

**European Network on New Sensing Technologies for Air Pollution  
Control and Environmental Sustainability - *EuNetAir*  
COST Action TD1105**

**INTERNATIONAL WG1-WG4 MEETING on**

***New Sensing Technologies and Modelling for Air-Pollution Monitoring***

**Institute for Environment and Development - IDAD**

**Aveiro, Portugal, 14 - 15 October 2014**

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 3: 2014-15 (*Ongoing Action*)

**Chemical Sondes using low-cost sensors:  
Project Aims and Outlines**

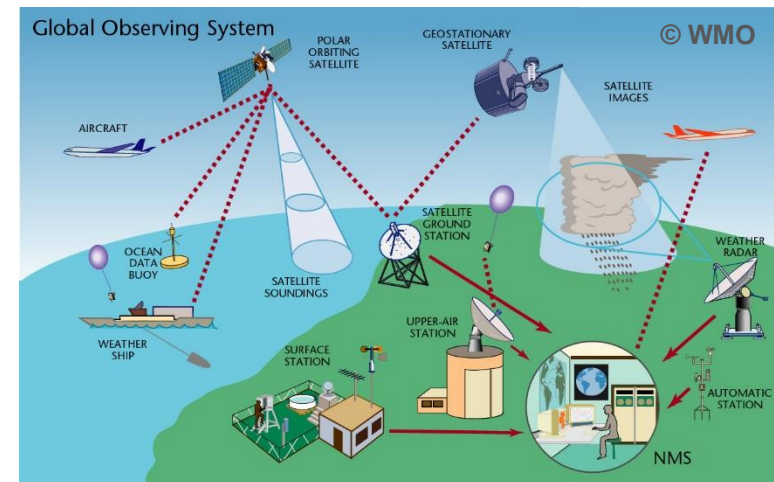
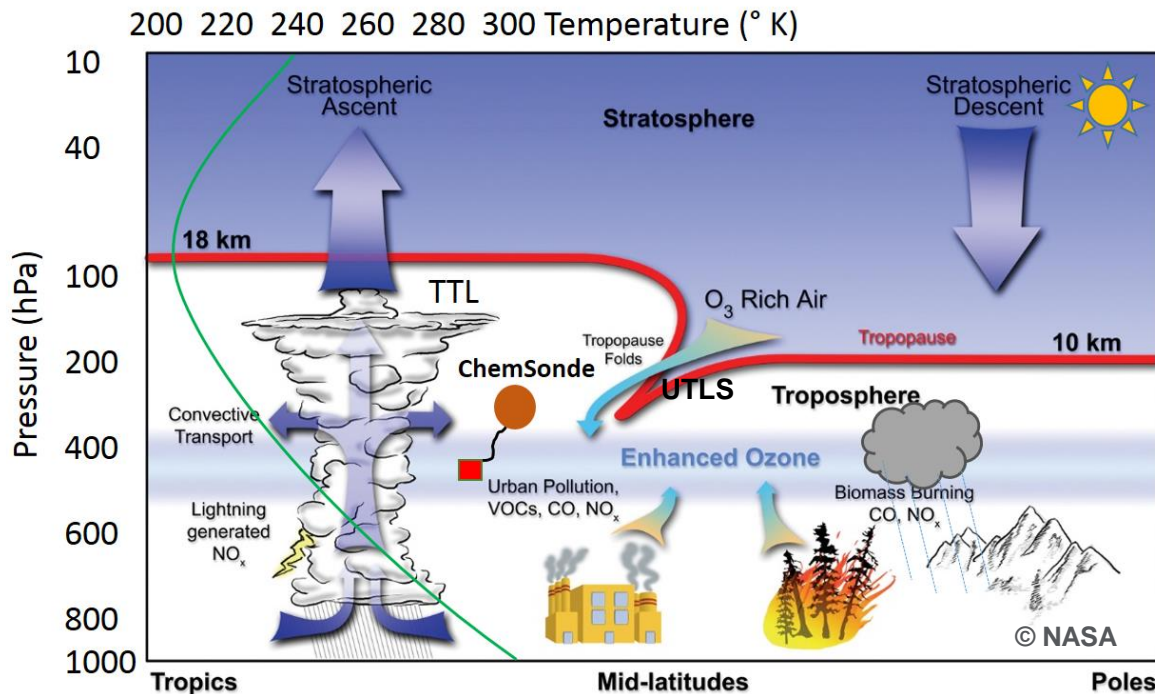
 **UNIVERSITY OF  
CAMBRIDGE**  
Department of Chemistry

