Integrated non-CO₂ Greenhouse gas Observing System

WP15 (JRA3): Integration of data with models

JRC-IES (P. Bergamaschi, E. Koffi, M. Alexe, G. Maenhout)

MPG (U. Karstens)

EMPA (D. Brunner, S. Henne)

UU (S. Houweling, G. Monteil)

CEA (M. Saunois, A. Berchet, I. Mappe-Fogaing, P. Bousquet)

NILU (R. Thompson, A. Stohl)

MET (T. Arnold, A. Manning)

ECN (A. Vermeulen)

UHEI (I. Levin)

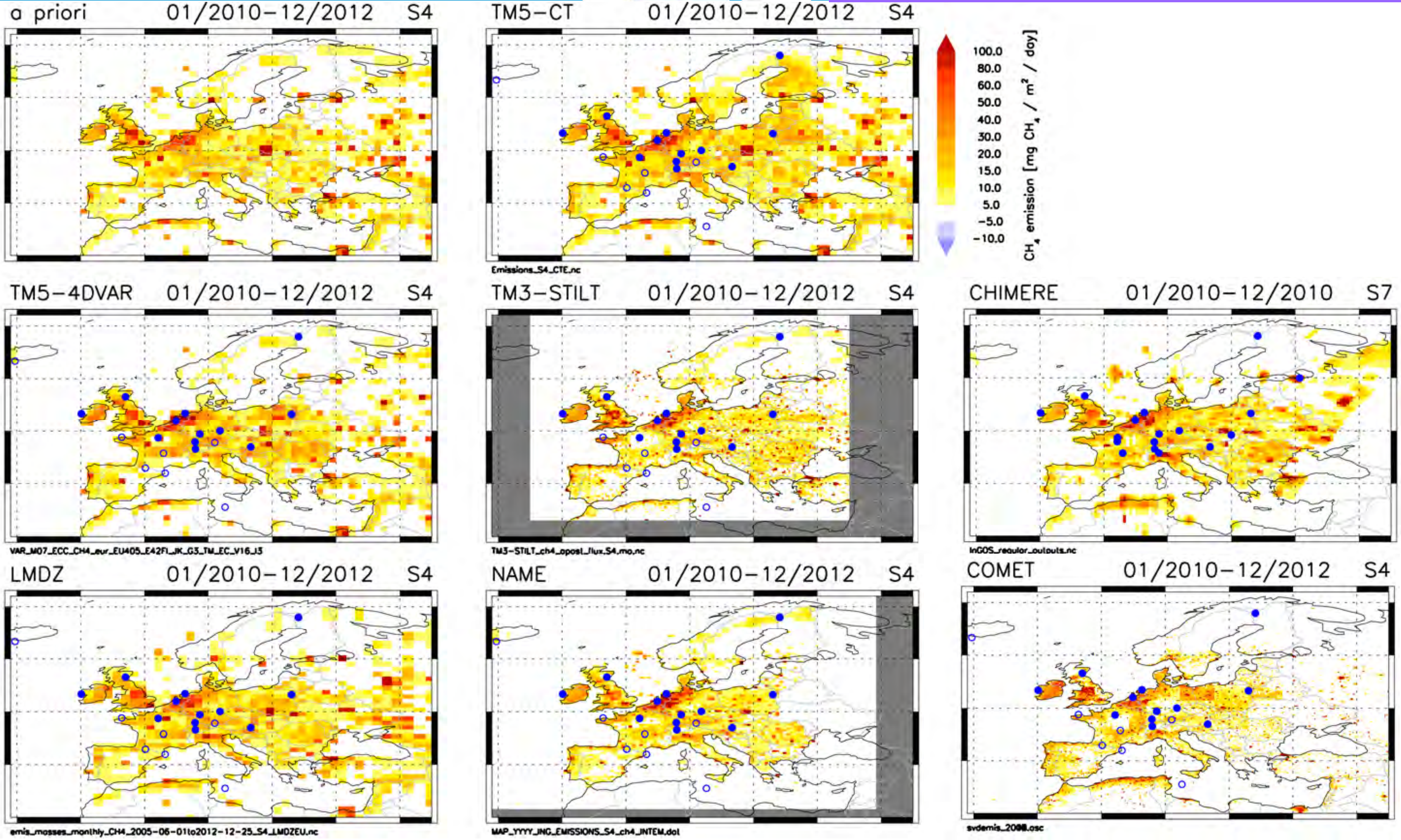
inverse models

task 15.1/2 Inverse modeling of CH4 / N2O

	horizontal resolution lon x lat	CH4				N2O			
		S4	S5	S6	S7	S1	S2	S3	S4
TM5-4DVAR	$1^o x 1^o$								
TM5-CT	$1^o x 1^o$								
LMDZ	$\sim 1.2^o x 0.8^o$								
TM3-STILT	$0.25^o x 0.25^o$								
NAME	$0.56^o x 0.37^o$								
CHIMERE	$0.5^o x 0.5^o$								
COMET	$0.17^o x 0.17^o$								

