



# Inverse modelling of methane emissions from satellite observations within the EVERGREEN project

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1. Status EVERGREEN
2. CH<sub>4</sub> inverse modelling





# EVERGREEN

## EnVisat for Environmental Regulation of GREENhouse gases



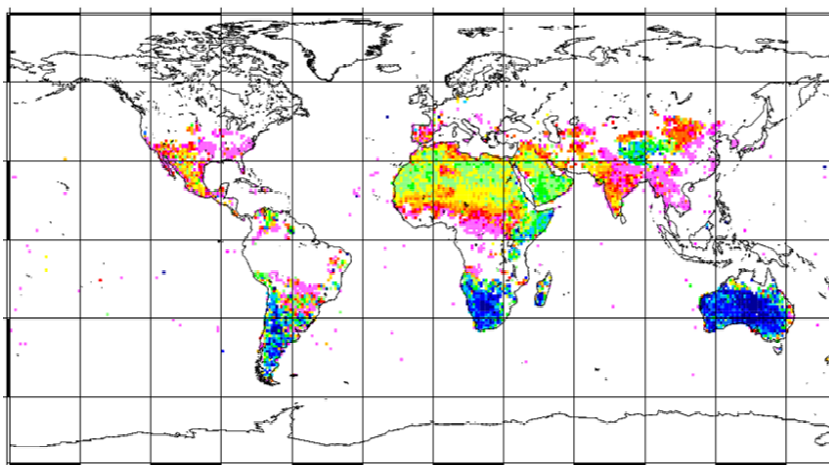
- EC 5<sup>th</sup> framework programme
- Feb. 2003 – Feb. 2006
- *Objective:* use ENVISAT (SCIAMACHY and MIPAS) measurements for inverse modelling of GHG emissions
- *Partners:* KNMI (NL, coordinator), Univ. Bremen (DE), Univ. Leicester (GB), Univ. Heidelberg (DE), NILU (NO), SRON (NL), MPI-BGC (DE), BIRA-IASB (BE), UPMC-SA (FR), RWE-Rheinbraun (DE), Univ. Liège (BE), EC-JRC-IES (IT)
- *Website:* <http://www.knmi.nl/evergreen>



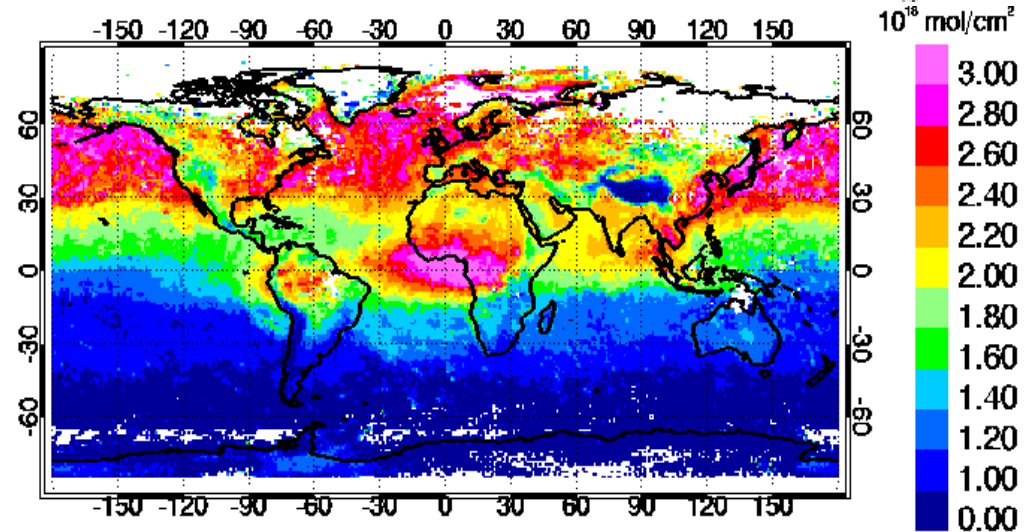
# EVERGREEN: tasks



- **Retrieval and validation:** CH<sub>4</sub>, CO, (CO<sub>2</sub>), O<sub>2</sub> columns; clouds
- **Radiation budget modelling:** use of measured trace gas distributions in radiative forcing calculations
- **(Inverse) modelling:** CH<sub>4</sub>, CO, CO<sub>2</sub>
  - emission inventory
  - model intercomparison (<sup>222</sup>Rn, SF<sub>6</sub>, ...)
  - inverse modelling



