



Validation of SAFNWC/MSG PGE09 High Resolution Winds

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Product Assessment Review Workshop, Madrid

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PGE09 Validation Procedure

- **Validation** based on the **Comparison of PGE09 Outputs with Radiosounding Winds** obtained from the GTS.
 - > Comparison with the **nearest Radiosounding**.
 - > Only cases where: **distance < 150 km.**
pressure difference < 25 hPa.

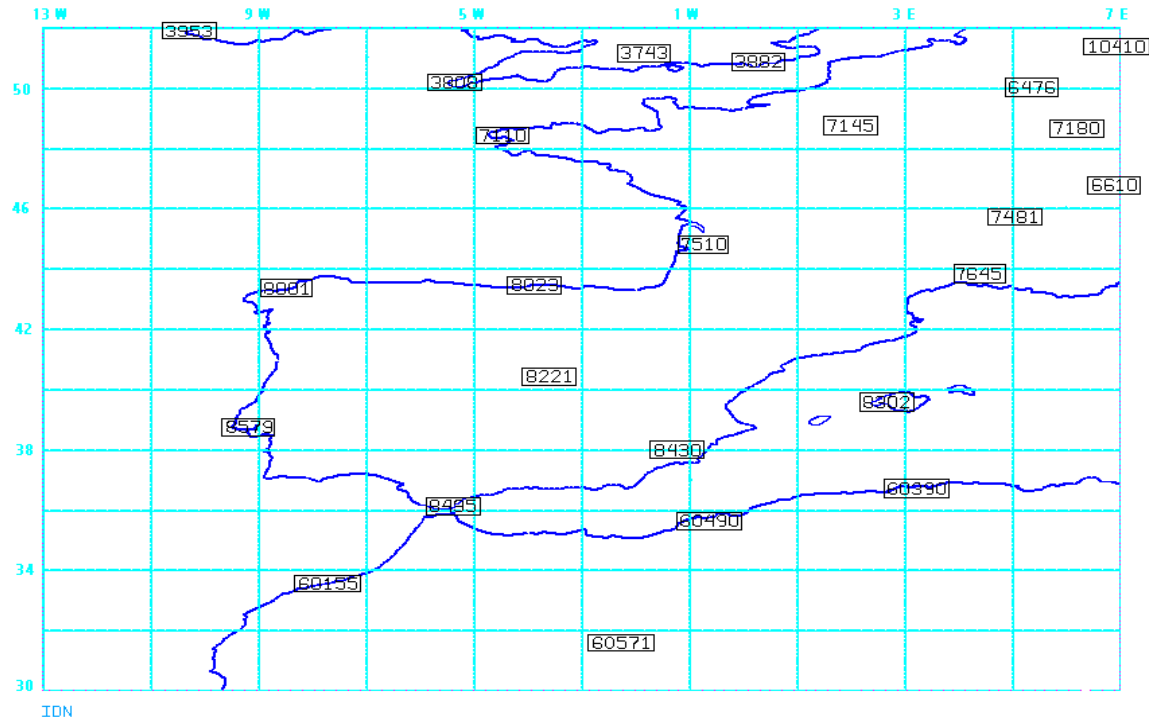
Validation Procedure proofs:

Distances and pressure differences
below these values are not affecting validation.

- **1200Z Radiosoundings compared to 1145Z PGE09 Slots**
(closest to the nominal time of Radiosounding launch).

PGE09 Validation Procedure

- Validation run on a region centred on Iberian Peninsula during the period Jan – Sep 2005.



1

McIDAS

PGE09 Validation Procedure

- Objectives:
 - To **calculate the Statistical Indicators established for Satellite Wind Verification, at Ascona 1996 Wind Workshop**

Generally followed by all Satellite Wind Centres;
Comparison of results possible
 - To **define the influence of Parameters associated to Wind Calculation on Validation Results:**
 - **Quality Index.**
 - **Quality Tests.**
 - **Speed Modulus.**
 - **Solar Elevation.**
 - **Geographical effects.**

PGE09 Validation Procedure

- Comparisons computed monthly for **Basic & Detailed winds**, for three layers:

HIGH (< 400 hPa)	MID (400 – 700 hPa)	LOW (> 700 hPa)
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- **Statistical Parameters** considered at Ascona meeting:
 - **NC**: Number of collocations
 - **SPD**: Mean wind speed
 - **BIAS**
 - **MVD**: Mean vector difference
 - **RMSVD**: Root mean square vector difference
- **Besides:**
 - **Normalized parameters: BIAS/SPD, MVD/SPD, RMSVD/SPD.**
(Independent of wind magnitude;
more easily comparable considering different samples).
 - **Correlation** between HRW speed and Radiosounding Speed.

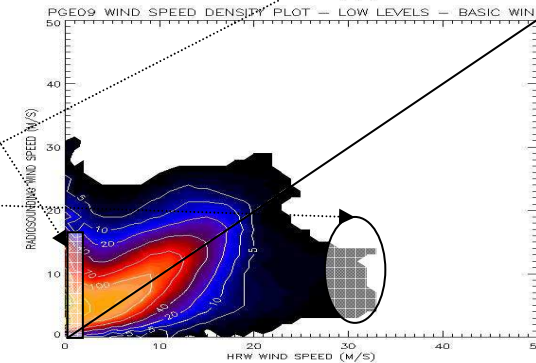
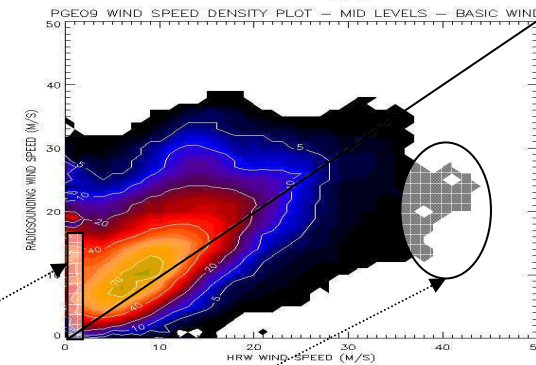
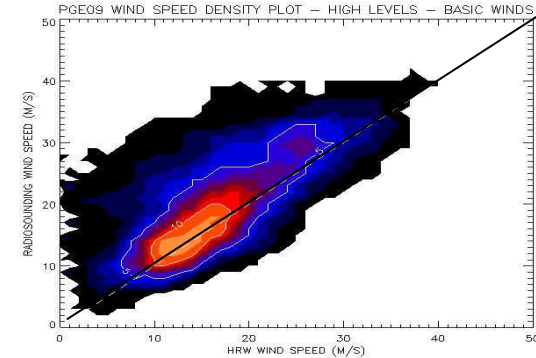
General distribution of Wind speeds

