ICON Namelist Overview

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Contents

1 ICON Namelists

1.1 Scripts, Namelist files and Programs

Run scripts starting the programs for the grid generation and the models are stored in run/. These scripts write namelist files containing the specified Fortran namelists. Programs are stored in < icon home>/build/<architecture>/bin/.

Table 1: Namelist files

Namelist file	**Purpose**	**Made by script**	**Used by program**
NAMELIST_GRAPH	Generate graphs	create_global_grids.run	grid_command
NAMELIST_GRID	Generate grids	create_global_grids.run	grid_command
NAMELIST_GRIDREF	Gen. nested domains	create_global_grids.run	grid_command
NAMELIST_ICON	Run ICON models	exp.<name>.run	control_model

1.2 Namelist parameters

The following subsections tabulate all available Fortran namelist parameters by name, type, default value, unit, description, and scope:

- *Type* refers to the type of the Fortran variable, in which the value is stored: I=INTEGER, L=LOGICAL, R=REAL, C=character string
- *Default* is the preset value, if defined, that is assigned to this parameter within the programs.
- *Unit* shows the unit of the control parameter, where applicable.
- *Description* explains in a few words the purpose of the parameter.
- *Scope* explains under which conditions the namelist parameter has any effect, if its scope is restricted to specific settings of other namelist parameters.

Information on the file, where the namelist is defined and used, is given at the end of each table.

2 Namelist parameters for grid generation

2.1 Namelist parameters defining the atmosphere grid

2.1.1 graph_ini (NAMELIST_GRAPH)

Parameter	Type	Default	Unit	Description	Scope
nroot	I	2		root subdivision of initial edges	
grid_levels	I	4		number of edge bisections following the root subdivision	
lplane	L	.FALSE.		switch for generating a double periodic planar grid. The root level consists of 8 triangles.	

Defined and used in: `src/grid_generator/mo_io_graph.f90`

2.1.2 grid_ini (NAMELIST_GRID)

Parameter	Type	Default	Unit	Description	Scope
nroot	I	2		root subdivision of initial edges	
grid_levels	I	4		number of edge bisections following the root subdivision	
lplane	L	.FALSE.		switch for generating planar grid. The root level consists of 8 triangles.	

Defined and used in: `src/grid_generator/mo_grid_levels.f90`

2.1.3 grid_options (NAMELIST_GRID)

Parameter	Type	Default	Unit	Description	Scope
x_rot_angle	R	0.0	deg	Rotation of the icosahedron about the x-axis (connecting the origin and [0°E, 0°N])	
y_rot_angle	R	0.0	deg	Rotation of the icosahedron about the y-axis (connecting the origin and [90°E, 0°N]), done after the rotation about the x-axis.	
z_rot_angle	R	0.0	deg	rotation of the icosahedron about the z-axis (connecting the origin and [0°E, 90°N]), done after the rotation about the y-axis.	
itype_optimize	I	4		Grid optimization type 0: no optimization 1: Heikes Randall 2: equal area 3: c-grid small circle 4: spring dynamics	
l_c_grid	L	.FALSE.		C-grid constraint on last level	
maxlev_optim	I	100		Maximum grid level where the optimization is applied	i_type_optimize = 1 or 4
beta_spring	R	0.90		tuning factor for target grid length	i_type_optimize = 4

Defined and used in: `src/grid_generator/mo_grid_levels.f90`

2.1.4 plane_options (NAMELIST_GRID)

Parameter	Type	Default	Unit	Description	Scope
tria_arc_km	R	10.0	km	length of triangle edge on plane	lplane=.TRUE.

The number of grid points is generated by root level section and further bisections. The double periodic root level consists of 8 triangles. The spatial coordinates are $-1 <= x <= 1$, and $-\sqrt{3}/2 <= y <= \sqrt{3}/2$. Currently the planar option can only be used as an f-plane.
Defined and used in: `src/grid_generator/mo_grid_levels.f90`

2.1.5 gridref_ini (NAMELIST_GRIDREF)

