Global Atmospheric Motion Vector inter-comparison study

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Niels Bormann[(1)], Peter Bauer[(1)]

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(3) UW-Madison/CIMSS, (4) Met Office, (5) NOAA-NESDIS

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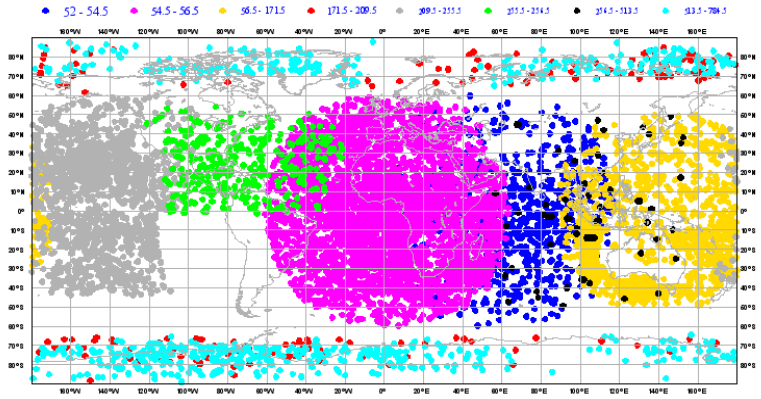
Ryo Oyama, Eun Ha Son, Louis Machado, Javier Garcia Pereda

10th International Winds Workshop, Tokyo, 22-26 Jan 2010

INTRODUCTION



Recommendation 34.15: There should be a comparison of the operational algorithms of all satellite wind producers for the height assignment of AMVs from clouds using a common data set from SEVIRI on MSG, and the same ancillary data ."

CGMS-34 Report excerpt

Participants

EUMETSAT, CIMSS/NESDIS

Japan Meteorological Agency (JMA)

Korea Meteorological Administration (KMA)

National Institute for Space Research (INPE)

STUDY SETUP

Derive AMVs from 18 August 2006, 12:00-12:30 UTC image triplet, IR(10.8µm) band
Apply your own operational wind retrieval algorithm; at first using your own forecast profile and next, using common EUMETSAT forecast model data.
Use 12:15 UTC image for height assignment step if algorithm allows.

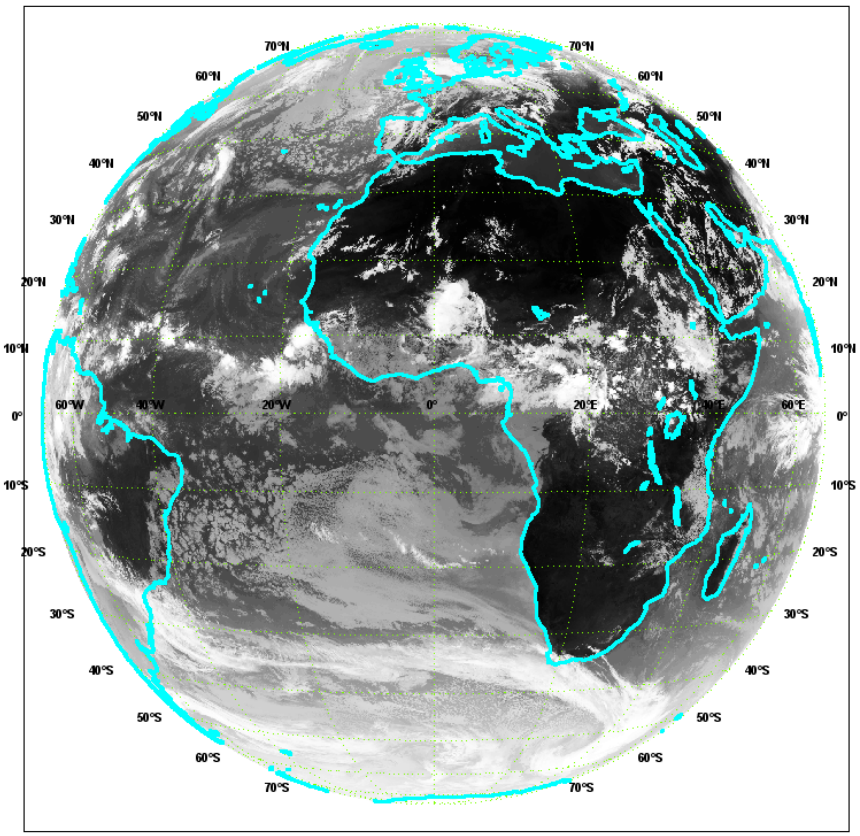
***Output**: AMV's location, Target and Search box size, Speed, Direction, Altitude,*
Low level correction, Guess Speed and Direction,
Height Assignment Method, Quality Indicator (forecast independent)

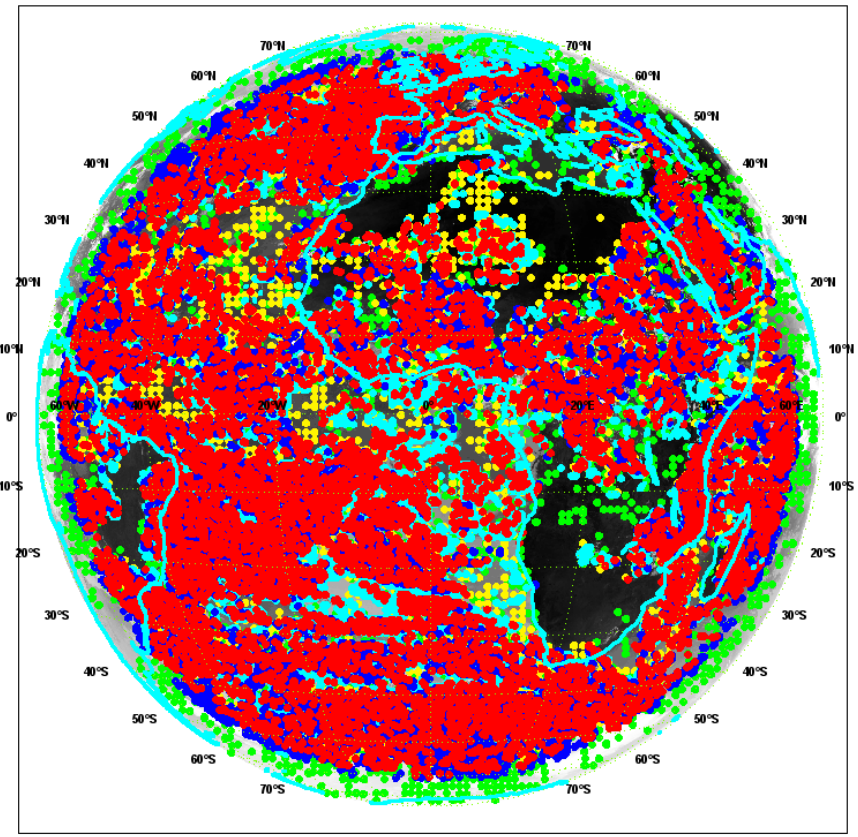
AMV Algorithms Summary:

AMV Producer	EUMESAT	CIMSS/NESDIS	Brazil	JMA	KMA
Steps subsequence	target, track, height assign.	target, height assign., track	target, track, height assign.	target, track, height assign.	target, track, height assign.
Target box	24x24 pix	15x15 pix	32x32 pix	32x32 pix	32x32 pix
Search box	80x80 pix	**36x52 pix**	50x50 pix	64x64 pix	64x64 pix
Target selection	no threshold	7 bright. units	no threshold	no threshold	5 Kelvin
Height	coldest CTP peak, average interm. prod.	25% coldest pixels, middle image only	10% coldest pixels, average interm. prod.	highest CTP peak, second interm.prod.	15% coldest pixels, average interm. prod.
QI implementation	single band, average interm. prod	all bands, one final QI	single band, average interm. prod.	single band, second interm.prod.	single band, average interm. prod.

DATA

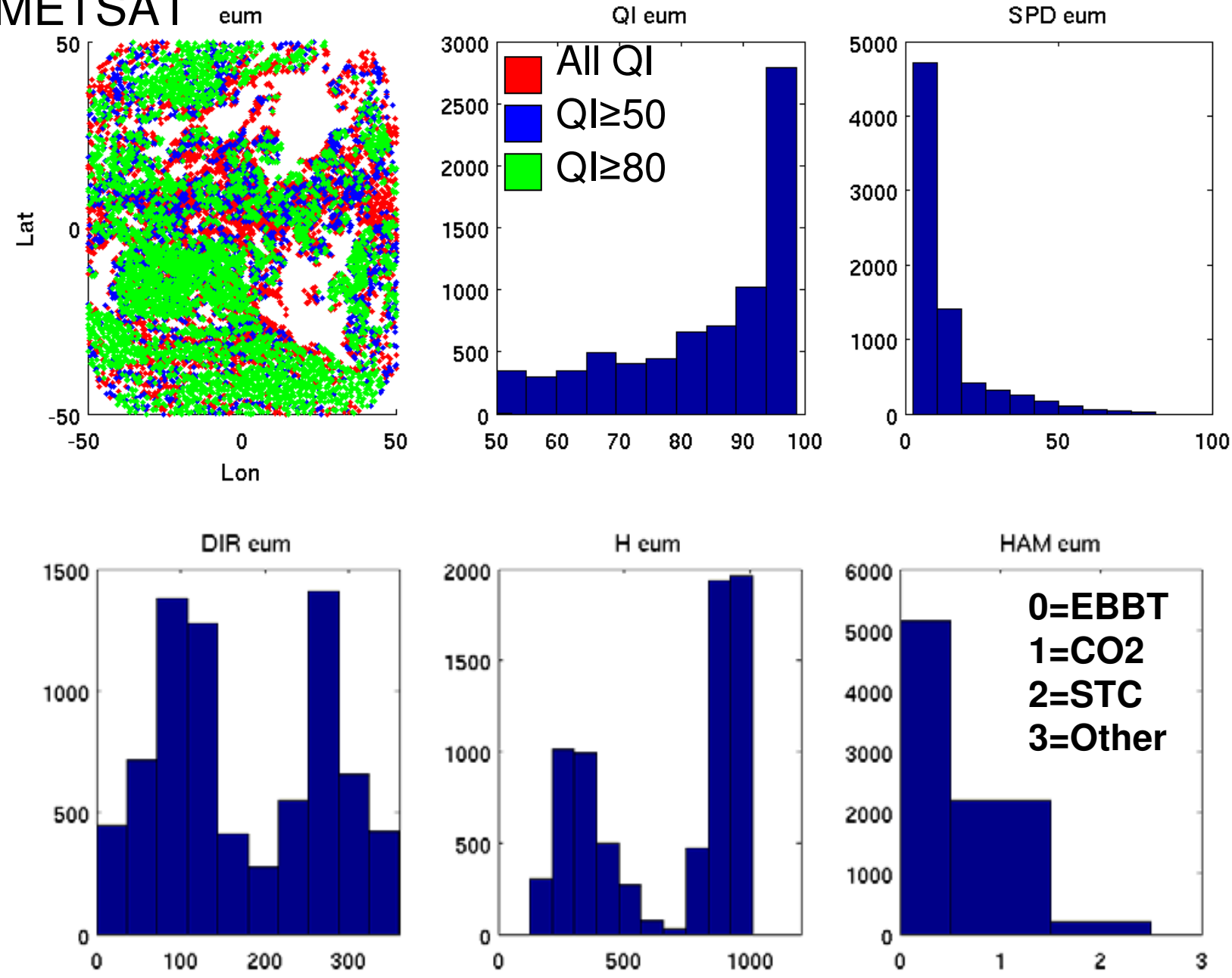
METEOSAT 8 SEVIRI (Channel 9 IR10.8) Brightness Temperature Friday 18 August 2006 1200UTC





IR10.8	EUMETSAT	CIMSS	Brazil	JMA	KMA
Total num winds	10775	13003	7051	11006	4072
Winds QI>=50	7506	13003	5017	10216	3501

