DKRZ
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The Coupling Library YAC

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Topics

- Masks types
- Configuration files
- Definition of couples
- Synchronisation of definitions
- Querying of definitions

Masks types

Core mask

defined per grid

masked out cells/vertices/edges are completely ignored by YAC

used to mask out degenerated and duplicated cells/vertices/edges

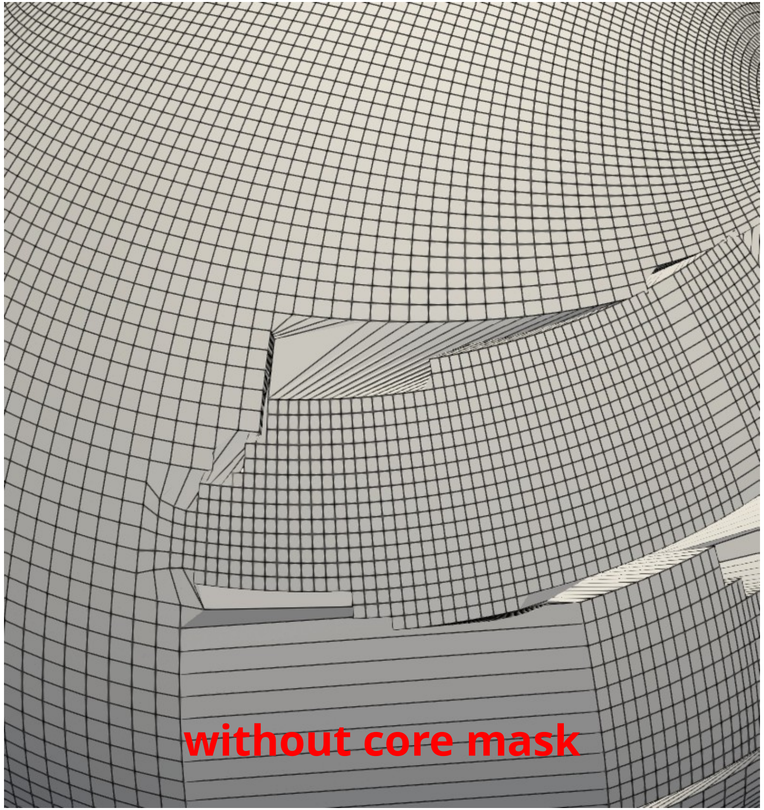
Field mask

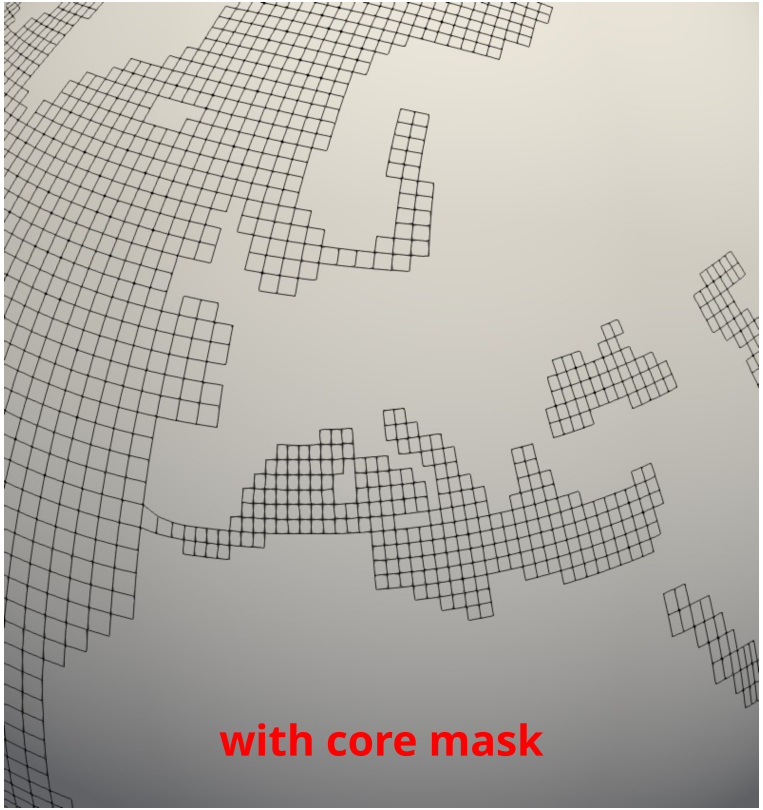
defined per points or per field

mask out cells/vertices/edges are ignored in the weight computation

used to mask out cells/vertices/edges that have no valid data assigned to them (e.g. halos) or that should not receive data

Core mask example





Field mask application

