The e-infrastructure at C-DAC for Climate & Weather Research

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[Software Developer, Technical Side]

Computational Atmospheric Science

C-DAC, Pune

C-DAC : What we do

Activities:

Computational Research
Workflow Environment
Development
Grid Computing
Technology Development
Parallel Programming
Model Porting, Optimization & Simulations

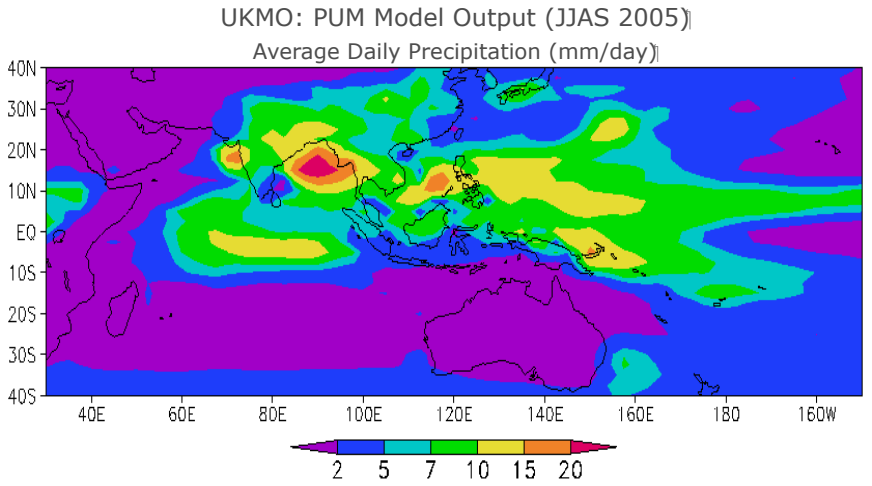
- **Joint Collaborative Research**
- **Contract Projects**

Outline:

- ➔ CAS team activities
- ➔ Regional coupled model simulations
- ➔ Grid-based Meteorology-Air Quality Modeling
- ➔ WRF-STEM on grid

Computational Atmospheric Sciences

- **Global Forecast Models**
  - **NCEP's T170/T254/T382/PUM**
  - **Multi-institutional ERMP program**
- **Regional Weather Research**
  - **MM5 / WRF / MM5 Climate / RegCM / RSM**
  - **Real Time Weather System (RTWS)**
  - **Coupled system development (IITM Collaboration)**
- **Climate Models**
  - **CCSM**
  - **Climate Change Studies**
- **Ocean Models**
  - **MOM4 / POM / ROMS / HYCOM**
  - **Coupled system development (IITM collaboration)**
  - **Ocean response studies**



- **Air Quality/Environmental Computing**
  - **GIS based emissions modeling with IITM**
  - **Offline WRFChem with NOAA/FSL**
  - **WRF+AERMOD for Pune AQM with USEPA**
  - **Aerosol studies using LMDzT – Off-line version with IIT-B**

Real Time Weather simulation (RTWS)

http://rtws.cdac.in

Forecast time = 72 hours

Anuman
Real Time Weather System

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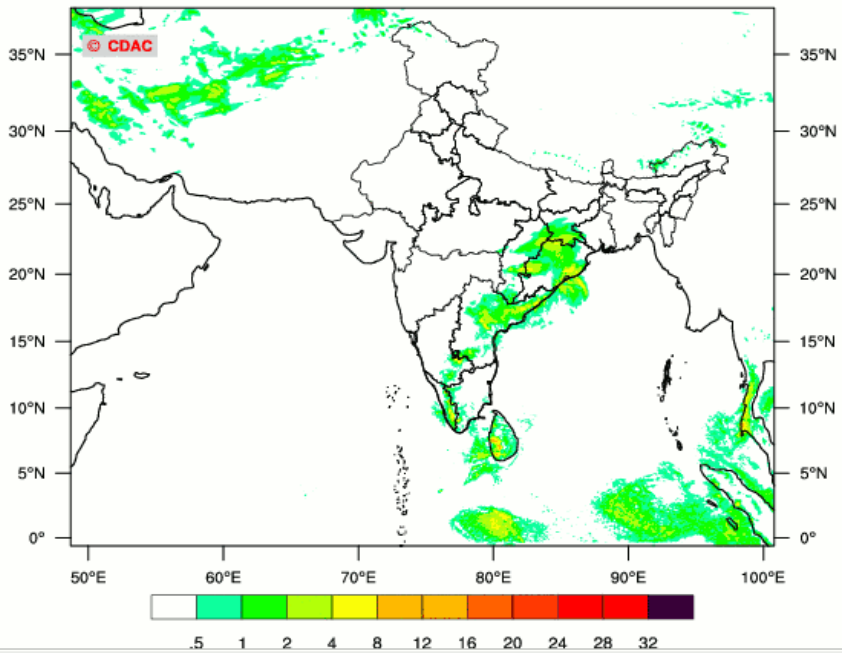
- Daily Rainfall
- Hourly Rainfall
- Maximum Temperature
- Minimum Temperature
- Mean Sea Level Pressure
- Relative Vorticity
- Divergence
- Temperature
- Dew Point Temperature
- Eqv. Potential Temperature
- Winds
- Vertical Velocity
- Relative Humidity
- Maximum Reflectivity
- Stability Indices

