ESA - MOST Dragon 2 Programme

2011 DRAGON 2 SYMPOSIUM

中国科技部-欧洲空间局合作 "龙计划"二期

"龙计划"二期2011年学术研讨会

Improving methods of crop monitoring with ENVISAT data

Li Qiangzi

Institute of Remote Sensing Applications (IRSA)
Chinese Academy of Sciences, P. R. China

Outline

- Overview
- Crop Classification combine HJ-1 A CCD and ENVISAT ASAR
- Classification of winter wheat and cotton Using multi-configuration SAR data in the North China Plain
- Next steps

Overview

Project ID 5279

- Objects:
  - Develop new crop identification and crop acreage estimation methodologies based on ENVISAT ASAR/MERIS data
  - Crop yield estimation based on crop simulation models driven by ENVISAT derived index
- Research group
  - China side: IRSA, CAS
    - Prof. Wu Bingfang (PI)
    - Assoc. Prof. Li Qiangzi, Jia Kun, Meng Jihua, Du Xin, Zhang Feifei
    - Ph. D. Candidate, Zhang Miao
  - European partener: VITO TAP, Belgium
    - Ir. Herman Eerens (Co-PI)
    - Dr. Qinghan Dong

ESA - MOST Dragon 2 Programme

2011 DRAGON 2 SYMPOSIUM

中国科技部-欧洲空间局合作 "龙计划"二期

"龙计划"二期2011年学术研讨会

Crop Classification combine HJ-1 A CCD and ENVISAT ASAR

20 - 24 June 2011 | Prague | Czech Republic

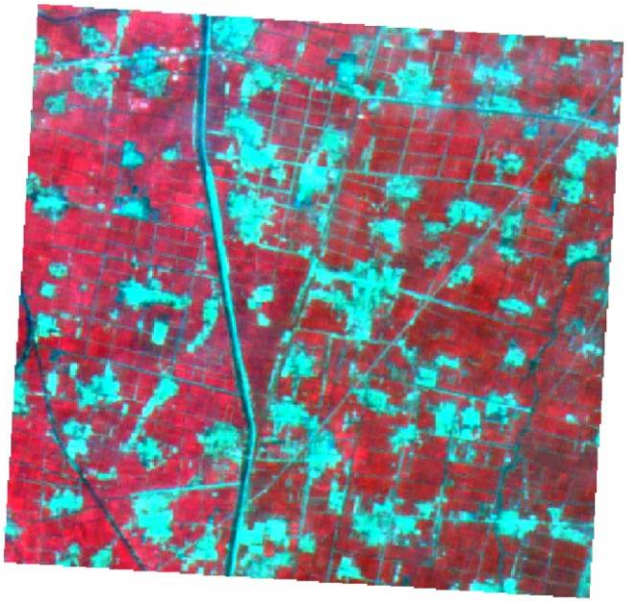
捷克 布拉格 2011年6月20-24日

Study area

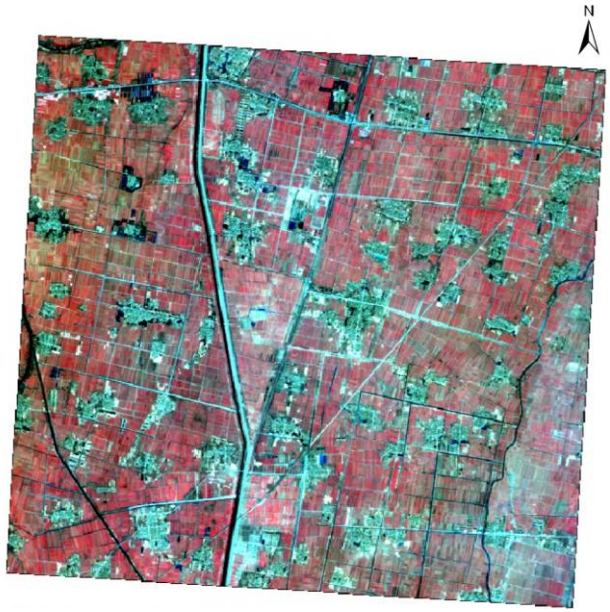
- Yucheng is a typical area of North China Plain where winter wheat are widely planted.

