Improving access to VEGETATION data: some results of on-going experiments

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Summary

Distribution of VEGETATION data is currently based on two different procedures: express courier and transfer by ftp. The purpose of the study, carried out in the framework of the Share Cost Action “improvements for the continuity and operationality of the VEGETATION mission”, is to find ways by which access to data can be facilitated and speeded up especially for operational users.

This study shows that for VEGETATION data distribution the end-user service can easily be improved at marginal cost by improving the use of available telecommunication infrastructure. This can be achieved with limited impact on the current central processing facility architecture. Users can be served all over the world with such techniques. By doing so delivery times are fully compatible with most operational applications. Yet, considering limited access to on-line services for many potential users, it is important to provide easy off-line access to technical documentation, data catalogue and ordering procedures.

Introduction

The Central Processing Facility (CTIV) of the VEGETATION system was conceived to be able to generate standard products of any region of the world within two days after imaging for daily (P and S1) products, and four days after the end of a 10-day period for composite products (S10). These timings do not include delivery time. This can be almost immediate when electronic data transfer is used, but can also take several days when express courier is used to bring products to final users in remote locations.

On the other hand operational users have their own time constraints for what regards the information they retrieve from satellite data and forward to their own users. Typically the total acceptable time-lag between the end of a 10-day period and the moment the derived information is published is about 10 days, with more or less flexibility according to the type of application. A good case in point is EMPRES, the FAO-based desert-locust monitoring programme, where VEGETATION data are tested to issue warning messages to local plant-protection services. These on their turn send field-teams to check the actual presence of locusts. Late information would be useless, because the plague could have migrated to other regions in the meantime.

It is thus important, on one hand for CTIV to process data within the nominal timeframe, and on the other hand to reduce as much as possible delays due to delivery operations.

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An other aspect of system efficiency is the easiness of data reception and use. Although the situation has significantly improved during these recent years (the access to high-quality pre-processed VEGETATION data instead of raw signal is a good example), there is still a long way to go before reaching the ideal situation. Somehow the user dreams of a “virtual VEGETATION-man”, who, like the milkman that delivers milk bottles at the doorstep every morning, would bring the VEGETATION data into his/her computer as soon as they are ready. This is indeed one step forward compared to the current situation, where the user still needs to access an ftp site to retrieve data. This is really a cumbersome task when it has to be done on a daily basis.

The objective of the activity presented here is to test and provide solutions both to the VEGETATION programme and to the users to facilitate access to- and use of VEGETATION data.

Delivering VEGETATION data: the situation seen from the user side

The analysis here after is based on actual observations made from a series of orders placed by the Global Vegetation Monitoring Unit at JRC Ispra.

Fig. 1 shows the evolution of total delivery time for a series of S10 global data acquired since the start of operations of CTIV. It illustrates the difficulties of launching a large processing and distribution facility during the six first months. Few data were processed within the expected delay and final delivery occurred more than 10 days after the acquisition period in 50% of cases, with up to more than one month delay. After these six first months the situation has clearly improved, although it is not yet nominal (average 5.5 days). Delivery occurs only exceptionally within 2 days after production (average: 3 days\(^*\)). Thus in average only 1.5 day is left to the analyst to make use of the data before the end of the 10-day period following the acquisition window.

\[\text{Figure 1: evolution of delivery time for S10 global products (all channels) acquired at JRC. Green bars correspond to processing time since period end, red bars to courier transfer.}\]

The figure 2 shows the production time observed for a series of S1 “local products” (surface $< 10^6 \text{ km}^2$), 50% of all products were made available on the ftp site within the expected 2 days (fig. 3). A detailed analysis of fig. 2 shows a slowing down during the period 20/10-20/11/99, and a

\(^*\) This includes in fact the delay between the production and the collection of the parcel by the express courier (5 days/week), and the transfer time between CTIVV and JRC, including interruptions for week-ends.
series of asymmetric peaks where production was stopped for several days and the backlog could be processed within one day after restart. From these observations it can be concluded that CTIV is not too far away from a quasi-nominal operation mode for what regards production times. However reduction of production time is still needed. The average of 3 days spent within Europe for courier delivery indicate that even more time might be needed for more remote destinations.