Scatter plots show an **adequate data distribution**
(Population maximums generally near the diagonal).

Correlation: **~ 0.70 High layers**
~ 0.60 Mid & Low layers

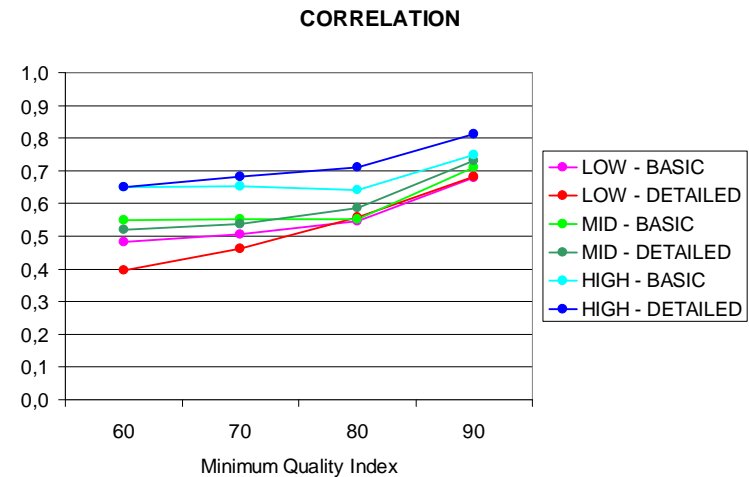
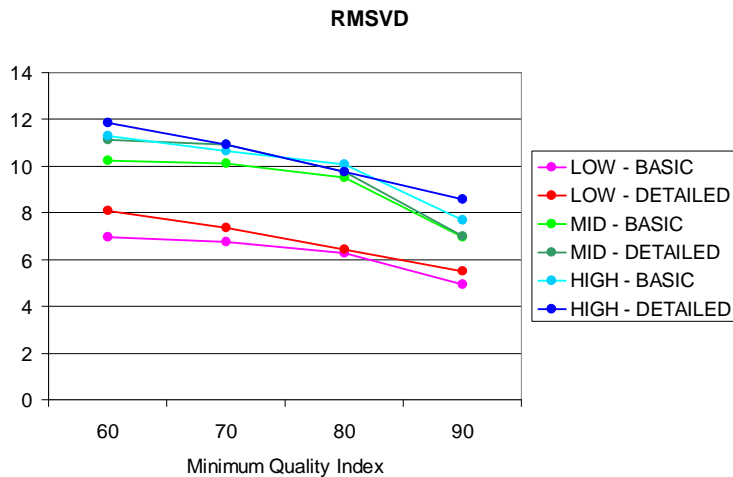
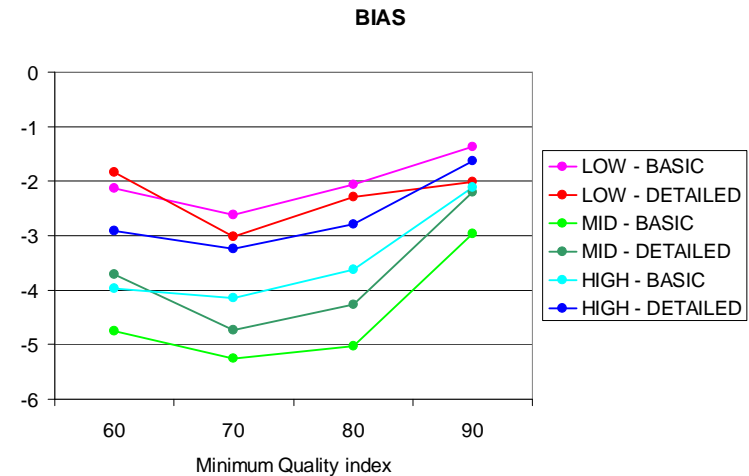
Remarks:

- Population **maximums at left of diagonal**
Effect of negative BIAS
- Part of population concentrated on vertical axis at mid & low levels
Blocked tracers
- Some **too fast winds** at mid & low levels
Thin cirrus, whose motion is detected and erroneously assigned to lower levels



Influence of Quality Index

- MVD, RMSVD & Correlation **reduce significantly** when QI Threshold becomes higher.
- **BIAS** **reduces only** when QI Threshold is over 80.
- Differences Bas-Det are small (<10%), but MVD & RMSVD tend to be smaller for Basic Winds.

