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METHODOLOGY FOR CONVERTING ASOS METEOROLOGICAL DATA FOR USE IN THE MACCS CODE

Daniel J. Clayton

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MACCS Accident Consequence Model

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U.S. DEPARTMENT OF ENERGY

NNSA

MOTIVATION

MACCS
Accident Consequence Model

Certain regulatory actions require the **assessment** of potential off-site **consequence risks** to public safety and the environment from a hypothetical severe accident

The analysis of the off-site consequences begins with **atmospheric dispersion modeling** utilizing onsite meteorological data

These assessments may be for locations where **onsite meteorological data does not currently exist**

The Automated Surface Observing Systems (**ASOS**) program

- Joint effort of the National Weather Service, the Federal Aviation Administration, and the Department of Defense
- Serves as the nation's primary surface weather observing network
- **Designed** to support aviation operations at both large and small airports and support the needs of the **meteorological**, hydrological, and climatological **research** communities
- Archives provide a **potential source of meteorological data** where onsite data does not currently exist

MACCS

Created by Sandia to **support NRC research** and regulatory requirements

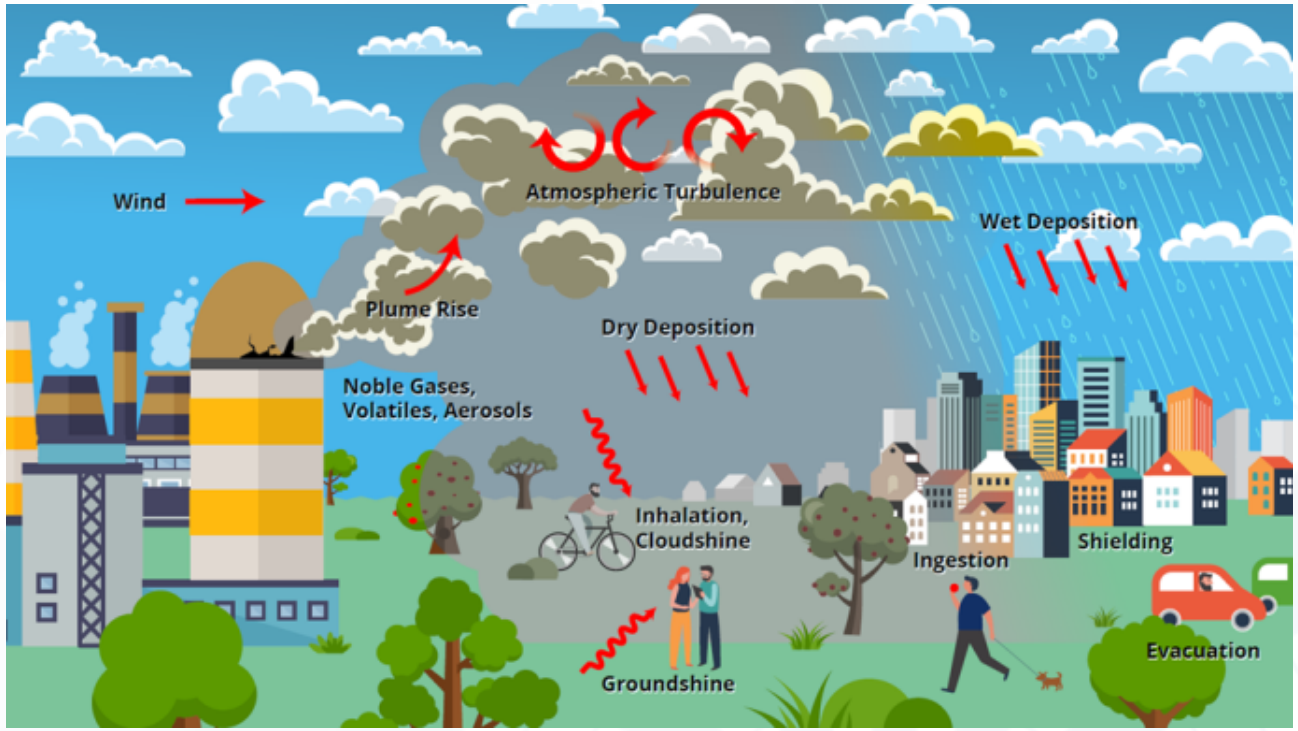
- Origins go back to the 1970s

Typically used for **prospective analyses** (evaluation over the course of a year or more)