**Paul Smith, Ray Freshwater, Rod Jones, Neil Harris**  
Function in the Action: ????

**University of Cambridge, UK**

# Scientific context and objectives

- Composition studies of TTL & UTLS limited to in-situ measurements with aircraft or instrumented balloons – intermittent & expensive...
- Satellites – global, but also costly, limited lifespan, issues with cloud (radiative)..
- Spatially, species (e.g.  $O_3$ ,  $CO$ ,  $H_2O$ ,  $CO_2$ ) are dynamic, variable & complex...
- TTL / UTLS very important globally. Critical to understand anthropogenic impacts on composition, transport processes & warming trends to constrain models...



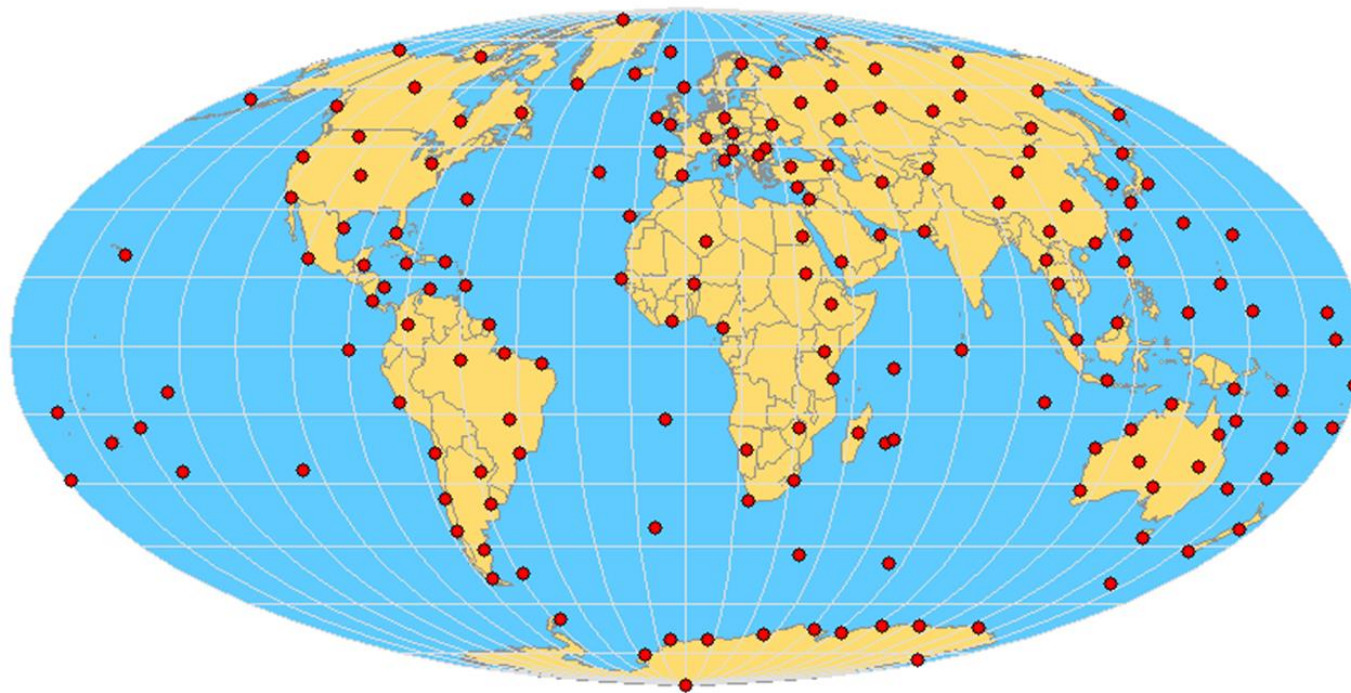
**ChemSonde can help fill these data gaps by utilising existing radiosondes!**

