# Rising methane - 1 -The use of C-isotopes in understanding the growth in atmospheric methane 2007-14.


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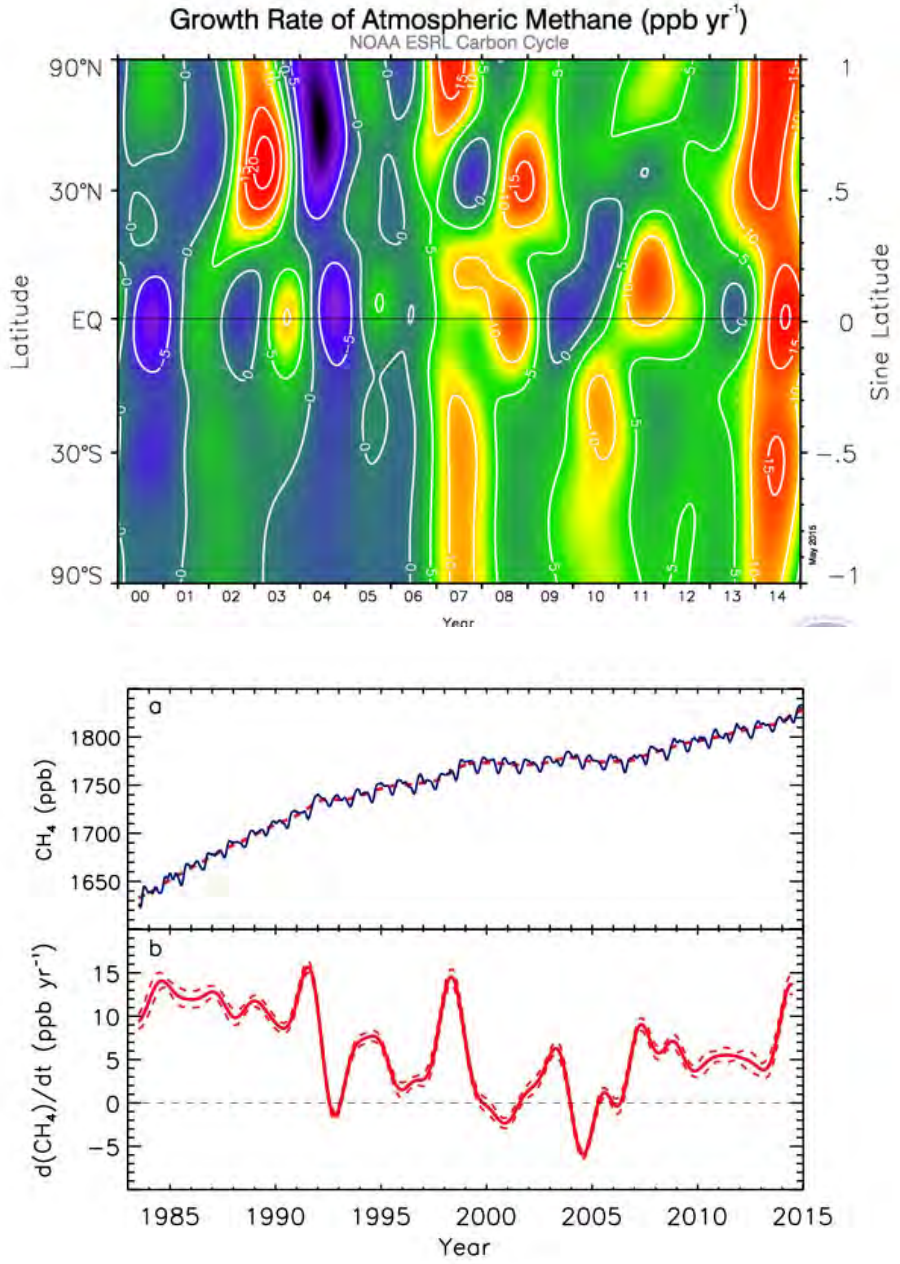
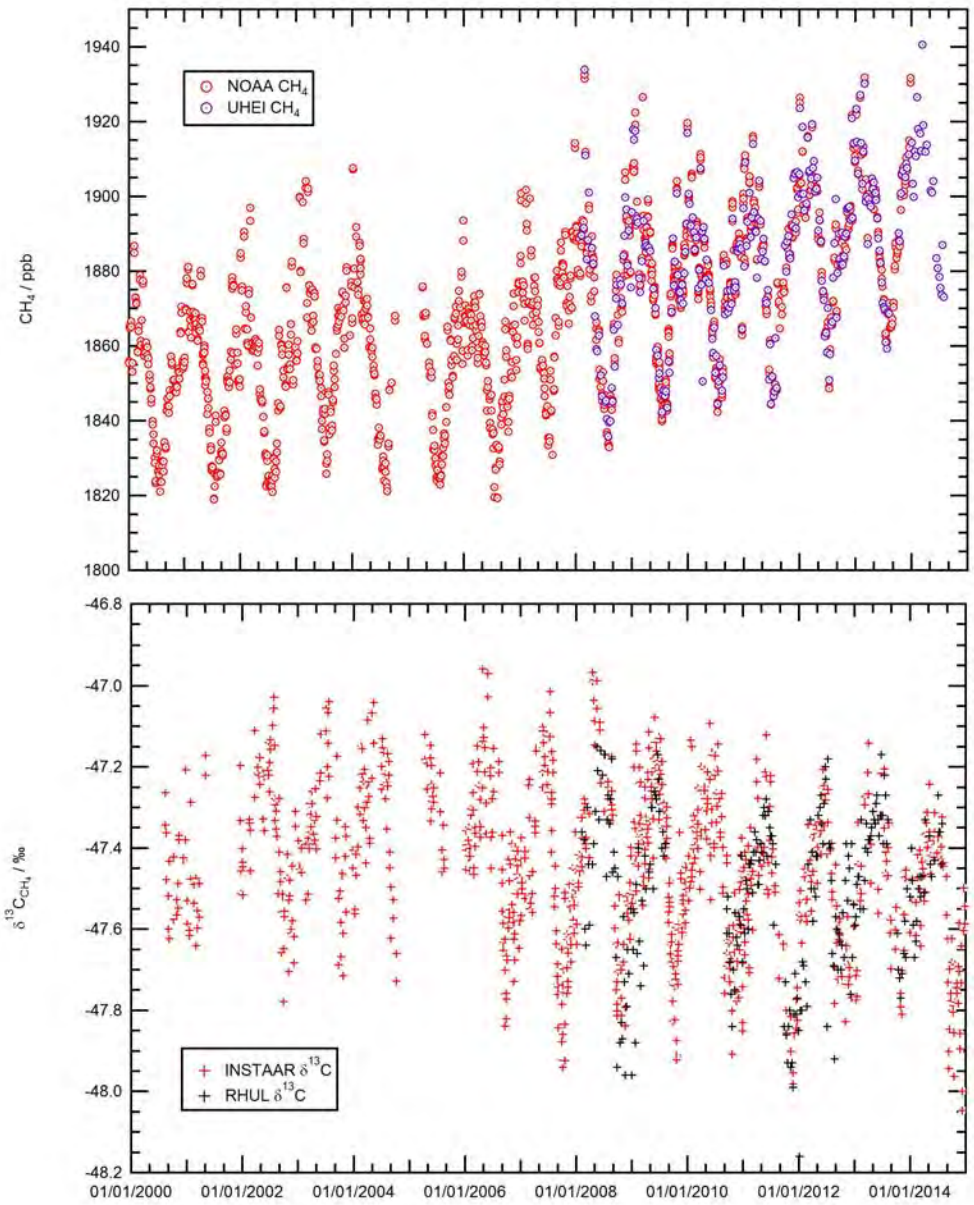



Rising methane - Ed's plots from yesterday:

1. Methane burden has risen since 2007
2. Much of the rise has been a steady growth in the S. hemisphere
3. Methane was near equilibrium late 1980s to 2006, though disrupted by one-offs




The Alert $CH_4$ record: sudden growth in autumn 2007.

