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IceChrono v1: a probabilistic model to compute a common and optimal chronology for several ice cores

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Polar ice cores provide exceptional archives of past environmental conditions. The dating of ice cores is essential to interpret the paleo records that they contain, but it is a complicated problem since it involves different dating methods. Here I present IceChrono v1, a new probabilistic model to combine different kinds of chronological information to obtain a common and optimized chronology for several ice cores, as well as its uncertainty. It is based on the inversion of three quantities: the surface accumulation rate, the Lock-In Depth (LID) of air bubbles and the vertical thinning function. The chronological information used are: models of the sedimentation process (accumulation of snow, densification of snow into ice and air trapping, ice flow), ice and gas dated horizons, ice and gas dated depth intervals, Δdepth observations (depth shift between synchronous events recorded in the ice and in the air), stratigraphic links in between ice cores (ice-ice, air-air or mix ice-air and air-ice links). The optimization problem is formulated as a least squares problems, that is, all densities of probabilities are assumed gaussian. It is numerically solved using the Levenberg-Marquardt algorithm and a numerical evaluation of the model's Jacobian. IceChrono is similar in scope to the Datice model, but has differences from the mathematical, numerical and programming point of views. I apply IceChrono on an AICC2012-like experiment and I find similar results than Datice within a few centuries, which is a confirmation of both IceChrono and Datice codes. IceChrono v1 is freely available under the GPL v3 open source license.