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DRAFT

Memorandum of Understanding

for the implementation of a European Concerted Research Action designated as

COST Action 723

"The Role of the Upper Troposphere and Lower Stratosphere in Global Change"

The Signatories to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the Technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 267/00 "Rules and Procedures for Implementing COST Actions", the contents of which the Signatories are fully aware of.

2. The main objective of the Action is to advance the understanding of the state of the global upper troposphere and lower stratosphere, and the role of the dynamical, chemical, and radiative processes in this altitude region, in order to provide an improved basis for policy advice in connection with global change.

3. The overall cost of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 7 million in 2001 prices.

4. The Memorandum of Understanding will take effect on being signed by at least five Signatories.

5. The Memorandum of Understanding will remain in force for a period of four years, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1 above.

Technical Annex

A. Background

This COST Action deals with the global upper troposphere and lower stratosphere (UTLS), the region approximately 5 kilometres above and below the tropopause. This altitude region of the Earth's atmosphere plays an important role in the Earth's climate and in possible climate change.

The UTLS region is crucial for the Earth's energy balance, as changes in the composition of the UTLS, notably the water vapour and ozone distributions, have a direct impact on the amount of radiation absorbed and emitted. Water vapour is the main source of cooling in the upper troposphere, whereas ozone is the main source of warming in the lower stratosphere. Thus, changes in UTLS water vapour and ozone can change the temperature structure of the atmosphere, and hence atmospheric transport and cloud formation. This constitutes a complex feedback mechanism, as subsequent changes in UTLS temperature and transport exert a controlling influence on the ozone and water vapour distributions in the UTLS and stratosphere.

An understanding of the UTLS region requires knowledge of composition, radiation, dynamics, transport, photochemistry, and cloud microphysics; knowledge of the climatology, variability, and long-term trends in the UTLS region; knowledge of the interactions between the troposphere and stratosphere, and between the tropics and extra-tropics. Current concerns about climate change and ozone depletion have also highlighted the need to have the ability to simulate and predict both natural and anthropogenically induced variability in the UTLS region.

The climate system and the UTLS region in particular, have several strong feedback mechanisms involving water vapour, ozone and clouds. These mechanisms involve radiative, photochemical, dynamical, transport, and microphysical processes. Despite their importance, the composition and processes in the UTLS region are not well understood. There is both a lack of data, and a lack of models which resolve the crucial processes.

Currently, global remote sensing methods from operational or research satellite platforms are unable to make accurate height-resolved measurements in the UTLS region. In situ measurements in the UTLS region suffer from a lack of global coverage. To capture the behaviour of the UTLS region, processes such as cloud formation and chemistry on cloud particle surfaces must be modelled. Such processes are notoriously difficult to model because of the need for parameterisations in large-scale numerical models, and a lack of understanding of many of the crucial microphysical and photochemical processes.

The monitoring of the UTLS region requires an appreciation of the strengths and weaknesses of the various measurement techniques. It also requires the use of data assimilation techniques to confront observations and models, and combine them if they are consistent, thus adding value to the observations and evaluating both the observations and the models.

Modelling developments such as the coupling of climate and chemistry models, and observations from ESA's forthcoming Envisat satellite (as well as NASA's forthcoming EOS Aura satellite) will play an important role in our understanding of the UTLS region and will be a focus of this COST Action.

Understanding and monitoring the UTLS region requires a coordinated, broad-based and multi-disciplinary approach which brings together the world-class expertise available in Europe. Key elements of this task are: (1) the optimum use of scarce Earth Observation and modelling resources which builds upon existing resources and avoids duplication of effort, (2) the exchange of ideas and information in order to advance understanding, and (3) the development of links (including electronic networks) for European and world-wide collaboration. A COST Action incorporates all of these key elements. Thus, it is a particularly suited tool to achieve the sustained multi-disciplinary effort that is necessary to provide policy makers with the information needed to make decisions in response to perceived environmental threats.

