INVERSE PROBLEMS IN GREENHOUSE GAS MODELLING

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1. INTRODUCTION

The concentrations of radiatively active gases, including CO_2, N_2O and CH_4, in the atmosphere have been steadily increasing, as indicated by both direct observations and measurements of gas concentrations in air bubbles trapped in polar ice. The influence of these gases on the earth's radiation budget is predicted to change the earth's climate by an amount greater than any change in recorded history. Because of these effects, the study of the sources and sinks of these gases has taken on considerable importance.

The biogeochemical cycles involving these so-called 'greenhouse gases' are of considerable complexity and have been the subject of many investigations. However much of the information that is obtainable gives only indirect measures of the key processes involved. In mathematical terms, the consequence of this reliance on indirect information is that many modelling studies of greenhouse gases involve ill-conditioned inverse problems. In only a small proportion of such studies has the associated inverse problem been analysed in any detail [1], [2].

The purpose of this report is to draw attention to a number of inverse problems in the area of greenhouse gas modelling, in the hope of stimulating further study in this area. Many of the examples are expressed in terms related to ODEs rather than the PDEs which are the main topic of this volume. However, it must be appreciated that such 'ODE' formulations are almost always 'lumped' representations of multi-dimensional systems whose properties are described in terms of PDEs, particularly those representing