**Second meeting of the Expert Team on National Climate Monitoring Products**

20-22 September 2016, Melbourne, Australia

**Guidance**

The first final draft guidance was sent to CCl in August. Comments were received from Tom Peterson and Andrew Tait.

There are currently three pieces to the guidance:

1. The guide
2. The annex to the guide
3. The software manual

We need to be clear about who the intended reader of each of the guidance documents is. The guide is intended as a general introduction to the NCMPs and their calculation. It is intended to provide the focal point with a general overview of the NCMPs. The annex to the guide is a mathematical description of the process, which is intended to allow a programmer to make software that calculates the NCMPs. It also provides the mathematical underpinning which will be of interest to scientists. The software manual is intended for whoever runs the software, which may be the focal point.

Tom Peterson suggested a fourth piece to cap these three off, which would be a WMO bulletin article aimed at the heads of NHMSs. This will be discussed further in the section on raising awareness of NCMPs. Tom also suggested reducing the use of WMO acronyms and other terms of art: ETCCDI, ETNCMP, CCl, OPACE etc.

There are some areas where the guidance is currently deficient. We need to state more clearly why these 6 NCMPs have been chosen and what the benefits are of generating NCMPs at all. Some careful words need to be chosen to explain that while we define a specific method, it is not the only method nor necessarily the best method, but it is our method and the one that, widely used, will ensure consistency. The process of calculating and interpreting a variogram needs a better explanation and more supporting examples. Another thing that needs clarifying is how we deal with non-contiguous countries such as the US or Denmark. At the moment we don’t, but the focal points might be asked to consider this.

The plan for updating the guidance is this. No further reviews will be sought (though any reviews we do receive can be incorporated later). Comments received so far and those generated during the Melbourne meeting will be considered in a revised document that John will produce and forward to Lucie by mid-October. Lucie will then ensure that the software and guidance are consistent. The updated guidance, software and manual will then be released to the whole team at the end of November. A beta-version of the NCMPs will be released to the focal points in early 2017 (exact timings are given in the workplan) and they will be encouraged to implement the NCMP process over a period of months and send feedback to the team later in 2017 so that we can reflect on the results, which we will discuss at the next face to face meeting in September 2017, and report to CCl in March 2018.

**Software**

We have in place, thanks to the great efforts of Lucie and her student, an end-to-end system for quality controlling daily data and calculating the NCMPs from them. There are separate modules for each step in the processing and where possible, code has been reused from Rclim-dex or tested against output from existing software to ensure consistency. The code is thoroughly commented and there is a user manual which takes users through much of the process of calculating NCMPs. The manual includes a list of likely error messages and how to resolve them. Lucie has run the code on three test regions and John and Ladislaus have run the code for the US and Tanzania respectively.

A number of improvements were suggested during the course of the meeting and the calculation and interpretation of the variograms was identified as a particularly difficult point. First, it is not easy to understand. Second, it requires a degree of expertise particularly when station data are few. The team expressed concern that this step might be a step too far for some.

There are a number of ways to make the variogram step more comprehensible and thus achievable. First, the guidance and software manual can be expanded to include some examples for different networks and give some guidance on the interpretation of the variograms. Second, the process itself can be modified. For example, the team can precalculate example variograms using HadGHCN-D and possibly ask GPCC for their help with precipitation. The precalculated variograms can be used in countries which have too few stations to reliably calculate their own. Another option might be to use resistant statistics in the fitting – Lucie showed an example where the functional variogram was too flat because of outliers in the empirical variogram – but that could slow the process down. Another option is to see how variograms are taught elsewhere. Kriging is a standard, widely-taught method, so there must be existing examples.

Another sticking point, which is technically outside our remit, is the input data format. We have no control over the formats used by NHMSs to store their data. This could cause problems for NHMSs and it could also slow things down during a workshop. ETCCDI have a pre-workshop phase during which participants interact with the organizers to ensure that their data is in an appropriate format before the workshop begins. Lucie, indeed, offered to help with this, but we do not yet know the full extent of the problem and won’t until we run a workshop. It is possible that we could get some information on typical outputs from some standard climate data management systems.

As the software will have to be run each month (eventually) usability and ease of adoption are critical. The software needs to be easy to run and to run quickly.

The calculation of the indices and the quality control are relatively mature pieces of code. The calculation of the variogram (as well as having other problems as noted above) and the interpolation are less mature and initial scientific and code reviews (which Karl’s colleague has offered to perform) will focus on these.

