

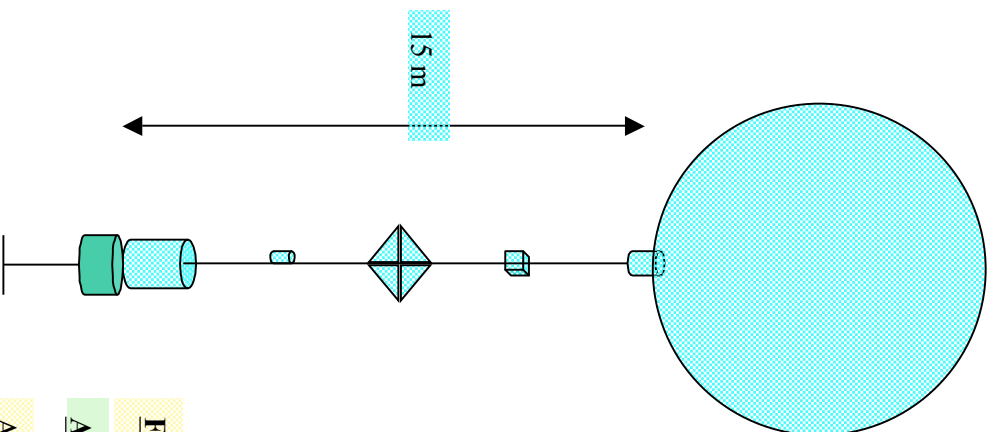
VORCORE / STRATEOLE Workshop

September 16-17 , 2002

Paris

- ◆ **VORCORE SYSTEM DESCRIPTION**
- ◆ **QUALIFICATION RESULTS**
- ◆ **VORCORE IMPLEMENTATION**

Flight configuration, Antarctica



Balloon :

D=10m, 25Kg

or D=8.5m, 18.5 Kg

✓ Balloon envelope :

- polymer film 50 microns thickness
- Metallic end fittings

✓ Flight train :

- Balloon sensors and housing
- Cut off device
- Back-up cut off command
- Radar Reflector
- Flash-light
- Lines and cables
- Automatic ballast release system

✓ F. C./Sc. Gondola "Rumba" :

- GPS and Atmospheric sensors
- Flight Management unit
- Back up flight termination system
- Argos Transmitter/Beacon

✓ Additional payload (optional)

- Instrument
- Power
- Thermal control

Flight Control/Science gondola : 9 Kg

Additional payload : up to 8 Kg

Air temperature sensors

Data acquisition, Flight monitoring

◆ Telemetry by Argos transmitter

- After collection by Argos receivers (on board various polar orbiting Satellites) data are transmitted to Toulouse acquisition center and then automatically dispatched on two web sites

- Science : LMD web site

- Flight monitoring : CNES web site

- ✓ Trajectory

- ✓ Flight system condition for predicting remaining life time

➤ Additional payload

- Telemetry through Rumba gondola

Main performances :

➤ Measurements by Rumba :

Recurrence	Accuracy	Air pressure	15 min +/-	- 20pa	Air Pressure	variati

➤ Additional payload telemetry rate :

- 3072 bytes/day

➤ Flight duration :

- Specified lifetime : 3 weeks
- Design lifetime : 2 months

➤ Flight levels (without additional payload) :

