3rd FIG Regional Conference, Jakarta, Indonesia, October 3-7, 2004

**An overview of the CHRIS/PROBA Mission:
A new generation of multi-angle hyperspectral remote sensing and its potential application to agriculture**

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What the Presentation About….

⌘ **CHRIS/Proba Mission Objective and Platform Characteristic**
⌘ **Data Quality Assessment of test sites**
 ➢ **CHRIS DATA Quality at test sites**
 ➢ **Spatial and Spectral Comparison**
 ➢ **Classification Result..example**
⌘ **Potential use for agriculture**
⌘ **Current issue of CHRIS acquisition at Australia test sites**
⌘ **Summary**

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CHRIS/PROBA

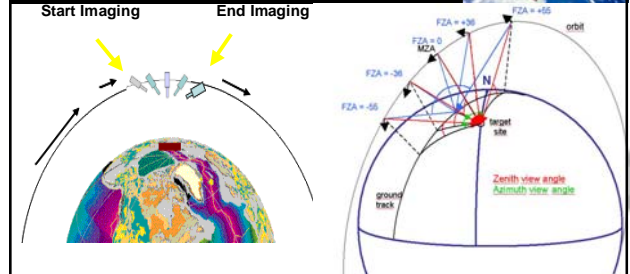**CHRIS :** Compact High Resolution Imaging Spectrometer
PROBA: Project for On-Board Autonomy

Mission Objectives

✴ **Provide Earth Surface Reflectance at 400-1050 nm (VIS/NIR), 'high spatial' & spectral resolution using 'lite' satellite**
✴ **Used for atmospheric, land, water and vegetation studies**
✴ **Capability to acquire data at different <u>viewing angle configuration</u> in short time interval**

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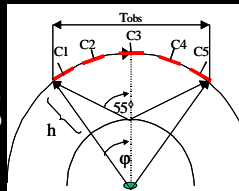# CHRIS Multi-angular Viewing and Observation Time During Acquisition

- **Five different angles acquisition for each target site**
- **Interval angle (Fly Zenith Angle) 20-35º**
- **Average time observation 00.03'20"**

CHRIS Acquisition Time at Colly site

$$Tobs =$$
Tsc+Tmar+ → 1st Acquisition (C1)
Tsl+Tmar+Tsc+Tmar+ → 2nd acquisition (C2)
Tsl+Tmar+Tsc+Tmar+ → 3rd Acquisition (C3)
Tsl+Tmar+Tsc+Tmar+ → 4th Acquisition (C4)
Tsl+Tmar+Tsc → 5th Acquisition (C5)

Date	+55 (C1)	+36(C2)	0(C3)	-36(C4)	-55(C5)	Tobs
Nov-03	11.35.02	11.35.52	11.36.42	11.37.32	11.38.22	00.03'20''
Feb-04	11.32.01	11.32.51	11.33.49	11.34.31	11.35.22	00.03'21''
Mar-04	11.39.01'	11.39.51	11.40.41	11.41.31	11.42.22	00.03'21''
May-04	10.37.09	10.37.59	10.38.49	10.39.39	10.40.29	00.03'20''

