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RETRIEVAL OF SOIL MOISTURE OVER SOUTH AMERICA DERIVED FROM MICROWAVE OBSERVATIONS

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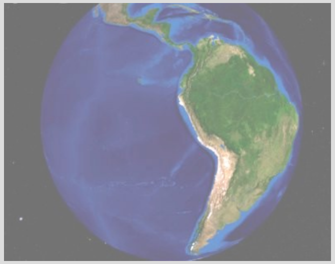
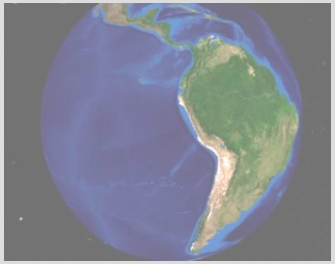
SUMMARY



- Motivation;
- Objectives;
- Material and Methods;
- Results;
- Conclusions;

MOTIVATION



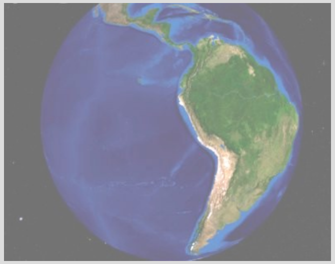
- Surface soil moisture plays an important role in the interactions between land surface and atmosphere;

- Techniques for soil moisture determination, mainly passive microwave remote sensing, which penetrate clouds and provide physical information of the land surface;

- Many approaches have been developed considering various effects that contribute to the surface microwave emission;

- Potential of soil moisture retrieval using remote sensing in large areas is not evaluate over South America;

OBJECTIVES



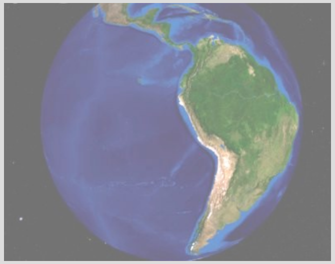

- Evaluate the quality of soil moisture products over South America;

- Satellite soil moisture from AMSR-E observations was compared to surface soil moisture as derived from Eta model;

- An intercomparison analysis was applied between satellite derived soil moisture and precipitation products;

- Verify the impact of soil moisture in weather forecasts over South America during the months more representative of the seasons;

MATERIAL AND METHODS



- C band AMSR-E observations during 2003 were used for soil moisture retrieval;

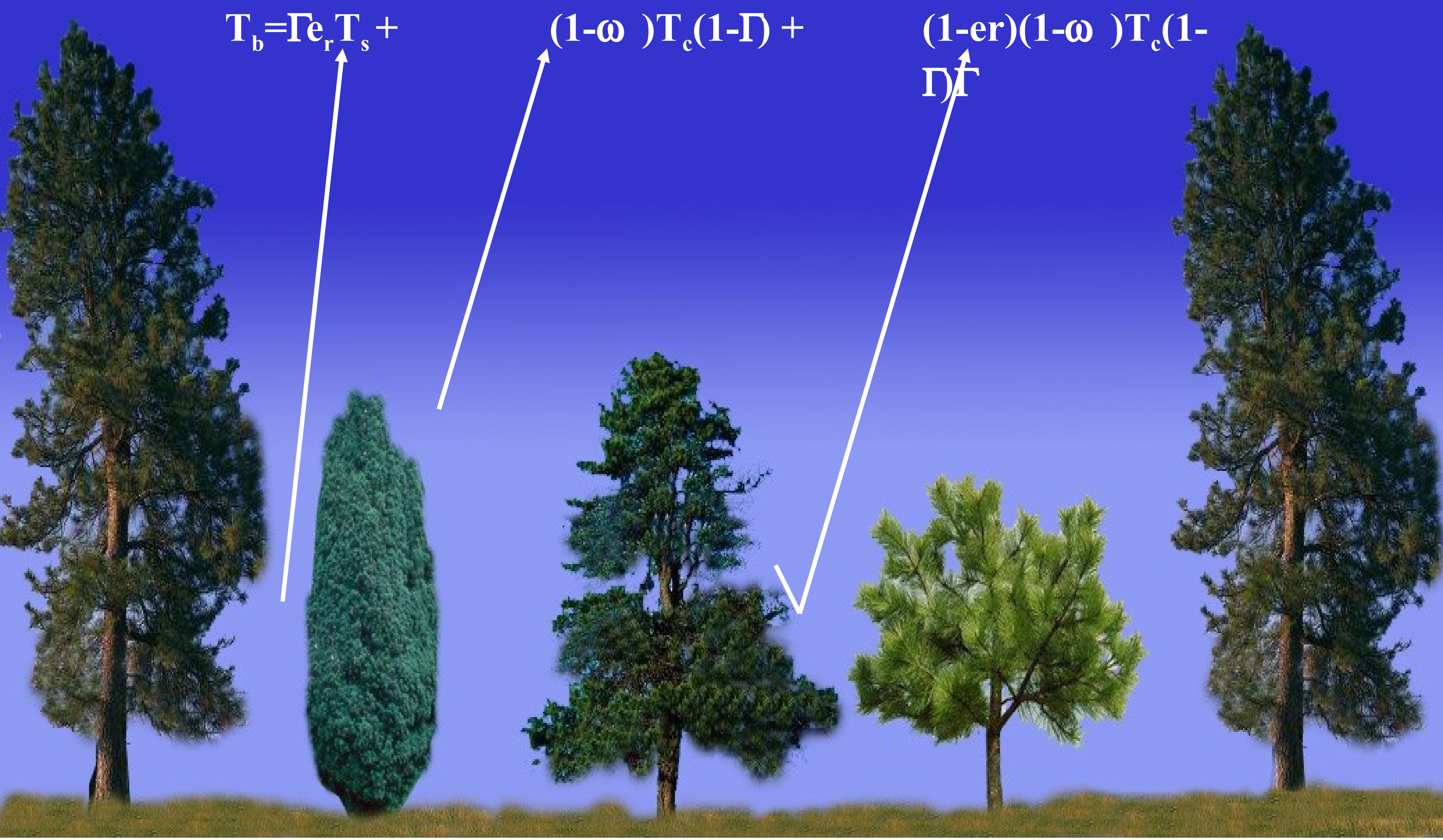
- Retrieval of soil moisture: Land Surface Paramenter Model (LPRM) developed jointly by researchers of NASA Goddard Space Flight Center and the Vrije Universiteit Amsterdam;

