

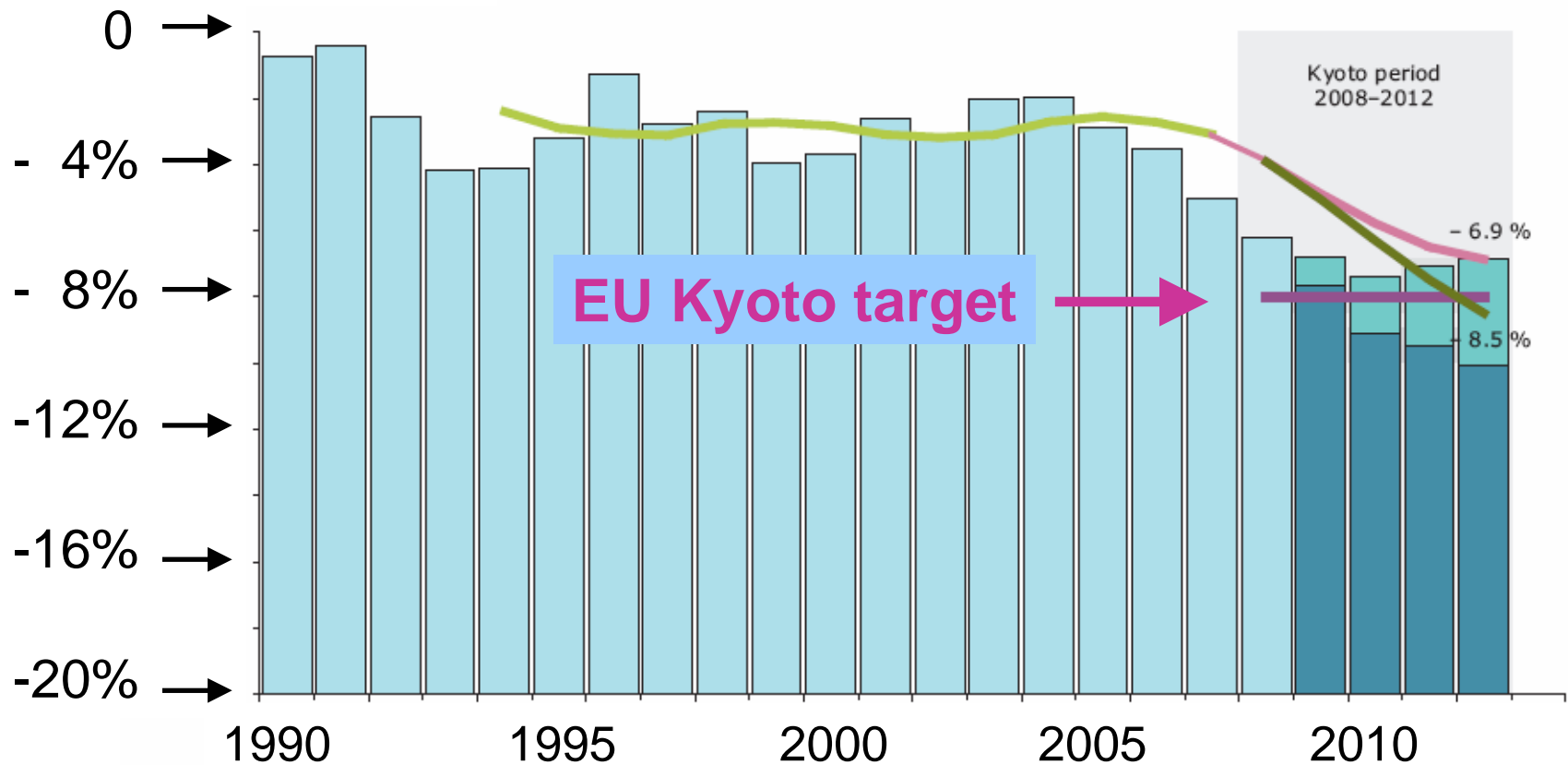
Greenhouse gases emission reductions in Europe until 2020 by more than 20% – reality or fiction ?

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and Felix Vogel

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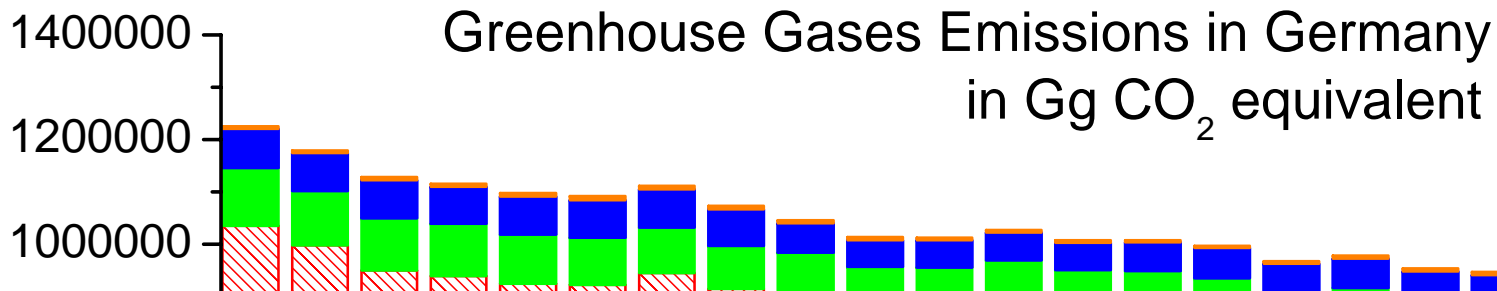


European (EU-15) Greenhouse Gases Emission Trends and Perspectives

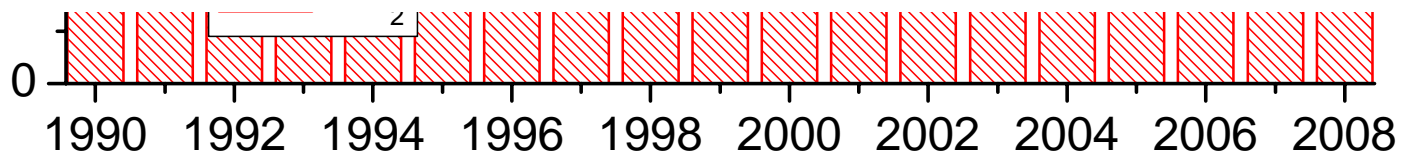


20% GHG emission reductions promised until 2020 (EU-27)

Germany proposed 21% GHG emissions reductions until 2020

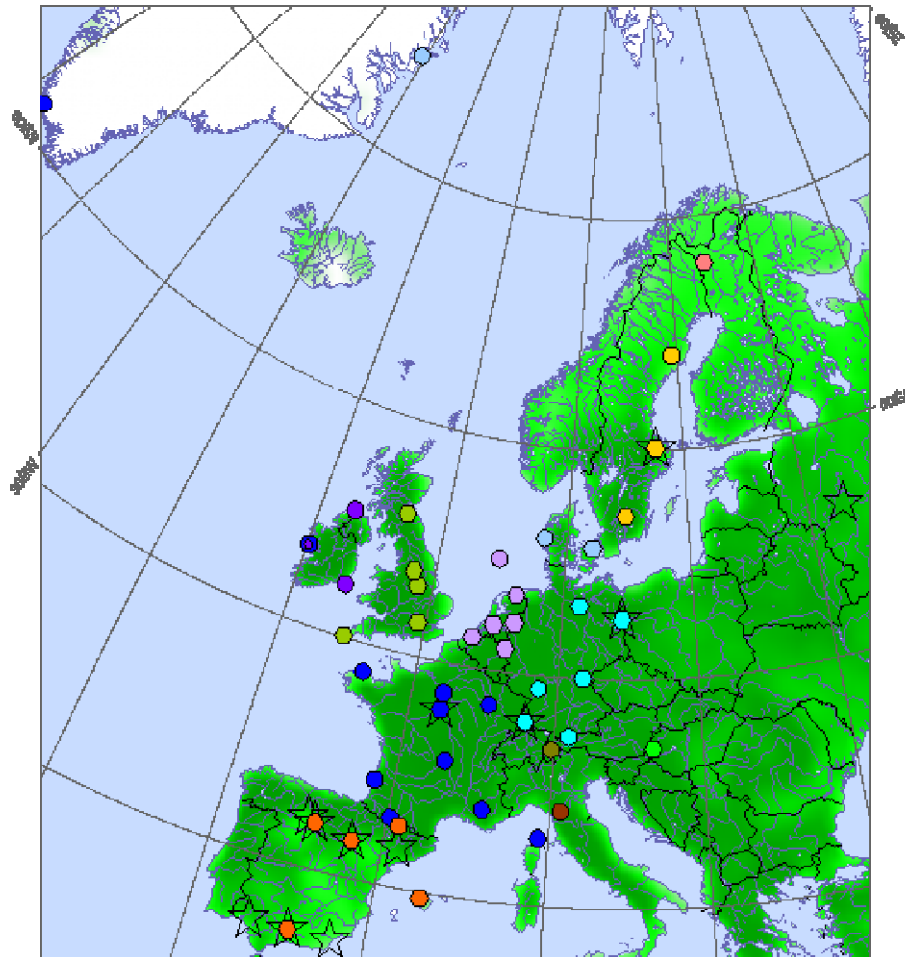


Can we trust these reports ?