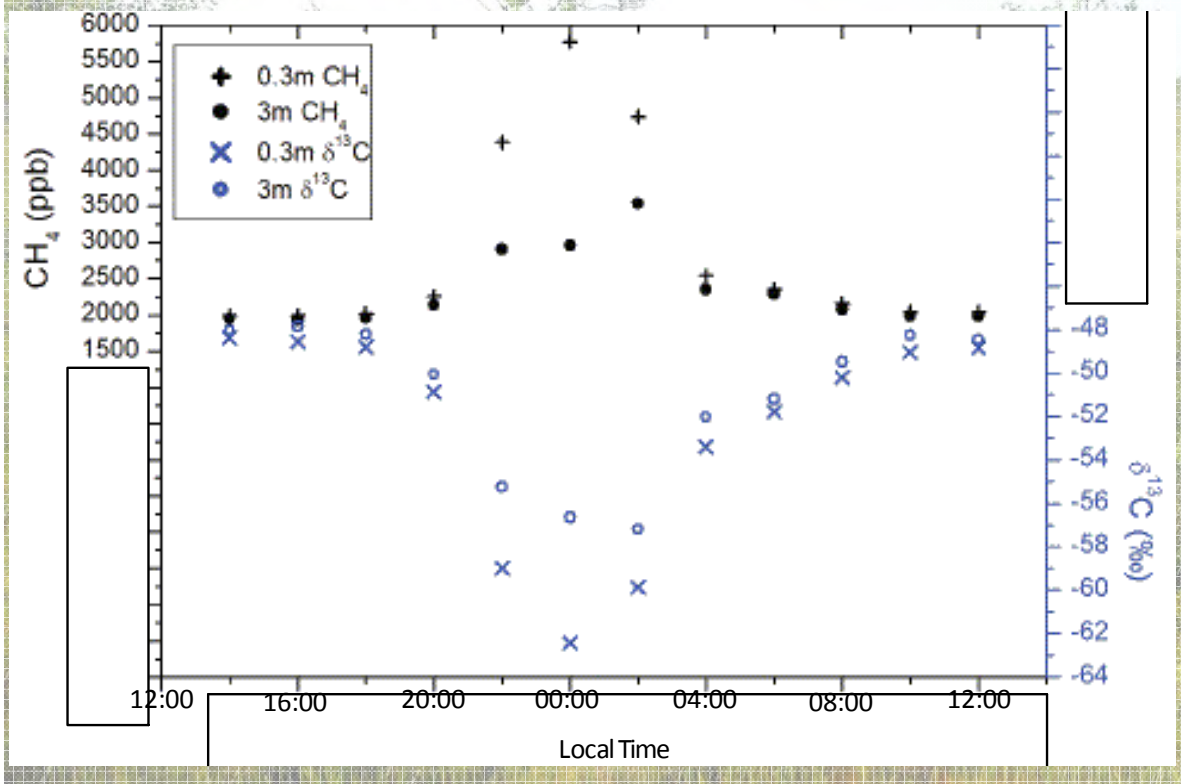
Alert $\delta^{13}C_{CH4}$: steps more negative when growth occurs.

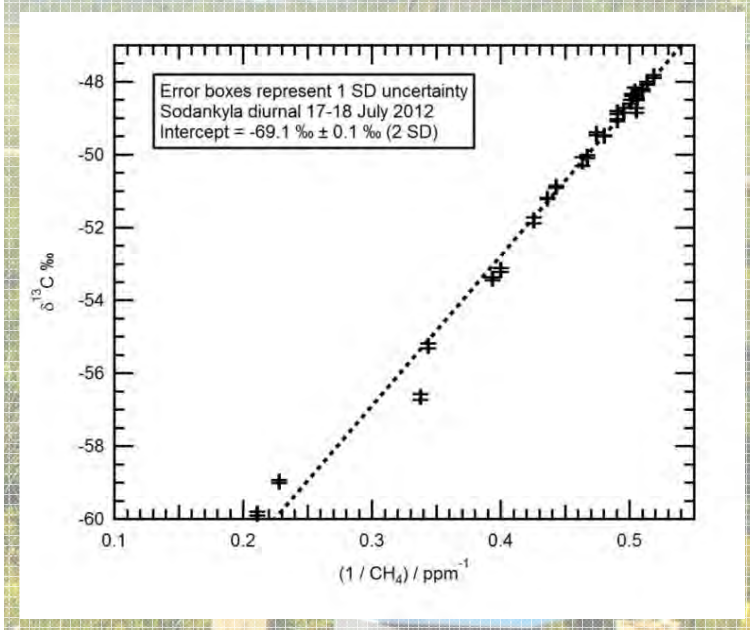
Implies wetland source (Arctic and boreal wetland emissions have $\delta^{13}C_{CH4}$ -65 to -72‰)

# Identifying the average isotopic signature of emissions to the atmosphere from a wetland

Air samples collected through diurnal cycles at 3 m and 0.3 m above the ground

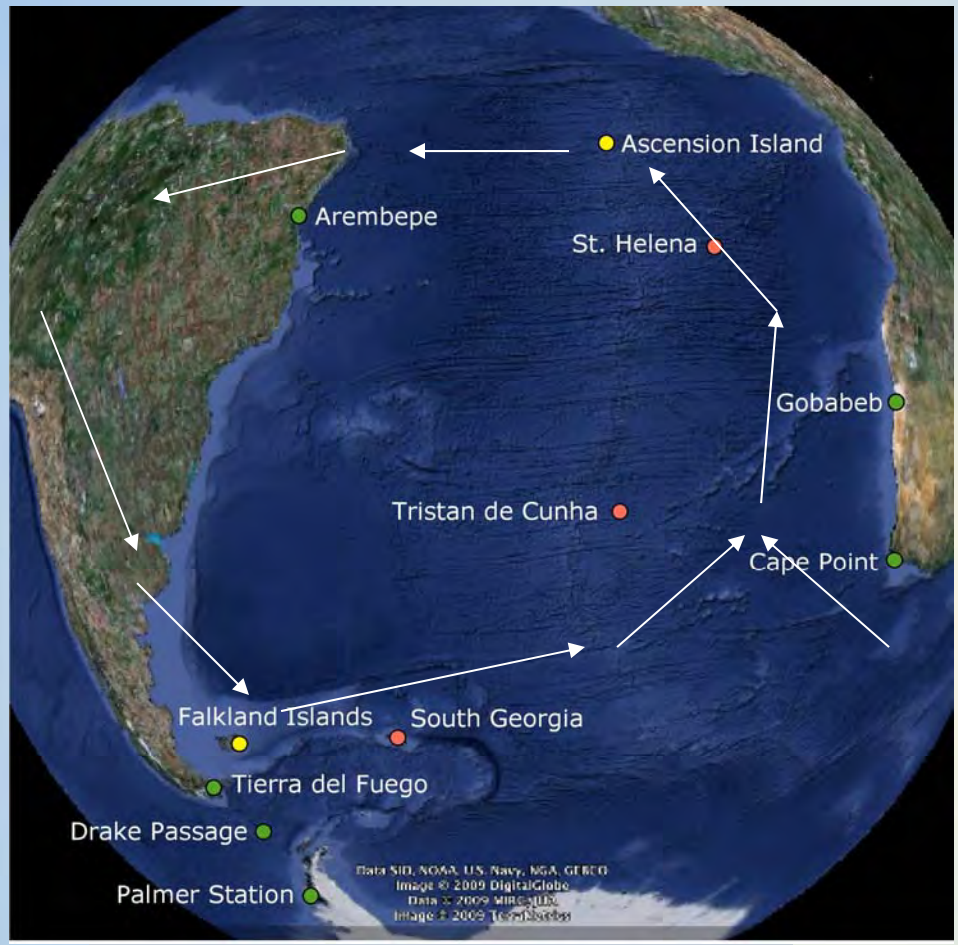
'Keeling plot' technique used to identify the signature of the methane source