SRON IMLM algorithm, H. Schrijver 2004

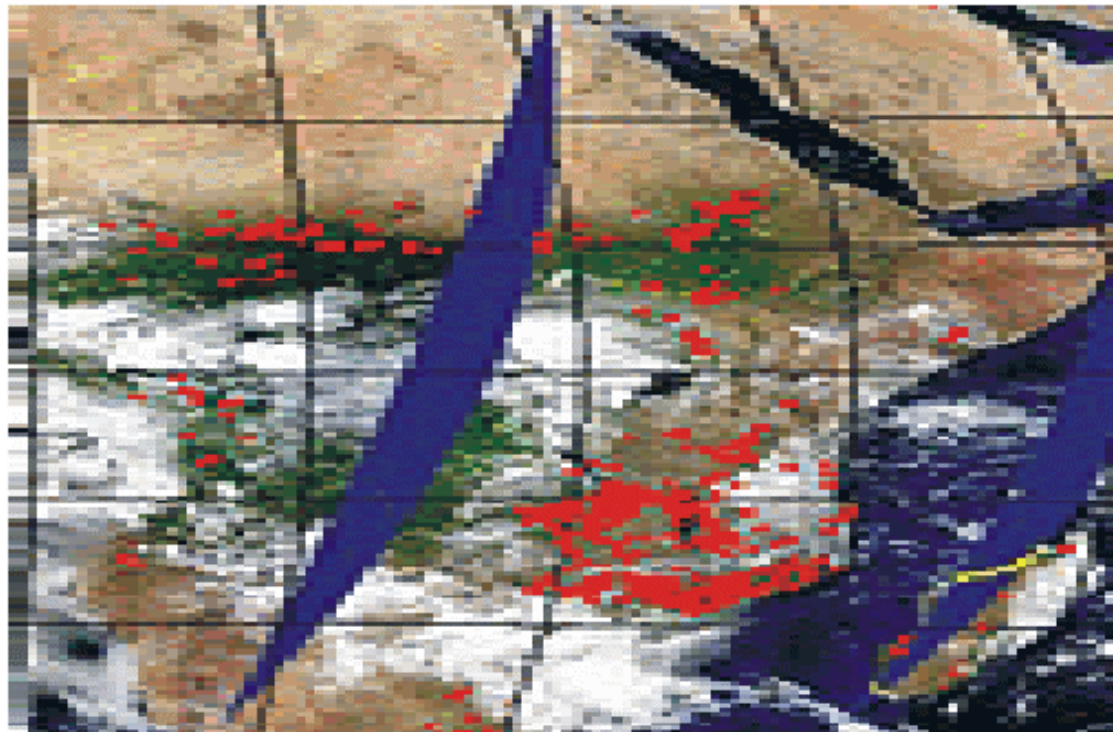


Downloaded from: [www.eos.ucar.edu/mopitt](http://www.eos.ucar.edu/mopitt)

- Large-scale features in good agreement
- Differences:
  - Cloud masks
  - Scaling with surface pressure

# CO from SCIA

MODIS/Terra 20031027



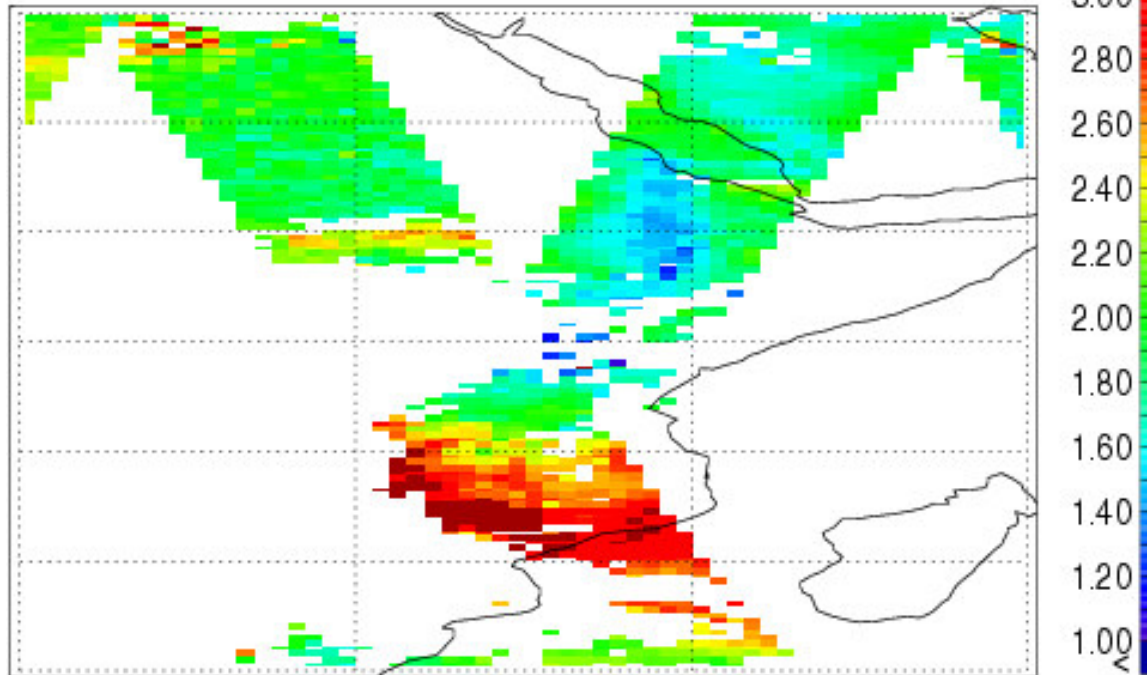
M. Buchwitz et al. , ACPD, 4 (2004)



