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Atmospheric mercury monitoring in Australia

Professor Peter Nelson



Sources, Transportation & Fate Study



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- Australian response required to UN initiative
 - Sources, transport & fate
 - Existing guidelines, standards, regulations
- In the face of:
 - Poor local emissions data
 - Anthropogenic
 - Natural (vegetation, water, soils, fires)
 - No local measurements of atmospheric concentrations or deposition
 - No capability to model transport and fate at continental scale
- Two reports to Australian Government

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Mercury Sources, Transportation and Fate in Australia

**Final Report to the Department of Environment, Water, Heritage
& the Arts
RFT 100/0607**

**Peter F Nelson, Hao Nguyen, Anthony L Morrison and Hugh
Malfroy**
Graduate School of the Environment
Macquarie University

**Martin E Cope, Mark F Hibberd, Sunhee Lee, John L McGregor,
Mick (CP) Meyer**
The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

December 2009

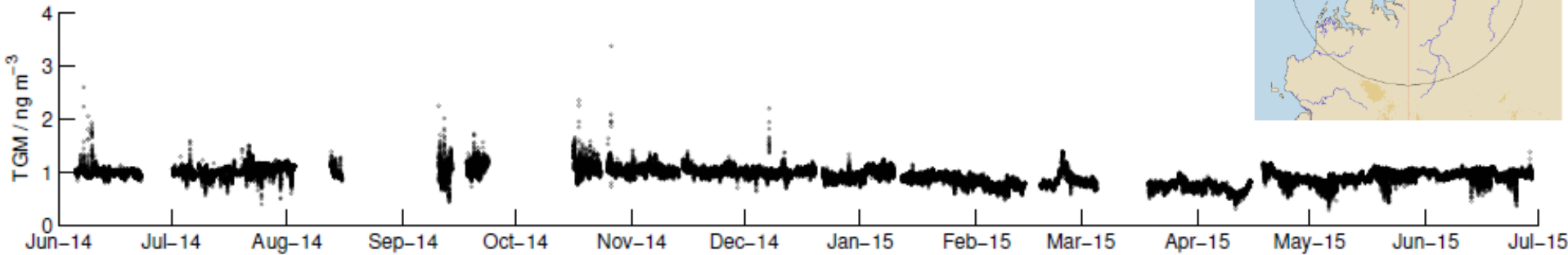
	Hg ⁰ (tonnes)	RGM (tonnes)	Hg ^p (tonnes)		Total Hg Range ¹ (tonnes)	(%)
Anthropogenic						
Industrial	10.7	2.4	0.9	14	10-18	7
Commercial, Domestic + diffuse	0.8	0.1	0.1	1.0	0.5-1.5	0.4
Natural/ Re-emitted						
Vegetation	8	0	0	8	4-12	4
Canopy-soil	54	0	0	54	27-81	27
Bare soil	86	0	0	86	43-129	42
Fires	33	3	5	42	21-63	20

¹ Based on reported uncertainty estimates (AMAP/UNEP 2008; Friedli et al. 2009b; Mason 2009)

See: Nelson, P.F., Morrison, A.L., Malfroy, H.J., Cope, M., Lee, S., Hibberd, M.L., Meyer, C.P.(M.), McGregor, J., Atmospheric mercury emissions in Australia from anthropogenic, natural and recycled sources, *Atmospheric Environment* (2012), doi: 10.1016/j.atmosenv.2012.07.067.

Mercury in Australia

- ▶ *First Australian Power Station Measurements of mercury species*
- ▶ *Australian inventory from all sources- informing response to Minamata Convention*
- ▶ *First gas phase concentrations of mercury in Australia - Almost no SH data, providing constraints and tests of global mercury modelling and mercury atmospheric chemistry*
- ▶ *Invitation to join the Global Mercury Observing System (GMOS) led by EU*
- ▶ *First measurements of mercury in wet and dry deposition*
- ▶ *First mercury measured in fires in Australia; emission factors, and firefighter exposure*
- ▶ *Member UNEP Expert Group on Global Inventory (2010 Global Inventory, 2018 Assessment)*
- ▶ *Lead author (non ferrous smelting and roasting), UNEP Expert Group on Minamata Convention*
- ▶ *Long-term measurements and modelling in Sydney, Hunter Valley and Northern Australia - Included in Global Mercury Observing System*

