The ATSR World Fire Atlas and a Synergy with POLDER Aerosol Products

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Abstract
Data from the ERS-2 ATSR-2 instrument have been used to derive a world fire atlas for the year 1997. The IGBP-DIS is currently coordinating the validation of this product. 33 scientists are taking part in the validation process over several representative areas of the world. This first data set once validated will be extended to the whole ATSR data set from 1995 to now. An example of synergy with POLDER aerosol products is provided by analysing the correlation between biomass burning aerosol presence and the fire distribution. This analysis has been performed for the overall life time of POLDER on ADEOS from November 1996 to June 1997. With the AATSR onboard ENVISAT, the ATSR World Fire Atlas will be the first calibrated world fire distribution record over a period exceeding 10 years. POLDER-2 will fly on ADEOS-2.

1. ATSR Fire Atlas:

Introduction

A long-term and frequently updated fire atlas is needed for land use, forestry, atmospheric chemistry, global climate, fire management studies and applications. The fire product has been identified by IGBP as an important input for global change analysis as underlined by *Malingreau*, (1990) and *Andreae et al*., (1990).
According to *Malingreau*, (1990) and *Hao and Liu*, (1994), the only solution for a rapid and efficient survey of biomass burning is the use of permanent operational satellite.

Algorithm

ATSR data are well suited to identify hot spots on the earth surface (derived from *Dozier*, 1981). As seen in Figure 1 ATSR 3.7 channel is very sensitive to radiation emitted at temperature ranging from 500K to 1000K.

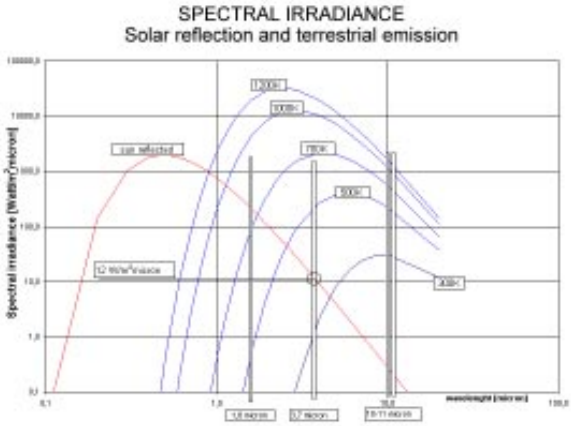

Figure 1

Therefore, considering the absence of artifact due to the solar reflection during night time, the detection capabilities of ATSR can be estimated as follows: range from 0.1 ha at 600K, to 0.01 ha at 800K (Figure 2).

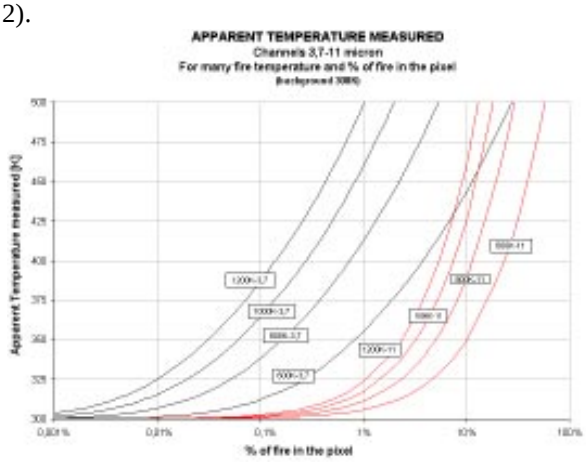

Figure 2

The very good calibration of ATSR-2 Level 1B data (*Mason*, 1991, RAL, 1995, *Mutlow et al*., 1995) is achieved by the use of low noise infrared detectors cooled to near-optimum temperature by a Stirling cycle mechanical cooler and by the continuous on-board

radiometric calibration of the infrared channel against 2 blackbody targets.
The stability of ERS-2 orbit along with the good orbit prediction algorithm ensure a precise geolocation (*Dow and al*., 1999).

