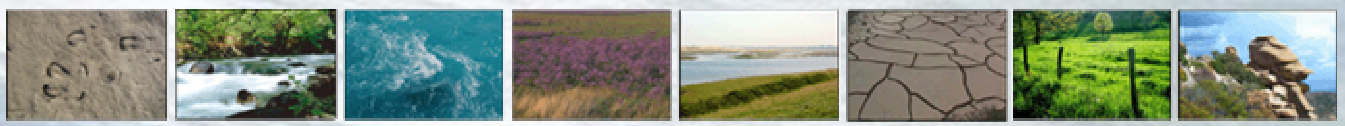
AIRBORNE IMAGING SPECTROSCOPY WORKSHOP

10 October 2006 – Bruges, Belgium

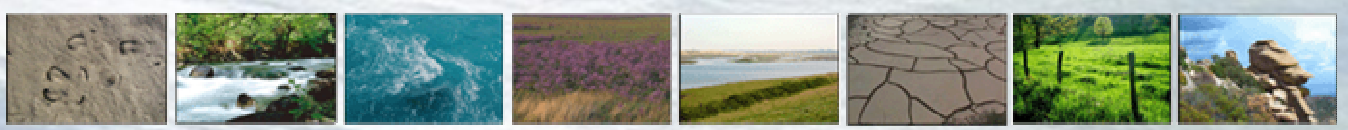


BELGIAN SCIENCE POLICY

RESULTS OF THE CONSULTATION

4 flight campaigns

Lessons learned



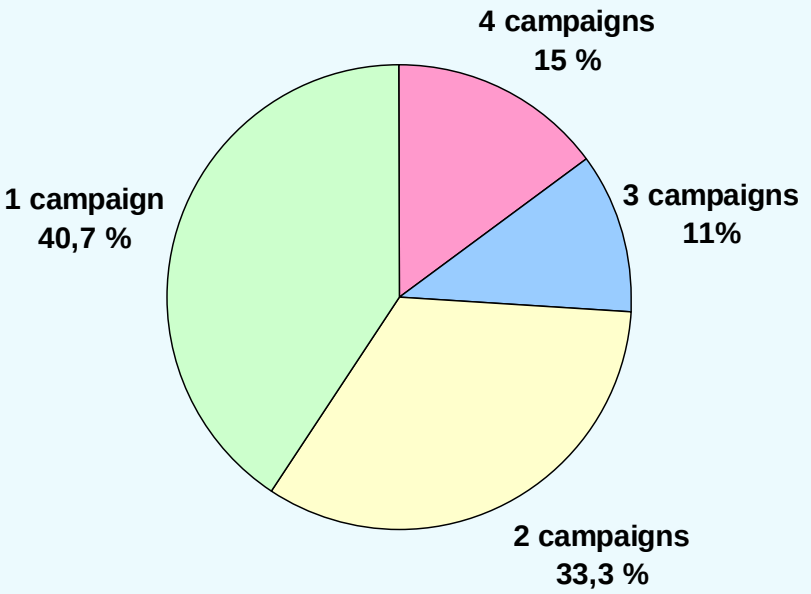
Participation in the consultation

27/52 teams answered

Participation of 52 %

40 % : used hyperspectral data previously

60% : never used hyperspectral data



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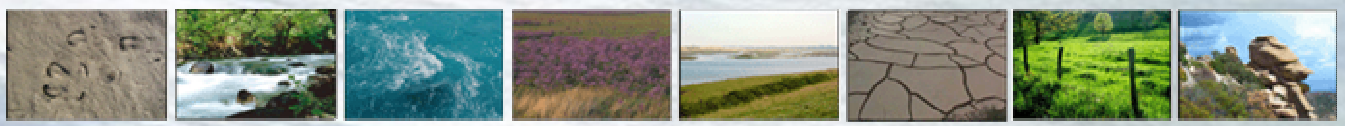
I. USE OF HYPERSPECTRAL DATA

6 questions



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1. If no previous experience : did you get the results you set out to achieve?

