Surface Ozone Trends at Cape Grim 41 S: producing a homogenous data set and interpreting the results

Melita Keywood on behalf of Ian Galbally

39th NOAA ESRL Global Monitoring Annual Conference

17 May 2011

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Acknowledgements

The Cape Grim program, established by the Australian Government to monitor and study global atmospheric composition, is a joint responsibility of the Bureau of Meteorology and the CSIRO

Staff (past and present) involved on the ozone program include:

CSIRO: Ian Galbally, Suzie Molloy Simon Bentley, Mick Meyer, Malcolm Elsworth, Wayne Knight, Michael Douglas, Ian Morrissey, John Osborne, Jason Ward

Cape Grim: Laurie Porter, Ross Paterson, Randall Wheaton, Stuart Baly, Jeremy Ward

Collaboration: Sam Oltmans NOAA

The scientific challenge: can we observe, explain and predict:

- **the current distribution of ozone in the troposphere?**
- **the past and future trends in ozone in the troposphere?**

Do we understand:

- the distribution of ozone source and sink regions in the southern hemisphere troposphere?

The Technical Challenge

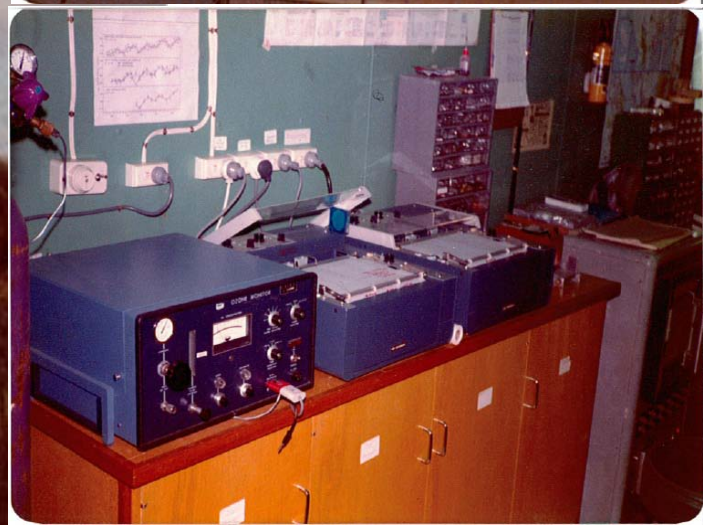
With changing and newly emerging technologies can/did we maintain an atmospheric ozone record over 30-50 years that:

- **is a representative record of ozone in the marine boundary layer upwind of Cape Grim**
- **has internal consistency such that ozone variations on timescales from hours to decades are recorded with minimum and unchanging, or quantified, bias over the period of the record**