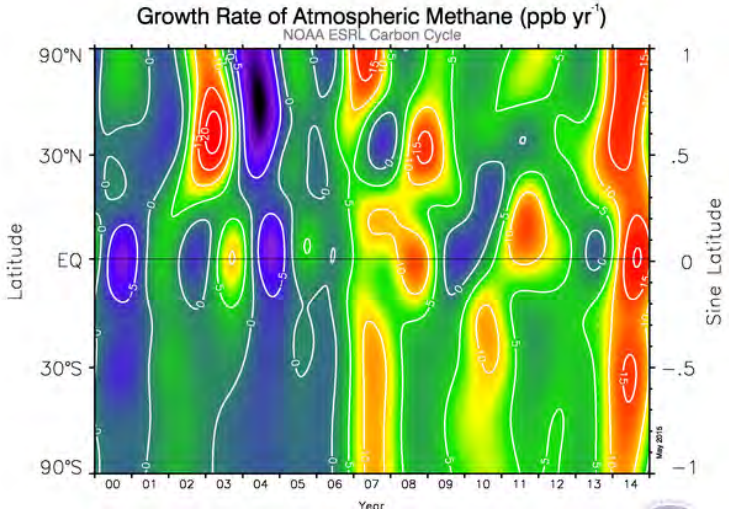

Sriskantharajah et al., Tellus B, 2012

# Ascension Is. 8°S, 14°W

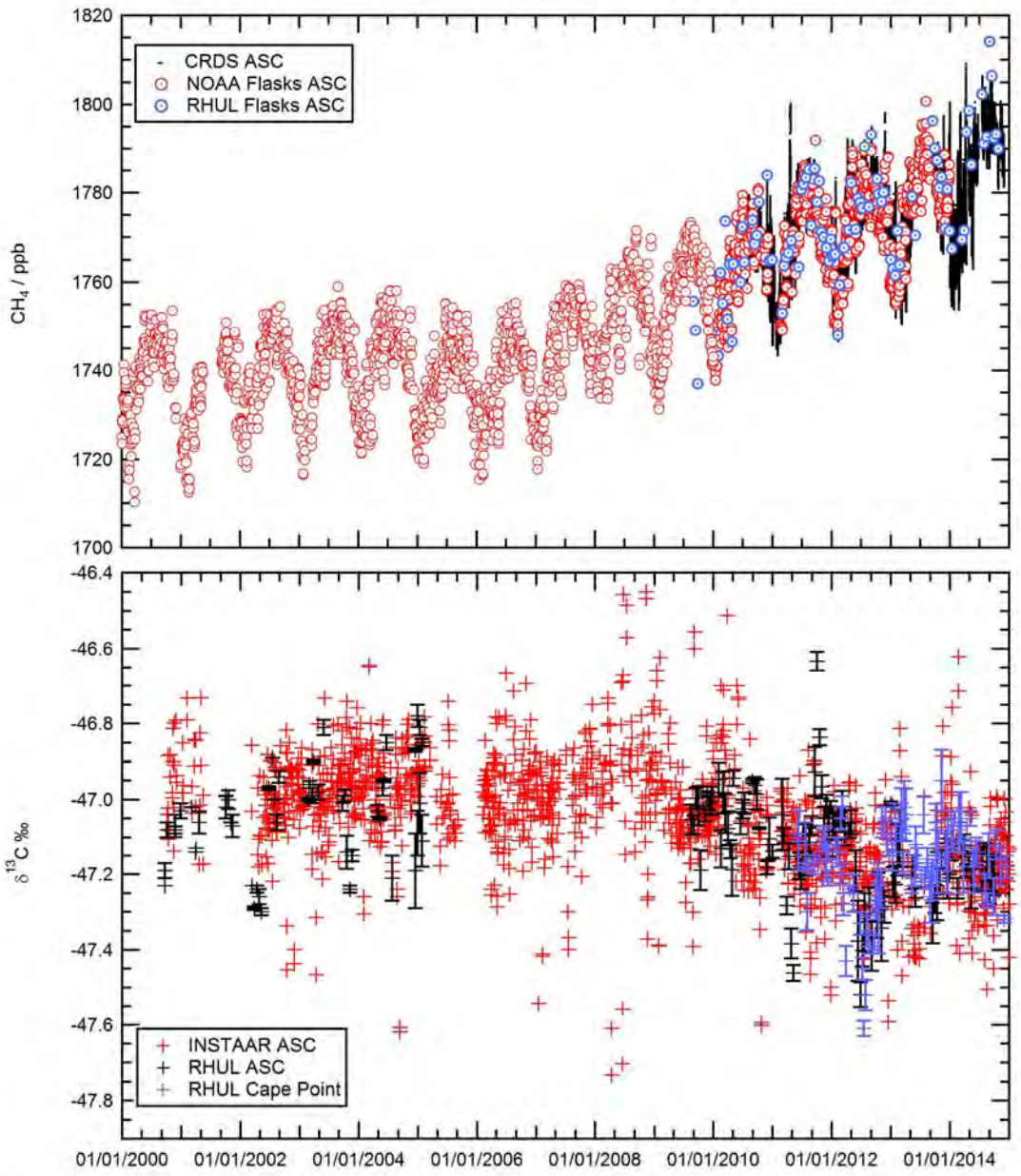



## Ascension Island, 8°S

Picarro 1301 installed June 2010
at the Airhead,
co-located with NOAA flasks.