YES: 25 % **NO: 75 %**

Lack of experience and education:

- Too high expectations, more quantitative results expected
- Too high volume of data
- Not aware of HS data limitations: high correlation between bands and need for ground truth

Technical reasons:

- Poor image quality, noisy bands
- Difficult to synchronise flight with vegetation growth and development stages
- Timing of the campaigns not always optimal

Administrative reason:

- Too short time contract: impossible to get into depth

2. If no previous experience : did you experience any problem processing them?

YES: 50 % NO: 50 %

PROBLEM	SOLUTION
AHS	
radiometric stability	✓ additional re-correction by VITO
more systematic noise in SWIR bands	✓ high-pass filtering applied ✓ spectral treatment (e.g. smoothing)
poor signal to noise ratio in mid and far IR (ice on one of the image tracks)	✓ exclusion of poor quality spectral bands ✓ cross-track balancing of spectral data
volume of data	
CASI-SWIR	
sun glint and systematic cross track artefacts	✓ across track correlation was applied, but insufficient results
noise in the NIR bands (850-927 nm)	✓ no use of those bands
bad meteorological conditions affected the data	✓ only a subset of the image was used

2. If no previous experience : did you experience any problem processing them?

PROBLEM	SOLUTION
CASI-ATM	
bad meteorological conditions affected the data	✓ only a subset of the image was used
calibration from radiance to reflectance	✓ atmospheric corrections
HYMAP	
calibration from radiance to reflectance	✓ atmospheric corrections
volume of data	
geometric corrections (GPS info from the plane was missing)	✓ rubber sheeting the images with tie points from a DEM

3. If previous experience : other sources of hyperspectral data?

SENSOR	PROVIDER
AISA	AERODATA
ASTER	-
AVIRIS	NASA
CASI-2	DLR, NERC, ITRES/HDI, Freie Universität Berlin
CHRIS/PROBA	-
DAEDALUS	-
DAIS	DLR
FLI/PMI	-
HYMAP	HYVISTA, DLR
HYPERION	-
MERIS	-
MIVIS	-
MODIS	-
ROSIS	DLR
SASI	NERC
SmartSpectra	-
TriOS-RAMSES (in-situ measurements)	-

4. How do the STEREO flight campaigns compare with other previous experience?

Positive (10)	Negative (1)
- Good programme, centralised campaign and sharing of costs - Very efficient, mainly the pre-processing of the data - Better data than CHRIS satellite data - Wider spatial coverage than with in-situ data	- Check before the campaign: The data provider has the ability to provide information on the **quality of the pre-processing**

5. Do you intend to use hyperspectral data in the future?

YES: 92.6 % NO: 7.4%

Planned activities:

- To feed models, high information content is needed (e.g. quantification of surface properties)
- For crop characteristics and soil organic carbon estimation
- In the area of forest inventory

- Interested in developing classification algorithms
- For applying image processing techniques or learning machine in itself
- To improve methods and calibration techniques

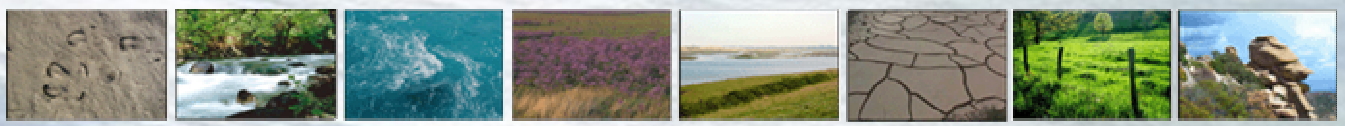
- Plan to purchase a radiospectrometer and to extend computational resources
- Mainly in-situ measurements
- New PhD student working with those data
- No new dataset is necessary (not yet fully explored)

6. If yes, even when the STEREO II programme would no longer provide them ?

YES: 80 %	NO: 20%
Money availability: - If reasonable prices - Depending on budget and contracts available - Ready to pay the commercial rates ***Alternative way to get data:*** - Common acquisition with other labs - Look for other providers (ESA, Flemish Government, Dutch Government) - Apply to EUFAR ***Sensor availability:*** - Depending on the sensors available - Interest in ARES, AHI, HYMAP, HYPERION, new NERC sensor	***Money availability:*** - No money - No money to pay at commercial rates ***Technical limitations:*** - Not enough providers - Limitation in agriculture: need of several acquisitions over the growth season - Need of more studies before the technique is operational and profitable ***Sensor availability:*** - Optimal satellite or airborne sensor not yet defined for soil applications - Lack of satellite mission - If no more STEREO campaigns, use of CHRIS/PROBA

II. THE ORGANISATION OF THE CAMPAIGNS

8 questions



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1. Did you like the formula: group shoots ?

