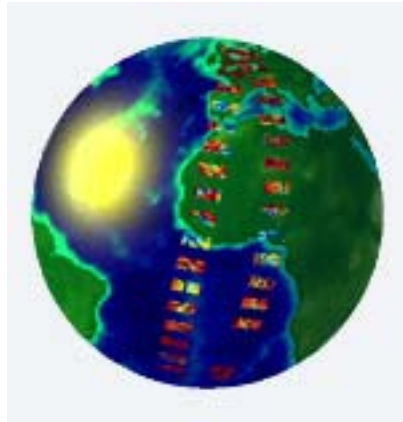


Satellite chartography of atmospheric methane (and carbon monoxide)



C. Frankenberg¹, U. Platt¹ and T. Wagner¹
J.F. Merink², P. Bergamaschi³



¹Institute of Environmental Physics, University of Heidelberg, Germany

²IMAU, University of Utrecht, The Netherlands

³JRC, Ispra, Italy

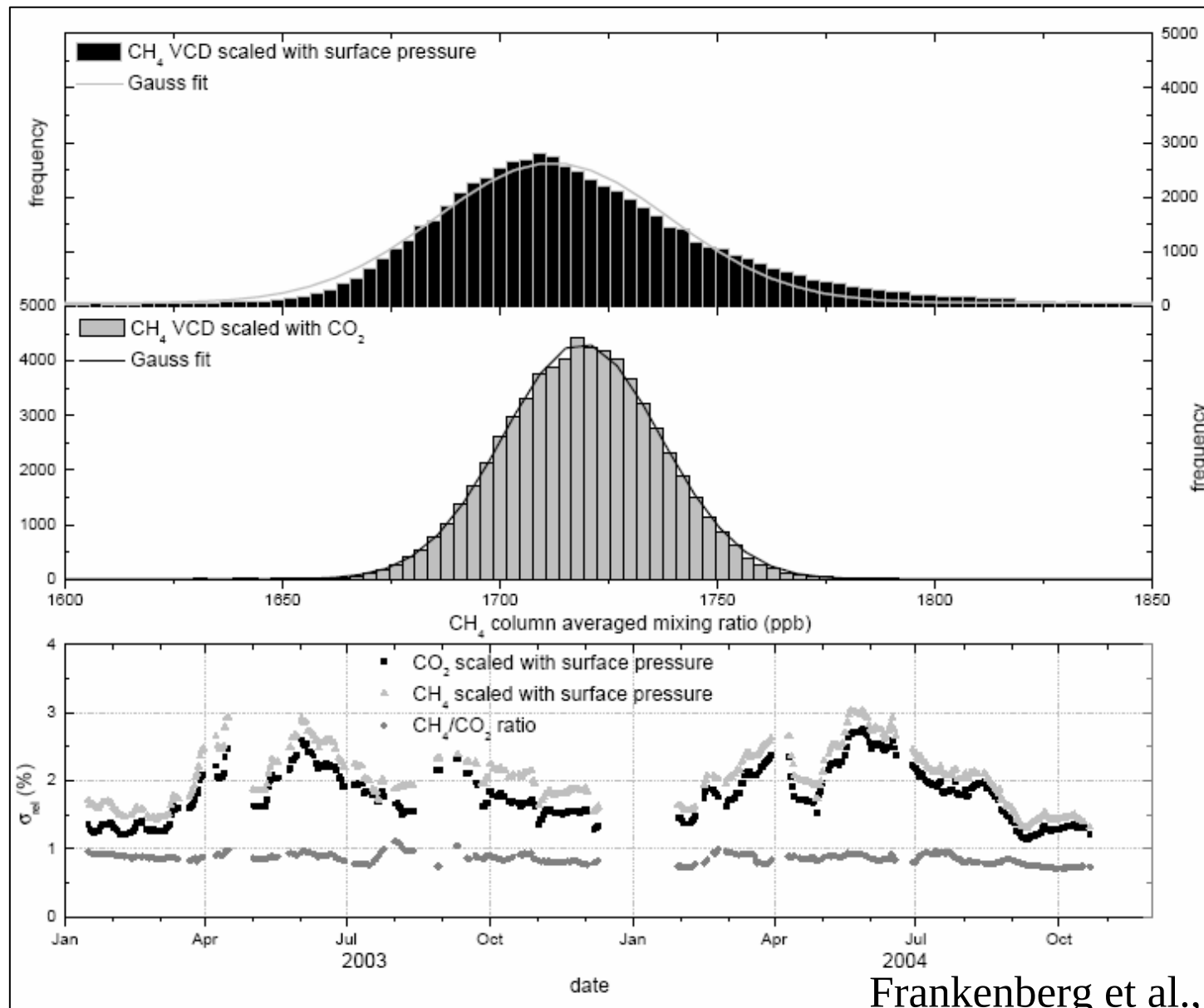


IMAP DOAS

- Iterative Maximum a Posteriori DOAS (Frankenberg et al, ACP, 2005)
- Applied to SCIAMACHY channel 6 spectra, retrieval windows nearby
(CO₂ @ 1580nm, CH₄ @ 1670nm)
- C++ core, simplified radiative transfer, convolutions in each iteration step (FFT or multigrid binomial filters)
1 month data approx. 3 hours for CH₄ and CO₂ on a single CPU (3GHz)
- Challenging task: Retrieve small variations on top of a huge background (CO₂: 1.6kgC/m², CH₄: 8gC/m²)
- --> variations are small (lifetime of 8 years)



Using CO₂ as proxy for CH₄ (Example: Sahara)



Frankenberg et al., JGR 2006



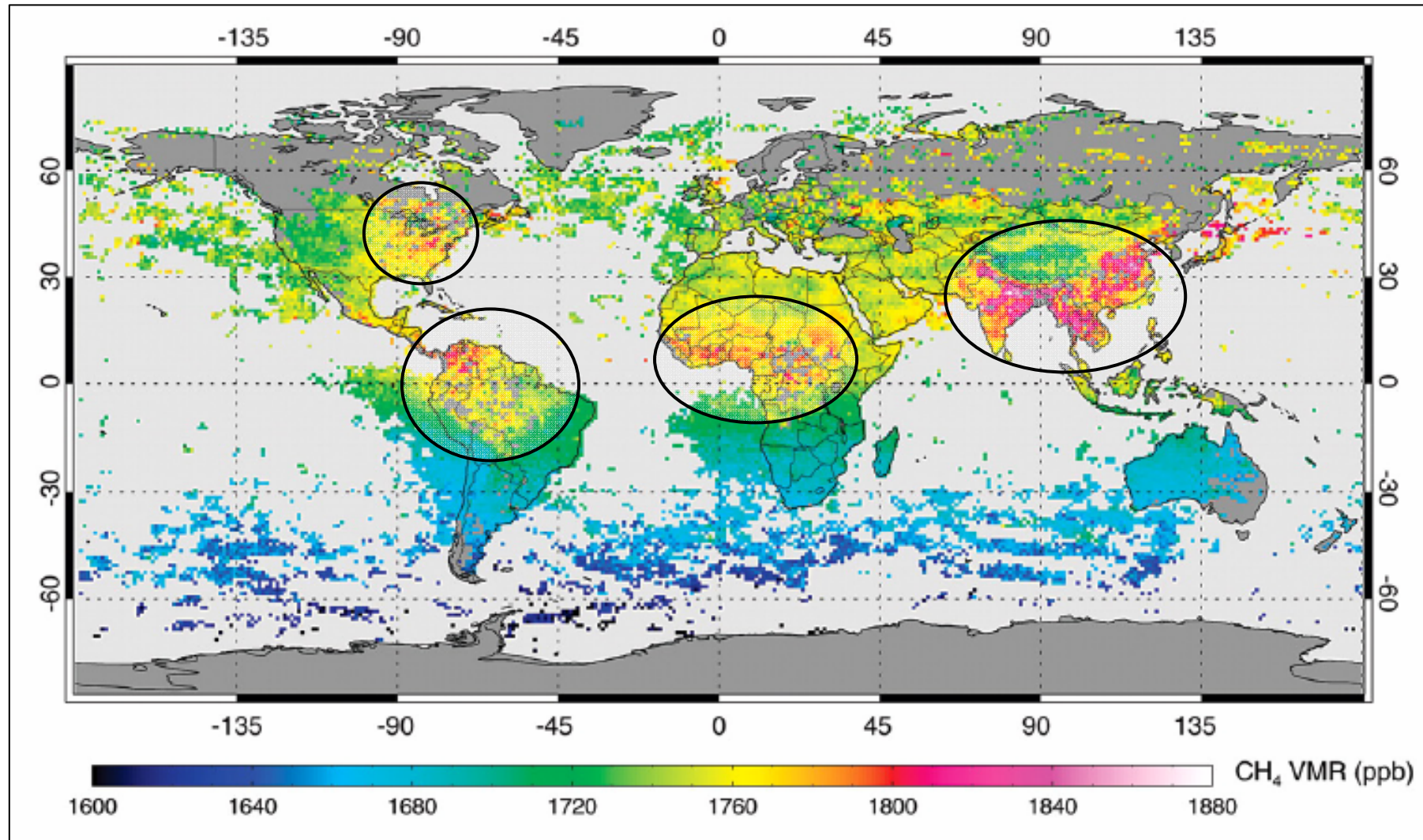
First approach

CO₂ assumed to be constant

$$\overline{VMR}(\text{CH}_4) = \frac{V_{meas}(\text{CH}_4)}{V_{meas}(\text{CO}_2)} \cdot \overline{VMR}(\text{CO}_2) ,$$

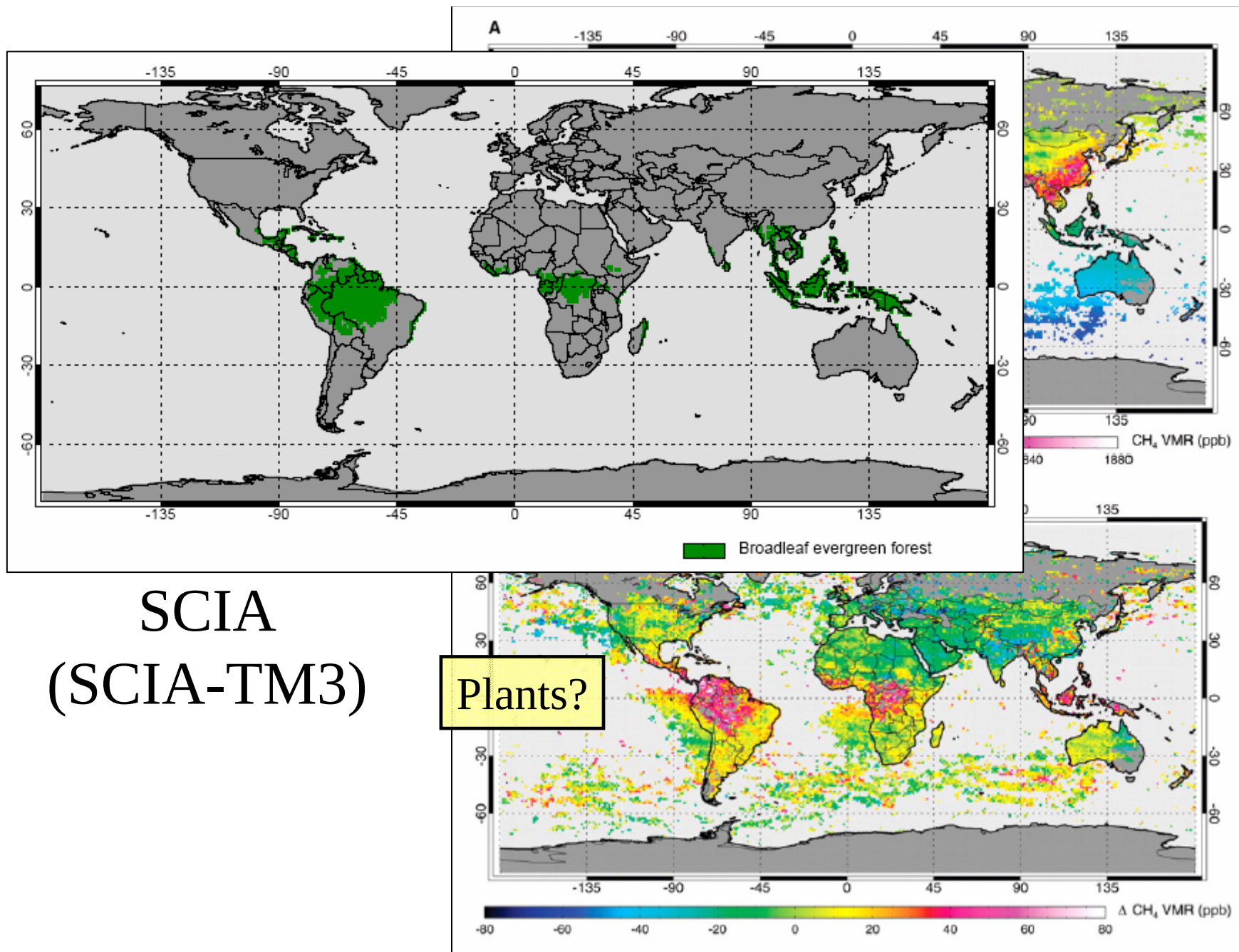


CH₄ VMR August through November 2003



Frankenberg et al., Assessing methane emissions from global space borne observations, Science 2005





SCIA
(SCIA-TM3)

Plants?