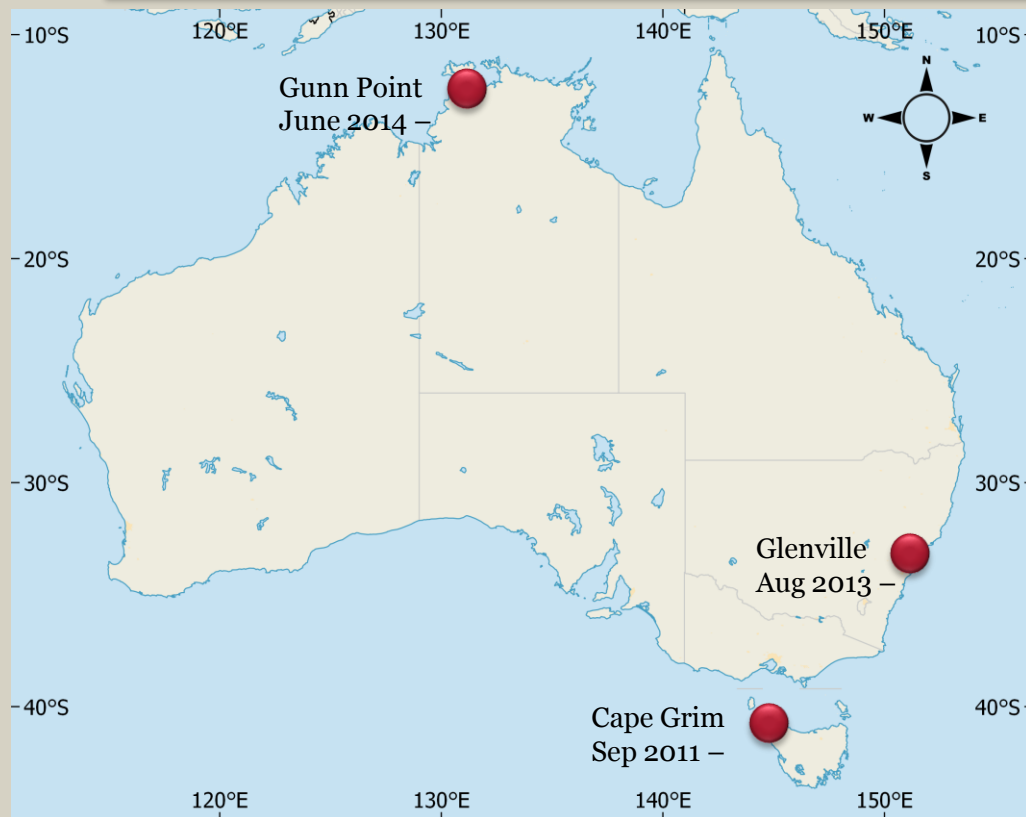


Atmospheric Mercury

AUSTRALIAN LONG-TERM MONITORING SITES



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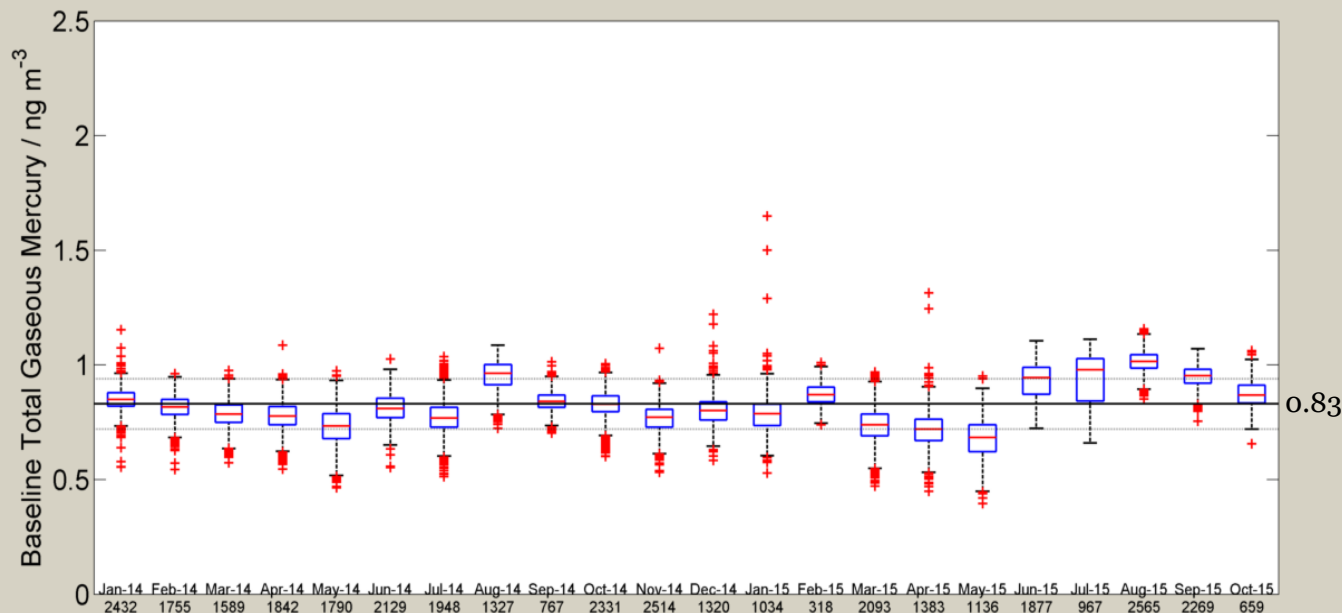
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Seasonal Variation

CAPE GRIM, Tasmania (40.7° S, 144.7° E)



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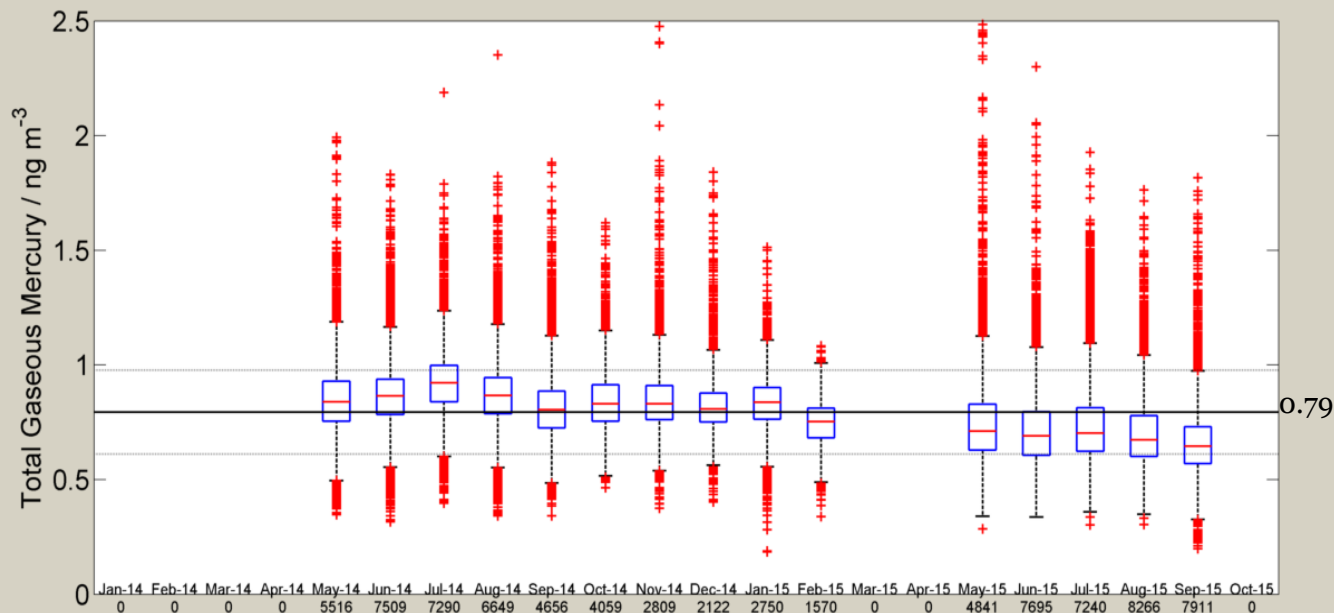


Seasonal Variation

GLENVILLE, NSW (32.4° S, 151.1° E)



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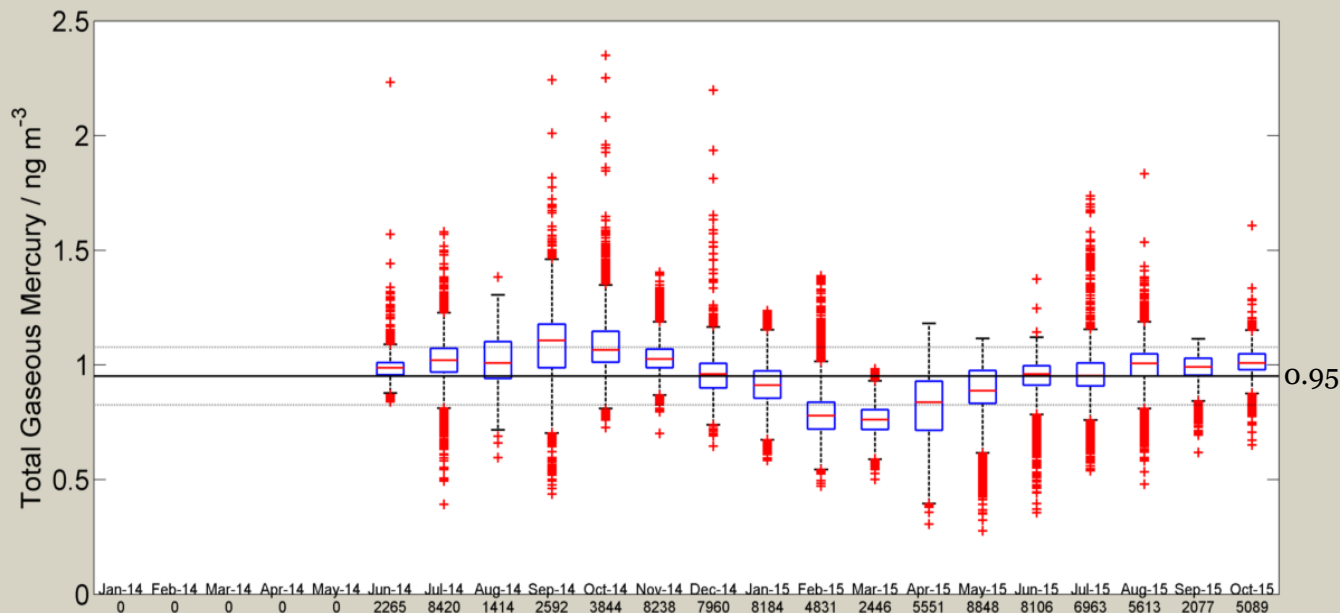


Seasonal Variation

GUNN POINT, Northern Territory (12.2° S, 131.0° E)



