

WMO, Geneva (21-22 September 2011)

Report of GIFS-TIGGE WG
(Submitted by Zoltan Toth and Richard Swinbank)

1. Introduction

The GIFS-TIGGE working group was established in 2005, first to manage the TIGGE (THORPEX Interactive Grand Global Ensemble) project to support research on ensemble prediction, and second to support the application of ensemble forecasts as the basis of a future Global Interactive Forecast System (GIFS).

The main focus of the working group has been the establishment of the TIGGE data set, comprising regular ensemble forecasts from ten of the leading global numerical weather prediction centres. These data are made available for use by the international research community through three archive centres, fostering collaboration between operational forecast centres and universities. Particular areas of research interest for the GIFS TIGGE WG are:

- *a posteriori* calibration of ensemble forecasts in all its forms (bias correction, downscaling, etc.);
- optimum combination of information from ensemble members produced by multiple models;
- use of information in control forecasts;
- research to support probabilistic forecast products, including developments for GIFS.

The TIGGE data are also invaluable for a much wider range of research and development, including the fields covered by the two other THORPEX working groups - Data Assimilation and Observing System (DAOS) and Predictability and Dynamical Processes (PDP) - and other WWRP working groups, including the Working Group on Numerical Experimentation (WGNE), Socio-economic Research and Applications (SERA) and the Joint Working Group on Forecast Verification Research (JWGFVR).

2. Meetings to progress TIGGE and GIFS

Members of the GIFS-TIGGE working group contributed to several meetings and conferences during 2010/11. The following are of particular note:

8th GIFS-TIGGE WG, Geneva, February 2010

In order to start to develop links with the CBS Severe Weather Forecast Demonstration Project (SWFDP), this meeting was scheduled in parallel with the SWFDP steering group, with a half-day joint session. First, the meeting reviewed progress with the TIGGE project, and recent research based on TIGGE data. Second, the meeting agreed mechanisms for collaboration between the GIFS-TIGGE project and the SWFDP, including representation at each others meetings.

Workshop on Improvement of Weather and Environmental Prediction in Polar Regions Oslo, October 2010.

Following the success of the International Polar Year (IPY), the workshop was held to consider the establishment of a THORPEX Polar Research project. The GIFS-TIGGE WG was represented at the workshop by L. Wilson. The project's objectives would be to improve understanding of the impact of polar processes on polar weather, the assimilation of data in Polar Regions, and the prediction of high impact weather over Polar Regions. TIGGE was considered to be an important example for the design of research databases to support research studies on polar prediction.

7th International Workshop of Tropical Cyclones, la Reunion, November 2010

R. Swinbank (co-chair) and T. Nakazawa (chief, WWRP) attended this meeting. They and several other WG members contributed to the report on probabilistic tropical cyclone forecast products that was presented at a keynote session by G. Foley and C. Landsea. The presentation included several types of probabilistic forecast which could contribute to GIFS. T. Nakazawa chaired a special focus session on the use of TIGGE for tropical cyclone forecast products. The session opened with a presentation by R. Swinbank on TIGGE and plans for development of GIFS, then T. Nakazawa and H. Yu then presented examples of tropical cyclone forecast products developed for the projects currently in progress in the NW Pacific. The special focus session was well attended with some good discussion of the talks; this demonstrated a lot of interest in TIGGE from the TC community.

SWFDDP meeting, Wellington, November 2010

E. Ebert attended a meeting of the Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project (SWFDDP) – the SW Pacific component of SWFDDP, also in November. This helped build links between GIFS-TIGGE and the SWFDDP, and present the potential use of probabilistic TC forecast products in that region. It also proved very helpful to get a better understanding of the needs of users in that region.

Workshop of sub-seasonal to seasonal forecasting, Exeter, December 2010

The aims of this workshop were to review the current capabilities for sub-seasonal to seasonal prediction, to identify high-priority areas for research, and to foster international collaboration. R. Swinbank gave a presentation on TIGGE, which was agreed to be a good example of an international data archive. There was particular interest in development of precipitation products based on TIGGE forecasts, for regions including the La Plata Basin in S. America and parts of Africa. The meeting recommended that an international research project on sub-seasonal prediction be established.

9th GIFS-TIGGE WG, Geneva, September 2011

The meeting first reviewed progress of the TIGGE project. Since the previous meeting, several centres have implemented improvements to their global ensemble prediction systems that are contributed to the TIGGE archive, including some significant improvements in model resolution. The archive centres have also benefited from improvements, including developments to the model validation portal at NCAR; enhancements to the ECMWF portal are also planned, supported by funding from the EU via the GEOWOW project.