- 10 m balloons : 92.5 +/- 2.5 g/m³
- 8.5 m balloons : 127.5 +/- 2.5 g/m³

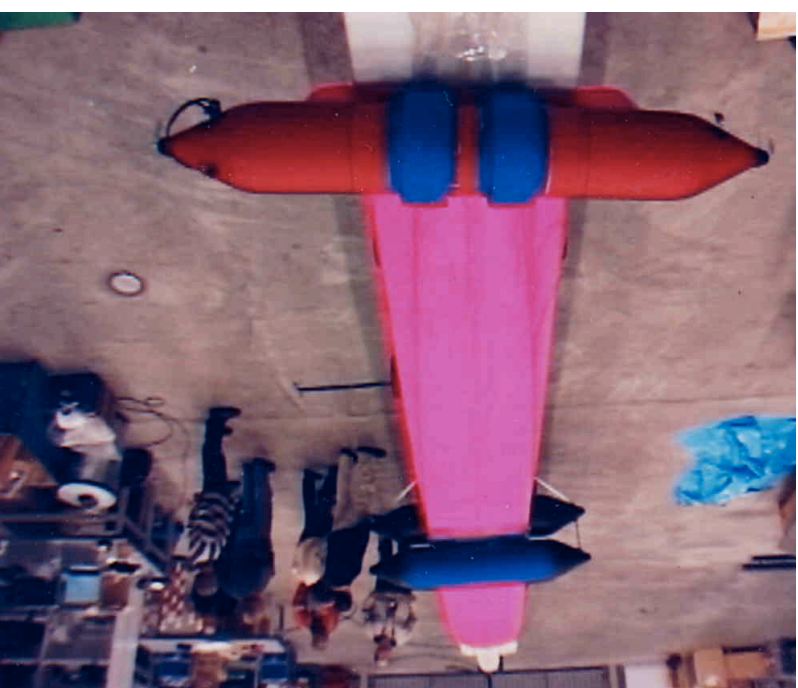
Operations

- ◆ Launch windows are defined on science criteria (adequate distribution of the balloons)
- ◆ Launch opportunity is then confirmed based on local meteorology (ground wind, icing conditions...)
- ◆ Launch operations are ~ 2.5 hours long
 - Payload final check out
 - Balloon control and layout on the inflation/launch table
 - Balloon inflation at a first dedicated location under ground wind speed up to 3/4 m/s
 - Balloon move to the launch pad
