

Cabauw GHG Indicator

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den Bulk, A.T. Vermeulen

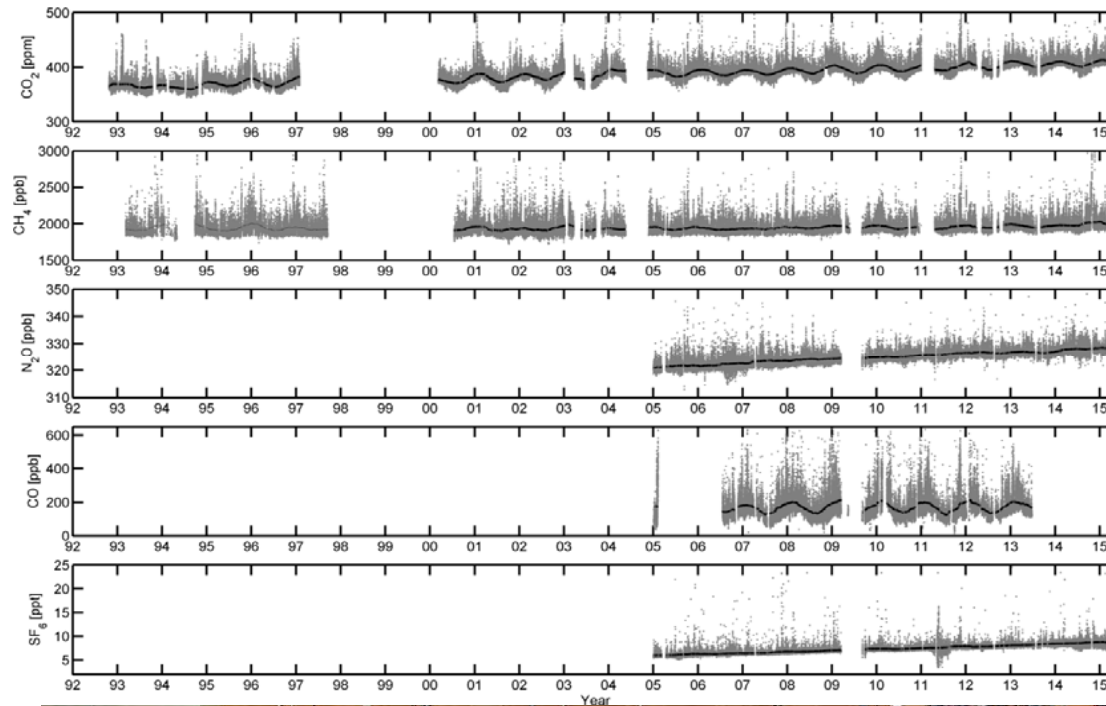
Utrecht
24 sept 2015

www.ecn.nl

The InGOS approach



Cabauw measurements



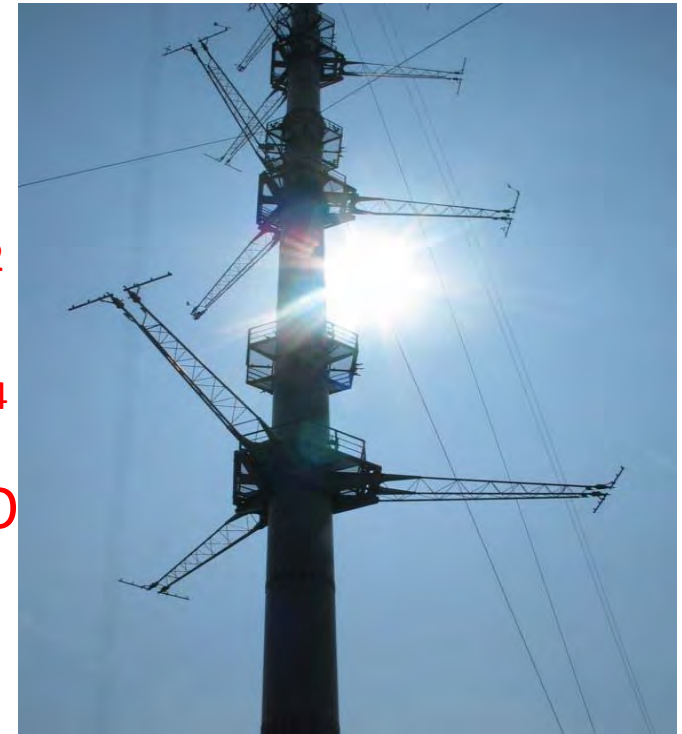
CO₂

CH₄

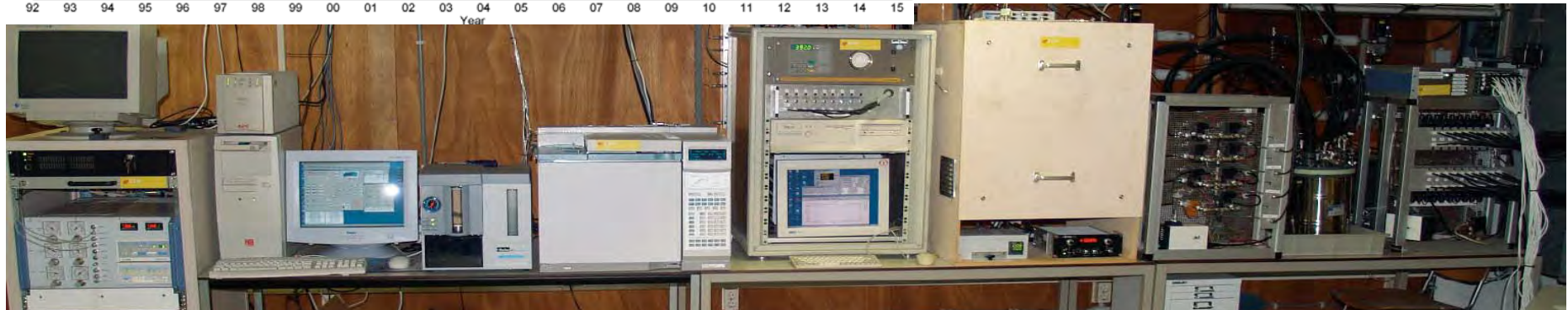
N₂O

CO

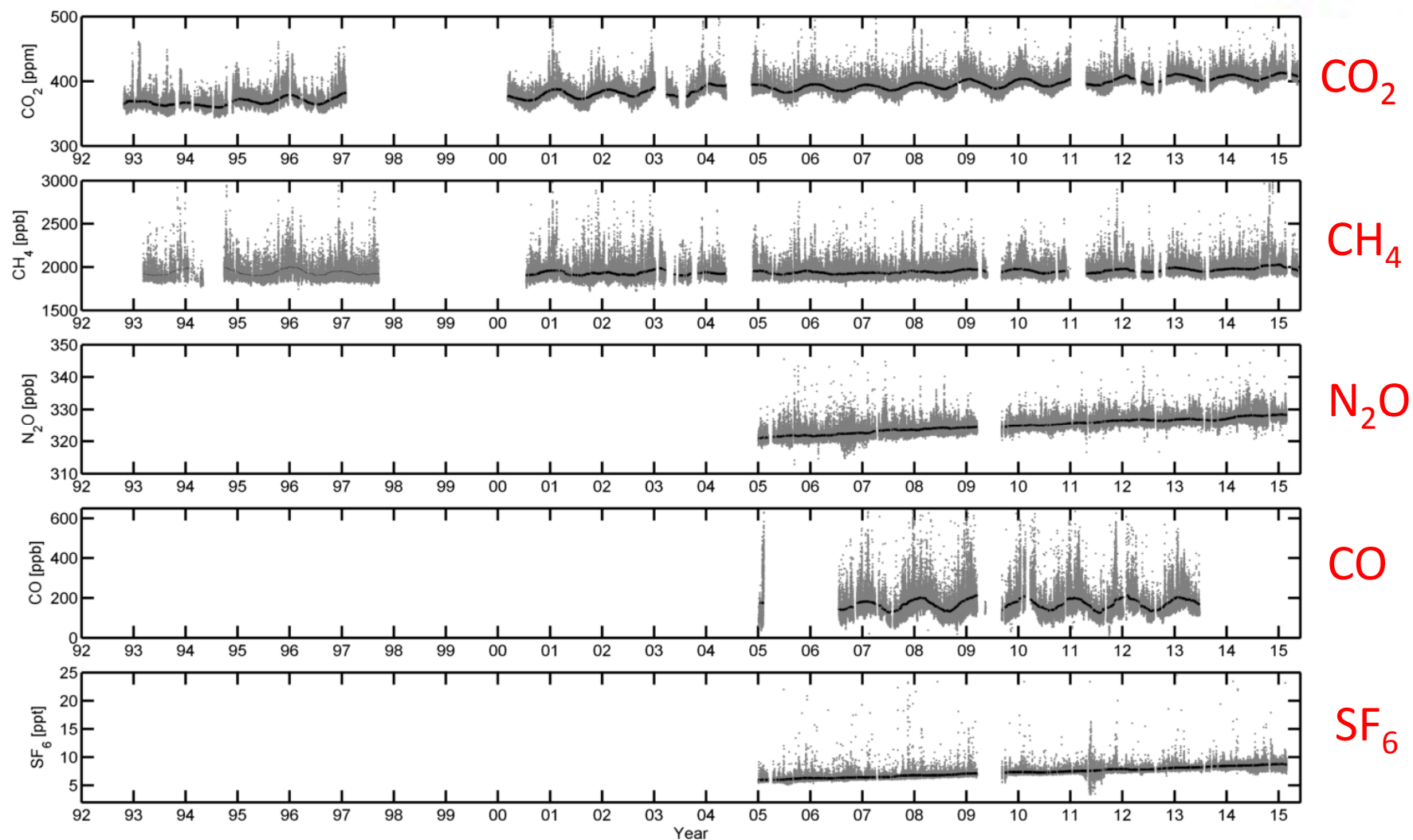
SF₆



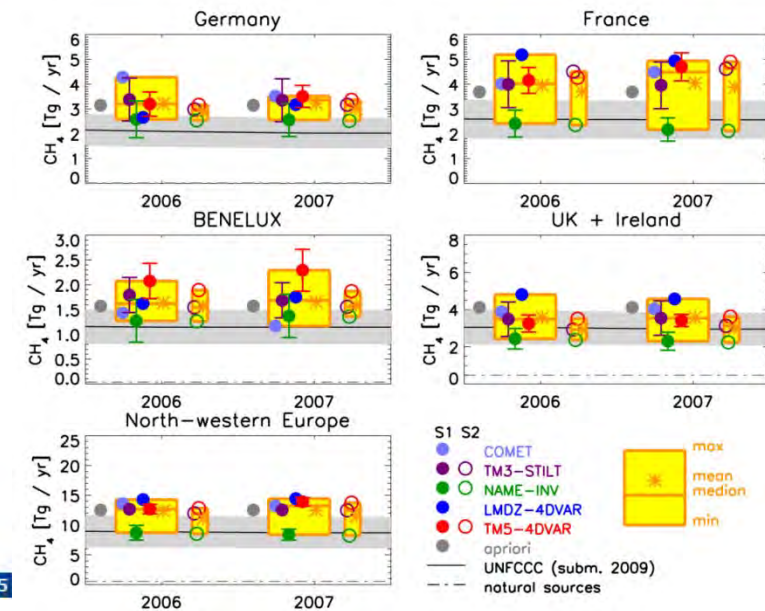
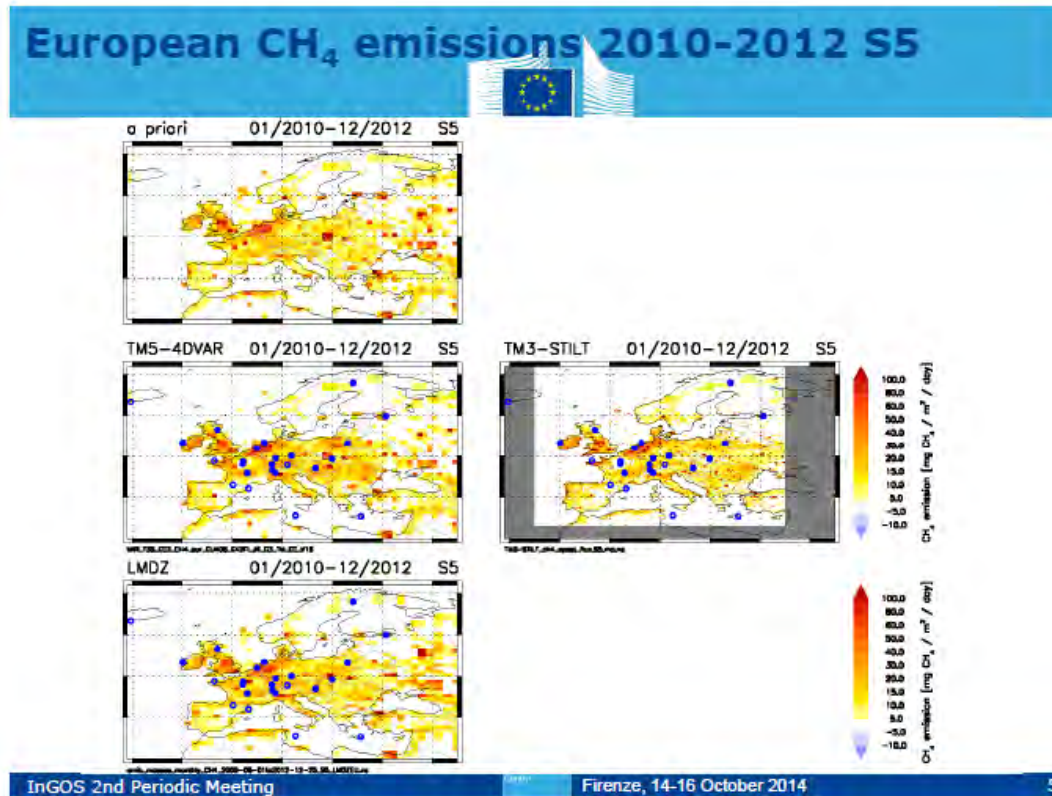
Nu : 200,120,60,20 m hoog