... and reported for 2008 reductions by already 22% !

Reduction numbers need independent verification
e.g. by atmospheric observations



ICOS aims at running a harmonised atmospheric monitoring network for CO_2 and CH_4 to understand the European carbon budget ...

... and to monitor GHGs emission changes !

Atmospheric verification:
How could this work ?



[Google Earth]

Baden-Württemberg

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50°51'01.42" N 9°04'20.25" E Höhe 398 m

Sichthöhe 154



[Google Earth]

Heidelberg
region

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Worms

Ludwigshafen am Rhein

Mannheim

Heidelberg

Heidelberg

Heilbronn

[Google Earth]

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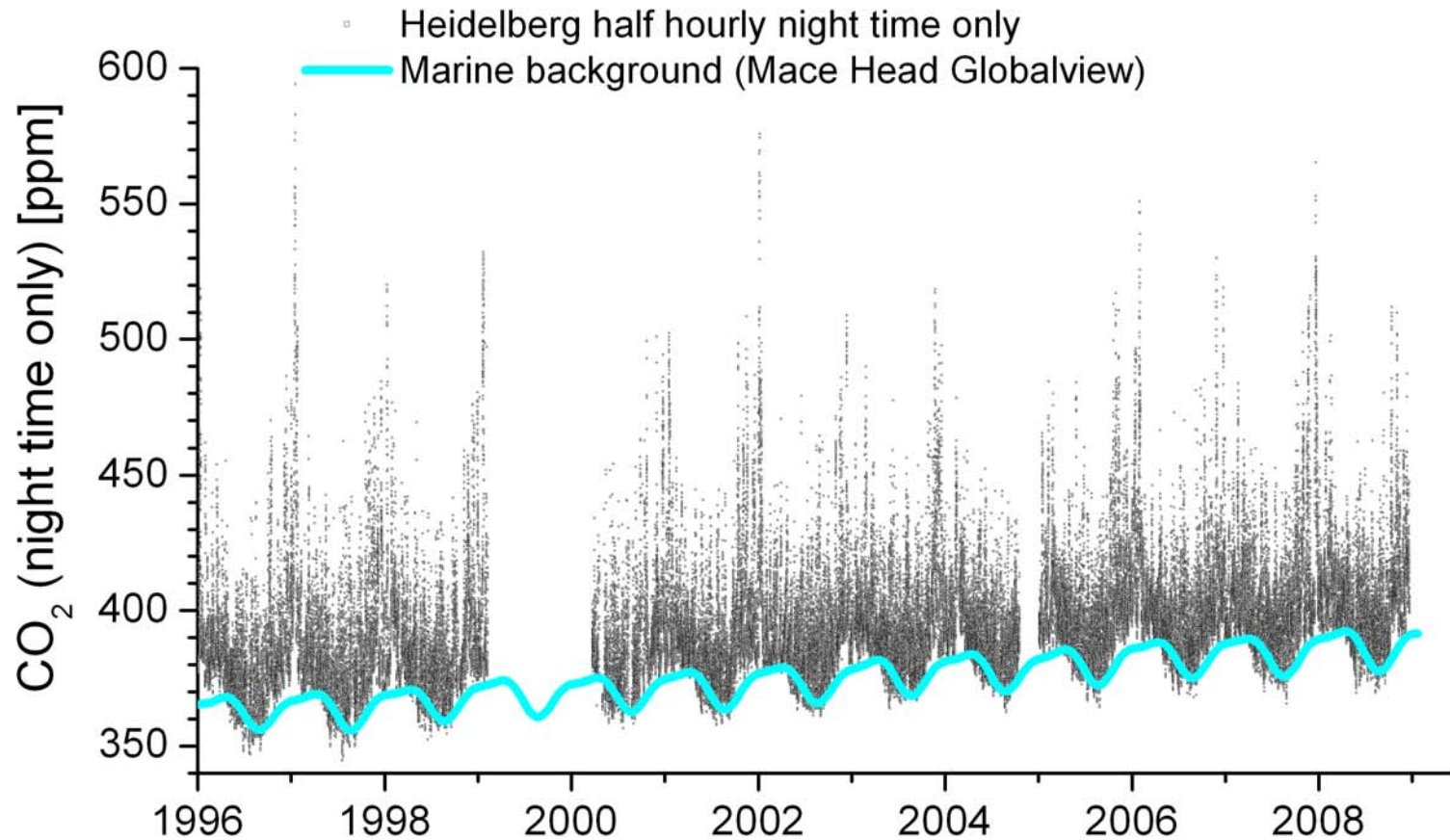
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49°22'05.24" N 8°45'46.57" E Höhe 127 m

