CTTH
Cloud Top Temperature and Height

15th June 2004

Madrid

Hervé Le Gléau and Marcel Derrien
Météo-France / CMS lannion

Plan of CTTH presentation

Algorithms' short description

Some examples

Planned activities in 2004

CTTH product

Products		
Cloud Top Temperature	180 - 320 K	step: 1 K
Cloud Top Pressure	0 - 1050 hPa	step: 25 hPa
Cloud Top Height	-400 - 20000 m	step: 200 m
Cloud Effective Cloudiness	0% - 100 %	step: 5 %

Quality flag: NWP input data availability
SEVIRI data availability
CTTH quality itself
Indication on the method used

CTTH algorithm: generality

✓Vertical temperature & humidity profile forecast by NWP needed

✓TOA radiances from the top of overcast opaque clouds put at various pressure levels are simulated with RTTOV (NWP vertical profiles are temporally interpolated to each slot)

✓Cloud top pressure is first extracted using RTTOV simulated radiances; Method depending on cloud type.

✓Cloud top temperature & height are derived from their pressure (using vertical temperature & humidity profile forecast by NWP).

CTTH algorithm: opaque clouds

For opaque clouds (known from CT)

The cloud top pressure corresponds to the best fit between the simulated and measured 10.8µm radiances (simulated radiances are spatially interpolated to individual pixel)

For broken low clouds

No technique has yet been implemented.

