



The spatio-temporal characteristics of forest fires in China: observations from hybrid remote sensing data

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Fire as a global 'herbivore': the ecology and evolution of flammable ecosystems

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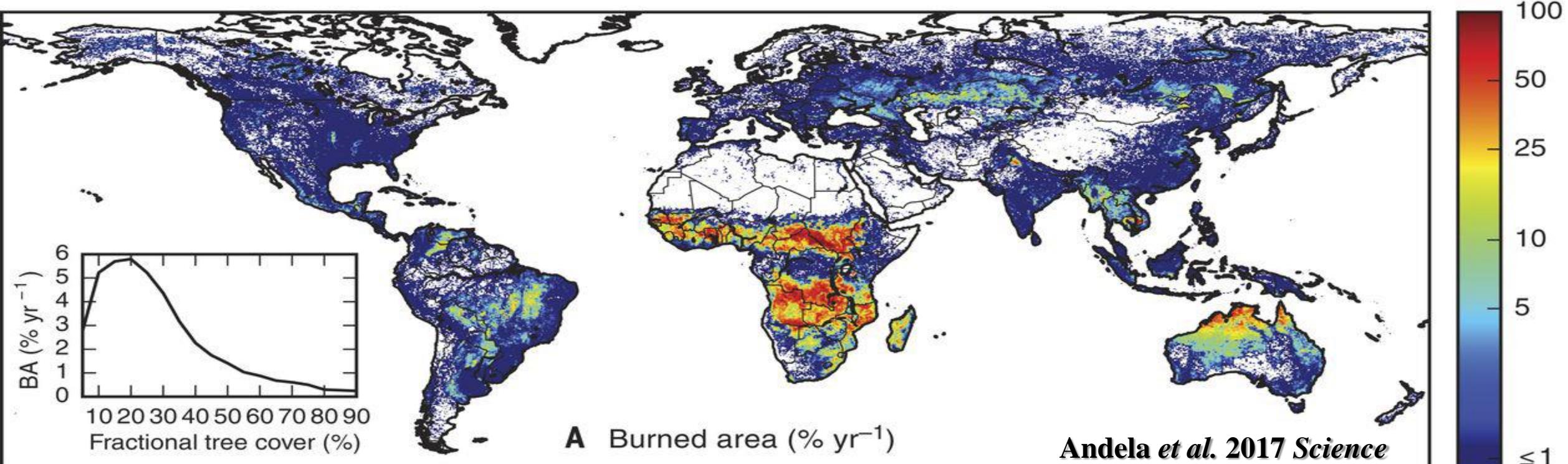
³Department of Ecology and Evolutionary Biology, University of California, Los Angeles, CA 90095, USA

Fire in the Earth System

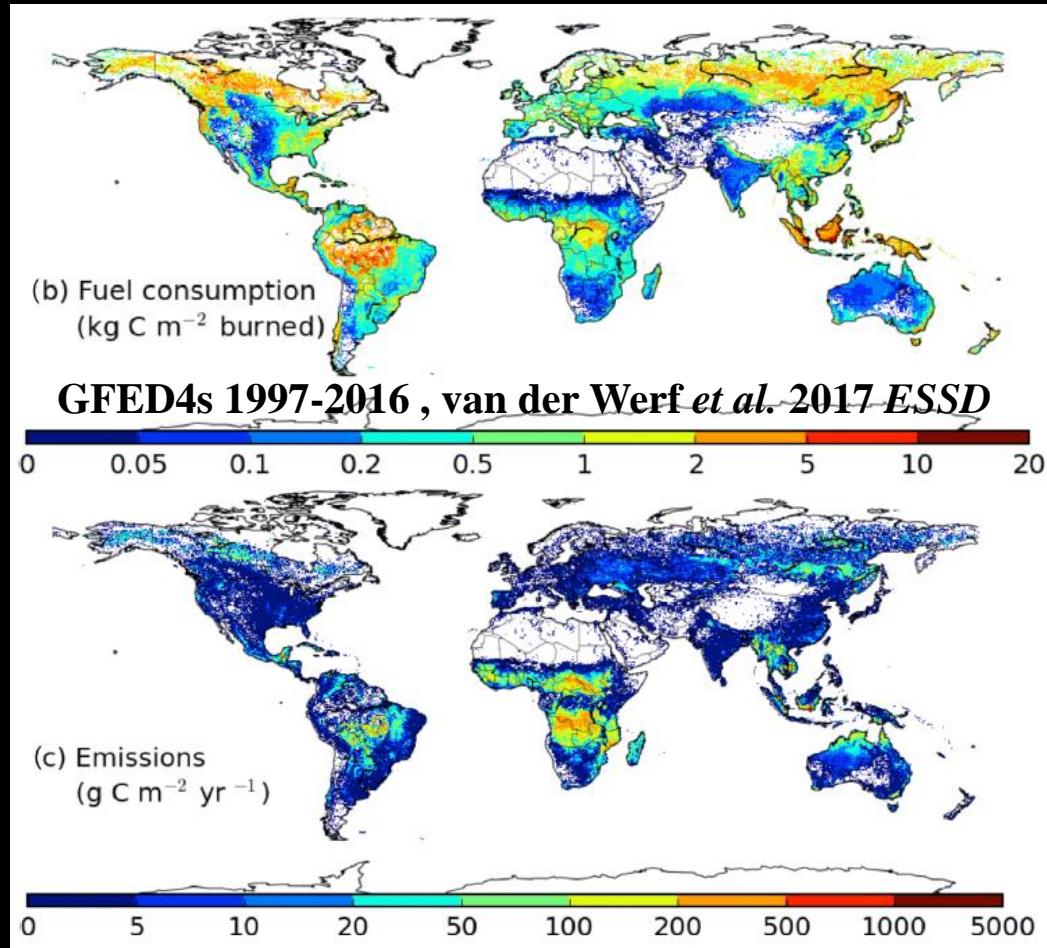
Science

David M. J. S. Bowman,^{1*} Jennifer K. Balch,^{2,3,4*} Paulo Artaxo,⁵ William J. Bond,⁶ Jean M. Carlson,⁷ Mark A. Cochrane,⁸ Carla M. D'Antonio,⁹ Ruth S. DeFries,¹⁰ John C. Doyle,¹¹ Sandy P. Harrison,¹² Fay H. Johnston,¹³ Jon E. Keeley,^{14,15} Meg A. Krawchuk,¹⁶ Christian A. Kull,¹⁷ J. Brad Marston,¹⁸ Max A. Moritz,¹⁶ I. Colin Prentice,¹⁹ Christopher I. Roos,²⁰ Andrew C. Scott,²¹ Thomas W. Swetnam,²² Guido R. van der Werf,²³ Stephen J. Pyne²⁴

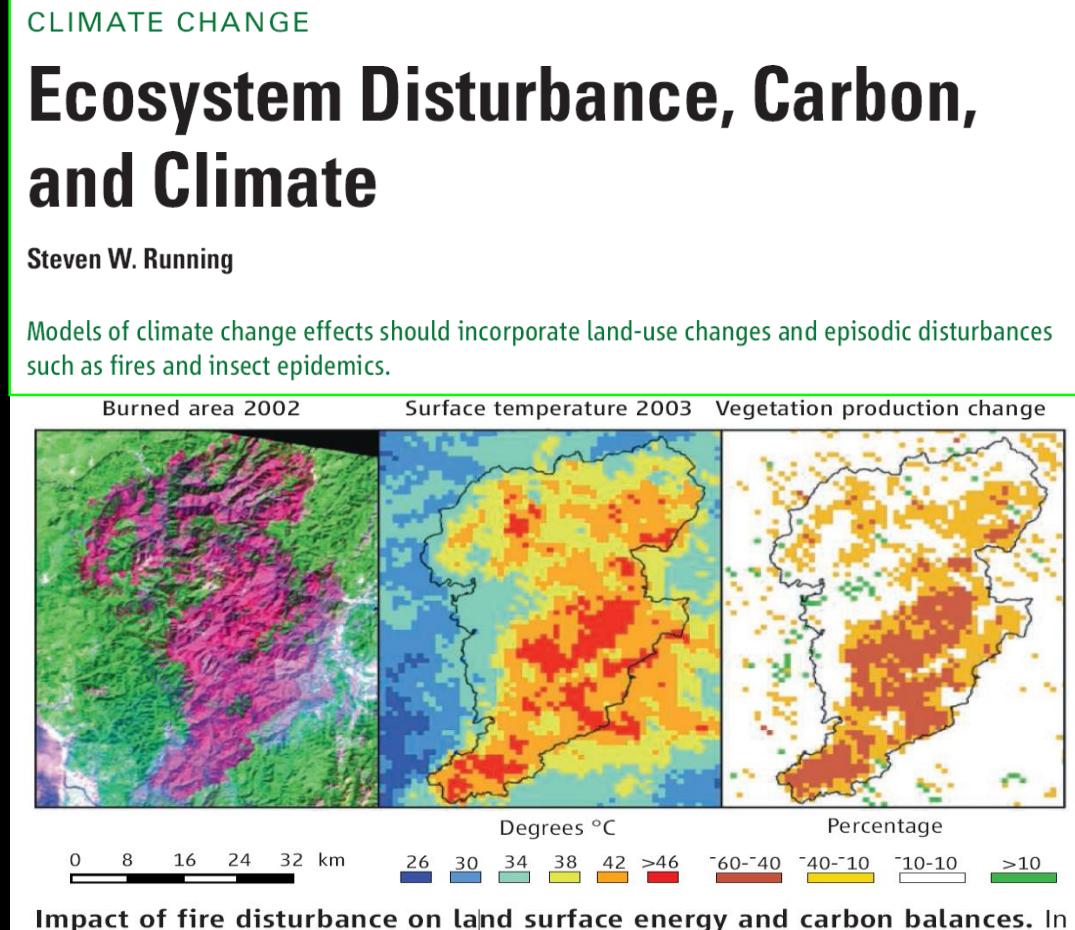
Fire is compared to be a huge "herbivore" as it consumes biomass, drives plant evolution, shapes the geo-distribution of flora and fauna.



