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"VEGETATION" onboard SPOT 4

PRODUCTS SPECIFICATIONS

Version 2 (05/18/94)

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VERSIONS

Version 0	02/11/93	Initial specifications
Version 1	03/02/94	Proposal for System Concept Review (to be approved by IUC)
Version 2	05/18/94	Include comments from the System Concept Review

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I. INTRODUCTION

The VEGETATION mission was defined to fulfill objectives which were described in (Ref. 4), detailed specifications derived from this definition being given in (Ref. 7). During the first meeting of the User's Committee in Brussels on 11/05/92 (Ref. 6), particular recommendations were given by the participants to define the products of the system:

1. the ground systems providing the VEGETATION different levels of products should complement the onboard instruments to provide to end-users the **operational service** which was initially defined as being one of the key aspects of this mission, They must provide **continuity of the service** on a long lifetime to be coherent with the planned uses (Ref. 7), especially monitoring of vegetation areas, both for production estimates and for studies related to interaction between the biosphere and the climate changes.
2. as many projects are now existing which will be important users of the system, strong interaction and coordination with these projects or with entities which are being set up to facilitate their realization must be provided in the first stages of definition and implementation :
    - the definition of products, either in terms of levels or for the algorithms to be applied for data processing, should be based on the needs of the existing projects or, when possible, on existing specifications of similar products, as soon as these definitions are widely accepted in the community of the potential users. Among existing projects, specifications designed by IGBP (Ref. 5) or by the international expert group of the Sahara Sahel Observatory (Ref. 8) should be the basis for detailed product definition. Other aspects on archiving consideration should also be based on work done for the definition of a number of data base systems dedicated to remote sensing data, for example a study done for the Centre Pilote d'Etude Spatiale de la Biosphère Africaine (CEPESBA, Ref. 9)
    - coordination with these projects for specific and adapted processing must be taken into account as soon as possible, either to provide better products suited to particular uses or to prepare, within the ground system itself, data sets or ancillary data that will allow more efficient uses of the VEGETATION data.
    - finally, to benefit from developing centers for archiving or data processing, creation of Specialized Processing Centers for particular products should be envisaged to optimize the task that should be undertaken by the VEGETATION ground system.
3. to fully benefit from the simultaneity of high spatial resolution and high frequency measurements provided by the HRVIR and VEGETATION instruments, adapted products to facilitate coherent use of both data types should be designed.

The following description of the products specifications should provide the capability for the entire VEGETATION system to ensure adequate service to the different types of users, building on existing knowledge and projects for the data to be integrated as soon as possible (within 3 to 4 months after SPOT 4 launch) in the global and regional data sets made available to the community.

During 1993, the International Users Committee set up a joint Working Group with the Integrated Project Team to refine and detail the definition of the products. The participation of the IPT insured realistic assumptions about the capabilities of the system and a clear understanding of product definition and operational constraints. The conclusions of this working group were presented to the IUC on Jan 24th 1994 and the general definition was approved. A survey on potential users of the VEGETATION system was performed during January 1994 : using the preliminary results of this survey, the most probable characteristics of requests as well as further details on the products themselves could be obtained and included in version 1. The general principles which had been defined in 1993 were confirmed and some new aspects were introduced :

- the products available from the VEGETATION system Ground Segment should be specifically designed for the use in studies on vegetation, providing as much coherence as possible with other data sets commonly used in these studies. The capability to adapt to important projects and to allow some evolution of the products delivered to users was again emphasized.
- the specifications apply to the data processing segment which is connected to the onboard system but are not mandatory for secondary receiving stations that will also have the capability to preprocess and deliver different products to users. However, it is strongly recommended that these secondary stations as well as other entities that would process VEGETATION data, be as much as possible coherent with the definition or algorithms proposed here, to ensure a wider use of these data, allowing comparisons, both for different regions and at different times. System parameters which are necessary for some of the corrections should be made available through proper arrangements.
- other possible data sets will not be made available as current products but some capabilities to provide them, especially for raw data sets, should be retained (for example under special agreement between the Ground Processing entity and users).

The System Concept Review held in Toulouse in April 1994 made some recommandations on the product definition which were included for a more detailed description of the different product levels.

This document is organized in two main sections : the first one presents the general structure of the products, with as much as possible justification or explanation of the choice of these products. The second section lists the specifications that should apply to the VEGETATION products.