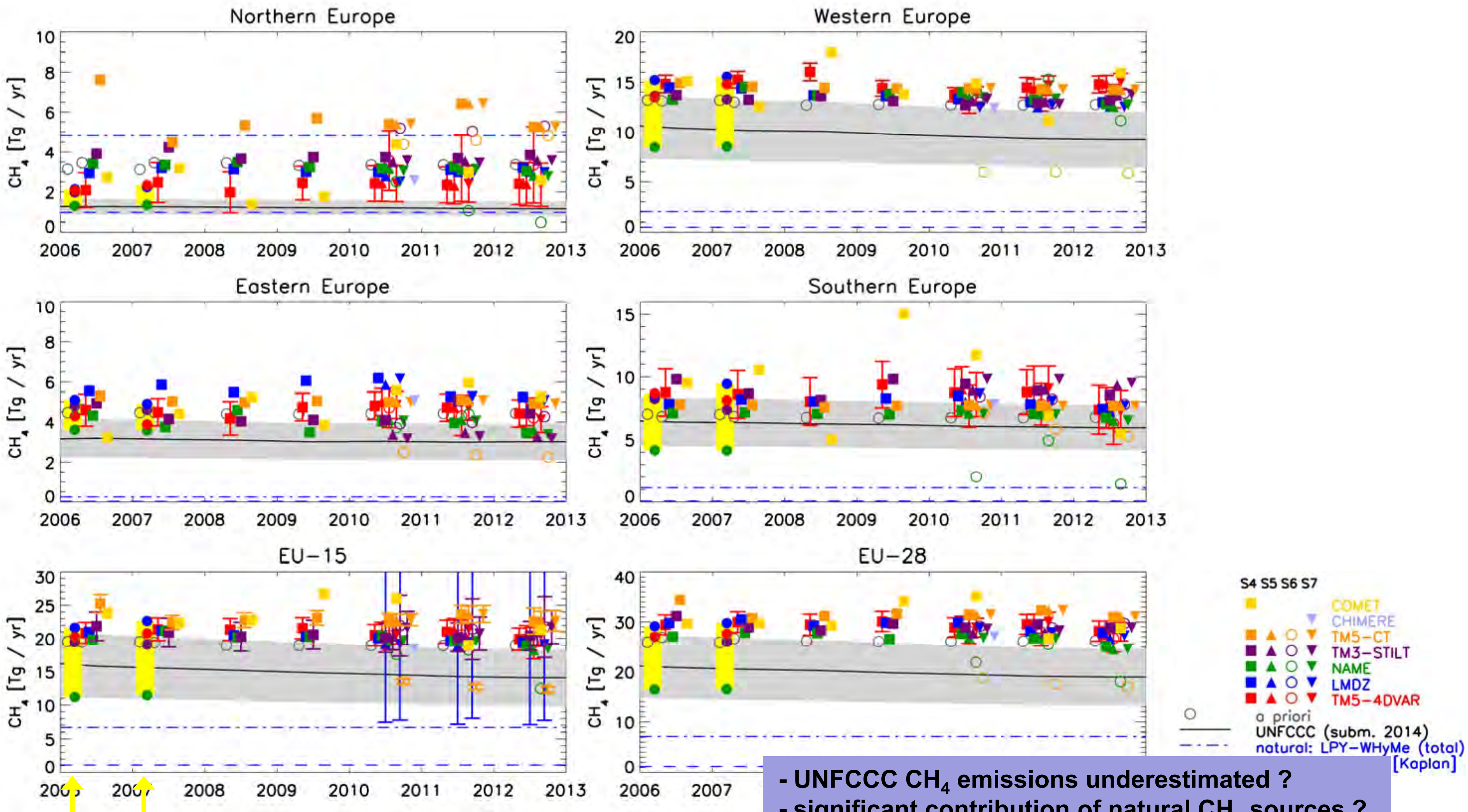
European CH_4 emissions 2010-2012

task 15.1 Inverse modeling of CH4



European CH_4 emissions - country totals EU

task 15.1 Inverse modeling of CH4



