2 April 2009 00:00 GMT

Legend:
- RETIRA ≥ 3 (yellow)
- RETIRA ≥ 3,5 (orange)
- RETIRA ≥ 4 (red)
- Clouds (grey)
- no data (black)
- ∿ Tectonic lineaments (green)

3 April 2009 00:00 GMT

RETIRA ≥ 3
RETIRA ≥ 3,5
RETIRA ≥ 4
Clouds
no data
~ Tectonic lineaments

4 April 2009 00:00 GMT

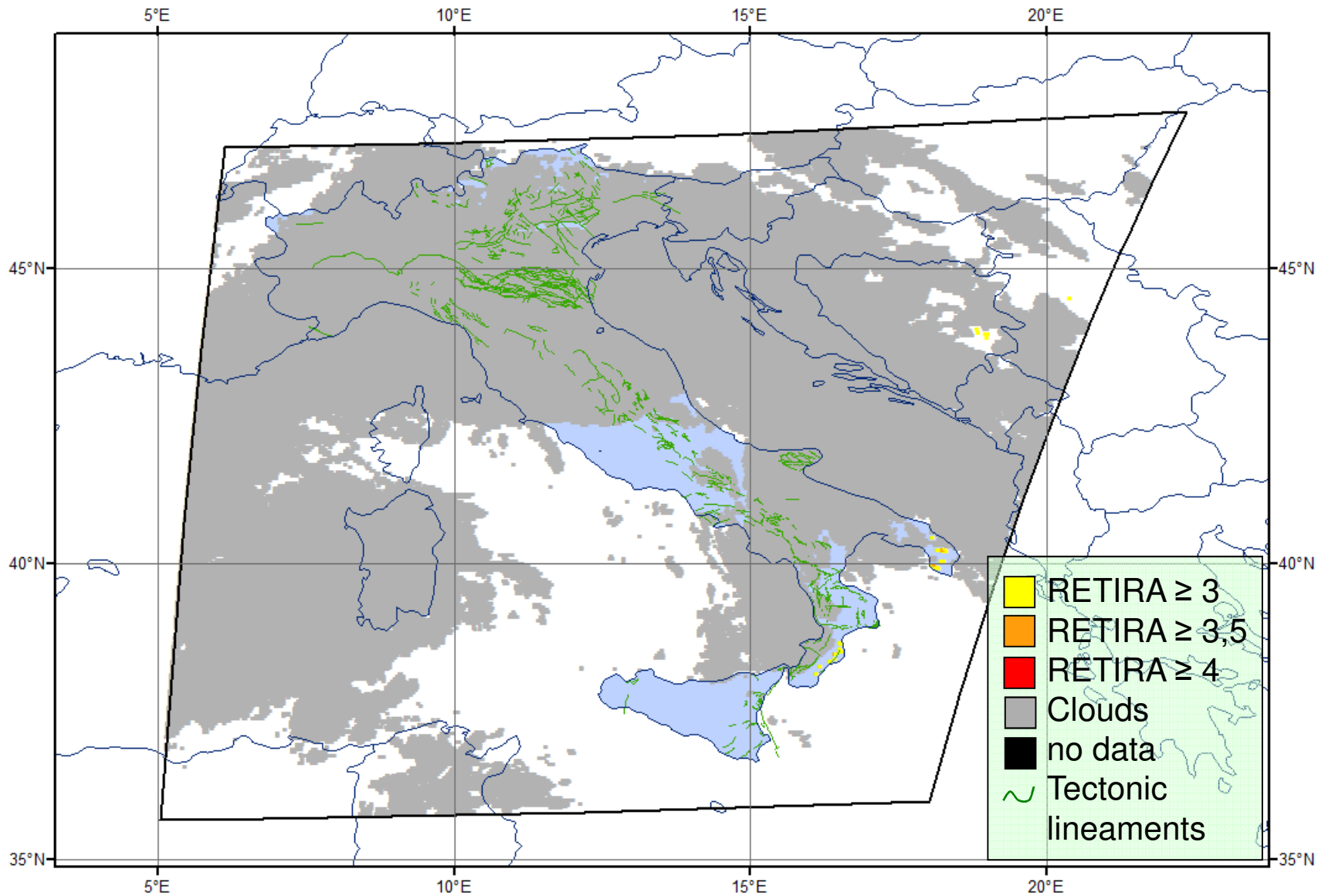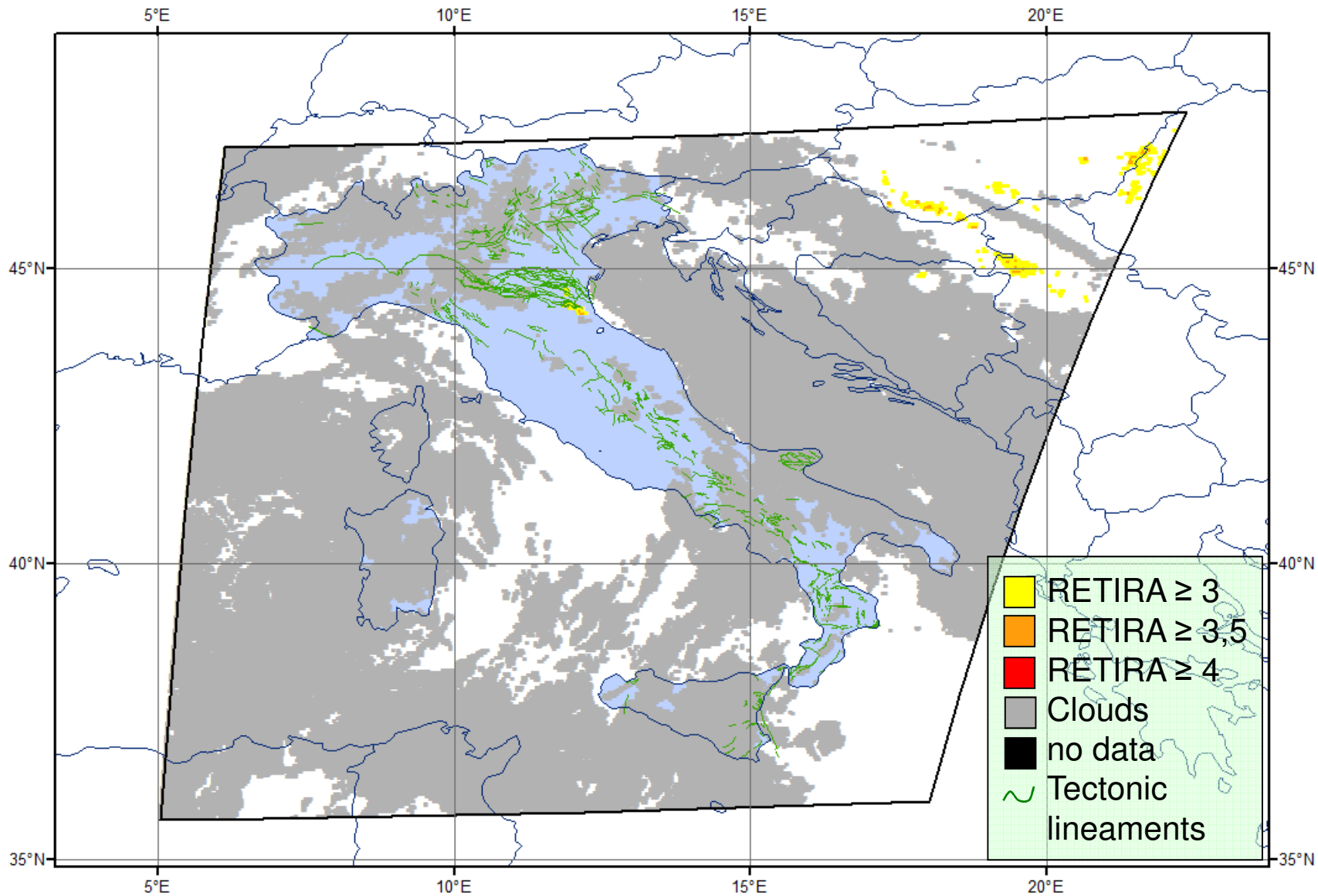Legend:
- RETIRA ≥ 3
- RETIRA ≥ 3,5
- RETIRA ≥ 4
- Clouds
- no data
- ∿ Tectonic lineaments

5 April 2009 00:00 GMT

6 April 2009 00:00 GMT

Legend:
- RETIRA ≥ 3
- RETIRA ≥ 3,5
- RETIRA ≥ 4
- Clouds
- no data
- ∿ Tectonic lineaments

7 April 2009 00:00 GMT

Legend:
- RETIRA ≥ 3 (yellow)
- RETIRA ≥ 3,5 (orange)
- RETIRA ≥ 4 (red)
- Clouds (grey)
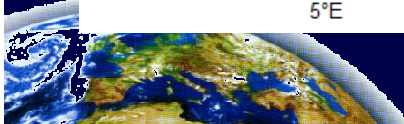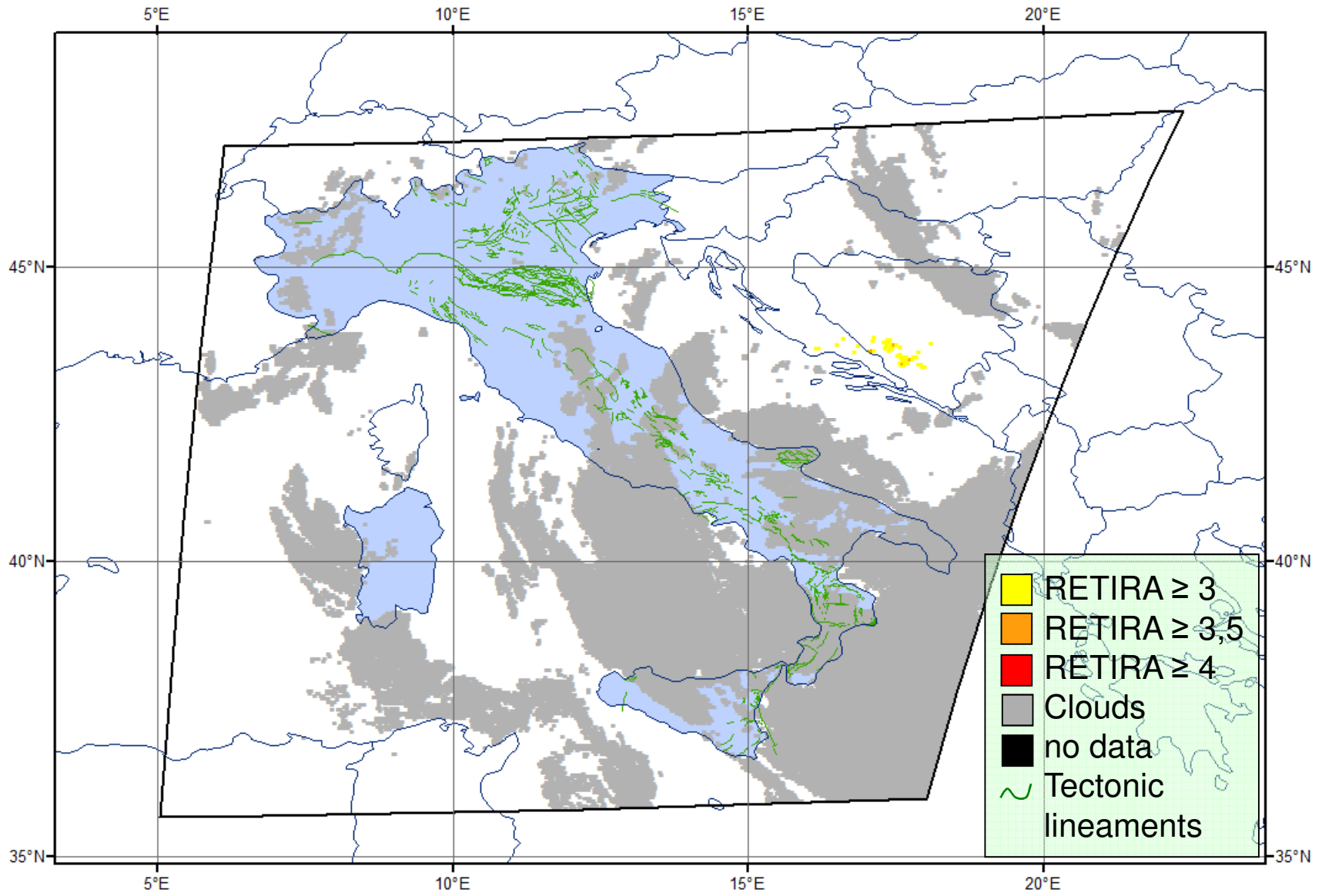- no data (black)
- ∿ Tectonic lineaments (green)