Parameter	Type	Default	Unit	Description	Scope
grid_root	I	2		root subdivision of initial edges	
start_lev	I	4		number of edge bisections following the root subdivision	
n_dom	I	2		number of logical model domains, including the global one	
n_phys_dom	I	n_dom		number of physical model domains, may be larger than n_dom (in this case, domain merging is applied)	
parent_id	I(n_phys_dom-1)	i		ID of parent domain (first entry refers to first nested domain; needs to be specified only in case of more than one nested domain per grid level)	
logical_id	I(n_phys_dom-1)	i+1		logical grid ID of domain (first entry refers to first nested domain; needs to be specified only in case of domain merging, i.e. n_dom < n_phys_dom)	
l_plot	L	.FALSE.		produces GMT plots showing the locations of the nested domains	
l_circ	L	.FALSE.		Create circular (.T.) or rectangular (.F.) refined domains	
l_rotate	L	.FALSE.		Rotates center point into the equator in case of l_circ = .FALSE.	lcirc=.FALSE.

Parameter	Type	Default	Unit	Description	Scope
write_hierarchy	I	1		0: Output only computational grids 1: Output in addition parent grid of global model domain (required for computing physics on a reduced grid) 2: Output all grids back to level 0 (required for hierarchical search algorithms)	
lsep_gridref_info	L	.FALSE.		.TRUE.: write fields describing parent-child connectivities into separate grid files	
uuid_sourcefile	C(n_dom)	'EMPTY'		If specified, provides the names of existing grid files from which the uuid shall be copied. If a radiation grid is present, the first entry refers to this grid.	
bdy_indexing_depth	I	12		Number of cell rows along the lateral boundary of a model domain for which the refin_ctrl fields contain the distance from the lateral boundary; needs to be enlarged when lateral boundary nudging is required for one-way nesting	
radius	R(n_dom-1)	30.	deg	radius of nested domain (first entry refers to first nested domain; needs to be specified for each nested domain separately)	lcirc=.TRUE.
hwidth_lon	R(n_dom-1)	20.	deg	zonal half-width of refined domain (first entry refers to first nested domain; needs to be specified for each nested domain separately)	lcirc=.FALSE.
hwidth_lat	R(n_dom-1)	20.	deg	meridional half-width of refined domain (first entry refers to first nested domain; needs to be specified for each nested domain separately)	lcirc=.FALSE.
center_lon	R(n_dom-1)	30.	deg	center longitude of refined domain (first entry refers to first nested domain; needs to be specified for each nested domain separately)	
center_lat	R(n_dom-1)	90.	deg	center latitude of refined domain (first entry refers to first nested domain; needs to be specified for each nested domain separately)	

Defined and used in: `src/grid_generator/mo_gridrefinement.f90`

2.1.6 gridref_metadata (NAMELIST_GRIDREF)

Parameter	Type	Default	Unit	Description	Scope
number_of_grid_used	I(n_dom+1)	0		sets the number of grid used in the netcdf header; the number of entries must be n_dom+1 since the first number refers to the radiation grid	
centre	I	0		centre running the grid generator 78: EDZW (DWD) 252: MPIM	
subcentre	I	0		subcentre to be assigned by centre, usually 0	
outname_style	I	1		Output name style 1: Standard: *iconRXBXX_DOMXX.nc* 2: DWD: *icon_grid_XXXX_RXXBXX_X.nc*	

Defined and used in: `src/grid_generator/mo_gridrefinement.f90`

3 Namelist parameters defining the atmospheric model

Namelist parameters for the ICON models are organized in several thematic Fortran namelists controling the experiment, and the properties of dynamics, transport, physics etc.

3.1 coupling_nml

Parameter	Type	Default	Unit	Description	Scope
name	C	blank		short name of the coupling field	
dt_coupling	I	0	s	coupling time step / coupling interval	
dt_model	I	0	s	model time step	
lag	I	0		offset to coupling event in number of model time steps	
l_time_average	L	.FALSE.		.TRUE.: time averaging between two coupling events	
l_time_accumulation	L	.FALSE.		.TRUE.: accumulation of coupling fields in time between two coupling events	

Parameter	Type	Default	Unit	Description	Scope
l_diagnostic	L	.FALSE.		.TRUE.: simple diagnostics (min, max, avg) for coupling fields is switched on	
l_activated	L	.FALSE.		.TRUE.: activate the coupling of the respective coupling field	

