Parallel version of the spectral model of the Hydrometcenter of Russia

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A parallel version of the spectral model of the Hydrometcenter of Russia [1, 2] was developed. It is based on the MPI technology and uses one-dimensional decompositions for computations in grid and spectral spaces. In the grid space, each processor element (PE) makes computations for two latitude belts located symmetrically with respect to the equator. The need for application of the two symmetric belts follows from symmetry of the Legendre polynomials. Because of this, the maximum number of PEs the model can run on is equal to the number of latitude rows divided by two. Another restriction on the number of PEs that can be used by the model follows from the decomposition of the spectral space in wavenumber, but it is less strong. The fast Fourier transformation programs used in the model were optimized for Intel compilers. The parallel versions of the T169L31 and T339L31 spectral model were tested on SMP computers based on Intel Itanium and Xeon processors. The results are demonstrated in Figs. 1 and 2. The additional application of SHMEM library for reduction operations was found to decrease communication costs and thus to improve the speedup (Figs. 1b and 2). The use of 'heavier' physics (compare variants with radiation block called at every time step and with cloud-radiation interaction computed once a day, Fig. 1(*a*)) makes the speedup better. This suggests that the future improvement of parameterizations of subgrid-scale processes, which will become more time-consuming, will not meet problems with computation time in multiprocessor mode. Note that the time necessary to integrate the T169L31 and T339L31 models on 32 PEs is small enough to use them in operational mode when a new computer arrives at the Hydrometcenter of Russia (in 2007). The development of the parallel version of the spectral model also makes it possible to use a model with higher resolution in the ensemble prediction system without decreasing the number of ensemble members.

It is expected that the parallel version of the T85L31 spectral model will be operationally used for deterministic medium-range forecasting at the Hydrometcenter of Russia after May 2006, while the T169L31 version is to be implemented in October 2006. The research ensemble prediction system will incorporate the parallel model in December 2005.

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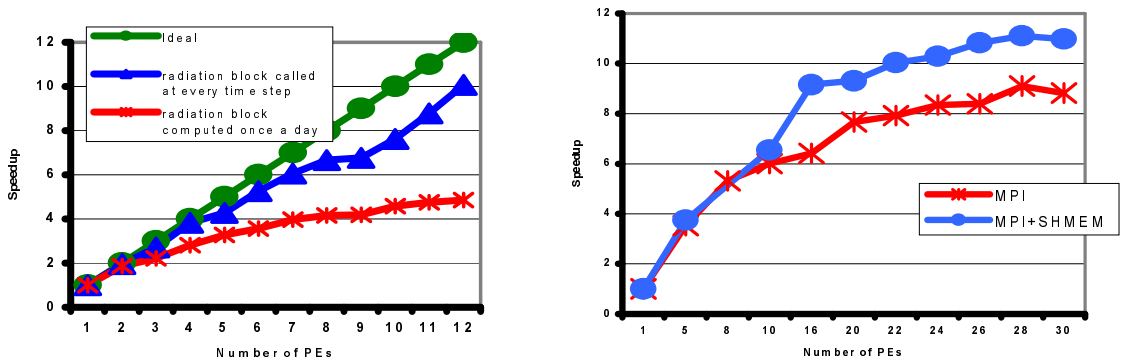

a) *b)*

Fig. 1. The speedup of the T169L31 (a) and T339L31 (b) models as a function of the number of processor elements.

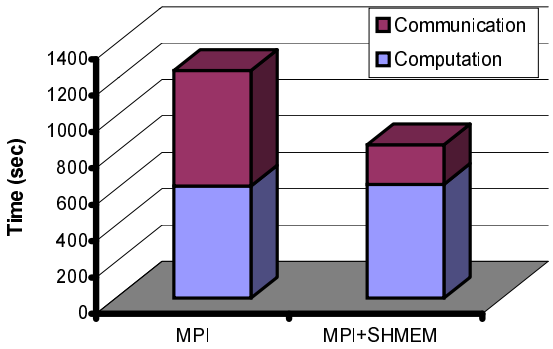

Fig. 2. Comparison of communication and computation costs for T339L31 based on MPI only and on MPI + SHMEM (32 PEs).