Airport Runway Location and Orientation

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Runway Location Considerations

The following factors should be considered in locating and orienting a runway:

- Wind
- Airspace availability
- Environmental factors (noise, air and water quality)
- Obstructions to navigation
- Air traffic control visibility
- Wildlife hazards

Read Chapter 2 of FAA AC/150-5300-13a for more information about each topic.

Demonstrated Wind Conditions

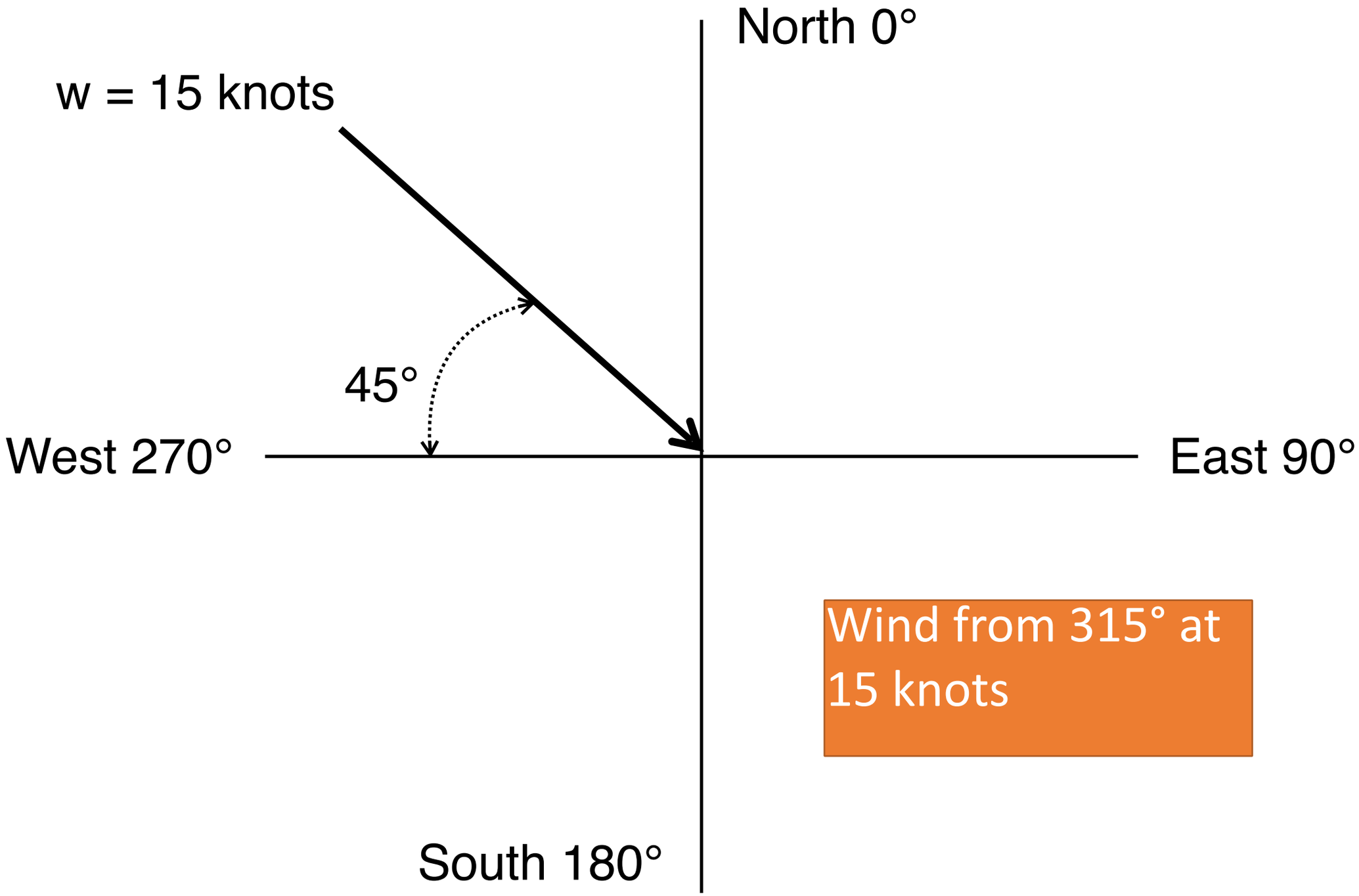
Each aircraft has a uniquely stated maximum crosswind component (derived from flight test experiments)

- A Boeing 727-200 (approach group C) has a maximum demonstrated wind component of 35 knots
- A Cessna 172 (a single engine aircraft falling in approach speed group A) has a maximum demonstrated crosswind component of 17 knots

The challenge for the designer is to accommodate all of the aircraft using the facility in a reliable and reasonable manner

Reporting Wind Conditions

Wind is reported on an azimuthal basis as shown below



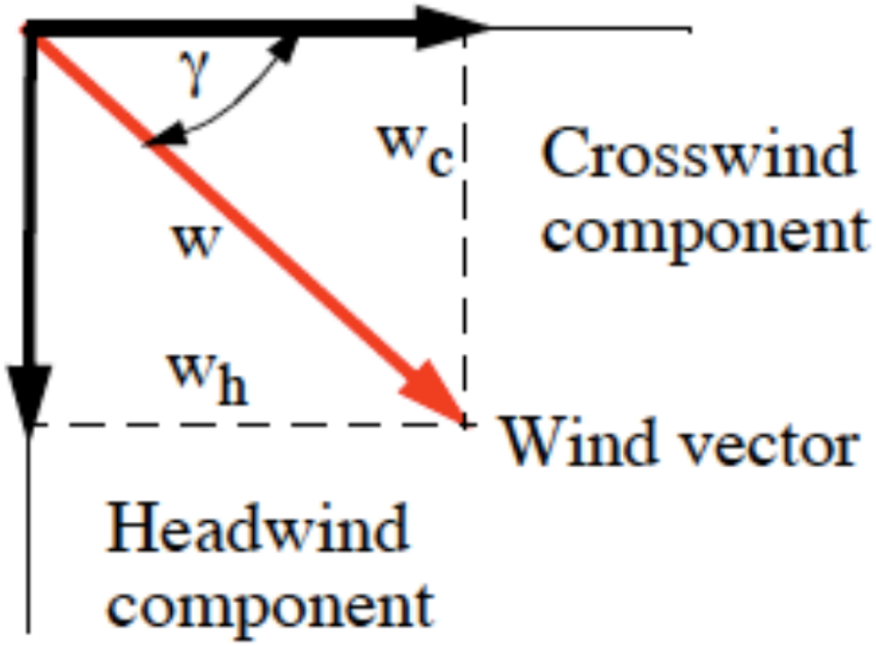
Wind from 315° at 15 knots

Sample Crosswind Computation

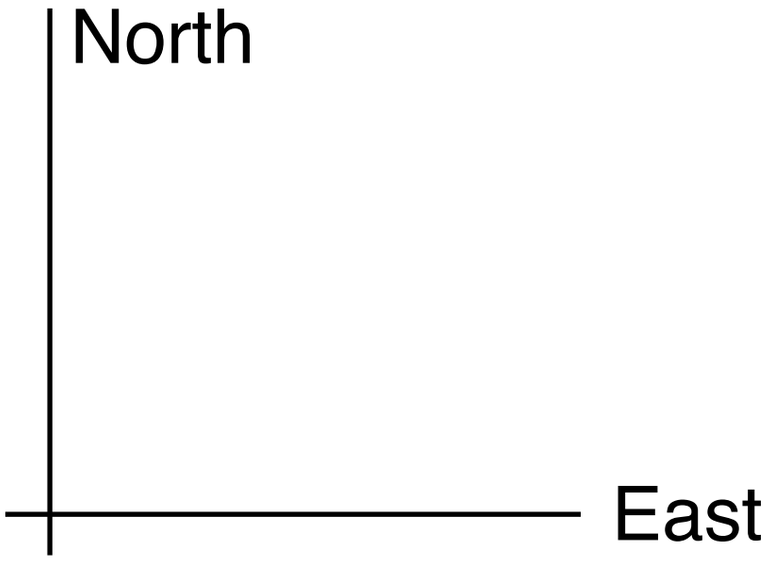
Wind is reported on an azimuthal basis as shown below

Runway 27

$$w_c = w \sin(\gamma)$$
$$w_h = w \cos(\gamma)$$



NOTE: Winds are reported with respect to the magnetic North (in ATC transmissions) but many times reported with respect to the true North in printed applications.



Design Criteria (FAA and ICAO)

- Read Chapter 2 of FAA AC 150/5300-13 or Aerodrome Design Manual (Volume 1 for ICAO standards)
- Employ the **most critical aircraft expected to operate** in the airfield (in this context the most critical is the largest
- Employ the most critical aircraft expected to operate in the airfield (**in this context the most critical is the largest aircraft**)
- Provide a **runway (or runways) orientation that satisfies 95% coverage** (i.e., crosswinds below a critical value) considering multiple year wind conditions
- If **one runway does not meet the 95% criteria provide a second crosswind runway**

FAA Crosswind Design Criteria

Recognizing that each aircraft has unique maximum demonstrated crosswind characteristics the FAA (and ICAO as well) set a low value for crosswind design criteria.

RDC	Allowable Crosswind Component
A-I and B-I *	10.5 knots
A-II and B-II	13 knots
A-III, B-III, C-I through D-III D-I through D-III	16 knots
A-IV and B-IV, C-IV through C-VI, D-IV through D-VI	20 knots
E-I through E-VI	20 knots

* Includes A-I and B-I small aircraft.

Source: Table 3.1 of FAA AC 150/5300-13A

ICAO Airport Codes

ICAO has two aerodrome classifications shown in the table below.

Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wing span (4)	Outer main gear wheel span[a] (5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

a. Distance between the outside edges of the main gear wheels.

ICAO Aerodrome Design and Operations (Volume 1)

ICAO Crosswind Design Criteria

Similar to the FAA criteria in many ways but simpler (only three design values - instead of four).

Runway Length (m.)	Design Crosswind Value (knots)
< 1,200	10.0
1,200 - 1,500	13.0
> 1,500	20.0

For airports that experience poor braking action with regular frequency use 13 knots instead of 20 knots.

Wind Data Needs for Airport Design

For mountainous terrain with data without wind data, the use of nearby stations is of questionable value

- Take one year of wind data if possible
- Several automated reporting systems exist at airports that can be used for this purpose

AWOS - Automated Weather Observation System

- The data available from NOAA usually includes 10-15 years (daily observations)
- Use 5-10 years of data for airport planning purposes (except when you are collecting the data yourself)

Sample Wind Data (Electronic Format)

	Hourly Observations of Wind Speed (knots)									
Direction	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	> 41	Total
10°	137	929	846	970	149	17	2	2	0	3052
20°	171	894	608	436	42	6	2	0	0	2159
30°	131	749	441	248	14	1	2	0	0	1586
40°	129	603	339	163	13	0	1	2	0	1250
50°	116	645	347	203	22	1	0	0	0	1334
60°	89	616	273	149	12	1	0	0	0	1140
70°	119	668	289	163	11	1	0	0	0	1251
80°	129	725	310	175	27	1	0	0	0	1367
90°	113	748	311	185	31	2	1	2	0	1393
100°	102	860	378	229	27	5	0	0	0	1601
110°	116	802	494	353	47	1	1	0	0	1814
120°	177	1060	781	625	98	14	1	0	0	2756
130°	147	1444	1133	1092	178	19	5	0	0	4018
140°	176	2002	1485	1619	314	22	0	0	0	5618
150°	176	2354	2024	2330	521	68	3	0	0	7476
160°	195	2455	2134	3288	920	114	1	0	0	9107

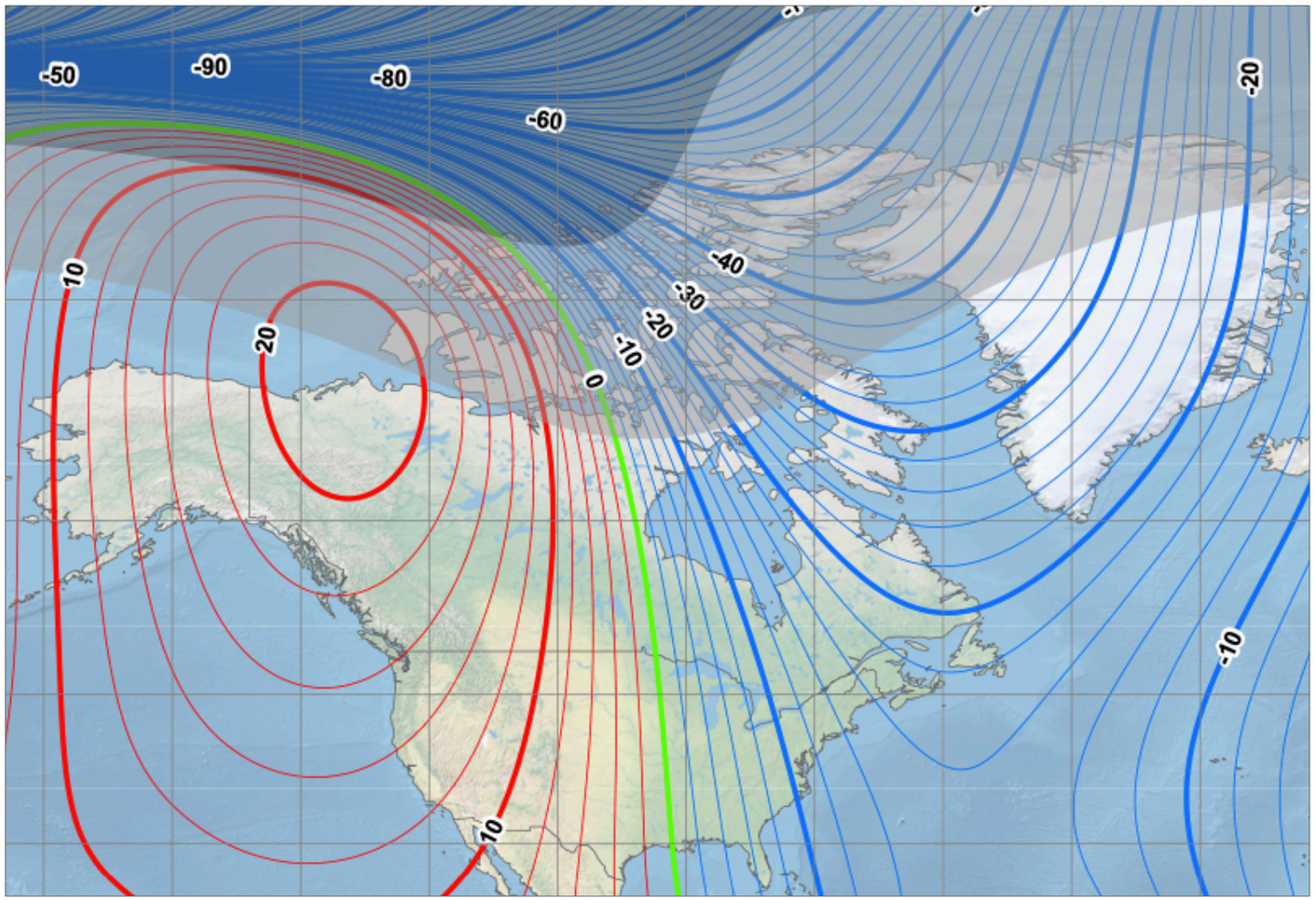
An Issue About Wind Data

- Wind data from automated weather stations at airports (including ATIS information) is reported with reference to the **magnetic north**
- Aviation weather reports such as Meteorological Aerodrome Reports (METAR) and Terminal Area Forecasts (TAF) are referenced to **true North**
- Winds Aloft, etc. are given with reference to **true North**
- Check the source of the wind data to make sure your analysis is accurate

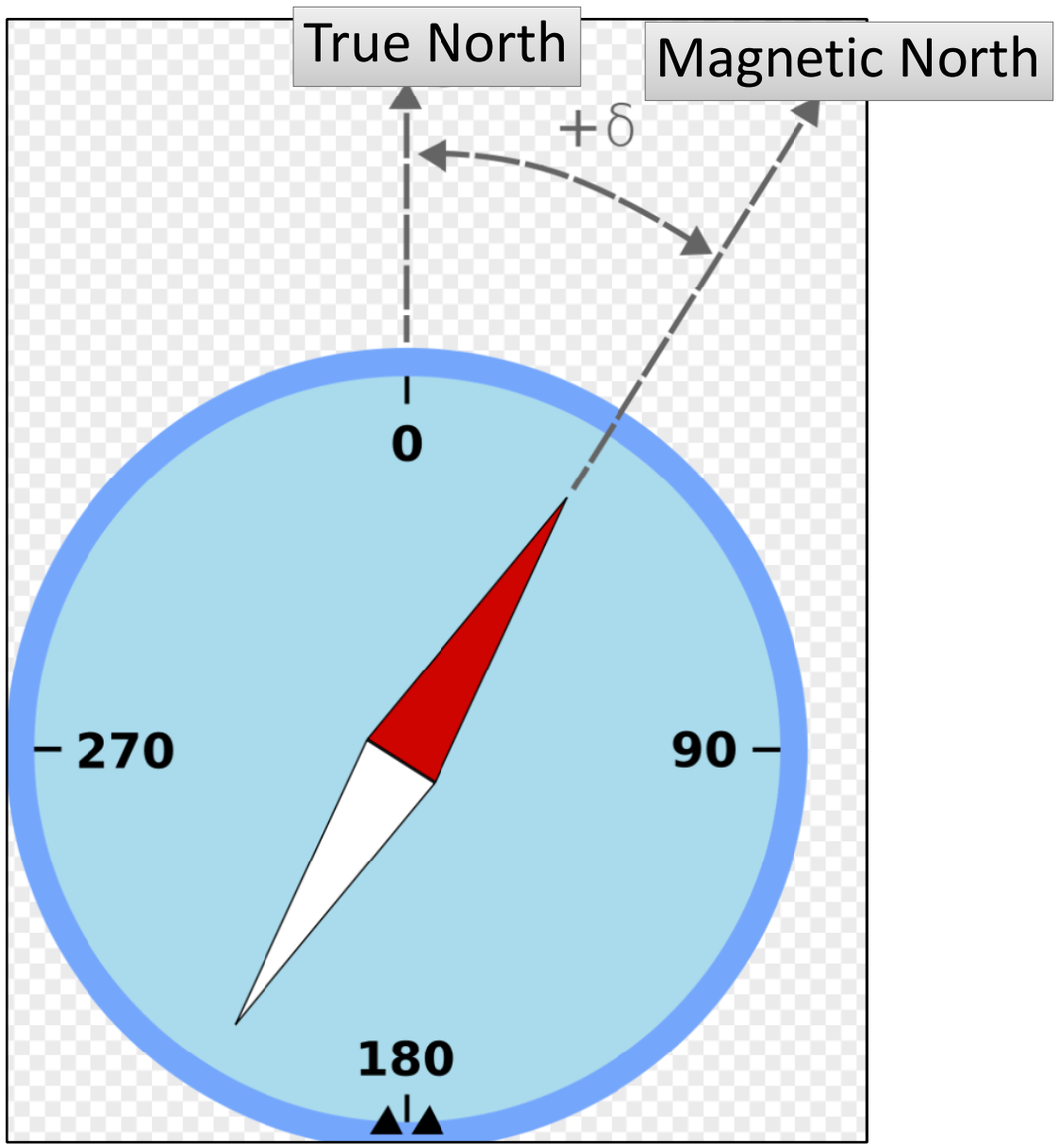
Virginia Tech Montgomery Executive Airport
Automated Weather Observing System (AWOS)

Magnetic and True North are Seldom the Same

- *"Magnetic variation, is the angle on the horizontal plane between magnetic north (the direction the north end of a magnetized compass needle points, corresponding to the direction of the Earth's magnetic field lines) and the true north." (Wikipedia)*
- Magnetic variation changes over time and position on Earth



Source: Wikipedia



Source: Wikipedia

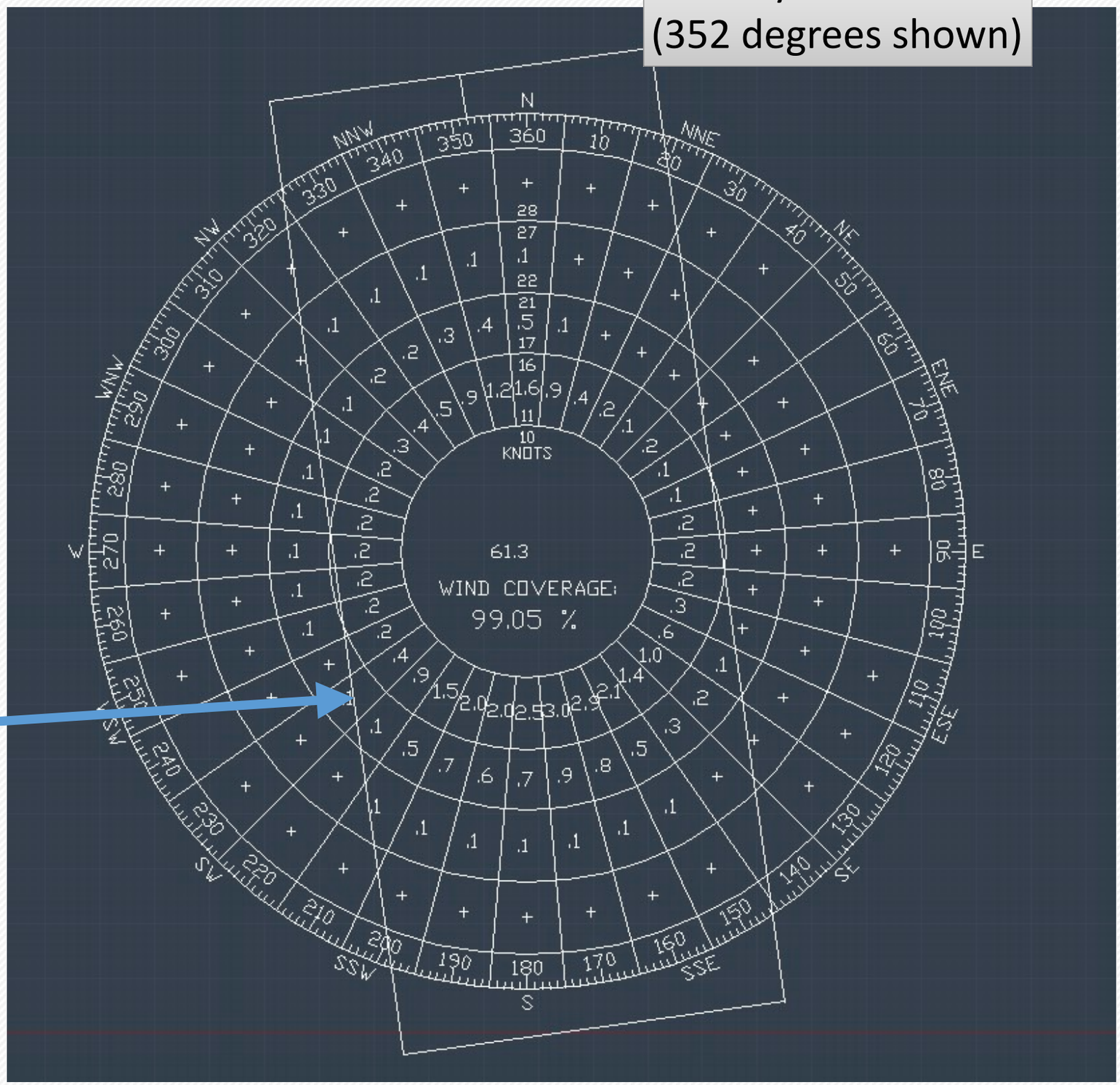
Wind Rose Analysis

- A clever way to portray all wind data in a graphical template
- Used to estimate the percent of time wind coverage satisfies a threshold crosswind value
- The wind rose is just a graphical way to decompose wind vector data
- The wind rose is populated with percentages derived from wind observations
- Wind rose is part of the data provided in the Airport Layout Plan (ALP)

Wind Rose Template

The Wind Rose contains the percent of the time the wind blows from a narrow set of azimuthal directions and within a range of wind speeds

