

# **Navy Rules Database METOC Server Integration**

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## **Executive Summary**

This report presents a summary of enhancements made to the NRL METOC Server to allow integration with the Navy Rules Database (NRDB). With these changes NRDB can be used across various endpoints in the METOC server to visualize the impact of weather conditions on equipment listed within the database.

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## Navy Rules Database METOC Server Integration

### Introduction

The Navy Rules Database (NRDB) is a collection of rules describing the operational impact of weather conditions on various pieces of Navy equipment. NRDB contains rules based on numerous weather parameters such as air temperature, salinity, wind speed, etc. These rules are defined for a wide variety of equipment including, but not limited to, attack helicopters, jets, and missiles. Given the number of weather conditions that can impact a given piece of equipment it can prove challenging for a user to source the information required to determine whether a piece of equipment is safe to use.

It is for this reason that NRDB has been integrated with the METOC Server, a web service developed by the Naval Research Laboratory at the Stennis Space Center (NRL SSC) designed to facilitate the transfer of large amounts of Meteorological and Oceanographic (METOC) data. The METOC Server catalogs the metadata of METOC files into a portable and highly performant binary cache, allowing for the distribution of large sets of METOC data. Additionally, the METOC Server features a Web Map Service (WMS) and Web Coverage Service (WCS) implementation that complies with the specification defined by the Open Geospatial Consortium (OGC) to facilitate the visualization of cataloged data. Combining the METOC Server's existing data aggregation/visualization capabilities with the rules defined in NRDB results in a web service that enables users to quickly and easily view where equipment can and cannot be safely operated.

### NRDB

The rules within NRDB are formally known as "Impact Rules" and equipment is referred to as "Assets". Each impact rule has a corresponding "Impact Status" which describes the severity of the impact of the given weather condition. The two impact statuses which are used most commonly within the database are "Marginal" and "Unfavorable". A marginal impact status indicates "moderate" degradation to operational conditions while an unfavorable status indicates "severe" degradation. For a given weather condition, if no rule exists which matches it then conditions can be considered as "Favorable".

An example of a set of impact rules that could be listed in the database regarding air temperature for a hypothetical asset named "Asset-B" would be as follows, "Moderate degradation occurs to Asset-B with air temperature > 90 F" and "Severe degradation occurs to Asset-B with air temperature > 110F". In this scenario Asset-B would have an impact status of "marginal" for temperature T where  $110\text{ F} > T > 90\text{ F}$  and an impact status of "severe" for any

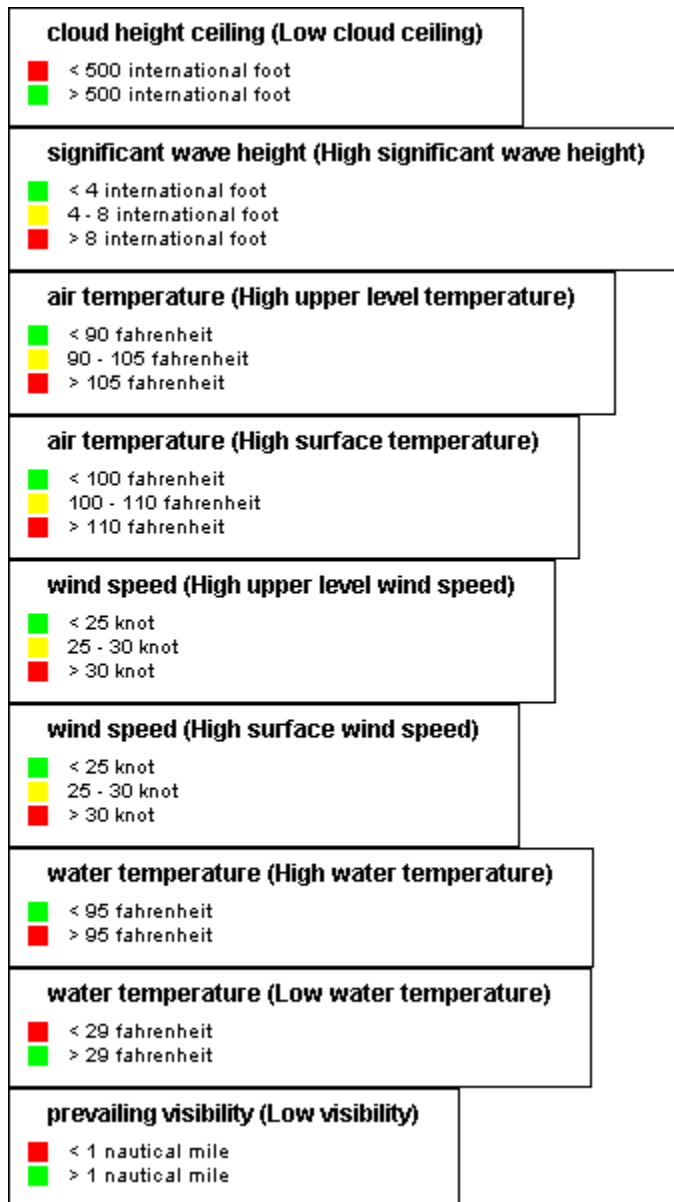
temperature greater than 110 F. Any temperature less than or equal to 90 F would be considered favorable. A given asset can have multiple sets of impact rules for various weather conditions such as air temperature, water temperature, salinity, etc. For assets that have multiple rules for multiple weather conditions, the overall impact status for that asset at a given location is decided by the worst impact status. For example, if an asset had an impact status of severe due to the air temperature being too high, marginal due to the wind speed, and favorable from cloud coverage, then the impact status at that location would be considered severe even though two of the three conditions are not.