Letter

Nature **439**, 187–191 (12 January 2006) | [doi:10.1038/nature04420](https://doi.org/10.1038/nature04420)

Methane emissions from terrestrial plants under aerobic conditions

Frank Keppler¹, John T. G. Hamilton², Marc Braß^{1,3} and Thomas Röckmann^{1,3}

Plant emissions, Media response



The latest threat to the world's climate?

Catherine Bishic
12 January 2006
Source: SciDev.Net

The world of climate change science and policy has been rocked by the discovery that plants produce up to one-third of the second most important greenhouse gas.

The findings are published in *Nature* today (12 January) by a team led by Frank Keppler from the Max-Planck Institute in Germany.

Until now, researchers thought that most methane was produced by bacteria in environments lacking oxygen, such as the digestive system of cows and Asia's flooded rice fields (see [Major methane emitter identified in Asian rice fields](#)).



Plants were not known to emit methane until now

Global warming: plants are not to blame

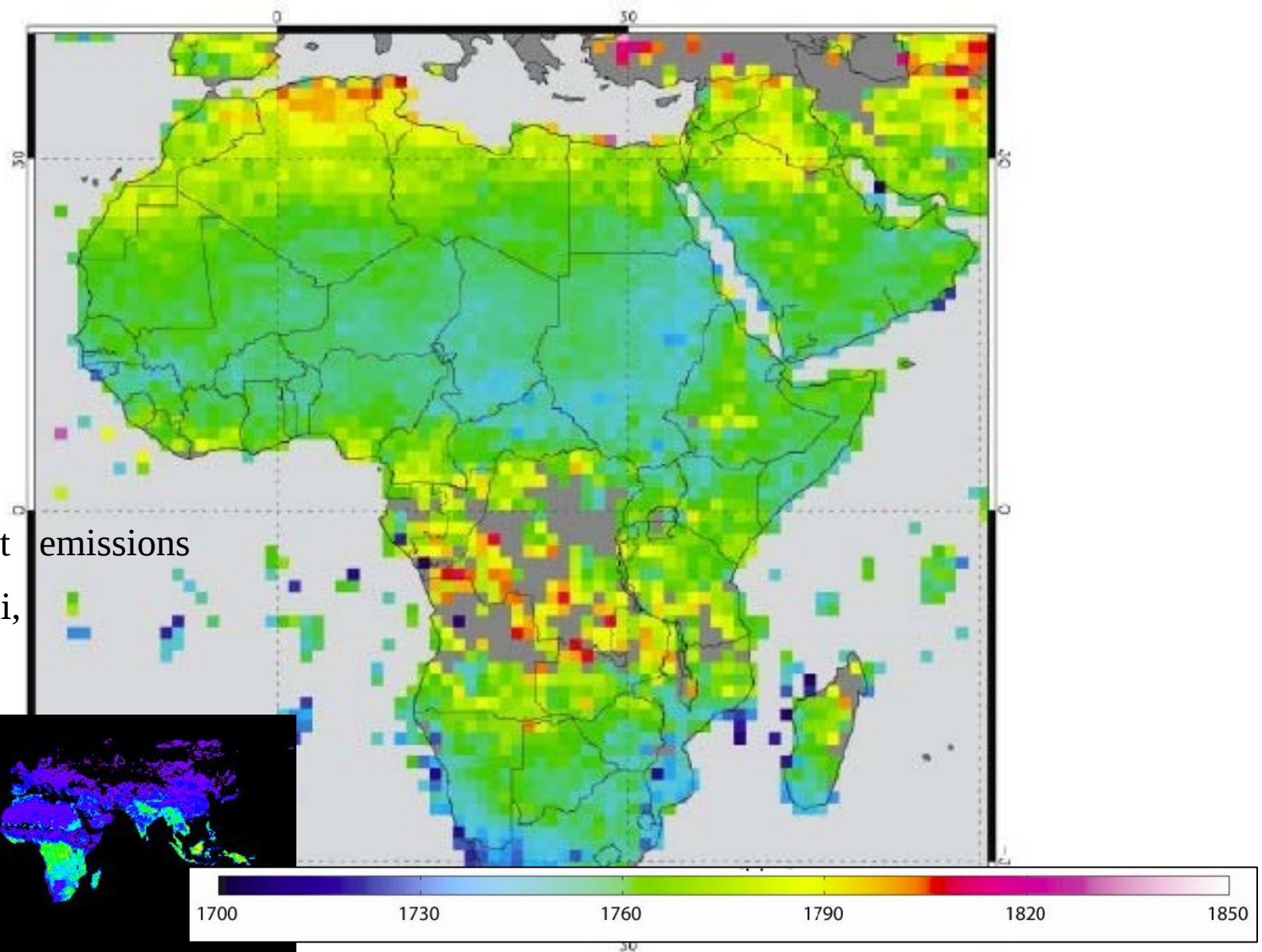
Catherine Bishic
20 January 2006
Source: SciDev.Net

Plants are not to blame for climate change, according to a statement issued this week (18 January) by the researchers who reported eight days ago that plants emit up to a third of the methane — a potent greenhouse gas — in the atmosphere (see [The latest threat to the world's climate?](#)).



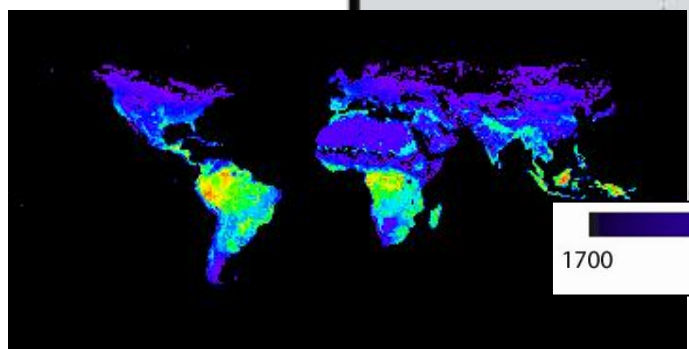
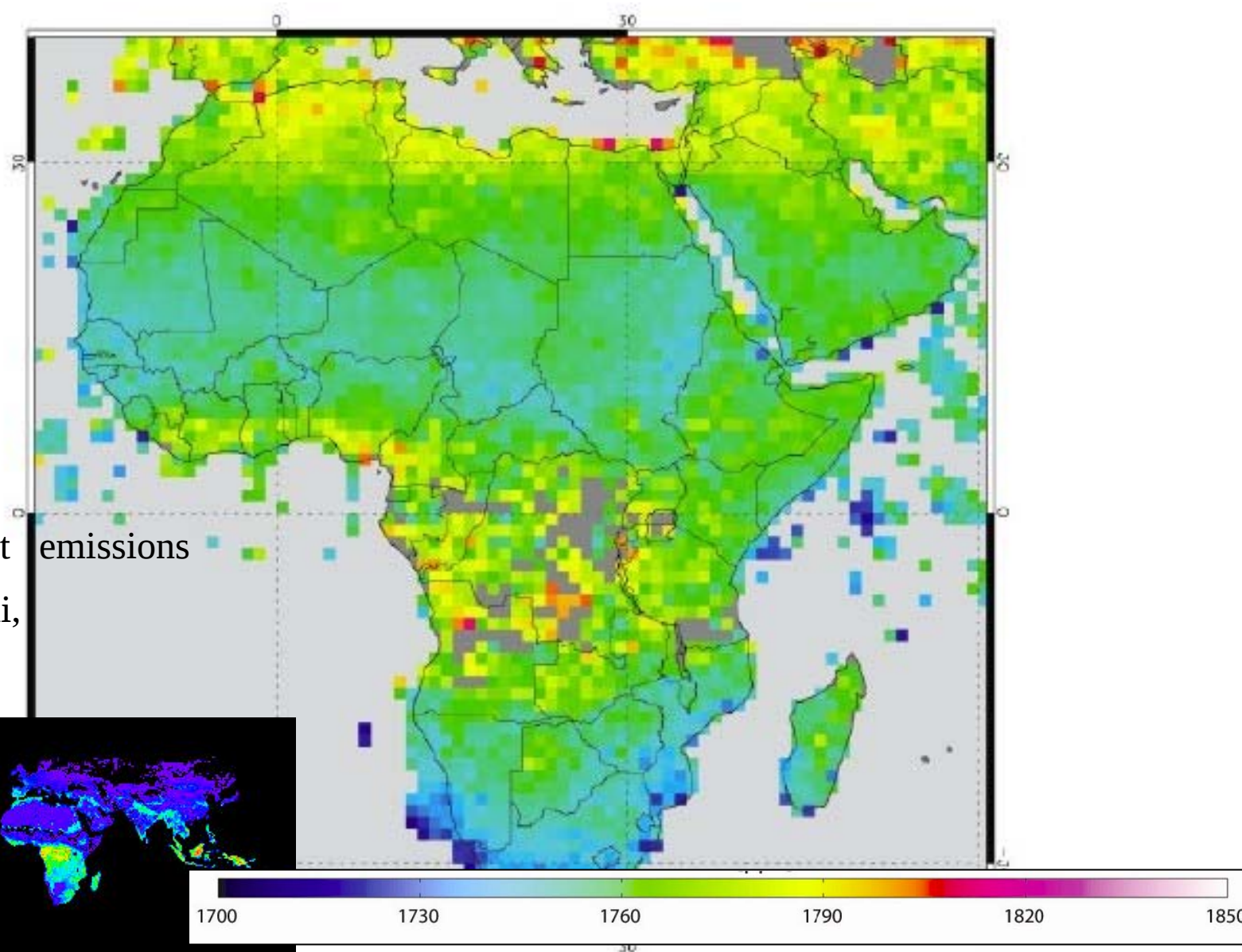
Feb. 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



