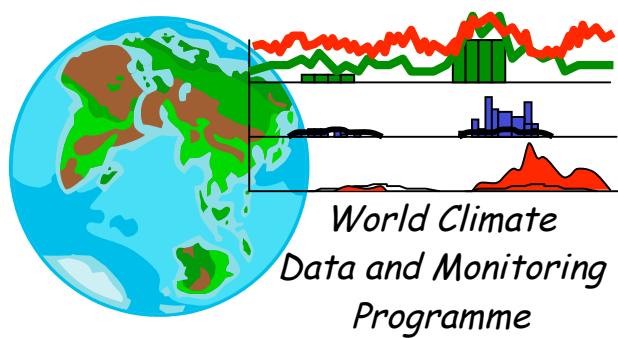


JOINT CCL/CLIVAR/JCOMM EXPERT TEAM ON CLIMATE CHANGE DETECTION AND INDICES

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ETCCDI WORKPLAN

ACTIONS	TIMEFRAME TO COMPLETE ACTION
Liaise with JCOMM to include the ET on JCOMM's organisational chart (Val Swail and Scott Woodruff).	<i>Immediate</i>
Develop a list of indices to be placed on the ET website hosted by Environment Canada. CLIVAR and CCI ET's websites to link to this website (Chris Folland, Xuebin Zhang, Nico Caltabiano and Omar Baddour)	<i>Immediate</i>
Publish atmospheric circulation and land surface cover indices on the ET website (Chris Folland, Xuebin Zhang)	<i>MAM / 07</i>
Consult with JCOMM experts and report back to ET with a white paper on ocean and marine indices (Elizabeth Kent, Val Swail, Scott Woodruff, Chris Folland)	<i>April / 07</i>
Report to CLIMAR3 (May 2008), including a publication, and description of indices available to date, opportunity to engage a broader community (Elizabeth Kent, Val Swail, Scott Woodruff, Chris Folland)	<i>May / 08</i>
Deliver indices to ET website starting with, e.g., ocean surface indices, including humidity, SST, NMAT (Chris Folland, Xuebin Zhang)	<i>MAM / 07</i>
Publish Arctic and Antarctic sea-ice extent (automatically updated monthly at the Hadley Centre), initially using a link (Chris Folland, Xuebin Zhang)	<i>Dec / 06</i>
Link subsurface ocean indices (when posted on HadGOA's website) from CLIVAR website (Nico Caltabiano)	<i>Immediate</i>
Take the ET recommendations on State of the Ocean Climate webpage to OOPC (Nico Caltabiano)	<i>Immediate</i>
Provide TGICA with indices from model-based data averaged over the Giorgi areas (David Karoly)	<i>SON / 07</i>
Provide indices advice to WGCM (David Karoly, Phil Jones, Xuebin Zhang, Francis Zwiers, Nico Caltabiano)	<i>Immediate</i>
Draft a brochure to support the case for workshop funding and circulate to panel for comments and review (Tom Peterson, Omar Baddour, Nico Caltabiano)	<i>May / 07</i>
Investigate the possibility to have a joint data management and indices/homogenization workshop, funded by CCI (Omar Baddour)	<i>Immediate</i>
Start discussion on an intercomparison between indices calculated by different groups (Albert Klein-Tank to lead)	<i>Immediate</i>
Start discussion by email on the review of ET indices (Phil Jones, David Karoly, Xuebin Zhang)	<i>Immediate</i>
Draft a review paper and circulate to panel for comments (Xuebin Zhang)	<i>AMJ / 07</i>
Produce a guidance document on the calculation and use of indices for	<i>JFM / 08</i>

distribution to national meteorological services (Albert Klein-Tank, Francis Zwiers, Omar Baddour)	
Investigate the feasibility of using the ECA&D interface for publishing the indices and implement if feasible (Xuebin Zhang)	<i>Immediate</i>
Seek more details and advice from the European feasibility study on updating of indices using data on GTS, and report back to the ET (Albert Klein-Tank, Phil Jones)	<i>JJA / 07</i>
Publish model simulated indices and links to the model output data portals (Xuebin Zhang, Albert Klein-Tank, David Karoly)	<i>SON / 07</i>
Publish indices from gridded observations (Xuebin Zhang, David Karoly)	<i>SON / 07</i>
Publish ocean surface indices indicated by JCOMM representatives (Xuebin Zhang, Chris Folland)	<i>MAM / 07</i>
Prepare a list of indices websites with a brief description of each and place on CLIVAR's ET webpage (Expert Team, Nico Caltabiano)	<i>Immediate</i>
Prepare a way to present classic examples of homogeneity problems using data from the workshops, besides other regional examples (Lucie Vincent, Xiaolan Wang, Tom Peterson, Lisa Alexander)	<i>JJA / 07</i>
Initiate an assessment of need for a detailed homogenisation of extreme indices (Xiaolan Wang, Lucie Vincent, Xuebin Zhang, Albert Klein-Tank, Francis Zwiers, Blair Trewin, Gabriele Hegerl)	<i>SON / 07</i>
Check feasibility of translation of the software manual to other languages by WMO Translations Services (Omar Baddour)	<i>Immediate</i>
Inter-compare available indices and advise on how to calculate a simple index based on Q and T (Phil Jones, Lucie Vincent, Chris Folland, David Karoly)	<i>Initiate immediately</i>
Publish index of precipitable water based on satellite data (Chris Folland)	<i>MAM / 07</i>
Publish surface humidity index (Phil Jones and Blair Trewin)	<i>Initiate immediately</i>
Establish contact with GEWEX/WISE group and USCLIVAR WG on droughts (Albert Klein Tank, Francis Zwiers, David Karoly)	<i>Immediate</i>
Publish global drought index based on self calibrating PDSI calculated from HadCRU gridded T, P, Q, and cloud cover (Phil Jones, Albert Klein Tank, Xuebin Zhang, Tom Peterson, Blair Trewin)	<i>JJA / 07</i>
Explore possibilities in developing a Greenhouse Gases climate response index (David Karoly, Xuebin Zhang, Tom Peterson, Chris Folland)	<i>JJA / 08</i>
Circulate to panel a draft a letter to be sent to NCDC, CCI, Met Services (Xuebin Zhang, Phil Jones)	<i>Jan / 07</i>
Include quality of precipitation data issue in the report to the WMO congress (Omar Baddour)	<i>Jan / 07</i>

1. INTRODUCTION

The Expert Team on Climate Change Detection and Indices (ETCCDI) is jointly sponsored by the Commission for Climatology (CCI) of the World Meteorological Organization's (WMO) World Climate Data and Monitoring Programme (WCDMP), the Climate Variability and Predictability (CLIVAR) Programme of the World Climate Research Programme (WCRP) and the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).

The Panel's Terms of Reference are:

1. To provide international coordination and help organize collaboration on climate change detection and indices relevant to climate change detection;
2. To further develop and publicize indices and indicators of climate variability and change from the surface and sub-surface ocean to the stratosphere;
3. To encourage the comparison of modeled data and observations perhaps via the development of indices appropriate for both sources of information;
4. To coordinate these and other relevant activities the ET chooses to engage in (such as perhaps observing system experiments that help determine where observations are needed for climate change detection) with other appropriate agencies such as GCOS, CBS, CIMO, CAgM, CHy, IPCC, START etc. as well with the joint WCRP JSC/CLIVAR Working Group on Coupled Modelling, the WCRP Observations and Assimilation Panel and regional associations;
5. To explore, document and make recommendations for addressing the needs for capacity building in each region, pertinent to this topic;
6. To submit reports in accordance with timetables established by the OPAG¹ chair and/or Management Group.

2. OPENING SESSION

The Second Session of the CCI/CLIVAR/JCOMM Expert Team On Climate Change Detection and Indices was held at the Prince of Wales Hotel, in Niagara-on-the-Lake, Canada on 14-16 November 2006. The meeting agenda can be seen in Appendix A. The panel co-chair and host, Francis Zweirs opened the meeting welcoming panel members and guests (Appendix B). Apologies were received from Gabriele Hegerl (panel member) and Claudia Tebaldi (invited expert). The agenda was reviewed by all participants and suggested modifications agreed. Nico Caltabiano, ICPO staffer, and Xuebin Zhang, local host, provided logistical information and local arrangements.

2.1. The ET sponsors perspective/contribution

Representatives of the three sponsors of the ETCCDI gave presentations highlighting their perspective on the ET and contributions that can be made to successful development of a work plan for the Team for the next three years. Tom Peterson gave a presentation on CCI background and talked about what a group of experts could accomplish. The ET has, in its favour, several strong points: international recognition, global coordination and its past history in serving as the inspiration for local and regional activity in climate change detection and indices. But this certainly requires commitment of all members so the whole group can achieve its goals. Omar Baddour talked on WMO programmes with a focus on climate providing an overview of their structural organisation and planned activities. He reminded the panel that the World Climate Data and Monitoring Programme (WCDMP) has several training workshops planned on data management and data rescue. These workshops, in addition to any future workshop planned by the ET, could be an effective way to encourage submission of national datasets sent to international archives. However, as Albert Klein-Tank pointed out, there is also a need, during workshops, to make sure that the quality control of the data is good.

Nico Caltabiano presented an overview of CLIVAR structure and the "CLIVAR Road Map", as planned during the 14th Session of the CLIVAR Scientific Steering Group (SSG) in Buenos Aires, April 2006. The presentation focused on the aspects of the Road Map that are relevant to the ET, with contributions to the

¹ ¹ Open Programme Area Group of the WMO Commission for Climatology (CCI). ETCCDI is the ET 2.1 of OPAG 2: Monitoring and Analysis of Climate Variability and Change.

understanding of Anthropogenic Climate Change (ACC), and to ocean observations and the CLIVAR legacy.