- The LPRM is an update version of the existing approach:

  Owe et al., 2001
  De Jeu, 2003

- based on tau-omega model, a simplified zero-order radiative transfer approach (Mo et al., 1982).

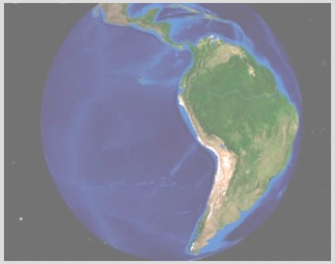
Schematic representation of the partitioning of microwave radiation from a vegetation covered surface in terms of the brightness temperature



T_s = soil temperature; T_c = canopy temperature; e_r = Rough surface emissivity,

ω = Single scattering albedo; Γ = Transmissivity of the vegetation.

MATERIAL AND METHODS



- Canopy temperature: $T_s = 0,861 T_{b(37GHz)} + 52.55$
- Soil temperature: $T_s = T_c$
- Rough surface emissivity: $e_{r(l)} = 1 - R_{(l)} \exp(-h \cos^2 u)$

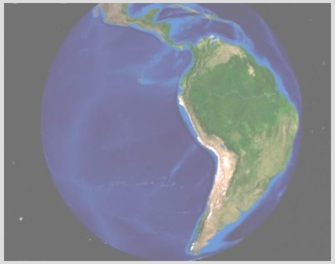
  Choudhury et al. 1979

  Choudhury et al. 1976

  Wang e Schmugge (1980).
- Vegetation optical depth

  Meesters et al. (2005)

MATERIAL AND METHODS



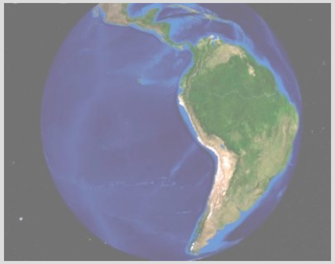
- The model is expressed in terms of dielectric constant and MPDI (Microwave Polarization Difference Index):

$$\tau = \cos u \ln\left(ad + \sqrt{(ad)^2 + a + 1}\right)$$

$$a = \frac{1}{2}\left[\frac{e_{r(V)} - e_{r(H)}}{MPDI} - e_V - e_H\right] \qquad MPDI = \frac{T_{b(V)} - T_{b(H)}}{T_{b(V)} + T_{b(H)}} \qquad d = \frac{1}{2}\frac{\omega}{(1-\omega)}$$

