Universitatea Politehnica București

Facultatea de Automatică și Calculatoare

Catedra de Calculatoare

Optimizarea modelului WRF de prognoză meteorologică

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Cuprins

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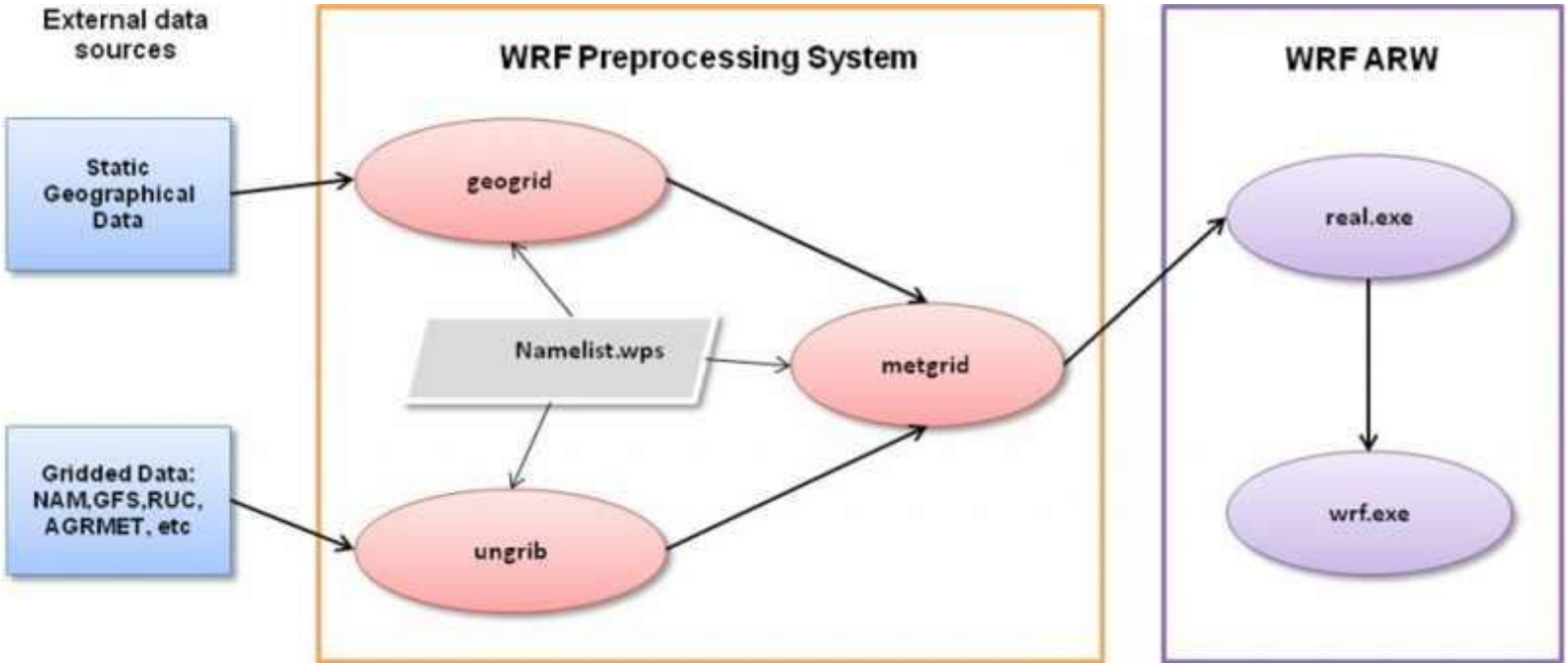
- Prelucrarea domeniilor
- Schimburi de date
- Optimizări
- Rezultate
- Concluzii
- Cuvinte cheie