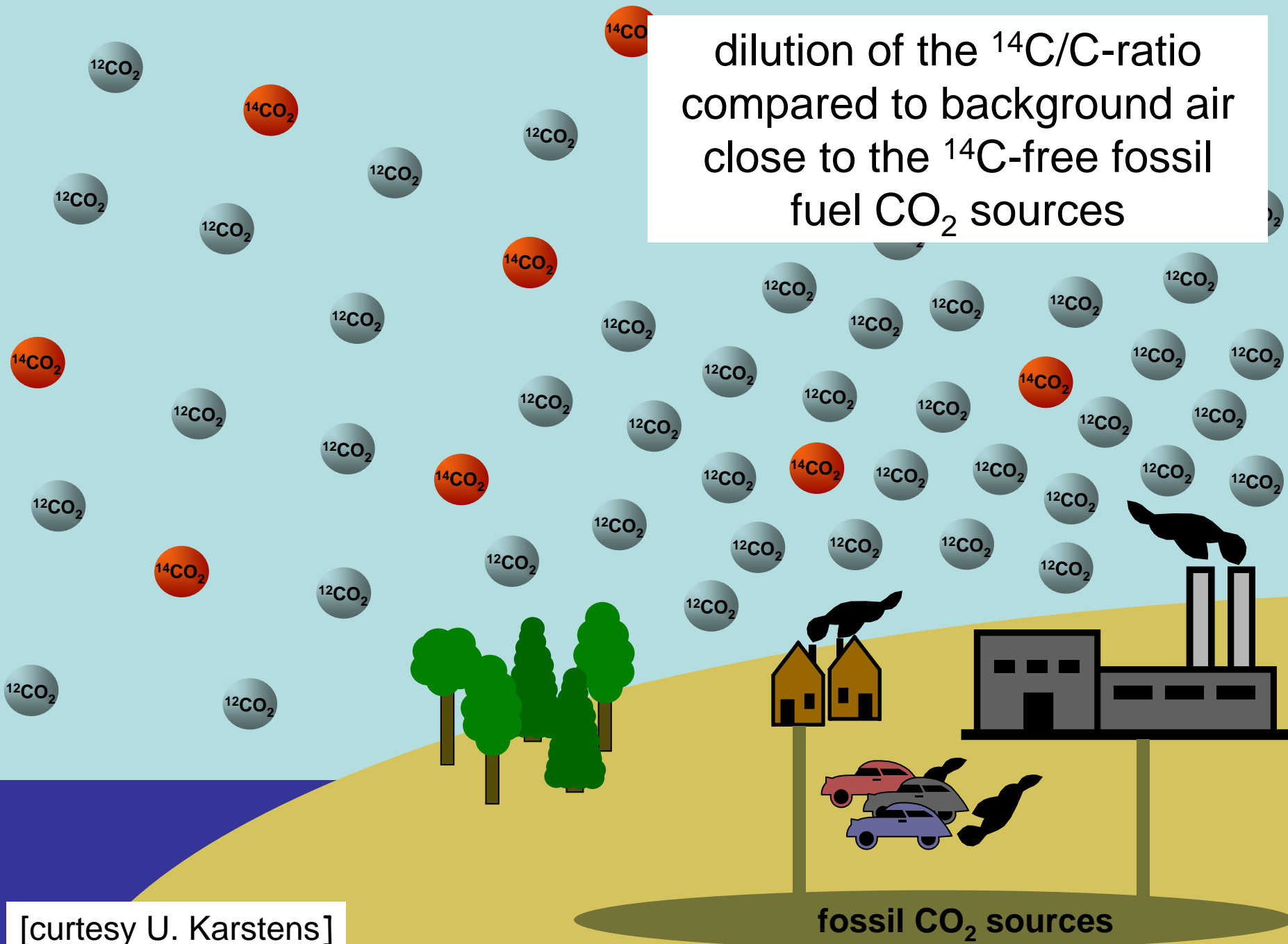
Sichthöhe

CO₂ mixing ratio in ambient Heidelberg air



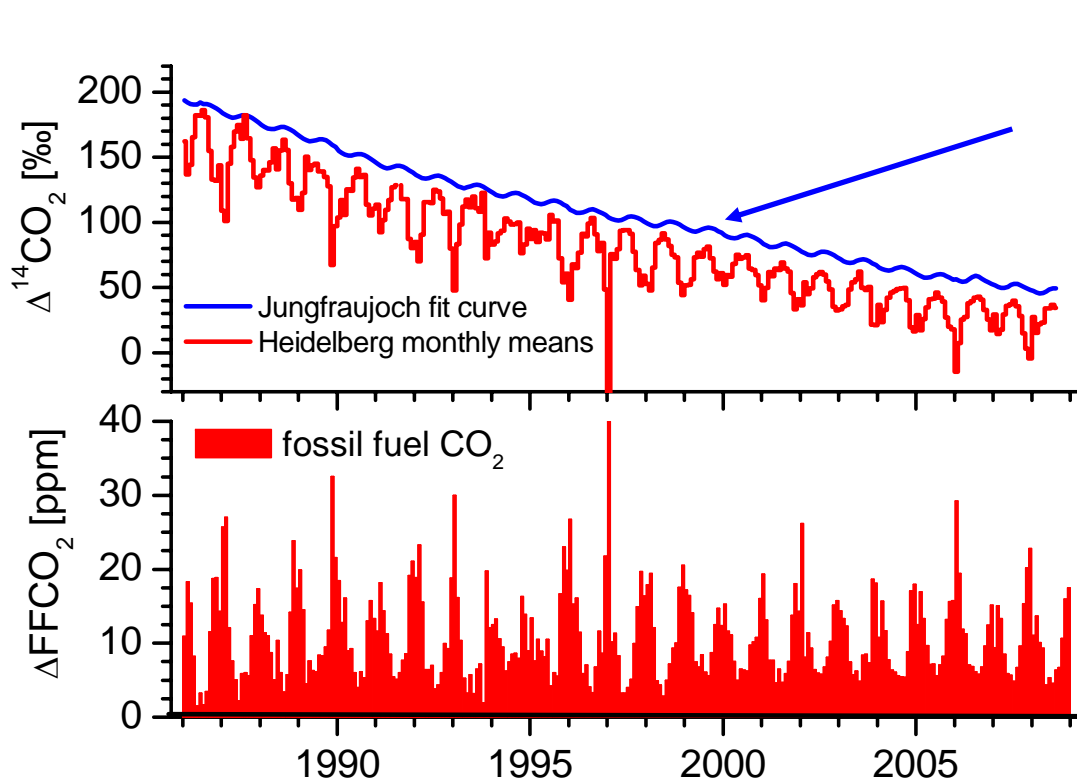
How can we separate fossil fuel from
biogenic CO₂ offsets ?

dilution of the $^{14}\text{C}/\text{C}$ -ratio
compared to background air
close to the ^{14}C -free fossil
fuel CO_2 sources



[courtesy U. Karstens]

