The Australasian Wind Engineer

www.awes.org

Welcome Wind Engineers to the first AWES Newsletter of the year!

You will see we have a slightly new format that we have adopted to issue more frequent (albeit smaller) newsletters throughout the year.

This year will also see a push into social media, and all the details on how to access AWES via these portals is within.

As always, a newsletter cannot exist without news, so any stories, photos or information on upcoming events will always be appreciated.

And finally, as for the best collective noun for a wind engineer…..the winning entry goes to a "Gust" of Wind Engineers (a frightening thought!).

Cheers,

Leighton

Editor: Leighton Aurelius, newsletter@awes.org

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Chairman's Message: AWES Committee elections

Chairman: Matthew Mason, chair@awes.org

In December 2015 the AWES held its biennial elections to select its National Committee to lead the Society for the coming two years (2016/17). For the first time this was done through an online polling system, which ran smoothly and efficiently.

A group of 6 Committee members were voted in by members, with specific roles assigned by and from the Committee. Elected office bearers for 2016/17 and their associated roles are listed below:

- Matthew Mason (Chair)
- David Henderson (Secretary)
- Harry Fricke (Treasurer)
- Leighton Cochran (Website management)
- Leighton Aurelius (Newsletter editor)
- Richard Flay (NZ representative)

Through the Society's constitution, the National Committee has the capacity to co-opt a further two members. As has become general practice, the Chair of the Organising Committee of the next AWES Workshop is co-opted (Leo Noicos), and Daniel Smith's co-opted role aimed at enhancing the Society's social media presence has been extended.

The National Committee would just like to take this opportunity to thank members for their involvement in the Society and for the faith they have placed in us to ensure it stays a vibrant, valuable and engaging society to belong.

A number of new initiatives will be rolled out over the coming year, and we look forward to sharing these with you as they unfold. In the end though, this is your AWES, so if you have any suggestions, concerns or comments please do not hesitate to contact me at **chair@awes.org**.

AWES Membership Fees

Treasurer: Harry Fricke, treasurer@awes.org

Membership fees are now due for the two-year period 2016-2017. Online payment is available through the AWES website with Mastercard or Visa or by direct bank transfer. You may still pay by cheque by contacting me directly but I certainly encourage everyone to use the new system.

Membership fees are unchanged:

- Undergrads: free

- Postgrads: $40
- Full members: $95

Make sure you download your membership certificate, print it and display it with pride. Please also keep a copy of your payment receipt for tax purposes.

Workshop Update

AWES Workshop Chair: Leo Noicos,

A final reminder - abstracts are due 8th March 2016, and please notify leo.noicos@adelaide.edu.au for further information.

Notification of acceptance of abstracts will be made on 5th April 2016 requesting authors to submit their final paper(s) to a prescribed format (which will be issued along with the acceptance).

Tickets for attending the Workshop are now on sale with all the details to book and pay online - follow the links on the AWES website.

Social Media News

AWES Social Media Editor: Daniel Smith

AWES is on social media! For the most up to date information, please follow AWES on:

- **Facebook:** www.facebook.com/windengineering
- **Twitter:** @AusWindEngineer
- **LinkedIn:** search "Australasian Wind Engineering Society" to see our group

You can also find more information about AWES and the 18th AWES workshop at:

www.awes.org/events/awes18

Technical Note - Kurnell Tornado and Thunderstorm Outflow Events: 16 December 2015

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Kurnell, New South Wales (NSW) experienced both tornadic supercell and thunderstorm outflow winds on 16 December 2015. Both were measured by the Bureau of Meteorology (BoM) Automatic Weather Station (AWS), providing a unique opportunity to analyse (at least at a single point), the wind field of two localised convectively driven wind events. This article briefly describes a meteorological synopsis of activity on 16 December that led to the two wind events, a description of the one-minute AWS wind data captured at the Kurnell and Sydney Airport AWSs, and an overview of damage survey work carried out by CPP wind engineers and researchers from The University of Queensland.

Meteorological Synopsis and Wind Records

The supercell that went on to produce what is believed to be tornado damage in Kurnell originally formed southeast of Port Kembla, NSW around 07:25 (local Sydney time) on 16 December. For the next two hours, the supercell continued to evolve as it tracked north-northeast along the coast of NSW. Rapid intensification was observed at 09:19 and was signified by a folded (e.g. aliased radial velocities that exceed the Doppler radar Nyquist velocity) Doppler radial velocity signature noted in the 0.9^{o} elevation plan position indicator (PPI) inbound radial velocity field (Figure 1). A distinct velocity couplet is also seen in this PPI, which in this instance signifies strong rotation associated with the supercell mesocyclone at approximately 650 m elevation. A clear hook-echo is also evident in radar reflectivity PPIs (not shown), again signifying localised rotation in the vicinity of the Kurnell region and AWS.

