





## COUNCIL DIRECTIVE 96/29 EURATOM

13 May 1996 applicable May 2000

The undertakings shall take appropriate measure in particular

- ◆ To assess the exposure of crew concerned
- ◆ To take into account the assessed exposure when organizing working schedules with a view to reducing the doses of highly exposed aircrews.
- ◆ To apply article 10 to female aircrew  
< 1 mSv during pregnancy

# SIEVERT PROJECT

Système d'Information et d'Evaluation par Vol de l'Exposition au Rayonnement cosmique dans les Transports aériens

Computerized System for Flight Assessment of Exposure to Cosmic Radiation in Air Transport



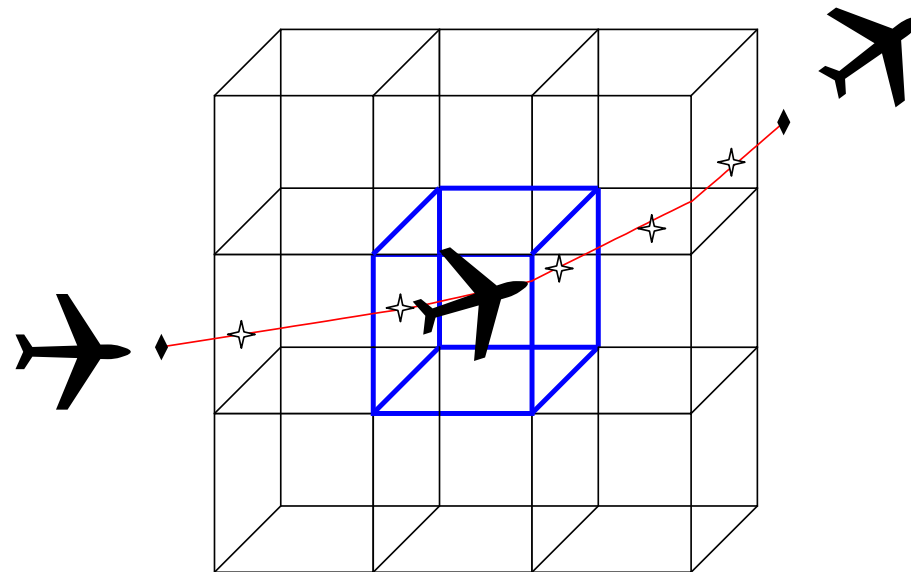
- DGAC French General Directorate of Civil Aviation
- IRSN French Institute for Research and Nuclear Safety
- PARIS – MEUDON Observatory
- IFRTP French Institute for Research and Polar Technology
- Air France

**3D + TIME Route with corresponding date**

map of dose rate values

2000-2003 CARI 6

2004----- EPCARD 3 validated by IRSN

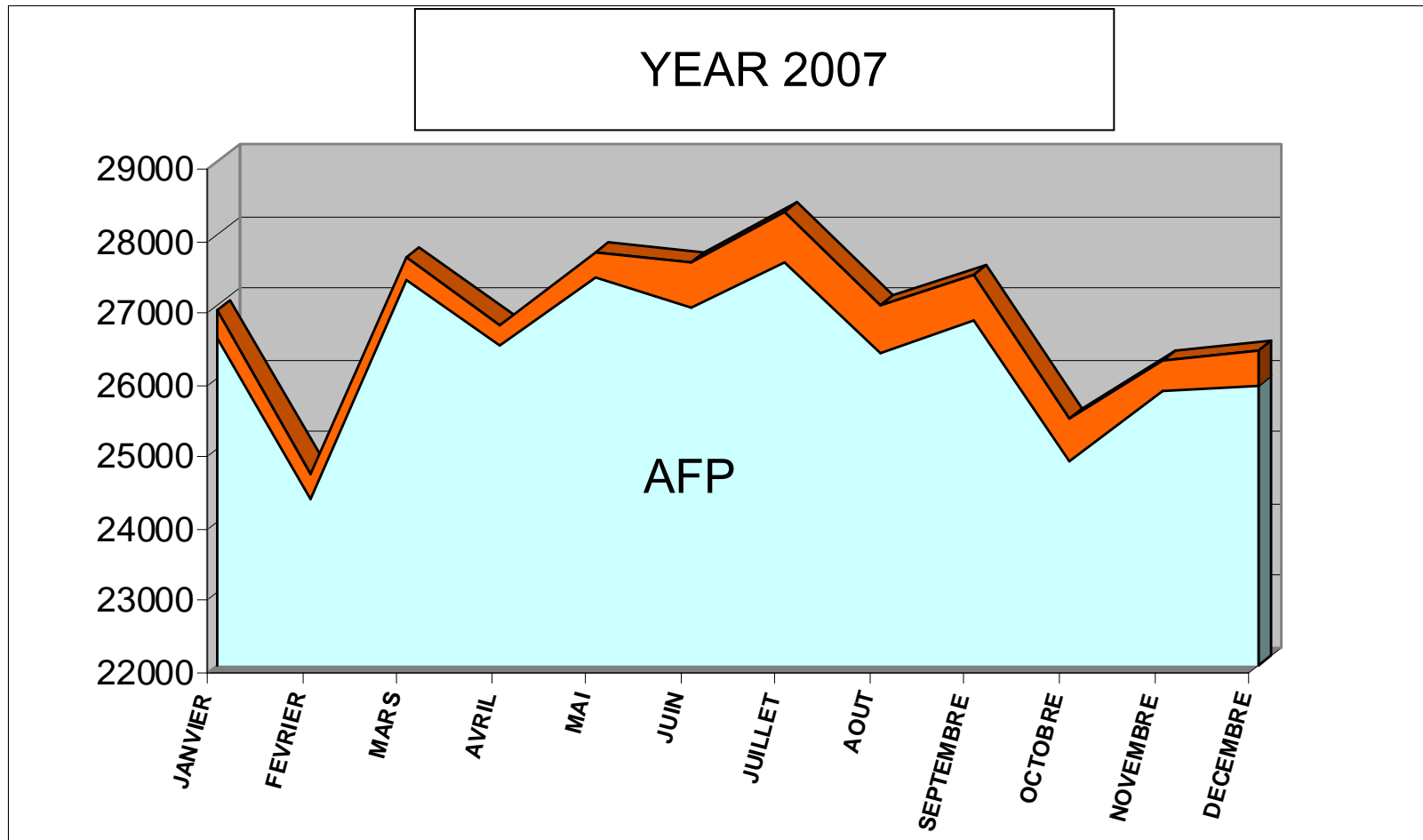


✦ Pass through points

◆ Way points

Cells     Altitude 1000 feet from ground to 80 000 feet  
           Latitude 2°  
           Longitude 10°