Effects of Fire on Terrestrial Ecosystem



Consume biomass and release greenhouse gases



Alter budgets of carbon, water, and energy

Effects of Fire on Forest Ecosystem



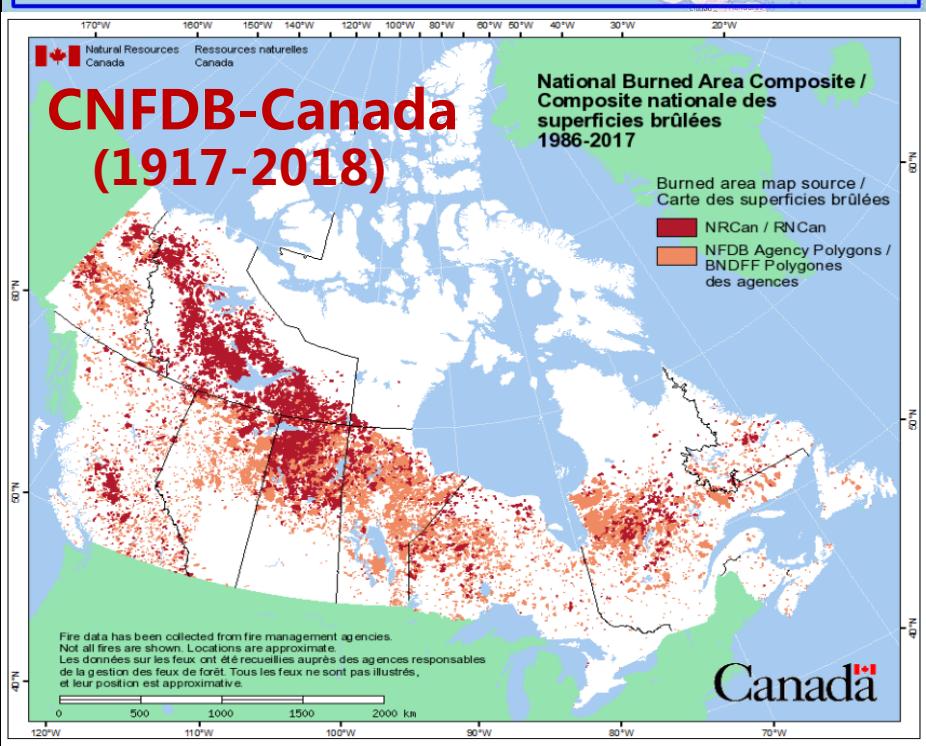
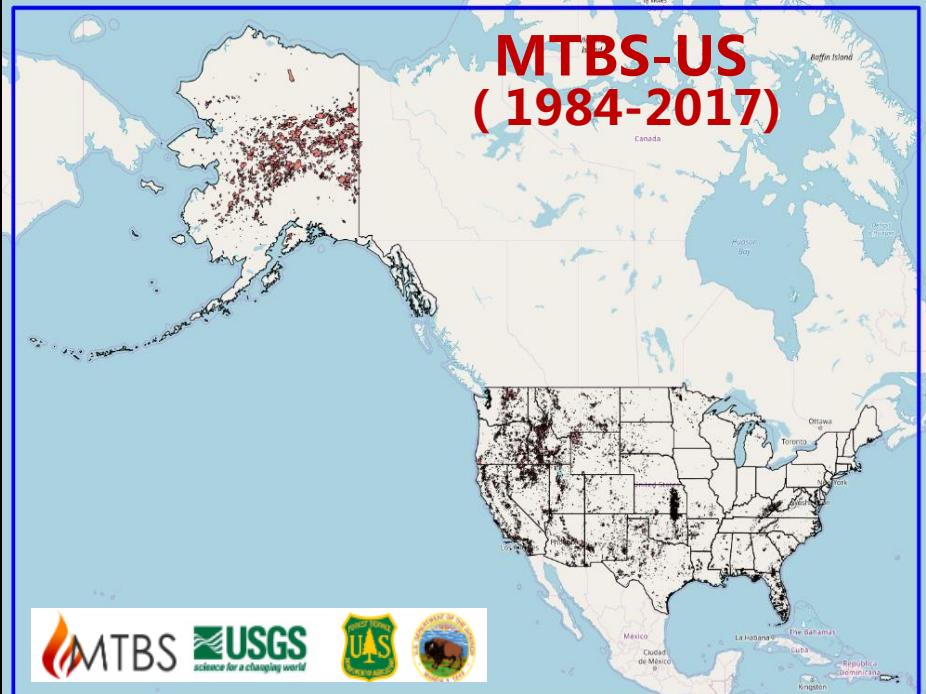
BIRDCALLS
News and Perspectives on Bird Conservation

Set With Care, Fire Creates Habitat For Many Declining Bird Species

By Rebecca Heisman | February 07, 2018



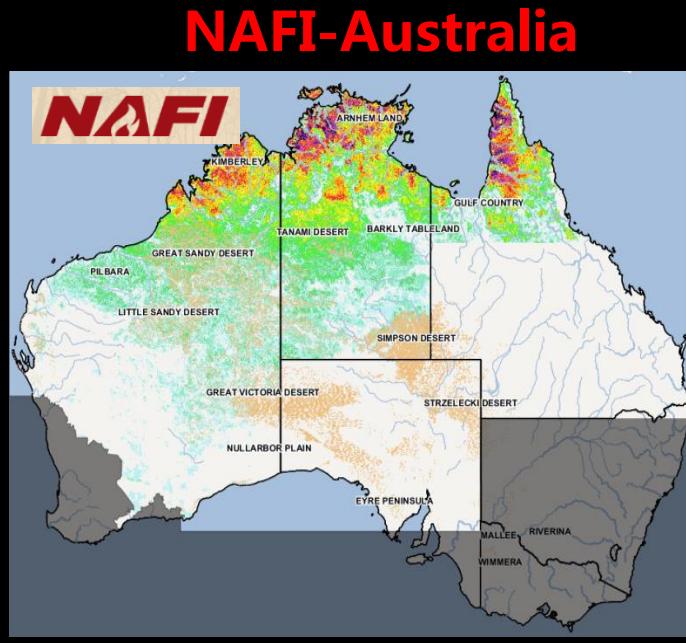
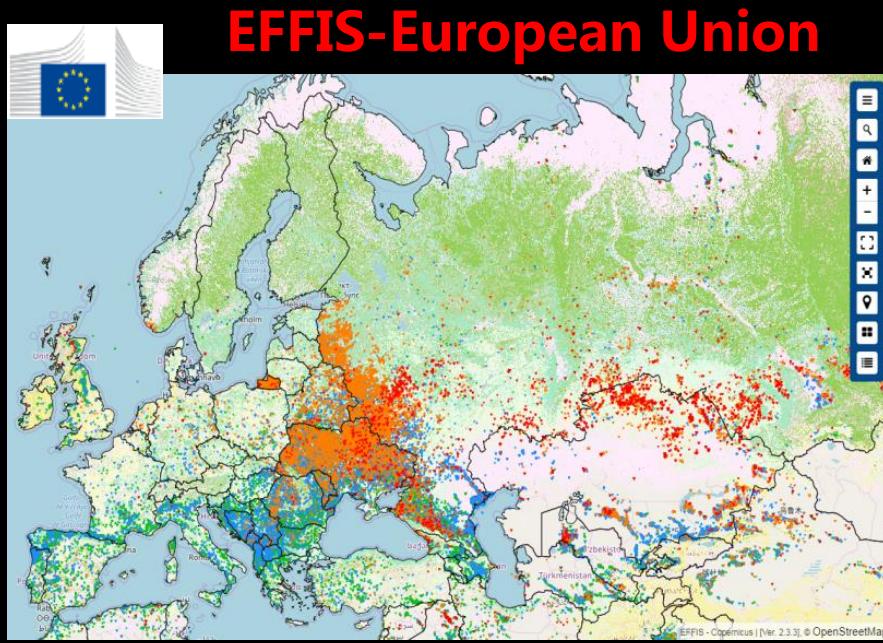
Creat canopy gap, alter soil properties, trigger forest regeneration, improve habitat of specific wildlives...



National Fire Database

- **Fire atlas: long-term & consistent**
- **Open access for publics**
- **Spatially-related Info (e.g., severity, perimeter)**

**Why this study ?
BA map is important for fire management,
but such data base is absent in China.**



Remote Sensed Global Burned Area Datasets

Why use remote sensed BA?

- Advantages of RS for BA mapping
- Mature methods and global BA products

Reviewed by Chuvieco *et al.* 2019 RSE

Name of burned area dataset	Time span	Sensor/method	Spatial resolution g=grid; p=pixel; d=degree	Temporal compositing	Development purpose	Reference
GBA2000	2000	SPOT VGT	p: 1 km , g: 0.25 d , 0.5 d , 1d	Monthly	Prototype	Tansey <i>et al.</i> (2004a,2004b)
GLOBSCAR	2000	ERS2-ATSR2	p: 1 km	Monthly	Prototype	Simon <i>et al.</i> (2004)
L3JRC	2000–2007	SPOT VGT	p: 1 km	Monthly	General purpose	Tansey <i>et al.</i> (2008)
GLOBCARBON	1998–2007	SPOT VGT, ATSR-2, AATSR	p: 1 km , g: 10 km , 0.25 d , 0.5 d	Monthly	Global carbon cycling and climate models	Plummer <i>et al.</i> (2006)
GIO-GL1*	1999-present	SPOT VGT; from 04/2014 onwards: PROBA-V	p: 1 km	10-day composite	GHG reporting	Tansey <i>et al.</i> (2008)
GIO-GL1 300*	04/2014-present	PROBA-V	p: 300m	10-day composite	GHG reporting	
FireCCI41	2005–2011	Hybrid: MERIS reflectances guided by MODIS hotspots	p: 300m , g: 0.25 d	Monthly Biweekly	Climate and dynamic vegetation models	Chuvieco <i>et al.</i> (2016)
FireCCI51	2001–2018	Hybrid: MODIS reflectances guided by MODIS hotspots	p: 250m , g: 0.25 d	Monthly	Climate and dynamic vegetation models	Chuvieco <i>et al.</i> (2018)
GFED4s	1997-present	Aug-2000 to present: MCD64A1 supplemented by small fire burned area (from scaled hotspots)	g: 0.25 d	Monthly with scalars for daily and 3-hourly estimations	Atmospheric and biogeochemical models;	van der Werf <i>et al.</i> (2017)
GFED4	1995-present	Aug-2000 to present: MCD64A1 before: scaled ATSR or VIRS hotspots	g: 0.25 d	Monthly Daily (from Aug-2000)	Atmospheric and biogeochemical models;	Giglio <i>et al.</i> (2013)
MCD45A1 c51	2000–01/2017	MODIS bi-directional reflectance (BRDF) temporal trends	p: 500m	Monthly	General purpose	Roy <i>et al.</i> (2008)
MCD64A1 c6	2000-present	Direct broadcast algorithm Hybrid: MODIS reflectances guided by MODIS hotspots	p: 500m , g: 0.25 d	Monthly	General purpose	Giglio <i>et al.</i> (2018)

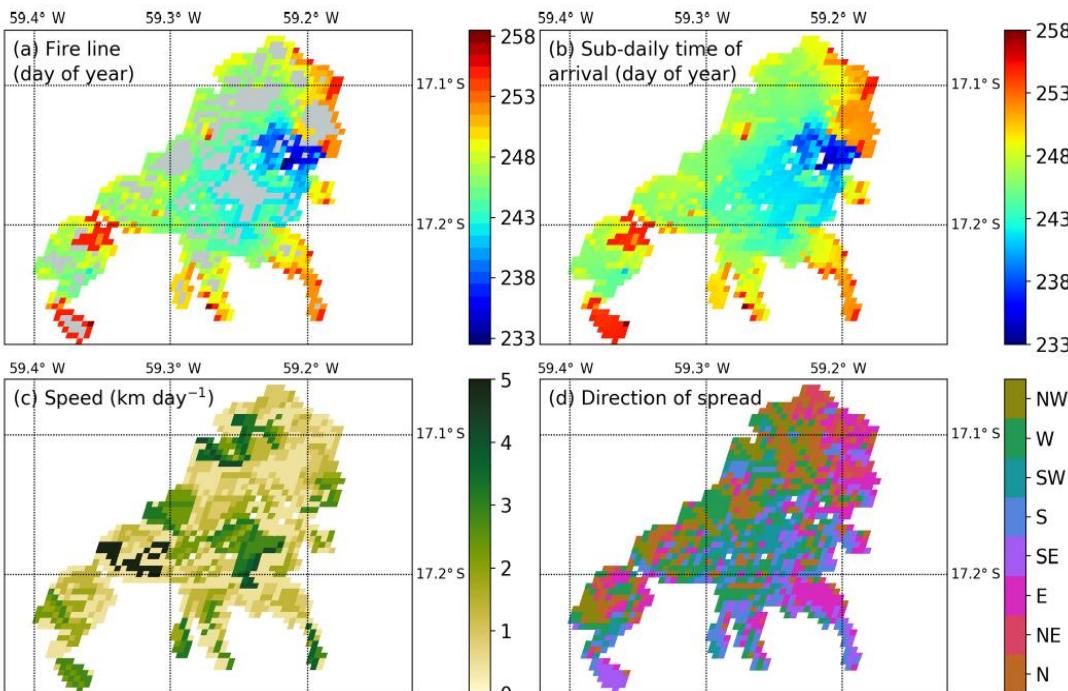
Advance of MODIS-based BA

- Characteristics: global, 2003-2016, 500 m
- Fire behavior: size, duration, spread rate&direction