WRF THE WEATHER RESEARCH & FORECASTING MODEL

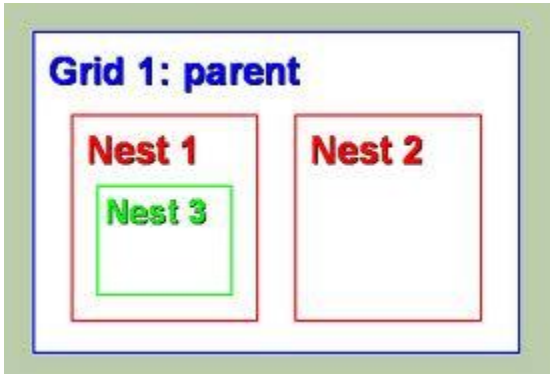
Prezentare generală

- **Weather Research and Forecasting Model**
  - Model numeric regional, dezvoltat relativ recent
  - Scalabilitate și eficiență
  - Suport MPI/OpenMP pe diverse platforme
  - Rezultate stocate în format NETCDF



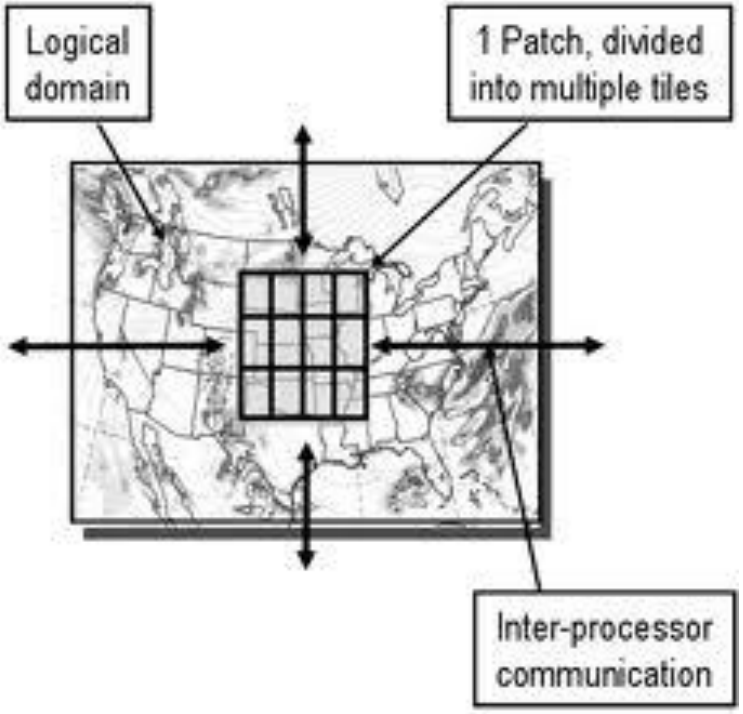
Prelucrarea domeniilor

Domenii imbricate



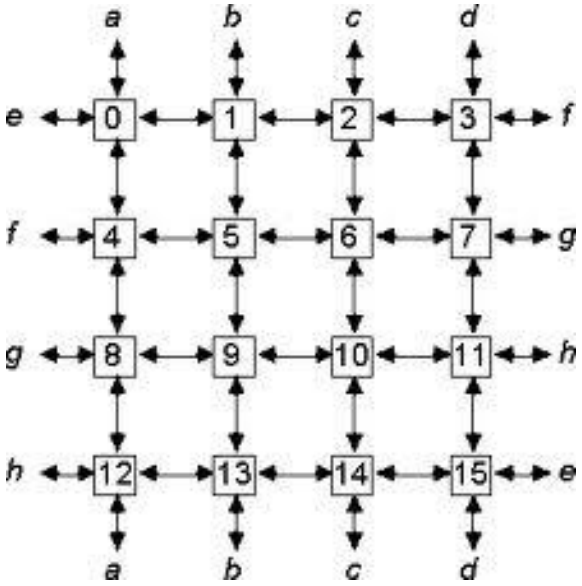
- Rezoluții diferite
- Efort computațional

