European Cooperation in the field of Scientific and Technical Research

- COST -

Brussels, 22 November 2013

COST 055/13

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action ES1308: ClimMani: Climate Change Manipulation Experiments in Terrestrial Ecosystems: Networking and Outreach

Delegations will find attached the Memorandum of Understanding for COST Action ES1308 as approved by the COST Committee of Senior Officials (CSO) at its 188th meeting on 14 November 2013.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action ES1308
CLIMMANI: CLIMATE CHANGE MANIPULATION EXPERIMENTS IN TERRESTRIAL ECOSYSTEMS: NETWORKING AND OUTREACH

The Parties 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 4114/13 "COST Action Management" and document COST 4112/13 "Rules for Participation in and Implementation of COST Activities" , or in any new document amending or replacing them, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to provide guidance for future climate change manipulation experiments in terrestrial ecosystems including the use of observations along natural climatic gradients, to improve access to and sharing of data and to integrate ecosystem modellers and experimentalists better .

3. The economic dimension 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 96 million in 2013 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of section *2. Changes to a COST Action* in the document COST 4114/13.

A. ABSTRACT AND KEYWORDS

Many climate change manipulation experiments have been carried out in recent decades. However, several challenges still exist or have emerged which limit our understanding of ecosystem functioning under future climate change. These include inadequate representation of biomes, artifacts, incomparable experiments, poor representation of relevant scenarios, in particular extreme events, lack of research communication sharing of results and lack of good data for modelling. This Action will develop a network for the experimental climate change research community brining experimentalists and modellers together in order to provide solutions to these recurrent challenges.

The Action will organise workshops addressing key challenges in climate change experiments and modelling, support research exchange, educate young scientists and facilitate better sharing and access to experimental data.

The Action will be organised within four Working Groups to address:

1. Experimental best practice
2. Natural climate gradients as experimental proxies
3. Data sharing
4. Data-model interaction

The Action will provide added value to European climate change research by linking high level national research groups and projects to a supra-national level and provide strong links and interactions with the global research community.

Keywords: Climate change, experiments, modelling, terrestrial ecosystems, effects

B. BACKGROUND

B.1 General background

Global atmospheric and climate change with elevated atmospheric carbon dioxide (CO_2), increased temperature and altered precipitation will fundamentally affect key drivers for ecosystem functioning and lead to adverse effects in terrestrial ecosystems across the globe (IPCC, 2007). Our understanding of these impacts and how they are controlled by changes in the drivers, and thereby how we can adapt or mitigate the changes, largely depend on observations and studies in ecosystem

experiments deriving the mechanistic understanding needed for incorporation into dynamic ecosystem models (e.g. Beier, 2004; Rustad, 2008).

A large number of manipulation experiments have been carried out in recent decades in order to test the responses of ecosystems to the anticipated changes in atmospheric and climatic conditions (e.g. Dieleman et al., 2012). However, a recently ended ESF network of climate change experiments and recent studies reviewing and comparing past experiments have identified several problems which significantly hamper our understanding and limit our ability to predict ecosystem functioning and atmospheric feedback under future climate (Leuzinger et al., 2011; Beier et al., 2012; De Boeck et al., 2012; Vicca et al., 2012; Kreyling and Beier, 2013; Lee and Mischurov, 2013). Solving these problems and new challenges requires a strong continued and closer collaboration and coordination of experiments and modelling at the climate change arena. This Action will provide an important platform for continuing the existing successful and fruitful network and will facilitate a series of new and innovative activities particularly aimed at improving climate change experiments and modelling.

B.2 Current state of knowledge

Climate manipulation experiments is an important tool for understanding the response of ecosystems to atmospheric and climatic changes (e.g. Rustad 2008). CO_2, temperature and precipitation have different characteristics, which lead to different considerations regarding the design of the experiments and the scenarios to be tested.

Atmospheric CO_2, partly driving the change in the greenhouse effect and thereby the change in climate, is a continuous variable with a relatively even global distribution and being relatively predictable. Consequently experiments with elevated CO_2 have focused on a given target providing a constant CO_2 concentration (e.g. Ainsworth et al., 2008; Mikkelsen et al., 2008).

