

COST

Domain Committee ESSEM

COST Action ES1004

Start Date 28/02/2011

*European framework for online integrated air quality
and meteorology modelling*

MONITORING PROGRESS REPORT

Reporting Period: 28/02/2011 – 01/05/2012

This Report is presented to the relevant Domain Committee.
It contains three parts:

- I. Management Report*** prepared by the COST Office/Grant Holder
- II. Scientific Report*** prepared by the Chair of the Management Committee of the Action
- III. Previous versions of the Scientific Report; i.e., part II of past reporting periods***

The report is a “cumulative” report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter *II.D. Self evaluation*.

Based on the monitoring results, the COST Office will decide on the following year’s budget allocation.

Executive summary (max.250 words): The COST Action - European framework for online integrated air quality and meteorology modelling (EuMetChem, <http://eumetchem.info/>) is focusing on a new generation of online integrated Atmospheric Chemical Transport (ACT) and Meteorology (Numerical Weather Prediction and Climate) models with two-way interactions between different atmospheric processes including chemistry (both gases and aerosols), clouds, radiation, boundary layer, emissions, meteorology and climate. Two major application areas of the integrated modelling are considered: (i) improved numerical weather prediction (NWP) and chemical weather forecasting (CWF) with short-term feedbacks of aerosols and chemistry on meteorological variables, and (ii) two-way interactions between atmospheric pollution/ composition and climate variability/change. The frame-work consists of 4 WGs namely: 1) Strategy and framework for online integrated modelling; 2) Interactions, parameterisations and feedback mechanisms; 3) Chemical data assimilation in integrated models; and 4) Evaluation, validation, and applications. Establishment of such a European framework (involving also key American experts) enables the EU to develop world class capabilities in integrated ACT/NWP-Climate modelling systems, including research, education and forecasting.

I. Management Report prepared by the COST Office/Grant Holder



I.A. COST Action Fact Sheet

Title
European framework for online integrated air quality and meteorology modelling

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Details	
Draft Mou: oc-2010-1-6355	Mou:
Start of Action: 28/02/2011	Entry into force: 17/01/2011
End of Action: 27/02/2015	CSO approval date: 02/12/2010

Objectives
The COST Action - European framework for online integrated air quality and meteorology modelling (EuMetChem) is focusing on a new generation of online integrated Atmospheric Chemical Transport (ACT) and Meteorology (Numerical Weather Prediction and Climate) models with two-way interactions between different atmospheric processes including chemistry (both gases and aerosols), clouds, radiation, boundary layer, emissions, meteorology and climate. Two major application areas of the integrated modelling are considered: (i) improved numerical weather prediction (NWP) and chemical weather forecasting (CWF) with short-term feedbacks of aerosols and chemistry on meteorological variables, and (ii) two-way interactions between atmospheric pollution/ composition and climate variability/change. The framework consists of four working groups namely: 1) Strategy and framework for online integrated modelling; 2) Interactions, parameterisations and feedback mechanisms; 3) Chemical data assimilation in integrated models; and finally 4) Evaluation, validation, and applications. Establishment of such a European framework (involving also key American experts) enables the EU to develop world class capabilities in integrated ACT/NWP-Climate modelling systems, including research, education and forecasting.

Parties							
Country	Date	Country	Date	Country	Date	Country	Date
Austria	04/05/2011	Bulgaria	11/02/2011	Denmark	31/01/2011	Estonia	23/02/2011
Finland	07/02/2011	France	17/01/2011	Germany	20/01/2011	Greece	17/01/2011
Hungary	12/04/2011	Israel	11/02/2011	Italy	17/01/2011	Malta	23/02/2011
Netherlands	21/01/2011	Norway	11/02/2011	Poland	17/01/2011	Portugal	20/04/2012
Serbia	04/04/2011	Slovenia	29/11/2011	Spain	21/01/2011	Sweden	16/09/2011
Switzerland	23/02/2011	Turkey	20/04/2012	United Kingdom	17/01/2011		

Total: 23

Intentions to accept the MoU							
Country	Date	Country	Date	Country	Date	Country	Date

