Drag Coefficient Distribution and Wind Speed Dependence in Tropical Cyclones

Mid Year Progress Report to the Joint Hurricane Testbed

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Project Abstract

This project will update the most recent measurements of surface drag coefficient (Cd) in hurricanes to extend the measurements to mean boundary layer (MBL) winds over 70 m/s. All available GPS sonde profiles collected in hurricanes from 1997-2004 will be processed, stored in a modern relational database, quality controlled, and organized by mean boundary layer wind speed, storm relative location, and water depth. Profiles will be averaged and analyzed to provide updated values of surface stress, roughness, and Cd as a function of wind speed, storm-relative azimuth, and water depth. These mean profiles and associated derived surface exchange quantities will be made available to modelers to evaluate existing model surface layer momentum flux packages as well as develop new parameterizations for the coupled H-WRF model. The proposed effort is applied towards numerical weather prediction priorities EMC-1 and EMC-2.

Progress Report:

During the first few months of the project we have focused on database design, sonde inventory, and developing a prototype interface for database queries and organization.

1. The database schema was designed and tested in Oracle 10g and resides on an existing server at HRD.

2. An inventory was assembled to allow the investigators to determine how many sondes have been launched for each research or recon flight, how many were transmitted, and how many were post processed. The inventory contains 3303 sondes from 194 flight missions.

3. Post-processed sondes files have been assembled and we are in the process of loading them into the database. So far, 1027 sonde files for 47 flight missions from 1997-2004 (out of the 3003 total) have been loaded into the database.

4. Storm track files have been constructed for each of the 194 flights in the inventory, which will allow calculation of the radial and azimuthal wind components and storm-relative sonde splash locations.

5. Water depth data have been obtained from the National Geophysical Data Center using the Oct. 2001 version of the 2-minute Gridded Global Relief Data (ETOPO2) from the World Data Center for Marine Geology and Geophysics in Boulder CO. These data have been added to the database so water depth is associated with each sonde splash location.

6. The large amount of sonde data makes analysis difficult without modern database software. An interface has been constructed to allow examination of the sonde inventory, uploading newly processed files, updating files that have already been processed, and to conduct queries of the sonde data. While this interface and software and been developed specifically for this project to