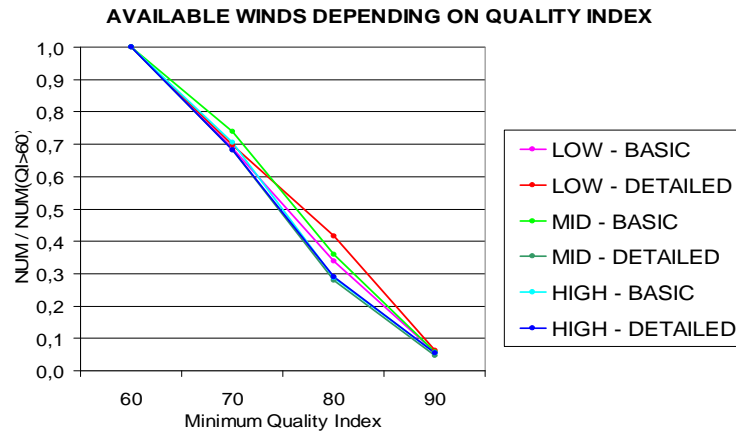


Influence of Quality Index

- Criterion to define a QI Threshold:

Which proportion of Wind Population is kept?

- Comparing with QI Thr. = 60:
 - QI Thr. = 90 keeps 1 out of 20 winds.
 - QI Thr. = 80 keeps 1 out of 3 winds.
 - QI Thr. = 75 keeps 1 out of 2 winds.
- Using both Basic and Detailed sets of winds:
 - Reduction of population due to a higher QI Threshold compensated by winds contributed by Detailed set.



Validation results with various QI Thresholds

$QI \geq 60$

Considering Statistics for $QI \geq 80$:

- RMSVD values range:**
 5-8 m/s at **Low levels**;
 8-11 m/s at **Mid & High levels**.
- MVD values range:**
 4-7 m/s at **Low levels**;
 6-9 m/s at **Mid & High levels**.
- BIAS values range:**
 -1 to -3 m/s at **Low levels**;
 -3 to -7 m/s at **Mid levels**;
 -2 to -5 m/s at **High levels**.

Comparing with Statistics for $QI \geq 60$

(Nominal QI threshold):

- **RMSVD & MVD** reduces up to 20%.
- **BIAS** reduces up to 20% at high levels
(No positive effect at mid & low levels).

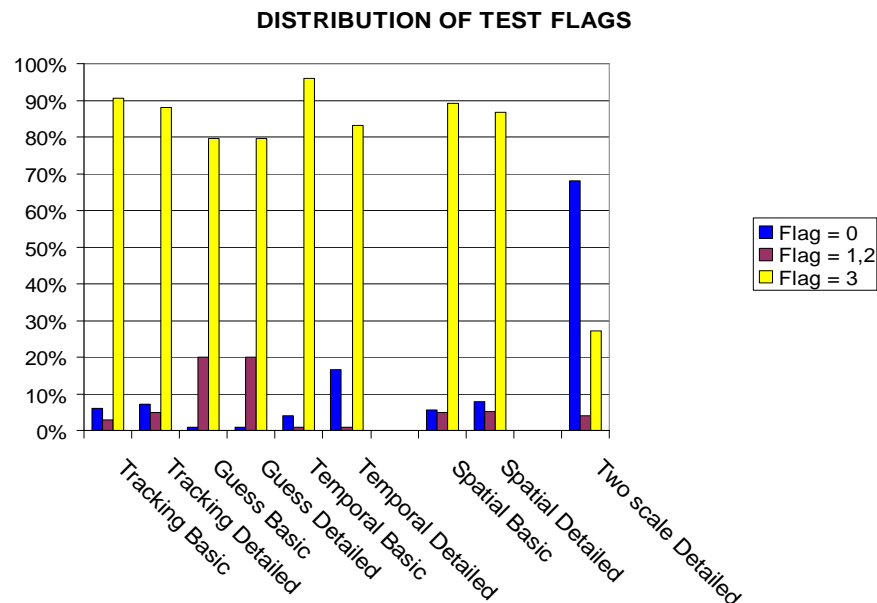
BASIC WINDS		JAN 05	FEB 05	MAR 05	APR 05	MAY 05	JUN 05	JUL 05	AUG 05	SEP 05
HIGH LEVELS	NC	10	312	973	534	648	680	417	878	1016
	SPD		25,90	20,27	21,08	24,79	22,72	25,56	23,73	21,60
	MVD		9,72	7,99	8,47	9,80	8,95	8,66	8,53	9,49
	RMSVD		12,26	10,58	10,59	12,21	10,77	10,49	10,74	11,85
	RMSVD/SPD		0,47	0,52	0,50	0,49	0,47	0,41	0,45	0,55
	BIAS		-3,89	-3,05	-4,13	-5,59	-3,49	-3,76	-3,26	-3,33
MID LEVELS	NC	992	3250	4104	2657	1966	2247	2009	1965	2429
	SPD	17,71	15,97	13,90	14,65	16,76	14,27	14,59	13,83	12,96
	MVD	11,18	9,42	7,68	7,64	7,69	7,38	7,34	7,24	7,44
	RMSVD	12,93	11,25	9,38	9,51	9,39	9,06	8,92	8,90	9,17
	RMSVD/SPD	0,73	0,70	0,67	0,65	0,56	0,63	0,61	0,64	0,71
	BIAS	-7,55	-5,56	-4,01	-4,35	-3,94	-3,06	-3,24	-3,56	-2,77
LOW LEVELS	NC	1601	4461	3451	2313	2186	2111	2278	2240	2553
	SPD	11,00	9,48	8,22	8,60	8,68	7,96	8,65	7,72	7,37
	MVD	7,23	5,79	5,43	4,61	4,91	5,45	5,52	4,79	4,89
	RMSVD	8,80	7,28	6,71	5,83	6,31	6,72	6,89	6,10	6,31
	RMSVD/SPD	0,80	0,77	0,82	0,68	0,73	0,84	0,80	0,79	0,86
	BIAS	-3,30	-2,68	-2,28	-1,17	-1,39	-1,93	-2,09	-1,77	-1,28

