400 YEARS OF LARGE FLUENCE SOLAR PROTON EVENTS

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The geophysical significance of the thin nitrate-rich layers found in both Arctic and Antarctic firn and ice cores, dating from the period 1561- 1991, is examined in detail. The thin nitrate layers have a characteristic short time scale (< 6 weeks) and are highly correlated with periods of major solar-terrestrial disturbance. A one to one correlation is demonstrated between the seven largest solar proton fluence events that have been observed since continuous recording of the cosmic radiation and the corresponding thin nitrate layers for the event date. A conversion factor has been established between the impulsive transient nitrate concentrations and the >30 MeV solar proton fluence. We have computed proton fluence data for the largest 125 impulsive nitrate events These events, all with >30 MeV proton fluences exceeding $1x10^9/cm^2$ have been used to derive a cumulative normalized probabilities for the occurrence of large fluence >30 MeV solar proton events during this 400-year interval. The proton fluence probability distribution derived from these large impulsive nitrate events are in good agreement with earlier studies of the cumulative probabilities of solar proton events and with the observation of cosmogenic isotopes in moon rocks.