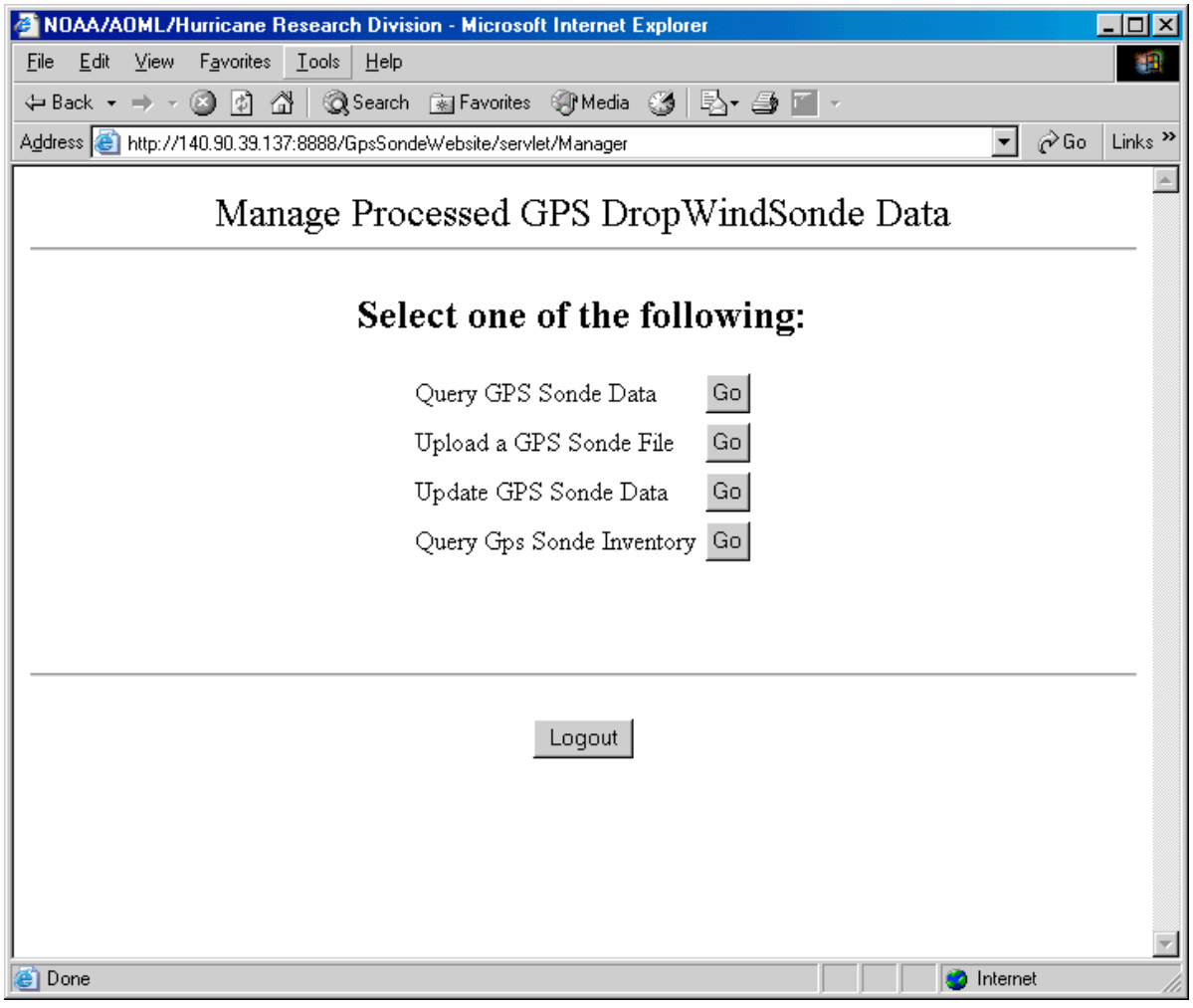


Fig. 1 Prototype interface for GPS sonde database queries.

assist in analysis, it is possible that it may be appropriate for more general use after completion of the project. The interface software is not considered a deliverable for this particular project but has been developed to assist in the forthcoming analysis.

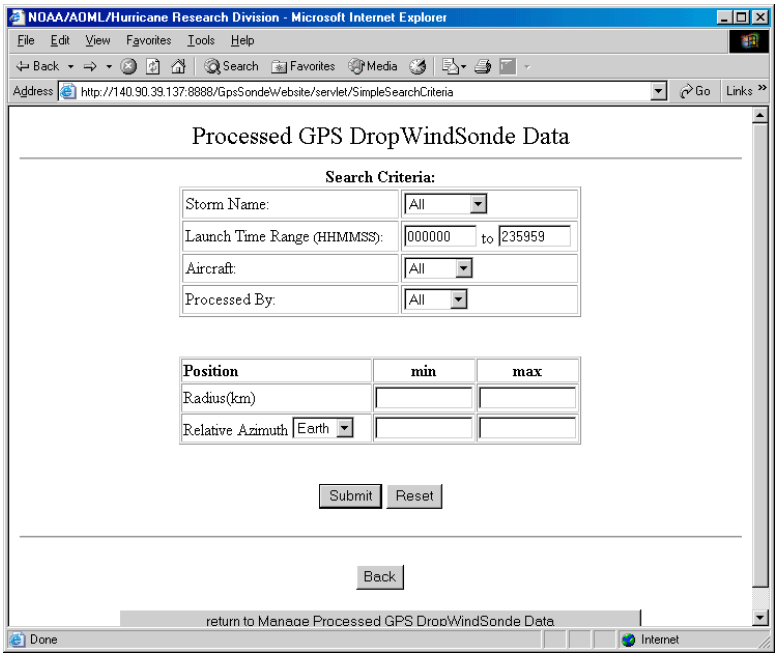


Fig. 2 Screen grab of prototype interface for initial search of the sonde database.

