Hail Size and Dual-Polarization Doppler on Wheels Radar Observations during RELAMPAGO

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Key Takeaways

- For the first time, adaptive hailpad networks were deployed during RELAMPAGO
- 2285 hailstone impacts were recorded
- Sizes estimated from hailpads are consistent with collocated manual measurements; distributions are narrow
- Drone aerial photogrammetry was applied successfully for the first time
- Dual-pol DOW radar signatures consistent with observed hailfall

Adaptive Hailpads

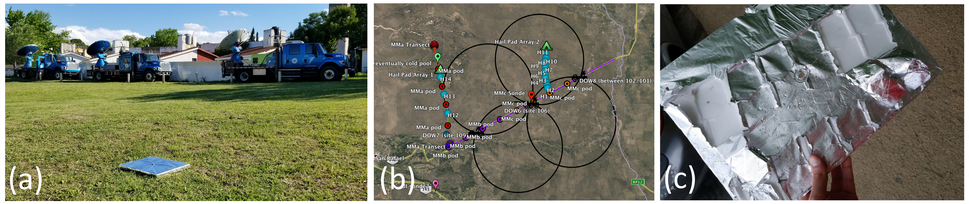
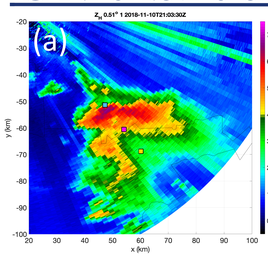


Fig. 1: *Photographs of (a) an adaptive hailpad with the 3 X-band DOW radars in the background; (b) an adaptive hailpad network (blue circles) on a RELAMPAGO IOP deployment plan; (c) an unfortunate hailpad that met an untimely fate.*

Overview of Observations

IOP4: 10 Nov 2018



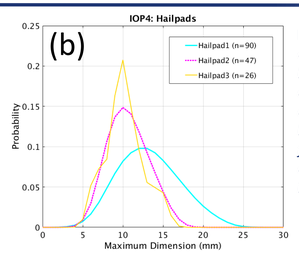


Fig. 2: *(a) RMA1 (C-band) observed Z_H with hailpad locations overlaid in the colored square markers; (b) estimated distribution of hail maximum dimensions from the hailpads. Colors correspond to the markers in (a).*

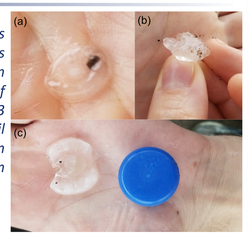


Fig. 3: *Photographs of hailstones collected between the locations of hailpads H2 and H3 by the PSU Hail Team. Blue cap in panel (c) is 3.2 cm in diameter*

IOP9: 25 Nov 2018

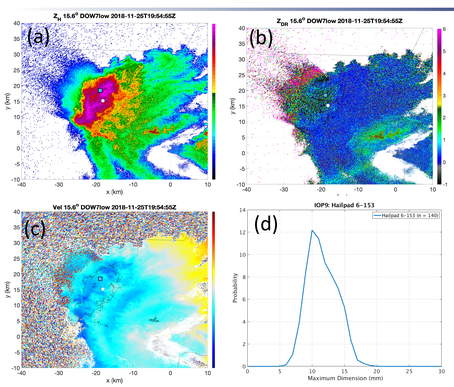


Fig. 4: *Observed fields of DOW7 (X-band) (a) Z_H (b) Z_{DR}, and (c) mean radial velocity at 15.6° elevation angle. A prominent polarimetric three-body scattering signature is observed behind the cell. Overlaid blue square marker indicates the hailpad location. Overlaid white circle marker indicates the location of manual measurements (hail maximum dimensions of 10-11 mm observed) and drone flight shown in* **Fig. 5**. *(d) Distribution of hailstone maximum dimensions estimated from the hailpad.*

Fig. 5: *Drone photograph of the hail swath edge, obtained at 500 m AGL. The image contrast has been enhanced. The image was taken at the location of the white circle marker in* **Fig. 4a-c**.

IOP10: 26 Nov 2018

Fig. 6: *Photograph of the approaching IOP10 storm. Taken by Holly Mallinson.*

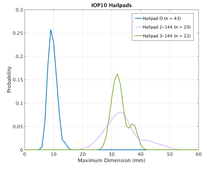


Fig. 8: *Estimated distributions of hail maximum dimension for the hail pads. Note: Hailpad O is not in the domain of* **Fig. 7** *(it was impacted by the storm earlier in its lifetime). Hailpad 1-144 was destroyed by the hail (see* **Fig. 9**).