Precipitation is temporally and spatially variable with relatively uncertain scenarios for the future (IPCC, 2007) making the range of experimental conditions required more complex and less comparable. Consequently, precipitation manipulations have been carried out in many different contexts, by many different designs, and testing very different precipitation scenarios generally reducing comparability (Beier et al., 2012). Therefore, a general and comprehensive understanding of the impacts of altered precipitation, variability, extremity and threshold exceedance is lacking (e.g. Knapp et al., 2008) and a new generation of precipitation experiments are needed (Beier et al., 2012).

Temperature is a continuous variable and less variable and more predictable than precipitation

(IPCC 2007) and experiments have applied approaches almost entirely focusing on average increases in temperature (Kreyling and Beier, 2013). In consequence, the conducted warming experiments are more comparable, facilitating comprehensive meta-analyses (e.g. Rustad et al. 2001, Lin et al. 2010, Wu et al., 2011; Dieleman et al. 2012). However, there is a general lack of studies on extremes and temporal variability in temperature change (Kreyling and Beier, 2013). This is despite the fact that locally and regionally the global temperature increase will manifest by highly variable changes such as uneven warming, heat waves, increased freeze/thaw cycles and at some places even cooling (IPCC 2007). Therefore, complexity needs to be stronger and more adequately covered in future temperature change experiments (Kreyling and Beier, 2013).
Climate factors work in combination and multifactor experiments are therefore crucial in order to test interactions among several simultaneous factors (Mikkelsen et al., 2008). This is particularly important taken into consideration that the relatively few multifactor studies conducted so far indicate that combined effects of climate factors may not always be predictable from single factor experiments (e.g. Leuzinger et al., 2011; Larsen et al.; 2011; Dieleman et al., 2012).
Also studies carried out along climatic gradients may provide an important and significant tool to understand climatic impacts on ecosystem processes and functioning. Gradients exist over large, regional distances such as a European N-S temperature and precipitation gradient (e.g. Penuelas et al., 2004) as well as short local distances such as altitudinal temperature gradient (e.g. Ineson et al., 2005). Gradient studies could be used more intensively to elucidate climate change impacts and combining experiments and gradient studies by conducting the same experimental manipulations along environmental gradients can improve external validity of controlled experiments (Penuelas et al. 2007, Beier et al., 2008, Beier et al. 2012).
Finally, modelling provides a significant and important tool to generate hypotheses (e.g. Gerten et al., 2008), design experiments and generalize and upscale their results. This is of particular importance related to experiments focusing on complexity (Kreyling and Beier, 2013). Modelling could further include “virtual experiments” with unlimited choices of scenarios (e.g. Gerten et al. 2008, Luo et al. 2008).
In summary, this Action will be innovative in addressing the following 7 “big challenges” related to climate change experimentation and modelling:

- Most experiments have been carried out in grasslands and forests of the temperate region, while the southern hemisphere and ecosystems at extreme conditions are poorly represented (Beier et al., 2012).

- Manipulations, especially of precipitation and temperature regimes, have not realistically covered the future forecasted conditions, for example extreme events (Beier et al., 2012; Kreyling and Beier, 2013).

- Experimental designs may cause unwanted side effects such as reduced wind speed, altered light and temperature conditions and shading (De Boeck et al., 2012).

- Manipulation experiments are often incomparable because of different and incomparable manipulation scenarios, techniques and or lack of data (Vicca et al., 2012).

- Coherent and/or relevant response variables and benchmarking data across different manipulation experiments are missing which limits the value to the modelling community (Beier et al., 2012).

- Single factor experiments do not adequately provide information to predict effects of multiple simultaneous climatic changes (Leuzinger et al., 2011)

- Models do not address multi factor interactions well (Leuzinger et al., 2011) and stronger interactions between experiments and models are needed (Lee and Mischurov, 2013).