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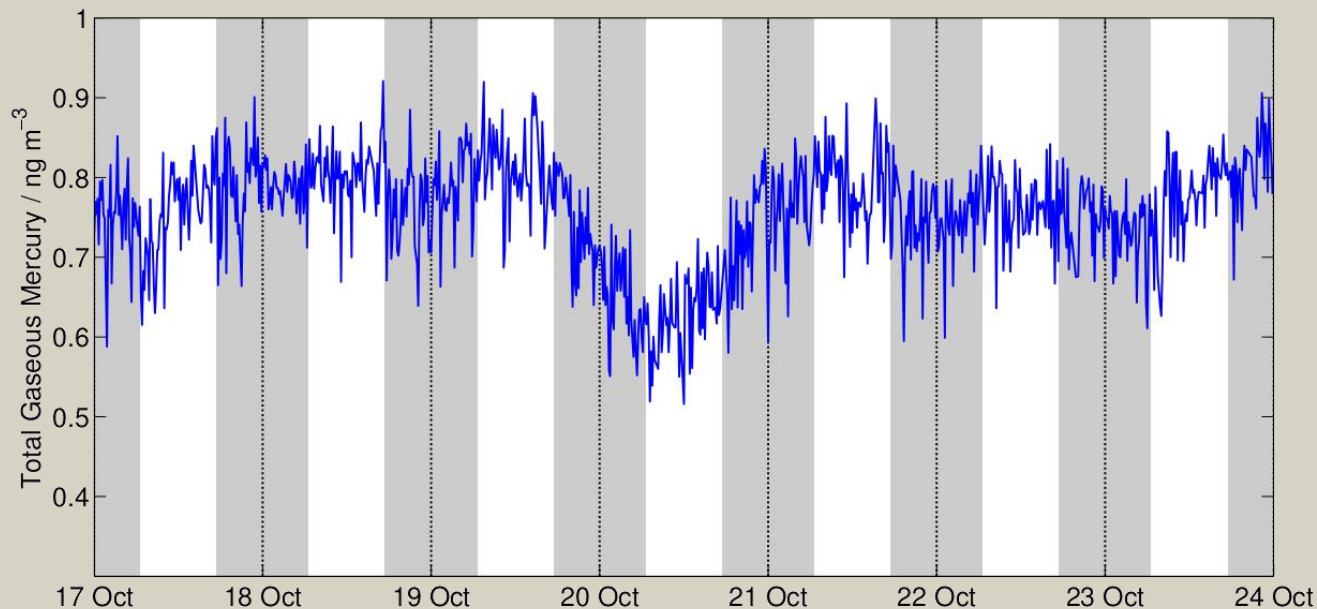


Daily Variation

CAPE GRIM, TAS



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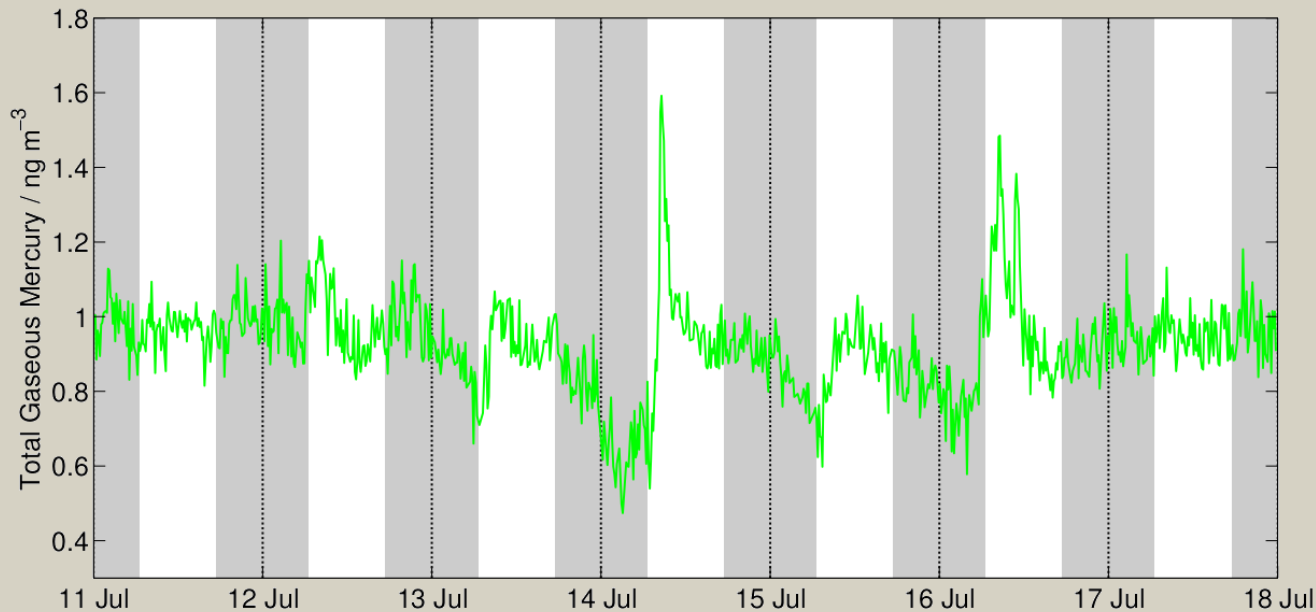


Daily Variation

GLENVILLE, NSW



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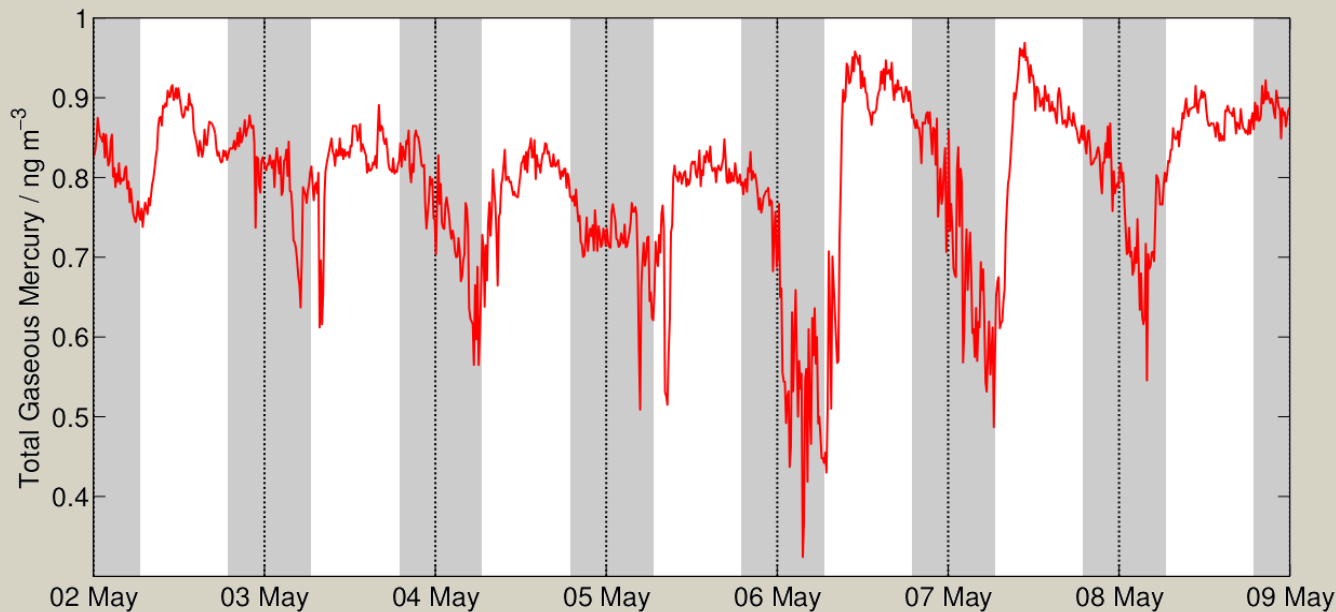