To support development of GIFS, websites have been established to display prototype products to support forecasts of tropical cyclones, and other high-impact weather events. Two representatives of the SWFDDP steering group attended the meeting. It was agreed that the SWFDDP would provide the GIFS-TIGGE working group with feedback on the prototype products, to establish which products could be adapted for use and evaluation in the SWFDDP subprojects.

As noted in the introduction, the GIFS-TIGGE has taken a particular interest in research on ensemble calibration and combination, plus development and evaluation of forecast products. It was agreed that in future the group should also be a forum to discuss research and development of EPS improvements, including defining initial conditions for ensemble forecasts and taking account of the effect of model errors.

The future membership of the group was considered, and the proposed list of members is shown in Annex A. Annex B lists the actions for WG members and associates that were agreed at the meeting.

3. TIGGE activities

The three archive and data portal centres (ECMWF, NCAR and CMA) each hold copies of the global TIGGE ensemble forecast data set. The archives start in October 2006, so almost 5 years of data are now available from some of the data providers. The archive contains

forecasts from ten global weather prediction centres, although at the time of writing delivery of new forecasts has temporarily been suspended by two of the data providers.

Access to the data set is given to researchers, following a simple registration process. Normally access is granted with a delay of 48 hours after the initial time of the forecast. Real time access is granted in some cases e.g. for field experiments and projects of special interest. Registration for real time access is handled by the WWRP-THORPEX International Programme Office at the WMO. There are a large number of registered users across the three archive centres, but a more meaningful statistic is that there are about 60 active archive users each month – see Figure 1 (note that CMA usage data is incomplete). This is thought to underestimate the number of active users of TIGGE data, since some users access the data via other routes.

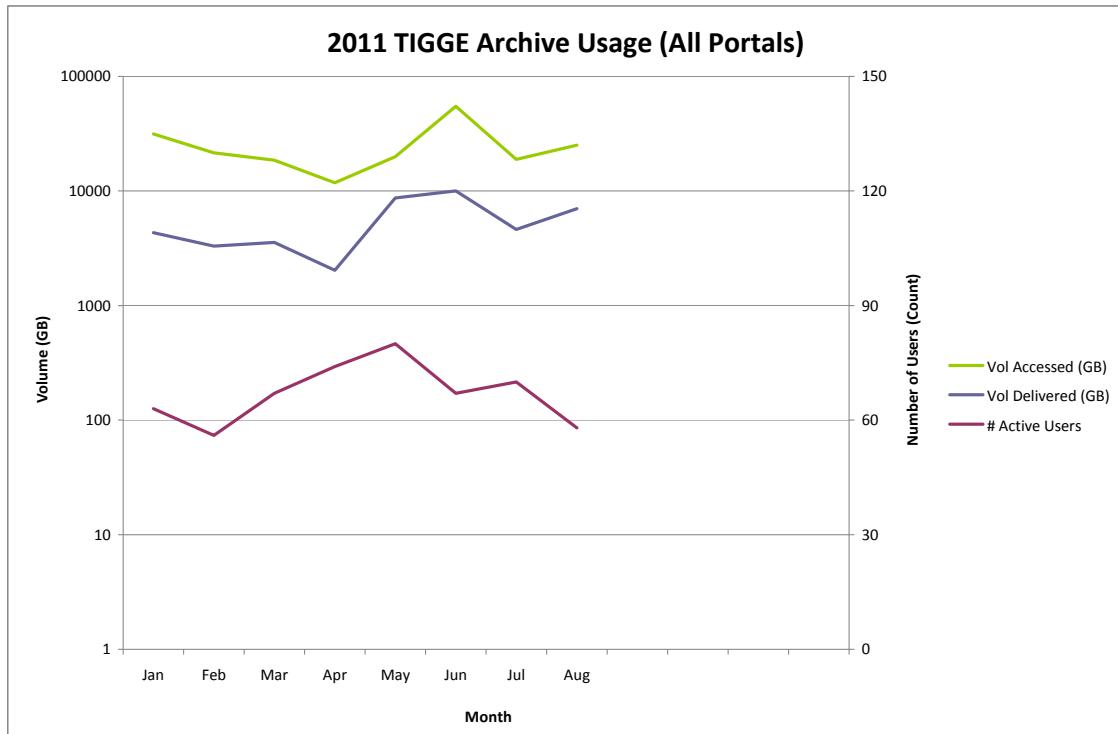


Figure 1 – Time series of monthly usage of TIGGE archive portals during 2011

A TIGGE-LAM expert panel has been established to focus on regional ensemble forecasting, to complement the global focus of the GIFS-TIGGE WG. The panel facilitates the interoperability of the different regional modelling systems contributing and coordinates the archiving of limited-area ensemble forecasts. The three TIGGE archive centres have agreed to host a sub-set of high priority TIGGE-LAM data. The TIGGE-LAM group has recently been restructured into regional sub-groups to allow better focus on regional activities. Regional sub-groups have been formed for North America, Europe, Asia, South America and Africa. The TIGGE-LAM group has also established a strong working relationship with the WWRP/MWFR (Mesoscale Weather Forecasting Research) group.

