continuation of a long-term warming. However, the warming appears to have been accelerated towards the present day.

Integration of the complementary information greatly improves the comparability of the reconstructed temperatures and the Crowley (2000) radiative forcing history (Fig. 2). Analysis of the reconstructed temperature and radiative forcing series offers an independent estimate of the transient climate-forcing response rate of 0.4 - 0.7 K per Wm$^{-2}$ and predicts a temperature increase of 1.0-1.7 K in 50 years (Huang, 2004).

**Discussion**

It is worth pointing out that the integrated reconstruction is not a simple superposition of the high frequencies of the multi-proxy reconstruction on the lower frequencies of the borehole reconstruction. The integrated reconstruction consolidates information given in the subsurface temperature data and in the a priori model. For the 20th century, where the a priori multi-proxy model is well trained by the meteorological record, little alternation is made through the inversion. At very long periods, the subsurface temperature data provide information that is weak or absent in the multi-proxy reconstruction. At intermediate periods both the a priori model and subsurface data provide important constraints.

The improvement in the comparability between climate reconstruction and the radiative forcing series is a validation of the climate information integration strategy. The good agreement between the integrated reconstruction and the forcing model confirms that there are both natural and anthropogenic factors influencing the recent warming.

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**References**


For full references please consult: www.pages-igcop.org/products/newsletters/ref2006_2.html
these models, such that multiple circulation strengths occur for the same rate of freshwater supply to the high latitudes. The freshwater hypothesis is apparently supported by the observation of ice rafted debris in North Atlantic sediments during the cold phases of abrupt climate change. Records of global sea level, which provide an integrated measure of the freshwater forcing history, would provide another test for this hypothesis.

**Uncertain physics**

Among the major uncertainties in numerical models of the ocean circulation is the representation of sub-grid scale phenomena. The most common assumption is that the transport of properties such as momentum, heat, and salt at small scales acts as a diffusion of these variables at large scales that is effectively resolved by the models. Most notably, the issue of the representation of small-scale vertical mixing is gaining a lot of attention, following a claim that this mixing may actually force the meridional circulation and its attendant heat flux (Munk and Wunsch, 1998).

According to a scaling theory of the oceanic thermocline based on various approximations in the equations of motion, different assumptions about vertical mixing leads to a qualitatively different response of the meridional circulation to the surface freshwater forcing (Fig. 1a). The assumptions considered are representative of the range of what is physically justifiable, including mixing represented with constant vertical diffusivity, stability-dependent diffusivity, and fixed mixing energy. The solutions are generated from a 4-box model of the global meridional circulation, thereby extending the single-hemisphere model study of Nilsson and Walin (2001).

**Bayesian stochastic inversion**

For each of the three mixing representations, we use a method of "Bayesian Stochastic Inversion" (Jackson et al., 2004) to estimate the time evolution of freshwater forcing (Fig. 1b) that permits each model to reproduce the Greenland ice core record between 39-30 ka BP (Fig. 1c). The method works by randomly guessing the freshwater forcing for 81 evenly spaced points along the 9 kyr interval and using information about the effects of this guess on model-data mismatch to guide subsequent forcing histories. This process is repeated multiple times and the statistics of the results are collected. Thus, solutions may be represented by a multi-dimensional probability distribution indicating the relative likelihood, the uncertainties, and the dependencies of the different quantities that are inferred from the original data. Illustrated in Figure 1b-c are the optimal (most likely) solutions that provide the minimum mismatch between the data and the model.
Late Holocene hydrological variability in ombrotrophic peatlands of eastern North America

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Introduction
Ombrotrophic peatlands, particularly “raised bogs”, comprise a rich but underutilized source of Holocene paleoenvironmental records for North America. These peatlands, which are scattered from the Atlantic to the Pacific coasts at latitudes between 42° and 65°N, are dominated by Sphagnum moss and a few vascular plants, have elevated surfaces, and receive all surface moisture directly from the atmosphere. Water tables of these bogs are perched above the groundwater table, and most water loss is through evapotranspiration. Accordingly, ombrotrophic bogs are hydrologically sensitive to precipitation and temperature variations across a range of temporal scales, from seasonal to millennial.

Sedimentary records from ombrotrophic peats can span 1000-10,000 years, with temporal resolution ranging from sub-centennial to sub-decadal depending on accumulation rates. A variety of paleoenvironmental proxies, including testate-amoebae, peat humification, pollen, plant macrofossils, charcoal, stable isotopes (H, C, O), and biomolecular markers, are preserved in these peats. We are conducting a study of all of these proxies in late Holocene peats from raised bogs along a transect spanning the Great Lakes/St. Lawrence corridor, from Minnesota to Maine. We are coupling these paleoclimate reconstructions with extensive modern calibration studies and investigations of historical climate variability. These studies are leading to detailed multivariate climatic reconstructions and development and testing of hypotheses regarding the underlying climate dynamics.

Peatland records of drought synchrony in the Central United States
Peat records from sites 1000 km apart in north-central Minnesota (Hole Bog) and southeastern Michigan (Minden Bog) span the past...