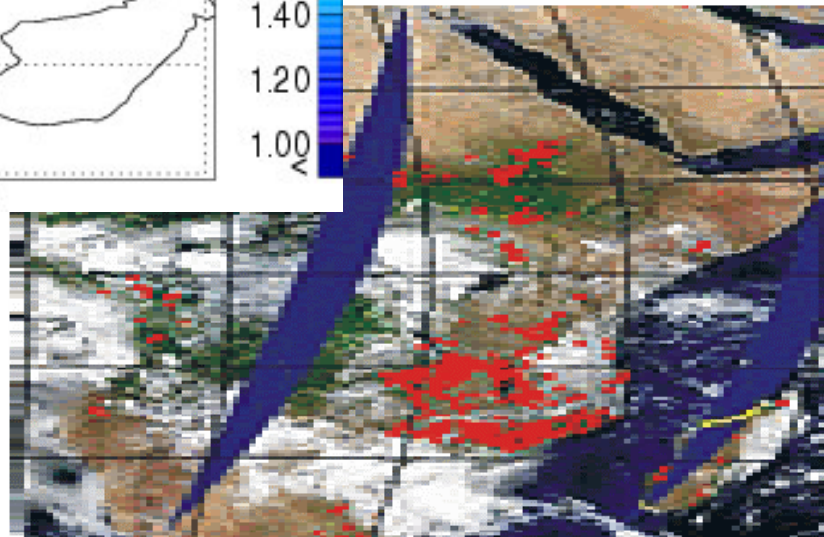
# CO from SCIA

CO MOPITT 20031027

VC [ $10^{18}$  molec./cm<sup>2</sup>]



Terra 20031027

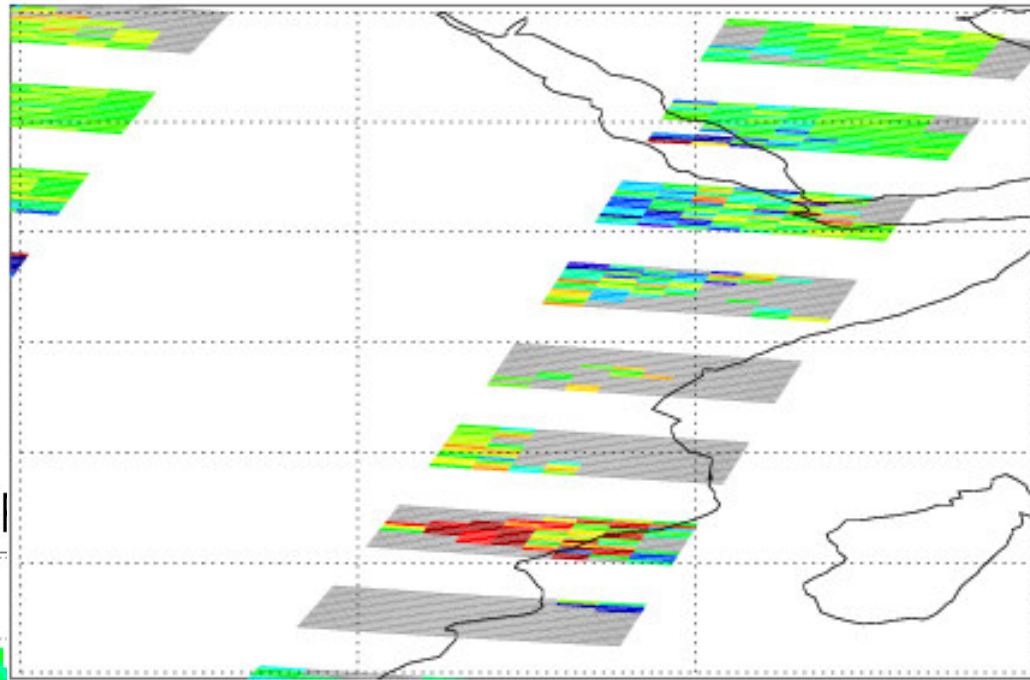
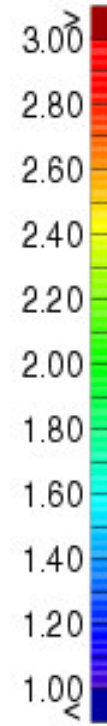


