ACCORD

ATMOSPHERIC CIRCULATION CLASSIFICATION

AND REGIONAL DOWNSCALING

ENV-4-CT97-0530

Minutes of the first progress meeting

16-17 October 1998

Universitaet of Stuttgart, Stuttgart, DE

Summary of agreed action points

- The first annual report is due in Brussels at the end of November. UEA will write a short project synthesis to accompany the individual reports. Copies of the submitted material will be circulated to ACCORD participants.

- All ACCORD groups must provide annual cost statements by 31 December 1998 (to be sent to Mrs Janet Sear, UEA).

- The next ACCORD progress meeting will take place in Bologna, 26-27 March 1999, as previously agreed. More time will be spent discussing the project as a whole, including how to compare and evaluate results and how to fully link the different components.

- It was agreed to hold the final progress meeting in Thessaloniki, rather than Copenhagen, in October 1999 (precise date to be confirmed).

- ACCORD participants are encouraged to provide additional material for the ACCORD web site (http://www.cru.uea.ac.uk/cru/projects/accord/). Links to other web sites are particularly welcome. The following will be added to the web site in the near future: the Vienna conference paper, the annual report synthesis, a list of ACCORD publications, Appendices 7 and 8 from the start-up meeting minutes.

- The ACCORD email list (accord@uea.ac.uk) can be used by all ACCORD participants to circulate news and information.

- UEA agreed, if possible, to extract an extended data window for key NCEP Reanalysis variables. The wording of an acknowledgement for using NCEP data will be added to the CRU web site (http://www.cru.uea.ac.uk/cru/data/ncep/) and circulated to ACCORD participants.

- Daily temperature and precipitation data series will be put into a common format and added to the CRU web site (http://www.cru.uea.ac.uk/cru/data/). The gap in data coverage over Spain will be filled by purchasing appropriate data.

- In order to assist comparison of the different classification schemes and methodologies, ACCORD participants should produce output for a common period (1971-1980). However, this does not mean that all analyses should be restricted to this period. ACCORD participants also need to consider Appendices 7 and 8 from the start-up meeting minutes (to be added to the ACCORD web site) which address standardisation issues.

- Consideration needs to be given as to how ACCORD might best contribute to Chapter 10 of the IPCC Third Assessment Report which will be on regional climate modelling. It would be appropriate to send copies of relevant reprints to Hans von Storch and/or Mike Hulme (chapter co-authors).

MINUTES OF THE FIRST ACCORD PROGRESS MEETING

UNIVERSITAET STUTTGART, 16-17 OCTOBER 1998

LIST OF PARTICIPANTS (see Appendix 1)

AGENDA (see Appendix 2)

All groups were asked to bring copies of their first annual reports to the meeting. These were circulated to all participants and contain full details of completed work. Thus these minutes focus on the general discussions following each presentation.

No.	Acronym	Partner
01	UEA	Climatic Research Unit, University of East Anglia, UK
02	DMI	Danish Meteorological Institute, Denmark
03	ARPA-SMR	Servizio Meteorologico Regionale, ARPA-Emilia Romagna, Italy
04	CNRS	Laboratoire de Météorologie Dynamique, Centre National de la Recherche Scientifique, France
05	IWS	Institut für Wasserbau, Universität Stuttgart, Germany
06	FTS	Fachhochschule für Technik, Stuttgart, Germany
07	U.BERN	Geographisches Institut, University of Berne, Switzerland
08	UD	University of Derby, UK
09	UT	University of Thessaloniki, Greece
10	VI	Verdustofan Islands, Icelandic Meteorological Office, Iceland
Subcontractors		
	ETH	Eidgenössische Technische Hochschule, Switzerland
	INLN	Institut Non-Lineaire de Nice, France

GENERAL ADMINISTRATIVE ISSUES (Phil Jones)

Apologies
Apologies were received from Christoph Frei, Trausti Jonsson, Antonio Navarra, Christoph Schaer, Robert Vautard and Rob Wilby.

Introductions
Participants who did not come to the start-up meeting were introduced and welcomed. A particular welcome was extended to two of the external reviewers who were attending the meeting: Bennert Machenhauer and Hans von Storch.

Annual reports
All groups were asked to bring copies of their first annual report to the meeting. These were distributed to participants. The first annual report is due in Brussels at the end of the first contract year (30 November 1998). The co-ordinators (UEA) had asked groups to provide the reports somewhat early in order to avoid having to produce separate progress reports for this meeting. UEA will write a short project synthesis to accompany the individual reports when they are sent to Brussels. Copies of the submitted material will be circulated to ACCORD participants.

Annual cost statements
All ACCORD groups must provide annual cost statements by 31 December 1998. These should be sent to:

Mrs Janet Sear
Finance Division
The Registry
UEA
Norwich
NR4 7TJ
UK

Any questions should also be addressed to Janet Sear (j.sear@uea.ac.uk).

Future ACCORD meetings
The next ACCORD progress meeting will take place in Bologna, 26-27 March 1999, as previously agreed. The meeting will again occupy all Friday, finishing by 1300 on Saturday. Carlo Cacciamani noted that March was a busy period for hotel accommodation in Bologna and we will need to book early. UEA will discuss details of the meeting with ARPA-SMR in January 1999.

For a number of practical reasons it was agreed to move the venue of the final ACCORD meeting from Copenhagen to Thessaloniki. The meeting will be held in October 1999. Panagiotis Maheras and Ted Karacostas will send UEA details about the likely cost of hotels/meeting rooms in the city and on the Halkidiki peninsula.

No-funds extension
In view of the late notification of the start date and the delay in receiving the first slice of money, a three-month no-funds extension will be sought at an appropriate later date. If agreed to, this means that the final report will be due 29 February 2000.

European Climate Science Conference
Phil Jones will give a ten-minute presentation on ACCORD at the European Climate Science Conference in Vienna next week. An eight-page paper for inclusion in the conference proceedings has been produced by UEA. Copies of this paper, which incorporates contributions sent in by many ACCORD partners, were distributed to the meeting participants. UEA will report back to ACCORD partners any relevant news from the conference.

