MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Status of the operational satellite winds production at CPTEC/INPE and its usage in regional data assimilation over South America

13th International Winds Workshop
Monterey, CA, US, 27th june 2016

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Ministério da Ciência, Tecnologia e Inovação
GOVERNO FEDERAL BRASIL PÁTRIA EDUCADORA

AMVs at CPTEC/INPE

- Activities:
  - AMV production over South America using GOES-East and MSG 0°
  - Assimilation on NPW models:
    - **BAM** (Brazilian Global Atmospheric Model - operational)
    - **BRAMS** (Brazilian developments on the Regional Atmospheric Modeling System, RAMS - operational)
    - **WRF** (regional mode, research)
  - Used on nowcasting and weather forecast/monitoring

AMV activities at CPTEC/INPE

	High	Med	Low
Visible			X
Near infrared (3.9 μm)			X
Water vapor (6.7 μm)	X	X	
Infrared (10.2 μm)	X	X	X

Expected for 2016's 2nd half (in progress)

- MSG
  - Only over Atlantic and South America
  - Vis, 3.9, 6.2, 7.2 and 10.8 μm
  - Why?
    - Extend spatial cover to regional models
    - When GOES unavailable
    - Coastal monitoring (navy / petrol extraction)

CPTEC/INPE winds algorithm

- Uses an image triplet with at least 30 minutes intervals
- Tracking method: MCC
- Height assignment methods:
  - EBBT (opaque clouds)
  - WV intercept (semi-transparent)
  - CO2 slicing (semi-transparent)
- QI

QI scheme

direction $QI_a = 1 \quad \tanh \dfrac{\left|D_1 \quad D_2\right|}{Ae^{\frac{vlc}{B}} + C}^{D}$

D1,D2 : direção dos vetores V1,V2

speed $QI_b = 1 \quad \tanh \dfrac{\left\|\vec{V}_1\right| \quad \left|\vec{V}_2\right\|}{MAX(Avlc, B) + C}^{D}$

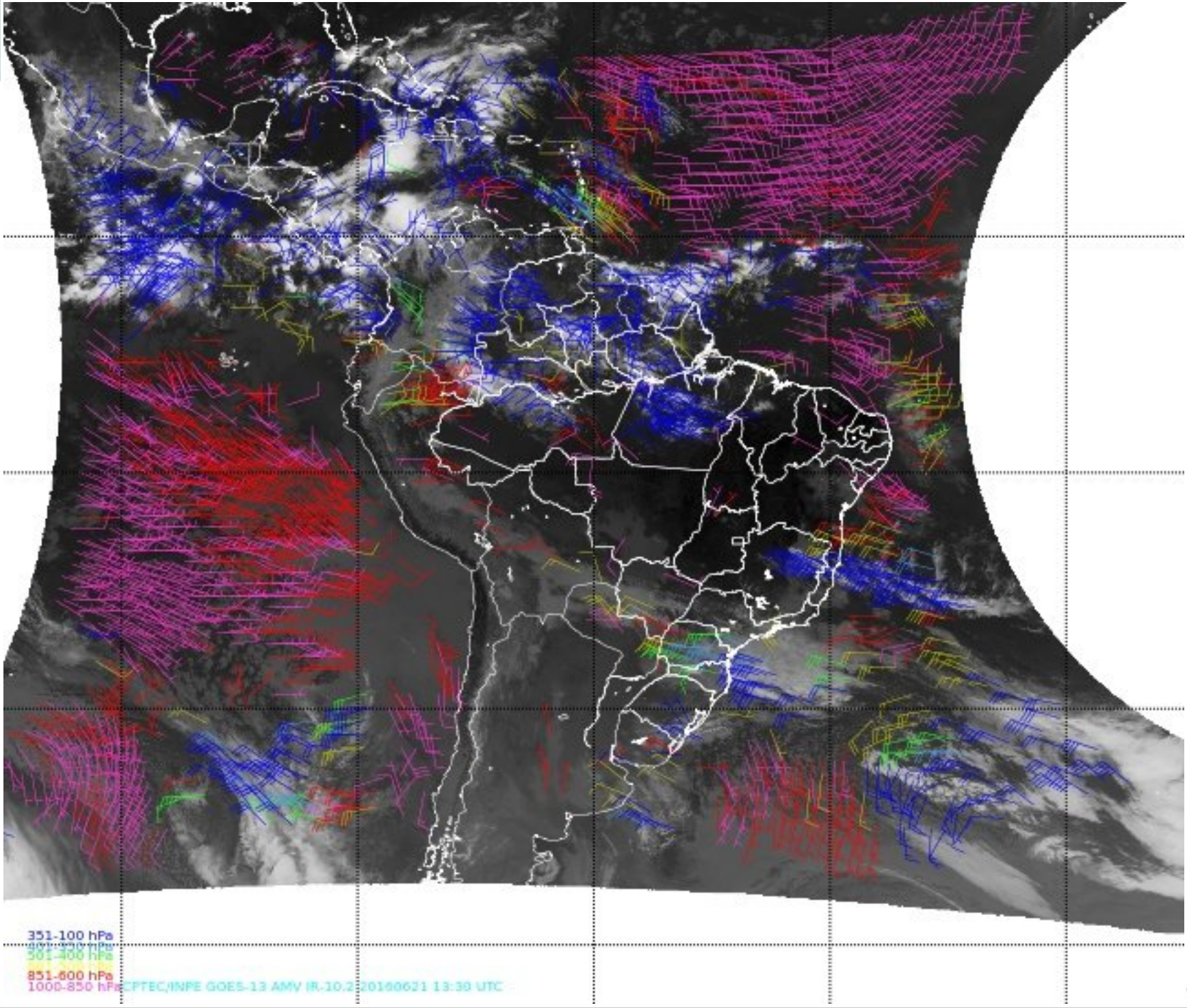
$$QI = \frac{AQI_a + BQI_b + CQI + DQI_d}{A + B + C + D}$$

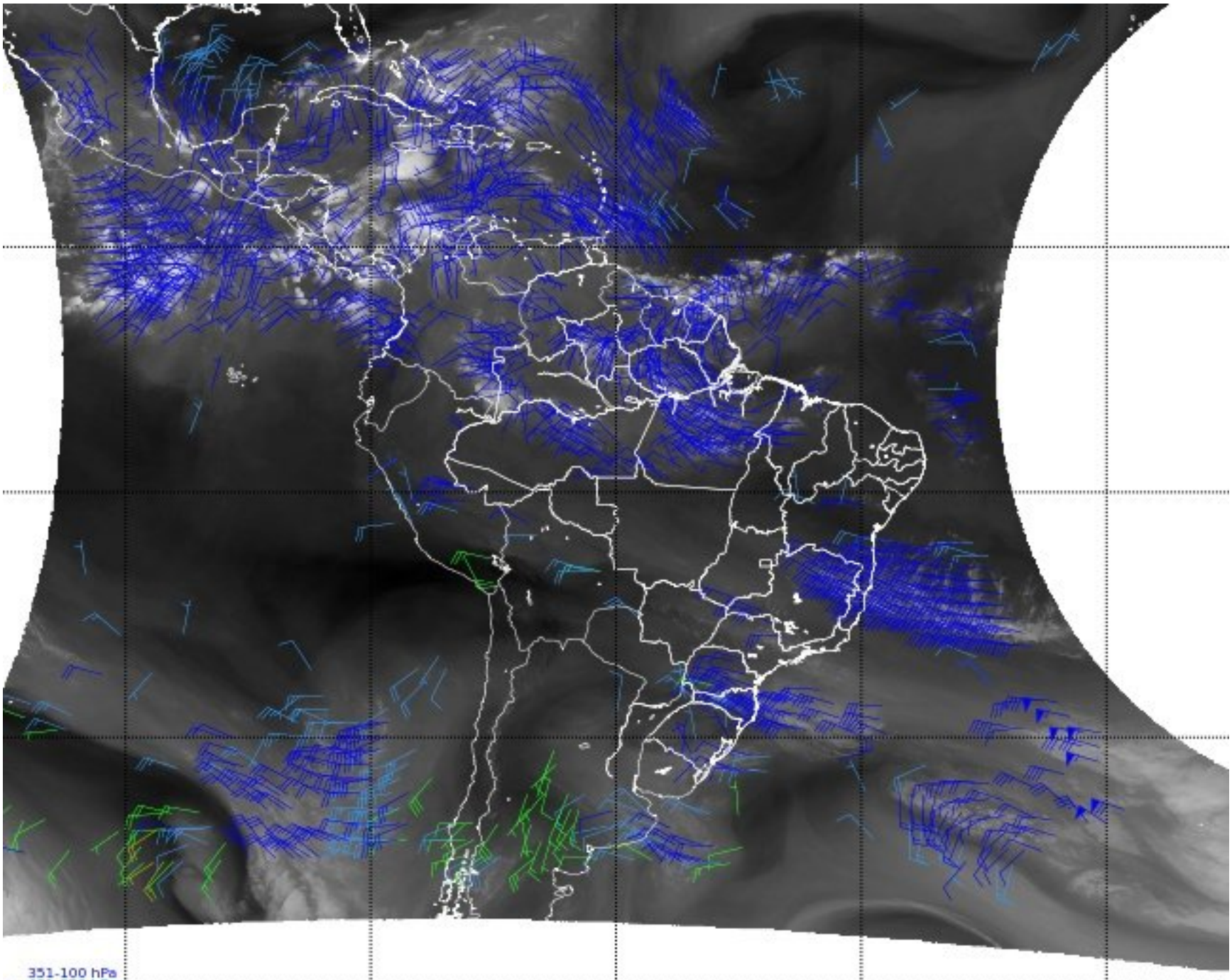
Vector consistency $QI_c = 1 \quad \tanh \dfrac{\left|\vec{V}_1 \quad \vec{V}_2\right|}{MAX(Avlc, B) + C}^{D}$

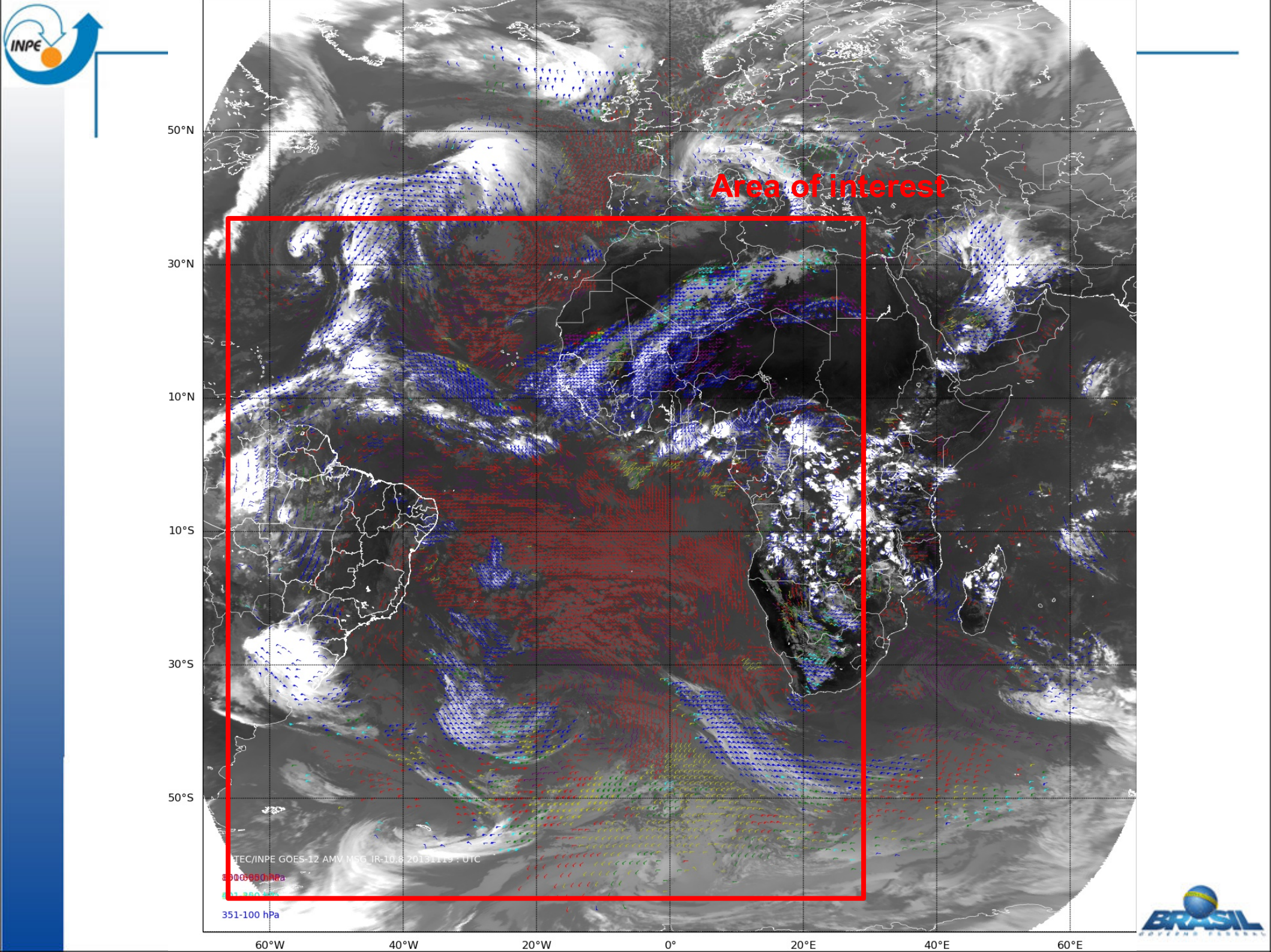
spatial consistency $QI_d = 1 \quad \tanh \dfrac{\left|\vec{V}_2 \quad \vec{V}_k\right|}{MAX(Avlc, B) + C}^{D}$

