CCl/CLIVAR Expert Team for Climate Change Detection Monitoring and Indices (ETCCDMI) First Team Meeting Report

24-26 November 2003

Zuckerman Institute / Climatic Research Unit, East Anglia University, Norwich, UK

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Action list

1. Circulate to members and inform CLIVAR SSG of the ET interpretation of the terms of reference that resulted from discussion during the team meeting and is summarized in the meeting report. ***Zwiers/Yan***

2. Prepare a template letter to WMO Permanent Representatives in relevant countries, which states objectives and benefits of workshop and type of participant desired. ***Mokssit/Zwiers/Alexander/Haylock/Hewitson(Llanso/Detemmerman to resurrect previously used letter by early January 2004)***

3. Develop a template screening questionnaire for choosing workshop participants, based on previously used. ***Mokssit/Zwiers/Hewitson***

4. Check all aspects of the ClimDex software that will be used in workshops. ***Klein-Tank/Alexander***

5. Prepare a Resource CD containing ClimDex documentation and other supporting materials for workshops. ***Alexander/New/Stephenson***

6. Arrange for translation of the software document into other languages. ***Stephenson for Portuguese /Llanso for French and Spanish (Carriers of Actions 4&5 to make sure that the document is ready by 1 March 2004)***

7. Identify targeted regions not covered by pervious workshops. ***Mokssit/Alexander/Haylock***

8. Organize and deliver workshops in coordination with supporting organizations and funders (see Table 1). ***Local organizers / ET contacts***

9. Prepare a short document on preferred practices for index construction and analysis, including guidance for 'reanalysis' of previously collected indices. Include a cross-referenced list of indices computed by the various pieces of software that are currently available so as to identify differences in index definitions. Also include advice on analysis methods appropriate to each index. Publish as a CCl/CLIVAR report and post on the web. ***Stephenson/Klein-Tank/Haylock/Zwiers/Zhang***

10. Make sure that workshop information (including outputs and follow-up activities) is available at the ET website and linked to the CLIVAR website. ***Zhang/Zwiers/Yan***

11. Prepare a short document on suggested large-scale atmospheric, oceanic and marine climate indices for monitoring and detection that should be considered for the IPCC 4th Assessment Report (AR4). ***Bindoff/Folland/Swail/Karoly***

12. Write to JCOMM expressing need for marine climate change detection, monitoring and indices. ***Co-chairs/Swail***

13. Develop an ET website focused on local indices. If feasible, include with group email/discussion capability and data-visualizing tools. ***Zhang/Zwiers***

14. Prepare a timetable for ETCCDMI activities, taking the IPCC AR4 and CLIVAR and relevant WMO activities into account. ***Co-chairs/Yan***

Table 1. Summary of ET regional workshop planning

Region	S Africa	S America	C America	Tibet	Asia Minor /Caucasus
Area covered	Africa with priority for regions not covered by Casablanca	Most of S American	Central and northern S America	Asian plateau	W Asian and some SE European countries

	Workshop				
Time	31 May - 4 June 2004	August 2004	November 2004	Late 2004	2 weeks in May 2005
Venue	University of Cape Town and South Africa Weather Service, Cape Town, South Africa	University Federal de Alagoas, Maceio-Alagoas, Brazil (offers also from CPTEC and IAI)	Netherlands Antilles	WMO Beijing Climate Center, Beijing, China	Meteorological Guest House Alanya, Antalya, Turkey
Organizer /ET contact	Hewitson /Zwiers	Molion/Peterson /Karoly	Martis/Peterson /Jones	Zhai /Yan	Sensoy /Mokssit
Lecturers /Instructors (more to be considered)	New Stephenson Collins	Alexander Haylock Sensoy	Alexander Zwiers	Stephenson Folland Sensoy	Jones Mokssit Klein-Tank
Associated meeting /conference	9th Int. Mtg. Stat. Climat. 24-28 May 2004	No	No	To be considered	To be considered

General requirements

Length: a week with/plus two days for lectures

Language: English desirable for participants

Technical needs: computer facilities with Windows95 up and better one person capable of Visual Basic

Data needs: GSN sites and reference stations with metadata (less than 10% missing records) from 1950 (or at least 1961) onwards, in format suitable for input into ClimDex software **Variables**: including daily Tmean, Tmax, Tmin and precipitation

Expected outcomes	
For organizers	For participants
• Inventory of daily data • Indices • Improved access to daily data • Greater understanding of data-sparse regions problems • Contribution of results to a central (ET) website within 2 months • Feedback on software and documentation • Feedback on indices • Peer reviewed publication • CD of outputs	• Inventory of daily data • Quality-controlled daily data • Skills in climate data analysis • Appreciation of wider picture (global change issues in the region) and of value of sharing data • National report on climate change as indicated by indices (in regional context) • Increased capacity to institute regular climate change reporting • Ongoing regional network • Peer reviewed publication for input to IPCC • CD of outputs

Background

The Expert Team for Climate Change Detection Monitoring and Indices (ETCCDMI) is jointly sponsored by the Commission of Climatology (CCl) of the World Meteorological Organization (WMO) and the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Programme (WCRP). It plays an important role in developing and implementing CLIVAR's research programme for climate change detection and attribution and in coordinating and providing guidance for

CCl's global climate monitoring activities. The ETCCDMI is the successor of the CCl/CLIVAR Working Group on Climate Change Detection (with a history archived at http://www.clivar.org/publications/wg_reports/wgccd/wgccd_report_3.pdf). The terms of reference for the new team (http://www.clivar.org/organization/etccd/index.htm) had been discussed by the team by email and its interpretation is summarized later in this report (section 2.3).

The current team members are:

Dr. A. Mokssit (Co-chair), Meteo Moroc, Casablanca, Morocco

Dr. F. Zwiers (Co-chair), Canadian Centre for Climate, Victoria, Canada

Dr. N. Bindoff, University of Tasmania, Hobart, Australia

Prof. C. Folland, Met Office, Exeter, UK

Prof. P. Jones, University of East Anglia, Norwich, UK

Prof. D. Karoly, University of Oklahoma, Norman, USA

Mr. L. Molion, Universidade Federal de Alagoas, Alagoas, Brazil

Mr. S. Sensoy, Turkish State Met Service, Kalaba / Ankara, Turkey

Dr. D. Stephenson, University of Reading, Reading, UK, is a Special Advisor to the team. Dr. X. Zhang, Climate Monitoring and Data Interpretation Division, Meteorological Service of Canada, coordinates the development of the ET/CCDMI website. The International CLIVAR Project Office contact for the team is Dr. Z. Yan.