EUMETSAT


eum
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QI≥80
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2
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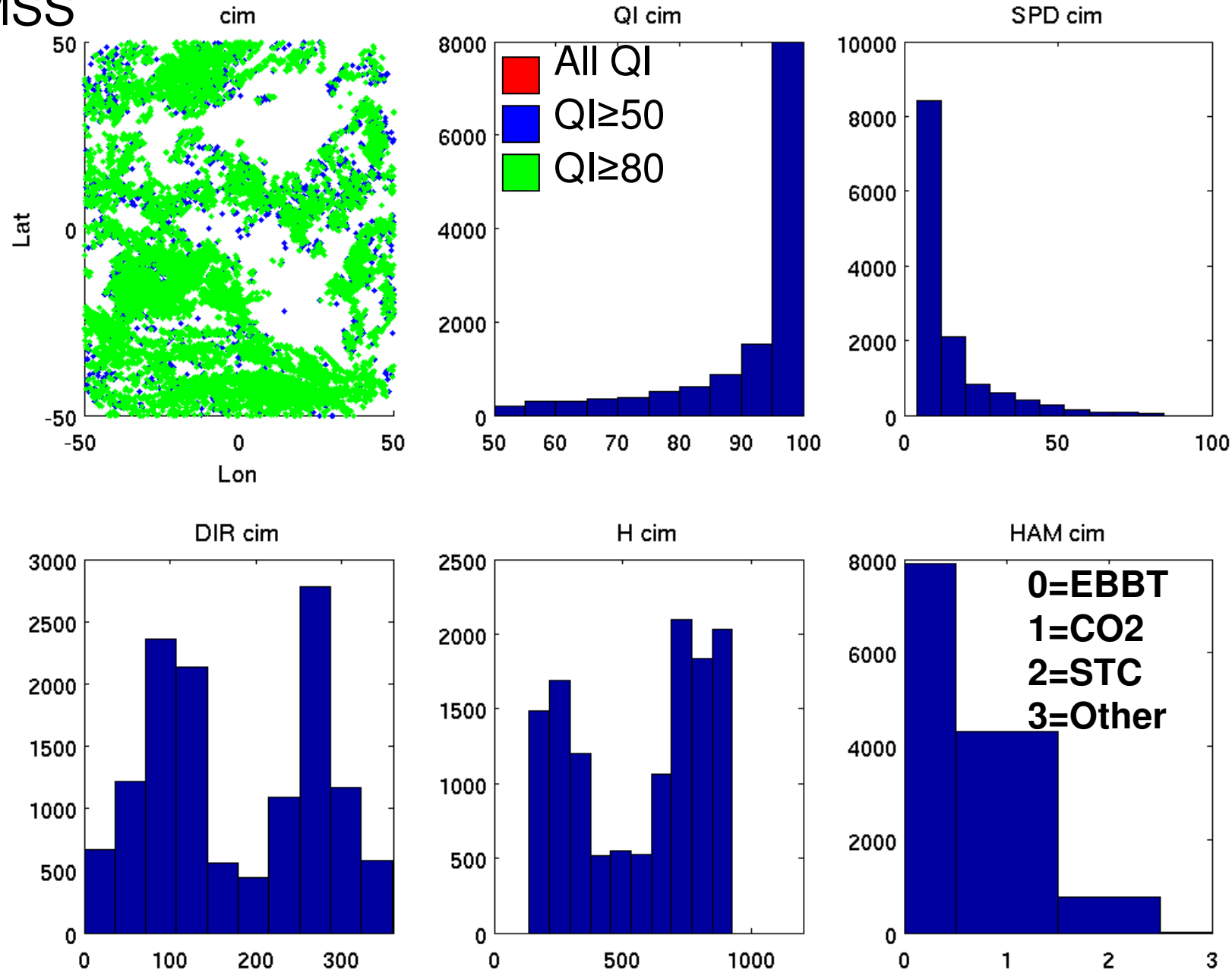
0=EBBT
1=CO2
2=STC
3=Other

CIMSS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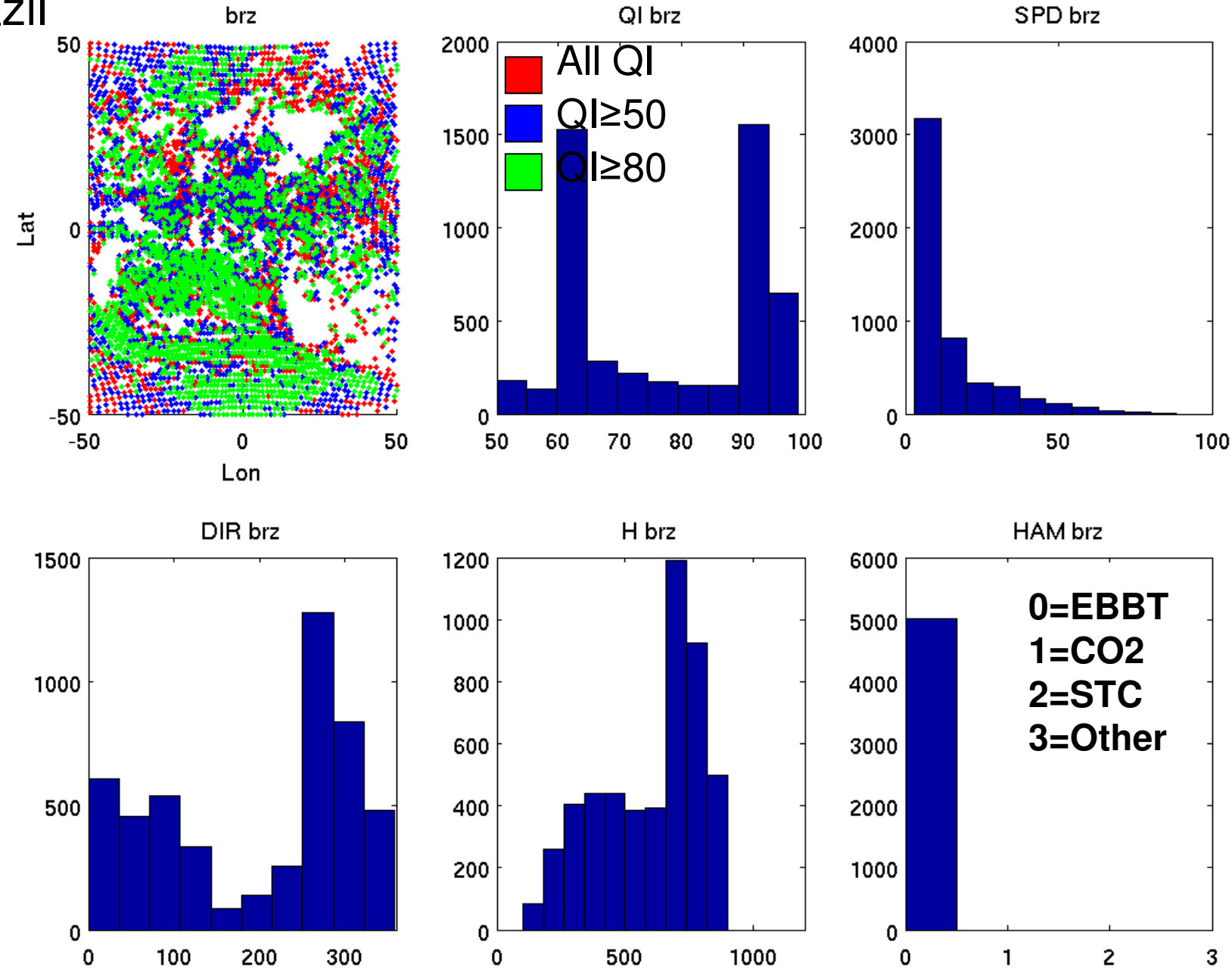
2=STC
3=Other

Brazil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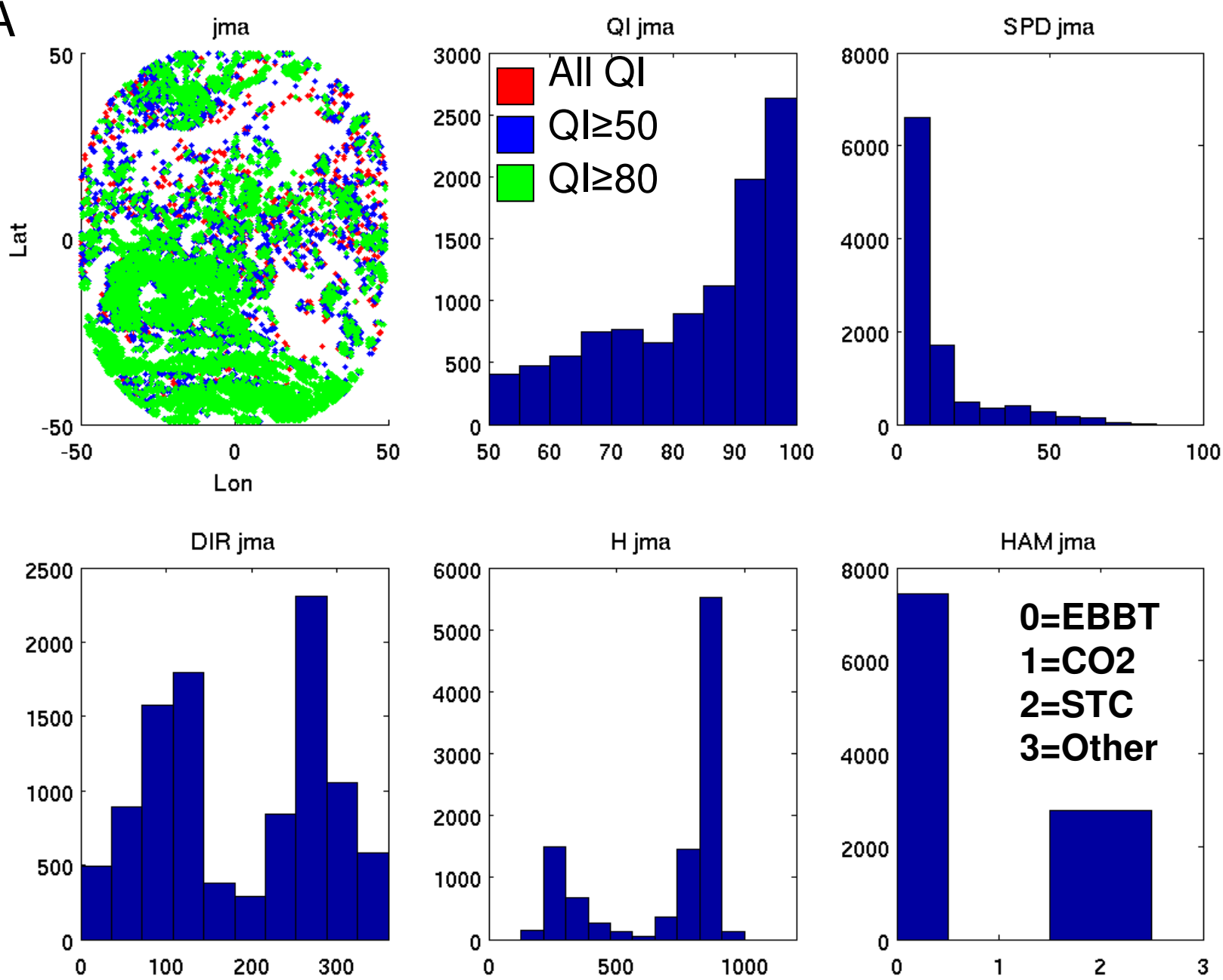
1=CO2
2=STC
3=Other