 - Balloon release under ground wind up to 4/6 m/s
- No need for large ground infrastructure

Inflation



Balloon stretched on launch table





Release



Moving to the launch pad



Nighttime launch

Development overview

1996/1999 :

- **Balloon system designed by extrapolation of earlier programs**
- **Rumba gondola design, driven by low weight requirement**
 - mitigated success of long duration flight at low latitude (Equator 98)
 - failure of the three long duration flights in Arctic during winter 99

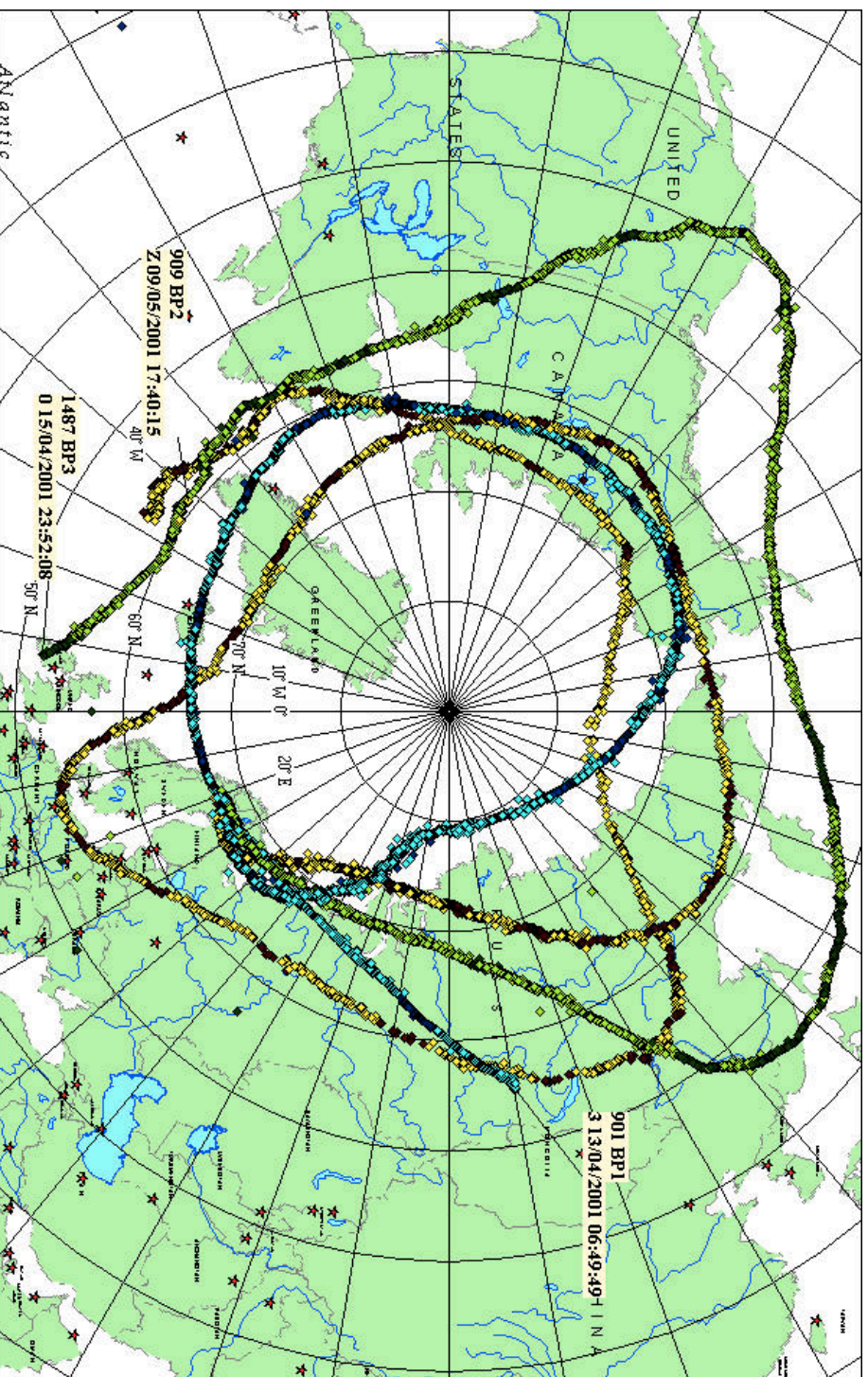
1999/2002 :