The objectives of the first team meeting were

- to review progress in the field of CCDMI and identify priorities for the near future,
- to pave the way towards successful regional workshops in 2004-2005, and
- to develop marine / oceanic aspects of CCDMI.

1. Introductory remarks

The first CCl/CLIVAR ETCCDMI meeting was held at the new Zuckerman Institute, University of East Anglia, Norwich, UK. Dr. F. Zwiers (Co-chair) opened the 2.5-day meeting on the morning of 24 November 2003. He thanked Prof. P. Jones, Ms. J Burgess and Dr. Z. Yan for their efforts in organizing the meeting and CCl and CLIVAR for their sponsorship. Prof. Jones, the director of the host institute (Climatic Research Unit), welcomed the team and experts (Appendix 1) to Norwich and expressed appreciation of the team meeting at East Anglia as a first international venture in the new institute.

The Co-Chairs introduced the meeting agenda (Appendix 2) and objectives. They expected to make a 2-3-year work plan for the team, as annual team meetings are unlikely. Dr. Zwiers expected that the team would contribute to CLIVAR and IPCC by improving global coverage for climate change indices and analysis tools and providing global assessment to indices. The team could also contribute to CCl's implementation programme by developing an official toolkit (software, documentation and supporting

materials) to be promoted for application in national operational agencies, reviewing the Annual WMO Climate Assessment and by the capacity building in the detection and monitoring area through regional workshops.

Dr. Mokssit stressed that the team should work on both scientific (CLIVAR) and operational (CCl) aspects. It was desirable that the teamwork would lead to more national operational agencies being involved in the process of capacity building in the CCDMI area. For workshops, Dr. Mokssit stressed the importance of workshop follow-up activities in order to assure sustainability of the teamwork.

The participants discussed the meeting agenda and agreed with the deliverables and expectations introduced by the co-chairs. Dr. M. Haylock reminded the team of possible links to the START / Asian-Pacific Network (APN), which also would organize similar regional workshops. It was noted that CLIVAR SSG (12th session, Victoria, May 2003) encouraged the team to work with START and GCOS when planning regional workshops. The team agreed to keep up information and communication with relevant organizations through both the ICPO and the team members.

2. The ET role in CCl and CLIVAR

2.1. The CCl perspective

Mr. P. Llanso, Chief of the World Climate Data and Monitoring Programme (WCDMP) under the World Climate Programme (WCP), outlined relevant aspects of the WCP, WCDMP and CCl. He pointed out some WCP areas of interest, including

- monitoring and understanding the global climate system,
- collection, rescue and management of climate data,
- detection and assessment of climate variability and changes, and
- capacity building, transfer of knowledge, techniques and guidance.

As Mr. Llanso outlined, the WCDMP was aimed at

- detection of climate change,
- analysis of interannual variability of the global climate system,
- implementation of methods to rescue, preserve and manage climate data, and
- preparation and distribution of global and regional data sets, including metadata.

The team is well-positioned to contribute to these objectives.

With support from WCDMP, CCl has established 3 Open Programme Area Groups (OPAGs), each with an Implementation/Coordination Team (ICT), and an Expert Team (ET) and Rapporteurs. The 3 OPAGs are (1) Climate Data and Data Management, (2) Monitoring and Analysis of Climate Variability and Change, and (3) Climate Applications, Information and Prediction Services. As a part of

the effort to fulfill the CCl's tasks, a CCl/CLIVAR Working Group for Climate Change Detection (WGCCD) was established in 1999, which organized two regional workshops, one in Kingston (January 2001) for the Caribbean area and another in Casablanca (February 2001) for Africa. To progress further, CCl established the ETCCDMI under OPAG2, in coordination with CLIVAR during late 2002.

Mr. Llanso summarized the CCl expectation for the ETCCDMI. These include activities to

- develop indices of climate change and variability, with emphasis on daily to seasonal extremes, and standardized software packages,
- study further indices, application of indices as input data to models and homogeneity issues, and
- provide guidance for NMHS needs, including guidelines on CCDMI, planning workshops, and inputting to the annual WMO Statement on the Status of the Global Climate, etc.

During discussion, Dr. N. Bindoff questioned the relationship between the Expert Team (ET) and the Implementation/Coordination Team (ICT). Logically, it was anticipated that the ET provide scientific guidance and develop software while the ICT would carry out applications and capacity building in WMO member countries. Mr. V. Swail commented that CCl might need to pay more attention to marine and oceanic aspects of climate.

2.2. The CLIVAR perspective

Dr. Yan briefed the team on relevant aspects of WCRP and CLIVAR. He forwarded an apology from Dr. H Cattle, the director of the International CLIVAR Project Office, who co-authored the presentation but was unable to attend the meeting. As the presentation showed, the Joint Scientific Committee (JSC) reaffirmed during its recent annual meeting that, after discussions initiated by the WCRP Banner Project, the aims of WCRP remained as originally specified, i.e.,

- to determine to what extent climate can be predicted and the extent of human influence on climate, aiming at the goal of greatly improved understanding of the role of climate in the total earth system.

To help achieve this overall objective, CLIVAR has been set up with 4 specific objectives:

- to describe and understand the physical processes responsible for climate variability and predictability on seasonal, interannual, decadal, and centennial time-scales,
- to extend the record of climate variability over the time-scales of interest through the assembly of quality-controlled instrumental and proxy data sets,
- to extend the range and accuracy of seasonal to interannual climate prediction through the development of global coupled predictive models, and
- to understand and predict the response of the climate system to increases of radiatively active gases and aerosols and to compare these predictions to the observed climate record in order to detect the anthropogenic modification of the natural climate signal.

Dr. Yan anticipated that the ETCCDMI's activities would contribute directly to the 2nd and 4th specific

objectives and help in some aspects for achieving the other two. He suggested the team consider possible links and coordination with other CLIVAR activities, especially those of the CLIVAR Data and Information System, the CLIVAR/PAGES Working Group, and the Working Group for Coupled Modeling. Links to developing CLIVAR basin panels are also encouraged, as part of the team's effort to promote the development of marine and oceanic aspects of CCDMI.

The team was also briefed on some outcomes from the 12th CLIVAR SSG session (Victoria, May 2003). The SSG agreed to suggested changes in TOR resulting from discussions among team members early this year and encouraged the team to work with START and GCOS when planning regional workshops. The ET Terms of Reference are discussed further below.

The team was encouraged to use the CLIVAR Exchanges newsletter for publishing outcomes of the regional workshops as appropriate and to take part in the first International CLIVAR Science Conference, 21-25 June 2004, Baltimore, USA.

