

Florida Public Hurricane Loss Model

FPHLM

(Release V.2.6)

PRIMARY DOCUMENT BINDER

The Document

This binder contains a complete set of documents specifying the model structure, detailed software description, and functionality.

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3.3. Wind Speed Correction (WSC) Use Case V

3.3.1. General Description Of WSC

WSC, shorts for Wind Speed Correction, is the fifth use case of the Florida Hurricane Loss Model. It aims at refining open terrain wind speed produced by the hurricane wind model with respect to the actual terrain (based on land use – land cover).

3.3.2. WSC General Requirements

Name: Wind Speed Correction

Description: The inputs are zip code, surface wind speed for open terrain produced by the wind model, surface wind direction, and roughness length for open terrain. The system generates the following:

- (1) **Surface wind speed for actual terrain (m/s).**
- (2) **10-minute sustained wind speed for actual terrain (mph).**
- (3) **3-Second gust wind speed for actual terrain (mph).**

1. Following are the input data:

Zip: Zip Code

Vo: Surface Wind Speed for open terrain produced by the wind model (m/s)

WD: Surface Wind Direction (Deg from North)

Zoo: Roughness Length (m) for open terrain = 0.03m

Zoa: Roughness length based on upstream terrain

Lat: Latitude

2. Based on the input data from step 1, the system queries the database and returns Zoa parameter, which corresponds to the actual roughness length based on FEMA HAZUS conversion table relating land use-land cover (LULC) to aerodynamic roughness (m). Roughness represents a weighted average of all roughness pixels within a 45-degree sector with origin at the population-weighted centroid of the zip code and extending outward to 20 km from the centroid. The weighting function for averaging the roughness values is a Gaussian filter with a half power point at 3 km. The format of the lookup table is as following:

Zip	Lon	Lat	Zo1	Zo2	Zo3	Zo4	Zo5	Zo6	Zo7	Zo8
------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------

Where:

Zo1 = Actual Roughness for wind directions inclusive of 46-90

Zo2 = Actual Roughness for wind directions inclusive of 1-45

Zo3 = Actual Roughness for wind directions inclusive of 316-0, 360

Zo4 = Actual Roughness for wind directions inclusive of 271-315

Zo5 = Actual Roughness for wind directions inclusive of 226-270

Zo6 = Actual Roughness for wind directions inclusive of 181-225

Zo7 = Actual Roughness for wind directions inclusive of 136-180

Zo8 = Actual Roughness for wind directions inclusive of 91-135

Table 3.3.1 shows a sample record from the lookup table.

Zip	33172
Lon	80.358246
Lat	25.775768
Zo1	.254
Zo2	.277
Zo3	.333
Zo4	.253
Zo5	.297
Zo6	.274
Zo7	.287
Zo8	.281

Table 3.3.1: A sample record for the lookup table

- Given the wind direction for each zip code centroid, the appropriate value for actual terrain roughness is extracted from the lookup table. The system then computes the output values as below:

Compute open terrain friction velocity U_o (Unit: m/s):

$$U_o = V_o * 0.4 / [\text{Ln} (10.0 / 0.03)]$$

Compute actual terrain friction velocity U_a (Unit: m/s, using equation 3 of Powell et al., 1996)

$$U_a = U_o / ([Z_{oo} / Z_{oa}] ^{0.0706})$$

Compute actual terrain wind speed at 10 m V_a :

$$V_a = (U_a / 0.4) (\text{Ln} (10 / Z_{oa}))$$

Convert wind speed to the unit of MPH:

$$V_{\text{mph}} = V_a * 2.2369$$

Compute gust factors for peak 1 min wind over 10 min $G_{10\text{min},60}$ and peak 3s wind over 10 min $G_{10\text{min},3}$ based on the actual roughness. [See gust factor calculations below]

Compute max 1 min wind (m/s) occurring within 10 min period

$$V_1 = V_a * G_{10\text{min},60}$$

$$\text{ZipOTWS1} = V_a * 1.142$$

Compute max 1 min sustained wind speed in mph

$$V_{1\text{mph}} = V_1 * 2.2369$$

Compute peak 3s gust in mph

$$V_{3\text{mph}} = V_a * G_{10\text{min},3} * 2.2369$$

4. Gust factor calculations

2. Compute friction velocity (u)

$$u = \frac{0.4Va}{Ln\left(\frac{10}{Zoa}\right)}$$

4.1. Compute Height scaling parameter based on a height of 10 m

$$\eta = 1 - 6f\left(\frac{10}{u}\right)$$

where $f = 2(7.292 * 10^{-5} \sin(Lat))$ is the Coriolis parameter

4.2. Compute the standard deviation of the wind speed

$$\sigma_u(z) = \frac{7.5\eta u \left[0.09Ln\left(\frac{10}{Zoa}\right) + 0.538\right]^{\eta^{16}}}{\left(1 + 0.156Ln\left(\frac{u}{f.Zoa}\right)\right)}$$

4.3. Compute the standard deviation of the low-pass filtered wind speed considering a filter with a cut-off frequency of 1 cycle per 3 seconds (for the peak 3s gust) and 1 cycle per 60 seconds (for the maximum 1 min sustained wind speed calculation:

$$\sigma_u(z,60) = \sigma_u(z) \left(1 - 0.193 \left(\frac{I_t}{60} + 0.1\right)^{-0.68}\right)$$

$$\sigma_u(z,60) = 0.386762 \sigma_u(z)$$

where 60 represents 1 min or 60 seconds and the integral scale time parameter I_t is,

$$I_t = 3.13Z^{0.2}$$

$$I_t = 4.96$$

In which $Z = 10$ meters is used.

$$\sigma_u(z,3) = \sigma_u(z) \left(1 - 0.193 \left(\frac{I_t}{3} + 0.1\right)^{-0.68}\right)$$

$$\sigma_u(z,3) = 0.868256421 \sigma_u(z)$$

Where 3 represents 3 seconds

4.4. Compute the wind fluctuation cycling rates:

$$C_r(60) = \frac{\left(0.007 + 0.213 \left(\frac{I_t}{60}\right)^{0.654}\right)}{I_t}$$

$$C_r(60) = 0.00982$$

$$C_r(3) = \frac{\left(0.007 + 0.213 \left(\frac{I_t}{3}\right)^{0.654}\right)}{I_t}$$

$$C_r(3) = 0.061$$

4.5. Compute the Peak factors for the max 1 min (60 sec) and max 3 second winds

$$P_f(3) = \left[\sqrt{2Ln(600C_r)} + \frac{0.557}{\sqrt{2Ln(600C_r)}} \right] \frac{\sigma_u(z,3)}{\sigma_u(z)}$$

$$P_f(60) = \left[\sqrt{2Ln(600C_r)} + \frac{0.557}{\sqrt{2Ln(600C_r)}} \right] \frac{\sigma_u(z,60)}{\sigma_u(z)}$$

4.6. Compute the longitudinal turbulent intensity

$$T_{il} = \frac{\sigma_u(z)}{U_h}$$

4.7. Compute the gust factors:

$$G_{10\text{min},60} = 1 + T_{il}P_f(60)$$

$$G_{10\text{min},3} = 1 + T_{il}P_f(3)$$

A sample calculation is as follows:

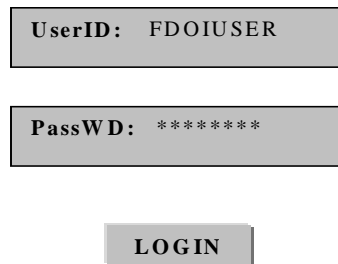
Input	Lookup value	Output
Zip = 33133 Vo = 50 m/s WD = 60 Zoo = 0.03 Lat = 25.73	Zoa = 0.431 m	Uo = 3.44 m/s, Ua = 4.16 m/s, Va = 32.66 m/s, V1mph = 90.08 mph, V3mph = 123.55 mph

3.3.3. WSC Interface Design Requirements

This section presents the Graphic User Interface design for the Wind Speed Correction (WSC).

