Sounding balloon data analysis

This project has been funded with support from the European Commission.

OUR PROJECT

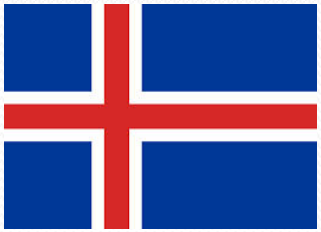
- EDUCATIONAL SOFTWARE AND E-LEARNING IN MATHS FOR EUROPEAN STUDENTS (*ESEMES*)

COMENIUS

- **Comenius project 2013-2015**
- IES José Saramago

PROJECT ESEMES





*GEOGEBRA software as a tool for sounding balloon data analysis and outline of Lower atmosphere structure in Majadahonda (*Spain*) and Kopavogur (Iceland). (SPAICE)*

PROJECT ESEMES

- Duration: September 2014-April 2015.

- Participating schools and agencies involved:

→ Menntaskólinn í Kopavogi (Kópa*vogur, Iceland).*

→ IES José Saramago (*Majadahonda, Spain).*

→ Agencia Estatal de Meteorología (*Madrid*, *Spain*)

AIMS

- To develop a collaboration between our two schools with both Icelandic and Spanish National Meteorological Services and other institutions.
- Use of *GEOGEBRA* Math Software and other auxiliary software tools (*EXCEL*) to store, plot and interpret mathematical data obtained from natural phenomena.
- To acquire a basic comprehension of the structure and composition of the Lower Atmosphere.
- To analyze and represent sounding balloon data provided by different meteorological stations placed throughout Europe.

AIMS

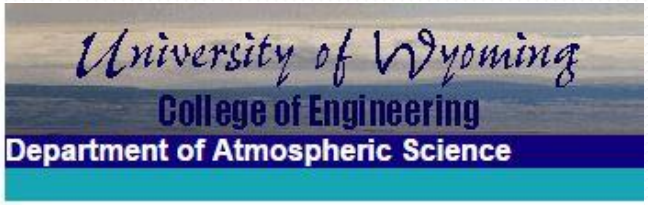
- To design, assemble, launch and recovery our own stratospheric sounding balloon device.
- To compare atmospheric features in different cities at different latitudes.
- To produce a basic sketch on variations in this features depending on the latitude.
- To use data from standardized official balloon launches and from our own balloon, so to be able to compare them with theoretical models on the structure of Lower Atmosphere (Troposphere-Stratosphere).

Description of the project

Work in Iceland

- Data recompilation

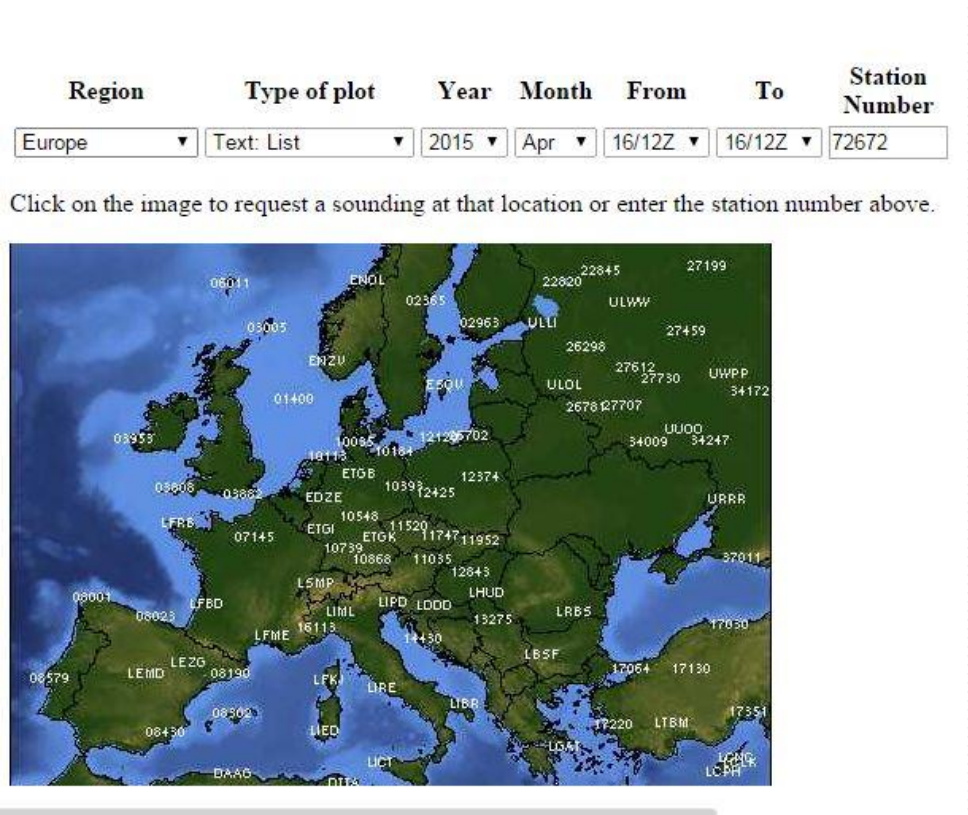
University of Wyoming



Upperair Air Data

- Upper Air Maps
- Soundings

Weather.uwyo.edu/upperair

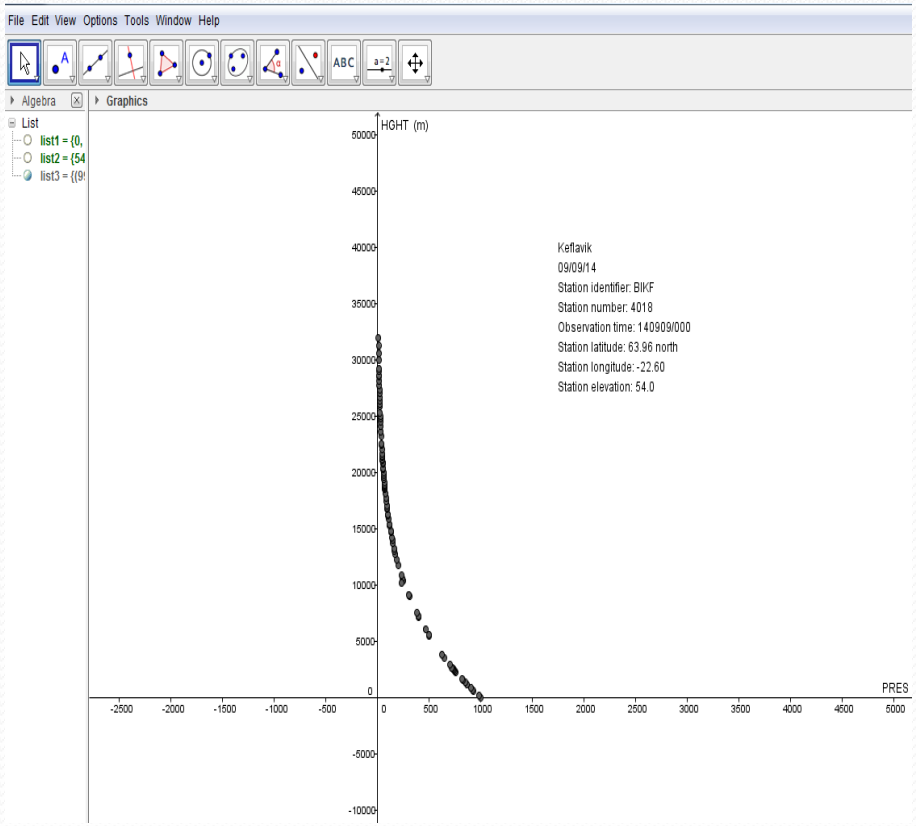


Work in Iceland

- Creating the graphs using Geogebra

04018 BIKF Keflavikurflugvollur Observations at 12Z

PRES hPa	HGHT m	TEMP C	DWPT C	RELH %	MIXR g/kg	DRCT deg	SKNT knot	THTA K	THTE K	THTV K
1002.0	54	6.4	4.4	87	5.26	0	0	279.4	294.0	280.3
1000.0	53	6.0	3.8	86	5.05	170	8	279.1	293.2	280.0
997.0	77	5.8	3.7	86	5.02	165	10	279.2	293.1	280.0
991.0	127	5.3	3.4	88	4.96	165	14	279.2	293.0	280.0
952.0	453	2.2	1.7	96	4.57	175	17	279.2	292.0	280.0
934.0	607	1.1	0.8	98	4.37	180	19	279.7	292.0	280.4
925.0	685	0.6	0.4	99	4.28	180	21	279.9	291.9	280.6
857.0	1294	-3.5	-3.5	100	3.46	189	9	281.8	291.7	282.4
853.0	1331	-1.1	-1.3	99	4.10	190	9	284.7	296.5	285.4
850.0	1359	-1.1	-2.1	93	3.87	190	8	285.0	296.2	285.6
848.0	1378	-0.9	-3.6	82	3.47	189	9	285.4	295.5	286.0
847.0	1387	-1.1	-4.9	75	3.15	188	9	285.3	294.5	285.8
843.0	1425	-0.6	-7.4	60	2.61	185	10	286.1	293.9	286.6
836.0	1492	0.2	-11.8	40	1.86	186	10	287.7	293.4	288.0
834.0	1511	0.6	-11.4	40	1.93	186	9	288.3	294.2	288.7
822.0	1628	1.8	-12.2	35	1.83	187	9	290.8	296.5	291.1
808.0	1766	1.4	-12.6	34	1.81	188	8	291.8	297.4	292.1
792.0	1927	0.4	-5.7	64	3.17	190	7	292.4	301.9	292.9
789.0	1957	0.2	-4.4	71	3.51	188	7	292.5	303.0	293.1
770.0	2152	-0.9	-6.9	64	2.97	172	8	293.4	302.4	293.9
763.0	2225	-0.7	-15.7	31	1.48	166	9	294.3	299.1	294.6
757.0	2288	-0.9	-21.9	19	0.88	161	9	294.8	297.7	294.9
751.0	2351	-1.3	-11.3	47	2.16	155	9	295.0	301.8	295.4
739.0	2480	-1.9	-26.9	13	0.58	145	10	295.7	297.7	295.8
731.0	2566	-2.3	-17.3	31	1.35	151	11	296.2	300.6	296.5
710.0	2797	-3.1	-29.1	11	0.49	167	12	297.8	299.5	297.9
705.0	2853	-3.5	-16.5	36	1.50	171	13	298.0	302.8	298.2
700.0	2909	-3.9	-19.9	28	1.13	175	13	298.1	301.9	298.3
698.0	2932	-4.0	-20.0	28	1.13	180	13	298.3	302.0	298.5
695.0	2965	-4.1	-20.1	28	1.12	179	14	298.5	302.2	298.7
661.0	3357	-7.0	-20.2	34	1.17	165	21	299.5	303.4	299.7
636.0	3657	-9.3	-20.3	40	1.20	166	21	300.3	304.2	300.5
630.0	3730	-9.7	-24.7	28	0.82	167	21	300.6	303.4	300.8