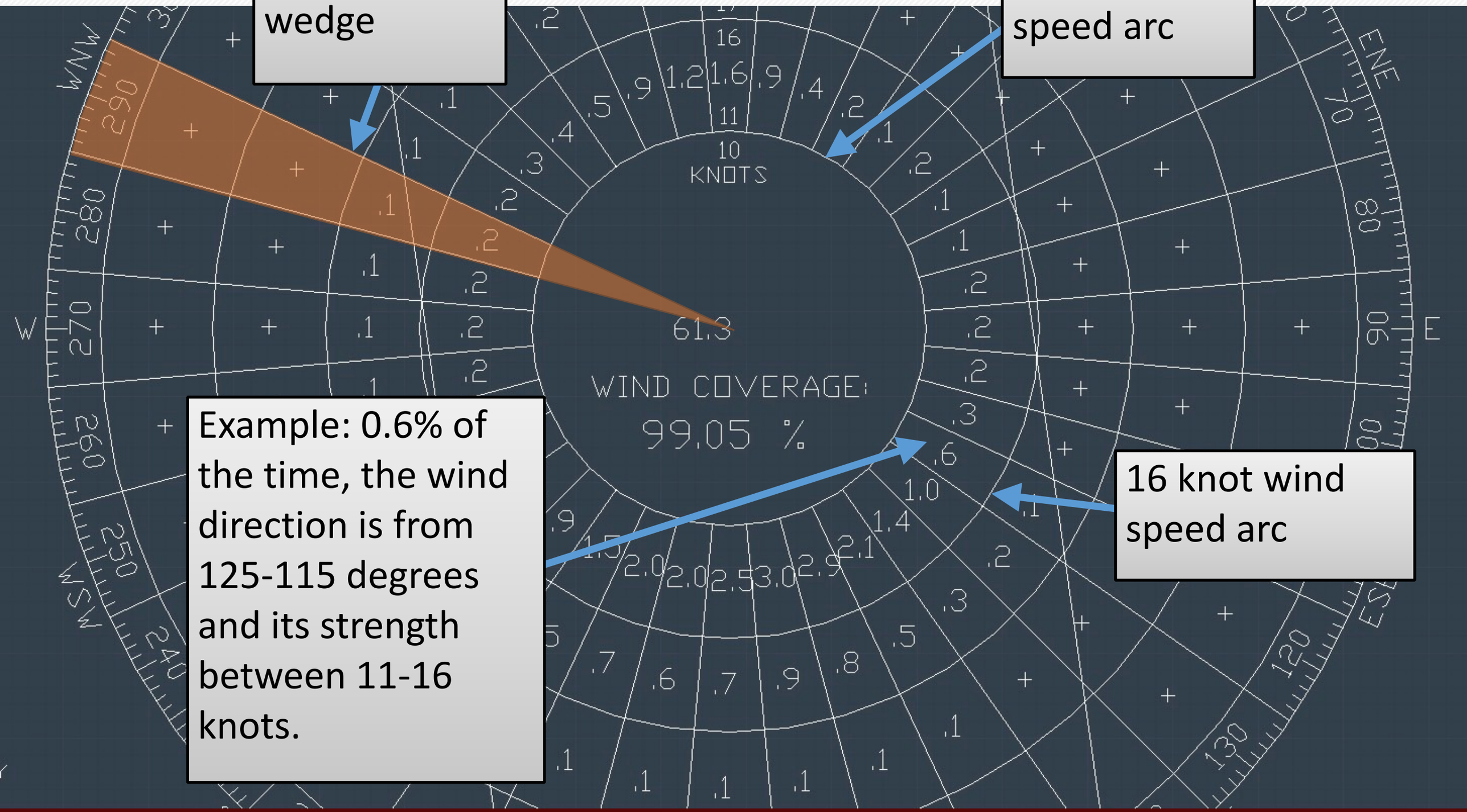
Rectangular template indicates critical cross wind strength (16 knots shown)



Sample Wind Rose with Data

285-295 degree wind wedge

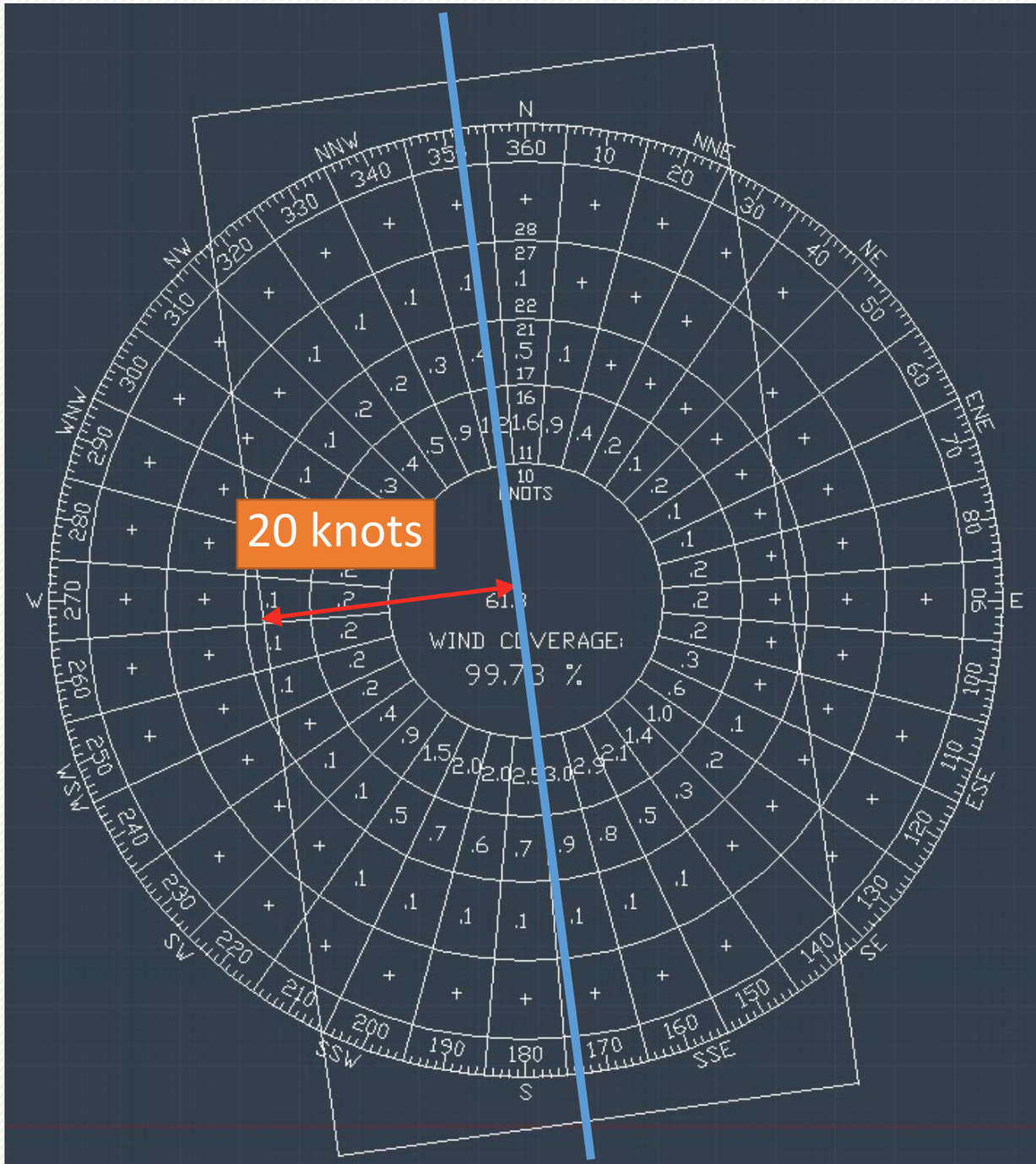
10 knot wind speed arc



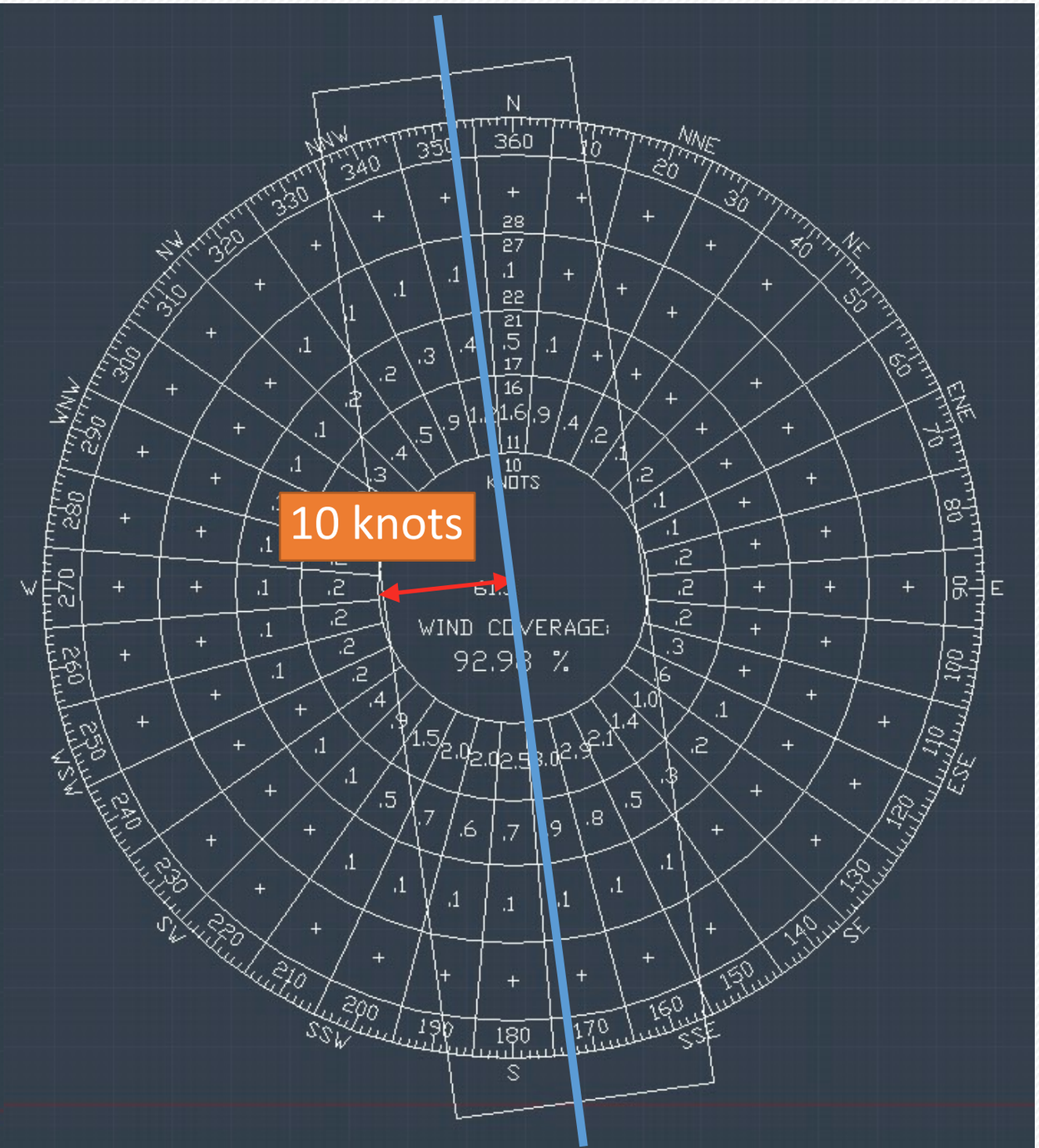
Example: 0.6% of the time, the wind direction is from 125-115 degrees and its strength between 11-16 knots.

16 knot wind speed arc

Wind Rose Coverage (Single Runway)



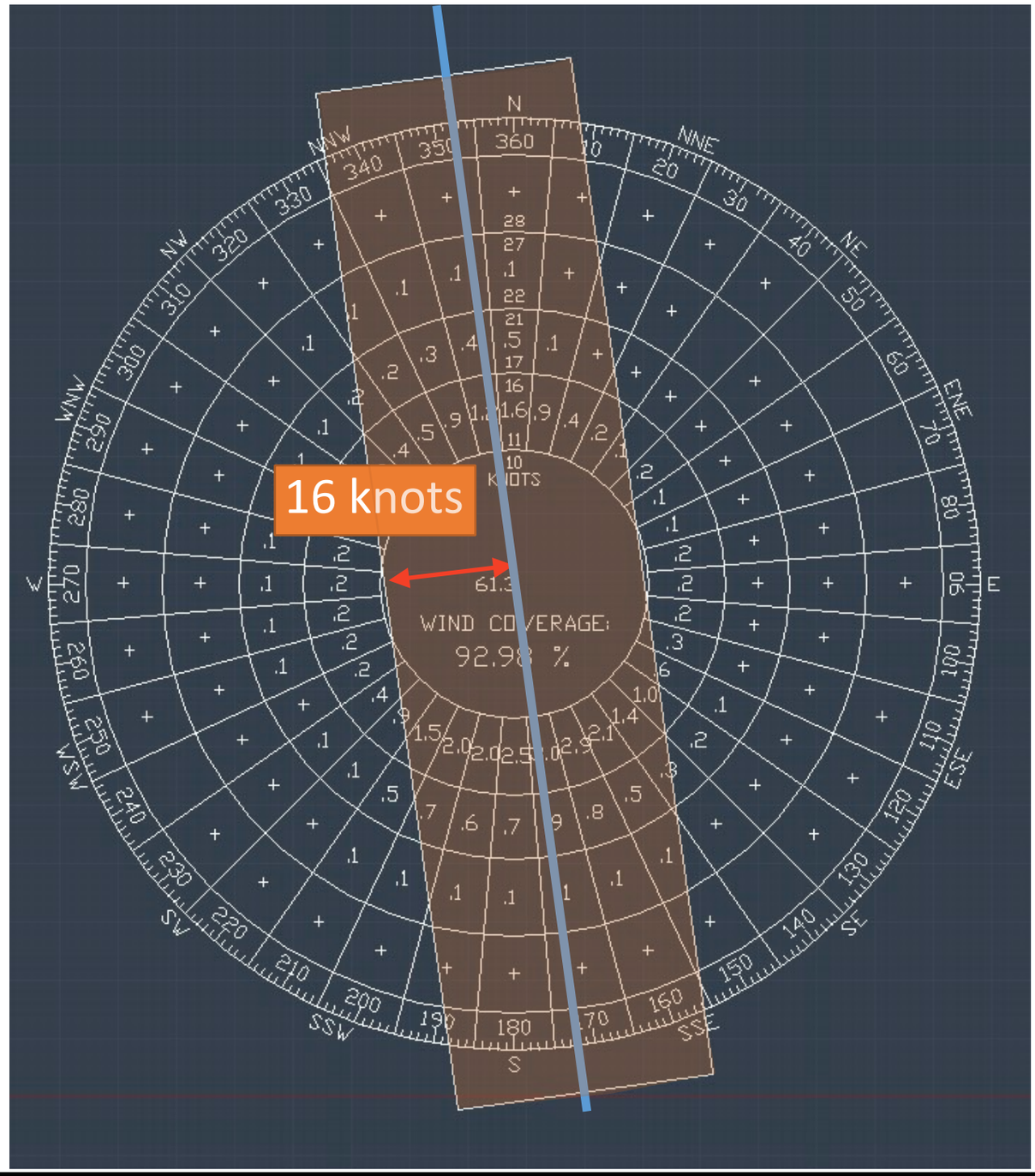
20 knot crosswind (99.73%)



10 knot crosswind (92.98%)

Principle of Why the Wind Rose Works

- The wind rose is a clever way to decompose wind vectors
- The Wind Rose determines the cross wind component for a given wind direction and speed
- If the “wedge” of wind is covered by the rectangular template, the cross wind is below the critical crosswind used to draw the rectangle



Principle of Why the Wind Rose Works

Average wind vector:

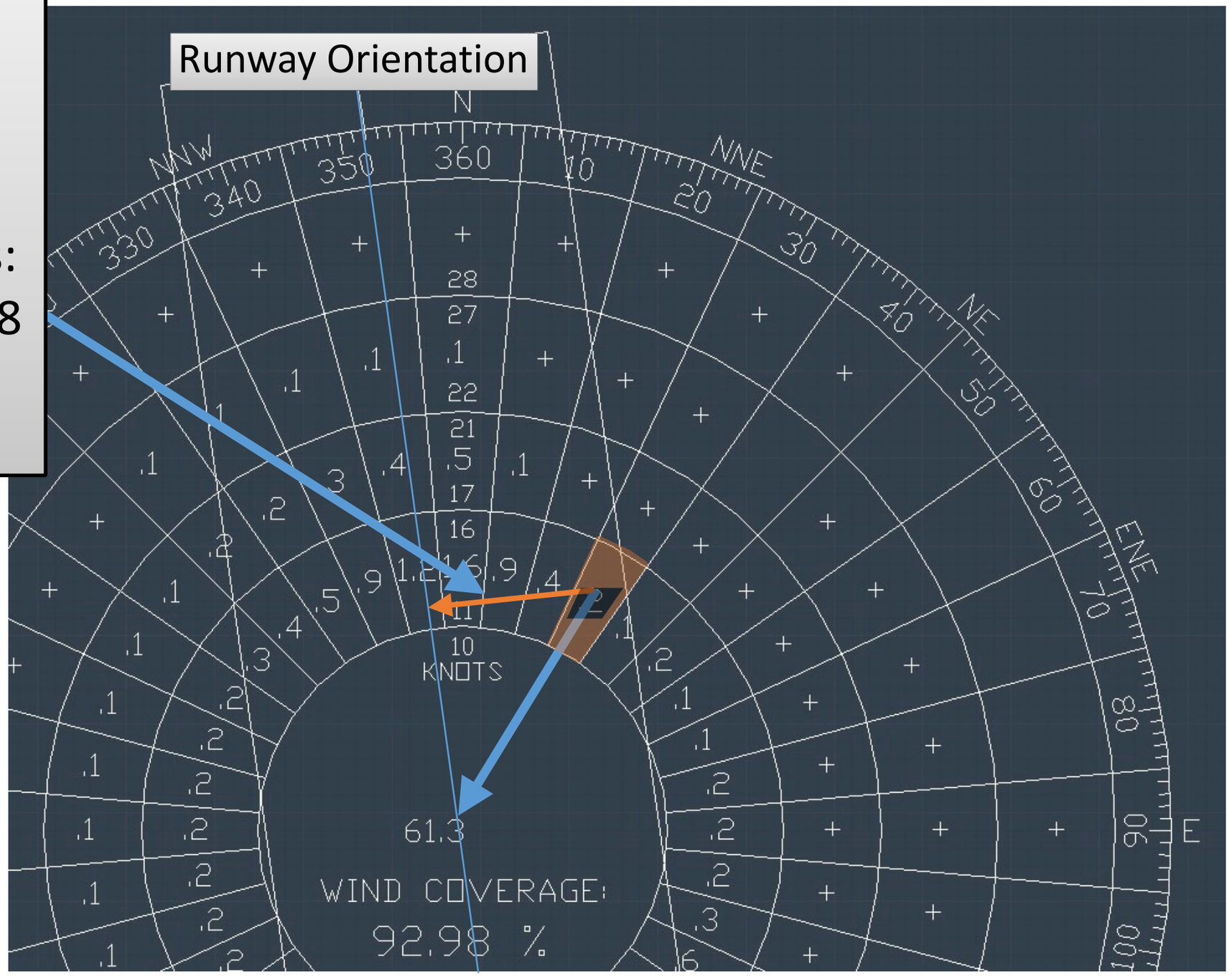
a) 25-35 degrees

b) 11-16 knots

crosswind magnitude is:

W_c = (13.5 knots) sin (38 deg) = 8.31 knots

Crosswind component of average wind vector is contained by the 10 knot rectangular boundary (hence covered)



Wind Data Sources

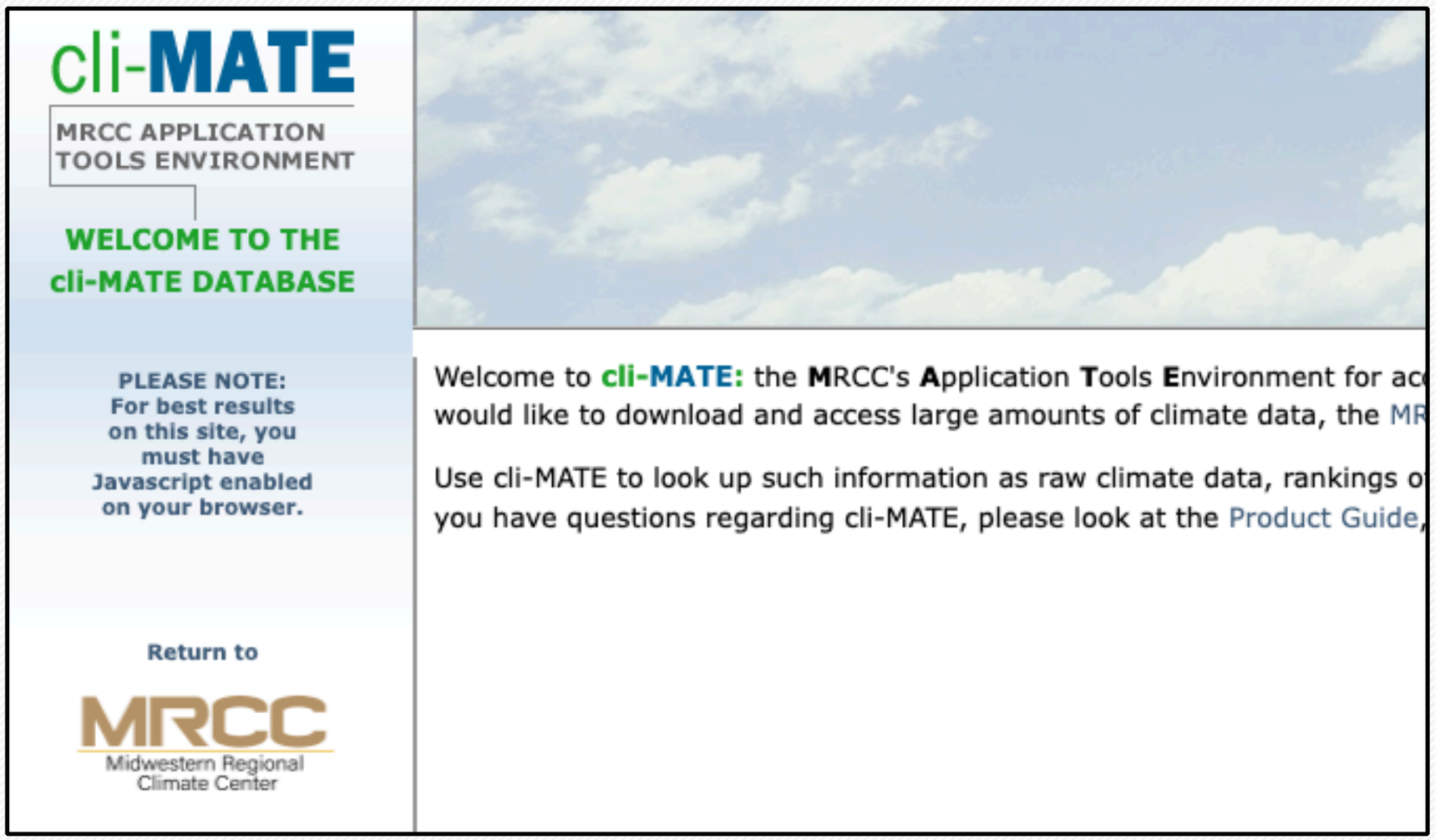
Cessna Citation Latitude landing at BCB airport (A. Trani)

Obtaining Wind Data for Wind Rose Analysis

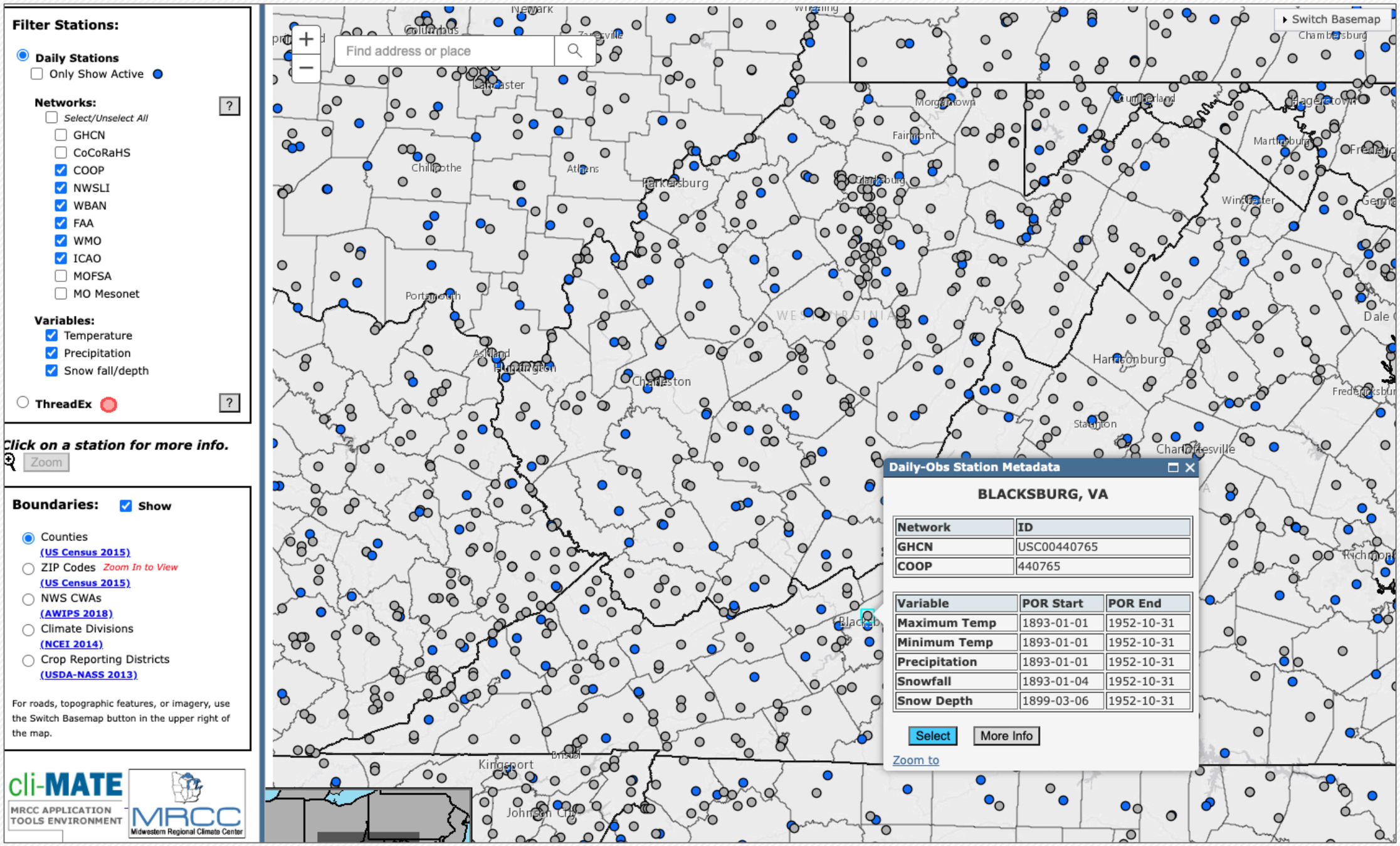
Source	Data	Website
cli-MATE	*Integrated site with wind data and wind rose analysis*	*https://mrcc.purdue.edu/CLIMATE/welcome.jsp*
Federal Aviation Administration Airport Data Information Portal (ADIP)	*Nice integrated site with wind data and wind rose analysis* *Wind data every 10 degrees of azimuth (36 bins)*	*https://adip.faa.gov/agis/portal/#/portal*
Iowa State University Mesonet Site	*Integrated site with wind data and wind rose analysis* *Wind data every 10 degrees of azimuth (36 bins)*	*https://mesonet.agron.iastate.edu/agweather/*