1. The first step: the user logs in the system

Figure 3.3.1 shows the Login Interface. User needs to enter the user id and password to enter the system. The system verifies the user's information with the login data extracted from the database. If it matches, the user logs into the system successfully. Otherwise, system displays the "wrong user name/password" error and requests the user to login again.

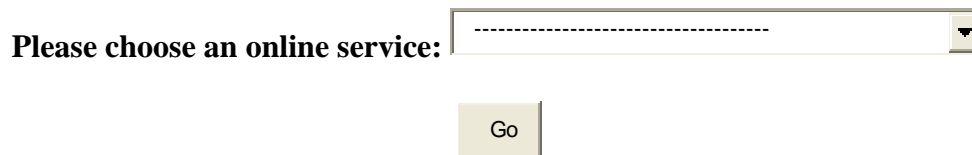


The figure shows a login interface with two input fields and a button. The first field is labeled 'UserID:' and contains the text 'FDOIUSER'. The second field is labeled 'PassWD:' and contains seven asterisks '*****'. Below these fields is a rectangular button labeled 'LOGIN'.

Figure 3.3.1: Login Interface

2. The second step: select the use case from the service selection page

Figure 3.3.2 is the service selection page interface. System presents a list of available use cases to the user. User selects "Wind Speed Correction Model" use case and clicks "Go" to submit.



The figure shows a service selection interface. It starts with the text 'Please choose an online service:' followed by a dropdown menu. The dropdown menu is currently empty, showing a dashed line and a downward arrow. Below the dropdown menu is a rectangular button labeled 'Go'.

Figure 3.3.2: Service Selection Interface

3. The third step: The user provides the input from the wind model

In this step, system provides the interface for the user to input data generated by the wind model. The following inputs are required and are illustrated by Figure 3.3.3:

- *Zip code:*

- *Wind Speed*: Surface wind speed (m/s) for open terrain produced by the wind model.
- *Wind Direction*: Surface wind direction (Degree(s) from the North).
- *Roughness Length*: Roughness length (m) for open terrain = 0.03 m.
- *Latitude*:

Num	Zip Code	Wind Speed (m/s)	Wind Direction	Roughness length (m)	Latitude (deg)
1	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 3.3.3: Input from Wind Model Interface

4. The forth step: The system displays the result in the interface

In this step, system calculates the result and displays both the input and the output to the user as shown in Figure 3.3.4. The output includes:

- *Zoa*: Actual roughness length based on FEMA HAZUS conversion table relating land use land cover (LULC) to aerodynamic roughness (m).
- *Uo*: Open terrain friction velocity (m/s).
- *Ua*: Actual terrain friction velocity (m/s).
- *Va*: Surface wind speed for actual terrain (m/s).
- *Vamph*: Above with English units of statute miles per hour.

Input				Output						
Zip	V_o (m/s)	Wd	Zoo	Z_{oa} (m)	U_o (m/s)	U_a (m/s)	V_a (m/s)	V_{amph} (mph)	V_{1mph} (mph)	V_{3mph} (mph)
33133	50.0	60	0.03	0.431	3.44	4.16	32.66	73.17	90.08	123.55

Figure 3.3.4: Wind Speed Correction Calculation Result Interface

3.3.4. Computer Model Design

3.3.4.1. Use Case View of WSC

A. Actors:

There is one actor, scientist in WSC.

C. Use Case:

WSC is used to convert open terrain winds produced by the hurricane wind model to winds more representative of the actual terrain (based on land use- land cover).

C. Use Case Diagram:



Figure 3.3.5: Use Case Diagram for WSC

3.3.4.2. System Design

This section includes the appropriate diagrams to describe the system classes, components, activities and the overall flow chart of WSC.

3.3.4.3. Program Flow Chart of WSC

The flow chart of WSC is depicted in Figure 3.3.6.