The COST Action can contribute to the European-wide training of scientists, the exploitation of Europe's world-class skills in Earth Observation and modelling, a European policy for Earth Observation and climate monitoring, and the concept of a European Research Area. Thus, the COST Action can help to provide the healthy and attractive research environment in Europe needed to retain the best scientists from Europe and elsewhere. All these issues have been identified as being highly desirable by the European Commission (EC) and the European Science Committee of the European Science Foundation (ESF).

In consonance with the goals of the European Research Area concept, the COST Action brings together several important European activities in the area of Earth Observation, modelling and data assimilation. These activities are described in Section D-4.

B. Objectives and Benefits

The main objective of the Action is to advance the understanding of the state of the global upper troposphere and lower stratosphere, and the role of the dynamical, chemical, and radiative processes in this altitude region, in order to provide an improved basis for policy advice in connection with global change.

The UTLS altitude region is crucial for several strong feedback mechanisms in the climate system and the current knowledge is sparse. This is one of the weaknesses in current climate predictions. Nevertheless, in the next decade policy makers in Europe (and elsewhere) will have to react to the perceived threat of global change, and will urgently require input from the European scientific community.

To achieve the general objective, the Action has the following practical objectives:

1. To help address and coordinate the development of new measurement techniques that are particularly suited for the UTLS region.

2. To evaluate measurement campaigns and use the results and experience gathered to help plan and promote new campaigns.

3. To develop algorithms to assimilate an increasing variety of UTLS datasets into global circulation models (GCMs) and chemistry transport models (CTMs) which encompass the troposphere and stratosphere.

4. Using the developed algorithms, to provide a quality-controlled assimilated UTLS ozone and water vapour dataset for the use of the scientific community.

5. To assess the state of the UTLS and to understand the relevant processes, using both assimilated data and other data records.

6. To use the collected information under the points above to give a comprehensive analysis of the anthropogenic impact on the UTLS region.

The beneficiaries of these objectives are the scientific community as a whole, in particular atmospheric scientists, climate modellers, the coupled chemistry-transport modelling community, and the Earth Observation community. Further beneficiaries include weather agencies, space agencies, and agencies concerned with air-pollution abatement.

Another potential beneficiary is the European Commission's GMES (Global Monitoring for Environment and Security) initiative, which aims to support European policies on the basis of an operational environmental monitoring system. The outcome of the Action will guide GMES regarding monitoring of the UTLS.

Finally, the Action will provide important information to policy makers and funding agencies who will have to address global change.

C. Scientific Programme

The above objectives can be addressed by considering the three areas of observations, data analysis, and understanding. These areas are interconnected in various ways. For example, understanding of atmospheric processes cannot come without accurate observations and subsequent analysis. Analysis can reveal shortcomings in the observations, which can be addressed through improvements in measurement techniques. The following subsections describe the scientific programme in these three areas.

C-1 Observations

This first point of the work programme deals with the procurement of data to be used in the subsequent points. Besides the basic meteorological parameters like temperature and wind fields, the most important parameters are humidity, the concentration of ozone and other trace gases, as well as aerosol and cloud parameters like ice water content. These parameters are crucial, since through their absorption and scattering properties they determine the radiative balance, and hence have a direct link to the dynamics. To obtain these parameters the Action will make full use of all current and planned UTLS data sources. This includes in situ techniques and remote sensing techniques from all possible platforms: ground based, aircraft, balloon, and satellite.

Radiosonde data will be extracted from archives at the meteorological services or reference stations. Results from campaigns will be gathered and presented in a unified way. Satellite data will be obtained and processed to derive the desired parameters. The ensuing harmonisation and compatibility work will be a tedious but essential activity. The objective is not to create another database, but to make the data usable for the research work to be carried out within the Action. This requires not only obtaining the data (which is not always easy in practice, due to bureaucratic obstacles, and at best is quite time consuming), but also pre-processing it where necessary (for example in the case of satellite measurements).

The COST Action will require a careful collection of these various data in order to have them in a coherent format for further analysis and computations by the participants of the Action and other scientists. This process will also make it possible to get a better estimate of the relative quality of the different data sources, which will be a major benefit from the Action. It will be part of the Actions's work to conduct a critical assessment of the weak links in our measurement capability and help to identify new measurement techniques and platforms to strengthen them.

