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1. INTRODUCTION

TIGGE, the THORPEX Interactive Grand Global Ensemble, is a key component of the World Weather Research Programme intended to accelerate improvements in 1-day to 2-week weather forecasts. Centralized archives of ensemble model forecast data, from many international centers, will be used to enable extensive data sharing and research during Phase I of the project. The designated TIGGE archive centers include the Chinese Meteorological Administration (CMA), The European Center for Medium-Range Weather Forecasts (ECMWF), and The National Center for Atmospheric Research (NCAR). Scientific data requirements and archive planning solidified in late 2005, and archive collection was initiated in October 2006 with receipt of partial sets of parameters from multiple data providers. This paper will review the status and plans for TIGGE at NCAR and ECMWF.

2. DATA COLLECTION AT ARCHIVE CENTERS

The Unidata Internet Data Distribution (IDD) system is used to transport the ensemble model data from the providers to the Archive Centers (<http://www.unidata.ucar.edu/software/idd/>). Currently, the output from the ECMWF, UK Met Office (UKMO), and Japanese Meteorological Agency (JMA) global models, totaling 143 GB/day, is moved at 10 GB/hour from ECMWF to NCAR. Additionally, output from the National Center for Environmental Prediction (NCEP) global model totaling 7 GB/day is transmitted to both NCAR and ECMWF (Table 1).

Data Provider	Conforming Parameters	Fcts/Day	GB/Day	Fields/Day	Ens. Members
ECMWF	70/71	2	115	289,734	51
UKMO	62/71	2	21	175,680	24
JMA	48/71	1	7	52,938	51
NCEP	41/71	4	7	92,084	11

Table1. Summary of TIGGE Forecast Data received at the Archive Centers (NCAR and ECMWF) on Nov. 1, 2006. Number of conforming parameters of the requested set of 71, number of forecast runs per day, number of 2D grids per day, and number of ensemble members per forecast for each of the contributing operational weather forecast centers.

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When other international centers (from Australia, Brazil, Canada, China, Korea and France) join the TIGGE data effort, the flow is expected to top 200 GB/day and be well within the capacity for the IDD. CMA plans on joining the archiving effort after upgrades to their network infrastructure.

3. DATA ACCESS

TIGGE data are delivered in near real-time and by default are available to the public for non-commercial research, with a 48-hour delay after forecast initialization time. Registration is required for all users and will be handled electronically by simple agreement to the TIGGE data policies. Real-time access can be granted by special permission from the THORPEX International Program Office, e.g. for field programs and projects recognized by THORPEX. At NCAR, users can discover data through the TIGGE web portal (<http://tigge.ucar.edu>) and directly download complete forecast files for the most current two to three week period. Forecast files are organized by initialization date/time, data provider, parameter level type (single level, pressure level, potential vorticity level, and potential temperature level), and forecast time-step. All ensemble members are included in each forecast file (deterministic model data are also included in ECMWF forecast files). At ECMWF, users can discover and download data through a web interface linked to the Meteorological Archival and Retrieval System (MARS) <http://www.ecmwf.int/services/archive/>. Each center will offer fast access to terabytes of data kept online and delayed access to the long term archives preserved in their respective archive systems. Offline data will be available by request and through a delayed mode process.

Planned future additions to the TIGGE portals include user specified spatial, temporal, and parameter sub-setting, and uniform interpolation across multiple center output. Interpolation software, to be developed and supported by each data provider, will be implemented at archive centers once available and tested. Interpolation software will also be made available to individual users. Web services that will give users a common interface to request data at all archive centers will be developed and implemented as resources allow.

In cases where access to the TIGGE archive through the Internet is not practical, the data may be copied to writeable media. Media options will be commensurate with the data request size.

Finally, the entire TIGGE archive is also available on the NCAR Mass Storage System (MSS). Access to the MSS is restricted to users with NCAR computer accounts as provided by NCAR's Computational and Information Systems Laboratory (CISL). To apply for an account, please contact Database Services at

dbs@ucar.edu or visit the web page at <http://www.cisl.ucar.edu/docs/access/accounts.html> .

4. DATA FORMAT AND SOFTWARE

TIGGE parameter fields, atmospheric levels, and physical units are consistent across all data from the providers as initially defined by the TIGGE working groups and documented in the workshop report (WMO, 2005). After discussions a finalized list of fields and levels was agreed upon and is now available at <http://tigge.ecmwf.int/>. Data will be stored in GRIB-2 format with parameter encoding also consistent across all data providers. GRIB-2 TIGGE parameter encoding definitions can also be found at <http://tigge.ecmwf.int/>.

In contrast to parameter fields and format, each data provider may submit their model output in a resolution they choose (Table 2). This will allow for research opportunities to study the impact of model resolution. As discussed above, Archive Centers will provide services for user selected sub-setting and interpolation in mid-2007. Until then, it will be the user's responsibility to perform any of these operations.

Data Provider	Model Resolution
ECMWF	N200 (Reduced Gaussian)
UKMO	1.25 x 2/3 Deg Lat/Lon
JMA	1.25 x 1.25 Deg Lat/Lon
NCEP	1.00 x 1.00 Deg Lat/Lon

Table 2. Model Grid Resolutions received from the providers at the TIGGE Archive Centers on Nov. 1, 2006

4.1 Software

TIGGE data analysis tools include the NCAR Command Language (NCL), ECMWF's GRIB-API, and Unidata's Gempack software. As GRIB-2 is a relatively new standard, analysis tools may only provide basic functionality in initial releases. Links to the supporting sites of analysis software can be found through the NCAR TIGGE web portal (<http://tigge.ucar.edu>).

5. SUMMARY

The TIGGE data archive provides a valuable resource for research of probabilistic forecast techniques. Archive Centers at ECMWF and NCAR are currently collecting and archiving 150 GB/day of global ensemble model data from ECMWF, UKMO, NCEP, and JMA. Additional data providers plan on initiating TIGGE data contributions in the near future. Access to the TIGGE archive is offered in several ways:

- Forecast files organized by model initialization date/time, data provider, parameter level type, and forecast time-step (the most recent two to three weeks of forecast data available for immediate download at NCAR).
- Data may be provided on writeable media, upon request.
- All TIGGE data are available to NCAR users from the MSS.
- Subset and interpolated grids across all data providers will be available by delayed mode processing by mid-2007.

The primary focus is to provide a high quality archive with an emphasis on data delivery. The NCAR TIGGE archive has been designed to promote efficient access for a large variety of users and requests. It is actively supported by data specialists who provide: consultation on the archive products; locally developed software; and individual requests that require non-routine data processing and possible data delivery on media. Basic data services and access methods for the archive are now available with additional services coming in the near future.

References

WMO, 2005: *First Workshop on the THORPEX Interactive Grand Global Ensemble (TIGGE)*. WMO, TD-No.1237, http://www.wmo.int/thorpex/pdf/tigge_first_workshop_report.pdf