

Atmospheric Observation Network for New Zealand

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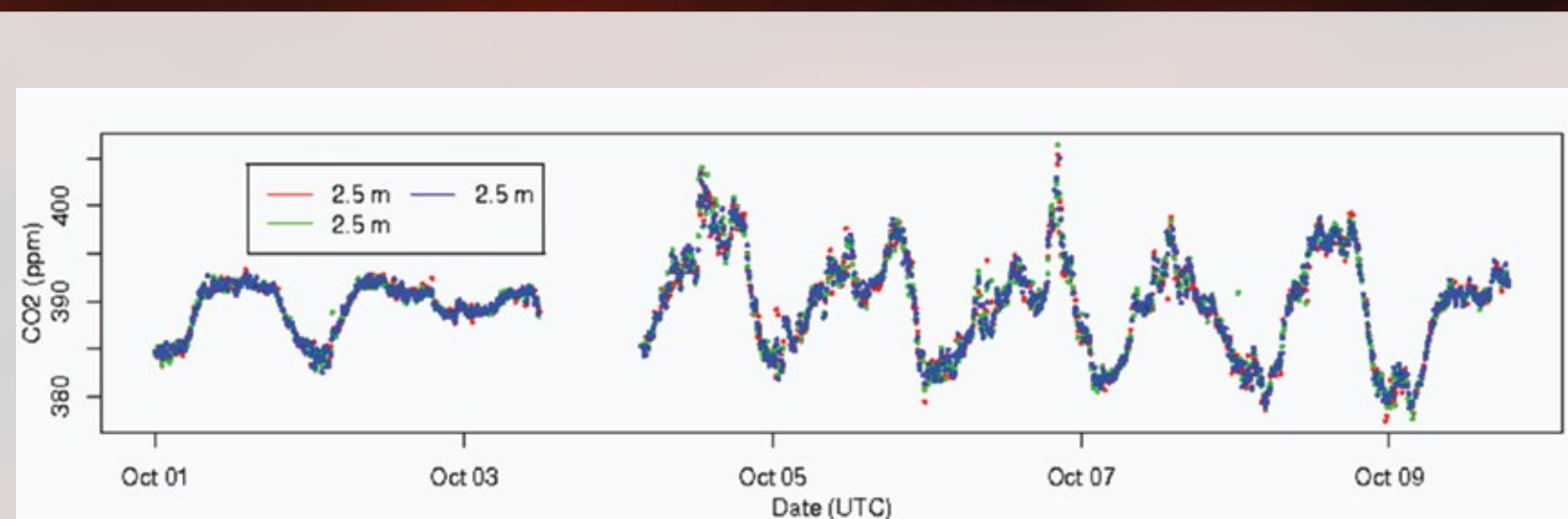
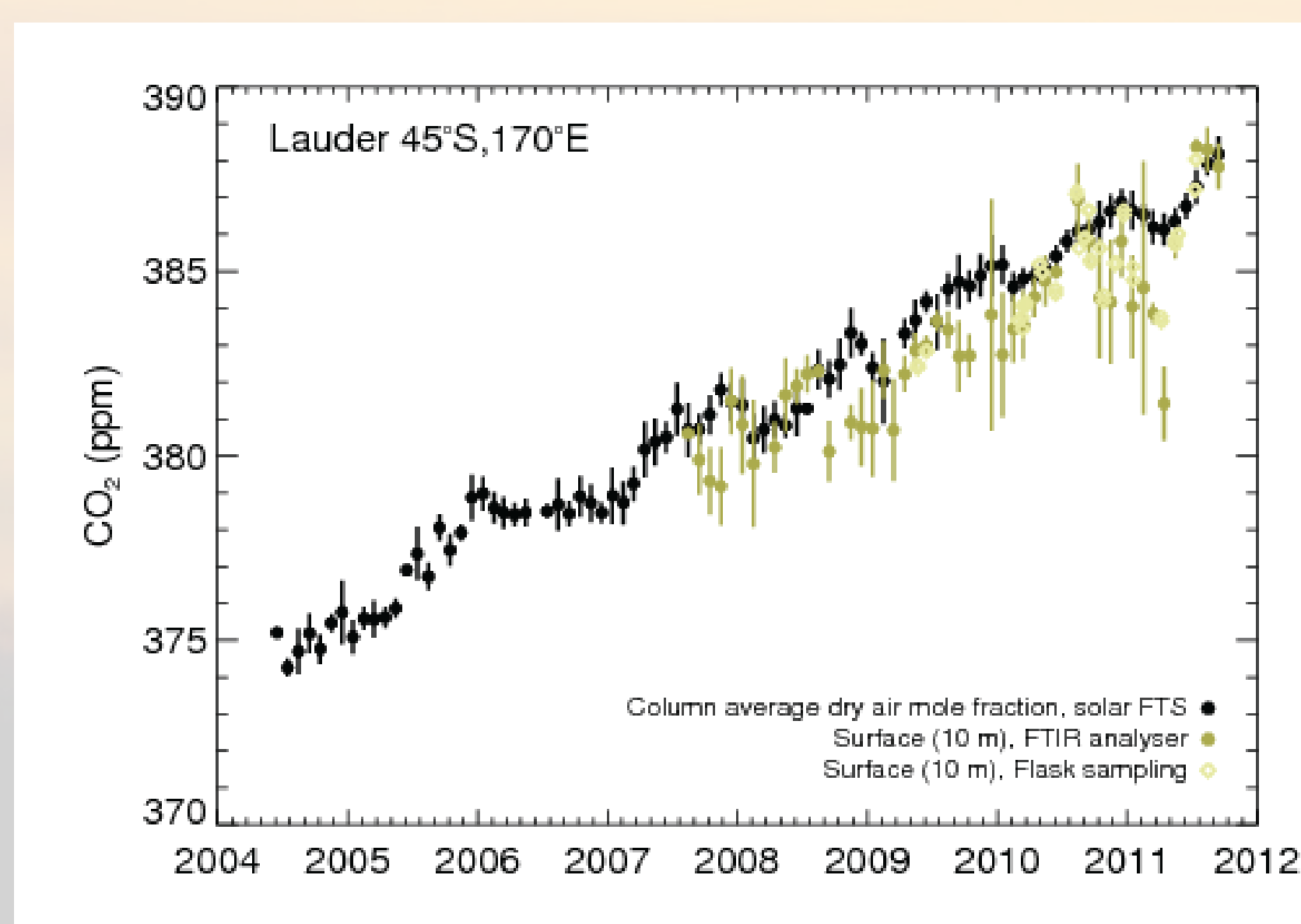
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Atmospheric observations have been a key component of research at NIWA with the first observations starting in 1954 with atmospheric ¹⁴CO₂, and followed later with the first southern hemisphere continuous CO₂ measurement programme at Makara, Wellington in 1970 and relocated to Baring Head, Wellington in 1972. The programme has now expanded to include non-CO₂ greenhouse gases and other tracers that assist in understanding both the carbon cycle and atmospheric chemistry. The carbon cycle programme utilises precise determination of CO₂ at three in-situ sites within the network: Baring Head, Lauder and Rainbow Mountain. Baring Head includes additional observations that provide further understanding of carbon cycling with stable isotopes and radiocarbon of CO₂, and O₂/N₂. While Lauder (Central Otago) makes both total column and in situ observations of CO₂ and greenhouse gas species (see poster GP3, Smale et al). A surface pCO₂ time series out to the sub antarctic surface waters off Dunedin has been running for over ten years. Antarctic atmospheric observations are made routinely at Arrival Heights and periodic transects are collected across the Pacific between New Zealand and the USA and more recently to Japan (see poster FP11, Bromley et al).