Defined and used in: `src/namelists/mo_coupling_nml.f90`

3.2 diffusion_nml

Parameter	Type	Default	Unit	Description	Scope
lhdiff_temp	L	.TRUE.		Diffusion on the temperature field	
lhdiff_vn	L	.TRUE.		Diffusion on the horizontal wind field	
lhdiff_w	L	.TRUE.		Diffusion on the vertical wind field	
hdiff_order	I	4 (hydro) 5 (NH)		Order of ∇ operator for diffusion: -1: no diffusion 2: ∇^2 diffusion 3: Smagorinsky ∇^2 diffusion 4: ∇^4 diffusion 5: Smagorinsky ∇^2 diffusion combined with ∇^4 background diffusion as specified via hdiff_efdt_ratio 24 or 42: $\nabla 2$ diffusion from model top to a certain level (cf. k2_pres_max and k2_klev_max below); ∇^4 for the lower levels.	Options 2, 24 and 42 are allowed only in the hydrostatic atm model (iequations = 1 or 2 in dynamics_nml).
lsmag_3d	L	.FALSE.		.TRUE.: Use 3D Smagorinsky formulation for computing the horizontal diffusion coefficient (recommended at mesh sizes finer than 1 km if the LES turbulence scheme is not used)	hdiff_order=3 or 5; itype_vn_diffu=1
itype_vn_diffu	I	1		Reconstruction method used for Smagorinsky diffusion: 1: u/v reconstruction at vertices only 2: u/v reconstruction at cells and vertices	iequations=3, hdiff_order=3 or 5

Parameter	Type	Default	Unit	Description	Scope
itype_t_diffu	I	2		Discretization of temperature diffusion: 1: $K_h\nabla^2T$ 2: $\nabla\cdot(K_h\nabla T)$	iequations=3, hdiff_order=3 or 5
k2_pres_max	R	-99.	Pa	Pressure level above which ∇^2 diffusion is applied.	hdiff_order = 24 or 42, and dynamics_nml:iequations = 1 or 2.
k2_klev_max	I	0		Index of the vertical level till which (from the model top) ∇^2 diffusion is applied. If a positive value is specified for k2_pres_max, k2_klev_max is reset accordingly during the initialization of a model run.	hdiff_order = 24 or 42, and dynamics_nml:iequations = 1 or 2.
hdiff_efdt_ratio	R	1.0 (hydro) 36.0 (NH)		ratio of e-folding time to time step (or 2* time step when using a 3 time level time stepping scheme) (for triangular NH model, values above 30 are recommended when using hdiff_order=5)	
hdiff_w_efdt_ratio	R	15.0		ratio of e-folding time to time step for diffusion on vertical wind speed	iequations=3
hdiff_min_efdt_ratio	R	1.0		minimum value of hdiff_efdt_ratio near model top	iequations=3 .AND. hdiff_order=4
hdiff_tv_ratio	R	1.0		Ratio of diffusion coefficients for temperature and normal wind: $T : v_n$	
hdiff_multfac	R	1.0		Multiplication factor of normalized diffusion coefficient for nested domains	n_dom>1
hdiff_smag_fac	R	0.15 (hydro) 0.015 (NH)		Scaling factor for Smagorinsky diffusion	iequations=3

Defined and used in: `src/namelists/mo_diffusion_nml.f90`

3.3 dynamics_nml

This namelist is relevant if run_nml:ldynamics=.TRUE.

Parameter	Type	Default	Unit	Description	Scope
iequations	I	3		Equations and prognostic variables. Use positive indices for the atmosphere and negative indices for the ocean. 0: shallow water model 1: hydrostatic atmosphere, T 2: hydrostatic atm., θ·dp 3: non-hydrostatic atmosphere -1: hydrostatic ocean	
idiv_method	I	1		Method for divergence computation: 1: Standard Gaussian integral. Hydrostatic atm. model: for unaveraged normal components Non-hydrostatic atm. model: for averaged normal components 2: bilinear averaging of divergence	
divavg_cntrwgt	R	0.5		Weight of central cell for divergence averaging	idiv_method= 2
lcoriolis	L	.TRUE.		Coriolis force	
sw_ref_height	R	0.9* 2.94e4/g	m	Reference height of shallow water model used for linearization in the semi-implicit time stepping scheme	

Defined and used in: `src/namelists/mo_dynamics_nml.f90`

3.4 echam_conv_nml

Parameter	Type	Default	Unit	Description	Scope
iconv	I	1		Choice of cumulus convection scheme. 1: Nordeng scheme 2: Tiedtke scheme 3: hybrid scheme	iforcing = 2 .AND. lconv = .TRUE.
ncvmicro	I	0		Choice of convective microphysics scheme.	iforcing = 2 .AND. lconv = .TRUE.