8 April 2009 00:00 GMT

9 April 2009 00:00 GMT

10 April 2009 00:00 GMT

11 April 2009 00:00 GMT
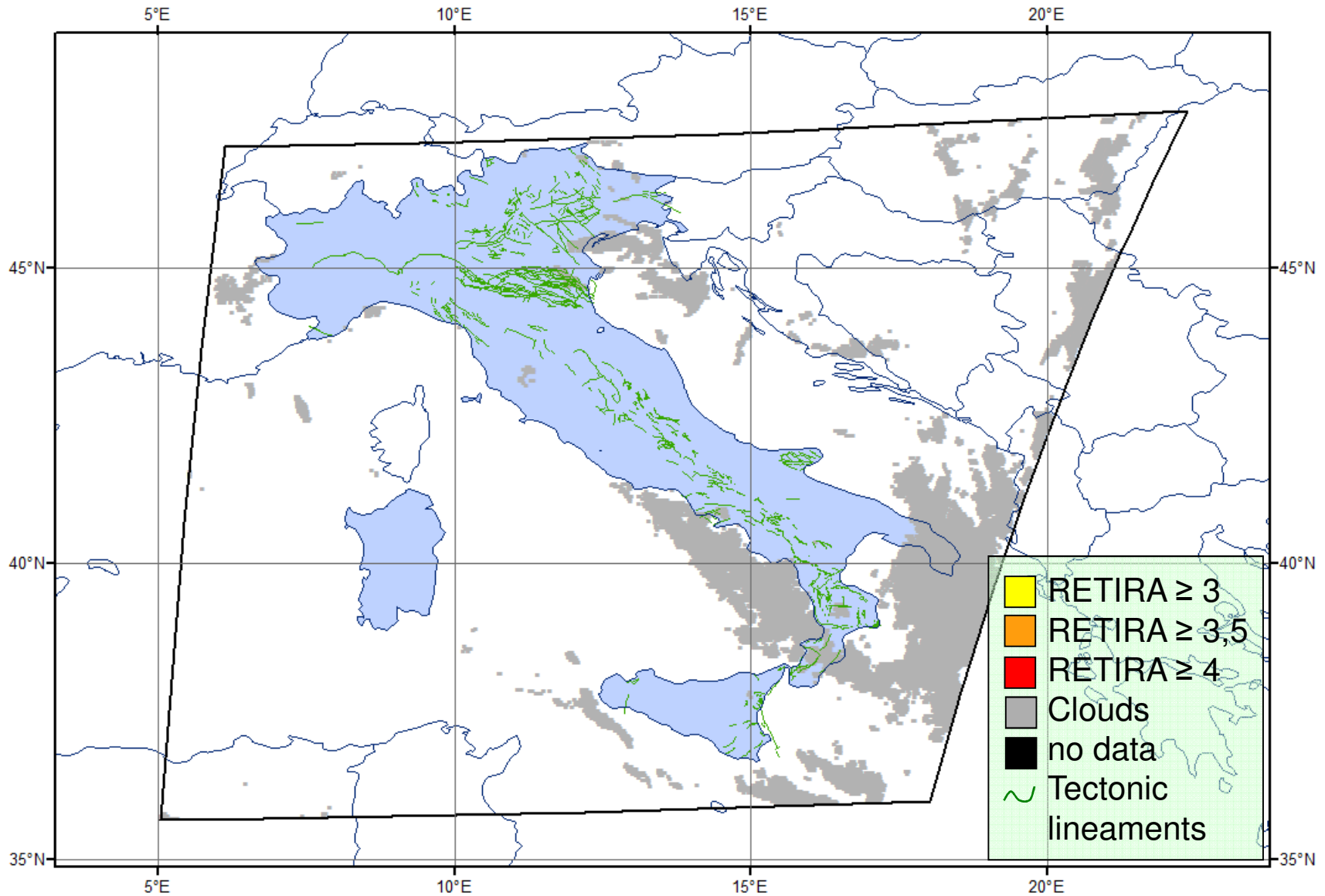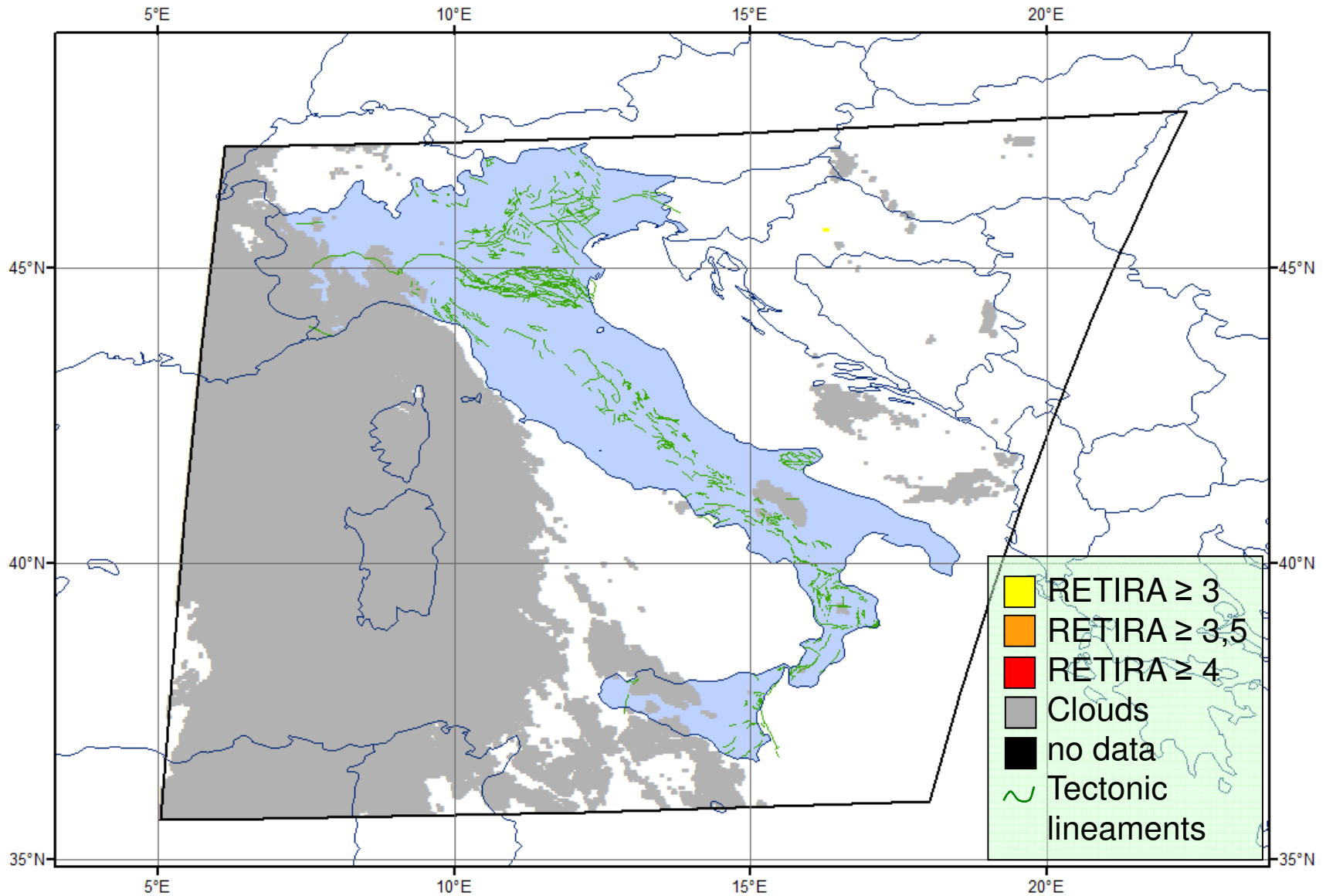