

MEDEX Second Phase: Design and Implementation Plan (June 2005)

Introduction

The general objectives for MEDEX (the MEDiterranean EXperiment on cyclones that produce high impact weather in the Mediterranean) are the same in the Second Phase as in the First Phase: the better understanding and the better forecasting of the cyclones that produce high impact weather in the Mediterranean. In fact, the final objective of MEDEX is the better forecasting of the high impact weather itself, in order to reduce the negative social and economic impacts.

High impact weather in the Mediterranean is mostly related to the presence and influence of cyclones. For that reason and to face a more affordable general objective, MEDEX is focused on the cyclones that produce high impact weather, not in the high impact weather itself, although the very final objective have always to be kept in mind.

Being the general objective of THORPEX “Accelerating improvements in the accuracy of high-impact 1-14 day weather forecasts for the benefit of society and economy”, the final general objective of MEDEX can be seen as a particular (regional) aspect of the THORPEX general objective. Nevertheless, when going to specific objectives, there are some differences between MEDEX and THORPEX to consider MEDEX as an independent project, which needs coordination with THORPEX, but that is more than a subproject of THORPEX.

The first detailed definition of MEDEX is the “MEDEX Preliminary Proposal” (2000; available from <http://medex.inm.uib.es>). A set of inter-connected actions was there considered (see fig. 1).

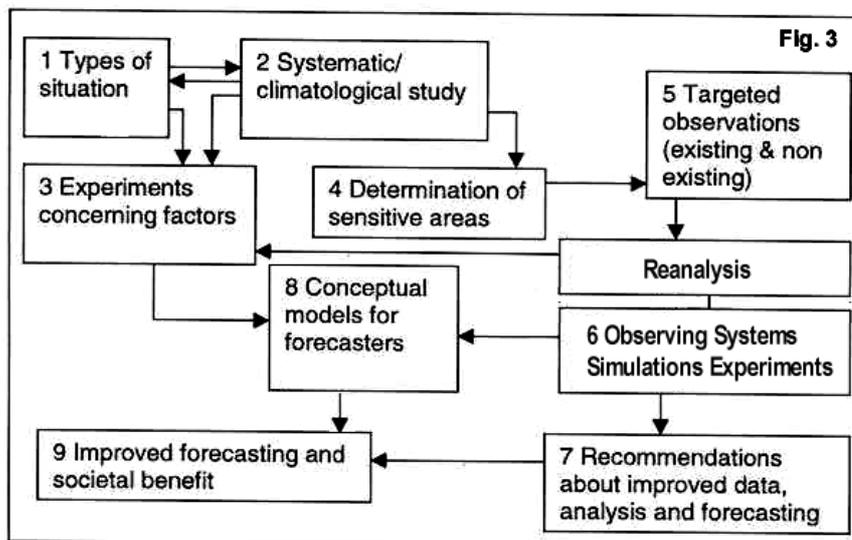


Fig. 1 (From “MEDEX Preliminary Proposal”)

The actions 5 to 6 were removed (or minimised) to define the “MEDEX First Phase Full Proposal” (2001; also available from <http://medex.inm.uib.es>). Therefore, we can consider that the MEDEX First Phase is the part of MEDEX that can be afforded without obtaining and using additional data. The Second Phase of MEDEX would be characterised by the acquisition and use of additional data. But this is too much simplified indeed.

The MEDEX First Phase included three specific objectives, to which a forth-specific objective was added later. The four specific objectives for the MEDEX First Phase have been:

- The elaboration of a dynamic climatology of the cyclones that produce high impact weather in the Mediterranean.
- The better understanding of the genesis and evolution of the cyclones that produce high impact weather in the Mediterranean, together with the analysis of the behaviour of the numerical prediction models in the simulation of these processes.
- The identification of the most sensitive areas in which an improvement of the observation leads more clearly to a better forecasting.
- The societal impact branch, including the evaluation of the societal impact of the hazardous weather associated to some Mediterranean cyclones, as well as the development of verification procedures to determine the quality of the forecasts and the establishment of ways to translate the scientific achievements to the operational meteorological community.

Several instruments were implemented to contribute to the achievement of the objectives above. The most significant of them are grouped in the MEDEX database (accessible through Internet) that contains:

- Several databases of cyclones in the Mediterranean area, based on the objective analyses from HIRLAM-INM, operational ECMWF model and ERA-40.
- A systematic calendar a potential high impact weather events (heavy rain and strong wind cases) in the Mediterranean area.
- A list of selected cases.

