



# Request handbook for the simulation of the SVO mission on ORFEO

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# **Request handbook for the simulation of the SVO mission on ORFEO**

## **Space Volcano Observatory**

*S. Quéré, Y. Trembley, P. Briole*

### **Summary**

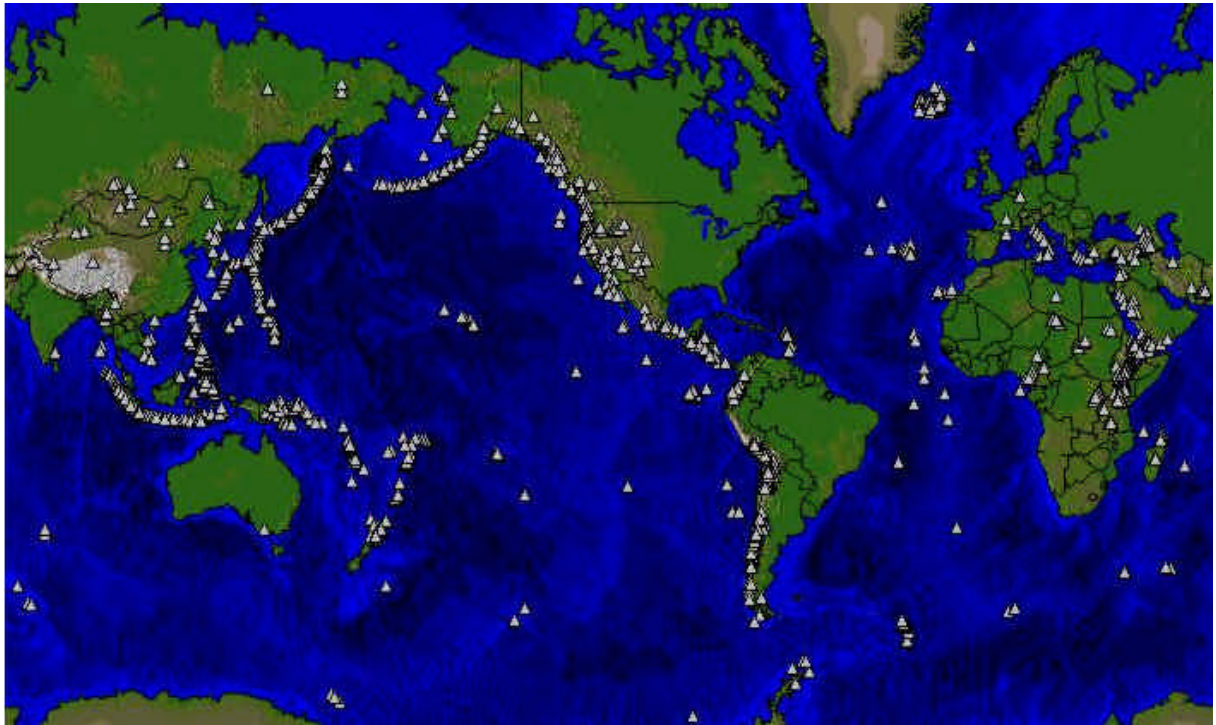
- 1. Introduction**
- 2. Volcanoes to be monitored**
- 3. Risks related to volcanic eruptions**
- 4. Foot print to be monitored**
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- 6. Frequency of the eruptions**
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**29 July 2002**

**Institut de Physique du Globe de Paris**

## 1. Introduction

1500 volcanoes on the Earth are potentially active (see figure 1). One third of them have been active during this century. At the beginning of the third millenium, 10% of the world population is living in areas directly threatened by these potentially active volcanoes.



*Figure 1 : Map of the potentially active volcanoes.*

The aim of this work is to provide the control simulator of the Pleiades mission (C.N.E.S.) with data on volcanic risks. The simulation is made on the basis of the real activities of the world volcanoes in the period 1999-2001.

