Monitoring Update RMNP Agriculture Subcommittee

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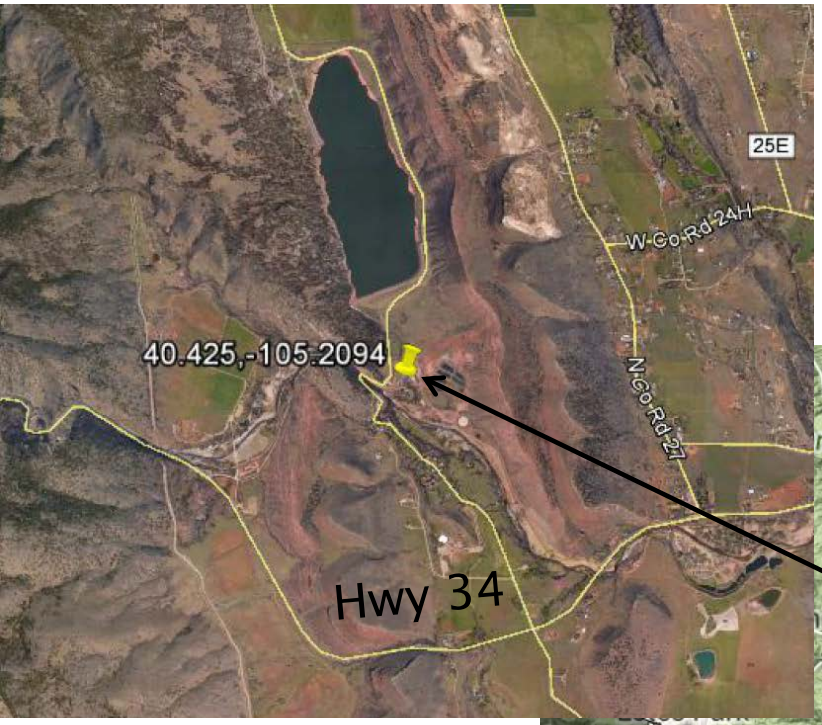
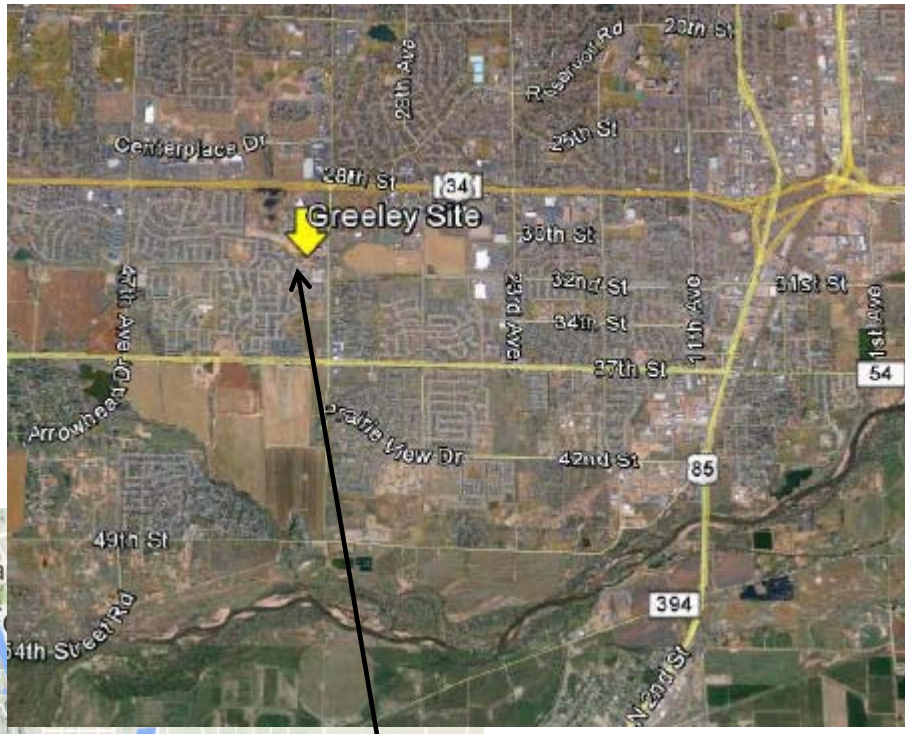
Included data are preliminary and subject to further quality assurance review

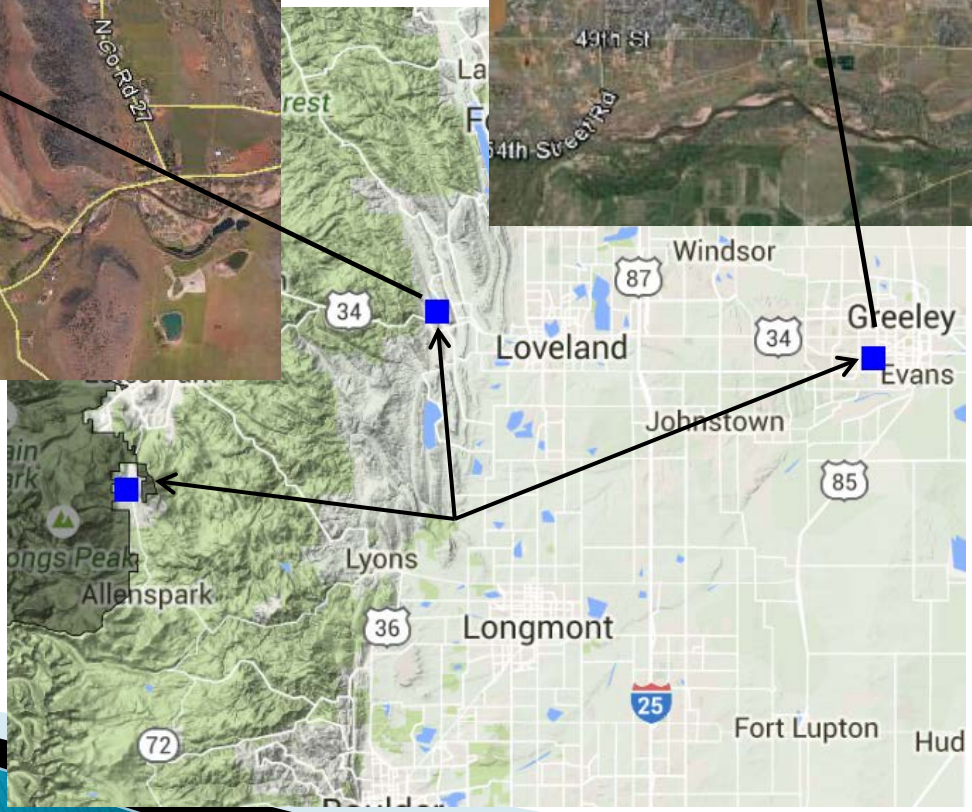
Monitoring activities

- Monitoring focus: mid-March to mid-October
  - upslope transport common
- RMNP
  - Continuous NH_3
  - Daily gas and particle phase oxidized and reduced N
  - 3x/week wet dep of oxidized, reduced, and organic N
- Greeley (began summer 2014)
  - Continuous NH_3
- West Loveland (began summer 2015)
  - Continuous NH_3
- NE Colorado (several years of summer data)
  - Passive NH_3 monitoring network

Continuous NH_3 Monitoring







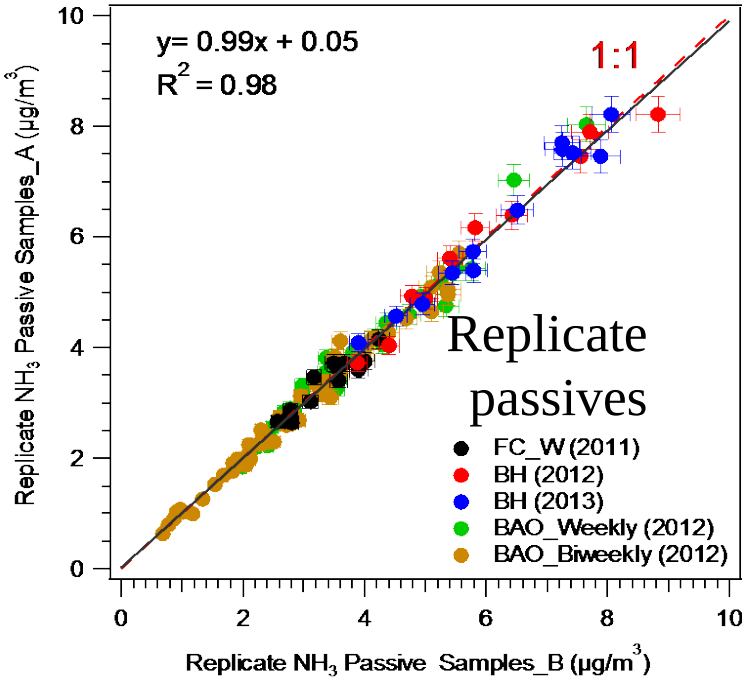
Greeley Site Photos

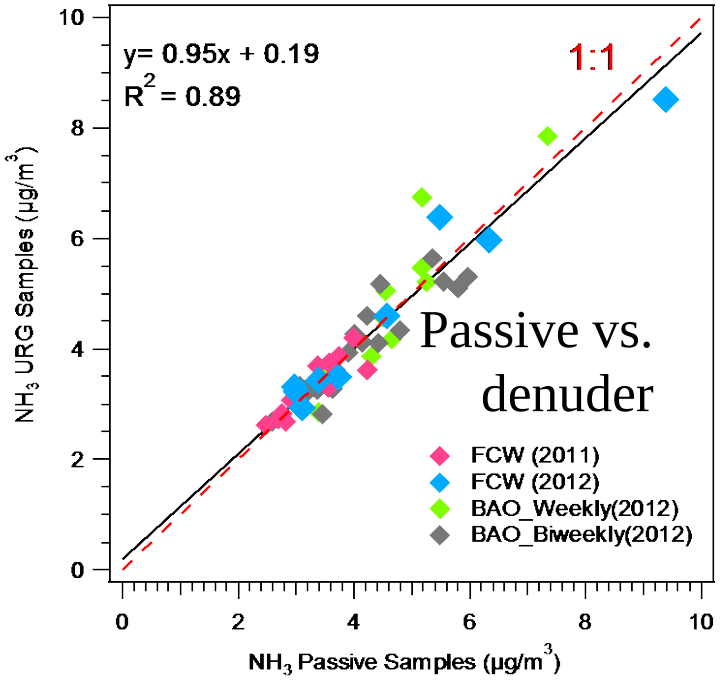
Loveland Site Photos

Radiello passive NH_3 samplers

- Inexpensive
- Greater spatial coverage
- ~1-2 week time resolution
- Excellent precision and accuracy

