



# Was Australia a sink or source of CO<sub>2</sub> in 2015? Data assimilation using OCO-2 satellite data

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# Australian Carbon Budget

## Why we should care about it?

- In a global context, terrestrial ecosystems are important because they absorb about one quarter of the anthropogenic emissions (help to mitigate climate change) (Ciais et al., 2013).
- However, the contribution of regional ecosystems (such as Australia) are not well understood, and may be highly variable (Ahlström et al., 2015)
- Australian carbon budget made by (Haverd et al., 2013) shows that the decadal mean flux between 1999-2011 for the continent was about  $-0.059 \text{ (PgC y}^{-1}\text{)}$ .
- This flux estimation differs considerably from global inversions estimates (Peylin et al., 2013), which show that the decadal mean flux over Australia was more variable  $-0.26$  to  $0.31 \text{ (PgC y}^{-1}\text{)}$ .
- So far, it is difficult to reconcile these differences (Canadell et al., 2011) and validate the Australian terrestrial carbon budget against global inversions. According to Haverd et al. (2013), global inversions do not represent an accurate estimate of the Australia carbon flux.

Ciais, Philippe, et al. "Carbon and other biogeochemical cycles." (2014): 465-570.

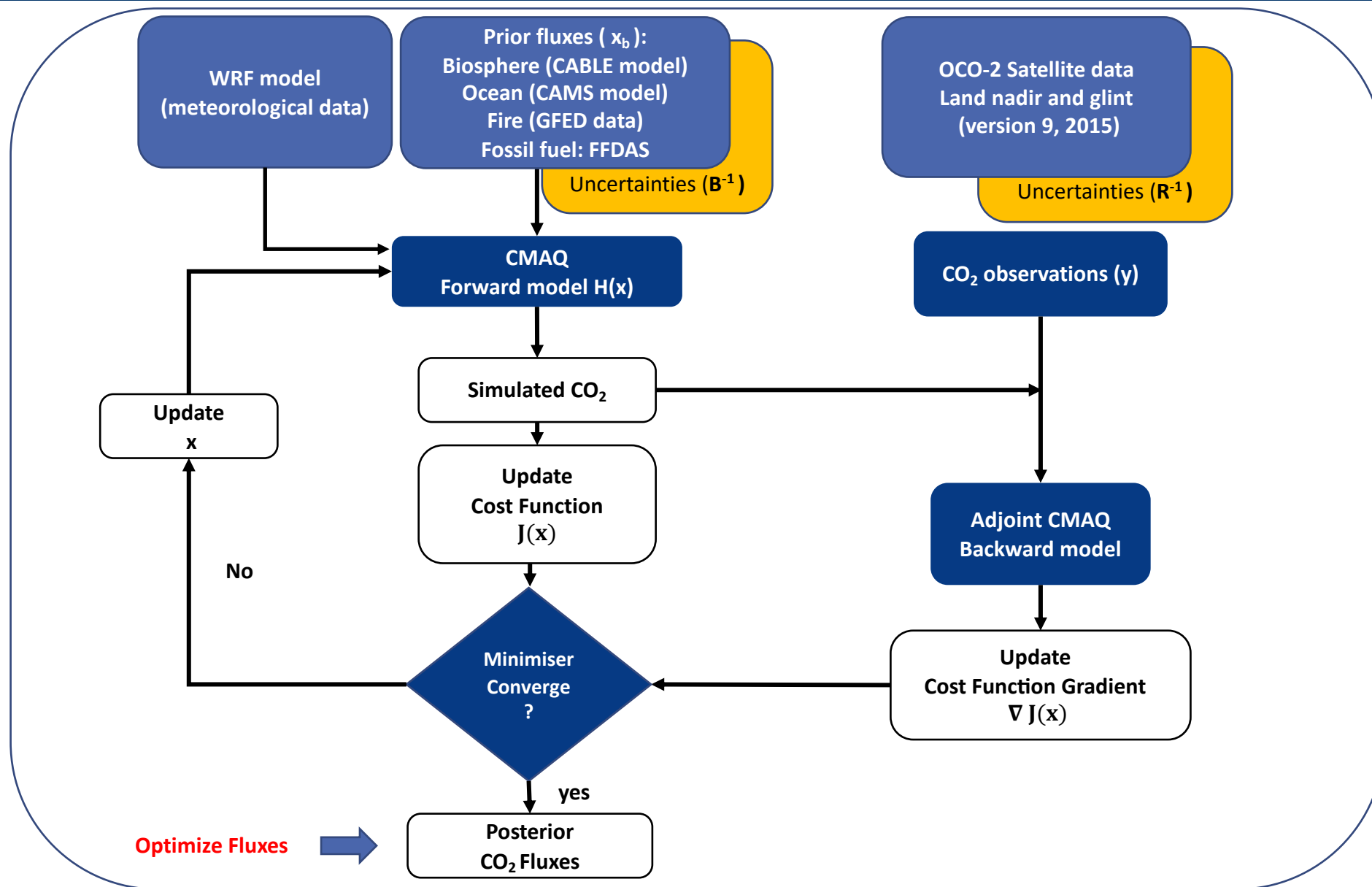
Ahlström et al. Science. 348.6237 (2015): 895-899)

Haverd, V., et al. "The Australian terrestrial carbon budget." (2013): 851-869.

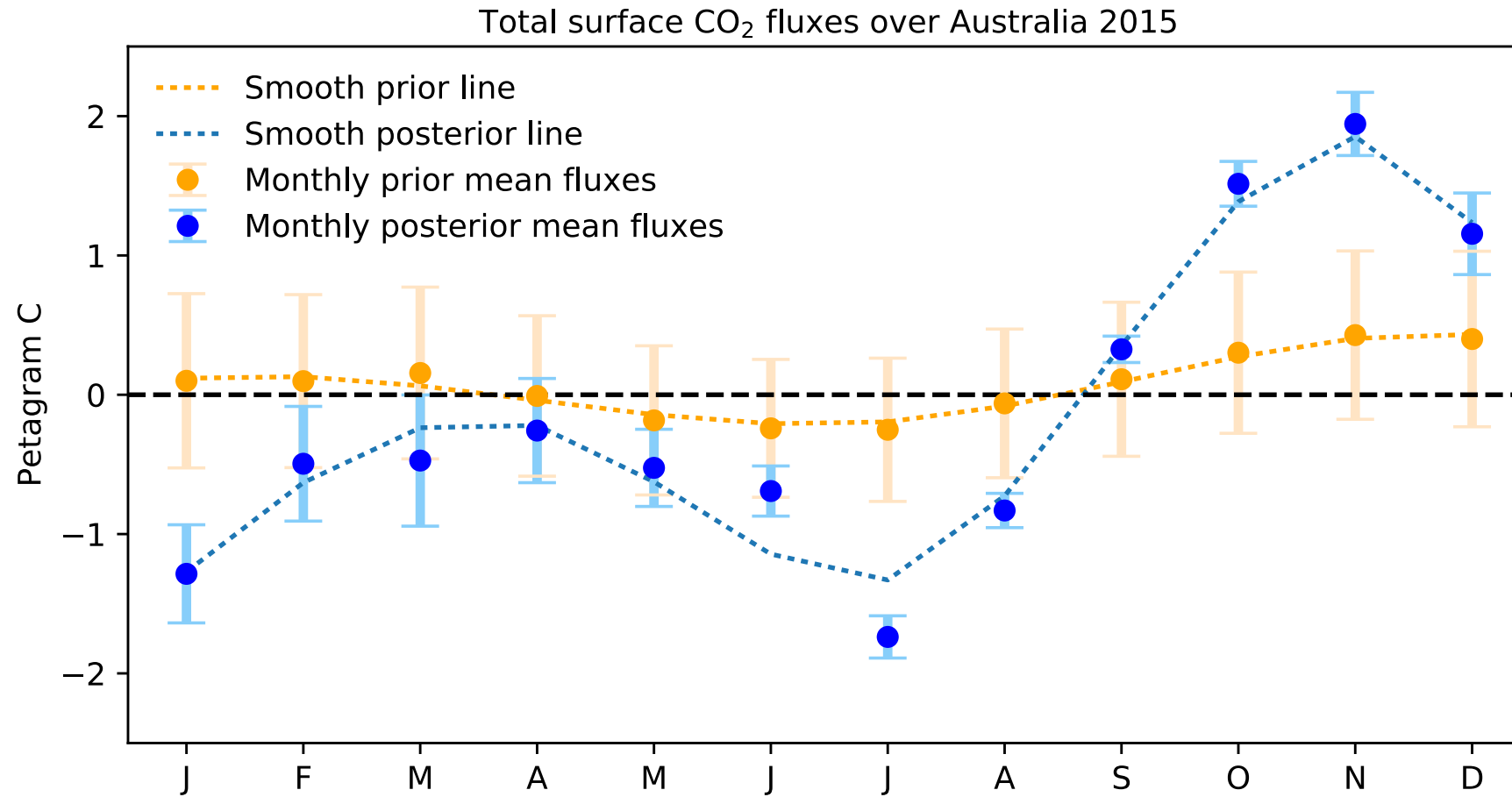
Peylin, P., et al. "Global atmospheric carbon budget: results from an ensemble of atmospheric CO<sub>2</sub> inversions." *Biogeosciences* 10 (2013): 6699-6720.