Maparea MPI/OPENMP

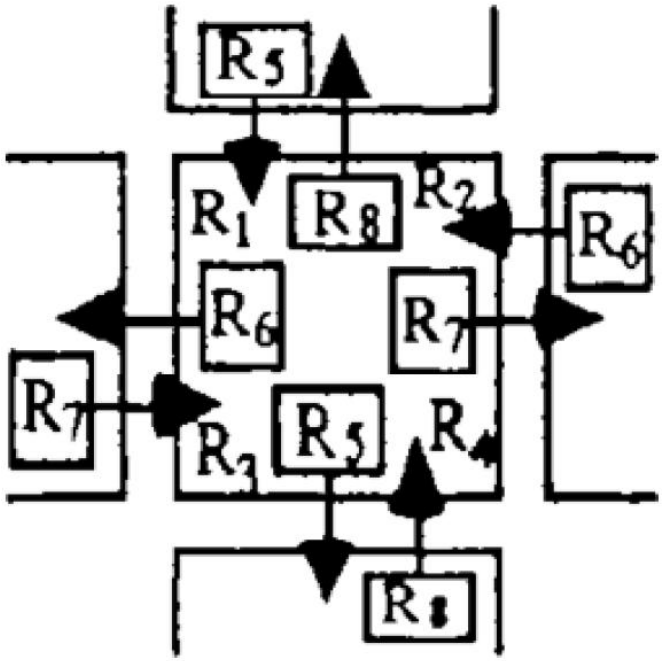


Schimburi de date (I)

Organizarea proceselor



Organizarea bufferelor

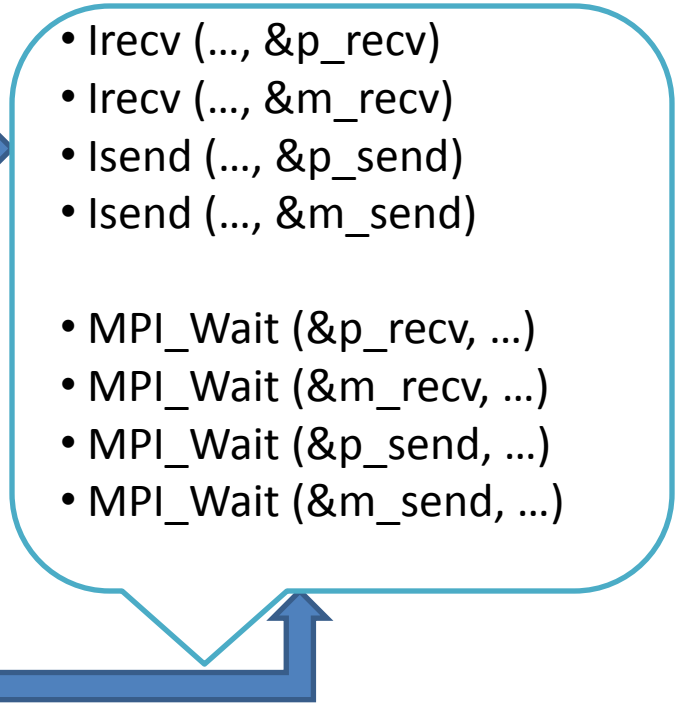


- MPI_Cart_* => yp, ym, xp, xm

Schimburi de date (II)

- RSL_LITE_INIT_EXCH (Y) – alocare buffere
- n x RSL_LITE_PACK (Y)
- RSL_LITE_EXCH_Y
- n x RSL_LITE_UNPACK (Y)

