



**PAE**

**PACIFIC AIR & ENVIRONMENT**



# Sub-hourly modelling and calms

Resolving anomalous (or pseudo) calms and their effects using sub hourly modelling time steps

# The Situation

- Investigating a large industrial facility with multiple sources of SO<sub>2</sub>
- Modelling in a coastal environment
- Had already modelled multiple years (6 yrs) using Bureau of Meteorology (BoM) stations only

# The Catalyst

- The catalyst for deeper analysis of the project was the addition of two monitoring stations, fitted with sonic anemometers, into existing modelling. This shifted maximum concentrations from onsite to offsite.

# Analysis of meteorology

- Analysis of the meteorology indicated that many of the BoM calms were occurring during changes in wind direction
- The stall speed of the most significant BoM station was high  $> 0.5$  m/s
- Therefore the calms in periods during wind changes were suspected of being related to vector averaging rather than a true calm event

# Observations

	Site 7 km NNW		On site		Site 14 km NW		Site 20 km W	
Date and time	Wind speed (m/s)	Wind direction (°)	Wind speed (m/s)	Wind direction (°)	Wind speed (m/s)	Wind direction (°)	Wind speed (m/s)	Wind direction (°)
26/09/2007 5:00	2.6	360	2.6	300	1.5	330	0	0
26/09/2007 6:00	3.1	328	2.6	330	1.5	320	0	0
26/09/2007 7:00	2.6	325	2.6	300	0.5	310	1.5	270
26/09/2007 8:00	2.1	303	2.1	290	2.1	300	0.5	320
26/09/2007 9:00	1.5	59	1.5	330	1	290	1.5	230
26/09/2007 10:00	3.1	171	0	0	1.5	50	2.6	340
26/09/2007 11:00	4.1	134	4.1	80	4.1	40	2.6	80
26/09/2007 12:00	6.2	78	4.6	80	4.6	70	4.1	50
26/09/2007 13:00	7.2	71	7.2	60	6.2	90	4.6	50

# Methodology to assess and correct

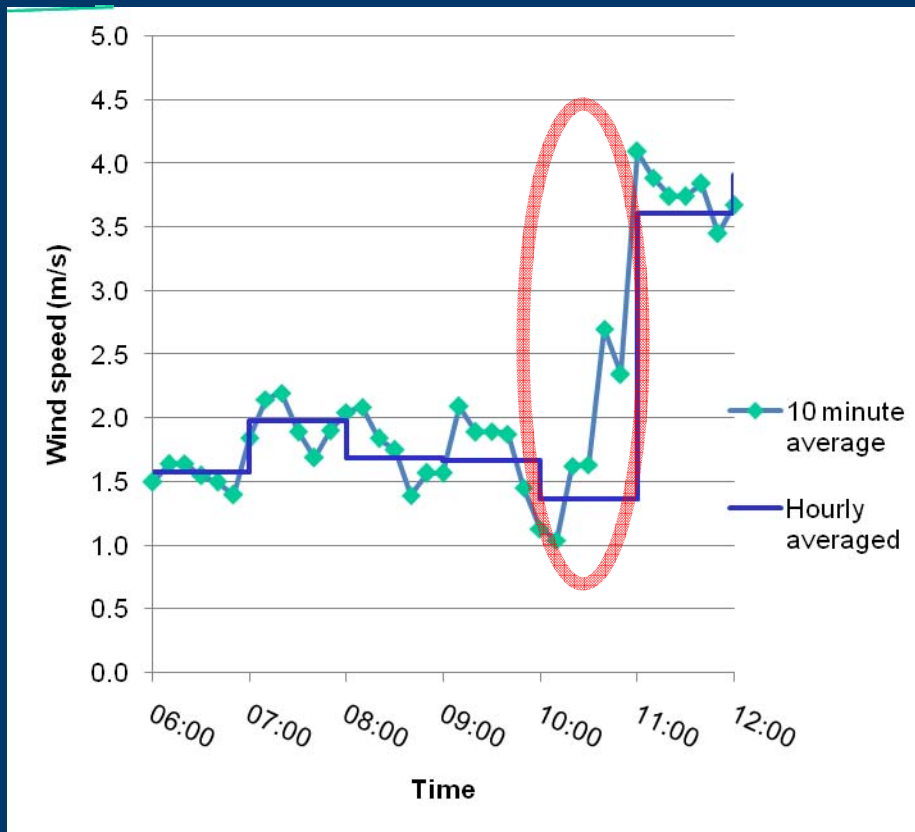
- Data was not available to analyse scalar vs. vector averaging of wind speed and direction at the BoM site
- However, the two new meteorological stations provided data with much better temporal resolution and lower threshold (< 0.1 m/s)
- Sub hourly timestep modelling was used to investigate problem hours more closely