Val Swail and Scott Woodruff presented the structural organisation of JCOMM, and the contribution that can be made toward ocean indices based on surface and sub-surface variables. It was noted that the ET was not part of JCOMM's organisational chart.

ACTION: Liaise with JCOMM to include the ET on JCOMM's organisational chart (Val Swail and Scott Woodruff).

They showed the status of the multi-year phased implementation plan for the ocean observing system which showed that about 55% of the planned observing system is complete and that the implementation timetable remains close to that planned. However the necessarily broad overview given by monitoring a subset of representative milestones can hide some underlying problems. For example the plan states that the VOSCLim program has reached its target of 200 ships and is therefore fully implemented. However this was a preliminary target, due for revision upwards following analysis of the project dataset. The number of ships participating in the VOS program from which VOSCLim recruits ships making the highest quality observations is presently declining, making it uncertain whether VOSCLim will be able to recruit the ships it needs to replace those leaving the program. Many VOS do not report the fully range of variables, for example only about half of ships report wave parameters. This low reporting rate will impact on the quality of any wave indices calculated from VOS data. Val Swail also noted that the Third JCOMM Workshop on Advances in Marine Climatology (CLIMAR-3) is planned to be held in Gdynia, Poland, in May 2008] and this could be a good opportunity for a better interaction between the ET and JCOMM.

2.2 The ET role in IPCC

The ET had played an important role at the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). Phil Jones presented a review on how the ET has helped to ensure that the most up to date assessment, with respect to Climate Change, Detection, and most importantly, Indices, as input to the IPCC. Previous IPCC Assessments had identified areas where little or no work was being done, so the ET, in its previous configuration, had encouraged a number of regional-based workshops, contributing to global datasets and generating research and papers to be reviewed by the IPCC. These workshops expanded from just gaining access to data, but also to developing analysis packages so indices were calculated in consistent ways across regions. Regarding to extremes, these datasets have given AR4 much more to say than before (through a number of regional papers and one at the global-scale), but all need to be repeated and expanded for AR5 as there is still no way of simply updating extreme indices time series.

To overcome this would ideally require daily data to be obtained real-time and pass through a quality control and homogenisation scheme which would deliver good quality datasets. This, if achievable, would benefit studies on extreme indices to be used by the next IPCC assessment. If there is no improvement on the real-time aspects of extreme indices, it is possible to imagine that the next generation of reanalyses would be used by AR5 or AR6 for the purpose.

Phil Jones provided a number of illustrations of a number of results from detection studies feeding into IPCC, concluding with some suggestions on issues that he sees important for future planning by the ET, which would reflect on the next and any subsequent IPCC assessments:

- It is important to start planning for a new set of workshops leading up to AR5. IPCC needs papers to make future assessments
- Improve the accessibility of the basic station data, both for real-time assessment and for the long time series
- Improvements are needed in homogeneity assessment of long daily records, partly to ensure that a few simple tests do not highlight problems. However there is also a need to address whether the homogeneity is worth all the effort
- Workshops could move beyond station-based extremes, to tropical/extratropical storms and small-scale severe-weather phenomenon (tornadoes, dust storms, hail, lightning strikes).

A discussion followed on these suggestions, with some members saying that maybe tropical storms do not need to be addressed by the ET since it will be well studied. David Karoly noted that changes in observing

practices of severe storms have led to problems in the climatology, so there is a need to discuss approaches to homogeneity assessment depending on the variables. The panel agreed to take these issues discussed into the workshop planning session, incorporating them into the workplan as appropriate.

2.3 Global indices

David Karoly gave a presentation on the evaluation of simulations of global climate variability and change using simple global indices. The reason for using indices in this evaluation is that they can represent important impact-relevant aspects of the climate system, and can synthesize information from several different components of it. With calculation of indices, it is possible to reduce climate noise by combining different components of the climate system, allowing an intercomparison of variations of these components.

The approach was illustrated via selection of a small number of indices of surface temperature variations that represent different aspects of natural climate variability but represent well key features of patterns of anthropogenic climate change. These indices (Global mean surface temperature, mean land-ocean temperature difference, mean magnitude of the annual cycle over land, mean meridional temperature gradient in the Northern Hemisphere and diurnal temperature range over land) have also shown a common signal due to greenhouse climate change but nearly independent for natural climate variations. If calculated from observations, they are more coherent than if calculated by model outputs, possibly related to atmospheric circulation. These indices could be easily adapted to any regions but indices should be chosen if relevant to that particular region.

3. MARINE INDICES SESSION

3.1 Review of worldwide indices

With JCOMM as a new co-sponsor, the ET had extensive discussion to explore the best approaches to developing ocean and surface marine indices that would be complementary to the terrestrial indices that it has focussed on previously. Chris Folland presented a review (Appendix D) of worldwide indices and how they might be best presented to the community by the ET. The considerations he identified included: (1) Indices should be primarily based on observed data. However this may include reanalyses where it is judged the science allows this; (2) Wherever possible, indices should have estimates of uncertainty attached to them; (3) Indices, with uncertainties, should be based on more than one recognised data set where possible; and, (4) given an emphasis on Climate Change Detection or even the time scales of seasonal to decadal prediction, selected model predictions of such indices could be usefully displayed side by side with the observed counterparts.

The panel appreciated that Chris Folland's presentation had provided a very comprehensive review. However they also recognised that to gather those indices into a website and respond to changes would require considerable dedication of resources. The panel agreed that a simpler approach should be used to start with, allowing the webpage to be developed with time. Links to other websites which already calculate those indices would be a very good strategy. The website could be developed by identifying indices important regionally. The ET website hosted by Environment Canada would be the appropriate place to include this list, and its development should take this into account. The CLIVAR and CCI ET's websites should link to this website.

ACTION: Develop a list of indices to be placed on the ET website hosted by Environment Canada. CLIVAR and CCI ET's websites to link to this website (Chris Folland, Xuebin Zhang, Nico Caltabiano and Omar Baddour)

One issue that the panel thought that should be addressed was the publication of atmospheric circulation and land surface cover indices as defined and calculate for IPCC AR4. Chris Folland noted that the MetOffice has released a new dataset of monthly gridded Sea Level Pressure, which spans from 1850 to 2004.

ACTION: Publish atmospheric circulation and land surface cover indices on the ET website (Chris Folland, Xuebin Zhang)

3.2 Surface Marine Datasets

Elizabeth Kent led a discussion on surface marine datasets and indices. She indicated that while the inhomogeneity of marine meteorological data is a recognized problem, in situ data products are well advanced in the development of uncertainty estimates. Sea surface temperature (SST) is the only variable with a large variety of datasets, and it would be useful to be in the same position for other variables. Regarding marine and ocean indices, Chris Folland's presentation showed a very comprehensive list of indices. However, as Elizabeth Kent showed, new robust indices could be calculated from the ICOADS dataset, based on monthly mean pressure or SST. In addition to that, new indices could be developed for intra-annual temperature ranges, solid precipitation over the ocean and cloudiness and humidity. Some of these indices could be published now, initially through a link, from the ET website.

There are still several questions to be addressed as how one can extend the range of marine meteorological indices and to what extent they can be calculated similarly to indices over land. Val Swail noted that JCOMM could make a good contribution to the development of new indices assessing direct impact on marine transportation, oil industry and coastal environment. It was agreed that the ET JCOMM representatives would consult extensively with other JCOMM experts and develop a plan to address these issues.

ACTION: Consult with JCOMM experts and report back to ET with a white paper on ocean and marine indices (Elizabeth Kent, Val Swail, Scott Woodruff, Chris Folland)

ACTION: Report to CLIMAR3 (May 2008), including a publication, and description of indices available to date, opportunity to engage a broader community (Elizabeth Kent, Val Swail, Scott Woodruff, Chris Folland)

ACTION: Deliver indices to ET website starting with, e.g., ocean surface indices, including humidity, SST, NMAT (Chris Folland, Xuebin Zhang)

ACTION: Publish Arctic and Antarctic sea-ice extent (automatically updated monthly at the Hadley Centre), initially using a link (Chris Folland, Xuebin Zhang)

3.3 Observational Subsurface Ocean indices for climate

Indices for climate monitoring calculated using subsurface ocean datasets were also discussed during the meeting. Matthew Palmer gave a brief review on ocean climate indices with particular focus on the ocean heat uptake. This index has been subject of great interest and uncertainties lately from the perspective of identifying the rate of oceanic heat uptake and its trend, and whether the decadal variability seen in observations, but not in models, is real. In order to address some of the uncertainties in the calculation of this index, it is necessary to have a comprehensive error estimate for the observed time series, with a good understanding of the existing bias between platforms. As an example, XBT/MBT data are biased warm relative to CTD/bottle data. These biases in the data need to be corrected, for example by collocation of XBT and CTD data. The biggest challenges to assessment of the historical ocean state are bias errors and sampling uncertainty, and the Argo dataset can help in addressing both issues.

Matthew Palmer also listed the efforts at the Hadley Centre (<http://www.hadobs.org/>) in producing subsurface ocean analyses for use in climate monitoring and climate modelling. The presentation focused on the details of the HadGOA, which is a project to develop an ocean subsurface analysis and climatology product designed for model validation and evaluation of historical ocean variability. It was recognized that it would be very useful to carry out a comprehensive comparison of the available observational datasets, which could possibly be included in the next IPCC assessment. Some subsurface indices will be calculated and posted on HadGOA's website and a link should be placed at the CLIVAR ET's website.