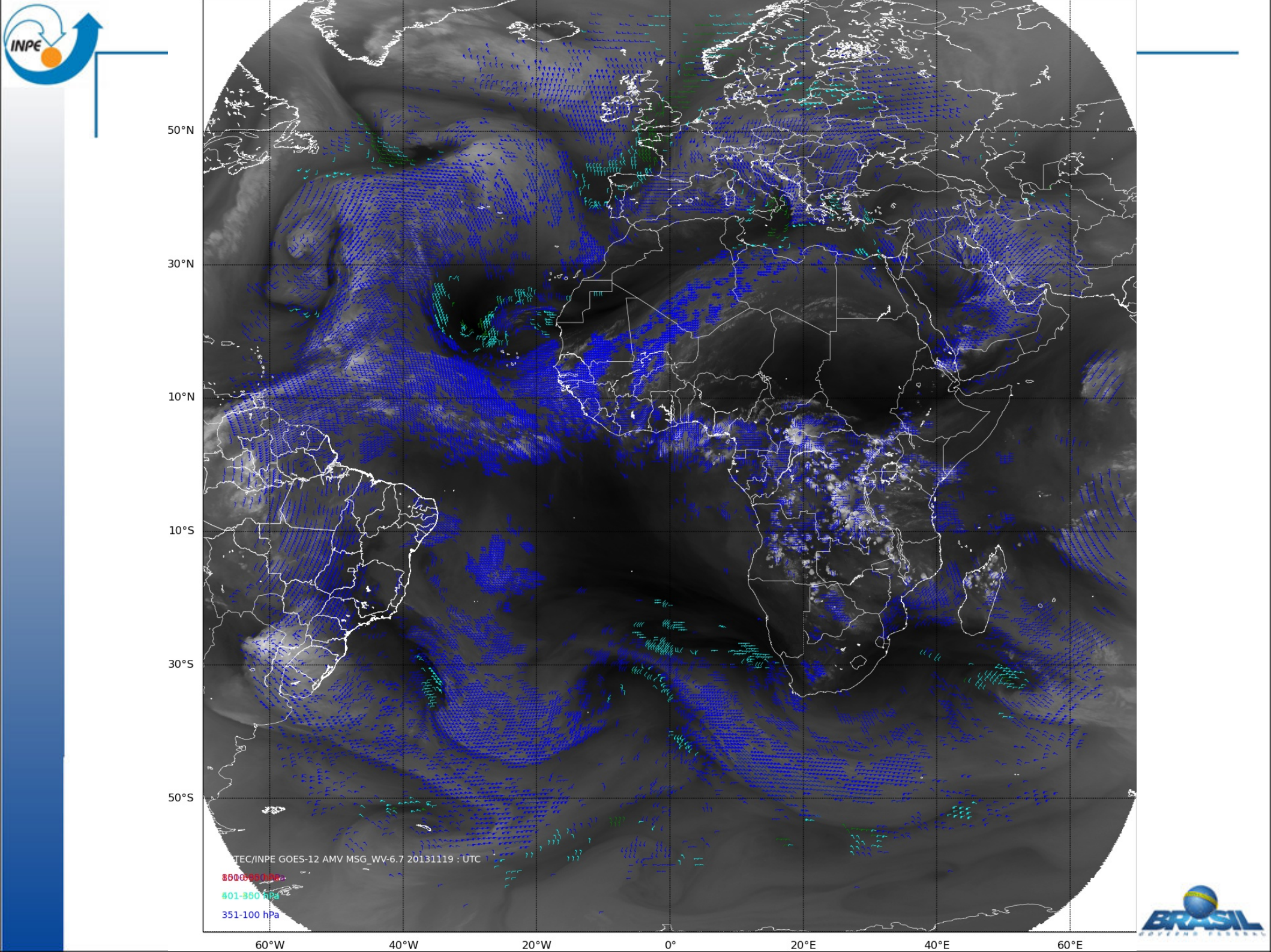
Vk: vetor mais próximo de V2

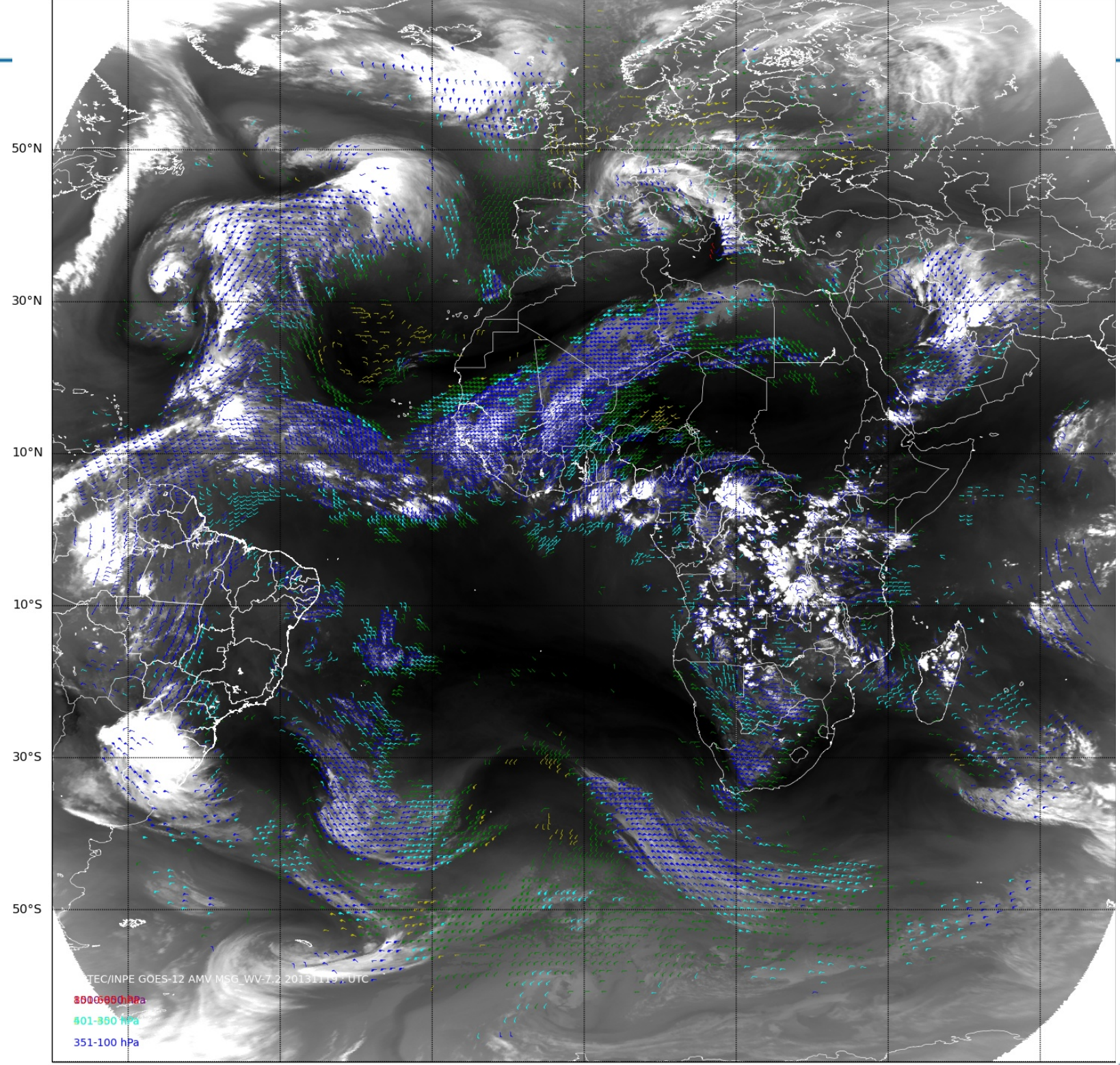
	A	B	C	D
QIa (direção)	20	10	10	4
QIb (velocidade)	0,1	0,01	1	2,5
QIc (consist. vetorial)	0,2	0,01	1	3
QId (consist. espacial)	0,2	0,01	1	3
QI (final)	1	1	1	2

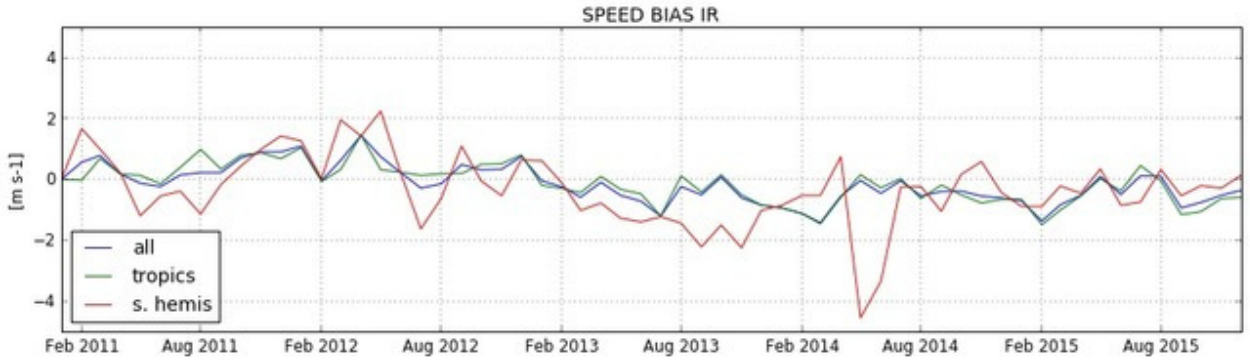

351-100 hPa
851-600 hPa
1000-850 hPa
CPTEC/INPE GOES-13 AMV IR-10.2 20160621 13:30 UTC

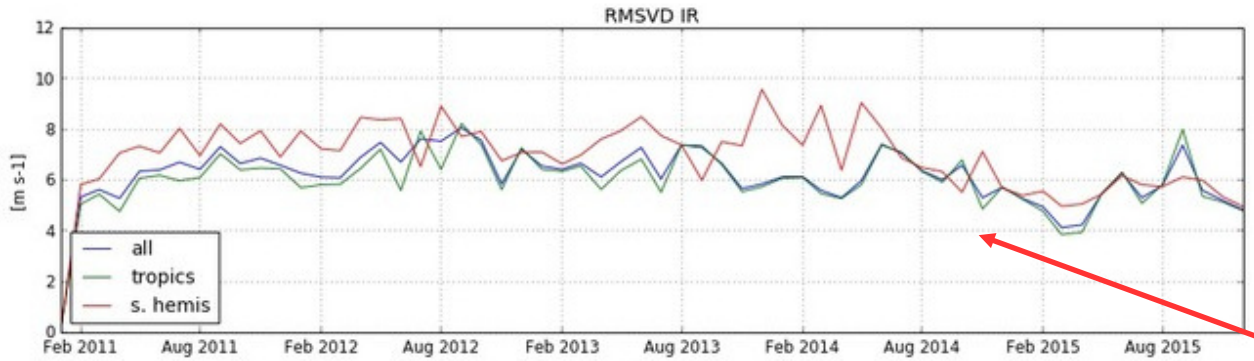

351-100 hPa
851-600 hPa
1000-850 hPa
CPTEC/INPE GOES-13 AMV WV-6.2 20160621 13:30 UTC

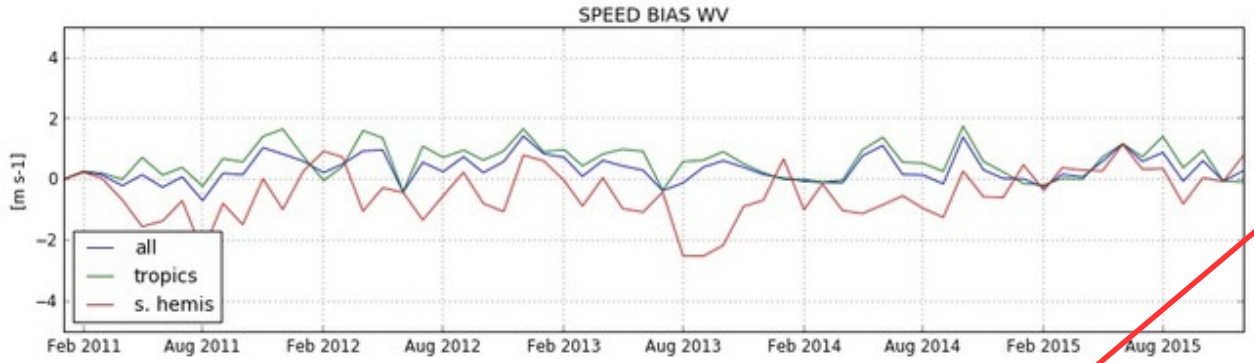

Area of interest
50°N
30°N
10°N
10°S
30°S
50°S
60°W
40°W
20°W
0°
20°E
40°E
60°E
TEC/INPE GOES-12 AMV MSG IR-10.8 20131119 : UTC
351-100 hPa

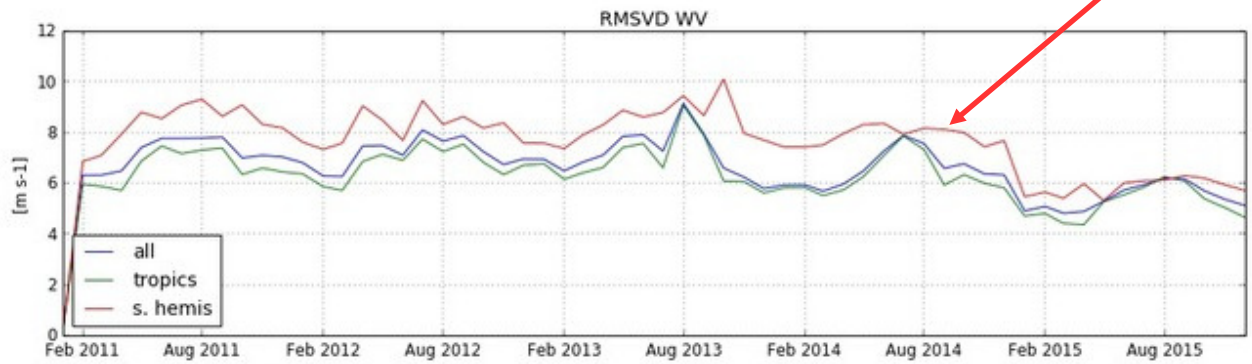

50°N
30°N
10°N
10°S
30°S
50°S
60°W
40°W
20°W
0°
20°E
40°E
60°E
TEC/INPE GOES-12 AMV MSG_WV-6.7 20131119 : UTC
401-350 hPa
351-100 hPa


50°N
30°N
10°N
10°S
30°S
50°S
60°W
40°W
20°W
0°
20°E
40°E
60°E
TEC/INPE GOES-12 AMV MSG_WV-7.2 20131113 UTC
801-850 hPa
601-800 hPa
401-600 hPa
351-400 hPa
101-350 hPa









Comparison AMVs x Radiossondes

HAM atualization

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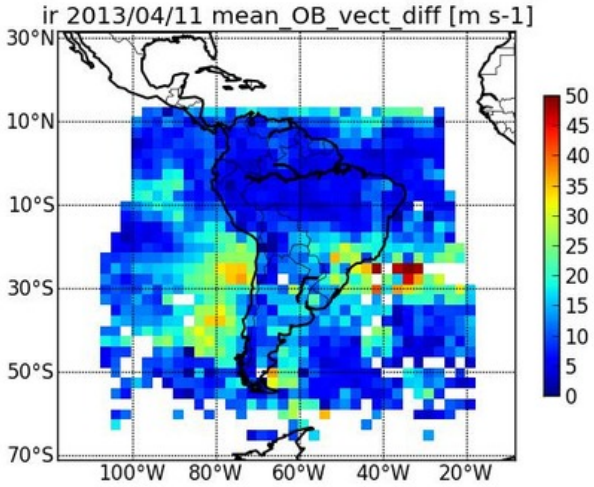
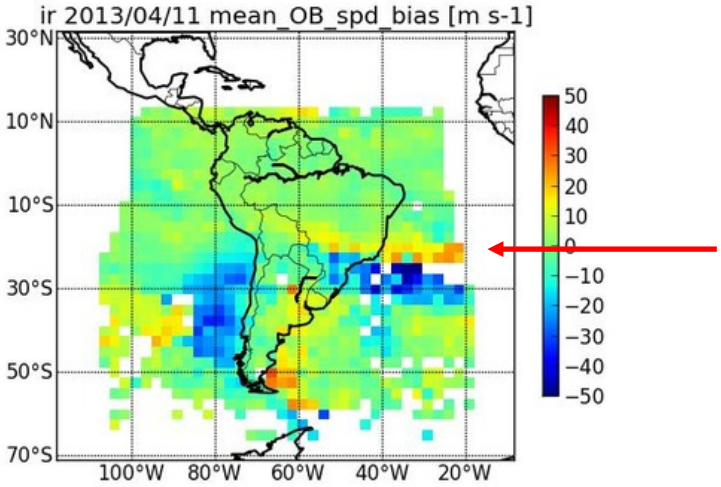
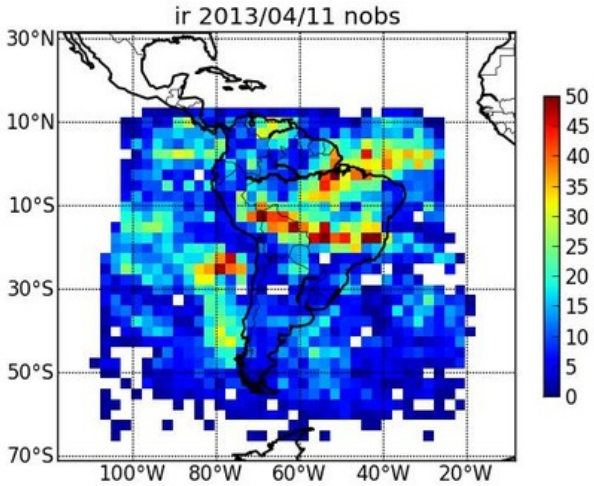
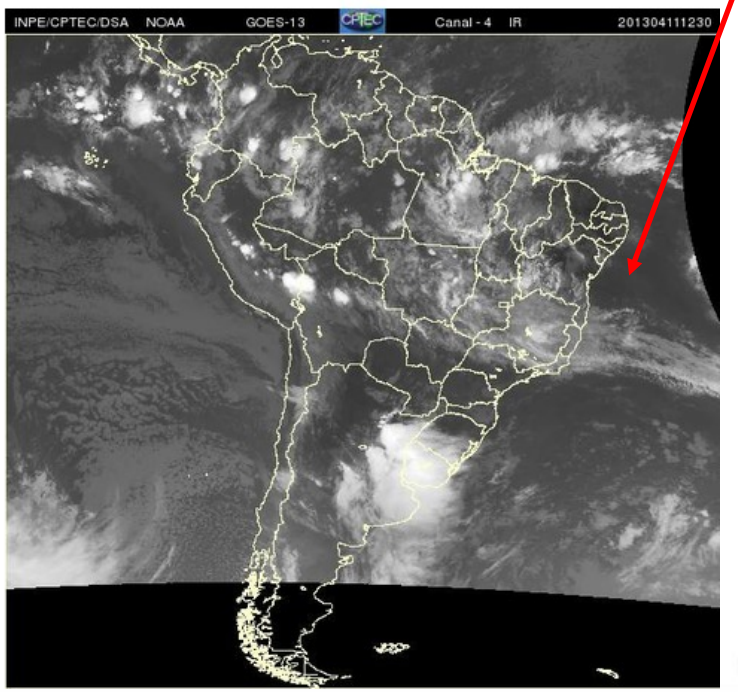
Comparison AMVs x Reanalysis





