Statistical dependences in input data of national GHG emission inventories: Effects on the overall GHG uncertainty and related policy issues

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Background: Austrian experience

- Independent assessment of uncertainties connected to the Austrian GHG inventory (report May 2000)
- Methodology is adapted to inventory improvements and applied on a routine basis (e.g., in recent reports for 2004) and refers to key sources (Tier 1 – approach)
- Comprehensive re-evaluation of all components, Monte-Carlo based assessment of uncertainy of key sources as well as non-key sources

Regulatory requirements

- Uncertainty assessment embedded in QA/QC program
- Methodological inventory development routinely coupled with uncertainty analysis
- Inventory improvement (also) based on a-priori uncertainty information:
  priorities set to assess more uncertain parameters
- Inventory uncertainty is ***not*** used to qualify inventory data (no posterior use)

Uncertainty propagation …

- Error propagation algorithms work as well as Monte-Carlo methods do …

… as long as correlation is addressed adequately.

Error propagation works for uncorrelated (independent) variables:

$$E = EF_1 * A_1 + EF_2 * A_2 + EF_3 * A_3 + \ldots$$

Note: additive terms allow for overall <u>decrease</u> of relative uncertainty

MESSAGE 1:
error propagation also works for correlated input

Transformation required to remove correlated parameters from calculation:

$E = EF_1 * A_1 + EF_2 * A_2 + EF_2 * A_3 + \ldots$

→ $E = EF_1 * A_1 + EF_2 \, (A_2 + A_3) + \ldots$

Note: Uncertainty decrease diminishes (especially if – in the above example – the major uncertainty is with EF)

Correlated parameters in practice

- Example 1: Energy balance

Sum = $A_1 + A_2 + A_3 + \ldots$

(with Sum at much lower absolute uncertainty than any of the elements)

- Example 2: Methane emissions from combustion

$E = \gamma_1 * EF_1 * A_1 + \gamma_1 + EF_2 * A_2 + \gamma_1 + EF_3 * A_3 + \ldots$

→ $E = \gamma_1 * (EF_1 * A_1 + EF_2 * A_2 + EF_3 * A_3 + \ldots)$

Note: Despite of apparently different EF's, the largest share of uncertainty (γ_1 as fraction of HC measured considered methane) is maintained due to correlation

MESSAGE 2:
Tier 1 calculation won't work with correlated input

A	B	C	D	E	F	G	H	I
IPCC Source category	**Gas**	**Base year emissions 1990**	**Year 2005 emissions**	**Activity data uncertainty**	**Emission factor uncertainty**	**Combined uncertainty**	**Combined uncertainty as % of total national emissions in 1990**	**Type sens ity**
		Input data	**Input data**	**Input data**	**Input data**			**Note**
		Gg CO_2 equivalent	**Gg CO_2 equivalent**	**%**	**%**	**%**	**%**	**%**
1 A 1 a liquid: Public Electricity and Heat Production	CO_2	1229	1083	0.5	0.5	0.7	**0.01**	- 0.00
1 A 1 a other: Public Electricity and Heat Production	CO_2	118	490	10.0	0.5	10.0	**0.05**	0.00
1 A 1 a solid: Public Electricity and Heat Production	CO_2	6247	5844	0.5	0.5	0.7	**0.05**	- 0.02
1 A 1 b liquid: Petroleum refining	CO_2	1957	2151	0.5	0.3	0.6	**0.01**	- 0.00
1 A 2 mobile-liquid: Manufacturing Industries and Construction	CO_2	1018	1161	1.0	0.5	1.1	**0.01**	- 0.00
1 A 2 other: Manufacturing Industries and Construction	CO_2	375	849	10.0	0.5	10.0	**0.09**	0.01
1 A 2 solid: Manufacturing Industries and Construction	CO_2	5014	5602	1.0	0.5	1.1	**0.07**	- 0.00
1 A 2 stat-liquid: Manufacturing Industries and Construction	CO_2	2883	1920	1.0	0.5	1.1	**0.02**	- 0.02
1 A 3 a jet kerosene: Civil Aviation	CO_2	24	209	5.0	3.0	5.8	**0.01**	0.00
1 A 3 b diesel oil: Road Transportation	CO_2	4013	16645	5.0	3.0	5.8	**1.07**	0.16
1 A 3 b gasoline: Road Transportation	CO_2	7911	6393	5.0	3.0	5.8	**0.41**	- 0.04

independent?