ACTION: Link subsurface ocean indices (when posted on HadGOA's website) from CLIVAR website (Nico Caltabiano)

The Ocean Observations Panel for Climate (OOPC) has identified a need to develop tools for system evaluation of the sustained global ocean observing system. In order to respond to this, it has developed a website to display a series of indices that have been calculated using observational analyses sourced from

different operational centers, and updated on a weekly or monthly basis. Nico Caltabiano, on behalf of Albert Fischer, OOPC's Technical Officer, presented an overview of the OOPC's State of the Ocean Climate webpage (http://ioc3.unesco.org/oopc/state_of_the_ocean/). These indices are quantities that act as estimators of climate variability, and can also be linked to major patterns of climate variability with significant social impact. They can be a test of our ability to observe the ocean. From a liaison and outreach perspective, they are a way to communicate information about the ocean observing system and the ocean's role in climate and climate variability. Future plans include the addition of other subsurface indices.

The panel acknowledged the importance in such indices being calculated but recommended that the surface ocean data displayed should be extended by using longer time series. The inclusion of other subsurface indices was noted and very much recommended. A further recommendation would be the inclusion of some global indices.

ACTION: Take the ET recommendations on State of the Ocean Climate webpage to OOPC (Nico Caltabiano)

4. EXPERT TEAM LINKS TO OTHER PROGRAMMES

4.1 WCRP Observation and Assimilation Panel (WOAP)

Elizabeth Kent presented an overview of WOAP and the discussions that took place during the Second WOAP meeting, held in Ispra (Italy) in August 2006. WOAP is focused on datasets reprocessing activities and reanalysis, and has a strong relationship with GCOS (Global Climate Observing System) and GEOSS (Global Earth Observation System of Systems). Two new working groups are being set up by WOAP and will work from 2007: a WCRP data management task group and a working group on development of improved observational datasets for reanalyses.

Regarding data release for any of the activities of the ET, Tom Peterson reminded panel members of the importance of developing a good relationship with GEOSS. GEOSS can deal at ministerial level with the countries that have signed up to it, so, in principle, if an institution within a country does not provide needed data, it is possible to query this at high level. Chris Folland told the panel about the expansion of ERA-40 reanalysis datasets from 1959 to the present. Data archaeology and quality control will be central for this activity. Therefore, contacts with national meteorological services would be essential. But, as Elizabeth Kent said, this can sometimes be difficult because of problematic relationships in some countries between national meteorological services and institutions that make the observations.

4.2 Links to the Asia-Pacific Network (APN) for Global Change Research Project

Details of a series of workshops organised by the APN were presented by Blair Trewin. Between 1998 and 2004, APN developed eight workshops which involved a wide range of countries from the South Pacific and East Asia. In these workshops, representatives from each participating country met for a period of about one week, bringing relevant data to subject to common analysis methods. Usually the same participant attended the whole series, which is beneficial in developing good working relationships. The themes of the workshops have varied, but have covered topics such as analysis of data and production of indices relevant to climate change, data homogenisation, metadata and data rescue, and relationships between surface climate variables and broadscale climate influences (e.g. ENSO). The workshop on data rescue was probably the most useful of the workshops overall because there was a great amount learned from the groundwork. By end of each workshop, one or more papers were drafted presenting key results from that workshop

ET members recognised that this a great opportunity to strengthen the relationship with APN and take advantage of the experience gained by APN in promoting these workshops though it was also appreciated that whilst a great deal of key groundwork has already been done, continuous updating is needed, and the links and relationships formed need to be maintained. In the Asia-Pacific area, there is a large potential for analysis of other locally-relevant variables (e.g. improved tropical cyclone records). David Karoly enquired if APN has plans to encourage workshop participants to use model-generated indices. Blair Trewin said that this would be possible and would certainly be useful.

4.3 Links to the European Climate Assessment and Dataset (ECA&D) Project and ENSEMBLES Project

Albert Klein-Tank presented an overview of the ECA&D and ENSEMBLES projects. The ECA&D Project, initiated in 1998 and coordinated by KNMI in The Netherlands, has 54 participants (data holding institutions) from 42 countries (WMO Region VI). For this project, daily station data are collected, processed at KNMI, and made available through a public website (<http://eca.knmi.nl>). This website has been operational for 6 years and enables free download of about 75% of the daily station series. Users can also perform Quality Control (QC) and homogeneity tests for each series, as well as access indices time series.

Regarding future work, ECA&D plans to update long time series by concatenating and filling gaps with GTS data. Other future plans include solving data QC and homogeneity problems related to different observation times and station relocations (lack of metadata); checks of suspicious extremes with radar data and/or weather maps; inclusion of “drought” related indices; transforming the ECA&D system into an operational functionality for WMO Region VI and making further connections to the KNMI Climate Explorer at <http://climexp.knmi.nl> (by Geert Jan van Oldenborgh), which already includes a long list of all kinds of indices.

Albert Klein-Tank then talked about related activities in the EU-project ENSEMBLES. In the ENSEMBLES project, the daily station database of ECA&D is being extended and improved, to include data from other projects such as STARDEX, EMULATE, GHCND, GSN, MAP, as well as many more national series (KNMI, MeteoSwiss). A daily gridded dataset (1960-2000) has been produced for Europe at 25x25 km² resolution using spatiotemporal stochastic simulation. ENSEMBLES now plans to (i) evaluate its gridded dataset, in particular for the representation of extremes, to study changes in the occurrence of extremes in the gridded dataset using core indices and more advanced techniques (e.g. using spatial pooling of GEV parameters), and (ii) to study relations with modes of natural variability.

Albert Klein-Tank asked the ET to consider including some additional indices from the ECA&D list in the core set (e.g. drought related indices), as well coordinating an extension of the high resolution daily gridded dataset (developed for Europe in ENSEMBLES) to other regions.

4.4 ETCCDI Interactions with TGICA and WGCM

David Karoly talked about possible interactions between the ET, the IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA) and the WCRP JSC/CLIVAR Working Group on Coupled Modelling (WGCM). The mandate of the TGICA is to facilitate wide availability of climate change related data and scenarios to enable research and sharing of information across the three IPCC working groups. It coordinates the IPCC Data Distribution Centre (DDC), located at the Max-Planck Institute, which provides data sets, climate and other scenarios, and other materials. TGICA is interested in facilitating access to the IPCC model run data archived at PCMDI through the DDC, and will also provide the software for data analysis. TGICA also identifies information needs in support of IPCC work, facilitates research on climate impacts, adaptation, and mitigation, and makes related recommendations on cross-cutting issues. Regarding capacity building in the use of data and scenarios for climate-related research, TGICA contributes by providing training and opportunities in developing and transition-economy regions and countries.

TGICA would like to make available regional averages of extremes indices from the PCMDI WCRP archive of control 20C3M and future simulations, probably in the Giorgi regions, together with observed index data for the same regions. This would be a very useful output from ETCCDI to IPCC and TGICA. TGICA would also like input on impact-relevant variables and indices to be calculated and archived from new climate model runs being planned for the next generation of climate and earth system simulations. ET members decided that a discussion on the suggested variables and indices to be made available from the new climate model runs should be included in the planned review paper on indices (see item 5.2).

ACTION: Provide TGICA with indices from model-based data averaged over the Giorgi areas (David Karoly)

WGCM reviews and fosters the development of coupled climate models, including organisation of model intercomparisons and utilisation of available instrumental records and paleo-climatic data for model validation and diagnosis of shortcomings. It also promotes co-ordinated experimentation with coupled

models aiming to understand natural climate variability on decadal to centennial time scales and its predictability, and to predict the response of the climate system to changes in natural and anthropogenic forcing. WGCM has planned and coordinated the coupled model simulations and WCRP data archive at PCMDI as part of CMIP3 for the IPCC AR4. These experiments have calculated annual values for 10 Frich extremes indices from a number of models for control, 20C3M and future simulations. WGCM has asked input from the ET on two issues:

- the value and uses of the current model data archive, and suggestions on archiving the same or additional variables, including extremes indices; and,
- the PCMDI archive includes much daily data but it does not include daily Tmin, Tmax and precipitation for all control runs or all 20C3M simulations, as they only requested daily data in 30 year blocks. Should it?

A discussion followed and the participants considered these requests of input from TGICA and WGCM. It was agreed to make suggestions for the modelling centres to archive the daily data of Tmin, Ymax, precipitation for the next runs. Panel members also noted that there is also a need for discussing the techniques used to compare model-based with in-situ indices, and the need for archiving hourly data, although some previous experience shows that the volume of data can be overwhelming.

ACTION: Provide indices advice to WGCM (David Karoly, Phil Jones, Xuebin Zhang, Francis Zwiers, Nico Caltabiano)

4.5 Contribution to coming CCSP report on extremes

Francis Zwiers reported on the activities organized by the US Climate Change Science Program (CCSP) for the production of the Synthesis and Assessment Product (SAP) 3.3 on “Weather and Climate Extremes in a Change Climate”. CCSP produced a very detailed schedule to meet the publication deadline on 28th February 2008. Francis Zwiers said that CCSP would welcome contributions from the ET. SAP 3.3 has four chapters: 1. Why Weather and Climate Extremes Matter; 2. Observed Changes of Weather and Climate Extremes; 3. Do We Understand the Causes of Observed Changes in Extremes and What are the Projected Future Changes; and, 4. Recommendations for Improving Our Understanding.

Francis Zwiers and Gabriele Hegerl, in addition to Tom Peterson, are contributors to some of these chapters and could bring ET recommendations to CCSP.