Location Specific Forecast

Forecast Date : 21 FEB 2011 Animation : Start Date : 21 FEB 2011
End Date : 21 FEB 2011

Forecast based on 12 UTC 20 FEB 2011 valid for 00 UTC 21 FEB 2011
24 hr Rainfall (cm)



Real Time forecast for Village [Location Specific Forecast]

www.indg.in India Development Gateway

Forecast Last Updated: September 14, 2010 08:15 AM IST **Current Date and Time:** September 14, 2010 15:14:45 IST

Search By ◉ District/Taluk/Village ○ Location Name — Andhra Pradesh | Adilabad | Adilabad | Jamdapur

Three Days Weather Forecast For JAMDAPUR (Adilabad Distt., AP)

View 6-Hourly Forecast

	Today(2:30 PM - 8:30 PM)	Tomorrow(2:30 PM - 8:30 PM)	Thursday(2:30 PM - 8:30 PM)
Sky Condition	Mainly Cloudy Sky	Mainly Cloudy Sky	Cloudy Sky
Min Temp	24.4 °C (±2°C)	25.5 °C (±2°C)	25.5 °C (±2°C)
Max Temp	31.6 °C (±2°C)	32.5 °C (±2°C)	32.5 °C (±2°C)
Relative Humidity	66.8 %	59.8 %	64.5 %
Wind Speed	12.7 km/hr	15.5 km/hr	16.2 km/hr
Wind Direction	West of North West	North of North West	West of North West
12-hr Rainfall	0-2.5 mm	0-2.5 mm	0 mm
Chance of Rainfall	17 %	7 %	0 %

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Right now giving 3 days forecast for 6 states.
Available in 8 regional languages.

Regional Atmosphere-Ocean Coupled Model

- ➔ **EUIndia Project: [with ICTP]**

  Development of regional coupled model on Grid

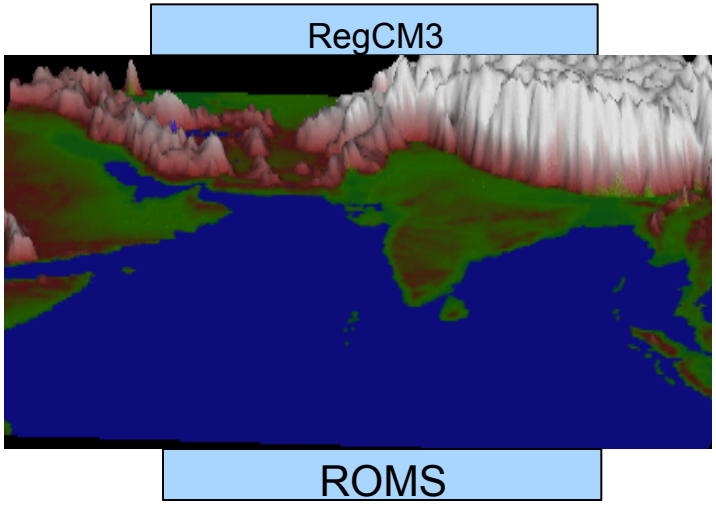
- ➔ **Regional Climate Model (RegCM3): Atmospheric, Regional Ocean Modeling System (ROMS): Ocean**

- ➔ **Development of online coupler : RegCM3 and ROMS**

- ➔ **Coupled System tested on EGEE grid**

- ➔ **Publication in international Journal 'Climate Dynamics'**

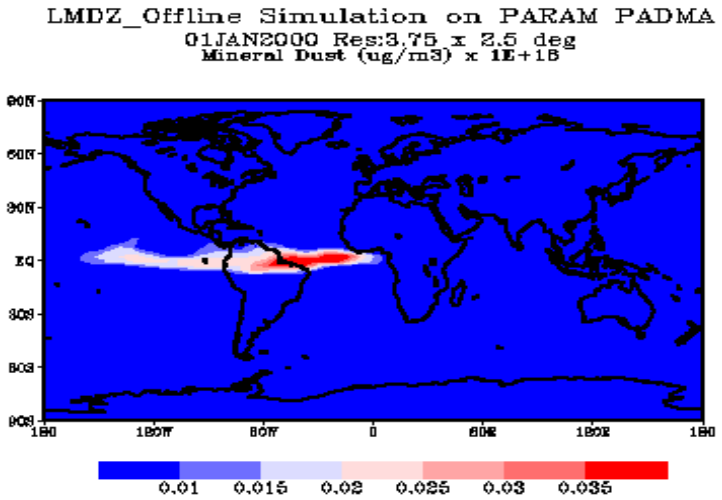
- ➔ **Grid Enabled Coupled System available for scientists for Climate change studies this year ....**



Ratnam et al, 2008

Aerosol Chemistry Modeling

Parallel Offline LMD-ZT Aerosol Chemistry Model



- LMD-ZT Model with aerosol chemistry used by IITB, LOA for INDOEX studies
- India-specific emissions inventory of IIT-B used for studying regional contributions

