Targeted Observations by Radars and UAS of Supercells (TORUS): Overview of 2019 Field Phase

Adam Houston, University of Nebraska – Lincoln
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Brian Argrow, University of Colorado
Mike Coniglio, NSSL
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Knowledge Gaps and Forecasting Challenges

Severe thunderstorm warnings:
- Probability of detection (POD) “high” and unchanged
- False alarm rate (FAR) “low” and unchanged

Tornado warnings:
- POD “low” and decreasing
- FAR “high” and largely unchanged

NOAA (2018)
The aim of TORUS is to close fundamental knowledge gaps by explicating the relationship of storm-generated boundaries and coherent (O[1,000 s]) structures within supercell thunderstorm outflow to the generation/amplification of near-surface rotation.
Knowledge Gaps and Forecasting Challenges

Supplemental video from Orf et al. (2017)
Experiment Design Objective

Coordinated and tightly-focused deployments of new and established remote and in situ instruments tasked to collect thermodynamic and kinematic observations both aloft and at the surface.
Instruments

- 16 platforms
- 22 vehicles
- ~60 people
Instruments

RAAVEN

- 91" wing span
- BST multi-hole probe for 3D wind
- Vaisala RSS-421 (temperature, humidity)
- iMet EE03 (pressure, temperature, humidity)
- VectorNav VN-200 IMU+GPS
- Pixhawk Cube autopilot (custom designed carrier board)
Roof-mounted, pneumatic catapult
Instruments

- Texas Tech Ka-band Radars
- NOAA P3
- Mobile LIDAR
- NOXP
- Windsonde System
- Combined Mesonet and Tracker
- Mobile Sounding System
- NSSL Mobile Mesonets

[Images showing the listed instruments]
Mission Areas
<table>
<thead>
<tr>
<th></th>
<th>VORTEX2</th>
<th>TORUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;400’ COAs</td>
<td>~35,000 km²</td>
<td>~951,000 km²</td>
</tr>
<tr>
<td>Simultaneous operation of</td>
<td>Prohibited</td>
<td>Allowed</td>
</tr>
<tr>
<td>multiple UAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOTAM issuance</td>
<td>2 hour lead</td>
<td>1 hour lead</td>
</tr>
<tr>
<td>Flight ceiling</td>
<td>1000’</td>
<td>2500’ (5000’ in some areas)</td>
</tr>
<tr>
<td>Ground station mobility during</td>
<td>Prohibited</td>
<td>Allowed</td>
</tr>
<tr>
<td>flights</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight times</td>
<td>~45 min</td>
<td>&gt;150 min</td>
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</tbody>
</table>
2019 Deployments

- Coordinated obs on 17 supercells
- 7 tornadic supercells targeted
- 2 preconvective missions
- 14 total deployment days
- 51 UAS missions flown on 15 supercells
- 40.85 flight hours
# 2019 Deployments

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Supercell</th>
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<tbody>
<tr>
<td>5/17</td>
<td>Southwest NE</td>
<td>Yes</td>
</tr>
<tr>
<td>5/18</td>
<td>Northern OK</td>
<td>No</td>
</tr>
<tr>
<td>5/20</td>
<td>Southwest OK/Northwest TX</td>
<td>Yes</td>
</tr>
<tr>
<td>5/22</td>
<td>Central OK</td>
<td>N/A</td>
</tr>
<tr>
<td>5/23</td>
<td>Northeast TX Panhandle</td>
<td>Yes</td>
</tr>
<tr>
<td>5/24</td>
<td>Northwest TX</td>
<td>Yes</td>
</tr>
<tr>
<td>5/25</td>
<td>Central TX Panhandle</td>
<td>Yes</td>
</tr>
<tr>
<td>5/26</td>
<td>Southeast CO</td>
<td>Yes</td>
</tr>
<tr>
<td>5/27</td>
<td>Northeast CO/Southwest NE</td>
<td>Yes</td>
</tr>
<tr>
<td>5/28</td>
<td>Northern KS</td>
<td>Yes</td>
</tr>
<tr>
<td>6/2</td>
<td>OK Panhandle</td>
<td>No</td>
</tr>
<tr>
<td>6/8</td>
<td>Northwest KS</td>
<td>Yes</td>
</tr>
<tr>
<td>6/11</td>
<td>Southwest KS</td>
<td>Yes</td>
</tr>
<tr>
<td>6/13</td>
<td>OK Panhandle</td>
<td>No</td>
</tr>
<tr>
<td>6/14</td>
<td>OK Panhandle</td>
<td>N/A</td>
</tr>
<tr>
<td>6/15</td>
<td>Western TX Panhandle</td>
<td>Yes*</td>
</tr>
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Questions?

https://torus.unl.edu/

@torusexperiment
@torusupercell

TORUS Experiment