Influence of Growing-Season Meteorology on X/Q Values for Carbon-14 Dose Assessment

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Revisit of Growing Season X/Q Discussion

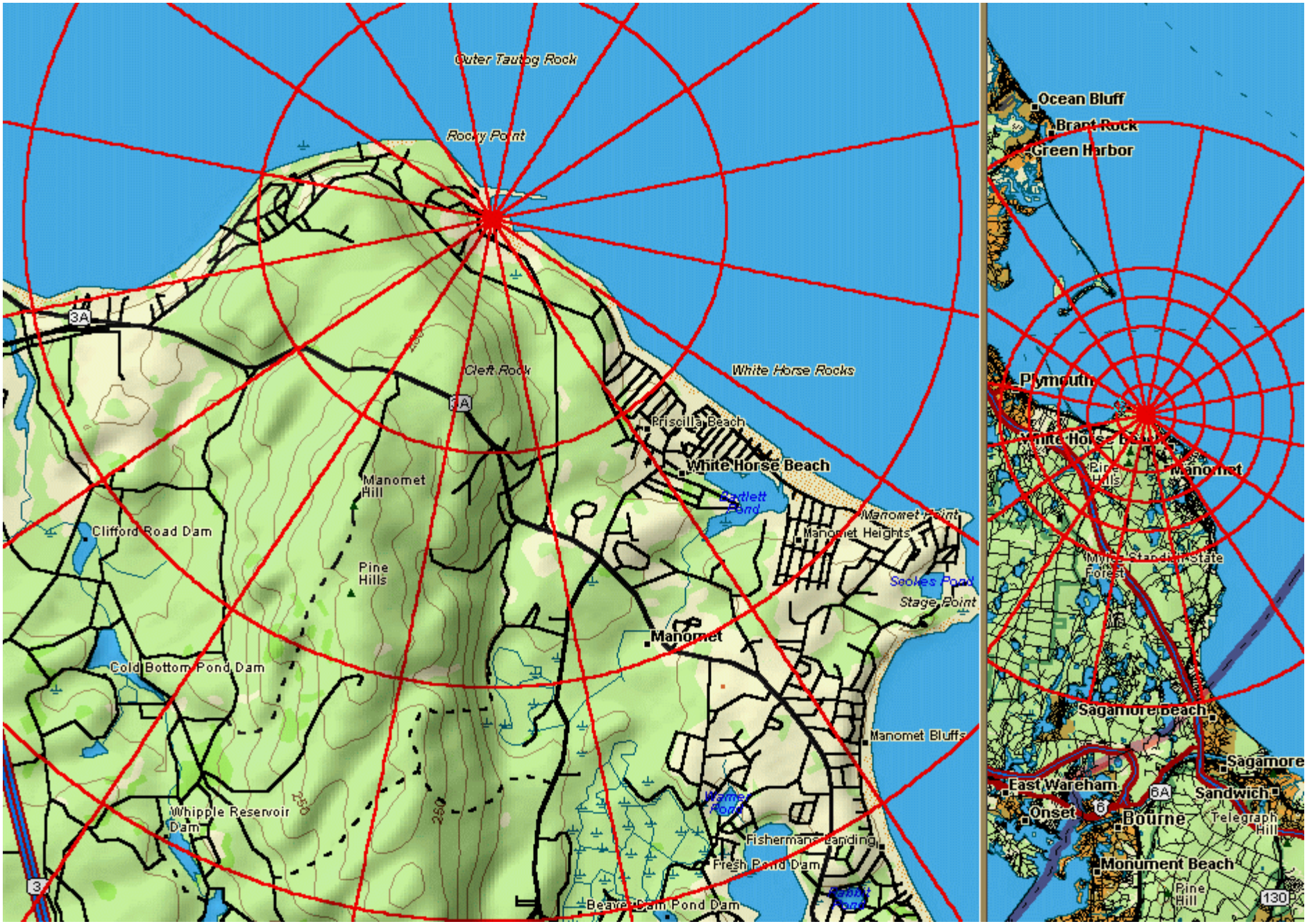
- Topic was originally prepared and presented at the 2012 RETS-REMP Workshop in Orlando, FL
- C-14 dose assessment still accounts for the majority of gaseous dose, and is still subject to question and misunderstanding
- NRC has been receptive to application of growing-season daytime X/Q for C-14 dose assessment

Reason for Concern

- Atmospheric dispersion X/Q factors are typically calculated using long-term, 24-hr/year-round meteorology... Regulatory Guide 1.111, NUREG-0133, etc.
- The primary exposure pathways for Carbon-14 involve incorporation of C-14 dioxide into vegetation via photosynthesis
- Most photosynthesis occurs during daytime hours during the primary growing season
- Inclusion of off-season and nighttime meteorology may result in erroneous X/Q values used to calculate C-14 vegetation concentrations and resulting dose