ACCORD web site
ACCORD participants are encouraged to provide additional material for the ACCORD web site (http://www.cru.uea.ac.uk/cru/projects/accord/), including any comments or corrections to existing material. Links to other web sites are particularly welcome. All contributions should be sent to Clare Goodess (c.goodess@uea.ac.uk). The web site will be expanded in the near future to include the Vienna conference paper, a summary of the annual reports and a list of ACCORD publications.

ACCORD mailing list
An ACCORD mailing list (accord@uea.ac.uk) was set up following the start-up meeting. It is used by UEA to circulate all project-related information. The list can also be used by all ACCORD participants to circulate news and information, and to disseminate/discuss project results. UEA hopes that increased use will be made of this facility in future months as major

results begin to emerge. Please inform Clare Goodess of any relevant email changes or of people who should be added to/removed from this mailing list.

Minutes of the ACCORD start-up meeting

The draft minutes of the ACCORD start-up meeting held in Norwich, February 1998 had been circulated to meeting participants for comment. The agreed minutes were then circulated to all ACCORD participants and to the three external experts in April 1998.

At the start-up meeting it was agreed that the ACCORD window for NCEP Reanalysis data should be 80-30N by 60W-70E. No amendments to this window were suggested following circulation of the minutes. Many variables have already been processed by UEA using this window. However, UT would now like the window to be extended down to 20N. Torben Schmith also asked if it would be possible to extend the window further westwards to 90W. UEA agreed, if possible, to extract an extended window for a few key variables, i.e. MSLP and 850/700/500 hPa geopotential pressure. There may, however, be some delay while UEA waits for delivery of a new storage disk.

UEA clarified that the NCEP Reanalysis data on the Climatic Research Unit (CRU) web site (http://www.cru.uea.ac.uk/cru/data/) are freely available for use by anyone, provided that an appropriate acknowledgement is used. The wording for this acknowledgement will be added to the web site and circulated to ACCORD participants.

NCEP DATA (Phil Jones)

Phil Jones presented results of the UEA work on evaluation of the NCEP Reanalysis data (Task 1.1, see Section 3 of the UEA annual report) and on the influence of the North Atlantic Oscillation (NAO) (Task 1.2, see Section 4 of the UEA annual report).

In the following discussion, Phil was asked why the differences between NCEP and UKMO MSLP change with time. Prior to 1967, the differences can be attributed to the incorrect adjustment and subsequent rejection of low MSLP values in the Reanalysis (see the UEA annual report and http://llnx21.wwb.noaa.gov/images/psfc/psfc.html for details). Another question was whether the errors/differences are propagated through to higher levels in the atmosphere. Clare Goodess reported that she has compared the NCEP 500 hPa data with NMC data. In this particular case, the differences are small and not systematic, indicating that the errors are not propagated upwards.

Phil stressed that it was important to remember that the NCEP data are not observations but a modelling synthesis. There is, for example, no satellite input data prior to 1977. The effect of this will be explored in future Reanalyses, but not during the lifetime of ACCORD. The major NCEP-UKMO differences occur over Greenland and southeast Europe and indicate positive trends. Part of these differences may be due to problems with the observed data which are being used for the comparison.

Another questioner asked about the effect of the different NCEP/UKMO grid resolutions on the MSLP PCAs. This may be why the differences between the two sets of PCs are greatest in summer. In response to another question, Phil considered that any errors in the NCEP data may have less of an impact at the daily level than at the monthly or seasonal level. He added that it is difficult to know what criteria NCEP use for rejecting input data.

It was noted that an exact match between MSLP at an individual station, such as Reykjavik, and interpolated NCEP values is not expected. The smoothing and interpolation means that small and deep pressure centres may not be picked up.

Phil noted that the observed daily temperature data had not been adjusted to sea level before being compared with NCEP data, but altitude should have little effect in the three selected grid boxes. Results for an Italian grid box were also shown in addition to those for two UK grid boxes (the UK results are included in the annual report). The NCEP-observed differences are larger for the Italian grid box than for the two UK grid boxes. This may be because fewer Italian station series are available. It was suggested that NCEP would be expected to underestimate Tmin/Tmax values because the Reanalysis model needs to spin-up over each day. It was reported that UEA had identified a problem with the daily Tmax/Tmin values supplied by NCEP. These values were calculated as the mean of the four 6-hourly values, rather than by taking the maximum/minimum value. These files were removed from the CRU web site when the problem was discovered and will be replaced as soon as the correct data files are received from NCAR and processed. Finally, it was noted that UEA has not yet compared maximum daily rainfall values.

OTHER ACCORD DATA SETS (Phil Jones)

Phil Jones reported that daily data series available in the Climatic Research Unit (CRU) are being put into a common format (see Section 2.2 and Figure 1 of the UEA annual report). These data will be placed on the CRU web site. The temperature and precipitation time series will be subject to brief homogeneity checking (e.g. inspection of monthly means/totals). These series include a number from Italy. These come from three different sources (the Met. Service, the electrical service (ENR) and Ispra). Data from the different sources don't always agree and in some cases it has been impossible to reconcile different series for the same location.

There is a gap in coverage over Spain and Portugal. Rafael Boren and Jaime Ribalaygua have identified a set of 15 stations evenly distributed over Spain which have daily data for the period 1958-1997 and very few missing values. These data could be purchased from the Spanish National Meteorological Institute for 150,000 pesetas (~895 ECUs) for use in the ACCORD project. They could be made available relatively quickly and would be subject to homogeneity checks by Rafael and Jaime. If the data are purchased, UEA would also like permission to use them in the WRINCLE and MEDALUS projects (both EC-funded). The UEA ACCORD budget includes some money for data purchase on behalf of the project.

Carlo Cacciamani reported that ARPA-SMR has purchased 25 years of 3-hourly data for 20 Italian stations at a cost of about 2000 ECU. These data cannot be passed on to anybody else. It would cost almost as much to buy daily data as 3-hourly data.

Clare Goodess reported that daily temperature and rainfall data for a number of Spanish stations obtained during the course of the MEDALUS project are now available for use by other projects. However, the stations are concentrated in the southeast of Spain and data are only available for 1958-1987.