Total: 0

Participating Institutions from non-COST countries

United States	University of Iowa
Ukraine	Odessa State Environmental University

Participating Institutions from the European Commission

Joint Research Center, Institute for Environment and Sustainability

Participating European/International Bodies

European Centre for Medium-Range Weather Forecasts
European Environment Agency, EEA

Working Groups

WG1: Strategy and framework for online integrated modelling
WG2: Interactions, parameterizations and feedback mechanisms
WG3: Chemical data assimilation in integrated model
WG4: Evaluation, validation and applications

Website

http://eumetchem.info/

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I.C. Overview activities and expenditure

Variant from the Grand Holder (Christina)

Instrument	Event					Total
Type	Start Date	End Date	City	Cntr.	Title	Total
DISSEMINATION	2011-08-29	2012-04-24	(n.a.)	(n.a.)	Overview of online coupled models paper	2300
DISSEMINATION	2011-08-29	2012-03-30	(n.a.)	(n.a.)	Action Website (part one)	1000
DISSEMINATION	2012-03-23	2012-03-30	(n.a.)	(n.a.)	Action Website (part two)	1000
DISSEMINATION	2012-04-04	2012-04-11	(n.a.)	(n.a.)	Extension of model data base of Meteorological Institute (University of Hamburg)	1500
DISSEMINATION	2012-04-04	2012-04-11	(n.a.)	(n.a.)	Laboratory of Heat Transfer and Environmental Engineering (Mechanical Engineering Department Aristotle University of Thessaloniki)	1500
MEETING	2011-04-06	2011-04-06	Vienna	AU	EGU session and joint ES1004 expert meeting	5151.53
MEETING	2011-08-11	2011-08-12	Brussels	BE	ES1004 Core Group meeting	6106,98

MEETING	2011-10-06	2011-10-07	KOS	EL	MC meeting	15502,26
MEETING	2011-11-28	2011-11-29	HAMBURG	DE	Working Group Meeting	12766,9
MEETING	2012-01-09	2012-01-10	Brussels	BE	Working Group + Editorial Group Meeting	6969,64
MEETING	2012-03-20	2012-03-21	Athens	EL	WG 1-4 COST ES1004 Expert Meeting	5119.64
STSM	2012-01-23	2012-02-12	Copenhagen	DK	European framework for online integrated air quality and meteorology modelling	2150
STSM	2012-03-20	2012-03-31	Barcelona	ES	Regular	1480
STSM	2012-03-26	2012-03-30	Cairo	EG	Near Neighbours	1509
OERTSA	2011-04-01	2012-03-31				447.50
					Science Expenditure	64503.45
Financial and Scientific Administration and Coordination						8553.16
					TOTAL EXPENDITURE	73056.61

II. Scientific Report prepared by the Chair of the Management Committee of the Action, describing results achieved during the Action operation in this period, in no more than 3 pages (the report is "cumulative"). All items listed in Sections A, B, and C, below, must be addressed.

The Phase I (1st year) was focussed on: Planning, operational arrangements, establishment of WGs and model inventories, realised without initial splitting into WGs. A preparatory phase was implemented during the first year and built an initial inventory of existing activities in various European countries and outside Europe. Much of the compilation work was conducted using participants' networks and national arrangements. This preliminary inventory resulted in the establishment of the detailed work programme, activities and the members of WGs. One first objective is about the state of the art of online coupled models, which should be achieved before the fall 2012 (this includes also a review paper) and in August 2012 (extended version of the paper towards a report format). Annual workshop (November 2011, Hamburg, Germany) and young scientists' school (July 2011, Odessa, Ukraine) with invited experts and lecturers were organized during the first year. Two special sessions on international conferences (EGU-2011 in Vienna, Austria and AQ2012 in Athens, Greece) and one multidisciplinary workshop (May, 2011, Dubrovnik, Croatia) were organised by the action. The following Working Groups were formed and started their activities.