- Offline version of Model parallelized at CDAC : Domain Decomposition and MPI for inter processor communication.
- Upto 80% reduction in simulation time at 36 cpus

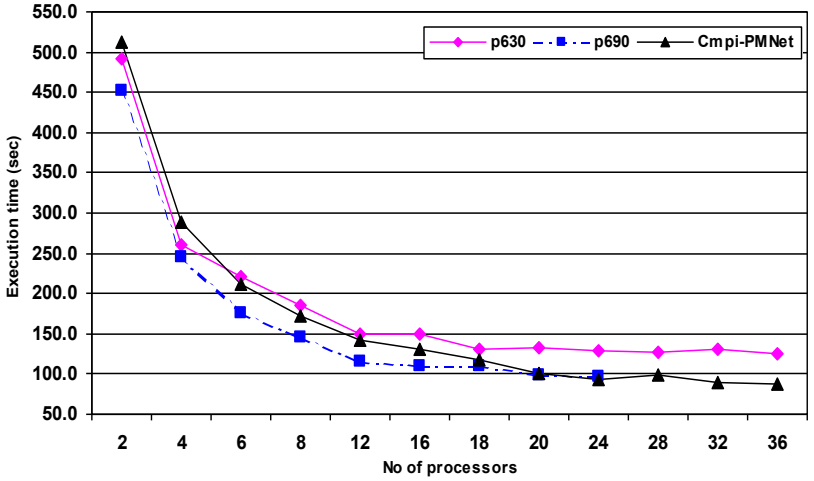


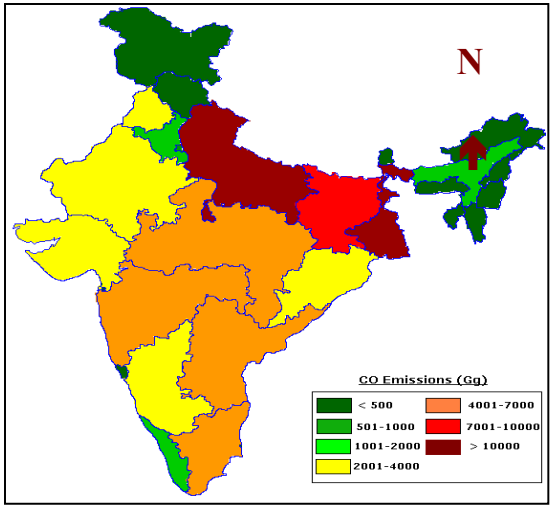
Figure-3: Performance of the LMD-ZT Offline Model (Non-Zoom Configuration)

*** MHRD Project in collaboration with IIT-Bombay and LOA, France**

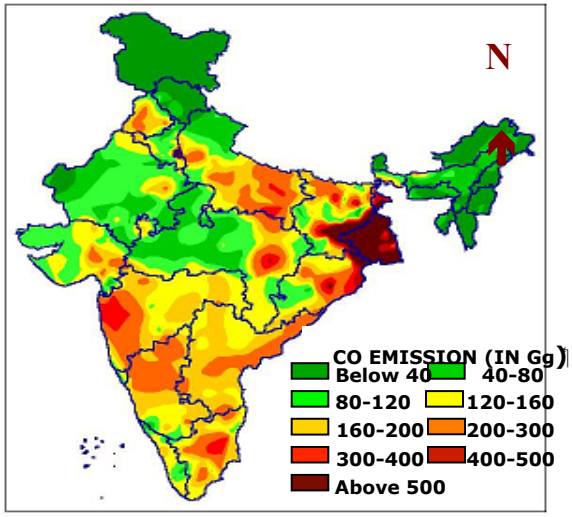
Aerosol Chemistry Modeling

Gridded Emissions Database using GIS

- Gridded emission data required for Atmospheric Chemistry Models
- Most emission inventories developed at larger (state, national) scales
- **Methodology developed for conversion of large-scale inventory to grids using GIS techniques & local level source surrogates**
- Case Study : Indian CO & NOx Inventories- 2001 - state to $1^0 x 1^0$ grid
- Research Paper in Atmospheric Environment. Vol 40 (16) June 2006