UT reported that they are waiting to receive recent data from the Greek meteorological service. These data should be received by the end of the year. It was noted that the CRU should already hold some Greek data obtained during the course of previous projects.

Finally, it was suggested that a common data analysis period should be used by all groups. In view of the wide variations in data availability it was agreed that analyses should not be restricted to a standard period. In many cases it is necessary to use as long a period of record as possible. However, it was agreed that in order to assist comparison of the different classification schemes and methodologies, output for a common period should always be produced as well. It was further agreed that this period should be 1971-1980.

CNRS/INLN PROGRESS REPORT (Guy Plaut)

Guy Plaut reported that an INLN post-doctoral researcher (Eric Simonnet) will be working on ACCORD from February 1999. ACCORD work to date has focused on the classification of 700 hPa fields and investigation of relationships with intense precipitation days over the Alpes Maritimes. This comes under Task 3.2 and can be considered as a feasibility study for Task 3.5. Future work will include Multi-Channel Single Spectral Analysis (MSSA) of 120-year MSLP records. These daily data are being processed and the analysis will be carried out next year.

Guy outlined the particular competencies of INLN relevant to ACCORD. These include MSSA and the ANAXV software package. The latter allows the "automisation of almost any numerical experiment with data" and is readily transferable.

Guy then described the INLN work on extreme precipitation events in the Alpes Maritime (see the CNRS/INLN annual report). Intense precipitation days (IPDs) are defined as days with over 40 mm precipitation for at least one grid point over the Alpes Maritimes. About 10 events occur each year, mainly in fall and winter. The same circulation cluster centres were obtained using a threshold of 50 mm. This work uses data from the Alpine Precipitation Climatology developed at ETH, and Guy thanked Christoph Frei for making these data available.

Two robust clusters were identified in the 700 hPa fields. These were found to be statistically significant using the method for calculating confidence limits described at the ACCORD start-up meeting. Precipitation composites, contingency tables and probabilities have been calculated for these clusters. These reveal distinct relationships between the circulation clusters and IPDs which can potentially be used for downscaling and prediction. It is important to note that such good results would not have been obtained if all days rather than just IPDs had been analysed to define clusters.

It is planned to use this methodology with space-time PCs next month. Other predictor variables and spatial domains will also be tested. Then the methodology could be applied to other Alpine sub-regions. Next year, MSSA of daily SLP data over the last 120 years will be performed. This work will focus on the stationarity of oscillatory modes. Consideration will also be given to the stationarity of relationships between circulation regimes and extreme events. Canonical Correlation Analysis (CCA) will be used to investigate relationships between cyclone activity over the western Mediterranean (if available) and large-scale circulation indices (on the monthly time scale).

Guy is happy for ACCORD partners to use the ANAXV software package and demonstrated how easy it is to use. It should be possible to install this package in 2-3 days.

In the ensuing discussion, Guy was asked about the distribution of precipitation within the region and why such different clusters of precipitation are found in such a small region. When asked what is the measure of a good cluster, Guy replied that it related to the confidence level and discriminating power. There may be inter-seasonal differences in the circulation/precipitation relationships and it is intended to look at these. It would also be possible to incorporate the development of systems over 2 or more days. Finally, Guy was asked whether 700 hPa was the best indicator? Hans Bardossy noted that in their work, they had obtained similar results using 700 and 500 hPa, but different results using SLP.

IWS PROGRESS REPORT (Andras Bardossy and Uwe Lorch)

Andras Bardossy introduced the work on fuzzy classification being undertaken by IWS (described in detail in the joint IWS/FTS annual report). The main aim is to improve the existing methodology, particularly the links to surface variables.

The classification method consists of three steps: data transformation (three normalisation methods have been tested); definition of fuzzy rules; and classification of observed data. In the third stage, the fuzzy rules can be modified in order to improve the optimisation criteria (O_1-O_5):

O_1: day-to-day reproduction of subjective circulation patterns (CPs);
O_2: reasonable rules, i.e. similar to expert rules;
O_3: reproduction of certain CP groups;
O_4: reproduction of precipitation probabilities; and,
O_5: reproduction of precipitation amount.

An overall objective (O) is defined using a weighted combination of the five criteria. The optimisation algorithm used is Simulated Annealing.

Andras concluded by noting that further research was needed to:

- include temperature in the objectives (possibly in a separate classification);
- classify time periods (i.e. how to use 6-hourly data);
- make direct links with rule combinations (for downscaling); and,
- apply the precipitation/temperature simulation model.

Uwe Lorch then presented some preliminary results demonstrating the application of the fuzzy-rule optimisation process to the Hess-Brezowsky (H-B) classification scheme and the Stuttgart precipitation record (see Section 4.1 of the joint IWS/FTS annual report). At least 5-years of data is needed for the calibration/validation periods. Using 10 years rather than 5 years for calibration improves performance by ~15%. Day-to-day agreement with the observed classification is ~25% over all 29 H-B classes. For the three major circulation groups (zonal, meridional and mixed), day-to-day agreement is ~65%. Better results are obtained for winter than for summer. The method has also been tested for Alexandropouli, Greece (using 14 circulation types).

In the following discussion of the IWS results, it was noted that the statistical tests show an improvement in the classification from doing nothing, i.e. the results are much better than random results would be. It was also noted that, when combining circulation patterns for the

statistical tests, it is not necessary to confine classes to those showing the same causal relationships.

Another questioner asked how good is the Grosswetterlagen scheme over Germany? IWS thought that the main problem with the fuzzy-rule methodology is that it is confined to individual days. It might be better to use successive days and to look at the time structure. Another question to be explored is, if a classification scheme is optimised on the basis of precipitation, how different are the subsequent circulation patterns from those described by subjectively-based schemes?

FTS PROGRESS REPORT (Hans Caspary)

Hans Caspary then described the application of the fuzzy-rule methodology to four stations in the Aller catchment (see Sections 4.2 and 4.3 of the joint IWS/FTS annual report). In this region, two H-B classes are important for high precipitation: Wz and NWz. It is necessary to distinguish between summer and winter when considering circulation/precipitation relationships. Differences were also found in these relationships between the subjective and fuzzy-rule schemes.