# ACCURATE FLIGHT PROFILES / STANDARD PROFILES



# SCREEN INDIVIDUAL DOSE VALUES

FRSD CONSULTATION PN/DOSE 05/09/05 08:42:48

1 F

MATRICULE : 33718513

NOM : SC [REDACTED]

PRENOM : CE [REDACTED]

FONCTION : STEWARD/HOTESSE

DOSES ANNUELLES (MILLI SVT) :

2001 : 00,7166      2002 : 01,1512      2003 : 02,4880      2004 : 03,5711

ANNEE EN COURS : 01,3027 + ERUPTION SOLAIRE

24 DERNIERES DOSES MENSUELLES

01 / 2004 : 00,3052	01 / 2005 : 00,3600	ERUPTION
02 / 2004 : 00,3127	02 / 2005 : 00,1858	
03 / 2004 : 00,3634	03 / 2005 : 00,2880	
04 / 2004 : 00,2545	04 / 2005 : 00,2927	
05 / 2004 : 00,1751	05 / 2005 : 00,1762	
06 / 2004 : 00,3323	06 / 2005 : 00,0000	
07 / 2004 : 00,4411	07 / 2005 : 00,0000	
08 / 2004 : 00,1680	08 / 2005 : 00,0000	
09 / 2004 : 00,3096	09 / 2005 : 00,0000	
10 / 2004 : 00,4036	10 / 2005 : 00,0000	
11 / 2004 : 00,2756	11 / 2005 : 00,0000	
12 / 2004 : 00,2300	12 / 2005 : 00,0000	

# 50 HIGHER EXPOSED AICREW IN 8 ROLLING MONTHS

FRSG LISTE DES PN LES PLUS EXPOSES SUR 8 MOIS GLISSANTS 20/08/08 12:57:49

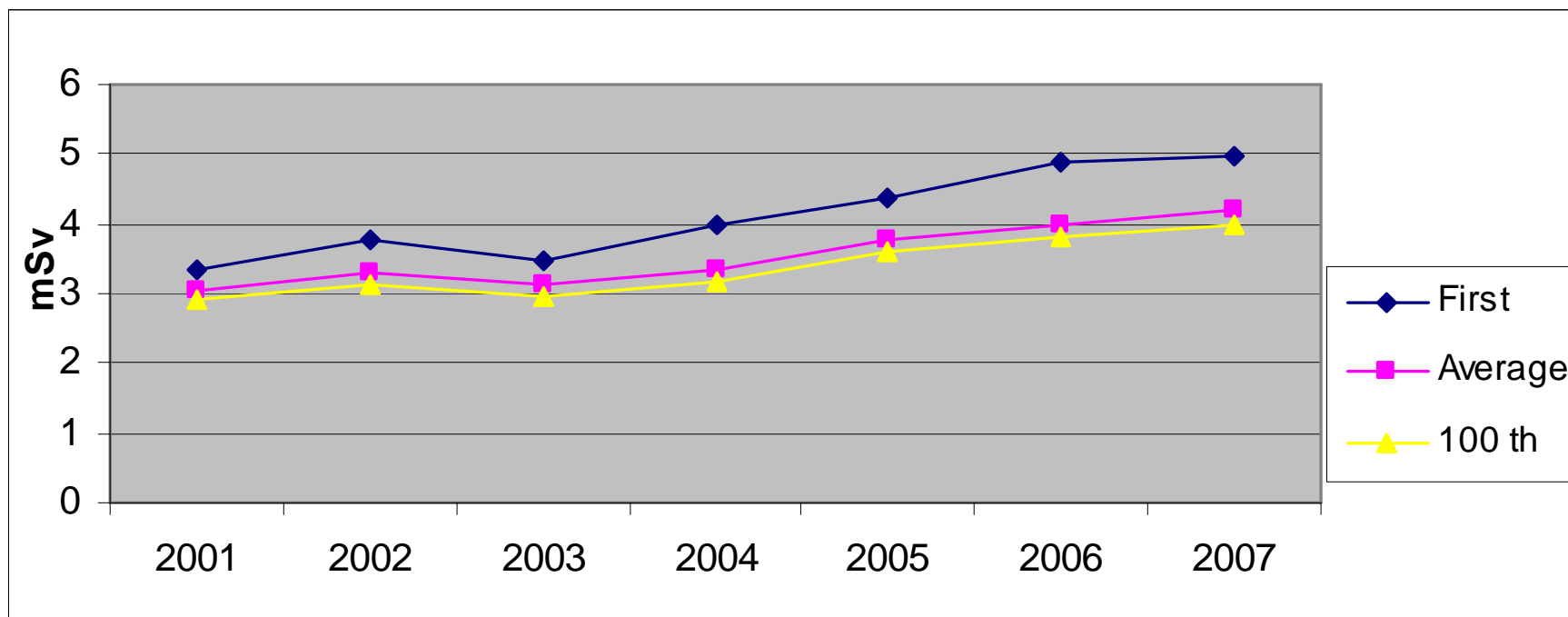
1

MOIS : 06 ANNEE : 2008 IMPRESSION : (O POUR IMPRIMER)

DOSES EN (MILLI SVT) :