Briggsdale Site

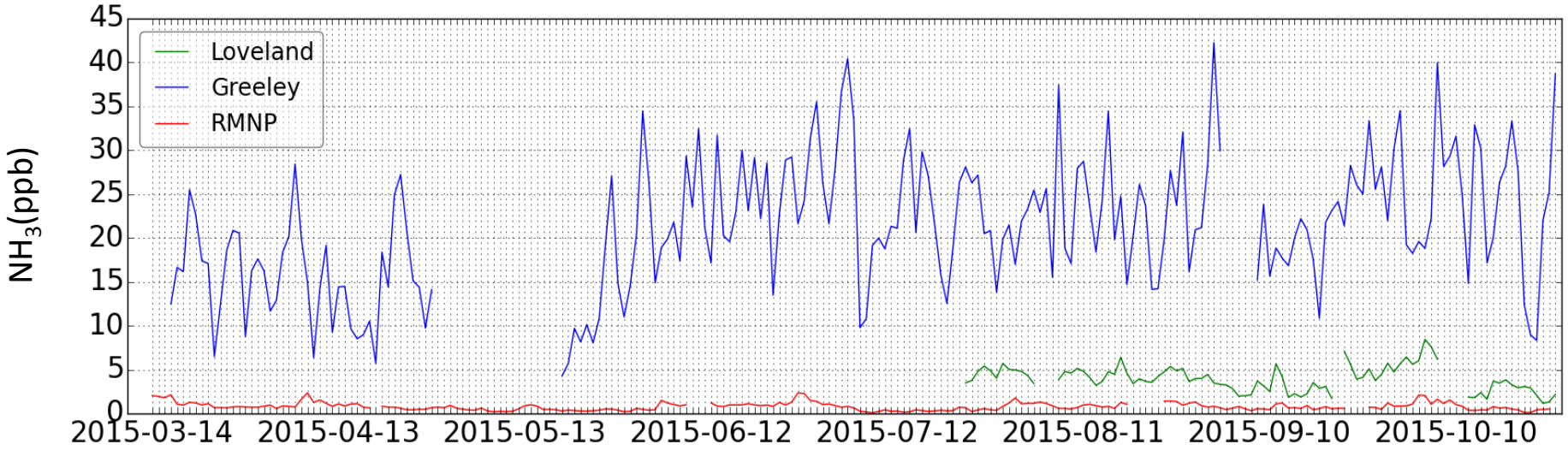




How can we use monitoring obs?

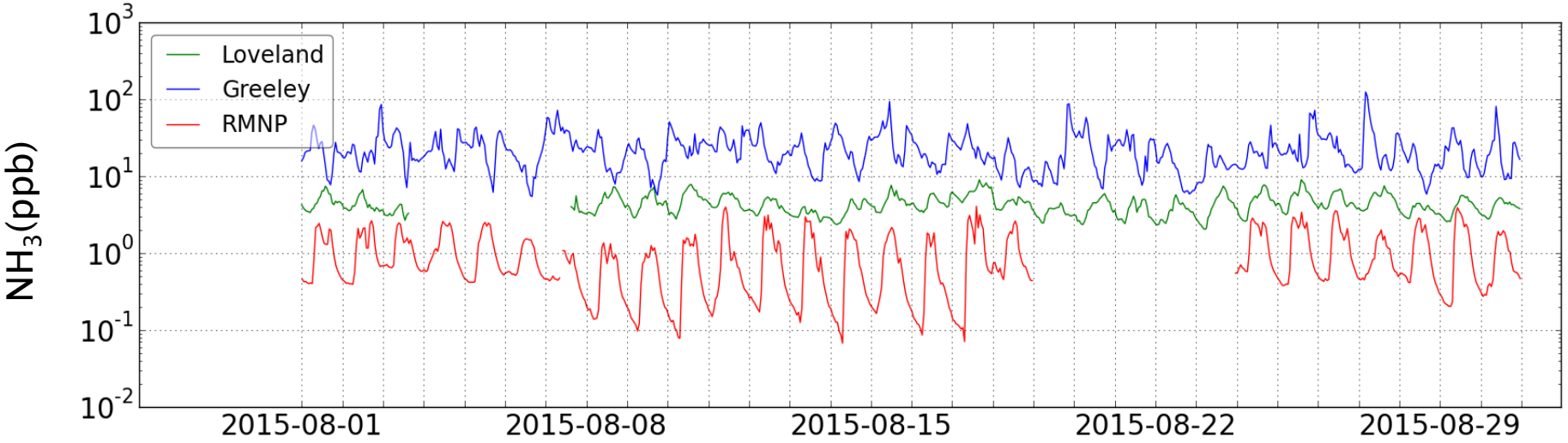
- Examine how concentrations & gradients change with wind direction?
  - Track westward transport of NH_3 during upslope
- Refine evaluation of early warning system transport predictions
  - Previous evaluations used weekly NADP wet deposition to evaluate EWS prediction accuracy
  - We can now evaluate using
    - 3x/week wet dep
    - Hourly NH_3
    - Daily oxidized and reduced gas and particle phase N
- Examine long-term trends in NE Colorado NH_3
- Help validate satellite observations and model predictions

