Chapter 6: Options for Elements of a Standard to Protect Against Effects from Aquatic Acidification

Comments from Andrzej Bytnerowicz

15. **To what extent does the Panel agree that the proposal to develop an Atmospheric Acidification Potential Index (AAPI) linked to key determinants of aquatic ANC is a reasonable approach to developing an ecologically relevant standard? Does the Panel generally agree that the secondary standard options identified by staff (including indicator, averaging time, form, and level) are generally consistent with the available scientific and technical information and are appropriate for consideration by the Administrator?**

In a general sense this is a reasonable approach that links ecological responses (ANC as an ecological indicator), acidifying deposition of N and S (resulting from most important forms of atmospheric sulfur and reactive nitrogen), and ambient NOx and SOx concentrations. Science and logic behind this concept are good and based on the current understanding of the effects of atmospheric deposition on aquatic ecosystems. I would like to complement the EPA authors for developing a concept that logically links the concentration-based standards for NOx and SOx with ecological effects of total N and S deposition that at the same time includes reduced form of N as part of the background chemical environment of the evaluated watersheds. Potential problems related to the proposed approach are mainly related to conversion of deposition to concentrations and to the unknown levels of uncertainty of various stages of the proposed methodology. While an averaging time of a single year for acidification of aquatic ecosystems could be probably justified, a similar approach for the terrestrial ecosystems is too coarse and therefore is not recommended. For terrestrial ecosystems the annual averages should be based on aggregated values of the individual phases of physiological activity of vegetation specific for various ecological zones.

16. **What are the views of the Panel on the degree of uncertainty associated with each element of the suggested standard, e.g. the ecological indicator; the concentration to deposition ratios, reduced nitrogen, the natural background ANC, and the ambient indicator and averaging time for NOx and SOx , and its relationship to the degree of protection that could be expected from the standard? What are the views of the Panel on how to fairly characterize the uncertainty associated with the degree of protection that such a standard would provide for aquatic acidification?**

Scientific information on levels of acid neutralizing capacity (ANC) protective to fish and aquatic biota has been well developed and therefore present the lowest level of uncertainty. On the other hand, the concentrations to deposition ratios present a very high level of uncertainty. Various individual components behind the total V_N or V_S are not very well defined and could be quite variable. According to my understanding of the problem, a level of uncertainty for water surfaces is lower than for the terrestrial ecosystems. Deposition velocities of reactive N species, such as NH_3 and organic N, both for the aquatic and terrestrial ecosystems have high level of uncertainty. Information on ambient levels and distribution of the reduced N forms, NH_3 and NH_4^+, are scarce and therefore there is very high level of uncertainty on distribution of these pollutants, especially in remote areas, and specifically in the mountainous complex terrain.

Ammonia concentration values from the CMAQ model are not reliable and have not matched the ground-level measurements (Fenn et al., 2009). In summary, the expected level of uncertainty of the proposed methodology for protection against acidification of the aquatic ecosystems is high.

17. What are the views of the Panel on aggregating the terms (Q, N_{eco} and BC_{0*}) used in estimating natural background ANC, denoted by the function g(·), into 5 bins based on the geologic classification scheme?

Introduction of function g(·) aggregating Q, N_{eco} and BC_o seems to be appropriate. Using the geologic classification scheme is a good idea since chemistry and weathering of geologic material are the main factors affecting abilities of the aquatic ecosystems to cope with acidification caused by the atmospherically deposited S and N compounds.

18. What are the views of the Panel on the use of regional air quality modeling (e.g., CMAQ) results to establish the concentration-to-deposition ratio (V_{NOy}, V_{SOx}) and reduced nitrogen deposition (NHx) in the AAPI calculation? What are the views of the Panel on the critical uncertainties associated with the use of CMAQ to generate these parameters, and the potential implications of these uncertainties for the secondary standards?

First, I would like to suggest changing symbol "V" describing "concentration-to-deposition ratios" to a different one. Symbol "V", at least in my understanding, has been used for description of deposition velocity (calculated by dividing deposition, or flux, of a given pollutant by its ambient concentration). As I stated above (point No. 16 above), the CMAQ model outputs often do not agree with the ground-level measurements, especially for the reduced N compounds (Fenn et al., 2009). Therefore I strongly support the recent EPA's efforts to enhance a national network of NH_3 monitoring using passive samplers. This effort should continue especially in remote areas. Implementation of passive sampling methodology is needed and various passive samplers (such as Alpha, Ogawa or Radiello) could be used. It would make sense to include such measurements as a permanent feature of the national monitoring networks such as CASTNET or NADP.

19. What are the views of the Panel regarding presentation of the standards as a set of tradeoff curves for NOx and SOx associated with specific levels of AAPI, and specific values of the g, V_{NOx}, V_{SOx}, and NHx terms?

It is a reasonable way of dealing with two elements which simultaneously are responsible for acidification of the aquatic and terrestrial ecosystems. As I have stated above, the V values for specific components of deposition generally will have a high level of uncertainty. Therefore final calculations of the NOx or SOx concentrations might be problematic.

20. What are the views of the Panel on using a single year or a three year average of recent year CMAQ modeling results to estimate the AAPI terms?

A single year or an average of three years of measurements based on the CMAQ model is not adequate. There will be large differences in concentrations of the pollutants responsible for

acidification as well as significant spatial and temporal differences in N and S fluxes due to changing weather, distribution of emission sources, and levels of emissions. With an increasing use of green energy and unpredictable climate changes, year-to-year information on annual values (possibly also presented as a running mean of three years) would greatly help in reliable estimates of the AAPI values and reduction of their uncertainties.

21. What are the views of the panel on the ambient monitoring requirements? Is for the proposed three ambient air measurements – NOy, SO_2 and particulate sulfate – sufficient to judge compliance with and AAPI?

Some of the major components of NOy are measured on national air quality monitoring networks (NO and NO_2) as well as SO_2. Fine particulate sulfate has been extensively measured within the IMPROVE and CASTNET networks in remote areas of the US. Among the NOy species, HNO_3 and particulate NO_3 are measured in the CASTNET network. However, organic N is not routinely measured although it may provide substantial levels of reactive N (Zhang et al, 2008). In summary – for a successful national program designed for a long-term understanding of acidifying effects of atmospheric deposition, and information on relevant N and S species, a thorough evaluation of the national air quality monitoring efforts in remote areas is needed. Some techniques, such as the already mentioned passive sampling, should be considered. They can be successfully used for monitoring concentrations of NO, NO_2, NH_3, HONO and HNO_3 and SO_2. Such efforts are already underway in Europe on the ICP Forests Level II plots and have also been conducted in selected areas of the United States and Canada.

22. What are the views of the Panel on using existing NOy and PM2.5 sulfate measurement techniques as the basis for defining a Federal Reference Method to judge compliance with and standard?

Use of chemiluminescence for total NOy measurements seems to be an accepted methodology although uncertainties exist related to reduction of the organically bound and mineralized N (page 2008 of the reviewed document and Navas et al., 1997). Extensive sulfate measurements have been conducted nationwide within the CASTNET, IMPROVE and EPA CNS networks. It seems that these methodologies could be used for defining the Federal Reference Method, although an opinion of experienced atmospheric chemists is recommended.

References:

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