Fire mapping - "Direct Readout" near-realtime fire applications in CONABIO

CREDITS (since 1998…)

Isabel Cruz, Gerardo Lopez, Michael Schmidt,
Raul Jiménez, Silke Ressl, Bart Wickel, Luis Sanchez

Why -the hell- do I have to present this?

Michael Schmidt → Ran away to DLR
Bart Wickel → Ran away to WWF
Gerardo Lopez → Wants to run away , but I don´t let him
Isabel Cruz → Quickly booked a "business trip"
Raul Jiménez → Doesn´t want to be here in the first place
Silke Ressl → Ran away to Raul
Luis Sanchez → Still a "greenhorn"

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Rapid fire detection program

More than 80,000 hectares are affected by fires in Mexico every year.

Fires have a huge impact on global and local environmental processes

Identification and mapping of burned areas is critical for fire management
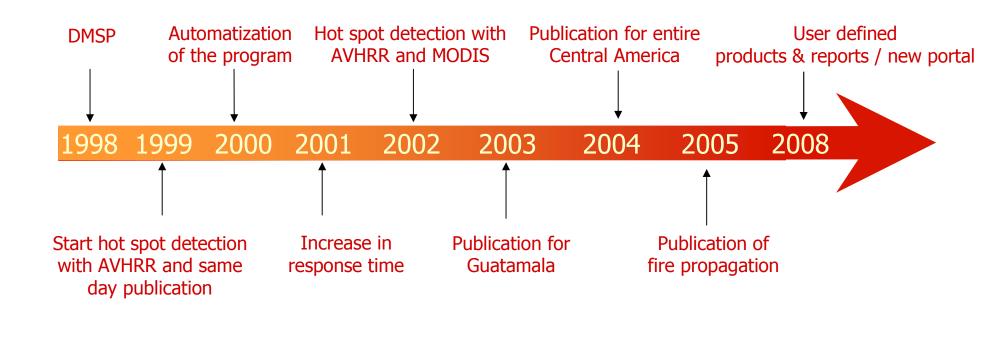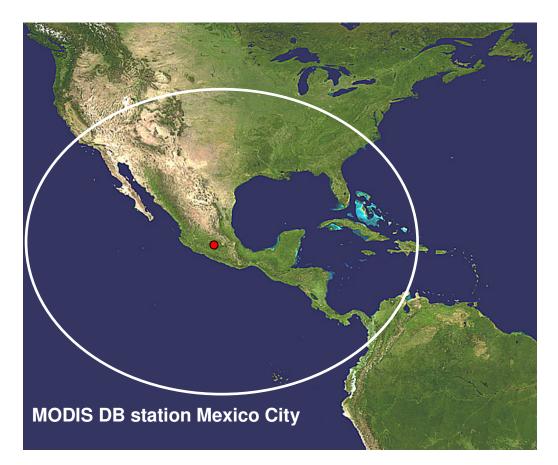
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Photography by: Fulvio Eccardi

Rapid fire detection program

History of fire related activities at CONABIO

DMSP

Automatization of the program

Hot spot detection with AVHRR and MODIS

Publication for entire Central America

User defined products & reports / new portal

| 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2008 |

Start hot spot detection with AVHRR and same day publication

Increase in response time

Publication for Guatamala

Publication of fire propagation

CONABIO

Rapid fire detection program

Continuous fire monitoring through complementary suite of satellites

MODIS DB station Mexico City

MODIS DB station (X band antenna)

8 passes /day receiving MODIS Aqua / Terra

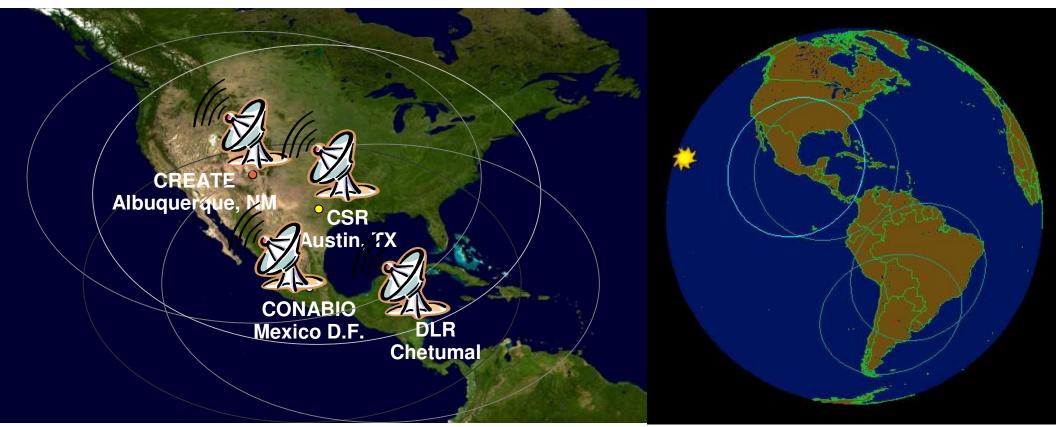**AVHRR (L band antenna)**

Mainly NOAA 15,17 and 18

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Direct Readout data networking

