Atmospheric observation-based global SF_6 emissions: comparison of top-down and bottom-up estimates

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Sulphur Hexafluoride: SF_6

… is a very stable man-made Greenhouse Gas

Mean atmospheric lifetime: ≈ 3 000 years
Global Warming Potential: ≈ 23 000 x CO_2 (100 yr time horizon)
→ Kyoto - reported

Atmospheric mixing ratio today: ≈ 7 ppt (10^{-12} mol/mol)

Sources of SF_6:

- ca. 75% from electrical applications
- Magnesium industry
- adiabatic applications

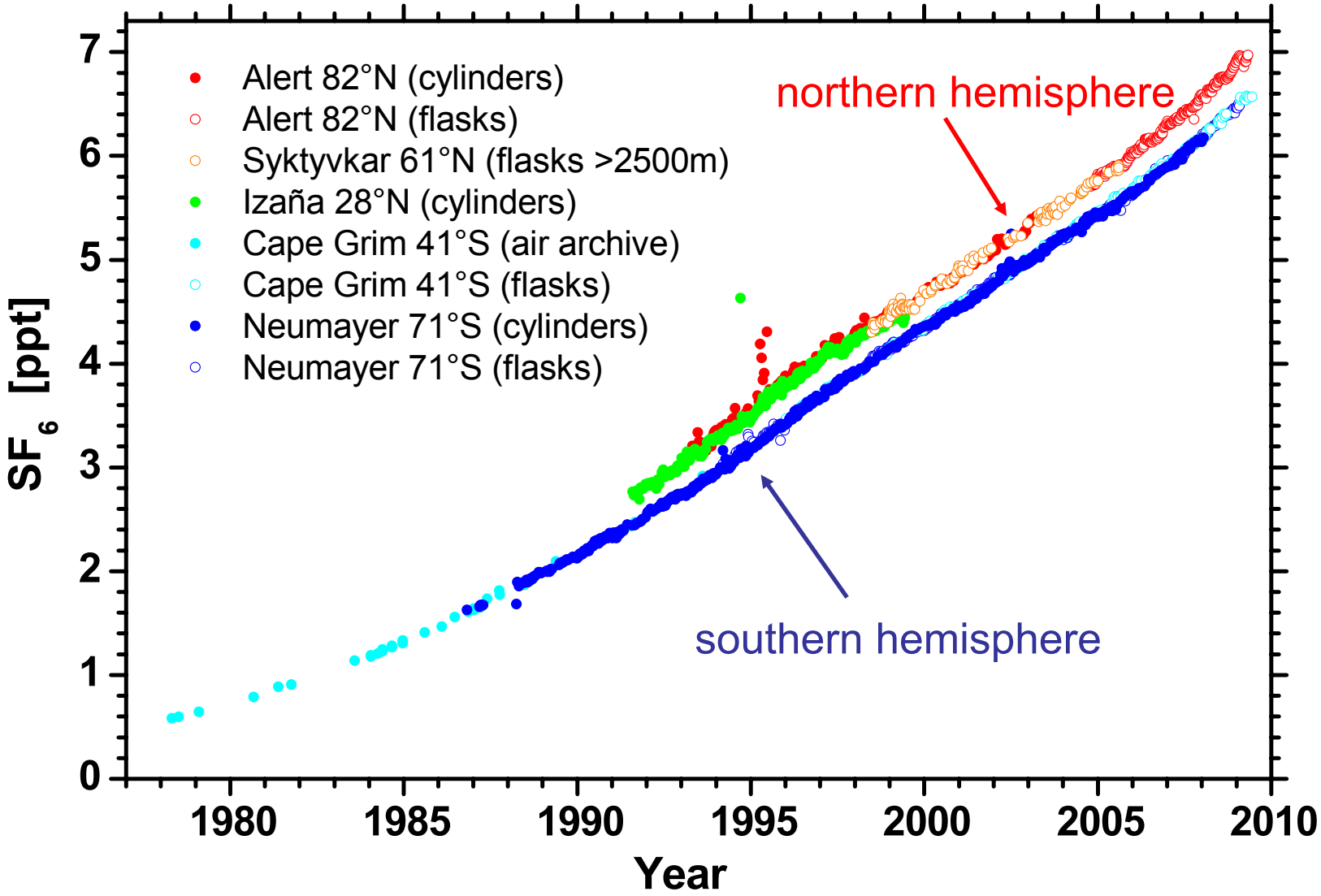
Sinks of SF_6: only in the Mesosphere > 60 km

- UV Absorption (λ < 130 nm)
- electron reactions

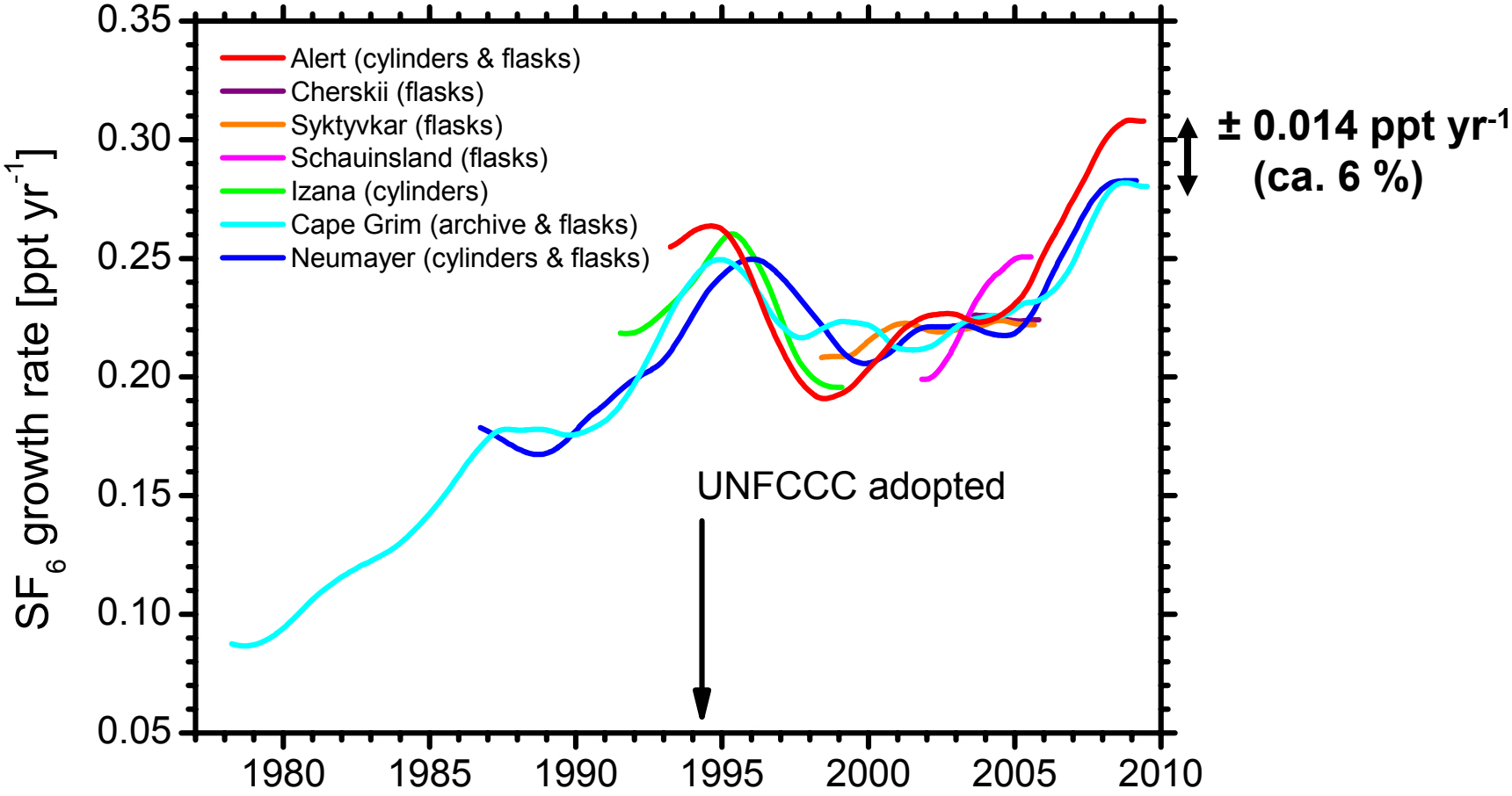
Heidelberg co-operative network of tropospheric SF_6 observations