Global Fire Atlas (2003-2016)

The Global Fire Atlas of individual fire size, duration, speed and direction

Niels Andela^{1,2}, Douglas C. Morton¹, Louis Giglio³, Ronan Paugam⁴, Yang Chen², Stijn Hantson², Guido R. van der Werf⁵, and James T. Randerson²

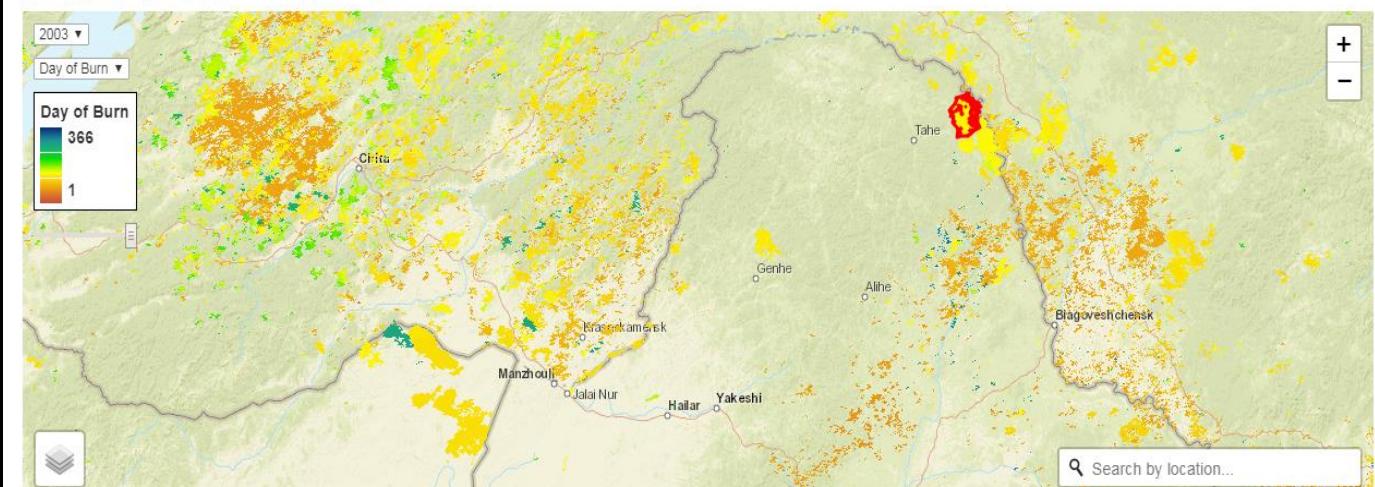


Explore data online

The data explorer tool below allows for exploration of the ignition point (red dots) and fire perimeter (black lines) shapefiles with corresponding attribute tables as well as the underlying 500 m gridded data on individual fire behavior (Table 1).

The example fire in northern Botswana burned across an area of 1600 km² during 24 days. Interestingly, fire behavior (e.g. speed and direction of spread) varied widely within the fire boundaries and across different days.

Please zoom in to any region of interest and click on any fire to explore regional fire behavior across the globe. The dropdown lists in the upper left corner allow users to change the year and the underlying 500 m gridded data on individual fire behavior.



Current Selection: Fire_ID #889292

Lat, Lon	52.697899, 125.877403	Start Date	2003-05-15	Daily Fire Line	82.91 km
Perimeter	568.56 km	Duration	16 days	Speed	20.28001 km/day
Size	1297.15 km ²	Daily Fire Expansion	81.07 km ² /day	Direction of Spread	southwest

ESA FireCCI Products

Generation and analysis of a new global burned area product based on MODIS 250 m reflectance bands and thermal anomalies

Open Access
Earth System
Science
Data

Emilio Chuvieco¹, Joshua Lizundia-Loiola¹, Maria Lucrecia Pettinari¹, Ruben Ramo¹, Marc Padilla², Kevin Tansey², Florent Mouillot³, Pierre Laurent⁴, Thomas Storm⁵, Angelika Heil⁶, and Stephen Plummer⁷



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Contents lists available at ScienceDirect

Remote Sensing of Environment

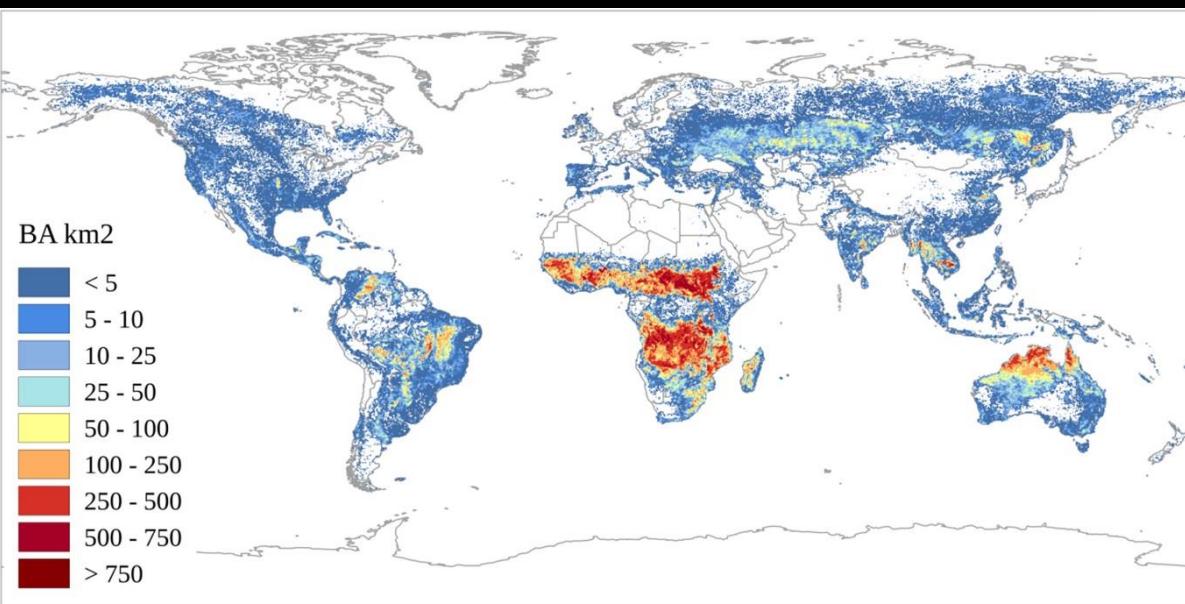
journal homepage: www.elsevier.com/locate/rse



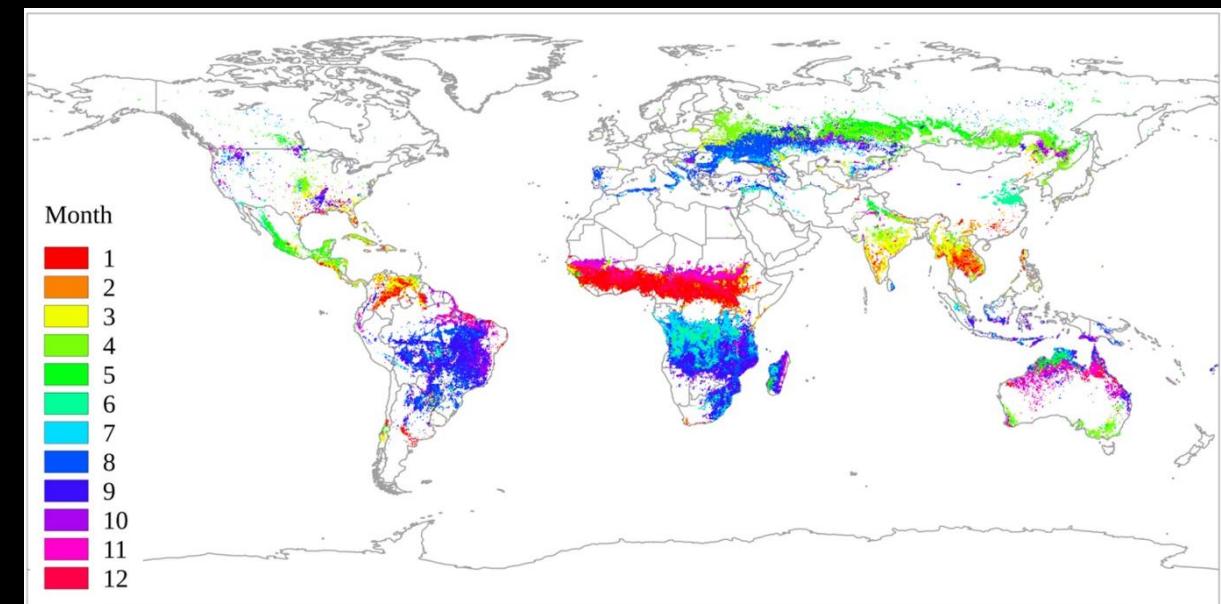
A spatio-temporal active-fire clustering approach for global burned area mapping at 250 m from MODIS data

Joshua Lizundia-Loiola*, Gonzalo Otón, Rubén Ramo, Emilio Chuvieco

Environmental Remote Sensing Research Group, Department of Geology, Geography and the Environment, Universidad de Alcalá, Calle Colegios 2, Alcalá de Henares, 28801, Spain



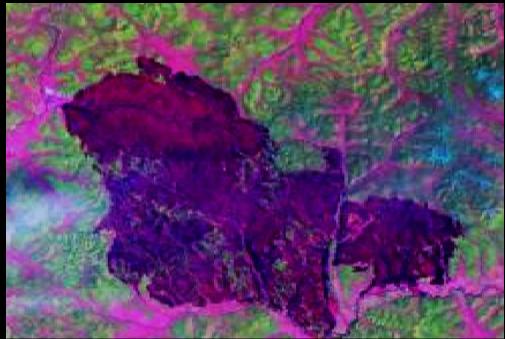
Mean annual BA obtained from FireCCI50



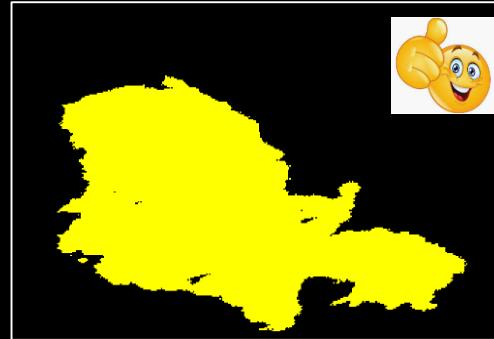
The most frequent peak month of fire Occurrence obtained from FireCCI51