Working Group 1: Strategy and framework for online integrated modelling

- The overall objectives of WG1 are to develop model frameworks and effective code implementation and management strategies for online-coupled meteorology and chemistry models and to identify the model development priorities and milestones.
- A survey of current state-of-science of available online coupled modeling systems in Europe has been conducted.
- Results were incorporated into the COST728 model data base in Hamburg, see: <http://www.mi.uni-hamburg.de/costmodinv>
- Based on the draft manuscript of Online Coupled Regional Meteorology-Chemistry Models in Europe first recommendations for module implementation priorities and strategies have been identified

Working Group 2: Interactions, parameterizations and feedback mechanisms

- The objectives of WG2 are to establish the current state-of-the-science in the meteorology-chemistry interactions and to provide a framework for the development of accurate yet efficient techniques for the coupling of NWP and atmosphere via process-oriented parameterizations and feedback algorithms, which will improve the NWP and CWF.
- A detailed list of processes of interactions between chemical and meteorological parameters has been put together. This list is important for identifying specific focal areas for the Action and has already been valuable for identifying model variables which are most relevant for evaluating feedback mechanisms in online coupled models (◇ WG 4). It will also be used for updating the COST728 model data base.
- Relevant discussions during dedicated WG 2 meetings have already led to a better understanding of technical terms, which are widely used but often differently, e.g. feedback mechanisms, feedback chains, coupling processes, etc. A note has been written defining coupling mechanisms between chemical and dynamics mathematically.
- Close collaboration with WG 4 has been established, and contributions to the online models overview paper have been made by several WG 2 participants. This overview paper is the basis for one of the WG 2 deliverables (Overview of the current state-of-the-science on interactions, parameterizations and feedback mechanisms for integrated modelling).

Working Group 3: Chemical data assimilation in integrated model

- The objective of WG3 is to establish the current state-of-the-science in this area and to provide a framework for the development of efficient techniques for data assimilation in integrated models.
- A section of the draft manuscript was written, which describes the current status of chemical data assimilation (CDA) in air quality modeling, with a particular focus on integrated models, and provides some recommendations.
- The first meeting took place. Major outcomes are the decision to include both meteorological and chemical data assimilation (MDA & CDA), to provide a listing of available databases, and to emphasize the operational aspects of MDA and CDA in air quality forecasting.
- A draft manuscript on MAD & CDA in integrated modeling for air quality forecasting is in preparation.
- The initial discussions of WG3 have provided an essential assessment of the current status of chemical data assimilation in air quality modeling, which can now serve as a basis for developing some general directions to advance the state-of-the-science and make specific recommendations to improve air quality forecasts. The combination of experts in theoretical aspects of data assimilation and scientists with operational experience is key to the success of WG3.
- The nature of this action is inter-disciplinary. An example of interactions between meteorology and chemistry is data assimilation in air quality modeling (WG3). At the first meeting of WG3, it appeared clearly that one could not dissociate chemical data assimilation from meteorological data assimilation in integrated air quality models because of the strong interactions between air quality (mostly particulate matter) and meteorology. Consequently, it was decided to expand the original scope of WG3 to add meteorological data assimilation.
- Involvement of scientists from the USA is being very beneficial to WG3 because of their existing hands-on experience in data assimilation in the WRF-Chem integrated air quality model. The participation of the European Centre for Medium Range Weather Forecasting (ECMWF) is also very valuable in that respect.

Working Group 4: Evaluation, validation and applications

- The objective of WG4 is to develop tools and methodologies to validate and evaluate integrated meteorology-chemistry models and make recommendations on applications of such models.
- The WG will provide a summary of online modeling system performance through validation for selected case studies/episodes as well as for long time periods. It will provide recommendations for optimal validation methodologies and protocols as well as for suitable applications of such models.

- An adaptation and update of the COST728 meta-database was performed in order to facilitate the validation of online models (currently at: <http://pandora.meng.auth.gr/mqatcopy>)
- WG4 is closely collaborating with the international programme AQMEII to plan and execute a comprehensive model evaluation exercise in 2012/2013.
- An adaptation of the COST model inventory meta-database is improved in order to better document the status of feedback processes in online models, at: <http://www.mi.uni-hamburg.de/costmodinv>.