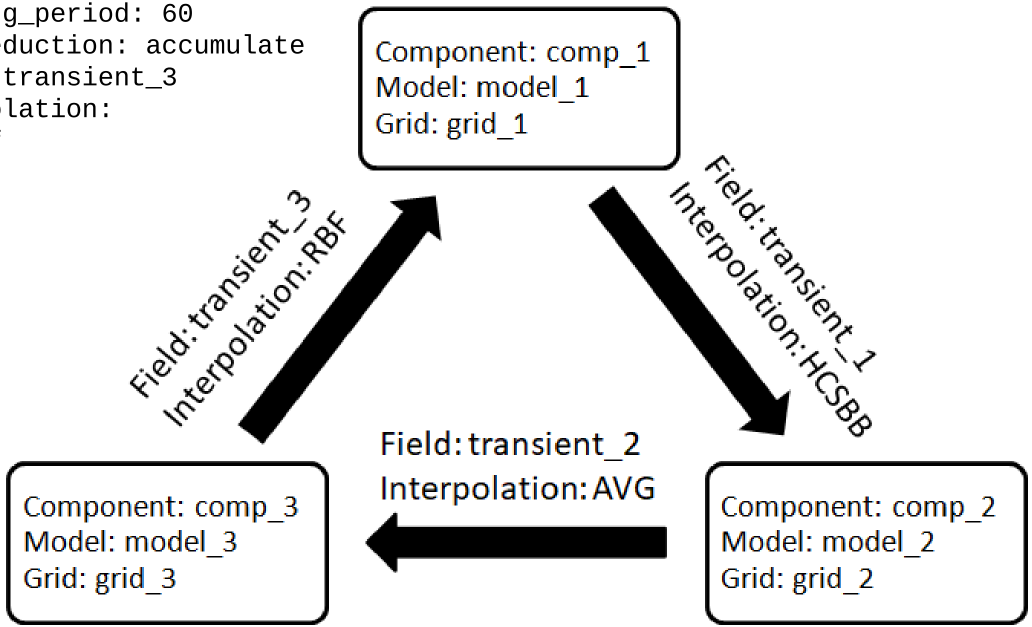
- In atmo/ocean coupling
  - deactivate land points in global atmo grid
- Halos
  - deactivate halos for outgoing fields
    → send only valid data
  - activate halos for ingoing fields
    → no halo update required after coupling

Configuration files

- Contains information about
  - (optional) start- and end date of the run
  - (optional) calendar to be used
  - which fields are supposed to be coupled
  - what interpolation is supposed to be used
  - at which frequency the coupling is supposed to be executed
- Have to be read in by at least one process
- One or more configuration files can be read by arbitrary processes
- Full support of YAML Version 1.2
- Documentation at:
  https://dkrz-sw.gitlab-pages.dkrz.de/yac/dd/dfa/yaml_file.html

