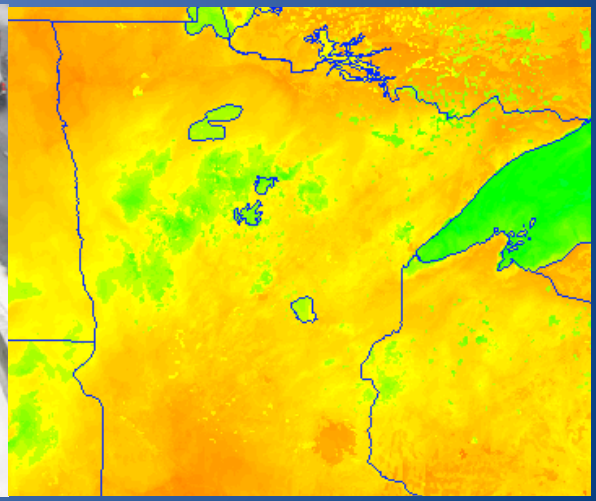
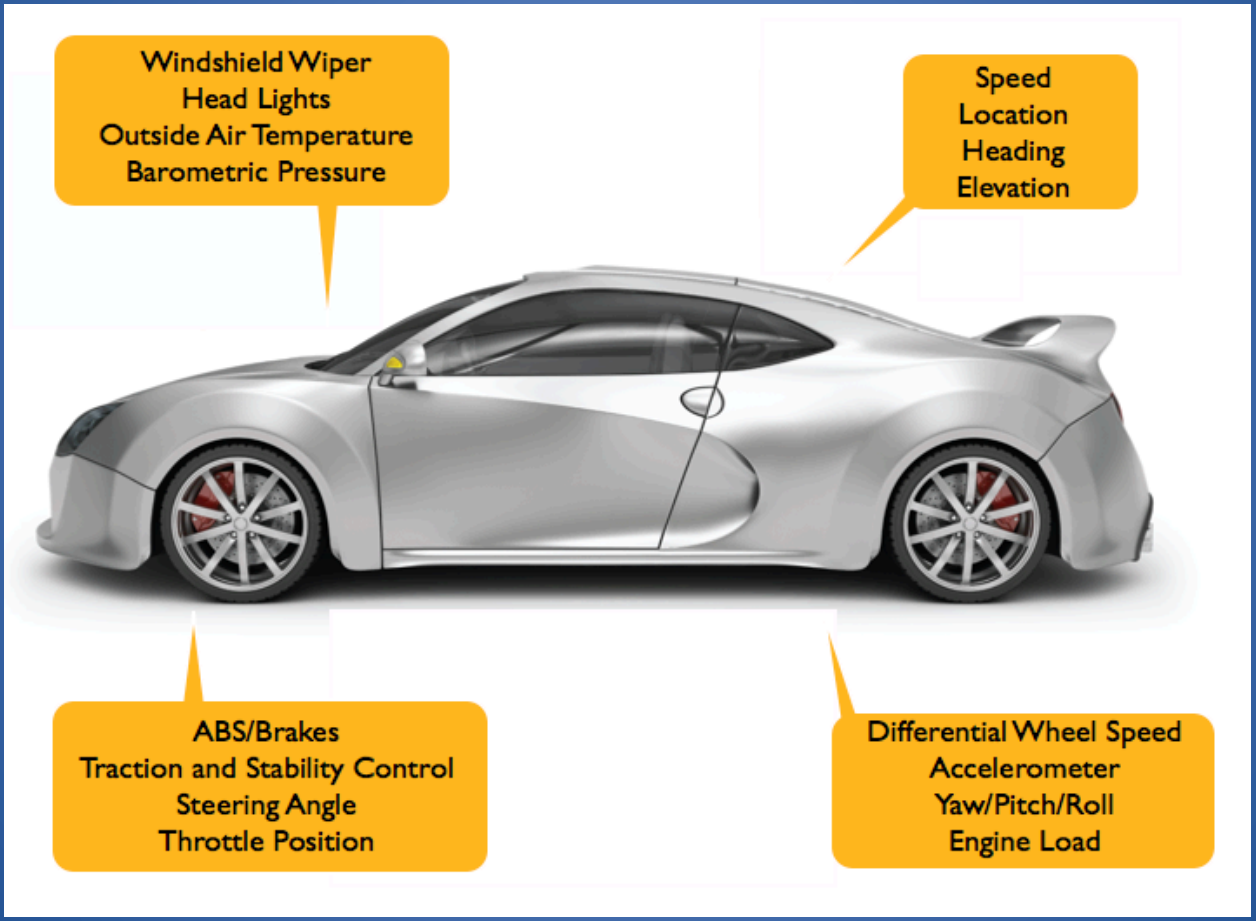
Connected Vehicles: Filling in the Observation Gap for Data Assimilation

Amanda R.S. Anderson, **Jared A. Lee**, Barbara G. Brown,
Gerry M. Weiner, Sheldon D. Drobot, Paul Pisano, and Leigh Sturges