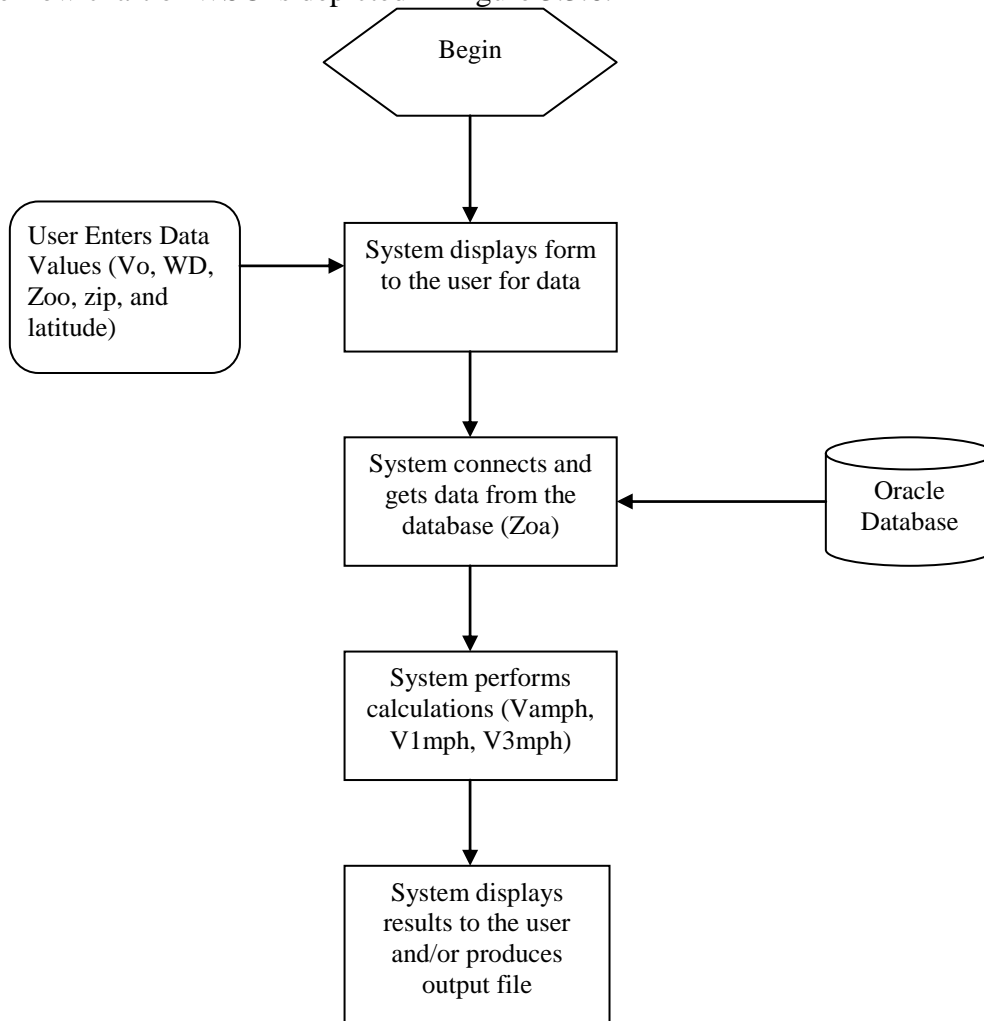


Figure 3.3.6: Flow chart of WSC

3.3.4.4. Detailed Flowchart

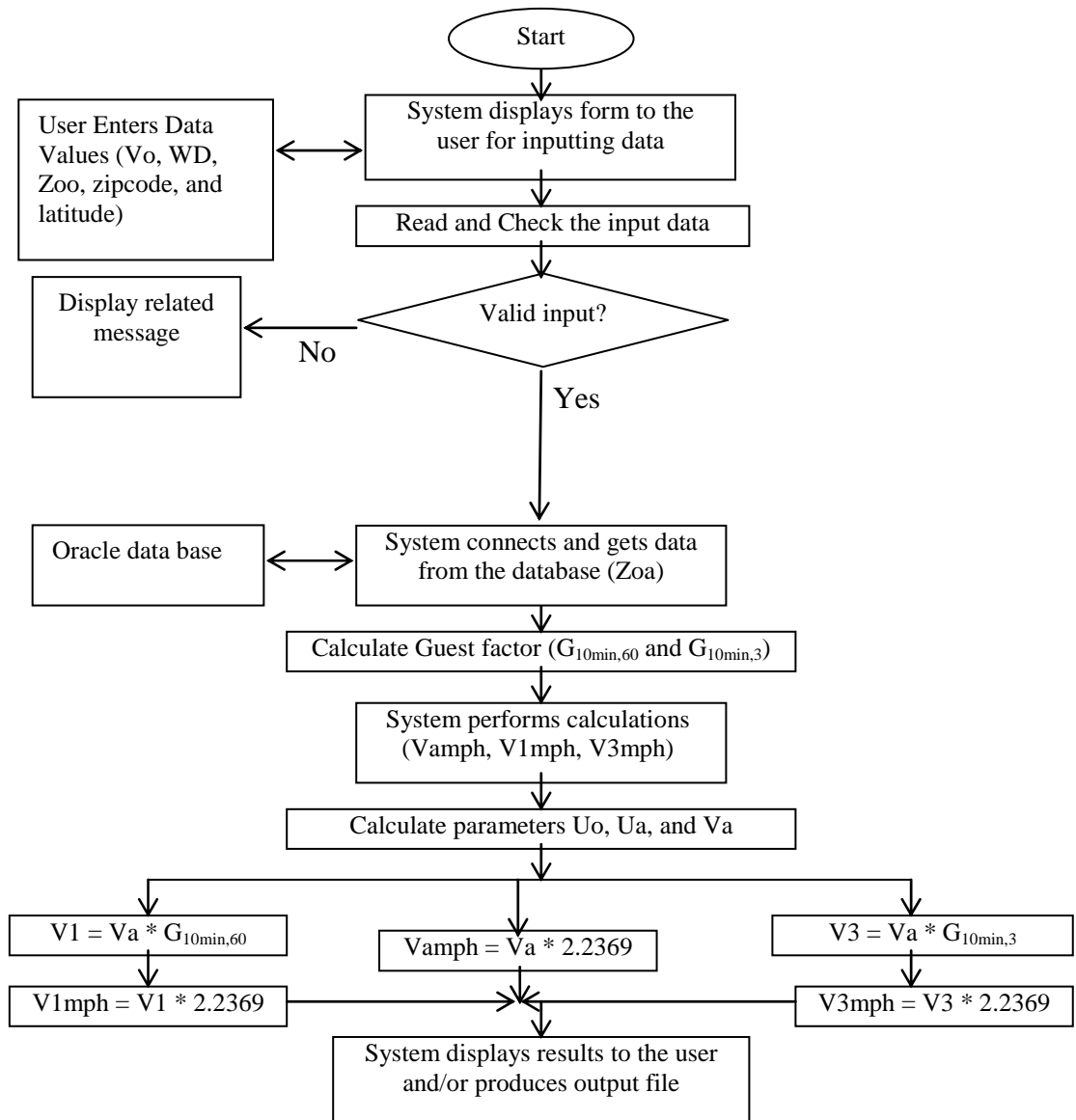


Figure 3.3.7: Detailed Flow chart of WSC

3.3.4.5. Class Diagram and Description

A. Class Diagram

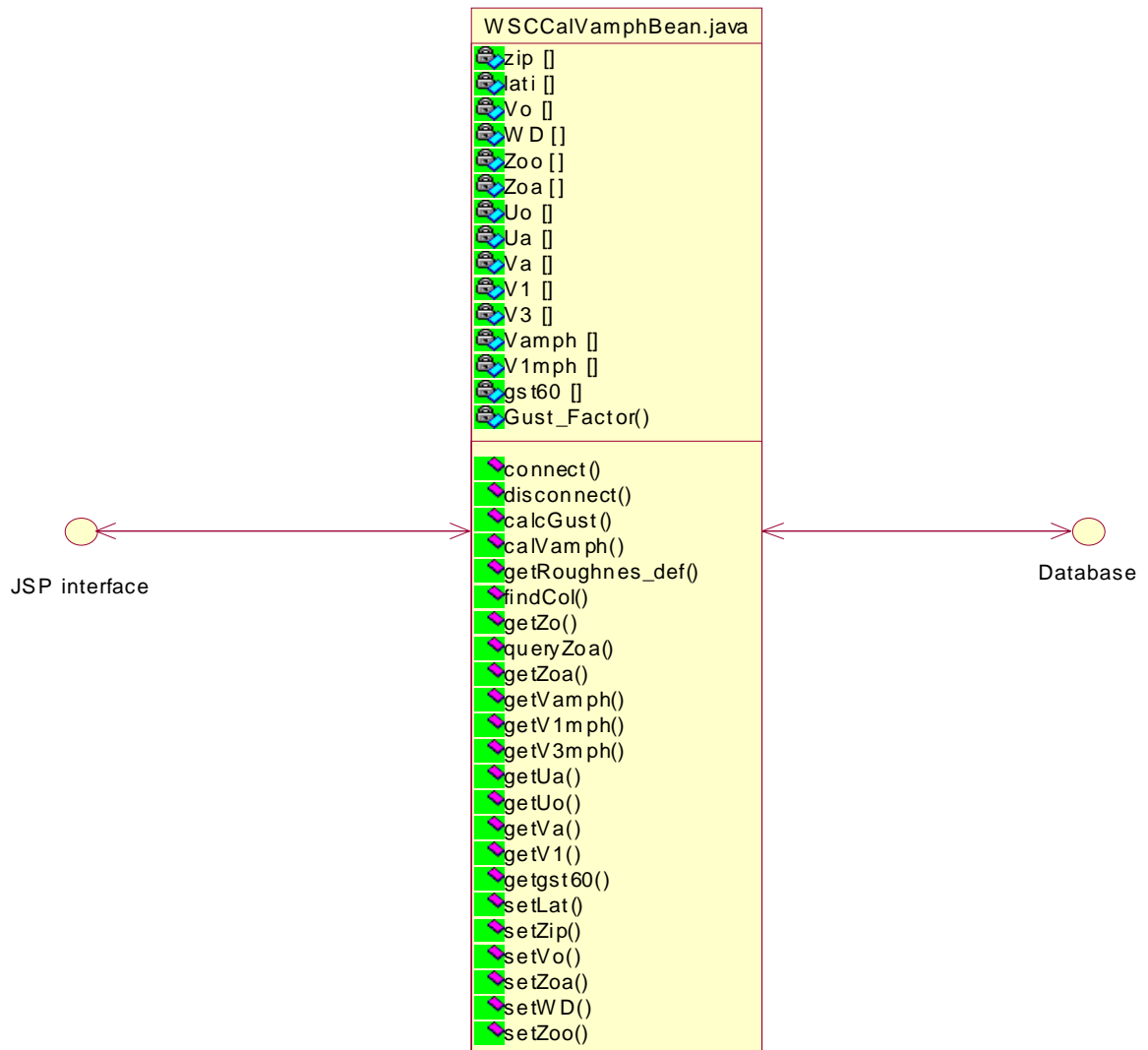


Figure 3.3.8: Class Diagram for WSC

B. Classes Descriptions

Here is a brief introduction of the functions in the class we used.