5. ET INDICES AND APPLICATIONS

5.1 Regional workshop planning

Tom Peterson gave an overview presentation on the Regional Climate Change Workshops. The ET series of workshops consisted of five workshops: Southern Africa, Southern South America, Southwest Asia, Central America and Northern South America, and South-Central Asia. All these workshops produced peer-reviewed papers and contributed to a global indices analyses article based on available daily data and indices calculated at the workshops. All these papers were published in time to contribute to IPCC AR4.

These activities need a careful planning and a post-workshop follow-up if concrete results are to be achieved. They were mainly funded by U.S. State Department, WCRP(CLIVAR), START, WCDMP (CCI), NOAA and IAI, and highly recognised as very successful activities which should be continued. However there is a need to identify new funding, and new workshops need to have clear justification. They would certainly serve as inspiration for continued data rescue and digitization but would also make a great contribution to adaptation and disaster mitigation. CCI has received specific requests to have workshops that focus on data homogeneity. To support the case for funding, it would be a good strategy to produce a brochure that highlights the importance of the workshops. It could expand on the existing CLIVAR folders.

ACTION: Draft a brochure to support the case for workshop funding and circulate to panel for comments and review (Tom Peterson, Omar Baddour, Nico Caltabiano)

Omar Baddour noted that since capacity building is a key WMO priority, it would be a good strategy to take advantage of planned data management workshops organised by CCI. One workshop is already funded in the

African francophone region, and there is a possibility that two ET experts could be invited. The panel appreciated this opportunity and suggested that there is a need for 4-5 days to be dedicated to homogenization/indices activities.

ACTION: Investigate the possibility to have a joint data management and indices/homogenization workshop, funded by CCI (Omar Baddour)

The participants had a lively discussion on the need and planning of future workshops. An ultimate capacity building goal for the workshops is to have members of the countries attending the workshops to contribute to IPCC AR5 as chapter authors. David Karoly pointed that during the 8th International Conference on Southern Hemisphere Meteorology and Oceanography, held in Foz do Iguacu (Brazil), and organized by the American Meteorological Society, several papers on studies of extremes were presented, mainly done by researchers from universities that continued work initiated at the workshops. This exemplifies how successful the workshops were.

A question that was asked was whether, if multiple workshops are planned, if they would have a similar theme, or whether each one would have a theme that would suit a regional need. The panel debated this issue and concluded that if some participants from previous workshops are encouraged to attend any future activities, this would be a good strategy since the workshops could be focused on issues that were not addressed during earlier ones. However, it was suggested that for participants to attend any future workshops, it would be mandatory to bring datasets and make them publicly available.

RECOMMENDATION: It be mandatory that datasets brought to the workshops by participants are made publicly available.

5.2 Review paper on indices and their applications

Xuebin Zhang led a discussion on the need to write a review paper on the indices proposed by the ET. A desirable index is one easy to compute, and to update, easy to understand and physically meaningful. It also has to have a high signal-to-noise ratio for climate change detection and its impact needs to be relevant. The ET has defined 27 indices previously, which are a sub-set from early indices and are relevant for regional and global analyses. Another thing to take into consideration when proposing new indices is whether they hold a definition already used by other groups/programmes. One example is in the STARDEX indices. Some STARDEX indices have the same name as ET indices but with different meaning, which certainly causes confusion. In view of this, it was suggested that it would be opportune to start a discussion on an intercomparison between indices calculated by different groups. The panel agreed to follow Xuebin Zhang's suggestion on the review of indices.

ACTION: Start discussion on an intercomparison between indices calculated by different groups (Albert Klein-Tank to lead)

One issue noted is that the ET should not rename indices and should keep their definition and a suggestion made that perhaps the ET could define a short number (~10) of indices. It was also suggested that the review should take into account indices covering different time scales. A paper reviewing these indices should be drafted and submitted to a peer-reviewed journal. This paper should refer to 1997 Asheville meeting and papers in Climatic Change 1999 (Neville Nichols, Chris Folland, Kevin Trenberth). It would also be a "blue" book, reviewing extremes indices that are already offered to the community.

ACTION: Start discussion by email on the review of ET indices (Phil Jones, David Karoly, Xuebin Zhang)

ACTION: Draft a review paper and circulate to panel for comments (Xuebin Zhang)

The panel also suggested that following the publication of the review paper on indices, a guidelines document on best practices for detection and calculation of indices should be produced. This would serve as a mechanism to inform national meteorological services of availability of software and subsequent updates, besides marketing the ET software and indices as a tool for disaster prevention and mitigation. It should be published in all WMO languages and distributed to national meteorological services.

ACTION: Produce a guidance document on the calculation and use of indices for distribution to national meteorological services (Albert Klein-Tank, Francis Zwiers, Omar Baddour)

5.3 ET website plans

The ET has two dedicated websites: one sits on the CLIVAR website, mainly used for coordination of activities and publication of panel meeting reports, and it is maintained by Nico Caltabiano. The second one sits on the Environment Canada Climate Research Branch website, and it is the source of all the software developed by the ET and global indices. The website is maintained by Xuebin Zhang who presented the actual structure of the website and plans for further development. The website has a new look developed recently and is easy to maintain. It provides easy access to data, global indices and software, this last one being updated regularly. It also has summaries of the workshops and links to their papers/reports. Data made available through the website are the workshop indices, North American indices and other regional indices.

The panel discussed all the modifications and made some suggestions that could be included in the plans for further developments. One of the suggestions would be to investigate the feasibility of using the ECA&D interface for publishing the indices. There is also a need for regular update of indices and the panel discussed the possibility of using data from the Global Telecommunication System (GTS). Albert Klein-Tank mentioned that there is a feasibility study underway in Europe and some advice should be sought from there.

ACTION: Investigate the feasibility of using the ECA&D interface for publishing the indices and implement if feasible (Xuebin Zhang)

ACTION: Seek more details and advice from the European feasibility study on updating of indices using data on GTS, and report back to the ET (Albert Klein-Tank, Phil Jones)

There was a strong suggestion to publish model simulated indices with a short definition on how the indices were computed, and possibly also derivable from daily model output. David Karoly offered to provide links to the model output data portals. It would also be interesting to have indices from gridded observations, like HadEX, published for comparison.

ACTION: Publish model simulated indices and links to the model output data portals (Xuebin Zhang, Albert Klein-Tank, David Karoly)

ACTION: Publish indices from gridded observations (Xuebin Zhang, David Karoly)

Following the earlier discussions on marine indices, a further development for the ET website could be the inclusion of some ocean surface indices which are found appropriate by JCOMM representatives in the panel. Some examples include humidity and sea surface temperature among others. Also, Arctic and Antarctic sea-ice extent, which are available and updated monthly at the Hadley Centre.

ACTION: Publish ocean surface indices indicated by JCOMM representatives (Xuebin Zhang, Chris Folland)

Lucie Vincent raised the point that there are several parallel activities regarding indices running in parallel and users can get confused with different websites publishing similar indices. Perhaps it would be a good idea to place a list of these efforts with a brief description of each on the CLIVAR's ET website. The panel agreed with this proposal and asked each member to contribute to this task.

ACTION: Prepare a list of indices websites with a brief description of each and place on CLIVAR's ET webpage (Expert Team, Nico Caltabiano)

6. EXPERT TEAM SOFTWARE

6.1 Climate Data Homogenisation – new methods/algorithms and software

Xiaolan Wang gave a presentation on some statistical methods for detecting change in climate data series that she has developed with colleagues, in addition to the development and future plans for the RHtest

software. The RHTest software package is used for data homogenisation, and is able to detect (and adjust for) multiple step-change points that could exist in a time series. The planned updates to the package include the addition of a function to automatically incorporate dates of documented changes (metadata), as well as addition of new model/algorithm options.

Xuebin Zhang reminded the ET that the RHTest Package was not used in the regional workshops but there are plans to include it in any workshops that the ET organises in the future. The main problem is that the documentation of the RHTest package is in only written in English, and should be translated to other languages.

The panel discussed a suggestion that a very useful activity would be to present classic examples of homogeneity problems, perhaps using the ET website. These examples should show some cases which appeared during the workshops, besides regional examples from, for instance, Canada, Europe, United Kingdom, USA.

ACTION: Prepare a way to present classic examples of homogeneity problems using data from the workshops, besides other regional examples (Lucie Vincent, Xiaolan Wang, Tom Peterson, Lisa Alexander)

Lucie Vincent informed the panel that Environment Canada runs a series of workshops on homogenisation, targeted to the operational climatology community. They work by revisiting homogenised datasets using updated homogenisation methods, with the ultimate goal of creating a homogeneous North American dataset. The panel recognised the importance of these workshops and recommend that all members should look for existence of similar activities in other countries.

It was also noted by the panel that an assessment of need for a detailed homogenisation of extreme indices should be made, possibly using the dense European network.

ACTION: Initiate an assessment of need for a detailed homogenisation of extreme indices (Xiaolan Wang, Lucie Vincent, Xuebin Zhang, Albert Klein-Tank, Francis Zwiers, Blair Trewin, Gabriele Hegerl)

6.2 R-based indices software

One of the reasons for the success of the regional workshops organised by the previous ET was the development and use of a user-friendly software package written in R language, with a user guide written in English and Spanish. Xuebin Zhang gave an overview of the packages used in the workshops and the future development plans. The choice of R language is because it is a powerful computing environment for statistical analysis, freely available and portable across all platforms (Unix, MS-Windows, MacOS), without need to make any change. The two main packages developed in R-language are RClimDex and RHTest.

