A REAL TIME PIPELINE TO LINK METEOROLOGICAL DATA TO TGFS DETECTED BY AGILE

Alessandro Ursi

Rome, May 26th 2015
A real time pipeline to link meteorological data to TGFs

Collaboration:

• the AGILE Team
• Institute of Atmospheric Sciences and Climate (ISAC – CNR)
  S. Dietrich, D. Casella, P. Sanò, M. Petracca
• Italian Air Force
TGFs detected by AGILE + information by meteo satellites
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• Cloud Top Altitude (CTA)
• Atmospheric Motion Vectors (AMV)
• Multi-sensor Precipitation Estimate (MPE)
• CLoud Analysis (CLA)
• Global Convective Diagnostics (GCD)
• IR 10.8 µm
• WV 6.2 µm
TGFs detected by AGILE + information by meteo satellites

- Cloud Top Altitude (CTA)
- Atmospheric Motion Vectors (AMV)
- Multi-sensor Precipitation Estimate (MPE)
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- IR 10.8 μm
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Global Convective Diagnostics (GCD)

Deep convection is present if $GCD = T_b^{IR} - T_b^{WV} \leq 1$ K
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General concept

TGFs detected by AGILE + information by meteo satellites

- Cloud Top Altitude (CTA)
- Atmospheric Motion Vectors (AMV)
- Multi-sensor Precipitation Estimate (MPE)
- CCloud Analysis (CLA)
- Global Convective Diagnostics (GCD)
- IR 10.8 µm
- WV 6.2 µm

Global Convective Diagnostics (GCD)

deep convection is present if $GCD = T_b^{\text{IR}} - T_b^{\text{WV}} \leq 1 \text{ K}$
1) check of convection within the TGF production region

2) first time follow-up of the TGF-producing thundercloud

3) specific class of thunderstorms producing TGFs

4) real time (= as-fast-as-possible) service to alert aircraft networks
Global meteorological coverage
Global meteorological coverage

AGILE satellite

whole orbit ~ 90'

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Global meteorological coverage

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Global meteorological coverage

Geostationary meteorological satellites

- Meteosat-7
- MT-SAT
- GOES-E

AGILE satellite

- whole orbit ~ 90'
- data available every ~ 15'÷30'

A real time pipeline to link meteorological data to TGFs detected by AGILE

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new data every ~ 90'

AGILE data packets

orbit 41179 12/04/2015
orbit 41180 12/04/2015
orbit 41181 12/04/2015
orbit 41182 12/04/2015
orbit 41183 12/04/2015
orbit 41184 12/04/2015
orbit 41185 12/04/2015
orbit 41186 12/04/2015
orbit 41187 12/04/2015
orbit 41188 12/04/2015
orbit 41189 12/04/2015
orbit 41190 12/04/2015
A real time pipeline to link meteorological data to TGFs detected by AGILE

How does it work?

new data every ~ 90'

search algorithm
- off line quest for TGFs

TGF profile
date: 12/04/2015
time: 12:11:44
gEO: 23.74° -2.01°
E(max) = 6.70 MeV
How does it work?

A real time pipeline to link meteorological data to TGFs detected by AGILE

AGILE data packets
- orbit 41179 12/04/2015
- orbit 41180 12/04/2015
- orbit 41181 12/04/2015
- orbit 41182 12/04/2015
- orbit 41183 12/04/2015
- orbit 41184 12/04/2015
- orbit 41185 12/04/2015
- orbit 41186 12/04/2015
- orbit 41187 12/04/2015
- orbit 41188 12/04/2015
- orbit 41189 12/04/2015
- orbit 41190 12/04/2015

off line quest for TGFs

new data every ~ 90'

CNR antenna data buffer
- 5 days meteo data from geostat. satellites

longitude | satellite       | Δt |
---       | ---             | ---|
-60° ÷ 60°| Meteosat 10     | 15'|
0° ÷ 120° | Meteosat 7      | 15'|
50° ÷ 170°| Feng Yun 2      | 30'|
80° ÷ 200°| MT-SAT          | 30'|
170° ÷ 290°| GOES-West      | 30'|
220° ÷ 340°| GOES-East     | 30'|

TGF profile
date: 12/04/2015
ime: 12:11:44
geo: 23.74° - 2.01°
E(max) = 6.70 MeV

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How does it work?

new data every ~ 90'

off line quest for TGFs

CNR antenna data buffer – 5 days meteo data from geostat. satellites

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<td>30'</td>
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</table>

TGF profile
date: 12/04/2015
time: 12:11:44
geo: 23.74° - 2.01°
E(max) = 6.70 MeV
How does it work?

1. TGF profile
date: 12/04/2015
time: 12:11:44
geo: 23.74° - 2.01°
E(max) = 6.70 MeV

2. meteo data from CNR antenna

3. Meteosat 10 data
12/04/2014

search for the nearest images in time

new data every ~ 90'

off line quest for TGFs

meteo data from CNR antenna

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A real time pipeline to link meteorological data to TGFs detected by AGILE

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How does it work?

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How does it work?

A real time pipeline to link meteorological data to TGFs detected by AGILE:

1. Off line quest for TGFs
2. Search for the nearest images
3. Meteo data from CNR antenna
4. Final product
5. Overshooting top

New data every ~ 90'

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TGF profile
- Date: 12/04/2015
- Time: 12:11:44
- geo: 23.74°-2.01°
- E(max) = 6.70 MeV
Some examples: real time correlation

"AFAP" meteo correlation

TGF 20150522 (few days ago...)
orbit: 041759
UTC: 16:13:50
geo: 21.55°, -2.40°

Info on timing

time (event) 16:13:50
time (data packet) 17:12:00
time (MSG3) 16:15:00
time (TOTAL) 17:20:00

~ 19°
~ 5 mins

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Some examples: real time correlation

22/05/2015 16:15

IR channel

22/05/2015 16:15

WV channel

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Some examples: real time correlation

22/05/2015 16:15

A real time pipeline to link meteorological data to TGFs detected by AGILE
Some examples: real time correlation

16:15 ➔ 17:45

22/05/2015 16:15

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Some examples: real time correlation

15:00 ← 16:15

22/05/2015 16:15

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AGILE new TGF detection rate

AGILE 700 TGFs
rate ~ 100 TGFs/month
we expect to reach 1000 TGFs in ~ 3 months!
AGILE new TGF detection rate

<table>
<thead>
<tr>
<th># TGF</th>
<th>dd-mm-yyyy</th>
<th>hh:mm:ss</th>
<th>lon (deg)</th>
<th>lat (deg)</th>
<th>Δt (hh:mm:ss)</th>
<th>Δlon (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
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<td>...</td>
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<td>...</td>
<td></td>
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<tr>
<td>562</td>
<td>8-04-2015</td>
<td>13:56:21</td>
<td>21,01</td>
<td>-1,70</td>
<td>0:00:08</td>
<td>0,45</td>
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<tr>
<td>563</td>
<td>8-04-2015</td>
<td>13:56:29</td>
<td>21,46</td>
<td>-1,72</td>
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<td>...</td>
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<td>...</td>
<td>0:00:17</td>
<td>1,00</td>
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<tr>
<td>583</td>
<td>13-04-2015</td>
<td>12:06:36</td>
<td>99,78</td>
<td>-1,65</td>
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<td>584</td>
<td>13-04-2015</td>
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<td>-1,62</td>
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<td>1,23</td>
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<td>606</td>
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<td>517</td>
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<td>1,48</td>
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<td>18:49:41</td>
<td>96,79</td>
<td>2,10</td>
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<td></td>
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Some examples: "multiple" TGFs

UTC 00:42:40

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Some examples: "multiple" TGFs

UTC 00:42:40

1 orbit

UTC 02:27:40

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Some examples: "multiple" TGFs

UTC 12:12:40

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Some examples: "multiple" TGFs

UTC 12:12:40

1 orbit

UTC 13:57:41

GCD

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Some examples: "multiple" TGFs

UTC
13:42:40

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Some examples: "multiple" TGFs

1st TGF

2nd TGF
A real time pipeline to link meteorological data to TGFs detected by AGILE

Some examples: "multiple" TGFs

UTC 15:42:40

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Conclusions:

• we can provide very fast meteorological information about the TGF-producing thunderstorm (cloud top altitude, temperature and presence of convection)
• we have now a meteorological data buffer continuously downloading data by geostationary satellites with a global equatorial coverage

Future perspectives:

• improve the pipeline and the TGF-meteo algorithm
• exploit data by polar satellites (TRMM, GPM, ...)
• study meteorological historical data to better characterize the TGF-producing thunderstorms
THANK YOU

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