Consequence for Austria

- Tier 1 approach (error propagation sheet)

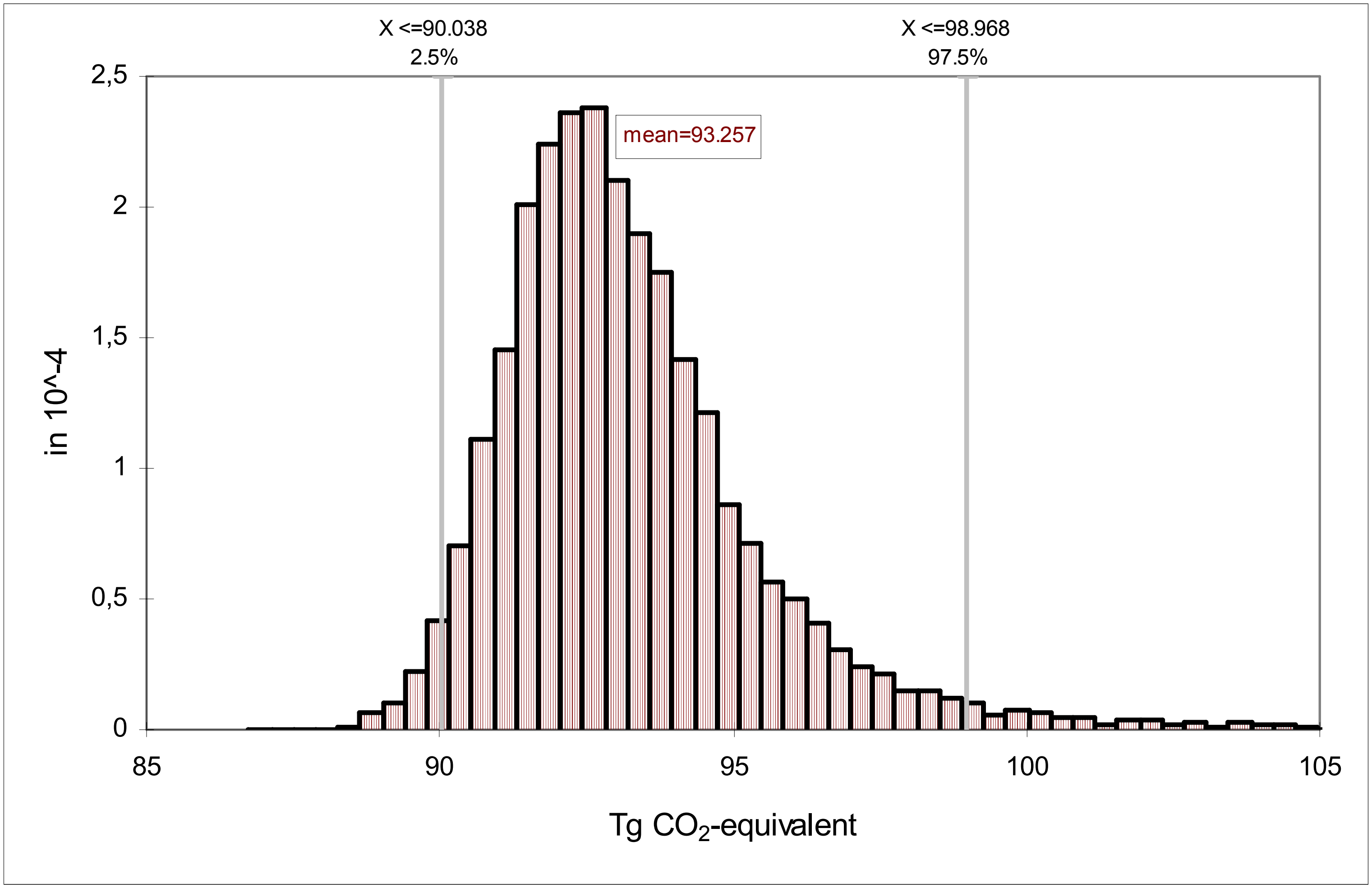
Level uncertainty 2005:	3.66 %
Trend uncertainty 1990-2005:	2.84 %-points

- Tier 2 approach (Monte-Carlo)
  – attempts to exclude occurrence of correlated inputs