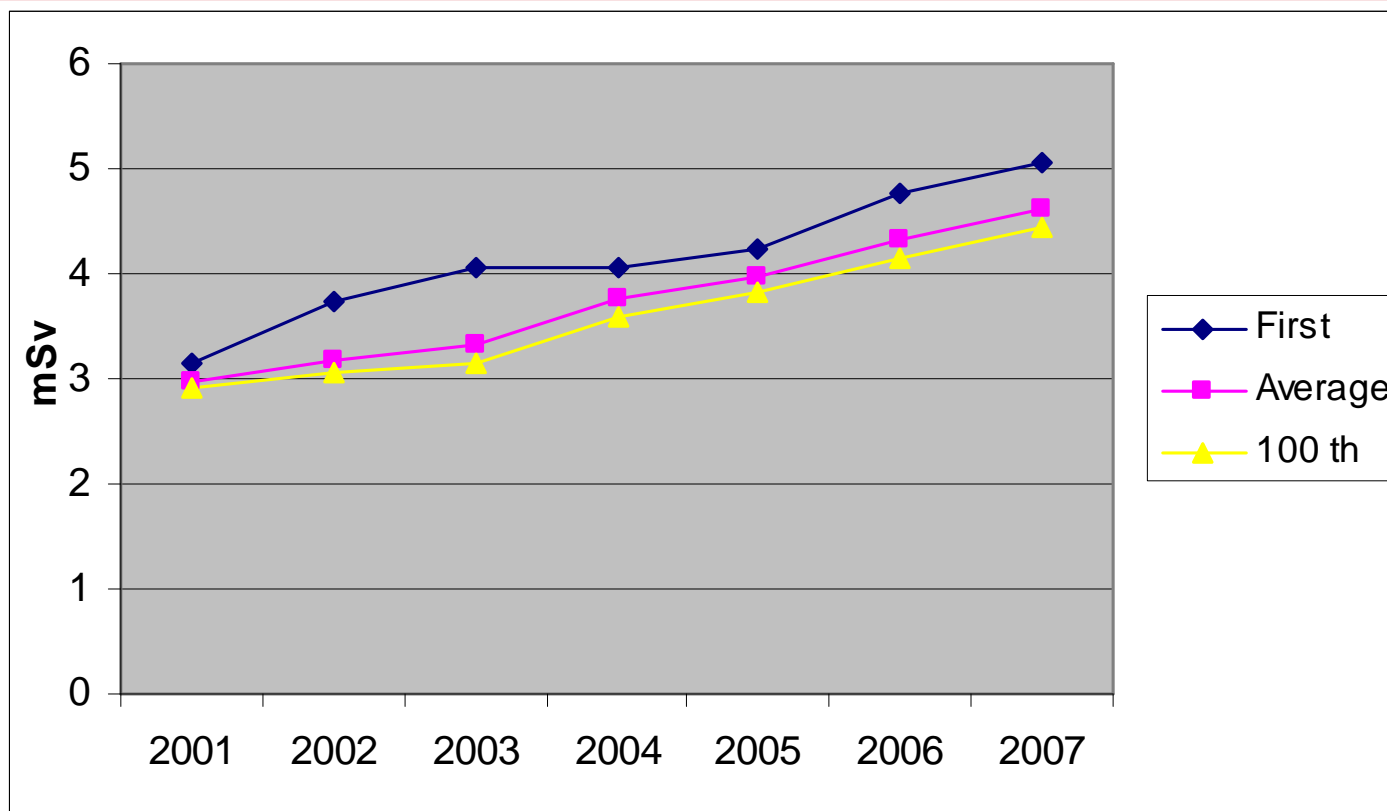
01 - 07715338 PIE	GERARD	OFFICIER PILOTE	04,2579
02 - 34283133 AIT	SAMIA	STEWARD/HOTESSE	04,1308
03 - 34216344 PRA	CYRILLE	OFFICIER PILOTE	04,0265
04 - 33688100 LAI	FRANCOIS	STEWARD/HOTESSE	04,0198
05 - 31215913 DOR	DAVID	OFFICIER PILOTE	03,8921
06 - 09427790 GOR	PASCALE	CHEF DE CABINE	03,8635
07 - 34033155 DEG	SABRINA	STEWARD/HOTESSE	03,8420
08 - 36690450 LHE	JEROME	CHEF DE CABINE	03,8308
09 - 08829424 MIQ	JEAN CHRIS	COMMAND DE BORD	03,8282
10 - 09748294 LAU	FREDERIC	COMMAND DE BORD	03,8017
11 - 15592243 TER	MASAKO	STEWARD/HOTESSE	03,7970
12 - 34493301 COT	YVES	STEWARD/HOTESSE	03,7679

# TOP 100 higher exposed flight deck crew



YEAR	2001	2002	2003	2004	2005	2006	2007
First	3,328	3,776.2	3,483.5	3,985.7	4,386.1	4,890.4	4,962.3
Average	3,047.9	3,280.9	3,109	3,357.3	3,775.1	3,98	4,201.4
100 th	2,915.5	3,109.7	2,957.3	3,189.3	3,609.8	3,800.2	3,973.1

