Semi-continuous measurements of $\text{Ar}/\text{N}_2$, $\text{O}_2/\text{N}_2$, and $\text{CO}_2$ at the Scripps pier: The “Pierline”

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Semi-continuous measurements of Ar/N₂ at La Jolla

Started by Tegan Blaine
11+ years of data nearly every weekend, on usual flask instrument
Pre-July 2011: data highly QC’ed. Post July 2011: less well constrained
Atmospheric Ar/N\textsubscript{2} = tracer of ocean heat content

- Ar is about twice as soluble as N\textsubscript{2} in seawater
- Warming ocean increases atmospheric Ar/N\textsubscript{2}, cooling opposite
Semi-continuous measurements of Ar/N₂ at La Jolla

Drift in time series of +0.23 per meg / year
Expected trend is rise of +0.3 per meg / year
Semi-continuous measurements of Ar/N\textsubscript{2} at La Jolla

Drift in time series of +0.23 per meg / year
Expected trend is rise of +0.3 per meg / year
Except interannual variations are large compared to trend

Seasonal cycle is 17 per meg peak to trough
Semi-continuous measurements of CO₂ at La Jolla

Large industrial / fossil fuel excursions from background values
Identify background values as times with stable CO₂ (hourly std dev of < 0.35ppm, blue points) to define trend and seasonal cycle
Semi-continuous measurements of APO at La Jolla

Industrial excursions still perturb much of the record
Some high APO events in summer (will compare to Ar/N₂)
Deconvolution of seasonal cycles

Baseline CO$_2$ cycle yields land biology, Ar/N$_2$ corrected for solubility differences yields air-sea heat flux, Ocean biology / ventilation is the rest (APO – heat flux)

Air-sea heat flux causes 23% of APO fluxes detected at La Jolla
Ocean minimums and maximums line up within a week
Pierline precision much better than flasks for $\text{Ar/N}_2$

Pierline is still far more precise than flask measurements
Aspirator on inlet in mid-2006 improved flask measurements
Interannual variability in record is large

Recent data since 2013 is above the regular seasonal cycle
Winter 2005 also unusually high
Interannual variability in record is large

Residuals from the regular seasonal cycle show similar deviations
Wintertime North Pacific Sea Surface Temperature Anomalies

Feb 2005, 2014, 2015 are standout warm years
La Jolla Ar/N₂ tracks North Pacific mean SST fairly well

Full time series of each
La Jolla Ar/N$_2$ tracks North Pacific mean SST fairly well

Residuals of each
“The Blob” – Anomalously warm N Pacific SST

Feb 2014 SST anomaly (°C) from NCEP GODAS relative to 1981-2010 mean

High SLP suppressed wind stress and winter heat loss

Oct 2013 – Jan 2014 SLP anomaly (hPa) relative to 1981-2010 mean

La Jolla Ar/N₂ tracks North Pacific mean SST fairly well

Residuals of each
Ar/N₂ Primaries on ljoms1 (S1 scale)

Tank stability was a significant issue pre 2006
Source of sudden offset in 2009 unclear
Lateral gradients must exist even in horizontal cylinders.

Adding diptubes to remove gas from the exact center of the cylinder improved standard stability (working tanks and hi-lo-ox cylinders).

- No diptube
- Too long diptube
- Just right

Pier working tank Ar/N₂ concentrations

- Hi span gets short diptube 12-Jun-2006
- Lo span gets long diptube 28-Jan-2005, Short diptube 17-Nov-2006
- Ox span gets short diptube in Oct-2008
Semi-continuous measurements of Ar/N$_2$ at La Jolla

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Short, high Ar/N₂ events

Events have higher APO, but not with consistent Ar/N₂ / APO ratio

CO₂ not necessarily high or baseline

Air masses tend to come over coastal zone
Short, high Ar/N$_2$ events

No clear correlation with Air T, Wind Direction, etc...

Anecdotal evidence that events occur during fog, suggesting a role for atmospheric inversion and thin boundary layer

What is best proxy for this?
Conclusions

11+ years of semi-continuous Ar/N\(_2\), APO data at La Jolla
Global warming trend cannot be detected yet
Seasonal deconvolution indicates heat fluxes drive 23% of APO cycle
Interannual variability may be linked to North Pacific temperature changes
Enigmatic short term events show high Ar/N\(_2\) and high APO

Remaining questions

Are the interannual variations robust to standard calibration?
Are recent Ar/N2 increases related to ocean warming, anomalous atmospheric transport, or both?
What proxy could be used to prove high events are linked to boundary layer dynamics?