Obtaining Wind Data from cli-MATE

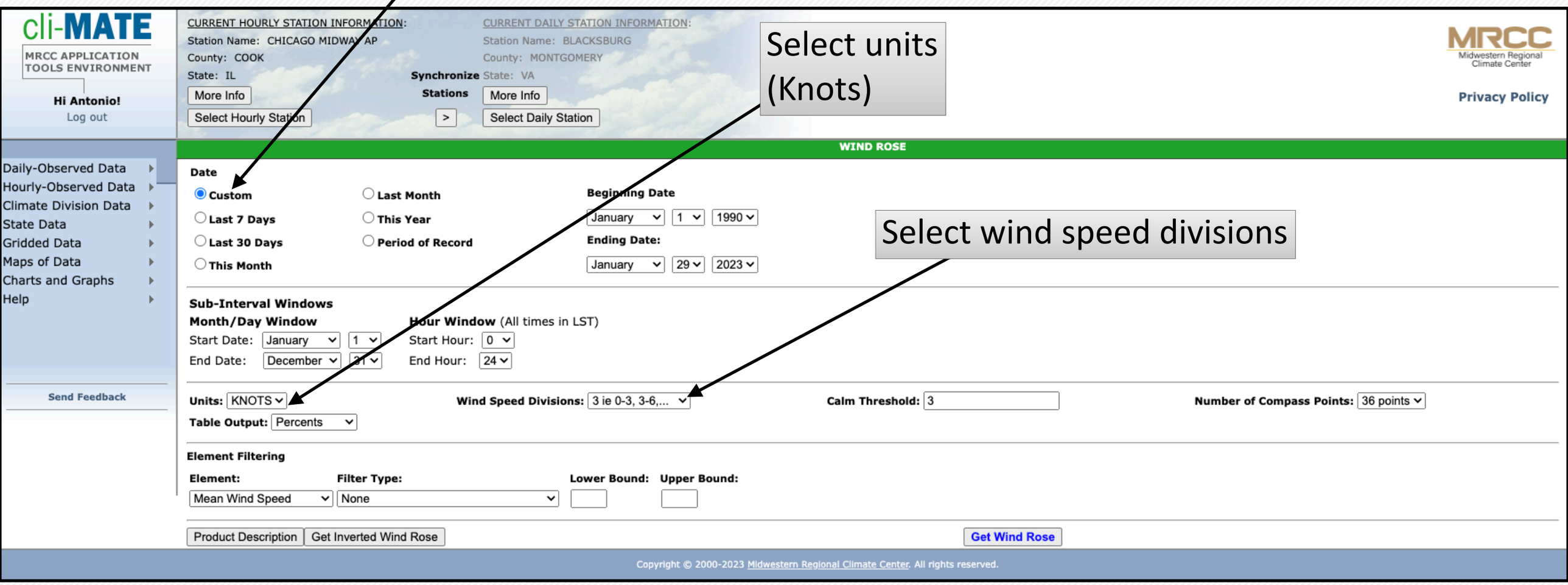
1. Go to https://mrcc.purdue.edu/CLIMATE/welcome.jsp
2. You need to register to use this site (free)
3. Select wind rose panel
4. Data is maintained by the Midwestern Regional Climate Center's



Graphic Interface to Obtain Wind Data from cli-MATE



Select the Wind Summary Type Wanted and the Number of Compass Points



Wind Rose (Example for Midway Airport)

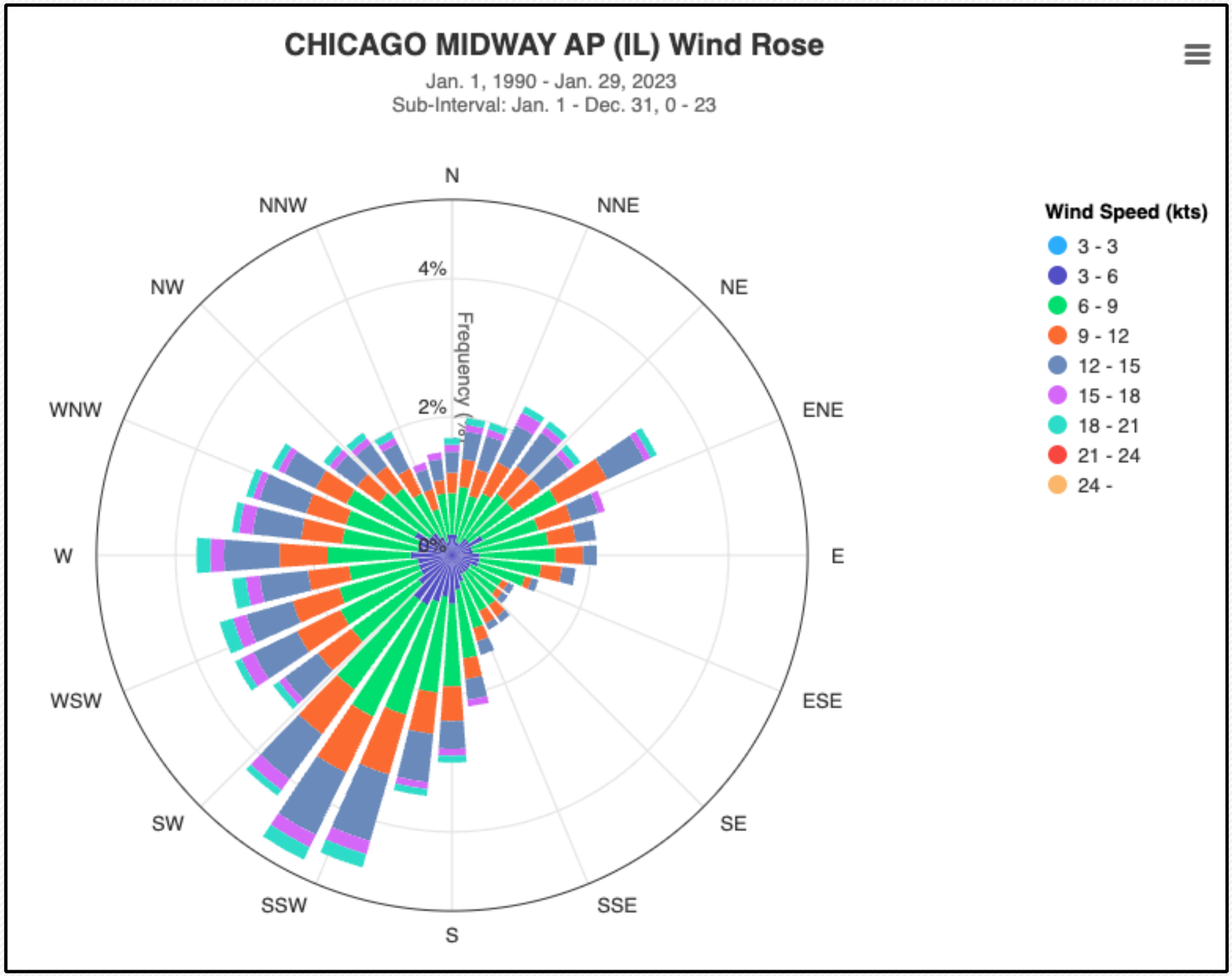


Table Depiction of Wind Rose Data

CHICAGO MIDWAY AP (IL) - Wind Frequency Table (percentage)

Latitude : 41.7861
Longitude : -87.7522
Elevation : 612 ft.
Element : Mean Wind Speed

Start Date : Jan. 1, 1990
End Date : Jan. 29, 2023
# of Days : 12082 of 12082
obs : poss : 277518 of 289224

Sub Interval Windows

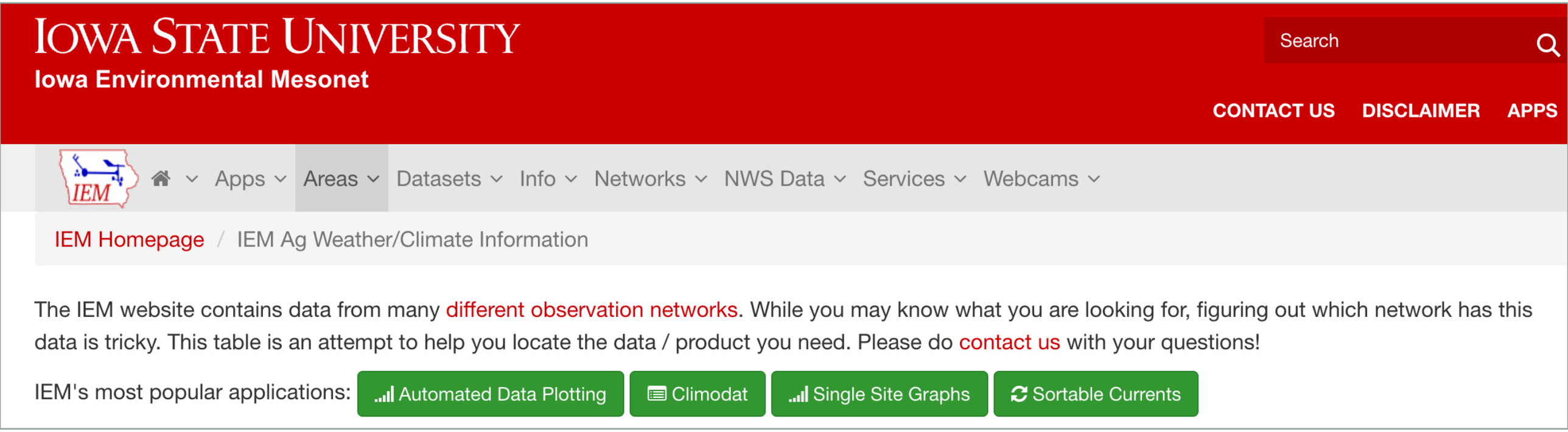
	Start	End
Date	Jan. 1	Dec. 31
Hour	0	23

(Greater than or equal to initial interval value and Less than ending interval value.)

Range (knots)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	Total
3 - 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 - 6	0.3	0.3	0.2	0.2	0.3	0.3	0.5	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.5	0.7	0.6	0.7	0.8	0.8	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.6	0.4	0.4	0.3	0.2	0.3	15.5
6 - 9	0.6	0.7	0.7	0.8	0.8	0.8	1.2	1.0	1.1	1.1	0.9	0.7	0.5	0.5	0.6	0.6	0.7	1.0	1.2	1.4	1.7	1.8	1.6	1.2	1.3	1.2	1.0	1.2	1.1	1.1	1.1	0.9	0.8	0.7	0.5	0.6	34.7
9 - 12	0.3	0.4	0.4	0.5	0.5	0.5	0.8	0.5	0.4	0.4	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.5	0.6	0.9	0.9	0.8	0.6	0.7	0.7	0.6	0.7	0.6	0.6	0.5	0.4	0.4	0.4	0.3	0.2	16.7
12 - 15	0.3	0.4	0.5	0.6	0.6	0.5	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.7	1.0	1.0	0.8	0.6	0.7	0.7	0.7	0.8	0.7	0.7	0.5	0.4	0.4	0.4	0.3	0.3	16.6
15 - 18	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.6
18 - 21	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	2.8
21 - 24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
24 -	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Total(%)	1.7	1.9	2.2	2.5	2.4	2.3	3.3	2.3	2.1	2.2	1.8	1.3	1.2	1.1	1.3	1.2	1.5	2.2	2.9	3.6	4.8	4.9	4.3	3.1	3.6	3.5	3.2	3.8	3.3	3.2	2.9	2.3	2.0	2.0	1.5	1.5	90.7
Calm (<3)																																					9.3
Ave Speed	9.5	10.2	10.6	10.8	10.1	9.9	9.6	9.3	8.8	8.4	8.0	7.8	7.9	8.0	8.4	8.1	8.2	8.7	8.9	9.6	10.1	9.8	9.6	9.5	10.0	10.3	10.7	10.5	10.2	9.9	9.4	9.4	9.6	10.0	9.9	9.3	8.7

Iowa State Mesonet Data

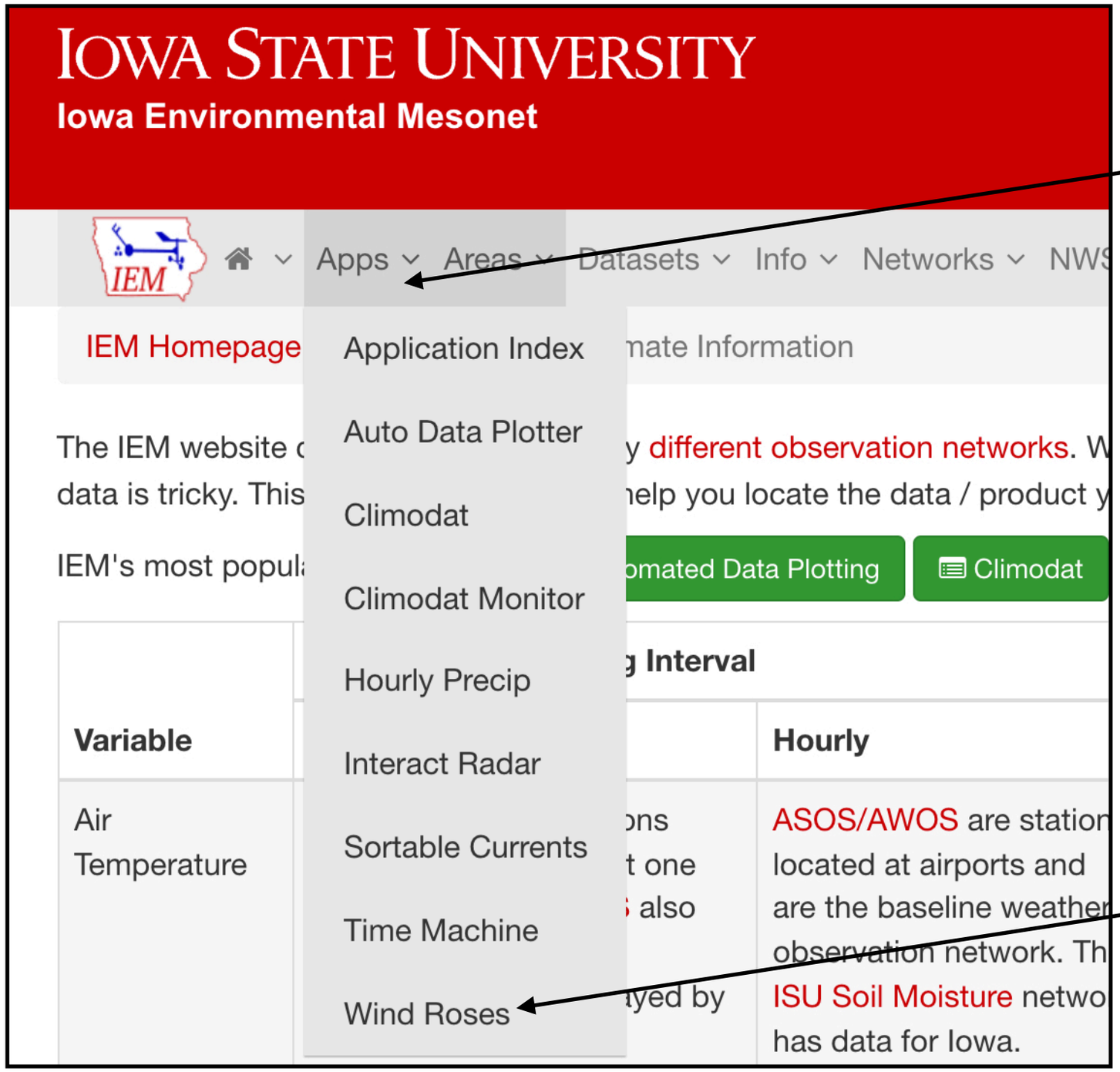
Iowa State University Mesonet Data



Website: https://mesonet.agron.iastate.edu/agweather/

- Allows customization of the wind rose data
- Worldwide data from various automated weather sensors (ASOS and AWOS networks)
- Provides graphical and table outputs that needs further interpretation for airport design use

Iowa State University Mesonet Data



Select the Apps pulldown menu

Select the Wind Roses

Website: https://mesonet.agron.iastate.edu/agweather/

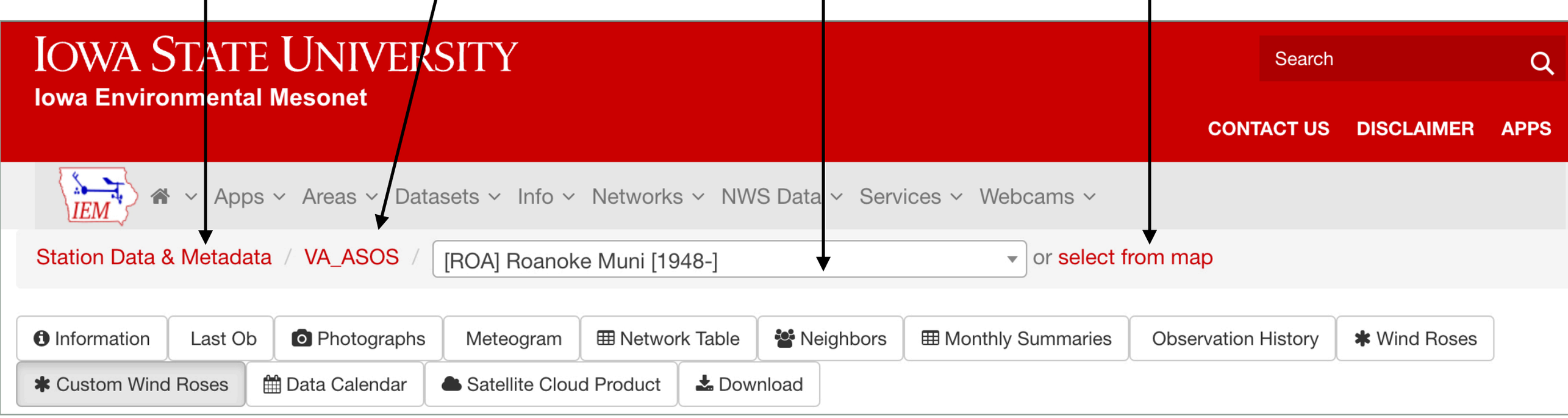
Steps to Obtain Mesonet Data

Select the station data

Select the world or state desired

Select the name of the station where data is collected

or select the station from the interactive map provided



Wind Rose Data Pulaski/River Valley Airport

IOWA STATE UNIVERSITY
Iowa Environmental Mesonet

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Select the network data

IEM Site Information

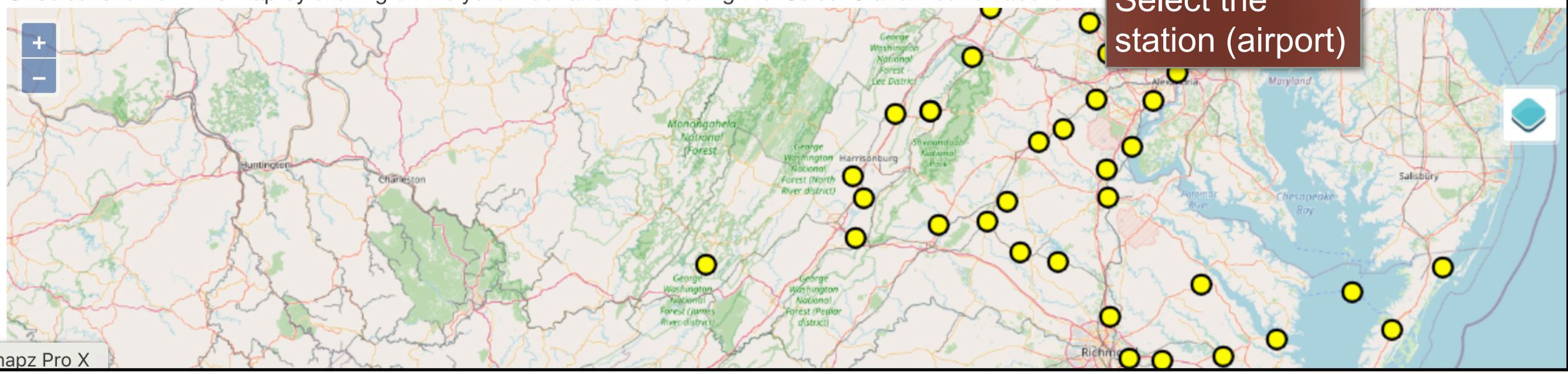
The IEM collects information from many sites. These sites are organized into networks based on their geography and/or the organization who administers the network. This application provides some metadata and site specific applications you may find useful.

Select By Network: Virginia ASOS — Switch Network

Select By Station: [PSK] DUBLIN/NEW RIV VLLY [1948-] — Select Station

Select the station (airport)

Or select site from this map by clicking on the yellow dot and then clicking the 'Select Station' button above.



Snapz Pro X

Wind Rose Data forNew River Valley Airport

Switch to Custom Wind Rose

IOWA STATE UNIVERSITY
Iowa Environmental Mesonet

Search

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Station Data & Metadata / VA_ASOS / [PSK] DUBLIN/NEW RIV VLLY [1948-] or select from map

Information | Last Ob | Photographs | Meteogram | Network Table | Neighbors | Monthly Summaries | Observation History | Wind Roses
Custom Wind Roses | Data Calendar | Satellite Cloud Product | Download

Station Identifier:	PSK
Station Name:	DUBLIN/NEW RIV VLLY
Network:	VA_ASOS
County:	Pulaski
State:	VA
Latitude:	37.13735
Longitude:	-80.67848
Elevation [m]:	642
Time Zone:	America/New_York

View VA_ASOS Network Table

Snapz Pro X

Custom Wind Rose Data (PSK Airport)

✱ Custom Wind Roses | Data Calendar | Satellite Cloud Product | Download

Custom Wind Rose Plots

This application attempts to generate a wind rose for a time period of your choice. Please be patient when submitting this form, as it may take up to a few minutes to generate the plot due to the large amount of data that this application processes. You can limit the dataset from which the windrose is derived in three ways:

1. By only including observations from a specific hour
2. By only including observations from a specific month
3. By only including observations between a start and

You can also, optionally, prescribe six wind speed bins, in he first bin from zero to your value is assumed to be calm values. The last bin represents the last value to infinity.

Select Start/End Time:

(Times are in America/New_York time zone)

	Year	Month	Day	Hour	Minute
Start:	2000	January	1	12 AM	0
End:	2020	December	1	11 PM	0

☐ 1. Limit to Hour of Start Time
☐ 2. Limit to Month of Start Time
☑ 3. Limit to Range of hours given by start and end time
☐ Optional: Hard code the frequency axis limit to 100%
☑ Optional. User provided wind speed bins

0 - 3 - 5 - 10.6 - 16 - 20.1 - 27 +

Values between 0 and the first bin are counted as calm.