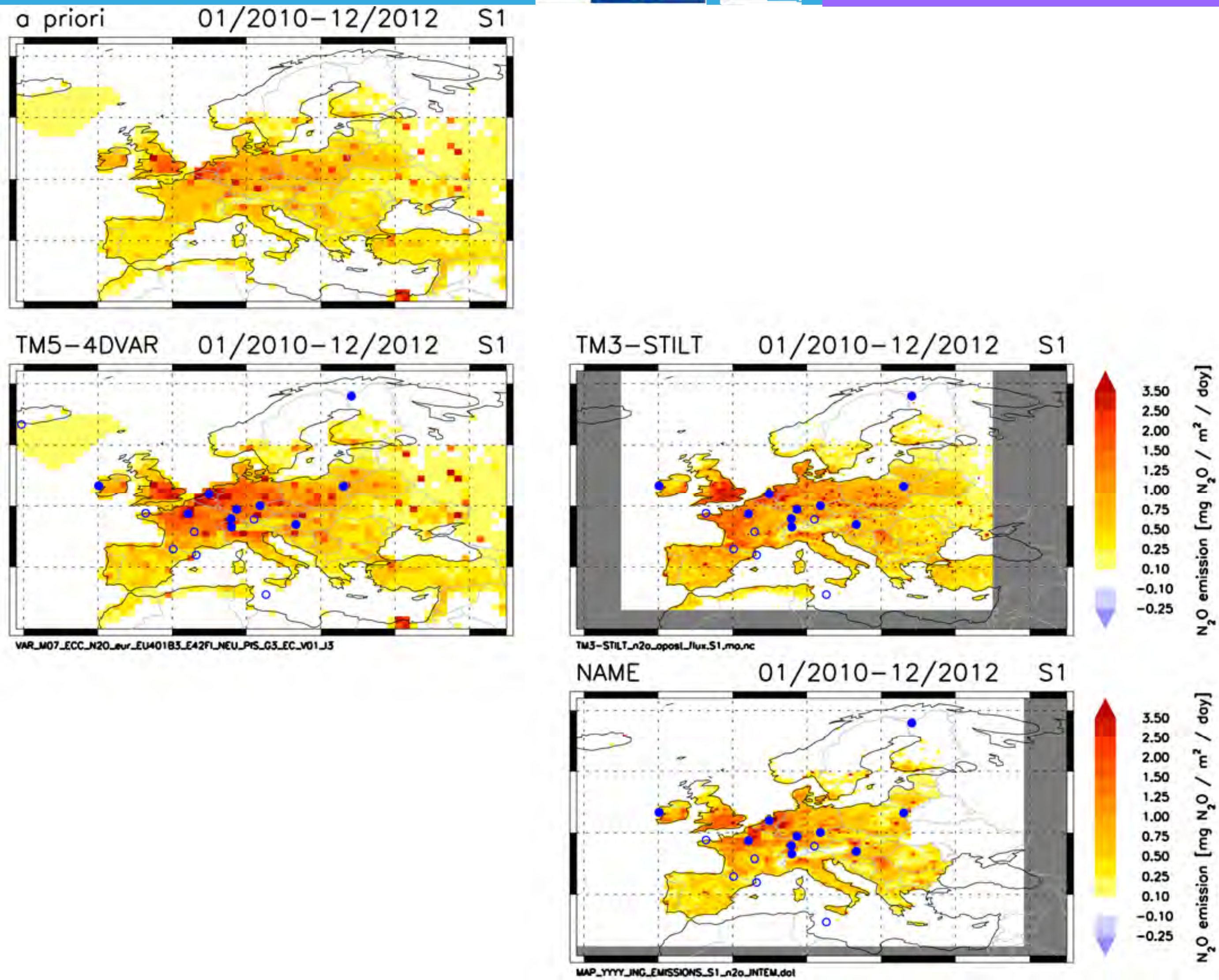
[Bergamaschi et al., ACP, 2015]

- **UNFCCC CH_4 emissions underestimated ?**
- **significant contribution of natural CH_4 sources ?**
- **model biases ?**

