PGE06 TPW
Total Precipitable Water

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Total Precipitable Water goal

- Total Precipitable Water (TPW) is the amount of liquid water, in mm, if all the atmospheric water vapour in the column were condensed.
- High values of TPW in clear air often become antecedent conditions prior to the development of heavy precipitation and flash floods.
- When high TPW values areas present a lifting mechanism and warm advection in low levels, heavy precipitation often occurs.
- These data can provide to forecasters an important tool for very short range forecasting.
- Within the SAF NWC context, the main goal is to provide TPW data in clear air pixel by pixel in image format for Nowcasting purposes.

Total Precipitable Water algorithms

- The algorithms assume the lower and mid troposphere as a thick layer at temperature **Tair** overlying a surface with skin temperature **Tsfc.**
- The brightness temperature **T** for a window **IR** channel observed at Zenith angle θ is a combination of **Tsfc** and **Tair** weighted by the channel transmittance τ which has a contribution from the carbon dioxide absorption α and water vapour absorption β

$$T = Tsfc * \tau + Tair * (1 - \tau) \qquad (1)$$

- Assuming the transmittance difference proportional to the water vapour content:

$$\tau = EXP\,[\,-(\alpha + \beta * PW)\,] * \sec\theta \qquad (2)$$

- And approximating the transmittance, assuming low carbon dioxide absorption:

$$\tau = 1 - \beta * PW * \sec \qquad (3)$$

Total Precipitable Water algorithms

Two different approaches for the estimation of the TPW can be derived:

1. When the Surface Temperature can be accurately obtained (over **SEA**), by subtracting IR10.8 and IR12.0 channels brightness temperature in Equation (1) we have:

$$\mathbf{T10.8 - T12.0 = (Tsfc - Tair) * \Delta\tau}$$

   By applying Equation (3), and assuming Tair the SEVIRI channel IR13.4 brightness temperature and Tsfc a SST obtained from a Split Window algorithm, the TPW algorithm becomes the Split-Window Difference Algorithm called SD algorithm:

$$\mathbf{TPW = B + A * [(T10.8 - T12.0) / (SST - T13.4)] * \cos\theta} \qquad (4)$$

Total Precipitable Water algorithms

2. When the Surface Temperature accuracy cannot be assured, using Equations (1) and (2) applied to the IR10.8 and IR12.0 channels and eliminating Tsfc, the difference in brightness temperature is related to the differential absorption projected along the Zenith angle:

$$(T10.8 - Tair) \; / \; (T12.0 - Tair) = EXP\,[\, (\Delta\alpha + \Delta\beta * PW) * \sec\theta]$$

Assuming Tair the SEVIRI channel IR13.4 brightness temperature, the resulting algorithm for TPW over **LAND** called Logarithm Ratio or LR Algorithm is:

$$TPW = B + A * LN\,[\, (T10.8 - T13.4) / (T12.0 - T13.4) \,] * \cos\theta \qquad (5)$$

Total Precipitable Water algorithms

Coefficients have been obtained with real SEVIRI data from October, November and December 2003 using Radio Soundings for LAND and ECMWF data for SEA

- **Land Algorithm: TPW (mm)= B + A * LN [(T10.8 – T13.4) / (T12.0 – T13.4)] * cos θ**

  With coefficients:

	A	B	R
LAND DAY	219,11	6,88	0,75
LAND NIGHT	227,34	10,46	0,69

- **Sea Algorithm: TPW (mm)= B + A * [(T10.8 - T12.0) / (SST – T13.4)] * cos θ**

  With coefficients:

	A	B	R
SEA DAY/NIGHT	429,87	1,79	0,79

Total Precipitable Water inputs and output

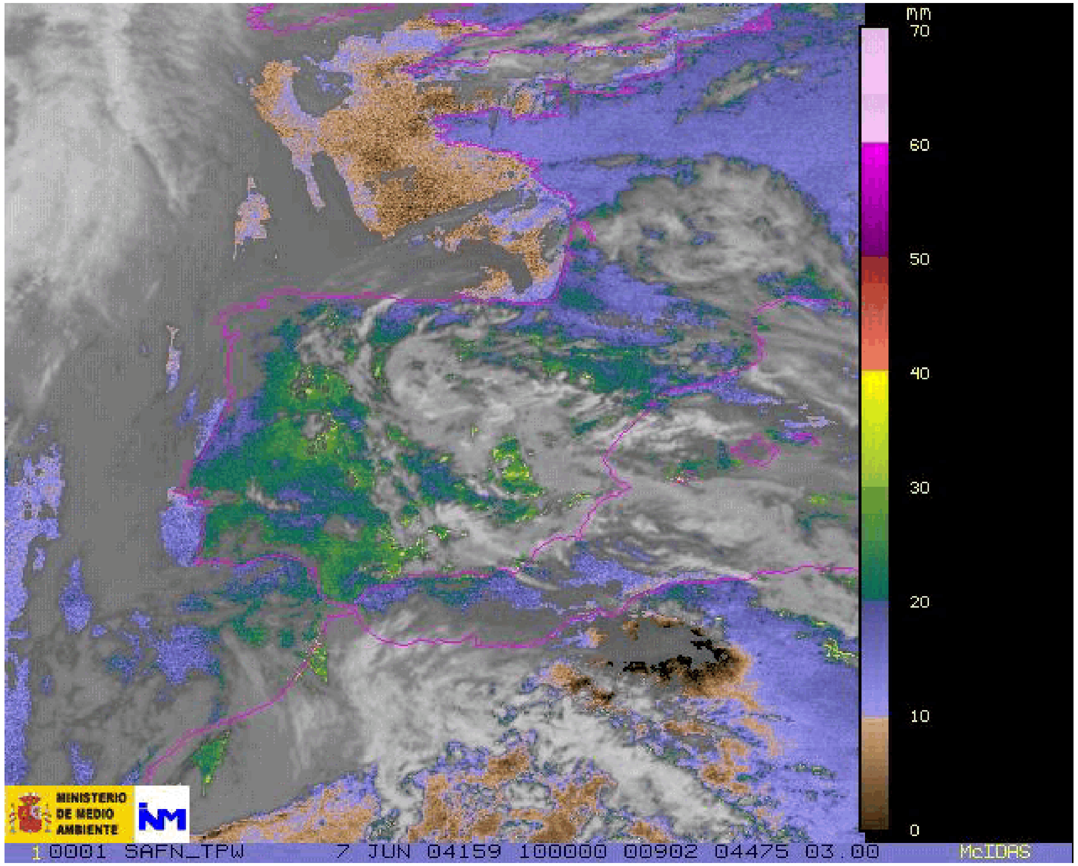
INPUTS:

- SEVIRI data at full IR spatial resolution: **T10.8 μm, T12.0 μm & T13.4 μm**
- Auxiliary data: **CMa, TPW** (from previous slot for QC)
- Ancillary data: **Land/Sea atlas, Sun Zenith Angle & Satellite Zenith Angle**

