



**Joint CCI/WCRP-Clivar/JCOMM Expert Team
on Climate Change Detection and Indices
(ETCCDI)**

**Report of sub-group ad hoc meeting
10-12 March 2014, Egmond aan Zee, The Netherlands**

March 2014

Key outcome of the Meeting

At the kind invitation of KNMI, the Joint CCI/WCRP-Clivar/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI) organized an ad-hoc meeting of a subgroup of the team in Egmond aan Zee, the Netherlands, 10-12 March 2014. It discussed in a comprehensive way past achievements and new challenges and opportunities for ETCCDI. The meeting agreed on proposing a new (expanded) role for the ETCCDI reflecting the influence of the high level agendas of the sponsors, including the WCRP Grand Challenge on climate extremes, the need to support WMO's Global Framework for Climate Services (GFCS) agenda, and the need for a more focused approach to marine aspects and the development of related indices. Accordingly, the meeting developed new Terms of Reference (T.o.R) and a work plan to be proposed for the next CCI intersession period (2014-2018) after endorsement by the decision-making bodies of the other two co-sponsors WCRP and JCOMM. The new proposed T.o.R and work plan are attached to this report (Annex)



Albert Klein Tank, Xuebin Zhang, Xiaolan Wang, Francis Zwiers, Blair Trewin, Scott Woodruff, Omar Baddour, Jana Sillmann

Opening

Xuebin Zhang and Albert Klein Tank, the ETCCDI co-chairs welcomed the participants, an ad hoc subgroup of the team and a few additional experts from KNMI and CICERO who provided advice to the ETCCDI participants. They described the expected outcomes of the meeting including the review of ETCCDI achievements and the development of new T.o.R and a workplan for the ET in the next intersession period 2014-2018 of the WMO Commission for Climatology (CCI). The input of this meeting will feed into the discussions during the next CCI session (CCI-16) to be held in Heidelberg, Germany, 3-8 July 2014. The floor was open for introduction of the participants and then for adoption of the agenda.

WMO/CCI perspective

Omar Baddour provided updates on the preparation of CCI sixteenth session (CCI-16) which will take place in Heidelberg, Germany 3-8 July 2014 and its preceding Technical Conference (TECO) taking place at the same venue 30 June – 2 July 2014 which includes a joint session with WCRP. CCI-Management Group recommended in October 2013 a new working structure for the next intersession period to be decided upon by CCI-16. He informed participants of other relevant meetings, including the upcoming WMO Executive Council (EC-66) in June. This is the last EC session before the next 17th session of the WMO Congress which will take place in

2015. He briefly informed on the outcome of the first meeting of Intergovernmental Board on Climate Services (IBCS-1) which took place in June 2013 – IBCS is the main GFCS decision making body which reports to WMO Congress, and the preparation for the upcoming IBCS-2 scheduled in November 2014. Other events relevant to ETCCDI include the international workshop on the recovery of climate heritage in the Indian Ocean rim countries and Islands, Maputo, Mozambique, 21-24 April 2014 and the proposed CIIFEN-WMO workshop on marine indices which is being discussed with Rodney Martinez (from CIIFEN) who co-chairs CCI/OPACE-4.

WCRP/Clivar perspective

Xuebin Zhang presented recent developments related to the WCRP Grand Challenge on climate extremes. The WCRP JSC in consultations with sponsors and other stakeholders and a network of scientists identified several Grand Challenges that represent major areas of scientific research, modeling, analysis and observations for WCRP in the coming decade. The WCRP Grand challenges include: 1) Clouds, Circulation and Climate Sensitivity, 2) Changes in Cryosphere, 3) Climate Extremes, 4) Regional Climate Information, 5) Regional Sea level rise and 6) Water Availability. They are meant to be highly specific, and focused on identifying critical areas of climate science that have the potential of achieving significant progress over 5-10 years. WCRP promotes these Grand Challenges through various mechanisms including workshops, conferences and other meetings.

The meeting agreed that, as ETCCDI plays a significant role in linking climate science (WCRP) to climate services through CCI and JCOMM, the ETCCDI should actively contribute to this WCRP Grand Challenge and that its new T.o.R should reflect this need.

JCOMM perspective

Xiaolan Wang and Scott Woodruff provided a JCOMM perspective on the ETCCDI. Key JCOMM activities that are relevant to the ETCCDI include the work of the ET on Waves and Coastal Hazards Forecasting Systems (ETWCH) and its Coordinated Ocean Wave Climate Projections (COWCLIP) project, the ET on Marine Climatology (ETMC) which has a strong potential for liaising with CCI on datasets through the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) and the activities that the ET undertakes on recovering past marine records. There is also a potential for direct extensions to the existing ETCCDI indices work, based on ICOADS datasets as a direct contribution to previously adopted tasks in 2011. The meeting noted the need for continuous interaction and coordination between land and ocean data management and data rescue. Land surface and marine/ocean data are managed and archived very differently, and it was noted that the ETCCDI offers a good intersection point between JCOMM and CCI that can be explored for improving the harmonization of data management in the two domains.

Current ETCCDI plan and progress

Albert Klein Tank informed on the current ETCCDI plan and the progress made so far since the fourth session in 2011. Good progress was made in workshop activities around the world, including covering more geographical areas (see also the item on regional workshops), producing global datasets of indices based on observations (see also item on the CLIMDEX project) and on the development and assessment of indices from global climate models (see also the item on global model based indices). A review paper on indices for monitoring changes in extremes based on daily temperature and precipitation data has been published, as well as papers on model indices and the development of a database of model indices. In order to secure regular indices updates on a regional basis, progress has been made in implementing the ICA&D system, which is an extension of ECA&D in Europe, to other sub-regions such as West Africa, South-East Asia and Southern America.