Three algorithms are implemented (using nighttime data only):

- Algorithm 1: 3.7 microns > 312 K. (ATSR-2 saturation).
- Algorithm 2: 3.7 microns > 308 K.
- Algorithm 3: 3.7 - 11.0 > 10K and 11.0 > 283K.

These three algorithms use only the 3.7 and 11.0 microns channels, but 1.6 and 12.0 microns channels are also available in the ATSR Level 1B data and can be use for future algorithm development (*Striker et al*., 1995).

Processing Facility

To create this fire atlas, more than 70000 ATSR-2 Level 1B products have been generated from Level 0 data. Each Level 1B product generated is systematically archived and can be retrieved to regenerate fire products with new algorithms. For this purpose, the processing facility has been designed to allow the generation of fire products from both ATSR-2 Level 0 data and ATSR-2 Level 1B data.

Product Description

The fire product gives for each hot spot detected, the following information:

- Date
- Time
- Precise location in Latitude/longitude

The frame-based products are merged on a monthly basis.

Results

The three algorithms give the following results:

- Algorithm 1: (ATSR Saturation) gives good results. The hot spots distribution is coherent with the one obtained with AVHRR, DMSP and GOES data.
- Algorithm 2: (lowering of the threshold to 308 K) does not introduce obvious false alarms and can be considered reliable.
- Algorithm 3: Produces a lot of false alarms on water areas and need to be improved.

The fire distribution can be summarized as follow:

- Permanent hot spots over ocean and desert area. Most of them are gas flares (Gulf of Mexico, Gulf of Guinea, North Sea, Persian Gulf, Iran/Iraq, Algeria/Libya, Russia...)
- Exceptional fire event in Indonesia (August/November 1997)
- Savannah seasonal fires. Southern hemisphere (June-October), Northern hemisphere (November-May)
- Other seasonal fires (Europe, Russia, southern Asia)

The user of the fire product should be aware of the algorithm limitations (e.g. coverage, cloud presence, atmospheric effects, bi-directionality of emissivity, fire temperature versus extension...).

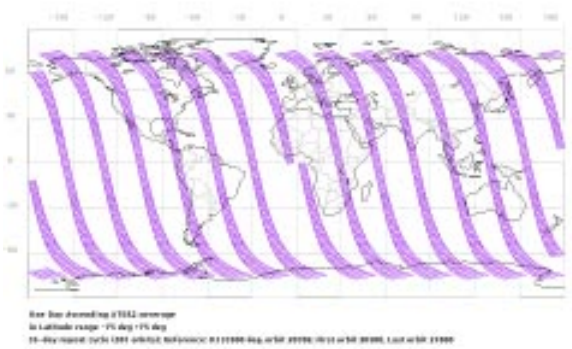

Figure 3

Figure 3 shows the ATSR-2 daily ascending coverage (nighttime).

Figure 4 and table 1 show the 1997 fire distribution bounded at the 75 latitude in the Northern Hemisphere. All daytime ascending frames have been discarded from the processing.

Months	Frames	Hot spots (Algo 1)	Hot spots (Algo 2)
January	6733	5088	8506
February	5907	4196	7363
March	6832	4273	7723
April	6260	4353	7051
May	5575	4657	8671
June	4813	4897	8901
July	5180	6034	13513
August	6025	13410	22479
September	6513	17403	29136
October	6560	16129	26394
November	6673	7816	13379
december	6908	6363	11811
Total	**73979**	**94619**	**164929**

Table 1

Our results are consistent with those of *Cahoon et al*., (1992) and *Arino and Melinotte*, 1997 and 1998.
Feedback from the forestry, (*Calvin*, 1997) and the atmospheric community, (*Jenkins et al*., 1997) confirm the interest for their own field of research for that kind of products. The main requests were first to extend the coverage and second to ensure the continuity of the service across the years.

Conclusion
The 5 years ATSR global archive provides, thanks to the excellence of the satellite and the instrument, a unique opportunity to derive a global multi-year fire atlas not corrupted by environmental effects.
This product will soon be available to the whole scientific community.

