

COSMO – ICON Physics

Block physics implementation

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Block physics overview

- Block format data representation used in the ICON-COSMO
- $f(nproma, ke)$, where $nproma$ is a user defined parameter. The data is thus divided in $nblock$ blocks which are related to the COSMO ijk -representation $f(ie, je, ke)$ with $nblock = (ie - 2 \times nboundlines) \times (je - 2 \times nboundlines) / nproma$.
- All inputs and outputs fields of the physics need therefore to be copied to, respectively from the block format.
- An automatized copy infrastructure for copying data to and from the block format is provided

Code restructuring

- In COSMO, all physical parameterizations may be called inside a loop over the blocks which can potentially improve cache reuse and reduce number of required copies
- Within the block code data is considered as a set of independent vertical columns and there is no information about the neighbouring grid points. All operations which need such information, e.g. de-staggering or averaging, need to be computed before the block loop
- Common design for all parametrizations in COSMO separating block and non block codes would be desired.

organize_physics restructuring

```
if (lzrad) call radiation_prepare
if (lzturb) call turbulence_prepare
```

Operations requiring neighbouring information : ex averaging

...

do ib=1,nblock

```
!set ipend the horizontal compute domain
```

...

```
if (lzgsp) call request_copy(gscpCopylist)
```

```
if (lzrad) call request_copy(radCopylist)
```

```
if (lztrub) call request_copy(turbCopylist)
```

...

```
call copy_to_block
```

Preparing required copyto/from block (see copy infrastructure)

Apply copy to block

```
if (lzgsp) call gscp_organize(ipend,ib)
```

```
if (lzrad) call radiation_organize(ipend,ib)
```

```
if (lztrub) call turbulence_organize(ipend,ib)
```

Routines below will be shared with ICON. Fields are passed via argument list, ex : `call fesft(t_b(:,:,), ...`

...

```
call copy_fromblock
```

Apply copy from block

end do

Physics schemes restructuring

For each parametrization:

- **parameterization_interface.f90** (COSMO specific), which contains:
 - parameterization_init: call init routines
 - parameterization_init_copy: initialize required copy
 - parameterization_prepare: do all operations requiring neighbouring information, or that should be done outside of the block loop.
 - parameterization_organize: call the actual scheme(s)
 - parameterization_finalize: clean up physics (if required)
- **parameterization_scheme.f90**, (file shared with ICON) which contains the scheme implementation of the parameterization
 - For example the microphysics is organized as follows:
 - gscp_inteface.f90 contains: gscp_init, gscp_init_copy , gscp_organize
 - gscp_hydc_i_pp.f90 contains: hydc_i_pp_init, hydc_i_pp, hydc_i_pp

Automatic copy to block

- The need to copy back and forth fields from the ijk to the block format before and after the physics introduces some additional complexity
- Avoid, for performance reasons, to copy multiple times a variable which is used in multiple physical parameterizations.
- In order to facilitate the programmer's work, an automatized copy infrastructure is provided.
 - Correspondence table between block fields and ijk fields
 - Developer provides a list of input and output field for a given physics.
 - The required fields are then automatically copied before the call to the physics parameterizations.
- A user guide is available to use the automatic copies.

Example, microphysics register copy

```
!Initialize the list of fields to be copied to/from the block st  
CALL init_copy_list(shallowCopyList)
```

```
!Register the fields
```

```
!Variables with intent IN
```

```
CALL register_copy(hhl_b      ,shallowCopyList,copyToBlockF)  
CALL register_copy(t_b       ,shallowCopyList,copyToBlockF)  
CALL register_copy(qv_b      ,shallowCopyList,copyToBlockF)  
CALL register_copy(p0_b      ,shallowCopyList,copyToBlockF)  
CALL register_copy(pp_b      ,shallowCopyList,copyToBlockF)  
CALL register_copy(p0hl_b    ,shallowCopyList,copyToBlockF)  
CALL register_copy(ps_b      ,shallowCopyList,copyToBlockF)  
CALL register_copy(dqvdt_conv_b ,shallowCopyList,copyToBlockF)
```

```
!Variables with intent INOUT
```

```
CALL register_copy(bas_con_b  ,shallowCopyList,copyToBlockF)  
CALL register_copy(bas_con_b  ,shallowCopyList,copyFromBlockF)  
CALL register_copy(top_con_b  ,shallowCopyList,copyToBlockF)
```

organize_physics (gscp call)

```
!Request copy to/from block
CALL request_copy(gscpCopyList,ierror,yerrmsg);
IF (ierror /= 0) RETURN

!Apply copy to block
CALL copy_to_block(gscpCopyList,ipend,ib,ierror,yerrmsg)
IF (ierror /= 0) RETURN

CALL gscp_organize(ipend,ib,ierror,yerrmsg)
IF (ierror /= 0) RETURN

!Apply copy back
CALL copy_from_block(gscpCopyList,ipend,ib,ierror,yerrmsg)
IF (ierror>0) RETURN
```


Physical parametrizations

Scheme	C-1	Status	Delivery	Code origin
microphysics - hydc_i_pp (ice scheme) - hydc_i_pp_gr (graupel) - other schemes	x	done done not considered		ICON ICON
sub grid scale oro. (SSO)		only in 4.19		COSMO 4.19
radiation	x	on-going (no lradav)	18/09/2014	COSMO 5.1
turbulence	x	done	5/09/2014	ICON dev (2013)
soil model - terra_multlay - terra	x	done not considered		ICON dev (2013)
convection - conv_tiedtke - conv_shallow	 x	only in 4.19 done		COSMO 4.19 COSMO 5.0
seaice		not considered		
flake	x	not started		

Thank you