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1. Introduction

The 11th ALPEX-Regional Meeting took place at the University of Innsbruck on June 17/18, 1993. 42 participants from Austria, Croatia, Germany, Italy, Poland, Slovenia, Switzerland, and USA attended, and 24 presentations were given. The main part of the meeting was dedicated to the preparation and planning of the "Mesoscale Alpine Project - MAP", but ALPEX activities, e.g. ALPEX Level III-b Analysis and numerical simulations of ALPEX-SOP cyclogeneses, were also reported. Details about the presentations and discussions including the report of the MAP-working group are given in this issue of the ALPEX-Regional Bulletin.

The 12th ALPEX-Regional Meeting will take place in Zürich on June 9/10, 1994: Only a session of the extended MAP-working group is planned to prepare the MAP Workshop which will be held just after the ITAM-94 in Lindau (D) or in Zürich. The scientific sessions to prepare a proposal for MAP will be held there. For details see chapter 3 of this issue.

Helmut Pichler, Innsbruck

3.3 MAP-Proposal, March 1993

MESOSCALE ALPINE PROJECT

M A P

A proposal to be presented to the "Informal Conference of Directors of Western European National Meteorological Services"

Roma, 28-30 April 1993

compiled by an ad-hoc working group of the ALPEX-Regional group

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March 1993

LIST OF ABBREVIATIONS:

A	Austria
ALPEX	Alpine Experiment (Special Observing Period March and April 1982)
CH	Confoederatio Helvetica (Switzerland)
COST	European Co-operation in the Field of Scientific and Technical Research
D	Deutschland (Germany)
DLR	Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V.
DM	Deutschland-Modell DMI Danish Meteorological Institute
DNMI	Den Norske Meteorologiske Institutt (Norwegian Meteorological Institute)
DWD	Deutscher Wetterdienst
ECMWF	European Centre for Medium-Range Weather Forecasts
EM	Europa-Modell
ETEX	European Tracer Experiment
ETH	Eidgenössische Technische Hochschule
FMI	Finnish Meteorological Institute
GEWEX	Global Energy and Water Cycle Experiment
HIRLAM	High Resolution Limited Area Model
I	Italia (Italy)
ICWED	Informal Conference of Directors of Western European National Meteorological Services
IPCC	Intergovernmental Panel on Climate Change
IR	Infrared channel of Meteosat
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Dutch Meteorological Institute)
LAM50/25	Limited Area Model of DNMI (with 50 or 25 km mesh size)
NWP	Numerical Weather Prediction
PV	Potential Vorticity
PYREX	Pyrenees Experiment (Oct. and Nov. 1990)
SESAME	Second European Stratospheric Artic and Mid-latitude Experiment
SI	Slovenia
SM	Schweizer Modell
SMA	Schweizerische Meteorologische Anstalt

SMHI	Swedish Meteorological and Hydrological Institute
UKFM	United Kingdom Fine Mesh Model
UKMM	United Kingdom Mesoscale Model
TOVS	Tiros Operational Vertical Sounder (satellite instrument to retrieve temperature profiles)
VIS	Visible channel of Meteosat
WV	Water vapour channel of Meteosat

REMARK:

The selected references, which are quoted in the text and listed in the last section, are by no means exhaustive. They are given to indicate fields of current research with relevance to MAP. The emphasis is put on work by European researchers (including the working group members).

SUMMARY

The Alpine region in the middle of Europe is shared by more than half a dozen states. The Alps - the major obstacle for the atmosphere over Europe - have a significant influence on atmospheric processes of all scales. At present much interest of applied and basic research is directed to the meso-scale, and its meso-β part in particular. The latter comprises phenomena with horizontal extents of 25 to 250 km. This proposal advertises the launch of a "Mesoscale Alpine Project" (MAP), which is to start from issues relevant to operational weather forecast models and related basic dynamical problems and which may eventually lead to a dedicated field campaign in, say, 1997. Experiences from previous field experiments are taken into account and links to related international projects are identified.

The Western European National Meteorological Services are asked to respond to this proposal. In particular we ask whether any of the MAP objectives coincide with their own research programme aims. If they do, are the services prepared to become involved with MAP and if so in what way? For example MAP will need to use operational and research models, measuring platforms and observing systems.

INTRODUCTION

More than ten years ago the Alpine Experiment (ALPEX) took place lasting for one year with a two month period of intensive observations. It was the last in a series of major field studies undertaken under the Global Atmospheric Research Programme and the first one ever attempted on such a large scale to study the behaviour of the air flow over and around mountains. Since then remarkable scientific progress has been made in theoretical, diagnostic and modelling studies of atmospheric flow over orography, particularly in the meso-α scale and regarding the prediction of lee cyclogenesis.