As the tornadic supercell continued moving north-northeast, the BoM AWS located on a jetty north of Kurnell recorded a maximum three-second gust of 213 km h^{-1} at 10 m above ground level (Figure 2, upper). This was the strongest wind gust ever recorded by a BoM AWS station in NSW. The gust factor ($G_{3,60}$, defined as the maximum three-second gust divided by the one-minute average wind speed) was 1.72 at the time of the maximum gust (Figure 2, lower). Inspecting the wind direction plot, Figure 2 middle, a sudden shift in the one-minute mean wind direction from 280 degrees to 200 degrees is shown in the few minutes around the peak. Winds continue to back from a southerly direction for the next ten minutes before gradually shifting through to the northeast over the next hour.

Inspecting then the Sydney Airport AWS, located 7 km to the north-northwest of the Kurnell AWS, a maximum gust of only 72 km h^{-1} at 10 m above ground level was recorded. The associated gust factor at the time was 1.49. Interestingly, the pattern of gust wind speed time histories, albeit lagged in time, is quite similar when the tornadic supercell passed over both AWS stations. The wind direction also followed a similar sudden shift to that measured at Kurnell, but the change was from an almost northerly direction through to south.

The surface observation at both sites, coupled with available radar images, show that a strong rear-flank downdraft (RFD) occurred, with different parts of this outflow measured by each tower. The significantly higher gust recorded at Kurnell does suggest some other localised mechanism (such as a tornado) was also recorded at that location, but it is not possible to conclusively say this based on the radar and AWS data alone. The rapid change in wind speed and wind direction could be reasoned to be that of an RFD alone.

Later in the morning, around 11:18 am, a convective thunderstorm complex developed east of Stanwell Park. The complex of thunderstorms followed a similar track to the tornadic supercell and travelled northward along the NSW coastline towards Kurnell. An outflow radar signature was noted in the 0.9o elevation PPI beginning at 11:25 and propagated over the Kurnell AWS around 11:49 (Figure 2). A maximum three-second gust of 111 km h-1 was recorded by the Kurnell AWS during the passage of the outflow and the gust factor was G3,60 = 1.59 (Figure 2, lower).

At the same time the Sydney Airport AWS measured a maximum three-second gust of 102 km h-1 and gust factor of 1.97. It was surprising to see the gust factor measured by the Sydney Airport AWS was larger than the Kurnell AWS gust factors computed during the passage of both the tornadic supercell and thunderstorm outflow. This second wind event displayed a more common, larger scale convective outflow signature than the first, and gusts near to the magnitudes recorded at Kurnell and Sydney Airport were measured at several stations across the Sydney basin. A sudden wind direction shift from northeasterly inflow to southwesterly outflow was recorded almost simultaneously at both stations, along with a 4-5oC drop in temperature.

Of note was that maximum wind gusts at both sites occurred several minutes after the outflow was first recorded. This second outflow provides an interesting counterpoint to the first and highlights differences that can exist between different wind events associated with convective thunderstorms.

Damage Surveys

Following the storms, several damage surveys were undertaken by Matt Glanville from CPP and Matthew Mason and Richard Krupar III from The University of Queensland to assess damage incurred to the built and natural environments in Kurnell. Surveys were carried out in the worst affected areas with notional Enhanced Fujita scale (EF-Scale) damage categories assigned to buildings based on observable damage from the street. Figure 3 highlights the streets and paths surveyed by both teams as accessed by car and mountain bike. Surveys were conducted during the afternoons of 17-18 and 24 December 2015. Photographic evidence and aerial photography in the media was also reviewed as part of survey activities.

Inspecting damage to structures throughout the Kurnell region, a swathe of about 200-250 m wide was evident moving north from the desalination plant into Botany Bay. Figure 3 maps all observed damage rated against the EF-scale with damage generally being assigned an EF0 or EF1 rating.

Based on our analysis of radar data the localised high-wind feature looked to approach from the southwest over Bate Bay, however little observed evidence of scouring or vegetation damage within the dunes of Greenhills Beach was observed (Figure 3). A small seaside hamlet comprising lightweight sheds and caravans is outlined by a rectangle in Figure 3. Residents reported seeing a tornado vortex pass to the west of them, thankfully missing their shelters. Moving northward into bushland there was clear evidence of tree damage, denuded and broken tree trunks and limbs.