- Data exchange with other direct Broadcast stations for continuous monitoring
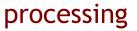- Data redundancy in case of data losses
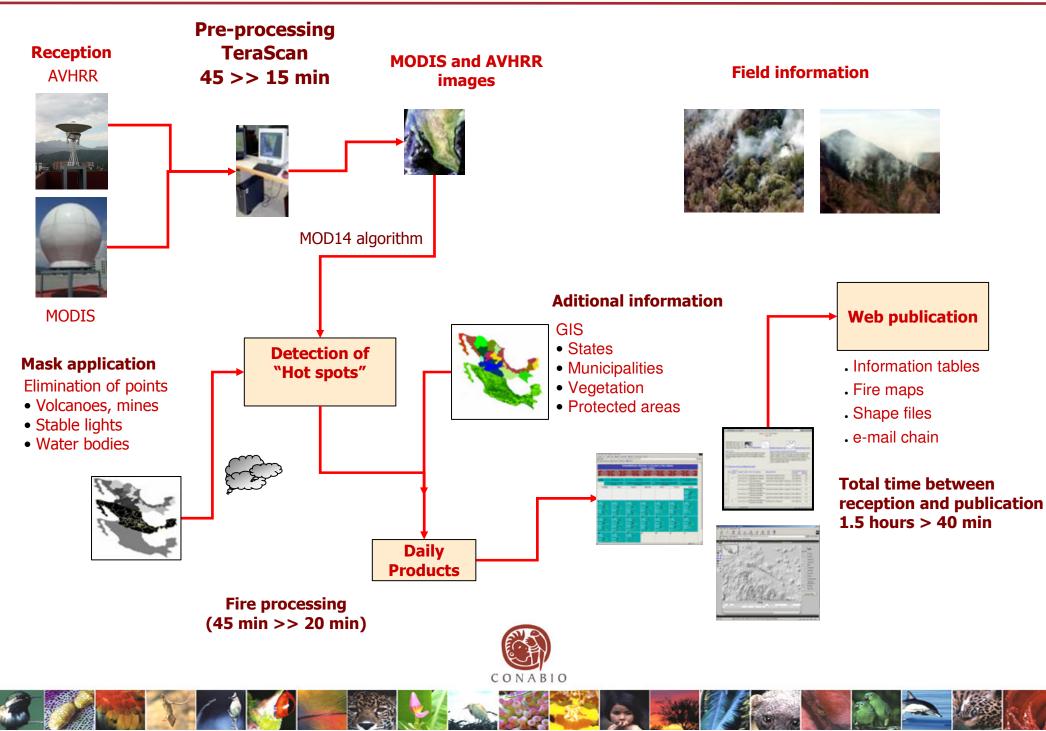- Larger coverage for monitoring

Sentinel "Latin America"?

CREATE Albuquerque, NM

CSR Austin, TX

CONABIO Mexico D.F.

DLR Chetumal

Reception

AVHRR

Pre-processing TeraScan 45 >> 15 min

MODIS and AVHRR images

Field information

MODIS

MOD14 algorithm

Mask application

Elimination of points
- Volcanoes, mines
- Stable lights
- Water bodies

Detection of "Hot spots"

Aditional information

GIS
- States
- Municipalities
- Vegetation
- Protected areas

Web publication

- Information tables
- Fire maps
- Shape files
- e-mail chain

Daily Products

Total time between reception and publication 1.5 hours > 40 min

Fire processing (45 min >> 20 min)

CONABIO

Rapid fire detection program

Near-realtime fire detection program for México and Central America
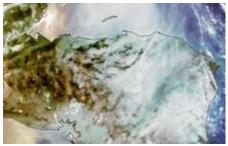
Time from reception to information release:
- **Currently ~ 1.5 hours**
- **April 2008 < 20 min**

- **Suite of products Low >> High tech**
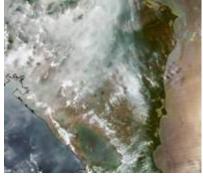
Guatemala