Work in Iceland

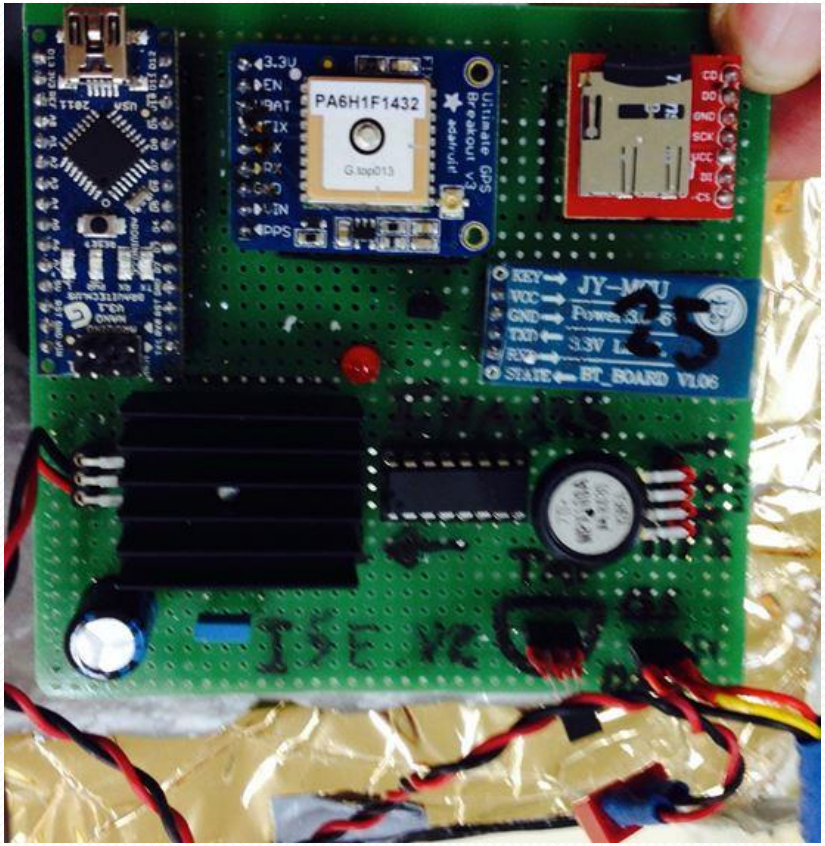
Work in Iceland

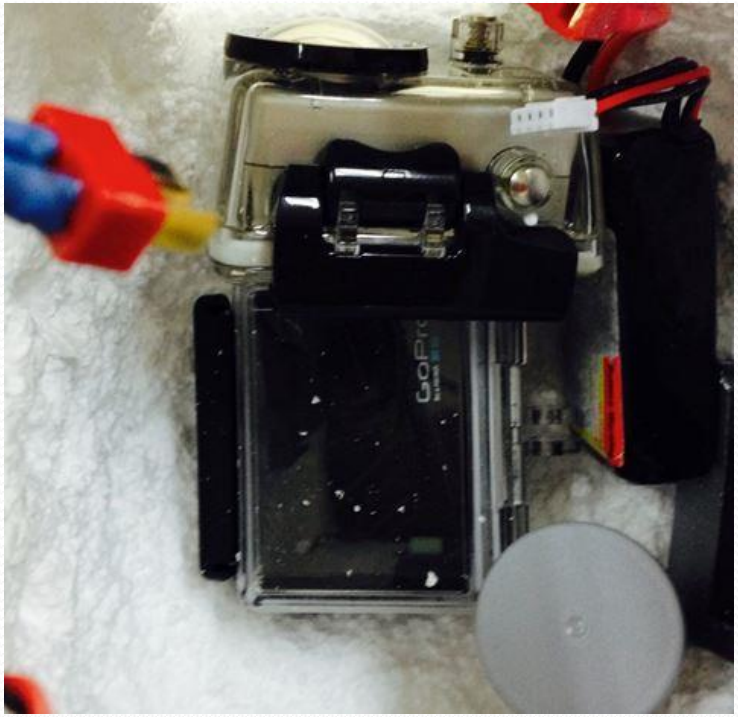
Work in Spain

- Our sounding ballon

Work in Spain

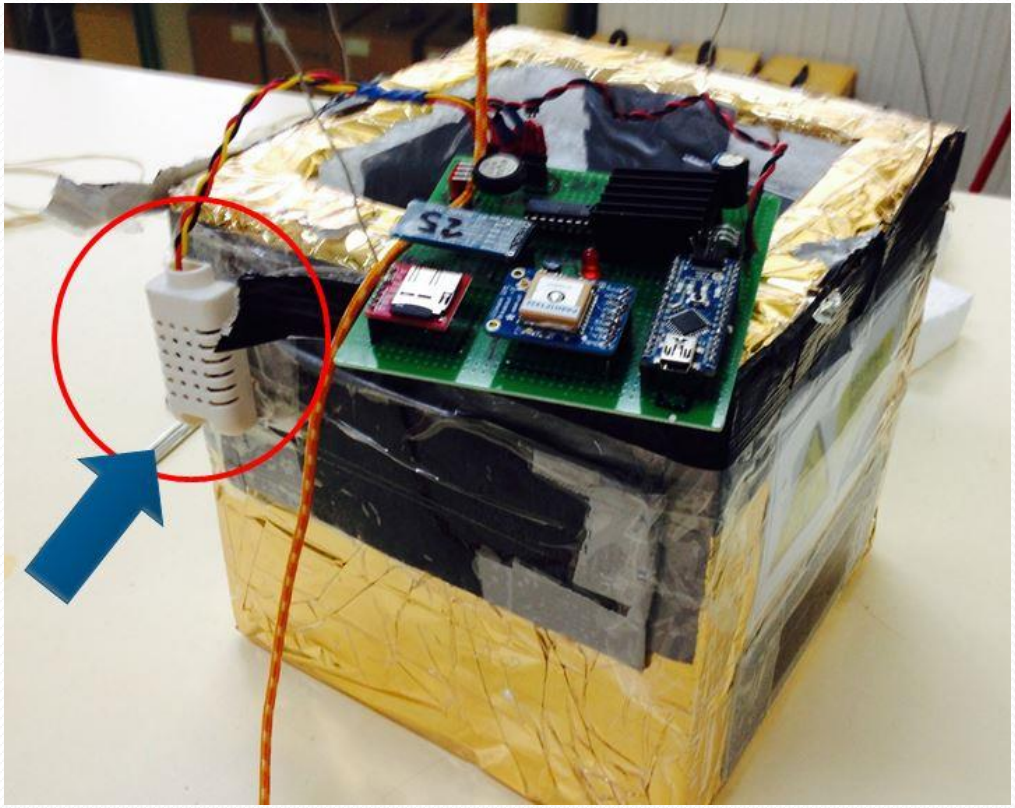
- Our sounding ballon





Work in Spain

- Our sounding ballon



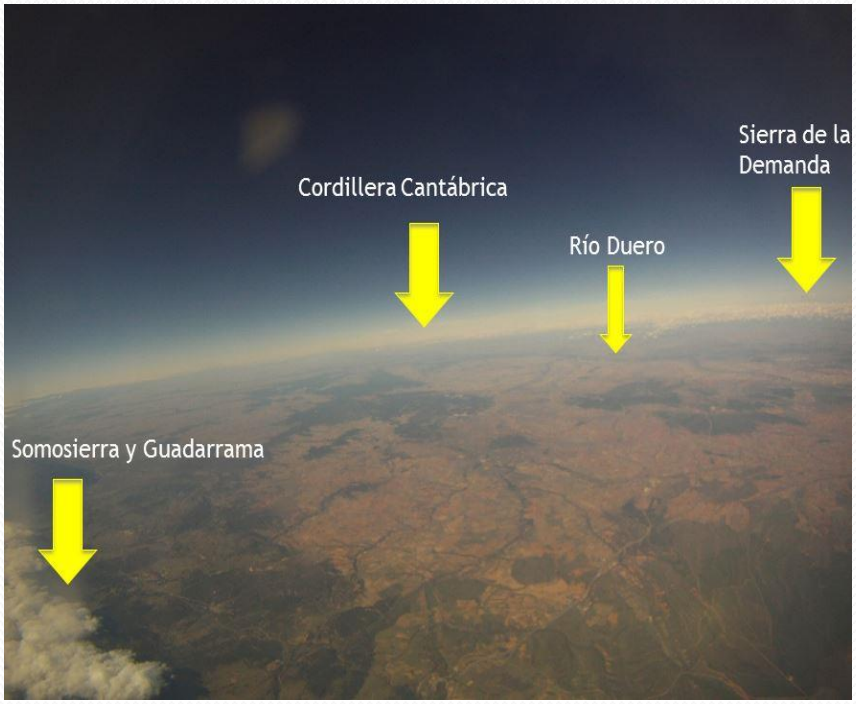
Work in Spain

- Winning construction team