- Probabilistic risk assessments (NUREG-1150 and Level 3 PRA)
- Probabilistic consequence assessments (SOARCA)
- Cost/benefit analyses (commonly used in environmental assessments for in licensing)

Two ATD model options

- Gaussian plume segment (analytical)
- Lagrangian particle/puff (HYSPLIT)



METEOROLOGICAL NEEDS

MACCS
Accident Consequence Model

Gaussian plume segment model

- Wind speed
- Wind direction
- Pasquill-Gifford stability class
- Precipitation

HYSPLIT model

- Extensive compatible data sets with time-dependent, three dimensional information

Need meteorological data over the course of a **year or more**

- Sampling weather sequence
- Calculate mean values and percentile values of consequence metrics

ASOS

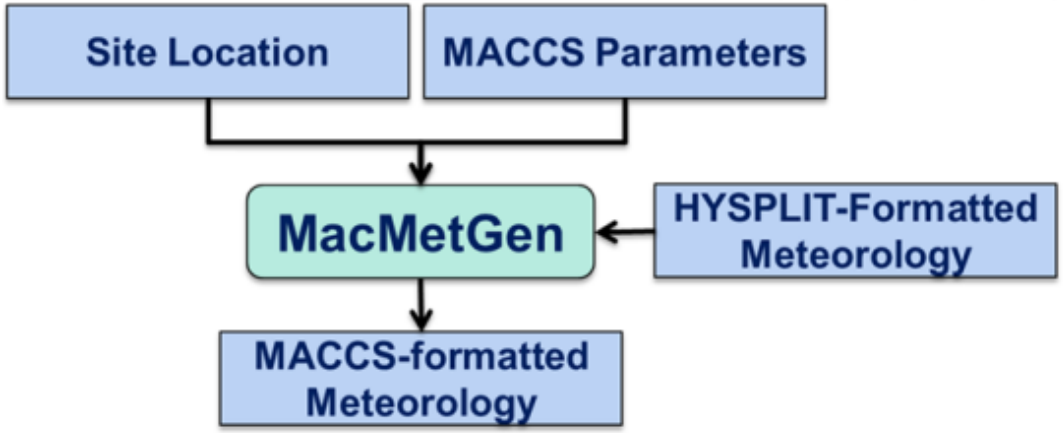
- Wind speed
- Wind direction
- Cloud coverage
  - Can use Turner's method to get stability class
- Precipitation
- Multi-year archives

DATA EXTRACTION AND CONVERSION

MACCS
Accident Consequence Model

MacMetGen

- Developed by Sandia to ensure **consistency** between meteorological data used with Gaussian plume segment and HYSPLIT models
- **Extracts meteorological data** from HYSPLIT data sets and **generates** MACCS-formatted file



Process used in this analysis

- **Extract** ASOS data from web source[1] for the year 2022
- **Convert** to same format that MacMetGen extracts from HYSPLIT-compatible data sets
- Run **MacMetGen** to determine stability class and generate MACCS-formatted meteorology
- **Analyze** wind roses and stability class distributions
- **Ensure** MACCS execution
- Multiple sites to check for **robustness**