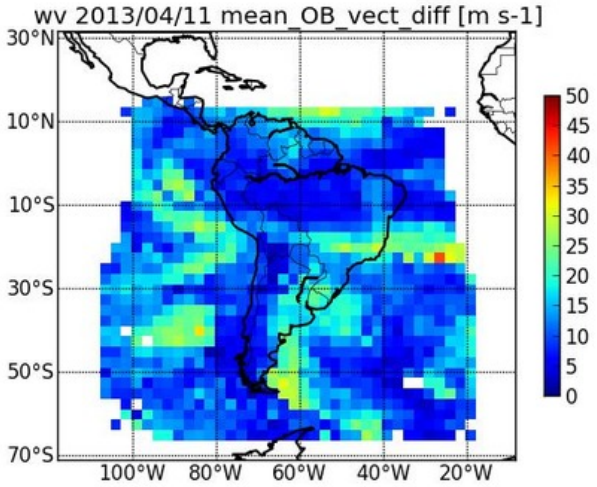


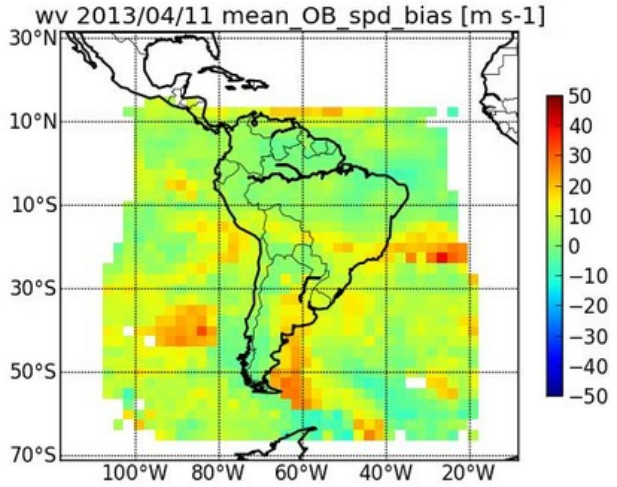


GOES IR 10.2 µm

Systematic error over frontal zones due to semi-transparent clouds

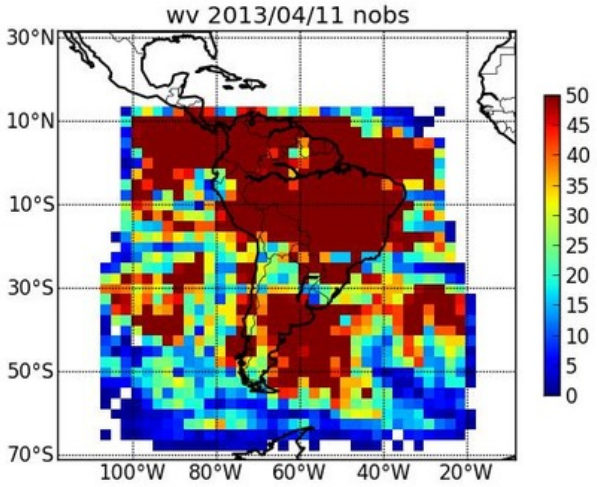
AMVs x Reanalysis

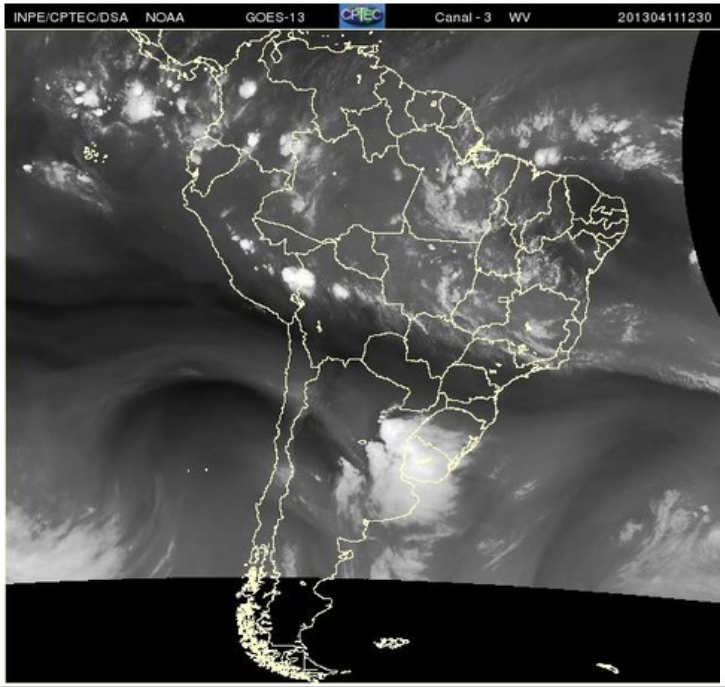




GOES WV 6.2 µm

Smaller errors for WV AMVs





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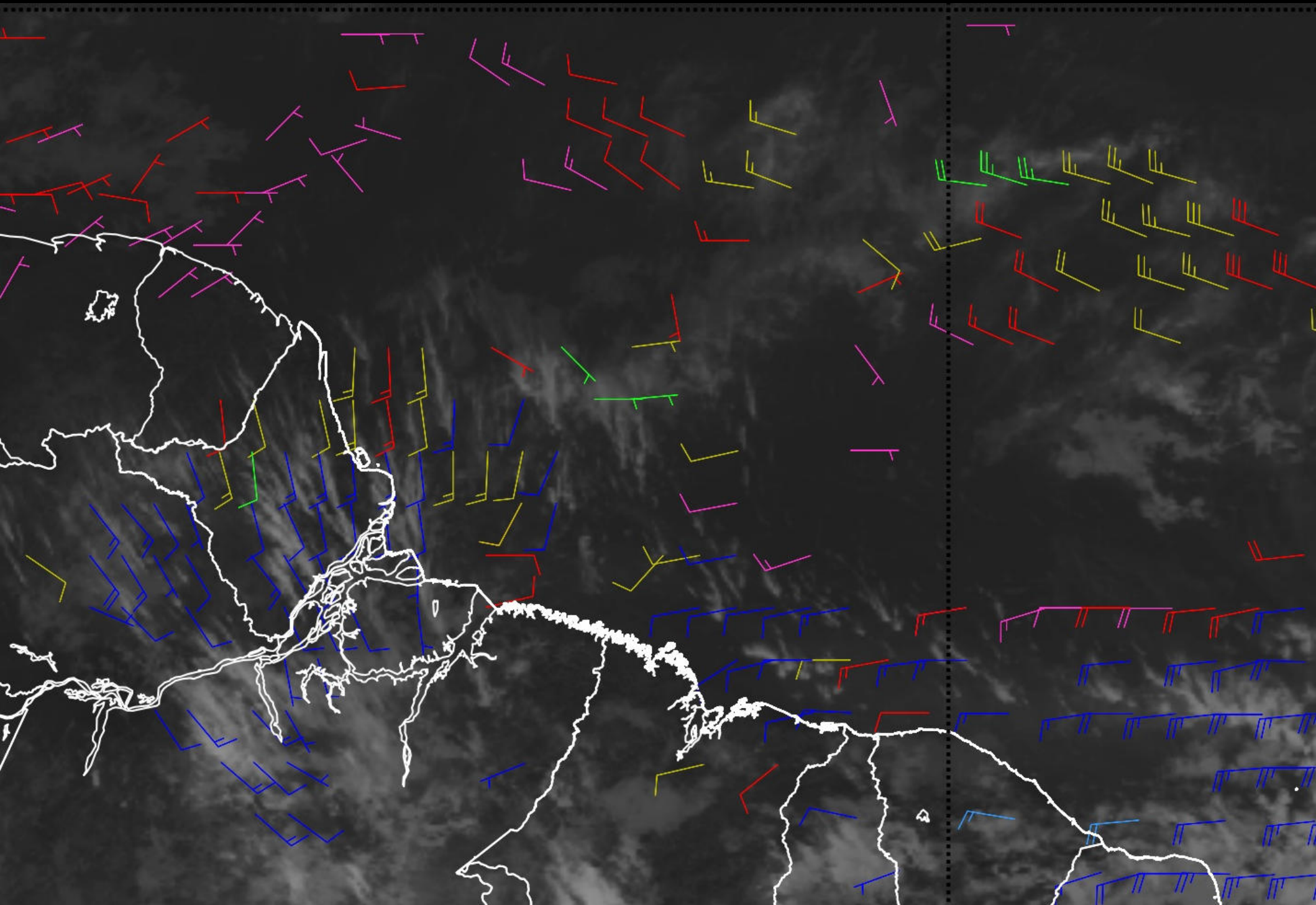
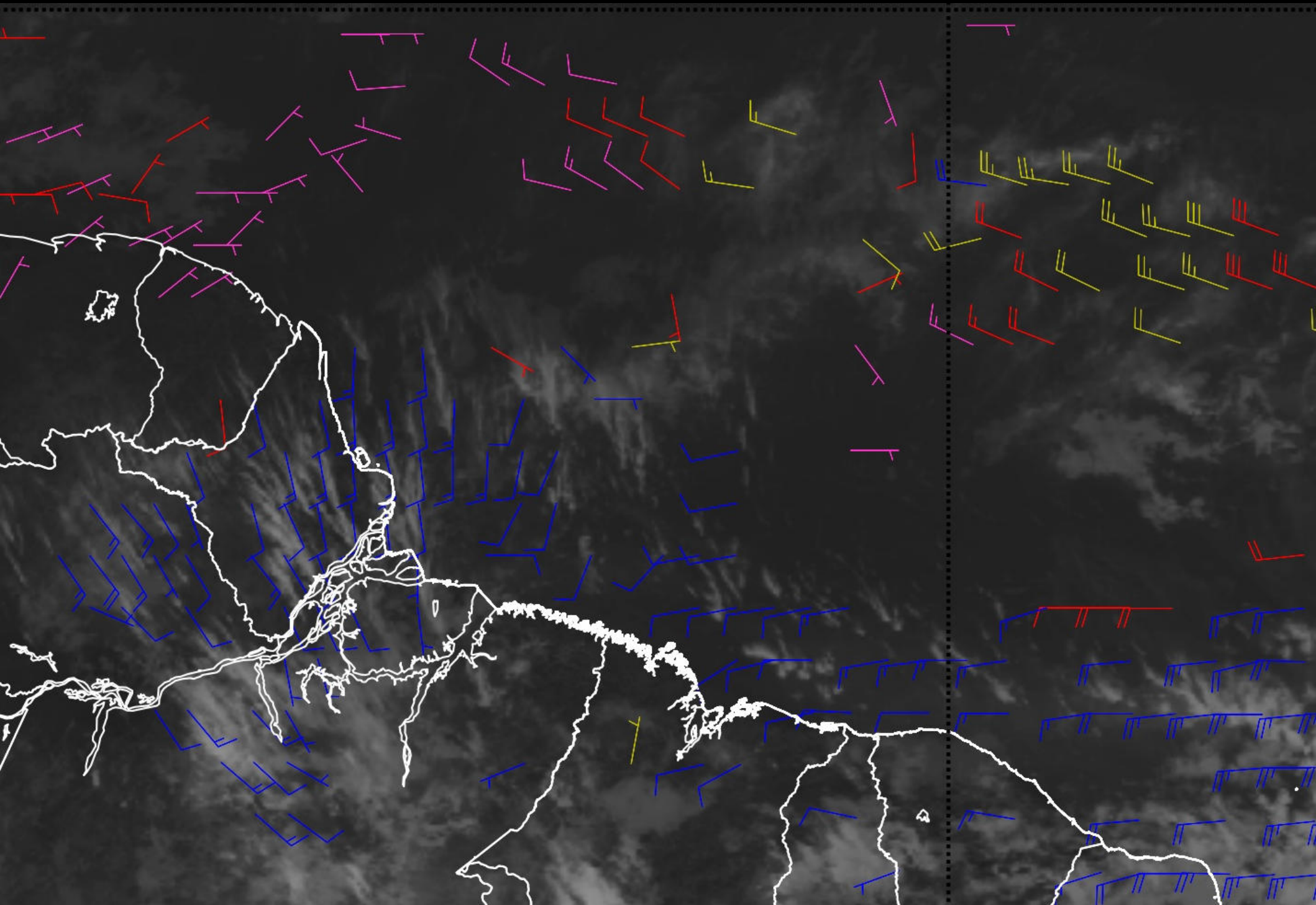
BRASIL

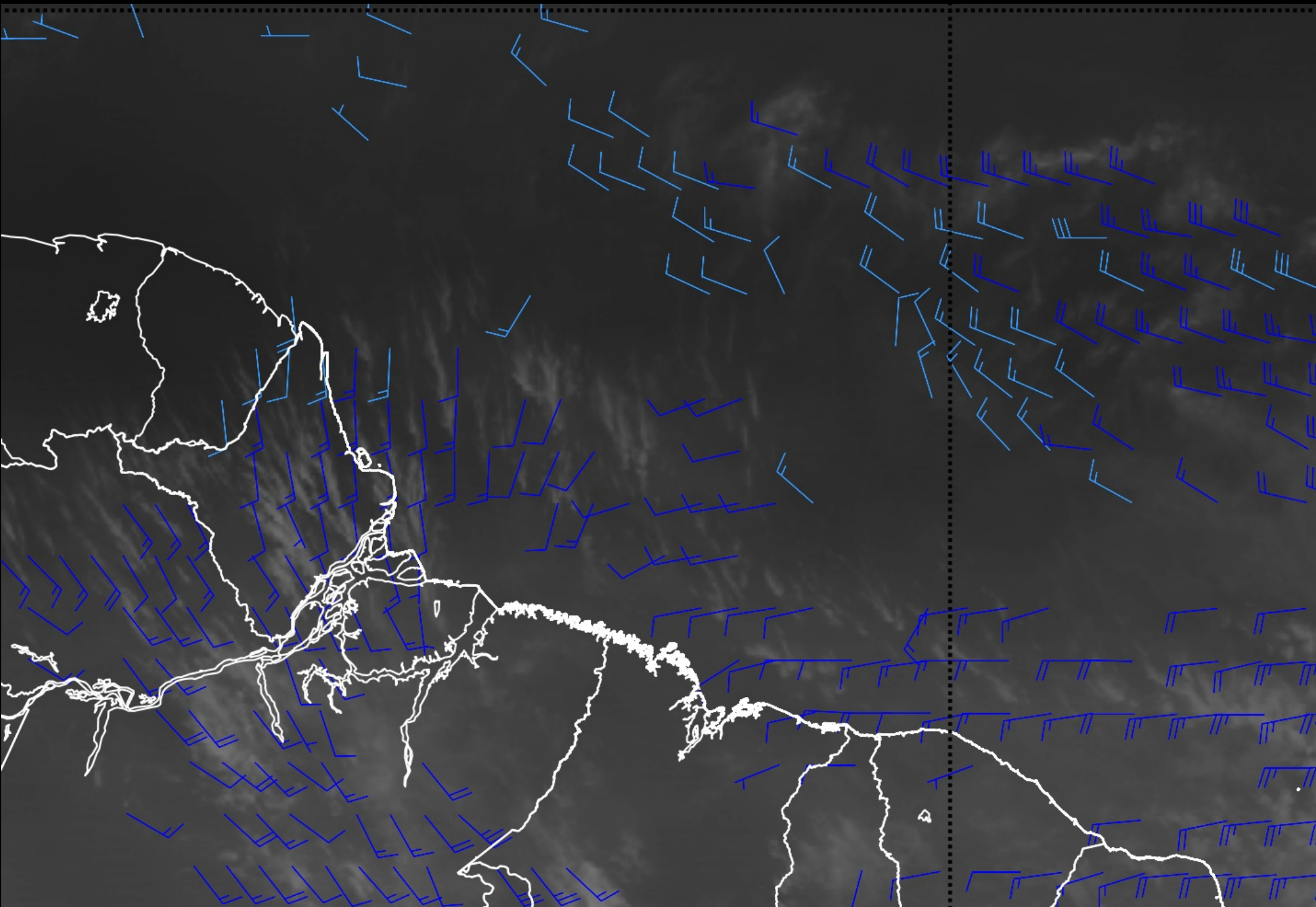
GOES 10.2 μm AMVs before height assignment method improvement



GOES 10.2 μm AMVs after height assignment method improvement

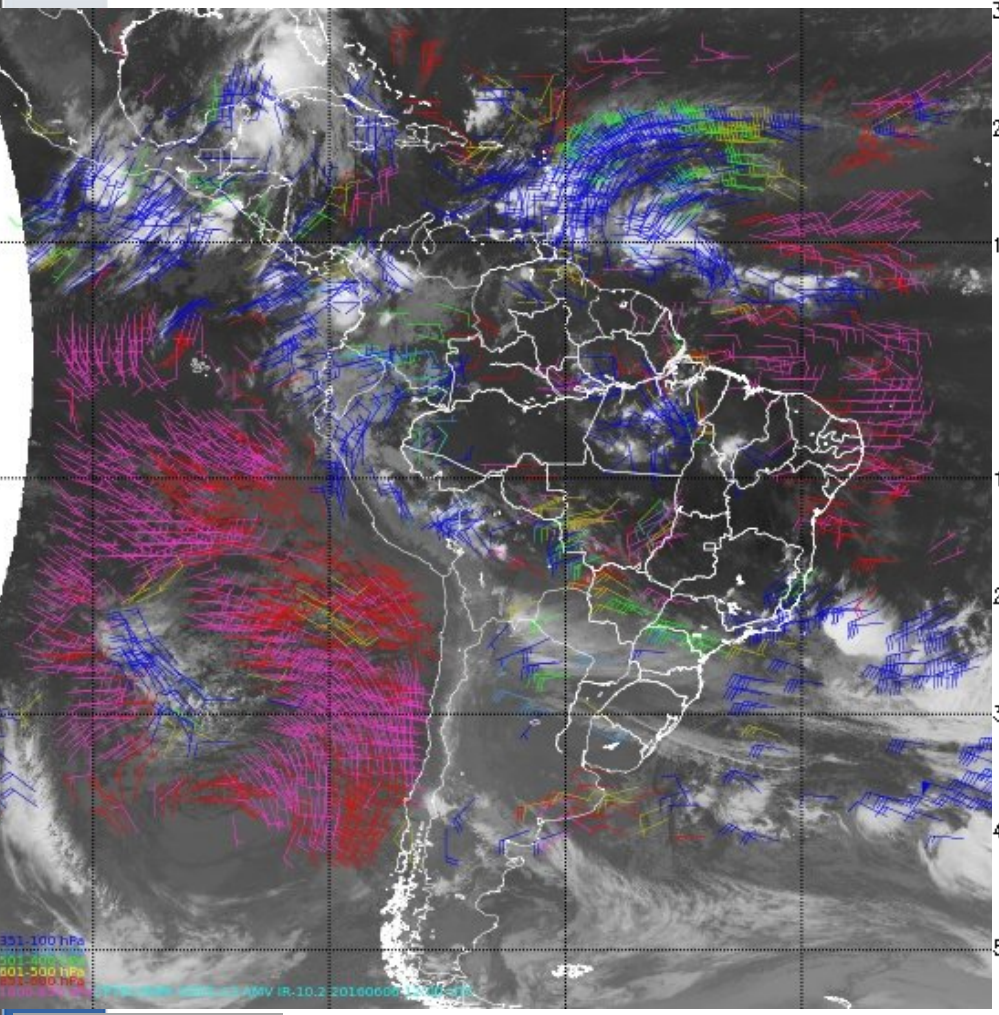


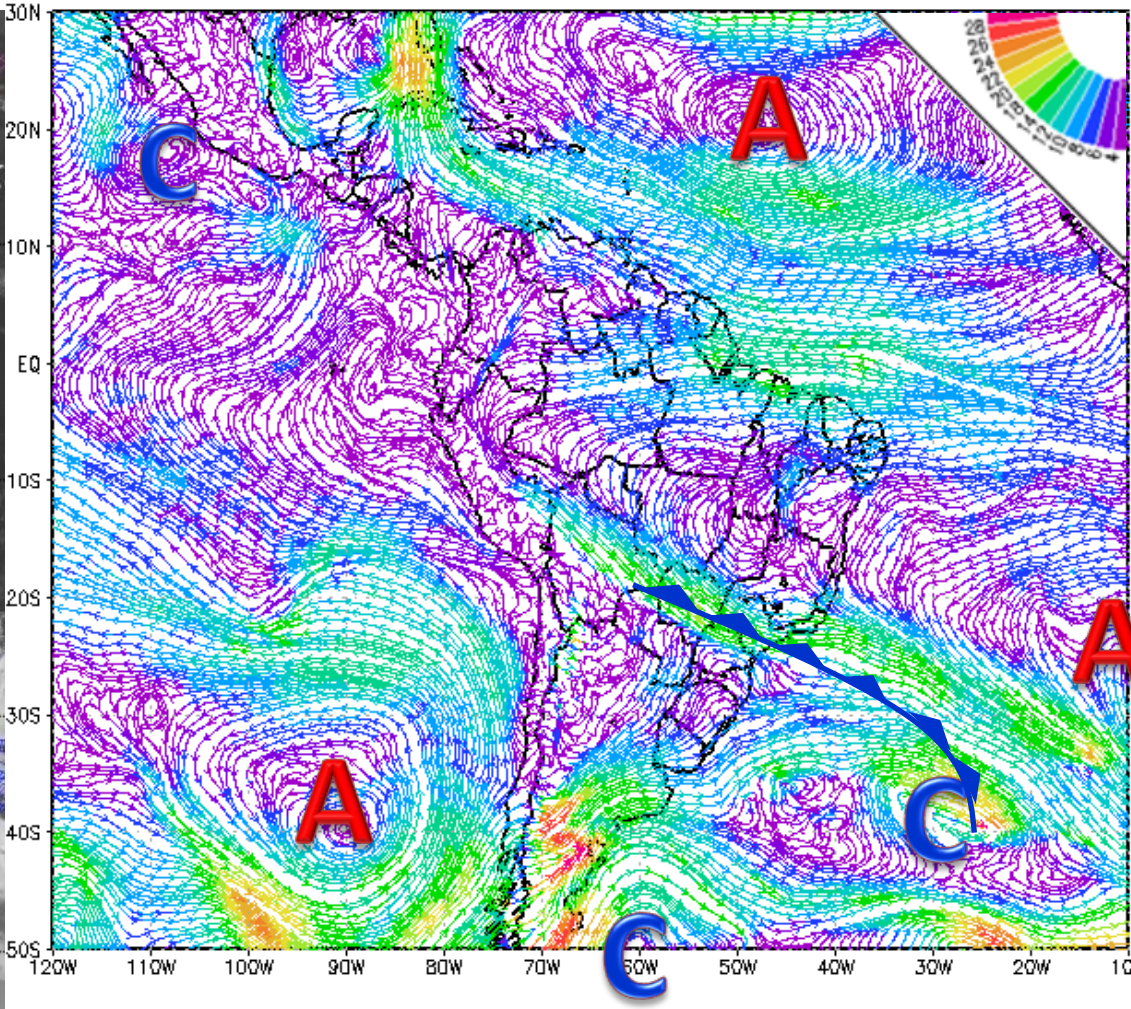
GOES 6.7 µm AMVs



CPTEC INPE GOES-13 AMV IR 10.2
20160606 12UTC

CPTEC INPE BAM (Brazilian Global Atmospheric Model)
20160606 12UTC - wind 850 hPa