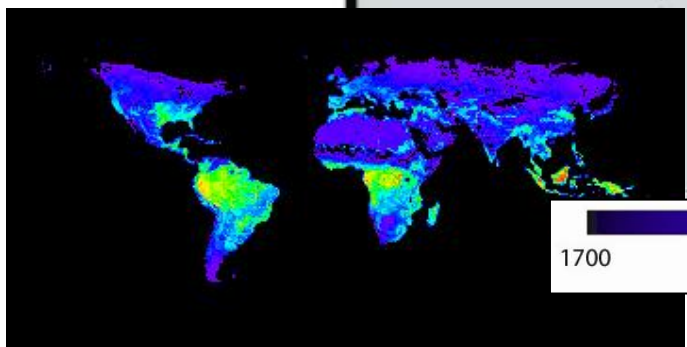
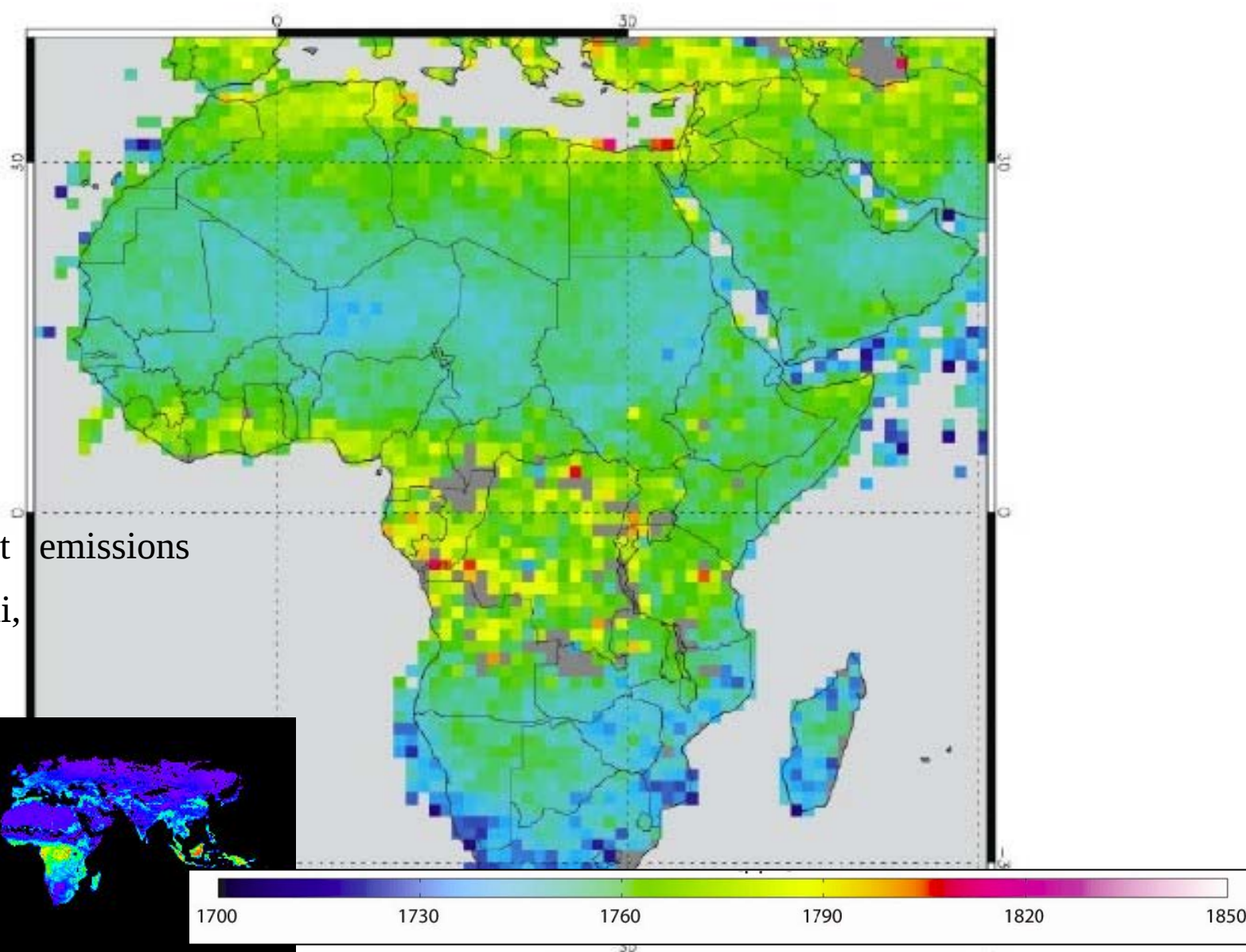
Mar. 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



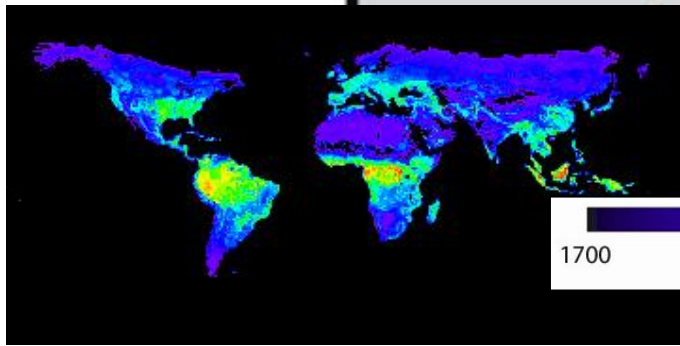
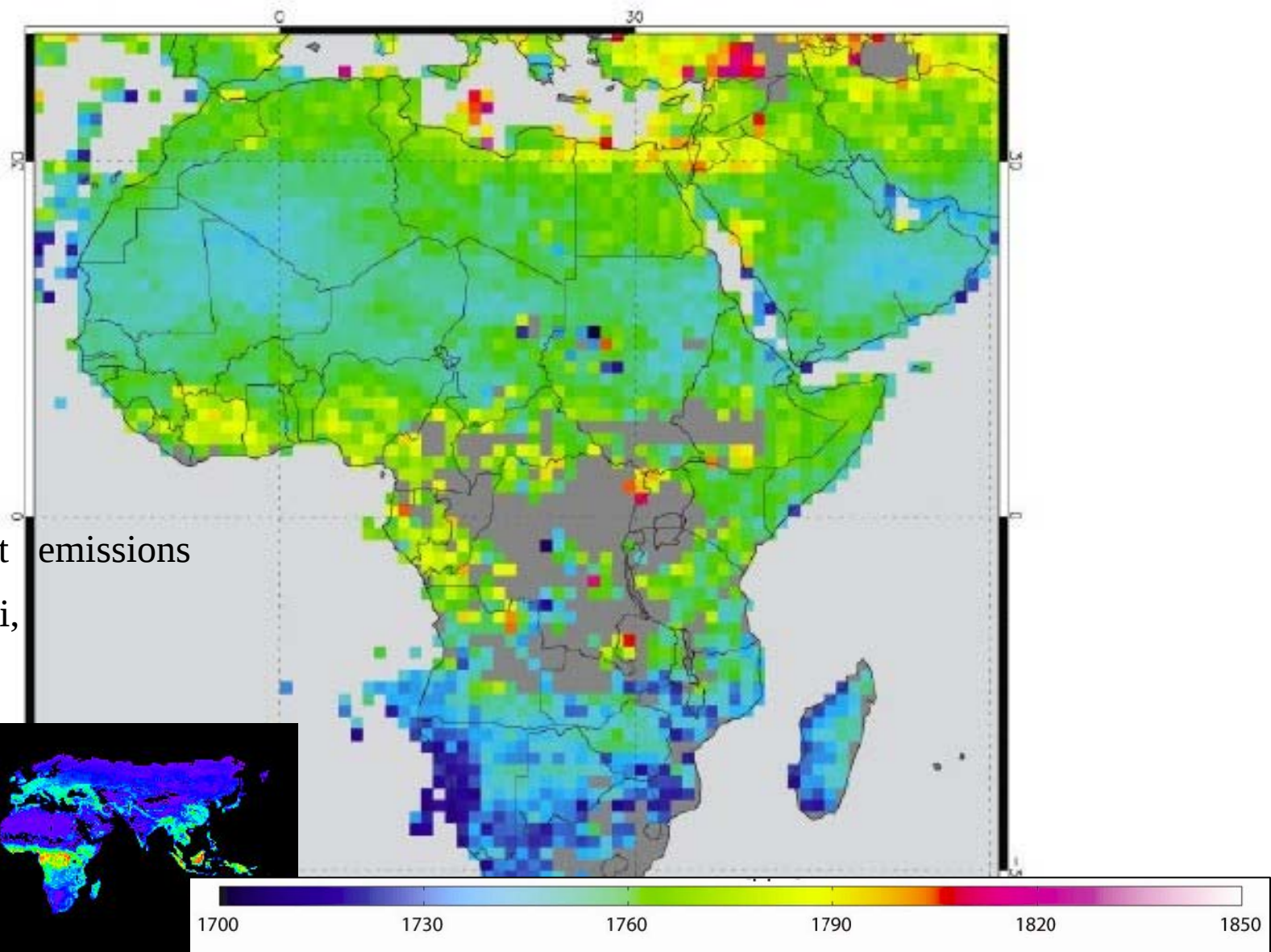
Apr. 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



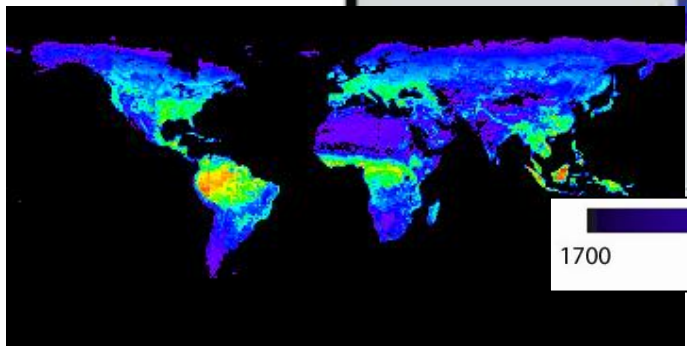
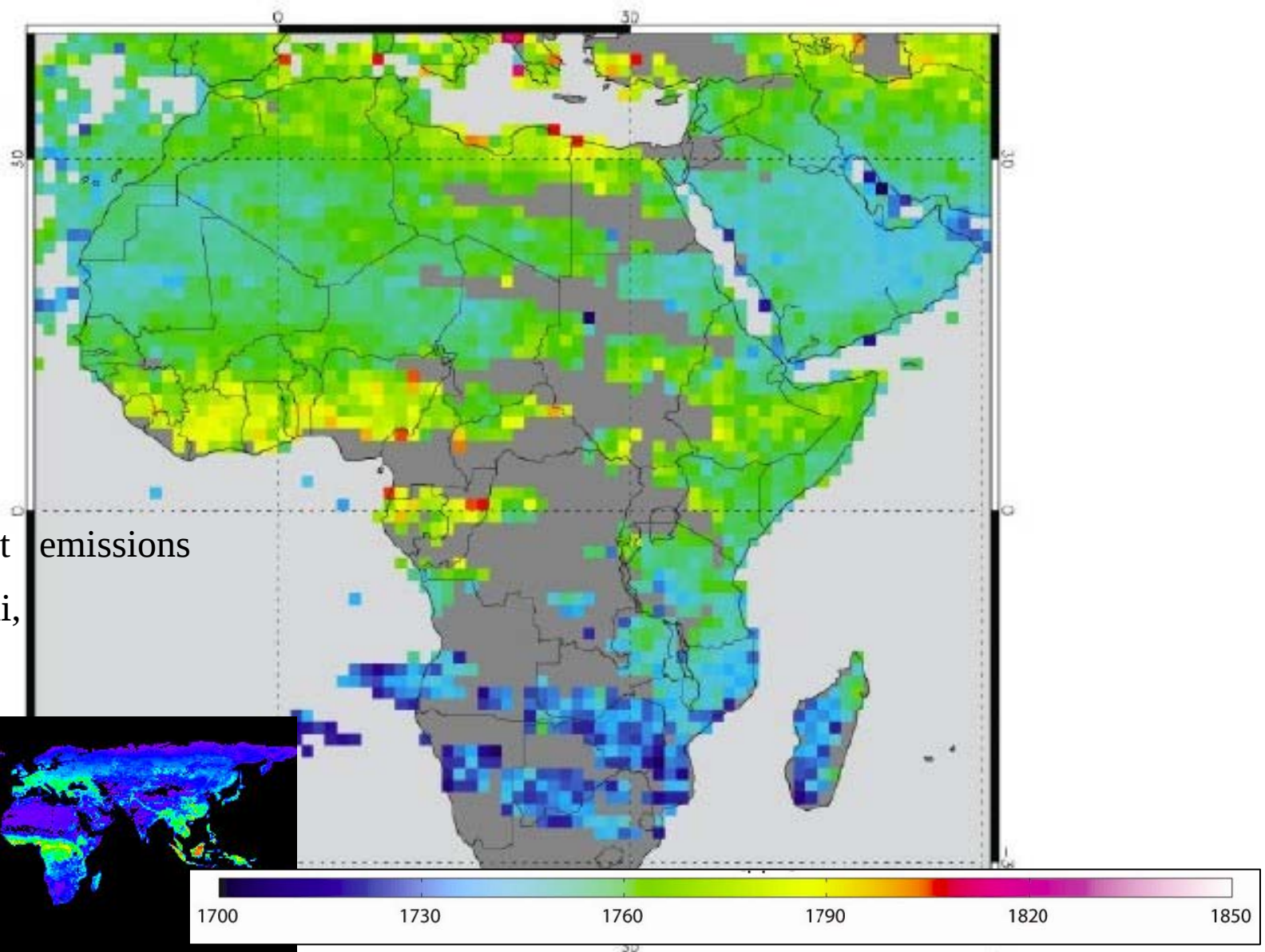
May 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