M. Buchwitz et al. , ACPD, 4  
(2004)

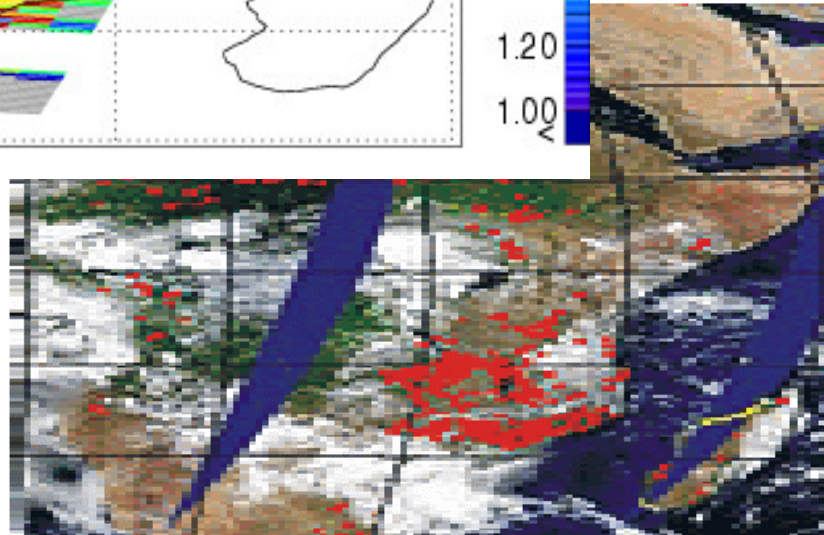
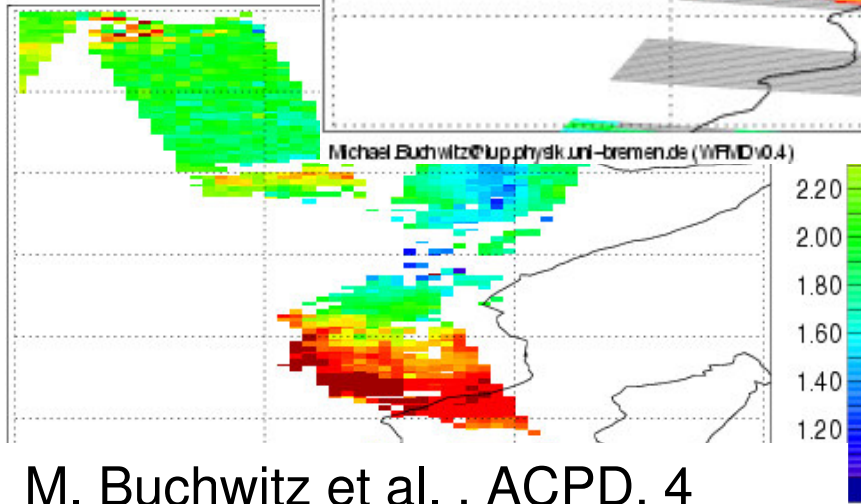
# CO from SCIA

CO SCIA/WFMD 20031027

VC [10<sup>18</sup> molec./cm<sup>2</sup>]