Data and method

ASAR IMP Data
Polarization: VV
Resolution: 30m
Date: 20090508
Acquired from ESA



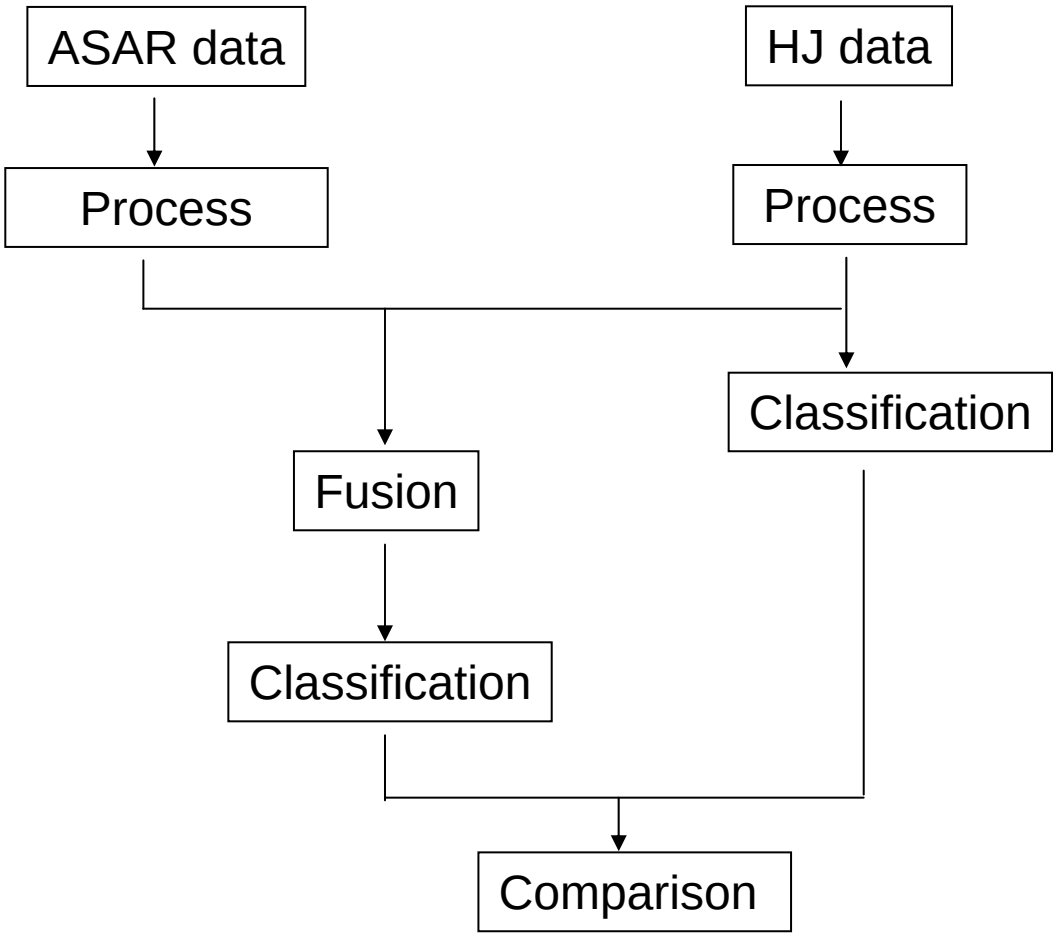
HJ CCD Data
Resolution: 30m
Date: 20090512
Acquired from China