[1]https://mesonet.agron.iastate.edu/request/download.phtml

SITES & DATA STATISTICS

MACCS
Accident Consequence Model

Alaskan coastal orography

- Anchorage, AL
- **PANC** ASOS station

Large river valley

- Chattanooga, TN
- **KCHA** ASOS station

Flat terrain

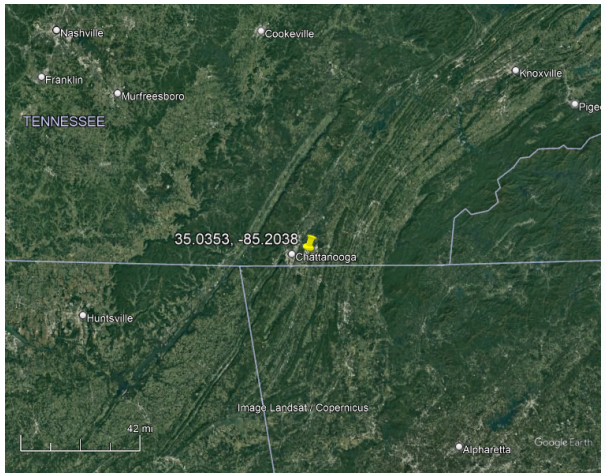
- Phillips, SD
- **KPHP** ASOS station

Gulf coast

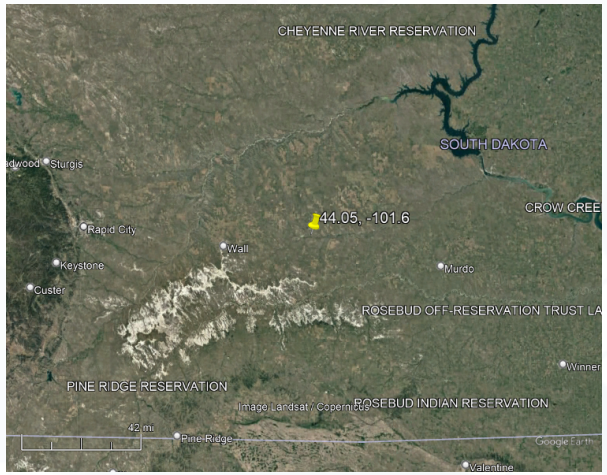
- Rockport, TX
- **KRKP** ASOS station

Site	# of Initial Data Points	# of Nulls	Calms	Missing
PANC	10,895	604	14.7%	5.3%
KCHA	10,632	475	31.9%	4.1%
KPHP	10,136	671	7.2%	4.1%
KRKP	12,298	833	3.9%	5.1%

PANC



KCHA



KPHP

KRKP

ASOS DATA CONVERSION METHODOLOGY

MACCS
Accident Consequence Model

1. Convert **cloud** information from key words to numerical values

2. Fill **small gaps** (<1 hour) in data using interpolation

3. Interpolate onto **uniform time grid**, using persistence near larger gaps (>1 hour)

Time stamp	tmpc	drct	sped	p01m	skyc1	skyl1
1/4/2022 0:53	16.67	230	3.45	0	SCT	3600
1/4/2022 1:39	16.11	200	4.6	0.0001	FEW	4000
1/4/2022 1:53	16.67	null	5.75	0.25	FEW	4000
1/4/2022 2:06	17.22	310	20.7	0.25	SCT	2200
1/4/2022 2:10	17.22	290	18.4	0.76	SCT	1700
1/4/2022 2:53	16	320	9.2	5.2	BKN	1300
1/4/2022 3:53	null	null	3.45	14.99	FEW	1200
1/4/2022 4:53	16.11	110	2.5	16.76	FEW	2800
1/4/2022 5:53	16.11	0	0	17.27	FEW	1000

Time stamp	Temp (C)	Direct (deg)	Speed (mph)	Precip (mm/hr)	Cld Cover (%)	Cld Hgt (ft)
1/4/2022 1:00	16.58	225	3.62	0.00	45	3661
1/4/2022 2:00	16.97	286	13.80	0.25	36	3031
1/4/2022 3:00	16.00	320	8.53	6.34	73	1288
1/4/2022 4:00	null	null	3.34	15.20	20	1387
1/4/2022 5:00	16.11	110	2.50	16.82	20	2590
1/4/2022 6:00	16.11	0	0	17.21	20	1210

ASOS DATA CONVERSION METHODOLOGY

4. Convert to **units** needed for MacMetGen

5. Change **calms** (0,0) to random direction and minimum wind speed (0.5 m/s)

6. Interpolate +- 2 days within three hour block to fill **large gaps** (>1 hour)

Time stamp	Temp (C)	Direct (deg)	Speed (mph)	Precip (mm/hr)	Cld Cover (%)	Cld Hgt (ft)
1/4/2022 1:00	16.58	225	3.62	0.00	45	3661
1/4/2022 2:00	16.97	286	13.80	0.25	36	3031
1/4/2022 3:00	16.00	320	8.53	6.34	73	1288
1/4/2022 4:00	null	null	3.34	15.20	20	1387
1/4/2022 5:00	16.11	110	2.50	16.82	20	2590
1/4/2022 6:00	16.11	0	0	17.21	20	1210