CO Emission values at State-level



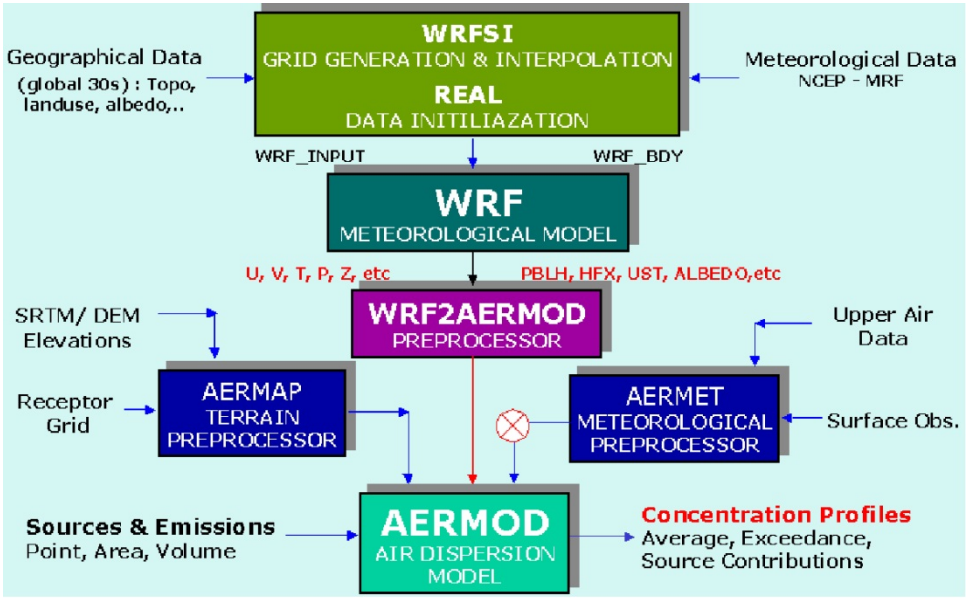
CO Emission Pattern after Gridding

In collaboration with IITM, Pune and NPL, New Delhi

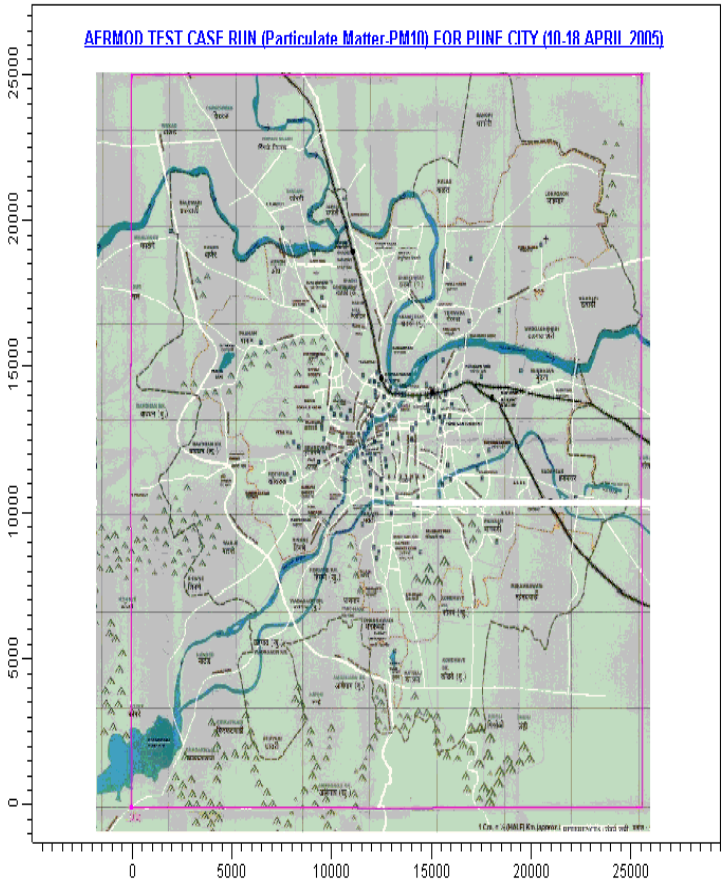
Environmental Modeling

WRF-AERMOD coupling for Pune Air Quality Modeling
(MOEF-USEPA Program for Urban Air Quality Management)