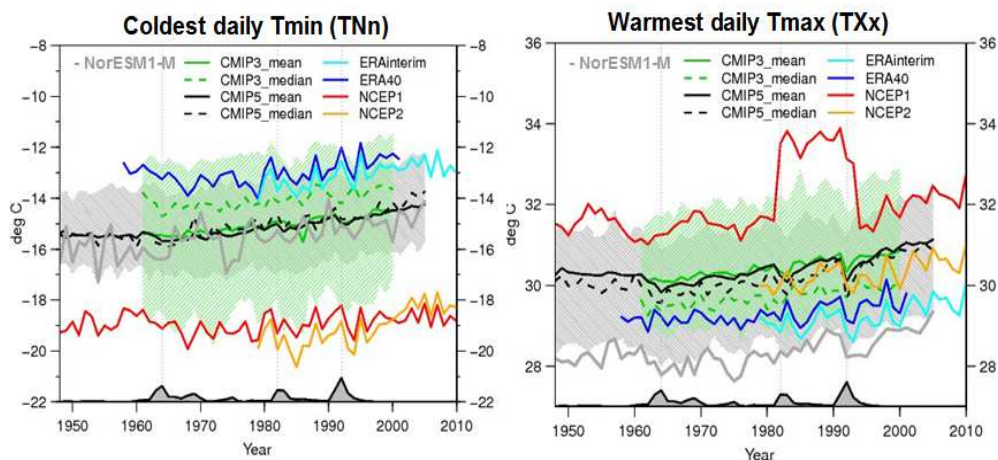
The meeting noted the importance of ETCCDI activities as evidenced by the ETCCDI indices related materials being assessed in multiple chapters of the IPCC AR5 WGI report and as expressed at various meetings and conferences. There is also an increasing number of requests for ETCCDI documents and expressions of interest in its workshops.

Some tasks however have not yet been undertaken. In particular, a JCOMM white paper on marine indices has not yet been started. Nevertheless, discussion within the JCOMM community has laid a foundation for the development of marine indices, especially those related to coastal hazards.

Global Model based indices

Jana Sillmann, invited expert from Center for International Climate and Environment Research in Oslo, Norway, gave a presentation on the comparison of observation and model output based indices. She showed results from a global comparison between indices from reanalyses and CMIP3/CMIP5 model simulations, with a conclusion that model and reanalysis performance depends on the index considered. Differences between reanalyses can be as large as intermodel spread, which raises the issue of whether reanalyses can be used for model evaluation. The meeting recognized that there is a need for coordination of indices calculated from observations (i.e. HadEX2, GHCNDEX) and models to address the scale issue, since models do not always simulate extremes on the same scale as that on which they are observed. Also, it was recognized that there is a need to maintain and further improve the related software code to ensure that it incorporates the capability to calculate additional indices and that it operates efficiently with model output. Jana led the calculation of model based indices which are now freely available from a publically accessible website (<http://www.cccma.ec.gc.ca/data/climdex/>).

The meeting further recognized the need for improving the model-based ETCCDI indices archive, which is currently FTP based, and for improved user interfaces, download procedures and user manuals. It also noted the need for revising some indices definitions and introduction of new indices.



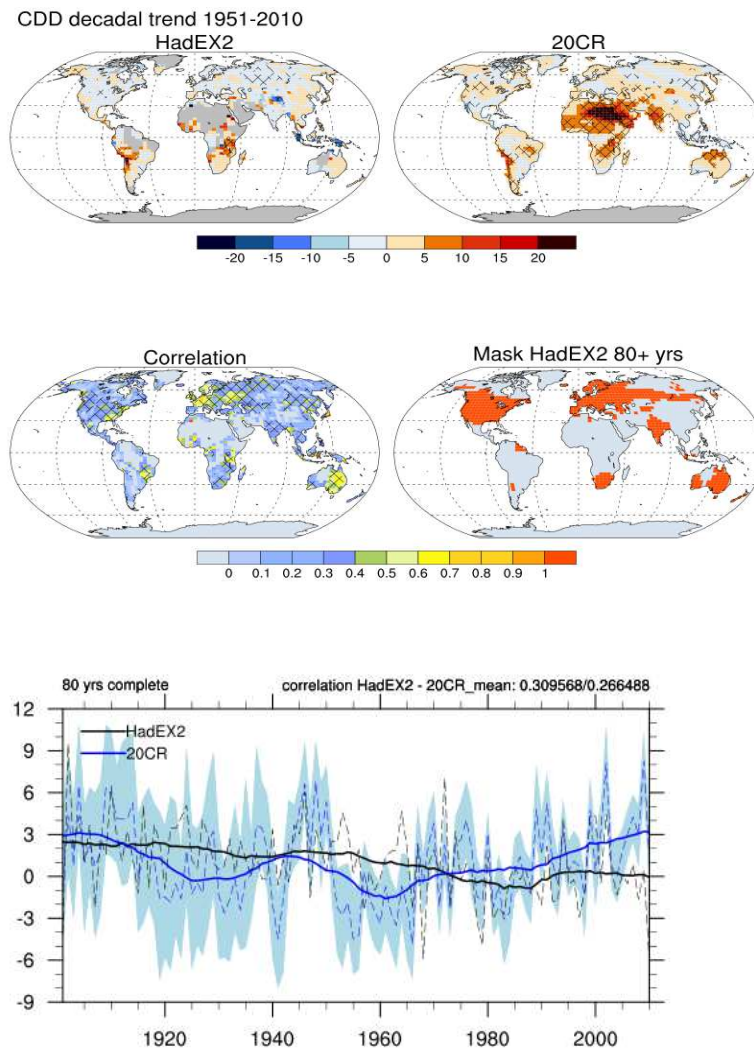
From Sillmann et al. (2013)*: Global spatial means of temperature indices over land from 1948 to 2005 of the ensemble mean (solid) and median (dashed) of 31 CMIP5 (black) and 18 CMIP3 (green) models. Shading indicates the interquartile model spread (range between the 25th and 75th quantiles). Also shown are the reanalysis ERA40 (blue) from 1958 to 2001, ERA-Interim (cyan) and NCEP2 (orange) from 1979 to 2010, and NCEP1 (red) from 1948 to 2005. Grey shading along the horizontal x-axis indicates the evolution of globally averaged volcanic forcing according to Sato et al. [1993].

