European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs & MC Meeting at SOFIA (BG), 16-18 December 2015

New Sensing Technologies for Indoor Air Quality Monitoring: Trends and Challenges

Action Start date: 01/07/2012 - Action End date: 30/04/2016 - Year 4: 1 July 2015 - 30 April 2016

ChemSonde: Trace Gas Measurements with Radiosondes

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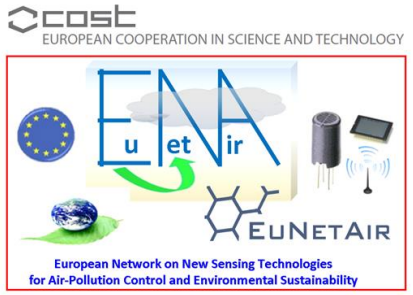

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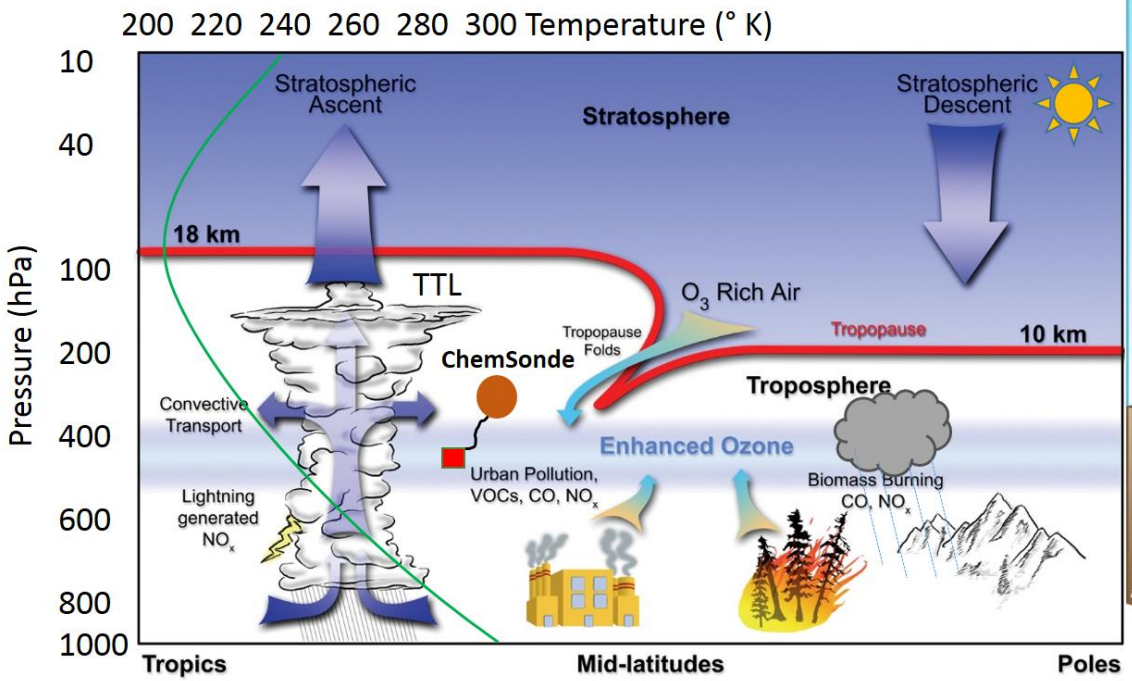
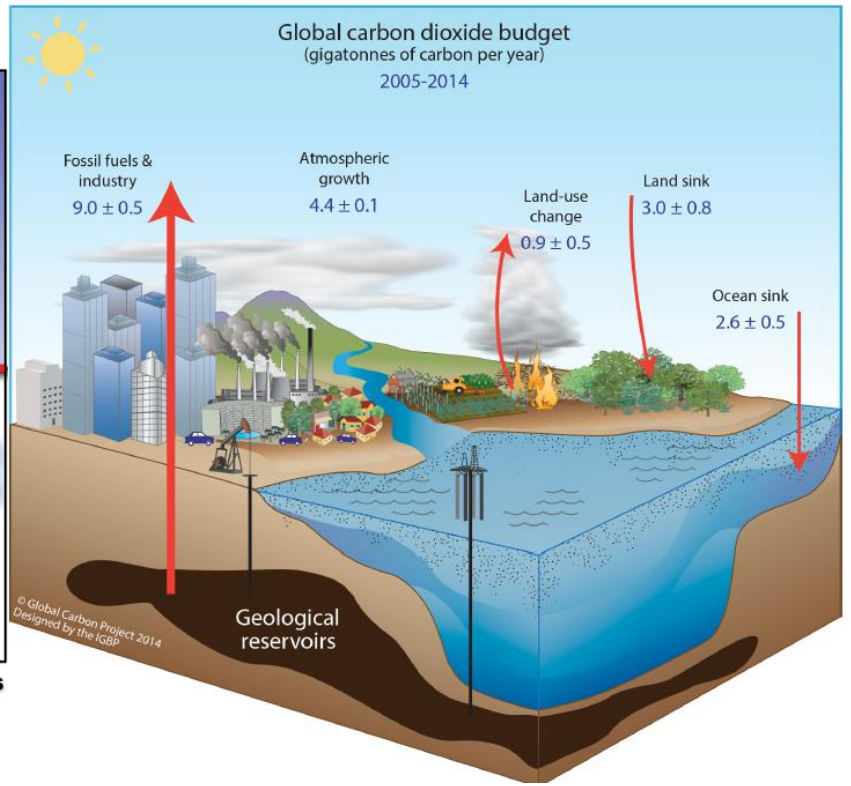
1. Scientific context and objectives in the Action