Measured brightness temperature

Retrieved cloud top pressure

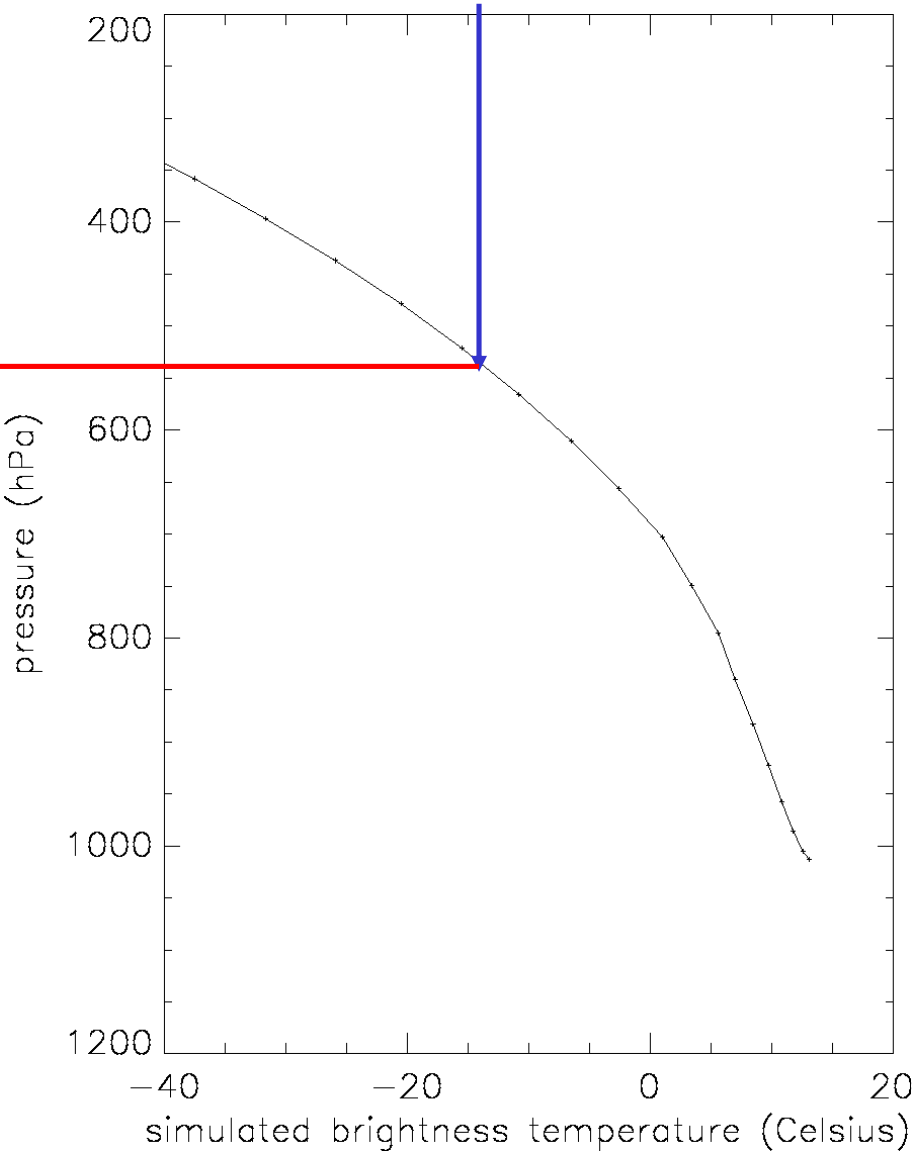


Illustration of **opaque clouds** cloud top pressure retrieval

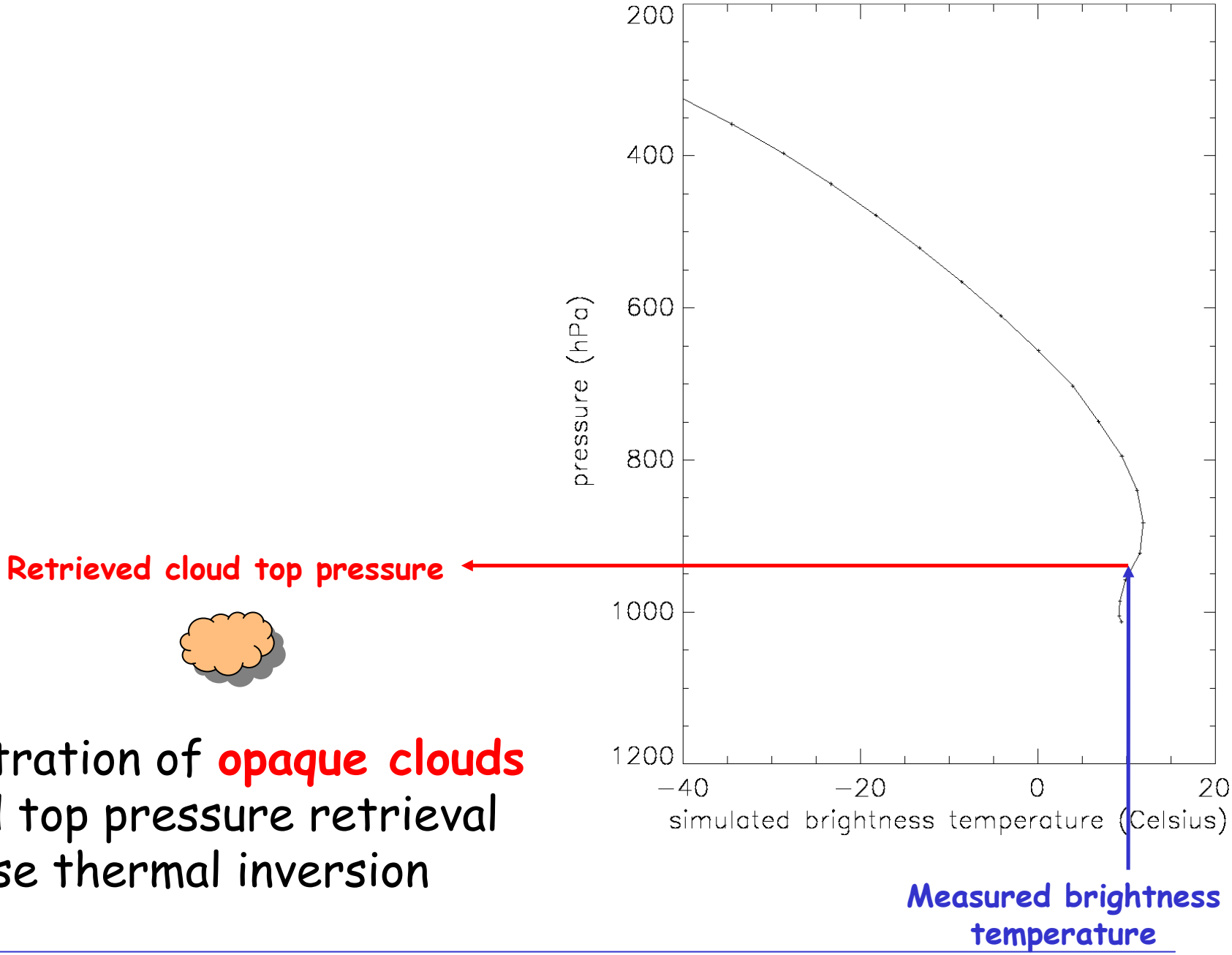


Illustration of **opaque clouds** cloud top pressure retrieval in case thermal inversion

CTTH algorithm: semi-transparent clouds

For semi-transparent clouds :

✓A correction of the semi-transparency is applied, using a pair of infrared channels:

-a window channel: 10.8μm and

-a sounding channel (13.4μm, 7.3μm or 6.2μm)

✓The basis is:

A cloud corresponding to a given radiative temperature in the window channel will have a higher impact in the sounding channel if the cloud is at a higher altitude.

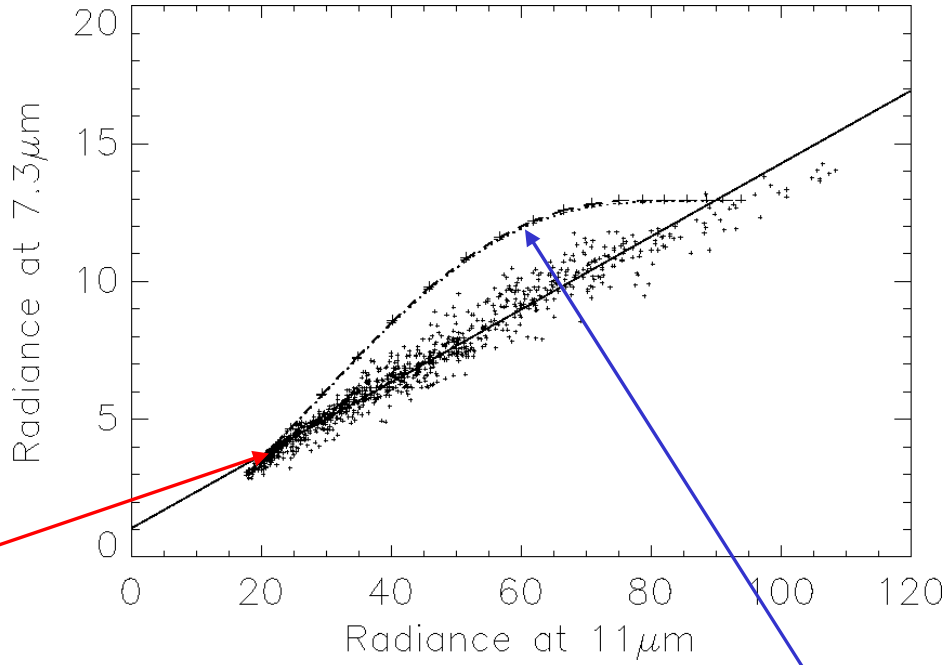
CTTH algorithm: semi-transparent clouds

For semi-transparent clouds :

✓Two methods are applied, relying on RTTOV simulations:

- ✓Intercept method based on histogram analysis
- ✓Radiance ratioing applied on a pixel basis

Illustration of intercept method



Top pressure of the semi-transparent cloud layer is retrieved from the intersection between:

- -Simulated radiances of opaque clouds at various pressure levels.
- -Regression line on measured radiances of clouds at the same height, but with varying thickness.

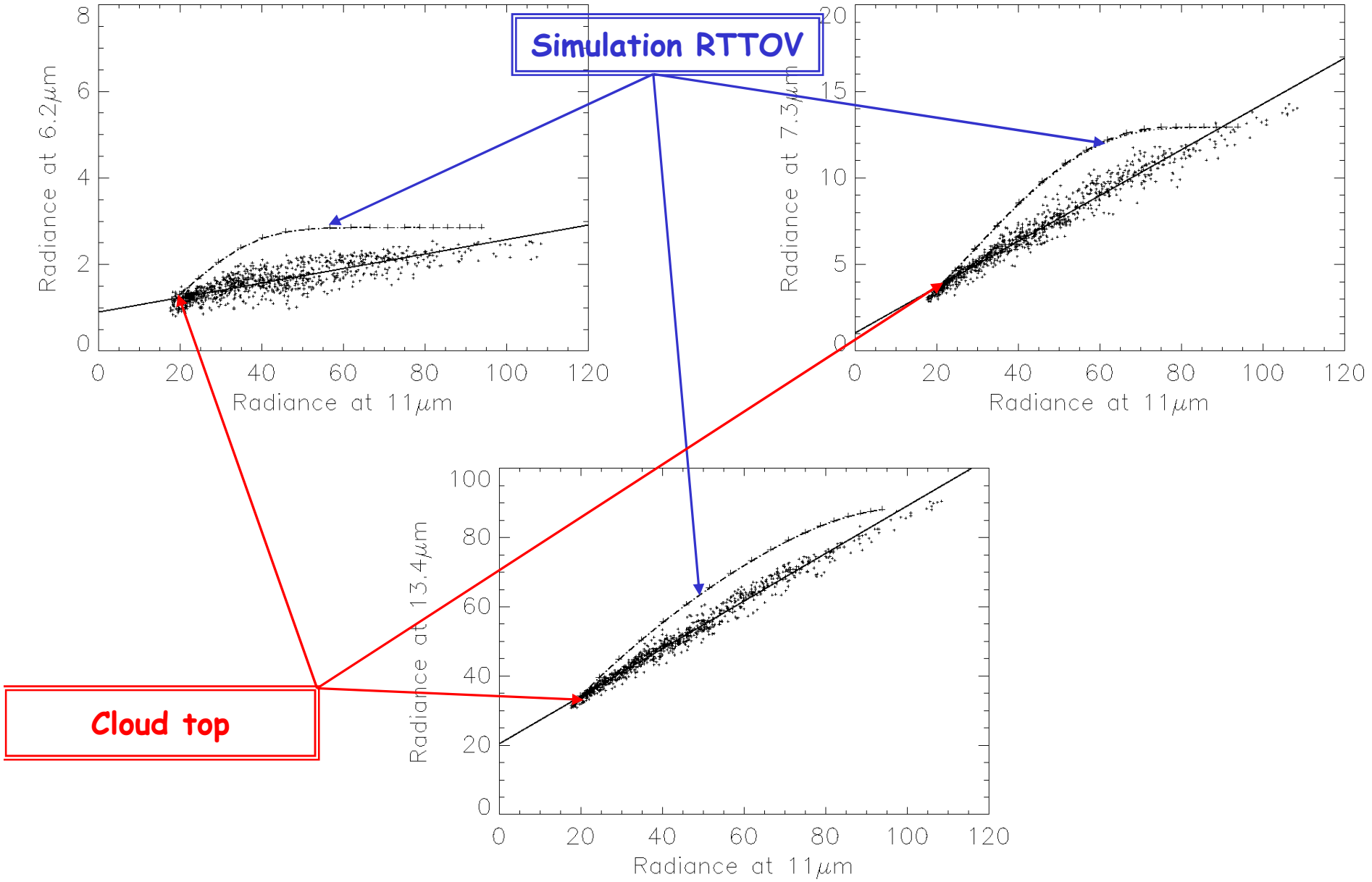
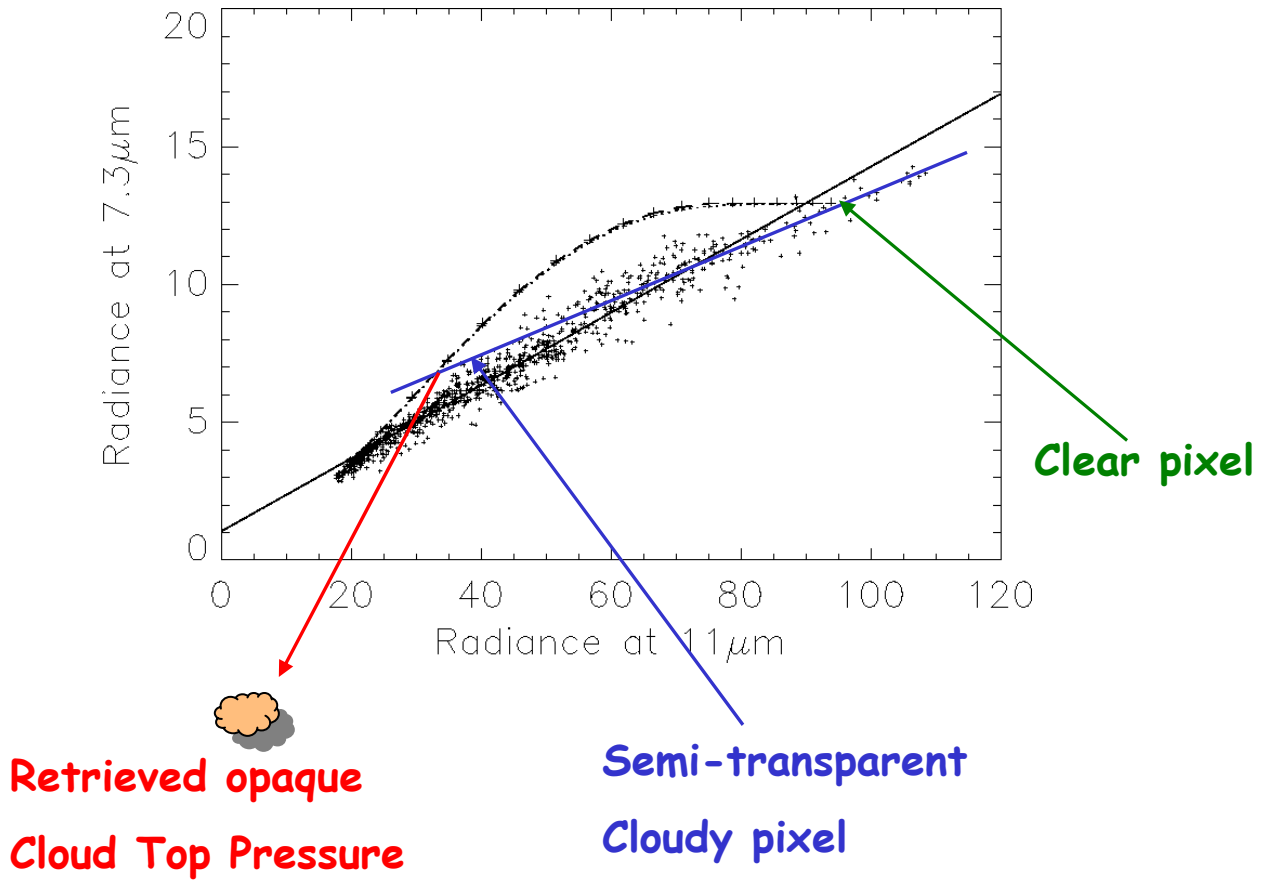

Simulation RTTOV
Radiance at 6.2μm
Radiance at 11μm
Radiance at 7.3μm
Radiance at 11μm
Radiance at 13.4μm
Radiance at 11μm
Cloud top

Illustration of radiance ratioing



Comparison of radiance ratioing and intercept methods

- ✓Both methods are sensitive to RTTOV simulations from NWP
- ✓Intercept method
  - ✓gives results at histogram box scale
- ✓Radiance ratioing
  - ✓gives results at pixel scale
  - ✓but is very sensitive to clear pixel's choice
  - ✓is not applied to too thin clouds

Examples of cloud top pressure

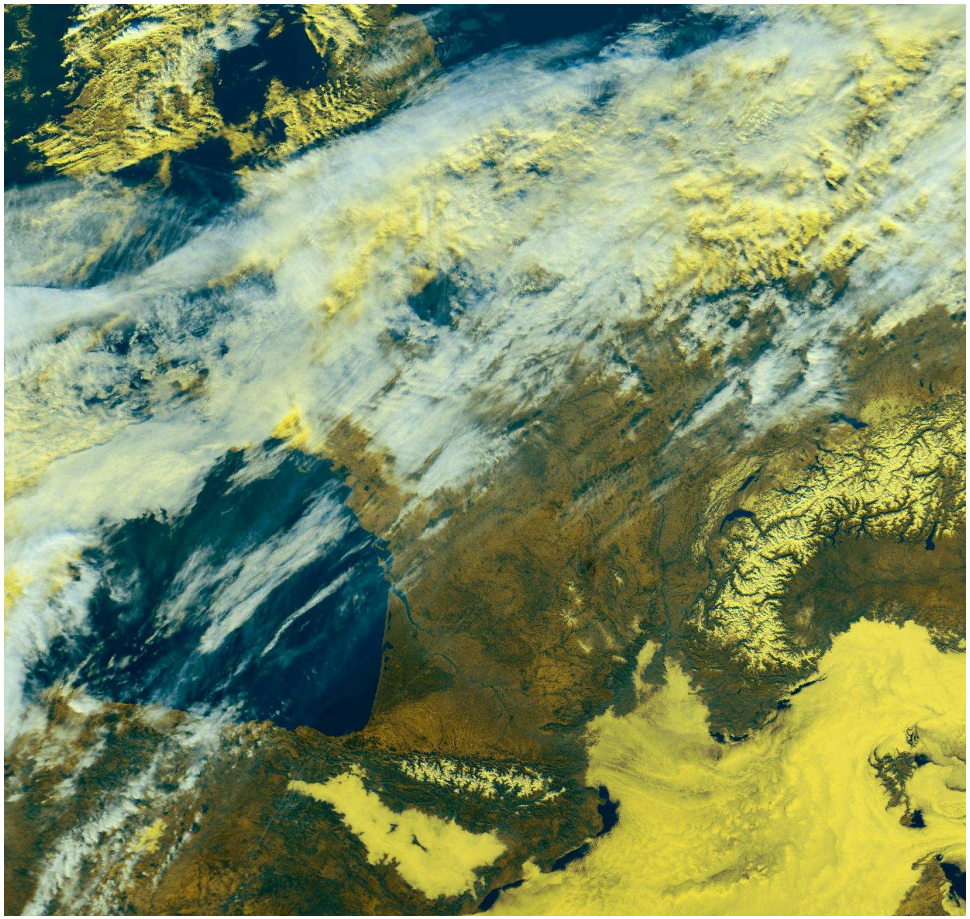
Cloud top pressures are displayed using colour palette available in hdf file.

- Low clouds and fog 5th February 2004 0h & 12h

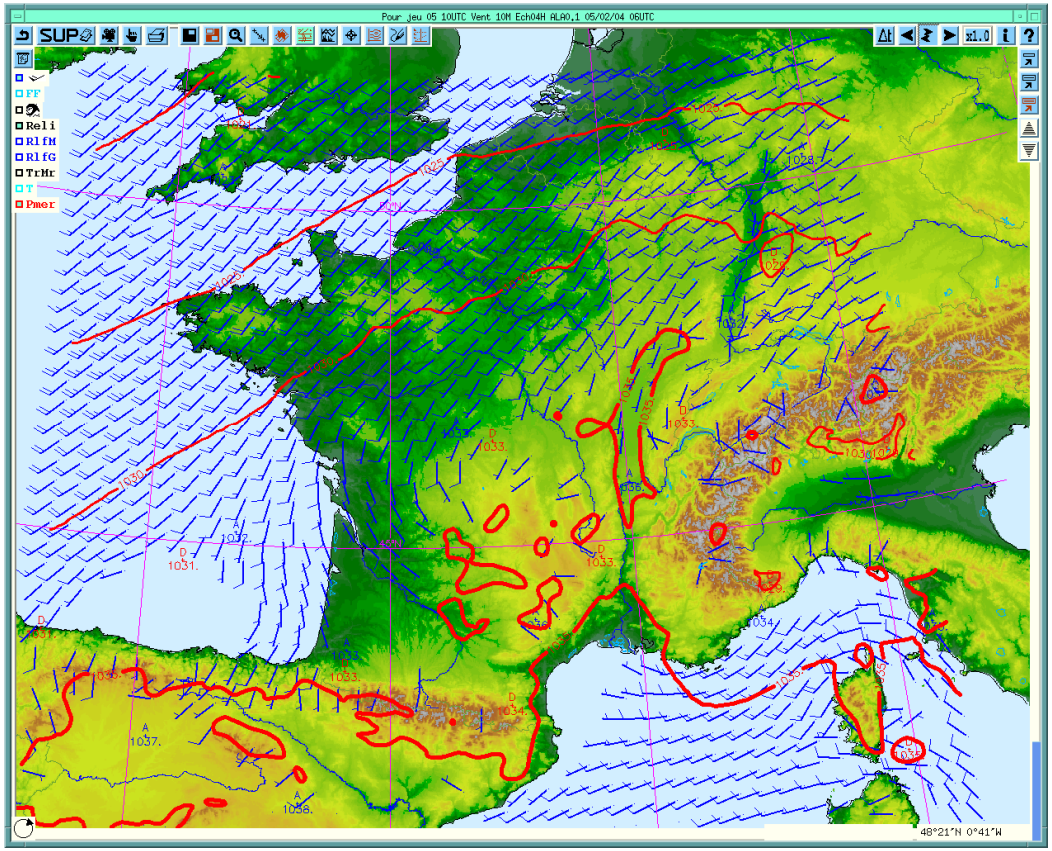
- Convection 28th July 2003 12h-16h

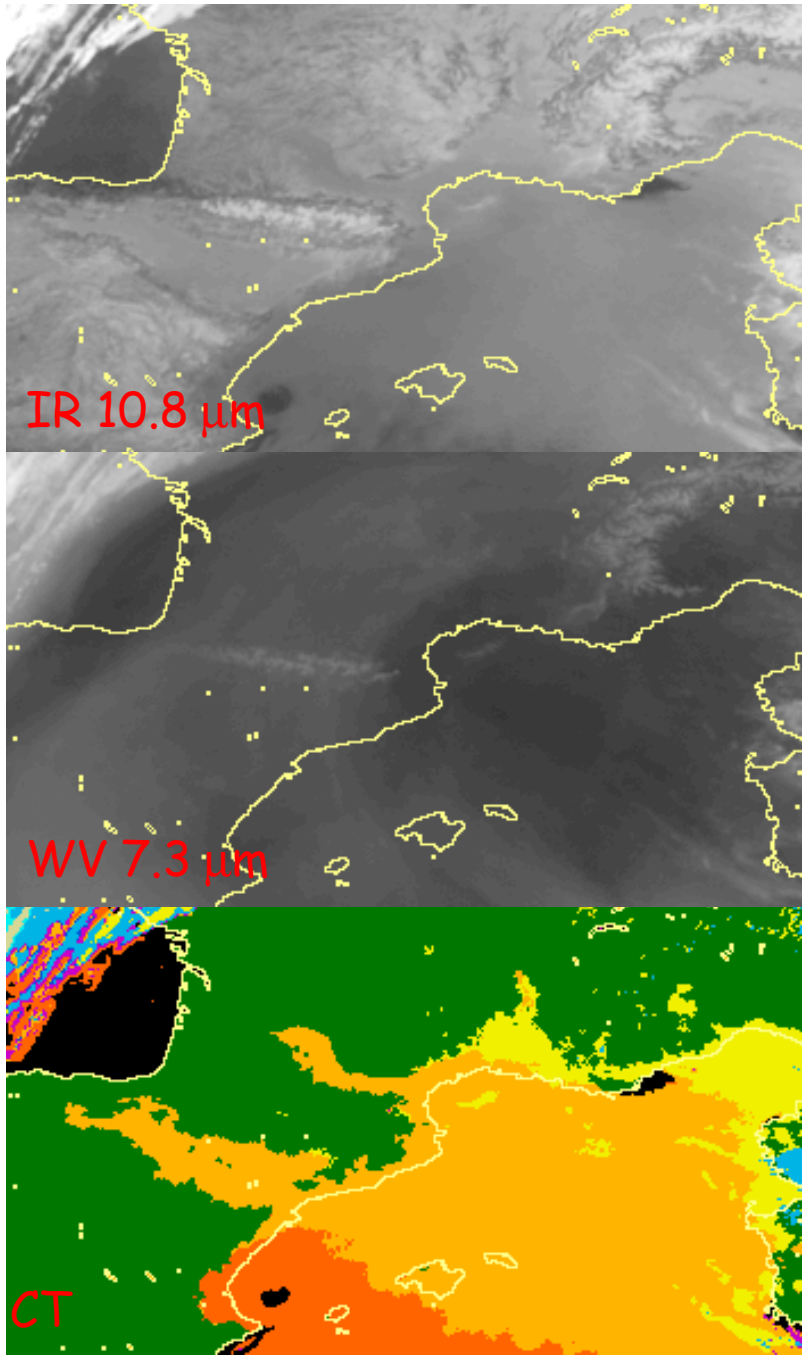
Low clouds case: 5th February 2005 0h and 12h TU

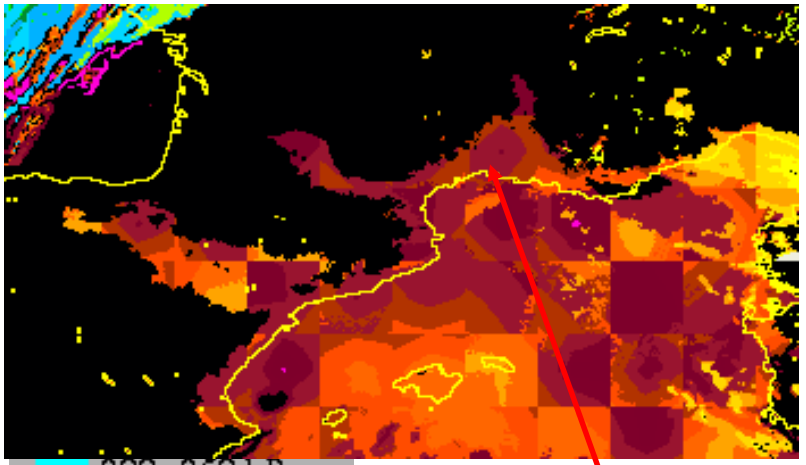
NOAA-16 14hTU

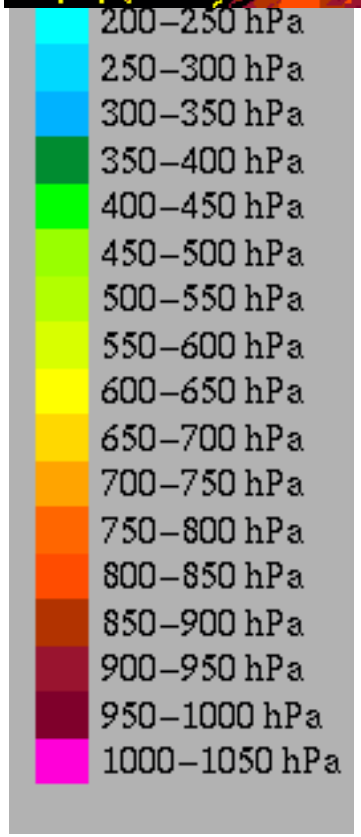


Forecast wind and surface pressure
5th February 2004 10h







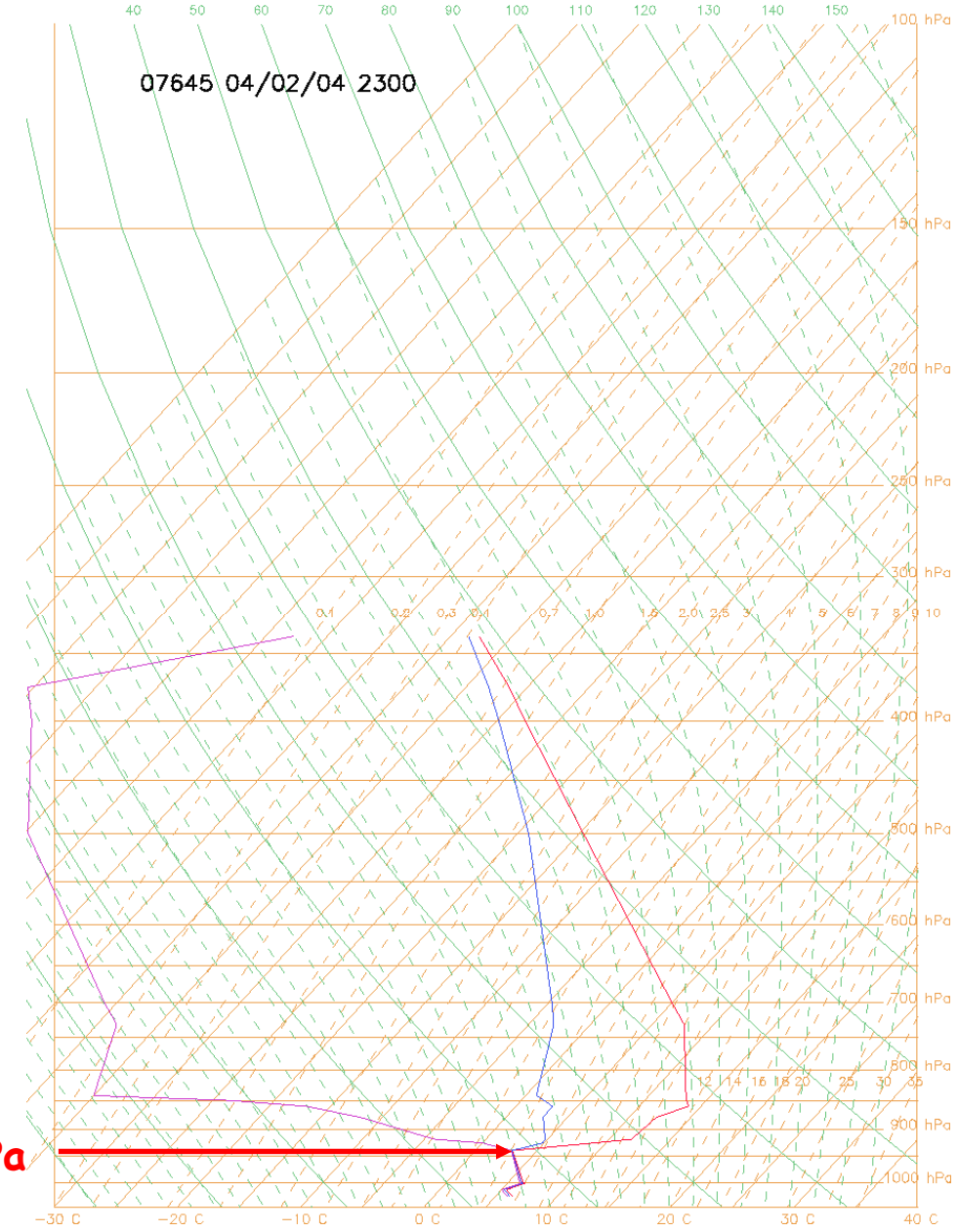


Nimes: 900-950hPa
(T10.8µm=3°C)

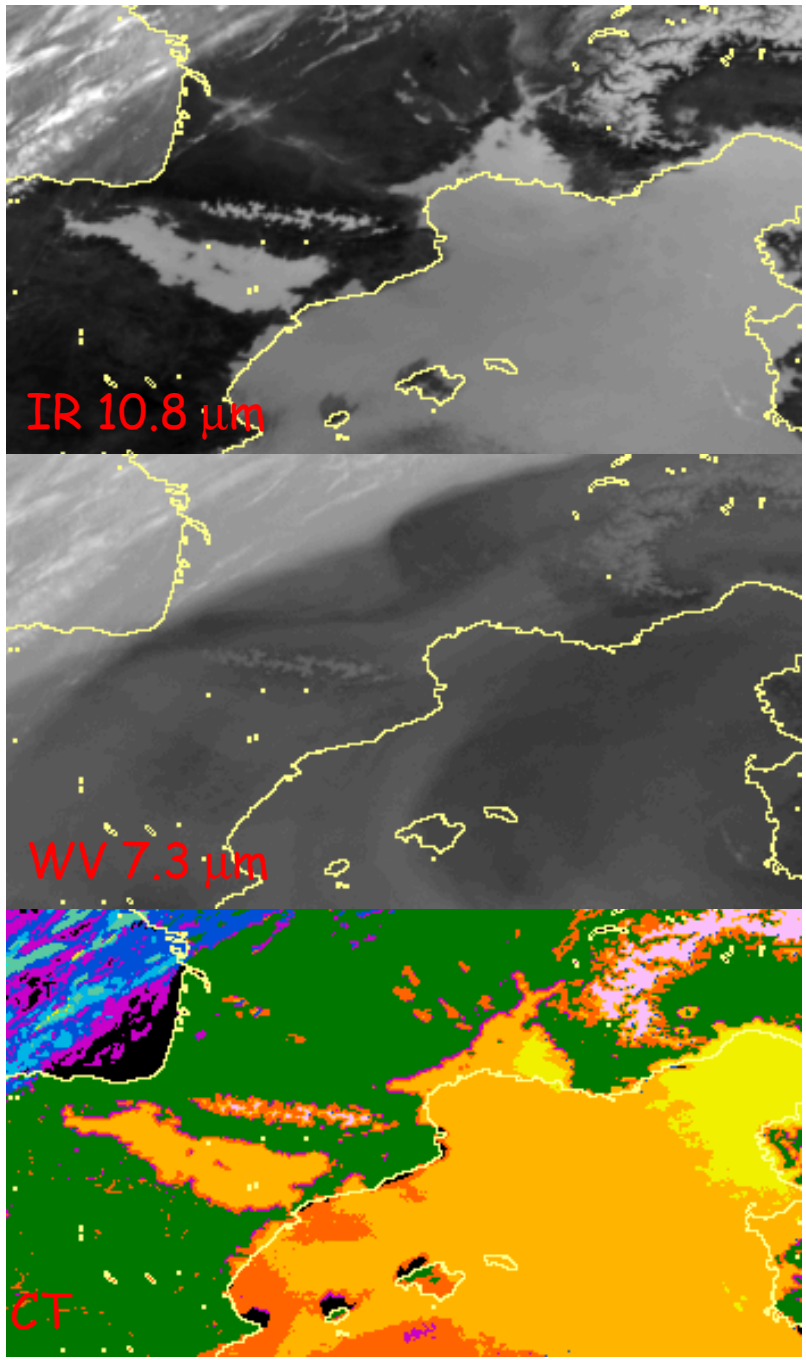
5th February 2004 0h

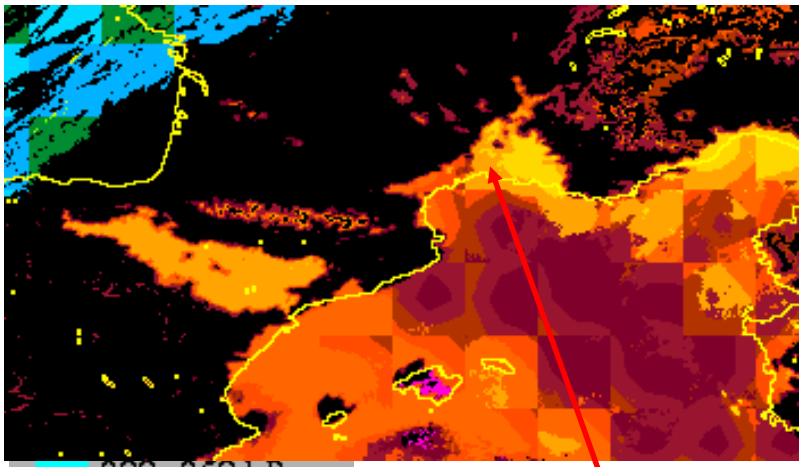
Radiosounding at
Nimes (south France)

5th February 2004 0h



Cloud top pressure: 940hPa
(3°C)





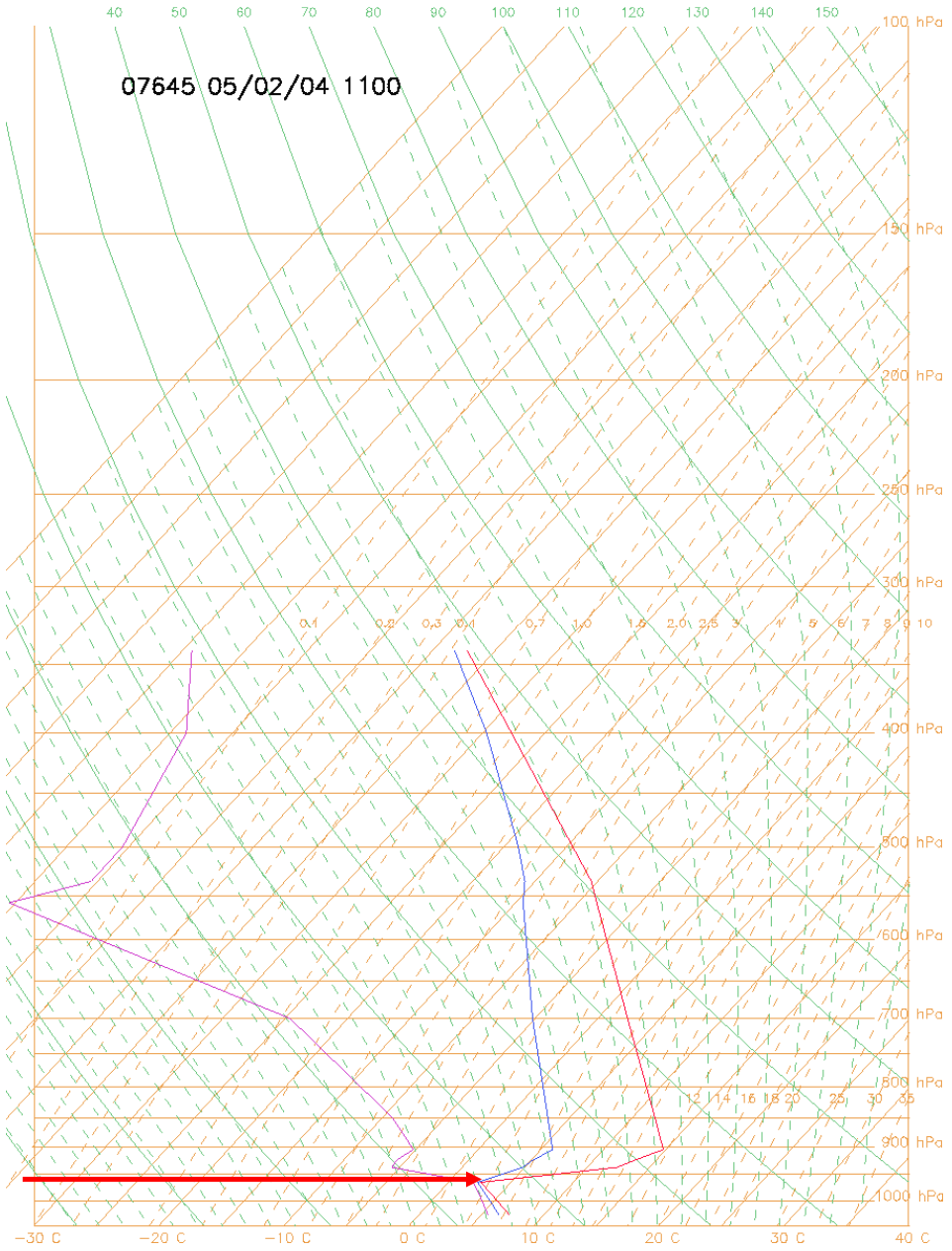
200–250 hPa
250–300 hPa
300–350 hPa
350–400 hPa
400–450 hPa
450–500 hPa
500–550 hPa
550–600 hPa
600–650 hPa
650–700 hPa
700–750 hPa
750–800 hPa
800–850 hPa
850–900 hPa
900–950 hPa
950–1000 hPa
1000–1050 hPa

Nimes: 700-800hPa
(T10.8µm=3°C)

5th February 2004 12h

Radiosounding at
Nimes (south France)

5th February 2004 12h

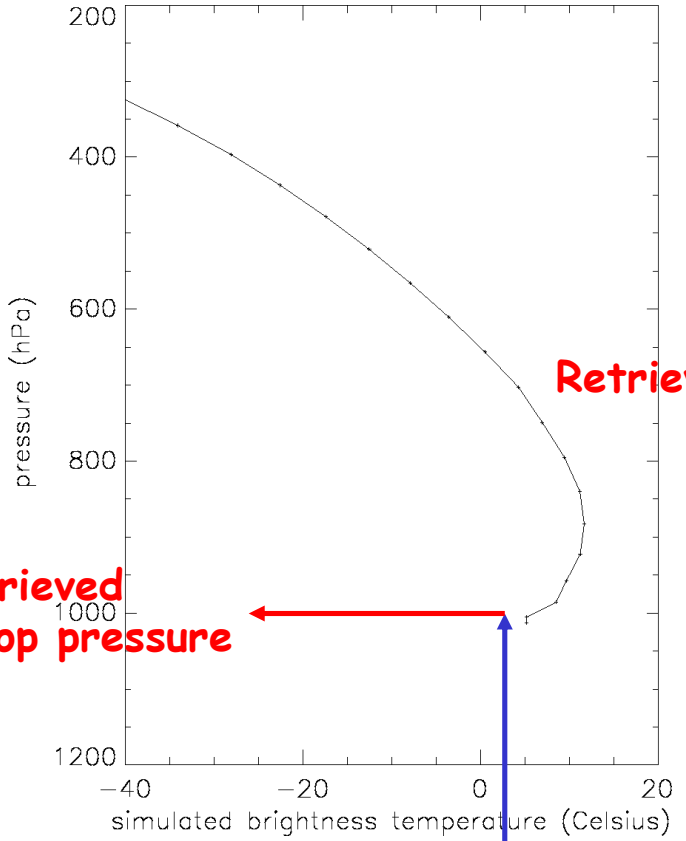


Cloud top pressure: 960hPa
(2.5°C)

Computed from ARPEGE forecastNear Nimes (south France)

5th February 2004

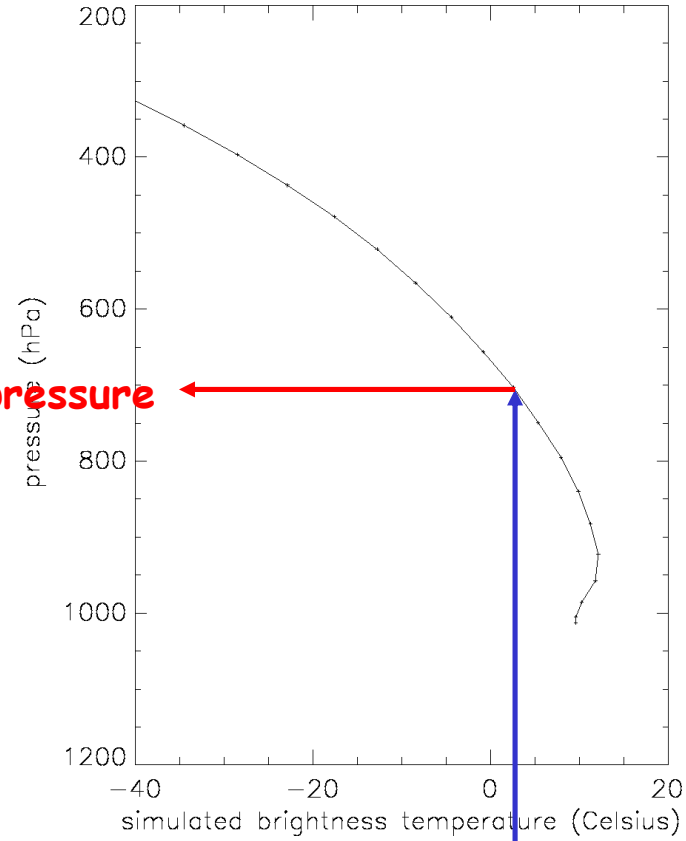
At 0h00



Retrieved cloud top pressure

Brightness temperature: 3°C

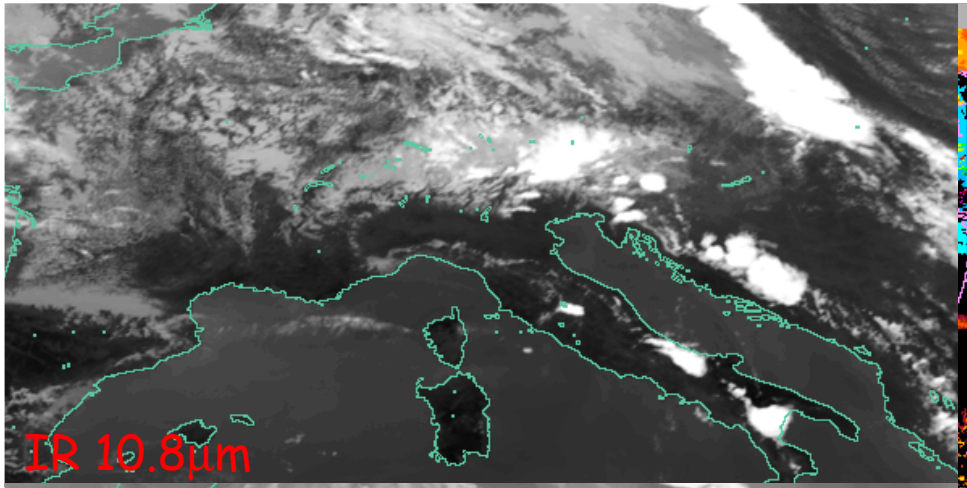
At 12h00

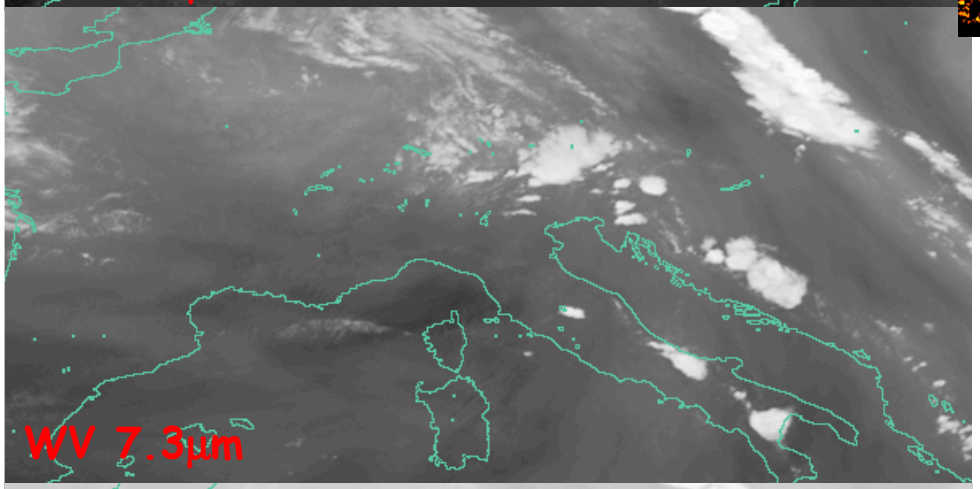


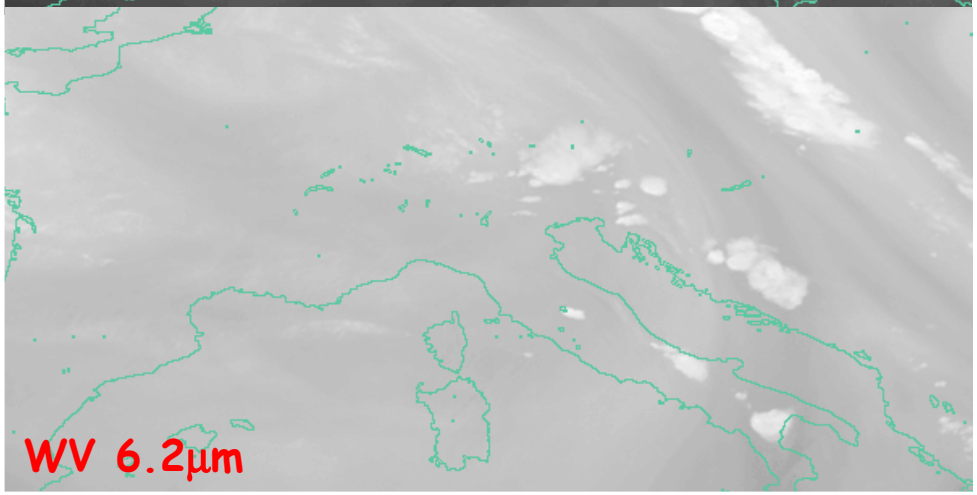
Retrieved cloud top pressure

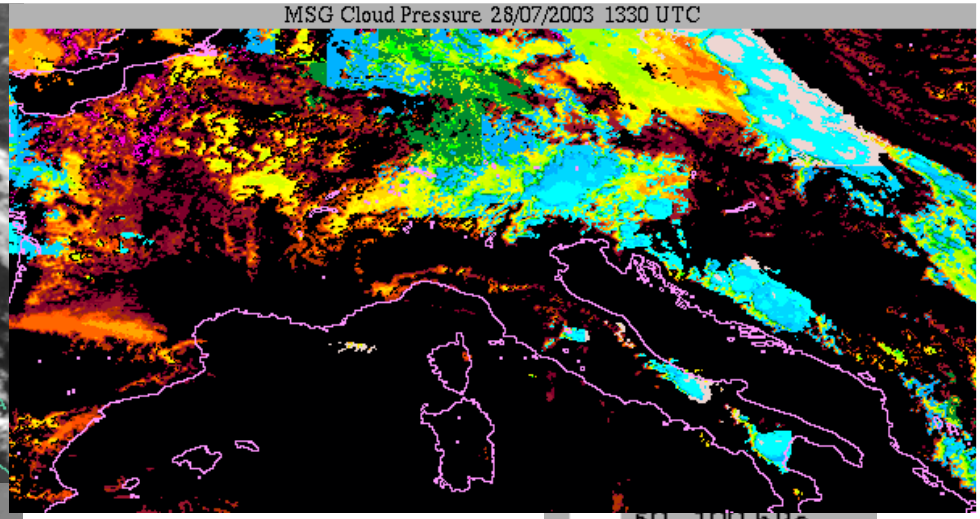
Brightness temperature: 3°C

Convective case: 28th July 2003 12-16hTU





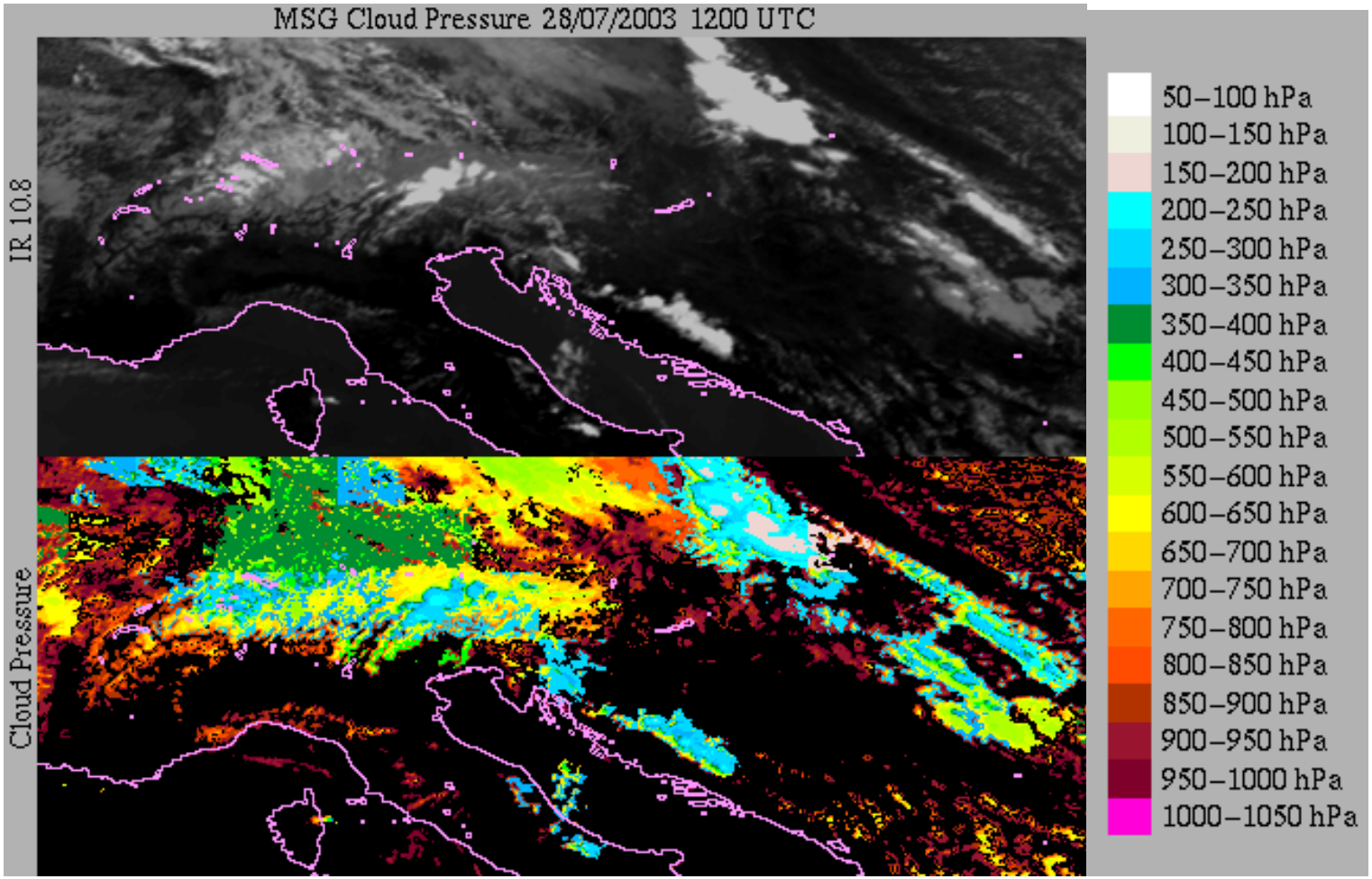




Cloud Top Pressure

50–100 hPa
100–150 hPa
150–200 hPa
200–250 hPa
250–300 hPa
300–350 hPa
350–400 hPa
400–450 hPa
450–500 hPa
500–550 hPa
550–600 hPa
600–650 hPa
650–700 hPa
700–750 hPa
750–800 hPa
800–850 hPa
850–900 hPa
900–950 hPa
950–1000 hPa
1000–1050 hPa

Convective case: 28th July 2003 12-16hTU



Known problems

CTTH :

- ✓ CTTH may be wrong if CT is wrong (method used by CTTH is different for opaque or semi-transparent clouds)
- ✓ No CTTH is available for clouds classified as fractional
- ✓ CTTH may not be computed for too thin cirrus
- ✓ CTTH for cirrus may have a square-like appearance due to the use of histogram analysis in the retrieval process
- ✓ Retrieved low cloud top height may be overestimated

Planned activities in 2004

Improvements to be included in **SAFNWC (v1.2)**

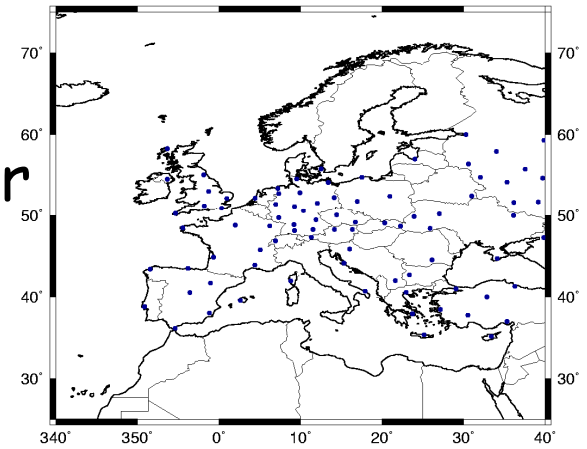
✓Top height of low clouds in case thermal inversion

✓Use of RTTOV7 instead RTTOV6

Validation of cloud top height:

✓high semi-transparent clouds: with lidar

✓low cloud: with radio-sounding



Validation TEMP Stations