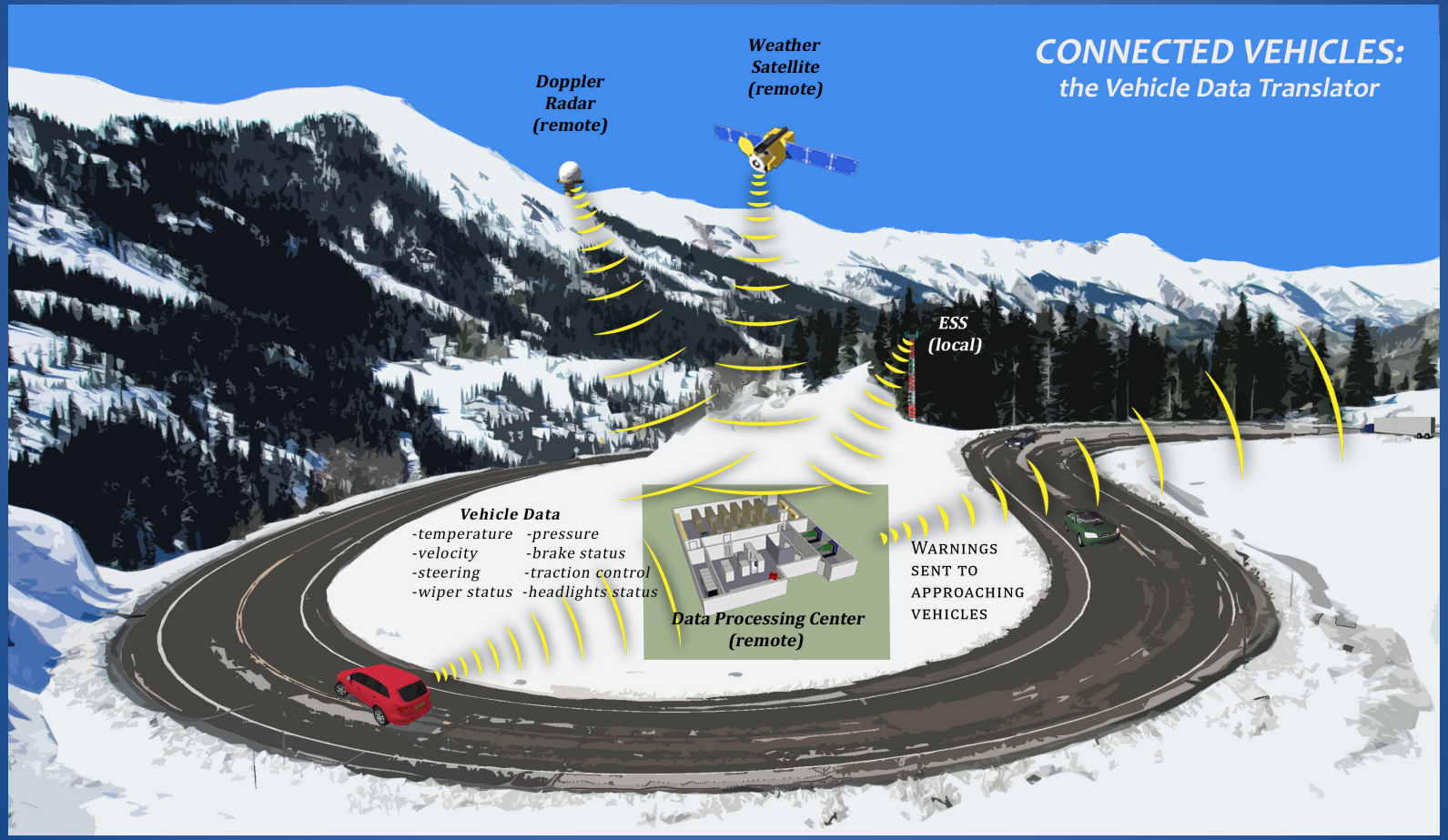


16th Annual WRF User's Workshop ◆ Boulder, Colorado ◆ 18 June 2014 ◆ Talk 6a.5

Connected Vehicles



Connected Vehicles

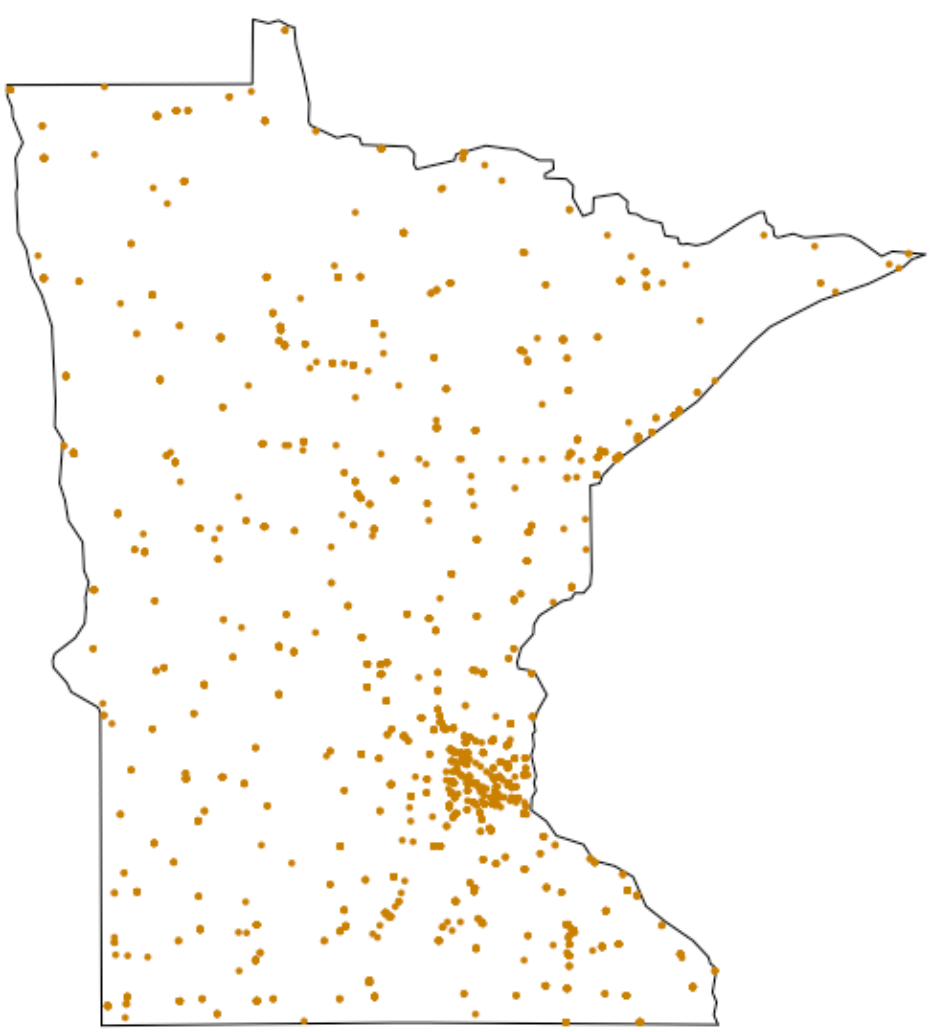


Motivation

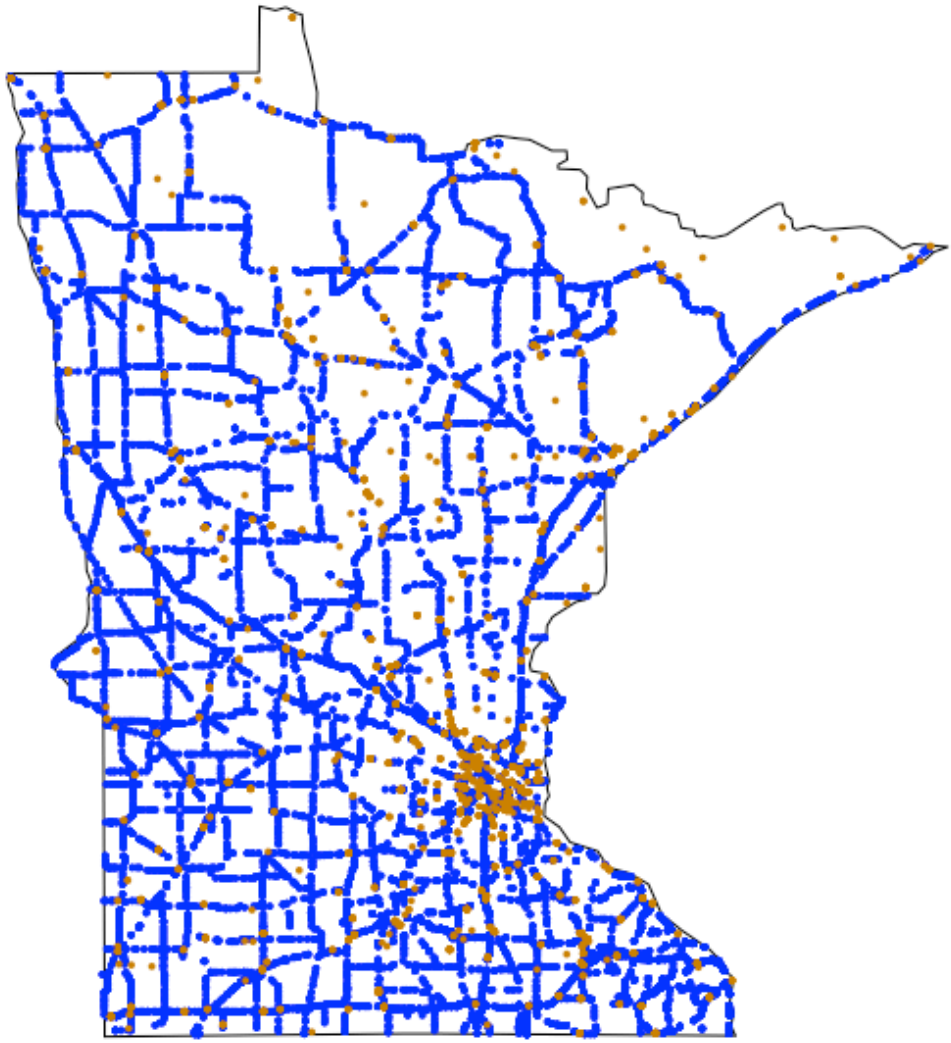
- Paradigm of connected vehicles is coming
- Potential wealth of observations
  - Very high spatial and temporal density
- Can these vehicle-based observations be used to improve NWP forecasts?
- Technology not widely deployed yet, so need to simulate vehicle obs