The RClimDex package provides a friendly graphical user interface to compute all 27 core indices defined by the ET. It also conducts simple quality control on the input daily data. The RHTest package, as presented by Xiaolan Wang, is based on a two-phase regression and runs with a GUI and command line. Other new methods are already being implemented. These two packages have also been developed with FORTRAN codes (FClimDex and FHtest), and have been cross-checked with R codes. RHTest and FHtest are updated regularly. RClimDex was tailored for the workshops at short notice and needs more detailed documentation, and should also be written in other languages. It can certainly be developed further, with addition of new indices depending on demand, however this further development is dependent of funding availability.

The panel appreciated Xuebin Zhang's effort in the development of the these packages and noted his suggestions in develop versions of the manual in other languages. Omar Baddour offered to check with WMO translation services if this is possible to be done there.

ACTION: Check feasibility of translation of the software manual to other languages by WMO Translations Services (Omar Baddour)

7. ETCCDI WORKPLAN

At the end of the meeting, participants discussed at length a workplan for the next three years, which would guide the ET progress during this period. All the discussions during the presentations and subsequent action items will be included as part of the workplan. In addition, other issues highlighted during these discussions are listed below.

7.1 Heat stress index

It seems that now the community is ready to provide this index as there is more confidence in humidity data, in addition to some detection results. There are, however, some requirements that should be followed. It should be applicable across a range of climates, be acceptable to the WMO, and give a high signal-to-noise ratio. Several methods have been developed including the UK Ministry of Defence method and the Canadian “humidex”. The US has standard methods as well. An intercomparison of some of the available indices would be appropriate.

ACTION: Inter-compare available indices and advise on how to calculate a simple index based on Q and T (Phil Jones, Lucie Vincent, Chris Folland, David Karoly)

Chris Folland pointed out that he is reasonably hopeful that humidity and heat stress datasets will be developed by the Hadley Centre during the life of this ET. The panel agreed that it would be useful to publish a surface humidity index when the humidity dataset is available.

ACTION: Publish index of precipitable water based on satellite data (Chris Folland)

ACTION: Publish surface humidity index (Phil Jones and Blair Trewin)

7.2 Drought index

The panel discussed the publication of global drought indices. A potential difficulty is availability of global soil type data. There are several other programmes and monitoring centres focusing on droughts. US CLIVAR has established a working group on drought, co-chaired by Siegfried Schubert (NASA/GSFC) and Dave Gutzler (Univ. New Mexico). In North America, there is a North American drought monitor and several global drought monitoring centres. GEWEX has a Worldwide Integrated Study of Extremes (WISE) working group, chaired by Ron Stewart. The panel agreed that it is very important to establish contact with these groups and form collaborations with them. It is also important to note that WCRP has extremes as one of its cross-cutting topics and the ET should be aware of any activities proposed by WCRP on this issue.

ACTION: Establish contact with GEWEX/WISE group and US CLIVAR WG on droughts (Albert Klein Tank, Francis Zwiers, David Karoly)

The panel has also decided that one activity for the group could be to publish global drought index based on self-calibrating PDSI calculated from HadCRU gridded T, P, Q, and cloud cover.

ACTION: Publish global drought index based on self-calibrating PDSI calculated from HadCRU gridded T, P, Q, and cloud cover (Phil Jones, Albert Klein Tank, Xuebin Zhang, Tom Peterson, Blair Trewin)

7.3 Dow Jones-like “pain” index

The panel discussed the possibility of developing a Greenhouse Gases climate response index, e.g. some standardized combination of SST, humidity and air temperature. A similar index has been developed which had a somewhat different combination (summer drought, winter rainfall). Chris Folland noted that UK DEFRA would certainly like to have such an index available. However, this index would have to be tailored regionally.

ACTION: Explore possibilities in developing a Greenhouse Gases climate response index (David Karoly, Xuebin Zhang, Tom Peterson, Chris Folland)

7.4 Quality of precipitation data

The panel discussed the issue of quality of precipitation data and if a recommendation on coverage required, QC, recent apparent drop off, world weather record volume should be made. Phil Jones noted that there is a paper on resolution of precipitation data required for homogenization (Auer et al., Int. Journal of Climate., 2005). The panel decided that this issue should be raised to NCDC, CCI, Meteorological Services and WMO.

ACTON: Circulate to panel a draft a letter to be sent to NCDC, CCI, Met Services (Xuebin Zhang, Phil Jones)

ACTON: Include quality of precipitation data issue in the report to the WMO congress (Omar Baddour)

8. DATE OF NEXT MEETING

The panel appreciates that there are severe budget issues from the sponsors but feels that it is necessary to hold another meeting in about 18 months in order to keep the momentum and to help with workshops organisation and evaluation. The ET co-chair Albert Klein-Tank offered to host the next meeting at KNMI (The Netherlands). Dates are still to be confirmed but likely to be Northern Hemisphere Spring-Summer 2008.

APPENDIX A

Second CCI/CLIVAR/JCOMM ETCCDI meeting Niagara-on-the-Lake, Canada 14-16 Nov 2006

AGENDA

Day 1: Tuesday 14 November 2006

08:30 – 09:00 Welcome

09:00 – 09:15 Introduction and review of agenda (co-chairs)

The ET sponsors perspective/contribution

09:15 – 09:30 CCI

09:30 – 09:45 CLIVAR

09:45 – 10:00 JCOMM (Val Swail/Scott Woodruff)

10:00 – 10:30 What can a small group of ET volunteers accomplish? (Tom Peterson)

10:30 – 11:00 Coffee Break

11:00 – 11:30 The ET role in IPCC (Phil Jones)

11:30 – 12:00 Review of worldwide indices work (Chris Folland)

12:00 – 12:30 Discussion

12:30 – 13:30 Lunch

13:30 – 14:00 Surface marine data sets (Liz Kent)

14:00 – 14:30 New subsurface ocean datasets and indices (Matthew Palmer)

14:30 – 14:50 OOPC's State of the Ocean (Nico Caltabiano)

14:50 – 15:30 Discussion on ocean related indices

15:30 – 16:00 Coffee Break

16:00 – 16:30 Global indices (David Karoly)

16:30 – 17:00 Data homogenization (Xiaolan Wang)

17:00 – 17:30 Discussion

Day 2: Wednesday 15 November 2006

08:30 – 09:00 Report on the WOAP-2 meeting and links to the ET (Liz Kent)

09:00 – 09:30 Links to APN project (Blair Trewin)

09:30 – 10:00 Links to ECA&D project (Albert Klein Tank)

10:00 – 10:30 Discussion how the ET may benefit from these links

10:30 – 11:00 Coffee Break

11:00 – 11:30 Application of indices to climate model output (Claudia Tebaldi)

11:30 – 12:00 Discussion on suitable indices for climate model evaluation

12:00 – 12:30 Links with TGICA on extremes indices (David Karoly)

12:30 – 13:30 Lunch

13:30 – 14:00 Detection of external influence in precipitation data (Francis Zwiers)
14:00 – 14:30 Discussion on how further developed
14:30 – 15:00 Basic set of common indices and ET website plans (Xuebin Zhang)
15:00 – 15:30 Discussion

15:30 – 16:00 Coffee Break

16:00 – 17:30 Introduction to the ET-work plan for next ~3 years

Day 3: Thursday 16 November 2006

08:30 – 09:00 Regional workshop planning (Tom Peterson)
09:00 – 09:30 Discussion on how to update regional results on regular basis
09:30 – 10:00 R-based indices software (Xuebin Zhang)
10:00 – 10:30 Discussion on further software developments

10:30 – 11:00 Coffee Break

11:00 – 11:30 Review paper on indices and their applications (Xuebin Zhang)
11:30 – 12:00 Contribution to coming CCSP report on extremes (Francis Zwiers)
12:00 – 12:30 Finalizing the ET workplan for next ~3 years

12:30 – 13:30 Lunch

13:30 – 14:00 Any other business
14:00 – 14.30 Need for future meetings
14:30 – 15:00 Action review, end of meeting

APPENDIX B

LIST OF ATTENDEES

<p>BADDOUR, Omar World Climate Data and Monitoring Program World Climate Programme (WCP) World Meteorological Organization 7 bis, avenue de la Paix CH-1211 Geneve 2, Switzerland Obaddour@wmo.int</p>	<p>CALTABIANO, Antonio International CLIVAR Project Office National Oceanography Centre, Southampton European Way, Southampton, UK SO14 3ZH caetano@noc.soton.ac.uk</p>
<p>FOLLAND, Chris Met Office, Hadley Centre Fitzroy Rd, Exeter, Devon, UK EX1 3PB chris.folland@metoffice.gov.uk</p>	<p>JONES, Phil Climatic Research Unit School of Environmental Sciences University of East Anglia Norwich, UK, NR4 7TJ p.jones@uea.ac.uk</p>
<p>KAROLY, David School of Meteorology National Weather Center University of Oklahoma 120 David L. Boren Blvd Norman, OK, USA 73072-7307 dkaroly@ou.edu</p>	<p>KENT, Elizabeth Ocean Observing and Climate National Oceanography Centre, Southampton European Way, Southampton, UK SO14 3ZH eck@noc.soton.ac.uk</p>
<p>KLEIN-TANK, Albert KNMI, Climate Services Division PO Box 201 NL-3730 AE De Bilt Netherlands Albert.Klein.Tank@knmi.nl</p>	<p>PALMER, Matthew Met Office, Hadley Centre Fitzroy Rd, Exeter, Devon, UK EX1 3PB matthew.palmer@metoffice.gov.uk</p>
<p>PETERSON, Tom NOAA's National Climatic Data Center 151 Patton Avenue Asheville, NC 28801, USA Thomas.C.Peterson@noaa.gov</p>	<p>SWAIL, Val Climate Research Division Environment Canada 4905 Dufferin Street Downsview, Ontario, Canada, M3H 5T4 Val.Swail@ec.gc.ca</p>
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ZWIERS, Francis Climate Research Division Environment Canada 4905 Dufferin Street <i>Downsview</i> , Toronto, Ontario, M3H 5T4 francis.zwiers@ec.gc.ca	
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APPENDIX C**PANEL MEMBERS**