Furthermore, all sources of data will benefit from inter-comparisons and from the confrontation with models (see Section C-2). The experience gathered can be used to improve both measurement techniques and data processing methods. Examples of possible improvements are new calibration methods for radiosonde humidity sensors, new retrieval methods for satellite data, and new measurement campaigns. Furthermore, the work in the other two parts of the work programme (analysis and understanding) will help identify current gaps in the observational database. Suggestions how to close the gaps will be developed.

Radiosoundings are part of the daily routine measurements at various meteorological stations worldwide. Relative humidity (RH) has been measured with Vaisala Humicap technology since the early 80’s on the majority of them, and the recordings continue to the present. Unfortunately, these RH measurements suffer from a lack of accuracy in the UTLS region. This problem is currently being tackled with correction algorithms. However, RH sensor changes between successive sonde generations make the homogenisation of the data over extended periods a difficult task. The radiosonde data to be used for the Action include that of the national reference stations Lindenberg (German weather service), Legionowo (Polish weather service), Sodankylä and Marambio (Finnish weather service), and Tenerife (Spanish Weather Service), all of which have data records going back more than 40 years. These stations are at the forefront of developing correction algorithms and of using new measurement techniques (e.g., with frostpoint hygrometers). Data from the 150 radiosonde stations of the Upper Air Network of the Global Climate Observing System GCOS (GUAN) will also be used. These stations are particularly suitable to address global issues, since they are globally distributed. Another important source of in situ data which will be used are measurements from in-service aircraft, collected by the MOZAIC program.

The Network for the Detection of Stratospheric Change (NDSC) offers a wealth of data, including ozone profiles measured by radiosondes and by ground based remote sensing methods (microwave radiometers, lidar). This is also a very valuable dataset for global studies, due to the global distribution of the NDSC stations.

A valuable source of long-term data are operational meteorological satellite instruments, such as the TIROS Operational Vertical Sounder (TOVS) on the polar orbiting satellites of the US National Oceanographic and Atmospheric Administration (NOAA). These data can be reanalysed in order to derive a unified data record of upper tropospheric temperature. Since 1995 water vapour measurements from the Advanced Microwave Sounding Unit (AMSU-B) are also available. Since these satellite data are measurements of radiances at the top of the atmosphere, rather than direct measurements of the desired parameters, significant research work has to be done in order to make them useful to the Action.

A new type of remote sensing instrument for operational meteorological satellites are Global Navigation Satellite System Receivers for Atmospheric Sounding (GRAS), due to fly on the planned European polar orbiting meteorological satellite Metop. The technique uses the delay of GPS signals as they travel through the atmosphere in an occultation geometry. These instruments can have the capability to deliver accurate profiles of temperature, pressure, and humidity, particularly in the upper troposphere. Although Metop is not planned to be launched before the year 2005, already now two research satellites are making GPS occultation measurements, the German CHAMP satellite and the Argentinean SAC-C satellite.

Another source of satellite data are research satellites like Envisat, which is due to be launched by the end of November 2001. Envisat hosts a comprehensive suite of earth observation sensors, the most important for atmospheric research being MIPAS (Michelson Interferometer for Passive Sounding), SCIAMACHY (SCanning Imaging Absorption SpectroMeter for Atmospheric CartograpHY), and GOMOS (Global Ozone Monitoring by Occultation of the Stars). These instruments will provide global coverage of vertically resolved information such as temperature, ozone, and other trace gases from the tropopause to the thermosphere. In the case of SCIAMACHY it is expected that also water vapour can be measured with good vertical resolution from the stratosphere down to the upper troposphere. Furthermore, SCIAMACHY measures in both limb and nadir geometry, thus potentially allowing good vertical and horizontal resolution with suitable assimilation techniques (See Section C-2). The tracers measured by Envisat are not only important for UTLS chemistry, but also for the radiative balance (e.g., ozone), and as a tool for understanding vertical transport. As in the case of the operational satellites, these data require significant processing, which is in itself an active research area.

Finally, a very important source of data are measurement campaigns, for example with balloons and with the Airborne Platform for Earth Observations (APE) on the M55-Geophysica research aircraft. Balloon campaigns at low latitudes are presently being planned, and results from such activities will be integrated with the COST Action as soon as they become available.