After the experiment the ALPEX-Regional group came into existence as an informal forum to discuss scientific issues related to Alpine meteorology between researchers from the meteorological services, university groups and research institutes mainly in Austria, Germany, Italy and Switzerland. In January 1992 an ad-hoc working group was formed to review the developments in Alpine meteorology since ALPEX, to identify specific research needs and to make suggestions for a possible further international project.

This paper aims at briefly highlighting the present situation from the following five points of view:

- progress in operational numerical weather prediction
- basic dynamical problems
- observational technologies

- experiences from ALPEX and related campaigns
- related international projects.

After having outlined these we indicate routes which should be followed within the proposed "Mesoscale Alpine Project" and ask for response from the ICWED.

PROGRESS IN OPERATIONAL WEATHER PREDICTION

During the last decade limited area models became operational for short range forecasts (up to 72 h) at several European weather services, e.g. EM (DWD), HIRLAM (DMI, FMI, KNMI, SMHI), LAM50/LAM25 (DNMI), Peridot (Meteo France), UKFM/UKMM (Met. Office). They vary to some extent in the basic model equations, in the parameterization schemes, in horizontal resolution and in the computational domains. The Alps are contained in all domains except that of UKMM and LAM50/25 (the latter cover the Scandinavian mountains as major orographic fea- ture). The general shape of the Alps can be resolved by the mesh sizes of typically 50 km. The same applies since autumn 1991 for the global T213-model of ECMWF.

At DWD and SMA a joint project is well under way aiming at the opera- tional run of two 36 h forecasts per day on 15 km grids covering different portions of central Europe including the Alpine region (model configurations DM and SM). The operational start is scheduled for summer 1993. Pre-operational tests revealed a wealth of meso-β scale structures as, e.g., highly structured precipitation patterns, sub-synoptic high and low pressure regions adjacent to mountains and respective horizontal circulation patterns, wind shear lines at fronts, enhanced thermodynamical contrasts at fronts. Such features often appear to be very plausible, but the resolution of the model is so far ahead that of routine observations - particularly above the surface - that case study oriented, quantitative verifications are hardly possible (cf. e.g. Volkert et al., 1991; Volkert et al., 1992).

Diagnosing the performance of operational weather prediction models and verification of their forecasts have become standard tasks for the meteorological services which operate the models. Various statistics and skill scores are applied mostly for extended regions and longer time periods. As DM and SM are being developed in order to better resolve the forcing which the topography exerts on the atmosphere additional validation methods appear to be necessary, especially in regions close to prominent orographic features as the Alps. A classification of different weather types or flow regimes should be undertaken as well as case study oriented evaluations of prototype situations. Furthermore, a generalized approach for an objective frontal analysis appears to be promising for both observations and model data (cf. Steinacker, 1992).

For quite some time schemes for the parameterization of gravity wave drag are included in weather and climate forecast models. They are mostly based on highly simplified ideas of the structure of inertiagravity waves over mountains. To improve these schemes it is crucial to have further observations of the waves over the Alps. Similarly near surface weather parameters - important mesoscale NWP products - are highly dependent on the characteristics of the planetary boundary layer. But appropriate parameterizations for the boundary layer in mountainous regions are not available. Furthermore, up to now no method exists to establish proper initial conditions for meso-β scale NWP models. In practice the initial fields are interpolated from larger scale representations and the fine structure is expected to evolve during the integration.

The calculation of trajectories (backward and foreward) and the determination of transport and dispersion of pollutants are receiving considerable attention within and outside the meteorological services. The quality of such products in the Alpine region awaits to be assessed.

In summary, we list five problem areas, which are motivated from the routine operation of weather prediction models in the mesoscale and which, therefore, call for applied research efforts:

- analysis scheme tailored for meso-β scale resolution,
- parameterizations suitable for the planetary boundary layer over steep orography,
- improvement of gravity wave drag parameterization,
- flow regime oriented validation methods, and

- impact of meso-β scale resolution on the calculation of trajectories and the transport of pollutants in the vicinity of the Alps.

It is expected that co-ordinated theoretical, numerical, and observational efforts can substantially contribute to progress in these areas.

