Air Mass Analysis

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…principal problems of validation still remain

- The key problem of the validation of the air mass classification product: “There is no unique or optimal way for classifying air masses or weather types” (Bejarán and Camilloni, TAC, 74, 93-103)
- Not only is there a multitude of methodologies, but also no consensus on classes (#: 4 – 19)
- "The only foundation is that significantly different air masses should not be designated equally and air masses without a significant difference should not be designated with different namings". (Geb, 1981, Meteorologische Abhandlungen, Institut für Meteorologie der Freien Universität Berlin, Serie B, Band 31, Heft 4, SO 7/81.)

Temperature issue in AM classification (another 2005 statement)

- Surface temperature turned out to be no good air mass descriptor… (but is the primary variable in AMA)
- (As so many other MSG products) jumps at coastlines as permanent feature
- Diurnal changes in classification not in agreement with air mass notion
- Even though there is no absolute reference classification it is possible to predict that tuning of temperature thresholds will not resolve the problem → inspection of alternative concepts
- Envisaged alternative parameters: Vertically integrated/averaged temperature: Tropopause height / ozone content

Validation and tuning of the supplementary products? (2005)

- Dark stripes in WV (ch.5) imagery
- Ridge lines of equivalent-potential temperature (purely NWP-based)
- Pre-frontal temperature gradient zones (much NWP, some IR 10.8 influence)
- Generally, these are patterns whose connection to triggering of convection is proven – yet without a stringent “if….then…”-relationship….
- Hence, objective validation of the type “pattern! → convection?” will yield enormous false alarm rates…
- …not reflecting the usefulness to forecasters who have learned to handle such information.
- But then…what remains for validation and tuning?

Validation and tuning! (2005)

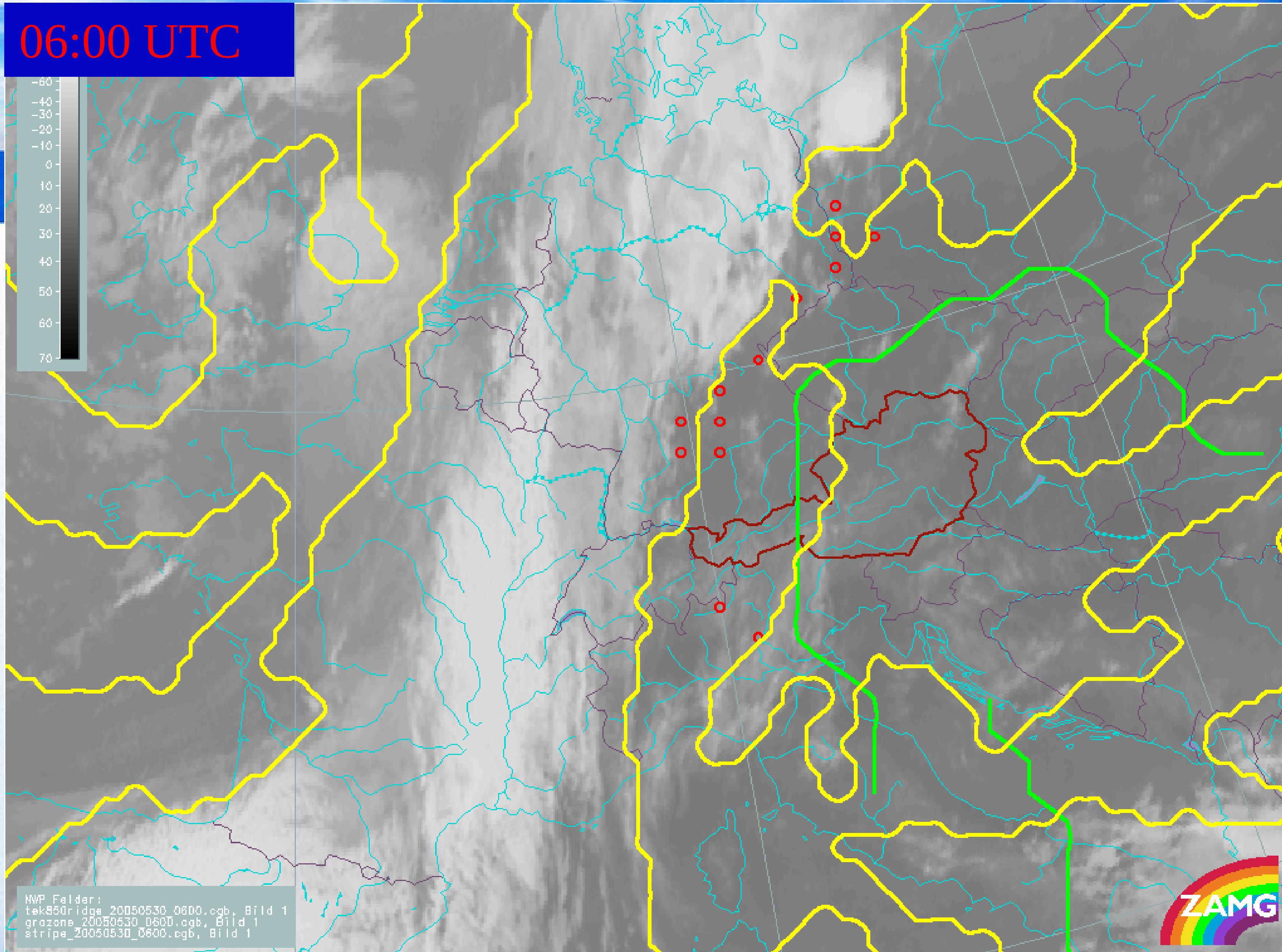
- Verify / improve objective recognition through comparison with subjective analyses of patterns, consideration of temporal continuity

✓ To a large degree work of the development phase – behind us!

- Validate the completeness of the product catalogue

✓ Done in 2005. Approach: 1) convection! → pattern? 2) If not, what could be the missing complement?