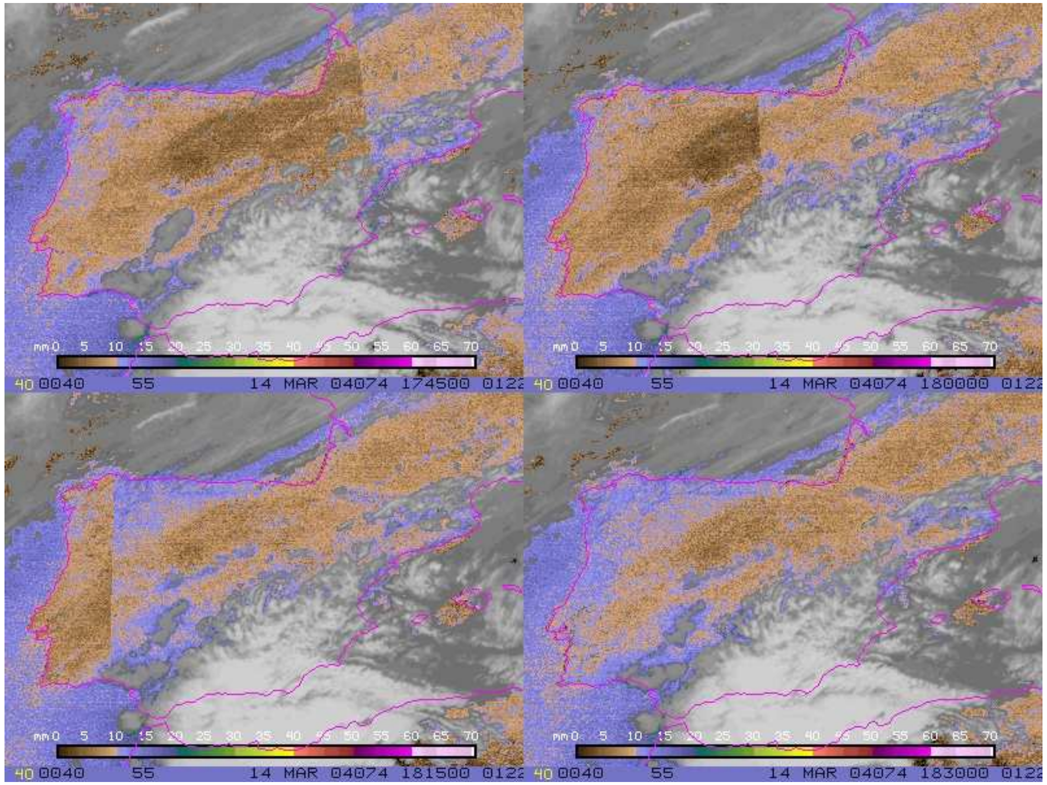
OUTPUT:

The output is an image in HDF-5 format with TPW values in mm in clear areas and enhanced IR10.8 in cloudy areas.