- **Balloon Redesign based on innovative solutions :**
 - Balloon architecture
 - Envelope film
 - Launch means and procedures
 - Extensive qualification program
- **Rumba Gondola redesign :**
 - Simplification
 - Correction of several design flaws
 - Flight validation program

Balloon verification program :

- ◆ **Ground tests**
- ◆ **Extensive Flight tests :**
 - **20 flights, Spring/Winter Arctic (Kiruna, Sweden, 68°N) :**
 - ✓ Spring 2000 : 4 short duration flights
 - ✓ Winter 2000/2001 : 11 short duration flights
 - ✓ Spring 2001 : 3 long duration flights
 - ✓ Winter 2001/2002 : 2 medium duration flights
 - **Balloon ready for system qualification by late January 2002**

◆ **Spring 2001 : 3 long duration flights**



Rumba gondola verification program :

◆ Flight tests : 6 flights

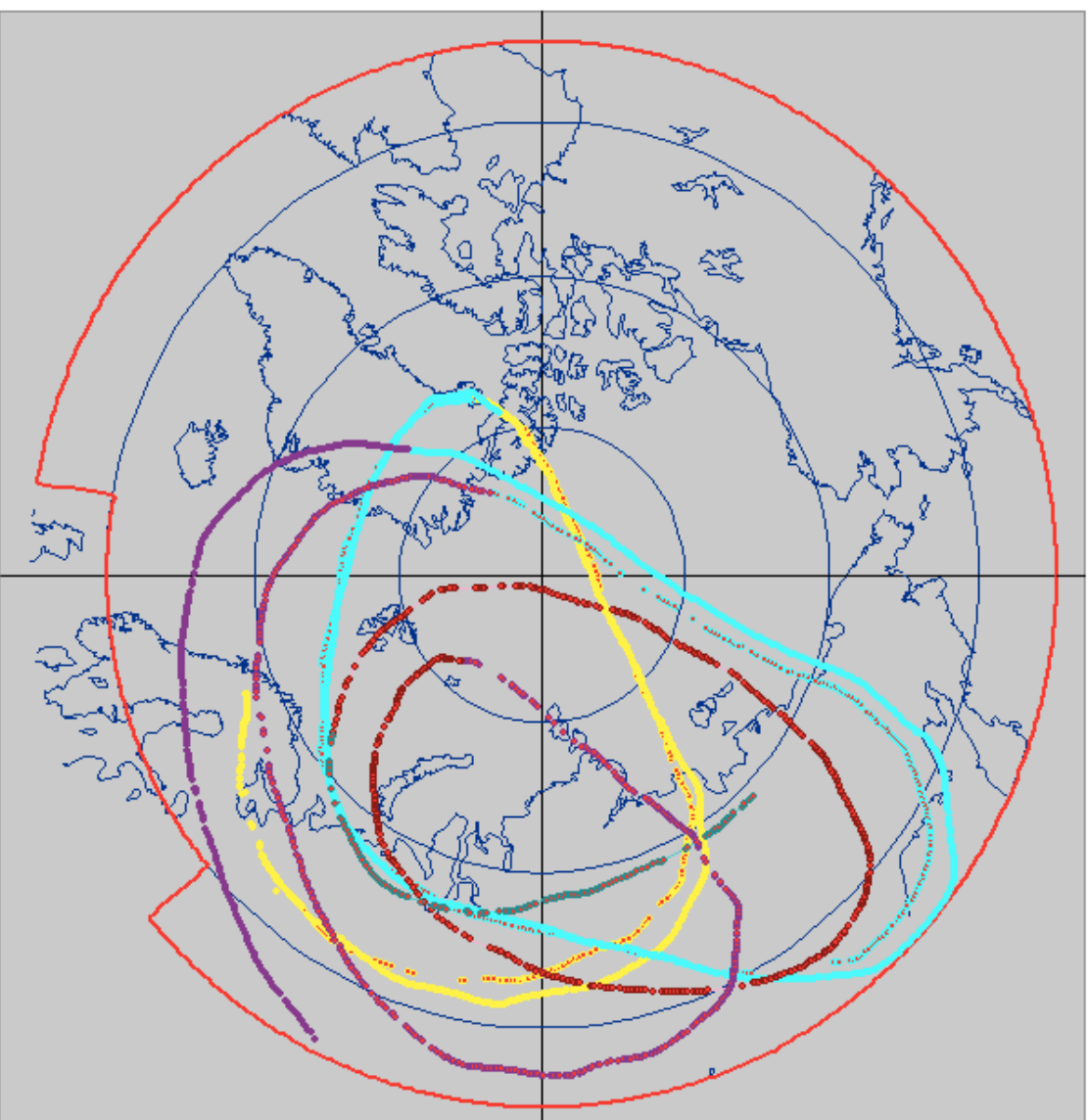
- From Kiruna :
 - ✓ Winter 1999/2000 : 2 flights under “Infra Red Montgolfières”
- From Bauru (Brazil) :
 - ✓ Winter 2000/20001 : 3 flights under “Infra Red Montgolfières”
- From Kiruna :
 - ✓ Spring 2001 : 1 flight under super-pressure balloon
- Rumba Gondola ready for system qualification by mid 2001

Vorcore system qualification :

- ◆ **Pre-Vorcore campaign, Kiruna January/March 2002**
 - **Each one of the three Vorcore flight configurations validated through two long duration flights :**
 - For flight level 92.5 g/m³ : flights **PV-1** and **PV-2**
 - For flight level 127.5 g/m³ : flights **PV-4** and **PV-5**
 - For intermediate flight level (additional payload) : flights **PV-6** and **PV-7**

Note :

- ✓ Flight trains included a radar transponder (3.4Kg), which is not requested for Vorcore. As a consequence, actual flight levels are lower than for Vorcore : resp. 99, 135, and 108 g/m³
- ✓ **PV-3** balloon did burst



Flight Level :

99+-2g/m³
(18000/19000m)