Figure 2: processing time for S1 “local” products (all channels, < 10\(^6\) km\(^2\)) delivered by ftp to JRC

Figure 3: graph of frequencies for production time-lag of S1 products

There is thus scope for electronic data transfer provided that a series of conditions are met:
- Cost-efficiency: the additional cost of data transfer must remain marginal compared to the cost of the data themselves (one year of S10 NDVI up to 10\(^6\) km\(^2\) costs between ±1000 and ±3500 € according to user category).
- Technical efficiency: transfer capacity must be compatible with data volume. This means that the time needed for data transfer must remain “reasonable”, i.e. max several hours to a half-
day. We are faced with a special difficulty: for most users data are transferred once every 10 days. Huge communication capacities can hardly be amortised only with such a traffic level.

- Reliability: service availability must be guaranteed at any time and on the long term. This is better achieved by making use of tried and tested techniques with a large customer-base rather than with ad-hoc and user-specific solution.

**Existing Internet capacity: a case study in Africa**

At an early stage of this project a series of transmission tests were carried out between the met office in Burkina Faso and JRC. Like in many places around the world Internet access is ensured at the met office in a rather basic manner: a PC with modem accesses a local service provider through a normal telephone line. The connection is activated according to user needs.

The trials demonstrated that although email service was (almost) perfect, even with attached files up to 1 MB in size, it was practically impossible to access foreign web sites in a useful manner, or to carry out ftp data transfer. Transfer time was 5 to 10 times slower with ftp protocol than for email retrieval, and the data were sometimes corrupted.

![International bandwidth available for each African country for Internet connection](image1)

**Figure 4** international bandwidth available for each African country for Internet connection

![International bandwidth by user for African countries (in 1000 users/Kbps)](image2)

**Figure 5**: international bandwidth by user for African countries (in 1000 users/Kbps)

The explanation must be found in the limited capacity of international connections. Typically many countries have an international bandwidth similar to what is offered by standard computer modems (64 Kbps, fig. 4). It is thus no surprise that the bandwidth by user is also very low (fig 5). Moreover there are still countries that still do not have permanent access to international Internet connection. Although the situation improves rapidly, it is clear that the African continent is the ideal region to push telecommunication capacities to their limits: if it is possible to deliver
VEGETATION data by Internet with the infrastructure available there, than it will be possible almost everywhere else!

**Actual data transfer tests**

A series of partners have been contacted to test in the long terms the feasibility and stability of data transfer with existing infrastructure: FAO (Italy), UCL (Belgium), CTIV/VITO(B), NRI (UK), U. Lisbon (P), Met Office (Burkina Faso) AGRHYMET Centre (Niger), National Food Info System (Eritrea), IRSA (China), and CSIRO/EOC (Australia). (fig. 6).

![Figure 6: location of partners who have participated to communication tests](image)

Three main categories of utilisation have been considered, with special attention to operational users:

- **Global applications**
- **Regional/continental applications**
- **Local/national applications**

The conclusions are the following:

- At the present stage operational users are interested only in 10-day NDVI products and corresponding cloud-mask, which can directly replace equivalent AVHRR products with only minor modifications
- The transfer of the full global dataset (1.5GB) is feasible within Europe provided that there is a high capacity connection at the user-end. (test carried out between JRC and CTIV). Yet, with currently available networks it is advisable to limit such transfer to S10 products only.
- The transfer of one S10 global NDVI (150 MB) may require up to 6 hours for a “normal” permanent connection and elsewhere in the world where connections are “good”. The same applies to the transfer of (sub-) continental products
- The transfer of S10 continental NDVI (5-25 MB) is feasible with “fair” connections

The transfer of national to regional NDVI (1-15 MB) is feasible everywhere with email, even with non-permanent connection. This was successfully tested with Eritrea. The only constraint is to handle wisely the maximum allowed email size and mailbox size allocated to the user. To this end we systematically splitted files into block of < 1MB.
Alternative solutions to Internet connections

The table 1 summarises the technical solutions currently offered to access Internet service. These solutions are of interests especially for users either who do not have the necessity to maintain a high capacity permanent connection or who are not constrained by limited bandwidth for international connections.