Continuing north, the desalination plant lost metal deck sheeting over much of its roof plan with sheeting and insulation found deposited hundreds of metres from the plant. Much of Sir Joseph Banks Drive was littered with debris from this and other buildings (Figure 4). Distinct signs of multidirectional flow can be seen in the lower two images of Figure 4, where roof sheeting is seen deposited on all sides of the plant building. A clear swathe of sheeting is shown to the south (lower left) of the plant—this is the opposite direction to the movement of the storm—with sheeting also seen to be blown hard-up against the southerly side of the fence in the lower right image. Industrial units in the direct path suffered façade breaches including broken windows and lifted roof sheeting. On Chisholm Road a lorry was blown over onto an adjacent and thankfully empty parked car (Figure 5). As the tornado continued northwards crossing Captain Cook Drive it passed over roadside high voltage transmission lines, but no damage was evident to these structures. Similarly, no obvious damage could be sighted to the refinery east of Captain Cook Drive.

The tornado passed directly over the residential township of Kurnell northward to Botany Bay. Inspecting damage in the residential zone was reminiscent of surveying water spout damage in Lennox Head 2010 in that damage was confined to a finite width outside of which little permanent damage could be observed. (Figure 5). Roof damage was common to buildings in the damage swathe, with lifted roof sheeting, missing tiles and lifted solar panels observed. Temporary structures were also displaced (e.g. garden sheds, awnings a trampoline and fallen trees). An interesting video of the swathe captured by a drone flight (http://www.dailymail.co.uk/news/article-3363439/Drone-footage-shows-damage-Kurnell-tornado.html) shows the extent of damage through the township.

Parting Thoughts

In a rare occurrence, both a tornadic supercell and severe thunderstorm outflow passed over the Kurnell BoM AWS station on 16 December 2015. The peak recorded three-second gust of 213 km h-1 was well beyond what would be considered a 'design-level' wind speed, and in fact is well beyond the stated 10,000 year return period wind gust in AS/NZS1170.2 (0.2-second gust = 184 km h-1). Observed damage rated against the EF-Scale ranged from EF0 to EF1, which was somewhat surprising given the wind speed magnitude recorded. It is still unclear if a tornado vortex or RFD wind caused the maximum gust at the Kurnell BoM AWS anemometer, but given the magnitude recorded and location of the station with respect to observed damage, it is reasoned that a vortex was likely the cause. Future work will be carried out to confirm this hypothesis.

Acknowledgements

Survey work by UQ researchers was supported by a grant from the Australian Research Council (Project DE150101347). Discussion with Dr Bruce Buckley, Dr David Henderson, Dr John Holmes and Dr Jeff Kepert about wind data was also fruitful—but they can't be blamed for any of our mistakes!