BASIC WINDS		JAN 05	FEB 05	MAR 05	APR 05	MAY 05	JUN 05	JUL 05	AUG 05	SEP 05
HIGH LEVELS	NC	5	114	349	176	235	184	142	305	295
	SPD		29,45	19,98	22,18	26,38	22,64	25,06	25,16	22,93
	MVD		8,61	6,71	7,41	8,65	8,64	7,79	7,65	8,76
	RMSVD		10,58	9,12	9,36	10,78	10,47	9,21	9,38	11,05
	RMSVD/SPD		0,36	0,46	0,42	0,41	0,46	0,37	0,37	0,48
	BIAS		-2,84	-2,73	-4,03	-5,31	-3,17	-2,90	-3,16	-3,20
MID LEVELS	NC	320	1101	1466	959	753	868	766	698	802
	SPD	18,06	17,50	14,11	15,31	17,23	15,02	14,81	15,67	13,36
	MVD	10,80	9,29	6,90	6,98	6,80	6,65	6,86	7,06	7,06
	RMSVD	12,51	11,06	8,54	8,62	8,08	8,13	8,25	8,48	8,42
	RMSVD/SPD	0,69	0,63	0,61	0,56	0,47	0,54	0,56	0,54	0,63
	BIAS	-8,20	-6,35	-4,04	-4,45	-3,78	-3,37	-3,57	4,26	-2,93
LOW LEVELS	NC	573	1692	1154	875	855	825	927	851	996
	SPD	11,16	9,95	8,53	9,15	9,12	8,98	8,83	7,80	7,93
	MVD	6,74	5,22	4,69	4,27	4,38	5,10	4,82	4,24	4,45
	RMSVD	8,06	6,50	5,72	5,32	5,76	6,20	5,75	5,34	5,58
	RMSVD/SPD	0,72	0,65	0,67	0,58	0,63	0,69	0,65	0,68	0,70
	BIAS	-3,29	-2,78	-2,09	-1,06	-1,21	-1,99	-2,06	-1,36	-1,40

$QI \geq 80$

Influence of Quality Test Flags on Verification

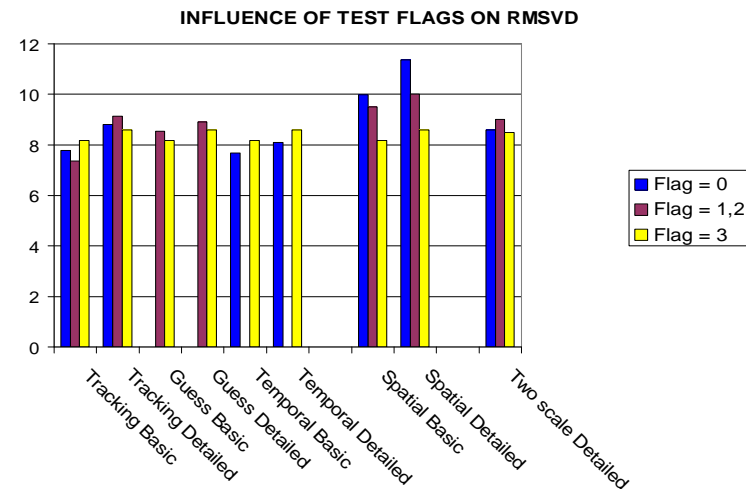
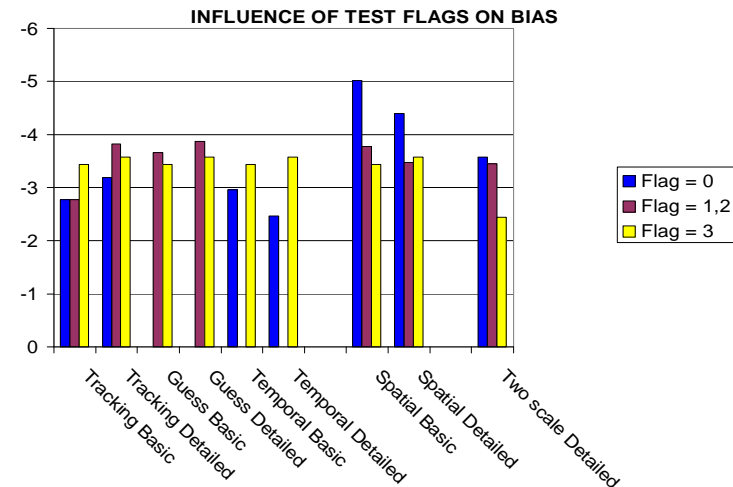
- Five tests are applied on PGE09 winds:
 - At Wind Calculation Algorithm: **Tracking.**
 - At Quality Control: **Guess, Temporal, Spatial test.**
Two scale test (Only detailed winds).
- **Distribution of Test Flags (Values: 0, 1, 2, 3),**
when **three winds are calculated per tracer:**



Influence of Quality Test Flags on Verification

- **BIAS & RMSVD** reduce significantly when **Spatial Test Flag** is higher.
- **BIAS** reduces also when **Two Scale Test** is higher.
- **No significant influence on verification for the other tests.**
- **Only one recommendation without reducing too much the population of winds:**

To use only winds with Spatial test = 3
(Reduction of population < 15%)



Influence of Speed modulus on Verification

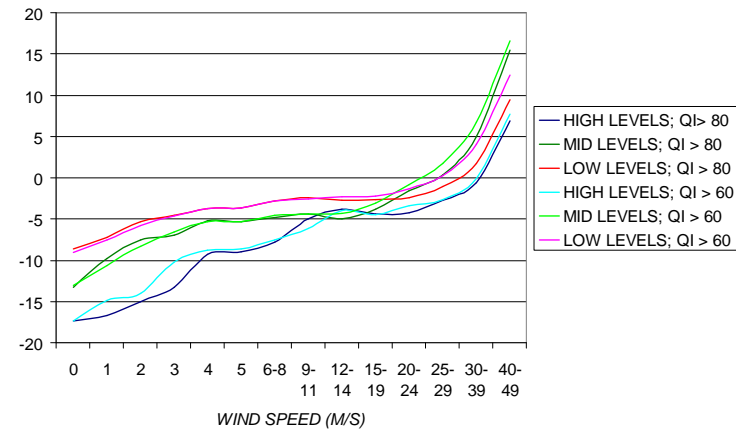
- **Statistical parameters are best in the range of wind speeds 4-29 m/s:**

- **BIAS & RMSVD double with speed approaching 0 m/s.**
→ Tracers blocked by orography.

