

Speculation on the origin of sub-baseline excursions of CH₄ at Cape Grim

GMAC 2016, Boulder, Colorado

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17 May 2016

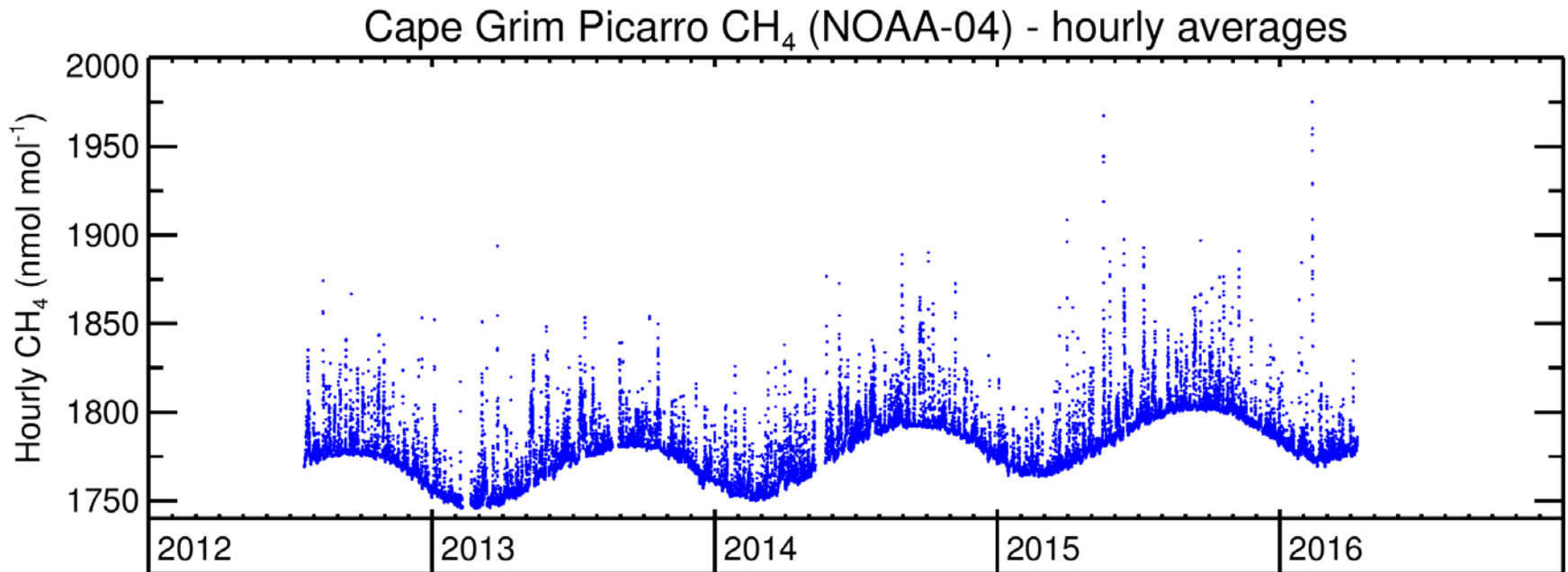
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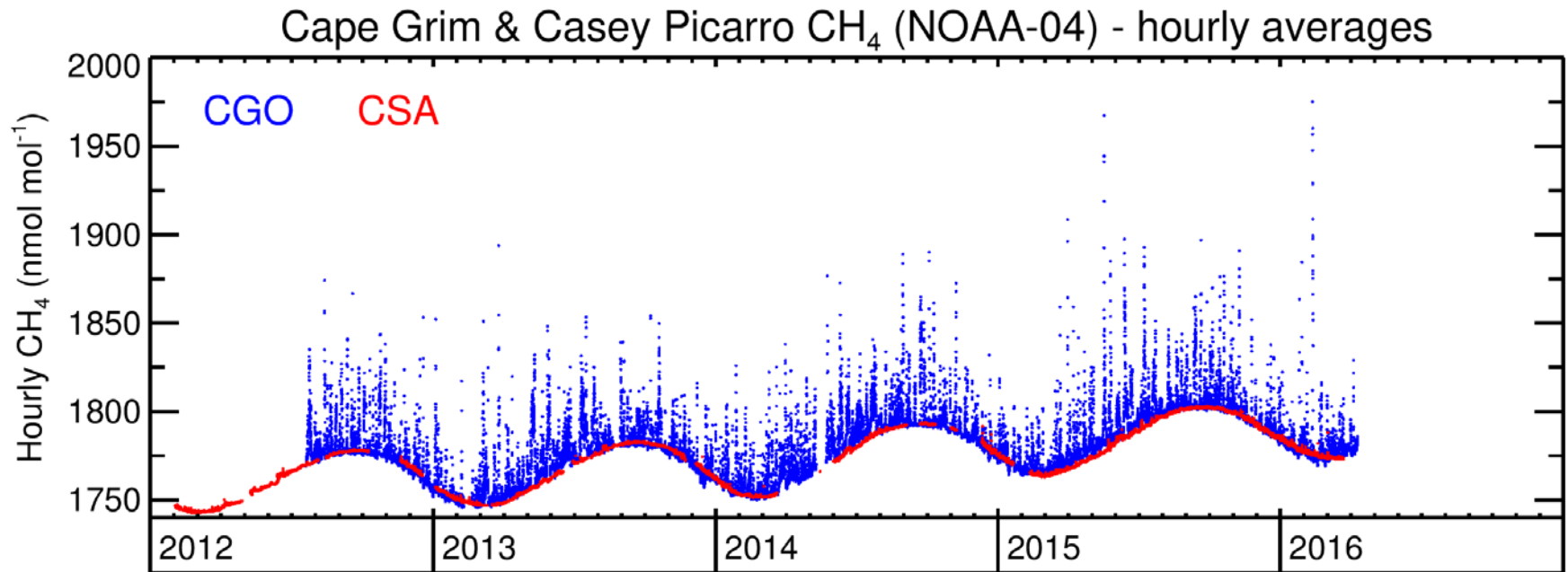
Co-authors

- O&A:
 - Paul Krummel, Rebecca Gregory, Paul Steele, Marcel van der Schoot, Darren Spencer, David Thornton, Bronwyn Dunse and Ian Galbally
- O&A/University of Bristol:
 - Ann Stavert
- Cape Grim BoM staff:
 - Jeremy Ward and Nigel Somerville + all those at Casey in recent years
- ANSTO
 - Scott Chambers and Alastair Williams