Method of Analysis

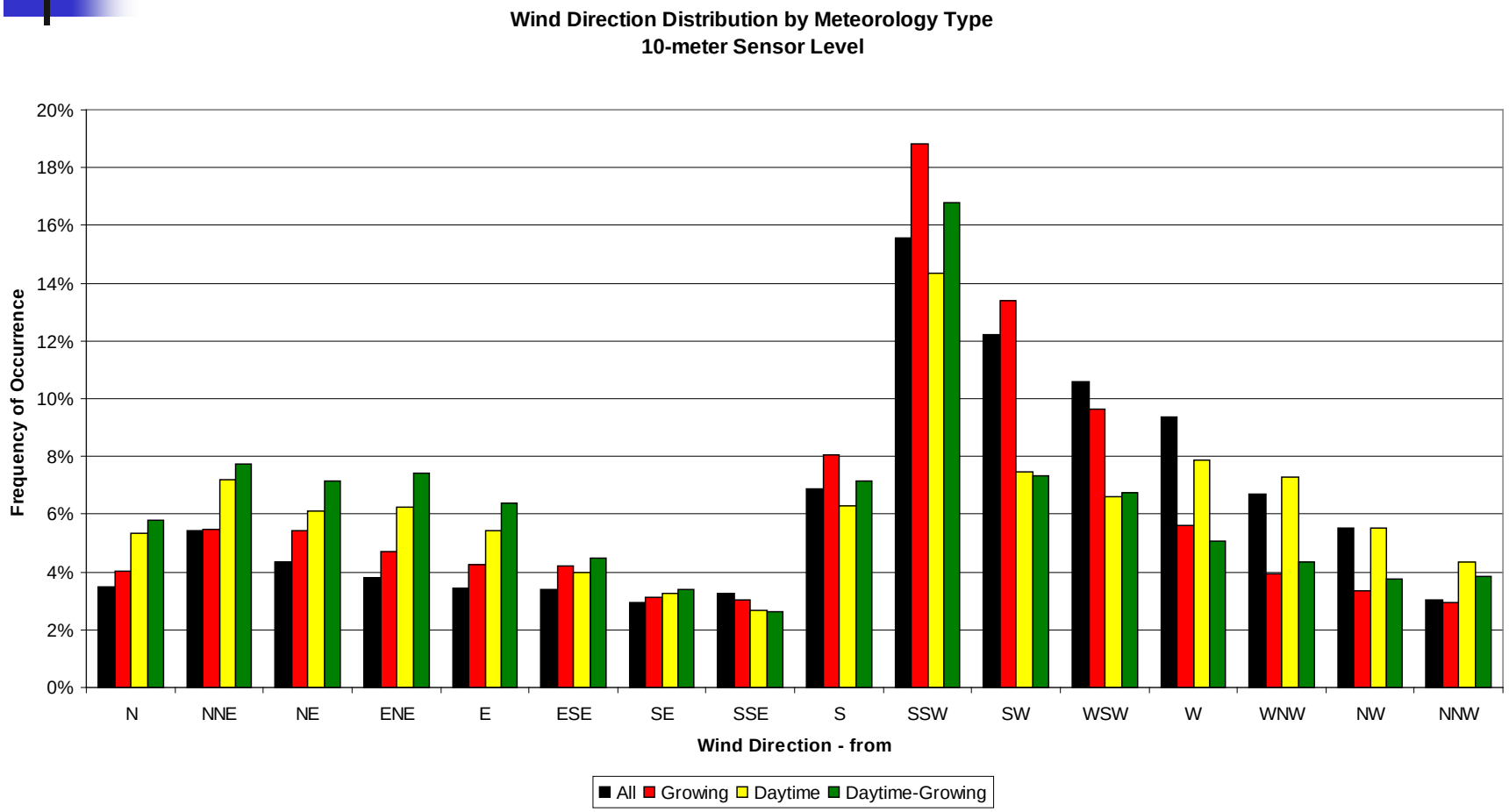
- Utilize XOQDOQ software package developed for NRC
- Utilize two-year data set (2010,2011) for analysis
- Calculate X/Q values using all data, growing-season data, daytime data, and daytime/growing-season datasets
- Apply terrain height corrections


Outer Tautog Rock
Rocky Point
Cleft Rock
White Horse Rocks
Priscilla Beach
White Horse Beach
Bartlett Pond
Manomet Point
Manomet Heights
Scokes Pond
Stage Point
Manomet
Manomet Hill
Pine Hills
Clifford Road Dam
Cold Bottom Pond Dam
Whipple Reservoir Dam
Manomet Bluffs
Warren Pond
Fishermans Landing
Fresh Pond Dam
Beaver Dam Pond Dam
Rabbit Pond
3A
3
250
Ocean Bluff
Brant Rock
Green Harbor
Plymouth
Manomet
Myles Standish State Forest
Sagamore Beach
Sagamore
East Wareham
Onset
Bourne
Sandwich
Telegraph Hill
Monument Beach
Pine Hill
6A
6
130

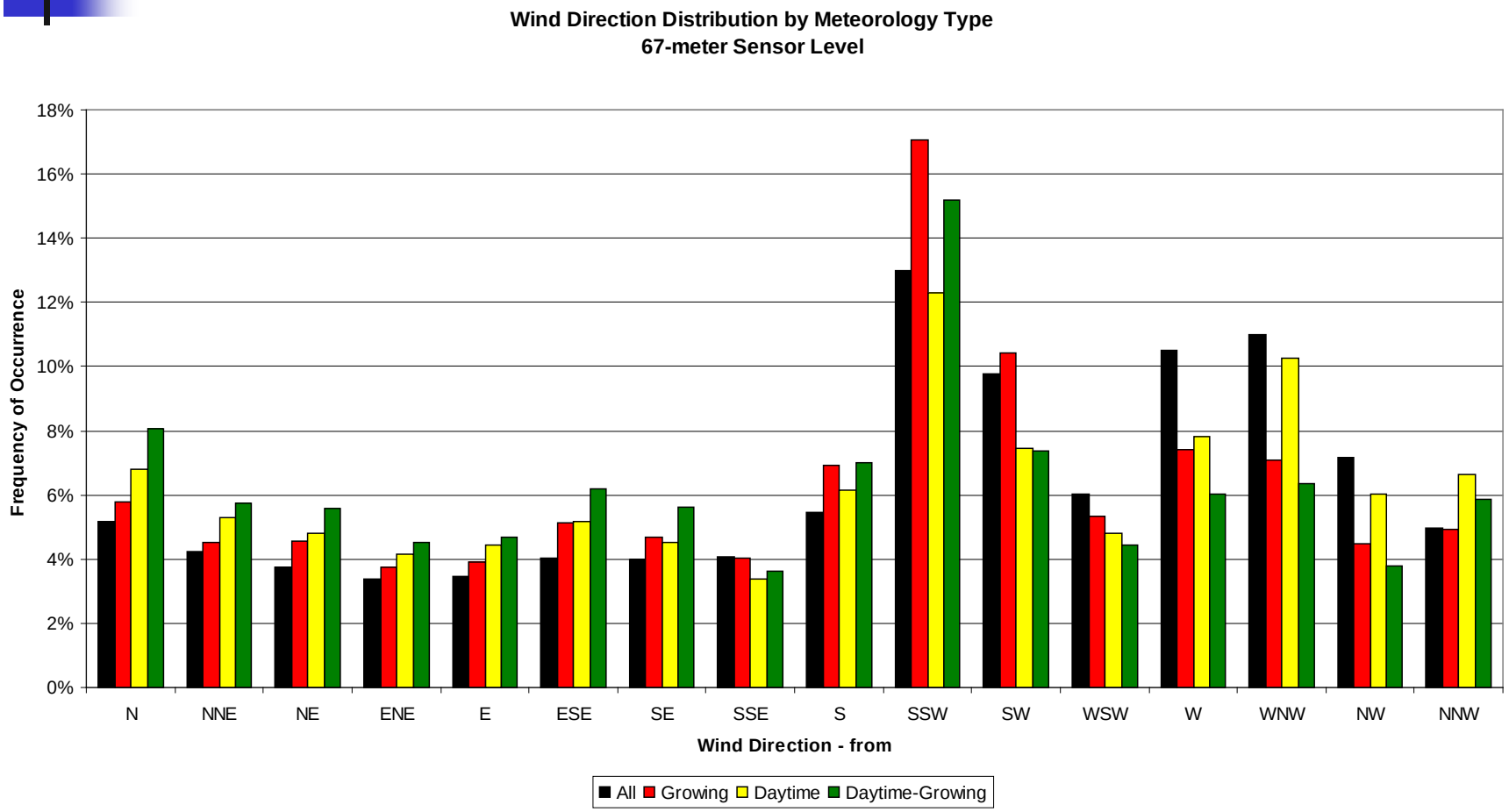
Meteorological Data Sets

- All dataset
  - 17,330 hourly-average records
- Growing-season dataset
  - Growing season assumed to be from 16-Apr through 15-Oct
  - 8,784 hourly-average records
- Daytime dataset
  - Daytime assumed to contain records from 1-hour after sunrise through 1-hour before sunset; facilitate solar warming
  - 8,806 hourly-average records
- Daytime/growing-season dataset
  - Daytime dataset trimmed to 16-Apr through 15-Oct
  - 4,416 hourly-average records