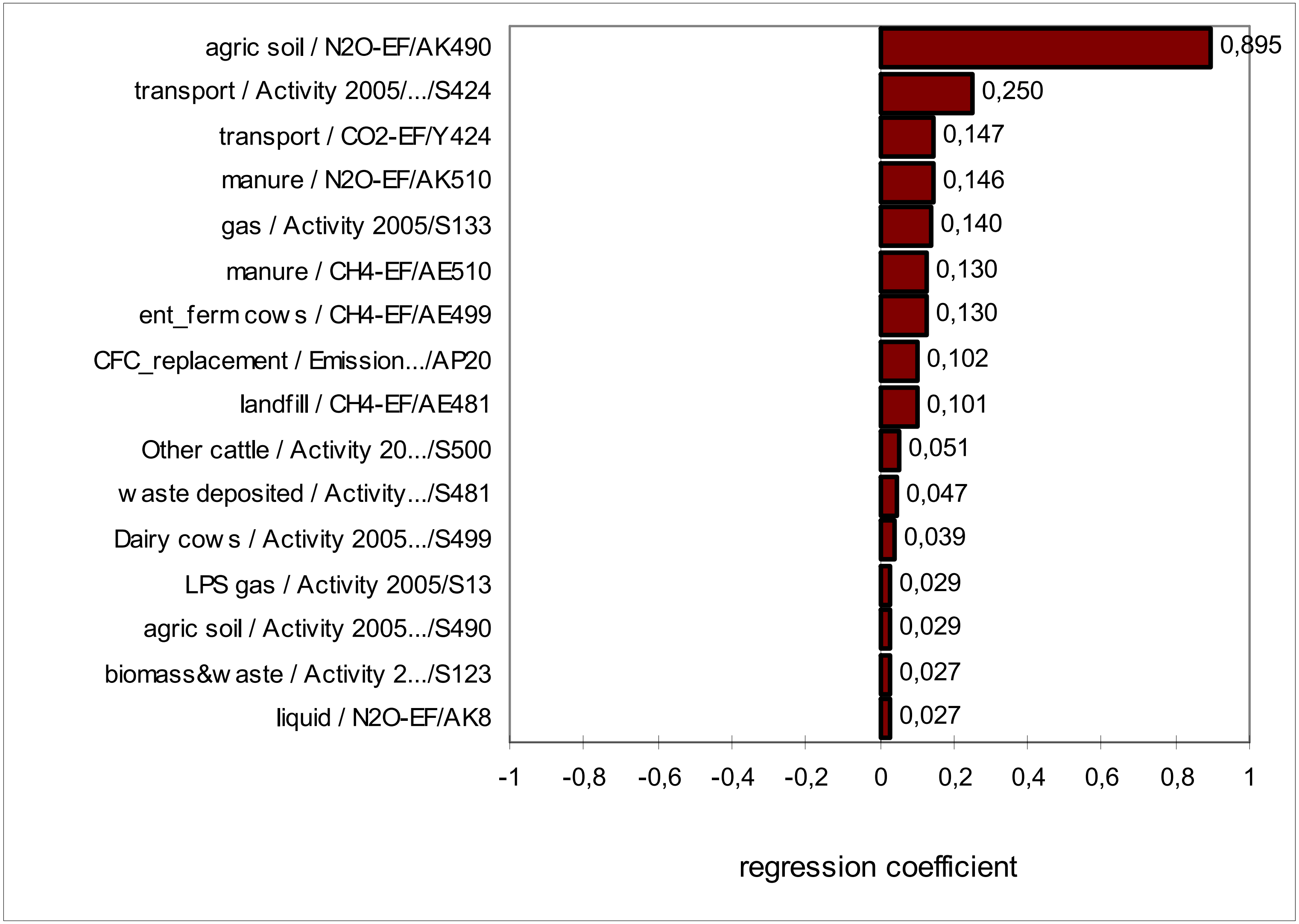
Level uncertainty 2005:	5.14 %
Trend uncertainty 1990-2005:	2.69 %-points

Additional effort leads to higher uncertainty ??

Sensitivity and uncertainty (1)



Sensitivity and uncertainty (2)



MESSAGE 3:
it all depends on soil N_2O …

- Direct and indirect N_2O EF's should be considered correlated → main difference between results using Tier 1 and 2
- Skewness of PDF fully reflects lognorm distrubution of N_2O EF uncertainty
- Compared to an earlier uncertainty estimate for Austria, the present IPCC uncertainty range seems more credible (factor 10 instead of previously 100), thus could not be easily dismissed → overall uncertainty becomes higher
- Arbitrary assumptions on soil N_2O determine final results on uncertainty:
  observed variability ≠ uncertainty

Conclusions

- Uncertainty analysis helps identify areas of inventory that provide least information.
- Uncertainty analyis – if correctly interpreted – also allows to understand the level of precision required for other inventory work.
- In practice very few sources determine overall uncertainty – their behaviour then determines immprovements (soil N_2O!).

Note: IPCC key source concept has been developed to optimize use of resources – i.e. only key sources should be treated in detail.