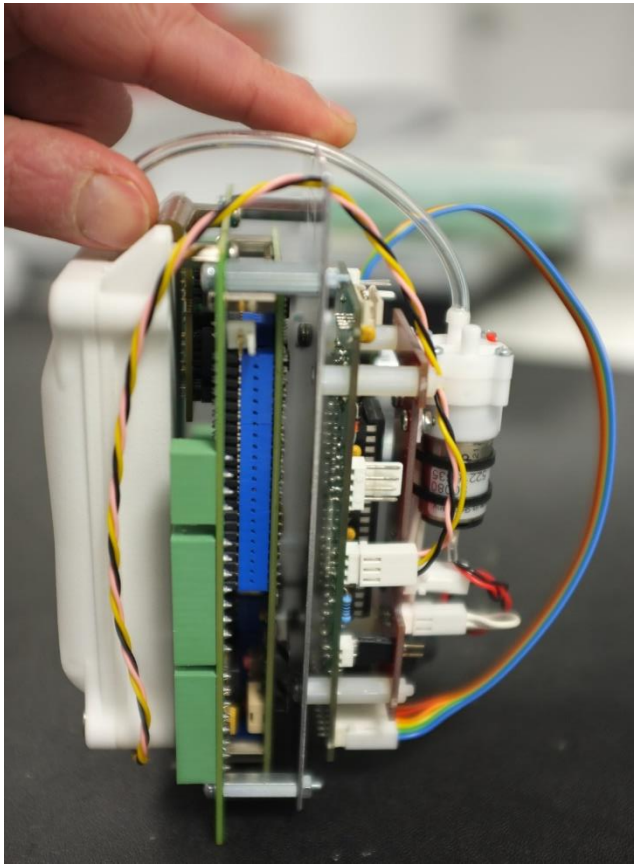
- Composition studies of the upper troposphere / lower stratosphere (UTLS) are limited to in-situ measurements with specialist aircraft or large instrumented balloons – intermittent & also expensive. Satellites can provide global coverage but have issues with cloud (radiative effects) and provide a column average of concentrations.
- Spatially, trace gas species (e.g. O_3, CO, H_2O, CO_2) are dynamic, variable & complex, so how to measure?
- UTLS very important globally, to understand anthropogenic impacts on composition, transport processes & warming trends – to constrain models, we need more regular in-situ measurements.
- Globally, weather balloons (radiosondes) are launched regularly – we could use these to carry micro sensors.
- Many profiles would give better representation of atmospheric processes and the data could then inform and improve modelled outputs and predictions.

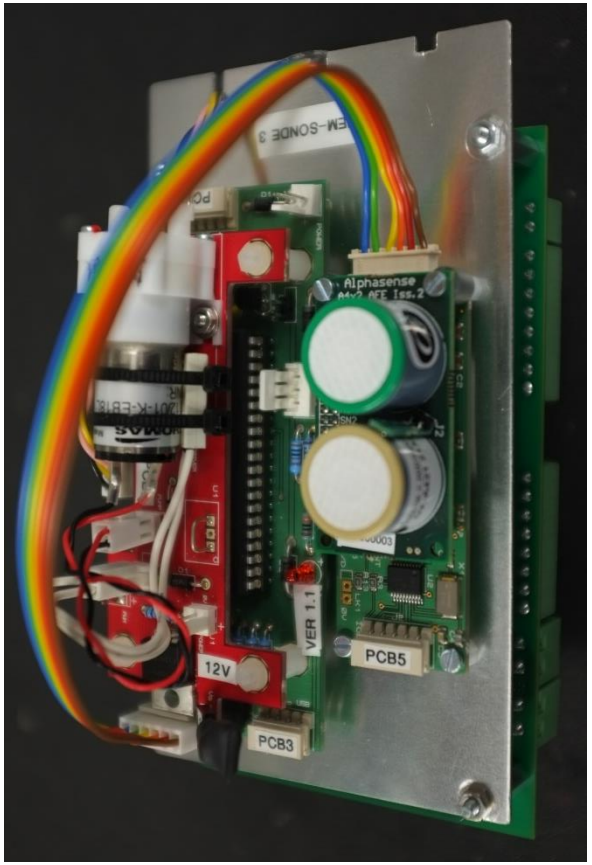




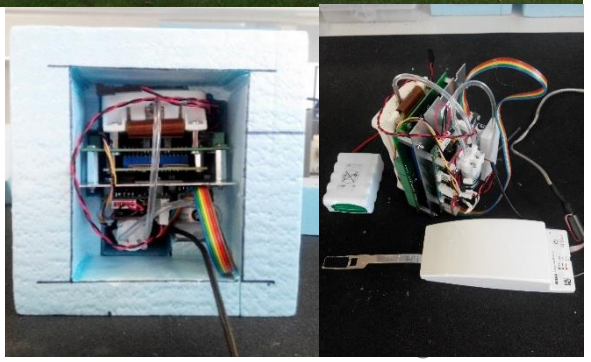
Le Quiere et al; Earth Syst. Sci. Data, 7, 349–396, 2015