Parameter	Type	Default	Unit	Description	Scope
lmfpen	L	.TRUE.		Switch on penetrative convection.	iforcing = 2 .AND. lconv = .TRUE.
lmfmid	L	.TRUE.		Switch on midlevel convection.	iforcing = 2 .AND. lconv = .TRUE.
lmfdd	L	.TRUE.		Switch on cumulus downdraft.	iforcing = 2 .AND. lconv = .TRUE.
lmfdudv	L	.TRUE.		Switch on cumulus friction.	iforcing = 2 .AND. lconv = .TRUE.
cmftau	R	10800.		Characteristic convective adjustment time scale.	iforcing = 2 .AND. lconv = .TRUE.
cmfctop	R	0.3		Fractional convective mass flux (valid range [0,1]) across the top of cloud	iforcing = 2 .AND. lconv = .TRUE.
cprcon	R	1.0e-4		Coefficient for determining conversion from cloud water to rain.	iforcing = 2 .AND. lconv = .TRUE.
cminbuoy	R	0.025		Minimum excess buoyancy.	iforcing = 2 .AND. lconv = .TRUE.
entrpen	R	1.0e-4		Entrainment rate for penetrative convection.	iforcing = 2 .AND. lconv = .TRUE.
dlev	R	3.e4	Pa	Critical thickness necessary for the onset of convective precipitation.	iforcing = 2 .AND. lconv = .TRUE.

Defined and used in: `src/namelists/mo_echam_conv_nml.f90`

3.5 echam_phy_nml

Parameter	Type	Default	Unit	Description	Scope
lrad	L	.TRUE.		.TRUE. for radiation.	run_nml/iforcing = 2
dt_rad	R	3600.	s	time interval for radiative transfer computation	run_nml/iforcing = 2
lvdiff	L	.TRUE.		.TRUE. for vertical turbulent diffusion	run_nml/iforcing = 2
lconv	L	.TRUE.		.TRUE. for cumulus convection	run_nml/iforcing = 2
lcond	L	.TRUE.		.TRUE. for large scale condensation	run_nml/iforcing = 2
icover	I	1		1 = diagnostic cloud cover scheme (Sunquist)	run_nml/iforcing = 2
lgw_hines	L	.TRUE.		.TRUE. for non-orographic gravity wave drag (Hines)	run_nml/iforcing = 2
lssodrag	L	.TRUE.		.TRUE. for subgrid scale orographic effects (Lott and Miller)	run_nml/iforcing = 2
lice	L	.FALSE.		.TRUE. for sea-ice temperature calculation	run_nml/iforcing = 2
lmlo	L	.FALSE.		.TRUE. for mixed layer ocean	run_nml/iforcing = 2
ljsbach	L	.FALSE.		.TRUE. for calculating land surface properties (JSBACH)	run_nml/iforcing = 2
lamip	L	.FALSE.		.TRUE. for AMIP boundary conditions	run_nml/iforcing = 2

Defined and used in: `src/namelists/mo_echam_phy_nml.f90`

3.6 ensemble_pert_nml

Parameter	Type	Default	Unit	Description	Scope
use_ensemble_pert	L	.FALSE.		Main switch to activate physics parameter perturbations for ensemble forecasts / ensemble data assimilation; the perturbations are applied via random numbers depending on the perturbationNumber (ensemble member ID) specified in gribout_nml	run_nml:iforcing = inwp
range_gkwake	R	0.1666		Variability range for low level wake drag constant	
range_gkdrag	R	0.02		Variability range for orographic gravity wave drag constant	

Parameter	Type	Default	Unit	Description	Scope
range_gfluxlaun	R	0.50e-3		Variability range for non-orographic gravity wave launch momentum flux	
range_zvz0i	R	0.125	m/s	Variability range for terminal fall velocity of ice	inwp_gscp = 1 or 2
range_entrorg	R	0.125e-3	1/m	Variability range for entrainment parameter in convection scheme	
range_capdcfac_et	R	0.1		Maximum fraction of CAPE diurnal cycle correction applied in the extratropics	icapdcycl = 3
range_box_liq	R	0.01		Variability range for box width scale of liquid clouds in cloud cover scheme	inwp_cldcover = 1
range_tkhmin	R	0.15		Variability range for minimum vertical diffusion for heat/moisture	inwp_turb = 1
range_tkmmin	R	0.15		Variability range for minimum vertical diffusion for momentum	inwp_turb = 1
range_rlam_heat	R	1.5		Variability range (multiplicative!) of laminar transport resistance parameter	inwp_turb = 1