C-2 Analysis

Observational data from different platforms have different representativeness, structure, and resolution, so that they must be assimilated in order to obtain a unified picture of the state of the atmosphere. Data assimilation is a technique involving the input and synthesis of a range of observations from many sources, and with a variety of errors, into a numerical model of an evolving system (e.g., the atmosphere). The Action will extend existing capabilities to assimilate atmospheric observations into several established Global Circulation Models (GCMs) and Chemistry Transport Models (CTMs) in the UTLS region. The extensions will concern the assimilation of:

- Novel observation geometries (limb and nadir)
- Novel observation types (retrieved profiles, radiances)
- A comprehensive suite of species (ozone, water vapour, NO2 and CO) as well as temperature

The developed assimilation schemes will be applied for a period of at least one year in order to provide a quality-controlled self-consistent 4-d dataset for the UTLS region. This dataset will be a major deliverable of the Action. It will be used within the Action (see Section C-3) to assess the UTLS mean state and variability, to assess trends where possible, and to study processes in the UTLS region and their role in global change. In addition, the dataset will be made available for the scientific community. It will help improve models by confronting them with observations, and, consequently, will stimulate laboratory and modelling studies to improve parameterisations of physical and chemical processes. The new UTLS dataset will also help improve the accuracy of weather forecasts as provided by the meteorological agencies, and will help plan future space missions.

A statistical analysis of the model and observation errors, and a comparison of the 3-D simulations with and without chemical data assimilation will be made, with special emphasis on the UTLS region.

The research satellite observations will be provided by the GOME instrument, Envisat instruments (GOMOS, MIPAS and SCIAMACHY), and Eos Aura instruments (Eos MLS, HIRDLS, OMI, and TES). In the case of GCMs, operational satellite observations from the ATOVS instrument aboard the NOAA-15/NOAA-16 satellites will also be used. Other data sources that are suitable for the task and are available at the time will also be used.

Some of the CTMs that will be applied are the TM3 model from KNMI, the CTM2 model from the University of Oslo, and the EURAD CTM2 from the University of Köln. These models are set up to study the UTLS region and have tropospheric and stratospheric chemistry modules. They are coupled (off-line) to ECMWF analyses, and should provide realistic descriptions of constituent transport and chemical oxidation.

One of the GCMs that will be applied is the troposphere-stratosphere GCM from the Met Office, (UK), which is being used by the UK's Natural Environment Research Council (NERC) Data Assimilation Research Centre (DARC) to assimilate research satellite observations. The assimilation scheme which involves the Met Office GCM incorporates all available operational observations, and allows the feedback between the assimilated fields and the dynamics. The assimilation scheme also includes a parametrisation of the photochemical sources and sinks of ozone, and a parametrisation of methane oxidation (which in the stratosphere is a source of water vapour) and of water vapour photolysis (which in the mesosphere is a sink of water vapour).

Other available models are the French IPSL/LMDz general circulation model, coupled with the chemistry module INCA, as well as the Meso-NH mesoscale non-hydrostatic model, coupled with chemistry. The latter should be particularly useful for studies of UTLS processes related to convective systems. A third option is the Mocage chemistry module coupled with the Météo-France GCM.

C-3 Understanding

The high quality datasets gathered in C-1 and the consistent analyses of C-2 will allow unprecedented studies of the global climatology, trends, and dynamical processes in the UTLS region. Participating scientists will have easy and direct access to data and analysis, thus greatly reducing the cost and effort that is usually involved in obtaining data from operational or research data bases. The experience gathered will be used to estimate the anthropogenic impact on the UTLS region. The results of the Action will thus be a basis for other activities aimed at predicting future impact and will be a major asset to the European scientific community.