$^{14}\text{CO}_2$ and fossil fuel CO_2 variability in Heidelberg

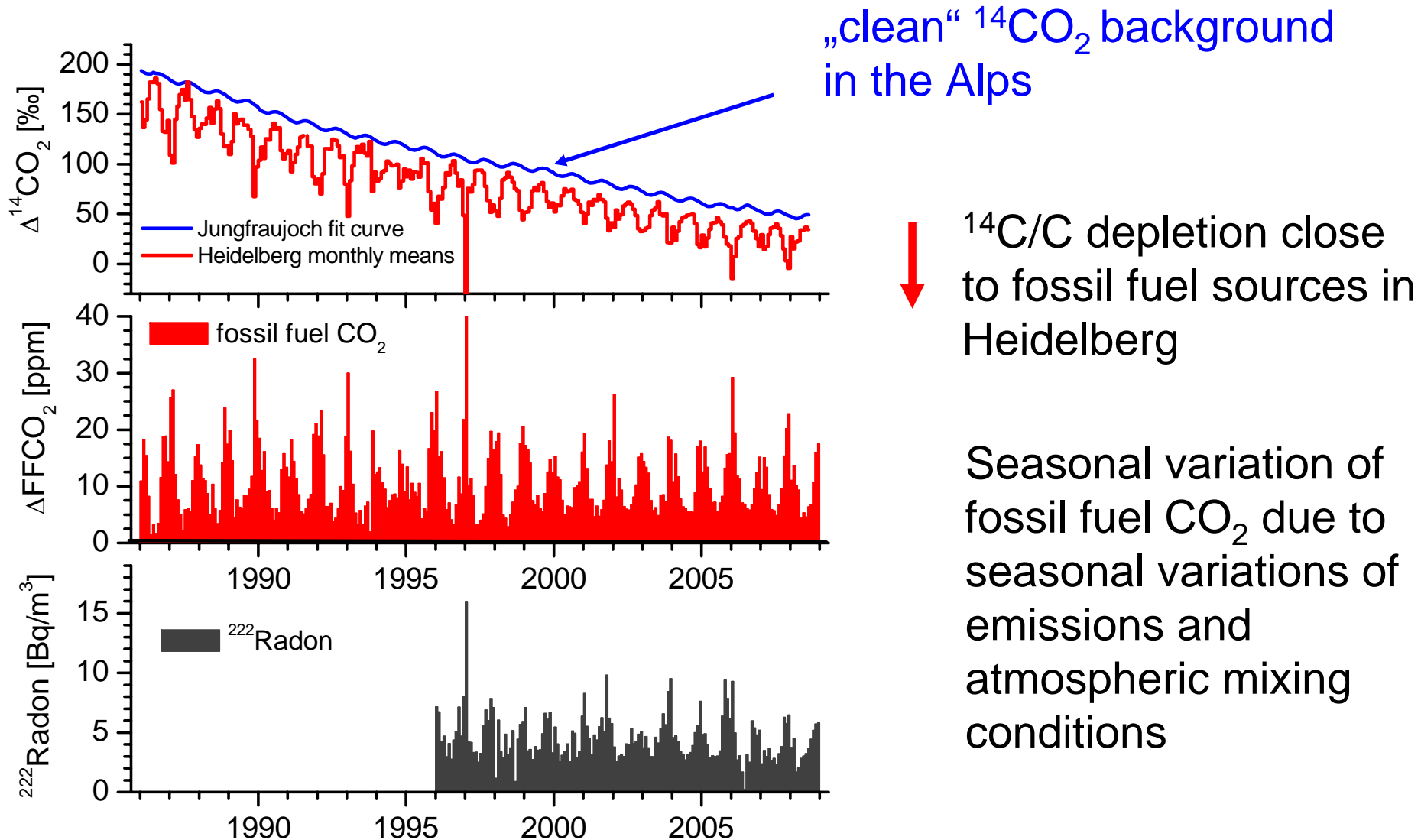


„clean“ $^{14}\text{CO}_2$ background
in the Alps

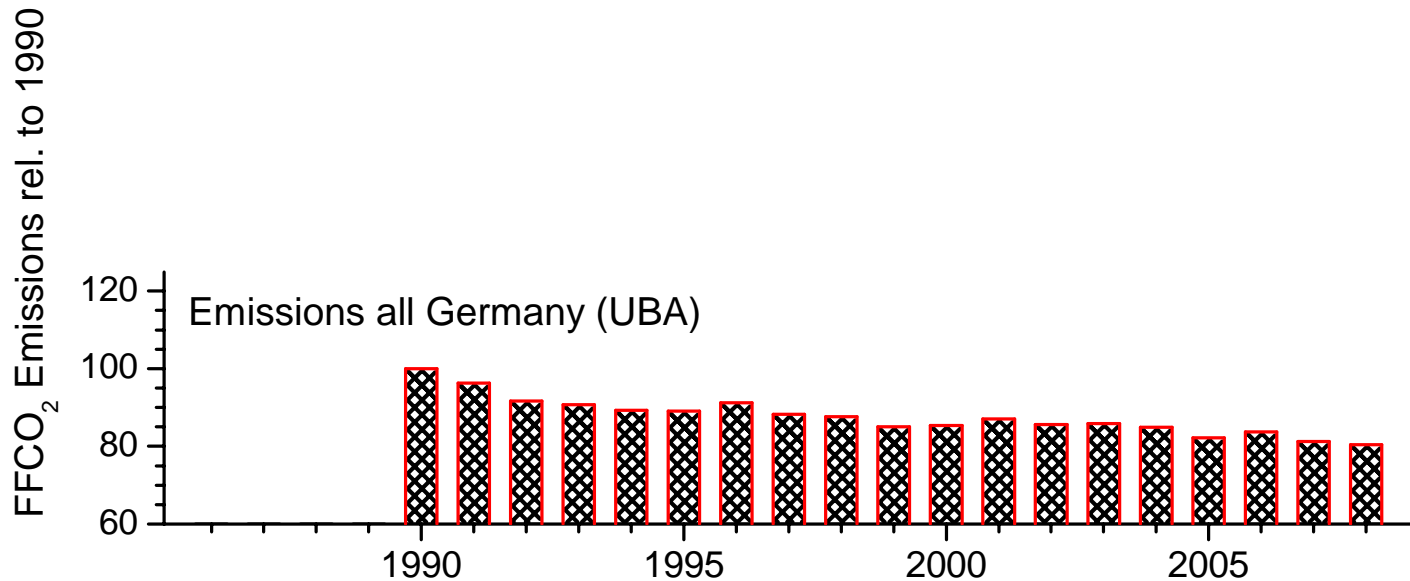
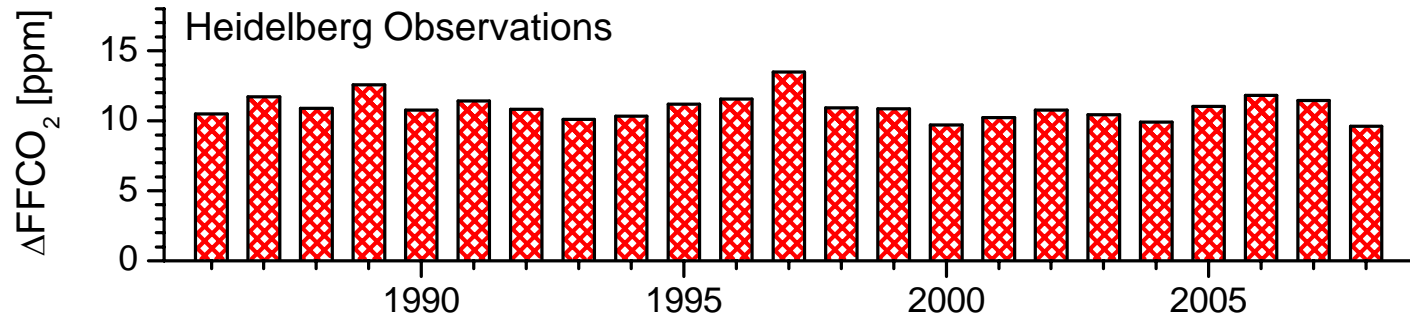
$^{14}\text{C}/\text{C}$ depletion close
to fossil fuel sources in
Heidelberg

Seasonal variation of
fossil fuel CO_2 due to
seasonal variations of
emissions and
atmospheric mixing
conditions

$^{14}\text{CO}_2$ and fossil fuel CO_2 variability in Heidelberg



Long-term trend of regional fossil fuel CO₂ and fossil fuel CO₂ emissions





[Google Earth]