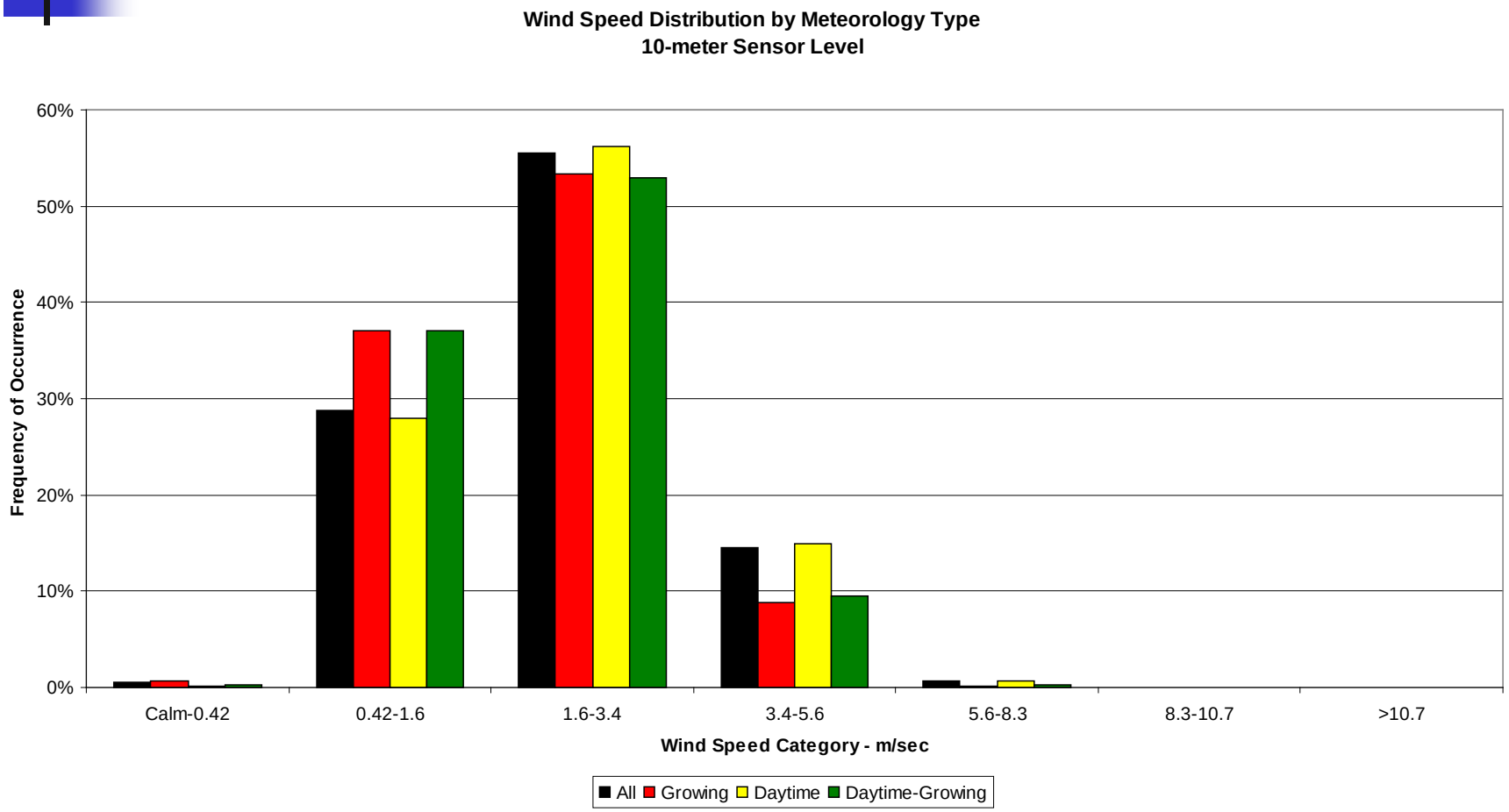
Difference in Meteorology: Wind Direction, 10-meter elevation



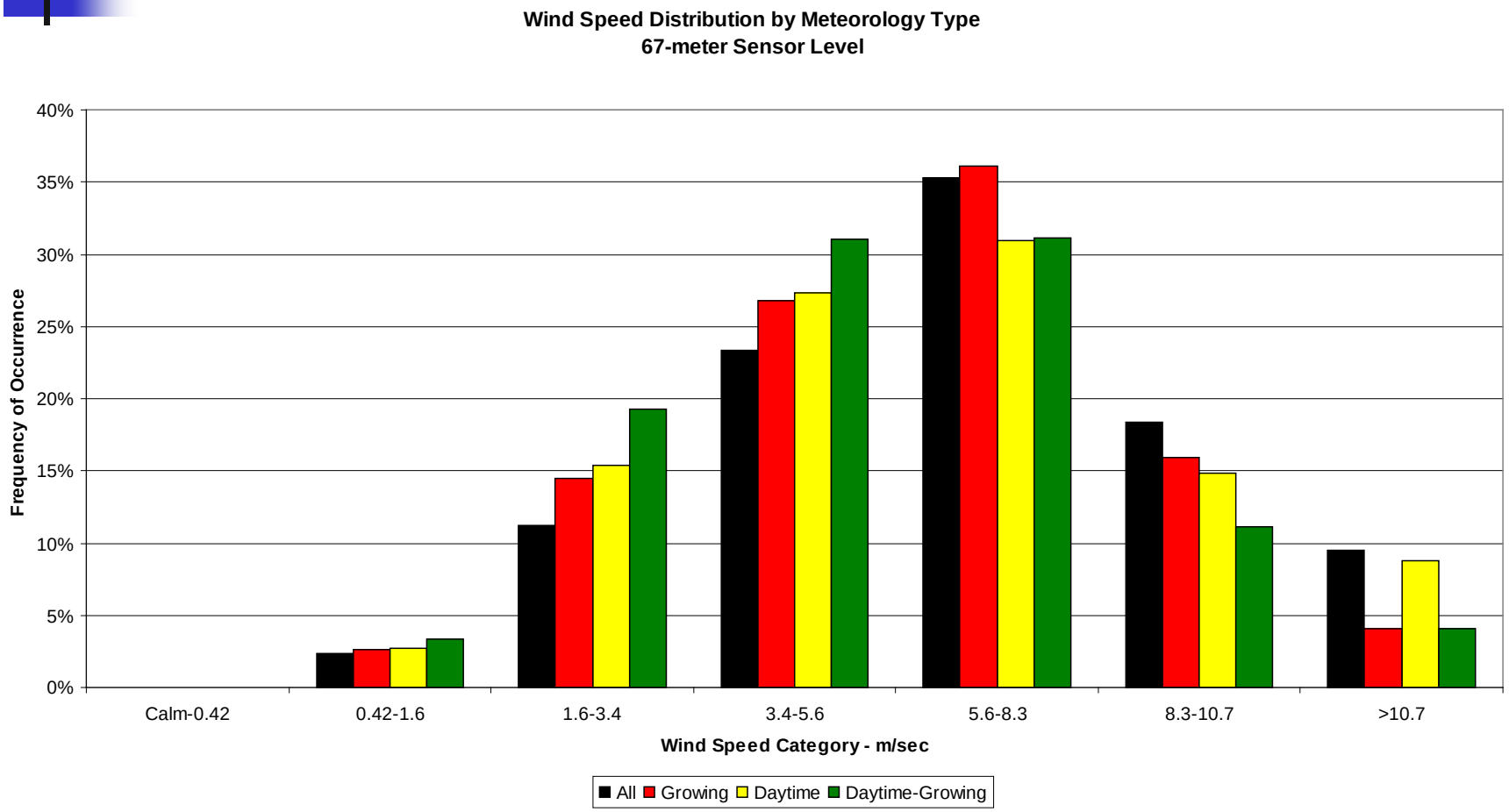
Difference in Meteorology: Wind Direction, 67-meter elevation