Cabauw data 1992-now



And send it to Peter et al



Peter Bergamashi et al

But this costs money

- A Cabauw supersite cost 1.5-2 Meuro per year
 - Meteo function
 - Air quality function
 - Cloud reserach
 - Greenhouse gas
 - Remote sensing facilities
 - Turbulence
- Plus ecosystem site Loobos & Horstermeer
- Plus North NL site Lutjewad

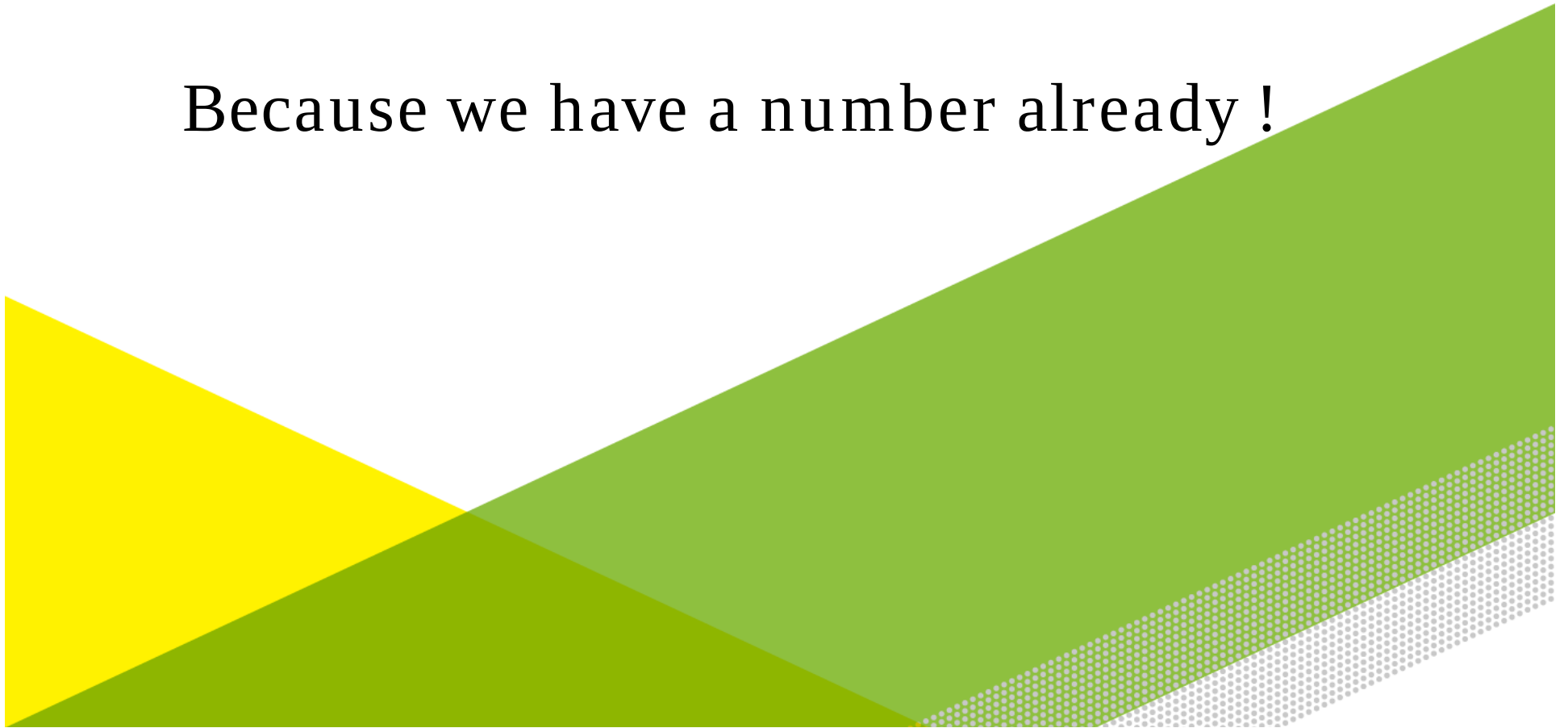
IDEA !



We stop
measurements
and
safe money !



Because we have a number already !



Emissie broeikasgassen Volgens IPCC Guidelines 1996					
	Koolstofdioxide (CO ₂)	Methaan (CH ₄)	Distikstof-oxide (N ₂ O)	F-gassen (HFK / PFK / SF ₆)	Totaal broeikasgassen
	<i>Mton CO₂-equivalenten</i>				
Basisjaar Kyoto Proto	159.2	25.7	20.0	8.2	213.2
1990	159.2	25.7	20.0	6.9	211.8
1991	164.2	26.1	20.3	5.8	216.4
1992	162.3	25.7	20.5	6.6	215.1
1993	166.7	25.3	20.7	7.2	220.0
1994	166.7	24.6	20.0	8.7	219.9
1995	170.7	24.3	19.9	8.2	223.2
1996	177.7	23.7	19.8	10.1	231.3
1997	171.5	22.6	19.5	11.0	224.6
1998	173.4	21.8	18.8	11.5	225.5
1999	167.8	20.8	18.1	6.7	213.3
2000	169.9	19.9	17.4	5.8	213.0
2001	175.7	19.1	16.3	3.4	214.5
2002	176.0	18.0	15.5	4.1	213.5
2003	179.6	17.1	15.3	2.3	214.3
2004	181.0	16.6	15.7	2.2	215.5
2005	175.9	16.1	15.5	2.0	209.4
2006	172.3	15.7	15.3	2.2	205.6
2007	172.4	15.8	13.6	2.4	204.2
2008	175.2	16.1	9.7	2.4	203.3
2009	169.9	16.0	9.5	2.4	197.8
2010	181.4	15.9	9.3	2.6	209.3
2011	168.1	15.3	9.3	2.5	195.1
2012	165.3	14.9	9.1	2.4	191.7
2013	165.4	15.1	9.4	2.4	192.2
2014					
Bron:	Emissieregistratie.				
Referentiecode:	CBS/okt14				
Indicatorcode:	i-nl-0165				
Indicatorversie:	25				



National reporting.

2013:

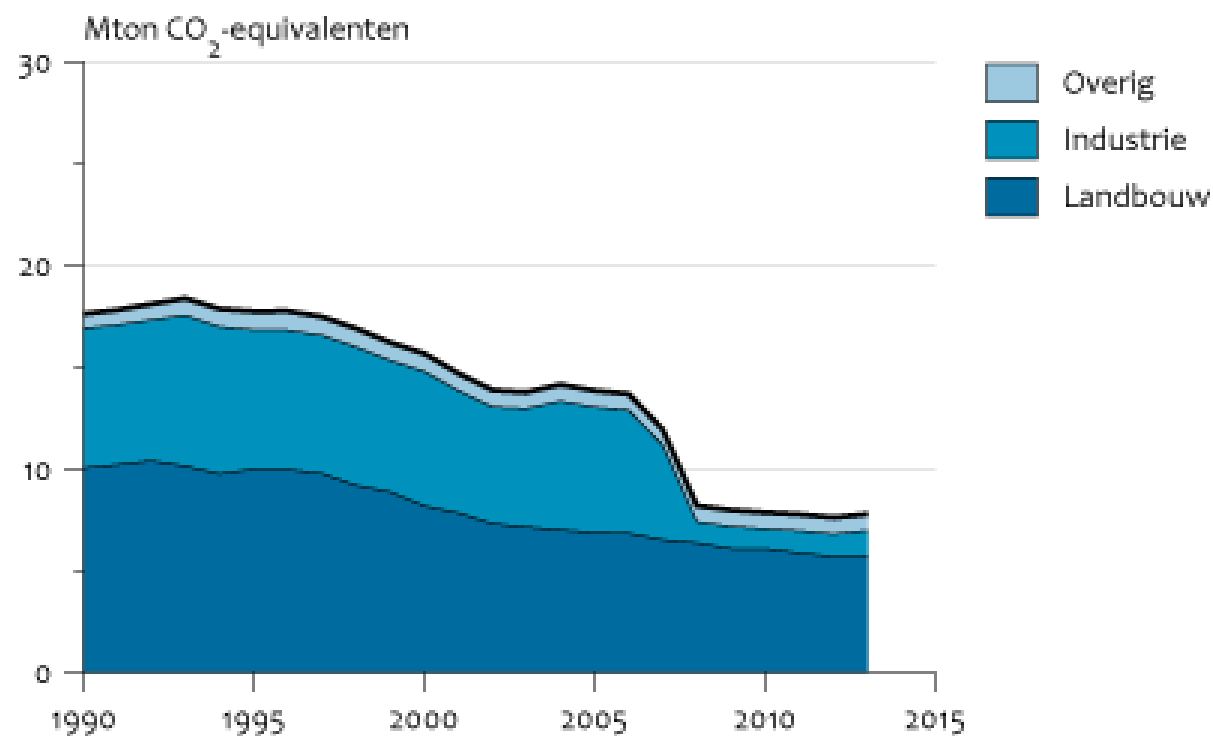
CO₂ = 165.4

CH₄ = 15.1

N₂O = 9.4

NL emission registration may 2015

Emissie distikstofoxide (N_2O) per sector



Bron: Emissieregistratie.

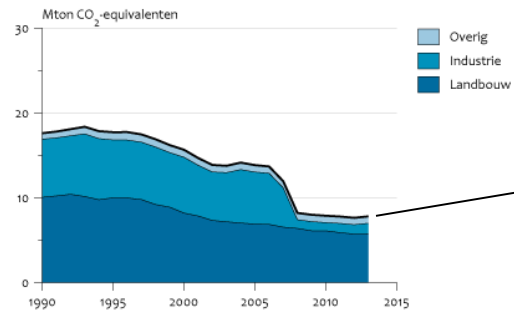
CBS/apr15
www.clo.nl/nl016526

27-9-2015

In different years, these numbers are different

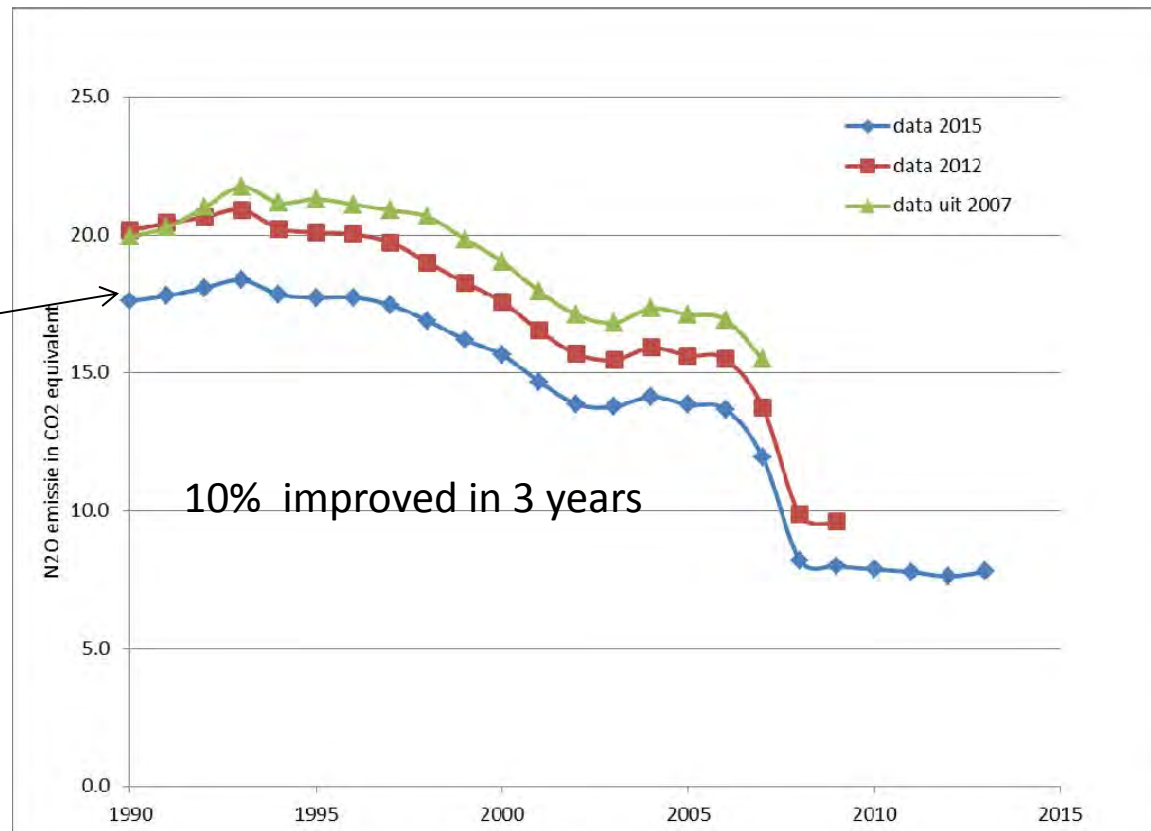


Emissie distikstofoxide (N_2O) per sector



Bron: Emissieregistratie.