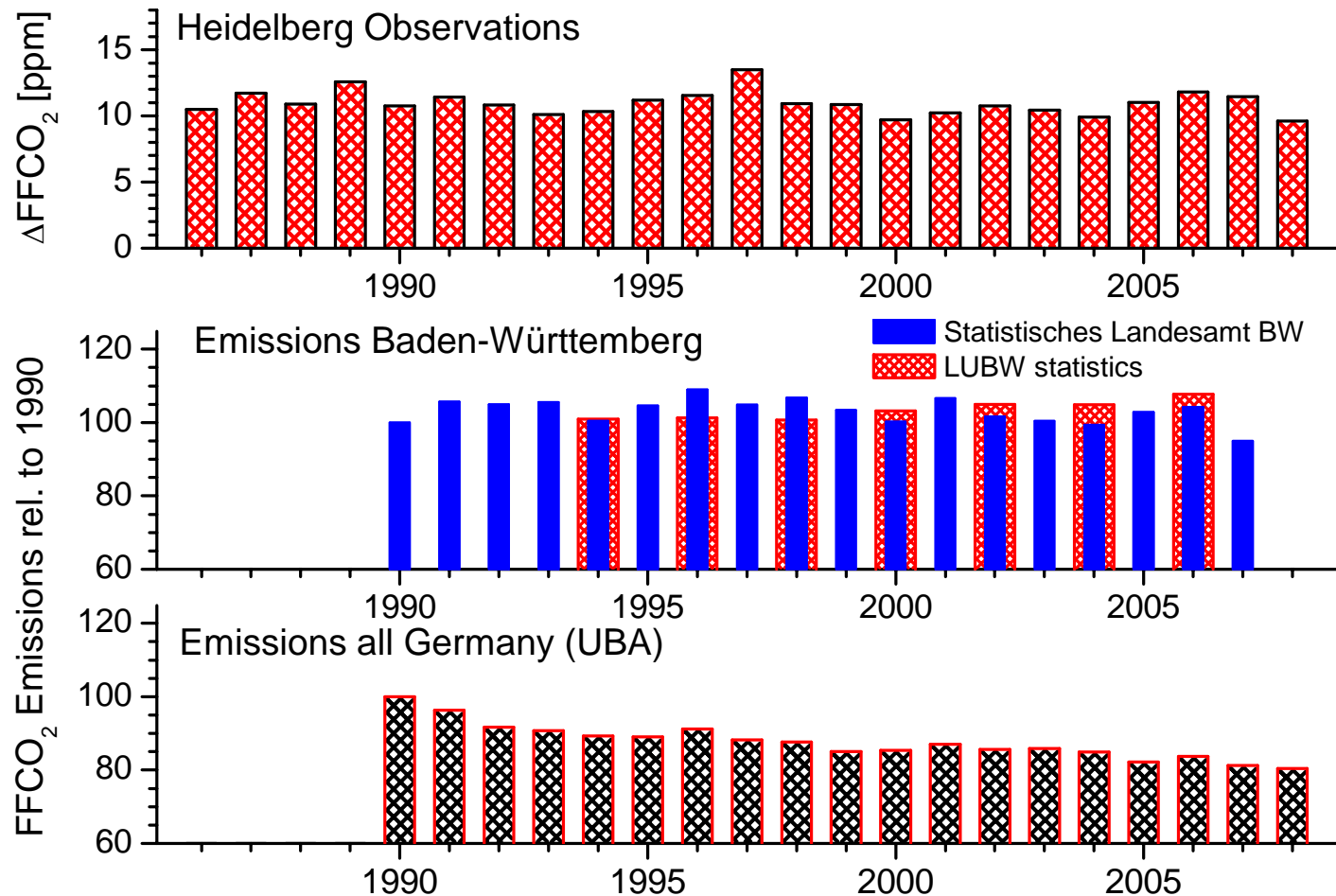
Baden-Württemberg

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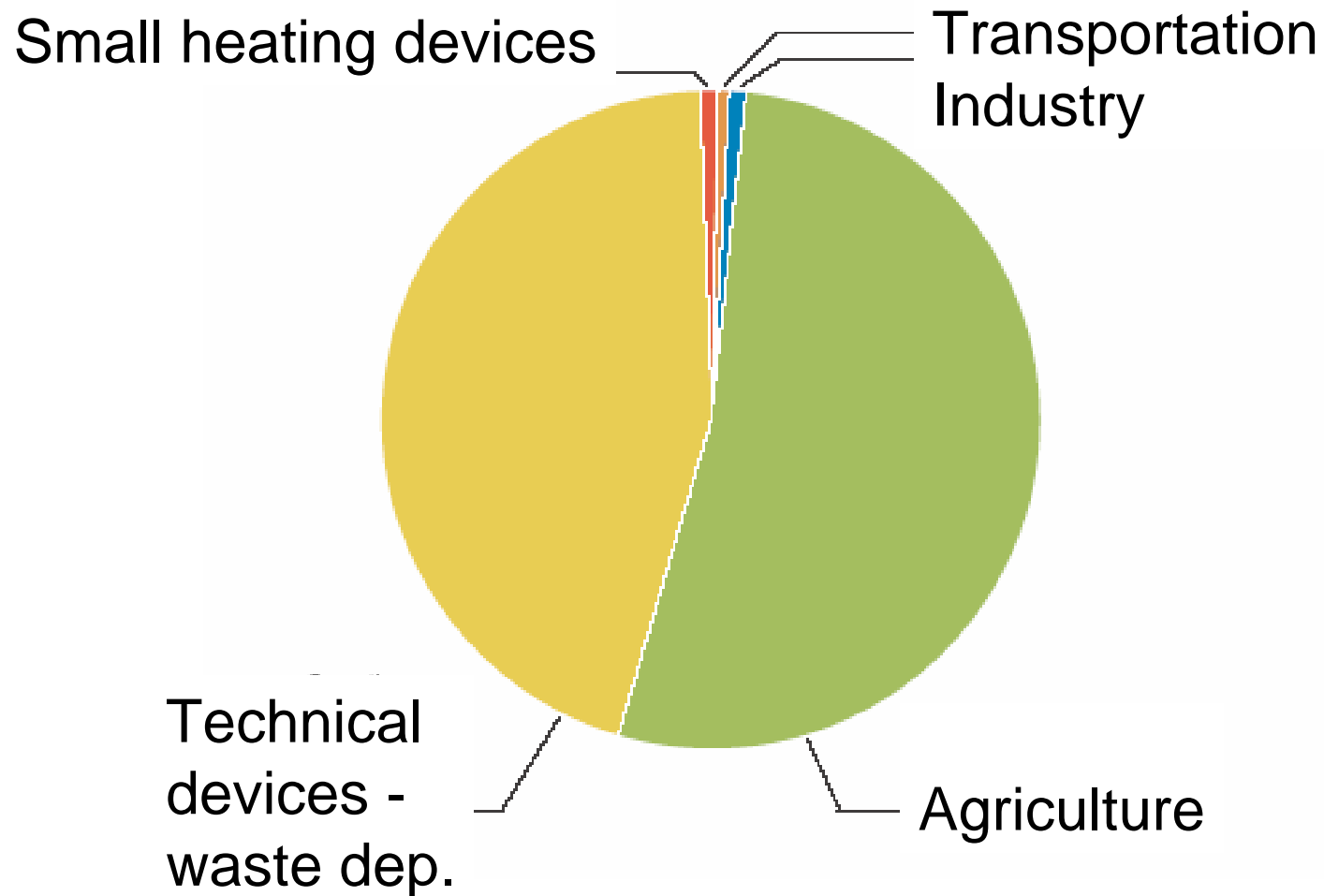
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Sichthöhe 154

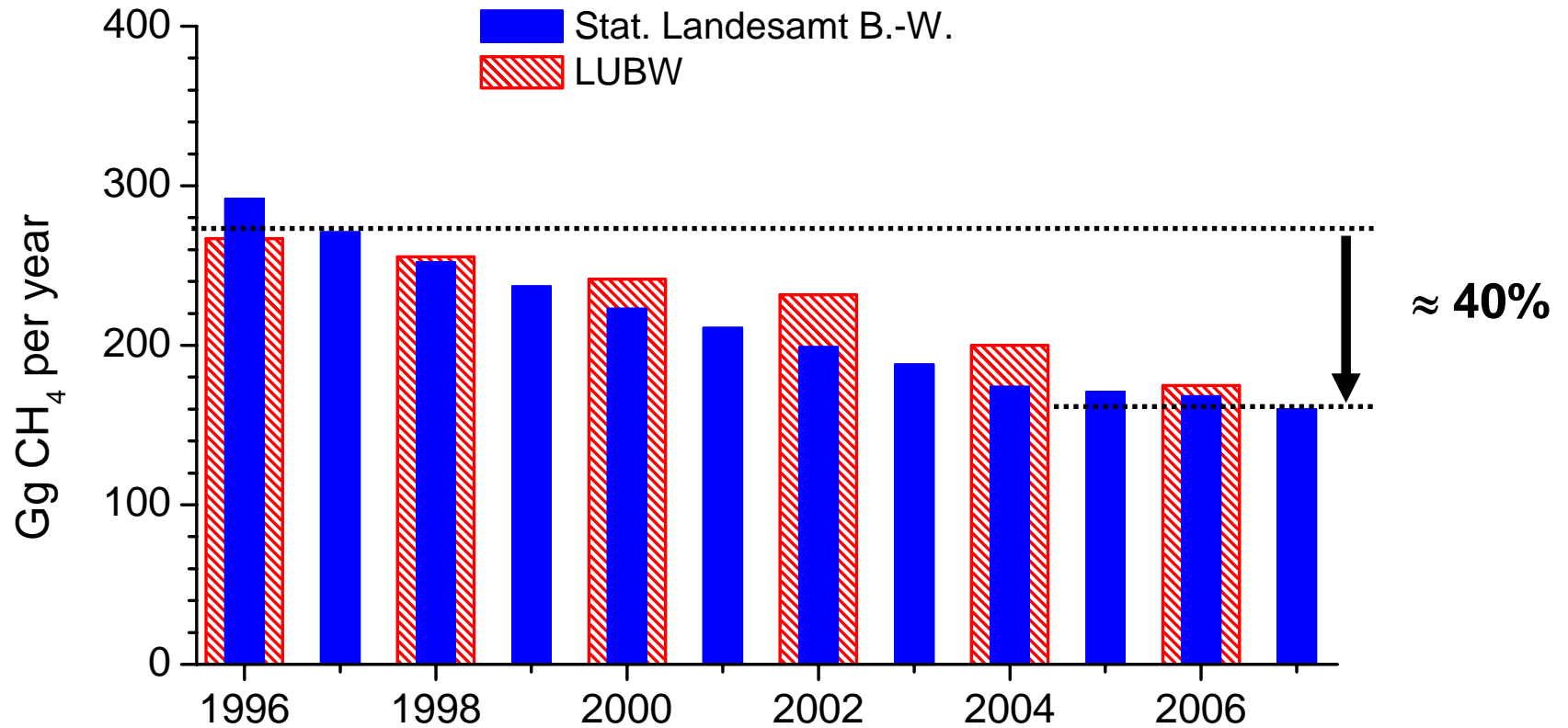
Long-term trend of regional fossil fuel CO₂ and fossil fuel CO₂ emissions