B.3 Reasons for the Action

European research groups have contributed significantly to advance the science as well as the experimental finesse within climate change impacts research over the past two decades through national or EU supported research projects. However, the global dimension of climate change as well as the highly complex and multi-facetted aspect of both drivers and responses requires investigations, data and modelling to be coordinated at an international/global level (Lou et al., 2011). Solving the abovementioned limitations in climate change experimentation requires significant attention and a joint effort of the scientific community with close collaboration and coordination between experiments and between experimentalists and modellers as well as through better communication and sharing of experiences and data. This Action will provide a strong framework for such an effort bringing together experiences from the specific climate change as well as research communities in order to develop new guidelines and conceptual frameworks, educating a new generation of climate change experimentalists and modellers and linking significant European research with corresponding research globally.
The Action will aim at scientific/technological advancement and will provide immediate benefits to the scientific community by:

- continuing and strengthening a significant network of climate change experiments across Europe
- providing close interaction between experimentalists and modellers
- providing training and education of the next generation of researchers in climate change experiments
- identifying gaps in knowledge and guiding future research, particularly related to extreme events
- providing a strong collaborative counterpart to global research networks such as INTERFACE in US

In the longer run, future benefits of the Action will be:

- guidelines for climate change experiments
- coordinated meta database for climate change research
- strengthened international collaboration
- significant inputs to EU ESFRI infrastructures in the area

B.4 Complementarity with other research programmes

The Action complements and supports several on going activities in Europe with very little overlap. National, EU and JPI research programmes related to climate change focus on specific research projects and infrastructures while at present there are no networks or programmes providing networking across climate change experiments. The Action continues a successful ESF network CLIMMANI, which have networked European climate change experiments over the past 5 years, ending in June 2013. This network has been key to provide a strong network in Europe and form a counterpart for the corresponding US network INTERFACE. With the end of CLIMMANI and the change in the ESF profile, a Action will be a strong platform for future networking of European climate change experiments.

At the project level, most national (e.g. FORHOT (IL), CLIMAITE (DK), GARRAF (SP), Plynlimon (UK)) and EU (e.g. INCREASE, ECLAIRE) funded projects relating to climate change impacts will be directly involved in ClimMani and will benefit from ClimMani as a platform for discussions, experience exchange, development of new ideas and international networking and exchange. Furthermore the Action will provide a significant platform for ESR for training and

exchange. In addition, the Action will provide a network to continue and exploit experience developed in previous EU projects (e.g. CarboExtreme, CLIMMOOR, VULCAN, NitroEurope IP, ECLAIRE, EPRECOT, Ecocraft, Forcast) and international networks such as ESF ClimMani.
At the infrastructure level, the Action will complement and provide strong added value by providing a network of national and international experiments beyond the infrastructures themselves and therefore a platform for development of new ideas and conceptual frameworks to complement the infrastructures. The Action will also provide a good platform for advertising infrastructure services and thereby promote transnational access and use of the infrastructures. Researchers involved in the experimental infrastructures such as INCREASE (EU), EXPEER (EU) and the ESFRI project ANAEE (EU) are included in the potential list of participants in the Action. Finally, the Action will complement research strategies developed under EU frameworks under Horizon 2020 and under the Joint Programming Initiatives, particularly JPI CLIMATE and JPI FACCE.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The aim of the Action is to improve the quality and appropriateness of experiments, data and modelling in climate change research, facilitate better use of experimental data for scenario building and process understanding and promote the training of the next generation of climate change researchers in experimentation and modelling. This ambitious goal will be achieved by bringing together a community of researchers designing and conducting climate change experiments and measuring and modelling the experimental impacts. This community will have a highly multidisciplinary profile including areas like plant-, soil- and community ecology, ecophysiology, microbiology, hydrology, genetics, biogeochemistry, bio-meteorology, physics, technical design, modelling and data management and therefore have the capabilities to provide holistic views and assessments of climate change impacts on terrestrial ecosystems and how this can/should be studied. Climate change research is particularly challenged with the complexity in individual drivers as well as their combination and with providing interaction between data and modelling. This Action will deliver scientific syntheses of the current understanding of climate change impacts, identify gaps in knowledge and provide guidelines for future experimentation, especially focusing on new emerging challenges like multifactor pressure and extreme events. Further, the Action will address the key scientific challenges and produce guidelines for improved data and meta data facilities and better linkages between experimentalists and modellers.

C.2 Objectives

The Action has four main objectives:

1. To produce frameworks and best practice guidance for future climate change manipulation experiments in terrestrial ecosystem responses with particular focus on extreme events

2. To synthesise and promote the use of observations along natural climatic gradients as a proxy for climatic experiments and as a tool to obtain mechanistic understanding

3. To provide progress in data sharing through creation of meta databases and guidelines for data bases and data sharing

4. To integrate ecosystem modellers and experimentalists in order to facilitate and improve the use of models in experimental design, evaluation and extrapolation of extreme events experiments, increase the awareness of the issues of scaling and transfer of data and knowledge.

