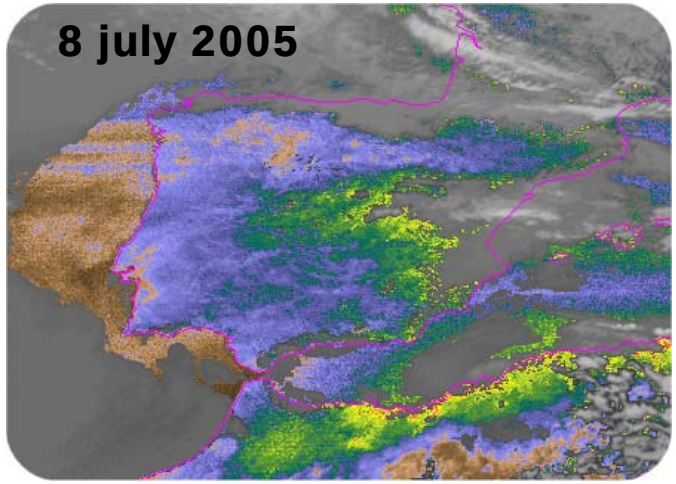
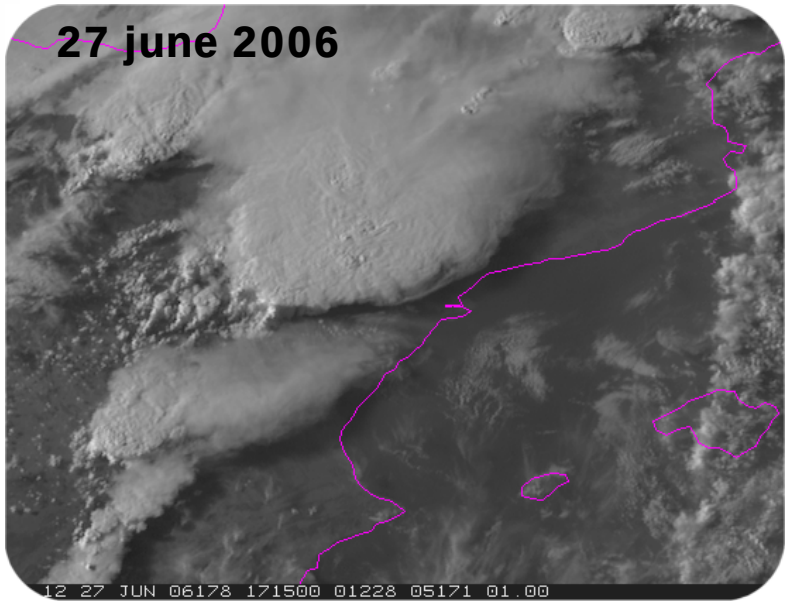
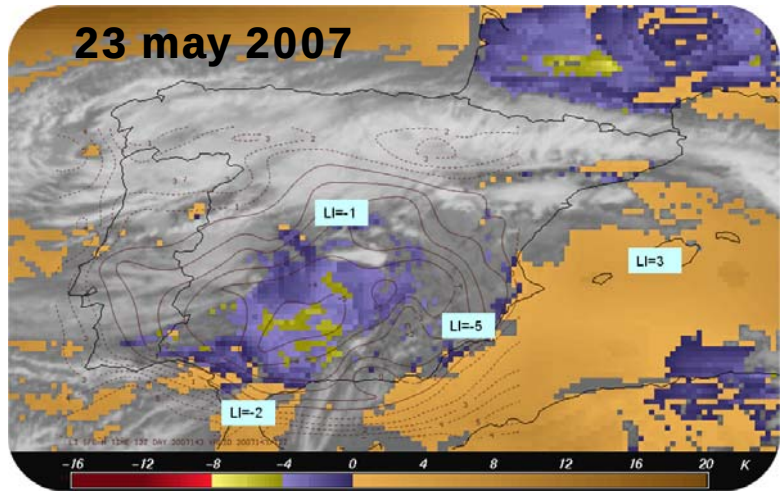
MSG derived instability products for three severe weather events in Spain

Ramón Vázquez,
Spanish Meteorological Insitute, Spain







Some notes on parcel “instabilities”:

- LI or CAPE are not a measure of atmospheric instability, not a measure of probability of convective initiation

- LI or CAPE have no skill to answer deep convection **yes / no** forecasting questions

Tuduri and Ramis, 1997
(Sounding derived)

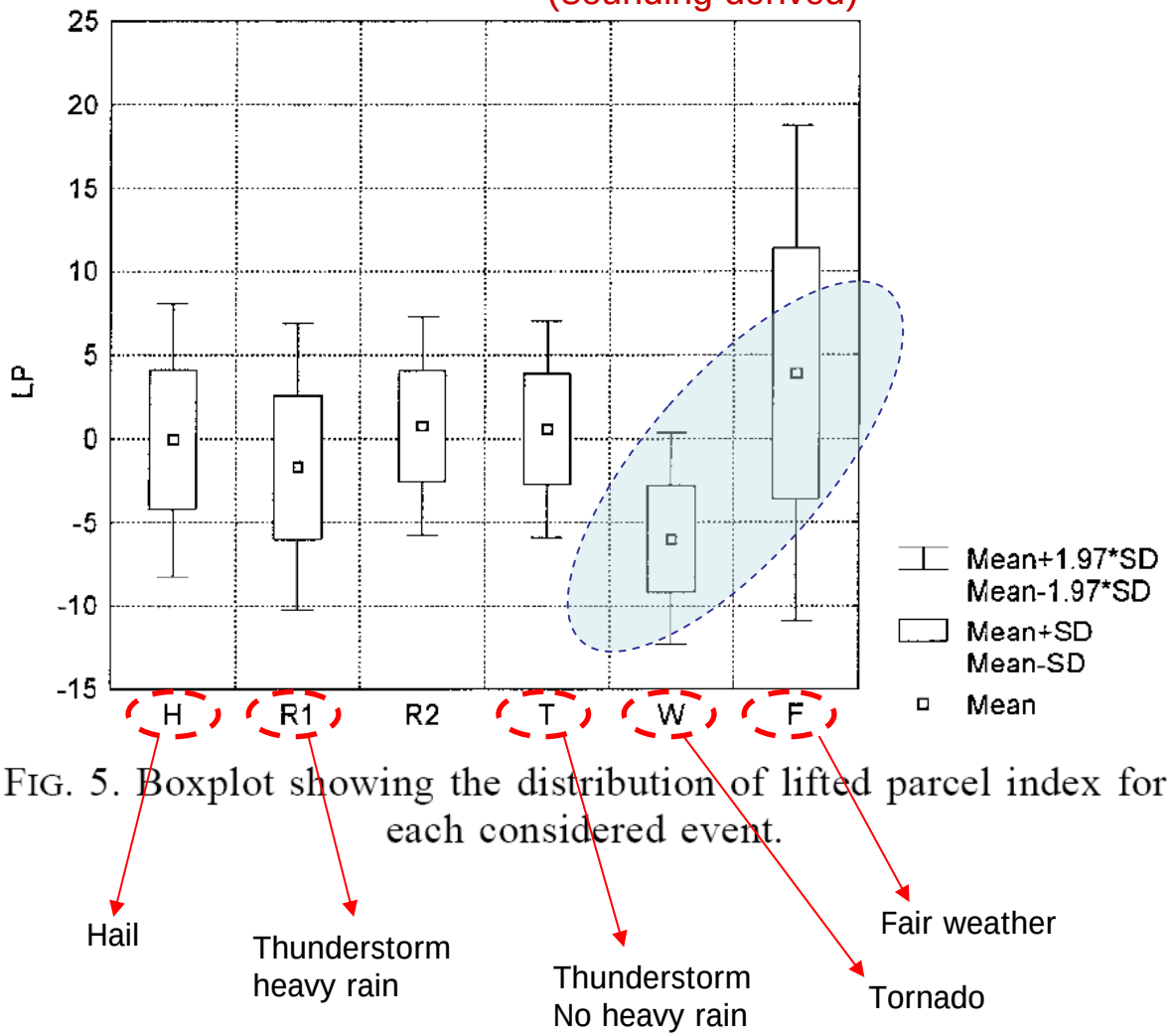


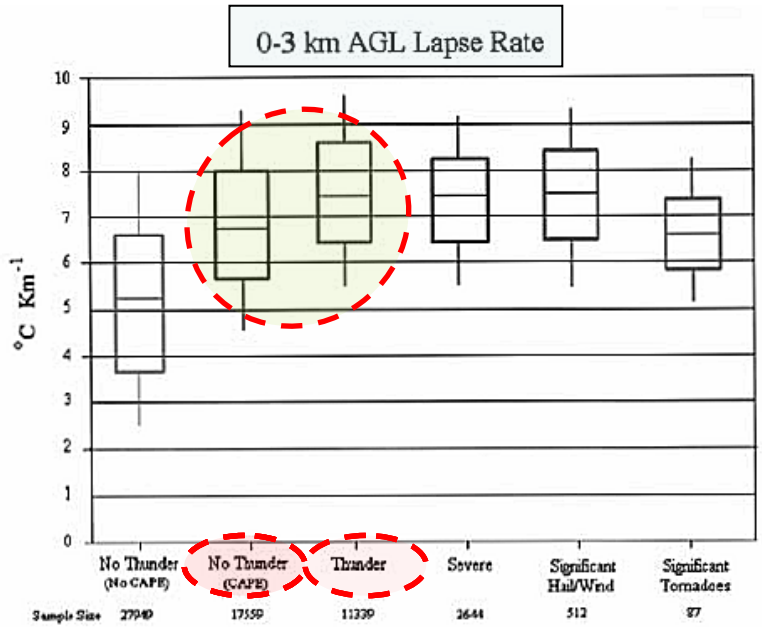
FIG. 5. Boxplot showing the distribution of lifted parcel index for each considered event.

Some notes on parcel “instabilities”:

- LI or CAPE are not a measure of atmospheric instability, not a measure of probability of convective initiation

- LI or CAPE have no skill to answer deep convection **yes / no** forecasting questions

Low level lapse rate have skill to answer **yes / no** type questions:



BASELINE CLIMATOLOGY OF SOUNDING DERIVED PARAMETERS ASSOCIATED WITH DEEP MOIST CONVECTION

Jeffrey P. Craven and Harold E. Brooks

Some notes on parcel “instabilities”:

However, LI or CAPE have proved to be good at nowcasting convection intensity (when initiated)

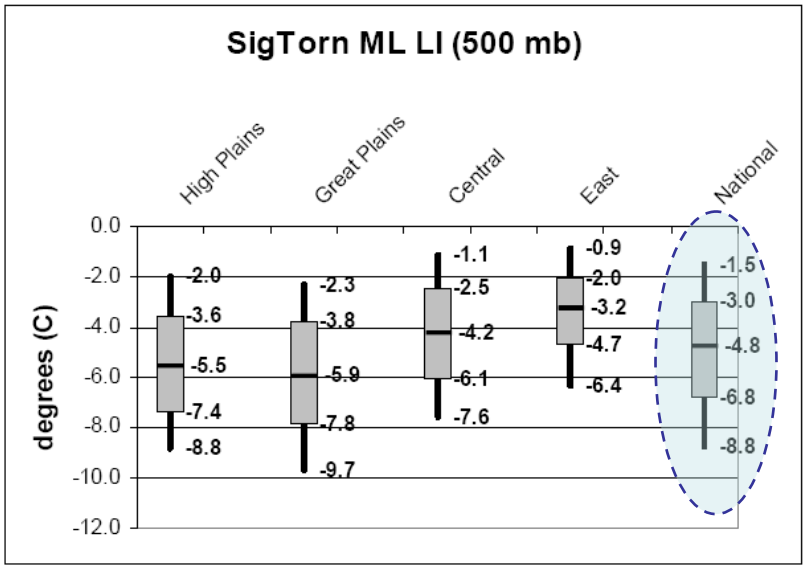


Figure 7. Geographic Comparison of SigTorn ML LI distributions.

K. Potvin et al., 2003
(Sounding derived)

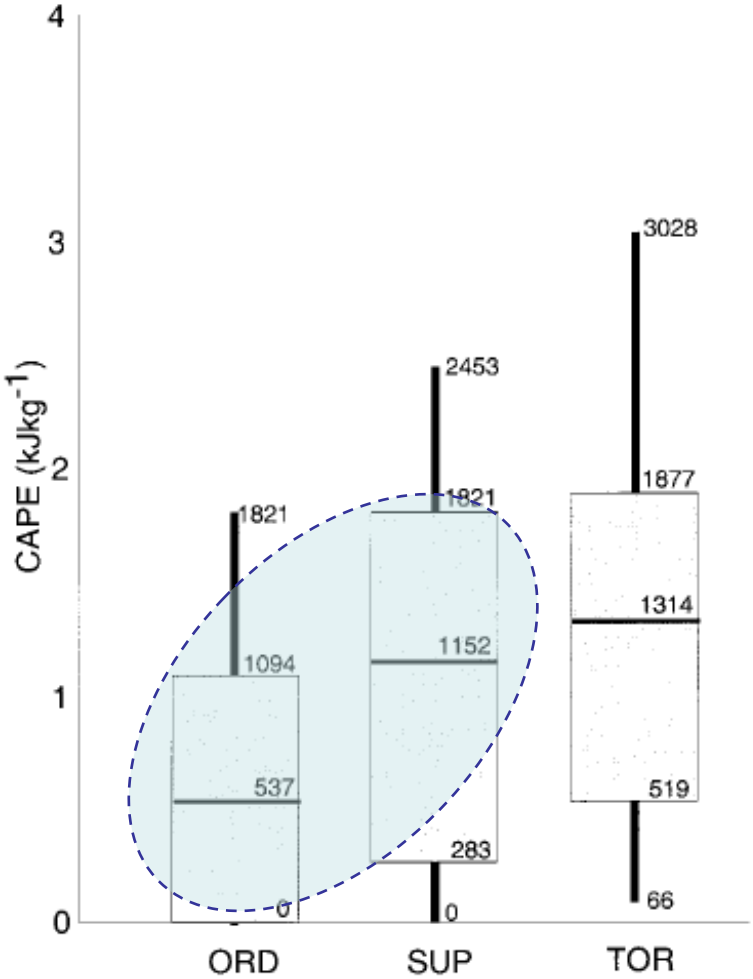


FIG. 7. As in Fig. 3 except for CAPE.

Rasmussen and Blanchard, 1998
(Sounding derived)

Some notes on parcel “instabilities”:

- Surface based LI is just a measure of surface temperature and moisture, as well as 500 hpa temperature:

Operational NWP models seem to be not enough skillfull at detecting rapid changes in surface moisture

- Convection is not always rooted on surface !

  In that cases we are chosing a wrong parcel to assess “instablity”,

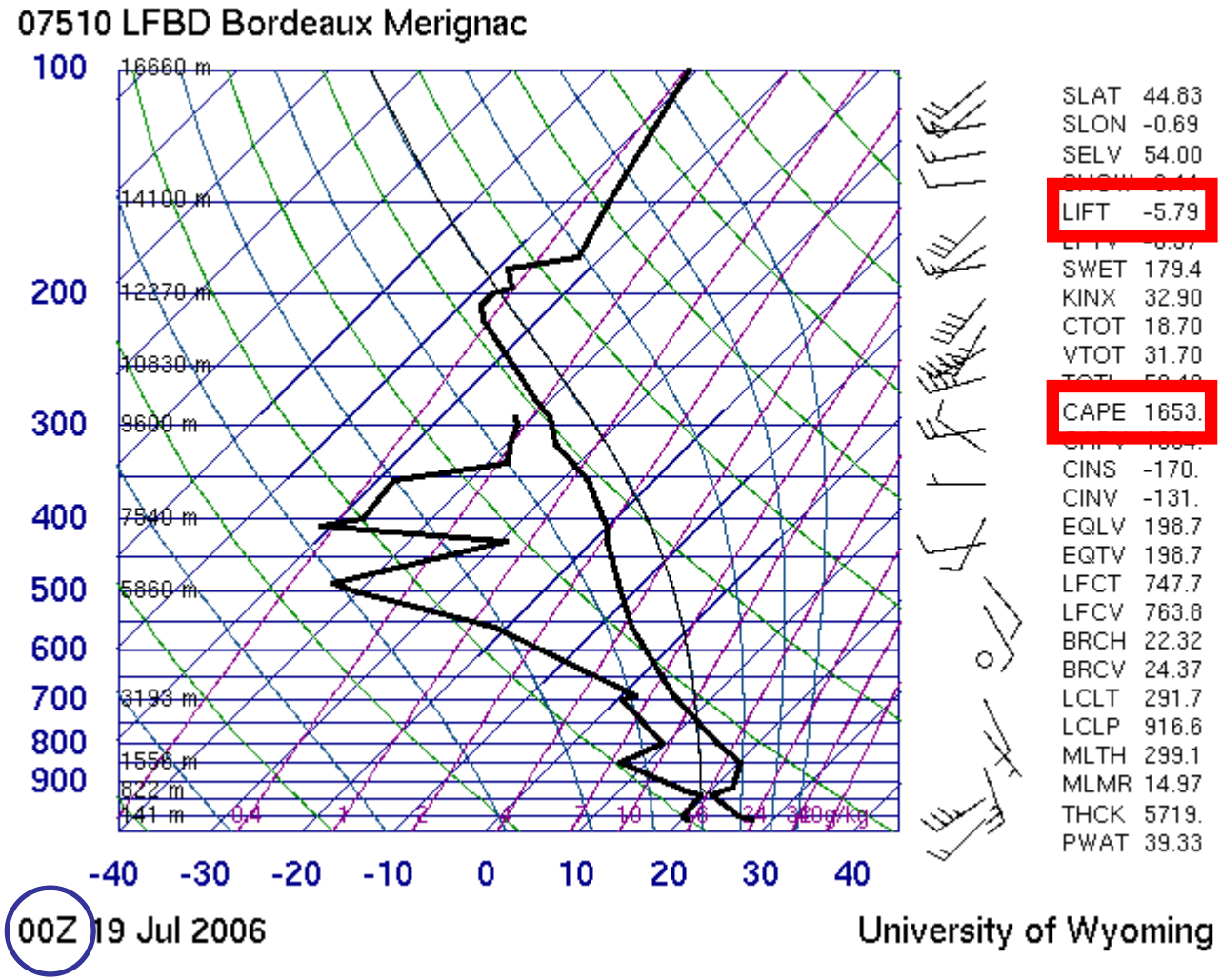
- 3 sources of error when computing LI:

1 ºC error in $T_d)_{sfc}$ → error in surface based LI ~ 1 ºC or greater
1 ºC error in $T)_{sfc}$ → error in surface based LI ~ 0.5 ºC
1 ºC error in $T)_{500}$ → error in surface based LI = 1 ºC

¡ Highest LI (also CAPE) sensitivity to surface moisture errors, that is, to surface mixing ratio errors!

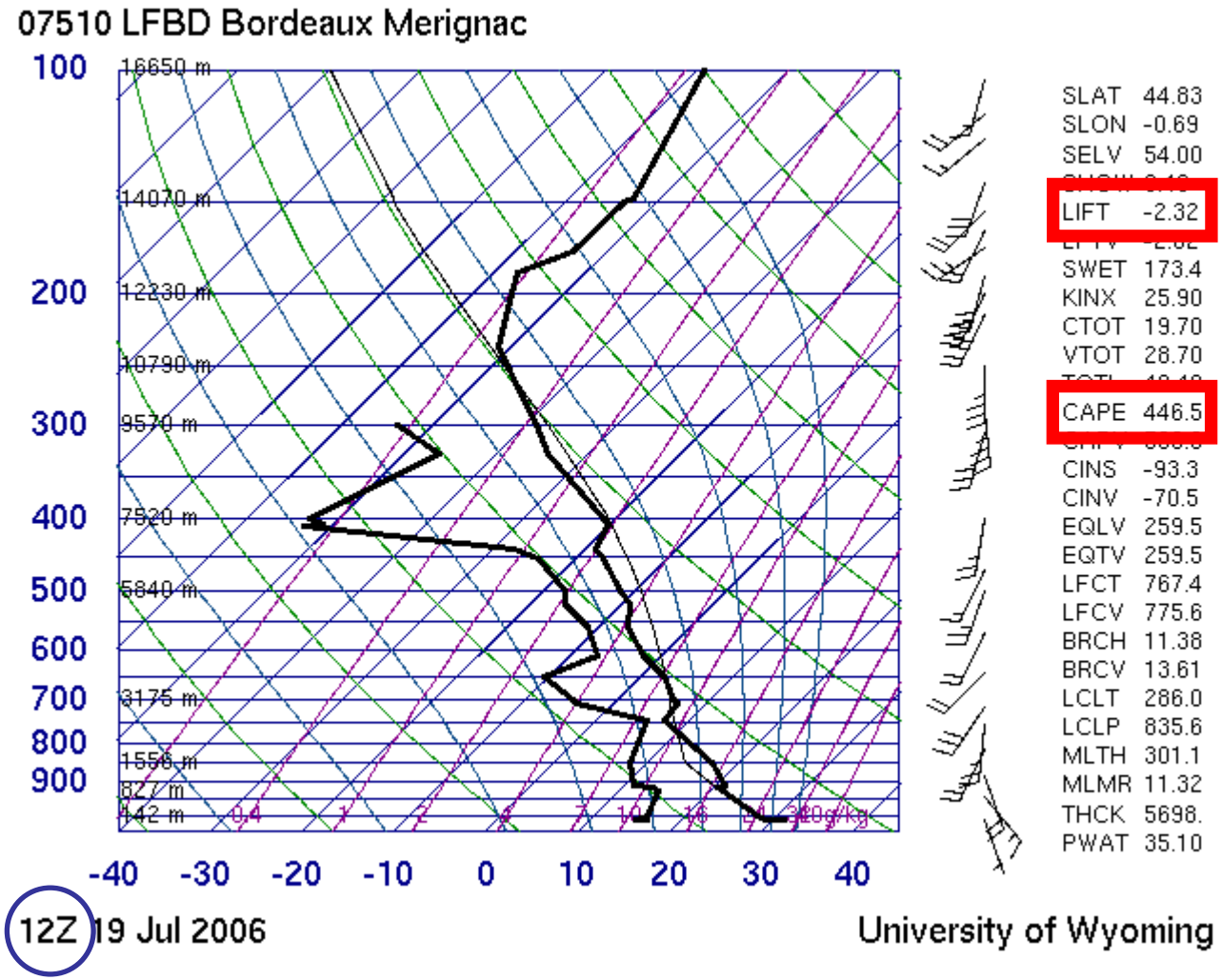
Some notes on parcel “instabilities”:

Sensitivity of LI and CAPE to rapid changes in low level parameters



Some notes on parcel “instabilities”:

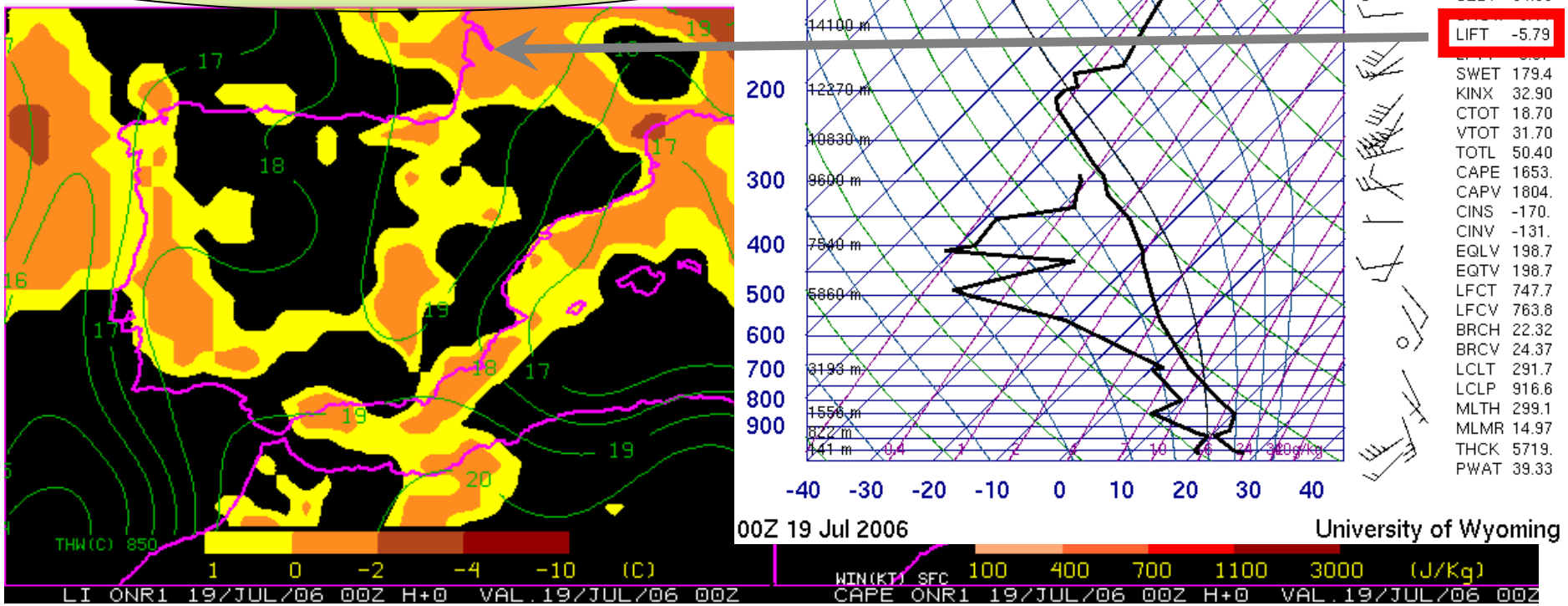
Sensitivity of LI and CAPE to rapid changes in low level parameters



