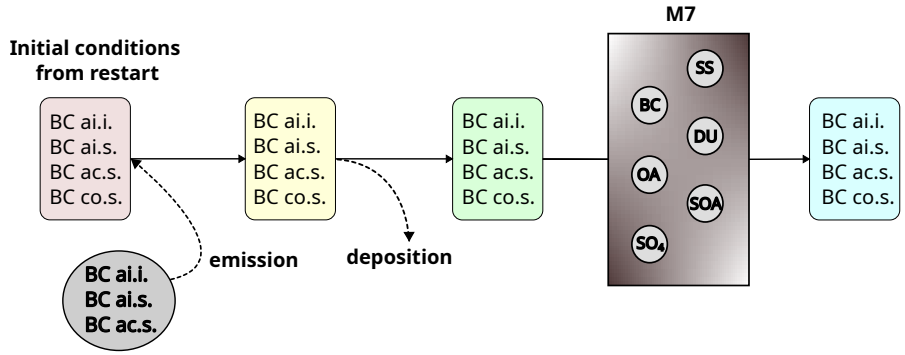
TM5-MP:

- Meteorology ERA5 (Hersbach et al. 2020)
- 1°x1° horizontal resolution x 34 vertical levels
- Anthropogenic emissions CMIP6 SSP3-7.0 (Feng et al.2020)
- Biomass Burning CMIP7 from 2016
- Chemistry (mCB05) (Williams et al. 2017)

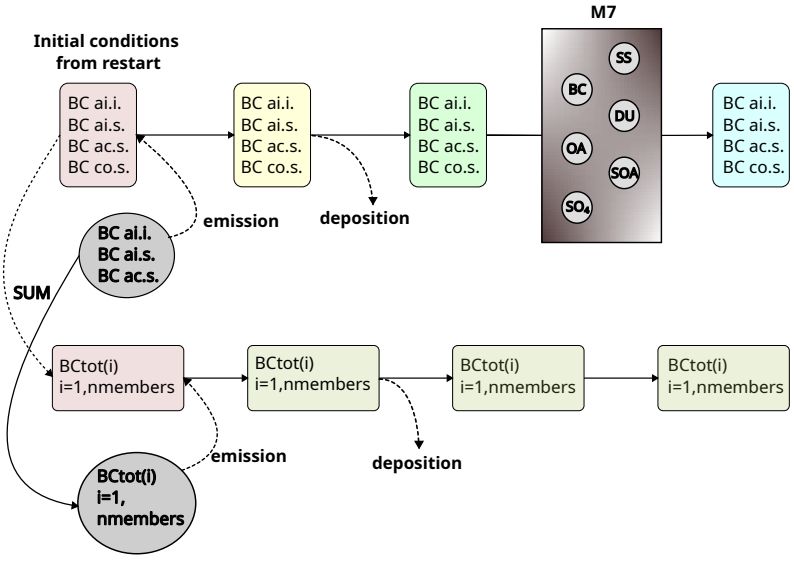
Simulations:

- Simulation Period 2015-2023
- 50 ensemble members of total BC emissions
- Assimilation window of 1 week
- Lag 2 weeks
- Sampling window of 1 day
- No localization

