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Toward unified ice core chronologies with the DatIce tool

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Antarctic and Greenland ice cores provide a means to study the phase relationships of climate changes in both hemispheres. They also enable to study the timing between climate, and greenhouse gases or orbital forcings. One key step for such studies is to improve the absolute and relative precisions of ice core age scales (for ice and trapped gas), and beyond that, to try to reach the best consistency between chronologies of paleo records of any kind.

The DatIce tool is designed to increase the consistency between pre-existing (also called background) core chronologies. It formulates a variational inverse problem which aims at correcting three key quantities that uniquely define the core age scales: the accumulation rate, the total thinning function, and the close-off depth. For that purpose, it integrates paleo data constraints of many types among which age markers (with for instance documented volcanoes eruptions), and stratigraphic links (with for instance abrupt changes in methane concentration). A cost function is built that enables to calculate new chronologies by making a trade-off between all the constraints (background chronologies and paleo data). The method presented in Lemieux-Dudon et al (2010) has already been applied simultaneously to EPICA EDML and EDC, Vostok and NGRIP. Currently, on going works are conducted at LSCE Saclay and LGGE Grenoble laboratories to construct unified Antarctic chronologies by applying the DatIce tool with new ice cores and new sets of paleo measurements.

We here present the DatIce tool, the underlying methodology, and its potential applications. We further show some improvements that have been made recently. We especially adress the issue related to the calibration of the error of pre-existing core chronologies. They are inputs that may have a strong impact on the results. However these uncertainties are uneasy to analyze, since prior chronologies are most of the time assessed on the basis of glaciological models (firn densification and ice flow models) which still face large uncertainties (forcing fields, model parameters, mechanic and physic formulation). For that reason, we chose to calibrate errors by applying consistency diagnostics, a classical method in data assimilation (Desrozier et al, 2009).