# Sub-hourly modelling detail

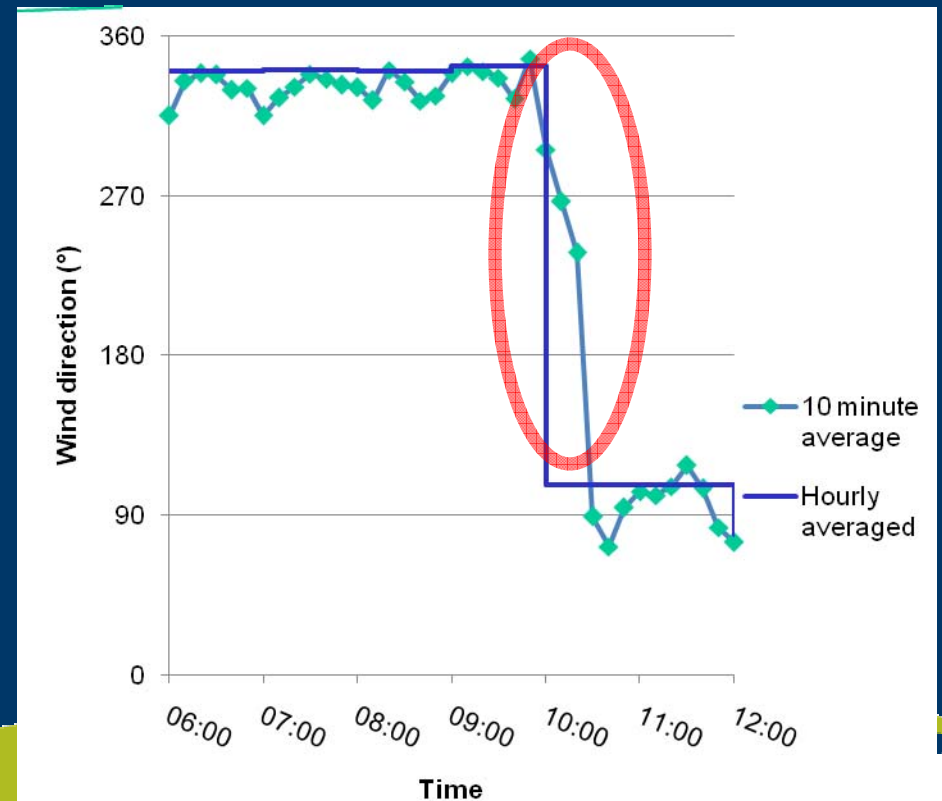
- Only periods of interest were modelled to save computation time
- 10 minute averaged winds for two new stations were incorporated into the met data
- Existing BoM stations were treated as readings from the last ten minutes of the hour
- Parameters such as cloud height, cloud amount, pressure and relative humidity were kept constant across the whole hour