By the end of 2005, when MEDEX First Phase is expected to be finished, results will be obtained regarding the four specific objectives, but these results can only be considered as preliminary, no final. Even the MEDEX database will not be finished in all its details.

Therefore the MEDEX Second Phase do not have to face only the acquisition and use of additional data, but it has to revisit the objectives of the First Phase, to continue with them and to re-orient them, if necessary. Furthermore, objectives directly oriented towards a better forecasting of the cyclones that produce high impact weather (event the high impact weather itself) have to be introduced.

Specific Objectives for MEDEX Second Phase

The following specific objectives are identified:

1. Improvement of the climatological knowledge on the cyclones that produce high impact weather in the Mediterranean, including aspects related to the inter-annual variability and tendencies.
2. Improvement of the understanding of the dynamical and physical processes that are involved in the genesis and evolution of the cyclones that produce high impact weather in the Mediterranean.
3. Development and testing of observational targeting and adaptive strategies and of assimilation of new observations, oriented to the improvement of the forecasting of the cyclones that produce high impact weather in the Mediterranean.
4. Development and testing of forecasting techniques, like different kinds of ensemble forecasting and statistical post-processing of the numerical prediction model outputs, to improve the forecasting of the cyclones that produce high impact weather in the Mediterranean and of the high impact weather itself.
5. Evaluation of the social and economical benefit of improved forecasts of cyclones that produce high impact weather in the Mediterranean and of the high impact weather itself.

With more detail:

1. Improvement of the climatological knowledge on the cyclones that produce high impact weather in the Mediterranean, with inclusion aspects related to the inter-annual variability and tendencies.

A comprehensive climatology of the cyclones that produce high impact weather in the Mediterranean will be obtained from the MEDEX First Phase. But new inclusions of information are foreseen in the MEDEX database when the Second Phase is initiated, in particular with reference to the calendar of events. This will imply additional or complementary climatological studies.

On the other hand, the inter-annual variability and tendencies were not considered in the MEDEX First Phase, but this is a very important aspect, mainly in the present circumstances of a changing climate. The ERA-40 database of cyclones permits this kind of studies.

Establishing relations between the large scale circulation patterns and the cyclonic activity in the past will permit, not only a deeper knowledge on the observed inter-annual variability and tendencies of the Mediterranean cyclonic activity and their tendencies, but also the inference of the future of this activity, according to the future tendencies for the large scale circulation patterns, in the frame of the climatic change. As a consequence, due to the relation between cyclones and high impact weather, certain tendencies for the high impact weather can also be obtained.

2. Improvement of the understanding of the dynamical and physical processes that are involved in the genesis and evolution of the cyclones that produce high impact weather in the Mediterranean.

This objective was also included in the MEDEX First Phase. Although in the frame of MEDEX First Phase, an improvement of the understanding of the dynamical and physical processes that are involved in the genesis and evolution of the cyclones that produce high impact weather in the Mediterranean has been achieved (there is a Report on results under preparation), the knowledge on this field will never be perfect.

Studies on sensitivity of the evolutions to the initial conditions, already started within the MEDEX First Phase, have to be further explored. The role of physical factors, like the orography or the sea / air fluxes, has to be retained and studied, but it is important to analyse the effect of the initial disturbances, not only in upper levels (upper level potential vorticity anomalies), but also and the intermediate and low levels. PV inversion techniques can be useful for that, among other possibilities to be explored.

The availability of additional observations, coming from field campaigns (see objective 3 and implementation plan), will permit an improvement in the diagnosis studies of new cases and of the knowledge about the processes in these cases.

This second objective also includes the analysis of the behaviour of the numerical weather prediction models in simulating the evolutions of interest. In this sense, it is important to analyse the effect of assimilating some magnitudes, not usually assimilated. This aspect is common between this objective and the objective 3.

3. Development and testing of observational targeting and adaptive strategies and of new assimilation procedures and assimilation of new observations, oriented to the improvement of the forecasting of the cyclones that produce high impact weather in the Mediterranean.

The MEDEX First Phase was devoted to the identification of the most sensitive areas, where an improvement in the observations can produce the more important improvement on the forecasting of the cyclones that produce high impact weather in the Mediterranean (a Report of results is also under preparation).

Although the studies on the former direction have not to be interrupted, a new aspect has to be introduced in the MEDEX Second Phase. Ways to produce the improvement of observation in high sensitivity zones have to be developed and tested. The possibility of the permanent installation of new observational means in places with high sensitivity from the climatological point of view (for a set of cases of cyclones that produce high impact

weather) cannot be rejected, but the deployment of this kind of observations would be more a consequence of the MEDEX First Phase activity than an objective for the Second Phase. But the analysis of the impact of these new observations on the forecasting would be part of the objective 3 of the MEDEX Second Phase.