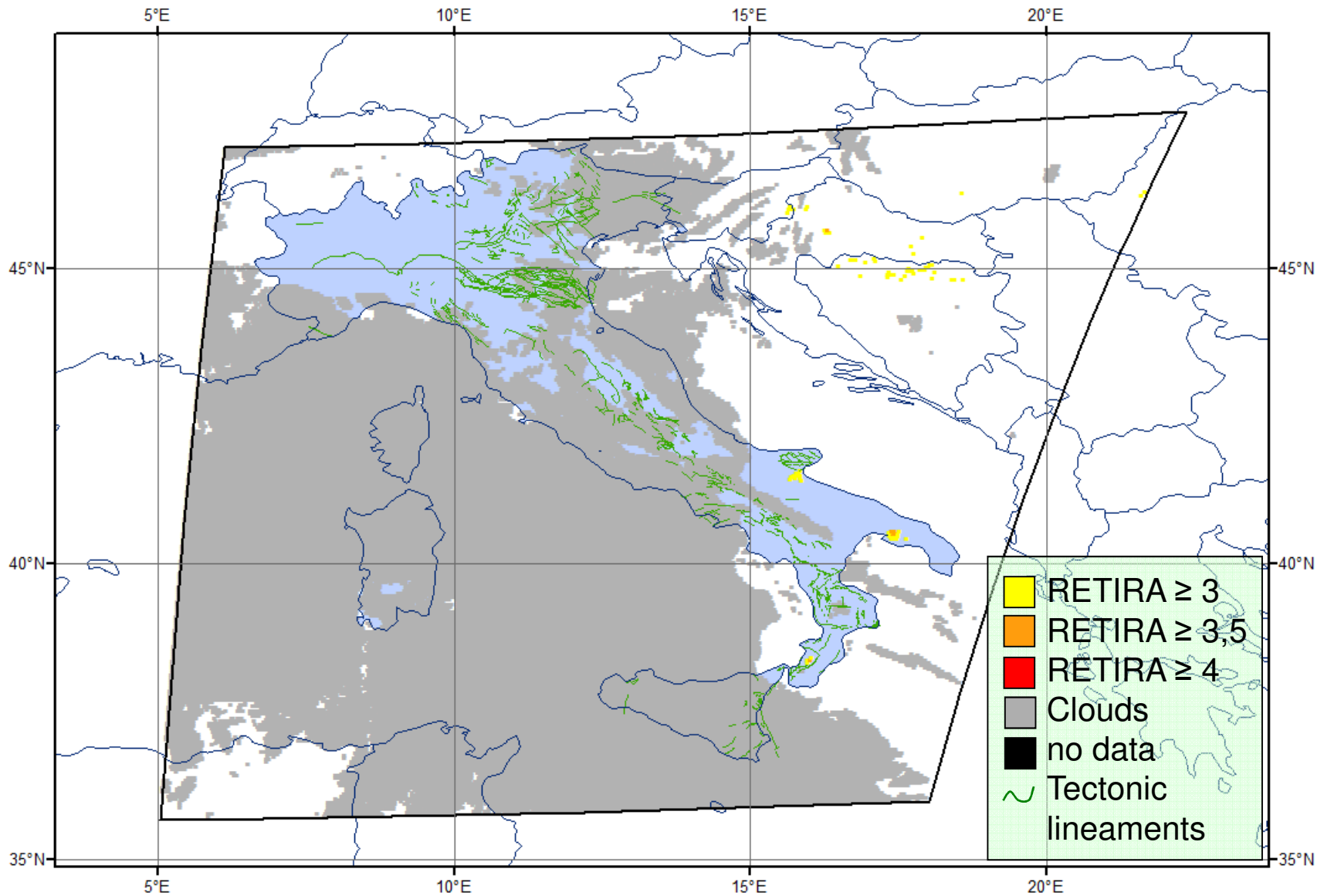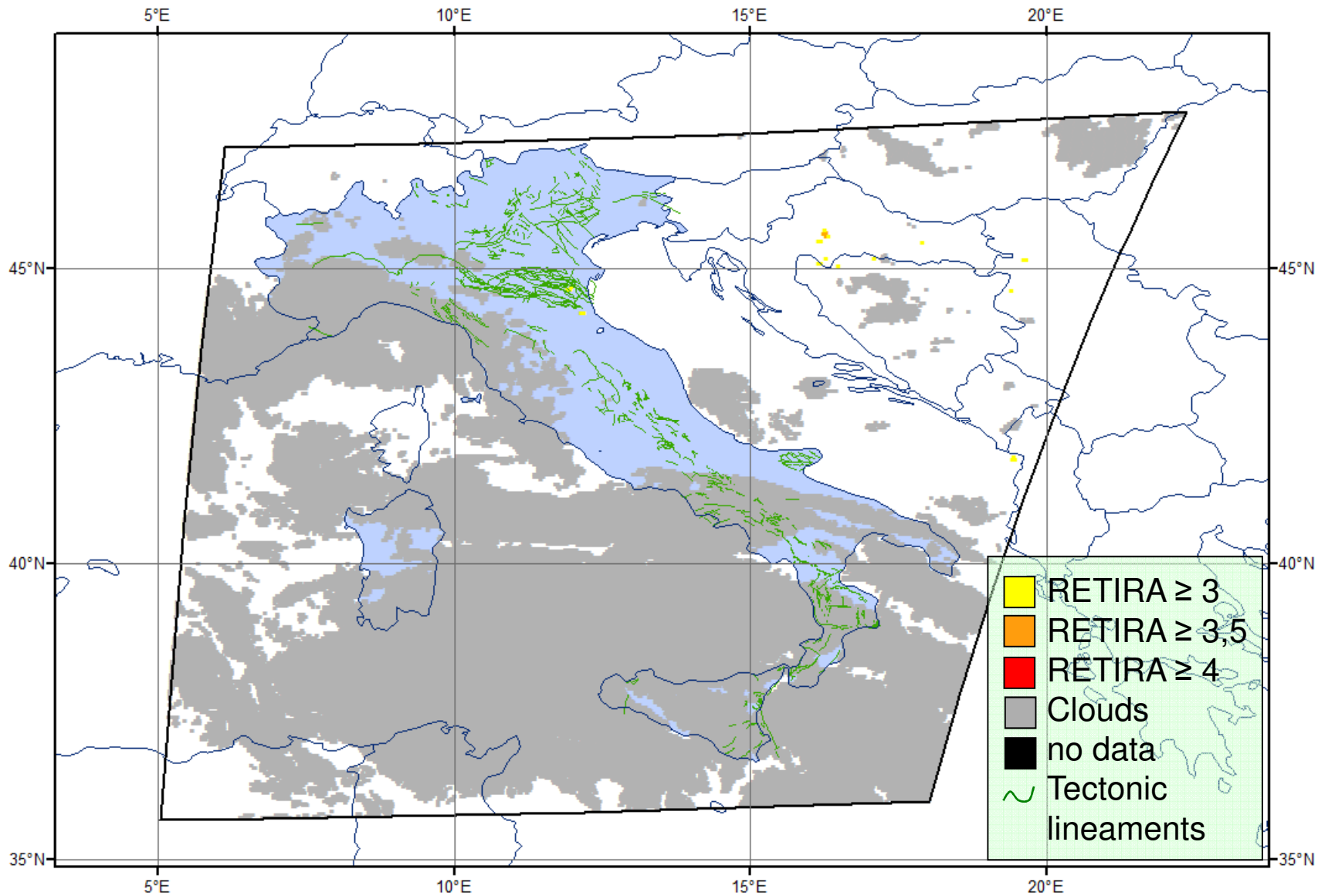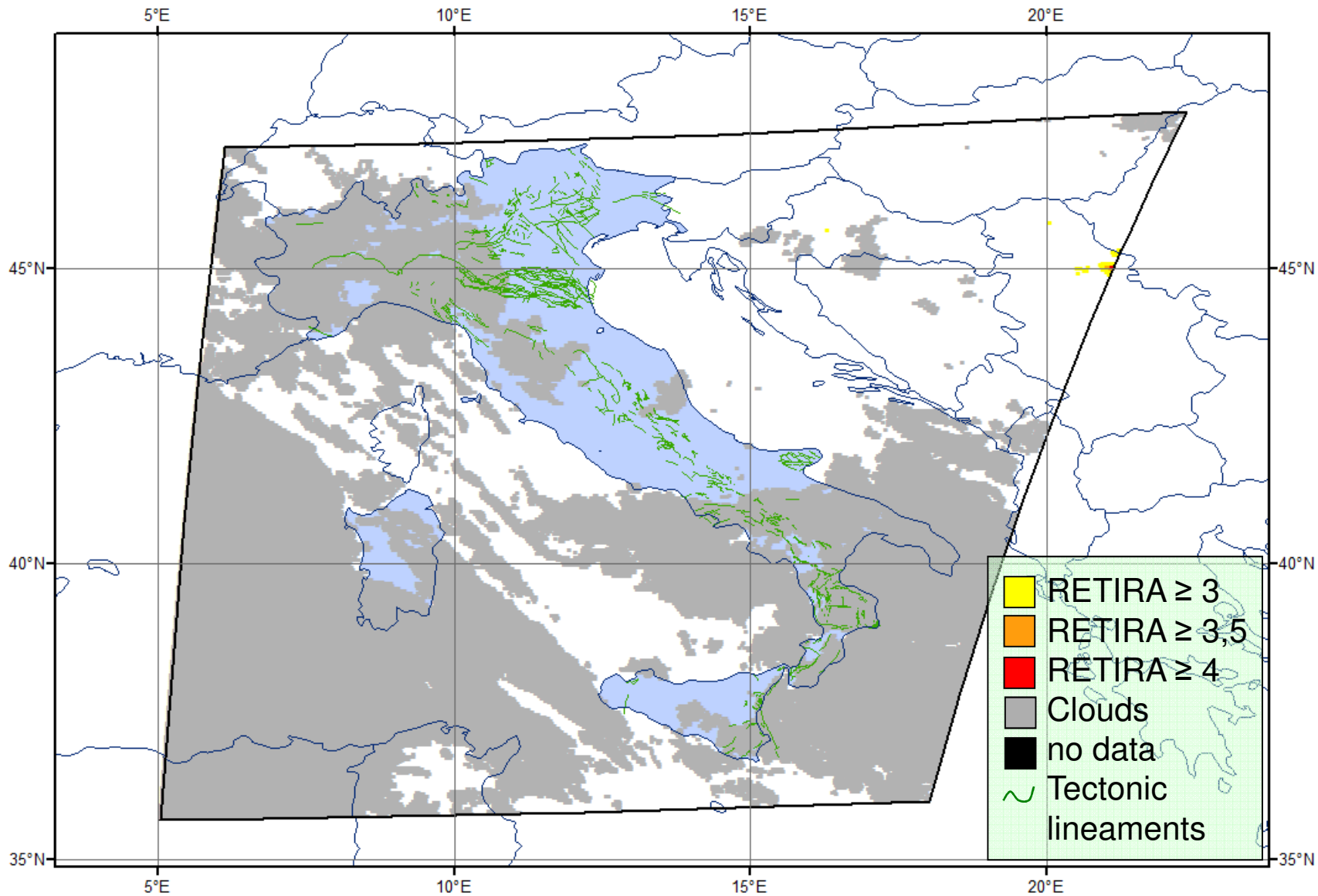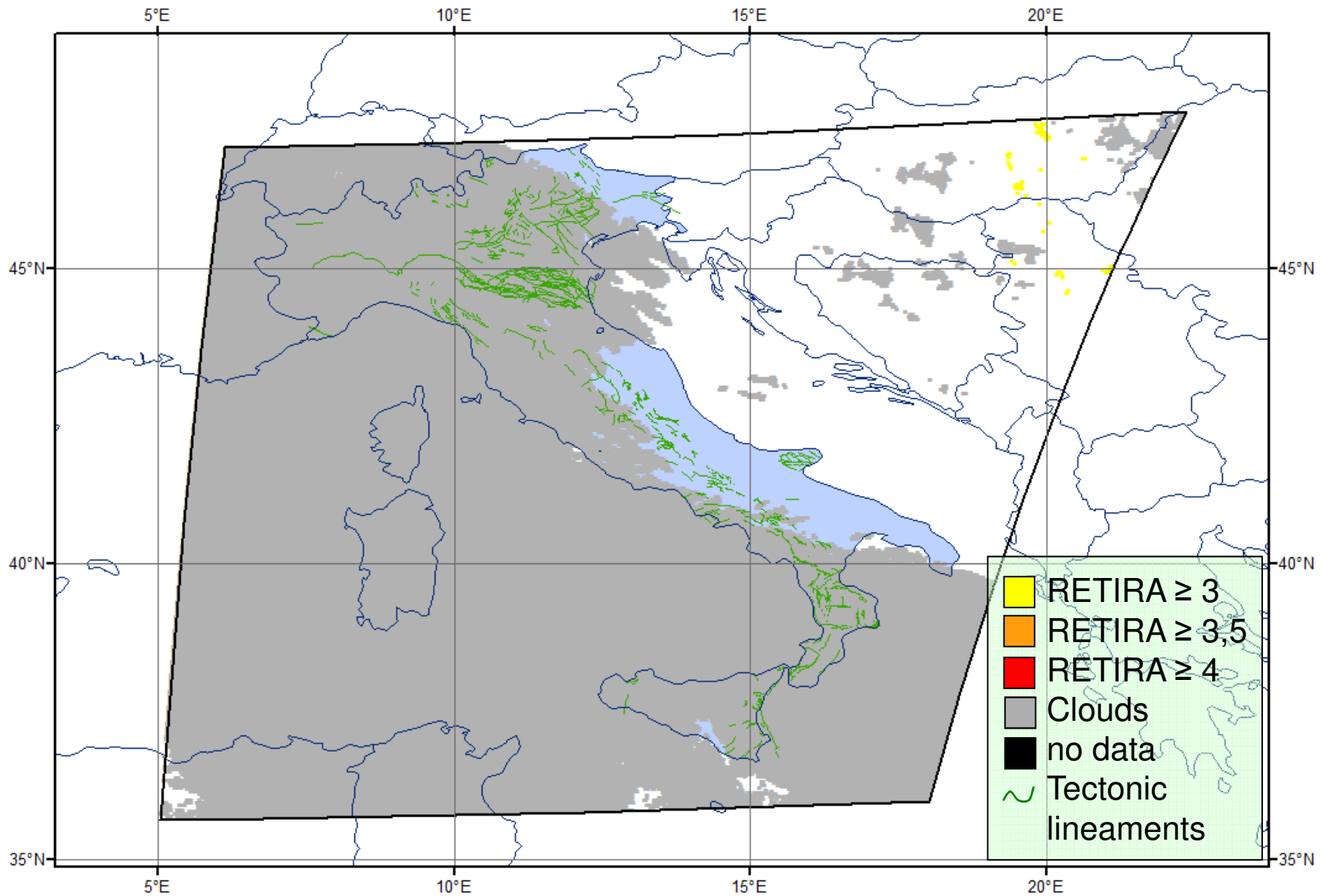