C.3 How networking within the Action will yield the objectives?

The Action will achieve its objectives by:

- Creating a multidisciplinary network of experimental and modelling scientists in order to promote a new generation of experiments and modelling especially within extreme events.

- Organising topical and cross disciplinary workshops involving relevant scientists in experiments and modelling.

- Organising summer schools specifically targeted towards training of ESR related to both scientific and technical aspects of climate change experiments.

- Establishing a Young Scientists Forum (YSF) providing a network for young scientists and with potential to organise small topical YSF workshops.

- Supporting Short Term Scientific Missions (STSM) for researchers (particularly ESR) to visit another research institution.

Organising two international conferences focusing on the overarching goals of ClimMani, specifically one in collaboration with other international networks such as INTERFACE.

C.4 Potential impact of the Action

The Action will be scientifically innovative and have potential impacts on:

- **Improved manipulation experiments:** The Action will provide guidance to the European climate manipulation community with respect to setting-up and running experiments, choosing scenarios, and minimising artifacts. Thereby this Action will help to improve the quality and relevance of the experiments. A specific focus on extreme events and multifactor approaches will provide a much needed and innovative progress.

- **Guidance for new experiments focusing on thresholds and extreme events:** Extreme events is an area with increasing concern and very little experience. This Action provides an important platform to develop such new experiments and interact with modellers to take on board the new ideas and data in modelling activities.

- **Meta databases and data sharing:** Existing databases from climate change manipulation experiments are typically fragmented and difficult to access. The Action will deliver a meta database to improve the overview of experiments, data and models and produce guidelines and protocols on core measurements to increase the use of experimental results, data base development and improved data access for modellers.

- **Up scaling of results:** The Action will increase the awareness and understanding of the scale issue in experiments, improved understanding of how well relatively small and short lasting experiments can be scaled to larger spatial units and extrapolated in time.

- **Improved use of facilities:** The Action will support scientific missions and trans-national access to research facilities by other scientists and especially ESR

- **Scientific integration and visibility of European experimental research:** The Action will establish close collaboration with InterFace (US) and other international research networks thereby improving the visibility of European research communities in the field.

- **Education of a new generation of scientists in climate change experiments:** ClimMani will provide training for young scientists through workshops, scientific missions, summer schools and a Young Scientists Forum.

- **High level scientific position papers:** The Action will produce 5 perspectives papers outlining state of the art and proposing future research needs within its overall area and the four specific objectives.

C.5 Target groups/end users

The strongest direct interest in the activities of the Action will be from the scientific community and companies conducting experiments or modelling of climate change impacts in terrestrial ecosystems. This will be a wide and highly interdisciplinary community also embracing communities focusing on understanding climate change impacts such as specific EU framework projects (e.g. ECLAIRE), national research projects (e.g. CLiMA!TE (DK)) and the Joint Programming Initiatives (e.g. JPI FACCE and JPI CLIMAITE). Further, ClimMani will be of direct interest to communities in running experimental facilities and infrastructures (e.g. EU infrastructures INCREASE and EXPEER and ESFRI infrastructures like ANAEE, ICOS and LIFEWATCH).
Indirectly, the work of ClimMani will be of interest and relevant for national and international policy makers and policy oriented organisations with a focus on “ecosystem services” provided by terrestrial ecosystems such as Food and Agriculture Organisation of the United Nations (FAO), United Nations Environment Programme (UNEP), UN-Habitat and the Convention on Biodiversity (CBD) of the United Nations will be end users of this Action. Potentially also organisations providing data on environmental status and impacts will be interested in the work, such as European Environment Agency (EEA).

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action will be based on four tasks:

- Task 1: Frameworks and best practice guidance for future climate change manipulation experiments
- Task 2: Use of observations along natural climatic gradients as a proxy for climatic experiments
- Task 3: Data sharing and meta data
- Task 4: Integrated ecosystem experimentation and modelling

Given these four Tasks, the scientific focus of the Action will be to identify and guide how climate change experiments and modelling can be improved individually and together in order to address the most prominent challenges for society in the future of understanding how climate change will impact terrestrial ecosystems and how we can potentially mitigate these impacts or the potential for plants and ecosystems to adapt to future conditions.