II. MAIN FUNCTIONS and OVERALL ORGANIZATION

Four main functions have to be provided by the data processing segment to satisfy the general definition of the mission. These functions are the following:

- the generation and maintenance of a Core Archive which contains all the data received from the instrument system as well as the minimum ancillary data which are necessary to preprocess the raw data,
- the generation of enhanced products at different levels, both as basic products that should be made widely available and as particular products or information data sets that should be adapted to important projects,
- the maintenance of a catalogue of existing data, accessed through easy communication means to the users, to provide timely information on data availability and quality,
- the contacts with the users and projects to facilitate the use of VEGETATION products and the development of enhanced or new products, taking into account both the evolution of the needs of the community and the increasing capability to correct raw data for system or observational effects and to extract new informations.

A. GENERATION OF A "CORE ARCHIVE"

The basis for any other product generation is the data set composed of the original raw VEGETATION data as received from the primary receiving station and of all the system data which must be attached to the image data : calibration informations, geometric information on viewing conditions, location and datation of the images...

To allow further preprocessing steps, any information that could be used to characterize the conditions in which the data were acquired should be added and registered to the image and system data. Taking into account the existing knowledge and predicting what could be possibly done in the 10 or 15 years, the minimum set of ancillary data that should be appended to the image and system data is the following :

- **topography information**, using available digital terrain models with a resolution both in the horizontal plane and on the elevation which is compatible with the spatial resolution of VEGETATION and the needed accuracy both for accurate location of pixels and atmospheric corrections for constant gases absorption and Rayleigh scattering (Refs 1, 2). A possible model is ETOPO5 from NOAA/NGDC, but digital model under development should also be considered. The needed spatial resolution is about 1km while the elevation resolution is of the order of hundred meters.

  The topography information could and will most probably be used as information on slope and orientation of terrain for further corrections to take into account variations of sun illumination. In that case, the appropriate information might not be derived directly from the same topography model but from other sources more adapted to the estimation of slope and orientation for such a spatial resolution.
- **atmospheric conditions informations** : from present knowledge, the minimum information that should be provided is the standard climatic tables for ozone and water vapour concentration, aerosol optical depth with seasonal dependence. It must be noted that as research work is being done on the atmospheric corrections, other informations might be desired for future corrections : for example, distribution of water vapour derived from meteorological models or aerosol distribution measured from photometers networks. The use of these descriptions, which have to be updated regularly, will increase both the workload of the system (establish links with other centers for reception of the relevant data) and the volume of data to be archived. Ancillary data needed for an atmospheric correction using the experimental blue band should also be considered.
- **other information : TBD**

These data sets are not corrected but only annotated with all the information (system and other) that would be necessary for correction. Then, the geometric structure of this data set is identical to the raw data geometric structure and related to instrument viewing properties. No data should be deleted, for example data acquired on the same geographical location on the same day due to the overlap between successive orbits should be kept entirely.

To indicate the relevance of each measurement, a "status image" should be computed and added to the data : for each pixel of raw data, it should indicate a general category in the following set : cloud, snow/ice, water, land.

This Core Archive data set must be considered as the most basic data set of the system and archived from the beginning of the operational life with no limit concerning duration.

This data set is not made available to users, except under special agreement and for volumes that would have to fit the possibilities of the Ground Segment system.

B. GENERATION OF ENHANCED PRODUCTS

From the Core Archive, enhanced data products can be derived at different levels with increasing processing complexity and/or information synthesis. They have to be defined from characteristics which are common to many potential users to offer basic general products. Adapted data sets, either image or ancillary information data, should be made available to dedicated projects; interaction for the definition of these adapted products should also lead to the possible creation of Specialized Processing Centers, embedded or not in the projects, with particular connections to the data processing segment.

Two levels of enhanced products can now be defined, corresponding to the existing needs of potential users :

- VGT-P products correspond to data which will be mostly used by physicists for methodological development that could be embedded into applications using VEGETATION data.
- VGT-S products where some synthesis is applied on the “Core Archive” data to provide ground reflectances as well as some simply derived parameters.

In general, the products will be requested in advance, for selected areas and periods : users will require to be sent every data set acquired or generated on a regular basis. This characteristic is quite specific to the VEGETATION system for which very few requests will be done *a posteriori* using a catalogue of available data. However, the Integrated Project Team should take into account that some time will be needed after the launch of the system so that the users get acquainted with its capabilities and quality : the volumes given below for the different product levels are volumes that should be requested after this adaptation phase, which could last about one year.