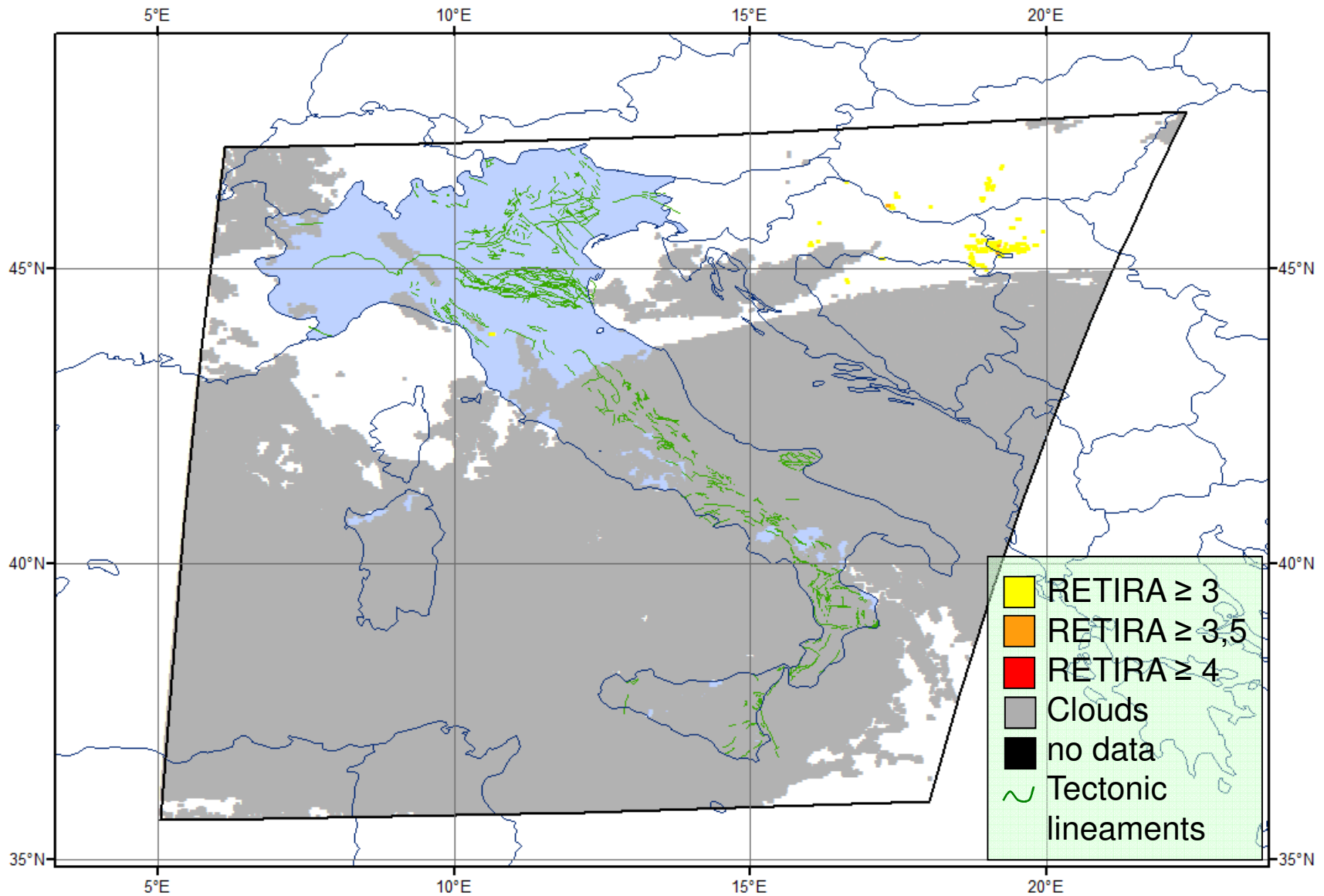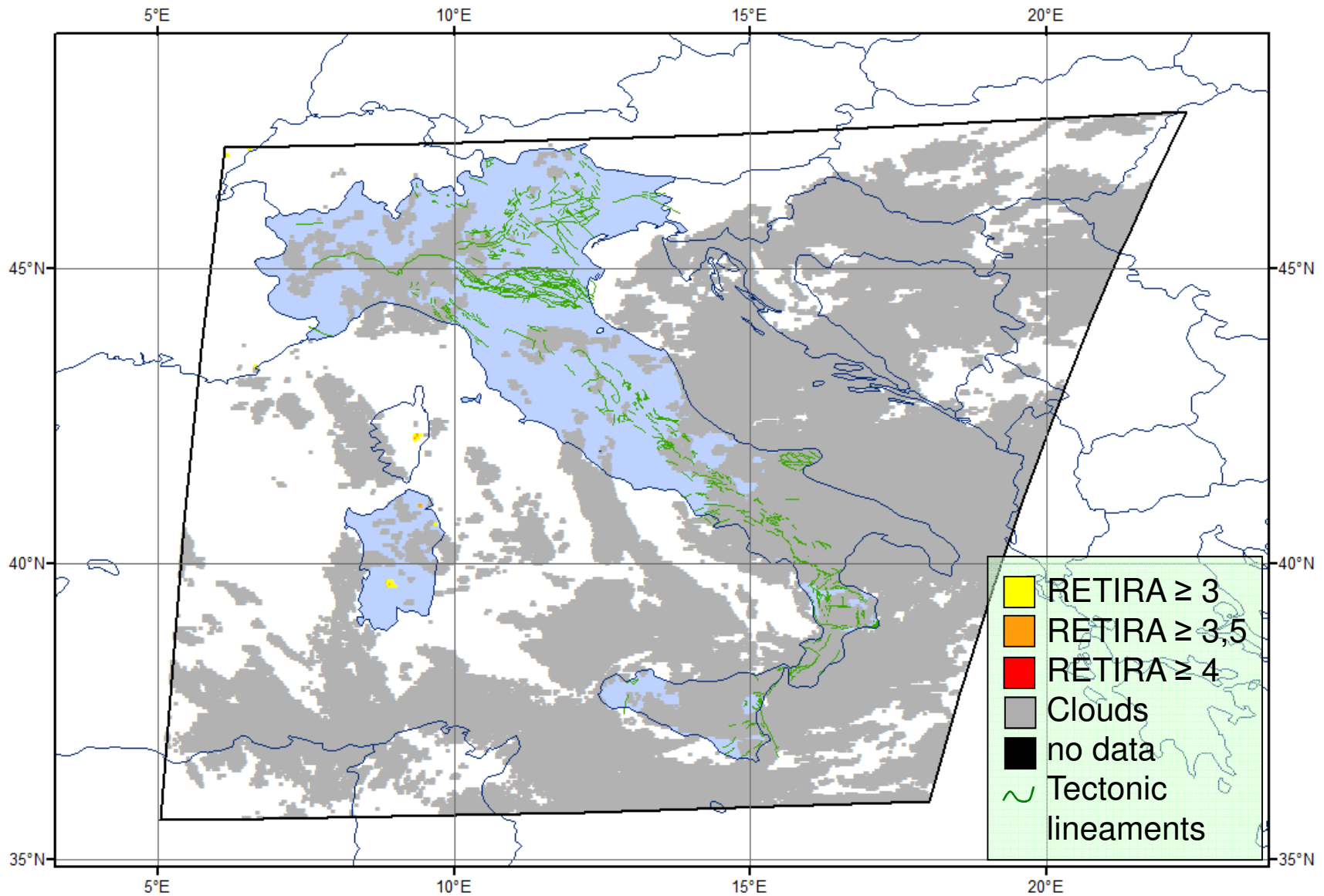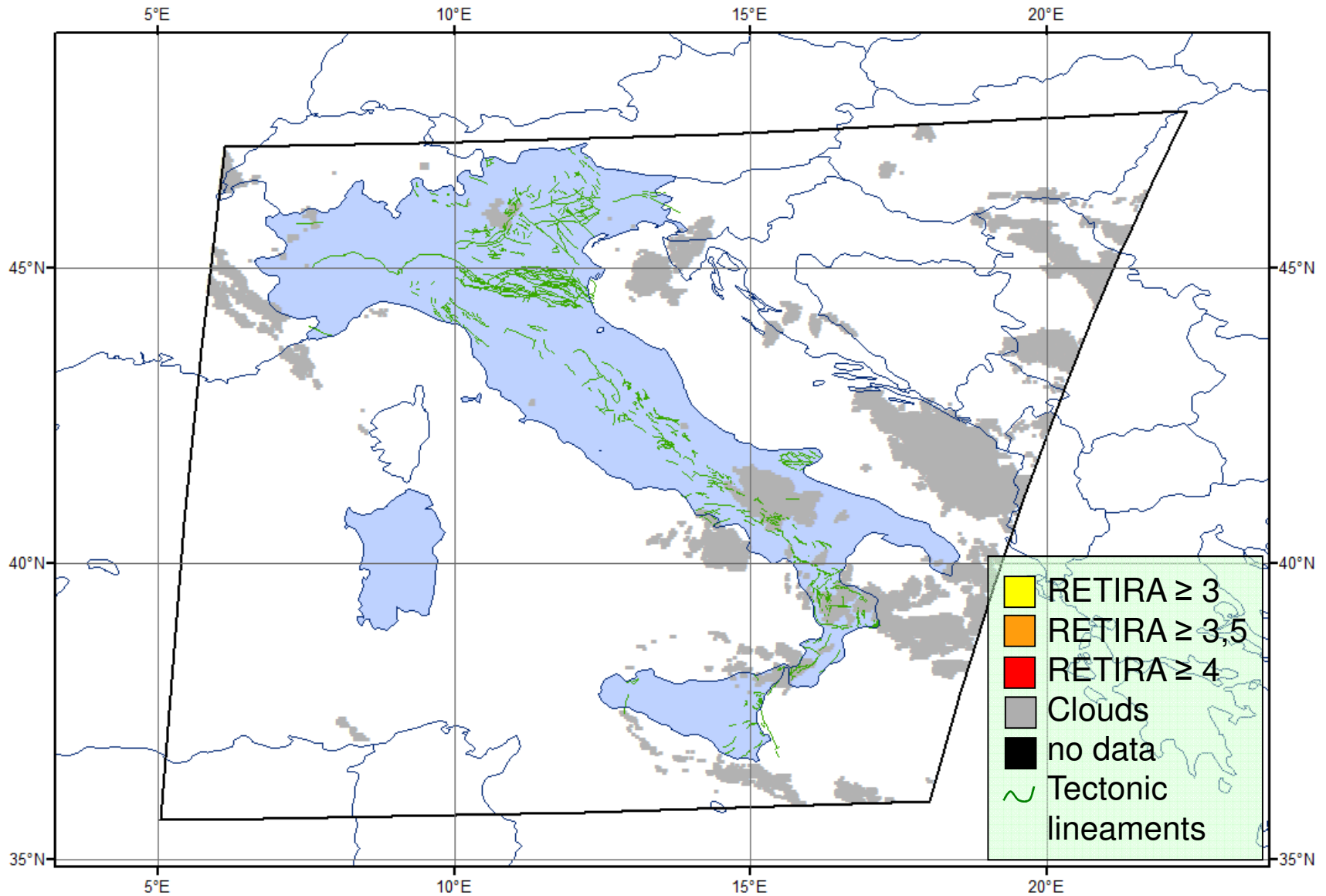
12 April 2009 00:00 GMT