Acknowledgments
The ongoing validation activity is managed by *Gerard Szejwach* and carried out by the following people:
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Mutlow CT, DT Llewellyn-Jones, AM Zadovy, IJ Barton, Sea-surface temperature measurement by ATSR on the ERS-1 satellite: Early Result. JGR, 99, 22, 575-22, 588, 1994

RAL, 1995: SADIST-2 v200 Products, *P. Bailey* ER-TN-RAL-AT-2164, Ruth. Appleton Lab., 6 Sept. 1995 Release.

1997 World ATSR Fire Product:
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2. ATSR Fire Atlas / POLDER Aerosol Index correlation

POLDER Aerosol

The aerosol index derived from POLDER ADEOS-1 data can be interpreted as an indicator of polarising aerosols. This early study is based on the fact, that smoke particles strongly polarised the light. Thus it can be used as a validation data set for the ATSR Fire Atlas hot spots distribution.

First Results

To achieve this study we use the 8 months data (December 1996 – June 1997) corresponding to the lifetime of ADEOS-1.
A strong correlation can be notice on various regions. Six areas of interest have been selected and the results are presented in figure 5. For each areas, a graphic shows the average aerosol index along with the hot spots number. A serie of thumbnails shows, for each month:

- The POLDER Aerosol Index.
- The ATSR hot spots distribution.
- The wind direction.

References (POLDER Aerosol Index)

Deuze J.L., Breon F.M., Devaux C. Goloud P., Lafrance B., Marchand A., Nadal F., Perry G., Tanre D., Magnand F, 1999: Remote Sensing of Aerosols over Land Surface from POLDER/ADEOS Polarized Measurements, submitted to Geophys. Res. Lett.

Herman M., Deuze J.L., Devaux C., Goloub P., Breon F.M. and Tanre D., 1997: Remote Sensing of aerosols over land surfaces including polarization measurements and application to POLDER measurements, J. Geophys. Res., 102, 17, 039-17, 049.

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POLDER Aerosol Index:

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Figure 4: 1997 ATSR World Fire Atlas