YES: 74.1 %	NO: 25.9%
-To start, it was ok but for future activity, more funding per group is essential - Opportunity to test new data for free - Ideal formula to get acquainted with new data - Good to foster people to work with unknown data - Good way to share knowledge and to create a new community - One group shoot **should cover the same topic** (e.g. vegetation monitoring) - Good idea to test different sensors (at that condition that weather and circumstances are similar)	- Not enough support to existing thematic pools in the programme (e.g. urban RS) ***Choice of the sensor:*** - Better to stick to **one sensor** (effort to grasp the weaknesses and strong points of one sensor) - No sensor is optimal for all applications - Difficult to acquire “time series” of data (no reproducibility) -No common interest in the group => **better to organize thematic groups** ***Flight organization:*** -No flexibility to suit the specific requirements of a team ***Money:*** - The small budget does not allow much work, not enough to pay personnel. This makes the planning of the work difficult.

2. Were you satisfied with the choice of sensors?

YES: 77.8 % NO: 22.2%

3. If more than one STEREO campaign: which sensor was the most adequate for your task and why?

HYMAP	**7/15**
CASI	**4/15**
AHS	**2/15**
SWIR – ATM	**1/15**

4. Did you get involved in new partnerships because of the campaigns?

YES: 77.8 % NO: 22.2%

- Biologists of mud
- Other colleagues from other Belgian or international universities specialised in the same area
- VMM, NIOO, INBO, ONERA France, TOTAL, Nynas, Sfax and Tunis

5. Did the campaigns foster new scientific ideas within your team?

YES: 75.2 % NO: 14.8%

- Financial means did not follow
- The projects were too short to develop these new ideas
- The absence of personnel hampered to progress

6. Was the information adequate?

	YES	NO
Information files from BELSPO	**100 %**	0 %
Kick-off meeting	**96.3 %**	3.07%
Sensor information prior to the campaign	**88.9 %**	11.1 %
Preparation of the campaign with VITO	**74.1 %**	25.9 %
Communication VITO/scientists during the flight campaign	**92.6 %**	7.4 %
Communication VITO/scientists after acquisition	**85.2 %**	14.8 %

6. Was the information adequate?

Positive	Negative
- Satisfactory - People at VITO available, helpful and informative, even after the campaign about data analysis - Close collaboration between VITO and research teams - An important point is the communication on the required measurements for atmospheric correction of the images	- Not enough information about the delivery period of the data - More insufficient communication between VITO and the subcontractors than between VITO and research teams concerning the delivery of the data -The way of the decision Flight/No flight within VITO was not enough transparent - Not enough information about the SNR and the quality of the data

7. Pool of instruments for ground measurements: should it be sustained and expanded?

YES: 55.5 % **NO: 44.6 %**

Other instruments suggested

- To estimate energy budget
- GER spectrometers (easy to handle on the field)
- SOC-400 sensor : ground spectra measurements in TIR
- Black body calibrators if thermal acquisitions are planned

8. Were the ground measurements carried out in a professional and timely manner ?

YES: 77.8 % **NO: 22.2 %**

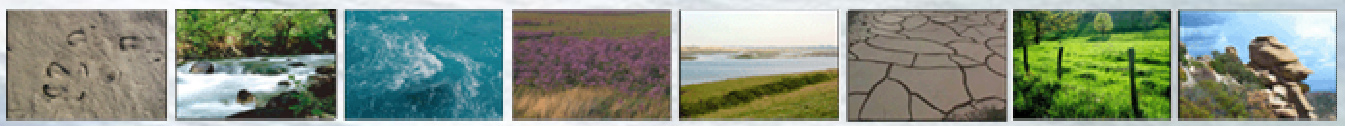
Comments

- CASI 2003: too poor field measurements
- HYMAP and AHS: good field measurements
- HYMAP: due to logistic problems (3 flights on one day), no proper atmospheric measurements were made

- Good, but too expensive: 2
- ASD bought by BELSPO: renting price too high => will be rent in The Netherlands

III. THE QUALITY OF THE DATA

6 questions



1. What do you consider timely delivery of data ?

1 month and less:	4
2 months:	2
3 months:	**10**
6 months:	1
On time:	1
No Answer (NA):	**9**

2. Were the data delivered on time ?

YES: 29.6 % **NO: 70.4 %**

Processing chain at VITO

- Delivering data in time is not interesting if they have to be processed again due to errors
- One month should be possible with an efficient processing chain
- Processing chain at VITO should be improved to avoid delay of delivery
- Delivery time also depends on sub-contractors. VITO should have strict conditions with them

3. Was the quality of the data adequate ?

YES: 66.7 % NO: 33.3 %

If not, what was the problem?