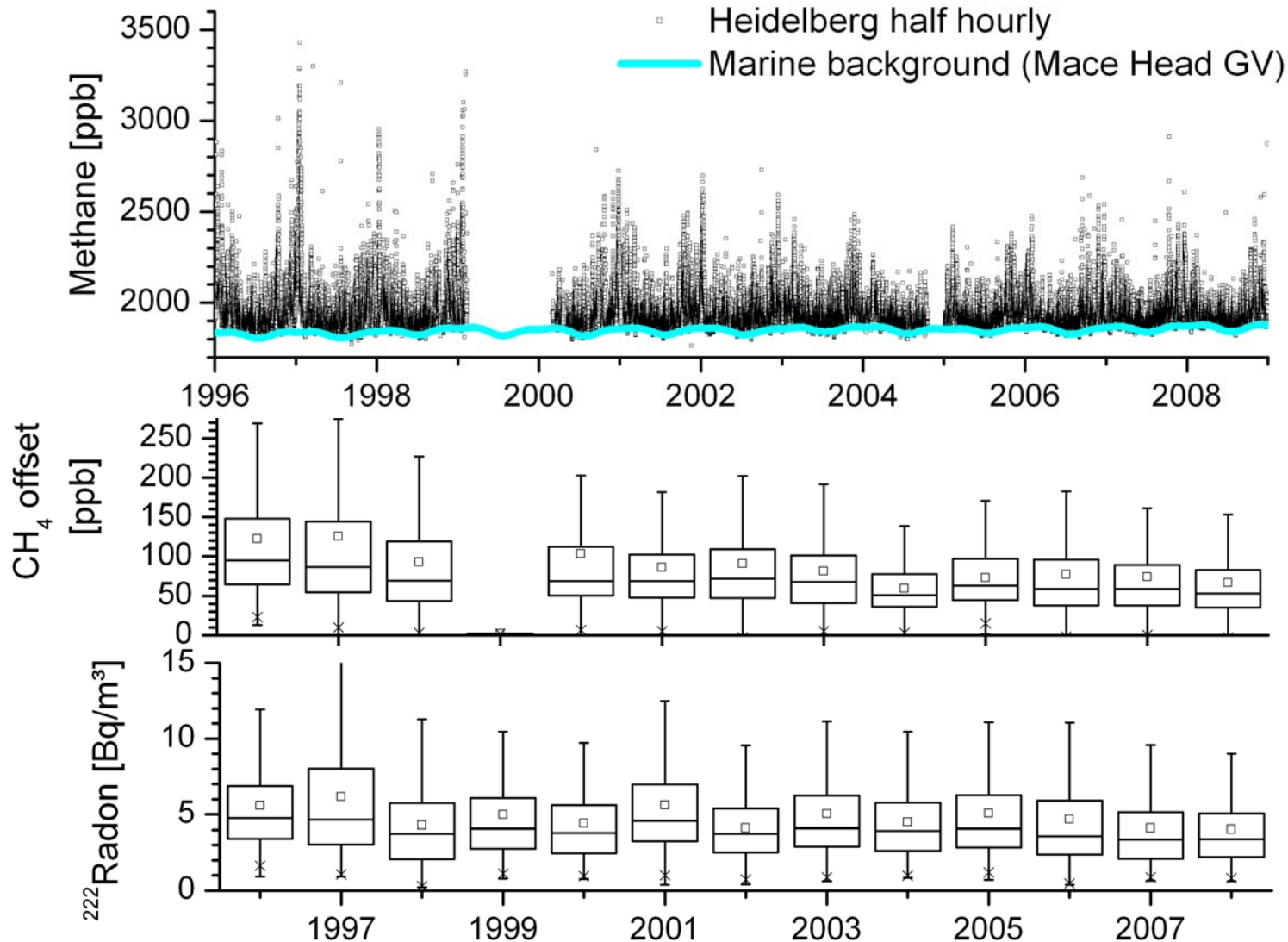
CH₄ sources in Baden-Württemberg 2004



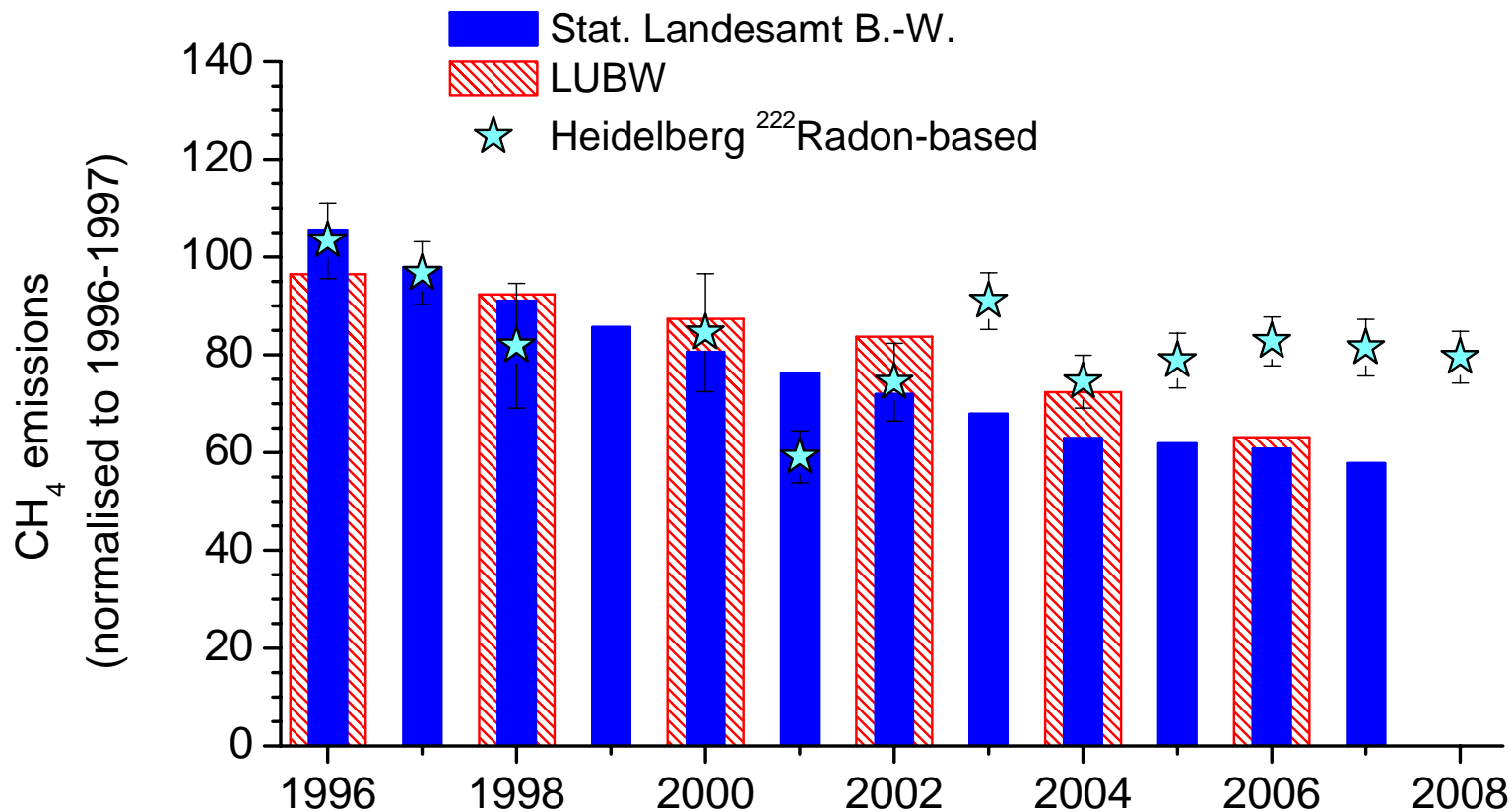
Long-term trend of CH₄ emissions in Baden-Württemberg



Observed CH₄ in Heidelberg and its annual offsets relative to background air



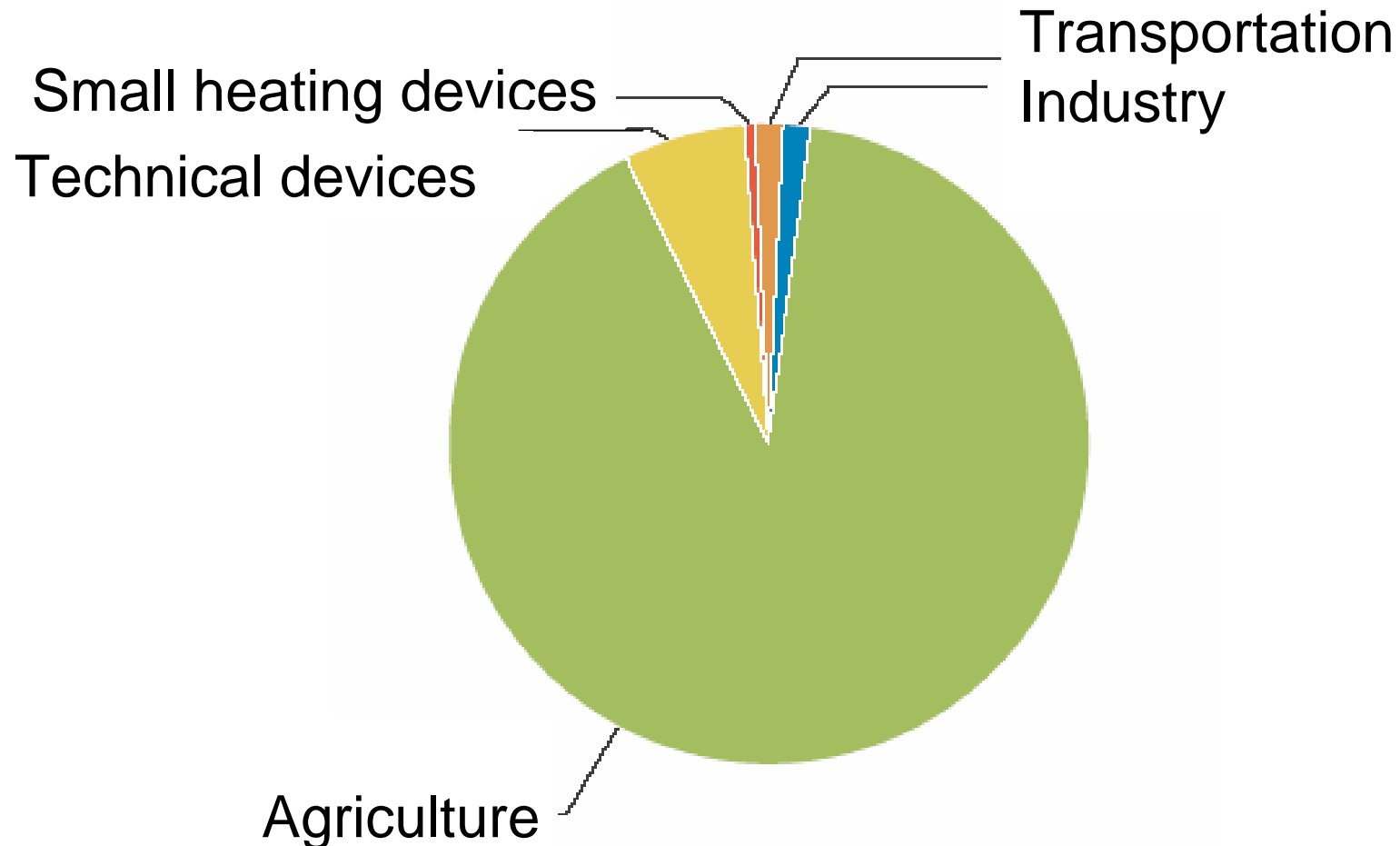
Normalised (to 1996-97) bottom-up vs. Radon-based top-down CH_4 emission estimates



