
ONE POWER COMPANY
AN INDUSTRIAL POWER COMPANY
continuum
Wind Energy Software
CONTINUUM
TOWN HALL
FEBRUARY 26 2025 | 11am EST
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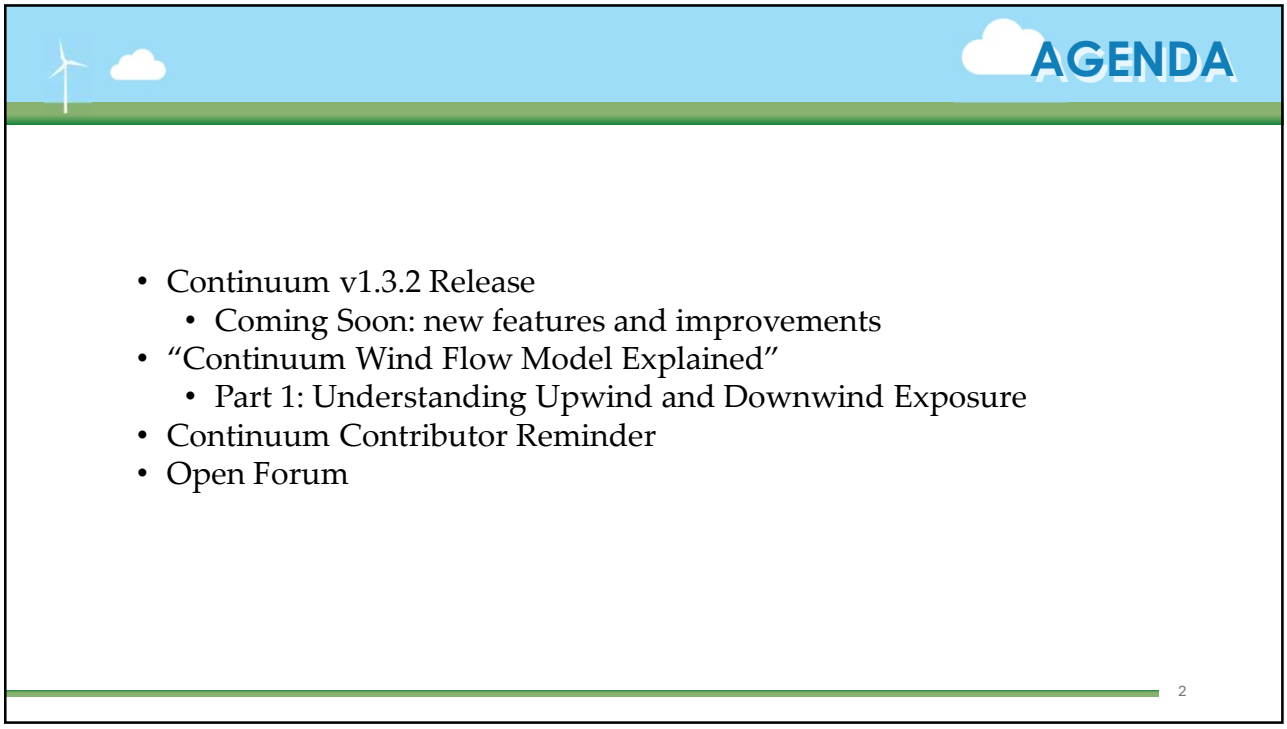
AGENDA
• Continuum v1.3.2 Release
• Coming Soon: new features and improvements
• "Continuum Wind Flow Model Explained"
• Part 1: Understanding Upwind and Downwind Exposure
• Continuum Contributor Reminder
• Open Forum
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NEW FEATURES

CONTINUUM 1.3.2: COMING SOON

Summary of New Features and Updates

- New release alert
- LT Reference TAB file export
- Fixed issue with map generation
  - Parallel threading / Writing/Accessing database
- USGS 10m data now available through 'Download Topography'
- South Africa Land Cover Key
- ERA5 10m data download fix