TPW Loop

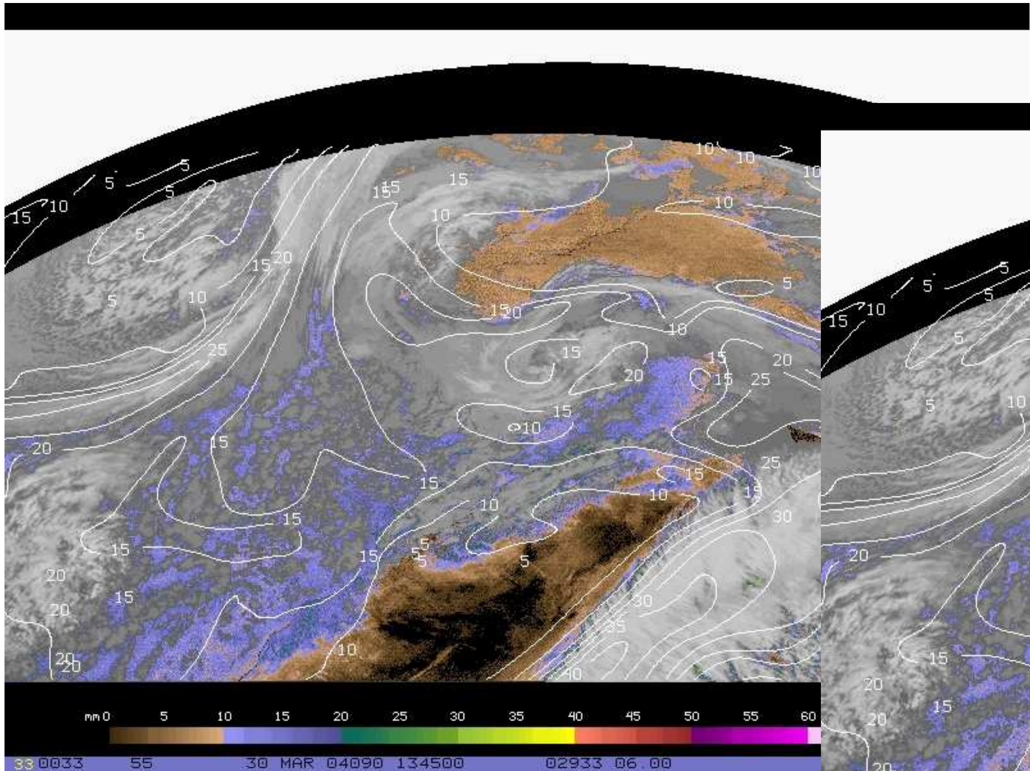

mm
70
60
50
40
30
20
10
0
MINISTERIO DE MEDIO AMBIENTE
INM
1 0001 SAFN_TPW 7 JUN 04159 100000 00902 04475 03.00
McIDAS

TPW day/night gap

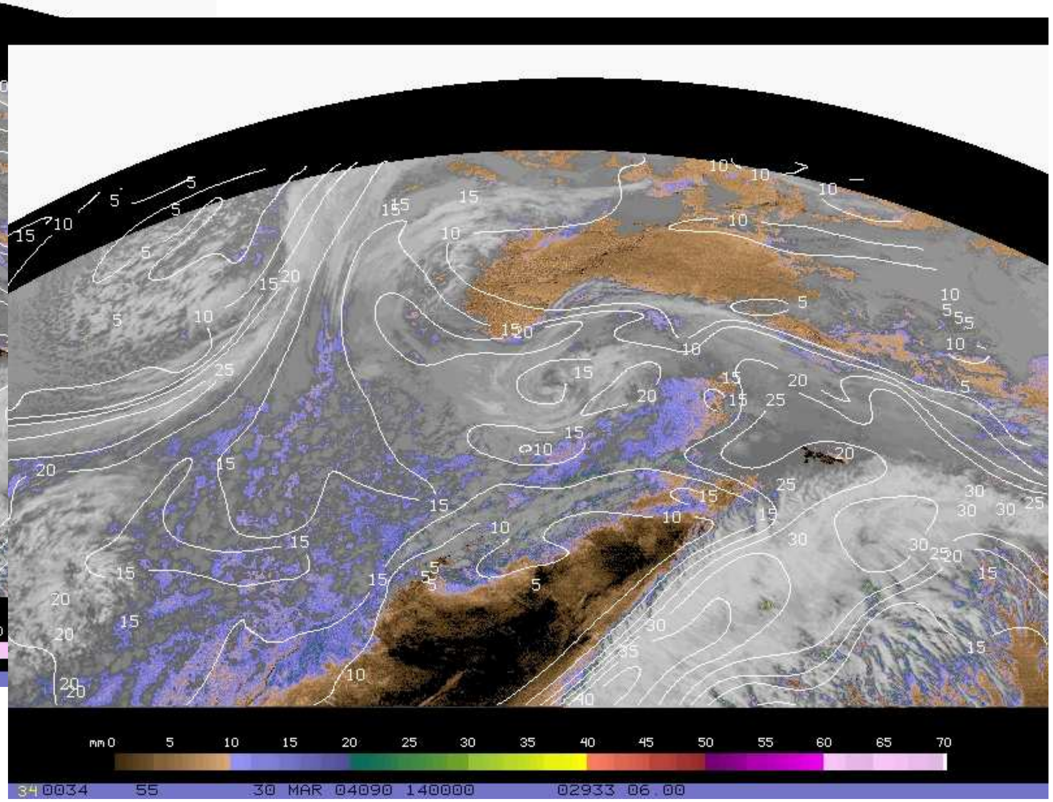


TPW calibration changes impact:

30th March 2004



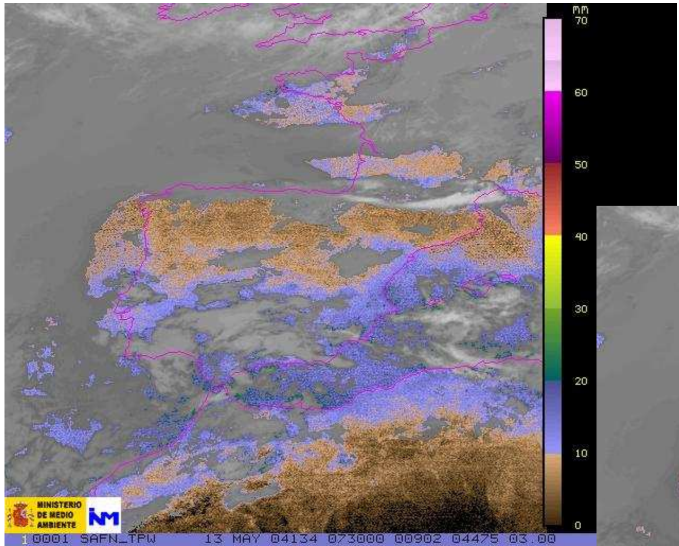
13:45



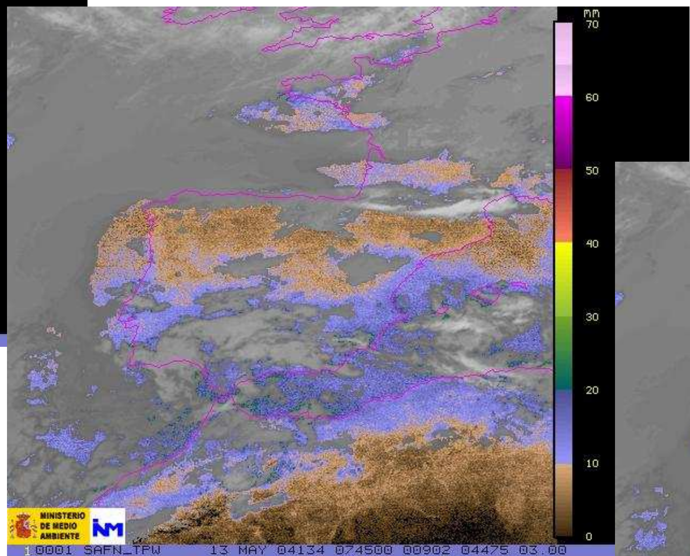
14:00

TPW calibration changes impact:

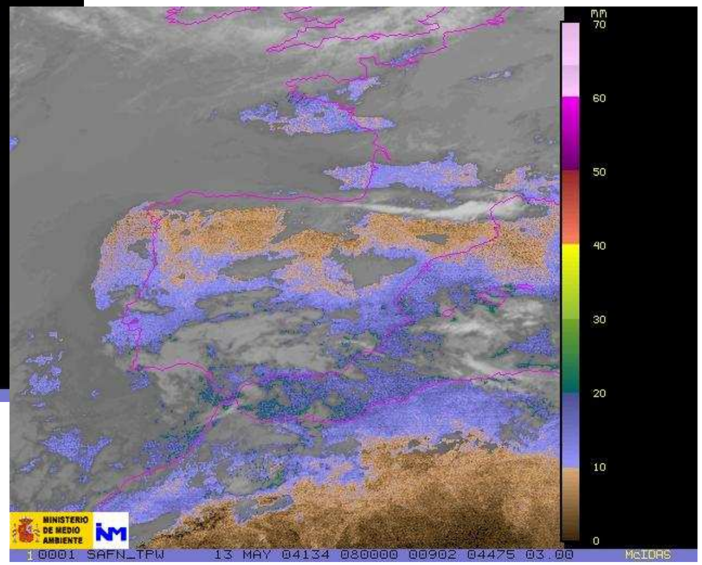
13th May 2004



07:30

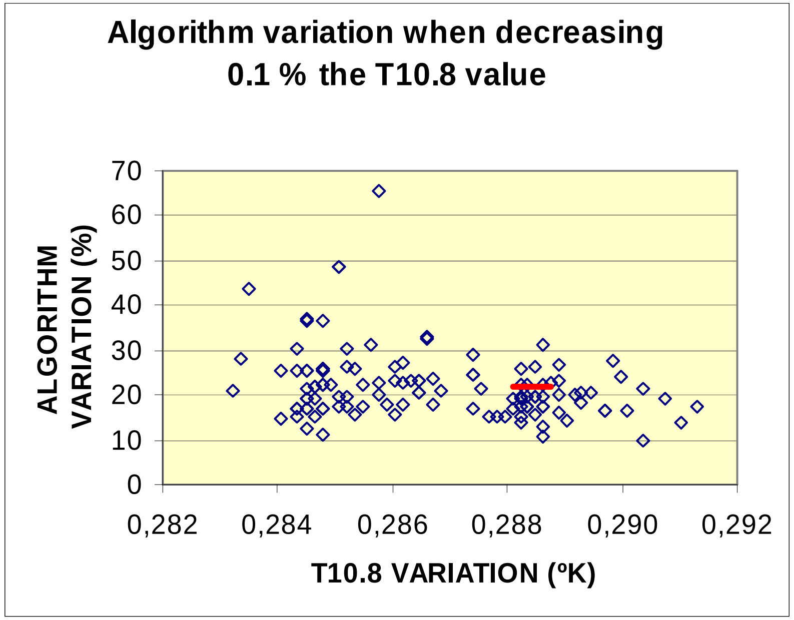


07:45

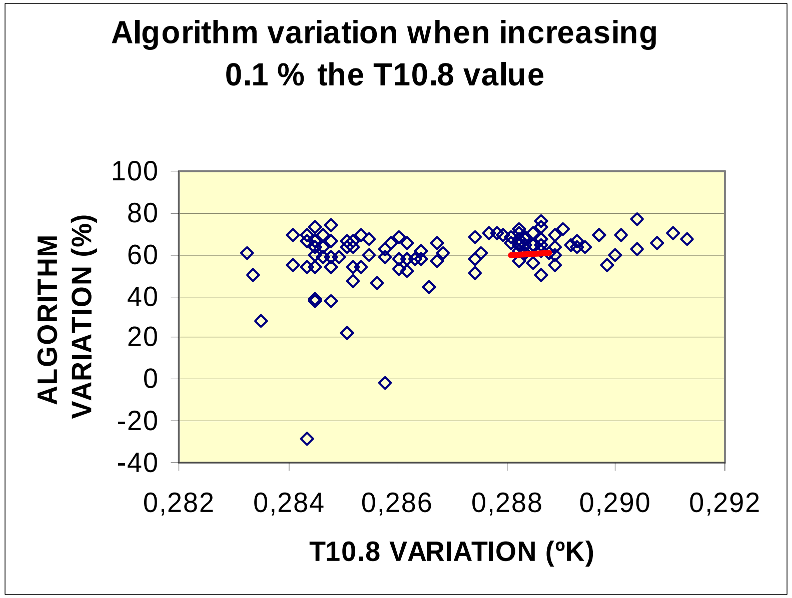


08:00

Calibration changes impact in TPW over SEA: IR10.8



22% average



60% average