ESA FireCCI51 for mapping fires in NE China

Landsat Image-2003 Genhe Fire



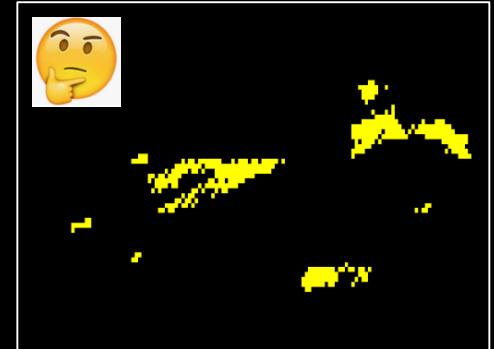
CCI_Fire51



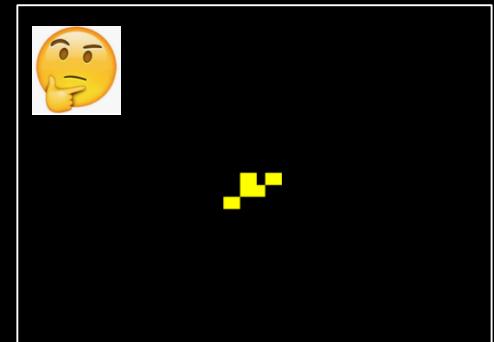
Landsat Image-2010 Huzhong Fire



CCI_Fire51



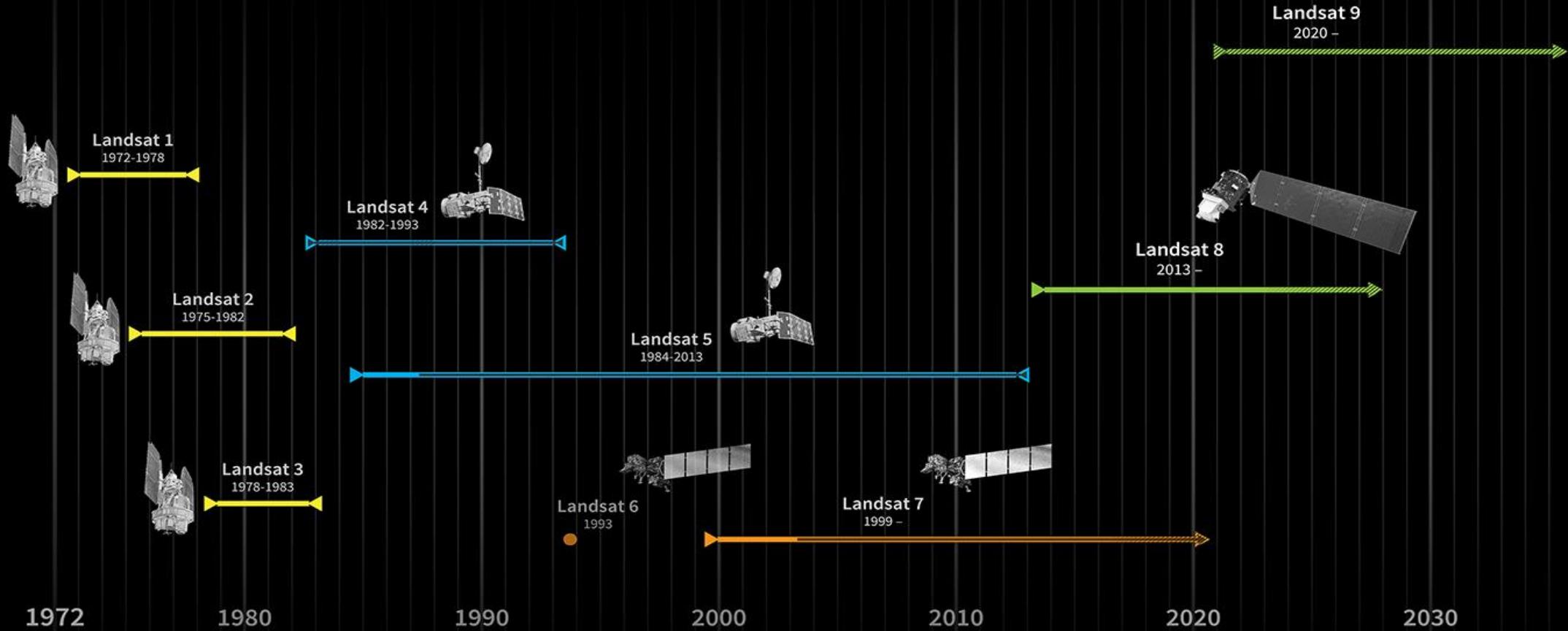
Landsat Image-2003 Nanwenghe Fire



Omission problem of small fires is evident in NE China.

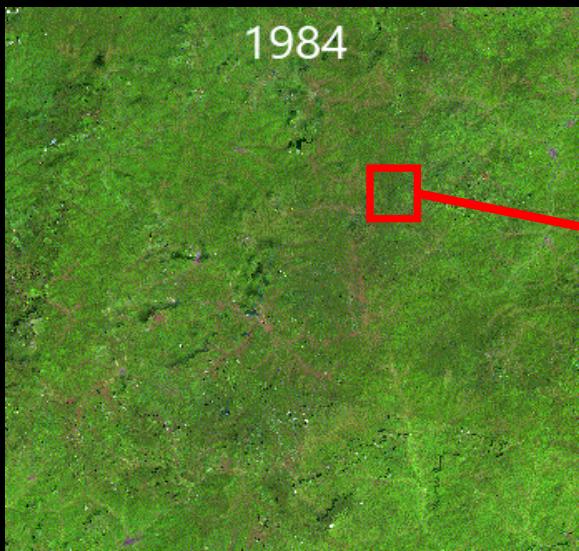
Landsat Time Series Stacks (LTSS)

BUILDING ON THE LANDSAT LEGACY

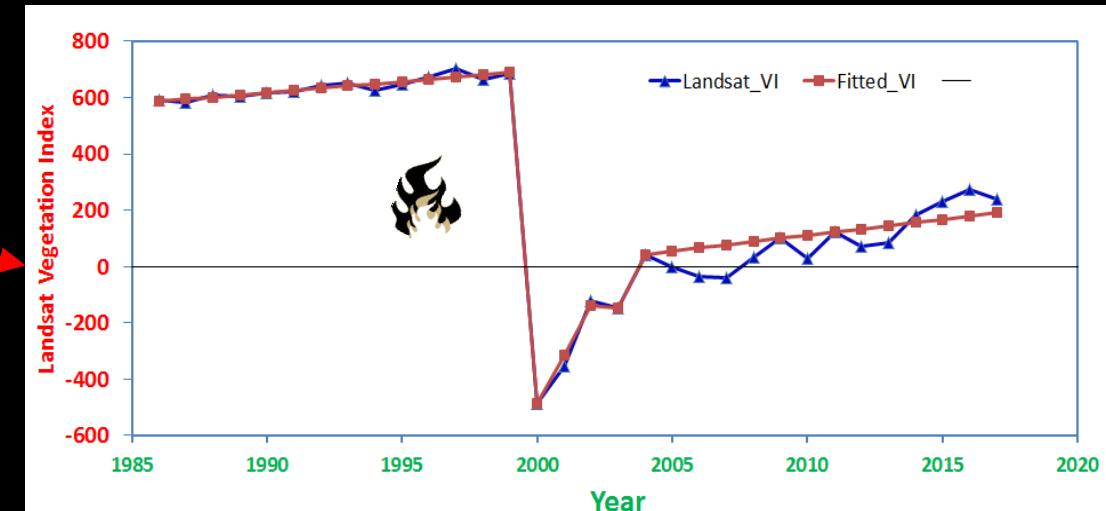


Disturbance Detection Based on LTSS

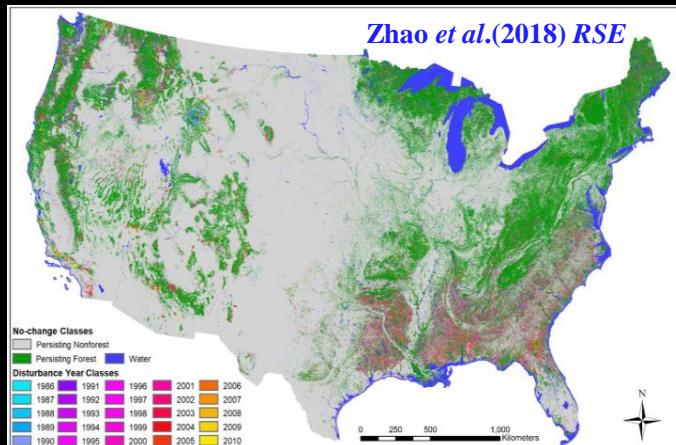
LTSS in Huzhong, NE China



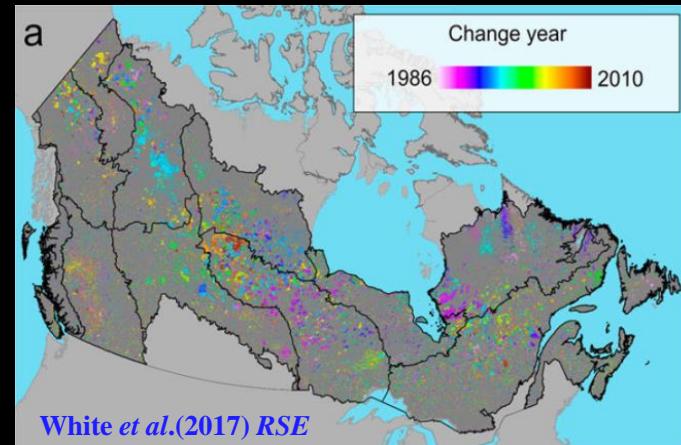
LandTrendr VI trajectory of a burned pixel



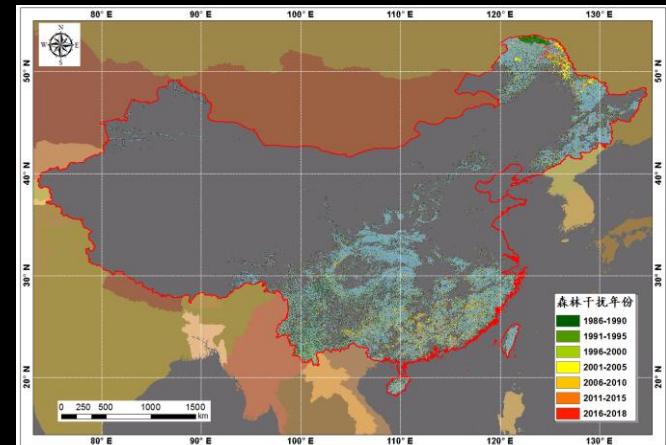
1986-2010 Disturbance History in US



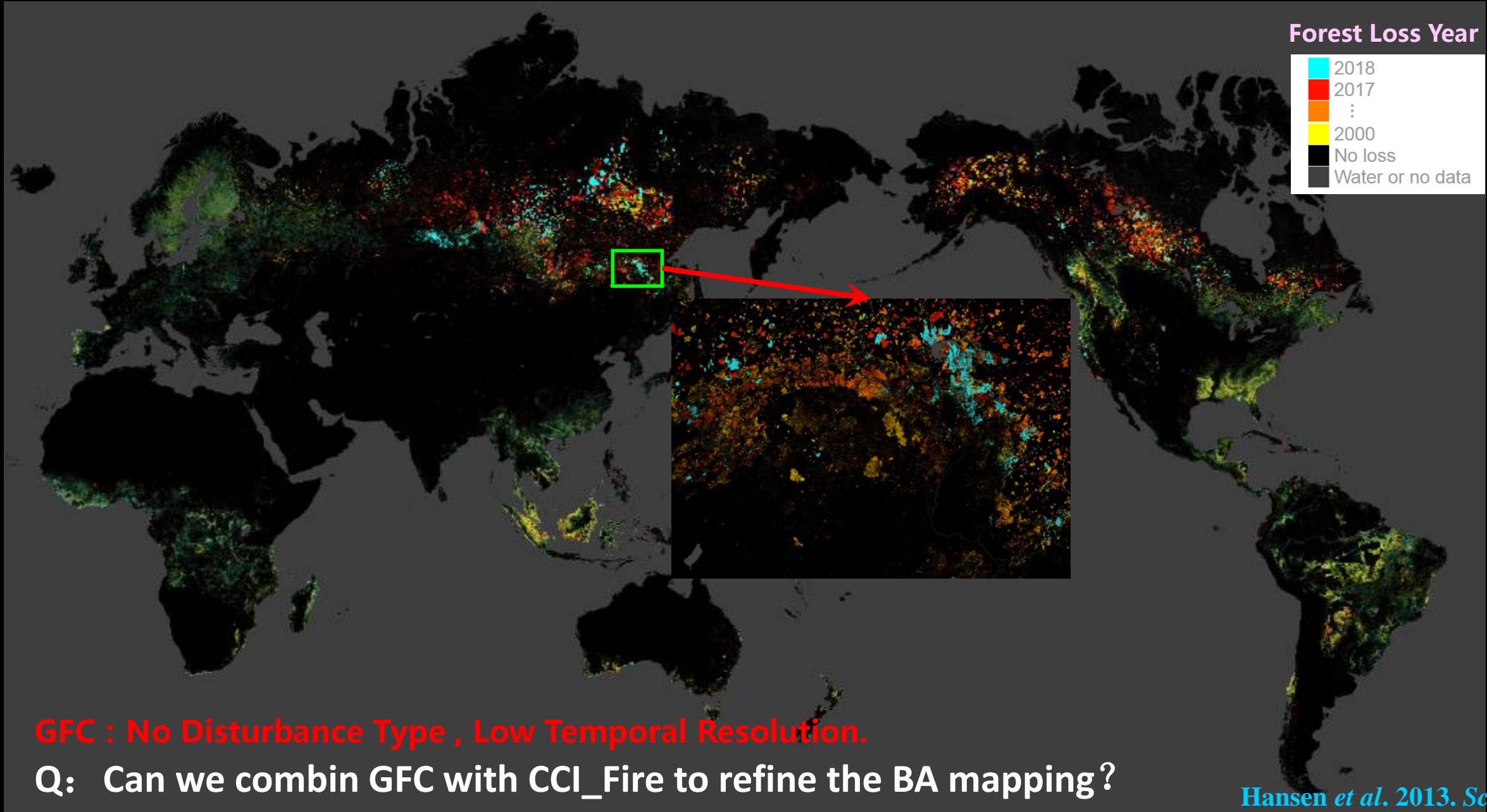
1986-2010 Disturbance History in Canada



1986-2018 Disturbance History in China (Unpublished)