A major article describing the TIGGE project, and some early results, was published in the *Bulletin of the American Meteorological Society* (Bougeault et al, 2010). Many research projects using TIGGE data are underway, and a steady stream of papers is starting to appear in scientific journals. Up to the end of 2010, 43 articles related to TIGGE have been published in the scientific literature. A research topic particularly relevant to TIGGE is the benefit of combining ensemble prediction from multiple centres. Research studies have demonstrated that combination of multiple ensembles improves the skill of forecasts of surface air temperatures, compared to any single ensemble. More recent (as yet unpublished) studies have also confirmed the improved skill in precipitation forecasts.

TIGGE data has also been used for a range of predictability studies, including forecasts of extratropical cyclone and predictions of tropical cyclone tracks.

In order to increase awareness of TIGGE, the working group, with support from the THORPEX IPO, has produced a leaflet to help publicise the TIGGE project at scientific meetings. Additional information about the TIGGE project and plans for GIFS has also been added to the TIGGE website, which is hosted by ECMWF. As well as being part of THORPEX, TIGGE is GEO (Group on Earth Observations) task WE-06-03. A section illustrating the use of TIGGE data to support the forecasting of Tropical Cyclones was included in the GEO book "*Crafting Geoinformation*" (GEO, 2010), and an article based on the same forecast case study was published in the *WMO Bulletin* (Mc Caslin et al, 2010)

4. GIFS developments

TIGGE is paving the way towards the development of a Global Interactive Forecasting System (GIFS), as envisaged in the THORPEX international research implementation plan. In order to carry this work forward, a GIFS development project has been established. A phased approach has been adopted, starting with the real-time exchange of tropical cyclone track forecasts, using a new XML-based format (known as CXML), during the T-PARC field programme. The exchange of tropical cyclone forecasts has been maintained, for the ongoing NorthWest Pacific Tropical Cyclone Project and other regional demonstration projects.

The aim of the GIFS development project is to establish a framework for the experimental provision of products to enhance the prediction of high-impact weather and evaluation of those products. The GIFS development project will support the development of additional forecast products to contribute to the regional subprojects of the SWFDP. This project will enhance links between WWRP-THORPEX and the operational weather forecasting community, and allow products based on TIGGE forecasts and multi-model ensemble to supplement the data available from the SWFDP to operational forecasters. Several of the partners in the GIFS-TIGGE project have developed products that use the tropical cyclone forecasts exchanged using CXML. MRI/JMA has developed a website to display tropical cyclone forecast products for the NW Pacific project, while Météo-France has set up a TC website to support the Southern Africa SWFDP subproject. MRI/JMA has also developed a website of prototype high-impact weather products based on gridded fields from the TIGGE data set. It is planned that these products would form the basis for products to be used in some of the SWFDP regional subprojects. Objective verification and user evaluation of the GIFS products will be a key part of this collaboration.

References

Bougeault, P., Z. Toth, C. Bishop, Barbara Brown, David Burridge, De Hui Chen, Beth Ebert, Manuel Fuentes, Tom Hamill, Ken Mylne, Jean Nicolau, Tiziana Paccagnella, Young-Youn Park, David Parsons, Baudouin Raoult, Doug Schuster, Pedro Silva Dias, Richard Swinbank, Yoshiaki Takeuchi, Warren Tennant, Laurie Wilson and Steve Worley, 2010: The THORPEX Interactive Grand Global Ensemble (TIGGE). *Bull. Amer. Meteorol. Soc.*, **91**, 1059–1072.

GEO, 2010: "*Crafting geoinformation*", available from www.earthobservations.org/documents/geo_vii/geo7_crafting_geoinformation.pdf

McCaslin, P., T. Nakazawa, R. Swinbank and Z. Toth, 2010: Improving cyclone warning Case study: Philippines. *WMO Bulletin*, **59**(2), 79-81.

Annex A: Proposed GIFS-TIGGE WG membership, for endorsement by ICSC

Richard Swinbank, co-chair,	Met Office, UK
Young-Youn Park, co chair	KMA, Korea
Laurie Wilson	EC, Canada
Tiziana Paccagnella	ARPA-SIM, Italy
Gong Jiandong	CMA, China
David Richardson	ECMWF, UK
Masayuki Kyouda	JMA, Japan
Michael Naughton	BoM, Australia
Philippe Arbogast	Meteo-France, France
Oswaldo Moraes	CPTEC, Brazil
Doug Schuster	NCAR, USA
Yuejian Zhu	NOAA/NCEP, USA

The entries in **bold italics** are changes since ICSC-8 and require approval by ICSC.