Difference in Meteorology: Wind Speed, 10-meter elevation

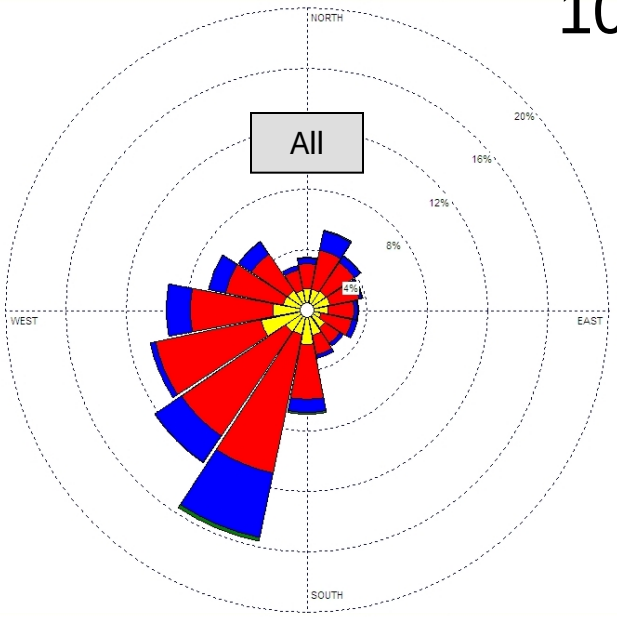


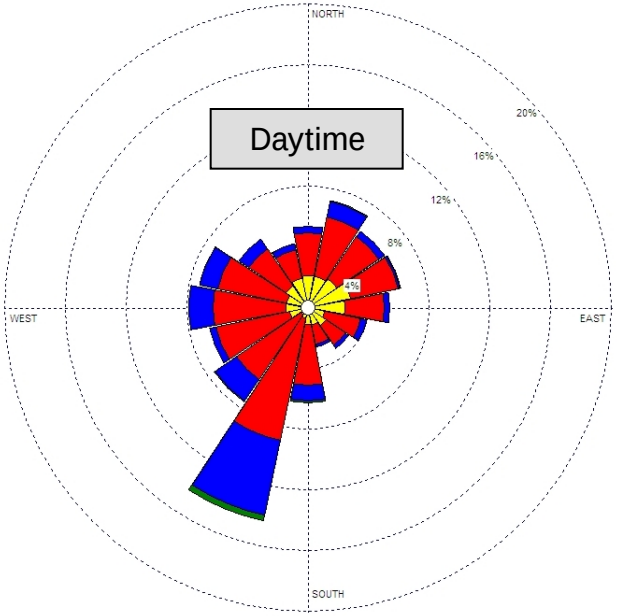
Difference in Meteorology: Wind Speed, 67-meter elevation