Balloon Diam. **10m**
Suspended Weight: **18kg**

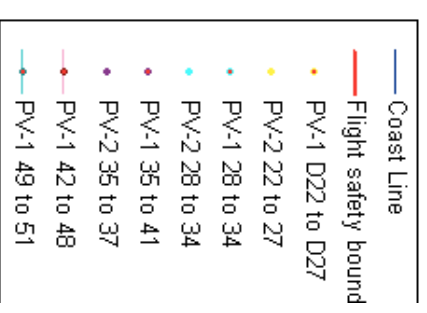
PV-1 : 29 days

Jan. 22nd(11H) to Feb. 20I

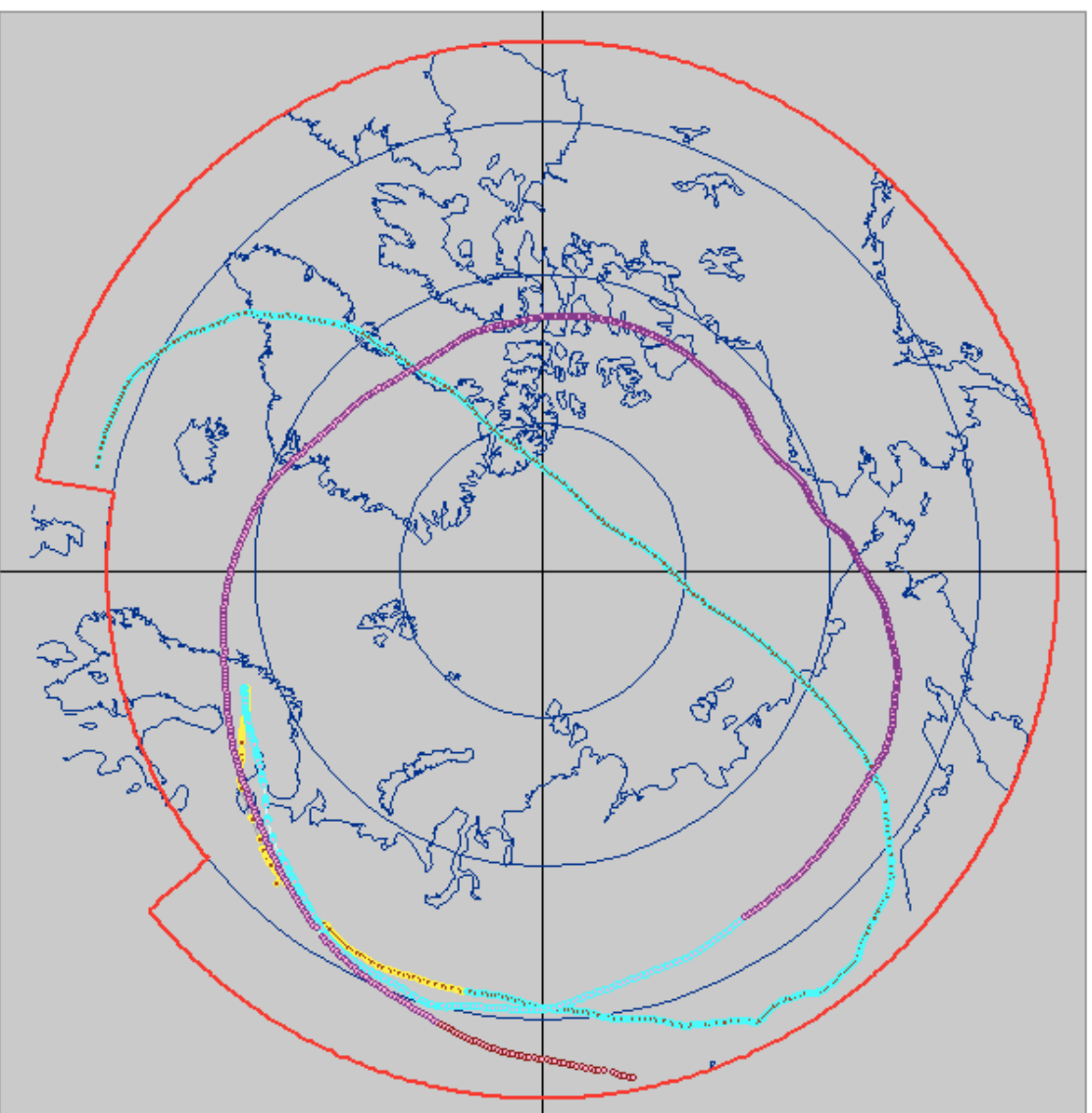
PV-2 : 14 days

Jan. 22nd(16H) to Feb. 6I

Flight termination caused by
PV-1 : Low Energy (excess
GPS convergence time)
PV-2 : Balloon reaching Fli
safety boundary