CHRIS/PROBA Key Characteristics & Sensor Modes

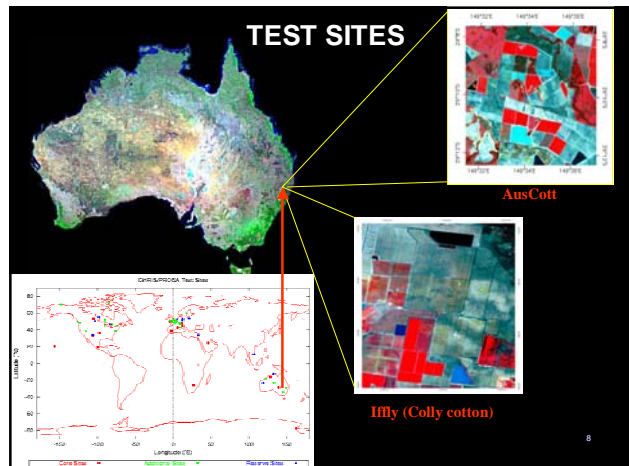|	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5
Band Number.	62	18	18	18	37
Band Range (nm)	406- 992	406-1003	438-1035	486-788	438-1003
Band With (nm)	6-20	6-33	6-33	6-11	6-33
Resolution at nadir	34	17	17	17	17
Mean Altitude Range	615 (560-670)km				
Type of Orbit	Sun Synchronous				
Equator Crossing time	10.30				
Orbital Period	96.95 minutes				
Inclination	97.898 degrees				
Eccentricity	0.01				
Repeat cycles	Approximately 16 days				
Orbit Drift	< 2 degrees per year				
Bands Application	Atm / agri	Water	Land	Chlorophyll	Land

Test sites (Australia)

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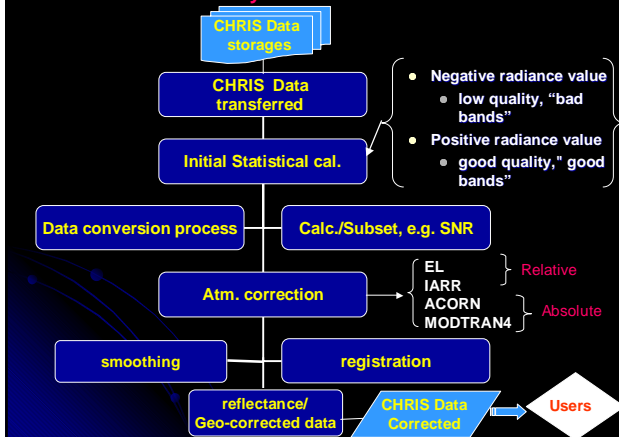## 18-band CHRIS Datasets (Mode3)..an example

Mode information for each channel:
- Minimum wavelength
- Maximum wavelength
- Middle wavelength
- Band Width
- Gain
- Row Number for Minimum wavelength
- Row number for Maximum wavelength
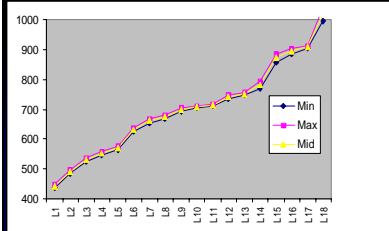
Band	Mid	width
L1	442.347	12.150
L2	490.983	11.577
L3	530.713	11.492
L4	551.949	12.878
L5	570.543	10.663
L6	631.732	14.046
L7	661.351	15.681
L8	674.730	10.933
L9	697.428	11.777
L10	706.333	6.0845
L11	712.509	6.1816
L12	741.471	13.452
L13	751.694	6.9621
L14	780.421	22.342
L15	870.936	27.154
L16	894.079	18.856
L17	908.298	9.6018
L18	1016.591	43.491

TEST SITES

AusCott

Iffly (Colly cotton)

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Initial Data Quality Assessment Method

- Negative radiance value
  - low quality, "bad bands"
- Positive radiance value
  - good quality," good bands"