KEEP AN EYE OUT FOR THE NEW RELEASE

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CONTINUUM EXPLAINED

CONTINUUM EXPLAINED: WIND FLOW MODEL LECTURE SERIES

$$\Delta WS = m_{UW}\Delta Exp_{UW} + m_{DW}\Delta Exp_{DW} + \left[\frac{WS_1\left(ln\left(\frac{z-d_{2_{UW}}}{z_{02_{UW}}}\right)+\psi_{2_{UW}}\right)}{\ln\left(\frac{z-d_{1_{UW}}}{z_{01_{UW}}}\right)+\psi_{1_{UW}}} - WS_1\right] + \left[\frac{WS_1\left(ln\left(\frac{z-d_{2_{DW}}}{z_{02_{DW}}}\right)+\psi_{2_{DW}}\right)}{\ln\left(\frac{z-d_{1_{DW}}}{z_{01_{DW}}}\right)+\psi_{1_{DW}}} - WS_1\right] + m_{Elev}\Delta\text{Elev} + m_{Valley}\Delta(Exp_{UW} + Exp_{DW})$$

SESSION 1&2:	Understanding the UW and DW exposure components, flow types
SESSION 3:	Understanding the UW and DW SR/DH components
SESSION 4:	Understanding the elevation and valley components
SESSION 5:	Understanding terrain complexity and model coefficient definitions
SESSION 6:	Understanding machine learning model coefficient determination

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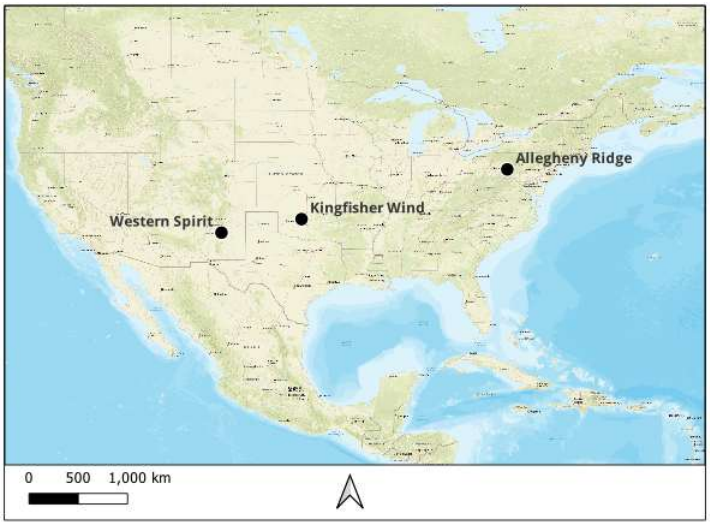
CONTINUUM EXPLAINED

Wind Farms for Examples

Three wind farms selected with low, moderate, and high levels of complexity

- Kingfisher Wind (low)
- Western Spirit (moderate)
- Allegheny Ridge (high)



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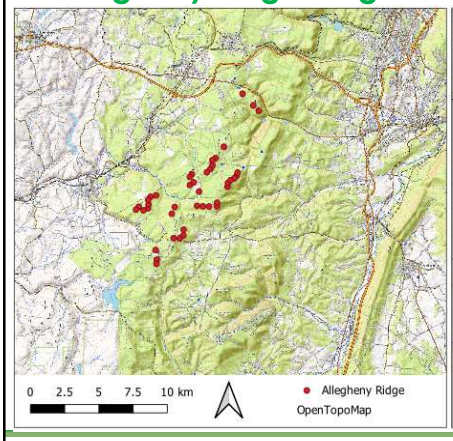
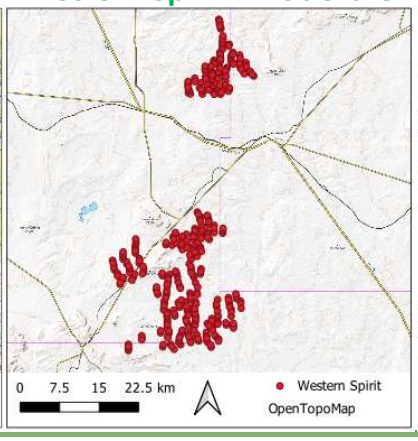
CONTINUUM EXPLAINED