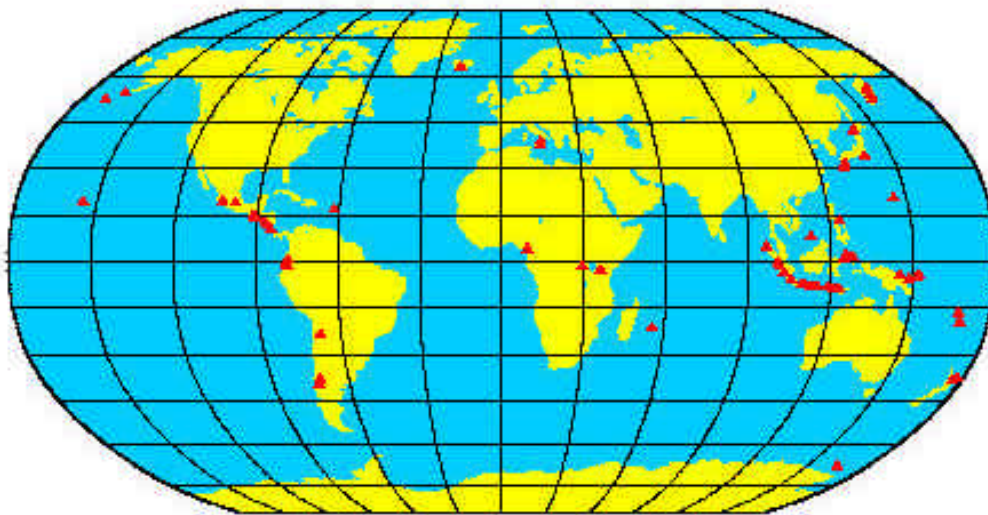
## 2. Volcanoes to be monitored

The list of the volcanoes to be monitored by the system in priority has been established using the archive from the Smithsonian Institute (web adress). For active volcanoes, we mean volcanoes in eruption between january 1999 and june 2001. Moreover, for the same period, we can add about forty inactive volcanoes, whose localization and forewarnings of activity make them highly dangerous for the neighbouring population. This represents a totality of 115 volcanoes (see figures 2 and 3 and tables 1 and 2). For the simulation, we have used the data relative to the year 2000.

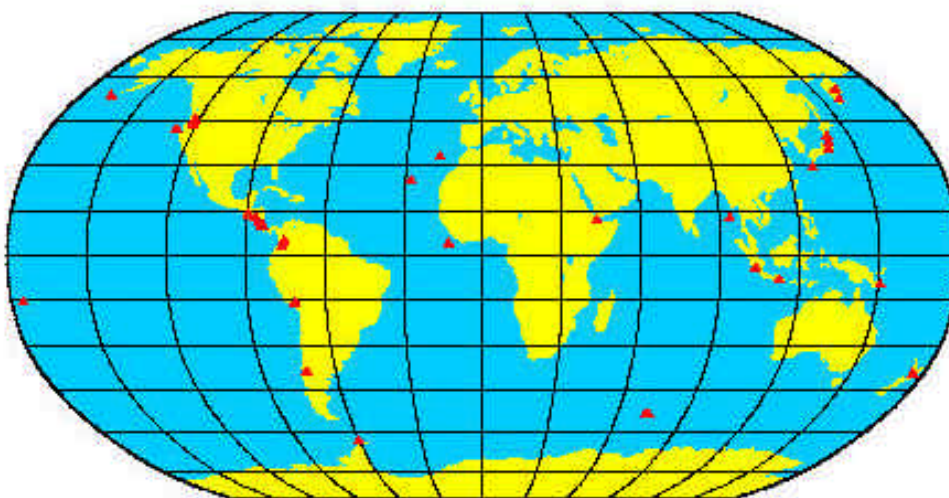
Volcano	Latitude	Longitude
Batur	-8.24	115.37
Bromo	-7.9	113
Ibu	1.48	127.63
Ijen	-8.058	114.242
Inielika	-8.73	120.98
Kaba	-3.52	102.62
Karangetang	2.47	125.29
Kerinci	-1.69	101.27
Krakatau	-6.1	105.42
Lewotobi	-8.53	122.78
Lokon-empung	1.36	124.79
Merapi	-0.38	100.47
Marapi	-7.54	110.44
Peuet Sague	4.92	96.33
Raung	2.28	125.43
Sangeang Api	-8.18	119.06
Semeru	8.11	112.92
Slamet	-7.24	109.21
Soputan	1.11	124.73
Piton de la Fournaise	-21.23	55.71
Soufriere Hills	16.72	-62.18
Kilauea	19.425	-155.292
Shishaldin	54.75	-163.97
Altar	-1.67	-78.42
Guagua Pichincha	-0.171	-78.598
Tungurahua	-1.467	-78.442
Copahue	-37.85	-71.17
Lascar	-23.37	-67.73
Planchon Peteroa	-35.24	-70.57
Villarrica	-39.42	-71.93
Cerro Negro	0.828	-77.964
Concepcion	11.538	-85.622
Masaya	11.984	-86.161
San Cristobal	12.702	-87.004
Telica	12.603	-86.845
Arenal	10.463	-84.703
Fuego	14.47	-90.88
Pacaya	14.38	-90.6
Santa Maria	14.756	-91.552
Colima	19.514	-103.62
Popocatepetl	19.023	-98.622
Hekla	63.98	-19.7
Katla	63.63	-19.05
Tengger Caldera	-7.94	112.95
Mayon	13.257	123.685
Langila	-5.53	148.42
Manam	-4.1	145.06
Etna	37.73	15
Stromboli	38.79	15.21
Mt. Cameroun	4.2	9.17
Ol Doinyo Lengai	-2.751	35.902
Nyamuragira	-1.408	29.2