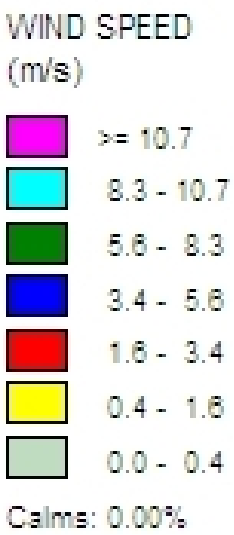


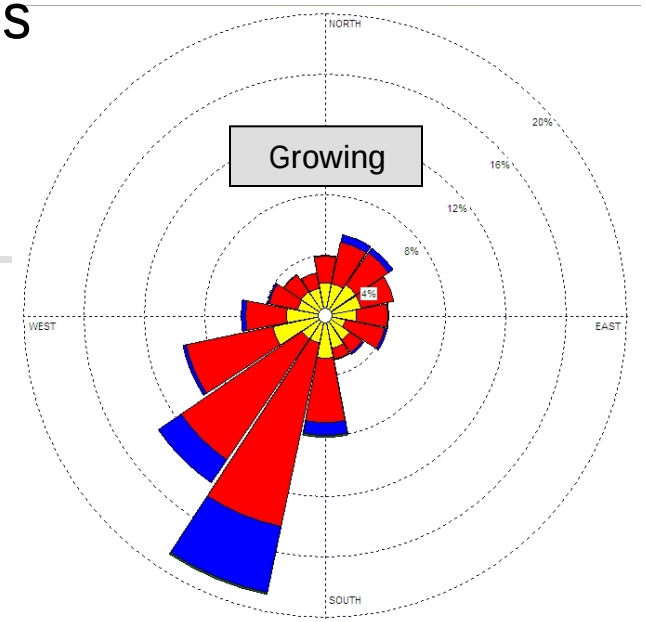
10-m Wind Roses

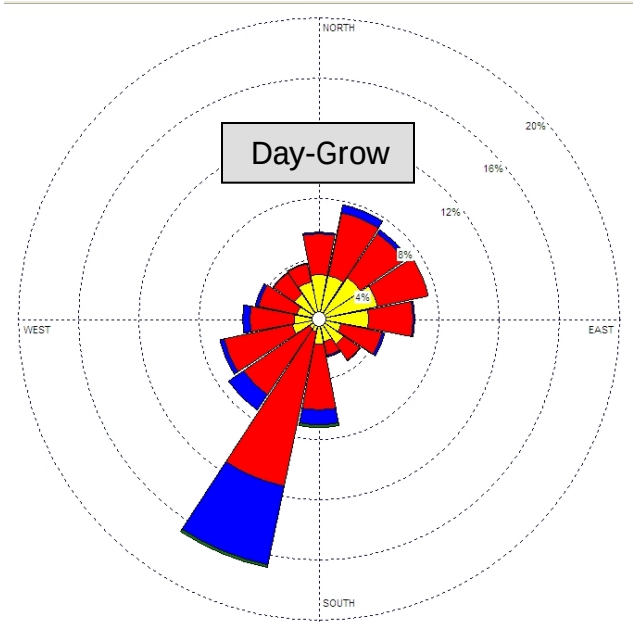
Direction from





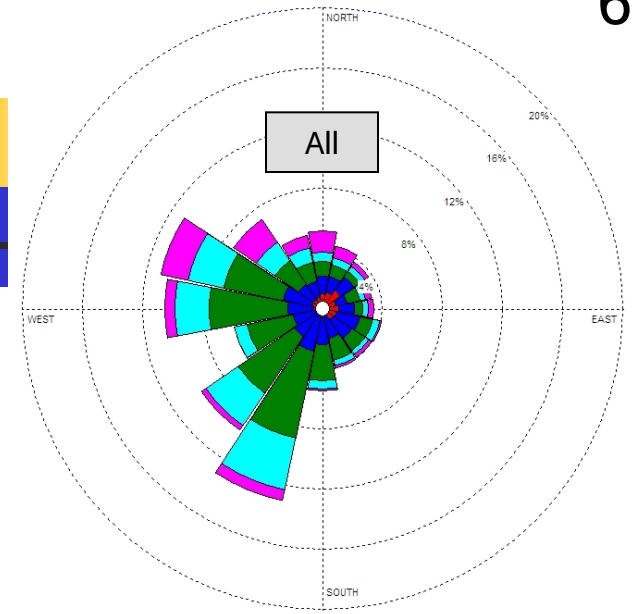


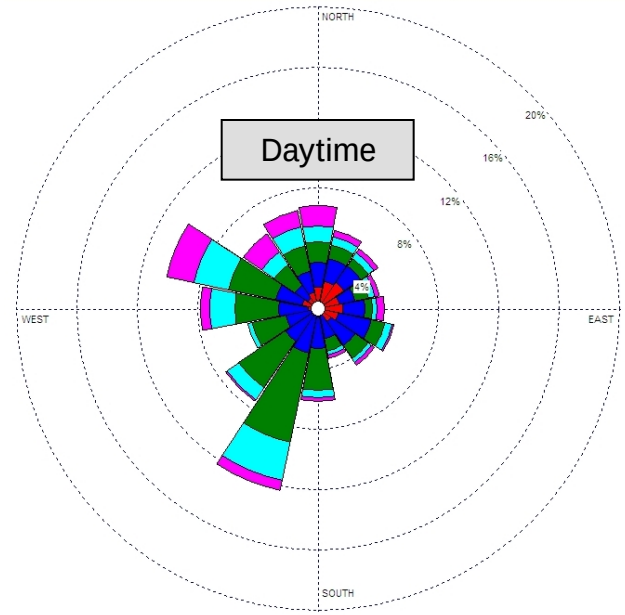