## **METOC Server Integration**

### **Web Map Service**

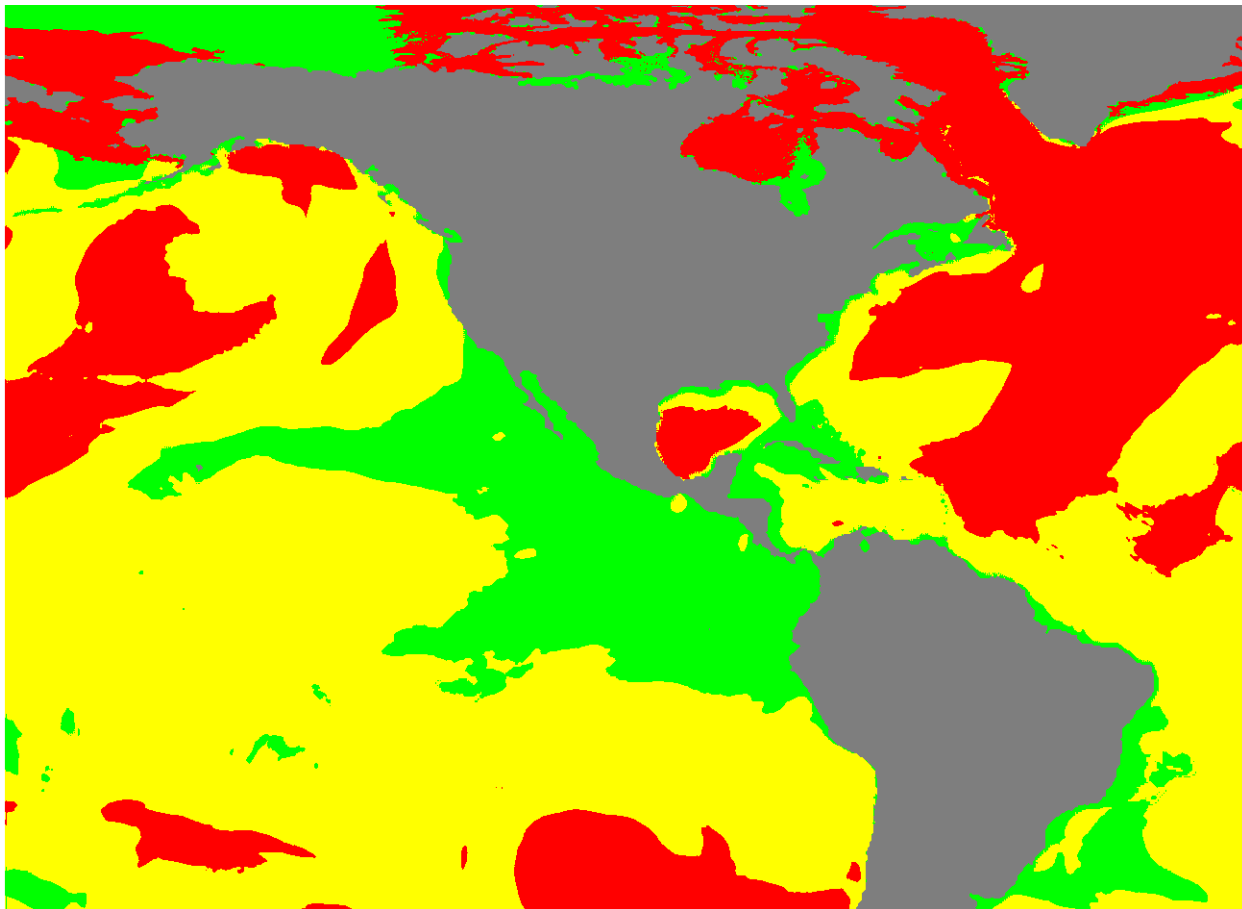
One of the most common uses of the METOC Server is for data visualization through its WMS. Users may visit the “metocserver/ogc/wms” endpoint to view a list of the available data models supported by the service. Traditionally each model that is listed in the WMS is backed by data found in the METOC Server catalog under the same model name. Some examples of such models are HYCOM, NAVGEM, and COAMPS. The NRDB WMS service is an exception to this. There are no NRDB specific NetCDF or GRIB files cataloged in the METOC Server. NRDB is instead classified as a “derived” product, a product whose values are calculated using a combination of variables from existing models. To service a request for a given platform NRDB will often end up reading data from more than one model. For example, HYCOM might be used to retrieve salinity, NAVGEM for air temp, and COAMPS for ice coverage. This is necessary because NRDB WMS queries are performed on a specific asset, and assets often have rules that are based on data found across multiple models.