Display Units: knots (KTS)
Direction Bins: 36
Image Format: PNG Image (.PNG)
Image DPI: 100
Submit

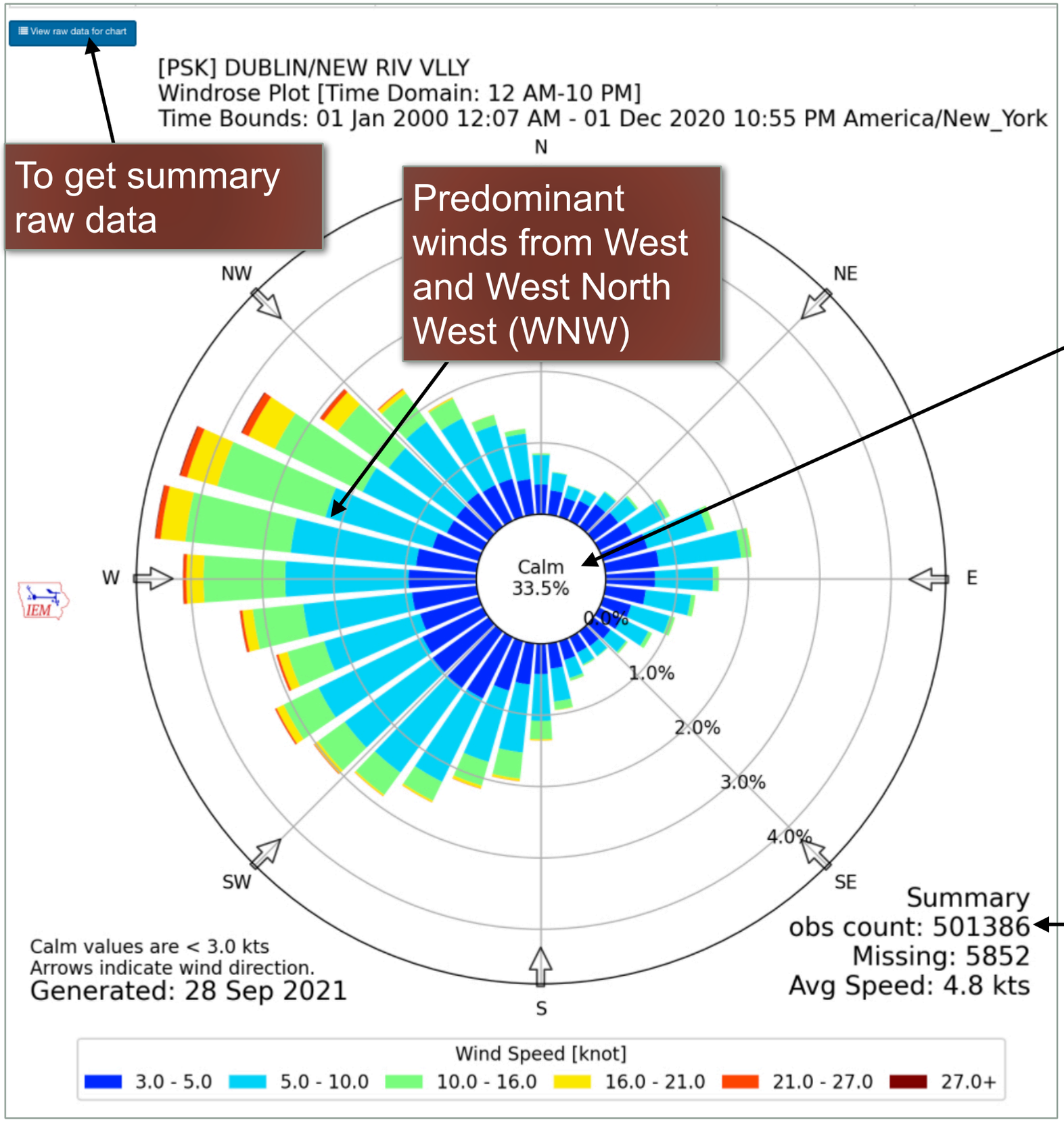
Start the data from January 2000

Specify the desired wind speed bins

End data in December 2020

Select units to be knots (airport wind roses are estimated in knots)

Custom Wind Rose Data (PSK Airport)



To get summary raw data

Predominant winds from West and West North West (WNW)

FAA defines calm winds to be less than 3 knots

33.5 % of the time at PSK winds are calm

More than 501,000 observations used in the wind rose (20 years)

Summary Raw Wind Rose Data (PSK Airport)

```
# Windrose Data Table (Percent Frequency) for DUBLIN/NEW RIV VLLY (PSK)
# Observations Used/Missing/Total: 495534/5852/501386
# 01 Jan 2000 12:07 AM - 01 Dec 2020 10:55 PM America/New_York
# Hour Limiter: (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22)
# Month Limiter: All included
# Wind Speed Units: knots
# Generated 29 Sep 2021 00:05 UTC, contact: akrherz@iastate.edu
# First value in table is CALM
Direction,     Calm, 3.0  4.9, 5.0  9.9,10.0 15.9,16.0 20.9,21.0 26.9,    27.0+
355-004  ,     33.5,    0.417,    0.415,    0.021,    0.001,    0.000,    0.000
005-014  ,          ,    0.340,    0.252,    0.010,    0.000,    0.000,    0.000
015-024  ,          ,    0.279,    0.177,    0.007,    0.000,    0.000,    0.000
025-034  ,          ,    0.314,    0.167,    0.005,    0.000,    0.000,    0.000
035-044  ,          ,    0.391,    0.208,    0.015,    0.000,    0.000,    0.000
045-054  ,          ,    0.433,    0.311,    0.030,    0.001,    0.000,    0.000
055-064  ,          ,    0.515,    0.521,    0.065,    0.002,    0.001,    0.000
065-074  ,          ,    0.645,    0.872,    0.100,    0.003,    0.000,    0.000
075-084  ,          ,    0.755,    1.158,    0.142,    0.007,    0.000,    0.000
085-094  ,          ,    0.689,    0.813,    0.081,    0.003,    0.000,    0.000
095-104  ,          ,    0.567,    0.640,    0.060,    0.003,    0.000,    0.000
105-114  ,          ,    0.407,    0.564,    0.074,    0.002,    0.000,    0.000
115-124  ,          ,    0.348,    0.420,    0.058,    0.001,    0.000,    0.000
125-134  ,          ,    0.298,    0.268,    0.028,    0.001,    0.000,    0.000
135-144  ,          ,    0.256,    0.172,    0.009,    0.000,    0.000,    0.000
145-154  ,          ,    0.244,    0.182,    0.018,    0.001,    0.000,    0.000
155-164  ,          ,    0.274,    0.262,    0.041,    0.001,    0.000,    0.000
165-174  ,          ,    0.356,    0.464,    0.118,    0.005,    0.000,    0.000
175-184  ,          ,    0.426,    0.655,    0.256,    0.020,    0.001,    0.000
185-194  ,          ,    0.580,    0.958,    0.368,    0.036,    0.003,    0.000
195-204  ,          ,    0.720,    1.039,    0.345,    0.044,    0.004,    0.000
205-214  ,          ,    0.955,    1.300,    0.293,    0.029,    0.002,    0.000
215-224  ,          ,    0.978,    1.469,    0.382,    0.025,    0.003,    0.000
225-234  ,          ,    0.972,    1.523,    0.460,    0.067,    0.009,    0.001
235-244  ,          ,    0.944,    1.622,    0.542,    0.112,    0.022,    0.002
245-254  ,          ,    0.856,    1.401,    0.535,    0.131,    0.030,    0.002
255-264  ,          ,    0.911,    1.534,    0.710,    0.148,    0.034,    0.003
265-274  ,          ,    0.949,    1.731,    1.143,    0.244,    0.043,    0.004
275-284  ,          ,    0.854,    1.769,    1.484,    0.349,    0.072,    0.010
285-294  ,          ,    0.674,    1.565,    1.574,    0.442,    0.096,    0.014
295-304  ,          ,    0.563,    1.314,    1.367,    0.412,    0.100,    0.014
305-314  ,          ,    0.564,    1.173,    0.879,    0.245,    0.059,    0.006
315-324  ,          ,    0.586,    1.231,    0.489,    0.072,    0.013,    0.002
325-334  ,          ,    0.559,    1.042,    0.302,    0.021,    0.002,    0.000
335-344  ,          ,    0.554,    0.788,    0.143,    0.003,    0.001,    0.000
345-354  ,          ,    0.501,    0.640,    0.067,    0.001,    0.000,    0.000
```

FAA defines calm winds to be less than 3 knots

33.5 % of the time at PSK winds are calm

Percent winds from an azimuth and wind speed range

More than 501,000 observations used in the wind rose (20 years)

Import the Summary Raw Data to Excel

	A	B	C	D	E	F	G	H
1	Direction (deg)	Calm	3.0 - 4.9	5.0 - 9.9	10.0- 15.9	16.0- 20.9	21.0- 26.9	27.0+
2	355-004	33.5	0.417	0.415	0.021	0.001	0	0
3	005-014		0.34	0.252	0.01	0	0	0
4	015-024		0.279	0.177	0.007	0	0	0
5	025-034		0.314	0.167	0.005	0	0	0
6	035-044		0.391	0.208	0.015	0	0	0
7	045-054		0.433	0.311	0.03	0.001	0	0
8	055-064		0.515	0.521	0.065	0.002	0.001	0
9	065-074		0.645	0.872	0.1	0.003	0	0
10	075-084		0.755	1.158	0.142	0.007	0	0
11	085-094		0.689	0.813	0.081	0.003	0	0
12	095-104		0.567	0.64	0.06	0.003	0	0
13	105-114		0.407	0.564	0.074	0.002	0	0
14	115-124		0.348	0.42	0.058	0.001	0	0
15	125-134		0.298	0.268	0.028	0.001	0	0
16	135-144		0.256	0.172	0.009	0	0	0
17	145-154		0.244	0.182	0.018	0.001	0	0
18	155-164		0.274	0.262	0.041	0.001	0	0
19	165-174		0.356	0.464	0.118	0.005	0	0

Percent winds from an azimuth and wind speed range

Verify the total is 100%

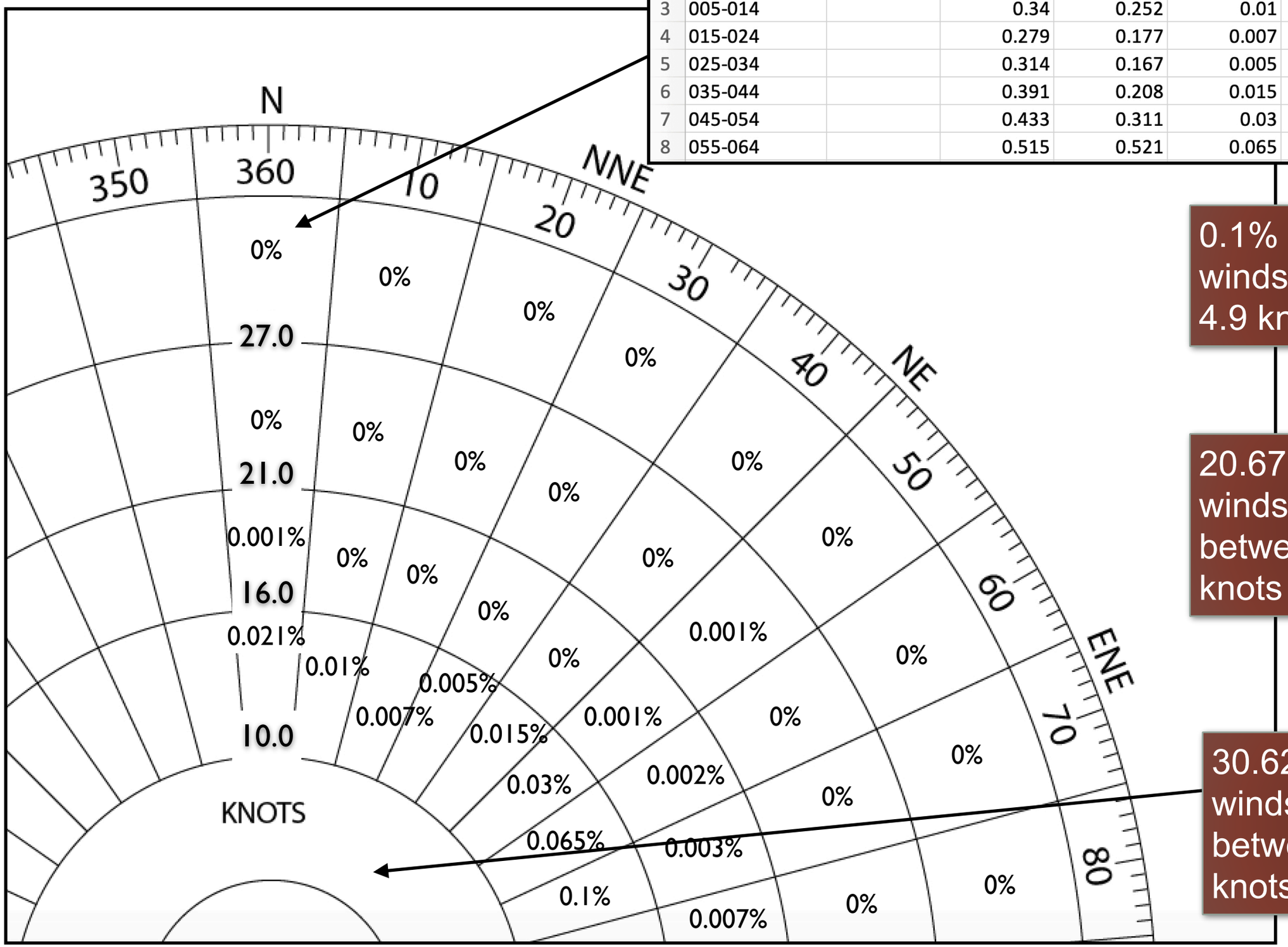
	A	B	C	D	E	F	G	H	I
1	Direction (deg)	Calm	3.0 - 4.9	5.0 - 9.9	10.0- 15.9	16.0- 20.9	21.0- 26.9	27.0+	
33	305-314		0.564	1.173	0.879	0.245	0.059	0.006	
34	315-324		0.586	1.231	0.489	0.072	0.013	0.002	
35	325-334		0.559	1.042	0.302	0.021	0.002	0	
36	335-344		0.554	0.788	0.143	0.003	0.001	0	
37	345-354		0.501	0.64	0.067	0.001	0	0	
38									
39	Totals	33.50	20.67	30.62	12.22	2.43	0.50	0.06	100.00

Creating your own Wind Rose Analysis

- Download the NCDC or Mesonet data per our instructions
- Use the Autocad DXF or DWG file provided to construct a wind rose
- Fill in the NCDC wind summary data into the Autocad wind rose template
- Setup up a rectangular coverage element to estimate the percent of time crosswinds are not covered
- Calculate the wind coverage from the wind rose by adding all sectors covered by the crosswind rectangle

Populate the Wind Rose for PSK Airport

	A	B	C	D	E	F	G	H
1	Direction (deg)	Calm	3.0 - 4.9	5.0 - 9.9	10.0- 15.9	16.0- 20.9	21.0- 26.9	27.0+
2	355-004	33.5	0.417	0.415	0.021	0.001	0	0
3	005-014		0.34	0.252	0.01	0	0	0
4	015-024		0.279	0.177	0.007	0	0	0
5	025-034		0.314	0.167	0.005	0	0	0
6	035-044		0.391	0.208	0.015	0	0	0
7	045-054		0.433	0.311	0.03	0.001	0	0
8	055-064		0.515	0.521	0.065	0.002	0.001	0



0.1% of the time winds between 3 and 4.9 knots at PSK

20.67% of the time winds have a speed between 3 and 4.9 knots at PSK

30.62% of the time winds have a speed between 5 and 9.9 knots at PSK

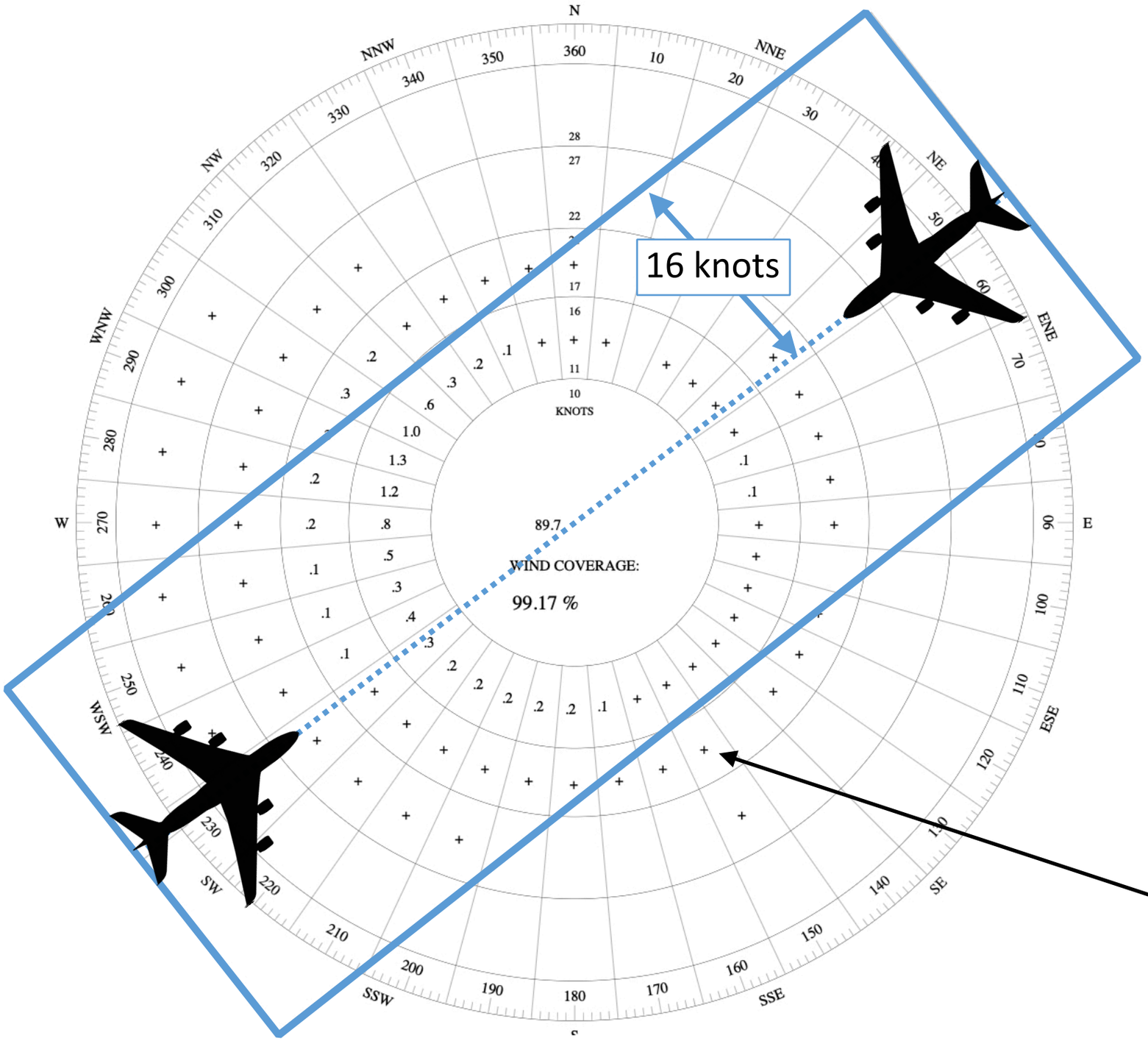
Airnav Runway Data for PSK Airport

Runway 6/24

Dimensions:	6201 x 150 ft. / 1890 x 46 m	
Surface:	asphalt/grooved, in good condition	
Weight bearing capacity:	Double wheel: 60.0	
Runway edge lights:	high intensity	
	RUNWAY 6	**RUNWAY 24**
Latitude:	37-07.927017N	37-08.554433N
Longitude:	080-41.212667W	080-40.205317W
Elevation:	2104.6 ft.	2073.2 ft.
Traffic pattern:	left	left
Runway heading:	058 magnetic, 052 true	238 magnetic, 232 true
Markings:	precision, in fair condition	nonprecision, in fair condition
Visual slope indicator:	4-light PAPI on left (3.00 degrees glide path)	4-light PAPI on left (3.00 degrees glide path)
Approach lights:	MALSR: 1,400 foot medium intensity approach lighting system with runway alignment indicator lights	
Runway end identifier lights:		yes
Touchdown point:	yes, no lights	yes, no lights
Instrument approach:	ILS	
Obstructions:	93 ft. trees, 2205 ft. from runway, 531 ft. right of	none

Runway Orientation (heading)

PSK Wind Rose (RDC C-II)



According to the analysis:

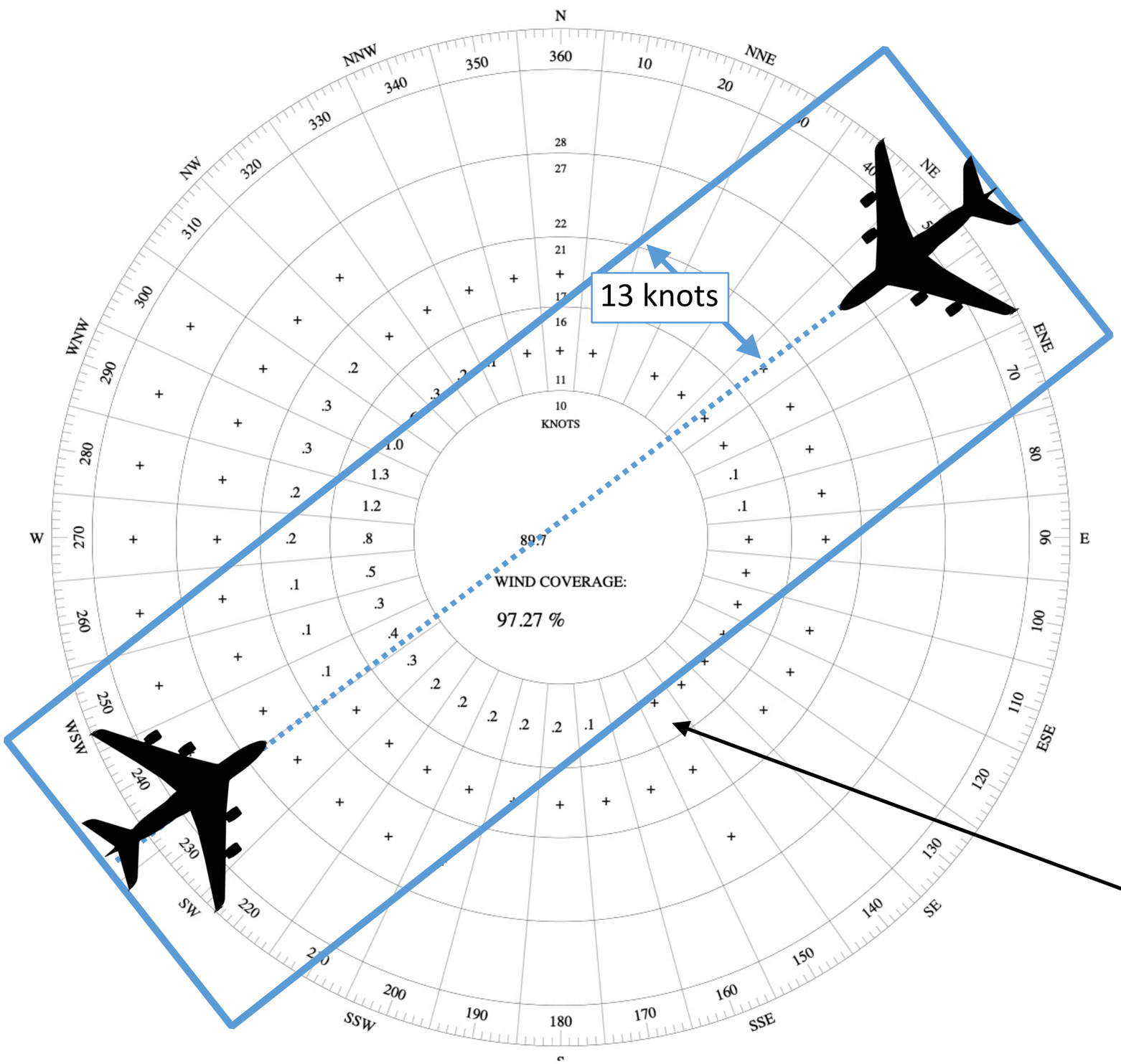
99.17% coverage with a single runway oriented 52 and 232 degrees from true North

PSK satisfies the 95% critical crosswind
conditions for 16 knots crosswind

Use your CAD skills
to solve the wind rose problem
if the FAA site is not available

Count the
percent of
time operations
are not covered by the
16 knot rectangle

PSK Wind Rose (RDC B-II)



According to the analysis:

97.27% coverage with a single runway oriented 52 and 232 degrees from true North

PSK satisfies the 95% critical crosswind
conditions for 13 knots crosswind

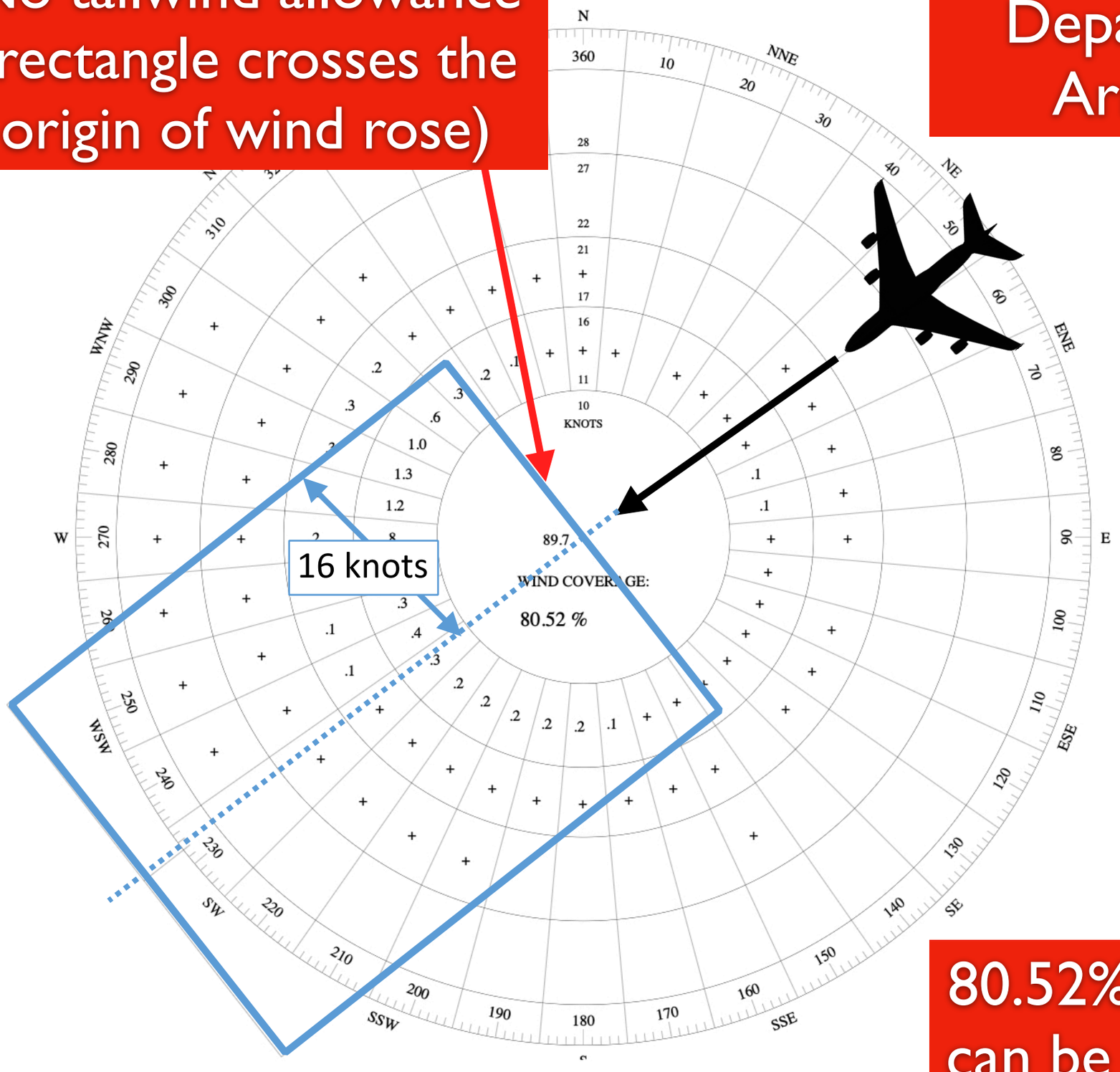
Use your CAD skills to solve the wind rose problem if the FAA site is not available