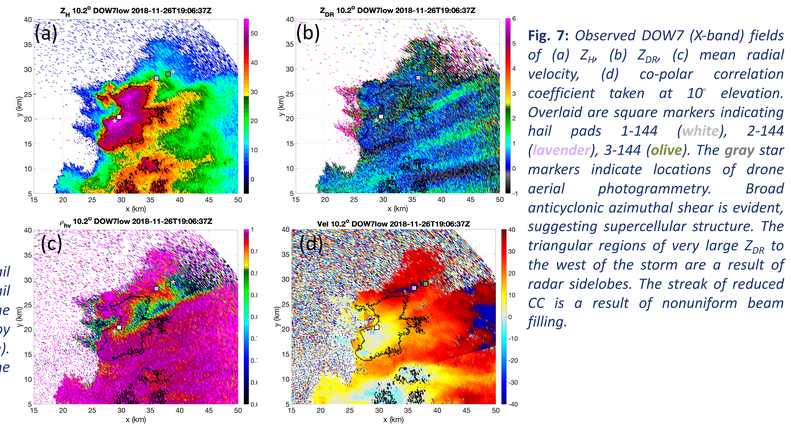


Fig. 7: *Observed DOW7 (X-band) fields of (a) Z_H, (b) Z_{DR}, (c) mean radial velocity, (d) co-polar correlation coefficient taken at 10° elevation. Overlaid are square markers indicating hail pads 1-144 (white), 2-144 (lavender), 3-144 (olive). The gray star markers indicate locations of drone aerial photogrammetry. Broad anticyclonic azimuthal shear is evident, suggesting supercellular structure. The triangular regions of very large Z_{DR} to the west of the storm are a result of radar sidelobes. The streak of reduced CC is a result of nonuniform beam filling.*

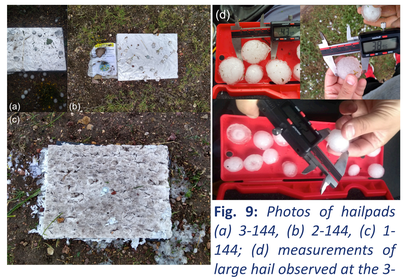


Fig. 9: *Photos of hailpads (a) 3-144, (b) 2-144, (c) 1-144; (d) measurements of large hail observed at the 3-144 site.*

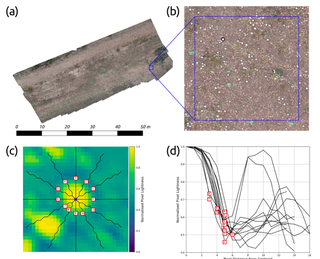


Fig. 10: *HailPixel technique as applied to site 3-144. From Soderholm et al. (2020)*

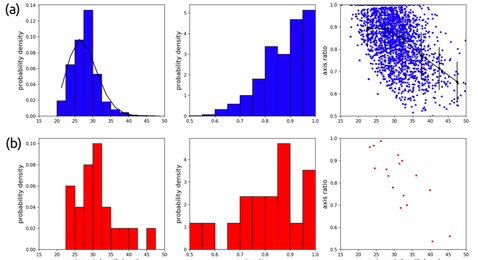


Fig. 11: *(a) Hail size distribution and axis ratio distribution estimated by the drone using the HailPixel technique (n = 15,983); (b) as in (a), but from hailpad 3-144. From Soderholm et al. (2020).*

IOP14: 5 Dec 2018

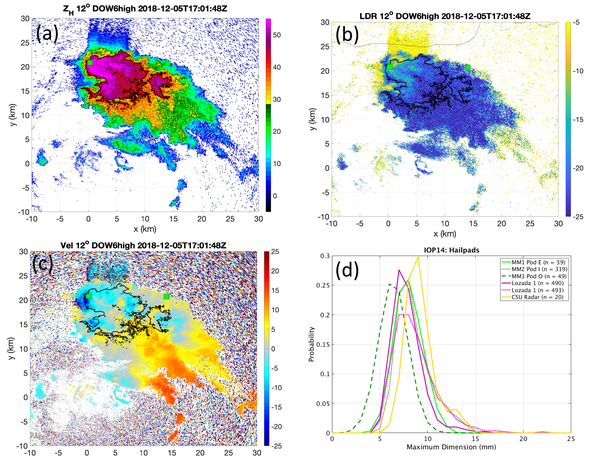


Fig. 12: *DOW7-observed (a) Z_H, (b) LDR, and (c) mean radial velocity, taken at 12° elevation angle. Overlaid markers show hailpad locations. (d) Distribution of hail maximum dimensions estimated from various hailpads; Pod E and Pod I are shown in (a)-(c).*

IOP17: 13-14 Dec 2018

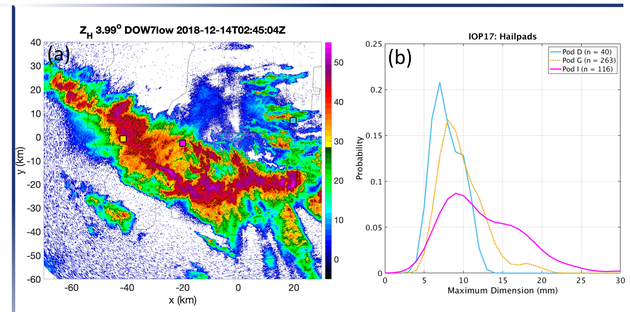


Fig. 13: *(a) DOW7-observed Z_H, taken at 4° elevation angle. Overlaid markers show hailpad locations, color coded with panel (b). (b) Distribution of hail maximum dimensions estimated from various hailpads. The multimodal distribution sampled at Pod I is likely owing to several convective cells passing over the same hailpad.*

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