

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

1. Summary

Currently all ten global weather prediction centres are providing ensemble forecasts to the three TIGGE data archive centres. All three global archive and data portal centres (ECMWF, NCAR and CMA) have all now been operational for at least one year. The archives contain data starting in October 2006, so now contain data for more than three years from some providers. Under a simple registration process access is given 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. The number of users is currently over 200 (combining the number of users of all three archive centres) – although this is thought to underestimate the number of active users of TIGGE data, since some users access the data via other routes. A general announcement that the TIGGE capability and service is available to users was made via the AGU publication EOS – see Annex 1.

Early science results indicate that multi-model ensemble forecasts are in general better than the forecasts of the best component system. The benefit appears to be clearer for fields such as surface air temperature, but only marginal for dynamical variables such as sea level pressure or geopotential height. Furthermore, the gain is highly variable depending on component systems, parameters, forecast ranges and bias corrections applied. More research is needed to establish the cost/benefits of operational multi-model systems. Research papers based on the TIGGE data set are now starting to be published in peer-reviewed journals.

A TIGGE-LAM expert panel has been set up to define arrangements for TIGGE-LAM databases, building on the global TIGGE arrangements as much as possible. The priority here is to develop standard formats enhancing the interoperability of the existing systems. Another objective is to facilitate the use of lateral boundary conditions from various global systems by limited-area models.

TIGGE is paving the way towards a Global Interactive Forecasting System (GIFS). An urgent development to make GIFS a reality is to accelerate data exchange between the partners and a phased approach has been adopted. A pilot project, based on the real-time exchange of tropical cyclone tracks, was successfully run during the T-PARC field programme. In order to carry this work forward, it is proposed to establish a GIFS Research and Development Project (GIFS-RDP). The GIFS-RDP will provide a framework for the experimental provision of products to enhance the prediction of high-impact weather. It is planned that GIFS-RDP will initially operate alongside regional subprojects of the CBS Severe Weather Forecast Demonstration Project (SWFDP). This will enhance links between WWRP-THORPEX GIFS 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. Objective verification and user evaluation of the GIFS products will be a key part of GIFS-RDP. For further details, see the draft GIFS-RDP proposal (item 7.2).

2. Meetings

The Third THORPEX International Science Symposium, held in Monterey in September 2009, included a TIGGE user workshop. The components of the TIGGE user workshop included:

- A joint presentation on the TIGGE archive on behalf of the three archive centres
- Hands-on user demonstrations of how to access the TIGGE archive by representatives of all three data centres
- The opportunity for users to provide feedback to archive centres and data providers.
- Presentations on some early results of research based on TIGGE data.
- Presentation and discussion of plans for the development of GIFS.
- The opportunity to get involved in focus groups to contribute to technical developments for GIFS.

The GIFS-TIGGE working group held a brief meeting after the symposium session on 15th September. Minutes of this meeting are shown in Annex II.

A longer working group meeting is proposed in which details of plans for GIFS and the GIFS-RDP will be discussed with other interested parties, including WWRP, THORPEX, CBS and representatives of other THORPEX regional committees and working groups. This meeting is expected to take place in Geneva in February 2010.

To develop detailed technical solutions in support of the technical implementation of GIFS and the GIFS-RDP (including generation of different products, such as TC, PQPF), it is proposed to create two focus groups:

- **Focus Group 1:** Access to and distribution of real time and archived ensemble data
- **Focus Group 2:** Ensemble-based products and services for high impact events

During the THORPEX science symposium an additional meeting was held for those who were interested in participating in either of the GIFS focus groups. Further details of this meeting are given in Annex III.

ANNEX I

Improving High Impact Weather Forecasts

To accelerate improvements in 1-day to 14-day high impact weather forecasts, the World Meteorological Organization's (WMO) World Weather Research Programme established the Observing System Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble (TIGGE) in 2005. The key objectives of TIGGE are enhanced international collaboration on ensemble prediction, determining new methods for combining ensembles from different sources, gaining a deeper understanding of forecast error and the feasibility of interactive ensemble systems, and developing a prototype for a future Global Interactive Forecasting System (GIFS).