Sturge Island	-67.4	164.83
Rabaul	-4.271	152.203
Ulawun	-5.04	151.34
Ambrym	-16.25	168.12
Lopevi	-16.507	168.346
Yasur	-19.52	169.43
Rotorua	-38.08	176.27
White Island	-37.52	177.78
Kikai	30.78	130.28
Komaga take	42.07	140.68
Miyake jima	34.08	139.53
Sakura jima	31.58	130.67
Usu	42.53	140.83
Ahyi	20.43	145.03
Bezmianny	55.98	160.59
Karymsky	54.05	159.43
Kliuchevskoi	56.06	160.64
Mutnovsky	52.453	158.195
Shiveluch	56.653	161.36
Cleveland	52.82	-169.95
Piton de la Fournaise	-21.23	55.71
Soufriere Hills	16.72	-62.18
Kilauea	19.425	-155.292
Shishaldin	54.75	-163.97
Altar	-1.67	-78.42
Guagua Pichincha	-0.171	-78.598
Tungurahua	-1.467	-78.442
Copahue	-37.85	-71.17
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Pacaya	14.38	-90.6
Santa Maria	14.756	-91.552
Colima	19.514	-103.62
Popocatepetl	19.023	-98.622
Hekla	63.98	-19.7
Katla	63.63	-19.05
Etna	37.73	15
Stromboli	38.79	15.21
Mt. Cameroun	4.2	9.17
Ol Doinyo Lengai	-2.751	35.902
Nyamuragira	-1.408	29.2
Sturge Island	-67.4	164.83

*Table 2 : Selection of volcanoes to be monitored in priority 1*



*Figure 2 : Map of the active volcanoes from january 1999 to june 2001*



*Figure 3 : Inactive but potentially dangerous volcanoes from january 1999 to june 2001*

### **3. Risks related to volcanic eruptions**

The risks associated with volcanic eruptions depend at first order on the effusive or explosive nature of the volcano.

Effusive volcanoes generally do not represent any vital risk for the population. Their activity is characterised by lava flows. The velocity of a lava flow, less than one km per hour in common cases, allows people evacuation in general. There are exceptions like the Nyiragongo area (where lava flows reached several tens of km per hour in 1977), or Hawaiï or Piton de la Fournaise where lava flows can be very fast close to the vents and thus mean a risk for visitors and in some cases the inhabitants of the villages.

However, they can cause important damages to the goods or to the economy. The area covered by a lava flow is typically about ten kilometres over a few hundred of meters width. According to the volcanoes type, the eruption duration differs from a few weeks for the Mont Etna (Sicilia) or the Piton de la Fournaise (Réunion Island) to a quasi-permanent activity for the Kilauea (Hawāi). Seismic activity and deformations at centimetre level of the edifice could occur a few weeks before the eruption.

Because of the violence and extent of the eruptions, explosive volcanoes create a more important risk to the population. They represent 90% of the active volcanoes. Their activity is sometimes characterised by domes growth (diameter of several hundreds of meters, growing at about 2 meters per day) and also by collapses sequences which may cause pyroclastic flows and landslides. The velocity of the propagation of a pyroclastic flow (which is a mixing of gas and rocks at high temperature) can by far exceed 100 km per hour over distances of about ten kilometres. The collapse of a caldeira (like Santorini in Greece or Krakatau in Indonesia) or the collapse of a flank (like Saint Helens Mount in 1980 at the USA) cause partial or total destructions at a regional scale. Nevertheless, their frequency is smaller (one or two events per century).

Other common risks exist between these two types of volcanism:

- Ash columns: they can reach 30 km in altitude. They represent a major hazard for the air traffic. This kind of activity is actually monitored by meteorological satellites. When they are thick, the deposits of such columns can trigger roof collapses of buildings.
- Lahars: mixing of volcanic deposits and water (due to the melting of a glacier or due to precipitations of recent deposits). These mud flows could cause, several months after the eruptions, important disasters over a distance of hundreds of kilometres.

#### **4. Foot print to be monitored**

For most of the volcanoes, the active zone covers an area of about 5 km x 5 km, centred on the summit of the volcano. Eruptive faults, domes and precursor signs of activity are concentrated in this zone. A larger area (10 km x 10 km) includes almost all the volcanic deposits. This area could be offset and extended depending on the presence or not of habitations near the volcano. The proposed area for SVO concerns a foot print of 6 km x 6 km.

#### **5. Atmospheric conditions**

The quality of images is not only constrained by atmospheric conditions (snow, clouds...) but also by the presence before, during and after eruptions, of ash and gas columns. These returns reduce the frequency of the observations in visible domain.

The cloud coverage must be less than 10 % for the images used for the creation of a D.E.M. (Digital Elevation Model) and less than 25 % for the monitoring. But, it should be highlighted, that for a dome growing, the local presence of clouds is much more decisive than the rate of clouds for the whole image.

