



# 遥感技术用于中国森林资源监测与评估

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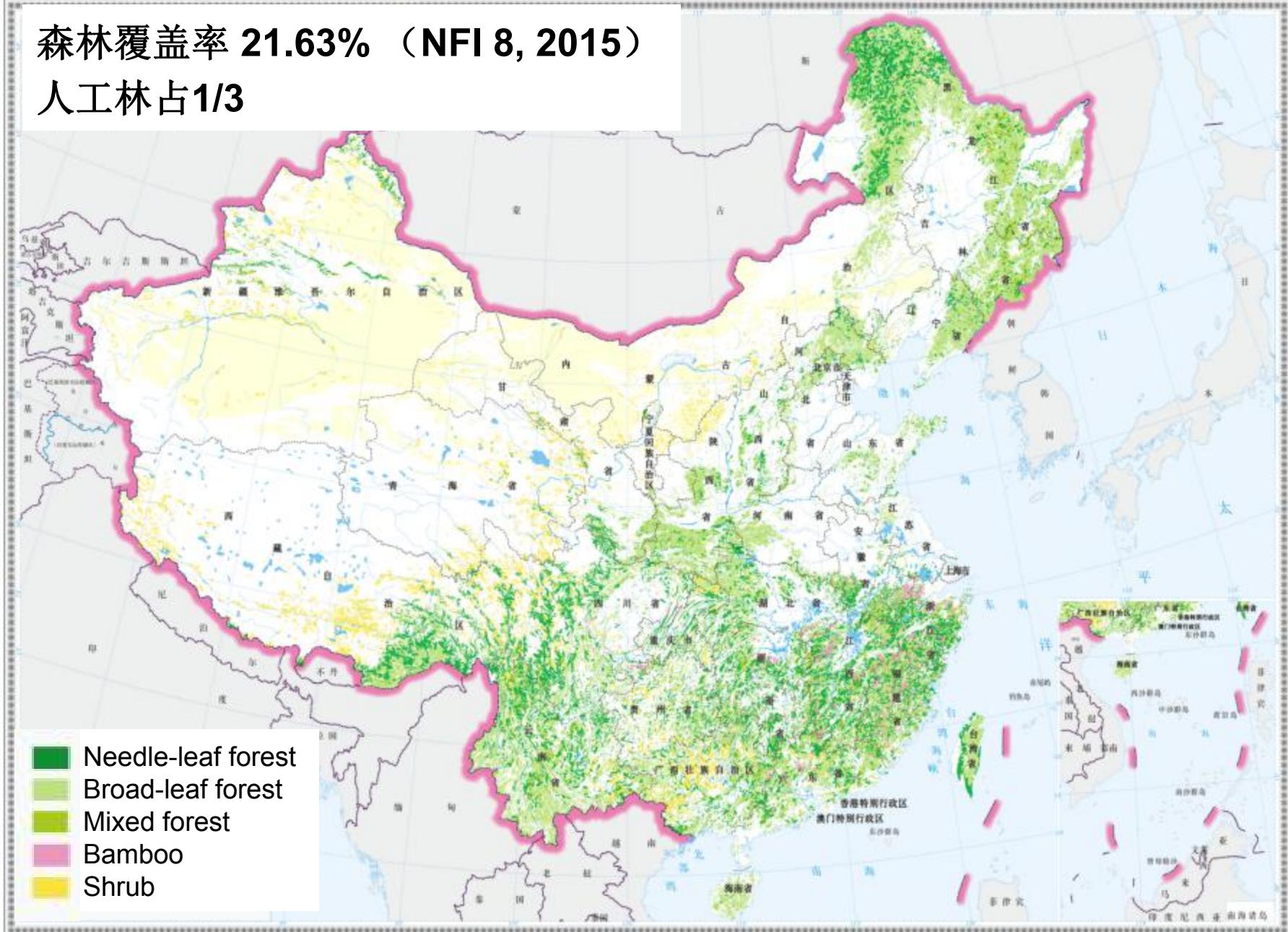
# 报告大纲

1. 引言
2. 中国高分对地观测系统及林业应用
3. 星机地综合观测及森林参数反演
4. 国际合作
5. 小结
6. 合作机会展望

# 中国森林资源

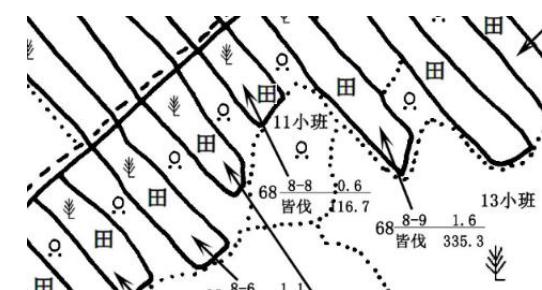
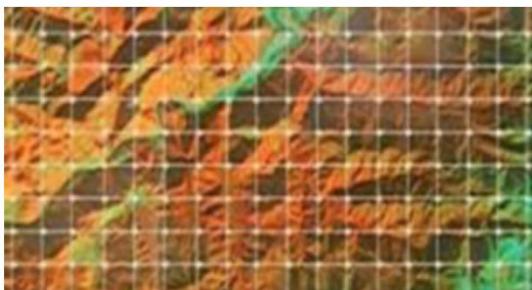
森林覆盖率 21.63% (NFI 8, 2015)

人工林占1/3



# 中国森林资源调查体系

Types (Tasks)	Institution	Period	Scope
<b>National forest inventory (NFI) (Level I)</b>	<b>Provincial Forestry Department under the coordination of the State Forest Administration (SFA)</b>	<b>5 yrs</b>	<b>National</b>
<b>Forest management planning inventory (Level II)</b>	<b>Provincial Forestry Department</b>	<b>5 or 10 yrs</b>	<b>County Forest management unit (FMU)</b>
<b>Forest operational design inventory (Level III)</b>	<b>Forest Management Unit Forest enterprises</b>	<b>on demand</b>	<b>Sub-compartment</b>

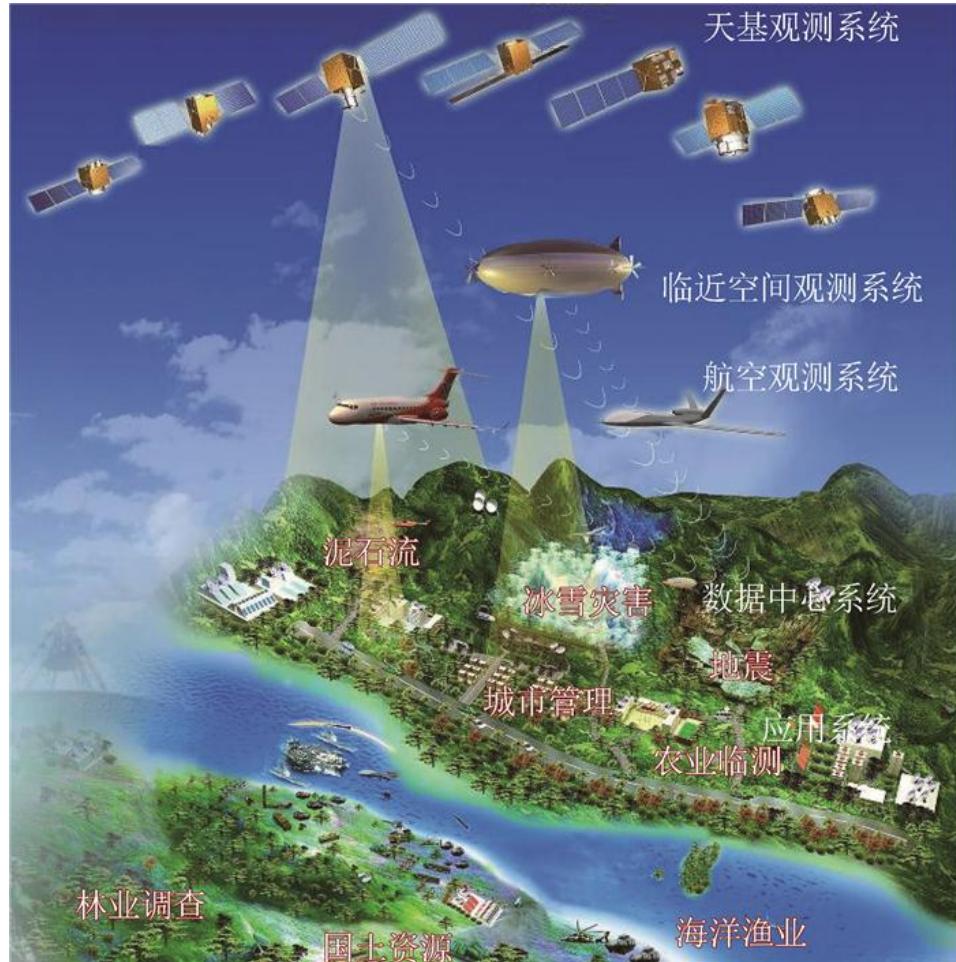


# 中国高分辨率对地观测系统 (简称高分)

中国高分辨率对地观测系统（简称“高分专项”），是《国家中长期科学和技术发展规划纲要（2006～2020年）》所确定的16个重大专项之一，于2010年经过国务院批准启动实施。

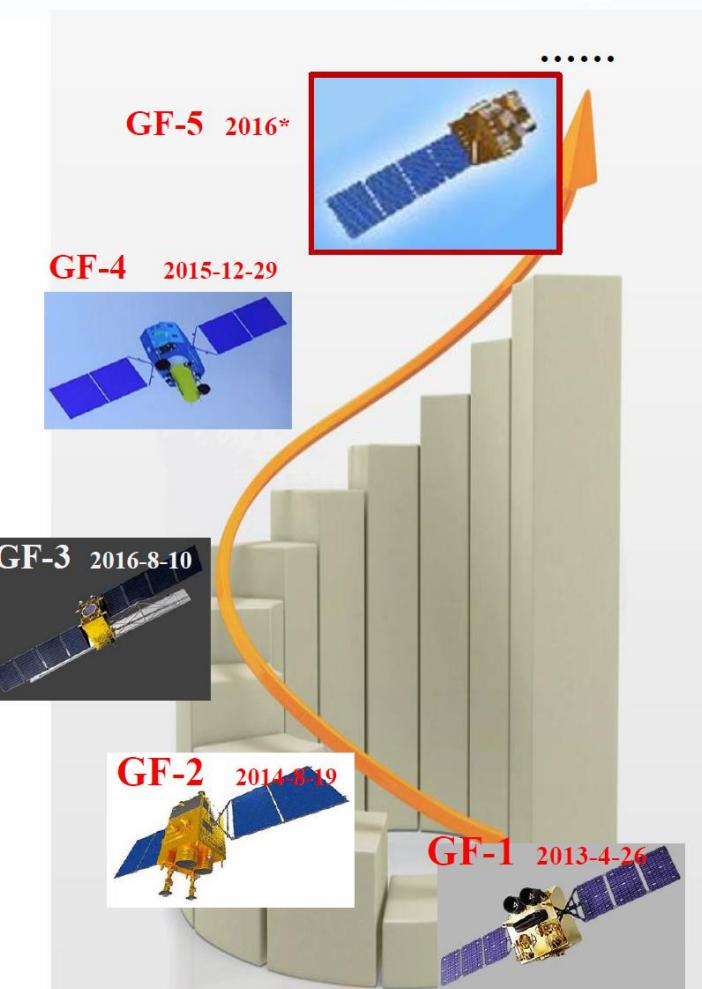
计划到2020年建成，该系统包括：

- 天基观测系统
- 临近空间观测系统
- 航空观测系统
- 地面系统
- 应用系统



# CHEOS (Gaofen) satellites

	Sensor	Launch date
GF-1	Pan: 2m Multi-spectral: 8m/16m	2013.04.26
GF-2	Pan: 1m Multi-spectral: 4m	2014.08.19
GF-3	SAR: C-band 1m	2016.08.10
GF-4	Multi-spectral: 50 m, minute-level repeat	2015.12.29
GF-5	Hyperspectral	2017
GF-6	Same as GF-1	2018
GF-7	Triple Linear Array CCD for stereo mapping	2018



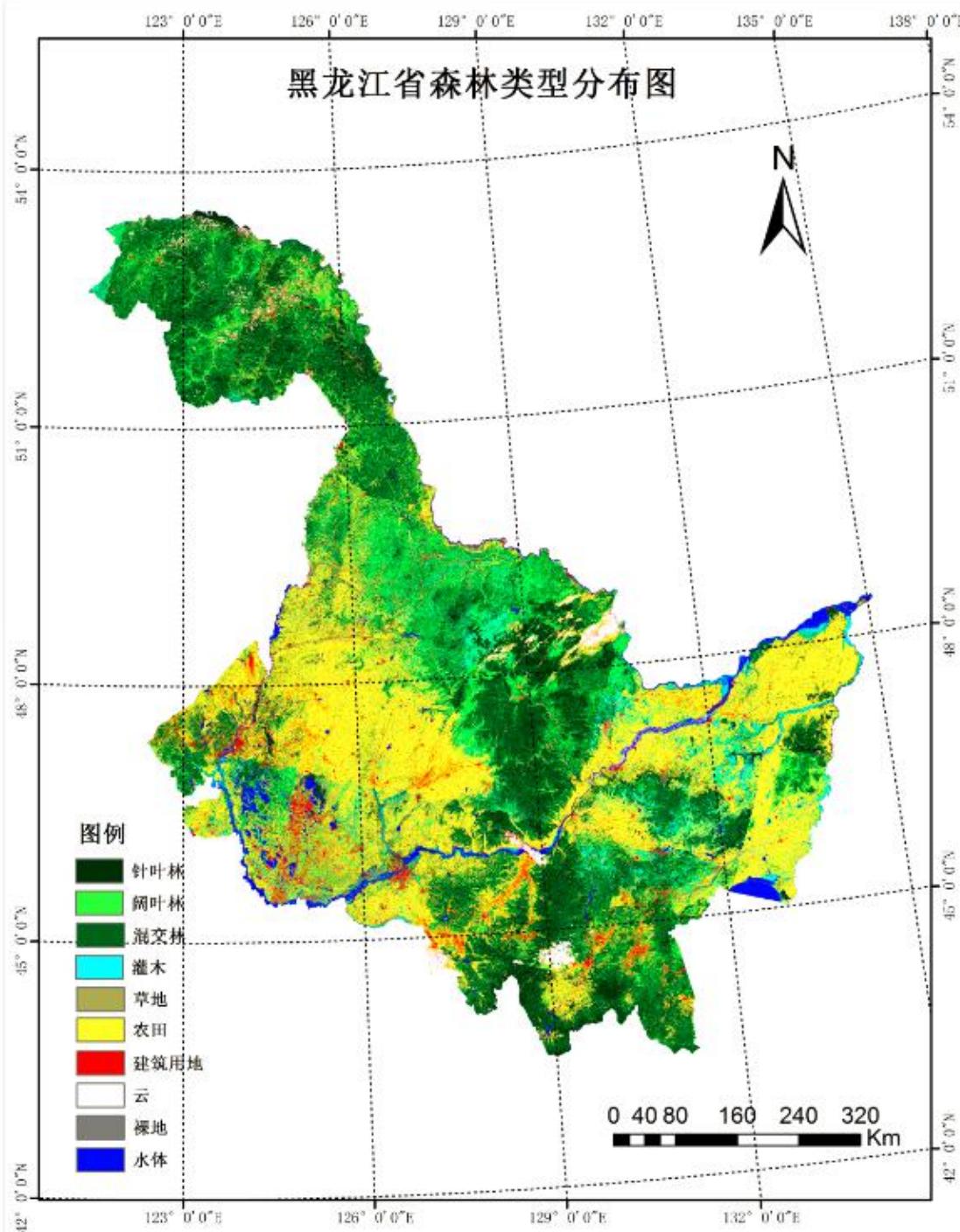
All data are free to public-welfare users.  
Cheap price for commercial applications.