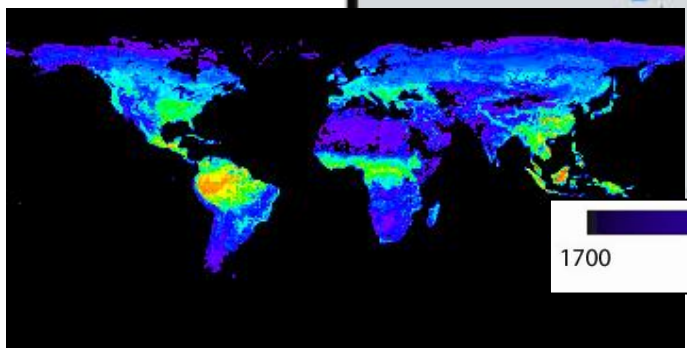
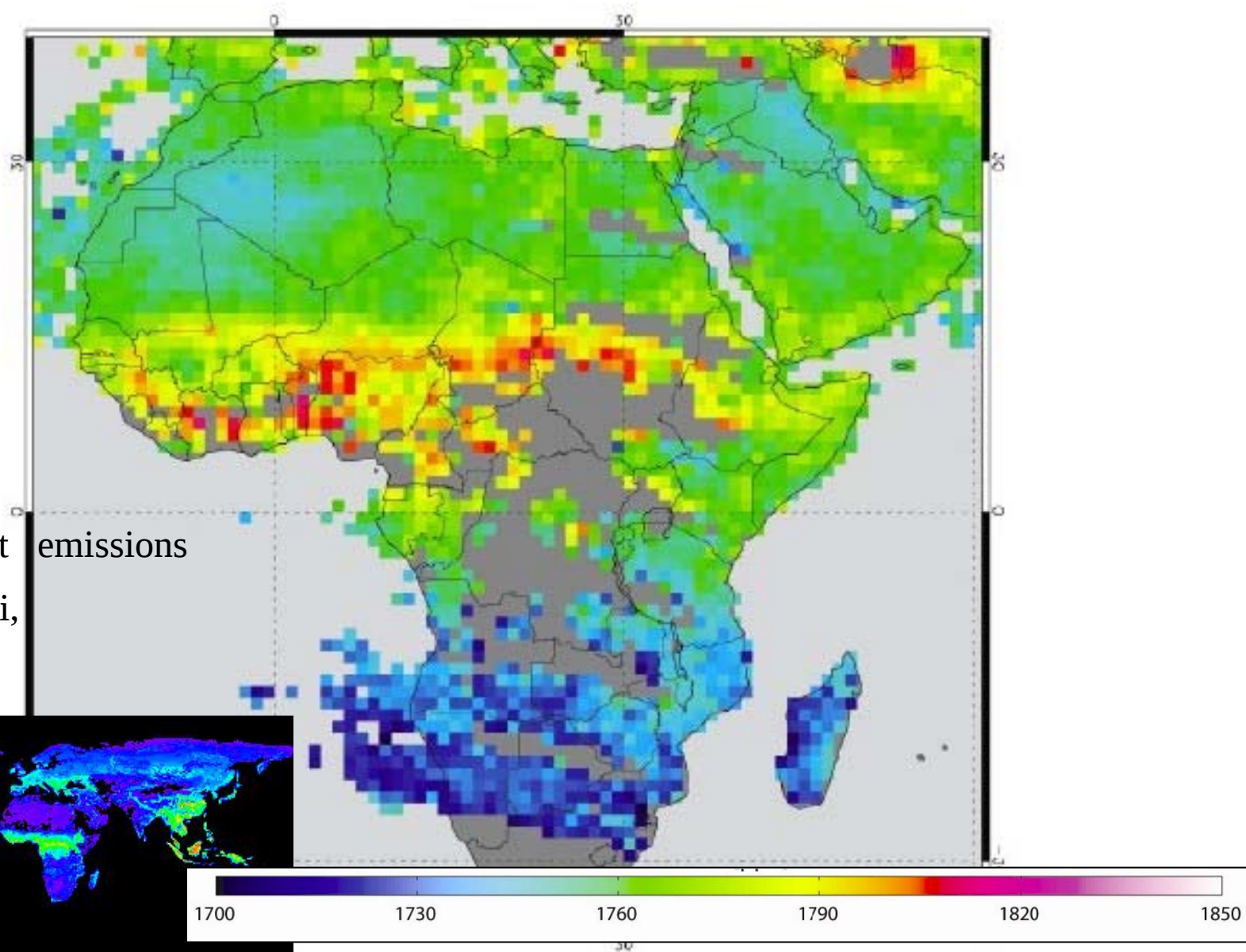
June. 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



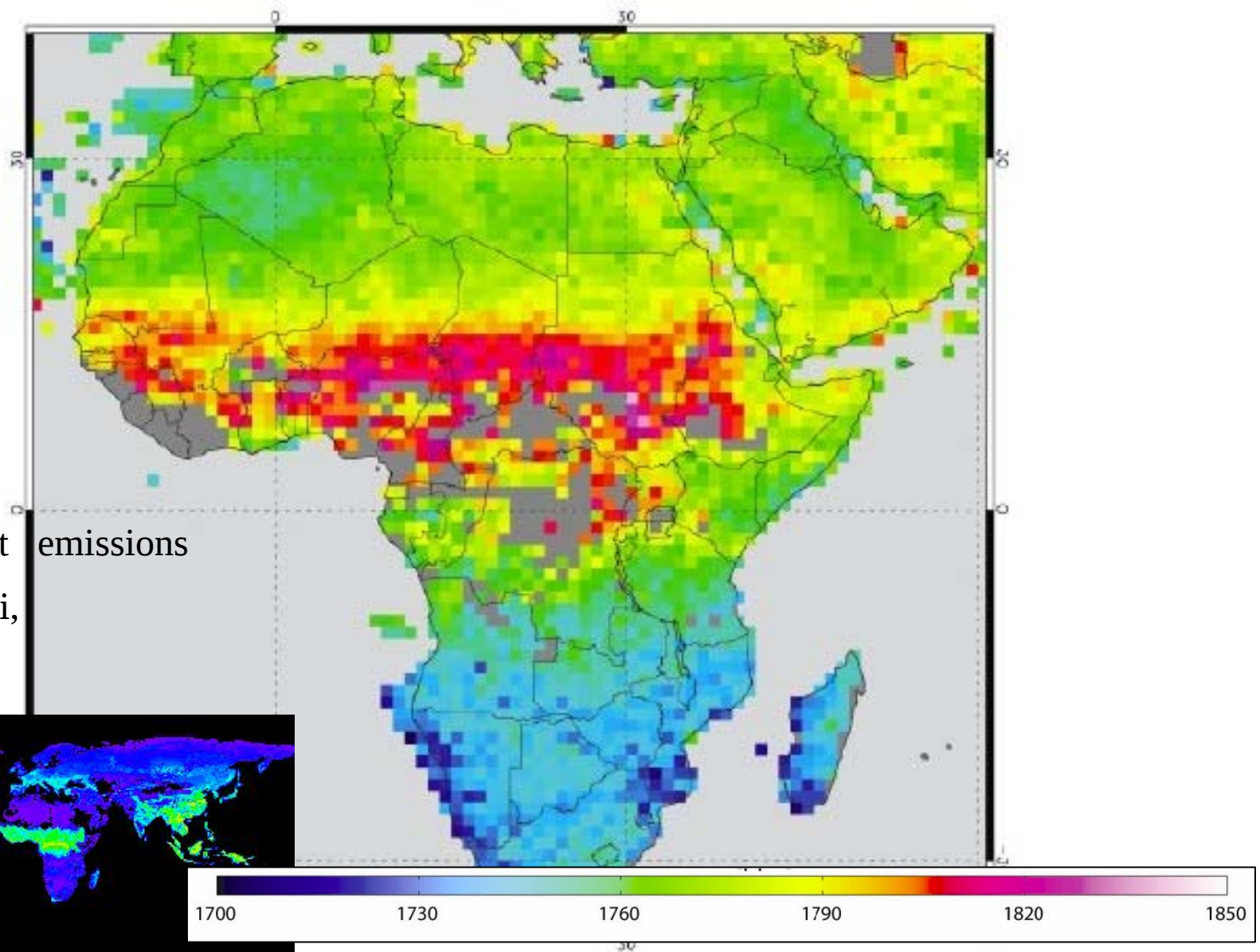
July 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