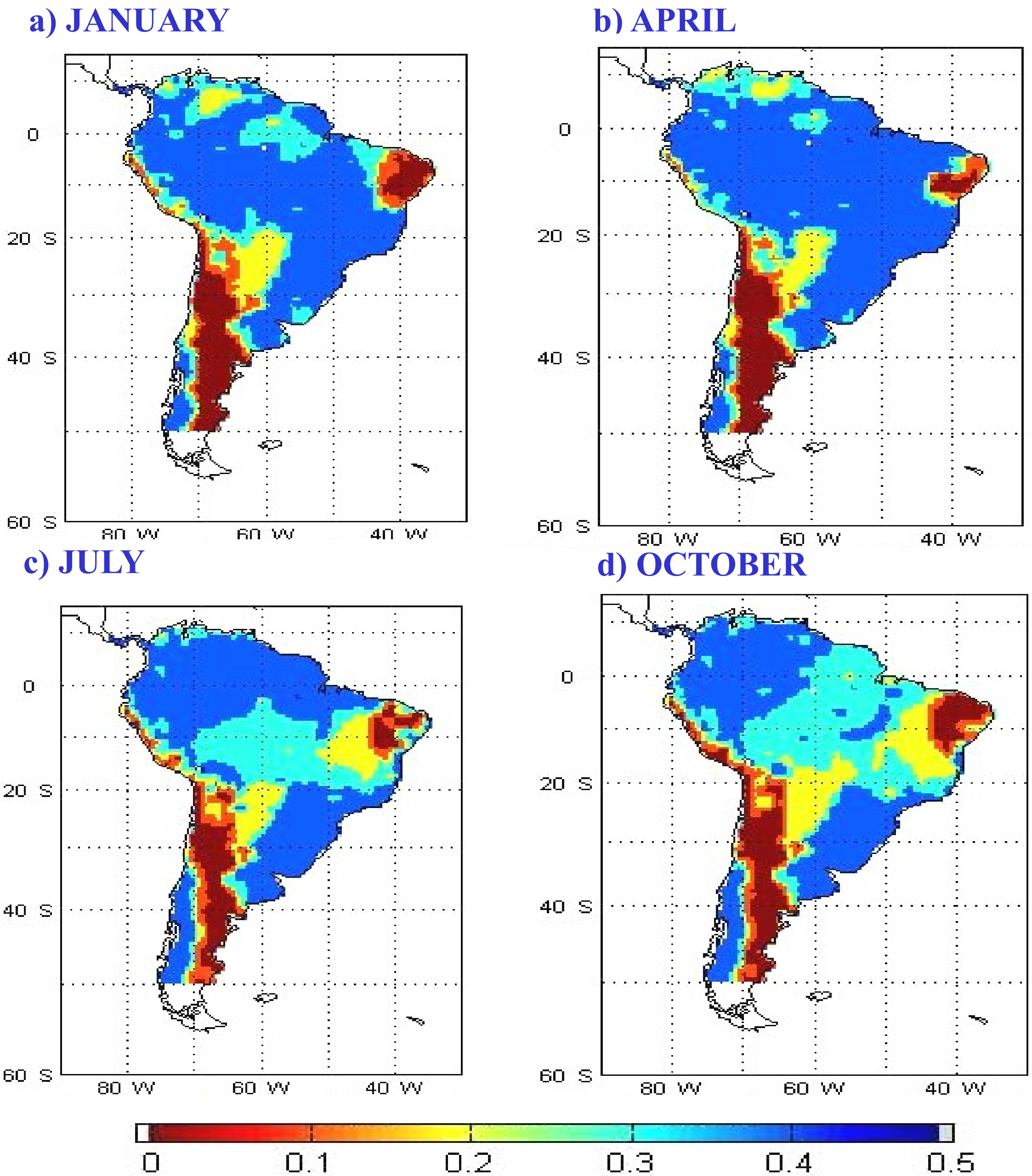
and ω is single scattering albedo.

MATERIAL AND METHODS



Soil moisture comparisons: **ETA Model** (Center for Numerical Weather Forecast and Climate Studies - CPTEC)

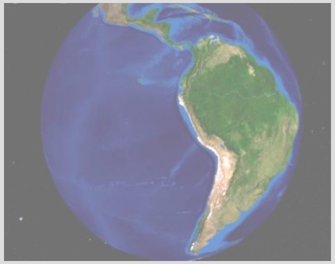
Eta model: - developed by Mesinger et. al, 1988
- domain covers most of South America.
- configured with 40 km resolution.



- Low soil moisture for Northeast Brazil;
- High soil moisture for North region;
- decrease soil moisture im many regions during July and October months;

Monthly mean surface soil moisture (m3.m-3) derived by Eta model during 2003 for the months with spatial resolution of 0.5º x 0.5º: a) January; b) April; c) July; d) October.