Joint Research Centre

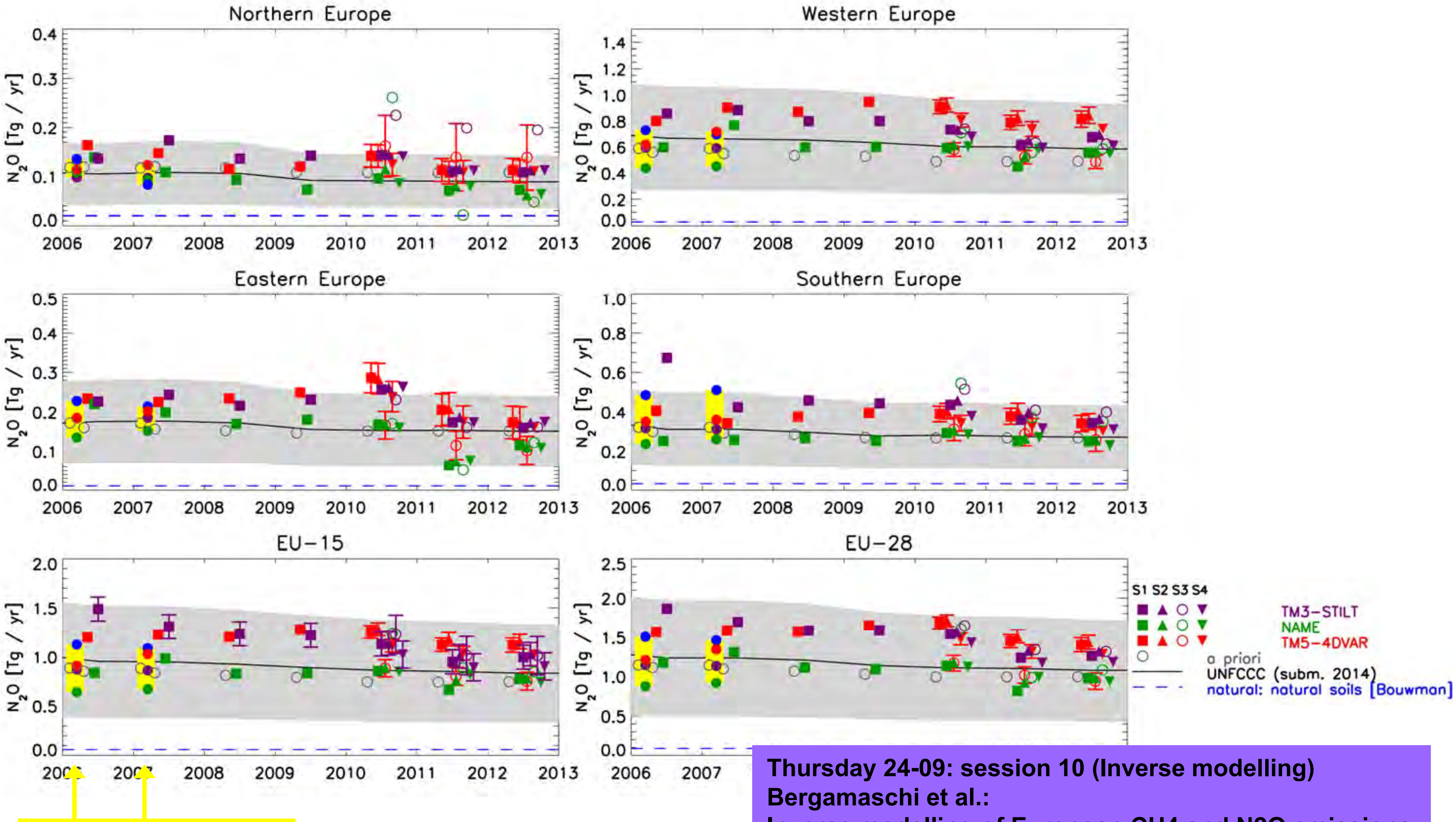
European N_2O emissions 2010-2012 S1

task 15.2 Inverse modeling of N2O



European N_2O emissions - country totals EU

task 15.2 Inverse modeling of N2O



[Bergamaschi et al., ACP, 2015]

Thursday 24-09: session 10 (Inverse modelling)
Bergamaschi et al.:
Inverse modelling of European CH4 and N2O emissions

Joint Research Centre

Task 15.3: Model Validation

task 15.3 Model validation

1. Development of a European ^{222}Rn flux map
   - ✓ Karstens et al., ACPD, 2015

2. ^{222}Radon simulations and comparison with measurements
   - Initial comparison summarized in report D15.4
   - Update of ^{222}Rn measurement intercalibration (WP 2)

3. Comparison of model boundary layer height with measurements
   - Initial comparison summarized in report D15.5

Papers on model validation:

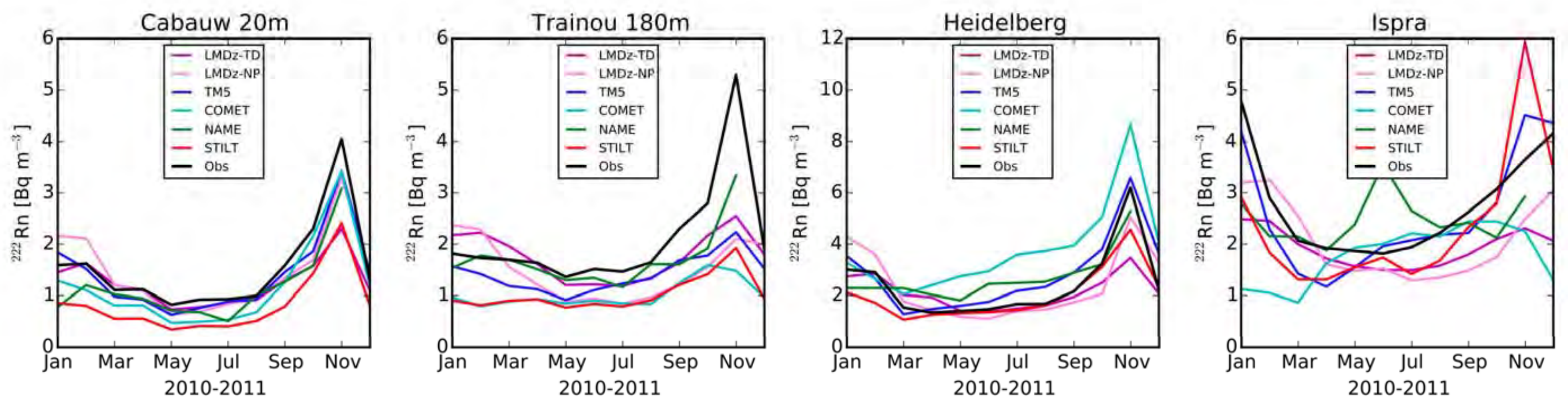
- ✓ Locatelli et al. (GMD, 2015): LMDz
- ✓ Koffi et al. (in preparation): TM5
- ? Common paper on model intercomparison and validation ?