➤ WSCalVamphBean

This class performance all the functionalities needed for the wind speed correction calculation. It includes the following main methods:

- connect()

Method is used to establish a connection to the database

- setLat (double [] l)

Method takes an array of doubles and sets the latitude array to the passed array

- setZip(int [] z)

Method takes an array of integers and sets the zip array to the passed array

- setVo(double [] z)

Method takes an array of doubles and sets the Vo array to the passed array

- setWD(int [] w)

Method takes an array of integers and sets the WD array to the passed array

- setZoo(double [] z)

Method takes an array of doubles and sets the Zoo array to the passed array

- queryZoa()

Uses the connection to the database to send a query and retrieve the value for Zoa based on the zip and the returned string value from a call to the findCol method.

- calVamph()

Method is used to calculate the Vamph, Va, Uo and Ua using the following input values from the user Vo, Zoo and Zoa

- calcGust()

Method is used to calculate the gust factors $G_{10min,60}$ and $G_{10min,3}$ using the following input values Lat, WD, Zoa and Va

- GetRoughness_def()

Method uses the established connection to the database to find and return the column names and starting and ending degrees corresponding to each column of the roughness_def table.

- findCol(int wd)

Method takes a wind direction (WD) as a parameter. It uses the established connection to the database to find and return the correct string, using the WD, which represents the column in the lookup table for Zoa.

- get Zoa()

Return the value of Zoa

- getVamph()

Return the value of Vamph

- getV1mph()

Return the value of V1mph

- getV3mph()

Return the value of V3mph

- getUa()

Return the value of Ua

- getUo()

Return the value of Uo

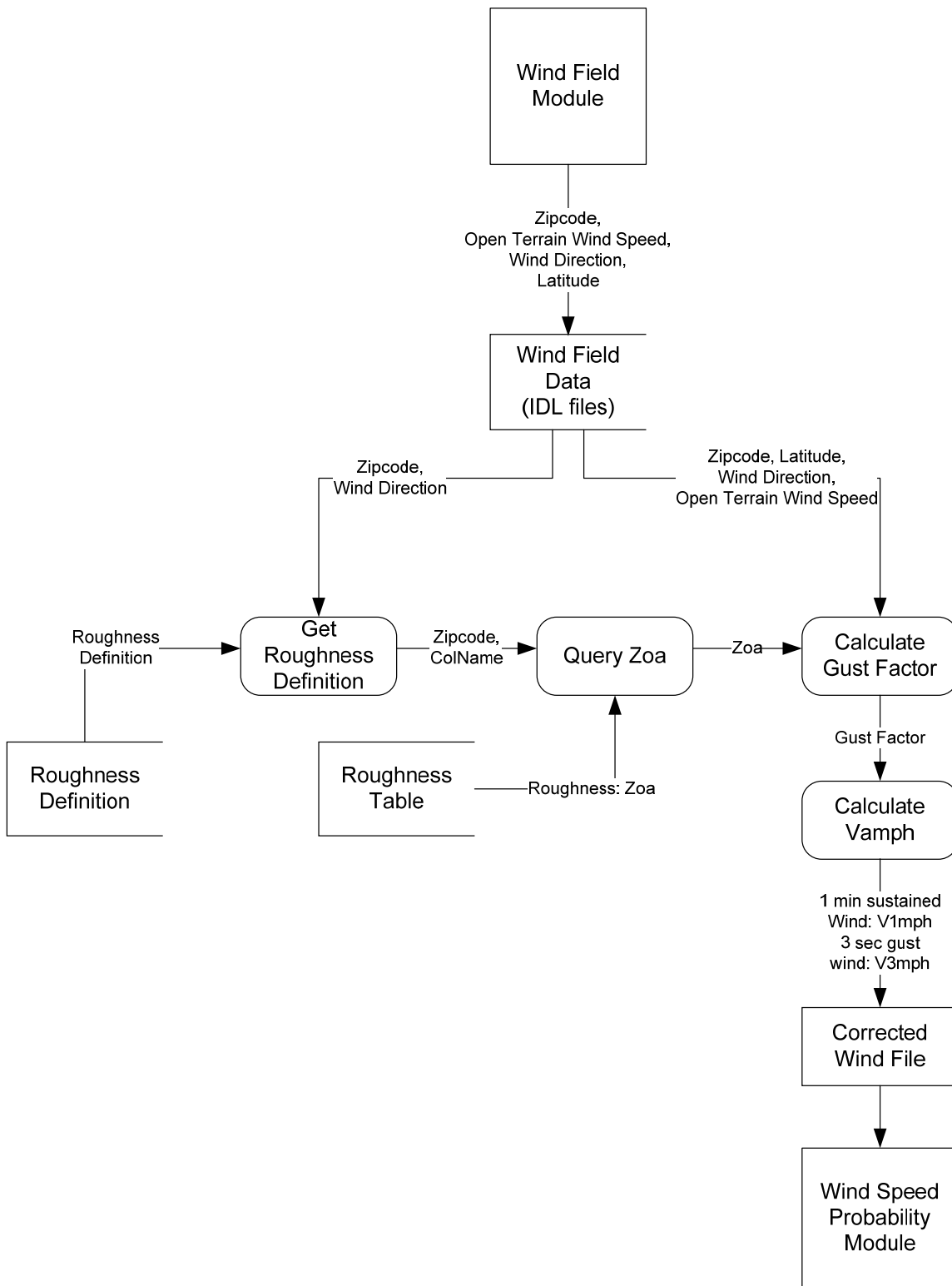
- getVa()

Return the value of Va

- disconnect()

Method is used to disconnect from the database

3.3.4.6. Data Flow Diagram



3.3.4.7. State Chart Diagram

Figure 3.3.8 depicts the state chart diagram for Use Case Five. This diagram illustrates states that the use case goes through from beginning to end.