Figures

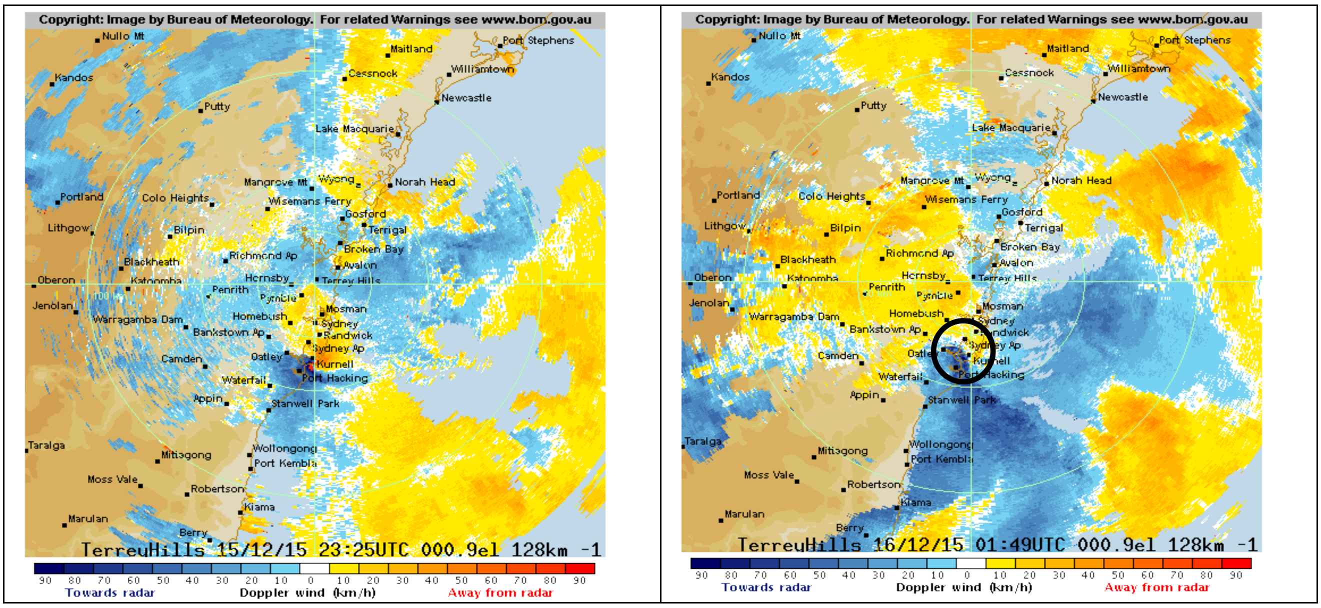

Figure 1. The 128 km 0.9o elevation PPI of Doppler radial velocity (km h-1) from the Terrey Hills Doppler radar at 09:25 (left) and 11:49 (right) on 16 December 2015. Cool colours represent inbound radial velocities towards the radar and hotter colours represent outbound radial velocities away from the radar. The thick red arrow in the left figure points to the folded radial velocities that exceeded the Nyquist velocity of the Doppler radar. The leading edge of the thunderstorm outflow winds is circled in black in the right image.