## **6. Frequency of the eruptions**

During the year 2000, according to the accurate knowing and dangerousness of each volcano, 77 volcanoes are counted as active - even if it is not really the fact - in order to establish a table with the best expected acquisition frequency. A few number of volcanoes show activity signals. Among them, one or two are located near inhabited areas. The difference between active volcanoes and volcanoes with precursor activity signals can be due essentially to the lack of available data for volcanoes situated in uninhabited zones or without permanent tools of observation. In fact, with respect to the earthquakes, volcanoes begin their eruption producing precursor signals which are studied by actual monitoring tools.

## **7. Expected specifications of the images**

The expected resolution for the visible images is 1 meter or best in panchromatic and multispectral modes. Such a resolution allows the monitoring of a lava dome growing.

We estimate that the most favourable hour for the acquisition is 10 A.M. (local time) because images have to show lighting conditions as more constant as possible.

## **8. Simulation of the types of requests**

The frequency of observations for a volcano depends on two parameters: its activity and the proximity of population. The volcanic activity can be split in several phases:

- Inactive phase: the acquisition is limited to stereoscopic shot for the creation or actualisation of a D.E. M.
- Alert: once precursor signals of an imminent eruption are detected by volcanological observatories or by seismological stations, an accentuated monitoring of the volcano is needed in order to study the future eruption as best as possible.
- Eruption: regular monitoring of the area with a frequency depending on the type and localization of the volcano.

For the simulation, 8 cases have been taken into account according to two criteria: the activity type and the density of population. The 8 cases are described with the figure 4. In addition to these 8 cases, the creation of a complete data set has to be added, that is to say 2 images in stereoscopic conditions per volcano for a year. This data base will be a reference tool for the study of the deformations of the edifice during eruptions. The percentage of cloud coverage is required at 0 % because this base could be realised over a year.

The priorities of the acquisitions will be set according to the two criteria over a scale from 0 to 5 (0 means the highest priority).

Comment: although the creation of the data base covers several years, only forty inactive volcanoes will be selected for the simulated year.

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Images will be required in stereoscopic conditions, except the request at level 0 (higher priority, eruptive volcanoes with high or mean density of population). In these areas, we privilege the access to a big number of images in order to study the risks as soon as possible.

The total number of requests for the simulated year is 3266 for 115 monitored volcanoes.

This selection includes 77 active volcanoes.

The abbreviations used as description in the .MID file are:

- Erup\_thab : Eruption in highly inhabited zone
- Erup\_mhab : Eruption in moderately inhabited zone
- Erup\_fhab : Eruption in weakly inhabited zone
- Erup\_ihap : Eruption in uninhabited zone
- Aler\_thab : Alert state in highly inhabited zone
- Aler\_mhab : Alert state in moderately inhabited zone
- Aler\_fhab : Alert state in weakly inhabited zone
- Aler\_ihap : Alert state in weakly inhabited zone
- Base\_volc : Data base of volcanoes

**Process used to establish the level of priorities and frequency of images acquisition:**

Density of population	Activity level	Frequency acquisition of images & rate cloud coverage	Notation	Priority
Highly	Eruption	→ 1 / 1 day - 25 % →	1 : Erup_thab	0
	Alert state	→ 1 / 3 days - 25 % →	2 : Aler_thab	1
Moderately	Eruption	→ 1 / 3 days - 25 % →	3 : Erup_mhab	0
	Alert state	→ 1 / 1 week - Stereo - 10 % →	4 : Aler_mhab	2
Weakly	Eruption	→ 1 / 1 week - 25 % →	5 : Erup_fhab	3
	Alert state	→ 1 / 1 month - Stereo - 10 % →	6 : Aler_fhab	4
Nul	Eruption	→ 1 / 1 month - Stereo - 10 % →	7 : Erup_ihap	5
	Alert state	→ 1 / 1 month - Stereo - 10 % →	8 : Aler_ihab	5
Data base	→ Survey	→ 1 / 1 year - Stereo - 0 % →	0 : Base_volc	5

**Figure 4 :** Process used to establish the level of priorities and frequency of images acquisition



## **Annex 1: Control simulator parameters for the Pleiades mission.**

The required parameters concern :

- Images localisation
- Sizes of the zones
- Spectral bands
- Resolution
- Access angular conditions
- Required periods of the shots and the validity date including the multitemporal aspect if necessary
- Demands priority
- Maximum required percentage of the cloud coverage
- Required B/H value

The simulation requires the following parameters:

The notation 'generic format' means that the parameter is not very useful for this Spot specified control simulator.