A strong scientific focus will be on “best practice” experience and guidelines in ecosystem experimentation. Experiments should ideally provide realistic manipulations according to a given scenario and be associated with minimal artifacts (e.g. Beier et al., 1994). There is still a strong need to improve considerations of the applied scenarios, methodologies, potential artifacts, statistical designs, relevant response measurements, multifactor approaches etc. Also, scientific focus will embrace the use of natural environmental gradients as a proxy for experiments and as a tool to obtain mechanistic understanding. Natural differences and gradients (both large and small scale) in for example temperature and moisture can be used to understand how these climatically related factors will affect ecosystem processes and functioning, which, however, could be exploited much more extensively.

Particular scientific focus will be directed towards the challenge of extreme events and how this can be addressed experimentally and through modelling in the future. The majority of climate change experiments to date have focused on the changes in “mean” annual drivers such as temperature and precipitation, while experiments with extreme events have been mostly based on arbitrary scenarios.

Since the complexity in extreme events scenarios and their combinations is enormous, there is a strong need to develop more consistent and coherent guidelines with respect to scenarios to be tested and the experimental techniques to be applied.
Finally, scientific focus will directed to stronger and more efficient integration of ecosystem models into climate change experiments. This can be traditional use of models for evaluating results or upscaling results, but can also be using models more consistently in the design of experiments to generate hypotheses or fine tuning scenarios to apply. Such enhanced use of models require better data and better data access. Also, in light of the complex challenges of extreme weather events, experimental support for future impacts will have to rely more heavily on model integration as well as models better developed and tested for these extreme events.

D.2 Scientific work plan methods and means

The Action will be based on 4 Working Groups following the 4 tasks described above:

WG1 - Frameworks and best practice guidance for future climate change manipulation experiments

The objective of WG1 is to review the “state of the art” in climate change experiments, summarise key findings, identify “best practice” principles and produce guidelines for the use of experiments to explore the mechanistic understanding of climate change drivers and their impacts. A special subtask will be devoted to extreme events and how this particularly challenging issue can be addressed in future experiments conceptually as well as technically. The understanding of impacts of extreme events will require a new conceptual framework and new experimental approaches in order to identify key issues like, timing, amplitudes, thresholds and tipping points, which have not be well addressed in the past. A network approach like COST will be particularly relevant for this type of development because no individual experiment will cover the issues alone. Another subtask will be to analyse how multifactor impacts can be most efficiently addressed by experiments. Finally subtasks will devoted to integrate with the WG on gradients to explore the combination of experiments and gradients and integrate with the WGs on data and on modelling to consider the contribution of data and information to meta data bases and sharing of data for syntheses and modelling. WG1 will organise annual topical workshops related to the overall task with at least one being devoted to extreme events and one devoted to multifactor approaches. In order to assure close integration of the issues of gradients, data and modelling, one workshop will be joint with WG2, one with WG3 and one with WG4. WG1 will host at least one summer school at a site with relevant field scale experiments in order to address key issues of experimental design, scenarios, artifacts,

response measurements and interactions with models.

WG2 - Climatic gradients as proxies for climatic experiments

The objective of WG2 will be to review and analyse the use of natural gradients in climatic drivers and summarise experiences and key findings. Best practice principles will be identified and guidelines for the use of natural gradients to explore the mechanistic understanding of drivers and impacts will be produced. A special subtask will be devoted to addressing how/if gradients can be used to address impacts of climate extremes. Another subtask will be to analyse major limitations in the use of gradients, such as lack of coherent complementary site conditions (e.g. soils), multifactor issues and replication. The WG will also collaborate with WG3 on data to consider better data sharing and meta data reporting from gradiental studies as well as with WG4 on the use of models to analyse and extrapolate the results. WG2 will organise annual topical workshops related to the overall task. At least one of these will be joint with WG1 and one will be joint with WG4. WG2 will host at least one summer school at a site representing a natural climatic gradient.