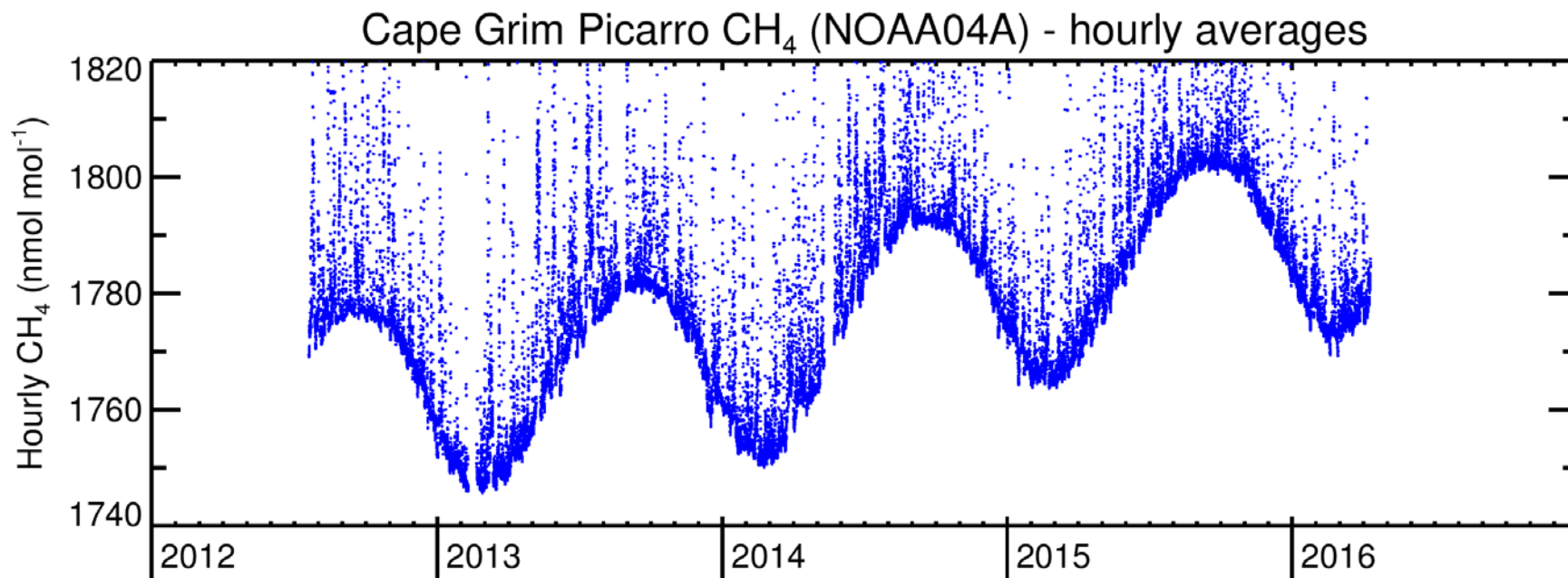
Continuous methane data: Cape Grim



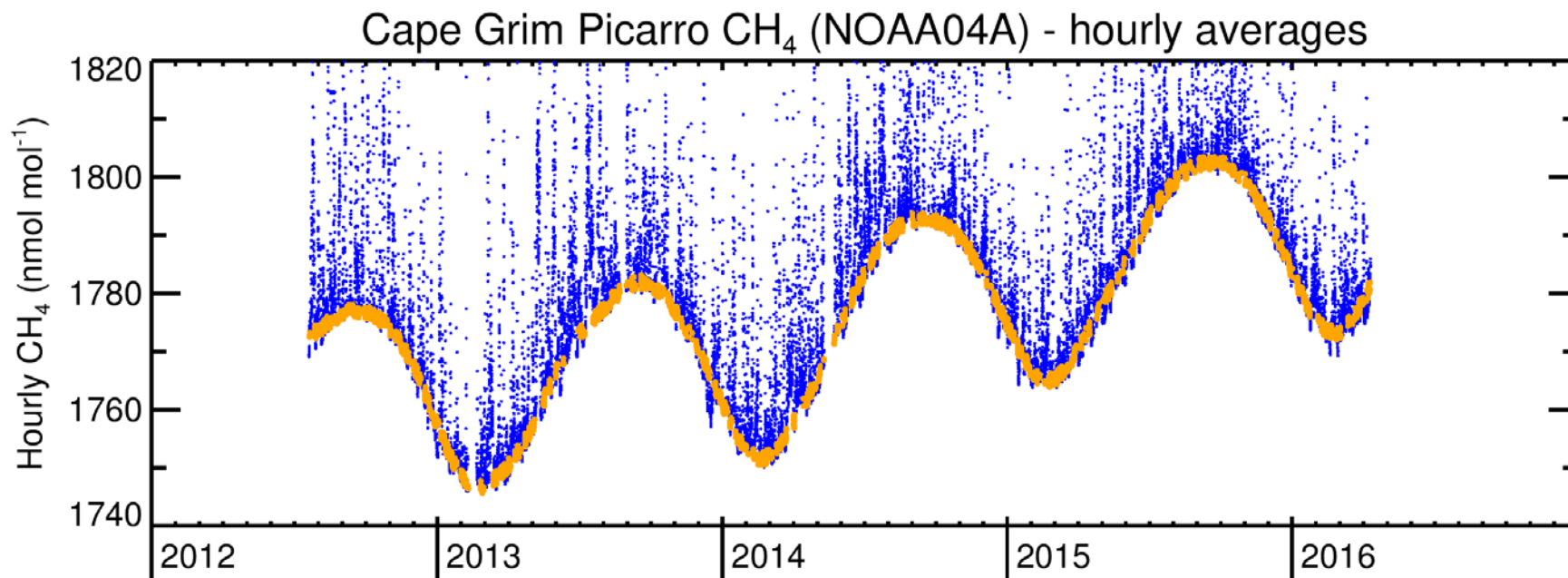
Continuous methane data: Cape Grim & Casey



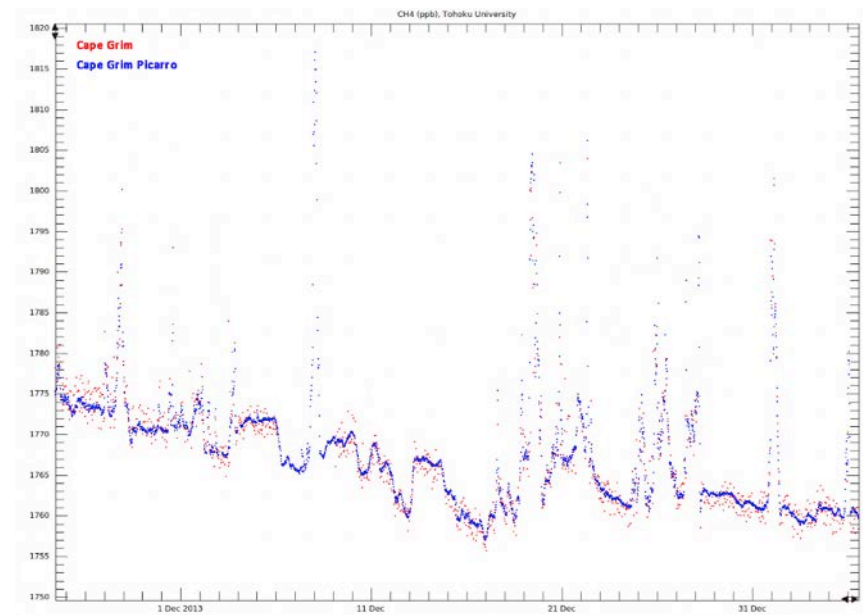
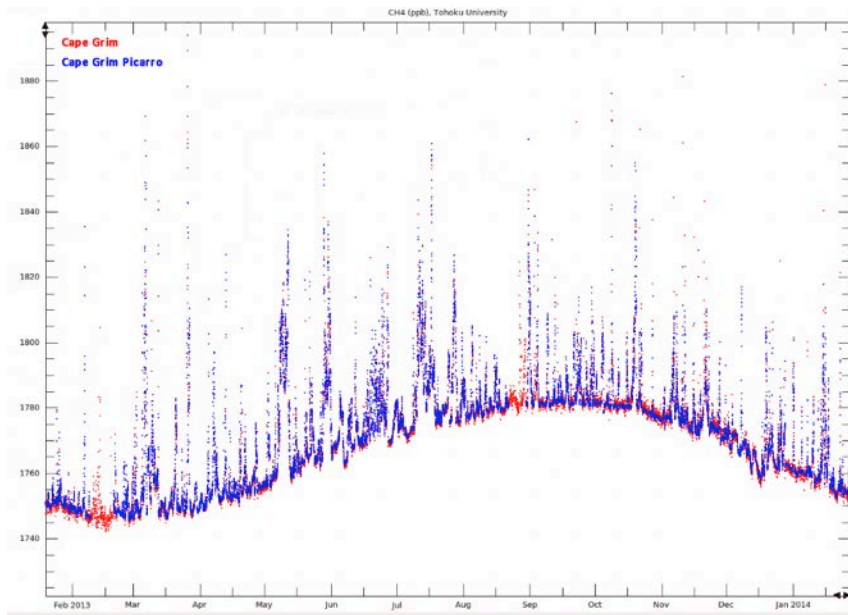
Sub-baseline methane excursions