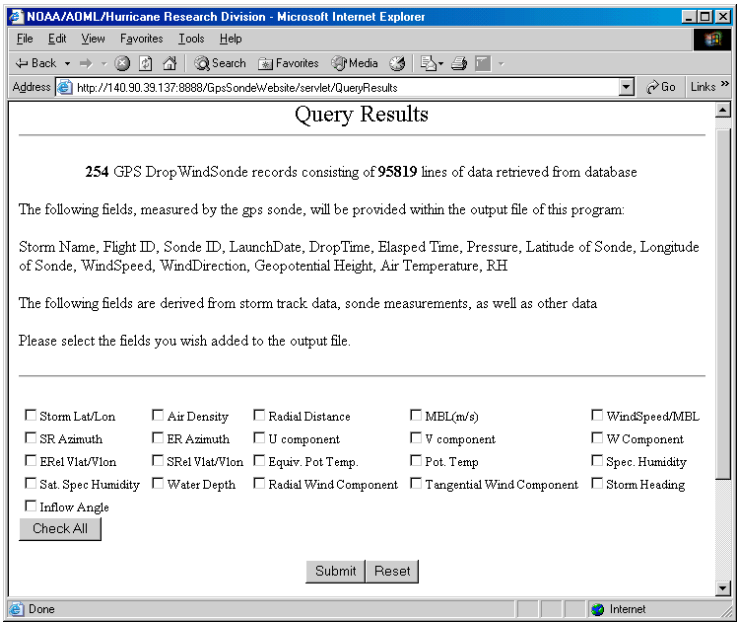
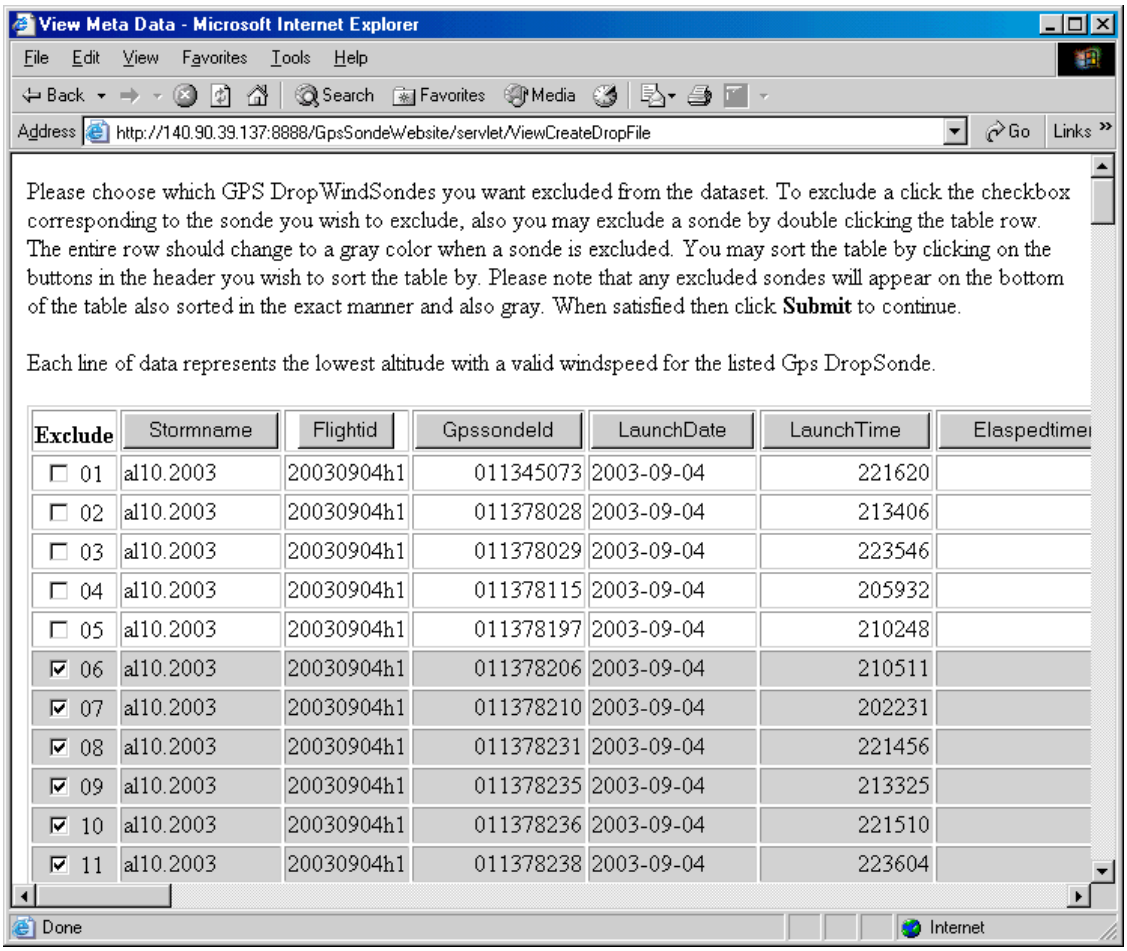