Work in Spain

- Launching the ballon

Work in Spain

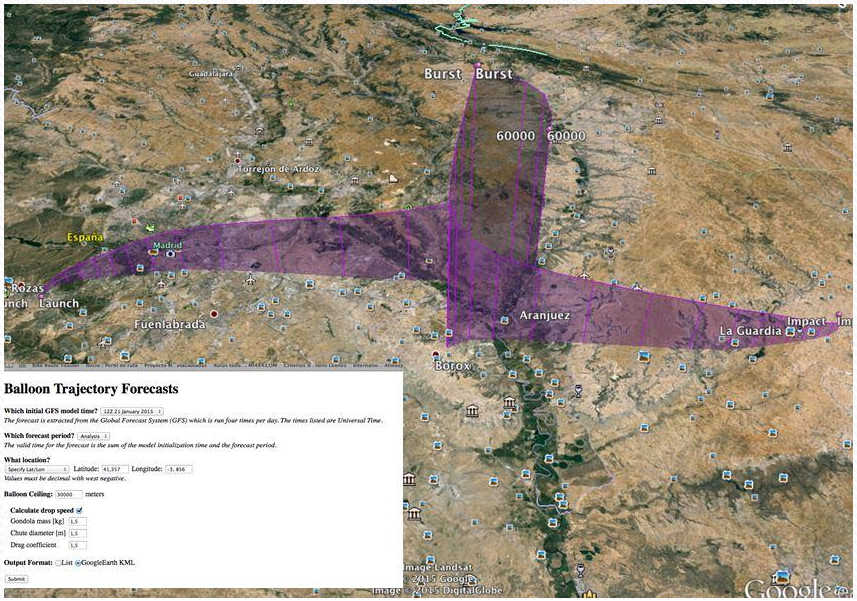


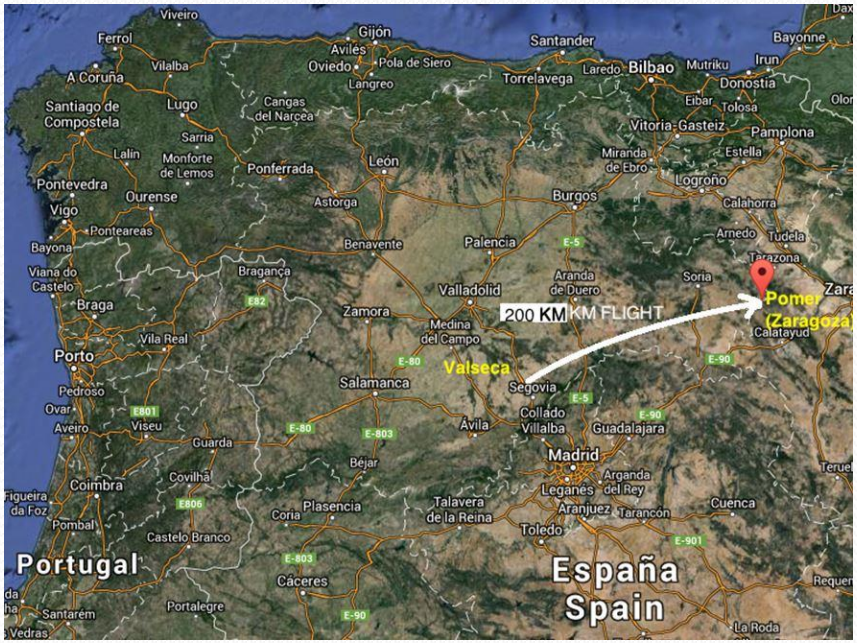
Work in Spain

- Amazing sights

Work in Spain

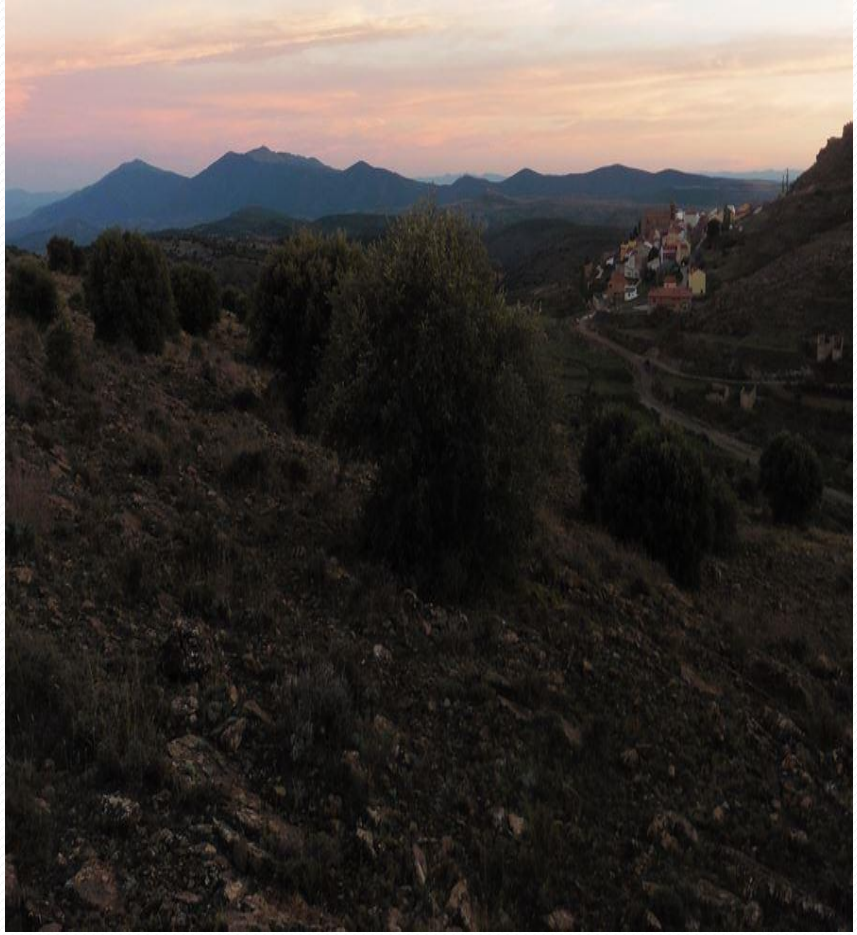
Expectation VS Reality





Work in Spain

- Landing



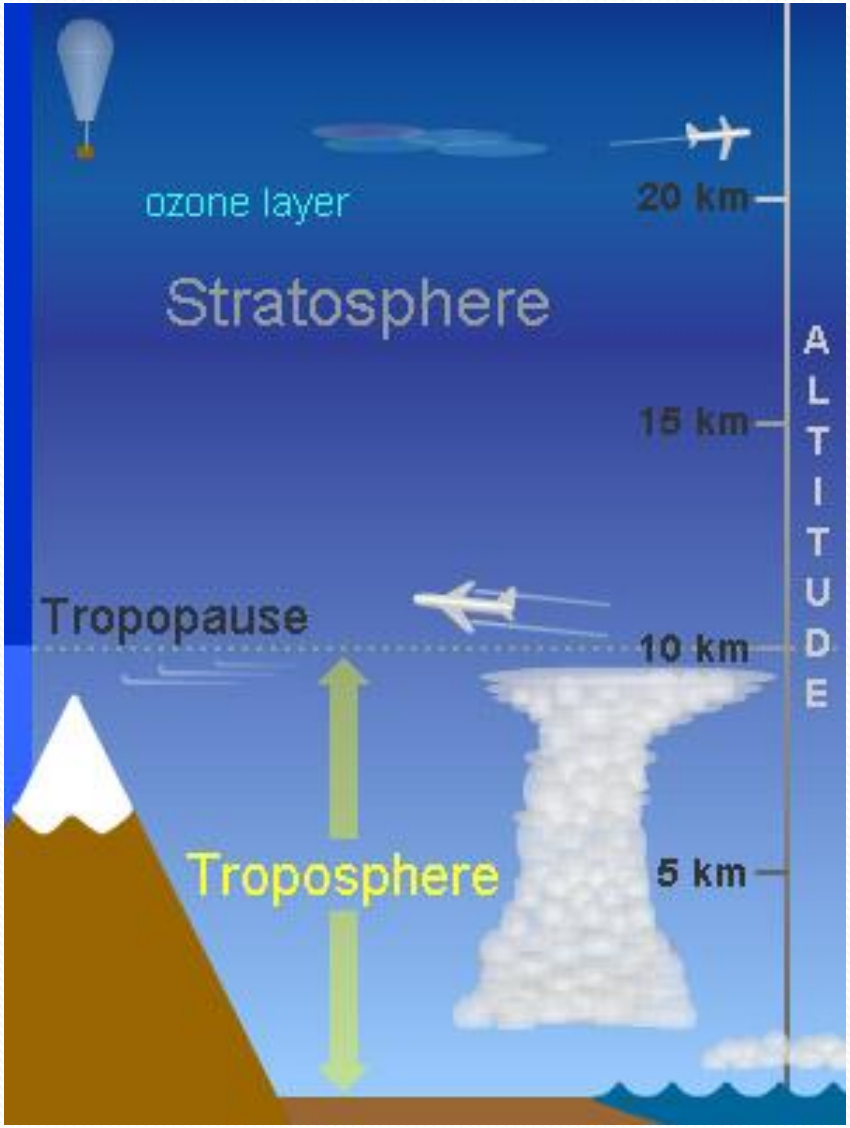
Work in Spain

Obtained data and graphics.