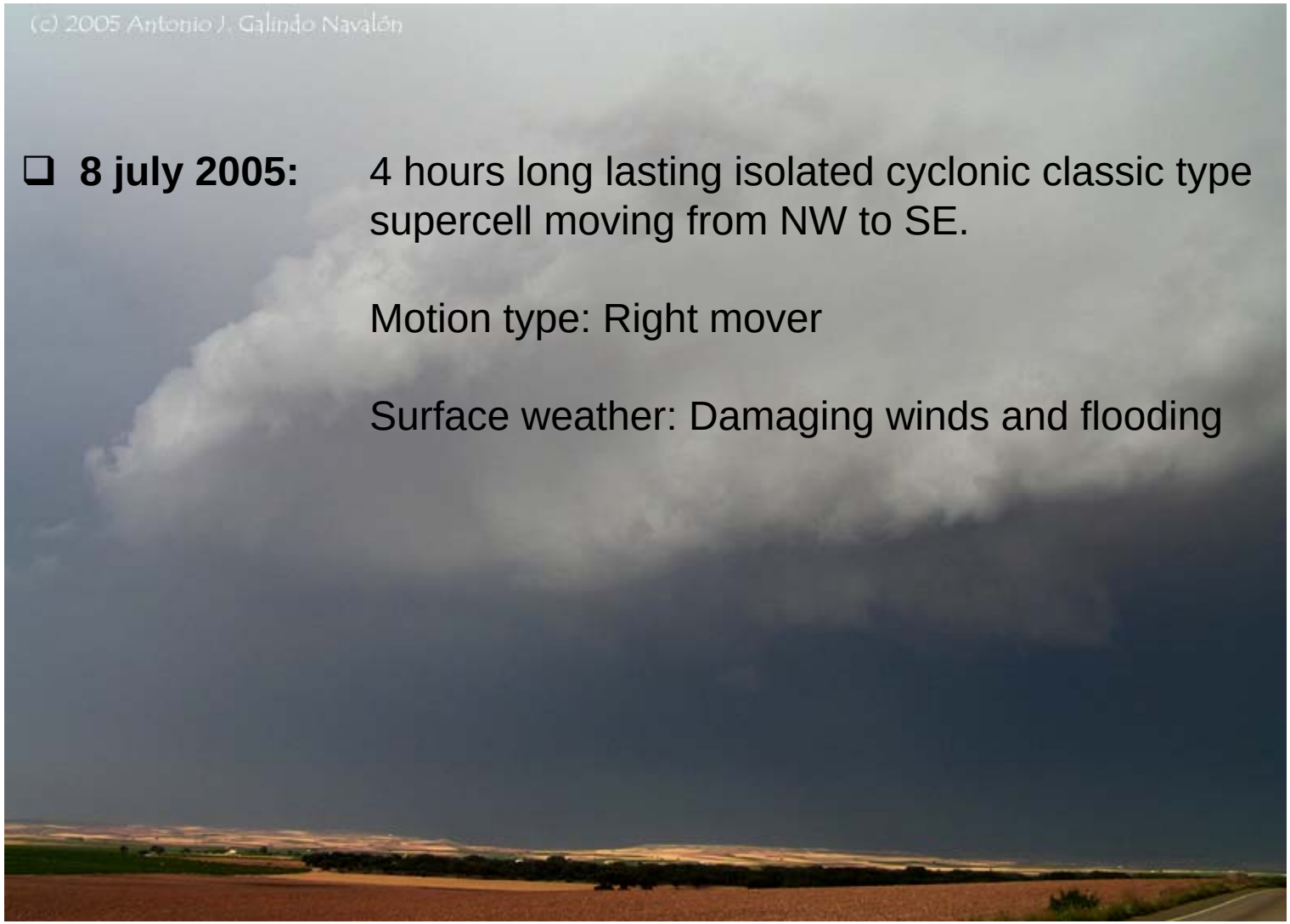
Some notes on parcel “instabilities”:

Sensitivity of LI and CAPE to rapid changes in low level parameters

Sometimes large errors even in model analysis !



The events (sc_1):

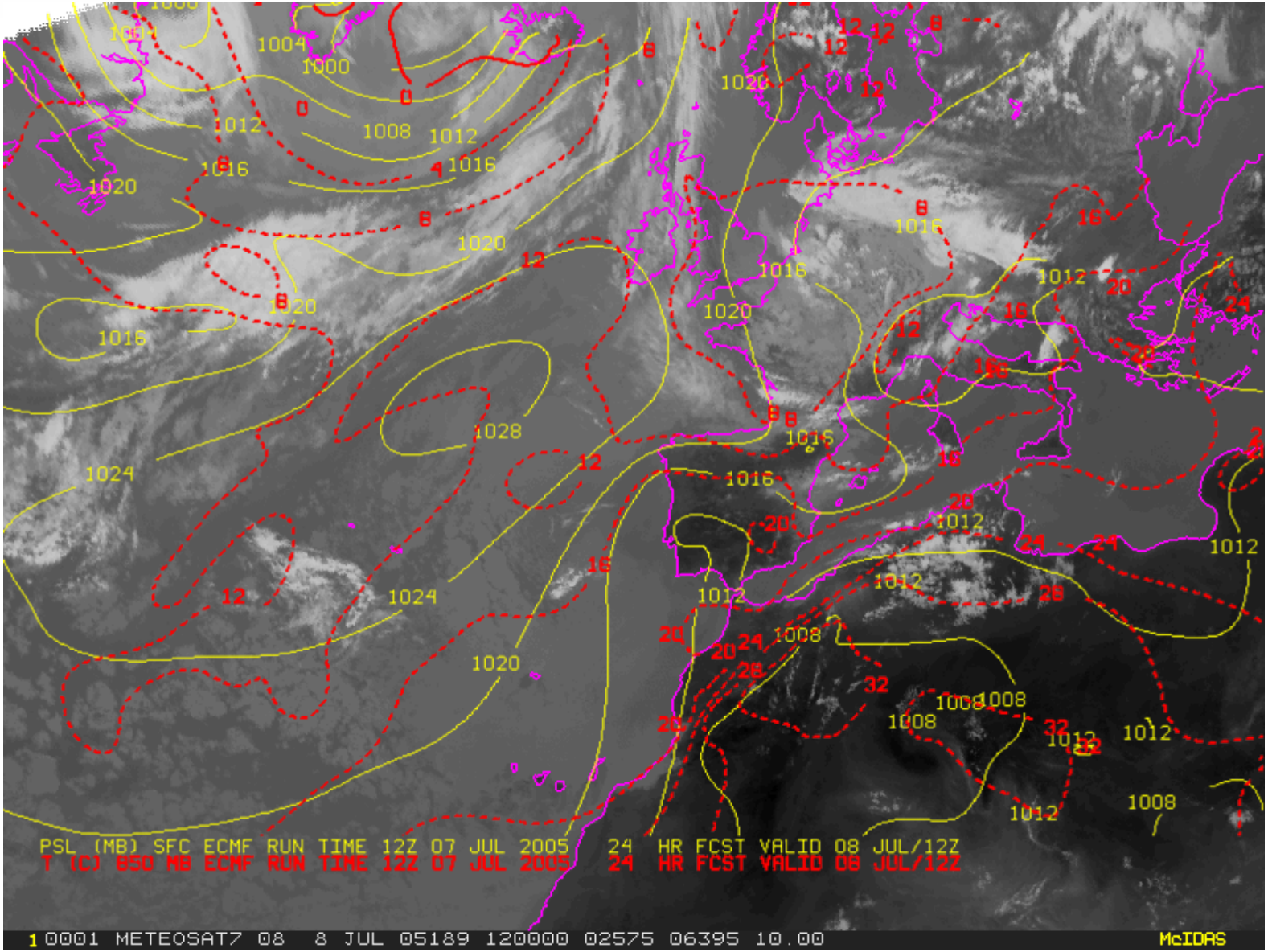


- **8 july 2005:** 4 hours long lasting isolated cyclonic classic type supercell moving from NW to SE.

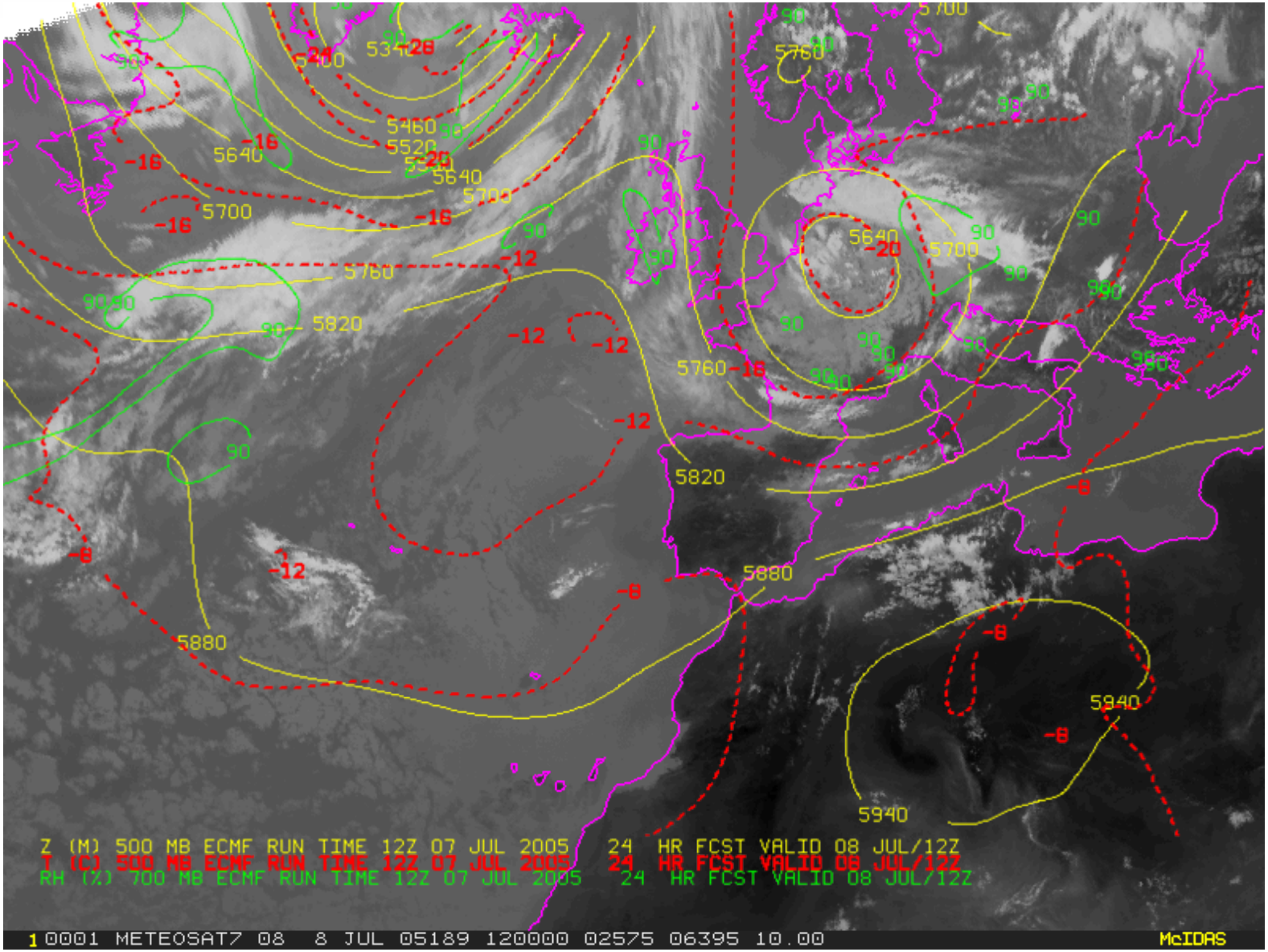
  Motion type: Right mover

  Surface weather: Damaging winds and flooding

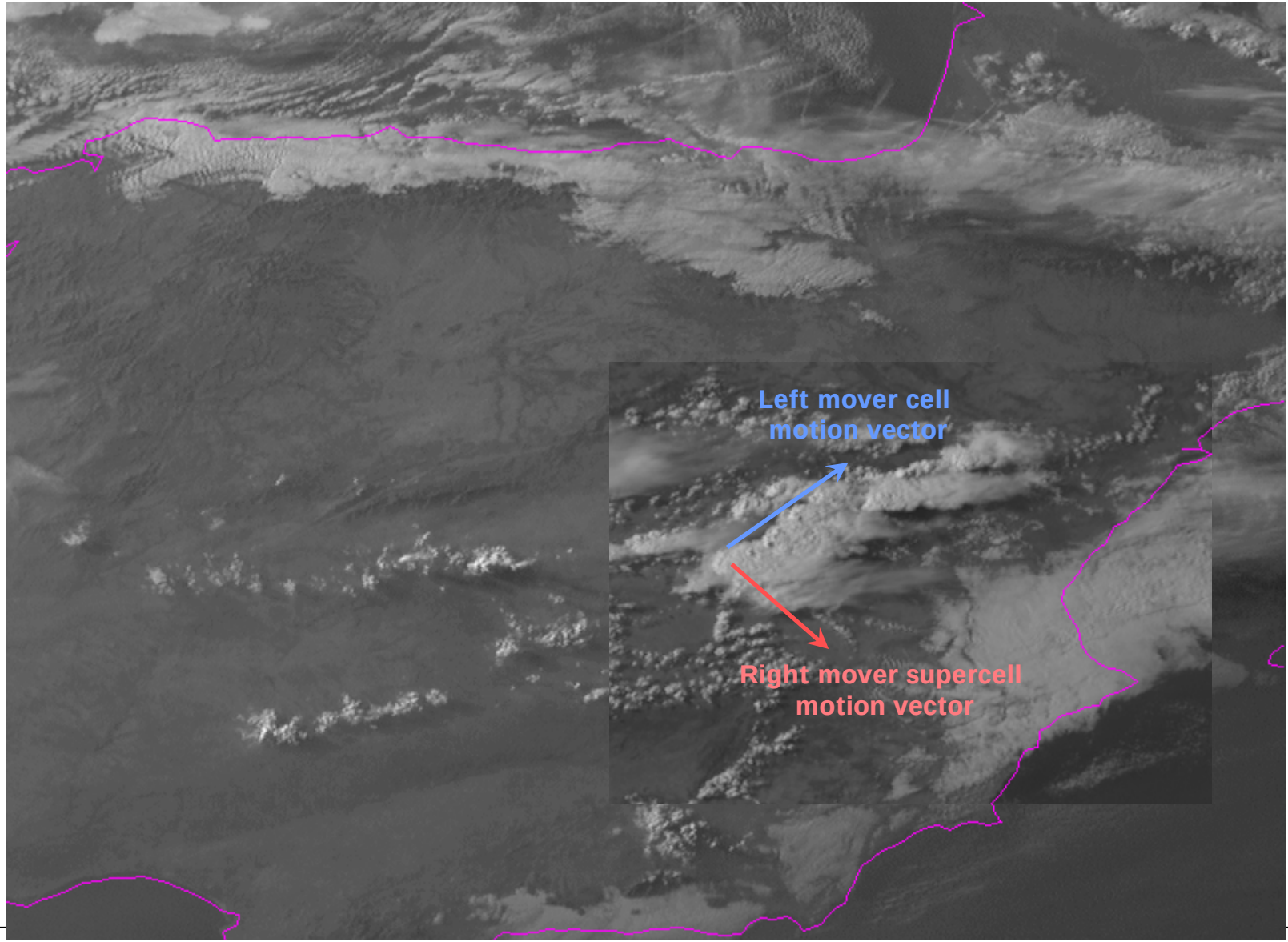
Sc_1 synoptic setting: (8 july 2005, 12 UTC)



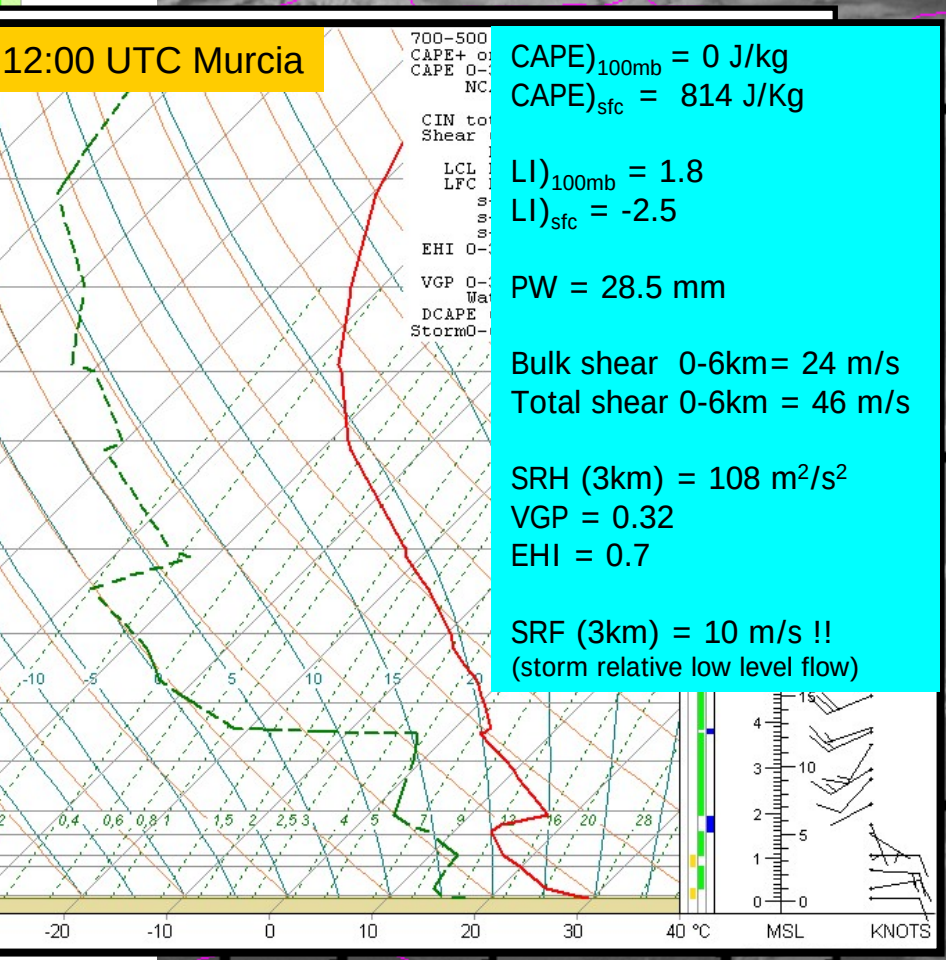
Sc_1 synoptic setting: (8 july 2005, 12 UTC)



sc_1 (8 july 2005, storm splitting loop, MSG HRV channel)



Sc_1: First approach to instability assessment: Use an upstream proximity sounding (often not available)



$CAPE)_{100mb}$ = 0 J/kg
$CAPE)_{sfc}$ = 814 J/Kg

$LI)_{100mb}$ = 1.8
$LI)_{sfc}$ = -2.5

PW = 28.5 mm

Bulk shear 0-6km= 24 m/s
Total shear 0-6km = 46 m/s

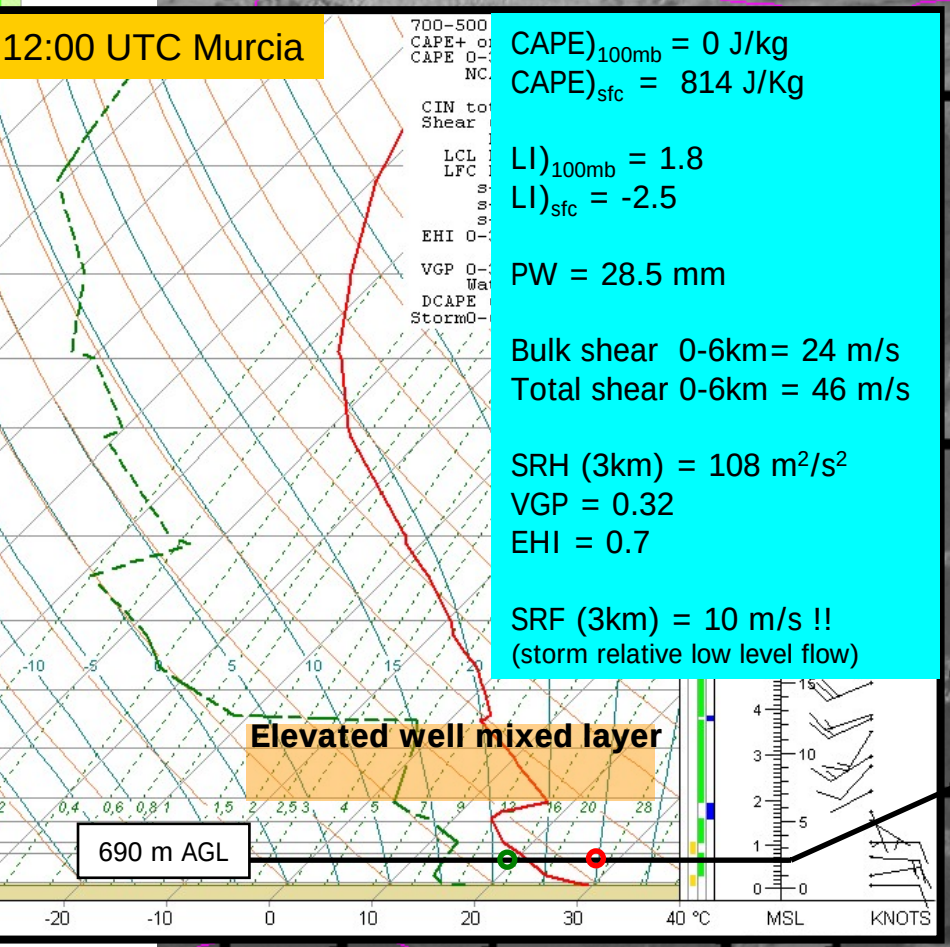
SRH (3km) = 108 m^2/s^2
VGP = 0.32
EHI = 0.7

SRF (3km) = 10 m/s !!
(storm relative low level flow)

Murcia (12Z $T_d)_{sfc}$ = 17.6 ºC)

¿proximity sounding?

Sc_1: First approach: a further improvement
Modify sfc values with observed ones in a nearby station



CAPE)$_{100mb}$ = 0 J/kg
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SRH (3km) = 108 m^2/s^2
VGP = 0.32
EHI = 0.7

SRF (3km) = 10 m/s !!
(storm relative low level flow)

Albacete (15Z $T_d)_{sfc}$ =19.2 ºC)

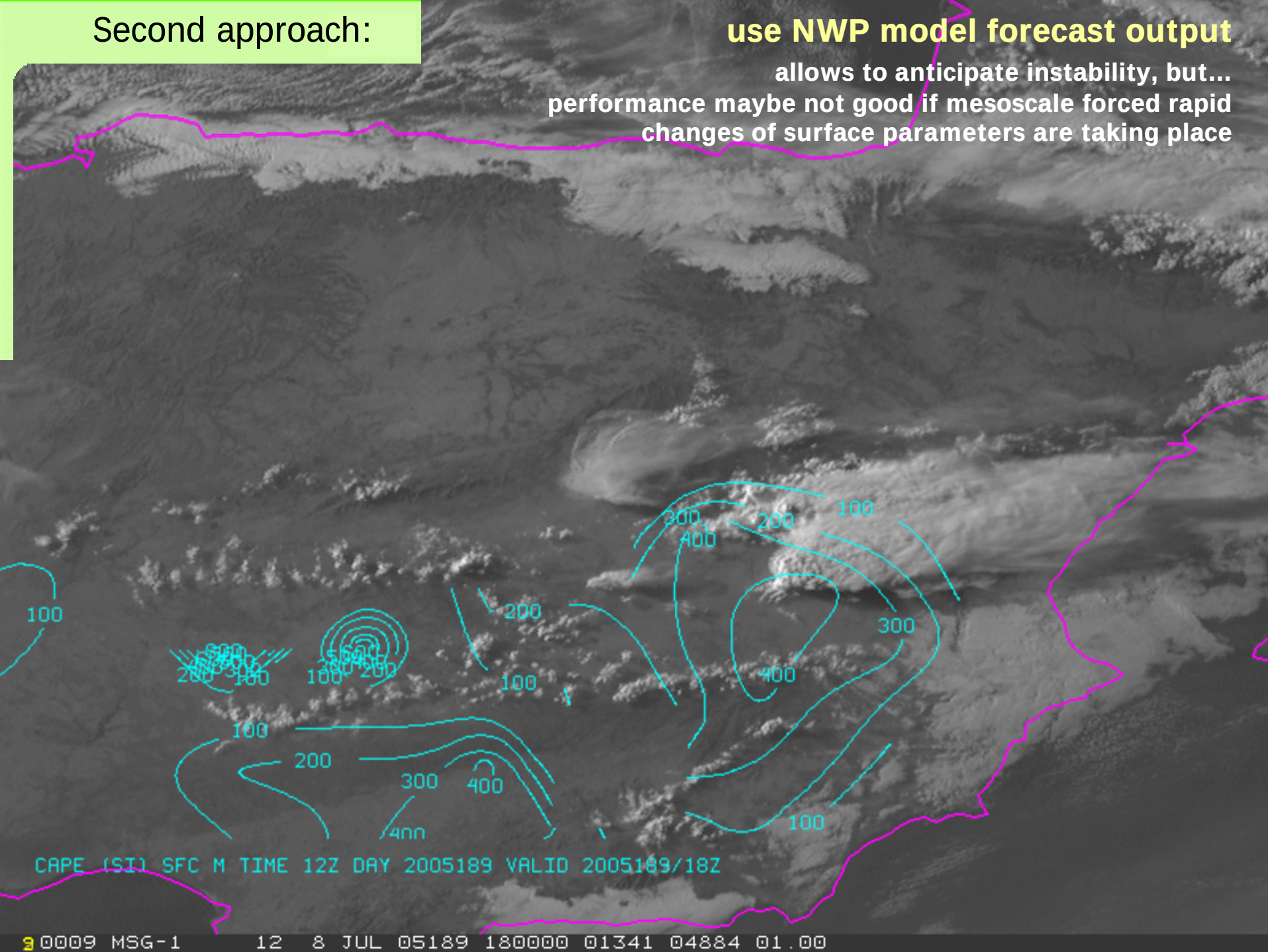
Murcia (12Z $T_d)_{sfc}$ = 17.6 ºC)

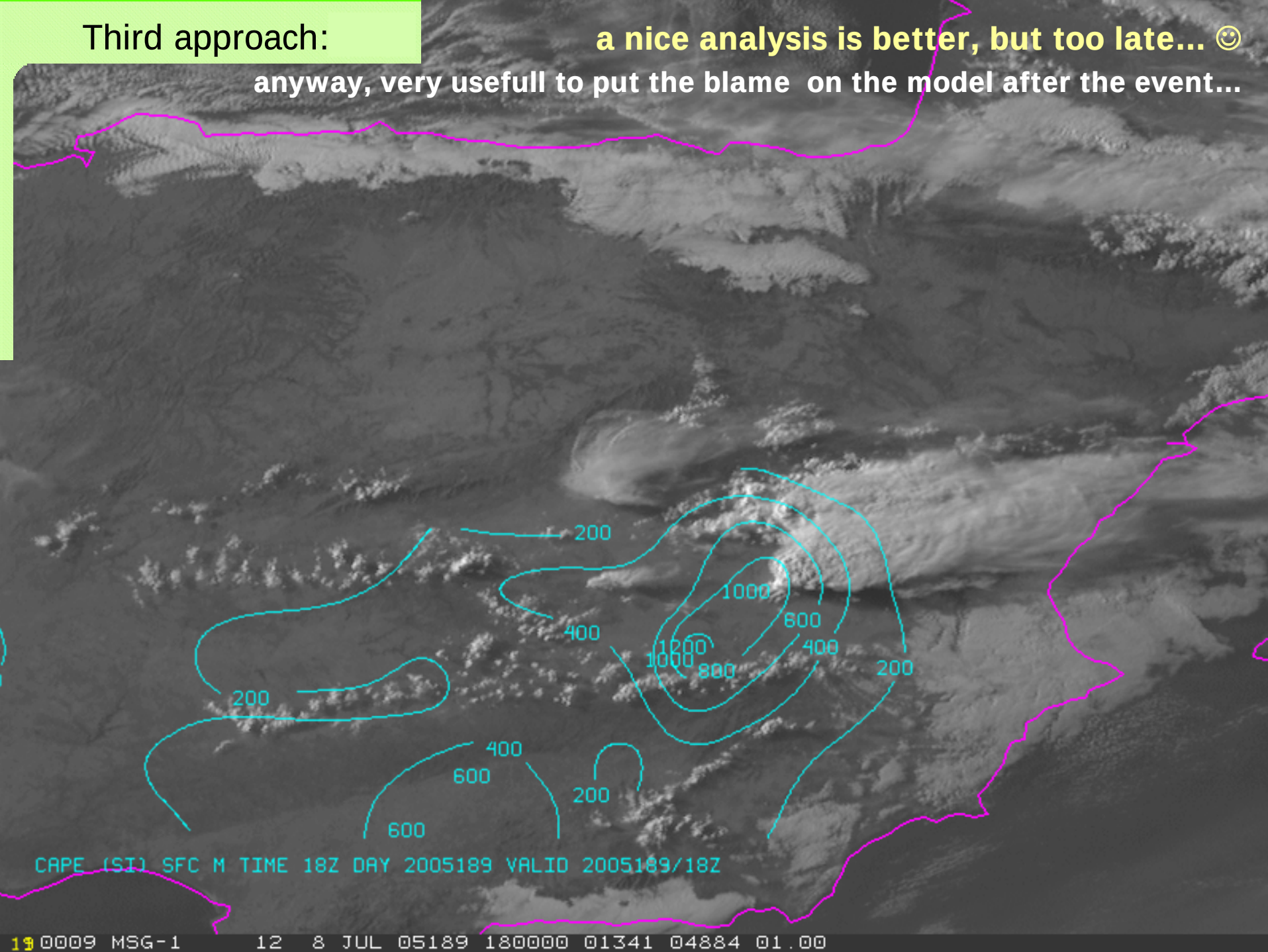
¿proximity sounding?

Second approach:

use NWP model forecast output

allows to anticipate instability, but...
performance maybe not good if mesoscale forced rapid changes of surface parameters are taking place



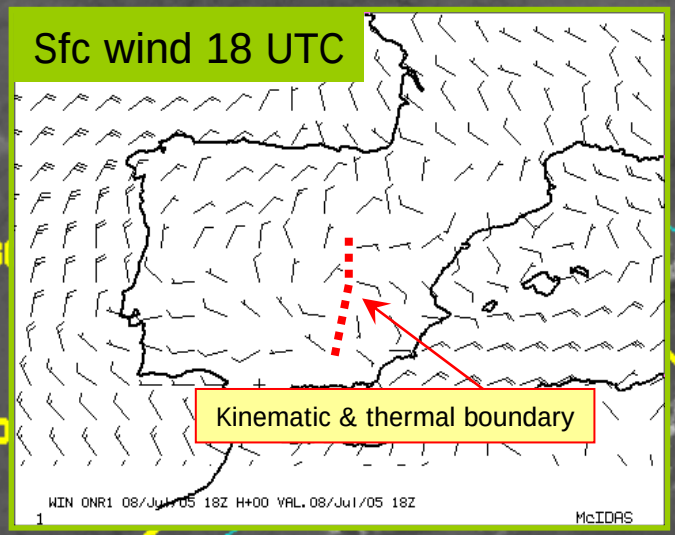

Third approach:
a nice analysis is better, but too late... ☺
anyway, very usefull to put the blame on the model after the event...
200
400
600
800
1000
1200
CAPE (SI) SFC M TIME 18Z DAY 2005189 VALID 2005189/18Z
19 0009 MSG-1 12 8 JUL 05189 180000 01341 04884 01.00

Third approach:

and to understand better the situation...
or learn from errors...

(Max CAPE && Min CIN) area

Sfc wind 18 UTC



200 400 500 600 1000 800 300

CIN (SI) SFC M TIME 18Z DAY 2005189 VALID 2005189/18Z

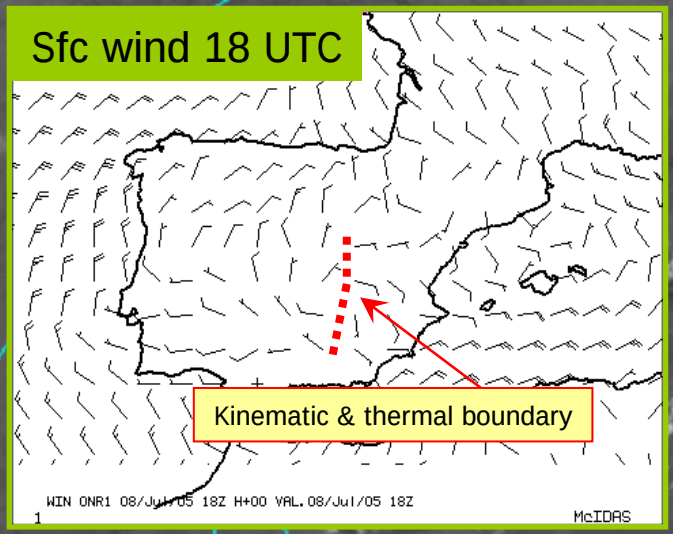
0009 MSG-1 12 8 JUL 05189 180000 01341 04884 01.00

Third approach:

and to understand better the situation...

(Max CAPE && Min CIN) area

Sfc wind 18 UTC



PFT (SID) 925 MB TIME 12Z DAY 2005189 VALID 2005189/18Z

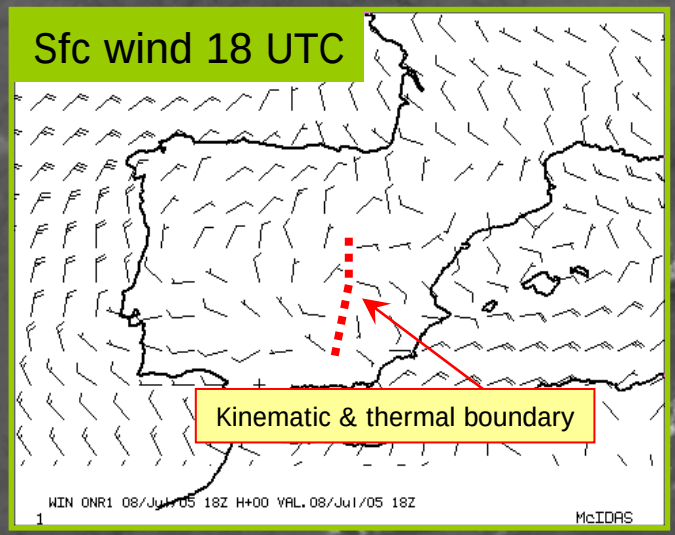
8 0009 MSG-1 12 8 JUL 05189 180000 01341 04884 01.00

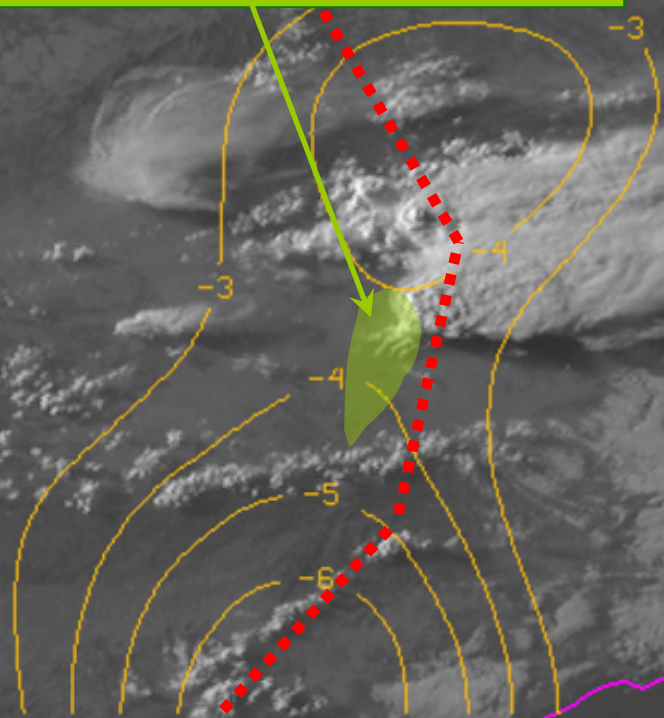
Third approach:

and to understand better the situation...

(Max CAPE && Min CIN) area

Sfc wind 18 UTC



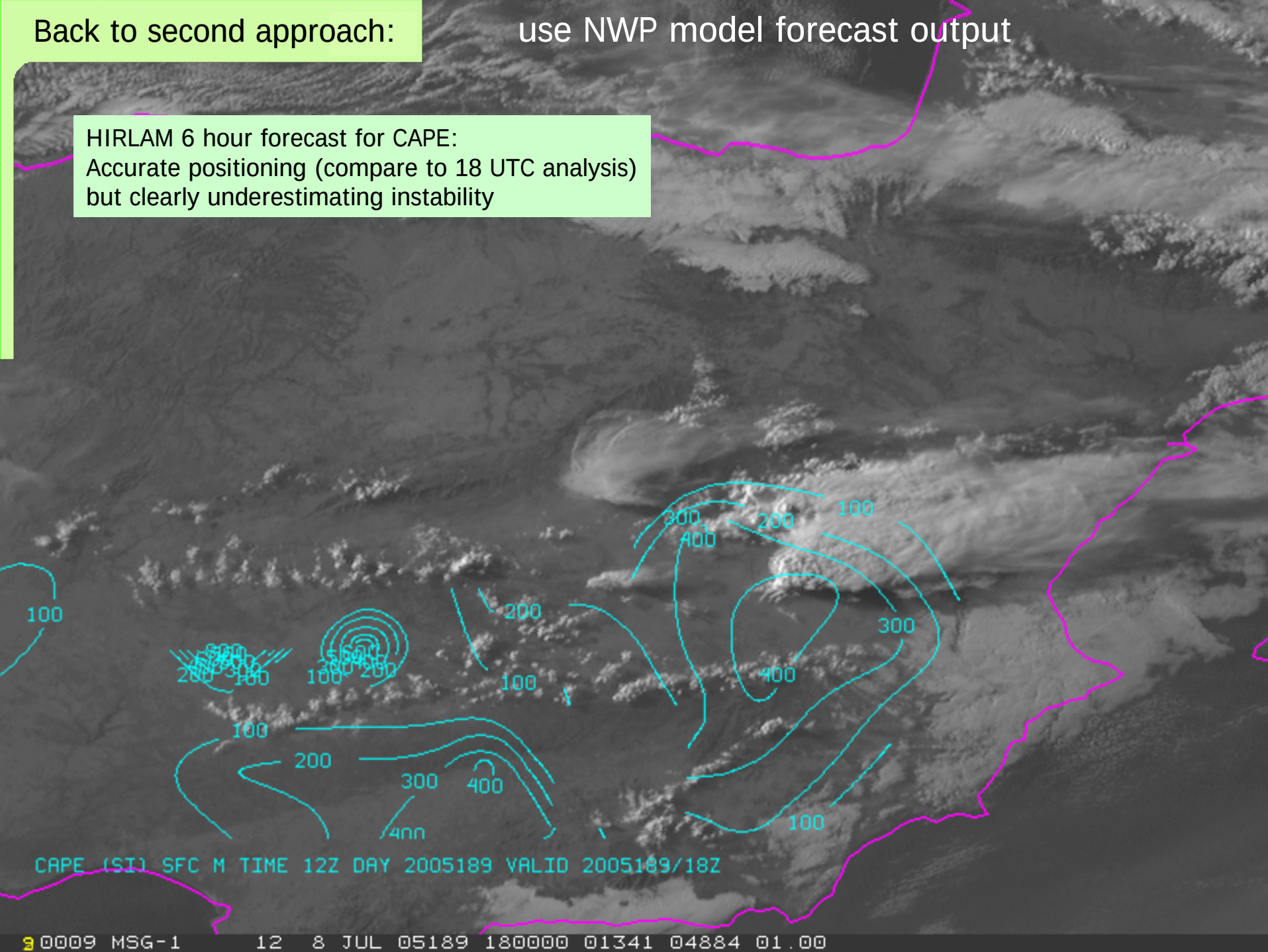


CONH (GK6H) 925 MB TIME 12Z DAY 2005189 VALID 2005189/18Z

9 0009 MSG-1 12 8 JUL 05189 180000 01341 04884 01.00

Back to second approach: use NWP model forecast output

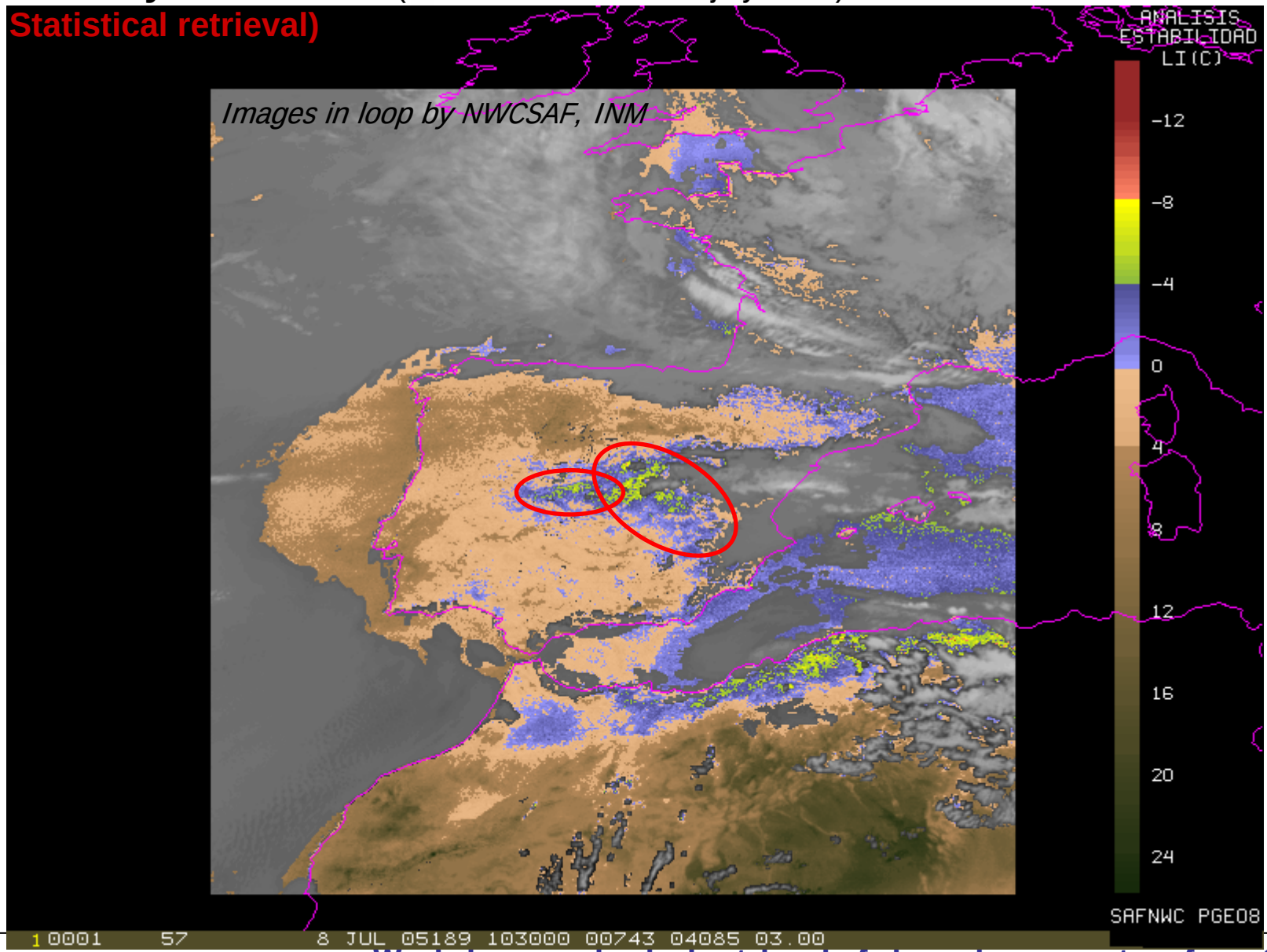
HIRLAM 6 hour forecast for CAPE:
Accurate positioning (compare to 18 UTC analysis)
but clearly underestimating instability



Fourth approach: let the satellite assess the “instability” field

Sc_1 SAI by NWCSAF: (10:30 – 12:30 UTC, 8 july 2005)

(LI, Statistical retrieval)

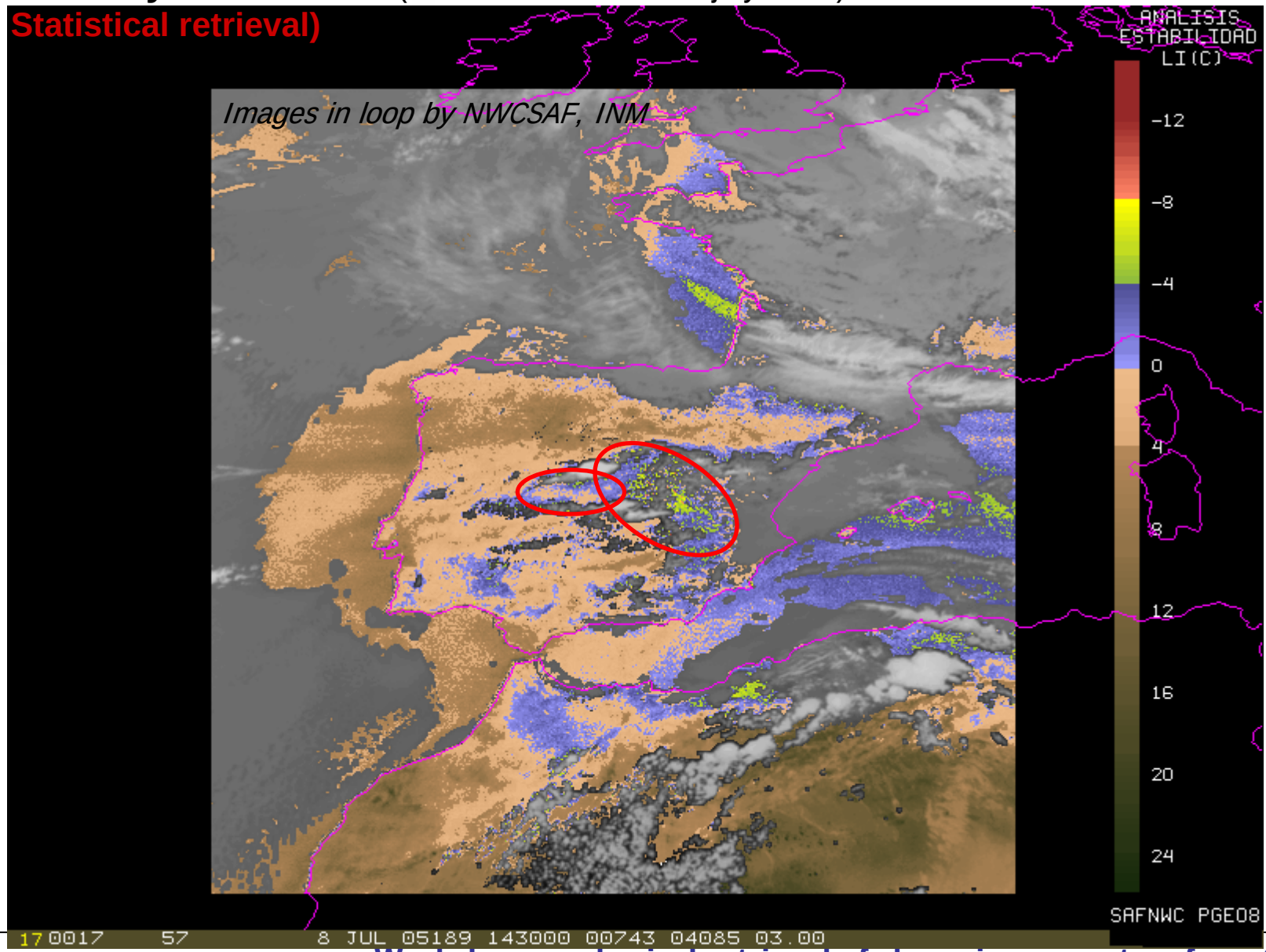


Images in loop by NWCSAF, INM

Fourth approach: let the satellite assess the “instability” field

Sc_1 SAI by NWCSAF: (14:30 – 12:15 UTC, 8 july 2005)

(LI, Statistical retrieval)

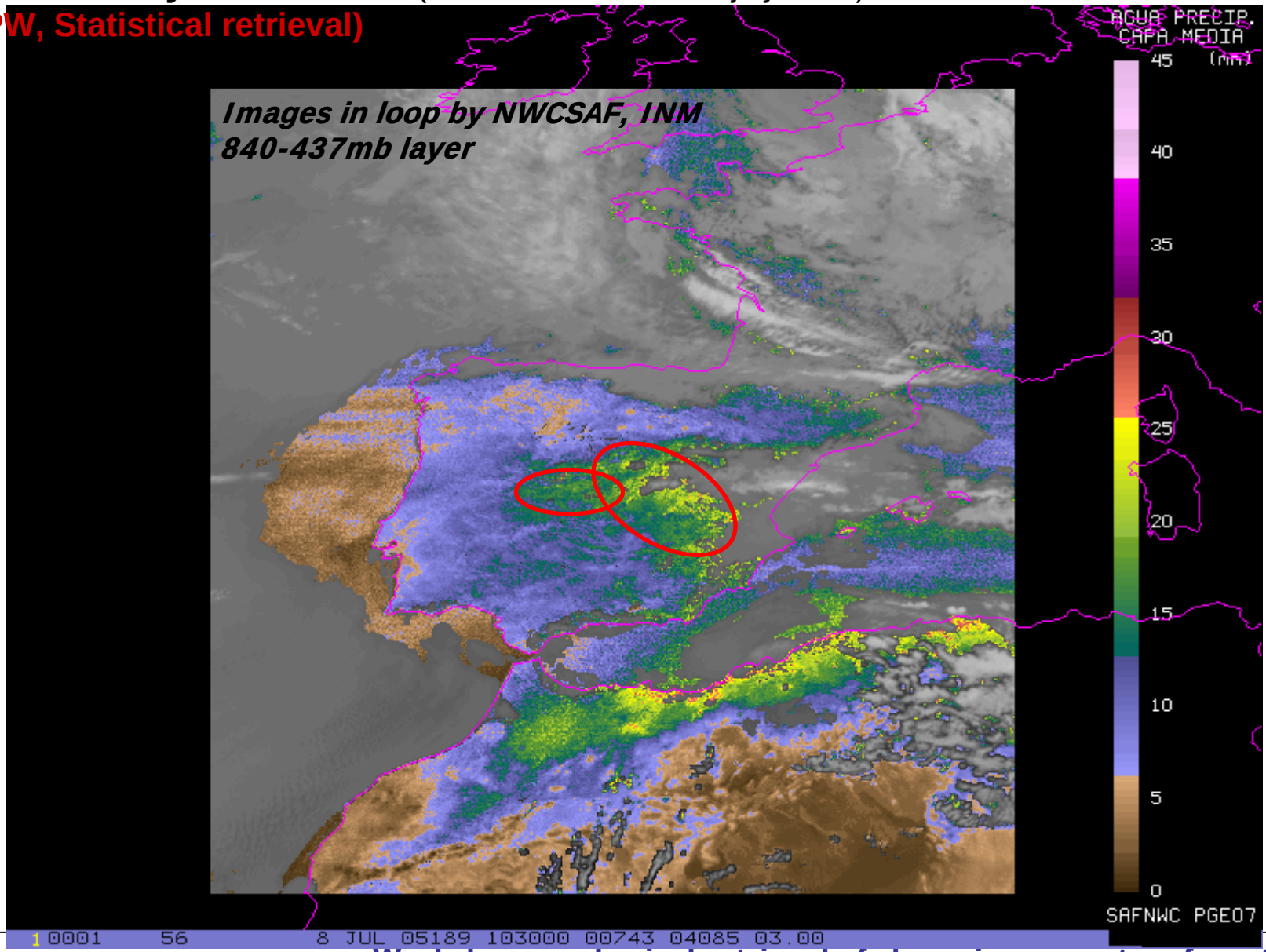


Images in loop by NWCSAF, INM

Fourth approach: vertically integrated moisture retrieved from satellite

Sc_1 LPW by NWCSAF: (10:30 – 13:30 UTC, 8 july 2005)

(LPW, Statistical retrieval)

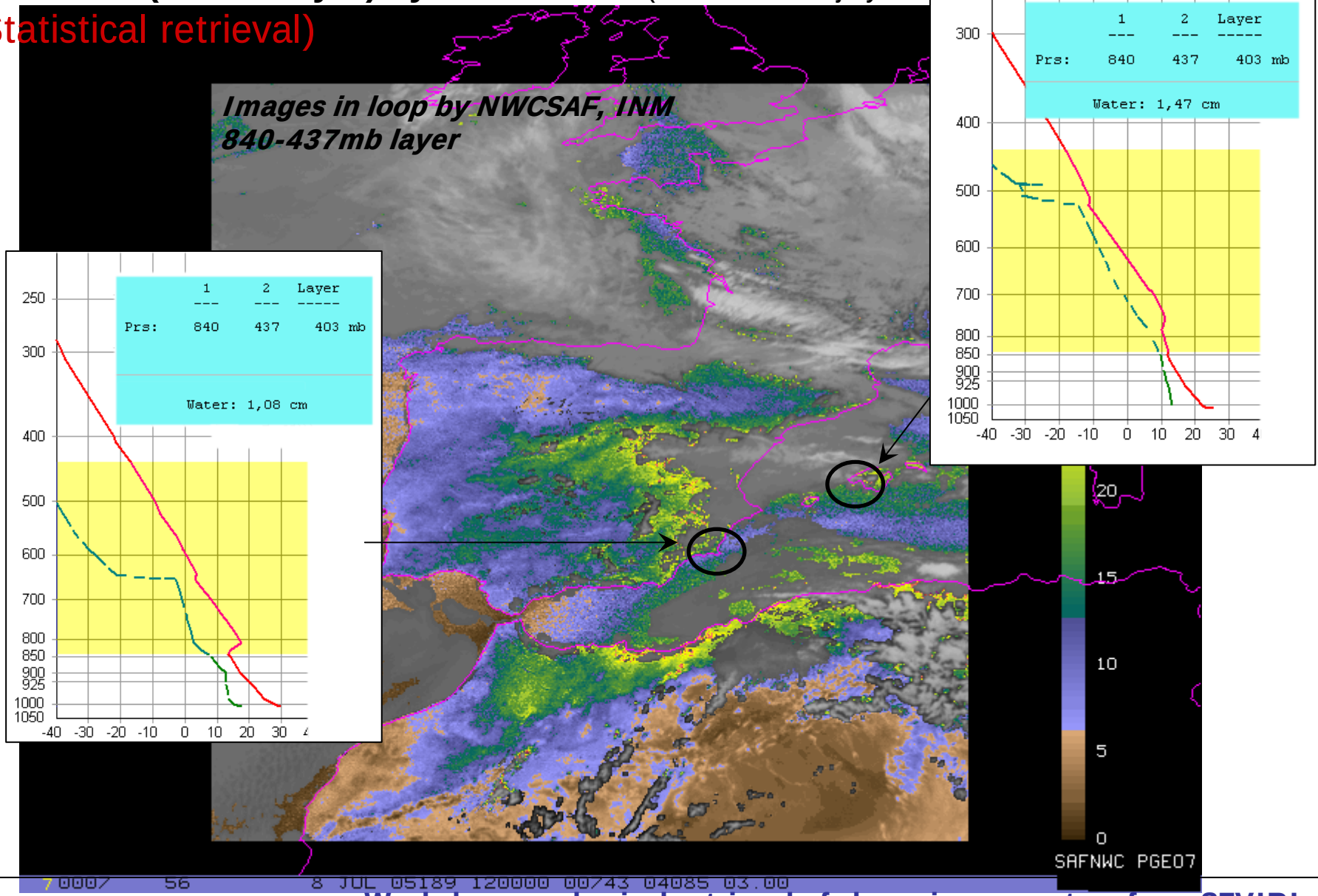


Images in loop by NWCSAF, INM
840-437mb layer

Fourth approach: vertically integrated moisture retrieved from satellite

Sc_1 LPW (middle layer) by NWCSAF: (12:00 UTC, 8 july 200

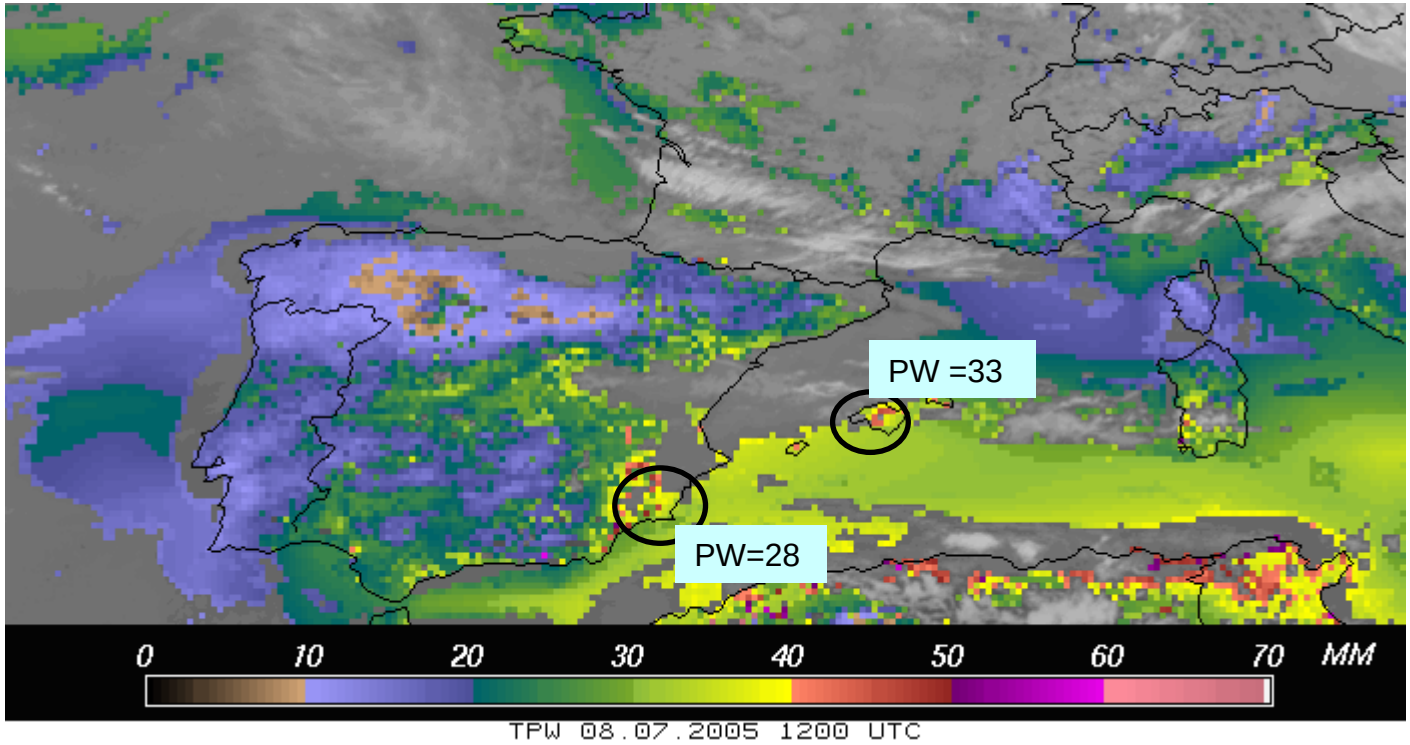
(Statistical retrieval)



Fourth approach: vertically integrated moisture retrieved from satellite

Sc_1 PW by Eumetsat: (12:00 UTC, 8 july 2005)

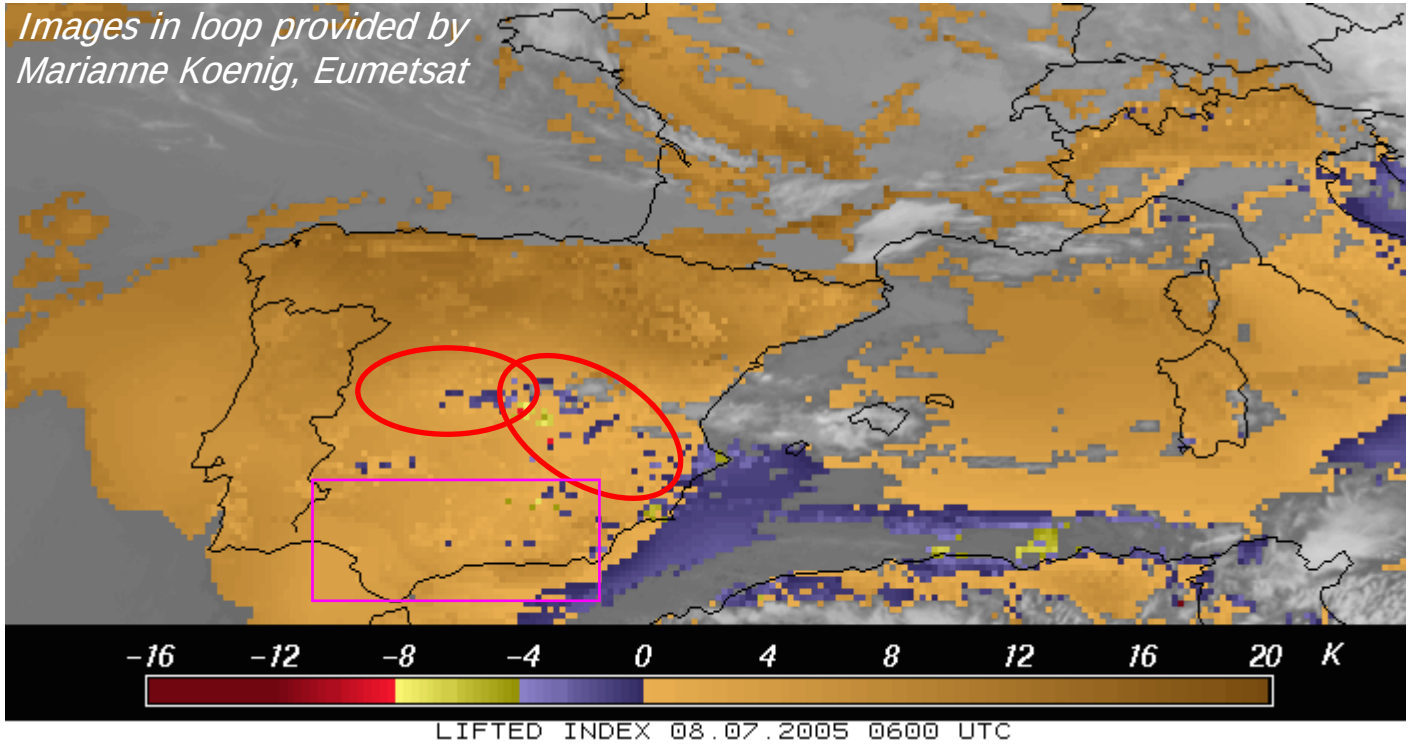
(Physical retrieval)



Fith approach: satellite working together with a model forecast

Sc_1 GII by Eumetsat: (06:00 – 19:00 UTC, 8 july 2005)

(LI, Physical retrieval)

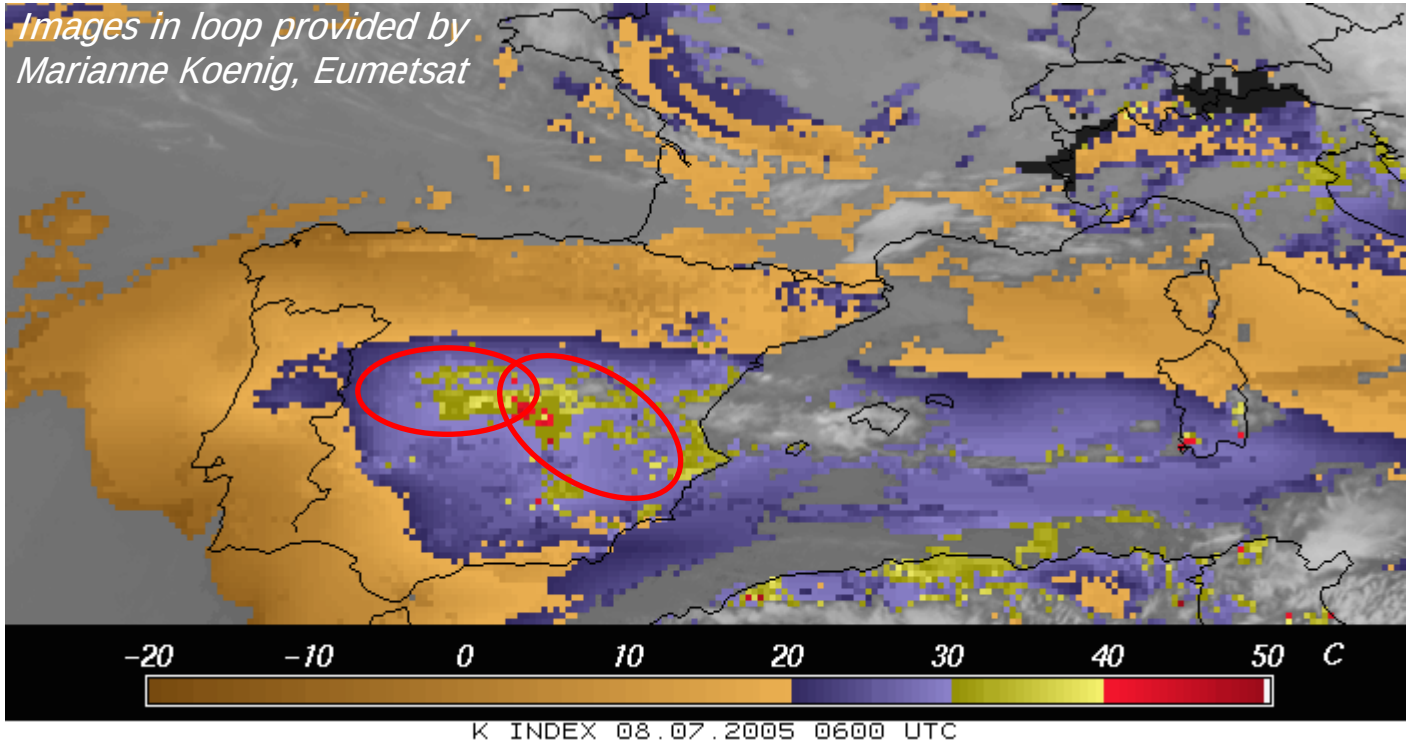


Good accuracy when the model is performing well

Fith approach: satellite working together with a model forecast

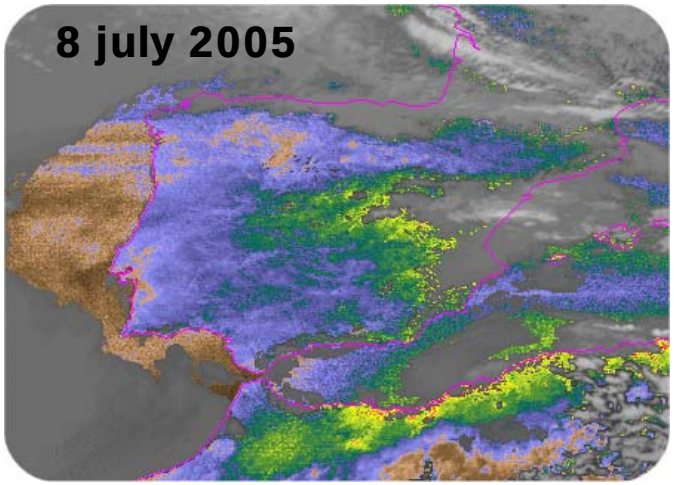
Sc_1 GII by Eumetsat: (06:00 – 19:00 UTC, 8 july 2005)

(KI, Physical retrieval)



Good accuracy when the model is performing well

Comments for Sc_1 event:



Statistical retrieval:

LI: seem to focus instability areas properly
get "switched off" very early (and rapidly)

LPW: slightly overestimate medium layer PW,
but focus it properly

Physical retrieval:

LI: Seem to focus instability areas properly. Very noisy. Do not show a decrease in values as evening get closer

KI: Seem to focus instability areas properly. Smother and more stable field as expected (not dependance on sfc parameters)

PW: overestimate total PW, but focus it properly

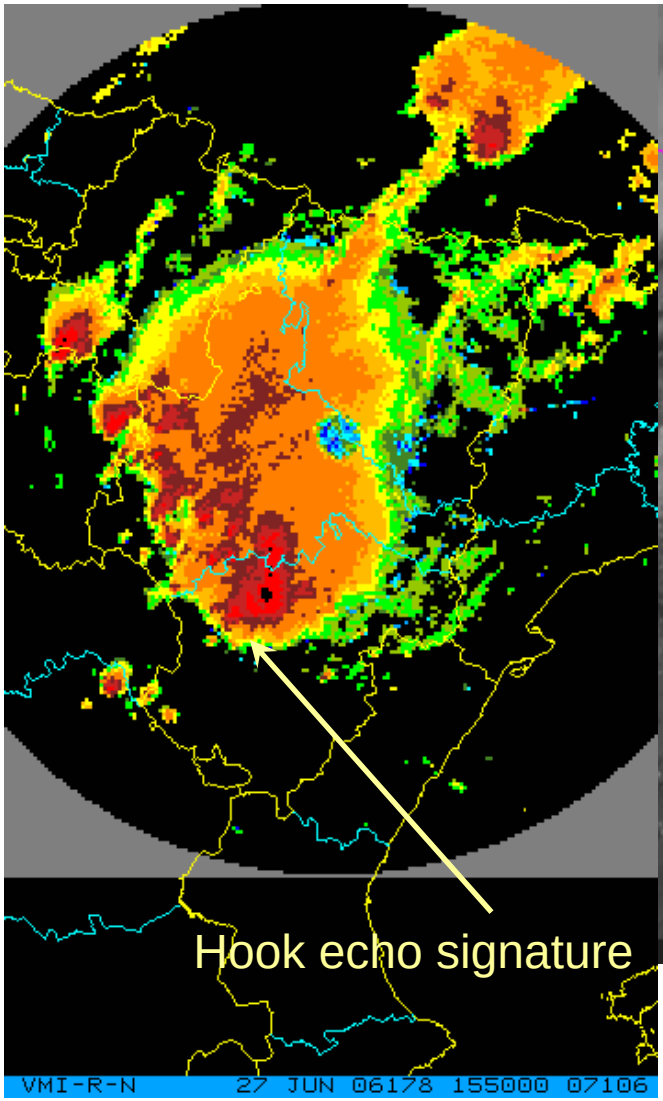
The events (Sc_2):

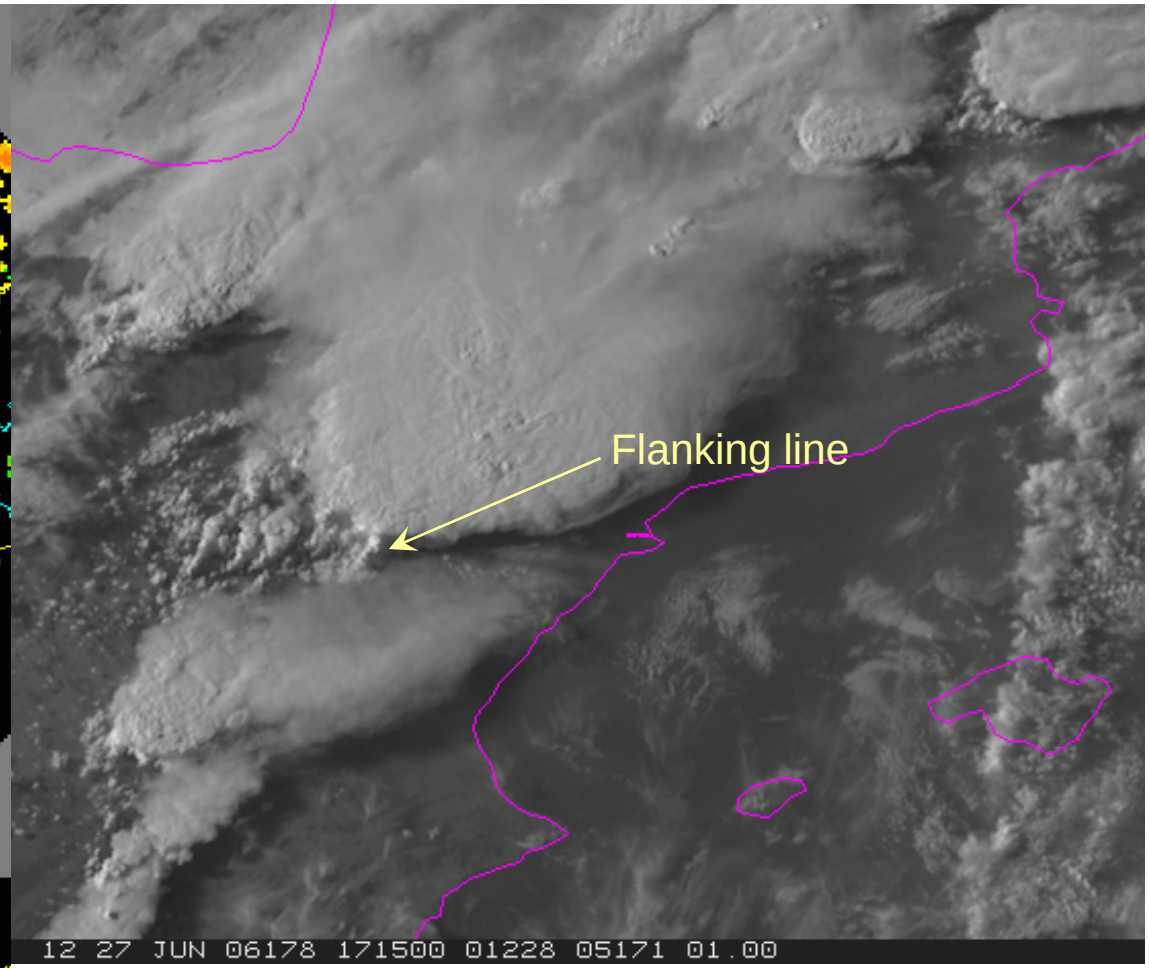
- **27 june 2006:** 3 hours long lasting cyclonic classic type supercell embedded in a multicell system, moving from W to E

  Motion type: Right mover

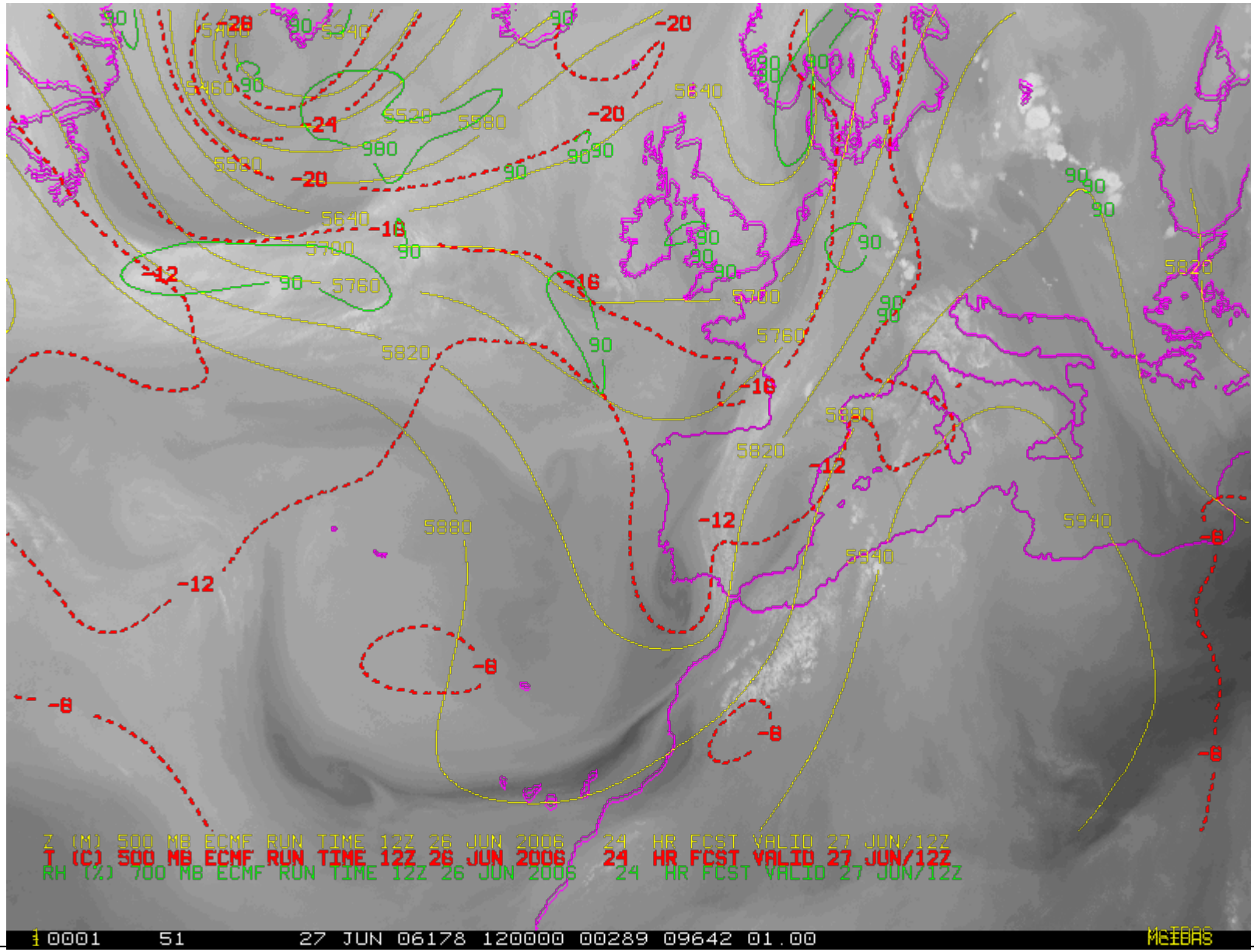
  Surface weather: Large hail, heavy rain

Sc_2 supercell signatures:

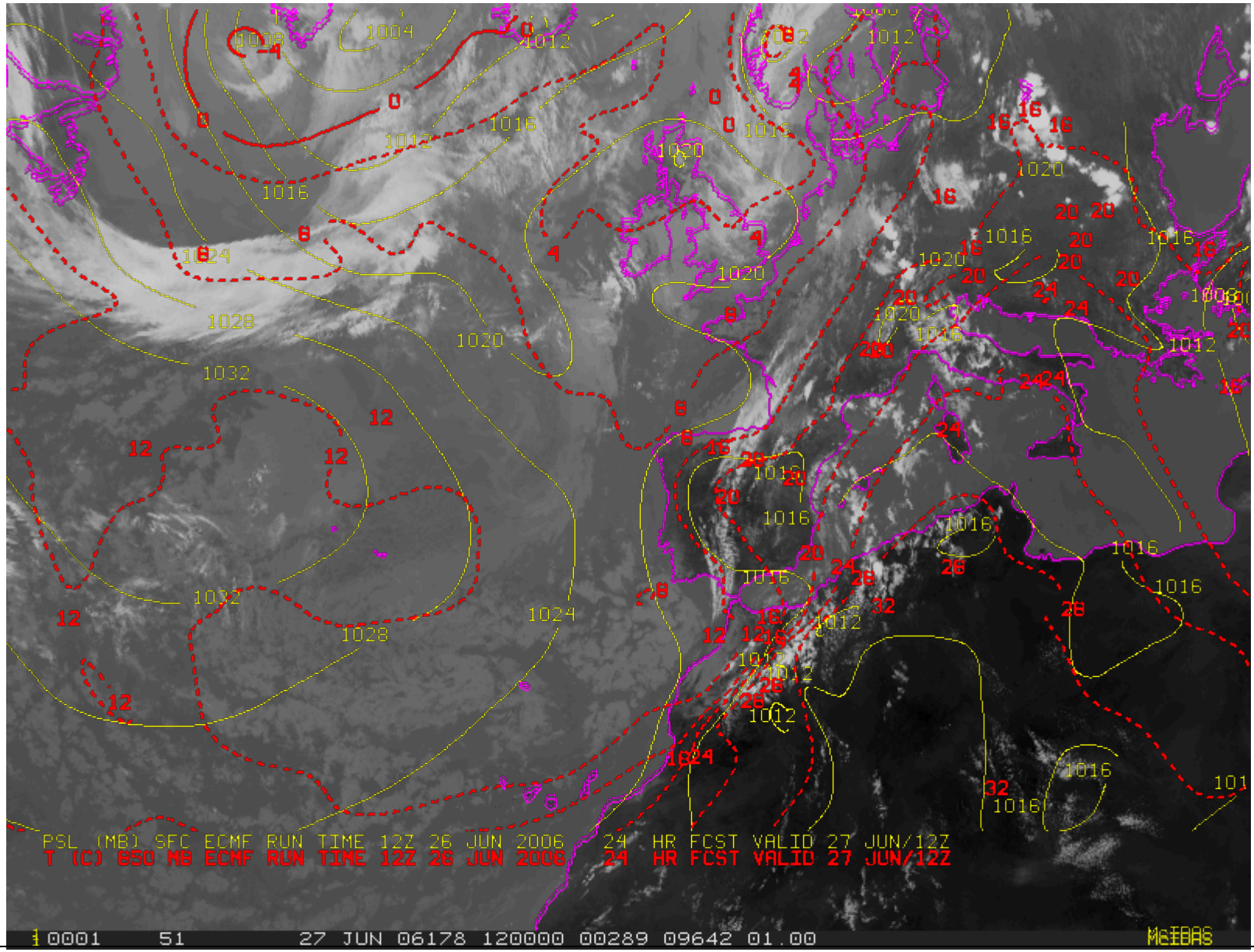




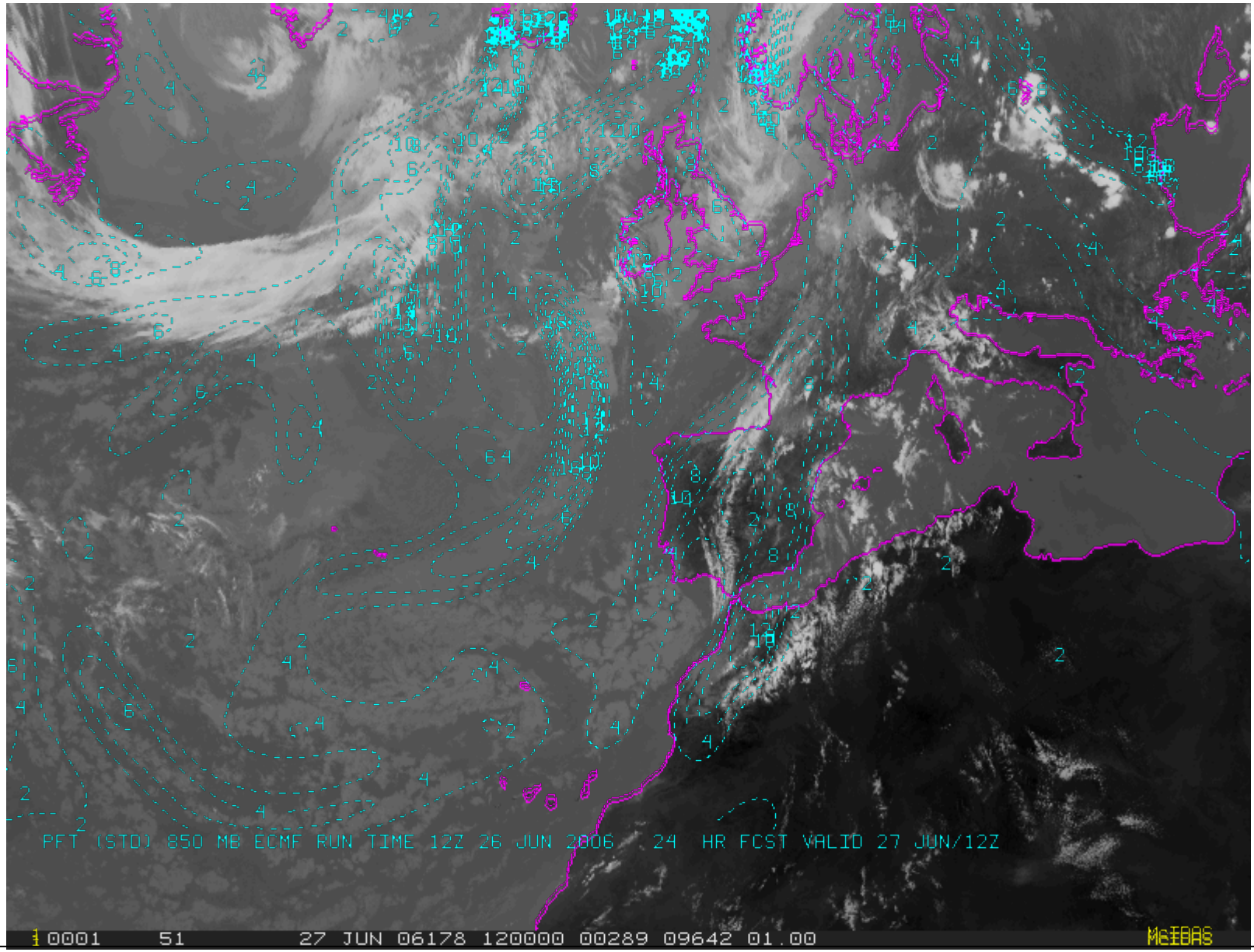
Sc_2 synoptic setting: (27 june 2006, 12 UTC)



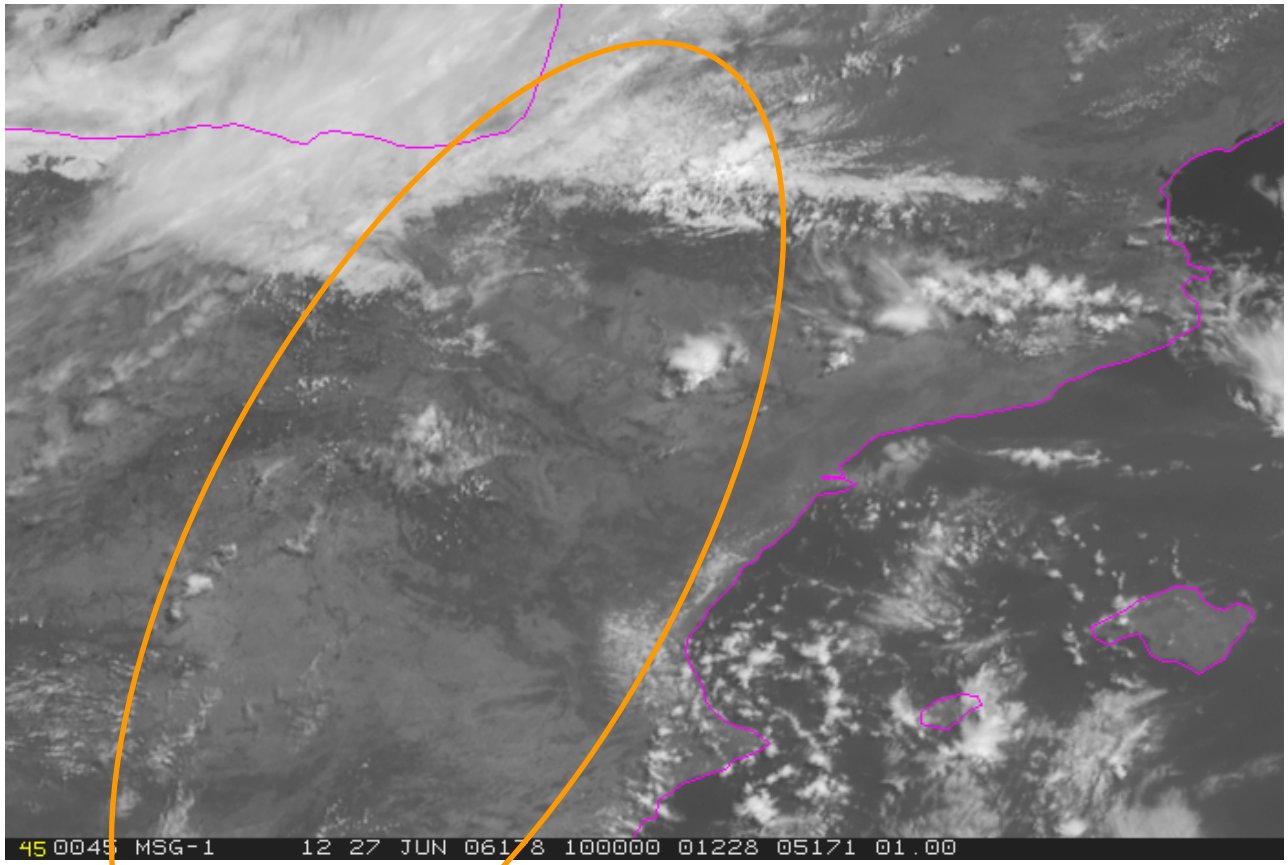
Sc_2 synoptic setting: (27 june 2006, 12 UTC)



Sc_2 synoptic setting: (27 june 2006, 12 UTC)

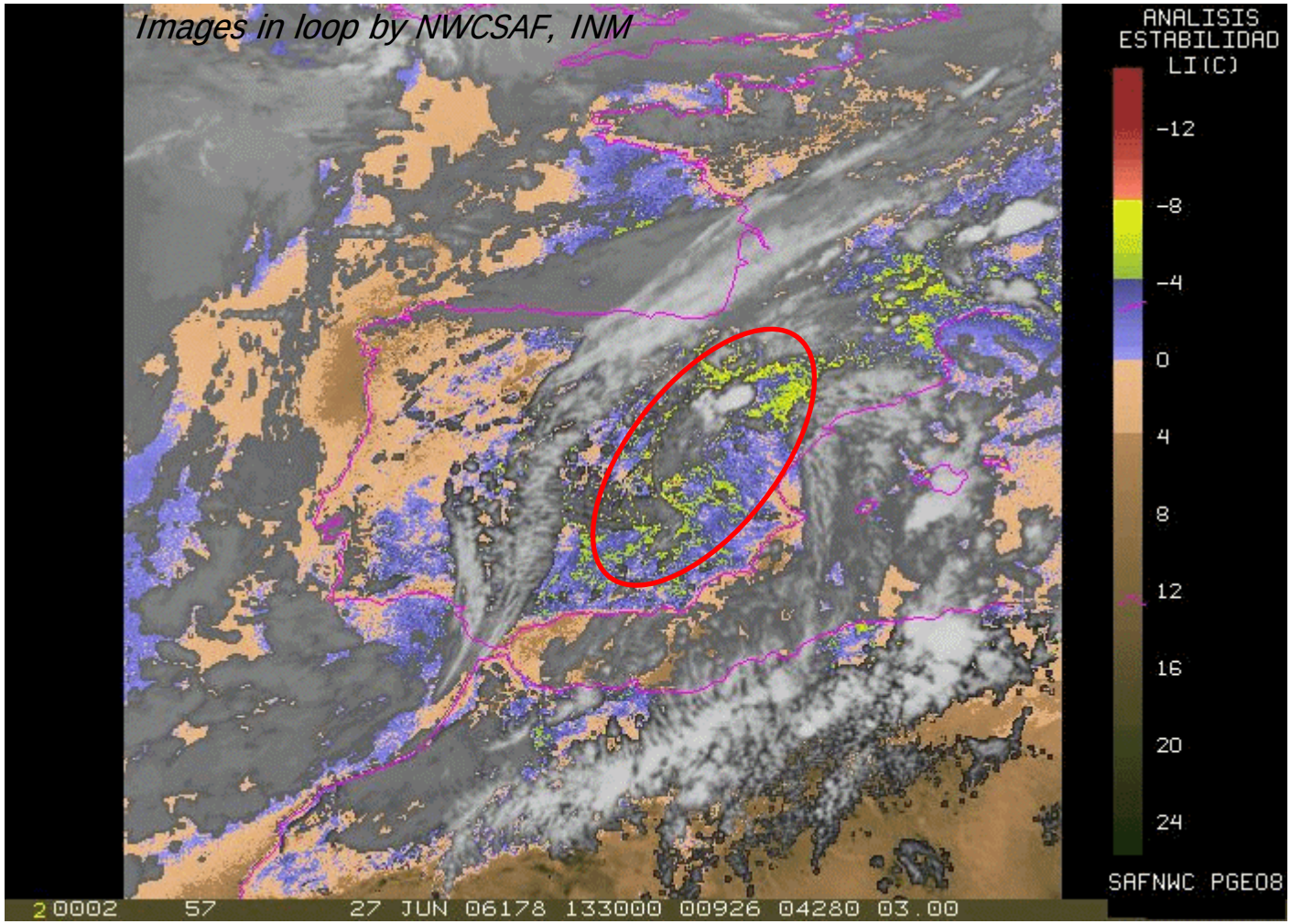


Sc_2 MSG HRV loop: (27 june 2006, 10:00 to 19:15 UTC)



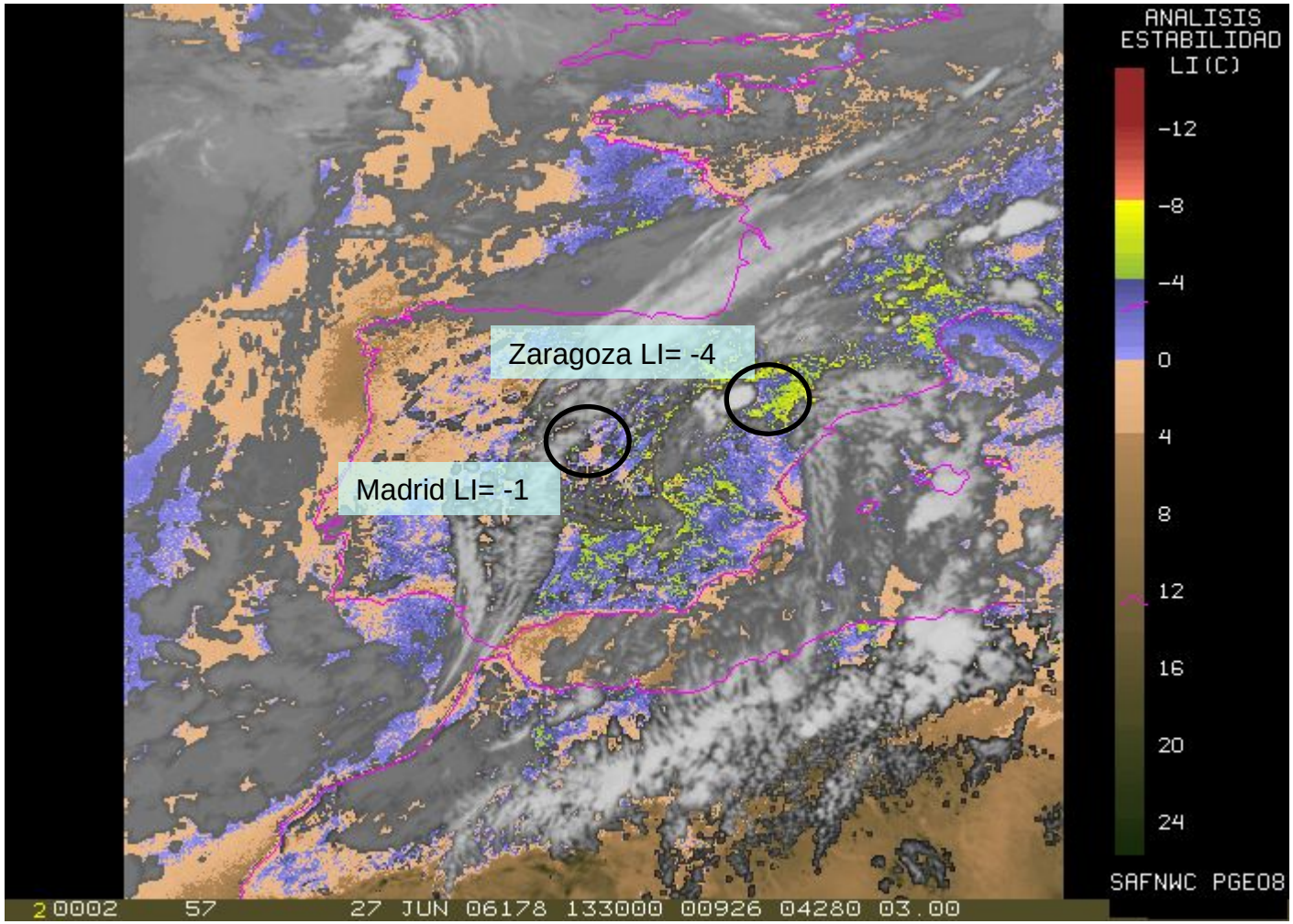
NWCSAF “instability” area

Sc_2 pre - convective "instability" by NWCSAF: (13:30 -16:30 UTC, 27 june 2006)
(LI, Statistical retrieval)

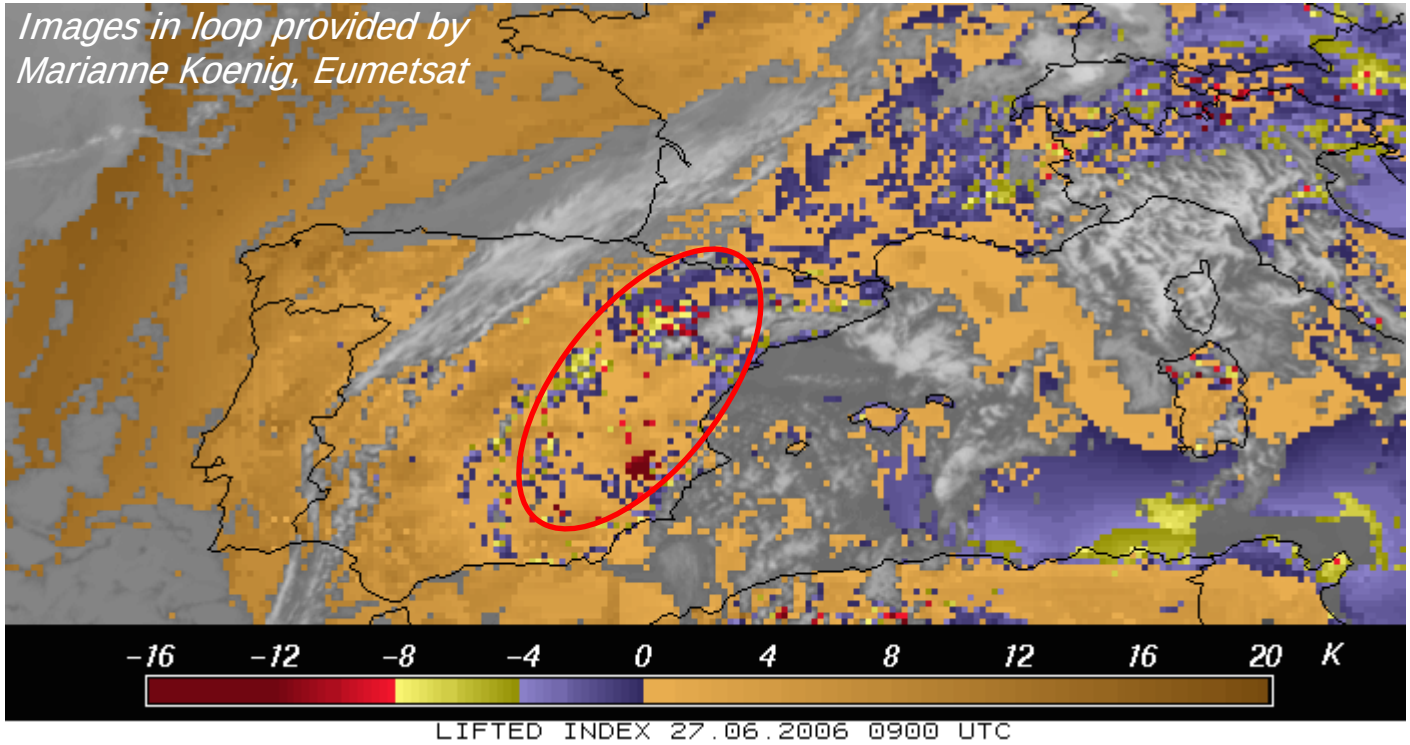


Sc_2 pre - convective “instability” by NWCSAF: (13:30 UTC, 27 june 2006)

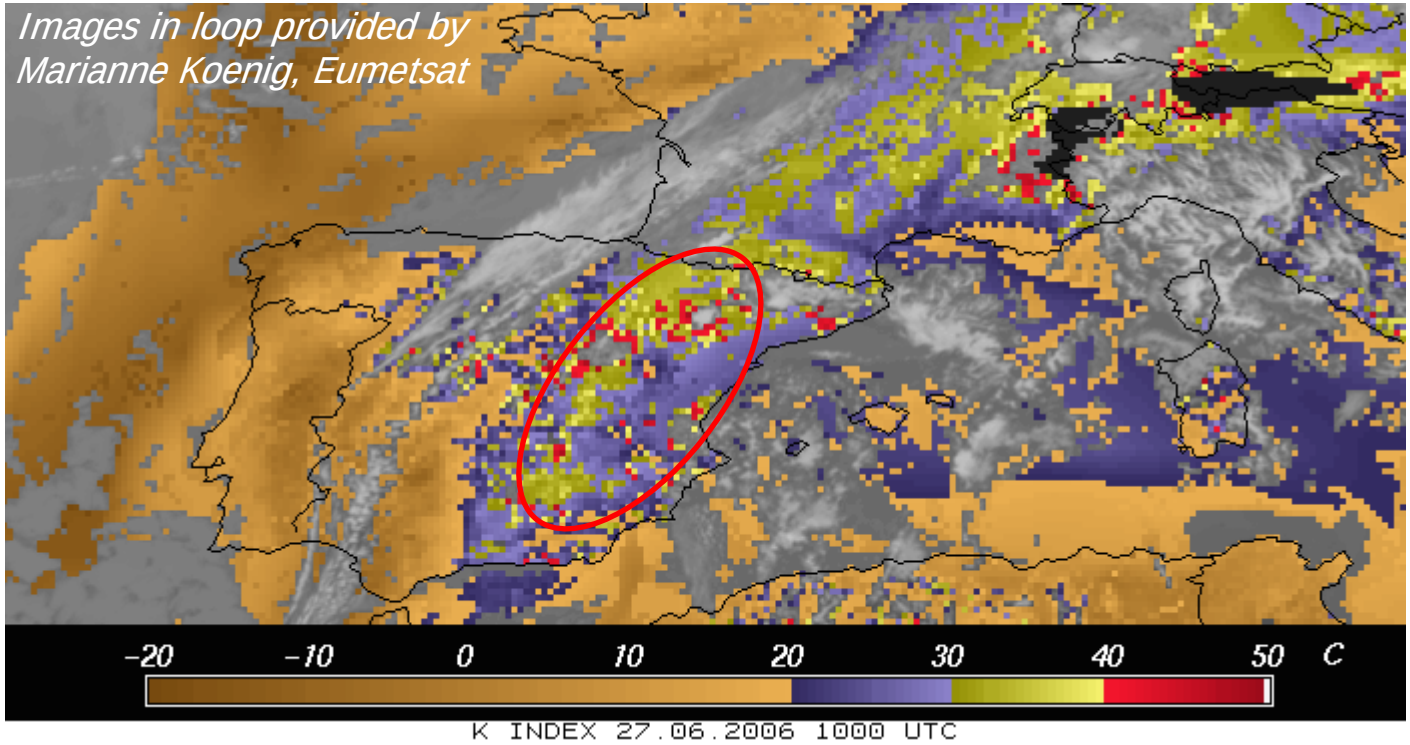
(LI, Statistical retrieval)



Sc_2 pre - convective instability by EUMETSAT GII: (09:00 – 17:00 UTC, 27 june 2006)
(LI, Physical retrieval)

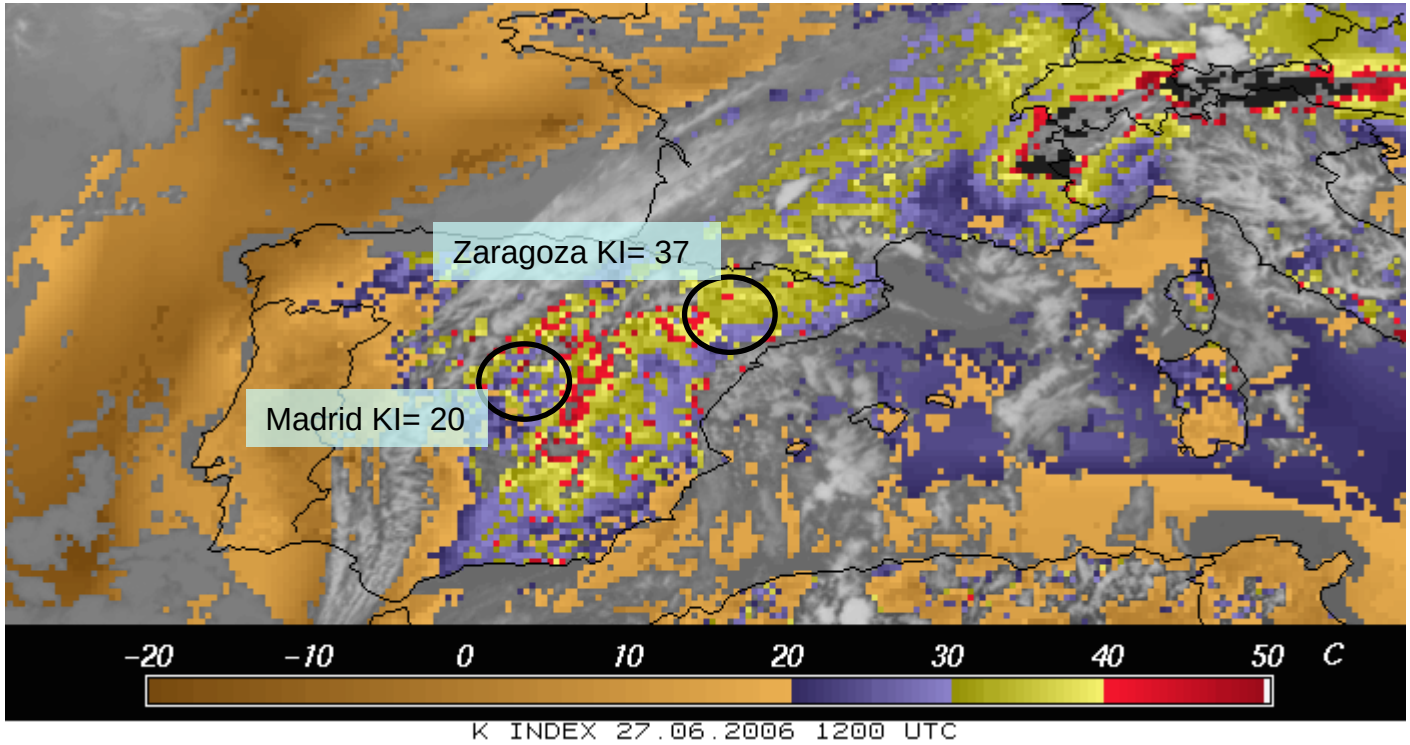


Sc_2 pre - convective instability by EUMETSAT GII: (09:00 – 17:00 UTC, 27 june 2006)
(KI, Physical retrieval)



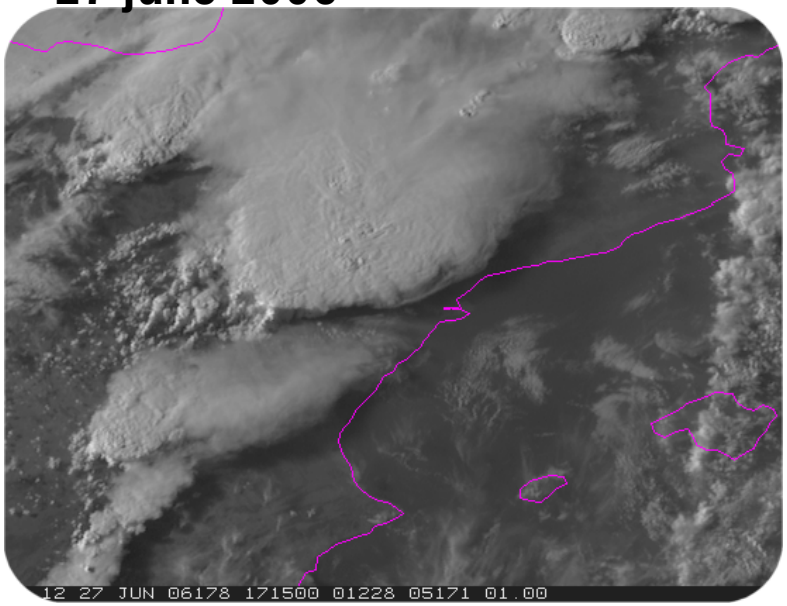
Sc_2 pre - convective instability by EUMETSAT GII: (12:00 UTC, 27 june 2006)

(KI, Physical retrieval)



Comments for Sc_2 event:

27 june 2006



Statistical retrieval:

LI: seem to focus instability areas properly, also accurate in values when compared to soundings.
Again, get “switch off” very early

Physical retrieval:

LI: Seem to focus instability areas properly. Very noisy.

KI: Seem to focus instability areas properly. Smother and more stable field as expected (not dependance on sfc parameters)

The events (Sc_3):

- **23 may 2007:**

4 hours long lasting isolated cyclonic HP type supercell slightly moving from S to N.

Motion type: nearly stationary

Surface weather: Large hail and flooding (up to 240 mm in 6h)

The events (Sc_3):

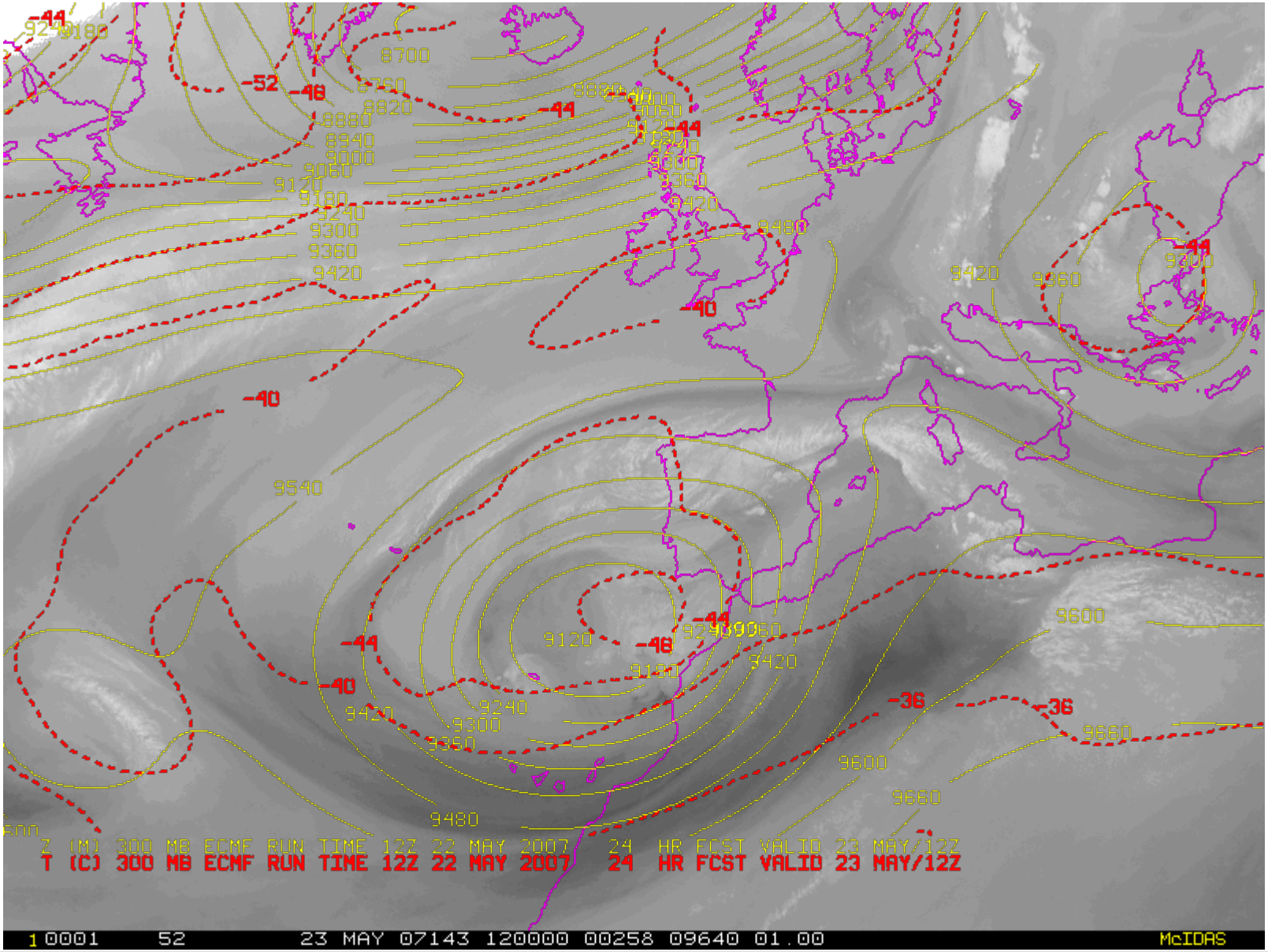
- **23 may 2007:**

4 hours long lasting isolated cyclonic HP type supercell slightly moving from S to N.

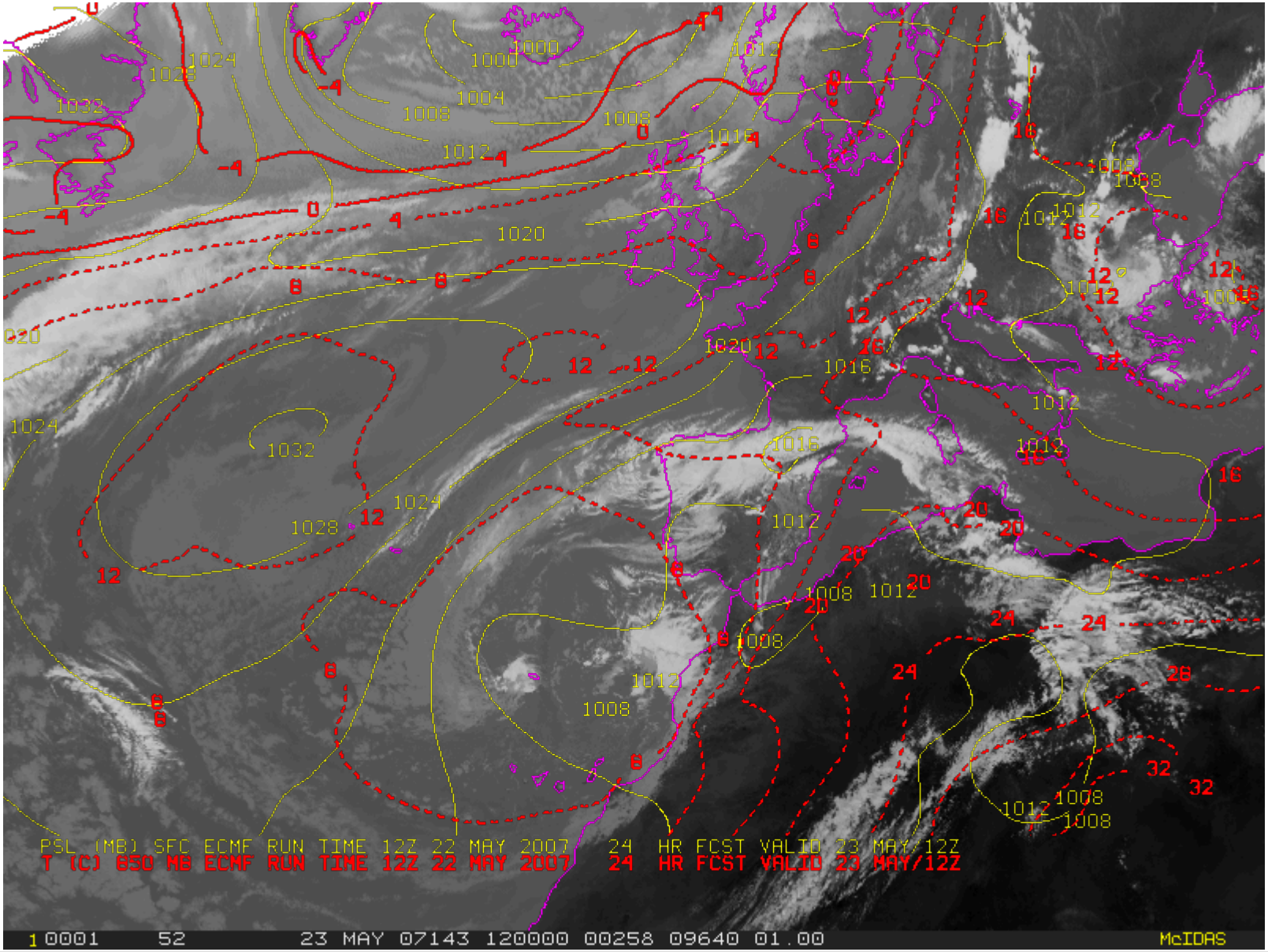
Motion type: nearly stationary

Surface weather: Large hail and flooding (up to 240 mm in 6h)

Sc_3 synoptic setting:



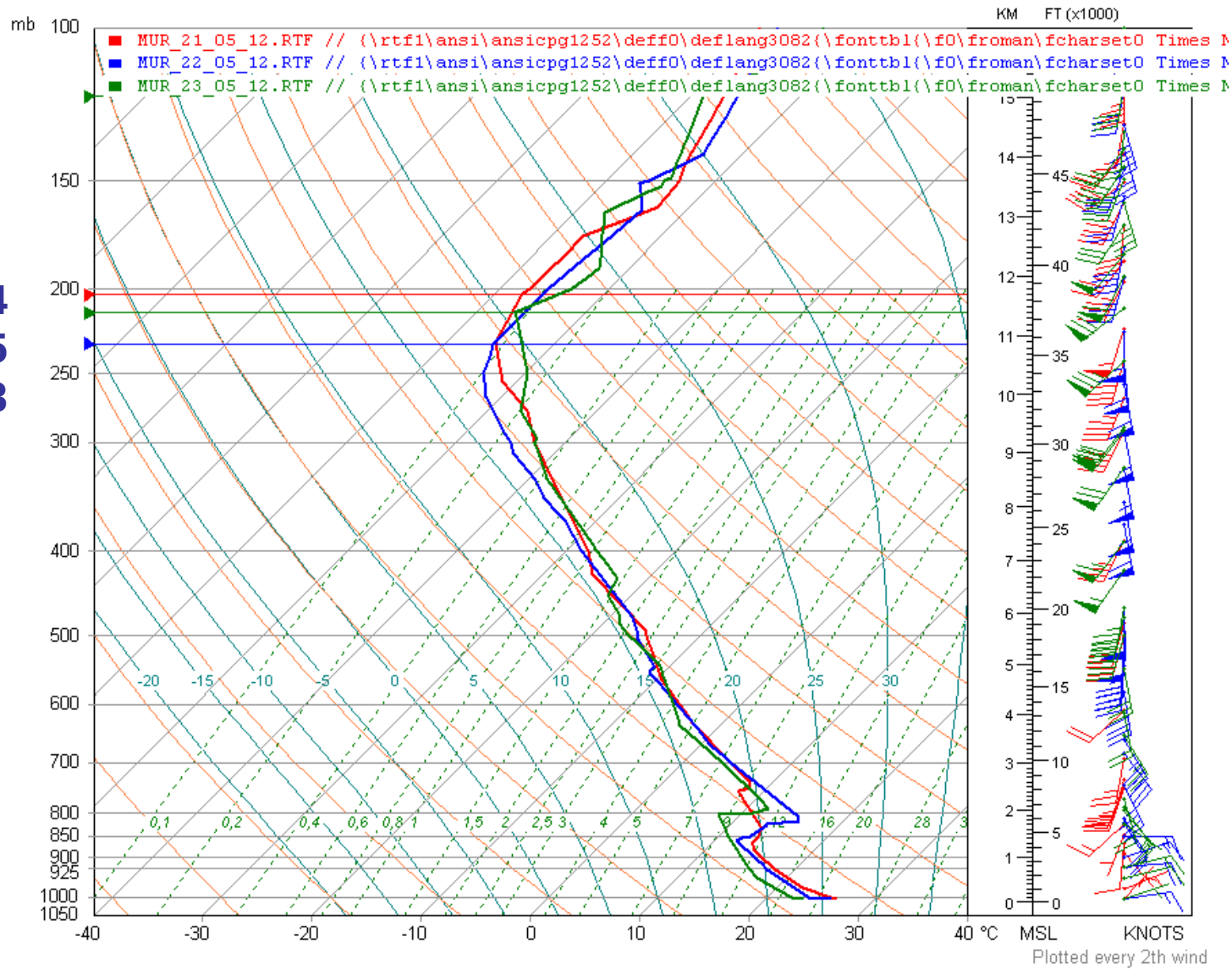
Sc_3 synoptic setting:



Air mass T. Profile over Murcia: (from observed soundings at 12 UTC, 21 - 23 may 2007)

LI observed values:

21/05/12Z: **- 5.4**
22/05/12Z: **- 7.5**
23/05/12Z: **- 5.3**

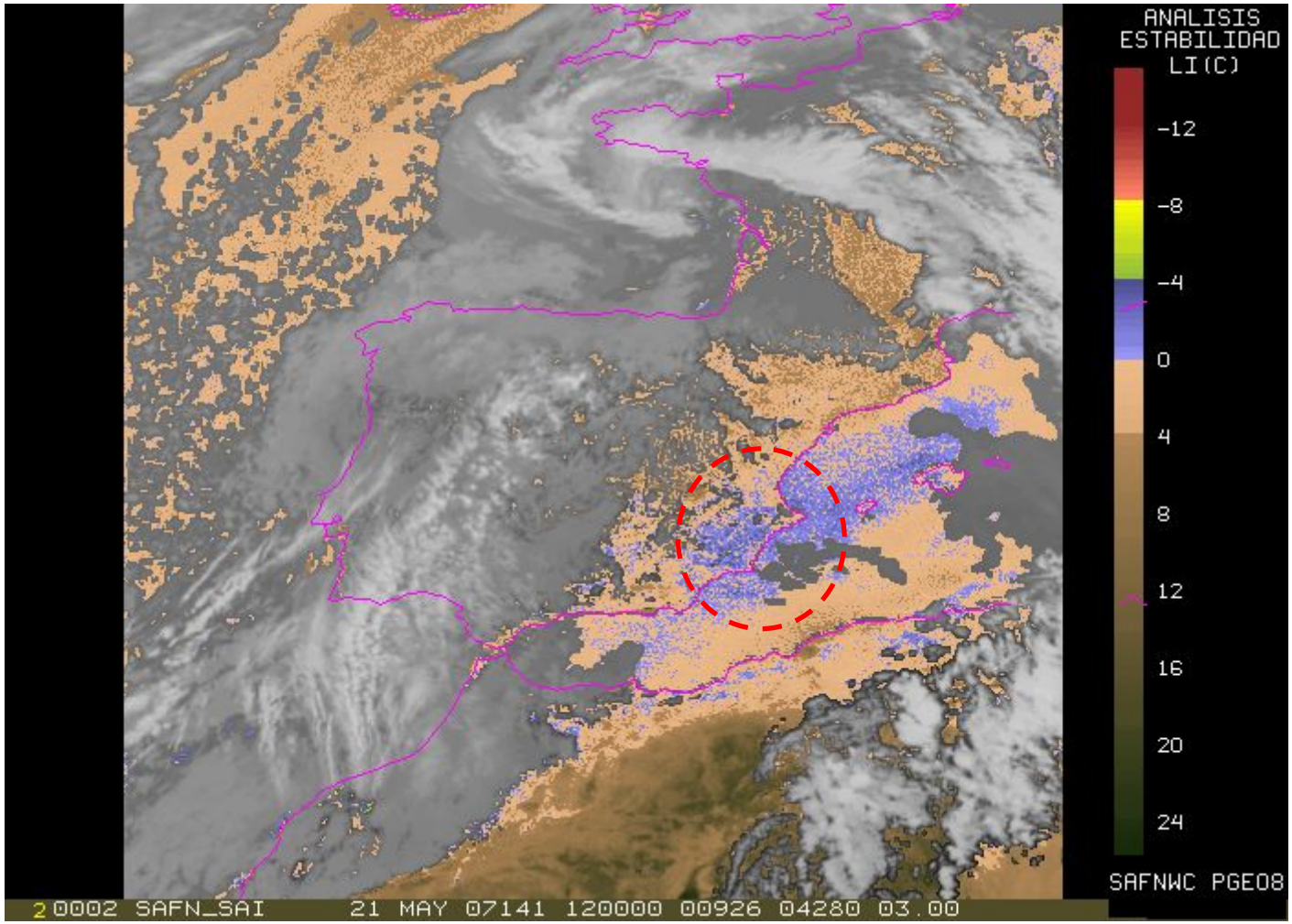


Pre – convective instability by NWCSAF: (12 UTC, 21 may 2007)

(LI, Statistical retrieval)

LI observed at Murcia:

21/05/12Z: **- 5.4**

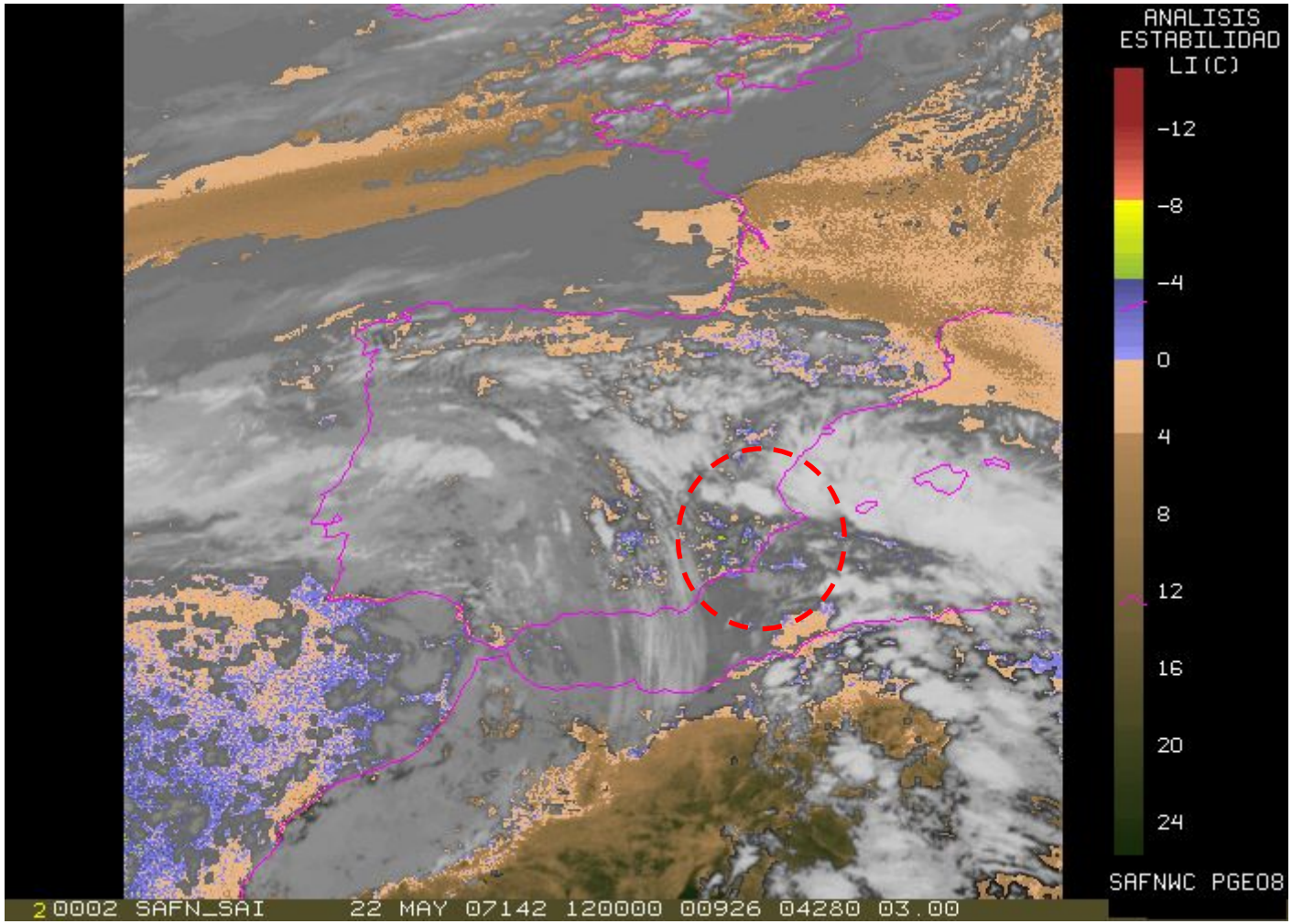


Pre – convective instability by NWCSAF: (12 UTC, 22 may 2007)

(LI, Statistical retrieval)

LI observed at Murcia:

22/05/12Z: **- 7.5**

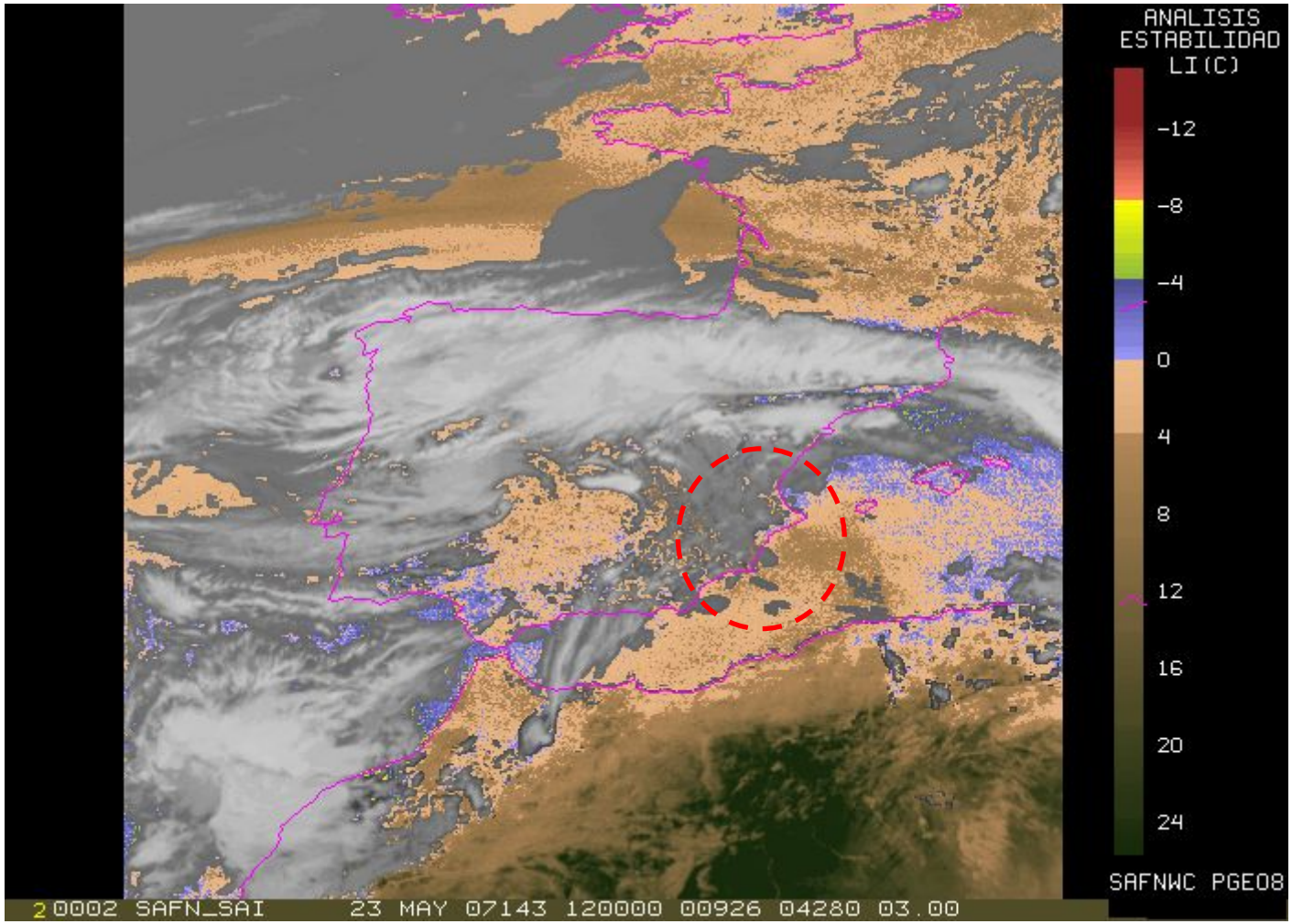


Pre – convective instability by NWCSAF: (12 UTC, 23 may 2007)

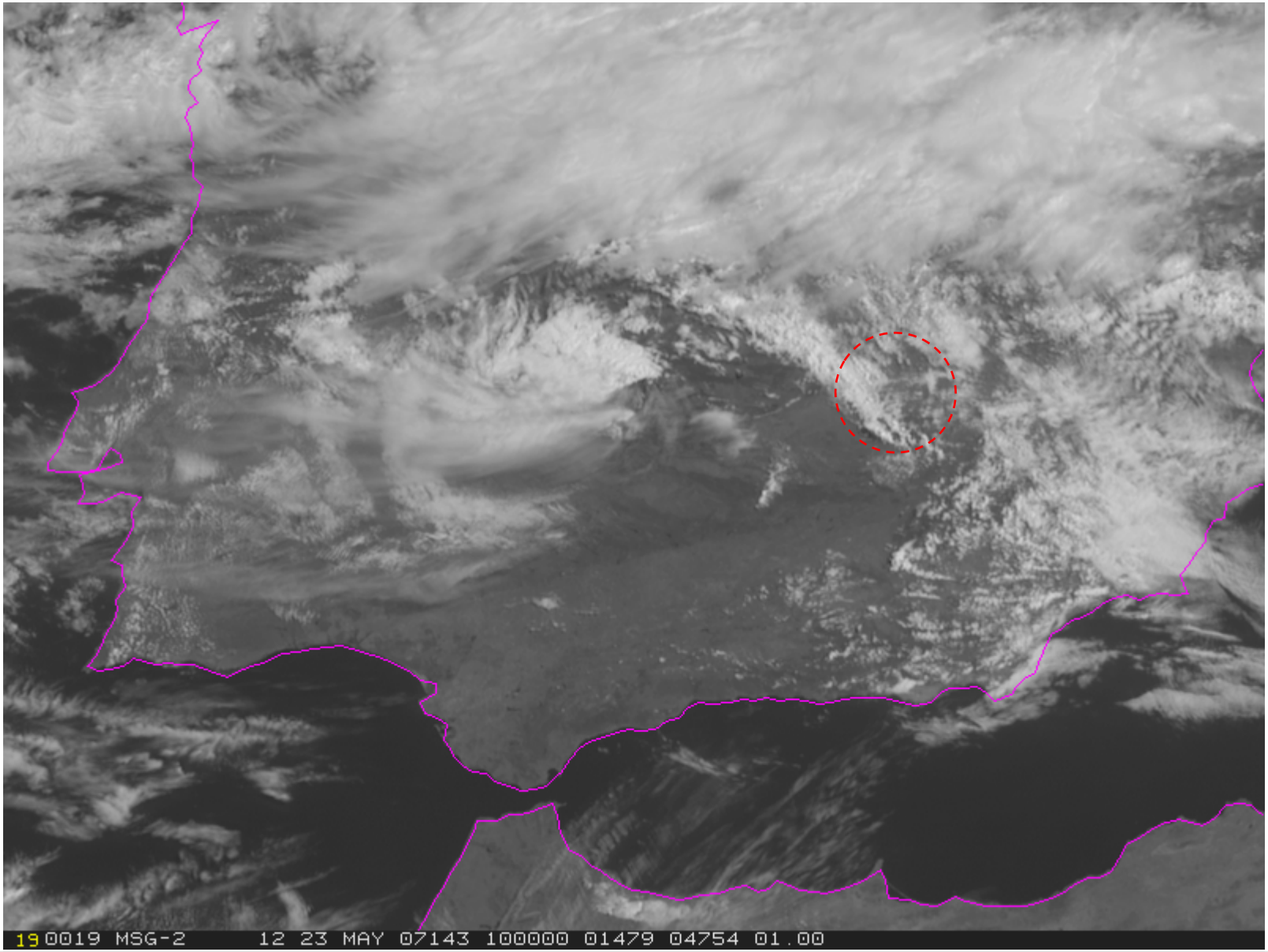
(LI, Statistical retrieval)

LI observed at Murcia:

23/05/12Z: **- 5.3**

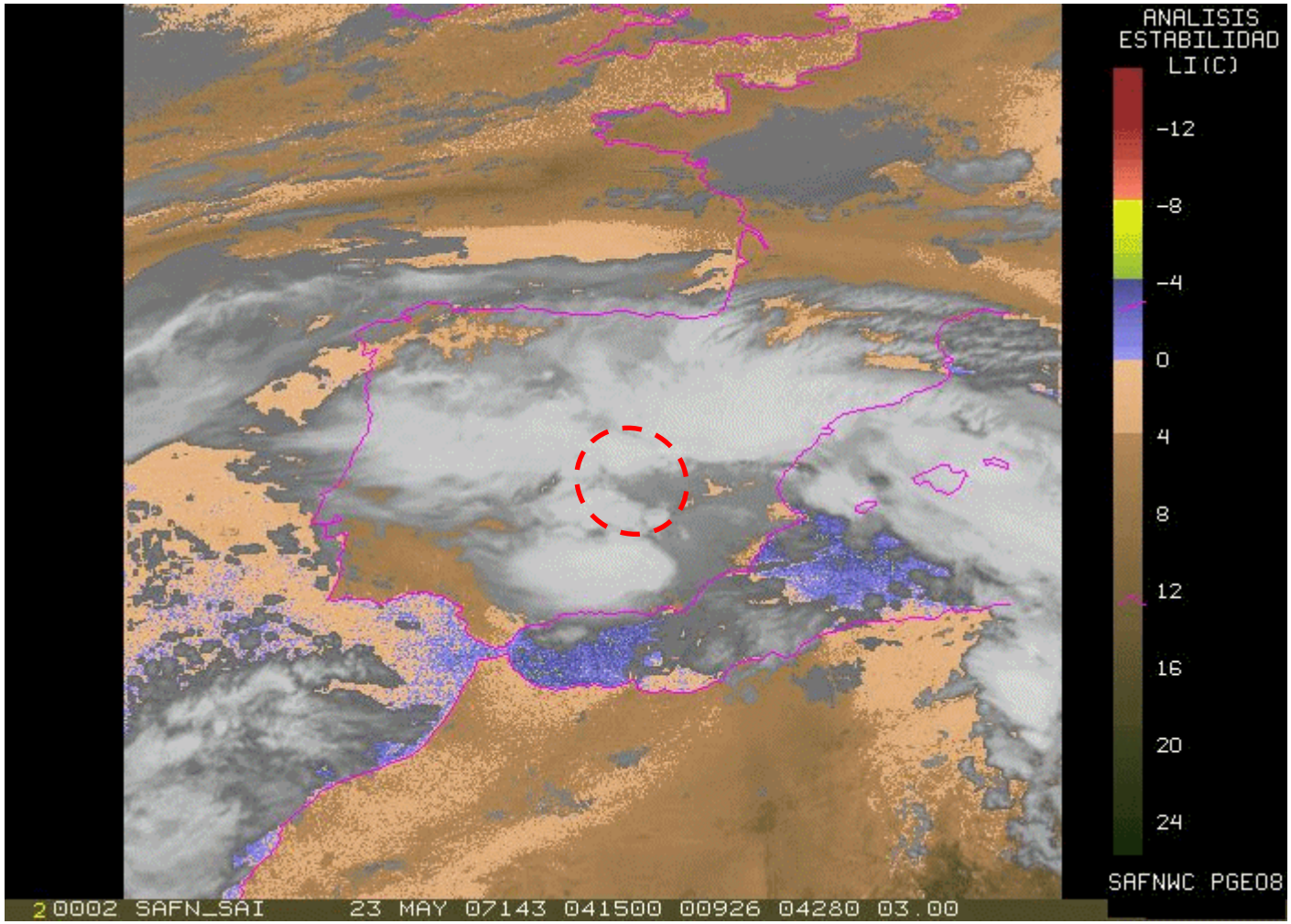


Sc_3 hrv loop: (04:15 – 20:00 UTC, 23 may 2007)

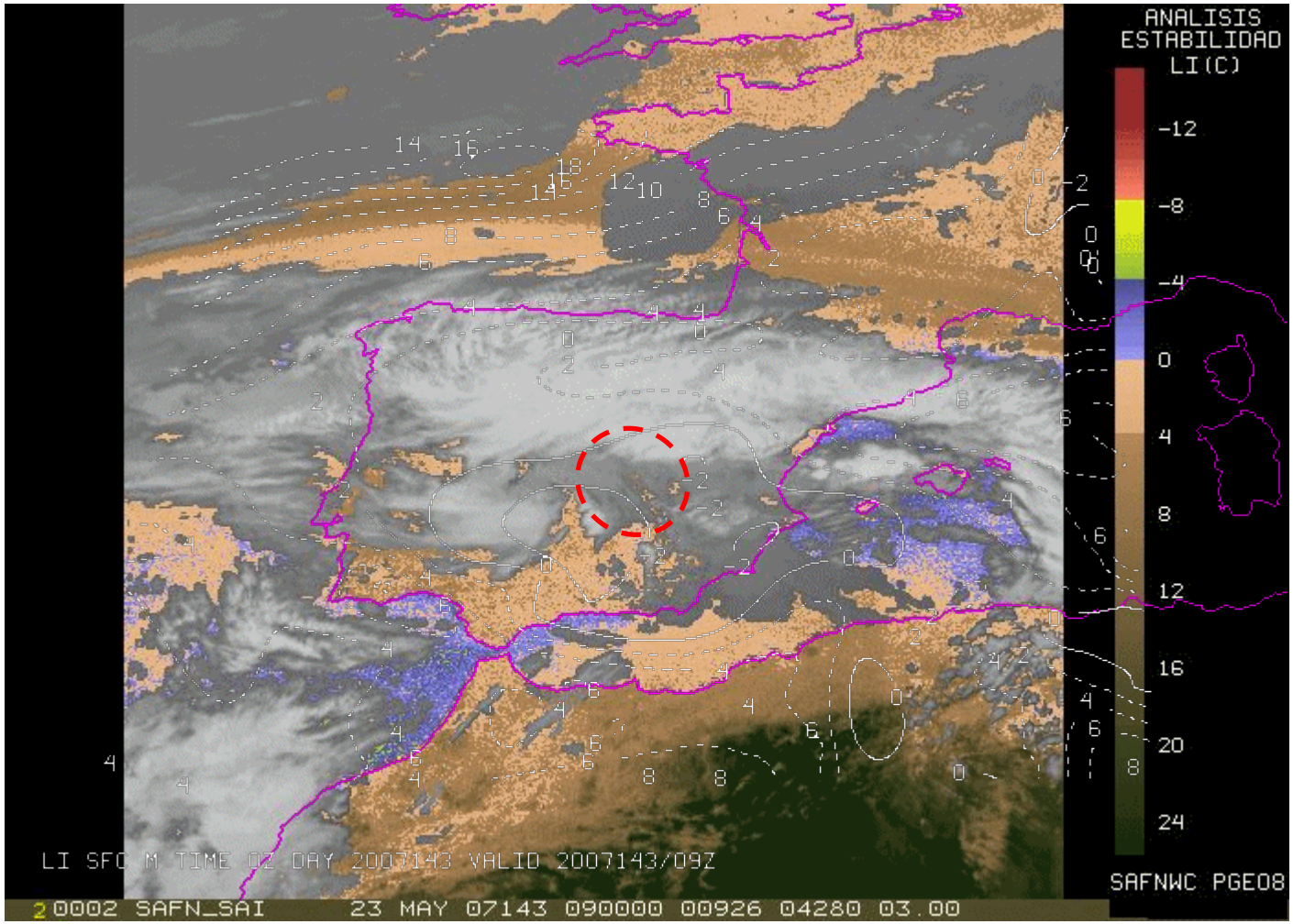


Sc_3 pre - convective "instability" by NWCSAF: (04:15 – 20:00 UTC, 23 may 2007)

(LI, Statistical retrieval)

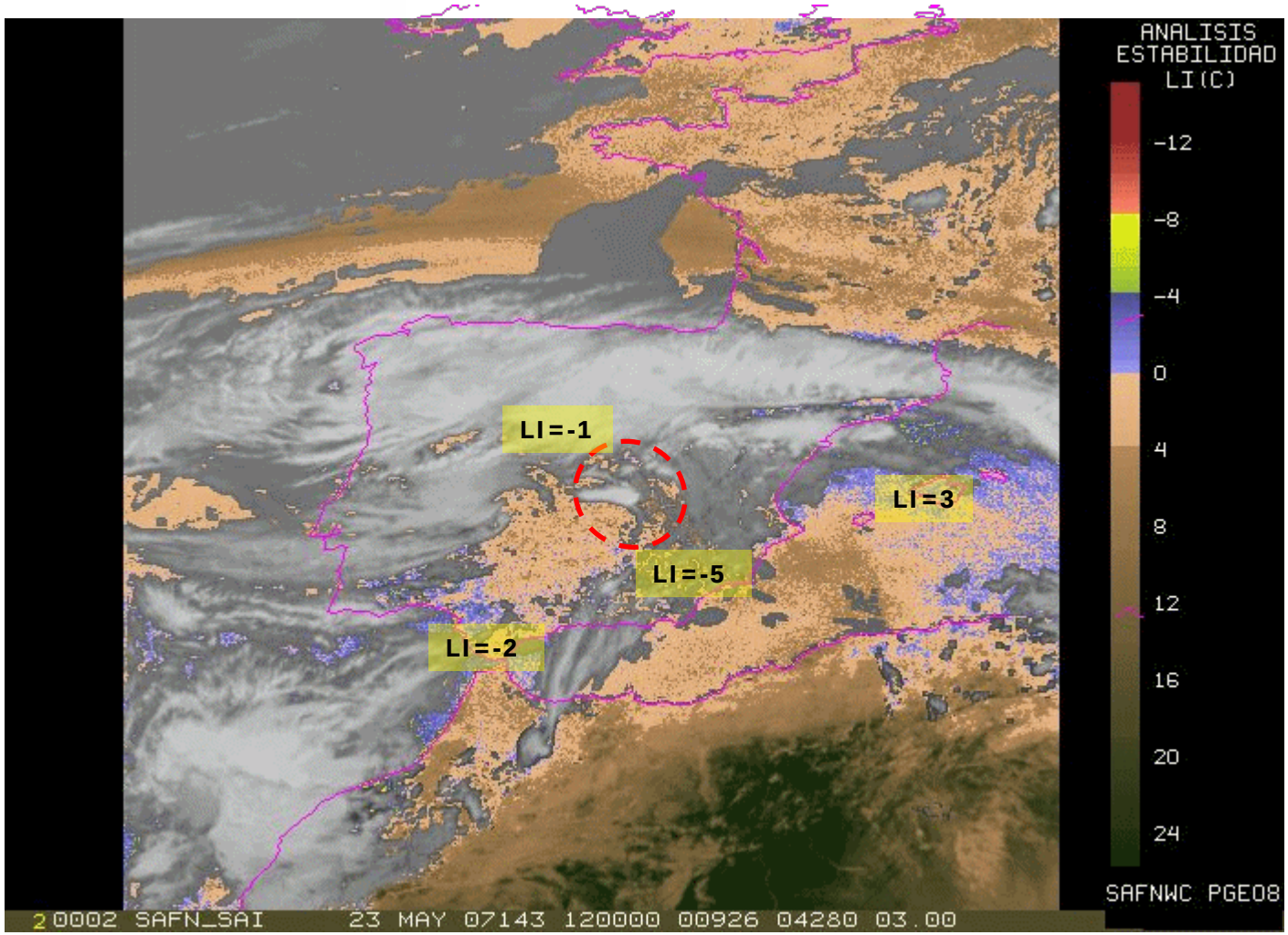


Sc_3 pre - convective instability by NWCSAF: (09 UTC, 23 may 2007)
(LI, Statistical retrieval)