The plan is that Lucie will implement the suggested changes in the code by the end of October. The code will then be passed to Karl who will have the code reviewed by the end of November possibly even starting review before then. The code will then be distributed to all members of the team who will then use the code to calculate NCMPs for their country (and indeed any other country for which they have data). This they will do by the end of January. Although, this testing phase will not necessarily include the code being used in “update” mode, which is how it will be most commonly used, the team will reflect on this aspect whilst using the code.

John will investigate the possibility of a quasi-permanent software repository on GitHub, to be hosted by the Met Office (this is possible, it turns out). A repository like GitHub has a number of attractive features. First, it is accessible via the web. Second, it allows proper version controlling of the code. Third, the code can be modified by any member of the team, or by anyone to whom the team extends such privileges and GitHub will automatically credit any modifications to the code to the person who made them. Fourth, the person working on the code does not assume the burden of hosting and distributing the software.

The specific feedback on the existing software includes a number of points not all of which need to be fixed immediately:

* We need to modify the output to include the 6 NCMPs in one file and the summary for the current month and year in another. The filenames of these files should be meaningful and allow the WMO annual statement coordinator to instantly identify the country. E.g. Cambodia\_NCMP\_annual\_summary.csv
* Cran mirrors don’t cover all countries. We need to point out that it doesn’t really matter and that you can download from anywhere (if this is the case).
* No exact data format is given. It might help to be more specific about what is and isn’t allowed in the input.
* Can the code auto-detect the number of stations from P0\_Station\_List.txt? Why is the maximum number of stations set at 200? Some countries e.g the USA have upward of 1000 stations.
* Defaults should be harder to change by first asking the user if they wish to use the WMO recommended values and only offering them the choice if they say “No” and then “Yes, I’m sure” and “Yes, I’m really really sure”.
* Remove the option to perform regional averages so that the code is focused more towards the National NCMPs that are our focus.
* The grid resolution is pre-defined to be 2-degrees and needs to be flexible – the user needs to be able to define this as 2-degrees will be too large for most countries.
* A “maximum separation” value should be an option in the variogram calculation (possibly, the guidance will be updated to reflect this).
* The criteria for missing data are inevitably a little ad hoc. The limits need to be stated and the guidance might need to be updated to say why we have relaxed the criteria relative to the ETCCDI values (which were rather strict).
* Calculation of area-weighting can be checked during the code review (Karl)
* John Lanzanted recommended that a resistant estimate of the standard deviation could be used to improve the quality control limits.
* The variogram has problems when multiple zeroes in input (e.g. rainfall) (John/Lucie to investigate)
* Variogram does not compute when there are strange values in the index. (inf)
* Add diagnostic maps to the regional average section which show the interpolated values, the country borders/coast lines and station locations.
* With intermediate output files, it is possible that there will be a loss of precision in the NCMPs. Maintaining precision through calculation will help with error tracking and reproducibility, but will increase size of the intermediate files.
* The error messages are useful so it might be better to have more of them though it was noted that this can be a rather laborious task.

**Focal Points**

Focal points have been nominated by 63 countries. The terms of reference of the focal points are:

* To collaborate with ET-NCMP on identifying existing national sources for climate monitoring products and related capacities as well as related training and capacity building needs;
* To raise awareness of the NMHS staff and other relevant stakeholders on the need for and the importance of NCMPs;
* To facilitate the calculation of NCMPs including its dissemination via agreed protocols;
* To prepare and submit feedback to ET-NCMP on the challenges and the need for improvement emanating from the preparation and dissemination of the NCMPs.

There are some obvious gaps in the network: Germany, China, India stand out in particular. The team considered ways in which the network might be expanded. The following plans were made. When we have the first release of the software in early 2017 (see workplan for details), we will write to all member PRs once again, with a copy of the WMO annual statement featured article and ask those countries that have not yet nominated a focal point to do so. In parallel, but with, say, a one month delay, the same request will be sent out to our informal list of contacts which is maintained by Jessica (minus those countries that have already nominated). Ladislaus noted the success he had soliciting responses to the earlier task team survey via personal contacts at meetings and such. Team members are encouraged to raise the question when circumstances are appropriate.

