Global Hydrology Resource Center

Data User Guide

GRIP Hurricane and Tropical Storm Forecasts

Introduction

The GRIP Hurricane and Tropical Storm Forecasts dataset consists of tropical cyclone model forecast tracks archived during the NASA Genesis and Rapid Intensification Processes (GRIP) field campaign. GRIP was one of three hurricane field campaigns conducted during the 2010 Atlantic/Pacific hurricane season. This tri-agency effort included NASA GRIP, the NSF Pre-Depression Investigation of Cloud-systems in the Tropics (PREDICT) and the NOAA Intensity Forecasting Experiment 2010 (IFEX10). The hurricane and tropical storm forecasts data files are available from August 12 through November 14, 2010 in ASCII text format with browse files in KML format, viewable in Google Earth. The ASCII text files contain 5-day model "consensus" forecasts and the KML browse files contain model forecasts ranging from 5-days to 10-days.

Notice:
The storm track files provided in this dataset do not include all of the tropical weather systems observed during the course of the campaign.

Citation

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Keywords:

NASA, GHRC, GRIP, NSF, PREDICT, NOAA, IFEX10, NHC, CPHC, easterly wave pouch, tropical cyclone, hurricane, rapid intensification, numerical weather prediction

Campaign

The NASA Genesis and Rapid Intensification Processes (GRIP) field campaign was an in-depth study of the formation and intensification of tropical cyclones from August 15 through September 30, 2010, during the Atlantic/Pacific hurricane season. The campaign coordinated with two other hurricane field campaigns; the National Science Foundation (NSF) Pre-Depression Investigation of Cloud-systems in the Tropics (PREDICT) field experiment and the National Oceanic and Atmospheric Administration (NOAA) Intensity Forecasting Experiment 2010 (IFEX10). GRIP specifically aimed to study the genesis and rapid intensification of tropical storm systems. The team looked to gain an in-depth look at how tropical easterly waves develop into tropical cyclones and examine the rapid strengthening process of these tropical cyclone systems. Tropical easterly waves are cyclonic disturbances that move from East to West within the Trade Winds. GRIP and the partnering campaigns used the *marsupial method* developed by Wang et al (2009) to track tropical easterly wave pouches. The *marsupial method* (*marsupial* meaning "resembling a pouch") aims to locate the initial areas of closed circulation called "pouches", that are imbedded within easterly waves. These "pouches" are monitored as locations of interest for tropical cyclone formation and development.

The GRIP campaign utilized an extensive network of ground instruments, airborne instruments onboard the NASA DC-8, Global Hawk, and WB-57 aircraft, and satellite observations. GRIP had an additional goal of applying new technologies to hurricane research. The team was able to observe and collect data from Hurricane Karl, Tropical Storm Matthew, Tropical Storm Gaston, and Hurricane Earl (Figure 1) from genesis to mature tropical cyclones. Notably, the campaign was able to observe the rapid intensification of Hurricanes Earl and Karl. The GRIP campaign gathered extensive data on hurricane development that contributed to the advancement of hurricane monitoring and forecasting capabilities. More information about the GRIP field campaign is available on the GRIP Field Campaign Project Homepage.

Figure 1: Hurricane Earl during the GRIP Field Campaign
(Image source: NASA GHRC Flickr)

Instrument Description

Weather forecast models are tools used to help predict the future state of the weather or atmosphere. There are various types of weather forecast models that each use a different prediction method. The main model types include dynamical (i.e., numerical), statistical, statistical-dynamical, trajectory, and consensus/ensemble. Dynamical forecast models are essentially computer programs that run mathematical simulations of the Earth's atmosphere largely based on the Equations of Motion, in order to predict a future state of the atmosphere. Statistical forecast models utilize statistical equations to forecast the behavior of a weather system based on the behavior of past systems. Statistical-dynamical models employ prediction methods from both of the previous two types. Trajectory models use output from a dynamical model to predict a storm track based on the dominant atmospheric flow acting on that particular weather system. Consensus/Ensemble models are those that consist of more than one model. In particular, consensus models show an average of the outputs from a number of different models while ensemble models demonstrate uncertainty by showing the variation between model results when they are run with slightly different initial conditions. More information on the types of weather forecast models is available on the NHC Track and Intensity Model webpage.