Time stamp	Temp (K)	Direct (deg)	Speed (m/s)	Precip (mm/hr)	Cld Cover (frac)	Cld Hgt (m)
1/4/2022 1:00	289.7	225	1.6	0	0.45	1129
1/4/2022 2:00	290.1	286	6.2	0.25	0.36	935
1/4/2022 3:00	289.2	320	3.8	6.34	0.73	397
1/4/2022 4:00	289.2	256	1.5	15.20	0.20	428
1/4/2022 5:00	289.3	110	1.1	16.82	0.20	799
1/4/2022 6:00	289.3	67	0.5	17.21	0.20	373

Average of
1/2/2022 3:00-5:00
1/3/2022 3:00-5:00
1/4/2022 3:00
1/4/2022 5:00
1/5/2022 3:00-5:00
1/6/2022 3:00-5:00

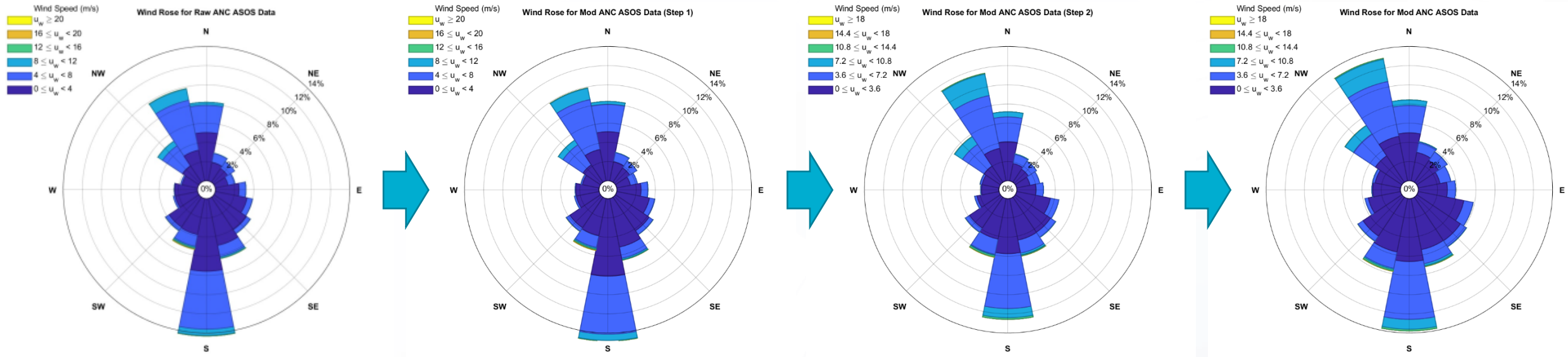
DATA PROGRESSION FOR PANC

MACCS
Accident Consequence Model

Fill small gaps (Phases 1-2)

Interpolate to uniform time grid (Phase 3)

Replace calms and fill large gaps (Phases 4-6)

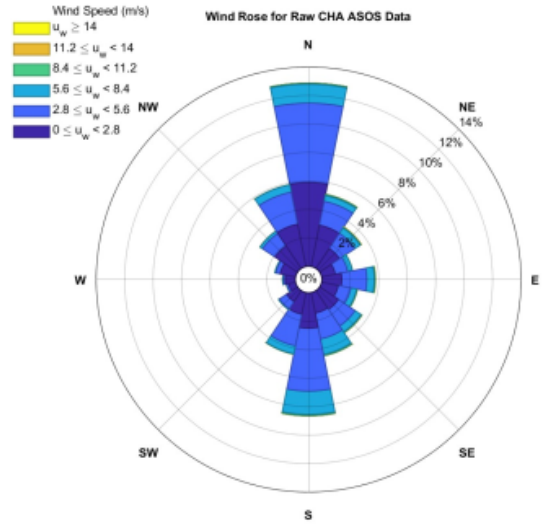


Successful execution in MACCS!