Defined and used in: `src/namelists/mo_ensemble_pert_nml.f90`

3.7 gribout_nml

Parameter	Type	Default	Unit	Description	Scope
preset	C	"determ..."		Setting this different to "none" enables a couple of defaults for the other `gribout_nml` namelist parameters. If, additionally, the user tries to set any of these other parameters to a conflicting value, an error message is thrown. Possible values are "none", "deterministic", "ensemble".	filetype=2
backgroundProcess	I	0		Background process - GRIB2 code table backgroundProcess.table	filetype=2

Parameter	Type	Default	Unit	Description	Scope
generatingCenter	I	-1		Output generating center. If this key is not set, center information is taken from the grid file DWD: 78 MPIMET: 98 ECMWF: 98	filetype=2
generatingSubcenter	I	-1		Output generating Subcenter. If this key is not set, subcenter information is taken from the grid file DWD: 255 MPIMET: 232 ECMWF: 0	filetype=2
generatingProcess Identifier	I(n_dom)	1		generating Process Identifier - GRIB2 code table generatingProcessIdentifier.table	filetype=2
numberOfForecastsIn-Ensemble	I	-1		Local definiton for ensemble products, (only set if value changed from default)	filetype=2
perturbationNumber	I	-1		Local definiton for ensemble products, (only set if value changed from default)	filetype=2
productionStatusOfPro-cessedData	I	1		Production status of data - GRIB2 code table 1.3	filetype=2
significanceOfReference-Time	I	1		Significance of reference time - GRIB2 code table 1.2	filetype=2
typeOfEnsembleForecast	I	-1		Local definiton for ensemble products (only set if value changed from default)	filetype=2
typeOfGeneratingPro-cess	I	-1		Type of generating process - GRIB2 code table 4.3	filetype=2
typeOfProcessedData	I	-1		Type of data - GRIB2 code table 1.4	filetype=2
localDefinitionNumber	I	-1		local Definition Number - GRIB2 code table grib2LocalSectionNumber.78.table	filetype=2
localNumberOfExperi-ment	I	1		local Number of Experiment	filetype=2
localTypeOfEnsemble-Forecast	I	-1		Local definiton for ensemble products (only set if value changed from default)	filetype=2

Parameter	Type	Default	Unit	Description	Scope
lspecialdate_invar	L	.FALSE.		Special reference date for invariant and climatological fields .TRUE.: set special reference date 0001-01-01, 00:00 .FASLE.: no special reference date	filetype = 2
ldate_grib_act	L	.TRUE.		GRIB creation date .TRUE.: add creation date .FALSE.: add dummy date	filetype=2
lgribout_24bit	L	.FALSE.		If TRUE, write thermodynamic fields ρ, θ_v, T, p with 24bit precision instead of 16bit	filetype=2

Defined and used in: `src/namelists/mo_gribout_nml.f90`

3.8 grid_nml

Parameter	Type	Default	Unit	Description	Scope
cell_type	I	3		Cell type: not used	
lplane	L	.FALSE.		planar option	
is_plane_torus	L	.FALSE.		f-plane approximation on triangular grid	
corio_lat	R	0.0	deg	Center of the f-plane is located at this geographical latitude	lplane=.TRUE. and is_plane_torus=.TRUE.
grid_angular _velocity	R	Earth's	rad/s	The angular velocity in rad per sec.	
l_limited_area	L	.FALSE.			
grid_rescale_factor	R	1.0		The geometry and the timestep will be multiplied by this factor. The angular velocity will be divided by this factor.	
lfeedback	L(n_dom)	.TRUE.		Specifies if feedback to parent grid is performed. Setting lfeedback(1)=.false. turns off feedback for all nested domains; to turn off feedback for selected nested domains, set lfeedback(1)=.true. and set ".false." for the desired model domains	n_dom>1