MATERIAL AND METHODS



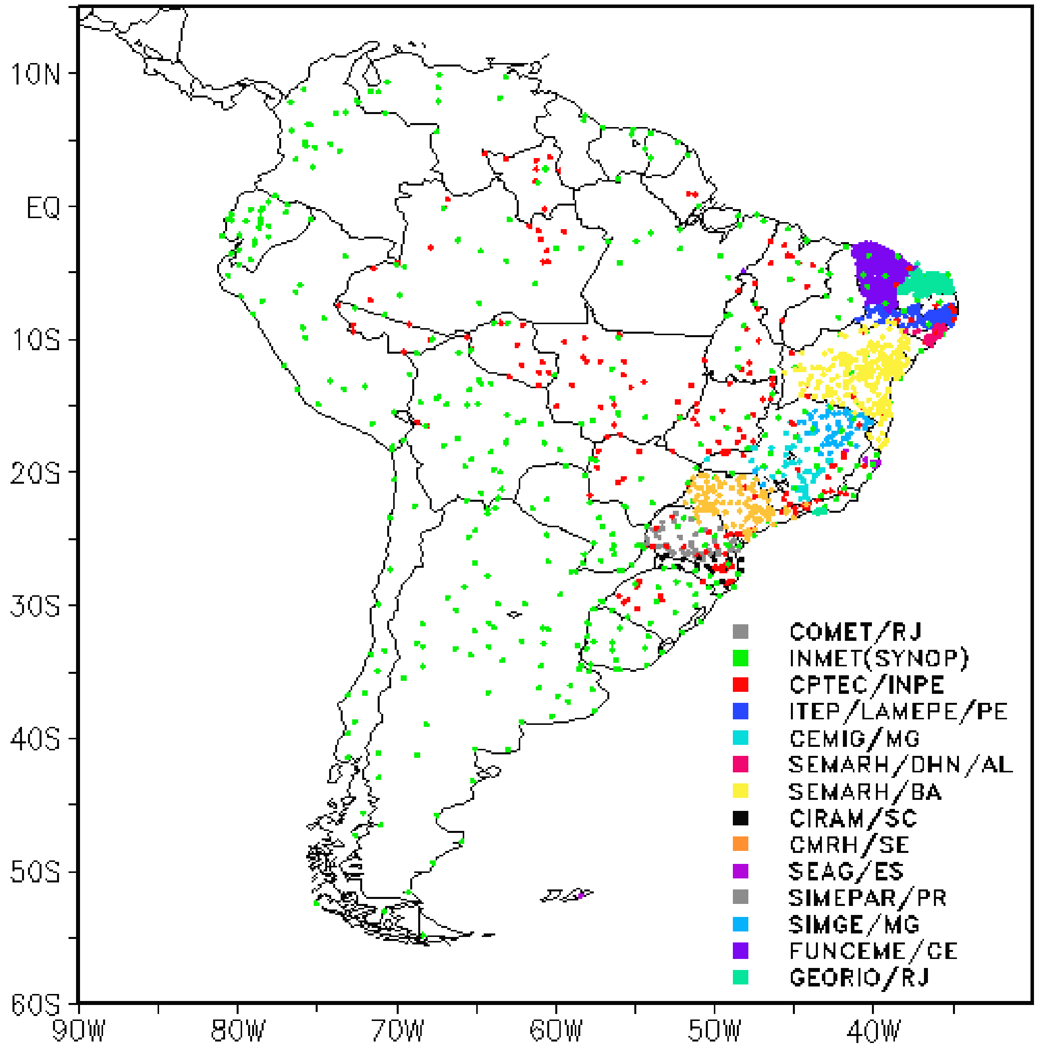

In absence soil moisture in-situ

↓

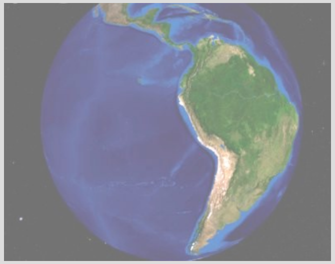
Precipitation CPTEC

↓

Spatial distributions of the stations meteorological obtained by CPTEC/ INPE over South America.



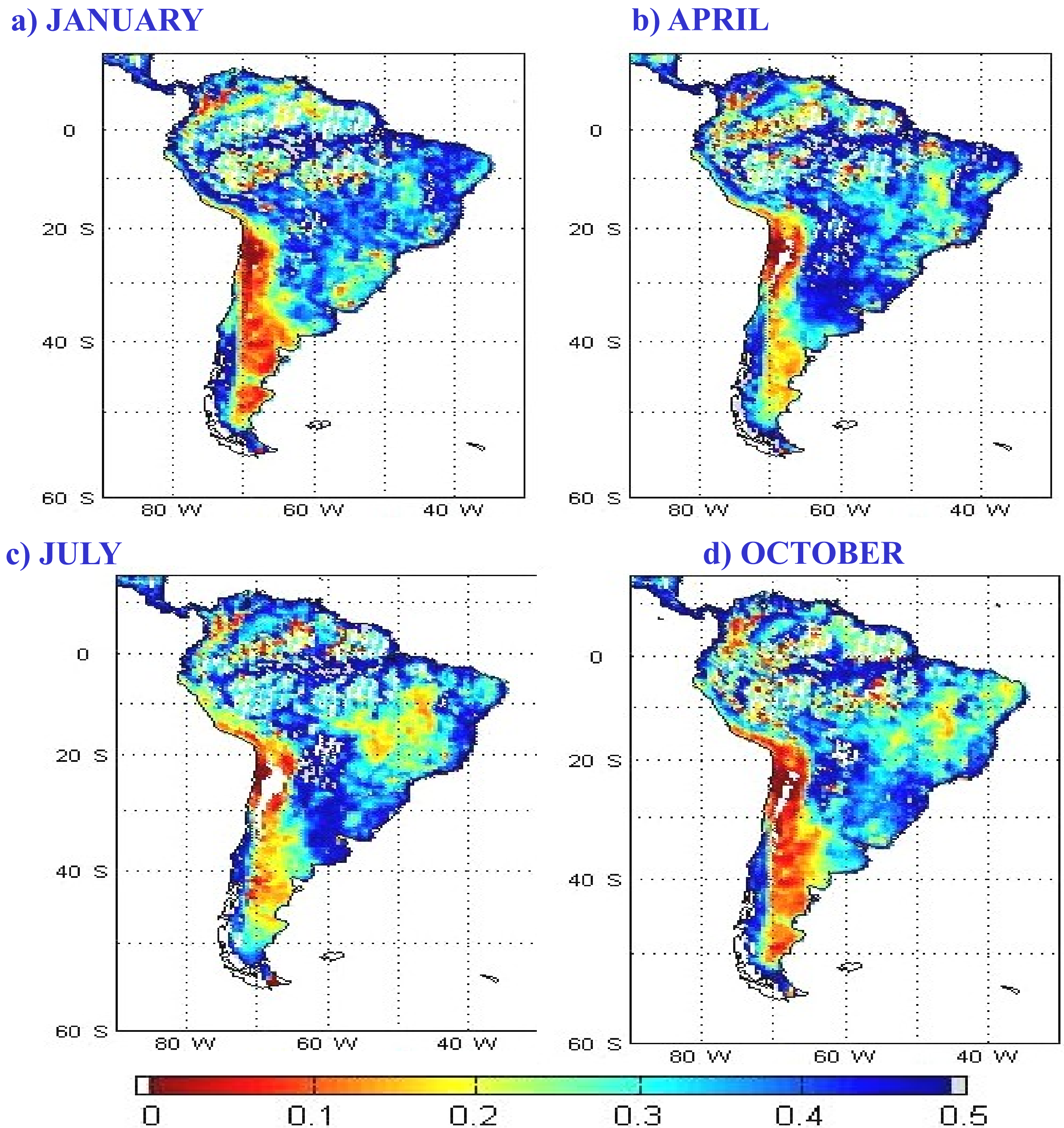
RESULTS




LPRM:

The soil moisture derived from AMSR-E observations at 6.9 GHz were retrieved for during 2003 year.