# 基于高分一号 WFM数据的省级 森林覆盖制图

Data: GF-1 WFM 16 m

Date: July-Sep., 2013 with 4  
days repeat cycle.

Heilongjiang Province



# 基于GF-2数据的森林变化检测

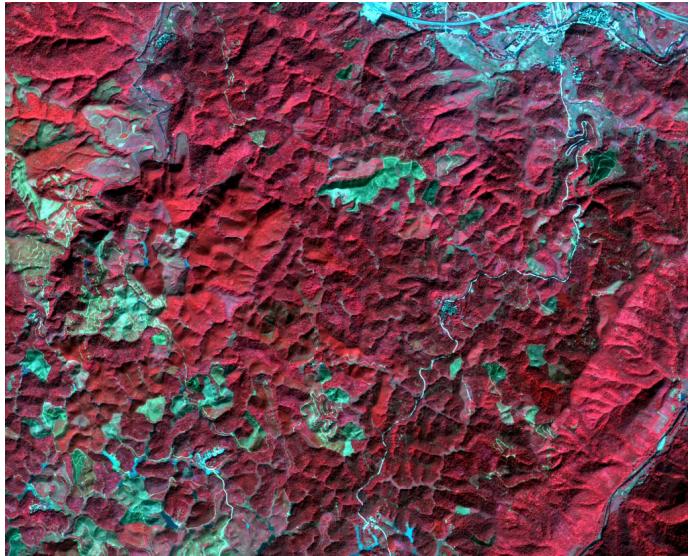


Image of 14 Jan., 2015

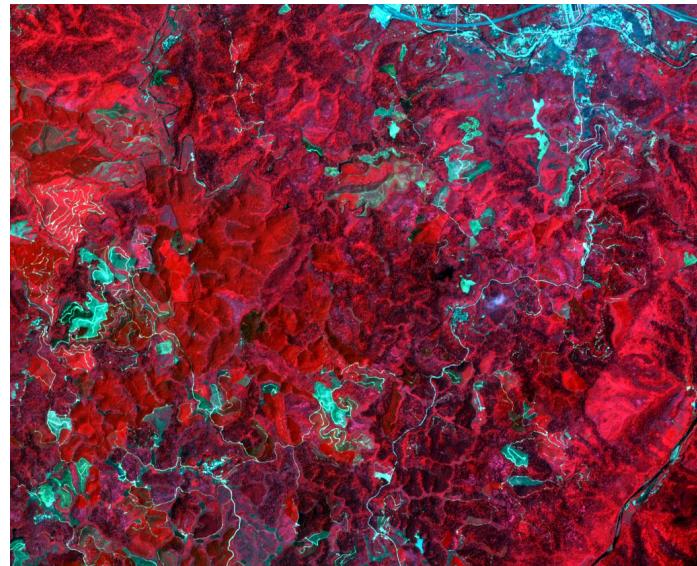
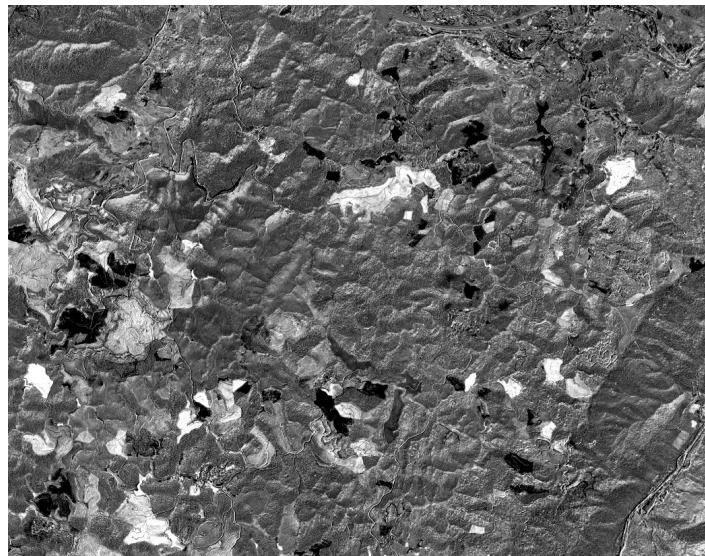
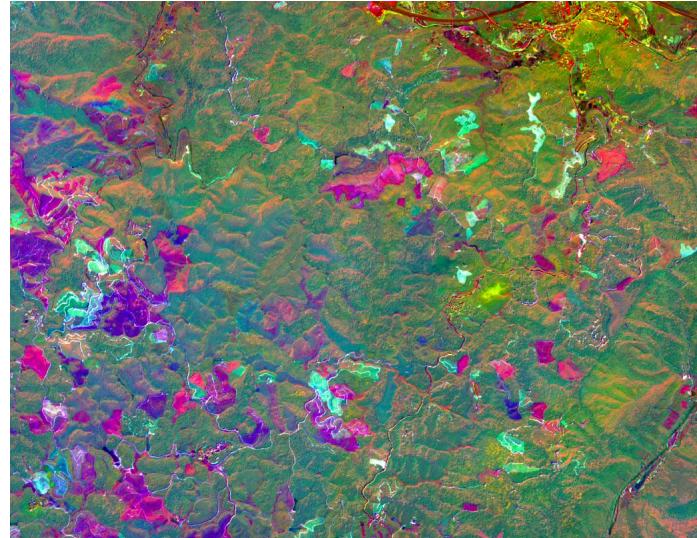