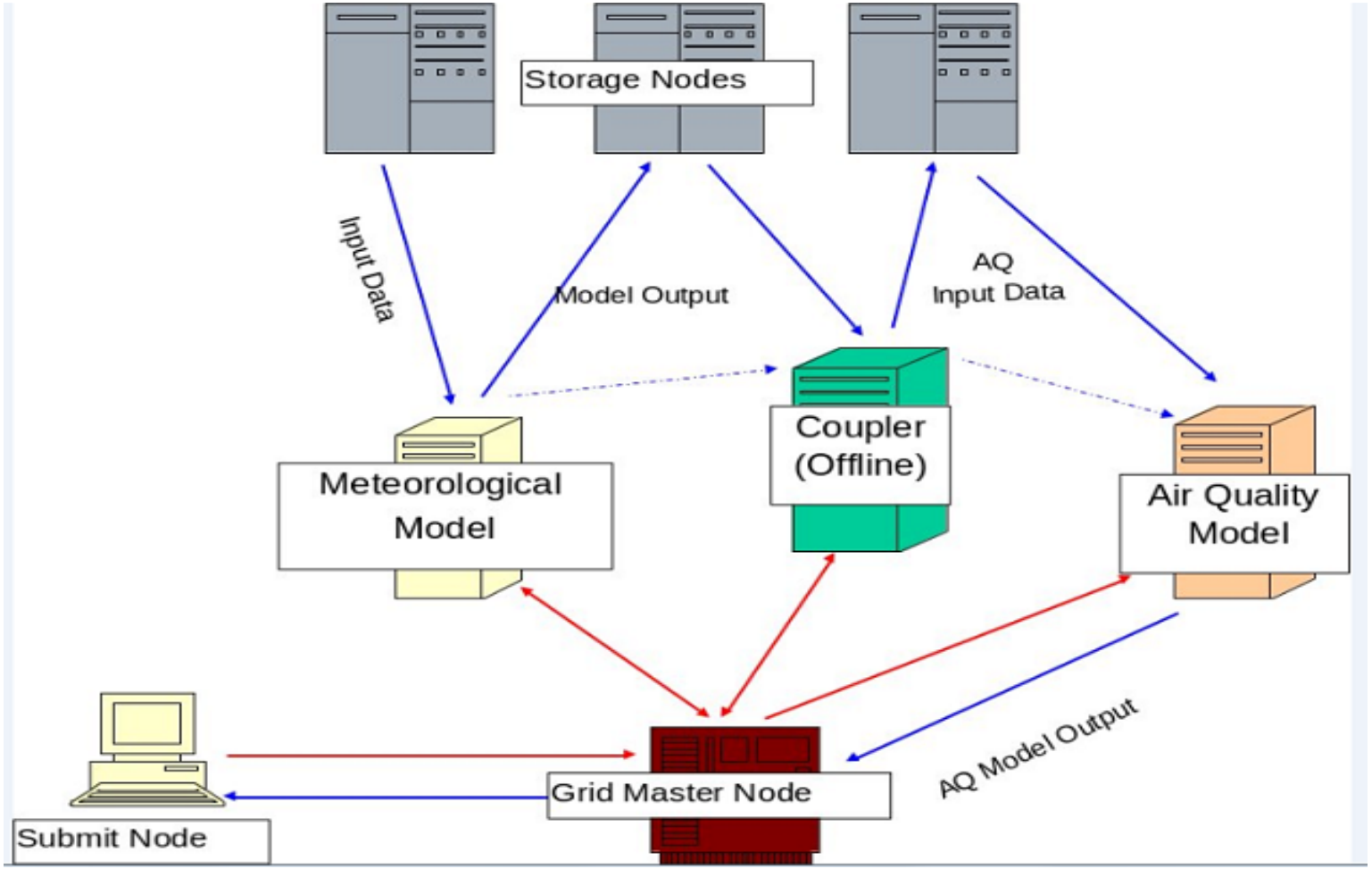
- C-DAC role: Emission inventory, data processing, air quality modeling
- Hourly meteorology req. for AERMOD air quality model
- First time in the world Development of Preprocessor for coupling WRF and AERMOD
- Stakeholders: PMC, NEERI, MPCB, C-DAC ,. .