Honduras

Nicaragua

CONABIO

Rapid fire detection program – web access monthly data
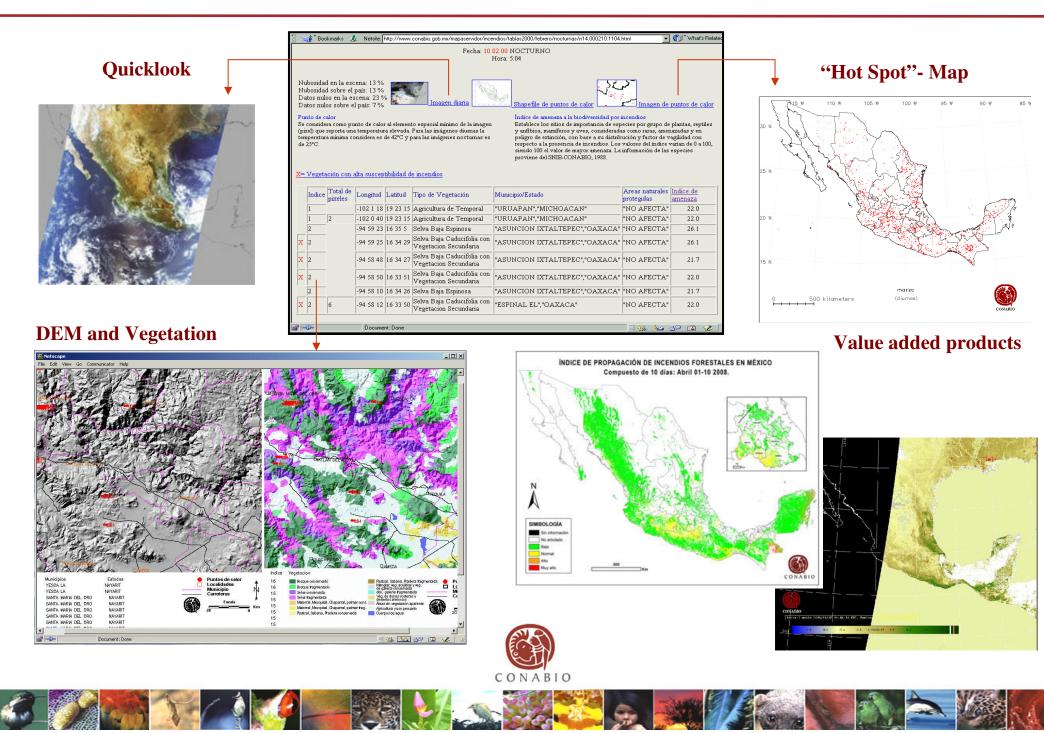
Estadísticas mensuales año 2006 - Mozilla Firefox

http://www.conabio.gob.mx/mapaservidor/incendios/tablas2006/2006.html

Acceso a estadísticas mensuales y diarias para el 2006

AVHRR Compuesto nocturno (Shapefile)	AVHRR Compuesto nocturno (PNG)	AVHRR Compuesto diurno (Shapefile)	AVHRR Compuesto diurno (PNG)	TERRA/AQUA Compuesto nocturno (Shapefile)	TERRA/AQUA Compuesto nocturno (PNG)	TERRA/AQUA Compuesto diurno (Shapefile)	TERRA/AQUA Compuesto diurno (PNG)

Enero

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	127
	Diurna	1612

Febrero

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	66
	Diurna	1983

Marzo

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	214
	Diurna	4155

Abril

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	1266
	Diurna	13438

Mayo

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	2039
	Diurna	18220

Junio

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	439
	Diurna	2054

Julio

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	107
	Diurna	420

Agosto

AVHRR		TOTAL
	Nocturna	
	Diurna	
MODIS		
	Nocturna	82
	Diurna	274

Septiembre

AVHRR		TOTAL
	Nocturna	
	Diurna	--
MODIS		
	Nocturna	48
	Diurna	149

Octubre

AVHRR		TOTAL
	Nocturna	
	Diurna	--
MODIS		
	Nocturna	
	Diurna	

Noviembre

AVHRR		TOTAL
	Nocturna	
	Diurna	--
MODIS		
	Nocturna	
	Diurna	

Diciembre

AVHRR		TOTAL
	Nocturna	
	Diurna	--
MODIS		
	Nocturna	--
	Diurna	

C O N A B I O

Rapid fire detection program – web access to daily data

Rapid fire detection program

Quicklook

"Hot Spot"- Map

DEM and Vegetation

Value added products

Rapid fire detection program – daily products

Rapid fire detection program - Registration

Here you can register!
Ándale!

Statistics of the operational fire detection program at CONABIO

- Approx. 1 Mio. hits on fire page every month → *Vince, I still don´t believe this!*

- Average response time from satellite overpass to end user less than 30 min.