& stratospheric profiles from Kiruna, Aire sur l'Adour, Teresina

Global long-term trend of SF_6 in the troposphere



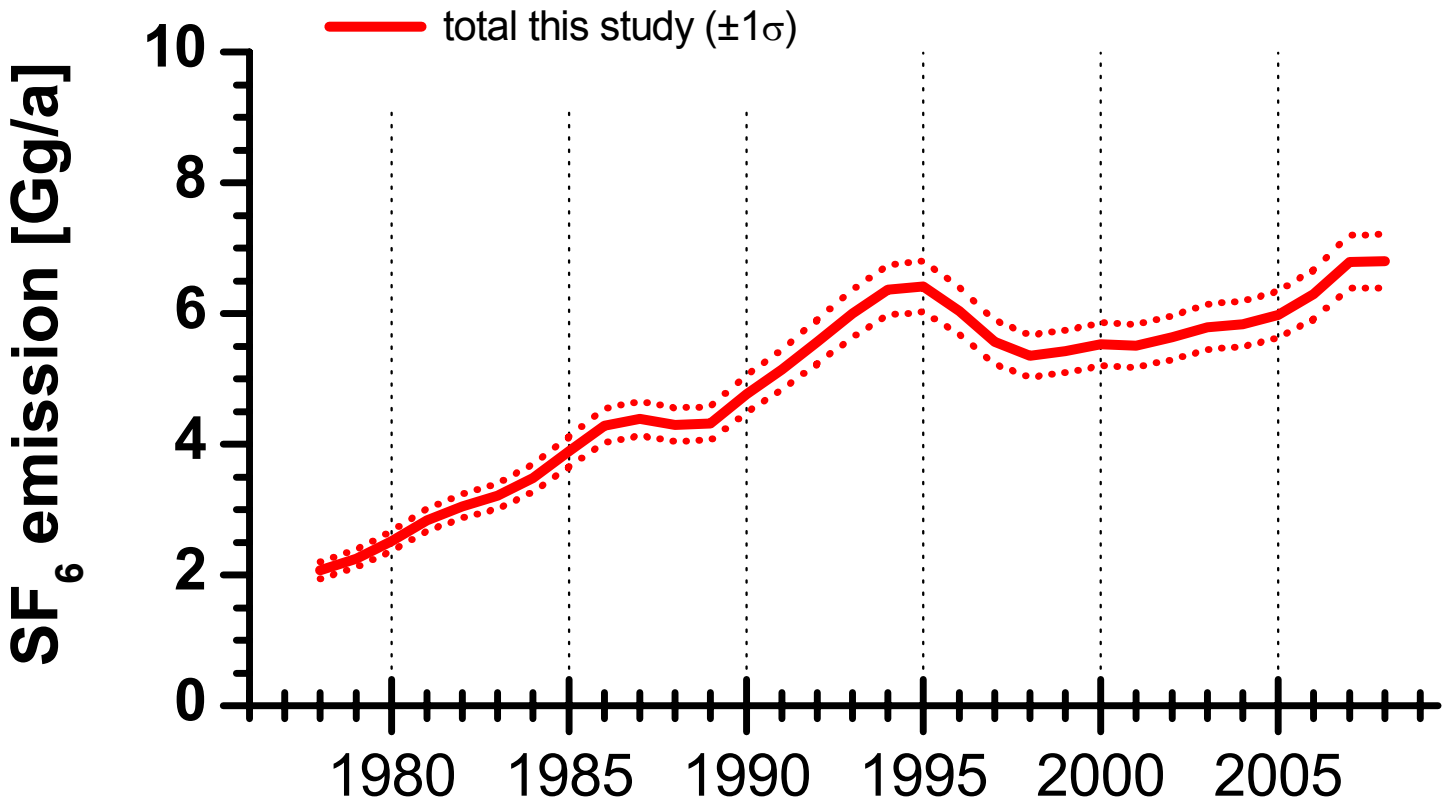
Observed tropospheric SF_6 growth rates



Practically no SF_6 sinks:

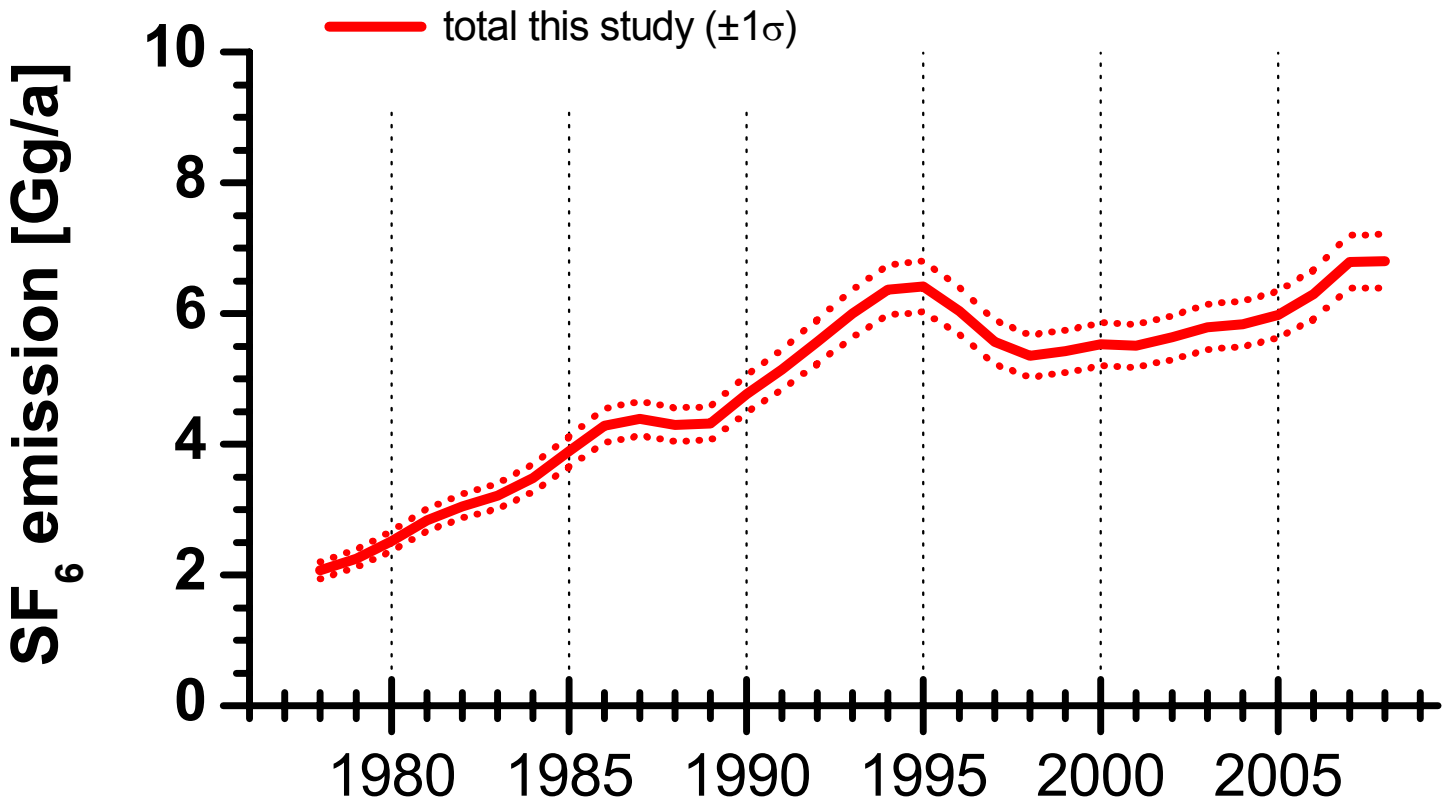
global mean growth rate $\cong$ global mean SF_6 emissions