RapidEye Data
Resolution: 5m
Date: 20090220

Data and method

Main Concept

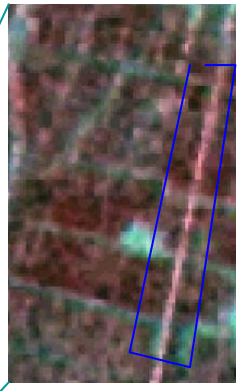


Data preprocessing

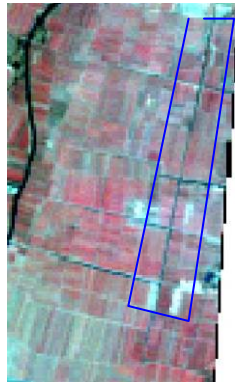
- ASAR data process
  - Tools: NEXT 3A
  - The main process step
    - Import
    - Calibration
    - Filter
    - Projection
- HJ data process
  - The main process step
    - Calibration
    - Geo code

Date fusion

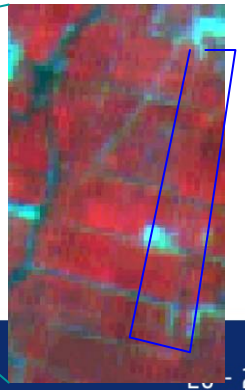
ASAR and HJ data have the same spatial resolution, but the ASAR VV data is more sensitive to border of farm field, in order to get better classification result, we fused the ASAR and HJ data using PCA method.



Merged data



RapidEye



HJ

Classification

- Classification methods used in this study
  - Maximum Likelihood Classification
  - Support Vector Machine
  - Neural network

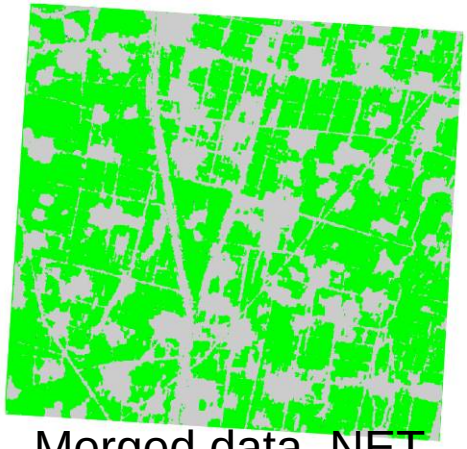
Classification Results

Classification of HJ data and fusion data, using MLC, SVM and NET classify method.