# Scientific context and objectives

## GCOS Upper-Air Network (171 Stations)

© WMO

© jma.go.jp

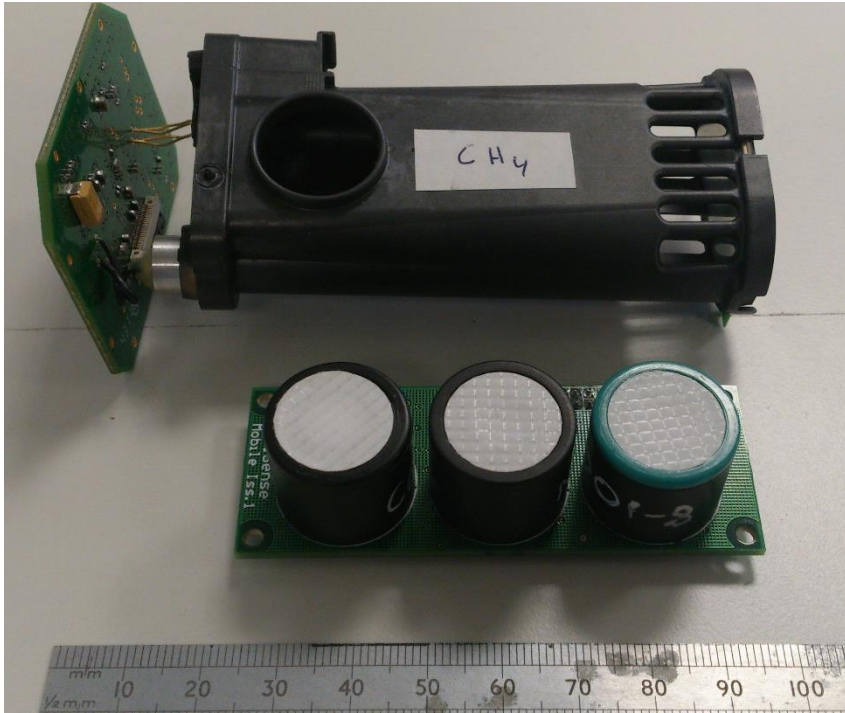


GCOS Secretariat, 1 March 2014



- Many routine launches of radiosondes for weather forecasting globally....
- We can 'piggy-back' onto this network using our small gas sensors...
- Cheap & disposable, but with good temporal and spatial coverage..

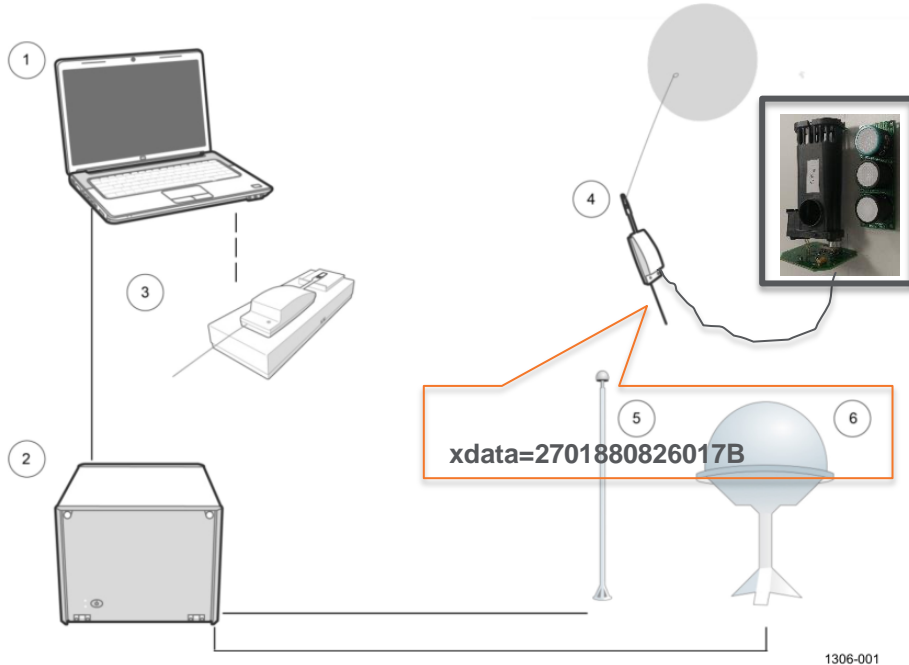
# Proposed package (1)