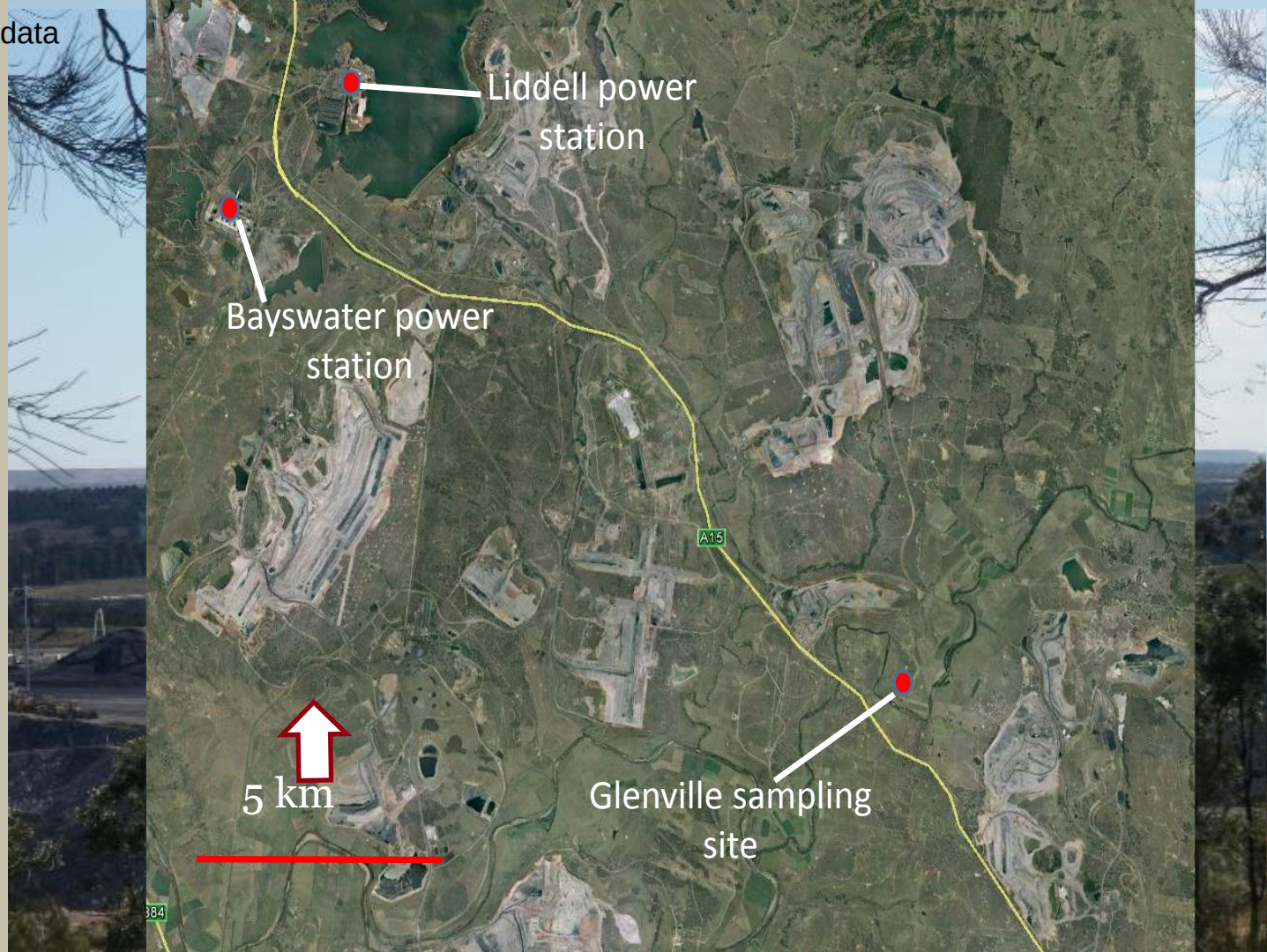
Daily Variation

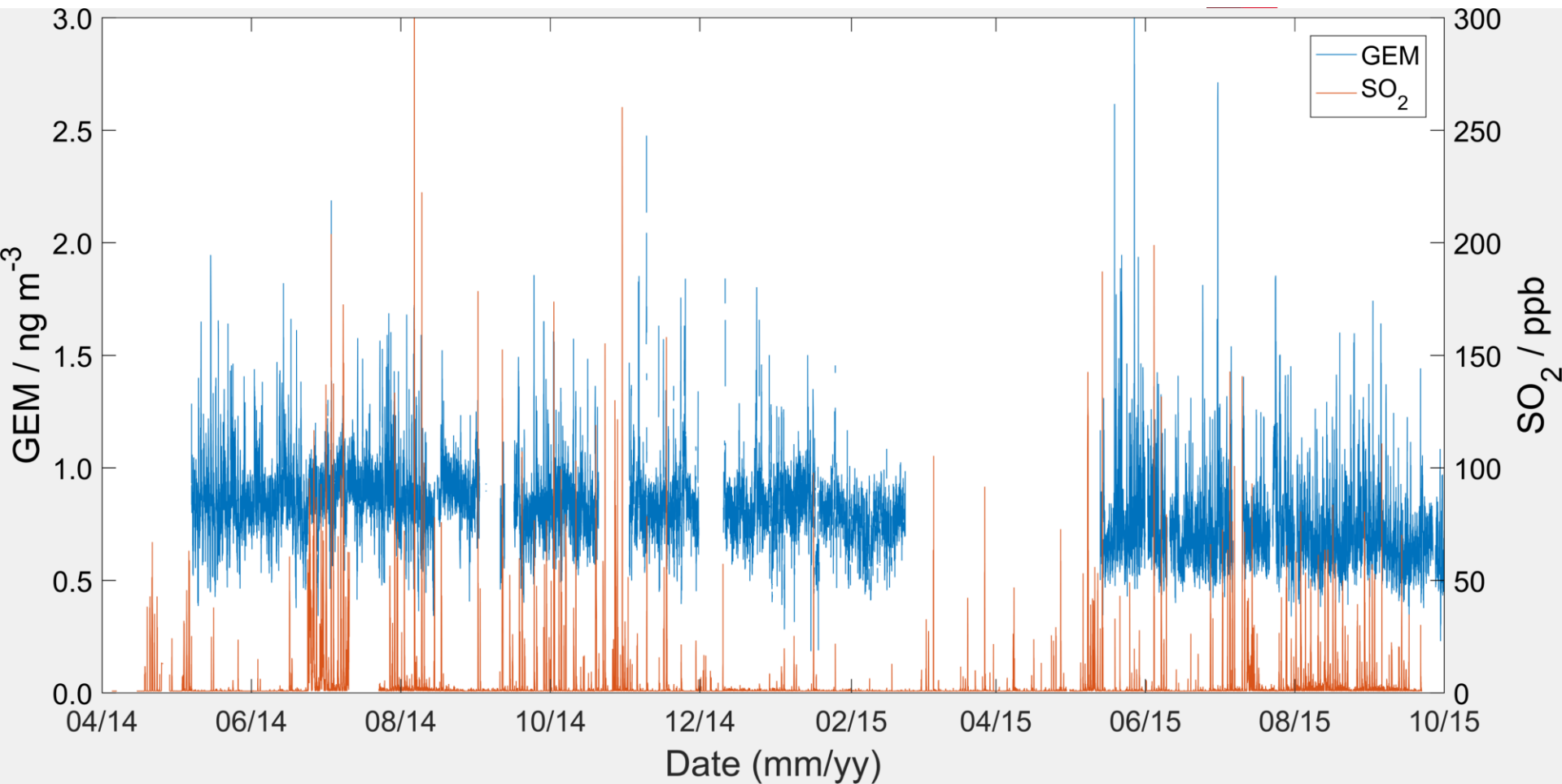
GUNN POINT, NT

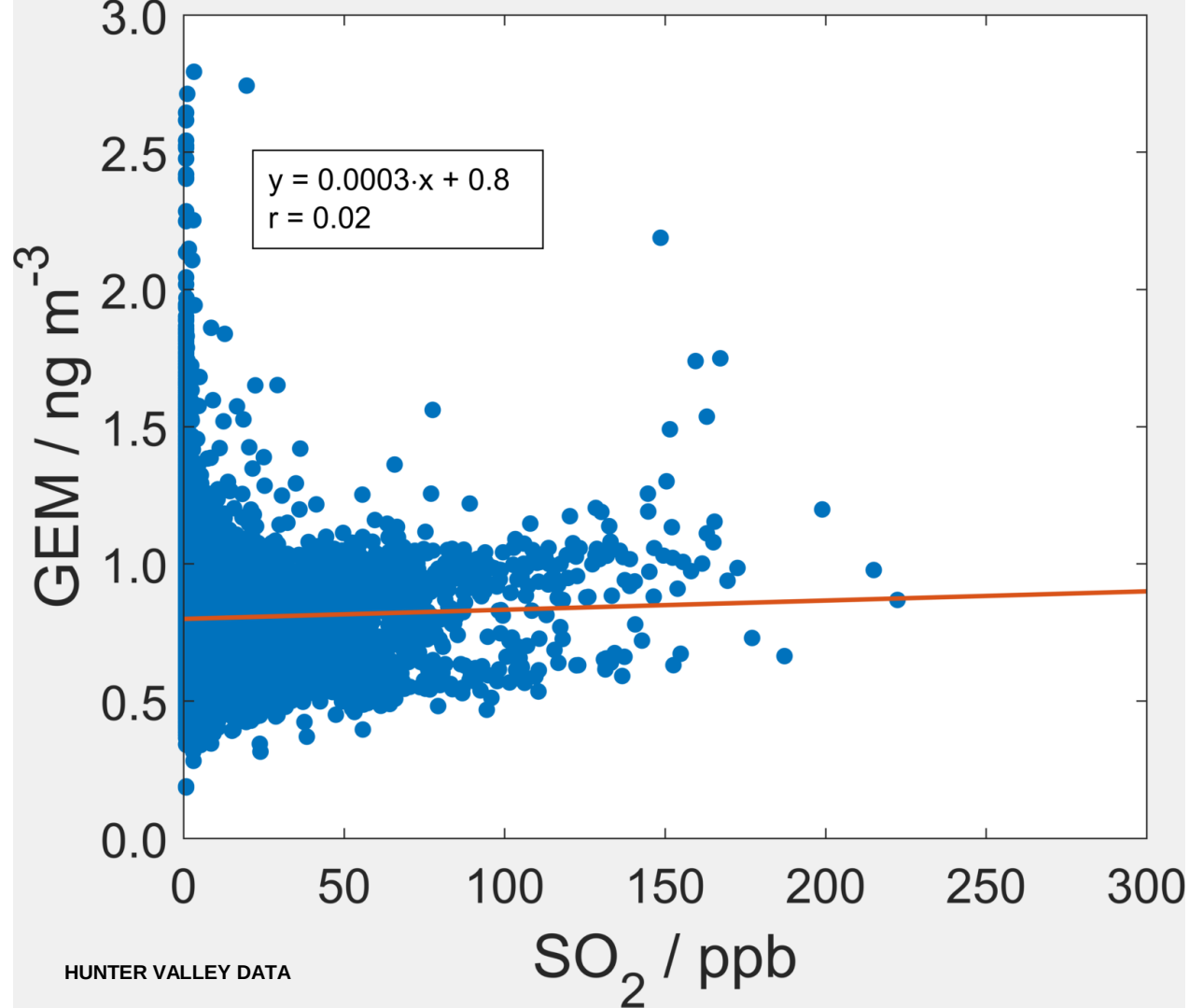