Parameter	Type	Default	Unit	Description	Scope
ifeedback_type	I	2		1: incremental feedback 2: relaxation-based feedback Note: vertical nesting requires option 2 to run numerically stable over longer time periods	n_dom>1
start_time	R(n_dom)	0.	s	Time when a nested domain starts to be active (namelist entry is ignored for the global domain)	n_dom>1
end_time	R(n_dom)	1.E30	s	Time when a nested domain terminates (namelist entry is ignored for the global domain)	n_dom>1
patch_weight	R(n_dom)	0.		If patch_weight is set to a value > 0 for any of the first level child patches, processor splitting will be performed, i.e. every of the first level child patches gets a subset of the total number or processors corresponding to its patch_weight. A value of 0. corresponds to exactly 1 processor for this patch, regardless of the total number of processors. For the root patch and higher level childs, patch_weight is not used. However, patch_weight must be set to 0 for these patches to avoid confusion.	n_dom>1
lredgrid_phys	L	.FALSE.		If set to .true. radiation is calculated on a reduced grid (= one grid level higher)	
dynamics_grid_filename	C			Array of the grid filenames to be used by the dycore. May contain the keyword `<path>` which will be substituted by `model_base_dir`.	
dynamics_parent_grid_id	I(n_dom)	$i-1$		Array of the indexes of the parent grid filenames, as described by the dynamics_grid_filename array. Indexes start at 1, an index of 0 indicates no parent.	
radiation_grid_filename	C			Array of the grid filenames to be used for the radiation model. Filled only if the radiation grid is different from the dycore grid. May contain the keyword `<path>` which will be substituted by `model_base_dir`.	lredgrid_phys=.TRUE.

Parameter	Type	Default	Unit	Description	Scope
dynamics_radiation_grid_link	I(n_dom)	1 for i=1		Array of the indexes linking the dycore grids, as described by the dynamics_grid_filename array, and the radiation_grid_filename array. It provides the link index of the radiation_grid_filename, for each entry of the dynamics_grid_filename array. Indexes start at 1, an index of 0 indicates that the radiation grid is the same as the dycore grid. Only needs to be filled when the radiation_grid_filename is defined.	
create_vgrid	L	.FALSE.		.TRUE.: Write vertical grid files containing (`vct_a`, `vct_b`, `z_ifc`, and `z_ifv`.	
vertical_grid_filename	C(n_dom)			Array of filenames. These files contain the vertical grid definition (`vct_a`, `vct_b`, `z_ifc`). If empty, the vertical grid is created within ICON during the setup phase.	
use_duplicated_connectivity	L	.TRUE.		if .TRUE., the zero connectivity is replaced by the last non-zero value	
use_dummy_cell_closure	L	.FALSE.		if .TRUE. then create a dummy cell and connect it to cells and edges with no neighbor	

Defined and used in: `src/namelists/mo_grid_nml.f90`

3.9 gridref_nml

Parameter	Type	Default	Unit	Description	Scope
grf_intmethod_c	I	2		Interpolation method for grid refinement (cell-based dynamical variables): 1: parent-to-child copying 2: gradient-based interpolation	n_dom>1
grf_intmethod_ct	I	2		Interpolation method for grid refinement (cell-based tracer variables): 1: parent-to-child copying 2: gradient-based interpolation	n_dom>1

Parameter	Type	Default	Unit	Description	Scope
grf_intmethod_e	I	6		Interpolation method for grid refinement (edge-based variables): 1: inverse-distance weighting (IDW) 2: RBF interpolation 3: combination gradient-based / IDW 4: combination gradient-based / RBF 5/6: same as 3/4, respectively, but direct interpolation of mass fluxes along nest interface edges	n_dom>1
grf_velfbk	I	1		Method of velocity feedback: 1: average of child edges 1 and 2 2: 2nd-order method using RBF interpolation	n_dom>1
grf_scalfbk	I	2		Feedback method for dynamical scalar variables (T, p_{sfc}): 1: area-weighted averaging 2: bilinear interpolation	n_dom>1
grf_tracfbk	I	2		Feedback method for tracer variables: 1: area-weighted averaging 2: bilinear interpolation	n_dom>1
grf_idw_exp_e12	R	1.2		exponent of generalized IDW function for child edges 1/2	n_dom>1
grf_idw_exp_e34	R	1.7		exponent of generalized IDW function for child edges 3/4	n_dom>1
rbf_vec_kern_grf_e	I	1		RBF kernel for grid refinement (edges): 1: Gaussian 2: $1/(1+r^2)$ 3: inverse multiquadric	n_dom>1
rbf_scale_grf_e	R(n_dom)	0.5		RBF scale factor for grid refinement (lateral boundary interpolation to edges). Refers to the respective parent domain and thus does not need to be specified for the innermost nest. Lower values than the default of 0.5 are needed for child mesh sizes less than about 500 m.	n_dom>1