1. *VGT - P* products :

Designed to be **used by physicists**, they can be defined as data that would have been acquired by an « ideal system ». The distorsions due to the system itself should be corrected to provide a product on which mission quality specifications apply (radiometry and geometry). The quantities which are provided are standardized to constant sun illumination on top of the atmosphere and will be scaled to equivalent Top of Atmosphere reflectances.
They must provide direct capability of registration between VEGETATION images acquired at different dates and between VEGETATION and HRVIR acquired simultaneously by instruments which are both on the same satellite, with the accuracy specified in the mission specifications.
The processing system should be able to process requests from the users giving:

1. the geographical location of their zone of interest,
2. the geographic projection to be used, selected among a set of available projections.

Data provided in return will consist of entire lines acquired on an orbital segment necessary to cover the geographical zone.

2. *VGT - .S* products :

VGT-S products take into account some **synthesis capability between successive orbits**, either on the same day or on different days : from the “Core Archive”, data can be processed to extract the best possible measurement for a given period following carefully chosen criteria. Taking into account the existing uses of NOAA-AVHRR data and the definition of data used by projects, two types of standard products can be defined :

- a daily synthesis (**VGT-DS**), with ground reflectance and NDVI computed from the ground reflectances (this type of synthesis only takes into account multiple measurements obtained through the overlap between successive passes at high latitudes),
- a 10 day period synthesis (**VGT-PS**) similar to the composites already computed from NOAA-AVHRR data.

Both standard products are global on land and should be processed to provide a standard geometric sampling preserving the 1km raw data resolution. The cartographic projections to be used for that product should provide as much coherence as possible with projections generally used either at regional or at global level.
Synthesis should be done through selection of the best measurement acquired during one day or one decade : the most commonly used method is the maximum composite value selection which retains the measurement corresponding to the highest NDVI value computed on top of atmosphere reflectances. This selection method tends to decrease atmospheric condition influence and appears to be the best known method to get rid of the worst atmospheric conditions, but ground directional effects are not taken into account (Ref. 10). The compositing methods will have to be reviewed and updated as new methodologies are validated, especially when directional effects can be modelled and integrated into the composition technique.
As these products will most certainly be the most frequently required product, even for retrospective studies, they both should be archived in a « Global Archive ».
During a transition phase (18 months to 2 years), degraded resolution products should be made available while users are developping their own capacity to handle the VEGETATION data sets.
The processing system should be able to process requests from the users giving:

1. the spectral bands (including known indices, NDVI at the beginning) that should be included in the product,
2. the geographical location of their zone of interest,
3. the geographic projection to be used, selected among the set of available projections.

C. CATALOGUE INFORMATIONS

The catalogue should be organized so that users could have some on line access to

- information on existing data, their level of processing, their quality,
- an interactive display of the status image of each of these data with browsing capability,
- for the global 10-day synthesis, a status image should present for each pixel its current status : valid ground measurement or still cloudy or with "bad" atmospheric conditions in the current period (**TBD**),
- an indication of available HRVIR images (to be studied and defined with SPOT Image),

- the ordering system as well as information of the status of the processing of their orders.

To provide these capabilities, different solutions might be developped and implemented, from a plain text catalog to a fully graphic catalog, with quick look images, full references to both VEGETATION data and High Resolution images... Taking into account the type of request which will most frequently be done *a priori*, the users will not in general need a full graphic display of images in real or near real time. The development of a highly sophisticated graphic catalog should probably not be a priority for the system, except if the need for real time information on the VGT-PS is needed for users that would like to order the product before the end of the period if a sufficient portion of their area is cloud free.
A periodic edition of a catalog of quick look images (similar to VGT-PS4 or PS8 for sampling with full information on quality and cloudiness) must be implemented for historical studies. This catalog should be available on a support like CDROM for easy handling.

D. CONTACTS WITH USERS AND PROJECTS

A close contact between the VEGETATION data processing segment and its users should be provided to ensure the full use of the system capabilities.