Based on the rules for each asset, the METOC Server builds a mapping of value ranges to impact statuses. This mapping can be displayed in the form of a legend using a “GetLegendGraphic” request. Traditionally legends are often built for a single variable, but since NRDB assets have rules that may span many variables the NRDB legend can be thought of as a combination of multiple smaller legends. The legend provides users with a way to quickly identify the value ranges associated with each impact status. An example Legend is provided in Figure 1. Note that all example outputs presented in this document are generated using a set of fake impact rules and assets.



*Figure 1: NRDB Legend Produced by a GetLegendGraphic Request*

When using a WMS users may send a GetMap request to receive a color coded map image which is generally used in an external client such QGIS or ArcMap. Each pixel in an NRDB GetMap request is colored according to the most severe impact status at that location. Red corresponds to severe, Yellow to marginal, green to favorable, and grey is unknown (instances where no data is present). The image in Figure 2 is the result of a query that requests data only at the ocean's surface. Because of this, North and South America appear in grey since there is no data to be displayed over land.



*Figure 2: Image Response of GetMap Request*

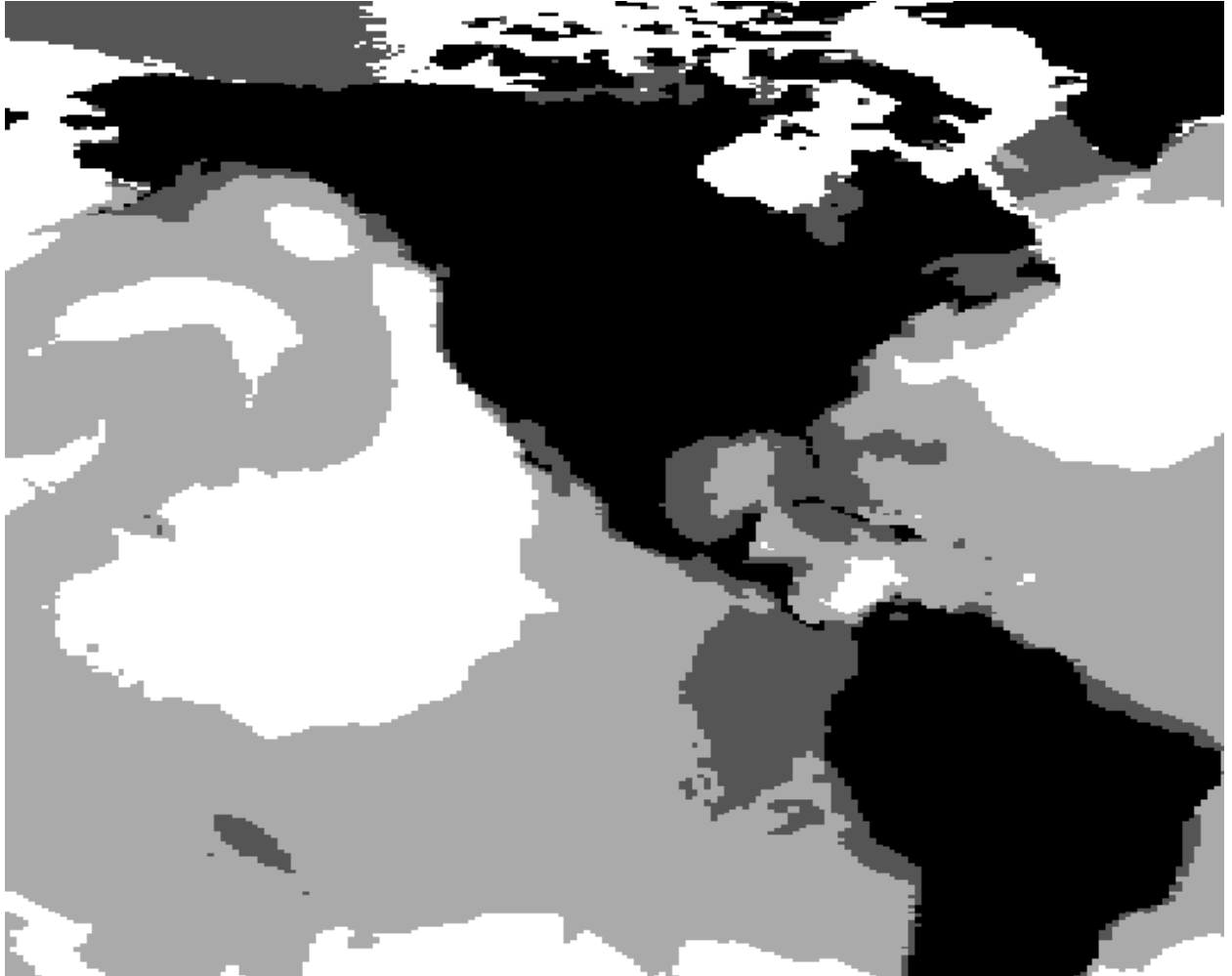
The GetMap request provides a generalized overview of regions where a given asset is safe to operate, but some users might desire more information regarding conditions at a specific latitude or longitude. For these circumstances a GetFeatureInfo request may be used. A GetFeatureInfo request can be used in the METOC Server to return either an HTML or JSON response containing further information regarding the specific impact rules at a given location. Figure 3 provides an example response for a request performed on the same asset used in Figure 2. The response provides detailed information regarding each variable involved in deciding the impact status. In the given example significant wave height and water temperature are the two variables used. The latitude and longitude that is being queried for is listed at the top of the response, followed by information such as impact status, value, unit, elevation, etc. for each relevant variable. For instances in which the impact status is either marginal or unfavorable the impact text of the specific rule that was violated is provided.