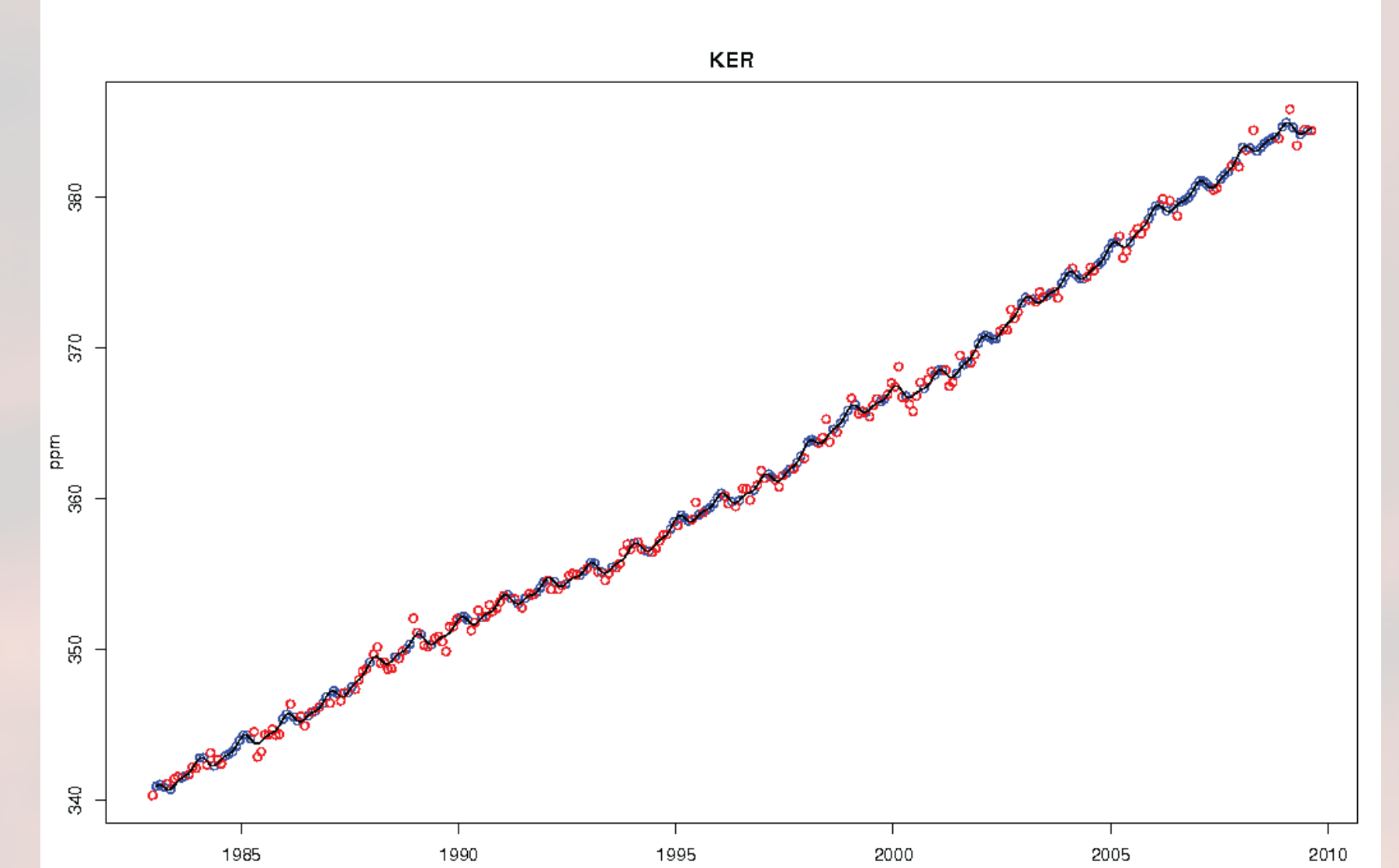
Baring Head has been the site for observations of an extensive set of species that focus on understanding the temporal and the composition changes of greenhouse gas species through mixing ratio determination and the use of isotopic studies. The table below lists each species measured. The site is regularly exposed to air masses that are representative of mid to high latitude southern hemisphere air. Atmospheric CO₂, O₃ and O₂/N₂ observations are made continuously at the site, while flasks and cylinders of air are sampled for the other species during periods of high CO₂ stability.

