Exascale supercomputers’ high performance allows climate simulations to target high-resolution simulations (e.g. 2.5 km) for longer simulation times.

But heterogeneous hardware architectures (CPU+GPU, vector systems, ...) are a challenge for scientific software development.

WarmWorld is a German national project that aims to use advances in information technology to compute and evaluate climate warming trajectories.

**Target Global Objectives**
1. Enable portable performance improvement with scalable development
2. Free, Open Source, refactored ICON for scalable development
3. Over 0.5 simulated years per day (SYPD) on ≤ 2.5km grid

**Exascale supercomputers’**

**Heterogeneous hardware architectures**

**WarmWorld Faster**

Challenges of Language Interoperability

- The memory manager has to register various fields
- Many ICON components touch the fields
- Most vendors are C++ based while ICON is Fortran based (Kokkos, RAJA, ...)
- Fortran - C++ interface is not fully supported

Opportunities

- Modularize the code
- Easy extension
- Favor reusing existing building blocks
- Better GPU support for a C++ front end than the legacy fortran code

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![Fortran Component](image1.png)

**Composable**

**Interoperable**

**Modular Design**

**Scalable**

**Performance**

**Development**

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**Memory Manager Design**

**Idiomatic interface, e.g. Fortran**

```fortran
interface
  function register_real32(ctx, desc_c, & num_elem) &
  & result(err) bind(c)
  & end function register_real32
end interface
contains
  function register(ctx_id, desc, & kind, num_elem) &
  & result(err)
  & end function
select case(kind)
  err = register_real32(get_ctx(ctx_id), & to_c_desc(desc), & int(num_elem, & kind=c_int))
  & end select
end function
```

**C for ABI**

```c
struct ctx;
struct var_descriptor;
int register_real32(struct ctx* device, struct var_descriptor* desc, const size_t num_elem);
```

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**Towards sustainable software development of the ICON Climate and Weather Prediction Model**

Leveraging the memory-manager for sustainable development

Integrating the memory-manager within the ICON climate and weather prediction model allows to bring sustainable development and to introduce further optimizations:
1. Iterative modularization to generate independent model components
2. Well-defined interfaces allows to replace components by e.g. vendor-optimized code or third-party components
3. Allows easy serialization of data, eases component testing
4. Abstraction allows reuse by other projects
5. Towards a data-driven control flow of the ICON code base