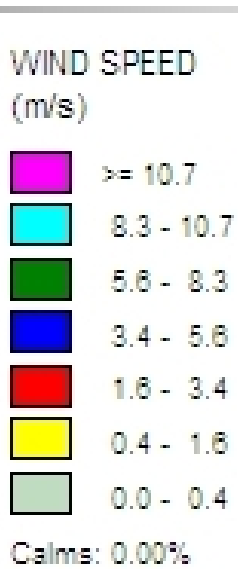


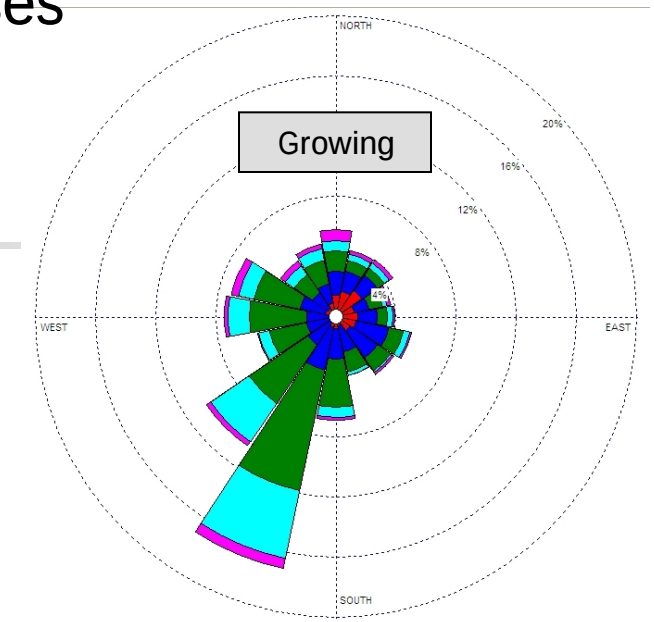
67-m Wind Roses

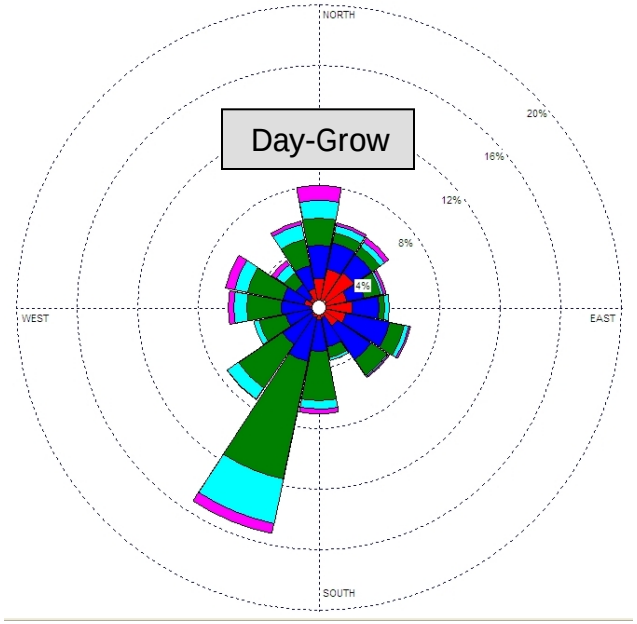
Direction from



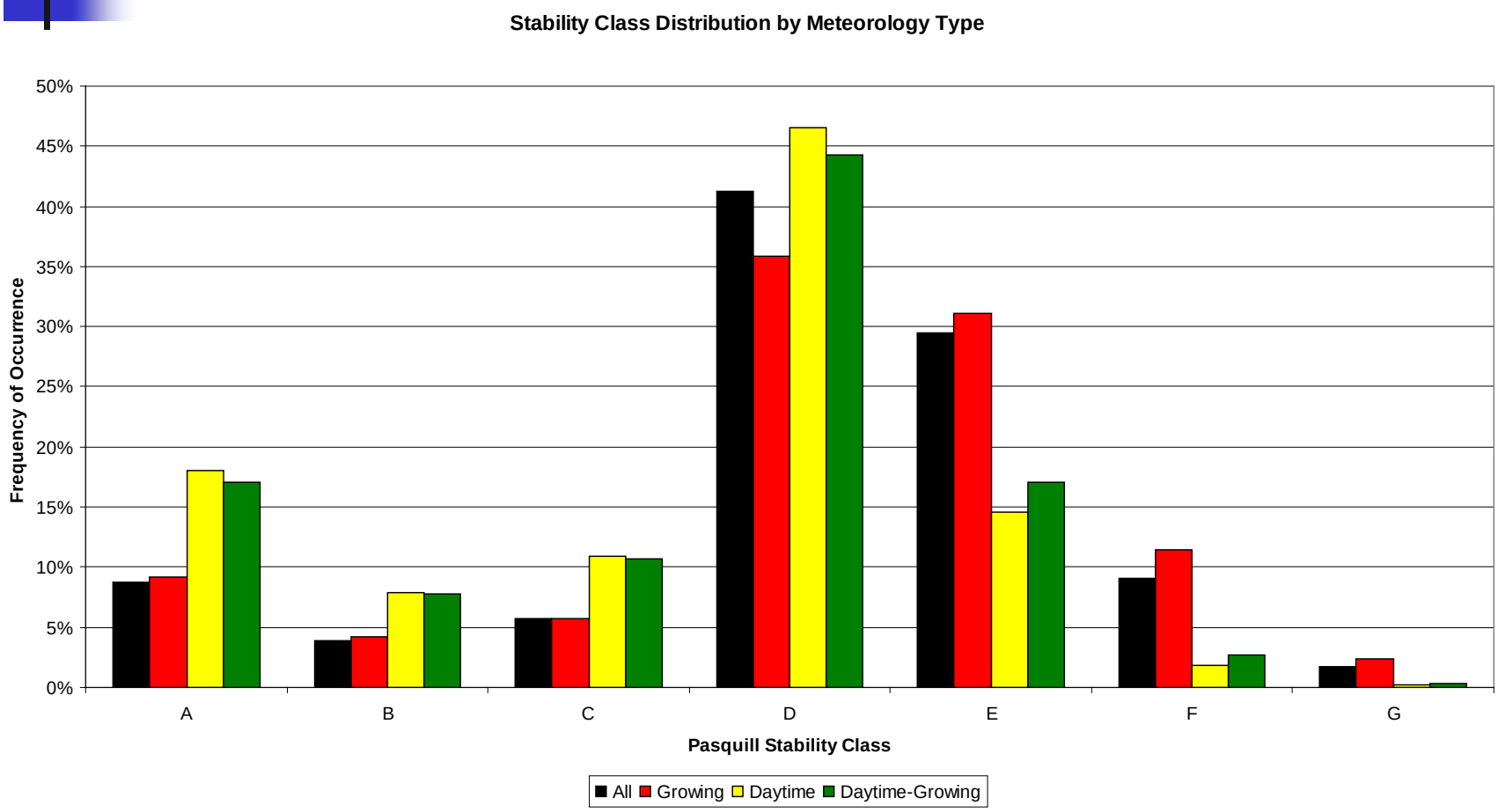




