Reconstruction of the Interhemispheric Methane $\delta^{13}C$ Gradient from Polar Firn Air

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A diffusion model for gas isotopes in polar firn (compact snow) is being developed to reconstruct the interhemispheric $\delta^{13}C$ gradient in methane extending towards the beginning of the pre-industrial era. Polar firn preserves a record of the atmospheric composition over time, and measurements of the air within the snow can be used to reproduce the atmospheric history of methane. Firn diffusion models are necessary to correct for diffusional, gravitational, and advective processes that affect the composition of the air in the firn column after the air has become separated from the mixing processes at the snow surface (see Figure 1). Isotopes of stable gases such as N_2 are used to calibrate the magnitude of these effects (see Figure 2). Methane $\delta^{13}C$ data is available from two Greenland expeditions: Tunu (1996) and North Greenland Ice Core Project (GRIP) (2001) and three Antarctic expeditions: South Pole (1995 and 2001) and Siple Dome (1996). Data from Northern and Southern Hemisphere sites make possible the reconstruction of the interhemispheric gradient in $\delta^{13}C$, and a combination of sites with high and low snow accumulation rates in each hemisphere offers both a longer atmospheric history and higher resolution records. Results from the model study will be compared with methane mixing ratio and $\delta^{13}C$ measurements at Alert, Canada and South Pole Observatory as a check for consistency. Preliminary data and details of the model will be presented.

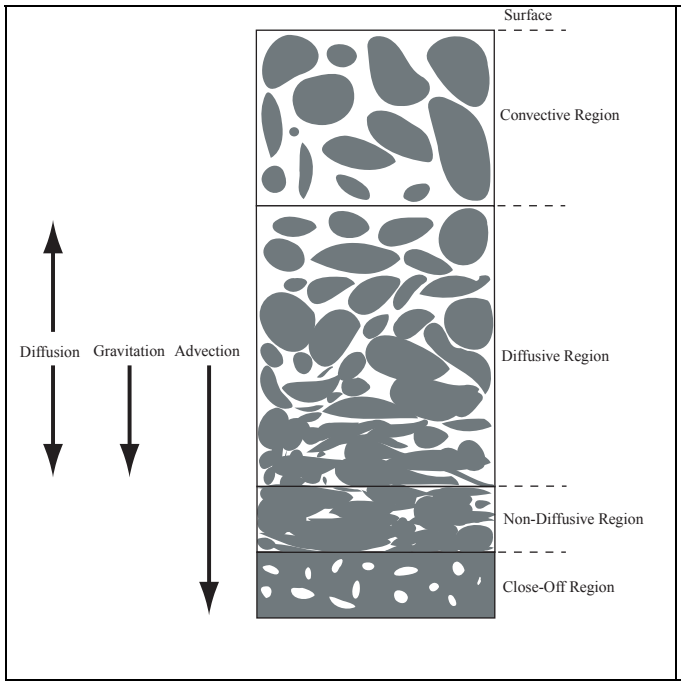

Figure 1. Firn column illustration of regimes that affect air composition. Shaded regions represent snow and white regions are open pore spaces.

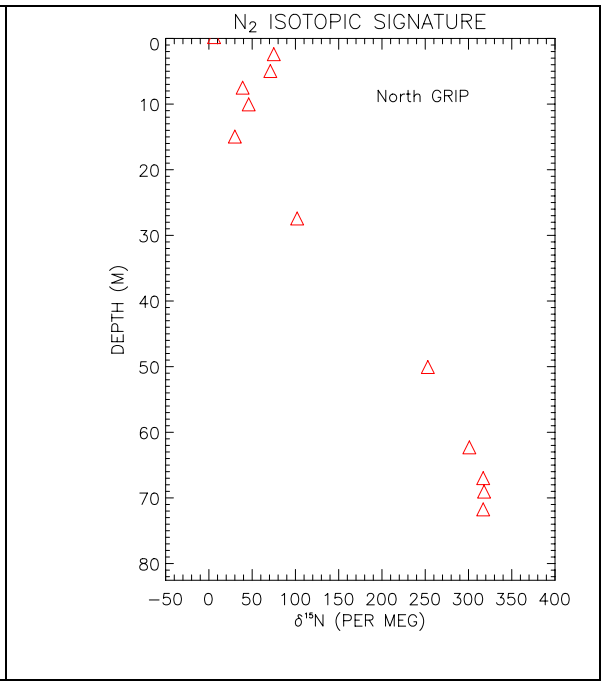

Figure 2. The effect of gravitational settling in the diffusion region can be seen in $\delta^{15}N$ measurements ("per meg" is the difference in nitrogen isotopic ratio from the atmosphere in parts per million).