STATION MAP


ISLANDIA
Reykjavyk
IS. FEROE
Thorshavn
NORUEGA
SUECIA
FINLANDIA
Helsinki
Oslo
Estocolmo
Tallinn
ESTONIA
RUSIA
Moscú
LETONIA
Riga
DINAMARCA
Copenhague
LITUANIA
Vilnius
RUS.
Minsk
BIELORRUSIA
IRLANDA
Dublín
REINO UNIDO
Londres
Amsterdam
Berlín
ALEMANIA
Varsovia
POLONIA
Kiev
UCRANIA
Bruselas
Luxemburgo
(LUX.)
Praga
CHEQUIA
ESLOVAQUIA
Bratislava
MOLDAVIA
Kisinev
Bakú
Tbilisi
GEORGIA
AZERBAIJAN
ARMENIA
Erevan
Vaduz
(LIECH.)
Viena
Budapest
AUSTRIA
HUNGRÍA
RUMANÍA
Bucarest
Berna
SUIZA
Ljubljana
ESLOVENIA
Zagreb
CROACIA
Belgrado
FRANCIA
Mónaco
(MON.)
San Marino
Sarajevo
SERBIA
BULGARIA
Sofia
Andorra
la Vella
ITALIA
BOSNIA H.
MONTENEGRO
Podgorica
Skopje
ALBANIA
MACEDONIA
Roma
Ciudad del
Vaticano
Tirana
TURQUÍA
Ankara
PORTUGAL
Lisboa
Madrid
ESPAÑA
GRECIA
Atenas
Nicosia
CHIPRE
La Valetta
MALTA

ATMOSPHERE STRUCTURE



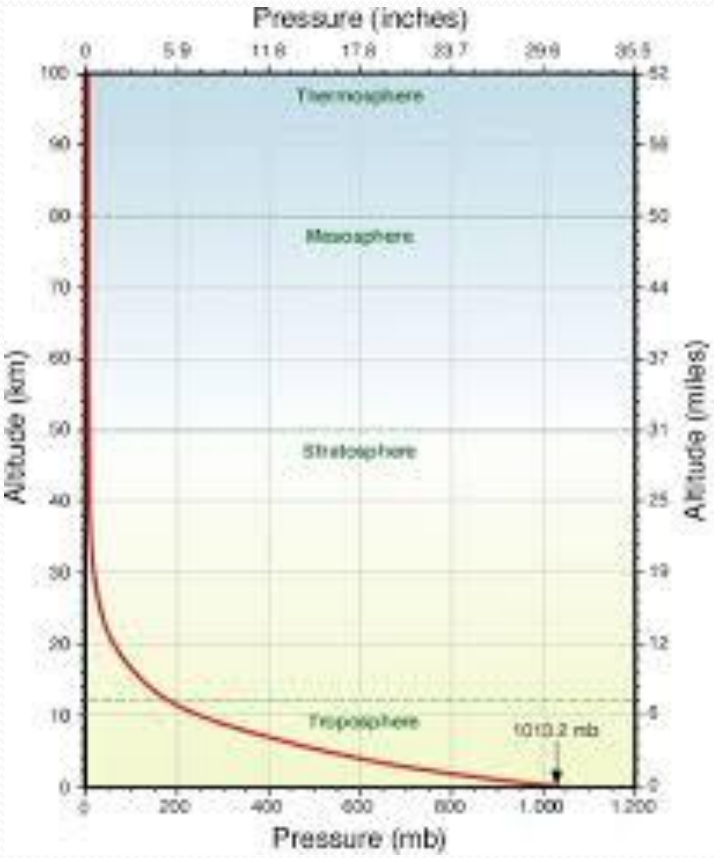
GRAPH TYPES

- Pressure-Height
- Relative humidity-Height
- Temperature-Height

COMENIUS

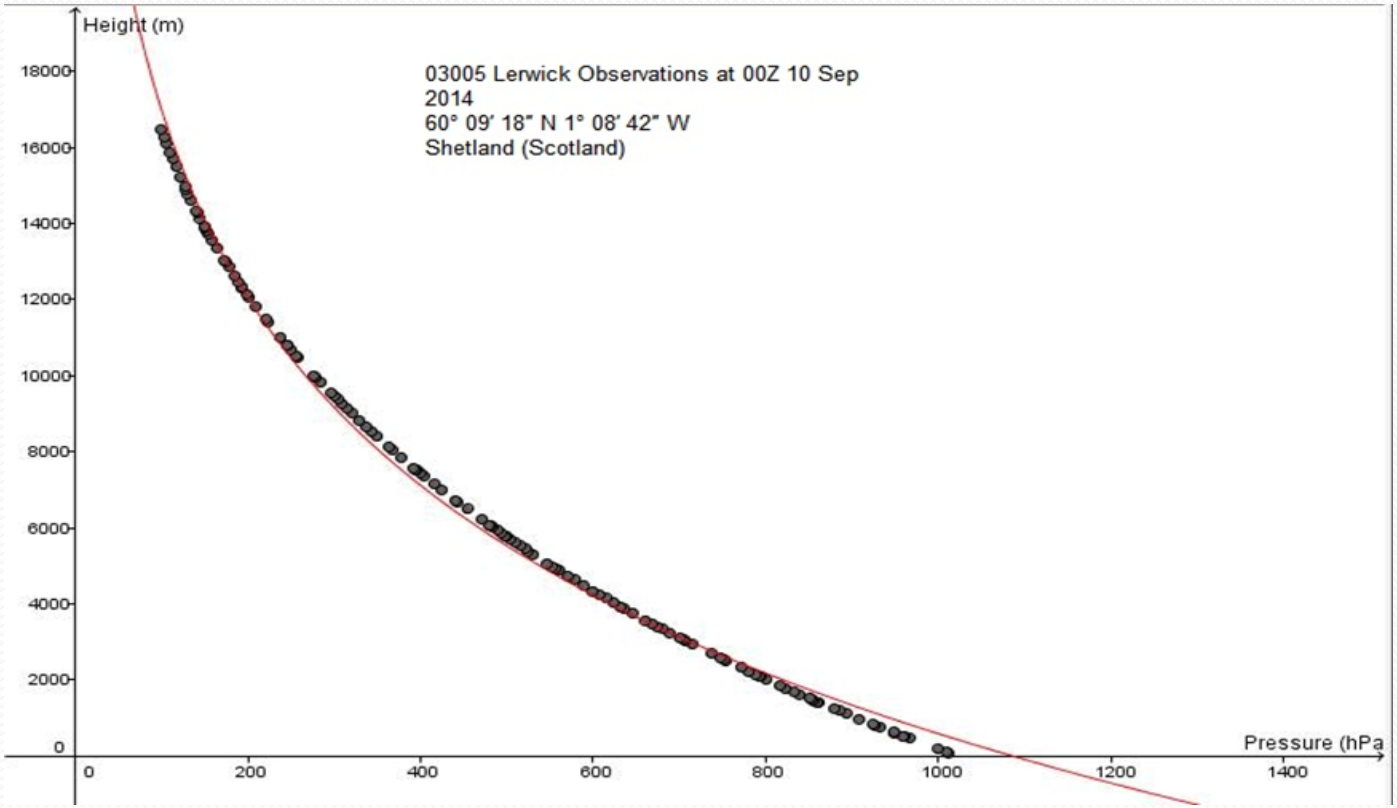
Theorical introduction

- Pressure decreases exponentially with altitude in the lower layers of the atmosphere, during first 25-30 km of altitude.



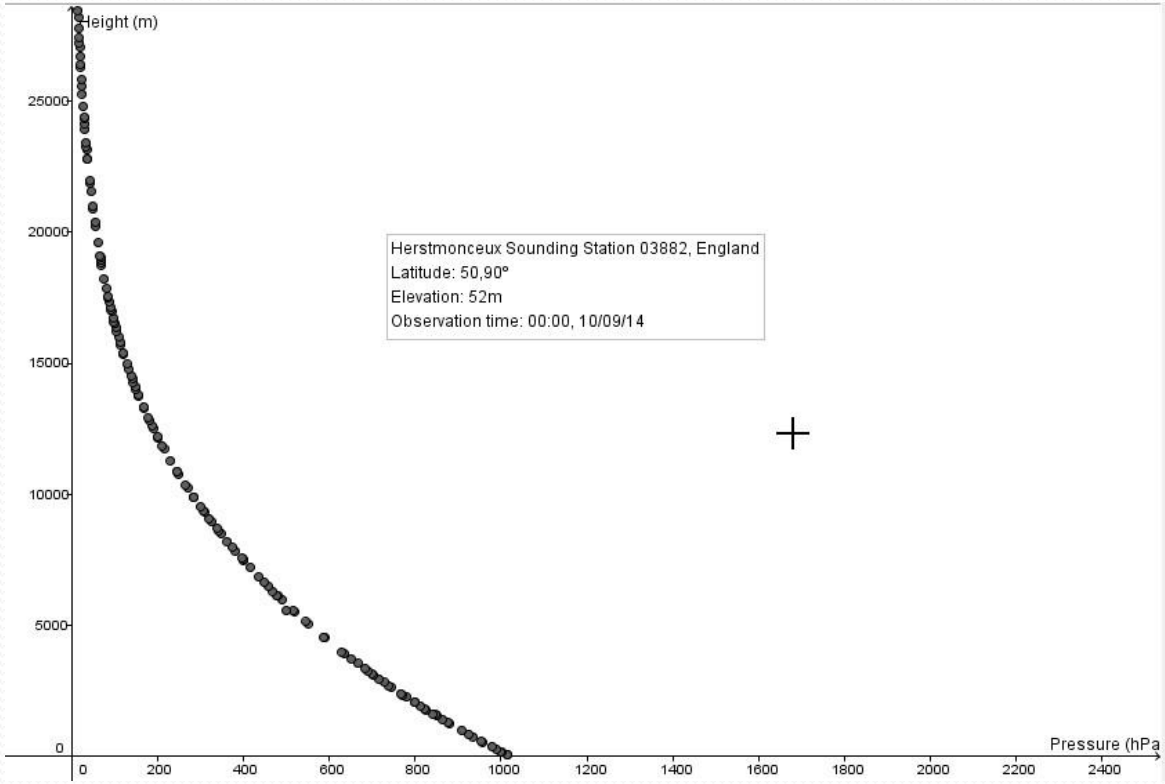
Pressure-Height graphics

This graph shows how the pressure varies in the lower layer of the atmosphere.