- 3896 "hot spots" (night) and 39442 "hot spots" (day) detected, classified and reported in the year of 2007

- 330 user defined e-mails with fire related products sent out daily to méxican and central american end users (currently 48 dependencias)

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Rapid Fire Processing @ CONABIO

XITLE

2 Procesadores Intel Xeon Dual-Core 3.4 GHz
32GB RAM
HDD 1.8 TB
Sistema Operativo: CentOS 4.2 (32 bits)

MODIS 2

2 Procesadores Intel Xeon Quad-Core 2.66 GHz,
32 GB RAM, Un arreglo de 6 HDD
SCSI 300 GB a 15000 rpm (1.8 TB)
Sistema Operativo: CentOS 4.1 (64 bits

CLUSTER LINUX

El Clúster cuenta con 12 nodos montados
en 6 gabinetes y cada nodo tiene:
2 procesadores Intel XEON E5430 a 2.66GHz 12Mb caché,
1333 MHz, Quad-Core, 4GB de Memoria RAM 667MHz DDR2,
1 Disco Duro de 250GB Enterprise
SATA 3Gb/s 16MB buffer 7.2k rpm 3.5".
El Clúster a su total capacidad podría utiliza
96 procesadores,
48 GB de memoria RAM y 3 TB de Disco Duro

Processing time:
30-40 min   15 min   ?? Min (sure kicks butt!)
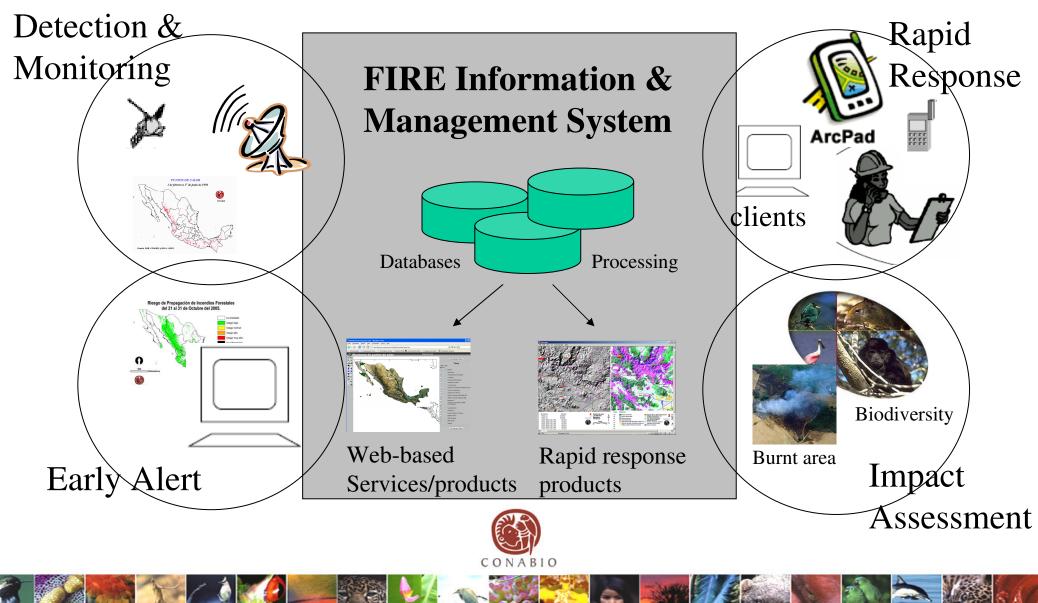
Rapid fire detection program – Future components
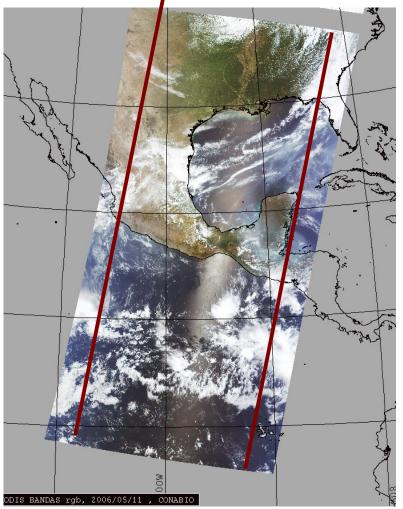
Early Alert, Monitoring and Impact Assessment System for
Forest Fires in Mexico and Central America