WG3 - Data sharing and meta data

The objective of WG3 will be to address the challenge of providing open information on experiments, gradients and modelling to facilitate sharing of data and results for general synthesis, meta analyses and modelling. A specific subtask will be to create overview of ongoing and past experiments, their characteristics, response measurements and the data availability. This work will build on a combination of ongoing and/or pilot meta databases created within a previous ESF network and within the EU infrastructure projects. Another subtask will be to identify the needs and most useful means to promote data sharing and identify current obstacles and needed promotions. Within this subtask, strategies for promotion of data sharing facilities based on databases or web or cloud based data sharing “hubs” (e.g. ENCORE) will be outlined and implemented. WG3 will organise workshop for each of the three mentioned steps inviting relevant experimentalists and data managers from major national and European framework projects to discuss and propose solutions to data sharing issues. WG3 will further interact and engage in workshops from all other WGs to assure that the data sharing issue is an integrated part of the experimental and modelling discussions

WG4 - Integrated ecosystem experimentation and modelling

The objective of WG4 will be to outline strategies to improve integration between ecosystem experiments and dynamic ecosystem modelling. A subtask will analyse how well current ecosystem models can address climate extremes such as long-term droughts, heat waves, flooding or drought promoted fires and propose needed improvements. This will focus on both the short term immediate impacts of the extreme events as well as the long term recovery after such events. A second subtask will focus on improved integration of experiments and modelling and propose best practice

guidelines for such integration, underlined by examples. WG4 will organise workshops related to both dimensions aiming to produce a position paper for each dimension. WG4 will further organise a summer school directed to integrating models and experiments along the full chain from design over experimentation and results to up scaling. WG4 will also offer training sites as part of the short term mission program.

Deliverables

Upon agreement among the participating institutions, the main deliverables of ClimMani will be:

1. **Guidelines for experimentalists** on "best practice" in experimental manipulations, use of gradients and data-model interactions (3 perspectives papers).

2. **Conceptual frameworks** for extreme events experiments and threshold testing and for data sharing facilities (2 perspectives papers).

3. **Meta database** providing searchable information of experiments, gradients and models related to climate change (information of site, experimental characteristic, methodologies, response measurements, model-data integration, data availability, publications, contacts etc.).

4. **Summer schools** on experiments, gradients and modelling. The summer schools will be targeted specifically at ESR and will combine theoretical and "hands on" experiences (2-3 summer schools).

5. **Two international conferences** organised in collaboration with other international networks. One will include societal stakeholders such as research managers and policy makers.

6. **Workshops** on WG specific topics for a smaller audience, eventually in relation to annual conferences (> 6 workshops)

7. **Short Term Scientific Missions** – Each WG will provide announcements of STSMs. Priority will be on STSMs related to the development of the Action area and with publication potential (>20 STSM).

8. **An interactive website** – Launched in month 3 and continuously updated providing information on activities, key findings and information from other relevant activities.

E. ORGANISATION

E.1 Coordination and organisation

Organisation and management - The organisation and management of the Action will consist of the following entities:

- *Management Committee (MC):* The MC will be responsible for the overall coordination of the Action through annual meetings.

- *Working groups (WG):* Four WGs will form the basis of the Action. A WG chair and vice chair will be responsible for the WG specific activities such as workshops, summer schools and short term missions.

- *Steering Committee (SC):* The SC (Chair, Vice Chair, WG Chairs, STSM chair and YSF chair) will be responsible for the "daily" management decisions and monitoring of activities of the Action.

- *Short Term Scientific Mission panel (STSM):* The Action is determined to strongly promote training of young researcher for example through STSM support. The STSM panel will include a delegate from each WG and will manage and evaluate STSM applications. An STSM chair will be elected.

- *Young scientist Forum (YSF):* An informal forum of young scientists (YSM) will be formed based on the ESR participants and in the Action and the summer schools. The YSF will nominate a chair.

Meetings and communication - a number of meetings and communication activities will be organised to ensure the activities and the networking. These are:

- *Workshops:* The Action will organise two sets of workshops. 1) Annual international workshops (hosted by partners in the Action) bringing together a wide community of research scientists to present the "state of the art" and outline future research needs related to the COST Action area. 2) Smaller (10-30 people) WG specific topical workshops targeted at the deliverables of the WG. All workshops will be obliged to

ensure 10-20% Early Stage Researcher participation. The WG workshops will be encouraged to produce a high level position paper as an outcome of each workshop.

- *MC meetings:* The MC will meet separately at the annual meeting to discuss and decide the progress of the Action, WGs, deliverables and future activities. The MC will specifically discuss potential collaborators and actions that each MC member should take forward to engage to guarantee the transfer of knowledge at national level, e.g. in relation to annual workshops.

