

# Component Concurrency in Atmospheric Simulation



**PALMOD**

GERMAN CLIMATE MODELING INITIATIVE



Federal Ministry of Education and Research

Mohammad Reza Heidari, Joerg Behrens, Hendryk Bockelmann  
Deutsches Klimarechenzentrum GmbH

## Introduction / Motivation

- Scalability of ECHAM6 at low resolution suffers from the limited number of gridpoints.
- Potential of current HPC architectures, therefore, cannot be used at full scale.
- Moore's law is at its end and CPU clocks will not increase considerably any longer.
- Future technologies will offer even higher concurrency as more CPU cores.
- Component concurrency promises to create more parallelism in the earth system models.
- Radiation component is one of the most expensive computational parts in ECHAM6, at least for paleo climate simulations.
- Independent columnwise-computations in radiation allows for a more flexible and finer data decomposition.
- Extracted radiation code from atmosphere realizes separation of concerns and allows for independent optimization.

## Outlook

### Next Steps :

- Fully asynchronous communications scheme
- Exploiting potential different data decomposition in radiation

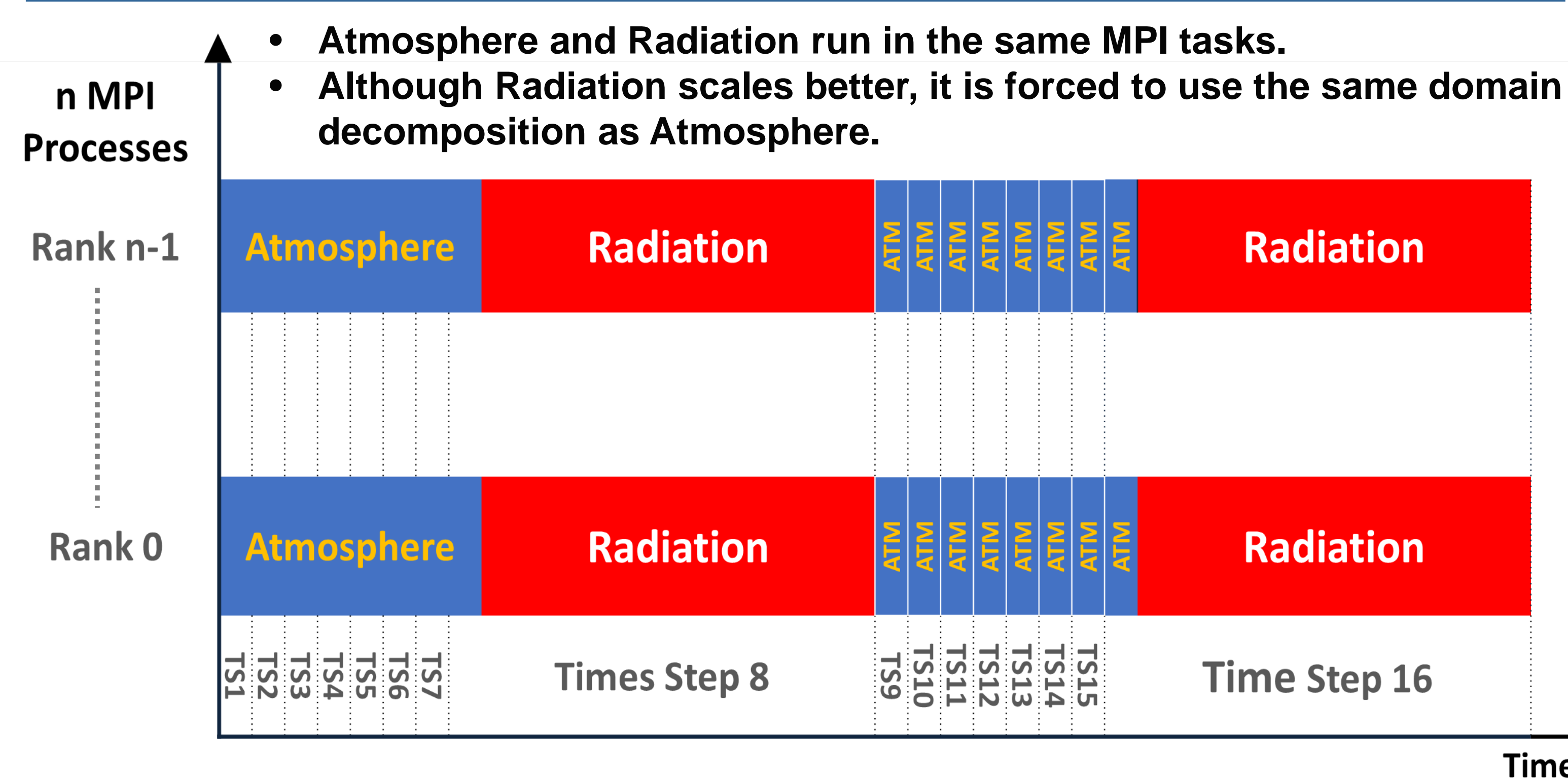
### Expected Performance Gain :

- 1.98x for T31
- 1.35x for T63

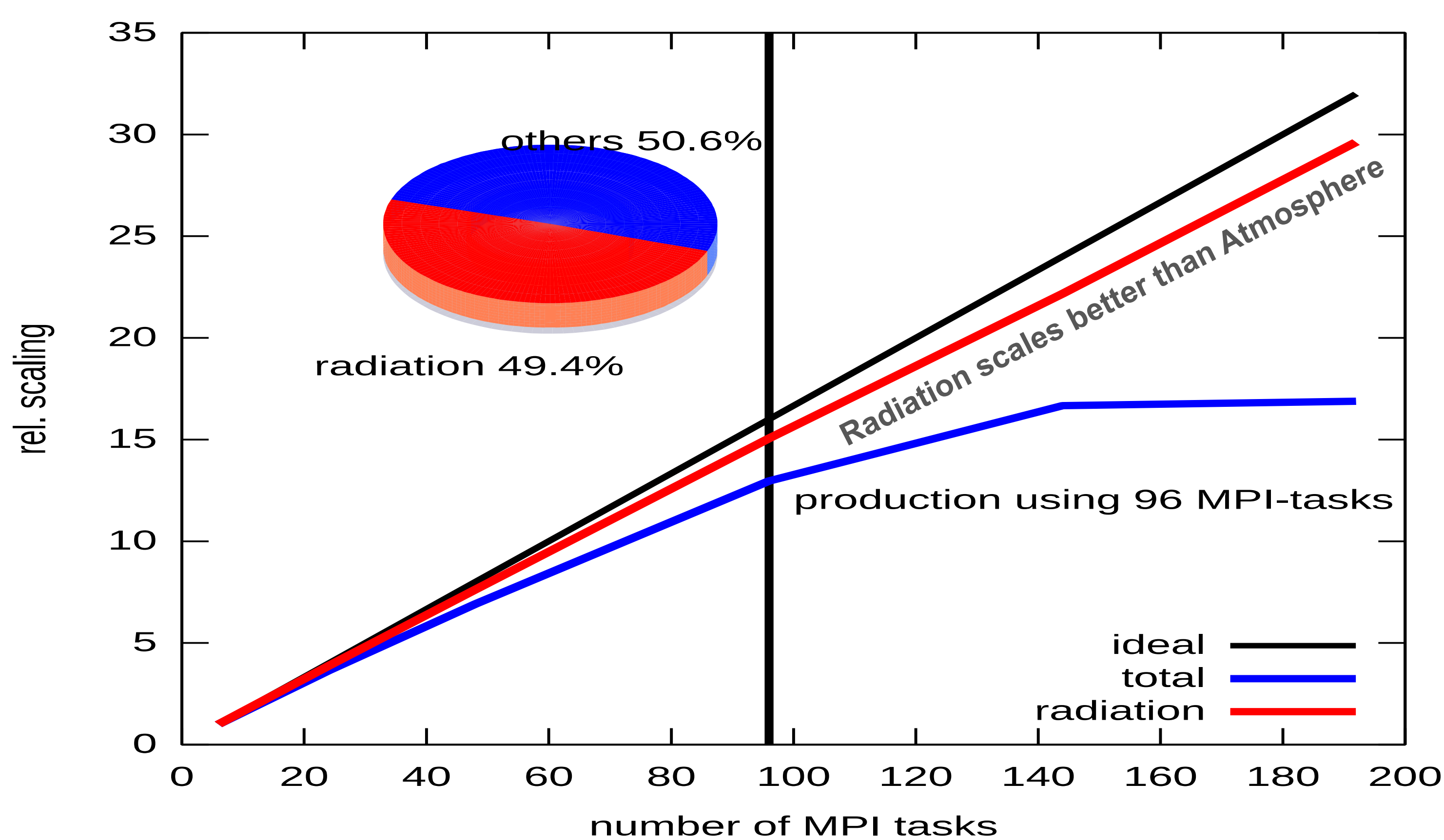
### Verification :