Detection &
Monitoring

Rapid
Response

FIRE Information &
Management System

clients

Databases

Processing

Web-based
Services/products

Rapid response
products

Burnt area

Biodiversity

Early Alert

Impact
Assessment

CONABIO

Rapid fire detection program – Impact assessment

MODIS- Composite generation:
- best viewing geometry (<= 45°)
- cloud and cloud shadow elimination
- minimum aerosol content
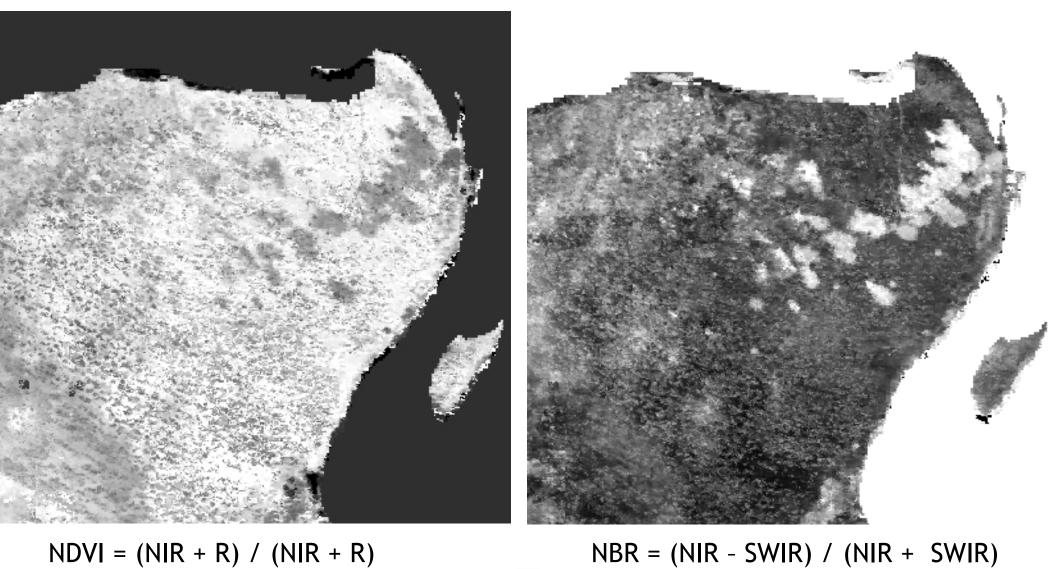
ODIS BANDAS rgb, 2006/05/11 , CONABIO

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NDVI = (NIR + R) / (NIR + R)

NBR = (NIR – SWIR) / (NIR + SWIR)

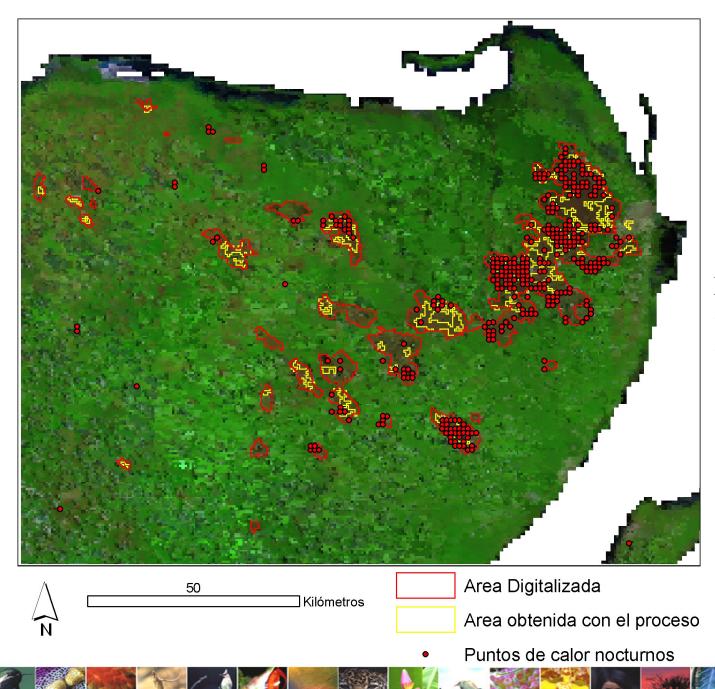CONABIO

Post fire impact assessment – Automated Burnt Area estimation

MODIS BA product
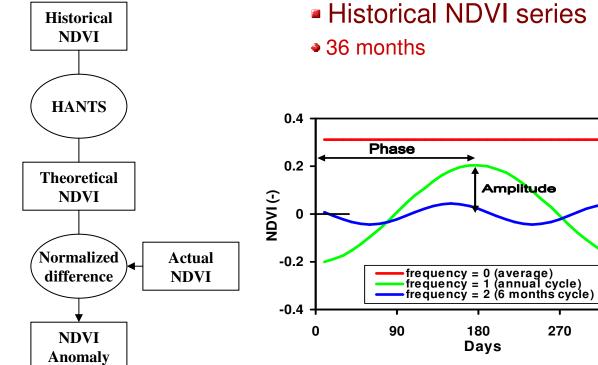
Validation with high resolution
satelite data (SPOT)

Problems:
- Still large omissions of BA
- Cloud border contamination

Legend:
- ☐ Area Digitalizada
- ☐ Area obtenida con el proceso
- • Puntos de calor nocturnos