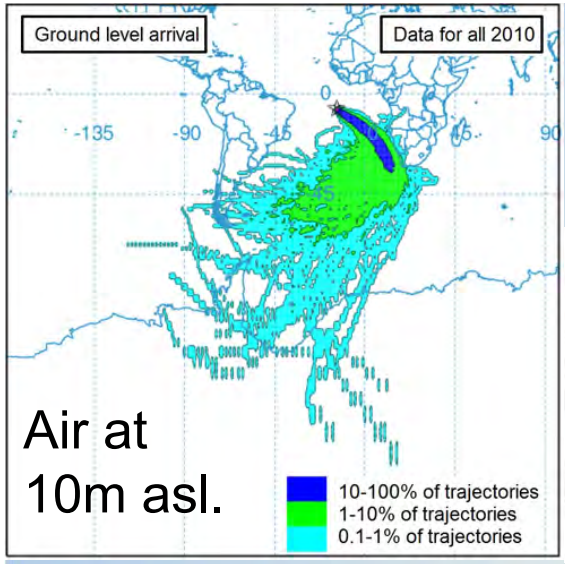


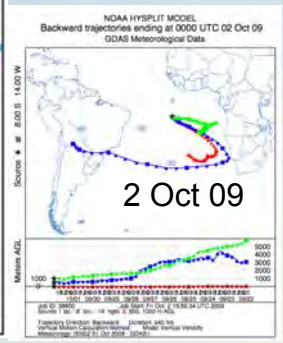

## Growth in Methane Mole Fraction since 2007

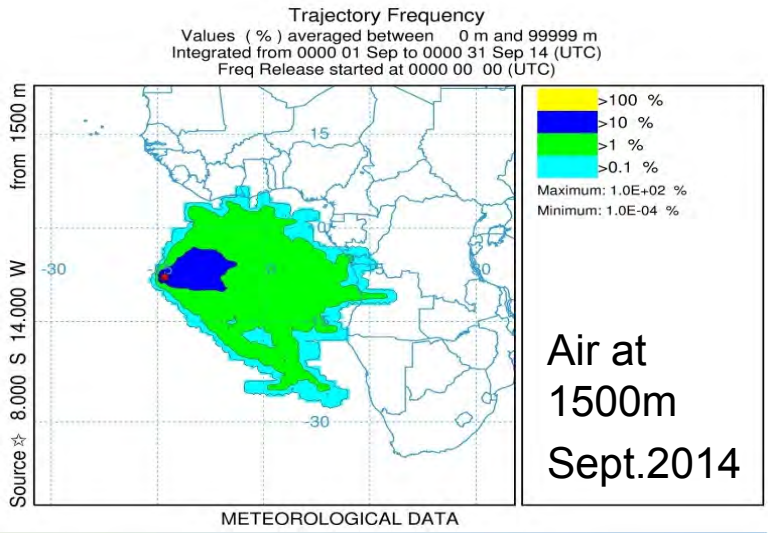



## Concurrent isotopic shift to ‘light’

# Sources of Air reaching Ascension

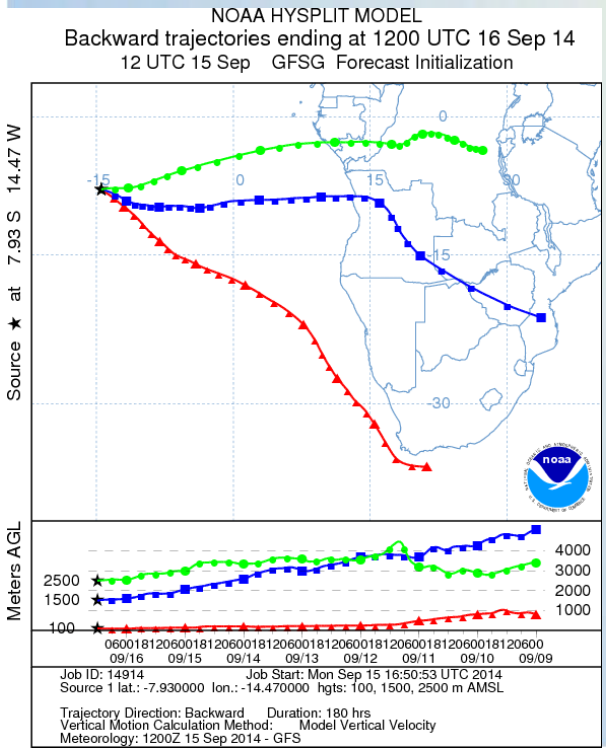


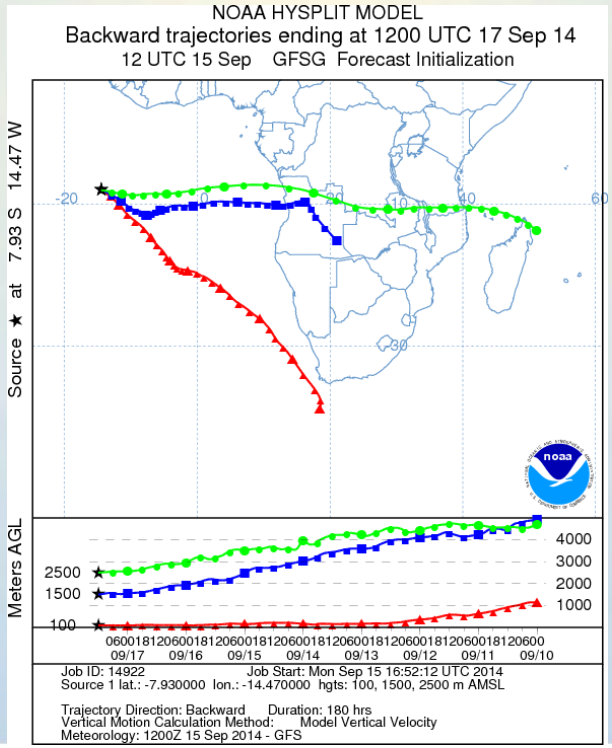



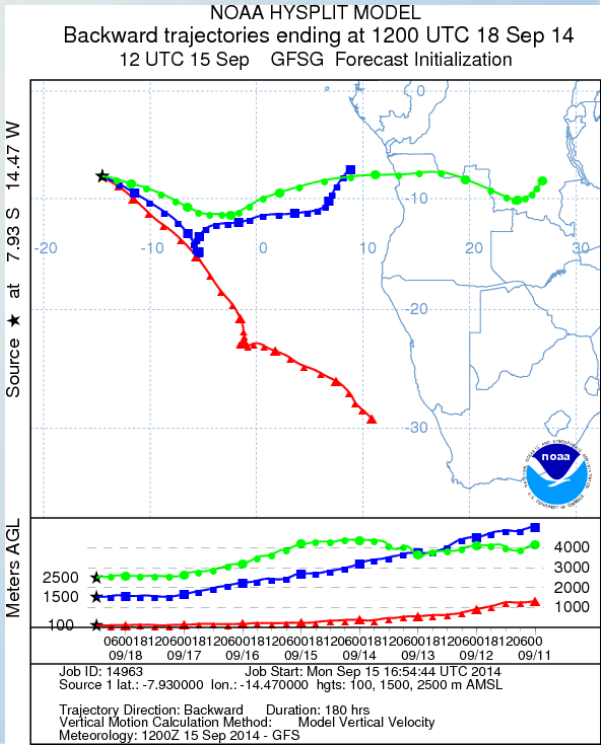



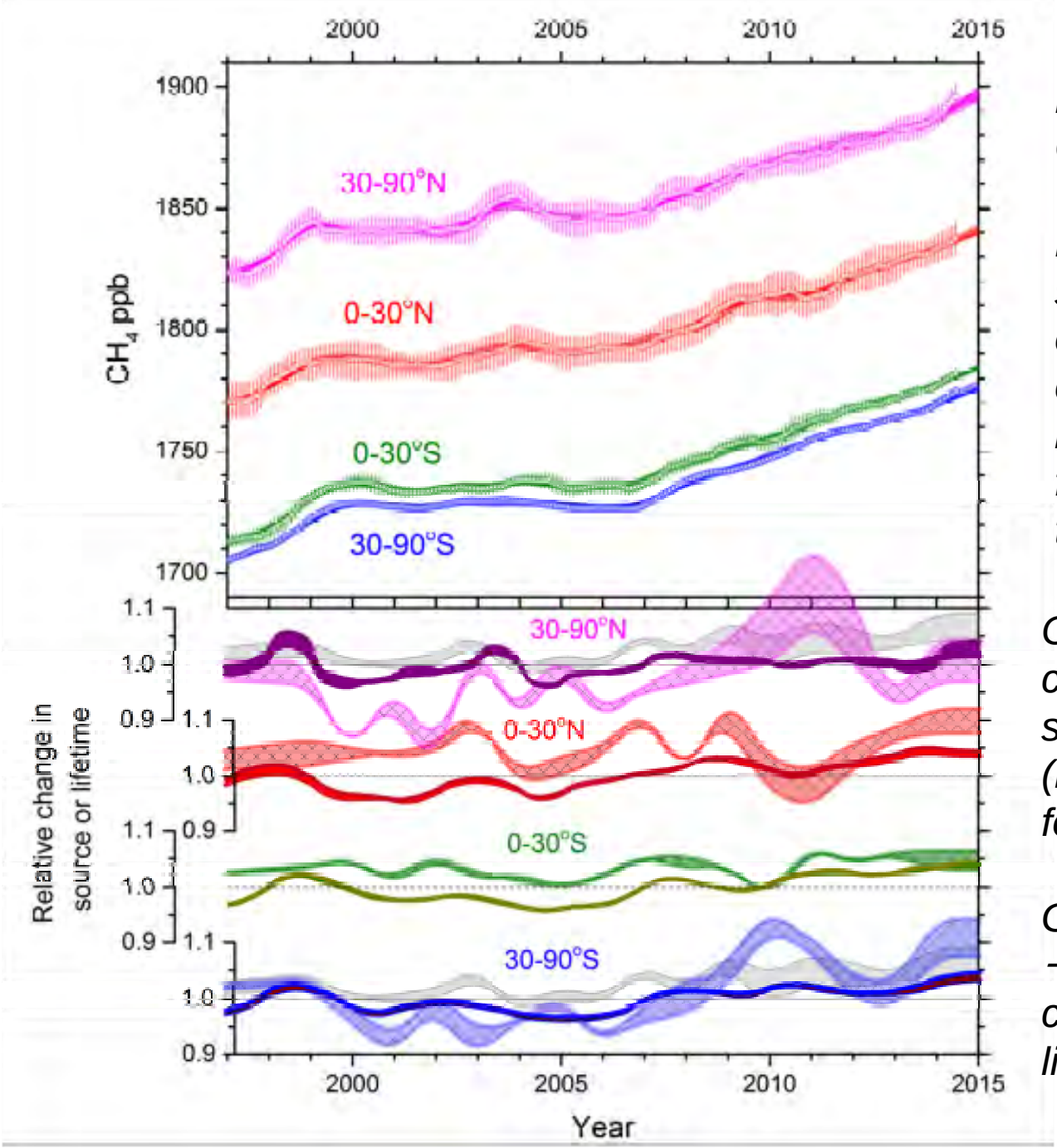

Marine boundary air from deep S. Atlantic, S. America & Southern Ocean

Air above the Trade Wind Inversion from tropical Africa and South America



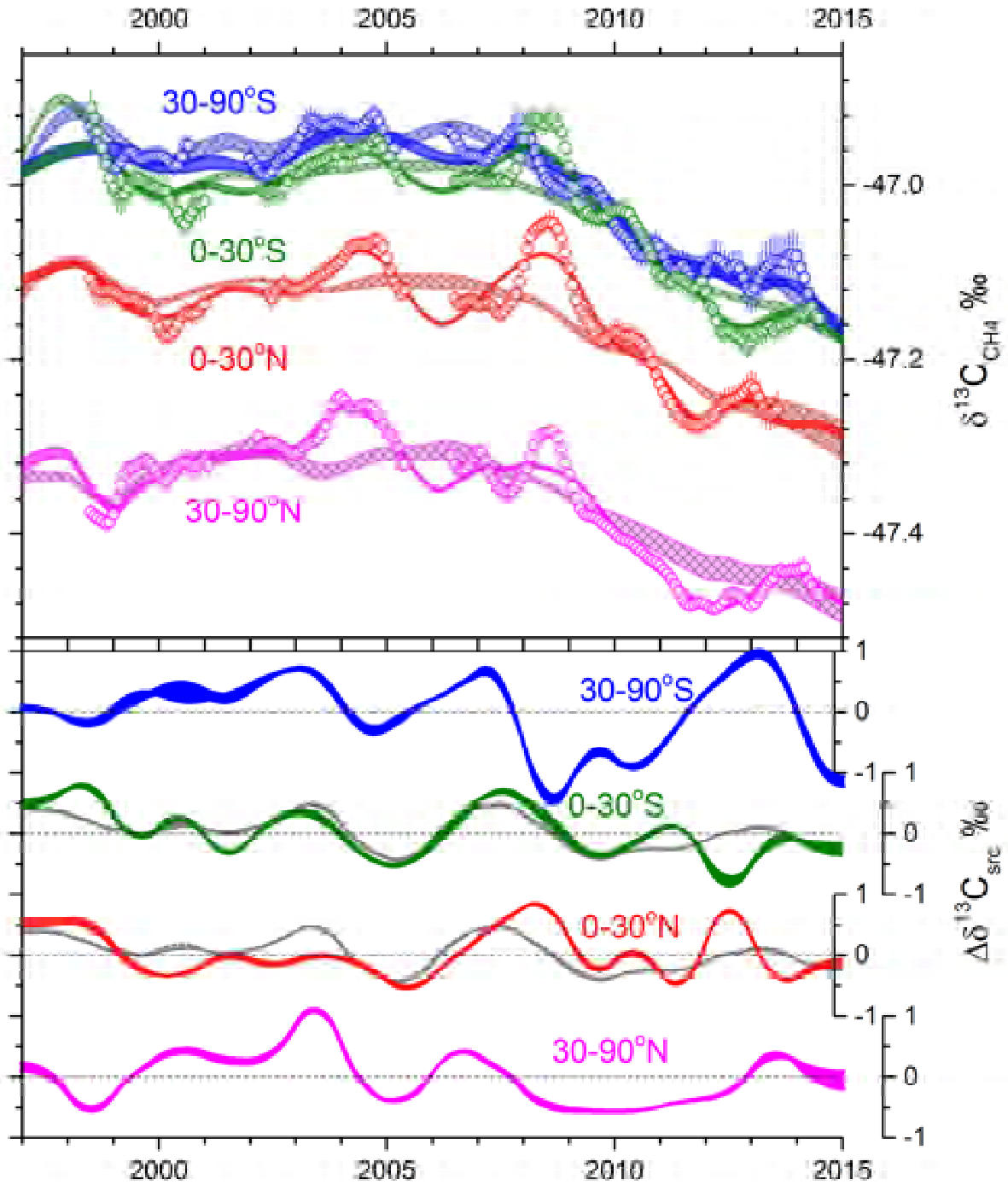



*Running 12-month means of $CH_4$ mole fractions from 0-30 −and 30-90− latitude zones. Ranges for fits to the data are shown using changes in either $CH_4$ sources (darker) or removal rates (lighter), however, as each give good fits to the mole fractions these are hard to distinguish.*