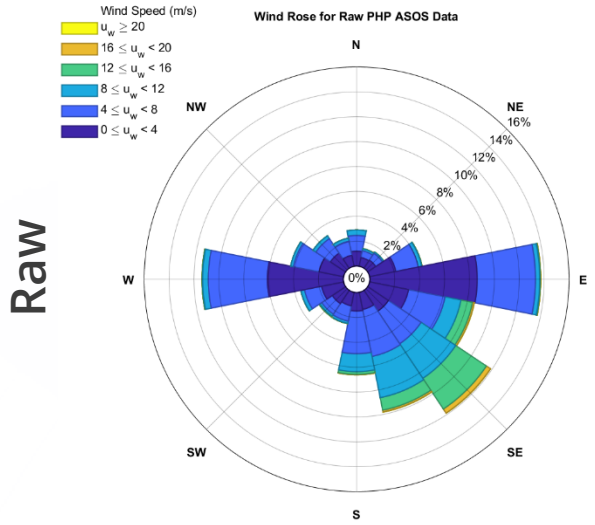
OTHER SITE COMPARISONS

MACCS
Accident Consequence Model

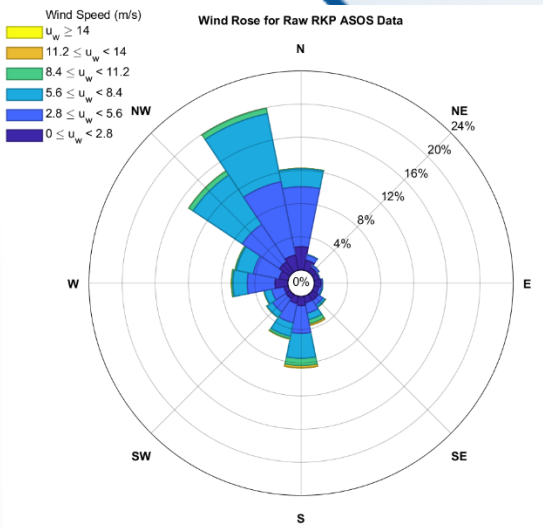
Raw



KCHA

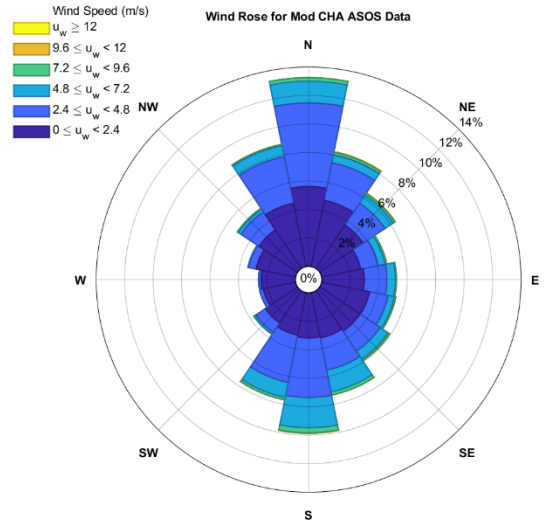


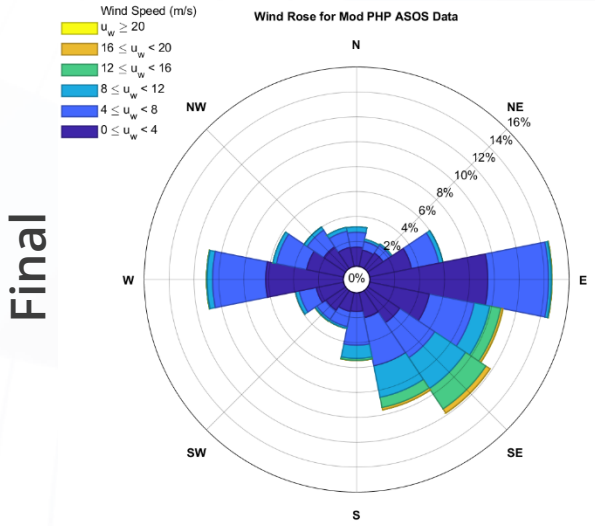
KPHP

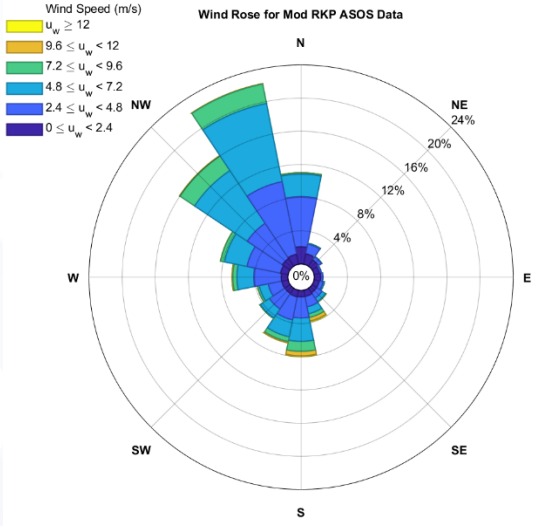


KRKP

Final



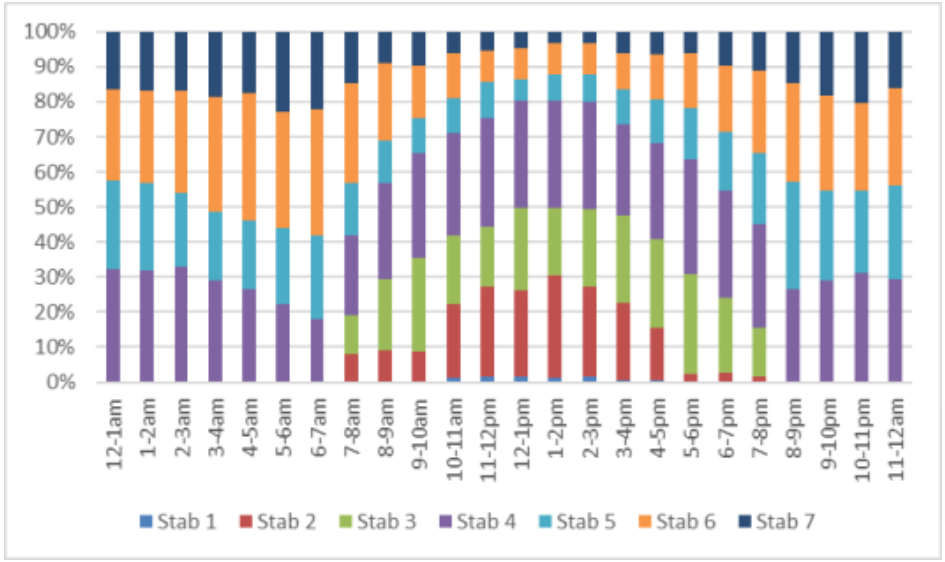