→ 2003 year was selected for validate with SMEX03 data.



We can observe that the potential of the land surface parameters retrieval using passive microwave are unreliable in dense vegetated areas (forest).

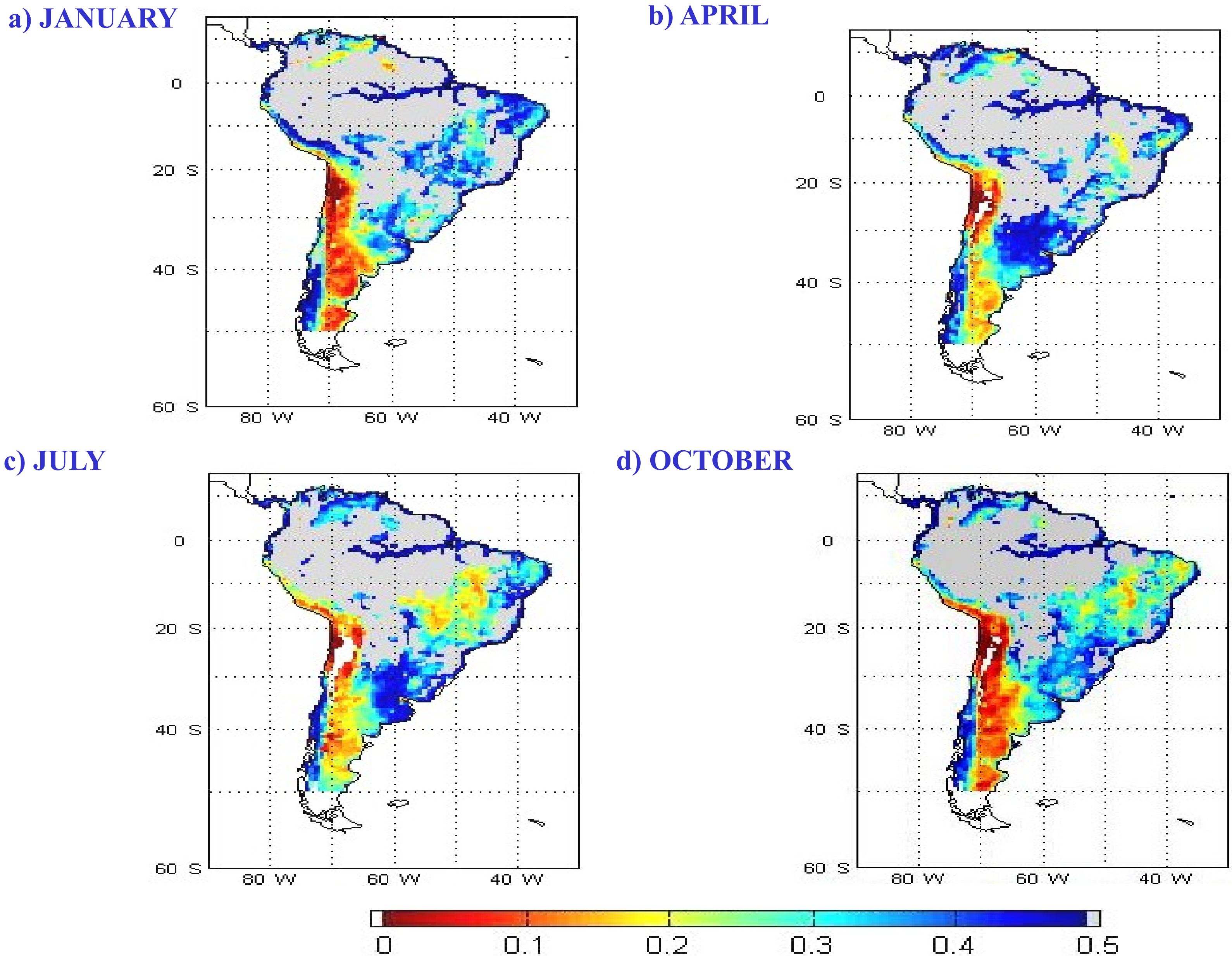
Monthly mean surface soil moisture (m3.m-3) derived from AMSR-E in C band during 2003 for the months: a) January; b) April; c) July; d) October.

RESULTS

- In order to obtain reliable data, soil moisture results for densily vegetation regions are not considered in analysis.