2015 Daily NH_3 timelines



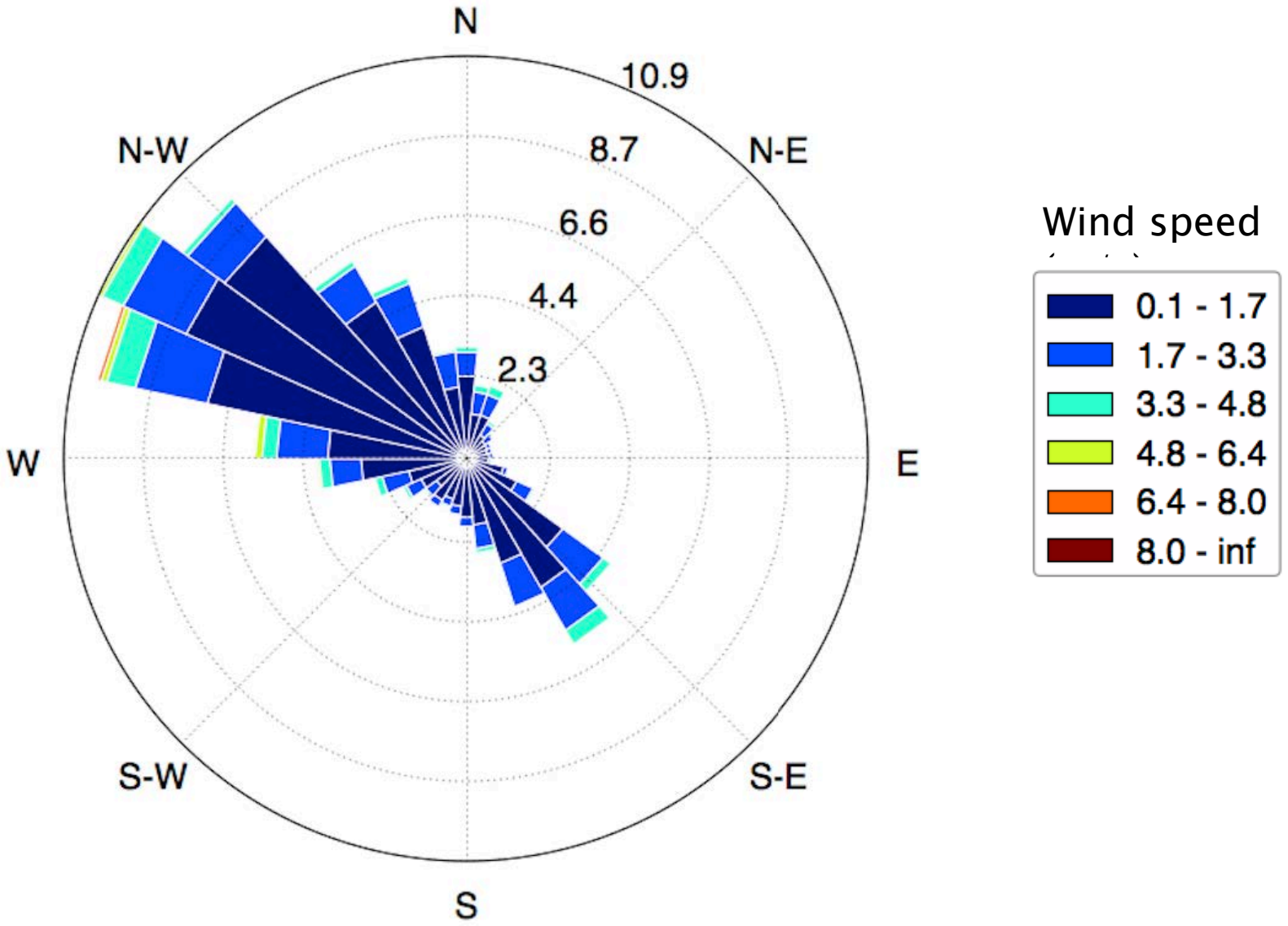
- Strong east → west NH_3 gradient

2015 Hourly NH_3 timelines

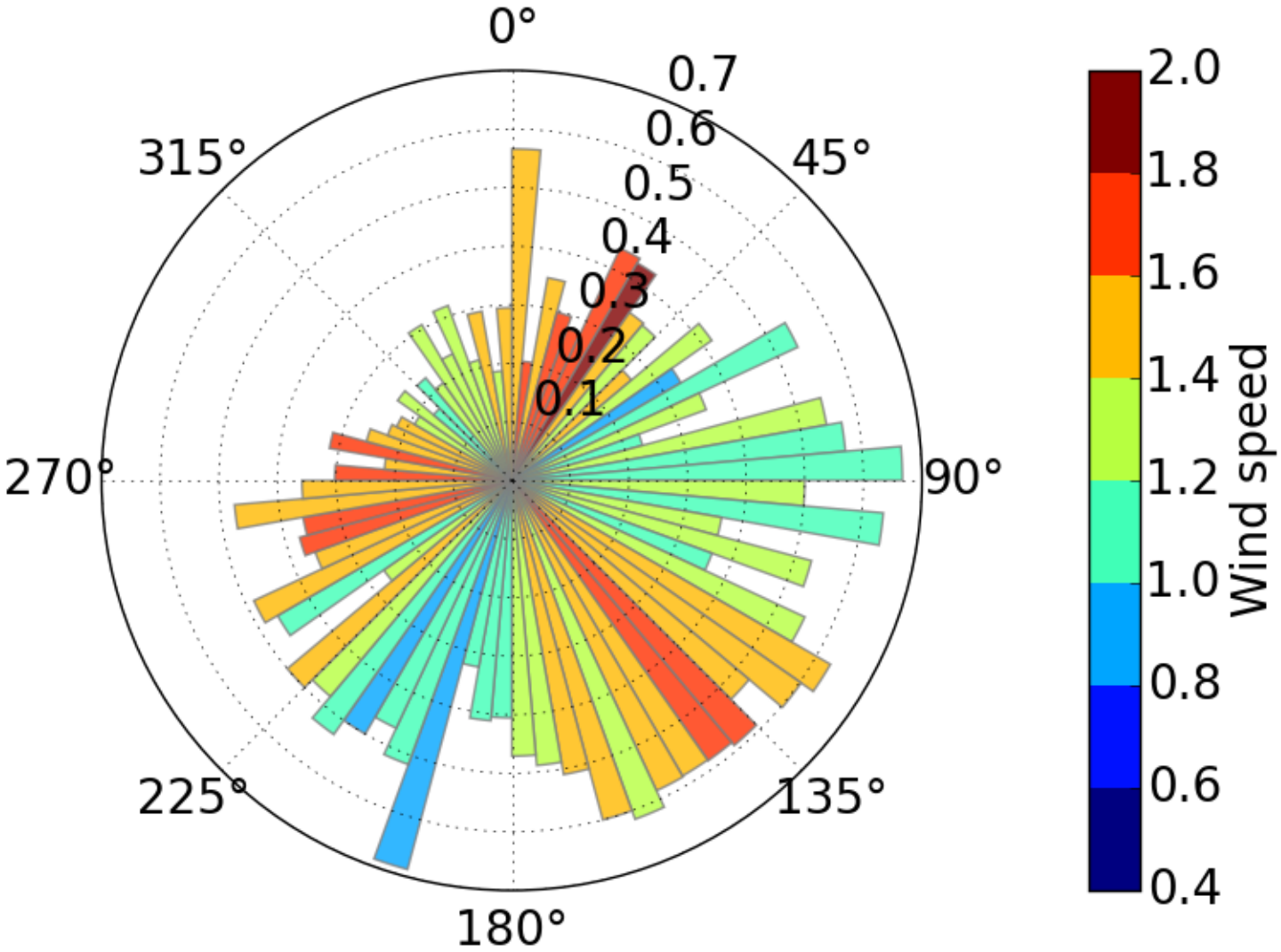


- Diurnal variability at all 3 sites
- Note logarithmic scale

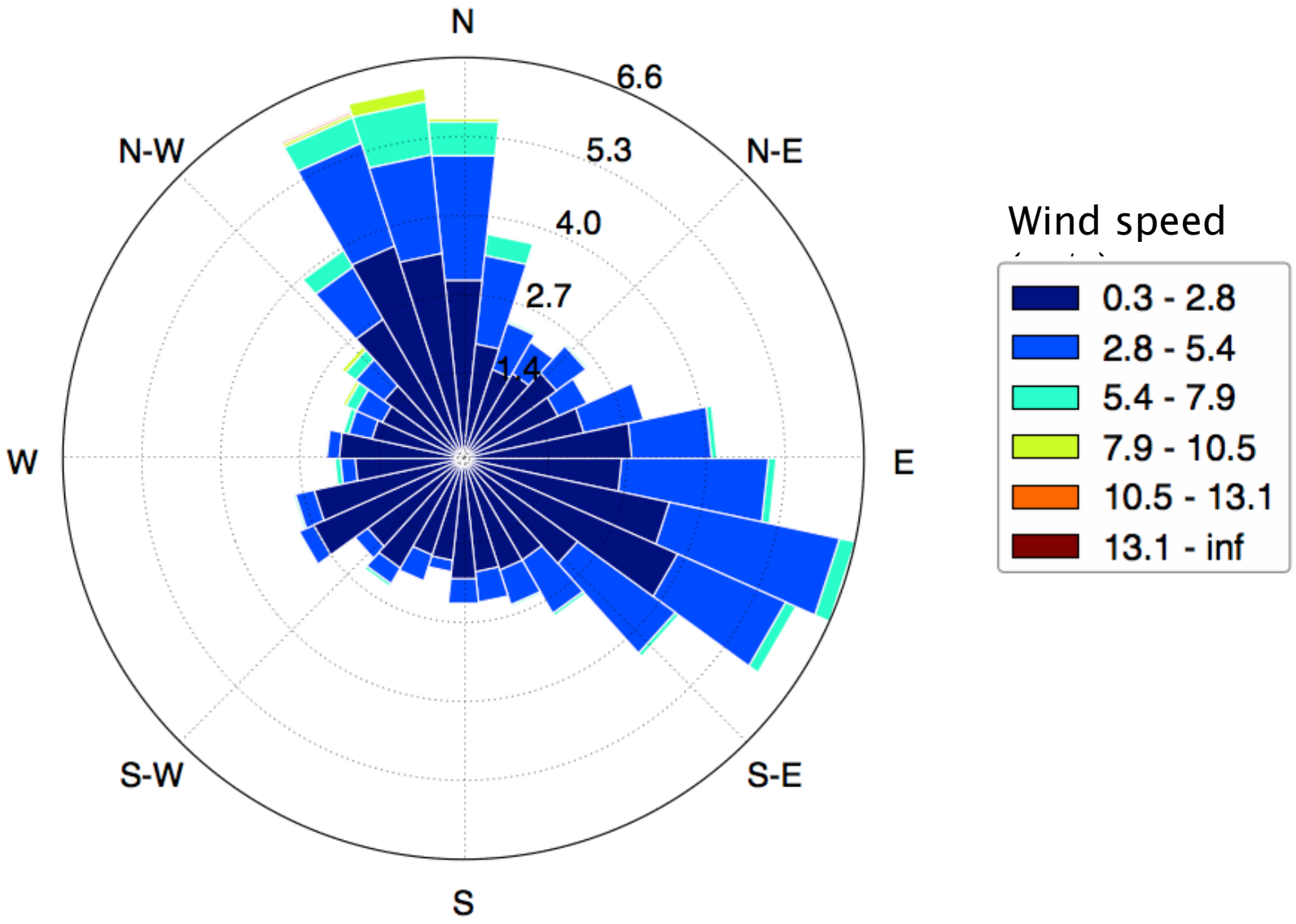
RMNP Windrose



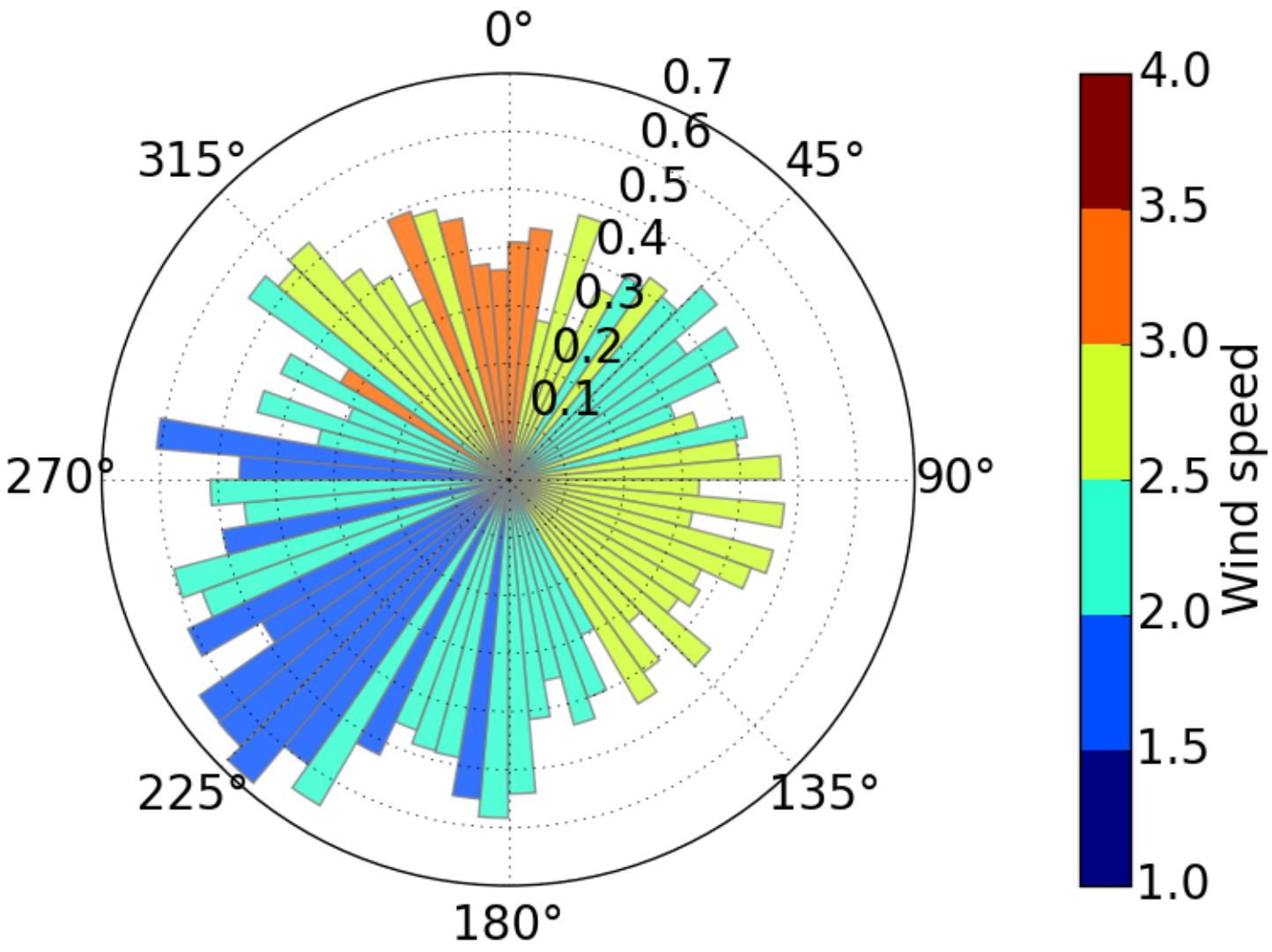
RMNP 95% CPF


0°
45°
90°
135°
180°
225°
270°
315°
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Wind speed
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4