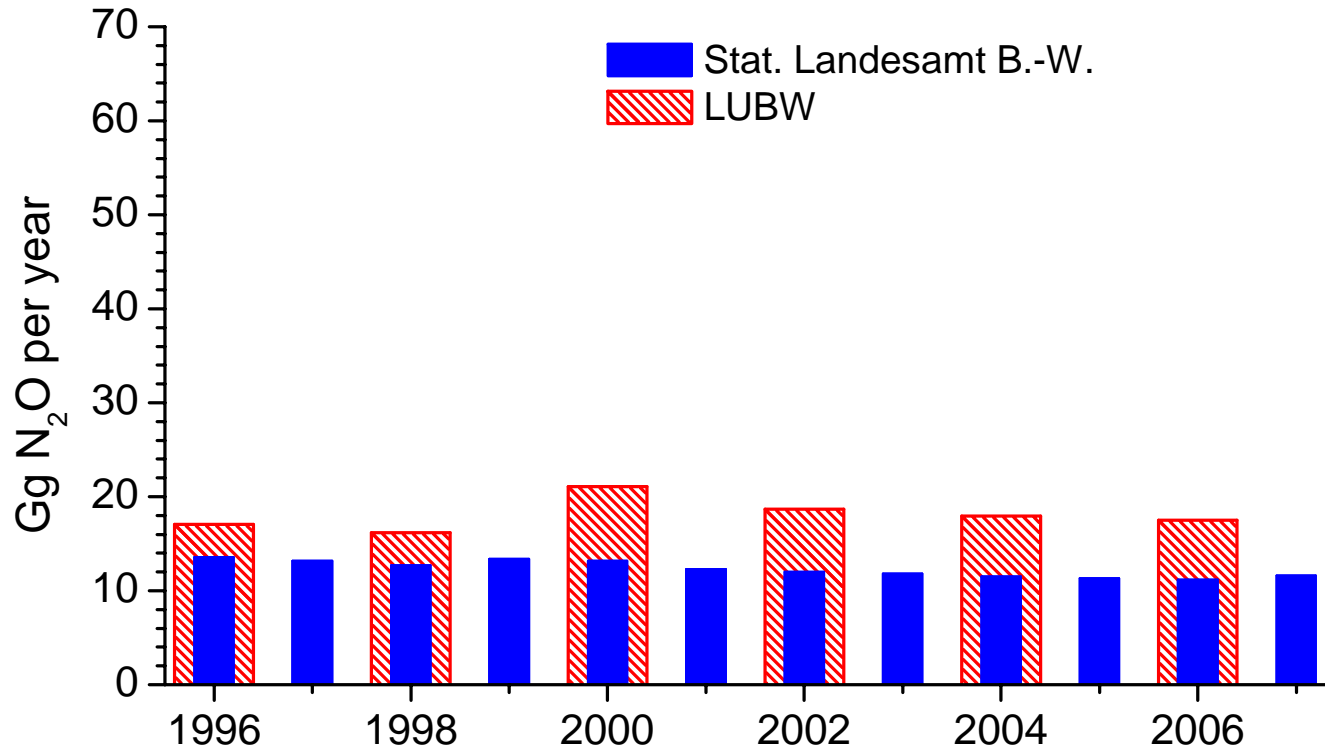
Why is the Radon-based CH₄ flux trend in Heidelberg smaller than the reported emissions ?

- Source distribution in catchment area may be different to the Baden-Württemberg mean
- Our top-down Radon-Tracer-Method does not take into account concentration spikes from point sources
- Bottom-up emission trends may be based on wrong assumptions
- others ?

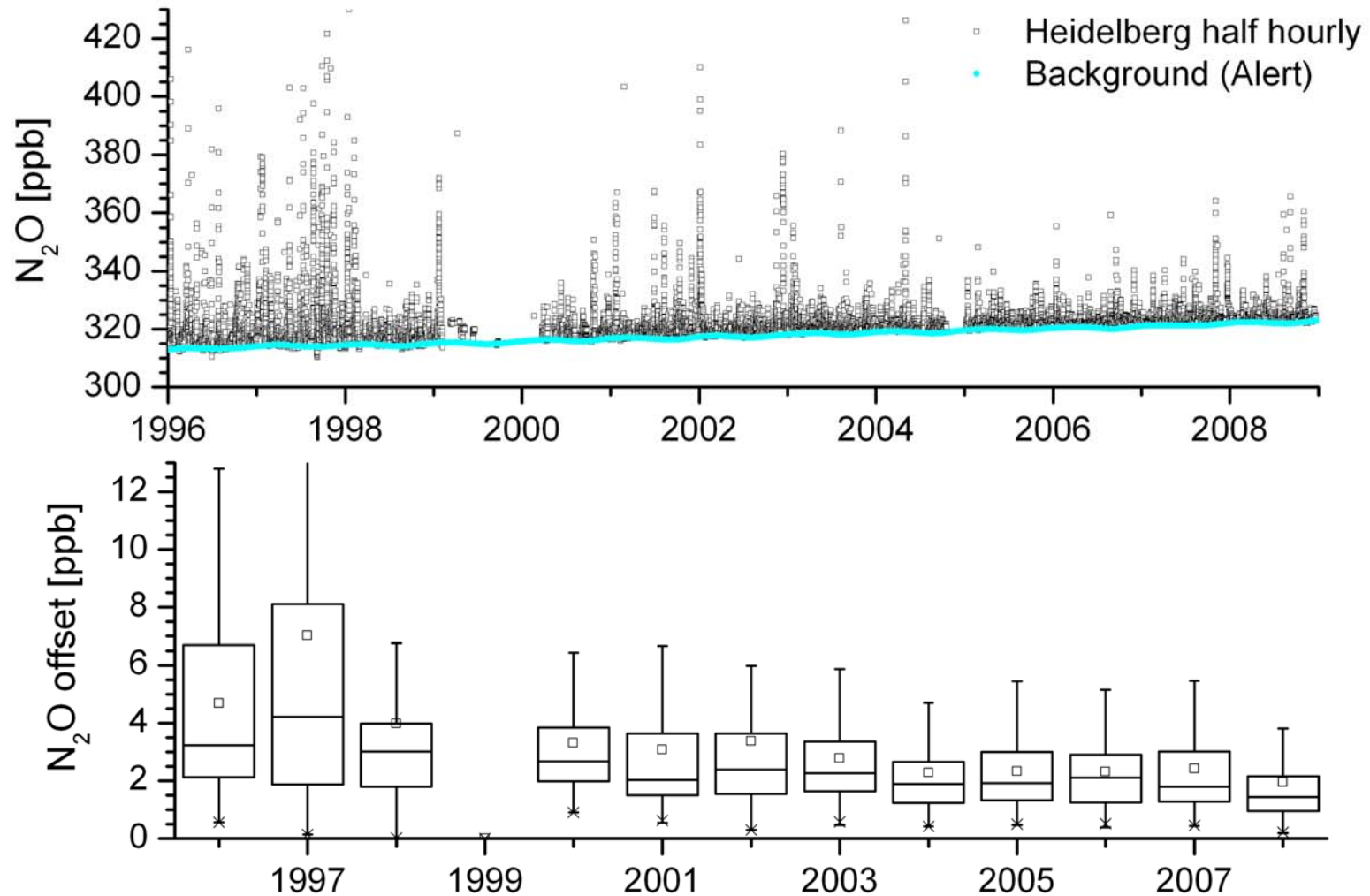
N₂O sources in Baden-Württemberg 2004



Long-term trend of N₂O emissions in Baden-Württemberg



Observed N_2O in Heidelberg and its annual mean offsets relative to background air





[Google Earth]