Scientific data needs and technical implementation for TIGGE were first considered in by international representatives from many weather prediction and weather research centers. A two-phased approach was planned. In phase 1, which became operational in 2006, the data are collected in near real-time at centralized TIGGE Archive Centers and redistributed worldwide with a short delay. In Phase 2, which is now proposed to begin in 2009, archiving will be decentralized (widely distributed), with more focus on real-time access directly from the data providers through a common interface employing Web-based technologies. Here, we report on the implementation and status of Phase 1.

Building Weather Forecast Archives

Three archive centers have been formed to receive, archive, and distribute ensemble model weather forecast data from 10 international data providers (Table 1). The TIGGE archive centers are hosted at the China Meteorological Administration (CMA), the European Center for Medium-Range Weather Forecasts (ECMWF), and the National Center for Atmospheric Research (NCAR).

The international community has recognized and agreed that the collection of ensemble data products needs to be as homogeneous as possible to make research easy across multiple forecast systems. To that end, it was agreed that a set of 73 gridded meteorological data fields would constitute the TIGGE standard collection: 28 single level fields, five fields on eight pressure levels between 1000 and 200 hectopascals, geopotential height at 50 Hectopascals, potential vorticity (PV) on the 320°K potential temperature surface, and three fields on the ± 2.0 PV surface. Details about the parameter fields are in the electronic supplement to this Eos issue (http://www.agu.org/eos_elec/). The new WMO Gridded Binary (GRIB) Edition 2 data format was chosen for TIGGE because the format is designed to hold ensemble data. ECMWF brought together these details by defining lists of GRIB2 codes, creating tables and templates for each parameter, and obtaining clarification and acceptance for new parameters from WMO.

Data providers are encouraged to submit all of the standard fields, but they are not required to do so. Details about the current state of archive completeness are in the electronic supplement. Several other data archive dimensions are independently determined by the providers and reflect their forecast systems: number of forecasts per day, forecast duration, and number of ensemble members (Table 1). Data providers are free to upgrade their ensemble prediction systems and are requested to coordinate changes with the archive centers. Metadata describing the changes are maintained and made accessible by the data providers. After a testing period, the first data arrived at the archive centers in October 2006, and by February 2008 all 10 providers were adding to the TIGGE Archives.

The Unidata Internet Data Distribution, Local Data Manager (IDD/LDM) (<http://www.unidata.ucar.edu/>) system is the primary data transport mechanism used between the archive centers. Some data providers also use IDD/LDM, and others use FTP and HTTP computer protocols to deliver data to the archives in near real-time. Details about

modes of data transport are shown in the electronic supplement. The data transport is about 1.6 million data fields and 240 gigabytes per day to NCAR. ECMWF and CMA receive somewhat less data because they perform dual roles as archive centers and data providers. The centers receive and share data every day, and to the greatest extent possible they have identical archives.

Access to the Archives

TIGGE data are available to the public for noncommercial research, with a 48-hour delay after the forecast initialization time. Electronic registration and acceptance of the data policy is required for all users. Exceptions to these requirements are granted from the THORPEX International Program Office, e.g. data support for field projects.

The data access interfaces at all three archive centers are similar; however, the systems behind each interface vary considerably. At the ECMWF TIGGE Web site (<http://tigge.ecmwf.int>), users can access a comprehensive set of technical and background documents, news, archive monitoring metrics, and the link to the data access portal. Data access services are provided by the ECMWF Meteorological Archival and Retrieval System and thus users can freely select date ranges from the full period of record, spatial subsetting from the global domain, individual parameter selection, and interpolation across multiple center native grids to a uniform resolution. The output data format is GRIB2.

