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Recent developments at FMI

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02/28/2019 **TM5 meeting, remote connection from FMI to LAMOS, Bremen**

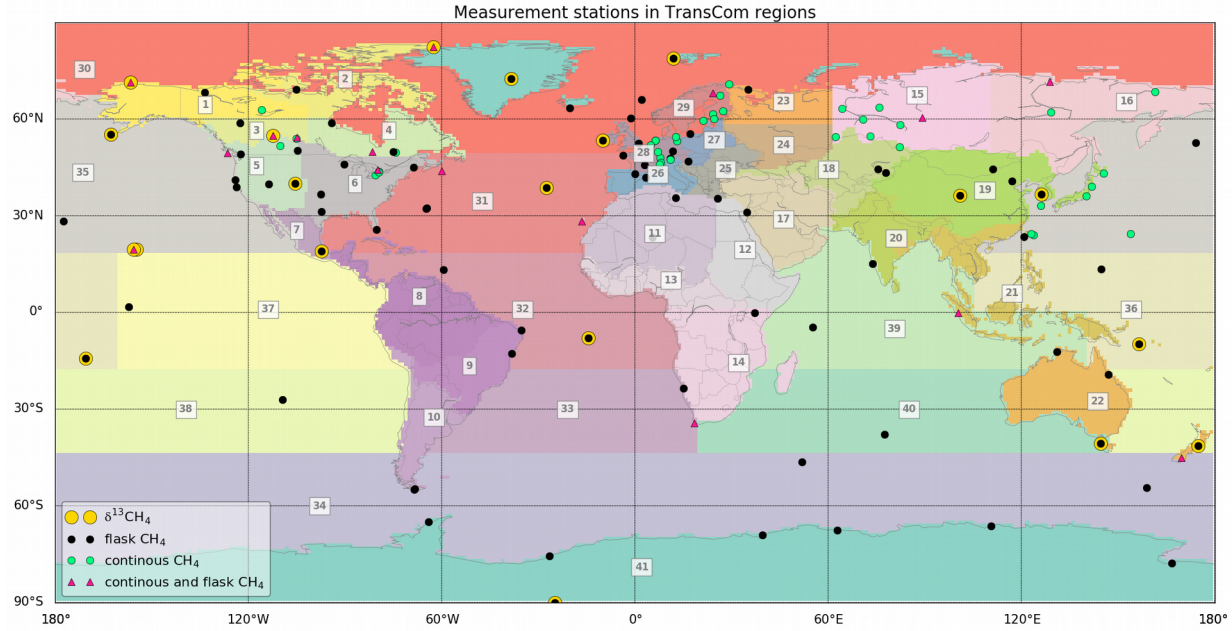
Contents

- CTE-$\delta^{13}C$-CH_4 (Vilma, Aki)
  - Status & preliminary results
- CTE-CH_4 (Aki, Tuula)
  - Contributions to GCP, GOSAT inversion
- “New” activities at FMI related to TM5 (Risto, Putian)
  - Development on aerosol scheme

CTE-$\delta^{13}C$-CH_4

- Assimilate $\delta^{13}C$-CH_4 together with CH_4 observations
  - $\delta^{13}C$-CH_4 obs from INSTAAR (NOAA)
  - CH_4 obs as in CTE-CH_4
- Optimize CH_4 emissions (same scaling for $^{13}CH_4$ emissions)
  - Wetlands + soil sink (LPX-Bern DYPTOP)
  - EDGAR* components (divided into 6)

    *Scaled to match CTE-CH_4 glb anth.
- Test cases for 2004–2006



CTE-$\delta^{13}C$-CH_4

- Optimized emission fields
  - Isotopic ratio from Monteil et al., 2011
- Optimized per modified TC regions (41 regions globally)
- Background covariance
  - Components uncorrelated
  - Uncertainty over land: 0.8
  - Correlation length
    (500 km over land, 900 km over ocean)

Components	Isotopic ratios (‰)	Unc. for ocean (+coasts)
Wetland (+ soil sink)	-59	0.2
Oil + gas	-40	0.2
Coal	-35	0.2
Entric fermentation + manure management	-62	1e-3
Rice	-63	1e-3
Residential	-38	1e-3
Landfill + waste water	-55	1e-3