4. Local comparison of inversion results with emission estimates from ^{222}Radon tracer method
   - still work in progress

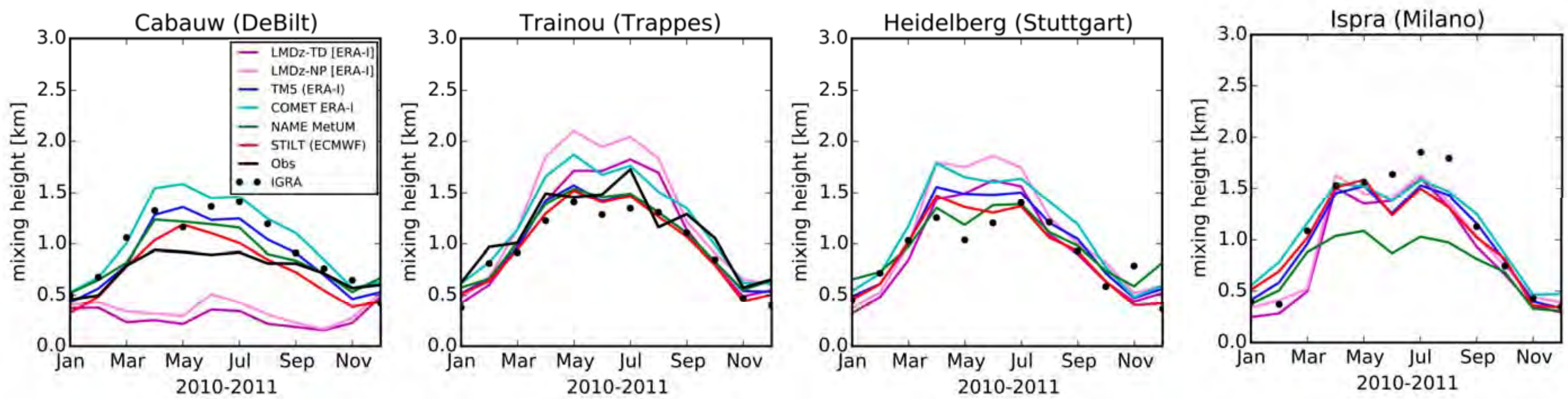
Seasonal cycle of daytime ^{222}Rn and mixing height

task 15.3 Model validation

Radon



Mixing height



European Commission

task 15.4 link to remote sensing

Provision of 3D CH_4 fields from CH_4 inversions for comparison with FTIR and satellite data

D15.6 (delivered 02/2014; updated 2015)

analysis ongoing:

- **comparison with GOSAT XCH_4**
- **comparison with TCCON (FTS) XCH_4**
- **tropospheric column-averaged CH_4 from FTS**

-> Wang et al. (paper in preparation)

- **ACE-FTS (on board the Canadian Space Agency SCISAT-1): FTS solar occultation mode**

-> Dils et al. (poster)

Tuesday 22-09: poster session
Dils et al.:
Validation of CH4 model data with ACE-FTS
poster P33

Intercomparison of four halocarbon emission inversions

task 15.5 Inverse modeling of halocarbons

Lagrangian transport model based inversion systems:

Group	Transport model	Meteorology	References
Empa	FLEXPART	ECMWF analyses 0.2° x 0.2°, 3hrly	Brunner et al., 2012, 2013
Empa2	FLEXPART	ECMWF analyses 0.2° x 0.2°, 3hrly	Vollmer et al., 2009 Keller et al., 2011, 2012
NILU	FLEXPART	ECMWF analyses 0.2° x 0.2°, 3hrly	Stohl et al., 2009, 2010 Thompson et al., 2014
UKMO	NAME	UKMO analyses 25 km x 25 km, 3hrly	Manning et al., 2011 Rigby et al., 2011