The NCAR TIGGE portal (<http://tigge.ucar.edu/>) provides access to the most recent two weeks of data through multiple options. Interfaces are available to browse the archive and select forecast files for download, or individual parameters, spatial subsets from the global domain, and user specified grid resolution across multiple centers. Additionally, online data are stored in a directory and file structure system and are available for direct download. The forecast files are only available in GRIB2 format, while users have the option of selecting either GRIB2 or netCDF (Network Common Data Form) output format through the subsetting interface. A selection of tools that perform data access and analysis are listed with links in the portal. Persons with NCAR computing privileges have access to the full period of record. For others, offline files can be restaged for online access.

The TIGGE portal at CMA (<http://wisportal.cma.gov.cn/tigge/>) has features in common with those at ECMWF and NCAR. The portal offers the most recent 10 days of data and an interface for specifying subsetting (temporal range, parameter, levels) across the provider centers. The interface also provides a way to monitor the data processing status and to download data by HTTP and FTP protocols.

The archive centers have had strong collaboration with each other in areas of efficient data transport methods, software for archive preparation, and interface development. The centers interlink with each other, and a community TIGGE user group Web forum (<http://www.unidata.ucar.edu/forums/forum.jspa?forumID=5>) has been created for broad user information exchange.

Modest archive and user access improvements will continue to be implemented at the TIGGE archive centers as resources and specific user needs become apparent.

International coordination for TIGGE Phase 1 and for the forthcoming Phase 2 is through the GIFS-TIGGE working group. The working group meets annually, occasionally in conjunction with other THORPEX meetings. Meeting reports are available from the ECMWF Web site. In March 2009, the TIGGE working group meeting will be expanded to include a users workshop. The meeting date and location will be posted on the archive center portals when they are determined. *[Note – the user workshop took place as part of the THORPEX science symposium in September 2009.]*

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Author Information

Steven Worley and Doug Schuster, NCAR, Boulder, Colo.; E-mail: worley@ucar.edu;
 Phillipe Bougeault and Baudouin Raoult, ECMWF, Reading, U.K.; and De Hui Chen and
 Jiandong Dong, CMA, Beijing

Table 1. Summary of THORPEX Interactive Grand Global Ensemble (TIGGE) Data Providers on 1 May 2008^a

	BOM	CMA ^b	CMC	CPTEC	ECMWF ^b	JMA	KMA	MF	NCEP	UKMO
Number of standard fields out of a recommended set of 73	55	60	56	55	70	61	46	62	59	70
Number of ensemble members	33	15	21	15	51	51	17	11	21	24
Forecast length (days)	10	10	16	15	15	9	10	2.5	16	15
Number of forecasts per day	2	2	2	2	2	1	2	1	4	2

^aAbbreviations are BOM, Bureau of Meteorology Research Centre; CMA, China Meteorological Administration; CMC, Centre Météorologique Canadien; CPTEC, Centro de Previsão de Tempo e Estudos Climáticos; ECMWF, European Centre for Medium-Range Weather Forecasts; JMA, Japan Meteorological Agency; KMA, Korea Meteorological Administration; MF, Météo-France; NCEP, National Centers for Environmental Prediction; UKMO, U.K. Met Office.

^bCMA and ECMWF perform dual roles as data providers and archive centers. NCAR, not shown in the table, is exclusively an archive center.

ANNEX II

GIFS-TIGGE Working Group Meeting

Seventh meeting

1800, 15 September 2009, Driftwood 1, Portola Hotel, Monterey

MINUTES

Present: Zoltan Toth (NOAA), Richard Swinbank (UKMO), Ken Mylne (UKMO), Carole Labadie (Meteo-France), David Monkam (Univ. Douala), Jim Caughey (WMO), David Burridge (WMO), Dave Parsons (WMO), Olivier Talagrand (LMD/CNRS), Tom Hamill (NOAA), Kaustuha Bhattacharya (NCMRWF), Bian Xiaofeng (CMA), Jing Chen (CMA), Tetsuo Nakazawa (JMA), Mio Matsueda (JMA), Laurie Wilson (EC), Tiziana Pacagnella (ARPA-SIM), Craig Bishop (NRL) Baudouin Raoult (ECMWF), Kamal Puri (BoM), David Richardson (ECMWF), Peter Chen (WMO), Doug Schuster (NCAR)

1. Opening

RS welcomed everyone to the meeting. Given the limited time available this evening, RS explained that we would not go through the detailed actions agreed at the previous working group (WG) meeting, but we would instead limit the agenda to the highest priority items. We plan to have a full meeting in a few months' time where issues would be discussed at greater length. Since several attendees were observers or were standing in for regular WG members, all the meeting participants introduced themselves before proceeding with the formal agenda.