JMA


jma
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All QI
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QI≥80
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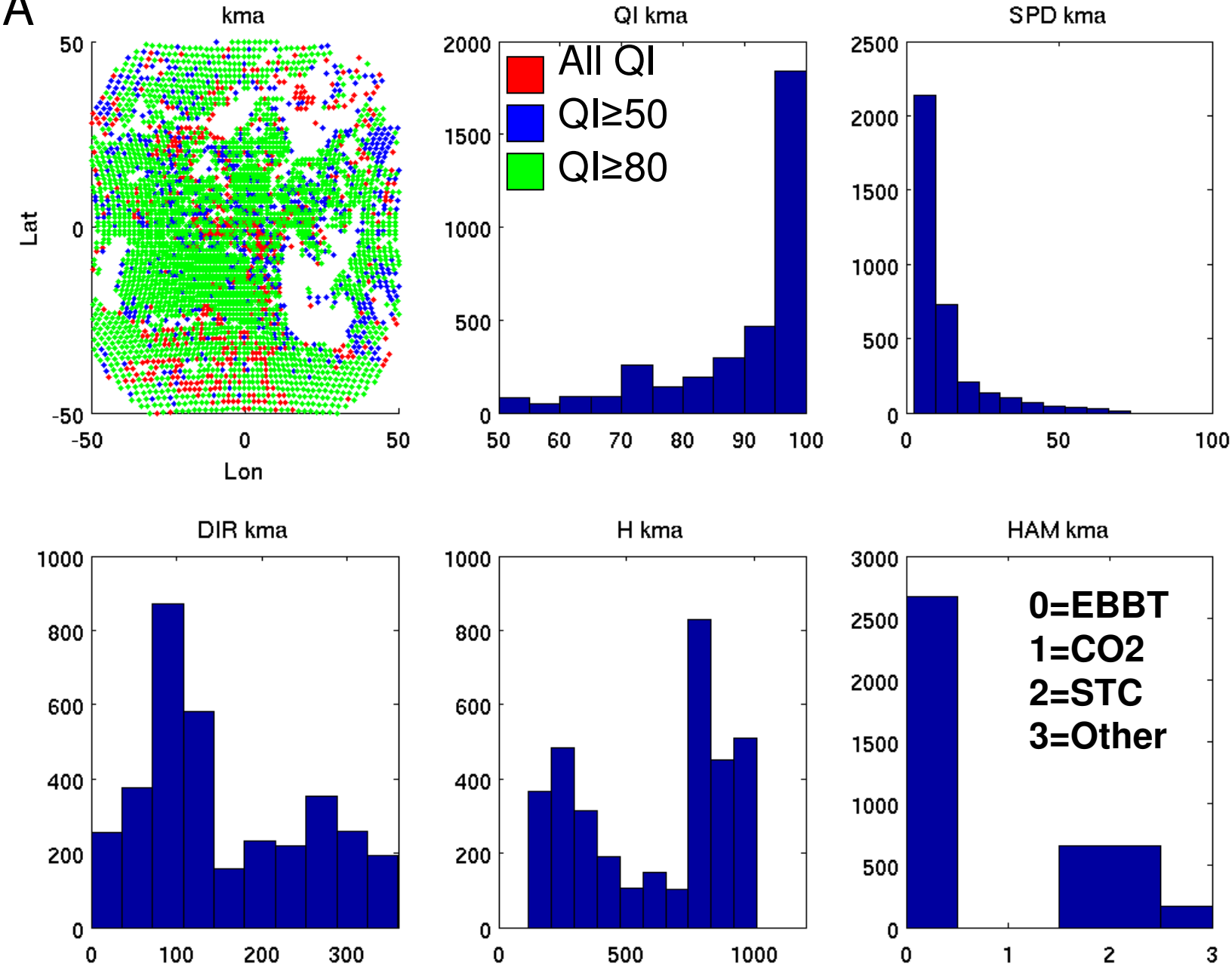
2=STC
3=Other

KMA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QI kma
All QI
QI≥50
QI≥80
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SPD kma
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DIR kma
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HAM kma
3000
2500
2000
1500
1000
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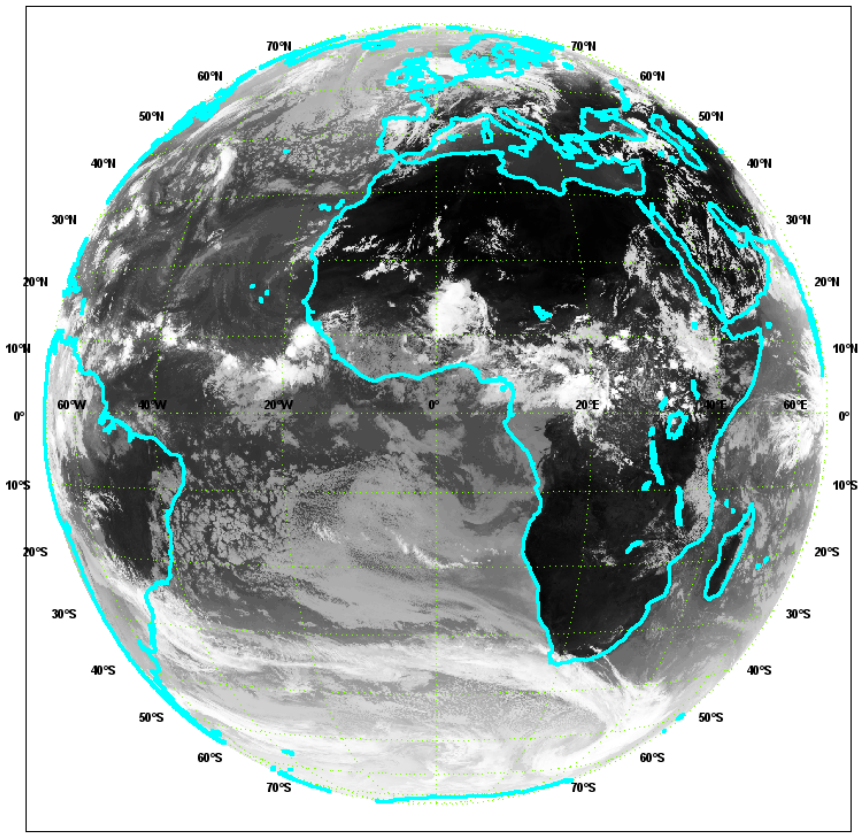
0
1
2
3
0=EBBT
1=CO2
2=STC
3=Other

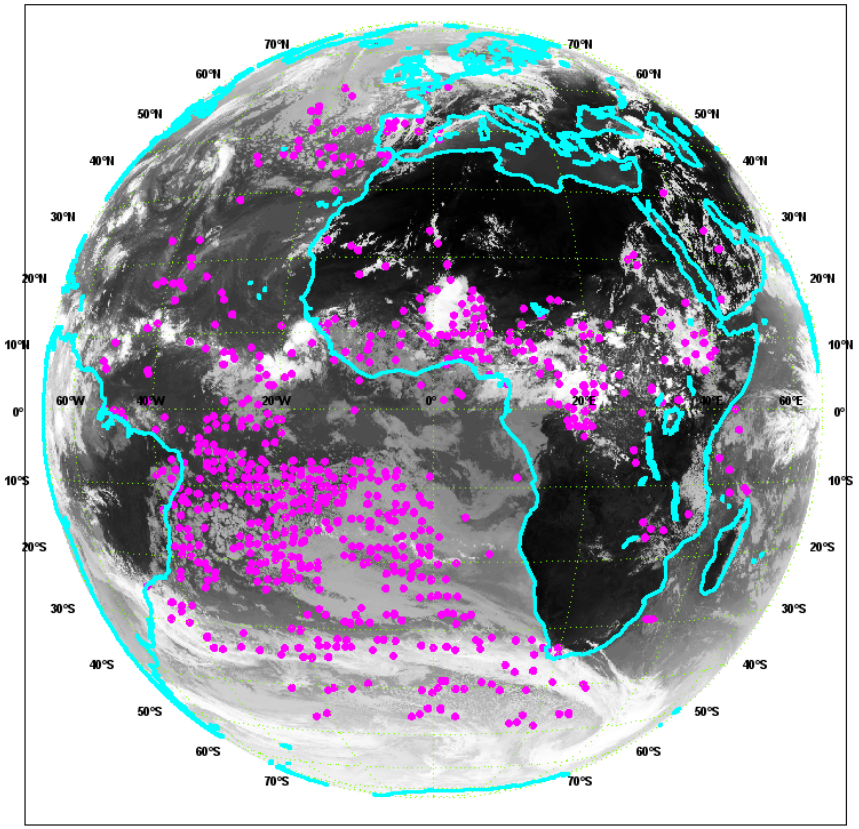
DATA

	EUMETSAT	NESDIS	Brazil	JMA	KMA
Total num winds	10775	13003	7051	11006	4072
Winds QI>=50	7506	13003	5017	10216	3501
Winds QI>=80	5099	11081	2503	6805	2819
********** For AMV with QI>=50 **********					
SPD min	2.50	4.00	3.04	2.5	2.51
SPD max	81.60	84.20	88.50	84.66	73.30
SPD mean	13.18	14.41	14.19	13.79	12.08
P min	102.17	137.00	101.00	125.96	115.00
P max	1008.59	925.00	900.00	997.70	1009.98
P mean	669.27	566.49	598.04	704.34	609.20
Low winds%	57.73	45.87	42.58	72.18	53.61
Mid winds%	11.62	18.81	36.14	4.33	12.11
High winds%	30.66	35.32	21.29	23.49	34.28
Low SPD min	2.50	4.00	3.12	2.50	2.56
Low SPD max	50.59	43.40	88.50	82.78	70.16
Low SPD mean	8.09	9.10	8.78	8.73	9.39
Low P min	700.63	700.00	700.00	701.24	700.56
Low P max	1008.59	925.00	900.00	997.70	1009.98
Low P mean	906.65	801.76	777.30	850.93	859.94
Mid SPD min	2.50	4.00	3.04	2.54	2.51
Mid SPD max	81.60	59.40	87.54	62.55	63.66
Mid SPD mean	15.53	14.27	15.29	15.42	15.36
Mid P min	400.13	412.00	401.00	400.57	400.02
Mid P max	698.77	687.00	699.00	699.84	698.11
Mid P mean	495.49	574.75	567.38	515.72	521.88
High SPD min	2.52	4.00	3.48	2.53	2.61
High SPD max	81.19	84.20	83.70	84.66	73.30
High SPD mean	21.88	21.37	23.12	29.01	15.12
High P min	102.17	137.00	101.00	125.96	115.00
High P max	399.93	400.00	400.00	399.89	399.77
High P mean	288.11	256.58	291.54	288.69	247.85

DATA

METEOSAT 8 SEVIRI (Channel 9 IR10.8) Brightness Temperature Friday 18 August 2006 1200UTC