Another way of deploying additional observations (that is an objective for the Second Phase) is their placement in changing areas, in transitory periods, in function of the weather situation, always thinking on the better forecasting of the cyclones that produce high impact weather in the Mediterranean area. This means in real time working, including real time identification of high sensitivity areas in actual, present events. The deployment of such targeted or adaptive observations has to be organised in the frame of field campaigns (see Implementation plan). Of course, the analysing of the impact of these targeted or adaptive observations is also part of this objective.

Also it is testing the assimilation of non-usually assimilated sources of data (like satellite radiances, satellite or radar precipitation, GPS humidity, VAD or Doppler radar winds, etc.), as well as the analysis of the impact of this assimilation on the forecasting.

4. Development and testing of forecasting techniques, like different kinds of ensemble forecasting and statistical post-processing of the numerical prediction model outputs, to improve the forecasting of the cyclones that produce high impact weather in the Mediterranean and of the high impact weather itself.

It is nowadays generally recognised that an important part of the inaccuracy of the forecasts come from the uncertainty in the definition of the initial conditions. Another part is associated to the misrepresentation of some of the physical processes in the numerical weather prediction models. The first is even true when using targeted or adaptive observations: the uncertainty in the initial conditions is then reduced, but not eliminated.

Both uncertainties lead us to say that the “perfect forecast” is not probably the best elaborated deterministic prediction, but it can most likely be contained within a set of probabilistic forecasts. This set of probabilistic forecasts can be produced with the ensemble prediction systems, with a variety of options, organised around two blocks: ensemble prediction systems based on the slight modification of the initial conditions (oriented to assess the impact of the uncertainty in the initial conditions) or ensemble multi-model prediction systems (oriented to assess the impact of physical processes misrepresentations).

Alternative or additional ways to produce probabilistic forecasts come from the statistical post-processing of both, the deterministic or the ensemble forecasts. Among other options, we have the method of the analogies or the application of some neural networks or expert systems.

MEDEX encourages the participant institutions to work on the development of both, ensemble prediction systems and statistical post-processes, for example, in the ways and methods to modify initial conditions for a multi-analysis ensemble prediction system appropriate for the prediction of cyclones that produce high impact weather in the Mediterranean. The best way to measure analogies (to apply the method of analogies) could be another particular sub-objective. Note that we could be more interested in the analogies in the representation of the cyclones than in other analogies between the whole fields.

Experimental or operational ensemble and statistical methods have to be tested in order to analyse their capability to include the best forecasting in cases of cyclones that produce high impact weather in the Mediterranean. This is another and essential aspect of this objective.

5. Evaluation of the social and economical benefit of improved forecasts of cyclones that produce high impact weather in the Mediterranean and of the high impact weather itself.

The societal and economical impact research for the MEDEX First Phase had modest and partial objectives that, on the other hand, have not been totally achieved. In the Second Phase the true final objective of this branch has to be identified, although the intermediate objectives will have to be maintained. The final objective is the evaluation of the benefit that can be associated to an improvement of the forecasting, coming from the use of targeted or adaptive observation or from the use of ensemble or statistically post-processed forecasts.

The final objective implies that the benefit of a correct forecast, in terms of damage reduction when reaction measures are applied, has to be determined. This benefit is modulated by the cost of the reaction measures. Of course, if the forecast is not totally correct, the benefit can be minimised, even reversed. In other words, the actual benefit of the forecasts need to be qualitatively evaluated and furthermore, the way in which the forecasts are received and used by the end users and decision makers is a highly relevant aspect.

Implementation plan: field campaigns

The achievement of the specific objectives of MEDEX Second Phase implies a series of actions to be undertaken, (a) by the institutions that are participating in MEDEX, every institution by itself and/or in coordination or collaboration with other participant institutions, (b) by the MEDEX community as a whole. This second group of actions has to lead to the development and common use of a series of specific instruments, like a completed and maintained MEDEX database, a common instrument for the specific verification and the performance of field campaigns. With regard to the first group of action, the collaboration between institutions is encouraged, as well as the exchange and discussion of results; instruments for doing that are the exchange through the MEDEX web site and the presentation and discussion of results in the MEDEX Meetings and in the EGU Plinius Conferences, among other meetings, workshops and conferences.