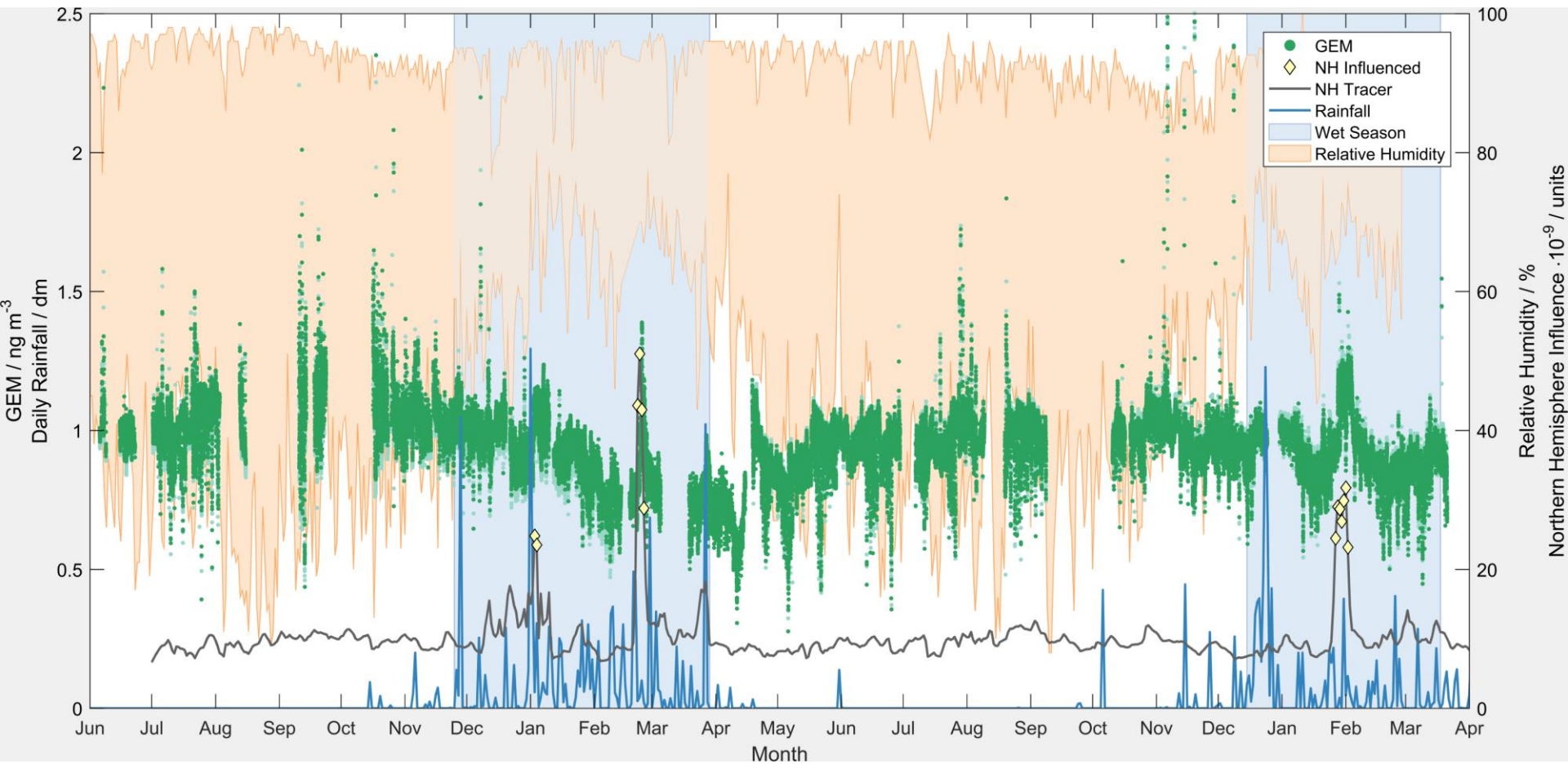
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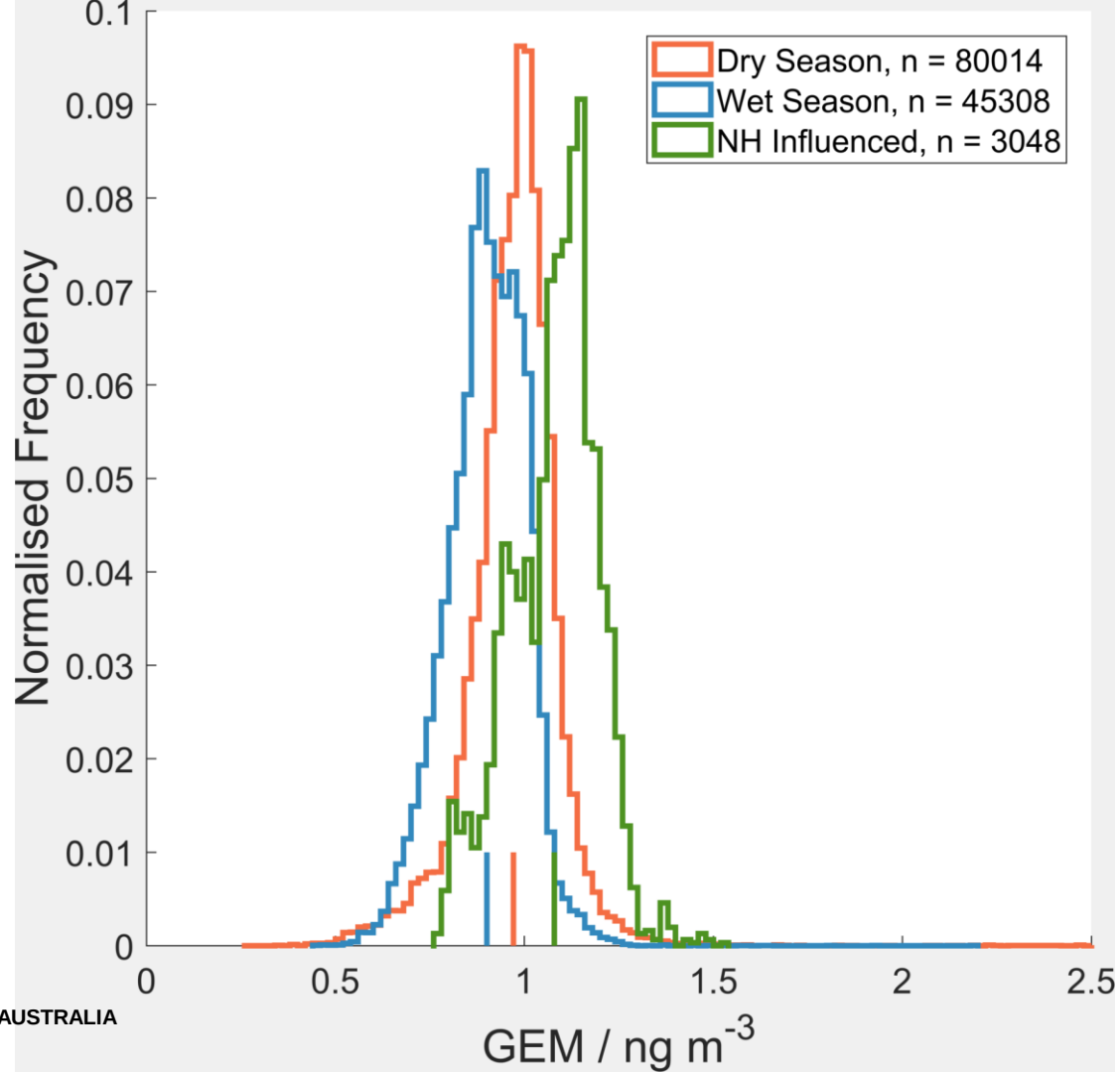