*Sillmann, J., V. V. Kharin, X. Zhang, F. W. Zwiers, and D. Bronaugh (2013), Climate extremes index in the CMIP5 multimodel ensemble: Part 1. Model evaluation in the present climate, *J. Geophys. Res. Atmos.*, 118, 1716–1733, doi:10.1002/jgrd.50203

CLIMDEX project

A presentation on the CLIMDEX project (www.climdex.org) was made by Xuebin Zhang on behalf of Lisa Alexander, who has developed several observationally based indices datasets at the University of New South Wales. The purpose of this project is to improve observed indices availability and accessibility, traceability in near real time. CLIMDEX data sets include HadEX2, GHCNDEX and HadGHCNDEX (temperature only). The meeting noted the broad agreement between HadEX2 and GHCNDEX for assessing trends in total precipitation and the comparison with 20CR data sets is reasonably good but dependent on index. Current and future plans focus on improving station coverage in particular in South America and Africa, through possible additional workshops or regional ICA&D implementations, assessment of uncertainties and

addressing scaling issues, development of daily gridded precipitation datasets as well as linking with GEWEX and the ET-CRSCI on extremes. The meeting noted the substantial contribution of the CLIMDEX project to the ETCCDI activities by collecting data from different sources, and by producing gridded global indices data.



Trends (days/decade) in consecutive dry days (CDD) for HadEX2 (top left) and the 56-member ensemble mean of the 20th Century Reanalysis (20CR; top right). (Bottom left) Correlations between HadEX2 and the ensemble mean 20CR and (bottom right) HadEX2 data mask where more 80% of years have data. Time series show annual average CDD for HadEX2 (black dashed line) and 20CR ensemble mean (blue dashed line). Solid lines are 21-year Gaussian smoothed data for HadEX2 (black) and 20CR (blue). Blue shading represents the spread of the 56 20CR ensemble members. [source Markus Donat]

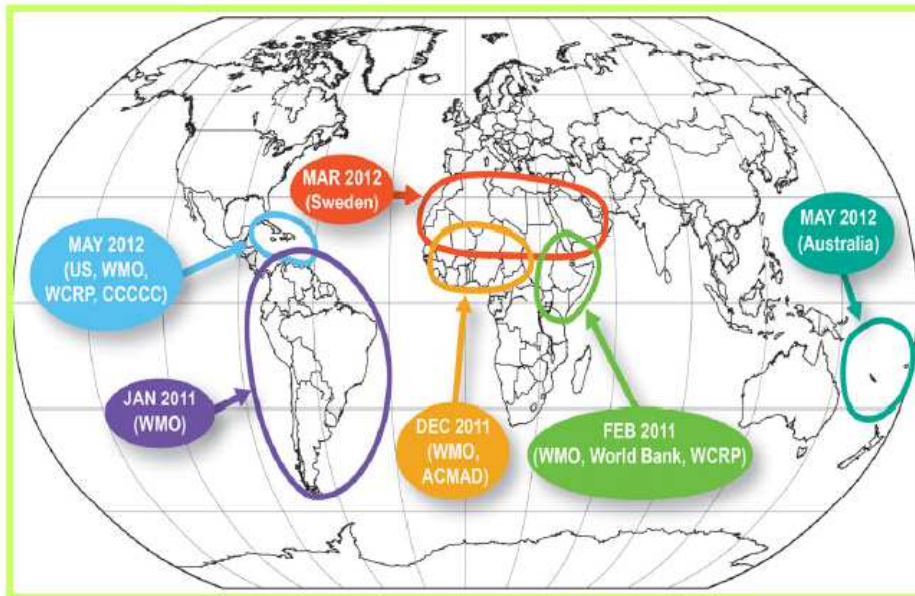
Regional workshops update

Albert Klein Tank described workshop activities during the period 2011-2013; a total of 6 ETCCDI workshops were carried out during 2011-2012 (see diagram), two additional workshops were organized in 2013 and 2 more are expected in 2014. The WMO Guidelines on the analysis of extremes in a changing climate in support of informed decisions for adaptation, by Albert Klein Tank, Francis Zwiers, and Xuebin Zhang 2009, has been widely recognized as a key publication which supports regional activities as well as being increasingly demanded by other international climate related organizations.

There has been a strong linkage between CCI Data Rescue and ETCCDI activities. This linkage prompted the efforts for expanding the European Climate Assessment and Data (ECA&D) initiative to other regions. A newly born International Climate Assessment and Data initiative (ICA&D) is currently benefiting from the technical and coordination support of the KNMI and is

being implemented in other regions. This has already been achieved in parts of South Asia, Latin America, and West Africa. The meeting recognized the importance of the ICA&D approach for organizing and coordinating access to data via a standardized user interface to facilitate post workshop analysis while carefully respecting national and regional data dissemination constraints. The meeting also recognized the potential of this approach to contribute to regular indices updates by developing capacity in the region, and develop more service oriented Data Rescue activities worldwide. However it was noted that there is still more to do to ensure that ICA&D becomes an operational platform for enhancing the availability of data and indices. The meeting recognized the importance of Regional Climate Centres and other existing or potential regional groups in supporting ICA&D for the computation of indices, their updates and exchange internationally. The meeting agreed on the importance of providing guidance to these centres to carry out climate indices activities on routine basis.

ETCCDI Regional Workshops 2011 - 2012

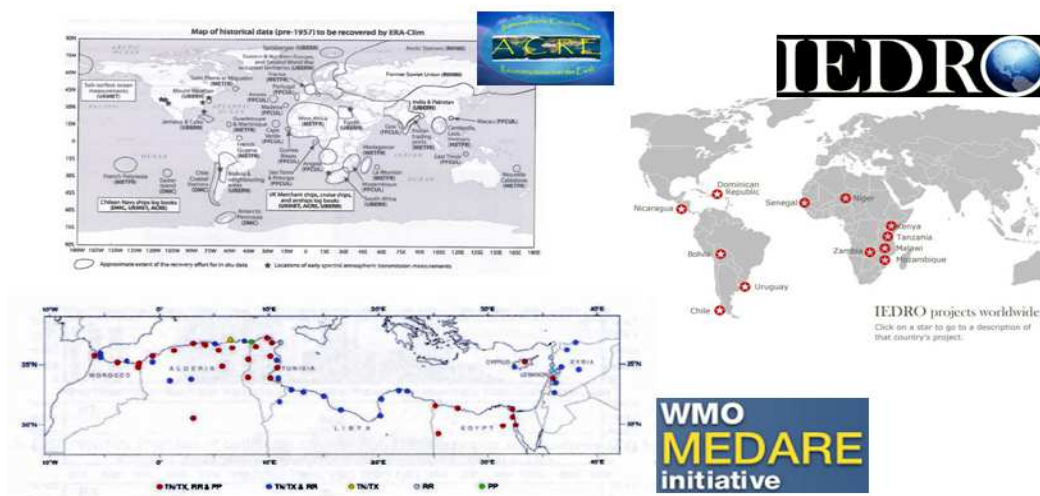


ETCCDI workshops which were organized in 2011-2012 in various regions with dates and funding source indicated