MEDEX Database

A MEDEX Database already exists from the MEDEX First Phase. Its design was presented and discussed in the MEDEX Meeting 2002-B (see “Minutes of the MEDEX Meeting 2002-B”, in <http://medex.inm.uib.es> , restricted area). The MEDEX Database covers (a) systematic information about cyclones, (b) systematic information about events and (c) information about selected cases. These blocks of information cover the period 1995-2004, except (a) that also includes a 40 year period. The database has to be conserved for the MEDEX Second Phase, mainly for studies concerning the specific objectives 1 and 2, perhaps even 5. In case the database is not complete when the MEDEX Second Phase is initiated, efforts have to be made to complete it.

A tool for verification

A specific tool for verification of the forecasts is needed with regard to the objectives 2, 3, 4 and 5. The usual verification scores, looking at the similarity between the forecasts and analysed fields (in general) or verifying the forecasts fields against observations, have to be taken into account, but they are not enough for the purposes of MEDEX. Magnitudes to describe the similarity between the forecasted and the observed (analysed) cyclone have to be introduced. These magnitudes will describe the quality of the forecasting, not in general, but with regard to the cyclones (that produce high impact weather). Note that the concept of similarity between forecast and observed cyclone can also be used to measure similarities between cyclones in past situations: a specific technique of forecasting by analogies (see specific objective 4) can be developed from this idea.

Field campaigns

The specific objective 3 implies the need of field campaigns to deploy targeted or adaptive observations in high sensitivity areas. Objective 2 will also be favoured if additional observations are deployed within the observed disturbances, in order to obtain more information about the processes that are occurring.

MEDEX Second Phase can consider field phases or campaigns of different intensity. First, long and frequent (several months, every year) low intensity campaigns, including only some extra-soundings and, perhaps, in agreement with EUCOS, some extra-AMDAR and extra-ASAP (as well as assimilation of infrequently assimilated data, like satellite or radar rainfall, GPS humidity, radar VAD and Doppler winds, etc.). Second, co-ordinated with THORPEX and EUCOS, one or several medium intensity shorter campaigns, like the past A-TREC; these are the THORPEX / EUCOS-type campaigns. If possible, at least one Mediterranean-TREC would be very positive. The MEDEX community would have to participate in the decision taking. The third kind (high intensity campaign) could be a specific Mediterranean field campaign with in situ deployment of as much observational means as possible, to be realized by 2010. Météo-France has already an initiative in this sense. The full involvement of Spain and Italy has to be discussed within the respective communities.

Low intensity campaigns

These campaigns, which can be extended during four to six months every year (2006, 2007, 2008, 2009), are the most specific MEDEX campaigns, although it is highly desirable to do them in coordination with or with the collaboration of EUCOS and THORPEX.

The procedure is analogous to that used in the EUCOS / THORPEX ATReC. A space in the MEDEX web site has to be open to serve as exchanger of information during every campaign. The participant institutions will daily follow the weather situation in order to anticipate evolutions of interest, regarding cyclones that can produce high impact weather in the Mediterranean. In case of a suspected situation of interest, a message will be sent to this space in the MEDEX web site. A permanent "centre of operations" also following the weather evolution, will propose (or not) the opening of a period of interest, before a special observing period. In that case, the participant institutions that are operating numerical prediction models, even in an experimental way, will send key product to be included in the specific space of the MEDEX web site. A few –one or two- institutions will be requested to compute sensitivities in real time. With all the material and after discussion, a special observing period will be open. During it, the participant institutions that have observational means within the sensitive areas will perform additional observations (like extra-soundings). They will also distribute among the MEDEX community non-common observations,

like satellite and radar precipitations, GPS humidity, VAD or Doppler radar winds, etc.

The preliminary studies referred to identification of high sensitive areas in case of cyclones that produce high impact weather in the Mediterranean, referred to West Mediterranean cases, suggest that the highest sensitive areas can be situated even out of the strictly speaking Mediterranean area, that is, to the north-African and east-Atlantic zone, see fig. 1, that is an example of sensitivity computations, taken from Homar, Romero & Ramis, "Sensitivities of West Mediterranean cyclones using an adjoint model", MEDEX Meeting 2004-B, Dubrovnik, 2004. This reveals the probable importance of Portugal, Spain, Morocco and Algeria as sources of additional observations, at least in West Mediterranean cases.