NRDB GetFeatureInfo	
Latitude	18.04834830019243
Longitude	-50.068633739576654
<b>significant wave height</b>	
Impact Status	UNFAVORABLE
Value	2.880000114440918
Unit	meter
Impact Text	Significant degradation to operations occurs with significant wave height > 8 ft
Valid Time	2023-03-19T12:00:00Z
Coverage	global_1440x721
Level	surface
Elevation	0.0
Model	WW3_GLOBAL
Download Link	<a href="#">WW3_GLOBAL_2023031906_global_1440x721_sig_wav_ht_surface_00000000_00000000_fcst_ops_0060.grb2</a>
<b>water temperature</b>	
Impact Status	FAVORABLE
Value	298.6409912109375
Unit	kelvin
Impact Text	N/A
Valid Time	2023-03-19T12:00:00Z
Coverage	hycom-glbua-1
Level	dpth_sfc
Elevation	0.0
Model	HYCOM
Download Link	<a href="#">HYCOM_2023031912_hycom-glbua-1_sea_temp_dpth_sfc_00000000_00000000_fcst_ops_0000.grb</a>

Figure 3: HTML Response of GetFeatureInfo request

### Web Coverage Service

The final feature which was implemented for NRDB was WCS support. Within the WCS a GetCoverage request can be used to retrieve a GeoTIFF file which can be loaded into a client such as QGIS. The GeoTIFF response can be used to visualize the impact statuses over a geographic region similarly to a WMS GetMap request but with the added benefit of allowing the user to view the impact status at a given latitude and longitude without having to send an additional GetFeatureInfo request since the underlying data at each coordinate is contained within the file. Within the GeoTIFF response the impact statuses are mapped to the following numerical values: -1 for Unknown, 0 for Favorable, 1 for Marginal, and 2 for Unfavorable.



*Figure 4: GeoTIFF response of GetCoverage request visualized in QGIS*



*Figure 5: Color Ramp Used by QGIS in Figure 4*

**References**

1. Open Geospatial Consortium Inc. 2006-03-15. OpenGIS® Web Map Server Implementation Specification.
2. General Dynamics Information Technology. 2015-09-29. Navy Rules Database (NRDB) User Interface