1. Evolution of product nature and quality

During the study for the definition of a standard processing system for OSS (Ref. 8), a recommendation was given from the beginning on the need to allow evolution of the processing methods applied to the data : while providing some *continuity* of the service, it is essential that the data processing segment be able to integrate *newly developed and validated methods* for data correction. These methods will be developed by the users community, either from experience gained on the VEGETATION data themselves or from experiments on other sensors : for example, some enhanced methods to address directional effects should come from the use of the POLDER sensor onboard ADEOS (launch in 95) as well as from the sensors that will be available onboard the EOS systems (MODIS, MISR...). As it is known that the proposed processing algorithms do not fully correct or take into account for atmospheric or directional effects, any evolution of the system that will allow a better use of the VEGETATION data should be integrated into the system.
Two particular enhancements should be available and implemented some years after the beginning of VEGETATION acquisitions :

- on atmospheric corrections: it is expected that the experimental blue band will allow development of new algorithms for evaluation of aerosol effects on the other spectral measurements. From ongoing studies and possibly from the use of other sensors, ground measurements (photometers networks) or atmospheric circulation models could also provide new ancillary information that should be included into the “Core Archive”.
- on directional effects: these effects can be seen as noise affecting the signal or as possible source of new information on the nature of the ground cover. As VEGETATION will provide measurements taken with different viewing and solar geometry on short periods of time (one day for high latitudes or some days for tropical zones when atmospheric conditions are good), any new algorithm allowing either the correction of these effects, especially for the 10-day synthesis of the “Global Archive”, or the definition of a new product where measurements acquired with different viewing conditions would be the basis for new informations, should be taken into account and considered for possible implementation.

The same evolution capability should also be provided for the nature of support of the products : the standard supports are evolving very rapidly, with increased capacity which will be more adapted to the volume of data generated by the VEGETATION system. Connections through international public networks will also see large increase in their capacity which will be able to ensure timely distribution of the products, especially for projects requesting frequent and high volume data sets.

3. “Non-data” products

As in all the other systems involving distribution of large volume data sets, data access and processing is generally time consuming, both during the development and operational phases. To facilitate the use of VEGETATION data, methods and standard software (for the most common computer systems) should be made available to users, projects, Specialized Processing Centers and the secondary receiving stations (Ref. 9). The knowledge which will be accumulated during the development phase and by users of the data sets should be referenced to allow exchanges both between the data processing segments and its users and between users.

E. OVERALL ORGANIZATION

The relationships between the different levels of products and the access that should be provided to users are presented in Figure 1. The general characteristics presented above show the central role of the two archives : the “Core Archive” from which any other data set is derived and the “Global Archive” which stores the enhanced data that should be the most widely requested.
The “*Core Archive*” will be the basis for the entire system as well as for scientific uses dealing with basic properties of the VEGETATION measurements.

The "*Global Archive*" will be the focus product of the entire VEGETATION system : the first priority for the data processing segment development should be to provide the easiest access to that product, both for *a priori* requests and for *a posteriori* requests through the catalogue (browsing capability), and ensure the best quality control both on product generation and on distribution through adapted means.