Link to TT-DARE

Aryan Van Engelen from KNMI, who was invited to the meeting as co-chair of the CCI Task Team on Data Rescue (TT-DARE), informed on the linkage that has been established between ETCCDI and TT-DARE. He highlighted that there are still large volumes of daily data that have not yet been digitized and therefore remain under-exploited for climate services development and by the research community. Successful ETCCDI/DARE workshops followed by implementing an ECA&D style website for sharing knowledge and data demonstrate the strong benefit of linking DARE and ETCCDI activities. For example, DARE workshops held for South East Asia in partnership with BMKG have produced such an outcome, which in turn led to increased Data Rescue activities and availability of data and indices in the regions where these workshops have been implemented.

The meeting was also informed on the TT-DARE follow-up to the CCI decision in 2005 that called for the creation of a specialized portal that links users with NMHS websites hosting data rescue activities. CCI TT-DARE is therefore currently developing, in partnership with ACRE, IEDRO and ICA&D, a project to establish an international Data Rescue Portal, I-DARE, to respond to this CCI decision as well as to the emerging needs of the GFCS. The International ASEAN SACA&D Conference and Workshop (Indonesia, Bogor, 20-23 May 2014) which was announced at the meeting will address the linkage between Data Rescue activities and the generation of climate services in the ASEAN area using the analysis of climate indices.



Overview of regions where the DARE communities that will participate in establishing the I-DARE Portal are active. Top left ERACLIM-ACRE, top right IEDRO and down left MEDARE-ECA&D

Links to TT-DEWCE




Blair Trewin informed the meeting on the activities of the CCI Task Team on the Definition of Extreme Weather and Climate Events (TT-DEWCE), which focuses on expanding definitions of events from a single observation at a single point to include events over time and space boundaries, sometimes called compound events. Using these expanded definitions, the TT seeks to establish a more comprehensive structure for reporting of extreme events in near real time and to establish an international database for extreme events and their impacts.

Some indices were proposed by TT-DEWCE as a basis for common reporting including; the number of days per month with Tmax above the 90th percentile (Tmin below 10th percentile), the number of days per month with precipitation above 95th percentile and the Standardized Precipitation Index (SPI) for past 12 months. The TT is still looking at resolving some questions such as characterizing multi-day heat and cold waves, and is carrying out a survey of definitions currently in operational use or in the scientific literature. The use of RCLimdex (with minor modifications that would be coordinated with the ETCCDI) is also being considered by the TT-DEWCE as likely to be the easiest option for index calculation.

Links to ET-CRSCI

On behalf of Lisa Alexander who leads the CCI Expert Team on Climate Risk and Sector specific Climate Indices (ET-CRSCI), Albert Klein Tank briefed on the activities to develop tools to generate sector specific indices and promote the use of these indices in sector applications. In pursuing this, the ET has a mandate to work with sector-based agencies and experts. The ET has developed 34 core indices and a software package called ClimPACT, which is largely based on RCLimDex. Amongst other plans, the ET will work on updating the ClimPACT software based on sector feedback from pilot workshops, coordinated with the ETCCDI to ensure consistency with RCLimDex, conduct analysis of case studies in South America and Australia and include other variables (humidity, wind, monsoon onset/cessation dates, etc). The ET will also work on an implementation strategy to be recommended for the NMHS and sector experts.

Examples of ET-CRSCI sector-relevant indices

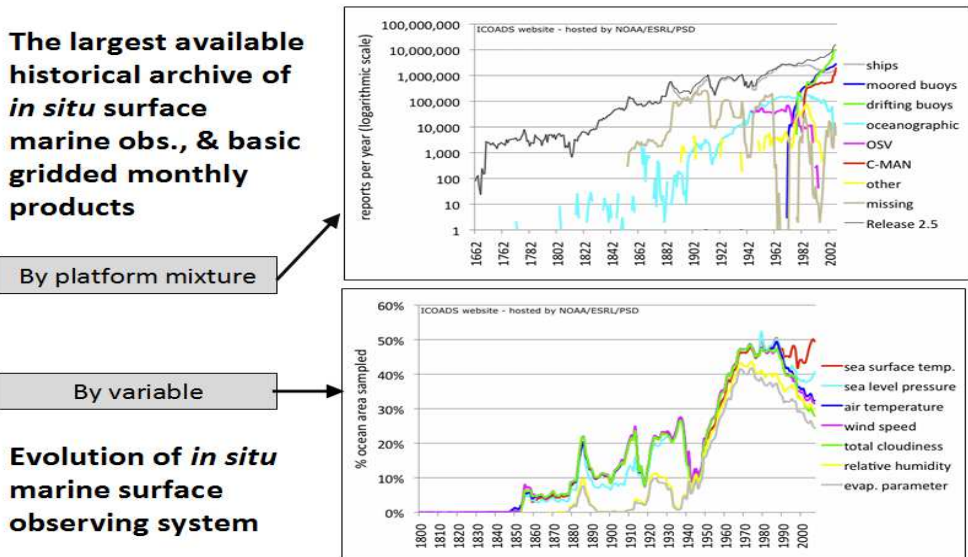
<p>Health</p>  <p>2 (or more) consecutive hot days followed by 2 (or more) consecutive hot nights</p> <p>Count of days where TX (daily maximum temperature) > X°C</p> <p>Count of days in a span of at least Z days where TX > 90th percentile</p>	<p>Agriculture/Food security</p>  <p>Growing degree days</p> <p>Growing season length</p> <p>Frost days</p>	<p>Water</p>  <p>Standardised precipitation index</p> <p>Monthly maximum consecutive <i>n</i>-day rainfall</p> <p>Consecutive dry days</p>
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Examples of indices which can be used in health, agriculture and water

JCOMM indices for coastal regions

Scott Woodruff from CIRES/University of Colorado and NOAA/NCDC reviewed the previously planned actions on marine indices with the recognition that most of these actions are still pending, and new opportunities are arising that may permit some projects on marine indices to be quickly undertaken. For example, ICOADS datasets can be explored for developing some selected indices for coastal marine areas. In particular, improved near real time (monthly) observations from North American coastal areas are planned to become available by 2015. Other upcoming ICOADS improvements by 2015 include the release of a major delayed mode update of ICOADS incorporating many new and improved data sources, including sea surface salinity (SSS) from the World Ocean Database (WOD) and additional coastal observations that have been keyed. Major sources of inhomogeneity in ICOADS data are being addressed to adjust data values. This is being carried out as part of the ICOADS Value-Added Database (IVAD) project.