Atmospheric observation-inferred global SF_6 emissions

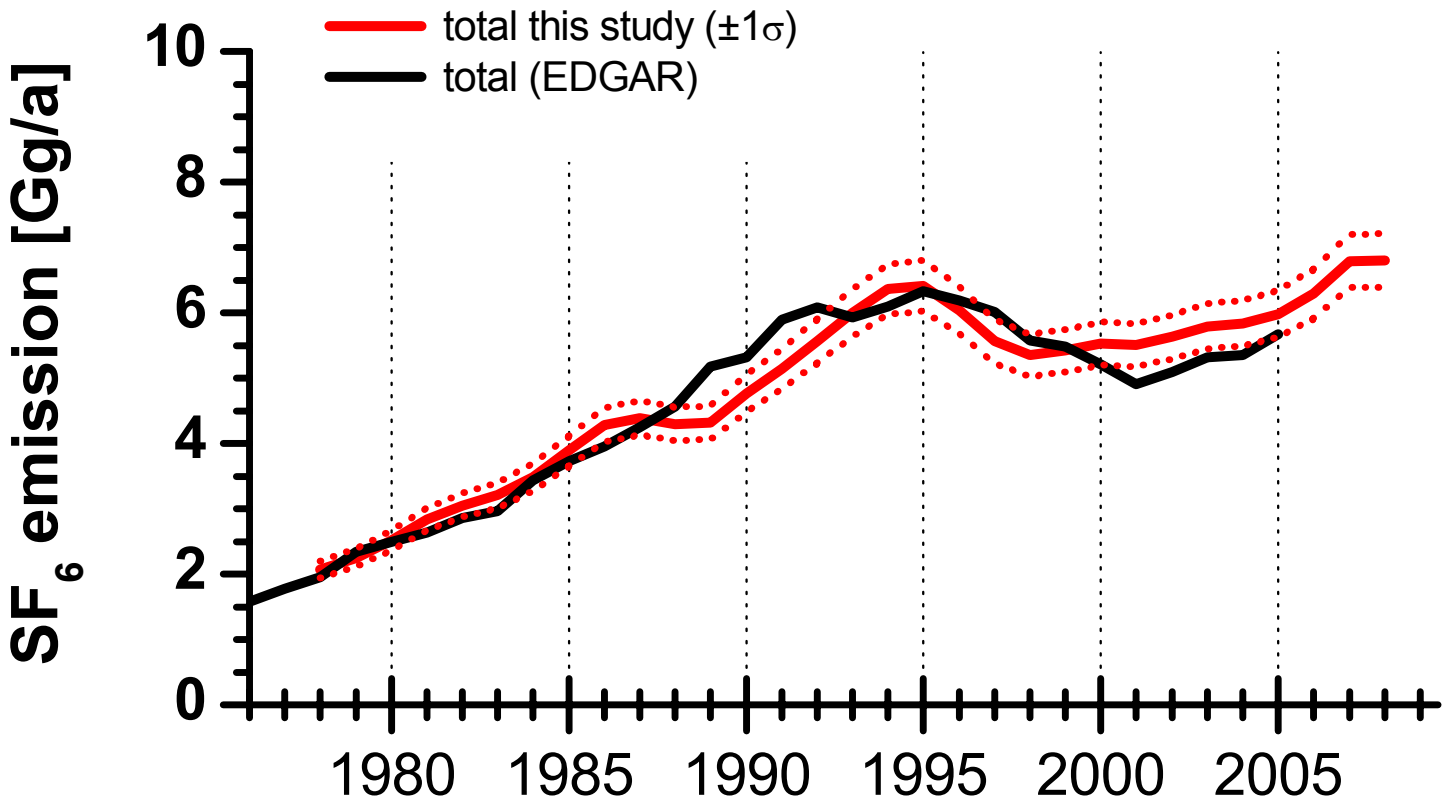


How well do the 2009 bottom-up EDGAR estimates compare to our atmospheric observation-based top-down emissions ?

Atmospheric observation-inferred global SF_6 emissions



Comparison with new global (bottom-up) EDGAR-estimated SF_6 emissions



How do UNFCCC-reported SF_6 emissions compare to our top-down estimate ?

Problem:

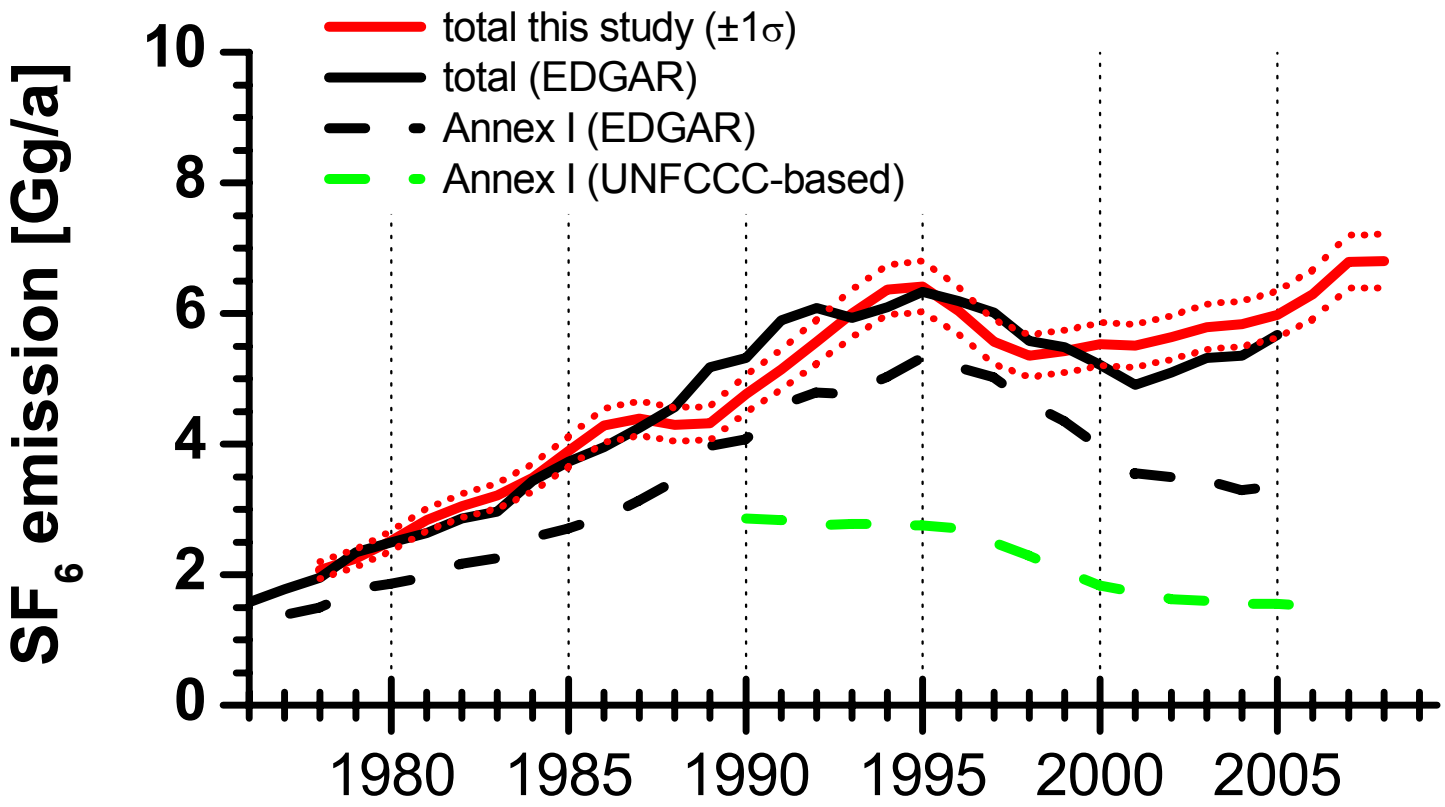
Only industrialised countries (Annex I) are required to report their GHG emissions to UNFCCC, these are