During discussion, it was stressed that the anthropogenic climate change (ACC) is a cross-cutting theme of the CLIVAR programme. However, as Prof. D. Karoly commented, CLIVAR might not have made sufficient effort in that direction. The ETCCDMI should be able to make substantial contributions in this area. Dr. Bindoff supported links between ETCCDMI and CLIVAR basin panels, in order to promote marine and oceanic aspects of CCDMI across the CLIVAR community.

2.3. The ET interpretation of the terms of reference

With respect to the CCl and CLIVAR perspectives, Drs. Zwiers and Mokssit guided the discussion on ET's terms of reference (TOR). A 10-item TOR was reported by Dr. Mokssit at CLIVAR SSG-11 (Xian, May 2002). The SSG recommended there could be fewer and simpler items, while keeping details in working plan. This led to discussions among team members and a shorter version resulted and presented to the CLIVAR SSG-12 earlier this year. The team reviewed each of the items. Table 2 summarizes the team's interpretation.

Table 2. The ET interpretation of the TOR

Item	*Interpretation (with item number in the shorter version)*
1. To further develop and publicize indices and indicators of climate change and variability, with particular emphasis on the creation of indices of daily to seasonal extremes covering the global land surface using standardized software packages	*Ok (1)*

2. To further develop other indices of value to the IPCC, related to changes in mean climate and its variability from the sub-surface of the oceans to the stratosphere	*Ok (2)*
3. To provide input on indices to WMO publications such as the Annual Statement on the Status of the Global Climate	*Ok (3)*
4. To compare modeled and observed indices, and report on the comparisons, with some emphasis on changing extremes	*Ok (4)*
5. To assist in the specification and implementation of observing system experiments with models used for global and regional climate change detection, with emphasis on the GUAN and GSN networks	*The team will work in this area as appropriate under item 8*
6. To arrange for or make assessments that identify and quantify the magnitude of biases introduced by automated means of measurements and their consequences for detection and attribution	*The homogeneity issues are recognized as being important and within the ET purview*
7. To consider other issues of homogeneity as deemed appropriate	*Within the ET purview*
8. To collaborate with and provide inputs to other groups, especially those set up under IPCC auspices, regarding the adequacy of the global observing system for the purposes of supplying advice to Conferences of the Parties to the Rio Greenhouse Gas Convention, and regarding the development of indices	*To collaborate with and provide inputs to other groups, especially those set up under IPCC auspices, regarding the adequacy of the global observing system and the development of indices (5)*
9. To maintain plans for capacity building	*The team will support*

in developing countries in the above activities, particularly through Workshops. In particular, to work closely with START on capacity building through its Monitoring Extreme Climate Events (START-MECE) group	*capacity building in the above activities, particularly through workshops and collaboration with START*
10. To submit reports in accordance with timetables established by the COPAG and/or Management Board, and agreed with CLIVAR participants	*Within the ET purview*

During discussion, Prof. C. Folland and Mr. L Molion noted that it could be worthwhile explicitly stating the homogeneity issues in the working plan for ETCCDMI activities, especially for the regional workshops, where homogeneity could be overlooked. The team agreed to circulate its interpretation of the TOR to relevant parties.

Action 1. Circulate to members and inform CLIVAR SSG of the ET interpretation of the terms of reference that resulted from discussion during the team meeting and is summarized in the meeting report. *Zwiers/Yan*

3. The ET role in other programs

A number of international programmes/organizations are engaged in the field of CCDMI. The team was briefed on some of these programs so that it would have the information necessary to ensur that its activities well coordinated with the existing activities.

GCOS - In his presentation of the Global Climate Observation System, Prof. Folland pointed out that indices could be a key issue for climate change detection and monitoring. He showed a few aspects to be considered in order to guide GCOS/ETCCDMI's work. The first is to identify questions indices should answer. Example questions are:

- How warm is the world now, including ocean and atmosphere and selected regions?
- What are the current/recent states of regional atmospheric circulation and how unusual are they?
- What are current/recent states of the ocean and how unusual are these states?
- What is the state of ENSO?
- Have recent extreme events broken records and if so where, and what types of extremes?

- For seasonal to interannual prediction, what is the expected state of key climatic indices in the near future and what is our confidence in the predictions?

Based on data availability, Prof. Folland discussed examples of indices related to these questions, including the global mean temperature, annual surface temperature anomalies and percentiles, upper-300m ocean temperature anomalies, seasonal anomalies of global temperature for the lower troposphere, global tropopause level, OLR, sea ice extent, land snow cover, monthly precipitation in typical regions such as the Asian monsoon region, and circulation indices for the North Atlantic Oscillation, Southern Oscillation and other modes of variability.

Prof. Folland called on the team to consider who its audiences are, what space and time scales are important, who else has developed climate indices, and how the GCOS/ETCCDMI group should choose from the vast range of possible indices. He wished for current index states to be put in historical context and include uncertainties where possible. He concluded with a recommendation to set up a dedicated web site hosting a new GCOS/ETCCD diagnostics/index monitoring system, which should complement and be linked to other sites. He noted this would need considerable expertise and time. He mentioned possible use of the ERA-40 reanalysis data set, which has recently been made available (free online).

JCOMM - Mr. V. Swail thanked Peter Dexter (JCOMM Secretariat, Geneva) for his input to his presentation. The WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology is an intergovernmental body of experts, which provides the international, intergovernmental coordination, regulation and management mechanism for an operational oceanographic and marine meteorological observing, data management and services system. As Mr. V. Swail showed, JCOMM makes effort to further develop the observing network, partly under the guidance of GCOS. Its data management activities are coordinated with other bodies including GOOS and WMO/CCl. JCOMM has archived various types of data for meteorology, surface oceanography, sea level and sea ice, including those from vo nteer vessels, drifters, buoys, and satellites, which are useful for studying seasonal to interannual and longer-term climate variability.

As Mr. Swail discussed, a notable JCOMM activity is the MCSS - Marine Climatological Summaries Scheme. Established in 1964, the MCSS has as its primary objective the international exchange, quality control and archival of delayed mode marine climatological data, in support of global climate studies and the provision of a range of marine climatological services. Two Global Data Collecting Centres (GCC) were established in 1993 in Germany and the United Kingdom. All data are eventually archived in the appropriate World Data Centres, such as the National Climatic Data Center (NCDC). Another notable advance took place with the CLIMAR workshops. As Mr. Swail outlined, the 1st CLIMAR workshop (Vancouver, 1999) brought together COADS and JCOMM, and was followed by workshop in Boulder (2002) and CLIMAR II (Brussels, 2003), which further developed CLIMAR's scope. CLIMAR set 3 streams of work on:

- historical data - to identify, locate, digitize, quality control, homogenize and exchange, leading to data products,
- climate analysis - mean, variability, extremes, uncertainty, trend, indices, leading to information products, and

- observational systems - involving GCOS/GOOS, VOSClim, AVOS, ocean observatories and satellite

A complete description of JCOMM's data activities can be found on the JCOMM website at: http://www.jcommops.org.

START - The IGBP/IHDP/WCRP co-sponsored SysTem for Analysis Research and Training plays an important role in capacity building for global change studies. START was involved in earlier CCl/CLIVAR regional workshops and is continuing its involvement by supporting the up-coming South African workshop. Although a START representative could not attend the meeting, the team highly appreciated START's contribution in past activities and would keep close collaboration with START in the future.

IPCC - Working Group I of the Inter-governmental Panel for Climate Change undertakes a periodic scientific assessment of climate change research and publishes IPCC Assessment Report (AR) every 4-5-6 years. Dr. Zwiers outlined plans for IPCC AR4 (co-chaired by Dahe Qin and Susan Solomon), to which the team will make considerable contribution. Specifically, the outputs of the regional workshops (details in section 5) will fill geographical gaps in observations of climate change for the AR4's Chapter 3 (Atmospheric and Surface Observations). The team may also be able to contribute to Chapters 4 and 5 (Cryosphere and Ocean). Dr. Zwiers anticipated potential impacts on other chapters, given the role of indices in:

- global and regional model assessment (Chapters 8 and 11)
- climate change detection and attribution (Chapter 9) and
- assessment of global and regional projections (Chapters 10 and 11)

Dr. Zwiers showed the AR4 time line and called on the team to plan its activities accordingly. A key time point is December 2005, when all material referenced should be in press or published. This should be considered when planning regional workshops. Dr. Mokssit added that the previous Caribbean and African workshops could also contribute to help fill the gaps in the map of climate change assessment based on CCI.

The team agreed in principle to adjust the working plan to the IPCC time line. However, as Dr. Stephenson argued and suggested, the team should also develop a wider scope. Nonetheless, it was recognized that in practical terms, the IPCC activities could serve as a driving force for the team activities. Thus the IPCC Third Assessment Report became a clear focus for the 1997-2001 CLIVAR/CCl Working Group on Climate Change Detection that preceded the current Expert Team and considerably helped the delivery of results.

4. Science review

There have been a number of European projects, which lead in the field of climate change, extremes and indices. The team was briefed on some of the scientific advances, in order to identify priorities for

future works.

MICE - Modeling the Impact of Climate Extremes. Prof. J. Palutikof introduced this project, as a part of a cluster of 3 projects dealing with extremes within European Union Framework 5, running from February 2002 until July 2005. The MICE project aims to

- identify and catalogue extremes in observed and modelled climate data,
- assess future changes in climate extremes using Extreme Value Theory,
- assess the impact of changes in extremes, and
- communicate the results to stakeholders.

As Prof. Palutikof explained, MICE does not carry out downscaling analysis, as many model-observation comparative studies do. It considers more weather types than single-station or -grid statistics. Prof. Palutikof showed some examples linking extremes and impacts, including energy consumption and crop production. For impact studies, the MICE experience suggests that down-scaling is not necessarily a better way. More details are online at http://www.cru.uea.ac.uk/cru/projects/mice/.

STARDEX - STatistical and Regional dynamical Downscaling of Extremes for European regions, is another of the three EU projects noted above. STARDEX is coordinated by the University of East Anglia and includes 12 European partners. As Dr. Haylock introduced, the objectives of STARDEX are to improve downscaling techniques of extremes and apply more robust techniques to providing projections of changes to climate extremes under climate change. STARDEX has developed a software tool that calculates 57 climate indices, mostly dealing with extremes. A core set of 10 indices is being used throughout the project to develop scenarios for Europe. There are differences in the definitions of some indices as compared with the methods of calculation used in other European studies. The question of what constitutes a climate 'extreme' has been an important point of discussion in STARDEX, but the need for statistical confidence in downscaling extremes means that only more moderate extremes (return periods of less than a year) can be currently considered. More details are available at http://www.cru.uea.ac.uk/cru/projects/stardex.

Questions were raised about the 57 indices and how to choose indices. Prof. Jones and Dr. Haylock explained that the project's top 10 indices were based on considerations of both practical and statistical significance and of modeler's interests. The team recognized the need for identifying different types of extreme indices for different climate regimes. In later discussions on workshops, Dr. Haylock agreed to collaborate with Dr. A. Klein-Tank and some others to make a table comparing all indices available and commonly used in international research, in order to assess the various indices.

ECA - European Climate Assessment. Dr. A. Klein-Tank introduced the project and discussed recent results obtained from studying trends in indices for extremes in Europe, as well as future plans. Currently ECA joins 41 participants from 39 countries in Europe and the Mediterranean. Under a contract of the organization of meteorological services in Western Europe (EUMETNET), the ECA

project will continue until at least 2008. The public website http://www.knmi.nl/samenw/eca gives access to all results (report, papers, presentations) and data (over 500 daily station series). Definitions for a core set of internationally agreed indices are also provided at the website. Among the indices described are those in the ClimDex software tool that has been developed by NCDC for the Caribbean and African workshops on extremes. Current ECA work includes improving data accessibility (netCDF, DODS, etc.), further developing techniques for homogeneity assessment of daily time series, providing monitoring of indices products (like the prototype shown for the 2003 summer heat wave in Europe) and investigating trends in extremes using more advanced statistical methods.

Dr. Klein-Tank noted that IPCC WGI (Beijing, 2002) recommended using more advanced methods than simple description of extremes. However, the question "which methods best supplement the 'simple' descriptive indices" remains open, although it is recognized that the indices that have been used so far describe only part of the characteristics of extremes (amplitude, rate, duration, persistence, etc.). Later discussions at the meeting made clear that the infrastructure developed at KNMI in the past 5 years and the coming years for ECA will be available for use in other regions and for the ETCCDMI.

Comparing observed and modeled changes - Prof. Folland introduced a recent study by Kiktev et al., who compared observed and modeled trends in extremes of surface temperature and precipitation during the second half of the 20th century. The study derived from station daily data a few annual climate indices (e.g., Frost Days and Consecutive Dry Days) and interpolated them to model grids. The maps show that data are available in North America, the Eurasian continent and Australia, leaving gaps elsewhere. The model outputs are from 3 ensembles of HadAM3 runs with observed SST and 3 types of external forcing: solar variability and volcanic forcing; greenhouse gases, direct aerosol effects and ozone factors; and indirect aerosol effects. The main conclusions are:

- Observed results mainly confirm earlier findings (Frich et al. 2002; IPCC TAR), but with more rigorous estimates of trend uncertainty to determine the significance of trend patterns.
- Gridding provides coherent observed trend patterns and allows comparison of observed trends with those simulated by models forced by observed SST, sea-ice and human-induced forcings.
- Comparisons with HadAM3 runs indicate that inclusion of anthropogenic effects in model integrations improves the simulation of changing extremes in temperatures over 1950-1995.
- HadAM3 shows little skill in simulating 1950-1995 precipitation extreme trend patterns.