13 April 2009 00:00 GMT

14 April 2009 00:00 GMT

Legend:
- RETIRA ≥ 3 (yellow)
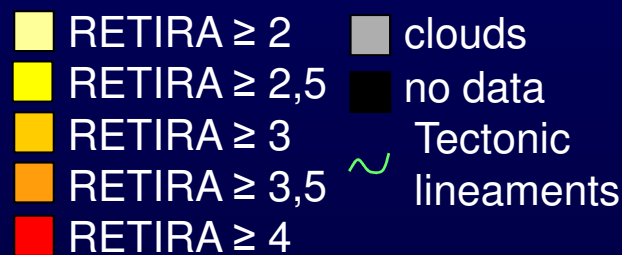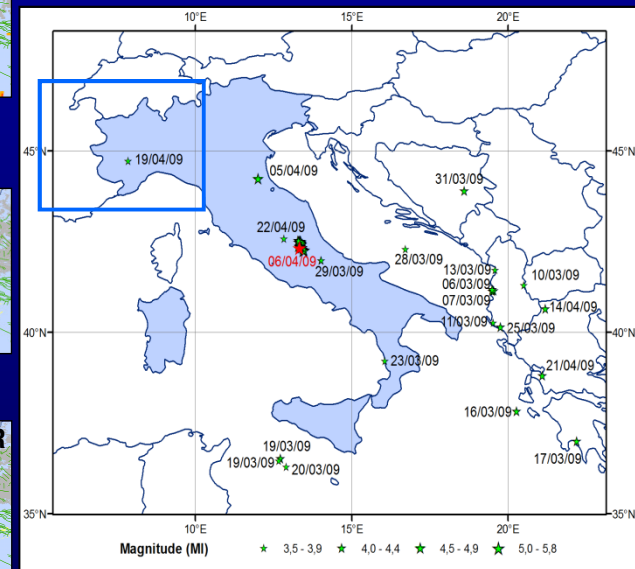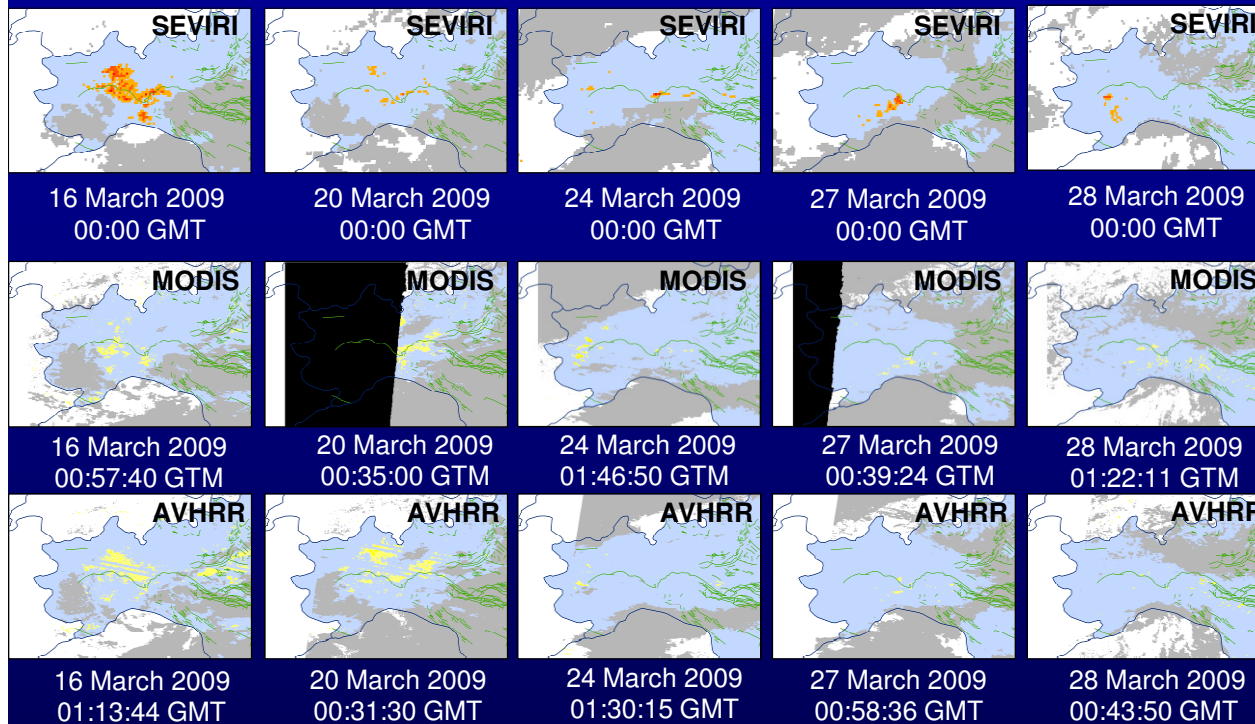- RETIRA ≥ 3,5 (orange)
- RETIRA ≥ 4 (red)
- Clouds (grey)
- no data (black)
- Tectonic lineaments (green)

V.Tramutoli - L'Aquila, 27 Aprile 2010 - (valerio.tramutoli@unibas.it +39-3293178385)

15 April 2009 00:00 GMT

Legend:
- RETIRA ≥ 3
- RETIRA ≥ 3,5
- RETIRA ≥ 4
- Clouds
- no data
- Tectonic lineaments

VALIDATION (March 15th – April 15th 2009)

Bra (Cuneo) TIR anomalies sequence

SEVIRI	SEVIRI	SEVIRI	SEVIRI	SEVIRI
16 March 2009 00:00 GMT	20 March 2009 00:00 GMT	24 March 2009 00:00 GMT	27 March 2009 00:00 GMT	28 March 2009 00:00 GMT

MODIS	MODIS	MODIS	MODIS	MODIS
16 March 2009 00:57:40 GTM	20 March 2009 00:35:00 GTM	24 March 2009 01:46:50 GTM	27 March 2009 00:39:24 GTM	28 March 2009 01:22:11 GTM

AVHRR	AVHRR	AVHRR	AVHRR	AVHRR
16 March 2009 01:13:44 GMT	20 March 2009 00:31:30 GMT	24 March 2009 01:30:15 GMT	27 March 2009 00:58:36 GMT	28 March 2009 00:43:50 GMT

RETIRA ≥ 2
RETIRA ≥ 2,5
RETIRA ≥ 3
RETIRA ≥ 3,5
RETIRA ≥ 4

clouds
no data
∼ Tectonic lineaments

VALIDATION (March 15th – April 15th 2009)

SEVIRI — 28 March 2009 00:00 GMT

SEVIRI — 3 April 2009 00:00 GMT

MODIS — 28 March 2009 01:22:11 GTM

MODIS — 03 April 2009 00:45:34 GTM

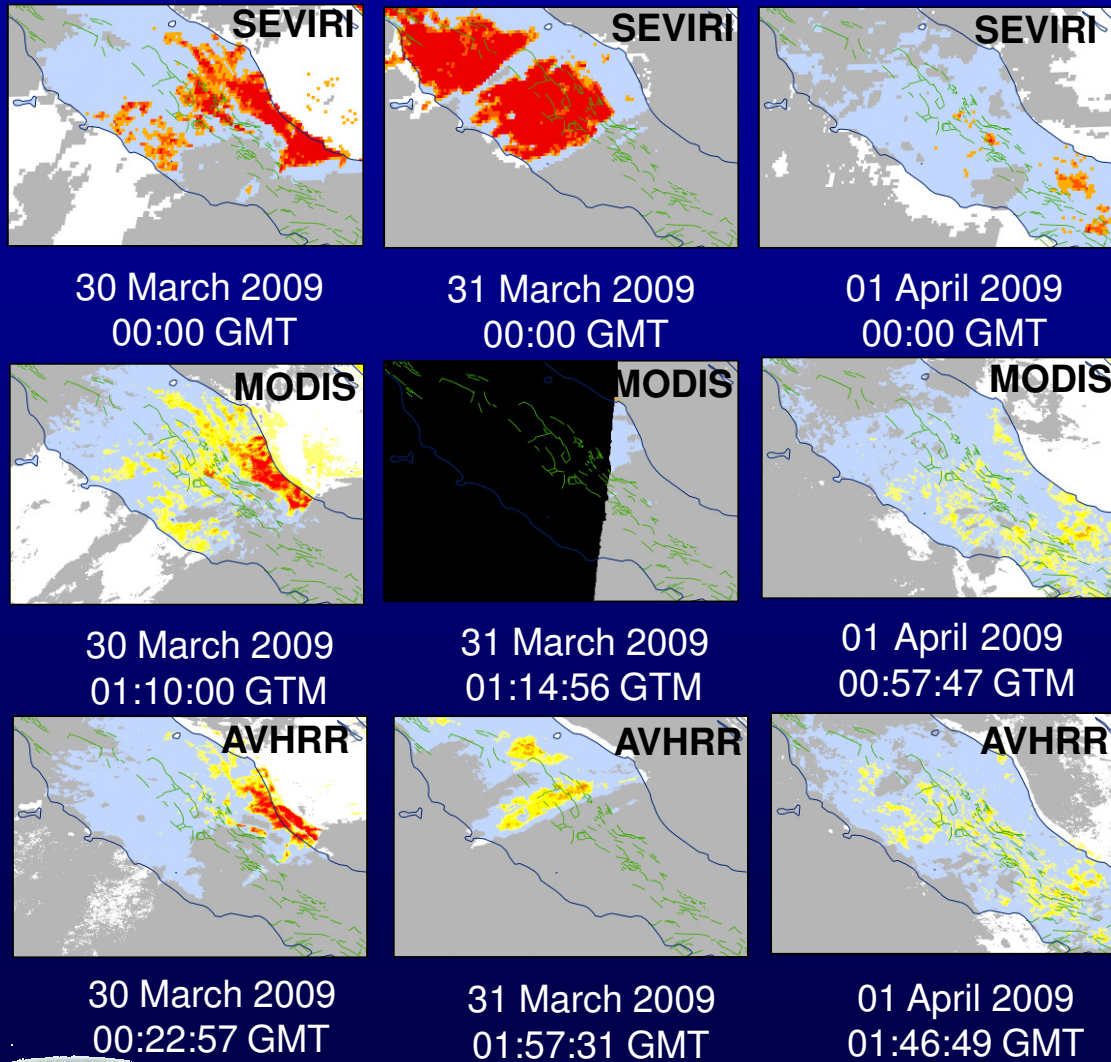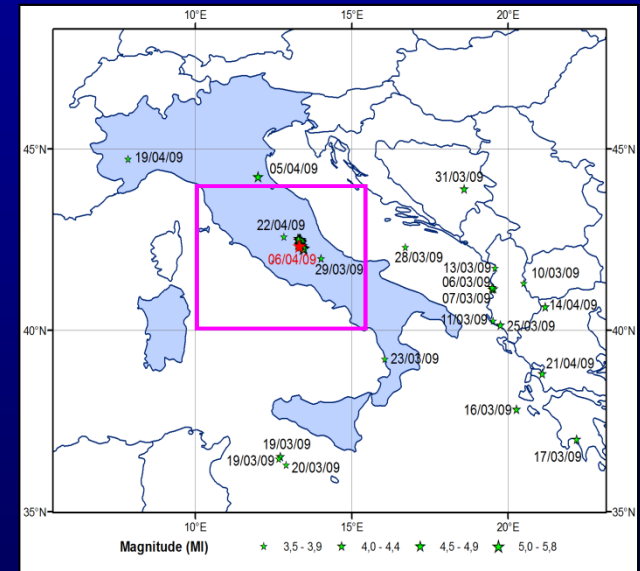**AVHRR** — 28 March 2009 00:43:50 GMT

AVHRR — 03 April 2009 01:25:37 GMT

Forlì TIR anomalies sequence

RETIRA ≥ 2
RETIRA ≥ 2,5
RETIRA ≥ 3
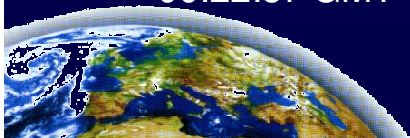RETIRA ≥ 3,5
RETIRA ≥ 4

clouds
no data
Tectonic lineaments

V.Tramutoli - L'Aquila, 27 Aprile 2010 -   (valerio.tramutoli@unibas.it +39-3293178385)
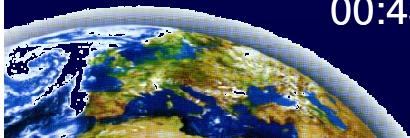
VALIDATION (March 15th – April 15th 2009)

Abruzzo TIR anomalies sequence

SEVIRI	SEVIRI	SEVIRI
30 March 2009 00:00 GMT	31 March 2009 00:00 GMT	01 April 2009 00:00 GMT
MODIS	MODIS	MODIS
30 March 2009 01:10:00 GTM	31 March 2009 01:14:56 GTM	01 April 2009 00:57:47 GTM
AVHRR	AVHRR	AVHRR
30 March 2009 00:22:57 GMT	31 March 2009 01:57:31 GMT	01 April 2009 01:46:49 GMT