351-100 hPa
401-350 hPa
501-400 hPa
601-500 hPa
851-600 hPa
1000-850 hPa

Issued 12Z.06jun2016

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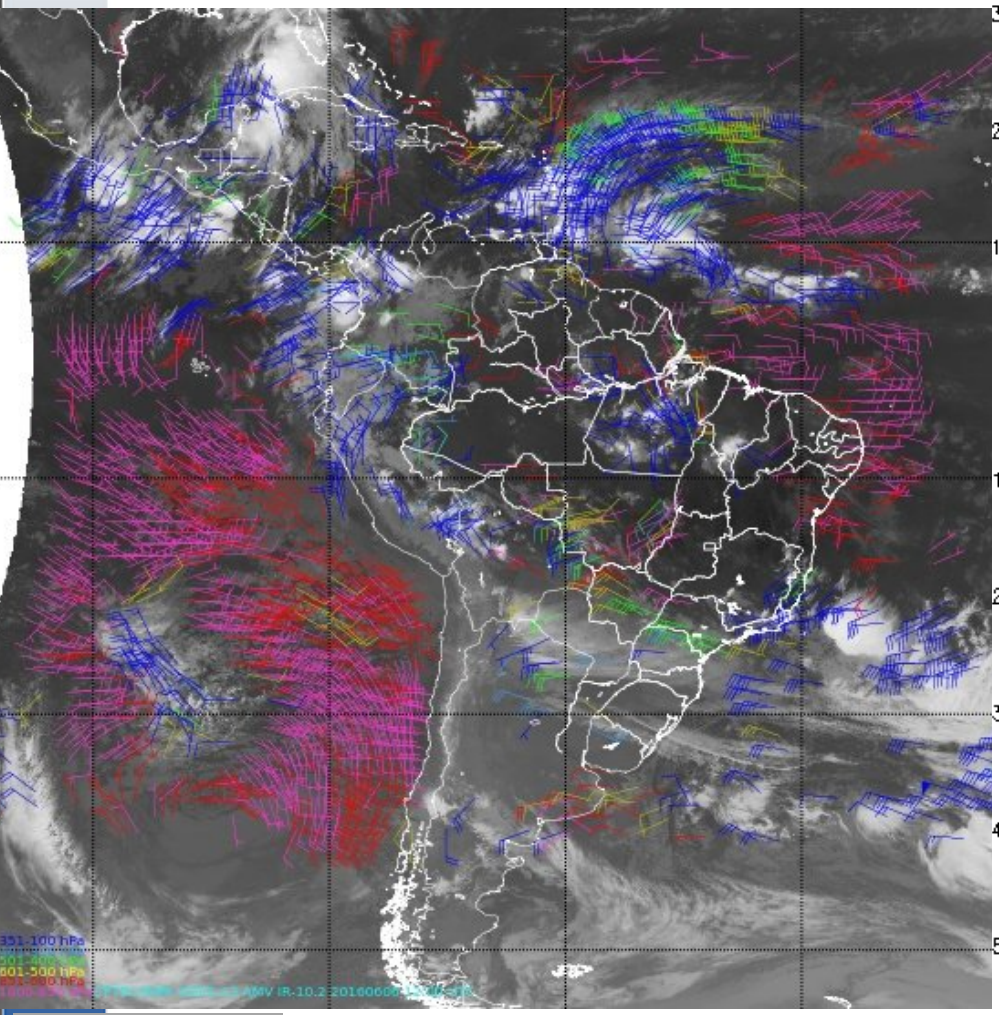
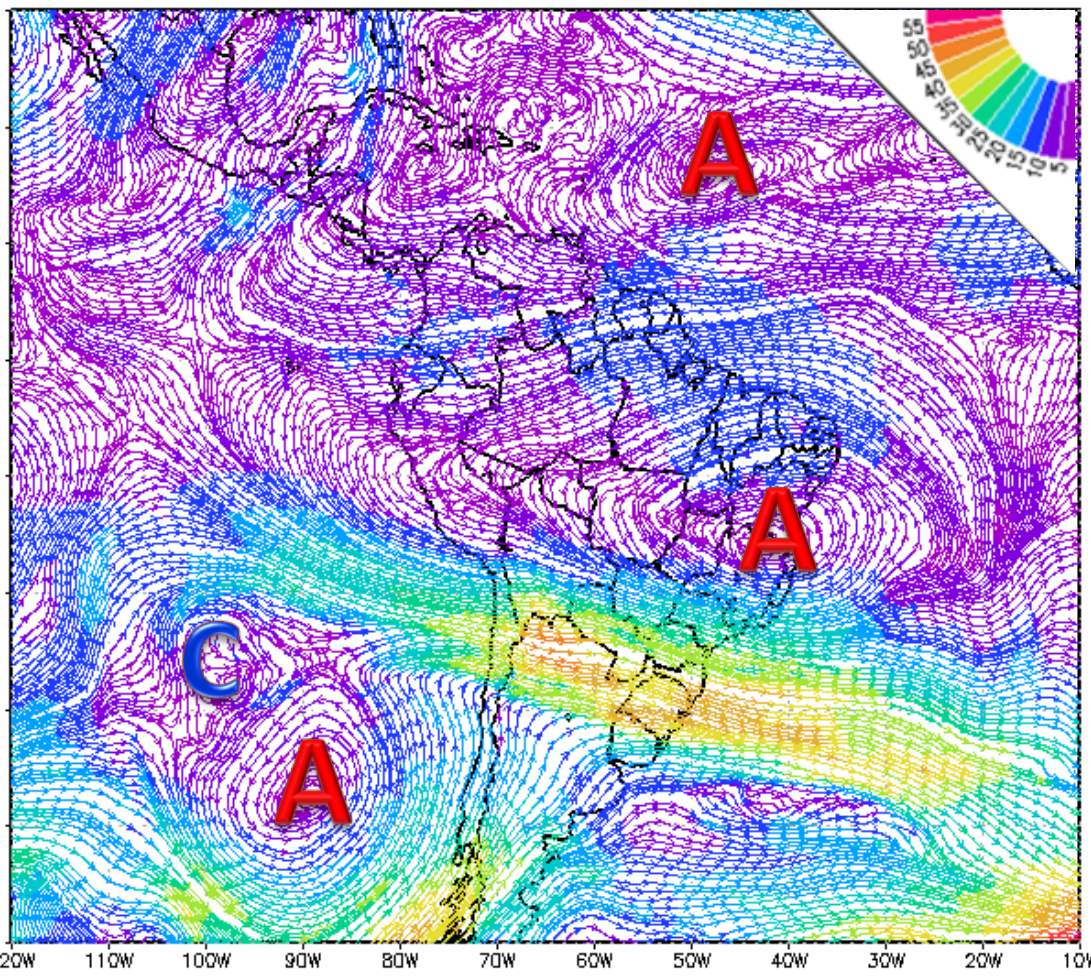
CPTEC INPE GOES-13 AMV IR 10.2
20160606 12UTC

CPTEC INPE BAM (Brazilian Global Atmospheric Model)
20160606 12UTC - wind 500 hPa





351-100 hPa
401-350 hPa
501-400 hPa
601-500 hPa
851-600 hPa
1000-850 hPa

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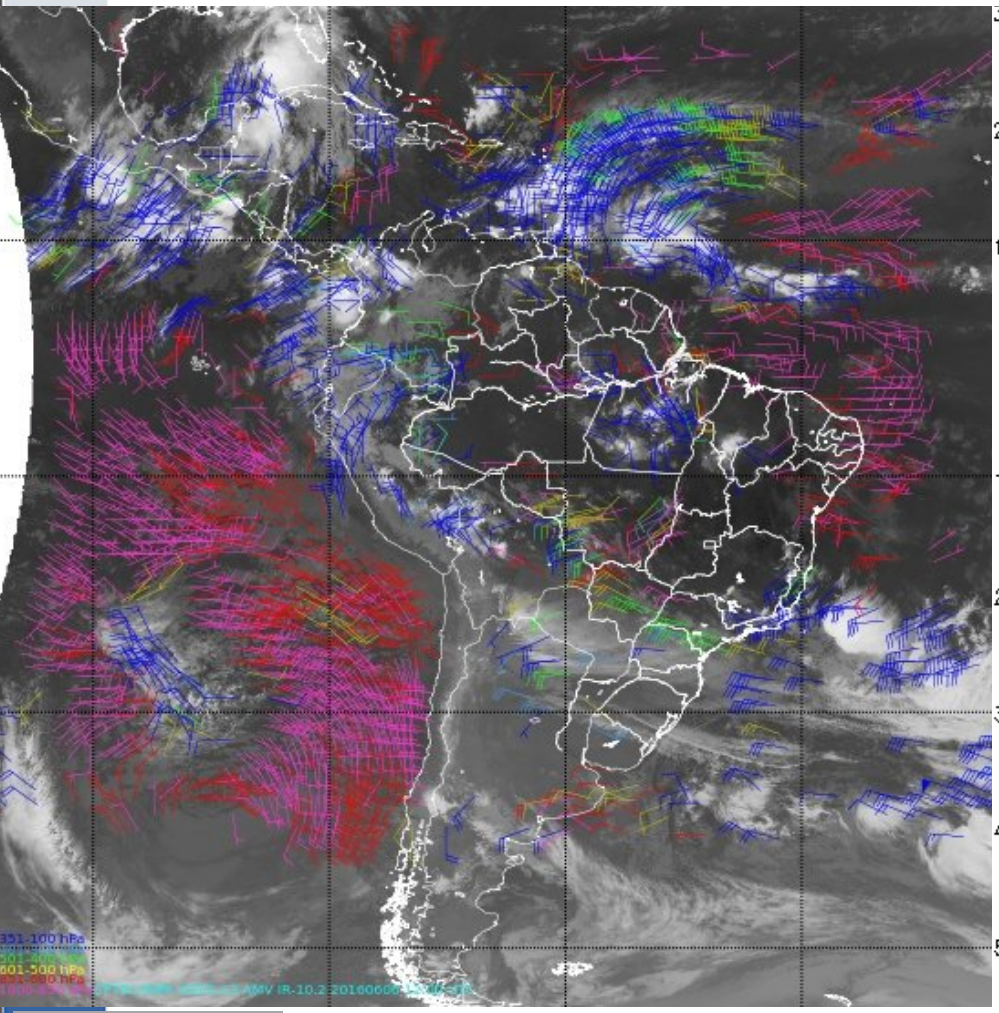
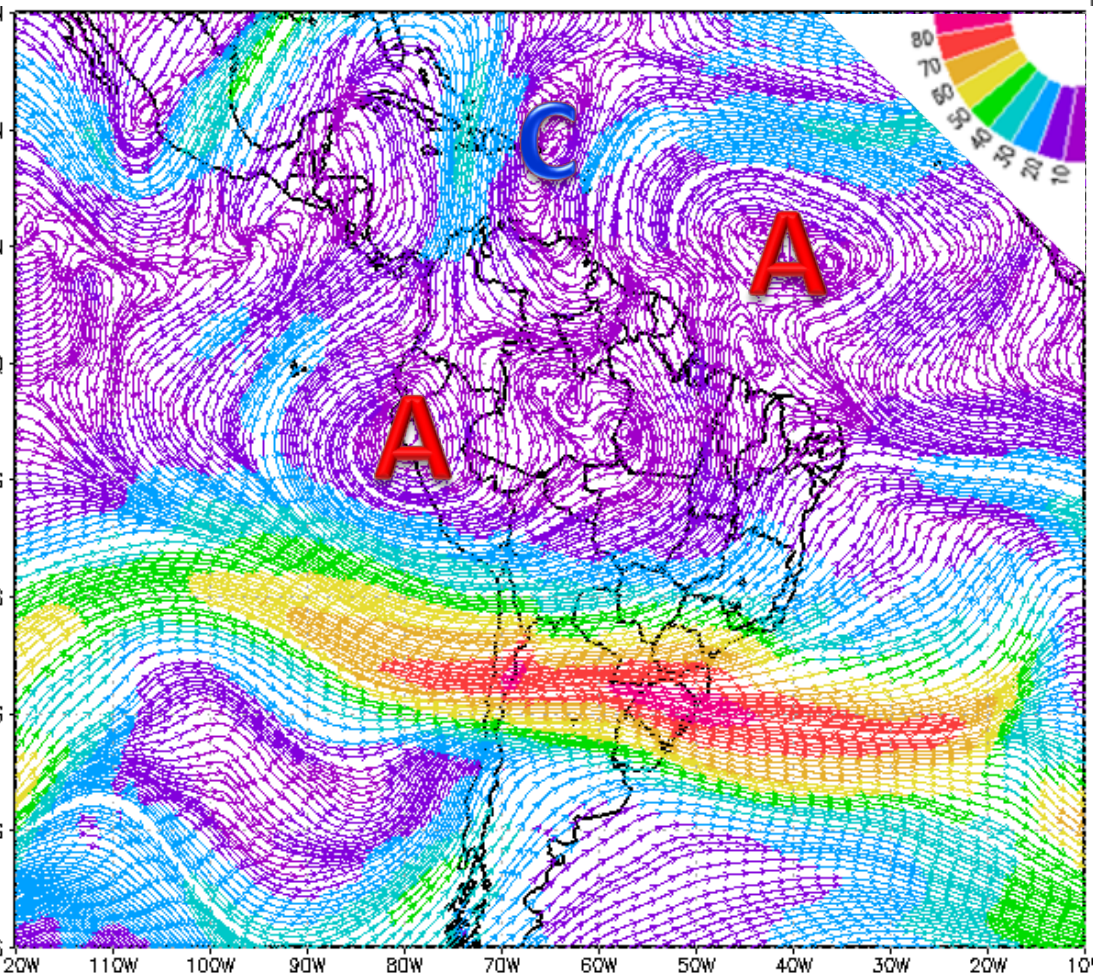
CPTEC INPE GOES-13 AMV IR 10.2
20160606 12UTC

CPTEC INPE BAM (Brazilian Global Atmospheric Model)
20160606 12UTC - wind 200 hPa





