# QUICK GUIDE - EMD-WRF ON-DEMAND ICING

## **Purpose:**

This quick guide shows you how to get icing losses into windPRO. With EMD-WRF On-Demand ICING, you only need to provide a geographical location and time period. From windPRO you can directly request icing estimates similar to other EMD-WRF On-Demand services. Modelled time series of ice growth, ice load, instrumental and meteorological icing meeting the industry standards are available alongside the raw WRF dataset specifically configured for icing purposes.

# **Outline of Guide:**

- Price structure and meso credits
- Running calculations
- Data included in the results

### 1. PRICE STRUCTURE AND MESO CREDITS

No special modules have to be purchased in order to run EMD-WRF OD ICING calculations. The calculations are paid as requested using EMDs "meso credits". Similar to other EMD-WRF OD calculations, the price depends on length of the requested time series. One month of hourly time series data with icing results costs 2 meso credits. A complete icing analysis requires a 10-year time series and the cost will be: 2 meso credits \* 12 (months) \* 10 (years) = 240 meso credits. The meso credits are purchased by contacting <u>sales@emd.dk</u> or by <u>ordering online</u>.

## 2. RUNNING CALCULATIONS

Requesting a EMD-WRF OD ICING run is very simple and follows the EMD-WRF OD services. You need to specify:

- ✓ Geographical location
- ✓ Time period

## 3. CALCULATION SETUP

To start a new calculation, you go to Mesoscale Data under the Climate tab.

File	Definitions	Geo Data	Climate	
			1	Con Mesoscale Data

A calculation setup window will open, as seen below.

Calculations Description					
Name EMD-WRF OD ICING					
Calculation Server					
Cerebrum HPC-Cluster at EMD Internatio	inal A/S	- Login	Logout	Setup	Server Informati
EMD Mesoscale Calculation Setup					
Position					
Select position for center of calculation:	Site center (1)				-
Longitude ±ddd.dddddd	16.233895°				
Latitude ±dd.dddddd	57.647035°	Select on Map			
Number of points:	1 -				
Model					
Configuration:	3 km ERA5 Icing				- Info
Icing information					
Current configuration includes EMD icing	calculations. Read mor	e here: Icing informat	ion.		
Please notice that EMD-WRF icing calcula	ations cost 2 credits per	month			
EMD-WRF calculations with less than 10	winter seasons do not i	nclude report, maps	etc.		
Period					
Start time (UTC):	01/09/2012 -				
End time (UTC):	01/09/2022 ~	Latest available	e data		
Start Calculation					
Credits needed for calculation: 256					Start on server
Ok Cancel					

Start by giving the calculation a name and press the Login button to connect to the computer cluster at EMD:

#### Mesoscale Data (Run WRF model on EMD cluster and extract data)

Main	Calculations	Description		
Nam	e			
Calc	ulation Serv	er		
Cer	ebrum HPC-C	luster at EMD	) International A/S -	Login

#### Select the position of the calculation:

Position	
Select position for center of calculation:	Site center (1)

The position can be defined based on another object in windPRO, it can be manually entered (user defined) or you can select the position on the map by clicking on it.

#### Select the model configuration "3 km ERA5 Icing":

Model	
Configuration:	3 km ERA5 Icing
	3 km ERA5T GlobCover
Icing information	3 km ERA-Interim GlobCover
Current configuration includes EMD icing	3 km MERRA-2 GlobCover
Please notice that EMD-WRE icing calcula	3 km CFSR/CFSv2 GlobCover
Thease house that End What long calcula	3 km ERA5 GlobCover
	2 km EPA5 Joing

The last thing to define before starting the calculation is the period you want.

**Note:** A complete icing analysis (reports, maps and raw WRF timeseries) requires minimum 10 seasons, whereas shorter time periods include only the raw EMD-WRF OD ICING timeseries.