RETIRA ≥ 2
RETIRA ≥ 2,5
RETIRA ≥ 3
RETIRA ≥ 3,5
RETIRA ≥ 4

clouds
no data
Tectonic lineaments

CONFUTATION

Main events (M ≥ 4) occurred in the area in the period March 1st - April 30th
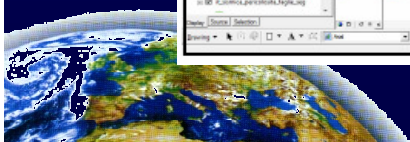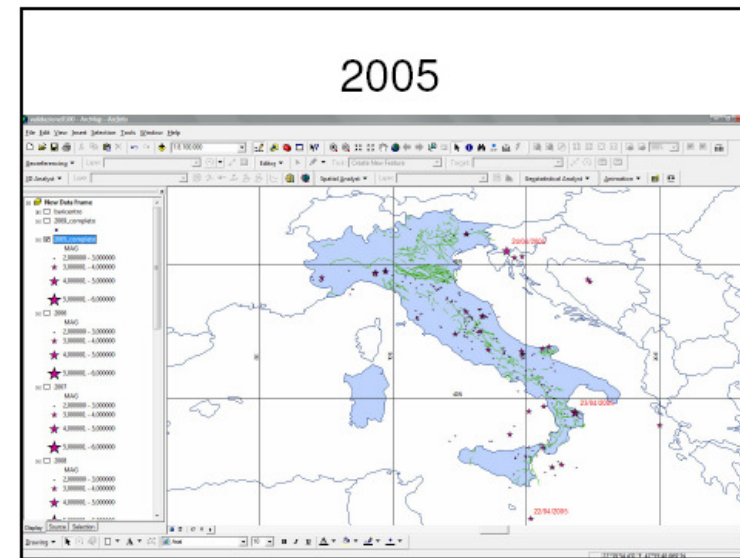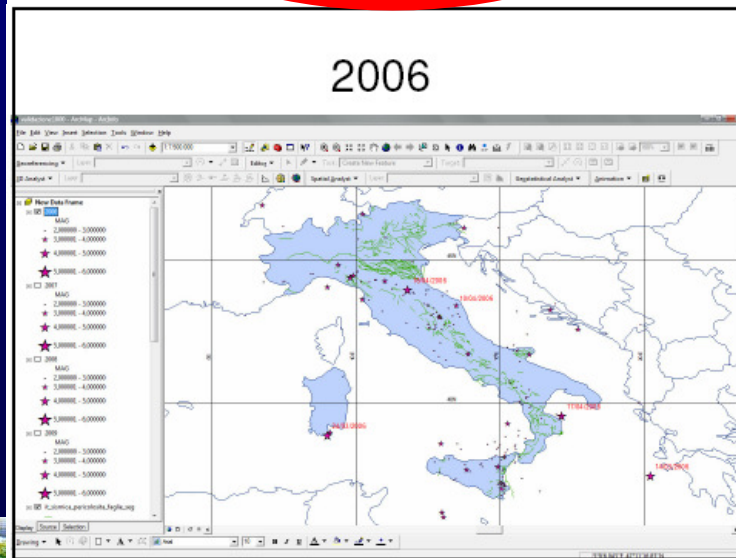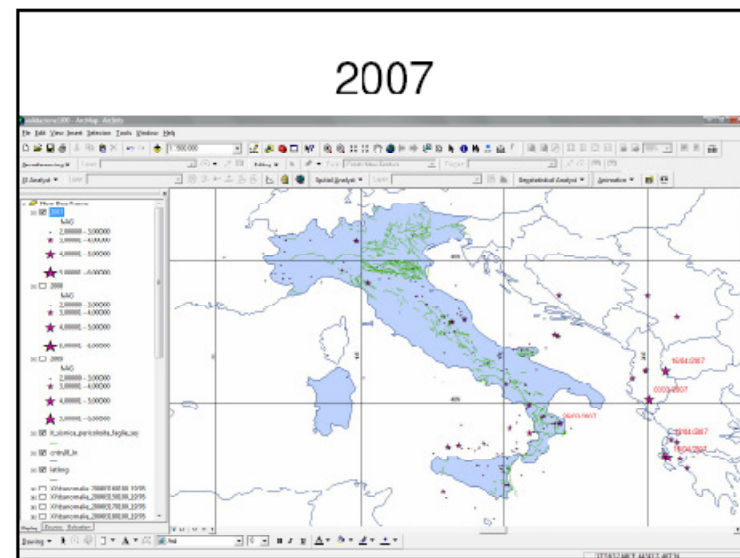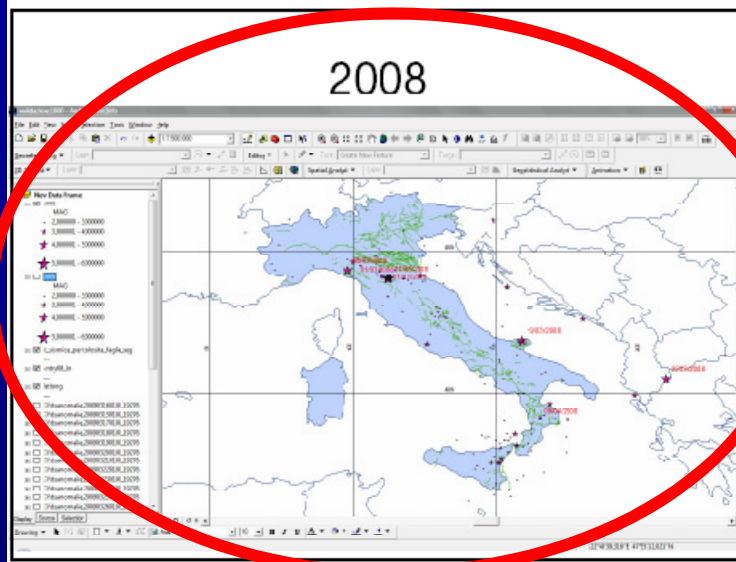
CONFUTATION
(March 15th – April 15th 2008, MSG-SEVIRI 00:00 GMT)
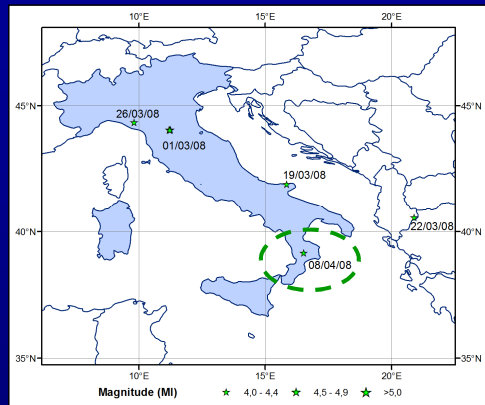
Seismic events (Ml>4) occurred during
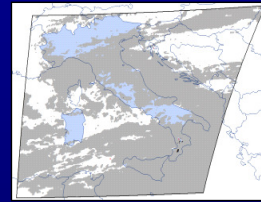March- April 2008 (INGV, 2009)
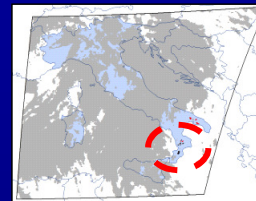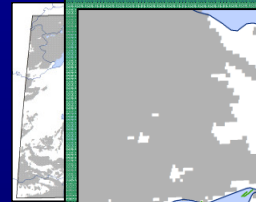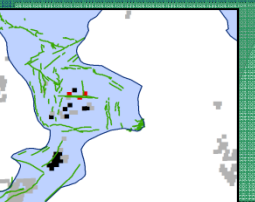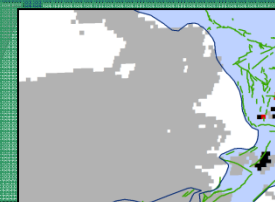
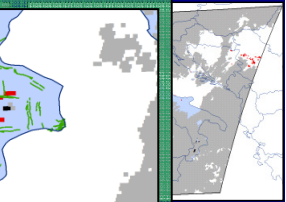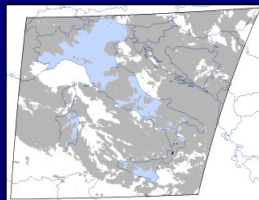15 March 2008   16 March 2008   17 March 2008   18 March 2008   19 March 2008
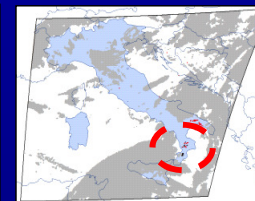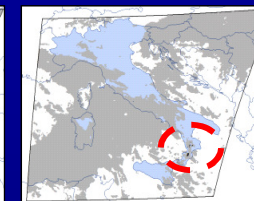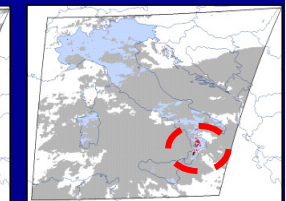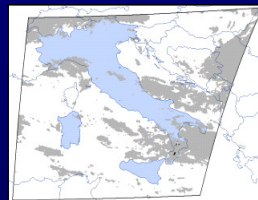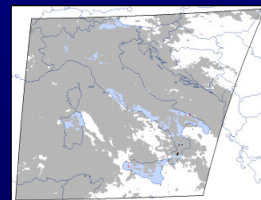
20 March 2008

16 March 2008   17 March 2008

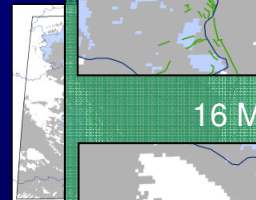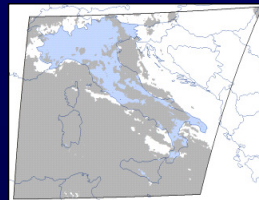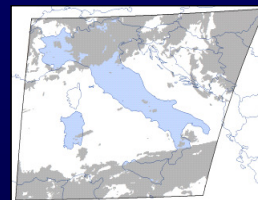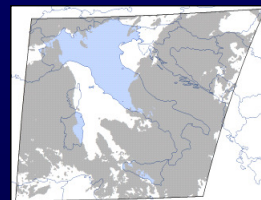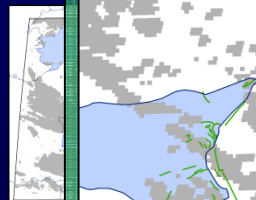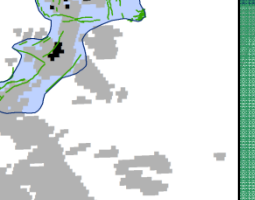18 March 2008   19 March 2008
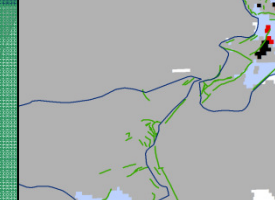
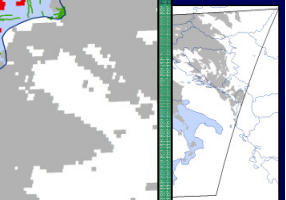25 March 2008   26 March 2008   27 March 2008