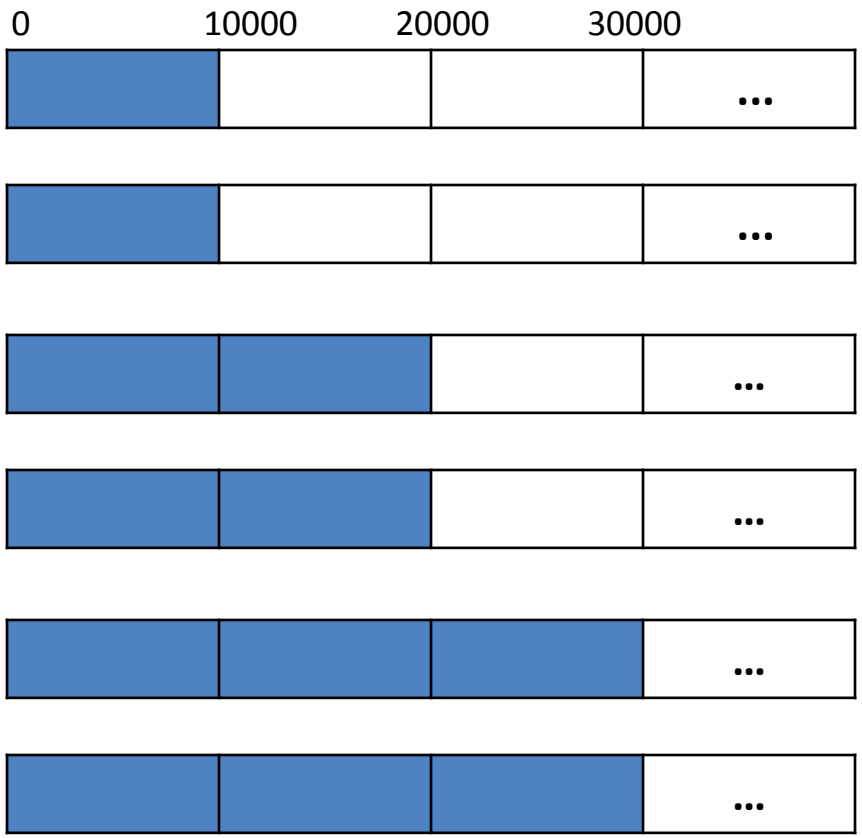
- RSL_LITE_INIT_EXCH (X)
- n x RSL_LITE_PACK (X)
- RSL_LITE_EXCH_X
- n x RSL_LITE_UNPACK (X)



Optimizări (I)

Transferuri multiple pe același buffer cu MPI_Wait întârziat

- UNPACK (0-5k) => MPI_Wait (0-10k)
- UNPACK (5k-10k)
- UNPACK (10k-15k) => MPI_Wait (10k-20k)
- UNPACK (15k-20k)
- UNPACK (20k-25k) => MPI_Wait (20k-30k)
- UNPACK (25k-30k)



Optimizări (II)

- RSL_LITE_INIT_EXCH (Y)
- n x RSL_LITE_PACK (Y)
- RSL_LITE_EXCH_Y

- MPI_Wait (&p_send,…)
- MPI_Wait (&m_send,…)

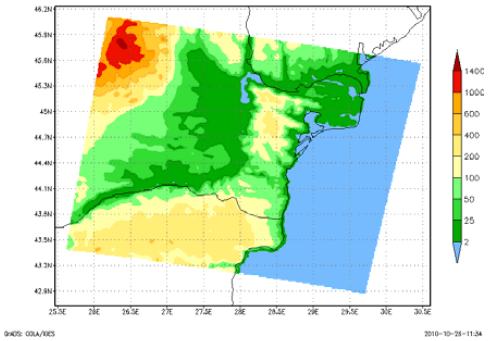
- Irecv (…, &p_recv)
- Irecv (…, &m_recv)
- Isend (…, &p_send)
- Isend (…, &m_send)

- RSL_LITE_INIT_EXCH (X)
- n x RSL_LITE_PACK (X)
- RSL_LITE_EXCH_X

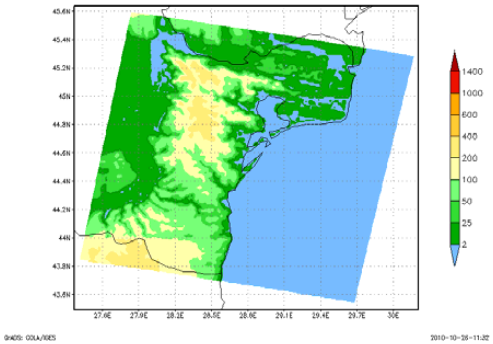
- n x RSL_LITE_UNPACK (Y)
- n x RSL_LITE_UNPACK (X)