The Action will assess the climatology, i.e., mean state and variability, of UTLS parameters which can provide a signature of global change, including:

- Temperature
- Winds
- Humidity
- Ozone
- Potential vorticity
- Tropopause altitude, temperature, pressure
- Ozonopause altitude, temperature, pressure
- Hygropause altitude, temperature, pressure
- Tropopause-ozonopause relation, hygropause-ozonopause relation
- Aerosol
- Clouds

Where the data record is long enough trends will also be assessed. For this work, in particular, the radiosonde data will be very valuable. Concerning tropopause altitude, special attention should be paid to the open question of dynamical and thermal tropopause definitions, since the European Centre for Medium-Range Weather Forecasting (ECMWF) uses normally the dynamical tropopause and the US National Center for Environmental Prediction (NCEP) uses the thermal tropopause.

The next step will be to study the important UTLS processes and their role in global change. Examples of these activities are:

- The study of the transport of constituents by the general circulation, with particular emphasis on the descent in the polar regions and at mid-latitudes, and the tropical ascent and meridional transport in the UTLS region.

- The study of mixing across the atmospheric transport barriers: the tropopause, the polar vortex "edge", and the sub-tropical "edge" of the surf zone.
- The study of the interplay between dynamics and chemistry in the UTLS region. (E.g., the study of the relative impact of Stratosphere-Troposphere Exchange (STE) processes on factors controlling the oxidation capacity of the troposphere and lower stratosphere; the study of the detailed mixing of tropospheric with stratospheric air, as the timescale of mixing is of key importance for atmospheric chemistry.)
- The study of the impact of clouds and aerosol on the dynamics and chemistry of the UTLS region.
- An analysis of the connection of processes in the UTLS with the polar and the subtropical jets, since around the jets stratosphere-troposphere exchange processes are particularly intense and have an impact on the distribution of key constituents (e.g., ozone and water vapour).
- The identification and quantification of the dynamical variability of constituents in the UTLS region.
- An analysis of NAO (North Atlantic Oscillation) influence on UTLS behaviour in middle latitudes.
- An analysis of connections of the processes in the UTLS with severe meteorological cases.
- Potential applications of dynamical processes in the lower stratosphere to medium range weather forecasting.

STE is one of the key factors controlling the budget of ozone, water vapour, and other constituents in the UTLS region. There is still no quantitative picture unifying the application of the "global downward control principle" which is used to describe transport at higher levels in the stratosphere, and the consideration of small-scale processes in the tropopause region (STE events).

These studies will allow a better description of relevant processes in weather and climate prediction models, lead to an improved capability to detect and forecast possible dynamical and chemical changes in the atmosphere, and make it possible to design comprehensive and cost-effective monitoring systems.

D. Organisation and Timetable

The management of the COST Action will follow the general guidelines established in the document "Rules and Procedures for Implementing COST Actions". A Management Committee (MC) will be set up. It will develop a work programme taking into account the research needs and objectives as outlined in Sections A and B. The programme will also take into account expertise, facilities, and interests of the participating institutions. According to the scientific programme in Section C, it is envisaged that three working groups will have to be established, corresponding to the three research areas identified.

D-1 Working Groups

The tasks of the individual WGs are listed here only briefly. See Section C for details.

WG1: Measurement Techniques and Campaigns

This WG has the following tasks:

- Gather data and make it available to the Action.
- Conduct a critical assessment of the weak links in our measurement capability and help to identify new measuring techniques and platforms to strengthen them.
- Improve the use of satellite data by the Earth Observation community and help to assess new sensors.
- Evaluate measurement campaigns and help plan and promote new campaigns.

WG2: An Assimilated Ozone and Humidity Dataset

This WG has the following tasks:

- Identify the most relevant datasets of atmospheric constituents and other key geophysical parameters for the UTLS.
- Develop and publish assimilation algorithms.
- Compute the assimilated UTLS dataset and make it available to the Action and the scientific community.
- Perform quality control of observations and models using statistical analyses of model and observation errors.
- Analyse the benefits of combining nadir and limb sounder information.
- Carry out preliminary studies toward the assimilation of instrument radiances from research satellites.

WG3: Assessing the State of the UTLS and Understanding the Relevant Processes

This WG has the following tasks:

- Assess the UTLS climatology (mean state and variability).
- Assess trends where possible.
- Study dynamical processes in the UTLS and their role in global change.
- Quantify the anthropogenic impact on the UTLS.