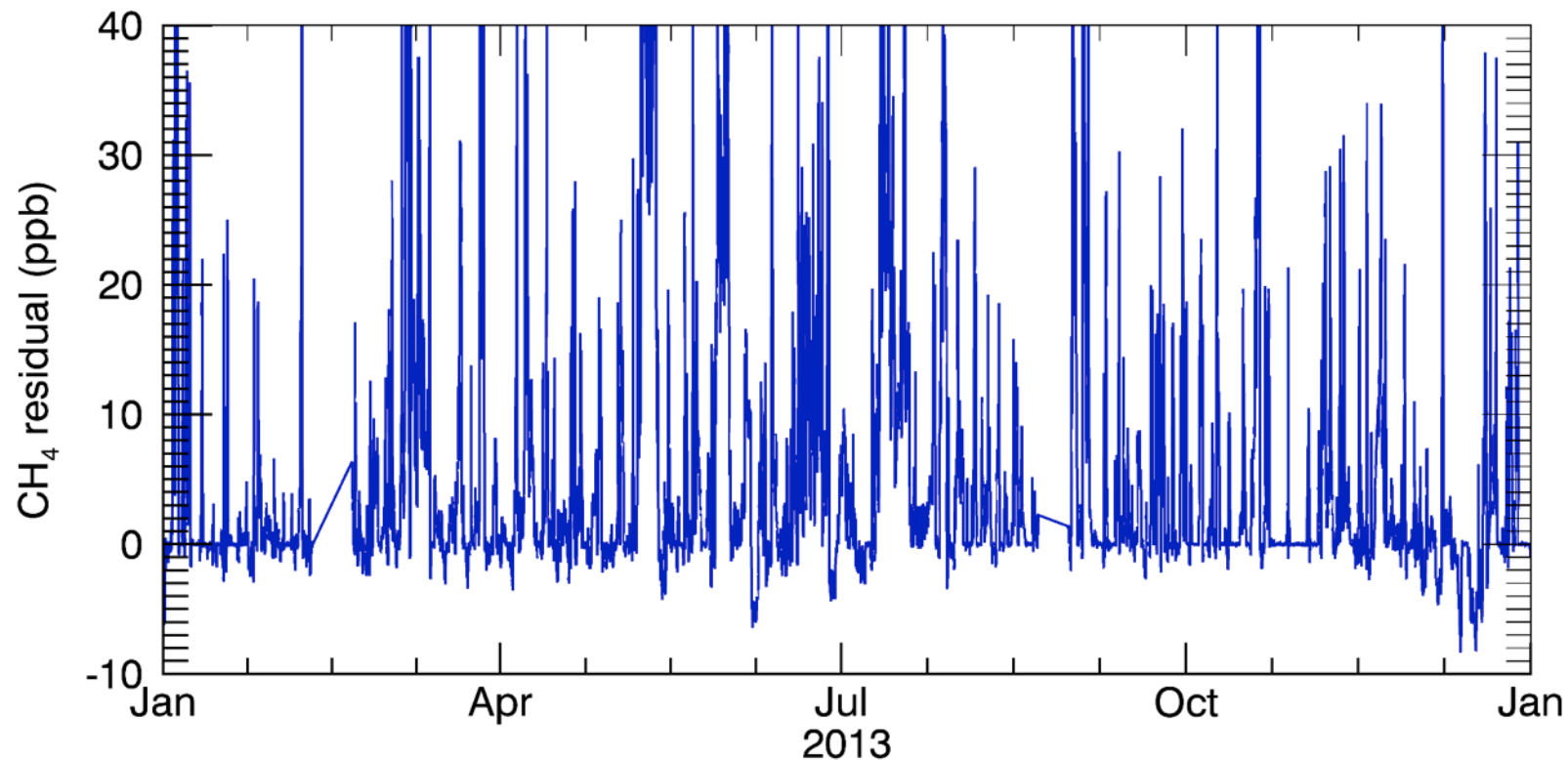
Sub-baseline methane excursions



CRDS and GC-FID measurements



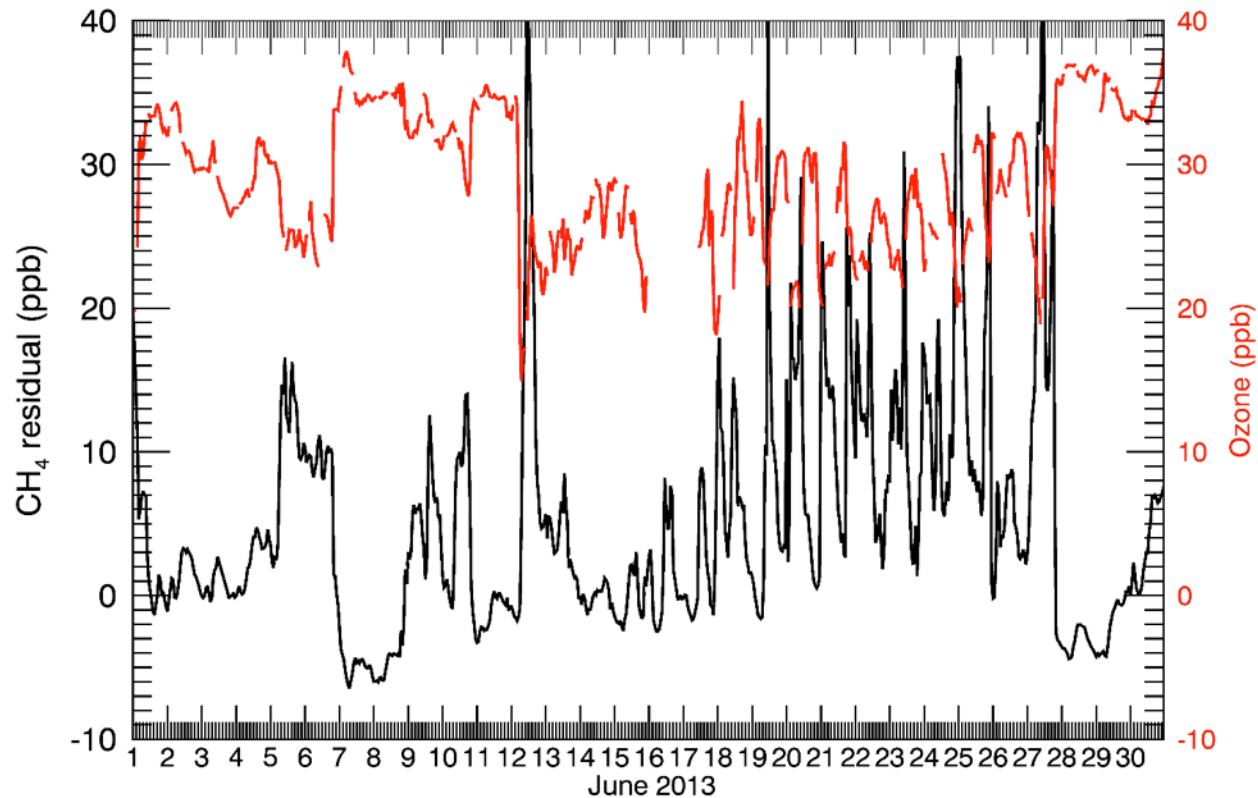
Cape Grim methane residuals: 2013



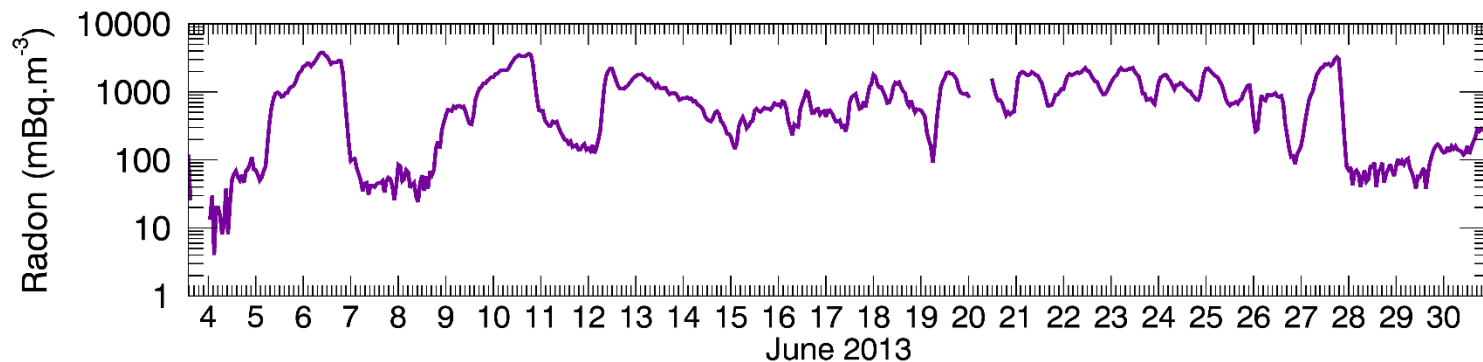
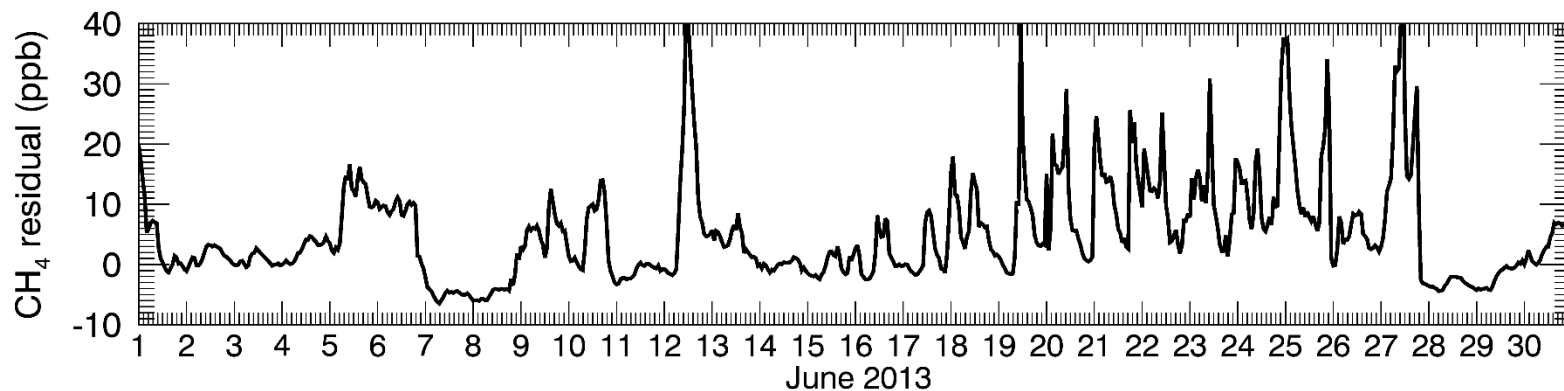
Possible mechanisms

- Intrusions of stratospheric air
 - Expect ozone to be anti-correlated with methane during the event
- Long range transport around the Southern Ocean
 - ‘Dynamic isolation’?
 - Look at the radon & trajectories
- Marine boundary layer chlorine radical attack
 - Look at the correlation with ethane

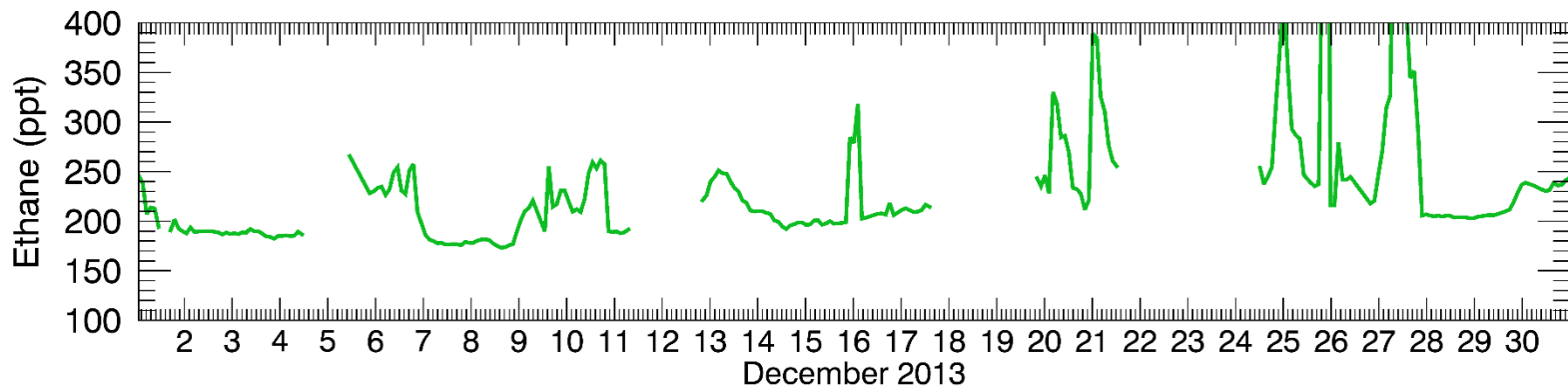
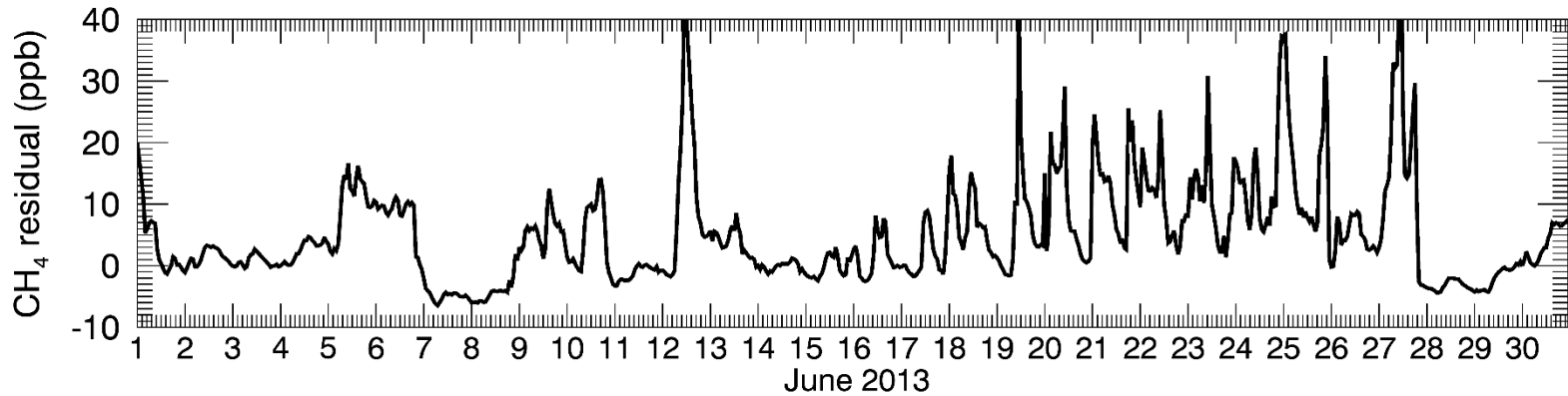
June 2013: Ozone