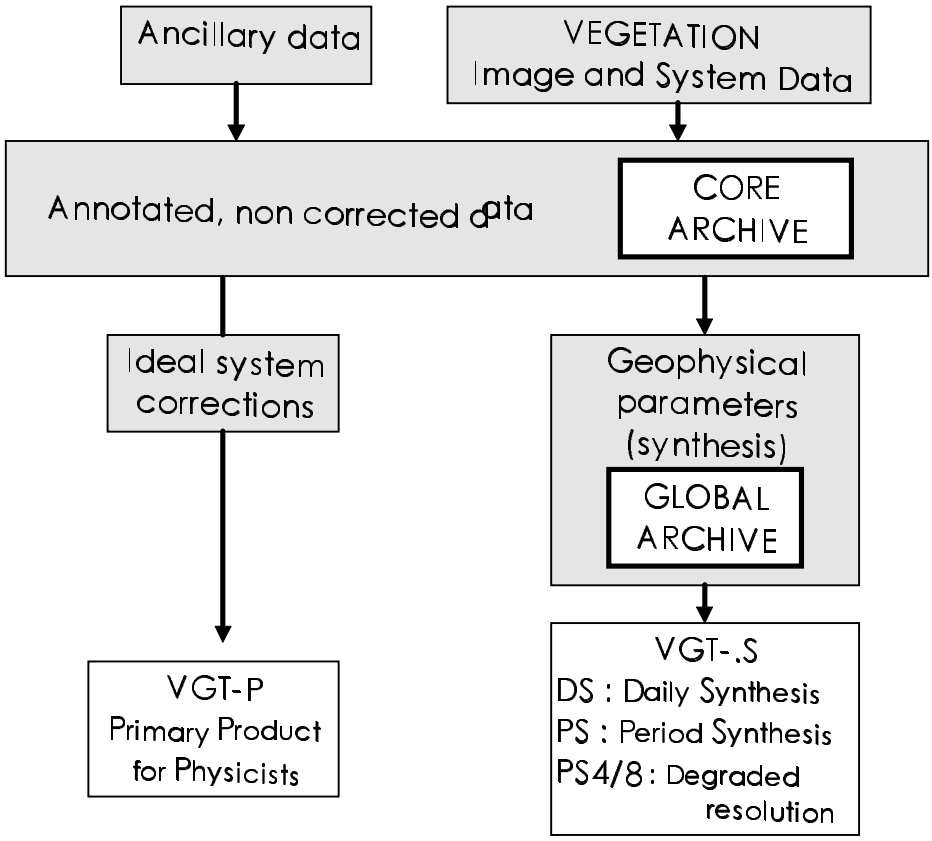

Figure 1 : Overall flowchart

III. PRODUCT SPECIFICATION

The above products are defined in terms of algorithms that should be applied for correction, nature and format of the data sets, volume and delivery time that should be provided as well as requesting information that would be used as controls for processing.

A. INPUT DATA FROM THE VEGETATION ONBOARD SYSTEM

The input to the VEGETATION data processing segment will come from the onboard system and the Vegetation Control Center. They must be :

- the four spectral bands measurements with proper reference data on acquisition time (time of measurement)...
- satellite characteristics : orbit parameters for determination of position and attitude, instrument parameters for geometric location...
- calibration coefficients for the four channels and all detectors

B. *VGT - P* PRODUCT :

The input system data will be processed using ancillary data necessary for radiometric and geometric corrections and annotation of the data set. The ancillary data include both system informations and external informations as described below.

The quality of VGT-P data must meet the specifications given for the mission (Ref.7)

The output data will correspond to the entire lines of the orbital segment which is necessary to overlap the geographical area requested by the user.

1 Radiometric corrections

Calibration information will be used to correct for detector normalization, absolute calibration and output values will be linearly related to equivalent « Top of the Atmosphere » reflectances. The linear relationship should use a null offset and a spectrally constant scaling factor allowing direct comparison between spectral reflectances. The quantization error should be coherent with the specified Noise Equivalent Reflectance. No saturation should be found at least for the specified ranges for each spectral band and, if possible, reflectances higher than the maximum specified range should be coded even if the radiometric quality does not meet the radiometric specifications.

Missing measurements should be corrected or indicated as follows :

1. interpolation using the mean value of their two neighbours should be used on the blind detectors in the SWIR spectral band,
2. identified « false detectors » in the VIS-NIR spectral bands should be interpolated the same way,
3. lost lines should not be replaced through interpolation,
4. interpolated and « missing » measurements should be flagged in the status map.

2 Geometric corrections

All pixels should be resampled onto a regular grid, taking into account :

1. spectral band registration,
2. satellite location and attitude correction (ground control points should be used if necessary to ensure the specified accuracy at mission level)
3. terrain elevation (from available global Digital Elevation Model, ETOPO5 **TBD**) to take into account parallax distorsion and provide orthoimages.

The regular grid should be defined using a small set of projections (10 to 12 **TBD**), for either global or regional mapping. **It is however essential that the set of projections chosen for the VGT-P products be compatible with the set of projections available for SPOT high resolution images to ensure direct registration between VEGETATION and HRVIR data**.

A final 1km resampling grid is required when the projection is adapted to such regular sampling.

3 Status map

A status map will be provided with the images, indicating for each pixel one of the following cover classes at the time of acquisition:

1. land or water (sea, lakes...) : it could be obtained from location information and reference maps,
2. snow, ice or cloud : they should be obtained at first from the spectral information. As complementary studies are necessary for a detailed definition of the algorithms, provisions should be made during the development of the ground segment to introduce methods that could be obtained through specific studies performed as part of the VEGETATION Preparatory Programme. Two approaches could be envisaged :
   - to use existing threshold algorithms adapted to the available spectral bands,

- to use seasonal statistics on spectral measurements as a basis for theshold definition. These statistics should come either from analysis of NOAA-AVHRR data or from the first year of exploitation of VEGETATION data.

