Earth (and Lunar) Based Observations of Volcanic Emissions to the Stratosphere – An Update Through 2011

R.A. Keen

University of Colorado, Emeritus, Department of Atmospheric and Oceanic Sciences, Boulder, CO 80309; 303-642-7721, E-mail: richard.keen@colorado.edu

In 2004, Dave Hofmann and Ellsworth Dutton of ESRL (CMDL), with T. Deshler, H. Jäger, R. Keen, and M. Osborn, summarized five decades of stratospheric aerosol observations (Hofmann et al., "Surface-Based Observations of Volcanic Emissions to the Stratosphere", in Volcanism and the Earth's Atmosphere, Geophysical Monograph 139, American Geophysical Union.) Among the records were 41 years of lunar eclipse Aerosol Optical Depth (AOD) determinations, now updated through 2011.

About once per year, on average, the moon is totally eclipsed; the moon is then illuminated by sunlight refracted into the umbra, primarily by the stratosphere. Stratospheric aerosols can affect the brightness of the eclipsed moon, and AOD can be determined from the difference between observed and predicted brightness.

AOD data from 1960 to 2011 and from 1880 to 1888 suggest that the impact of the Pinatubo eruption in 1991 was at least as great as that of Krakatau in 1883. Since 1996, stratospheric AOD have been near zero; this is the longest period with a clear stratosphere since before 1960.

Between 1979-1995 and 1996-2012, 17-year mean AOD decreased from 0.035 to 0.002, corresponding to a net increase in climate forcing of +0.71 W/m2 (e.g. Hansen et al., 2002). This is slightly greater than the +0.57 W/m2 increase due to total long-lived greenhouse gases over the same period (ESRL, 2012).

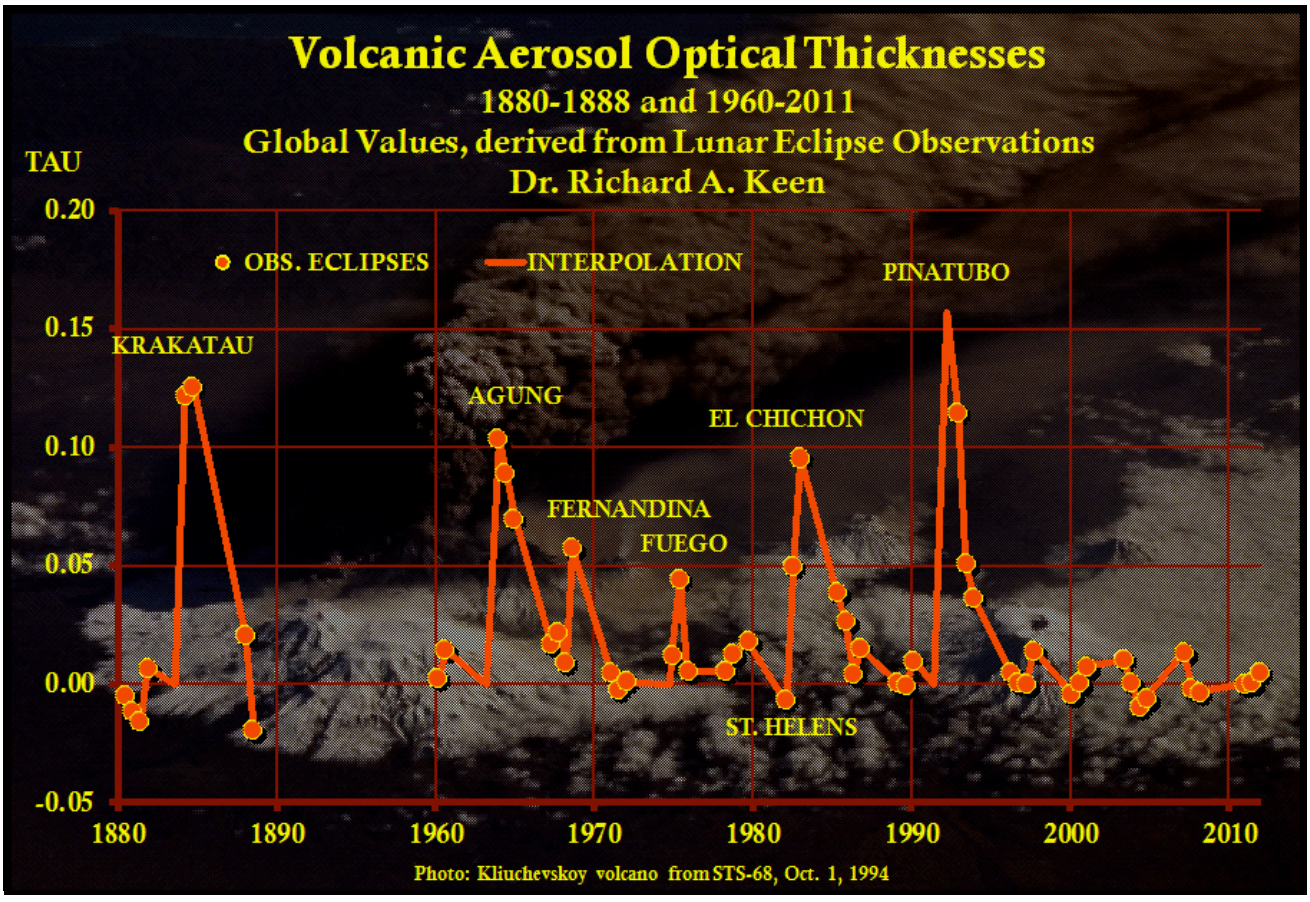

Figure 1. Globally integrated stratospheric aerosol optical depths derived from lunar eclipse observations, 1880-1888 and 1960-2011.