CTE-$\delta^{13}C$-CH_4

- Inversion setups
  - **CH4**: only CH_4 observations assimilated
  - **mdm1.0**: CH_4 and $\delta^{13}C$-CH_4 observations assimilated
    - mdm of $\delta^{13}C$-CH_4 observations = 1.0 ‰
  - **mdm0.1**: CH_4 and $\delta^{13}C$-CH_4 observations assimilated
    - mdm of $\delta^{13}C$-CH_4 observations = 0.1 ‰
  - All observations assimilated in all cases
    - mdm1.0 and mdm0.1 show only minor differences
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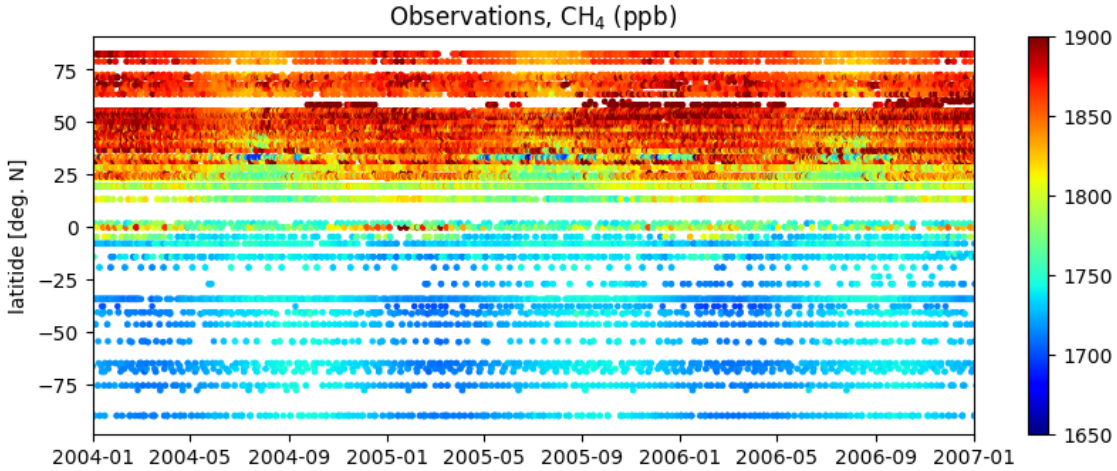
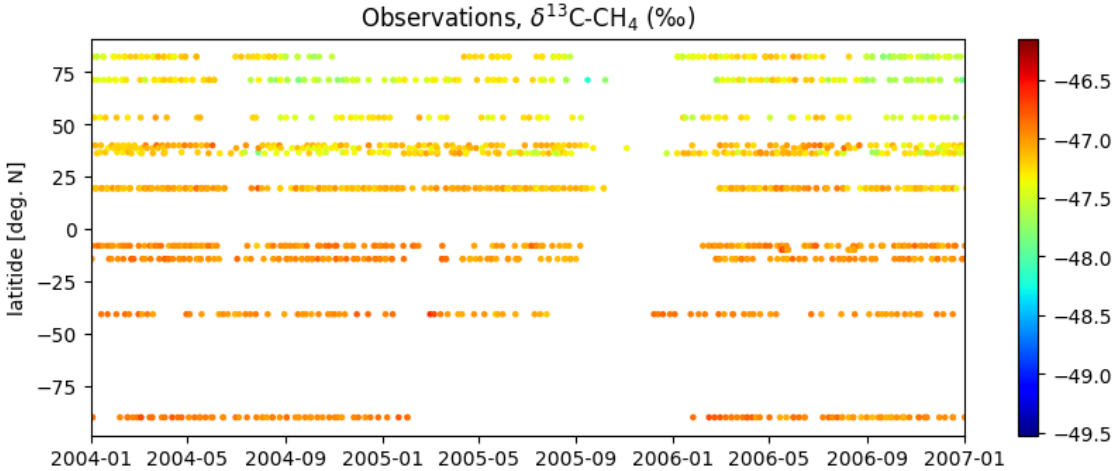
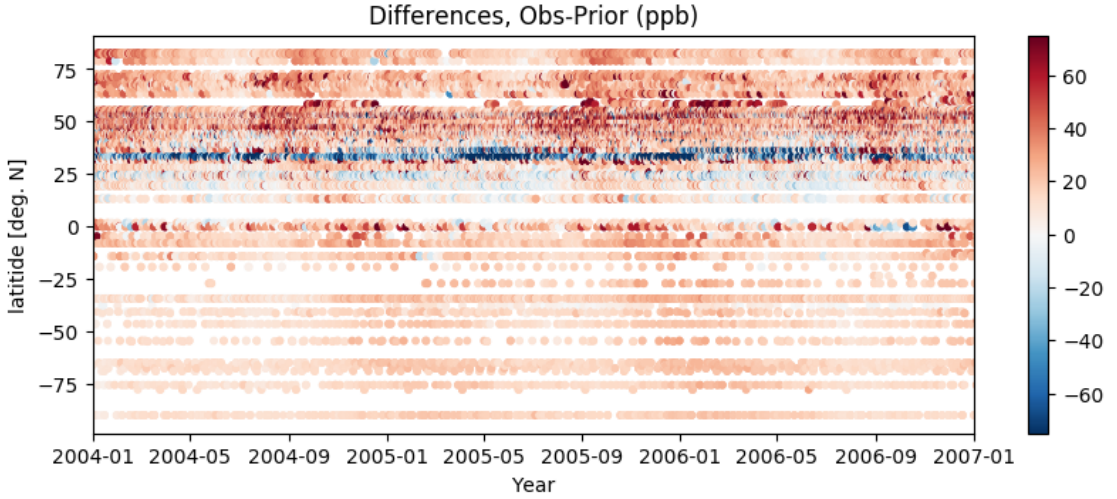
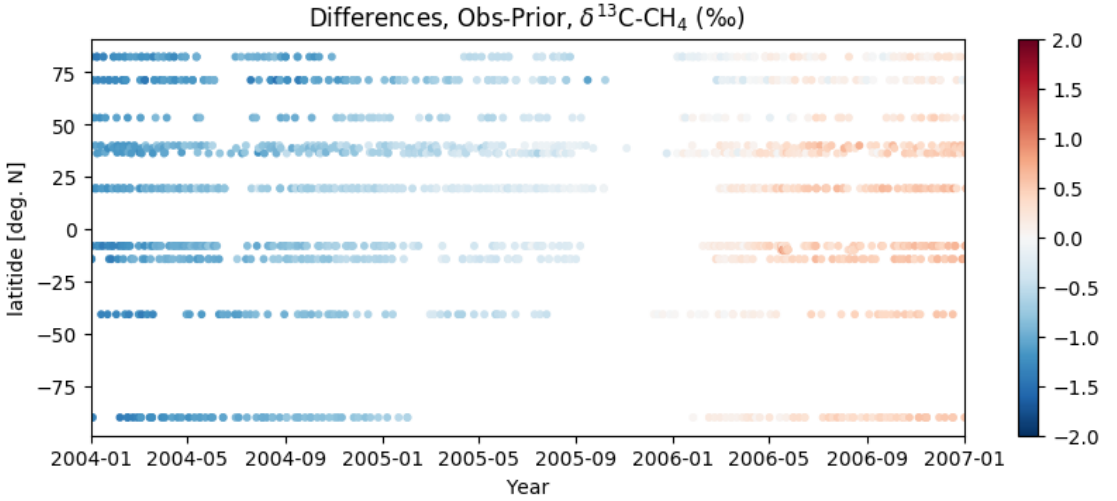
CTE-δ^{13}C-CH_4 Atmospheric concentrations