The capability to use cloud cover maps derived by meteorological services should also be studied.
It is important that a minimum valid information on declared cloudy pixels be included in the situation map : existing algorithms should be adapted to provide the least percentage of pixels flagged as cloudy while they actually are not, even if some proportion of actually cloudy pixels are not flagged. The performance of such algorithms should be discussed with the IUC for approval.
Indication of interpolated, lost pixels or lines should be part of the status map, even when it is spectrally dependant.

4 Ancillary data

The following information will be provided :

system information

1. methods and data to associate to each pixel its location and acquisition time as well as geometry of acquisition (solar zenith and azimuth angles, viewing zenith and azimuth angles, with an accuracy of around 1 to 2°)
2. reference to actual absolute calibration parameters used to allow reverse correction assuming the correction is linear.

atmosphere information

The standard correction method for all VEGETATION products will be based on SMAC (see Ref 12). Then, all necessary data for application of SMAC should be appended as ancillary data :

1. vertically integrated gaseous contents for water vapor and ozone,
2. aerosol optical depth at 550nm.

The IUC and Integrated Project Team together will analyze the capabilities of existing meteorological systems to provide these data coherently with the delivery time specified for each level of product. The sampling of these data will be adapted to existing data sets and coherent with other grids giving different type of ancillary information (geometric conditions...) : a typical sampling size would be of the order of 0.5° or a regular grid of 50 km or less spacing. In the case where actual values are not available in time for inclusion in the data flow during the operations, assumptions on values that should be used will be inferred from climatological tables.

The Integrated Project Team should make provision for evolution of the system taking into account possible use of

1. the blue band from which information on aerosols effects could be extracted. The blue band could be used for computation of the aerosol optical depth at 550nm or a standard algorithm to infer aerosol effects from the blue measurements could be indicated.
2. measurements acquired by regional networks for the determination of atmospheric properties. As some of the most important regions for the mission of VEGETATION will be covered by such atmospheric parameters estimates, this capability should be incorporated even if it cannot be made on a global basis.

topography information

the Ground Segment should at least indicate a reference to the elevation information data set that will be used for the geometric corrections. The users will then have the capability to retrieve topographic information from the known location of each pixel.

5 Elements for product request

To order a particular VGT-P product, users should have to specify (directly or via the interaction with a catalog) the following elements :

1. date and reference to the orbit path from which data should be obtained,
2. the geographic location of their zone of interest. If it is necessary to simplify the project development, the requested zone could have to be composed of an integer number of predefined 1000x1000km^2 scenes, but the image data should be arranged into only one image.
3. the geographic projection to be used, selected among the set of available projections.

No capability to deliver products containing only a subset of the original spectral bands collection and ancillary information should be made available.

6 Data volume and delay requests

The estimate of the volume of data to be distributed each day is corresponding to

- around 2 global land coverage per day for *a priori* requests with a delivery time of 2 to 4 days after acquisition,
- around 1 global land coverage for *a posteriori* requests, with a delivery time of about 1 week after the request.

NOTE : some areas might be requested several times while others would be requested only once.
For these products, as they will be mostly used for methodological development on a regional basis, the typical size of the area which will be requested by a particular user is between 10^6 and 25 10^6 km^2.

C. *VGT - S* PRODUCTS :

Level 3 products are extracted from the "Global Archive", either for the daily or decade data set.
The daily synthesis (VGT-DS) is computed from the different passes of one day on each location, each pass corresponding for high latitudes to different viewing angles.
The decade synthesis (VGT-PS) is computed from all the passes on each location acquired during 10 day periods. The periods will be defined according to the legal calendar : from 1st to 10th, from 11th to 20th, from 21st to the end of each month.
The quality of these products will be derived directly from the quality of VGT-PS products, so no particular new specification is given for them.
At this stage, synthesis between different passes must be performed selecting the best measurement of the period defined from the following criteria :

1. it should not correspond to a blind or interpolated pixel,
2. it should not be flagged as cloudy in the status map (snow covered pixels are considered as candidates for the selection),
3. it should correspond to the highest value of Top of Atmosphere NDVI. However some other choices should be considered for later decision by the IUC : either the highest sun illumination or the closest to nadir.

