Wind speed suppression by large buildings in hurricanes
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Near surface (<100 m above sea level (ASL)) ultra-fine-scale DOW\(^1\) radar velocity data reveal a systematic decrease in wind speeds in the hurricane boundary layer in the wake of tall structures. This wake persists for a couple to a few kilometers. Analyses of DOW data showing these effects obtained during the landfall of Hurricanes Frances (2004) are presented. Radar sweeps obtained at 0.5 and 1.1 degree elevations are analyzed on both sides, upstream and in the wake, of large buildings, such as shore-front condominiums. Differences in the decrease of wind speeds as parcels proceed across barrier islands with and without structures are compared.

**Methodology**

**DOW deployment sites and building group used for quantitative analysis.**

Above. Two DOW radars recorded wind flow across the buildings (blue box, inset and close-up photograph), each from a different range and Doppler angle.

Google Earth Street view of buildings looking SE. Buildings are about 45 m tall.

**Experiment 1: DOW2**

- Average of 27 0.5-degree elevation (75 m AGL at Target) scans.
- Target line speeds reduced by 4-5 m s\(^{-1}\) (17%) 1 km downwind.
- Speed reduction in lee of barrier island (blue dashed line) is evident.

**Experiment 2: DOW3**

- Average of 77 1.1-degree elevation (100 m AGL at Target) scans.
- Target line speeds reduced by 7-8 m s\(^{-1}\) (28%) 1 km downwind.

**Experiment 3: DOW3**

- Average of 14 0.5-degree elevation (55 m AGL at Target) scans.
- Speeds reduced by 9-10 m s\(^{-1}\) 0.5 km (29%) downwind.
- Wind shadows remain despite turning and strengthening of wind during eye wall approach.

**Results**

Graphs (far left column) display the reduction of wind speed in the wake of the buildings (solid black) as a function of distance downwind of the barrier island, and in the wake of no large obstructions (dotted/dashed lines) for comparison. Same lines are plotted on maps of average VR in right column.

**Results of three experiments depicted here show the following:**

1. Averaging of many scans reduces the magnitude of wind streaks allowing wind shadows to be seen. Especially apparent in Experiment 2 using 77 scans.
2. General reduction of wind strength lee of barrier island. Especially apparent in Experiment 1 with wider domain.
3. Reduction of wind strength by 20-30% in wake of 45-m tall “Target” line of buildings.
4. Individual above-average height buildings identifiable as reductions in wind field strength. Apparent from photographs in Experiment 3.
5. Results robust to:
   a) Radar being used (Experiment 1 vs. others)
   b) Wind direction (Experiment 3 vs. others)
   c) Wind strength (Experiment 3 vs. others)
   d) Elevation of scan (Experiment 2 vs. others)
   e) Distance to target (Experiment 1 vs. others)
   f) Obstruction size (Photographs in Experiment 3)

\(^{1}\) DOW radars sample every 0.4 deg in azimuth and 37 m (DOW2), 62 m (DOW3) in range completing each scan every 9–120 seconds depending on scan strategy.

\(^{2}\) The objective analysis is a two-pass Barnes scheme using kappa = 0.002 m\(^{2}\) and gamma = 0.3. Dx = Dy = 20 m. One sweep was used for each analysis time.

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