June 2013: Radon

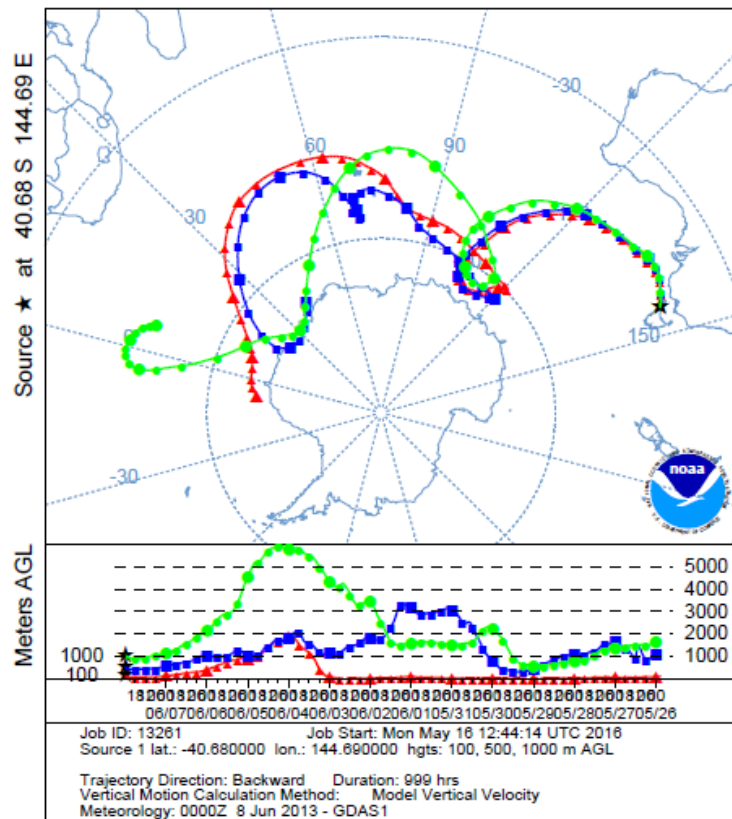


June 2013: Ethane



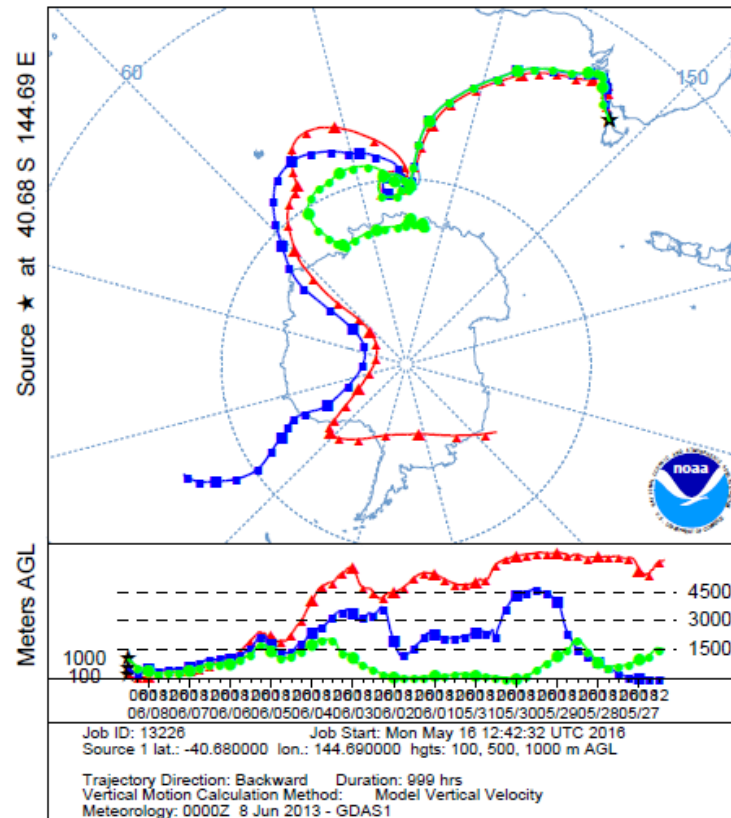
Trajectories

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 08 Jun 13
GDAS Meteorological Data