Wind Farms for Examples

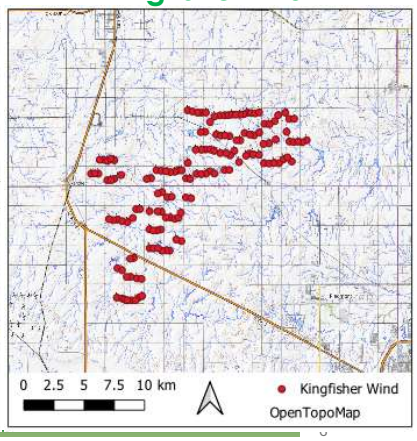
Allegheny Ridge - High



Western Spirit - Moderate



Kingfisher - Low



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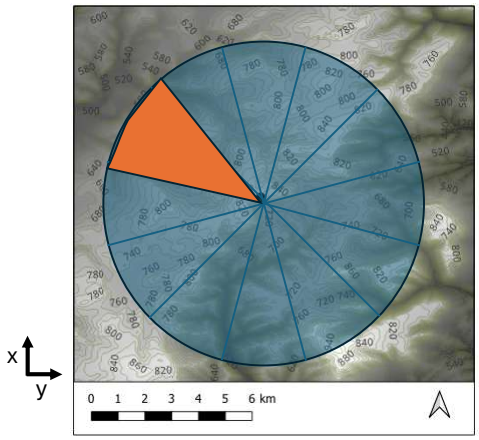
CONTINUUM EXPLAINED

What is Terrain Exposure?

Exposure = Average elevation difference between a site and the surrounding terrain (within a specified R) weighted by inverse distance.

$$Exposure_{\theta} = \left(\Sigma_{i=0}^{N} \frac{Z_o - Z_i}{(d_{z_o - z_i})^{\beta}}\right) \Big/ \left(\Sigma_{i=0}^{N} \frac{1}{(d_{z_o - z_i})^{\beta}}\right)$$



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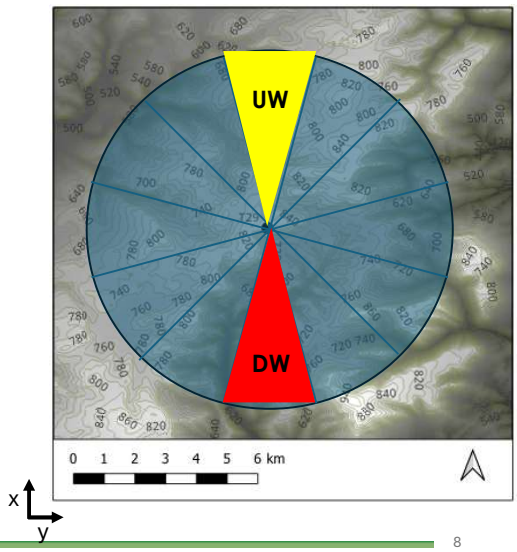
CONTINUUM EXPLAINED

Exposure has both an upwind (UW) and downwind (DW) component

WD Bin	Sector UW	θ UW Exposure	Sector DW	θ DW Exposure
0°	0°	54.3	180°	128.2



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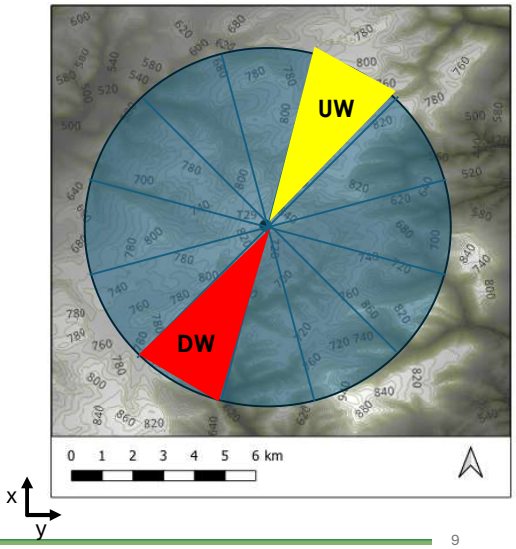
CONTINUUM EXPLAINED