D-2 Phases

Common workshops for all WGs are an important component of the Action. Their aim is to provide a forum for exchange between the involved scientific fields. Except for the Final Symposium, workshops are not only used to display results, but also to kick-off work to be continued in the WGs in the next project phase. The main objective of these workshops is that they should help to bring together experts from the different strands of science involved, therefore they should be open to all European researchers working in this field. Additionally, the WGs can organise smaller workshops on particular subjects.

The Action can be structured in four phases, separated by workshops:

Preparation Phase (Year 1, 6 months)	
	Opening Workshop
Gathering Phase (Years 1-2, 18 months)	
	Consolidation Workshop
Analysis and Recommendation Phase (Years 3-4, 18 months)	
	Final Symposium
Dissemination Phase (Year 4, 6 months)	

Note that there can be some overlap between the study phases, which will help to recover time in the case of a slow start due to delayed signatures of individual countries. Additional WG and MC meetings will be held between the workshops. As far as possible, meetings will be synchronised to enhance the exchange of information.

The estimated total duration of the Action is four years. More details for the different study phases are given below.

Preparation Phase:

- MC: Establish initial WGs and define provisional work programme.
- WGs and MC: Prepare Opening Workshop

Opening Workshop:

- Assess the state of the art in the Action areas, identify open issues and finalise schedule for the WGs.

Gathering Phase:

- WG1: Gather data and make it available to the Action.
- WG2: Develop algorithms and compute the assimilated dataset.
- WG3: Assess climatology, using radiosonde records and other available data. Identify trends where possible.

Consolidation Workshop

- Present and discuss results of the Gathering Phase. Identify open issues and necessary development work. Finalise the schedule for the Analysis and Recommendation Phase.

Analysis and Recommendation Phase:

- WG1: Explore ways to get improved data.
- WG2: Validate assimilated dataset, data, and models. Assimilation studies for new data.
- WG3: Study UTLS processes and their role in global change. Analyse anthropogenic impact.

Final Symposium:

- Summarise, present, and discuss results.
- Finalise dissemination plan.

Dissemination Phase:

- MC, WGs: Prepare Executive Summary, implement dissemination plan, prepare reports, conclusions, and recommendations.

D-3 Dissemination Plan

- A dedicated web-site will be set up at the start of the Action, as a platform to present the results to the scientific community and the general public. This will also be used to distribute data and documentation between the participants. The web-site should persist after the Action is finished.
- A mailing list will be set up at the start of the Action, which will be used to distribute and exchange information.
- There will be two workshops plus a final symposium. For each of these meetings proceedings will be published.
- It is anticipated that the Action will lead to a number of papers in refereed scientific journals, as well as contributions to international conferences.
- The results will be summarised in an Executive Summary.
- The dataset resulting from the work of WG2 will be made available to the community either on the Action's web-site and/or on one of the established data distribution sites like the British Atmospheric Data Centre (BADC).
- Where necessary WGs will issue technical reports summarising individual tasks. In particular, WG1 will issue a report with recommendations for coordinated campaigns and sensor development, WG2 will issue documentation for the compiled dataset, WG3 will produce papers in the peer-reviewed literature.
- The results of the Action will be an important contribution to future international assessments (climate, ozone, and aviation).

D-4 Interaction with other international research programmes and with other COST Actions

The proposed Action will enhance the coordination of UTLS research in Europe and will particularly promote analyses which combine models and measurements. Hence, there are important links to a number of other European research projects, both ongoing and planned.

1. NERC-funded activities such as the Clouds, Water Vapour and Climate (CWVC) and Upper Troposphere/Lower Stratosphere (UTLS Ozone) Thematic Programmes, and the NERC-funded Data Assimilation Research Centre (DARC), can contribute expertise on modelling, observations and data assimilation to the COST Action. Key personnel from these communities have contributed to this document and will be involved in the Action.

2. The German national atmospheric research programme AFO-2000 includes a number of projects focusing on the UTLS. In particular, the UTH-MOS project can contribute humidity information and will benefit from the validation resulting from the confrontation of data with transport models. The project SATEC4D can contribute studies on regional data assimilation to WG2, the project TRACHT simulations of the UTLS for CRISTA case studies, and the project SACADA analyses of long-term observations of the lower stratosphere. Members of these projects have contributed to this document and will be involved in the Action.