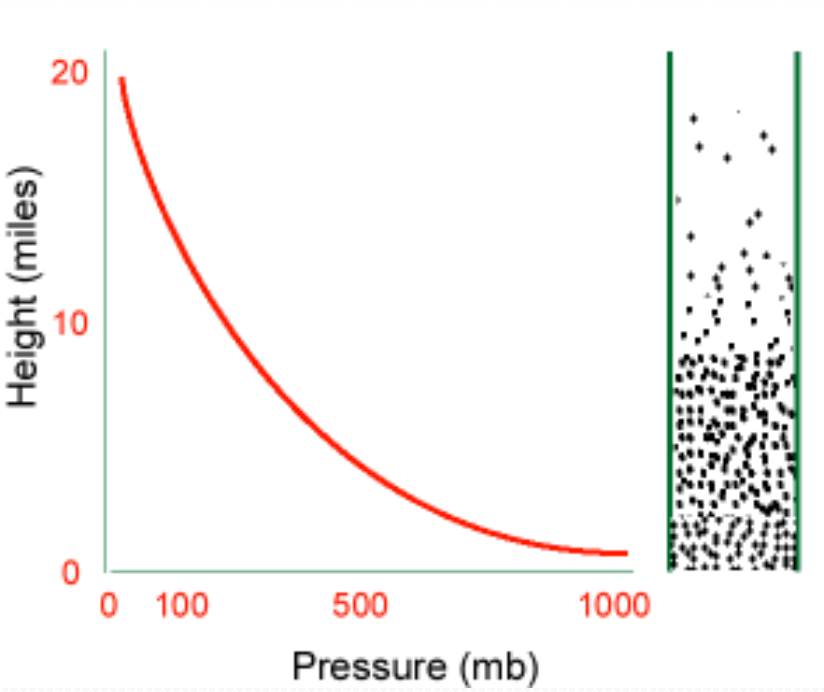
Pressure-Height graphics

In this one we can see the pressure becoming asimptotic as we reach higher levels of the atmosphere.



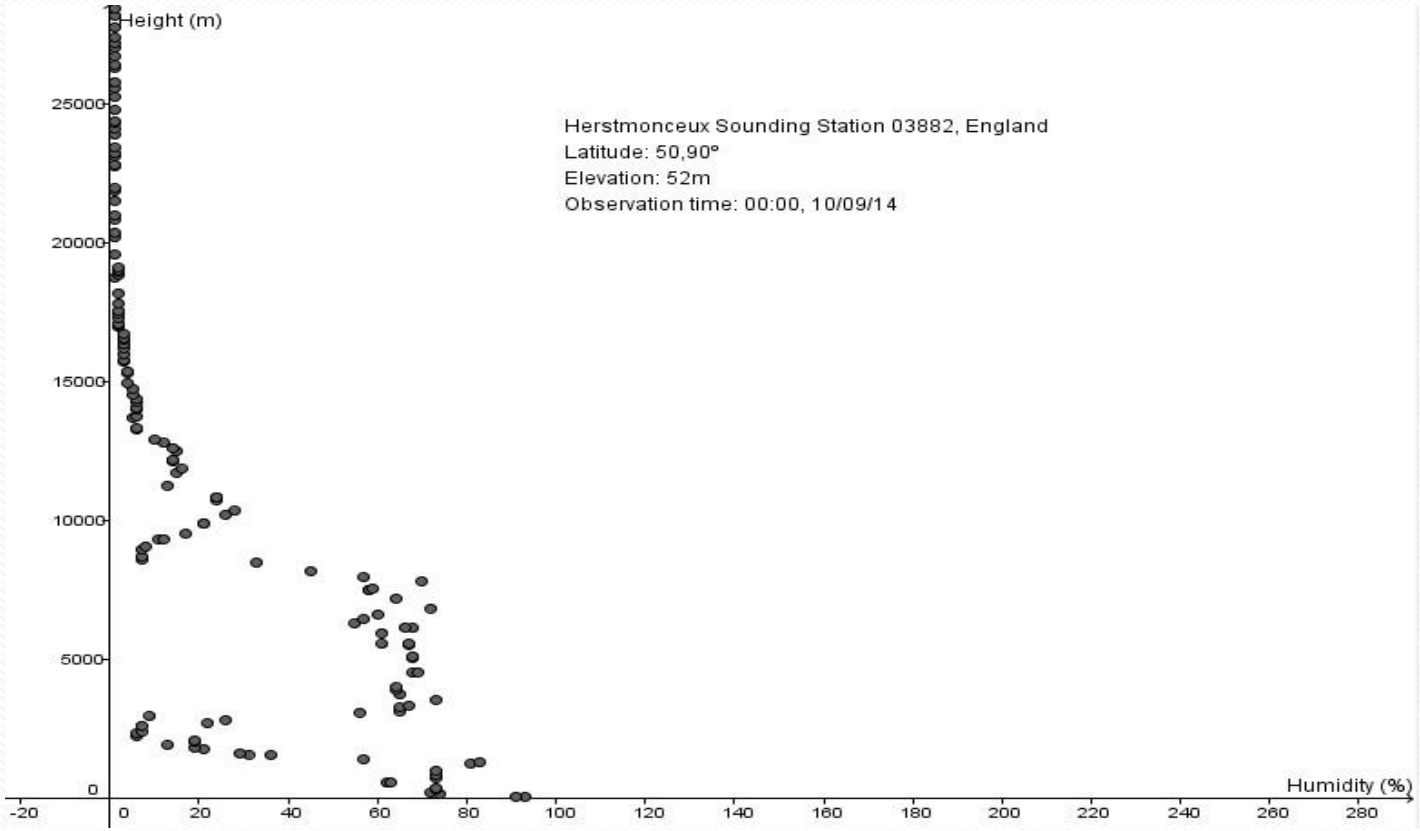
THEORETICAL MODEL

- The mass of the atmosphere is mostly concentrated in the first 20 km of atmosphere, and this 20 first km is called troposphere, which contains 75% of the mass, including humidity and particles in form of dust.



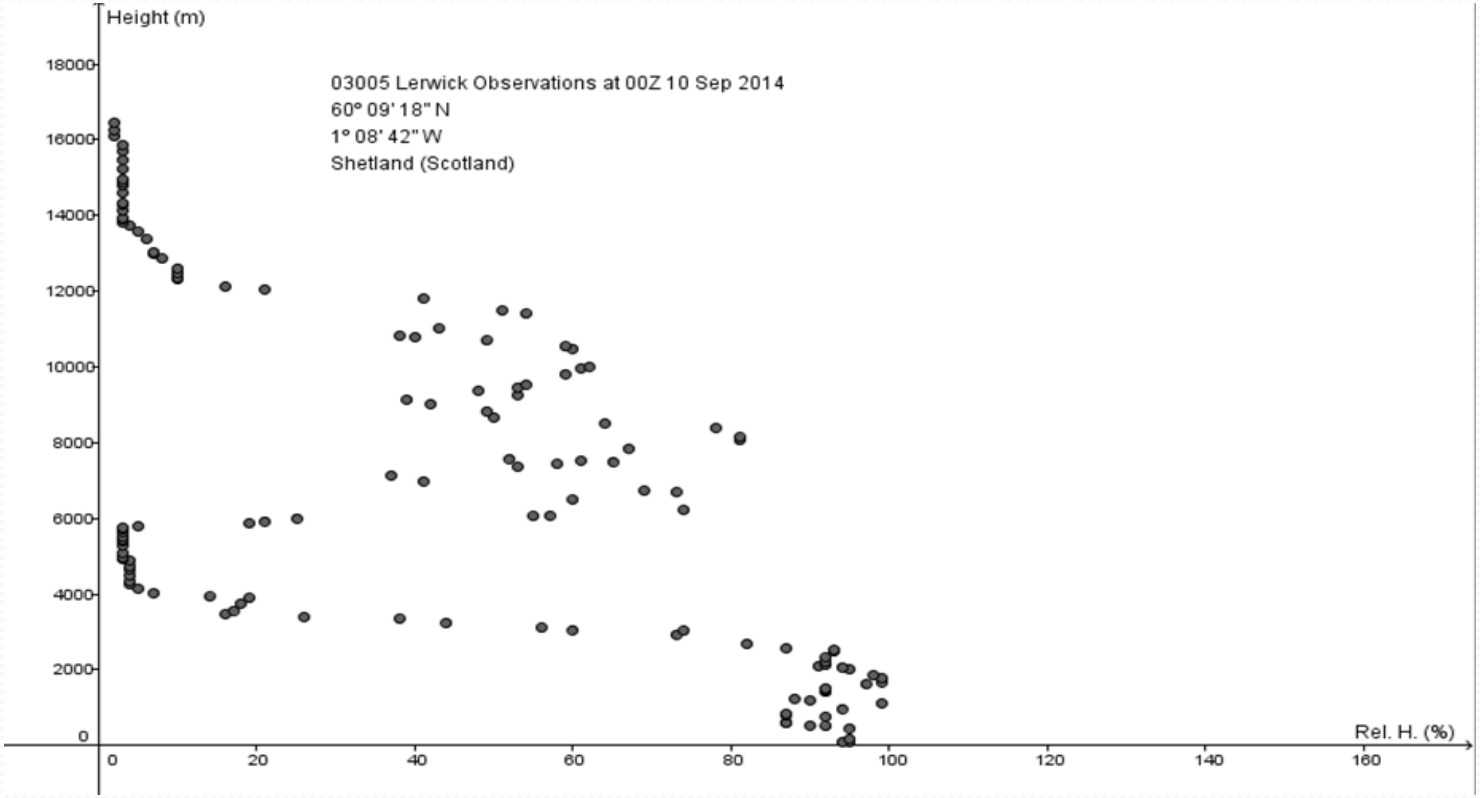
Relative humidity-Height graphics

As we can see there are no clouds once we reach higher levels (20km Aprox.)