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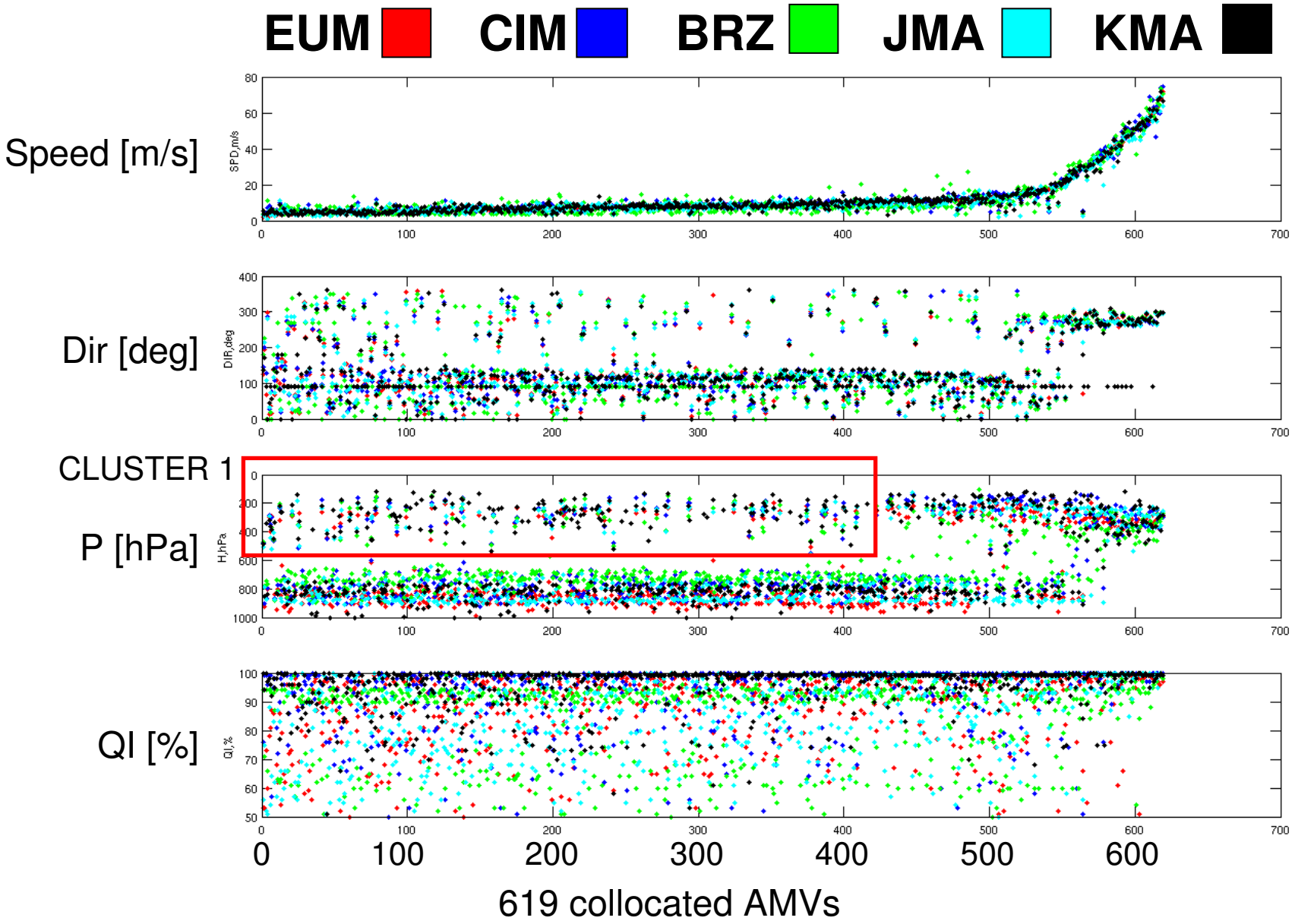
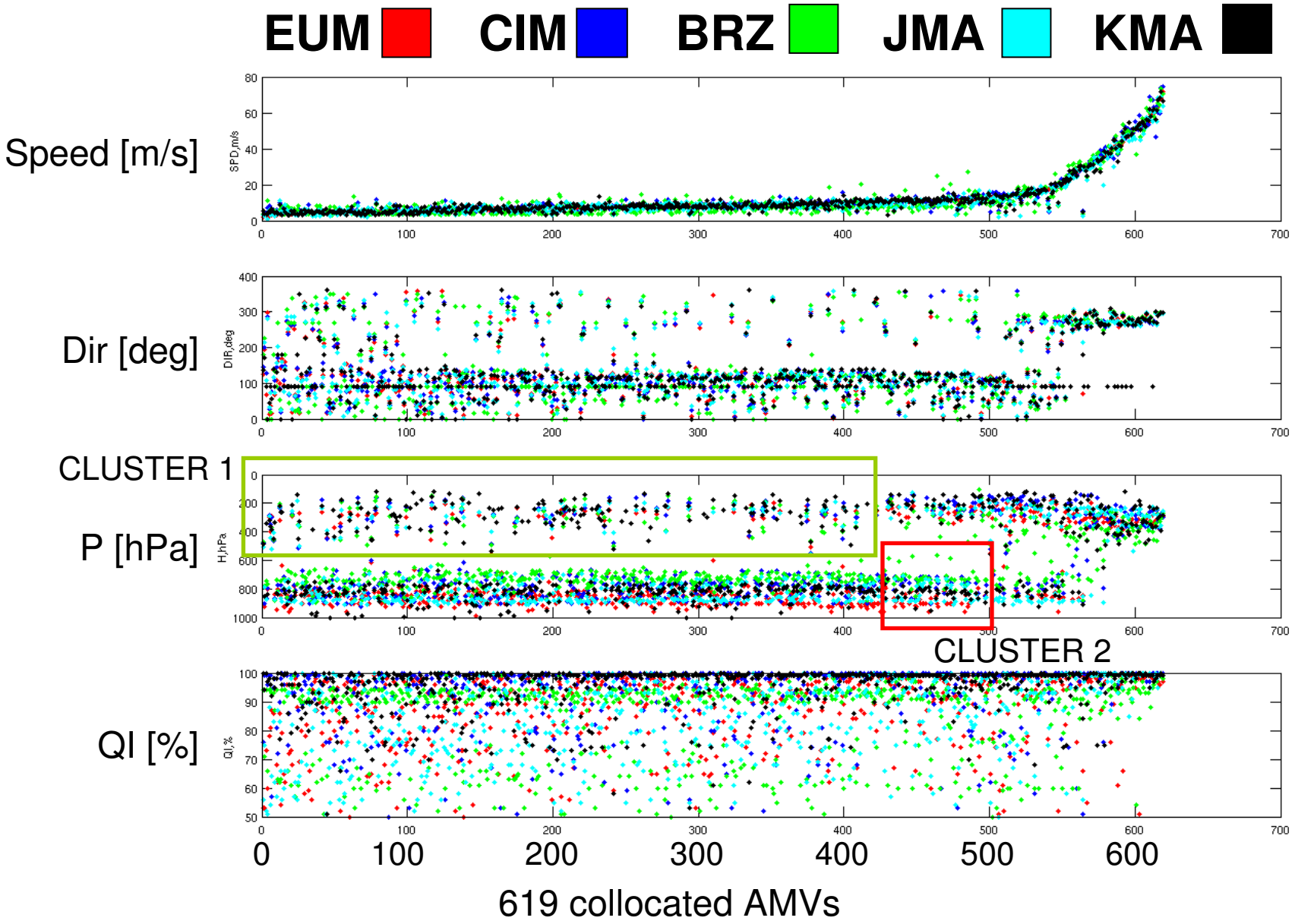
ANALYSIS


EUM
CIM
BRZ
JMA
KMA
Speed [m/s]
SPD,m/s
Dir [deg]
DIR,deg
CLUSTER 1
P [hPa]
H,hPa
QI [%]
QI,%
0
100
200
300
400
500
600
619 collocated AMVs

ANALYSIS


EUM
CIM
BRZ
JMA
KMA
Speed [m/s]
SPD,m/s
Dir [deg]
DIR,deg
CLUSTER 1
P [hPa]
H,hPa
CLUSTER 2
QI [%]
QI,%
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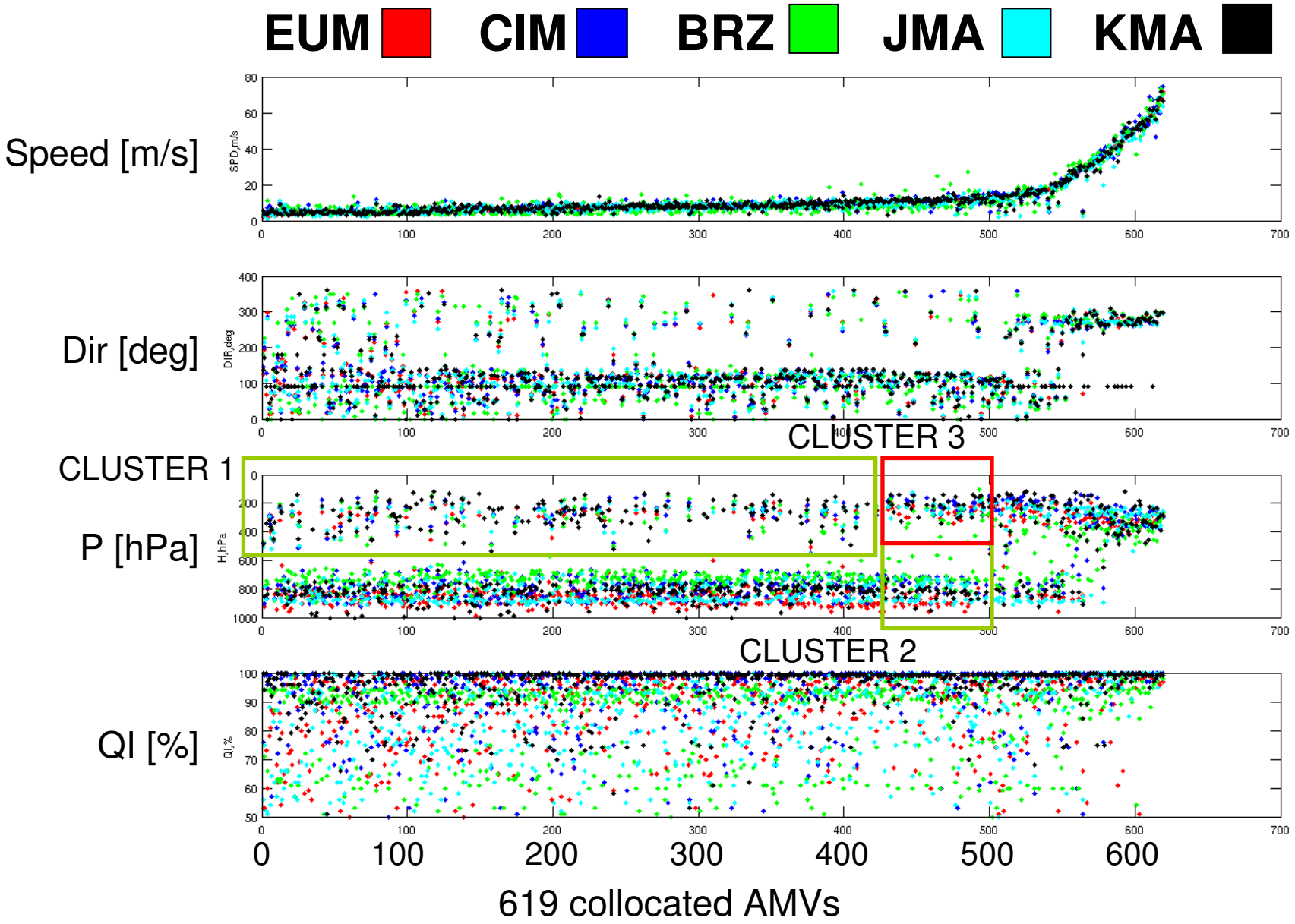
619 collocated AMVs

ANALYSIS


EUM
CIM
BRZ
JMA
KMA
Speed [m/s]
SPD,m/s
Dir [deg]
DIR,deg
CLUSTER 1
CLUSTER 3
P [hPa]
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CLUSTER 2
QI [%]
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0
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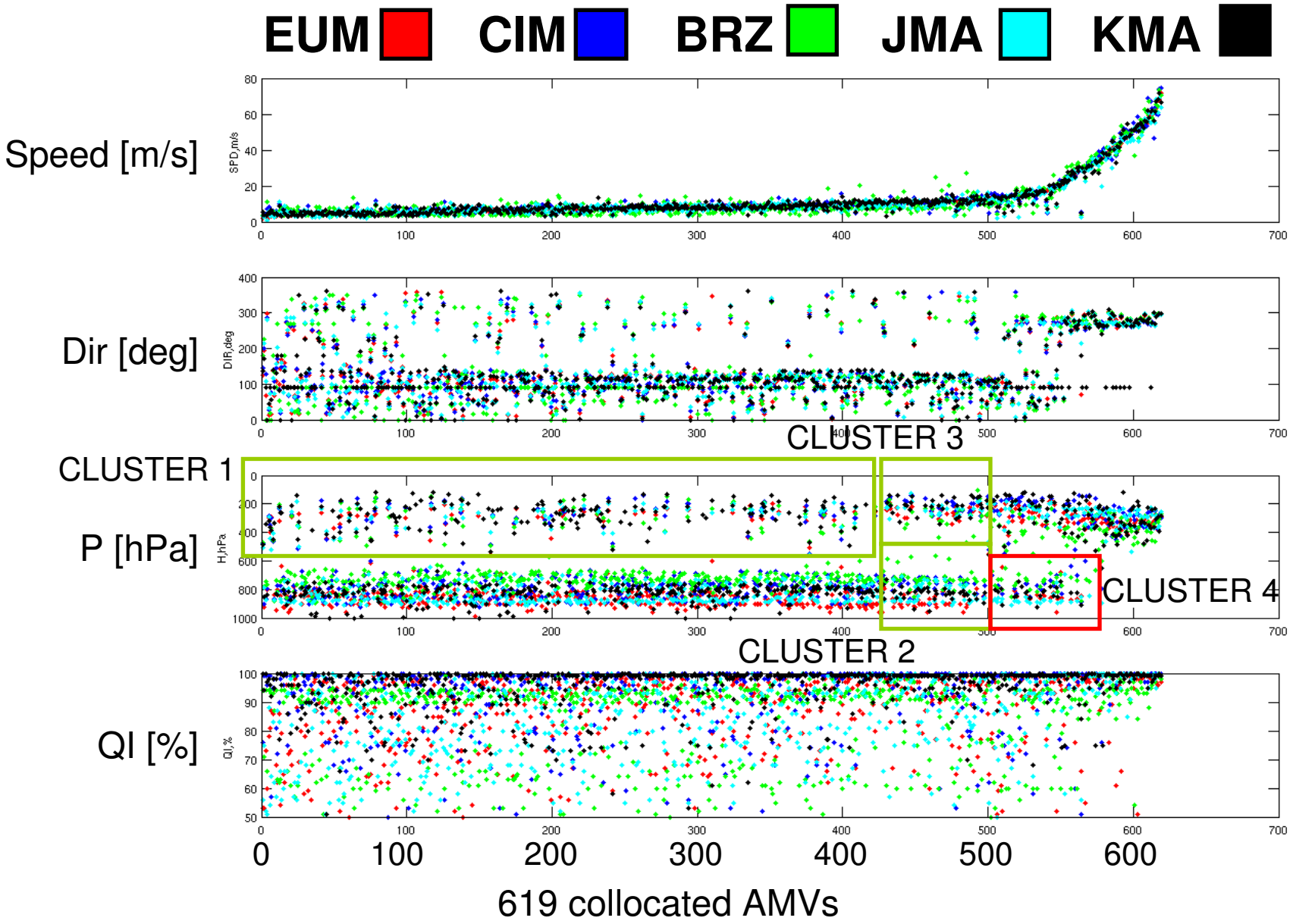
619 collocated AMVs