Exposure has both an upwind (UW) and downwind (DW) component

WD Bin	Sector UW	θ UW Exposure	Sector DW	θ DW Exposure
0°	0°	54.3	180°	128.2
30°	30°	21.8	210°	60.9



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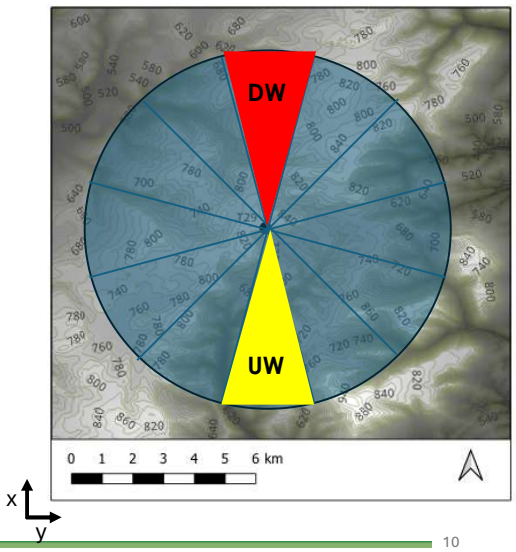
CONTINUUM EXPLAINED

Exposure has both an upwind (UW) and downwind (DW) component

WD Bin	Sector UW	θ UW Exposure	Sector DW	θ DW Exposure
0°	0°	54.3	180°	128.2
30°	30°	21.8	210°	60.9
60°	60°	47.1	240°	32.1
…	…	…	…	…
180°	180°	128.2	0°	54.3



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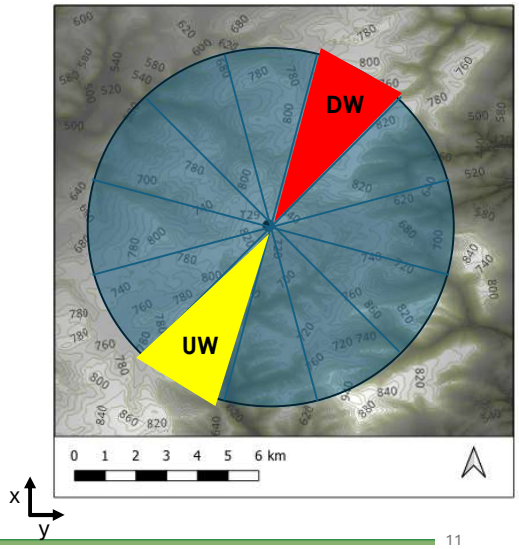
CONTINUUM EXPLAINED

Exposure has both an upwind (UW) and downwind (DW) component

WD Bin	Sector UW	θ UW Exposure	Sector DW	θ DW Exposure
0°	0°	54.3	180°	128.2
30°	30°	21.8	210°	60.9
60°	60°	47.1	240°	32.1
…	…	…	…	…
180°	180°	128.2	0°	54.3
210°	210°	60.9	30°	21.8
240°	240°	32.1	60°	47.1
…	…	…	…	…



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CONTINUUM EXPLAINED

Overall Exposure for both UW and DW are weighted by the wind rose at the site

$$Overall\ Exposure_{UW} = \sum_{\theta=0}^{Num\ WD\ Bins} Exposure_{\theta} \times Wind\ Rose\ Freq._{\theta}$$

$$Overall\ Exposure_{DW} = \sum_{\theta=0}^{Num\ WD\ Bins} Exposure_{\theta-180} \times Wind\ Rose\ Freq._{\theta}$$

