EC4MACS – An Integrated Assessment Toolbox of Well-Established Modeling Tools to Explore the Synergies and Interactions between Climate Change, Air Quality and Other Policy Objectives

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Abstract. EC4MACS (European Consortium for Modelling of Air Pollution and Climate Strategies) establishes a suite of modelling tools for a comprehensive integrated assessment of the effectiveness of emission control strategies for air pollutants and greenhouse gases. This assessment brought together expert knowledge in the fields of energy, transport, agriculture, forestry, land use, atmospheric dispersion, health and vegetation impacts, and it developed a coherent outlook into the future options to reduce atmospheric pollution in Europe. In this paper, first we introduce background to the EC4MACS framework, which links well-established sectoral models of the most relevant policy areas. In this context, an ETL package is used to gather extracted information from multiple model data sources. The integrated data are loaded into the GAINS (Greenhouse gas-Air pollution Interactions and Synergies) Data Warehouse. Afterwards, a web service based toolbox is developed to publish EC4MACS key data, which are represented in this paper in term of case studies.

Keywords: EC4MACS , Data Warehouse, ETL (Extraction, Transformation, and Loading process), Web Services, Integrated Assesment Model, GHG (greenhouse gas) emissions, pollutant.

1 Introduction

Emissions to the atmosphere cause a variety of negative impacts on climate and air quality. In addition, pollution does not comprise a single chemical substance, but consists of a cocktail of many pollutants originating from a wide range of human activities and natural sources that can be controlled to different extents at different costs [1,2]. Thus, cost-effective response strategies need to consider cause-effect relationships for multiple pollutants and multiple effects, and how they are interconnected with each other. To assess and compare mitigation potentials and costs, IIASA has employed its GAINS model [4,11], an extension of

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its flagship integrated assessment model RAINS. The GAINS approach provides a framework for a coherent international comparison of the potentials and costs for emission control measures, both for GHGs and air pollutants.

However, the GAINS model does not cover the full range of relevant driving forces that cause pollution, nor does it represent the full range of environmental and economic impacts of pollution [1,8]. As these aspects cannot be ignored in the design of cost-effective response strategies, the EC4MACS framework has been studied to link existing computer modeling tools to enable a holistic and coherent assessment of policy response options. In this context, the GAINS data warehouse, as the core integrated assessment tool of EC4MACS framework, represents the cause-effect chains for health impacts, vegetation damage and climate change, taking into account the sources and control potentials of five air pollutants and six greenhouse gases [9]. In particular, it describes the simultaneous effects of specific control measures on the emissions these air pollutants and greenhouse gases, and the physical and chemical interactions of these emissions in the atmosphere.

In this paper, the EC4MACS integrated assessment framework is presented as business intelligent system with web service-based software tool tointeractive among its multiple modes. First, we introduce EC4MAC multiple model concepts, which can be used to explain the basic workings of the framework. In this context, data from multiple models, i.e.the PRIMES energy model [3], the TREMOVE transport model [10], the CAPRI agriculture model [13], the EMEP atmospheric dispersion model [7], the GEM-E3 macro-economic general equilibrium model and the Beta and External benefit assessment approaches [5] are integrated into the GAINS Data Warehouse by using ETL process. Furthermore, the business intelligent toolbox can be considered as a suite to make available and to compare the implications of the outputs of different system models working at different spatial and temporal scales, and the EC4MACS system architecture illustrates the data interfaces among such models and the general data flows.

The rest of this paper is organized as follows: section 2 introduces some approaches and projects related to our work; in section 3, after an introduction of EC4MACS concepts, an EC4MACS data warehousing system architecture is presented. Section 4 will present our implementation results in term of typical case studies. At last, section 5 gives a summary of what have been achieved and future works.

2 Related Work

To assess and compare mitigation potentials and costs, IIASA has employed its GAINS model [4,11], an extension of its flagship integrated assessment model RAINS. The GAINS approach provides a framework for a coherent international comparison of the potentials and costs for emission control measures, both for GHGs and air pollutants. It estimates with which measures in which economic sector the emissions of the six greenhouse gases could be reduced to what extent,