2. Design of ChemSonde

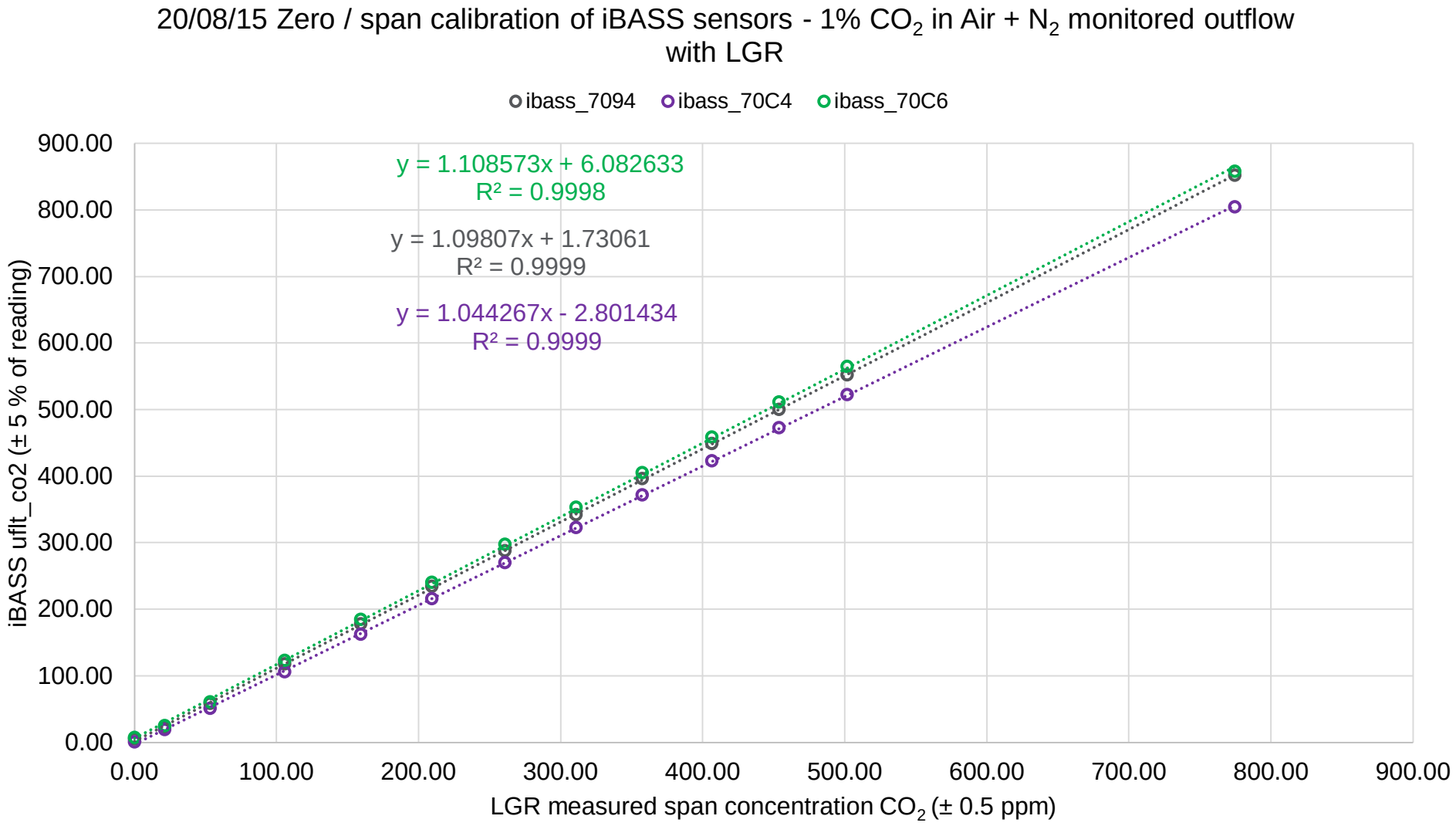




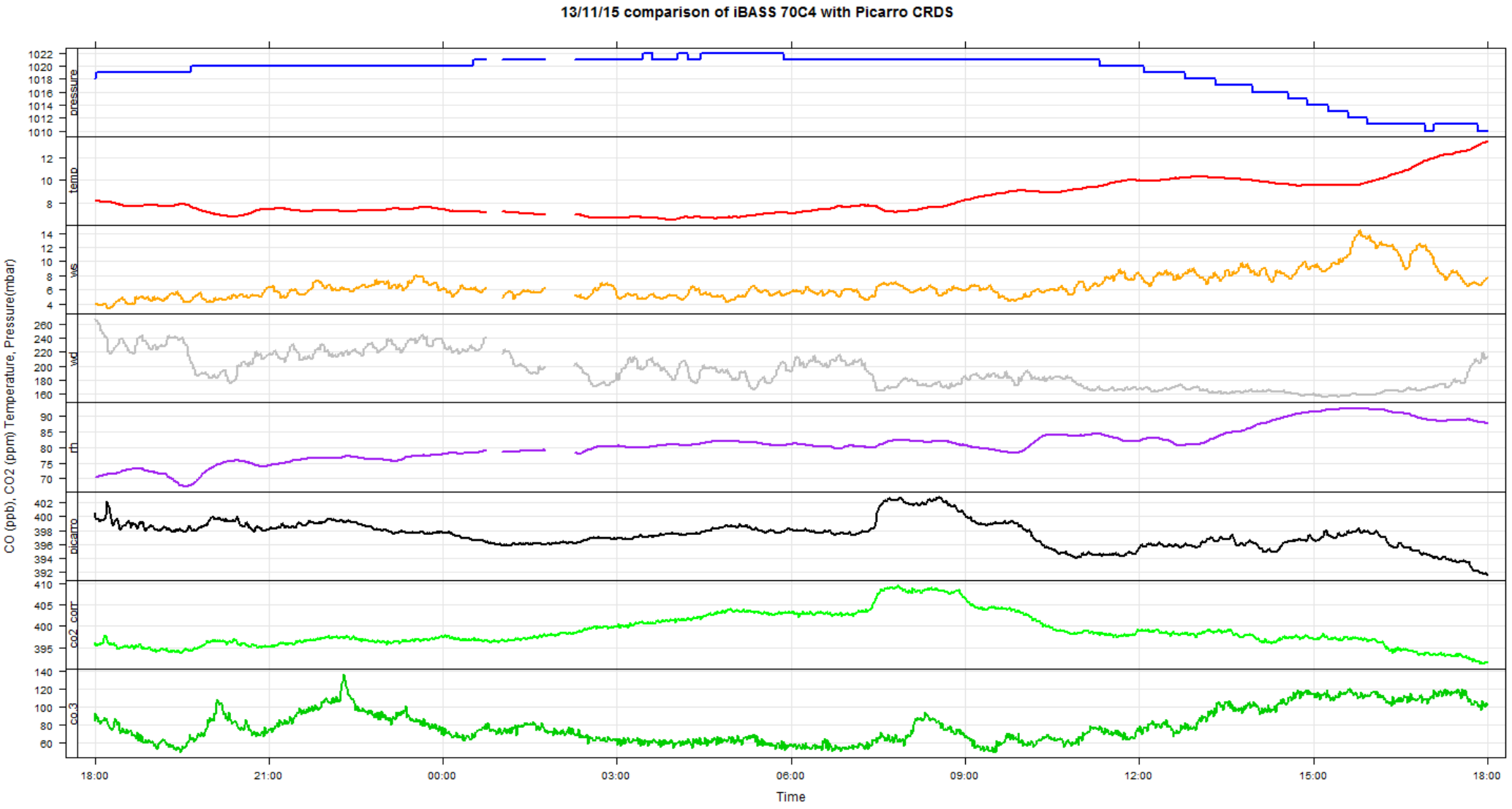
- Aim is to keep package small and thereby reduce weight
- Weight is critical because of size of balloon and He needed
- Currently about 1100 g which requires 90 bar He for 35 km alt.
- Foam box now incorporates RFI/EMI shielding – transmitter