Cape Grim Ozone Equipment 1982 - 2010

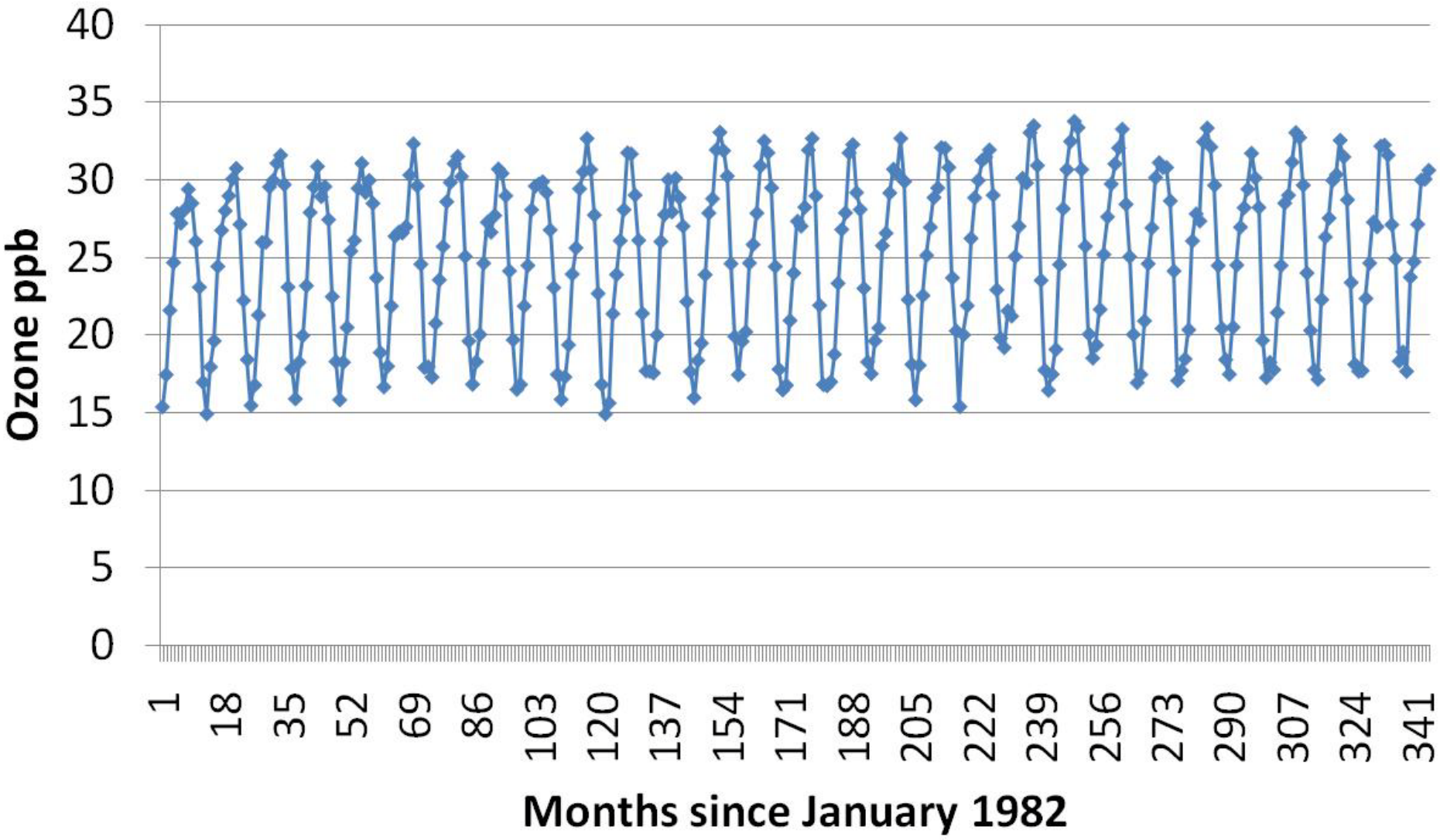
- 3 Ozone monitors
- 3 Inlets
- Chart based, magnetic cassette and computer based analog and digital data acquisition
- 3 sets of data reduction software
- 3 Zero and Span units
- 2 Calibrators
- 3 International calibrations