- Scientific evaluation of time stepping scheme

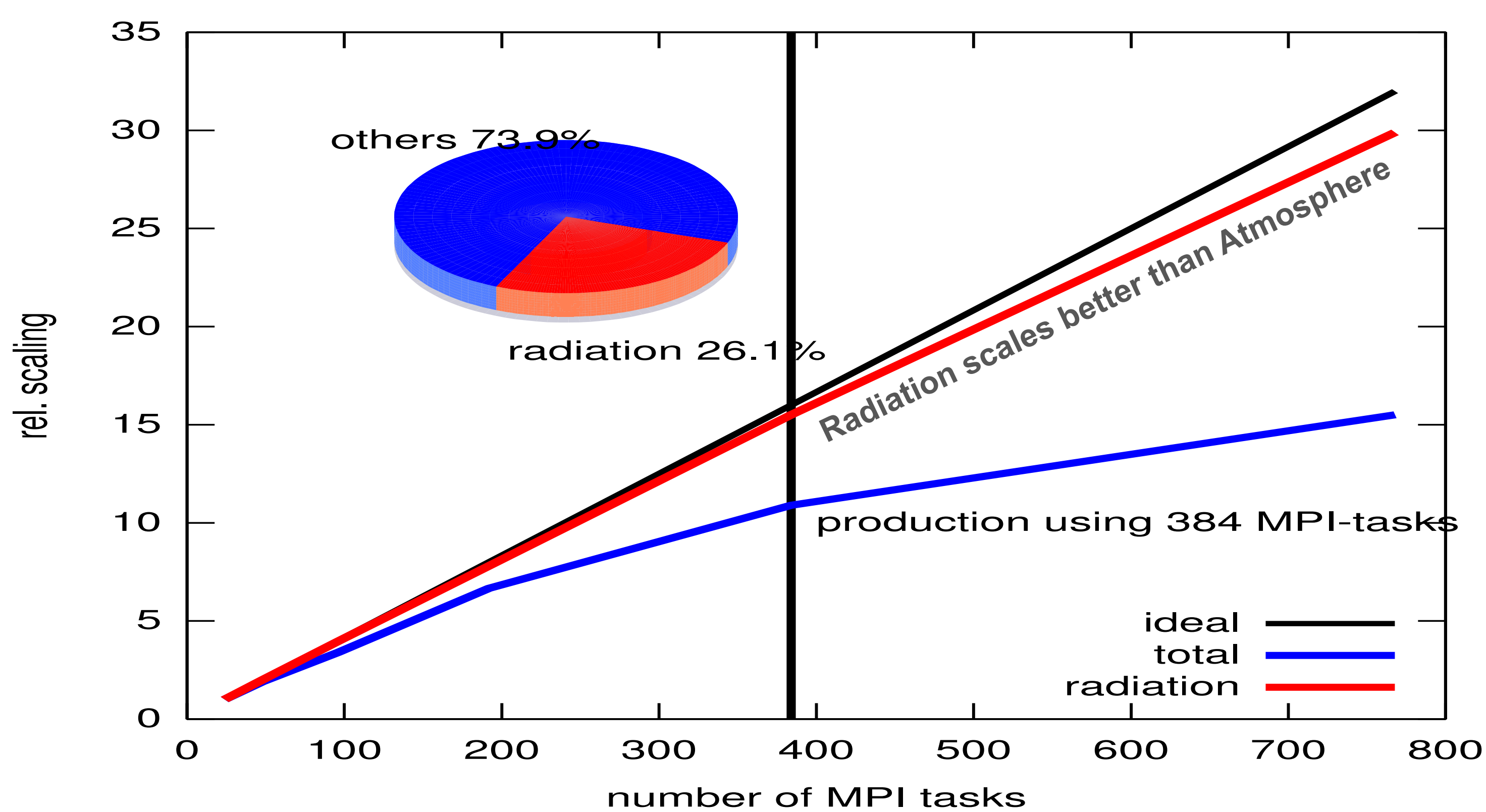
## In-situ Sequential Radiation Timeline (Already Implemented in ECHAM6)