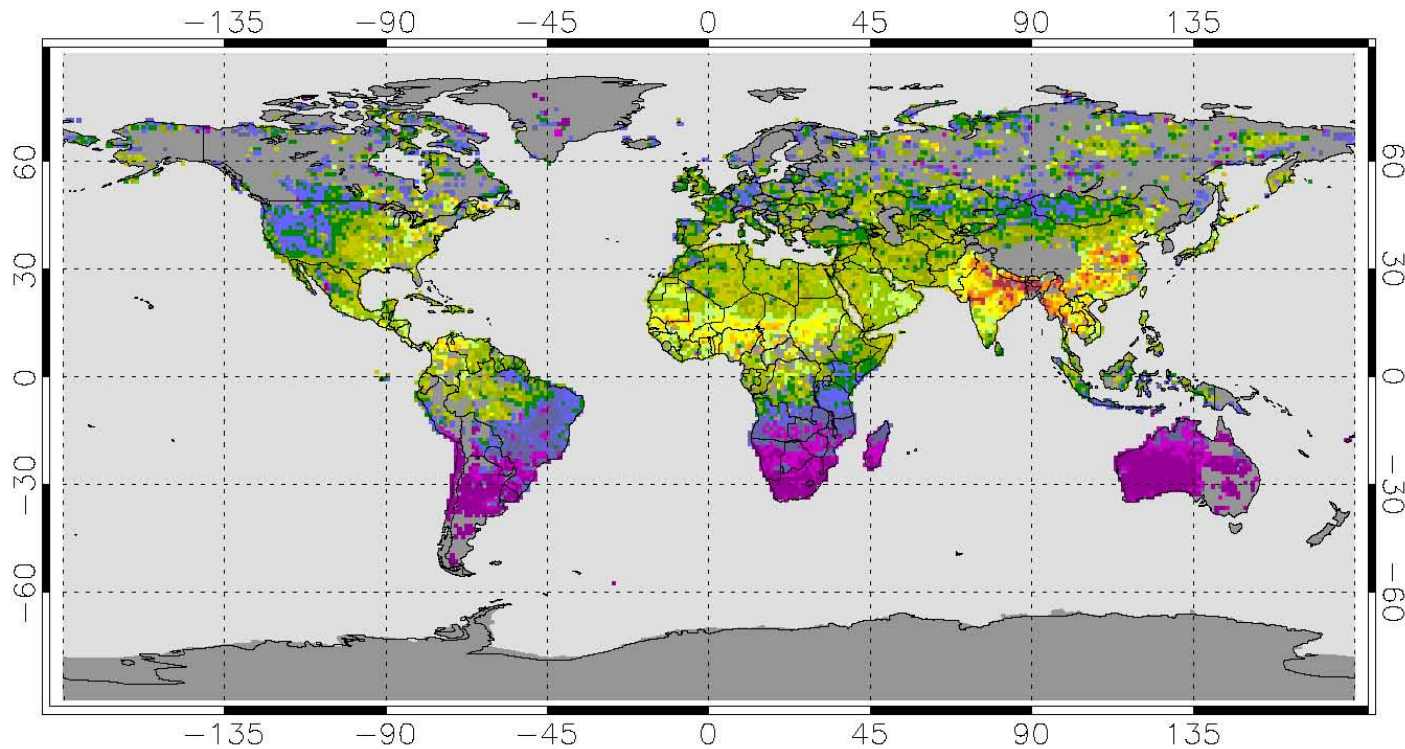
CO MOI



M. Buchwitz et al. , ACPD, 4 (2004)



# CH<sub>4</sub> from SCIA channel 6



CH<sub>4</sub> vertical column density 08–10 2003 scaled with CO<sub>2</sub> [molec/cm<sup>2</sup>]



3.70e+19 3.75e+19 3.80e+19 3.85e+19 3.90e+19 3.95e+19 4.00e+19 4.05e+19 4.10e+19



ENVISAT symposium, 6-10 Sept. 2004, Salzburg

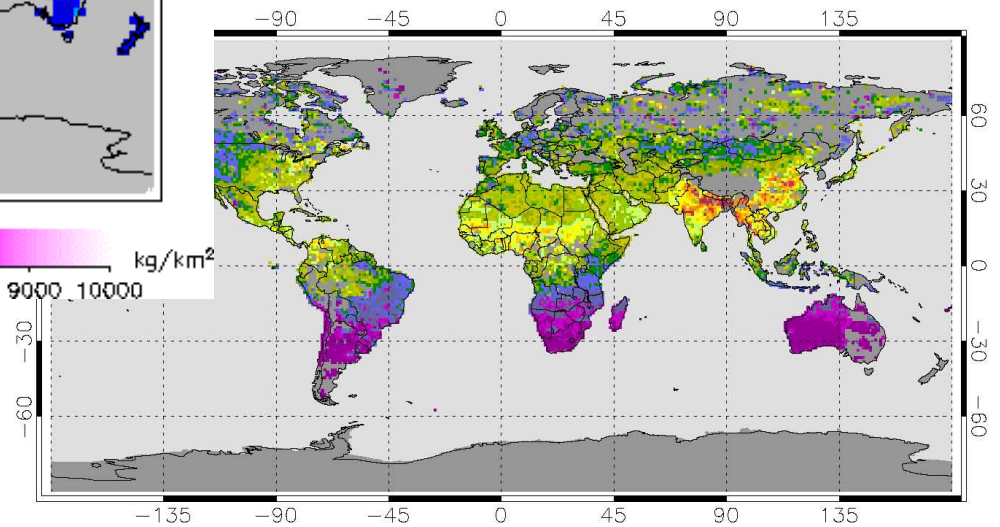
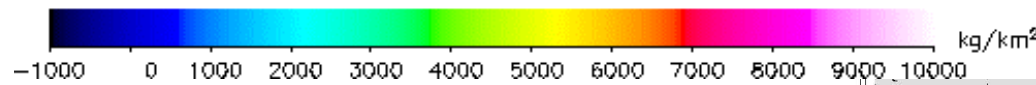
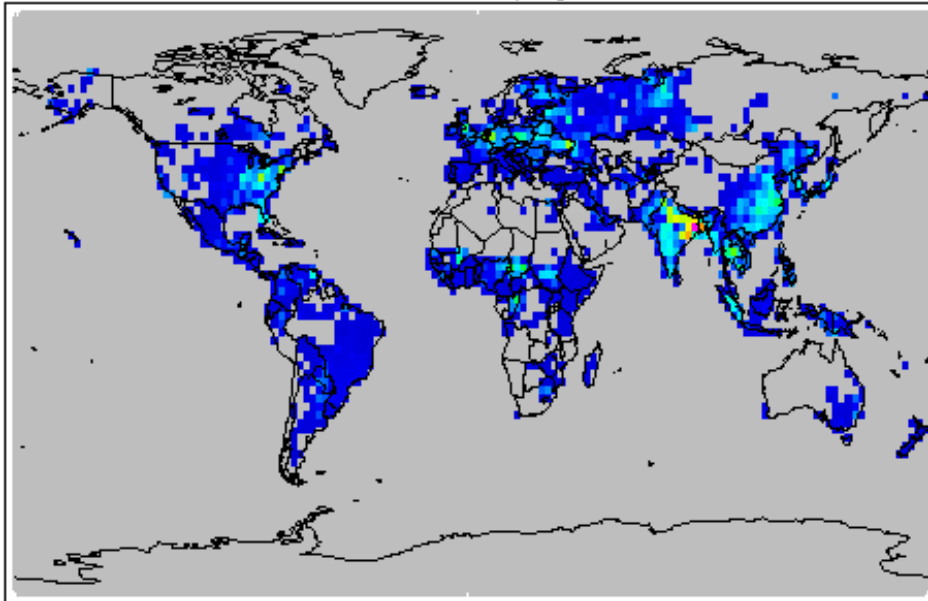