- Use WRF-FDDA as a tool to explore impacts

Surface Observation Networks



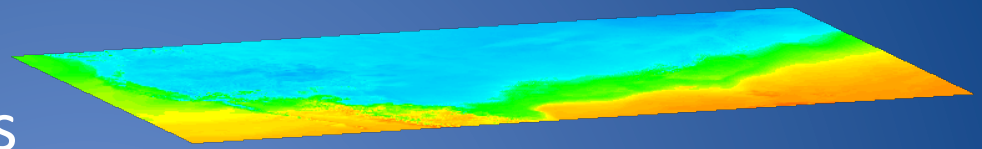
MADIS



MADIS + Interstate/US/State Highways

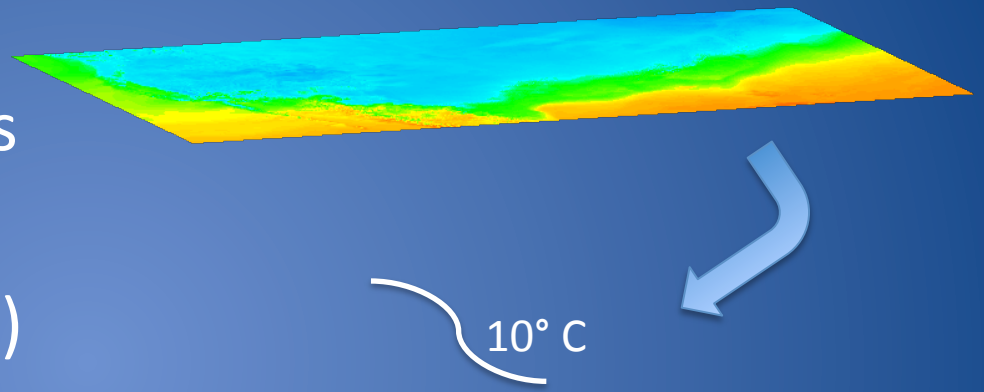
Vehicle Data Simulation

1. User provides weather observations and road segments



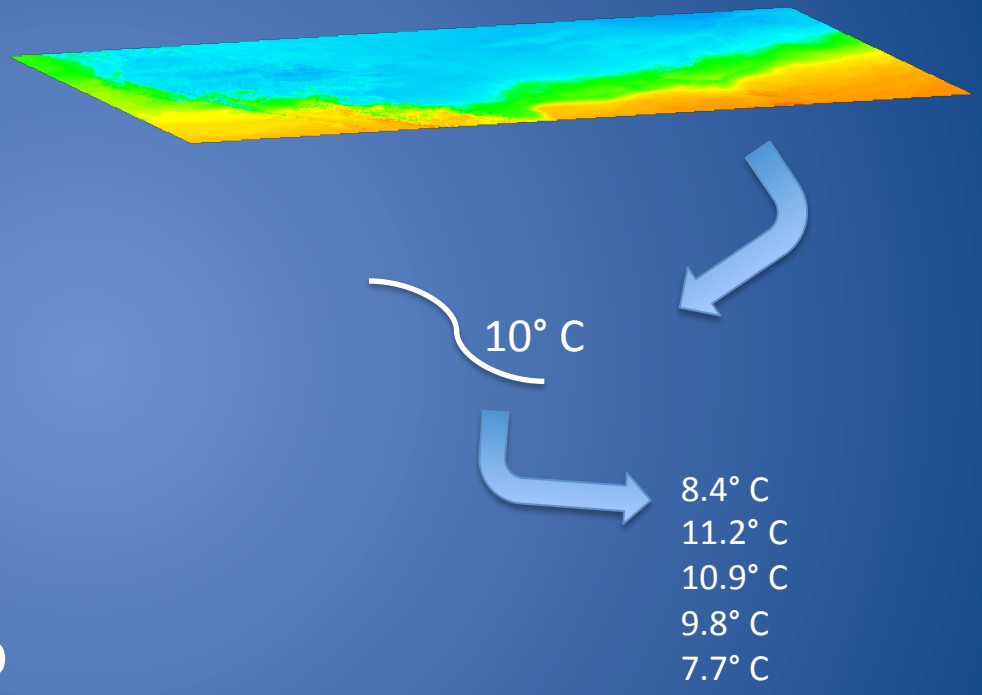
Vehicle Data Simulation

1. User provides weather observations and road segments
2. Weather data (RTMA) are interpolated to road segments



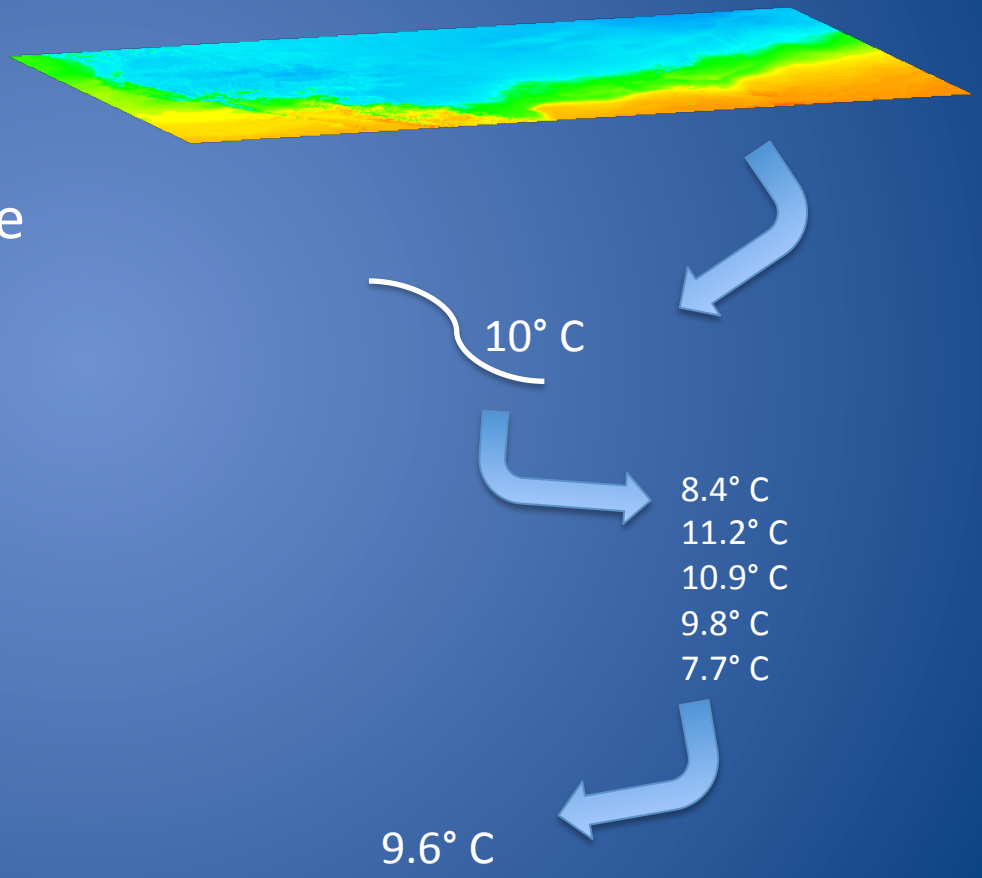
Vehicle Data Simulation

1. User provides weather observations and road segments
2. Weather data (RTMA) are interpolated to road segments
3. Specified number of vehicle observations are assigned to segment based on step 2
   - Varies by urban area
   - Varies by road type