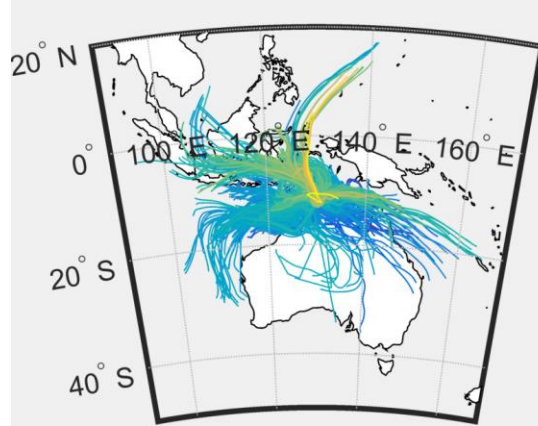




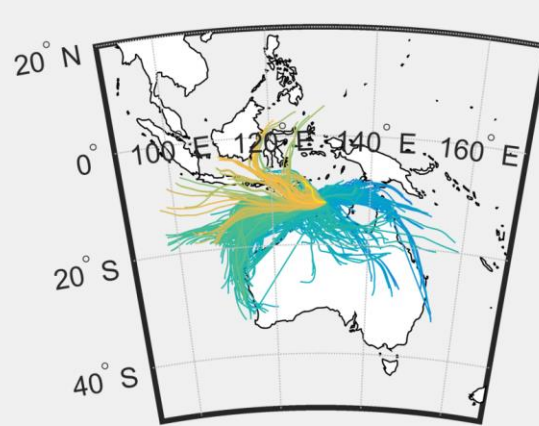


GUNN POINT, NORTHERN AUSTRALIA

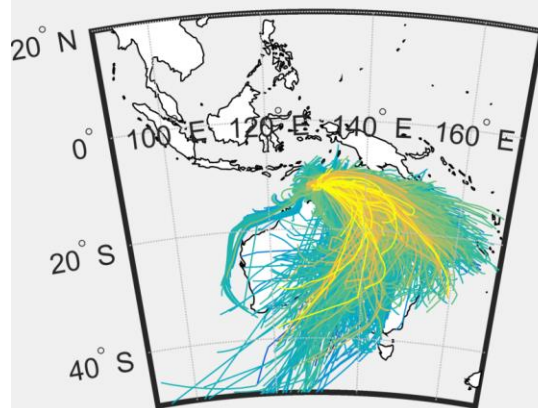
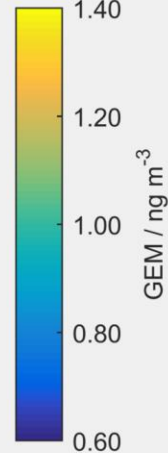




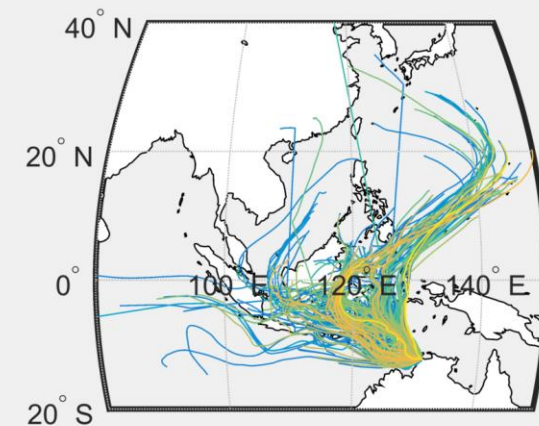
Wet Season 2014/15



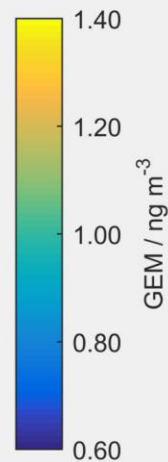
Wet Season 2015/16



Dry Seasons 2014-2016



NH-Influenced (Wet Seasons)