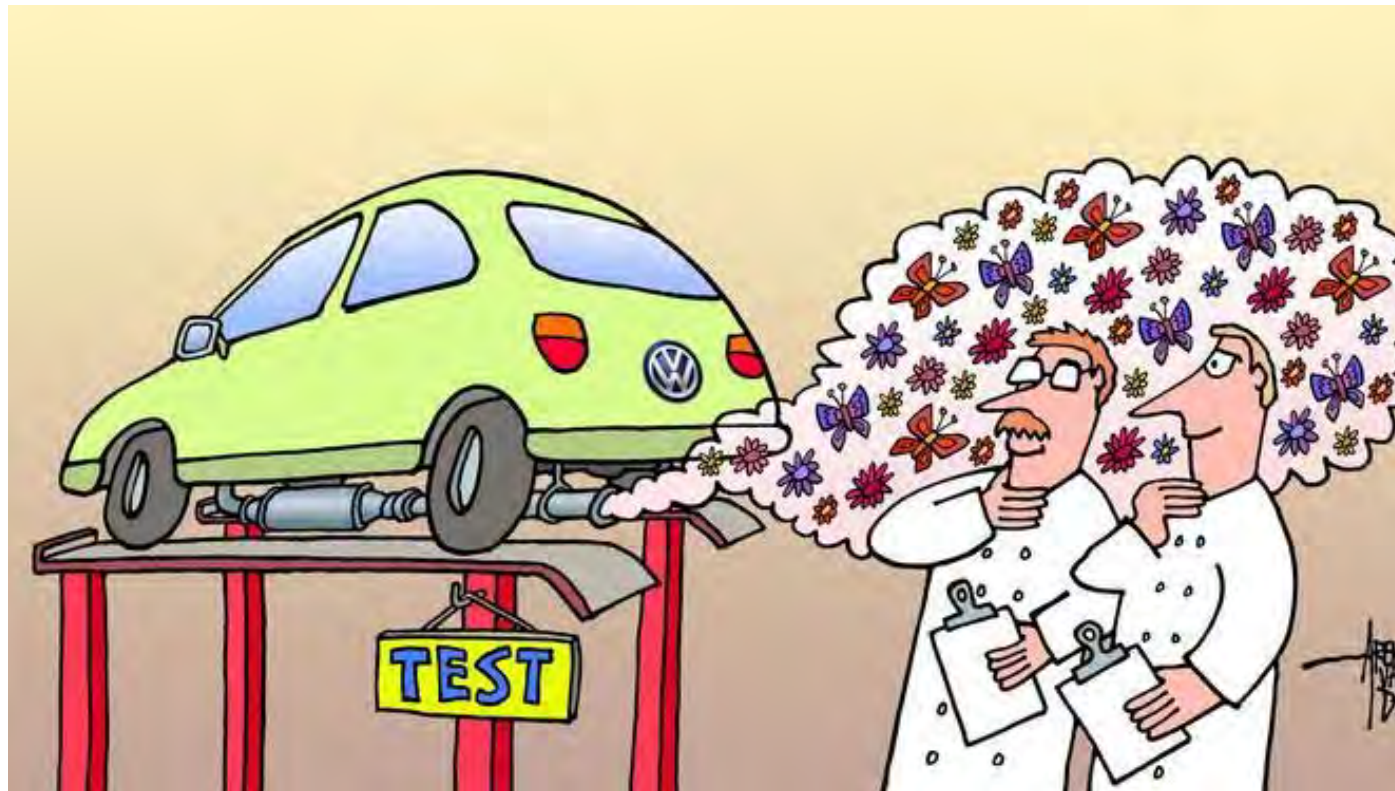
CBS/apr15
www.clo.nl/nl016526



Emission inventory

- Inventory Truth = Agreed truth
- Fair: everyone has to deal with the same numbers
- Yes these numbers might be wrong.
- But at least we can take decisions.

There are several reasons why
nrs can be wrong...



Do you rely on your nav system?



what if you know you did not update your maps for the last 3 years?

Do you rely on your nav system?



what if you know you did not update your maps for the last 3 years?
and you have a volkswagen.....

- Woman ignores gps less April 5, 2011

Navigation systems are not foolproof. If the system indicates a wrong route, men rather than women seem to doubt the evidence. This emerged from a survey by the British car insurer Swinton.

Of the total of 3000 drivers surveyed claiming 83% of men and 74% of women that they ignore the route guidance to an obviously incorrect route advice. 80% of drivers say that their navigation them in the past has repeatedly left in the lurch by giving wrong directions and them no reason to send the wrong side

Quote a Weiss man (woman) from across the ocean:

Taking emission reduction measures without
monitoring
is like
going on a diet
without weighing yourself.



Measure + Inverse modeling
is the way to go !

But.....



We WANT to stop
measurements
and
safe money !



Unless ...

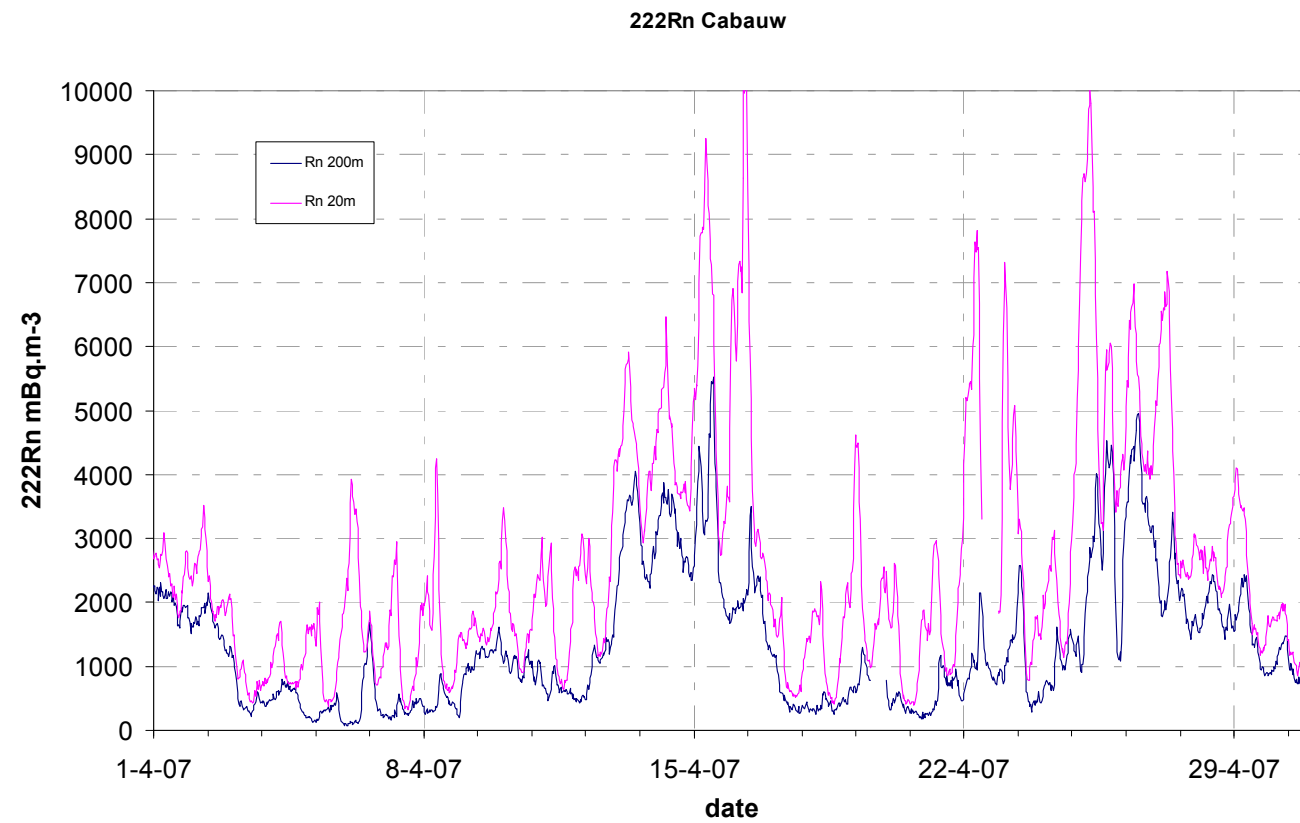
- Can you show that the measurements are useful?
- Not complicated please

- Game rules for non complicated explanation: you may not use the words
Concentration, Flux, Heterogeneity, Eddy correlation, Salinity, Boundary layers, Advection, Alan variance,
XCH₄, retrieval, FTIR, GC-MS-TOF, HZ1234, other silly abbreviations, Radiative forcing, lifetime, COS, etc,
etc.....

Three Indicator options

- Radon tracer
- Hump
- Percentile

Radon tracer



Radon tracer method

$$J_{CH_4} = J_{^{222}Rn} \frac{\Delta[CH_4]}{\Delta[^{222}Rn]}$$

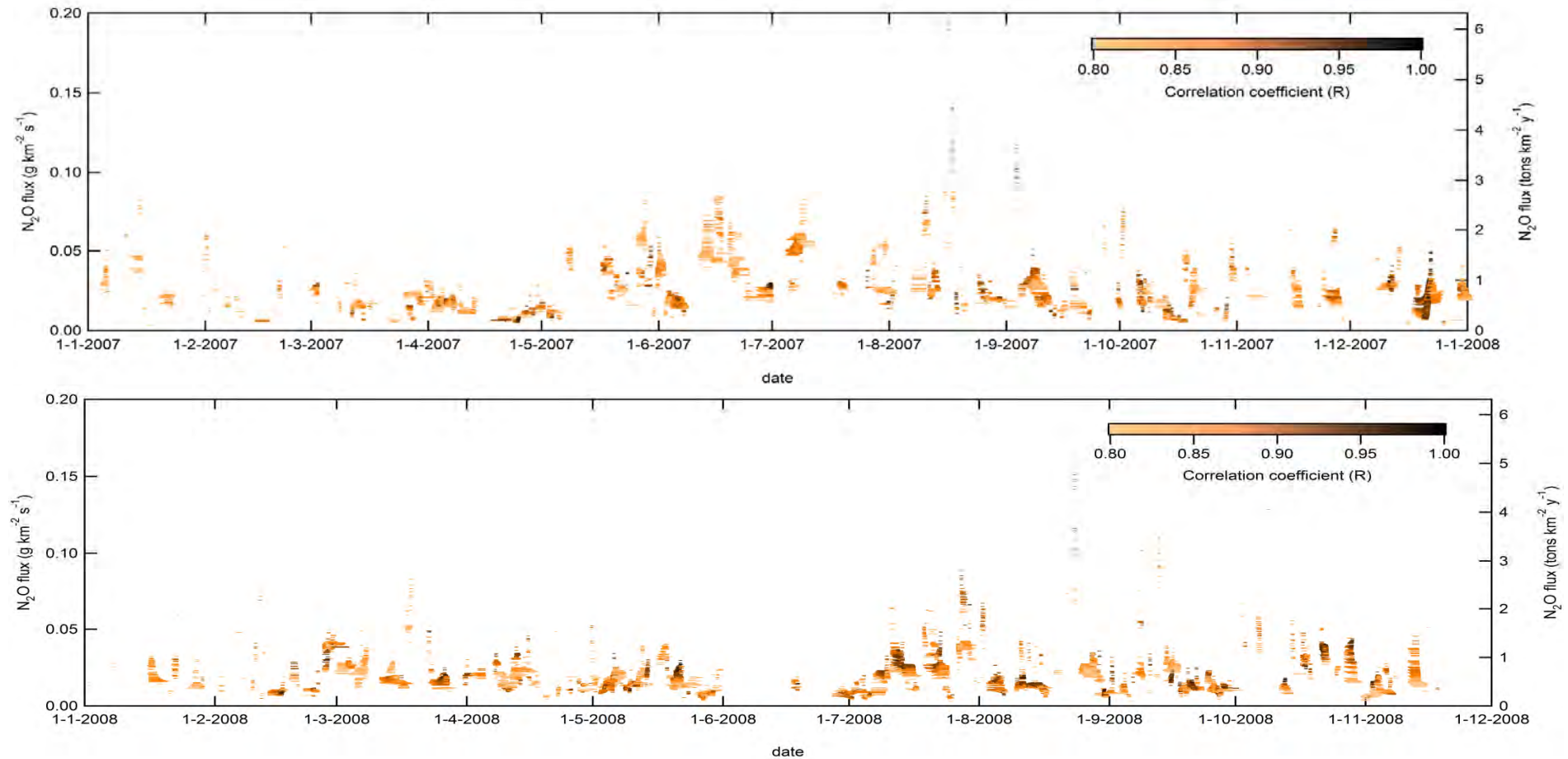
Where J_x is the flux of species x into the atmosphere.