NAME	AFFILIATION	REPRESENTATION
Francis Zwiers (co-chair)	Climate Research Division, Canada	CLIVAR
Albert Klein-Tank (co-chair)	KNMI, The Netherlands	CCI
Phil Jones	University East Anglia, Norwich, UK	CLIVAR
David Karoly	University of Oklahoma, Norman, USA	CLIVAR
Gabriele Hegerl	Duke University, USA	CLIVAR
Blair Trewin	Bureau of Meteorology, Australia	CCI
Xuebin Zhang	Climate Research Division, Canada	CCI
Chris Folland	Hadley Centre, UK	JCOMM
Elizabeth Ken	National Oceanography Centre, Southampton, UK	JCOMM
Val Swail	Climate Research Division, Canada	JCOMM
Scott Woodruff	NOAA, USA	JCOMM

APPENDIX D

POSSIBLE STRATEGY FOR DEVELOPING A GCOS/GEO CLIMATIC INDICES WEB SITE

Chris Folland, Hadley Centre, Met Office, U.K., with particular thanks to Nathan Bindoff of the 2001-5 Expert Team, and to Rob Allan, Hadley Centre.

The discussion below arose initially from an initiative by the AOPC in June 2002 to invite me to consider this topic. In addition, the 2001-2005 WMO CLIVAR/CCI Expert Team on Climate Change Detection, Monitoring and Indices appointed me to lead a subgroup on indices. The following is a synthesis of discussions in that team, discussions with colleagues and interactions on ocean indices with oceanographers involved with the CLIVAR Global Synthesis and Observations Panel, coordinated through Katy Hill of Southampton Oceanography Centre. I have also referred to some recent developments.

I have also consulted the paper "Where to look for anthropogenic changes in the ocean" by H. Banks and R. Wood, *J. Climate*, 15, 879-891, 2002. The ideas below are preliminary and need to be updated in the light of the latest science and e.g. the development of new sub surface ocean data sets like HadGOA, and wider discussions.

Some possible motivations for producing a set of climate indices and keeping them updated in quasi-real time, accessible via a well publicised web site, can include:

1. Climate monitoring in near real time (would help IPCC).
2. Climate Change Detection and Attribution (would help IPCC).
3. Seasonal to decadal prediction.
4. Detecting abrupt climate change (would help IPCC).

I have assumed all these goals are relevant but with some emphasis on 1. and 2. It is not currently clear how best to develop the indices idea through the Expert Team,. IPCC use many climate indices of course; their choice results from debates not only about the science but also about the quality of different data sets. Since this initiative was started, the Hadley Centre has developed a new externally available climate data web site, www.hadobs.org. Although quite comprehensive about the data sets, and often allowing downloading of data, this site has few indices at present. However a number of the type mentioned below could be placed on the site fairly soon or developed in the next couple of years or so, and periodically updated. Such indices would be based in part on the now quite numerous Hadley Centre data sets described by www.hadobs.org. As resources allow, many of indices could be developed to have uncertainties attached to them. The choice of indices would reflect the four types described above. A significant constraint is the limited effort available and indeed the need to make hardware enhancements if this site is to continue to function properly, not an easy task in current circumstances. This site, like others, could be linked in some way to a central GCOS/GEO site to create a centrally linked set of indices originating in different places. An alternative is that the ETCCD web site becomes the Indices Web Site and is regularly maintained, and this activity is made clear in GCOS/GEO links.

Consultation with colleagues also suggests the following desirable characteristics of an indices web site:

1. The indices should be primarily based on observed data. However this may include reanalyses where it is judged the science allows this (such as some aspects of ERA-40 from 1979 or perhaps the ENACT subsurface data set). So these could be atmospheric or oceanic reanalyses.
2. The indices wherever possible should have estimates of uncertainty attached to them.
3. The indices, with uncertainties, should be based on more than one recognised data set where possible. The method of presentation of such indices needs discussion and is beyond the scope of this note.
4. Given an emphasis on Climate Change Detection or even the time scales of seasonal to decadal prediction, selected model predictions of such indices could be usefully displayed side by side with the observed counterparts.

The web sites, or centrally coordinated site, should be updated at the minimum seasonally, though some indices may have only annual resolution. The web sites should also contain full details of how the indices and their uncertainties are calculated, including references to published papers.

The following list is purely for debate but has emerged as a potentially useful set.

A. Atmospheric and sea surface indices

1. Land Surface Air Temperature – Global, NH, SH anomaly (relative to 1961-90) time series 1850-date.

These indices would be updated monthly, seasonally and annually. There are several land surface air temperature data sets that merit inclusion. Uncertainties should be shown where known. The graphs of say annual temperature values should include superimposed low frequency curves e.g. as done in IPCC. The reference period is that currently used by IPCC. There should be a debate about whether this should be retained.

2. Sea surface temperature - Global, NH, SH anomaly (relative to 1961-90) time series 1850-date and an index of the Atlantic Multidecadal Oscillation (e.g. North Atlantic mean sea surface temperature).

Ideally these time series would be compared to simultaneous plots of night marine air temperature anomalies. The new ICOADS analysis published by the Hadley Centre allows an 1850 start. Update seasonally. The graphs should include superimposed low frequency curves.

3a. Surface Temperature (land surface air temperature and sea surface temperature) Global, NH, SH anomaly and NH minus SH (relative to 1961-90) time series 1850-date. Update seasonally. The graphs should include superimposed low frequency curves

3b. Spatial coloured maps of recent worldwide surface temperature anomalies (relative to 1961-90) & percentiles (monthly, seasonal and annual).

Additional maps showing the 1961-90 percentile that the local temperature anomaly corresponds to would be very useful

3c. Time series of global NMAT, SST and land surface air temperature on one graph as in IPCC, updated annually. Smoothed about decadal, and unsmoothed.

NB. Global and hemispheric paleoclimate temperature indices should be discussed. At present there is considerable controversy about all such indices. It might be useful to combine the palaeorecord with the observed global temperature record and with predictions for about the next 100 years, much as in the IPCC Third Assessment Report Synthesis Report. Watch the way the IPCC 4th Assessment Report deals with this.

4. Time series and maps of trends in diurnal range of the maximum, minimum and mean temperature, annually and possibly seasonally

5a. Time series of NINO3, 4 and 3.4 and the Southern Oscillation index.

These would be processed and smoothed according to the best advice in the literature. Probably necessary to use optimally interpolated SST data to get good early NINOx indices. Update seasonally and have a longer term average carried through the plots to highlight 'protracted' ENSO episodes.

Note that there is a practical debate between nations is going on about NINO SST indices led by CCI. An emerging issue is whether climate warming should be subtracted and how this should be done.

5b. Time series (and maps showing fixed patterns) of indices of low frequency ocean phenomena related to ENSO: the Pacific Decadal Oscillation and the Interdecadal Pacific Oscillation.

These also have some practical interest in agriculture, hydrology or fisheries.

6. Sea-Ice extent – Arctic & Antarctic time series (annual & latest season or month).

Consider whether a few regional sea ice extent series are important or whether time series of sea ice extent measured at particular times of the year are needed. Sea ice extent data are not very homogeneous so expert advice will be needed on which data to use initially. The HadISST data are being used in the IPCC 4AR as one resource.

7a. Precipitation – a. Worldwide maps of anomalies and percentiles for each month perhaps, but certainly seasonally and annually. The best way of doing this needs debating. Can the land and ocean be shown together?

7b. Time series and map of key regions of precipitation anomalies, updated seasonally

Regions should have long time series showing percentage of average rainfall, ideally using 1961-90 climatological period, but a later period may be preferred for practical reasons. The Climate Diagnostics Bulletin has pioneered this kind of analysis and their output should be studied as a starting point. This raises the point that NCEP should be key advisers; the GCOS/GEO web site should be linked to this site: http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/

8a. North Atlantic Oscillation (NAO), Arctic Oscillation (AO) – winter (Dec-Feb) and winter half year (Oct-Mar) only, including NAO forecasts where available.

Perhaps include time series of a representation the related tripole SST pattern in the North Atlantic

Include maps of fixed basic spatial patterns of each phenomenon for information.

8b. Other atmospheric circulation Indices such as the Pacific North American (PNA) pattern and its southern counterpart the PSA pattern; the Southern Annular mode (or Antarctic Oscillation) and perhaps the Antarctic Circumpolar Wave.

Some of these phenomena suffer at the moment from inadequate published long time series.

9. North Atlantic Hurricane index or indices. There are several indices that describe different aspects of hurricane activity such as the Accumulated Cyclone Energy (ACE) index.

This will need consultation with hurricane experts and this is a controversial area.

10. Lower Tropospheric and Lower Stratospheric temperature time series and zonal-average trends in temperatures aloft. The data would come from radiosondes and satellite-borne microwave sounding units.

Though some recent progress is evident, vertical profiles of trends in temperature remain an area of intense debate because of data issues and some apparent disagreements between observed trends in some of these data and model simulations. So they may not be a top priority initially.