Configuration files example

```yaml
start_date: 2008-03-09T16:05:07
end_date: 2008-03-10T16:05:07
timestep_unit: second
calendar: proleptic-gregorian
coupling:
# comp_1 -> comp_2
  - src_component: comp_1
    src_grid: grid_1
    tgt_component: comp_2
    tgt_grid: grid_2
    coupling_period: 60
    time_reduction: accumulate
    field: transient_1
    interpolation:
      - bernstein_bezier
# comp_2 -> comp_3
  - src_component: comp_2
    src_grid: grid_2
    tgt_component: comp_3
    tgt_grid: grid_3
    coupling_period: 60
    time_reduction: accumulate
    field: transient_2
    interpolation:
      - average
# comp_3 -> comp_1
  - src_component: comp_3
    src_grid: grid_3
    tgt_component: comp_1
    tgt_grid: grid_1
    coupling_period: 60
    time_reduction: accumulate
    field: transient_3
    interpolation:
      - rbf
```



Configuration files example

```
definitions:
  atm2oce: &atm2oce
    src_component: atmos
    src_grid: icon_atmos_grid
    tgt_component: ocean
    tgt_grid: icon_ocean_grid
    time_reduction: average
    src_lag: 1
    tgt_lag: 1
  oce2atm: &oce2atm
    src_component: ocean
    src_grid: icon_ocean_grid
    tgt_component: atmos
    tgt_grid: icon_atmos_grid
    time_reduction: average
    src_lag: 1
    tgt_lag: 1
  atm2riv: &atm2riv
    src_component: atmos
    src_grid: icon_atmos_grid
    tgt_component: HD
    tgt_grid: HD_GRID
    time_reduction: average
    src_lag: 1
    tgt_lag: 1
  riv2oce: &riv2oce
    src_component: HD
    src_grid: HD_GRID
    tgt_component: ocean
    tgt_grid: icon_ocean_grid
    time_reduction: average
    src_lag: 1
    tgt_lag: 1
```

```
interp_stacks:
  hcsbb_interp_stack: &hcsbb_interp_stack
    interpolation:
      - bernstein_bezier
      - nnn:
          n: 4
          weighted: arithmetic_average
      - fixed:
          user_value: -999.9
  conserv_interp_stack: &conserv_interp_stack
    interpolation:
      - conservative:
          order: 1
          enforced_conservation: false
          partial_coverage: true
          normalisation: fracarea
      - fixed:
          user_value: -999.9
  conserv_interp_dest: &conserv_interp_dest
    interpolation:
      - conservative:
          order: 1
          enforced_conservation: false
          partial_coverage: true
          normalisation: destarea
  spmap_interp_stack: &spmap_interp_stack
    interpolation:
      - source_to_target_map:
          spread_distance: 0.0
          max_search_distance: 0.0
      - fixed:
          user_value: 0.0
```

```
timestep_unit: ISO_format
calendar: proleptic-gregorian
coupling:
  - <<: [ *atm2oce, *hcsbb_interp_stack ]
    coupling_period: "PT30M"
    field: [surface_downward_eastward_stress,
            surface_downward_northward_stress]
  - <<: [ *atm2oce, *conserv_interp_stack ]
    coupling_period: "PT30M"
    field: [surface_fresh_water_flux,
            total_heat_flux,
            atmosphere_sea_ice_bundle]
  - <<: [ *oce2atm, *conserv_interp_stack ]
    coupling_period: "PT30M"
    field: [sea_surface_temperature,
            ocean_sea_ice_bundle]
  - <<: [ *atm2riv, *conserv_interp_dest ]
    coupling_period: "P01D"
    field: [surface_water_runoff,
            soil_water_runoff]
  - <<: [ *riv2oce, *spmap_interp_stack ]
    coupling_period: "P01D"
    field: river_runoff
```

Definition of couples

- Couples can be defined in definition phase by
  - reading of configuration file
  - call to user interface routine `yac_fdef_couple`