Image of 24 Aug., 2015

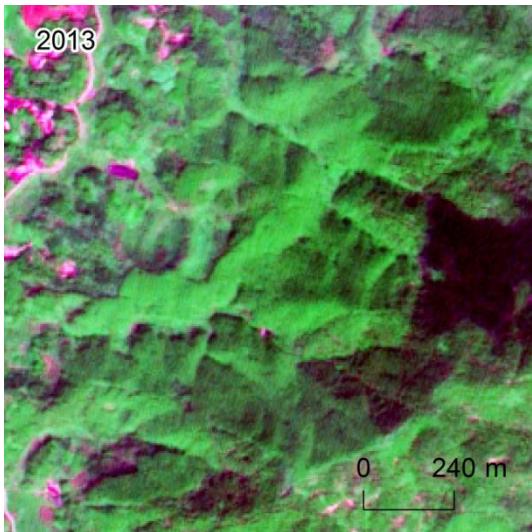


NDVI difference image

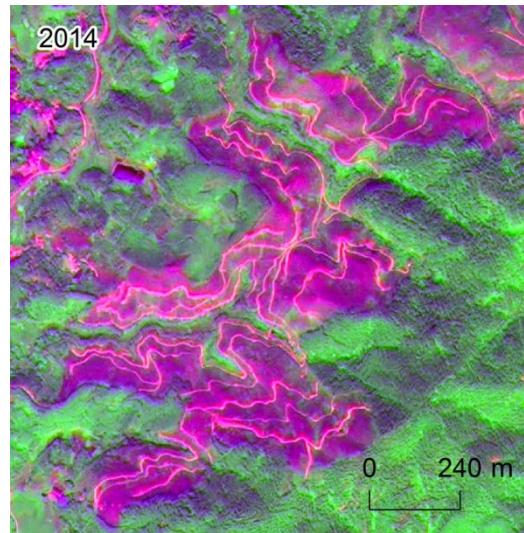


Composite image of PC3, PC4, PC5

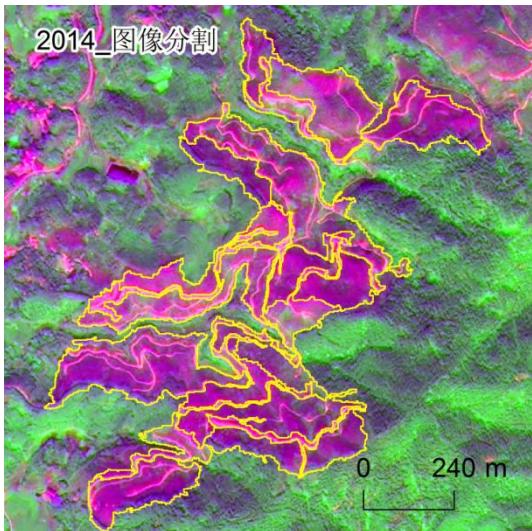
# 森林损失监测



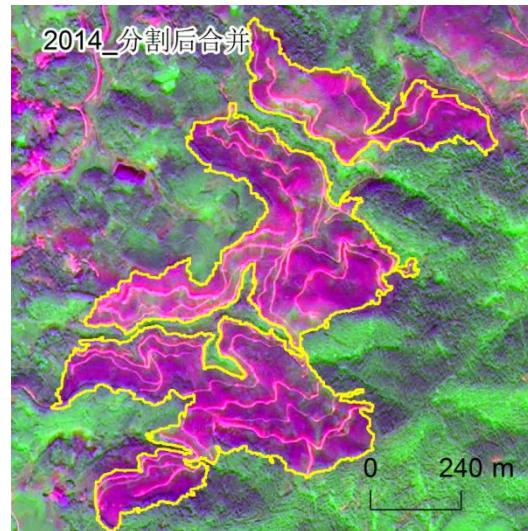
2013 Pre-change image



2014 Post-change image

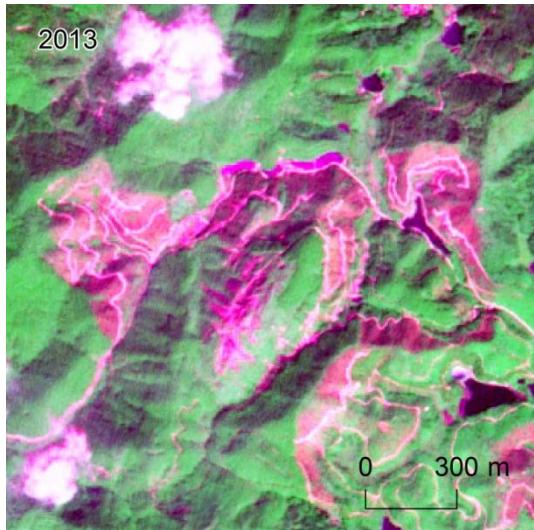


Segmented change image

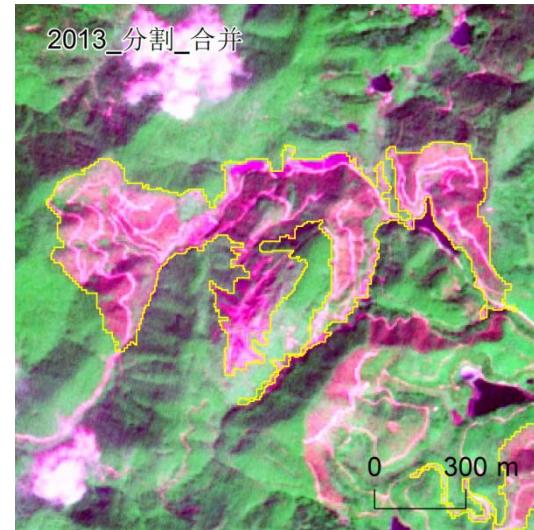


Merged change polygons

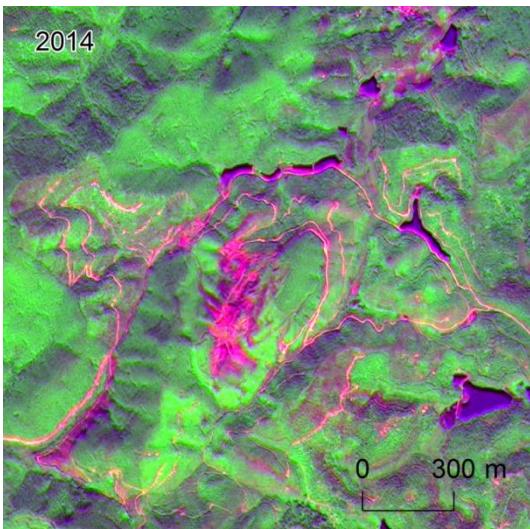
# 森林恢复监测



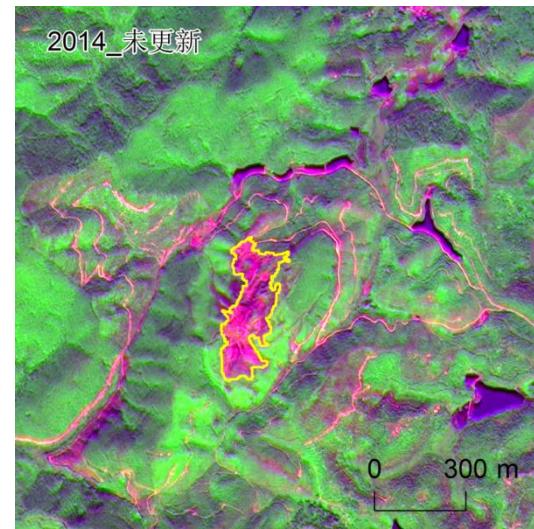
2013 image



Segmented forest loss polygons

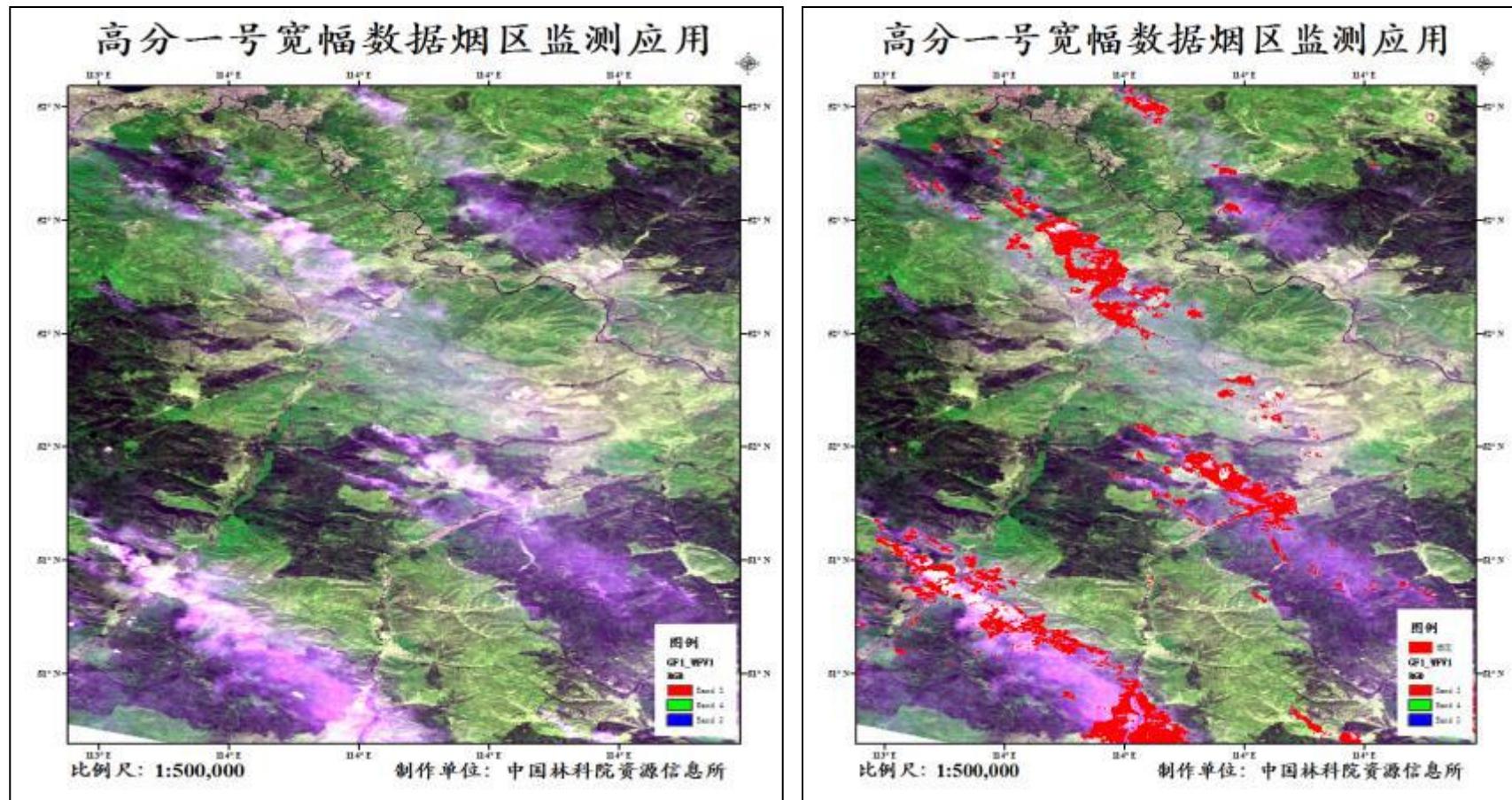


2014 image



Detected un-recovered polygon

# 森林烟区监测

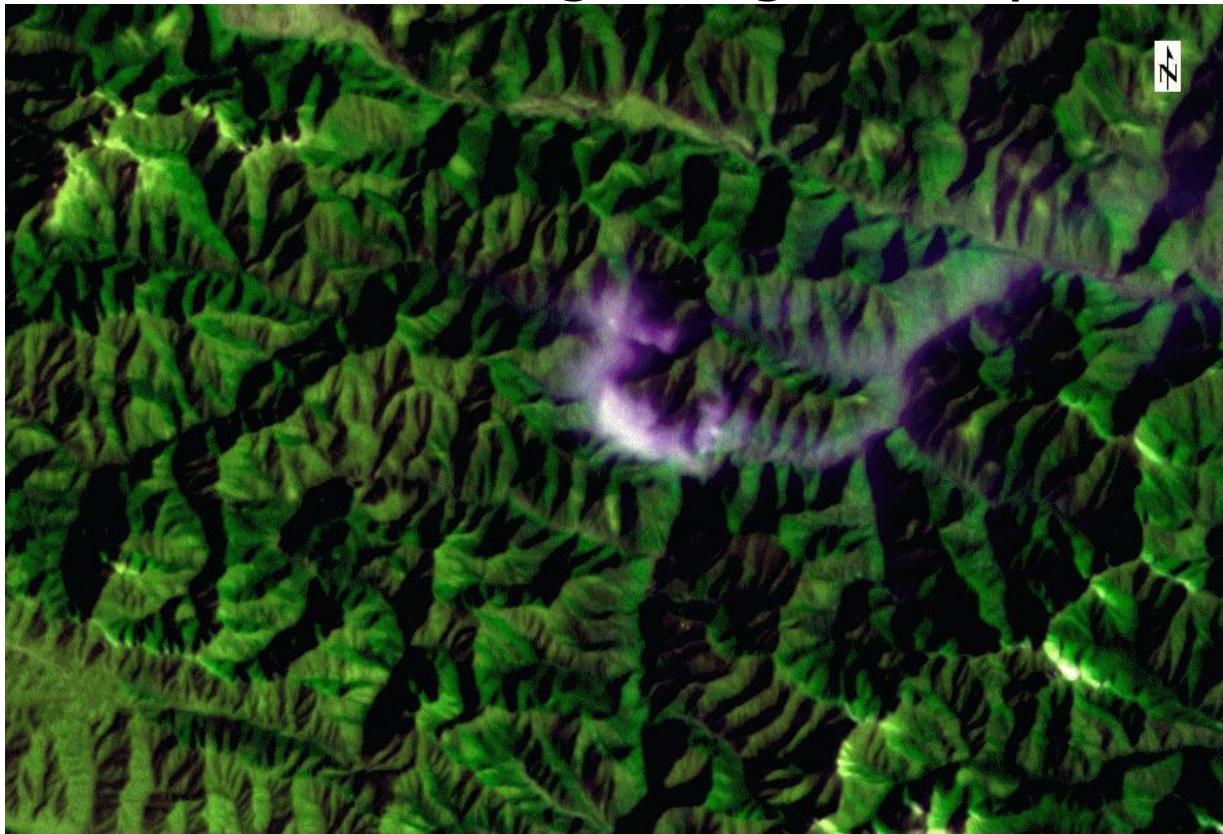


GF-1 WFW, May 3, 2015

by覃先林

# 基于GF-4数据的林火动态监测

- Fire smoke monitoring using multispectral data

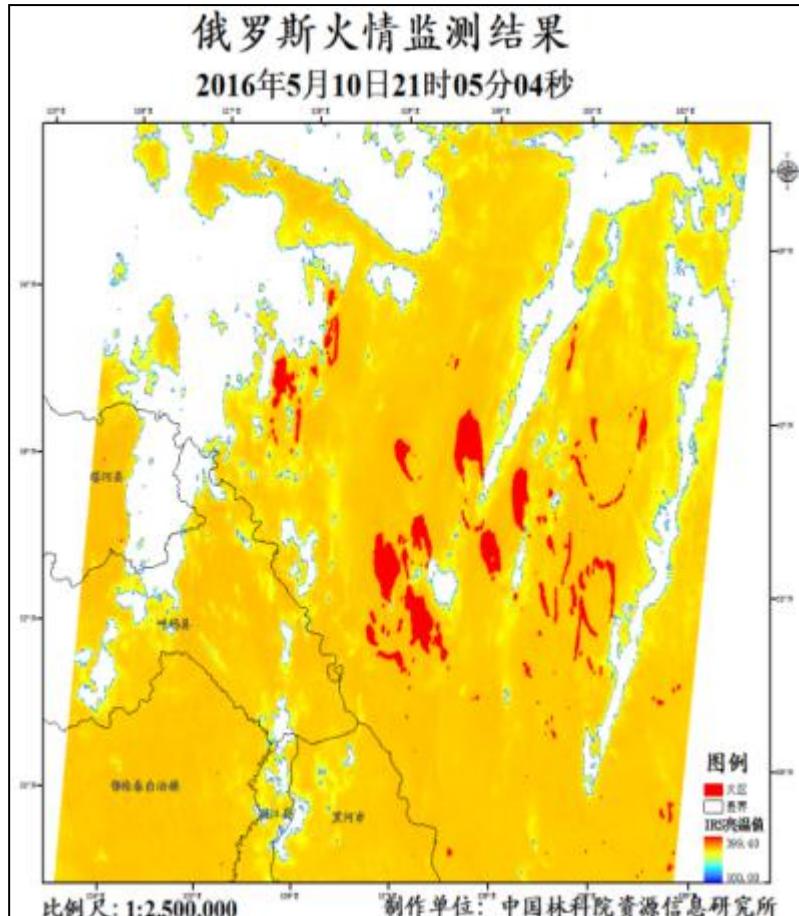


GF-4 has a 50 m staring camera, operating from GEO (Geostationary Earth Orbit).

Imaging area of 7000 km x 7000 km with each scene of 400 km x 400 km  
High temporal resolution at minute-level.

# 基于GF-4数据的林火动态监测

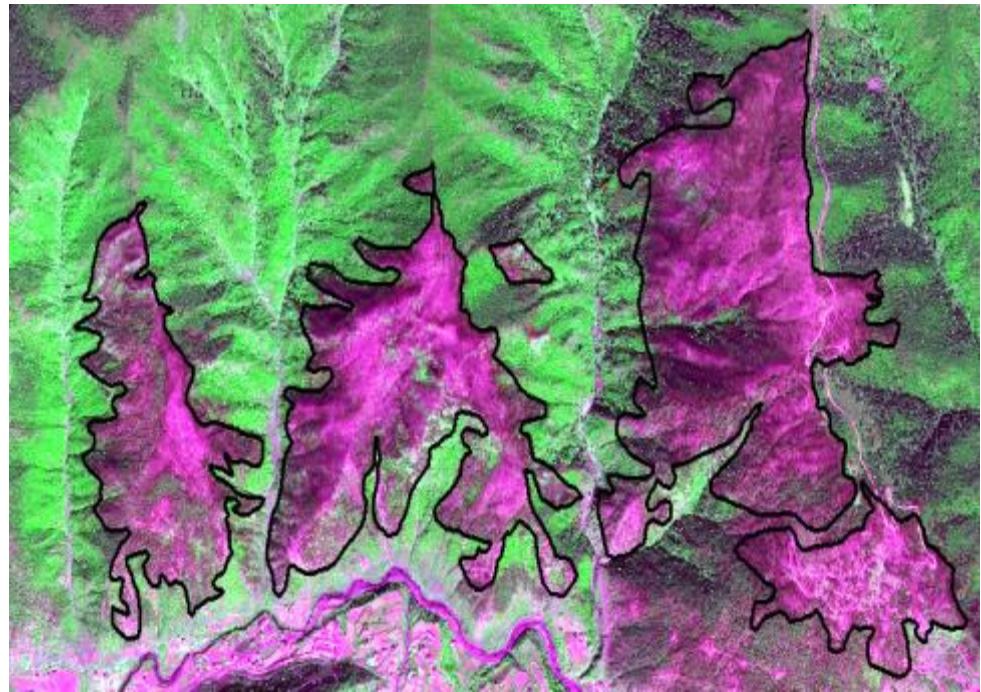
- Fire spread using thermal data



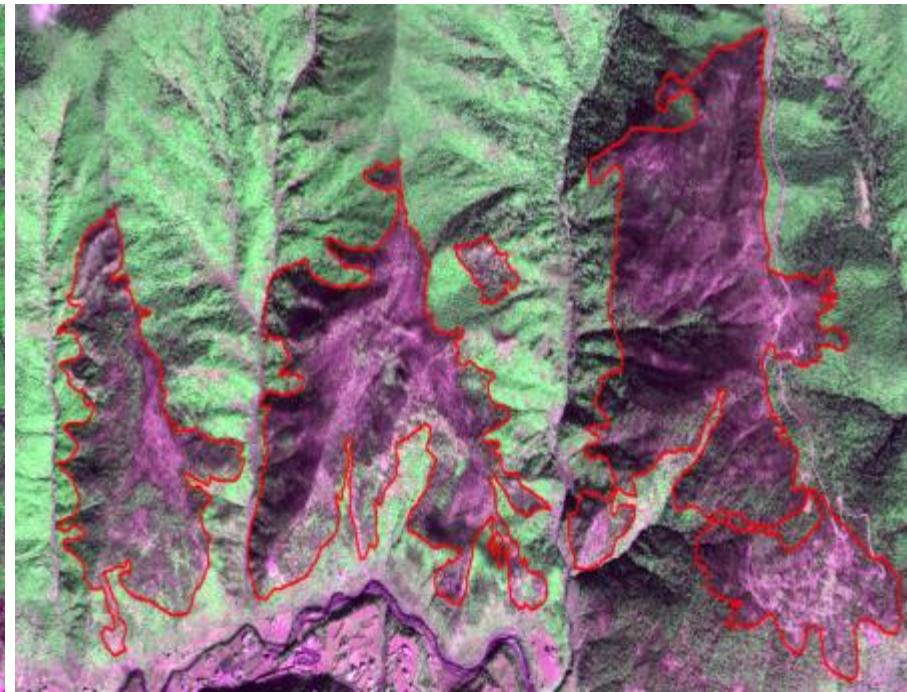
400 m spatial resolution thermal channel  
Temporal resolution at second-level.

