

The Inverse Problem

Definition and Properties

In this chapter the problem of obtaining information about the causative electron precipitation directly from X-ray measurements will be examined. We will term this the “X-ray inversion problem.” This type of analysis belongs to a broad class of what are called inverse problems, which attempt to reconstruct physical events based on limited measurement data. A classic example of an inverse problem is the determination of media velocities within the Earth based on seismic measurements at discrete points. The “forward problem” of predicting instrument responses based on an assumed physical event can be handled by, for example, computer simulations, as was done in the last chapter for the problem of predicting the measured X-ray distributions which result from a given electron precipitation event. Unlike forward problems, inverse problems have mathematical properties which make them difficult or impossible to solve without significant a-priori assumptions. For the X-ray inversion problem, we will show the reasons for this, and demonstrate some measures which can be taken to mitigate these effects.

We will use the terms used by Tarantola2004. Define the forward problem by the mapping:

equation $F:M \rightarrow D$