There is obviously a need for comparison with coupled model data to determine if changes in extremes are unusual in the context of natural climate variability, and to estimate total anthropogenic effects on changing climate extremes. Prof. Folland supposed this could be done with HadCM3 and CCM3 first. He suggested that this should be a recommendation of ETCCDMI to the CLIVAR WGCM.

Extremes simulated in models - Dr. Zwiers started his talk by showing a few local daily precipitation series, where the observed series can hardly be distinguished from the modeled series. Undoubtedly, models can produce local variability similar to the observed. However, as he further showed, there are still big gaps and difficulties. The study he described involved daily temperature from 12 models

participating in AMIP2 and precipitation from 16 such models, compared with station data and NCEP and ERA-15 reanalysis data. Classical extreme value theory was applied to fit annual extremes and to estimate 20-year return values. For temperature, models tend to underestimate warm and overestimate cold extremes. For precipitation, there are large differences between different data sets. Several models exhibit insufficient variability in the tropics and an erroneous split ITCZ. Some scenarios for 2050 simulated by CGCM2 were also presented.

Dr. Zwiers concluded that (1) while data for assessment of extremes is a serious problem, models are different from 'reality'; (2) it is difficult to identify causes of model problems, though there are indications that land surface parameterizations and parameterizations of convection are involved; and (3) there is confidence in some qualitative aspects of changes in future extremes (e.g., it seems likely that future precipitation extremes will be more intense than those experienced in today's climate).

Methodology in CCDMI - Dr. Stephenson focused his talk on statistical methods for estimating trends in climate change indices. He discussed indices used for monitoring and detecting climate change and how best to assess long-term trends in such indices. The basic definition of ETCCDMI "extremes" indices (as used in the CLIMDEX, ECA, STARDEX, and PRUDENCE projects) was first described and an interpretation in terms of "marked point process" of daily exceedences was presented. This was followed by a brief discussion of what is meant by an "extreme". The question of what exactly is a "trend" was then raised and various definitions were given. Trend analysis was illustrated on a particularly difficult example of a Russian Heat Wave Duration Index (HWDI) provided by Lisa Alexander at the Met Office. The probability model approach to describing a trend in the mean was explained. Residuals from a linear fit to the HWDI were shown to have very strange non-normal (non-Gaussian) behavior caused by the non-normal distribution of the HWDI variable. The advantage of using non-local in time robust fits such as LOWESS was demonstrated along with the idea of assessing trends on only the non-zero values of the HWDI. A list of problems with the usual linear least-squares trend approach was discussed and some alternative methods such as those based on Generalized Linear Models (GLM) was suggested. There is no unique definition of trend and so care should be taken when doing trend analysis of extremes indices. This will form ongoing work for the ETCCDMI team.

It was argued, however, that linear trend remains a most straightforward expression for climate change in many cases (e.g., global warming). Nevertheless, non-linear 'trends' will be more useful in analyzing series of climate extreme-related indices. During discussion, Prof. Folland emphasized that statistical uncertainty should be estimated for all climate change analyses. It was noted that well-designed GLMs could serve as a useful tool in estimating climate extremes and trends, with statistical uncertainty assessments explicitly included.

5. Regional workshop planning

Due to technical problems, the planned phone session with Dr. T Peterson was replaced by a later telephone-communication between Drs. Zwiers and Peterson. Dr. Yan briefed the team on a presentation by Dr. Peterson sent before the meeting, which provides context for the discussion of regional workshops. After a brief historical review, the presentation listed the general goals of regional workshops:

- Analyze indices from daily data, especially measures of changes in extremes
- Fill in blank areas in 'global' analyses
- Increase confidence in local analyses by placing these analyses in a larger, regional context that includes results from neighbouring stations and countries.
- Increase regional research synergies by sharing insights and improve analyses between neighbouring countries
- Foster greater appreciation for data and data archeology

Specific goals for each workshop include producing a peer-reviewed journal article on analysis of climate change for the giving region, and making available the data and indices used in the analyses. Careful post-workshop data analysis and coordination will be necessary to accomplish these goals.

Funding remains a critical factor for organizing workshops. The current information shows there could be limited funds for three regional workshops. Top three priorities were identified to be Southern Africa, Central America and South America. It was recommended that the Asian plateau and Southwest Asia be the next two targets. Possible actions for the ETCCDMI include

- Helping to identify potential participants for each workshop
- Helping to identify institutional support (CLIVAR and CCl)
- Providing recommendations/guidance
- Identifying additional funding to cover recommendations beyond contributing to IPCC and minor capacity building

Having considered Dr. Peterson's report and other relevant workshops (e.g., the SCAR READER project for Antarctic daily/sub-daily data in September 2004, the APN SE Asia workshop organized by Neville Nichols in March 2004, and the APN Oceania Workshop by Jim Salinger in December 2003), the team agreed a prioritized list of 5 workshops for S Africa, S America, C America, the Asian plateau and SW Asia during 2004-2005.

Taking the Casablanca workshop (summarized by Easterling et al., Bulletin of American Meteorological Society October 2003) as an example, Dr. Mokssit guided the team to consider more details of the objectives, deliverables and contents of such workshops. It was suggested that the workshops should include two context-setting seminars that would be given by invited experts. It would be very useful to have one lecture provide a general analysis of observed climate change with a focus on the region over the last 100 years or so. This would be based on instrumental datasets, gridded data sets, and where possible, could also be set in the context of a longer period of time through the examination of proxy datasets. It would also be useful to have a second lecture about climate change modeling with an IPCC-type background and scenarios with regional focus. Some significant analysis work would be required to create such regionally specific lectures. The discussion also led to a number of action-related agreements, including:

- The ClimDex software, used for previous workshops, will be maintained and improved and be

applied in future workshops. A thorough check and updated documentation will be made in accordance to the S Africa workshop planning.

- Document packages in French, Spanish and Portuguese, in addition to English, will help to promote activities for some regional workshops. An updated English document for ClimDex will be ready for translation to French, Spanish and Portuguese versions by the end of February 2004.
- The daily data series to be analyzed should be sufficiently long (at least since the 1960s), with a missing rate of less than 10%. The data should be prepared before the workshops in the format required by ClimDex.
- GSN (GCOS Surface Network) sites and neighboring reference sites are preferable. This point will be included in the letter and screening questionnaire to the WMO PRs in relevant countries, in order to choose data.
- An important criterion for the selection of workshop participants is their potential to serve as trainers of others in their home institutes in the homogenization and quality control of data, and calculation and analysis of indices. By 'training the trainers', the prospects for continuing post-workshop followup activities should be increased.