NUM\_DP : number of the request

SIGLE\_CLI : 0 (generic format)

REF\_CLI : 0 (generic format)

GROUP\_DP : 0 (generic format)

RESP\_PROG : 0 (generic format)

SERVICE : BLEU (Spot term)

CLASSE : request priority (from the highest priority 0 to the lowest priority 5)

POIDS : 0 (modulate the importance in the CLASSE)

NUM\_SPOT : 0 (generic format)

NUM\_3S : 1234 (the four satellites 1,2,3 et 4 will be used)

NUM\_HE : 0 (the HELIOS mode is not used)

MODE\_SPECTRAL\_SPOT : 0 (generic format)

MODE\_SPECTRAL\_3S : PA\_XS (panchromatic and multispectral)

MODE\_SPECTRAL\_HE : 0 (the HELIOS mode is not used)

RESOLUTION\_SPOT : 0 (generic format)

RESOLUTION\_3S : 1 (HR resolution)

RESOLUTION\_HE : 0 (the HELIOS mode is not used)

TYPE\_STEREO : INDIF=yes, NULLE=no

SYMETRIE\_STEREO : NON (no symmetry is required between the right and left images)

TYPE\_ACQ : SIMPLE (one simple acquisition per request, the request is not multitemporal)

NB\_REAL : 0 (generic format, modulated by TYPE\_ACQ)

NB\_PERIOD : 0 (generic format, modulated by TYPE\_ACQ)

DUREE\_PERIOD : 0 (generic format, modulated by TYPE\_ACQ)

DATE\_DEB Date : date of the beginning of the acquisition

DATE\_FIN Date : date of the end of the acquisition

INCID\_LAT\_MIN : - 22 degrees (minimal lateral angle of incidence)

INCID\_LAT\_MAX : + 22 degrees (maximal lateral angle of incidence)

BH\_MIN : 0.2 (no Digital Elevation Model); 0.5 (if DEM)

BH\_MAX : 0.9 (no Digital Elevation Model); 0.7 (if DEM)

TANGAGE\_MIN : -20 degrees (minimal angle of clearance)

TANGAGE\_MAX : +20 degrees (maximal angle de clearance)  
ETAT\_DP : 0 (generic format of the state of the request)  
DATE\_CREATION : date of the request creation  
NB\_INSTR : 0 (generic format)  
NCN\_CLIENT : 0; 10; 25 (percentage of the cloud coverage)  
NAT\_ZONE : CERCLE (nature of zone coverage)  
LONG\_CENTRE\_CERCLE : longitudinal localisation of the centre of the request  
LAT\_CENTRE\_CERCLE : latitudinal localisation of the centre of the request  
RAYON\_CERCLE : 0 (generic format)  
NAT\_CADRE : 0 (generic format of the centring used for the request treatment)  
LAT\_CAD : 0 (generic format))  
LONG\_CAD : 0 (generic format)  
REGION : 0 (generic format)  
PAYS : 0 (generic format)  
TYPE\_ANALYSE : 0 (generic format)  
COUPL\_INSTRUM : 0 (generic format)  
STATIONS\_CENTRAL : 0 (generic format)  
STATIONS\_LOCAL : 0 (generic format)  
ATT\_CAH : 0 (generic format)  
STEREO\_TANDEM : 0 (generic format)  
SEUIL\_METEO : 0 (generic format)  
TOPONYME : 0 (generic format)  
SURFACE : 0 (generic format)  
APPLICATION : specification of the request (facultative)  
DELAI\_STEREO : 0 (generic format)  
VIDAGE : 0 (generic format)  
NB\_SCENES\_DEMAND : 0 (generic format)  
NB\_SCENES\_CALCUL : 0 (generic format)  
NB\_BANDES : 0 (generic format)  
NB\_SCENES\_VALID : 0 (generic format of the number of the validated scenes)  
NB\_TENT\_NON\_VALID : 0 (generic format of the number of the validated requests)  
DATE\_PREM\_TENT : date (date of the first attempt)  
DATE\_DERN\_TENT : date (date of the last attempt)  
METEO\_MIN\_TENT : 0 (generic format)  
METEO\_MAX\_TENT : 0 (generic format)  
METEO\_MOY\_TENT : 0 (generic format)  
METEO\_SIGMA\_TENT : 0 (generic format)  
METEO\_MIN\_NON\_TENT : 0 (generic format)  
METEO\_MAX\_NON\_TENT : 0 (generic format)  
METEO\_MOY\_NON\_TENT : 0 (generic format)  
METEO\_SIGMA\_NON\_TENT : 0 (generic format)

**Annex 2 : Studied volcanoes from January 1999 to June 2001, including coordinates, duration and types of activity.**

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



**Annex 3 : Studied volcanoes with the expected frequency images acquisition using an accurate knowing of each volcano and real run risks for the particular year 2000.**

Volcano	Batur	Bromo	Dempo	Ibu	Ijen	Inielika	Kaba	Karangetang	Kelut	Kerinci	Krakatau	Lewotobi	Lokon-empun
Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Latitude	-8.24	-7.9	-4.03	1.48	-8.058	-8.73	-3.52	2.47	-7.93	-1.69	-6.1	-8.53	1.36
Longitude	115.37	113	103.13	127.63	114.242	120.98	102.62	125.29	112.31	101.27	105.42	122.78	124.79
Altitude	1717	2329	3173	1325	2386	1559	1952	1784	1731	3805	813	1703	1580
Country	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia
2000	January	3											
	Februar	3						3		3			
	Mars	3						3		3			
	April	3						3		3	Stereo - 30		
	Mai	3						3		3	Stereo - 30		7
	June	3						3		3			7
	July	3						3		3			7
	August	3					Stereo - 30	3		3			7
	September	3						3		3			7
	October	3				Stereo - 7		3		3	7		7
	November	3	7			Stereo - 7	Stereo - 30	3		3	7		
	December		7					3	3		7		