Western Europe, Canada, U.S.A., Japan, Australia, New Zealand, Eastern Europe, Russia & Turkey

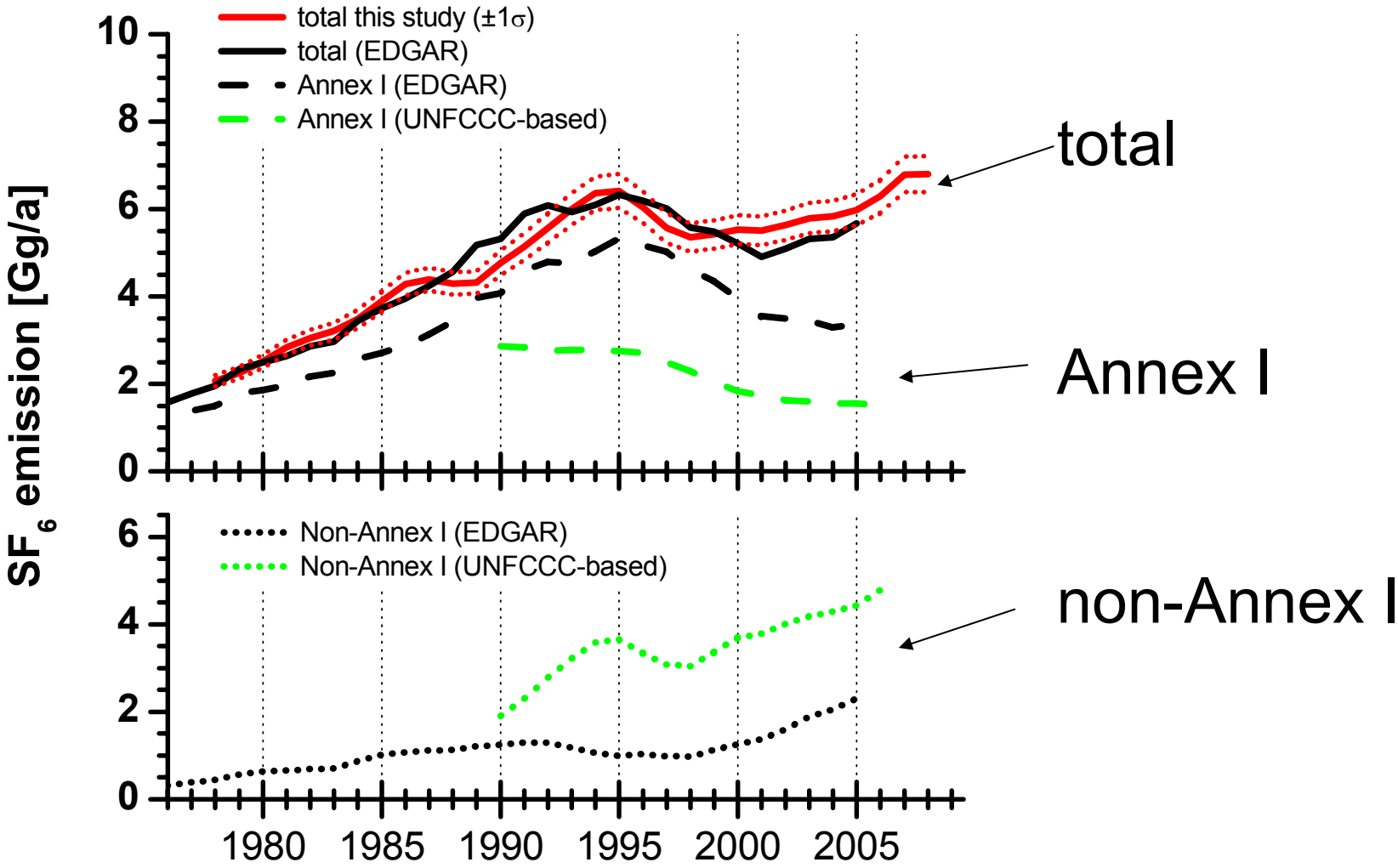
Therefore, we separate here into Annex I and non-Annex I

which are newly industrialised countries, i.e. *China, India, Brazil, others*

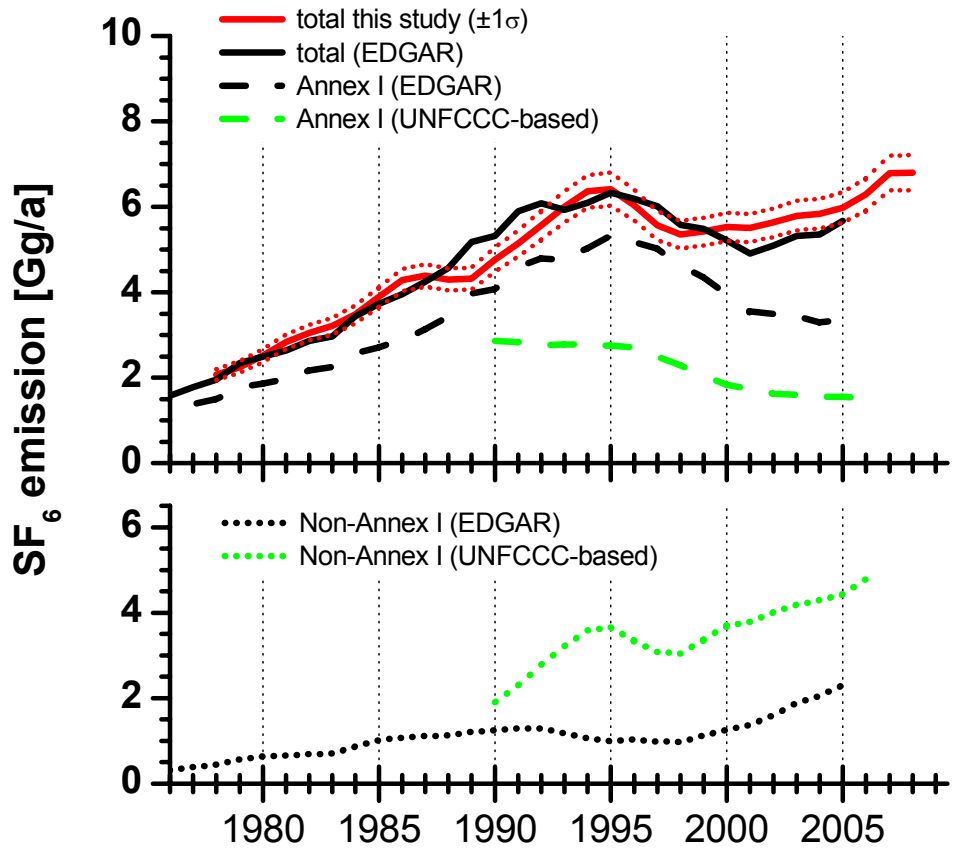
UNFCCC-based and EDGAR estimated Annex I SF_6 emissions