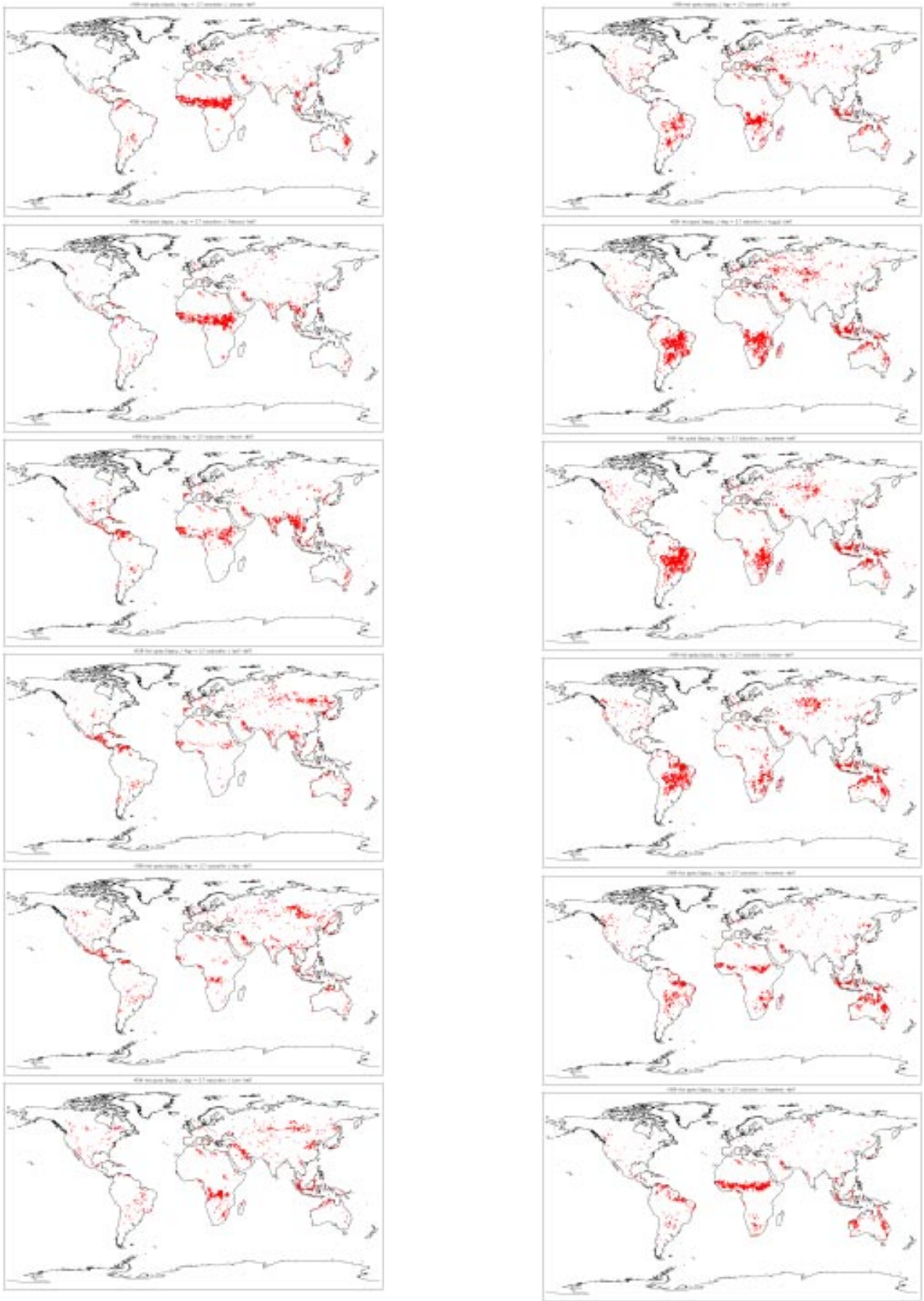
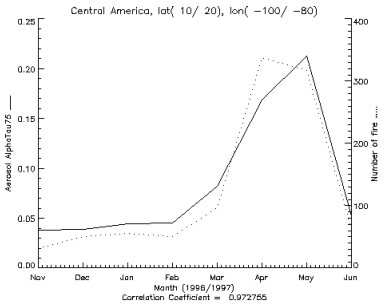
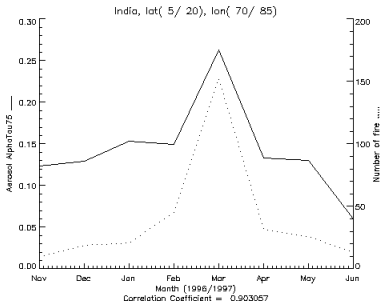
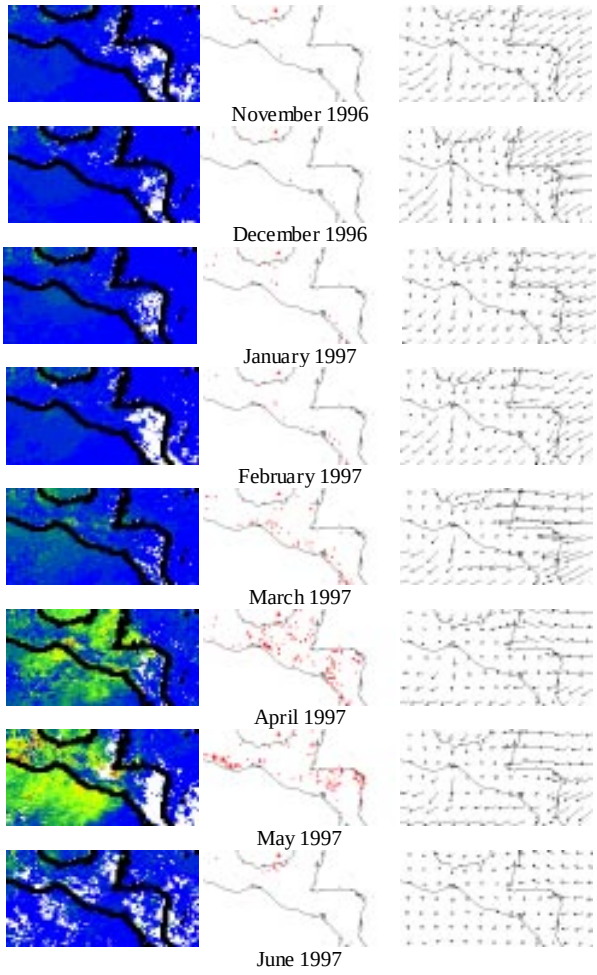
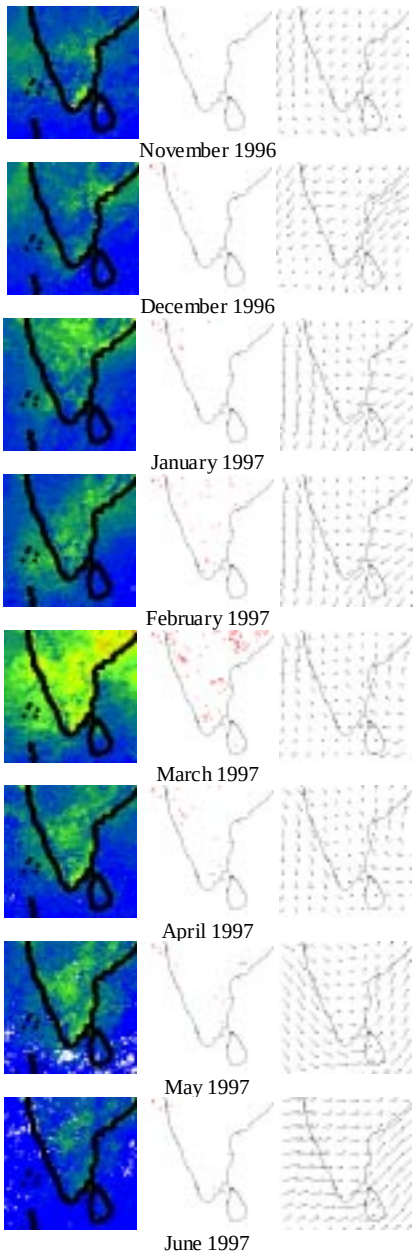


