

# **Memorandum submitted by the University of East Anglia**

## **1. Introduction**

1.1 This memorandum is submitted by the Vice-Chancellor, Professor Edward Acton, the University's principal academic and administrative officer, with additional comment provided, where indicated, by the University's Climatic Research Unit (CRU).

## **1.2 Freedom and Integrity of scientific research**

The University of East Anglia (UEA) was founded in 1963. For over forty-five years it has sought to identify fruitful fields for research and study, notably in the sciences, and to provide a free environment in which new and challenging research can flourish. It is now recognised as a world leader in several branches of the geophysical sciences, and it is understandably proud of that reputation.

1.3 Like all British universities, it has a set of policies, regulations and codes of good conduct which UEA's researchers are required to follow. At the heart of these is the requirement to maintain "honesty, openness, accountability and integrity." Plagiarism, deception or the fabrication or falsification of results are regarded as serious disciplinary offences, and are a betrayal of the life of science.

1.4 When assessing the quality of scientific research work, UEA relies first and foremost on critical evaluation by the international network of specialists working in each field. This "peer review" is the keystone for maintaining the integrity of scientific research: the scrutiny, probing, questioning and evaluation of the work of each scientist by other experts in the field. It is through peer review that scientific reputations and esteem are established, that competition for research funding is determined, and that editors decide which work to publish and which to reject.

## **1.5 The Climatic Research Unit**

Four decades ago, UEA identified climate as an important field of study but one in which the data and methods used were primitive. In 1972 the University founded the Climatic Research Unit (CRU) which has played a pioneering role in advancing human ability to understand the world's changing climate. It is part of a department with an international reputation.

1.6 CRU's contribution has included the compilation of a global land temperature record and the development of increasingly sophisticated methods by which to represent the average temperature of the globe and changes in that average over time. The evidence has steadily mounted of a marked increase in average global temperatures. This has given CRU's work momentous political and social significance.

1.7 We are well aware that research addressing issues with such profound implications for the human species is liable to trigger fierce debate. Moreover, we believe that such debate is a crucial and necessary part of the role of science in society. Currently there are deep concerns lest scientific analysis has exaggerated the rise in global temperature. But equally, there are fears that the rise may be underplayed, or dismissed altogether, by powerful commercial or political interests.

1.8 In the midst of this vital debate, the University's role remains unchanged. It is to pursue the best scientific research and data, to ensure that the research is pursued in conformity with our codes of good conduct, and that its quality is continuously tested and evaluated by peer review.

### **1.9 Independent Review**

Given the high profile and importance of this research, following the theft of CRU emails in November and allegations that some pieces of work in CRU were at odds with acceptable scientific practice and with the University's codes and policies, including that on Freedom of Information, we announced on 3 December an Independent Review led by Sir Muir Russell. The University will act appropriately on the Review's findings and any recommendations it makes.

## ***2. Are the terms of reference and scope of the Independent Review announced on 3 December 2009 by UEA adequate?***

2.1 The terms of reference address the key allegations against colleagues:

(a) manipulation of data, (b) manipulation of the peer review system, and (c) whether or not data have been dealt with in accordance with best scientific practice and the provisions of the Freedom of Information Act (FOIA).

2.2 To ensure the scope of Sir Muir Russell's review embraces all that is pertinent, the terms of reference also give him discretion to amend or add to them as he feels necessary.

2.3 Alongside Sir Muir Russell's Review, we have decided on an additional scientific assessment of CRU's key scientific publications; an external reappraisal of the science itself. The Royal Society has agreed to assist the University in identifying assessors with the requisite experience, standing and independence.

## ***3. What are the implications of the disclosures for the integrity of scientific research?***

3.1 The immediate effect of these disclosures has been to open up the climate change debate. The long-term effects, within the scientific community, depend on the outcome of the two Reviews referred to above. We fully accept that any of the following allegations, if proven, would have implications for the integrity of the scientific research and the scientists involved. They would also damage the elements of CRU's contribution to the body of international climate science involved; given the scale of that international body of work, it is doubtful that they would weaken the implications of modern climate research as a whole.

- (i) Fabrication: the creation of fictitious primary data, or documentation.
- (ii) Intent to mislead: deliberate selection and/or manipulation of data, or documentation.
- (iii) Misrepresentation: undisclosed suppression of findings and data.
- (iv) Deficient management, preservation and dissemination of data (and primary materials, such as tree samples).
- (v) Suppression or distortion of others' findings.

3.2 The Independent Review will examine whether there is substance to any of the allegations against CRU. Some detailed preliminary comments from CRU on the allegations are given below.