2. Publicising TIGGE

RS highlighted the importance of publicising TIGGE to both current and potential users of the TIGGE archive data. A particular priority, to help researchers understand the TIGGE data, is to ensure that the model descriptions that are available on the website are both complete and up to date. He noted that a few centres had still not provided model descriptions in the Excel format agreed previously by the WG.

Action 7.2.1: RS to send a further request to centres which have not provided descriptions in the agreed format.

Action 7.2.2: All to provide updates to model descriptions after significant changes

It was suggested that we should publicise both research studies carried out using TIGGE data, and information about ensemble forecasting techniques used by the TIGGE forecast centres. RS noted that the TIGGE website carries a list of TIGGE-related publication, though this is not necessarily up to date.

Action 7.2.3: All to send details of TIGGE-related papers to ECMWF for inclusion on the website.

DB asked the working group to consider ourselves a group of scientists promoting ensemble prediction, rather than just technical experts. RS said that the co-chairs would like to develop the TIGGE website to include more information about the GIFS-TIGGE working group and our meetings, and to include plans for GIFS as they develop. DR confirmed that ECMWF are happy to continue hosting the TIGGE website.

Action 7.2.4: RS & ZT to liaise with DR over expanding material on the TIGGE website
Although the usage of the TIGGE data was thought to be higher than suggested by the raw usage statistics of the TIGGE data, RS said that the WG needs to consider ways to publicise TIGGE both nationally and regionally. DB asked the co-chairs to provide illustrations and write a one-page description to help publicise TIGGE at the GEO plenary. This flyer could also be used for general promotion of TIGGE. DB suggested promoting TIGGE via national Meteorological Societies, and volunteered IPO help.

Action 7.2.5: RS & ZT to provide TIGGE illustrations and write one-pager to help promote TIGGE.

3. GIFS-FDP proposal

RS distributed copies of the latest draft (v4) of the proposal for a GIFS Forecasting Demonstration Project. The aim of the project is to develop and evaluate products to help forecast high-impact weather – specifically tropical cyclones and then heavy precipitation. It is planned to engage with the operational community by initially running GIFS-FDP regional subprojects in conjunction with the CBS Severe Weather Forecast Demonstration Project. The current draft takes into account points raised during the WG teleconference that took place on 10th July. Given that the briefness of this meeting, there would only be limited time for discussion, but the co-chairs would welcome comments sent by email after the meeting. DP commented that the project would be more appropriate as a WWRP research & demonstration project (RDP) than a forecast demonstration project (FDP). Verification should be an important component – including user-oriented verification as well as conventional verification statistics. It was noted that verification should be a key component of evaluating products in an RDP. PC commented that, in practice, it was not possible to do as much verification as intended in the Southern African SWFDP subproject. DB asked for additional feedback to be sent to the co-chairs by the end of September, to allow a revised version to be produced in good time for discussion at the ICSC-8.

Action 7.3.1: All to provide any additional comments to RS & ZT by end of September
ZT asked for volunteers to lead the two prototype product development groups. TN agreed to lead the Tropical Cyclone group, probably in conjunction with a colleague from CMA (to be nominated). KP suggested Beth Ebert would also be interested in co-leading the TC group. Although no-one committed themselves to leading the precipitation group, LW said he would consider this.