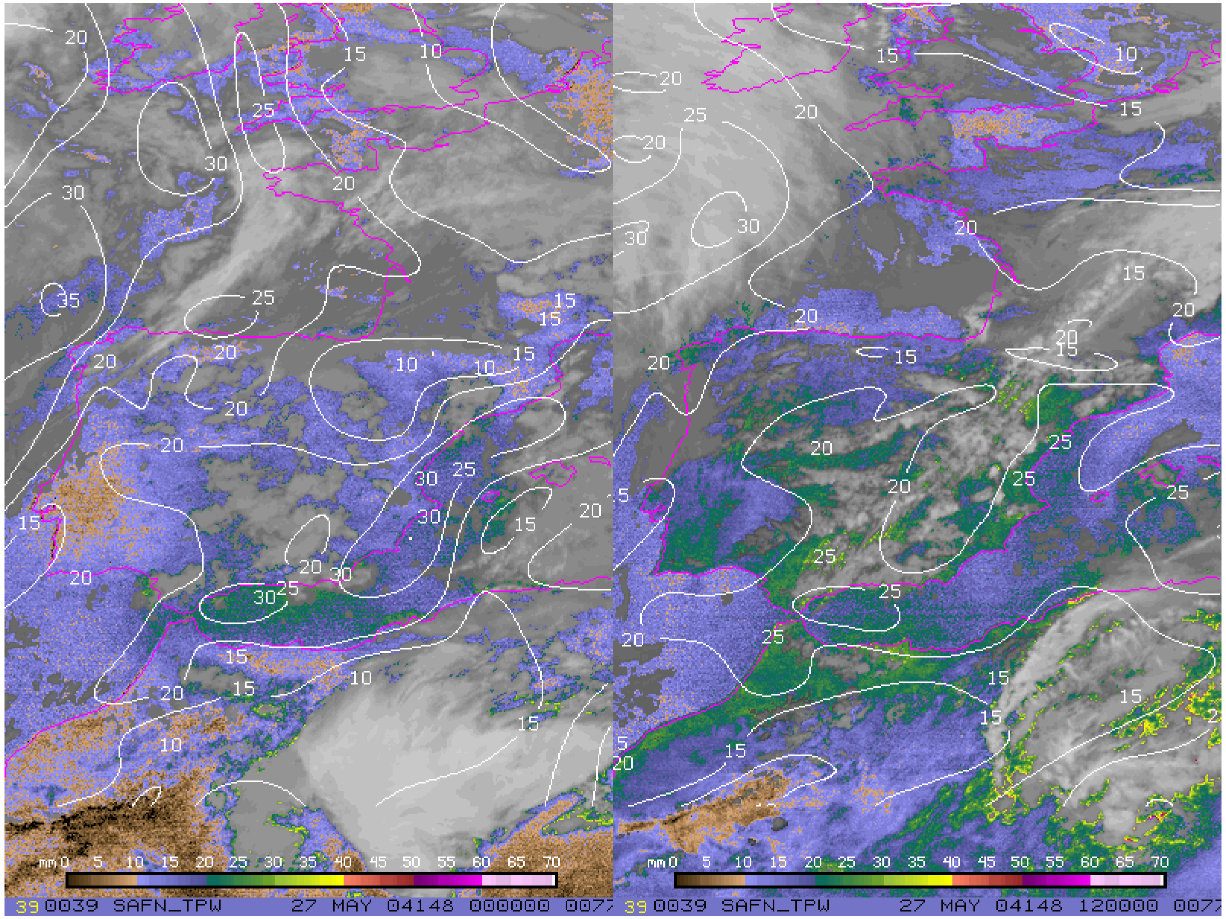
The variation is less than 10% over LAND

TPW examples and limitations

27th May 2004

- ✓ Sea values are mainly lower than actual
- ✓ Night land values lower than actual
- ✓ Higher values than actual in cloud edges