(answers: 1) dark stripes and θe ridge lines regularly found, gradient zone less so; 2) nothing identified)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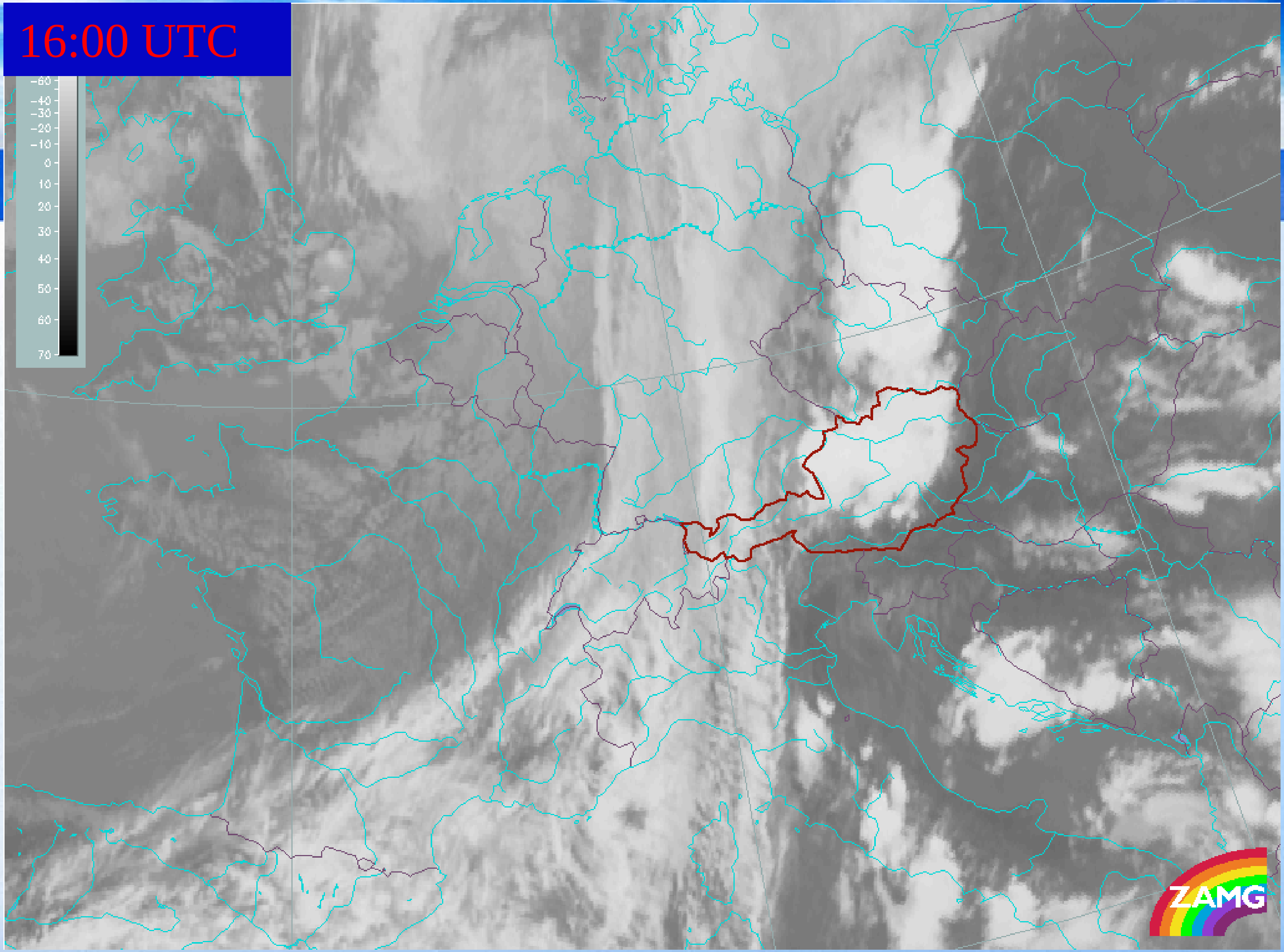
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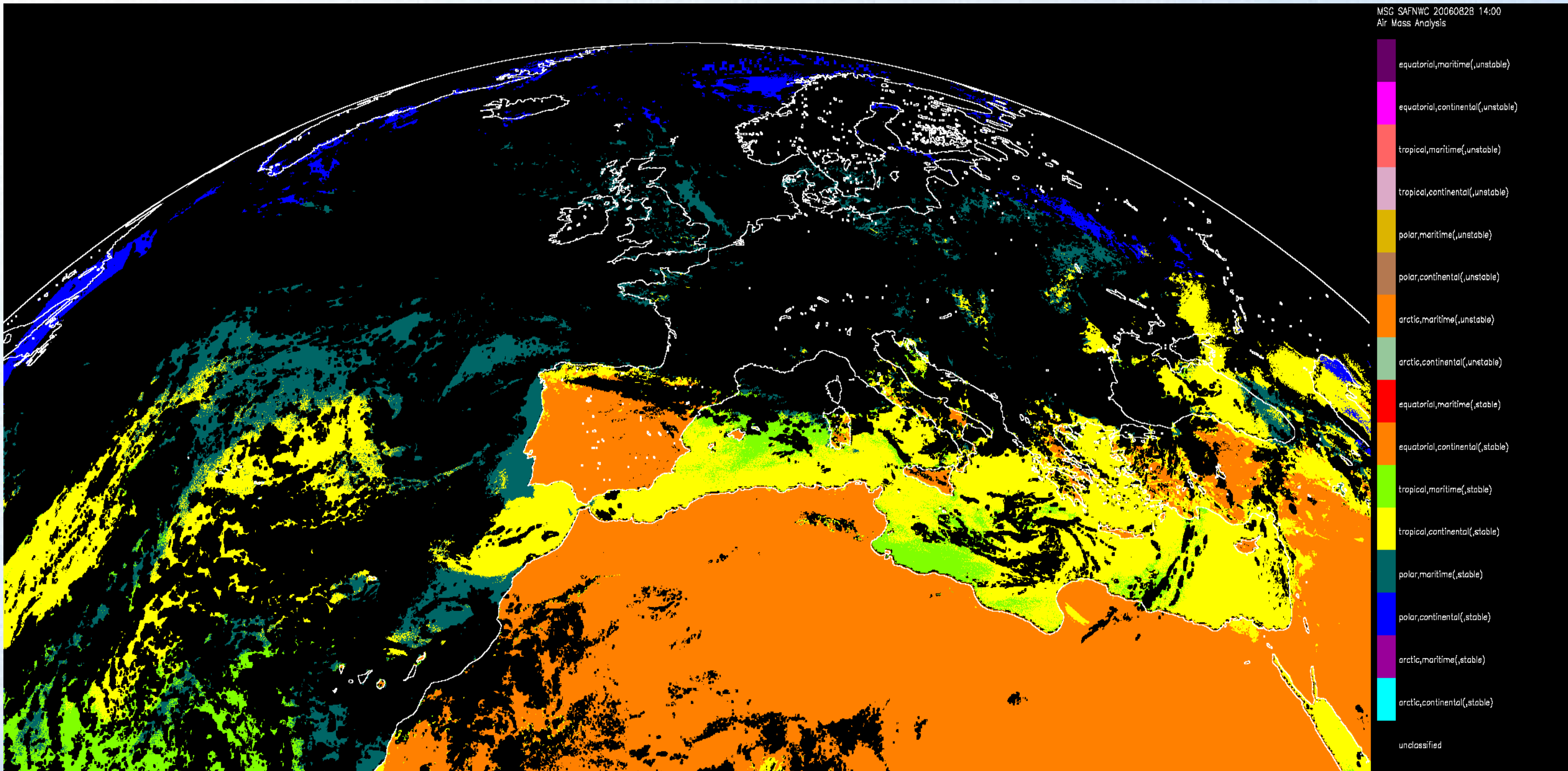
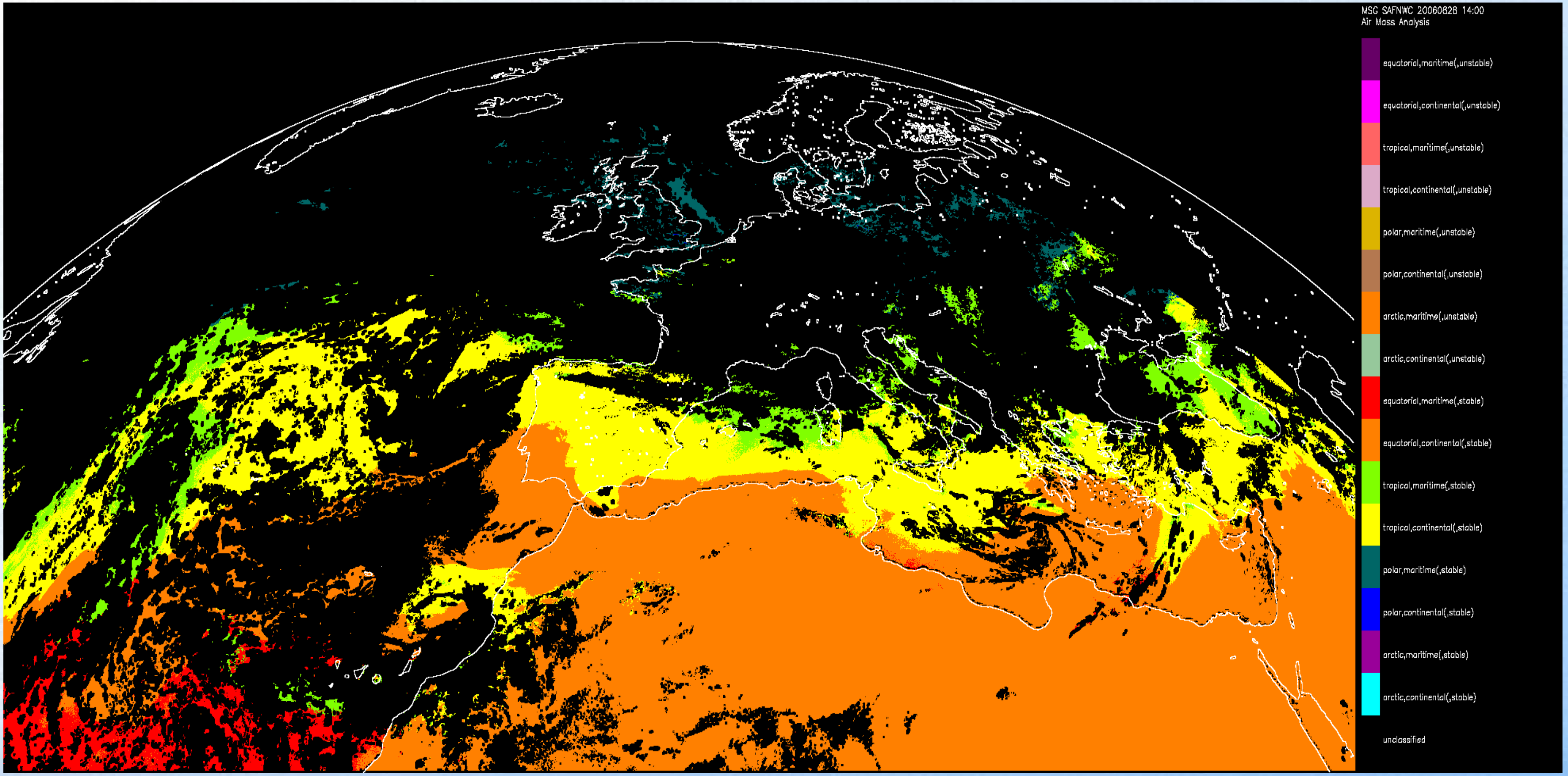
Advances in CDOP

- Products can be derived on arbitrary user-selected regions now
- WV stripe product and equivalent-potential temperature ridge lines: pattern recognition techniques proved robust, little reason for action; gradient zone product became an image-like product
- New air mass classification product:
  - finding reference pixels where IR13.4 "almost certainly" indicates the correct air mass type.
  - Multiple regression: WV7.3 brightness temperature at these pixels - latitude - longitude - air mass type (categories "arctic" to "equatorial" numerically translated to an "air mass code" from 1.0 - 4.0). The method thus 'interpolates' the "almost certain" air mass types along the structures of WV7.3.

Air mass classification product (IOP)



Air mass classification product (CDOP)



IASI and ATOVS level-2 profiles

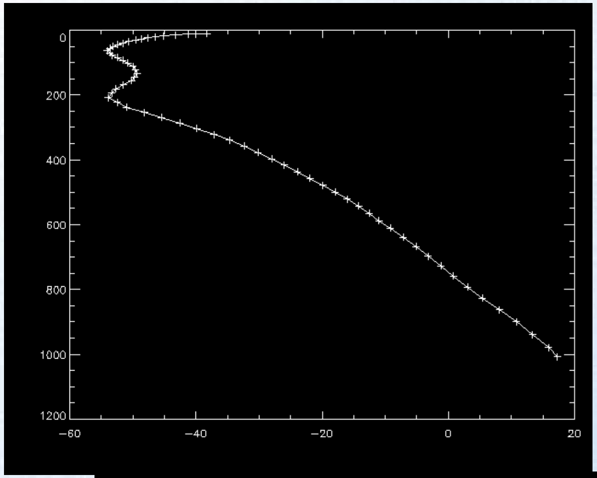
? A new ingredient for validation of air mass classification via, e.g.:

Airmass type	*Tropopause height range (Pressure p in hPa)*	*Colour coding used in subsequent diagrams*
Arctic	$p > 300$	Blue
Polar	$225 < p < 300$	Cyan
Tropical	$135 < p < 225$	Yellow
Equatorial	$p < 135$	Red