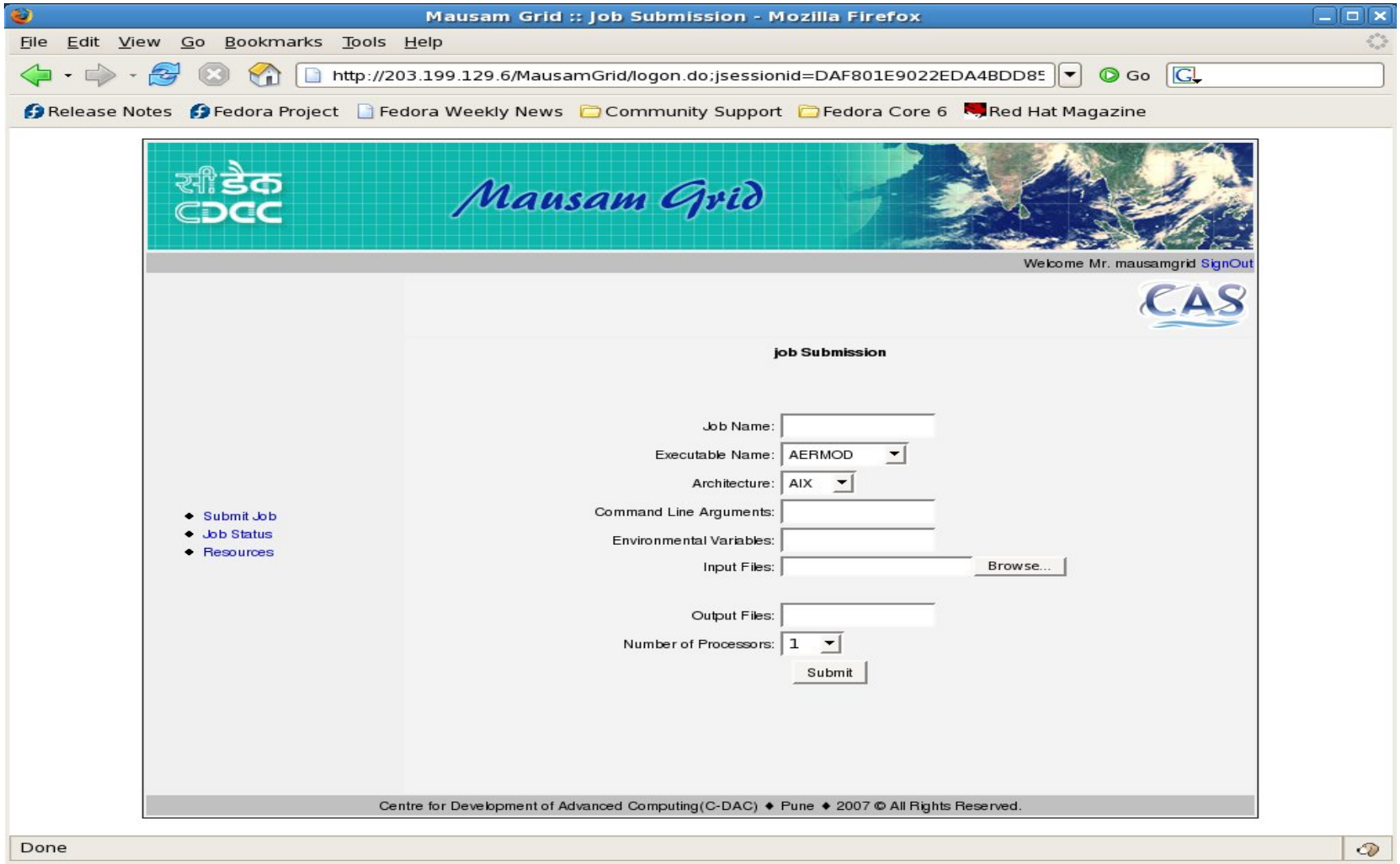
Flowchart for WRF-AERMOD Couping



WRF-AERMOD Grid Flow



WRF-AERMOD Grid



Aerosol Chemistry Modeling

Development of Offline WRF/Chemistry model

- WRF/Chem model developed as fully coupled online chemistry model with updated aerosol chemistry :

- **Need for Offline version:**

- Speed-up model development/ sensitivity studies/ testing

- Model Inter-Comparison with other online/offline models

- **Offline version developed and seamlessly integrated into WRF**

- **WRF/Chem Version 3 designed for global scale & climate change simulations**

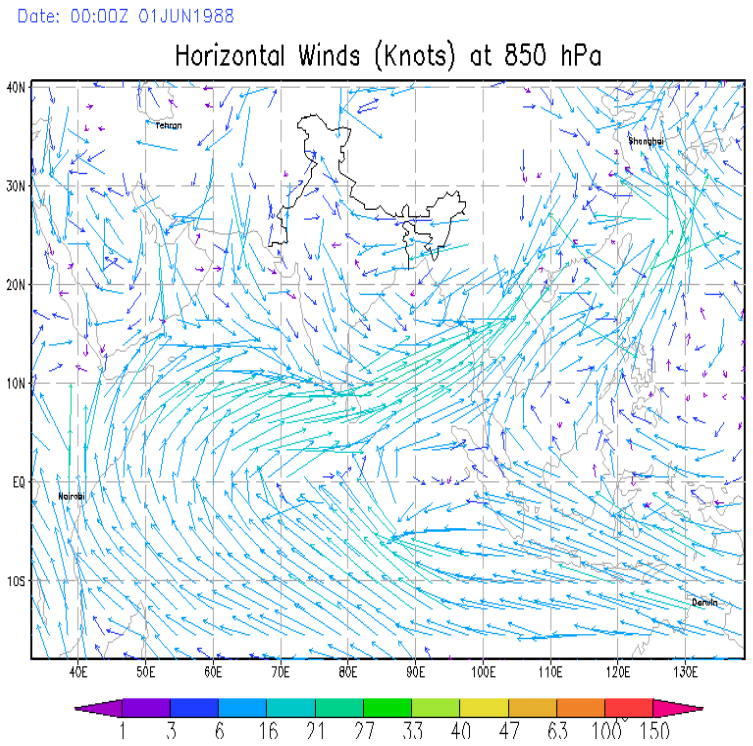
*Indo-US (DST-NSF) funded project in collaboration with CIRES/ NOAA/FSL, USA

