32. CLIMATE (ICE CORES) AND THE CONSTITUTION #5

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Former Senator Schmitt Summarizes the Role of Greenland and Antarctic Ice Cores in Climate Science

Analysis of ice cores from Antarctica **[1]** and Greenland **[2]** play an important role in understanding the history of global temperatures and atmospheric concentrations of carbon dioxide, methane, and other gases and aerosols. Through analysis of dust, they also provide up to 800,000-year chronologies of global scale volcanic eruptions and major trends toward desertification. Clearly, data from ice cores play a critical underlying role in the science of climate change.

Unfortunately, ice cores do not always appear to be a totally reliable record of past carbon dioxide or methane concentrations in the atmosphere. Their information needs to be confirmed by consistency with data from other sources. Particular care must be taken in the interpretation of the carbon dioxide "record" in ice cores due to core-specific uncertainties in the mechanics of gas preservation over time **[3]**.

In some cases, the trapped "atmosphere" in the ice sheets may not be part of a closed system. To be a closed system for carbon dioxide or methane, no gas components can escape or be added during the burial process; liquid water cannot have interacted with the gases; none of the trapped gas components can combine, separate, diffuse, or solidify; and all components must stay in the same proportions as pressure increases with time due to added ice above. The observational science of ice has demonstrated that for some cores all these conditions do not hold. Further, the process of core extraction from great depth to surface pressure may open and disturb the gas systems.

For example, the Siple Antarctic ice core would suggest that carbon dioxide reached a level of about 330ppm in about 1900. Comparison with the 1960 initial Mauna Loa measurement of 260ppm suggests that either (1) the Siple data is just wrong, or (2) there was a drop of about 60ppm in carbon dioxide level between 1900 and 1960, or (3) it takes 80 some years for the carbon dioxide gas system to close **[4]**. This discrepancy does not appear to have been resolved by the climate community **[5]**; but the smooth shape of the unaltered Siple core carbon dioxide curve as a function of core depth (approaching a constant level with increasing core depth/age) suggests it might not ever have been a closed system. Over time, carbon dioxide in the sampled Siple ice may have gradually equilibrated to a constant carbon dioxide value of about 280ppm now indicated in the 1720-year old and older lay-

ers. Also, this core suffered some melting during transport and prior to analysis [6]. An additional new problem to watch for has been identified at the Dome A site related to freezing from the base of the East Antarctic Ice Sheet, a process that could affect the oldest ice potentially available at some locations [7].

Not surprisingly, considering the known variability in ice preservation, measured carbon dioxide concentrations in the trapped gases of many cores older than about 300 years hold remarkably constant over the last 7-8000 years of ice accumulation [8]. This constancy is incompatible with variability shown in other data, including that from other ice cores and from preserved Ginkgo leaf stomata, both indicating significant variation during that period. Stomata are pores through which a plant takes in carbon dioxide. They vary in size depending on the carbon dioxide concentration in the air; and preserved stomata suggest that carbon dioxide levels ranged between 270 and 326ppm over the last 7-8000 years [9].

Some Greenland ice cores do not show expected temperature driven carbon dioxide increases during the Medieval Warm Period (~800-1300) or the expected decreases during the Little Ice Age (~1400-1900) [10], although these events show clearly in other cores [11]. This further indicates that some ice cores potentially give an unreliable history of atmospheric carbon dioxide, nitrogen, and methane concentrations. On the other hand, up to 123,000 years of climate temperature variations measured in three deep cores from the Greenland ice sheet (GRIP, GISP2, and NGRIP) appear to be consistent with other climate proxy data, such as North Atlantic sediment cores [12].

Analyses from the EPICA Dome C and Vostok cores of the Antarctic ice sheets, on the other hand, show plausible parameter variations. A strong correlation exists back to ~800,000 years ago between carbon dioxide and methane concentrations and deuterium and oxygen isotopic temperature determinations [13]. The approximately 500-year time resolution of these correlations, however, remains insufficient to determine if carbon dioxide and methane changes lead or lag temperature changes. Other, higher resolution ice core information indicates that increases in gas concentrations lag increases in temperature by hundreds of years [14]. Other geological studies suggest a similar lag. For example, about 56 million years ago, marine and continental isotopic records indicate that significant new light carbon appeared in the atmosphere, but isotopic evidence from mammalian teeth stratigraphicaly below the carbon anomaly indicates that a warming period preceded that release [15].

Although carbon dioxide measurements can be suspect in some ice cores, data from many others constitute extremely valuable records of additional parameters that exist within truly closed subsystems. For example, Greenland ice core data indicate that large climatic temperature shifts can occur over a very few years. Oxygen isotopes, deuterium, dust and calcium, sodium, and ice accumulation rates support data from cave deposits that indicate rapid cooling often follows periods of gradual natural warming [16].

The uncritical use of ice core data has characterized ideological presentations by various politicians as well as some climate scientists. One result of the 2010 and future elections must be to place wise officials in policy-making positions in Washington and in the various State Governments. These new officials must not only be committed to having access to good climate science and

debate but also to preventing bad science from being used to justify the further erosion of American liberty and constitutional government.

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