UNFCCC-based and EDGAR Annex I & non-Annex I SF_6 emissions

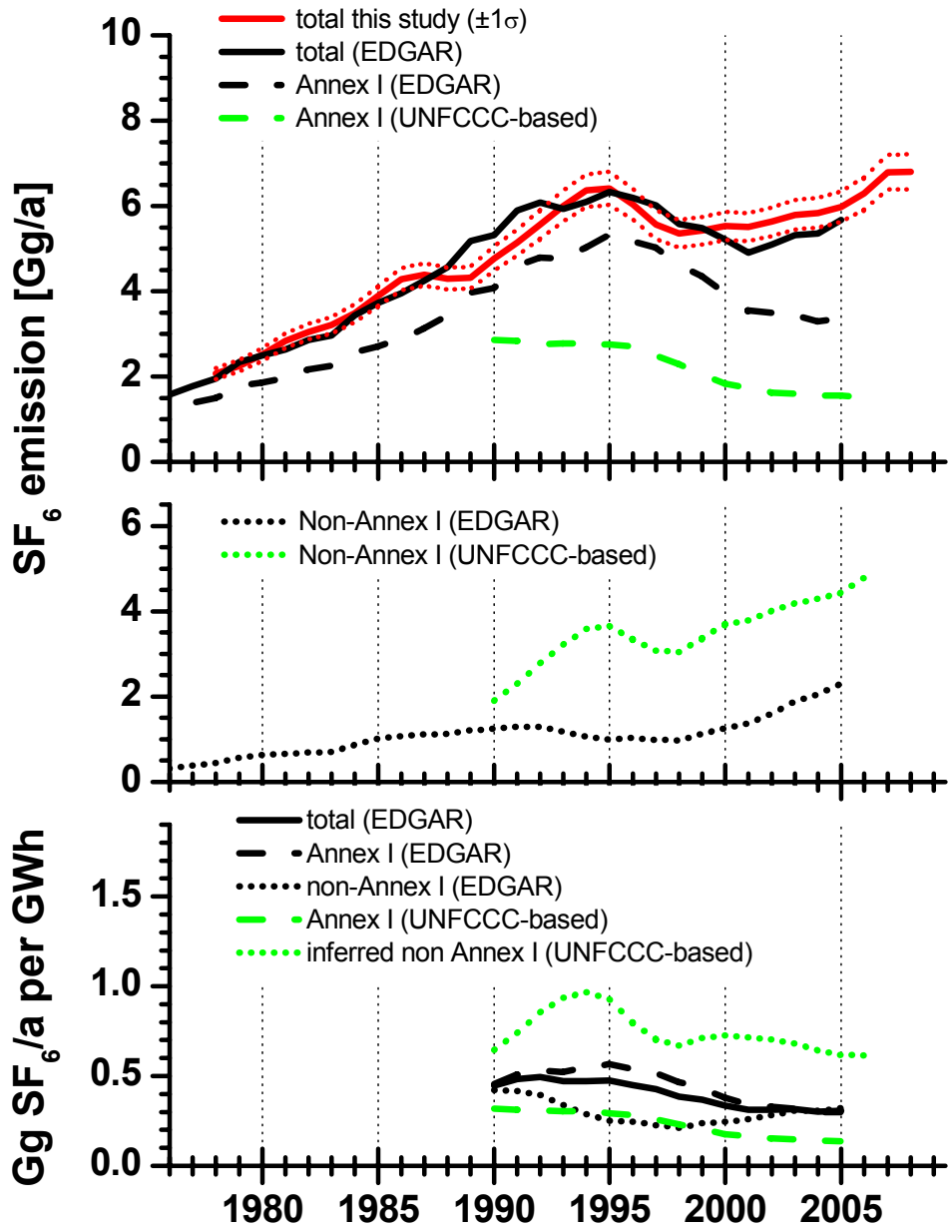


Are non-Annex I countries really responsible for the major part of global SF_6 emissions today ?

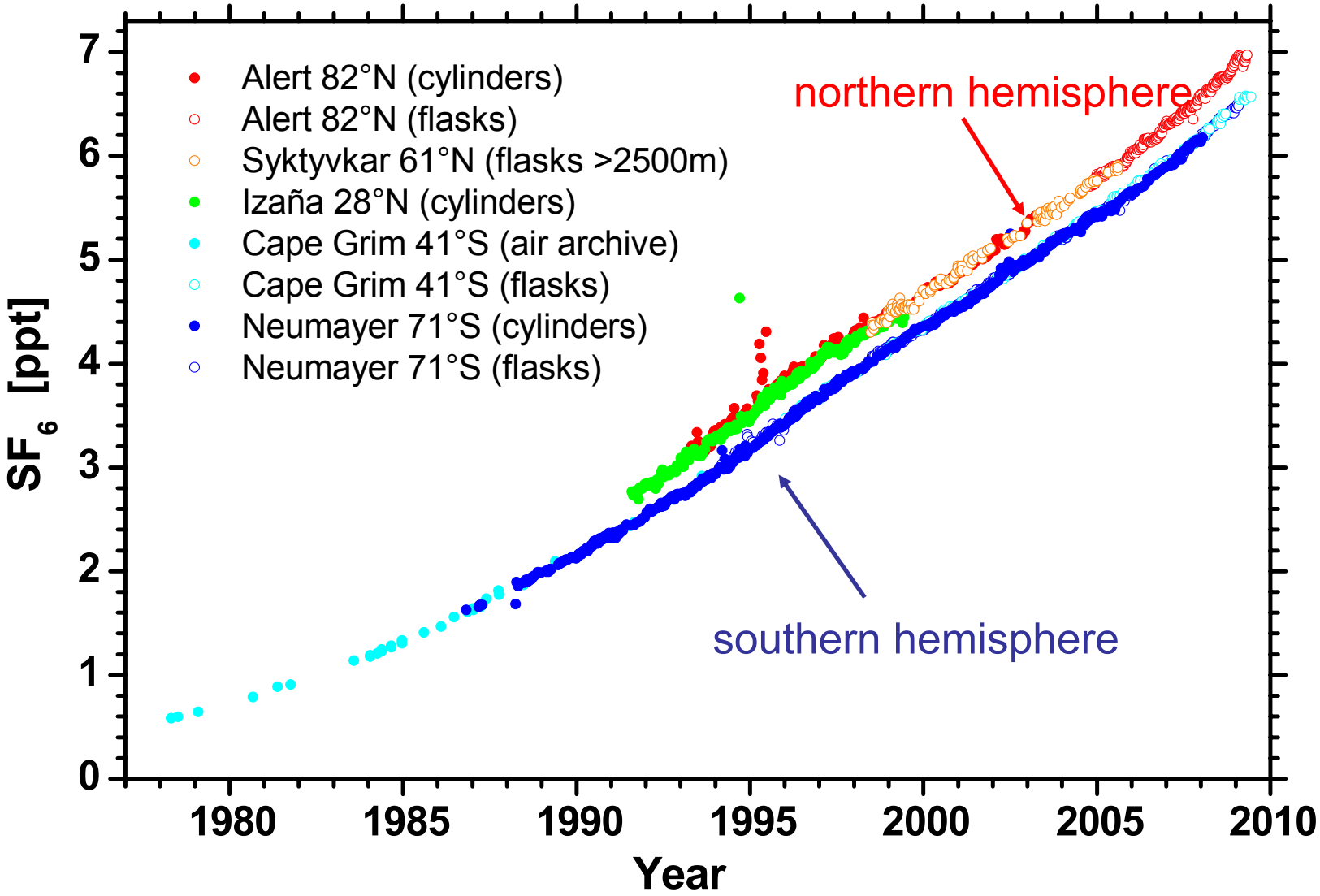


Are non-Annex I countries really responsible for the major part of global SF_6 emissions today ?