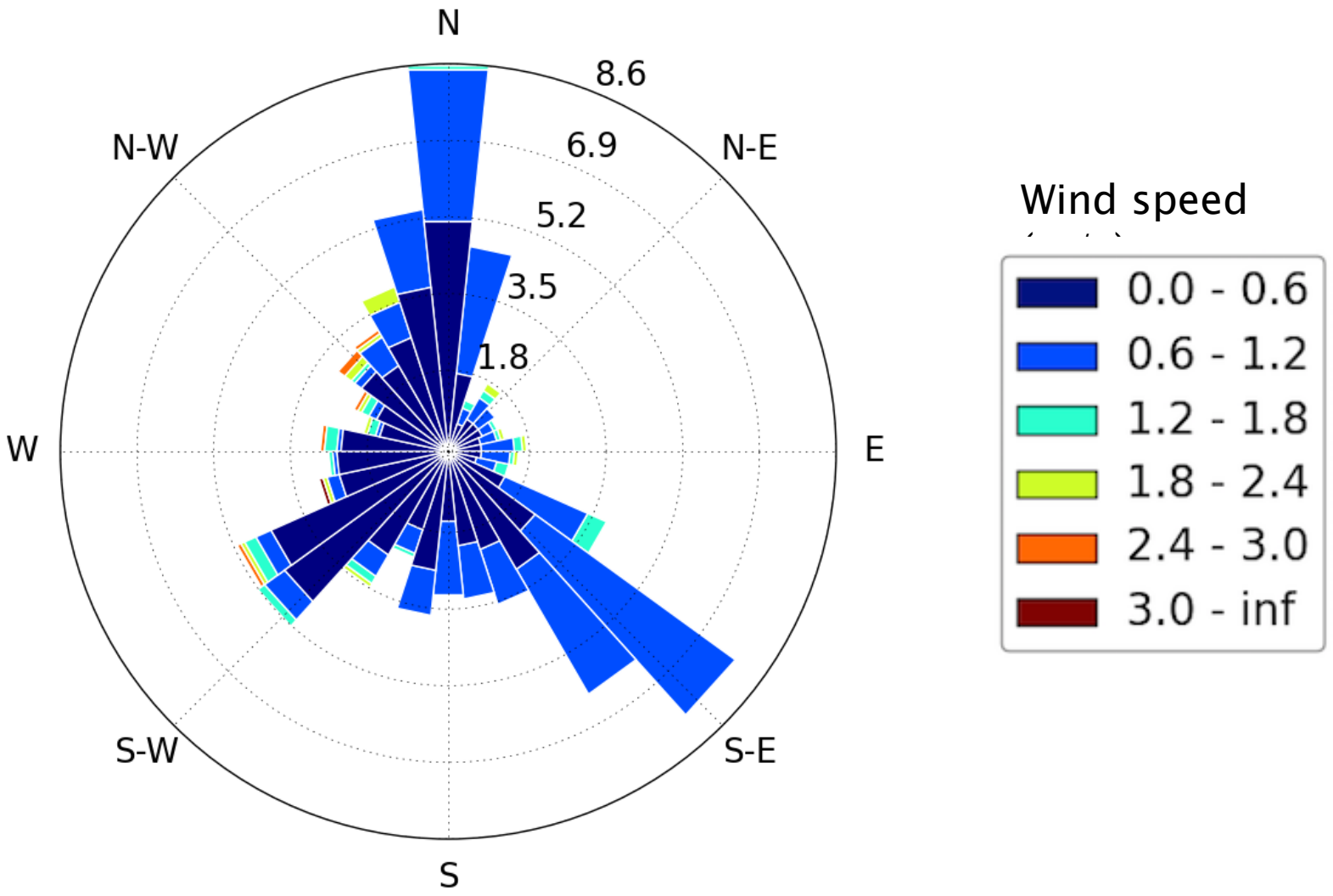
Greeley Windrose



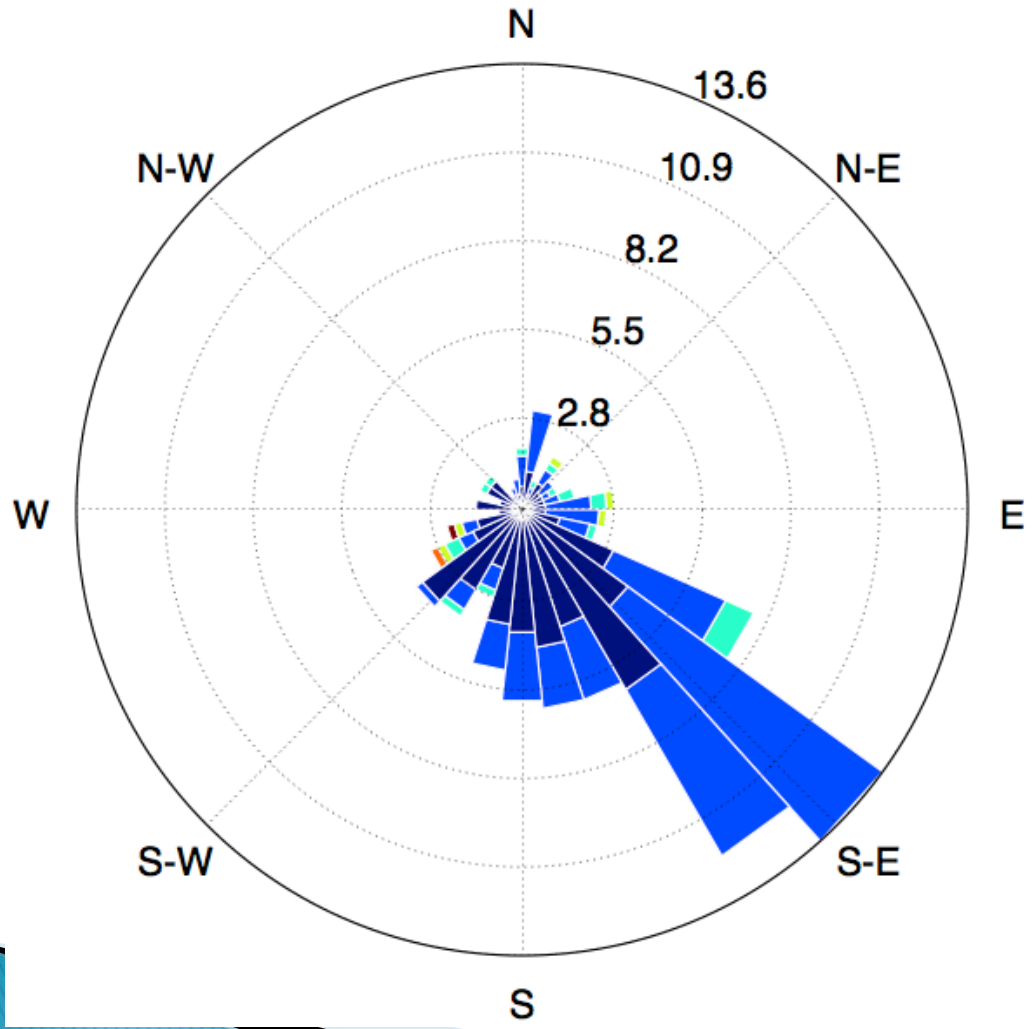
Greeley 95% CPF



Loveland Windrose



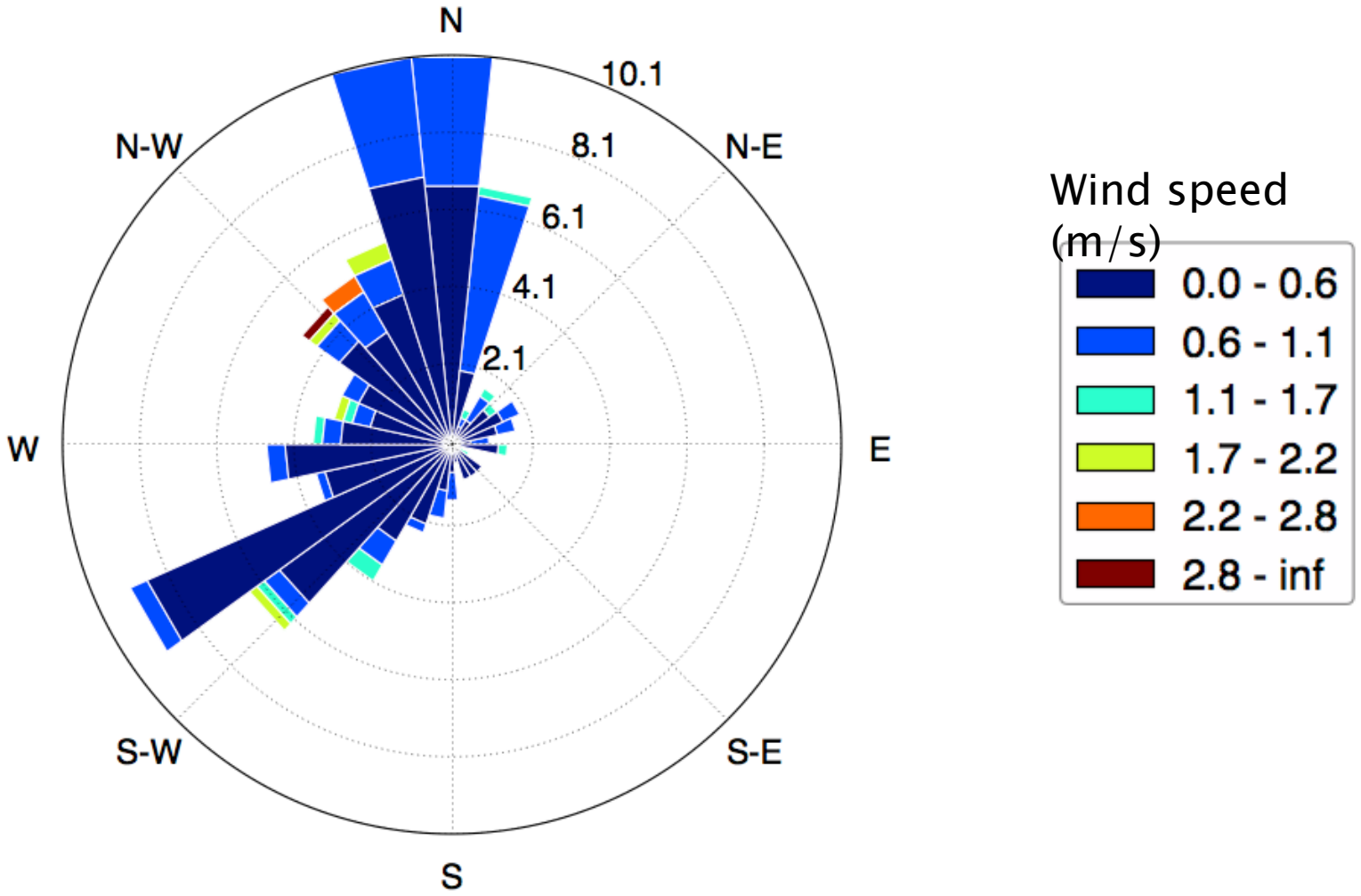
Loveland Windrose ---- daytime



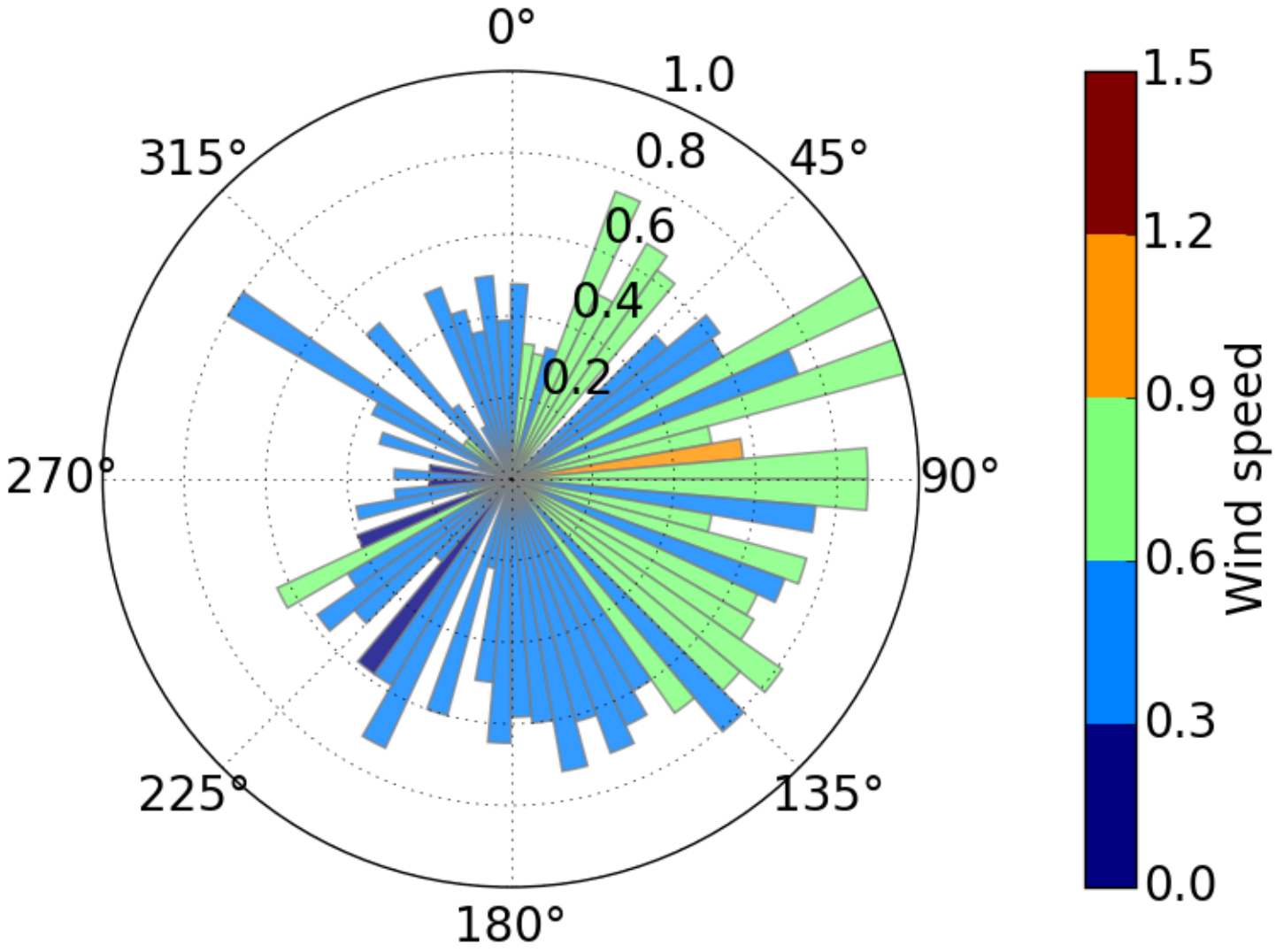
Wind speed (m/s)