# TOP 100 higher exposed cabin crew

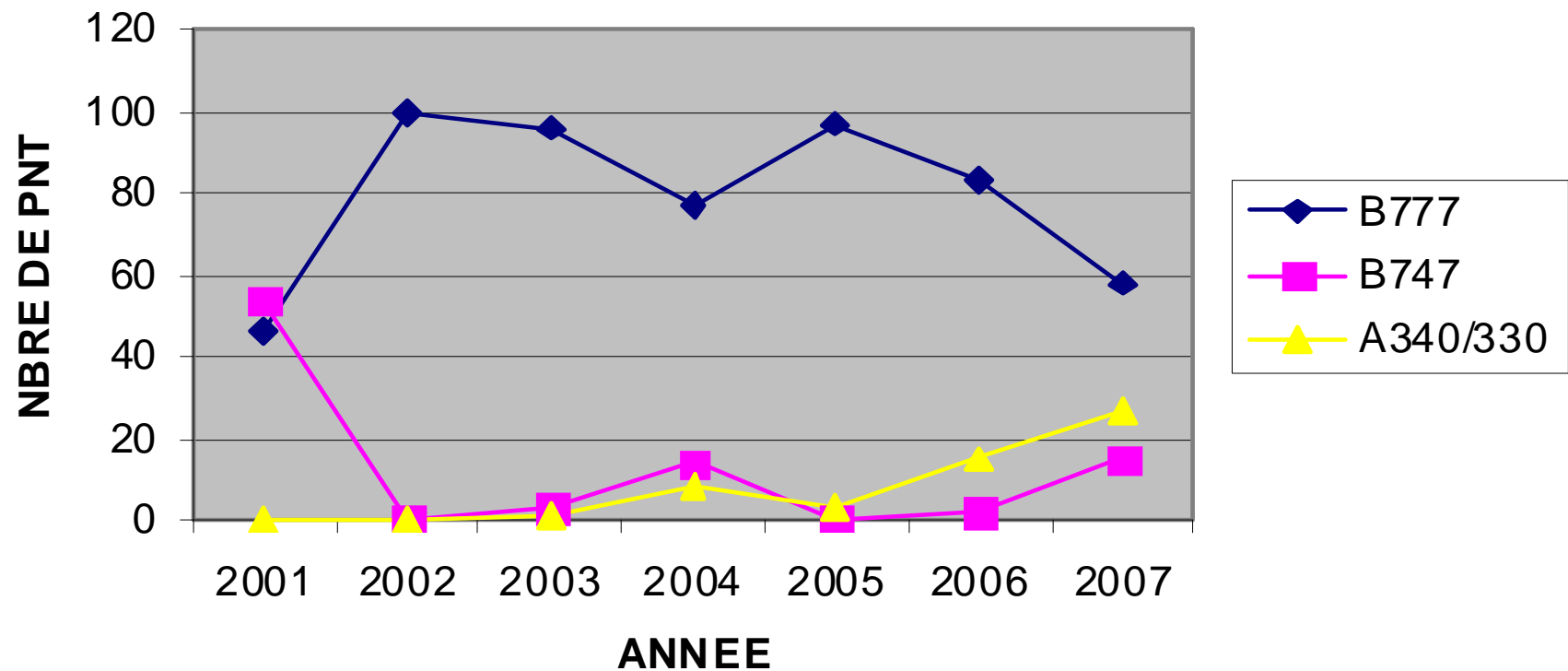


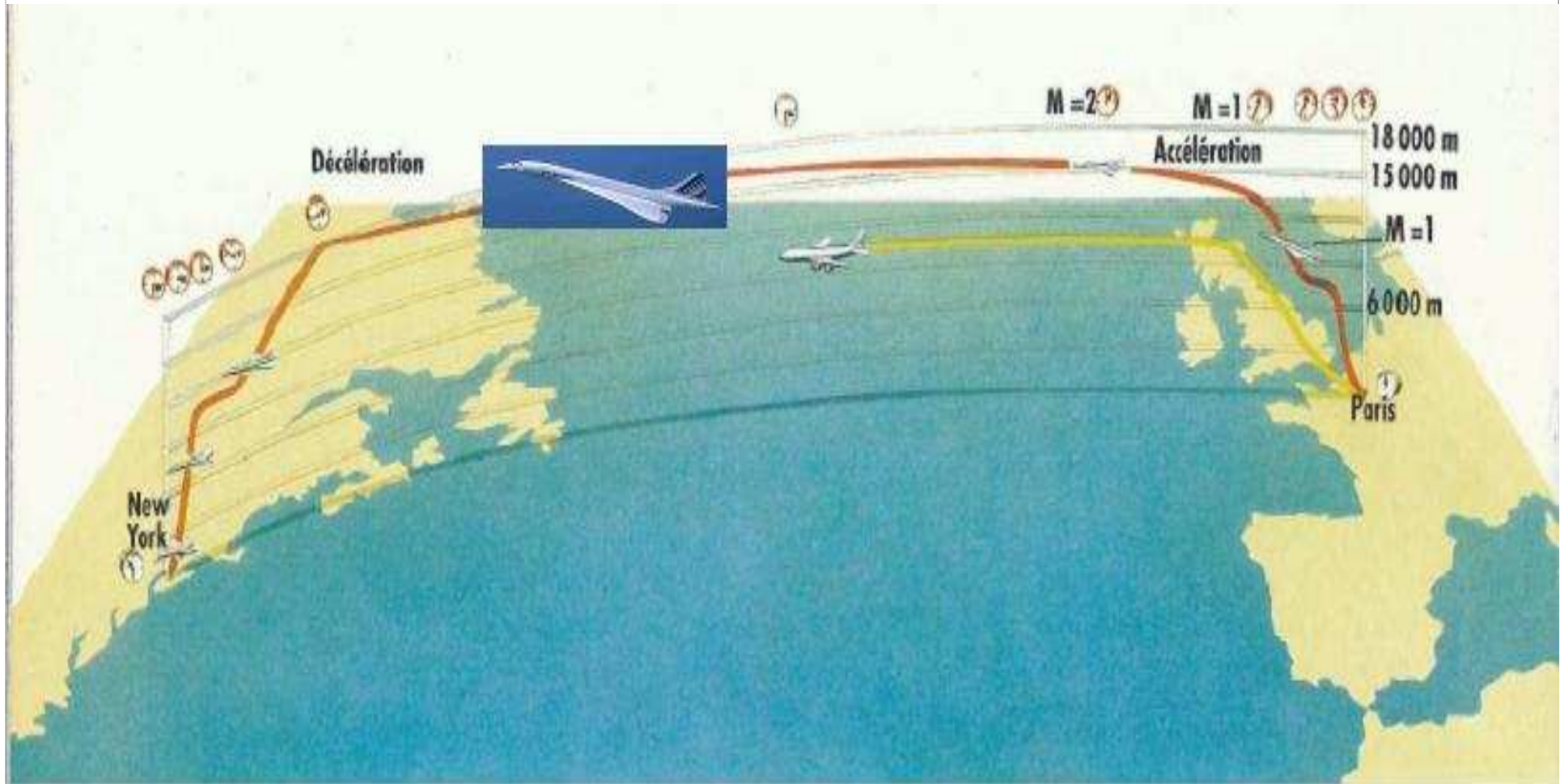
YEAR	2001	2002	2003	2004	2005	2006	2007
First	3,1535	3,7441	4,0629	4,0629	4,2482	4,7684	5,0676
Average	2,9767	3,1621	3,3179	3,7701	3,9815	4,3345	4,6288
100 th	2,9055	3,0621	3,1612	3,5869	3,8256	4,1602	4,4508