4. Proposed extended WG meeting

The next meeting of the GIFS-TIGGE WG is planned to be a joint meeting with WWRP-THORPEX and CBS/SWFDP experts. The main focus of the meeting would be development of details plans for the GIFS-FDP. RS suggested meeting in Geneva in February 2010; this would facilitate participation by WMO staff. It should also be possible to coordinate the WG meeting with a planned meeting of the SWFDP Steering Group which is also proposed for February. It was agreed that this would be a suitable time-frame.

Action 7.4.1: RS/ZT to finalise meeting dates, coordinating with planned SWFDP SG meeting.

5. Any Other Business

RS noted that the planned Shanghai EXPO project in Spring 2010 needs real-time access to CXML cyclone track forecasts. There was general agreement that this should be expedited.

Action 7.5.1: All data providers requested to enable real-time access to real-time cyclone track forecasts..

ANNEX III

GIFS Focus Group Meeting - Thursday 17th Sept 1530, Driftwood 1, Portola Hotel, Monterey.

Present: Zoltan Toth (NOAA), Richard Swinbank (UKMO), Peter Chen (WMO), David Richardson (ECMWF), David Monkam (Univ Douala), Tiziana Pacagnella (ARPA-SIM), Stephane Vannitsem (RMI), John Gaynor (NOAA), Olivier Talagrand (LMD/CNRS), Malaquias Peria (NOAA), Jing Chen (CMA), Tetsuo Nakazawa (JMA), Ken Mylne (UKMO), Warren Tennant (UKMO), Carole Labadie (Meteo-France), Kaustubha Bhattacharya (NCMRWF), Baudouin Raoult (ECMWF), Andrea Montani (ARPA-SIMC), Craig Bishop (NRL), Warwick Norton (Cumulus), Jennifer Adams (COLA), Laurie Wilson (EC), Doug Schuster (NCAR) and (via conference phone) Beth Ebert (BoM)

MINUTES

Zoltan Toth welcomed everyone to the meeting, and all introduced themselves. Beth Ebert participated via the teleconference facility. A sign-up sheet was passed around the room, allowing all to register an interest in taking part in either of the two focus groups. Zoltan had prepared some slides. Although there were no facilities to show them in the meeting room, he used them to outline the proposed roles of the focus groups, principally to agree technical approaches for data exchange, product generation and statistical correction. There was some discussion on how the groups should communicate with one another. It was agreed that initially, email mailing lists would be best. Other methods, such as weblogs may be adopted later. [Doug Schuster agreed afterwards to ask Unidata to host two focus group mailing lists, since they already host the TIGGE users list.]

The role of the proposed focus groups are:

1. Data exchange; archiving; data policy; web interface; exchanging products
2. Product algorithms; shared software tools; bias correction; standards; testing; web interface for product display

There is some overlap between the groups; in response to a query to Baudouin, Zoltan said that the essential distinction was that FG1 was IT-focused, while FG2 was mainly concerned with algorithms.

The initial aim is to develop technical solutions in support of GIFS-RDP.

GIFS should use WIS (WMO Information System) protocols and guidelines. WIS catalogues data using ISO standards. Whilst GTS is used just for exchanging operational data, both GTS and Internet are valid ways to exchange data under WIS. The practicalities of data access, and where products are calculated are to be resolved by the relevant members of the focus groups.

Zoltan listed various groups, mainly US-based, who could potentially contribute to technical work for GIFS. Zoltan said he would like those groups to be engaged with GIFS, and perhaps join the focus groups. RMORPH and CMORPH links should be added to the TIGGE website. Richard asked all to suggest similar groups in other countries who could be added to the list.

Zoltan asked for (one or more) volunteers to coordinate each focus group. Baudouin Raoult agreed to coordinate FG1. Lacking a volunteer, Richard suggested FG2, since it is more product focused, could be coordinated by the product interest group leads. At the GIFS-TIGGE WG, possible coordinators of the interest groups had been discussed. Nakazawa-san had agreed to coordinate the tropical cyclones (with probably someone from CMA, and possibly Beth Ebert). A coordinator for heavy precipitation has not yet been agreed (possibly Laurie?).

Meeting closed at 1625, in time for the symposium session.