

Parallel implementation in IAAAAH constellation of models (IFS/ARPEGE/ALADIN/ALARO/AROME/HARMONIE)

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P.L. on dynamics in HIRLAM-B

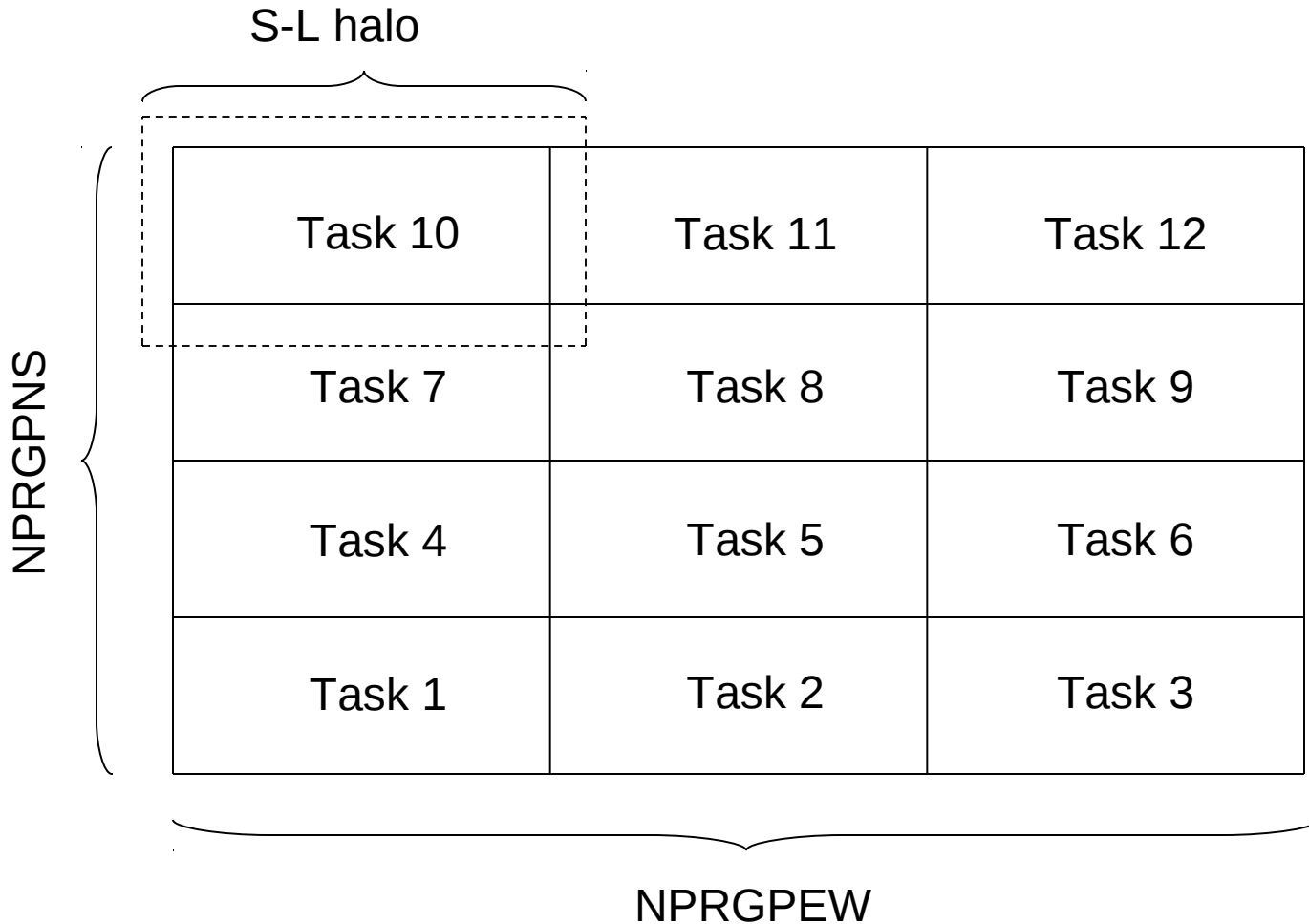
MPI and OpenMP parallelization

- MPI parallelization
 - Total amount of work divided into TASKS
 - Every task accesses its own memory
 - One task can see data from another one only if sent through the NETWORK.
 - Communications are performed by calls to MPI library subroutines.
 - In order to proceed, the TASK has to check that all the data needed have arrived.

OpenMP parallelization

- Shared memory parallelization
 - All the processors involved have access to the same memory
 - Every processor runs a part of the work called **THREAD**
 - One MPI task might include several OpenMP **THREADS**
 - Variables to be seen by only one **THREAD** should be declared **PRIVATE**

2D decomposition in g.p. space (distribution decided by the transform package)



OpenMP parallelization within a task

Dimension of fields

X(NPROMA,NFLEVG,NUMFLDS,NGPBLKS)

Typical parallel loop

```
!$OMP PARALLEL DO SCHEDULE(DYNAMIC,1) &  
!$OMP& PRIVATE (JKGLO,IBL,JROF,ICEND,JLEV) &  
!$OMP& PRIVATE(IFLD)
```

```
DO JKGLO=1,NGPTOT,NPROMA  
  IBL=(JKGLO-1)/NPROMA+1  
  ICEND=MIN(NPROMA,NGPTOT-JKGLO+1)  
  DO JLEV=1,NFLEVG  
    DO JROF=1,ICEND  
      X(JROF,JLEV,IFLD,IBL)= .....  
    ENDDO  
  ENDDO  
ENDDO  
!$OMP END PARALLEL DO
```

OpenMP parallelization (cont)

- In order to reduce the relative start-up time, the inner loop is not a single operation but the call to a tree of subroutines:

```
DO JKGLO=1,NGPTOT,NPROMA  
  IBL=(JKGLO-1)/NPROMA+1  
  IST=1  
  ICEND=MIN(NPROMA,NGPTOT-JKGLO+1)  
  CALL SUB(X(1,1,1,IBL),IST,ICEND,.....)  
ENDDO
```

Effect of NPROMA

- In vector machines it is the vector length in the loop (generally needed very large)
- In scalar machines it affects the amount of data in the cache (limited size)
- Automatic arrays in subroutines run by a thread dimensioned to (NPROMA,NFLEVG). Total memory increases with NPROMA

Transpositions

- For Fourier transforms in X , whole lines needed (including extension zone)
 - TRGTOL: go from g.p. distribution to whole lines
- For Fourier transforms in Y , wave m from all lines needed (including the extension zone)
 - TRLTOM: go from line distribution to wave-number distribution
- After inverse Fourier transforms in Y
 - TRMTOL
- After inverse Fourier transforms in X
 - TRLTOG

Communications strategy

- Communications restricted to a few isolated places
 - Spectral transforms
 - Semi-Lagrangian halo (it can be on-demand)
 - Computation of norms
 - Input/Output

Semi-Lagrangian computations

- A buffer (SLB1(NASLB1,NFLDS)) is defined to contain all the values needed for the interpolations
- Its size (NASLB1) is defined by VMAX2 through NSLWIDE
- Is filled in the non-lagged part of the computations and used in the lagged part
- SLCOMM1 and SLCOMM2A are called to get the points needed from neighbouring tasks

Any other info needed?

Just ask