Expression of Interest

for an

Integrated Project

QUANTIFY

Quantifying the Climate Impact Of Global and European Transport Systems

submitted by

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1. Motivation

The transport sector contributes about one third of the total global anthropogenic greenhouse gas emissions. The annual growth rate of transport related greenhouse gas emissions is larger than for other mature industrial sectors. In the light of the UN Climate Framework Convention, the Kyoto Protocol and follow-up Protocols, this rate of increase creates a severe problem when trying to achieve emission reduction targets. On the other hand, our economic system is largely dependent on an efficient transport system. This dependency has been growing during the recent decades. Furthermore, the current life style of the people in the developed countries creates the demand for transport. In addition, a strong growth is expected in the developing countries. Hence, in the long term we need a sustainable transport system which satisfies in an optimal way the demands of the economy and population whilst following the constraints of climate protection.

Transport can impact climate in several ways: (1) by direct emission of greenhouse gases, mainly CO_2 but also N_2O, PFCs or HFCs; (2) by emission of indirect greenhouse gases, i.e., precursors of greenhouse gases like NO_x, CO or VOCs; (3) by emission of aerosols, in particular soot and sulphur products, which are directly and indirectly (via cloud formation and cloud modification) radiatively (and chemically) active; (4) by directly triggering additional clouds (e.g., contrails). At present only the six gases from the Kyoto basket[1] can be included in emission trading, using the 100-year Global Warming Potential as exchange rate. Currently, no suitable metric has been agreed which allows for the scientifically credible inclusion of other effects, e.g. contrails, ozone precursors or particles. For these components the climate effect strongly depends on the *location* and *time* of the emission or on the positions of the additional clouds. An additional complication is that a large fraction of the traffic emissions, in particular from international aviation and ship traffic, occurs outside the borders of the nations, and may thus be difficult to regulate.

While the climate effects of the aviation sector have been the subject of assessment reports (e.g., Brasseur et al., 1998[2]; IPCC, 1999[3], Schumann and Ström, 2001[4]), the global climate impact of other sectors of transport have not yet been assessed in a consistent way. A consistent assessment would make possible a fair inter-comparison of individual contributions and therefore a fair judgement of impact of changes in the mode of transportation or the value of mitigation techniques. An example of the need for assessment of other forms of transport is the fact that CO_2 emissions from road traffic exceed by at least a factor of 5 those from air traffic.

In the light of the development time and long life time of land, sea and air vehicles, together with transport infrastructure (several decades up to 100 years), the long residence time of some of the emitted species and the high thermal inertia of the climate system, it is clear that the potential mitigation procedures need to be assessed soon in order provide policy makers and industry with a good guidance for their decisions.

2. Objectives and Questions

Based on the considerations outlined above the objective of QUANTIFY is

- *to quantify the climate impact of global and European transport systems for the present and for different scenarios of the future development.*

[1] CO_2, CH_4, N_2O, PFC, HFC, SF_6.

[2] Brasseur, Cox, Hauglustaine, Isaksen, Lelieveld, Lister, Sausen, Schumann, Wahner and Wiesen, 1998: European scientific assessment of the atmospheric effects of aircraft emissions. *Atmos. Environ. 32*, 2329-2418.

[3] IPCC, 1999: *Aviation and the Global Atmosphere.* A Special Report of IPCC Working Groups I and III. Cambridge University Press, Cambridge, UK, 185-215.

[4] Schumann, U. and J. Ström, 2001: Aviation imapct on atmospheric composition and climate. *European Research in the Stratosphere 1996-2000.* European Commission, EUR 19867, 257-307.

In order to achieve this objective the following questions need to be answered:[5]

- How are the present and future emissions of the various components of transport distributed both geographically and vertically? How are these emissions diluted on the global scale and what are the resulting distributions of radiatively active species?
- How does the geographical location, altitude and time of emissions impact the resulting distributions of radiatively active species and finally climate change
- What is the contribution from the various modes of transportation? How do the climate effects compare in terms of specific changes, e.g., climate changes per passenger kilometre or per tonne kilometre? How do the transport-induced climate changes compare with the total anthropogenic climate change and with natural climate variability?
- What metrics should be used to compare the climate effects of the various emissions and to generate an "exchange rate" for emission trading and comparison of transport alternatives?
- What are the impacts on economy and health?
- What would be the impact of using alternative fuels, e.g. hydrogen, in different sectors of transport?
- What is the potential for reducing climate change through reduction of emissions from transport? What are the policy options; i.e. what is technically and politically feasible? What are potential economic impacts of different mitigation measures?

3. Contribution to EU policies

The suggested Integrated Project QUANTIFY is not only interdisciplinary, but would also contribute to different priority thematic areas of FP6:

1.1.6.3 Global change and ecosystems;
1.1.6.2.i Sustainable surface transport: Developing environmentally friendly transport systems and means of transport;
1.1.6.1 Sustainable energy systems;
1.1.4.i Aeronautics.

During the last decade, the EC has funded several successful projects on the topic of the atmospheric impact of aviation. This resulted in the formation of a critical mass of research effort in Europe and brought Europe to a leading position. The IPCC Special report "Aviation and the Global Atmosphere" was triggered by a proceeding European Assessment. Likewise the Integrated Project QUANTIFY would promote a similar process for the total transport sector. This would strengthen the European position in IPCC and the post-Kyoto process. In total, Europe has the capacity to answer the above questions, while each of the individual countries would be unable the address the objective adequately. With early access to the results of the QUANTIFY project, European industry might gain a competitive advantage in the adaptation to sustainable production. It might even be expected that QUANTIFY could trigger an IPCC special report on Transport and Climate.