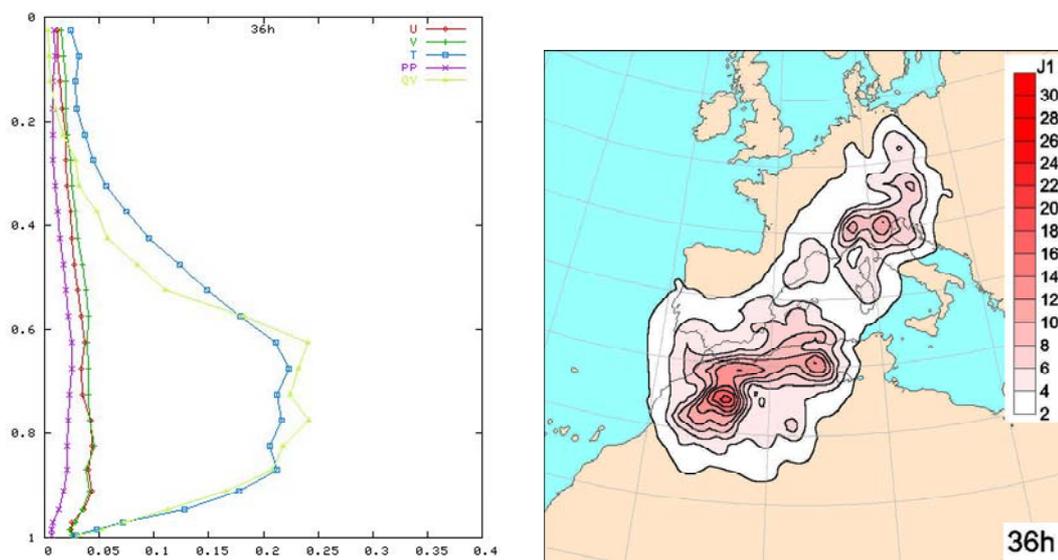


Figure 1: **36 h sensitivities for the Nov 2001 storm** (from Homar, Romero & Ramis, 2004), showing vertical integration of all the sensitivities (right) and vertical profiles of horizontally integrated sensitivities of different magnitudes (left) to the cyclonic vorticity. The vertical scale is sigma-levels)

Medium intensity campaign / s

It is supposed that during the period 2006-2009 EUCOS and THORPEX will perform one or two European-TReC or one European- and one Mediterranean-TReC. MEDEX is especially in favour of the second possibility. These probably will be two to three months campaigns that, if possible, would be framed within a low intensity MEDEX campaign.

The European- or Mediterranean-TReC will be directed by the EUCOS / European THORPEX organisation and non-conventional additional observations (from aircraft and other platforms, including drop-soundings and so on) will be deployed within the most sensitive areas. MEDEX would interact with EUCOS / THORPEX, through acting as in the Low Intensity Campaigns. MEDEX will provide to EUCOS / THORPEX the conclusions about the potential

importance of a pre-selected situation, as well as the results of the sensitivity computations. In case of activation of a special observing period, not only the European (EUMETNET) meteorological services would be requested for additional observations, but also the north-African ones.

High intensity campaign

In order to perform a comprehensive assessment of the Mediterranean meteorological events and of all their consequences, it is important to envisage at least one "high intensity campaign" which would involve all the atmospheric scales from the global large scales down to meso-scale events which are particularly important for the weather in some coastal regions and for its consequences in terms of hydrology, societal and environmental risks. Such a high intensity campaign should include first all the synoptic tools of the previous "medium intensity campaign" on a few month period (typically 3 months). On at least some sub-periods, it should include also specific research observations means for investigating meso-scale processes on one or two regions close to the Mediterranean Sea, which are particularly sensitive to extreme events (such as the Languedoc area in France close to the Cevennes mountains). Such a campaign should be also the opportunity to study in detail the interaction of the Mediterranean events with the local orography and the local hydrography on one or two sensitive coastal areas. A preliminary investigation limited to France seems to indicate that such a campaign could be organised in autumn 2010. The long delay is due to the necessity to concentrate observation means and human resources from many different sources at the same time.

Organisation

The elements of the organisation of MEDEX are:

- The Core Steering Committee
- The Science Steering Committee
- The MEDEX network of focal points and contacts
- The societal impact research group

Funding

Apart from the costs associated to meetings and travelling and to the organisation, the computer developments necessary to implement the field campaigns, as well as the performance of additional observations (at least, extra-soundings or additional AMDARs) are expenses that are necessary for the success of the MEDEX Second Phase.

External funding is a difficult solution, which probably has to be attempted again (an initial trying with the European Commission has been unsuccessful). In case of failure, or as a complement, some of the participant institutions will have to think on the convenience of providing direct financial contributions to MEDEX. Through EUMETNET and EUCOS, the European meteorological services could also do some contributions. A (new) agreement between EUCOS and MEDEX could be convenient.