Damage Survey and Analysis of the 20 May 2013 Newcastle-Moore, OK, EF-5 Tornado Kiel Ortega^{1,2}, Donald Burgess^{1,2}, Gabriel Garfield^{1,3}, Christopher Karstens^{1,2}, James LaDue⁴, Timothy Marshall⁵, Tiffany Meyer^{1,4}, Brandon Smith^{1,2}, ¹Univ. Oklahoma/CIMMS ² NOAA/OAR/NSSL ³NOAA/NWS/WFO OUN **Richard Smith³, Doug Speheger³, and Gregory Stumpf**^{1,6} ⁴ NOAA/NWS/WDTB ⁵Haag Engineering Company ⁶ NOAA/NWS/MDL



• 4 Norman-based survey teams initiated surveys on 21 May, plus aerial photography

 Centralized collection/coordination using NWS Damage Assessment Tool (DAT)

 Follow up surveys in the proceeding week (total ~20 people spanning public and private entities)

• Additional data from aerial photos, satellite images, and other ground teams

4,222 Damage Indicators (30 other points surveyed) EF0: 2,057 | EF1: 825 | EF2: 506 | EF3: 462 | EF4: 361 | EF5: 11



officially entered into Storm Date

s thunderstorm wind damage



EF-4 rated home







Path Start—Non-Tornadic? Definitive video evidence not present until official start •Lack of definite dual-pol debris signature until near official start Doppler velocity signature inbound-dominant; balanced over official start and path

Official Start:

1956Z



Justify EF5	Justify EF4
All had removal of some percentage of base plates	No capability to evaluate wall-to-roof connections
 All had some sort of anchor bolting; many bolts were bent. Evidence of the wall holding? 	 All had deficiencies w.r.t. WFCM Wide bolt spacing, lack of clips for wall stud-to-base plate
5 surveyed EF-5 rated homes had toe-nailed connections for wall stud- to-base plate connections	Several were within tight gradients of damage (1 w/ across the street EF1 neighbor)
Historical damage ratings of similar damage (3 May 1999, 24 May 2011)	
 Area near Moore Medical Center Tornado looped (via PX-1000 radar data) 	
 Vehicles parked at Moore Medical Center thrown west into open field and southeast into the Emergency Room entrance One vehicle landed on top of the 2-story MMC 	
	EF-scale contours (colored lines)
	Damage points (color coded by EF-rating) Tornado centerline in black
EF3 EF3 EF3 EF3 EF3 EF4 EF4 EF5 EF5 EF2 EF3 EF3 EF3 EF4 EF4 EF5 EF5 EF2 EF3 EF3 EF3 EF4 EF4 EF5 EF5 Imagery[Date: 11/7/2012 I	Yellow arrows illustrate vehicle lofting directions

Acknowledgments The authors would like to thank the other surveyors and those who provided support during the survey: Tanya Brown, Kristin Calhoun, Chuck Doswell, John Ferree, Jack Friedman, Darrel Kingfield, Patrick Marsh, Lans Rothfusz, Ashlie Sears, Bruce Thoren and Jeremy Wesely. Thanks also to Jim Kurdzo and the Advanced Radar Research Center for sharing PX-1000 images and loops. Additional thanks to all of the emergency responders, especially the Oklahoma Highway Patrol, Oklahoma City Police Department, Moore Police and Fire Departments, Norman Police Department and the Newcastle Fire Department, for their assistance in providing guidance (and a helicopter) to the survey teams and their tireless service in response to this tornado.

his poster was prepared by Kiel Ortega with funding provided by NOAA/Office of Oceanic and Atmospheric Research under NOAA-University o Oklahoma Cooperative Agreement #NA11OAR4320072, U.S. Department of Commerce. The statements, findings, conclusions, and ecommendations are those of the author(s) and do not necessarily reflect the views of NOAA or the U.S. Department of Commerce