We also talked about the communication plan for focal points. It is not clear what the appropriate frequency of communication is – arguments were made in favour of both ends of the spectrum – so we will have to try something and see. We will contact the focal points in November this year to inform them of the imminent arrival of the guidance and software (Peer to draft a letter for circulation to the team). In February 2017, there will be a follow up letter (as mentioned in the preceding paragraph) which will release the guidance and the beta-version of the software. Peer also said that the task teams on remote-sensing data and homogenisation would be interested in sharing their findings with the network of focal points. After that, it is expected that communication will be spontaneous (to a certain degree) with continued interactions between the expert team and the focal points.

Other actions: get latest spreadsheet from Jessica, Update list of missing focal points. Inform Peer of missing focal points.

**Survey**

The reports of the survey as collated and analysed by Jessica were presented. It (the survey, not the presentation) was considered a great success with a larger than usual number of respondents. No further work is anticipated on the survey so this task has been closed.

**Dissemination**

There are many potential users of the NCMPs, but it is hard to design something that has many users as their needs are hard to anticipate and oftentimes contradictory. The team focused on the WMO annual statement as user-zero drawing on the combined expertise of the three ex-coordinators – Peer, Jessica and John – who are on the team. A consideration in the following plan was that some countries might be reluctant to share monthly, historical data as this is not explicitly covered by WMO resolution 40. There is an ambiguity – which I believe is irresolvable – regarding the demarcation between data and products. Products are data, but are anyway treated differently and countries are far less likely to share “data” than they are “products”. We need to be careful to stress that NCMPs are products and not data.

Initially, dissemination will be by email from the focal points to the WMO secretariat at the generic (wcdmp@wmo.int) address. The software will create two files: one containing the monthly values of all 6 NCMPs for the whole of the record, the other containing a simple summary of the most recent year. The guidance will state clearly what is in each of the files and their purpose and it will then be up to the NHMSs to decide whether they send both files, or only the annual summary.

This ensures that the control of the products remains with the NHMS. In any case, the vast majority of the useful information (which is towards the data side of the data/product border) created by the software will remain at the NHMS. It must also be recognised that the expertise on the country’s climate is located within the country at the NHMS and that the software is intended to provide tools and information that will be of potential help to the local expert in supporting the WMO annual statement. Specific questions regarding events in the country, which are not resolved by the transmitted NCMPs should be referred to the focal points.

By hitching the NCMP wagon to the WMO annual statement horses (or vice versa), there is a natural update cycle for the NCMPs. At first, NCMPs would be used only in the brochure, which is produced in mid February, based on inputs received in January. This would give the focal points and NHMSs a month to update the NCMPs for the previous year. This does not seem unreasonable although it must be acknowledged that, at first, this will be an additional burden on top of existing commitments.

**Raising awareness of NCMPS**

The team generated a number of suggestions for raising awareness of the NCMPs. Lucie offered to draft a short article – one page of text and one or two figures – for inclusion as a “featured article” in the WMO annual statement in early 2017 that will not dwell upon the variogram. Tom Peterson’s suggestion to write a WMO bulletin article was deferred until such time as we have a neat story to tell, perhaps after the initial workshop. A BAMS state of the climate sidebar (in the regional chapter) might be another possibility once the NCMPs are more mature and start to filter through to BAMS. Other publications were discussed, including an article for BAMS or a technical scientific paper describing the methods. In addition, and as noted above, a number of letters will be written to the focal points and PRs regarding NCMPs.

Peer and Fatima mentioned meetings in late 2016 (CIIFEN) and in 2017 at which NCMP material could be presented.

An outline of the one-pager WMO annual statement featured article was produced. This will feed into the first draft of the article which Jessica will write by some time in January.

Our Aim is to promote the concept and increase awareness of NCMPs and of their importance. We will highlight the benefits for members that will come with improved national climate monitoring. The production of NCMPs will also have global benefits. The benefits include: assisting members in consistently monitoring national climate, develop capacity, to improve quality of national monitoring and of the data itself through QC, provides consistent information for the WMO annual statement, provides an international platform for national products, experts and networks, close holes in areas which are not well monitored. We need to mention that the production of NCMPs will be voluntary and not mandatory (should not shall). The basic method will be described in outline form (without dwelling on variograms). It will mention that the team has developed software and guidance and what the definitions of the NCMPS are. There will be 1 or 2 figures from the test phase based on the NCMPs produced by the team in January and these will, ideally, have relevance for 2016.