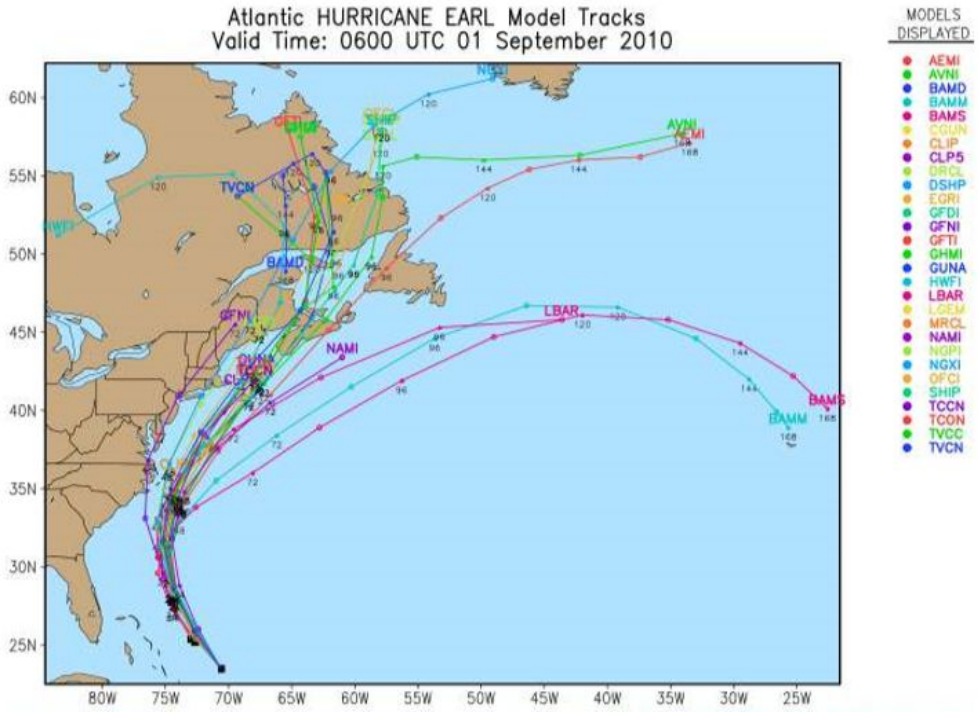

Figure 2: Image of model track predictions for Hurricane Earl
(Image source: GRIP Field Campaign Report)

Investigators

Michael Goodman
NASA MSFC
Huntsville, AL

Data Characteristics

The GRIP Hurricane and Tropical Storm Forecasts dataset consists of daily ASCII text data files and KML browse files containing model forecast tracks. These data are available at a Level 1A processing level. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	Global Forecast System (GFS), Global Ensemble Forecast System (GEFS), Beta and Advection Model (BAM#), Climatology and Persistence Model 5-day (CLP5), Hurricane Weather Research and Forecasting (HWRF) model, United Kingdom Met Office (UKMET) model, Track Consensus (TVC#) model, Navy Operational Global Atmospheric

	Prediction System (NOGAPS), Limited Area Barotropic Model (LBAR), Geophysical Fluid Dynamics Laboratory (GFDL) model, Official National Hurricane Center/Central Pacific Hurricane Center Forecast (OFC#)
Instrument	N/A
Spatial Coverage	N: 87.6 , S: 0.8 , E: 0.0 , W: -178.5 (Atlantic/Eastern Pacific Oceans)
Spatial Resolution	Varies
Temporal Coverage	August 12, 2010 - November 14, 2010
Temporal Resolution	Daily
Sampling Frequency	Hourly
Parameter	Latitude/Longitude
Version	1
Processing Level	1A

File Naming Convention

The GRIP Hurricane and Tropical Storm Forecasts dataset files are available in ASCII text and KML format (for Google Earth). The time listed in the file name is the initialization time of the model run. These files are named using the following convention:

Data files: grip_storm_YYYYMMDDhhmm_consensus-forecast.txt
Browse files: grip_storm_track_fcst_<##L>_<forecast type>_YYYYMMDDhhmm.kml

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit initialization year
MM	Two-digit initialization month
DD	Two-digit initialization day
hh	Two-digit hour (UTC)
mm	Two-digit minute (UTC)
<##L>	Two-digit "pouch" ID number (01L - 99L)
<forecast type>*	Forecast Type: *early_latest*, *ensemble_latest*, or *late_latest*
.txt	ASCII text file format
.kml	Google Earth file format (Keyhole Markup Language - KML)