### **Comment from the Climatic Research Unit at UEA**

#### **3.3 Fabrication of primary data**

##### ***(a) The CRU global and hemispheric land area temperature record***

All of CRU's primary (raw) station temperature data were accessed from National Meteorological Services (NMSs), or from published collations of such station data (e.g. the Global Historical Climatology Network, GHCN), to which anyone can gain access. CRU's sources have been published in various publications (e.g. TR017, TR022, TR027, Brohan et al., 2006).

##### ***(b) Tree-ring data***

Virtually all primary data used by CRU are acquired from collaborators or from public databases. In the "trick" and "hide the decline" case, discussed below, the data were provided by the Swiss Federal Institute of Forest, Snow and Landscape Research, and are publicly available.

#### **3.4 Intent to mislead**

3.4.1 CRU has been accused of manipulating/selecting data to exaggerate global warming. We strongly reject this, as a misunderstanding of the standard statistical techniques involved. It is sometimes necessary to adjust temperature data because changes in station location, instrument or observation time, or in the methods used to calculate monthly average temperatures can introduce false trends. These have to be removed or adjusted, or else the overall series of values will be incorrect. In the early 1980s, CRU painstakingly examined the long-term homogeneity of each station temperature series which it acquired. As a result, data were adjusted for about 10% of the sites, that is 314 sites out of a then-total of 3276. This was in complete accordance with standard practice, and all adjustments were documented in TR017, TR022, TR027.

3.4.2 A number of stations with problems too severe to adjust were omitted from the dataset. They were generally from data-dense regions, and so their exclusion did not materially affect the global record. All omissions were documented (TR022, TR027, Jones et al., 1986a, b).

3.4.3 Homogeneity assessment is best performed in-country by the NMSs themselves as they have access to the detailed local knowledge (Jones & Moberg, 2003). A number of NMSs have undertaken such exercises and, as they have become available, their homogenised series have been used to replace those in the CRU dataset.

3.4.4 One major CRU objective was to produce a gridded temperature dataset. This shows spatial patterns of change and, above all, avoids bias towards regions of greater station density. To produce the best-possible gridded dataset, it is necessary to utilise some of the station series which have been adjusted.

3.4.5 When the station temperature series are added together to produce global or hemispheric average temperatures, the adjustments (positive and negative) tend to cancel out; therefore having *little net effect* on the global/hemispheric average temperature record.

3.4.6 On 18 December 2009 the Met Office Hadley Centre (MOHC) released data from 1741 of the stations which comprise the World Meteorological Organization (WMO) Regional Baseline Climatological Network from which data are freely available, and which are a subset of CRUTEM3, as the CRU data set is known. The global average temperature record from this subset is very similar to the record derived from the full CRUTEM3 dataset. MOHC subsequently released data from 3780 stations (80% of the stations in CRUTEM3). Figure 1 shows the close agreement, with slight deviations only occurring in the 19<sup>th</sup> century (the early relatively data-poor period).

3.4.7 CRU has been accused of the effective, if not deliberate, falsification of findings through deployment of “substandard” computer programs and documentation. But the criticized computer programs were not used to produce CRUTEM3 data, nor were they written for third-party users. They were written for/by researchers who understand their limitations and who inspect intermediate results to identify and solve errors.

3.4.8 The different computer program used to produce the CRUTEM3 dataset has now been released by the MOHC with the support of CRU.

### **3.5 Misrepresentation**

3.5.1 CRU has been accused of hiding data flaws and research findings. But here there has been a simple misunderstanding of technical jargon.

#### **3.5.2 “Trick” and “hide the decline”.**

These accusations relate to the portrayal of the 1000-year Northern Hemisphere temperature record in one diagram in a publication for the WMO in 1999. The diagram integrated temperature records based on thermometer observations (which started in the 1850s) with “proxy” data (from ice cores, tree-rings, written and other sources), extending much further into the past than the instrumental record.

3.5.3 One of the three proxy-temperature reconstructions was based entirely on a particular set of tree-ring data which exhibited strong correlation with thermometer measured temperature from the 19th century to the mid-20th century. But after 1960 it did not show a realistic trend of temperature by comparison with these thermometer measurements.

3.5.4 This observation (that some otherwise temperature-sensitive tree-ring chronologies do not track the observed rise in recent temperatures) is well known. It is referred to in the literature as the “decline” or “divergence” phenomenon. The use of the term “hiding the decline” referred to the method of combining the tree-ring evidence and instrumental temperatures, removing the post-1960 tree-ring data to avoid giving a false impression of declining temperatures. What it did *not* refer to was any decline in the actual thermometer evidence of recent warming.