QUALIFICATION RESULTS



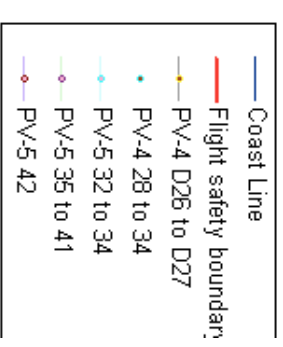
Flight Level :
135.5+/-2.5g/m³
(16000/17000m)

Balloon Diam: **8.5m**
Suspended Weight: **18kg**

PV-4 : 8 days
Jan. 26th to Feb. 3th

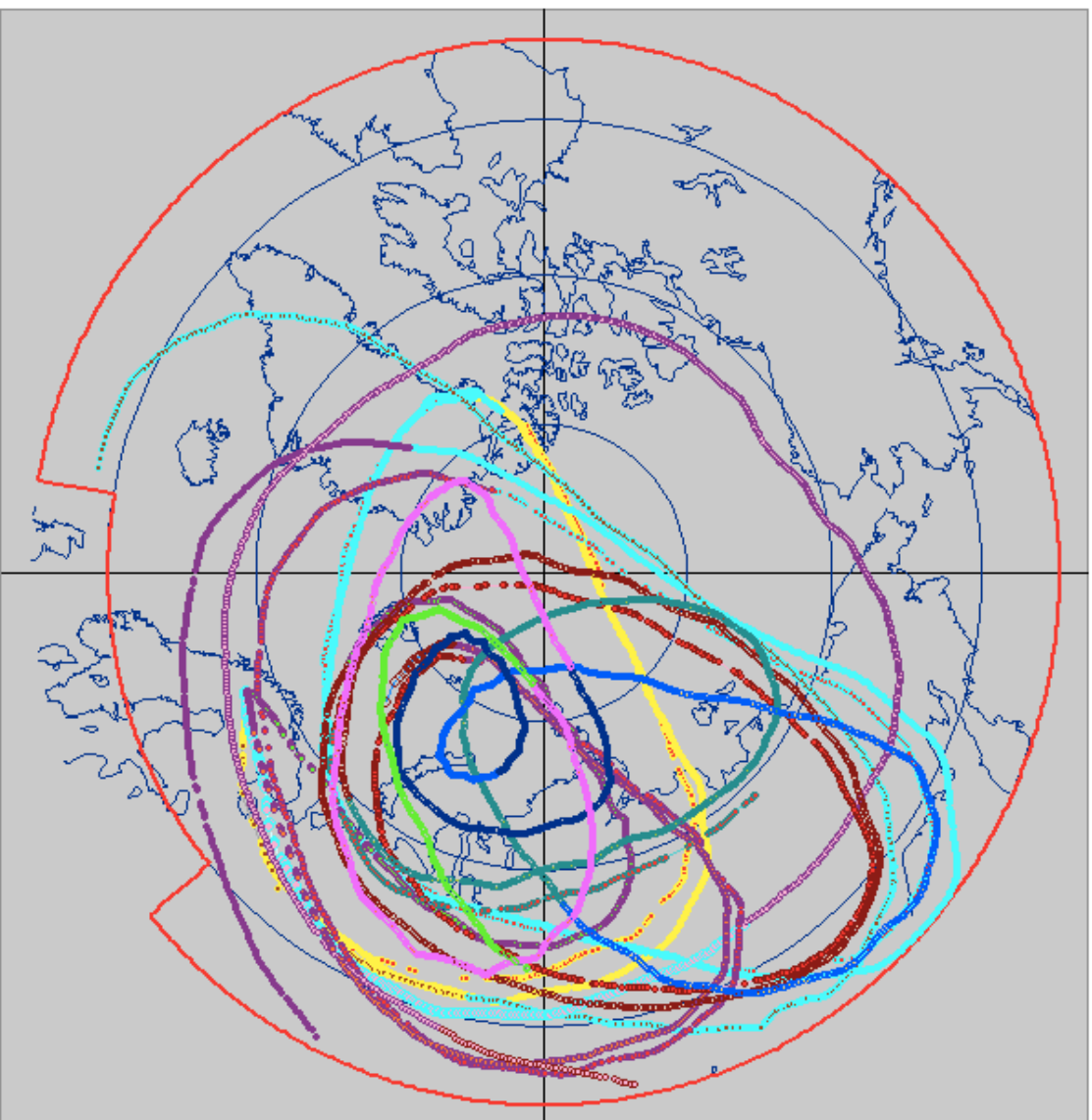
PV-5 : 10 days
Feb. 1st to 11th

Flight termination caused by :
PV-4 and **PV-5** : Balloon
reaching Flight safety boundary;



QUALIFICATION RESULTS

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Pré-VORCORI 6 flights

—	Coast Line
—	Flight safety bound
•	PV-1 D22 to D27
•	PV-2 J22to J27
—	PV-4 26 to27
•	PV-1 J28 to J34
•	PV-2 28 to 34
•	PV-4 28 to 34
•	PV-5 32 to 34
•	PV-1 35 to 41
•	PV-2 35 to 37
•	PV-5 35 to 41
•	PV-6 35 to 41
•	PV-7 36 to 41
•	PV-1 42 to 48
•	PV-5 42
•	PV-6 42 to 48
•	PV-7 42
•	PV-1 49 to 51
•	PV-6 49 to 55
•	PV-6 56 to 62
•	PV-6 63 to 69
•	PV-6 70 to 76
•	PV-6 77 to 80



Main conclusions after Pre-Vorcore flights :

➤ Balloon :

- ✓ One of the balloon did burst when reaching float altitude
- ✓ Based on leakage rate derived from flight parameters measurements :
 - All other balloons were compliant with the required gas tightness for the specified 3 weeks duration
 - Most of the balloons were compliant with the 2 months design lifetime
- ✓ Based on 10 long duration flights, a reliability level higher than 90% has been demonstrated

➤ Launch means and procedures :

- ✓ 7 launches in 15 days, launch rate could have been higher if requested, it was actually driven by Vortex situation and gondola preparation .
- ✓ Several launches were performed under very cold ground conditions (-30°C)

➤ **Gondola :**

- ✓ One gondola failed after less than the 3 weeks specified lifetime