CASI 2002

- Bad flight conditions
- Geometric and radiometric corrections

CASI 2003

- Bad flight conditions

HYMAP

- Some artefacts in the SWIR: inadequate ground measurements?
- Radiometric corrections

AHS

- Geo-referencing
- Radiometric stability: 4
- SNR too high in SWIR and doubts on atmospheric correction: 2

General

- Adequate control of the data delivered should be made by VITO before distribution
- Common terminology and units should be used

4. Did you receive enough ancillary data?

YES: 66.7 % NO: 33.3 %

- Not enough explanation on the data pre-processing
- No clear documentation

5. What was the spectral range you were interested in?

Ranking:

1. **VIS-NIR: 7** and **VIS-NIR-SWIR: 7**
2. VIS-NIR-SWIR-TIR: 4
3. VIS: 3
4. VIS-NIR-TIR: 1
5. TIR: 1
6. NA: 4

6. Which of the following data processing levels do you prefer to receive?

Ranking:

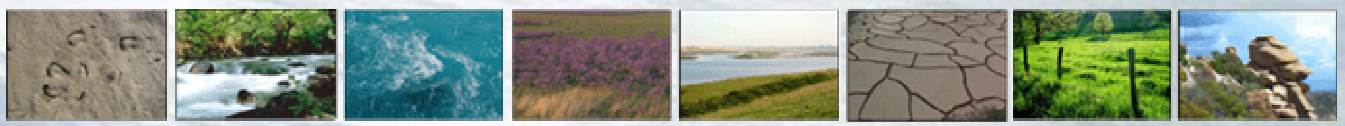
1. **Atmospherically corrected data: 19/24**
2. **Geo-corrected and geo-located data: 19/24**
3. System calibrated data: 11/24
4. Ancillary data (view/illumination angles): 8/24
5. Raw, uncorrected data: 7/24
6. Higher level products (surface albedo, LAI, fPAR, NPP, etc.): 3/24
7. NA: 3

Comments:

- The type of the data may vary depending on the research project
- Advanced pre-processed data are necessary to develop downstream applications

>< We need to be able to control the pre-processing (e.g. atmospheric corrections, geo-referencing)

IV. CONCLUSIONS AND SUGGESTIONS FOR CHANGE



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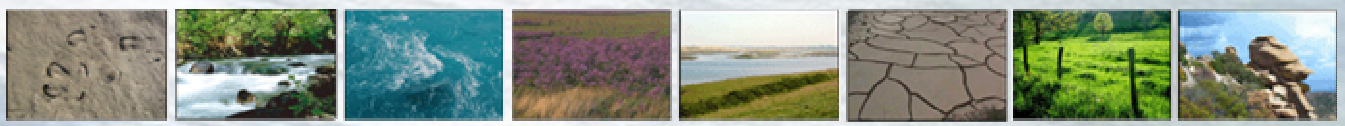
- In comparison with other flight campaigns, the STEREO ones were evaluated positively
- 75% of the new users of HS data did not get the results they expected
- 50% of them experienced problems in processing the data
- The group shoot formula was appreciated
- The HYMAP sensor covering VIS-NIR-SWIR seems to suit well to the need of the participants
- New partnerships and new ideas were fostered by the campaigns

- The information provided was adequate in general
- The pool of instruments for ground measurements had less success
- 3 months is considered as a timely delivery of data
- It was highlighted that during these campaigns the data were not delivered on time
- The participants were not always satisfied with the quality of the data
- Level-2 data are mainly expected
- More than 90% of the participants intend to use HS data in the future even if STEREO will no longer provide them

VITO	BELSPO
Time	***Objective of the campaigns***
- Improve the processing chain (quality and timely delivery)	- No more group shoots, but scientific projects
- More relaxed time table and increase the flexibility of the campaigns	- Thematic flight campaigns
Instrument pool	- Selection by external reviewers may hamper some teams to get experienced in hyperspectral RS
- Expansion of the instrument pool	***Money***
- Cost reduction of instrument pool	- Not enough budget, double it!
Sensor	- Longer projects needed
- Avoid noisy sensor	***Sensor***
Data documentation	- Stick to one sensor
- Provide information on the quality of the pre-processing	***Covered area***
Communication	- Not limit the campaign to Belgium and vicinity
- To be improved with the subcontractors	

Thank you for your participation

in this consultation



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