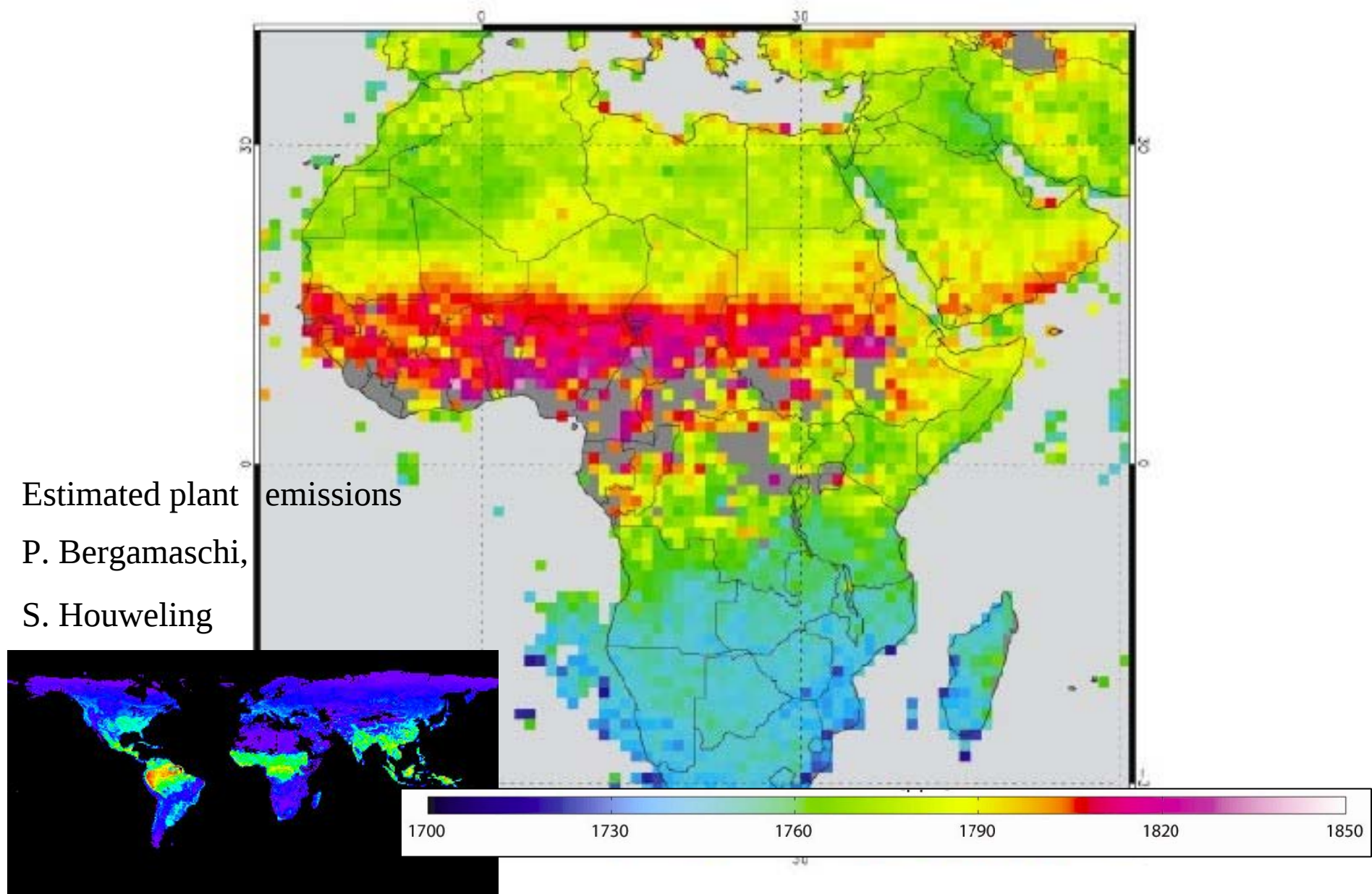
Aug. 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



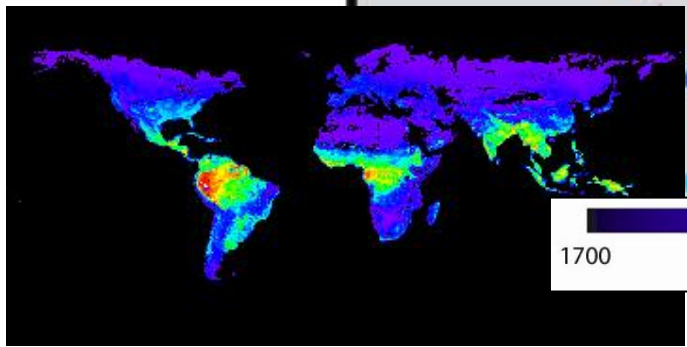
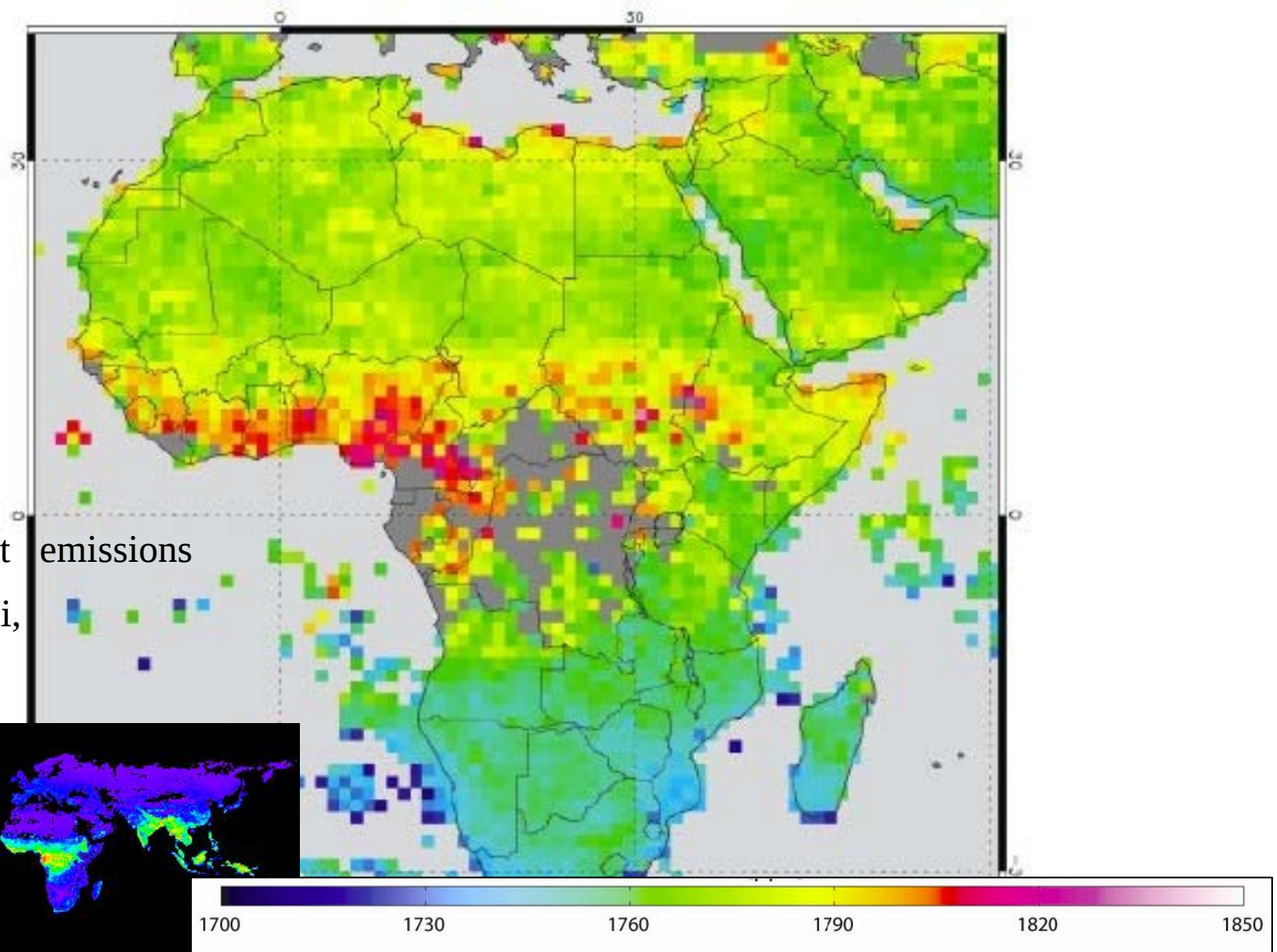
Sep. 2005

Estimated plant emissions
P. Bergamaschi,
S. Houweling



Oct. 2005

Estimated plant
emissions
P. Bergamaschi,
S. Houweling



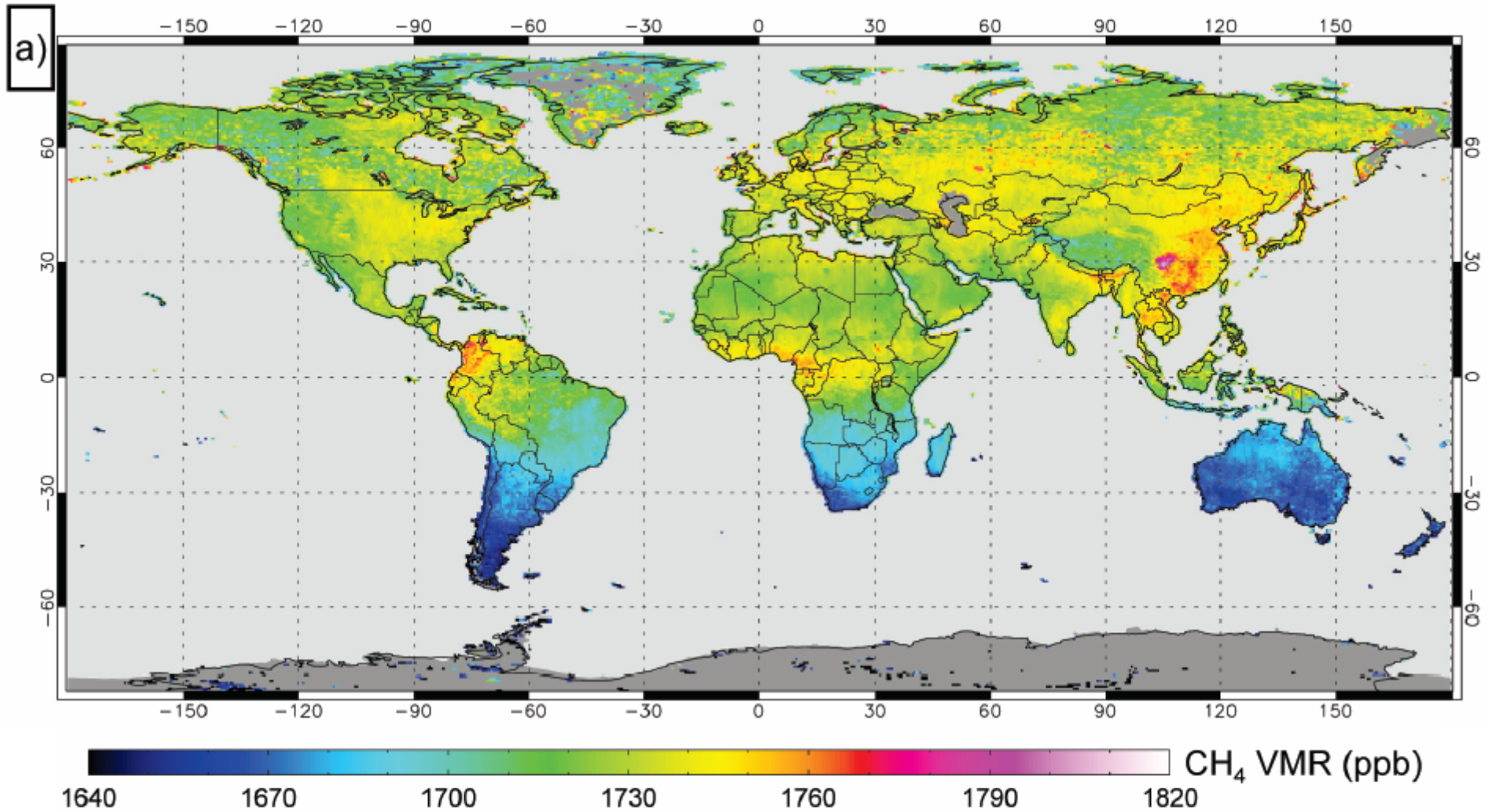
Second approach

CO₂ modelled (TM3 by MPI Jena)

$$\overline{VMR}(\text{CH}_4) = \frac{V_{meas}(\text{CH}_4)}{V_{meas}(\text{CO}_2)} \cdot \boxed{\overline{VMR}(\text{CO}_2)},$$



SCIA CH₄ (2003-2004)