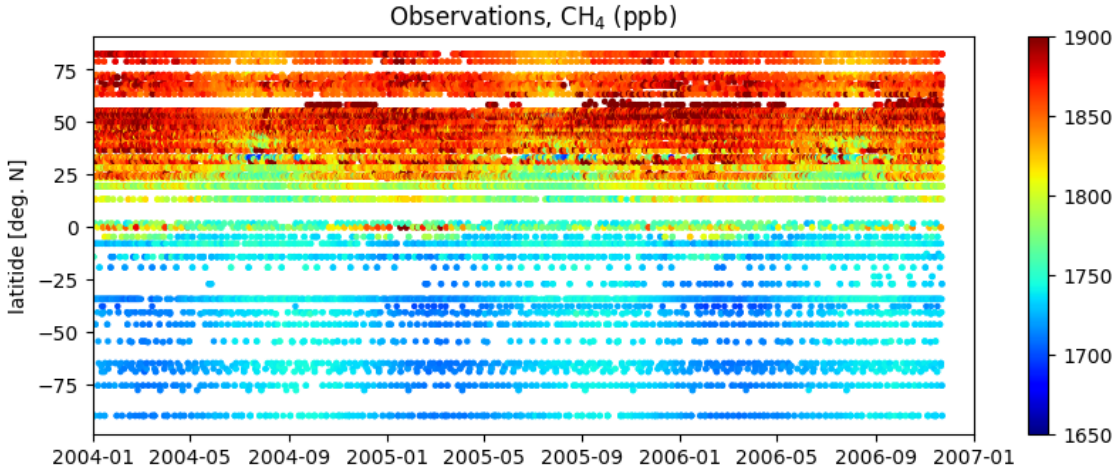


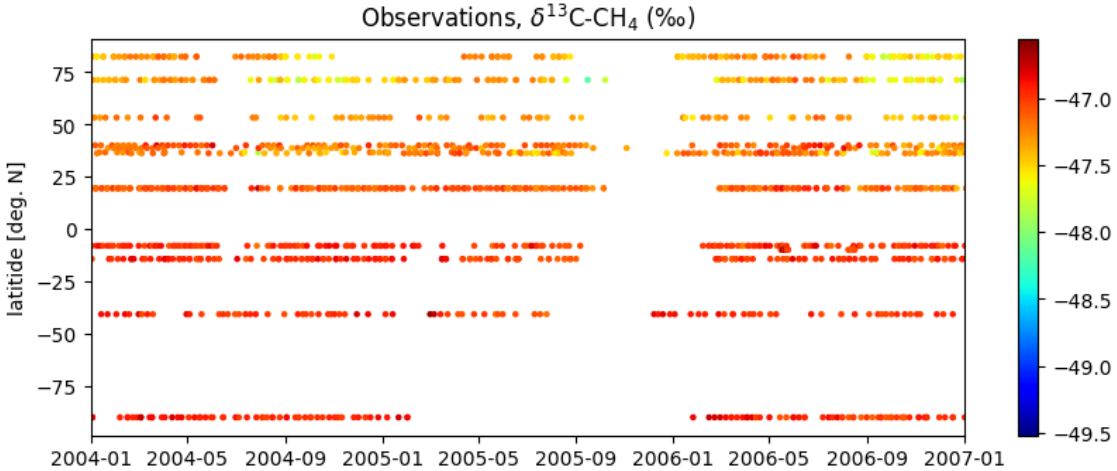


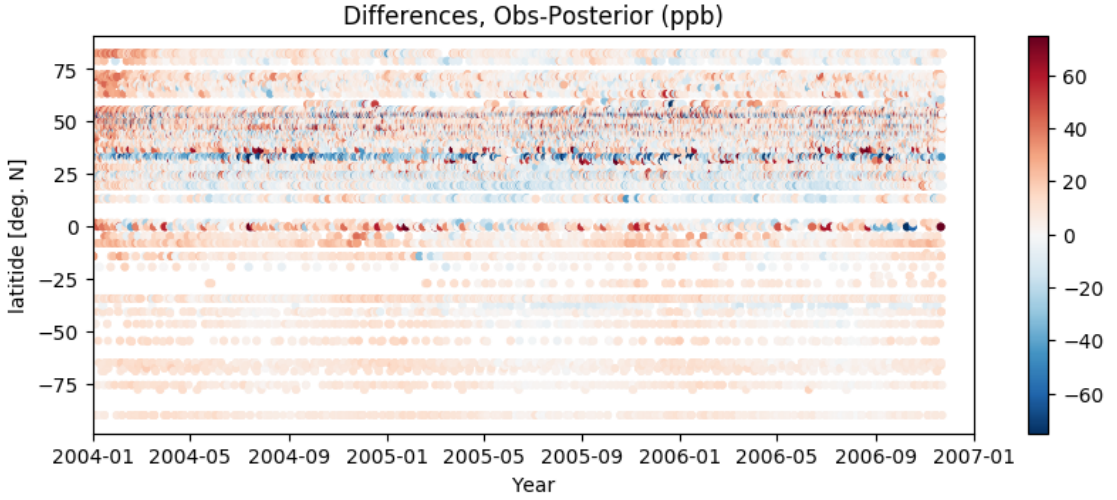


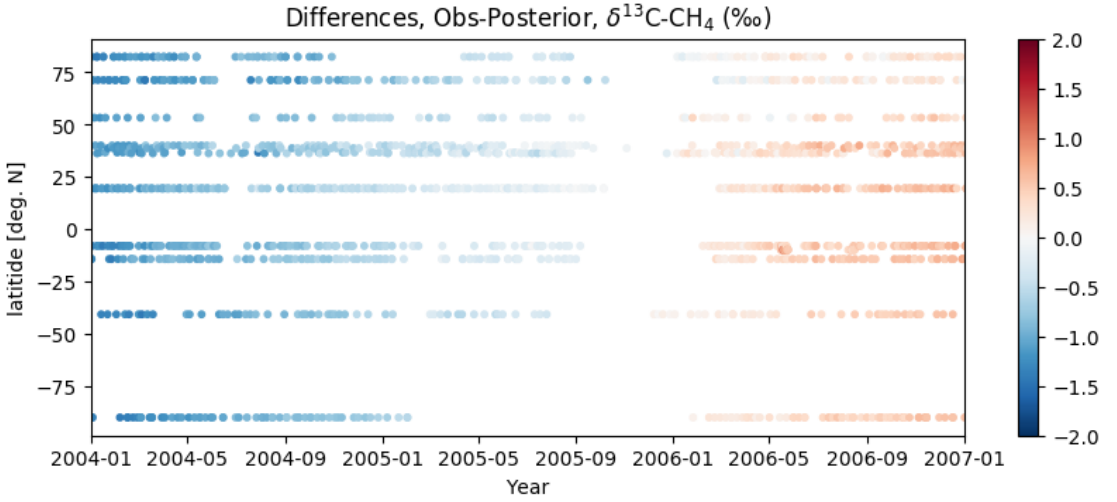
CTE-δ^{13}C-CH_4 Atmospheric concentrations