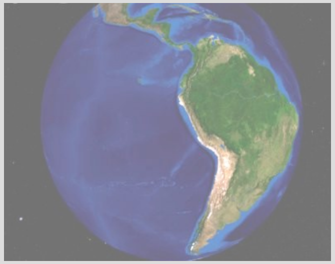
- Considering that the sensitivity of C-band measurements to optical depth variations significantly decreases when the optical depth is higher than 0.75;

- Soil moisture data were eliminated when optical depth is above 0.75.



Monthly mean surface soil moisture (m3.m-3) derived from AMSR-E in C band during 2003. No reliable data are represented by the color gray.

RESULTS

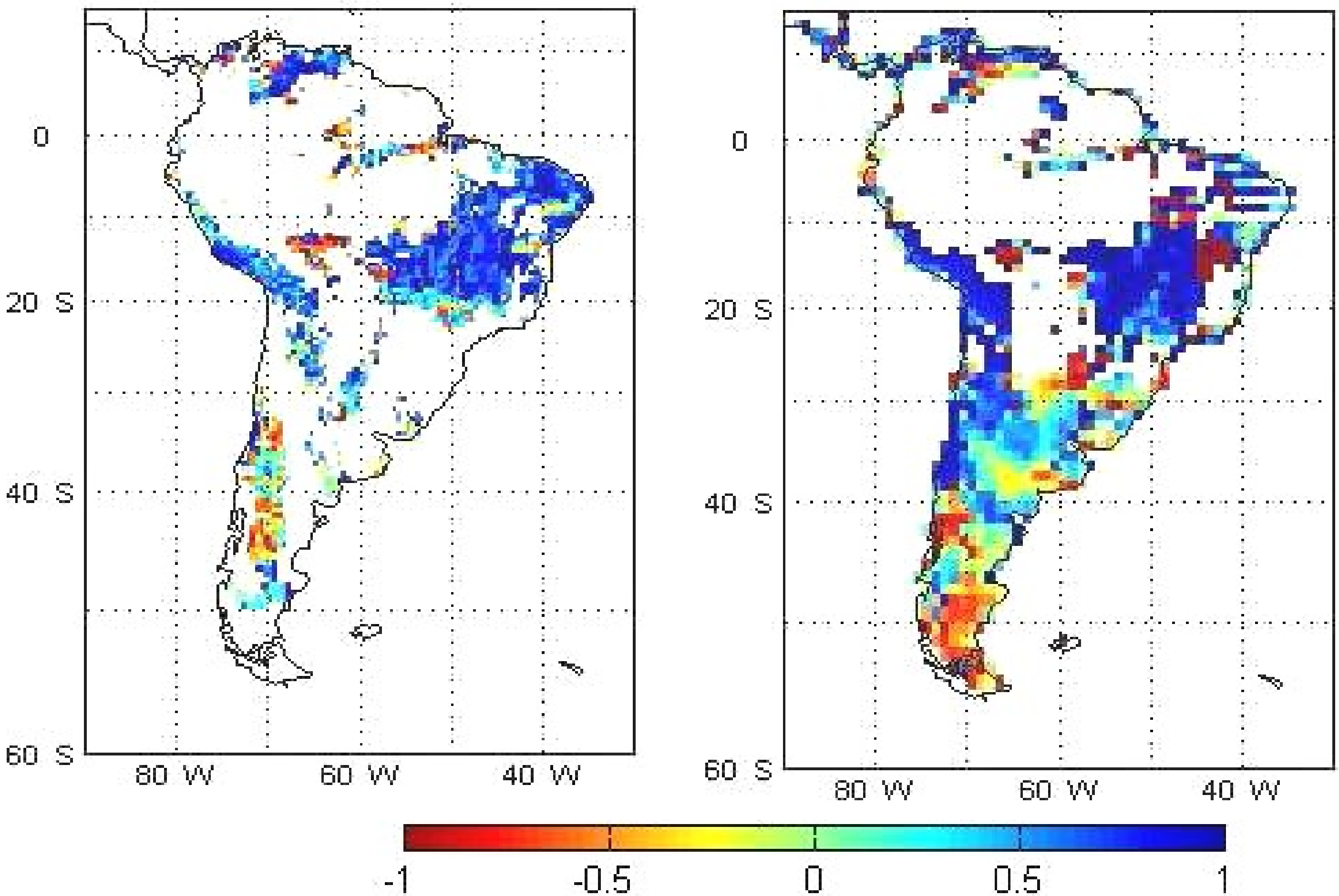



- From theses results, we have been evaluated the spatial correlation of satellite soil moisture with Eta model reanalysis and precipitation datasets over South America during 2003 year, for representative months of the wet (January and April) and dry (July and October) seasons.

CORRELATION MAPS

a) AMSR-E C x Eta

b) Prec x AMSR-E C

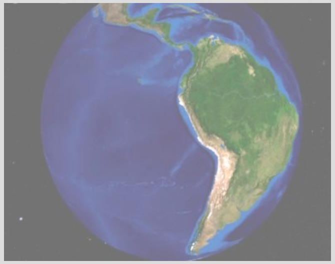


High correlations between soil moisture products are observed in different regions, mainly cerrado region.

- Correlation map between precipitation and AMSR-E product shows also high correlation for cerrado region.

Correlation coefficient maps using the monthly 2003 observations of: a) Eta model versus AMSR-E sensor (C band); b) Precipitation CPTEC versus AMSR-E sensor.

