Greenhouse Gas Observation in New Zealand

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enhancing the benefits of New Zealand's natural resources



Overview

- 1. New Zealand Observation network
- 2. Baring Head CO₂
- 3. Comparisons
- 4. Methane
- 5. Collaborations





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New Zealand Observations

Stations

Baring Head Lauder Rainbow Mountain Arrival Heights, Antarctica Raoul Island (SIO)

Ship based

RV Tangaroa (NIWA, Southern Ocean) Transfuture 5 (Toyofuji & NIES, Western Pacific)

Comparisons

SIO, NOAA, CSIRO, WCC-CH4 (Asia), NCAR

enhancing the benefits of New Zealand's natural resources



Baring Head CO₂: Baseline Air

- Two dominant wind directions, northerly and southerly
- Southerly air stable (< 0.1ppm over a period of 6hrs)
- High speed northerly approaching stable
- Filter data for southerly sector
- Discriminate for air that has been in contact with land (< 1mbar at Christchurch Hokitika)
- Remaining data is baseline data set.





NAME III- CO₂ footprints

Footprints for the air arriving at Baring Head are developed using the high resolution Lagrangian model NAME III

- Particles are released from the site and travel back in time using input from a regional forecast model NZLAM-12
- Baring Head has two significant wind directions indicated
- These are then clustered into groups with similar trajectory characteristics

Mean footprint BHD

731 day mean Boundary Layer footprint



Kay Steinkamp



1-σ band for the trajectory spread is shown for this southerly cluster. this cluster forms the majority of the background air data.

40 year time-series

- All data shown in black
- Baseline periods in red
- Scales
 - Observations have been made on two scales:
 - SIO-08A
 - WMO x2007
- All raw data stored in flat text files
- Ability to reprocess whole data set if new scale revisions are provided
- Still minor adjustments required in the 1970-1978 observations.
- Mean seasonal cycle around 0.95 ppm
- Long term growth rate of 1.5 ppm yr⁻¹



Tagged tracer

We employ a fine grid version of TM3¹ to nfer contributions of sources to the seasonal cycle

- Carbon Tracker² 2010 fluxes
- Resolution ~3.8° lat x 5 ° long
- 19 levels
- 2000-9 with the first three years discarded to allow for spin-up





- S Ocean flux peak in the autumn (May) a trough summer (Dec).
- N Land flux is lagged by about six months at Baring Head due to transport time
- S Land flux, similar phase and amplitude, peaks in late winter (Aug-Sep) troughs in autumn (Mar-Apr).
- TM3 model seasonal cycle is of the similar magnitude as the observations, with the phase advanced by one month.

Current in situ comparisons

Instrument transition

The existing NDIR (Ultramat 3) is being compared with a CRDS (Picarro G-2401

• Same: Airline, ref gases, calibration cycles

Co-located Instruments

Southern Ocean Network (0.05 ppm) CSIRO Loflo - NIWA Instruments

- Different: ref gases, processing protocol
- Same: Air

Future developments

 In situ atmospheric O₂ at Baring Head, Cape Grim and Macquarie



Current Flask comparisons



- NIWA SIO (1978- present)
 - Pair every 2 weeks
 - CO₂, ¹³CO₂
- NIWA NOAA (1999- present)
 - CO₂, ¹³CO₂, CH₄, N₂O, CO



Methane

Methane growth rate

- 1990 1999 increasing
- 1999 2005 static
- 2006-2013 increasing

Interpretation of changes can be assisted by utilizing the stable carbon isotopic composition ($\delta^{13}CH_4$).

- Small number of researchers measuring $\delta^{13}CH_4$, need for comparison between labs
- Suite of tanks being prepared for circulation as a tie between labs



Box model analysis - preliminary

Stabilisation of emissions at 1992 CF levels would lead to more gradual plateau than observed \rightarrow reduction of emissions

 δ 13C value of "missing emissions" as determined in box model runs:

- From 1992-1999: -50‰ •
- From 1999-2006: -40‰ ٠

Characteristic for

- Unchanged source mix until 1999 CE
- reduced emissions from fossil fuels after 1999 CF







Hinrich Sch

Box model analysis - preliminary

Renewed rise after 2006 CE

increase of a methane source

 δ^{13} C value of "additional emissions" as determined in box model runs: -65 to -70‰

Characteristic for:

- extremely "light" biogenic emissions (boreal wetlands?)
- an increased biogenic source while "heavy" emissions (fossil fuels, fires) decrease



pCH4 Source perturbation to match post-2006 increase

Collaborations in Asia-Pacific

ethane Western Pacific Transects: NIES/Toyo Fuji

our distinct zones for transects over a multiple voyages

- Clean mid-latitude SH
- Increased influence NH sources
- Stable area around ITCZ
- Influence of terrestrial Asia
- Significant structure which often relates to position of SPCZ
- Transport variability may be as important as source variability in models

outhern Ocean

- New Zealand Science Challenges Deep South
- Southern Ocean Observations
 - NIWA RV Tangaroa
 - KOPRI RV Araon

outh Pacific

• Fiji (developing)





Conclusion

Baring Head CO₂

- Mean seasonal cycle around 0.95 ppm
- Long term growth rate of 1.5 ppm yr⁻¹
- Model suggests southern ocean, southern land and northern land fluxes dominate BHD signal

Methane

Box model indicates shift in sources to lighter CH₄

Collaborations

- Deep South Challenge
- Western Pacific
- Southern Ocean