Species	Started	Method	Scale
¹⁴ CO ₂	1954	Counting and AMS	NBS Oxalic Acid
CO ₂	1970	NDIR	WMOx2007
¹³ CO ₂	1996	GC-IRMS	V-PDB (NBS19)
CH ₄	1989	GC-FID	NOAA04
¹³ CH ₄	1987	IRMS	V-PDB (NBS19), LSVEC
¹⁴ CH ₄	1987	AMS	NBS Oxalic Acid
CO	1989	GC	WMO2004
¹³ CO	1989	IRMS	V-PDB (NBS19), LSVEC
¹⁴ CO	1989	AMS	NBS Oxalic Acid
O ₃	1991	UV absorption	NIST
O ₂ /N ₂	1999	Paramagnetic	SIO
N ₂ O	1996	GC-ECD	NOAA2006

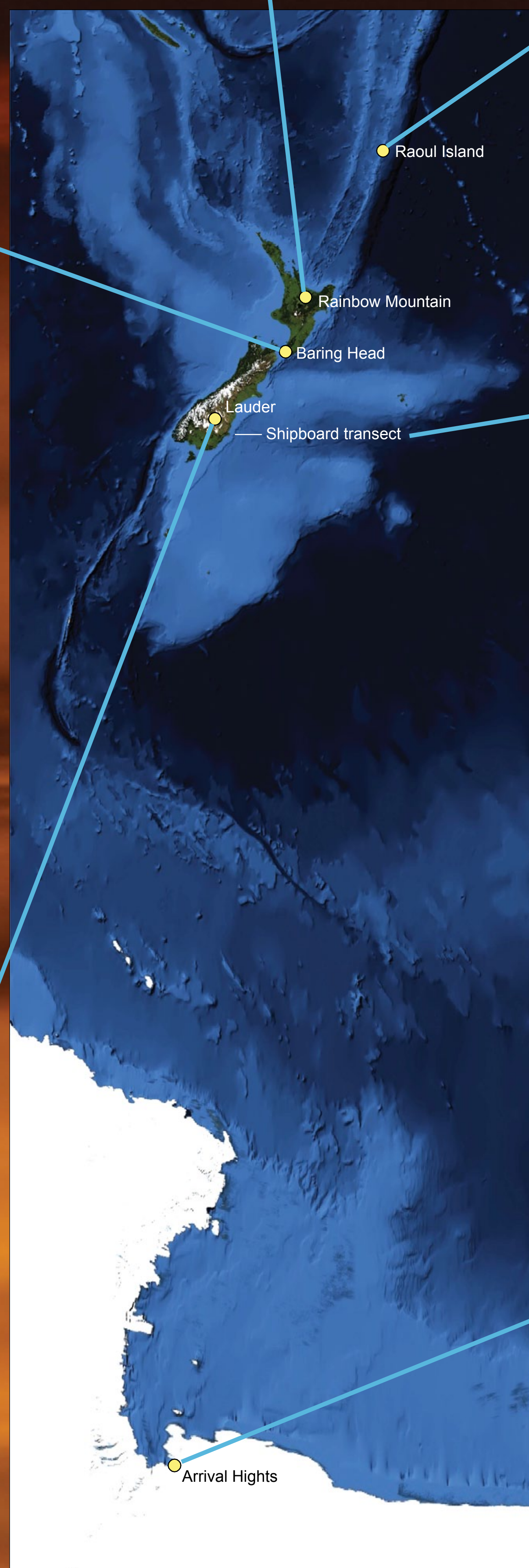
Lauder initiated ground-based remote sensing measurements of CO₂, CH₄, N₂O and CO within the framework of the Total Carbon Column Observing Network (TCCON) in 2004. In situ measurements of these species have been made using a FTIR trace gas analyser (see poster GP3), LiCor and flask sampling since 2007. Using co-incident aircraft profiling measurements during the HIPPO experiment, comparisons of column measurements are made with the to the WMO mole fraction scales. TCCON is the primary validation data for new near-infrared remote sensing measurements of CO₂ and CH₄ from space. TCCON data also provide complementary information to the surface monitoring network for carbon cycle research.



Rainbow Mountain, a recently added observation site (Sept 2011), measures the CO₂ flux associated with the central North Island, where extensive forestry occurs. Measurements to date demonstrate strong variation of CO₂ during daylight hours.