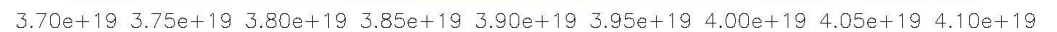
# CH<sub>4</sub> from SCIA channel 6



CH<sub>4</sub> emissions (Aug–Oct)



CH<sub>4</sub> vertical column density 08–10 2003 scaled with CO<sub>2</sub> [molec/cm<sup>2</sup>]



# Inverse modelling

- Goal: derive emissions from atmospheric concentrations
- Starting point: bottom-up emission inventories  
→ contain large uncertainties on regional scale
- Tools:
  - Synthesis inversion
  - 4D-var data assimilation

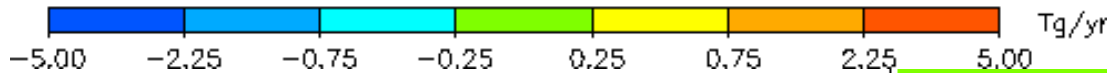
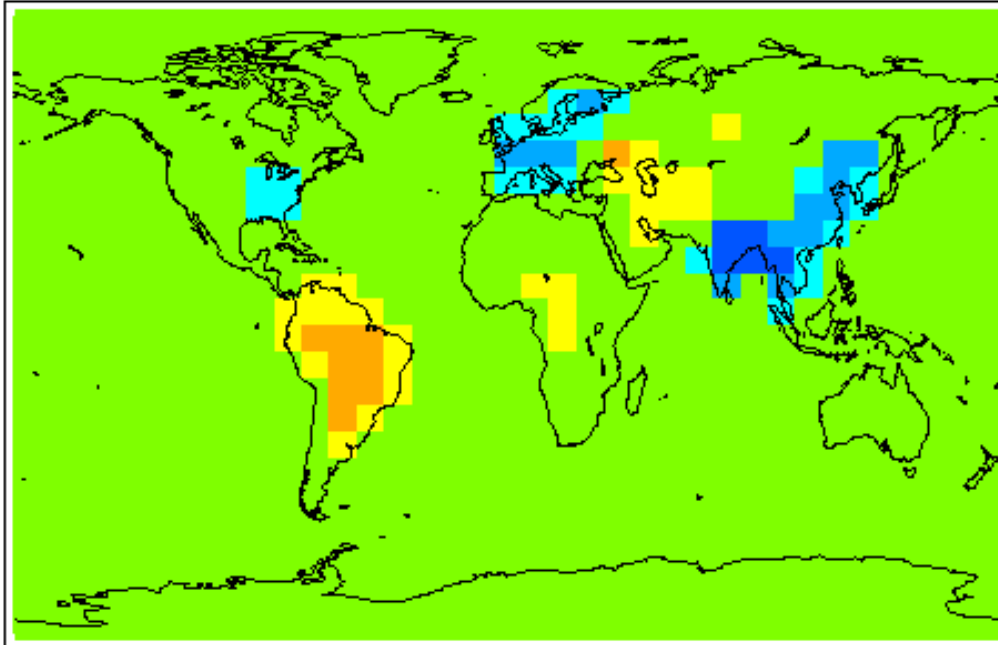