## 100 HIGHER EXPOSED CABIN CREW WORKING AREA GROUP

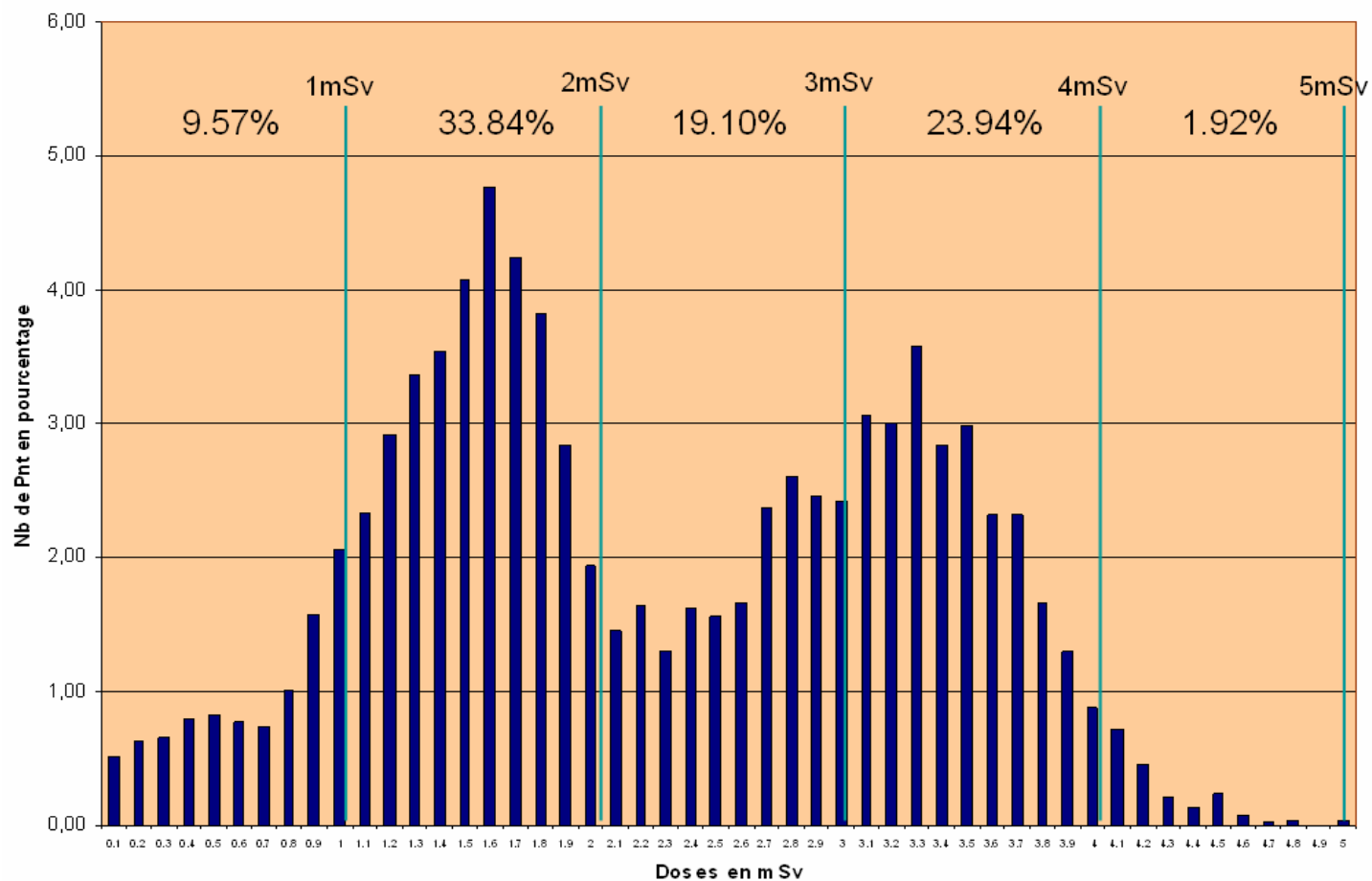


## TOP 100 higher exposed flight deck crew



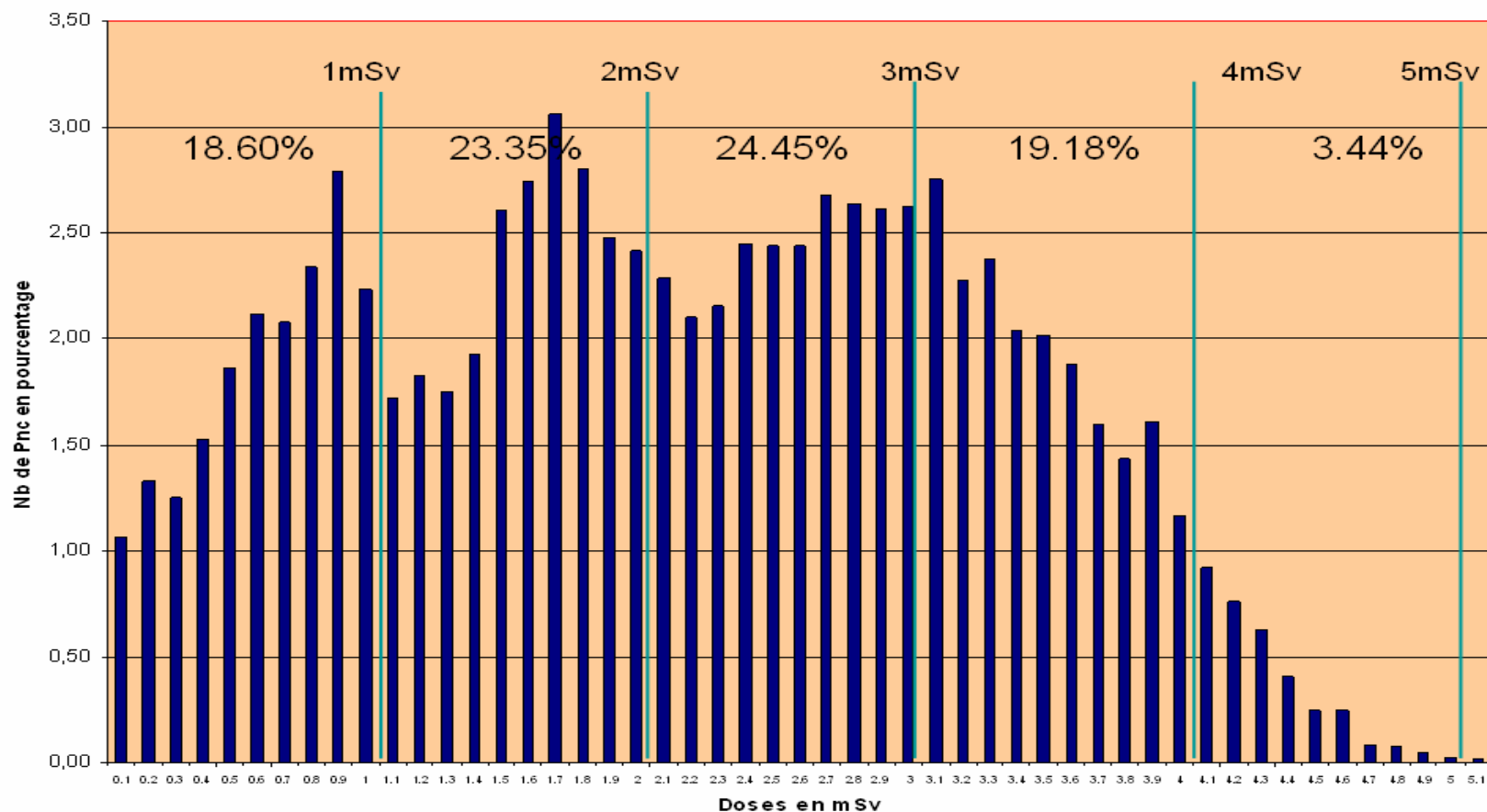


# 4204 FLIGHT DECK CREW EXPOSURES DISTRIBUTION YEAR 2007



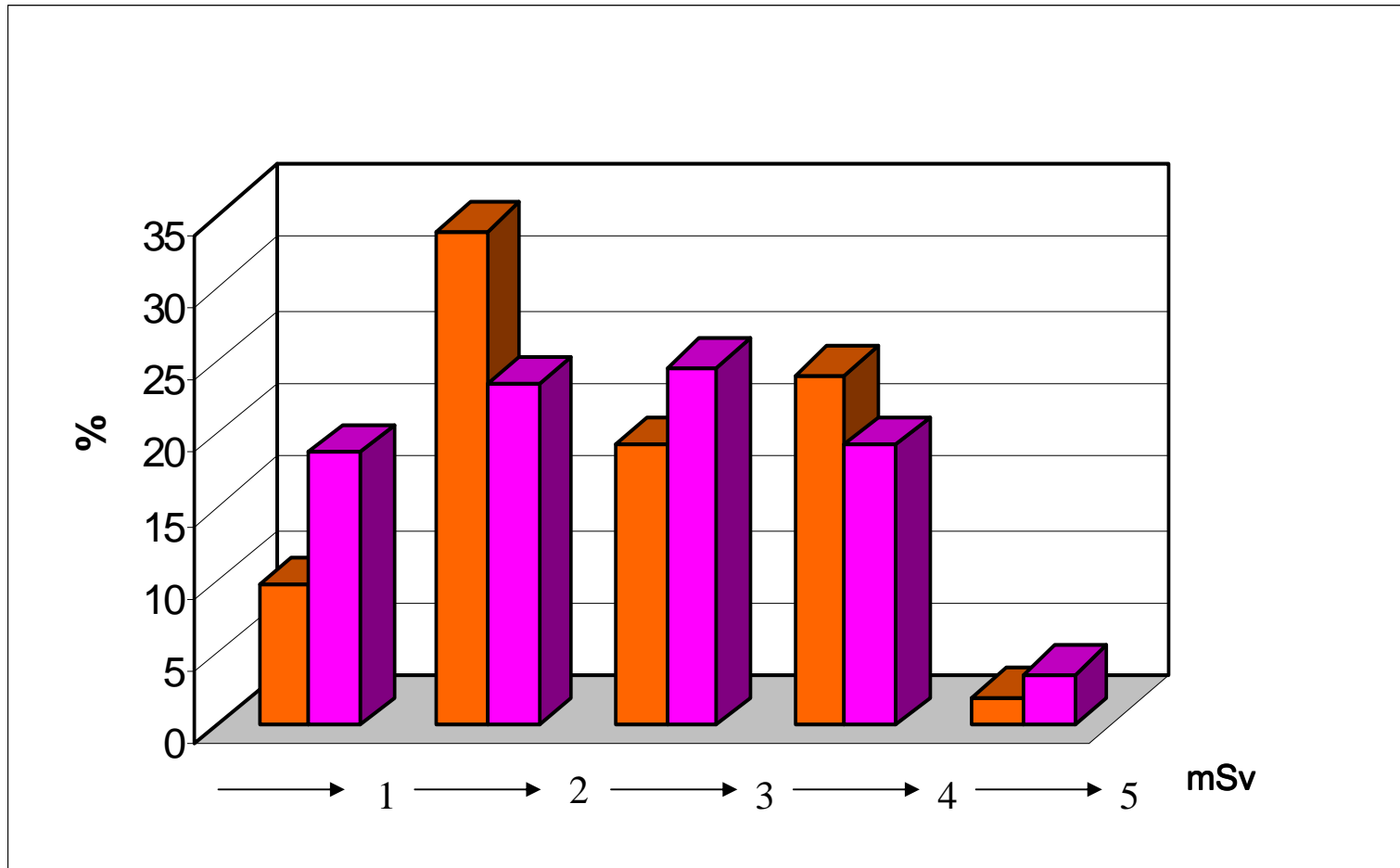