- 0.0 - 0.6
- 0.6 - 1.2
- 1.2 - 1.8
- 1.8 - 2.4
- 2.4 - 3.0
- 3.0 - inf

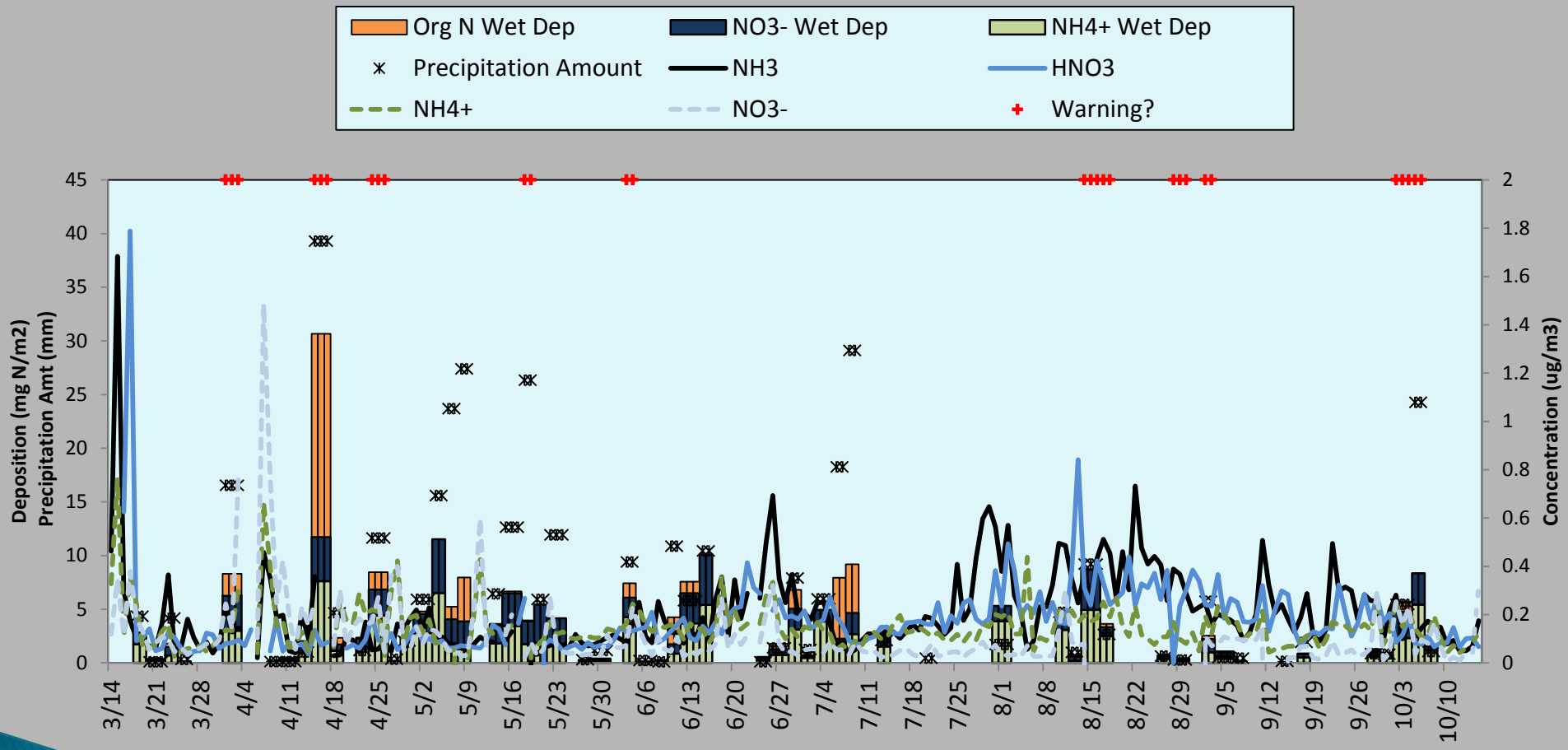
Loveland Windrose ---- night time



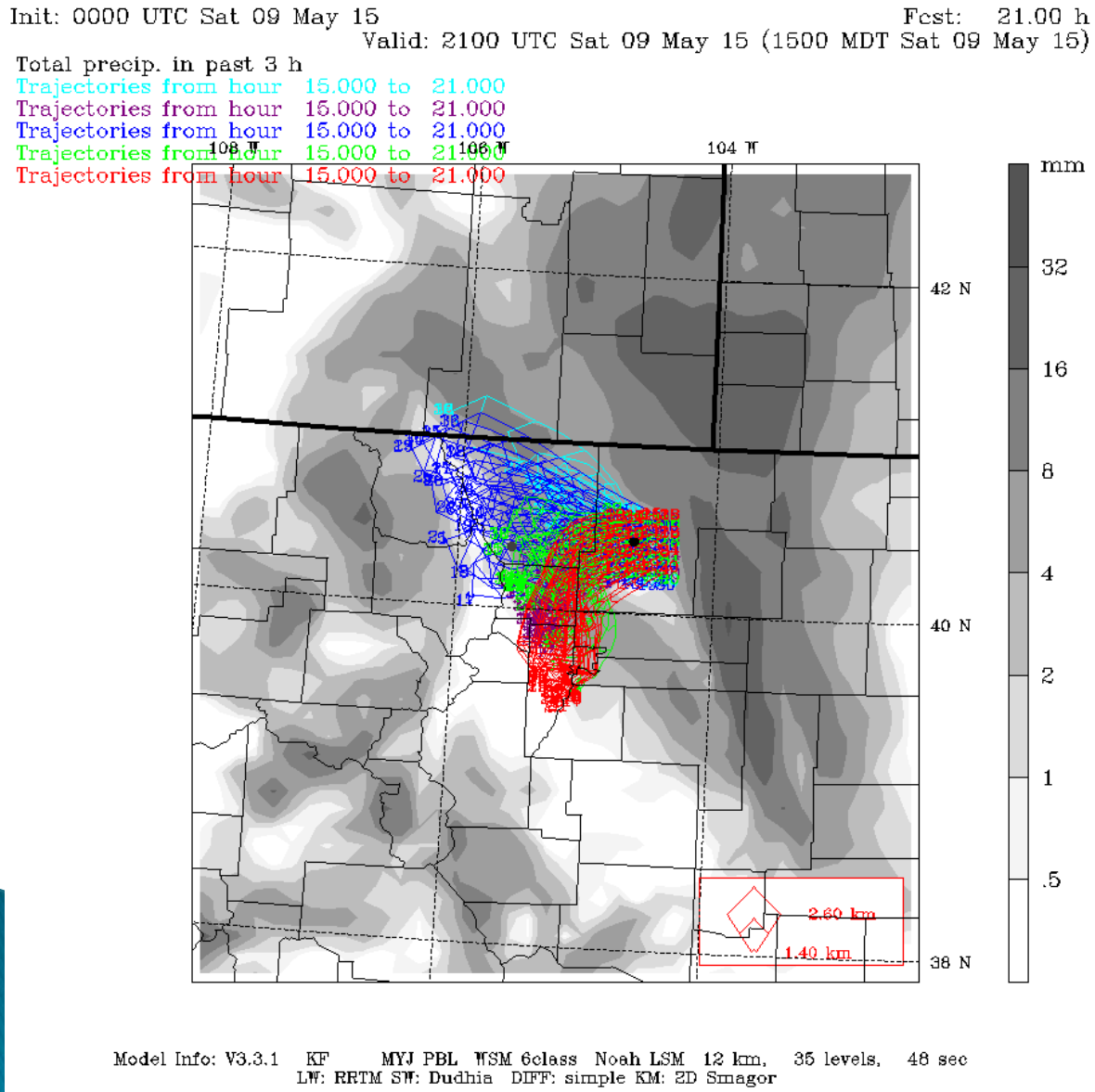
Loveland 95% CPF



RMNP Wet Deposition and daily oxidized and reduced N

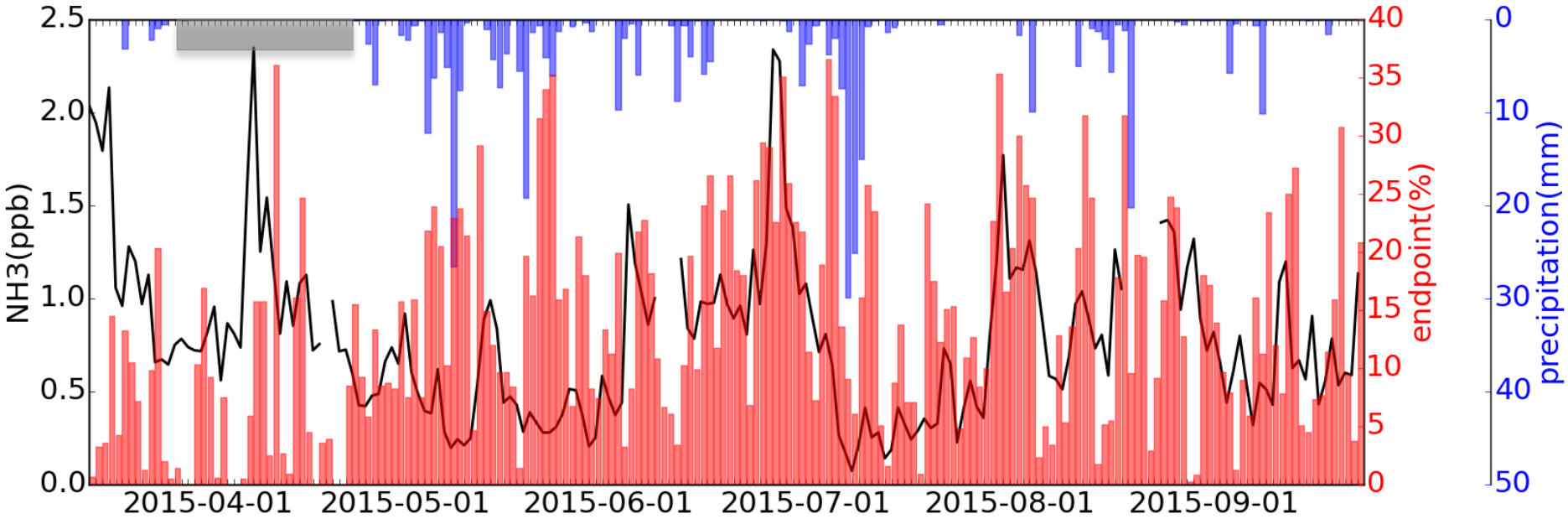


Greeley Trajectory example

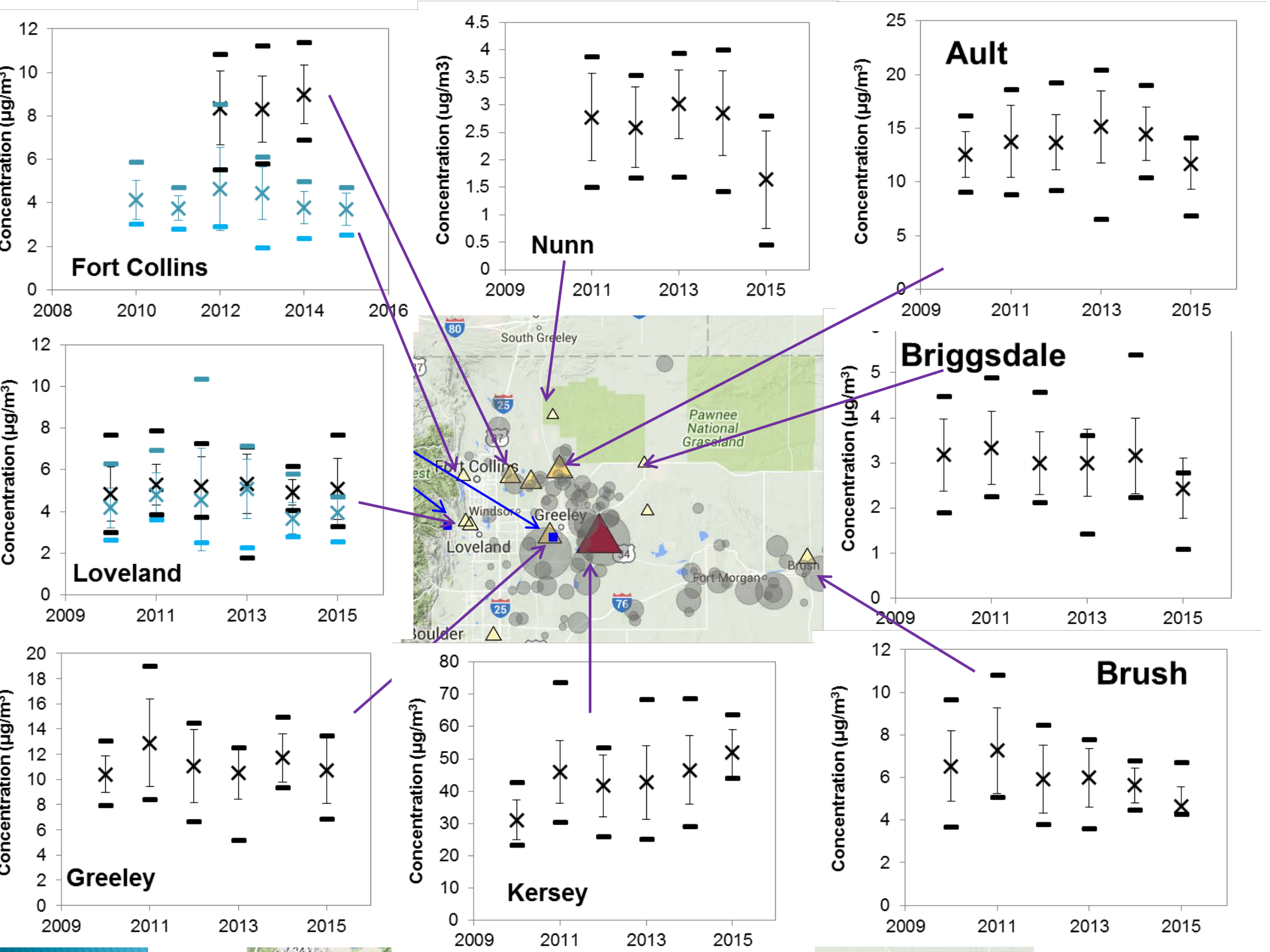