RESULTS



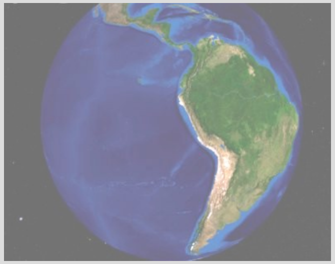

- The quality of products depends on validation with in-situ data;

- Thus, in this work were used soil moisture data collected during Soil Moisture Experiment 2003, located in Barreiras (Bahia State);

- Moreover, 2 others sites were included for validation: Ilha do Bananal and Santa Rita do Passa Quatro;

- Vegetation predominant is Cerrado;

RESULTS

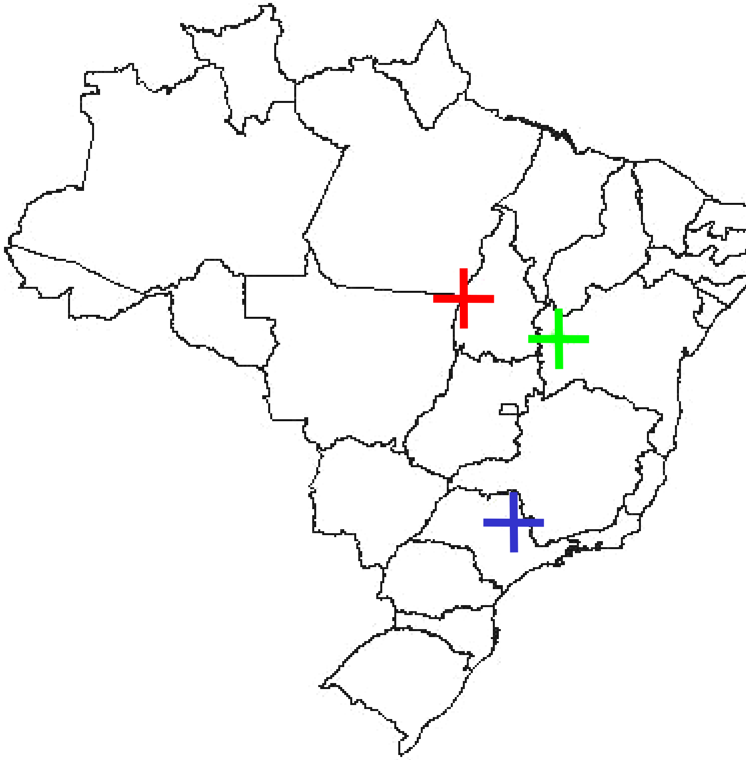



Validation Sites:

- **Bahia**: SMEX03, Barreiras city;

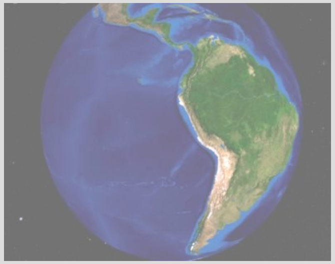
- **Sao Paulo**: Santa Rita do Passa Quatro (SP) site, which localization are 21º36'44"S e 47º34'41"W.

- **Tocantins**: Ilha do Bananal, which are located in 9º49'16.1"S and 50º08'55.3"W.



Location of the sites

RESULTS



States	Sites	Period
Bahia	BA-06	2-8 Dec - 2003
	BA-10	2-8 Dec - 2003
	BA-11	2-8 Dec - 2003
São Paulo	PDG	8 Aug - 29 Dec -2003
Tocantins	IB	1 Nov - 31 Dec - 2003

Period of the data:

→ 1 week

→ 5 months

→ 2 months

States	Sites	R^2
Bahia	BA-06	0.78
	BA-10	0.79
	BA-11	0.87
São Paulo	PDG	0.67
Tocantins	IB	0.52

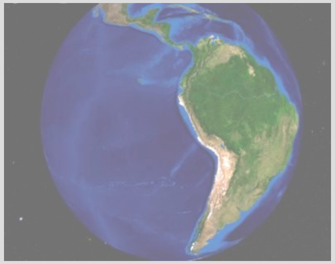
Highest correlations are found for:

→ **SMEX03**

→ **Ilha do Bananal**

worst correlations are found for:

RESULTS




Assimilation data:

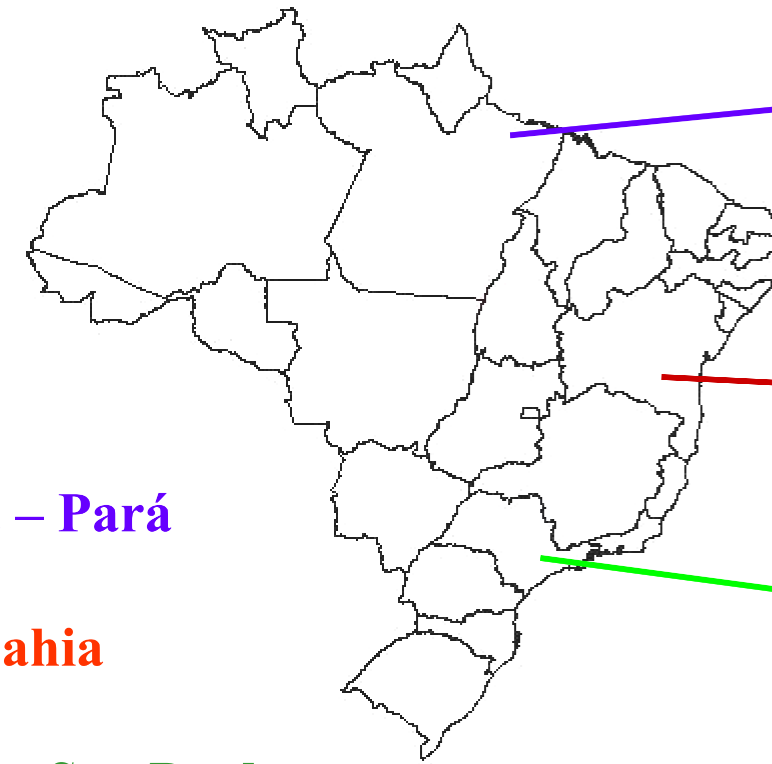
- The impact of soil moisture in surface model for weather and climate prediction was also evaluated using BRAMS(Brazilian Regional Atmospheric Modeling System) model.