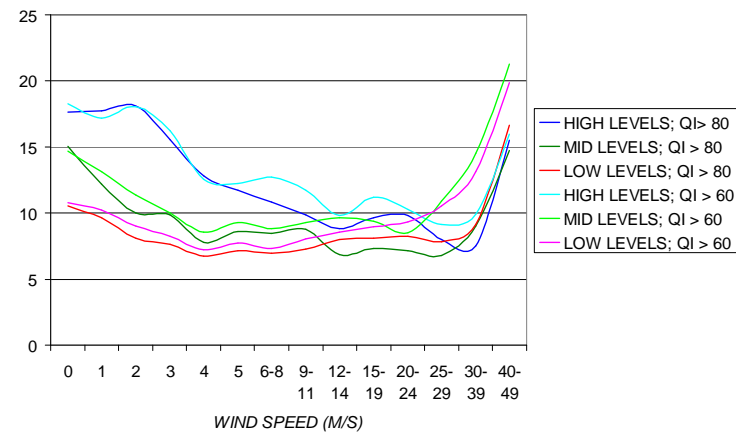
- **RMSVD doubles & BIAS becomes positive with speed over 30-40 m/s.**
→ Too fast winds related to thin cirrus undetected by cloud mask and assigned to lower levels.

- **4 m/s Speed Minimum recommended to avoid most of blocked tracers.**
2 m/s Speed Min. avoids a great proportion, not reducing excessively wind population
- **40 m/s Speed Maximum recommended to avoid “too fast winds” at low and mid levels.**

INFLUENCE OF WIND SPEED ON BIAS



INFLUENCE OF WIND SPEED ON RMSVD



Improvement of validation results with all conditions

QI ≥ 80

Comparing with Statistics for QI ≥ 80:

- **Very important reduction of BIAS at low levels (30-60%);**
- **A slight one at mid levels (up to 10%);**
No positive impact at high levels.
- **Reduction of MVD & RMSVD at all levels (up to 20%).**
- **New values are obtained with an additional reduction in population of winds of about 20-30%.**

Users should consider if these recommendations are useful for their exploitation of the product, specially at low levels.

BASIC WINDS		JAN 05	FEB 05	MAR 05	APR 05	MAY 05	JUN 05	JUL 05	AUG 05	SEP 05	
HIGH LEVELS	NC	5	114	349	176	235	184	142	305	295	
	SPD		29,45	19,98	22,18	26,38	22,64	25,06	25,16	22,93	
	MVD		8,61	6,71	7,41	8,65	8,64	7,79	7,65	8,76	
	RMSVD		10,58	9,12	9,36	10,78	10,47	9,21	9,38	11,05	
	RMSVD/SPD		0,36	0,46	0,42	0,41	0,46	0,37	0,37	0,48	
	BIAS		-2,84	-2,73	-4,03	-5,31	-3,17	-2,90	-3,16	-3,20	
MID LEVELS	NC	320	1101	1466	959	753	868	766	698	802	
	SPD		18,06	17,50	14,11	15,31	17,23	15,02	14,81	15,67	13,36
	MVD		10,80	9,29	6,90	6,98	6,80	6,65	6,86	7,06	7,06
	RMSVD		12,51	11,06	8,54	8,62	8,08	8,13	8,25	8,48	8,42
	RMSVD/SPD		0,69	0,63	0,61	0,56	0,47	0,54	0,56	0,54	0,63
	BIAS		-8,20	-6,35	-4,04	-4,45	-3,78	-3,37	-3,57	4,26	-2,93
LOW LEVELS	NC	573	1692	1154	875	855	825	927	851	996	
	SPD		11,16	9,95	8,53	9,15	9,12	8,98	8,83	7,80	7,93
	MVD		6,74	5,22	4,69	4,27	4,38	5,10	4,82	4,24	4,45
	RMSVD		8,06	6,50	5,72	5,32	5,76	6,20	5,75	5,34	5,58
	RMSVD/SPD		0,72	0,65	0,67	0,58	0,63	0,69	0,65	0,68	0,70
	BIAS		-3,29	-2,78	-2,09	-1,06	-1,21	-1,99	-2,06	-1,36	-1,40