Figure 5


Central America, lat(10/ 20), lon(-100/ -80)
Aerosol AlphaTau75
Number of fire .....
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Month (1996/1997)
Correlation Coefficient = 0.972755


India, lat(5/ 20), lon(70/ 85)
Aerosol AlphaTau75
Number of fire .....
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Month (1996/1997)
Correlation Coefficient = 0.903057


November 1996
December 1996
January 1997
February 1997
March 1997
April 1997
May 1997
June 1997


November 1996
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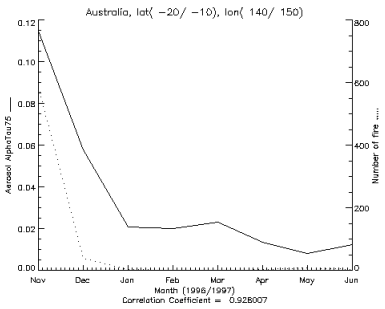
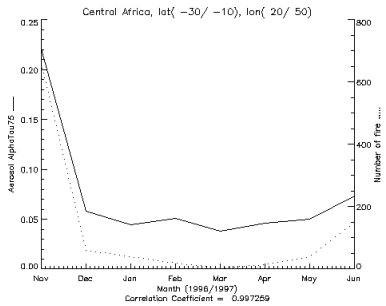
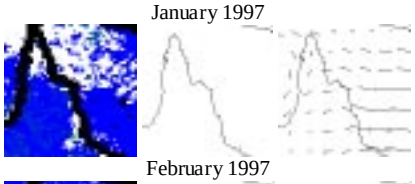




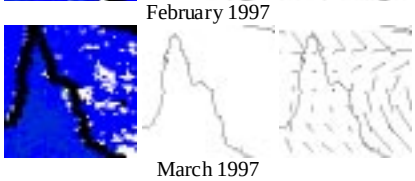
November 1996

December 1996

January 1997

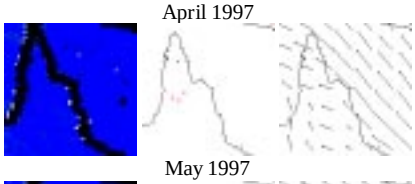


February 1997



March 1997

April 1997



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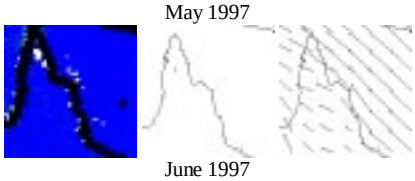