3. The Swiss National Centre of Competence in Research in Climate (NCCR Climate) is a long-term effort to form a network between different climate-research related activities like palaeoclimatology, atmospheric science, climate modelling as well as research on the socio-economic effects of climate change. Linkage will be by membership of key personnel.

4. Linkage with the Italian GCOT will be by membership of key personnel. GCOT (Earth Observation Coordination Group) is an Italian National Research Council (CNR) "horizontal institution" whose aim is the coordination, promotion, and support of the scientific community working in the Earth observation field. The Action can help to enhance the European recognition of research activities carried out by groups belonging to GCOT.

5. Linkage with French national programmes will be by membership of key personnel. In particular, the MOZAIC programme can provide valuable input data for the Action. Planned instruments like Picasso Cena can profit from the work carried out within the Action, in particular in WGs 1 and 2.

6. Linkage with the Norwegian Research Council programmes on stratospheric ozone and climate/chemistry research will be by memberships of key personnel.

7. The European Space Agency (ESA) Envisat mission will provide valuable height resolved and total column data that can be utilised directly by the scientists involved in the Action.

8. Data from the Swedish-French-Canadian research satellite Odin will be made publicly available during the duration of the Action.

9. Future atmospheric ESA missions proposed within ESA's Earth Observation Preparatory Programme (WATS, WALES, ACECHEM) are dependent upon stringent scientific and technical requirements, which will result from the work of WGs 1 and 2 (technical) and WG3 (scientific). The interaction with the Action could include holding one of the workshops at ESTEC or ESRIN, and including ESTEC/ESRIN key personnel as observers in MC or WGs.

10. The Action both supplements and complements the coordination carried out within the European Ozone Research Coordination Unit (EORCU) CORSAIRE cluster which has an emphasis on the impact of aviation and the GATO cluster which covers the use of long term stratospheric measurements. Other EC funded projects directly related to the objectives of the Action include MOZAIC III (Measurement of ozone and water vapour by Airbus in-service aircraft), METRO (dynamics of the low stratosphere), TRACAS (stratosphere-troposphere exchange and role of jet streams), STACCATO (stratosphere-troposphere exchange and chemistry), and INCA (cirrus and aerosol properties in the southern hemisphere).

11. Linkage with the Geophysica EEIG Italian-German consortium for the Airborne Platform for Earth Observations APE on the M55-Geophysica will be provided by inclusion of members of the research team. Experiences from campaigns are an important input for WG1. Recommendations given by the Action will help set up new instrumentation and campaigns.

12. As described in Section C, the national weather services and the European Centre for Medium Range Weather Forecasting (ECMWF) will contribute to the Action in several ways. Models of the weather services are crucial for WG2, notably the TM3 model of the KNMI (Netherlands) and the GCM of the Met Office, (UK). The ECMWF re-analysis data (ERA-15 and ERA-40) will also be crucial. The Finnish Weather Service FMI can contribute estimates of UV irradiance in the UTLS, as well as long term ozone and meteorological sounding records of Sodankylä (67 N) and Marambio (64 S). The German weather service DWD can contribute ozone and meteorological sounding records from Lindenberg (52 N). The Polish weather service can contribute ozone and meteorological sounding records from Legionowo (52 N), as well as Leba (55 N) and Wroclaw (51 N). In turn, the weather services will benefit from the exposure of models to a wealth of datasets. Key personnel from the weather services will be included in the MC and the WGs.

13. This COST Action is based on a recommendation given at the end of COST 712 ("Microwave Radiometry") by the management committee of that Action. Furthermore, it has a link to the COST Action 720 ("Integrated ground-based remote sensing stations for atmospheric profiling"), which will be included by participation of key personnel.

14. The EUMETSAT Satellite Application Facility on Ozone Monitoring (Ozone SAF) is a joint project of Finland, Germany, Netherlands, France, Belgium, Greece and Denmark. Its task is to set up the ground segment for ozone, trace gas and UV monitoring based on the METOP GOME-2, HIRS, and MSG Seviri instruments during 2003-2019. It will be represented by membership of key-personnel.