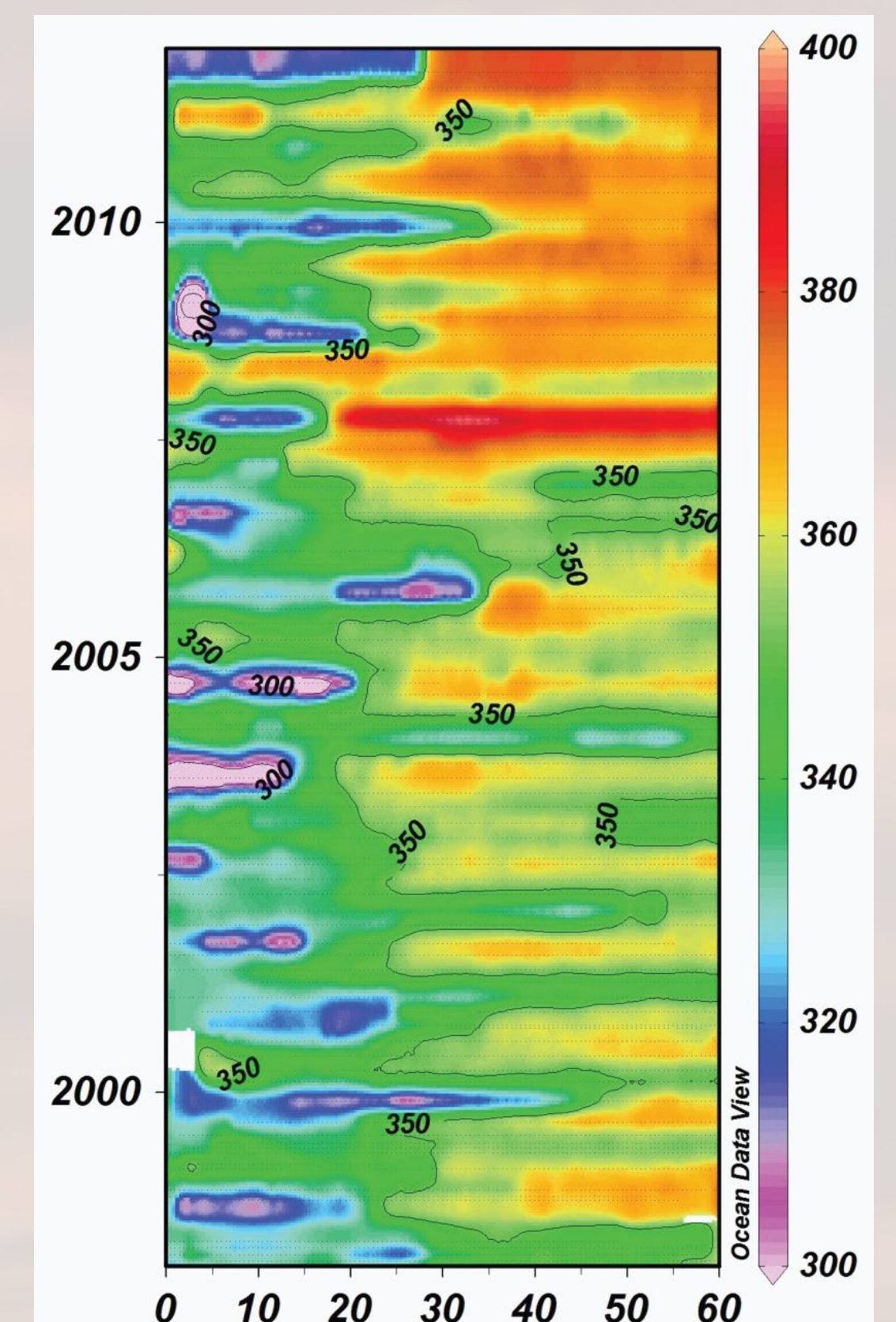


Raoul Island, Flask sampling for CO₂ and its stable isotopes, is a collaborative project with SIO. A similar programme at Baring Head forms part of a long term comparison of in situ and flask data.