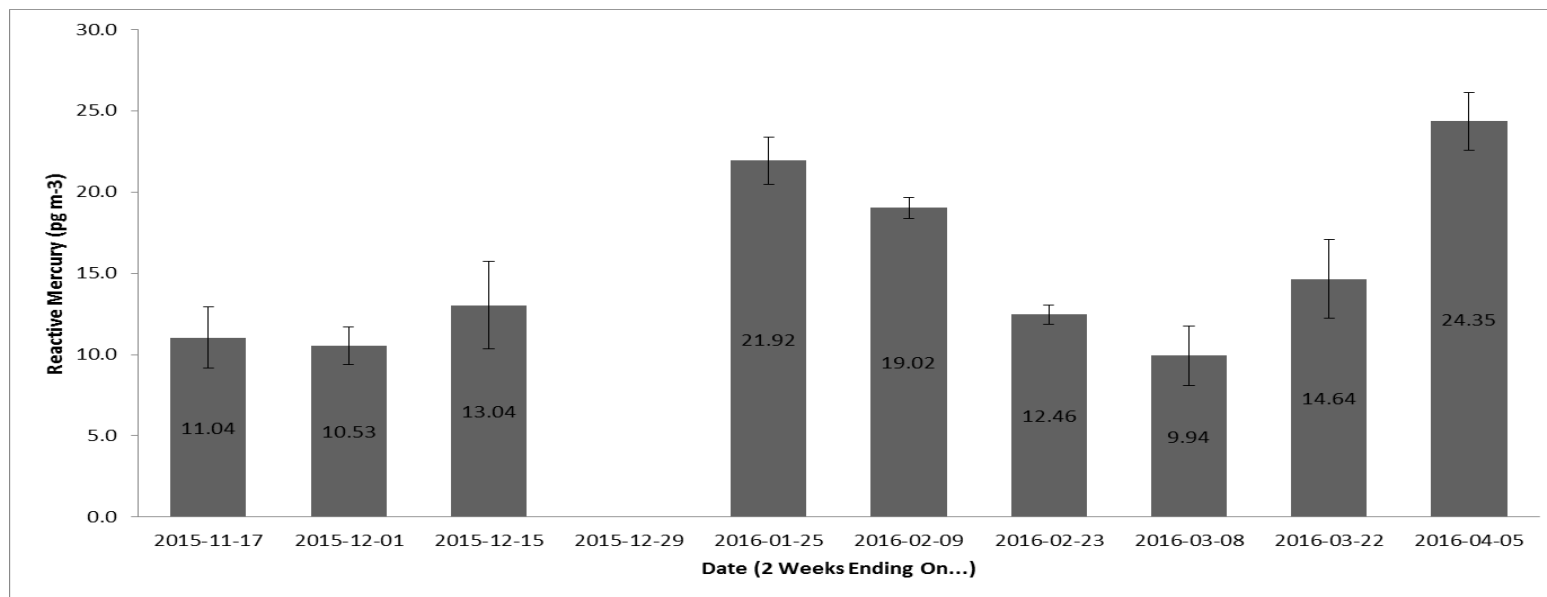
GUNN POINT,
NORTHERN AUSTRALIA



University of Nevada, Reno

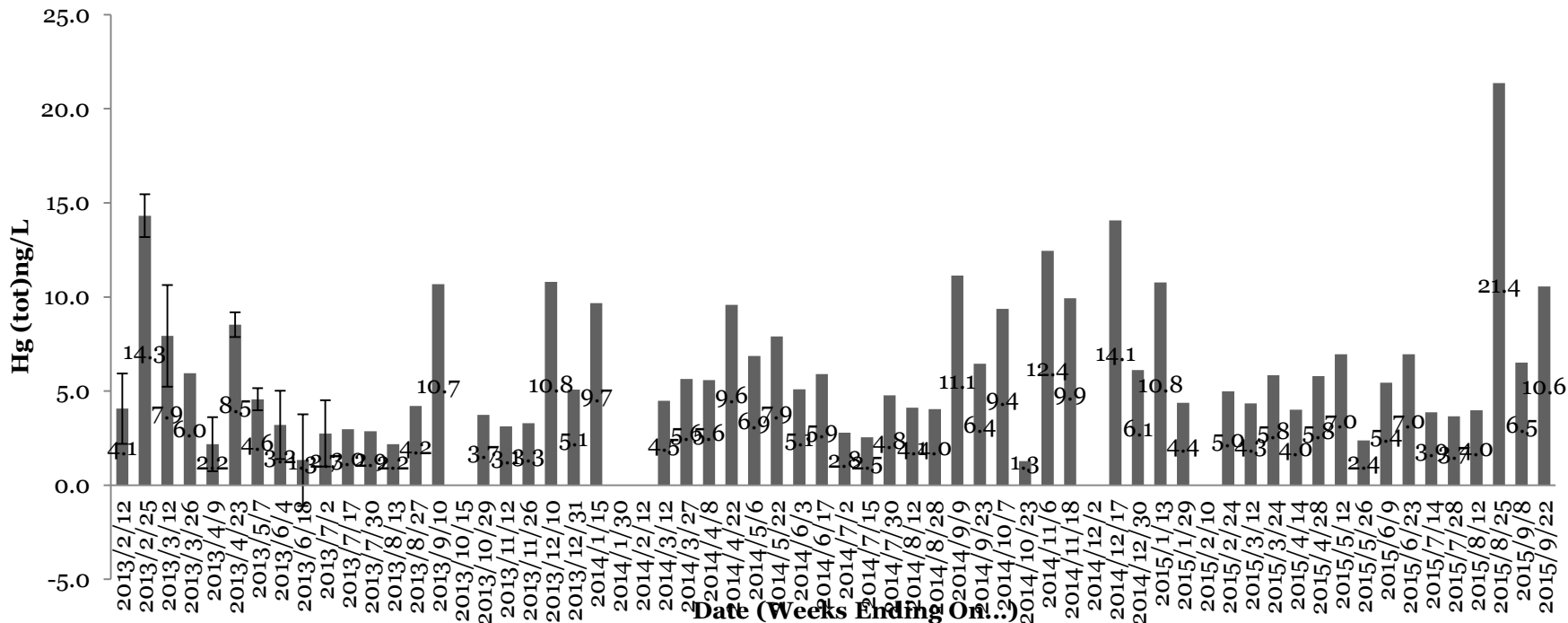


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Continuous Gaseous Oxidized Mercury Measurements at Cape Grim using CEM filter Technology

Matthieu Miller, Grant Edwards, Mae Gustin



Cape Grim Wet Deposition

Ingvar Wangberg

Modelling

EARLY DEVELOPMENTS



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- GEOS-CHEM used for Gunn Point Data (with University of Wollongong)
 - Ocean parameters: updated and original
 - AMS data
 - Sensitivities
 - Annual Trends
 - Diurnal cycle and depletion events
 - Dry deposition velocity
- Sydney and Hunter Valley data (with CSIRO)
 - CSIRO-CTM
 - depletion events
 - Variable success