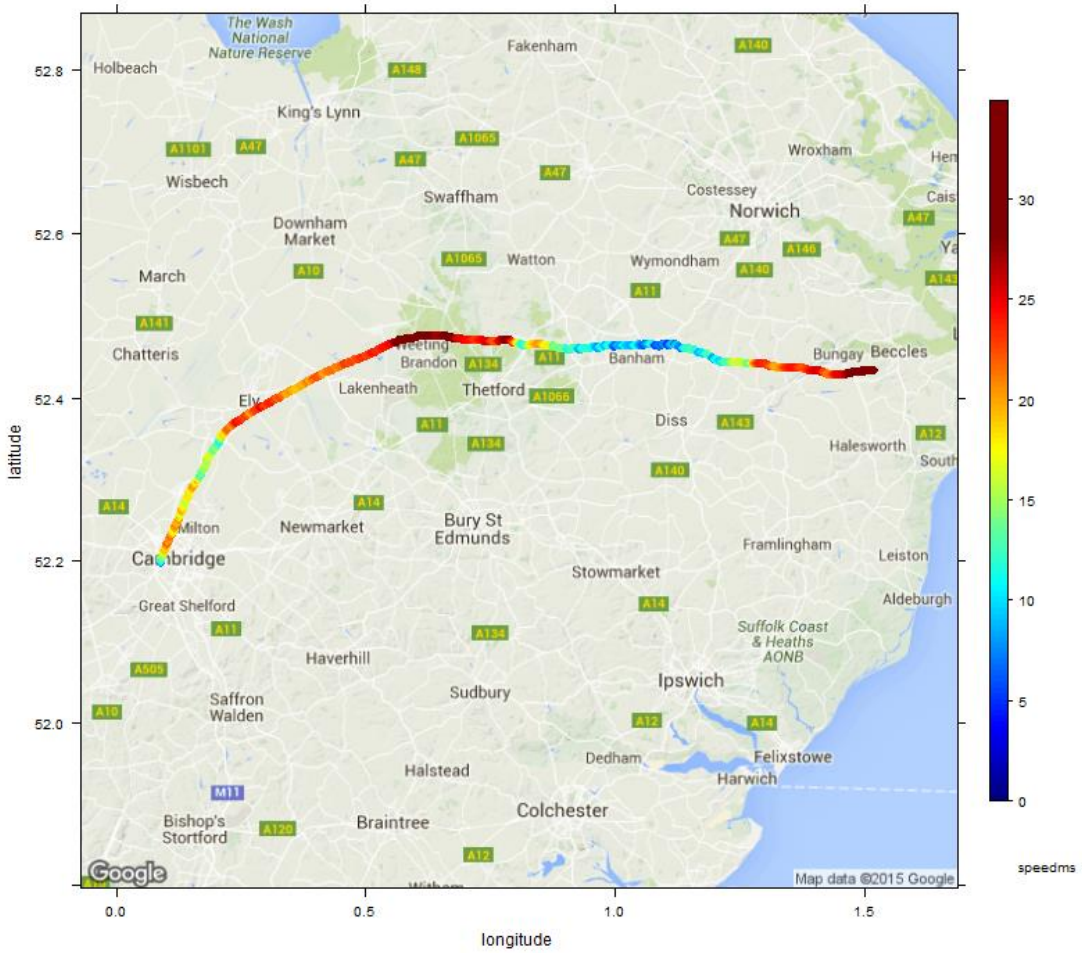
3. Intercomparison: LGR CRDS



3. Intercomparison: Picarro CRDS

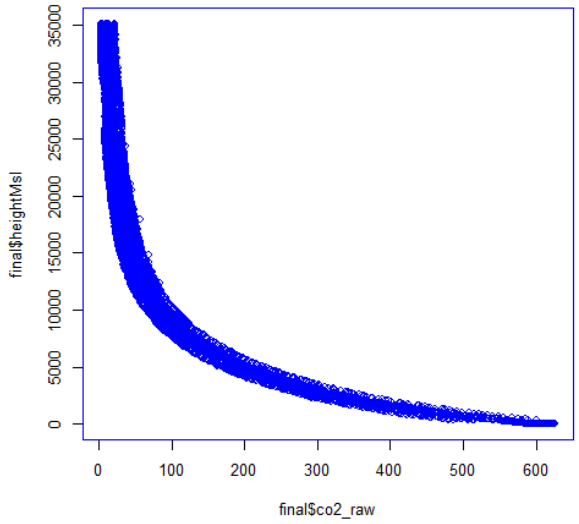


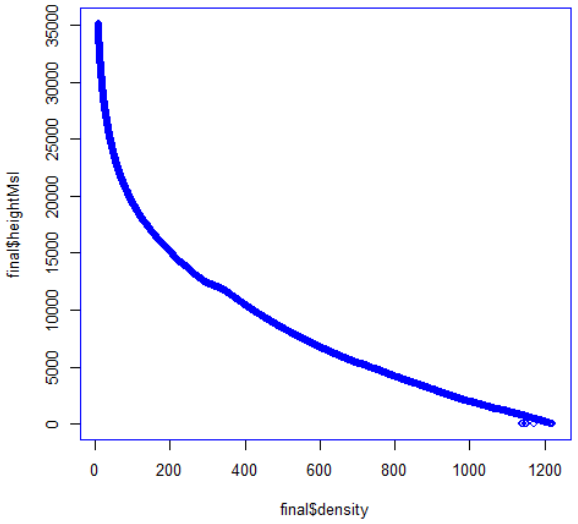
4. First launch – 05/11/15 Cambridge

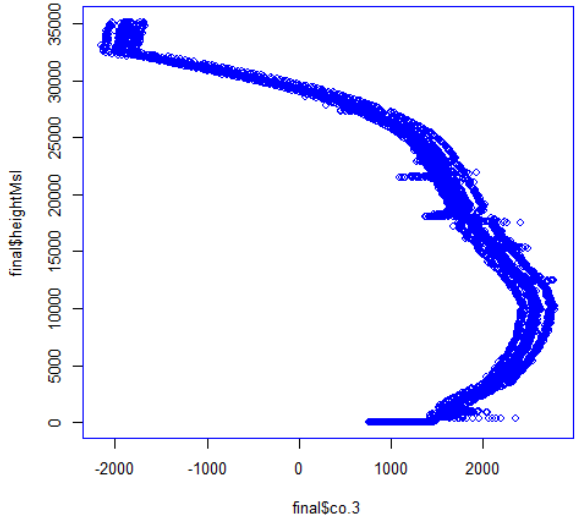


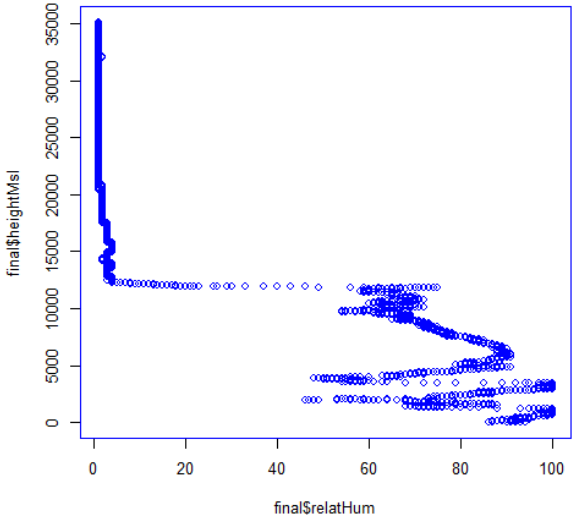
- Burst altitude = 35.1 km – 5 hPa
- Flight time = ~ 2.5 hrs
- Ascent rate = 4.98 m/s
- Lowest temp = -63.6