Volcano	Merapi	Marapi	Peuet Sague	Raung	Sangeang Ap	Semeru	Slamet	Soputan	engger Calde	Mayon	Esa'ala	Langila	Manam
Number	14	15	16	17	18	19	20	21	22	23	24	25	26
Latitude	-0.38	-7.54	4.92	2.28	-8.18	8.11	-7.24	1.11	-7.94	13.257	-9.68	-5.53	-4.1
Longitude	100.47	110.44	96.33	125.43	119.06	112.92	109.21	124.73	112.95	123.685	150.92	148.42	145.06
Altitude	2891	2911	2780	725	1949	3676	3418	1784	2329	2462	500	1330	1807
Country	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Indonesia	Philippines	pua New Guir	pua New Guir	pua New Guir
2000	January	3				Stereo - 7				3		3	Stereo - 30
	Februar	3				Stereo - 7				3		3	Stereo - 30
	Mars	3	1			3				3		Stereo - 7	Stereo - 30
	April	3	3			3		7		3		3	Stereo - 30
	Mai	3				3	Stereo - 30	7		3		Stereo - 7	Stereo - 30
	June	3				Stereo - 7	Stereo - 30	7		3		Stereo - 7	7
	July	3		7		3	Stereo - 30	7		Stereo - 30		3	7
	August	3				3	Stereo - 30	7		Stereo - 30		3	7
	September	3				Stereo - 7	Stereo - 30	7		Stereo - 30		3	7
	October	3					Stereo - 30	7		Stereo - 30		3	7
	November	1							Stereo - 30	Stereo - 30		Stereo - 7	7
	December	1							Stereo - 30	Stereo - 30			

Volcano	Rabaul	Ulawun	Ambrym	Aoba	Lopevi	Yasur	Niuafu'ou	Rotorua	Ruapehu	White Island	Bandai	Fuji	Iwate
Number	27	28	29	30	31	32	33	34	35	36	37	38	39
Latitude	-4.271	-5.04	-16.25	-15.38	-16.507	-19.52	-15.6	-38.08	-39.28	-37.52	37.6	35.35	39.85
Longitude	152.203	151.34	168.12	167.83	168.346	169.43	-175.63	176.27	175.57	177.78	140.08	138.73	141
Altitude	688	2334	1334	1496	1413	361	260	757	2779	321	1819	3776	2041
Country	pua New Guin	pua New Guir	Vanuatu	Vanuatu	Vanuatu	Vanuatu	Tonga	New Zealand	New Zealand	New Zealand	Japan	Japan	Japan

2000	January	1	Stereo - 7	7		Stereo - 7							
	Februar	1	Stereo - 7	7			3	7					
	Mars	3	Stereo - 7	7		Stereo - 7				Stereo - 30			
	April	3	Stereo - 7	7	Stereo - 30	Stereo - 7				Stereo - 7	Stereo - 30		
	Mai	3	Stereo - 7	7	Stereo - 30					Stereo - 7	Stereo - 30		
	June	1	Stereo - 7	7	Stereo - 30					Stereo - 7	Stereo - 30		
	July	3		3	7	Stereo - 30				Stereo - 7	Stereo - 30		
	August	1		3	7	Stereo - 30				Stereo - 7	Stereo - 30	3	
	September	1		3	7				Stereo - 30	Stereo - 7		Stereo - 7	Stereo - 7
	October	1		3	7					Stereo - 30			Stereo - 7
	November	3			7					Stereo - 30			Stereo - 7
	December				7								

Volcano	Kikai	Kirishima	Komaga take	Miyake jima	Sakura jima	suwanose jim	Usu	Ahyi	ackson Segme	Bezmianny	Gorely	Karymsky	Kliuchevskoi
Number	40	41	42	43	44	45	46	47	48	49	50	51	52
Latitude	30.78	31.93	42.07	34.08	31.58	29.53	42.53	20.43	42.15	55.98	52.558	54.05	56.06
Longitude	130.28	130.87	140.68	139.53	130.67	129.72	140.83	145.03	-127.05	160.59	158.03	159.43	160.64
Altitude	717	1700	1140	815	1117	799	731	-137	0	2882	1829	1536	4835
Country	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Mariana Island	NE Pacific	Kamchatka	Kamchatka	Kamchatka	Kamchatka
2000	January				Stereo - 30						Stereo - 30		Stereo - 30
	Februar				1					Stereo - 30	Stereo - 30	Stereo - 30	Stereo - 30
	Mars				Stereo - 30		1			7	Stereo - 30		Stereo - 30
	April				Stereo - 30		1				Stereo - 30		Stereo - 30
	Mai				Stereo - 30		1				Stereo - 30		
	June			3	Stereo - 30		1				Stereo - 30	Stereo - 30	
	July			1	Stereo - 30		3				Stereo - 30		
	August			1	Stereo - 30		Stereo - 30				Stereo - 30		
	September		1	1	Stereo - 30		Stereo - 30			Stereo - 30	Stereo - 30		Stereo - 30
	October		3	1	1		Stereo - 30			7	Stereo - 30		
	November		1	3	Stereo - 30		Stereo - 30						
	December		3	3	Stereo - 30		Stereo - 30						