The team was briefed on the preparation for the S African workshop by Dr. B. Hewitson over the telephone. The workshop will be hosted by the University of Cape Town and the South Africa Weather Service, Cape Town, during the 1st week of June 2004, immediately after the 9th International Meeting for Statistical Climatology. START has agreed to provide paritial support for this workshop and it is hoped that CLIVAR will be able to provide some additional support. The next steps in the development of this workshop will be to identify participants with the required data, to start training on software, and to plan seminars with invited experts. At least 15 computers plus appropriate technical support will be available for participants. As the team suggested, all countries in Africa are eligible to participate, with priority for those countries that were not covered by the Casablanca workshop. Some detailed requirements resulting from the team discussion will also be followed, as summarized in Table 1. The meeting and outputs will be reported over the coming weeks through a central ETCCDMI web. Dr. M. New agreed to draft a paper of the output of workshop as input to IPCC AR4.

The team recognized the necessity to prepare a Resource CD for the coming workshop. A list of contents of the CD-ROM were suggested, including:

- ClimDex Software and Manual (with the latter available in English, French, Spanish and Portuguese)
- IPCC WGI Third Assessment Report
- Frich et al., 2002: Observed coherent changes in climatic extremes during the second half of the twentieth century. Climate Research 19, 193-212
- Klein-Tank and Konnen 2003: Trends in indices of daily temperature and precipitation extremes in Europe 1946-1999. J. Clim. 16: 3665-3680

- Kiktev et al., 2003: Comparison of modeled and observed trends in indices of daily climate extremes. J. Clim. 16: 3560-
- Caribbean & African workshop papers (e.g., Easterling et al. 2003; Peterson et al., 2002)
- Table of categorized indices (Haylock/Klein-Tank)
- Document of methodology (Stephenson/Klein-Tank/Haylock/Zwiers/Zhang)
- Report of CCl/CLIVAR ETCCDMI-1
- Web links to useful sites and reference material
- GrADS software
- Test data

The CD will have 2 directories, one including software and documents, and another with reference papers and reports.

L. Molion and S. Sensoy briefed the team on their preliminary proposals for the S America and SW Asia workshops. As Mr. Molion described, the working environment for climate study in Brazil is getting better. He was optimistic for organizing the S America workshop in August 2004. The team appreciated Mr. Sensoy's proposal of a 2-week workshop in Turkey in May 2005. All possible aspects were discussed for each workshop, including dates, venue, targeted area, associated international meetings, experts and ET coordinators. The number of participants was estimated at 15-25 for each workshop, with 1-2 person(s) per country. It was recommended that SW Asia workshop include some SE European countries. Some members hoped the Asian plateau workshop would include India, while acknowledging the difficulty due to the large difference in climate between India and the plateau area. Table 1 summarizes the workshop planning, general requirements and expected deliverables. Administratively, a letter to the PRs of involved countries should be sent out as early as possible from WMO. A screening questionnaire for choosing candidates should be sent out through the PR from WMO. Additional participants might also be identified through the use of a selection committee.

Action 2. Prepare a template letter to WMO Permanent Representatives in relevant countries, which states objectives and benefits of workshop and type of participant desired. *Mokssit/Zwiers/Alexander/Haylock/Hewitson (Llanso/Detemmerman to resurrect previously used letter by early January 2004)*

Action 3. Develop a template screening questionnaire for choosing workshop participants, based on that previously used. *Mokssit/Zwiers/Hewitson*

Action 4. Check all aspects of the ClimDex software that will be used in workshops. *Klein-Tank/Alexander*

Action 5. Prepare a Resource CD containing ClimDex documentation and other supporting materials for workshops. *Alexander/New/Stephenson*

Action 6. Arrange for translation of the software document into other languages. *Stephenson for Portuguese /Llanso for French and Spanish (Carriers of Actions 4 and 5 to make sure that the document is ready by 1 March 2004)*

Action 7. Identify targeted regions not covered by pervious workshops. *Mokssit/Alexander/Haylock*

Action 8. Organize and deliver workshops in coordination with supporting organizations and funders (see Table 1). *Local organizers / ET contacts*

Action 9. Prepare a short document on preferred practices for index construction and analysis, including guidance for 'reanalysis' of previously collected indices. Include a cross-referenced list of indices computed by the various pieces of software that are currently available so as to identify differences in index definitions. Also include advice on analysis methods appropriate to each index. Publish as a CCl/CLIVAR report and post on the web. *Stephenson/Klein-Tank/Haylock/Zwiers/Zhang*

Action 10. Make sure that workshop information (including outputs and follow-up activities) is available at the ET web and linked to the CLIVAR web site. *Zhang/Zwiers/Yan*

6. Marine and oceanic aspects

There is great potential for developing marine and oceanic aspects in the area of CCDMI. A few talks were invited at ETCCDMI-1 to address relevant issues.

Status of marine data and monitoring - Prof. Folland provided a briefing on recent advances in developing global marine and ocean surface data sets, including:

- I-COADS - SST time series are being extended back to the 1840s (there are early sparse data) and improved with enhanced data since 1850 (compared to COADS), e.g., the Maury Collection of data, Japanese KOBE Observatory data, Japanese whaling ship data (30k reports). Sea ice data is also being enhanced that is not yet in the I-COADS set, e.g. with historical sea ice data from WMO Global digital Sea Ice Data Bank from Japan, Baltic, China and Russia. However, SST biases due to use of uninsulated buckets in earlier decades need re-assessing in the new I-COADS data set. In addition, there are thought to be smaller biases in some modern SST data which will need quantifying.

- Ocean air temperatures - recent improvements to NMAT using new corrections for marine screen heights and increased data from I-COADS.
- HadISST - improved from HadSST (used in IPCC 2001), HadISST1 combines SST and sea ice in a 'globally complete' data set. It is optimally interpolated and uses AVHRR satellite SST data.
- High-resolution Satellite SST - advances may be foreseen from the GODAE High Resolution (6 hour and 10 km) SST Pilot Project, aimed at high resolution global time and space SST analyses using polar orbiting and geostationary infrared data, microwave satellite data, and quality controlled ship, buoy and Argo data. A new HadISST2 analysis is planned which will include the new sea ice data and enhanced SST data from I-COADS.
- MSLP - development of HadSLP2m, with improved coverage (global 5x5deg) due to inclusion of I-COADS and additions from the terrestrial data bank, is underway. Daily gridded MSLP series 1850-2002 for the North Atlantic – European area is also being developed. The HadSLP2m data will be updated in near real time using GTS data.