From inversion mdm1.0



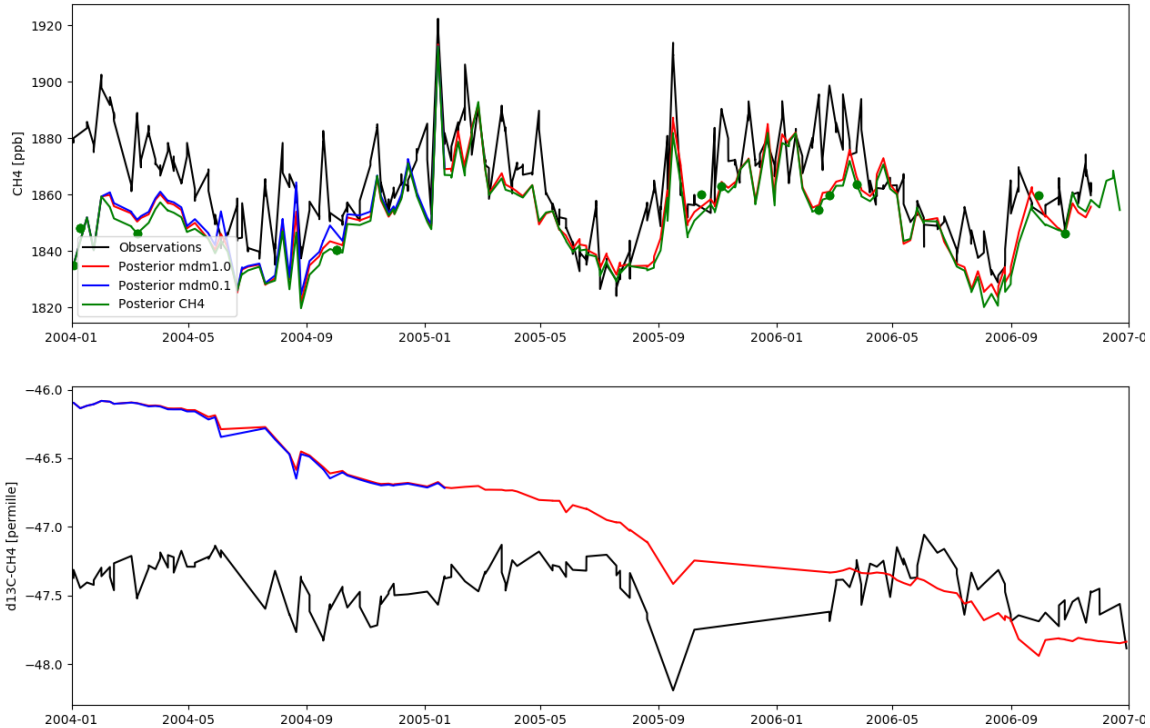




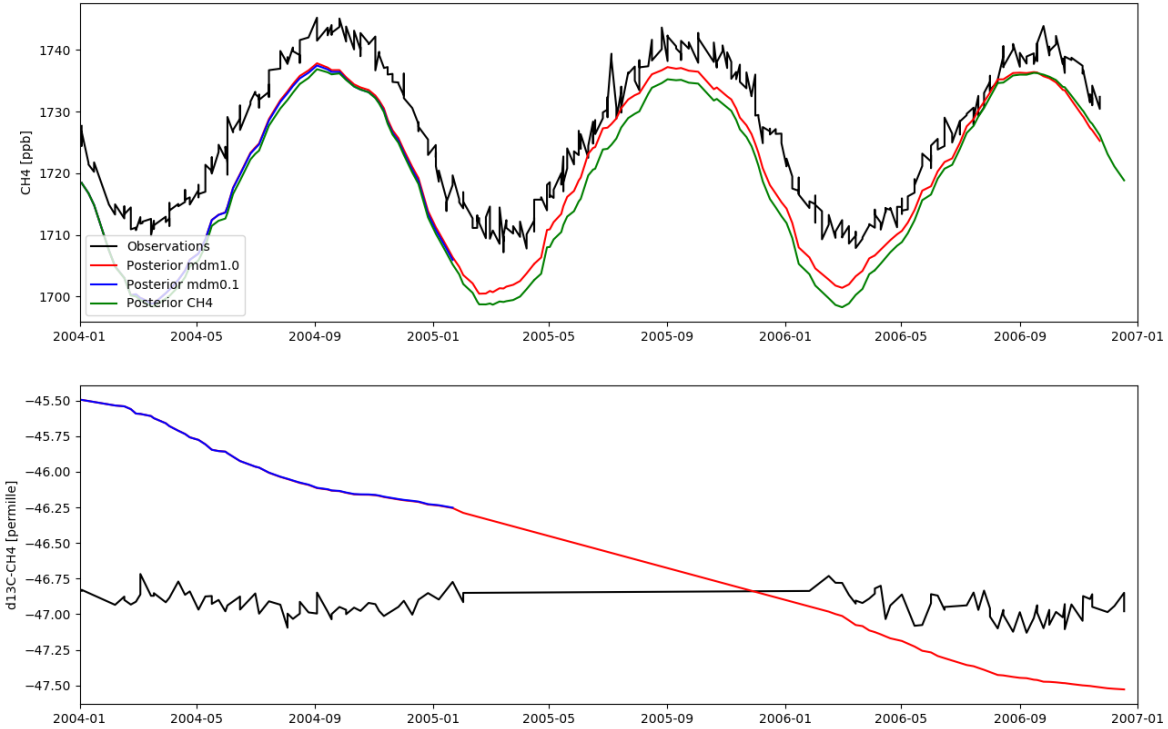


CTE-$\delta^{13}C$-CH_4 Atmospheric concentrations

Barrow



South Pole



CTE-$\delta^{13}C$-CH_4 Emission estimates

- Both inversions tend to show larger CH_4 emission than prior
- CH_4 inversion tend to show larger CH_4 emissions compared to mdm1.0 (except coal and rice)
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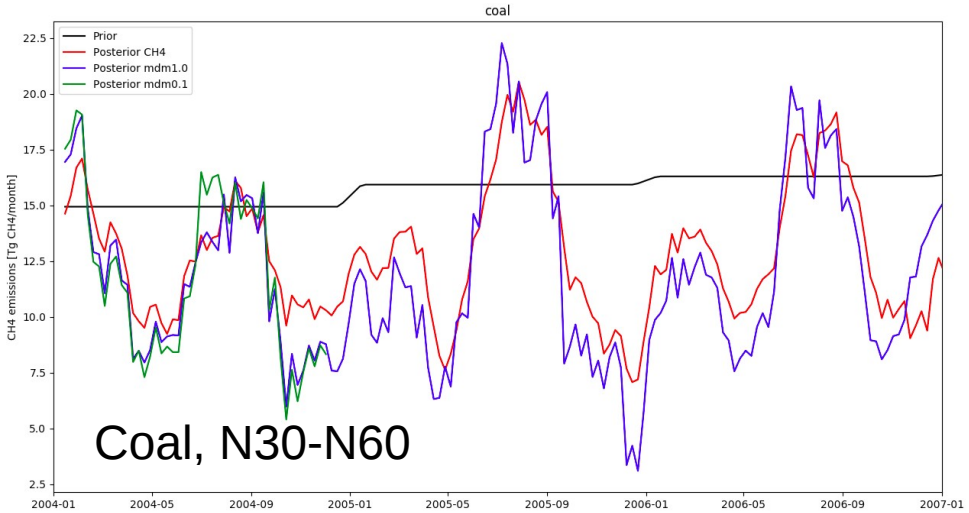
Average global total emissions for 2004-2006

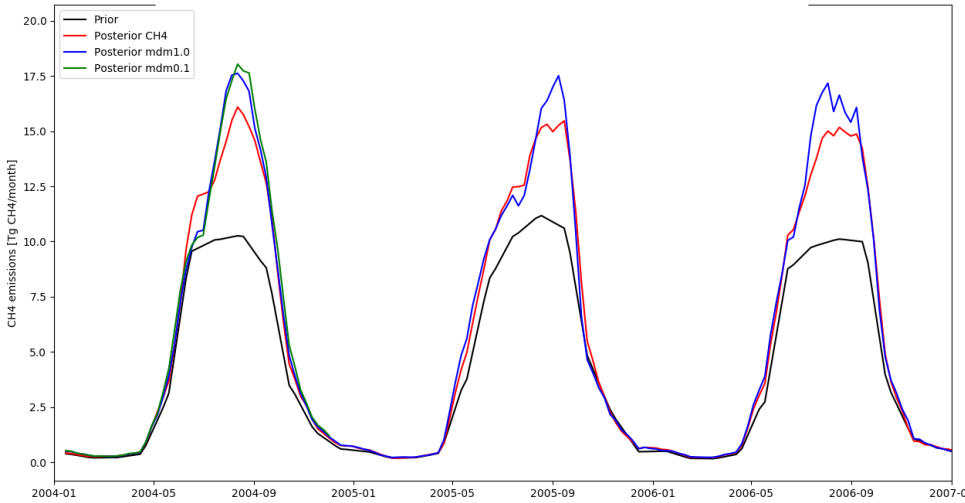
	Prior	CH_4	mdm1.0
Wetland (+ soil sink)	155	161	157
Oil + gas	62	68	66
Coal	**40**	**35**	**37**
Entric fermentation + manure management	105	112	108
Rice	**33**	**29**	**31**
Residential	11	10	10
Landfill + waste water	56	58	57

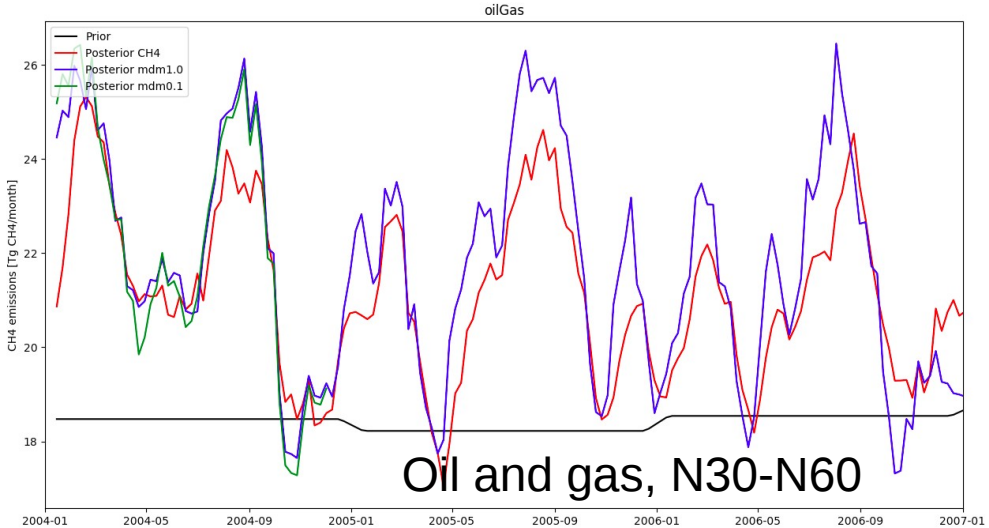
CTE-$\delta^{13}C$-CH_4 Emission estimates

- Wetlands: isotope inversions (II) give larger emissions over N60-N90
- Coal: II give lower winter emissions over N30-N60
- Oil and gas: II give larger emissions over N30-N60



Bio, N60-N90





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CTE-$\delta^{13}C$-CH_4

- From preliminary results, we learn...
  - Including $\delta^{13}C$-CH_4 observations gives better agreement in posterior CH_4.
  - Wetland emissions during NH summer, especially in high latitudes, are larger in isotope inversions
  - Oil and gas emissions for northern temperate regions, where major cities are located, are larger in isotope inversions (agrees with e.g. Schwietzke et al., 2016)
  - BUT
    - trend in $^{13}CH_4$ fields are still questionable (neg. trend in posterior $\delta^{13}C$-CH_4)
  -