HJ data, SVM

Merged data, MLC

Merged data, SVM



Merged data, NET

wheat

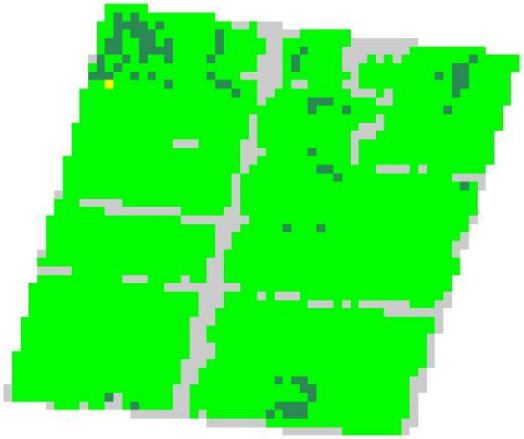
cotton

House & road

tree

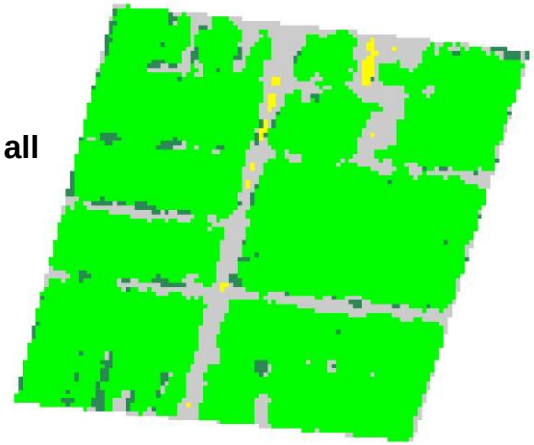
Validation

The ground truth of part of the study area

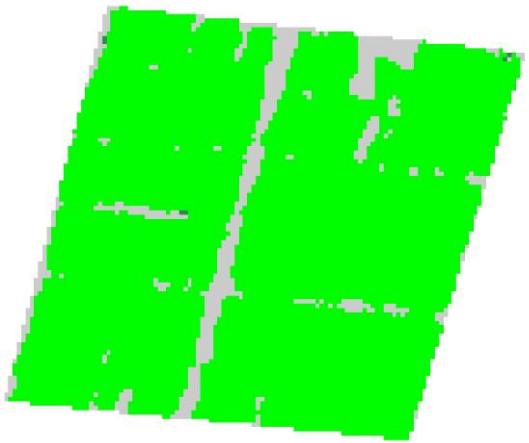


HJ, SVM

Merged, MLC



Merged, SVM



Merged, NET

Validation and precise assessment

Data used	Classification method	wheat	cotton	tree	House & road	Classification accuracy
Ground truth	--	88.38%	0.64%	1.94%	9.04%	--
HJ	SVM	84.75%	0.04%	3.57%	11.63%	89.2%
Merged	MLC	75.05%	3.01%	8.68%	13.26%	90.5%
Merged	SVM	85.12%	0.58%	2.82%	11.48%	94.3%
Merged	NET	90.85%	0.00%	0.07%	9.08%	92.4%

The classification accuracy in this study is calculated based on randomly selected ground truth regions

Conclusions

- HJ multi-spectral data can effectively classify crop, but the field border can not be effectively recognized and exist misclassification.
- ASAR VV polarization data can improve the spectral information of optical data, which leading to the enlarging of the spectral difference between different classes and improving the classification accuracy.
- The overall classification performance of the fusion data are better than only using HJ CCD data.
- Envisat ASAR VV polarization data is sensitive to the non-agrarian information of planted field, and VV polarization data joined classification can effectively distinguish the field border.
- VV polarization data is sensitive to structure information and leads to the enlarging of field borders, and then the crop acreage will be shrinking in the classification result.

ESA - MOST Dragon 2 Programme

2011 DRAGON 2 SYMPOSIUM

中国科技部-欧洲空间局合作 "龙计划"二期

"龙计划"二期2011年学术研讨会

Classification of winter wheat and cotton Using multi-configuration SAR data in the North China Plain