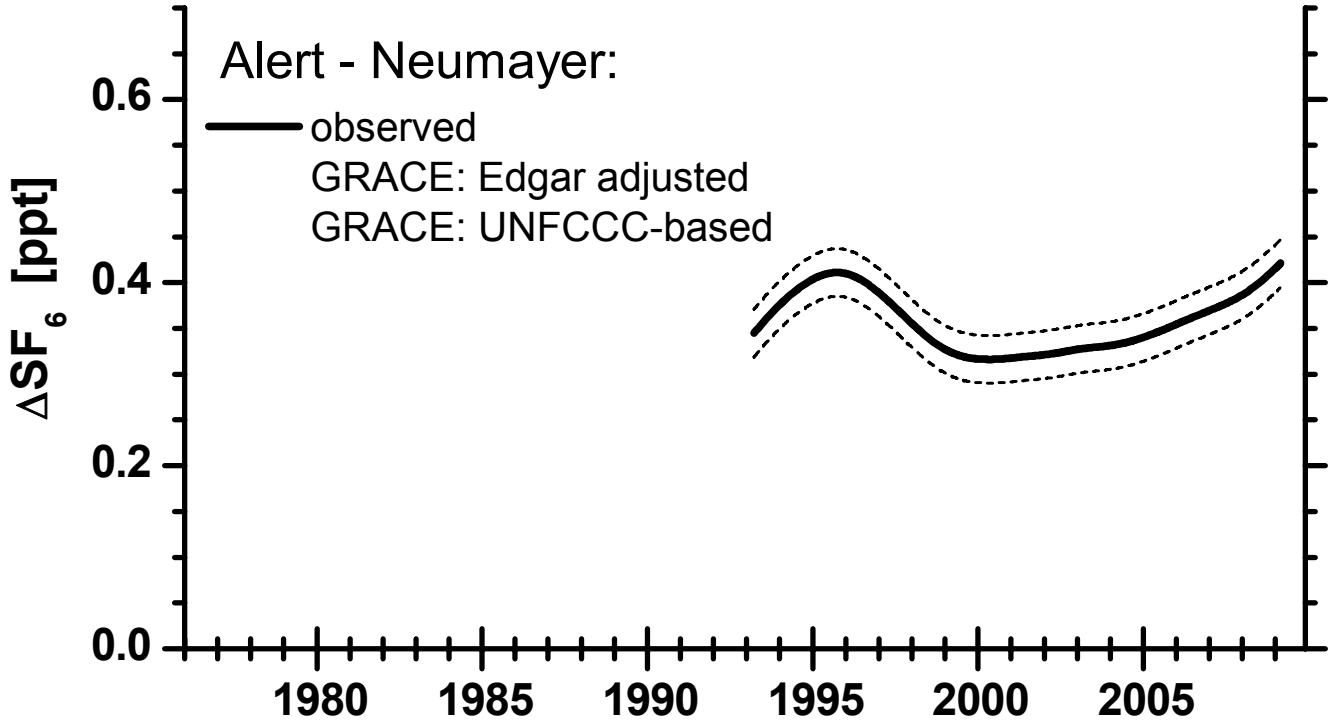
This would require much larger SF_6 emissions per electrical power production in non-Annex I than in Annex I countries



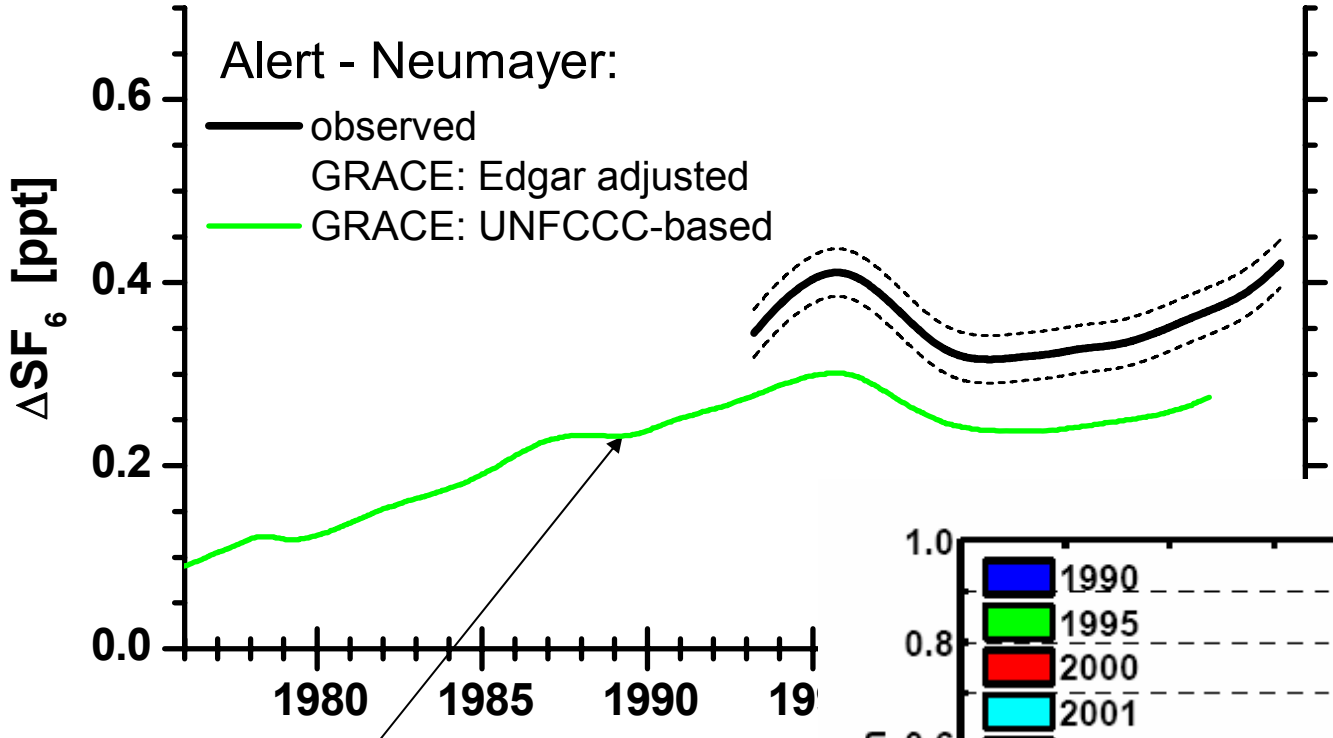
The SF_6 north-south gradient principally also provides information on the distribution of emissions



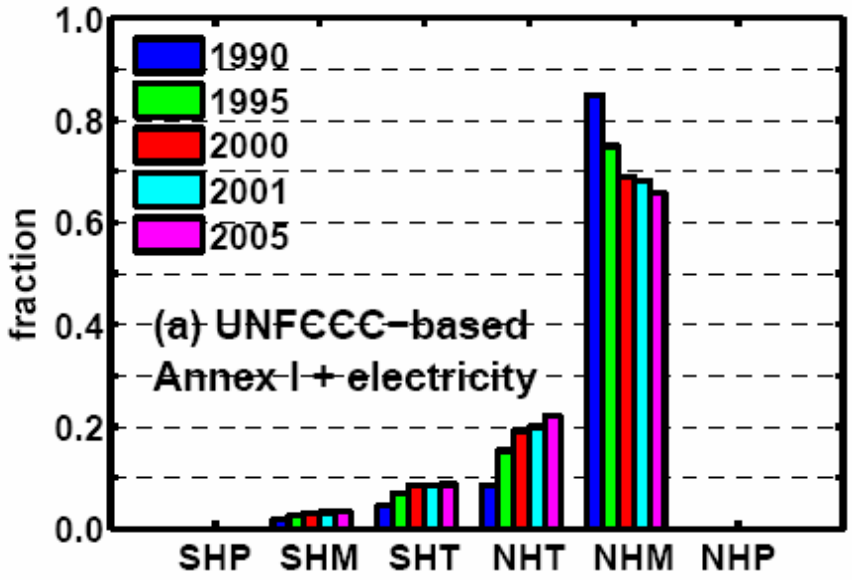
Observed difference between Alert (82°N) and Neumayer (71°S)



Observed and simulated difference between Alert (82°N) and Neumayer (71°S)



Simulation with the coarse-resolution atmospheric box model GRACE based on UNFCCC emissions