II.A. Innovative networking

- *Innovative knowledge resulting from COST networking through the Action. (Specific examples of Results vs. Objectives)*
 - An extensive overview of currently available online coupled model systems in Europe has been compiled in the framework of WG1 and this information is currently being fed into the COST728 model data base in Hamburg.
 - In WG2 a detailed list of processes of interactions between chemical and meteorological parameters has been put together. This list is important for identifying specific focal areas for the COST action and has already been valuable for identifying those model variables which are most relevant for evaluating feedback mechanisms in online coupled models.
 - The initial discussions of WG3 have provided an essential assessment of the current status of chemical data assimilation in air quality modeling, which can now serve as a basis for developing some general directions to advance the state-of-the-science and make specific recommendations to improve air quality forecasts. The combination of experts in theoretical aspects of data assimilation and scientists with operational experience is key to the success of WG3.
- *Significant scientific breakthroughs as part of the COST Action. (Specific examples)*
 - A comprehensive wet cloud chemistry and scavenging scheme originally developed for the global model ECHAM-Messy was been adopted and significantly enhanced for the regional model COSMO-ART. Probably for the first time in such a regional model it keeps track of the evolution and 3D transport of chemical species not only in the gas and cloud droplet phase but also in rain droplets and takes advantage of online coupling by using various cloud microphysical tendencies to compute tendencies of chemical species.
- *Tangible medium term socio-economic impacts achieved or expected. (Specific examples)*
 - Here we could mention the goal of improving weather forecasts with online coupled chemistry-meteorology models in particular during situations with high pollutant (aerosol) levels.
 - The goal of improving air quality forecasts and model analyses using such online coupled model systems.
- *Spin off of new EC RTD Framework Programme proposals/projects. (List)*

The Action was one of the initiators of a new EU project proposal ABCE (lead by FMI, M. Sofiev) in which DMI and MeteoSwiss are participating and planning to take first steps towards operational air quality / pollen forecasting using online models Enviro-HIRLAM in Denmark and COSMO-ART in Switzerland.
- *Spin off of new National Programme proposals/projects. (List)*
 - The Swiss COST office is supporting this COST Action through funding a 3 year PhD project "Prediction of future air quality in Europe and its links with climate studied with the online coupled meteorology-chemistry-land surface model COSMO-ART-CLM"
 - The Istanbul Technical University, Turkey is supporting the COST action through funding a national project.
 - The Odessa State Environmental University, Ukraine established a new educational and research online modelling Laboratory initiated by the COST Action.

II.B. Inter-disciplinary networking

- The nature of this Action is inter-disciplinary since one of the goals of the Action is to bring together the NWP and atmospheric chemistry / air quality communities. It involves specialists of various areas of atmospheric science including atmospheric physics (e.g., meteorologists, physicists), atmospheric chemistry (chemists and chemical engineers) and applied mathematics (mathematicians, computer scientists). An example of interactions between meteorology and chemistry is data assimilation in air quality modeling (WG3). At the first meeting of WG3, it appeared clearly that one could not dissociate chemical data assimilation from meteorological data assimilation in integrated air quality models because of the strong interactions between air quality (mostly particulate matter) and meteorology. Consequently, it was decided to expand the original scope of WG3 to add meteorological data assimilation.

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*

Close collaboration with the COST Actions ES 0602 and 0603 provided a new approach for integrated physical, chemical and biological weather forecasting, monitoring and assessment. Two joint scientific papers prepared: one is published in the ACP journal, another is accepted by the AMBIO interdisciplinary journal.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts. (Specific examples)*

In the framework of the 8th International Conference on Air Quality - Science and Application (Air Quality 2012, Athens, Greece, 19-23 March 2012), a special session on "Air Quality and Climate/Meteorology Interactions and Feedbacks" creating stronger links with the climate modelling community was organised. A joint paper in 'New Directions' was published in Atmospheric Environment journal.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts. (Specific examples)*

Expected benefits of this interdisciplinary network for society will include the following:

- Contribute to better forecasting of severe weather events and their consequences (forest fires, dust storms, flooding, volcano eruption, etc.),
- Contribute to reduction of detrimental combined health effects,
- Contribute to better prediction of climate change and to climate change adaptation strategy,
- Cost-effective measures to manage transport and energy production,
- Improved management and protection of terrestrial, coastal, and marine ecosystems,
- Enhanced quality of life, especially in urban areas,
- Decreased overlap and redundancy of national, regional or local activities and arrangements,
- Better possibilities to relate the AQ, meteo/climate factors with human health and impacts on ecosystems.