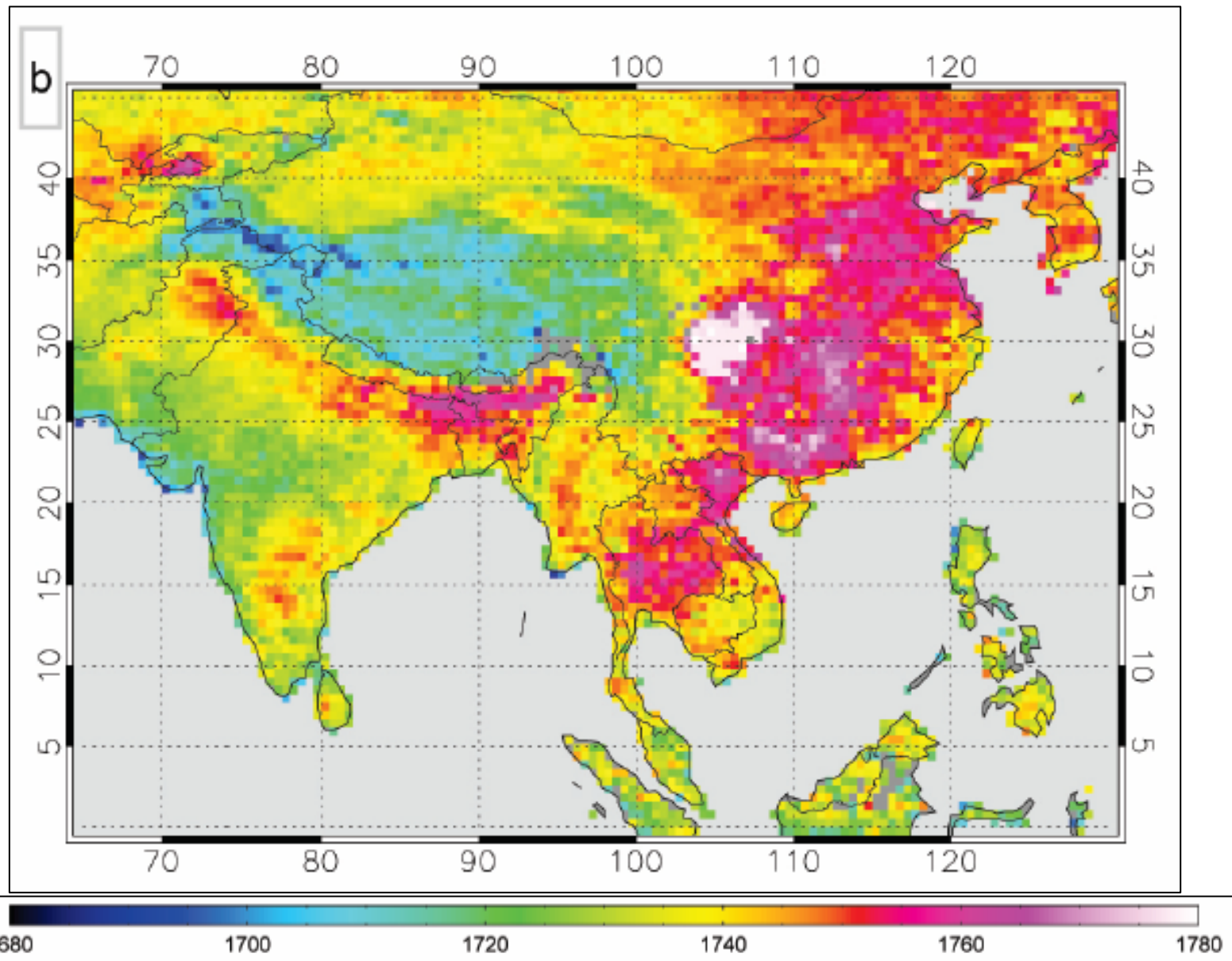


Frankenberg et al, JGR, 2006



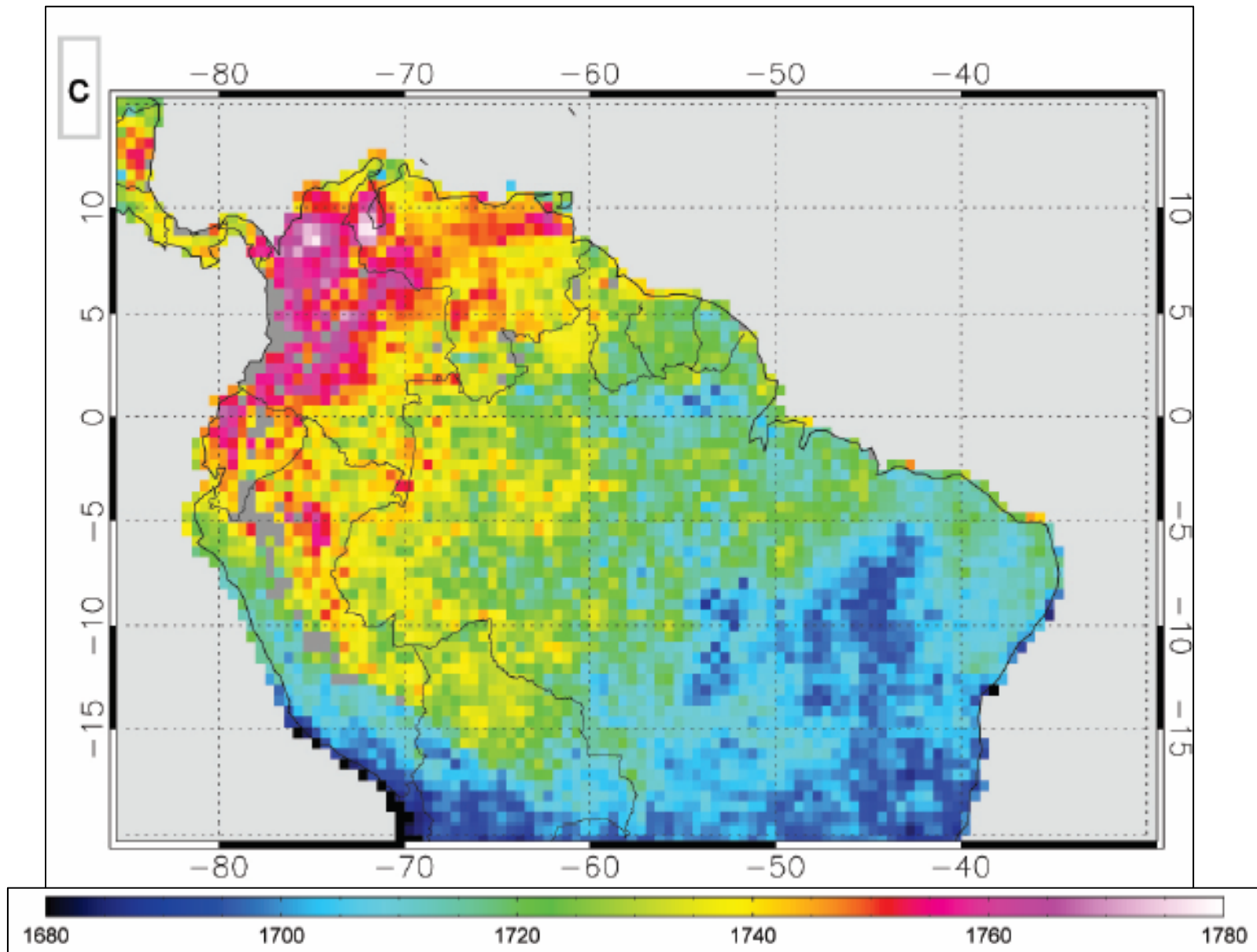
Asia

Frankenberg et al, JGR, 2006



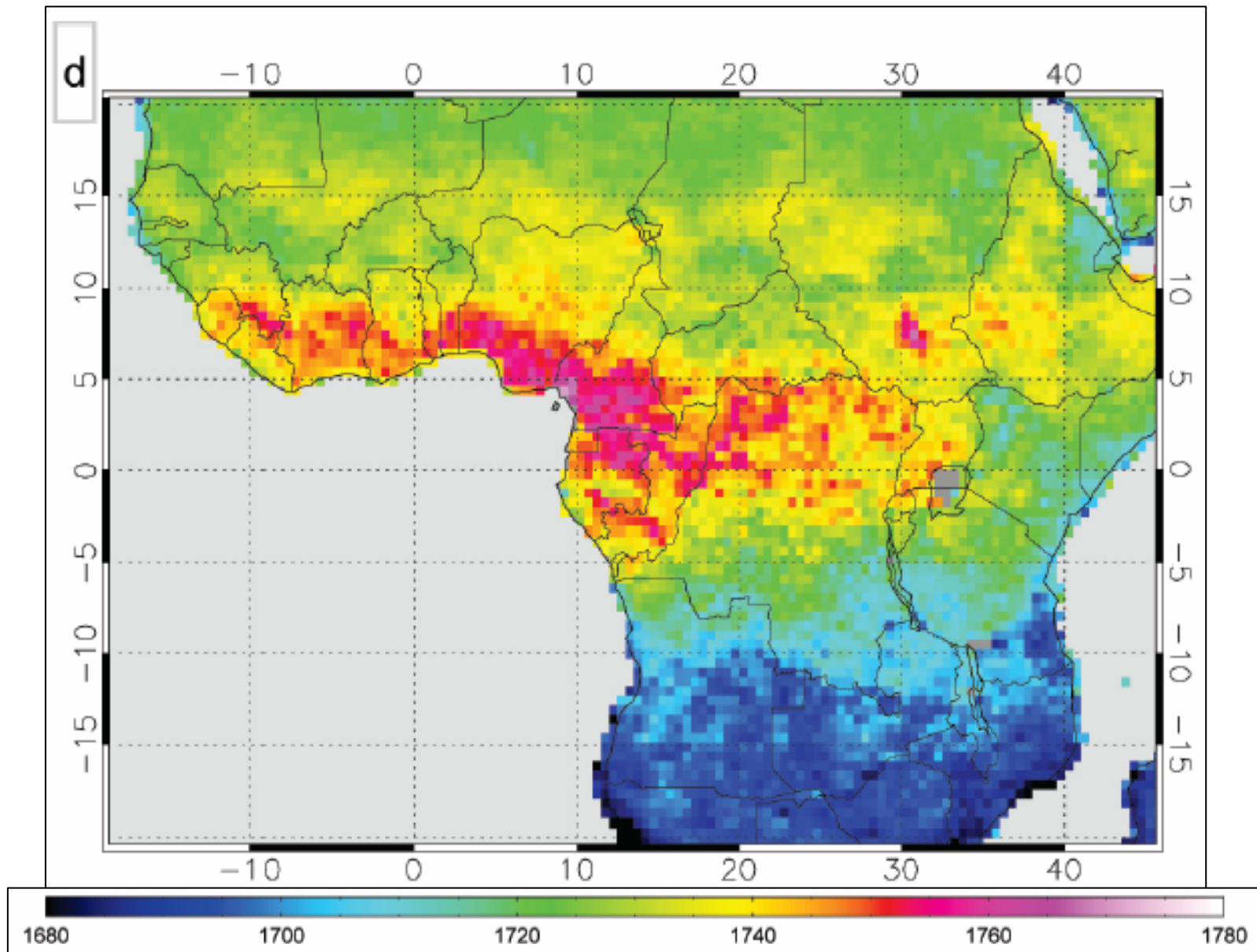
South America

Frankenberg et al, JGR, 2006

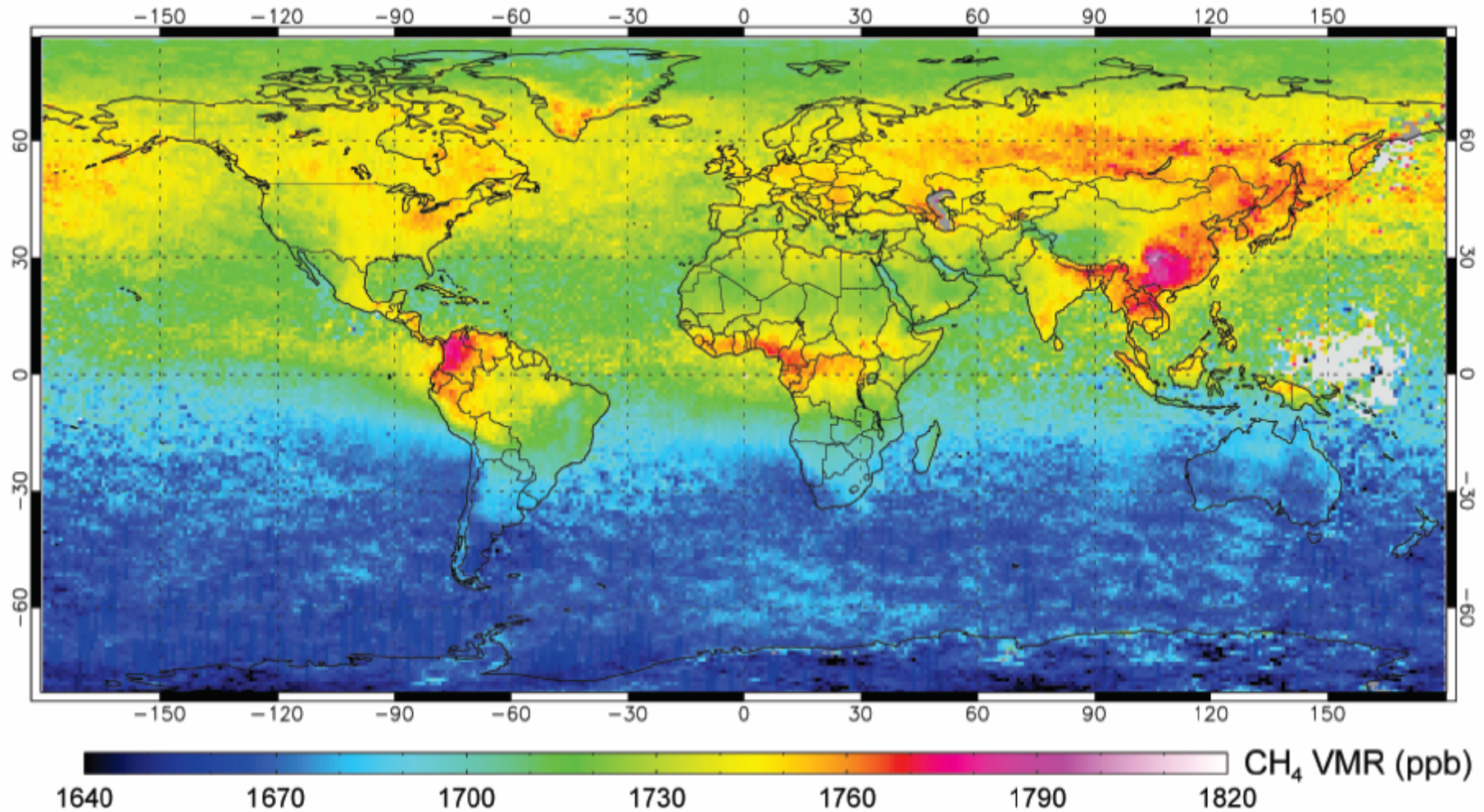