by覃先林

# 火烧迹地制图



GF-1 2m



GF-2 1m

by覃先林

# 中国林科院机载遥感系统（CAF-LiCHy）

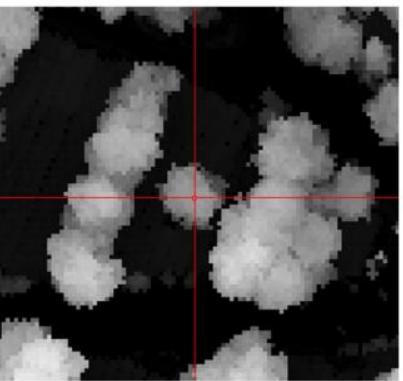
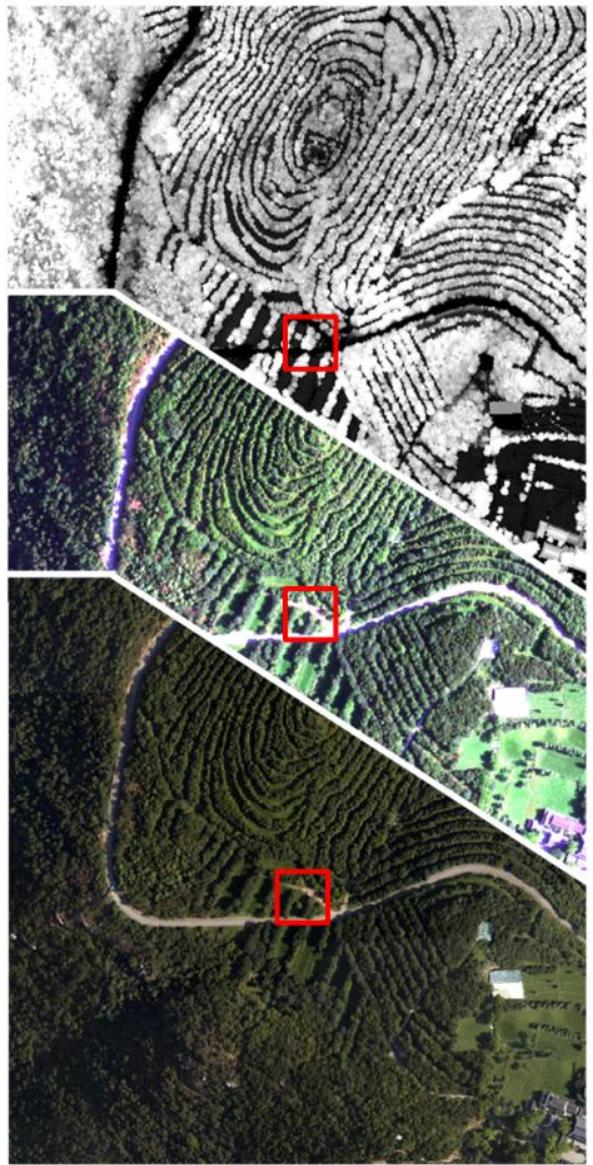


- ① 航空相机镜头；
- ② 高光谱传感器镜头；
- ③ 激光器收发窗口

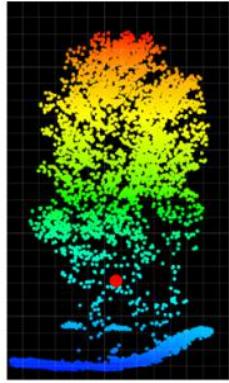
系统集成了高精度波形激光雷达、高分辨率航空数码相机、高光谱成像装置和高精度的导航及姿态测量系统，通过这些设备的有机集成，实现对被测量树木的光谱和三维空间属性信息的高效测量。



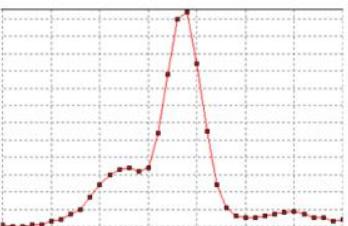
# CAF-LiCHy系统测量数据示例



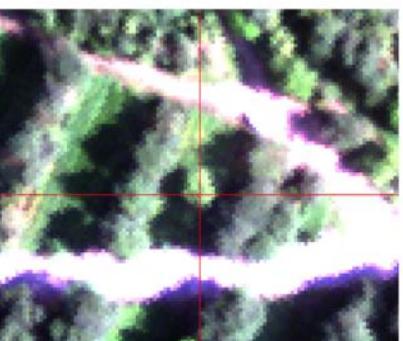
DEM image



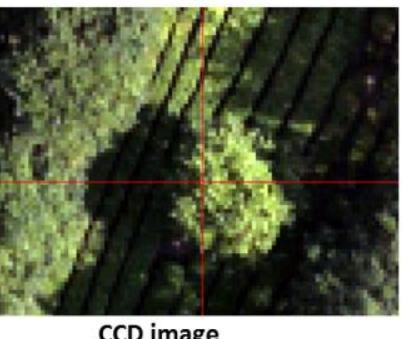
Side view of point  
cloud data



Single pulse waveform



Hyperpectral image



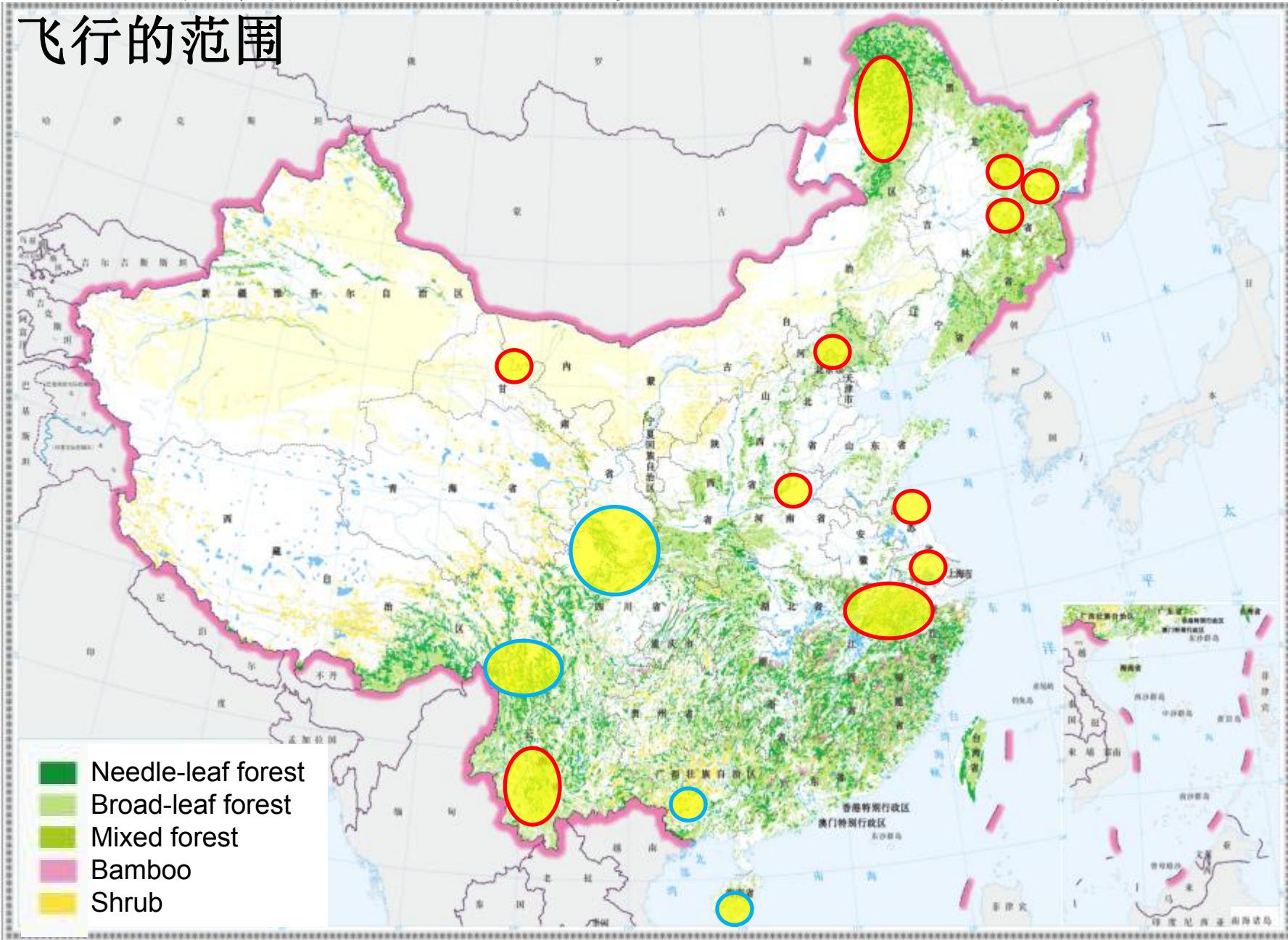
CCD image



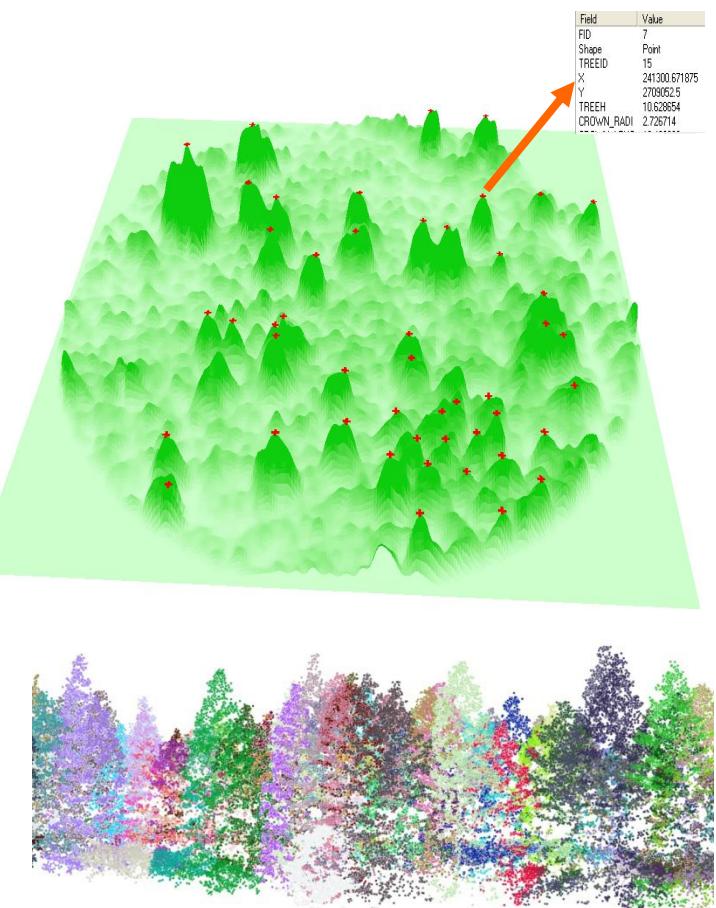
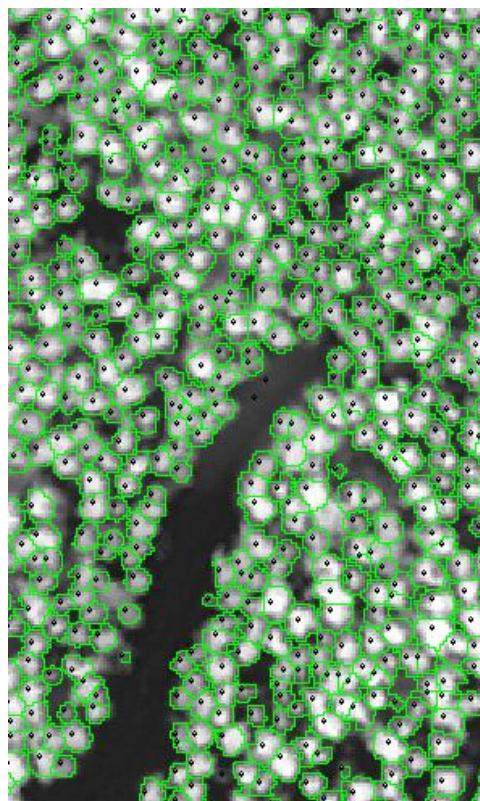
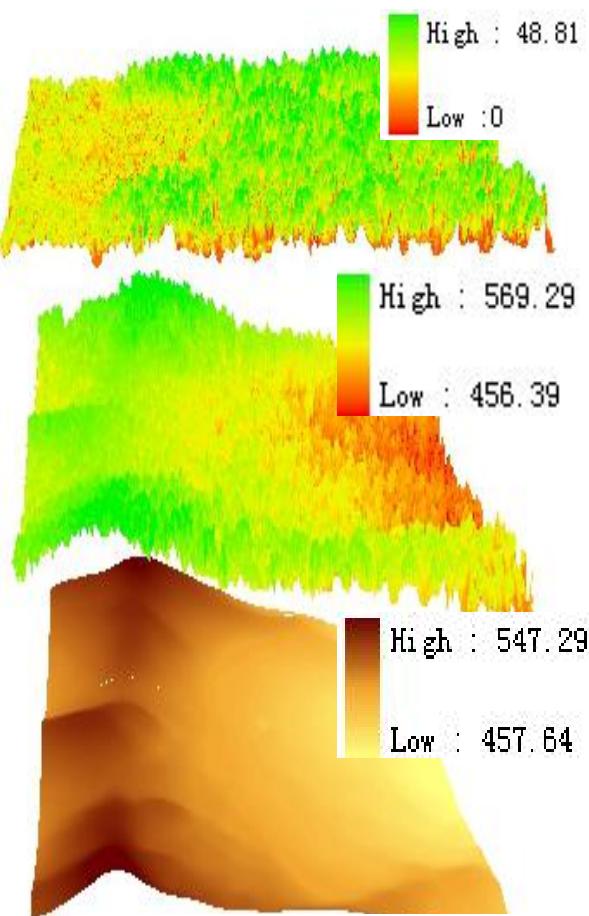
Hyperspectral spectrum cube



