A community model for transient thermo-mechanical evolution of firn density

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Firn density evolution is relevant for several lines of questioning in glaciology including mass balance and dating ice-cores. Mass-balance studies using laser altimetry must account for the density of the firn column. Interpretation of ice-core records is complicated by the difference in age (called delta age) between the air trapped in bubbles and the ice enclosing the air. Determining delta age requires understanding both densification of polar firn and gas transport through the firn. In the past individual research groups have developed independent models of firn densification and firn gas transport. As partners in the PIRE-ICEICS (*International Collaboration and Education in Ice Core Science*) project[1], we at UW are developing a web-based model of firn densification and gas transport that will combine the best features of those models and is freely accessible to research teams.

In the first and current online version, users can enter site-specific data (accumulation rate, temperature, surface density), and the model provides depth-density-age and delta-age results using the steady-state Herron and Langway[2] algorithm. Several measured density-depth profiles from sites in Greenland and Antarctica can be stored on the server, and can be compared graphically to the firn-density profiles computed with the user's parameters.

In addition to the web-based steady-state model, transient firn-densification and gas-transport models are under development. These models allow physical properties to evolve, resulting in more accurate delta-age approximations at times of rapid climate change in the past. These community models will be downloadable as open-source Python code. They will provide a framework for comparisons among datasets, or against other models. The models are modular, allowing users to choose preferred physical models and physical processes to include, based on available pre-coded options. Alternatively, users can adapt the code to include new or different physics. We hope that user-designed additions can then be added to the community model.

Here, we present results from the first web-based (Herron and Langway) model, and compare those results with measured firn-density profiles.

1. *http://iceics.science.oregonstate.edu*
2. Herron, M.M. and C.C. Langway. 1980. Firn densification: an empirical model. *Journal of Glaciology* 25(93), 373-385.