Parameter	Type	Default	Unit	Description	Scope
denom_diffu_t	R	135		Deniminator for lateral boundary diffusion of temperature	n_dom>1
denom_diffu_v	R	200		Deniminator for lateral boundary diffusion of velocity	n_dom>1
l_mass_consvcorr	L	.FALSE.		.TRUE.: Apply mass conservation correction in feedback routine	n_dom>1
l_density_nudging	L	.FALSE.		.TRUE.: Apply density nudging near lateral nest boundary if grf_intmethod_e $\leq$ 4	n_dom>1 .AND. lfeedback = .TRUE.
fbk_relax_timescale	R	10800		Relaxation time scale for feedback	n_dom>1 .AND. lfeedback = .TRUE. .AND. ifeedback_type = 2

Defined and used in: `src/namelists/mo_gridref_nml.f90`

3.10 gw_hines_nml (Scope: lgw_hines = .TRUE. in echam_phy_nml)

Parameter	Type	Default	Unit	Description	Scope
lheatcal	L	.FALSE.		.TRUE.: compute drag, heating rate and diffusion coefficient from the dissipation of gravity waves .FALSE.: compute drag only	
emiss_lev	I	10		Index of model level, counted from the surface, from which the gravity wave spectra are emitted	
rmscon	R	1.0	m/s	Root mean square gravity wave wind at the emission level	
kstar	R	5.0e-5	1/m	Typical gravity wave horizontal wavenumber	
m_min	R	0.0	1/m	Minimum bound in vertical wavenumber	
lrmscon_lat	L	.FALSE.		.TRUE.: use latitude dependent rms wind - |latitude| >= lat_rmscon: use rmscon - |latitude| <= lat_rmscon_eq: use rmscon_eq - lat_rmscon_eq < |latitude| < lat_rmscon: use linear interpolation between rmscon_eq and rmscon .FALSE.: use globally constant rms wind rmscon	

Parameter	Type	Default	Unit	Description	Scope
lat_rmscon_eq	R	5.0	deg N	rmscon_eq is used equatorward of this latitude	lrmscon_lat = .TRUE.
lat_rmscon	R	10.0	deg N	rmscon is used polward of this latitude	lrmscon_lat = .TRUE.
rmscon_eq	R	1.2	m/s	is used equatorward of latitude lat_rmscon_eq	lrmscon_lat = .TRUE.

Defined and used in: `src/namelists/mo_gw_hines_nml.f90`

3.11 ha_dyn_nml

This namelist is relevant if run_nml:ldynamics=.TRUE. and dynamics_nml:iequations=IHS_ATM_TEMP or IHS_ATM_THETA.

Parameter	Type	Default	Unit	Description	Scope
itime_scheme	I	14		Time integration scheme: 11: pure advection (no dynamics) 12: 2 time level semi implicit (not yet implemented) 13: 3 time level explicit 14: 3 time level with semi implicit correction 15: standard 4th-order Runge-Kutta method (4-stage) 16: SSPRK(5,4) scheme (5-stage)	
ileapfrog_startup	I	1		How to integrate the first time step when the leapfrog scheme is chosen. 1 = Euler forward; 2 = a series of sub-steps.	itime_scheme= 13 or 14
asselin_coeff	R	0.1		Asselin filter coefficient	itime_scheme= 13 or 14
si_2tls	R	0.6		weight of time step n+1. Valid range: [0,1]	itime_scheme=12
si_expl_scheme	I	2		scheme for the explicit part used in the 2 time level semi-implicit time stepping scheme. 1 = Euler forward; 2 = Adams-Bashforth 2nd order	itime_scheme=12
si_cmin	R	30.0	m/s	semi implicit correction is done for eigenmodes with speeds larger than si_cmin	itime_scheme=14 and lsi_3d=.FALSE.
si_coeff	R	1.0		weight of the semi implicit correction	itime_scheme=14
si_offctr	R	0.7			itime_scheme=14
si_rtol	R	1.0e-3		relative tolerance for GMRES solver	itime_scheme=14
lsi_3d	L	.FALSE.		3D GMRES solver or decomposistion into 2D problems	lshallow_water=.FALSE. and itime_scheme=14