The IPT must consider the capability to change to a better selection procedure or algorithm, but most probably change will occur only after 18 months to 2 years of operation of the VEGETATION system (experiments and wide approval by the user community)

1. Full resolution products

for each pixel

1. ground surface reflectance in the four spectral bands corresponding to the selected measurement, the atmospheric correction being performed using the annotations of VGT-P corresponding data and SMAC procedure (Ref. 12),
2. Normalized Difference Vegetation Index. This should be considered as a first example of a widely accepted surface parameter, and capabilities to include other quantities derived from surface reflectance should be preserved in the system. However, the definition of such new parameter will most probably not be available before some exploitation of the VEGETATION system itself.
3. geometric viewing conditions (similar to VGT-P product but it must be indicated for each pixel),
4. reference to date and time of selected measurement,
5. information on the composite status map.

for each data set

- references of all corrections applied for calibration, atmospheric correction and geometric processing.

The geometric projections should be taken in the same set as for the VGT-P products.
However, to reduce the amount of processing to adapt the projection to any request, it could be envisaged to choose one projection as the basic global projection from which all the other projections would be recomputed. The basic projection should then be a Plate Carrée projection leading to a sampling interval of 1km at the equator. This basic projection will be made available as a product to users, as well as derived products that will be obtained with different projections, through resampling using nearest neighbour replacement.

2. Degraded resolution products : *VGT-PS4 & VGT-PS8*

To ensure some continuity with existing projects and allow some training time, degraded resolution products should be made available, at least during the first two years of operation. They should be resampled from the VGT-PS product, with grid sizes of 4 and 8 km. The resampling should be performed selecting always the same pixel in the 16 or 64 $1km^2$ pixels.

3. Elements for product request

To order a particular VGT-S product, users should have to specify (directly or via the interaction with a catalog) the following elements :

1. date/reference to the day (for VGT-DS) or period (for VGT-PS) from which data should be obtained,
2. the geographic location of their zone of interest. If it is necessary to simplify the project development, the requested zone could have to be composed of an integer number of predefined $1000x1000km^2$ scenes, but the image data should be arranged into only one image.
3. the geographic projection to be used, selected among the set of available projections.
4. the subset of the original information collection (for example, the entire set of data or only NDVI with ancillary data or any subset of spectral bands...)

4. Data volume and delay requests

This product, especially the VGT-PS product, will certainly be the most requested product for large area coverage : some regional areas will be requested several times and regularly throughout the year. The total volume of requests averaged for each product instance is estimated to be :

- about 6 to 8 global land coverage for VGT-DS and *a priori* requests, with a delivery time of 2 to 4 days,
- about 10 global land coverage for VGT-PS and *a priori* requests, with a delivery time of less than 1 week,
- about 5 global land coverage for VGT-PS and *a posteriori* requests, with a delivery time of less than 1 week,
- a maximum of 10 global land coverage for both VGT-PS4 and VGT-PS8 for *a priori* requests and with a delivery time of less than 1 week. (transition phase)

This volume can be decomposed in a large number of regional requests (10^6 - 25 10^6 km^2) and a limited number of global requests (rarely one for VGT-DS, between 1 and 2 for VGT-PS, between 2 and 5 for VGT-PS4 & VGT-PS8)

E. SUMMARY ON REQUESTED VOLUMES and DELIVERY TIMES

The following table summarizes the estimates of volumes requested each day for each data product and mean delivery time.

Product Name	Nature	Zone	Type of request	Volume (1)	Mean delivery time (2)
VGT-P	« Ideal system » corrected data	Orbit segment	*a priori* *a posteriori*	2 1	2-4days <1week
VGT-DS	Daily synthesis	Geographical zone	*a priori*	6-8	2-4days
VGT-PS	Period synthesis	Geographical zone	*a priori* *a posteriori*	10 5	<1 week <1 week
VGT-PS4 VGT-PS8	Degraded resolution	Geographical zone	*a priori*	<10	<1 week

1: volumes are estimated in total global land coverage (some portions can be ordered several times). It corresponds to different volumes in bytes for the products.

2: delivery time is running from acquisition date for *a priori* requests and from ordering date for *a posteriori* requests.

Table 1 : Estimated volumes and delivery times for each category of product.

F. GENERAL SPECIFICATION FOR DATA FORMAT and SUPPORT

F.1 Format

The format for any product level should conform to the “Standard Family Tape Format" used widely for satellite remote sensing data, the evolution of the definition of other structures (HDF for EOS for example) should be studied by the project development team to propose the highest compatibility with other systems. In any case, as stated above, the algorithms and software (for the most common computer systems) should be made available as templates for these users to develop their own input/output software.