BASIC DYNAMICAL PROBLEMS

Beside the needs originating from operational models there are also basic dynamical problem areas for which the general understanding is quite limited, even after field campaigns as ALPEX (1982) or the Front Experiment '87. These dynamical issues are often directly related to specific forecasting problems. They include:

- the role of upper-level PV anomalies for frontogenesis, cyclogenesis, and the formation of mesoscale convective complexes (c.f. e.g. Tafferner and Egger, 1992);
- the characteristics and intensity of trans-Alpine flow as a function of upstream and downstream conditions;
- processes associated with three-dimensional gravity wave breaking (c.f. e.g. Stein and Bougeault, 1991; Smith and Gronas, 1993) and their impact for wave drag parameterizations (cf. Miranda and James, 1992);
- orographically induced low level vortices and shear lines (cf. e.g. Schär and Smith, 1993; Thorpe et al., 1993);
- the formation and erosion of Alpine boundary layers;
- the investigation of precipitation processes and the estimation of hydrological budgets over the Alpine region (cf. e.g. Binder, 1992; Buzzi and Alberoni, 1992; Frühwald, 1992);
- the effect of regional relief characteristics (e.g. size and height of massifs, depth and width of valleys) on weather phenomena as the strength of fronts or the evolution of storms (cf. e.g. Rakovec and Poredos, 1992);
- the orographic influence on tropospheric-stratospheric exchange;
- the impact of weather patterns on climatic parameters over the Alpine region (cf. e.g. Frey-Buness and Heimann, 1992).

Specific topics of these areas can employ existing operational or research type models to estimate the contributions of the key processes involved and to formulate hypotheses, which can be tested with data from one or several dedicated field experiments.

We note that about a dozen U.S. scientists as well as U.S. funding agencies have shown interest in the above mentioned topics concerning Alpine meteorology and a possible experimental campaign after 1995.

OBSERVATIONAL TECHNOLOGIES

Field experiments are usually not only motivated by scientific objectives, but the availability of new observational technologies can have a considerable triggering function. During ALPEX the aerological network of the World Weather Watch was augmented in space (additional stations) and time (6 hourly soundings) and special platforms were used, such as aircraft, groundbased radars and arrays of microbarographs.

In recent years additional observing systems and platforms have become available or are planned to be operational till 1995 such as wind and, possibly, temperature profilers, frangible dropsondes, airborne Doppler radar, and Lidar techniques. All of these have considerable potential to probe meso-β scale atmospheric structures in the Alpine region. One purpose of this proposal is to inform the agencies which operate such new systems about a possible application of their tools within MAP. Till 1995 operation plans could be worked out in close co-operation with the aforementioned modelling teams, and for 1997 a field experiment may be scheduled.

Any such campaign has to use both enhanced standard observation systems and new technologies, e.g.

- all SYNOP and METAR reports,
- networks of automatic surface stations,
- enhanced radiosonde network including wind,
- network of weather radars,
- arrays of microbarographs,
- satellite information (e.g. regular IR, VIS, WV pictures on stereographic projection; TOVS soundings),
- wind and temperature profilers,
- frangible dropsondes (deployed from C-130 or Strato-2C aircraft),
- airborne Doppler radar,
- Lidar measurements,
- earth observation satellites (to determine surface parameters for the numerical models),
- spherics location system.

EXPERIENCES FROM ALPEX AND RELATED CAMPAIGNS

The planning and conduct of ALPEX took place under the auspices of a "Joint Scientific Committee" between the "International Council of Scientific Unions" and the "World Meteorological Organization". The national European Meteorological Services were involved, but the leading role was taken by individual scientists from outside the services, and to a considerable part from overseas.

The ALPEX data set is claimed to be of unique value, especially with regard to meso-α scale features of cyclogenetic events. At DWD a re-assimilation project of the entire period March and April 1982 is close to completion using the latest Europa-Modell assimilation scheme. The resulting level III-b data set presents itself to determine the limits of the ALPEX observations with respect to meso-β scale phenomena.

The Front Experiment '87 and PYREX '90 were other recent field experiments addressing orographic effects on fronts over foreland north of the Alps and flow across and around the Pyrenees, respectively. During both campaigns enhanced radiosonde networks were, inter alia, in operation, but due to their spatial resolution only meso-α scale structures could be resolved over the entire experimental domain.

The "Mesoscale Alpine Project" should, of course, take into account previous experiences by making good use of the available datasets or by re-simulating past intense observation periods, particularly during its definition phase. A strong and direct involvement of the research departments of at least some meteorological services will be essential if MAP is to gain momentum. Their co-operation with university groups and research laboratories will ensure a fruitful blend of applied and basic research. To some extent this is already reflected in the affilations of the working group members, who compiled this proposal.