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CONTINUUM EXPLAINED

Overall Exposure for both UW and DW are weighted by the wind rose at the site

WD Bin	θ UW Exposure	θ DW Exposure	Wind Rose Freq
0°	54.3	128.2	3.3%
30°	21.8	60.9	2.4%
60°	47.1	32.1	2.4%
…	…	…	…
180°	128.2	54.3	8.2%
210°	60.9	21.8	8.7%
240°	32.1	47.1	13.2%
…	…	…	…

$$Overall\ Exposure_{UW} = (54.3 * 3.3\%) + (21.8 * 2.4\%) + \ldots + (128.2 * 8.2\%) + (60.9 * 8.7\%) + \ldots$$

$$Overall\ Exposure_{DW} = (128.2 * 3.3\%) + (60.9 * 2.4\%) + \ldots + (54.3 * 8.2\%) + (21.8 * 8.7\%) + \ldots$$

$$Overall\ Exposure_{UW} = \sum_{\theta=0}^{Num\ WD\ Bins} Exposure_{\theta} \times Wind\ Rose\ Freq._{\theta}$$

$$Overall\ Exposure_{DW} = \sum_{\theta=0}^{Num\ WD\ Bins} Exposure_{\theta-18} \times Wind\ Rose\ Freq._{\theta}$$

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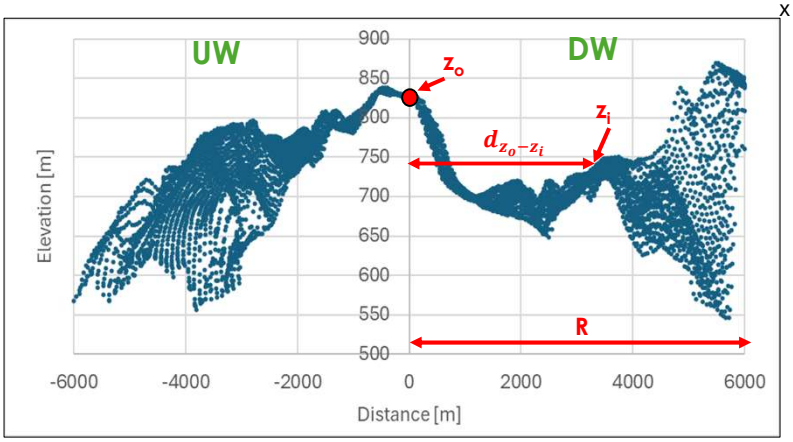
CONTINUUM EXPLAINED

How do we calculate a sector's exposure?

$$Exposure_{\theta} = \frac{\left(\sum_{i=0}^{N} \frac{Z_o - Z_i}{\left(d_{z_o - z_i}\right)^{\beta}}\right)}{\left(\sum_{i=0}^{N} \frac{1}{\left(d_{z_o - z_i}\right)^{\beta}}\right)}$$

N: all elevation datapoints within the directional sector



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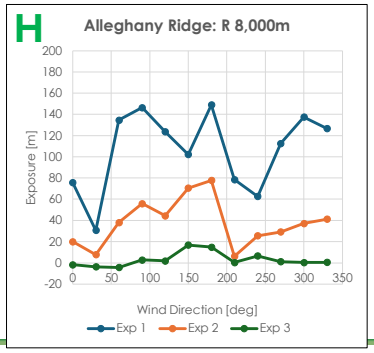
CONTINUUM EXPLAINED