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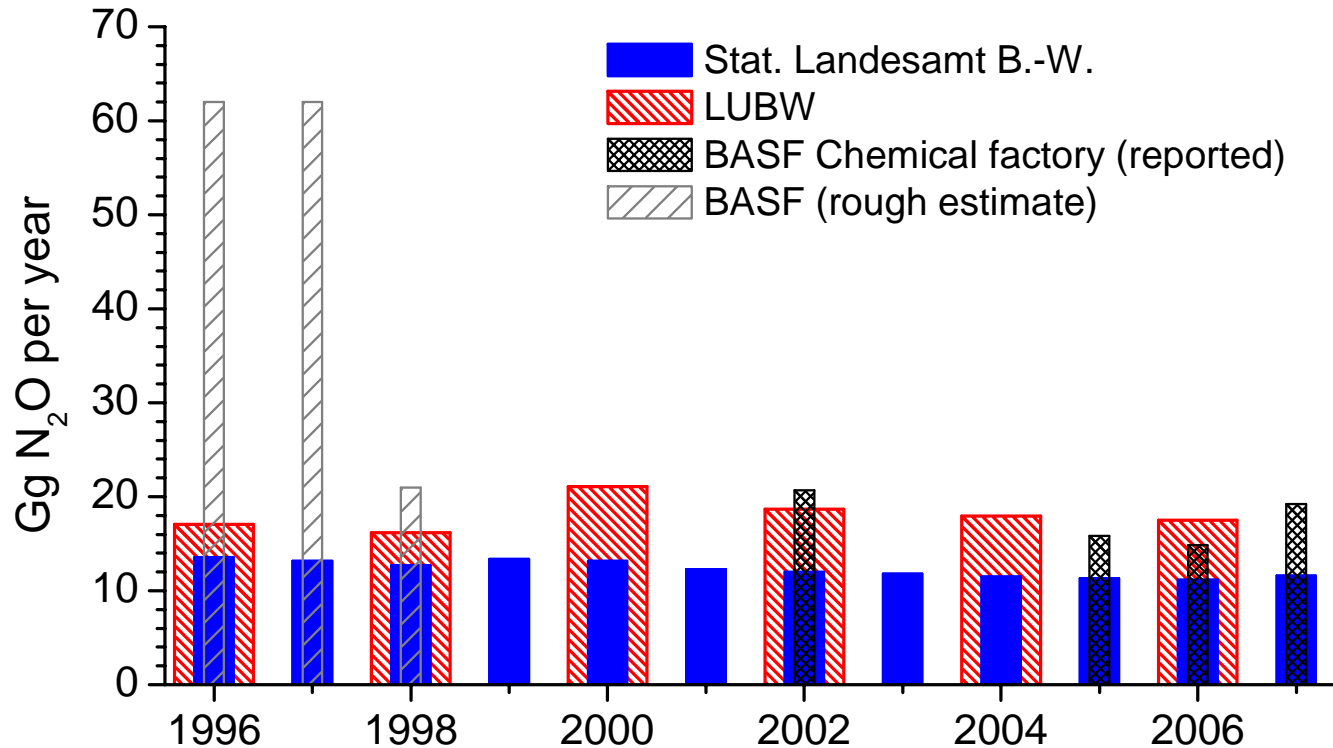
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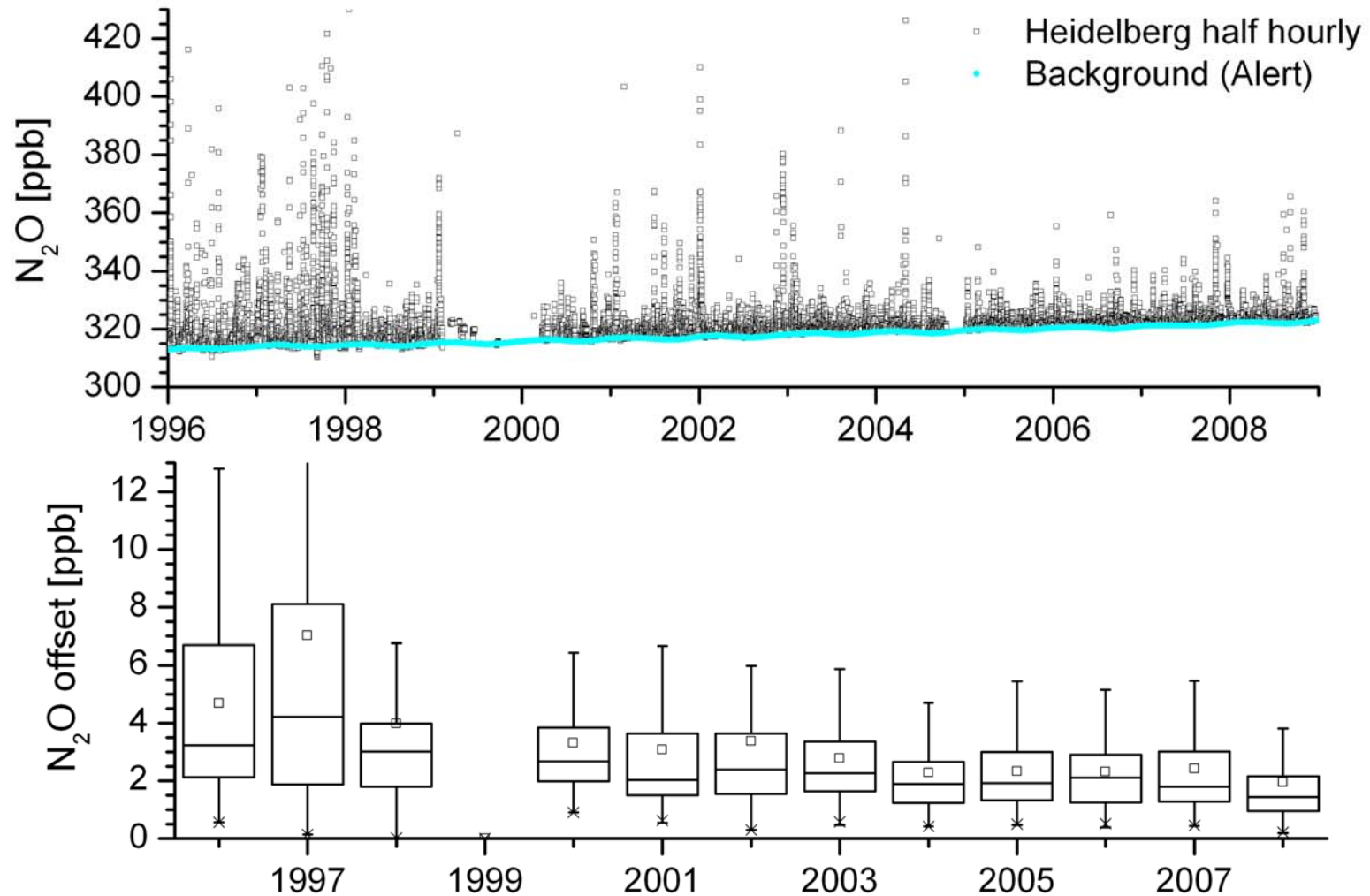
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Sichthöhe

Long-term trend of N₂O emissions in Baden-Württemberg & from BASF



Observed N_2O in Heidelberg and its annual mean offsets relative to background air



Summary and Conclusions (I)

- Long-term atmospheric observations in polluted areas allow monitoring GHG emission changes
 - The fossil CO₂ component can be separated by ¹⁴CO₂ measurements
 - It did not change in the Heidelberg catchment area, in agreement with emission inventories
 - CH₄ emission inventories report a significantly larger ($\approx 40\%$) decrease than we observe ($\approx 20\%$)
 - N₂O emissions changes in the Heidelberg catchment area can be qualitatively confirmed

Summary and Conclusions (II)

- Quantitative top-down validation of reported emissions is possible
 - if consistent long-term atmospheric observations are available in critical and/or representative source areas
 - if the reported emissions were available at high resolution (not only on the country level), and
 - If regional atmospheric transport models were applied to reliably estimate atmospheric dilution and transport
- Verification requires an integrative approach, expert knowledge of the sources in the catchment area, measurement of tracers, etc.

Greenhouse gases emission reductions in Europe until 2020 by more than 20% ?

We have strong evidence from our observations that GHGs emissions have been reduced in South West Germany, but this is just the first shot:

we (1) must put much more **effort in proofing this** also for other areas in Europe

we (2) need to **define** and **reduce** the **uncertainties** in both, the bottom-up inventory and the top-down atmospheric approach

Acknowledgements

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- The Ministry of Science and Education,
Baden-Württemberg
- The German Ministry of Science and Technology
- The German Umweltbundesamt
- The European Union

... and the help of many Students and Technicians
from Univ. of Heidelberg in the last 15 years