*See *Data Format and Parameters* section for more information on forecast types

Data Format and Parameters

The GRIP Hurricane and Tropical Storm Forecasts dataset files are available in ASCII text and KML format. The files contain the forecasted tracks for the "pouches" during the campaign. The ASCII text data files contain the model consensus forecast output. The KML browse files contain the latest available run of the "early", "late", and "ensemble" forecasts. Most numerical weather models are run every 6 hours at 0000 UTC, 0600 UTC, 1200 UTC,

and 1800 UTC. When a system reaches tropical cyclone status, the National Hurricane Center (NHC) releases public advisories at 0300 UTC, 0900 UTC, 1500 UTC, and 2100 UTC. Because it takes numerical weather models several hours to run, the model run closest to the official forecast release time is often not complete by the time of release. To address this issue, the previous completed forecast run is adjusted forward 6 hours to be valid for the next forecast time. This adjusted model run is classified as "early". "Late" signifies the run of the model after it has fully completed. This process is described in more detail on the NHC Track and Intensity Model webpage. More details on the ASCII and KML files are described below.

Note:
Times may be formatted as "1200 UTC" or "12Z". The "UTC" stands for "Coordinated Universal Time", which is a universal time system that allows the same time to be reported around the world. It is defined as the time in Greenwich, England. The "Z" stands for "Zulu time", which is the same as "UTC time".

ASCII Data Files

The ASCII text files consist of the 5-day (0 - 120 hours) "consensus" forecasts for each pouch. Each file contains 8 fields listing the location of each "pouch" on an hourly basis. Each field is described in Table 3 below.

Table 3: Data Fields

Field Number	Description	Unit
1	Pouch number given during the campaign	-
2	Pouch ID as *PGI##L* where: PGI = PREDICT-GRIP-IFEX ##L = 01L - 99L (pouch number)	-
3	Date in *YYMMDD* where: YY = two-digit year MM = two-digit month DD = two-digit day	-
4	Four-digit hour (UTC)	-
5	Latitude	degrees
6	Longitude	degrees
7	Ocean region (ATL -- Atlantic)	-

KML Browse Files

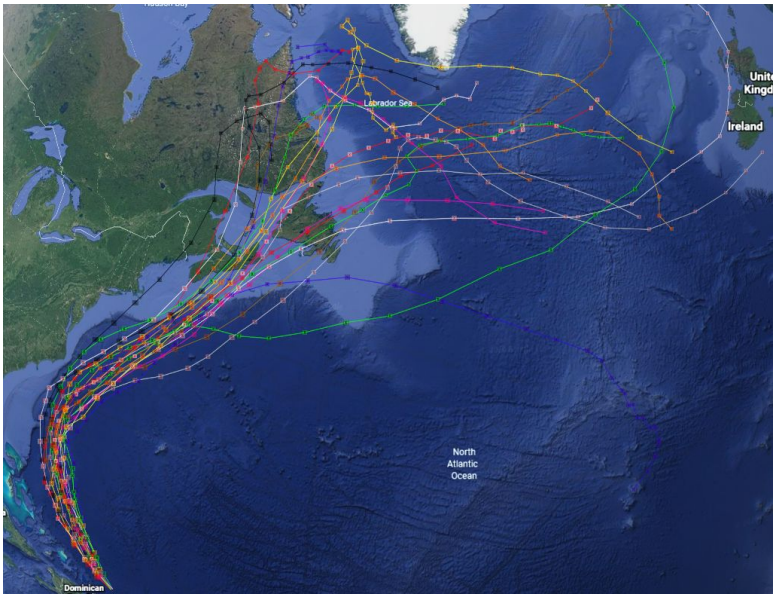

Figure 3: Google Earth KML file for PGI*07L* on August 31, 2010

The **early_latest*, **late_latest*, and **ensemble_latest* KML browse files can be displayed in Google Earth. Once downloaded, the KML files can be imported from your computer or Google Drive to be displayed on a Google Earth map. Once imported, the files will display the forecast paths generated by each model for the "pouch" indicated in the filename. Points are plotted along each path every 6 hours, each containing information about the "pouch" and it's forecasted path including the model name, time, forecast time, location, wind speed, and the central pressure. The forecasts range from 5-day (0 - 120 hours) to as far as 10-day (0 - 240 hours) forecasts. More information on how to import the KML files into Google Earth is available on the Google Earth Help webpage. The **ensemble_latest files* display the GFS ensemble forecast tracks. The **early_latest* and **late_latest* files display various "early" and "late" model tracks utilized during the campaign. Each of the models included in the KML files are listed in Table 4 below.