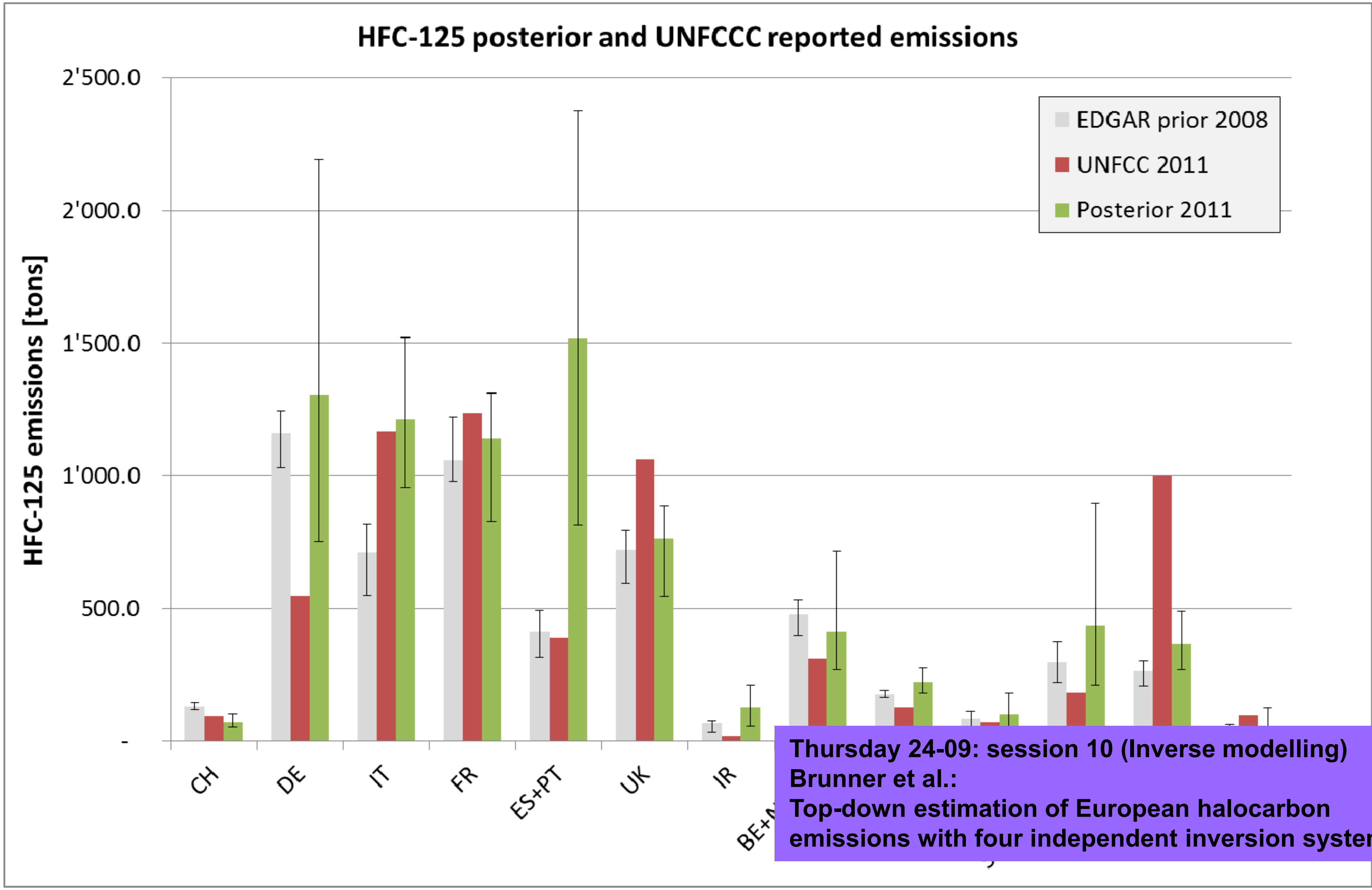
Joint experiments:

ID	Trace gas	A priori inventory	Time period
H11v3	HFC-125	EDGARv4.2 2008	2011
H12v3	HFC-134a	EDGARv4.2 2008	2011
H13v3	SF6	EDGARv4.2 2008	2011
H14v3	HFC-125	constant a priori	2011

Experiment H11v3, HFC-125

task 15.5 Inverse modeling of halocarbons

Summary comparison inversion estimates with UNFCCC & EDGAR



Thursday 24-09: session 10 (Inverse modelling)
Brunner et al.:
Top-down estimation of European halocarbon emissions with four independent inversion systems

task 15.6 : Modeling of d13CH4

Could high-frequency $\delta^{13}C\text{-}CH_4$ observation be used to contrain CH_4 emissions?