   - Varies by time of day



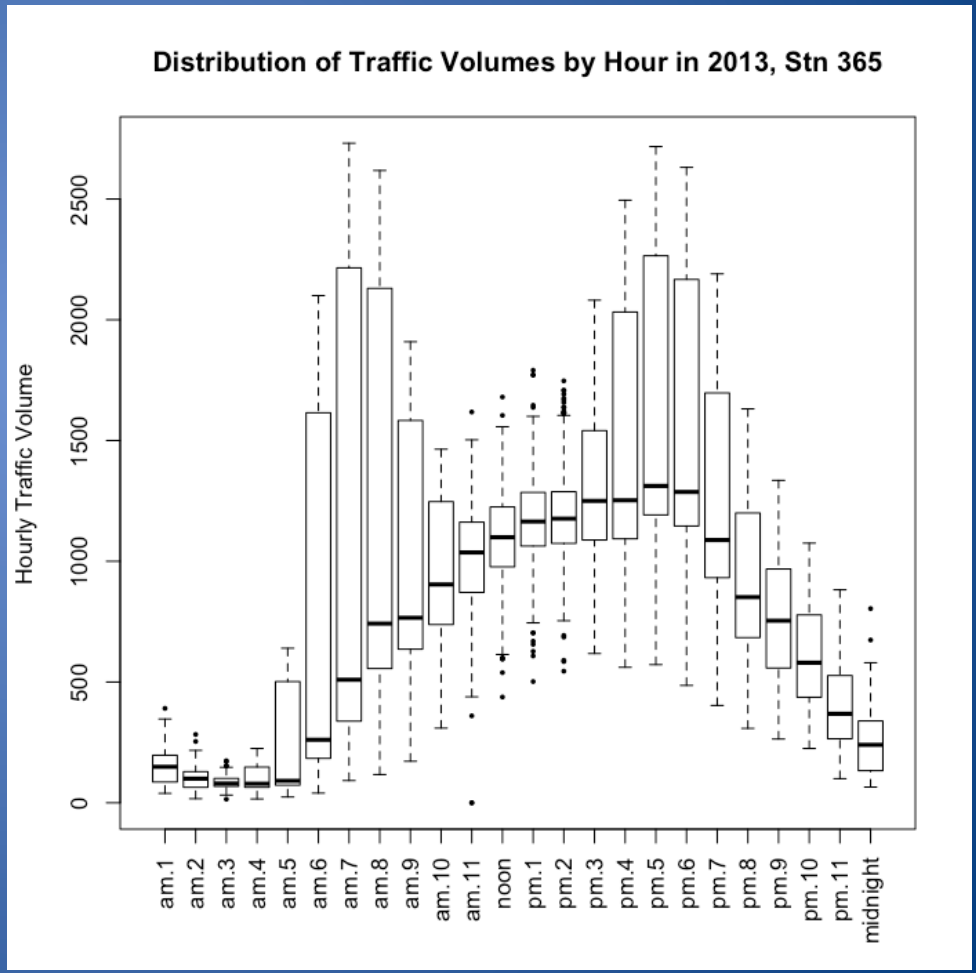
Vehicle Data Simulation

1. User provides weather observations and road segments
2. Weather data (RTMA) are interpolated to road segments
3. Specified number of vehicle observations are assigned to segment based on step 2
   - Varies by urban area
   - Varies by road type
   - Varies by time of day
4. Average value calculated at mid-point of segment for assimilation



Vehicle Data Simulation

- Traffic patterns were analyzed to determine average traffic densities across a 5 minute period
- Each urban area assigned one value for number of vehicles on interstate during rush hour
  - Penetration: 5% and 30%
  - Varies hourly based on time of day
  - US Hwy – 70% of interstate value
  - State Hwy – 35% of interstate value