CTE-$\delta^{13}C$-CH_4

- Future plans
  - Use original EDGAR
  - Tests on inversion parameters, e.g. mdm
  - Tests on different isotopic ratios
    - Isotopic ratio map by Ganesan et al., 2018, GRL
  - Optimize $^{13}CH_4$ emissions also
  - Tests on chemistry: atm. reaction ratios with OH
  - Longer simulations

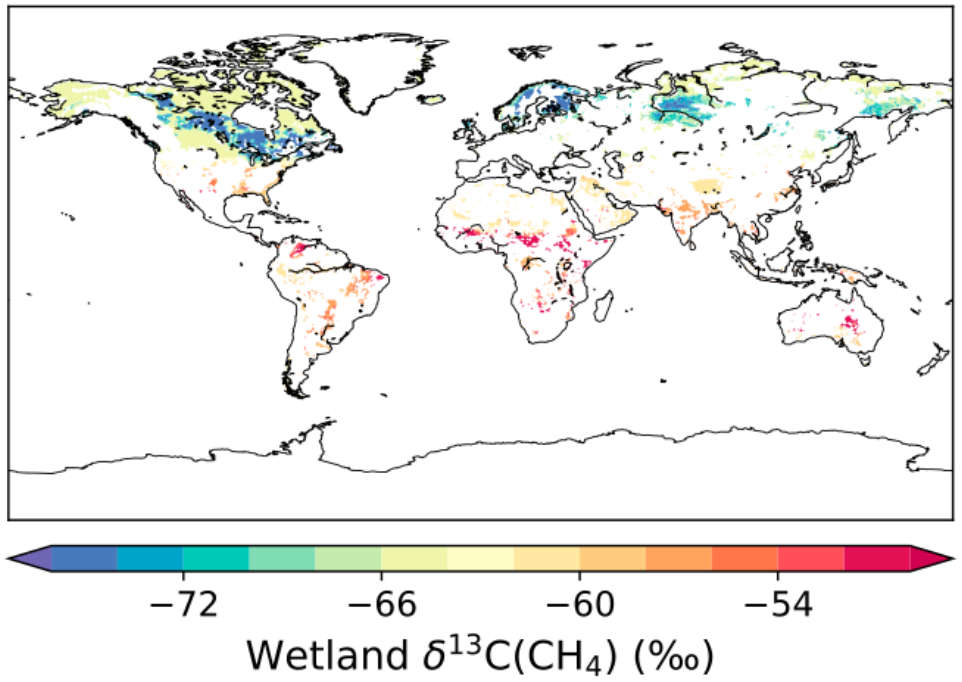


Figure 1. Wetland $\delta^{13}C(CH_4)$ source signature map (‰) masked for grid cells where wetland fraction is greater than 5% at any time during the period 2000–2012.

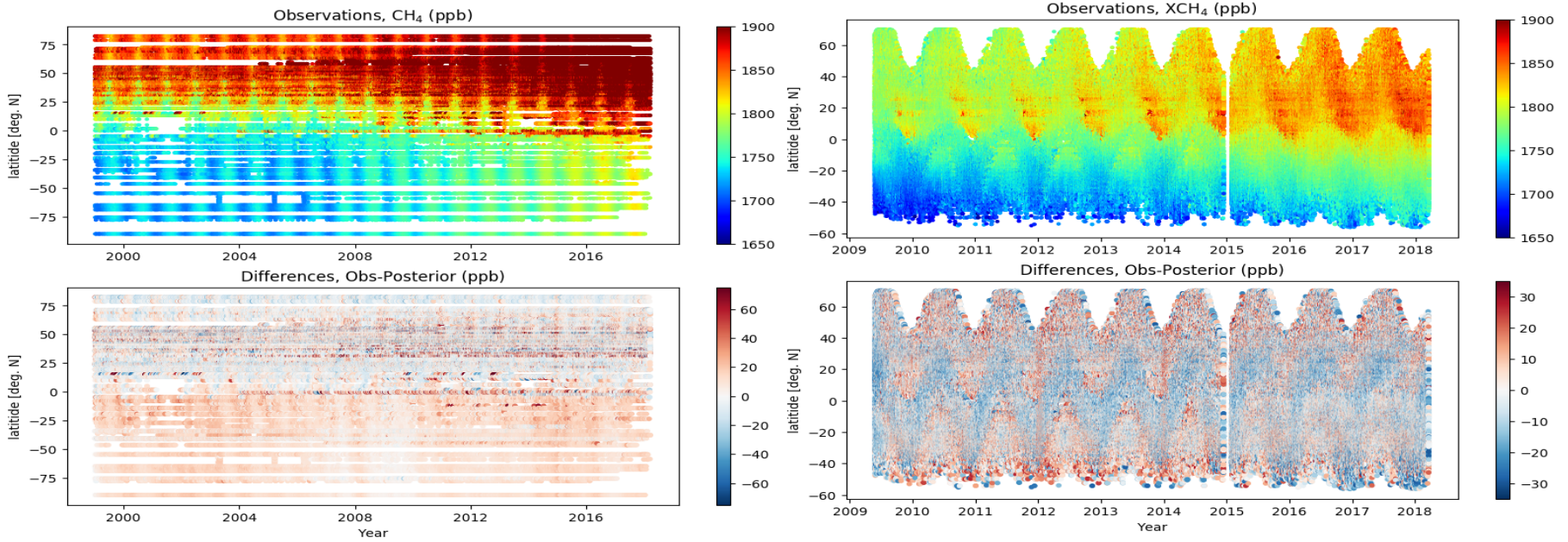
CTE-CH_4 for GCP

- SURF & GOSAT inversion for 2000-2017
- Global total OK, but...
- Bias in the latitudinal gradient
  - GOSAT-only inversions tend to give larger XCH_4 values compared to GOSAT+NOAA inversions (Monteil et al., 2013)
  - ”bias correction” in GOSAT inversion?
    - We removed 5deg. latitudinal gradient bias (compared to SURF inversion).
  - Something else in the model?