351-100 hPa
401-350 hPa
501-400 hPa
601-500 hPa
851-600 hPa
1000-850 hPa

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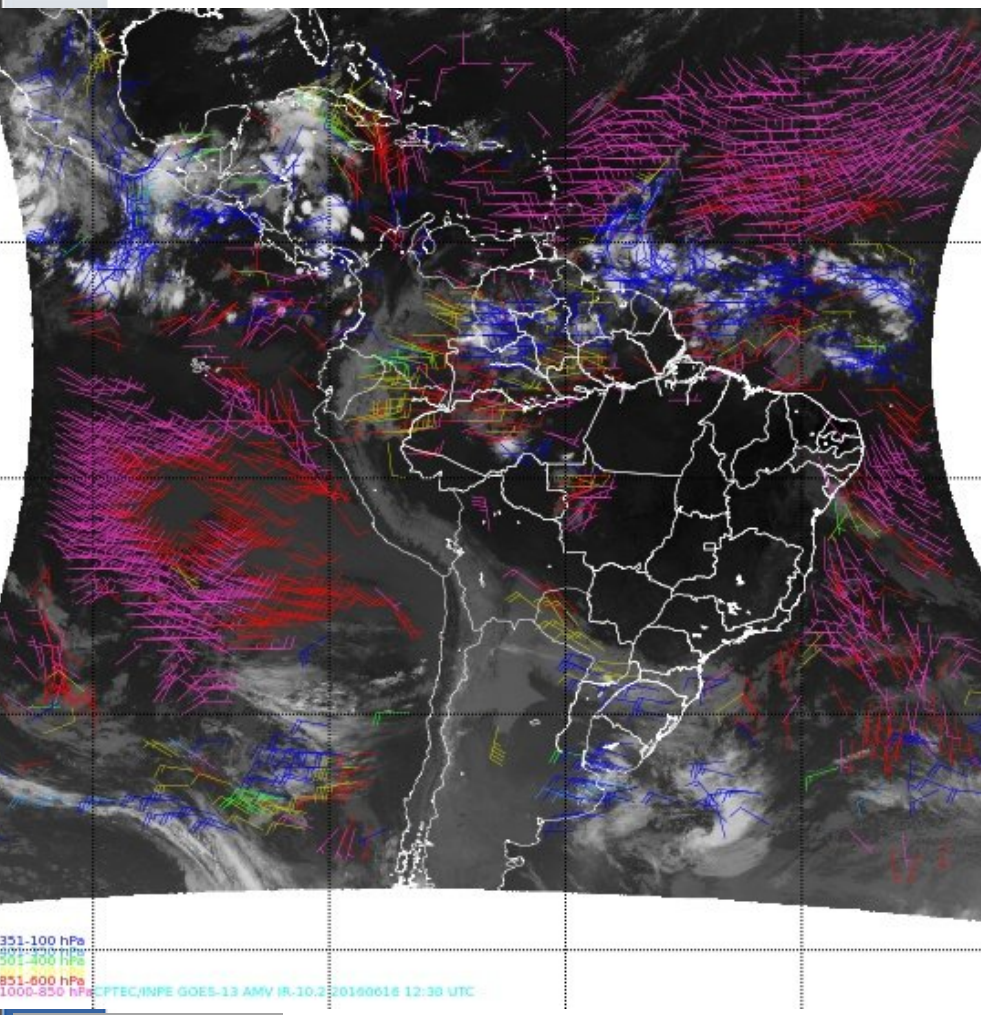
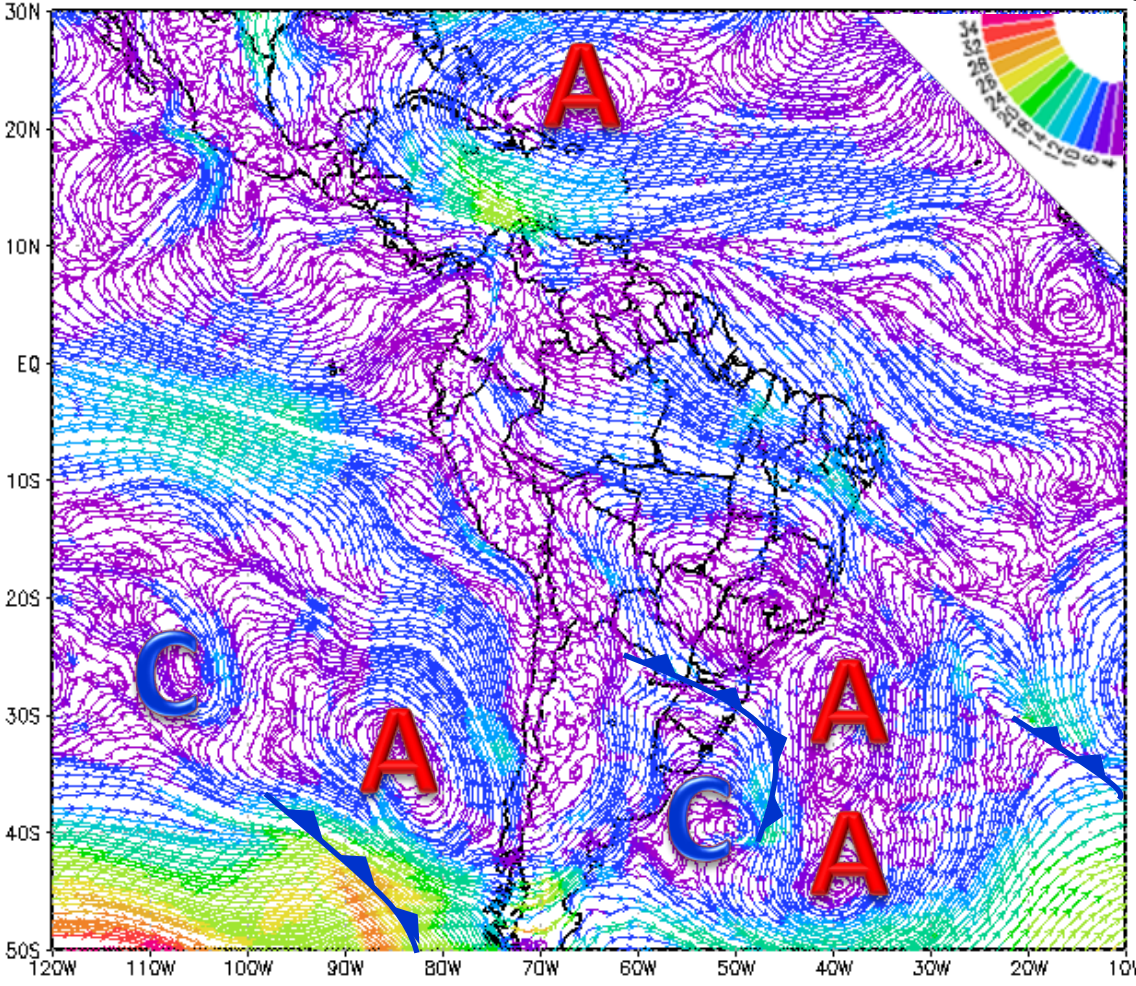
CPTEC INPE GOES-13 AMV IR 10.2
20160616 1230UTC

CPTEC INPE BAM (Brazilian Global Atmospheric Model)
20160616 12UTC - wind 850 hPa





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351-100 hPa
401-350 hPa
501-400 hPa
601-500 hPa
851-600 hPa
1000-850 hPa

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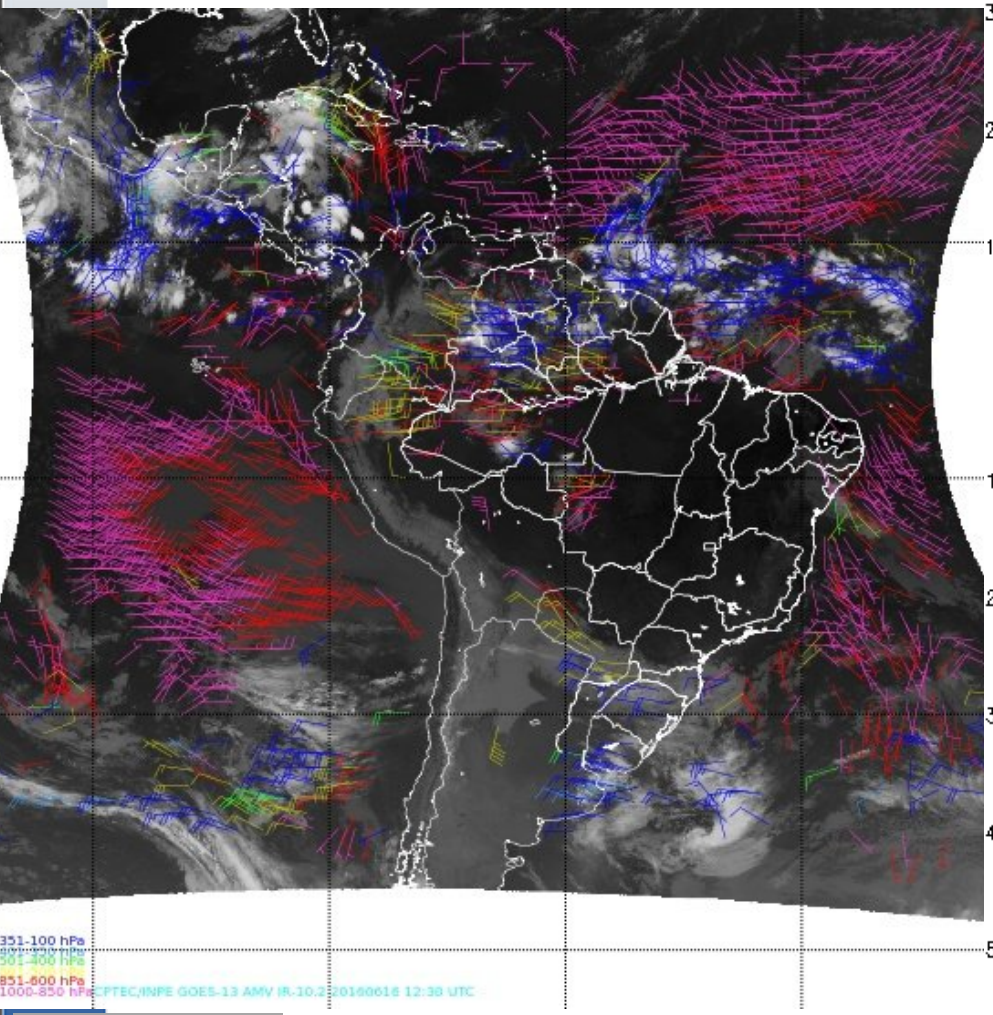
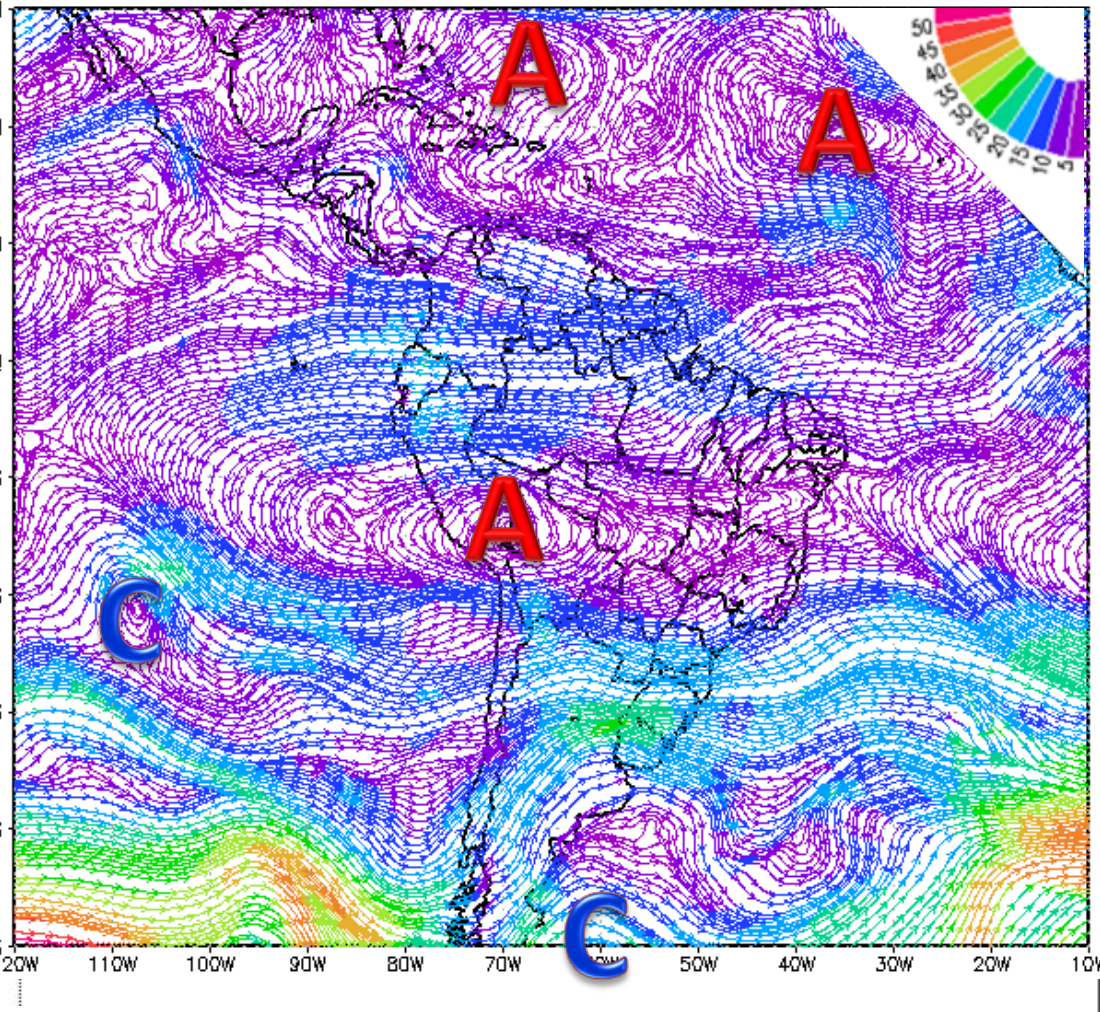
CPTEC INPE BAM (Brazilian Global Atmospheric Model)
20160616 12UTC - wind 500 hPa





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351-100 hPa
401-350 hPa
501-400 hPa
601-500 hPa
851-600 hPa
1000-850 hPa

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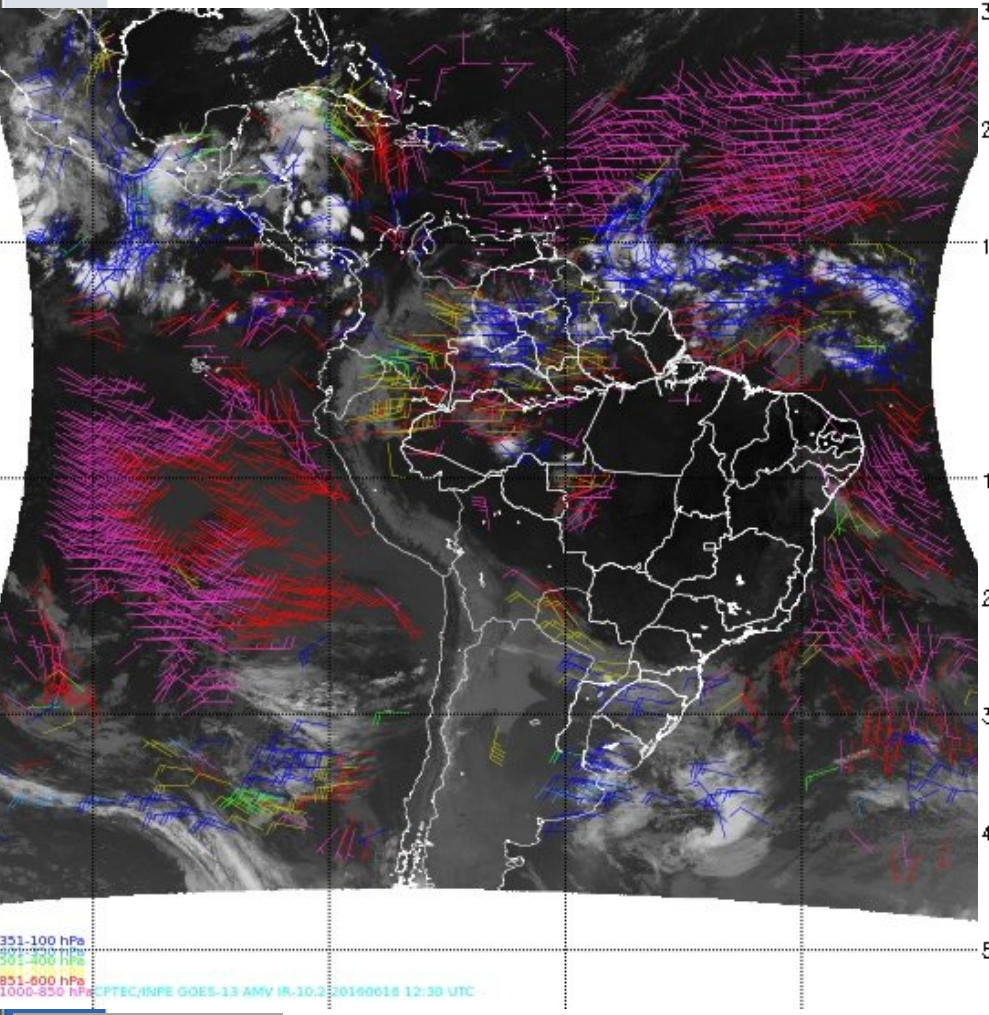
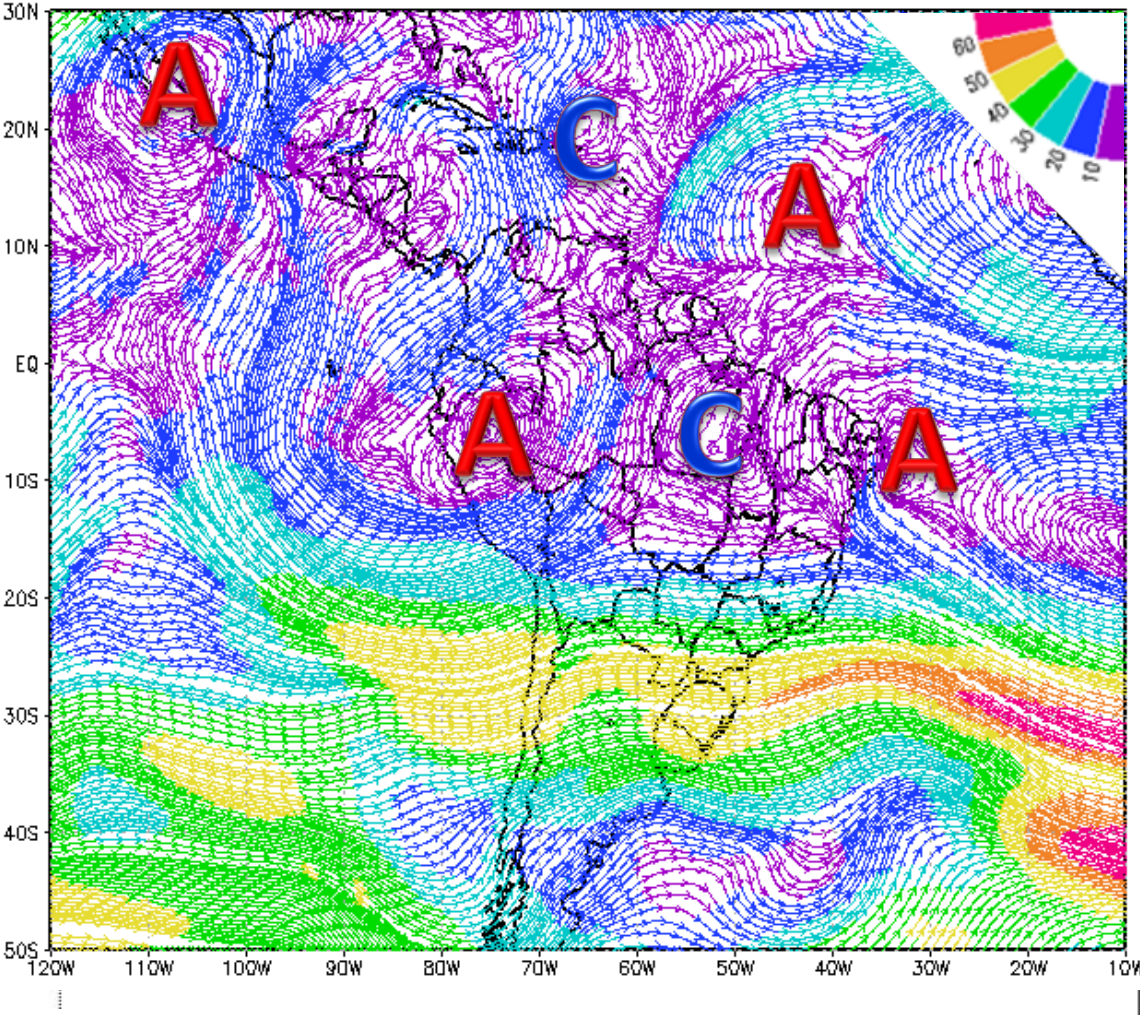
CPTEC INPE GOES-13 AMV IR 10.2
20160616 1230UTC

CPTEC INPE BAM (Brazilian Global Atmospheric Model)
20160616 12UTC - wind 200 hPa





351-100 hPa
401-350 hPa
501-400 hPa
601-500 hPa
851-600 hPa
1000-850 hPa

Issued 12Z.16jun2016

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CGMS 39 error in dir/spd

u/v speed differences between CPTEC and EUMETSAT AMVs

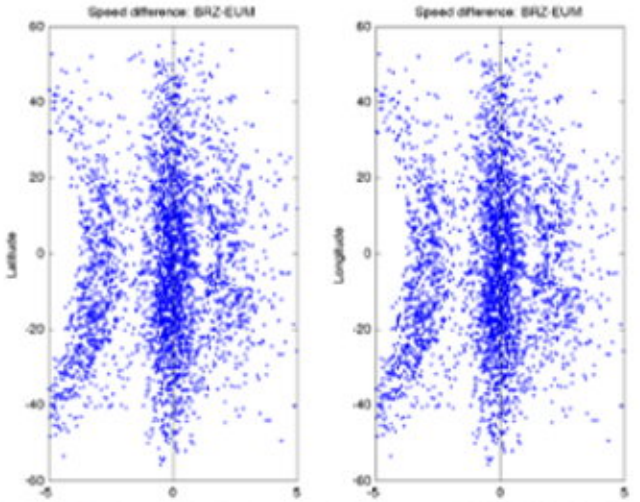


Figure 11: Experiment 1: Latitude vs. Speed difference BRZ-EUM (left); Longitude vs. Speed difference BRZ-EUM (right).