*Corresponding relative changes in regional $CH_4$ sources (darker) or lifetimes (lighter and crosshatched) for each region.*

*Grey range shown for 30-90 –S and 30-90–N is relative change in global average lifetimes.*

*Martin Manning*




*Running 12-month means for $\delta^{13}C_{CH4}$ from the NOAA and RHUL sites*

*Results from budget analysis shown for changes in sources (darker) or removal rates (lighter, cross-hatched)*

*Variation in source $\delta^{13}C_{CH4}$*

*Grey line is change in global average source $\delta^{13}C_{CH4}$*

# Rising methane - 2 - Sampling in 3D above Ascension Is.

**Rick Thomas (Birmingham), Tome Richardson & Jim Freer (Bristol)**

**Dave Lowry, Rebecca Brownlow, Rebecca Fisher, Mathias Lanoisellé and Euan Nisbet (RHUL)**

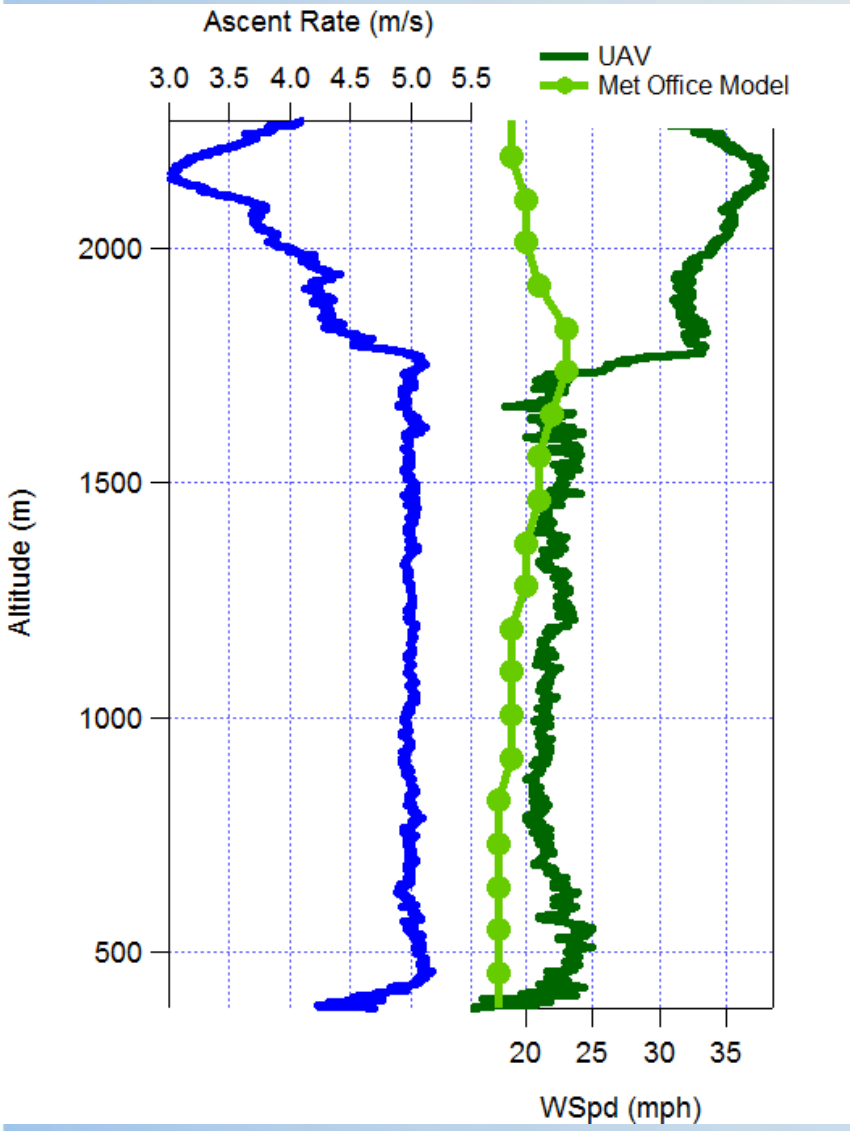
Drone with 3L Tedlar bag mounted beneath it.
Tedlar contains methane but is not secure for $CO_2$ or CO