CTE-CH_4 GOSAT inversion

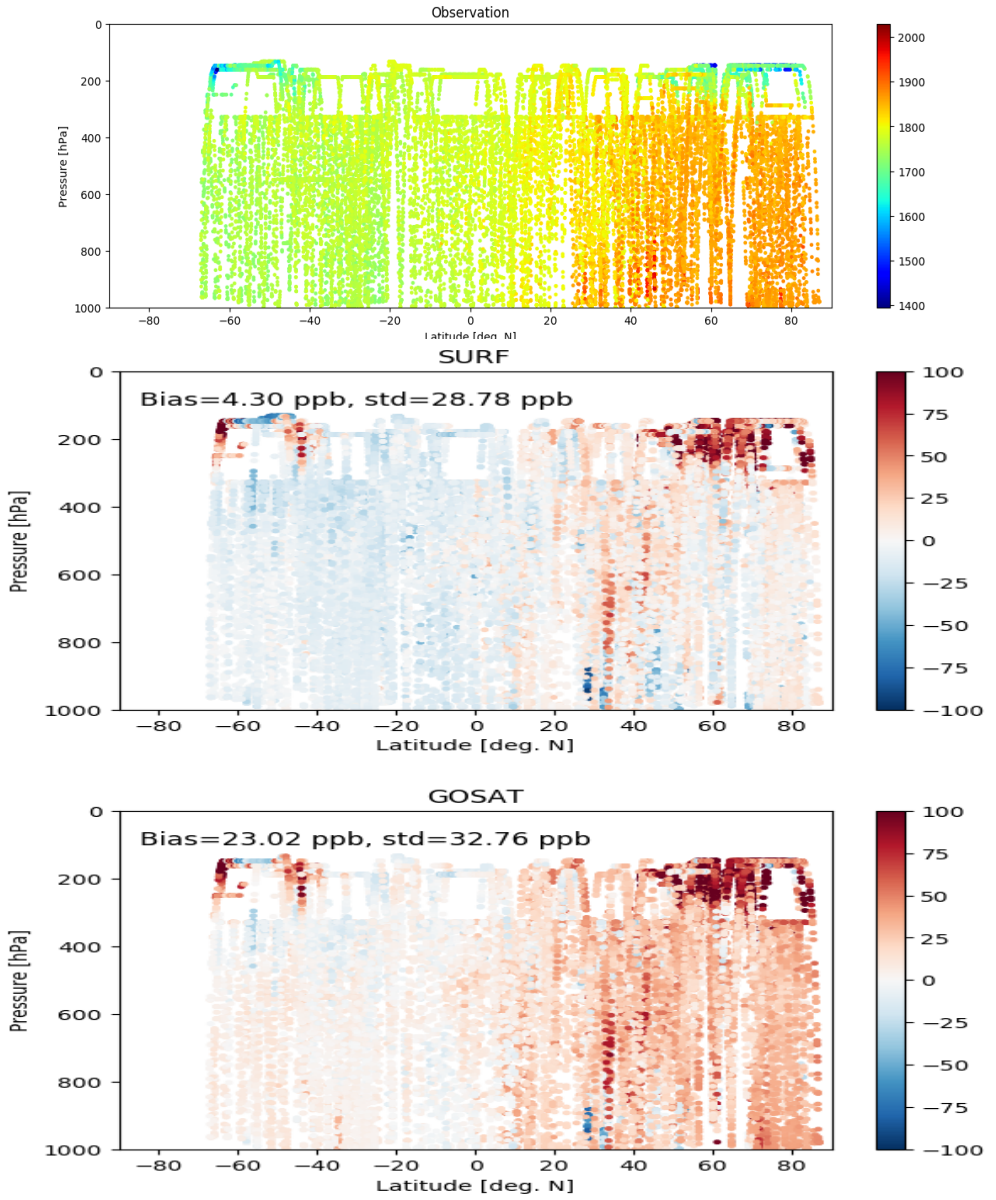
- Posterior concentrations looks ”OK”
  - Some latitudinal bias in SURF
  - Some seasonal bias in GOSAT