The format might be adapted to the support, especially to transmission via telecommunication lines: compression techniques might be applied, providing they are lossless compression or compatible with the radiometric quality when specified. In case of compression, capability to extract data from specific geographic areas or at different resolution would be appreciated.

F.2 Data coding

Coding should always be made on multiples of bytes and avoid intermediate number of bits (10,12...)

F.3 Supports

The support for data delivery must be adapted for the volume to be delivered and to particular constraints on time delay : the most standard and compact support should be proposed (from CDROMs to Exabyte cassettes for example, taking into account durable new standards which are flourishing) as well as network links which should be proposed when cost / effectiveness can be accepted by the users.

G. CATALOGUE

The main purpose of the catalogue will be to give information for *a posteriori* requests where users would order VEGETATION data which were acquired before the time of ordering. For *a priori* requests, the processing should be done without any interaction with the « customer » as soon as the characteristics of the request are accepted both by the customer and the Image Ground Segment entity.

To allow short term (between 6 month to one year) retrospective requests, an on-line catalogue must be available giving only quality information for all products which can be ordered. For longer term retrospective studies, it will be much easier to make available on « standard » supports a periodic catalogue, where « simplified » or « quick-look » image data could be appended to the quality information.

1. On-line catalogue

As a first implementation the catalogue should give access at least to information on the quality of the images (similar to the indications given in the status map, with or without cloud indication if no widely accepted method is retained), with indication of existing High Resolution data that could be ordered from SPOT Image. If a character mode catalog can synthetize the usefull information it could be acceptable. A simple graphical representation of information should however be preferred, and be designed to be coherent with standard Graphical User Interfaces available when SPOT 4 is launched.
Access to the catalogue must privilege the use of international networks connections.
As its main purpose will be for user to define *a posteriori* requests, procedures to establish a request and give all informations on the status of a particular request should be embedded or closely related to the catalogue.

2. Periodic catalogue

A periodic catalogue of VEGETATION data should be made available (on CDROM for example). It could be based on a sampled image (8km sampling) of red, near infrared and short wave infrared images in a standard graphical format for images and an indication of cloudiness computed from the status map (number of cloudy 1km pixels in the 8 km pixel) if the information can be obtained. This catalog should be edited every 6 or 12 months for the VGT-DS and VGT-PS products.

H. OPERATIONAL CONSTRAINTS

Apart constraints inferred from the characteristics of the products, the projected volume that could be ordered and the delivery time for each category, the development of the system should take into account the capability to evolve in response to the users community.
Particular attention must be given to the first year of the operational system, where users will most certainly place *a posteriori* orders, assess the quality of the data, products and services before they begin to place *a priori* orders. Then Table 1 must be considered as the profile of requests after the users community has got acquaintance with the entire system and operational projects which could make profit from the VEGETATION data have adapted their own system to operationally ingest these data. The time needed for such adaptation can be estimated to be around one year. One of the roles of the VEGETATION Preparatory Programme is to shorten and facilitate this phase as much as possible.
A second type of evolution that must be taken into account in the design of the system is the regular update of its procedures for data processing. As it was already mentionned, the availability of VEGETATION data will allow development of new methods for extraction of information or better processing. Some areas are already known as being only acceptable for a first implementation of the system, mainly the cloud detection and the synthesis procedures. However, the only way to improve these procedures is to process a significant amount of good quality data which will only be available from VEGETATION itself or systems that will provide measurement collections at almost the same time. Then capability to change some procedures must already be designed, especially for the two procedures mentionned above.
As a consequence, when the standard procedure is changed, solutions for keeping the coherence between products along the entire lifetime will have to be found : the reprocessing of the archive is a major task to undertake that should not be considered in the scope of the Image Ground Segment entity. At one particular time, the procedures to be applied for the production of any data sets should only be the current procedures, with the parameters which are appended as ancillary informations to VGT-P products. Processing data with a procedure which is not the current procedure at the time they are processed should not be considered as a priority for the Image Ground Segment entity and possible external facilities could be negociated for these particular tasks. The capability for such tasks should then be studied specifically, the decisions related to a general or partial archive reprocessing being taken in conjunction with users representatives in a manner similar to what is used for the first specifications of the products.

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