3.5.5 CRU never sought to disguise this specific type of tree-ring “decline or divergence”. On the contrary, CRU has published a number of pioneering articles that illustrate, suggest reasons for, and discuss the implications of this interesting phenomenon (e.g. Briffa et al., 1998 a, b; Briffa, 2000 listed in the legend of the WMO figure).

3.5.6 As for the (now notorious) word “trick”, so deeply appealing to the media, this has been richly misinterpreted and quoted out of context. It was used in an informal email, discussing the difficulties of statistical presentation. It does not mean a “ruse” or method of deception. In context it is obvious that it is used in the informal sense of “the best way of doing something”. In this case it was “the trick or knack” of constructing a statistical illustration which would combine the most reliable proxy and instrumental evidence of temperature trends.

### **3.6 Urbanization in China**

3.6.1 CRU has been accused of “hiding” climate data flaws by not acknowledging the degree to which the warming trend in China might be influenced by urbanization effects at some stations, and by withholding information on station moves, in Jones et al. (1990). This is not true.

3.6.2 CRU requested, and accepted, the best station temperature data obtainable from China at that time via a scientist working in the US in 1989/90. CRU responded positively to a Freedom of Information Act (FOIA) request in 2007 for these station data (2 sets of 42 stations - one rural, one urban), including location information for all stations. Jones et al. (1990) was referred to in the IPCC 2007 Report, as were other papers examining urbanization effects in other areas which, in turn, corroborated CRU’s findings that urbanization influences on a global land scale are small.

3.6.3 Furthermore, in 2007, CRU embarked on a detailed study of temperature trends in China using data from the China Meteorological Administration (CMA). An assessment of the consistency of 728 stations was published in Li and Li (2007), and all series were assessed and some adjusted by CMA for changes in location. CRU acquired the station data for the same stations that were used in the 1990 paper.

3.6.4 The subsequent analysis (Jones et al., 2008), which used the CMA data for the same period (1954-1983) as the 1990 study, produced results that were almost identical. Using the longer measurement records now available from CMA, it also concluded that there was a likely urbanization effect in China of 0.1°C per decade for the period 1951-2004. After making allowance for this urbanization effect, there is still a remaining large-scale climatic warming trend of 0.15°C per decade over the period 1951-2004, increasing to 0.47°C per decade over the period 1981-2004.

3.6.5 There was no attempt at misrepresentation. This is simply an example of scientific research evolving as more and better data become available.

### **3.7 Deficient management, preservation and dissemination of data**

3.7.1 CRU has been accused of “losing” primary station data. The accusation arose from misinterpretation of a CRU statement in summer 2009. CRU has not lost data. All the primary station data still exist, in the *World Weather Records* or in NMS

Yearbooks and similar sources (particularly GHCN). The sources are documented in CRU reports published in the 1980s, and in later peer-reviewed papers.

3.7.2 CRU has been accused of refusing to release data requested under the FOIA. There are many obstacles outside CRU's control surrounding the release of data provided by NMSs. Many FOIA requests made to CRU related to primary data provided by the NMSs. Some of these data are subject to formal non-publication agreements between the NMS and CRU. Other primary data had been provided to CRU on an individual-to-individual basis, with accompanying verbal agreements that they may be used within the gridded dataset, but should not be passed on to others. CRU responded to the FOIA requests for primary data by pointing out that data from approximately 90% of the stations in the CRU dataset are available from other sources, particularly GHCN.

3.7.3 Using these other sources, it has been possible – for a number of years – for anyone to construct their own global land temperature record, using whichever combination of stations they might choose.

3.7.4 In July 2009 UEA received an unprecedented, and frankly administratively overwhelming, deluge of FOIA requests related to CRU. These amounted to 61 requests out of a 2009 total of 107 related to CRU, compared to annual totals of 2 in 2008 and 4 in 2007 (University totals for those years were 204, 72 and 44 respectively). Accordingly CRU approached the Global Climate Observing System (GCOS), an organization within the WMO, to see if it would request the WMO to seek permission from each of its members (the NMSs) for CRU to release the primary station data for each country. WMO declined, but indicated that the appropriate procedure was for the request to come from the UK NMS (the Met Office). The Met Office agreed this was the correct procedure, and sent a letter of support to accompany an explanatory letter to each NMS on 30 November 2009. As of 1 February 2010, 35 responses to 160 requests have been received from the NMSs. Most are positive, but some are negative (confirming the constraints preventing CRU releasing the requested data).