Just over Trade Wind Inversion

Below Trade Wind Inversion

# Flight Operations: High wind speed aloft not in Met Office model

17/09/2014 12:41

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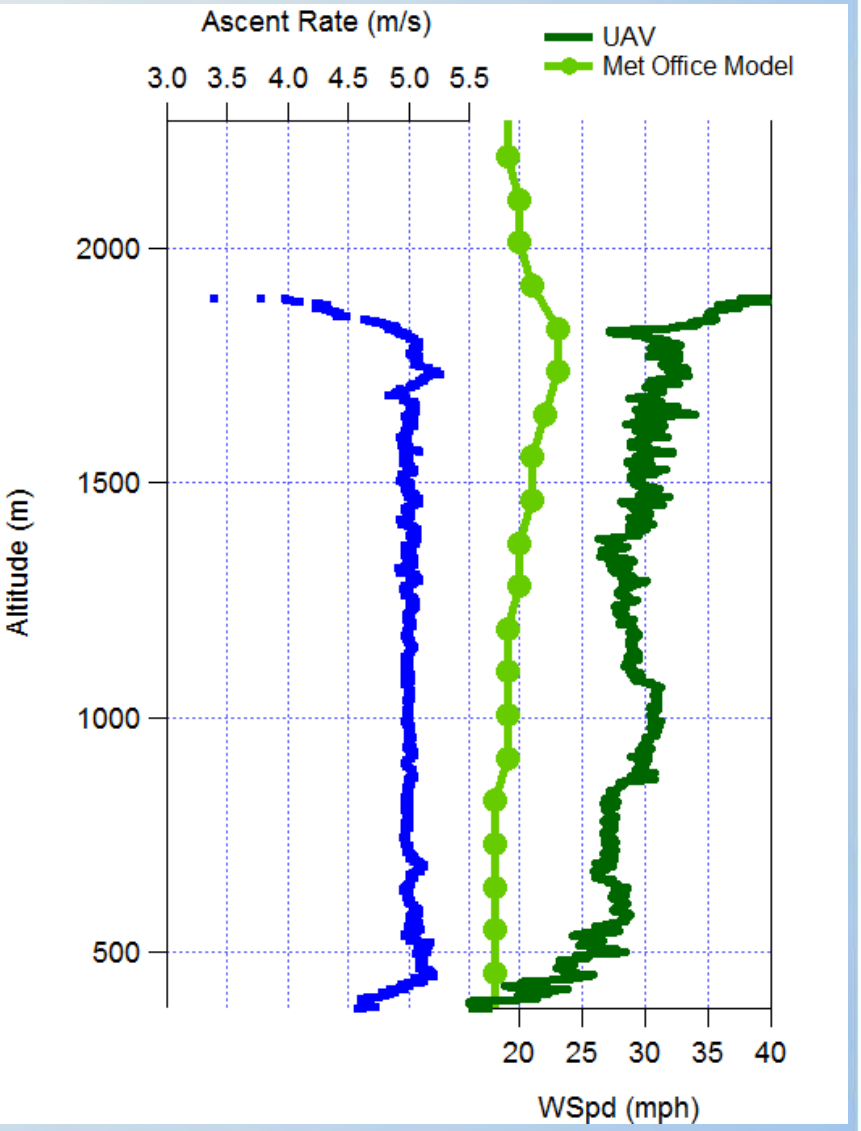
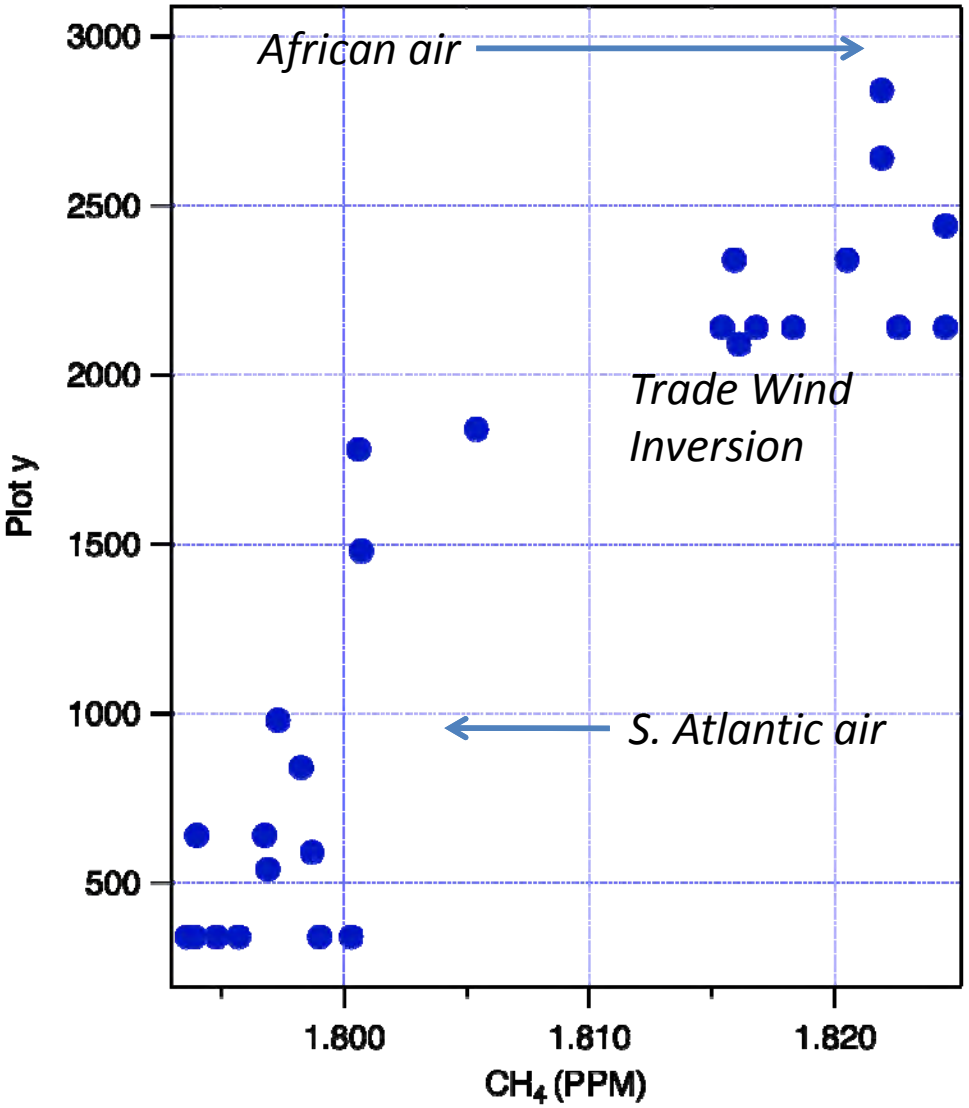
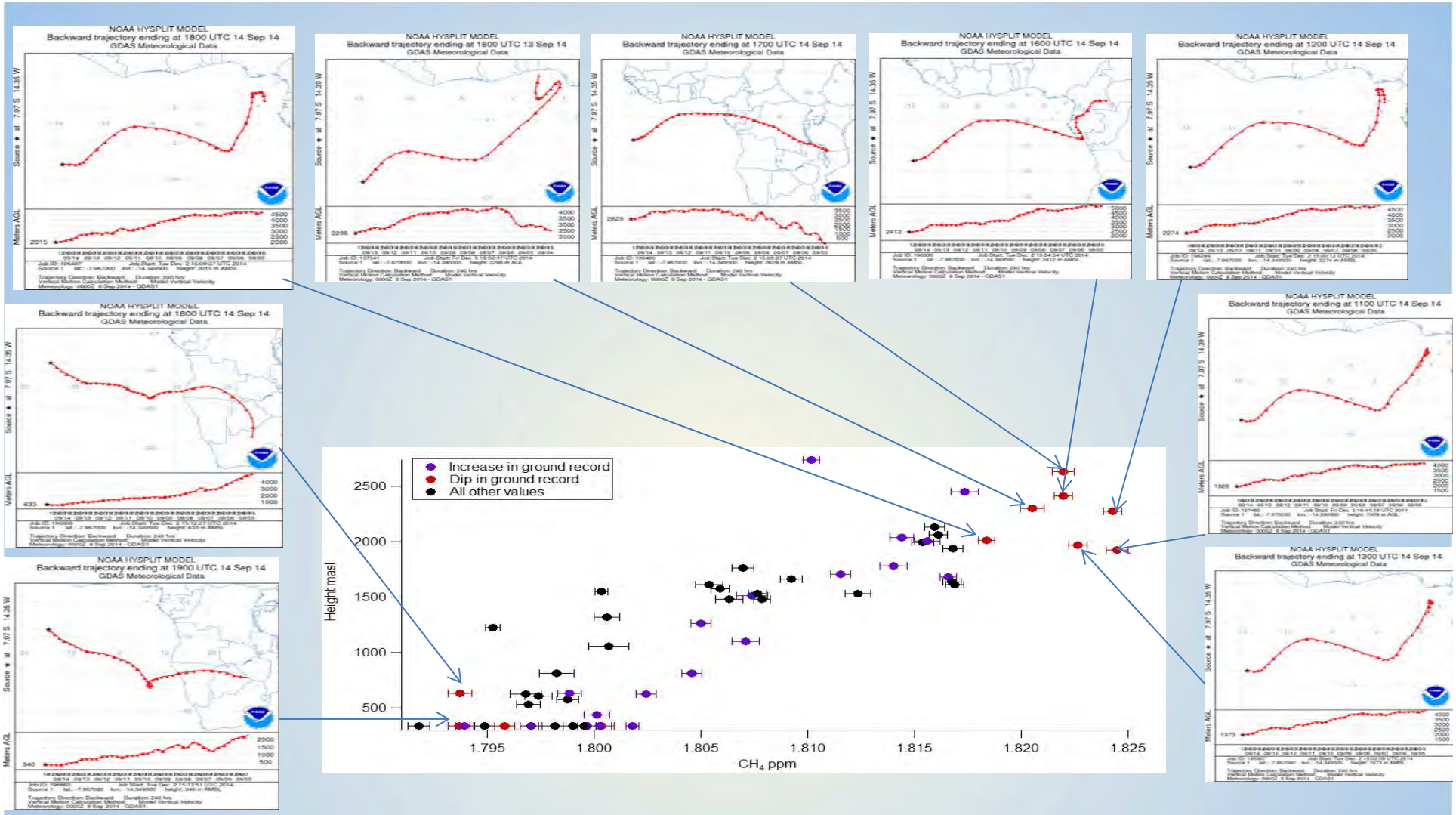


# Ascension air to 3000m

Height
(m)