Table 4: Forecast Model Identifiers for the KML browse files

Identifier	Model	Type
AEMN	GEFS mean forecast	Dynamical
AEMI	Previous AEMN forecast adjusted ahead 6 hours	Dynamical
AP##	GEFS member forecast (## = 01 to 20)	Dynamical
AVNO	GFS model forecast	Dynamical
AVNI	Previous GFS forecast adjusted ahead 6 hours	Dynamical
BAMD	Deep-Layer BAM track forecast	Trajectory
BAMM	Medium-Layer BAM track forecast	Trajectory
BAMS	Shallow-Layer BAM track forecast	Trajectory
CLP5	CLP5 track forecast	Statistical
GFDL	GFDL hurricane model forecast	Limited-area dynamical

GFDI	Previous GFDL model adjusted ahead 6 hours	Limited-area dynamical
HWRF	HWRF model forecast	Limited-area dynamical
HWFI	Previous HWRF forecast adjusted ahead 6 hours	Limited-area dynamical
LBAR	LBAR track forecast	Statistical
NGPS	U.S. Navy NOGAPS model forecast	Dynamical
NGPI	Previous NOGAPS forecast adjusted ahead 6 hours	Dynamical
OFCL	Official NHC/CPHC forecast	Official forecast
OFCI	Previous official NHC/CPHC forecast adjusted ahead 6 hours	Official forecast
TVCN	Variable consensus of 2 or more model track forecasts	Consensus
XTRP	Extrapolated (hurricane) model	Extrapolation
EGRR	UKMET model forecast	Dynamical
EGRI	Previous UKMET forecast adjusted ahead 6 hours	Dynamical

Note: The suffix "I" in the model identifier signifies an "early" model.

More information about each model is available on the NHC Track and Intensity Model webpage and the UW-M Hurricane Forecast Model Output webpage.

Algorithm

Numerical weather models utilize governing equations that describe the physical behavior of the atmosphere, numerical methods that allow computers to solve these equations, and parameterizations which are used to account for processes that cannot be explicitly calculated by the model. The models begin with a set of initial conditions that are used to solve mathematical equations and predict the future state of the atmosphere. Forecast models use measurements gathered from various sources including weather balloons, weather stations, satellites, and buoys. Data from current observations are combined with the previous model forecast to update the model to current conditions in a process called data assimilation. More information about how different weather forecast models work is available on the NHC Track and Intensity Model webpage.

Quality Assessment

There is uncertainty that comes with forecast model results. Various approximations and assumptions have to be made in order for the models to run, leading to discrepancies between the model and the actual behavior of the atmosphere. In addition, different forecast models use different approximations and assumptions that often lead to diverging results among models. Models are simply used as guidance tools when creating weather forecasts. The NHC offers details on the verification process for model results at the NHC Forecast Verification webpage. This site lists model error trends, annual forecast error

trends, and other related information. The ensemble forecast models discussed earlier also help demonstrate this uncertainty.

Software

The ASCII text files can be viewed in any text editor or spreadsheet software such as Notepad++ or Microsoft Excel. The KML files can be imported and viewed in Google Earth. The Google Earth Help webpage lists step-by-step instructions on how to import and view the KML files in Google Earth.

Known Issues or Missing Data

The storm track files provided in this dataset do not include all pouches observed during the course of the campaign. The KML browse files are only provided for pouches 05L-21L and 90L-99L. Inside some of the ASCII data files for 08/31/10, the two-digit day (*DD* in *YYMMDD*) listed for each hour extends past August 31 on to "32" and "33" due to error. Missing data values are denoted by 'NaN'.

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Related Data

All datasets collected during the GRIP field campaign are considered to be related. These datasets can be located by searching 'GRIP' in the GHRC HyDRO2.0 dataset search tool.

Contact Information

To order these data or for further information, please contact:

NASA Global Hydrology Resource Center DAAC
User Services
320 Sparkman Drive
Huntsville, AL 35805
Phone: 256-961-7932
E-mail: support-ghrc@earthdata.nasa.gov
Web: https://ghrc.nsstc.nasa.gov/

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