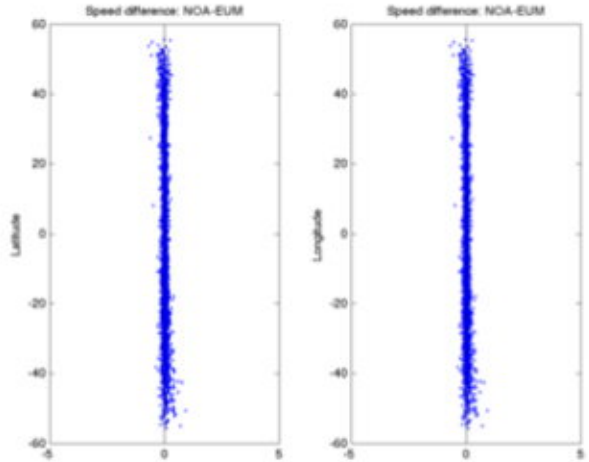


Figure 13: Experiment 1: Latitude vs. Speed difference NOA-EUM (left); Longitude vs. Speed difference NOA-EUM (right).

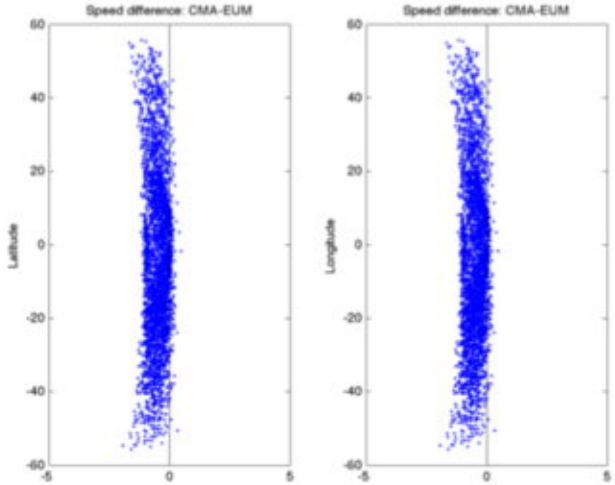


Figure 15: Experiment 1: Latitude vs. Speed difference CMA-EUM (left); Longitude vs. Speed difference CMA-EUM (right).

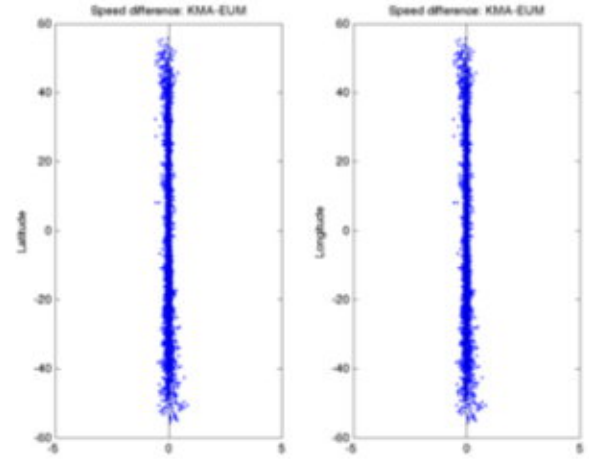
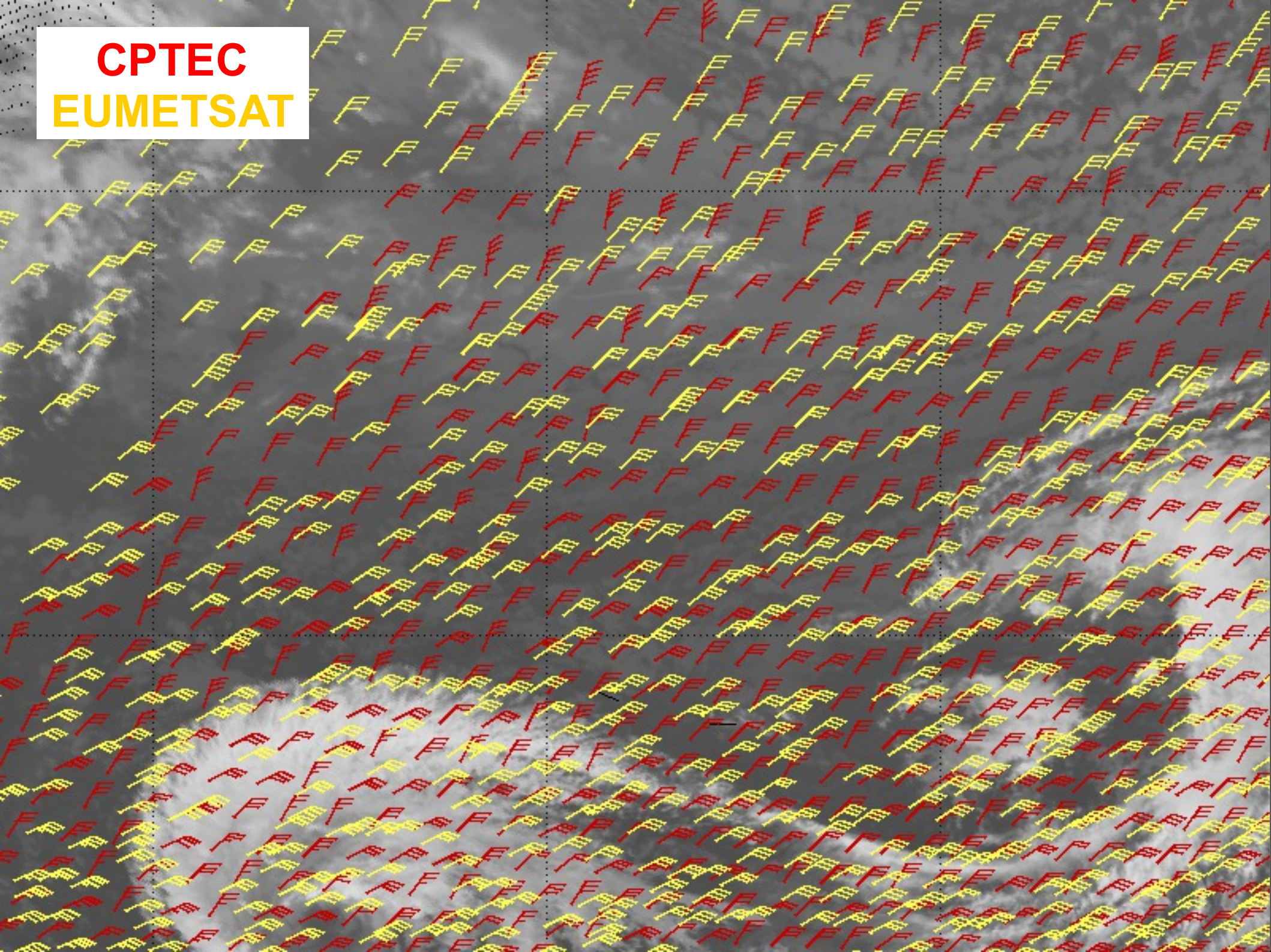
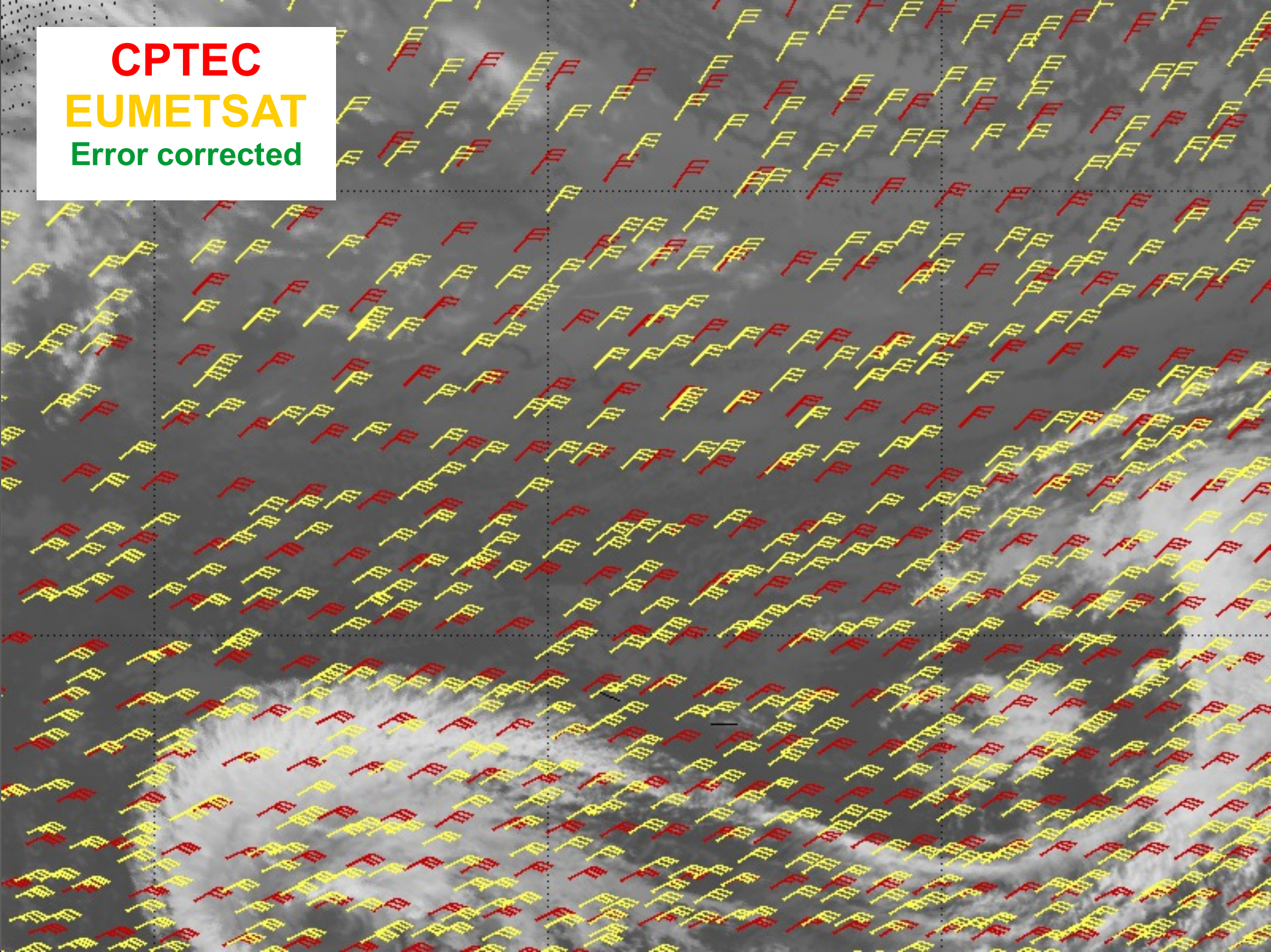


Figure 14: Experiment 1: Latitude vs. Speed difference KMA-EUM (left); Longitude vs. Speed difference KMA-EUM (right).

CGMS 39 error in dir/spd

- This deference was due a bug in an old piece of code used to compensate AMVs speed and direction over estimative (when 1 hour timesteps were used).
- It should modify slightly the AMV speed and direction but changed it considerably for high satellite viewing angles.
- This error never has been spot because it is more evident for viewing angles greater than 60 degrees, which is not the case for South America and surrounding oceans when using the last GOES east satellites.


CPTEC
EUMETSAT

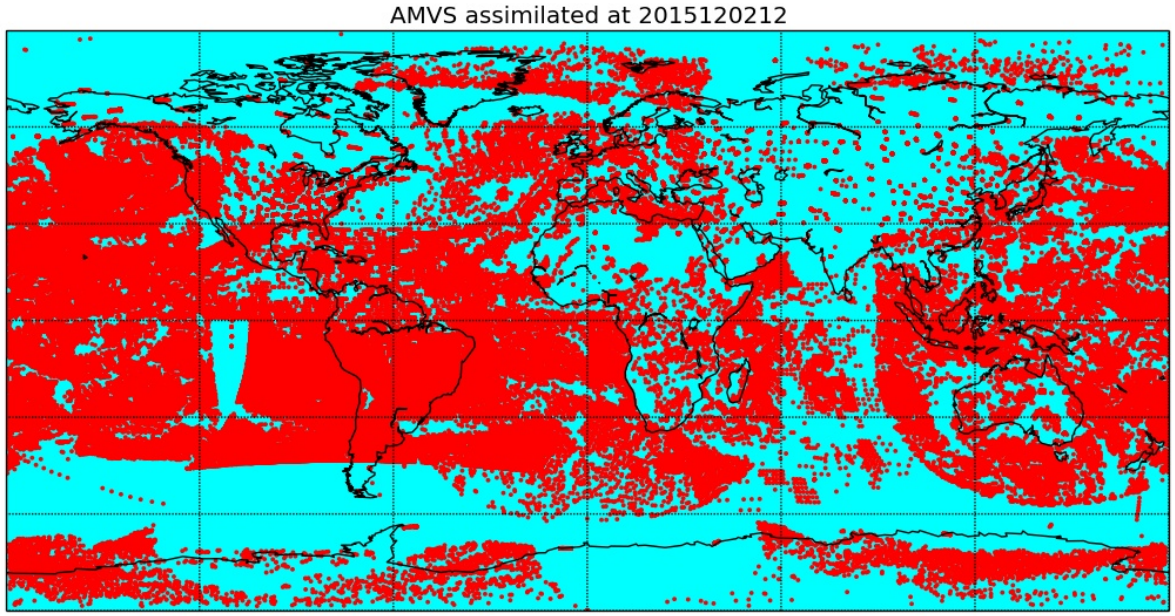

CPTEC
EUMETSAT
Error corrected

AMV use in global and regional NWP models at CPTEC/INPE

- CPTEC is assimilating satellite wind data, operationaly, only on the global scale.

- An efort has been done to assimilate wind at mesoescale resolution and high resolution from radar.

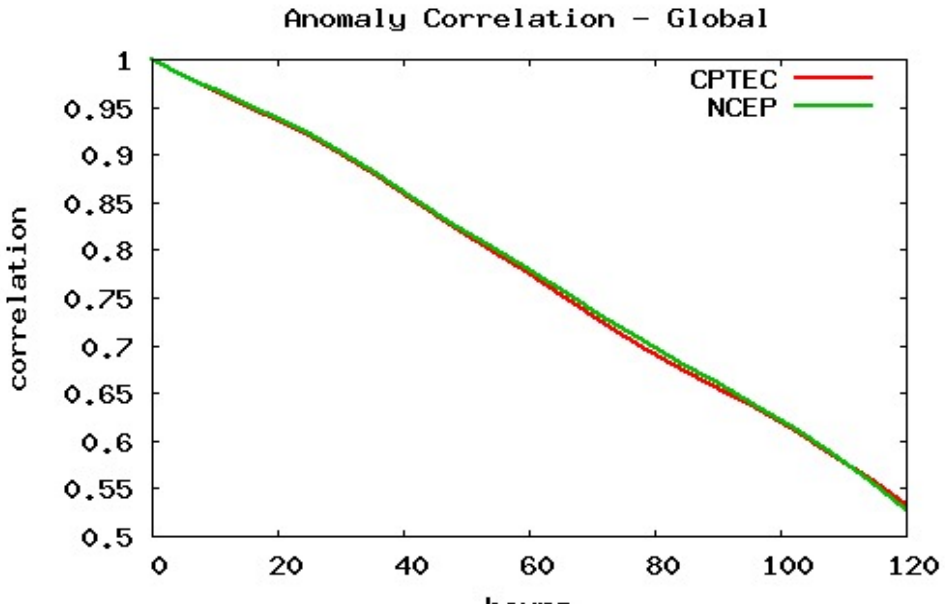
CPTEC Data Assimilation scheme



Courtesy: Sapucci, 2009

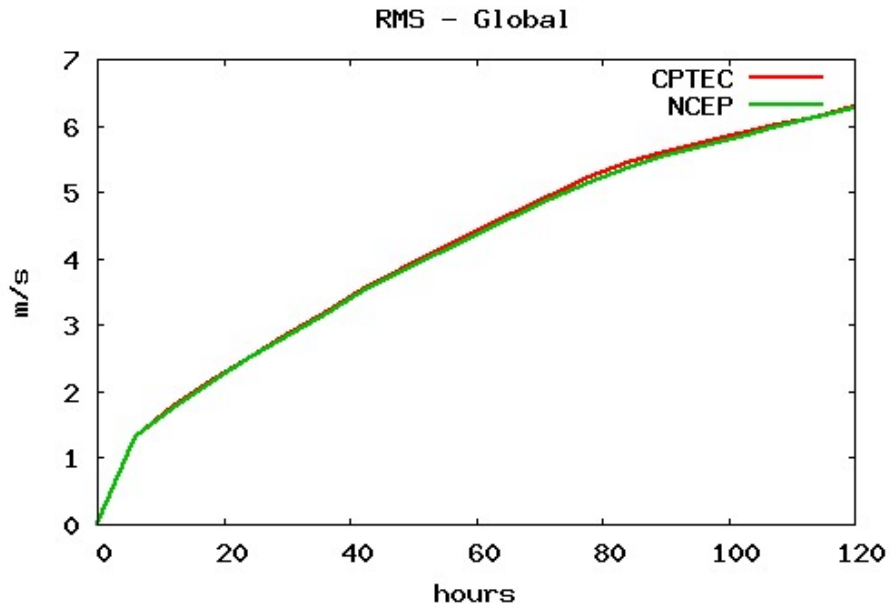
The current CPTEC's data assimilation system (GSI 3DVar). It has been used in the experiments of AMV data assimilation.