Scale: 50 Kilómetros

N

Fire propagation risk

- HANTS = Harmonic Analysis of Time Series

Historical NDVI

↓

HANTS

↓

Theoretical NDVI

↓

Normalized difference ← **Actual NDVI**

↓

NDVI Anomaly

- Historical NDVI series
  - 36 months

Phase

Amplitude

NDVI (-)

0.4
0.2
0
-0.2
-0.4

— frequency = 0 (average)
— frequency = 1 (annual cycle)
— frequency = 2 (6 months cycle)

0   90   180   270   360

Days
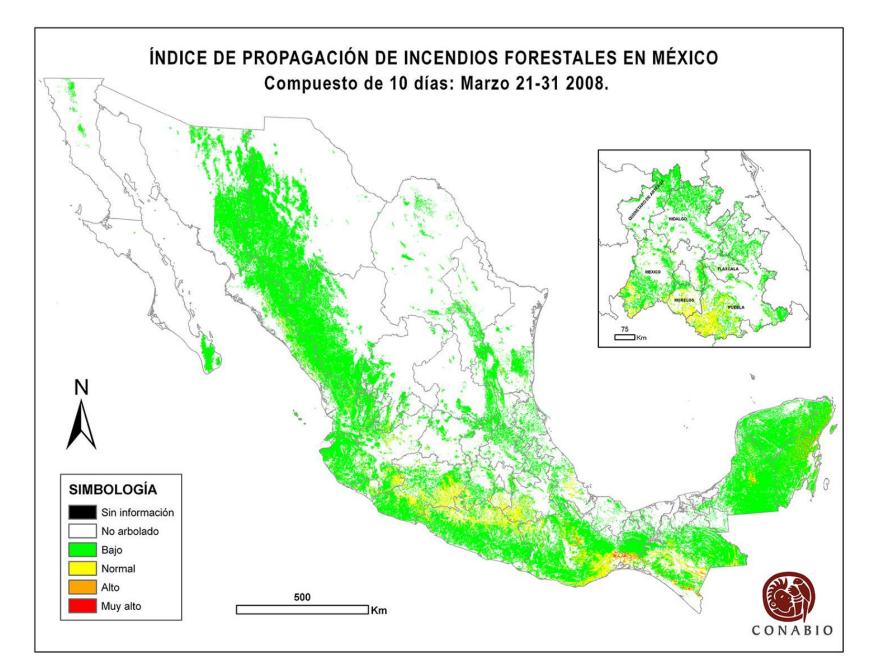
- Vegetation Cycles
  - Perennial
  - Deciduous
  - Agricultural areas
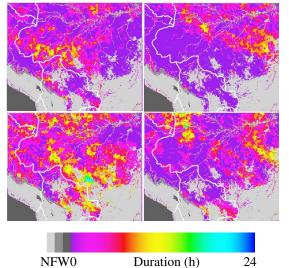
Early warning - Fire propagation risk

ÍNDICE DE PROPAGACIÓN DE INCENDIOS FORESTALES EN MÉXICO
Compuesto de 10 días: Marzo 21-31 2008.

SIMBOLOGÍA

- Sin información
- No arbolado
- Bajo
- Normal
- Alto
- Muy alto

CONABIO
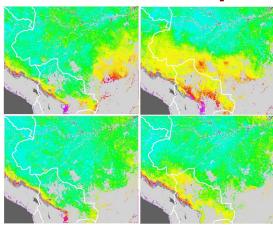
Conservation International - Fire propagation model

Rainfall

NFW0   Duration (h)   24
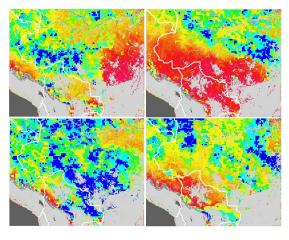
Land Surface Temperature

NFW0   deg C   40

Relative Humidity

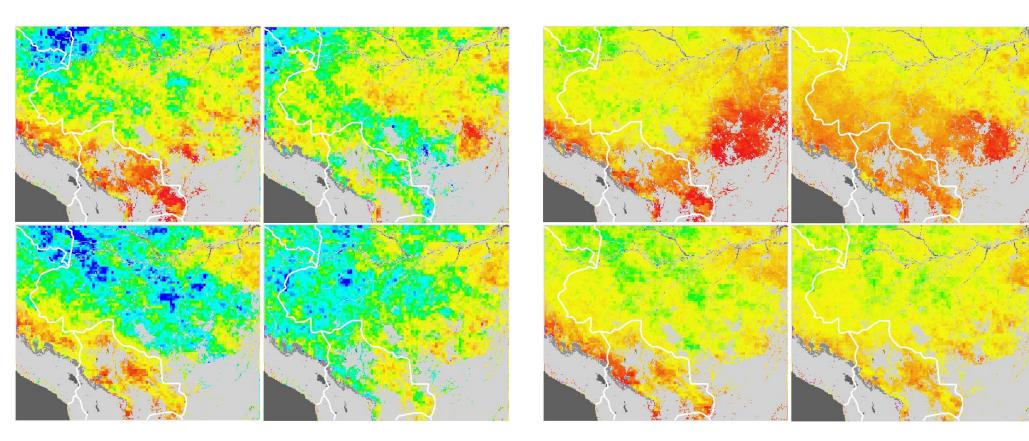NFW0   RH %   40

Model prediction – Litter Moisture

NFW0   Moisture %   40

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(Steininger et al., 2005)