ANALYSIS


EUM
CIM
BRZ
JMA
KMA
Speed [m/s]
SPD,m/s
Dir [deg]
DIR,deg
CLUSTER 1
CLUSTER 3
P [hPa]
H,hPa
CLUSTER 4
CLUSTER 2
QI [%]
QI,%
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100
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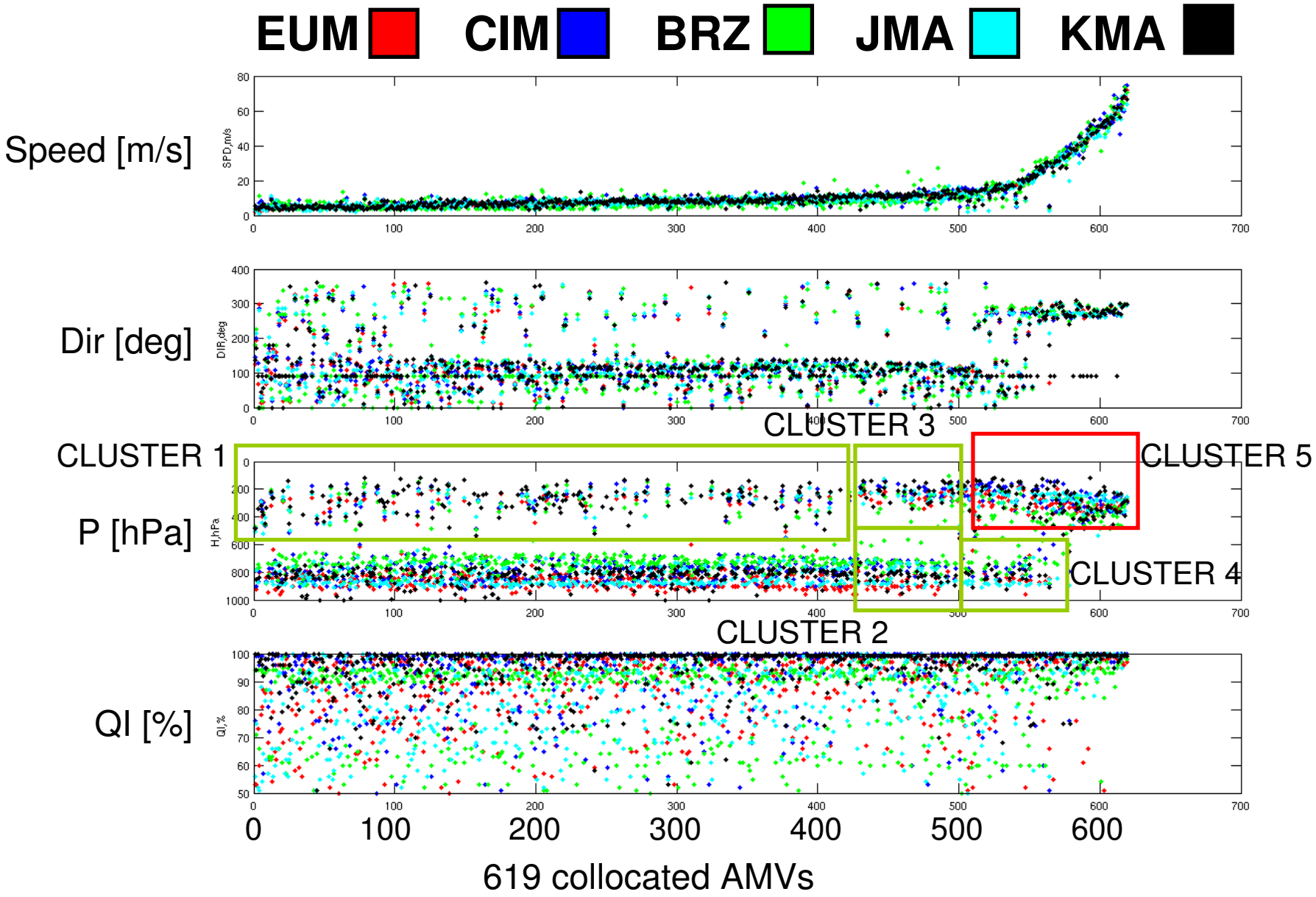
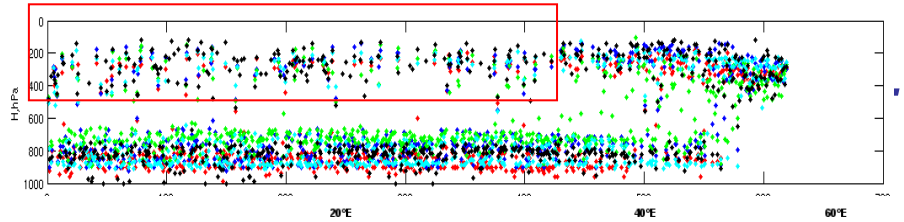
600
619 collocated AMVs

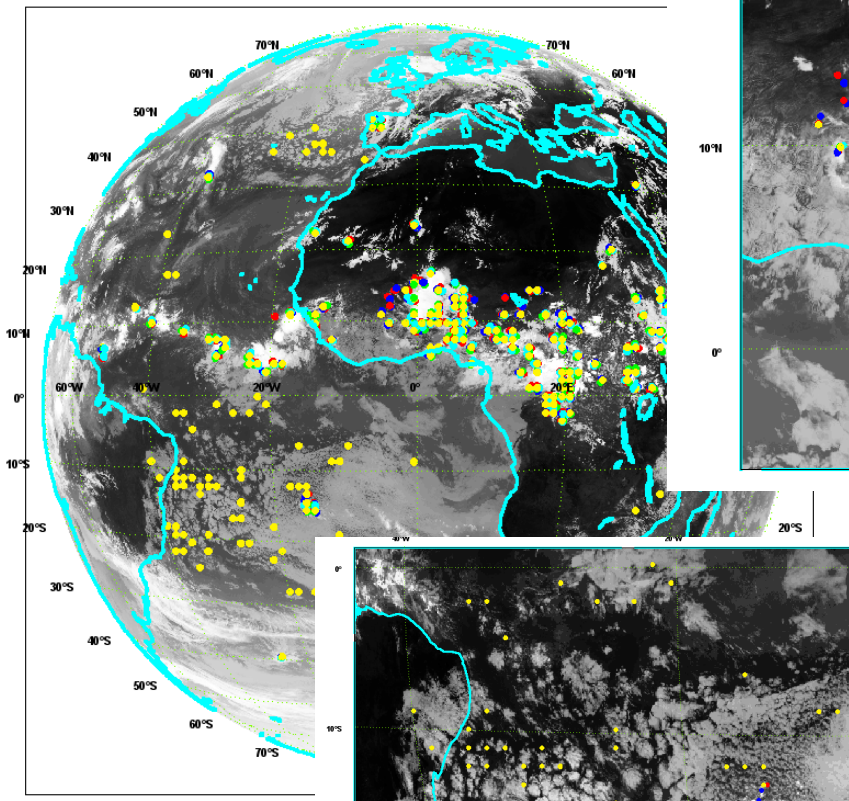
ANALYSIS

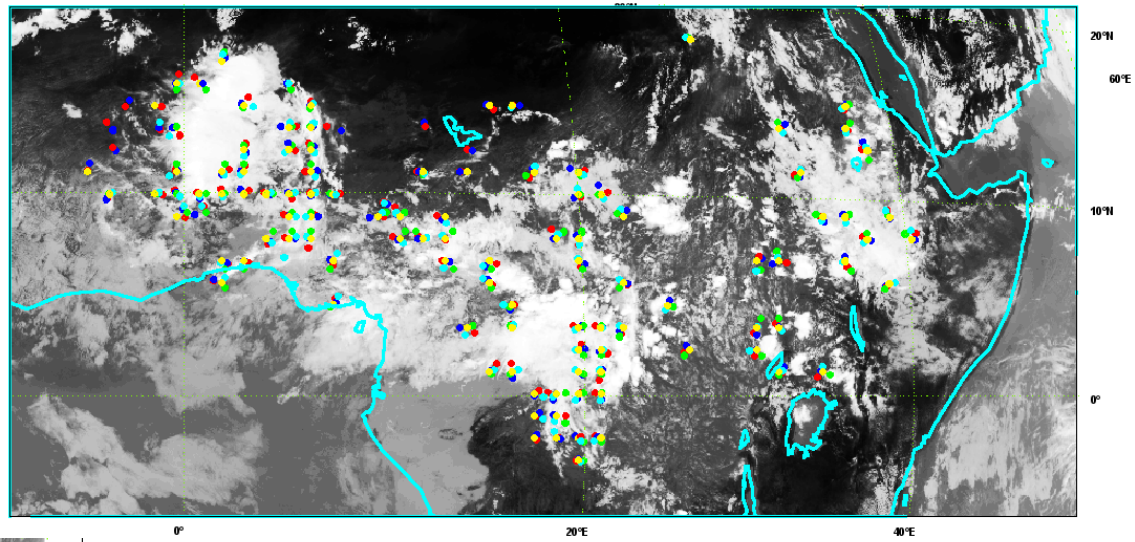

EUM
CIM
BRZ
JMA
KMA
Speed [m/s]
SPD,m/s
Dir [deg]
DIR,deg
CLUSTER 1
CLUSTER 3
CLUSTER 5
P [hPa]
H,hPa
CLUSTER 4
CLUSTER 2
QI [%]
QI,%
0
100
200
300
400
500
600
619 collocated AMVs