- *SC tele-meetings:* SC tele meetings will be held 4-6 times a year to discuss progress and on going matters.

- *Website:* The Action will establish a website to inform about the Action and its activities as well as activities elsewhere of relevance to ClimMani members (meetings, conferences, summer schools, publications etc.). Further, the MC will consider if ClimMani should establish a Facebook and/or a Twitter profile to keep a continuous dialogue with interested parties.

Milestones - the progress of the Action will be assured through observing the following milestones:

- *Kick off meeting:* The kick-off meeting at the beginning of the Action, which will involve agreeing on the constituency of the MC and SC, the Election of the Chair, Vice-Chair, Working Group (WG) Chairs, YSF chair and STSM panel.

- *Website:* The interactive Web-site for the Action will be operative from month 3.

- *Annual workshops:* A rough plan for annual Action workshops (including MC and SC meetings) as well as WG workshops will be outlined at the kick off meeting. Annual workshop will be outlined one year ahead, including election of an organising committee. The topical WG workshops will be proposed to the MC for approval 6 month in advance.

- *Summer schools:* Grand plans for summer schools (content, venue, size, budget) must be presented for discussion and decisions by the MC at the 2nd annual workshop

- *Data and meta base:* A strategy for a meta database and global data sharing facilities must be presented by WG3 and discussed by the MC at the 3rd Annual meeting to assure progress.

- *Position papers:* Plans for position papers and responsible lead authors will be decided at the 2nd annual workshop based on proposals from each WG.

- *Conferences:* A grand plan for international conferences and collaborators will be outlined at the kick off meeting and decided in more detail at the 2nd annual meeting.

- *YSF:* The Young Scientists Forum will be initiated at the kick off meeting

E.2 Working Groups

The Action will establish four Working Groups (WG) to focus on each of the four tasks:

WG 1 – Frameworks and best practice guidance for future climate change manipulation experiments

WG 2 - Use of observations along natural climatic gradients as a proxy for climatic experiments

WG 3 - Data sharing and meta data

WG 4 - Integrated ecosystem experimentation and modelling

The WGs will plan topical workshops, summer schools and STSMs within their area including in collaboration with other WGs. In order to assure coordination and maximum outcome major activities will be proposed to the MC for discussion and approval. For each WG a number of subtasks will be agreed in order to better ensure the implementation of the work plan and to achieve the objectives of the Action.

E.3 Liaison and interaction with other research programmes

This Action can involve collaboration with three on-going COST Actions: ES0805 The Terrestrial Biosphere in the Earth System, ES1101 Harmonising Global Biodiversity Modelling (HarmBio) and ES1203 Enhancing the resilience capacity of SENSitive mountain FORest ecosystems under environmental change (SENSFOR). Potentials for collaboration for example through joint involvement of researchers or organisation of joint meetings will be on the agenda for the MC.

The Action will directly involve scientists from on-going and past projects within EU framework programmes FP5-7 and ongoing EU climate change experimental research infrastructures. The specific structure and content of the coming EU research programme, Horizon 2020, is not known at present, but significant potentials for collaboration and support to projects is anticipated will be a specific task for MC to evolve.
This Action will provide outputs of direct relevance to JPI Climate (module 2 and 4) and JPI FACCE and involves partners involved in various research initiatives such as NORDFORSK, ECRA and ERA. Finally, the Action will collaborate with initiatives and activities on climate change experiments in national and regional research programmes through inputs from MC and WG members.

E.4 Gender balance and involvement of Early-Stage Researchers

This Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve Early-Stage Researchers. This item will also be placed as a standard item on all MC agendas and will specifically be addressed by establishment of a Young Scientists Forum (YSF).
In order to guarantee the gender balance, two of the WGs will be led by women and two by men and mixed gender representation in all activities will be ensured.
It is established as a rule that if sensible, each WG should have a Chair or Vice Chair being a woman ("sensible" meaning that if no women with relevant skills are available, the WG will be activated with a man instead.).
As described above, a significant part of the budget of the Action will be reserved for Early Stage Researchers (ESR) through required ESR participation in workshops and through funding STSMs and Summer schools, where ESR will have a priority. It is established as a rule that for each WG the Chair or the Vice Chair should be an ESR. The Action will include a Young Scientists Forum to encourage and ensure stronger ESR representation.