The meeting noted that NOAA Research budgetary problems impacted ICOADS in late 2011, but that an emerging international partnership with the UK and Germany is helping overcome some of the impacts. The JCOMM CLIMAR-4 workshop, which is taking place in Asheville, USA, 9-12 June 2014, will be a valuable JCOMM opportunity to discuss ETCCDI matters.



Evolution of marine climate reports by platforms (upper panel) and by variables (lower panel)

The meeting recognized the need for completing some of the critical pending tasks that are relevant to marine indices. It further recognized the need for CCI/JCOMM collaboration on Data Management issues, in particular to develop a future integrated Land-Marine Data Management linked appropriately with the JCOMM Marine Climate Data System initiative and the CCI Global Data Management System for Climate, which is currently still in a conceptual phase.

Grand Challenges on Extremes

Xuebin Zhang presented the key questions identified in the current draft of WCRP Grand Challenge white paper on climate extremes. He informed on the white paper and its drafting team composed of Xuebin Zhang, Gabi Hegerl, Sonia Seneviratne, Ronald Stewart and Francis Zwiers. A draft paper was posted on WCRP website and some related activities were indicated; including the GEWEX Science meeting in The Hague, July, and the WCRP summer school on climate extremes in Trieste, July 2014.

Gabi Hegerl joined via Skype and reiterated the need for ETCCDI involvement in the WCRP Grand Challenge activities. She emphasized the need for reviewing the draft paper by the ET members. Discussions pointed to the benefit from interactions with GEWEX on observational datasets on extremes (GHP, GDAP). Other aspects discussed covered model data, scaling issues, etc. The meeting also noted the need to strengthen GEWEX involvement in, and interactions with, the ETCCDI and recommended that the ETCCDI be proposed to coordinate the WCRP Grand Challenge on Climate Extremes.

Summary of agreed actions

1. Concept for marine indices (Xiaolan, Scott et al.)
2. Investigate possibility to make the WIRES indices review paper open access because of wide demand for the paper and limited subscription of the journal by many institutions (Xuebin)
3. Flag with Lisa Alexander and her team on software homogenization and ICA&D (Xuebin, Albert)
4. T.o.R document: a) polish work plan (Xuebin/Albert, done), b) circulate to members for comments (Xuebin/Albert, done), c) need input on marine indices from Kevin and Val (Scott/Xiaolan),
5. Distribute finished TORs and work plan draft to CCI, WCRP (CLIVAR, GEWEX), JCOMM for comments and feedback (Xuebin/Albert), discuss among CCI/WCRP/JCOMM on the expansion of scope of the ETCCDI (Omar)
6. Meeting report (Omar)
7. Inquire regarding permission from presenters for posting their presentations (Xuebin, Albert)
8. Contact Anna to ensure consistency among ETCCDI websites from CCI, CLIVAR, JCOMM (Xuebin, Albert, done)
9. Email to current CCI, CLIVAR members on nomination process (Xuebin, done)
10. Facilitate the liaison between ETCCDI JCOMM members with Rodney Martinez on the workshop on marine indices (Omar)
11. Involve ETCCDI topic in national GFCS consultation meetings (Omar to bring this to GFCS office in Geneva)
12. Reflect in the CCI doc as part of CCI decision making the role of ETCCDI network to accomplish ETCCDI activities in addition to the Core members (Omar)
13. Inform PR/CCI on linking with EC-WG on Data Policy (Xuebin and Albert)

Key issues rose during the meeting

- Grand Challenges, what ETCCDI role should be?
- Data Issues: Making indices available, Data quality, Access to daily data, Data Policy
- Improve coordination of both land and marine data management
- Reanalysis data sometimes are not well suited for comparisons between observations and model-based indices
- Scaling issues and interpretation of ETCCDI indices for gridded data
- Develop Marine Indices suitable for climate services
- How Met services should make better use of the knowledge they gained through ETCCDI workshops, including for improving quality of their data and providing services?
- Online training, liaison with WMO ETR
- What GEWEX should bring to the T.o.R and work plan of ETCCDI in the next 4 years?
- Standardization of Software
- How to ensure regular updates of indices?
- The role of regional centres (both formally established RCCs and other regional groups)
- Do we need one common ETCCDI official web site?
- Continuing ETCCDI and TT-DARE linkage in the next CCI intersession period

Recommendations

- i. Expand the scope of ETCCDI to include the coordination of WCRP Grand Challenge on Climate Extremes activities
- ii. Accelerate the work on Developing suitable and useful marine indices
- iii. Enhance capacity development activities through workshops, guidance to RCC, online training
- iv. Expand the network of experts to help on ETCCDI activities
- v. Have an official ETCCDI common website
- vi. Review indices in collaboration with other relevant ETs/TTs (e.g. ET-CRSCI, TT-DEWCE)
- vii. Recommend a Logo for ETCCDI

ANNEX: ETCCDI T.o.R and provisional work plan 2014-2018

Draft, 25 March 2014

T.o.R

The following text in italic will be used to introduce the proposed terms of reference for inclusion in the CCI document:

“ETCCDI is requested to carry out its work with the support of the Members both directly through its own efforts, by drawing upon the expertise and resources from the broader community, and by stimulating the development of a network of expert”.