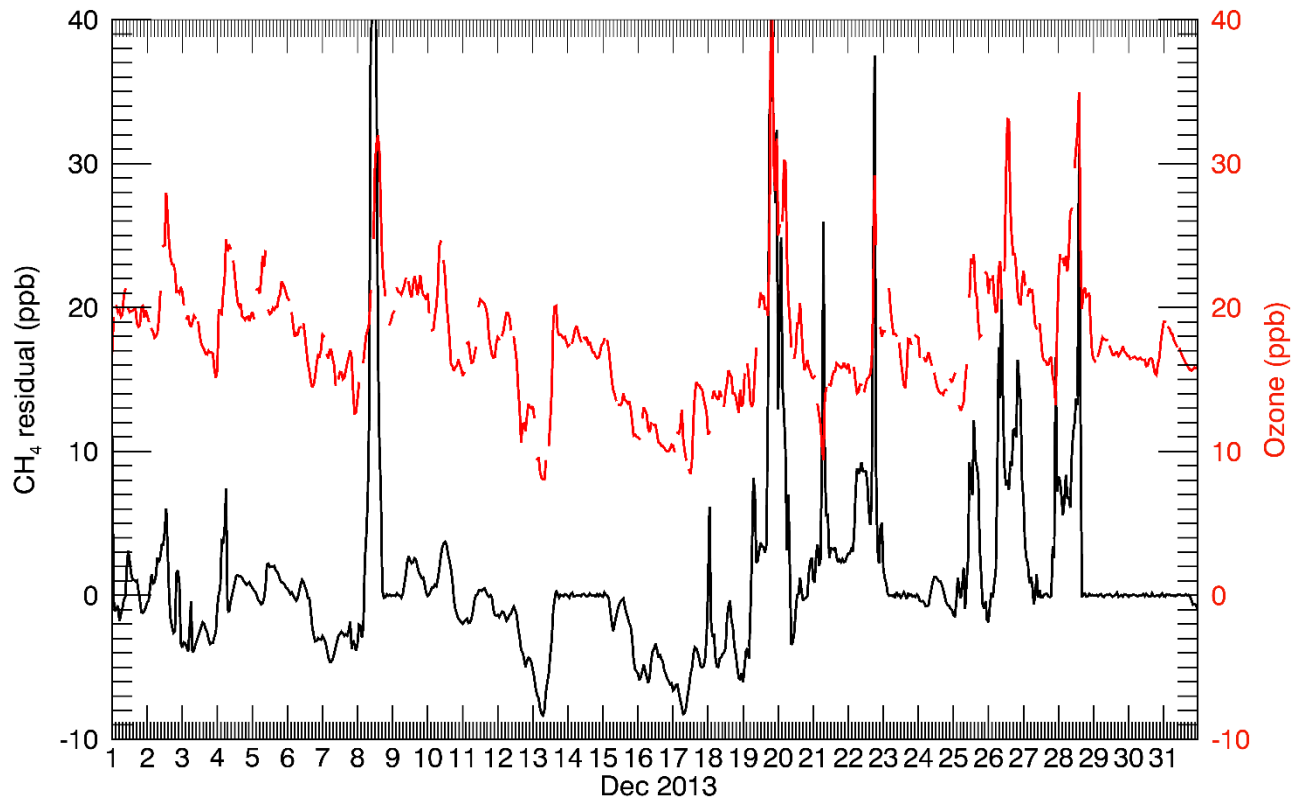


Trajectories

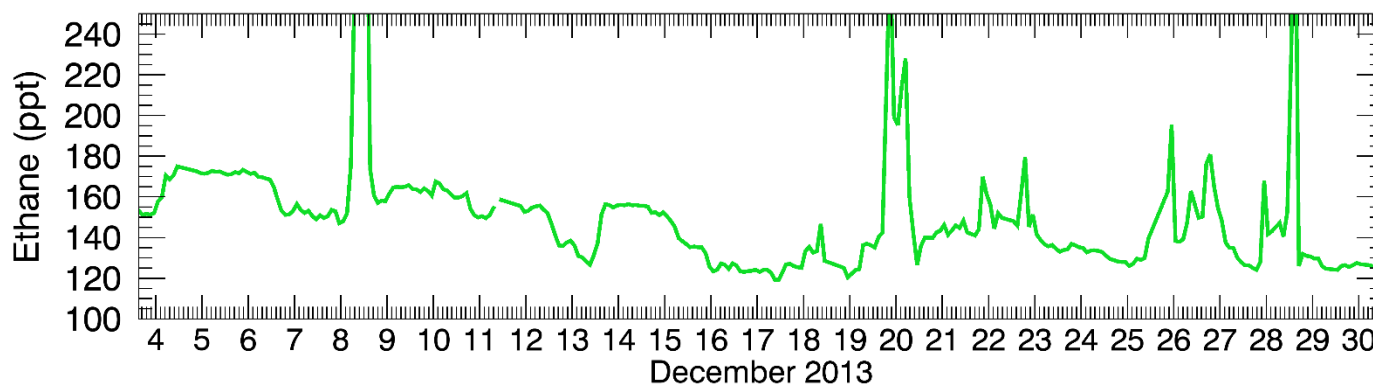
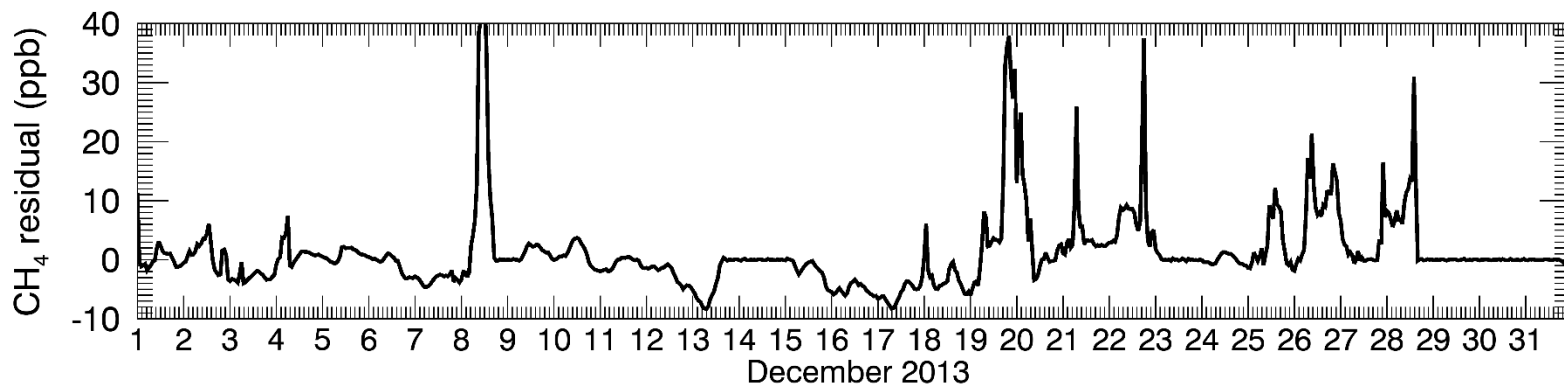
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 08 Jun 13
GDAS Meteorological Data



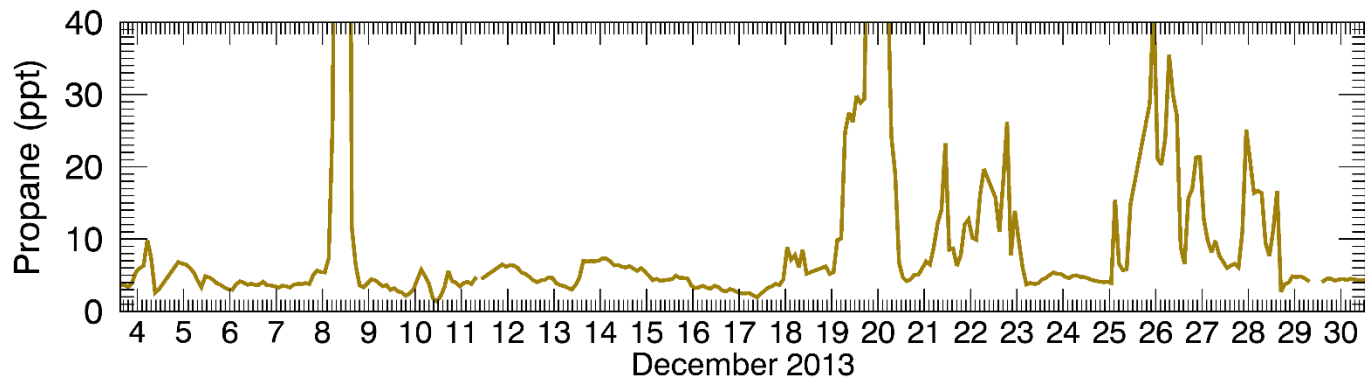
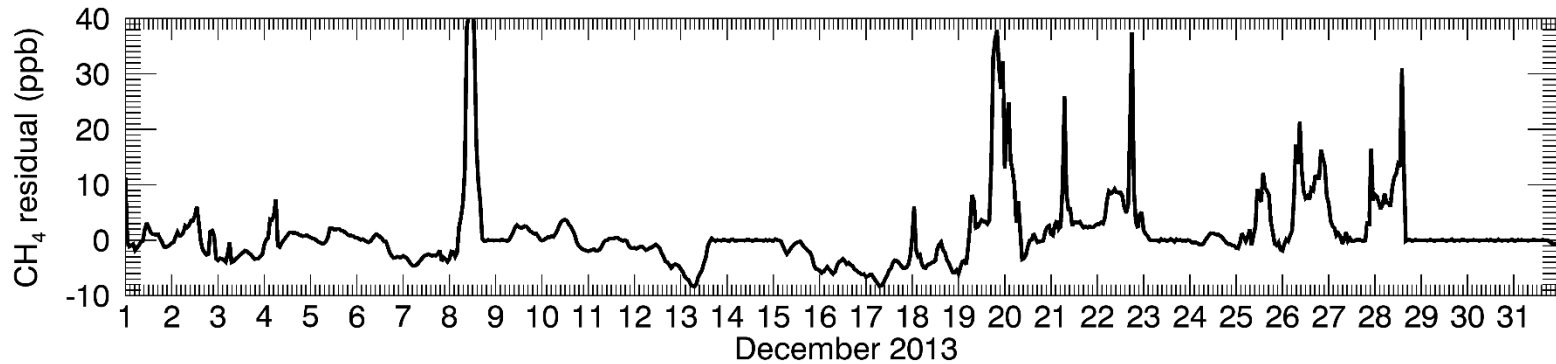
December 2013: Ozone



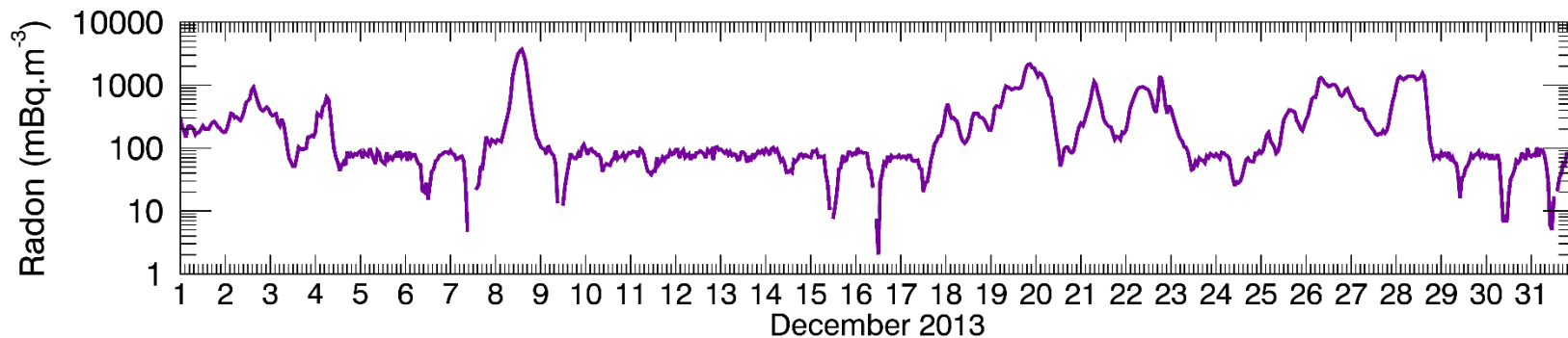
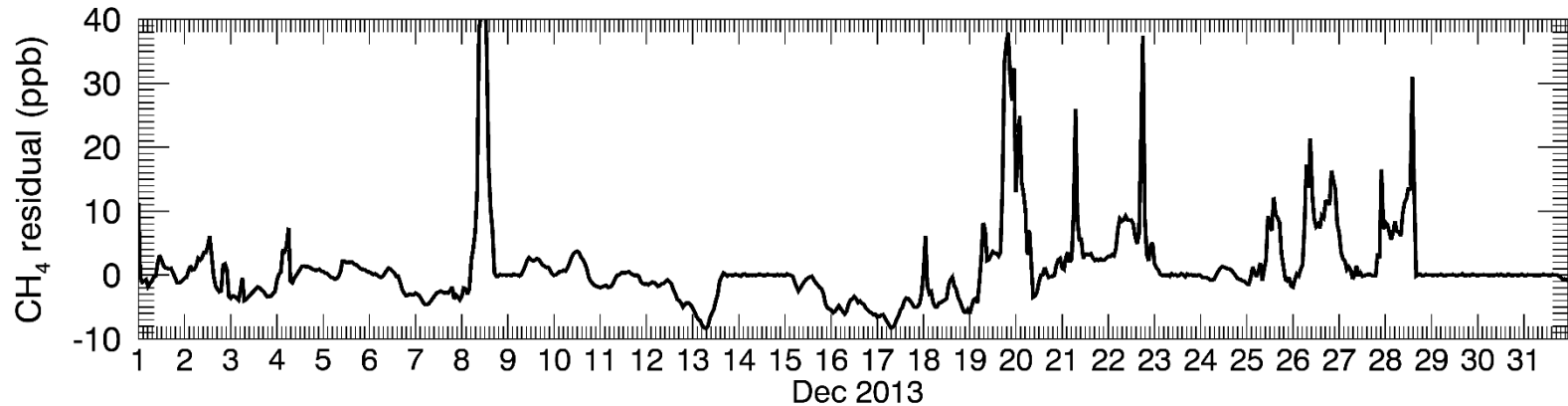
December 2013: Ethane