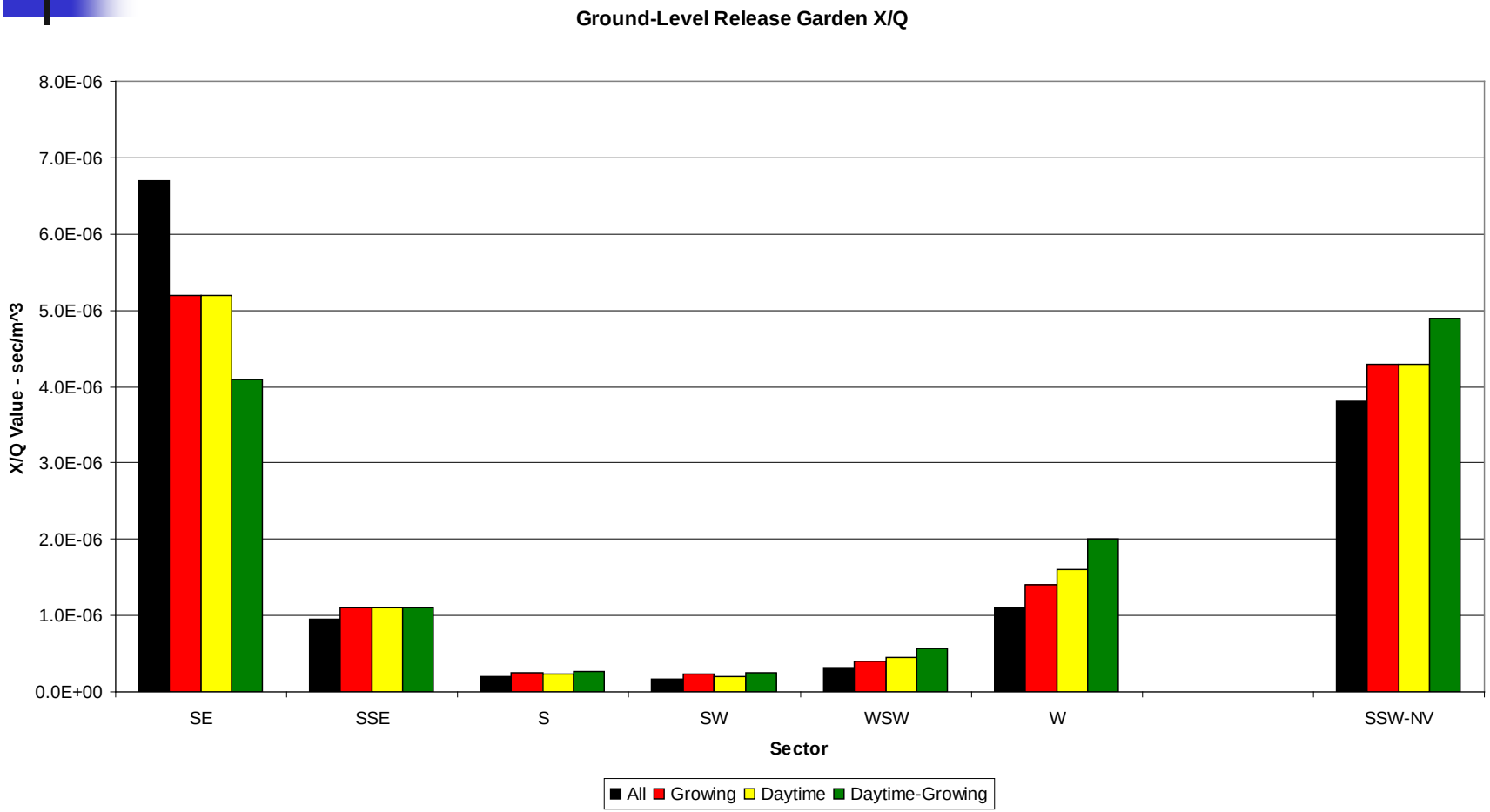




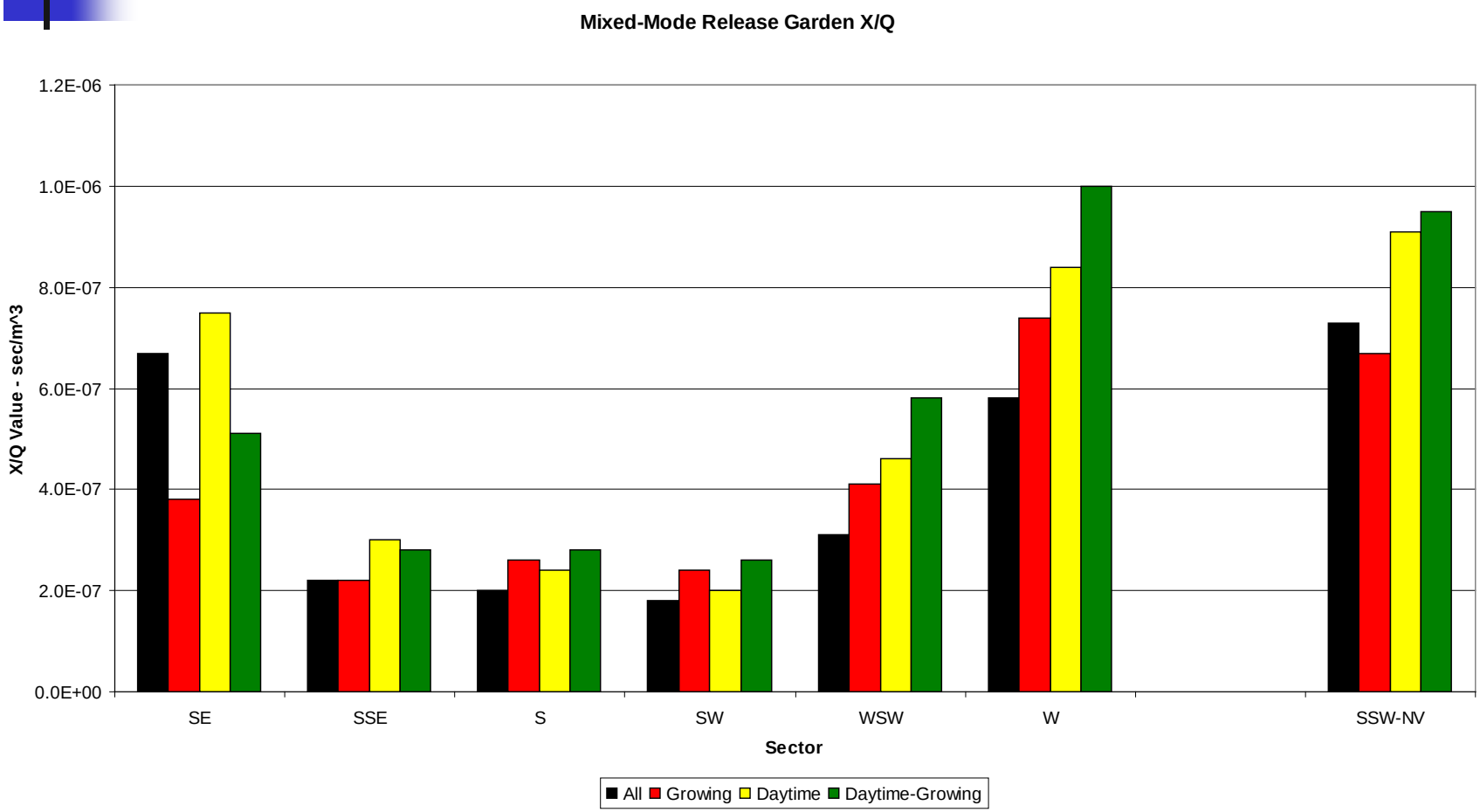
Difference in Meteorology: Pasquill Stability Class



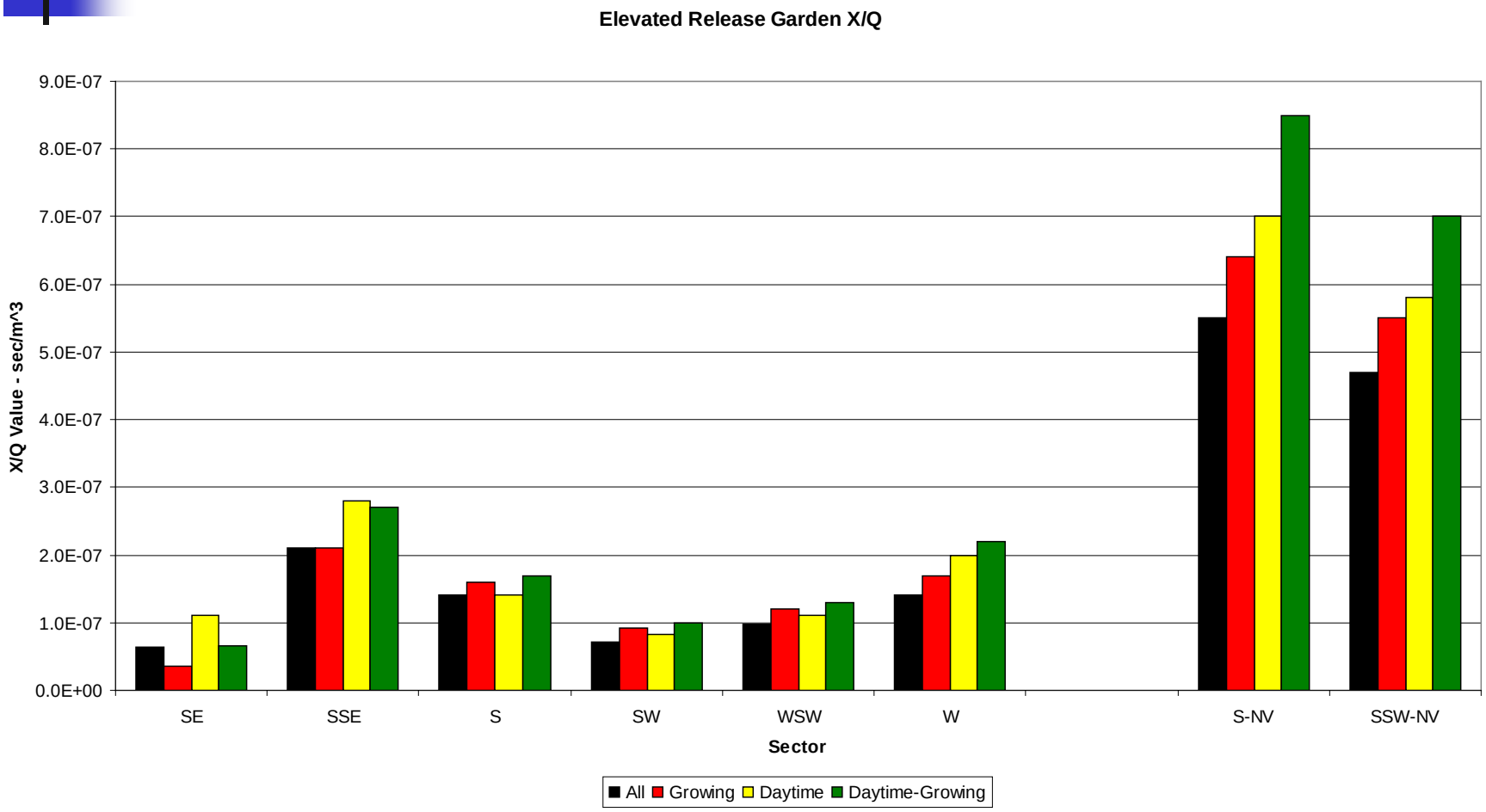
Impact on Dispersion Factor: Ground-level Release – Garden X/Q