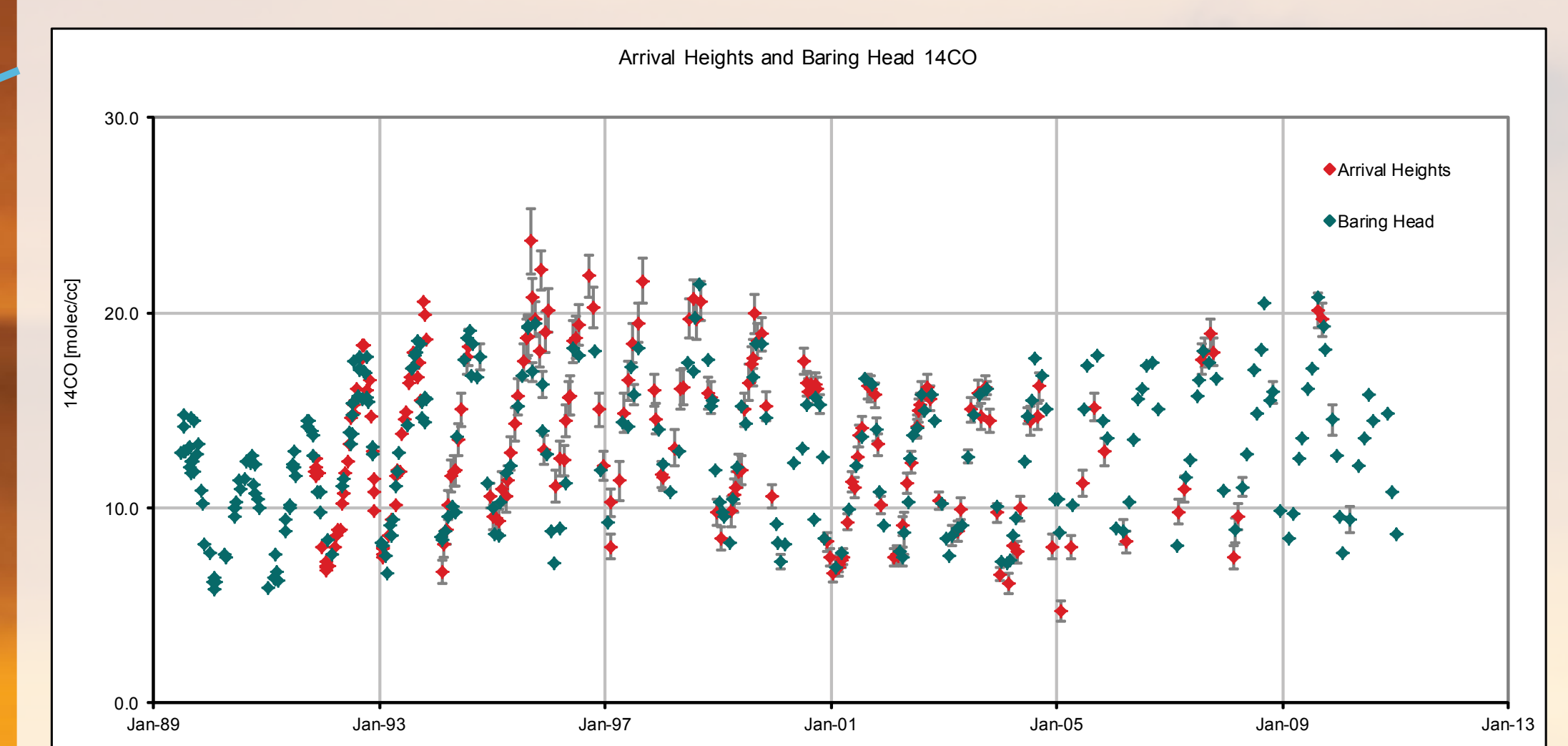


Munida pCO₂ transects

This transect is generally undersaturated, and the near shore waters are of lower pCO₂ than the offshore waters. In subantarctic surface water (SASW > 50km offshore) the seasonal cycle shows a minimum in late summer and a maximum in early spring. The cycle is dominated by biological drawdown, but this is modulated by the thermodynamic effect of changing seawater temperature. In SASW pCO₂ has increased by an average of 1.1 +/- 0.4 atm yr⁻¹, less than the atmospheric increase, thereby leading to an increase in the air-sea CO₂ difference, and an increase in the SASW sink for atmospheric CO₂.



Arrival Heights along with Baring Head has determinations of atmospheric ¹⁴CO. These data vary with the solar cycle and provide an insight into changes in atmospheric oxidation and chemistry. The Antarctic site offers the ability to monitor differences between New Zealand based sites and the higher latitude (-78 °)



Summary

The observation network operated by NIWA incorporates two high precision measurement sites at Lauder and Baring Head, providing key data both in situ and remote that forms the basis of our programme. Observations from Arrival Heights, Dunedin, Rainbow Mountain and Raoul Island add to these with either complimentary or supporting data. While the observations at these sites are carefully made each species measurement is supported by at least one form of comparison to ensure they are robust.

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