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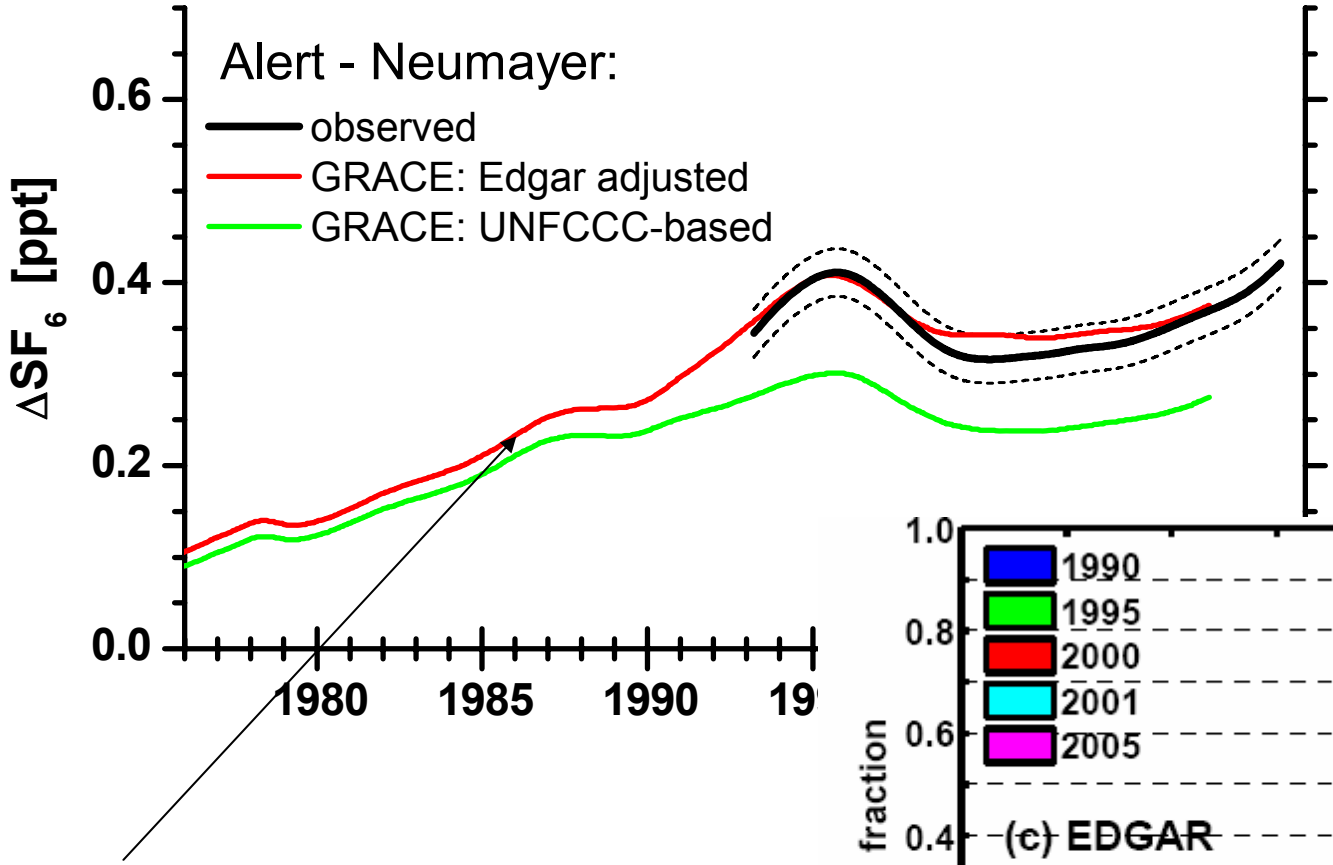
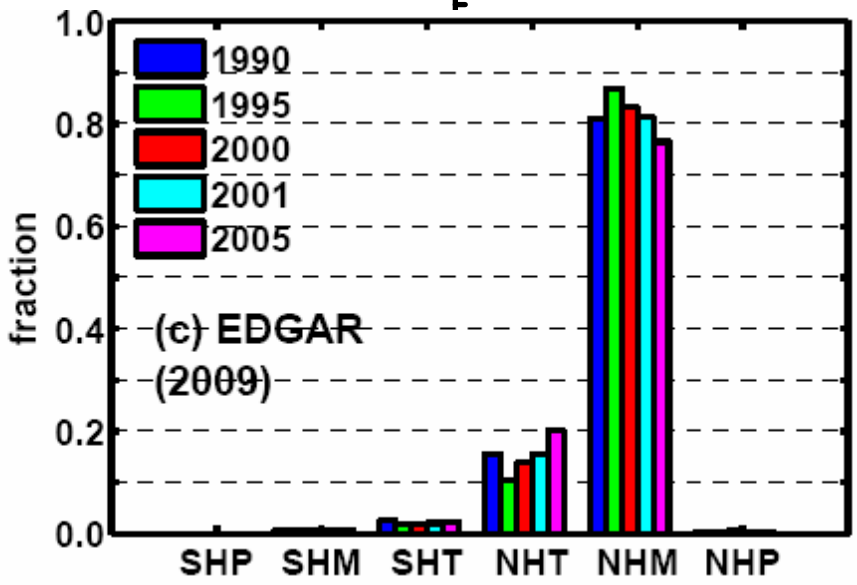
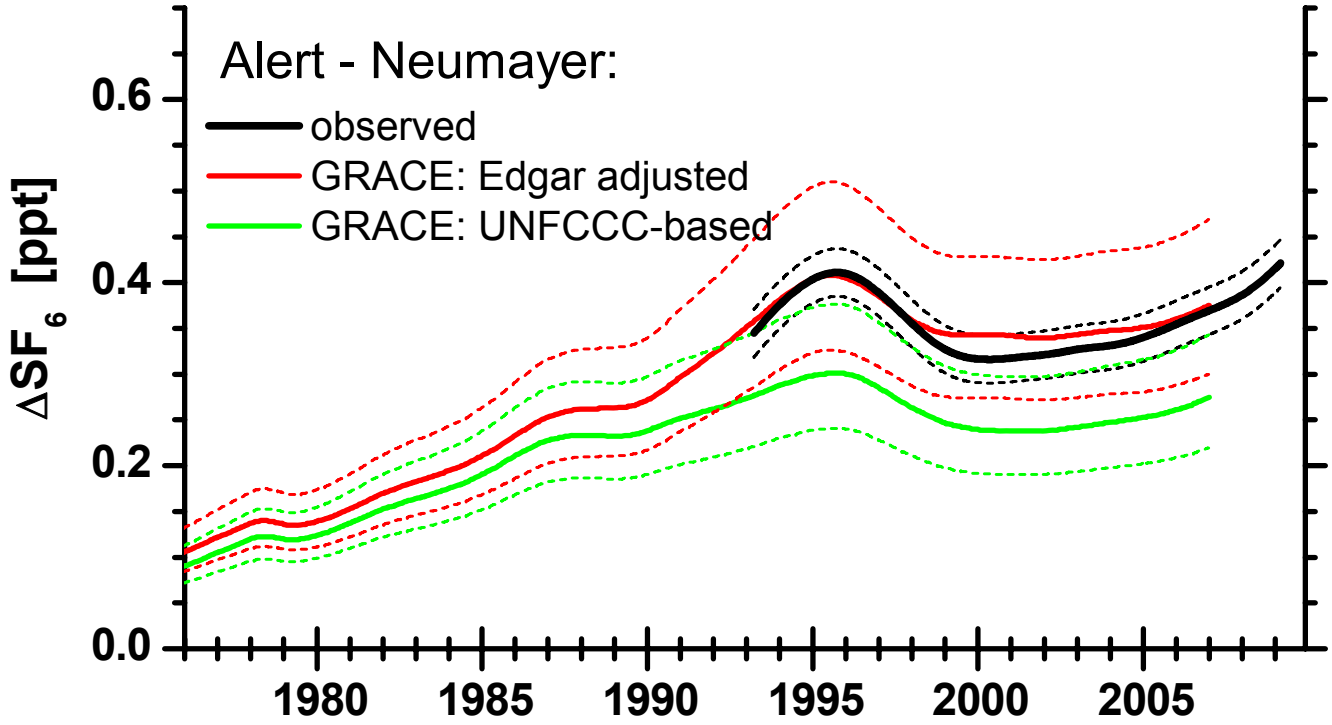




Simulations with EDGAR distribution

Observed and simulated difference between Alert (82°N) and Neumayer (71°S)



→ Model transport uncertainties limit constraints on the north-south distribution of emissions, this would also be a concern for high-resolution models !