4. First launch – 05/11/15 Cambridge

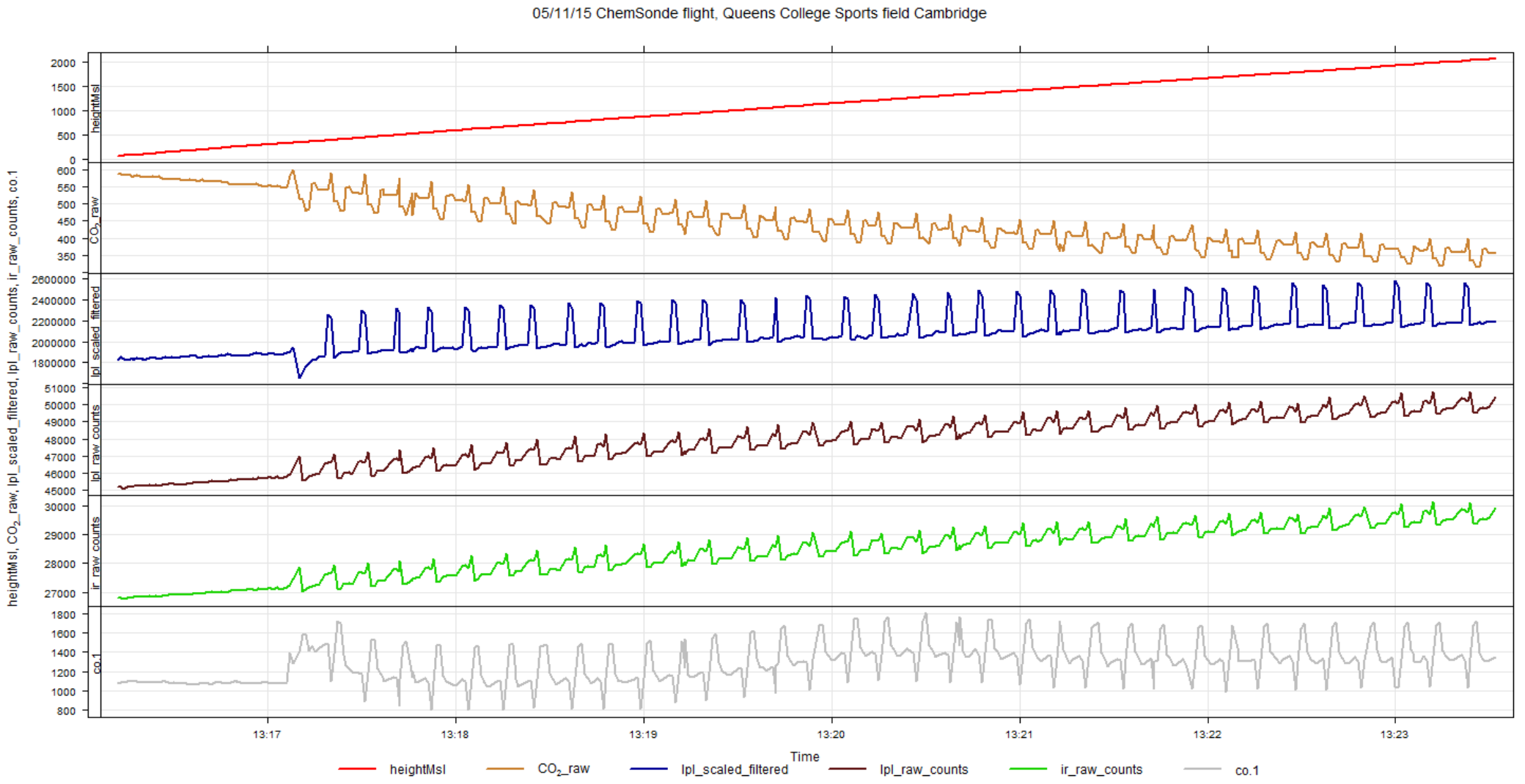




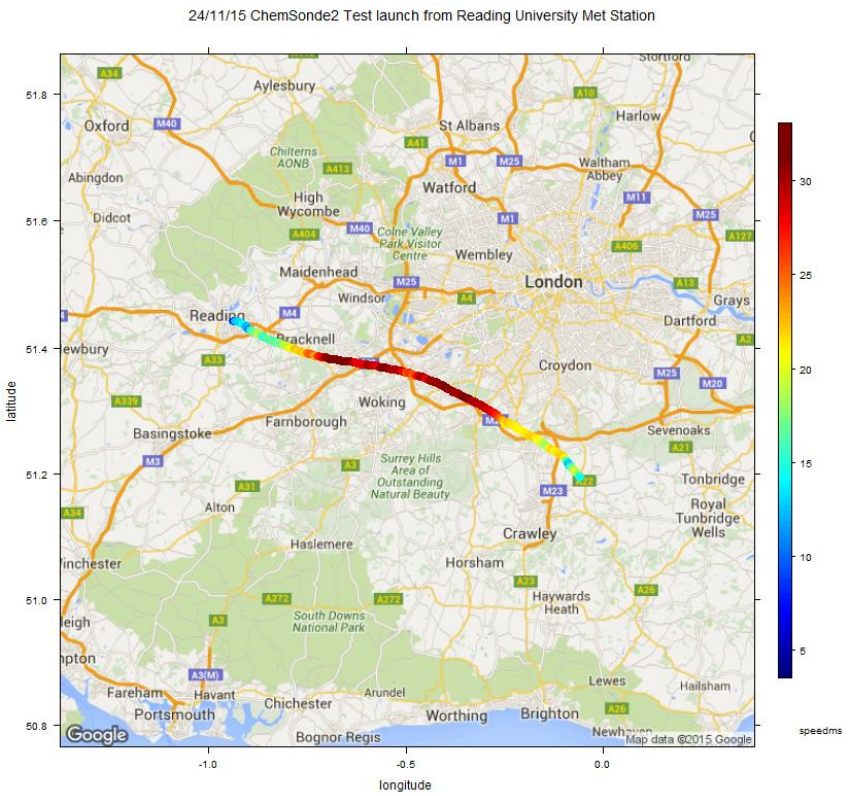


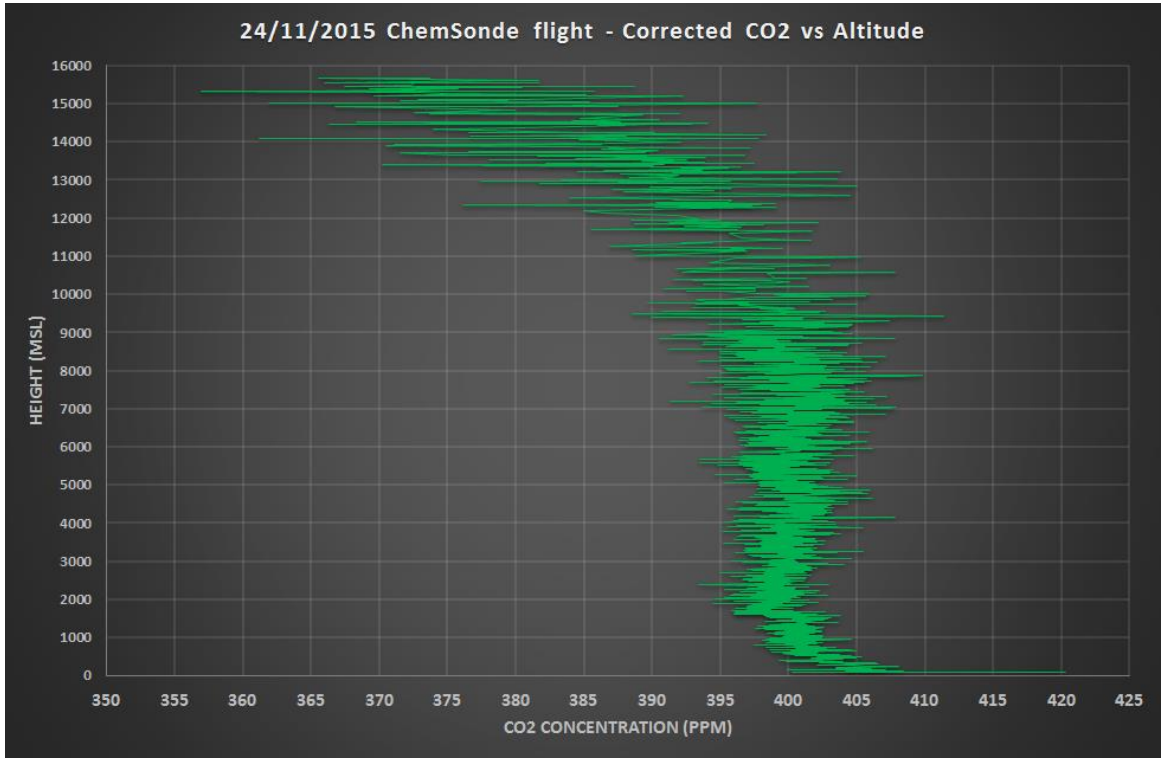


4. First launch – 05/11/15 Cambridge – issues



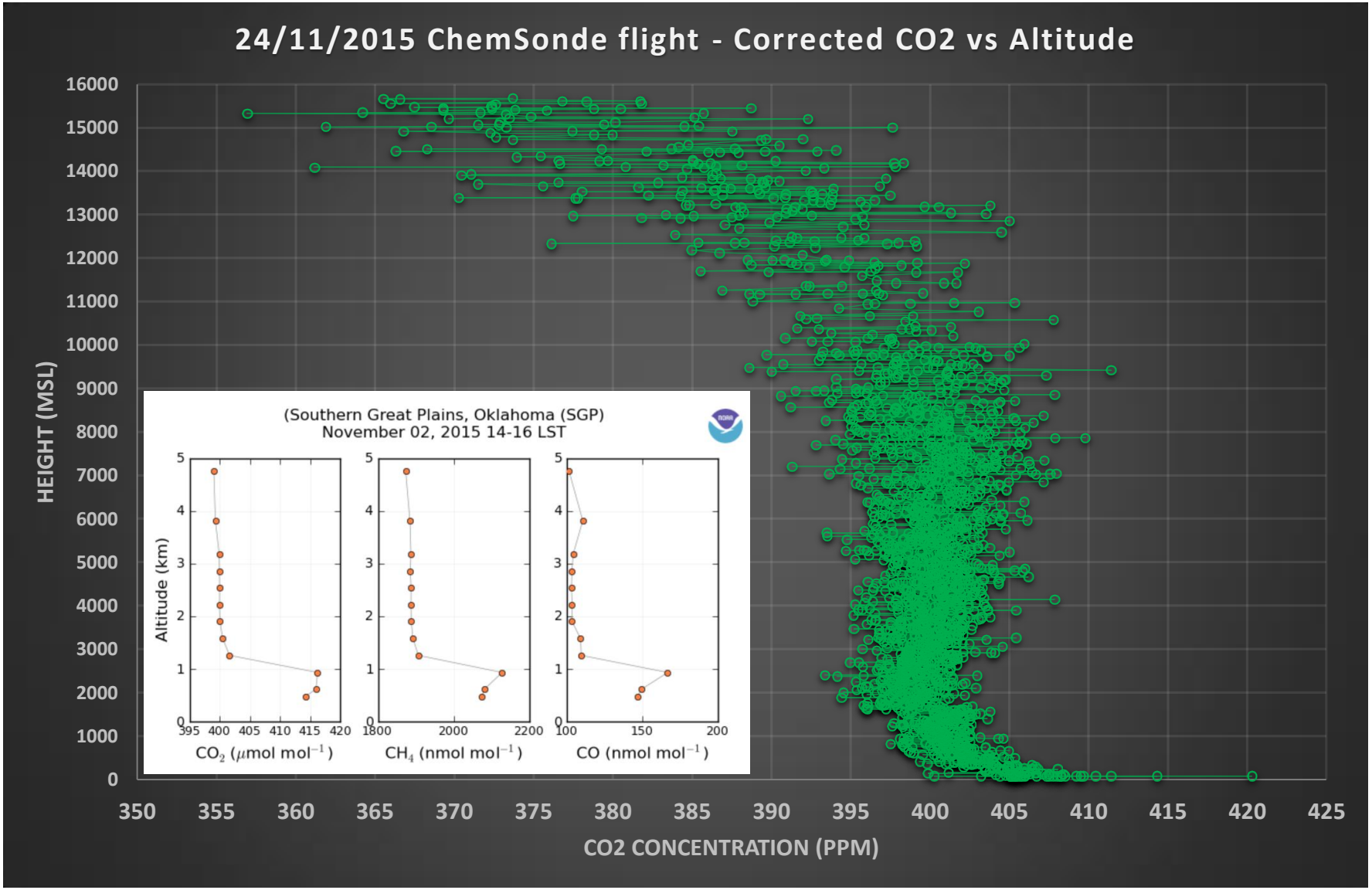