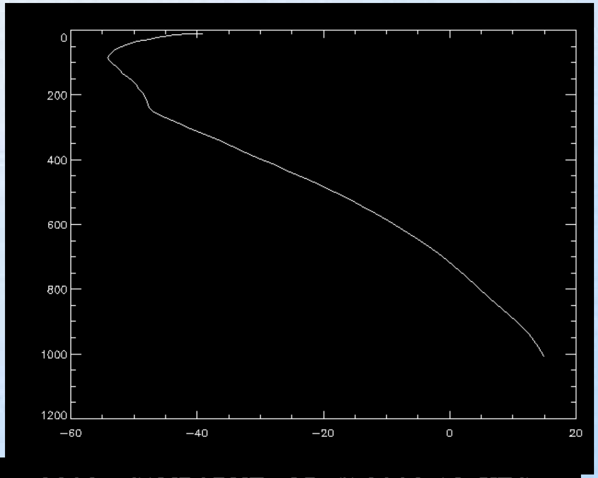
? or perhaps even more

MetOp vs. radiosounding

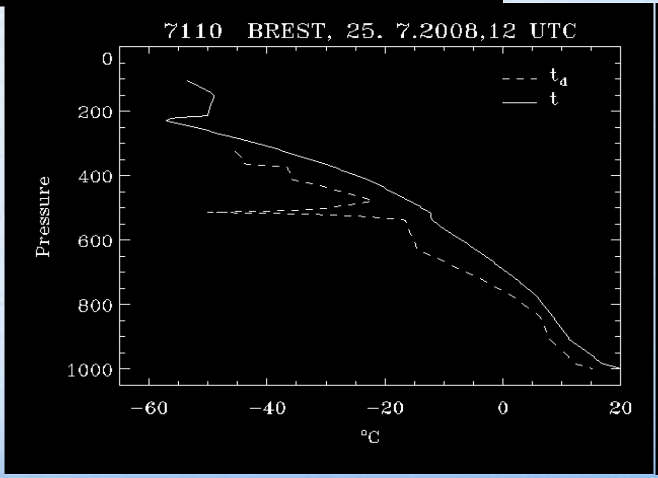
IASI

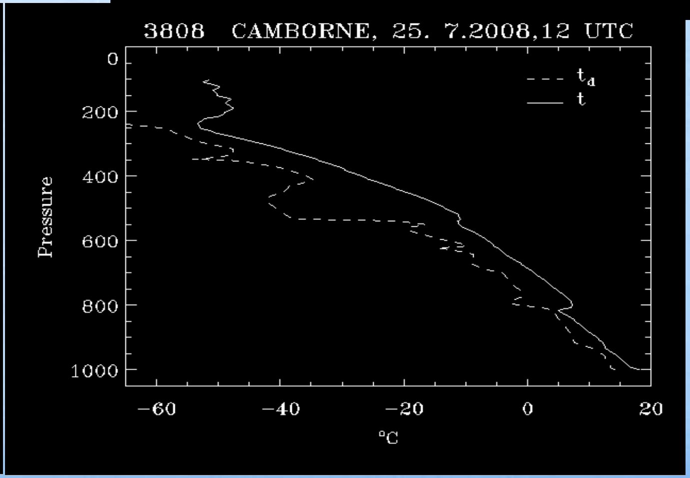


ATOVS

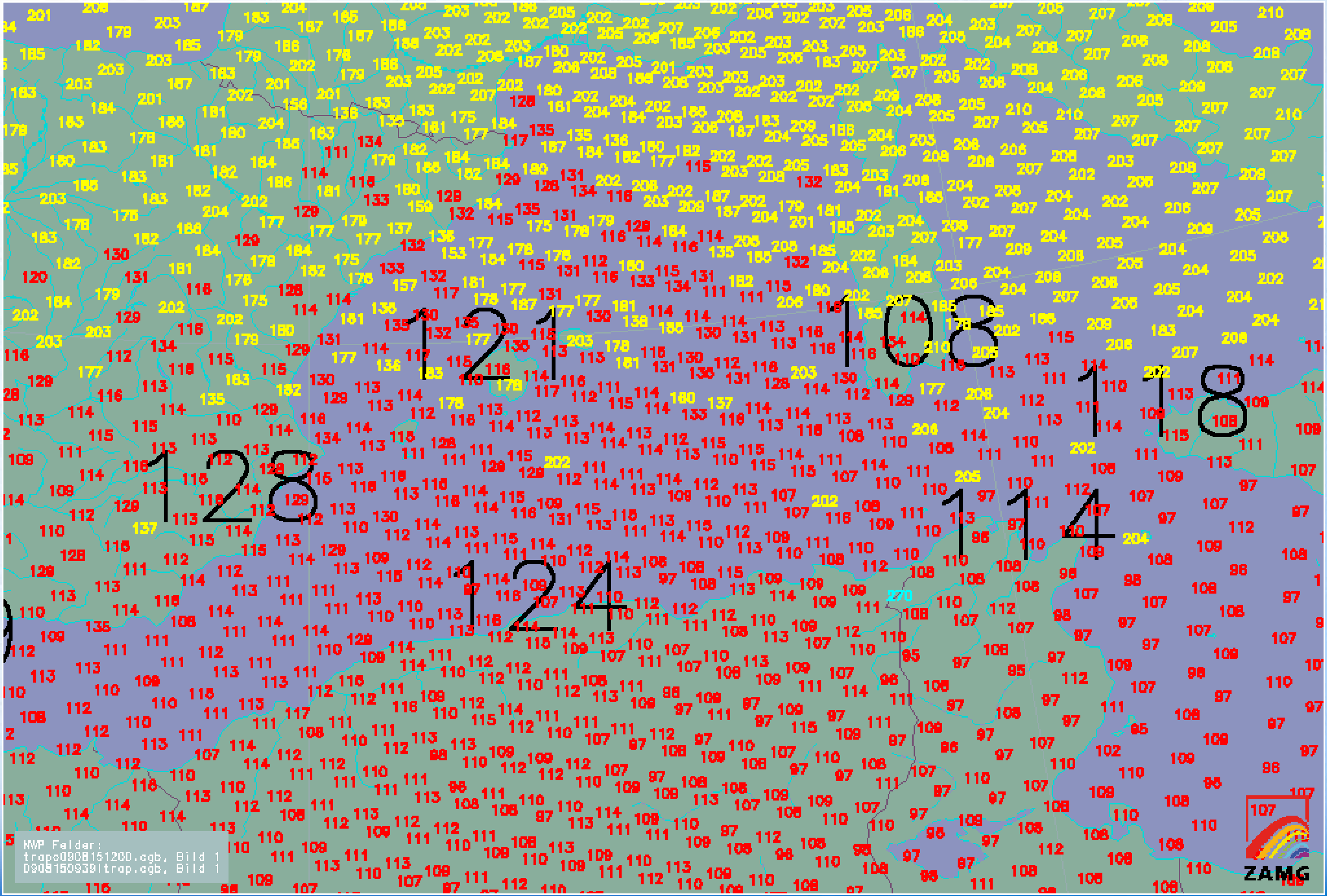


RASO

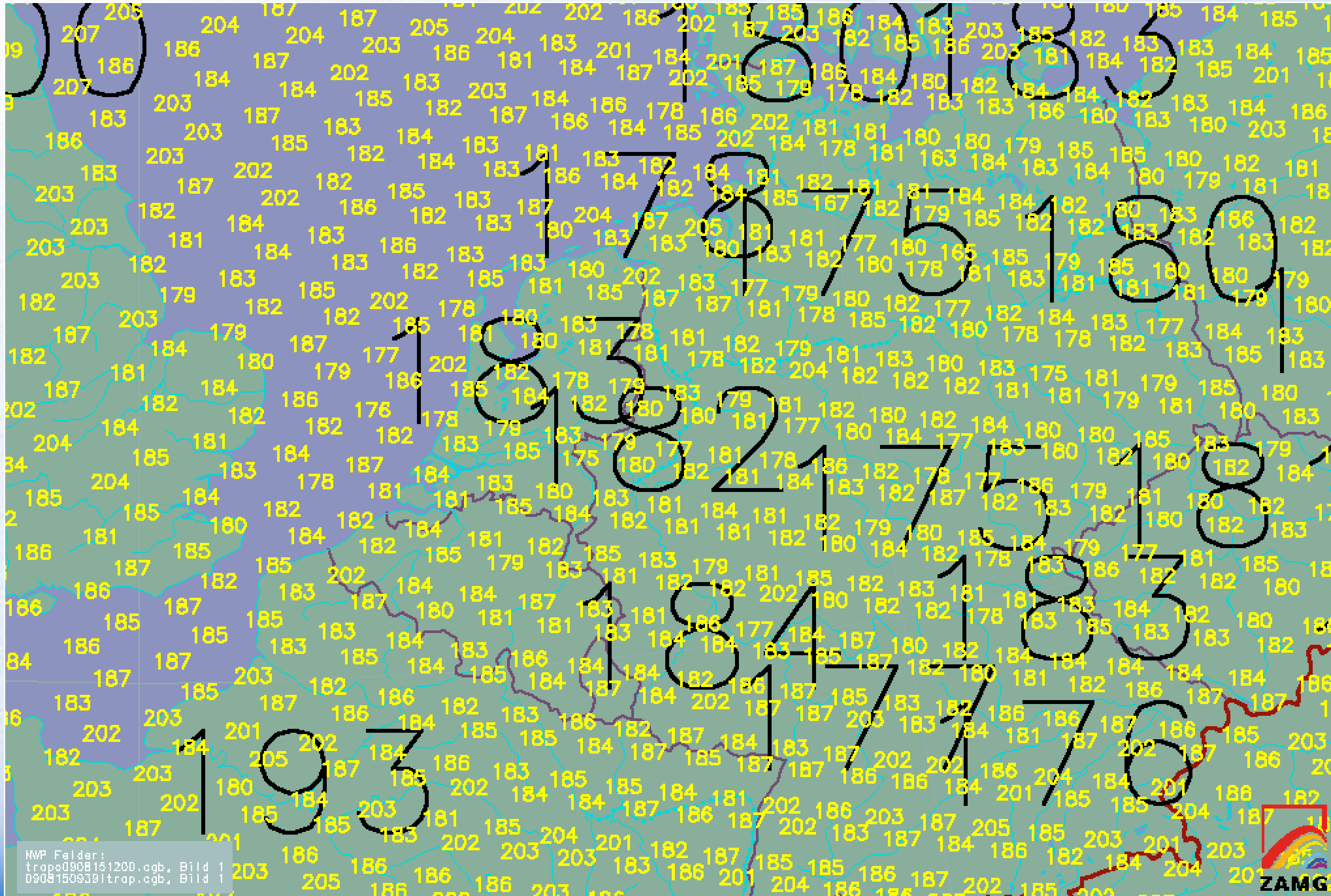




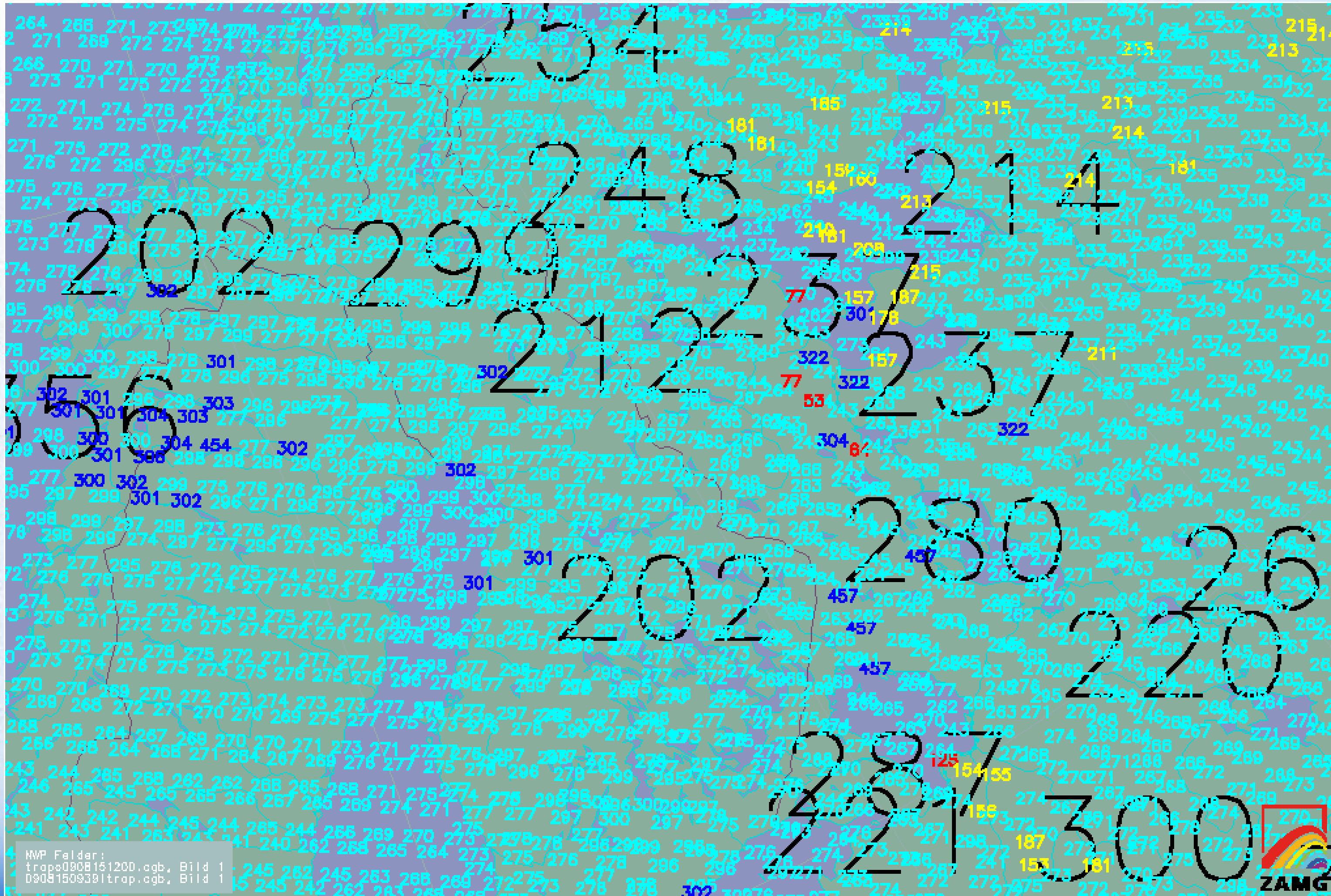
IASI vs. RASO – equatorial air mass



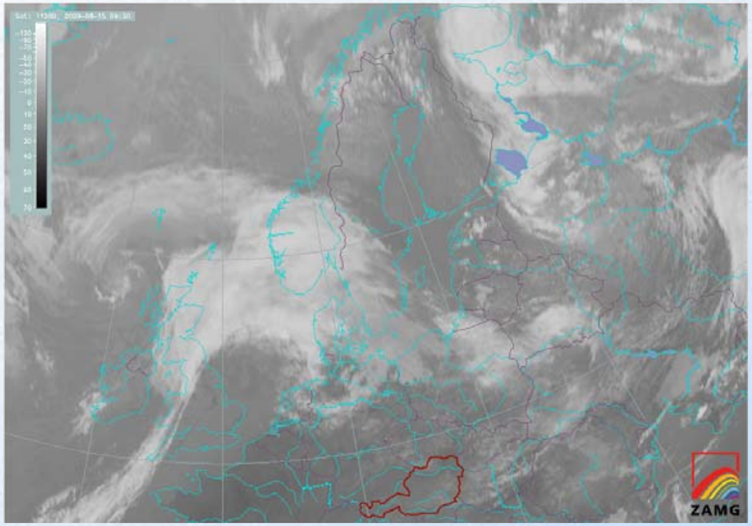
IASI vs. RASO – tropical air mass

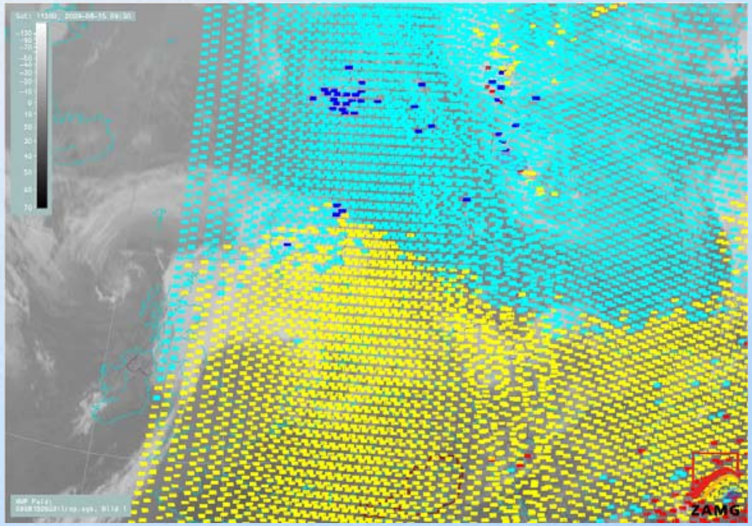


IASI vs. RASO – polar air mass

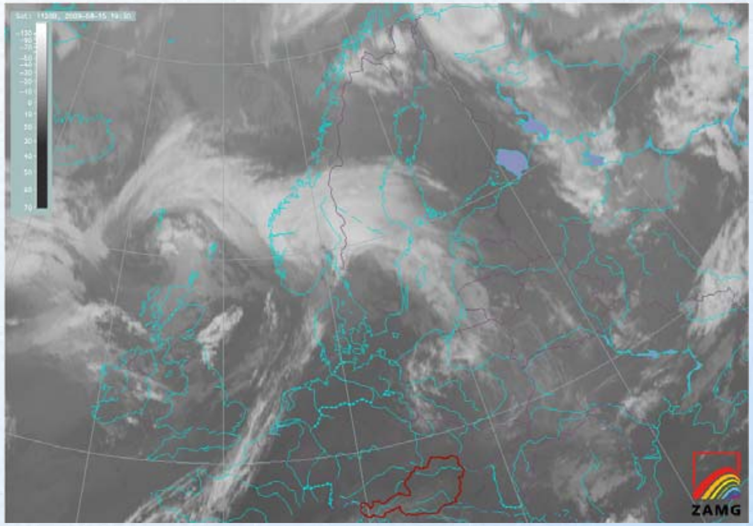


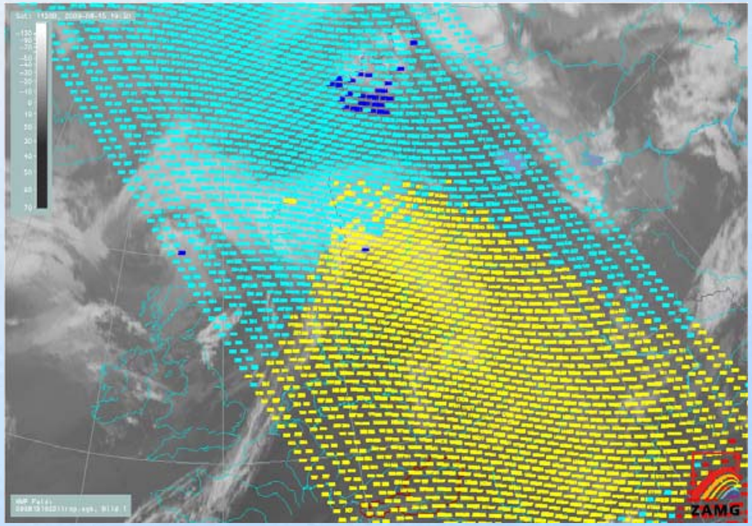
Synoptic view – morning orbit



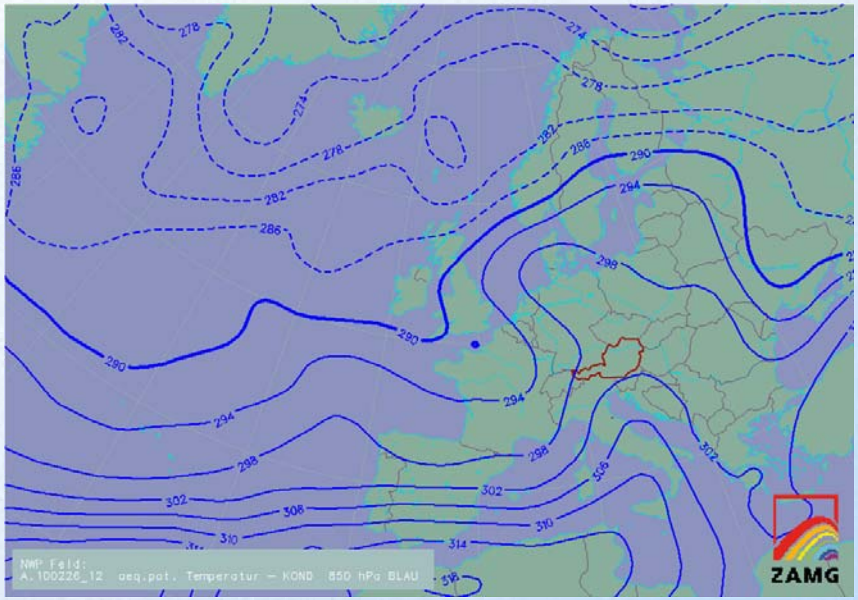


Synoptic view – evening orbit

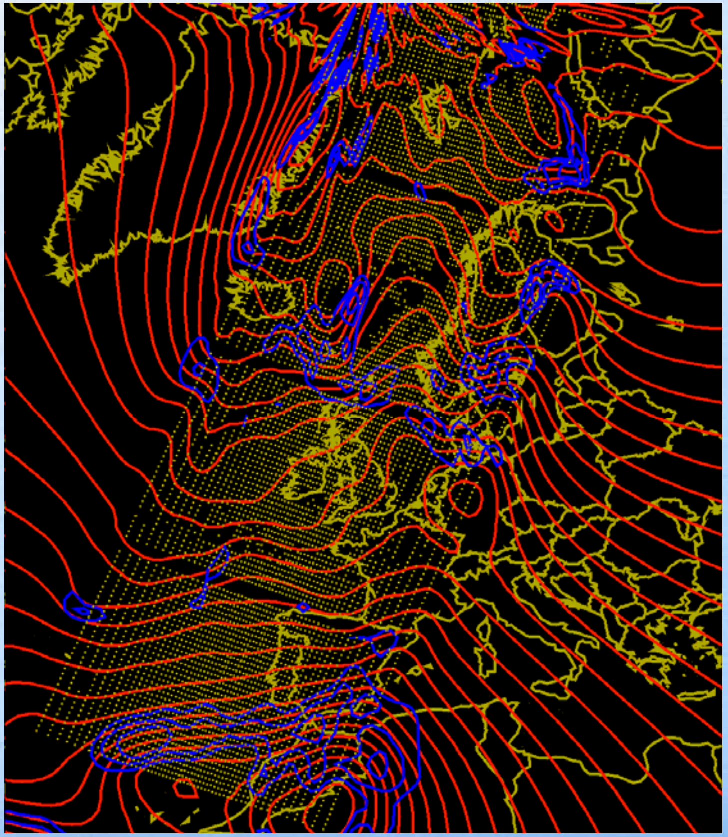




ECMWF analysis

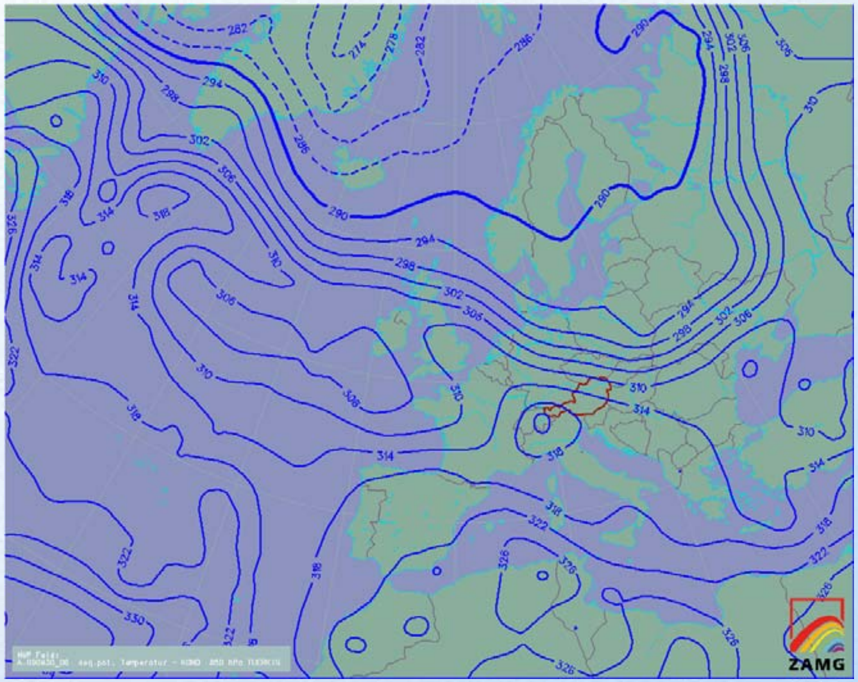


ATOVS L2

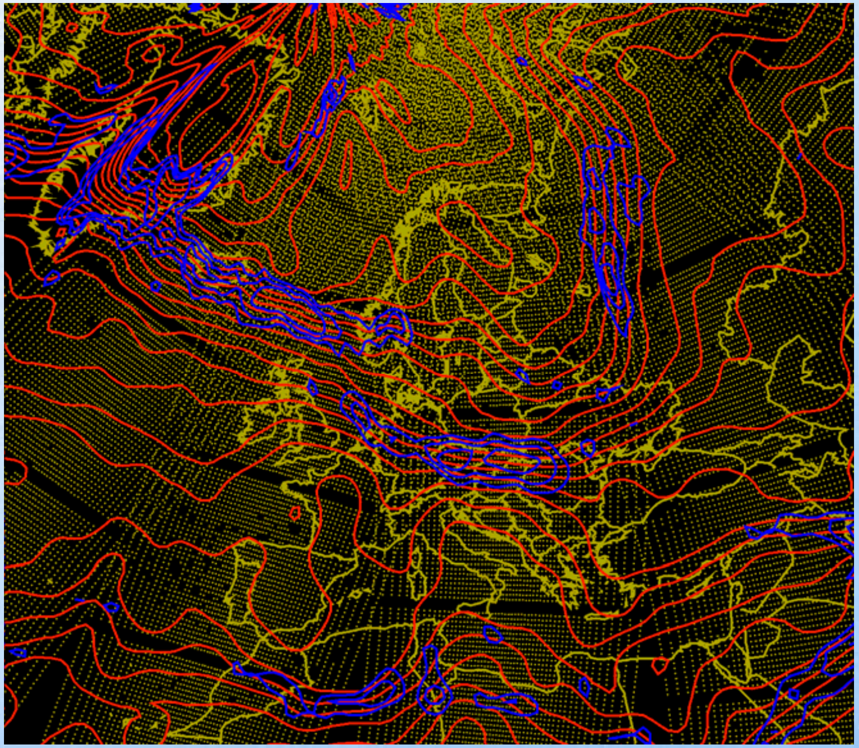


Equivalent-potential temperature products from ATOVS?

ECMWF analysis



ATOVS L2



MetOp and AMA - Conclusion