ECHAM6 scaling, T31L47, PaIMOD CR setting

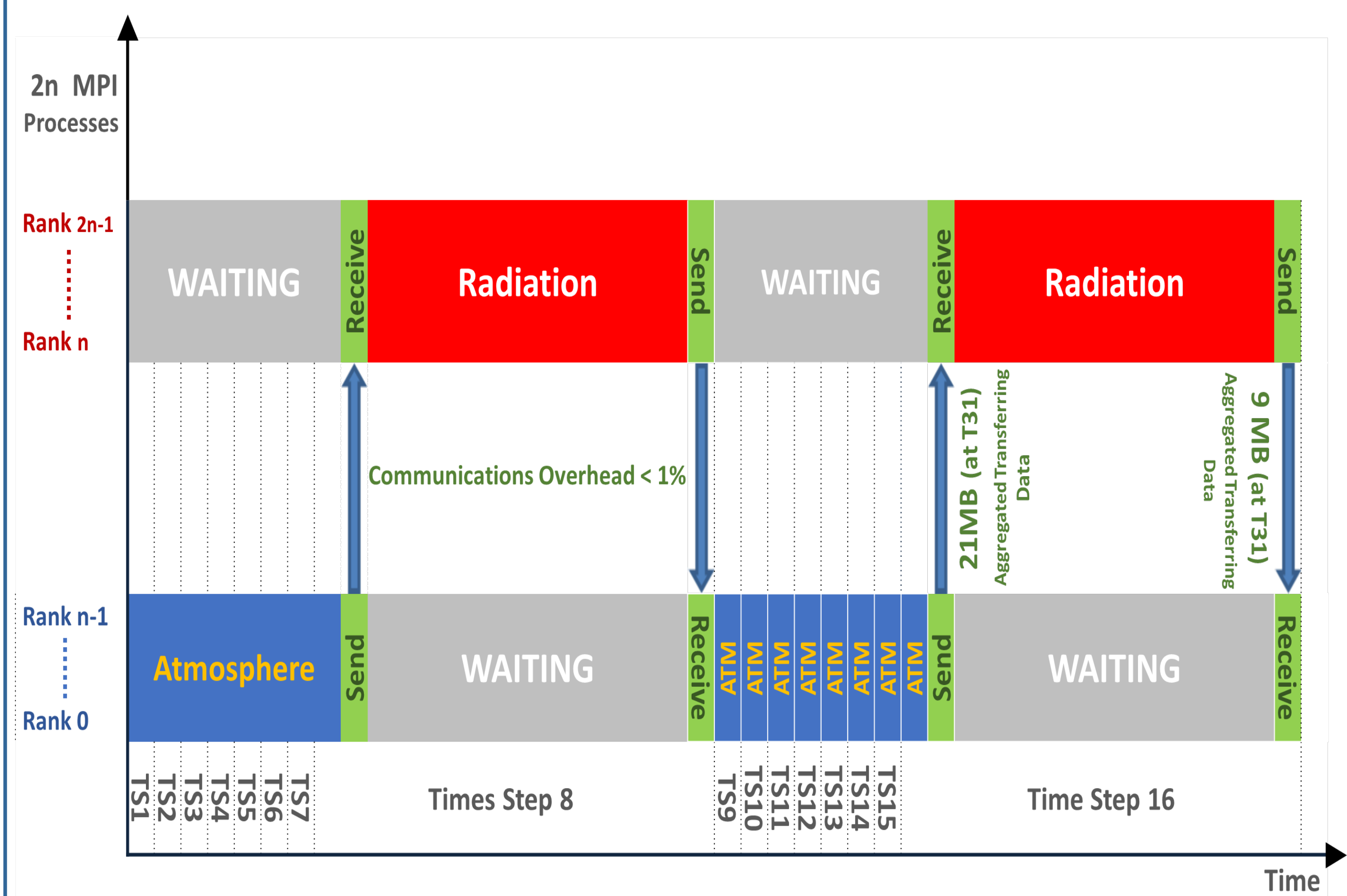


ECHAM6 scaling, T63L47, PaIMOD LR setting



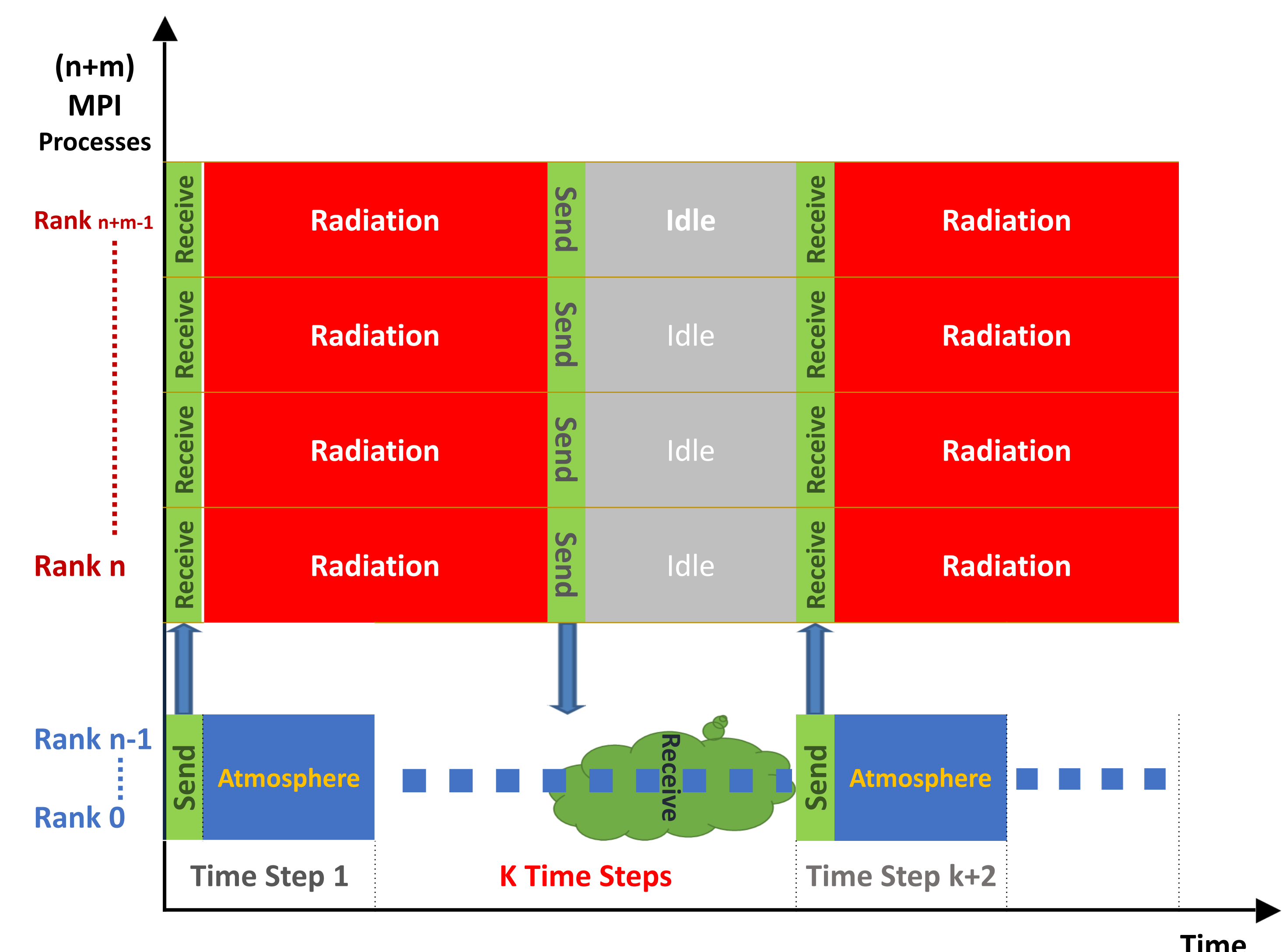
## Synchronous Remote Radiation Timeline (Our implementation)

- Atmosphere and Radiation run in separate MPI tasks.
- Atmosphere waits for Radiation to finish, however.
- Separation of Concerns (Radiation Code Separated from Atmosphere)
- Bit-identical Results (due to Blocking Communications)
- Communications Overhead Compared to Radiation Cost < 1%



## Asynchronous Remote Radiation Timeline (Our Future Plan)

- Atmosphere and Radiation run in separate MPI tasks.
- Atmosphere does not wait for Radiation any longer.
- Different domain-decomposition in Radiation should bring a higher speedup.
- Radiation sends results immediately.
- Atmosphere should choose to receive results in the best time step.
- If (idle time + communication overhead = 0), Speedup=1.98x at T31
- No longer Bit-identical Results (due to non-Blocking Communications)



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DEUTSCHES KLIMARECHENZENTRUM

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