THE GLOBAL TRENDS AND MASS BALANCE OF F-113

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The uses of Trichlorotrifluoroethane, also known an F-113 ($C_2CL_3F_3$), have been increasing rapidly leading to atmospheric growth rates of 10-12% per year. The concentrations have doubled during the last 5 years. We have taken weekly measurements that now span about 7 years and 7 sites distributed over latitudes ranging from inside the arctic circle to the south pole. The sites are Barrow, Alaska (72°N latitude), Mauna Loa Observatory and Cape Kumukahi (20°N latitude) in Hawaii, Samoa (10°S latitude), Cape Grim, Tasmania (42°S), and the South Pole. To analyze these data we constructed a time-dependent model describing the global transport and mass balance of F-113 in four regions of the atmosphere of equal masses, namely 0-30° and 30-90° latitudes in each hemisphere. The model is designed to simultaneously determine the optimal values of the increasing emissions and the lifetimes that would explain the observational data. The optimization is accomplished by weighted least squares comparing measured and calculated concentrations. In addition, the gradients between the 4 regions and the rates of increase in the 4 regions are also included in determining the optimal fits. The procedure uses an exact solution of the global mass balance equations. Tens of thousands of potential combinations of sources and sinks are assessed to find the optimal and near optimal solutions. This provides a measure of the uncertainties in the estimated lifetimes and emissions. The results are shown in the figure below which contains the measured concentrations and those optimally fitted by the model with an lifetime of 70 years an annual emissions of 100 million kg/yr increasing exponentially at 5% per year. The lifetime and estimated emissions agree well with other independent assessments.

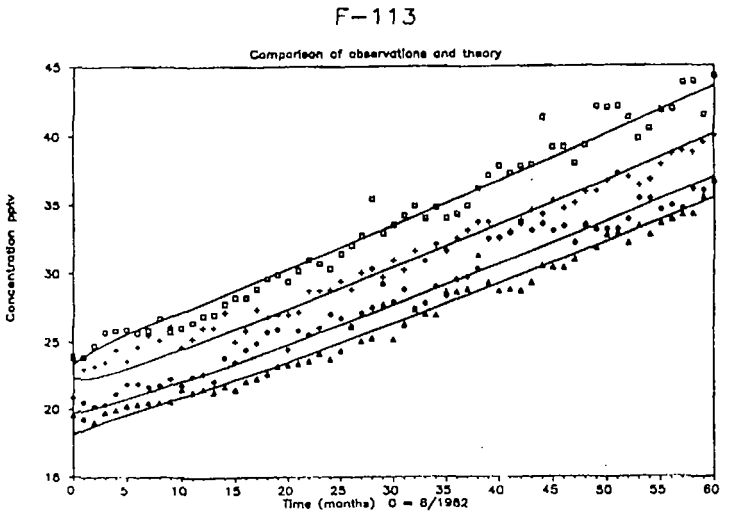

Fig. 1: MASS BALANCE OF F-113: Symbols are measured concentrations at latitudes between 0-30° and 30-90° in each hemisphere. The solid line is the optimal model fit described in the text.