Abrupt climate changes, in which temperatures may change by 10°C and/or precipitation may double or halve in a matter of years, are of great interest as such changes seriously challenge the adaptive capacity of even modern, wealthy societies. Greenland ice cores are well suited for the study of past abrupt climate changes because their relatively high snow accumulation rates allow single years to be identified well into the last glacial period. Isotopic and chemical impurity records from Greenland ice cores with sub-annual resolution across three fast climate transitions of the last deglacial termination reveal complex patterns of environmental change. In the NGRIP ice core, for example, each of these transitions is initiated by a 1-3 year mode shift in deuterium excess, a proxy for the Greenland precipitation moisture source. These mode shifts in deuterium excess are decoupled in time from the isotopic transitions from which they are derived. Along with other available paleo-data, these results indicate that the sum of an abrupt climate change is composed of multiple responses from different parts of the climate system, giving each a unique anatomy or structure. Here we expand this type of analysis with data from several abrupt transitions associated during the Last Glacial period (Dansgaard-Oeschger events) and with new data from several transitions recorded in the recently drilled NEEM ice core. Together with modeling and chemical impurity data, patterns can be identified that provide clues to the timing and origin of the oceanic and atmospheric changes that comprise an abrupt climate change.