5. Second launch – 24/11/2015 Reading preliminary data!!



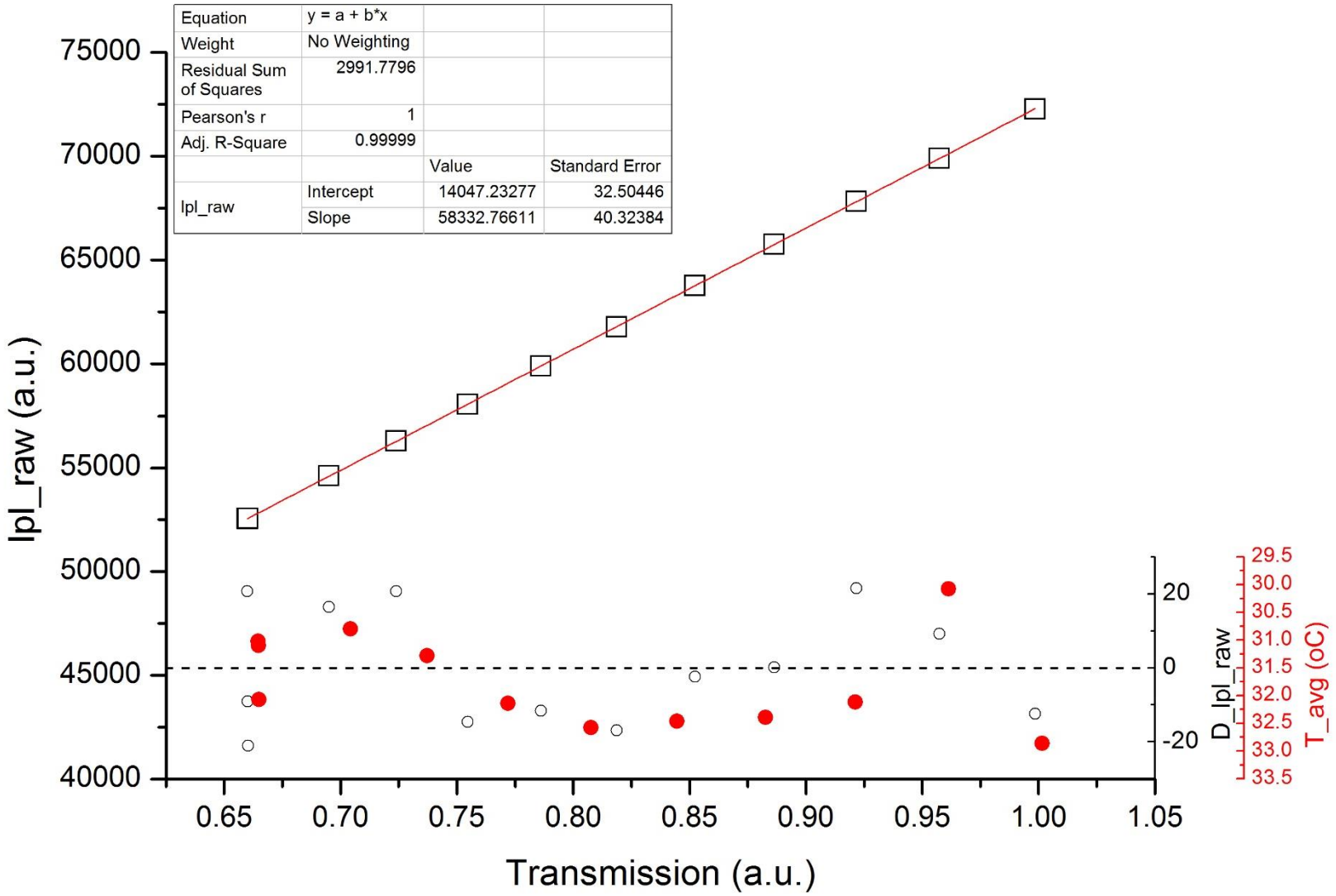


- First flight to back out [CO_2] based on calculations using raw signal, meteorological data.
- We lost contact after 15 km altitude due to ground station signal loss – aerial direction
- ChemSonde found near Calais in France > 100 km downwind must have reached >30 km
- Retrieved CO_2 'profile' is in agreement with previous measured aircraft concentrations.