1 April 2008   2 April 2008   3 April 2008

🟥 RETIRA ≥ 4   ⬜ clouds   ⬛ no data

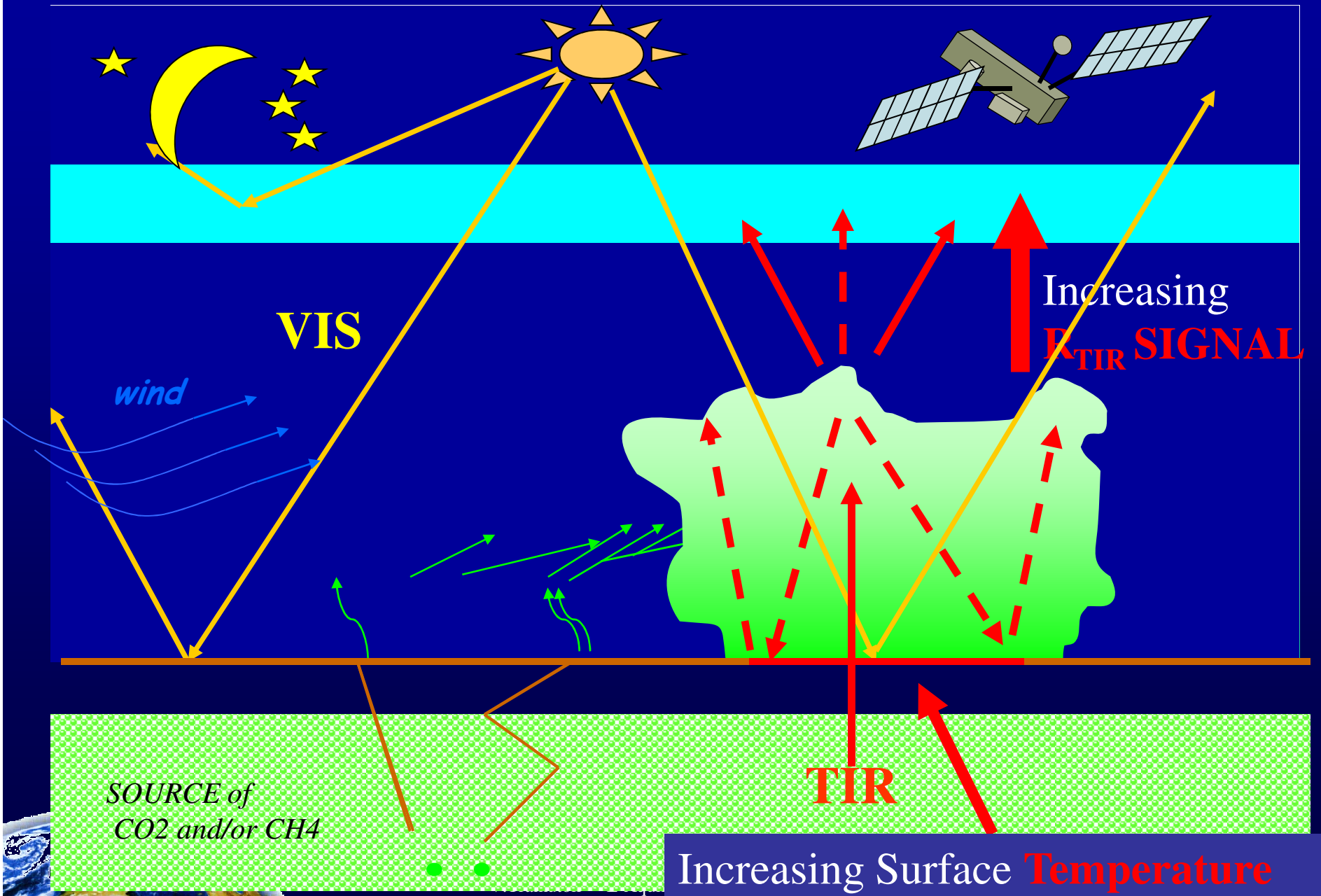W. Tramutolli L'Aquila, 25 Aprile 2009 –   (valerio.tramutoli@unibas.it +39 329 3117885)
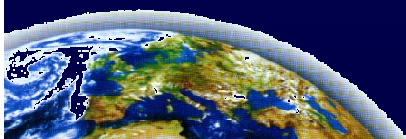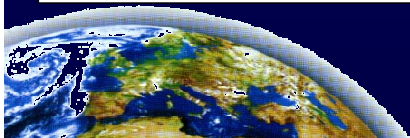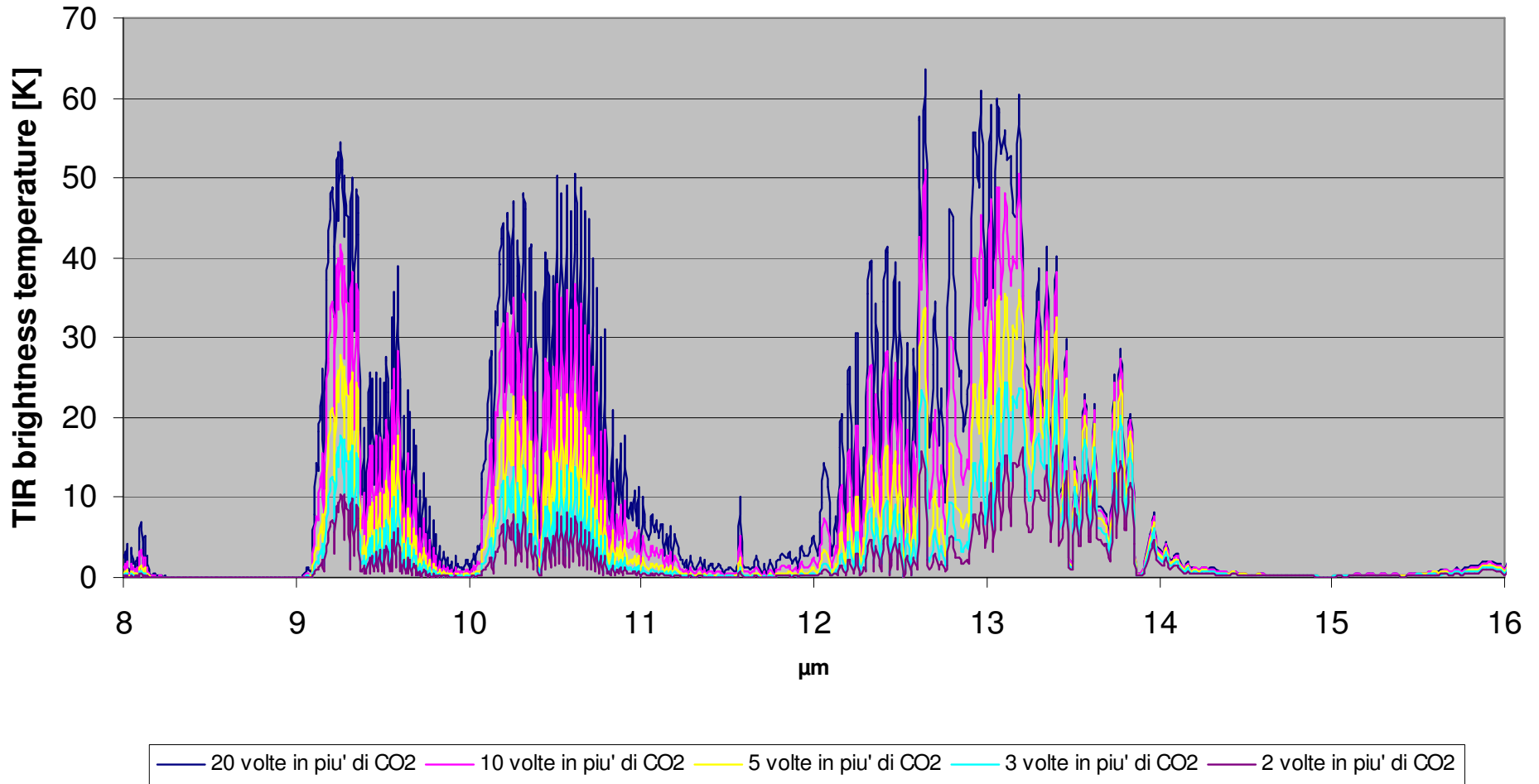
Conclusions ?
(status of the art)

- data analysis →
  - good (we can improve), satellite data are already available (unexpected performance achieved by the first use of MSG/SEVIRI)
  - when different sensors are compared coherent indications have been achieved (MODIS vs AVHRR vs SEVIRI)
- interpretation → integration of independent observations confirmed as fundamental (but we have to do them systematically)
- physical explanation → knowledge of physical processes related to EQ preparatory phases still poor, but models exist (still to be proved and improved!) able to explain observations.
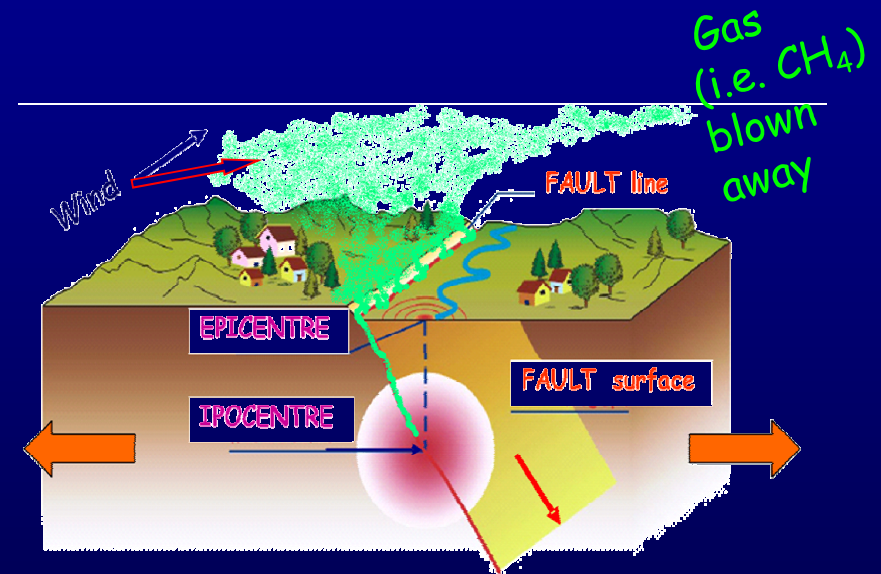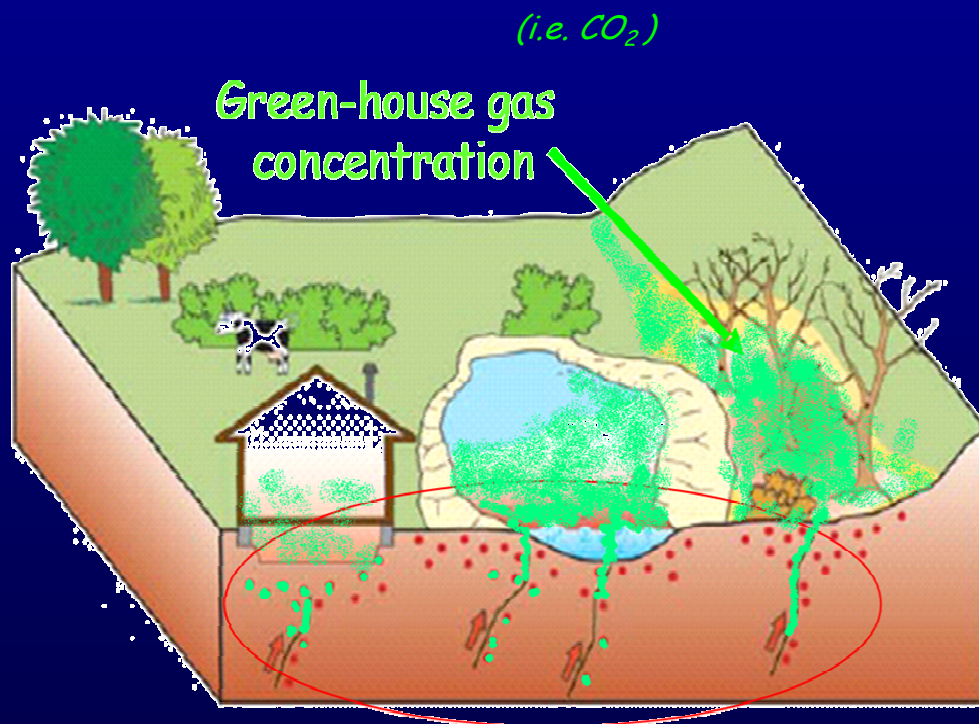
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Aliano et al. 2008

VIS

wind

Increasing R$_{TIR}$ SIGNAL

SOURCE of
CO2 and/or CH4

TIR

Increasing Surface **Temperature**
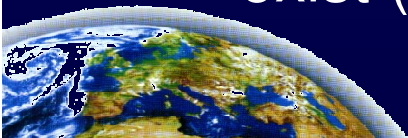
Expected atmospheric spectral radiance excesses (BT in K) at ground in presence of different CO2 concentrations

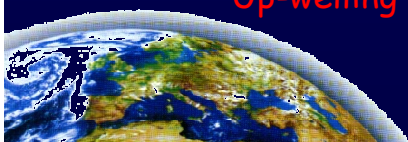Legend: 20 volte in piu' di CO2 — 10 volte in piu' di CO2 — 5 volte in piu' di CO2 — 3 volte in piu' di CO2 — 2 volte in piu' di CO2

