Abstract

The aim of this thesis is to present a new local analysis tool for analyzing the meteorological data assimilation problem. This analysis is based on the representation in form of wave-packets and extends the standard Fourier analysis for differential optimization problems governed by elliptic partial differential equations to non-elliptic problems. In our study the data assimilation which is an inverse problem is formulated as a constrained optimization problem, where the cost functional consists of a distance function and the constraint is given by a model problem. An accurate model for the data assimilation involves the Navier-Stokes equations and in certain cases the Euler equations. In order to understand the diverse and intricate aspects of the problem we have formulated three model problems which aim at tackling some of the basic difficulties faced in the real-life problem. We have studied the effect of dissipation and dispersion in different discretization schemes on the identifiability of the data in the problem. Due to a major loss of information in case of long distances, dissipation will, in principle, result in bad estimates if measurement locations are far away. We are demonstrating results of several model cases, including the advection equation and a system of wave equations. For this purpose, we have used different types of data, in terms of measurement locations and their amount.

Keywords: Constrained Optimization, Data Assimilation, Differential Optimization, Dissipation, Local Fourier Analysis