- IASI L2 tropopause proved useful in MSG product tuning…
- …even to such a degree that we had to *ask ourselves* whether we shouldn't make PPS tropopause) *the* AMA product (cloudy areas !!!!)
- *Asking the user* in the 2010 survey yielded:
  - 2 votes for a combined Metop-MSG product
  - 1 vote in favour of „geostationary only“
  - No one opted for „separate MetOp and MSG product“ or „MetOp only“

Air Mass Analysis – envisaged way forward

- Freeze MSG development
- Include IASI L2 tropopause derivation in PPS package
- Attempt blending with SEVIRI (most probably WV7.3) (provided it can be accommodated in the CDOP-2 proposal)
- Alternatively, envisage tropopause height derivation from MTG-S in a more distant future
- In case a user need can be identified, take ATOVS gradient zones and ridge lines onboard the PPS catalogue

Validation of the Automatic Satellite image Interpretation ASII-PGE10 v2010

NWC SAF 2010 Users' Workshop

Outline

Methodology

Validation dataset

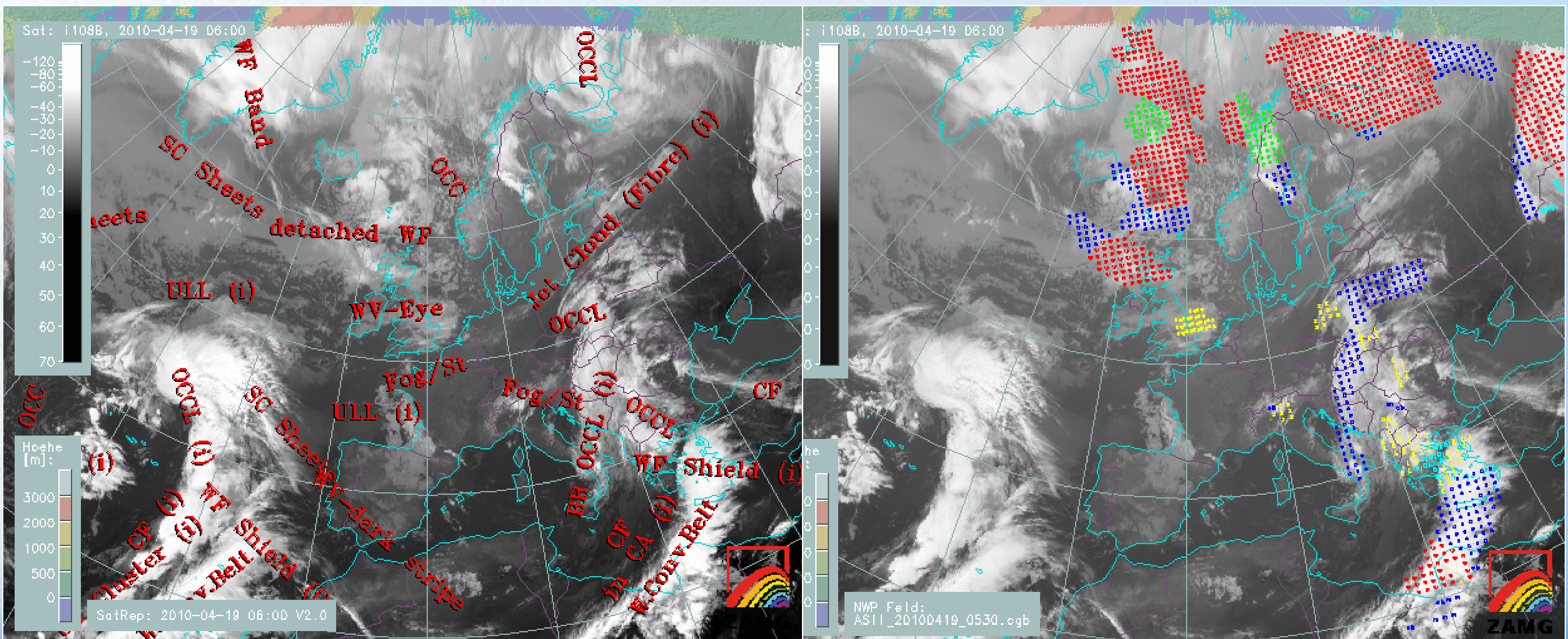
Validation approach:

- Evaluation of the overall stability of the product
- Investigation on minimum grid size
- Evaluation of the Stability of PGE10 against a small displacement of the processing area

Conclusions

Methodology

Previous validation attempts focused on the comparison of ASII to the manually generated SatRep



Methodology

A new approach for validation:

Evaluation of the product stability by grid wise inspection of the ASII output.

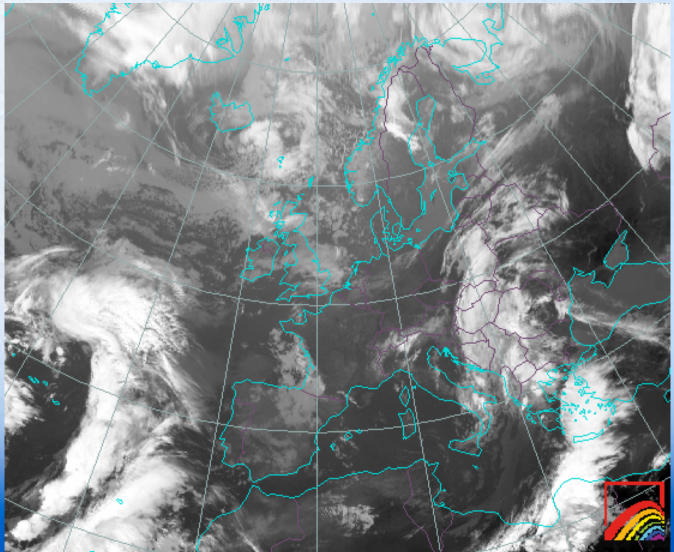
3 investigations were undertaken focusing on product stability

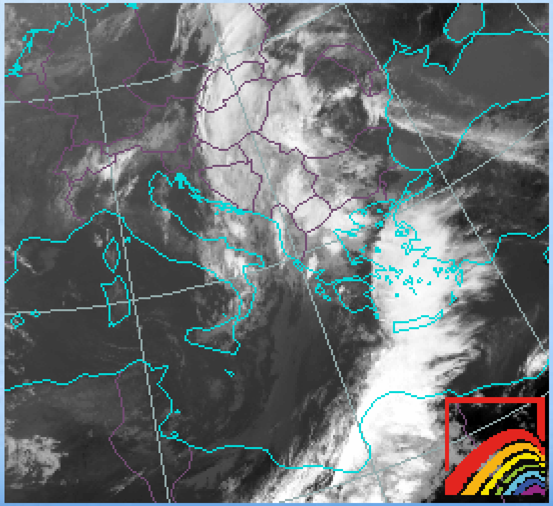
- Testing the product stability by reducing the grid size
- Investigations on minimum grid size to obtain a stable output
- Stability of PGE10 when the analysis grid is slightly shifted

Testing the product stability by reducing the grid size

This first investigation should help clarifying two questions:

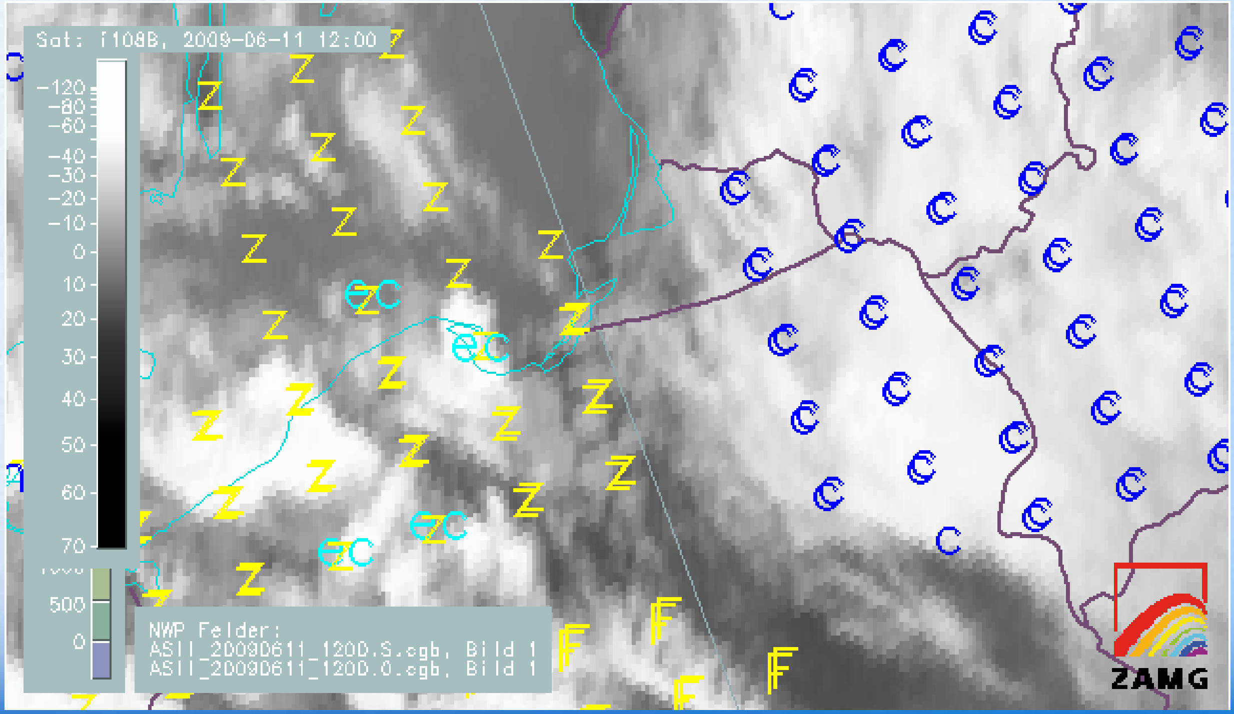
- How stable is the analysis of PGE10 when reducing the ROI (but preserving the geographical position of the remaining grid points)?
- What is the minimum size of the ROI for a certain conceptual model to be analysed automatically with sufficient quality?





Stability of PGE10 when the analysis grid is slightly shifted

To analyse the effect of slight image shifts on analysis stability, two displacements were made, shifting the image center by a few pixels relative to the reference grid on the original satellite projection.



Validation dataset

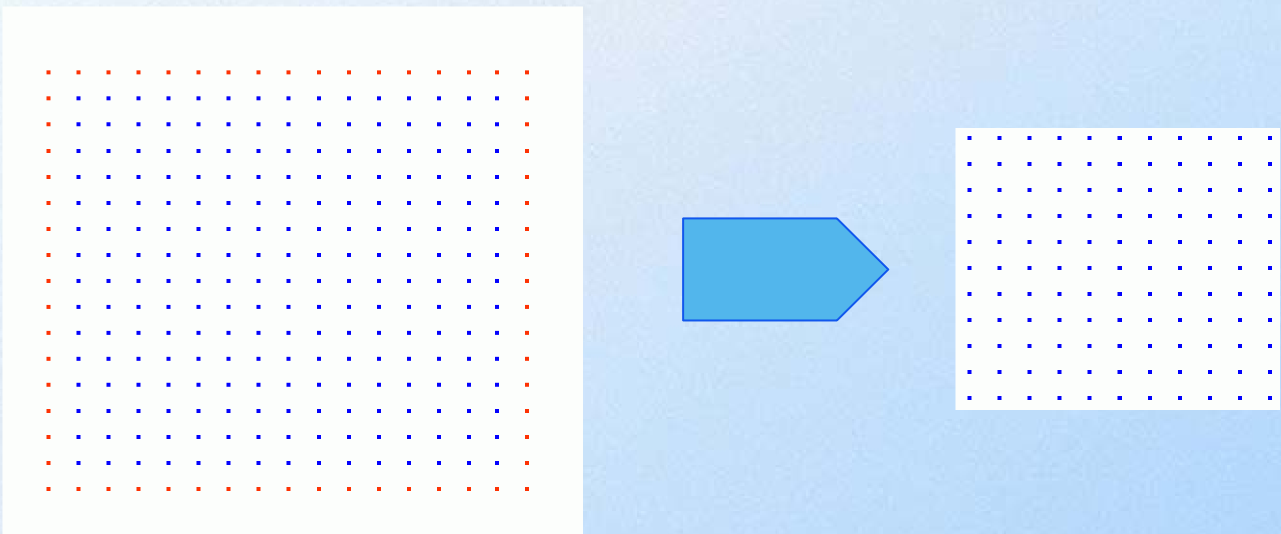
A validation dataset containing 20 cases was used, comprising scenes from winter and spring to early summer season. The cases from the early summer season 2009 were specifically selected with the aim of catching pronounced convective situations.

The dataset comprises the dates:

19 June 2007	03:00 UTC	1 June 2009	12:00 UTC
19 June 2007	15:00 UTC	10 June 2009	12:00 UTC
22 January 2008	12:30 UTC	11 June 2009	12:00 UTC
23 January 2008	07:30 UTC	22 June 2009	12:00 UTC
25 January 2008	00:30 UTC	25 June 2009	12:00 UTC
26 May 2009	12:00 UTC	27 June 2009	12:00 UTC
27 May 2009	18:00 UTC	28 June 2009	12:00 UTC
28 May 2009	06:00 UTC	29 June 2009	18:00 UTC
29 May 2009	12:00 UTC	30 June 2009	12:00 UTC
30 May 2009	18:00 UTC	1 July 2009	12:00 UTC

Evaluation of the overall stability of the product

Stepwise shrinking of the processing area from 100x100 grid points to 50x50 grid points.



Evaluation of the overall stability of the product

Frontal categories:	WF: 97,8%
	CF: 93,9%
	OC: 87,2%
Frontal Substructures:	WA: 88,8%
	WA+: 92,67%
	DI: 97%
Convection:	CB, MCS and embedded MCS: ~99%
Cold Air Features:	EC: 96,3%
	CO: 99,6%
	CAC: 99,46%
Other:	Jet Cloud Fibres: 99,8%
	Lee Clouds: 99,5%

Evaluation of the overall stability of the product

	n.a	WF	CF	WA	WA+	OC	DI	EC	CB	CB+	CB-	FIB	MCS	MCS+	MCS-	FMCS	FMCS-	CO	LEE	CAC
WF		97.81	0.84																	
CF		4.43	93.97																	
WA				88.8																
WA+					92.67															
OC		1.5				87.2														
DI							96.96													
EC								96.3												
CB									99.06											
CB+										98.9										
CB-											99.00									
FIB												99.87								
MCS													98.87							
MCS+														98.58						
MCS-															98.52					
FMCS																99.15				
FMCS-																	99.			
CO																		99.6		
LEE																			99.46	
CAC																				91.5

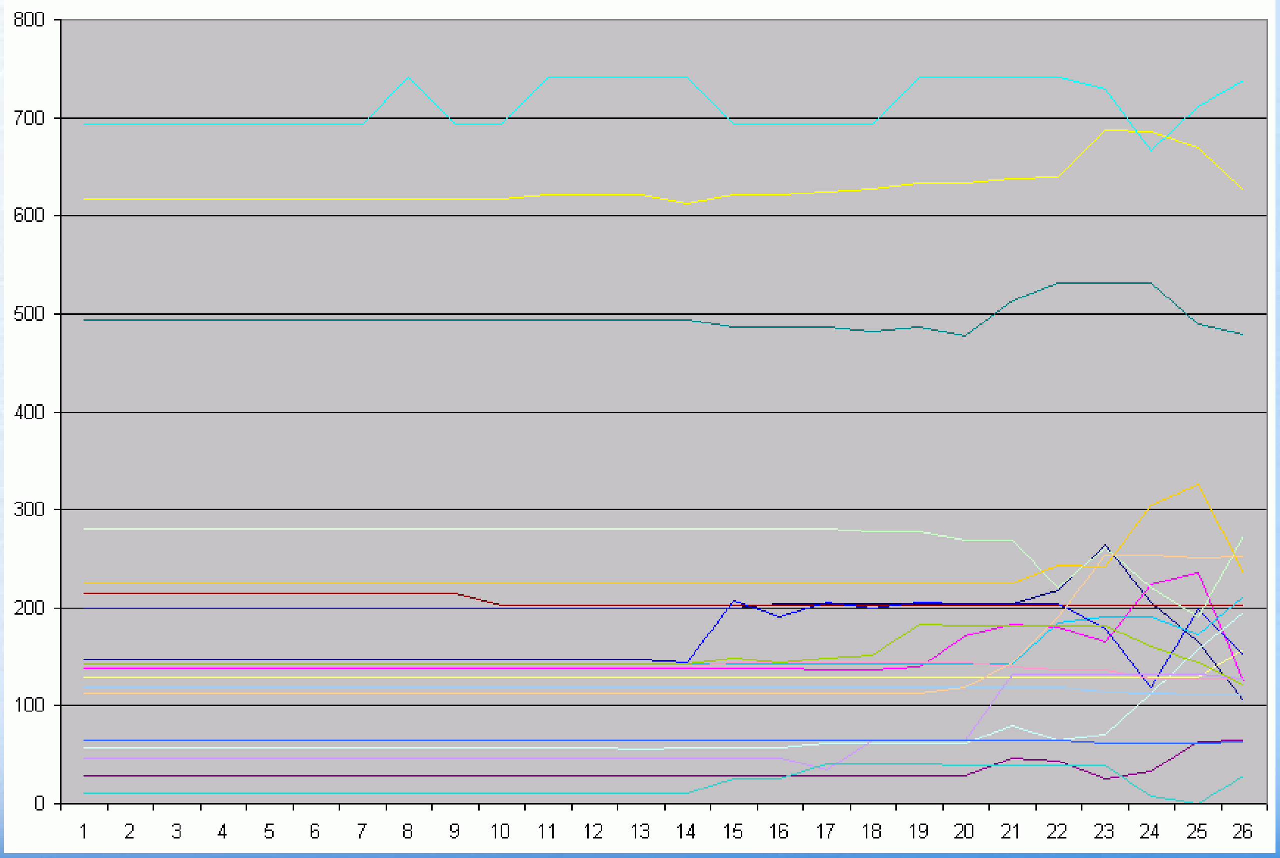
Investigation on minimum grid size

In the second part of the evaluation, the number of grid points with a specific CM in course of the image size reduction will be monitored.