BASIC WINDS		JAN 05	FEB 05	MAR 05	APR 05	MAY 05	JUN 05	JUL 05	AUG 05	SEP 05	
HIGH LEVELS	NC	4	74	280	135	166	125	118	231	236	
	SPD		27,08	18,87	21,04	25,87	21,22	25,00	24,42	22,12	
	MVD		7,71	6,11	7,39	8,25	7,77	7,74	7,21	7,75	
	RMSVD		9,88	8,15	9,22	10,42	9,19	9,05	8,83	9,69	
	RMSVD/SPD		0,36	0,43	0,44	0,40	0,43	0,36	0,36	0,44	
	BIAS		-3,56	-2,57	-4,48	-4,71	-3,10	-2,66	-3,33	-2,81	
MID LEVELS	NC	255	865	1212	774	615	585	682	546	683	
	SPD		18,40	17,95	13,94	15,69	16,64	14,11	14,83	15,57	13,25
	MVD		10,10	8,64	6,44	6,65	6,43	5,90	6,81	6,61	6,86
	RMSVD		11,68	10,20	7,97	8,23	7,63	7,25	8,15	7,83	8,11
	RMSVD/SPD		0,63	0,57	0,57	0,52	0,46	0,51	0,55	0,50	0,61
	BIAS		-7,30	-5,73	-3,57	-3,99	-3,46	-3,12	-3,53	-3,69	-2,85
LOW LEVELS	NC	401	1179	801	710	733	468	766	678	765	
	SPD		11,35	10,79	9,29	9,61	9,31	9,30	9,06	8,23	8,54
	MVD		5,60	4,50	4,24	3,99	4,08	4,94	4,44	3,99	4,43
	RMSVD		6,62	5,44	5,00	4,88	5,33	6,03	5,36	5,01	5,60
	RMSVD/SPD		0,58	0,50	0,54	0,51	0,57	0,65	0,59	0,61	0,66
	BIAS		-1,14	-1,27	-0,91	-0,44	-0,92	-1,28	-1,34	-0,70	-0,86

QI ≥ 80; Spatial test = 3; SPD = [2,40] m/s

Basic Winds: $QI \geq 60$

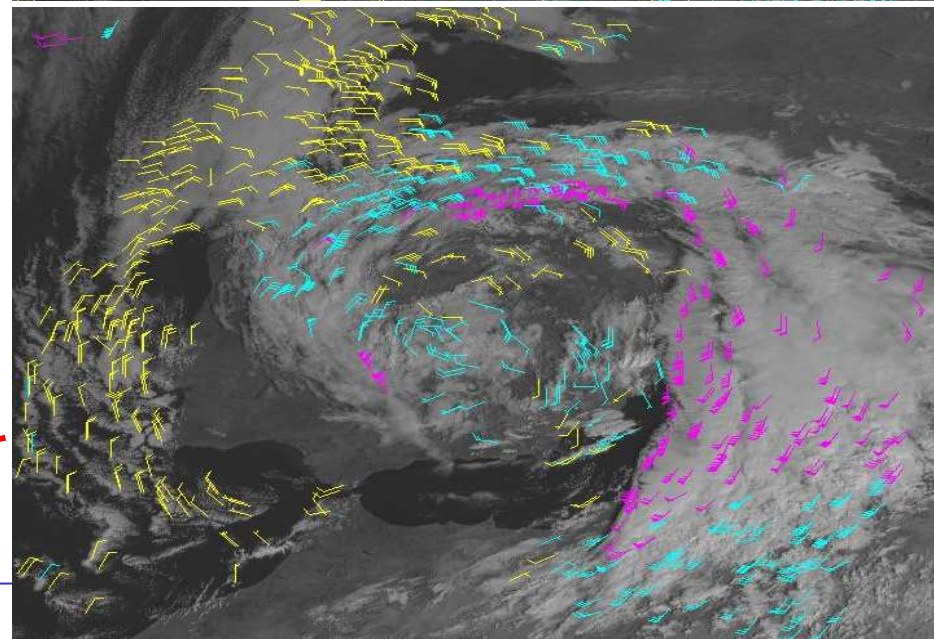
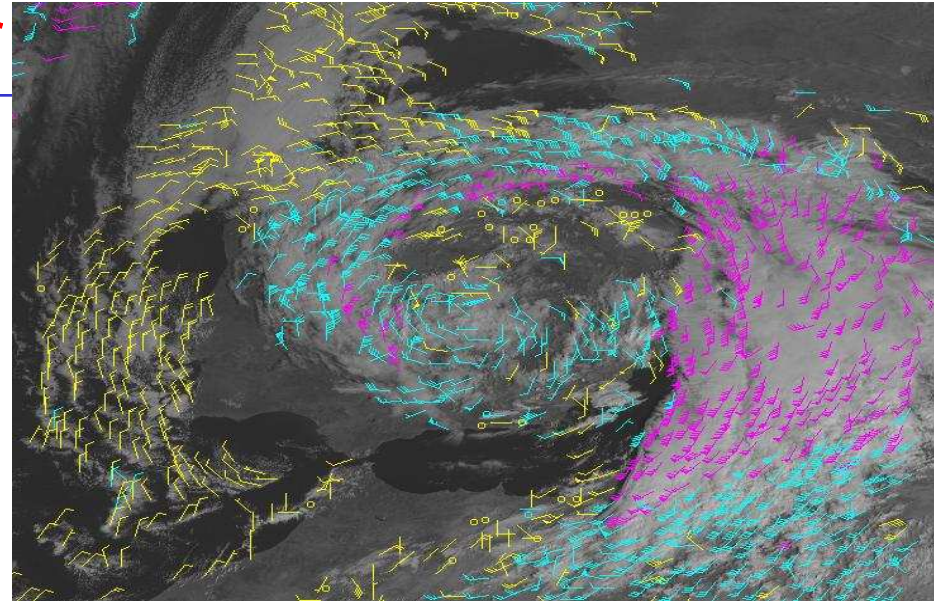
An example

(13th Oct. 2005; 0900Z)

**Imposing conditions,
when HR Winds are visualized,
in spite of Wind Number Reduction:**

- Air mass flux is more clearly seen on difficult areas.
- Most of “crossed winds” disappear.