$\delta^{13}C\text{-}CH_4$ observations contain information on the source mixture of the CH4 sampled:

$$\delta^{13}C_{obs} = H\,(\Sigma_i \delta^{13}C_i S_i) + \varepsilon_H + \varepsilon_{obs} + \Sigma_i\big(S_i\, \varepsilon_{\delta^{13}C_i}\big) + \Sigma_i(\varepsilon_S\, \delta^{13}C_i\ )$$

- H: transport model, transport model error
- S_i: Emission estimate for the source process
- $\delta^{13}C_i$: Isotopic signature of the source process i

- $\delta^{13}C$ observations useful if the observation uncertainty and the model error are lower than the two other uncertainty terms

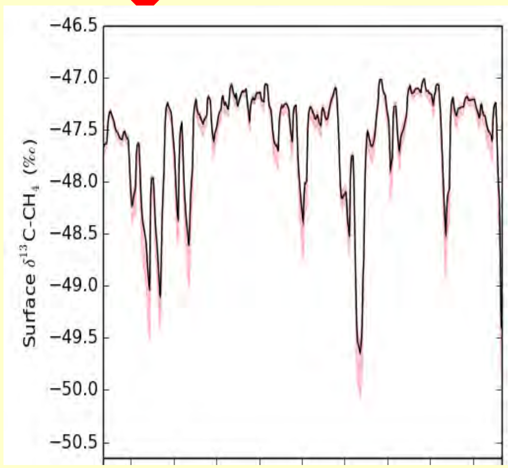
- $\delta^{13}C$ observations informative of the CH_4 emissions if the uncertainty on the source signatures ($\varepsilon_{\delta^{13}C}$) is lower than the uncertainty on the emissions themselves (ε_S)

➔ Uncertainty propagation study needed to compare these terms

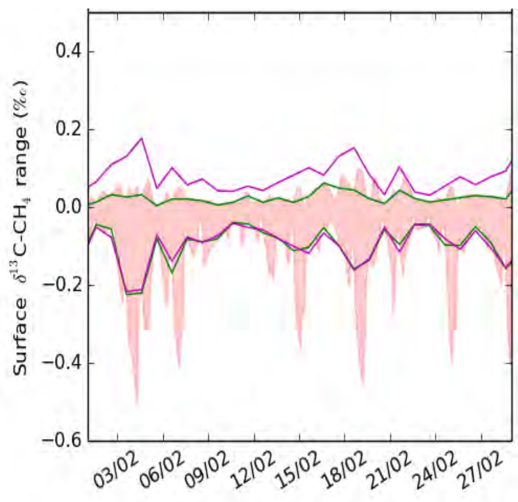
Base $CH_4/\delta^{13}C\text{-}CH_4$ scenario + uncertainties in emissions and source signatures

TM5 model

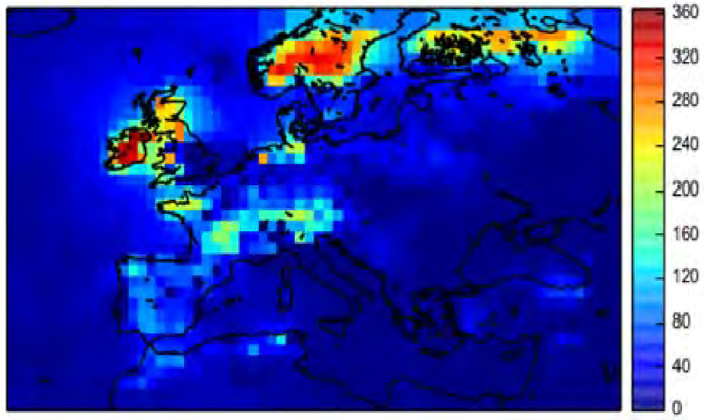
Atmospheric $\delta^{13}C\text{-}CH_4$ timeseries + propagated uncertainties



task 15.6 : Modeling of d13CH4



Uncertainties at Cabauw: same order of magnitude (Green=propagated CH4 emission uncertainties (daily); Magenta=propagated source signature uncertainties (daily); Shaded area: propagated CH4 uncertainties (hourly))



Number of days in one year when the uncertainty from CH4 emissions is the largest (I.e when d13C-CH4 observations would provide constraints on CH4 emissions)

Site	Latitude (°)	Longitude (°)	Altitude (meter a.m.s.l)	$\overline{r_\Delta}$	σ_{r_Δ}
Pallas	24.12	67.97	560	0.59	0.34
Voeikov	30.70	59.95	70	0.32	0.11
Angus	-2.98	56.55	313	0.97	0.42
Lutjewad	6.35	53.40	1	0.91	0.21
Mace Head	-9.90	53.33	25	1.82	0.85
Bialystok	23.01	53.23	183	0.71	0.25
Cabauw	4.93	51.97	20	0.91	0.18
Ochsenkopf	11.81	50.03	1022	0.56	0.17
Heidelberg	8.67	49.42	113	0.83	0.24
Kasprowy	19.98	49.23	1987	0.38	0.13
Gif-sur-Yvette	2.15	48.71	160	0.44	0.13
Trainou	2.11	47.96	131	0.89	0.39
Schauinsland	2.97	47.92	1205	0.54	0.20
Hohenpeissenberg	11.02	47.80	990	1.31	0.40
Puy-de-dome	2.96	45.77	1465	0.58	0.23
Lampedusa	12.61	35.51	50	0.38	0.12