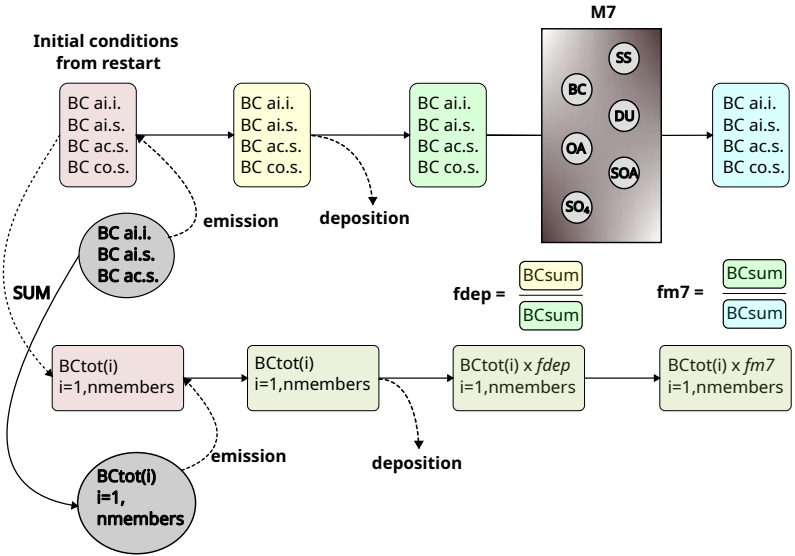
Approach in TM5



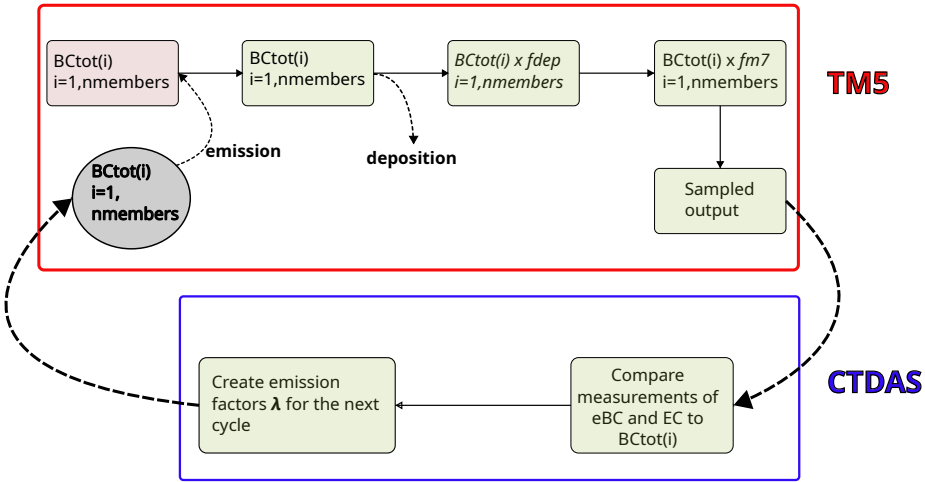
Approach in TM5



Approach in TM5

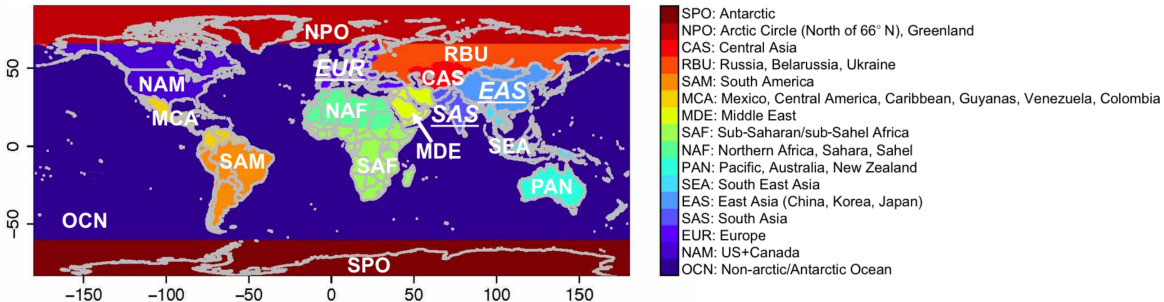


TM5 - CTDAS coupling

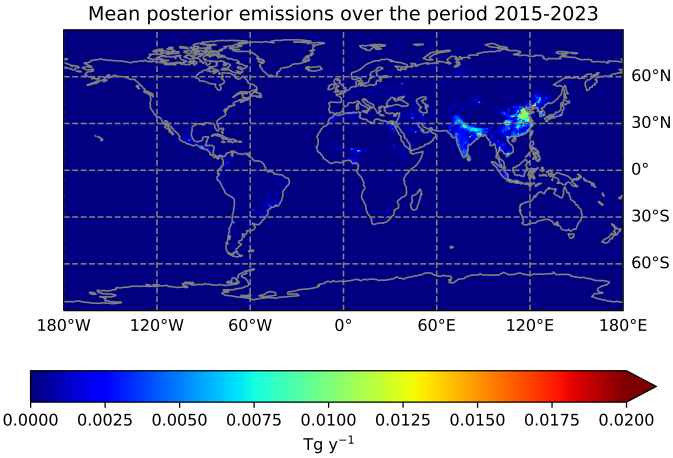


Regions of optimization

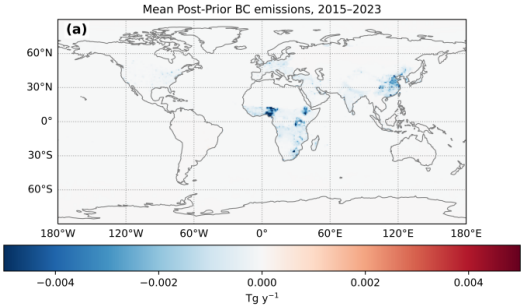
A scaling factor λ is created for each of the 16 HTAP source regions

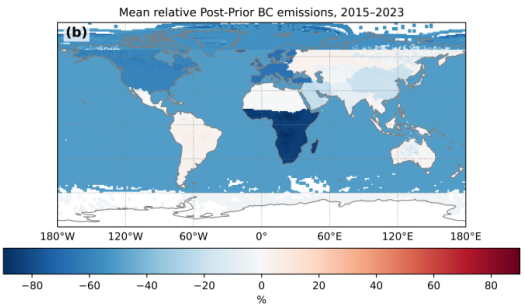


Results

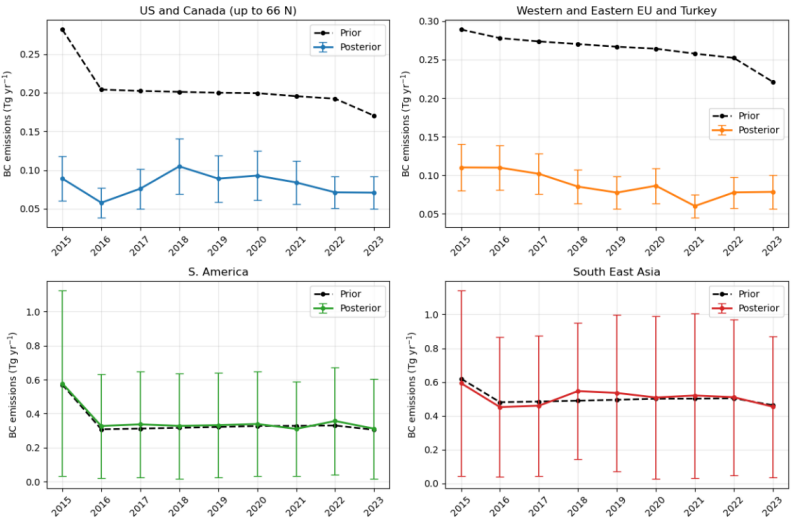

Mean posterior emissions over the period 2015-2023