	Volcano	Mutnovsky	Shiveluch	Tolbachik	Cleveland	Makushin	n de la Fourn	Karthala	Barren Island	Heard	c Donald Isla	Soufriere Hills	Kilauea	Shishaldin
	Number	53	54	55	56	57	58	59	60	61	62	63	64	65
	Latitude	52.453	56.653	55.83	52.82	53.9	-21.23	11.75	12.29	-53.106	-53.03	16.72	19.425	54.75
	Longitude	158.195	161.36	160.33	-169.95	-166.93	55.71	43.38	93.88	73.513	72.6	-62.18	-155.292	-163.97
	Altitude	2322	3283	3682	1730	2036	2631	2361	305	2745	186	915	1222	2857
	Country	Kamchatka	Kamchatka	Kamchatka	Aleutian	Aleutian	Reunion Island	Comores	India	Indian Ocean	Indian Ocean	Montserrat	Hawai	Alaska
2000	January		Stereo - 30				Stereo - 30		Stereo - 30			3	Stereo - 7	Stereo - 30
	Februar		Stereo - 30				1					1	Stereo - 7	
	Mars	Stereo - 30	Stereo - 30				1					1	Stereo - 7	
	April						Stereo - 30					3	Stereo - 7	
	Mai						Stereo - 30					1	Stereo - 7	Stereo - 30
	June	Stereo - 30	Stereo - 30				1					1	Stereo - 7	
	July	Stereo - 30	Stereo - 30			Stereo - 30	1	Stereo - 7				1	Stereo - 7	
	August		Stereo - 30			Stereo - 30	Stereo - 30	Stereo - 7				1	Stereo - 7	Stereo - 30
	September		Stereo - 30			Stereo - 30	Stereo - 30	Stereo - 7				3	Stereo - 7	
	October					Stereo - 30	1	Stereo - 7				3	Stereo - 7	
	November		Stereo - 30			Stereo - 30	1			Stereo - 30		3	Stereo - 7	
	December					Stereo - 30	Stereo - 30					3	Stereo - 7	

	Volcano	Hood	South Sister	Altar	Laguna Pichin	Tungurahua	Sabancaya	Copahue	Llaima	Lascar	Sancti Spiritus	Villarrica	Cerro Negro	Huila
	Number	66	67	68	69	70	71	72	73	74	75	76	77	78
	Latitude	45.374	44.1	-1.67	-0.171	-1.467	-15.78	-37.85	-38.69	-23.37	-35.24	-39.42	0.828	2.92
	Longitude	-121.694	-121.77	-78.42	-78.598	-78.442	-71.85	-71.17	-71.73	-67.73	-70.57	-71.93	-77.964	-76.05
	Altitude	3426	3157	5321	4784	5023	5967	2965	3125	5592	4107	2847	4445	5365
	Country	USA	USA	Equator	Equator	Equator	Peru	Argentina	Chile	Chile	Chile	Chile	Colombia	Colombia
2000	January				1	3						1		
	February				1	3								Stereo - 30
	Mars				1	3							Stereo - 30	Stereo - 30
	April				1	3	Stereo - 30						Stereo - 30	Stereo - 30
	May				1	3	Stereo - 30					1		Stereo - 30
	June				1	3								
	July				1	3		Stereo - 30		7		1		
	August				3	Stereo - 30		Stereo - 30						
	September				Stereo - 30	Stereo - 30		Stereo - 30						
	October			3	Stereo - 30	Stereo - 30		Stereo - 30				1		
	November				Stereo - 30	Stereo - 30						1		
	December				Stereo - 30	Stereo - 30						1		

Volcano	Purace	Ruiz	Concepcion	Masaya	Momotombo	San Cristobal	Telica	Arenal	Irazu	Poas	ncon de la Vid	Turrialba	Izalco
Number	79	80	81	82	83	84	85	86	87	88	89	90	91
Latitude	2.37	4.895	11.538	11.984	12.423	12.702	12.603	10.463	9.98	10.2	10.83	10.03	13.813
Longitude	-76.38	-75.323	-85.622	-86.161	-86.54	-87.004	-86.845	-84.703	-83.85	-84.233	-85.324	-83.77	-89.633
Altitude	4600	5321	1700	635	1258	1745	1061	1657	3432	2708	1916	3340	1950
Country	Colombia	Colombia	Nicaragua	Nicaragua	Nicaragua	Nicaragua	Nicaragua	Costa Rica	Costa Rica	Costa Rica	Costa Rica	Costa Rica	Salvador