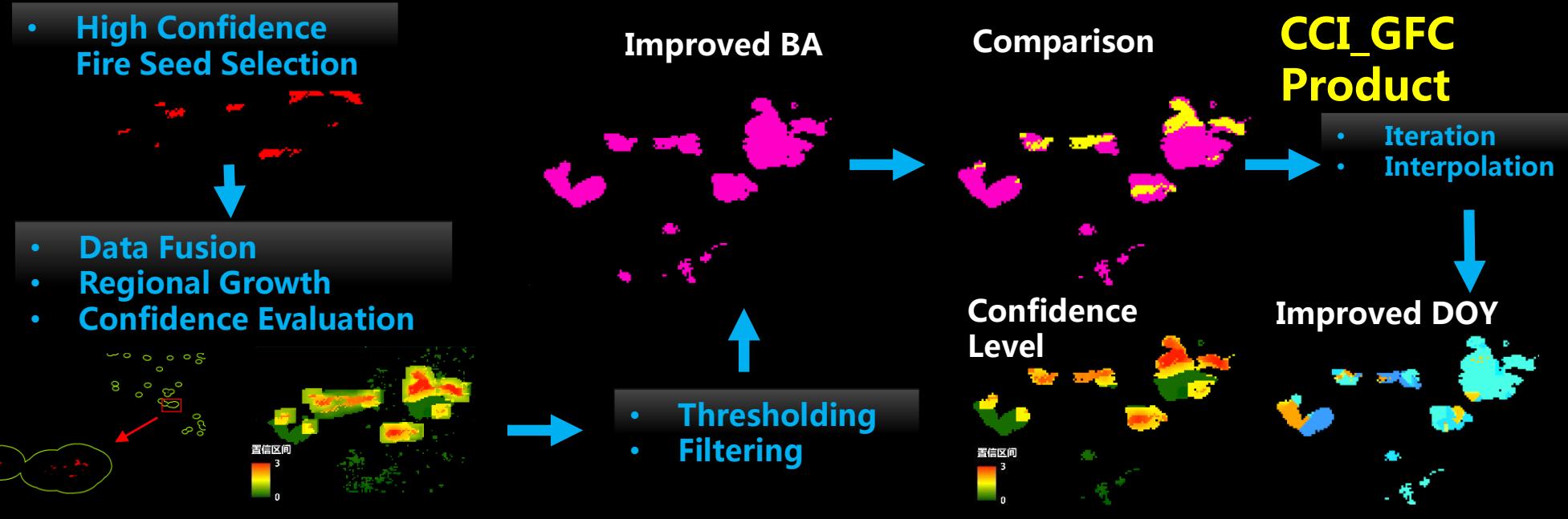
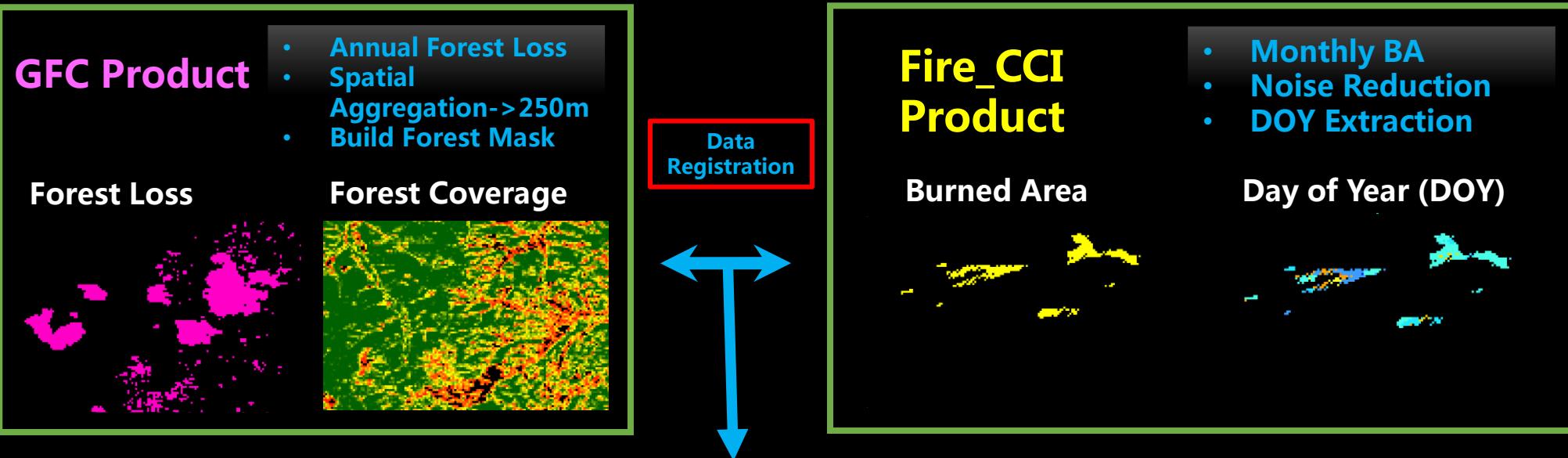


Global Forest Change(GFC) Product



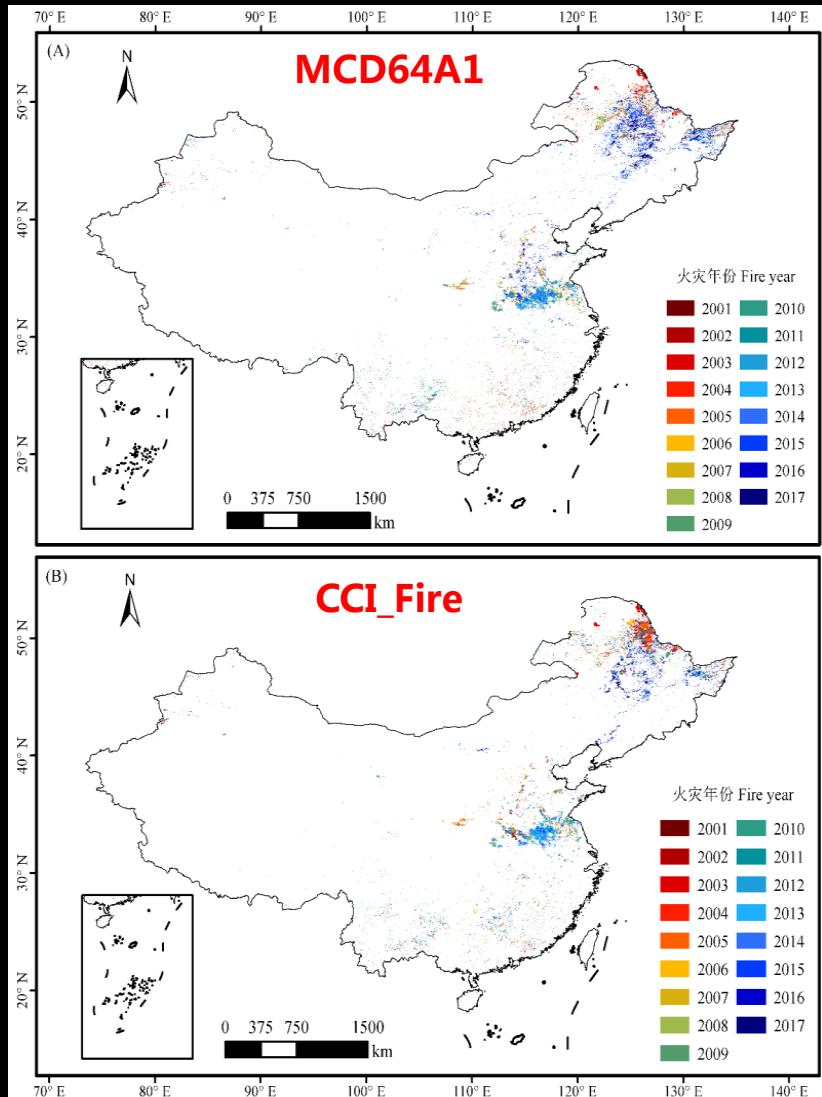
Hybrid Burned Area Mapping Approach

(Using Huzhong 2010 fires as the example)

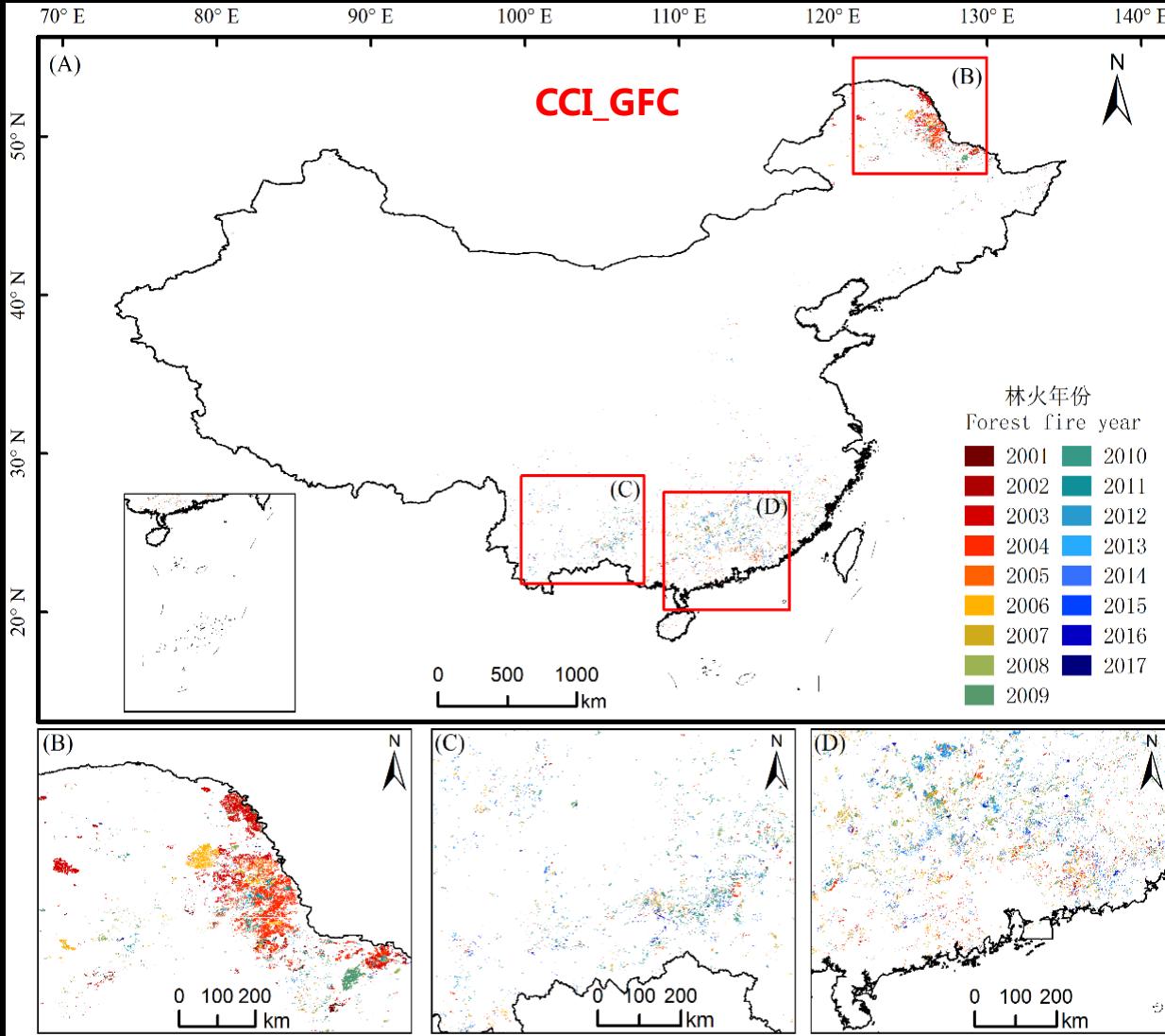


Results: 2001-2017 Forest Fire in China

Open Fire (Forest Fire+Crop Straw Burning)