- Trajectories are released from Greeley every 3 hours (06z, 09z, 12z…)
- Trajectories reach endpoints after 6 hours being released

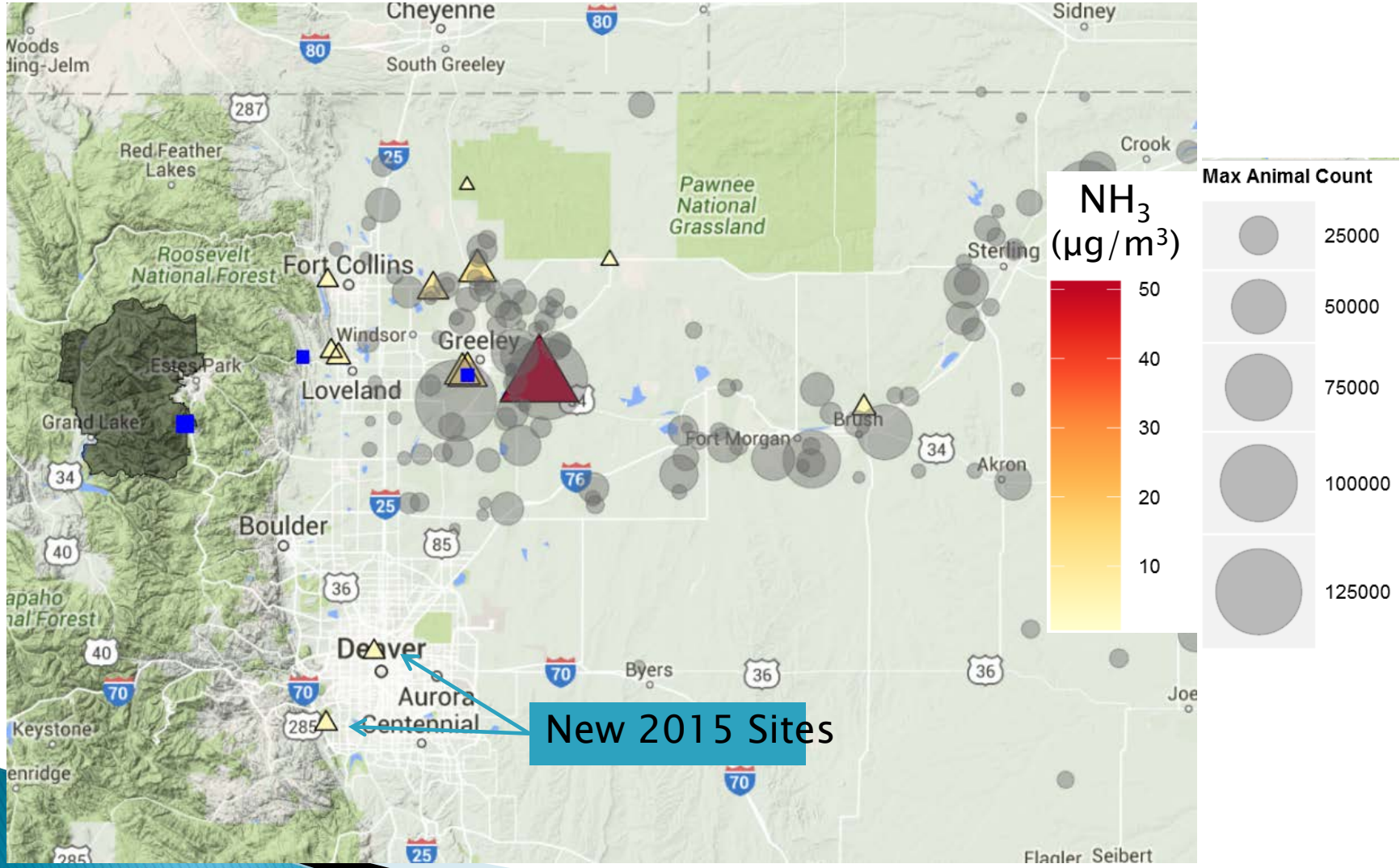
Endpoints% / daily Picarro NH3 / precipitation



- Percentage of endpoints that fall into a 2°×2° box centered in 105.5453° W, 40.2778° N
- Daily Precipitation from CASTNET (two weeks of data is missing marked in grey)
- Daily averaged ammonia concentration