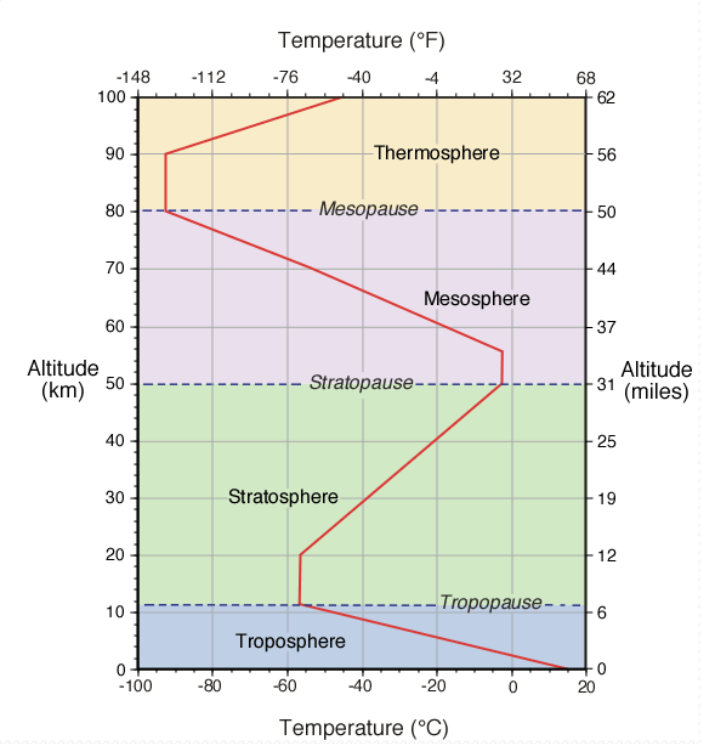


Relative humidity-Height graphics

In this graph we can appreciate the different types of clouds which can be found in different heights in the troposphere.

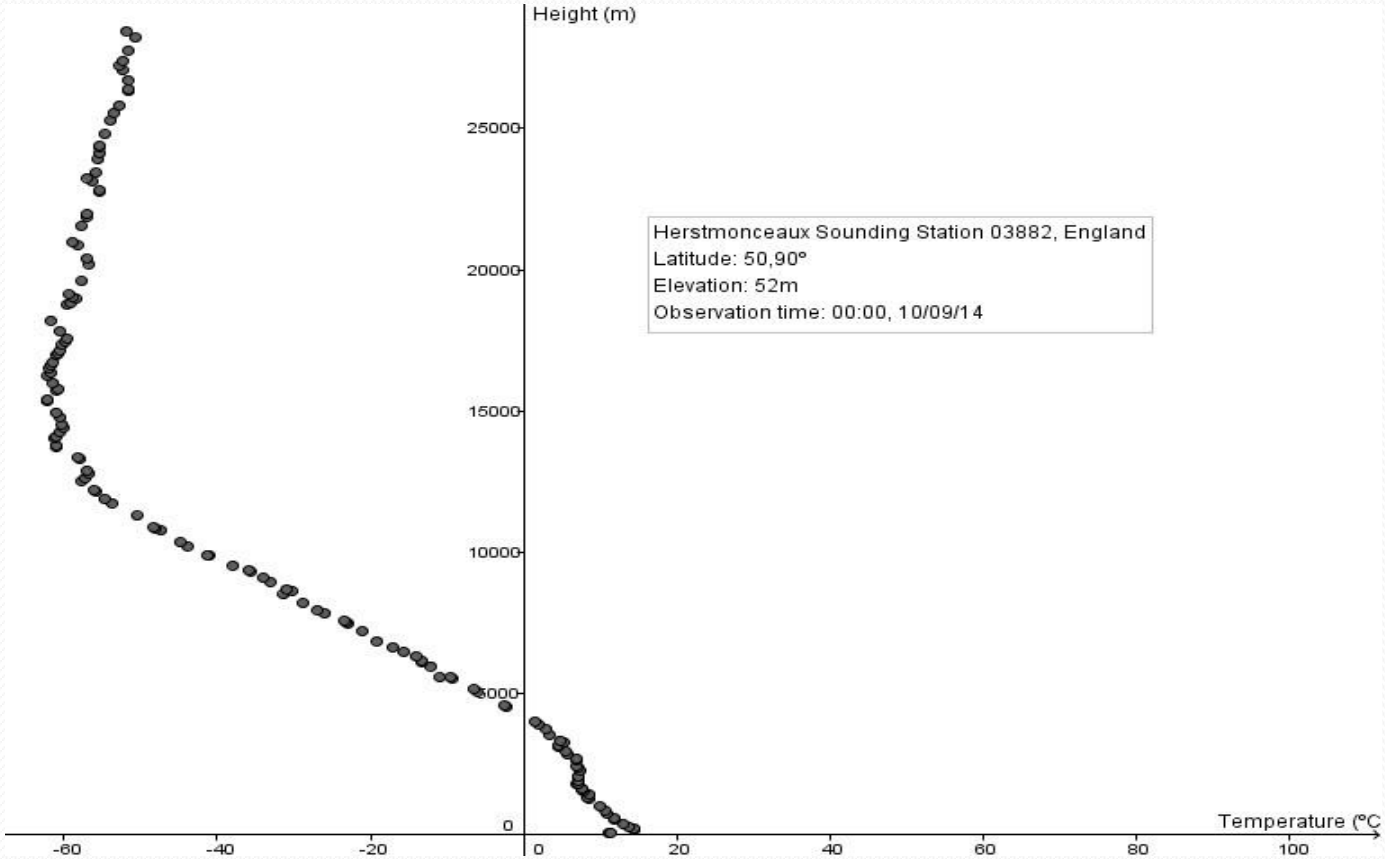


- **Temperature**: continuous decrease of temperature with increasing altitude in the lower layers of the atmosphere (troposphere),usually below 12-16000m.



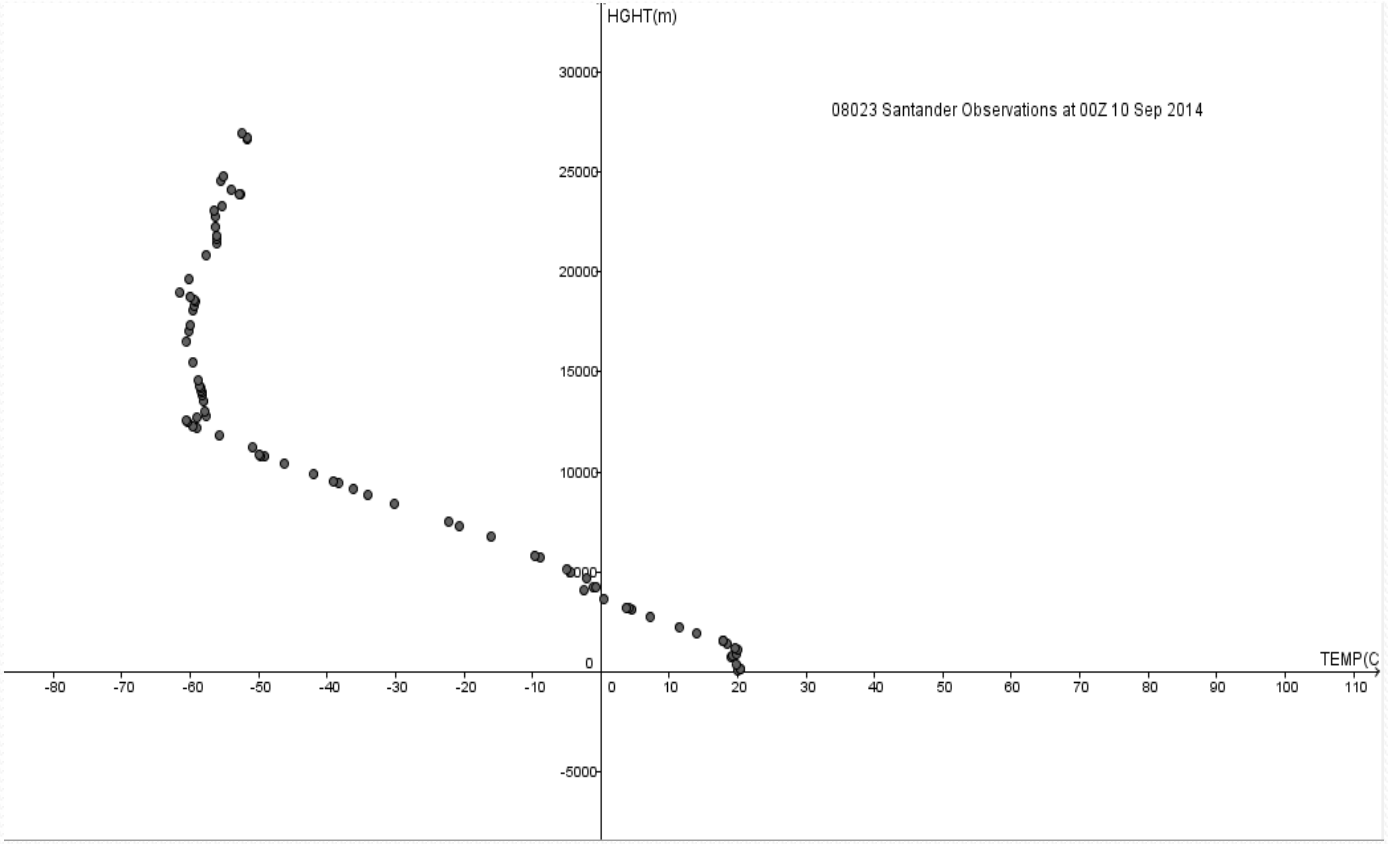
Temperature-Height

In the temperature graph we can locate the tropopause, shown by the phenomena of the termal inversion, happening around 14-16 km high.