The stationarity of circulation-precipitation relationships has also been explored. In the case of the station Unterlüß, the frequency of the Wz circulation type is shown to have increased over a 6-year period with no changes in the associated precipitation characteristics. Hans noted, however, that this is not the case for all circulation patterns.

Hans concluded by outlining planned future work:

- optimisation of automated fuzzy-rule classifications over central Europe and Greece;
- exploration of the temperature characteristics of circulation patterns;
- further development of the downscaling model;
- calibration/validation of the downscaling model in the Aller catchment; and,
- calibration/validation of the downscaling model in Greece.

The following discussion focused on the issue of stationarity. In one German downscaling study, for example, year-to-year variability is well reproduced but the observed trends can not be explained. It was noted that DMI and UD had reached similar conclusions from their ACCORD work. It was remarked that changes in atmospheric stability (which might contribute to past precipitation trends) are also likely to be important in a future greenhouse world. Nonetheless, Hans Caspary stressed that recent German flood events show good relationships with the occurrence of the Wz circulation pattern.

UT PROGRESS REPORT (Panagiotis Maheras)

Panagiotis Maheras described the method for the automatic classification of circulation types based on an existing manual classification scheme for Greece. The automated circulation scheme uses daily MSLP and 500 hPa data, and consists of 19 types: 6 anticyclonic types, 8 cyclonic types, 2 mixed types and 3 characteristic types. Panagiotis presented MSLP and 500 hPa composite maps for these types together with information about their frequencies and trends (see the UT annual report).

The automated classification has recently been repeated using 700 hPa data, for the anticyclonic and cyclonic types only. The day before the ACCORD progress meeting, the fuzzy-rule methodology was applied to the Greek scheme by Andras Bardossy. Both the fuzzy-rule classification and the automated UT classification indicate a negative trend in the frequency of the cyclonic types and a positive trend in the frequency of the anticyclonic types over the period of record (1950-1994).

In the ensuing discussion, UT were asked how their classification scheme compares with Grosswetterlagen and what additional information it contains which helps to identify links with Greek climate. A comparison with Grosswetterlagen is planned. It was remarked that the Greek circulation types are defined by particular pressure thresholds. This means that if mean pressure increases, the circulation-type frequencies may change. Finally Panagiotis Maheras responded that precipitation changes have followed the observed changes in the frequencies of the cyclonic/anticyclonic circulation types: precipitation has decreased by ~20% over the same period.

ARPA-SMR PROGRESS REPORT (Carlo Cacciamani)

Carlo Cacciamani described the ARPA-SMR work which has focused on three areas:

- provision and utilisation of data sets (see Section 2.1 of the ARPA-SMR annual report);
- development of Atlantic-European and Pacific blocking catalogues using the Tibaldi-Molteni blocking index (see Section 2.2 of the ARPA-SMR annual report); and,
- analysis of relationships between precipitation and atmospheric circulation in winter over an extended European area and a smaller Alpine region (see Section 2.3 of the ARPA-SMR annual report).

A bottom-up approach, in which 500 hPa pressure composites are constructed for precipitation EOFs, has been used to explore precipitation/circulation relationships. EOF decomposition has also been carried out on the basis of Z500 winter monthly anomalies over the European area, and related to precipitation over the Alpine area.

Future work will focus on the search for quantitative links between local weather (including extreme events) and circulation at the sub-regional scale (i.e. downscaling), particularly in the Alpine area and the Po Valley. The blocking catalogue will be re-calculated using NCEP Reanalysis data. It is also intended to update and utilise a pre-existing catalogue of cyclone genesis and occurrence in the Mediterranean area.

In the following discussion it was noted that a journal paper describing the construction of a Mediterranean cyclone index by a CRU PhD student will appear shortly. Carlo was asked whether it would be possible to incorporate convective available energy in the circulation/precipitation analysis. It was remarked that the ARPA-SMR approach could be used for historical reconstruction because it involves reconstructing the large-scale from the small-scale. Carlo noted, however, that he did not want to refer to the pressure composite maps as circulation types yet. Rafael Boren and Jaime Ribalaygua remarked that they had also used a bottom-up approach over Spain. Finally, it was noted that the ARPA-SMR pressure pattern for the first EOF is very similar to Cluster 1 identified by Guy Plaut.

"An hybrid circulation-based/linear-analysis downscaling approach: description and application" (Jaime Ribalaygua, Servicios Meteorol ógicos Avanzados, Madrid)
Rafael Boren and Jaime Ribalaygua were introduced to the meeting. They had approached the CRU to express their interest in the ACCORD project and in informal collaboration with ACCORD partners. CRU had invited them to the progress meeting (at no cost to ACCORD) to talk about the development of a downscaling method for Spain.

Jaime Ribalaygua described their hybrid circulation-based/linear analysis approach to downscaling and its application in Spain using HADCM2SUL GCM output. A similar presentation was to be made at the 2nd European Conference on Applied Climatology in Vienna the following week. The abstract prepared for this meeting is given in Appendix 3 of these minutes.

In the discussion following Jaime's presentation, Jaime and Rafael were asked what results would be obtained if randomly-selected analogues were used? It was replied that the method allows the analogue days to be selected from any season, thus the seasonal cycle would not be reproduced if the wrong analogues were being selected.

Another question concerned the validation of the method using HADCM2SUL control-run output. Jaime showed some of these results and noted that the model-output validation errors are larger than the observed-data validation errors. Performance is generally good using observed data, with the exception of autumn precipitation particularly over the southern coast of Spain. This suggests that it might be appropriate to incorporate atmospheric humidity. It is intended to incorporate a non-linear multiple-regression process for deriving precipitation from the analogue data, similar to that already used for temperature.

"Regional climate change experiments in Europe and regionalization projects" (Bennert Machenhauer, MPI, Hamburg)
Bennert Machenhauer, one of the invited external experts, gave a presentation on regional climate change experiments in Europe and regionalization projects.

A number of different Limited Area Models (LAMs) have been evaluated. These use three different types of boundary conditions and vary in their spatial resolution. The DMI model has the highest resolution (19 km), while the ARPEGE model uses a sliding grid (~T200 or ~ 60 km over Europe).

Bennert described LAM verification work which uses the CRU gridded data sets to evaluate the simulation of mean seasonal temperature and precipitation. MSLP data from ECMWF have also been used to examine the simulated pressure and cyclone tracks in the European area. MSLP tends to be too low in the LAMs and bands of too low pressure are also seen in the 500 hPa pressure and storm track (band-pass filtered) output. Advection errors can be linked to the systematic circulation errors. Sub-area validation studies have also been carried out over Europe, focusing on mean values and variability (in the 300-year ECHAM control simulation, for example).

Bennert also presented results from LAM climate change experiments, focusing on the ARPEGE and ECHAM models forced by CO_2 only. Future precipitation changes are only significant in a few sub areas of Europe and are different in the two models because of

differences in the underlying circulation. Significant changes only occur in the longer simulations. Larger changes in temperature are simulated. The average temperature changes over Europe are larger than the systematic control-run errors in global mean temperature, but they are only partially significant in terms of mean European temperature patterns.

Work has also been undertaken to see if model errors are the same in the control and perturbed runs, i.e. whether or not the model errors "cancel each other out" as is sometimes claimed. Examination of summer precipitation, for example, indicates that the pattern of simulated change might be affected by differences in model error between the two runs.

Finally, Bennert noted that a new project is investigating the reasons for the systematic cyclone/circulation errors.

DMI PROGRESS REPORT (Torben Schmith)

Torben Schmith described work on hindcasting winter precipitation using multi-linear regression over the period 1900-1990 for 117 stations in Scandinavia, Northwestern Europe and Northeast Atlantic (see Section 2 of the DMI annual report). Many stations show a positive trend in the residuals. This indicates that there is a non-stationarity in the supra-regional circulation/climate link, and raises the question as to whether there has been an increase in the number of low pressure systems or an increase in the amount of precipitation associated with each system?

Work has also been undertaken on the analysis of daily precipitation data for Denmark (see Section 3 of the annual report). Daily precipitation gauge data are still being digitised so shorter data sets, for the period 1961-1997, have been used for this work. On the daily time scale, links have been explored between vorticity, geostrophic flow and precipitation, and between vorticity/flow and the supra-regional circulation. Preliminary work has been undertaken on the construction of composites. Using vorticity it is possible to determine whether or not it is likely to rain on a particular day, but no information is provided about precipitation intensity. It is intended to adapt Rob Wilby's approach to try to improve the prediction of precipitation parameters (pww, pdd and μ). Observed and hindcast parameters will be compared and the residuals examined for trends.

In the following discussion Hans von Storch, one of the external experts, asked whether non-stationarity was the right word to use. Another possibility is that the circulation/surface climate link is dependent on the temporal scale and hence it might be necessary to fit the model using different data. With "real" non-stationarity it is necessary to consider additional variables such as SST. It is possible that the circulation/surface climate link is not the same on all time scales. If the concept of non-stationarity is accepted, it is also necessary to explain why some relationships/time periods do appear to display stationarity.

Finally, Torben was asked whether the observed changes in precipitation could be due to changes in the rainfall/snow ratio. He considered that this was an unlikely explanation.

UD PROGRESS REPORT (Phil Jones)

Rob Wilby had sent his apologies to the meeting, so Phil Jones presented some of the results reported in the UD annual report. Like the DMI work, the UD work raises the problem of non-stationarity. Three different daily precipitation parameters (μ, pww and pdd) have been

investigated. Three precipitation models have been tested: these use vorticity, SST and an NAO index as predictor variables. The calibration period is 1881-1935 and the validation period 1936-1990. Precipitation has been predicted for two stations in central/eastern England.

Phil concluded that the results indicate that including SST and the NAO as predictor variables makes little difference to model performance. The inclusion of SST probably does give some improvement, but using the NAO does not appear to add much additional information over vorticity. The additional variables might however produce additional improvements if regional-scale precipitation was considered rather than precipitation at single stations.

In the following discussion it was suggested that it might be better to use a non-linear method, such as rank correlations, rather than a linear model. A number of people commented that some of the SST/precipitation relationships seem counter-intuitive. Finally it was noted that care is needed with universal arguments/explanations of non-stationarity. If, for example, changes in atmospheric moisture content are invoked, you need to explain why the same changes don't occur everywhere.

CRU PROGRESS REPORT (Steve Dorling, Clare Goodess)

Steve Dorling outlined the work on circulation classification using neural nets undertaken at UEA (see Section 5 of the UEA annual report). Work to date has concentrated on the Lamb circulation types, but other classification schemes could also be used. ACCORD results based on the NCEP Reanalysis data are very similar to earlier results based on NMC data. There is some improvement in performance, probably due to the longer training period used with the NCEP data. A new Swedish student has undertaken some of the work and a new suite of computers (run as parallel processors) is available for ACCORD work.

The overall success rate in reproducing the subjective Lamb classification types is 52%. On some days classified as anticyclonic by the neural net, rather than as cyclonic as in the subjective scheme, recent developments can be detected in the upper air patterns. The neural net scheme is based only on 12Z MSLP, while the subjective scheme also considers upper air data and the development of systems over time. In the future it is intended to improve the method by using upper air data and a sliding window to catch the development of systems. The neural net approach will also be used to reproduce the Groswetterlagen classification and, if time permits, the Dzerdeevskii hemispheric-scale catalogue.

During the following discussion, Peter Bissolli reported that the German Weather Service has developed a classification scheme which is considered to be more appropriate for Germany than the Hess-Brezowsky/Grosswetterlagen scheme. It combines surface and 500 hPa pressure data, together with a humidity variable. Peter agreed to send details of this scheme to the ACCORD group (see Appendix 4).

Steve Dorling was asked whether the neural net approach has been used to reproduce the automated Lamb classification (based on Jenkinson and Collison's method). This has not been done, but would be a useful comparison. It was noted that the overall agreement between the subjective and automated Lamb classifications is about 43%. Finally, it was noted that the neural net scheme appears to have a problem classifying the hybrid-cyclonic group of circulation types which is important for precipitation over the study area.

Clare Goodess presented the final part of the UEA report. The UEA work has focused on a number of different ACCORD tasks and spatial scales. Phil Jones presented work on the construction of data sets and analysis of NCEP Reanalysis data the previous day. The work on neural nets described by Steve Dorling addresses regional-scale processes. Clare described work investigating links between circulation and daily precipitation on the sub-regional scale (see Section 6 of the UEA annual report). This work is being undertaken in the Guadalentin Basin, southeast Spain. The highly-seasonal Mediterranean rainfall regime of this area poses particular analytical problems, in relation to sample size for example.

The Spanish work is an extension of work undertaken as part of the MEDALUS project. The ACCORD work has focused on the construction of circulation composites for a number of case studies. The first group of case studies focus on autumn rainfall events, including the major, destructive storm events which are a characteristic feature of this area of Spain. These composites indicate that there is considerable variability within circulation types (defined as part of the MEDALUS work) and that it is important to consider upper air data as well as surface pressure.

Most of the work on Spain has used NMC pressure data. Preliminary work with NCEP Reanalysis data indicates that NCEP-NMC pressure differences are relatively small over most of the ACCORD window. The major differences occur over Greenland in MSLP fields only. A number of additional analyses based on the NCEP data are planned, including the development of classifications based on surface weather rather than on pressure patterns.

U.BERN PROGRESS REPORT (Evi Schuepbach, Jacques Ambuehl)

Evi Schuepbach outlined the various software suites developed at U.Bern for use in ACCORD. Work being undertaken by U.Bern covers a number of different ACCORD tasks (see the U. Bern annual report). The occurrence of cut-off lows over the Alps will be explored, for example, using very high resolution (T213, 3 and 6-hourly) ECMWF Reanalysis data. A bottom-up approach will also be used to investigate links between the hemispheric Dzerdeevskii classification scheme and surface variables. It is also intended to use a neural network approach to classify the circulation at the regional (sub-European) scale. The original neural network scheme was developed by the Swiss Meteorological Institute (SMI) and has been used for the classification of ECMWF ensemble forecasts since 1994-1995. Improvements in the neural network scheme and in the input data are planned during ACCORD. Evi had invited Jacques Ambuehl from SMI to describe the neural network methodology to the ACCORD group.

Jacques Ambuehl explained that the SMI neural network has 12x12 neurones (i.e. 144 circulation types are output) and 10x10 synapses (i.e. 100 geopotential grid points provide the input data). It is an unsupervised learning system (in contrast to the supervised system with a given output described by Steve Dorling). The system works by maximising internal correlations. It operates much like the human brain: leading neurones influence the nearest neurones (they copy the leading neurone) while all other neurones are deactivated. Two distances are considered: the distance between two neurones, and the distance between the meteorological and geopotential fields.

The neural network has been applied to ECMWF Reanalysis T850 and Z500 data for the period 1982-1994. Each neurone represents a systematic weather pattern. This approach has been applied to the evaluation of ECMWF ensemble forecasts. In such an application the

dispersion of the network is an indicator of predictability. Entropy can also be used as an indicator of predictability. Two different definitions of entropy can be identified: the classical definition and a geometrical definition which is better for forecasting purposes. This approach replaced the Model Output Statistics approach previously used by SMI and has been routinely used since 1994-1995 to analyse and present the ECMWF ensemble forecasts to the Swiss public.

Jacques Ambuehl concluded by noting that this neural network approach can also be used in downscaling. For example, the probability of a particular event occurring can be calculated for each neurone.

In the following discussion Jacques was asked whether predictability is really a function of the atmosphere rather than the underlying model? He argued that it is because of the properties of the climate attractor. He stressed that care is needed in presenting input data to the neural network. Data are presented randomly and with the seasonal mean removed in order to avoid over-fitting to the seasonal cycle. Finally, Jacques noted that the network is now shaped like a torus to avoid having neurones with no neighbours.

(The SMI neural network is described in: Eckert, P., Cattani, D. and Ambuehl, J., 1996: 'Classification of ensemble forecasts by means of an artificial neural network', *Meteorol. Appl.*, **3**, 169-178.)

FINAL DISCUSSION

Comments from Hans von Storch

Hans noted that the proposal was a "mixed-bag", but the presentations made during the course of the meeting indicated that most issues were being covered.

He made a distinction between "process-based downscaling" and the "modelling of statistics" in which hidden links occur at the monthly level. The latter is necessary if dealing with daily variability.

Hans suggested that ACCORD invite Adri Buishand from KNMI, Netherlands, to give a talk to the group on downscaling-related work.

Chapter 10 of the third IPCC assessment report will be on regional climate modelling, focusing on techniques rather than on detailed results. It is likely to describe the general philosophy behind different methods, together with a list of the methodologies and the regions in which they have been applied. Hans is one of the co-authors and thought that ACCORD could contribute significantly towards this chapter. We need to decide whether to contribute as a group or individually. In either case, it would be appropriate to send copies of relevant reprints to Hans and/or Mike Hulme (another co-author, based in CRU).

Hans noted that there will be a major session on downscaling at the next International Statistical Climatology meeting which will be held in Luneburg (near Hamburg), April 2001.

In response to a later comment, he replied that an important question for ACCORD is to determine to what extent local-scale features are controlled by the large-scale. Providing

information about these links in the form of conditional probability distributions is the best that can be done.

Comments from Bennert Machenhauer

Bennert reported that the regional modelling community is now looking at systematic model errors on a range of spatial scales. A number of questions as to how the ACCORD work might assist the evaluation of regional models were discussed:

- How do the circulation patterns identified in ACCORD compare with the systematic errors identified in the models?
- Do the models reproduce the circulation/weather clusters that ACCORD identifies as being important?
- Which physical processes are wrong in the models? More physical interpretation is wanted from ACCORD.
- Could ACCORD provide more useful information for regional model validation (e.g. parameters such as Pww mapped over Europe?). This type of information is probably not helpful at the moment.

Bennert concluded that there is a long-term need for statistical downscaling methods. Precipitation in the models is included for the model physics and dynamics rather than to provide the information required by hydrologists, for example. He considered that statistical downscaling techniques will be required for the next 10-20 years.

Closing Remarks

The co-ordinators stressed the importance of some standardisation of approach in order to facilitate comparison of the ACCORD classifications and methodologies. Participants were reminded about Appendix 7 (List of standard daily rainfall diagnostics) and Appendix 8 (The need for an overview) from the minutes of the start-up meeting. These will be put on the ACCORD web site. Participants were also reminded about the previous day's decision to provide output for a common period, 1971-1980. The issue of standardisation will be discussed in more detail at the next progress meeting in Bologna. More time will be spent discussing the project as a whole, including how to compare and evaluate results and how to fully link the different components.

On behalf of all the meeting participants, Phil Jones thanked Andras Bardossy, Hans Caspary and their colleagues for hosting the meeting. Particular thanks were extended to Uwe Lorch for all his work as local organiser before and during the meeting.

Clare Goodess
7 December 1998

APPENDIX 1

List of participants in the ACCORD start-up meeting

Name	Organisation
Ambuehl, Jacques	Swiss Met. Service
Bárdossy, András	IWS
Bissolli, Peter	GWD
Boren, Rafael	SMA, Madrid
Cacciamani, Carlo	ARPA-SMR
Caspary, Hans	FTS
Davies, Trevor	ENV, UEA
Dorling, Steve	ENV, UEA
Giese, Hartmut	IWS
Goodess, Clare	CRU, UEA
Jones, Phil	CRU, UEA
Karacostas, Theodore	UT
Lazzeri, Marco	ARPA-SMR
Lorch, Uwe	IWS
Machenhauer, Bennert	MPI
Maheras, Panagiotis	UT
Patrikas, Ionnis	UT
Plaut, Guy	INLN
Ribalaygua, Jaime	SMA, Madrid
Schmith, Torben	DMI
Schuepbach, Evi	U.BERN
Von Storch, Hans	GKSS

Contact details for most of the participants are available on the ACCORD web site (http://www.cru.uea.ac.uk/cru/projects/accord/partners.htm) and in the Minutes of the Start-up Meeting (Appendix 4). Contact details for the other participants are given below:

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Lazzeri, Dr Marco	ARPA – Servizio Meteorologico Regionale Viale Silvani n.6 Bologna, 40122, IT email: marco@adgb.df.unibo.it
Lorch, Mr Uwe	Institut für Wasserbau Universitaet Stuttgart PO Box 80 11 40, Pffaffenwaldring 61 Stuttgart, D-70550, DE email: lorch@iws.uni-stuttgart.de
Machenhauer, Prof. Bennert	Max Planck Institut für Meteorologie Bundestrasse D-20146 Hamburg, DE email: machenhauer@dkrz.de
Patrikas, Dr Ionnis	Dept. of Meteorology and Climatology, School of Geology Aristotelian University of Thessaloniki GR 540 06 Thessaloniki, GR
Ribalaygua, Dr Jaime	Servicios Meteorológicos Avanzados c/ Heliotropo, 5 – 3° 28029 Madrid, ES email: synoptic@mundivia.es
von Storch, Dr Hans	GKSS Geesthacht Institut für Gewässerphysik Max-Planck-Strasse D-21502 Geesthacht, DE email: storch@gkss.de

APPENDIX 2

Agenda of the first ACCORD progress meeting

Friday 16 October: Room 1.002, Institute for Hydraulic Engineering, Uni. of Stuttgart

0900-1000	General administrative issues: Minutes of the previous meeting Finances, meetings, reports, publications, communications
1000-1030	NCEP data (Phil Jones) Progress on extraction Quality control and initial analyses
1030-1100	Coffee
1100-1150	NCEP data (continued) Other ACCORD data sets (Phil Jones) Daily temperature/precipitation data available from CRU Filling the gaps
1150-1230	CNRS/INLN progress report (Guy Plaut)
1230-1400	Lunch in the Telecom Restaurant
1400-1430	IWS progress report (Andras Bardossy, Uwe Lorch)
1430-1500	FTS progress report (Hans Caspary)
1500-1530	UT progress report (Panagiotis Maheras, Ioannis Patrikas, Theodore Karacostas)
1530-1600	Coffee
1600-1630	ARPA/SMR progress report (Carlo Cacciamani, Marco Lazzeri)
1630-1650	Invited presentation on “An hybrid circulation-based/linear-analysis downscaling approach: description, validation and application” by Rafael Boren and Jaime Ribalaygua, Asociacion para la Investigacion del Clima, Madrid (who are interested in collaborating on ACCORD topics)
1650-1715	General discussion, including initial comments from the External Experts (Bennert Machenhauer and Hans von Storch) Sub-group meetings (if necessary)
Evening	Visit to the Stuttgart TV Tower Dinner in the Restaurant Landhaus

Saturday 17 October: Room 1.002, Institute for Hydraulic Engineering, Uni. Stuttgart

0910-0940	Progress report by DMI (Torben Schmith)
0940-0945	Progress report from VI
0945-1030	Progress report by CRU and UD (Trevor Davies, Steve Dorling, Clare Goodess, Phil Jones)
1030-1100	Coffee
1100-1145	Progress report by U.Bern (Evi Schuepbach, Jacques Ambuehl)
1145-1230	Final discussion, including: Standardisation of methodologies Comments from the External Experts
1230	Lunch in the Telecom Restaurant

APPENDIX 3

A statistical downscaling method: description, validation and application: first high resolution climate change scenarios for Spain

Jaime Ribalyagua, Rafael Borén and Luis Balairón

From: ***Proceedings of the 2nd European Conference on Applied Climatology, ECAC98, 19 to 23 October 1998, Vienna, Austria,*** **Österreichische Beiträge zu Meteorologie und Geophysik, Heft 19, Zentralanstalt für Meteorologie und Geodynamik, Wien, Publ. Nr. 384, ISSN 1016-6254, p. 6.**

A statistical method to obtain high resolution climate change scenarios of precipitation and near surface temperature from coarse resolution Atmospheric Ocean Coupled General Circulation Model (AOGCMs) outputs has been developed and validated.