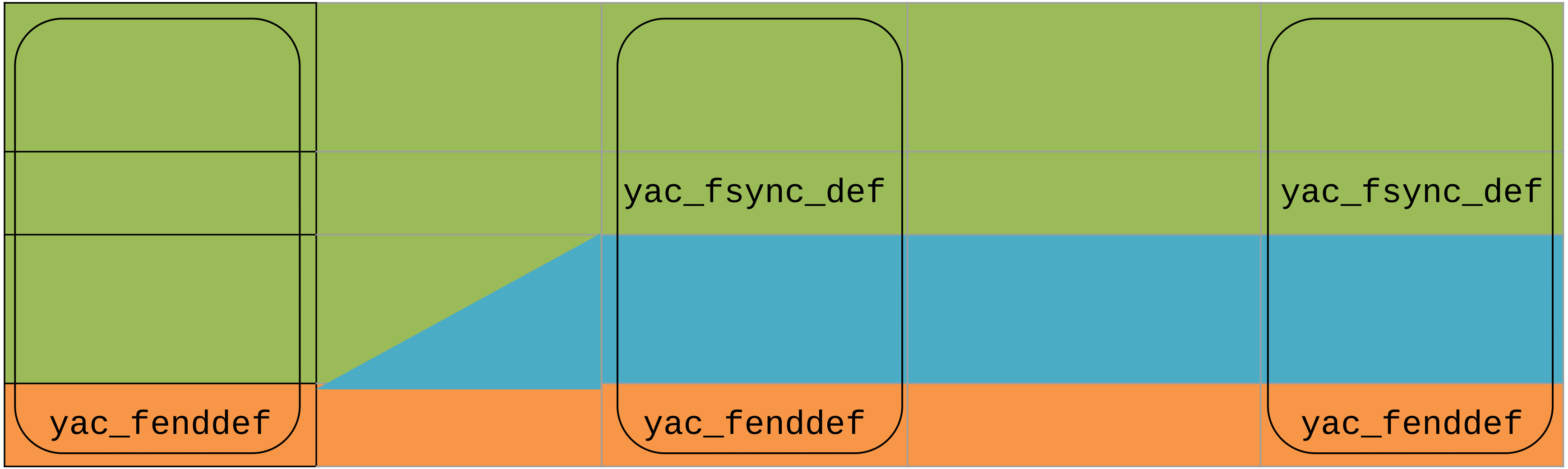
Definition of couples via user interface

```
subroutine yac_fdef_couple (                              &
  src_comp_name, src_grid_name, src_field_name, &
  tgt_comp_name, tgt_grid_name, tgt_field_name, &
  coupling_timestep, time_unit, time_reduction, &
  interp_stack_config_id, src_lag, tgt_lag,     &
  weight_file, mapping_side, scale_factor,      &
  scale_summand, src_mask_names, tgt_mask_name )

! *: optional arguments
```

Synchronisation of definitions

Definition phase (grids, fields, and couples)



Querying of definitions

- YAC internally keeps global configuration information about all components, grids, and fields on each process
- Each processes can query about this information
- Examples:
  - Is component “atmo” defined
  - Has component “ocean” defined field “sea_surface_temperature”
  - What is the collection size of field “total_heat_flux” on component “atmo”