# Inverse modelling at KNMI



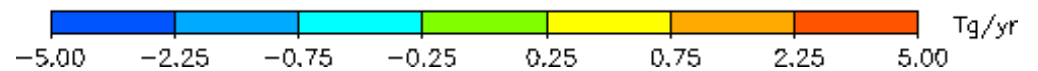
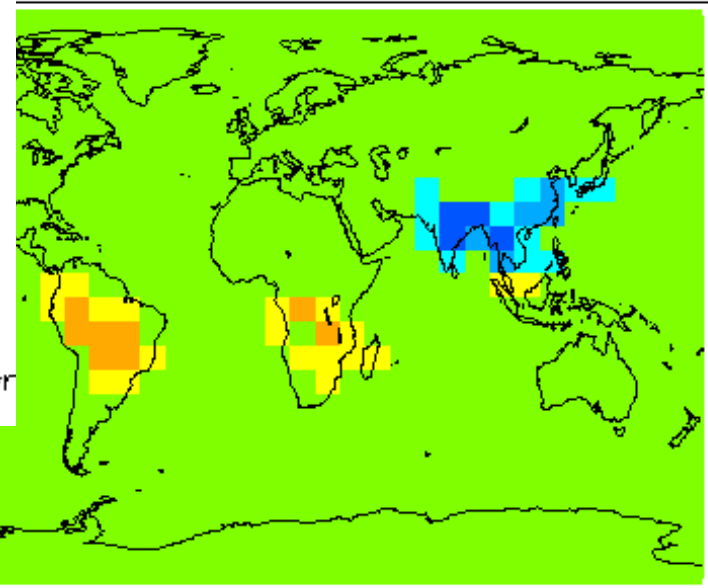
# Example 1: observation error

A posteriori minus a priori, run: 24399



- Obs. error ~ 2 % (at best)

Truth minus a priori

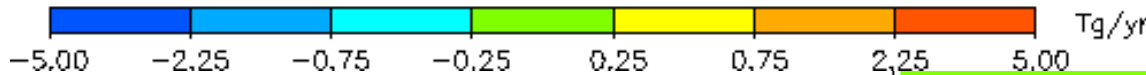
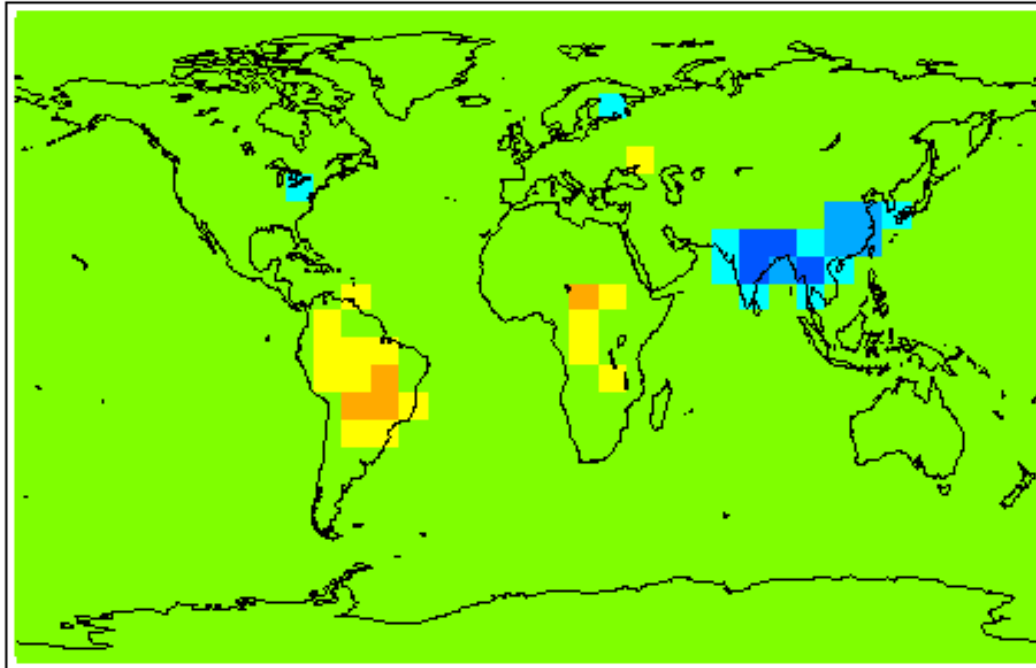