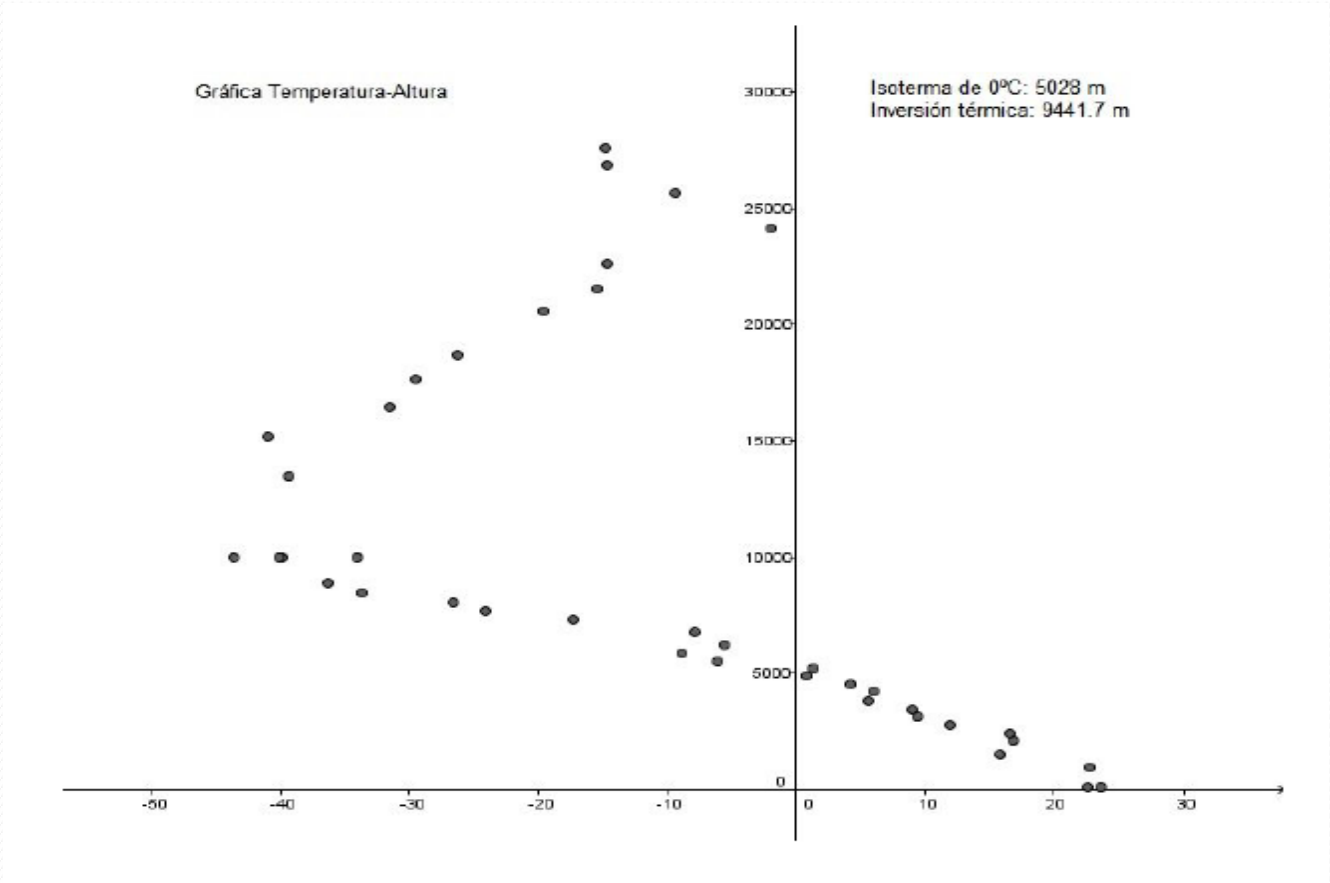
Temperature-Height

Another example of the termal inversion.



Graphics obtained from our balloon

Temperature-Height

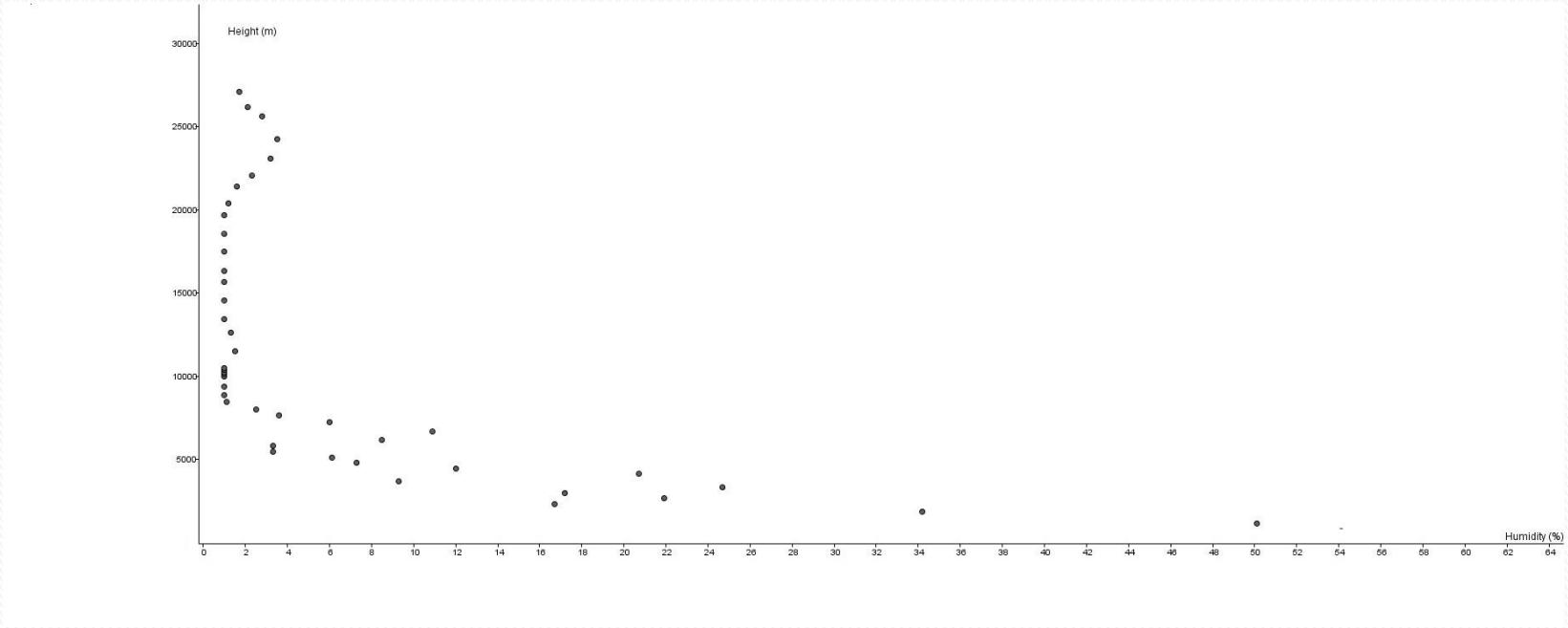


The temperature decreases as we go higher, reaching a temperature of around -50ºC.

Graphics obtained from our balloon

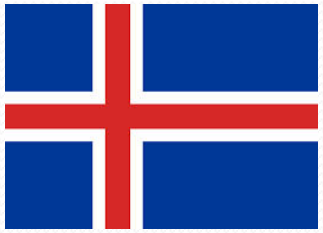
Relative humidity-Height

The weather events take place in this 20 first km due to the weight of the water and the pressure, since water is too heavy for the pressure at that height.



The graphics from our balloon match with the theoretical models as well as the ones obtained from the Wyoming wheather webpage.

The graphics obtained help us to understand better the data and to obtain general conclusions.



CONCLUSIONS

- Pressure decreases with height. The air particles are concentrated in the lower layer of the atmosphere, due to the gravity force → lower atmosphere layers have a higher density than higher ones.