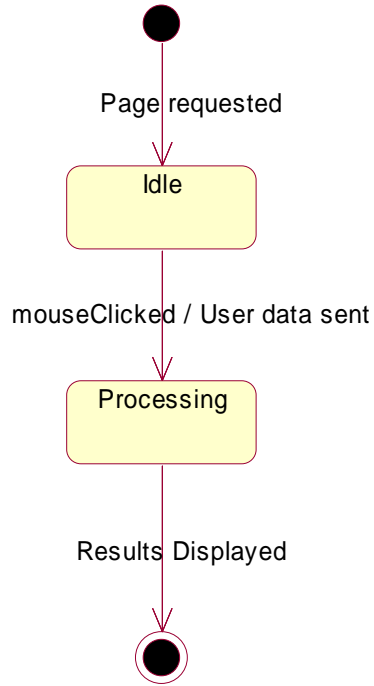


Figure 3.3.9: State Chart for WSC

3.3.4.8. Sequence Diagram

A. Sequence Diagram for the Vamph Calculation Process

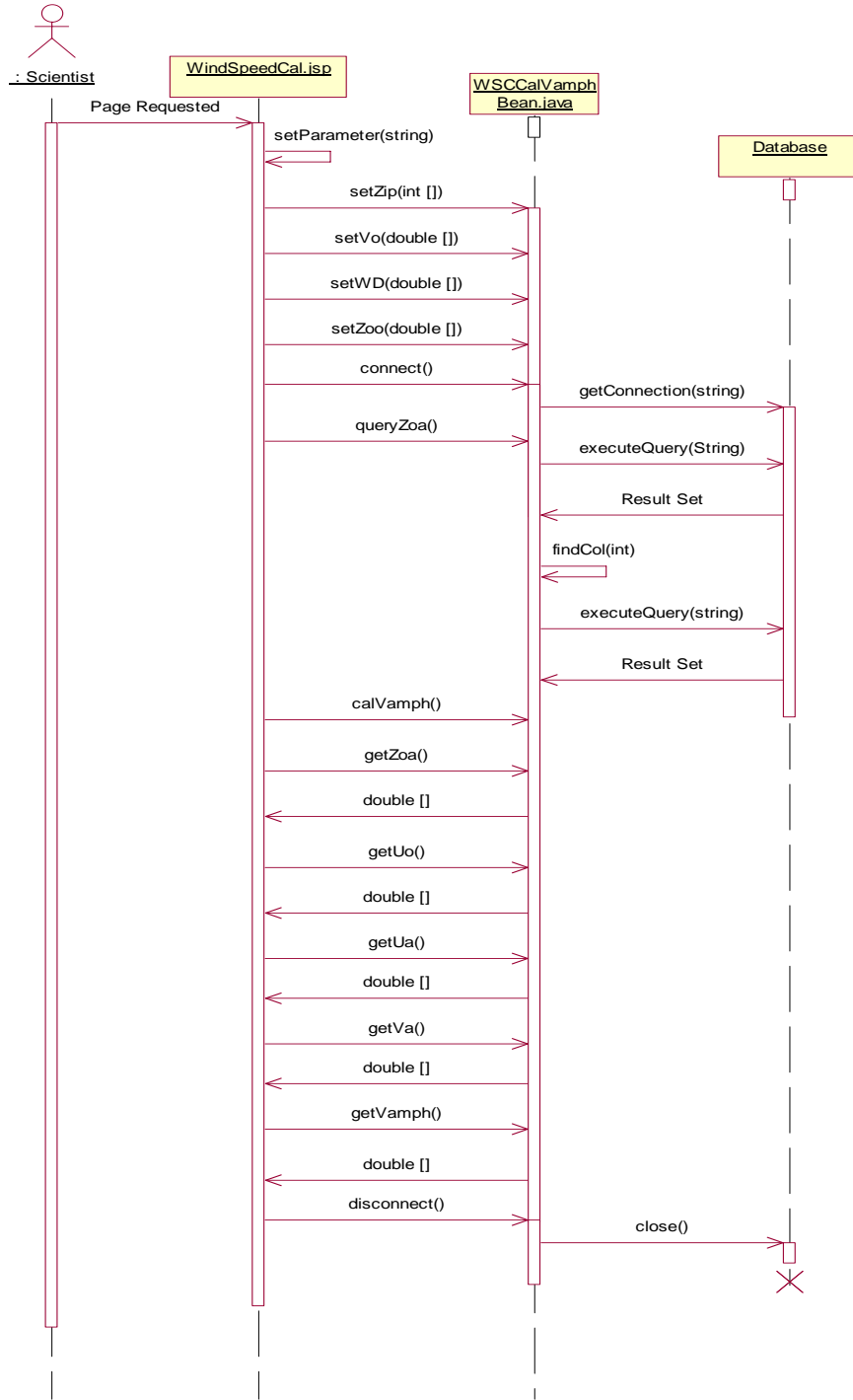


Figure 3.3.10: Sequence diagram for Vamph calculation process

B. Sequence Diagram Steps for the Vamph Calculation Process

- **Step 1:** The user requests the html page
- **Step 2:** The user enters the number of data sets to be calculated
- **Step 3:** The user inputs data for zip code, Vo, WD and Zoo and they are passed to the WSCCalVamphBean object
- **Step 4:** WindSpeedCalc.jsp requests WSCCalVamphBean object to establish a connection to the database
- **Step 5:** WSCCalVamphBean establishes a connection to the database
- **Step 6:** WindSpeedCalc.jsp requests WSCCalVamphBean to query the database based on data passed from JSP
- **Step 7:** WSCCalVamphBean queries the database which returns a ResultSet to the BEAN
- **Step 8:** WSCCalVamphBean calls its findCol method.
- **Step 9:** WSCCalVamphBean queries the database which returns a ResultSet to the BEAN
- **Step 10:** WindSpeedCalc.jsp requests to perform Vamph calculations.
- **Step 11:** WindSpeedCalc.jsp requests the results for Zoo, Uo, Ua, Va and Vamph and WSCCalVamphBean returns the required data.
- **Step 12:** WindSpeedCalc.jsp notifies that it is okay to close the database connection
- **Step 13:** WSCCalVamphBean closes the database connection

3.3.5. Implementation of WSC

Currently, the implementation for Use Case five (WSC) has been finished. The demo is reachable at <http://www.cs.fiu.edu/PHRLM>.

3.3.5.1. Login page:

Users need username/password to access the *Florida Hurricane Loss Model*. Following is a snapshot of the login web page.

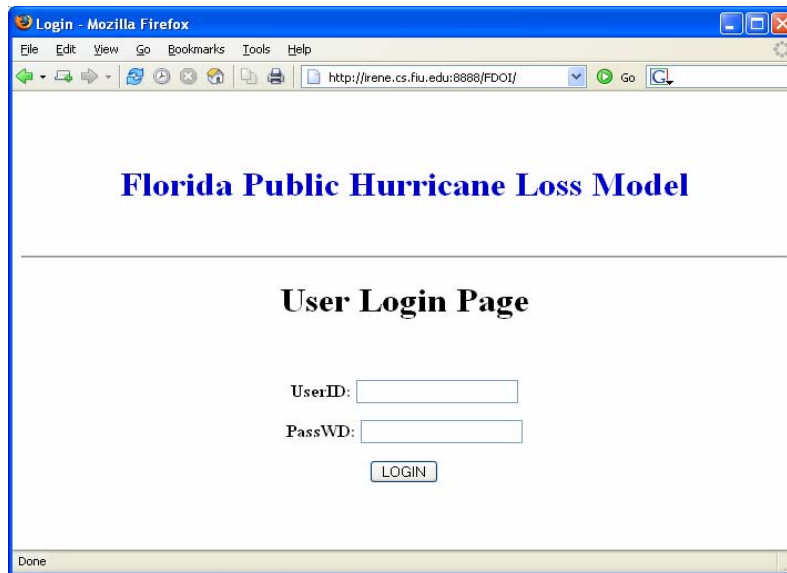


Figure 3.3.11. Login webpage for FPHLM

If the username/password is wrong, an error message will be displayed. User will be required to input the username and password again to enter.

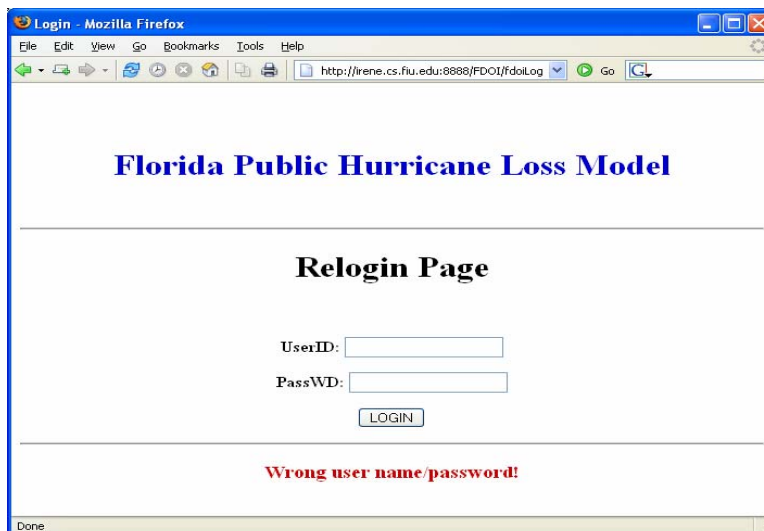


Figure 3.3.12. Login webpage shows the inputted user ID or password is wrong
3.3.5.2. WSC Page:

If the login is successful, the user can see the web page named “Service Selection Page” (as shown in Figure 3.3.13). To view the WSC use case page, from the drop-down list, select “Wind Speed Correction” and click “Go” button.

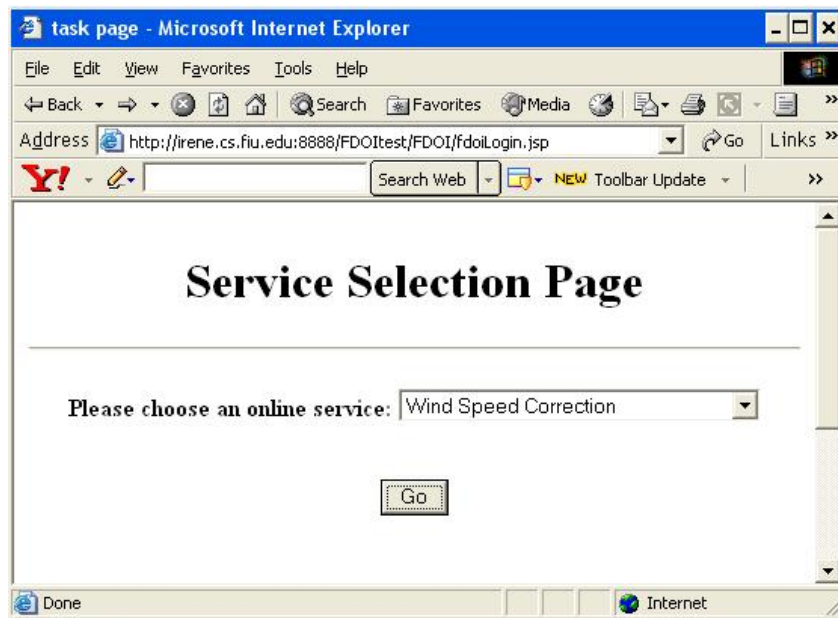


Figure 3.3.13. Service selection page for WSC

Several steps need to be followed to accomplish the task of Wind Speed Correction, User can select two input methods.

- a. Input from file (this is the use case four output)
- b. Manual Input

If user wants to take the input from file

1. Click on ‘From File’ radio button
2. Select the input data set from an available data set
3. Click on ‘submit’

If the user wants to enter the input manually, first click on ‘Manual Input’ radio button.

Step 1:

Then, the users need to input the wind field data fields. Input data sets from the wind model include the following fields:

- **Zip:** Zip code
- **Vo:** Surface wind speed for open terrain produced by the wind model (m/s)
- **Wd:** Surface wind direction (Deg from North). The data range for this field is from 0 to 360.
- **Zoo:** Roughness length (m) for open terrain = 0.03 m
- **Latitude:** Latitude of the corresponding zip code. (a value between 20 and 40)

A data input page is provided to facilitate users to input the corresponding data easily. Users are allowed to input a variety of collections of input data and submit this data for wind speed correction calculation.

By default, the number of input data sets is one. So initially, there is only one set of blank control for the user to input his/her data. Figure 3.3.14 illustrates the snapshot of the dataset input page for wind speed calculation.

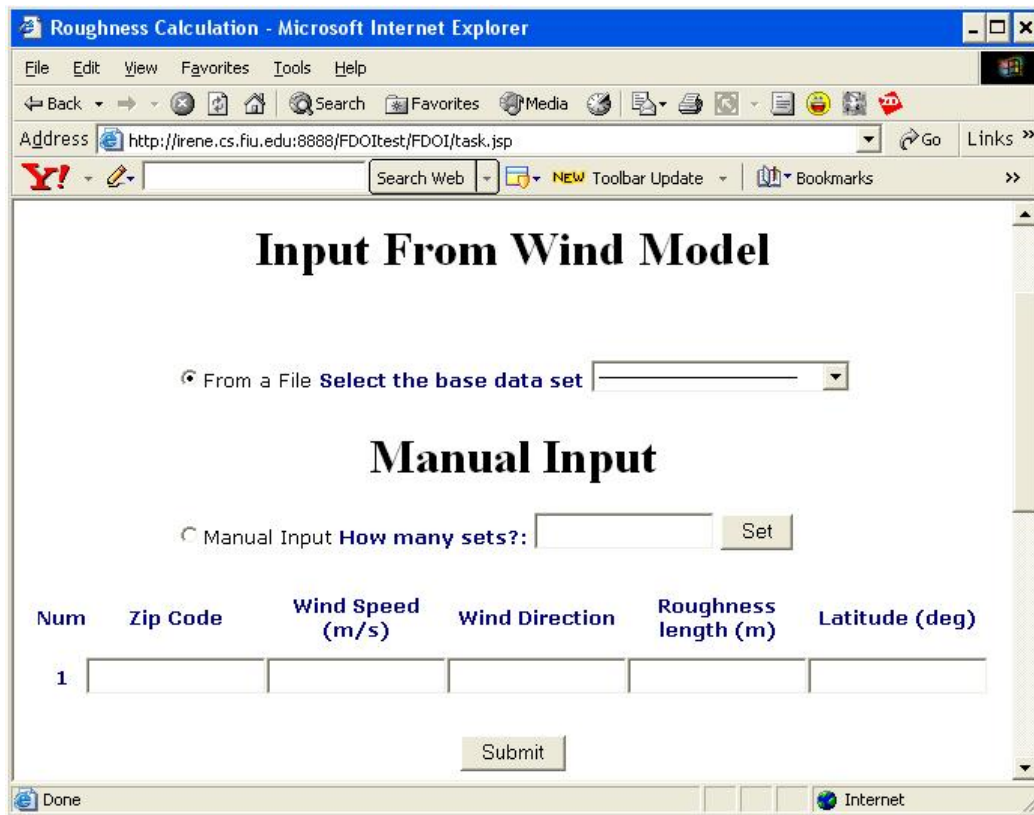


Figure 3.3.14. Snapshot of the first web page for WSC

To input more than one set of input data, the user can change the number of input data sets by using the “number of sets change“ option provided at the top of the dataset input page. The user inputs the desired number of data sets in the blank after “How many sets?”, and then clicks “Set” button. Figure 3.3.15 shows an example dataset input web page after the user requests three sets of input data.