Summary

Global atmospheric SF_6 mixing ratio has increased from almost zero in the 1970s to almost 7 ppt today

After a decrease of annual global emissions in 1996-1998, SF_6 sources increase again since 1998

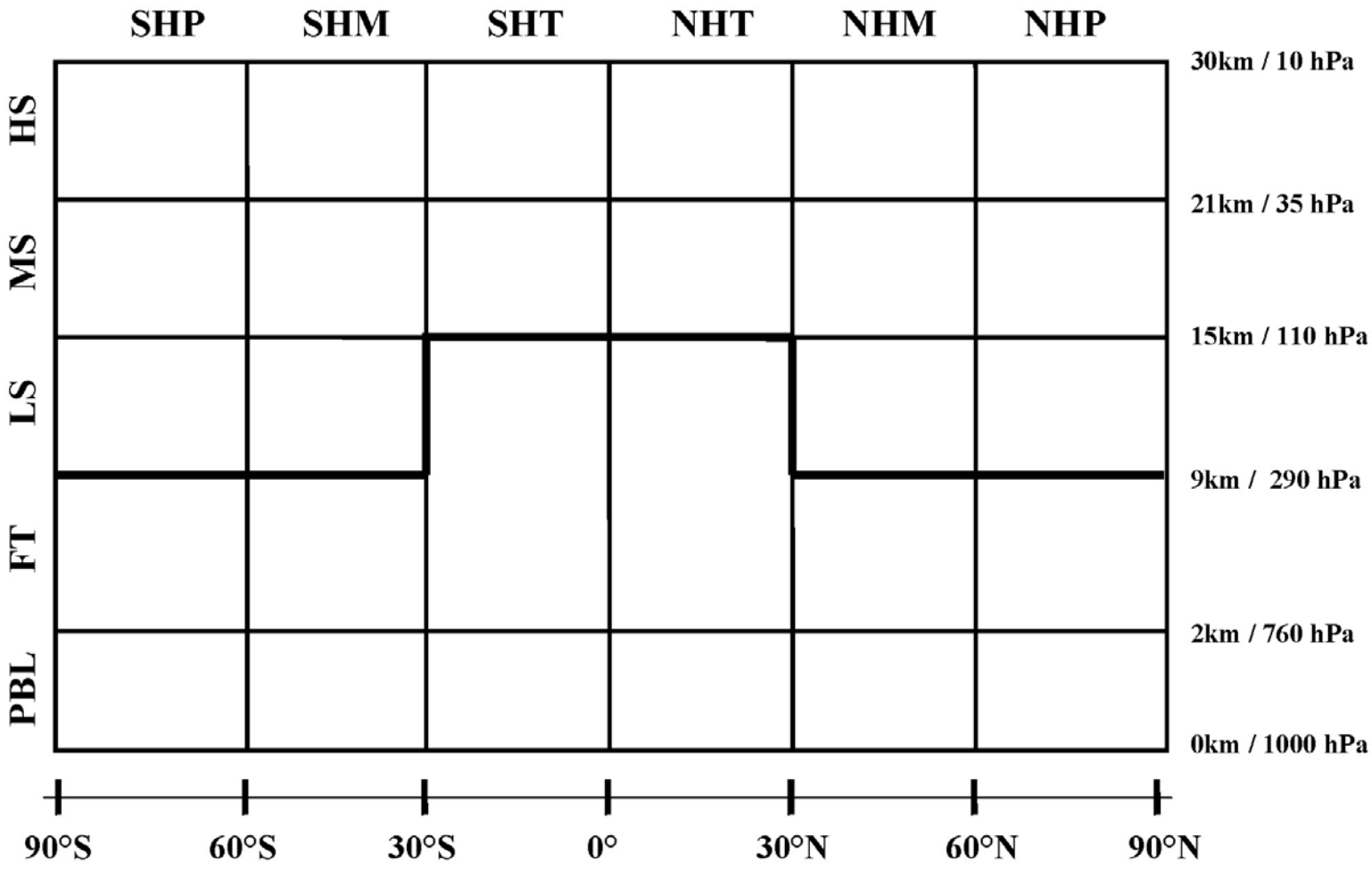
Bottom-up estimates by EDGAR compare well with our inferred emissions, however, for some periods, they are significantly different

Annex I reported emissions are surprisingly low and leave a large gap of non-reported emissions

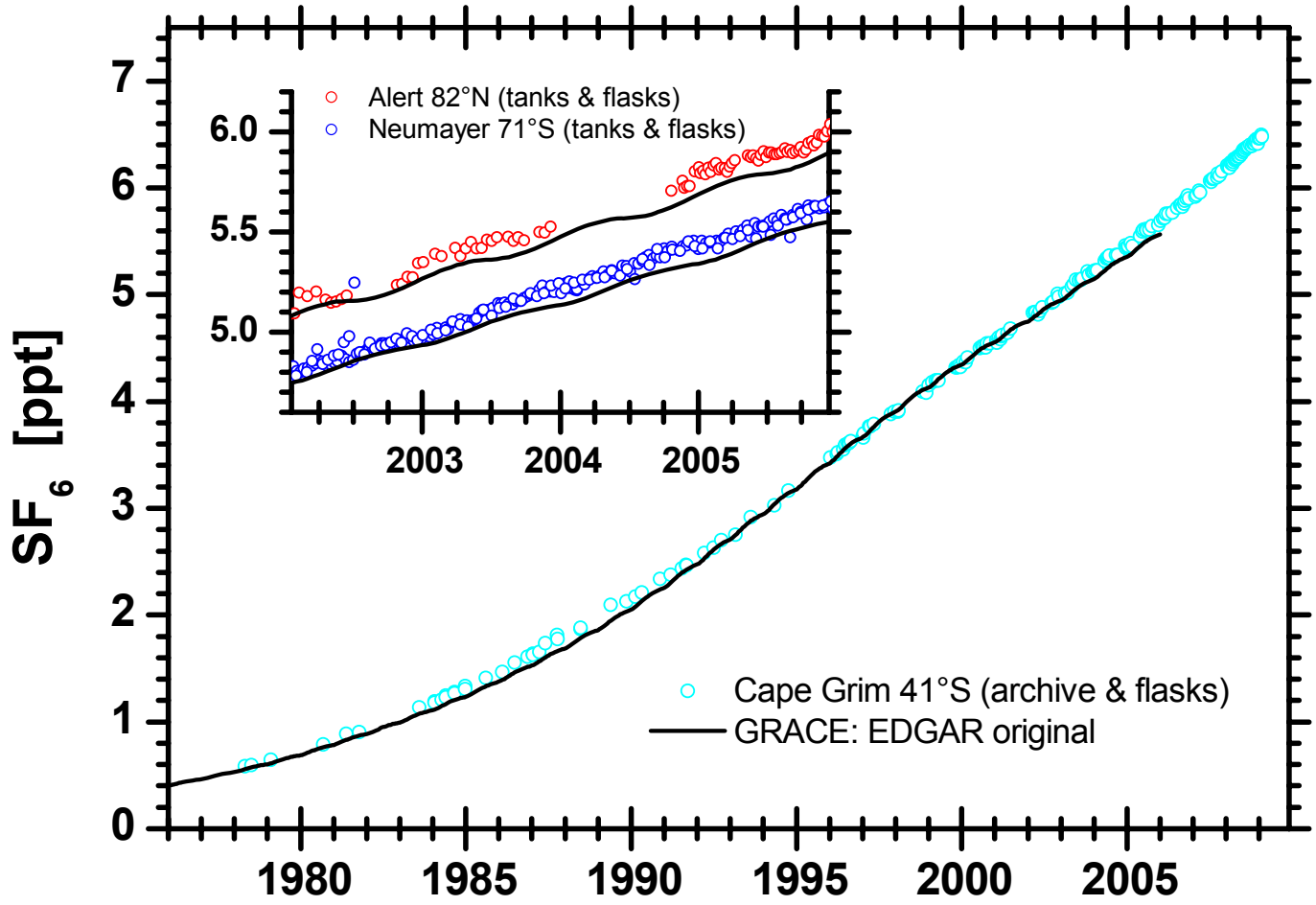
… but model transport uncertainties and the number of observational sites in our network limit emission apportionment to Annex I or non-Annex I countries

Thank you !

The coarse-resolution GRACE model



Simulating tropospheric SF_6 with EDGAR-estimated SF_6 emissions



Simulating tropospheric SF_6 with observation-inferred emissions