 - the failure has been well understood : spurious low altitude alarm caused by extremely low temperature inside the gondola caused by long night time period (50H, see comment p 13)
 - Although such conditions will not be met during Vorcore-Voredge, the gondola will be modified in order to to avoid such a spurious alarm.
- ✓ Two gondolas failed after less than the 2 months design lifetime
 - Caused by a slow convergence to 3D mode on some of the GPS receivers
 - For Vorcore, the management strategy of the GPS receiver will be modified to avoid unnecessary power consumption
- ✓ Based on the 9 long duration flights a reliability level higher than 88% has been demonstrated

Development is now completed :

- ◆ **System qualification has been achieved**
 - Up to now system reliability is 80%
 - Minor improvements of the gondola will increase this level
- ◆ **For Vorcore most of the balloons (70%) should meet the two months design lifetime**

- ◆ **McMurdo: cooperation with NSF**
 - **Well inside the Vortex (78°S)**
 - **Unique logistic support for early Spring campaign**



- ◆ **Site adequacy for balloon launches :**
 - **Checked with NSF**
 - **Included a visit Oct. 2001**



- ◆ **Launch strategy :**
 - **Nominally 20 launches :**
 - 10 balloons D10m
 - 4 balloons D10m with additional payload
 - Turbulence
 - 6 balloons D8.5m
 - **Launch window :**
 - 10/09/04 - 15/11/04
 - Tentatively all launches before end of October



◆ Schedule

- **Logistics constraint for Antarctica will require :**
 - Hardware shipment by boat during the Austral Summer 2003/2004
 - ✓ Must be ready for shipment from Europe in October 2003
 - Team transfer to McMurdo late August 2004, on “Winfly”
 - ✓ Only very limited hardware shipment at that time