**Model prediction – Litter Moisture
10 hour fuel class – 2.5 cm diam.**

**Model prediction – Litter Moisture
100 hour fuel class – 7 cm diam.**

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(Steininger et al., 2005)

Future fire missions- Sensors on FireBIRD+

BIRD +	Channel 1	Channel 2	Channel 3	Channel 4
Wavelength	0,440 µm – 0,510 µm	0,520 µm – 0,590 µm	0,630 µm – 0,700 µm	0,760 µm – 0,850µm (NIR)
Ground width (across track)	220km	220km	220km	220km
Ground resolution (pixel width)	100m	100m	100m	100m

BIRD +	Channel 5	Channel 6	Channel 7	Channel 8
Wavelength	0,840 µm – 0,900µm (NIR)	1,650 µm (SWIR)	3,4 – 4,2 µm (MIR)	8,5 – 9,3 µm (TIR)
Ground width (across track)	220km	220km	220km	220km
Ground resolution (pixel width)	100m	100 m	100m	100m

Category 1: On-Board Processing:

- Fire Location @ NRT (Near-real-time)

- Fire size

- Fire Front (Shape and geometrical properties)

- Fire Intensity (FRP – Fire Radiative Power)

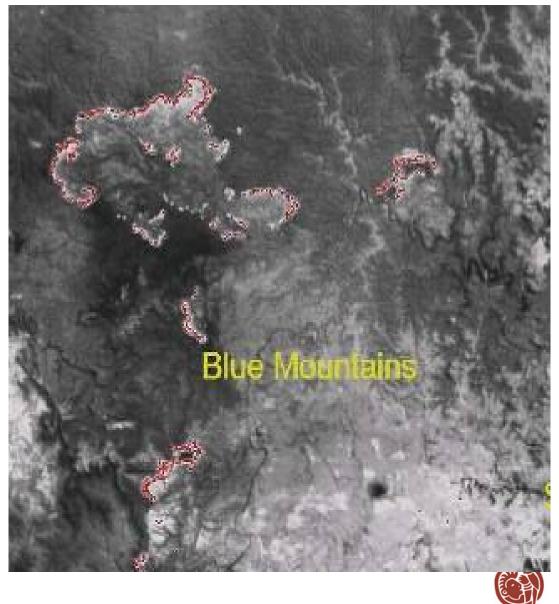- True/false estimation of fire detection

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Category 2: On-site processing, fire related properties, using dedicated, custom-developed processors:

- Burnt Area extent (raster – vector format), (SWIR Necessary)
- Degree of burn (burn severity), (SWIR Necessary)
- Completeness of burn, (SWIR necessary)
- Fire frequency (compiled fire history of predecessor and similar missions, compiled FireBIRD fire frequency and reoccurrence cycle, daily, monthly, yearly)
- Fire propagation, speed and direction (with ancillary data and supplementary data from weather services, wind speed)
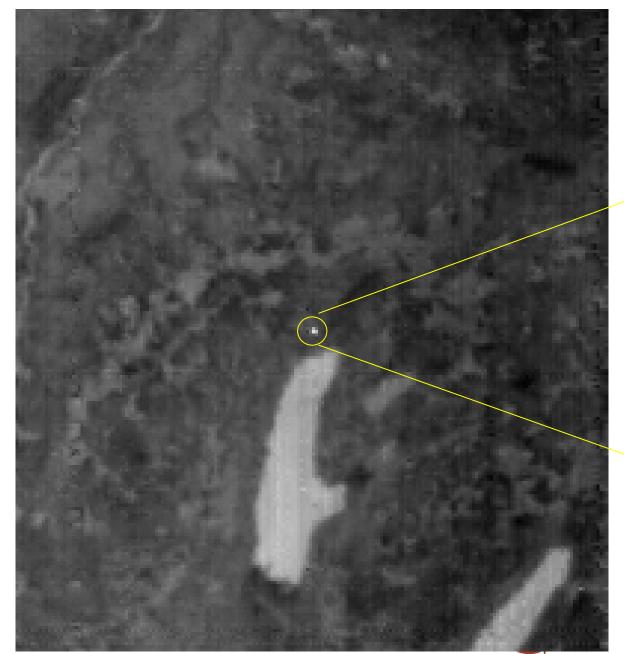
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Fire front detection with BIRD