Proposed Terms of References:

The ETCCDI will:

1. Coordinate and organize collaboration on climate extremes, indices and climate change detection, including the coordination of WCRP “grand challenge on extremes” activities and contributions to the development of extremes-related climate services in support of the GFCS
2. In conjunction with other relevant organizations, encourage and facilitate the development of national and international datasets to support research and services related to climate extremes, and land and ocean data management and rescue efforts
3. Further develop and publicize internationally agreed indices of global climate variability and change and related methodologies, with additional emphasis on marine climate indices
4. Facilitate the comparison of observations and model output and provide guidance on related data and model output requirements for extremes analysis
5. Liaise with, and carry out relevant joint activities with other appropriate working bodies including those affiliated with CCI, WCRP and JCOMM as well as other relevant regional and international bodies
6. Contribute to capacity-development with consideration of the GFCS requirements, provide relevant guidance to WMO Members, and undertake related projects (e.g. investigating new ways of delivering training)
7. Coordinate relevant regional activities, e.g. the calculation and exchange of indices through regional workshops and, on a routine basis, through regional centres and ICA&D
8. Submit reports in accordance with timetables established by the sponsoring bodies

The following text in italic was agreed to be provided in a relevant document that will be discussed at the 66th session of WMO Executive Council to be held in June 2014:

“ The Council noted with appreciation the work of the joint CCI/WCRP-CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI), which has helped improve understanding and characterization of climate variability and change, and climate services development for the GFCS. The Council urged Members to support the work of the Expert Team by establishing, regularly updating and sharing data sets of relevant climate indices. The Council highlighted the need to develop marine climate extremes indices, and urged CCI, WCRP and JCOMM to closely collaborate on this issue. The Council further emphasized the need for continued regional capacity development for the monitoring of changes in extremes and requested ETCCDI and the Secretariat to organize additional regional workshops and support to the RCCs in this respect.”

The following provisional workplan will be submitted for decision by ETCCDI sponsors: CCI, WCRP and JCOMM

Provisional work plan

The following is a work plan developed during an ETCCDI work planning meeting held in Egmond aan Zee, The Netherlands, March 10-12, 2014. This work plan is intended for discussion and adoption by CCI congress, and by WCRP at the pan-CLIVAR and pan-GEWEX meetings, and by JCOMM. It is envisaged that the ETCCDI will expand its scope to house the coordination of the WCRP Grand Challenge on Extremes in addition to its current charge. This work plan contains two main parts: the first part explains the rationale for the expansion of the current scope of the ETCCDI, the second part describes the recommended work related to climate indices.

PART A: Broadening the scope of the ETCCDI and coordination of the WCRP Grand Challenge on Extremes

The WCRP, as part of its efforts to plan and prioritize climate research over the next decade, has developed a series of Grand Challenges that identify key areas of research with good prospects for advancement over the next 5-10 years. The Grand Challenge on Extremes is particularly important because of the broad cross-cutting nature of the challenge and the pressing need to further develop our understanding of extremes, including improved monitoring and observing capabilities, process understanding and modelling, prediction on multiple timescales, and projection of long-term future change. The ETCCDI has up to now been focused on service objectives that, on the one hand, have contributed to CCI and JCOMM monitoring and capacity development objectives, and on the other hand, have contributed to WCRP objectives through the improvement of extremes datasets and by developing specific approaches for describing and evaluating changes in extremes that have focussed principally on indices based on daily temperature and precipitation data (both observed and simulated). In addition, the team has contributed to the evaluation of extremes in coupled model inter-comparison project (CMIP) experiments and has contributed to work on the detection of changes in extremes and attribution of the causes of those changes.

The adoption of the Grand Challenge on Extremes (GCE) presents both an opportunity and a challenge for the ETCCDI. To succeed, it will be necessary to develop an implementation plan for the GCE and to design and coordinate a series of activities that will engage and help to synchronize the work of the broad range of user and science communities that undertake work on extremes and their impacts. This will include wide consultation across both the user (CCI, JCOMM) and science (WCRP, including CLIVAR and GEWEX) communities and will require the development of clear objectives, timelines and coordinating mechanisms. The GCE white paper lays out the areas in which early progress should be possible and some possible early actions. These build on current initiatives (e.g., detection and attribution of climate extremes, event attribution, decadal prediction and a series of GEWEX activities), and include anticipated advances in observational capability and datasets, improvements in process knowledge and understanding, improved modelling and prediction capabilities, an emerging capability to quantify how human influences are affecting extremes, and the rapid development of event attribution as a focus of research and application.

Tools that will be available to develop and operationalize an implementation plan include a series of early workshops for consultation with the different communities who will contribute to the GCE and a subsequent multi-community conference on extremes that will evaluate early implementation progress. Other coordinating mechanisms that are foreseen include dedicated sessions at major meetings (AGU, EGU, AMS, IUGG, etc), additional summer schools on extremes, support and encouragement for specialized disciplinary meetings (e.g., on topics such as amplifying coupled feedback processes, specific extreme phenomena such as tropical and extratropical cyclones, drought, heat waves, etc., advanced statistical methodology for the analysis of extremes, and so on).

An expanded ETCCDI that builds on its current core activities would be very well placed to take on the dual challenges of developing and implementing a GCE implementation plan. Effective implementation will require continual attention to user needs, as reflected in two of the three ETCCDI parent organizations (CCI and JCOMM) and in the WCRP's objectives to support the Global Framework for Climate Services (GFCS). The ETCCDI is well placed to provide the liaison between the science and user communities and to further develop the synergies that already exist between these two communities. Undertaking this challenge would require the ETCCDI to evolve by including membership with expertise relevant to the questions identified in the GCE White Paper

while still retaining a core capability to meet CCI, JCOMM and GFCS service and capacity building objectives. This would imply a somewhat larger team, with perhaps as many as 16 members (4 each from CCI and JCOMM, plus 8 additional members representing CLIVAR and GEWEX, and other WCRP panels providing coverage of the GCE White Paper questions; ETCCDI currently has 13 members including two co-chairs).

PART B: Future work within the scope of the current ETCCDI

1. Need for indices for science and services

ETCCDI activities have been instrumental in developing and spreading knowledge for monitoring climate variability and climate change, in building NMHSs capacity in using knowledge and tools for analysing historical data, and in providing useful information on climate extremes and indices by translating raw data into information for decision making in climate adaptation and other applications. The emergence of new needs from the GFCS (Observation and Monitoring as well as Service Information Systems pillars) makes ETCCDI activities even more suitable in supporting the development of high quality climate (including marine climate) datasets and information that support GFCS priority areas in Agriculture, Water, Health and Disaster Risk Reduction through linkages with other CCI and JCOMM groups. It is therefore crucial for the ETCCDI to align its activities with the new and emerging needs and requirements for climate services. This means there is also a need to review indices in conjunction with other groups such as CCI Expert Team on Climate Risk and Sector-specific Climate Indices (ET-CRSCI) and CCI Task Team on Definition of Weather and Climate Extremes (TT-DEWCE).