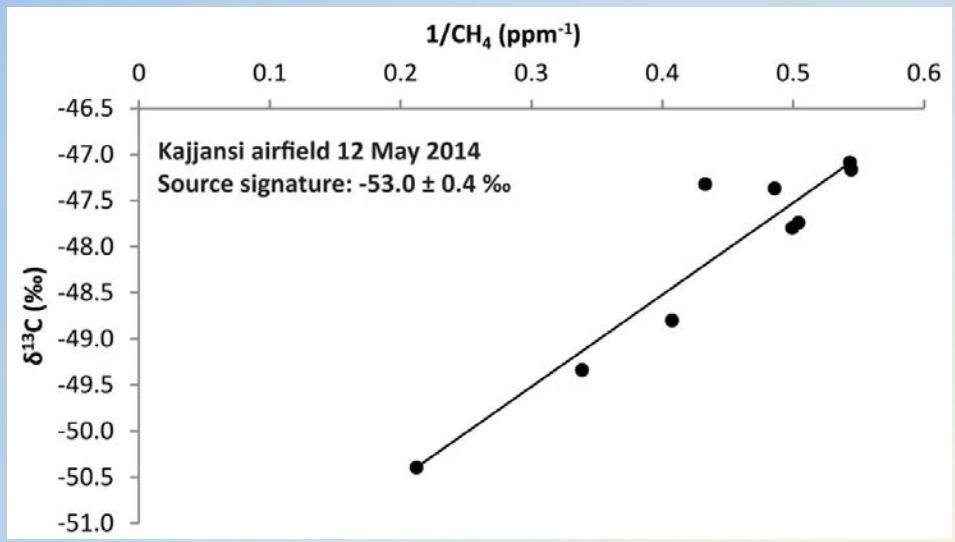

Ascension samples both deep Southern air (marine boundary layer) and tropical air from Africa and S. America.
Finding regional emissions by inverting satellite retrieval kernels may be difficult.

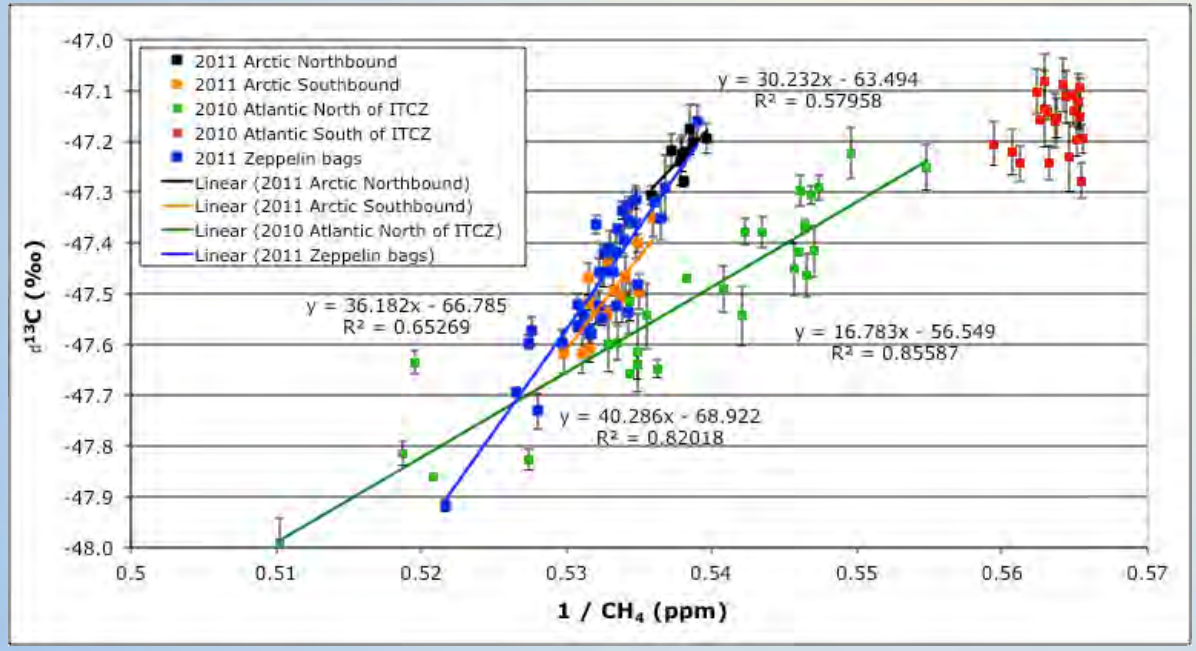


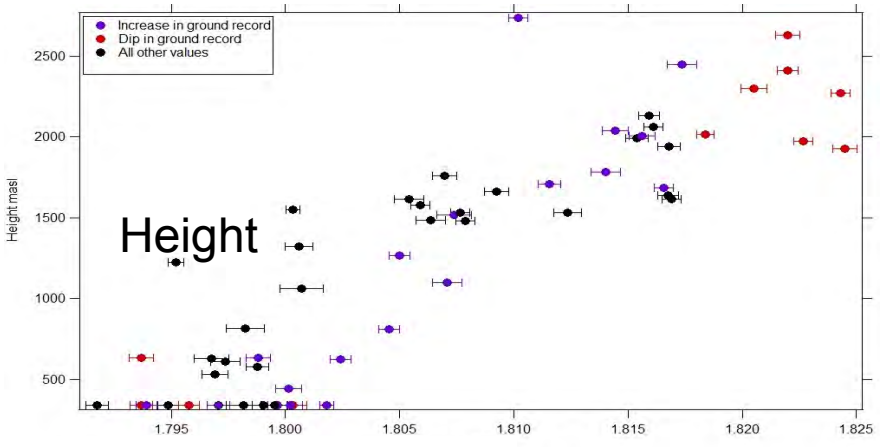

10 day Hysplit trajectories of samples taken during dip in ground sample mole fraction (13 Sept 2014 - 14 Sept 2014)

Conclusions from two campaigns in 2014 and 2015:

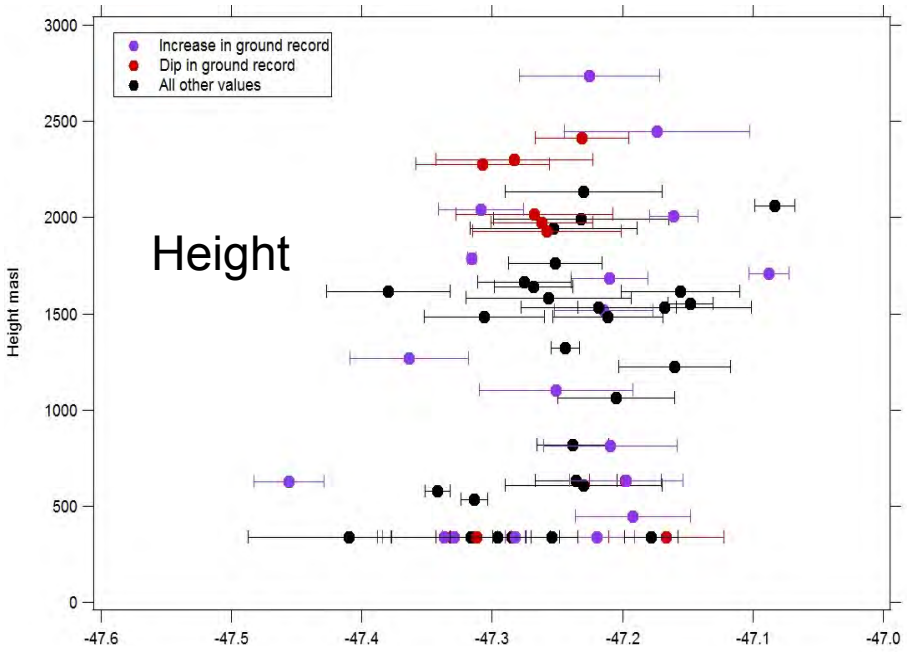
1. *Drones can radically enhance the sampling access, up to 3000m from a single well-located permitted site.*
2. *Needs high skills though - both flying, and in sample analysis on site.*


1/CH4 (ppm-1)
0
0.1
0.2
0.3
0.4
0.5
0.6
-46.5
-47.0
-47.5
-48.0
-48.5
-49.0
-49.5
-50.0
-50.5
-51.0
δ13C (‰)
Kajjansi airfield 12 May 2014
Source signature: -53.0 ± 0.4 ‰