3.7.5 Though never the subject of an FOIA request, CRU has been accused of not releasing original tree-ring width measurements from which regional chronologies in northern Eurasia were constructed (Briffa, 2000; Briffa et al., 2008). These datasets were never “owned” by CRU, but were provided by collaborating researchers. Initial requests for these data were redirected towards the appropriate institutions and individuals. Early release of these data (around 2000) was specifically embargoed by those collaborators who were still working towards further publications. Following publication of Briffa et al. (2008), CRU approached Swedish, Finnish and Russian colleagues for permission to release data. They were released in 2008/09.

3.7.6 On 22 January 2010, the Information Commissioner's Office (ICO) released a statement to a journalist, which was widely misinterpreted in the media as a finding by the ICO that UEA had breached Section 77 of the FOIA by withholding raw data. A subsequent letter to UEA from the ICO (29 January 2010) indicated that no breach of the law has been established; that the evidence the ICO had in mind about whether there was a breach was no more than *prima facie*; and that the FOI request at issue did not concern raw data but private email exchanges.

### **3.8 Suppression or distortion**

3.8.1 There has been much speculation over remarks made in an email about papers published by McKittrick & Michaels (2004) and Soon & Baliunas (2003), where it appears there was an attempt to exclude them from the Fourth Assessment Report of the IPCC (AR4).

3.8.2 The remarks were made before any of the four planning meetings for AR4. In the event, both papers were cited in AR4.

3.8.3 The original email was expressing doubts about the scientific rigour of the two papers. This concern appears to have been justified. The editor and publisher of the journal which published the second paper subsequently acknowledged the need to improve editorial procedures, and later related events led to half the journal's Editorial Board resigning. The first paper has subsequently received criticism over whether the statistical approaches used can support its conclusions (Benestad, 2004; Schmidt, 2009).

### ***4. How independent are the other two international datasets?***

4.1 Although all three datasets have a degree of commonality in terms of the sources of primary data, they can be regarded as completely independent in terms of adjustments, and in terms of the methodology for combining the data, including gridding methodologies.

4.2 The three basic datasets for land areas of the world are:

CRUTEM3 (Brohan et al., 2006)

Dataset held by the Goddard Institute for Space Studies (GISS, USA) (Hansen et al., 2001)

GHCN dataset held by National Climatic Data Center (NCDC, USA) (Smith & Reynolds, 2005; Smith et al., 2008)

4.3 All these datasets rely on primary observations recorded by NMSs across the globe.

4.4 GISS and NCDC each use at least 7200 stations. CRUTEM3 uses fewer. In CRUTEM3, each monthly temperature value is expressed as a departure from the average for the base period 1961-90. This "anomaly method" of expressing temperature records demands an adequate amount of data for the base period; this limitation reduces the number of stations used by CRUTEM3 to 4348 (from the dataset total of 5121). The latest NCDC analysis (Smith et al. 2008) has now moved to the "anomaly method" though with different refinements from those of CRU.

4.5 NCDC and GISS use different approaches to the problem of "absolute temperature" from those of CRUTEM3. The homogeneity procedures undertaken by GISS and NCDC are completely different from those adopted for CRUTEM3. NCDC has an automated adjustment procedure (Menne & Williams, 2009), whilst GISS additionally makes allowances for urbanization effects at some stations (Hansen et al., 2001).

4.6 Figure 2 shows five series of global/hemispheric average temperatures, including three versions from the NCDC dataset. One of the NCDC series is based on station temperature data which have undergone *no* adjustments for homogeneity. All data series follow each other, and are well within the error ranges calculated by Brohan et al. (2006). The similarities are most striking over the last 70 years, and in the Northern Hemisphere, reflecting the better station coverage.

4.7 Another independent verification of the accuracy of CRUTEM3, for the period 1973-2008, has been published by Simmons et al. (2010). CRUTEM3 is compared with reanalysis data which are, essentially, current weather forecast data, updated each day with new observations. The correlation between the two global series is extremely close, and between 0.96 and 0.99 for the six major continents (Antarctica was excluded because of lack of sufficient data for this analysis).

4.8 There is excellent agreement between the three independently developed series at the global and hemispheric scales. The new reanalysis data agree almost completely with CRUTEM3 when averaged over the regions for which CRUTEM3 has data.

## **5. Concluding Comments from the Vice-Chancellor**

The University looks forward to the results of the two reviews of the CRU. Given that the stakes for humanity are so high in correctly interpreting the evidence of global warming, we would meanwhile urge scientists, academics, journalists and public servants to resist the distortions of hearsay evidence or orchestrated campaigns of misinformation, and instead to encourage open, intelligent debate.

10 February 2010

The list of references and Figures are included in the Appendix to the Memorandum.