The data developed by the ETCCDI also provide fundamental information to support extremes related climate research, including the characterization of past changes in extremes, evaluation of model performance, determining the predictability of climate extremes, and improving process understanding.

2. Expansion to global coverage

The ETCCDI will continue the development of climate extreme indices data for the characterization of extremes, and promote the free and open international exchange of existing high time resolution data to improve global coverage of daily and sub-daily observations for temperature and precipitation extremes, and identify steps that would improve data sharing. On-going efforts have led to an improvement of the quality and coverage of observational data to monitor climate extremes. This effort particularly needs to focus on areas that still lack sufficient data coverage (e.g., South America, Africa, polar regions) and that are becoming increasingly important in terms of future climate change and the implementation of adaptation and mitigation strategies. New sources, such as remote sensing products, should be integrated in the process of filling in the gaps and improving information from, and coverage of, global observational datasets on extremes indices (e.g., HadEX2) to facilitate the evaluation of climate extremes on truly global scales.

In order to maximise the temporal and spatial coverage of information a particular objective of the ETCCDI is to have in place, by 2017, a further updated data set of climate extremes indices, supported by peer-reviewed science publications, which covers all parts of the world over which suitable observations have been made, and to the extent possible have arrangements put in place for the regular, routine updating of this data set. This will support the data and monitoring pillar of the GFCS, and will also support science undertaken by the WCRP.

An important part of achieving this objective will be to have strong regional arrangements in place to ensure the sustainable ongoing reporting and exchange of indices (or better even data which allow indices to be calculated). Regional centres (including both formally established Regional Climate Centers (RCCs) and other regional organisations) will play an important role in this process. The ETCCDI will work with regional centres to provide guidance and help put training and systems in place to support such regional activities. The objective is to have functional regional or national groups reporting such information on an ongoing basis by the end of 2017.

3. Routine updates for each region

In many regions of the world it is not yet possible to make firm assessments of how global warming has affected the regional climate and, in particular, climate extremes. Improved climate monitoring is necessary to determine what the changes are and to support adaptation in the most cost-effective manner. Continuous data series with at least daily time resolution are needed for this purpose. National Meteorological and Hydrological Services (NMHSs) have collected a large amount of high quality historical daily (or more frequent) station observations, but only a few NMHSs have digitized their entire daily data holdings. Fewer still have quality controlled and homogenized their long time-series and made these generally available for developing climate services or for climate change research.

The International Climate Assessment & Dataset (ICA&D) provides infrastructure to organize climate (indices) data on a regional basis, and to use these data both for climate change research and to develop climate services for users in various sectors. It builds on the expertise gained in the ad-hoc regional workshops organized by the ETCCDI. Sustained collaboration on sharing climate data for regional assessments in Europe resulted in a web-based information system that combines daily station data with the results of the list of ETCCDI indices and other derived climate indices information. Currently, this concept is being implemented in Southeast Asia (coordinated by Indonesian Agency for Meteorology, Climatology, and Geophysics, BMKG) and Latin America (coordinated by Centro Internacional para la Investigación del Fenómeno el Niño, CIIFEN, Ecuador) and recently in West Africa (coordinated by African Center of Meteorological Application for Development, ACMAD in Niger). It should be noted that ICA&D includes a capability to limit access to data held by the system in such a way that national and regional data access policies are respected. Nevertheless, it is hoped that ICA&D participants will make data freely available as widely and openly as their mandates allow.

Extending this concept to other regions of the world requires: i) cooperation between NMHSs and other institutions that gather and archive data and an agreement to house a copy of this data within the regional ICA&D system, ii) regional arrangement (such as RCCs) for operating and further developing the ICA&D system, iii) regional participation in indices calculation and climate change assessment, and iv) mutual respect for national and region data dissemination policies while at the same time supporting the development of data and information resources that support regional development and adaptation.

4. Marine indices

In addition to indices for land-based station data, the ETCCDI will develop indices for coastal areas, dealing with extreme water level related to waves, winds and storm surges. These variables are all impacts-relevant and will address several priorities of the WMO (and IOC) related to coastal hazards. These activities will also address common priorities of both the JCOMM Expert Team on Waves and Coastal Hazards Forecasting Systems (ETWCH) and CCI, and form direct contributions to the GFCS.

More specifically, the ETCCDI will develop by 2018 a set of coastal marine climate indices such as:

- annual, seasonal and monthly mean, maximum, and minimum water level from the Global Sea Level Observing System (GLOSS) tide gauge network
- annual, seasonal and monthly mean, and maximum: significant wave height (percentiles), and wind speed (percentiles) indices (e.g. threshold exceedances) from available coastal moored buoy networks (e.g. starting around US and Canadian coastlines)
- storm surge (more info to be added by Kevin Horsburgh)

Also, the potential for analysing and monitoring the interrelationships between these coastal marine climate indices will be considered (e.g. the coincidence of high water level and high waves, possibly incorporated into a combined index).

Further, the ETCCDI will coordinate the development of additional climate indices for the subsurface ocean, and possibly also utilize surface marine data elements from ICOADS, such as air temperature and sea surface temperature, e.g. in comparison (cross calibration) with land surface coastal air temperature and other data. Beyond that stage, it is anticipated to derive marine indices from reanalyses and model data.

5. Indices from models

The ETCCDI will develop, and coordinate the calculation of, standardized indices that are suitable for both observations and models in order to facilitate the comparison of observed indices with climate extremes information derived from global and regional climate models. This is important because while climate models provide valuable information on short-term, near-term and long-term climate change, model performance and the skill of short-term prediction can only be assessed when there are comparable observational reference datasets. The ETCCDI will also interact with model intercomparison projects (e.g., CMIP, CORDEX, other MIPs) to assist with the development of experimental designs that facilitates the analysis of climate extremes in general (i.e. output requirements) and across models and experiments (e.g., for D&A and event attribution purposes, to enhance process understanding, etc.).