Basic & Detailed Winds: $QI \geq 75$; Spatial test = 3; $SPD \geq 2$ m/s



Comparison with Eumetsat MPEF HRV Statistics

- **RMSVD/SPD at Eumetsat MPEF HRV Statistics: 0.40-0.50**
 - > **PGE09 similar at high levels (0.35-0.45)**
 - > **A bit worse at mid & low levels (0.50-0.65)**
- **BIAS at Eumetsat MPEF HRV Statistics also negative:**
 - > **PGE09 similar at high (-1 to -5 m/s) and low levels (0 to -2 m/s).**
 - > **A bit worse at mid levels (-2 to -5 m/s; Eumetsat val: -1 to -3 m/s).**

Reasons PGE09 Results may be a bit worse:

- Geographical working area is rather affected by orography. (Important proportion over land; various mountain systems).

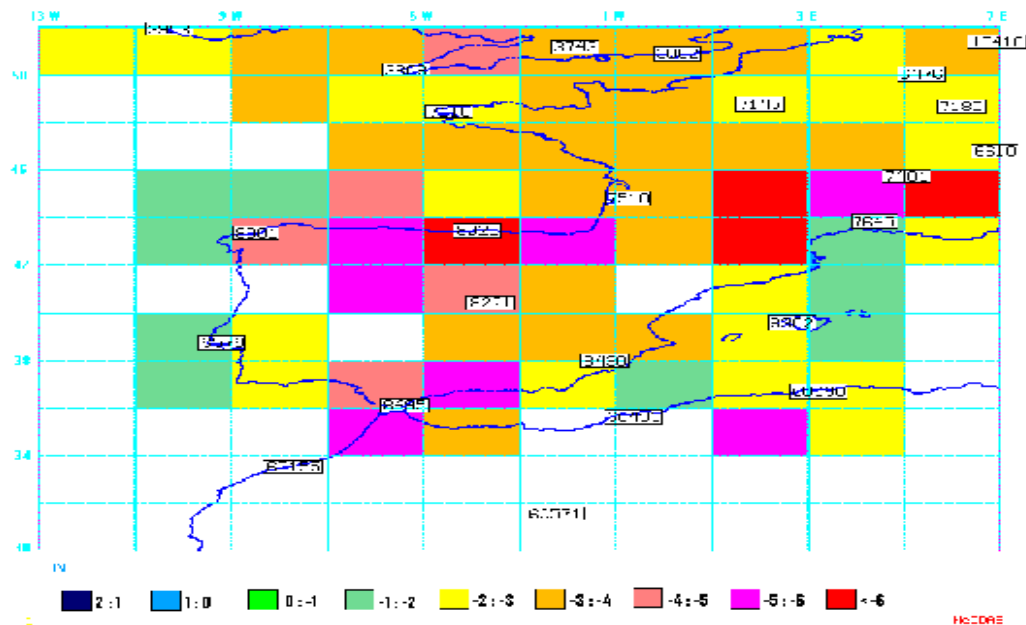
Necessary to recall PGE09 advantages:

- Winds calculated locally by the users few minutes after MSG data received, in the geographical area they need.
- Bigger density of data, every 15 minutes.

Influence of Orography on Verification

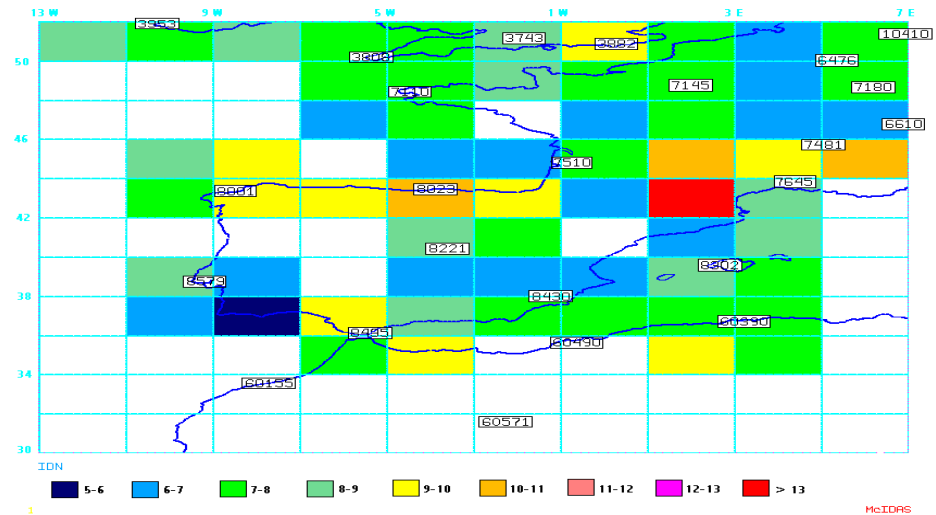
- **Best values** of BIAS, RMSVD & Correlation in **sea and low plain areas**.
- **Worst values** in **mountain areas**, specially at low levels.
 - > Differences in **BIAS & RMSVD** between both regions at least 4 m/s.
 - > **Correlation** (with QI > 80): 0.2-0.4 in mountain regions.
0.6-0.9 in sea and low plain regions.