# 10 minute v hourly averaged meteorology

## Wind Speed

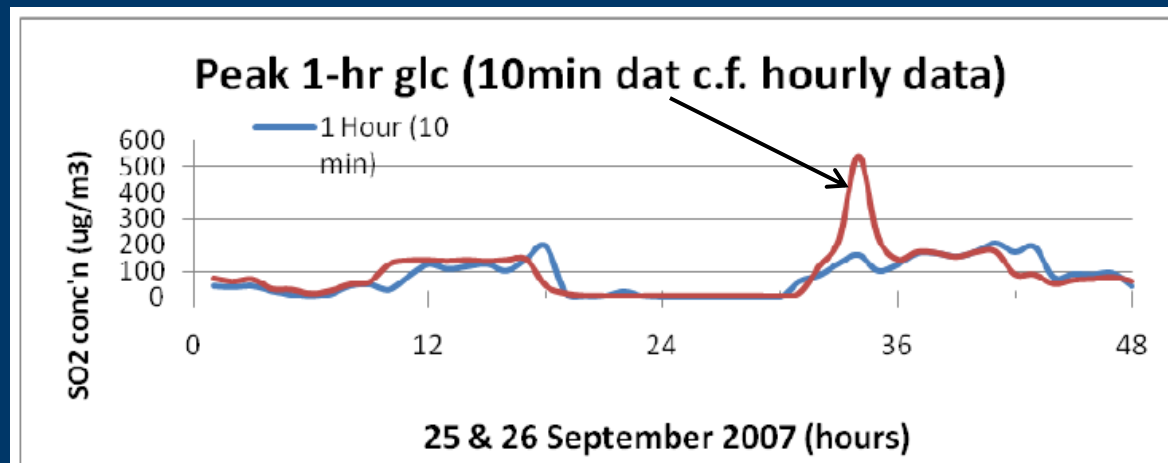


## Wind Direction

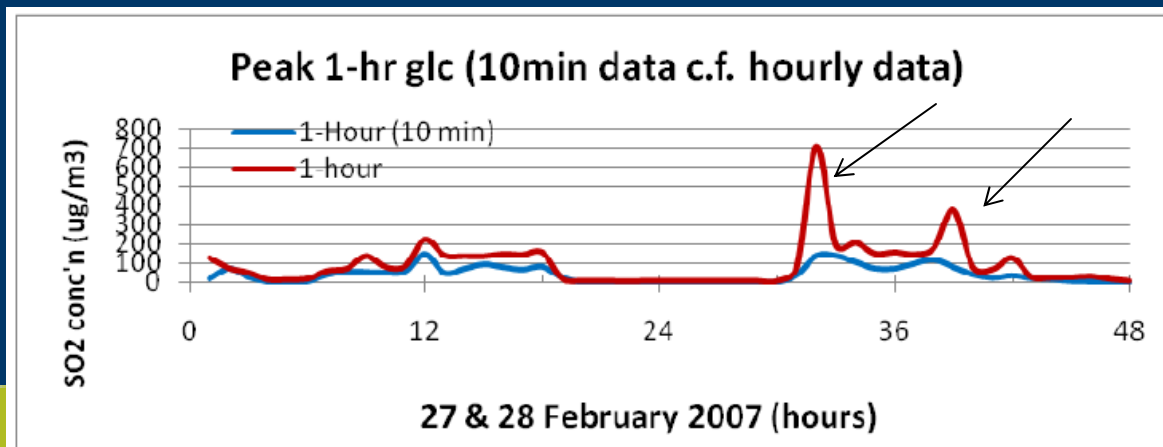
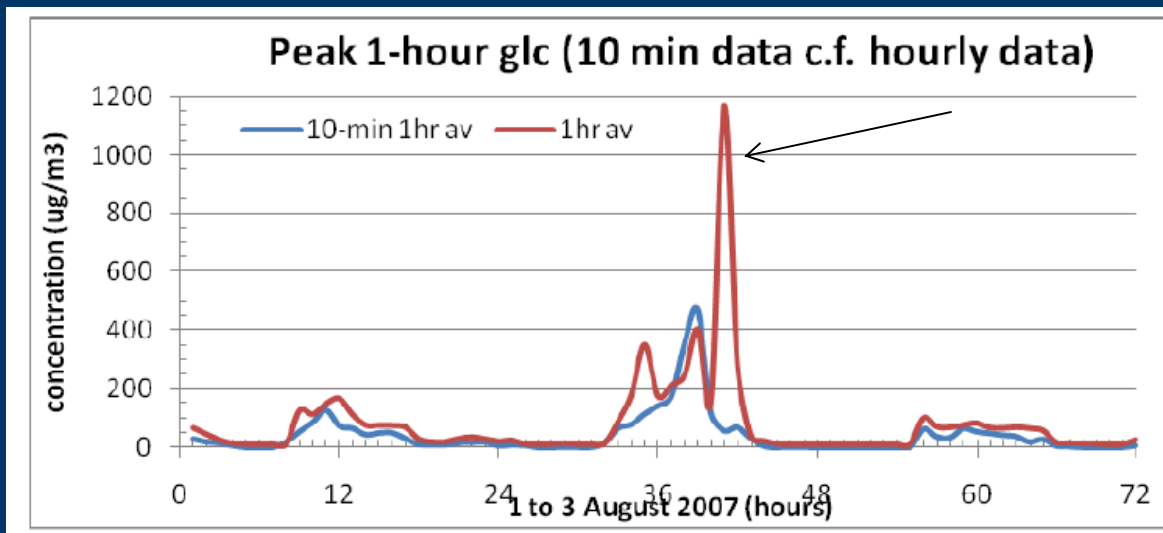


# Comparison of modelling results

Date	Time	SO <sub>2</sub> 1-hr µg/m <sup>3</sup>	SO <sub>2</sub> 1-hr (10-min) µg/m <sup>3</sup>	Difference Factor
2 August 2007	16:00	1169	489	2.4
28 February 2007	07:00	710	153	4.6
26 September 2007	09:00	539	176	3.1
24 December 2007	09:00	491	182	2.7



# To prove it was not a fluke



# Conclusions

- Vector averaging of wind speed can lead to “pseudo-calms” that mask a large shift in wind direction (particularly if the stall speed of the wind speed sensor is high)
- These pseudo-calms can lead to unrealistically high ground level concentrations
- Sub-hourly modelling represents a viable method of resolving issues of psuedo-calms, providing a more time-resolved and realistic answer

# Acknowledgements

- Bryan Beudeker – For a significant portion of the analysis
- Peter D'Abreton and Robin Ormerod for support
- The client