Sydney, Australia, 01-04-2002

New System Specs:
FireBIRD	185m TIR / 100m VIS
Modis	1000m TIR / 250m VIS

FireBIRD	600K Saturation (327°)
Modis	500/320K Saturation (238°/47°)

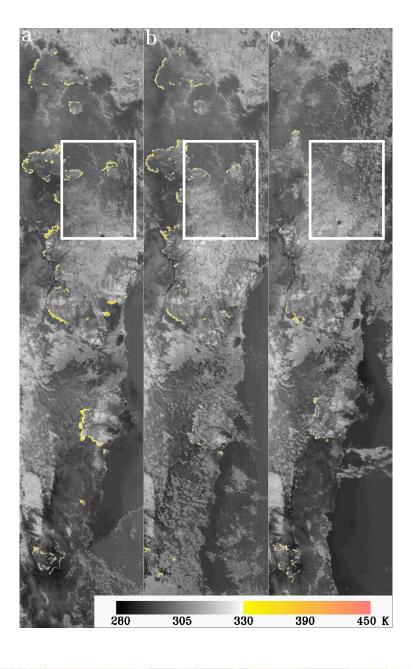|	
FireBIRD	4 m² Minimal Fire Size
Modis	121 m² Minimal Fire Size

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Future fire missions- FireBIRD

On-ground image of the test fire:
Size = 2 × 2 m
Max. temperature = 930-990 K
Energy release < 0.17-0.22 MW

BIRD image in MIR channel:
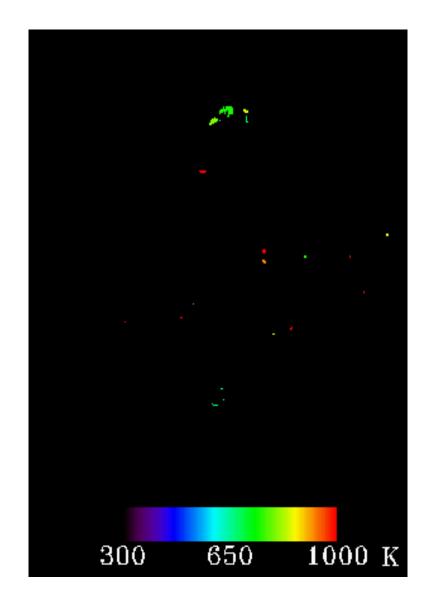Estimated fire energy release = 0.11 MW

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BIRD MIR images of bush fires, Sydney area, Australia

obtained on:

a - January 4, 2002

b - January 5, 2002

c - January 9, 2002

Future fire missions- FireBIRD
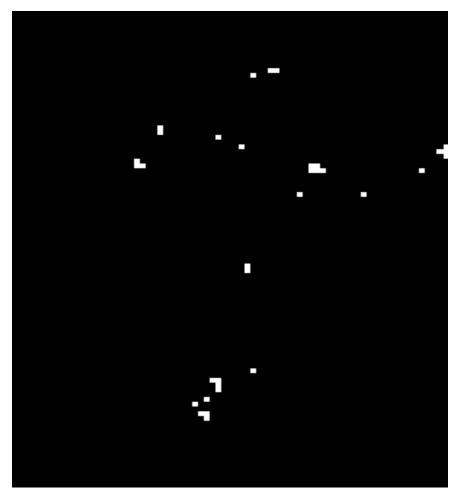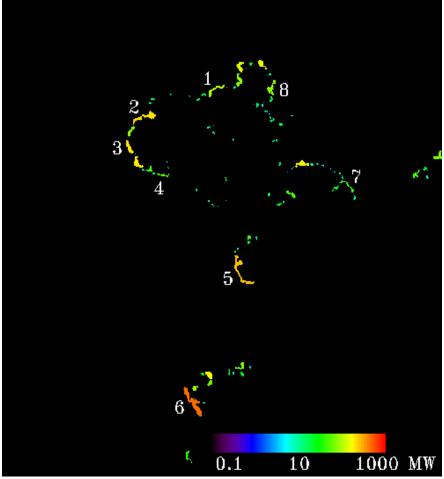

Detail from the BIRD-image at 04. Jan. 2002

1. NIR-channel

2. TIR- channel

3. MIR -channel

4. Fire fronts and temperature distribution

5. Fire fronts and temperature distribution from the image at 05.Jan.2002

6. Fire fronts and temperature distribution from the image at 09.Jan.2002

Bush fires in the Sydney area: MODIS and BIRD fire detection

MODIS standard fire
product

BIRD fire
map

Gracias

Danke

Thanks