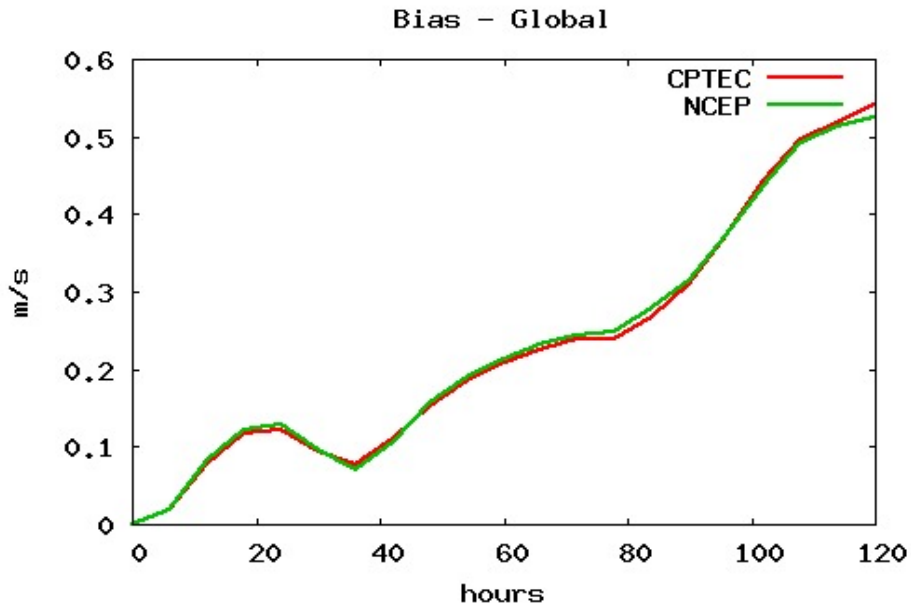
Comparison between CPTEC and GFS winds on the Brazilian Atmospheric Model (BAM)



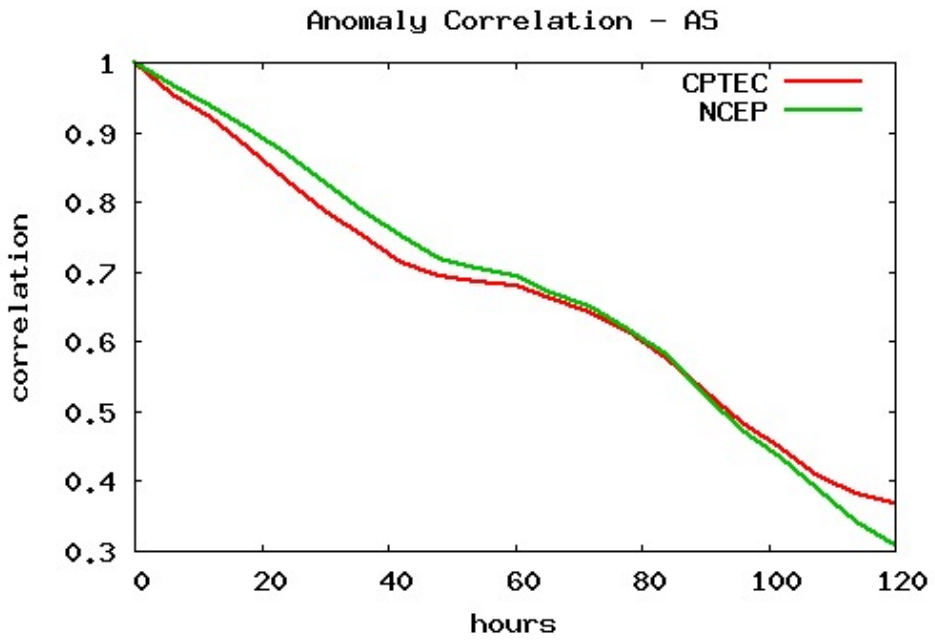
For the global simulation, the impact of the AMVs generated at CPTEC is very small.

Only the South America and surrounding areas were changed.



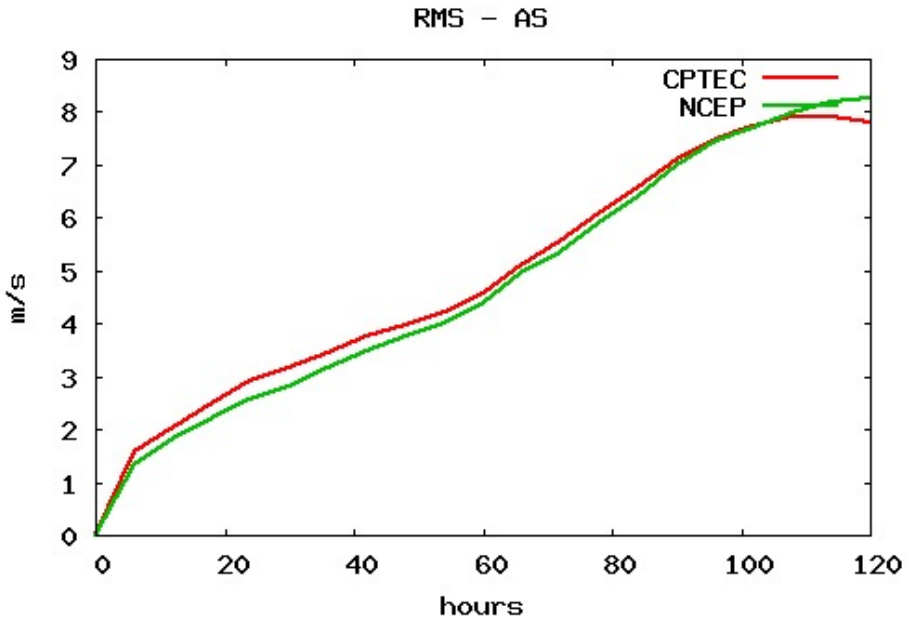


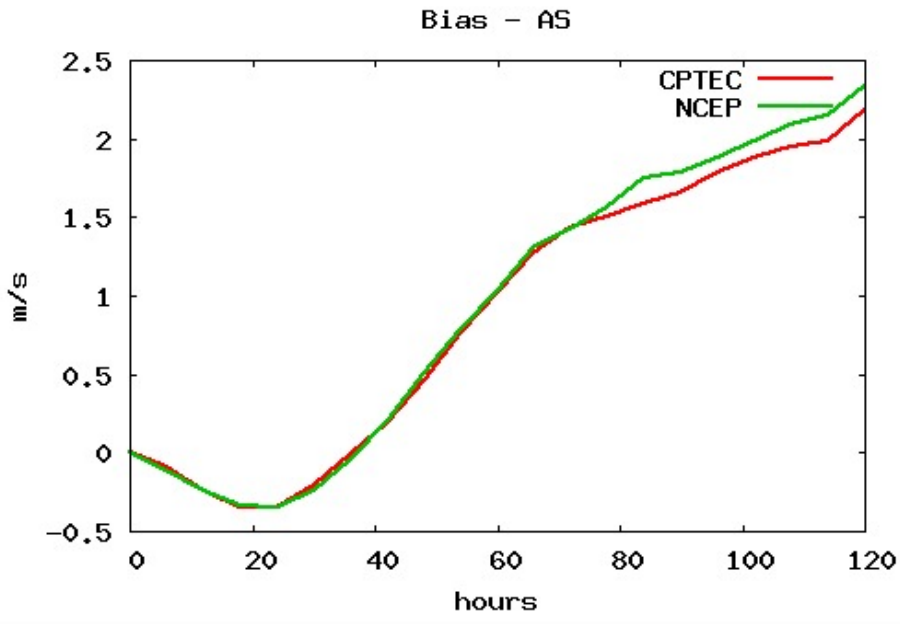
Comparison between CPTEC and GFS winds on the Brazilian Atmospheric Model (BAM)



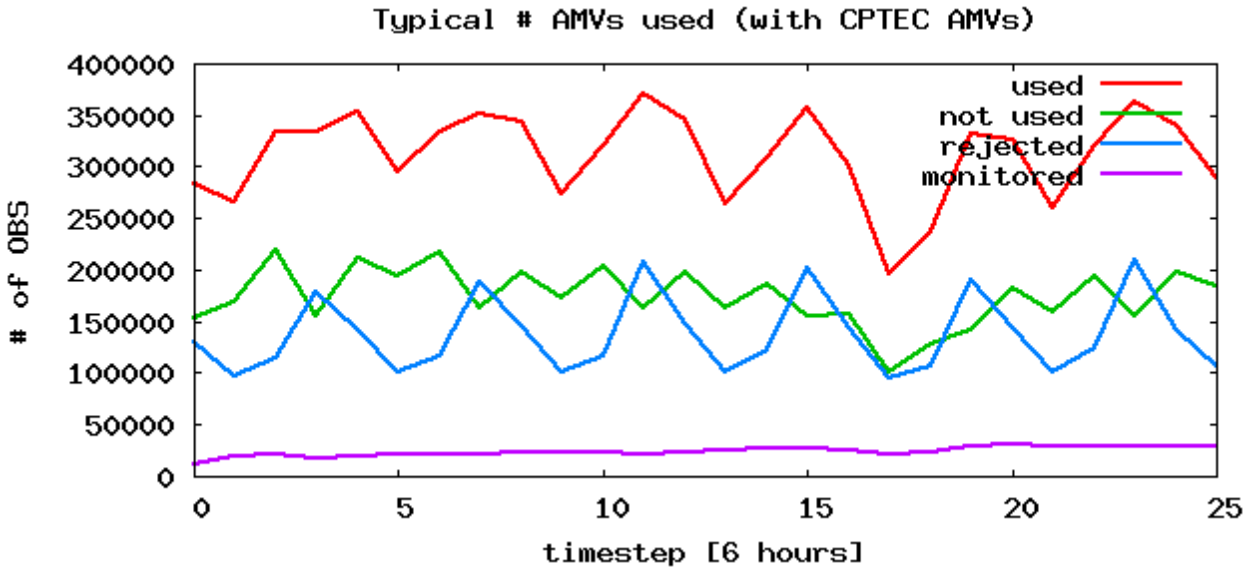
After substitute the GFS winds by the CPTEC/INPE ones over South America, the BAM's skill shows a small decrease.

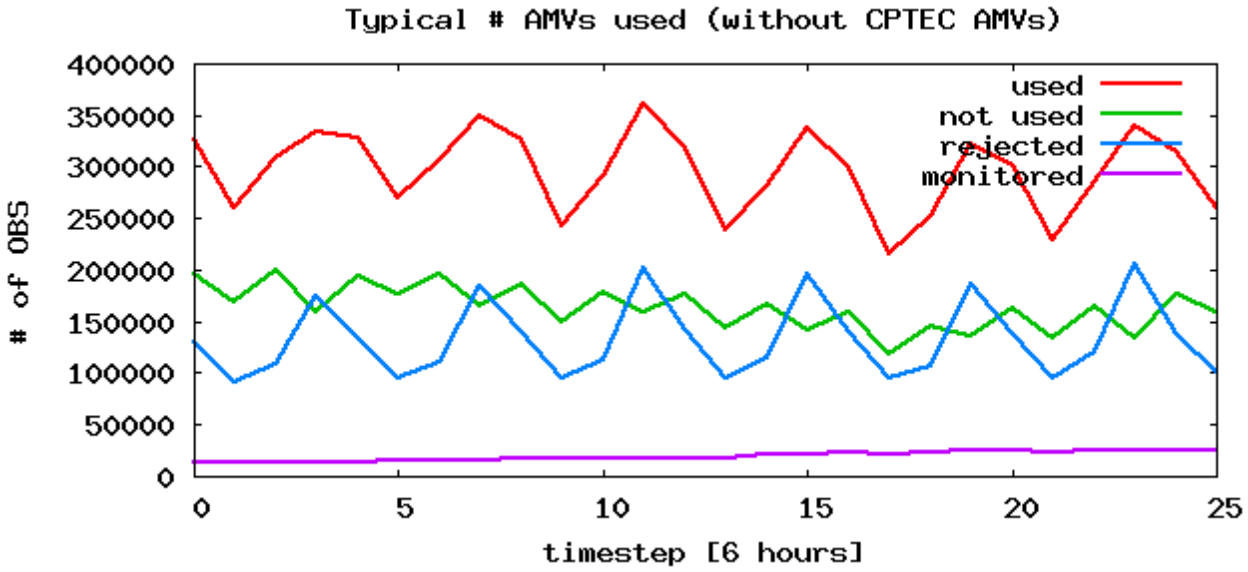
This can be explained due the lack of balance between the wind and the others atmospheric variables.