- Alphasense CO, O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>
- RT ~ 20 sec, 20.2 x 20.9 mm, 6 g
- SenseAir K92 NDIR CO<sub>2</sub>
- 1.2 m eqv. path, RT < 5 sec
- 1 ppm at 400 hPa 3 ppm at 100 hPa
- 100 x 40 x 20 mm, ~ 50 g

- Vaisala RS41 - RT ~ 1 sec, 3 hrs, 350 km
- Temp (resistor), RH (capacitor)
- Windspeed, direction, height & pressure all derived from GPS
- 129 g with unwinder, power 2 x AA lithium
- 200 bytes/sec ASCII string (added sensor)
- **£600 total cost per sonde launch (aim!)**

# Proposed package (2)



**Figure 1** DigiCORA Sounding System MW41 Overview with RS41

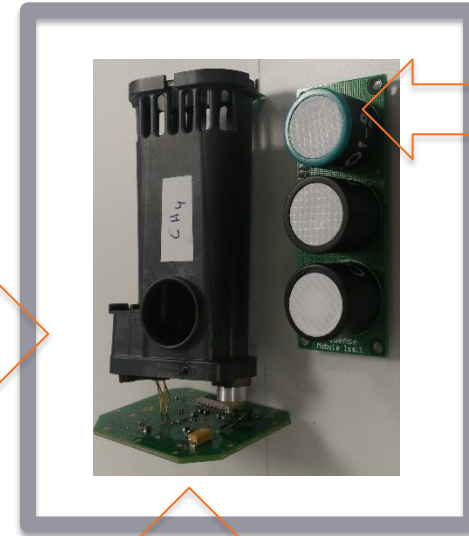
The following numbers refer to Figure 1 above:

- 1 = Sounding workstation PC
- 2 = Sounding Processing Subsystem SPS311
- 3 = Ground Check Device RI41 with RS41
- 4 = Radiosonde RS41
- 5 = GPS antenna
- 6 = UHF antenna

© Vaisala Radiosonde RS41 Additional Sensor Interface (August 2014)

**BUT..** →

Ascent rate ~ 5 ms<sup>-1</sup>



- Thermal protection!
- RFI / EMI protection !!
- Temperature inside critical
- Insulation?

- EC's don't like direct flow!
- Prefer stable temperature!
- Passive inlet?
- Comms...

- How to get air into cavity, pump?
- Weight, power!
- Heat air sample?
- Is pressure an issue?
- Comms critical...

**Problem shared is a problem solved...**

# Future planned activities

## **This project will be in four phases:**

### Development and construction (Oct 2014 – Jan 2015)

- Integrating EC's & CO<sub>2</sub> with Vaisala RS41 radiosonde – get them talking...
- Designing a suitable thermally efficient casing...non trivial!
- Tests at low temperature & pressure in our new chamber...

### Testing and validation (early 2015)

- Validation at JOSIE chamber – world standard for sensor testing
- Comparison flights with ozone sondes and possibly FAAM aircraft

### Field deployment (Summer / Autumn 2015)

- UK (GAUGE), Tropics (TTL)

### Data analysis

- Statistical analysis of composition profiles – comparison with models

# CONCLUSIONS

## Progress so far...

- Completed training with Vaisala on the MW41 ground-station & use of the RS92 and RS41 radiosondes.
- SenseAir working on supplying & supporting us with K92 Ipl CO<sub>2</sub> sensor
- Alphasense providing new EC sensors and digital comms board.
- We are designing a custom interface board to talk to the RS41 via RS232
- New thermal vacuum chamber to be installed for pressure & temperature tests

## Problems to solve...

- How to maintain thermal stability for optimal operation of the EC sensors?
- How to provide flow to the CO<sub>2</sub> sensor – miniature pump? vertical motion?
- How to maintain pressure across the CO<sub>2</sub> cell, pressure effects on LOD?
- Communications between RS41 and sensors – vital to get this working!

# Facilities available for the Partner

## Research/Measurement/Service Facilities:

