

# Model development overview at INPE/CPTEC

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# Model development overview at INPE/CPTEC

## Computer system

Cray XE 17472 cores (2010 used to have 30528) – research only (will be terminated in the end of 2021 – U\$ 1 million of electricity / year)

Cray XC50 4160 cores (2018) - operation only

New computer under tests (cluster DELL)

## Numerical models

- Limited-area models
  - BRAMS (since 2003) - AQ and NWP
  - Eta (since 1996) - NWP, Clim, Reg Proj
  - WRF (since 2018) - NWP
- Global model
  - BAM – NWP, Ensemble (15 days), Clim





# A new paradigm for the environmental modeling over South America

We proposed Brazil adopt a unified and community model of the Earth System

Everyone works on a single modeling system, a single computer code

- **Involves the main components of the Earth System**

Atmosphere, oceans, cryosphere, soil and vegetation, and upper space; some components with variable complexity (e.g., atmospheric chemistry and aerosol representation)

- **Unified**

- appropriated for an extensive range of spatial and temporal scales (seamless prediction)

- **Accurate**

- Reduced number of approximations and state-of-the-art numerical solvers
- Anchored by a robust data assimilation system and improved by AI techniques

- **Community**

- Open and free source, maintained by a group of HPC experts
- Workshops and training for the community
- HPC services available for the community

- **Multi-Institutional Governance**



## A new paradigm for the environmental modeling for South America

### Organization - Scientific Body

- Established by INPE's Director on April 2021
- Involved institutions: INPE, INMET, LNCC, INPA, CENSIPAM, DECEA, Brazilian Army, Brazilian Navy, Brazilian Air Force, several universities

#### Membership

- Internal members: 16
- External members: 19

**Leaders: Saulo Freitas (INPE) and Pedro Leite da Silva Dias (USP)**

35 members in total (5 female researchers)

#### Working groups

- Integrated Modeling System
- Atmosphere
- Land-surface
- Oceans and Continental and Maritime Ice
- Space Weather
- HPC and coding quality
- Data Assimilation (DA)
- Advanced DA and AI applications
- Hydrology
- Pre- and post-processing methods of weather and climate forecasts
- Representatives of universities
- CENSIPAM
- INMET
- Brazilian Army, Brazilian Navy, Brazilian Air Force



# A new paradigm for the environmental modeling for South America



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## Model development overview at INPE/CPTEC

### **New version Brazilian Atmospheric Model in Hybrid Coordinate (sigma-pressure - BAMh) and Data Assimilation**

- Better skill in NWP, S2S and seasonal forecasting.
- Provides a better representation of the atmospheric systems of the upper troposphere and the stratosphere. The new model also has the advantage of using horizontal diffusion in spectral space and physical space – better control of numerical stability and accuracy of results
- **GSI-BAMH** Global Data Assimilation Software in the final validation phase

### **Eta Regional Model Forecasts (v.1.4.0) 8km - NWP and medium range forecasts**

- Modernized and unified code to generate NWP, S2S and to generate climate change projections; it is a unified system to meet different applications, at different spatial and temporal scales

### **Availability of the new code of the Brazilian Earth System Model (BESM3.0)**

The coupling of the MOM6 ocean model with the BAM model in sigma coordinate in BESM was completed delivered in the 1st half of 2021. This software contains a complete review of the dynamics and all physical parameterizations used in the BAM model in sigma coordinate and the latest version of MOM6 ocean model

### **BRAMS**

- Implementation of the 6.0 version of the land-surface model JULES
- Plumerise model updated to be fully Thread safe ensuring use of OpenP and OpenACC
- For AQ, horizontal resolution increased from 20km to 15km over South America
- PREC-CHEM-SRC is user-friendly. It is able to initialize the atmosphere with CAMS climatological chemistry

### **Eta, WRF and BRAMS NWP forecast evaluation (8km)**

- Multimodel ensemble of regional models – product to be provided to the National Weather Service – INMET



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**Thanks!**