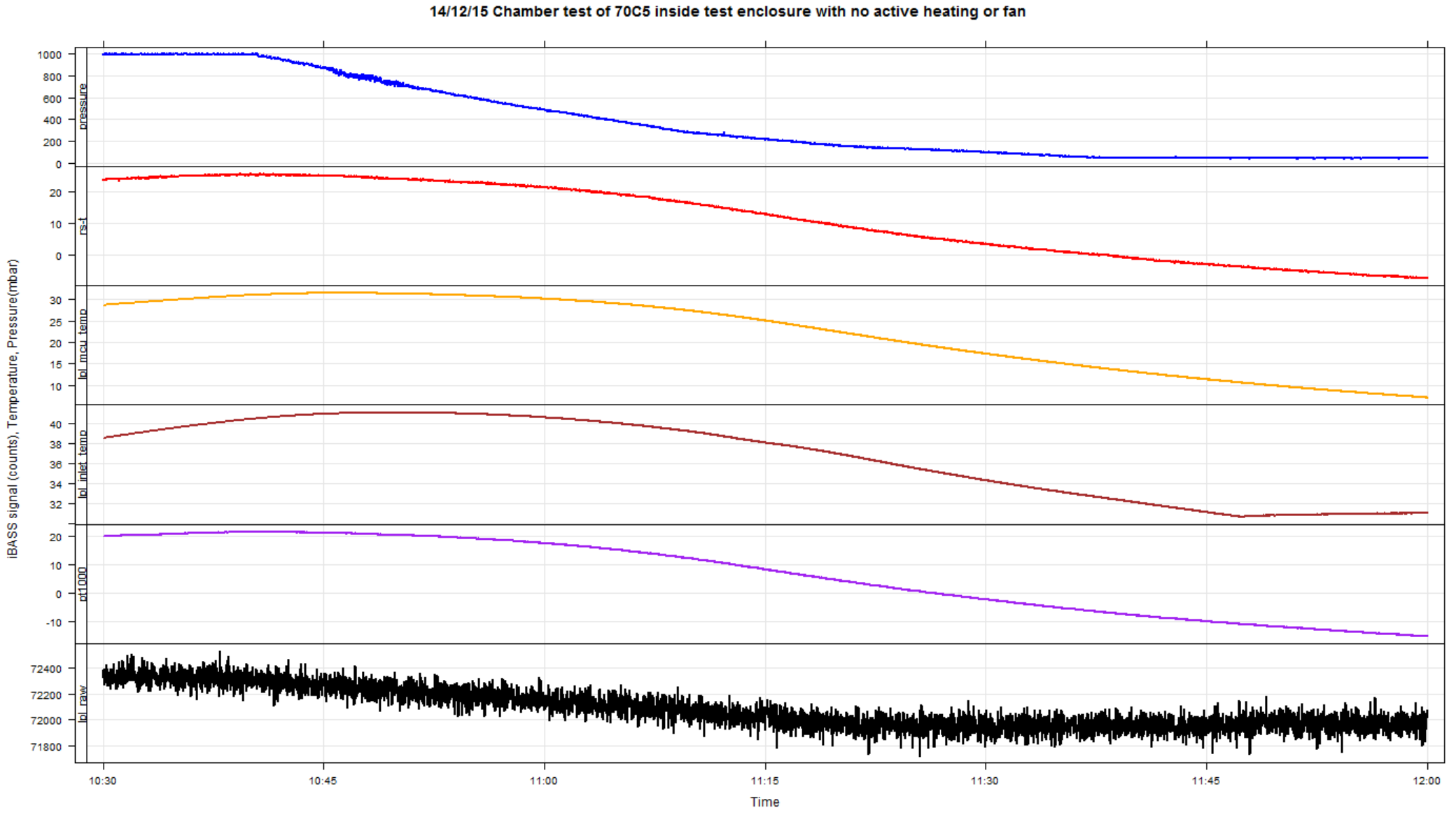
5. Second launch – 24/11/2015 Reading vs NOAA



5. Second launch - Characteristics



6. Pressure tests in our chamber – emitter effect (?)



7. Concluding remarks

Component	Weight (g)	Power (V)	Time* (hr)	Response / Sensitivity / Range
RS41 sonde	109	2 x Li 1.5 AA	> 4	0.3 – 0.5 s (temp / RH / pressure)
iBASS HPP CO_2	257	7.5 – 12**	3 – 5	< 10 s / ± 1-2 ppm / 0 – 3200 ppm
CO / Ox ECC + lid	46 (57 for 3 x CO)	3.3 – 6.4	5 – 8	< 20 s / ± 0.02 ppm / 0 – 500 ppm
Interface + cables	246	12	N/A	1 s transmission to sonde
Battery packs	285 (NiMh) 90 (Li)	12 or 6.2 1400 -2000 mAh	3 – 5	N/A

- We have a cost-effective (>£1k) package that can provide high spatial resolution data from surface to stratosphere, and which could be launched around the world from WMO sites.
- Instrument uses off-the-shelf sensors developed for indoor / outdoor air-quality monitoring.
- Further test launches planned for January 2016 and then IOP during Feb/March 2016 to coincide with instrumented aircraft flights by FAAM for UK GAUGE – help to determine anthropogenic and biogenic influence on outflow from UK.
- Future work could involve investigation of vertical transport and outflow in the UTLS/TTL from regions of biomass burning.
- Data from balloon studies can help improve satellite retreivals (e.g. EU Sentinal)

8. Alphasense ECC's for OX and CO