Africa

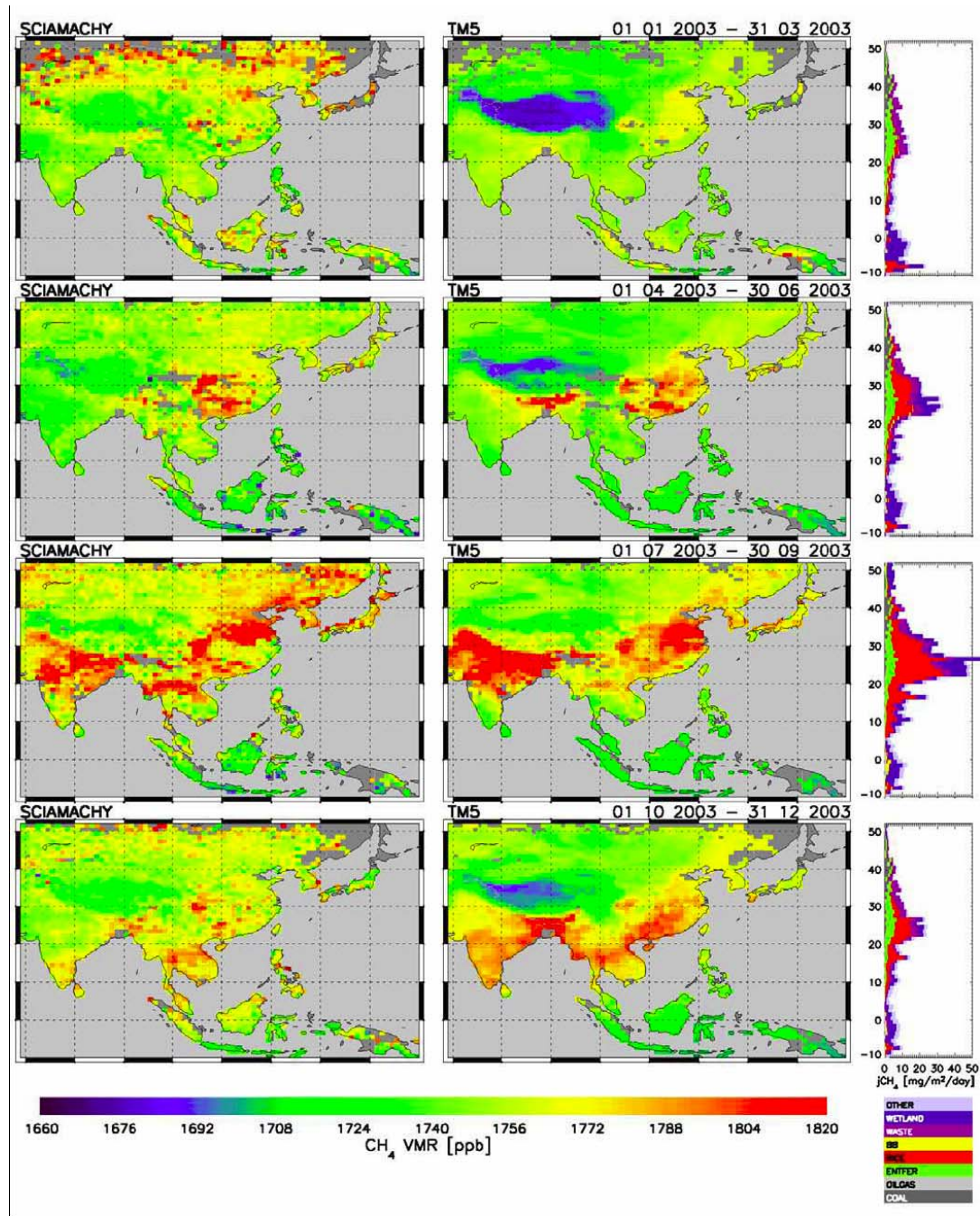
Frankenberg et al, JGR, 2006



Cloud top height < 2.5km: global view
(SCIA 2003-2004)



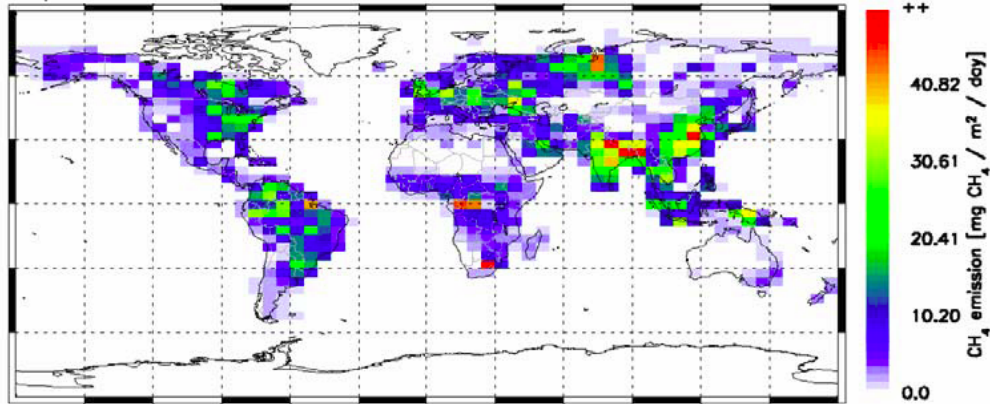
SCIAMACHY as used
In inverse simulations
(TM5 model, JRC Ispra)



