



Melting ice core samples in the methane extraction line at OSU. Photo by Logan Mitchell

Atmospheric Methane from WAIS Divide: 1000-1800 A.D.

Logan Mitchell, Ed Brook

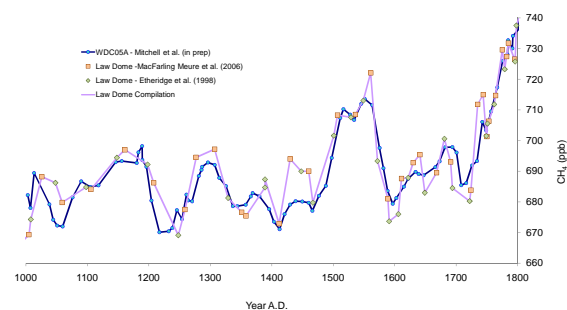
Oregon State University, Department of Geosciences

1. INTRODUCTION

Atmospheric methane has caused the second largest increase in radiative forcing from long lived greenhouse gases since the start of the industrial revolution. Here we present the completed high-precision, high-resolution, 1000 year record of atmospheric methane from the West Antarctic Ice Sheet Divide 05A (WDC05A) shallow gas core and preliminary results from the Greenland ice core GISP2D. These records include:

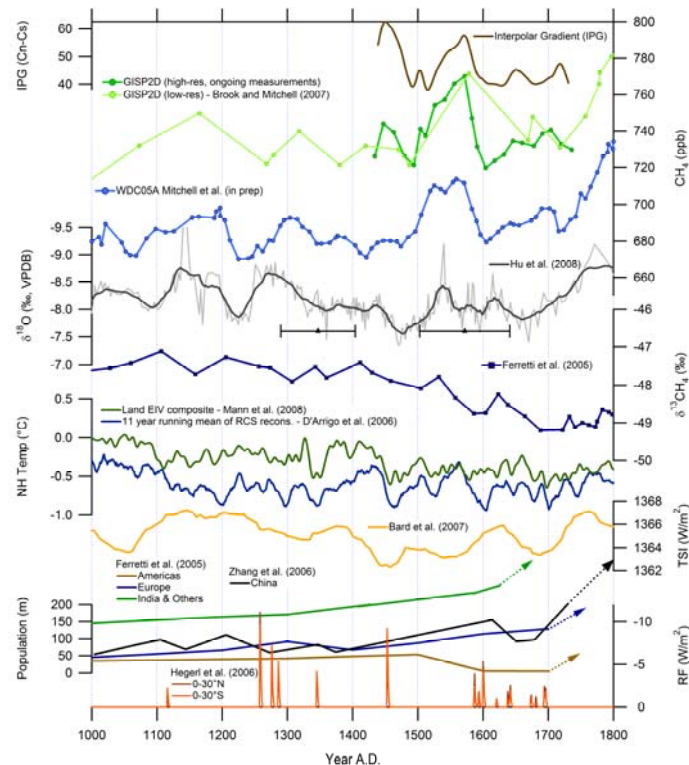
- 181 WDC05A samples analyzed with temporal resolution of ~9 years.
- Analytical precision of ± 3 ppb.
- Nearly identical patterns appearing in GISP2D high resolution data.
- High resolution Inter-Polar Gradient (IPG).
- High correlation with the Law Dome CH_4 record.