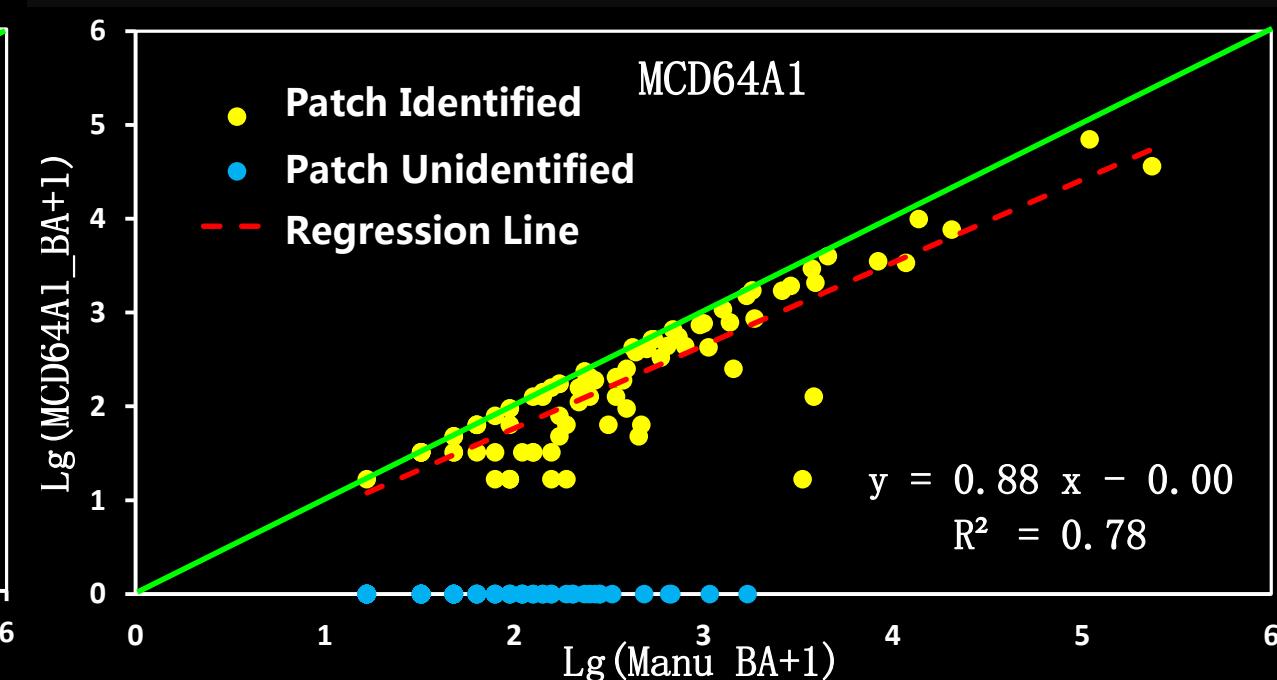
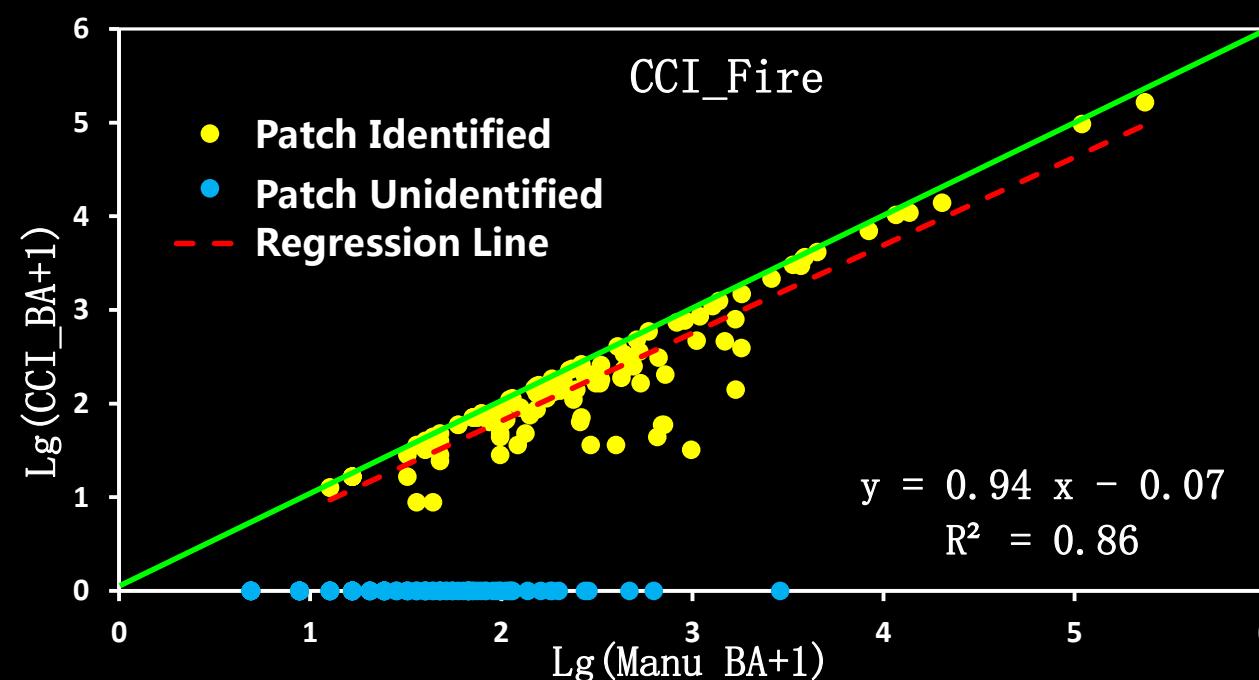
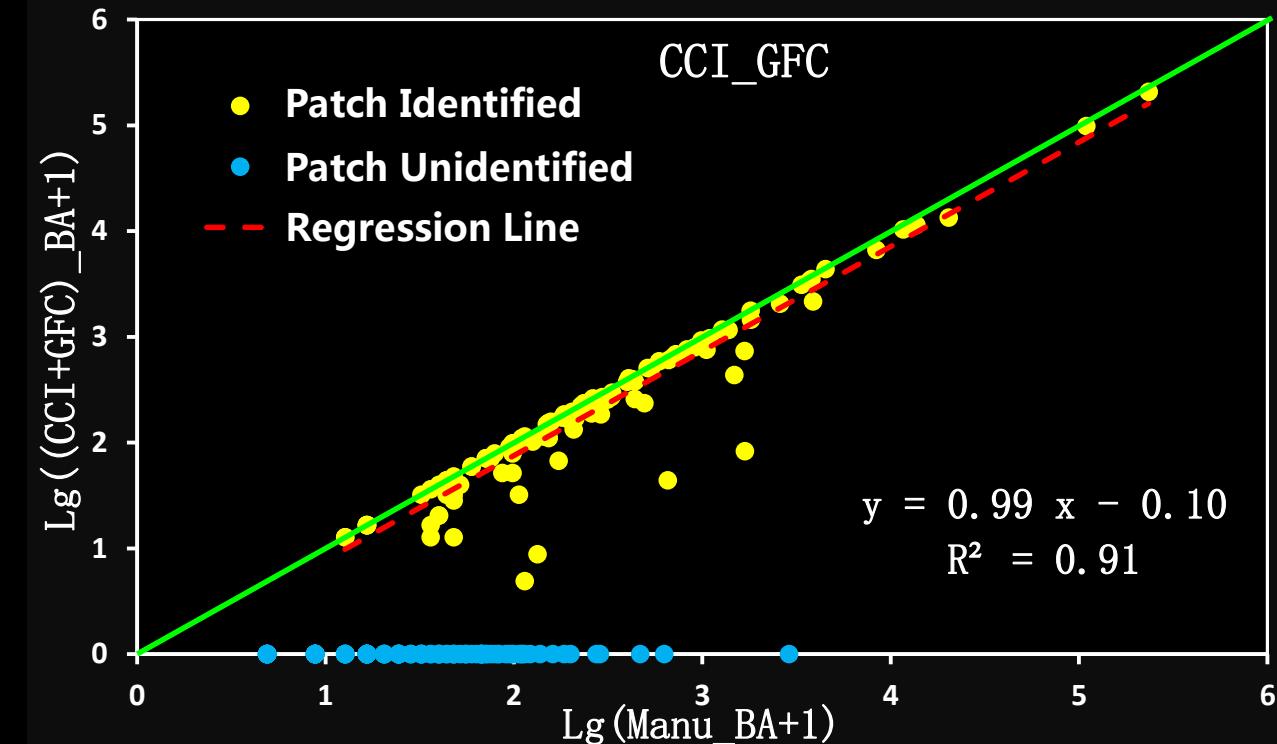
Forest Fire Only