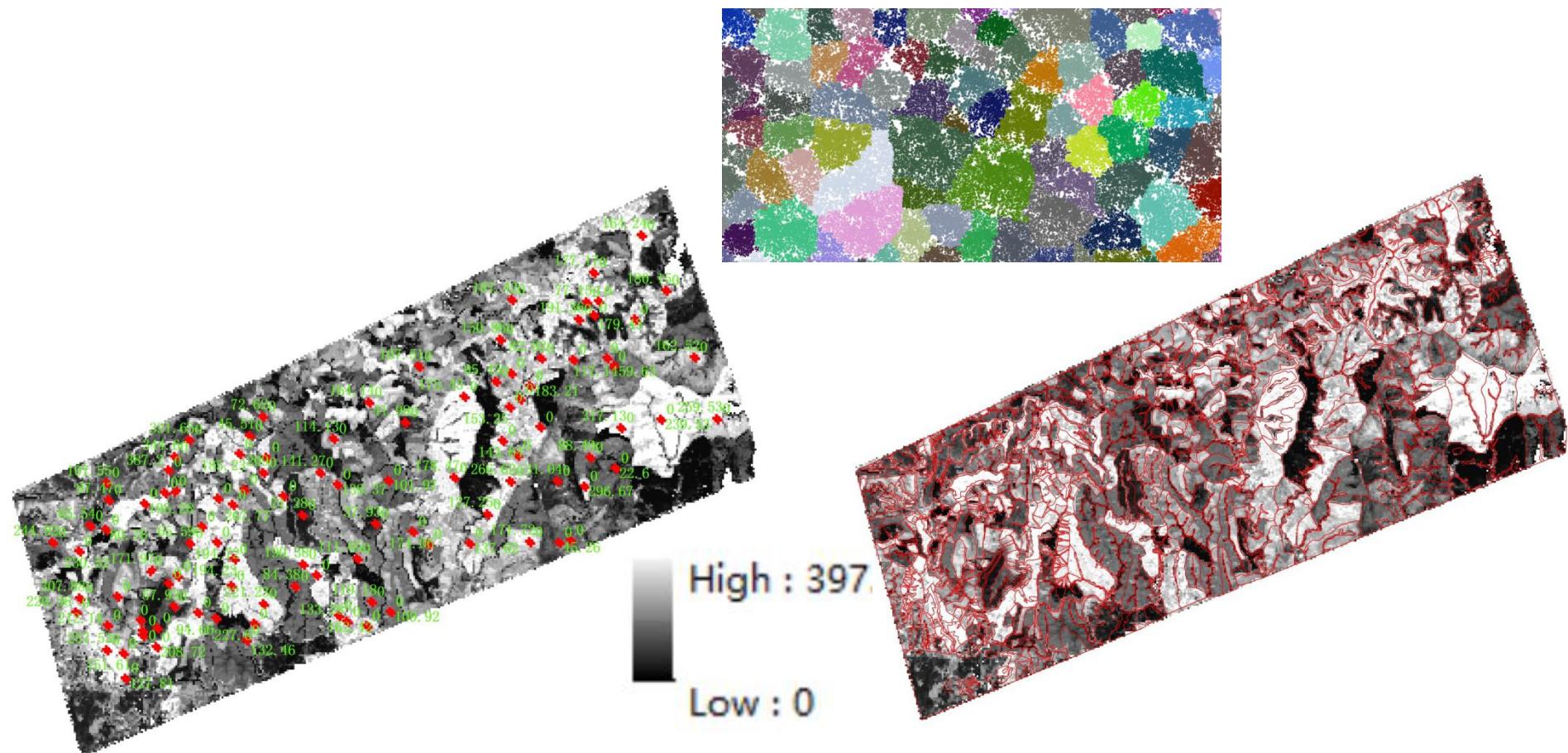
红色范围内为已经飞行的实验区；蓝色范围内为计划飞行的范围



# 激光雷达单木参数提取



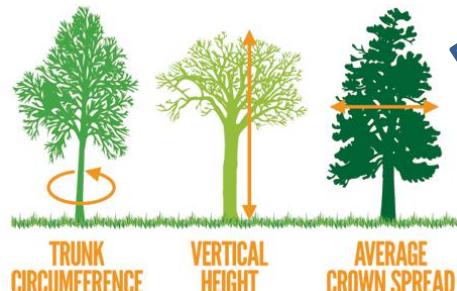
# 样地尺度参数估测和二类因子提取



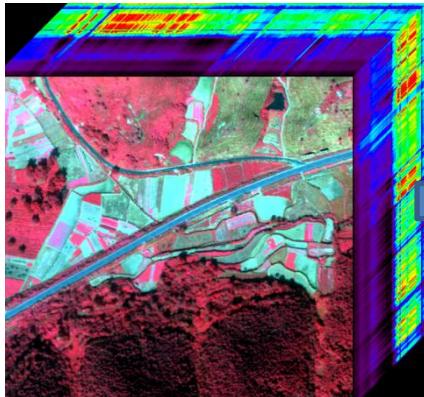
# 星机地数据协同的大区域森林参数反演



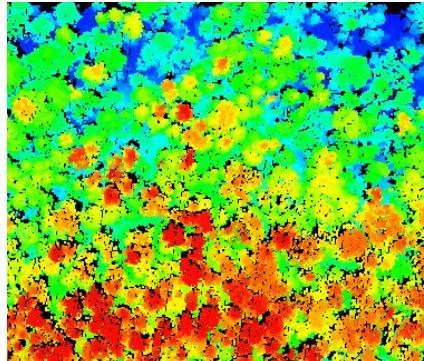
机载数据采集



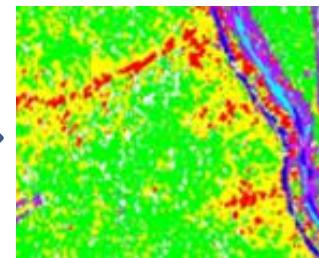
地面实地测量



机载高光谱



机载LiDAR



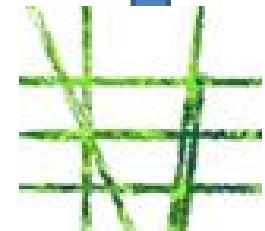
类型分裂



激光雷达变量



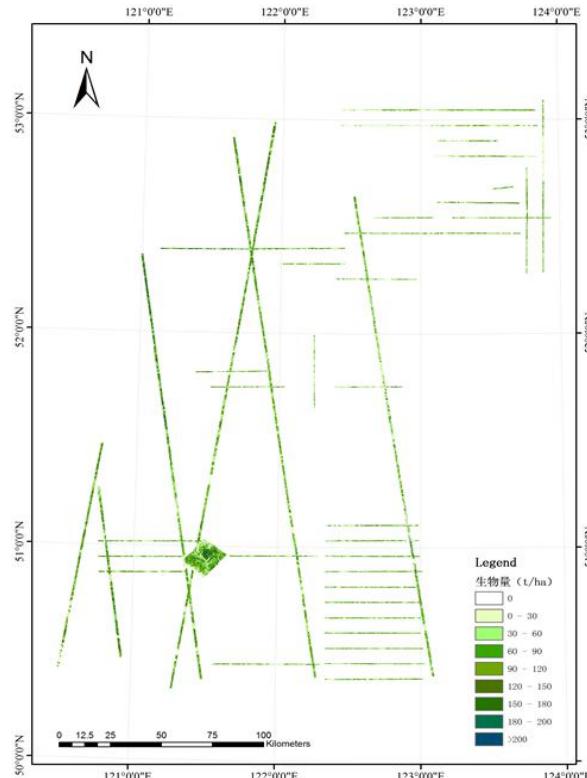
卫星数据建模估计



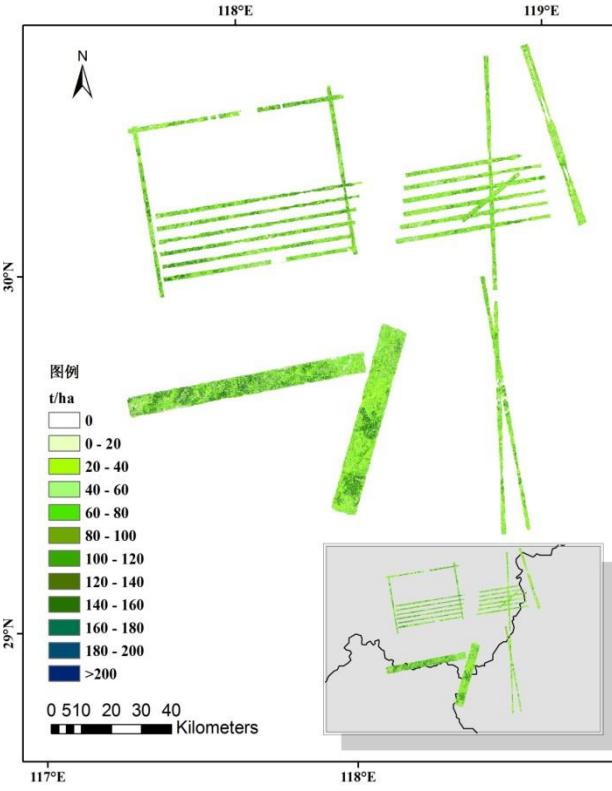
飞行航带的生物量估计



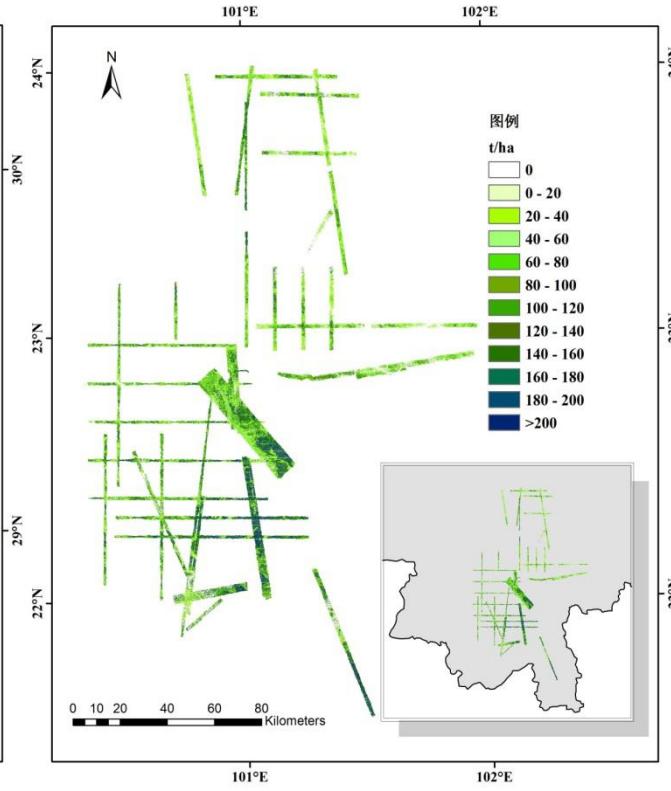
# 星机地综合试验区 机载激光雷达反演生物量



大兴安岭地区  
温带森林



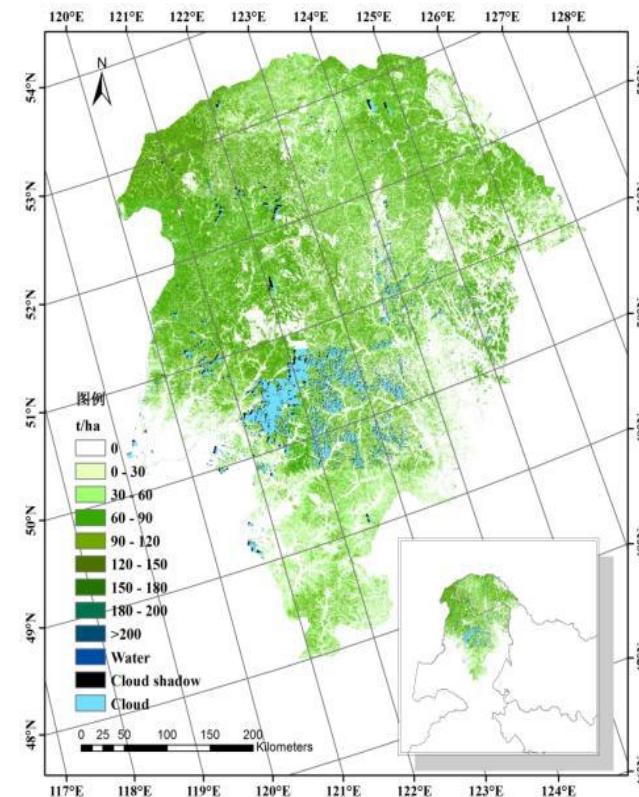
中部皖浙赣地区  
亚热带森林



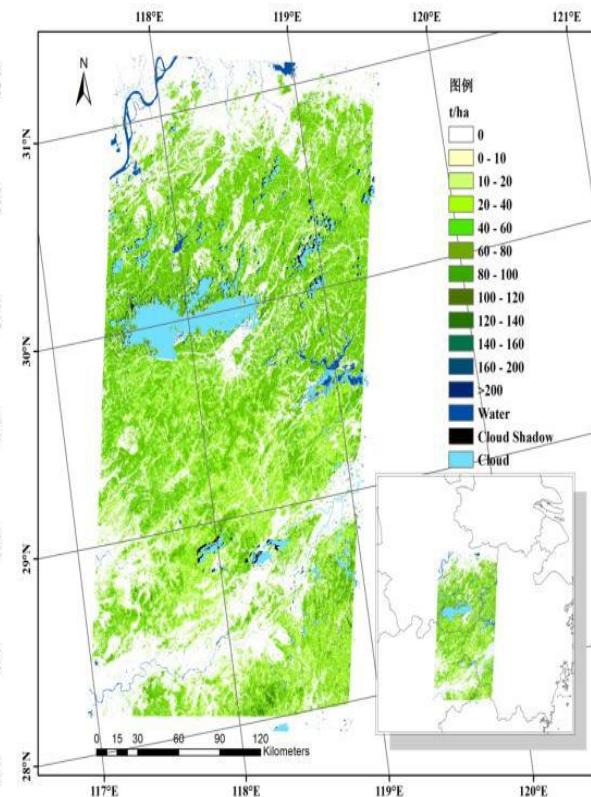
云南地区  
亚热带、热带森林



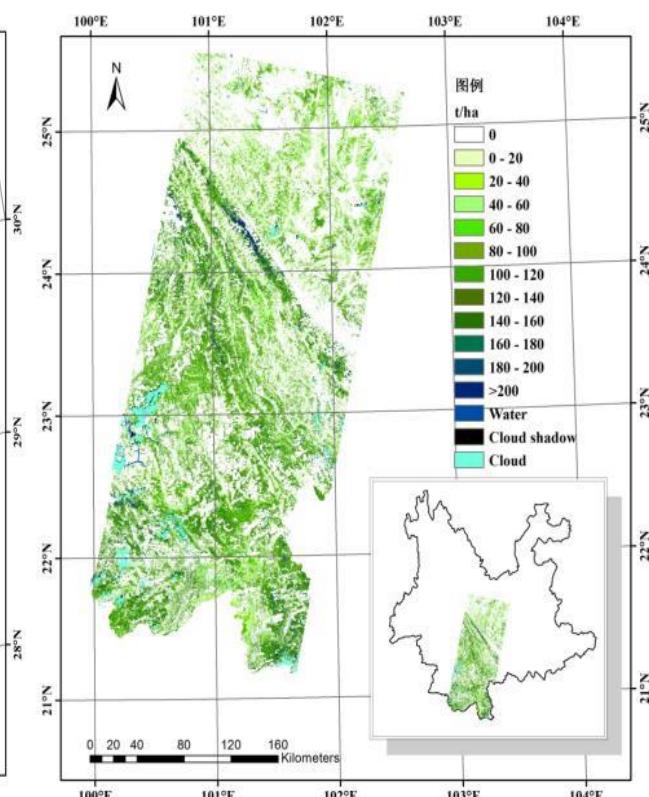
# 中国典型林区星机地协同估测 森林生物量产品



大兴安岭地区  