00:00



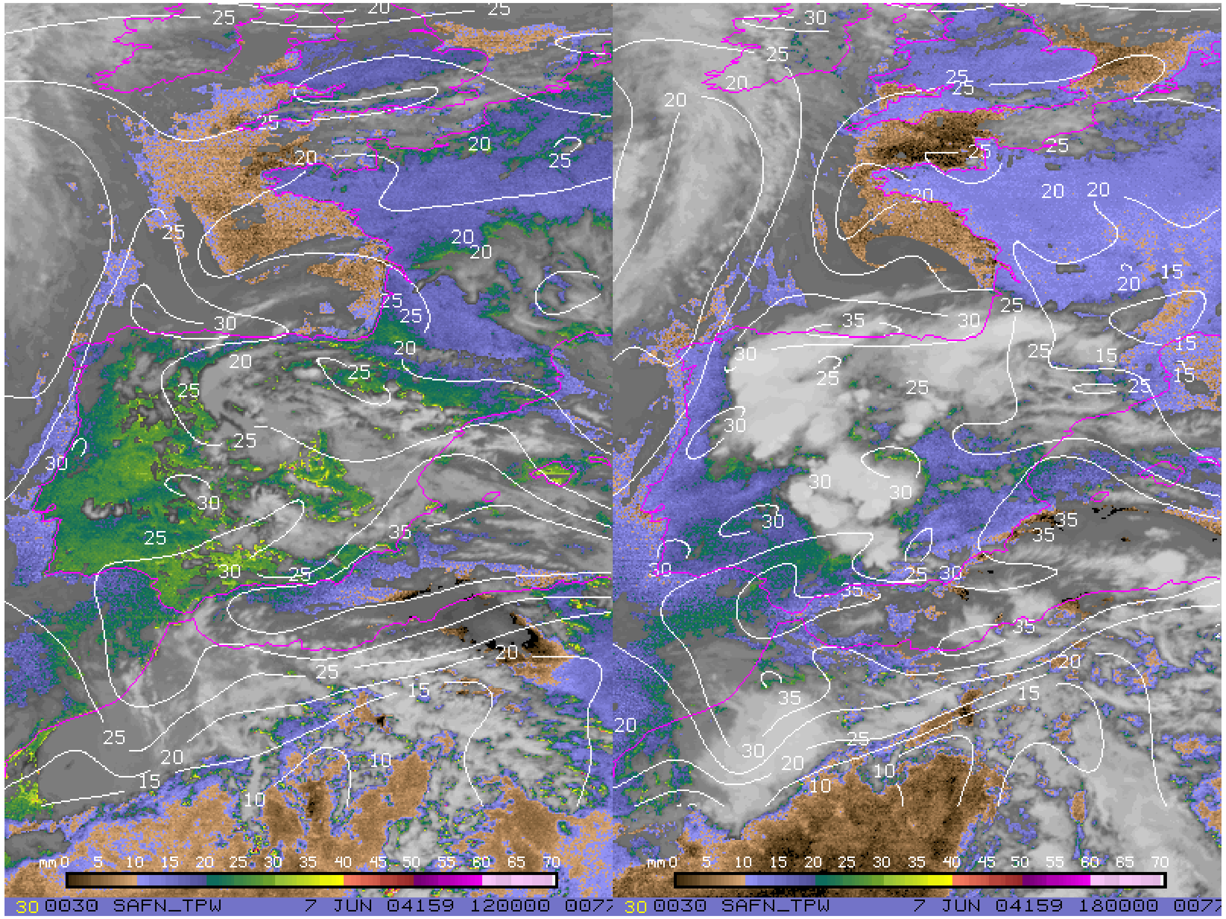
12:00

TPW examples and limitations

7th June 2004

- ✓ Very low values when dust contamination
- ✓ LAND/SEA gap due to lower values over sea
- ✓ Relatively high TPW values prior to convection
- ✓ ECMWF TPW features mainly agrees with TPW SEVIRI data

12:00



18:00

Conclusions

- The PGE06 TPW has to be re-calibrated using a full year data
- Coefficients variability over LAND has to be monitored in function of the sun zenith angle
- The use of WV SEVIRI channels has to be studied
- The improvement over SEA includes an improvement of the SST algorithm (O&SI SAF)
- Taking in account the current limitations, the TPW relative values obtained can be useful in situations prior to convection