December 2013: Propane

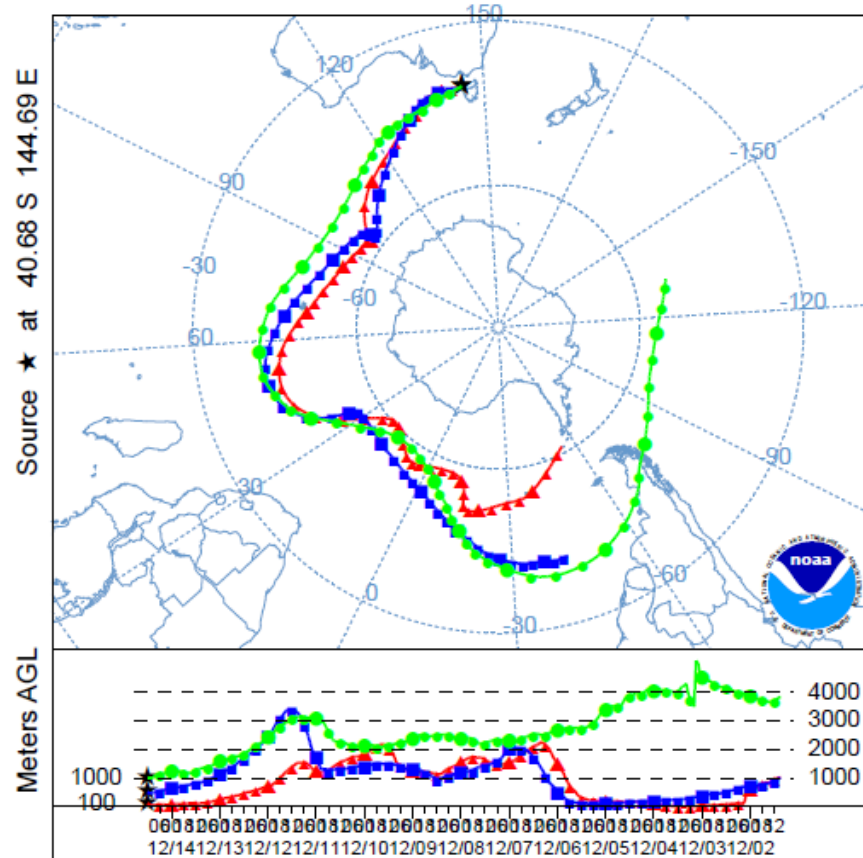


December 2013: Radon

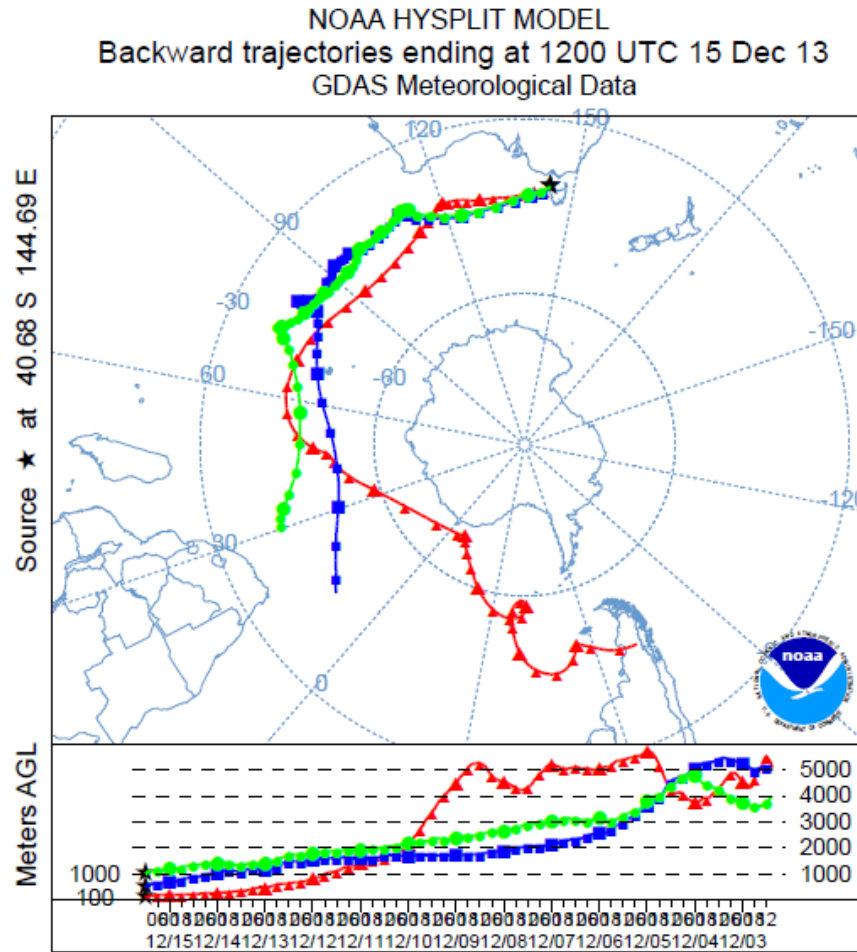


Trajectories

NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 14 Dec 13
GDAS Meteorological Data