WRF/FDDA Sensitivity Tests

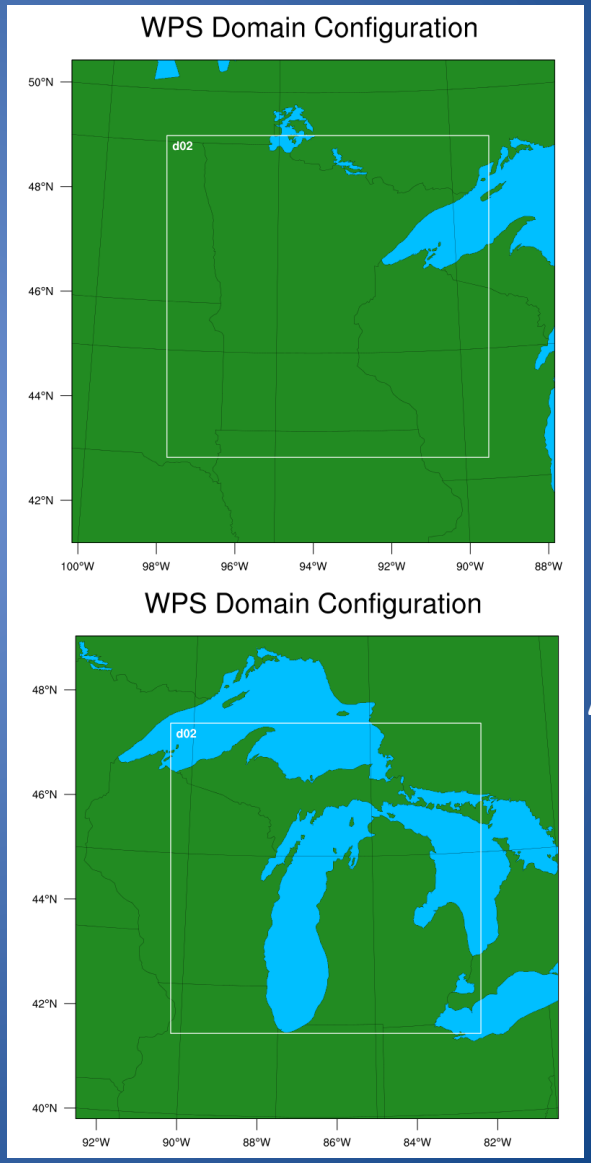
- "Baseline"
  - MADIS obs only
- "VehObs Less"
  - MADIS obs + less dense vehicle obs
  - Interstates & US Hwys, 5% tech penetration
- "VehObs More"
  - MADIS obs + more dense vehicle obs
  - Interstates, US & State Hwys, 30% tech penetration
- "VehObs More Wind"
  - MADIS obs + more dense vehicle obs incl. wind
  - Interstates, US & State Hwys, 30% tech penetration

- Use WRF-ARW v3.6.1 with FDDA obs nudging
- Use MET to verify against Stage IV and PREPBUFR obs

2014 Case Studies

- Case 1 (MN, heavy rain)
  31 May/05z – 01 Jun/05z
- Case 2 (MN, mostly dry)
  06 Apr/00z – 07 Apr/00z
- Case 3 (MN, rain/snow)
  31 Mar/12z – 01 Apr /12z
- Case 4 (MI, snow)
  05 Jan/05z – 06 Jan /05z
- Case 5 (MI, light snow)
  25 Feb/00z – 26 Feb/00z

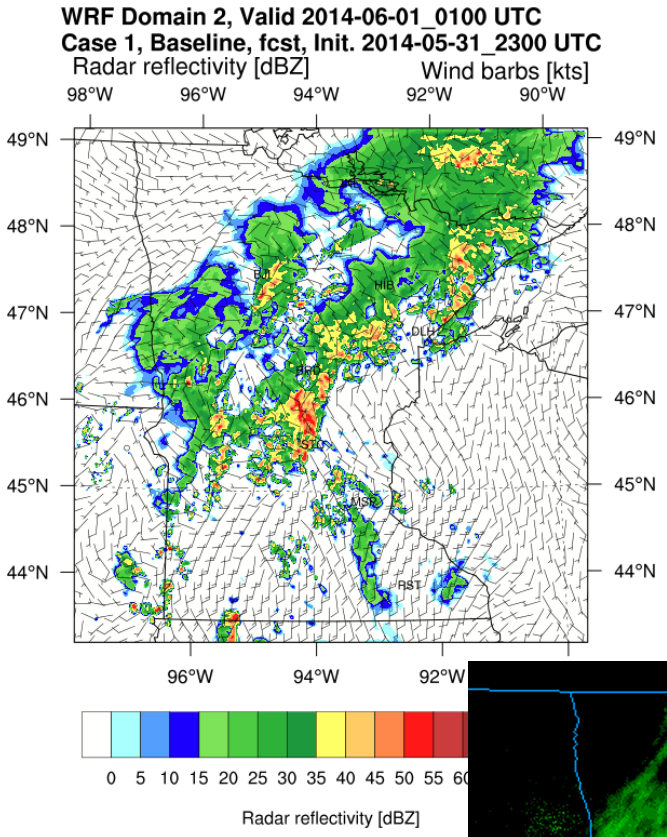
- 48-h FDDA runs (spinup first 24 h)
- 6-h WRF forecasts initialized from FDDA runs every 6 h throughout 24-h period of interest