<table>
<thead>
<tr>
<th>type of solution</th>
<th>max capacity</th>
<th>observed data transfer (Mbyte/min)</th>
<th>where is it available</th>
<th>when is it available</th>
<th>ad hoc hardware needed</th>
<th>hw cost (€)</th>
<th>technically adapted to data distribution</th>
<th>cost adapted to data distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM</td>
<td>9.6 Kbps</td>
<td>urbanized regions</td>
<td>now</td>
<td>modem</td>
<td>100-300</td>
<td>YES</td>
<td>local coverage, selected bands</td>
<td>YES</td>
</tr>
<tr>
<td>Analog Telephone Line</td>
<td>128 Kbps</td>
<td>0.05-0.10</td>
<td>everywhere</td>
<td>now</td>
<td>modem</td>
<td>50-200</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>ISDN (Integrated Services Network)</td>
<td>44/128 Kbps</td>
<td>0.1-0.5</td>
<td>almost everywhere</td>
<td>now</td>
<td>modem (computer board)</td>
<td>100-200</td>
<td>local/regional coverage, selected bands</td>
<td>YES</td>
</tr>
<tr>
<td>ADSL (asymmetric Digital Subscribe Line)</td>
<td>512-1024 Kbps</td>
<td>1.5-4.5</td>
<td>almost everywhere</td>
<td>experimental</td>
<td>modem (computer board)</td>
<td>100-200</td>
<td>experimental</td>
<td>YES</td>
</tr>
<tr>
<td>TV cable network</td>
<td>512-1024 Kbps</td>
<td>1.5-4.5</td>
<td>almost everywhere</td>
<td>just starting</td>
<td>modem (computer board)</td>
<td>100-200</td>
<td>experimental</td>
<td>YES</td>
</tr>
<tr>
<td>Satellite telephone (Inmarsat)</td>
<td>64Kbps</td>
<td>0.1-0.25</td>
<td>global</td>
<td>since mid March</td>
<td>satellite telephone + modem</td>
<td>3000-5000</td>
<td>local coverage, selected bands</td>
<td>NO</td>
</tr>
<tr>
<td>Satellite Internet (ASTRA, EUTELSAT)</td>
<td>500 Kbps</td>
<td>1.5-4.5</td>
<td>satellite footprint</td>
<td>20007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: comparison of alternative techniques for Internet connection

The following observations can be drawn from table 1:

- GSM is by no way an alternative to usual copper-line connection due to limited baud rate
- Satellite transmission is either expensive or not yet easily available, maybe because service provider have a weaker market position than major telephone companies
- A 10-time improvement of transfer capacity is provided both by ADSL (on normal copper lines) and by Internet on TV cable networks. In both cases costs are affordable (<1000 € for the first year) and infrastructure and hardware adaptation is limited. The offer is currently limited to few cities, but is due to grow rapidly. As soon as these services will become actually available and the usual trouble of emerging techniques will have been fixed, no doubt they will be of great interest for remote sensing image distribution.

Tools to facilitate access to- and use of VEGETATION data

A series of tools have been either developed or found on web servers, to help the user in retrieving and using VEGETATION data. They include routines (most often both for PC and Unix environments) for the following applications:

- automation of ftp transfer
- automation of email-based file transfer
- transformation of HDF to binary format
- 16 to 8 bit compression
- user-defined window extraction
- 1-bit plane extraction (cloud-mask) and 8-bit format storage
- production of high-quality quick-looks

All needed information may be found at the following web address:
http://www.mtv.sai.jrc.it/Vegetation/defaultVegetation.htm
Or by contacting directly the authors.
Conclusions

The VEGETATION instrument offers a global monitoring capacity, the potential market is not euro-centered but global. Data are processed in a centralised facility. It is thus important to be able to re-distribute products everywhere in a timely manner.

The main conclusion of this study is that the S10 NDVI, i.e. the most directly used product, can be redistributed everywhere in the world with existing Internet infrastructure.

For full products and daily data Internet distribution is feasible provided that Internet connections have a sufficient capacity.

It is also shown that data distribution to end-user can be automated in a sustainable manner.

Because of limited access to network resources, many users do not have access to on-line documentation and ordering procedures.

A pro-active data distribution policy should thus improve access to technical and commercial information and streamline Internet-based data delivery to end-users.

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