11. Snow Cover – Northern hemisphere. Annual and latest season.

12. Tropopause Height – Time series for extratropical NH, extratropical SH & Tropics.

Needs expert advice but this is a climate change detection variable. Probably only possible to create from reanalyses.

13. 200 hPa Velocity Potential – Global (Latest seasonal mean & anomaly).

This puts a number of the rainfall anomalies in context. The NCEP web site currently has arguably a good analysis but would ERA-40 give a similar result?

14. Global sea surface (or near sea surface) salinity.

Possibly for the future; global warming models predict a long term fall. ARGO data will help much here.

15. Global sea surface height updated annually.

This is another important long term variable. The error bars are likely to be very important. Based on the TOPEX/POSEIDON and JASON altimeter and possibly other satellites, mixed with the sea-level gauge data. Can be extended back in time to the 1950s and possibly to the early 1900s. Which analyses should be used?

16. Extremes. Although they cannot be updated frequently, the web site should contain indices or global maps of changing surface climate extremes.

B. Subsurface ocean indices

This needs much debate. A special subgroup should be set up of oceanographic and climate experts. The OOPC will probably need to be involved. The data from such indices can come from special sets of measurements (“sections”) or from analysed three dimensional data sets which can be purely observational or involve reanalyses. Thus the Hadley Centre is developing a new observation-only subsurface data base of temperature and salinity, HadGOA, and new reanalysed data bases are now becoming available like ENACT. The Banks and Woods paper is also a useful guide to the kinds of indices that may be useful.

A key quantity is:

17. Subsurface indices of annual oceanic heat content in about the upper 300m of the ocean (or other depth divisions), for the NH, SH, individual oceans and World Ocean. It is possible to show time series from the 1950s, based on analyses that combine the ARGO array, XBT networks and other subsurface temperature data. Such an index was used successfully in the 3rd IPCC Assessment.

The following ideas are speculative. In order that the indices are meaningful, rigorous error estimates would be needed and some ability to detect real variations shown before using:

18. Zonal average of storage terms in density layers, updated annually: temperature, salinity, sea-level height, thickness.

19. Zonal averages of water mass changes in depth layers, updated annually: temperature, salinity. This is a different perspective from (18), being based on depth layers. Here it is suggested that key water masses such as the “mode” waters - Subantarctic Mode Water (SAMW), North Pacific Mode Water (NPMW), and the Mediterranean Water (MW) - are tracked and their characteristics of temperature, salinity, and volume monitored. Banks and Wood and earlier papers recommend Indian Ocean sector SAMW salinity to be assessed at 32S. The HadGOA data set is designed to do this in principle.

20. Zonal and regional stratification indices of the surface mixed layer on an annual basis. We may not be able to achieve global indices, but basin-wide and spatial maps should be feasible now.

Ocean indices that are relatively hard to construct (but perhaps more relevant to local and global questions):

21..Regional forms of zonal ocean indices described above.

22. Regional sub-surface ocean indices linked to common climate phenomena that have been established to have important climatic impacts on nations, such as the Indian Ocean Dipole (controversial), the Aleutian Dipole, the North Atlantic SST tripole linked to the North Atlantic Oscillation. Recent seasonal forecasting

monitoring work in the Hadley Centre shows the latter can now be done successfully monthly with ARGO float input in at least the top 100m.

23. Monitoring the salinity of key water masses that are expected to become saltier or fresher, particularly on density surfaces, possibly using zonal averages in different oceans and all available density surfaces:

- a. Arctic and Atlantic: generally saltier with warming
- b. Southern Ocean generally saltier with warming
- c. Pacific generally fresher with warming

24. Indices of the thermohaline overturning circulation (streamfunction) e.g. from east-west density differences across the Atlantic basin at various latitudes and depths. This is relevant to “abrupt” climate change as well as climate change detection.

Many other oceanographic indices can be imagined which may become important as data bases expand/improve to support them.

APPENDIX E

REPORTS PUBLISHED IN THE WORLD CLIMATE DATA PROGRAMME (WCDP)/

WORLD CLIMATE DATA AND MONITORING PROGRAMME (WCDMP) SERIES

- WCDP-1 WMO REGION III/IV TRAINING SEMINAR ON CLIMATE DATA MANAGEMENT AND USER SERVICES, Barbados, 22-26 September 1986 and Panama, 29 September 3 October 1986 (available in English and Spanish) - (WMO-TD No. 227)
- WCDP-2 REPORT OF THE INTERNATIONAL PLANNING MEETING ON CLIMATE SYSTEM MONITORING, Washington DC, USA, 14-18 December 1987 - (WMO-TD No. 246)
- WCDP-3 GUIDELINES ON THE QUALITY CONTROL OF DATA FROM THE WORLD RADIOMETRIC NETWORK, Leningrad 1987 (prepared by the World Radiation Data Centre, Voeikov Main Geophysical Observatory) - (WMO-TD No. 258)
- WCDP-4 INPUT FORMAT GUIDELINES FOR WORLD RADIOMETRIC NETWORK DATA, Leningrad 1987 (prepared by the World Radiation Data Centre, Voeikov Main Geophysical Observatory) - (WMO-TD No. 253. p. 35)
- WCDP-5 INFOCLIMA CATALOGUE OF CLIMATE SYSTEM DATA SETS, 1989 edition (WMO-TD No. 293)
- WCDP-6 CLICOM PROJECT (Climate Data Management System), April 1989 (updated issue of WCP-1 1 9) - (WMO-TD No. 299)
- WCDP-7 STATISTICS ON REGIONAL NETWORKS OF CLIMATOLOGICAL STATIONS (based on the INFOCLIMA World Inventory). VOLUME II: WMO REGION I - AFRICA (WMO-TD No. 305)
- WCDP-8 INFOCLIMA CATALOGUE OF CLIMATE SYSTEM DATA SETS - HYDROLOGICAL DATA EXTRACT, April 1989 - (WMO-TD No. 343)
- WCDP-9 REPORT OF MEETING OF CLICOM EXPERTS, Paris, 11-15 September 1989 (available in English and French) - (WMO-TD No. 342)
- WCDP-10 CALCULATION OF MONTHLY AND ANNUAL 30-YEAR STANDARD NORMALS, March 1989 (prepared by a meeting of experts, Washington DC, USA) - (WMO-TD No. 341)
- WCDP-11 REPORT OF THE EXPERT GROUP ON GLOBAL BASELINE DATASETS, Asheville, USA, 22-26 January 1990 - (WMO-TD No. 359)
- WCDP-12 REPORT OF THE MEETING ON HISTORICAL ARCHIVAL SURVEY FOR CLIMATE HISTORY, Paris, 21-22 February 1990 - (WMO-TD No. 372)
- WCDP-13 REPORT OF THE MEETING OF EXPERTS ON CLIMATE CHANGE DETECTION PROJECT, Niagara-on-the-Lake, Canada, 26-30 November 1990 - (WMO-TD No. 418)

Note: Following the change of the name of the World Climate Data Programme (WCDP) to World Climate Data and Monitoring Programme (WCDMP) by the Eleventh WMO Congress (May 1991), the subsequent reports in this series will be published as WCDMP reports, the numbering being continued from No. 13 (the last 'WCDP' report).

- WCDMP-14 REPORT OF THE CCI WORKING GROUP ON CLIMATE CHANGE DETECTION, Geneva, 21-25 October 1991
- WCDMP-15 REPORT OF THE CCI EXPERTS MEETING ON CLIMATE CODE ADAPTATION, Geneva, 5-6 November 1991 - (WMO-TD No. 468)
- WCDMP-16 REPORT OF THE CCI EXPERTS MEETING ON TRACKING AND TRANSMISSION OF CLIMATE SYSTEM MONITORING INFORMATION, Geneva, 7-8 November 1991 - (WMO-TD No. 465)
- WCDMP-17 REPORT OF THE FIRST SESSION OF THE ADVISORY COMMITTEE ON CLIMATE APPLICATIONS AND DATA (ACCAD), Geneva, 19-20 November 1991 (also appears as WCASP-18) - (WMO-TD No. 475)
- WCDMP-18 CCI WORKING GROUP ON CLIMATE DATA, Geneva, 11-15 November 1991 (WMO-TD No. 488)
- WCDMP-19 REPORT OF THE SECOND CLICOM EXPERTS MEETING, Washington DC, 18-22 May 1992 - (WMO-TD No. 511)
- WCDMP-20 REPORT ON THE INFORMAL PLANNING MEETING ON STATISTICAL PROCEDURES FOR CLIMATE CHANGE DETECTION, Toronto, 25 June, 1992 (WMO-TD No. 498)
- WCDMP-21 FINAL REPORT OF THE CCI WORKING GROUP ON CLIMATE DATA AND ITS RAPPORTEURS, November 1992 - (WMO-TD No. 523)
- WCDMP-22 REPORT OF THE SECOND SESSION OF THE ADVISORY COMMITTEE ON CLIMATE APPLICATIONS AND DATA (ACCAD), Geneva, 16-17 November 1992 (also appears as WCASP-22) - (WMO-TD No. 529)
- WCDMP-23 REPORT OF THE EXPERTS MEETING ON REFERENCE CLIMATOLOGICAL STATIONS (RCS) AND NATIONAL CLIMATE DATA CATALOGUES (NCC), Offenbach am Main, Germany, 25-27 August 1992 - (WMO-TD No. 535)
- WCDMP-24 REPORT OF THE TENTH SESSION OF THE ADVISORY WORKING GROUP OF THE COMMISSION FOR CLIMATOLOGY, Geneva, 20-22 September 1995 (also appears as WCASP-34) - (WMO-TD No. 711)
- WCDMP-25 REPORT OF THE FIFTH SESSION OF THE ADVISORY COMMITTEE ON CLIMATE APPLICATIONS AND DATA (ACCAD), Geneva, 26 September 1995 (also appears as WCASP-35) - (WMO-TD No. 712)
- WCDMP-26 REPORT ON THE STATUS OF THE ARCHIVAL CLIMATE HISTORY SURVEY (ARCHISS) PROJECT, October 1996 (prepared by Mr M. Baker) - (WMO-TD No. 776)
- WCDMP-27 SUMMARY REPORT OF THE MEETING OF THE THIRD SESSION OF THE CCI WORKING GROUP ON CLIMATE CHANGE DETECTION, Geneva, 26 February - 1 March 1996 - (WMO-TD No. 818)