60°N
30°N
0°
30°S
60°S
180°W
120°W
60°W
0°
60°E
120°E
180°E
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
Tg y^{-1}

Results

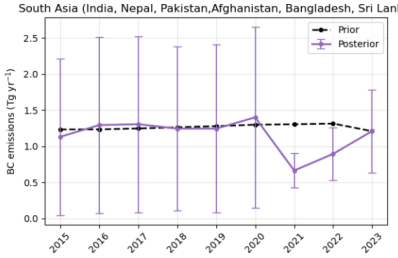

Mean Post-Prior BC emissions, 2015–2023
(a)
60°N
30°N
0°
30°S
60°S
180°W
120°W
60°W
0°
60°E
120°E
180°E
−0.004
−0.002
0.000
0.002
0.004
Tg y⁻¹

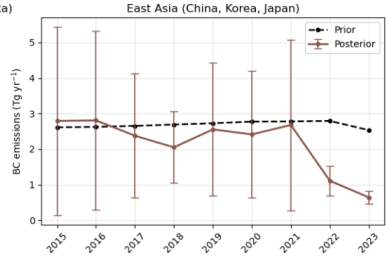

Mean relative Post-Prior BC emissions, 2015–2023
(b)
180°W
120°W
60°W
0°
60°E
120°E
180°E
−80
−60
−40
−20
0
20
40
60
80
%

