Long-term Influence of Explosive Volcanism. A Model - Data Intercomparison

C M Ammann (Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, CO 80307-3000; ph. 303-497-1705; fax 303-497-1348; e-mail: ammann@ucar.edu); B L Otto-Bliesner (Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, CO 80307-3000; ph. 303-497-1723; fax 303-497-1348; e-mail: ottobli@ucar.edu); J T Kiehl (Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, CO 80307-3000; ph. 303-497-1350; e-mail: jtkon@ucar.edu); W M Washington (Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, CO 80307-3000; ph. 303-497-1321; fax 303-497-1348; e-mail: wmw@ucar.edu)

The influence of explosive volcanism on climate is usually regarded as short-lived, lasting for a few years at the most. A series of ensemble modeling studies with two fully coupled Ocean-Atmosphere General Circulation Models (NCAR CSM~1.4 and NCAR PCM~1) are used to evaluate if temporal close spacing of large eruptions could extend the cooling impact of individual events. These models predict in detail the responses of the hydrologic cycle as a major player for feedback mechanisms that could be involved in buffering or prolonging of the volcanic signal. Additionally, the models reproduce some of the dynamic features that can orchestrate internal modes of climate variability, particularly over the Northern Hemisphere high latitudes during winter time. We focus both on a cold and a warm period to investigate long-term volcanic effects on climate. First, we evaluate possible volcanic contributions to the cooling episodes during the Maunder Minimum period (1645-1715). The cold conditions during this period are generally attributed to significantly reduced solar irradiance, though marked signals also coincide with large volcanic events. Second, as a comparison, we show the effects of volcanic aerosol perturbations to the climate evolution during the increasingly warm 20th-Century, and highlight the role of external forcing in the recent warming. These examples can then be used to compare the response of the climate system to a particular forcing for different states of climate. This aspect might be important to understand the range of the natural climate variability over time.