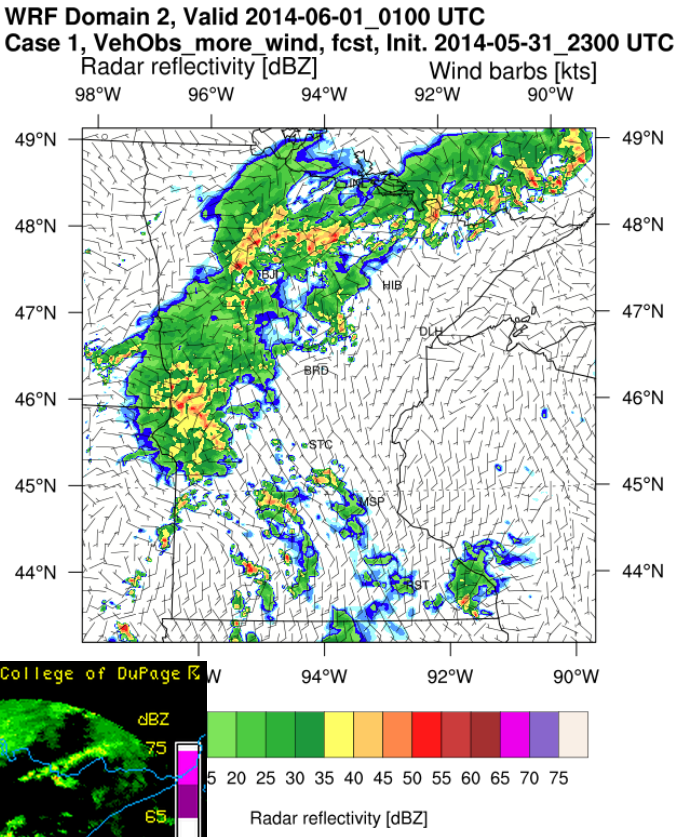
d01
Δx = 4 km

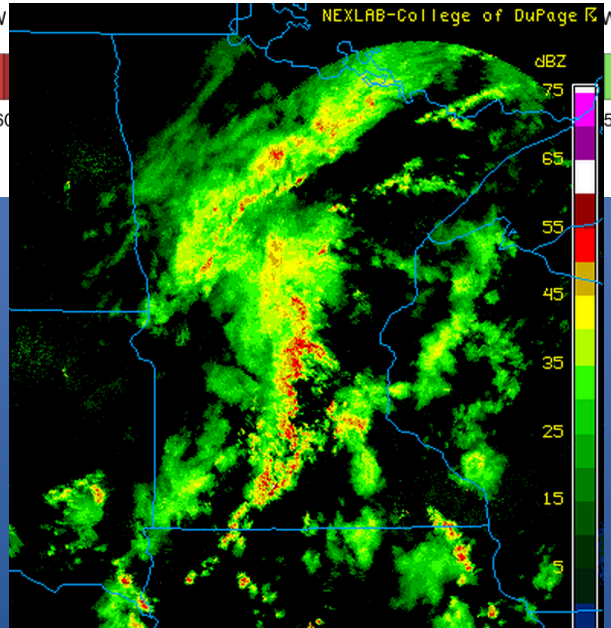
d02
Δx = 1.33 km

Baseline, f+2h



VehObs_more_wind, f+2h





NEXRAD Mosaic

http://www2.mmm.ucar.edu/imagearchive/

Valid

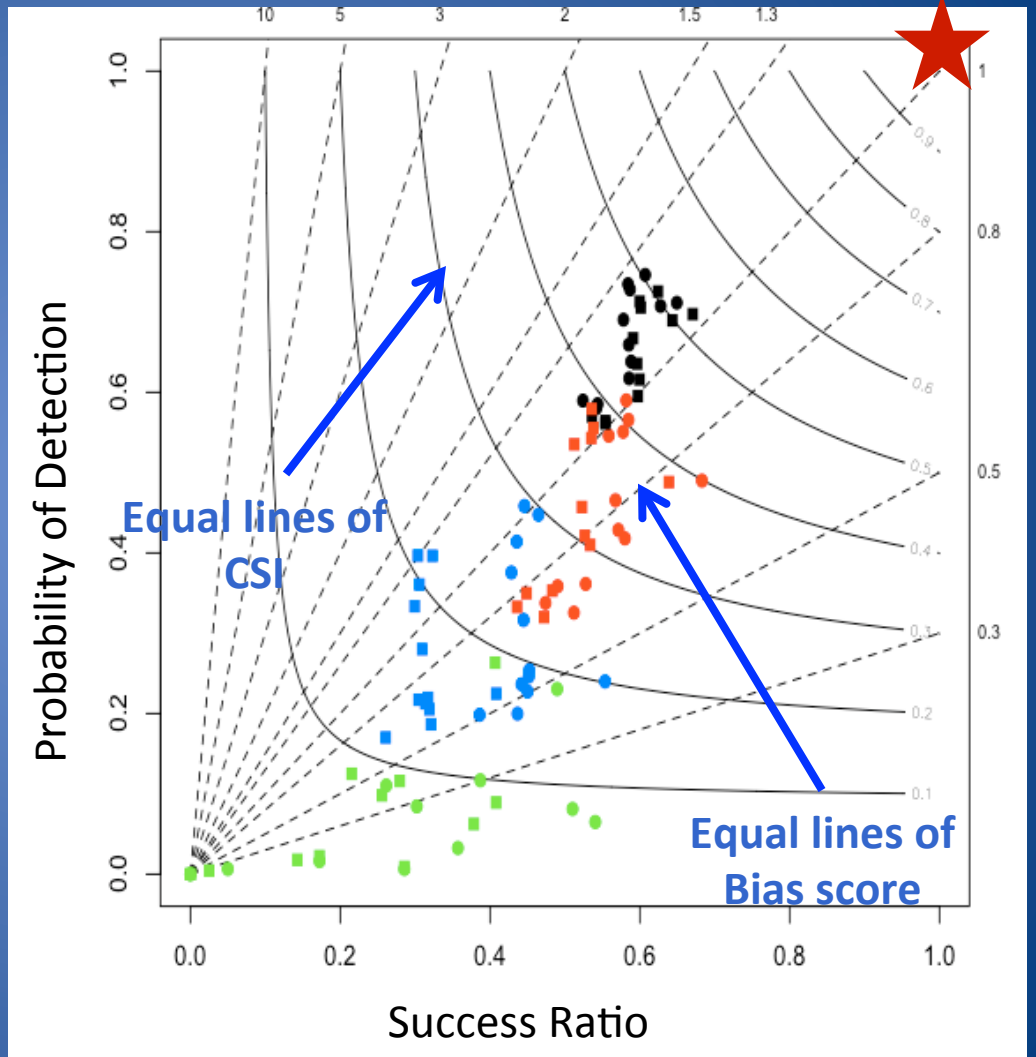
2014-06-01_0055 UTC

Performance diagrams

Take advantage of relationships among scores to show multiple scores at one time

Only need plot POD and 1-FAR

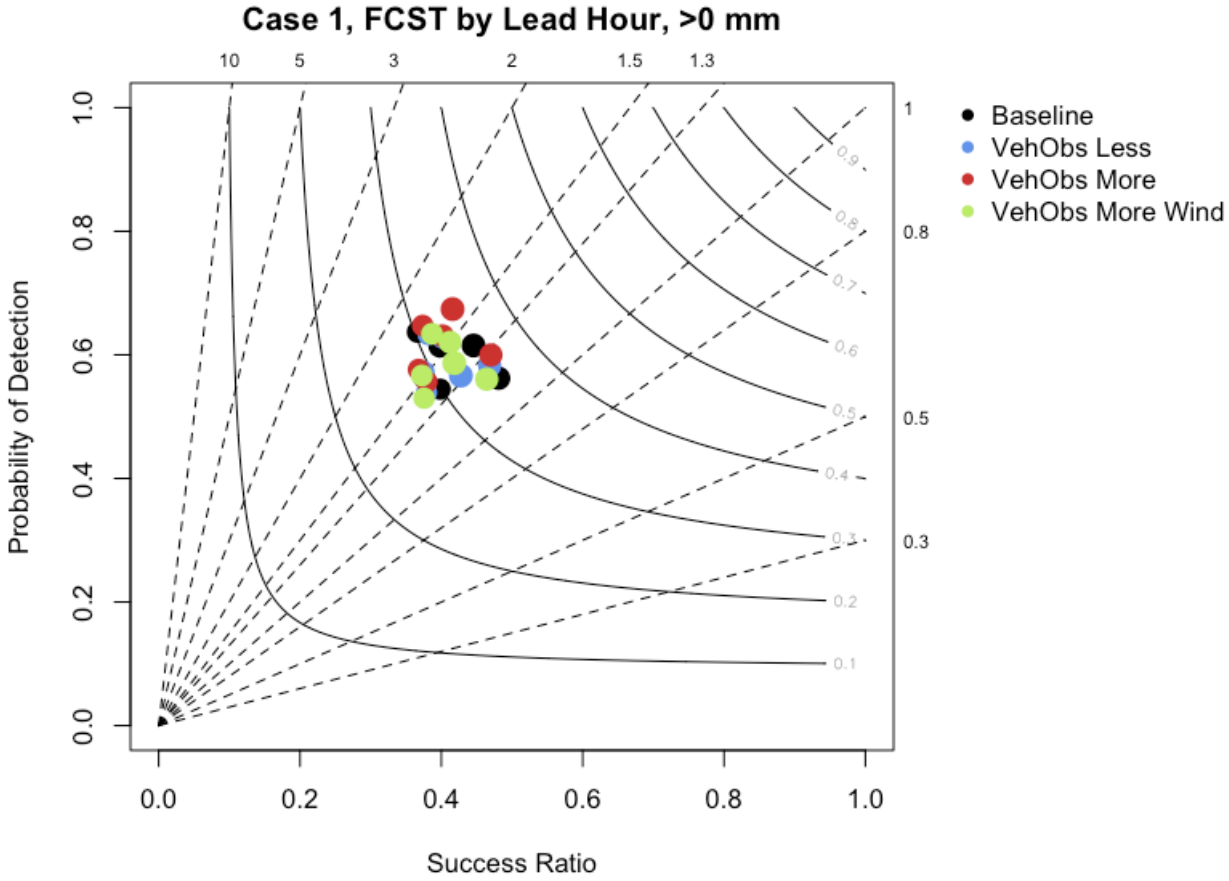
NOTE: Other forms of this type of diagram exist for different combinations of measures (see Jolliffe and Stephenson 2012)