温带森林



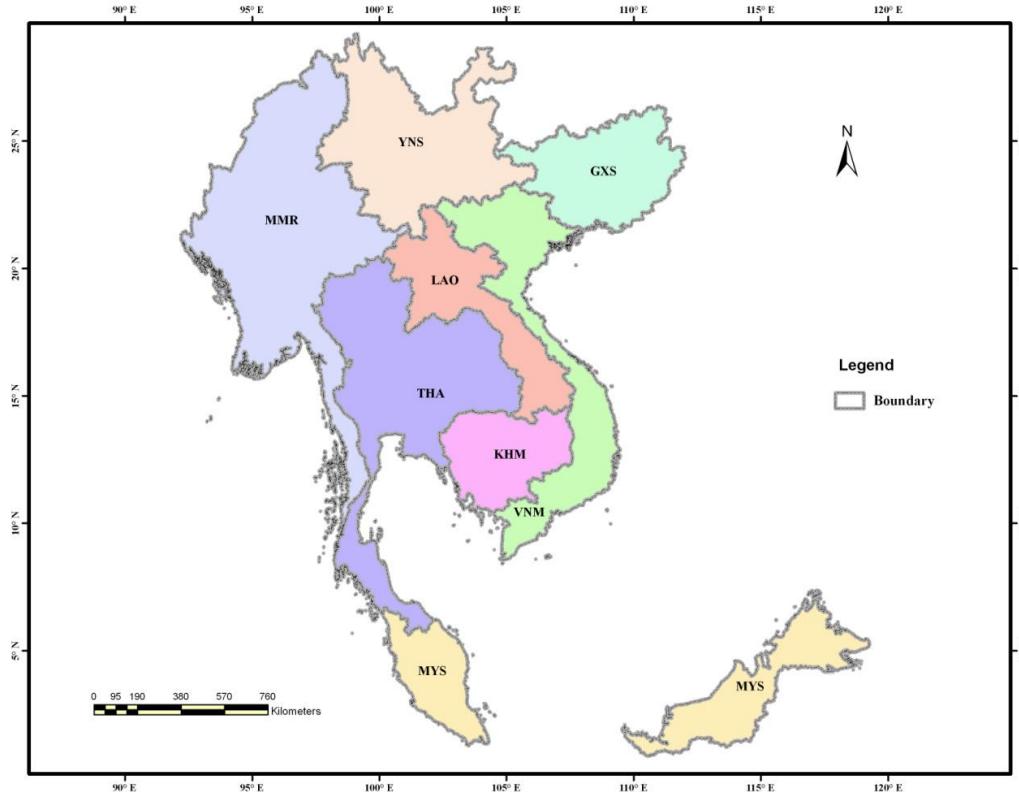
中部皖浙赣地区  
亚热带森林



云南地区  
亚热带、热带森林

# 大湄公河次区域和马来西亚森林覆盖制图项目

- 亚太森林网络（APFN额头）资助项目



- 柬埔寨
- 老挝
- 缅甸
- 泰国
- 越南
- 中国云南/广西
- 马来西亚

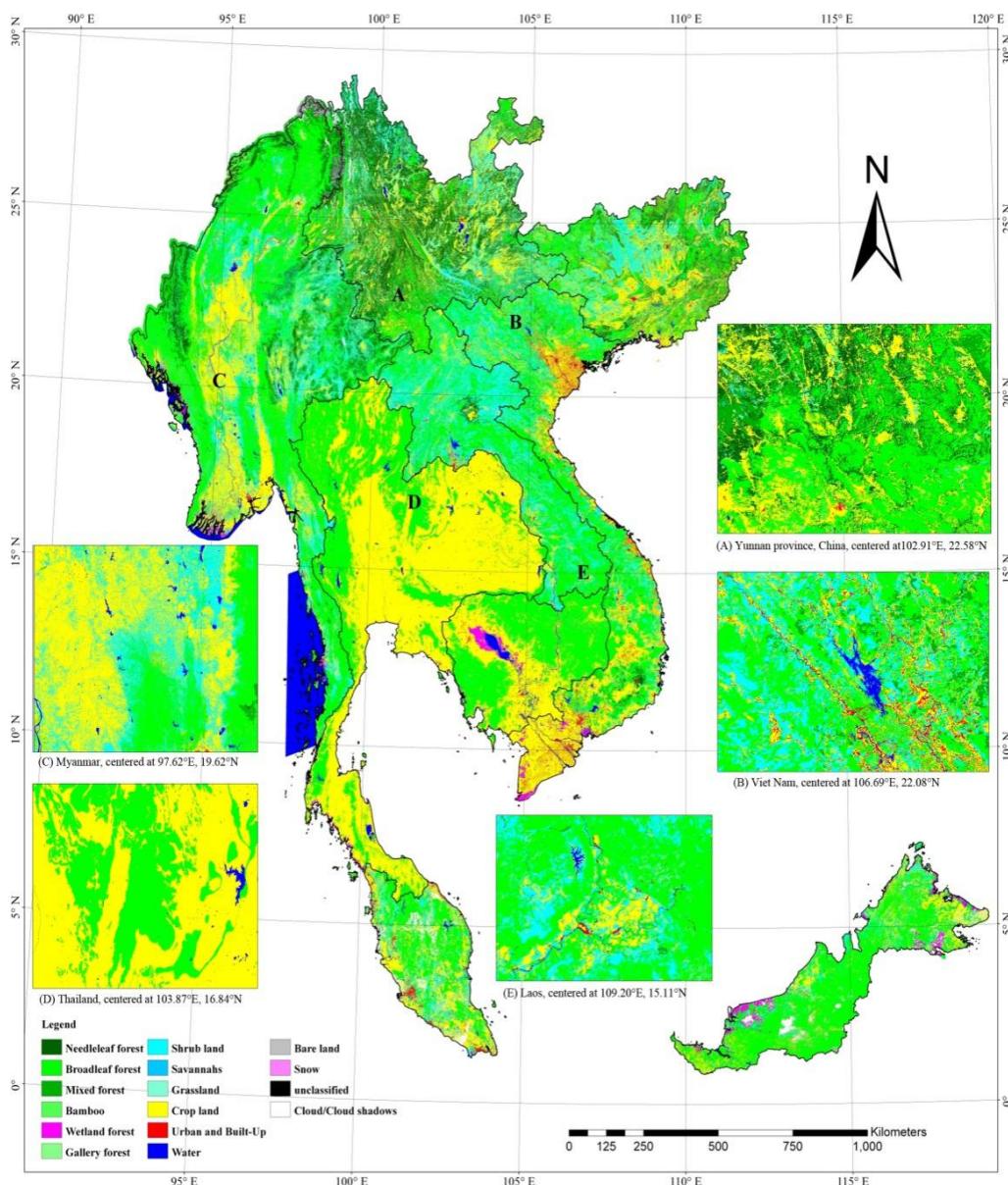


# 2005年森林覆盖图 (30 m)

- Whole region forest coverage is 45%.

**Forest coverage of each country is as (%):**

Cambodia	59
Guangxi, China	59.32
Lao	51.39
Malaysia	67.41
Myanmar	54
Thailand	33.79
Viet Nam	37
Yunnan, China	53.42

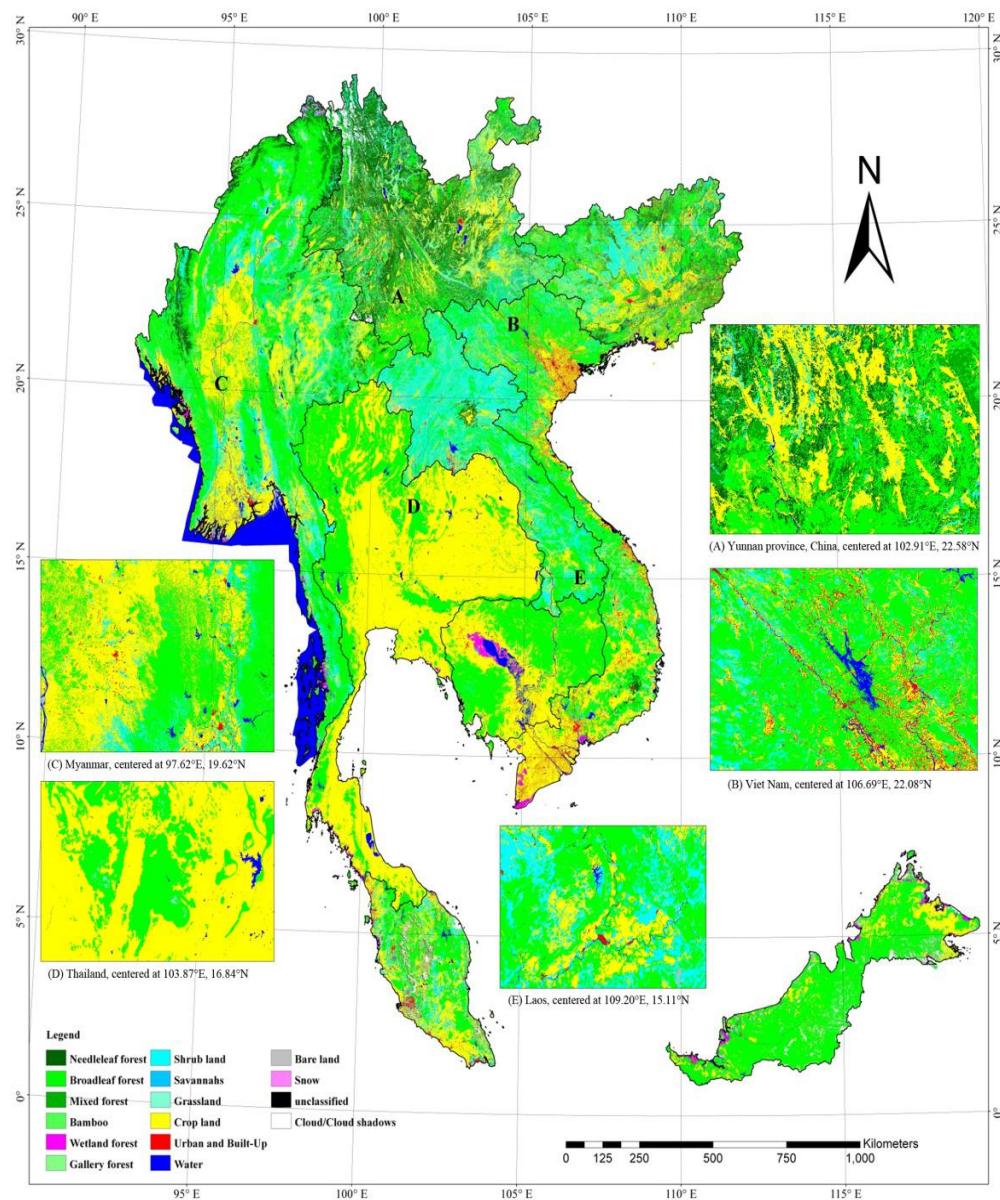


# 2010年森林覆盖图 (30 m)

- Whole region forest coverage is 42%.

**Forest coverage of each country is as (%):**

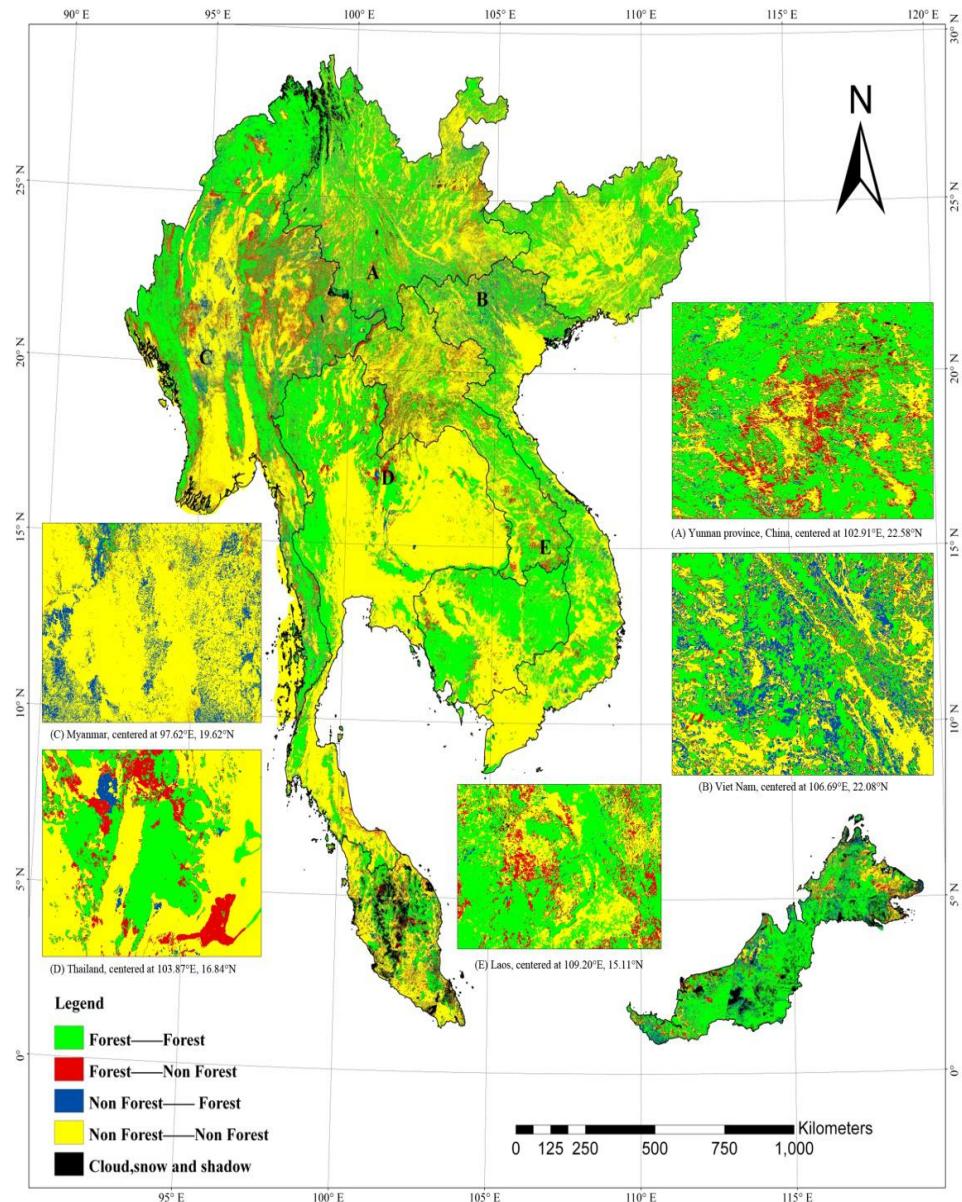
Cambodia	57
Guangxi, China	57.47
Lao	37.12
Malaysia	62.43
Myanmar	45
Thailand	31.57
Viet Nam	39.5
Yunnan, China	52.19