- WCDMP-28 SUMMARY NOTES AND RECOMMENDATIONS FOR CCI-XII FROM MEETINGS CONVENED TO PREPARE FOR PUBLISHING THE FIFTH AND SIXTH GLOBAL CLIMATE SYSTEM REVIEWS AND FOR A PUBLICATION ON THE CLIMATE OF THE 20TH CENTURY, July 1997 - (WMO-TD No. 830)
- WCDMP-29 CLIMATE CHANGE DETECTION REPORT - REPORTS FOR CCI-XII FROM RAPORTEURS THAT RELATE TO CLIMATE CHANGE DETECTION, July 1997 (WMO-TD No. 831)
- WCDMP-30 SUMMARY NOTES AND RECOMMENDATIONS ASSEMBLED FOR CCI-XII FROM RECENT ACTIVITIES CONCERNING CLIMATE DATA MANAGEMENT, July 1997 (WMO-TD No. 832)
- WCDMP-31 REPORTS FOR CCI-XII FROM RAPORTEURS THAT RELATE TO CLIMATE DATA MANAGEMENT, July 1997 - (WMO-TD No. 833)
- WCDMP-32 PROGRESS REPORTS TO CCI ON STATISTICAL METHODS, July 1997 (prepared by Mr Christian-Dietrich Schönwiese) (WMO-TD No 834)
- WCDMP-33 MEETING OF THE CCI WORKING GROUP ON CLIMATE DATA, Geneva, 30 January - 3 February 1995 - (WMO-TD No. 841)
- WCDMP-34 EXPERT MEETING TO REVIEW AND ASSESS THE ORACLE-BASED PROTOTYPE FOR FUTURE CLIMATE DATABASE MANAGEMENT SYSTEM (CDBMS), Toulouse, France, 12-16 May 1997 - (WMO-TD No. 902)
- WCDMP-35 REPORT OF THE ELEVENTH SESSION OF THE ADVISORY WORKING GROUP OF THE COMMISSION FOR CLIMATOLOGY, Mauritius, 9-14 February 1998 (also appears as WCASP-47) - (WMO-TD No. 895)
- WCDMP-36 REPORT OF THE MEETING OF THE CCI TASK TEAM ON CLIMATE ASPECTS OF RESOLUTION 40, Geneva, Switzerland, 10-11 June 1998 - (WMO-TD No. 925)
- WCDMP-37 REPORT OF THE MEETING OF THE JOINT CCI/CLIVAR TASK GROUP ON CLIMATE INDICES, Bracknell, UK, 2-4 September 1998 - (WMO-TD No. 930)
- WCDMP-38 REPORT OF THE MEETING OF THE WMO COMMISSION FOR CLIMATOLOGY (CCI) TASK GROUP ON A FUTURE WMO CLIMATE DATABASE MANAGEMENT SYSTEM (CDMS), Ostrava, Czech Republic, 10-13 November 1998 and FOLLOW-UP WORKSHOP TO THE WMO CCI TASK GROUP MEETING ON A FUTURE WMO CDMS, Toulouse, France, 30 March-1 April 1999 - (WMO-TD No. 932)
- WCDMP-39 REPORT OF THE MEETING OF THE CCI WORKING GROUP ON CLIMATE DATA, Geneva, Switzerland, 30 November-4 December 1998 - (WMO-TD No. 970)
- WCDMP-40 REPORT OF THE MEETING ON CLIMATE STATISTICS, PRODUCT DEVELOPMENT AND DATA EXCHANGE FOCUSING ON CLICOM 3.1, Geneva, 25-29 January 1999 - (WMO-TD No. 971)
- WCDMP-41 PROCEEDINGS OF THE SECOND SEMINAR FOR HOMOGENIZATION OF SURFACE CLIMATOLOGICAL DATA, Budapest, Hungary, 9-13 November 1998 (WMO-TD No. 962)
- WCDMP-42 REPORT OF THE MEETING OF EXPERTS ON THE CLIMATE OF THE 20TH CENTURY, Geneva, 26-30 April 1999 - (WMO-TD No. 972)

- WCDMP-43 REPORT OF THE TRAINING SEMINAR ON CLIMATE DATA MANAGEMENT FOCUSING ON CLICOM/CLIPS DEVELOPMENT AND EVALUATION, Niamey, Niger, 03 May-10 July 1999, (WMO-TD No. 973)
- WCDMP-44 REPRESENTATIVENESS, DATA GAPS AND UNCERTAINTIES IN CLIMATE OBSERVATIONS, Invited Scientific Lecture given by Chris Folland to the WMO Thirteenth Congress, Geneva, 21 May 1999 - (WMO-TD No. 977)
- WCDMP-45 WORLD CLIMATE PROGRAMME - WATER, DETECTING TREND AND OTHER CHANGES IN HYDROLOGICAL DATA, Zbigniew W. Kundzewicz and Alice Robson (Editors) - (WMO-TD No. 1013)
- WCDMP-46 MEETING OF THE WMO CCI TASK GROUP ON FUTURE WMO CLIMATE DATABASE MANAGEMENT SYSTEMS (CDMSs), Geneva, 3-5 May 2000 (WMO-TD No. 1025)
- WCDMP-47 REPORT ON THE ACTIVITIES OF THE WORKING GROUP ON CLIMATE CHANGE DETECTION AND RELATED RAPPORTEURS, 1998-2001 (May 2001, updated from March 2001) (WMO-TD No. 1071)
- WCDMP-48 REPORT OF THE FIRST SESSION OF THE MANAGEMENT GROUP OF THE COMMISSION FOR CLIMATOLOGY (Berlin, Germany, 5-8 March 2002) (also appears as WCASP-55) (WMO-TD No. 1110)
- WCDMP-49 1. REPORT ON THE CLICOM-DARE WORKSHOP (San José, Costa Rica, 17-28 July 2000); 2. REPORT OF THE INTERNATIONAL DATA RESCUE MEETING (Geneva, 11-13 September 2001) (WMO-TD No. 1128)
- WCDMP-50 REPORT OF THE CLIMATE DATABASE MANAGEMENT SYSTEMS EVALUATION WORKSHOP (Geneva, 11-13 September 2001) (WMO-TD No. 1130)
- WCDMP-51 SUMMARY REPORT OF THE EXPERT MEETING FOR THE PREPARATION OF THE SEVENTH GLOBAL CLIMATE SYSTEM REVIEW (7GCSR) (Geneva, 16-19 September 2002) (WMO-TD No. 1131)
- WCDMP-52 GUIDELINES ON CLIMATE OBSERVATION NETWORKS AND SYSTEMS (WMO-TD No. 1185)
- WCDMP-53 GUIDELINES ON CLIMATE METADATA AND HOMOGENIZATION (WMO-TD No. 1186)
- WCDMP-54 REPORT OF THE CCI/CLIVAR EXPERT TEAM ON CLIMATE CHANGE DETECTION, MONITORING AND INDICES (ETCCDMI) (Norwich, UK, 24-26 November 2003) (WMO-TD No. 1205)
- WCDMP-55 GUIDELINES ON CLIMATE DATA RESCUE (WMO-TD No. 1210)
- WCDMP-56 FOURTH SEMINAR FOR HOMOGENIZATION AND QUALITY CONTROL IN CLIMATOLOGICAL DATABASES (Budapest, Hungary, 6-10 October 2003) (WMO-TD No. 1236)
- WCDMP-57 REPORT OF THE RA V DATA MANAGEMENT WORKSHOP (Melbourne, Australia, 28 November-3 December 2004) (WMO-TD No. 1263)
- WCDMP-58 GUIDELINES ON CLIMATE WATCHES (WMO-TD No. 1269)

- WCDMP-59 REPORT OF THE MEETING OF THE RA I WORKING GROUP ON CLIMATE MATTERS (Dakar, Senegal, 22 – 24 February 2006) (WMO-TD No. 1351)
- WCDMP-60 GUIDELINES ON CLIMATE DATA MANAGEMENT (WMO-TD No. 1376)
- WCDMP-61 THE ROLE OF CLIMATOLOGICAL NORMALS IN A CHANGING CLIMATE (WMO-TD No. 1377)
- WCDMP-62 GUIDELINES FOR MANAGING CHANGES IN CLIMATE OBSERVATION PROGRAMMES (WMO-TD No. 1378)
- WCDMP-63 RA VI TRAINING SEMINAR ON CAPACITY BUILDING IN CLIMATE-RELATED MATTERS (Yerevan, Armenia, 2 – 5 October 2006) (WMO-TD No. 1386)
- WCDMP-64 JOINT CCL/CLIVAR/JCOMM EXPERT TEAM ON CLIMATE CHANGE DETECTION AND INDICES (Niagara-on-the-Lake, Canada, 14 - 16 November 2006) (WMO-TD No. 1402)