2. COMPARISON WITH LAW DOME



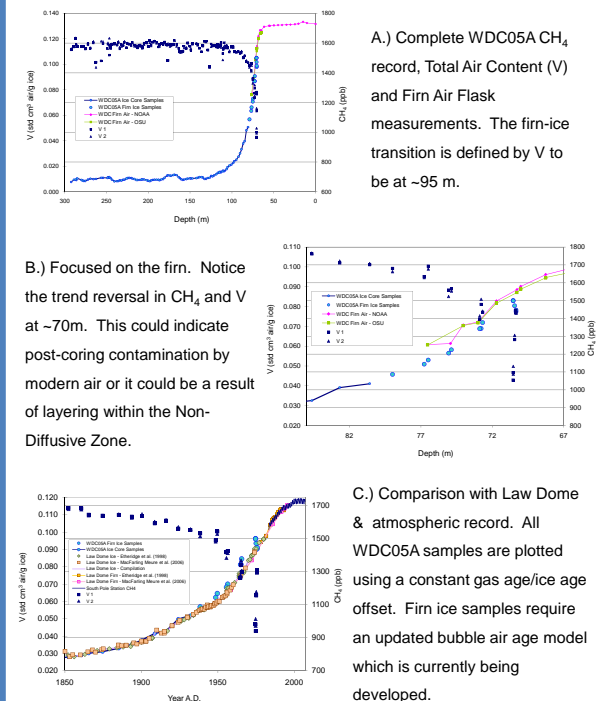
- Replication of paleoclimate records is an important means for verifying their reliability. The WDC05A and Law Dome records are nearly identical within analytical uncertainty. Raw data is highly correlated, $r^2 = 0.81$.
- WDC05A has lower analytical uncertainty (± 3 ppb vs. ± 5 ppb) using smaller sample sizes (~120 g vs. ~500-1500 g).
- Multi-decadal variability in WDC05A is ~20% smaller than Law Dome due to additional smoothing of the record by a lower accumulation rate at WDC05A (~24 cm ice/year vs. ~65 cm ice/year). Modeling of this is in prep.
- Duplication of high resolution CH_4 records could be used to establish chronological tie points on a multi-decadal scale between ice core gas records.

3. COMPARISON WITH OTHER PALEOCLIMATE RECORDS



- Our current focus is examining various paleoclimate archives relevant to the atmospheric CH_4 budget for signals that could contribute towards the observed multi-decadal variability.
- There is a possible weak correlation ($r^2 = 0.16$) between Chinese speleothems (Hu et al. 2008) which is a proxy for monsoon strength. However, this speleothem has relatively poor age control which could impact this correlation.
- Our initial findings indicate that there is no one source region, climate phenomenon (ENSO, PDO, drought pattern, etc), temperature reconstruction, precipitation anomaly, or anthropogenic pattern that can explain a significant portion of the observed multi-decadal variability. It is possible that these factors combine in various ways to produce the record.
- We are currently extending these high resolution measurements back to ~2,700 years B.P. This will allow us to observe the multi-decadal variability earlier in the Holocene when anthropogenic activities were less significant.

4. FIRN-ICE TRANSITION OBSERVATIONS



A.) Complete WDC05A CH_4 record, Total Air Content (V) and Firn Air Flask measurements. The firn-ice transition is defined by V to be at ~95 m.

B.) Focused on the firn. Notice the trend reversal in CH_4 and V at ~70m. This could indicate post-coring contamination by modern air or it could be a result of layering within the Non-Diffusive Zone.

C.) Comparison with Law Dome & atmospheric record. All WDC05A samples are plotted using a constant gas age/ice age offset. Firn ice samples require an updated bubble air age model which is currently being developed.

5. REFERENCES

Bard, E., et al. (2007). Solar activity during the last 1000 yr inferred from radionuclide records - *Comment, Quat. Sci. Rev.*, 26(17-18), 2301-2304.

Brook, E. J., and L. E. Mitchell (2007). Timing and Trends in Northern and Southern Hemispheric Atmospheric Methane During the Holocene: new Results from Antarctic and Greenlandic ice Cores. *EOS, Trans., AGU, 88(52)*, Fall Meeting Supplemental Abstract U21F-06.

D'Arrigo, R., et al. (2006). On the long-term context for late twentieth century warming. *J. Geophys. Res.-Atmos.*, 111(D3), 12.

Ferretti, D. F., et al. (2005). Unexpected Changes to the Global Methane Budget over the Past 2000 Years. *Science*, 309(5741), 1714-1717.

Hegerl, G. C., et al. (2006). Climate sensitivity constrained by temperature reconstructions over the past seven centuries. *Nature*, 440(7087), 1029-1032.

Hu, C. Y., et al. (2008). Quantification of Holocene Asian monsoon rainfall from spatially separated cave records. *Earth and Planetary Science Letters*, 266(3-4), 221-232.

Mann, M. E., et al. (2008). Proxy-based reconstructions of hemispheric and global surface temperature variations over the past two millennia. *Proceedings of the National Academy of Sciences*, 105(36), 13252-13257.

Zhang, D. D., et al. (2006). Climatic change, wars and dynastic cycles in China over the last millennium. *Clim. Change*, 76(3-4), 459-477.

We gratefully acknowledge the support for this research from NSF OPP grant # 0440615.