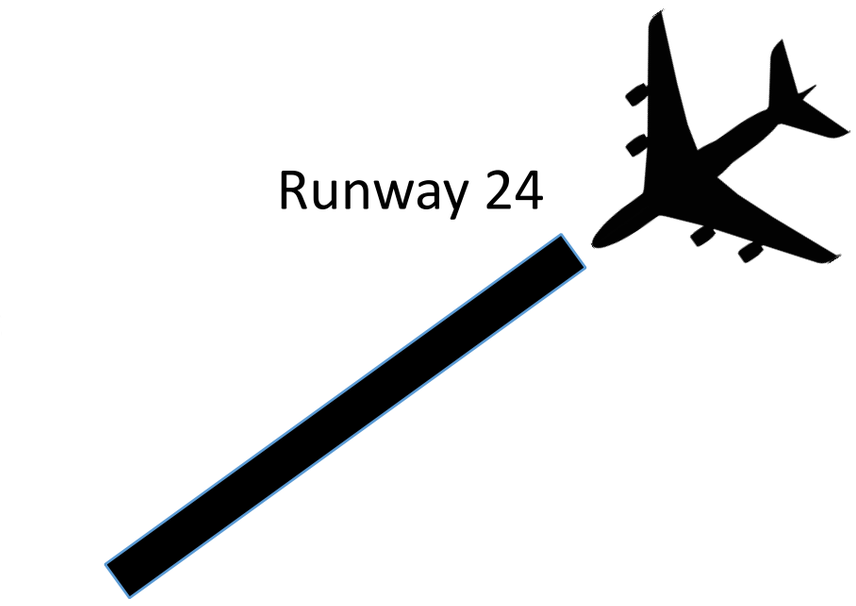
Count the percent of time operations are not covered by the 13 knot rectangle

PSK All Weather Wind Rose with no Tailwind

No tailwind allowance (rectangle crosses the origin of wind rose)

Departures on runway 24
Arrivals on runway 24

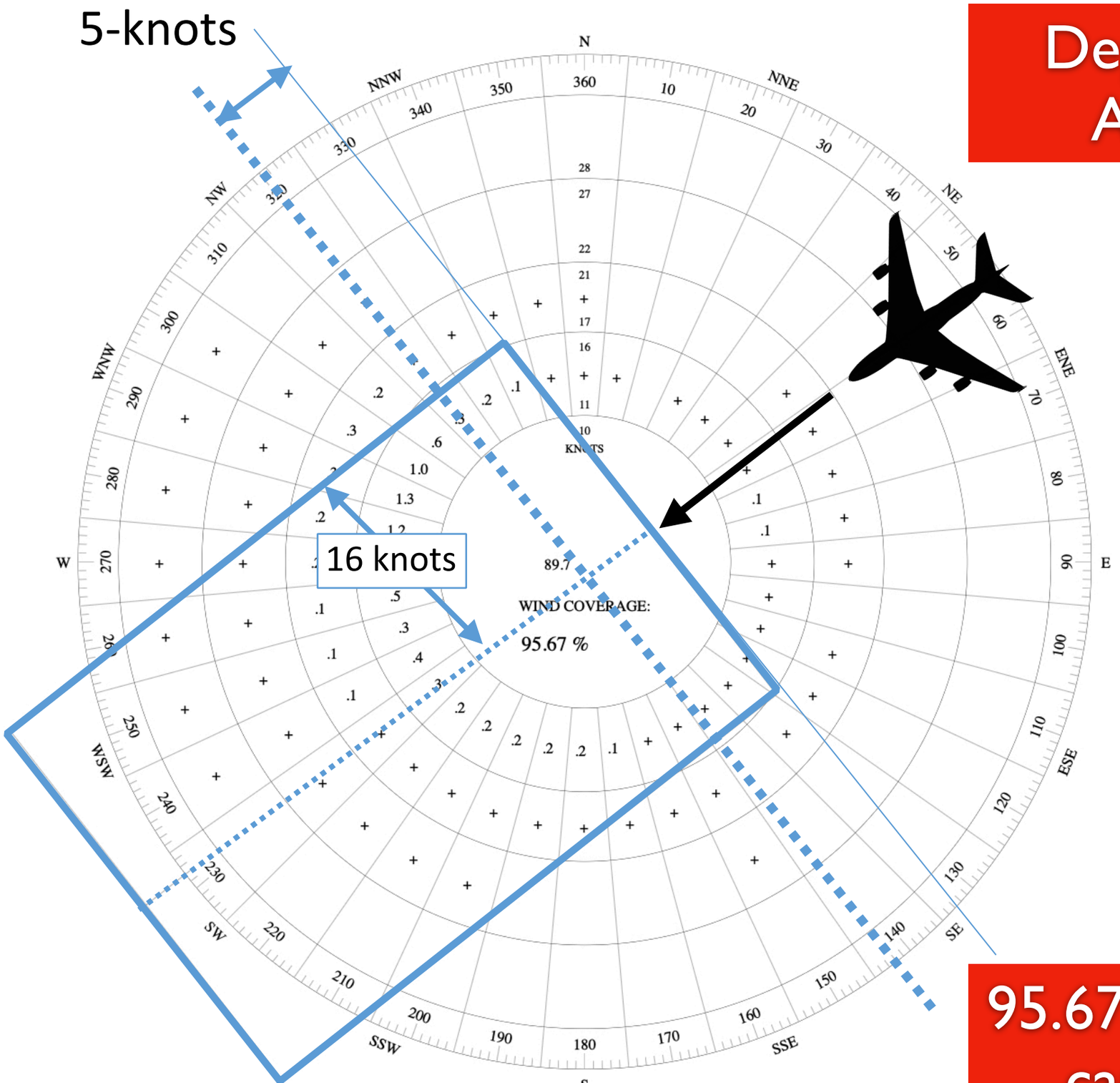




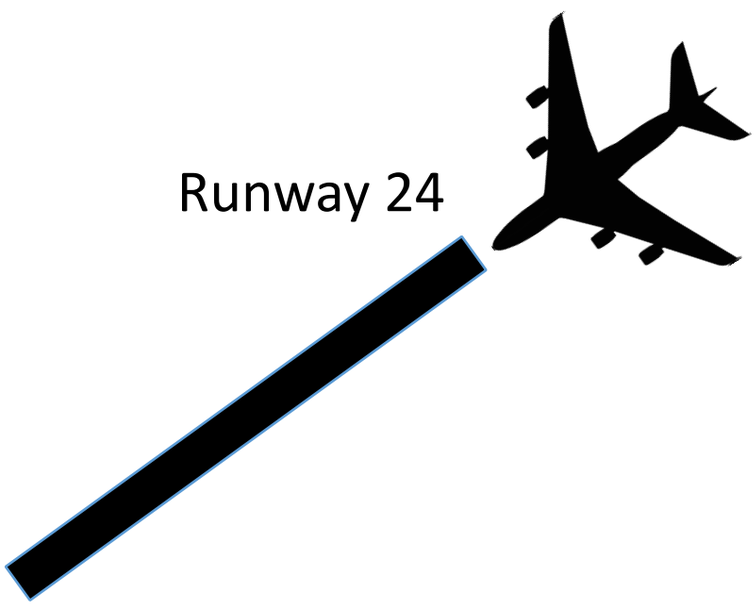
80.52% of the time, runway 24 can be used with zero tailwind allowance (16 knot crosswind)

PSK All Weather Wind Rose with 5-knots Tailwind

VirginiaTech
Invent the Future



Departures on runway 24
Arrivals on runway 24

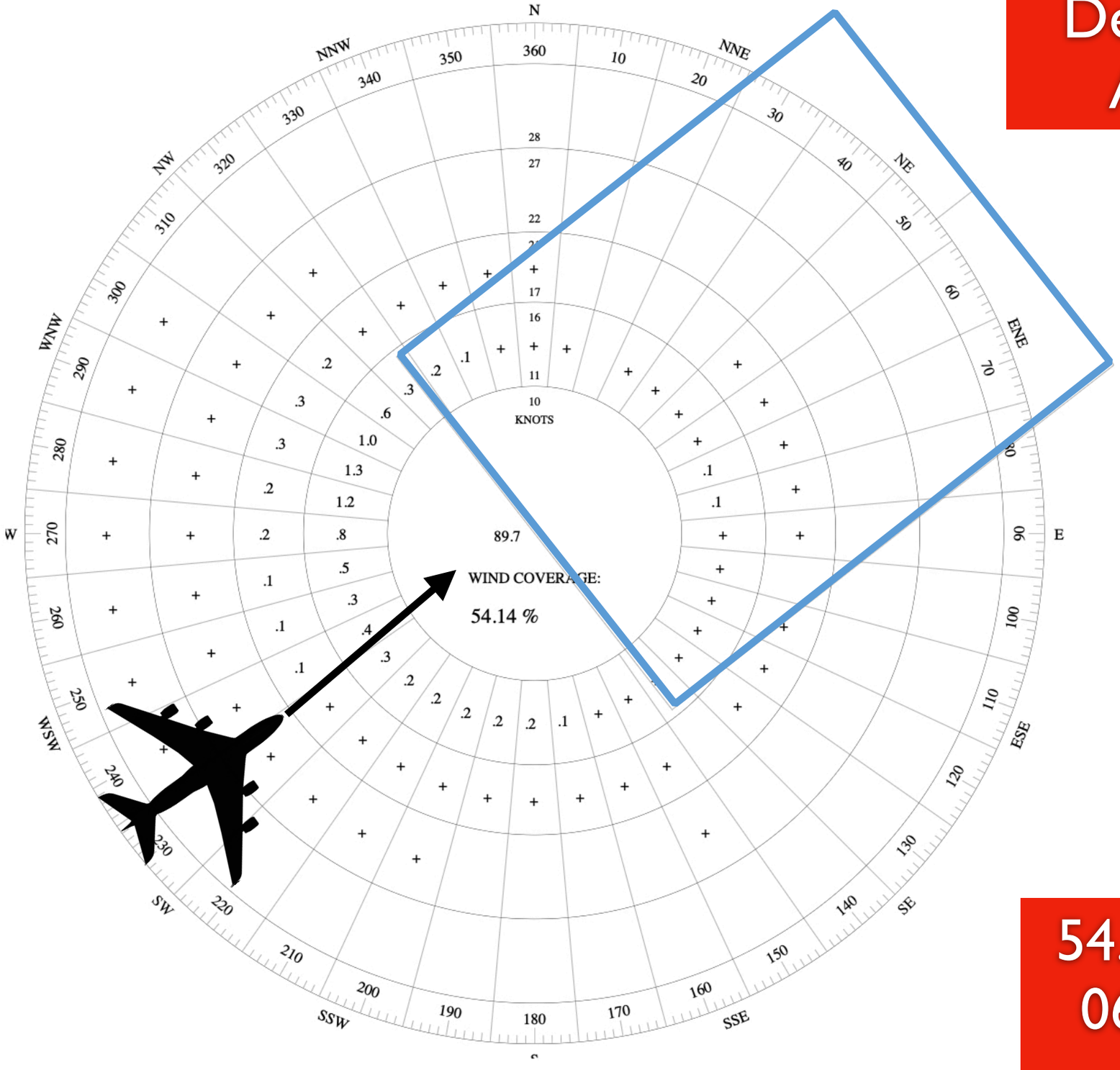


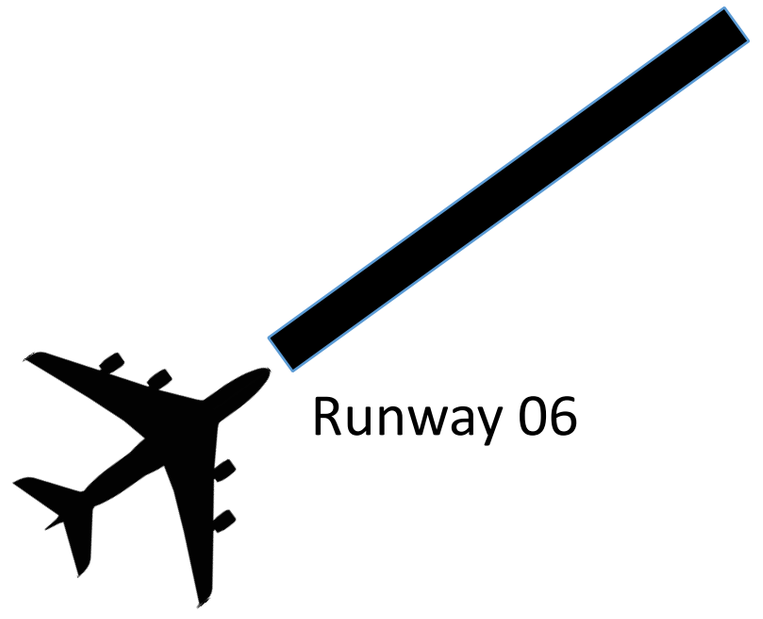
95.67% of the time, runway 24 can be used with 5-knot tailwind allowance

PSK All Weather Wind Rose with no Tailwind Allowance

VirginiaTech
Invent the Future

Departures on runway 06
Arrivals on runway 06

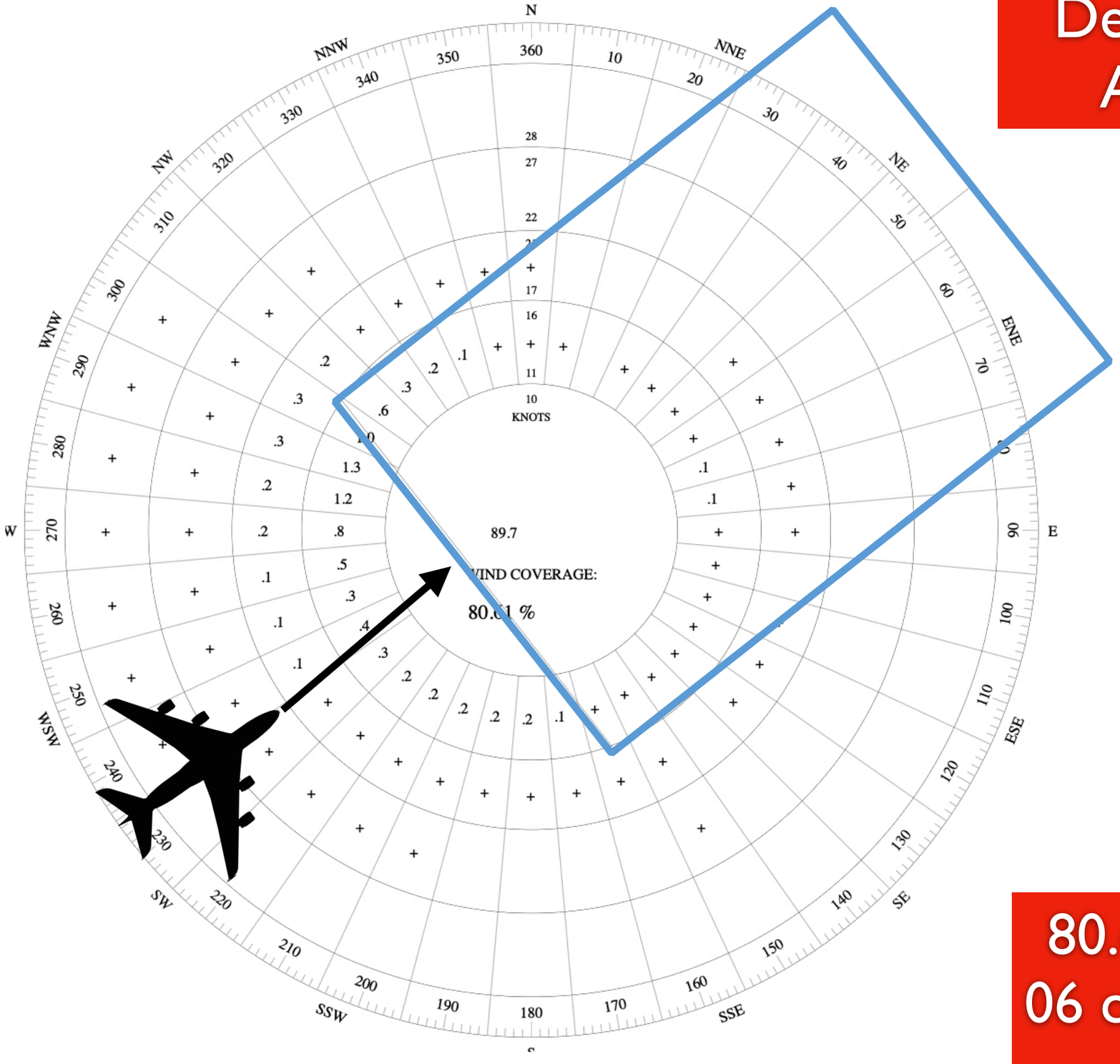




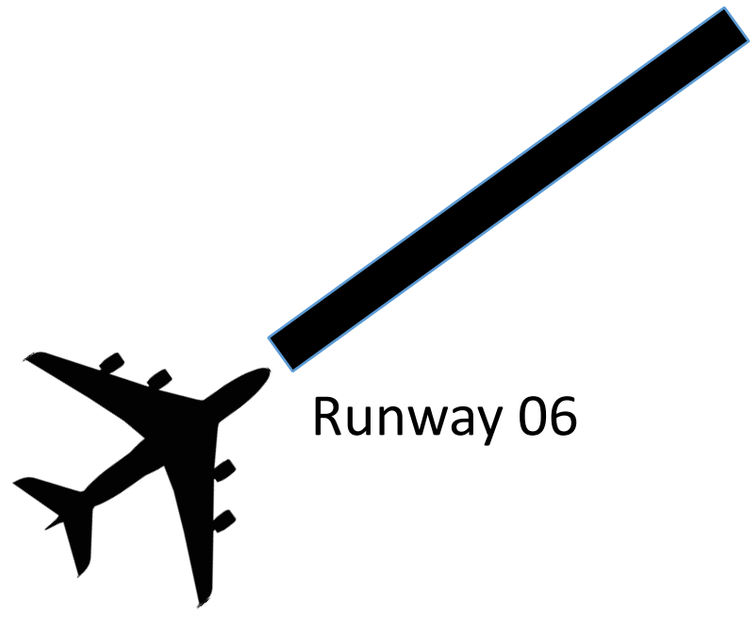
54.14% of the time, runway 06 can be used with zero tailwind allowance

PSK All Weather Wind Rose with no Tailwind Allowance

VirginiaTech
Invent the Future



Departures on runway 06
Arrivals on runway 06



80.64% of the time, runway 06 can be used with a 5-knot tailwind allowance

Conclusions of the Analysis

- A single runway at PSK airport satisfies the 95% critical crosswind coverage requirement
- Runway 24 is favored at PSK airport based on wind conditions
  - 80.52% of time runway 24 can be used with zero tailwind allowance
  - 95.67% of time runway 24 can be used with a 5-knot tailwind allowance
- Runway 06 can be used 54.1% of the time with no tailwind allowance

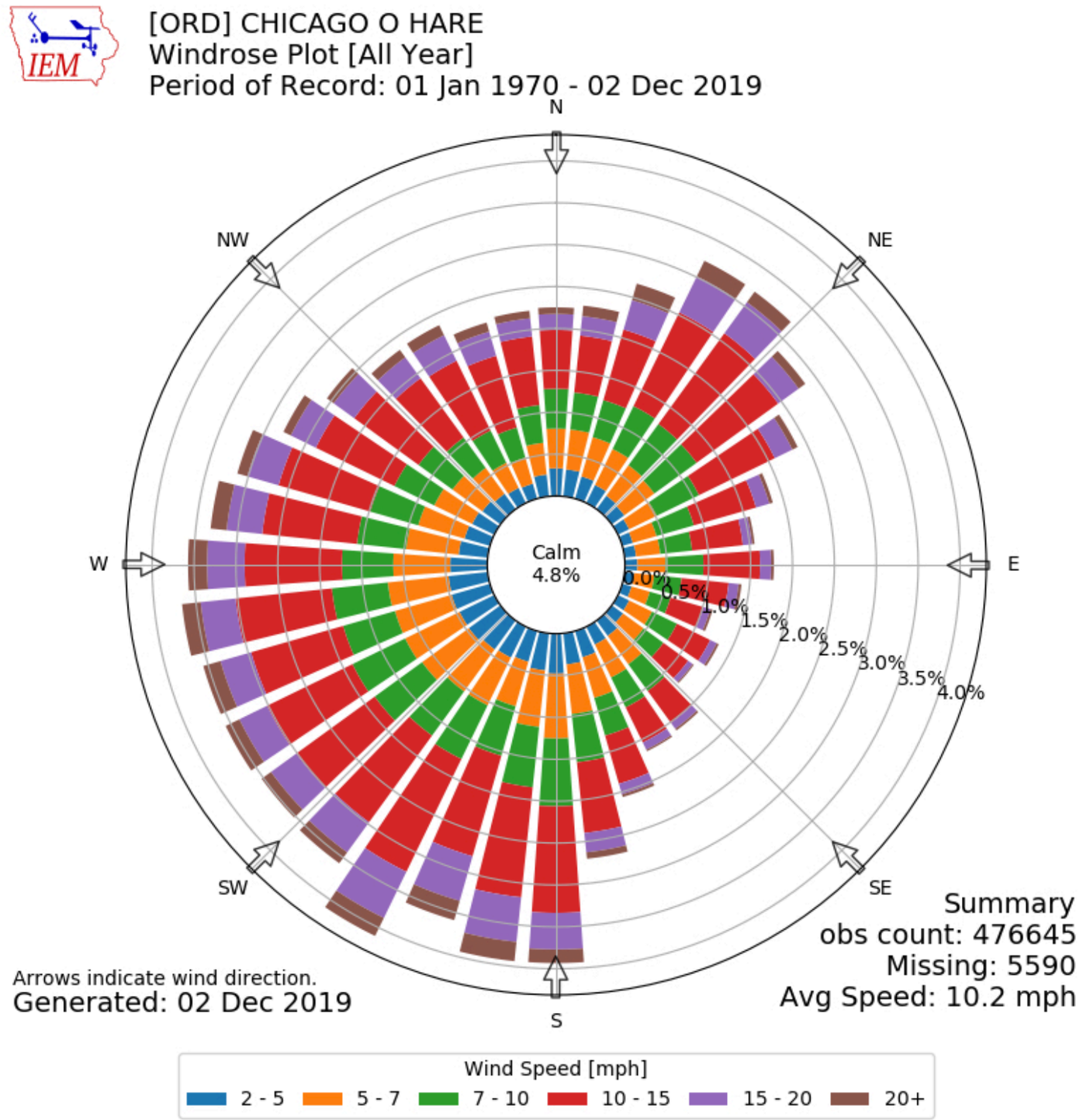
Chicago ORD Wind Data (All Weather)

ORD hourly observations (30 years)

Winds from the West, Southwest, and Northeast are more dominant at ORD

Favors **West flow** for East/ West parallels and Southwest flow for crosswind runways (22R and 22L)

Source: Iowa State University https://mesonet.agron.iastate.edu/sites/windrose.phtml?network=IL_ASOS&station=ORD



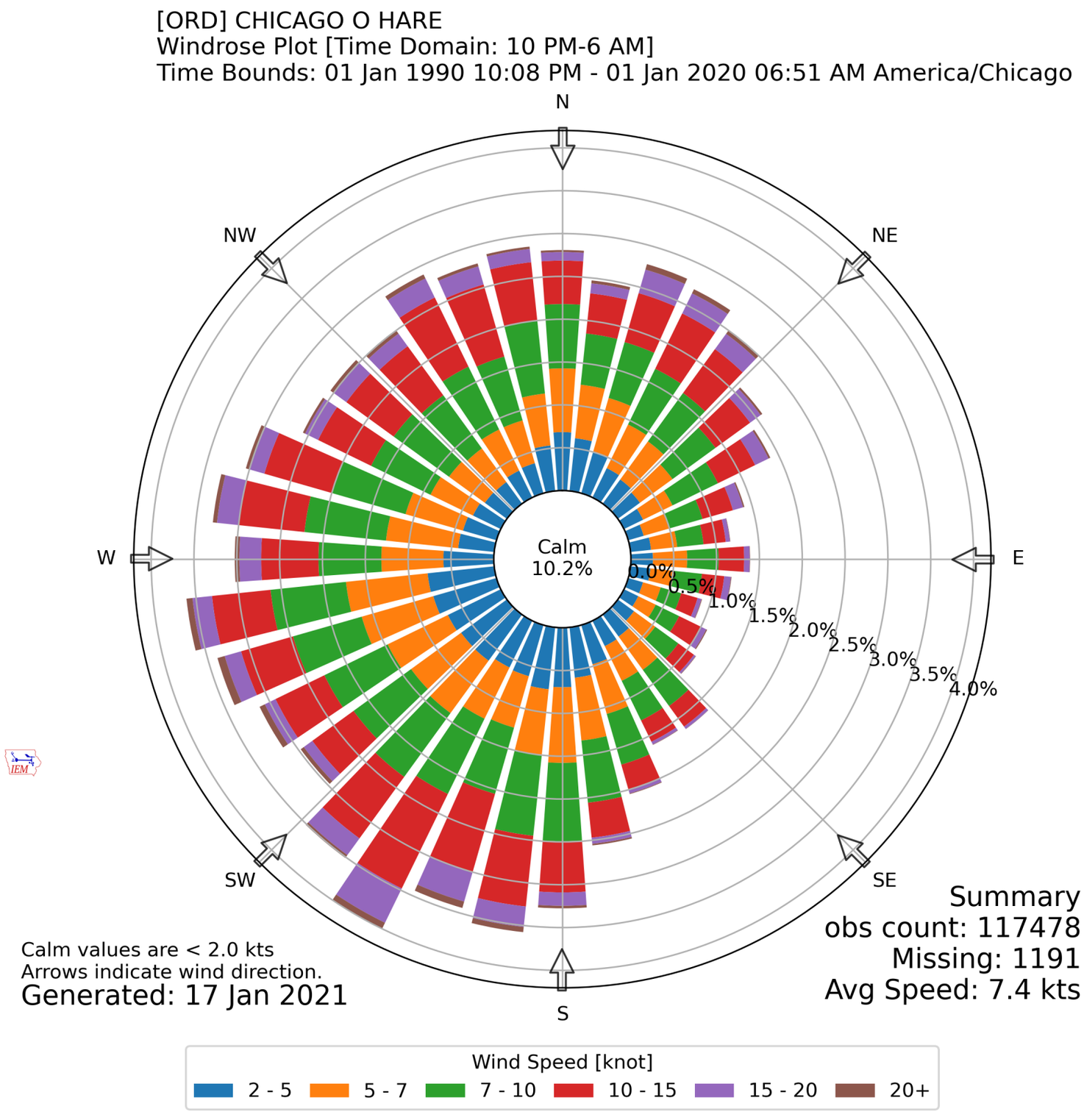
ORD Nighttime Wind Rose

Nighttime winds are lighter at ORD

117,478 nighttime hourly observations (30 years of data)