Canadell, Josep G., et al. "An international effort to quantify regional carbon fluxes." *Eos, Transactions American Geophysical Union* 92.10 (2011): 81-82.

# Data assimilation using OCO-2 Data

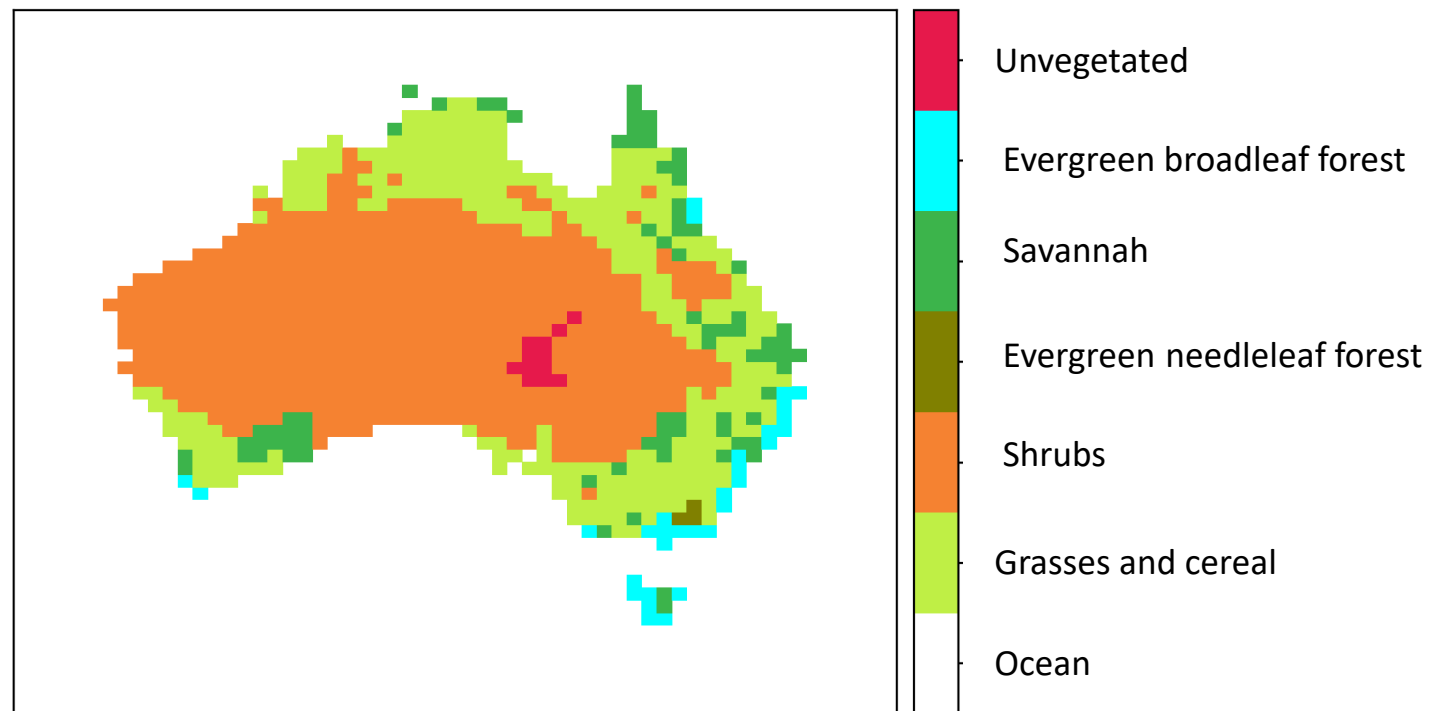


# Posterior monthly mean fluxes



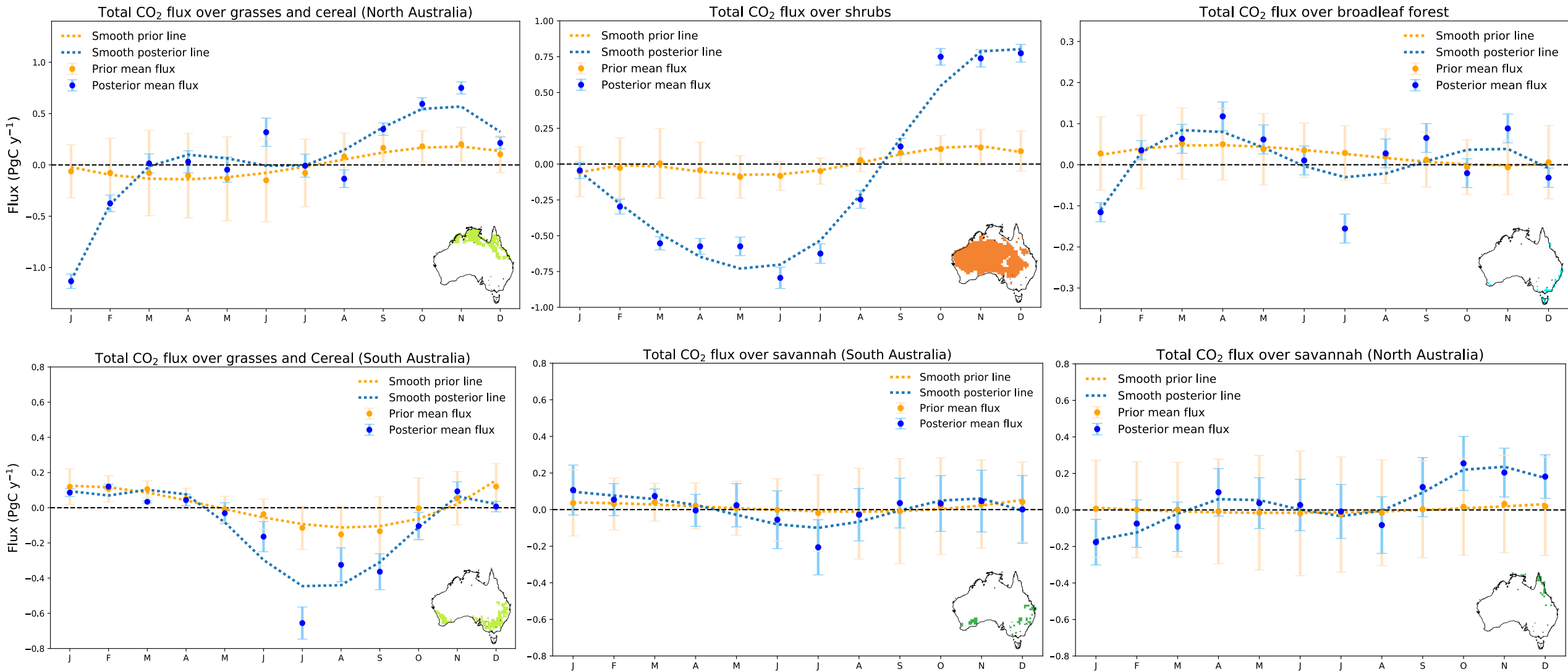


# MODIS land categorization



Aggregation of land cover classes over CMAQ domain using MODIS Land Cover Type Product (MCD12C1) Version 6 data product.