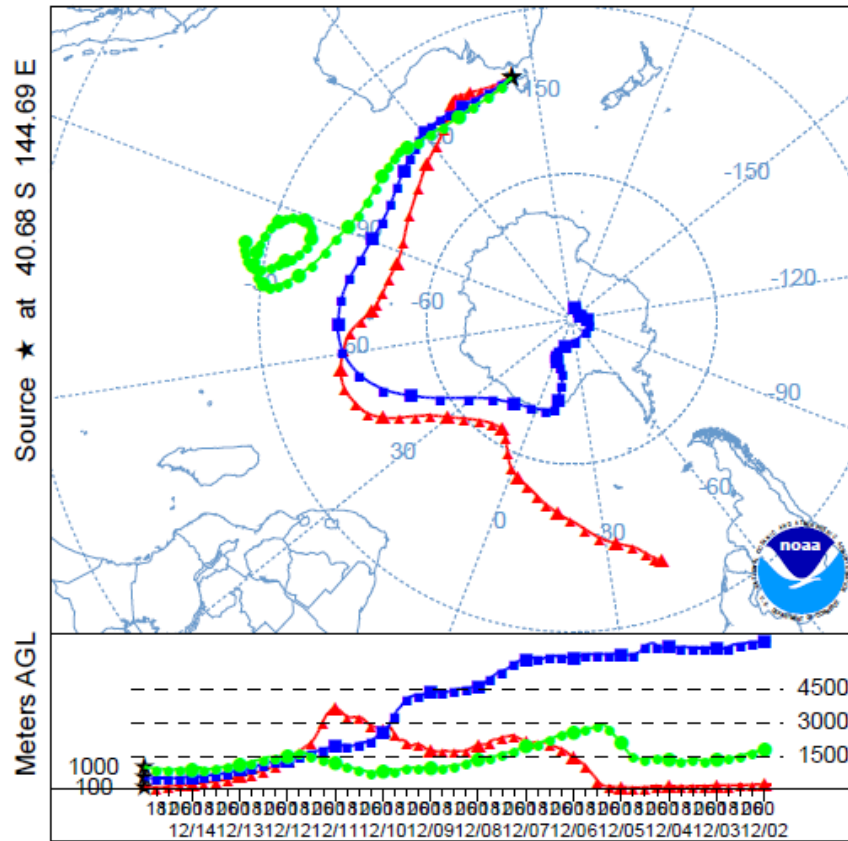


Trajectories



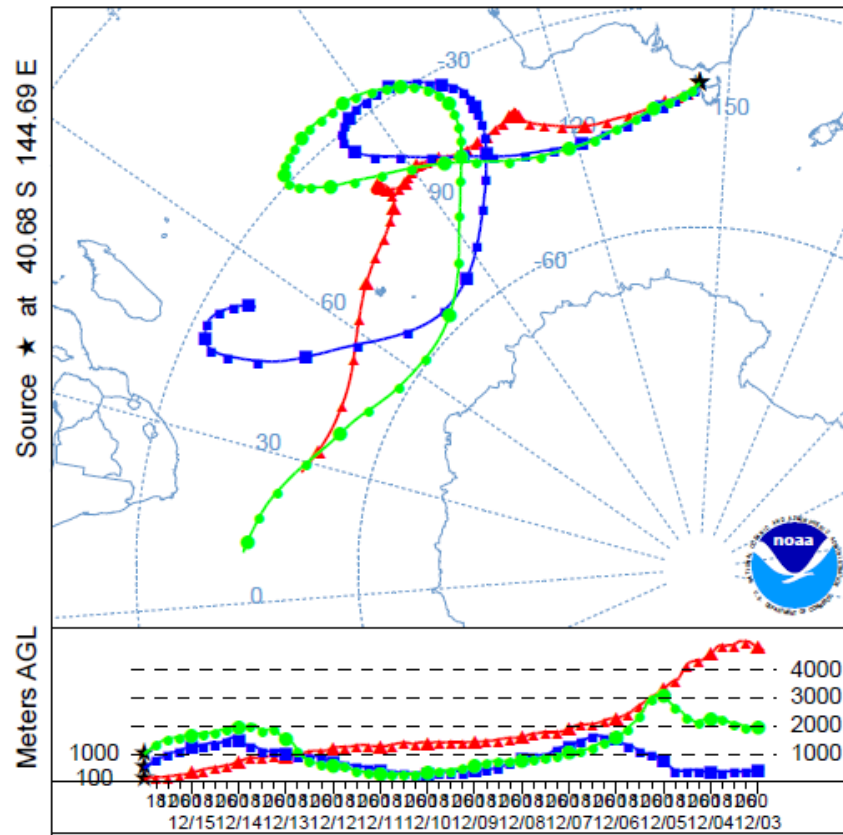
Trajectories

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 15 Dec 13
GDAS Meteorological Data



Trajectories

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 16 Dec 13
GDAS Meteorological Data



Possible mechanisms

- Intrusions of stratospheric air
 - Wintertime seems to have some of these type of events
- Long range transport around the Southern Ocean
 - Radon is sub 100mBq.m^{-3} , but not notably lower, however;
 - Trajectories do look to be long range SO transport
- Marine boundary layer chlorine radical attack
 - Depleted ozone, ethane and propane

Conclusions

- Sub-baseline excursions of CH₄
 - Do not (all) seem to be due to stratospheric intrusions
 - Possibly long range transport over the Southern Ocean – dynamic isolation
 - Possibly chlorine radical depletion of methane
- Do similar events occur at Casey?
 - If so, they are much smaller in magnitude. Does this tell us anything?... Mean latitudinal OH or source of MBL chlorine radical?

Thank you

O&A

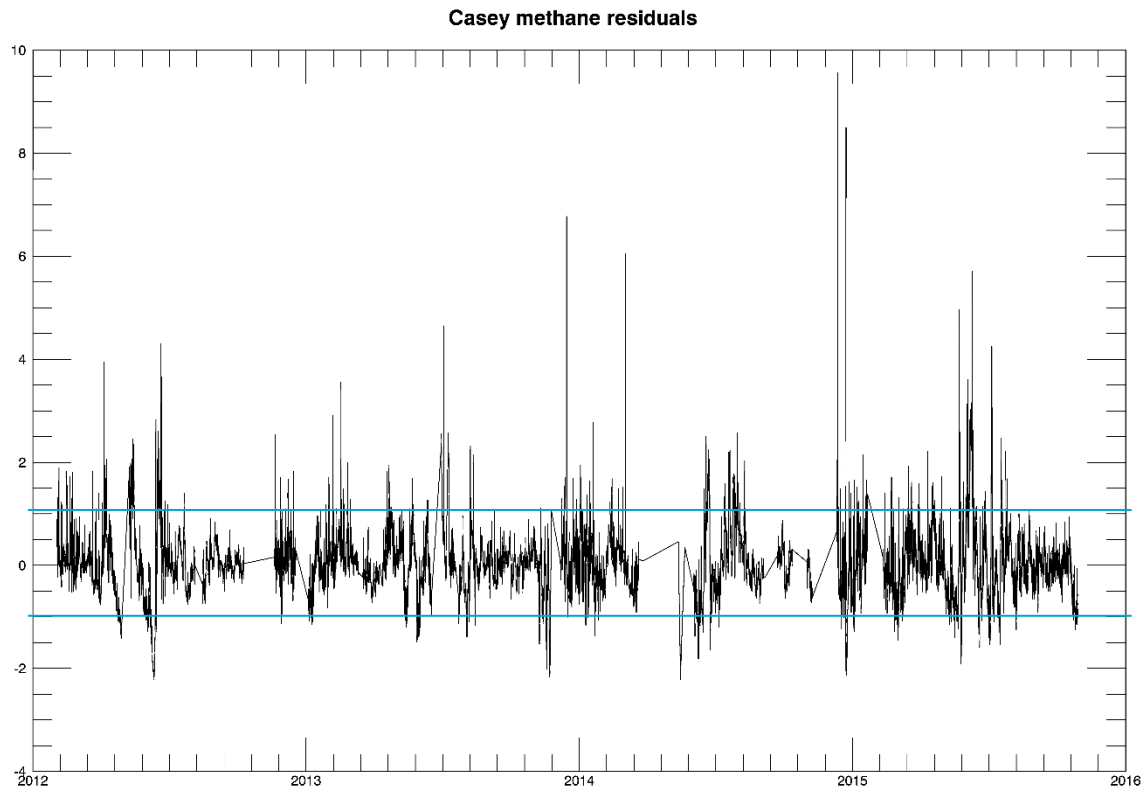
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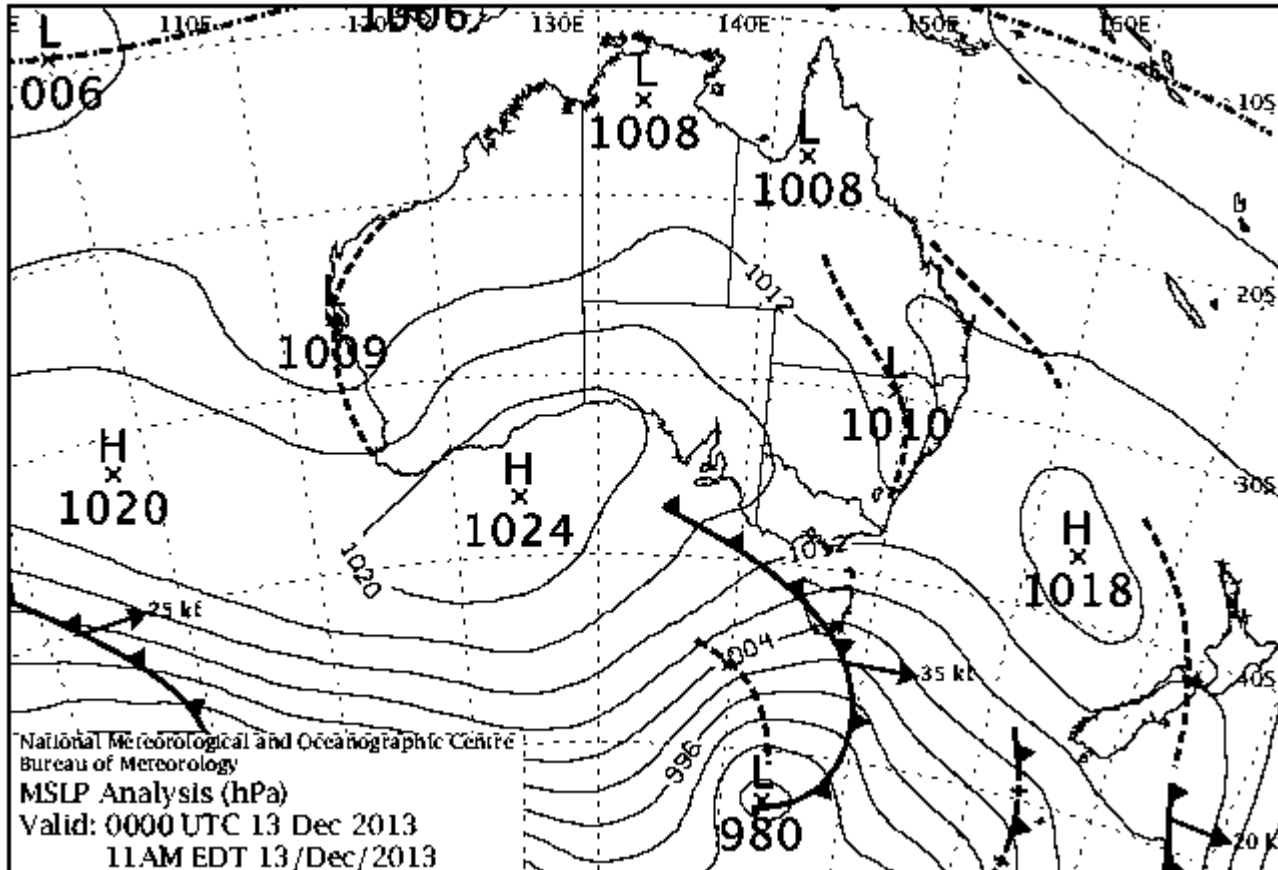
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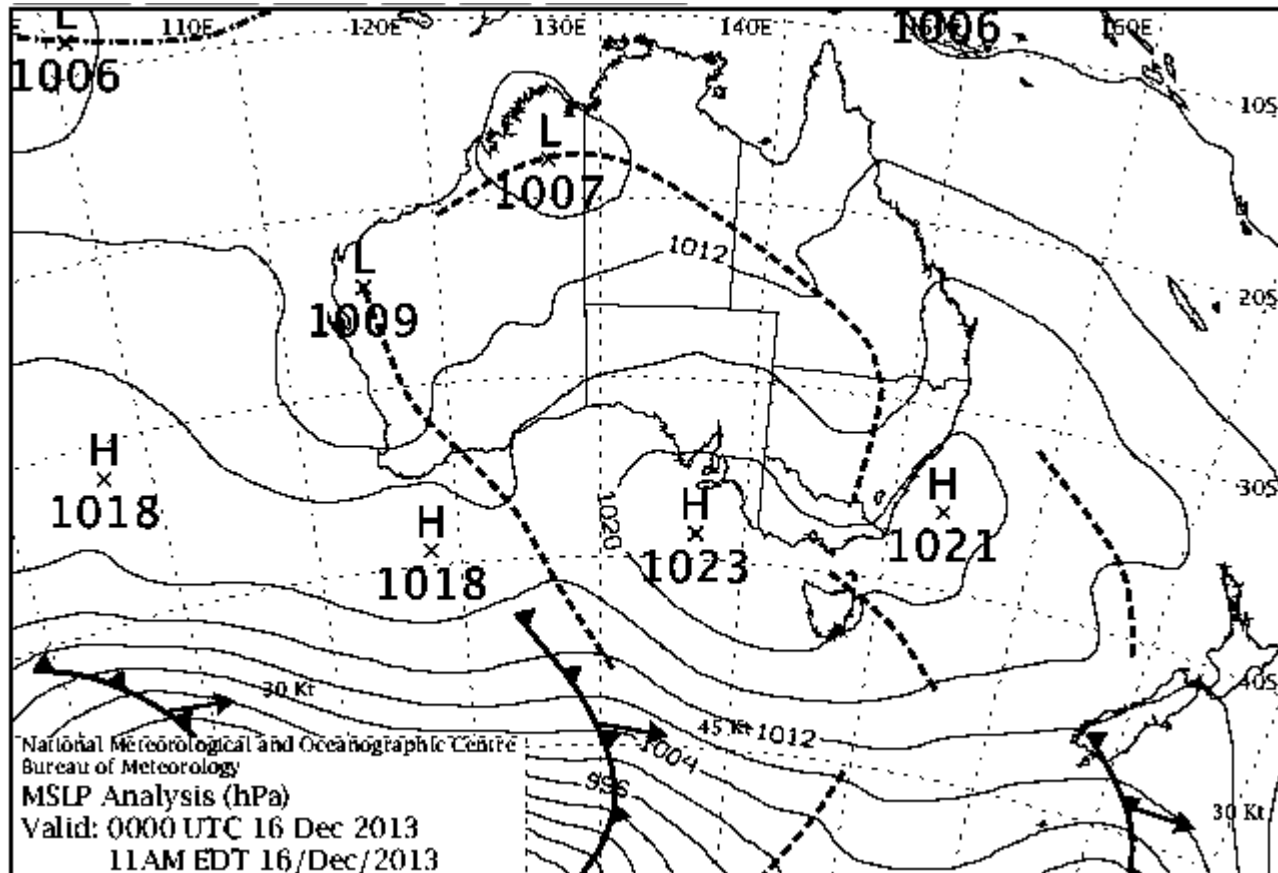
Residuals at Casey