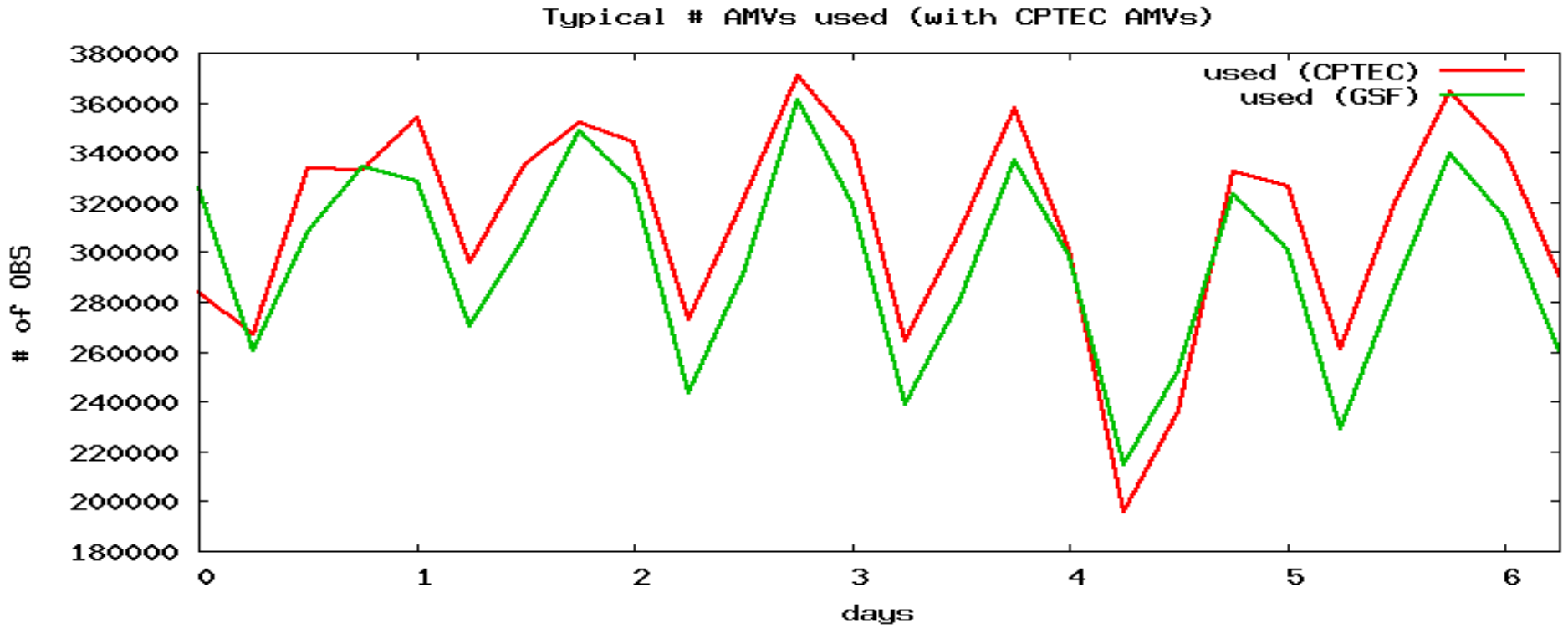


Typical number of AMVs used



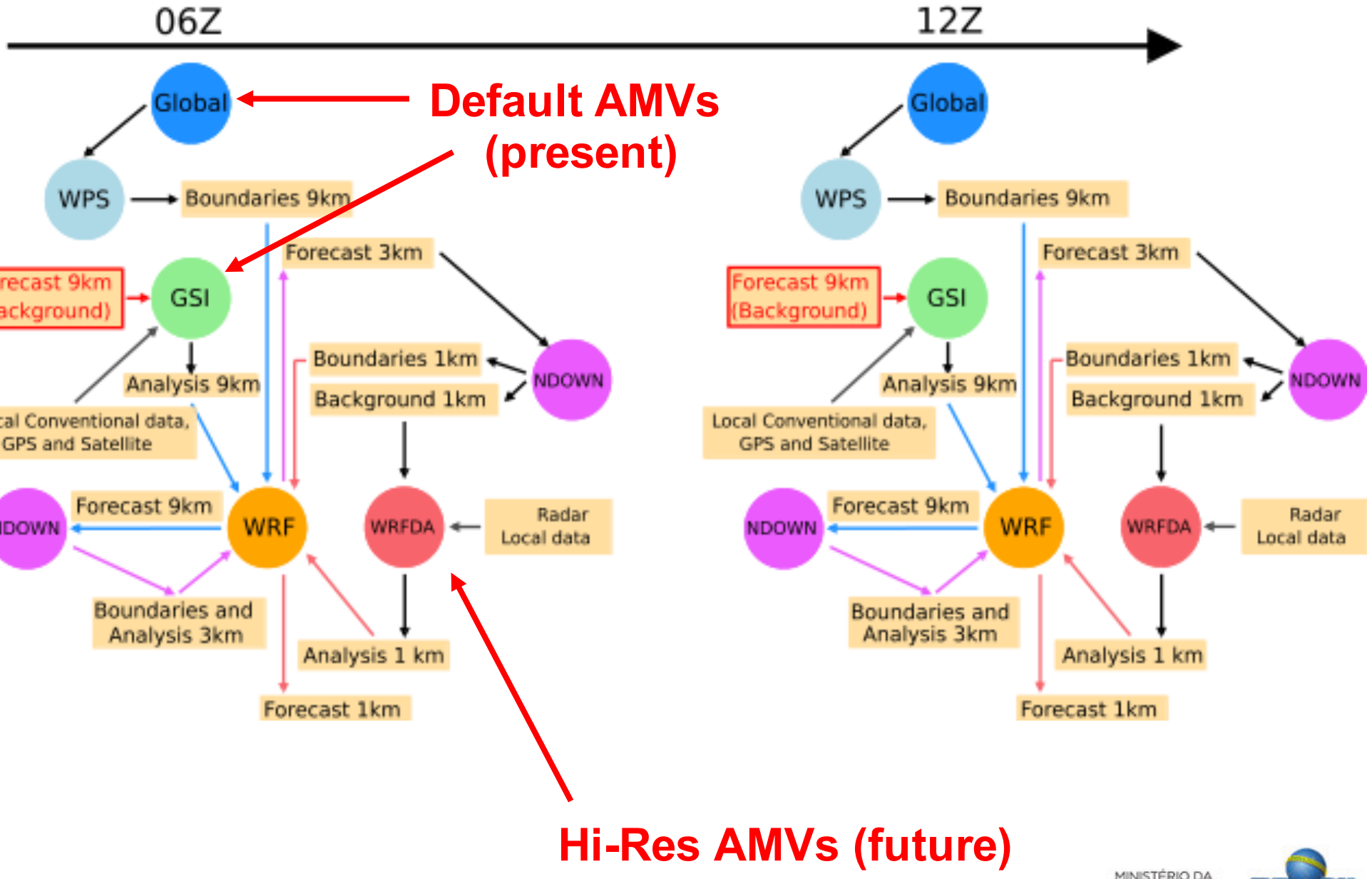


Typical number of AMVs used



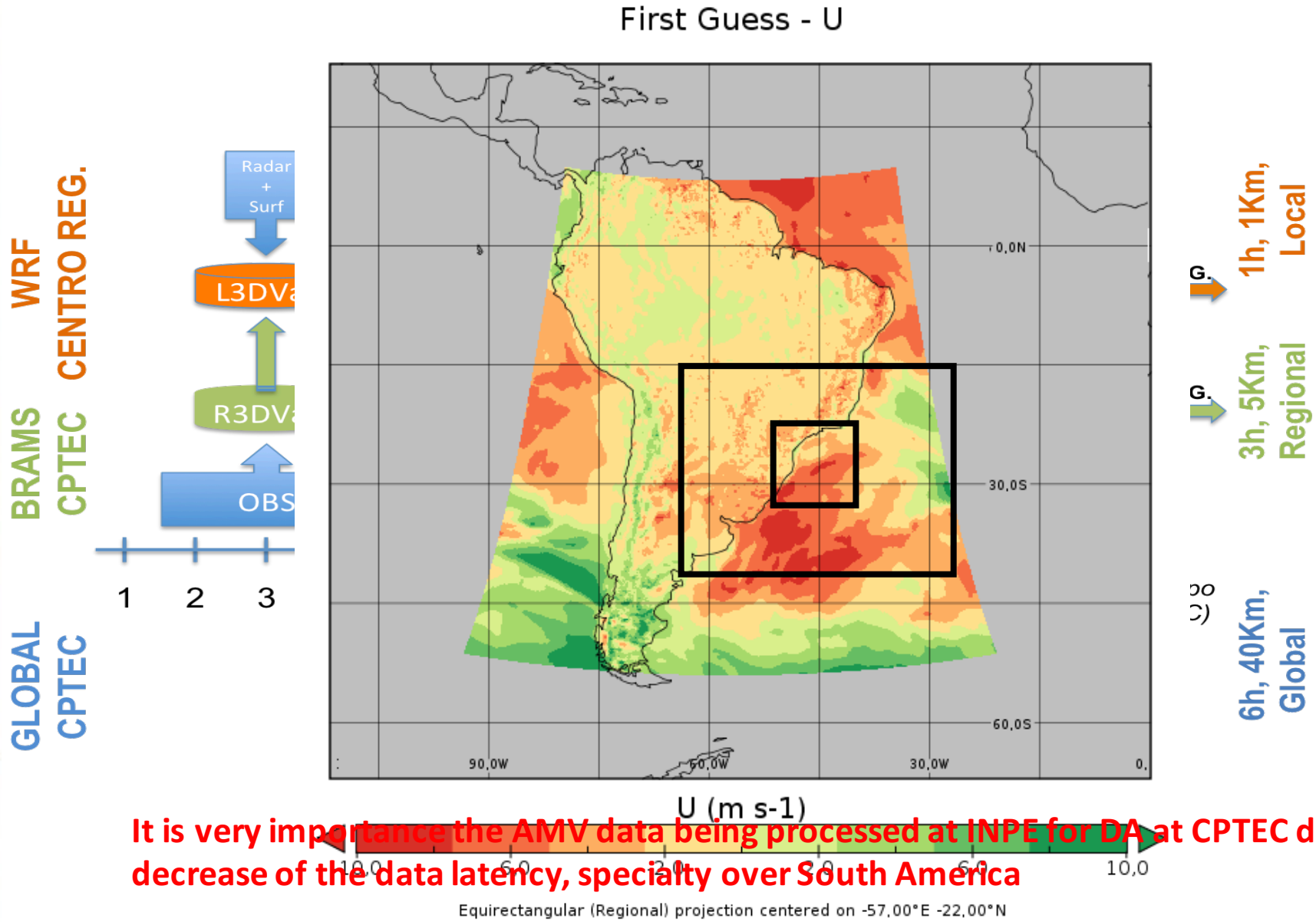
Substituting the South America AMVs from the GFS by the CPTEC ones cause a increase in the amount effectively used by the DA scheme.

CPTEC Data Assimilation scheme



MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

Current activity: Rapid Update Cycle of analysis over South American



It is very importance the AMV data being processed at INPE for DA at CPTEC due the decrease of the data latency, specialty over South America

Nowcasting and Weather Monitoring

- CPTEC/INPE has been created a nowcasting researching group

Nowcasting

Activities	Products	Services

• Know the state of art in *Nowcasting;*
• Select satellite, radar, observation and NWP high resolution data;
• Develop and implement algorithms in a *user-friendly plataform*;
• Evaluate the products and promote training to better use them
	• Pre-Convective **(A)**
	  • 21 products
	• Convection initiation **(B)**
	  • 9 products
	• Convection maturation **(C)**
	  • 19 products
	• Nowcasting system **(D)**
	  • 7 products
		• ***Nowcasting*** aim to offer information about:
		  • ***Detecção*** *de áreas com possível atividade convectiva*
		  • ***Tracking*** *de sistemas convectivos*
		  • ***Short range forecast*** *of storms (0,5 up 2h)*
		• **Usefull to:**
		  • *Aviation; Civil defense; Agriculture; Transport; Energy; Outdoor activities; etc.*

Nowcasting

	Produto	Fase	Dados
A1)	CAPE	2	Radiossonda, NWP
A2)	Shear weight	1	Radiossonda, NWP
A3)	Bulk Richardson Number	1	Radiossonda, NWP
A4)	GII	1	MSG
A5)	Índice K	1	Radiossonda, NWP, polar
A6)	Showalter	1	Radiossonda, NWP, polar
A7)	Vorticidade Potencial	2	Radiossonda, NWP
A8)	EHI (Energy Helicity Index)	2	Radiossonda, NWP
A9)	CINE	1	Radiossonda, NWP
A10)	IWV	1	MSG e radiossonda, polar
A11)	Tetae	1	Radiossonda, NWP, polar
A12)	D(Tetae)/dz	1	Radiossonda, NWP, polar
A13)	D(Tetaes)/dz	1	Radiossonda, NWP, polar
A14)	CDW – wv,ir,vis	1	GOES/MSG
A15)	Image Sandwich, difference	1	MSG e GOES
A16)	Convergência de umidade	3	Metar
A17)	Campos de CAPE vs Shear	3	Modelo

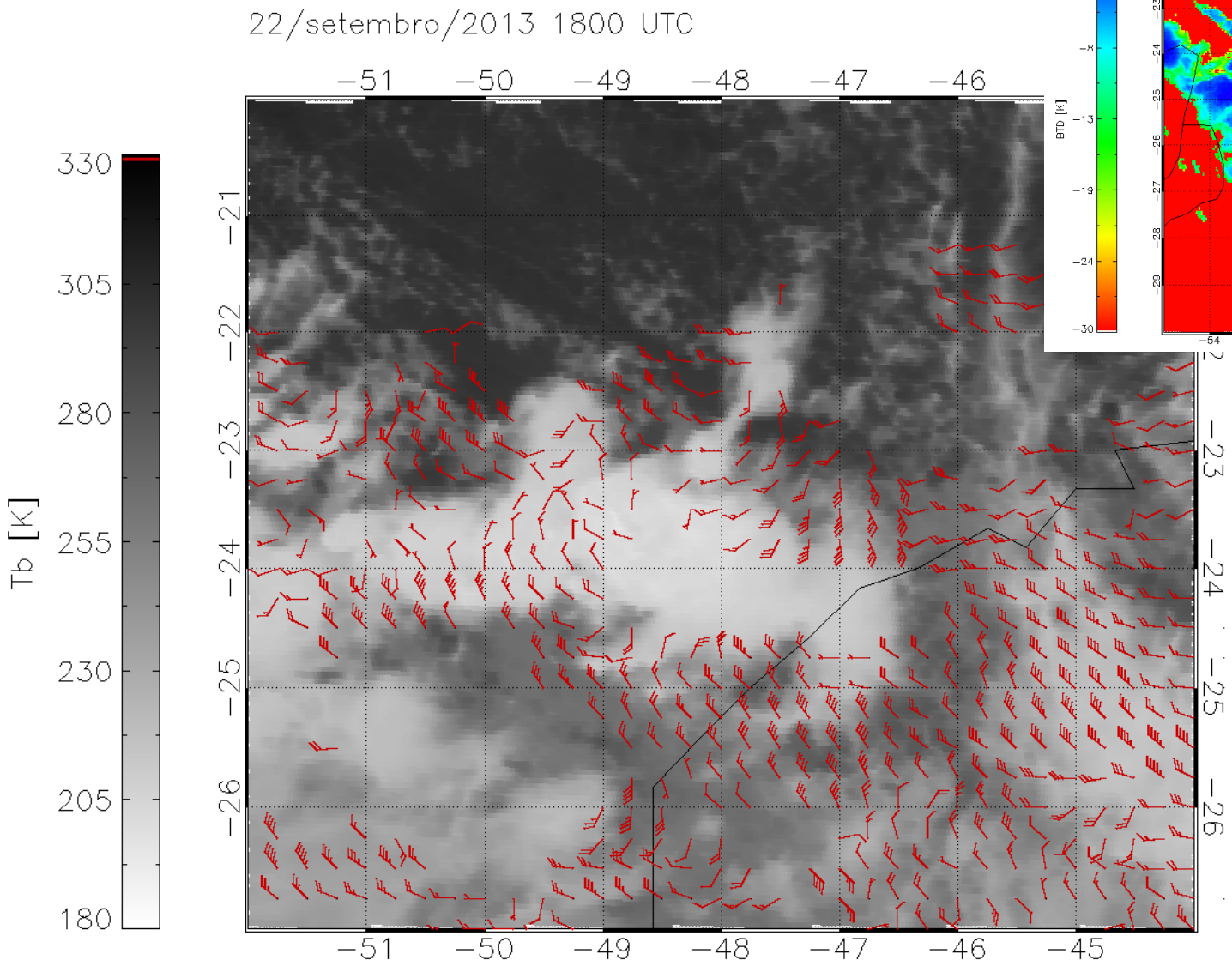
	Produto	Fase	Dados
C1)	Radar area expansion	1	S band
C2)	Wv-ir area expansion	1	GOES/MSG
C3)	D(htop)/dt	1	S band
C4)	VIL	1	S band
C5)	DVIL	1	S band
C6)	Waldwogel	1	S band
C7)	H 35dBZ	1	S band
C8)	Ice size, polarization, IWC	2	Polar microwave
C9)	Small ice regions	1	GOES – MSG
C10)	Ligtning jump	2	Brasildat
C11)	Zdr, kdp: warm, mixed1 e 2	3	Dual pol
C12)	Doppler V	1	S band
C13)	Conv, Wind VVT, VAD	3	Dual pol
C14)	Lightning forecast	3	Dual pol
C15)	Severity forecast	3	Dual pol
C16)	Rainfall integration satellite	1	GOES – GPM
C17)	Rainfall radar integration	2	S band

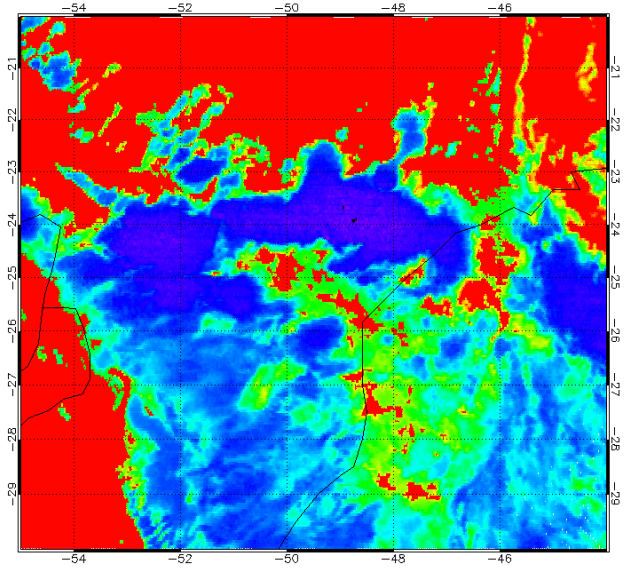
	Produto	Fase	Dados
B1)	Visible channel - looping	1	GOES – MSG
B2)	PPI (lower elevation) looping)	1	Radar
B3)	D(Tir)/dt	1	GOES
B4)	(1/a)da/dt e D(r)/dt	1	GOES
B5)	TRL	1	GOES – MSG
B6)	IWV jump	2	GPS
B7)	wv-ir div	2	GOES/MSG
B8)	Área fraction dif trend	2	MSG

	Produto	Fase	Dados
D1)	Fortracc2 – IR	1	GOES
D2)	Fortracc2 – Hydrotrack	2	NASA
D3)	Fortracc2 – Radar CAPPI	1	S band
D4)	Fortracc2 – wv-ir	1	GOES/MSG
D5)	Nearcast Tetae	2	Polar / GOES-R

Mesoscale wind fields for nowcasting

AMVs at ~20 km grid (8x8 pixel target window with 25% overlap)





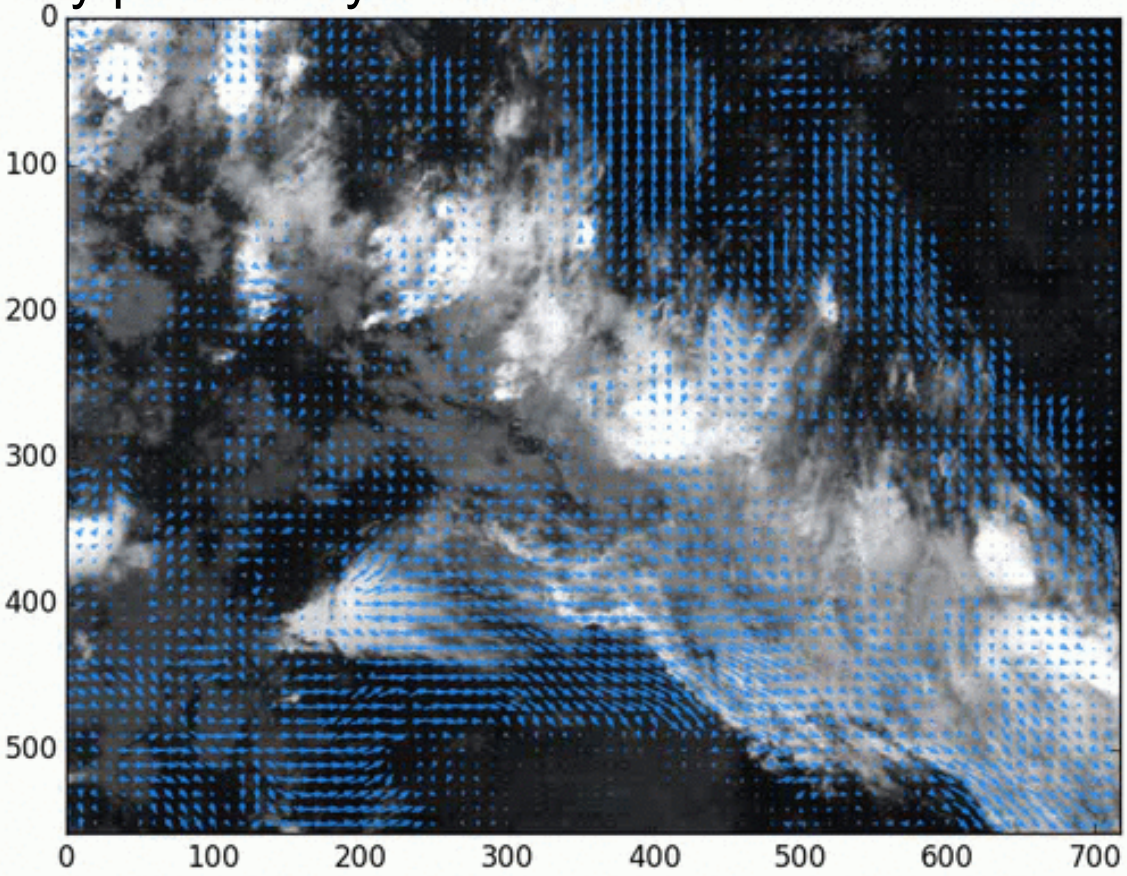
6-11μm image used as input

Pixel based tracking

CPTEC has begun to develop an pixel based tracking algorithm based on the optical flow methodology

This routines could be used to the high resolution wind estimative

Very preliminary results



Future plans (2016/2017)

- Finish the preaparation for GOES-R
- Evaluate the high resolution wind algorithm based on channel combinations
  - nowcasting
  - assimilation on cloud scale model (WRF and/or BRAMS)

Thanks !

And thanks to WMO for supporting my travel to the 13th International Winds Workshop