Used for time periods where CH_4 and ^{222}Rn are correlated ($R \geq 0.8$)

Assumption:

You know the Radon flux

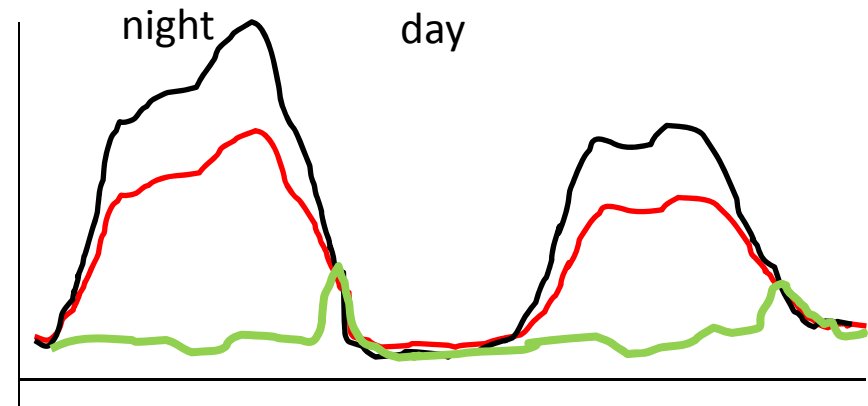
Inferred N₂O fluxes



Verheggen & Vermeulen in 2008

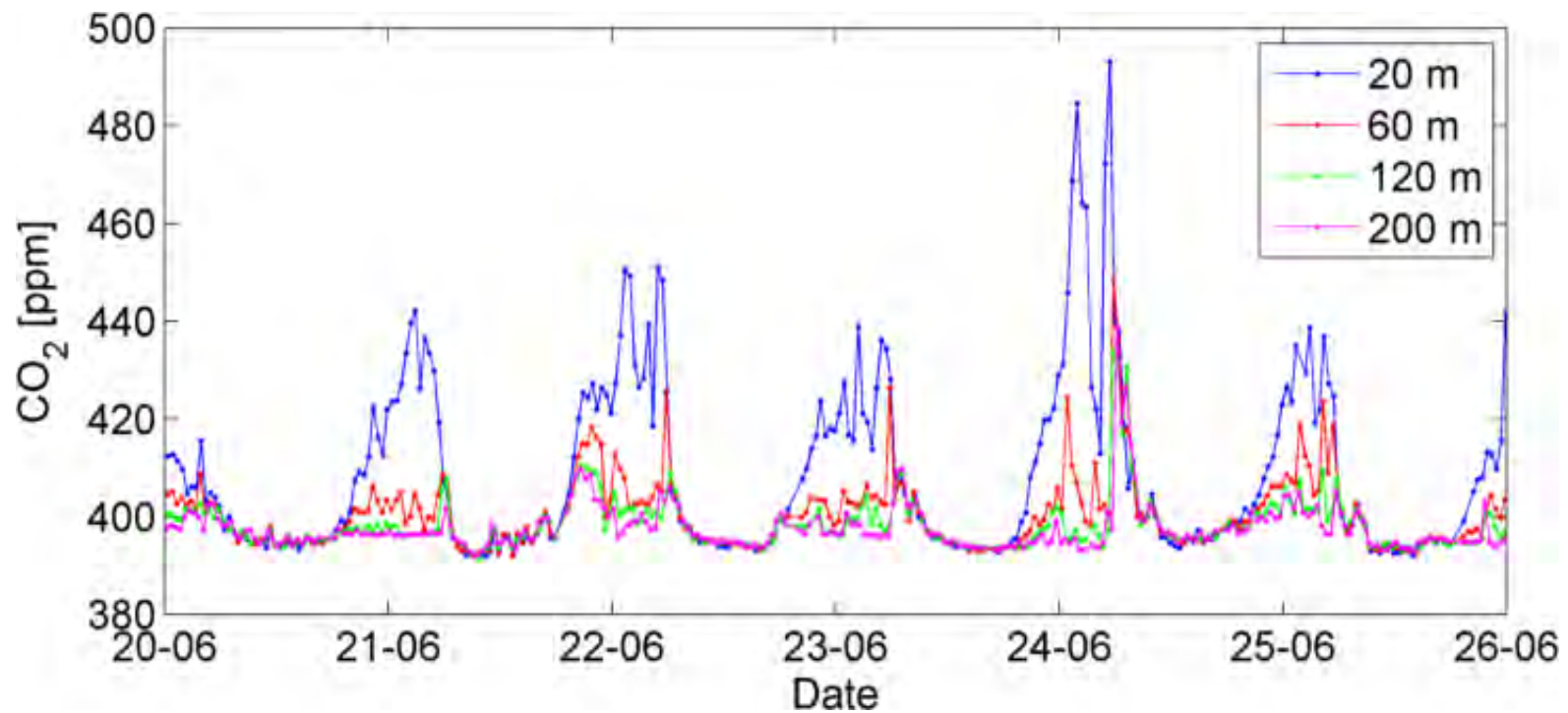
Hump

- Hump: in the early morning a sometimes the 200 m data jumps up when the night inversion layer breaks up.

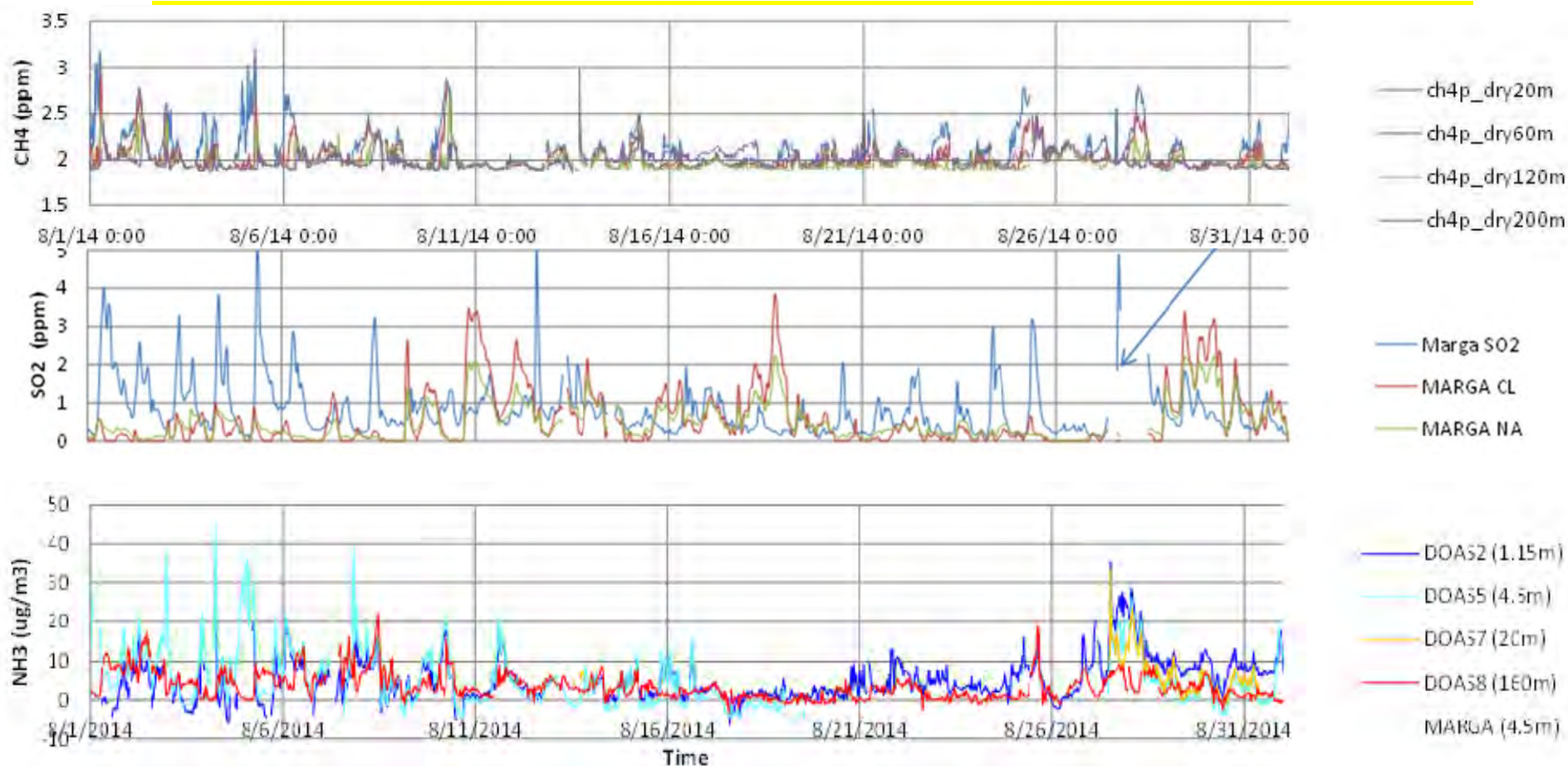


$$Q = \frac{(NH_3_{Jump} - NH_3_{Background}) * H}{(t_{start} - t_{end}))}$$

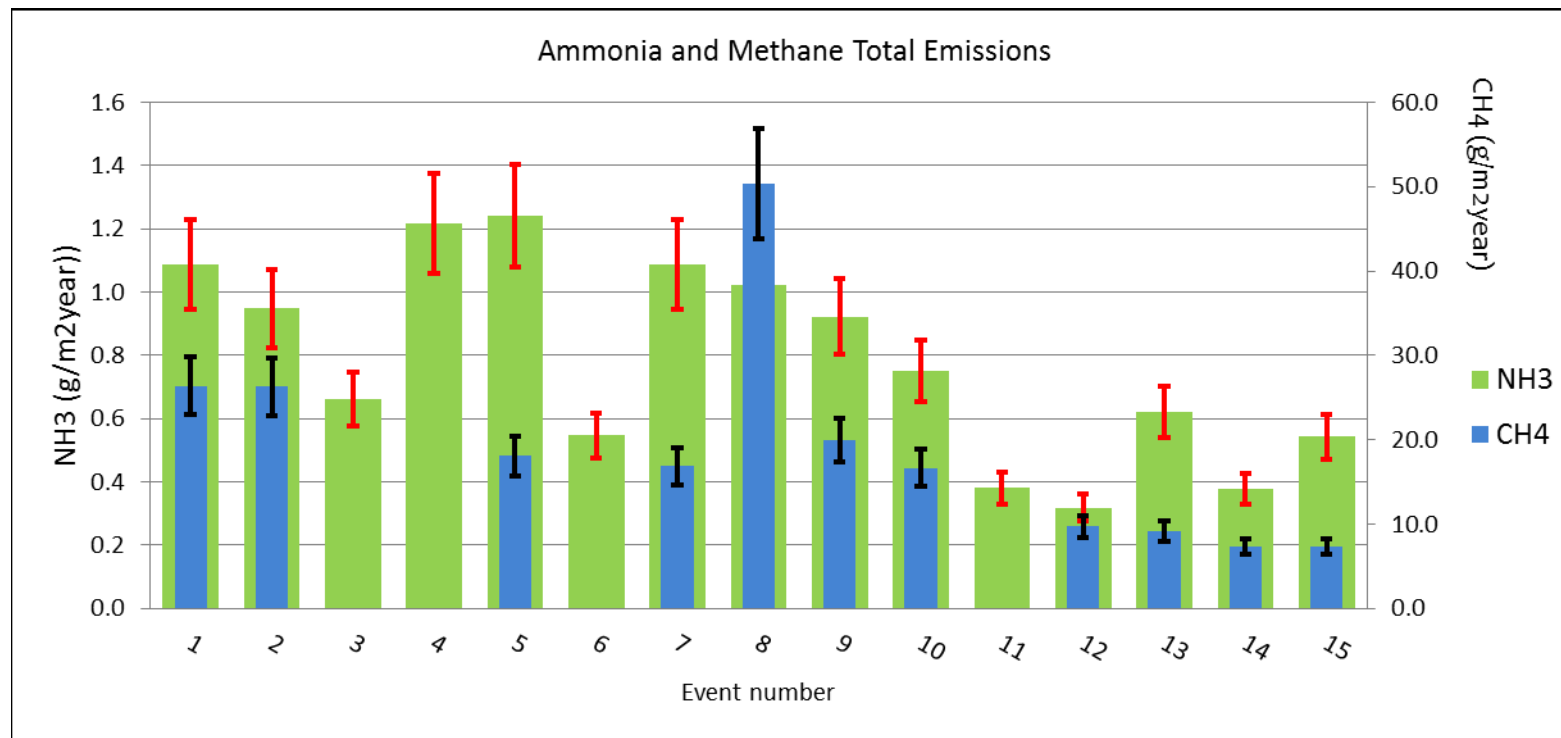
CO₂ example Cabauw



August 2014 Cabauw campaign



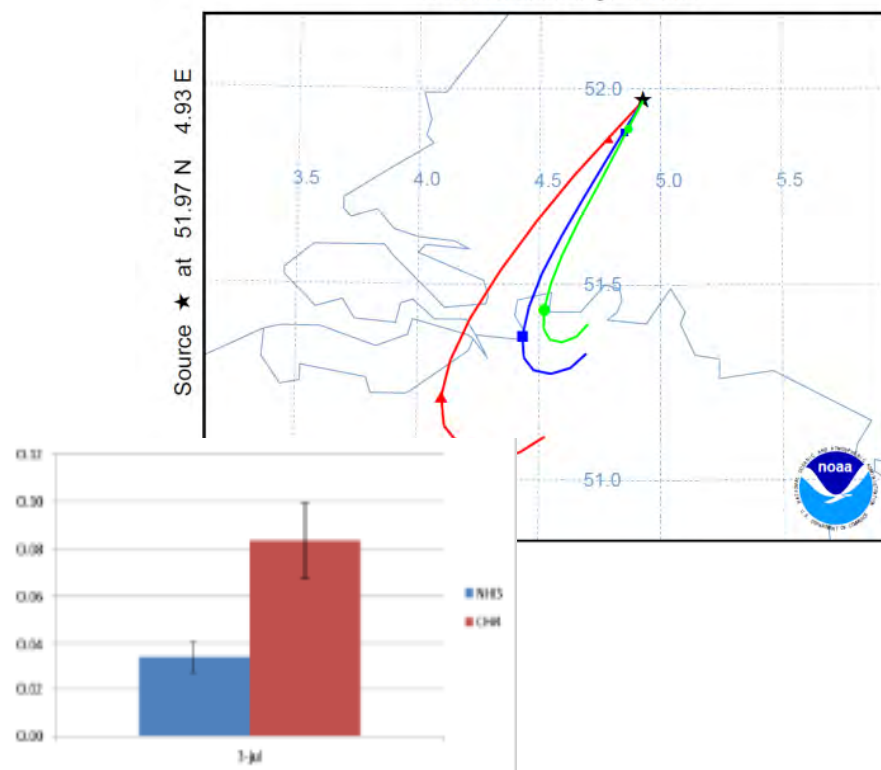
15 Examples from 3 months in 2014



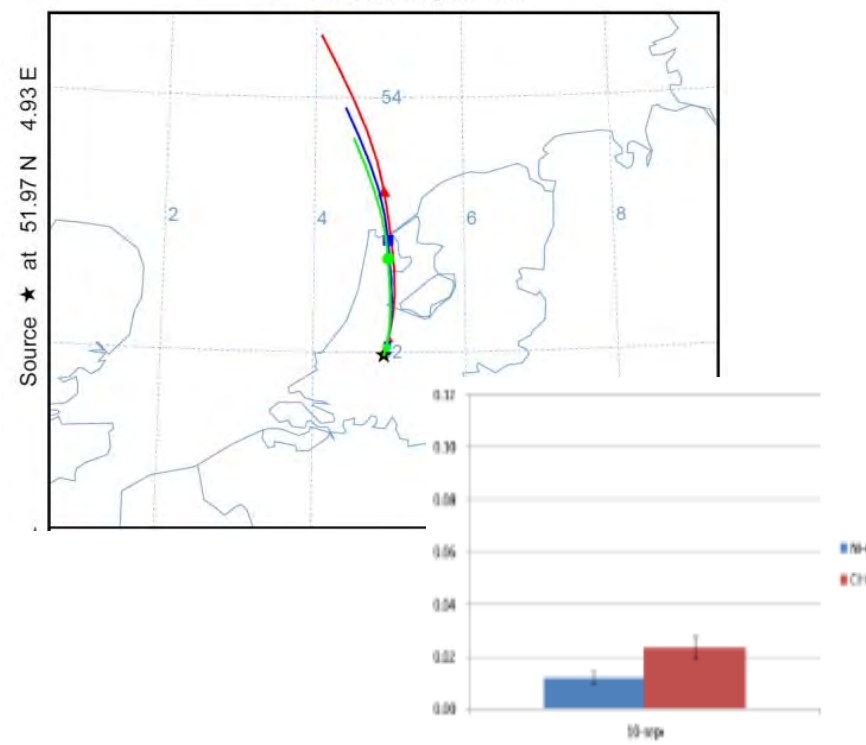
Courtesy NH3 data RIVM Hester Volten, Roy Laurijssen et al. 2015