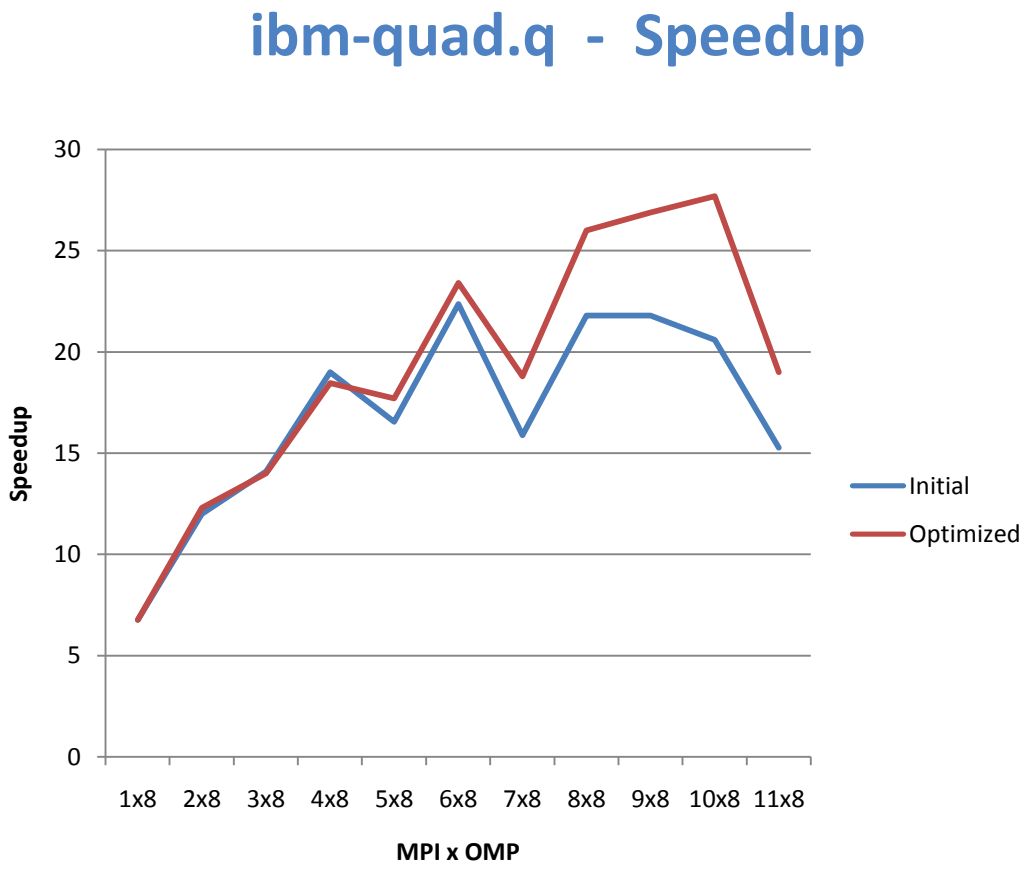
- MPI_Wait (&p_recv,…)
- MPI_Wait (&m_recv,…)

Rezultate – Dobrogea (I)