➔ Regional coupled model simulations

Regional Atmosphere-Ocean Coupled Model Strategy

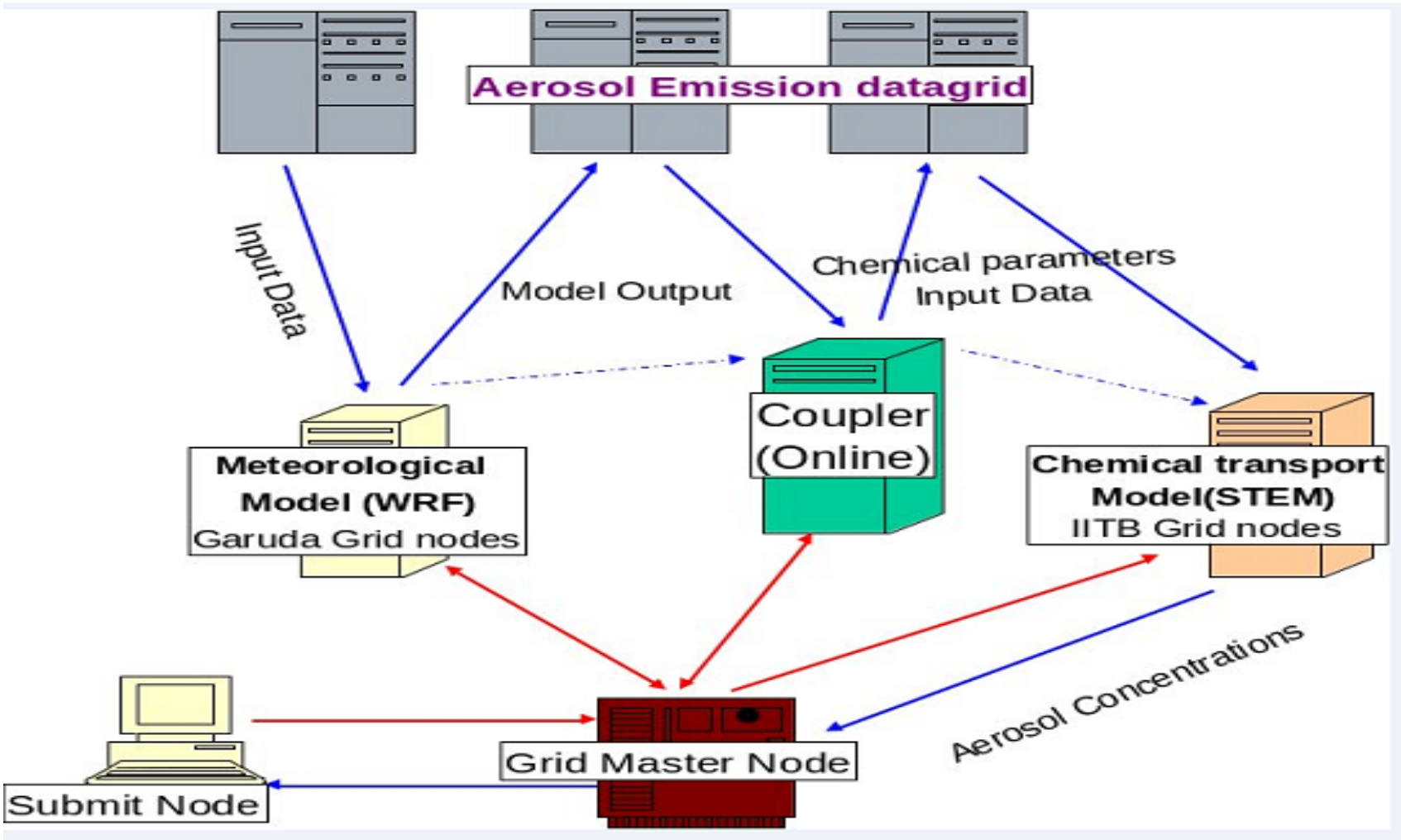
Objectives…

- Inter compare Regional Atmospheric models and Regional Ocean model
- Couple the Oceanic and Atmospheric components by selecting / developing a coupler
- Simulate the Indian monsoon using the coupled ocean-atmosphere regional model and analyze the simulations.



Collaborative Project with IITM, Pune, Sponsored by DST

Grid Enabling Aerosol Modeling System For Climate Change Studies



Grid Enabling Aerosol Modeling System For Climate Change Studies

Collaborative Project:
CDAC & IITB

Grid Enabled : Coupled atmosphere–chemical transport modeling for aerosol studies.

- ✓ Multicomponent on Garuda nodes system.
- ✓Online exchange of data through SRM.
- ✓PSE/Portal for selecting components to run model.
- ✓PSE will be available as grid utility for aerosol modeling VO.

Also we can explore this on EU India Grid. So that the EU India grid Users can use the portal services to run the model

Grid Components Used

SRM : - All the Input data will be saved to the SRM, after processing from the model the output is again saved into the SRM.

Middleware : - Middleware like scheduler
Load Leveler (for AIX platform) and
Torque (for Linux platform) are Local Resource Managers (LRM)

Globus :- GT4 is used in current Garuda structure.

IGCA :- IGCA grid certification authority is there for security purpose.

Data Portal Development

A software tool for quick access to the archived meta data from different data servers