EL / IARR — Relative
ACORN / MODTRAN4 — Absolute

A. CHRIS DATA QUALITY

1. 'Raw' Radiance Quality

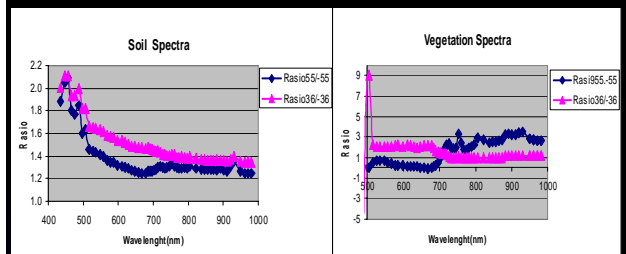| Sites	Date Acqu.	No. of Bands /Mode	Bad Band Band position	Bad Band Total	Good Band Band position	Good Band Total	Good/Bad Band Ratio
Colly	21-2-04	62 (1)	1,5-12	9 (14.52%)	2-4, 13-62	53 (85.48%)	7:1
	29-5-04	18 (3)	18	1 (5.55%)	1-17	17 94.45%	17:1
Aus-Cott	25-3-04	62 (1)	1-11, 16,	12 (19.35%)	12-15, 17-62	50 (80.65%)	5:1
	09-4-04	18 (3)	11-18	8 (44.44%)	1-10	10 (55.55%)	2:1

"Bad" = negative radiance
"Good" = positive radiance

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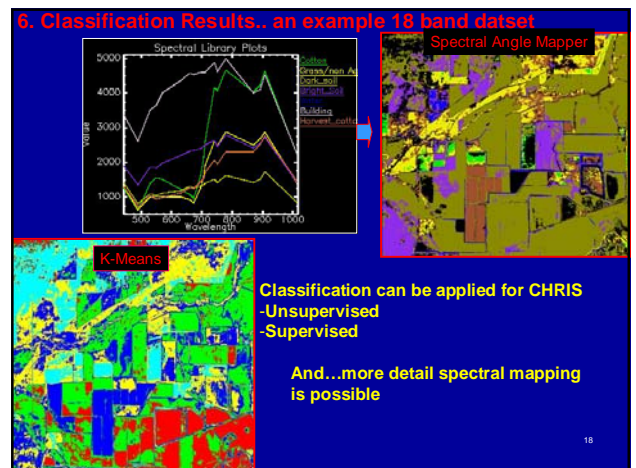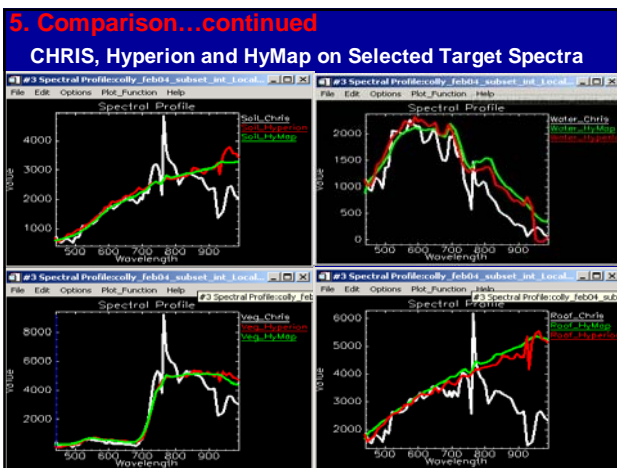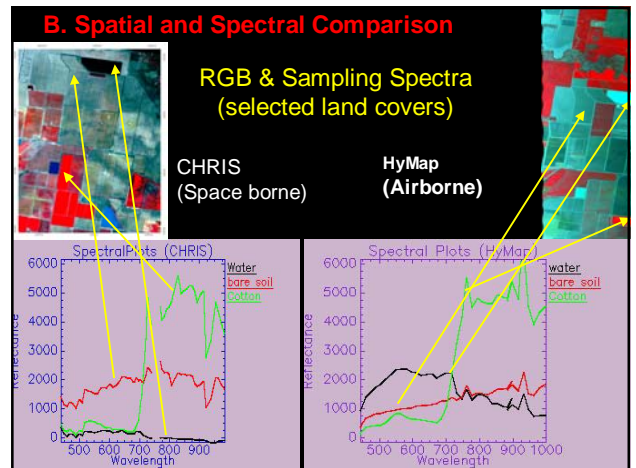### 2. SNR of CHRIS raw radiance values