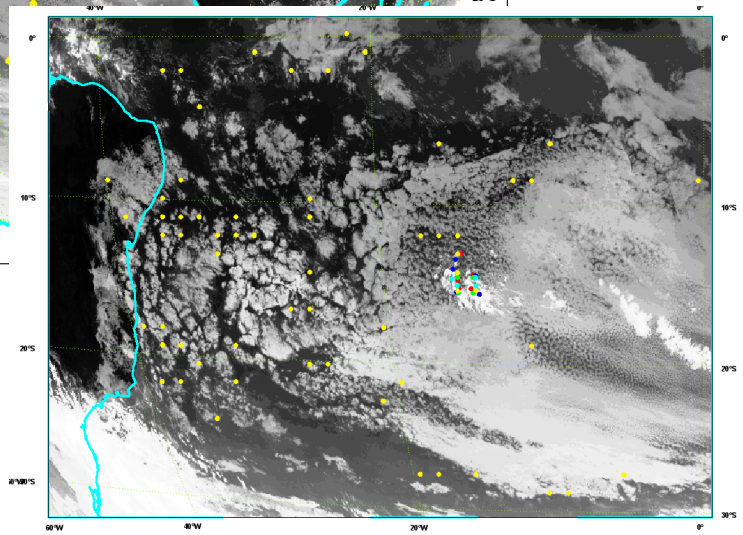
ANALYSIS – Cluster 1

Speed < 20m/s; P<500hPa





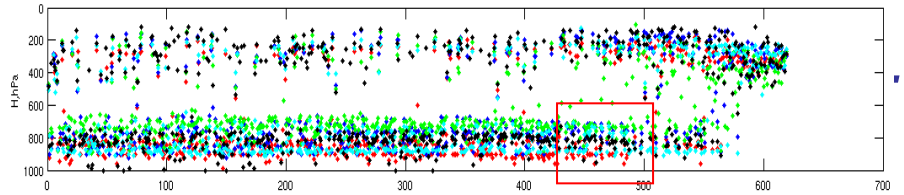




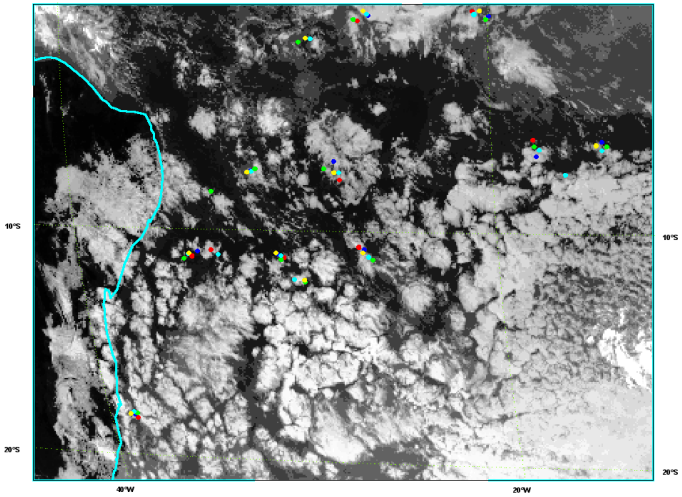
Convective systems over the Equator belt; vertically developing Cumulus; growing or dissipating clouds

Vertically misplaced winds from tracking open/closed cell marine cumulus

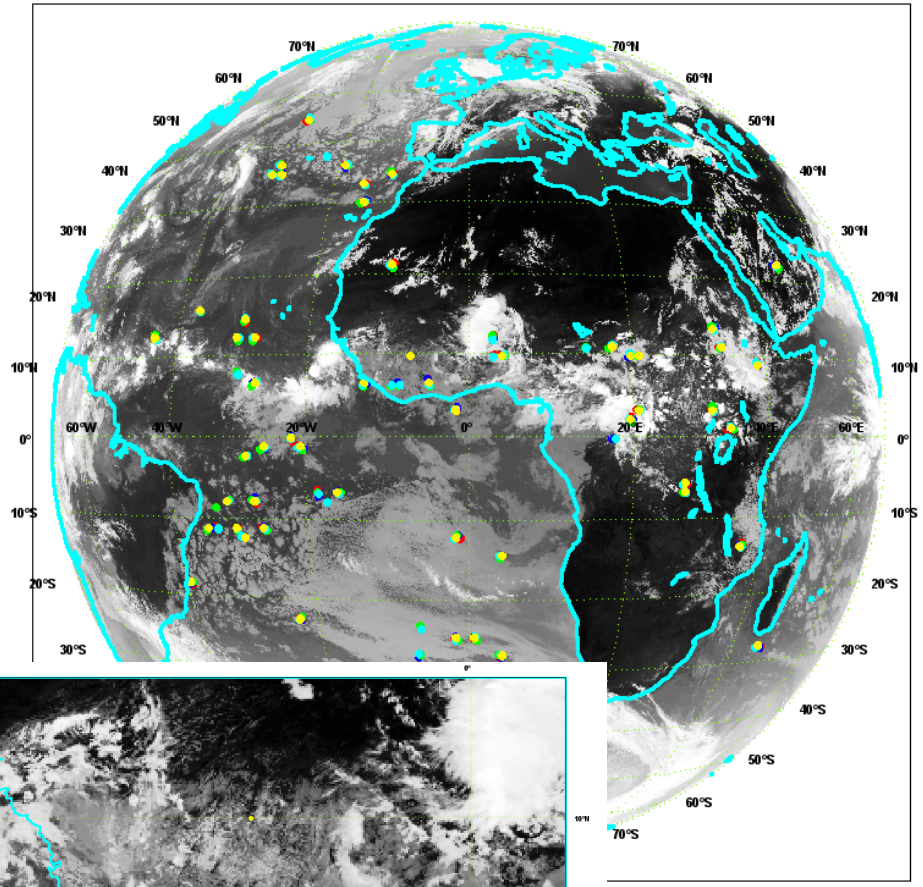
ANALYSIS – Cluster 2

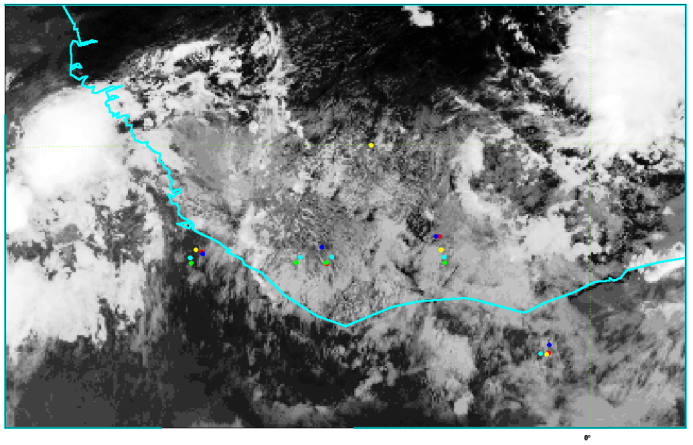


Speed < 20m/s; P>650hPa



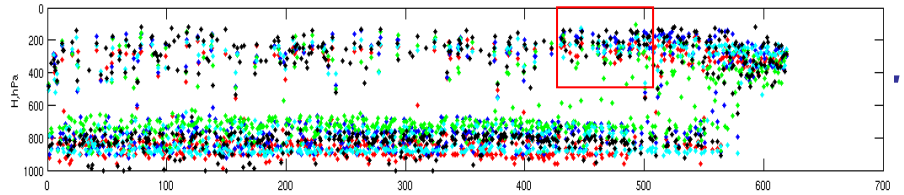
low marine cumulus



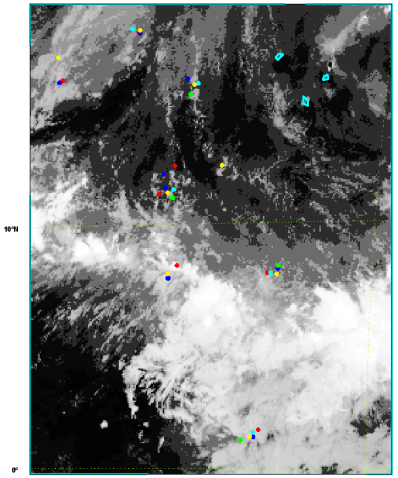


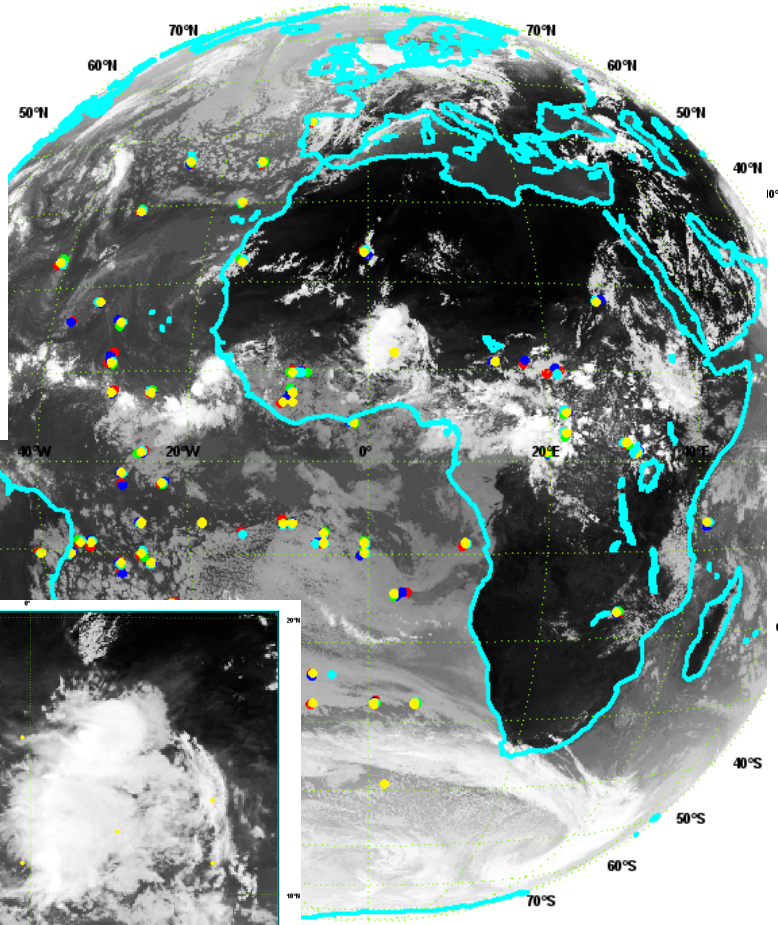
the lower surroundings of growing or dissipating vertically developing cumulus

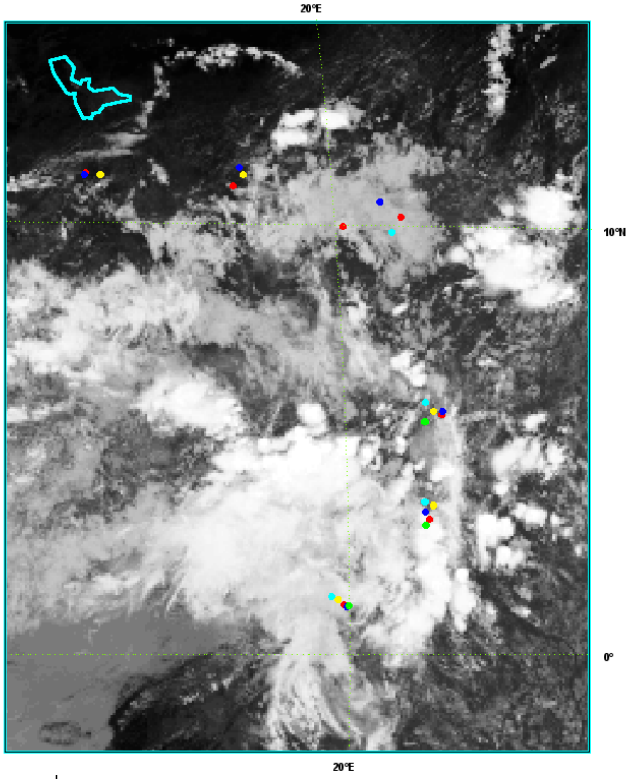
ANALYSIS – Cluster 3



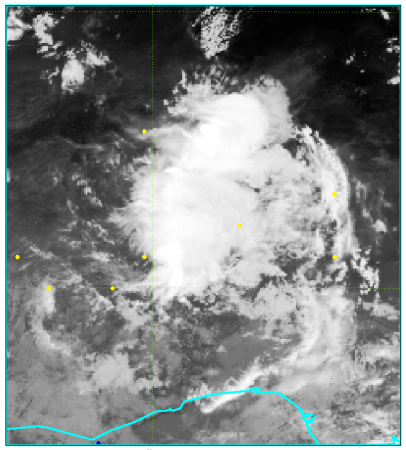
Speed < 20m/s; P<400hPa







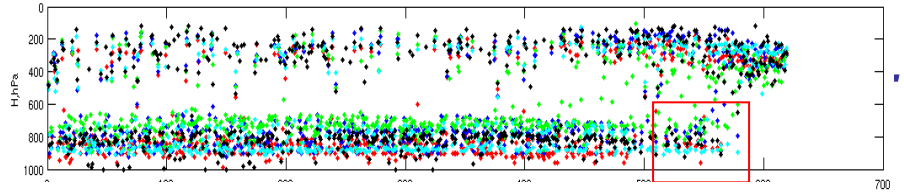
appear lower than assigned height



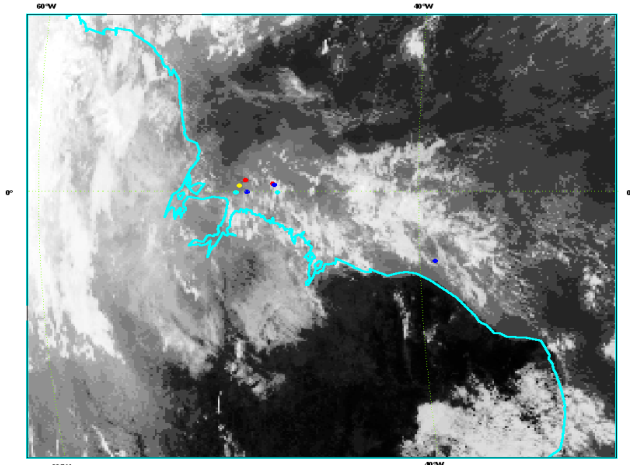
wrong heights

properly placed convective tracers

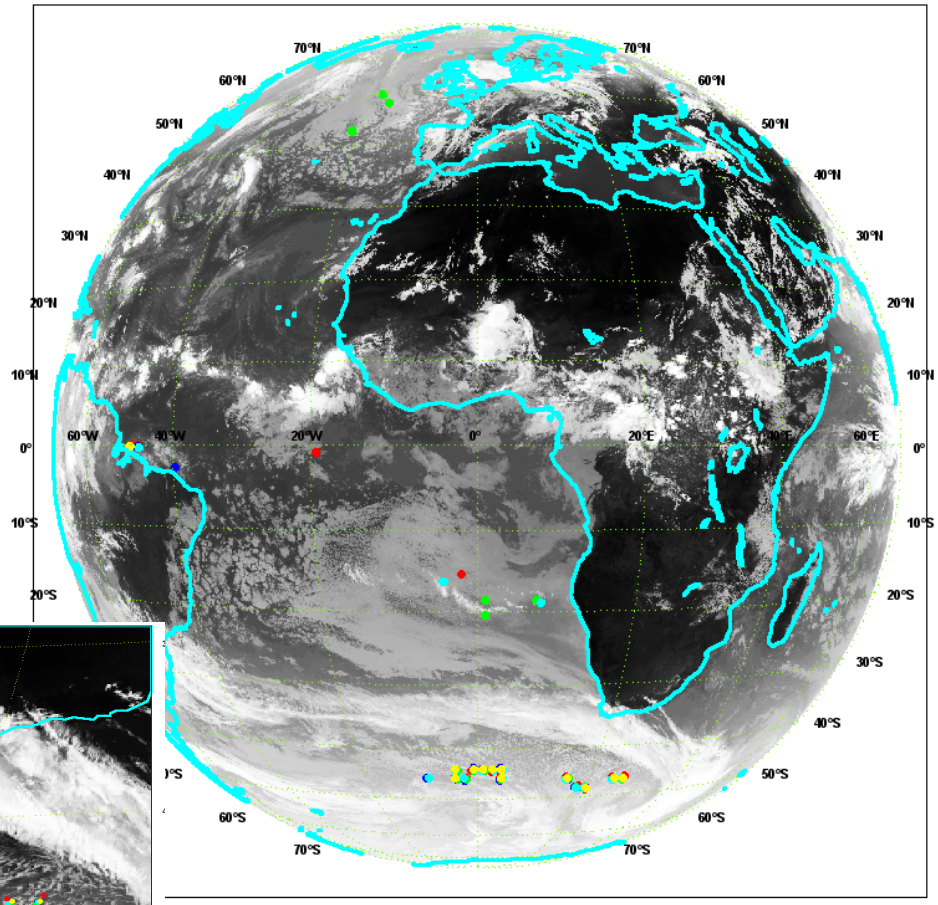
ANALYSIS – Cluster 4

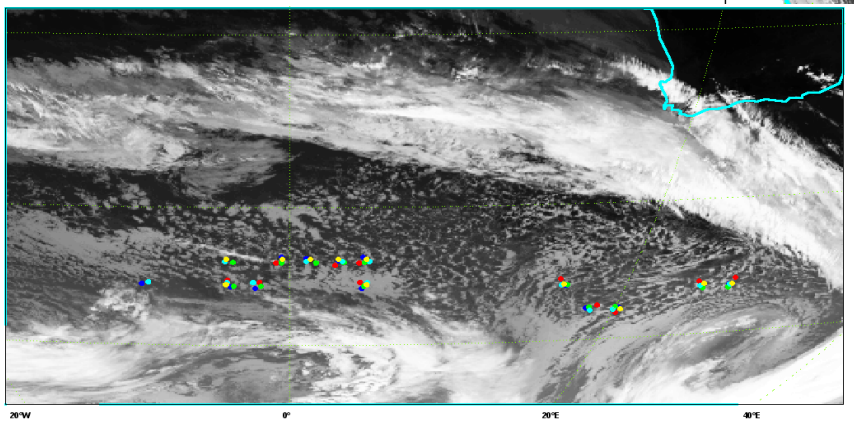


Speed > 20m/s; P>650hPa



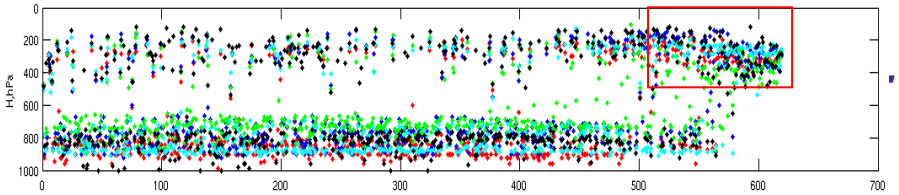
west trades



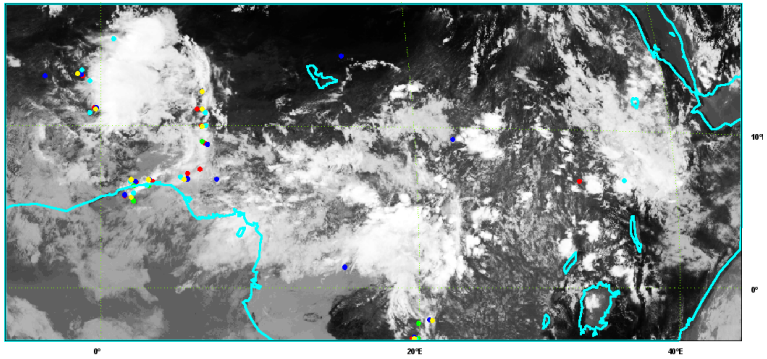


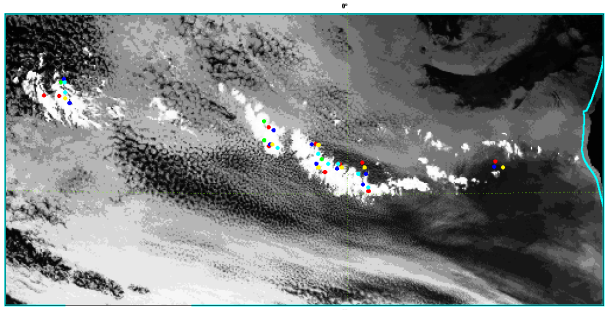
faster moving marine cumulus, possibly part of a polar front