Link with trajectory

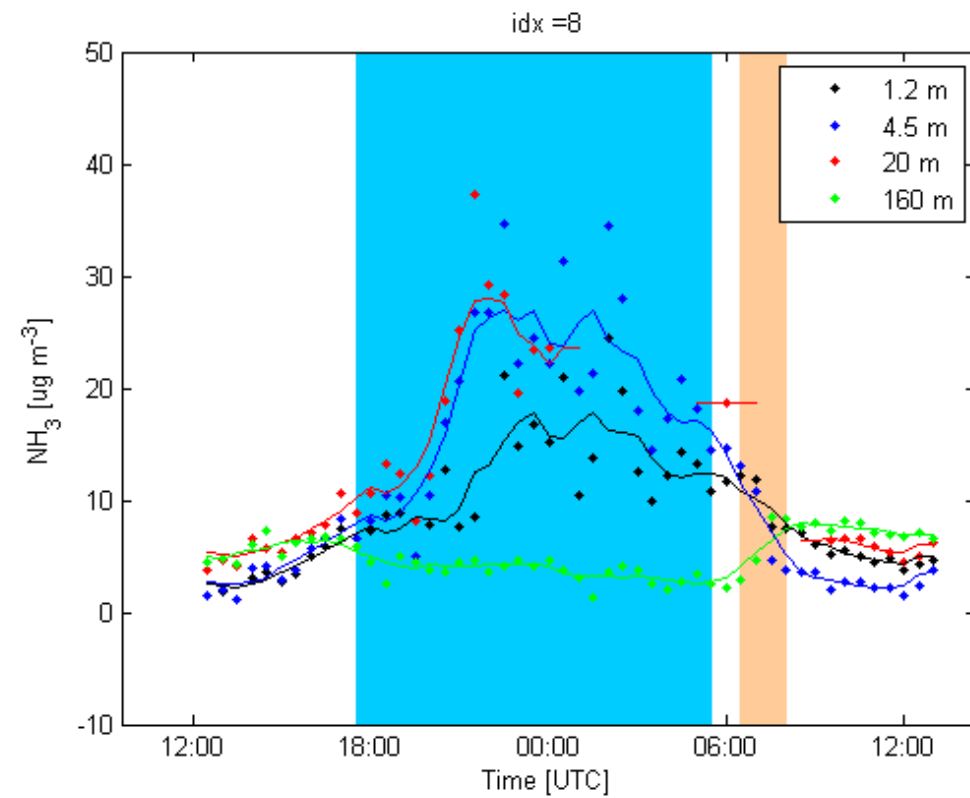
NOAA HYSPLIT MODEL
Backward trajectories ending at 0700 UTC 03 Jul 14
GDAS Meteorological Data

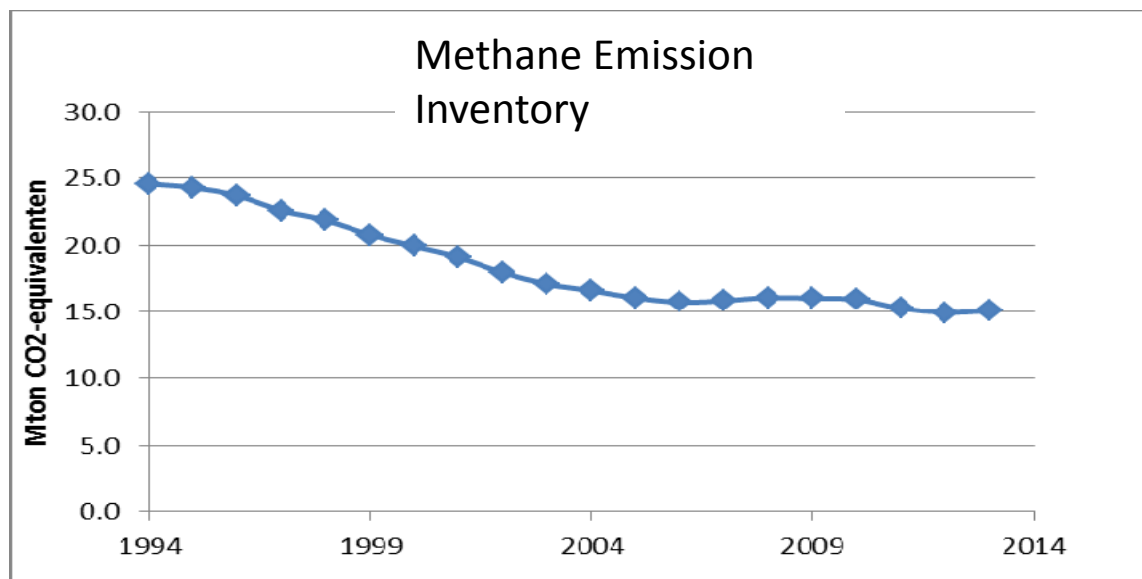


NOAA HYSPLIT MODEL
Backward trajectories ending at 0700 UTC 10 Sep 14
GDAS Meteorological Data



HUMP method automated....



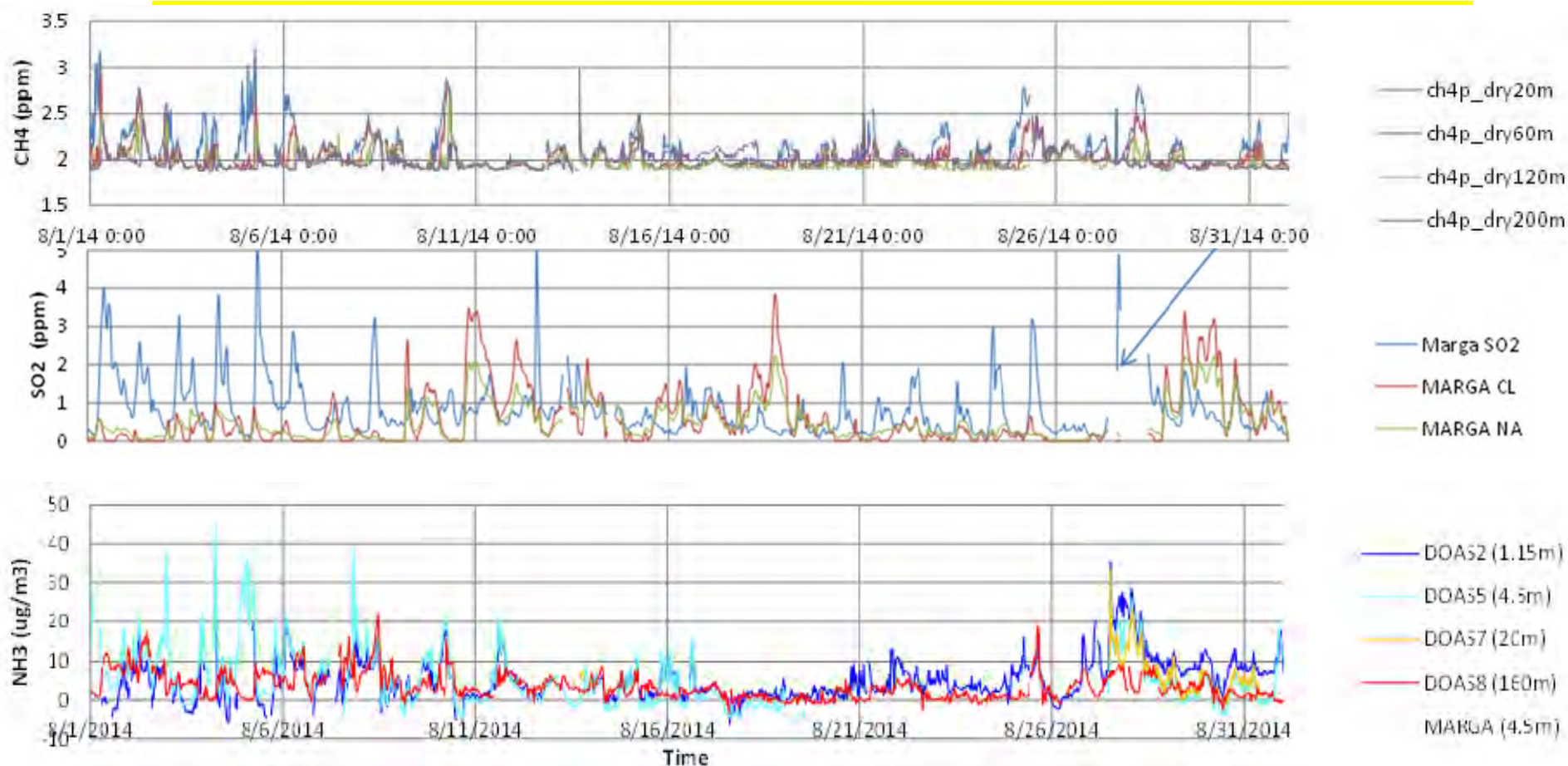


?????

Percentile

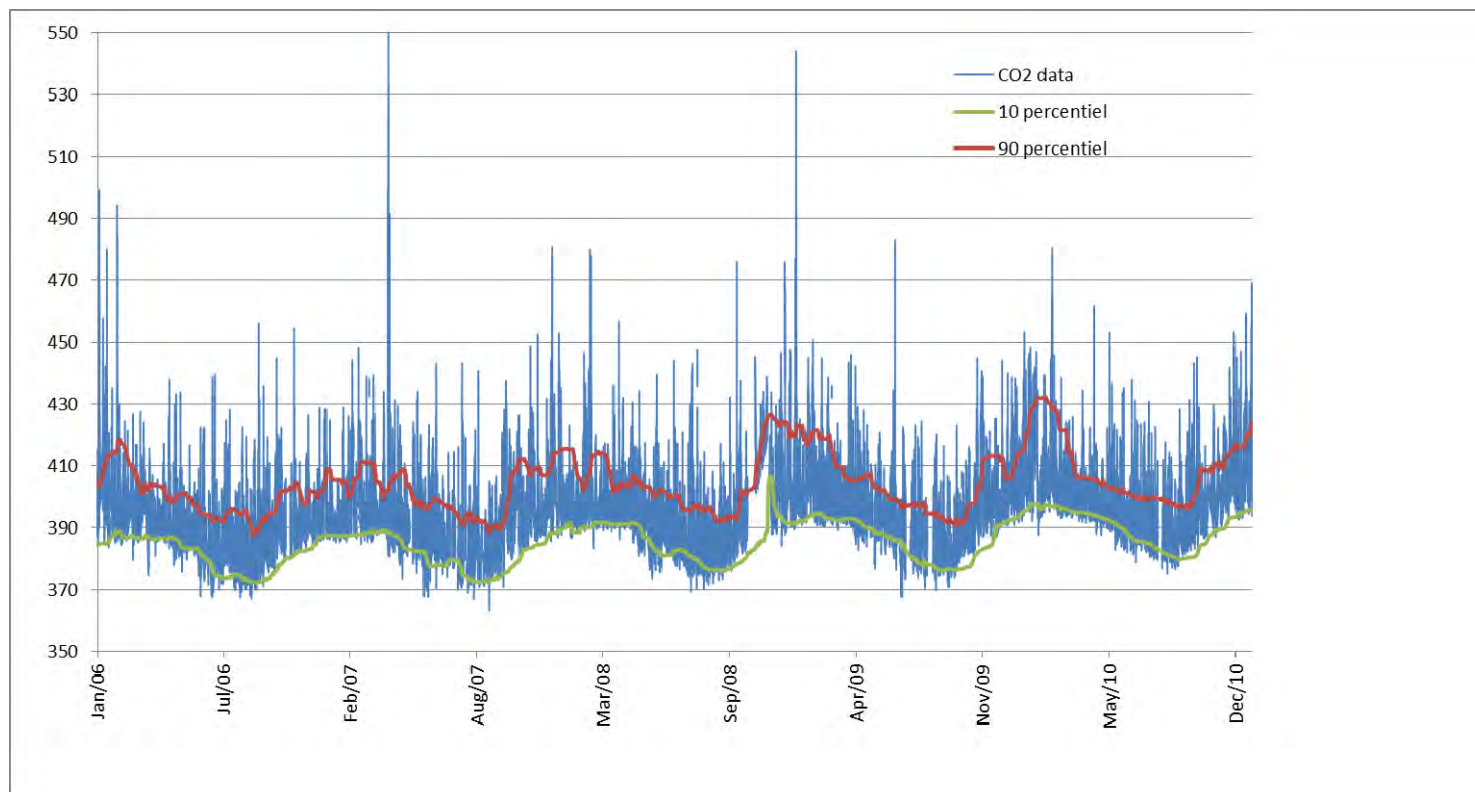
- If emissions around Cabauw de- or increase the peaks in the concentration will de- or increase too.