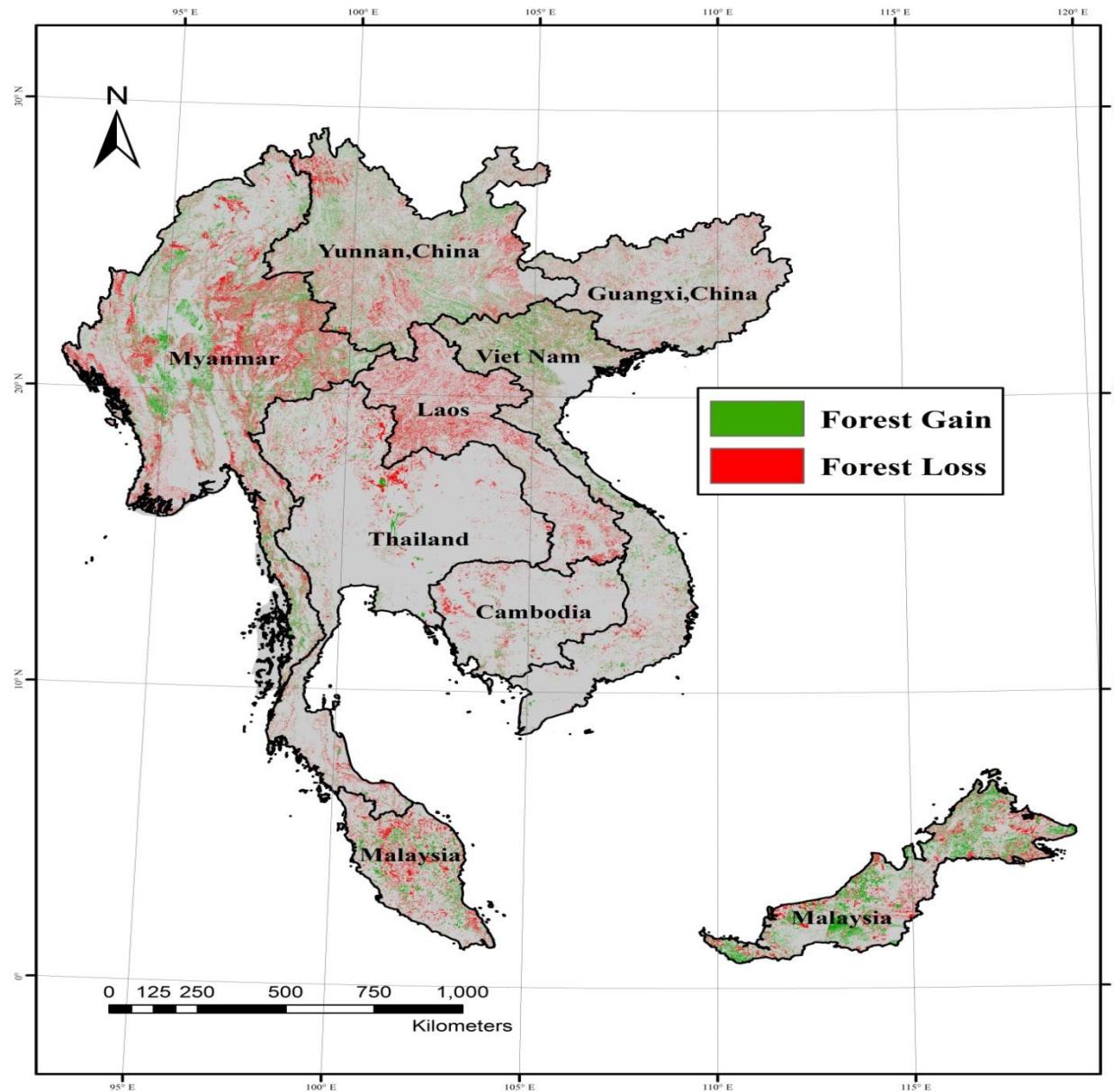
# 2005和2010间的森林变化

- Forest net loss 3%.

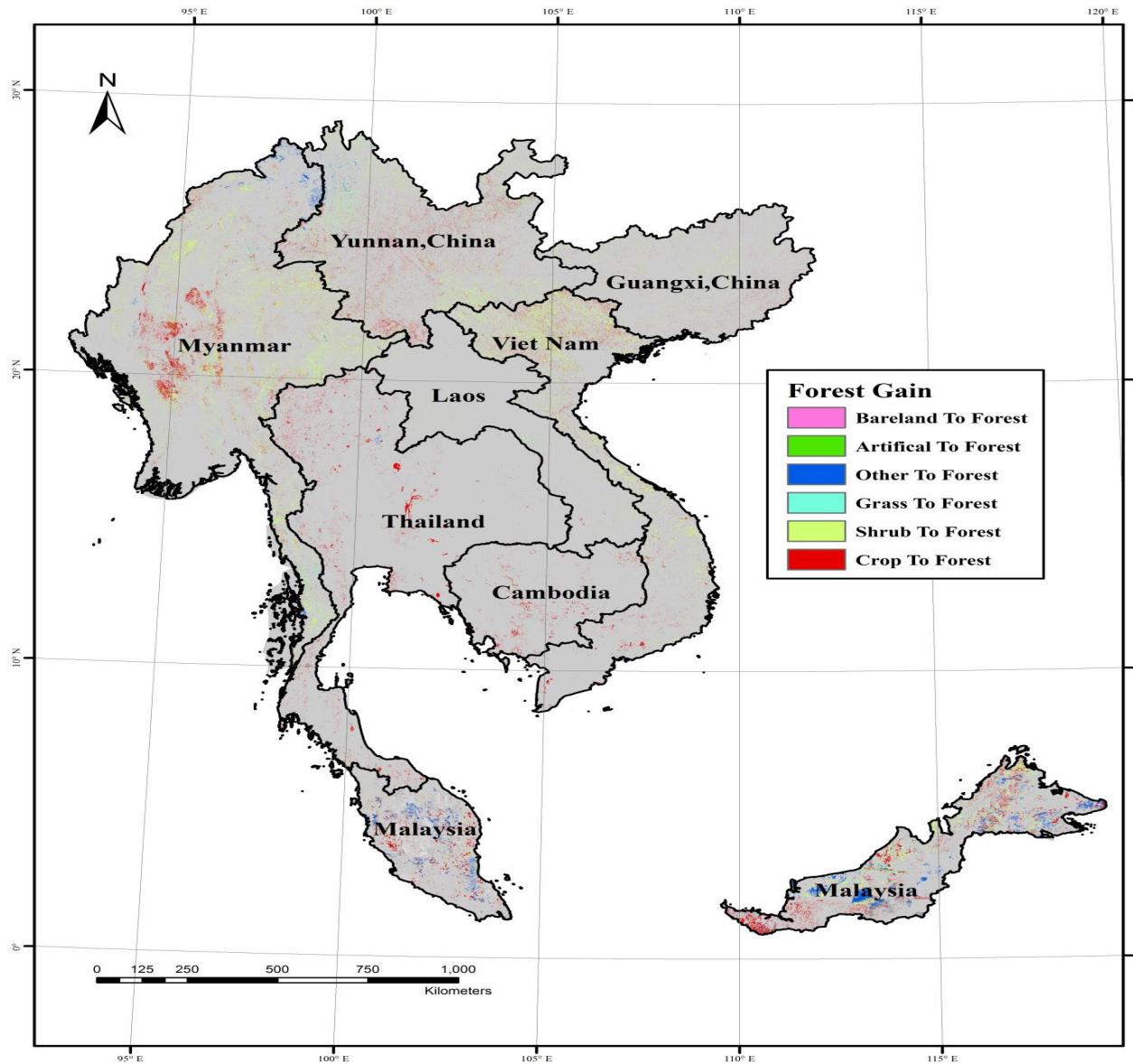
<i>country/ area</i>	<i>Forest cover 2005(%)</i>	<i>forest cover 2010(%)</i>
Cambodia	59	57
Guangxi, China	59. 32	57. 47
Lao	51. 39	37. 12
Malaysia	67. 41	62. 43
Myanmar	54	45
Thailand	33. 79	31. 57
Viet Nam	37	39. 5
Yunnan, China	53. 42	52. 19