# Total CO<sub>2</sub> fluxes classified by MODIS land ecotype

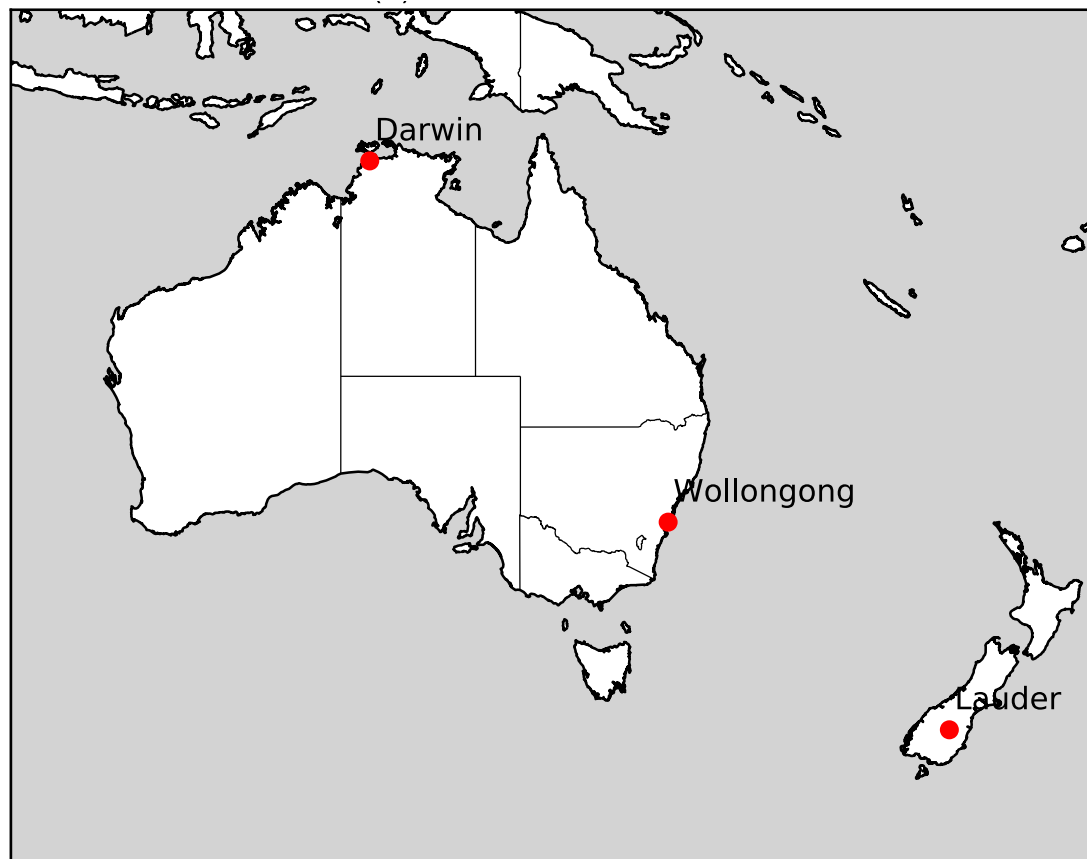




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# Validation inversion for 2015 with independent data

# Validation: The Total Carbon Column Observing Network (TCCON)

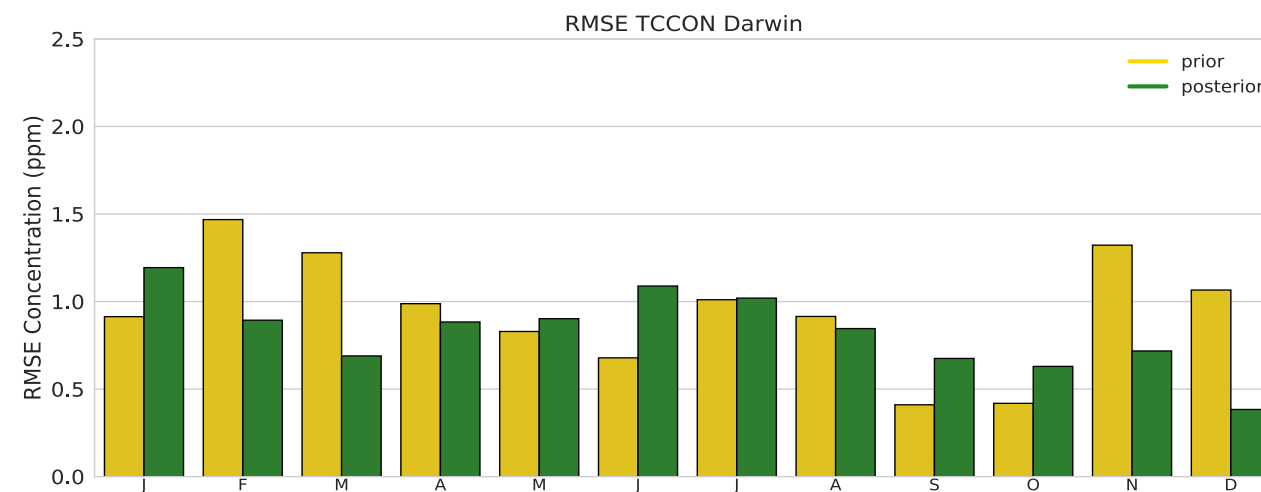
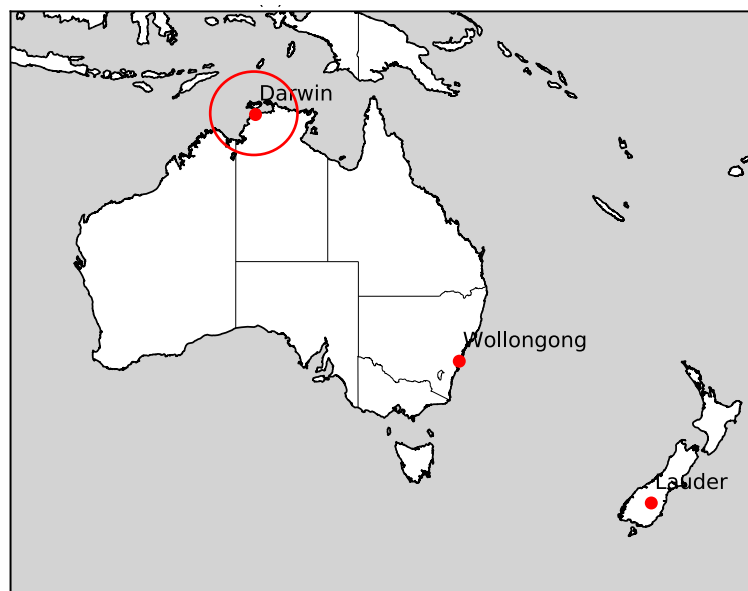
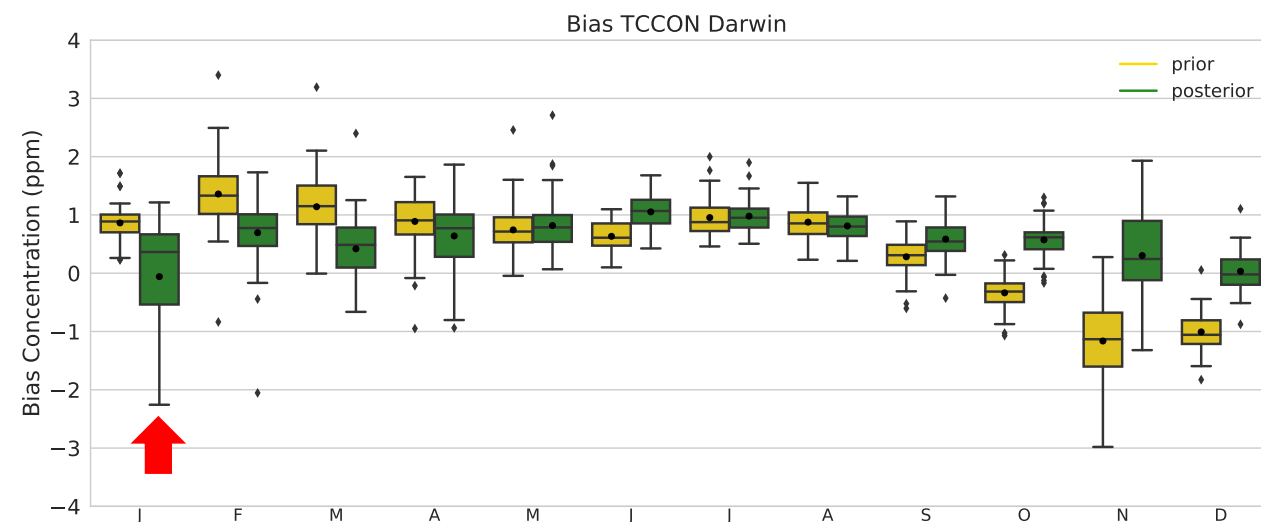
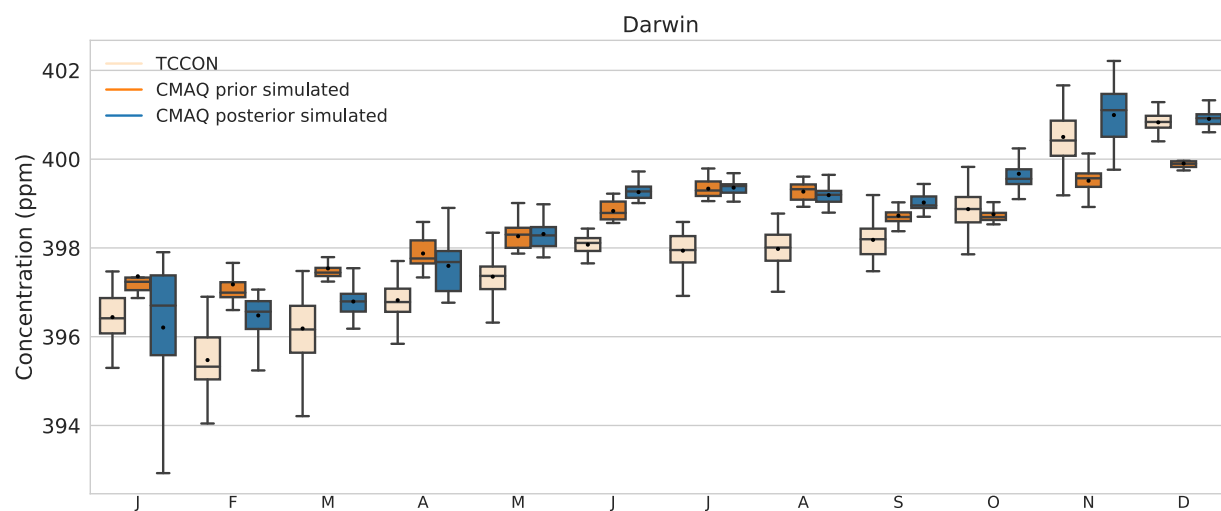