2000	January							7	Stereo - 30	Stereo - 30	Stereo - 30			
	Februar	Stereo - 30						7	Stereo - 30	Stereo - 30	Stereo - 30			
	Mars	Stereo - 30			3	Stereo - 30		Stereo - 30	Stereo - 30	Stereo - 30	Stereo - 30			
	April	Stereo - 30				Stereo - 30		Stereo - 30	Stereo - 30		Stereo - 30			
	Mai							Stereo - 30	Stereo - 30		Stereo - 30			
	June					Stereo - 30		Stereo - 30	Stereo - 30		Stereo - 30			
	July				Stereo - 7			Stereo - 30	Stereo - 30					
	August							Stereo - 30	1					
	September							Stereo - 30	Stereo - 30					
	October								Stereo - 30					
	November								Stereo - 30					
	December								Stereo - 30					



	Volcano	Fuego	Pacaya	Santa Ana	Santa Maria	Colima	Popocatepetl	Hekla	Katla	Krafla	Grimsvötn	Etna	Stromboli	Mt. Cameroun
	Number	92	93	94	95	96	97	98	99	100	101	102	103	104
	Latitude	14.47	14.38	13.853	14.756	19.514	19.023	63.98	63.63	65.73	64.42	37.73	38.79	4.2
	Longitude	-90.88	-90.6	-89.63	-91.552	-103.62	-98.622	-19.7	-19.05	-16.78	-17.33	15	15.21	9.17
	Altitude	3763	2552	2365	3772	3850	5426	1491	1512	650	2	3315	926	4095
	Country	Guatemala	Guatemala	Guatemala	Guatemala	Mexico	Mexico	Iceland	Iceland	Iceland	Iceland	Italy	Italy	Cameroun
2000	January	Stereo - 30	Stereo - 7		7	1						1	Stereo - 30	
	Februar	Stereo - 30	Stereo - 30		7	1	3	7				1	Stereo - 30	
	Mars		Stereo - 30		7	1	Stereo - 7	7				1	Stereo - 30	
	April		Stereo - 30		7	1	Stereo - 7					1	Stereo - 30	
	Mai		Stereo - 30		7	1	Stereo - 7					1	Stereo - 30	7
	June		Stereo - 30		7	Stereo - 30	Stereo - 7					1	Stereo - 30	7
	July		Stereo - 30	Stereo - 30	7	Stereo - 30		1				3	Stereo - 30	
	August		Stereo - 30	Stereo - 30	7	Stereo - 30	1					1	Stereo - 30	
	September		Stereo - 30	Stereo - 30	7	Stereo - 30	Stereo - 7					1	Stereo - 30	
	October		Stereo - 30	Stereo - 30	7	Stereo - 30	Stereo - 7					1	Stereo - 30	
	November		Stereo - 30	Stereo - 30	7	Stereo - 30	3					1	Stereo - 30	
	December	7	Stereo - 30	Stereo - 30	7	Stereo - 30	3					1	Stereo - 30	

Volcano	Doinyo Leng	Nyamuragira	Nyiragongo	Jeception Islar	Sturge Island	Sete Citades	Furnas	Faial	Pico	Teide	Lanzarote
Number	105	106	107	108	109	110	111	112	113	114	115
Latitude	-2.751	-1.408	-1.52	-62.97	-67.4	37.87	37.46	32.47	38.28	28.16	29.2
Longitude	35.902	29.2	29.25	-60.65	164.83	-25.78	-25.19	-16.52	-28.25	-16.38	-13.4
Altitude	2890	3058	3469	576	1167	856	?	?	?	?	?
Country	Tanzania	RD Congo	RD Congo	Antarctica	Balleny Islands	Azores	Azores	Azores	Azores	Canary Islands	Canary Islands

2000	January	Stereo - 30	7 Stereo - 30								
	Februar	Stereo - 30	Stereo - 30	Stereo - 30							
	Mars	Stereo - 30	Stereo - 30	Stereo - 30							
	April	Stereo - 30	Stereo - 30	Stereo - 30							
	Mai	Stereo - 30	Stereo - 30	Stereo - 30							
	June	Stereo - 30	Stereo - 30	Stereo - 30							
	July	Stereo - 30	Stereo - 30	Stereo - 30							
	August	Stereo - 30	Stereo - 30	Stereo - 30							
	September	Stereo - 30	Stereo - 30	Stereo - 30							
	October	Stereo - 30	Stereo - 30	Stereo - 30							
	November	Stereo - 30	Stereo - 30	Stereo - 30							
	December	Stereo - 30	Stereo - 30	Stereo - 30							