## 4. STARTING THE CALCULATION

The calculation is started on the computer cluster at EMD by pressing the "Start on Server" button, giving you the following window:

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limited	No limit	No limit	~	Details	<ul> <li></li> </ul>
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	limited	limited No limit	limited No limit No limit ing credits to start calculation: 0 Move up Move	imited No limit No limit 🗸	Imited No limit V Details

For this example, you can see that it requires 240 meso credits. Once you are ready press the "Ok" button to start the calculation. You will see one more confirmation dialog before the calculation is actually started. Simply click "Yes" if you are sure you want to start the calculation. When the calculation has started you will see the "Calculations" tab showing the actual calculation and the estimated completion time for the job. Click "Ok".

#### 5. DOWNLOADING THE RESULTS

You will receive an e-mail when the job is completed, and the results are ready for download in windPRO. Open the project in windPRO and find the MesoScaleData calculation and open it:

Calculations (11)		
* Name	Created	Calculated
> W MesoScaleData: 10 years	12/04/2022 20:21:52	17/04/2022 19:45:00

On the "Calculations" tab you should see the calculation you started and the button "Download results" should now be enabled. Click the button to download the results from the server. After the download completes the results are added as a Meteo object. If a complete 10 season+ icing analysis was run, a Result layer will also be loaded.

### 6. DATA INCLUDED IN THE RESULTS

A time period of 10 seasons (or more) will include the complete icing analysis:

- ✓ Icing reports as pdfs hub-heights; 100m, 150m and 200m (Including predicted AEP loss)
- ✓ Icing maps at hub-heights; 100m, 150m and 200m
  - IEA ice class, IEA Ice loss (% AEP) and modelled meteorological icing (icing rate > 10 g/h)
- ✓ Monthly, yearly and seasonal icing analysis and bin-sector analysis as csv-files
- ✓ Timeseries of raw WRF data and modelled icing

Please find more information on the EMD-WRF OD ICING dataset and the complete icing analysis here: <u>knowledgebase</u>.

Note: EMD-WRF OD ICING relies on a downscaling approach with coupled-modelling at both mesoscale (3km grid resolution) and microscale (30m grid resolution). However, when in complex terrain, these resolutions are not always fine enough to ensure sufficient modelling accuracy. If the differences between meso- and micro terrain elevations are large (some hundreds of meters), then caution is advised, and users should expect increased uncertainty in results. If you are an EMD-WRF OD ICING user, feel free to contact the modelling team through the windPRO support hotline for further guidance and recommendations (support@emd.dk)

#### 7. RESULTS IN THE METEO OBJECT

In the Meteo object you find the raw EMD-WRF OD ICING data, from where wind speed, wind direction, turbulence intensity, icing intensity, ice load, instrumental icing and meteorological icing are the default loaded parameters.

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2	Wind direction	v	wDir.10_Mean (10.0m)	w	Wind direction	0		
3	Icing itensity	-	iceInten.10_Mean (10.0m)	*	Icing itensity	0		
4	Icing load	-	Mice.10_Mean (10.0m)	-	Icing load	0		
	Instrumental icing	*	icePassive.10_Mean (10.0m)	*	Instrumental icing	0		
5			iceSignal.10 Mean (10.0m)		Meteorological icing	0		
5	Meteorological icing							





For the complete icing analysis of minimum 10 years, the Mesores tab in the Meteo object will show the PDF reports, summary sheets either as excel exports or csvfiles:

#### 钉 Meteorological Data

Position Layers Guide Purpose Data Graphics Statistics Shear Mesores Report I

#### Please click the "Show" buttons or "Save to Folder".

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In the PDF report you will find seasonal overview of climate and the modelled icing and icing losses. Example plots from the PDF report at 100m are shown next.







Figure 8: Left: all data and right: only during meteorological icing periods.



#### RESULTS IN THE RESULT LAYER

8.

In the Result layers you will find icing maps if the complete icing analysis is run. Double click to show the icing maps (IEA loss, IEA ice class or meteorological icing).