**11.63 % negligible doses**

# 15041 CABIN CREW EXPOSURES DISTRIBUTION YEAR 2007



10.98 % negligible doses

# COMPARISON CABIN / FLIGHT DECK CREW



# TRANSPOSITION INTO FRENCH REGULATION



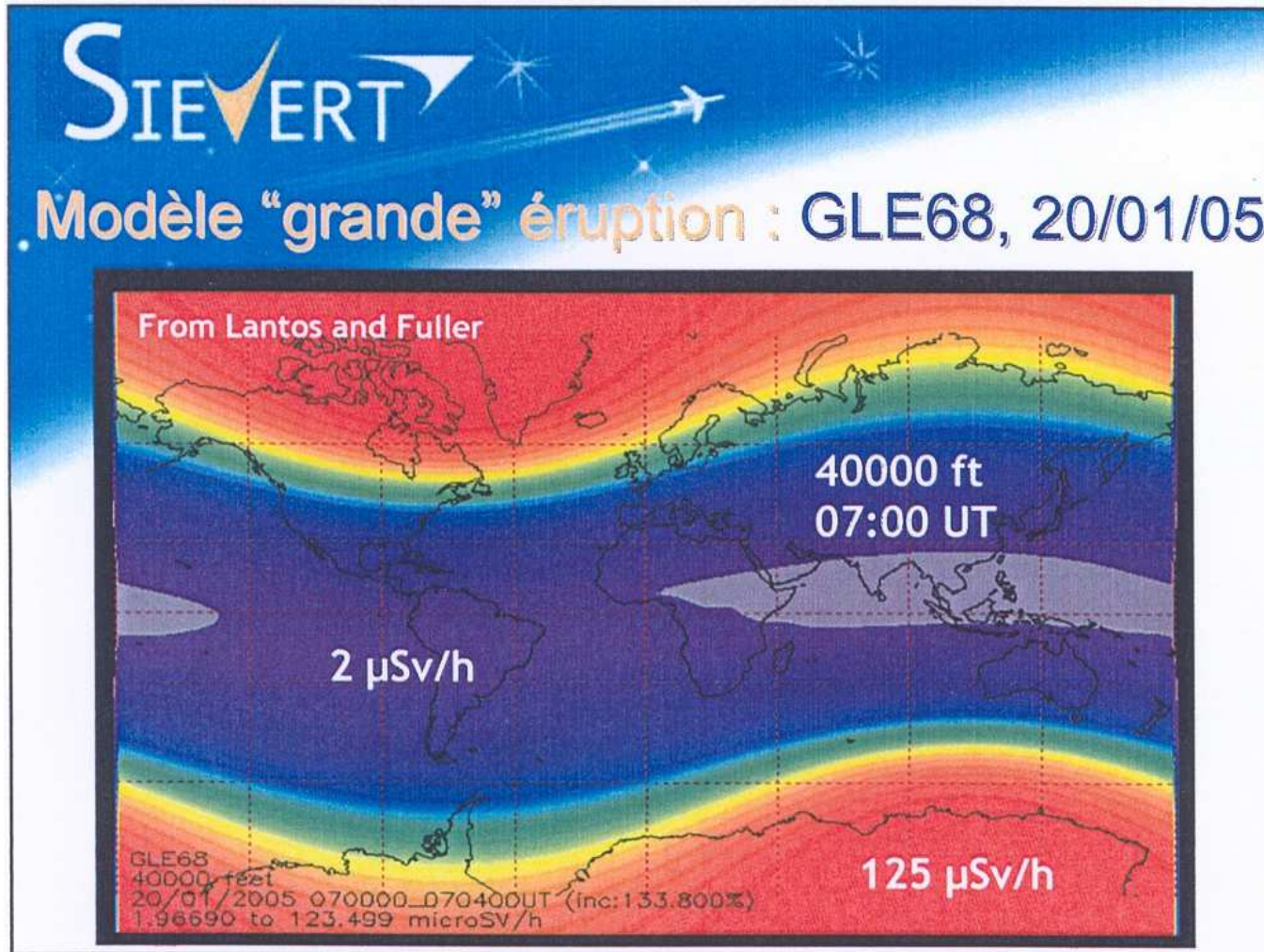
Decree 2003-296 31 March 2003

Order 8 December 2003

Two precisions :

- Assessment of exposure to cosmic radiation on board by means of computerized calculation is allowed
- To **take into account** normal solar activity and **exceptional solar activity**