20 - 24 June 2011 | Prague | Czech Republic

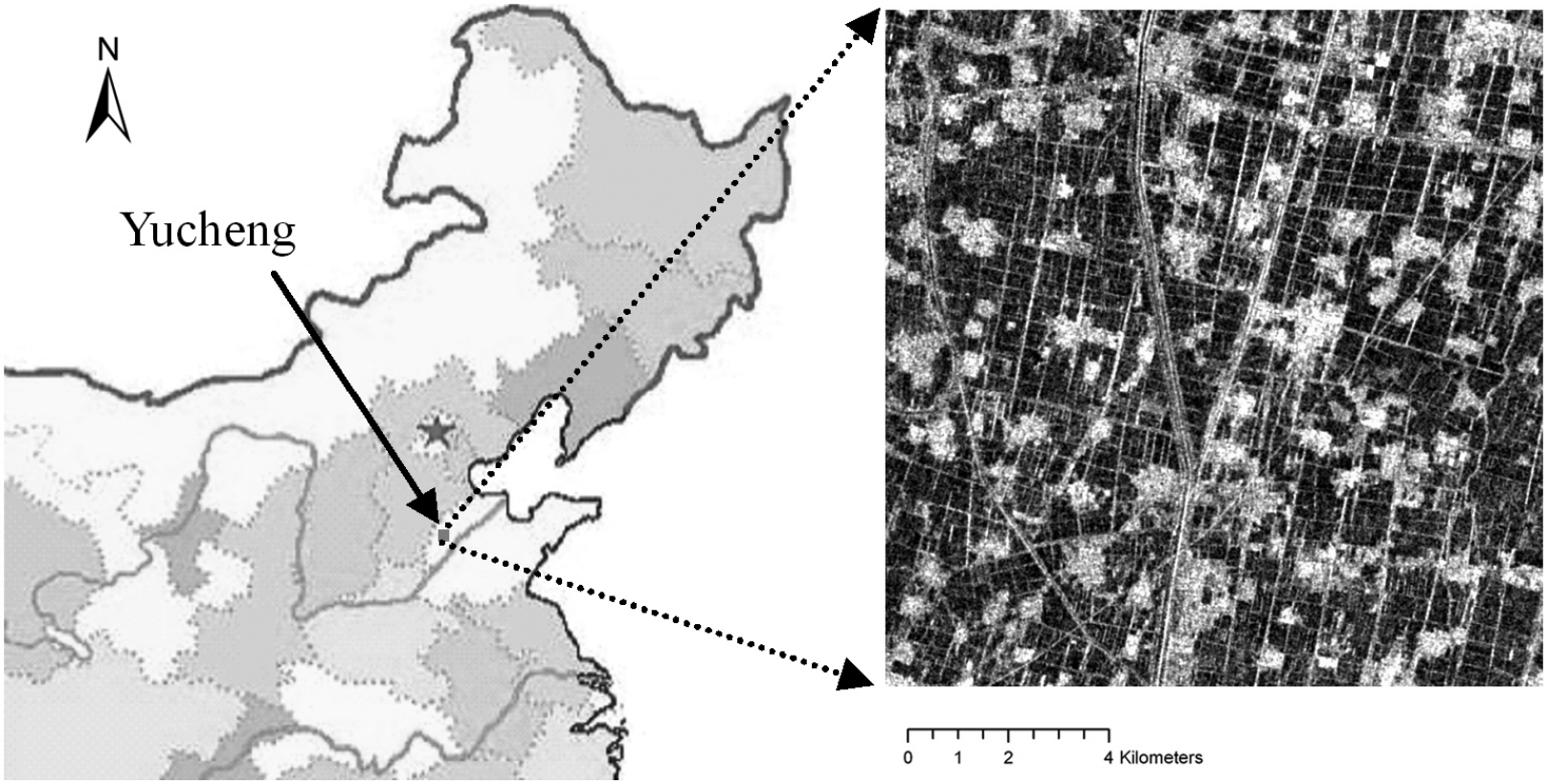
捷克 布拉格 2011年6月20-24日

Objective

- to evaluate the capability of SAR data for upland field classification
- classification accuracy improvement of integrating ASAR and TerraSAR-X data
- texture information for improving classification accuracy

Study area

- Yucheng is a typical region of North China Plain where winter wheat are widely planted.



Data

Table 1. Main characteristics of the data sets used in this study

SAR Type	Date (dd/mm/yy)	Incidence angle	Polarization	Mode	Periods of wheat	Simple code
ASAR	27/02/2009	19.2˚-26.2˚	VV	IMP	Regreen	A1
ASAR	03/04/2009	19.2˚-26.2˚	VV	IMP	Jointing	A2
ASAR	08/05/2009	19.2˚-26.2˚	VV	IMP	Flowering	A3
TerraSAR-X	10/05/2009	40.0˚~41.2˚	HH	Stripmode	Flowering	T

Data Preprocessing

- Envisat ASAR, C-band
  - **3** acquisition, **IMP** mode, **VV** polarization,**30** resolution
  - radiance calibration
  - geo-correction and speckle reduction was carried out in NEST 3A software

$$\sigma^0 = A^2 \times \sin(\alpha) / K$$

- TerraSAR, X-band
  - stripmap Mode
  - HH polarization
  - absolutely radiance calibration
  - geo-correction
  - speckle reduction.