- **2 domenii (3km, 1km)**
- **Prognoza pe 3 ore**

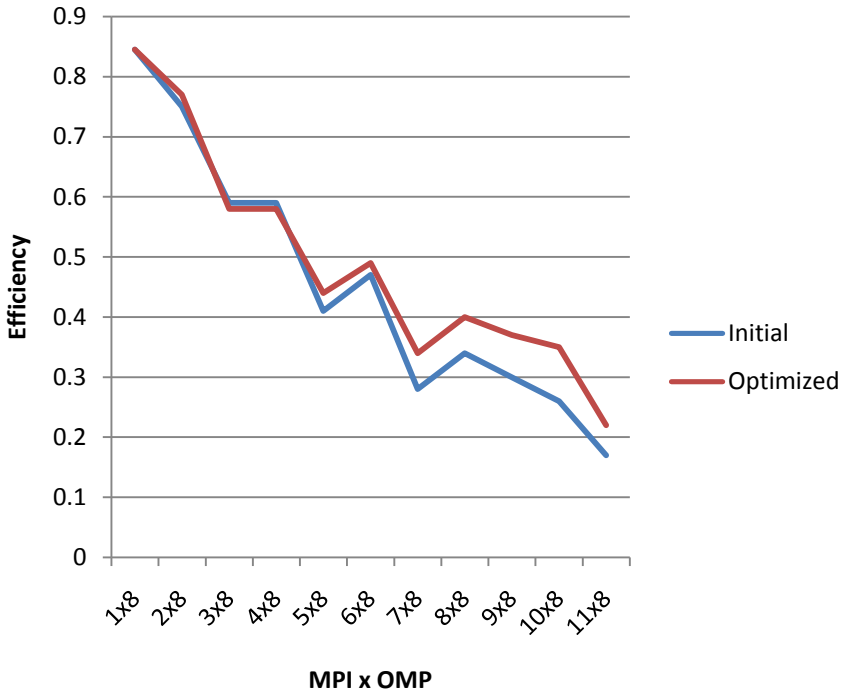


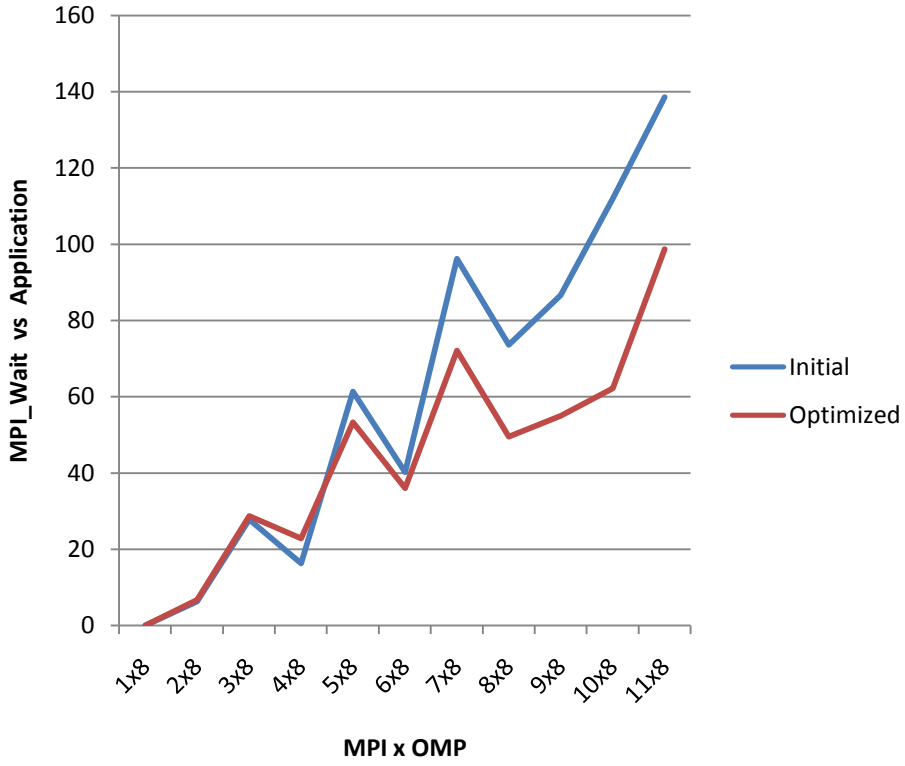


Timp serial – 720min

Rezultate – Dobrogea (II)