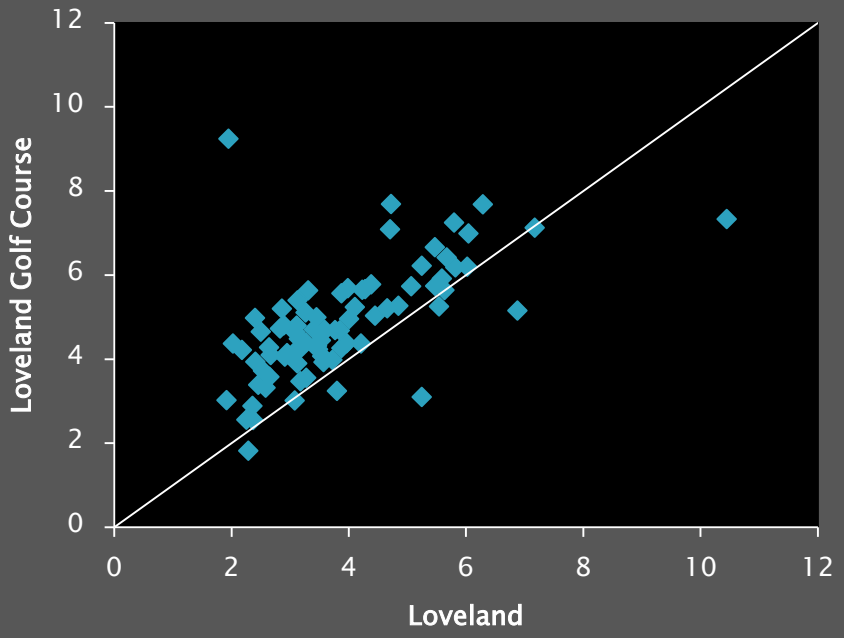

Fort Collins
Concentration (µg/m³)
Nunn
Concentration (ug/m3)
Ault
Concentration (µg/m³)
Loveland
Concentration (µg/m³)
Briggsdale
Concentration (µg/m³)
Greeley
Concentration (µg/m³)
Kersey
Concentration (µg/m³)
Brush
Concentration (µg/m³)
South Greeley
Pawnee National Grassland
Fort Collins
Windsor
Greeley
Loveland
Brush
Fort Morgan
Boulder

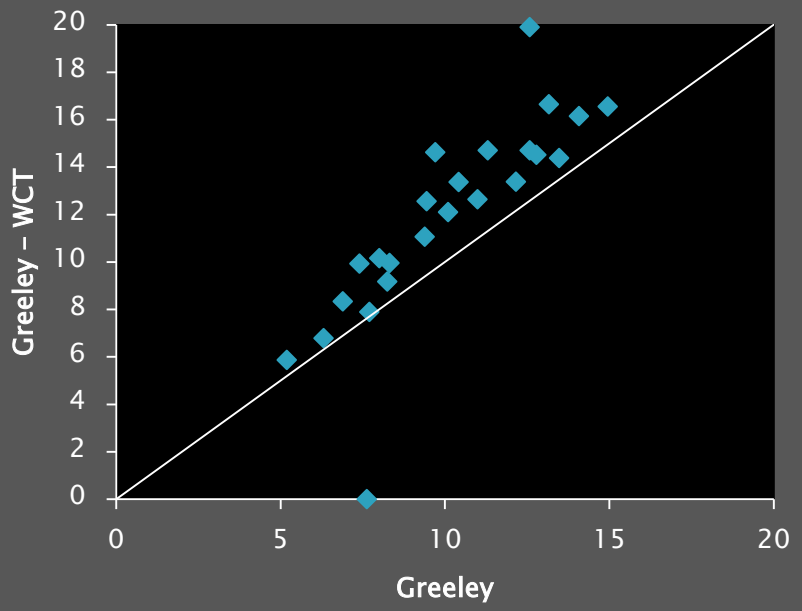
2015 June-August Average



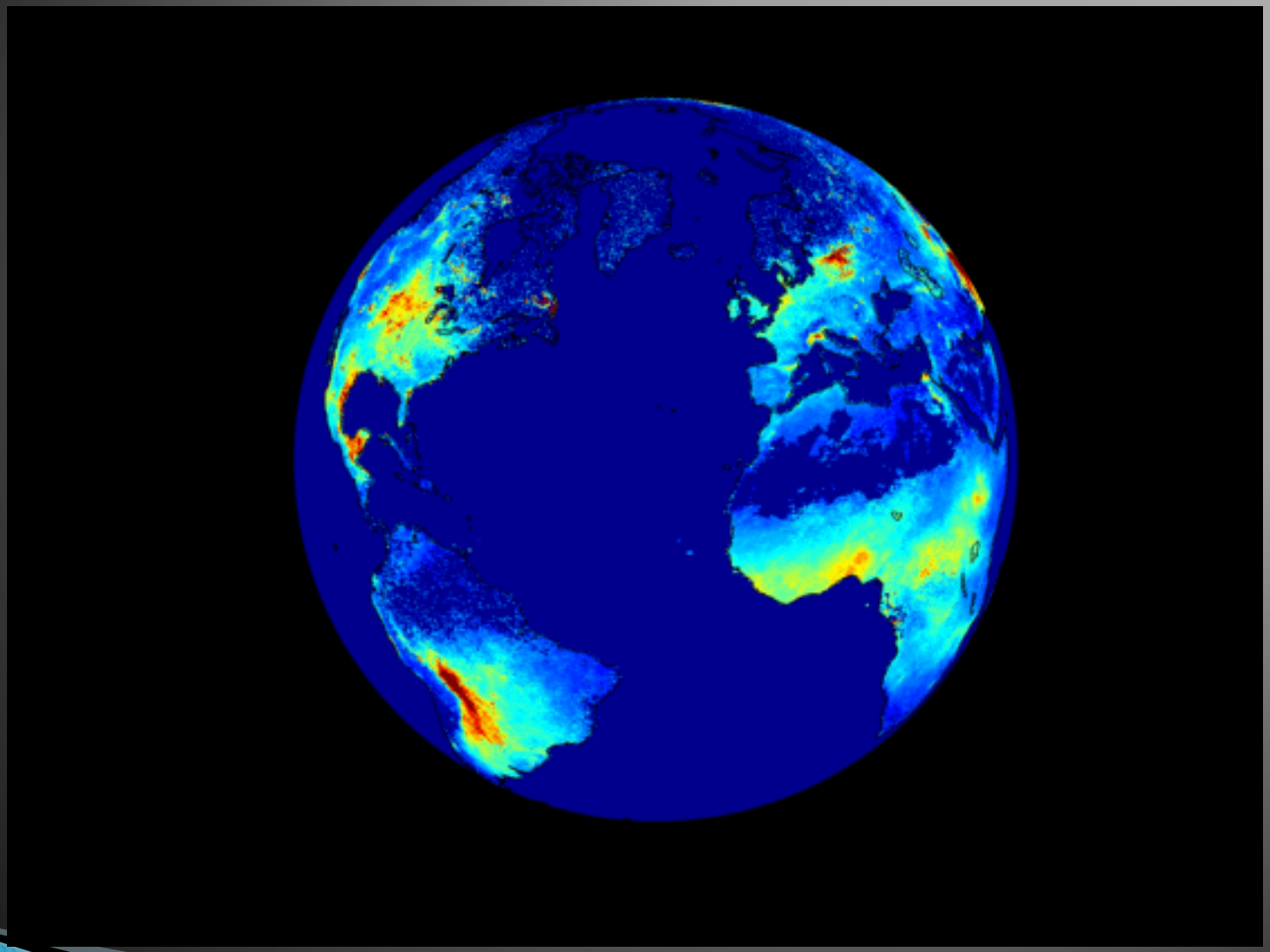
Sites Located in Close Proximity in the CSU Passive NH_3 Network

Concentrations are in $\mu g/m^3$



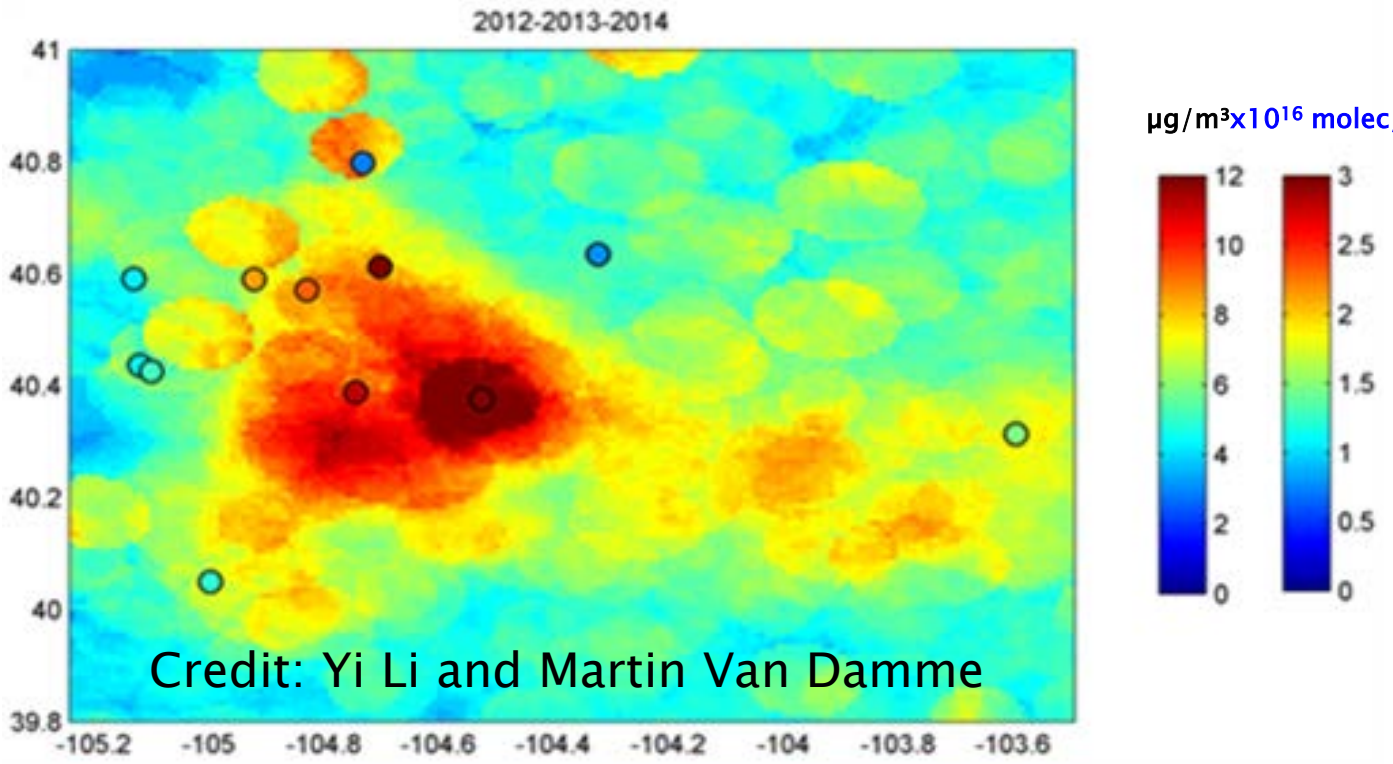


Satellite ammonia



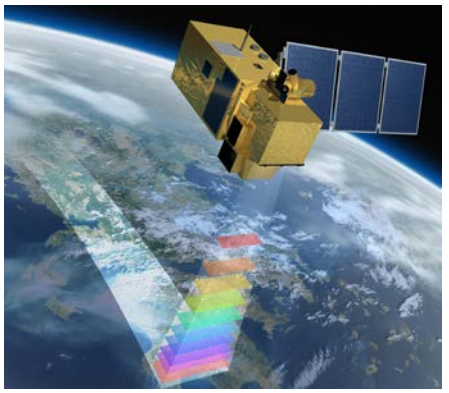
2011 IASI Satellite NH_3 distribution
Figure courtesy of M. Van Damme and J.W. Erisman