Winds from the West and Southwest are more dominant at ORD

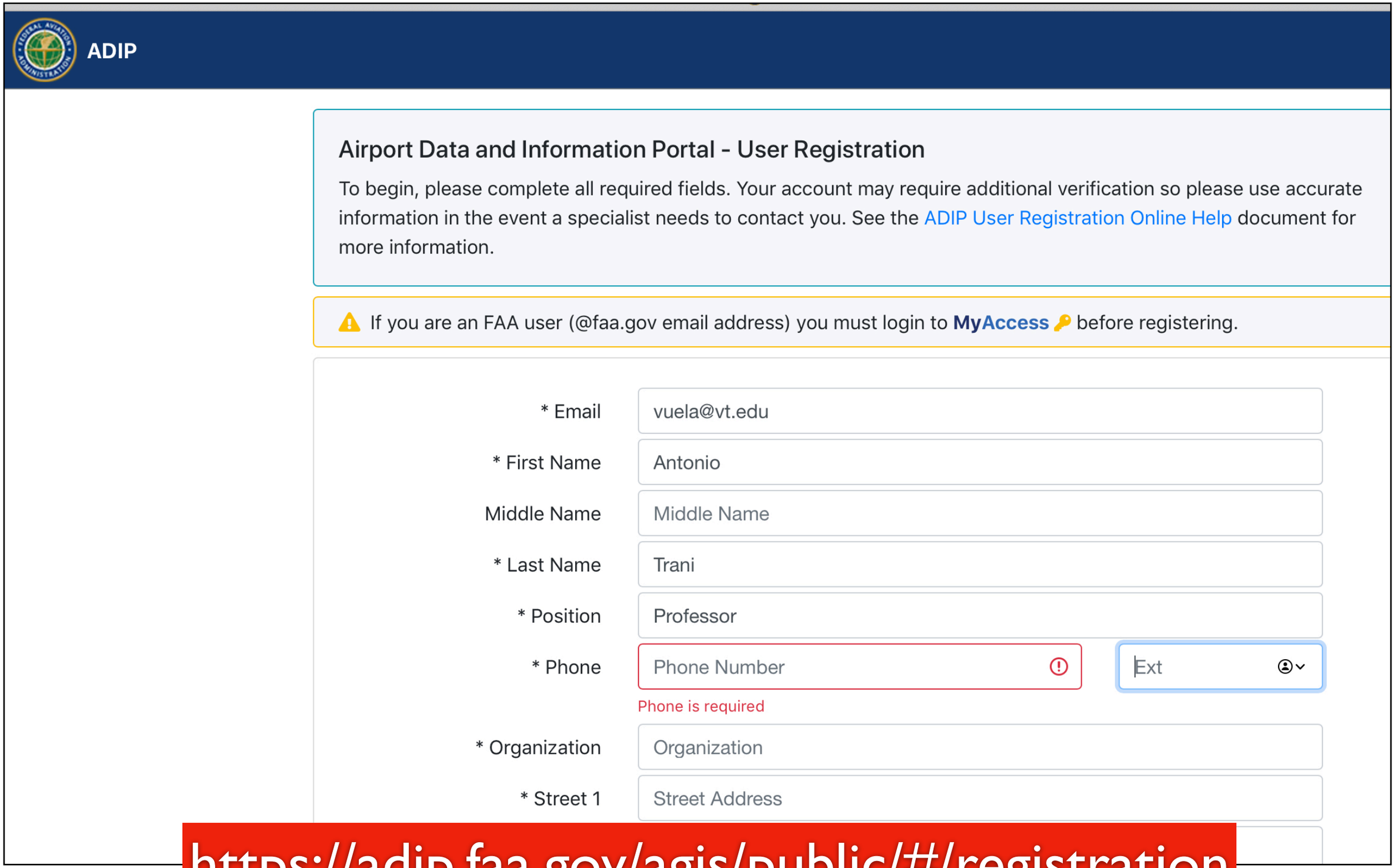
Favors West flow for East/ West parallels and Southwest flow for crosswind runways (22R and 22L)



Source: Iowa State University Mesonet Database

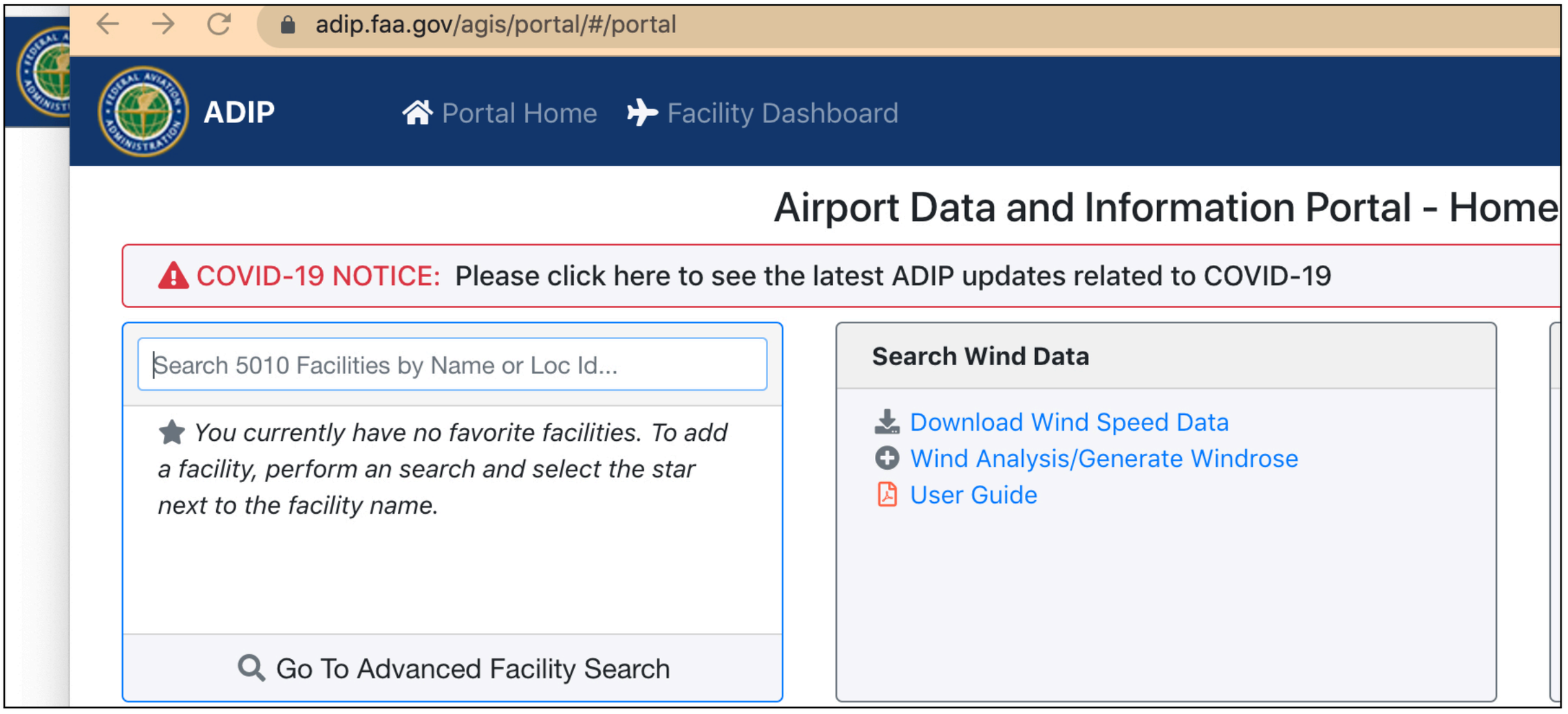
FAA Airport Data and Information Portal (ADIP)

Soliciting Access to Airport Tools (FAA)



https://adip.faa.gov/agis/public/#/registration

FAA ADIP Portal Tool



https://adip.faa.gov/agis/portal/#/portal

FAA ADIP Wind Rose Tool

ADIP | Portal Home | Facility Dashboard

All Weather Windrose

New All Weather Windrose | New IFR Windrose | New VFR Windrose | Open Windrose | Save Windrose

Upload Wind Data File | View Report | View Windrose | Download as DXF | Download as SVG

Go to Previous Page | Go to Search Page

No of Runways: 1

Runway 1

Runway Orientation: 0

Crosswind Component: 0 Calculate

Tailwind Component: 0

Note: Use a 60 knot tailwind to indicate runway is bi-directional.

Wind Coverage: 24.19%

Hourly Observations of Wind Speed (knots)

Direction	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	>41	Total
10°	807	654	20	4	0	0	0	0	0	1485
20°	627	534	15	0	0	0	0	0	0	1176
30°	539	497	7	8	2	0	0	0	0	1053

https://adip.faa.gov/agis/portal/#/portal

FAA ADIP Portal Tool

ADIP | Portal Home | Facility Dashboard | Help

Wind Data for SAN DIEGO INTERNATIONAL AIRPO

Airport ICAO Identifier	State	USAF	WBAN	Station Name	Available Years
KSAN	CA	722900	23188	SAN DIEGO INTERNATIONAL AIRPO	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020

Note: If 10 years of data is not available for this Airport, data that is available will be downloaded.

Wind Data Type	Generate Windrose
All Weather	Click Here

The following files are also available for download ALL_WEATHER_722900.PRN, IFR_722900.PRN and VFR_722900.PRN

https://adip.faa.gov/agis/portal/#/portal

San Diego Data

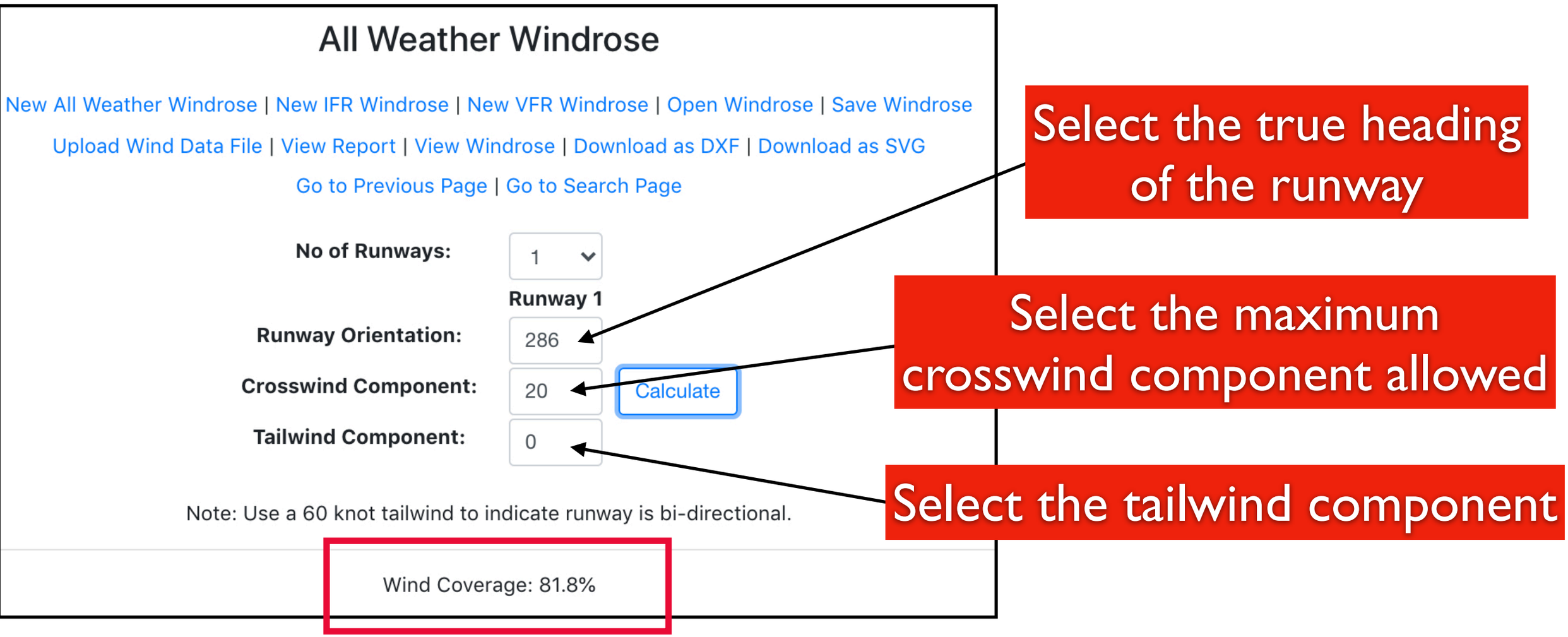
Runway 9/27

	RUNWAY 9	RUNWAY 27
Dimensions:	9400 x 200 ft. / 2865 x 61 m	
Surface:	asphalt/concrete/grooved, in excellent condition	
Weight bearing capacity:	PCN 75 /F/A/W/T	
Runway edge lights:	high intensity	
Operational restrictions:	CLSD TUE-SAT 0000-0500 LOCAL.	
Latitude:	32-44.227355N	32-43.800143N
Longitude:	117-12.261402W	117-10.498363W
Elevation:	13.7 ft.	16.4 ft.
Traffic pattern:	left	right
Runway heading:	095 magnetic, 106 true	275 magnetic, 286 true
Displaced threshold:	1000 ft.	1810 ft.
Declared distances:	TORA:8280 TODA:9401 ASDA:8280 LDA:7280	TORA:9401 TODA:9401 ASDA:9401 LDA:7591
Markings:	precision, in good condition	precision, in good condition
Visual slope indicator:	4-light PAPI on left (3.30 degrees glide path)	4-light PAPI on right (3.50 degrees glide path) PAPI UNUSBL BYD 5 DEG L & R OF CNTLN.
RVR equipment:	touchdown, rollout	touchdown, rollout
Approach lights:	MALSR: 1,400 foot medium intensity approach lighting system with runway	MALS: 1,400 foot medium intensity approach lighting

Remember: Wind is reported using True Heading

https://www.airnav.com/airport/KSAN

San Diego results with no Tailwind



San Diego results with 5 knot Tailwind

All Weather Windrose

New All Weather Windrose | New IFR Windrose | New VFR Windrose | Open Windrose | Save Windrose

Upload Wind Data File | View Report | View Windrose | Download as DXF | Download as SVG

Go to Previous Page | Go to Search Page

No of Runways: 1

Runway 1

Runway Orientation: 286

Crosswind Component: 20 Calculate

Tailwind Component: 5

Note: Use a 60 knot tailwind to indicate runway is bi-directional.

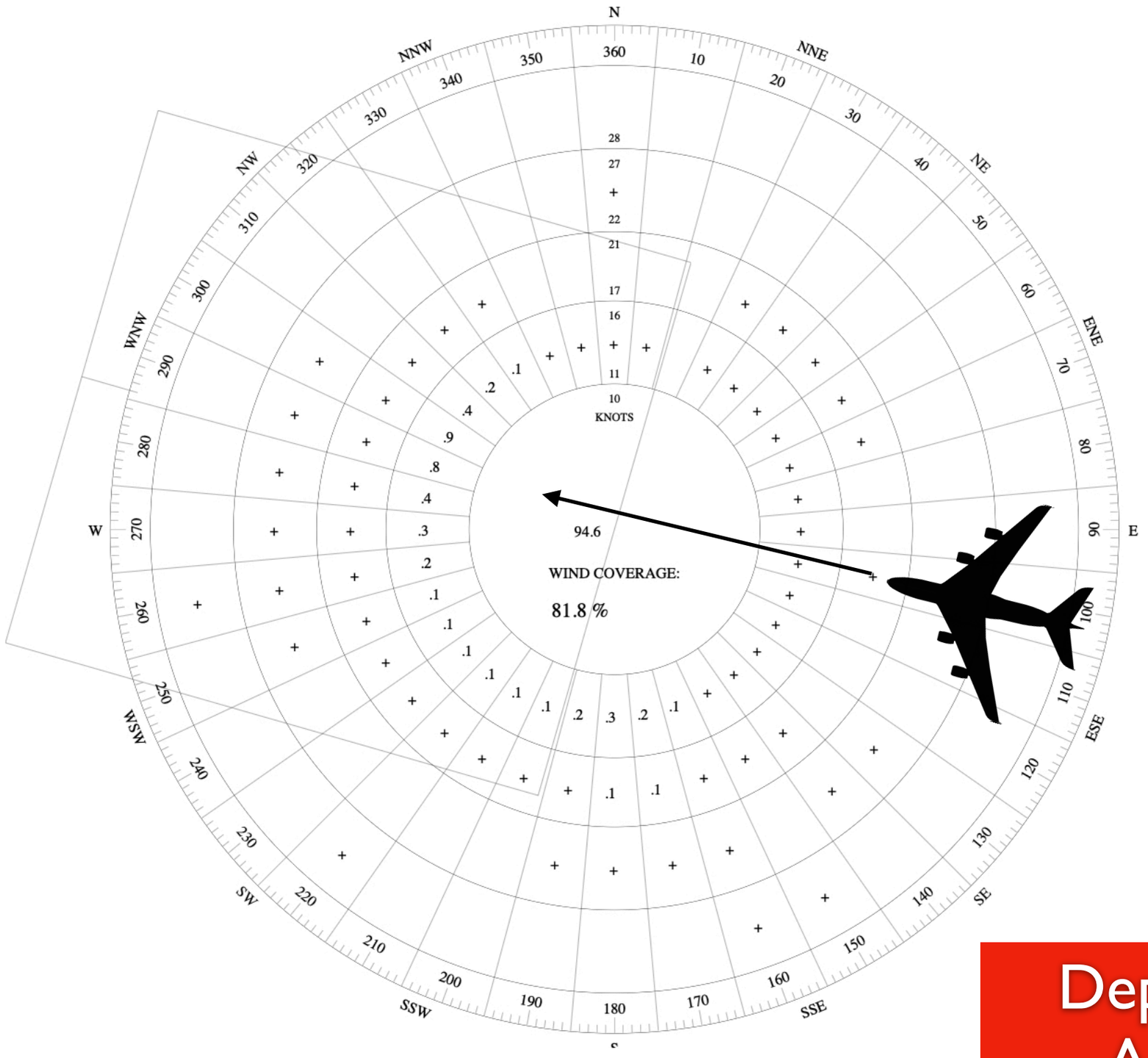
Wind Coverage: 97.77%

Select the true heading of the runway

Select the maximum crosswind component allowed

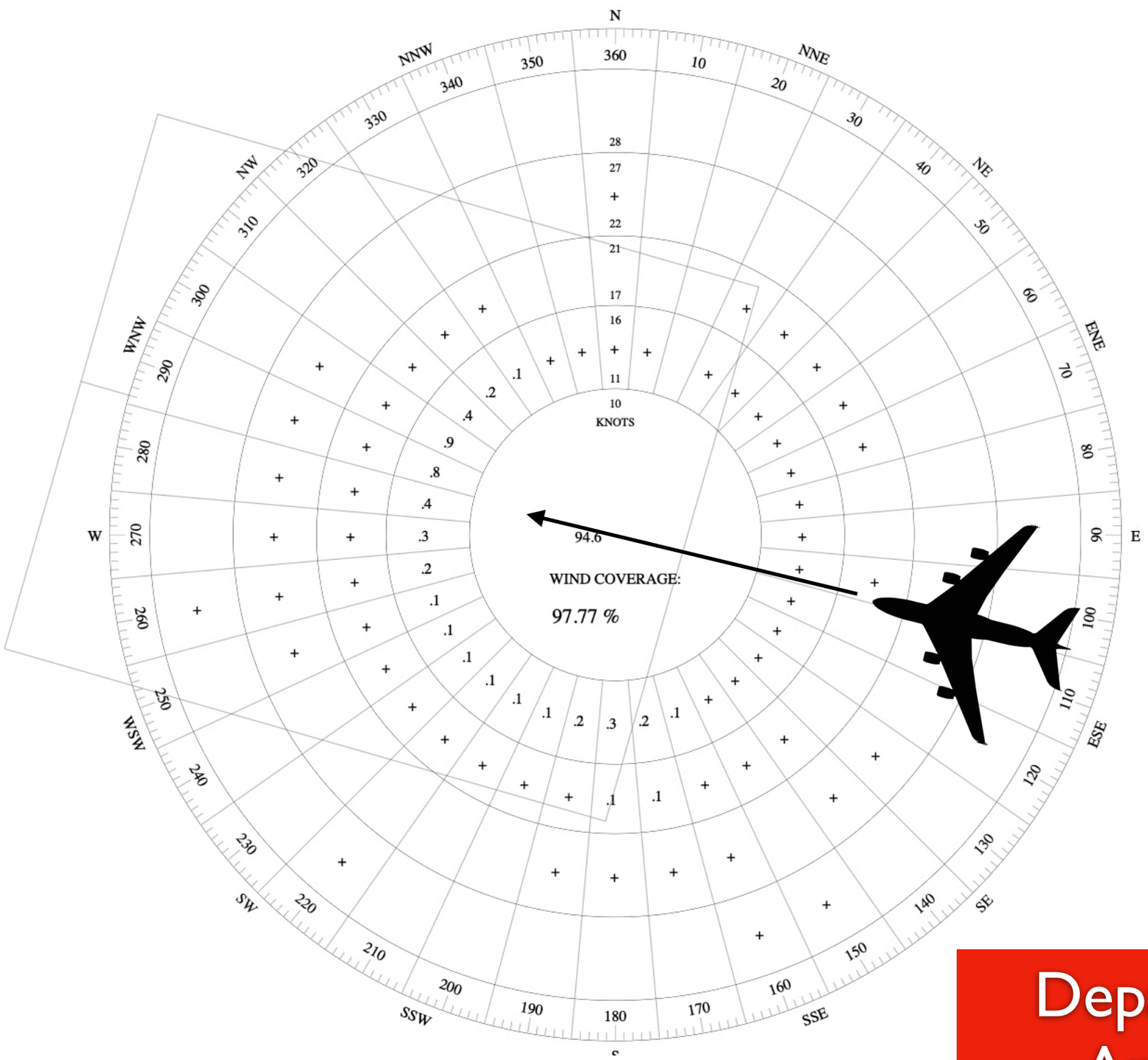
Select the tailwind component 5 knots in this case

San Diego All Weather Wind Rose with no Tailwind



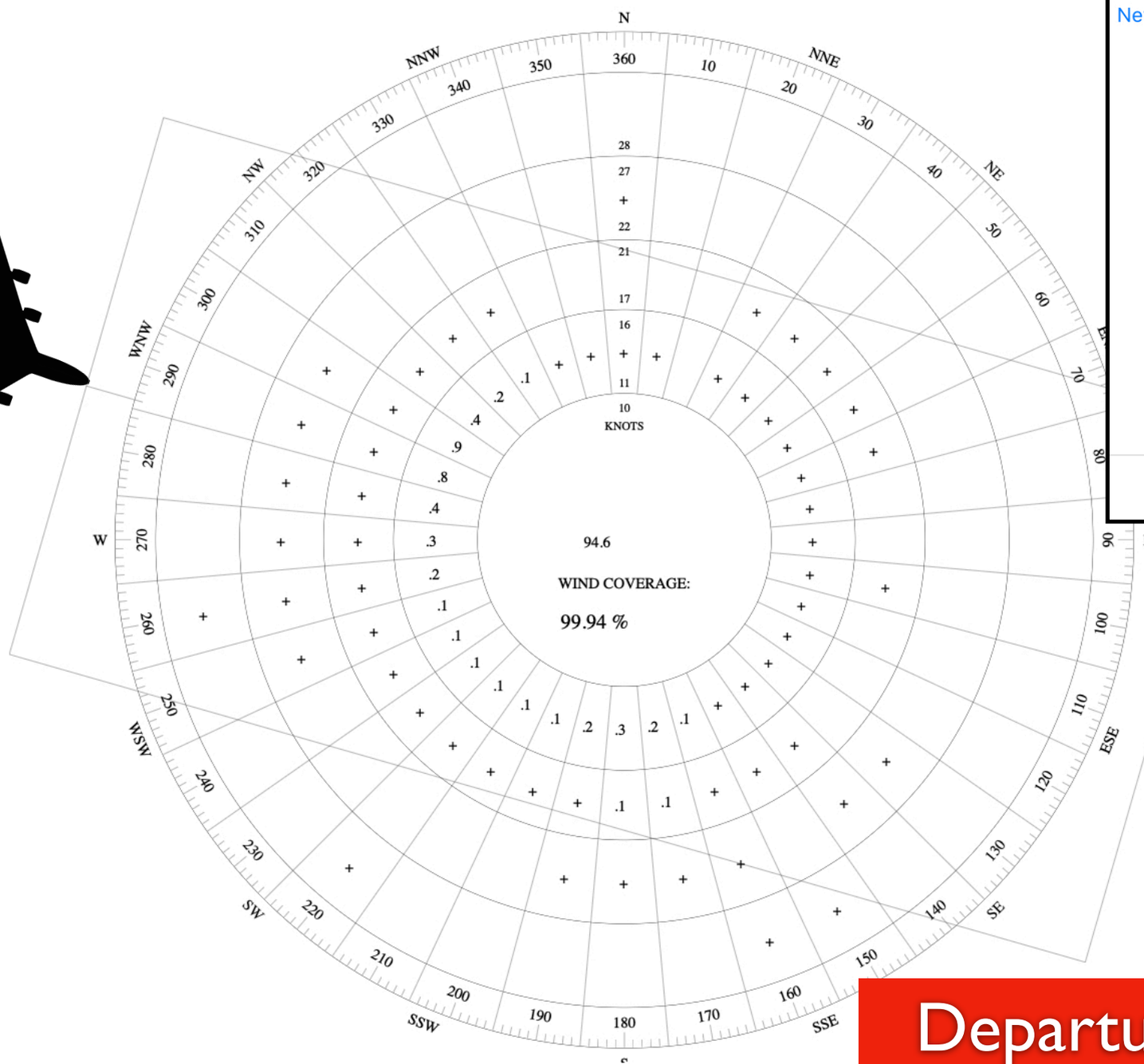
Departures on runway 27
Arrivals on runway 27

San Diego All Weather Wind Rose with 5 knot Tailwind



Departures on runway 27
Arrivals on runway 27

San Diego All Weather Wind Rose with 60 knot Tailwind (bidirectional)



All Weather Windrose

New All Weather Windrose | New IFR Windrose | New VFR Windrose | Open Windros

Upload Wind Data File | View Report | View Windrose | Download as DXF | Dow

Go to Previous Page | Go to Search Page

No of Runways: 1

Runway 1

Runway Orientation: 286

Crosswind Component: 20 Calculate

Tailwind Component: 60

Note: Use a 60 knot tailwind to indicate runway is bi-directional.