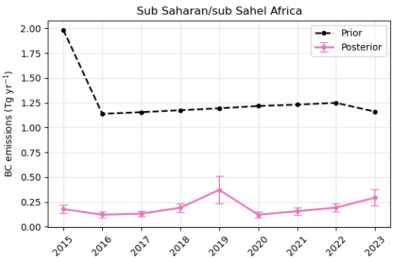
Results

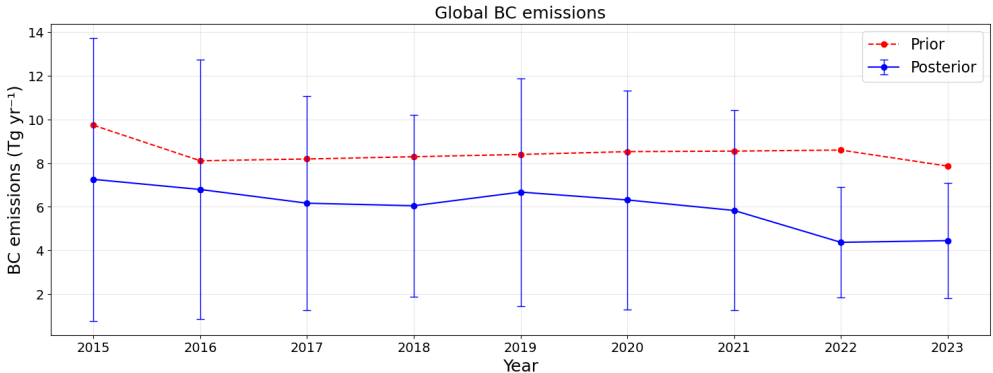

US and Canada (up to 66 N)
Western and Eastern EU and Turkey
S. America
South East Asia
Prior
Posterior
BC emissions (Tg yr⁻¹)
2015
2016
2017
2018
2019
2020
2021
2022
2023

Results

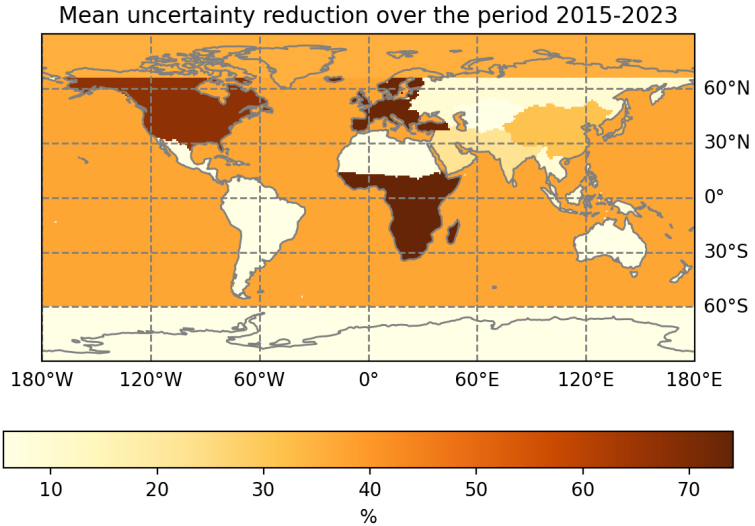

South Asia (India, Nepal, Pakistan,Afghanistan, Bangladesh, Sri Lanka)
Prior
Posterior
BC emissions (Tg yr⁻¹)
0.0
0.5
1.0
1.5
2.0
2.5
2015
2016
2017
2018
2019
2020
2021
2022
2023


East Asia (China, Korea, Japan)
Prior
Posterior
BC emissions (Tg yr⁻¹)
0
1
2
3
4
5
2015
2016
2017
2018
2019
2020
2021
2022
2023


Sub Saharan/sub Sahel Africa
Prior
Posterior
BC emissions (Tg yr⁻¹)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2015
2016
2017
2018
2019
2020
2021
2022
2023


Global BC emissions
Prior
Posterior
BC emissions (Tg yr⁻¹)
14
12
10
8
6
4
2
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year

Results


Mean uncertainty reduction over the period 2015-2023
60°N
30°N
0°
30°S
60°S
180°W
120°W
60°W
0°
60°E
120°E
180°E
10
20
30
40
50
60
70
%

On-Going Work

- Running with LRTAP anthropogenic emissions & GFAS biomass burning
- Testing inversions with more ensemble members
- Testing inversions with Gaussian localization

Acknowledgments

Thank you for your attention!

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