The knowledge gained from the analyses of these graphs should provide hints on the minimum grid size that is required for a certain CM to be correctly analysed in ASII.

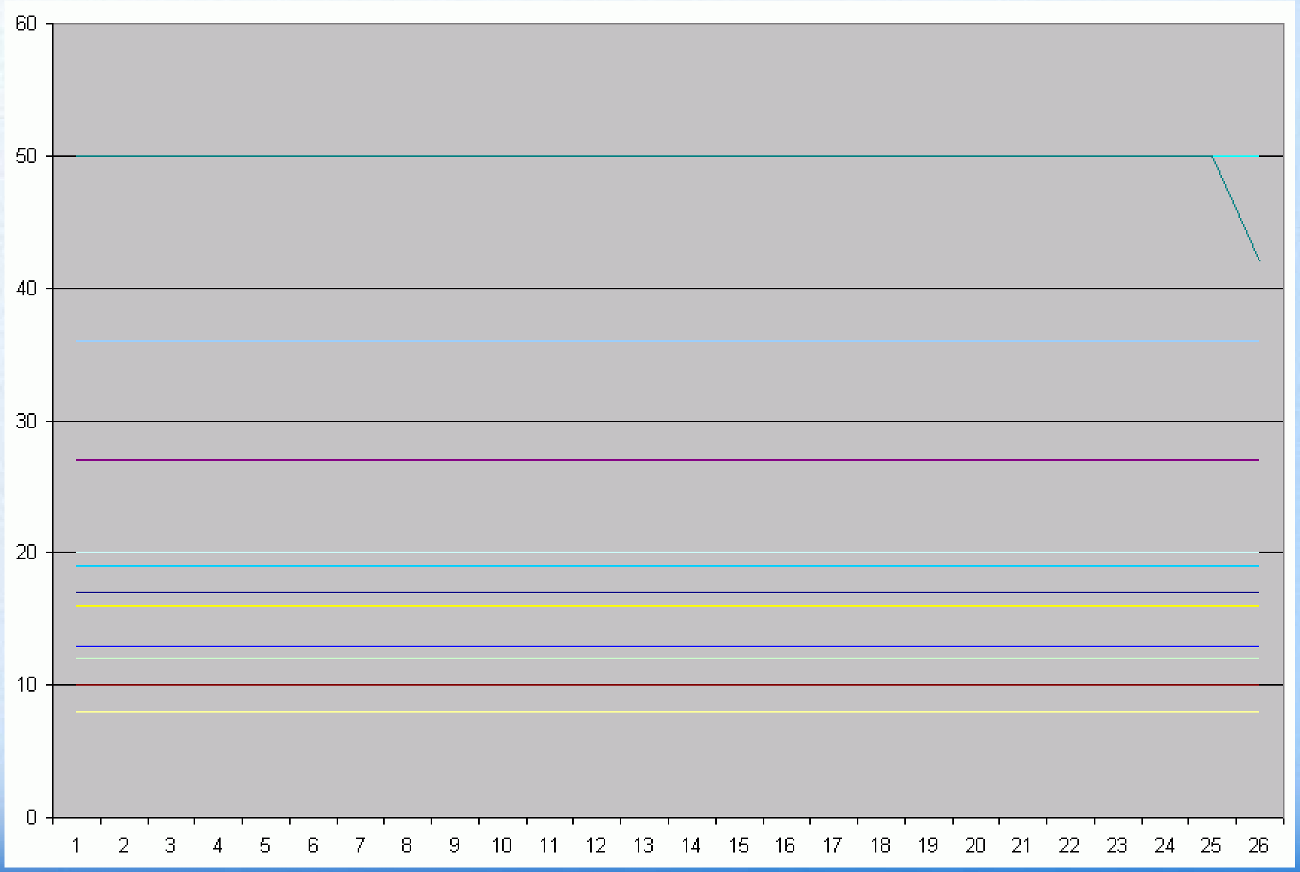
Investigation on minimum grid size

- Frontal category: Warm Fronts



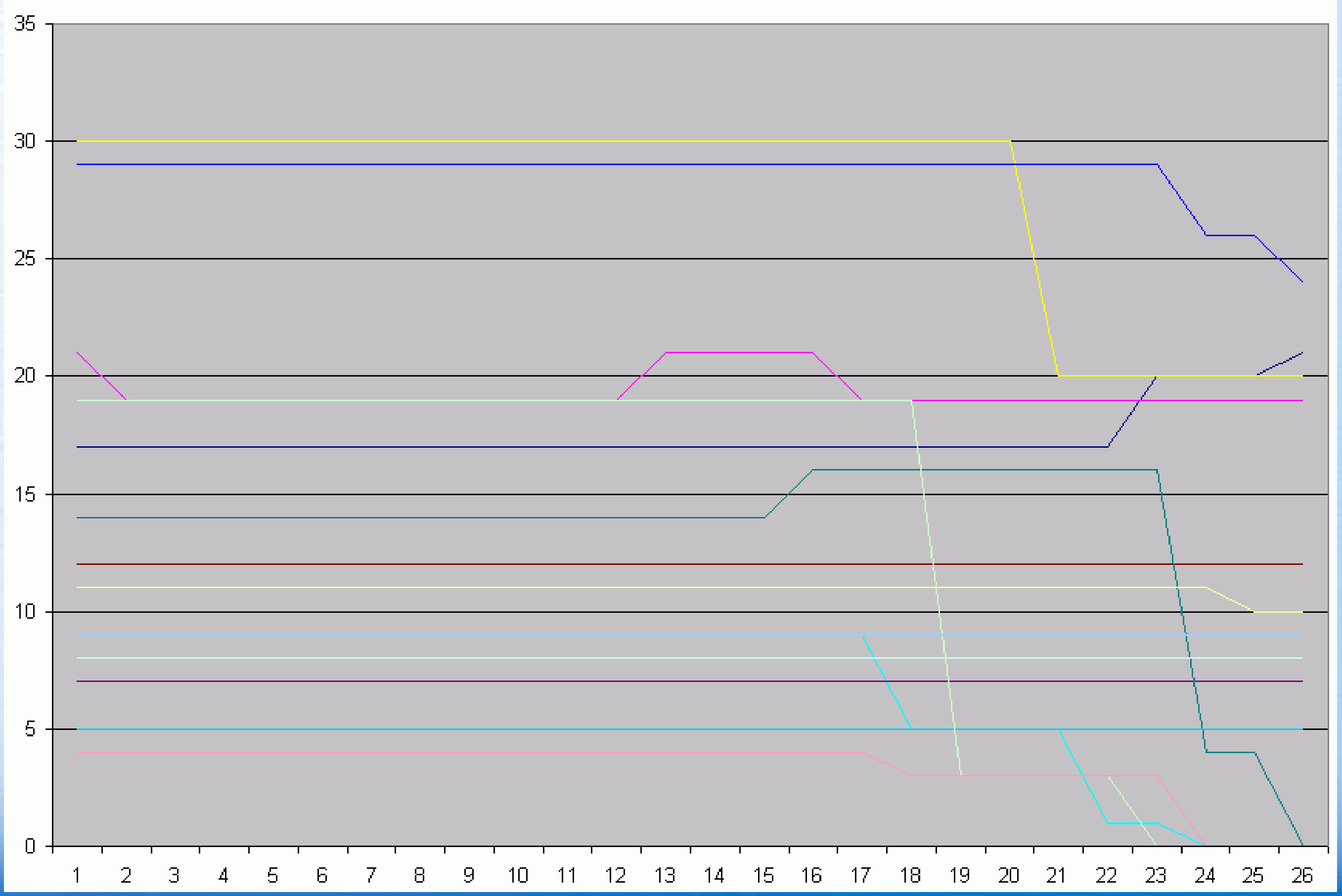
Investigation on minimum grid size

- Jet Cloud Fibre



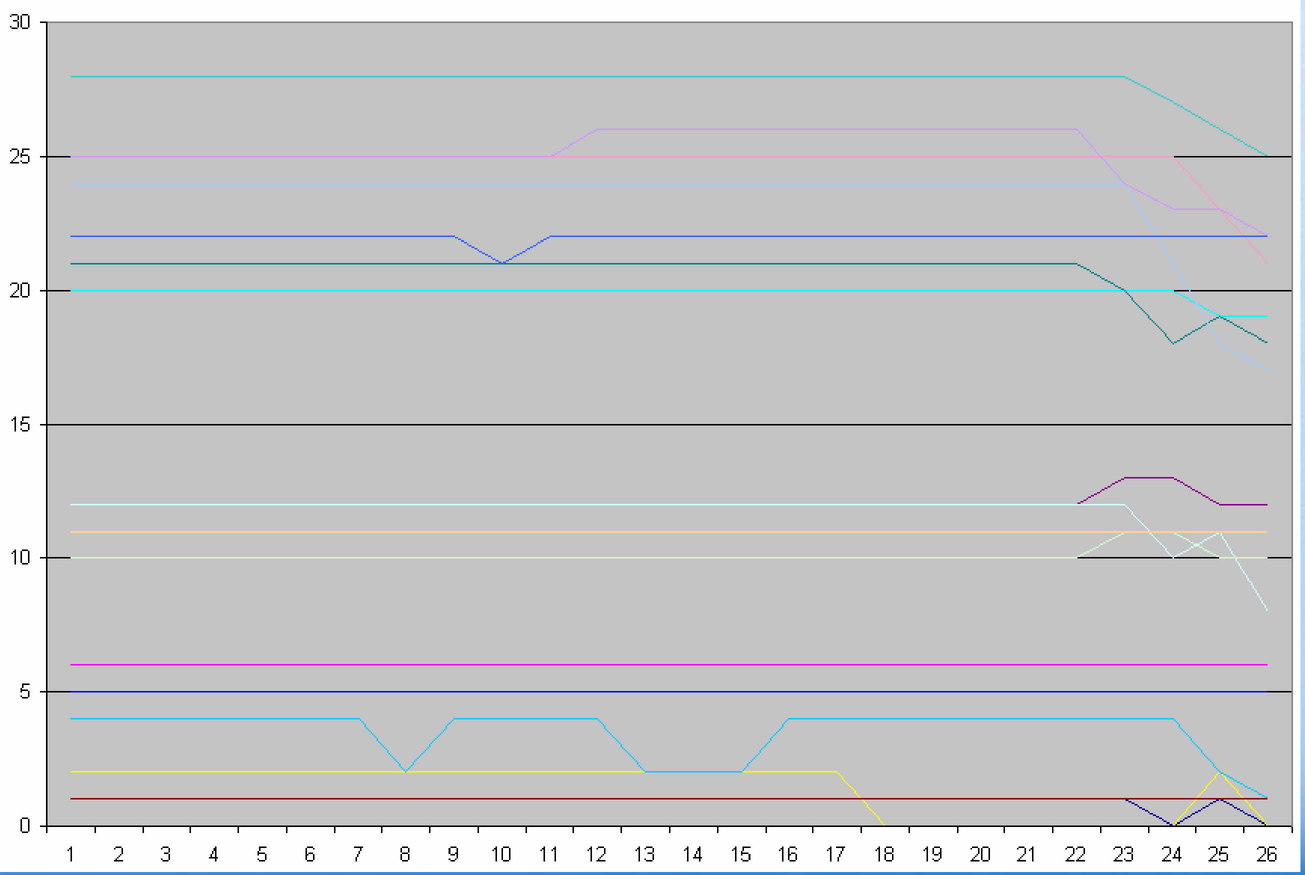
Investigation on minimum grid size

- Developing frontal wave:



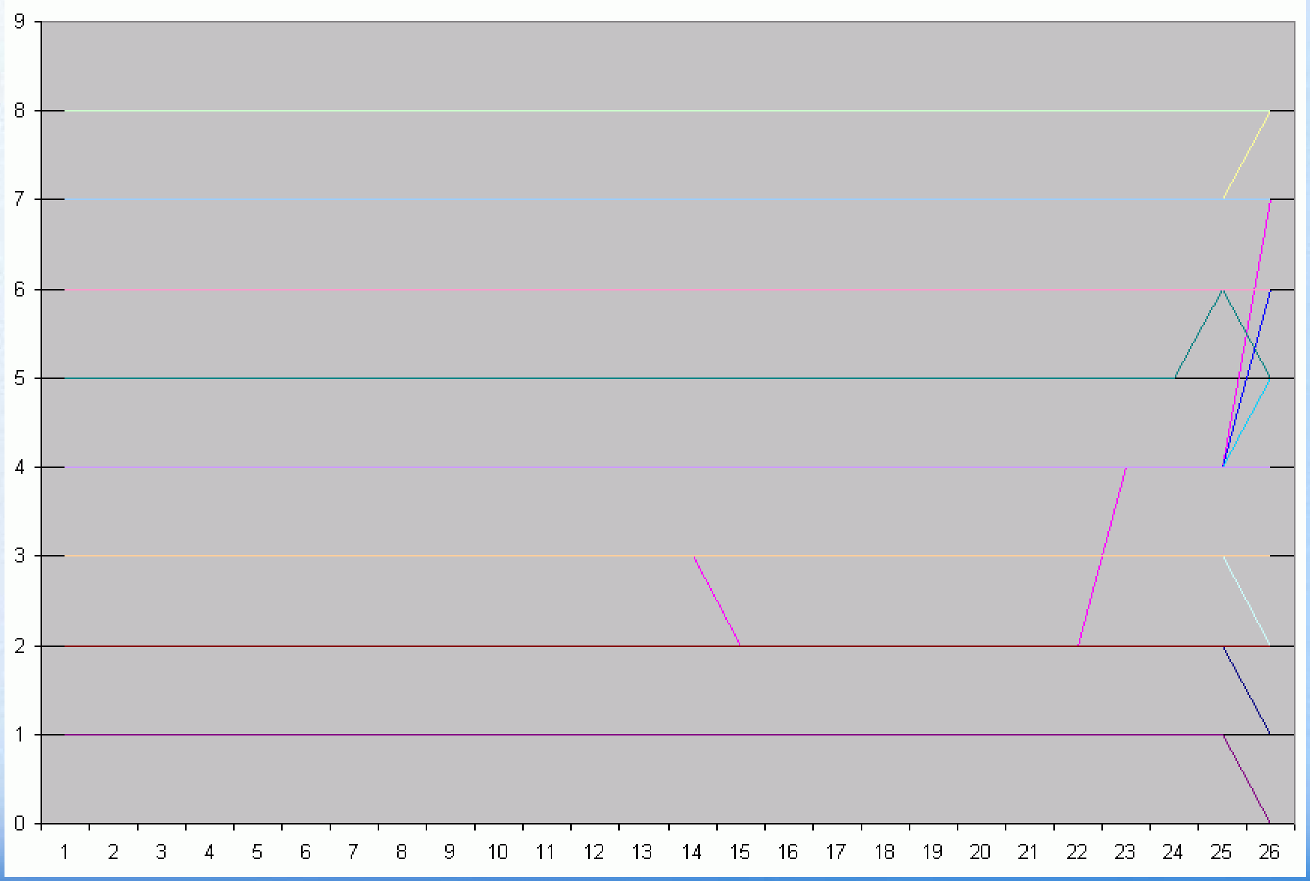
Investigation on minimum grid size

- Cold air feature: EC



Investigation on minimum grid size

- Convective Systems: MCS (mature stage)



Investigation on minimum grid size: Conclusions

- The limiting factor for reducing the analysis area is the correct detection of frontal systems.
- Sub-frontal structures (DI, WA or FMCS) are directly linked to the stability of frontal areas, therefore the same restrictions apply.
- Some CM detection (LEE, FIB) makes use of so-called neighbourhood functions, whose outcome depends on relations with values of surrounding grid points. These CM are stably analysed as long as the image border is not so close that it impacts the investigated region of influence.

Investigation on minimum grid size: Conclusions

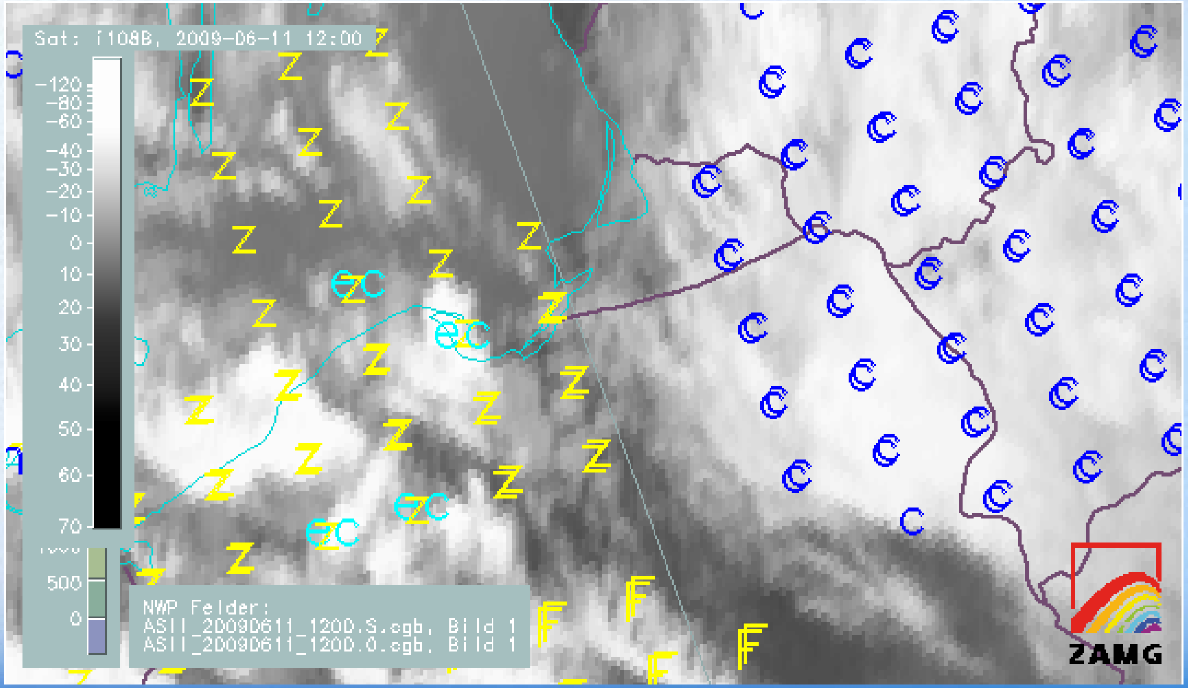
- For all other CMs except the CAC, an indirect influence of the frontal category exists. These CMs are by itself stably analysed for every grid size, because their detection method is constrained to local parameter values on the investigated grid point. There is, however, still an indirect influence of the frontal category visible: As soon as an area is not analysed as frontal anymore, it might happen that other CM take the vacant place.
- Recommendation:

  The minimum area in order to accomplish a reasonable analysis is 800x640 pixel on cylindrical projection or 1400x700 columns centered over Central Europe on the SEVIRI image.

Evaluation of the Stability of PGE10 against a small displacement of the processing area

Investigation on the stability of the ASII output by shifting the image center on satellite projection by a few pixels only.

The resulting shift of the processing grid on the projected image, was less than a grid mesh distance.



Evaluation of the Stability of PGE10 against a small displacement of the processing area

Frontal categories:	WF: 87,02%
	CF: 83,78%
	OC: 86,2%
Frontal Substructures:	WA: 50,0% (60%)
	WA+: 68,4% (74%)
	DI: 55,6%
Convection:	CB: 60-70% (65-76%)
	MCS: 73-85% (82-92%)
Cold Air Features:	EC: 70,4%
	CO: 63,6%
	CAC: 66,35%
Other:	Jet Cloud Fibres: 66,21%
	Lee Clouds: 87,85%

Evaluation of the Stability of PGE10 against a small displacement of the processing area

	n.a	WF	CF	WA	WA+	OC	DI	EC	CB	CB+	CB-	FIB	MCS	MCS+	MCS-	FMCS	FMCS-	CO	LEE	CAC
n.a																				
WF	4,43	87,02	7,79																	
CF	5,41	8,40	83,78																	
WA	3,03	11,11	25,25	50,00	10,61															
WA+	3,04	4,75	17,11	6,65	68,44															
OC	6,74	2,82	1,60			86,21												1,19		1,08
DI	43,40						55,66													
EC	15,36							70,42				1,63						5,88		5,07
CB	26,28								60,22	5,74	5,11									
CB+	34,85								6,06	59,09								1,89		
CB-	21,52								6,94		70,83									
FIB	25,86											66,21						1,11	1,85	2,22
MCS	3,75												85,00		7,08	3,33				
MCS+	11,32												6,60	78,30						
MCS-	11,11												9,40		73,50		1,28	1,28		1,70
FMCS	1,78	5,35	4,46			5,00										73,92	6,42			
FMCS-	1,56	2,08	7,29			1,04				2,08					2,60	6,25	77,08			
CO	18,00		7,71															63,6		5,77
LEE	4,76	4,24	1,69																87,85	
CAC	24,41		1,35					1,17										3,85		66,35

Evaluation of the Stability of PGE10 against a small displacement of the processing area Conclusions

Two factors influencing the stability of a CM analysis can be determined:

- CMs with larger extensions (e.g. CF, WF and OC) are more stable than those which are regularly confined to a sole grid point
- Some detection methods seem more stable than others

The next step of the evaluation on product stability will have to examine the reasons for the high lost rate especially for small scale CM.