4. Scientific topics

The following section provides an outline of the planned activities. More details will be developed during a definition phase prior to the call for proposals. The topics are organised such that similar tools are in the same topic, and not with respect to different sectors of traffic. This ensures that all sectors of transport will be subject to a systematic, consistent study. Eventually, this will allow for fair comparison of the sectors. Note also that the consortium will address some of these problems using a range of model types, as it is well known, within the atmospheric science community, that

[5] Note that some parts of the question have already been or are currently being addressed in EU research projects like AERO2K, METRIC or TRADEOFF. The suggested project will build on these projects by developing a more comprehensive approach.

different models can respond differently to the same scenarios. Understanding will be advanced by exploring the reasons for these different responses.

T 1 Traffic scenarios

Development of traffic scenarios including differentiation into different traffic modes. These scenarios will generally be consistent with selected IPCC SRES scenarios of economic and population growth, but we will not be bound by these scenarios where we believe that there is good reason to use alternatives. EU transport policies will also be assessed within these scenarios, including directives under preparation. Additionally, mitigation scenarios will be developed, including transition scenarios to alternative fuels like hydrogen. **Deliverables:** Description of traffic scenarios and 2D data of traffic flow distributions.

T 2 Emission scenarios

Updating emission indices by measurement and models, development of scenarios for future emission scenarios. For each transport sector the calculation of 3D/4D[6] emission inventories will be based on traffic scenarios, emission indices and a knowledge of the performance of land, air and sea vehicles. **Deliverables:** Emission inventories for multiple components.

T 3 Regional dilution of emissions

For selected regions, e.g. relatively clean or heavily polluted environments, calculation of the dilution and chemical/physical transformation of the primary emissions by means of simulations with small-scale and regional-scale models. Modification to the emission scenarios s will be included to account for sub-grid scale effects within the large scale emission scenarios. **Deliverables:** Modified emission inventories for multiple components.

T 4 Global and regional transport and transformation of emissions

Performing simulations with chemistry transport models and coupled climate-chemistry models (including aerosols) for various (modified) emission scenarios. Knowledge of the change in atmospheric composition will also allow for quantification of local air quality, transboundary photochemical oxidants and acid deposition. **Deliverables:** Global distribution of radiatively active species.

T 5 Climate simulations

Calculating the climate response to changes in the global distribution of radiatively active species for several scenarios by means of climate models (GCMs) or the response to emissions scenarios by means of coupled climate-chemistry models. **Deliverables:** Data on the change in meteorological variables both past and future describing the response to emissions associated with transport.

T 6 Development of metrics

Development of metrics applicable for emission trading, comparison of various transport alternatives and policy decisions. Currently used metrics, like radiative forcing or green house warming potential, are not adequate for short-lived species. Hence improved metrics should also account for the effects of these species. **Deliverables:** Formulae for the calculation of metrics and method for comparison.

T 7 Economic evaluation

Economic evaluation of several traffic scenarios and mitigation options, in part by applying integrated assessment models. The economic evaluation will include aspects of the ancillary benefits of transport-related mitigation, to ensure that issues such as the impacts of particulate and other emissions are considered fully within this framework. **Deliverables:** Evaluation reports.

T 8 Political and ethical evaluation

Analysis of the various scenarios and mitigation options from an ethical and political perspective. **Deliverables:** Evaluation reports.

[6] 2 (surface traffic) and 3 (aviation) dimensions in space and 1 dimension in time.

T 9 Impact on health
Analysis of the impact of various transport-induced emission and climate scenarios on health. **Deliverables:** Evaluation reports.

5. Tools

The objective of QUANTIFY will be addressed by a variety of scientific tools: in situ and remote sensing measurements, numerical models of various types, complexity and scales (ranging from integrated assessment models to comprehensive climate-chemistry models), theoretical considerations, thought experiments, valuation methodologies.

6. Management structure

The suggested Integrated Project QUANTIFY will have a size which requires a partitioning into several sub-projects each with a sub-project co-ordinator[7]. The co-ordinator and the sub-project co-ordinators will form the steering committee of the Integrated Project. In addition, an advisory board with scientists from outside the project, representatives from relevant industries and members from the EC would be established.

DLR is prepared to co-ordinate QUANTIFY. The co-ordinator will have assistance from a support unit, including a full time scientific administrator. DLR has the capability, experience[8] and personnel for such tasks. The support unit will assist in the implementation of an electronic data base for important results and input data, distribution of results via reports, joint peer reviewed papers, internet and special conferences and workshops. Finally an assessment report will be organised.

The consortium is not yet fixed at the stage of the EoI. Nevertheless, Annex 1 provides a list of potential members of the consortium, which are ready and willing to participate in QUANTIFY. [9]

The consortium is ready to accept further members, in particular from the accession countries. This is of particular importance as the increase in traffic in accession countries is expected to be particularly high.

7. Integrating activities

An inter-disciplinary project usually suffers from the different "languages" spoken by the different disciplines. This barrier in knowledge flux will be reduced by joint workshops and temporary exchange of personnel. In the course of the integrated project a joint understanding of the issues will occur despite the different disciplines involved in the QUANTIFY project. Such dialogue has already begun within Europe between the atmospheric science community and the aviation sector.

[7] At the stage of the EoI the sub-project co-ordinators have not yet been nominated.
[8] E.g., from space missions or from the German national "Schadstoffe in der Luftfahrt" programme.
[9] Annex 1 is available on request.