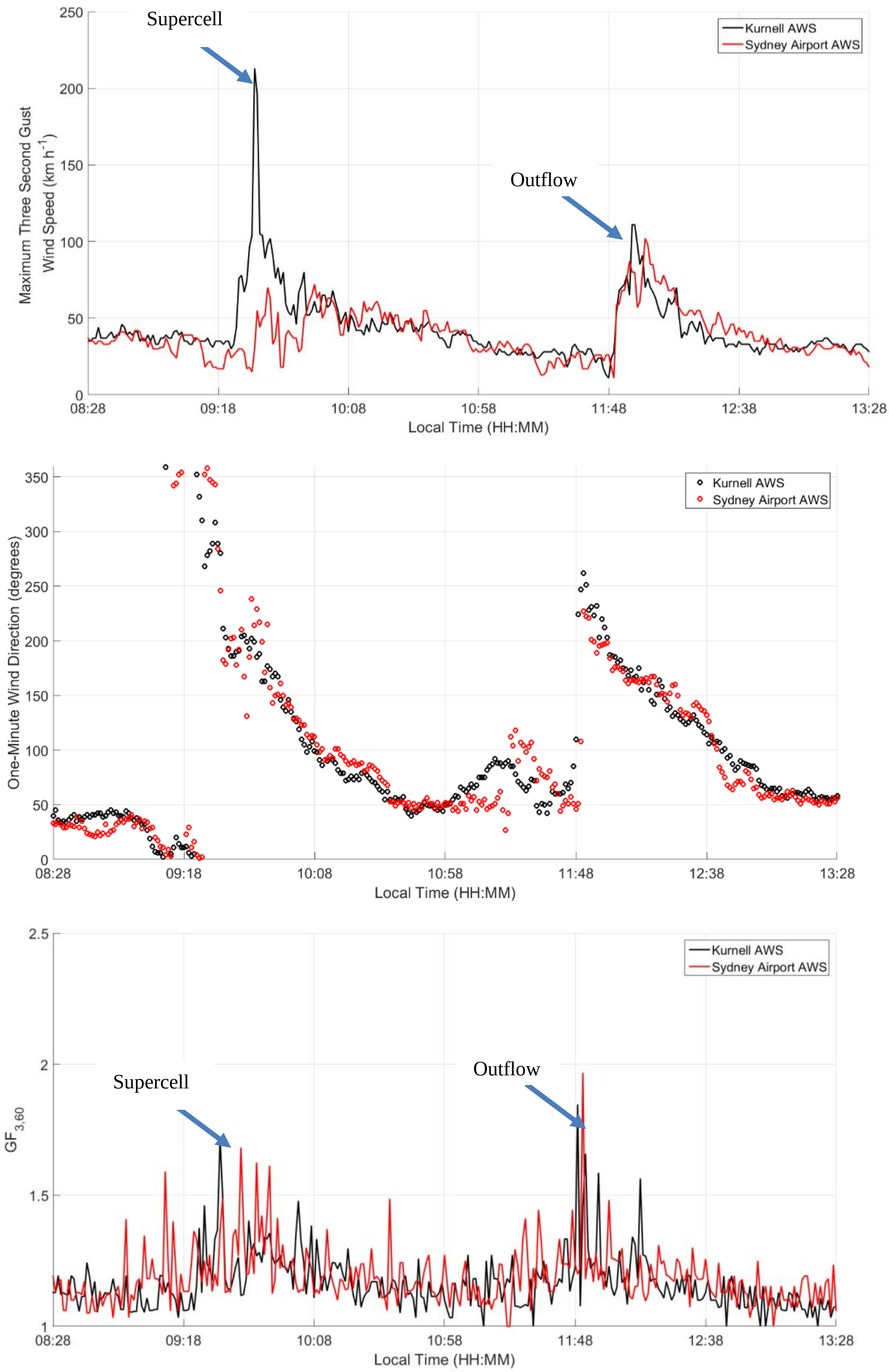

Figure 2. Kurnell (solid black line) and Sydney Airport (solid red line) AWS station maximum three-second gust wind speed time histories (upper), wind direction (middle) and gust factor (G3,60) (lower), during the passage of a tornadic supercell and thunderstorm outflow.

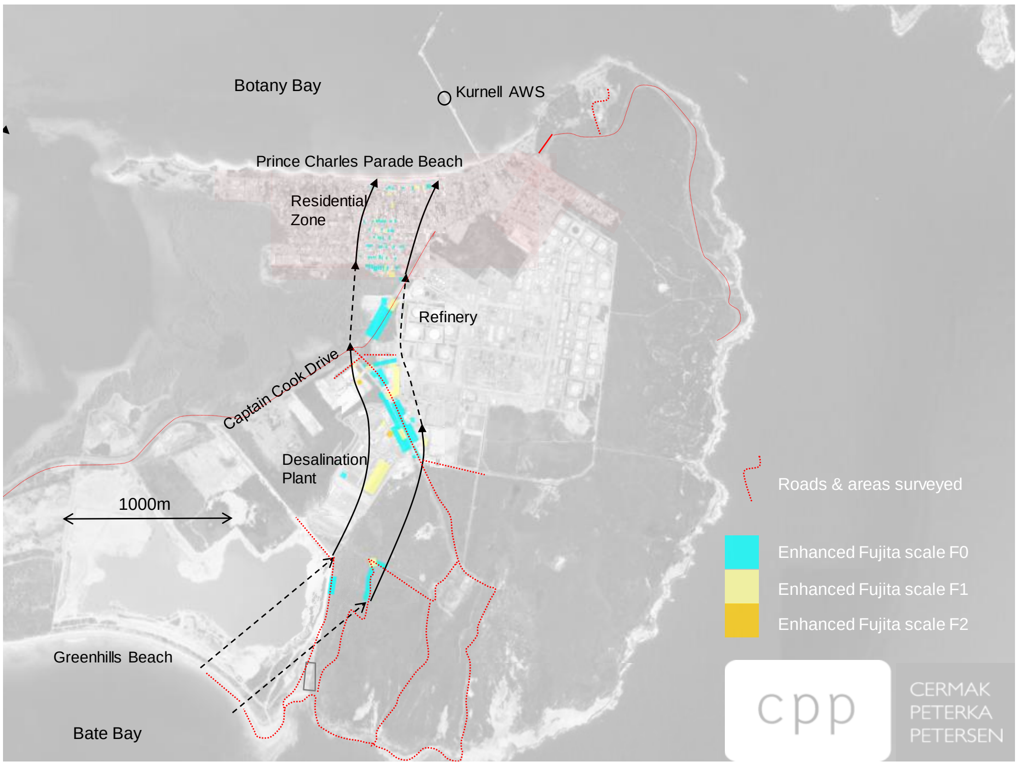

Figure 3. Streets and tracks surveyed by CPP and UQ survey teams. An approximate damage swathe is overlayed. Red lines indicate roads or tracks surveyed, while the Residential Zone (shaded red region) was surveyed either by car or on foot. Estimated damage swathe (dotted or solid black line) and associated EF-Scale damage ratings assigned to surveyed buildings.

Figure 4. Examples of the debris from the desalination plant and surrounding buildings. The upper two images are from Sir Joseph Banks Drive and the lower two images were captured by the Westpac Lifesaver Rescue Helicopter over the desalination plant.

Figure 5. Examples of damage to industrial buildings (upper two) and residential buildings (lower two).