The downscaling method estimates high resolution surface meteorological fields for a day "X", in two steps: in the first step, the "n" days more similar to the "X" day, attending to their low resolution atmospheric fields, are chosen from a reference data set. In the second step high resolution surface information is obtained in a different way for precipitation and temperature.

The surface data set is a gridded data set (203 gridpoints covering the Peninsular and Balearic Spain) with daily values for accumulated precipitation and maximum and minimum temperature. The atmospheric data set used is the NCAR/NCEP Reanalyses with a spatial resolution of 2.5° x 2.5°, similar to those offered by AOGCM output. Both reference (surface and atmospheric) data sets extend over the period 1961-1995 (12,783 days).

Precipitation is known to present strong non-linear relationships with its potential predictor variables, which makes analogue techniques specially indicated for its diagnosis. Precipitation diagnostic capability of the 1000 and 500 hPa geostrophic flux fields are owing to their relationships with important precipitation forcings (frontal and topographic forcings implicit in 1000 hPa flux and middle tropospheric dynamic forcing related with 500 hPa flux). The estimation procedure for temperature requires, after the selection of the "n" analogous days described above, a further diagnosis by multiple linear regression. The regression procedure used is performed in two steps in order to reduce the non-linear influence of cloudiness over the surface temperatures.

The performance of the downscaling method is assessed by an estimation of daily surface fields of precipitation and maximum and minimum temperatures for the 80's decade and the whole downscaling method is applied to the climate simulations of one transient AOGCM experiment: HADCM2SUL of Hadley Centre for the future decades (2000 to 2100 years). This experiment has been chosen because it starts running in 1890 and it considers recent past evolution of greenhouse gases and sulphate aerosol forcing.

APPENDIX 4

Brief description of the objective weather type classification of the German Weather Service

1 Objectives

The objective weather type classification (OWTC) of the German Weather Service was developed in 1995 to find an alternative which is more suitable for climatological purposes than the well-known subjective Hess-Brezowsky weather type classification (HBWTC).

Until now the HBWTC is still used very often for climatological and synoptical investigations because the daily data series covers more than 100 years since 1881. This classification represents well the typical main large scale weather situations for Central Europe. On the other hand the different weather types are defined subjectively and are not unequivocal for all situations.

In contrast the OWTC is unequivocally defined with numerical criteria and for a smaller scale (Germany). The weather types can be determined automatically, but the method is dependent on the availability and quality of numerical data and the grid of the based numerical model. The data series of the OWTC starts in 1979, but with availability of reanalysis data an extension to precedent years is principally possible.

At present both classifications (HBWTC and OWTC) are used at the German Weather Service, the daily series for both classifications will be continued at least in the near future. They are not directly comparable.

In the next sections only the OWTC is described.

2 Data base

The data based consists of the numerical 12 UTC analyses of German Weather Service forecast models. From July 1979 to December 1991 the old BKF model is used which has a resolution of 254 km. Since 1992 it is replaced by the European Model (EM) which has a better resolution (about 50 km over Central Europe) and is still in operational use until 1999. Only the gridpoints over a spatially limited area which covers Germany were selected. The chosen meteorological elements are the horizontal wind components, geopotential, temperature, and specific humidity.

3 Method

The classification is based on three criteria:

- cyclonality in 500 and 950 hPa,
- advection in 700 hPa,
- humidity (mean value of the troposphere).

3.1 Cyclonality

Cyclonality can be described by $\nabla^2\Phi$ (curvature of geopotential isolines). Area-weighted mean values of $\nabla^2\Phi$ are computed for each of the two levels: 500 hPa (550 hPa for BKF

model) and 950 hPa (1000 hPa for BKF). Positive values represent cyclonic, negative values anticyclonic conditions.

3.2 Advection

The wind direction of each gridpoint in 700 hPa is computed. If at least 2/3 of the wind directions can be found in one 90°-sector, a prevailing wind direction is assumed (either NE, SE, SW, NW, dependent on in which sector the maximum of the wind direction is counted). Otherwise a prevailing wind direction is not defined.

3.3 Humidity

The precipitable water for each gridpoint in six levels of the troposphere (from 950 up to 300 hPa) is computed and from these data an area-weighted daily mean value. If this daily mean value is greater than a monthly mean value for the whole period 1979-1996, a 'wet' day is

3.4 Definition of the weather types

The classification consists of 40 weather types, each having an identifier of 5 letters:

- The first 2 letters: advection type (5 classes):
  - NO: Nordost (northeast),
  - SO: Südost (southeast),
  - SW: Südwest (southwest),
  - NW: Nordwest (northwest),
  - XX: not defined.

- 3. Letter: cyclonality in 950 hPa (2 classes):
  - Z: zyklonal (cyclonic),
  - A: antizyklonal (anticyclonic).

- 4. Letter: cyclonality in 500 hPa (2 classes, Z or A like before).

- 5. Letter: humidity (2 classes):
  - F: feucht (wet, humid),
  - T: trocken (dry).

4 Data availability

OWTC data are available on daily basis for all interested scientific users. Please contact the address given below by mail or email.

5 Statistical evaluations

Some evaluations of the OWTC and its relation to climatic elements (temperature, precipitation, …) have been performed:

- frequency distributions,
- mean spatial geopotential distributions for the different weather types,
- spatial distributions of climatic elements for different weather types (coloured charts).

Some examples were sent to UEA with this note (please ask c.goodess@uea.ac.uk if you would like to be sent a copy of these figures). More investigations are in preparation.

6 Further information

A report has been published in 1995 (unfortunately only in German):

- E. Dittmann et al.: Objektive Wetterlagenklassifikation. Berichte des Deutschen Wetterdienstes Nr. 197 (1995).

A revised version will appear in 1999 (hopefully), an English version possibly afterwards.

Offenbach, 22.10.1998

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