- August 2003



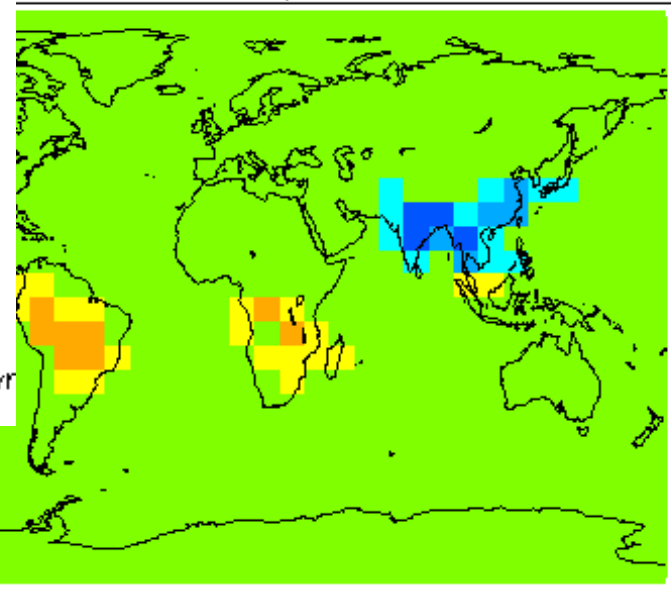
# Ex. 2: error in initial columns

A posteriori minus a priori, run: 3518



- Optimize emissions + initial concentrations

Truth minus a priori



- August 2003

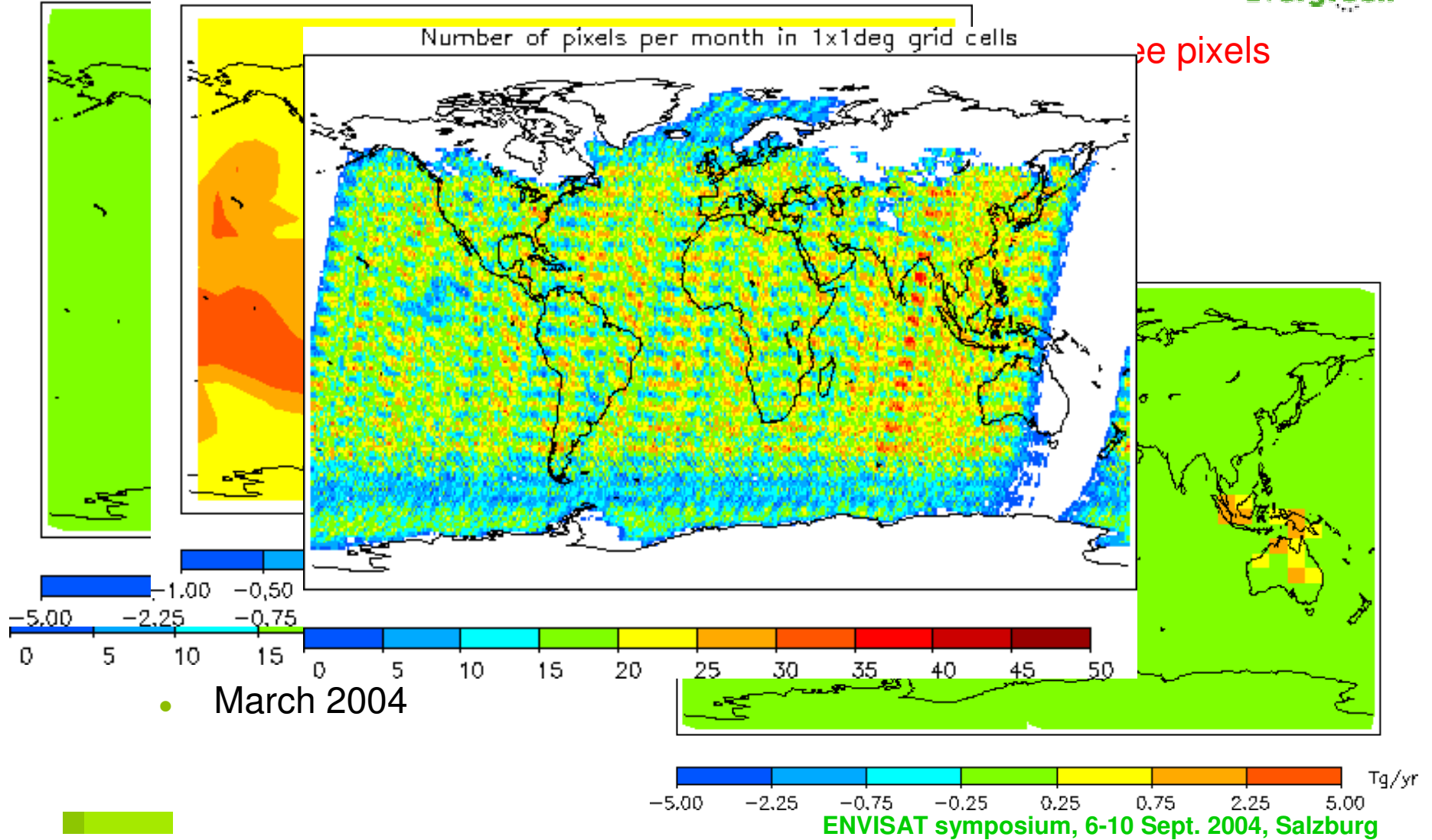




# Ex. 3: clouds



Effect at 100 hPa after 17 month





# Summary



- EC project EVERGREEN for improved *global emissions* of CH<sub>4</sub>, CO, and possibly CO<sub>2</sub>, using satellite data
- Website: <http://www.knmi.nl/evergreen>