

Interactive comment on “Twenty-five years of continuous sulphur dioxide emission reduction in Europe” by V. Vestreng et al.

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This is an important paper, documenting not only the emission estimates but also their quality, validation and verification.

General comments My initial general comments are generally well addressed. However, some elements could still be improved (or corrected).

Specific comments p. 5202, line 1-2: I miss the NEC targets in a column in Table 2. line 9: “.. from biofuel use, forest fires ..” line 16: pls. explain the term “critical loads”, which I expect is not familiar for most readers. p. 5203, line 10: “than before.”: recommend to also mention the old limits. p. 5204: line 2: I do not understand +-

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5-6%. Is it +5% or +6%?? line 16-17: Why not also compared to NEC targets? line 5-7: The source categories that are included in the inventory are not well defined and described. Please mention the number and level of detail of source categories reported, e.g. total industrial combustion or per major subsector, e.g. iron and steel, chemical industry. line 9-10: The methodologies used for the whole time series are not very specific. Since when are estimates made cf. the Guidebook? What are the main differences with previous methodologies/guidebooks. line 11-12: Are these also documented for the older emissions (e.g. for 1980)? p. 5107, line 23-24: Does replacement also take place if that would result again in an outlier? p. 5109, line 6: Why “tentatively”? It IS an outlier. You probably mean “identified as outlier, and thus possibly an error, which could however be well explained by national or source-specific circumstances.” p. 5111, line 4-5: I would recommend to add the % of emissions and % of land area covered by these 14 countries. p. 5112, line 1: “Bouwman, 1997” should be “et al.”, but more important that paper does not provide trends so I do not see the relevance of citing it in this context. p. 5113, line 13-14: “increasingly overestimated over the years” and “indicate .. trend .. is reasonable” are rather vague expressions. I recommend to provide some quantification for these statements. line 24: “somewhat too low”. Ibidem. line 27-30: “better reproduced .. indicating .. trend .. correspond to .. conc.”. Ibidem. p. 5114: Ch. 4: Would Chapter 4 not be more logically placed before Ch. 3? Then Ch. 6 with discussion follows more logically the text on validation. p. 5117, line 20: “..(FGD), mainly in power generation, ..” line 21: “to gas or to nuclear power”. p. 5120, Section 4.2: As mentioned before, I miss here a short discussion of the targets of the NEC Directive. line 26: For others, not familiar with conventions in uncertainties of emissions, please add that the uncertainties mentioned here are estimates for the 95% confidence interval (i.e. reflect 2 sigma of a normal distribution). p. 5123, line 4: “amount above +-20%”. Pls. provide a more approximate value or range. line 5-6: “EMEP inventory total .. between 3% and 25% for individual countries after 1990”. This is unclear: the first part suggests that the 3 to 25% refers to the EMEP total area of all countries, whereas the latter refers to specific countries. Do you

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mean that is the uncertainty estimate for the total EMEP area now estimated at 13 (+-10)%? p. 5124, line 20-21: The 1990 SO₂ emission factors provided by Berdowski are country-specific and based on the sulphur contents of different fuels and metal ores smelted and country-specific sulphur recovery by smelters, refineries and FGD in power generation. p. 5126, line 22-23: “.. implementation of measures and to economic recession.” Pls. add the fraction or % of each. I miss here the importance of changes in the fuel mix, notably from coal to oil and gas, which are often not due to policy regulation but e.g. to prices. line 24-27: For clarity I recommend to add average % numbers with the three periods, e.g. about 20% in the 80s, about 55% in the 90s and x% in the first half of the 2000s. p. 5127, line 2-14. I miss here a discussion of the importance of changes in the fuel mix, notably from coal to oil and gas. line 29-30: Phrasing is incorrect: “.. SO₂ emissions it will provide a regional warming effect in Europe.” line 8: “.. uses more detailed technology dependant emission factors and includes changes in technology mixes.” line 9: “.. importance of changes in technology mixes to estimate emissions ..” line 26: I miss here a conclusion on the importance of the non-regulated international shipping sources (e.g. present share in regional emissions and that their share increased and increases strongly). I also miss here a remark on the more strict NEC targets for EU countries. p. 5136: Table 1. It is unclear to me why for a particular country the same “gap filling/replacement” applies to all years. Doesn't the actual coverage of sources per country vary over time?

Technical comments p. 5105, line 4: “.. are national” p. 5111, line 7: I think “deriving” should be “using” p. 5112, line 17: “concentration measurements..”. p. 5117, line 20: “..(FGD), mainly in power generation, ..” p. 5117, line 21: “to gas or to nuclear power”. p. 5121, line 23: “greenhouse gases” p. 5122, line 17: “.. no substantial differences ..” p. 5128, line 7: “.. in the other inventories.”

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