**Reversal of Long-Term Trends in Ethane Identified from the Global Atmosphere Watch Reactive Gases Measurement Network**

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Long-term observations of reactive(i.e. short-lived) gases in the troposphere are important for understanding trace gas cycles, assessing impacts of emission changes, verifying numerical model simulations, and quantifying the contributions of short-lived compounds and their response to climate change. The World Meteorological Organization’s (WMO) Global Atmosphere Watch (GAW) program coordinates a global network of surface stations, some of which have measured reactive gases for more than 30 years.  Gas species included under this umbrella are ozone, carbon monoxide, nitrogen oxides, and volatile organic compounds (VOCs). There are many challenges involved in setting-up and maintaining such a network over many decades and to ensure that data are of high quality, regularly updated, and made easily accessible to users. Observations of the non-methane hydrocarbon (NMHC) ethane from the GAW network have shown a recent, remarkable reversal of the northern hemisphere long-term trend. Ethane, the longest-lived, and at levels of ∼0.4 – 2.5 nmol mol-1 (ppb) the most abundant NMHC in the background atmosphere is released from seepage of fossil carbon deposits, volcanoes, fires, and from human activities, with fossil fuel extraction, distribution, and industrial use being the major sources. Global atmospheric ethane peaked around 1970, followed by a downward trend for the next four decades. This was primarily due to reduced emissions from oil and gas industries and stricter air quality emission controls. The near 40-year trend of declining global ethane halted between 2005-2010 in the Northern Hemisphere, and has since reversed. These changes are occurring at a hemispheric scale, but are most evident in the eastern part of the North American continent, downwind over the North Atlantic, and in the free troposphere over Europe, and are most likely driven by emissions increases from North American oil and natural gas development. The ratio of ethane over other NMHC and ethane/methane relationships are used to infer associated emission changes of those gases, and, in combination with photochemical modeling, regional and continental scale impacts on surface ozone, which is an important climate gas. This study exemplifies the value of global reactive gases measurements and provides guidance for defining the observational requirements for monitoring these species.