$$\sigma^0 = (K_s \times DN^2 - NEBN) \times \sin\theta$$

$$NEBN = K_s \times \sum_{i=0}^{\deg} coeff_i \times (\tau - \tau_{ref})^i, \tau \in [\tau_{\min}, \tau_{\max}]$$

Methods

1. **Texture features extraction (**only use SAR data acquired in flowering period of wheat**)**
   - Homogeneity
   - Contrast
   - Entropy
   - Angular second moment

$$HOM = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1}\frac{P(i,j)}{1+(i-j)^2}$$

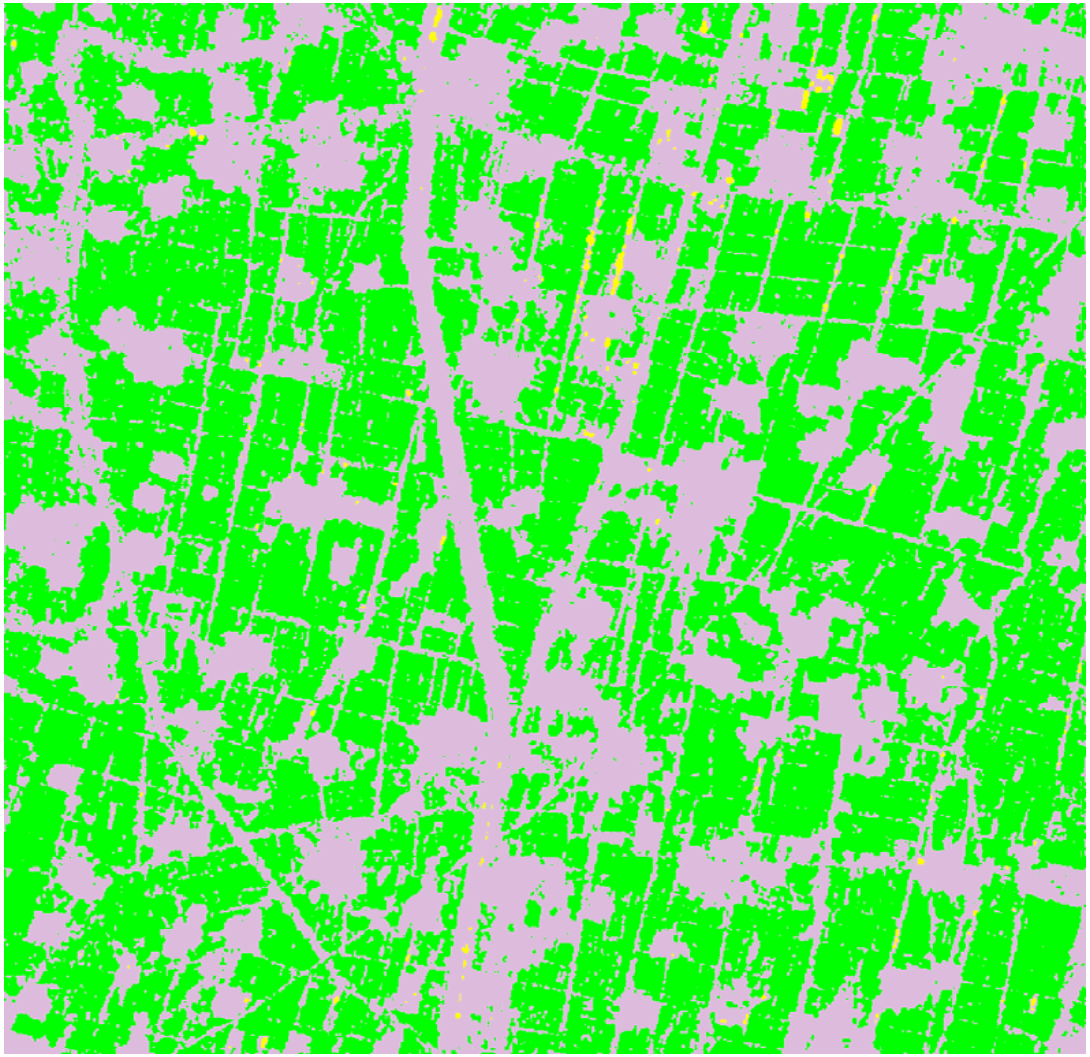
$$CON = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1}P(i,j)\times(i-j)^2$$