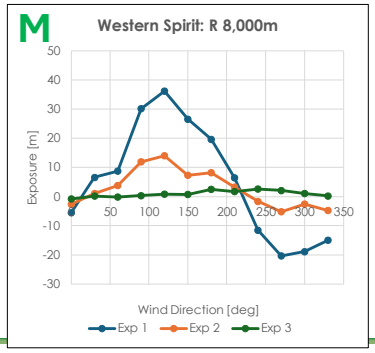
Inverse Distance Weighting

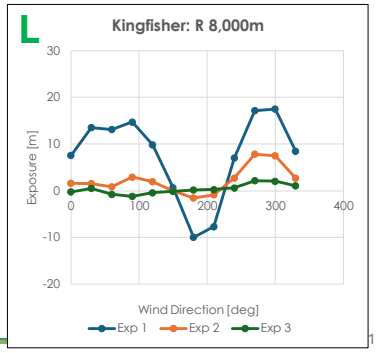
Exposure = Average elevation difference between a site and the surrounding terrain (within a specified R) **weighted by inverse distance**.

$$Exposure_\theta = \left(\sum_{i=0}^{N} \frac{Z_o - Z_i}{\left(d_{z_o - z_i}\right)^{\beta}}\right) \Big/ \left(\sum_{i=0}^{N} \frac{1}{\left(d_{z_o - z_i}\right)^{\beta}}\right)$$

Affects how quickly the influence of z_i diminishes with distance







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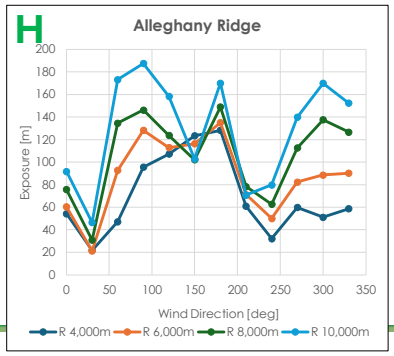
CONTINUUM EXPLAINED

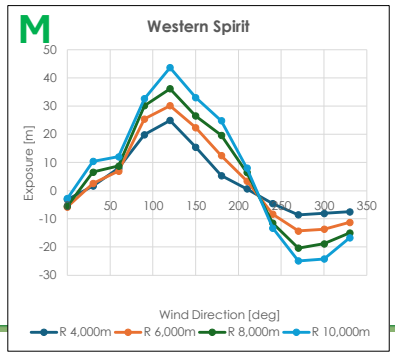
Radius of Investigation

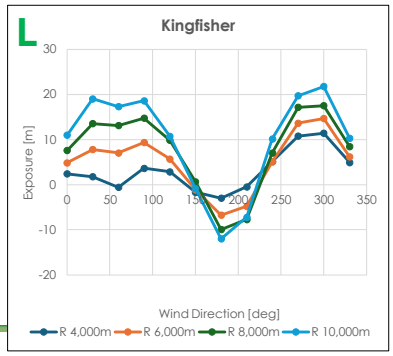
Exposure = Average elevation difference between a site and the surrounding terrain (**within a specified R**) weighted by inverse distance.

$$Exposure_\theta = \left(\sum_{i=0}^{N} \frac{Z_o - Z_i}{\left(d_{z_o - z_i}\right)^{\beta}}\right) \Big/ \left(\sum_{i=0}^{N} \frac{1}{\left(d_{z_o - z_i}\right)^{\beta}}\right)$$

Affects how many z_i within each sector to use







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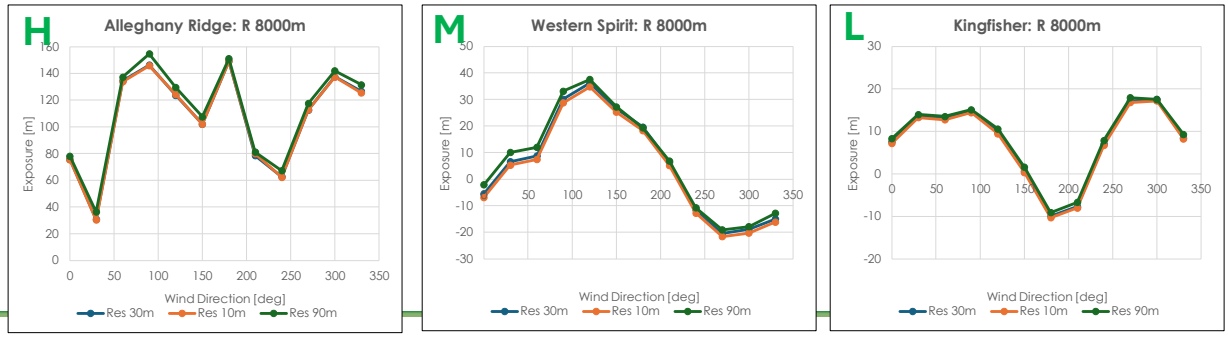
CONTINUUM EXPLAINED