STABILITY CLASS

MACCS
Accident Consequence Model

PANC



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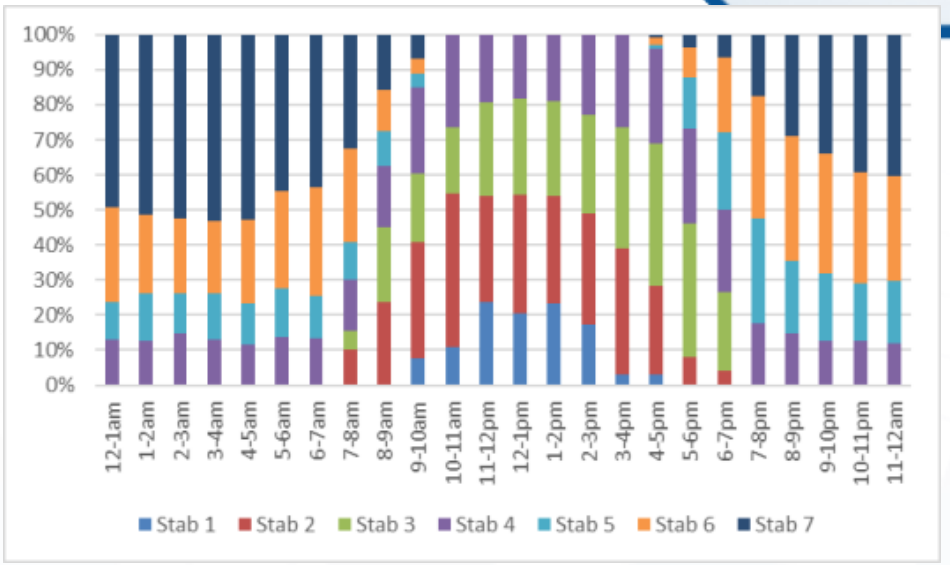
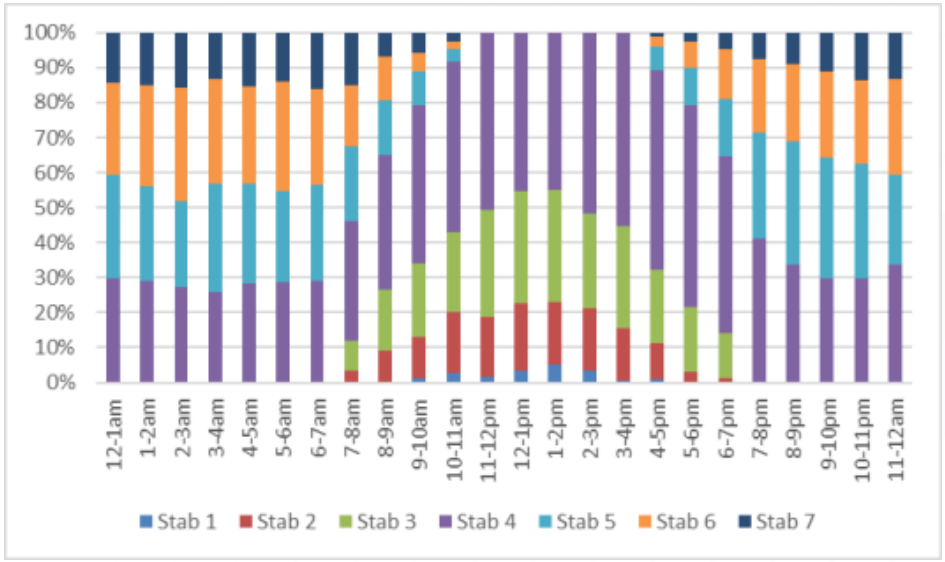


KPHP



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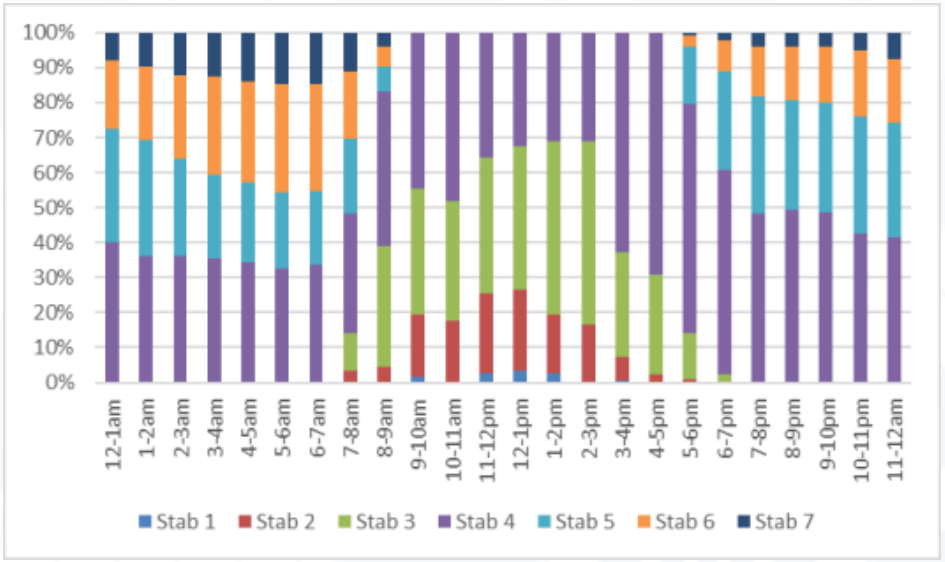

SUMMARY

Historical archives of ASOS data available for use

Methodology developed for conversion to file needed for MACCS Gaussian plume segment model

Executed methodology for four separate sites

Evaluations show consistent results between raw data and final data

MACCS runs successfully with all four meteorological files