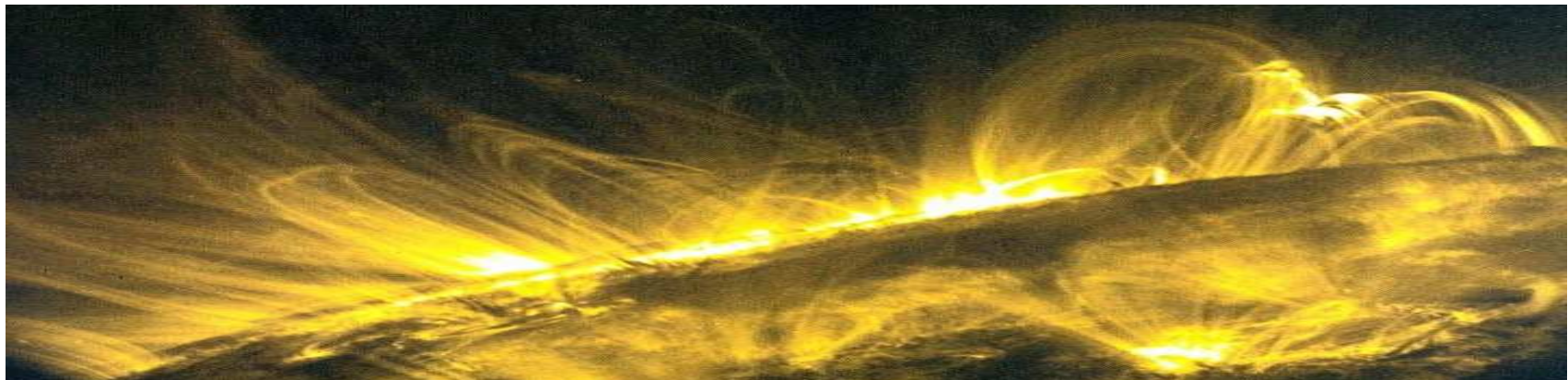
# MODELLING by the PARIS OBSERVATORY



# RADIATION STORMS

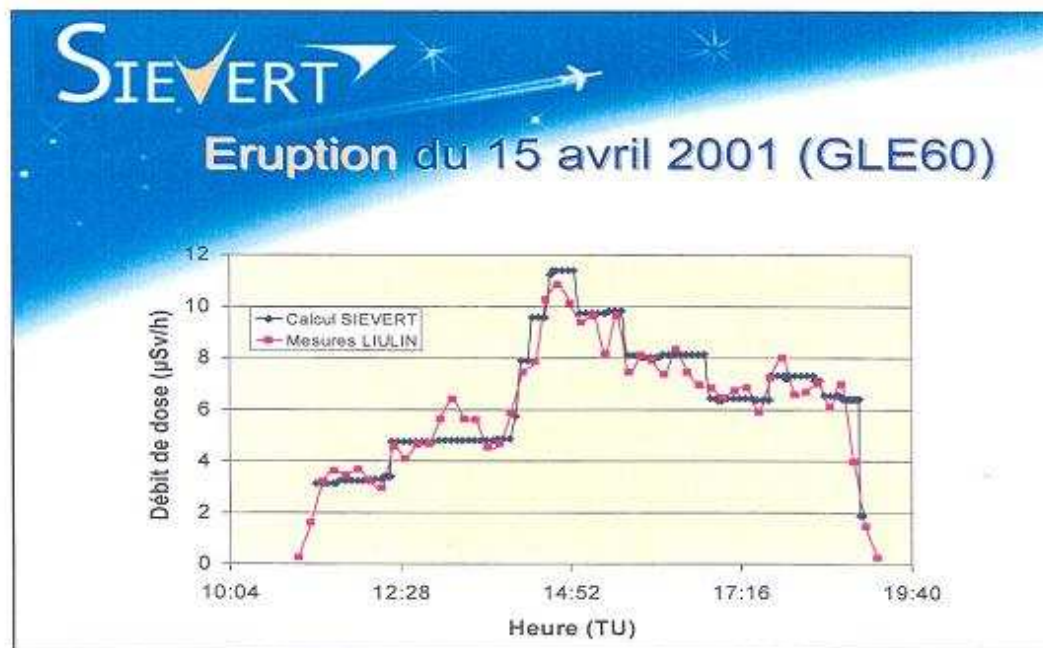
GLE taken into account since 2000

- July 10 th 2000
- April 15 th 2001
- January 20 th 2005
- December 12 th 2006



# RADIATION STORM FLUX

Strong S3 0,1 mSv/hour 12 000m  
mean duration : from 1 to 6 hours



# GLE DECEMBER 12th 2006

FRSD CONSULTATION PN/DOSE 20/02/07 07:55:21  
1 F

MATRICULE : 4277271

NOM : LAF PRENOM : MARJORIE FONCTION : STEWARD/HOTESSE

DOSES ANNUELLES (MILLI SVT) :

2003 : 02,3546 2004 : 02,8632 2005 : 03,5695 2006 : 04,0078

ANNEE EN COURS :

24 DERNIERES DOSES MENSUELLES

01 / 2006 : 00,1088

02 / 2006 : 00,4618

03 / 2006 : 00,3324

04 / 2006 : 00,2219

05 / 2006 : 00,4157

06 / 2006 : 00,2214

07 / 2006 : 00,4676

08 / 2006 : 00,3744

09 / 2006 : 00,2290

10 / 2006 : 00,4549

11 / 2006 : 00,2777

12 / 2006 : 00,4422 ERUPTION

## RADIATION STORMS PEAK FLUX

Severe S4            1 mSv/hour 12 000 m  
Extreme S5           10 mSv/hour 12 000 m  
February 23 th 1956    80 mSv/hour 18 000 m

## SUPERSONIC CONCORDE



- January 9 th 1997 amber alarm
- Radiometer 1 mSv/hour FL500 16.000 m  
10 mSv/hour FL550 17.600 m
- Return to FL 500
- PARIS-NEW YORK 0,5 mSv (X4)

# CONCLUSIONS

## French system SIEVERT

[www.sievert-system.org](http://www.sievert-system.org)

- replies fully to all operational constraints and provides a correct application of regulation
- is currently the only one tool able to compute the doses received during a solar flare

Data show that Air France's crew steadily employed on northern intercontinental flights

- can receive significant annual effective doses
- nevertheless smaller than the permissible limit