- The BRAMS is a numerical prediction model designed to simulate atmospheric circulations from hemispheric scales down to large eddy simulations (LES) of the planetary boundary layer.

- For 1 month of simulation were performed 2 experiments. Each experiment is differentiated by the type of soil moisture initial condition values: AMSR-E and BRAMS.

RESULTS

For analysis the simulations results were selected 3 sites and 2 variable: temperature and relative humidity.



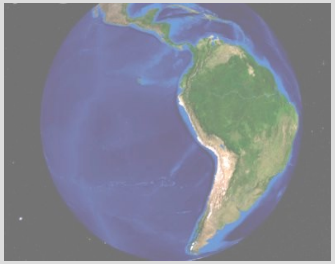
Sites:

Altamira – Pará

Piata – Bahia

Barretos – Sao Paulo

RESULTS

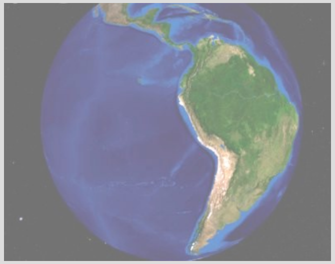



Temperature: observed x products

	BIAS				RMSE			
BARRETOS	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
AMSR x OBS	-1,03	-1,75	-2,03	-1,29	1,76	2,92	5,01	4,62
BRAMS x OBS	-1,03	-1,73	-2,63	-2,65	1,54	2,67	4,47	3,70
PIATA	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
AMSR x OBS	-2,30	-2,70	-2,17	-2,73	3,01	3,09	3,12	3,74
BRAMS x OBS	0,79	0,55	0,17	0,60	4,83	4,99	4,75	5,28
ALTAMIRA	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
AMSR x OBS	-1,42	-0,39	-0,66	0,75	1,04	1,36	2,46	3,93
BRAMS x OBS	-1,19	-0,48	-0,87	-0,71	1,49	1,57	2,48	2,43

For temperature, statistical analysis (BIAS and root mean square error) show that we have better result for AMSR-E in Piata and Altamira sites.

RESULTS



Relative humidity: observed x products

BARRETOS

	BIAS				REMQ			
	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
AMSR x OBS	-0,37	0,17	3,54	6,16	8,74	16,18	15,85	15,26
BRAMS x OBS	0,20	1,57	1,52	10,76	9,34	15,84	18,06	17,59

PIATA

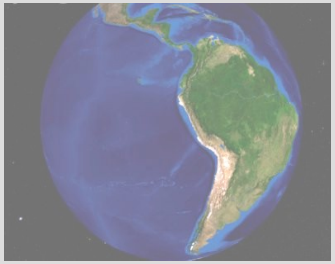
	BIAS				REMQ			
	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
AMSR x OBS	-1,54	4,09	5,10	1,55	15,88	14,43	14,56	12,86
BRAMS x OBS	-16,63	-12,94	-10,35	-7,32	15,50	13,21	15,13	13,25

ALTAMIRA

	BIAS				REMQ			
	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
AMSR x OBS	13,02	7,70	-4,29	-7,18	11,99	13,10	13,87	15,85
BRAMS x OBS	10,01	6,64	-3,63	-0,99	9,65	11,69	13,45	14,35

For RH, statistical analysis (BIAS and root mean square error) show that we have better result for AMSR-E in Piata and Barretos sites.

CONCLUSIONS




- Based on results it was observed that the potential of the soil moisture retrieval using passive microwave are more representative for the cerrado region and unreliable in dense vegetated areas (forest). So, we concluded that the LPRM needs to be adjusted for dense vegetated areas.

- In simulations, we can observed that soil moisture derived from AMSR have better performance in comparison with observed data at the Altamira, and Barretos Piata stations, showing that this new data is a great value for use in operational weather forecasting in meteorological centers for Brazil and the world.

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The GOES is a device of 5 spectral channels one Visible (0,55-0,75 μ m), three channels Infrared (3,8-4,0 μ m, 10,2-11 , 2 μ m, 11,5-12,5 μ m) and the channel of Water Vapor d'(6,5-7,0 μ m). No Visible channel, the resolution is 1 km. In Infrared channels, the resolution is 4 km. With Steam channel water, the resolution is 8 km.

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