Having illustrated some improvements and problems in data, Prof. Folland concluded:

- Historical SST and sea ice data can be considerably improved. Biases need additional attention post 1945 and around 1939-1941.
- Recent developments may particularly improve knowledge of ENSO, the Interdecadal Pacific Oscillation, and longer time scale SST variations in North Atlantic.
- Gridded SST data should be optimally interpolated (OI) with caution.
- Error bars should be placed on SST NMAT and MSLP with the help of optimum averaging and assessment of the bias correction uncertainties.
- It will be possible to develop high spatial and diurnal resolution worldwide SST using microwave and infrared satellite data and in situ data, perhaps including Argo.
- Substantial improvements to marine SLP data have emerged; The community is working towards two International historic SLP data sets (perhaps I-MSLPm and I-MSLPd).

Monitoring and assessing marine climate change - Focusing on winds and waves, Mr. Swail outlined current status, plans and targets for marine climate monitoring. A 42-year wind and wave hindcast developed by the Climate Monitoring and Data Interpretation Division of the Meteorological Service of Canada showed that in the period 1958-1997, the 90-percentiles of significant wave height for winter increased in the northeast North Atlantic by 2-6 cm/year and decreased by 1-3 cm/year in the subtropical North Atlantic. Analysis showed possible links between the wave height increases in the northeast Atlantic and the NAO variability. Study of marine climatology has obviously benefited our understanding of climate system. Mr. Swail noted that a first Global Wave Climatology Atlas derived from 45-year ECMWF reanalysis data was recently published (http://www.knmi.nl/onderzk/oceano/waves/era40/index.html). Monthly and seasonal statistics, anomalies and other wave/wind data and information are also available online, e.g., the I-COADS web http://www.cdc.noaa.gov/coads-las/servlets/dataset.

Mr. Swail briefed the ET on some of the recommendations from CLIMAR-II 2003, including

- Investigate how to apply proposed wind homogenization techniques to global data bases such as I-COADS where ancillary data and/or metadata are not always available. Is the SST adjustment approach suitable for winds?
- Recommend to I-COADS that they investigate the inclusion of wave information in their climate summaries.
- Develop a list of recommended climate indices for winds and waves, and pressures. Indices should be appropriate to the data bases used to develop them.
- Recommend to JCOMM that they promote the development of climate information, especially indices, as a logical update in technology to the outdated MCSS analysis.
- Recommend to JCOMM that they identify operational and experimental climate information products, and include these as part of the new JCOMM Products portal.
- Participate in the JCOMM Products Workshop Toulouse May 10-12, 2004.

The team discussed how to coordinate with JCOMM and agreed to write to JCOMM to express the need for marine and oceanic climate monitoring, change detection and indices.

Status of deep ocean data and monitoring - Dr. Bindoff reported on sub-surface ocean temperature and salinity observations (deeper than 10m) that are part of the CLIVAR program. He briefed the ET on the historical data that exist prior to the 1990's, during the WOCE experiment, and those that are planned for the CLIVAR repeat sections and for the carbon cycle work over the next 10-15 years. In addition, Dr. Bindoff reported on the Argo program, and showed new results from the November 2003 Argo Workshop in Japan. Although there are only ~1000 floats currently deployed in the oceans these data are already useful for estimating heat and freshwater changes on a zonal basis in the Northern and Southern subtropical gyres over the last decade. The importance of the Argo data set for climate change detection in the coming decades is going to increase. He appealed to the CLIVAR International Program for additional help in promoting and supporting Argo, and the CLIVAR repeat hydrography and carbon cycle sections.

Monitoring and assessing ocean climate change - Dr. Bindoff went on to report on ongoing efforts internationally to detect climate change signals in the major ocean basins. He showed examples from all ocean basins that support the notion that key oceanographic water masses in both the Southern and Northern Hemispheres are changing, in particular, the mode waters and intermediate waters in both hemispheres. The mode waters show warming, and the intermediate waters show a freshening, suggesting that both the surface temperatures and surface salinities are changing. The changes are broadly consistent with results from climate changes simulations.

The team discussed indices for detection of marine and ocean climate change. As Dr. Bindoff pointed out, one of the key issues in detecting climate change is the selection of suitable variables. Signal and noise are important considerations. It is clear from coupled model simulations of natural variations and

climate change that variables such as the transport of heat (at 24N in the Atlantic) are not significantly different from the control in the climate change simulations. On the other hand, sea-surface temperature, and water mass properties are significantly different. Similarly it is important to look at the water masses that are most likely to change, i.e., those that are relatively close to their source regions, and in areas where the natural variations are likely to be smaller. Coupled models suggest that water masses in the southern Ocean are a more sensitive indicator of change, because the signal-to-noise ratio is higher there. Thus, for the detection and attribution of climate change, the best ocean variables to use for indices would emphasize storage terms (such as heat, salt, carbon) variations in the water-mass properties and volumes, sea-level and perhaps large scale changes in ocean stratification. It is also important that these indices have value for establishing relationships between the oceans and terrestrial variations. Together, these requirements suggest that there will be a need for both global scale and regional scale indices.

The team recognized that for climate change detection and attribution, it is important to create proper indices. Example indices were proposed, including:

- global ocean heat content and sea level,
- zonally average salinity, temperature and heat content,
- water mass averaged quantities, thickness, etc.,
- indices indicating current bifurcation such as Indian Ocean Dipole and Aleutian Dipole,
- indices for ocean-atmosphere interactions such as Asian-Australian monsoon and overturning modes.

However, it was noted that the number of indices should remain small and should include those that have been commonly used, such as the well-known ENSO indices. The team charged Dr. Bindoff, Prof. Folland, Mr. Swail and Prof. Karoly with the task of summarizing and circulating a list of ET-recommended marine and oceanic indices for the IPCC AR4, together with the comparative list of indices made by Dr. Haylock.

Action 11. Prepare a short document on suggested large-scale atmospheric, oceanic and marine climate indices for monitoring and detection that should be considered for the IPCC 4th Assessment Report (AR4). *Bindoff/Folland/Swail/Karoly*

Action 12. Write to JCOMM expressing need for marine climate change detection, monitoring and indices. *Co-chairs/Swail*

7. ET web sites, national activities and others

ETCCDMI indices website - Dr. Zwiers proposed that an ET website be developed. Such a site could be focused on indices, and could contain information on software for calculating indices (or links, e.g.,

those of NCDC, ClimDex, APN and STARTDEX), post-processed peer-reviewed indices (downloadable), workshop reports and follow-up activities, homogenized daily data (or links) where available, post-workshop indices and an updated list of references. The site could also establish a mechanism for recognizing users through password-controlled download. It was hoped that the site would have a clickable map for choosing regional subsets of indices. Dr. Mokssit suggested that some modeled scenarios vs observations (e.g., from the EU project PRUDENCE and Meteo France) could be included. Dr. Bindoff noted that the web should be viable for marine indices, which are presently not available. Prof. Jones enquired whether frequencies of extremes could be included. It was also recommended that the web incorporate bulletin board service to facilitate discussion among the team members and users.