Elevation Data Resolution

Exposure = Average **elevation difference** between a site and the surrounding terrain (within a specified R) weighted by inverse distance.

$$Exposure_\theta = \left(\sum_{i=0}^{N} \frac{Z_o - Z_i}{(d_{z_o - z_i})^\beta}\right) \Big/ \left(\sum_{i=0}^{N} \frac{1}{(d_{z_o - z_i})^\beta}\right)$$

Affects how many z_i within each sector to use



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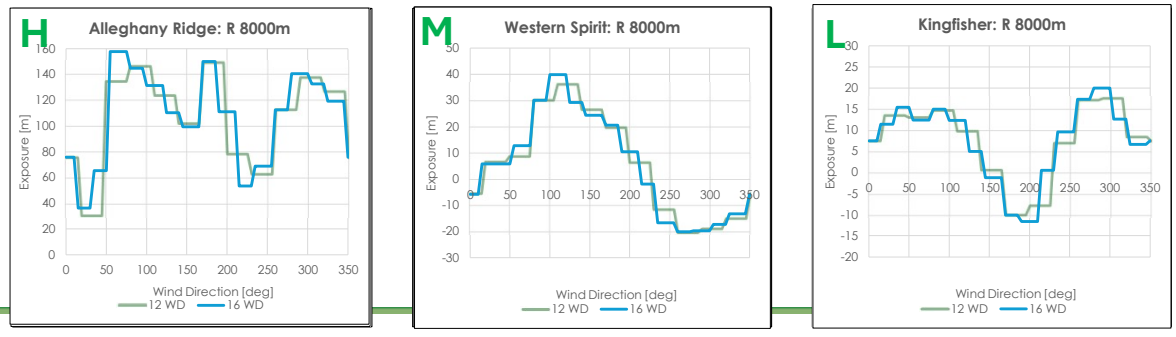
CONTINUUM EXPLAINED

WD Bin Size

Exposure = Average elevation difference **between a site and the surrounding terrain** (within a specified R) weighted by inverse distance.

$$Exposure_\theta = \left(\sum_{i=0}^{N} \frac{Z_o - Z_i}{(d_{z_o - z_i})^\beta}\right) \Big/ \left(\sum_{i=0}^{N} \frac{1}{(d_{z_o - z_i})^\beta}\right)$$

Affects how many sectors to use



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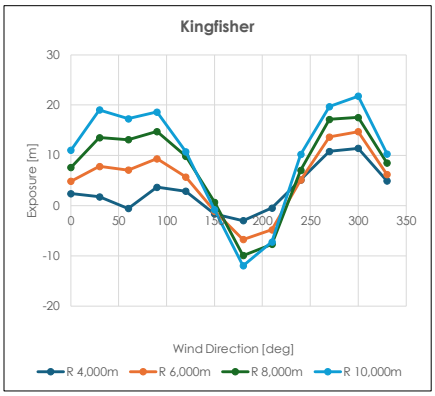
CONTINUUM EXPLAINED

Multiple Models



Varying radius of investigation (R) has spread in directional exposure

But which one should we use?