Success ratio = 1 - FAR

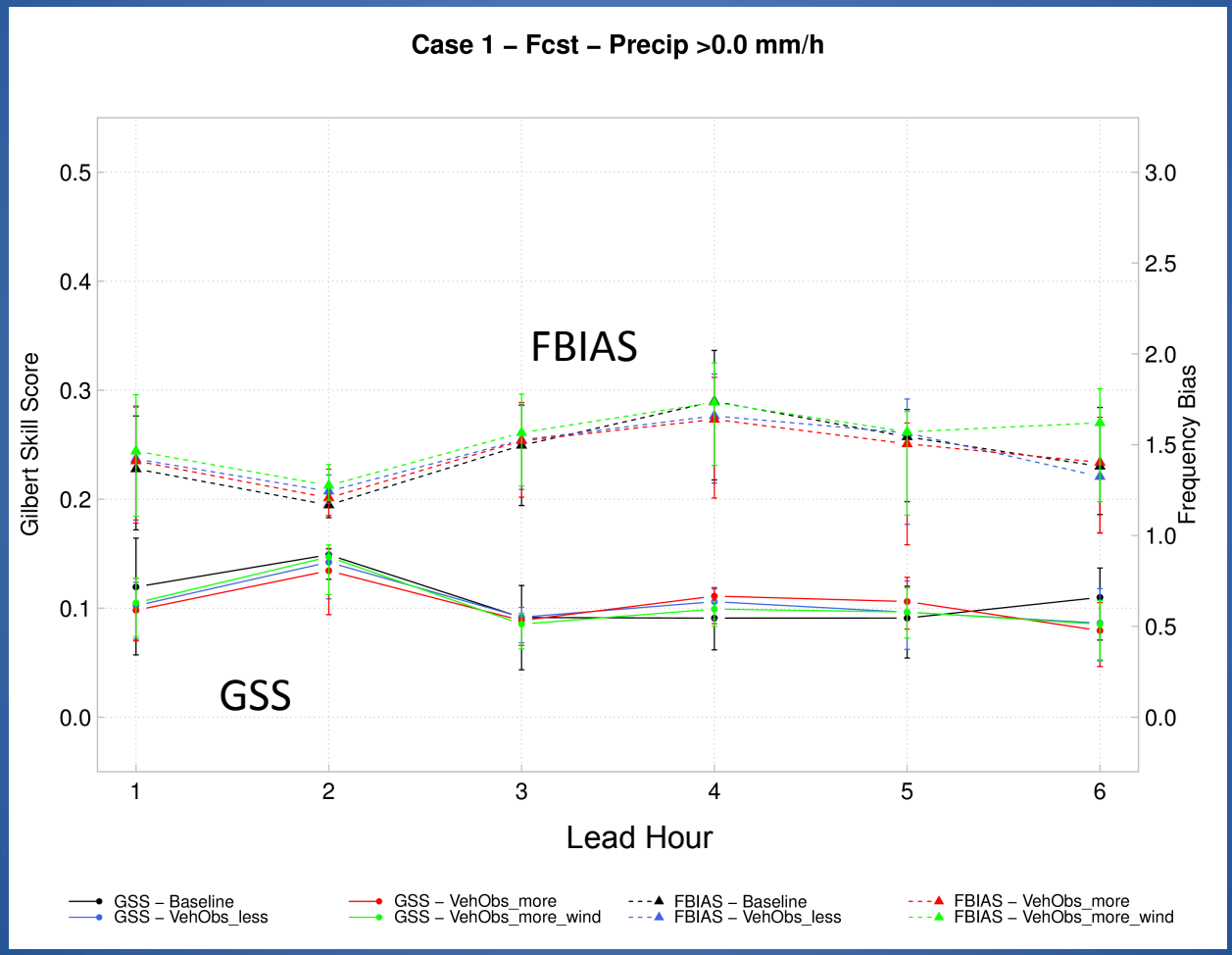
After Roebber 2009 and C. Wilson 2008

Preliminary Results (Case 1)



