



A perspective on time: Loss frequencies, time scales, and lifetimes

Michael Prather and Christopher Holmes

UC Irvine, Earth System Science Dept, Irvine CA, United States (mprather@uci.edu, 1 949 824 3874)

The need to describe the Earth system and its components with a quantity that has units of time is ubiquitous since the 1970s work of Bolin, Rodhe and Junge. These quantities are often used as metrics of the system to describe the duration or cumulative impact of an action, such as in global-warming and ozone-depletion potentials, as in the SPARC lifetime re-assessment. The quantity designated “lifetime” is often calculated inconsistently and/or misused when applied to the subsequent evaluations of impacts. A careful set of definitions and derivations is needed to ensure that we are reporting, publishing, and comparing the same quantities. There are many different ways to derive metrics of time, and they describe different properties of the system. Here we carefully define several of those metrics – denoted here as loss frequency, time scale, and lifetime – and demonstrate which properties of the system they describe. Three generalizable examples demonstrate (i) how the non-linear chemistry of tropospheric ozone makes simple approaches for tracking pollution in error; (ii) why the lifetime of a gas depends on the history of emissions, and (iii) when multiple reservoirs generate time scales quite separate from the traditionally defined lifetime. Proper use of the many “time” parameters in a system, however, gives a very powerful understanding of the response to anthropogenic perturbations.