$$ SNR_{i} = \frac{\overline{DN_{i}}}{\sigma_{i}} $$

← Mean in Channel i

← Standard Deviation in Channel i

Sites	Date	Total Bands	0deg Min	0deg Max	36deg Mi	36deg Max	-36deg Min	-36deg Max	55deg Min	55deg Max	-55deg Min	-55deg Max
Colly	21-2-04	62	3.3	10.6	3.4	12.6	3.1	10.3	5.2	18.3	4.8	11.4
	29/5/04	18	2.2	8.1	2.9	8.3	1.9	5.0	3.7	16.9	1.1	3.6
AusCot	25/03/04	62	2.4	8.0	2.7	8.6	1.9	7.4	2.7	8.6	2.4	8.6
	09/04/04	18	3.0	9.0	3.5	10.4	2.7	8.8	3.7	15.8	2.8	11.7

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- Ratio of corresponding view directions and wavelength

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3. CHRIS Radiance Image Sequence (Uncorrected)

+55º (N-S) +36º (N-S) (S-N)

18-band, 17 m

62-band, 34 m

18-bands

62-bands

4. CHRIS Image Sequence (corrected)

+55deg +36deg 0º(Nadir) -36deg -55deg

18-band, 17 m

62-band, 34 m

Reference points

CHRIS Surface Reflectance Data

ROI

18-band Spectra

0deg
36deg
min36deg
55deg
min55deg

62-band Spectra

0deg
36deg
min36deg
55deg
min55deg

B. Spatial and Spectral Comparison

RGB & Sampling Spectra
(selected land covers)

CHRIS
(Space borne)

HyMap
(Airborne)

Spectral Plots (CHRIS)

Spectral Plots (HyMap)

water
bare soil
Cotton

5. Comparison…continued

CHRIS, Hyperion and HyMap on Selected Target Spectra

Soil_Chris
Soil_Hyperion
Soil_HyMap

Water_Chris
Water_HyMap
Water_Hyperion

Veg_Chris
Veg_Hyperion
Veg_HyMap

Roof_Chris
Roof_HyMap
Roof_Hyperion

6. Classification Results.. an example 18 band datset

Spectral Library Plots

Spectral Angle Mapper

K-Means

Classification can be applied for CHRIS
-Unsupervised
-Supervised

And…more detail spectral mapping is possible

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Potential Use of CHRIS dataset for Agriculture

- ❏ **Selectable band modes**
  - ➢ Spectral Resolution (18, 37, 62 channels)
  - ➢ Spatial resolution (17, 34 m)
  - ➢ High percentage of "good" bands
- ❏ **Multi-angle viewing capability**

⌘ **CHRIS dataset can be used for:**

- ❖ Image Classification (spatial analysis)
- ❖ Spectral Analysis for Vegetation/Crop & Soil
- ❖ BRDF/Vegetation retrieval models

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Current Issues of CHRIS Application at Colly and AusCott

- ❏ Multi-date data set
  - CHRIS / PROBA as unique opportunity
  - Before, during and after growing season
  - Data assimilation (crop growth models)
- ❏ Noise correction
  - Drop outs (horizontal lines)
  - Vertical striping.
- ❏ Atmospheric correction
- ❏ CHRIS Modes Selection
- ❏ Validation
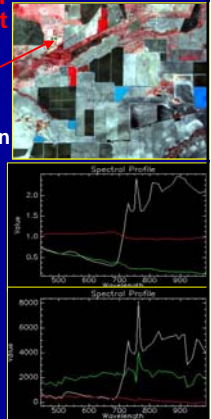
SUMMARY

CHRIS imagery of test site indicates

- ❖ Useful for mapping spatial variation of land surface
- ❖ Multi-angle images, possibility better classification.
- ❖ Inversion of canopy BRDF models possible.
- ❖ Available image analysis techniques could be used to derive better products, eg. red-edge, BRDF retrieval, spectral mapping etc.

Website : http://www.rsal.co.uk/chris