Variation synoptic and day

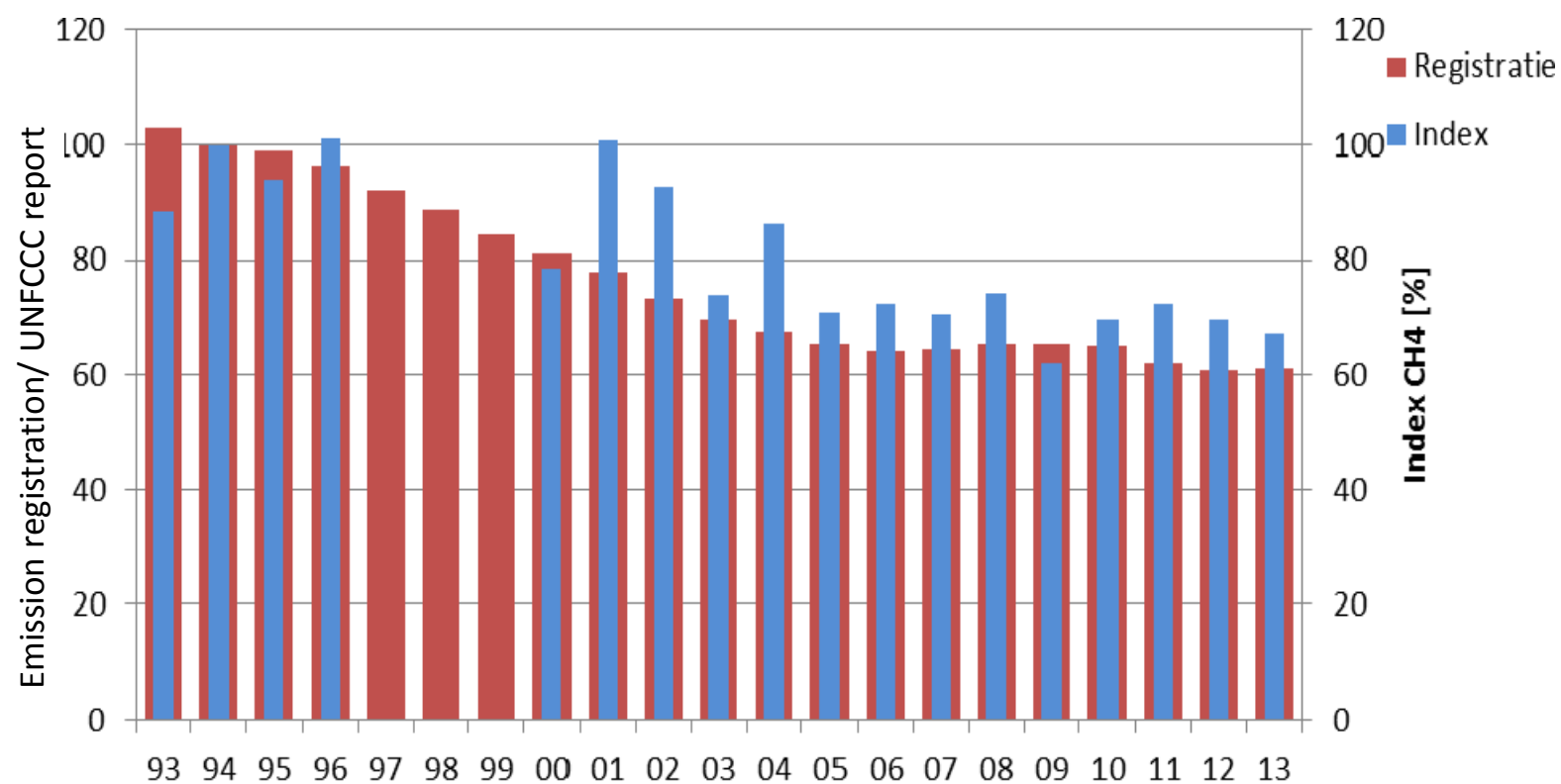


How high are the peaks

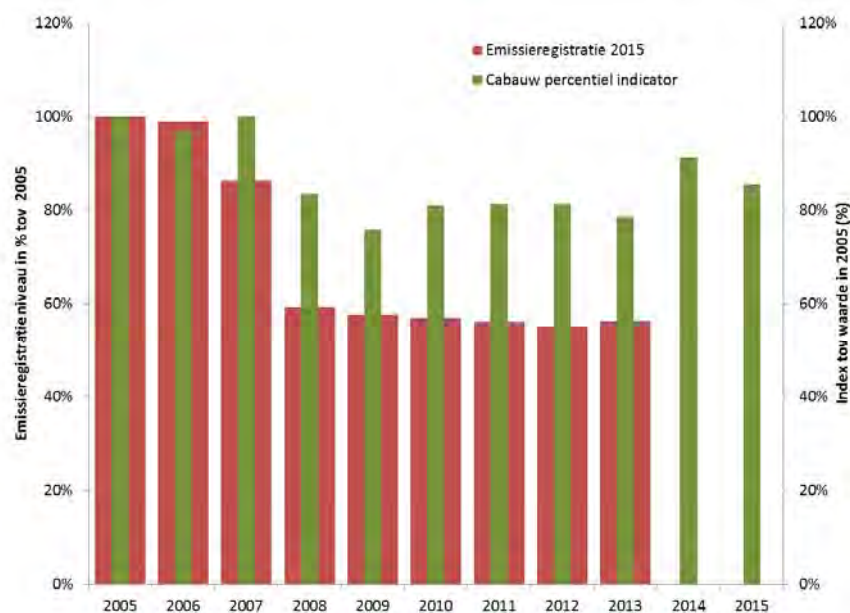
90 percentile-10 percentile



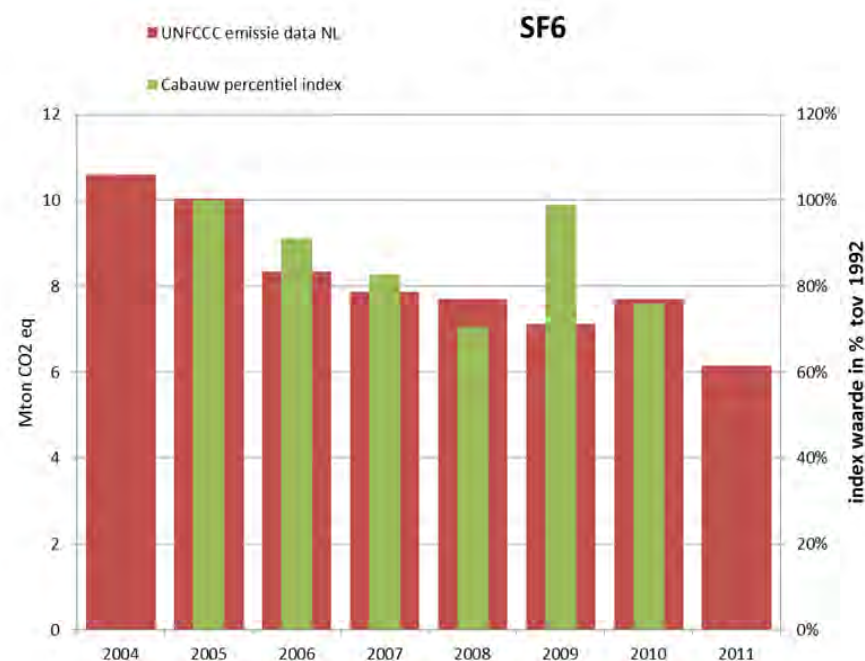
Methane indicator result



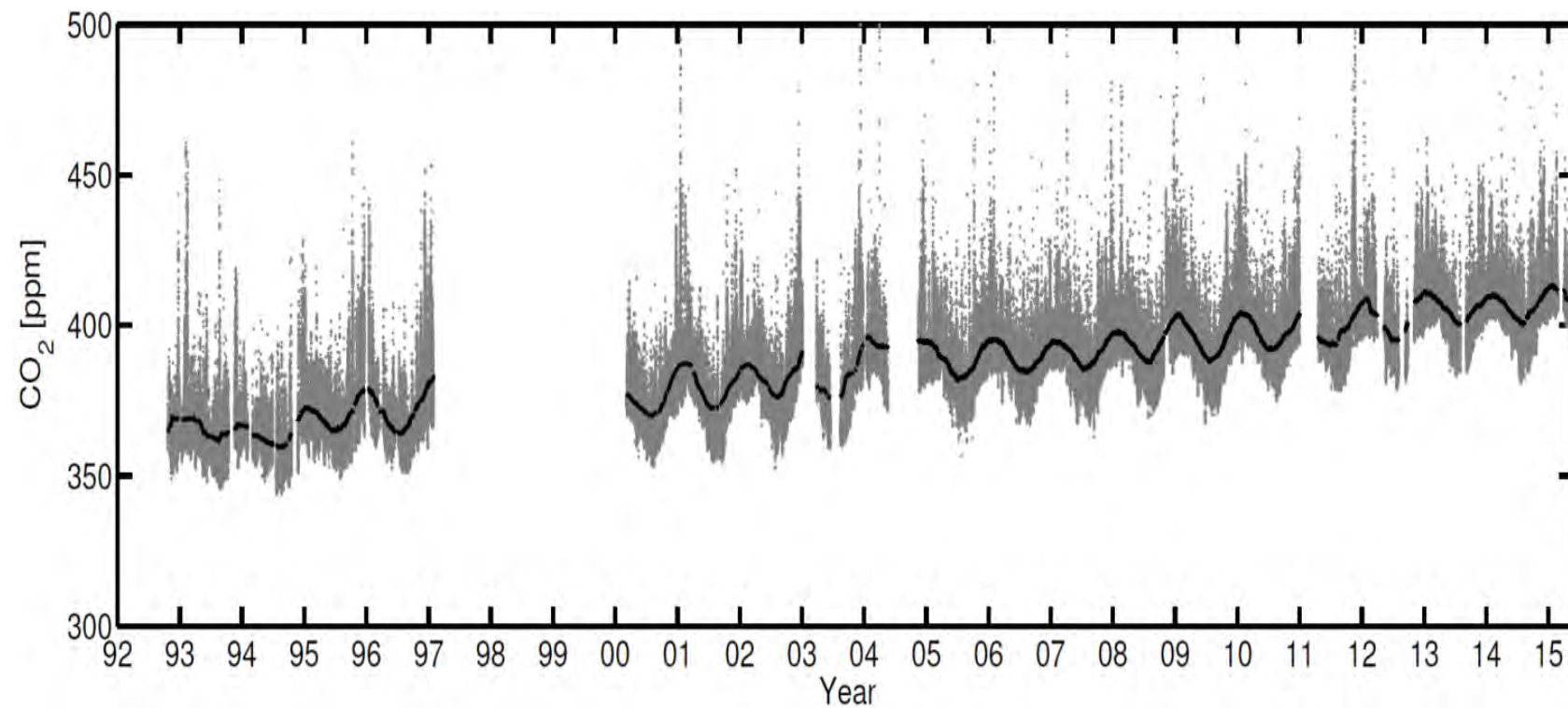
N₂O



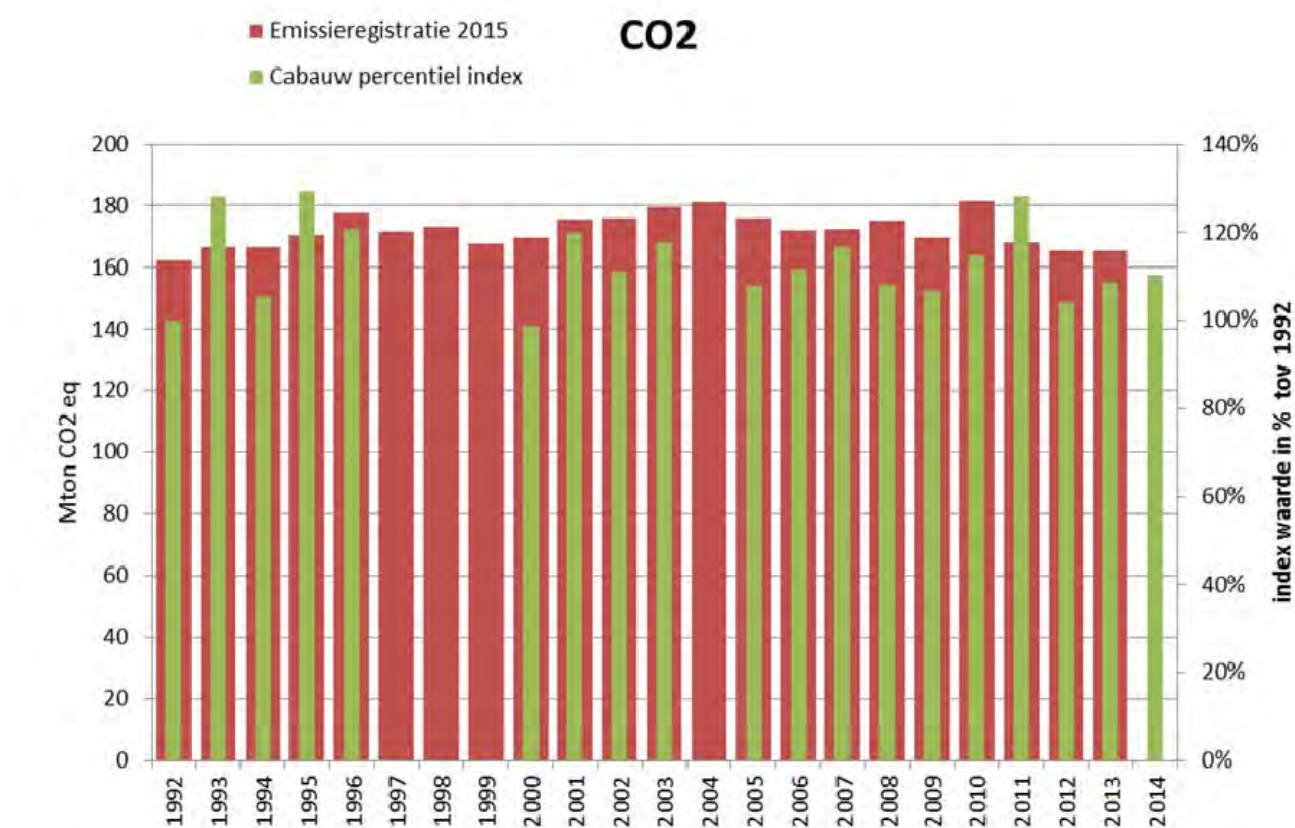
SF₆ until 2010



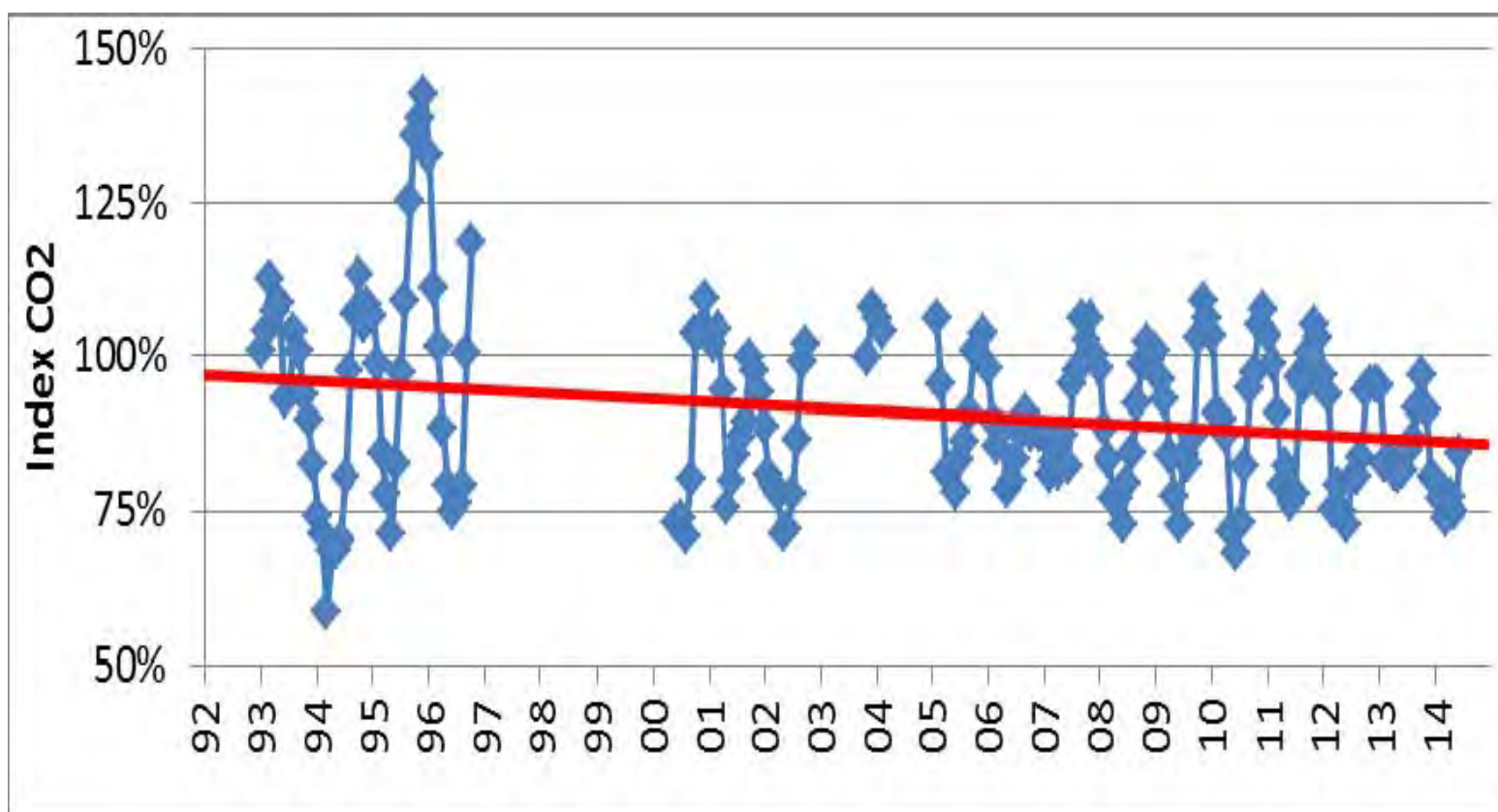
The Non InGOS gas



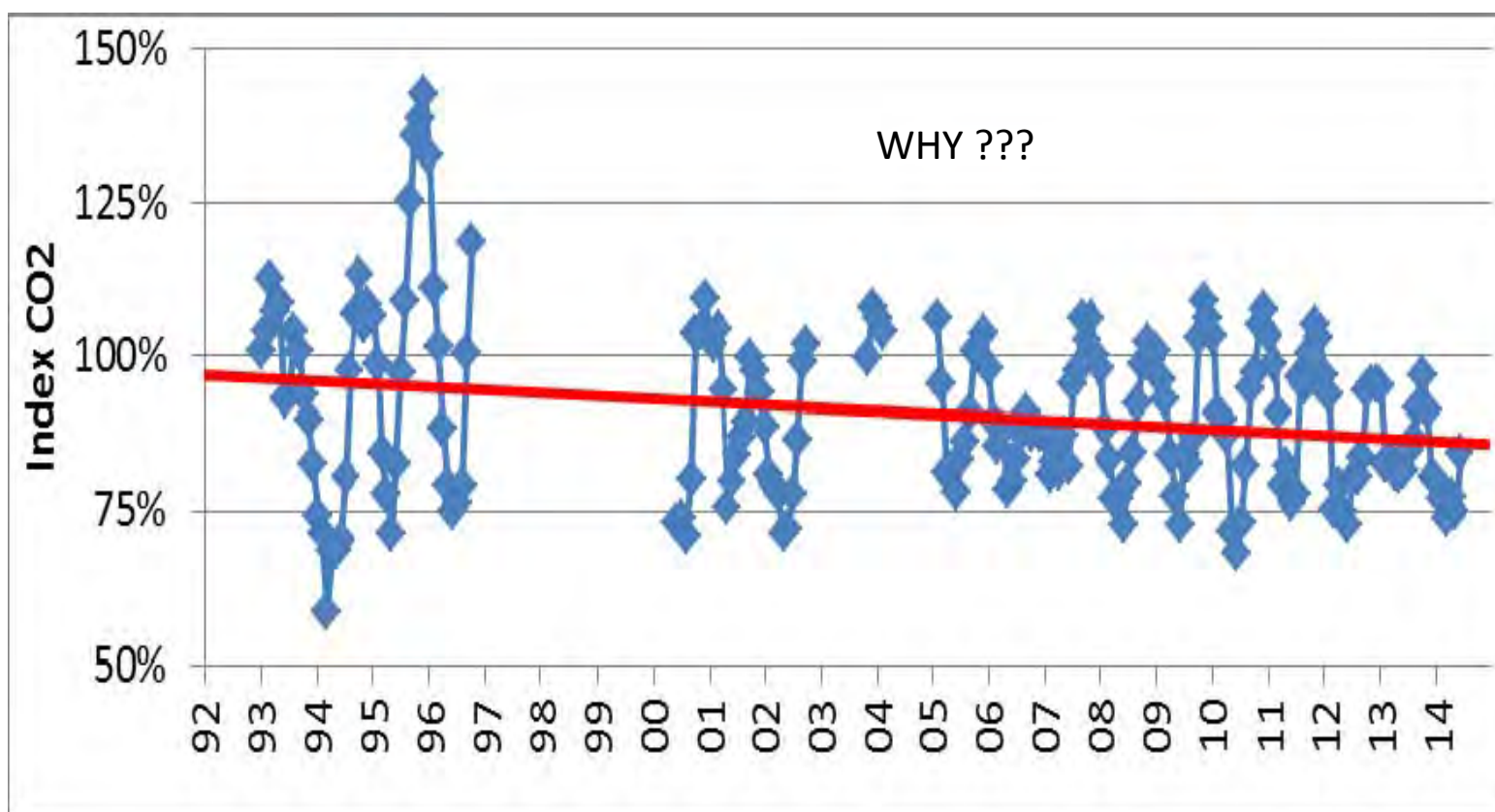