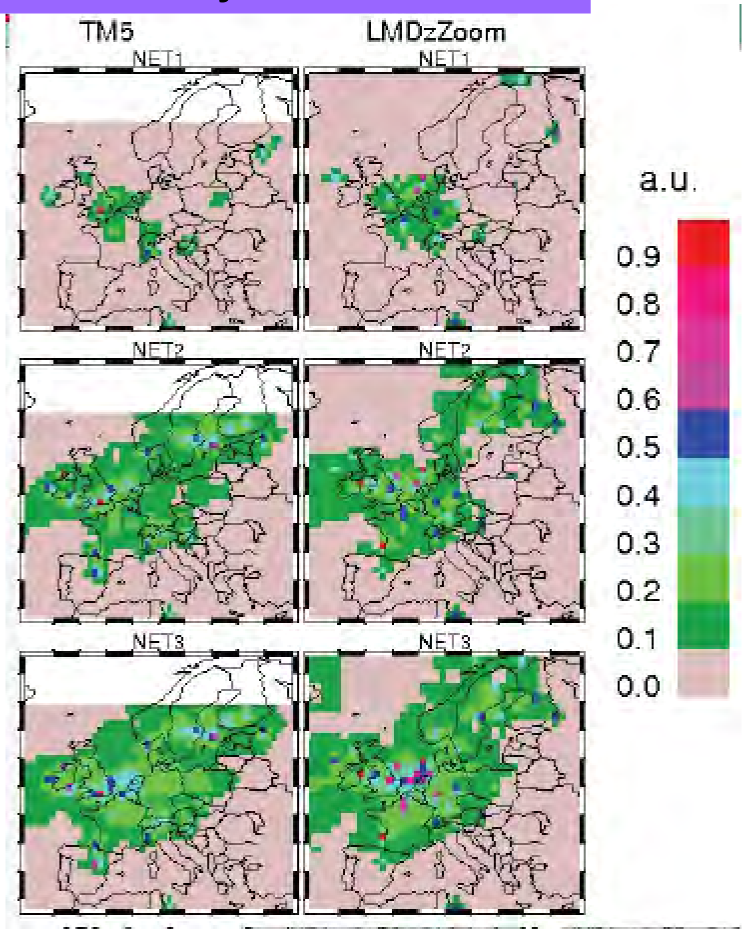
Conclusions:

- Model in qualitative agreement with observations
- Source signatures uncertainties slightly too large to provide constraints on the CH4 budget ➔ possible to use δ^{13}C obs., but some (moderate) effort is needed to better source signatures
- We can already suggest s

Wednesday 23-09: session 5 (Novel tracers: Isotopes and Multi–tracer methods)
Monteil et al.:
Modelling the variability of atmospheric CH4 and δ13C-CH4 over Europe

task 15.7 : network analysis and optimization

Annual cumulative sensitivity



deliverables

	Deliverable Title	Delivery Date
D15.1	Improved bottom up inventories for European CH4 emissions	12
D15.2	Improved bottom up inventories for European N2O emissions	12
D15.3	222Rn emission inventory (parameterized by soil type, porosity, moisture and water table depth	18
D15.4	Comparison of 222Rn simulations based on new 222Rn inventory (D15.3) with observations	24
D15.5	Comparison of simulated and observed boundary layer height	24
D15.6	Provision of 3D CH4 fields from CH4 inversions for comparison with FTIR and satellite data	24
D15.7	Model assessment of the potential to use δ13CH4	**30 Sept 2015**
D15.8	Analysis of sensitivity of the InGOS network to European emissions	**30 Nov 2015**
D15.9	European CH4 inversions using improved CH4 measurements from INGOS WP 2 and 3 (NA2 and N/	**10 Nov 2015**
D15.10	European N2O inversions using improved N2O measurements from INGOS WP 2 and 3 (NA2 and N/	**10 Nov 2015**
D15.11	European halocarbon inversions using improved halocarbon measurements at InGOS stations	**09 Nov 2015**
D15.12	Detailed model intercomparisons and analysis of European CH4 emissions	**30 Nov 2015**
D15.13	Model intercomparisons and analysis of European N2O emissions based on results from D15.10	**30 Nov 2015**
D15.14	Model intercomparison and analysis of European emissions of important halocarbons with large GWP	**29 Nov 2015**