Pre-seimic microfracturing

Co-seimic fault rupture

$(i.e.\ CO_2)$

Green-house gas concentration

Up-welling of fluids & gases

Gas $(i.e.\ CH_4)$ blown away

Wind

FAULT line

EPICENTRE

IPOCENTRE

FAULT surface

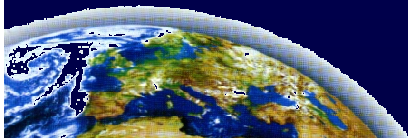Deep fluid & gas emission through the seismogenic fault
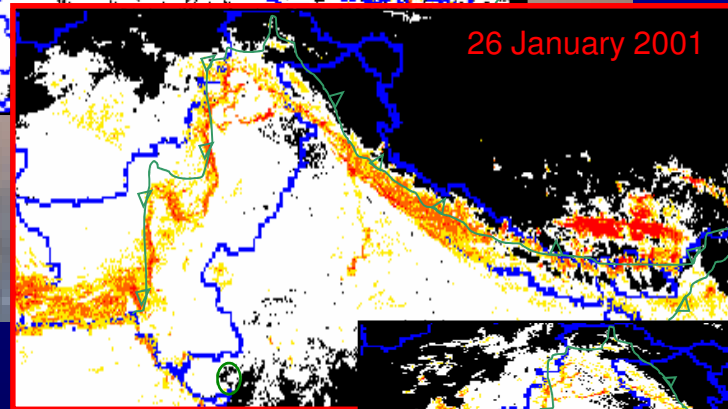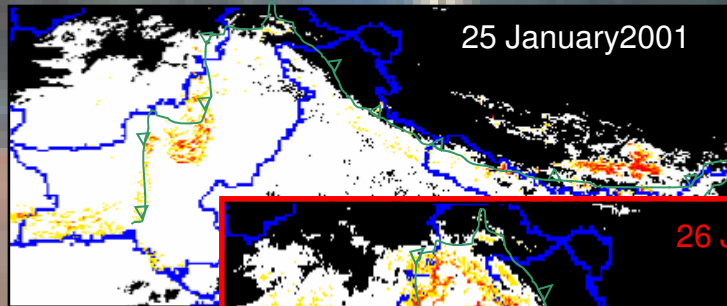
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Physical models: CO2

CO2 - river

CO2 - lake

Physical models: CO2

Bhuj-Gujarat (India), Ms= 7.9, 26 gennaio 2001 (Genzano et al.; Tectonophysics, 2007)
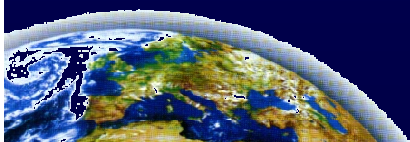
25 January2001

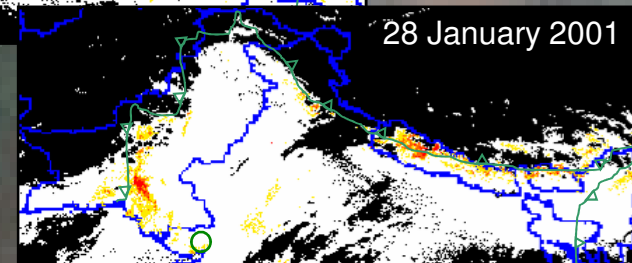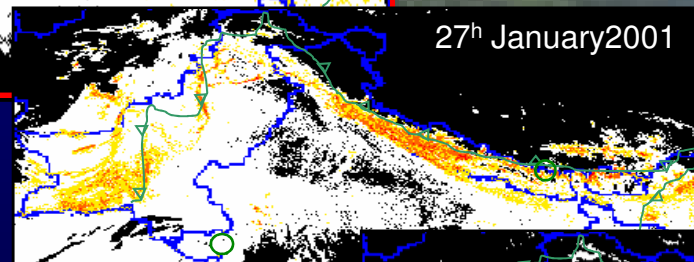26 January 2001

25 June1996 (4 days before EQ)

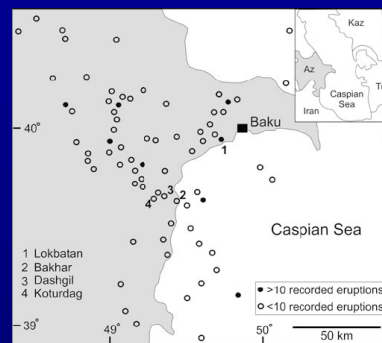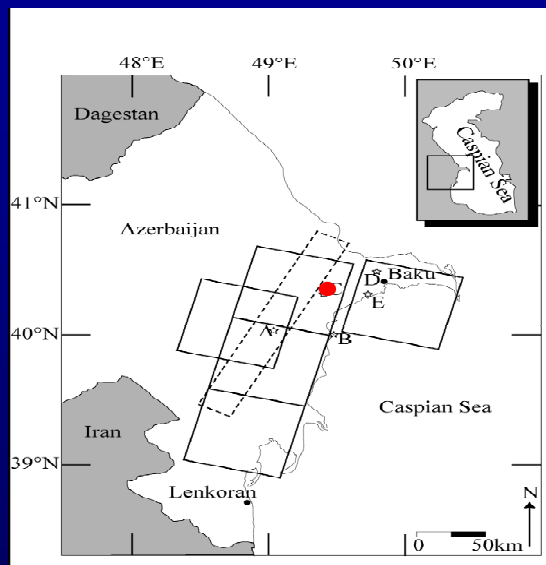**CO2 - river**

CO2 - lake

27h January2001

28 January 2001

Physical models: CH4
Mud Volcanoes in Azerbaijan as controled sources of methane

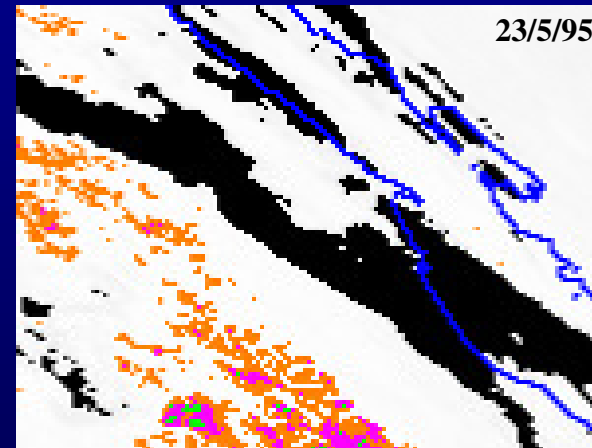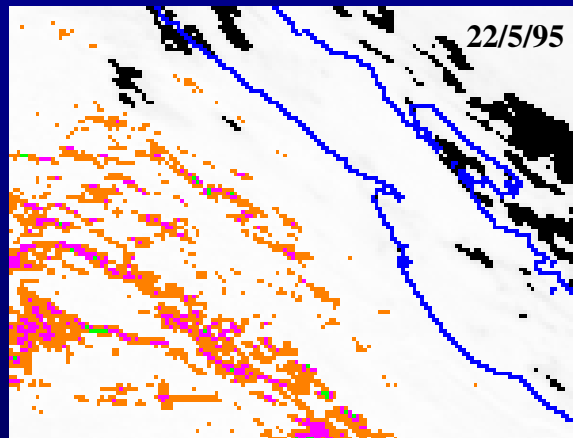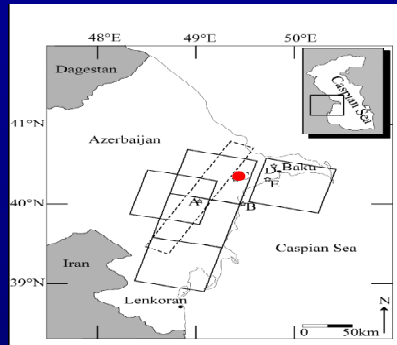more than 220 mud volcanoes, CH4 emission: 100-1000 ton/km2 per year (Etiope, 2003)

Panhai, Aliev, Guliev, Martinelli at Mefite, August 2006

V.Tramutoli - L'Aquila, 27 Aprile 2010 - (valerio.tramutoli@unibas.it +3
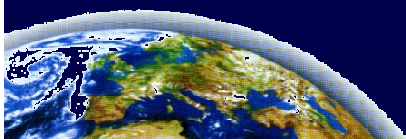
Physical models: CH4
Mud Volcanoes in Azerbaijan as controled sources of methane
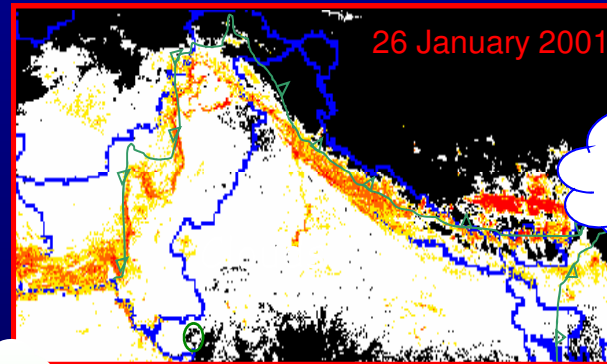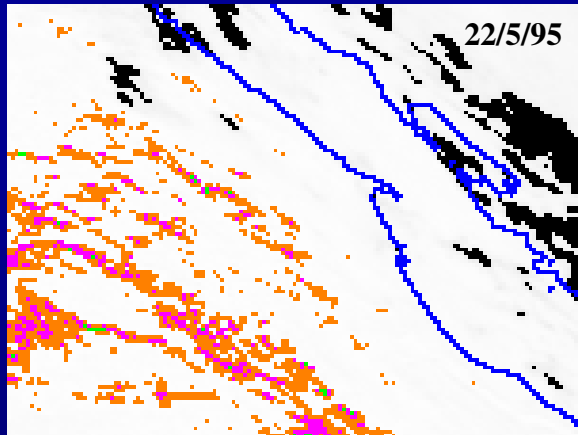
Aliano et al.; IEEE, 2008

22/5/95

23/5/95

Bozdagh volcano eruption
May 1995

No data (nuvole)

indice RETIRA ≥ 2
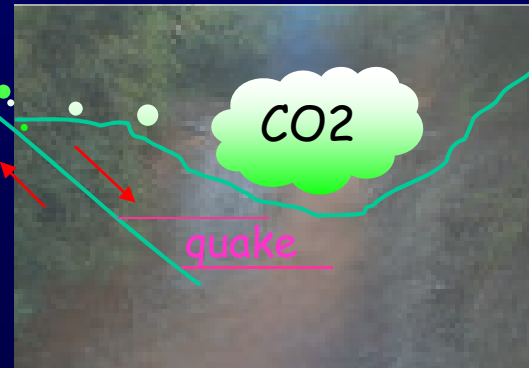
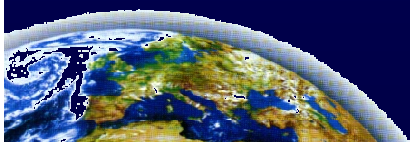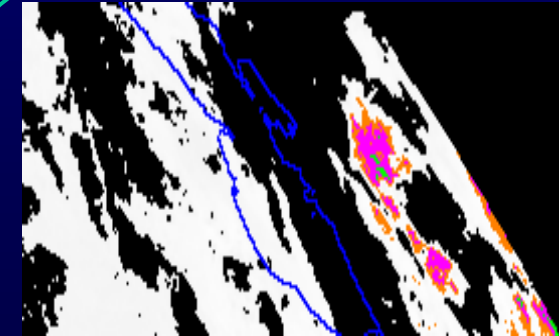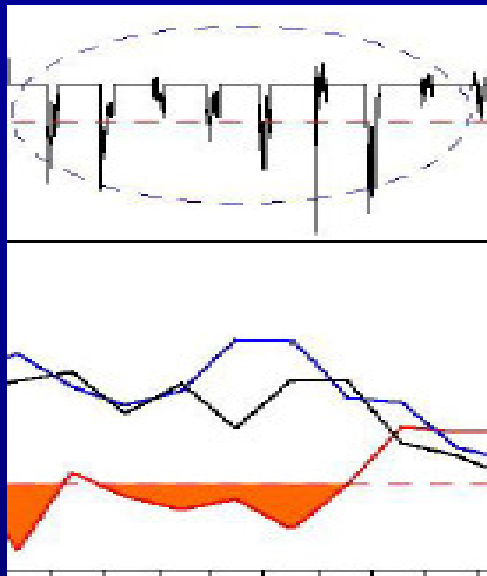indice RETIRA ≥ 2.5

indice RETIRA ≥ 3

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Physical models

**Anomalies in
VLF radio
signals**

Rozhnoi et al., 2009