Wind Coverage: 99.94%

Departures on runway 27 and 9
Arrivals on runway 27 and 9

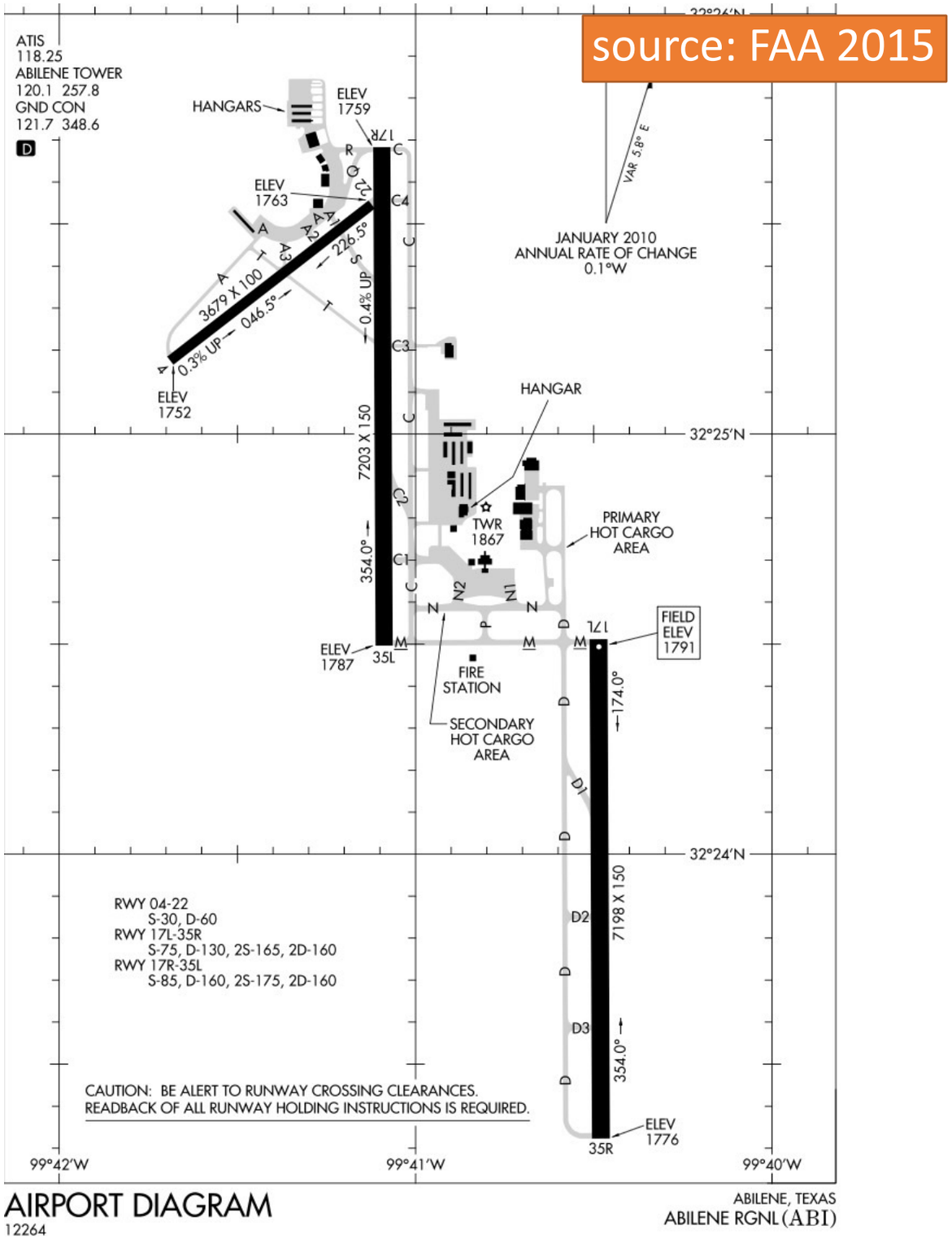
Example Problem:
Using Abilene Texas Municipal Airport Wind Data

Example: Abilene Municipal Airport

- Suppose we would like to know the wind situation for the existing airport
- The idea is to estimate the percent of time each runway can be used

Assume:
Critical aircraft for 17R/35L = D-III
Critical aircraft for 04/22 = B-II

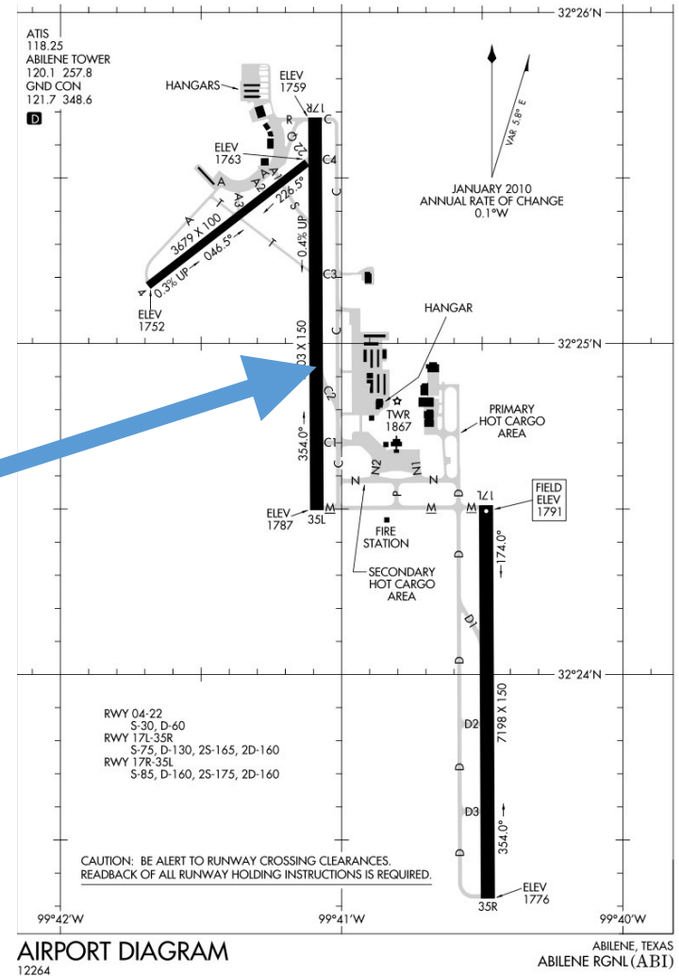
source: FAA 2015



Abilene Municipal Airport

Source: airnav.com

Assume Crosswind
Wind Design Component
is 16 knots (for FAA Aircraft
Design Group C-III)



AIRPORT DIAGRAM
12264
ABILENE, TEXAS
ABILENE RGNL (ABI)

Runway Information

Runway 17R/35L

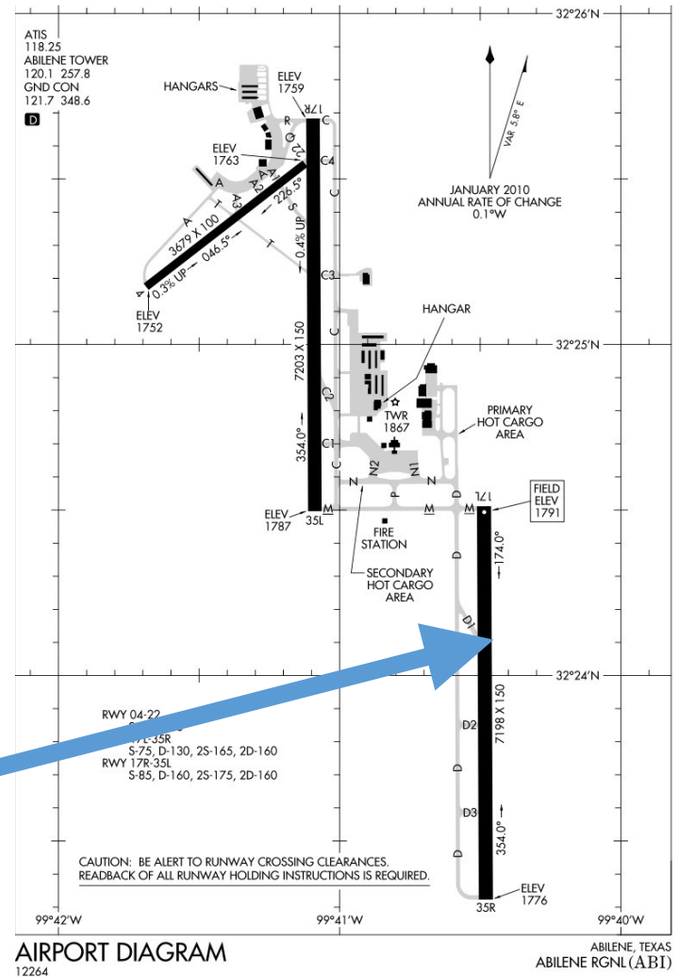
Dimensions: 7203 x 150 ft. / 2195 x 46 m
Surface: asphalt/grooved, in good condition
Weight bearing capacity: Single wheel: 85.0
Double wheel: 160.0
Double tandem: 160.0
Runway edge lights: high intensity
Runway edge markings: RY 17R/35L NSTD PIR MARKINGS - NO EDGE STRIPES.

	RUNWAY 17R	**RUNWAY 35L**
Latitude:	32-25.685068N	32-24.497238N
Longitude:	099-41.095172W	099-41.089295W
Elevation:	1758.6 ft.	1786.5 ft.
Gradient:	0.4% UP	0.3%
Traffic pattern:	right	left
Runway heading:	172 magnetic, 180 true	352 magnetic, 360 true
Declared distances:	TORA:7202 TODA:7202 ASDA:7202 LDA:7202	TORA:7202 TODA:7202 ASDA:7202 LDA:7202
Markings:	NSTD, in good condition	NSTD, in good condition
Visual slope indicator:	4-box VASI on left (3.00 degrees glide path)	4-box VASI on left (3.00 degrees glide path)
Runway end identifier lights:		yes
Touchdown point:	yes, no lights	yes, no lights
Instrument approach:	LOC/DME	

Abilene Municipal Airport

Source: airnav.com

Assume Crosswind
Wind Design Component
is 16 knots (for FAA Aircraft
Design Group C-III)



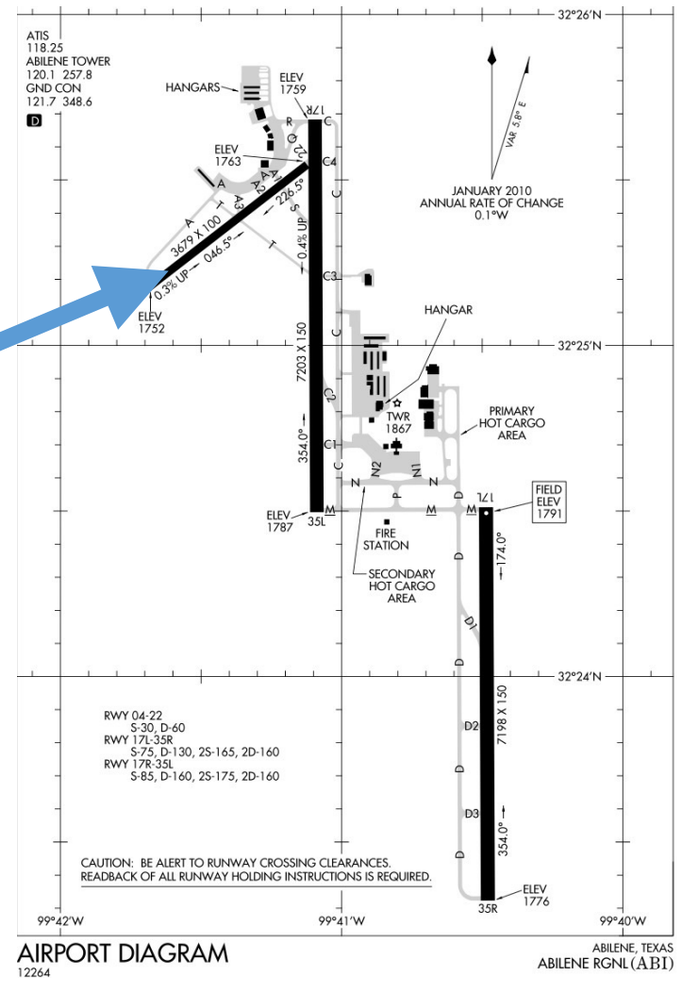
Runway 17L/35R

Dimensions:	7198 x 150 ft. / 2194 x 46 m	
Surface:	asphalt/grooved, in good condition FIRST 250 FT RYS 17L & 35R UNGROOVED.	
Weight bearing capacity:	Single wheel: 75.0 Double wheel: 130.0 Double tandem: 160.0	
Runway edge lights:	high intensity	
	RUNWAY 17L	**RUNWAY 35R**
Latitude:	32-24.511858N	32-23.324875N
Longitude:	099-40.486892W	099-40.480972W
Elevation:	1790.5 ft.	1775.9 ft.
Gradient:	0.4%	0.2% UP
Traffic pattern:	left	right
Runway heading:	172 magnetic, 180 true	352 magnetic, 360 true
Declared distances:	TORA:7198 TODA:7198 ASDA:7198 LDA:7198	TORA:7198 TODA:7198 ASDA:7198 LDA:7198
Markings:	precision, in good condition	precision, in good condition
Visual slope indicator:	4-light PAPI on left (3.00 degrees glide path)	
RVR equipment:		touchdown
Approach lights:		MALSR: 1,400 foot medium intensity approach lighting system with runway alignment indicator lights
Touchdown point:	yes, no lights	yes, no lights
Instrument approach:		ILS/DME
Obstructions:	2 ft. gnd, 200 ft. from runway	none

Abilene Municipal Airport

Source: airnav.com

Assume Crosswind
Wind Design Component
is 13 knots (since this is a small runway)



Runway 4/22

Dimensions: 3679 x 100 ft. / 1121 x 30 m
Surface: asphalt, in poor condition
Weight bearing capacity: Single wheel: 30.0
Double wheel: 60.0
Runway edge lights: medium intensity
Runway edge markings: RY MARKINGS FADED.

	RUNWAY 4	RUNWAY 22
Latitude:	32-25.176052N	32-25.547288N
Longitude:	099-41.688517W	099-41.123130W
Elevation:	1752.3 ft.	1763.0 ft.
Gradient:	0.3%	0.3%
Traffic pattern:	left	right
Runway heading:	044 magnetic, 052 true	224 magnetic, 232 true
Declared distances:	TORA:3678 TODA:3678 ASDA:3678 LDA:3678	TORA:3678 TODA:3678 ASDA:3678 LDA:3678
Markings:	nonprecision, in poor condition	nonprecision, in poor condition
Touchdown point:	yes, no lights	yes, no lights

Example: Abilene Municipal Airport

- Develop a Wind Rose analysis for Abilene Municipal airport
- Collect data from NCDC web site
- Use FAA Java toolbox

DFN:ALL_WEATHER_722660

"722660 ABILENE MUNICIPAL ANNUALPERIOD RECORD 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 "

1 137 929 846 970 149 17 2 2 0
2 171 894 608 436 42 6 2 0 0
3 131 749 441 248 14 1 2 0 0
4 129 603 339 163 13 0 1 2 0
5 116 645 347 203 22 1 0 0 0
6 89 616 273 149 12 1 0 0 0
7 119 668 289 163 11 1 0 0 0
8 129 725 310 175 27 1 0 0 0
9 113 748 311 185 31 2 1 2 0
10 102 860 378 229 27 5 0 0 0
11 116 802 494 353 47 1 1 0 0
12 177 1060 781 625 98 14 1 0 0
13 147 1444 1133 1092 178 19 5 0 0
14 176 2002 1485 1619 314 22 0 0 0
15 176 2354 2024 2330 521 68 3 0 0
16 195 2455 2134 3288 920 114 1 0 0
17 179 2238 1962 3394 1060 115 1 0 0
18 200 1786 1552 2772 776 79 5 0 0
19 218 1549 1238 2293 722 65 2 0 0
20 210 1428 1067 2237 786 82 1 0 0
21 160 963 915 1736 567 63 1 1 0
22 107 735 655 974 161 7 2 0 0
23 144 497 376 479 63 4 1 0 0
24 92 394 263 225 32 5 0 0 0
25 96 298 169 198 72 4 2 1 0
26 92 290 132 195 108 32 4 2 0
27 96 268 124 214 85 31 2 0 0
28 93 298 151 202 105 24 9 2 0
29 90 371 171 238 90 24 8 0 0
30 91 406 203 243 105 25 3 1 0
31 106 419 245 317 100 40 7 1 1
32 124 569 357 491 191 60 7 0 0
33 111 587 433 599 266 73 17 0 1
34 116 677 552 1004 388 117 16 5 0
35 129 910 773 1330 495 114 12 3 0
36 160 1171 1263 1793 513 96 14 3 1
0 6326

ABI airport wind data 10 year period (2004 to 2013)

FAA Wind Rose Java Tool

ALL_WEATHER Wind Rose Form

New All Weather Windrose | New IFR Windrose | New VFR Windrose | Open Windrose | Save Windrose

Data File | View Report | View Windrose | Download as DXF | Download as SVG | Help

Assume wind vectors are **true North directions**

Calculate

Two runways shown (since runways 17-35 are parallel)

Title: Abilene Municipal

	Num Runways: 2	Runway 1	Runway 2
	Runway Orientation:	360.0	52.0
	Crosswind Component:	16.0	13.0
	Tailwind Component:	60.0	60.0

60 knots means we want to get the percent coverage for bi-directional runways

Note: Use a 60 knot tailwind to indicate runway is bi-directional.

Wind Coverage: 99.37%

Total wind coverage (%)

NCDC Data downloaded according to the procedure stated in previous slides

Hourly Observations of Wind Speed (knots)

Direction	0-3	4-6	7-10	11-16	17-21	22-27	28-33			
10°	137	929	846	970	149	17	2			
20°	171	894	608	436	42	6	2	0	0	2159
30°	131	749	441	248	14	1	2	0	0	1586

Abilene Municipal Airport

ALL_WEATHER Wind Rose Form

New All Weather Windrose | New IFR Windrose | New VFR Windrose | Open Windrose | Save Windrose

Upload Wind Data File | View Report | View Windrose | Download as DXF | Download as SVG | Help

Calculate

Assume wind vectors are **true North directions**

Title: Abilene Municipal

		Runway 1	Runway 2
Num Runways:	2		
Runway Orientation:		360.0	52.0
Crosswind Component:		16.0	13.0
Tailwind Component:		60.0	60.0

Note: Use a 60 knot tailwind to indicate runway is bi-directional.

Wind Coverage: 99.37%

Percent wind coverage (all ruwways)

Hourly Observations of Wind Speed (knots)

Direction	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	> 41	Total
10°	137	929	846	970	149	17	2	2	0	3052
20°	171	894	608	436	42	6	2	0	0	2159
30°	131	749	441	248	14	1	2	0	0	1586

Abilene Municipal Airport

Some relevant questions:

1. What percent of the time can runways 35L and 35R be used?
2. What percent of time can the full runway 17R/35L be used?

- In the analysis, assume a 5 knot tailwind component is allowed for the operations.

Abilene Municipal Airport

1. What percent of the time can runways 35L and 35R be used for landings and departures?

ALL_WEATHER Wind Rose Form

New All Weather Windrose | New IFR Windrose | New VFR Windrose | Open Windrose | Save Windrose

Upload Wind Data File | View Report | View Windrose | Download as DXF | Download as SVG | Help

Calculate

Title: Abilene Municipal

Num Runways: 1 Runway 1

Runway Orientation: 360.0

Crosswind Component: 16.0

Tailwind Component: 5.0

Runway 35 true North orientation

Runway 35 design cross wind

5 knot tailwind

Note: Use a 60 knot tailwind to indicate runway is bi-directional.

Wind Coverage: 54.6%

Percent wind coverage (runway 35)

Abilene Municipal Airport

1. Estimate the percent of the time runways 35L and 35R be used.

ALL_WEATHER Wind Rose

New All Weather Windrose | New IFR Windrose | New VFR Windros

Upload Wind Data File | View Report | View Windrose | Download

Calculate

Title: Abilene Municipal

Num Runways: 1 Runway 1

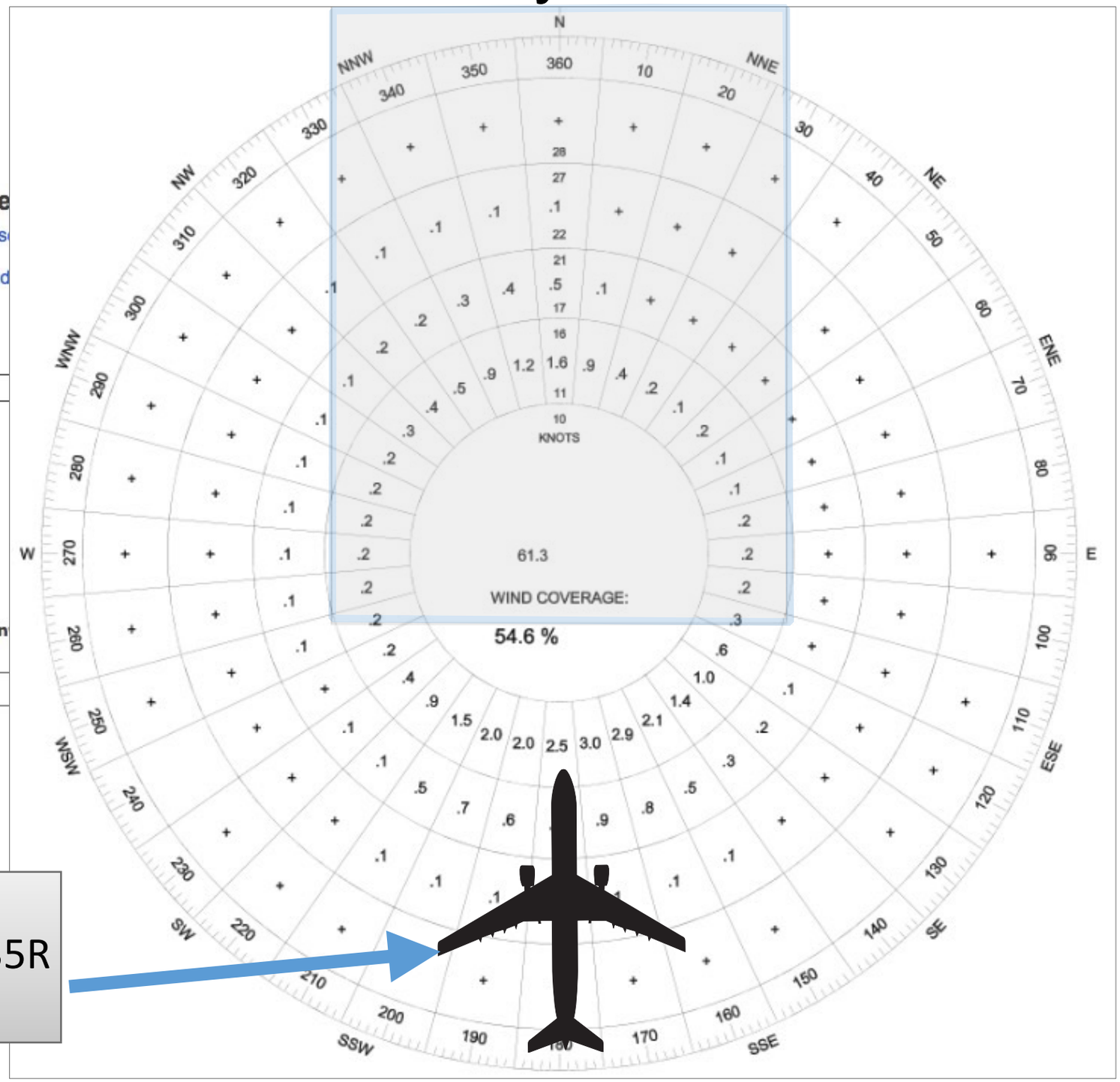
Runway Orientation: 360.0

Crosswind Component: 16.0

Tailwind Component: 5.0

Note: Use a 60 knot tailwind to indicate run

Wind Coverage: 54.6%



Landing and takeoff direction (runways 35R and 35L)

Abilene Municipal Airport

What percent of time can the full runway 17R/35L be used?