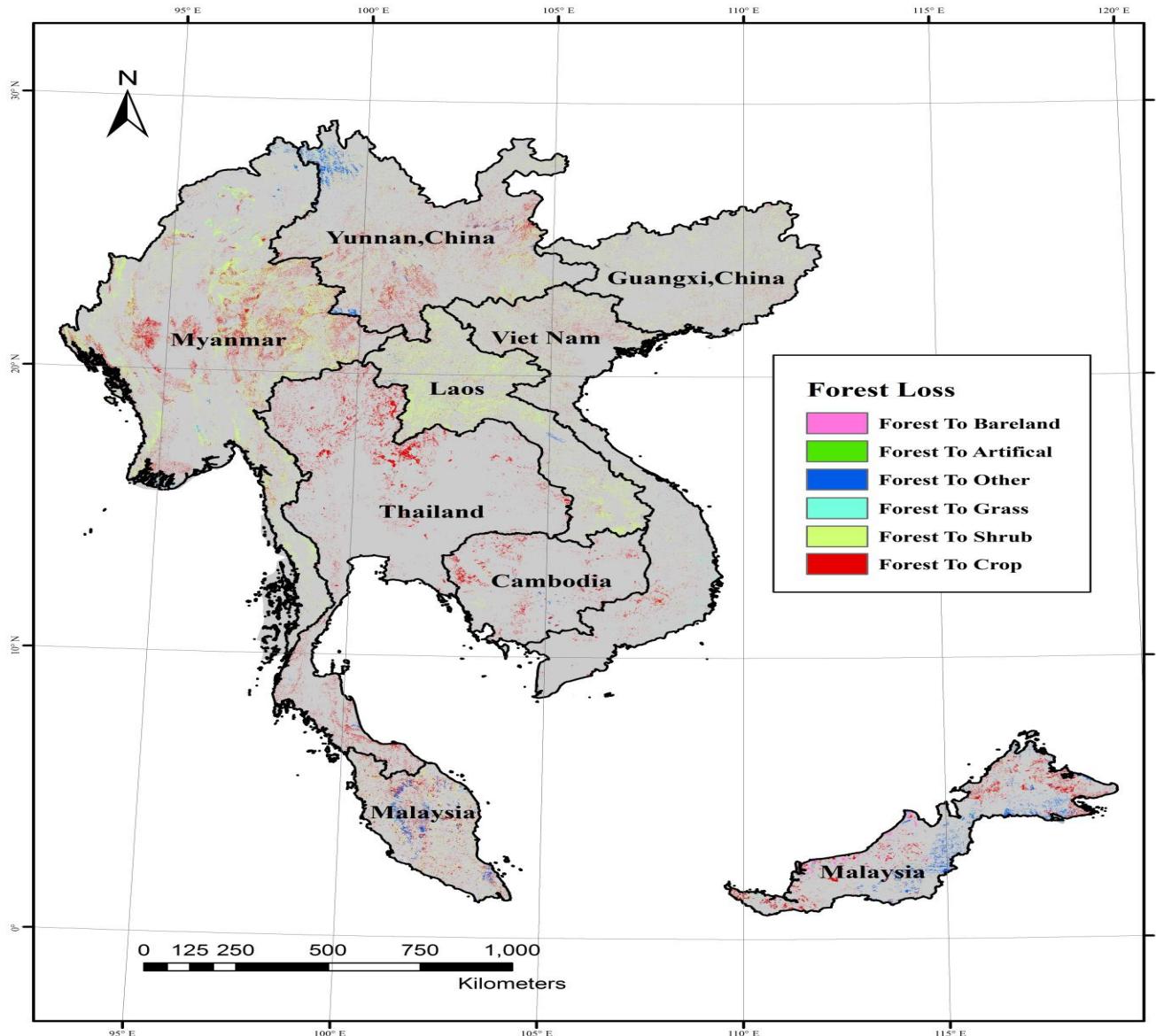
# 2005-2010年间的森林增加和减少



# 2005-2010年间的森林增加来源

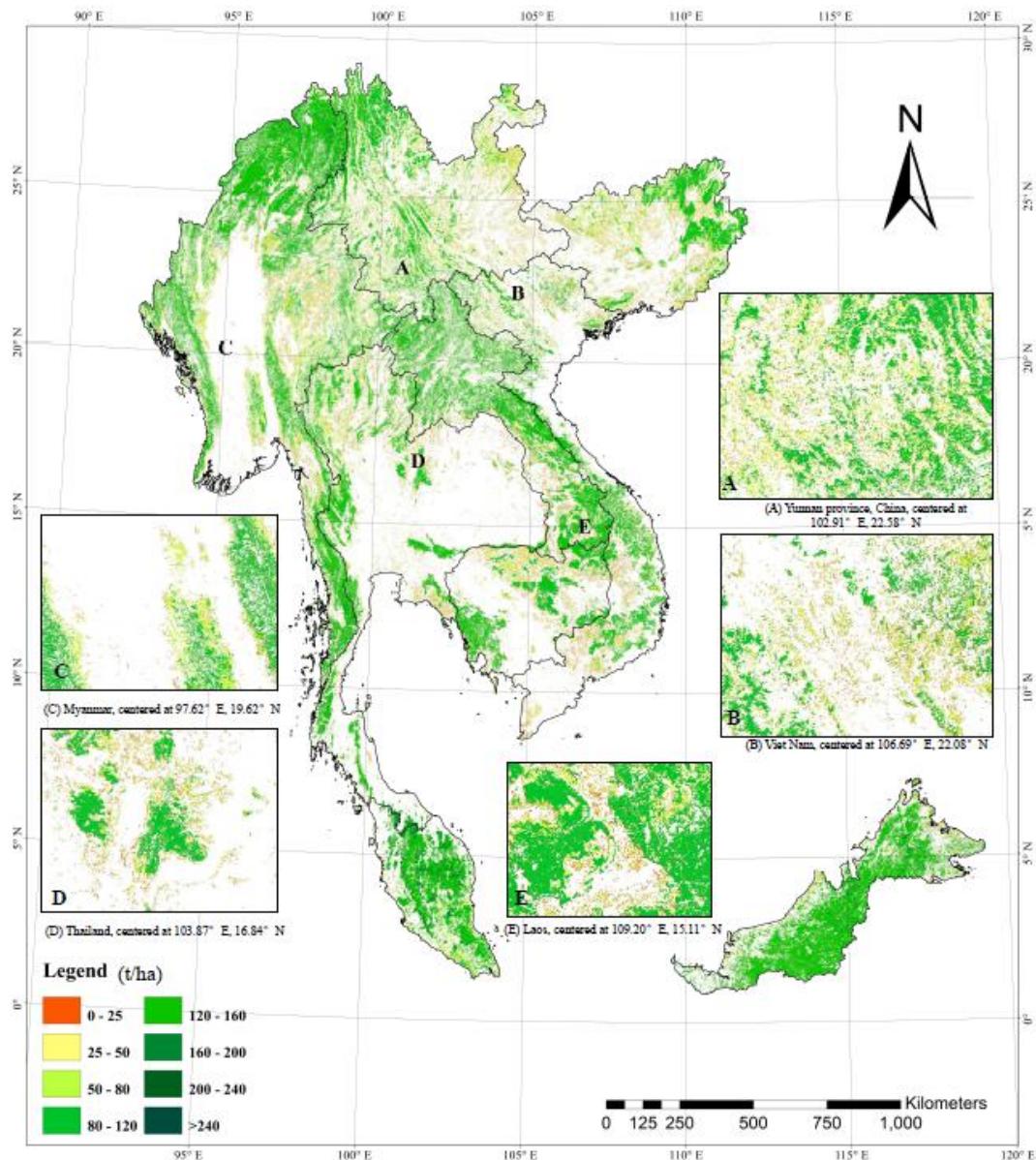


# 2005-2010年间的森林减少去向



# 2005年森林碳储量

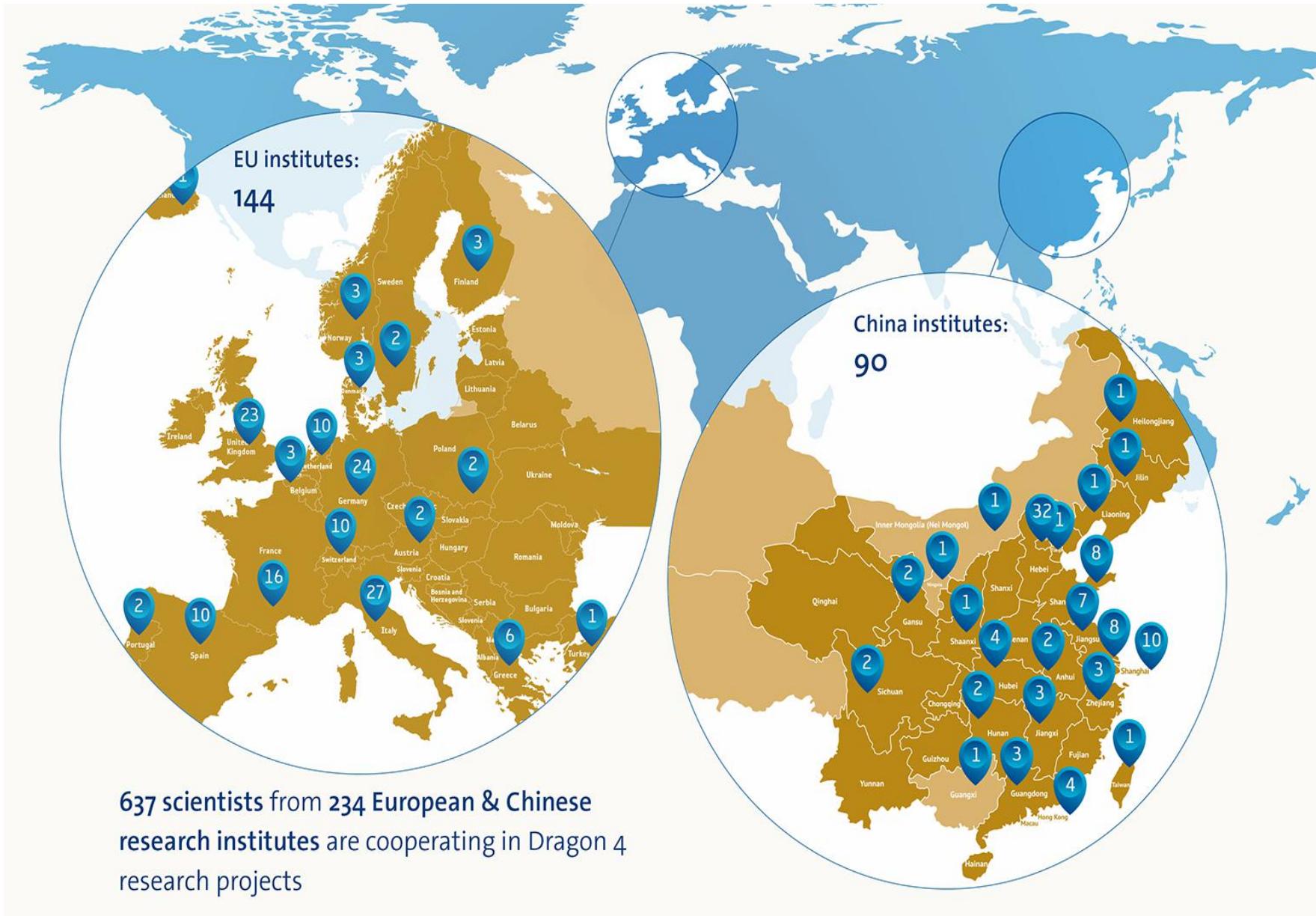
- The total estimated carbon stock was 10,165 million tons.
- Carbon density distribution pattern are along most mountain ranges.



# 欧洲空间局-中国国家遥感中心合作 龙计划项目

- 1. 2003 DRAGON Program agreement initiated by MOST minister and ESA to strengthen the cooperation in EO**
- 2. Dragon cooperation phases :**
  - **Dragon 1 (2004-2008) with 16 Sino-European projects**
  - **Dragon 2 (2008–2012) with 25 Sino-European projects,**
  - **Dragon 3 (2012-2016) with 51 Sino-European projects**
  - **Dragon 4 (2016-2020) with 27 Sino-European integrated projects (76 subprojects)**
- 4. EO data exploitation of ESA, ESA Third Party Missions, Copernicus Sentinels & Chinese EO missions**

# 中欧双方龙计划参与的机构数量





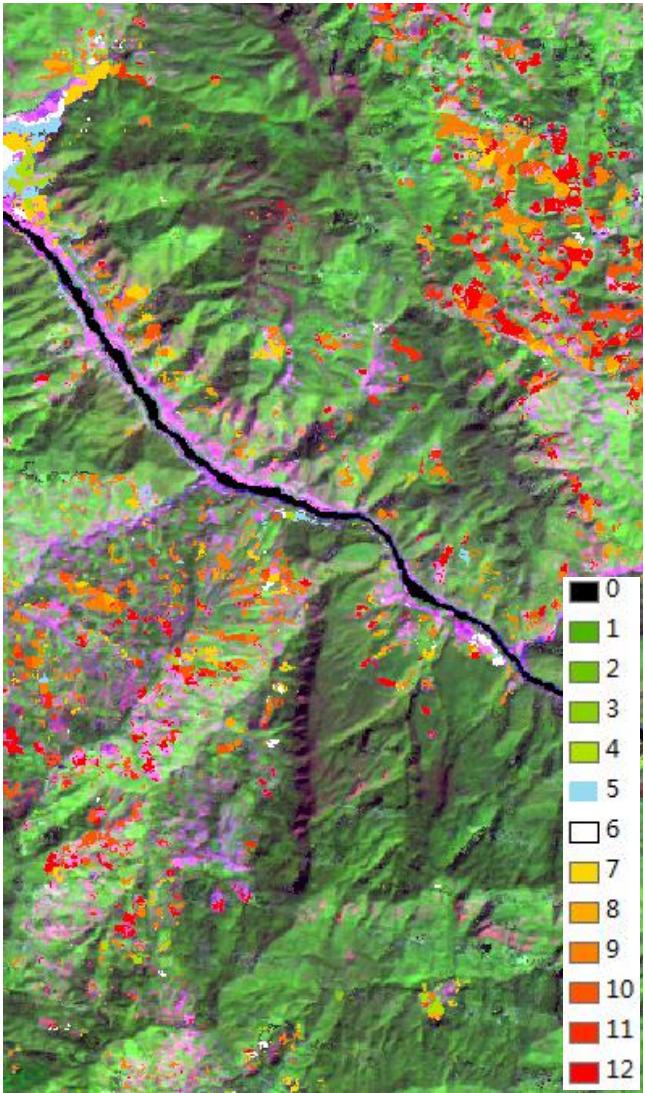
# 小结

1. 中国高分对地观测系统和其他卫星可以为森林监测制图提供免费或低价的高分辨率遥感数据。
2. 遥感产品可以与森林资源监测和管理活动结合起来。
3. 与东南亚和欧洲国家开展了卓有成效的合作。

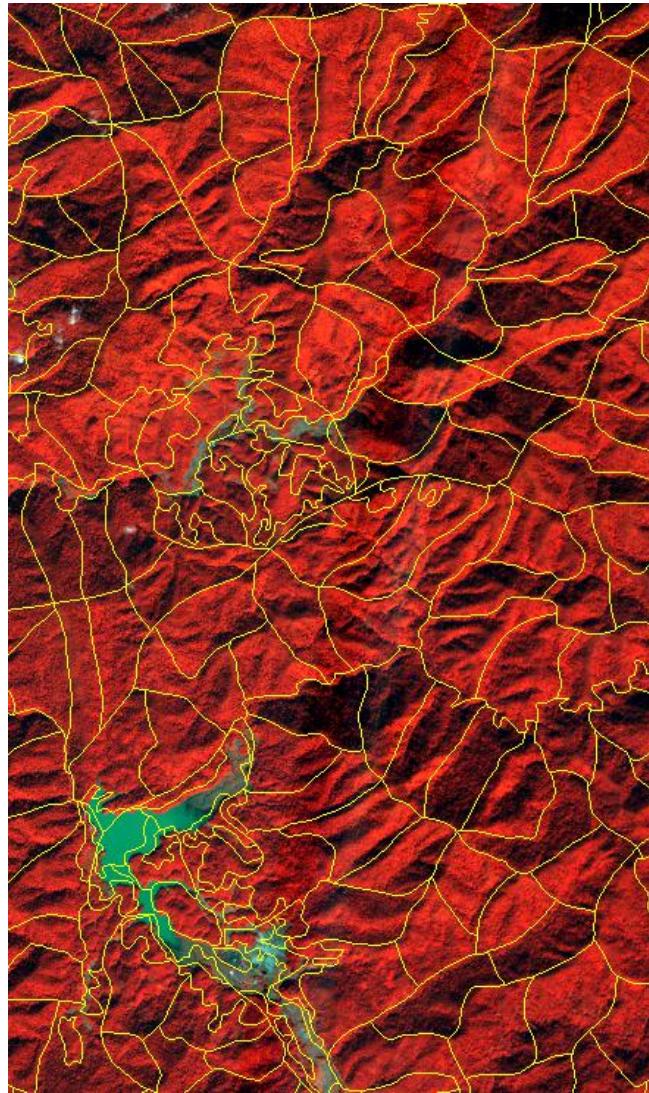
# 合作主题

- ① 成立中东欧森林资源监测评估网络和工作组
- ② 发展基于遥感技术的区域森林制图技术
- ③ 开展一次森林覆盖基准制图（如**2018年**）
- ④ 促进森林资源变化年度监测和报告编制工作
- ⑤ 开展方法示范
- ⑥ 联合举办技术交流研讨和培训

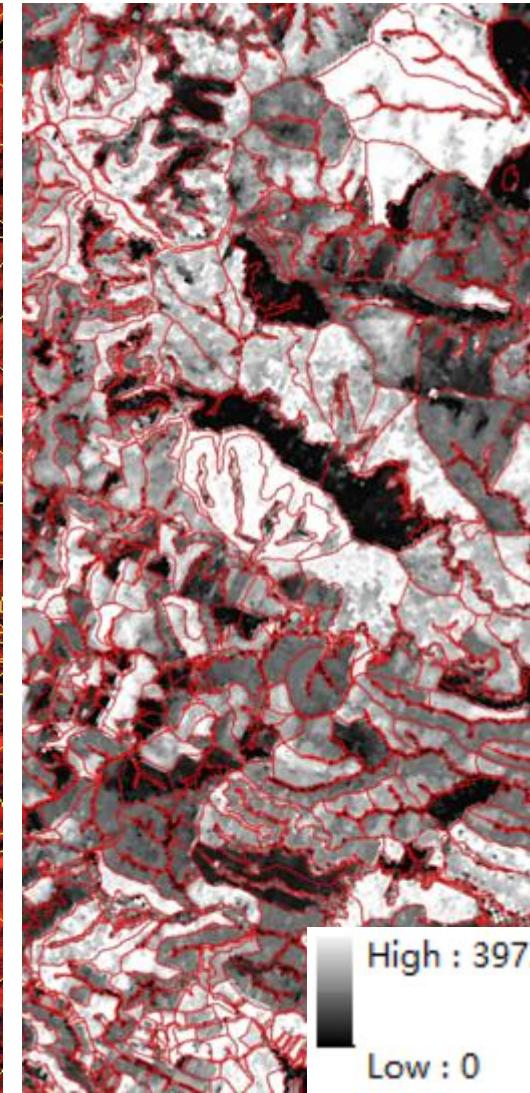
**Annual forest change  
detection of 2010-2015 (30 m)**



**Forest inventory map at  
stand level (2/8 m GF data)**



**Forest volume density  
using airborne Lidar**



**Demonstration at test sites for capacity building**



China and CEEC  
FORESTRY

# Thank You !

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