**Workshops**

One of the aims of the NCMPs is to develop the capacity of an NHMS to deploy a system for climate monitoring. From the survey we know that some NHMSs require support to implement the production of the 6 NCMPs. The software developed by Lucie removes one barrier to implementing such a system, but it creates another, smaller barrier: the focal point (or a colleague) needs to learn how to use the software. The ETCCDI has had great success running workshops to introduce people to the R-Climdex and RH-test software packages and so a similar approach might work for NCMPs.

The production of NCMPs, which is intended to be an operational affair, is somewhat different from the calculation of the ETTCDI indices, which was typically a one-off thing leading to a scientific paper. The implied commitment is much greater and the motivation ought therefore to be proportionally stronger. The target institutions are also different: ETCCDI work was often done by universities, whereas the NCMP work will usually be done by the NHMSs. A third difference is that, the calculation of indices (and their) trends was the intended outcome of the ETCCDI workshops, which already take a whole busy week to complete, whereas the calculation of indices is only the second step in the five or so steps needed to calculate the NCMPs. That would suggest more than one busy week would be needed, all else being equal.

The aim of a workshop would be to train participants in the creation of NCMPs. The initial workshop would also be a learning experience for the team. At the end of the workshop, the participants should: have a full set of NCMPs for their country; be able to operationally support the update of the NCMPs; be able to use the NCMPs to write a climate bulletin; be able to articulate the importance of climate monitoring.

For the initial workshop, the participants should be ‘typical’ participants in the sense that the difficulties they encounter should be representative of the difficulties that would be encountered if the workshops are hosted in other areas where capacity building is needed. A subsequent workshop might then be held with RCC representatives who would be trained to train focal points in their region.

Three locations for the first workshop were discussed in detail: SE Europe, SE Asia and the SW Pacific. The last of these was favoured as we can draw on the contacts within the Bureau of Meteorology, the use of CDMSs is widespread and there will be an interesting mixture of larger and smaller countries.

A timeline of the workshop was sketched out during the meeting. It will be fleshed out into a more detailed concept note by Ladislaus and Karl by the end of the year. This will be based on these notes and on similar concept notes produced for workshops attended by Peer and Lucie.

**Month -X**: location, time and local organiser of the workshop are identified

**Month -6**: WMO contacts PRs to identify participants and trainers. The PRs will be asked whether they are agreeable to the idea of producing NCMPs. Personal contacts might help where these exist (e.g. Pacific islands)

**Month -3**: contact participants and start the process of data preparation (asking about numbers of stations, data formats, checking software is installed and so on). Ensure visas are being arranged.

**Month 0**: one week workshop

**Month +3**: summarise the outcomes of the workshop for CCl, including feedback from participants.

**Month +6**: follow up with focal points to see how they are working with NCMPs, problems they have had, successes and so on.

During the workshop itself the approximate timeline would be:

**Monday**: local introduction from host, introduction to NCMPs from trainers, participants would give short introductory presentations, RCC to talk about general challenges they have in monitoring the climate.

**Tuesday**: quality control, and (anticipating problems with data formats) data wrangling.

**Wednesday**: calculate indices and variograms

**Thursday**: interpolation and regional averaging.

**Friday**: participants produce short presentations (maybe generate a climate bulleting) presenting their results and get a diploma signed byTom Peterson (or similar).

Methods for capacity building other than workshops were also discussed. There are the guidance and software manual. Additional material could be produced, which could be put on a CD or downloaded for use offline or where internet connections aren’t. Video tutorials might be of some use, but take time to produce (though this is true of any worthwhile materials). It might be possible to do shorter sessions attached to other meetings or conferences maybe using the introductory materials, or offering refresher courses for those who had already attended the full workshop. The ET-NCMP could provide support remotely via email or webex and there might be some use in providing shorter online workshops. But these were not discussed in details.

**Ongoing challenges**

The variogram step of the process has been identified as a challenge in a number of ways. It is difficult to explain and not always easy to calculate, particularly when there are few stations. John will update the guidance to reflect these difficulties, providing more examples, further information regarding the physical interpretation of the variogram and also exploring the way that the fit is performed. Mean Square Error is sensitive to outliers, so an option to use Mean Absolute Error could be given.

Range of nation sizes from one station to one thousand stations and everything in between. Need to be able to check the NCMPS on a range of countries and then iron out any problems as they arise.

Time and resources of the team is an ongoing issue. Despite this, considerable progress has been made and is being made.

**Other Stuff**

There were presentations from Blair Trewin, William Wright, Karen Bennett, and Roan Plotz.