ibm-quad.q

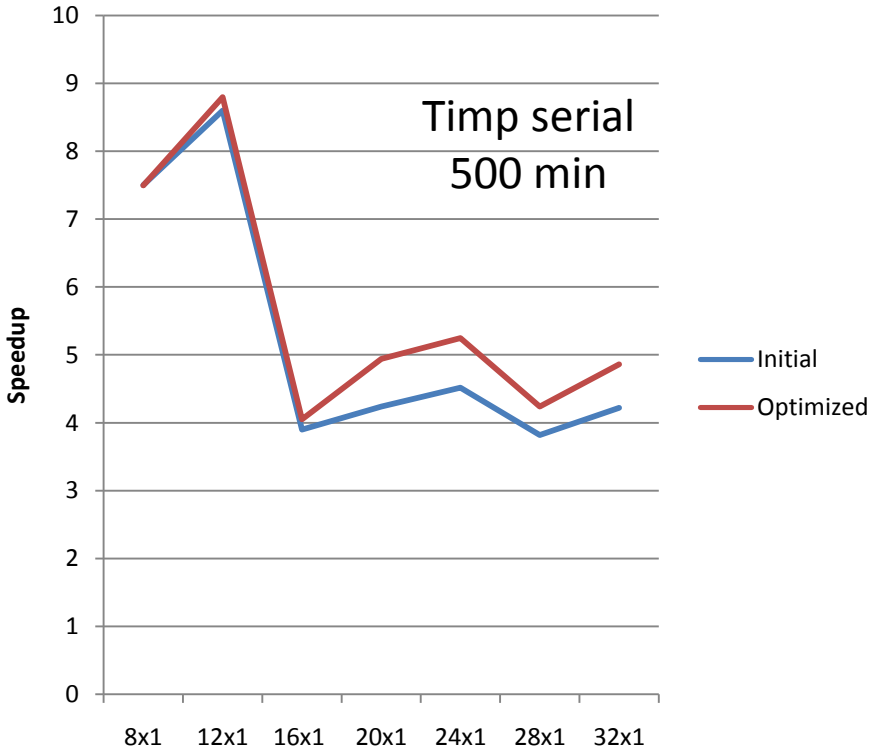




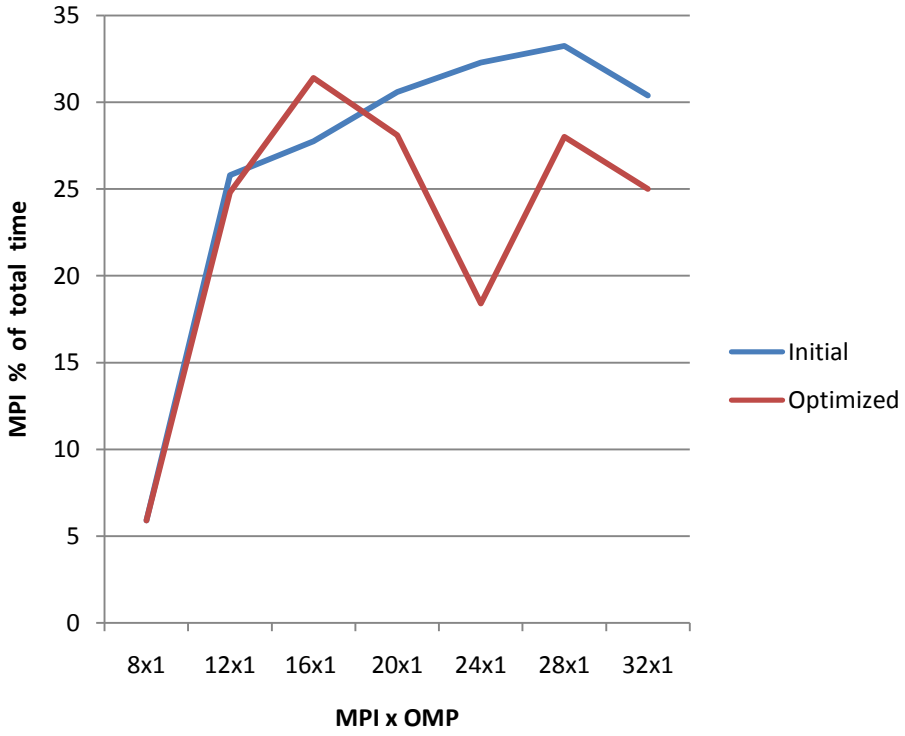
Eficiența **Impact MPI_Wait**

Rezultate – Dobrogea (III)