End

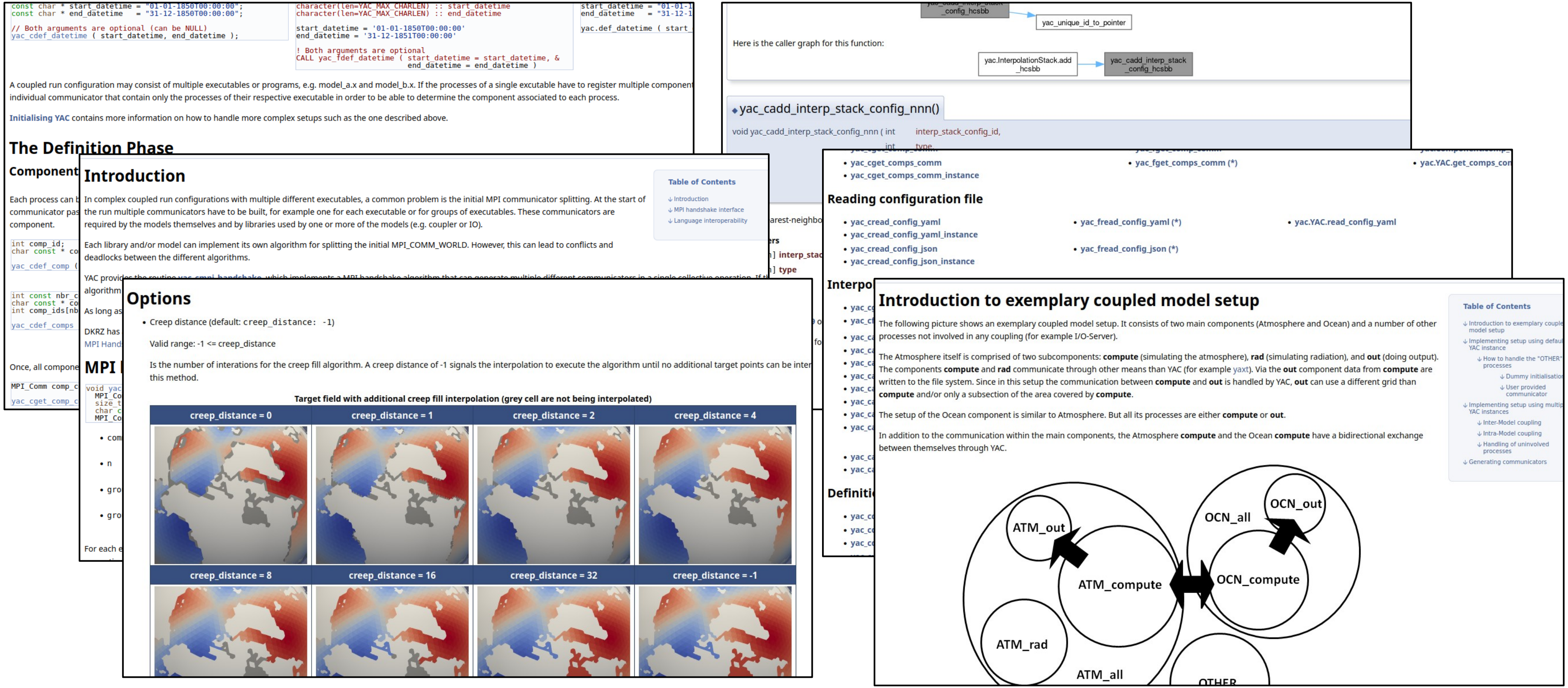
- Questions?
- Download: https://gitlab.dkrz.de/dkrz-sw/yac
- Documentation: https://dkrz-sw.gitlab-pages.dkrz.de/yac/
- References

  - M. Hanke, R. Redler, T. Holfeld und M. Yastremsky, 2016: YAC 1.2.0: new aspects for coupling software in Earth system modelling. Geoscientific Model Development, 9, 2755-2769, https://doi.org/10.5194/gmd-9-2755-2016
  - M. Hanke und R. Redler, 2019: New features with YAC 1.5.0. Reports on ICON, No 3. https://doi.org/10.5676/DWD_pub/nwv/icon_003
  - E. Kritsikis, M. Aechtner, Y. Meurdesoif, and T. Dubos: Conservative interpolation between general spherical meshes, Geosci. Model Dev., 10, 425–431, https://doi.org/10.5194/gmd-10-425-2017, 2017
  - Xiaoyu Liu, Larry L. Schumaker, Hybrid Bézier patches on sphere-like surfaces, Journal of Computational and Applied Mathematics, Volume 73, Issues 1–2, 1996, Pages 157-172, ISSN 0377-0427, https://doi.org/10.1016/0377-0427(96)00041-6

YAC in OASIS

- OASIS3-MCT 6.0 planned for end 2024
  - contains optional online weight computation by YAC

Documentation



Initial MPI communicator splitting

- initials communicator splitting is done by YAC using an MPI handshake algorithm
  - https://gitlab.dkrz.de/dkrz-sw/mpi-handshake
- processes not using YAC can take part in this splitting by using this algorithm, which is independent from YAC