CO2 Cabauw percentile index & ER



Cabauw CO2 index



Cabauw CO2 index



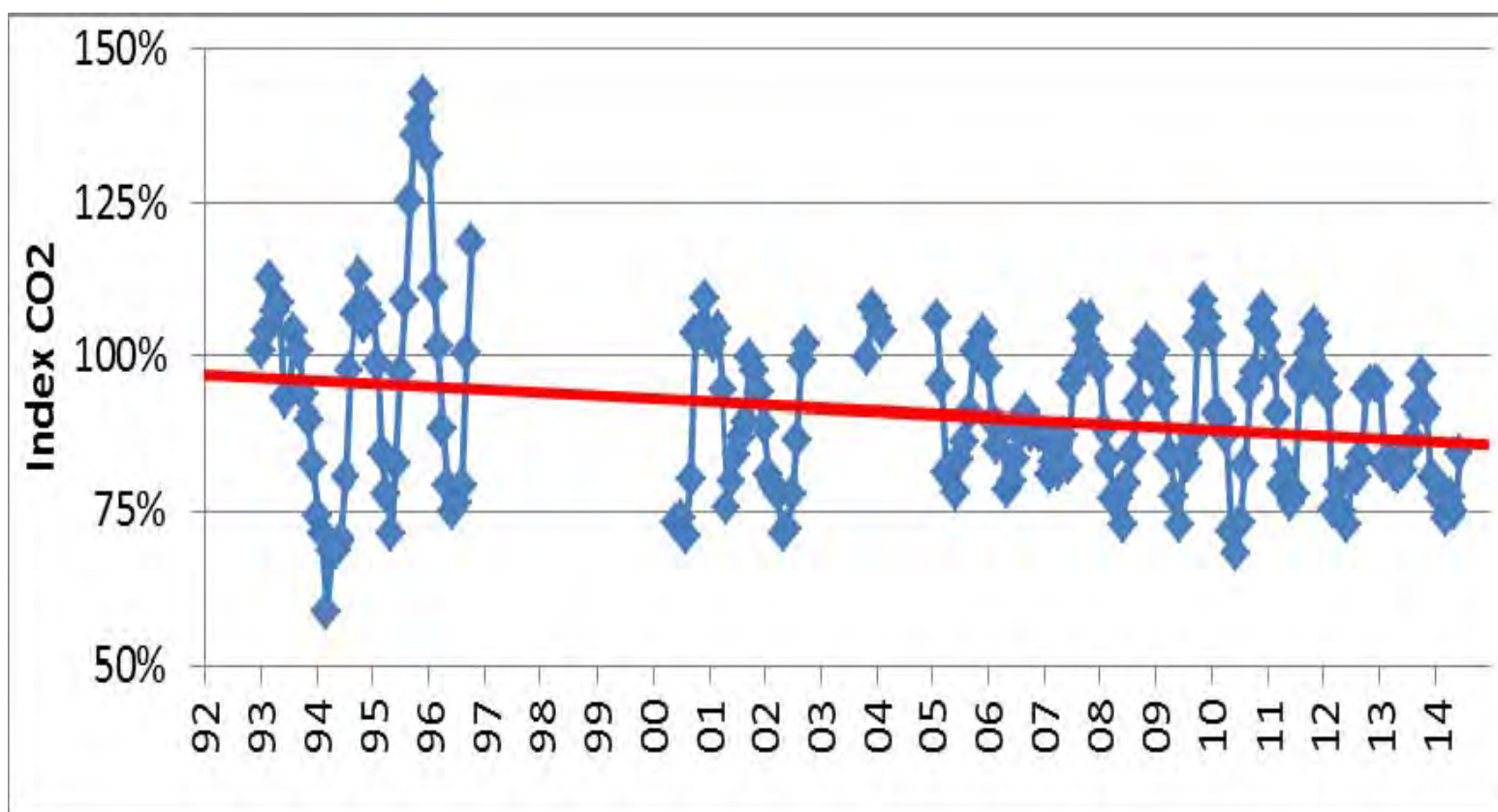
Still questions: Why do we see this

- Does it matter 90 percentile or 95 or 85?
 - Yes for abs value no for trend
- Switch between systems with different noise
 - Yes for N₂O, less for CH₄ no for CO₂

Not done yet:

- High sources versus low sources?
- Mixinglayer changed over time
 - If it did airquality is affected too
- Trend statistical relevant ?