2011 Arctic Northbound
2011 Arctic Southbound
2010 Atlantic North of ITCZ
2010 Atlantic South of ITCZ
2011 Zeppelin bags
Linear (2011 Arctic Northbound)
Linear (2011 Arctic Southbound)
Linear (2010 Atlantic North of ITCZ)
Linear (2011 Zeppelin bags)
y = 30.232x - 63.494
R² = 0.57958
y = 36.182x - 66.785
R² = 0.65269
y = 16.783x - 56.549
R² = 0.85587
y = 40.286x - 68.922
R² = 0.82018
δ13C (‰)
-47.0
-47.1
-47.2
-47.3
-47.4
-47.5
-47.6
-47.7
-47.8
-47.9
-48.0
0.5
0.51
0.52
0.53
0.54
0.55
0.56
0.57
1 / CH4 (ppm)




$CH_4$ vs height

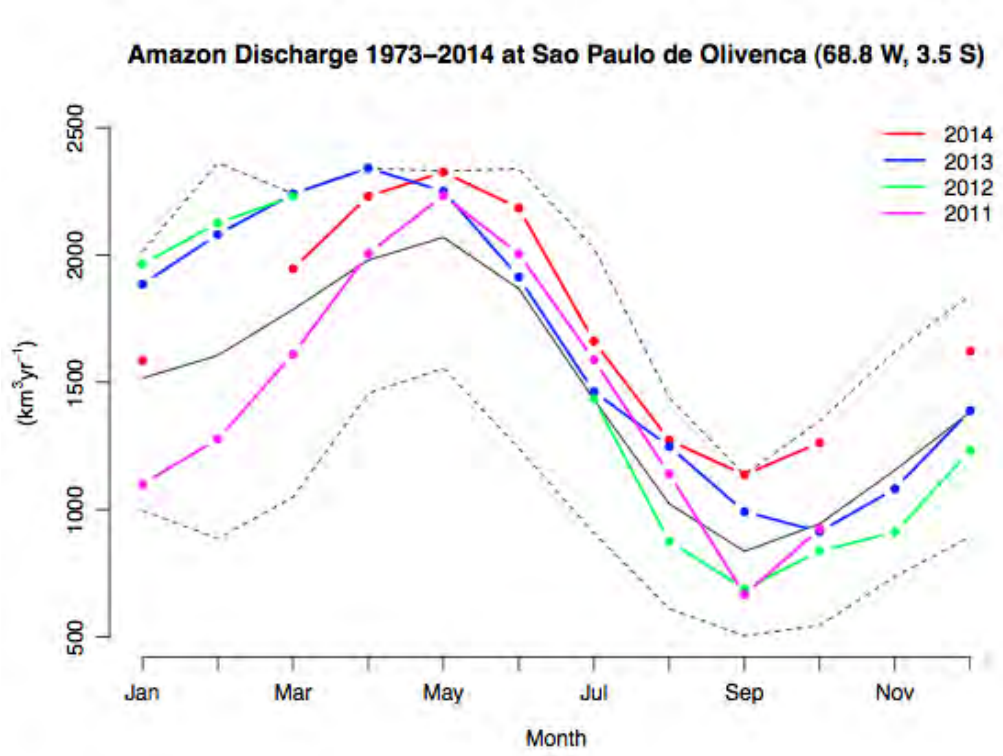



$\delta^{13}C$ vs Height

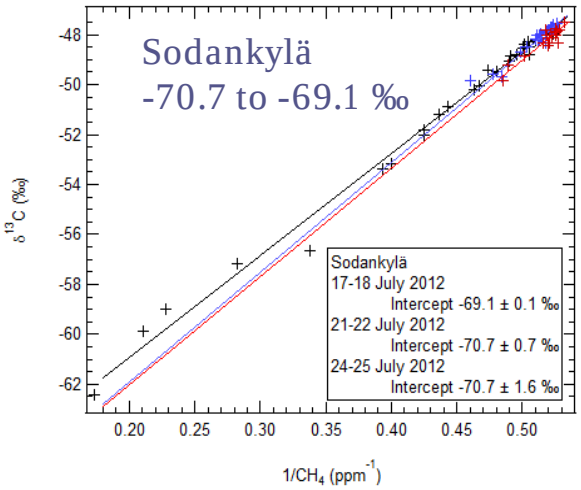
Equatorial wetlands

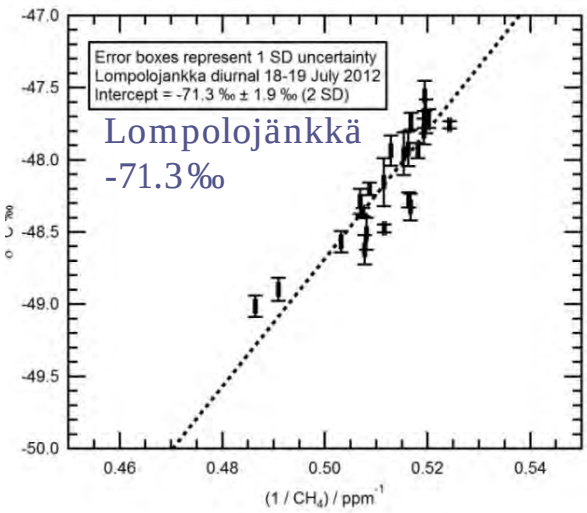
Discharge of the Amazon River at Sao Paulo de Olivenca no Amazonas, in Brazil near the tri-country border with Peru and Bolivia.

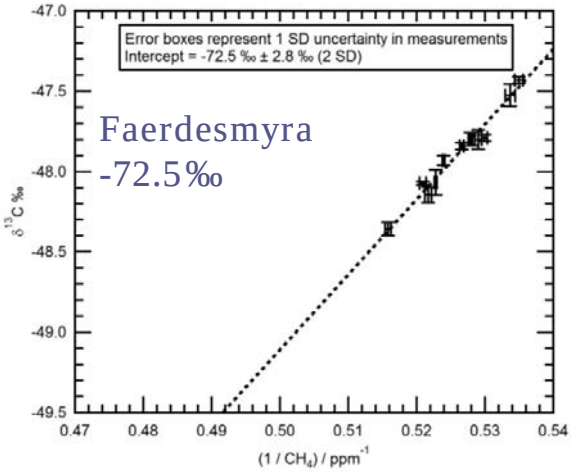
Dashed lines show maximum and minimum flood levels in the 1973-2014 period, and solid black line is the mean.
Note extreme flood volumes in March-June (after S. Hemisphere rains) in since 2011.



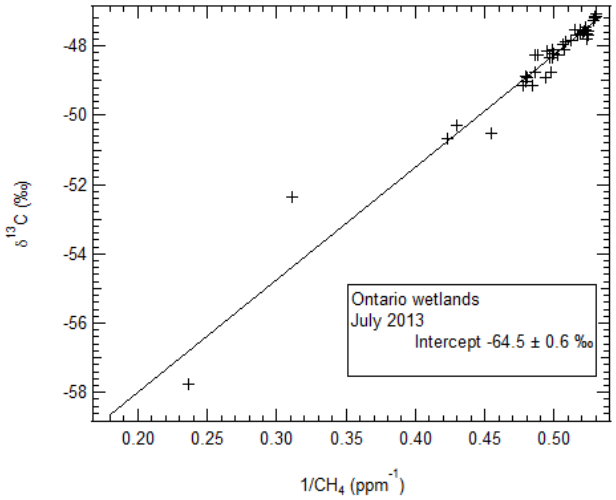
•Emissions from N Scandinavian wetlands in July/August 2012 have a mean value of -69.9 ± 2.6 ‰.

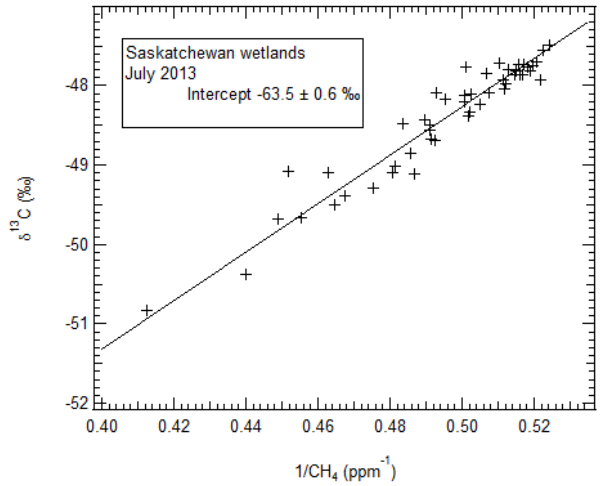




Wetlands in Canada give -64.5 ± 0.6 ‰ (Ontario, 49° N) and -63.5 ± 0.6 ‰ (Saskatchewan, 53 to 54° N)



# Flight Operations: Ascent leg