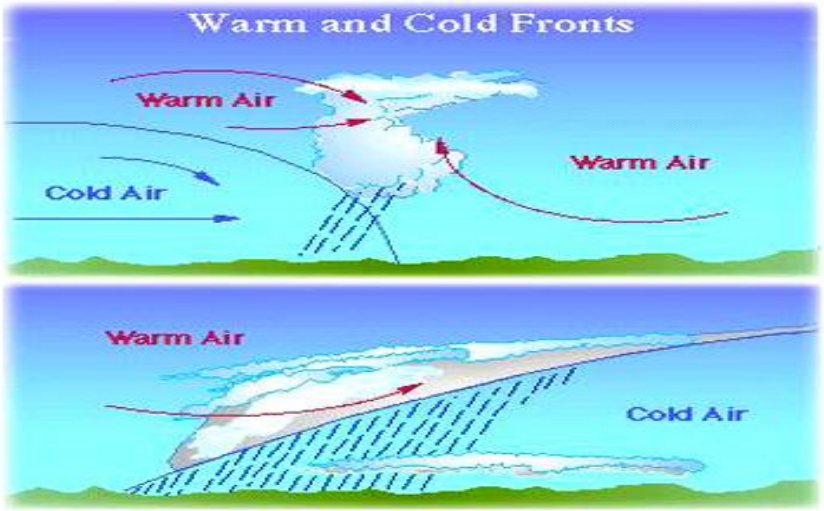
- Temperature starts to decrease with height, when the balloon reached 9441.7 m (-49°C), thermal inversion occurs. This marks the border between troposphere and stratosphere (Tropopause).

- Relative humidity tends to decrease with height. Water is really heavy, that's why it stays on the lower layers of the atmosphere.

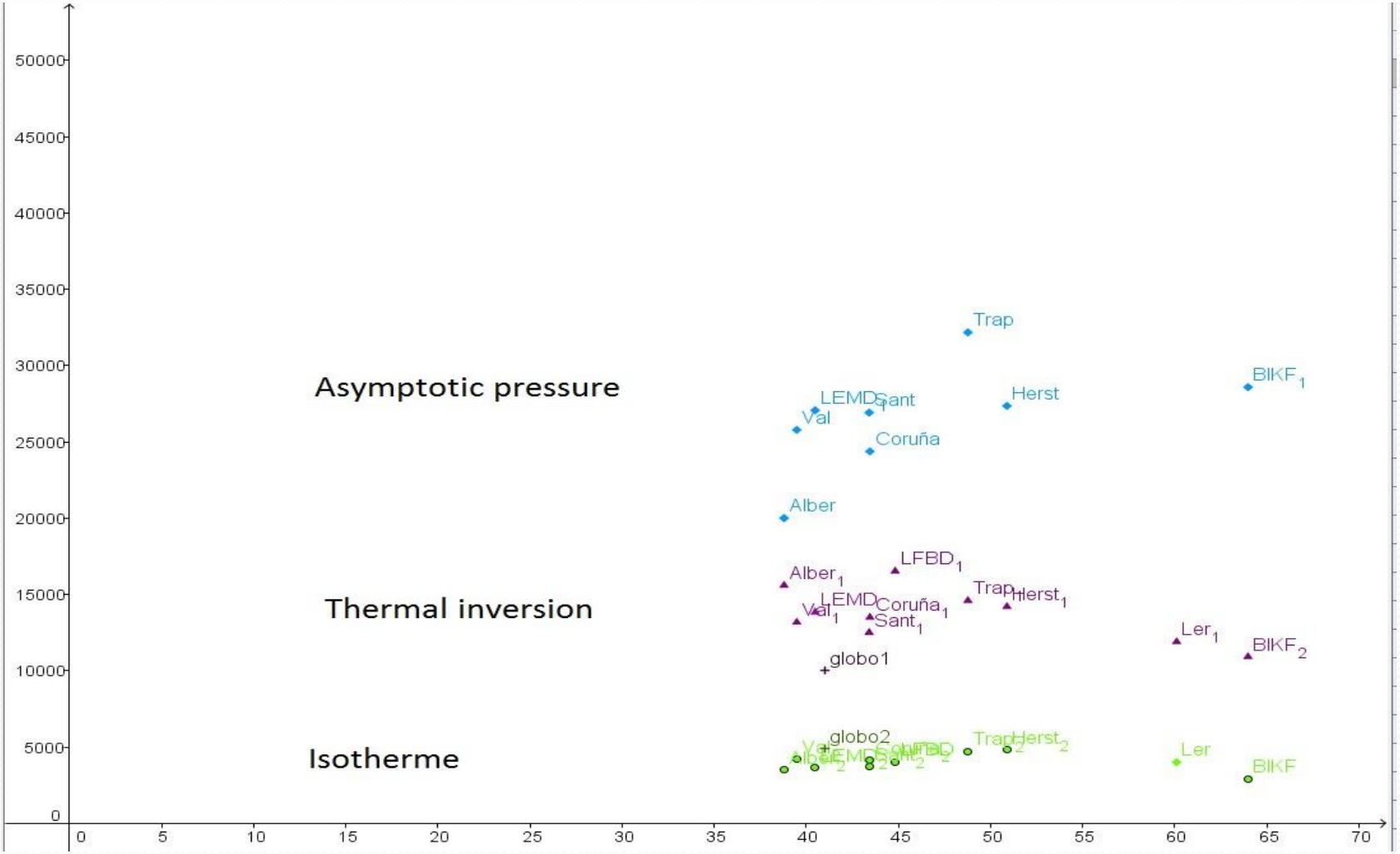
CONCLUSIONS

- Relative humidity tends to decrease with height. Water is really heavy, that's why it stays on the lower layers of the atmosphere.

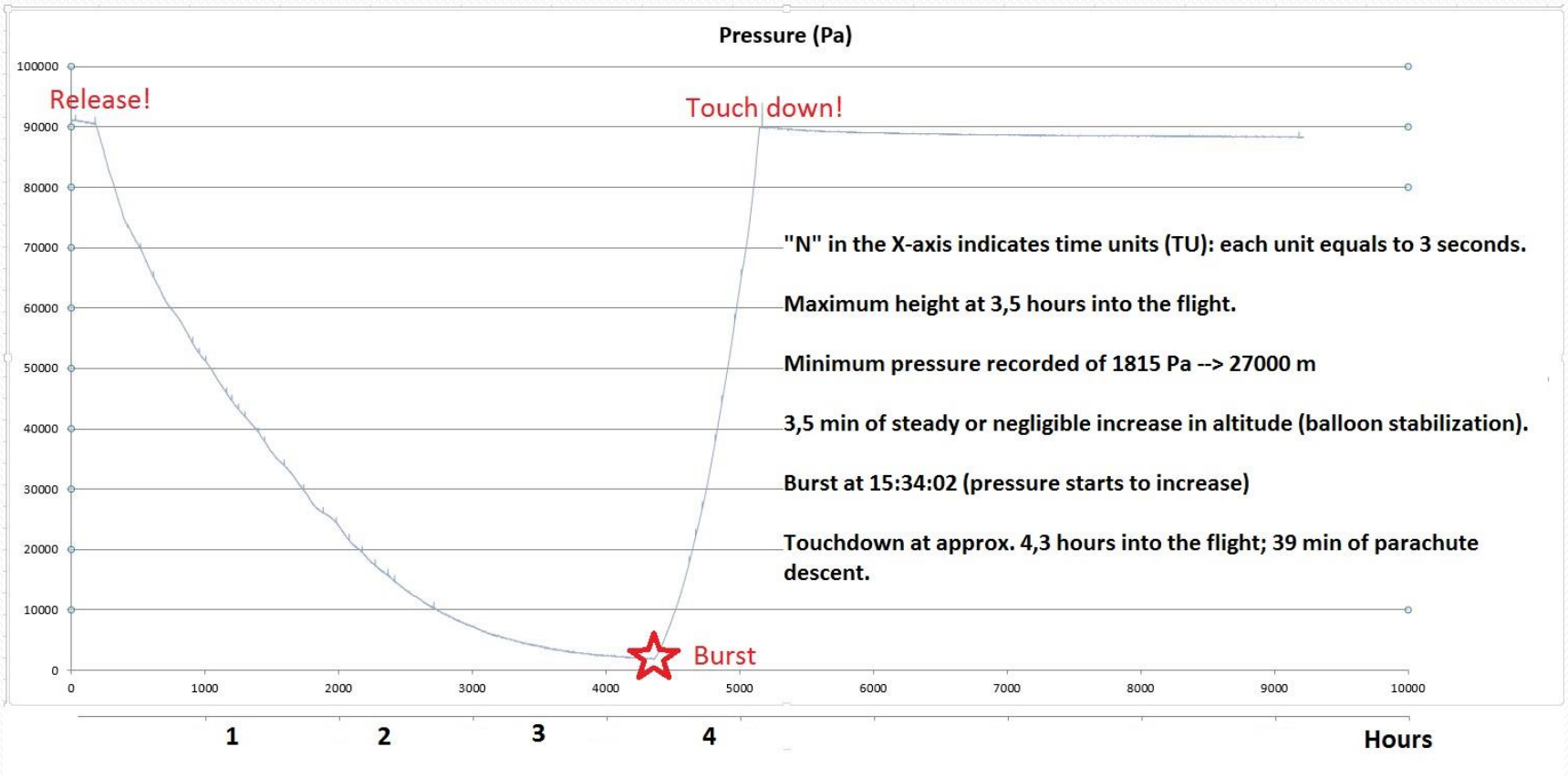
- Although we may find clouds in upper layers due to warm fronts.



Latitude variations



CONCLUSIONS



"N" in the X-axis indicates time units (TU): each unit equals to 3 seconds.

Maximum height at 3,5 hours into the flight.

Minimum pressure recorded of 1815 Pa --> 27000 m

3,5 min of steady or negligible increase in altitude (balloon stabilization).

Burst at 15:34:02 (pressure starts to increase)

Touchdown at approx. 4,3 hours into the flight; 39 min of parachute descent.