Locations of the TCCON sites over Australia and New Zealand

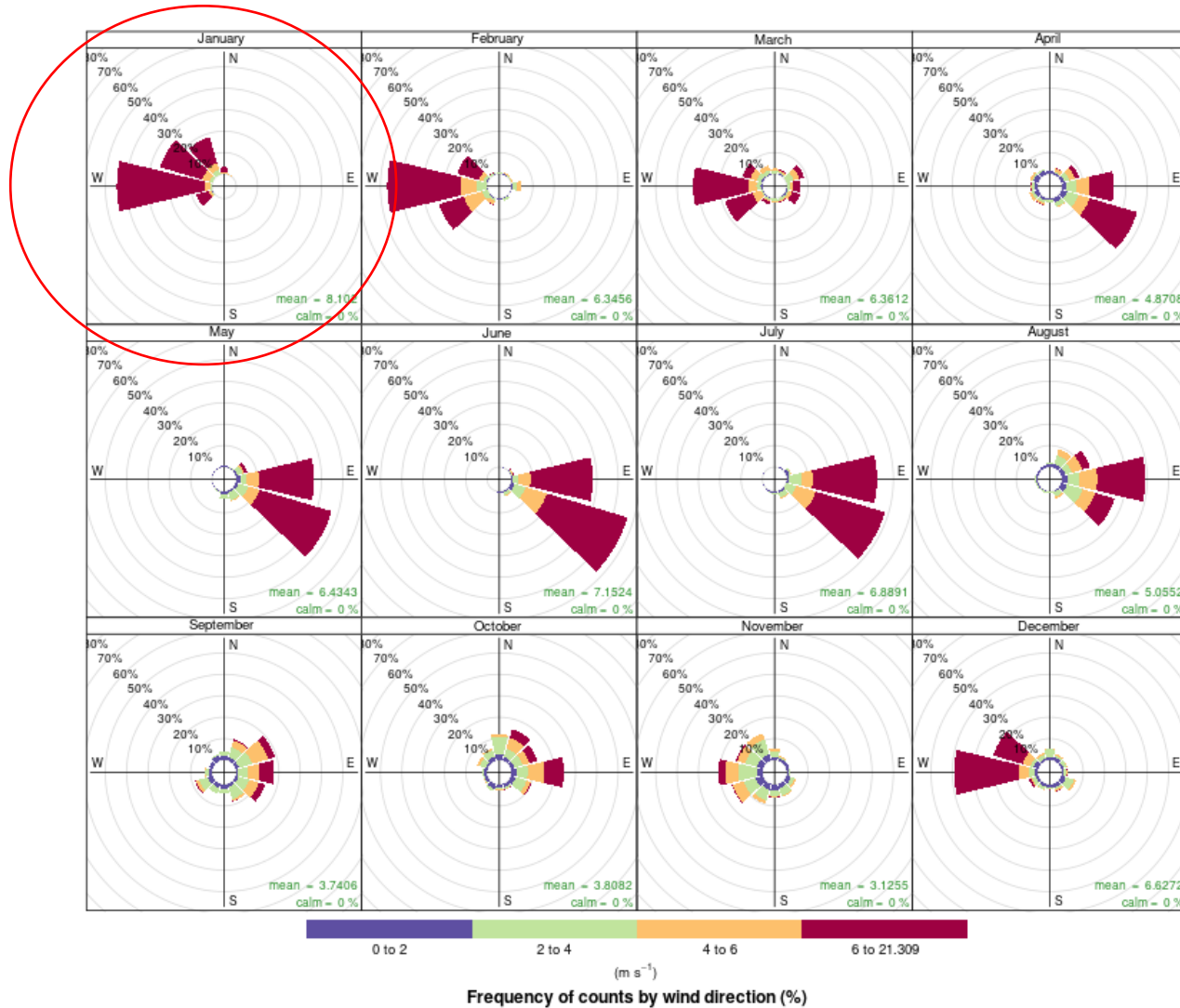


TCCON instrument located in Darwin.

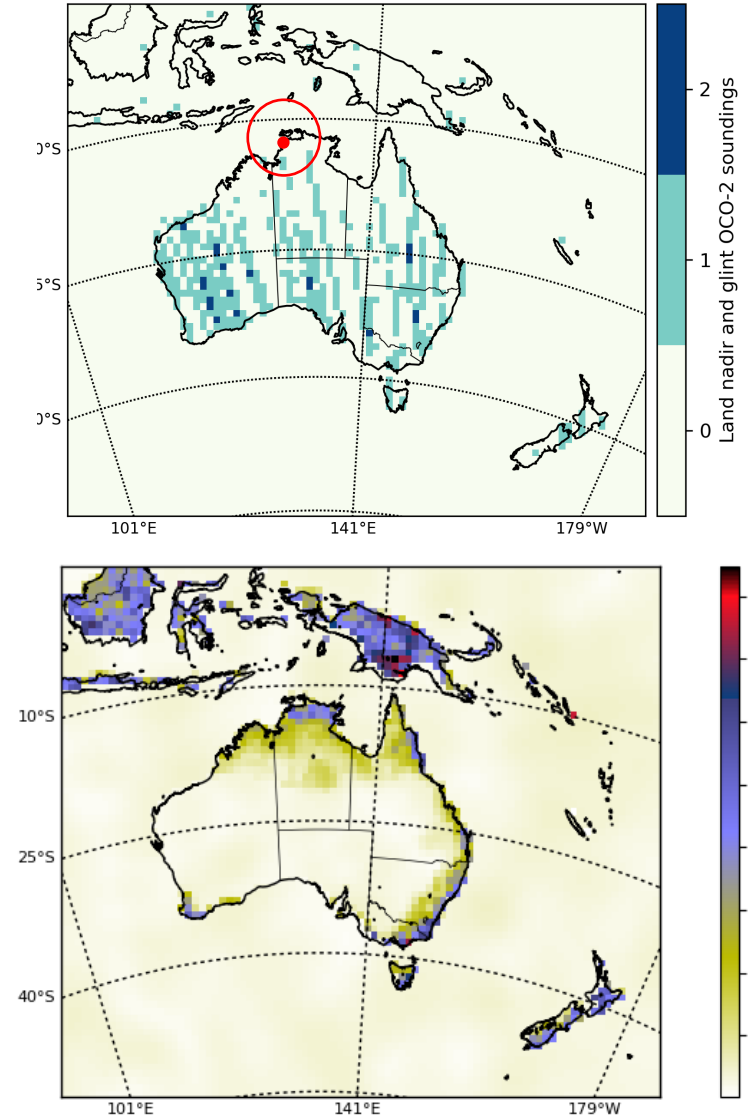
# TCCON Darwin



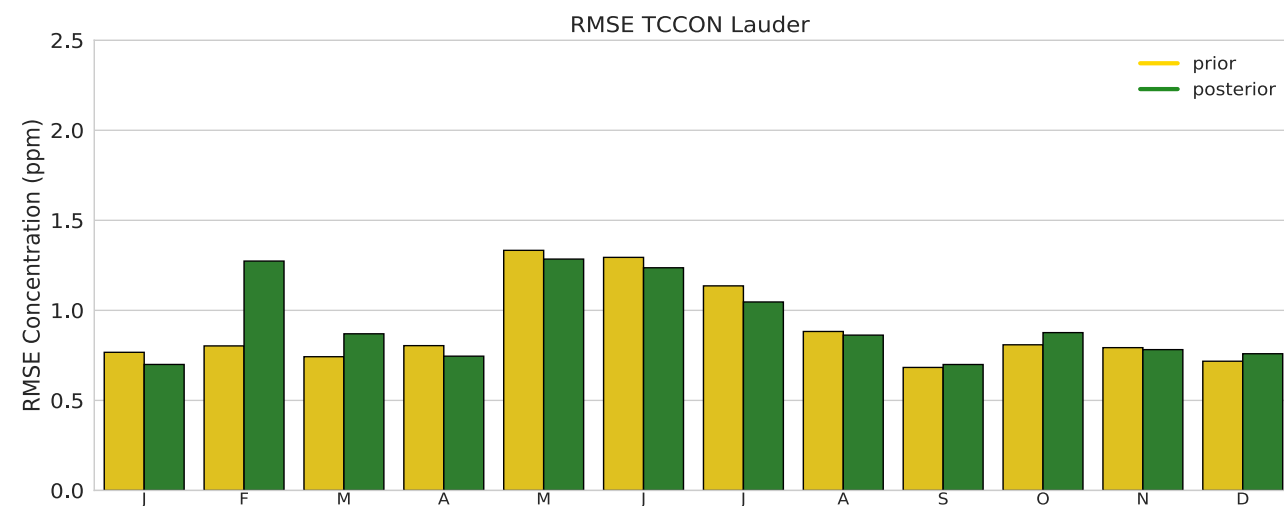
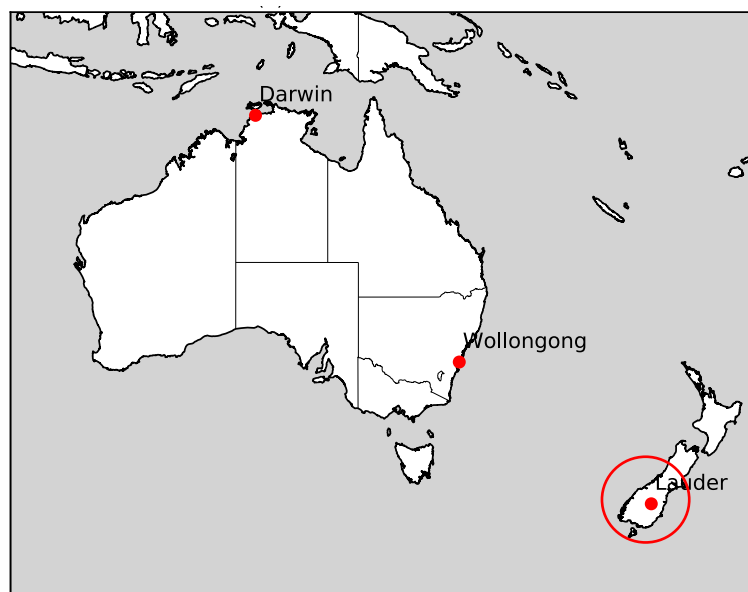
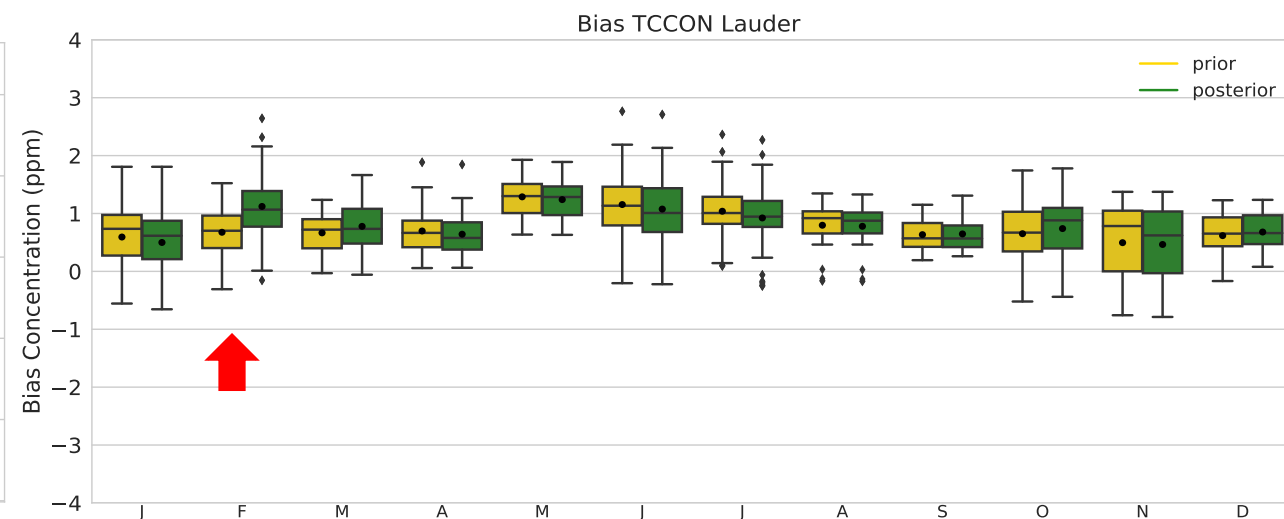
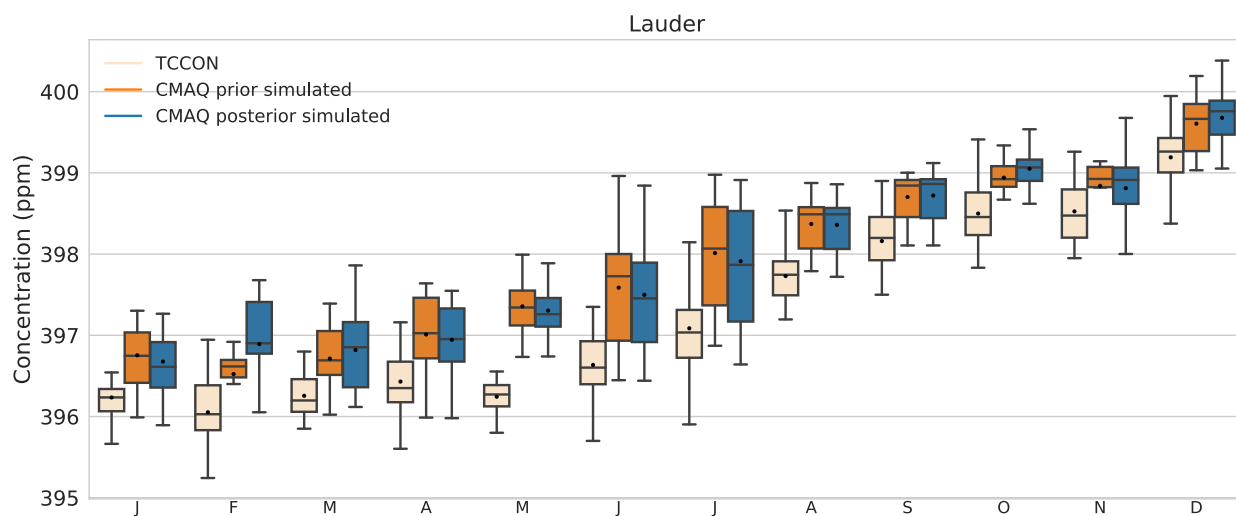
# Wind Rose (model winds in TCCON Darwin site)



OCO-2 soundings in January 2015

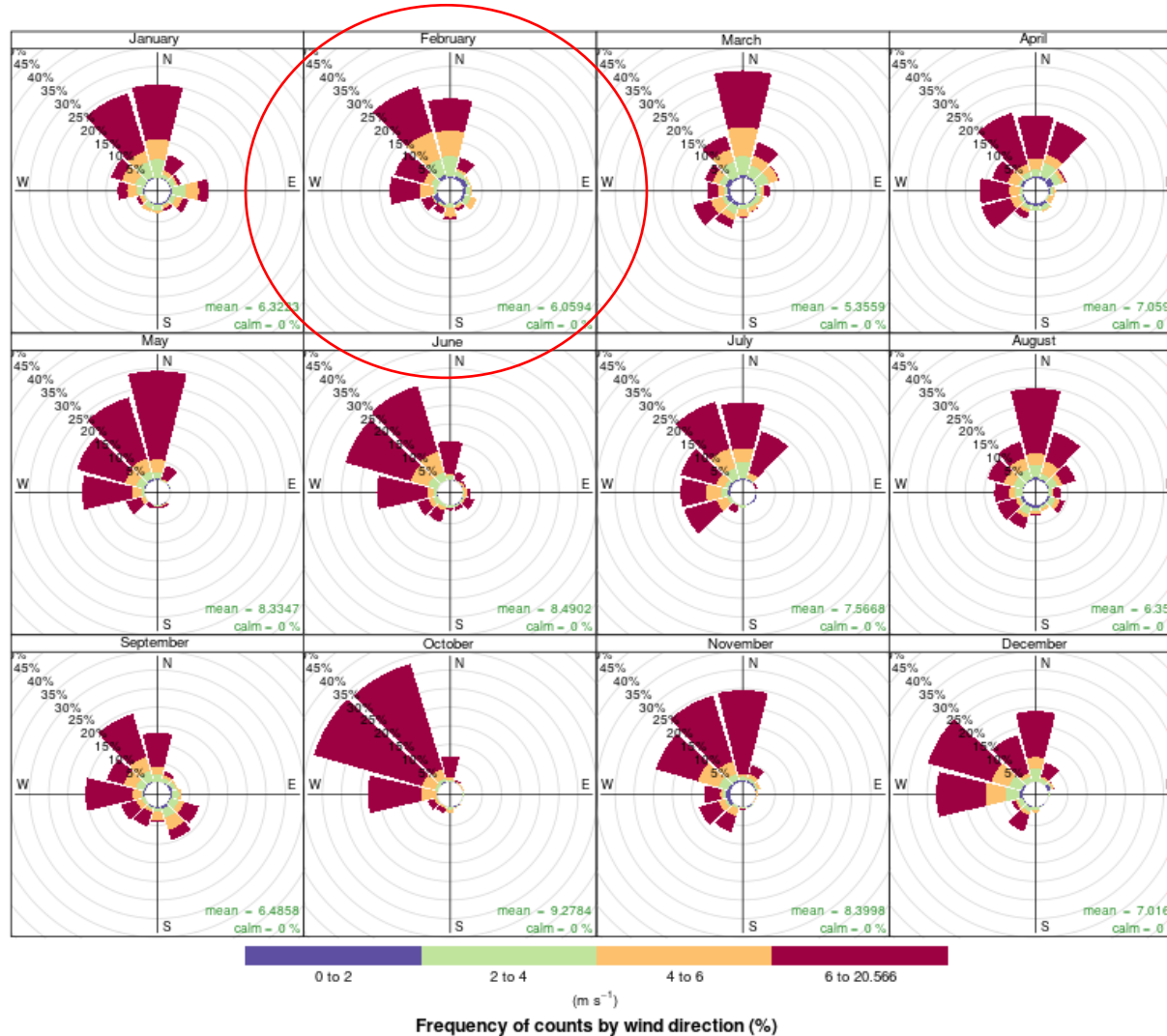


# TCCON Lauder

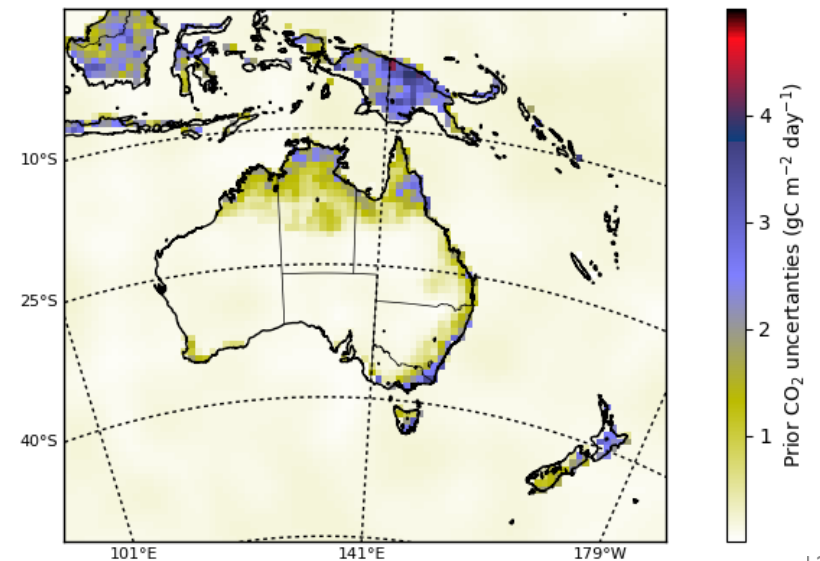
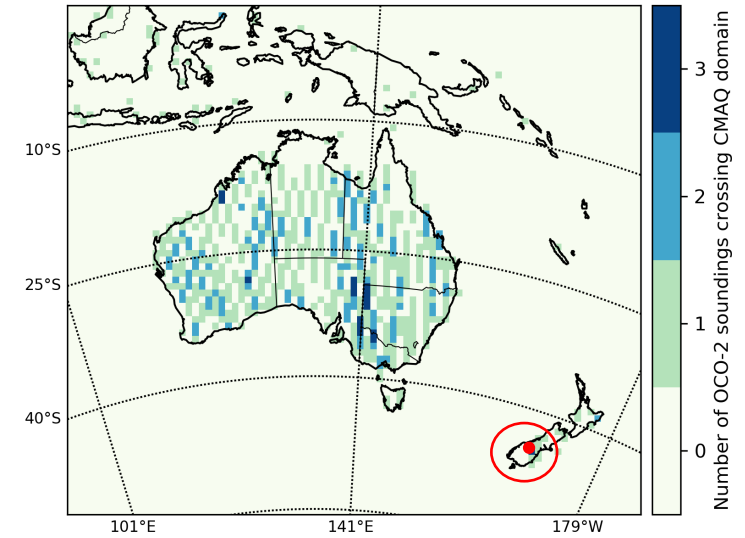




# Wind Rose (model winds in Lauder site)

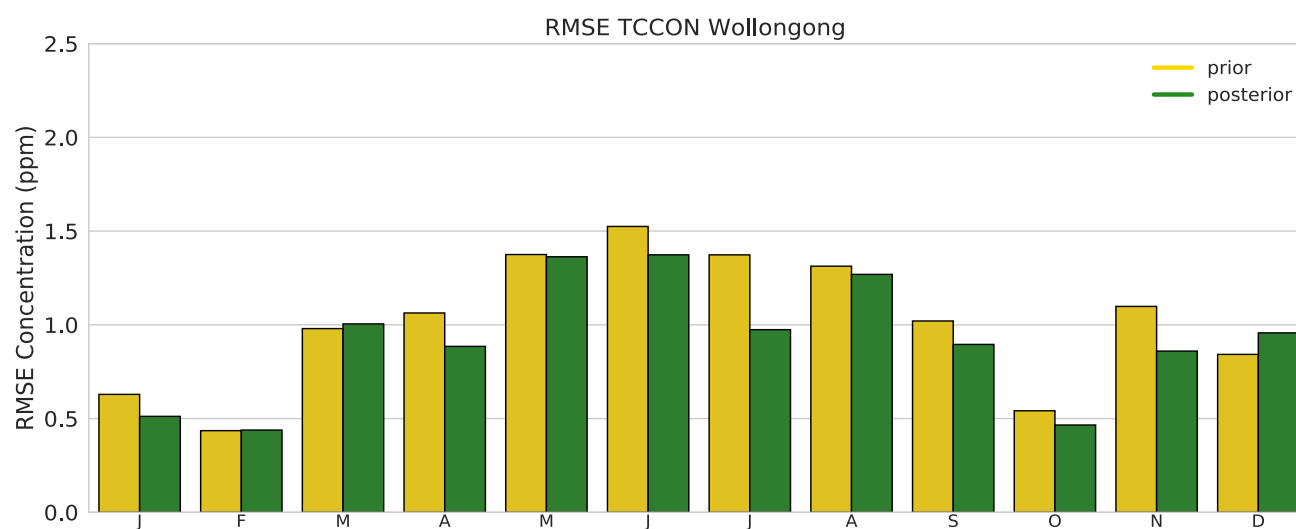
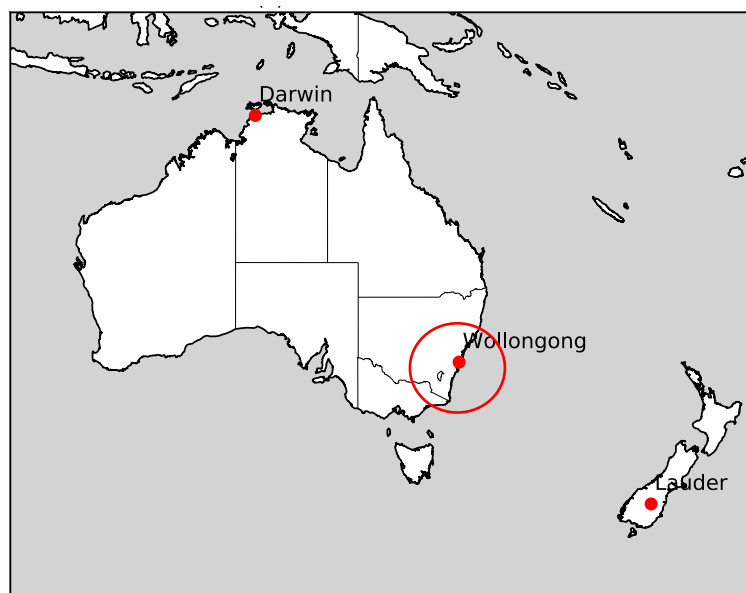
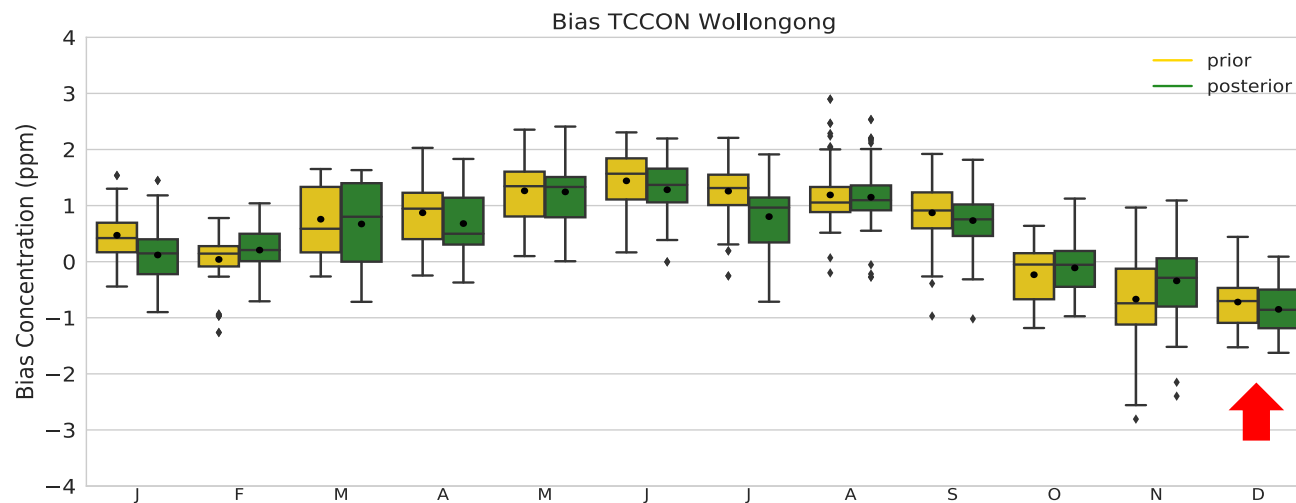
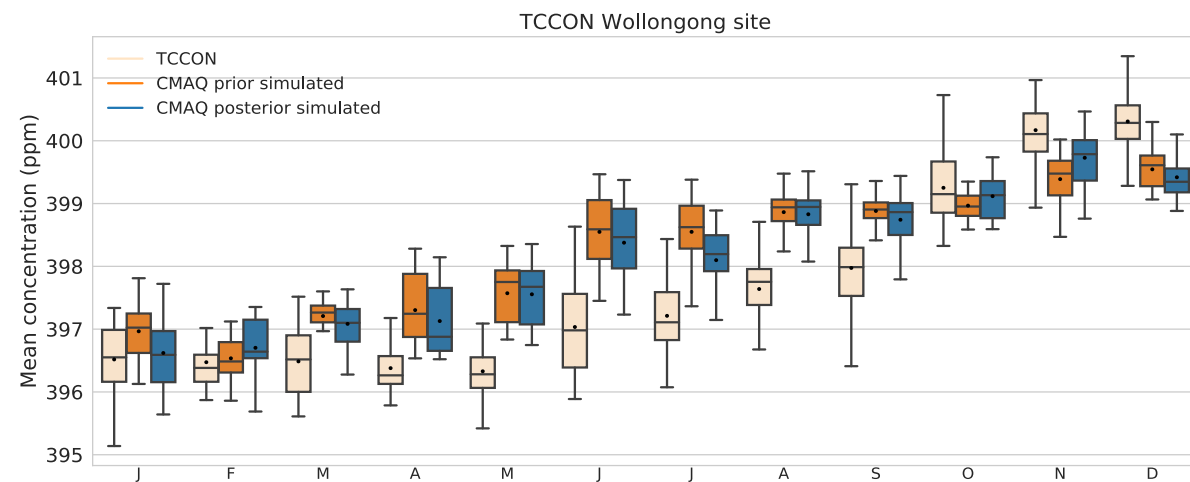


OCO-2 soundings in February 2015

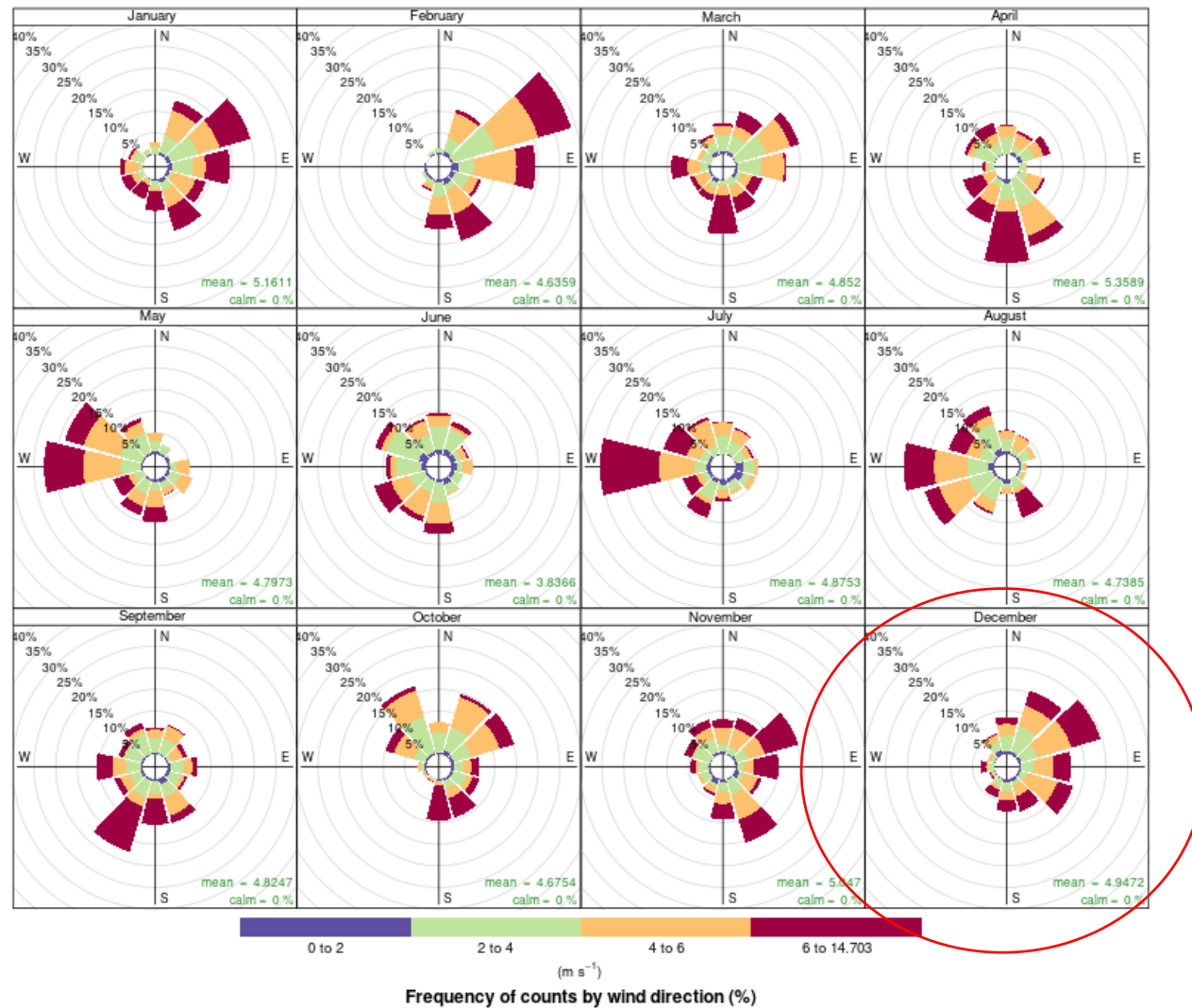




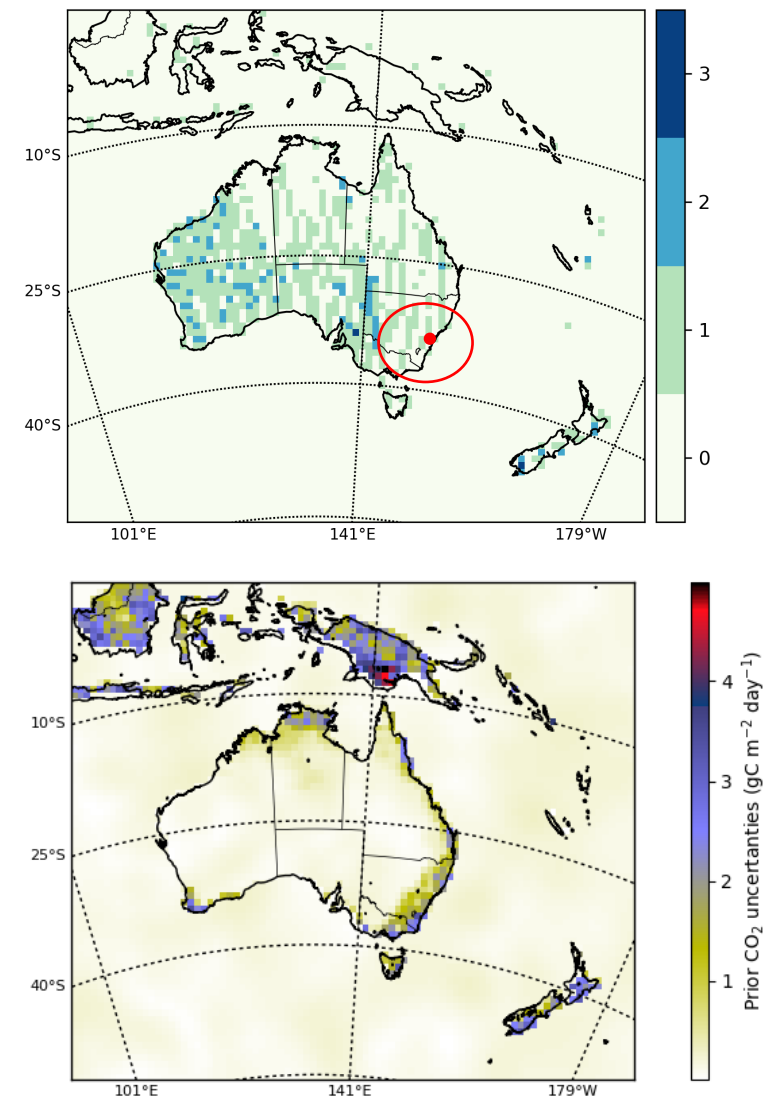
# TCCON Wollongong



# Wind Rose (model winds in TCCON Wollongong site)



OCO-2 soundings in December 2015



# Conclusions

## Was Australia a sink or source of CO<sub>2</sub> in 2015?

- Our results suggest that Australia was a slight carbon sink during 2015 of  $-0.16 \pm 0.15$  (PgCy<sup>-1</sup>) compared to the prior estimate, which suggests a source of CO<sub>2</sub>  $0.13 \pm 0.55$  (PgCy<sup>-1</sup>).
- In general, the trend of the monthly seasonal cycle shows that there was good agreement between the prior and posterior fluxes in 2015. However, the amplitude of both trends differ significantly in some months. Our monthly posterior estimates suggest that from January to May, Australia was a sink of CO<sub>2</sub> compared to the prior estimates, which shows an opposite sign.
- Monthly mean biases in TCCON Darwin are improved by almost 70 per cent. Lauder and Wollongong stations are strongly affected by ocean fluxes which have small prior uncertainty in this inversion. Biases are hence not much improved here. We verify this by relating bias to wind direction. If the winds come from the ocean, fluxes over Australia are less constrained by OCO-2 data.