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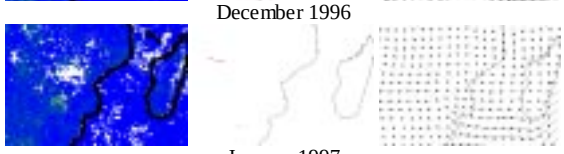
December 1996



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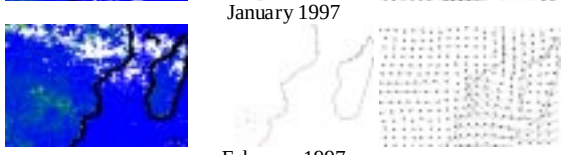

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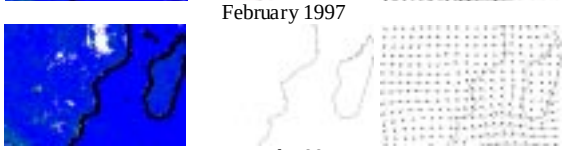

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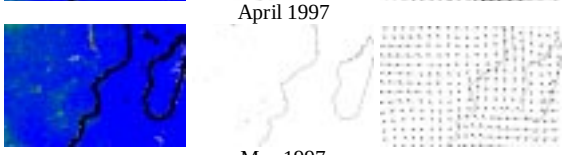

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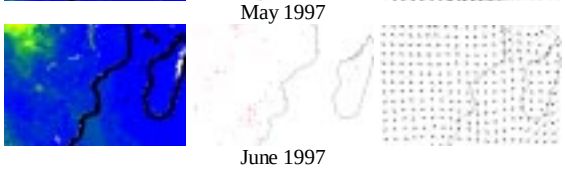

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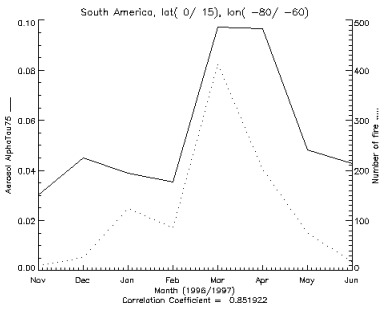
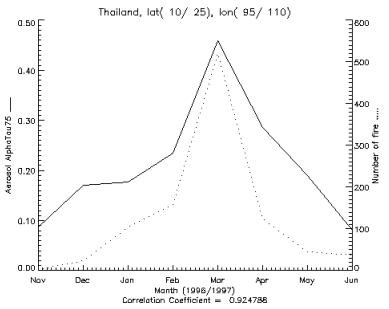


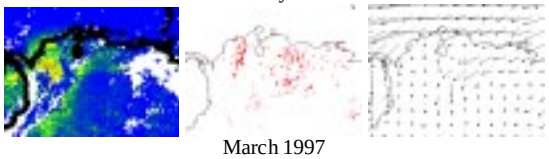


November 1996

December 1996

January 1997

February 1997



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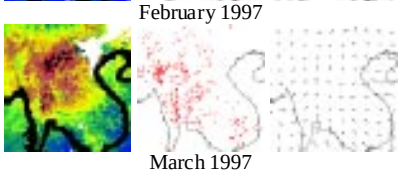

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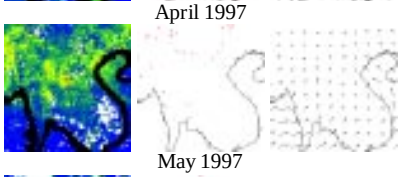

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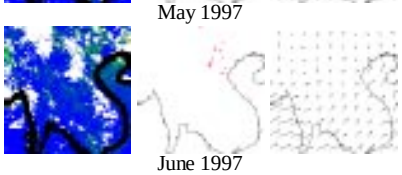

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