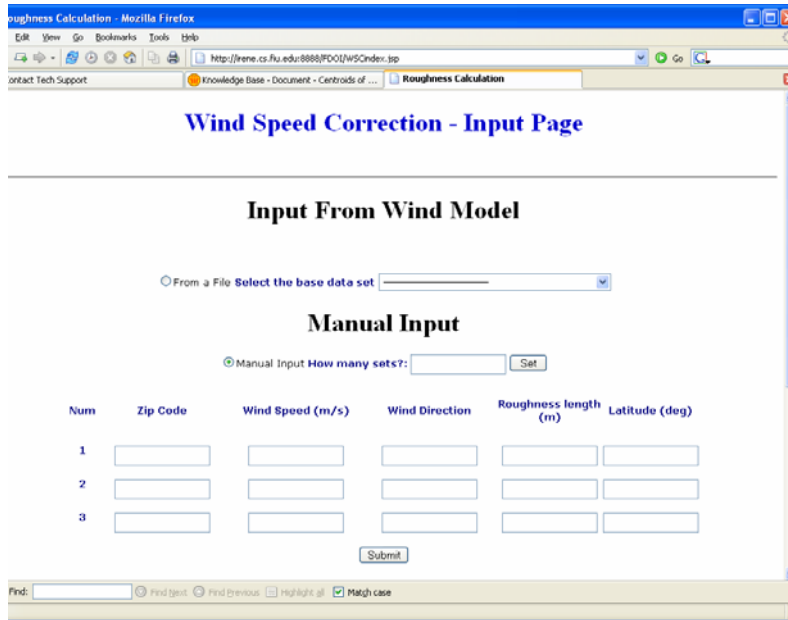


Figure 3.3.15. Snapshot of the web page after user specify the sets number to 3

Step 2:

Secondly, the system constructs a query using the user's data to obtain desired data from the underlying Oracle database. This desired data along with the user data is used to carry out the correction computation.

Once the correction computation is done, the system displays the whole data set: the input data set, retrieved data, and the computation results, back to the user. Figure 3.3.16 shows a result page as an example.

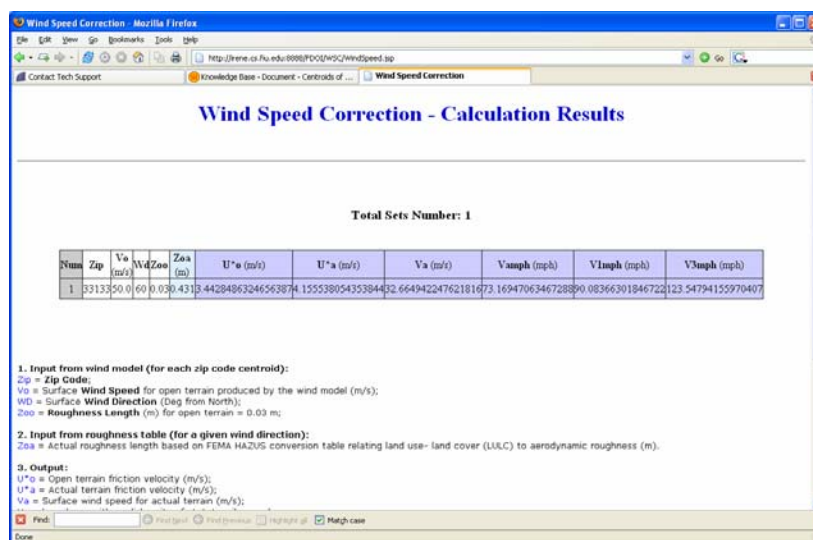


Figure 3.3.16: Snapshot of the result web page for WSC

3.3.5.3. Exception Handling:

Users may make some error inputs. The JSP webpage can catch the exceptions and show the error messages. Here we show some examples:

After user fills in the set number blank and clicks the “Set” button, the system will check if the inputted value is an integer. If no, the corresponding error message will be generated and shown under this blank (as shown in Figure 3.3.17).

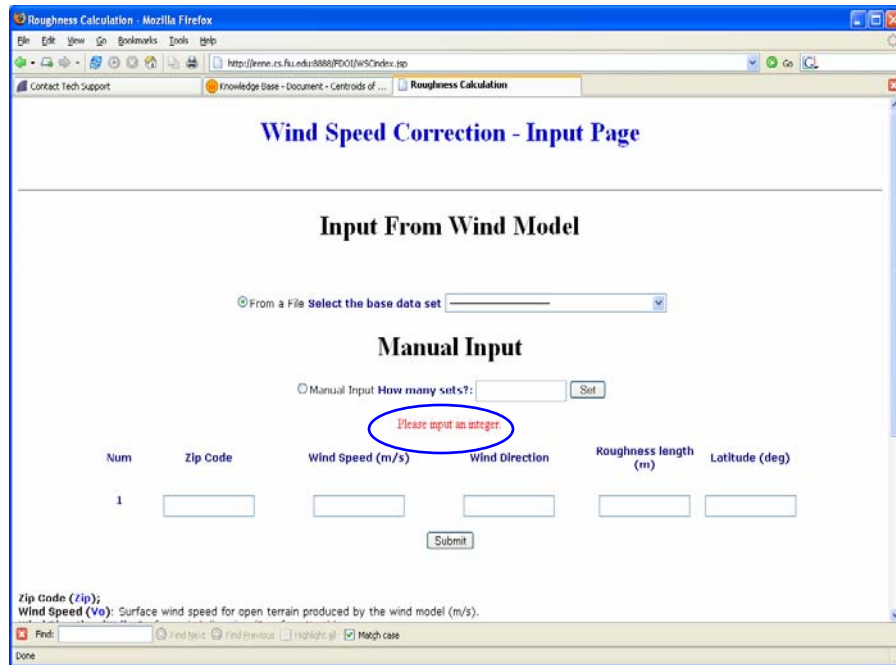


Figure 3.3.17. The input webpage shows the exception that the inputted set number is not an integer.

User needs to follow the instructions, fill in all the blanks and input the data sets in the correct format. Figure 3.3.18 shows some error inputs. For example: some blanks are not filled; the zip code field is filled by words; the wind direction is not in the interval [0, 360]; etc. Figure 3.3.19 displays the webpage which caught these exceptions and displays several error messages.