GCOS website - Prof. Folland introduced the planning of the possible website. Challenging questions the web site will face include:

- Who approves the content of a GCOS web site?
- Will we encourage on line debate on content and who monitors this?
- Can we obtain near real time updates of extremes behaviour?
- What about showing short-term climate predictions?
- Should animation be included?

It is possible that BMRC and Met Office will lead the initiative in 2004. One problem deals with some official limits for data release from Met Office/Hadley Center.

Additional web resources - Existing web resources dealing with climate extremes and indices include those web pages in association with the relevant EU projects at the Climatic Research Unit (http://www.cru.uea.ac.uk) and that of the ECA (http://www.knmi.nl/samenw/eca/index.html). As Dr. Klein-Tank reported, the ECA web will remain operational until at least 2008. It is updated every 6-months, Statistics show good visiting rates, about 10 questions and 30k page views per week. A list of FAQs is therefore very helpful. Dr. Yan assured the team that CLIVAR website will include all these links.

National activities - Almost all countries are involved in studies of climate change detection and monitoring, due to the widespread impact of climate change on many economical and social aspects. In Australia, as Dr. Bindoff briefed, relevant research activities are mainly organized through BMRC, CRC, CSIRO and several universities. A main driving force for Australia is associated with the role of land cover change. For regional cooperation, Australia plays a role in organizing APN workshops on climate extremes and indices. In Brazil, as Mr. Molion briefed, it is difficult to obtain daily data from met offices for research. However, it is easier to get daily hydrological data associated with hydropower applications, including rainfall and river runoff. He suspected the current indices (e.g., the 57 indices of STARDEX) might not be suitable for tropical climate regimes and urged the development

of indices that are more appropriate to the tropics. These indices might include those that reflect regional surface pressure variations that result from ENSO. He hoped the ET workshop would promote studies of climate in the country. A detailed report for Turkey by Mr. Sensoy, and one for the US special ad hoc Working Group on Climate Change Detection (IDAG, 2004) by Dr. Zwiers were also presented at the meeting. The reports are available at CLIVAR's web site (http://www.clivar.org/organization/etccd) through the ETCCDMI-1 meeting agenda. The team appreciated all the reported national activities, which are valuable for the development and implementation of CCl/CLIVAR's science plan.

During the last half hour of the meeting, the co-chairs reviewed the action list and deliverables. It was suggested that a timetable for ETCCDMI activities be established, taking into account the IPCC AR4 time lines and WMO/CLIVAR's long-term working plans. The co-chairs highly appreciated contributions from all participants and the help from the host, Prof. Jones and his team, which led to a very fruitful meeting. The 1st ETCCDMI team meeting was closed at noon on 26 November 2003.

Action 13. Develop an ET website focused on local indices. If feasible, include with group email/discussion capability and data-visualizing tools. *Zhang/Zwiers*

Action 14. Prepare a timetable for ETCCDMI activities, taking the IPCC AR4 and CLIVAR and relevant WMO activities into account. *Co-chairs/Yan*

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A number of relevant reports and recent research papers are listed online at http://www.clivar.org/organization/etccd/index.htm.

Appendix 1. Attendee list

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Appendix 2. Meeting agenda (is lost)

Appendix 3. Acronyms

Most of the acronyms used in this report are listed here. More can be found at http://www.clivar.org/publications/other_pubs/iplan/iip/appendix_6_acro.htm.

ACC	Anthropogenic Climate Change
AMIP	Atmospheric Model Intercomparison Project
AR4	4th Assessment Report (IPCC)
BMRC	Bureau of Meteorology Research Centre (Australia)
CCDMI	Climate Change Detection, Monitoring and Indices

CCl	Commission on Climatology (of WMO)
CCM	NCAR Community Climate Model
CGCM	Coupled General Circulation Model
CGCM2	The Second Generation Coupled General Circulation Model (Canada)
CLIMAR	Workshop on Advances in Marine Climatology
CLIVAR	Climate Variability and Predictability (WCRP component)
COADS	Comprehensive Ocean-Atmosphere Data Set
CRU	Climatic Research Unit (University of East Anglia, UK)
CSIRO	Commonwealth Scientific and Industrial Research Organization
ECA	European Climate Assessment
ECMWF	European Centre for Medium Range Weather Forecasts
ENSO	El Nino Southern Oscillation
ET	Expert Team
ETCCDMI	Expert Team for Climate Change Detection Monitoring and Indices
EU	European Union
GCOS	Global Climate Observing System (IOC/WMO/ICSU/UNEP)
GCM	General Circulation Model
GLM	Generalized Linear Model
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System (IOC)
GSN	GCOS Surface Network
GTS	Global Telecommunication System
GUAN	GCOS Upper-Air Network
HadCM	Hadley Centre Coupled Model (UK)
ICPO	International CLIVAR Project Office
ICSU	International Council of Scientific Unions
ICT	Implementation/Coordination Team (CCl OPAG)
IDAG	International ad hoc climate change Detection and Attribution Group (IDAG)
IGBP	International Geosphere Biosphere Programme
IHDP	International Human Dimensions of global change Programme
IOC	Intergovernmental Oceanographic Commission

IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
JCOMM	Joint Commission for Oceanography and Marine Meteorology (GCOS/GOOS)
JSC	Joint Scientific Committee for the World Climate Research Programme
KNMI	Koninklijk Nederlands Meteorologisch Instituut (The Netherlands)
MCSS	Marine Climatological Summaries Scheme
MICE	Modeling the Impact of Climate Extremes
MSLP	Mean sea level pressure
NAO	North Atlantic Oscillation
NCAR	National Center of Atmospheric Research (US)
NCDC	National Climate Data Center (US)
NCEP	National Center for Environmental Prediction (US)
OLR	Outgoing Longwave Radiation
OPAG	Open Programme Area Group (CCl)
PAGES	Past Global Changes (IGBP component)
SLP	Sea level pressure
SSG	Scientific Steering Group
STARDEX	STatistical and Regional dynamical Downscaling of Extremes
START	Global Change SysTem for Analysis, Research & Training
UNEP	United Nations Environment Programme
WCDMP	World Climate Data and Monitoring Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WGCM	Working Group on Coupled Modelling (JSC/CLIVAR)
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment (WCRP component)