Comparison with assimilated data
- GOSAT – “bias corrected” data



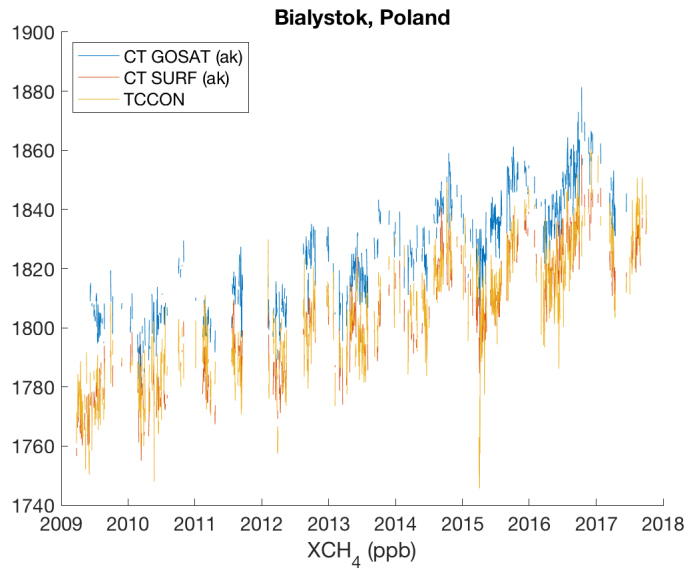
CTE-CH_4 GOSAT inversion

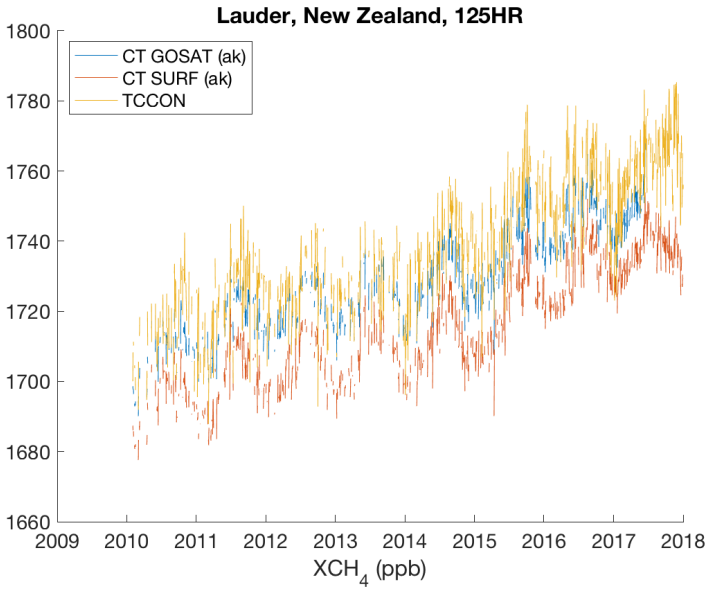
- HIPPO comparison
  - SURF looks quite good, similar to the comparison with assimilated observations
  - GOSAT show pos. bias in the NH



CTE-CH_4 GOSAT inversion

- TCCON comparison show
  - Good agreement in SURF for the NH
  - Neg. bias in SURF for the SH
  - Pos. bias in GOSAT for the NH
  - Better than SURF, bus some neg. bias in the SH





CTE-CH_4

- GOSAT inversion
  - Maybe should try other ”bias correction” methods

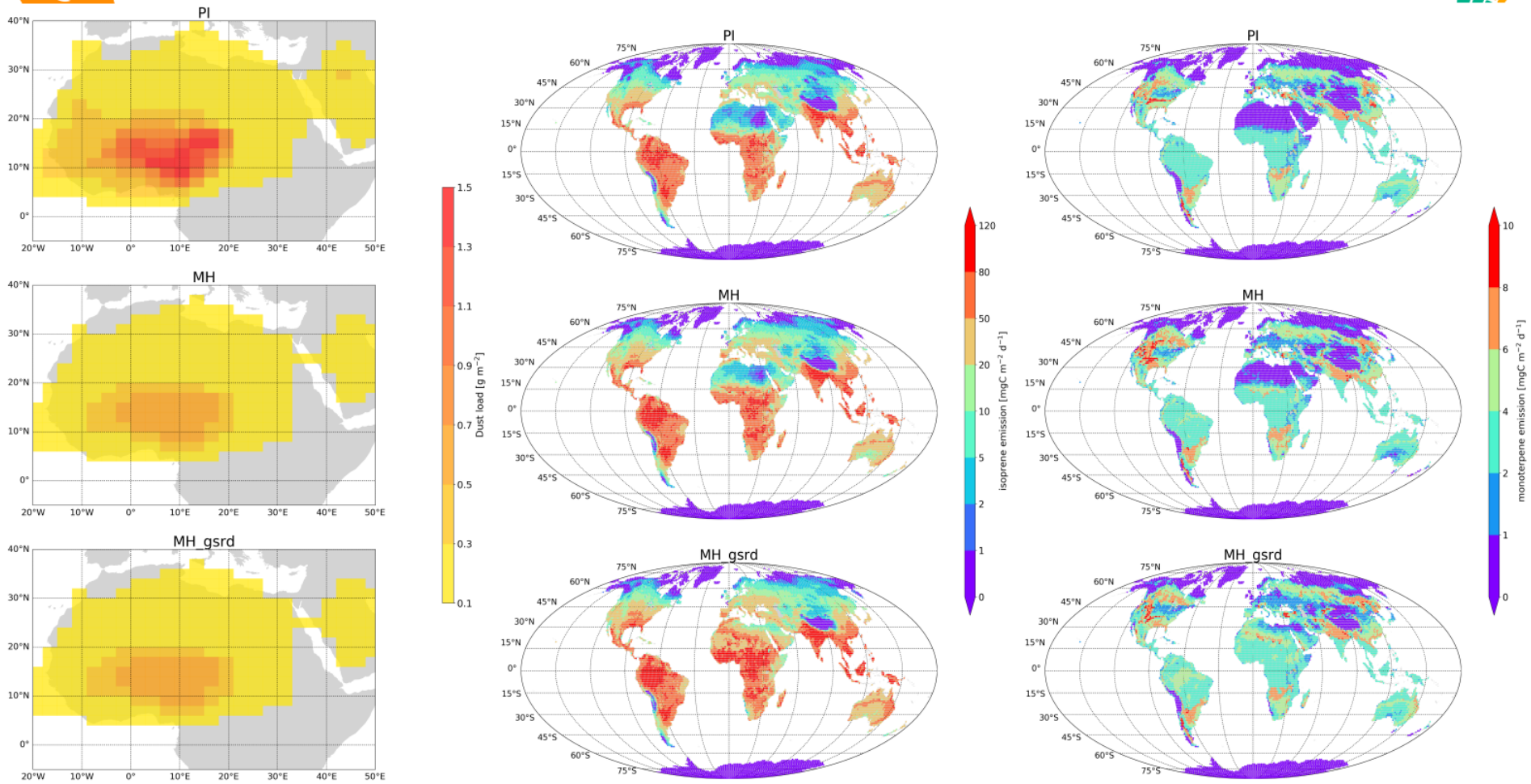
- CTE optimization needs development for large obs. datasets.
  - GOSAT inversion is approx. 4 times slower than surface
  - Consider future satellite observations, e.g. TROPOMI

Simulating the emissions of dust and BVOCs, SOA over northern Africa during mid-Holocene with prescribed vegetation

Zhou Putian

Co-authors: Jukka-Pekka Keskinen, Lu Zhengyao, Zhang Qiong, Bian Jianbu, Risto Makkonen

28.02.2019 - 01.03.2019
The TM5 meeting



The Sahara region was more humid than today during mid-Holocene (11 ka BP - 5 ka BP) where a large area was covered by vegetation.
The offline model TM5-MP was used to simulate three cases: PI (pre-industrial), MH (mid-Holocene), MH_gsrd (MH with prescribed Sahara vegetation and reduced dust concentration).
The dust load was ~ 45% lower in MH_gsrd than PI. The BVOC emissions were higher in mid-Holocene due to vegetation cover, and we still lack knowledge of its further effects, e.g., on SOA and CCN formation.