Equivalent to the percent of time runways 35 and 17 can be used (both directions)

Use 60 knots tailwind to make such calculation

ALL_WEATHER Wi

New All Weather Windrose | New IFR Wind rose | New V

Upload Wind Data File | View Report | iew Windrose

Calculat

Title: Abilene Municipal

Num Runways: 1 Runway 1

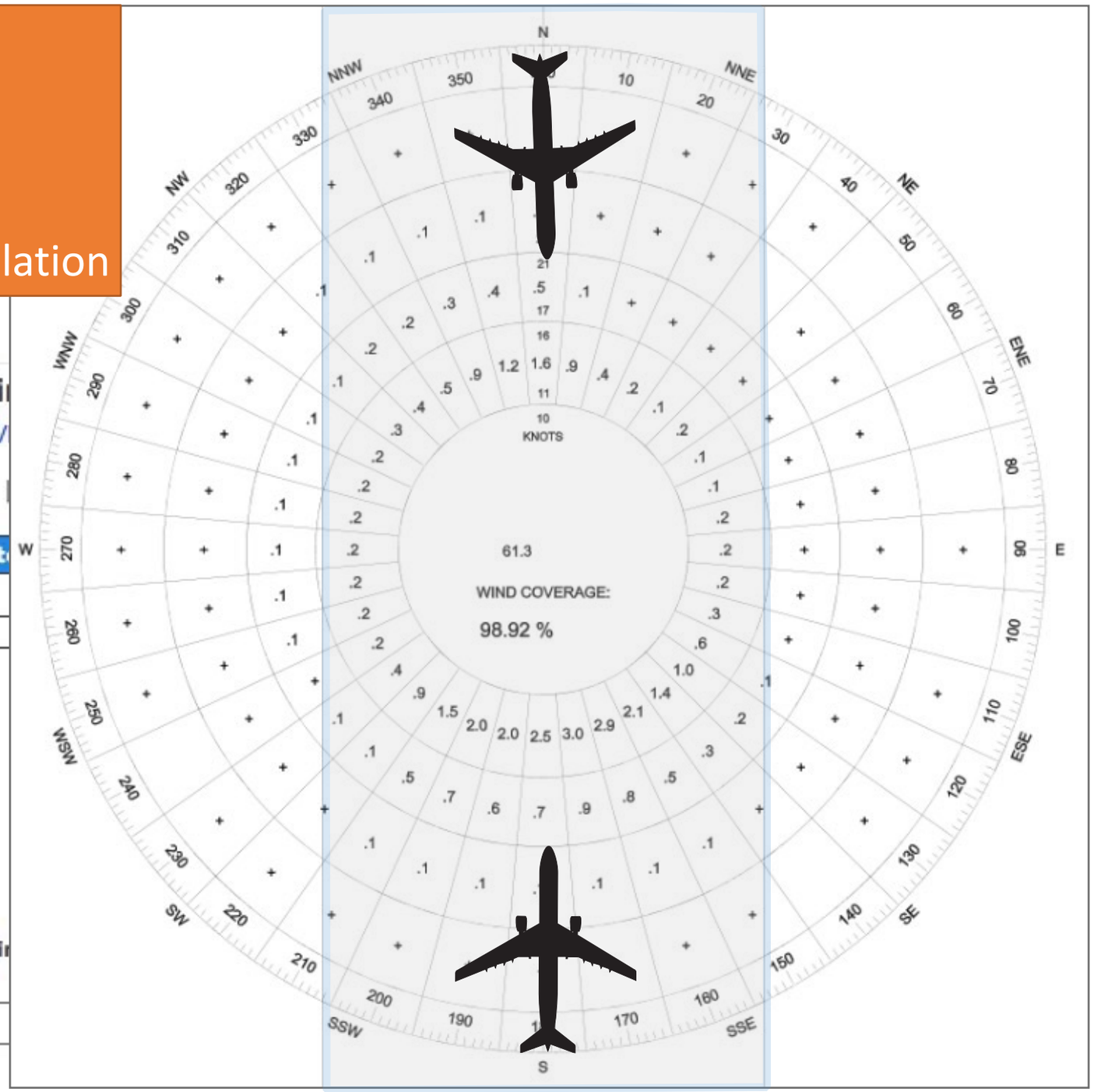
Runway Orientation: 360.0

Crosswind Component: 16.0

Tailwind Component: 60.0

Note: Use a 60 knot tailwind to i

Wind Coverage: 98.92%



When Do I use a 60 knot Tailwind?

- When you want to know the percent of time a runway is used from both runway ends (bi-direccional analysis), use an artificially high value of tailwind (60 knots)

- Calculates in one step the percent of time the runway is usable from both approaches.

Abilene Municipal Airport

Using two runway orientations 17/35 and 04/22 (bi-directional analysis)

Here we calculate the wind coverage for two runway orientations at Abilene Municipal airport

Note: we include two runways in the FAA Java tool

New All Weather Windrose | New IFR Windrose | New VF

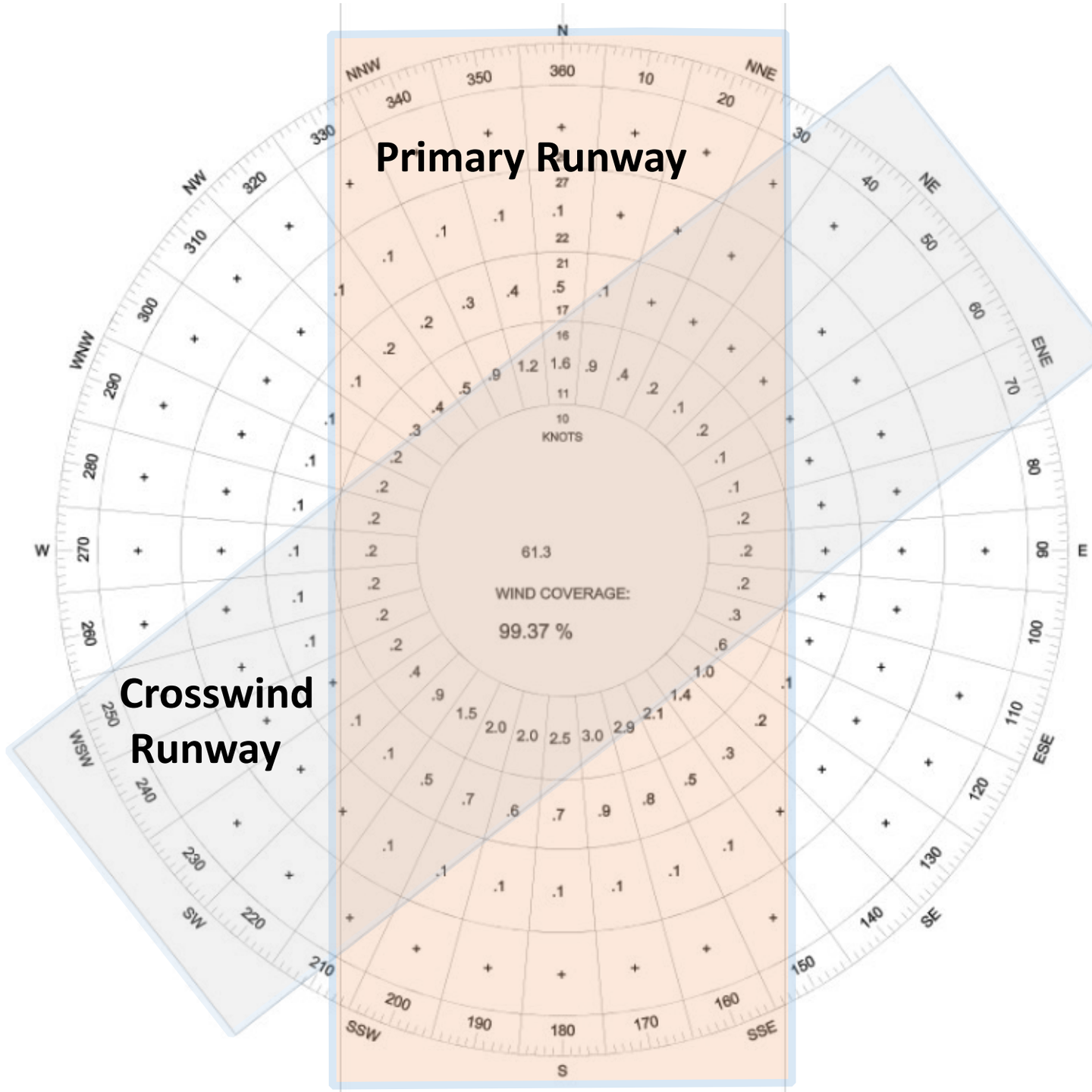
Upload Wind Data File | View Report | View Windrose |

Calculate

Title:	Abilene Municipal		
Num Runways:	2	Runway 1	Runway 2
Runway Orientation:		360.0	52.0
Crosswind Component:		16.0	13.0
Tailwind Component:		60.0	60.0

Note: Use a 60 knot tailwind to inc

Wind Coverage:	99.37%



Explanation About Tailwind Allowances

Aircraft are expected to land and takeoff against the wind

- Under some conditions, pilots are allowed to operate with a small tailwind component
- The amount of tailwind allowed in commercial operations varies from airline to airline but is seldom more than 8 knots (relatively small winds)

Implications of taking off with tailwinds

- longer runway length

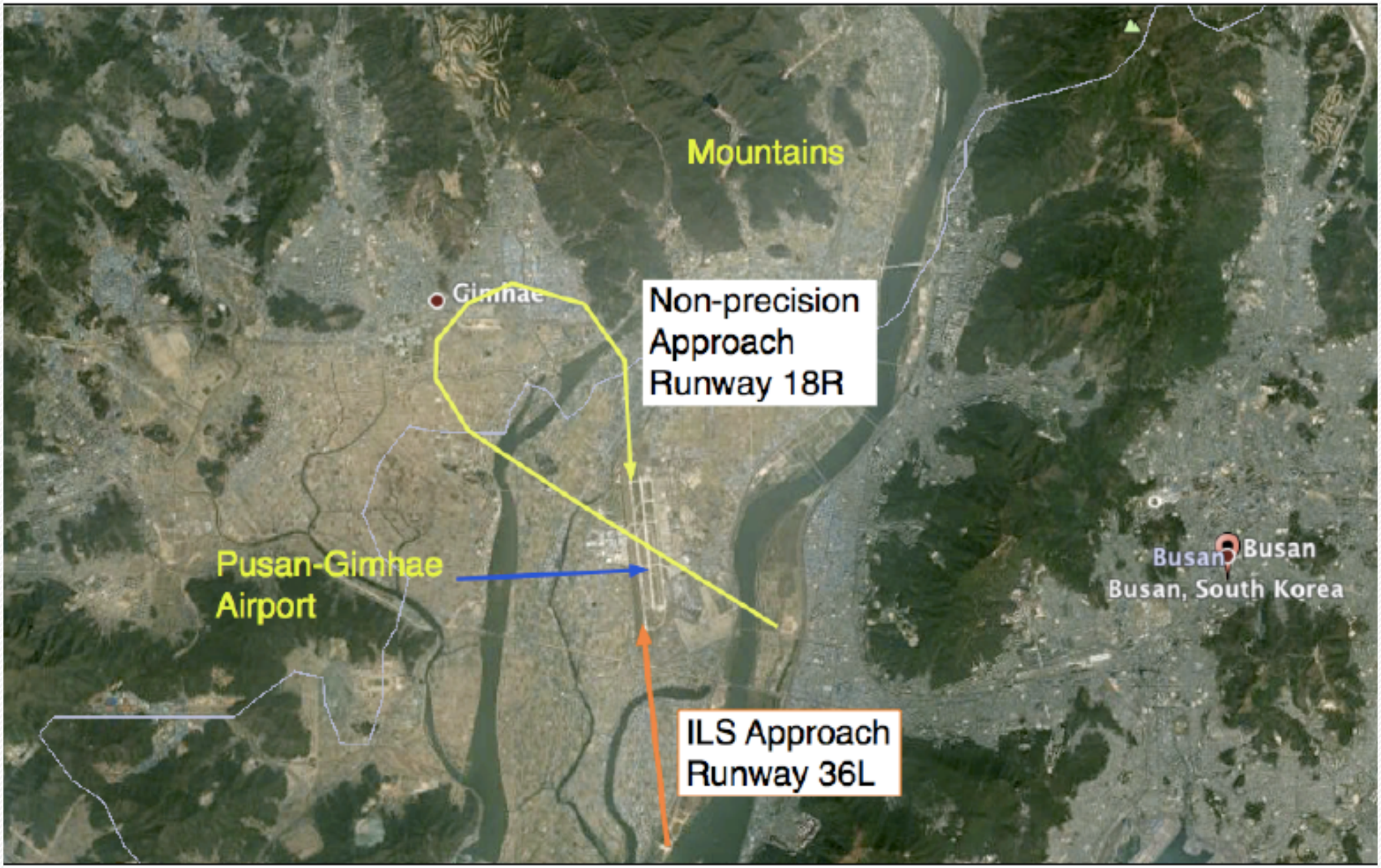
Implications of landing with tailwinds

- Faster approach speeds (i.e., ground speed)
- Longer landing runway requirements

Reasons for Tailwind Allowances

- Pilots may prefer to use a higher precision approach by taking a small tailwind component while landing
  - Busan (Korea) accident (http://aviation-safety.net/database/record.php?id=20020415-0)
  - Pilots landing at Kingston, Jamaica prefer runway 12 because it has an ILS approach (runway 30 does not have a precision approach)
- For Design of Runway Orientation;
  - Use 5 knots of tailwind to estimate the percent of time a runway end is used

Pusan, Korea


Mountains
Gimhae
Non-precision
Approach
Runway 18R
Pusan-Gimhae
Airport
Busan
Busan
Busan, South Korea
ILS Approach
Runway 36L

Wind Rose Workflow Example

Wind Rose Workflow Example

- Design the optimal runway orientation for an airport using FAA airport design code B-II

Solution:

Step 1:

- Determine the design crosswind component
- B-II requires 13 knots of cross wind component (see FAA AC 150/5300-13a)

Example Problem (cont.)

Step 2:

- Obtain the wind data from any one of the three sources described in the handout
- This step requires that you estimate the percent coverage for each runway orientation

Step 3:

- Find the new coverage for each new runway orientation (say every 1 to 5 degrees)
- Create a plot with coverage vs runway orientation

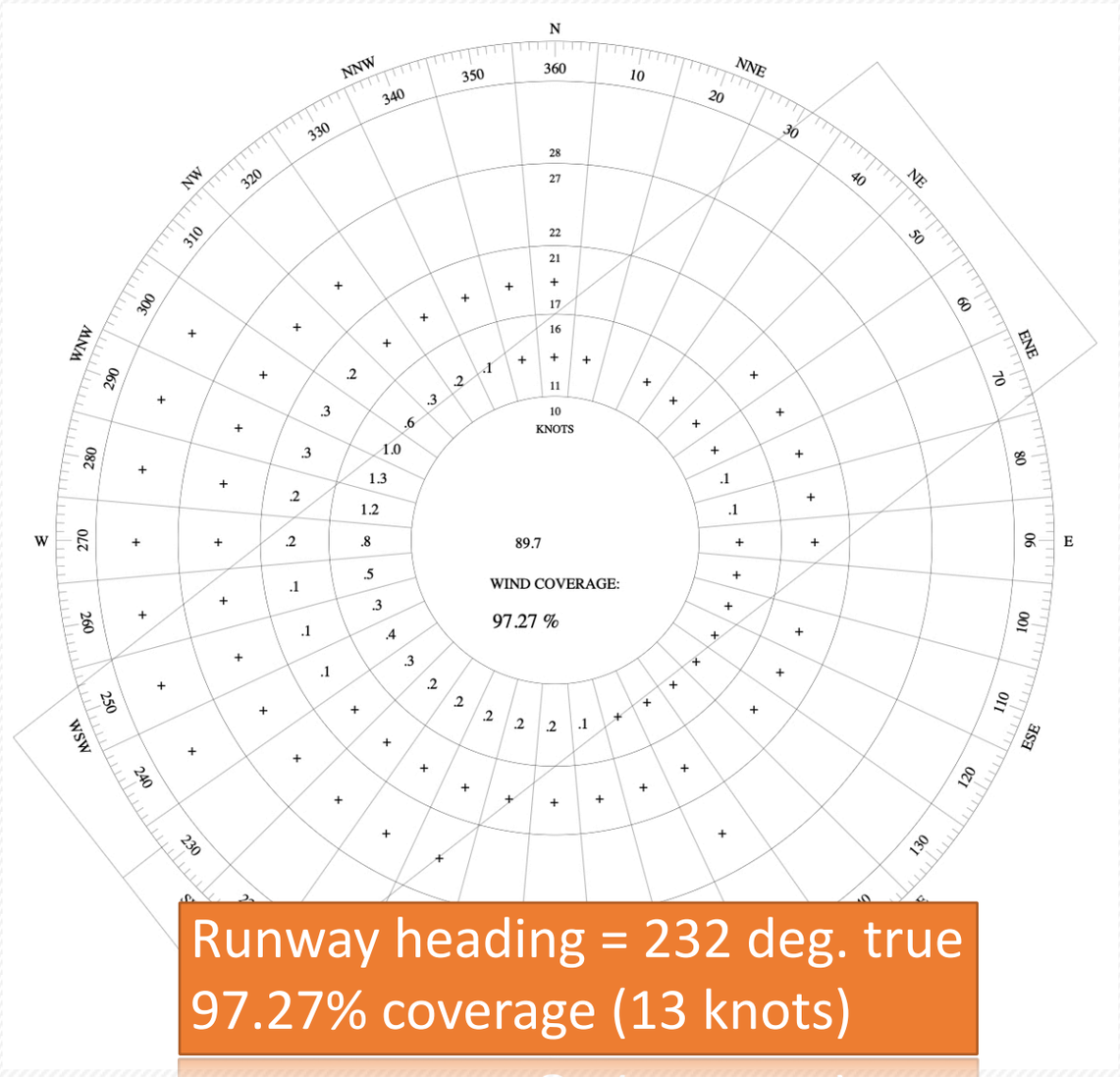
Step 4:

- Select the runway orientation that provides the highest coverage

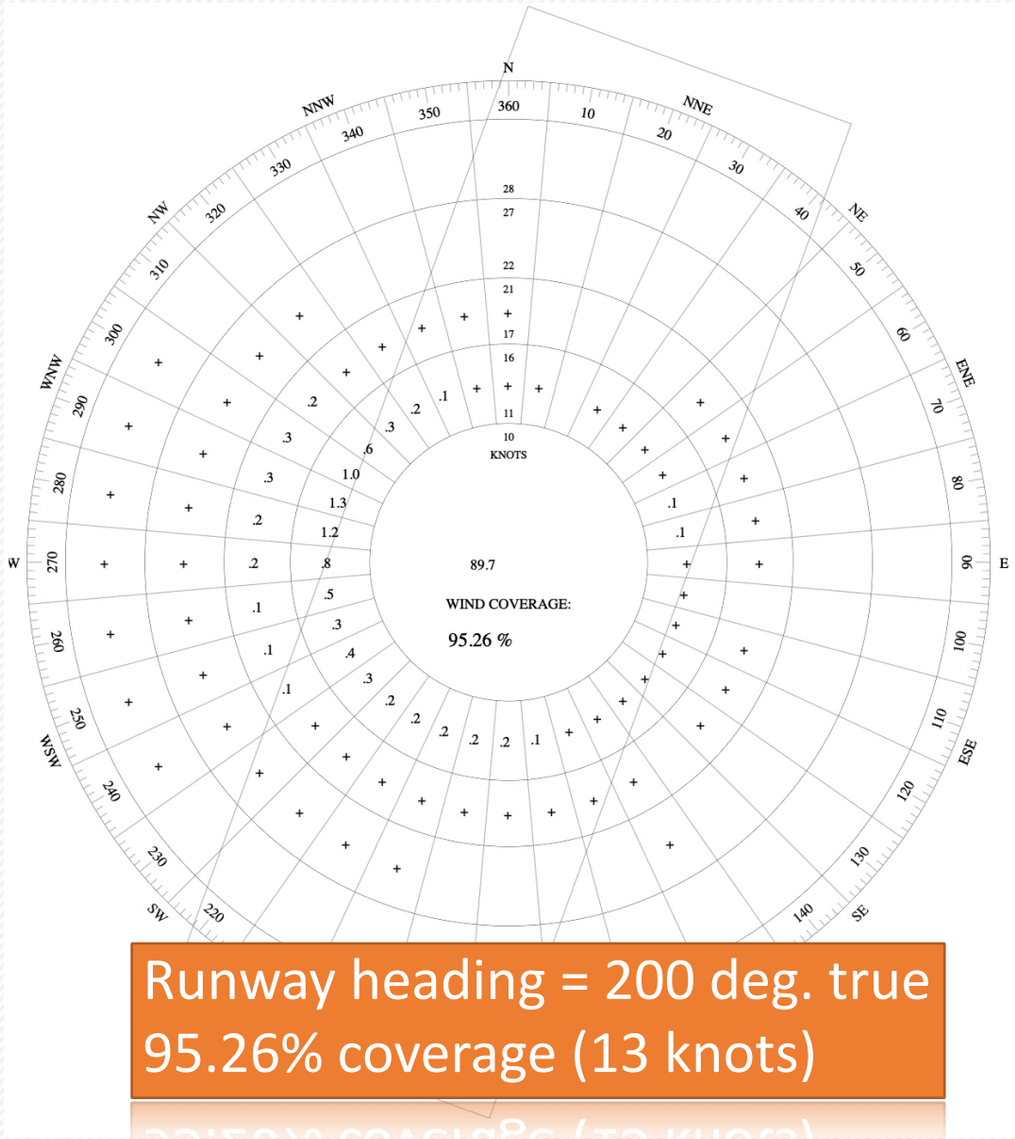
Example Problem (cont.)

Step 3:

- Find the new coverage for each new runway orientation (say every 1 to 5 degrees)

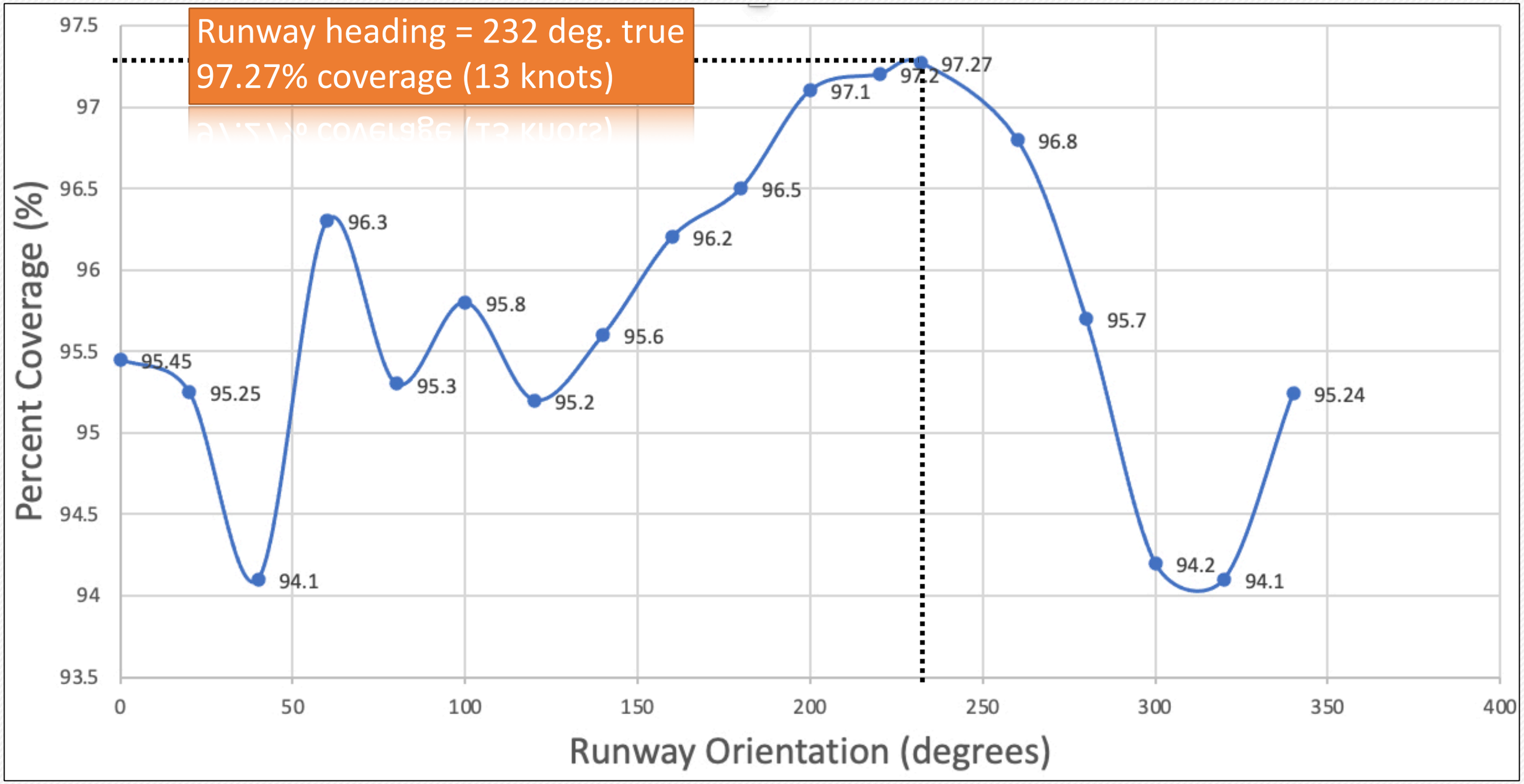


Runway heading = 232 deg. true
97.27% coverage (13 knots)



Runway heading = 200 deg. true
95.26% coverage (13 knots)

Example Problem (cont.)



Example Problem (cont.)

Step 5:

- Check if the coverage meets the 95% criteria required by FAA and ICAO
- If the 95% crosswind coverage is met you are done
- Otherwise add a second (crosswind) runway repeating steps 1-4 until the 95% criteria is achieved
- If a second runway is needed, first optimize the runway orientation of the primary runway
  - Then perform the best runway orientation of the second runway