Fig. 3 Screen grab of prototype interface showing fields that can be displayed and sorted to help refine data queries.



Exclude	Stormname	Flightid	GpssondeId	LaunchDate	LaunchTime	Elaspedtimer
☐ 01	al10.2003	20030904h1	011345073	2003-09-04	221620	
☐ 02	al10.2003	20030904h1	011378028	2003-09-04	213406	
☐ 03	al10.2003	20030904h1	011378029	2003-09-04	223546	
☐ 04	al10.2003	20030904h1	011378115	2003-09-04	205932	
☐ 05	al10.2003	20030904h1	011378197	2003-09-04	210248	
☑ 06	al10.2003	20030904h1	011378206	2003-09-04	210511	
☑ 07	al10.2003	20030904h1	011378210	2003-09-04	202231	
☑ 08	al10.2003	20030904h1	011378231	2003-09-04	221456	
☑ 09	al10.2003	20030904h1	011378235	2003-09-04	213325	
☑ 10	al10.2003	20030904h1	011378236	2003-09-04	221510	
☑ 11	al10.2003	20030904h1	011378238	2003-09-04	223604	

Fig. 4 Screen grab of results of prior query. Any column can be sorted and the scientist can then exclude files based on the sorting criteria.

7. The interface also allows sorting of sondes according to the criteria of the project, e.g. Date, Storm, radius, azimuth, water depth, MBL wind speed, etc. After conducting the sorting, a metadata file is generated that contains pertinent data consisting of one line per sonde. The metadata file is an ascii column oriented file that can easily be brought into a spreadsheet or other analysis package. After finalizing the metadata, the scientist can then query the database to construct a concatenated file containing all the sonde data that meet the criteria of the query. For example, all sondes for azimuths 340-090 degrees, for MBL wind speeds of 50-59 m/s, in water depths of < 200 m could be combined into one file to construct a mean vertical wind speed profile.

8. One of the more time consuming aspects of the project is to integrate a database of flight-level observations organized by radial flight legs. The scaled radial coordinate will be determined by using the maximum flight level wind speed on the particular radial leg on which a sonde has been launched. It is recognized that sondes launched on non-radial legs would be omitted from this type of analysis. We have begun ingesting the flight level data but do not expect to complete this until near the end of the first year.

Out of the 1027 sonde files loaded into the database the data are distributed by mean boundary layer (MBL) wind speed as follows:

MBL band (m/s)	Number of sonde files in database
0-9	135
10-19	118
20-29	137
30-39	153
40-49	141
50-59	123
60-69	86
70-79	84
80-89	50

So far, with only about a third of the database loaded, the 30-39 m/s MBL group meets the target of > 150 profiles needed to investigate azimuthal differences in the boundary layer and surface layer wind profiles. Hopefully as more data are added to the database several other MBL wind speed groups will meet the proposed target.

Hardware / software:

As per the proposal budget, a 1.2 terabyte JBOD hard disk drive was purchased to provide sufficient storage for the database. JMP 6.0 statistical software has also been ordered.

Summary

The project is progressing well and on schedule. We have designed and implemented a database and are continuing to load the processed sonde files. The database query designs and sorting routines are being tested and a prototype interface has been developed for interacting with the database and organizing the data.