Validation using burned patches of GXAM , NE China

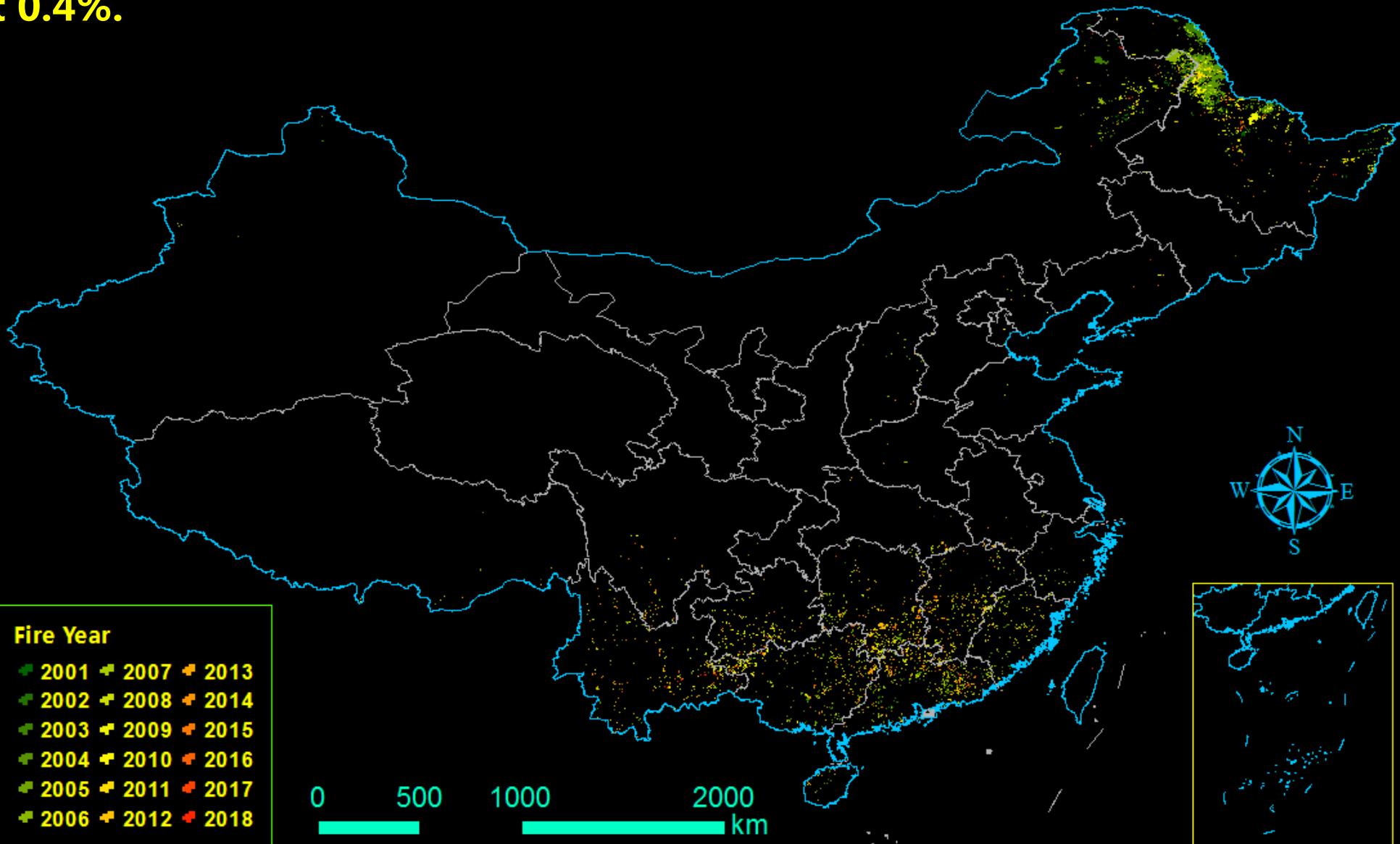
Number of patches: 248, ~ 46.2 million ha

	CCI_GFC	CCI_Fire	MCD64A1
Patches Identified	116	112	86
Area Identified (10×kha)	38.2	34.3	16.1



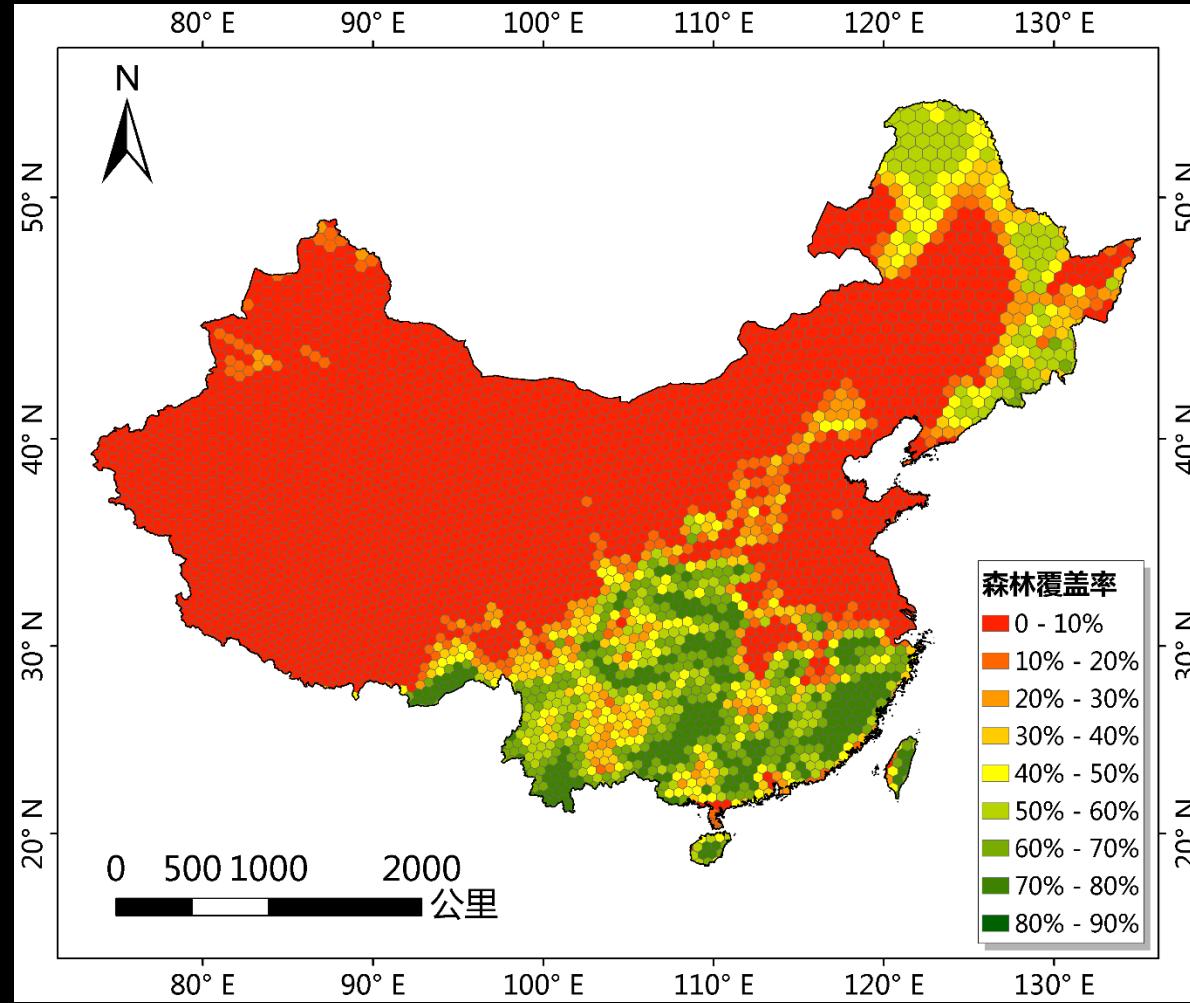
Distribution of Forest Fire in China

Forest loss caused by fire during 2001-2018
was about 0.4%.