RELATED INTERNATIONAL PROJECTS

It appears to be useful to identify interests, which MAP shares with other national and international projects, in order to develop possible research links.

In the context of global climate change, it has been stated in the IPCC report (Houghton et al., 1991, p. 324) that "appropriate field experiments will need to be carried out in different regions" in order to develop and test improved parameterization schemes for cloud and other processes. The GEWEX programme will be the focus internationally for research into water cycle related processes throughout the next decade. The primary German contribution will concentrate on the energetics and the hydrological cycle over the Baltic Sea area and its surroundings, but

studies concerning precipitation over the Alpine region fit well to the overall aims of GEWEX. A field campaign within MAP could, e.g., aim at providing sufficiently dense observations to validate new cloud parameterizations schemes over complex terrain (their importance regarding mesoscale forecasts for Switzerland is discussed in Binder, 1992).

Climate issues over the Alpine region are about to be addressed by the Swiss National Research Programme 31 on 'Climate Change and Natural Disasters' as well as by the Bavarian Cooperative Research Programme 'BayFORKLIM'. Simulation experiments of prototype or realistic weather situations within MAP are potentially useful for down scaling or regionalization aspects of climate simulation studies. In general, a detailed knowledge of all weather processes relevant for the Alpine region is necessary when reliable inferences of the Alpine climate and its possible change are sought.

The European SESAME project is about to be defined. It focuses on dynamical and chemical processes in the stratosphere which are relevant for ozone destruction. Besides concentrating on high latitudes the European region will become an additional focus. For the interpretation of regular ozone measurements from Alpine stations the actual flow patterns and orographically enhanced high level anomalies (e.g. cut off lows) appear to be important.

The ETEX campaign is scheduled for 1994 to assess the real time warning capabilities of the meterological services in the case of massive accidental releases of radioactive or chemical materials into the atmosphere. An inert tracer will be released and sampled at some 200 stations all over Europe. NWP and dispersion models have to predict the transport routes on short notice under quasi real time constraints. The Alpine region and the meso-β scale provide particular difficulties; thus, co-ordinated research may be valuable for parts of the ETEX evaluation.

Within the COST framework an international project "Nowcasting" is about to be established. It is scheduled to begin later in 1993 and will last for four years with many European countries and their national meteorological services as participants. The projects aims at the development of advanced (mainly diagnostic) techniques for detecting, nowcasting and very short range forecasting of convective systems, severe weather, and local weather hazards, as well as the subsequent transfer of know-how. An Austrian contribution deals with the development of a very fine mesh objective analysis scheme for the Alpine boundary layer.

CONCLUSIONS AND PROPOSAL

As has been outlined above Alpine meteorology is a field of the atmospheric science which calls for increasing research efforts during the next years. There exists an attractive combination of

- experiences and co-operations from previous campaigns,
- new operational tools with needs for applied research directed towards more accurate and more detailed forecasts,
- relevant problem areas for basic research, and
- the availability of new observational technologies.

The emphasis is placed on the Alpine region as a whole and on meso-β scale phenomena, but studies of more local (meso-γ scale) structures can be easily embedded.

Therefore it is proposed to launch the "Mesoscale Alpine Project (MAP)" at the 11th ALPEX-regional meeting, which will take place in Innsbruck on 17/18 June 1993. All interested groups are invited to attend.

During a one year definition phase (July 93 - June 94) the working group offers to collect proposals for project tasks, to facilitate bilateral co-operations, to work out a detailed project plan, and to look for project funds. At the end of this period an appropriate organisational structure has to be decided upon. The next International Conference for Alpine Meteorology in Lindau

(Sept. 1994) appears to be an excellent forum to review the achievements from the definition phase and to communicate the resulting objectives to the scientific community.

The following main phase is envisaged to consist of at least two branches, "numerical simulations" and "field measurements". The simulations serve, inter alia, to design suitable measuring strategies. By the end of 1995 details for the measurements should be agreed on and one (or several shorter) campaign(s) could take place in 1997 after tests for components of the entire measuring system during the previous year.

These figures can, of course, only be rough guide lines. At present it appears to be most important to collect all relevant information from the European Meteorological Services; cf. box on p. 24 for typical questions. The participants of ICWED in Roma are asked to pass their information to SMA (Dr. Gutermann) or to the chairman of the working group (see title page for the address), whenever possible before 10 June 1993.

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