I- Ocean parameters : Updated and Original

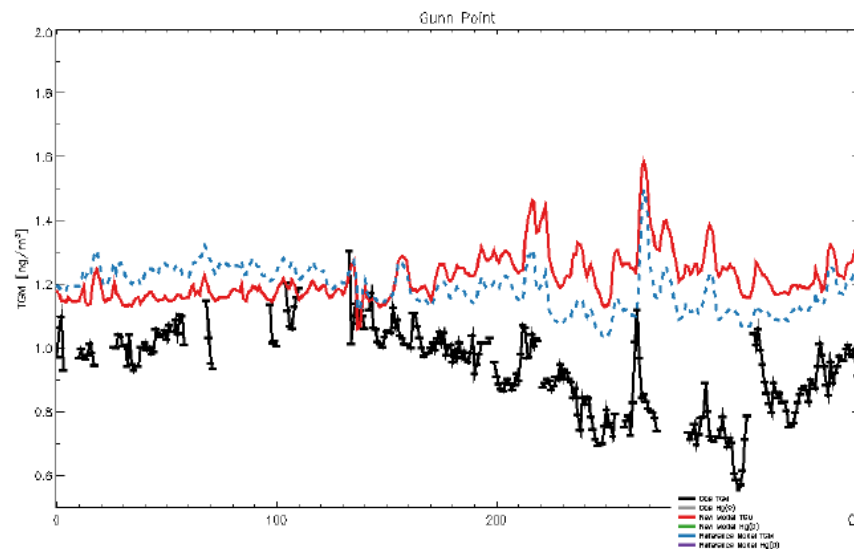


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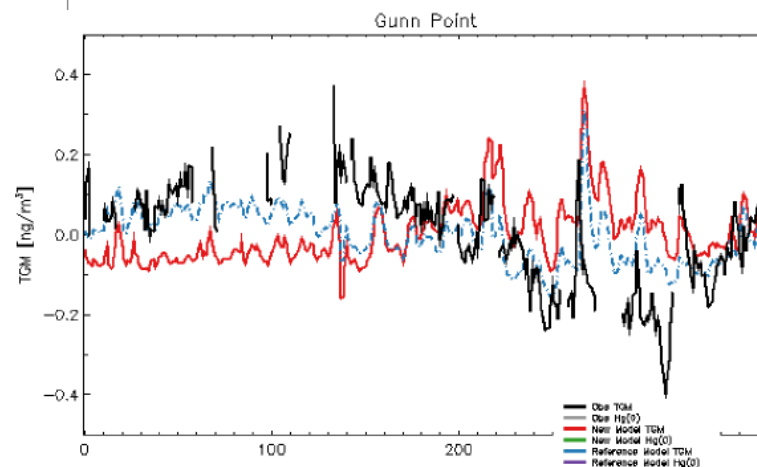


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Gunn Point 2014



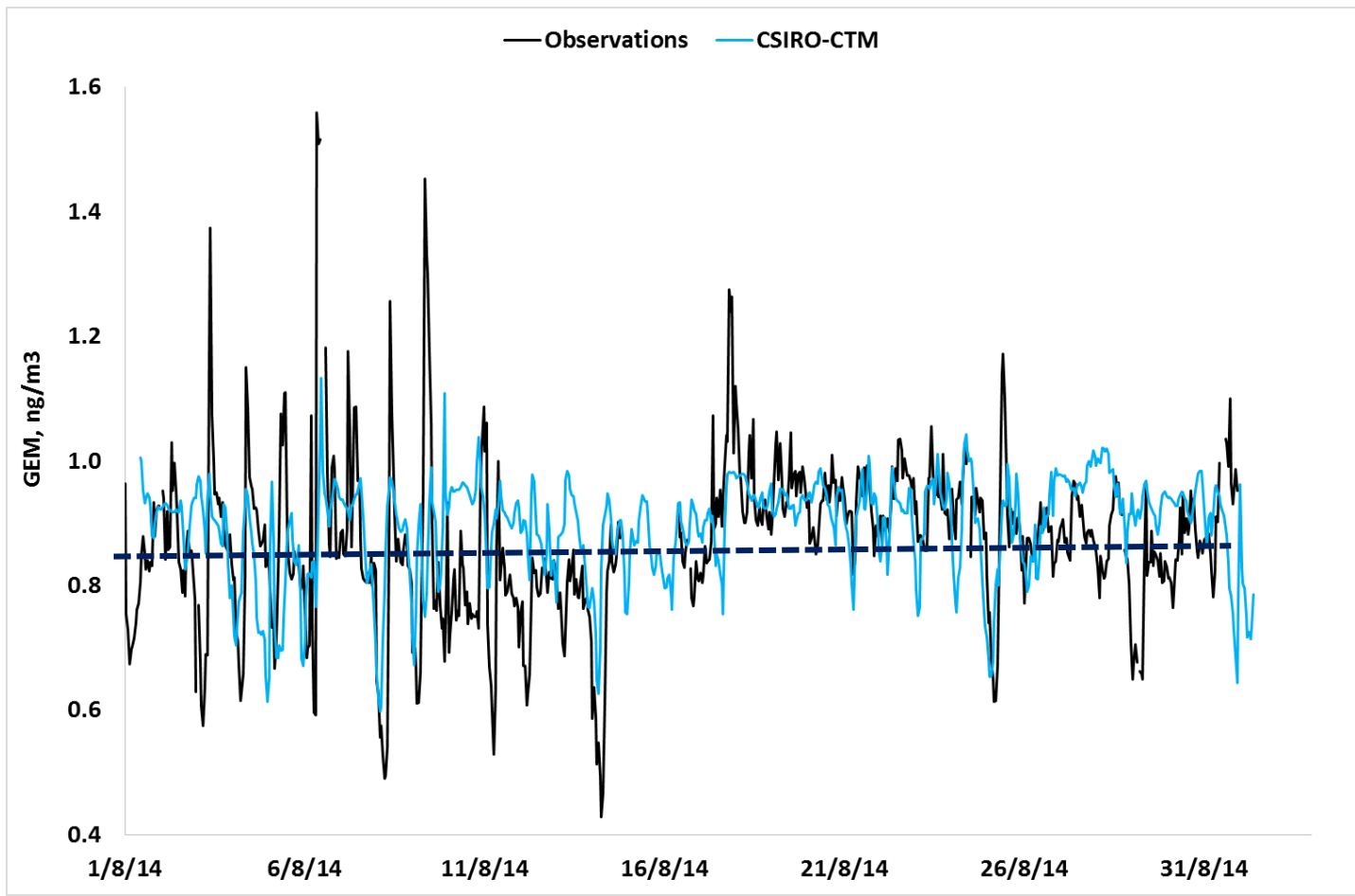
- Observations
- Original ocean parameters
- Updated ocean parameters



Glenville, Upper Hunter, August 2014



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In Summary

SEASONAL VARIATION AND LONG-RANGE TRANSPORT



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- Australia's emissions relatively low and dominated by industrial sources particularly non-ferrous sector
- Natural and re-emitted sources dominate over anthropogenic sources; fires significant particularly in northern Australia
- Atmospheric mercury measured at several sites since 2011
- Atmospheric mercury in temperate Australia may be relatively stable
 - Annual trends at Cape Grim similar to those shown in Slemr *et al.* (2015)
 - Similar mean concentration at Glenville, though with complicated sources
- Atmospheric mercury at Gunn Point shows significant annual variation
 - Higher median concentrations during dry season compared to wet
 - Maximum difference in monthly medians 0.35 ng m^{-3}
 - Northern hemisphere and fires contribute

In Summary

DAILY VARIATION AND DELIVERY TO ECOSYSTEMS



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- Both Glenville and Gunn Point show intermittent periods of TGM *depletion*
 - Generally only under calm, stable, nocturnal conditions
 - Concentrations at Gunn Point generally return to pre-nocturnal levels
 - Large spikes at Glenville may be due to fumigation into overlying weak mixed layer, or advection from nearby sources
- Drops in atmospheric mercury concentrations at Cape Grim not as pronounced and don't appear to be locally driven
- Nocturnal depletion of elemental mercury suggests significant conversion (and deposition) of reactive forms
 - Consistent with a *multi-hop* model of atmospheric mercury transport
 - Changes to the long-term atmospheric mercury pool will ultimately have an effect on the delivery of mercury to ecosystems
 - Thus understanding of this delivery requires understanding and measurement of all atmospheric mercury species
- Initial progress with wet deposition and modelling efforts
 - Depletion events are very interesting and need more investigation
 - Ocean impacts

Acknowledgements



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