15. The EUMETSAT Satellite Application Facility on Global Navigation Satellite System Receivers for Atmospheric Sounding (GRAS SAF) is hosted by the DMI (Danish Meteorological Institute), with partner institutes The Met Office, UK and the IEEC in Spain. The task of the GRAS SAF is to deliver accurate profiles of temperature, pressure, and humidity measured using the GRAS receiver onboard the future Metop satellite. GRAS data is a valuable source of information in the UTLS, as outlined in Section C-1. In return, the GRAS SAF will profit from participating in the Action by getting updated requirements for the data products to be developed, and by the exposure to other measurement techniques. Linkage will be by membership of key-personnel.

16. The SOLVE/THESEO activities and in particular the data base at NILU can contribute valuable data.

17. The Network for the Detection of Stratospheric Change (NDSC) has the aim to provide a consistent and verified set of long-term measurements of atmospheric trace gases, particles, and physical parameters via a selected suite of globally distributed ground-based sites using well calibrated remote sensing instrumentation. The variability of the atmospheric circulation, the evolution of water vapour in the stratosphere and its link to troposphere/stratosphere exchange are topics with which the NDSC will deal in the future. These activities as well as the overall objectives of the Network can be seen as substantial contributions to the COST Action. Linkage will be by membership of key-personnel.

18. The SPARC working group on Data Assimilation is currently being set up with membership from key meteorological agencies and academic institutions in Europe, USA, Canada and Japan. The list of members includes The Met Office (UK), Météo-France, KNMI, the Canadian Met Service, the Japanese Meteorological Agency (JMA), the Data Assimilation Research Centre (DARC), the Belgian Institute for Aeronomy (BIRA-IASB), the University of Köln, the Data Assimilation Office (DAO), and the National Center for Atmospheric Research (NCAR). Linkage will be by membership of key personnel.

19. World Meteorological Organisation (WMO) programmes will contribute valuable data. In particular, the Upper Air Network (GUAN) of the Global Climate Observing System (GCOS) can contribute radiosonde data.

D-5 Cost Benefit Ratio and Risk Assessment

The idea behind the Action is to integrate the important scientific activities that will be taking place in Europe in the field of UTLS research in forthcoming years. A COST Action is an ideal tool to achieve this. It will add value to the individual research activities and help to avoid the duplication of efforts, thus making best use of scarce resources. Because the financial volume of the Action itself is very small, compared to the volume of the integrated research activities, the cost benefit ratio should be very high.

The crucial point of the Action is that it aims to integrate research that is going on anyway in Europe. The greatest risk is that this approach could fail. Therefore, good support for the Action within the scientific community is crucial. That there is such a good support has been demonstrated by the large number of positive responses to the proposal. A list of scientists that either expressed interest or were directly involved in the preparation of the MoU and Technical Annex is given in the Annex.

Another point to consider is the risk resulting from possible internal problems of the activities that have been identified in Section D-4 as having a strong link with the Action. The Action depends on these to various degrees. There is a strong dependence on modelling activities at DARC and national weather services. The risk of these activities to be discontinued is estimated to be low.

Furthermore, there is a strong dependence on Envisat data. A total failure of Envisat would require major changes in the work programme, and in the case of WG2 would result in a less comprehensive assimilated dataset, since the main data sources would be only GOME, Eos Aura instruments, and ATOVS.

Other activities listed in Section D-4 could greatly benefit the Action (and benefit from the Action) but are not individually crucial for the Action to be successful.

E. Economic Dimension

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest:

- Denmark
- Finland
- France
- Germany
- Greece
- Italy
- The Netherlands
- Norway
- Poland
- Spain
- Sweden
- Switzerland
- United Kingdom

On the basis of national estimates provided by the representatives of these countries, the overall cost of the activities to be carried out under the Action has been estimated, in 2001 prices, at roughly EUR 7 million. The coordination costs are estimated at EUR 330 thousand at 2001 prices.

The estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.