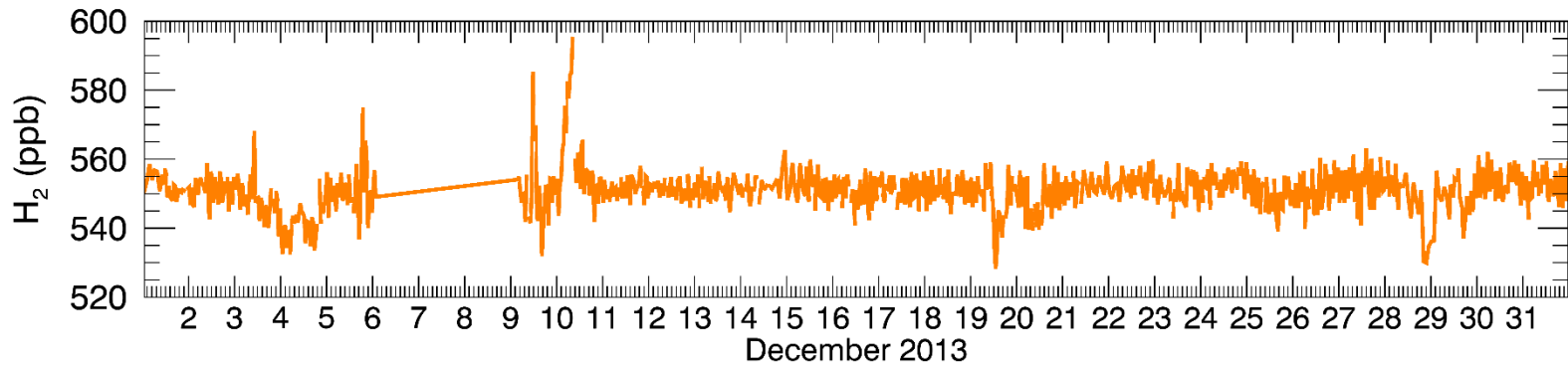
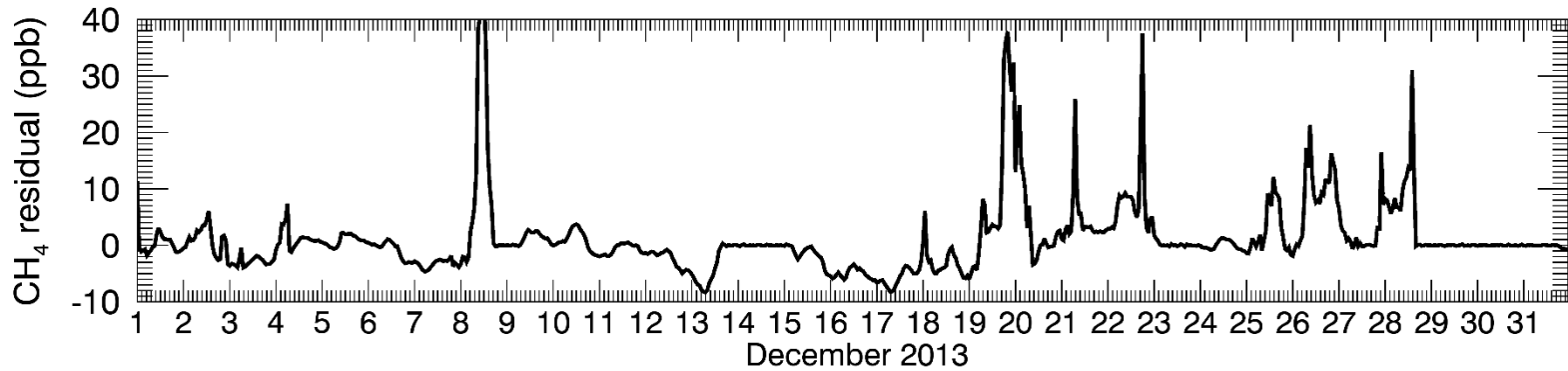
Synoptic conditions: 13 Dec 2013



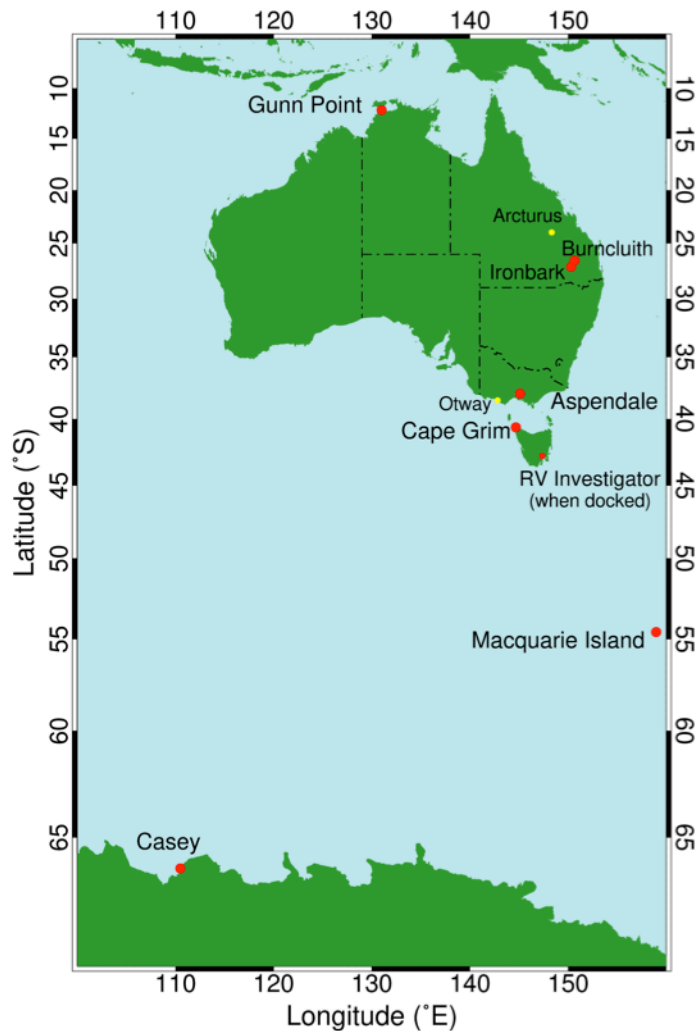
Synoptic conditions: 16 Dec 2013



December 2013: Hydrogen



Australian Greenhouse Gas Observation Network



- Cape Grim
- Gunn Point – tropical site
- Burncluith & Ironbark – coal seam gas fugitives
- Macquarie Island (LoFlo only)
- Casey Picarro G2301
- RV Investigator G2301 & Aerodyne N₂O/CO
- Arcturus & Otway (CCS) decommissioned