F. TIMETABLE

The Action will last for four years and the timetable of main activities are reported in the chart below:

	Yr 1 mth 1-6	Yr 1 mth 7-12	Yr 2 mth 1-6	Yr 2 mth 7-12	Yr 3 mth 1-6	Yr 3 mth 7-12	Yr 4 mth 1-6	Yr 4 mth 7-12
Kick off and internal mid-term assessment	X			X				
Web site	X	X	X	X	X	X	X	X
MC meeting	X		X		X		X	X
SC meetings/tele conf.	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X
Conference					X			X
WG – workshops	X	X	X	X	X	X	X	X
STSM		X	X	X	X	X	X	X
YSF meeting/workshop				X		X		
Summer schools			X		X		X	
Perspectives papers		X		X		X	X	X

MC: Management Committee; SC: Steering Committee

- MC meetings will occur typically at the beginning of each year.
- SC meetings will usually occur in association with the annual MC meetings and in addition every 3-6 months as tele-conferences.
- One main conference will be organised by the end of 2nd year or early 3rd year, and a second major conference at the end of the Action with the primary purpose of transferring knowledge and launching new initiatives emerging from the Action.
- The timing of the STSMs (two calls will be launched every year) and Summer schools (three will be organised – one each in the second, third and fourth years) will be decided by the WGs.

- The activities of the different WGs will start immediately after the first MC.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CH, CZ, DE, DK, EE, ES, FI, FR, HR, HU, IL, IS, IT, NL, NO, PL, PT, RO, RS, SE, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 96 Million € for the total duration of the Action. This 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.

H. DISSEMINATION PLAN

H.1 Who?

The target audiences for the dissemination of the results of the Action are:
Scientific Communities: It is evident that the topic of the Action will be mostly of direct relevance to the scientific community involved with climate change experiments and measuring and modelling the responses for whom the networking and the recommendations and guidelines for future experiments will be directly relevant. Also scientific communities establishing and providing research infrastructures and private companies engaging with experimental infrastructures and technical aspects of experimentation will be a relevant audience. Finally, Early-Stage Researchers will benefit strongly in their development from the workshops and especially the STSMs.
International and national research managers: New national and international research programmes will benefit from the recommendations and guidelines provided by this Action to address key scientific challenges by the most relevant approaches.
Policy makers: Societal bodies responsible for actions to adapt or mitigate to ongoing climate change will have an indirect interest in the results provided by the Action since the Action will provide improved guidelines for experiments, modelling and up scaling of results.

H.2 What?

The dissemination of the Action will be carried out through:

1. An interactive website providing information and hosting the main outputs of the Action including references to main guidelines and information about workshops, STSMs etc.

2. Topical workshops enabling dialogue between various scientific communities, especially among experimentalists and modellers. These may be in association with the annual workshops to save resources for STSMs.

3. Young Scientist Workshop addressing topics of particular relevance for ESR.

4. A major International conference on “Status and Challenges in climate change experiments and modelling” held in collaboration with other international networks.

5. A large Final Conference which will disseminate all the main findings and achievements of the Action to all the target audiences – including a session targeted at Young scientists and a session targeting “societal benefits from experiments”.

6. Five position/perspectives papers (peer reviewed), one for the Action and one for each WG, which will be mainly disseminated to the scientific community, focusing on gaps in knowledge and recommendations for future research.

7. Guidelines for research and modelling, which will be mainly disseminated to experimental communities.

8. 2-3 Summer schools focusing on scientific and technical aspects of climate change experimentation and modelling.

H.3 How?

The MC will specifically develop a detailed dissemination plan as part of the kick off meeting and will adapt it throughout the Action to meet identified needs and priorities. Some specific measures, such as total visits to the website, number of applications to the STSM calls and Summer Schools, and number of requests from people outside the MC to join the WGs, will give an indication of dissemination efficiency and will suggest actions to be undertaken to improve it throughout the Action.

All the activities of the Action, such as announcements for Workshops, Conferences, publications, STSMs, and Summer Schools, will be advertised through the web-site. Moreover, mailing lists provided by partners targeting European and national projects/networks/associations, will be used to further disseminate of information to a wider range of end-users.

Materials and/or minutes from the Workshops, Conference and Training Schools will be made available through the web-site.