Blair Trewin talked about the 5-year WMO statement on global climate. The 5-year reports allow us to look at longer-term events which don’t fit neatly into the annual reports. It also allows improved reporting of impacts and attribution. Sometimes impacts are separated from their causes by a span of time. The 5-year report (the first runs from 2011-2015) also samples both La Niña and El Niño conditions so smoothing out some of the roller coaster ups and downs of the annual reports. The statements draw on diverse sources of information, but all the information in the final reports must come from official sources: NHMSs, international centres such as GPCC, CIFEN, ACMAD etc.

Getting solid official information can be frustrating. Often records are reported in soft sources such as blogs or newspaper articles. Operational attribution is still in its infancy, requires extensive peer review and even then is liable to be published with numerous caveats. Information on impacts is scant and notoriously unreliable, with estimates for some event differing by three orders of magnitude.

William Wright talked about OPACE 1. OPACE1 and 2 overlap as both are data heavy. He asked why climate data is special. The answer (as any fule no) is that climate records need to be as long as possible, contain few gaps, have high levels of QC with confidence assessments. They need to be accessible (in digital formats), have adequate metadata and provenance information and be free from spurious trends. These are hard criteria to meet. The CDMS team has a “technology watch” component, taking a strategic view of data management and looks for upcoming technical solutions. For example openCDMS and cloud computing technologies point should enable a more universal approach to CDMS. I-DARE (International Data Rescue group) has a donate button, but no one presses on it. ET-CDMP – will develop manual on best practice in climate data management including QC. The retention strategy for climate is generally to “keep everything”.

Karen Bennett promised to change our lives by introducing us to zeetings (which is actually pretty cool). She talked about training workshops held across the Pacific. The training was intended to help met services learn to use software and provide products and services. The balance of the workshops seemed to be light on the actual software training and heavy on the supporting material. The aim being not to teach just the bare bones of running the software but also providing the framework and confidence necessary to understand, adapt, evolve and innovate with the software. Workshops were often attended by large numbers of people besides those most directly working in the area. Workshops used a variety of approaches in the training. These ranged from role playing, via sculpture building with craft materials, games, sticking stickers on walls, “world cafe” and other very active and involving exercises. The range of exercises helped to get involvement across the range of seniority, age and gender. Typical “discussion” formats are often dominated by a few voices, which are not always the voices most qualified to speak on the subject. The whole process was rather lengthy, taking a few weeks or more per met service.

Met services in the Pacific are very open to being upskilled. Basically, anything that helps them do their job is good. Lots of software (commercial and otherwise) is being thrust upon them. Consequently, producing/providing the software is less important than the initial and ongoing support, training, and adaptation of the software to their specific needs.

Roan Plotz talked about traditional knowledge. There is low uptake of met forecasts in many parts of the world and many are still relying solely on traditional knowledge. There is a move to preserve TK (traditional knowledge) before it is lost. The project started with four countries. Elders provided knowledge. TK is being lost for various reasons. e.g. young people are not always interested in learning it. Preservation is important, but there is also useful information there which can be used to complement modern seasonal forecasting methods. The key to this is gathering and assessing TK.

The monitoring process is rather involved. The first step is to establish objective indicators that can be used as predictors and predictands. What plants are being used as predictors, when do they flower? Where? To what extent? How reliable is this indicator (this is often underestimated)? In order to evaluated methods, multiple years of data are needed. This is not an easy process. Information has to be gathered locally.

Monitoring is used to create combined forecasts. There are various ways to do that: consensus (combine two strands by discussion), present both TK and model (side by side), other statistical combinations (combine mathematically). These need to be assessed.

BoM worked with the met services and the met services dealt with the local communities and stake holders.

With TK the whole story and context is important and TK is a sensitive subject for some people. Data is stored in the database with permission, and rules for sharing (or not sharing) are established up front. In some cases, TK is shared solely for preservation and is not accessible by anyone.

Data sharing is a long term trust game. There are sensitivities about sharing climate data. It is a good idea to ensure that there is an established protocol and that everyone sticks to the protocol. WMO and Bureau are more trusted, but other institutes (unis etc.) maybe less so. It takes time to build rapport. It can be a tricky concept to say “we want to assess your TK” and, as with most things, there is a need to emphasise the quid pro quo.

Build calendars as “clocks” indicating when seasons come, winds, flowerings, etc.

We need to explain why we want to do NCMPs and need to explore monitoring as it affects them. Focal points – might have limited influence.