Archived data size: ~30 TB

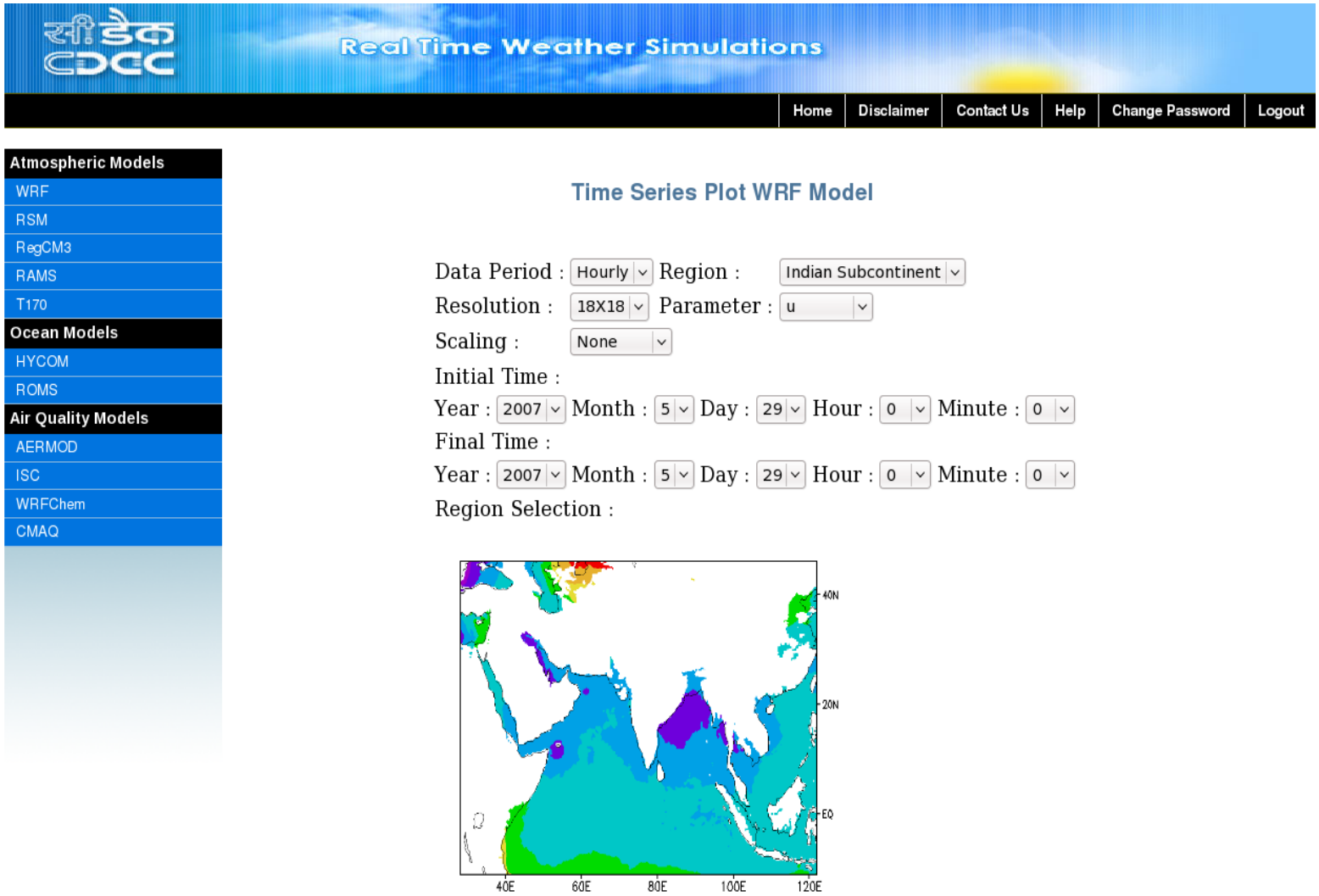
Source of Data generation: Different dynamical models used for Ocean, Atmosphere and AirQuality analysis

Objective: Accessibility of the archived data over the internet for any scientific usability and reuse for research

Can be used over the grid enabled environment.

It's a web based application user can login to the system and use different tool to generate image for a particular type of data

Functionality available:
Animation of images, Time series plot, data download, vertical profiling, etc



We can make it grid enabled on EU India Grid in collaboration with International organization.

DataPortal-Thermocline Plot - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://192.168.7.148:8090/DataPortal/portal/OceanTemperatureVsDepthPlot.action?region=Indian+Ocean&

Most Visited | Release Notes | Fedora Project | Red Hat | Free Content | Train running infor... | BSNL :: Pay Landli... | User Login

Real Time Weather Simulations

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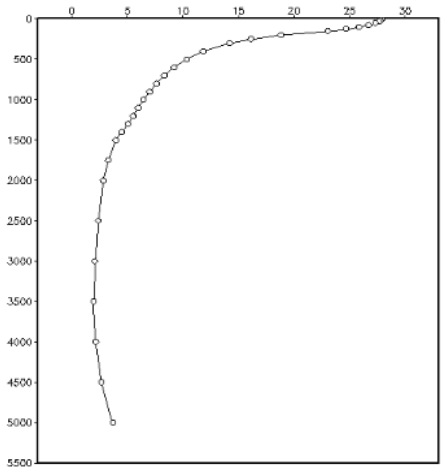
Atmospheric Models
- WRF
- RSM
- RegCM3
- RAMS
- T170

Ocean Models
- HYCOM
- ROMS

Air Quality Models
- AERMOD
- ISC
- WRFChem
- CMAQ

Thermocline plot for HYCOM Model

Model Resolution: 10X10
Start Longitude : 40 End Longitude : 50
Start Latitude : -20 End Latitude : 10
From Date : 01/01/2000
To Date : 01/01/2000



Done

Applications Places System Thu Aug 26, 2:51 PM

[Inbox (967 total) - Ev... | DataPortal-Thermocli...

Future Directions

- Development of PSE/Portal of WRF-Aerosol model to access using EU India grid.
- Grid enabling the DataPortal on EUIndia and Garuda grid.
- Optimization of climate change model on HPC systems.
- Seasonal monsoon forecast by using T170 / high resolution for 2011.
- Regional Coupled Ocean Atmosphere model in forecast mode.

Thank You

e-mail : cas@cdac.in