Cape Grim May 1978

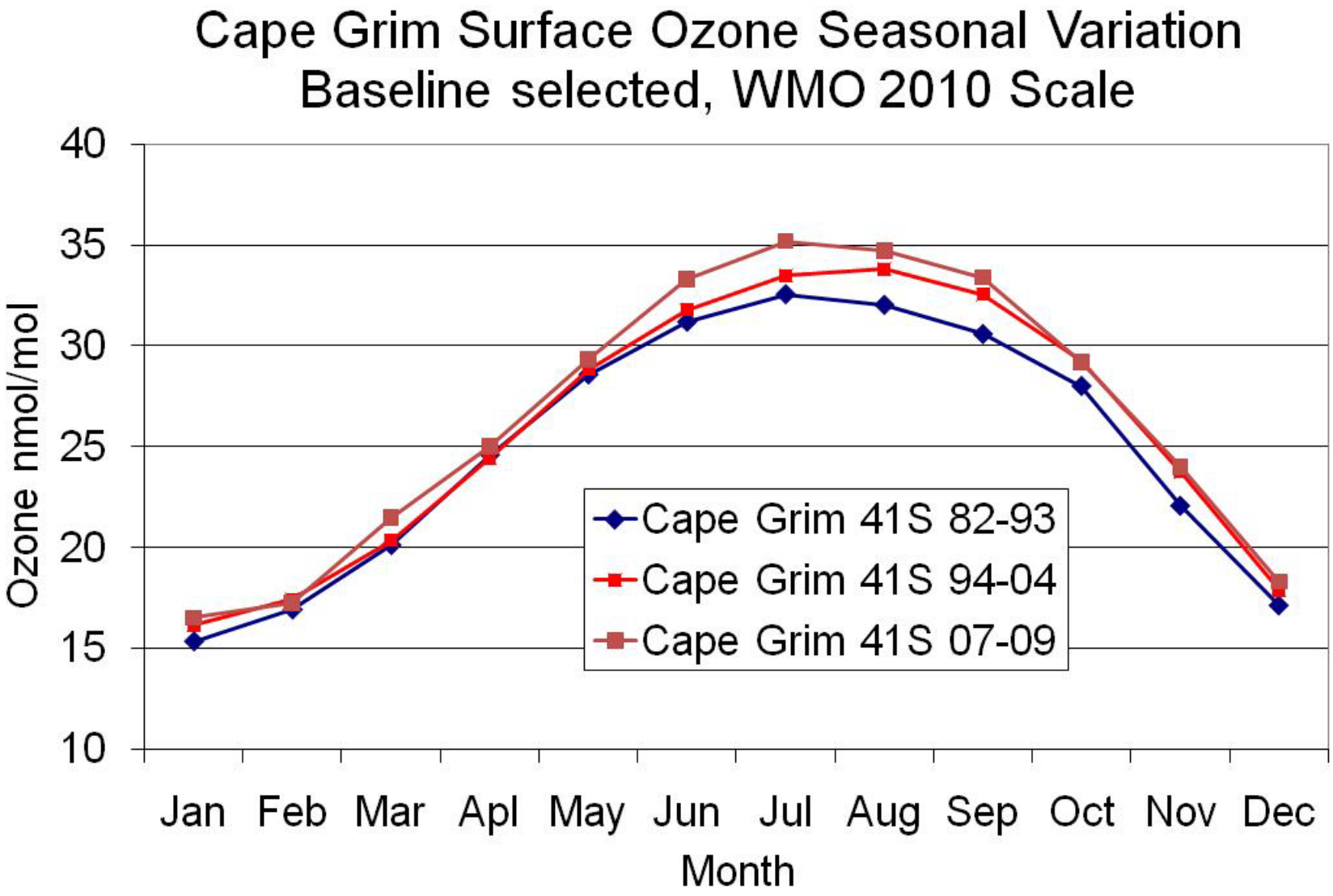


Cape Grim Ozone System 2009

Cape Grim monthly means: all data 1982 - 2010



The long term trend



Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Cape Grim Surface Ozone Yearly Trend Analysis based on monthly anomalies. Units: Intercept – ppb. Slope = β_1 - ppb/y. CI = 95%