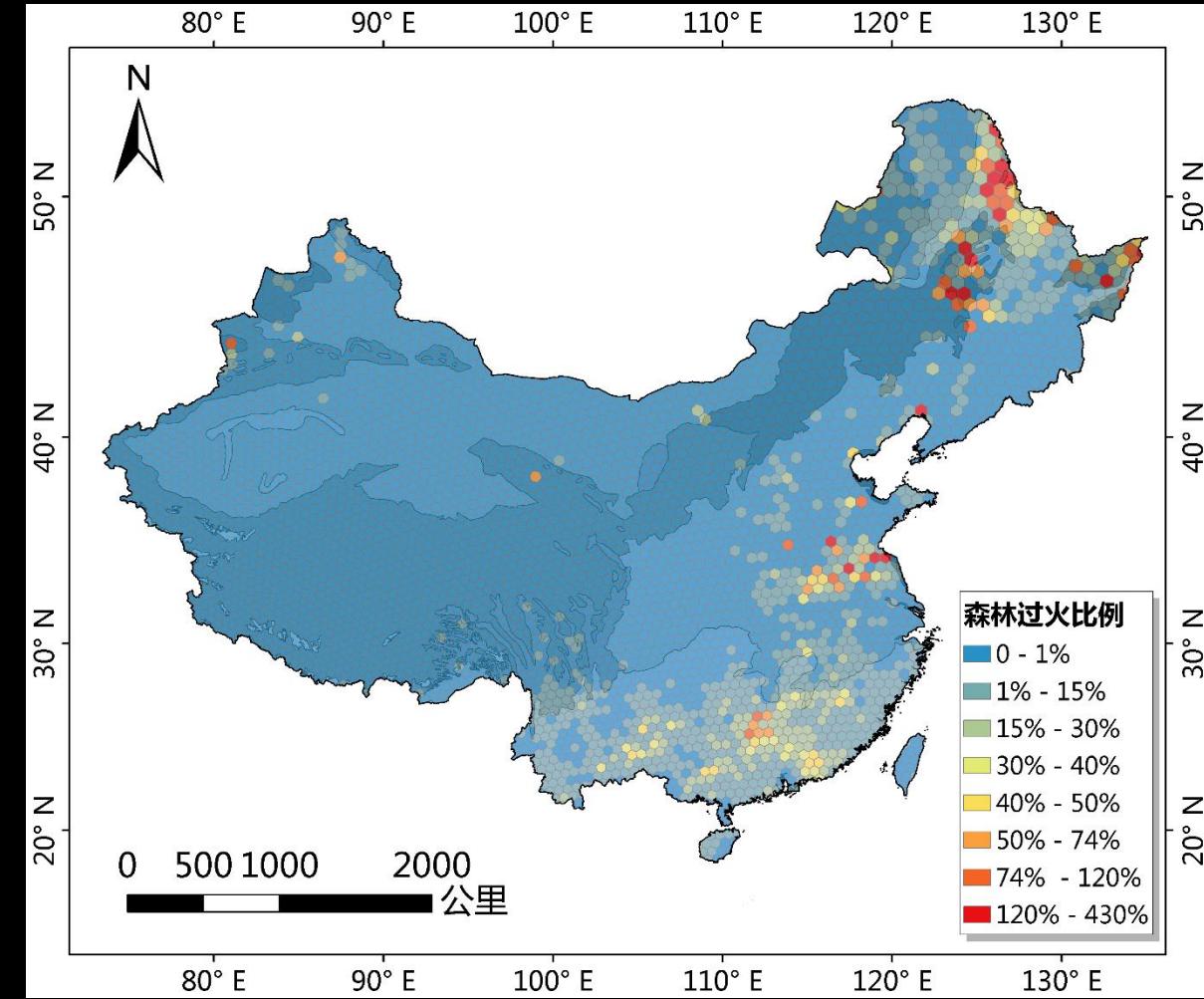


Hot Spot Region of China

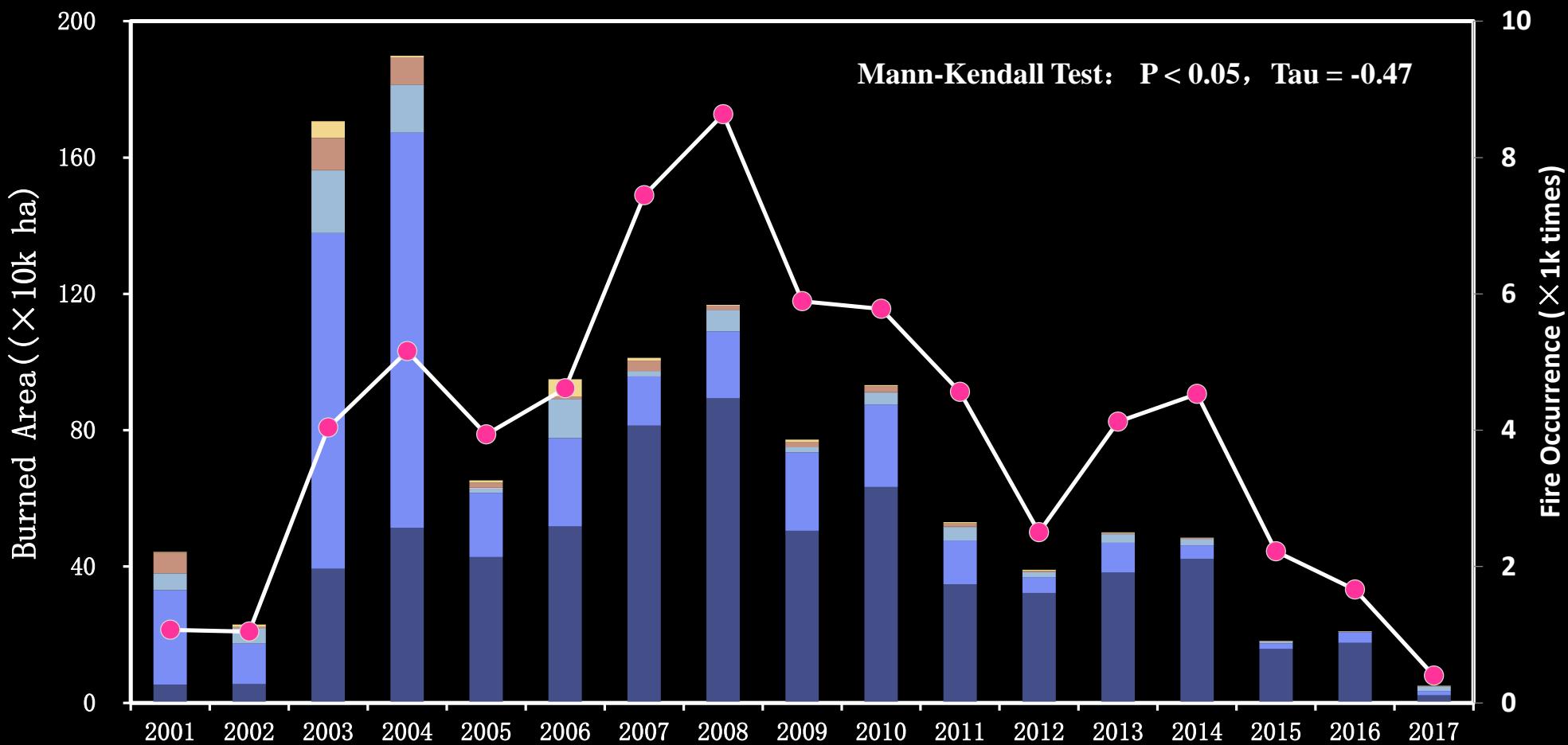
- $BFR = \frac{1}{FA} \sum_{i=1}^m BA_i \times 100\%$
where FA and BA_i are forest area and BA in each grid respectively, and m is number of years.



Forest Coverage of China
(using Hansen' s GFC product)



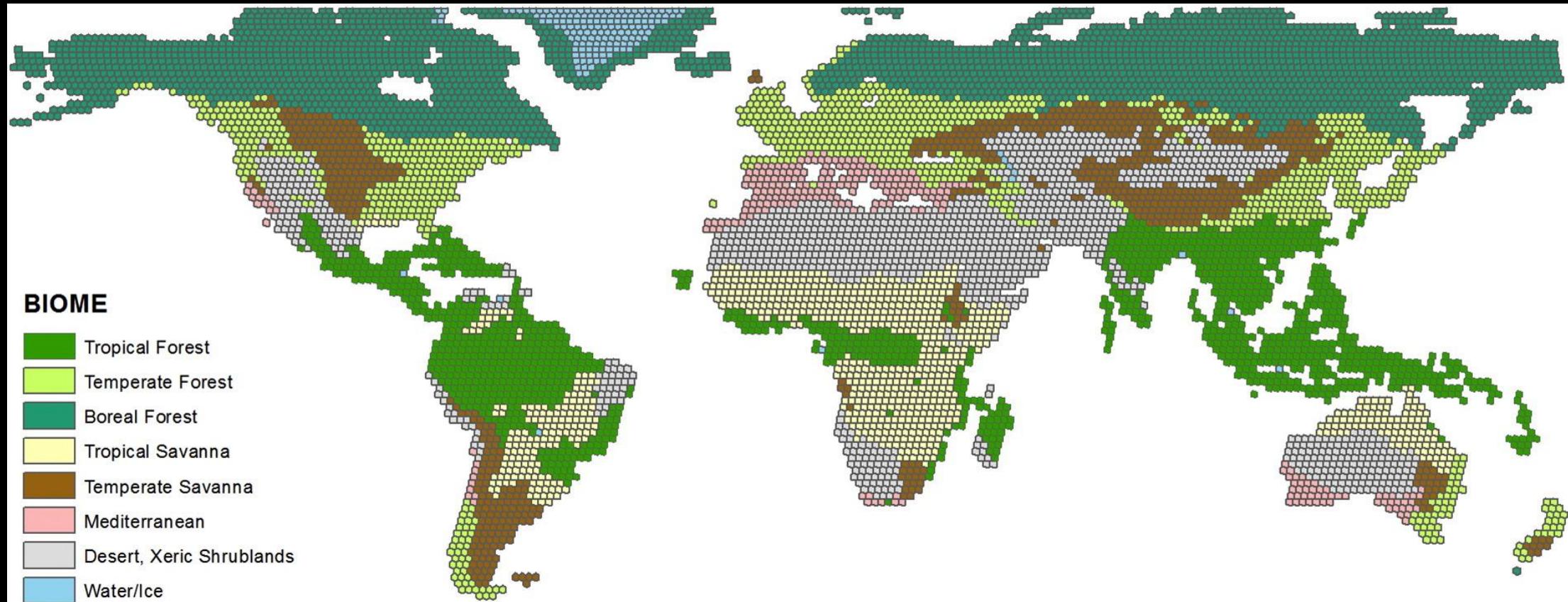
Burned Forest Rate (BFR) of China



Eco-Zone	Forest Area($\times 10k \text{ ha}$)	Total BA in 17 yrs($\times 10k \text{ ha}$)	Mean Annual BA ($\times 10k \text{ ha}$)	Mean Annual BFR
Tropical - subtropical evergreen broad-leaved forest	8818.90	663.97	39.06	0.44%
Temperate broad-leaved mixed forest	6942.71	416.29	24.49	0.35%
Temperate coniferous forests	3070.44	79.16	4.66	0.15%
Temperate steppe - shrub	325.96	15.08	0.89	0.27%
Wetland meadow - savanna	123.86	35.52	2.09	1.69%
Desert - desert shrub	10.51	0.11	0.01	0.06%
Plateau meadow - shrub	561.32	1.18	0.07	0.01%

Problems of this study : BA Product Validation

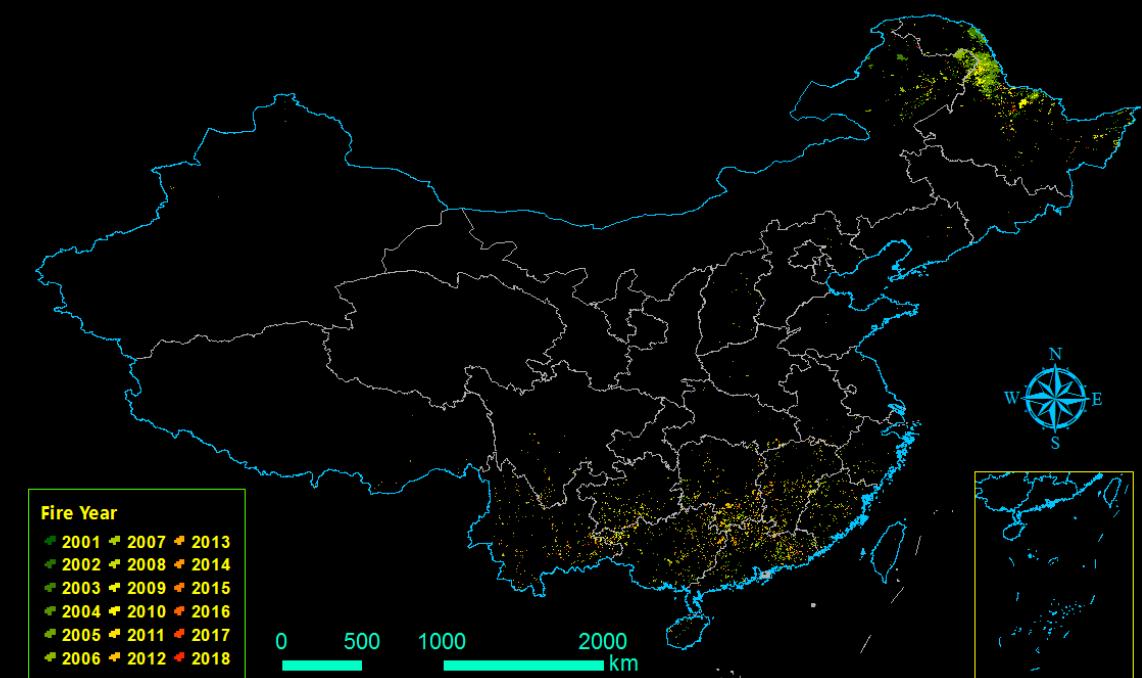
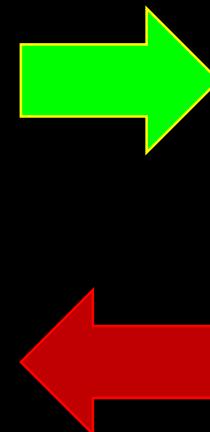
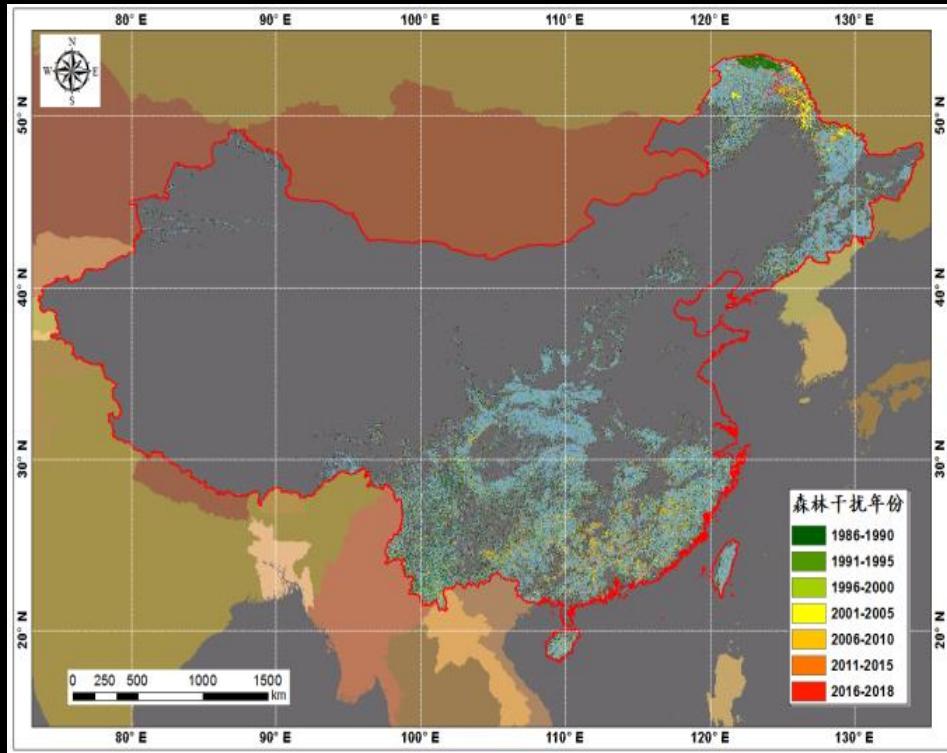
- Lack of reference BA data in China
- Need to systematically validation for different eco-zones.



Global Eco-zones

Problems of this study : BA Product Improvement

- Pro-long time series of BA mapping
- Improve the spatial resolution



Couple Landsat-derived Forest Disturbance with MODIS/NOAA-derived Fire Product.



Thanks for your attention!

Appreciation to ESA CCI_Fire team

and Matthew C. Hansen' s team.