Comparison with Satellite (IASI) Observations

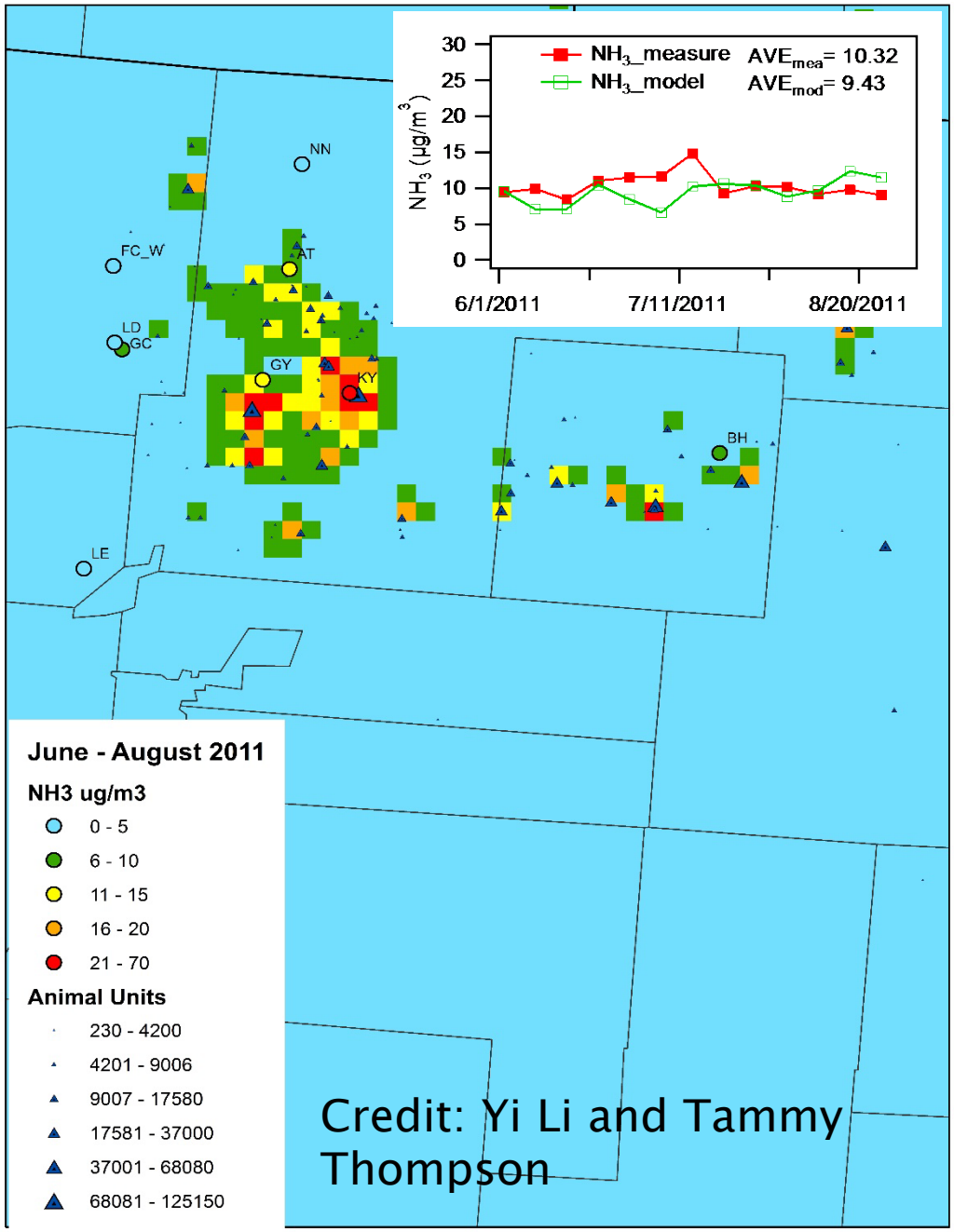


- Overpass times at 9:30 am and 9:30 pm
- Cloud cover below 25%
- IASI column observations and Radiello passive surface concentration measurements show similar spatial patterns on average

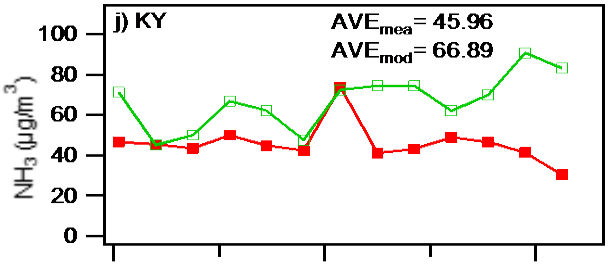
Infrared Atmospheric Sounding Interferometer



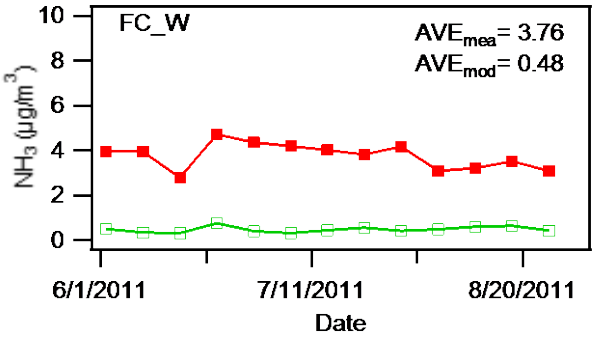
Comparison with CAMx Model Simulations (2011)



Near Source site (KY)



Distant site (FC_W)

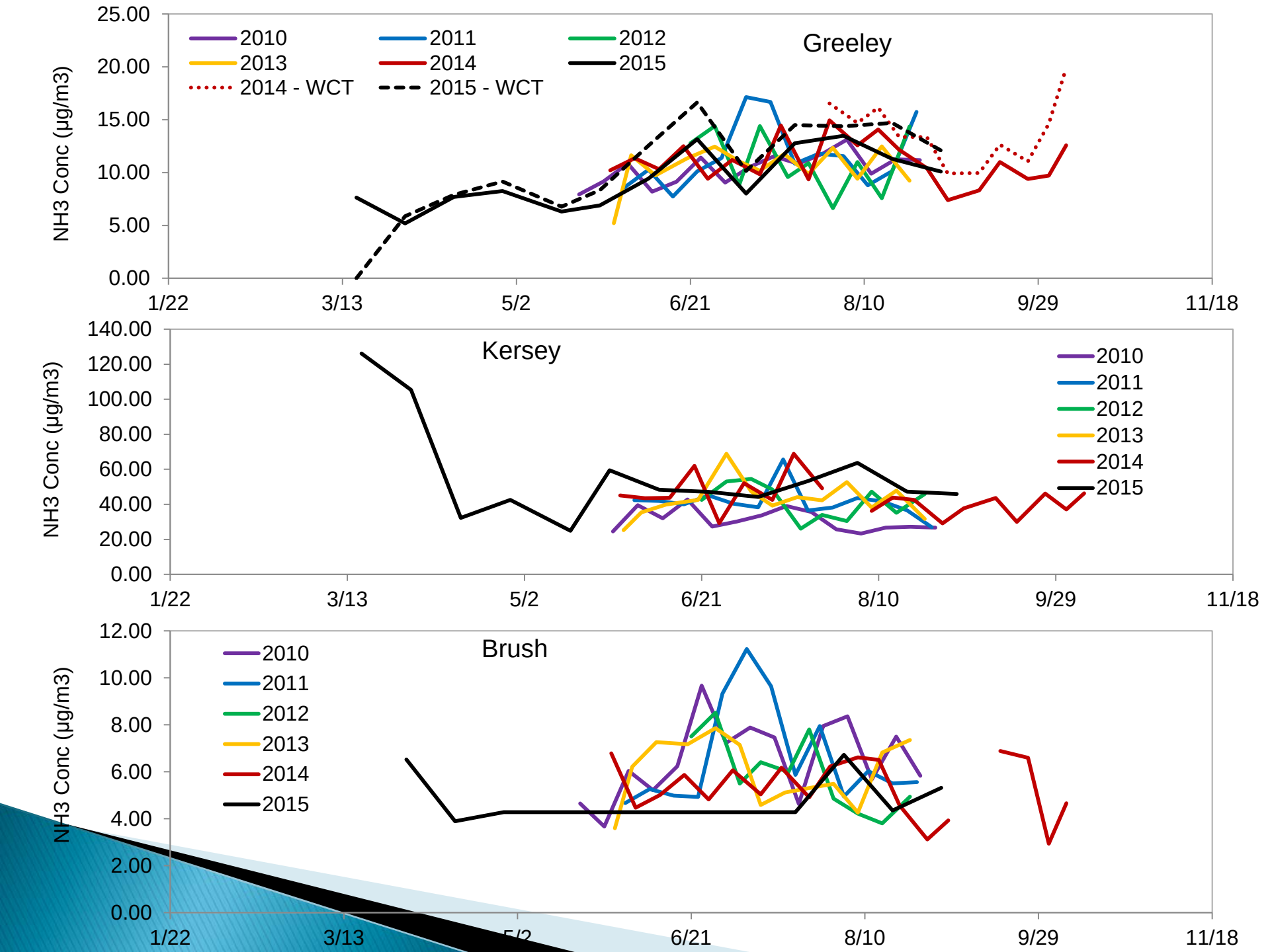


- Model predicts reasonably well on average
- Some overprediction near large sources
- Large underprediction far from major sources

Credit: Yi Li and Tammy Thompson

Next steps

- QA, digest, and analyze 2015 monitoring data
- Use high time resolution data to evaluate EWS predictions
- Secure funding and prepare for 2016 monitoring


Greeley
2010
2011
2012
2013
2014
2015
2014 - WCT
2015 - WCT
NH3 Conc (µg/m3)
25.00
20.00
15.00
10.00
5.00
0.00
1/22
3/13
5/2
6/21
8/10
9/29
11/18
Kersey
2010
2011
2012
2013
2014
2015
NH3 Conc (µg/m3)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1/22
3/13
5/2
6/21
8/10
9/29
11/18
Brush
2010
2011
2012
2013
2014
2015
NH3 Conc (µg/m3)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1/22
3/13
6/21
8/10
9/29
11/18