II.C. New networking

- *Additional new members joining the Action during its life.*

Several new members joined the action during the first year: Austria, Hungary, Serbia, Sweden (in 2011), recently two new member-countries Turkey and Portugal joined in 2012.

- *Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)*

- Number of MC Members: 51 and additionally more than 20 experts are involved into WGs.

- *Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if less than 4 STSMs were carried out during the year.*

- The Summer School on “Integrated Modelling of Meteorological and Chemical Transport Processes / Impact of Chemical Weather on Numerical Weather Prediction and Climate Modelling” was co-organised in cooperation with the Nordic MUSCATEN network, web-site: <http://www.ysss.osenu.org.ua/>.
- Formally only 3 STSMs were realised/funded by COST. However, about 30 young scientists participated in the organised by COST ES1004 Summer school in Odessa, Ukraine in July 2011. Plus two additional STSMs were funded by national grants. Besides, this was only the first year, that most applications came in towards the end of the first year and new STSM applications are already pending for the second year, indicating that this activity is picking up momentum.
- *Involvement of researchers from outside of COST Countries. (Number of participants from non-COST Countries approved by the CSO. Give % of such participants from countries with reciprocal agreements. Specify their contribution)*
 - Several international and non-COST organisations joined the Action, including: from the European Commission - Joint Research Center, Institute for Environment and Sustainability; the University of Iowa, USA; Odessa State Environmental University, Ukraine; European Centre for Medium-Range Weather Forecasts, ECMWF; European Environment Agency, EEA, etc.
 - An important step forward on online model evaluation was its teaming up with the international (European/North American) AQMEII program.
 - Involvement of scientists from the USA is being very beneficial to WG3 because of their existing hands-on experience in data assimilation in the WRF-Chem integrated air quality model. The participation of the European Centre for Medium-rang Weather Forecasting (ECMWF) is also very valuable in that respect.
- *Advancement and promotion of scientific knowledge through publications and other outreach activities. (Number of publications and other outreach activities that resulted from COST networking through the Action. Complete list should be given in an annex)*
 - As the main join outcome of the 1st year a review paper on ‘Online Coupled Regional Meteorology-Chemistry Models in Europe’ (about 60 pages) is prepared for publication (expected to be submitted after the Copenhagen meeting).
 - More than 10 scientific journal papers were published by partners during the first year.
 - One report of WG1 and summer school lectures are published on the web-site.
 - EGU-2001 Section AS4.25 ‘Integrated physical and chemical weather modelling with two-way interactions’ was organised with a great success, abstracts are published, <http://meetingorganizer.copernicus.org/EGU2011/session/7498>
 - In cooperation with COST 728 one book ‘Integrated Systems of Meso-Meteorological and Chemical Transport Models’ was published by Springer in 2011 and another one is waiting for publication.
- *Activities and projects with COST network colleagues.*

An extensive model evaluation exercise is being setup together with the AQMEII program and several members of the COST action are actively contributing to the planning of this exercise. This activity involves not only representatives of the member countries but also the two participating institutions JRC and ECMWF in a major way.
- *The capacity of the Action members to raise research funds.*

The COST action allowed the Swiss partner to initiate a new PhD project.

II.D. Self evaluation

- In general the work plan is realising without big delays or modifications.
- An important step forward for WG4 on model evaluation was its teaming up with the international (North American/European) AQMEII program. This helped going beyond the originally planned outlining of a conceptional framework for model evaluation but to setup a concrete model evaluation and intercomparison exercise taking advantage of the experience and infrastructure provided by AQMEII and moving AQMEII toward including expertise in online models. It motivated several members of the COST action to actively participate and invest significant resources into the exercise despite a lack of funding.

III. Previous scientific report(s)

This is the first year reporting, so there are no previous periods' scientific reports.

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