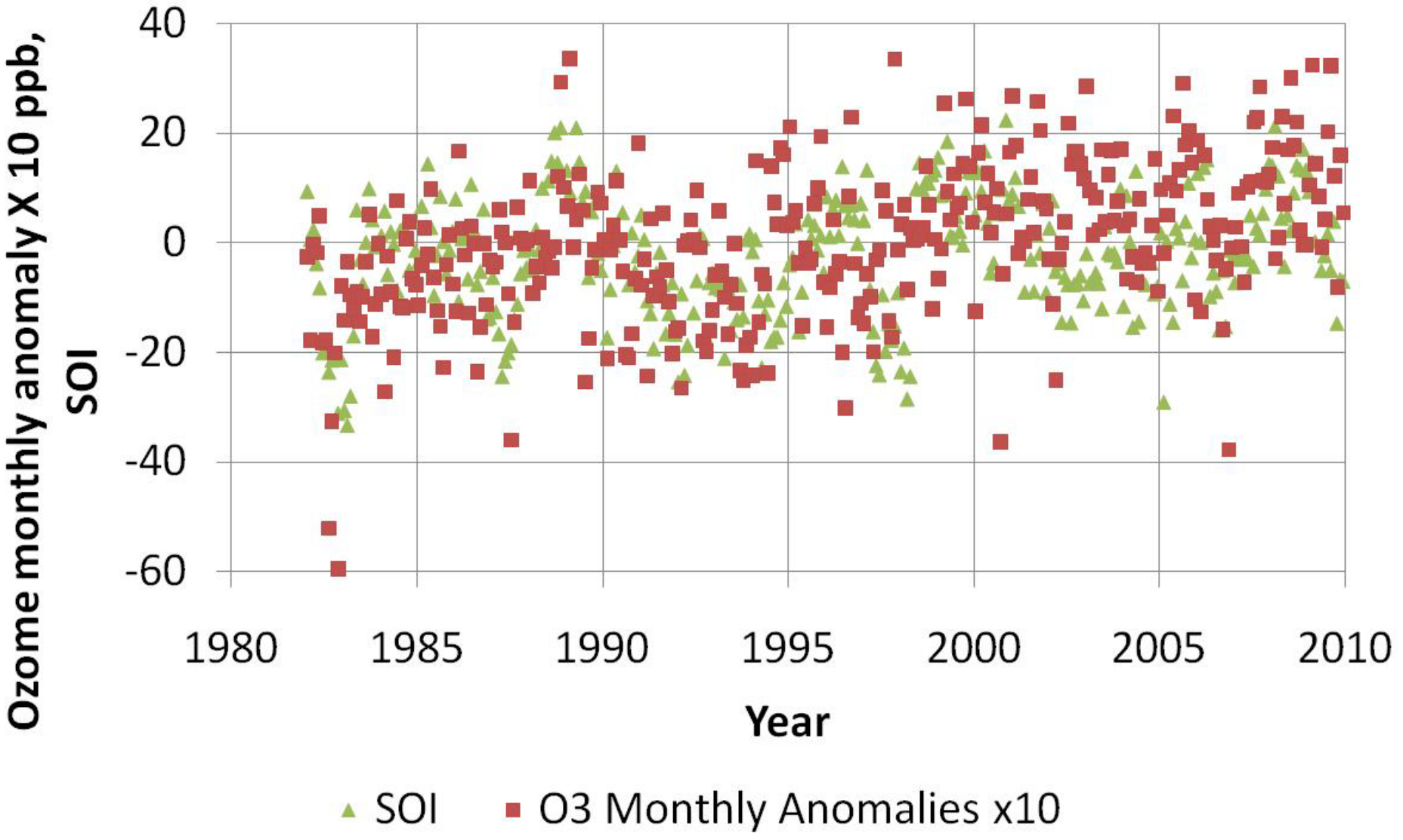


	All Data Monthly Mean Anomalies	Baseline Mean Monthly Anomalies	Non-Baseline Mean Monthly Anomalies
1982 - 1989	y = 0.124x + 1.737	y = 0.204x + 2.868	y = 0.162x + 2.279
	β_1 = 0.124 ± 0.086	β_1 = 0.204 ± 0.069	β_1 = 0.162 ± 0.095
1990 - 1999	y = 0.105x + 0.527	y = 0.121x + 0.611	y = 0.106x + 0.533
	β_1 = 0.105 ± 0.069	β_1 = 0.121 ± 0.067	β_1 = 0.106 ± 0.070
2000 - 2009	y = -0.082x + 0.405	y = -0.062x + 0.306	y = 0.019x - 0.096
	β_1 = -0.082 ± 0.068	β_1 = -0.062 ± 0.069	β_1 = 0.019 ± 0.071
1982 - 2009	y = 0.052x + 0.210	y = 0.055x + 0.221	y = 0.075x + 0.303
	β_1 = 0.052 ± 0.015	β_1 = 0.055 ± 0.015	β_1 = 0.075 ± 0.016

Cape Grim Surface Ozone Seasonal Trend Analysis based on monthly anomalies.

- Surface ozone in Austral spring (SON) and summer (DJF) show positive trends in the 1980's and 1990's and non-significant trends in the 2000's and positive trends over the three decades combined
- Surface ozone in Austral autumn (MAM) and winter (JJA) show non-significant trends in each of the three decades. Over the three decades there are ambivalent results concerning an upward trend in these seasons.

Cape Grim Ozone 1982 - 2009 and SOI



Cape Grim Surface Ozone monthly anomalies vs SOI (ENSO) and SAM.

- Correlation with SOI (ENSO) (r)
- DJF (Summer) = +0.246 (n = 83)
- MAM (Autumn) = +0.371 (n = 83)
- JJA (Winter) = +0.171 (n = 83) n.s.
- SON (Spring) = +0.384 (n = 83)
- More intense convection in the Australian region tropics is associated with positive ozone anomalies at Cape Grim
- Correlation with SAM = not significant

Possible explanations of southern hemisphere tropospheric ozone trends (1)

- Increased NO_x, VOC and CO emissions from biomass burning causing the surface ozone increase in the South Atlantic region from 1970's to present
- Increased NO_x emissions from shipping causing the surface ozone increase in the Southern Hemisphere from 1970's to present

Possible explanations of southern hemisphere tropospheric ozone trends (2)

- Stratospheric ozone depletion causing increased tropospheric uv causing downward surface ozone trend from 1980's to present at the South Pole?
- Unidentified circulation changes:
  - latitude of high pressure belt,
  - mid latitude vertical overturning,
  - changed strat-trop exchange?

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

The challenge now is to find a key in the ozone record that indicates what has caused the changed concentrations.

Thank you

www.cawcr.gov.au