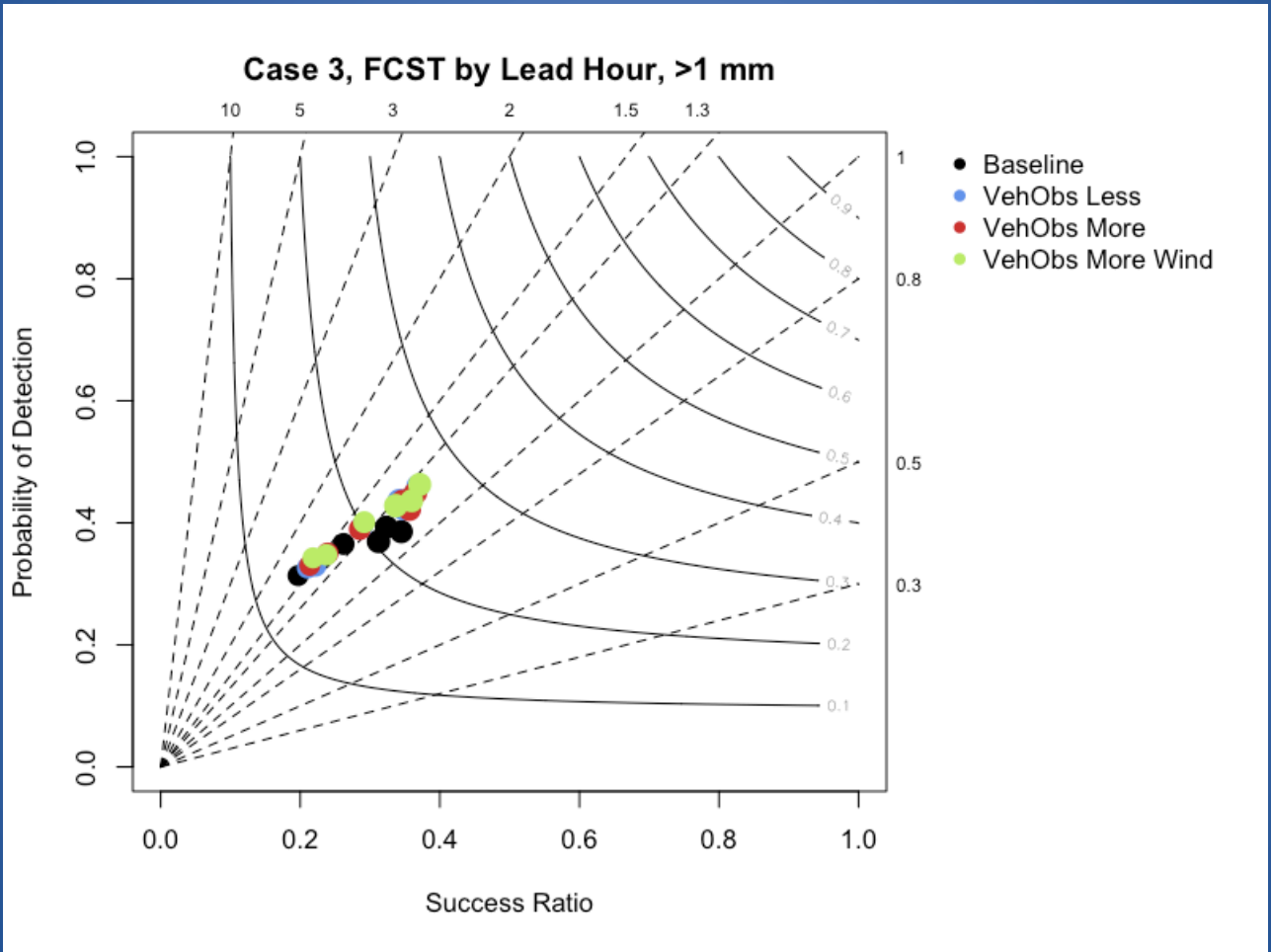
Mixed results for Case 1 precip verification …

Preliminary Results (Case 1)



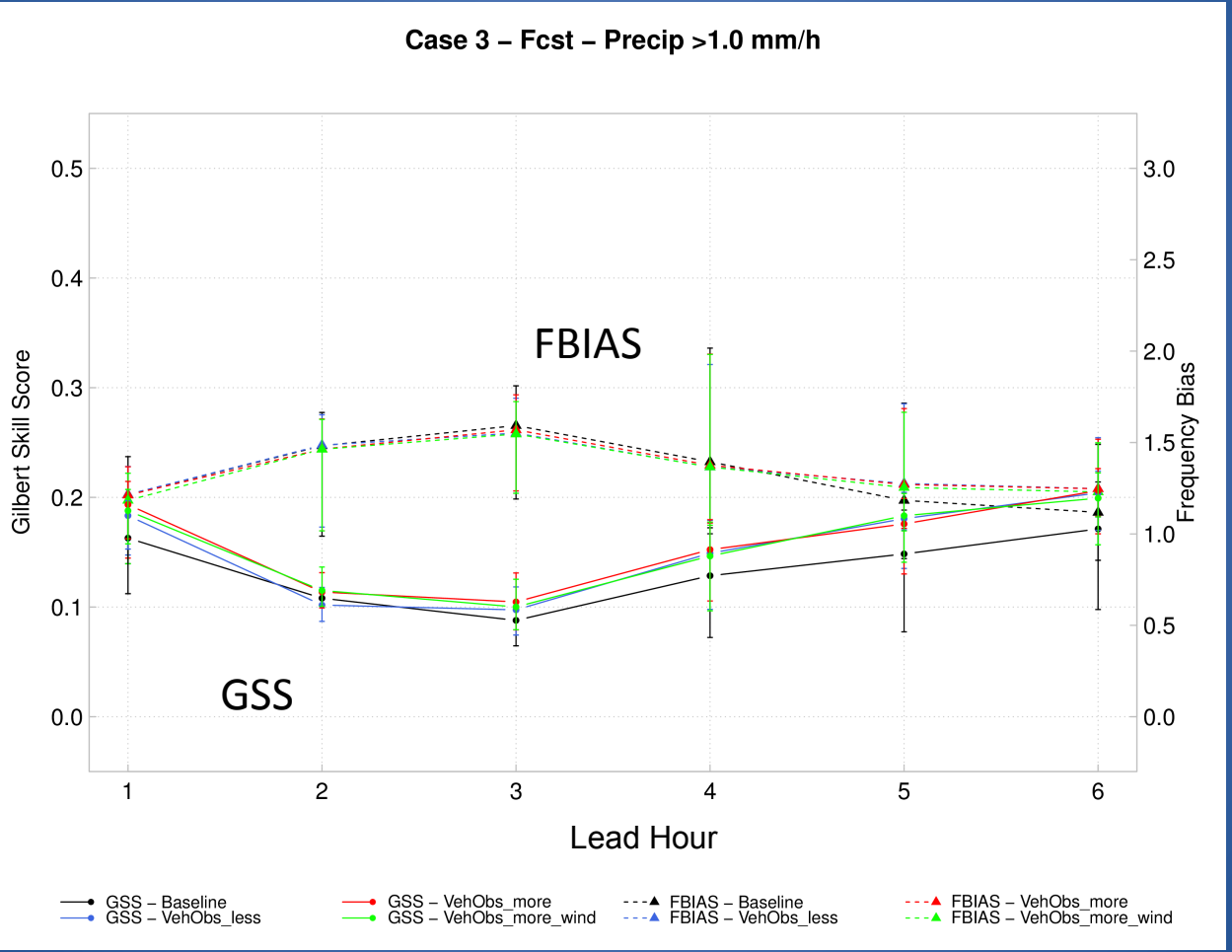
Mixed results for Case 1 precip verification …

Preliminary Results (Case 3)



… but for Case 3, vehicle obs seem to improve precip POD, reduce FAR

Preliminary Results (Case 3)



… but for Case 3, vehicle obs seem to improve precip POD, reduce FAR

Preliminary Summary & Ongoing Work

- Initial 1-h precip verification indicates mixed results for impact of vehicle obs assimilation
- Also performing precip verification with MODE tool
- Examining verification stats for T2, Td2, SLP
- How long into forecast is impact from vehicle obs retained?

Any questions?