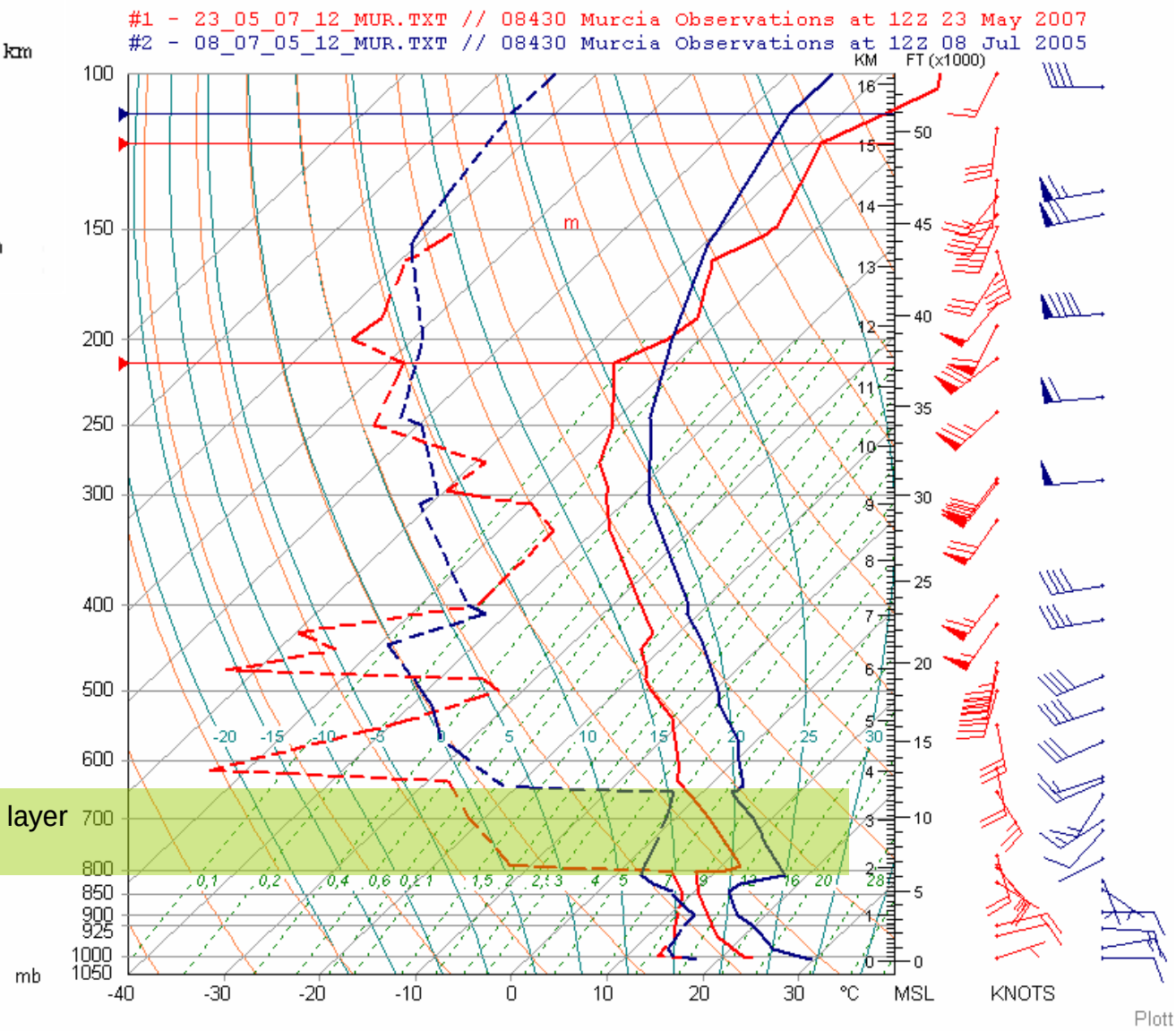
Sc_3 pre - convective instability by NWCSAF: (12 UTC, 23 may 2007)

(LI, Statistical retrieval)



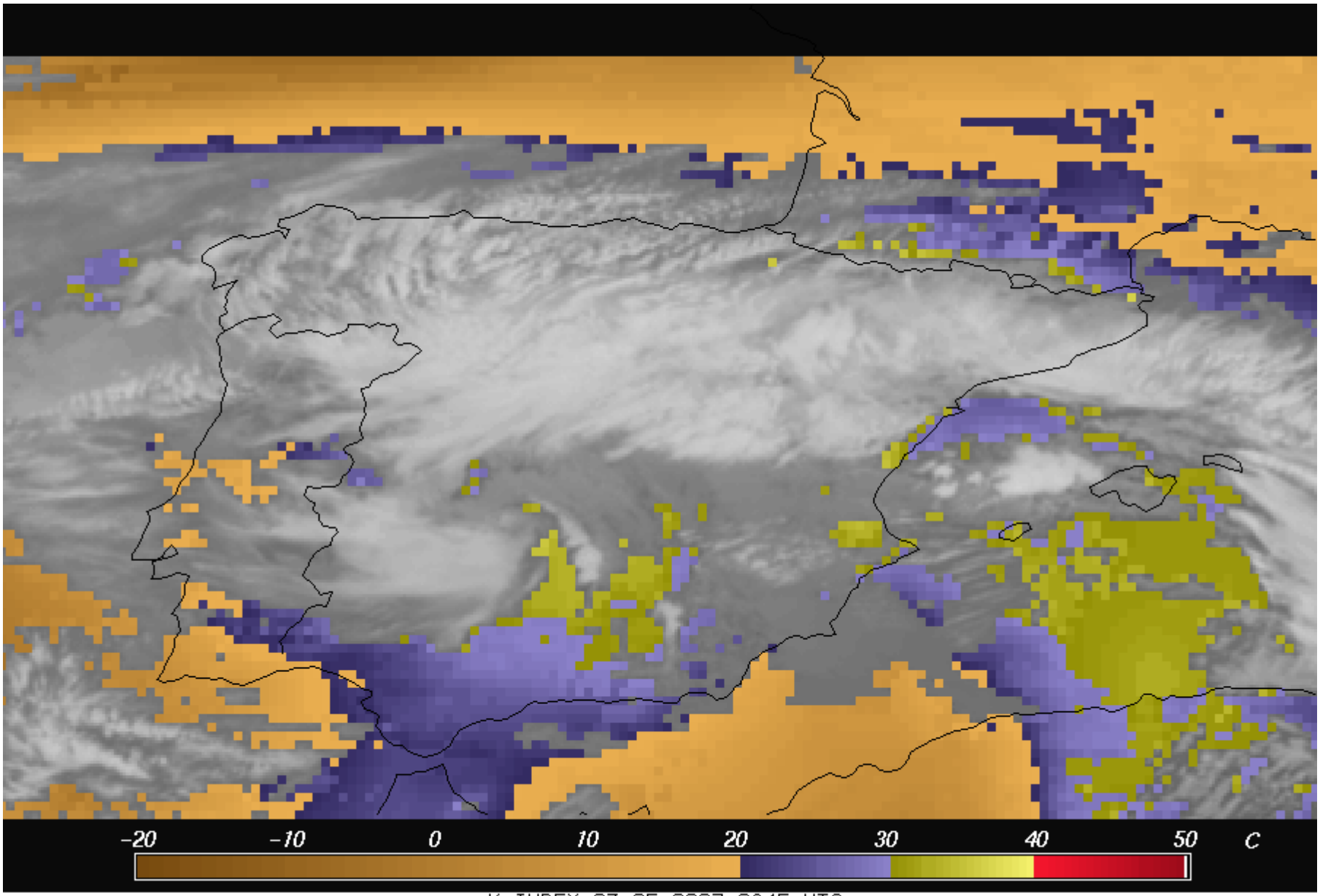
Sc_3 / Sc_1 pre - convective proximity sounding comparation (Murcia, 12 UTC)

	#1	#2	
700-500 LR:	-7,7	-6,6	°C/km
CAPE:	1048	814	J/kg
LI:	-5,3	-2,5	
KI:	11,4	22,5	
CIN total:	-43	-123	J/kg
Water:	2,17	2,85	cm

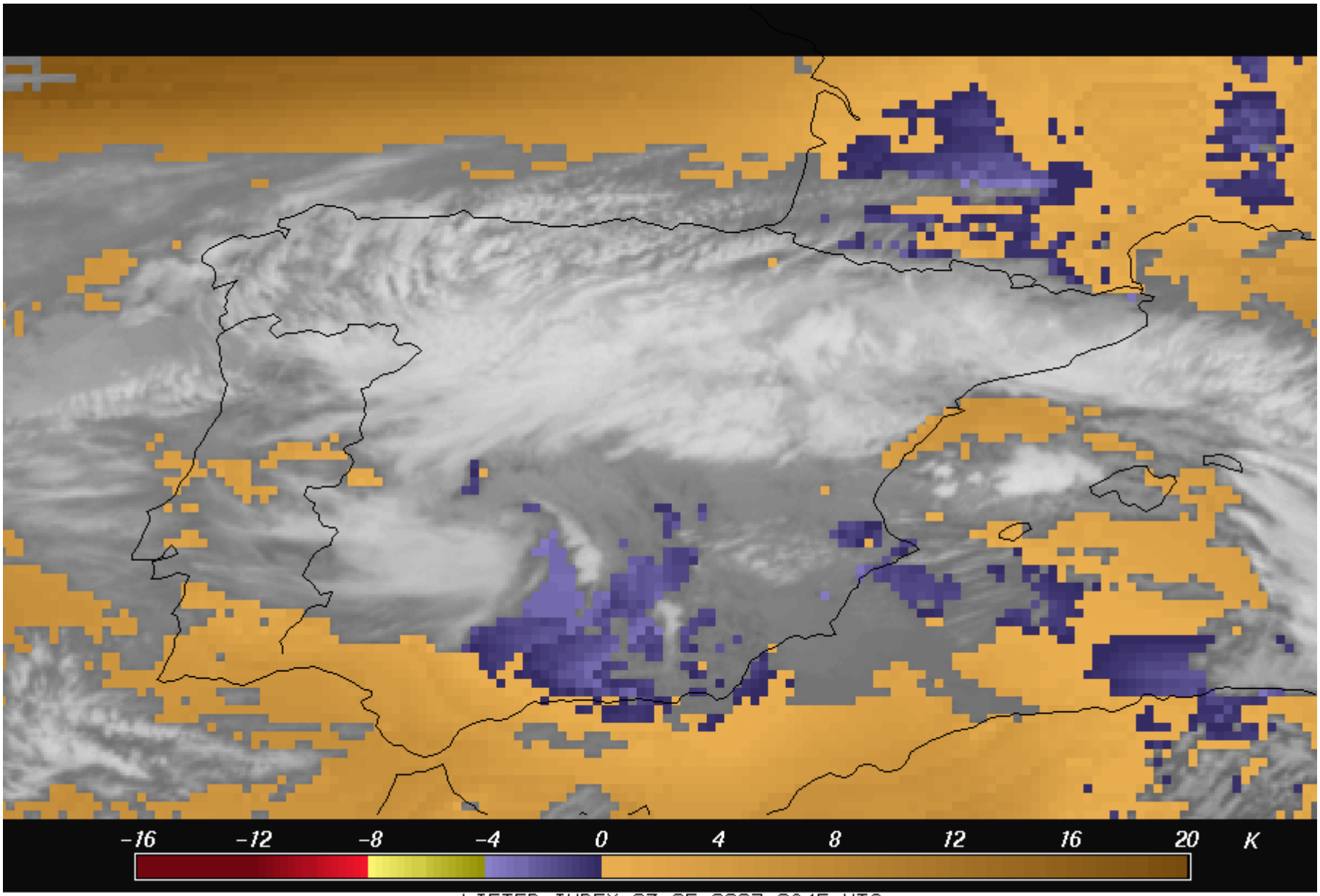


#2 elevated well mixed layer
#1 elevated dry layer

Sc_3 pre - convective instability by Eumetsat GII: (08:45 – 16:45 UTC, 23 may 2007)
(K Index, Physical retrieval)

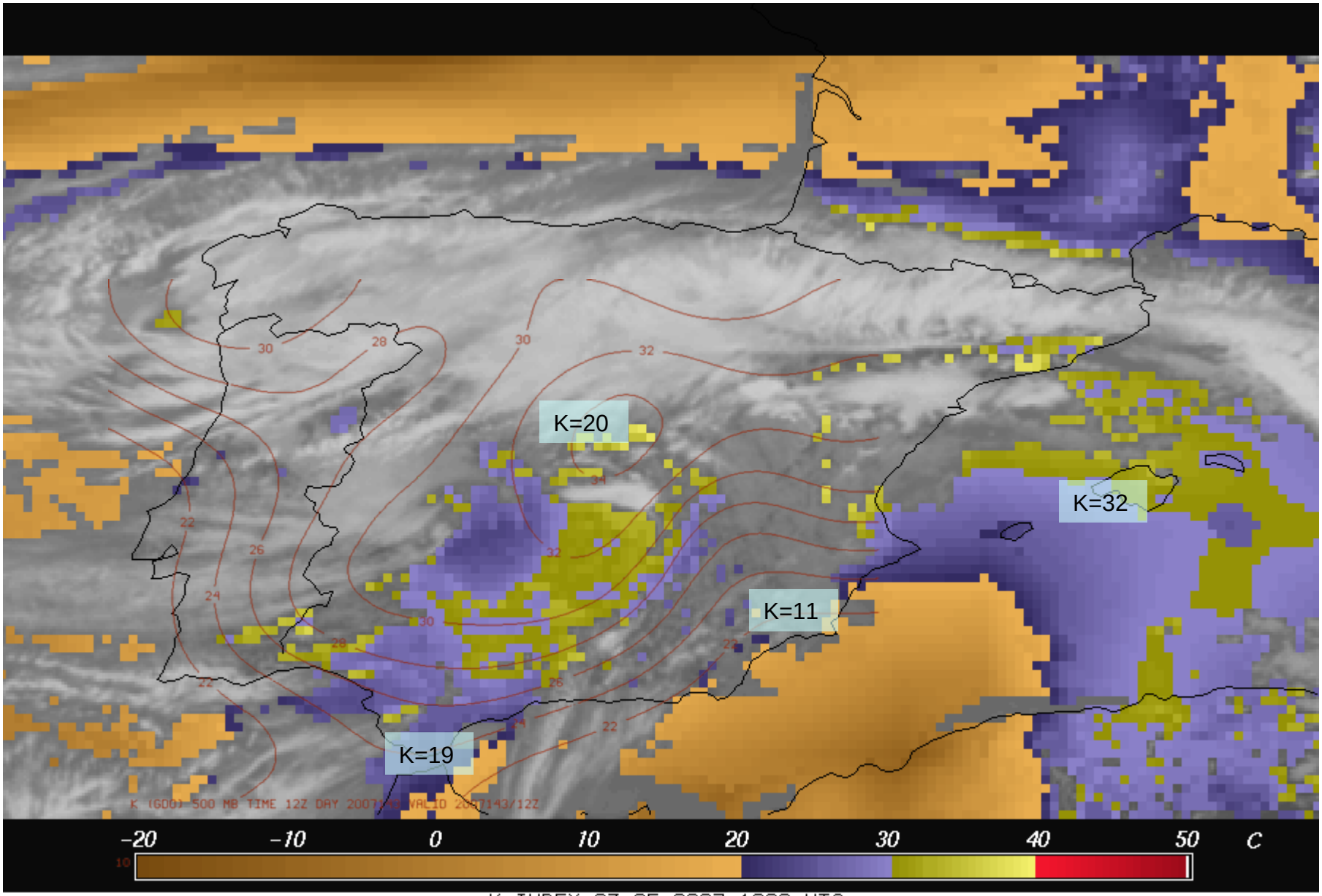


Sc_3 pre - convective instability by Eumetsat GII: (08:45 – 16:45 UTC, 23 may 2007)
(LI Index, Physical retrieval)



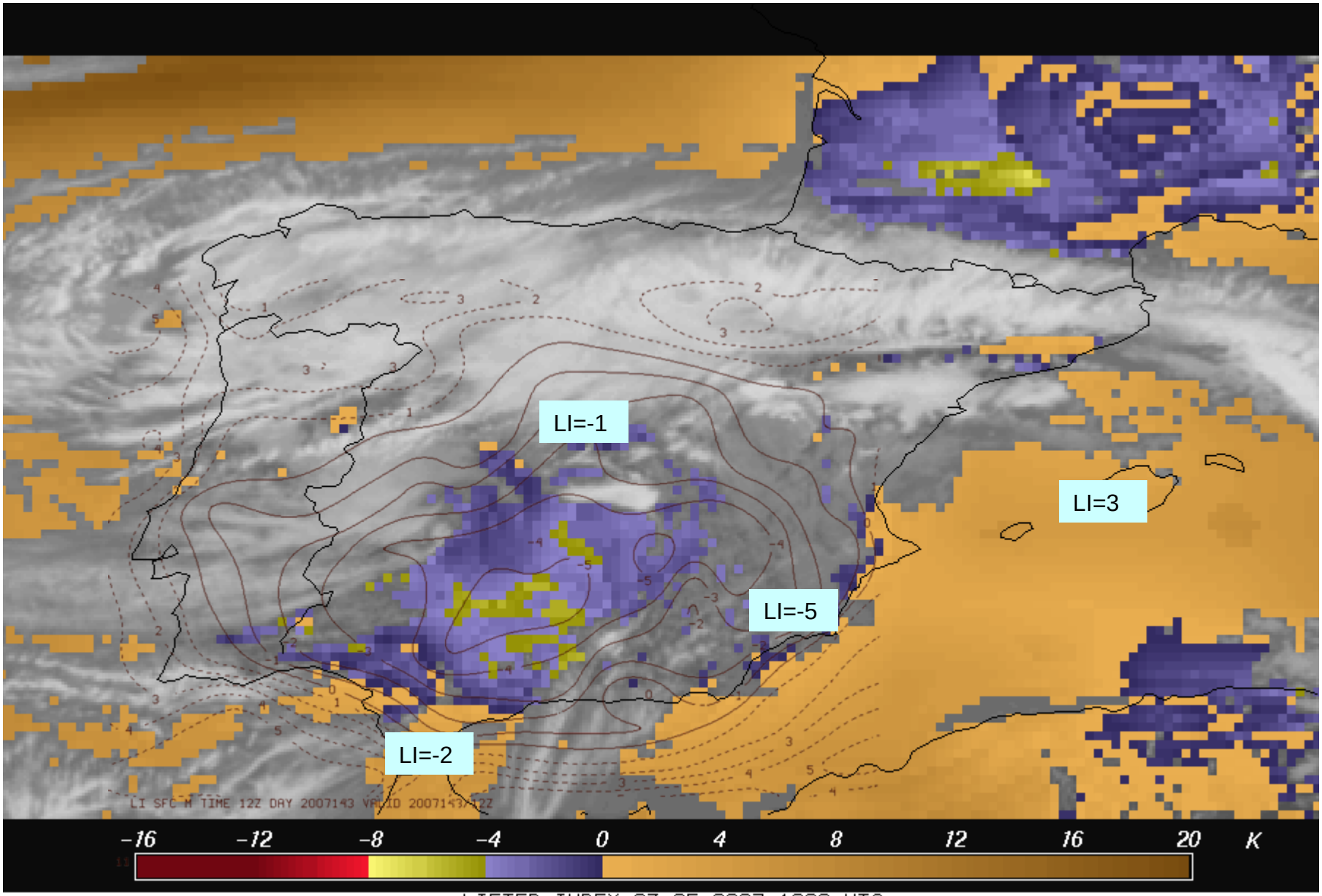
Sc_3 pre - convective instability by Eumetsat GII: (12 UTC, 23 may 2007)

(K Index, Physical retrieval + Ecmwf analysis + sounding values)



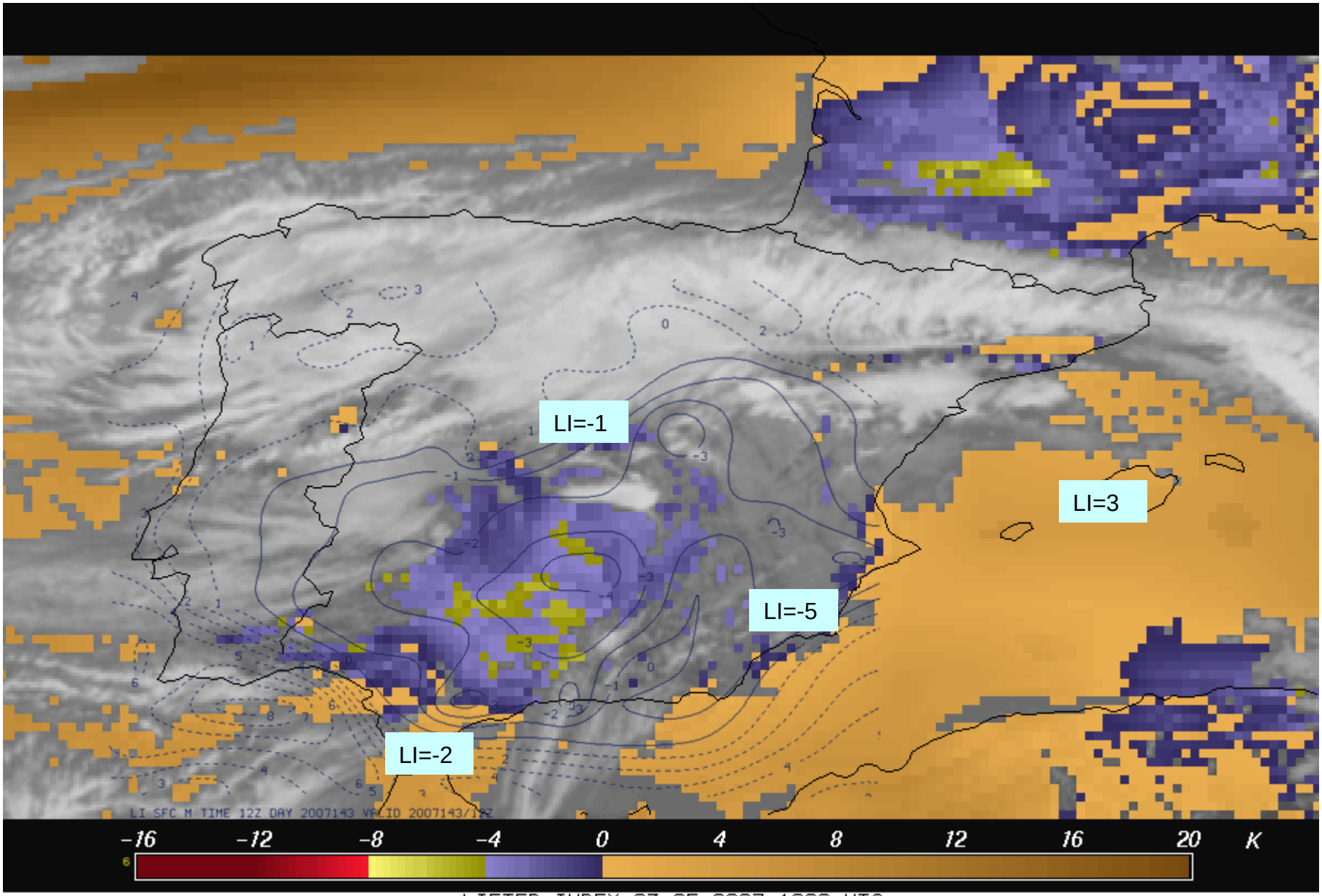
Sc_3 pre - convective instability by Eumetsat GII: (12 UTC, 23 may 2007)

(LI, Physical retrieval, parcel lifted from surface + Ecmwf, lifted from lowest 100 hpa)

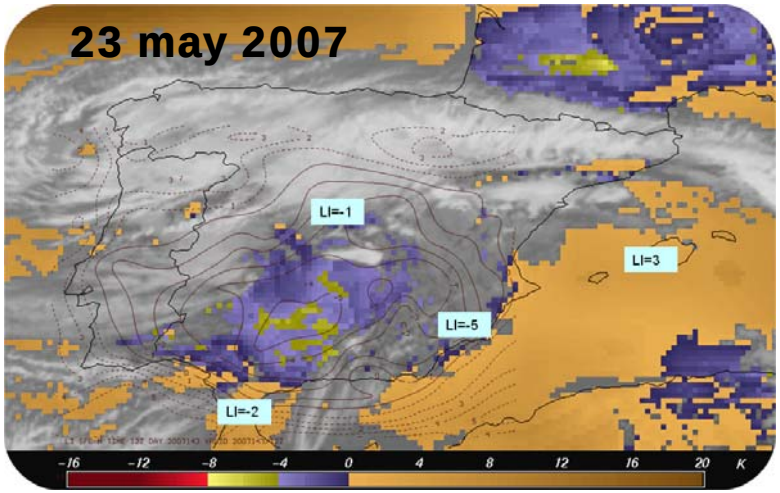


Sc_3 pre - convective instability by Eumetsat GII: (12 UTC, 23 may 2007)

(LI, Physical retrieval, parcel lifted from surface + Hirlam, lifted from lowest 100 hpa)



Comments for Sc_3 event:



Statistical retrieval:

LI: significative errors in location and parameter value ¿causes...? ¿impact of previous days precipitation on sfc temperatures...?

Physical retrieval:

LI: Seem to focus instability areas properly. No noisy this time. ¿Why? Good correlation with NWP model analysis. Get worse when comparing to soundings (as the model analysis do !!)

KI: Seem to focus instability areas properly. Good correlation with NWP model analysis. Get worse when comparing to soundings (as the model analysis do !!)

Final comments:

- All analized satellite derived products (LI, PW, KI) incorporate moisture information. It would be good to have a product that gives only instability information, as the forcasters approach to forecast convective events normally follow a methodology based in separate ingredients:

  - instability
  - moisture
  - forcing

Could low level or medium level lapse rates be accurately retrieved from satellite?

- NWP model outputs still seem to show important errors when calculating parcel instability indexes, maybe because of the large sensitivity to surface parameters, specially moisture. This has to be taken into account by those retrieval algorithms that rely very much on model output info.

- Moisture stratification (not just vertically integrated moisture) is a key factor in the task of forecasting deep convection, so, it seems sensible to retrieve PW values for as many separate layers as posible ...

Thank you
for your attention !