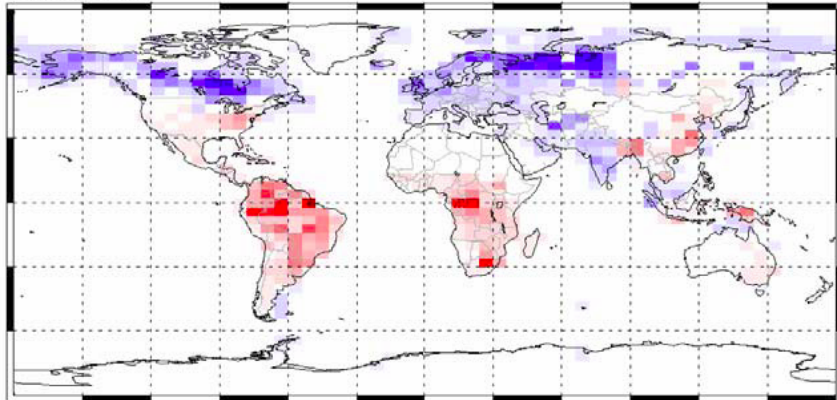
Bergamaschi et al, JGR, in review



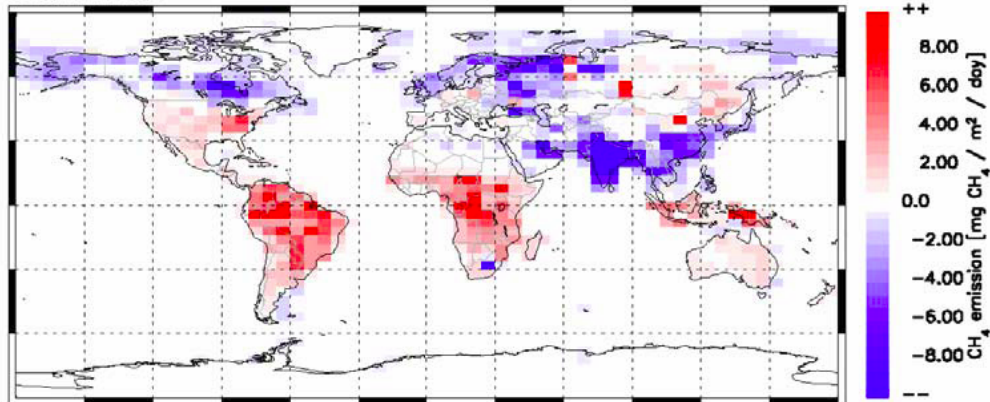
a priori emissions



scenario S1



scenario S3

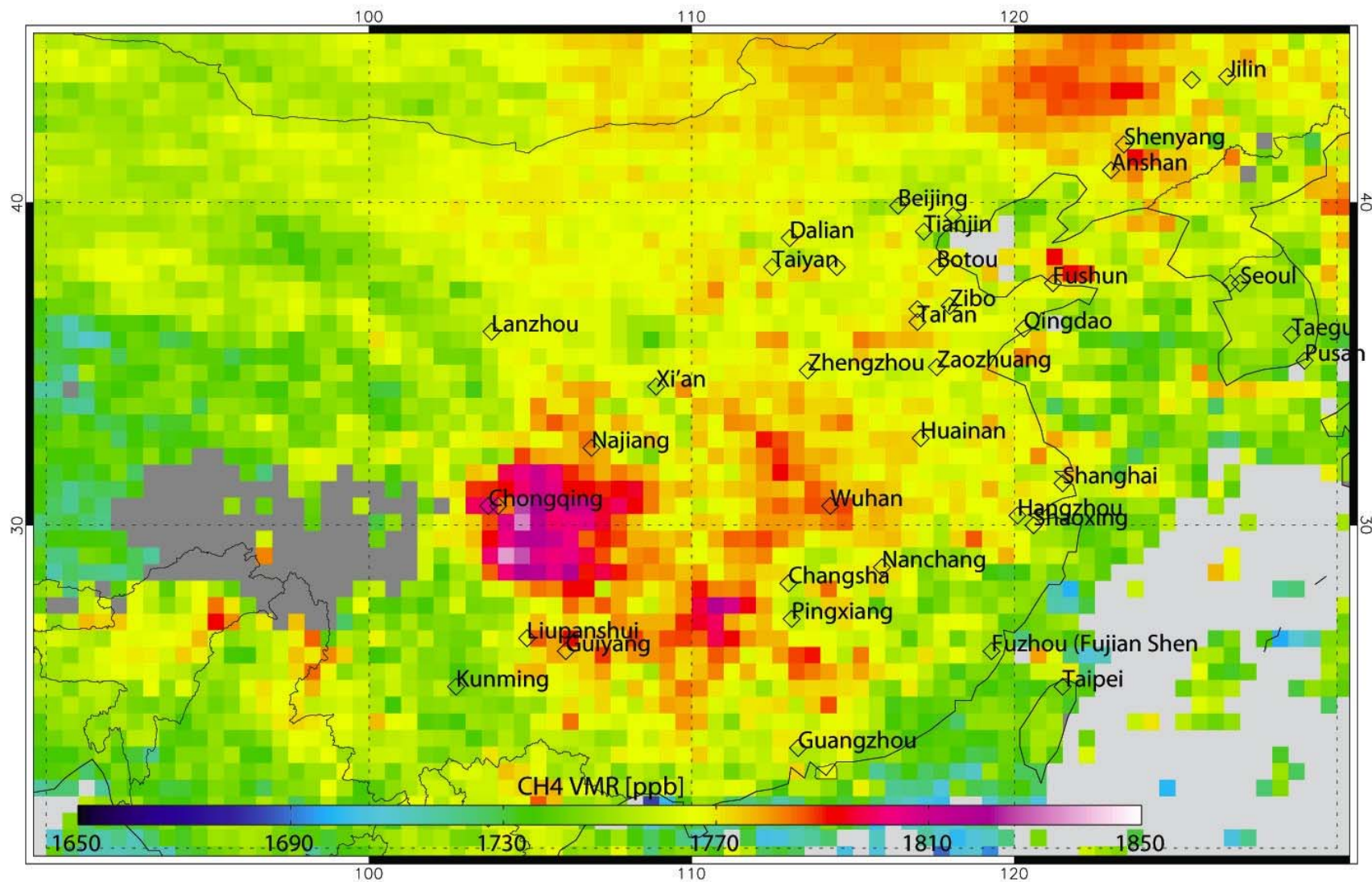


A posteriori emission increments
In the tropics!
(Inversion based on NOAA CMDL
and SCIAMACHY)

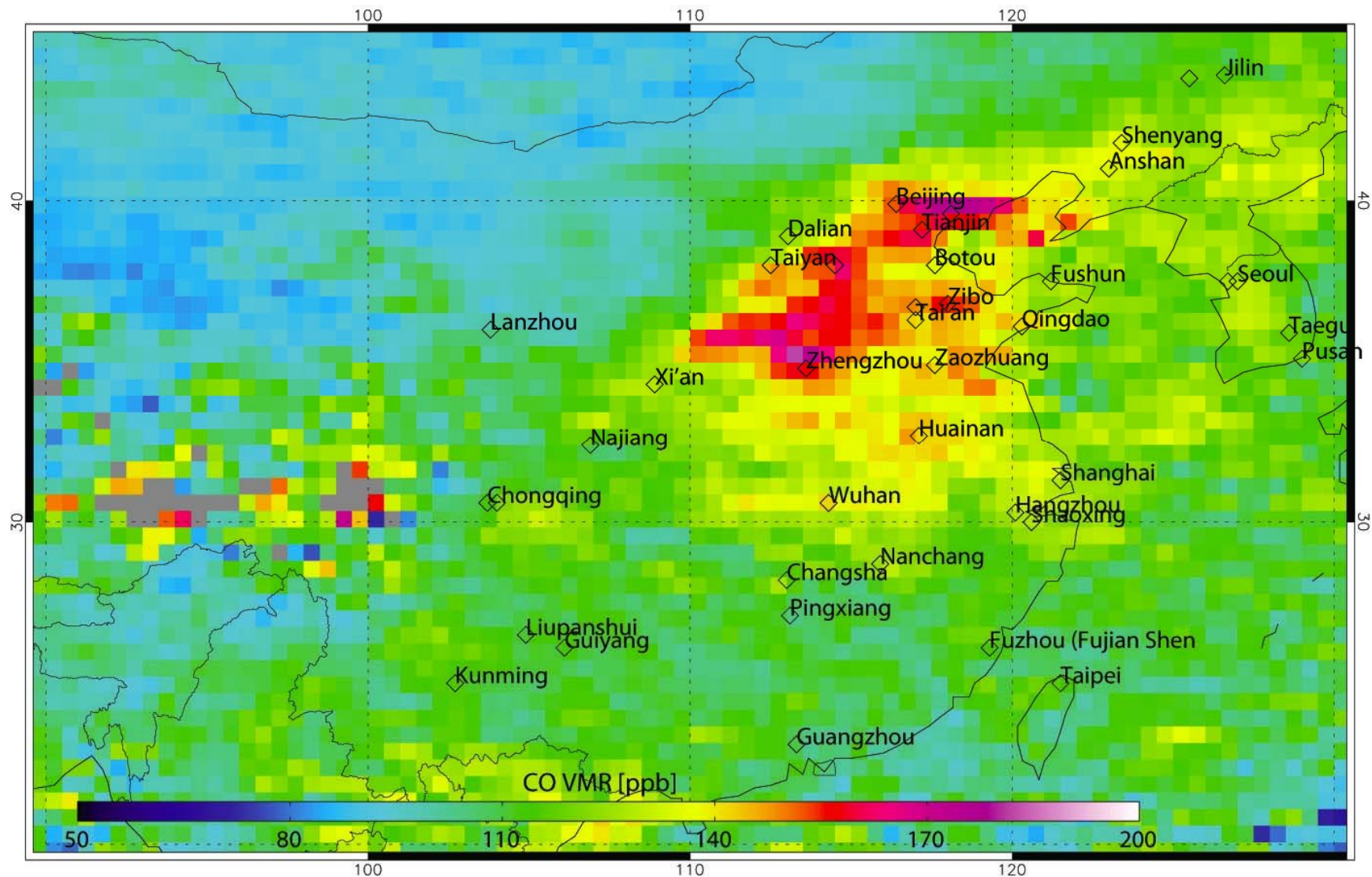
Bergamaschi et al, JGR, in review



CH₄ 2005



CO 2005



Conclusions

- Global space borne retrievals allow a completely new view on methane
- Application of CO₂ as proxy enables global CH₄ retrievals with 1-2% precision; drawback: systematic biases due to unaccounted CO₂ variations
- SCIAMACHY seems to track plant emissions, inverse modeling for the quantification of global sources is on the way
- Despite major problems in the beginning, CO retrievals are getting in shape
- See Posters by M. Buchwitz, H. Schrijver and listen to the following talks!



Websites (Data information, papers, thesis etc.)

<http://www.sciamachy.org/products>

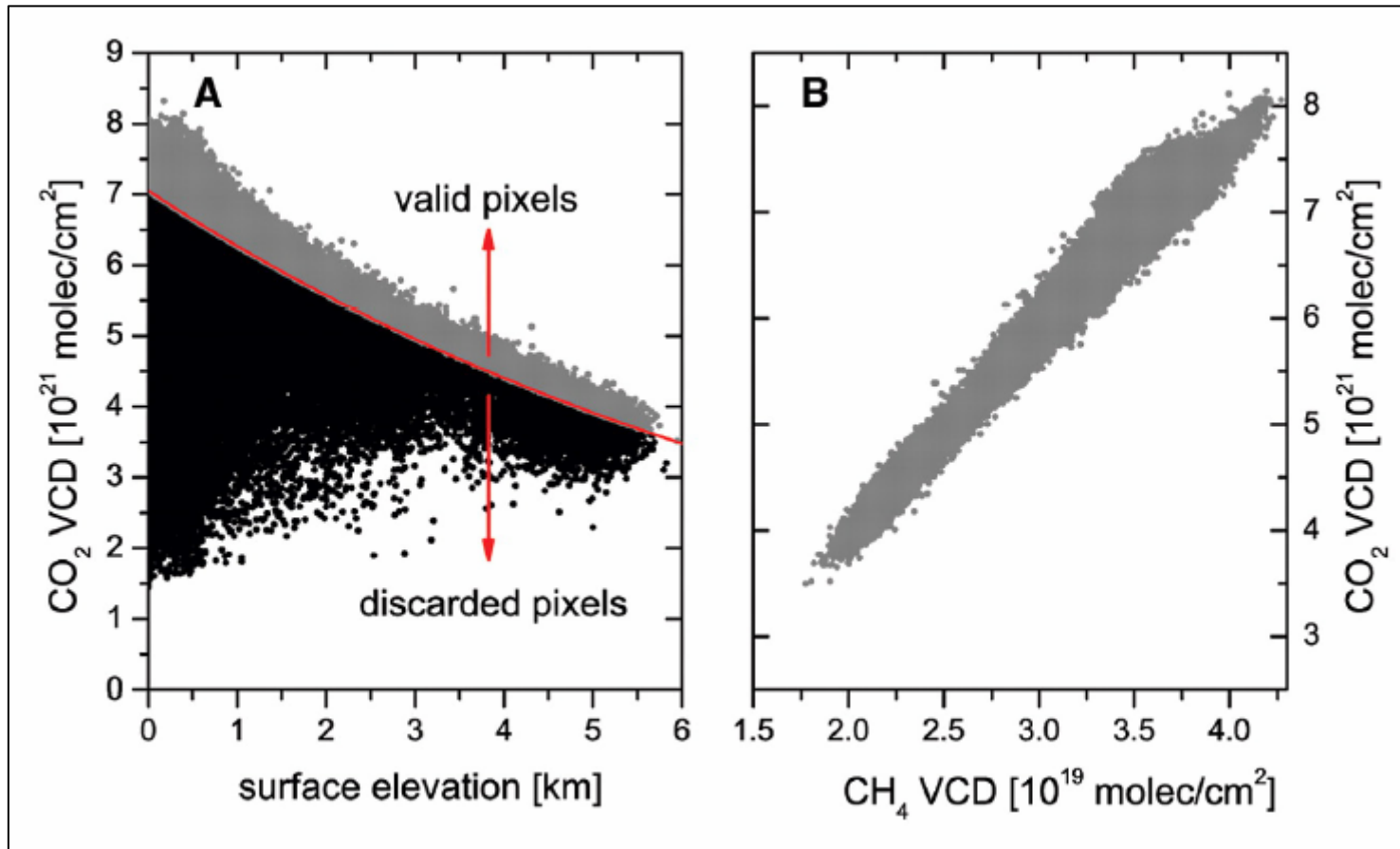
Cfranken@iup.uni-heidelberg.de

<http://satellite.iup.uni-heidelberg.de/~cfranken/>





CO₂ as Jack of all trades: Cloud filter and proxy



Frankenberg et al., Science, 2005