$$ENT = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1}-P(i,j)\times\log_e(P(i,j))$$

$$SAM = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1}P(i,j)^2$$

2. **Classification**
   - 3 class types: Wheat, cotton and non-crop
   - Using different combination of image and texture features
   - Classifier: Support Vector Machine (SVM)

Classification Results



Classification results using SVM classifier based on combinations of the three ASAR data, TerraSAR data and Texture features extracted from the SAR data acquired in flowering period of wheat

Wheat

Cotton

Non-crop

Accuracy analysis

Backscatter Data	Accuracy	Kappa	Backscatter + Texture	Accuracy	Kappa
A3[a]	65.19%	0.38	A3+Texture	70.42%	0.47
T	61.74%	0.32	T+Texture	65.90%	0.39
A1+A2	59.31%	0.25			
A1+A3	82.19%	0.67			
A2+A3	82.39%	0.68			
A1+A2+A3	84.12%	0.71	A1+A2+A3+Texture	88.62%	0.80
T+A1	71.74%	0.48			
T+A2	71.63%	0.48			
T+A3	86.55%	0.76			
T+A1+A2	71.23%	0.47			
T+A1+A3	86.91%	0.76			
T+A2+A3	87.72%	0.78			
T+A1+A2+A3	88.48%	0.79	T+A1+A2+A3+Texture	91.83%	0.86

[a]The sample code explanations are given in Table 1. (e.g.: A means ASAR data. A1+A2 means the classification was done using A1 and A2 data.

Discussion

- Considering only multi-temporal ASAR data
  - Accuracy increased with more ASAR data adding for classification
    - Overall classification accuracy 84.12% (A1+A2+A3)
  - Importance of ASAR acquired in different time
    - A3(anthesis stage) > A2 (jointing stage) > A1 (regreen stage)
  - A2+A3 performed nearly as well as A1+A2+A3

Discussion

- Considering multi-frequency SAR data (ASAR + TerraSAR)
  - Multi-frequency is better than multi-temporal
    - 86.55% (T+A3)
    - 84.12% (A1+A2+A3)
  - Importance of different frequency SAR data
    - A3 > T (overall accuracy: A3 > T, A2+A3 > T + A2) **???**
      - Maybe C band is better
      - Different polarization
      - Different spatial resolution
      - Investigation in future work

Discussion

- Considering texture features
  - When texture information involved in classification, the accuracy can be improved evidently
    - 2% to 6% classification accuracy improvement
- Classification accuracy improved as more and more information involved
  - All features used for classification achieved overall accuracy 91.83% (T+A1+A2+A3+Texture)

Conclusion

- Satisfactory accuracy would be got for upland crop classification if multi-configuration SAR data being available
- Classification accuracy could be improved when integrating of two frequency ASAR and TerraSAR-X data
- A combination of two frequencies SAR data (X- and C-band) is better than multi-temporal C-band SAR data for crop classification
- Two appropriate temporal SAR data sets are sufficient for crop classification in this study, and adding more temporal data has almost no effect on improving classification accuracy
- Texture information of SAR data was important for crop classification and improved classification accuracy obviously

Next steps

- New crop acreage estimation method research
- Envisat ASAR to be used for soil moisture inversion to support water stress factor of biomass model
- Crop yield model development assimilating field biomass and Harvest index estimation

Thanks for attention!
谢谢

Contact Information
Li Qiangzi
Tel: (86)10 64855094
Fax:(86)10 64858721
Email: lqz@irsa.ac.cn