ibm-nehalem.q



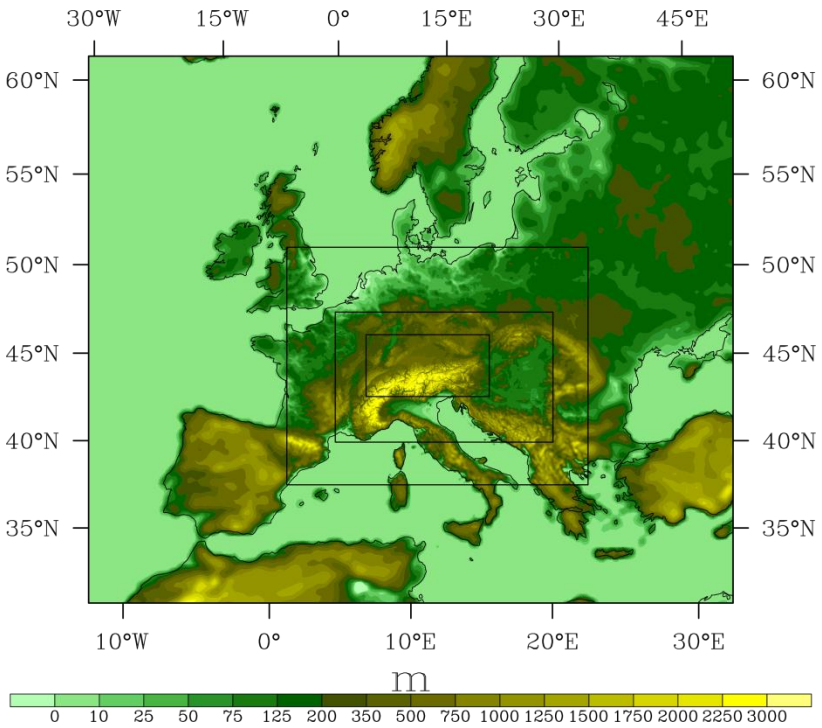
Speedup



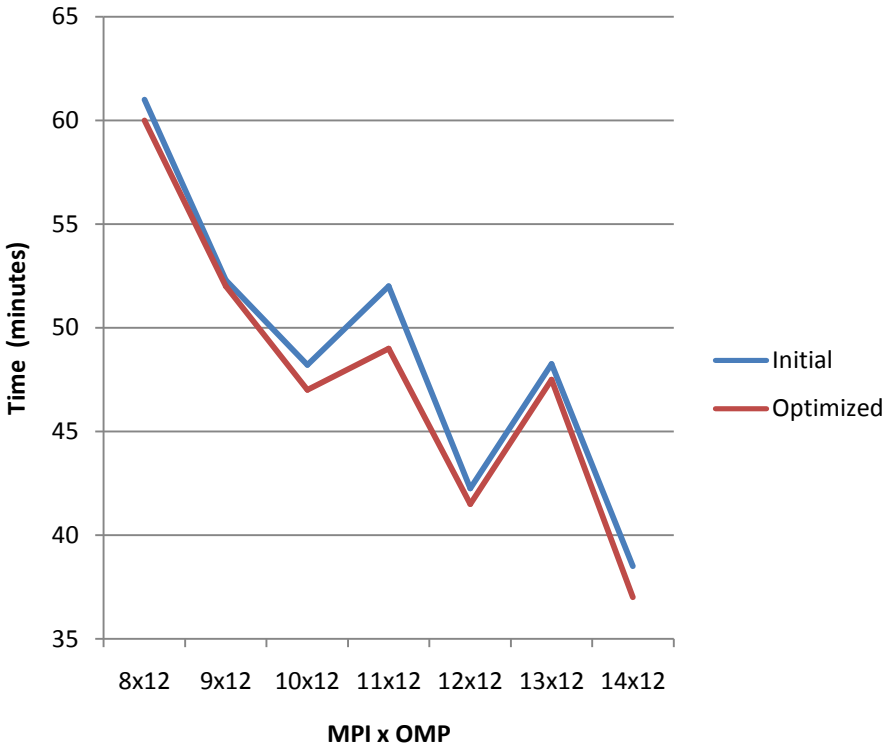
Impact MPI_Wait

Rezultate – Europa

- **3 domenii**
- **Prognoza pe o oră**



ibm-opteron.q - Timpi rulare



Concluzii

- **Implementarea inițială a modelului lasă de dorit în privința utilizării eficiente a lărgimii de bandă a conexiunilor dintre procesele MPI**

- **Corecțiile în acest sens pot duce la o reducere semnificativă a bottleneck-ului aplicației**

- **15% – 20% optimizare pentru interconexiuni lente**

- **4% - 5% optimizare pentru interconexiuni rapide**

Cuvinte cheie

- **WRF**
- **prognoză meteo**
- **model numeric**
- **MPI**
- **OMP**
- **domenii**
- **transfer MPI**
- **schimb de date**
- **optimizare**
- **MPI_Wait**
- **quad**
- **nehalem**
- **opteron**
- **Infiniband**
- **Dobrogea**
- **Europa**
- **benchmark**