Continuum creates four separate models with four different R's

- Generates multiple estimates which are then combined (ensemble approach)
- We'll talk about how they're combined in a later session

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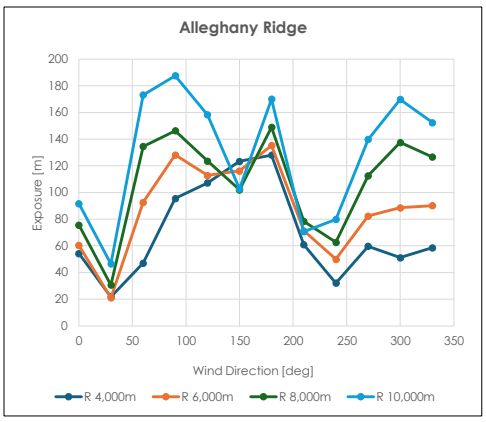
CONTINUUM EXPLAINED

Continuum Parameters for Exposure



Hardcoded

R using 4000, 6000, 8000, and 10000 m

β=1

User Defined

Elevation data resolution

Recommended at 30m

WD Bin Number

Recommended at 12

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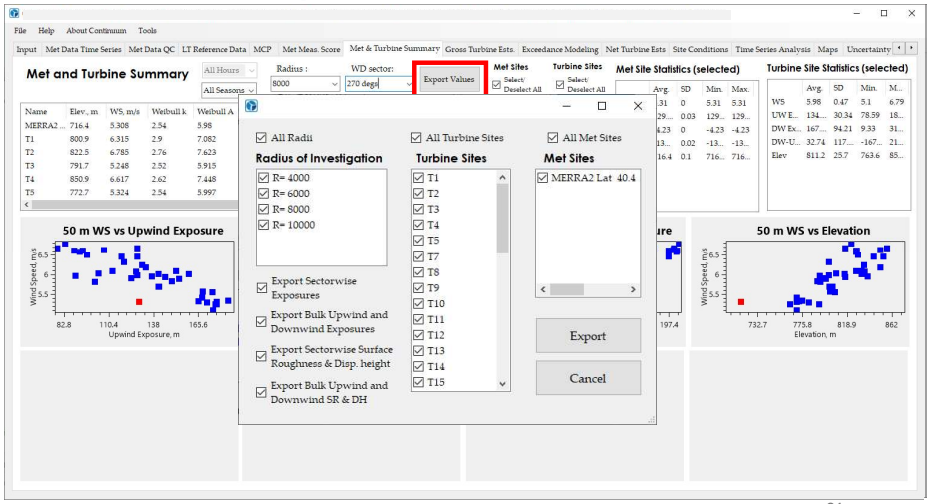
CONTINUUM EXPLAINED

Continuum Met & Turbine Summary Tab

- Examine/export exposure values at met and turbine sites
- Compare values using different ROIs
- View exposure in different WD bins
- Export exposure values to .CSV file
- Select Met/Turbine Sites
- Export sectorwise and/or overall UW/DW exposure



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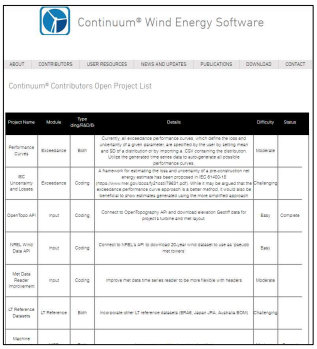
BECOME A CONTRIBUTOR

CONTINUUM CONTRIBUTOR: Someone who actively participates to enhance the Continuum® wind energy software

Continuum's mission is to further the pre-construction wind energy industry through collaboration of wind professionals, researchers, and students

We have an extensive list of projects to incorporate into the software on the Continuum website, but are always open to additions from the community



Projects are broken into two categories: software development and R&D

Software Development

- Getting into the code and making changes to existing framework
- Example: allow for manual filtering, incorporating other long-term reference datasets (non-US)

R&D

- New method development and analysis
- Example: wake loss model parameter sensitivity analysis, new ice impact model algorithm

https://www.continuumwind.com/contributors

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OPEN FORUM

ANY QUESTIONS, COMMENTS, CONCERNS ON CONTINUUM?

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continuum
Wind Energy Software

THANKS FOR JOINING!

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