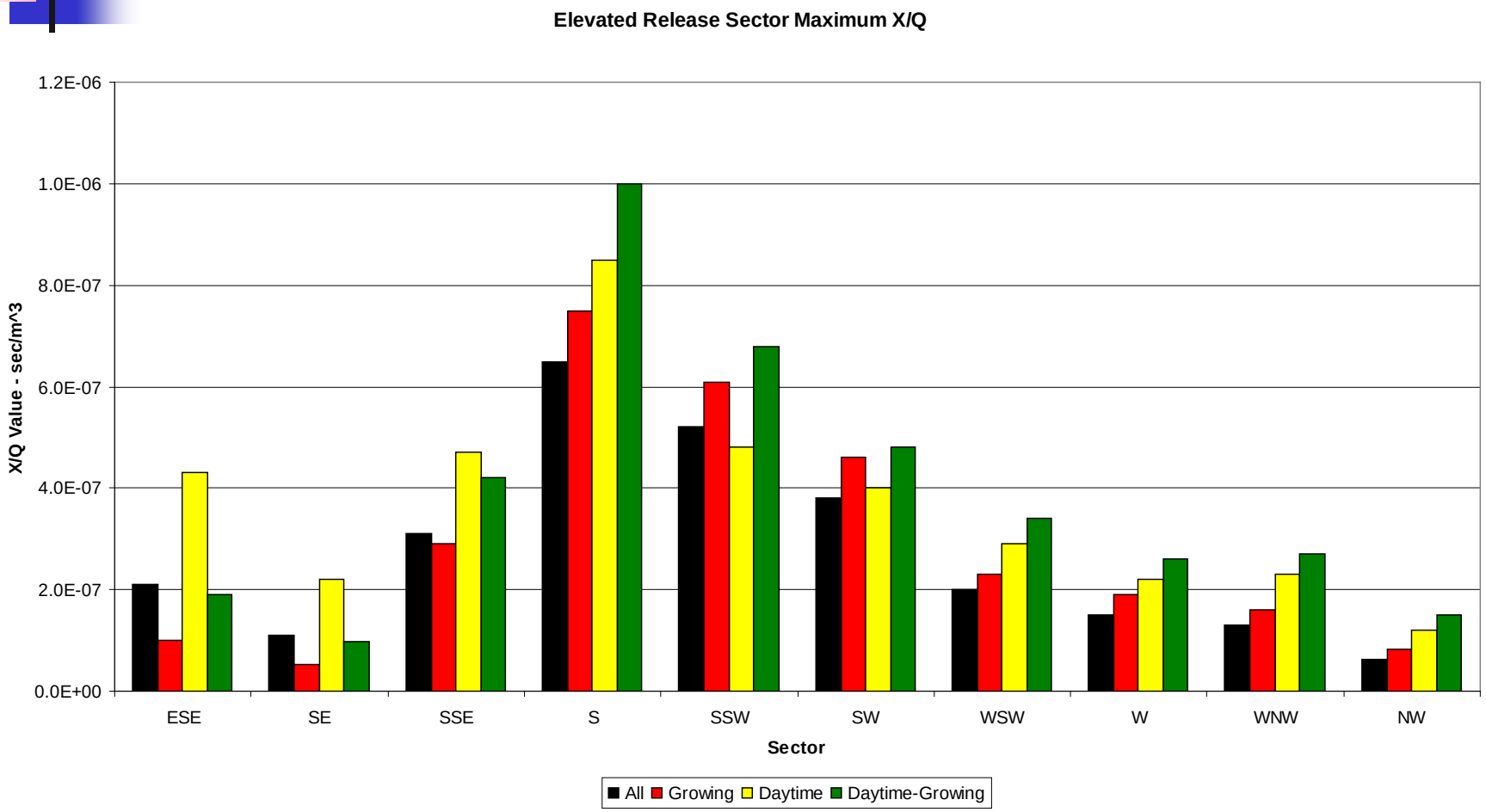
Impact on Dispersion Factor: Mixed-Mode Release – Garden X/Q



Impact on Dispersion Factor: Elevated Release – Garden X/Q



Impact on Dispersion Factor: Elevated Release – Sector Maximum X/Q



Summary

- Use of daytime/growing-season meteorology results in changes in parameters affecting atmospheric dispersion; complex interplay of parameters
  - Slight shifts in frequencies of onshore vs. offshore direction
  - Increase in frequency of lower-speed winds, resulting in less dispersion
  - Shift in frequency of Pasquill stability class to more unstable classes, resulting in greater dispersion

Summary (continued)

- No “one size fits all” approach... have to evaluate X/Q influence on a site-by-site basis
- Daytime effects only applicable to C-14 due to daytime photosynthesis; would not affect particulate activity deposited on vegetation
- Seasonal affects may have some limited impact on particulate activity deposition

Conclusion

- Differences in daytime and seasonal meteorology can result in significant changes (increase or decrease) in X/Q factors used to estimate C-14 concentrations in vegetation... possible significant impact on dose

Questions?