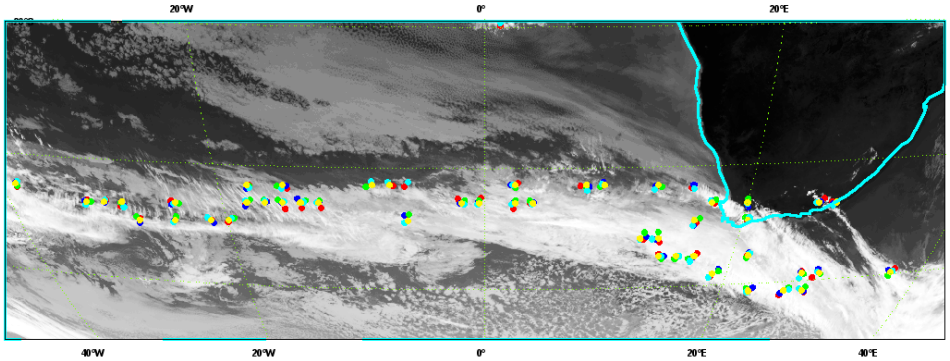
ANALYSIS – Cluster 5

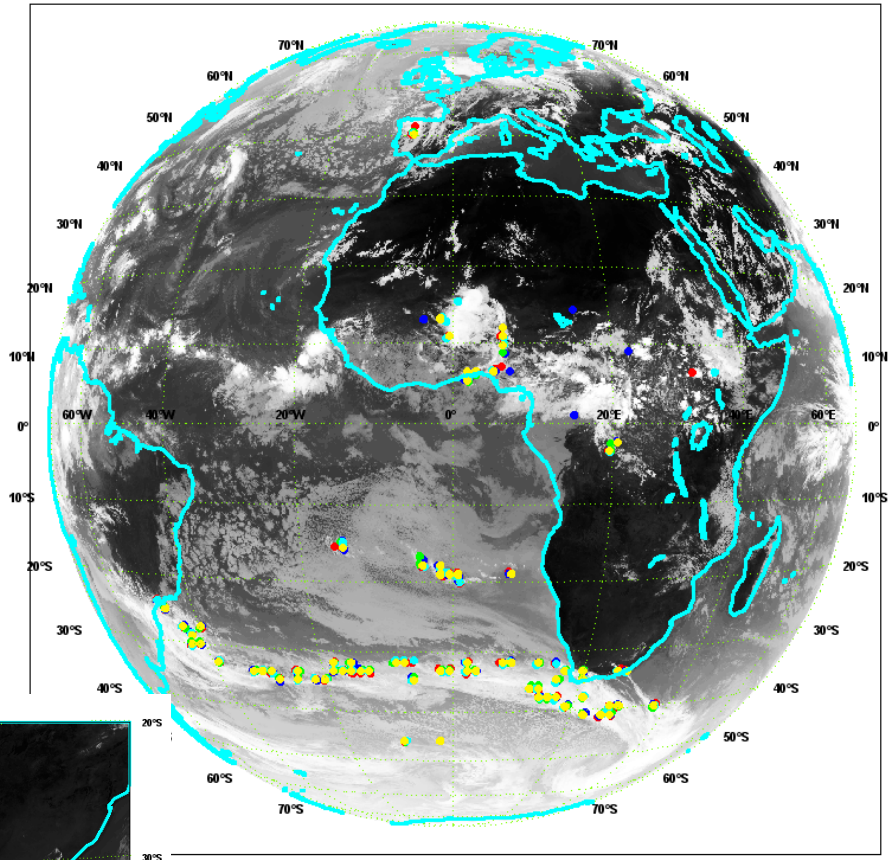


Speed > 20m/s; P<400hPa









well developed optically thick cirrus

ANALYSIS

EUM **CIM** **BRZ** **JMA** **KMA**

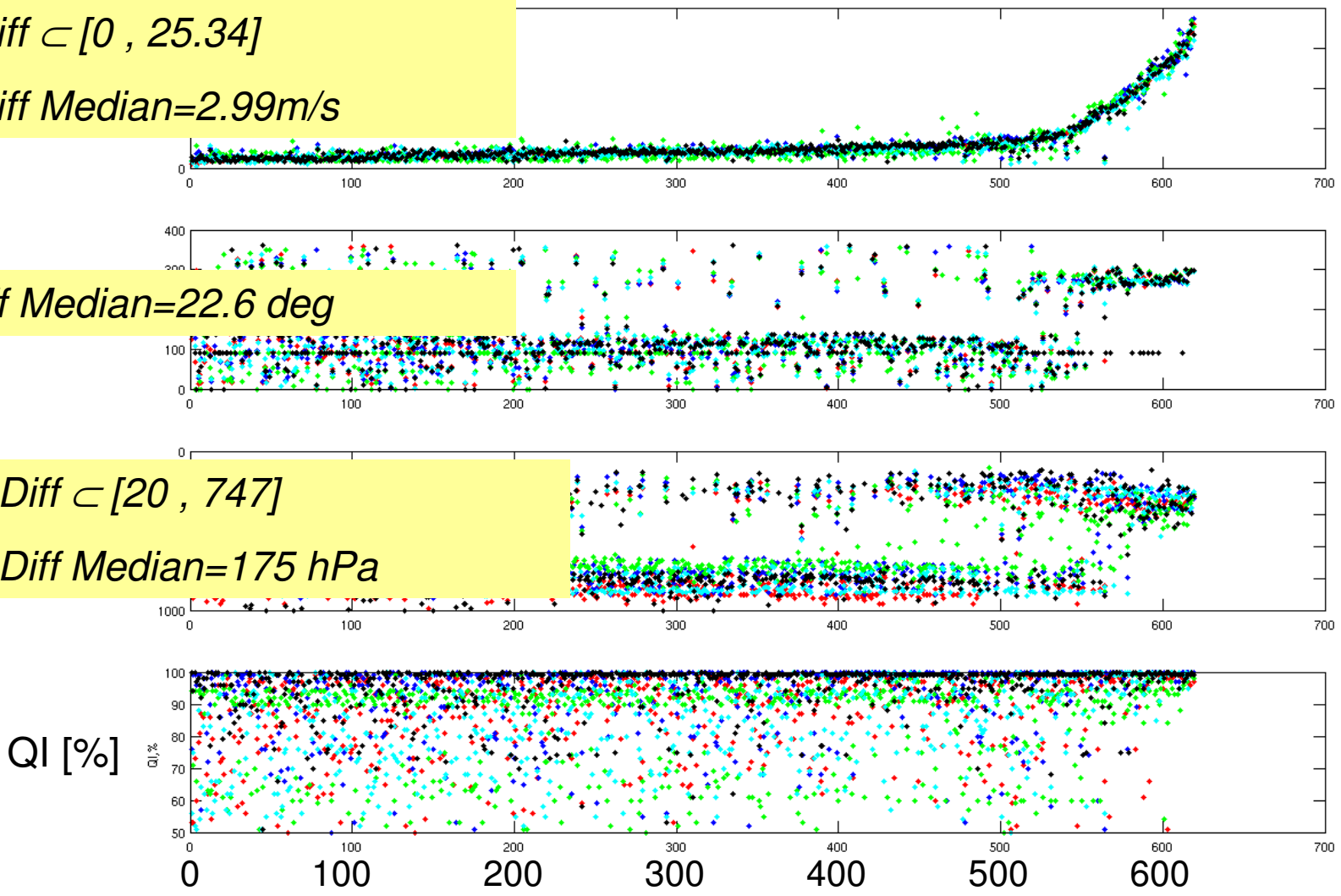
Spd Diff ⊂ [0 , 25.34]

Spd Diff Median=2.99m/s

Dir Diff Median=22.6 deg

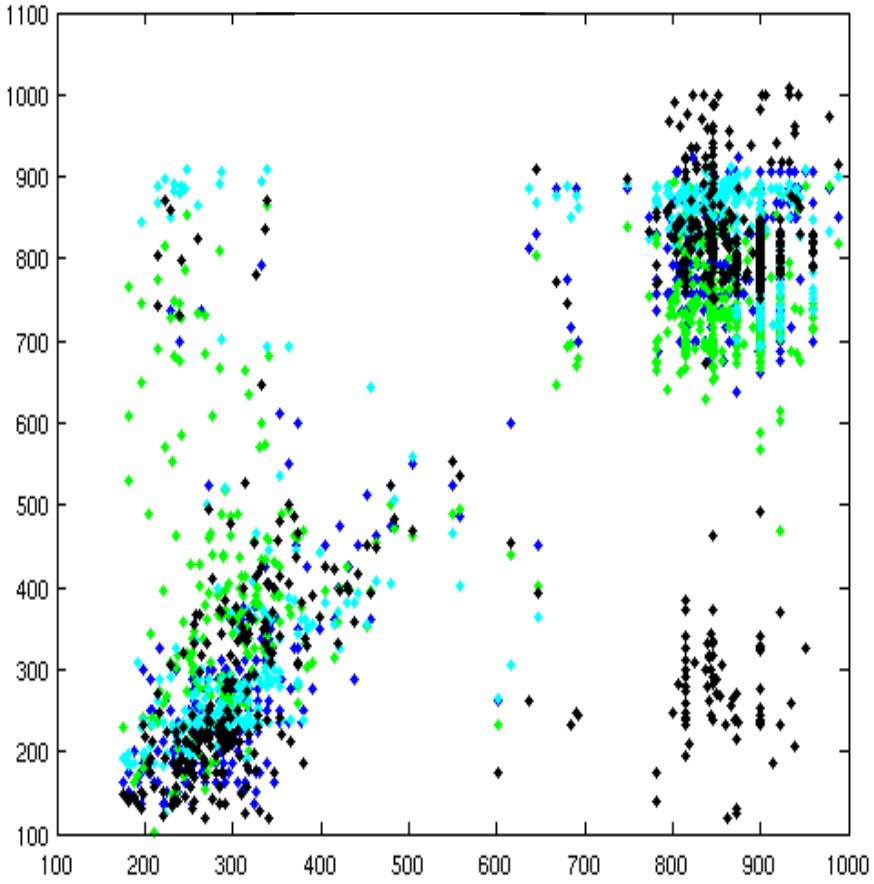
Press Diff ⊂ [20 , 747]

Press Diff Median=175 hPa



ANALYSIS

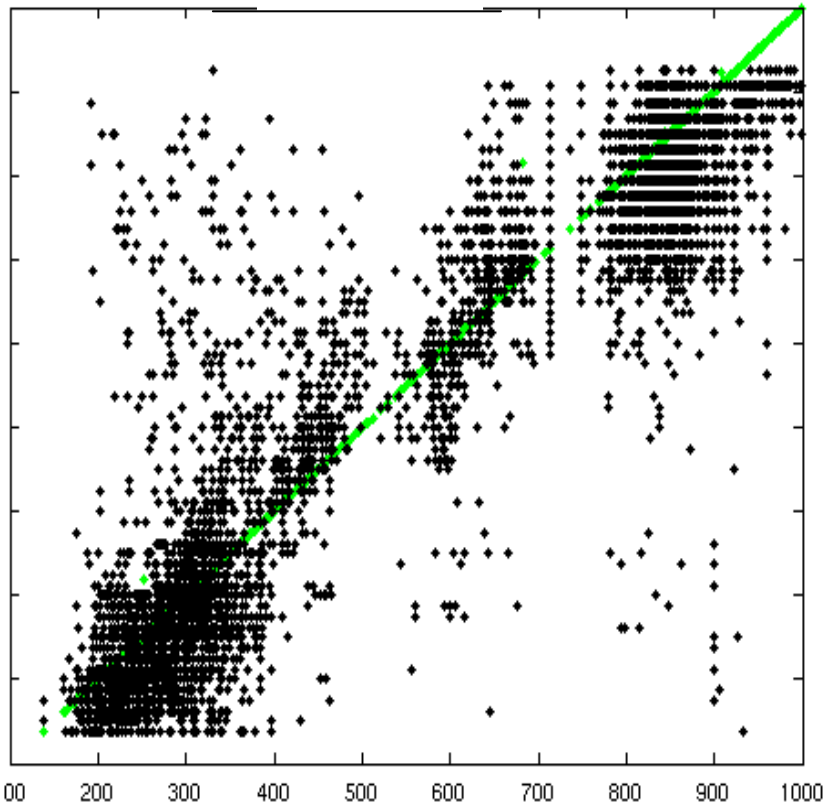
CIM BRZ JMA KMA



EUMETSAT Hamv, hPa

(619 points)

JMA CIM



EUMETSAT Hamv, hPa

(7649 points)

STATISTICAL ANALYSIS – Collocation with RAOBs

QI≥50	*Number*	*SPDbias*	*SPDrms*	*DIRbias*	*Vrms*
EUM	322	-1.17	5.54	0.66	7.25
NESDIS	802	-0.42	4.53	0.35	6.63
JMA	541	-3.21	8.05	3.30	9.34
BRZ	287	-1.28	7.32	3.47	10.52
KMA	175	-3.03	8.42	-11.67	12.57
QI≥80	*Number*	*SPDbias*	*SPDrms*	*DIRbias*	*Vrms*
EUM	205	-0.53	4.57	0.84	6.16
NESDIS	653	-0.17	4.40	-0.57	6.62
JMA	291	-1.57	7.42	0.24	8.64
BRZ	119	-0.07	6.34	-1.93	8.65
KMA	140	-2.57	7.53	-9.87	12.05

STATISTICAL ANALYSIS – Collocation with ECMWF forecast

QI≥50	ALL	HIGH	MIDDLE	LOW
EUMETSAT				
N	619	202	26	391
Mean	0.09	0.04	-0.97	0.19
Median	0.03	0.58	-0.59	-0.04
Std	3.04	4.28	2.75	2.14
NESDIS				
N	**619**	**196**	**47**	**376**
Mean	**0.23**	**-0.88**	**0.82**	**0.74**
Median	**0.22**	**-0.40**	**0.58**	**0.44**
Std	**3.58**	**4.83**	**3.61**	**2.53**
JMA				
N	619	187	19	413
Mean	-0.51	-2.39	0.83	0.27
Median	-0.44	-2.26	0.20	-0.03
Std	4.07	5.11	5.80	3.04
Brazil				
N	619	144	152	323
Mean	0.49	0.40	2.05	-0.20
Median	-0.24	-0.12	0.19	-0.42
Std	5.58	5.95	7.65	3.86
KMA				
N	619	254	35	330
Mean	-0.57	-2.60	2.91	0.61
Median	-0.19	-2.12	2.60	0.34
Std	5.48	6.85	8.15	2.74

QI≥85	ALL	HIGH	MIDDLE	LOW
EUMETSAT				
N	**439**	**136**	**10**	**293**
Mean	**0.27**	**0.75**	**-2.27**	**0.13**
Median	**0.15**	**1.12**	**-1.67**	**0.03**
Std	**2.66**	**4.08**	**3.07**	**1.52**
NESDIS				
N	516	164	30	322
Mean	0.53	-0.29	1.39	0.87
Median	0.57	0.08	1.43	0.60
Std	3.51	4.75	3.46	2.58
JMA				
N	**366**	**132**	**7**	**227**
Mean	**-0.46**	**-2.30**	**0.04**	**0.59**
Median	**-0.37**	**-2.24**	**-0.86**	**0.16**
Std	**4.39**	**5.38**	**7.00**	**3.15**
Brazil				
N	425	93	99	233
Mean	0.57	0.89	2.93	-0.56
Median	-0.32	0.00	0.97	-0.71
Std	5.83	6.02	8.26	3.90
KMA				
N	552	229	25	298
Mean	-0.49	-2.37	2.68	0.67
Median	-0.14	-2.06	2.69	0.42
Std	5.33	6.88	7.27	2.69

SUMMARY

- *The inter-comparison of AMVs derived by 5 producers from the same SEVIRI imagery estimated median values for the difference in Speed, Direction and Pressure to be 2.99m/s, 22 deg and 175 hPa*
- *Targets size, pixel selection and HA method are most important for the AMV height assignment accuracy*
- *Quality Indicator implementation varies across the AMV producing centers (not good), yet it is efficient for screening bad (spatially inconsistent) AMVs*
- *Collocation with RAOBs reports EUMETSAT and NESDIS winds to be of similar quality, while JMA's speed bias, rms and vector rms are about 1m/s, 3m/s and 2m/s worse*
- *First Guess departure analysis show EUMETSAT Low (700-1100hPa) and NESDIS Mid-level (400-700hPa) winds to be superior*
- *For All winds JMA's FG departures mean and standard deviations are larger by 0.2m/s and 2m/s*
- *Brazil and KMA's wind retrievals need further improvement*

ACTION STEPS

- *KMA has improved AMV algorithm - introduced at the 2008 EUMETSAT conference*
- *JMA implemented improved tracking and new pixel selection approach for the height assignment*
- *NESDIS is revisiting the low level inversion correction (GOES-R)*
- *EUMETSAT is testing new pixel selection approach and developing new cloud analysis product*

The data used in the study is now too old, but study could be repeated (periodically?) much faster with new data, if producers and users find results useful for further algorithm development and improved AMV use