Annex B: Actions from 9th meeting of GIFS-TIGGE WG

Permanent Actions

Action P.1: All archive centres to update statistics on TIGGE data users on an annual basis (end of each year), using similar statistics for users, active users, etc. Doug Schuster to coordinate.

Action P.2: Young-youn Park and Mio Matsueda to carry out literature search for papers based on TIGGE data, and summarise results. Archive centres to ask users to inform them when TIGGE papers are written, to enable the list of TIGGE publications to be kept up to date.

Action P.3: All data providers to provide model descriptions in agreed Excel format and to update the files after significant changes and send to ECMWF.

Action P.4: Co-chairs to request reports before each WG meeting on all actions, plus relevant progress reports.

New & amended Actions

Action 9.2.1: Co-chairs to establish contact with Thomas Jung (chair of polar project), establishing collaboration with polar project

Action 9.2.2: Co-chairs to establish links with new sub-seasonal to seasonal prediction project especially David Anderson (consultant), and Frederic Vitart and Andrew Robertson (co-chairs) to maximise compatibility between the new project archive and the existing TIGGE archive.

Action 9.2.3: Co-chairs to report on status of collaboration with SWFDP project at WWRP/JSC5 meeting, Spring 2012.

Action 9.2.4: WG members to consider developing an article reviewing TIGGE research in refereed literature, for discussion next WG meeting.

Action 9.3.1: All data providers are encouraged to provide T+0 data at 0 and 12 UT at least, 6 hourly if available, in consultation with archive centres.

Action 9.3.2: WG members to inform JMA by Nov 11 (ET-EPS meeting) what they propose to supply to WMO Lead Centre on EPS verification, and when.

Action 9.3.3: WG members to consider joining SNAP (Stratospheric Network on Assessment of Predictability) project and contribute ensemble forecast output fields to the SNAP project archive.

Action 9.3.4: WG members to consider adding to training material on the TIGGE data portals, including data access and manipulation examples, to help potential users of the TIGGE archive.

Action 9.4.1: Tiziana Paccagnella to arrange for report on European TIGGE-LAM interoperability to be circulated for the benefit of related activities in other regions by Dec 11.

Action 9.5.1: Co-chairs to arrange representation at the SWFDP SG meeting in early 2012 and use this meeting to establish links with RSMCs Pretoria, Wellington & Nairobi

Action 9.6.1: Tetsuo Nakazawa to request MRI to prepare questionnaire to obtain feedback from users of websites, including suggestions for improvement

Action 9.6.2: WG members encouraged to contribute additional products to the MRI TC website.

Action 9.6.3: Co-chairs to consider inviting an expert from HFIP to next WG meeting.

Action 9.6.4: TIGGE-LAM panel is encouraged to assess skill of TC intensity forecasts in high-resolution models.

Action 9.6.5: All data providers are invited to add central pressure information and max wind information to CXML, using conventions to be agreed, based on current practices.

Action 9.6.6: All data providers are encouraged to carry out TC forecast verification

Action 9.7.1: Co-chairs to invite Celeste Saulo to submit a formal application for a WWRP FDP/RDP based on weather elements of La Plata Basin project, in order to formalise links with GIFS-TIGGE.

Action 9.7.2: David Richardson to provide a report regarding application of EPS to hydrology.

Action 9.7.3: Mio Matsueda to draft brief documentation , including health warnings, of extreme weather products and work with co-chairs to finalise by Feb 2012

Action 9.7.4: SWFDP RSMCs invited to evaluate prototype products on Mio Matsueda's website and report back to next GIFS-TIGGE WG meeting, to assess requirements for near real-time versions of the products.

Action 9.8.1: Co-chairs to create new agenda item on EPS improvement for next WG meeting.

Action 9.8.2: KMA, NCEP, MO, MF, ECMWF, JMA, CMA to nominate people to form a TC focus group which will prepare a report on TC forecast product developments for next WG meeting. Names to be sent to co-chairs, by end Oct 2011. The WG seeks a volunteer to act as focal point for this group.

Action 9.8.3: All data providers to nominate people to form a precipitation focus group which will prepare a report on precipitation forecast product developments for next WG meeting. Names to be sent to co-chairs, by end Oct 2011. The WG seeks a volunteer to act as focal point for this group.

Action 9.10.1: Co-chairs to contact Pedro Silva Dias to request a nomination of a new representative from CPTEC, before ICSC-9 meeting.