6. Software development to support indices work

The ETCCDI will ensure that appropriate software is developed to calculate marine indices. It will also coordinate the continued development of software for indices calculation (including RClmDex and FClimDex) and provide standard software to ensure indices computed from model simulations and from observations are conducted in the same manner and indices computed in different regions and/or by using different computing environments are comparable. This will also simplify the maintenance of the software. Further, the ETCCDI will coordinate with other Expert Teams and bodies who wish to extend the capabilities of the standard software, to ensure that core indices continue to be computed correctly and efficiently, and that additional functionality is made available as broadly as possible.

7. Capacity development

Both the continued organization of regional indices workshops and the development of regional centres responsible for indices updates contribute to capacity development. The ETCCDI will provide technical and scientific guidance to the WMO RCCs and other similar affiliated institutions to help them perform operational indices calculation and updates in order to support the regional delivery of climate services. A particular near term goal is to organize, in collaboration with WMO and CIIFEN, a South American Workshop on Marine Indices in support of specific marine climate services in the region. This would be a demonstration of extending ETCCDI workshops to cover marine indices.

8. Extremes related research

The ETCCDI engages the International ad-hoc detection and attribution group (IDAG) through joint membership. The IDAG has coordinated detection and attribution studies for many years, with a focus on relevant variables including extremes at impact relevant scales. This activity confronts changes simulated by models with observations, and results can be used to quantify predictions and to constrain future projection. This activity also links closely to other CLIVAR activities focusing on modes of climate variability and decadal prediction.

The ETCCDI will also engage with 'event attribution' activities that are underway worldwide and rapidly gaining momentum (e.g., the ACE group, the EU project EUCLEIA, and activities at NOAA in the USA). Event attribution seeks to provide robust information on the extent to which specific observed extreme events have been affected by human influences on the climate. The ETCCDI will coordinate with IDAG and event attribution activities refine and improve the datasets, and also contribute to climate services development. **Specific linkage/delivable with GEWEX t.b.d.** One particular objective is to support the African research initiatives linked to the GFCS as organized by the WCRP.

9. Dissemination of indices data and data management

Providing observational and model-based indices through open-access data portals with user-friendly interfaces will support the Global Framework of Climate Services efforts with regard to risk

assessment and the development of regional and sector-specific adaptation and mitigation strategies.

At present, the ETCCDI may be the only institutional link between CCI and JCOMM and thus provides a very useful intersection point for data management. Land surface and marine/ocean data are managed and archived very differently (e.g. with the International Surface Temperature Initiative leveraging ICOADS "lessons learned"). An ETCCDI objective is to further promote coordination between land and ocean data management, including data rescue activities such as WMO I-DARE, and as facilitated by Atmospheric Circulation Reconstructions over the Earth (ACRE).

10. Linkages with other groups

There are numerous groups whose missions complement those of the ETCCDI which it would be appropriate for ETCCDI to seek linkages with. These include:

- CCI Expert Teams and Task Teams, including ET-CRSCI, ET-DARE, ET-NCMP, TT-DEWCE and the proposed TT on homogenisation
- JCOMM bodies/projects such as ETWCH, ETMC and COWCLIP
- WCRP panels such as GEWEX, CLIVAR and WGCM
- WMO working group on data policy
- Other WMO bodies such as GCOS (through AOPC), CBS, CIMO (standardisation), GCW, CAgM (drought, applications) and CHy
- Intergovernmental Panel on Climate Change (IPCC)
- WMO Regional Associations, RCCs and other centres carrying out a regional function
- Other relevant regional and international bodies

The nature of the linkages will vary from group to group. In some cases, particularly other ETs and TTs, the scope exists for ETCCDI to carry out joint projects with those groups, or the other group may already have carried out work which ETCCDI can draw on. In other cases, linkages will involve channels of communication, especially on specific topics relevant to the other group's activities (e.g. CAgM with respect to drought).

AGENDA

Monday 10 March		
9:00	Start, coffee/tea	
9:00	Welcome and agenda	Co-chairs
9:15	WMO/CCI perspective for the ET	Omar Baddour
9:30	WCRP/CLIVAR perspective	Xuebin Zhang for Valery Detemmerman
9:45	JCOMM perspective for the ET	Scott Woodruff / Xiaolan Wang for Boram Lee
10:00	Discussion	
10:15	Current work plan and progress	Albert Klein Tank / Xuebin Zhang
10:30	Model indices	Jana Sillmann
10:45	ClimDex project	Xuebin Zhang for Lisa Alexander
11:00	Regional workshops update	Albert Klein Tank
11:15	Discussion	
11:30	Links to ET-DARE	Aryan van Engelen
11:45	Links to TT-DEWCE	Blair Trewin
12:00	Links to ET-CRSCI	Albert Klein Tank for Lisa Alexander
12:15	Discussion	
12:30	JCOMM indices for coastal regions	Scott Woodruff / Xiaolan Wang
12:45	Discussion	
13:00	Lunch	
14:00	Grand Challenge on Extremes	Gabi Hegerl (via Skype) and Xuebin Zhang
14:30	Discussion	
15:00	2 break-out groups discuss general ideas for future directions	
17:00	Report of bog 1 and bog 2	
17:30	General discussion	<ul style="list-style-type: none"> - meaning indices for models - new name for HadEX - add S95pTOT index from Leander et al. - reanalysis and E-OBS indices - Climate Symposium 2014 session on prediction of extremes - CLIVAR open call for nominations - CCI membership renewed
19:00	Dinner	

Tuesday 11 March		
08:30	3 writing groups split by sponsor	
12:00	Integration of 3 groups	
13:00	Lunch	
14:00	3 writing groups split by sponsor continued	
16:00	Status reports of 3 groups	
19:00	Diner	
Wednesday 12 March		
08:30	Joint writing and integration and Wrap-up session	
13:00	Closing	

List of Participants

Albert Klein Tank, (CCI co-lead)
Xuebin Zhang (WCRP co-lead)
Xiaolan Wang, (JCOMM)
Francis Zwiers, (WCRP)
Blair Trewin, (CCI)
Scott Woodruff, (JCOMM)
Jana Sillmann (Invited expert from CICERO, Norway)
Omar Baddour (WMO)

Other experts participated in the first day:

Aryan Van Engelen (CCI-TT Data Rescue, first day)
Peter Seigmund (KNMI, first day)
Ge Verver (KNMI, first day)