BIAS (All levels)

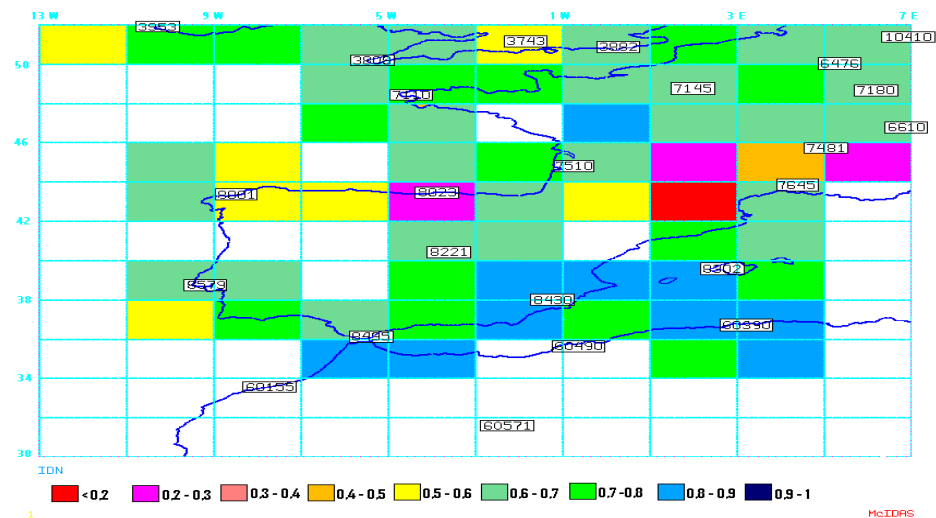


Influence of Orography on Verification

RMSVD (All levels)



Correlation (All levels)



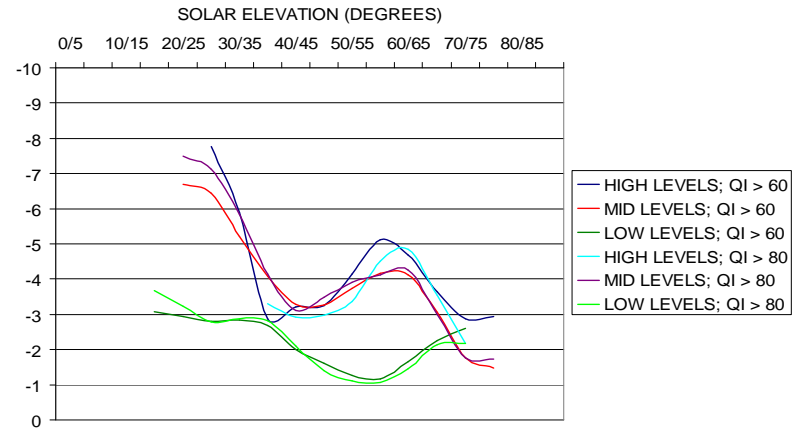
Influence of Solar elevation on Verification

- BIAS, RMSVD & Correlation
improve progressively
when solar elevation is higher.

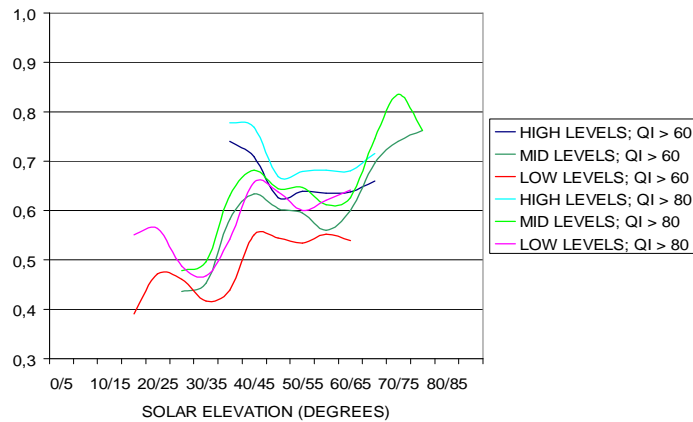
- No Threshold recommended:

There is no Solar Elevation value over which Verification Results are significantly better than below it.

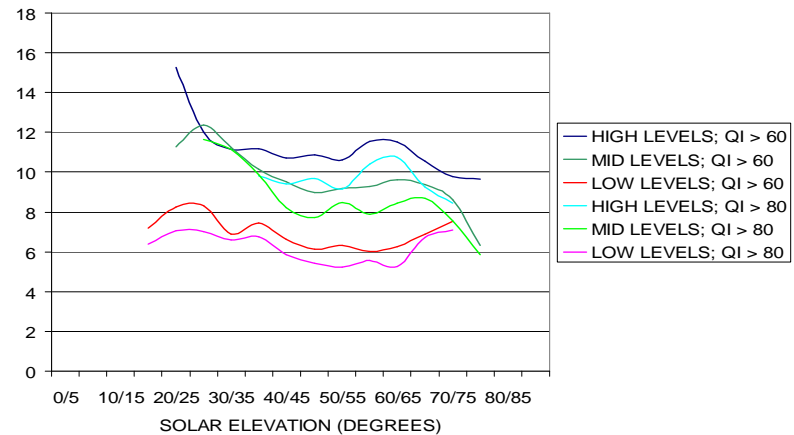
EFFECT OF SOLAR ELEVATION ON BIAS



EFFECT OF SOLAR ELEVATION ON CORRELATION



EFFECT OF SOLAR ELEVATION ON RMSVD



Conclusions

- **PGE09 Validation Parameters** compared to Eumetsat HRV MET8 Wind Statistics show:
 - **A similar Quality at High levels.**
 - **A bit worse Quality at Mid & Low levels**

→ Effect of Verification geographical area, very affected by orography.
(Orography is proofed to influence significantly Validation parameters).
- **Hints to improve Validation parameters:**
 - Higher QI Threshold (= 75, 80)
 - Spatial test value = 3
 - Minimum Speed Threshold (= 2, 4 m/s)
 - Maximum Speed Threshold at low & mid levels (= 40 m/s)

Future Developments

- **Better handling of Land Influence:**
 - Introduction of **Topographic Flag**, related to detection of:
 - Land tracers.
 - Tracers blocked through Orography.
 - Orographic waves.
 - Effect of this parameter on verification.
- Study to **reduce the dependence of PGE09 Algorithm on Numerical Model Data**, including:
 - Utilization of **CTTH Product for Tracer Level Assignment**.
- Study to **expand wind calculation to nighttime through IR Channels**.