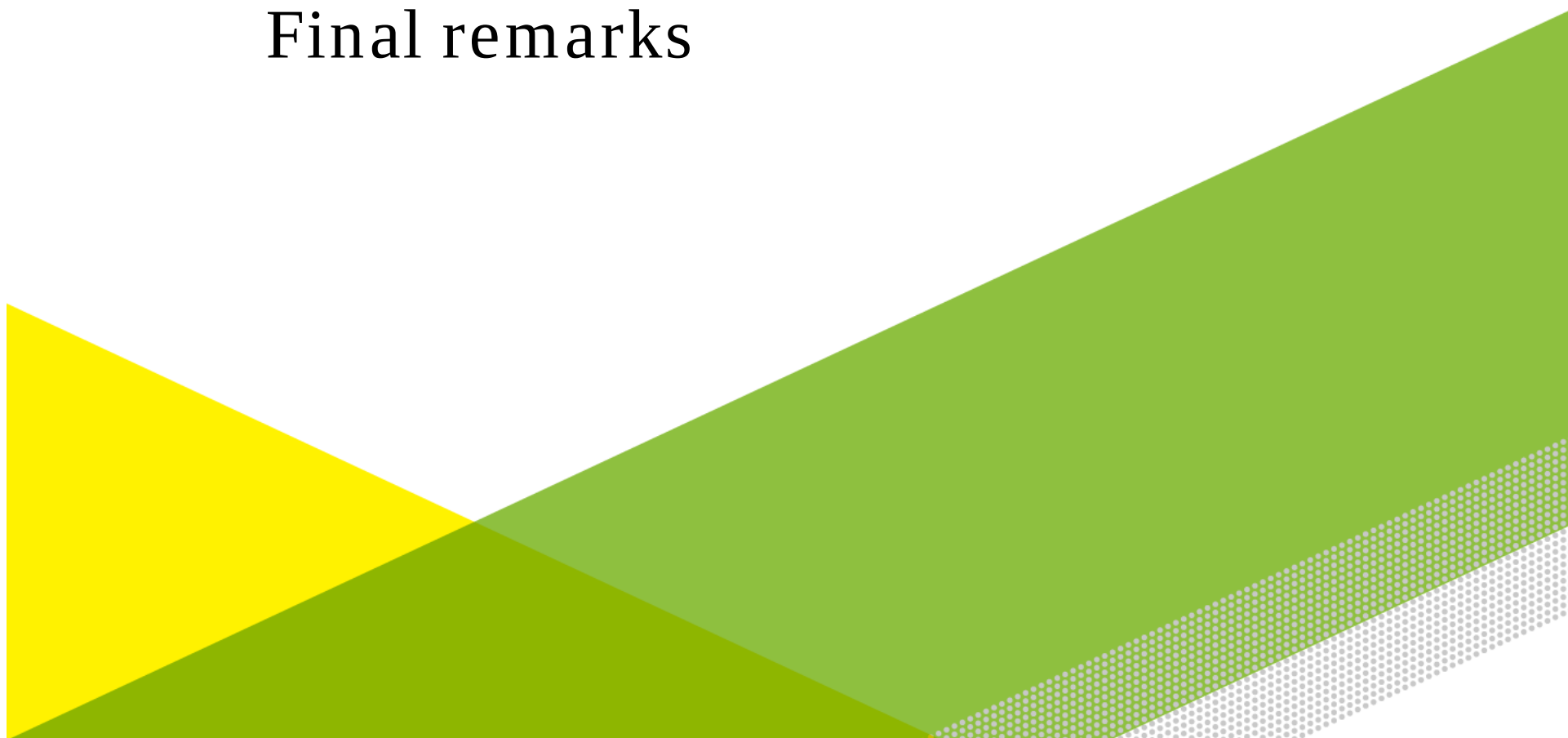
Cabauw CO2 index



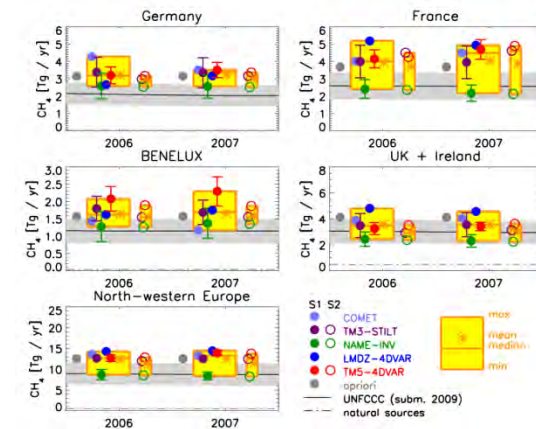
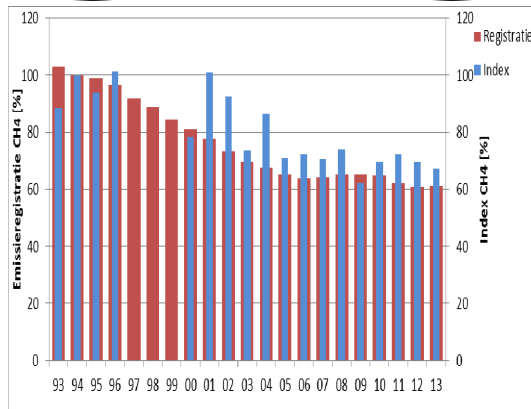
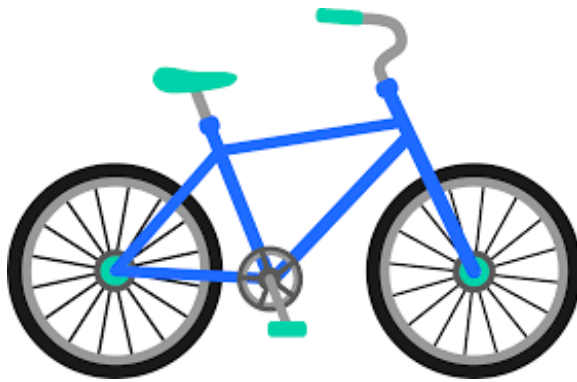
IF (big if) this is true....

- NL target = -17 %
- Trend = -10%

Final remarks



Maybe the indicator concept can help..



Conclusions

- Percentile index seems promising for “quick view” on emission trend
- Not an absolute emission level
- Not a replacement for full inversions
- If you were to believe the Index
 - Methane looks ok for NL
 - N₂O does not look ok
 - CO₂ has a surprise
- More testing needed: boundary layer & other stations are next

And then



Wauw: this helps us to
make better decisions!

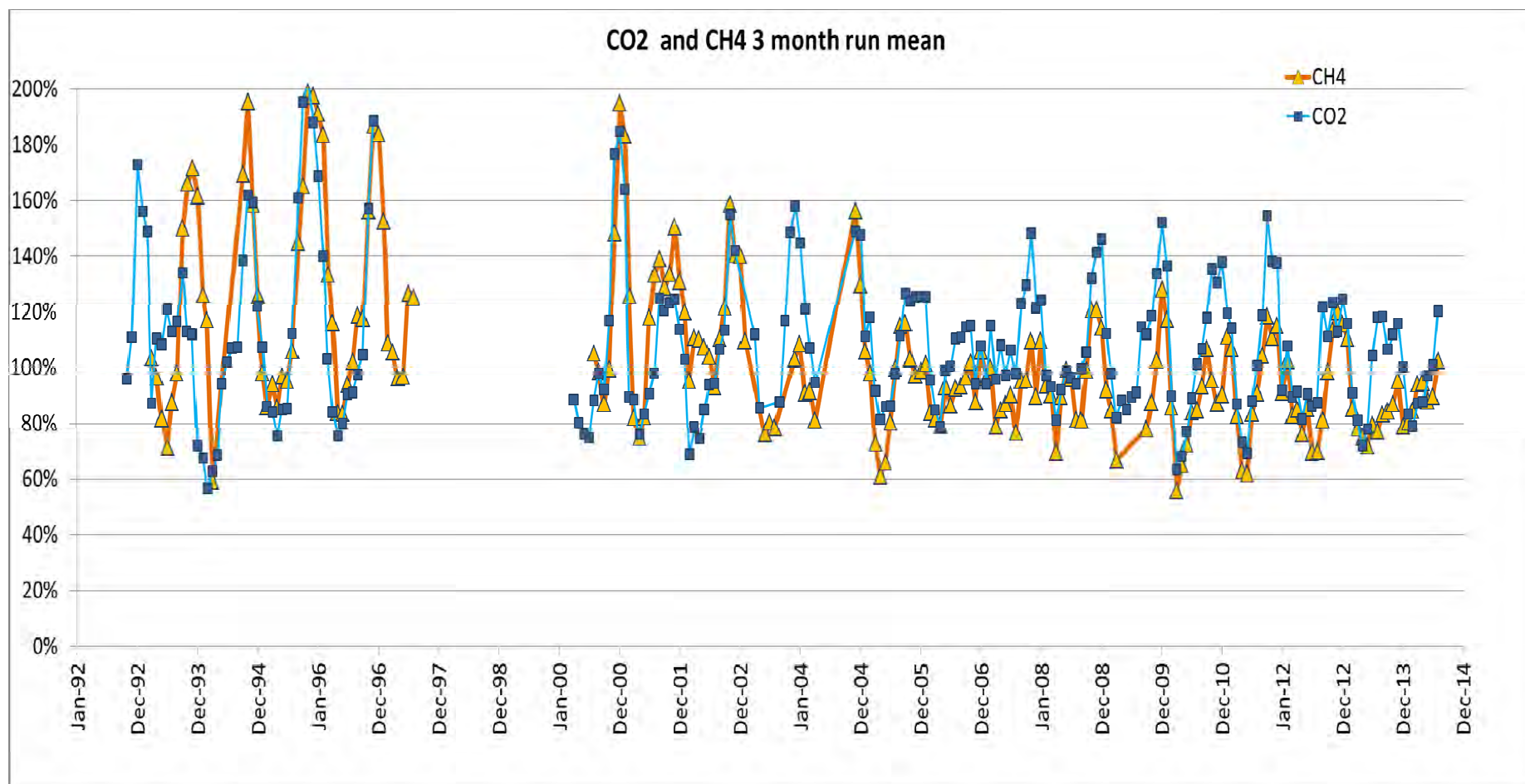
And can you explain
that total column
upwelling of HZY1235
again ?

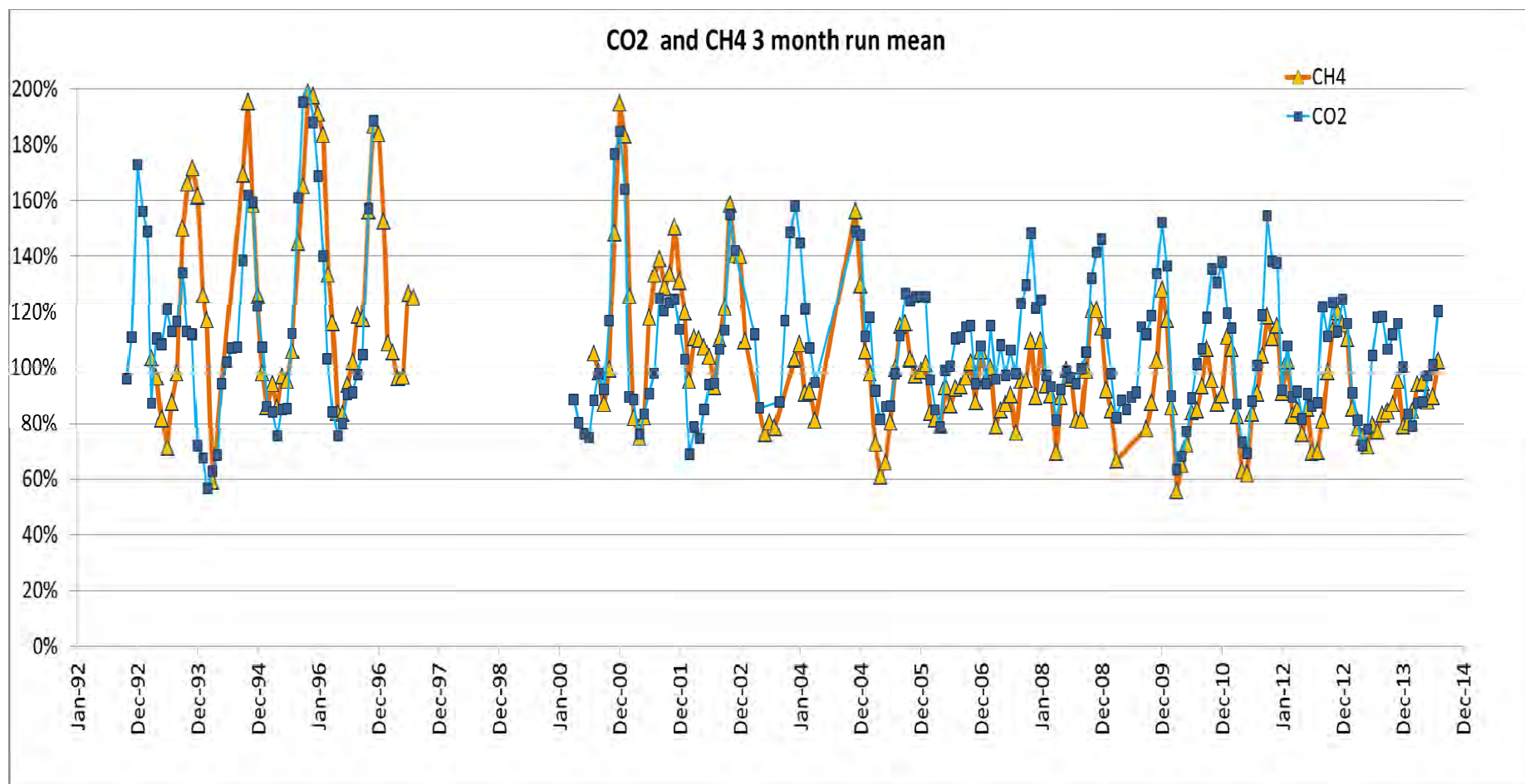


Thank you for coming to Utrecht and
have a safe trip back home !

Questions & comments: hensen@ecn.nl

www.ecn.nl





How to explain what we do ?

- Rule: you may not use the words
- Concentration, Flux, Heterogeneity, Eddy correlation, Salinity, Boundary layers, Advection, Alan variance, XCH₄, retrieval, FTIR, GC-MS-TOF, HZ1234, other silly abbreviations, Radiative forcing, lifetime, COS