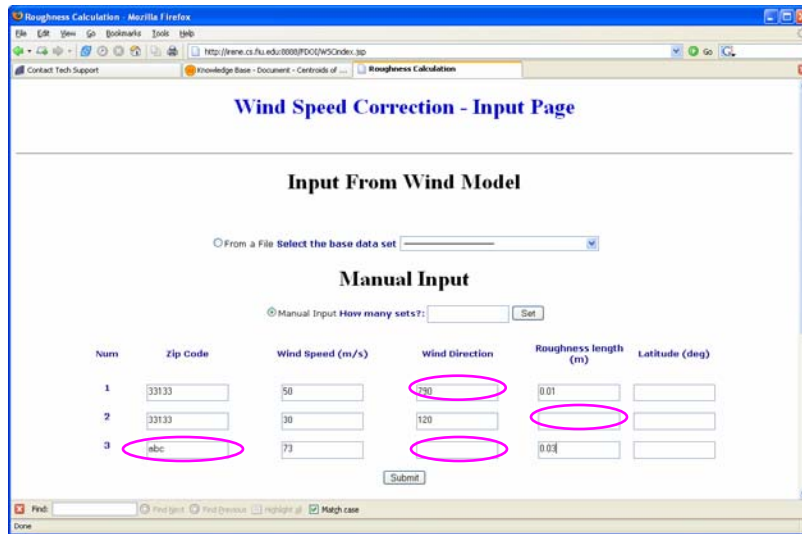


Figure 3.3.18: The input webpage contains a set of error inputs

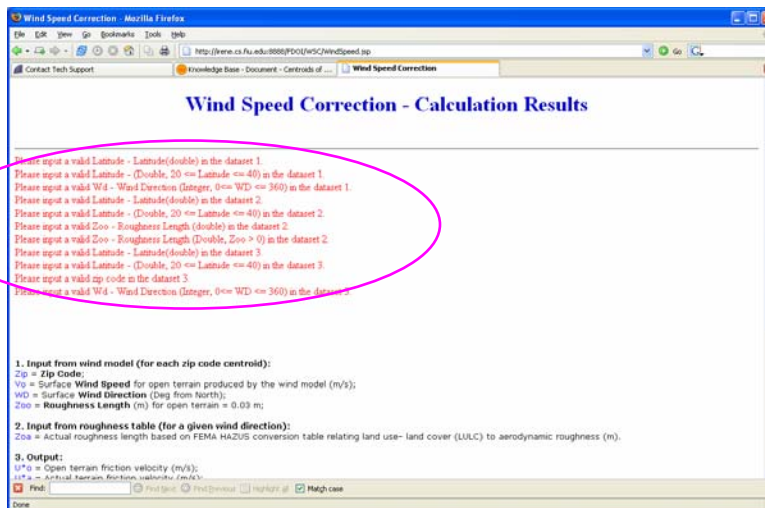


Figure 3.3.19: The result webpage catches all the available exceptions

Another possible exception is caused by the invalid zip code. Sometimes the user inputs the zip code within the correct format, but this zip code cannot be found in the specific lookup table. As shown in the Figure 3.3.20, user inputted a zip code as “12345”, which is not in the lookup table. In Figure 3.3.21, the webpage shows this message so that the user can identify this error.

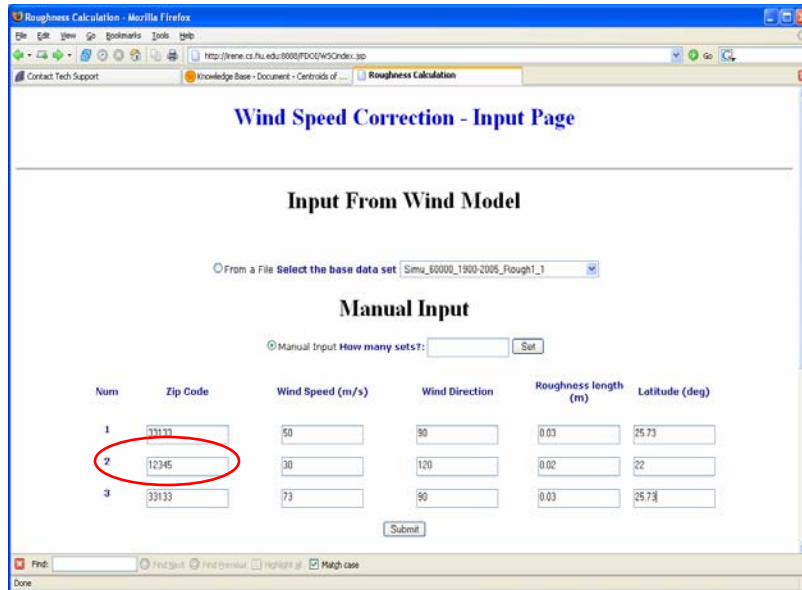


Figure 3.3.19: The input webpage contains a Zip code value which is not included in the lookup table

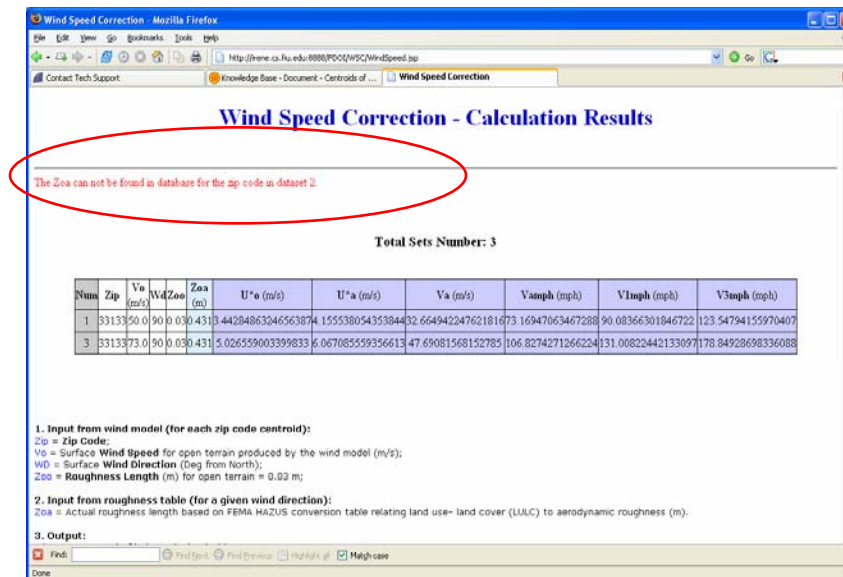


Figure 3.3.21: The result webpage which caught the exception when the Zoa value can not be fetched for some specific Zip code

3.3.6. FPHLM Roughness Classification Use Case

3.3.6.1. Purpose

To provide a table associating a value for aerodynamic roughness (Z_0) to the classification codes listed in the 2001 National Land Cover Database (NLCD). The

NLCD is developed from Landsat 7 imagery Multi-Resolution Land Characteristics Consortium (MRLC) <http://www.mrlc.gov/> The 2001 NLCD data will replace the circa 1994-1995 roughness obtained from FEMA's Hazus model that was used in FPHLM versions 2.5 and earlier.

3.3.6.2. *Background*

The classification codes are listed at (http://www.mrlc.gov/nlcd_definitions.asp). For codes whose descriptions are identical to the roughness classification table listed in the 2003 Hazus Technical Users manual, we leave the values unchanged. For new classifications, we use example images from NOAA's Coastal Services Center to estimate roughness based on field experience evaluating roughness from weather station site visits and aerial/satellite imagery for post-storm hurricane wind field reconstruction (see references). The code for determining roughness from NLCD data was written and implemented by Steve Cocke and is described in Axe 2003.

3.3.6.3. *References*

Coastal NLCD Classification Scheme
http://www.csc.noaa.gov/crs/lca/tech_cls.html - 17

NLCD Land Cover Classification definitions
http://www.mrlc.gov/nlcd_definitions.asp

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Homer, C. C. Huang, L. Yang, B. Wylie and M. Coan. 2004. Development of a 2001 National Landcover Database for the United States. Photogrammetric Engineering and Remote Sensing, Vol. 70, No. 7, July 2004, pp. 829-840.

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