Parameter	Type	Default	Unit	Description	Scope
ldry_dycore	L	.TRUE.		Assume dry atmosphere	iequations∈{1,2}
lref_temp	L	.FALSE.		Set a background temperature profile as base state when computing the pressure gradient force	iequations∈{1,2}

3.12 initicon_nml

Parameter	Type	Default	Unit	Description	Scope
init_mode	I	2		1: MODE_DWDANA start from DWD analysis or FG 2: MODE_IFSANA start from IFS analysis 3: MODE_COMBINED IFS atm + ICON/GME soil 4: MODE_COSMODE start from COSMO-DE forecast 5: MODE_IAU start from DWD analysis with incremental analysis update. Extension of MODE_IAU_OLD including snow increments 6: MODE_IAU_OLD start from DWD analysis with incremental analysis update. NOTE: Extension of mode MODE_DWDANA_INC including W_SO increments. 7: MODE_ICONVREMAP start from DWD first guess with subsequent vertical remapping (work in progress; so far, changing the number of model levels does not yet work)	
dt_iau	R	10800	s	Time interval during which an incremental analysis update (IAU) is performed	init_mode=5,6

Parameter	Type	Default	Unit	Description	Scope
dt_shift	R	0	s	Time by which the actual model start time is shifted ahead of the nominal date. Must be NEGATIVE, usually -0.5 dt_iau.	init_mode=5,6
start_time_avg_fg	R	0	s	Start time for calculating temporally averaged first guess output for data assimilation.	
end_time_avg_fg	R	0	s	End time for calculating temporally averaged first guess output for data assimilation. Setting end_time_avg_fg > start_time_avg_fg activates the averaging	
interval_avg_fg	R	0	s	Corresponding averaging interval. Note that end_time_avg_fg − start_time_avg_fg must not be smaller than the averaging interval	
rho_incr_filter_wgt	R	0		Vertical filtering weight on density increments	init_mode=5,6
type_iau_wgt	I	1		Weighting function for performing IAU 1: Top-Hat 2: SIN2	init_mode=5,6
nlevsoil_in	I	4		number of soil levels of input data	init_mode=2
zpbl1	R	500.0	m	bottom height (AGL) of layer used for gradient computation	
zpbl2	R	1000.0	m	top height (AGL) of layer used for gradient computation	
l_sst_in	L	.TRUE.		Logical switch. If true, the surface temperature of the water sea points is initialized with the SST provided in the ifs2icon file. If false, it is initialized with the skin temperature. If the SST is not provided in the ifs2icon file, l_sst_in is reset to false.	init_mode=2
lread_ana	L	.TRUE.		If .FALSE., ICON is started from first guess only. Analysis field is not required, and skipped if provided.	init_mode=1,3
lconsistency_checks	L	.TRUE.		If .FALSE., consistency checks for Analysis and First Guess fields are skipped. On default, checks are performed for *uuidOfHGrid* and *validity time*.	init_mode=1,3,4,5,6

Parameter	Type	Default	Unit	Description	Scope
l_coarse2fine_mode	L(n_dom)	.FALSE.		If true, apply corrections for coarse-to-fine mesh interpolation to wind and temperature	
lp2cintp_incr	L(n_dom)	.FALSE.		If true, interpolate atmospheric data assimilation increments from parent domain. Can be specified separately for each nested domain; setting the first (global) entry to true activates the interpolation for all nested domains.	init_mode=5,6
lp2cintp_sfcana	L(n_dom)	.FALSE.		If true, interpolate atmospheric surface analysis data from parent domain. Can be specified separately for each nested domain; setting the first (global) entry to true activates the interpolation for all nested domains.	init_mode=5,6
ltile_init	L	.FALSE.		True: initialize tiled surface fields from a first guess coming from a run without tiles. Along coastlines and lake shores, a neighbor search is executed to fill the variables on previously non-existing land or water points with reasonable values. Should be combined with ltile_coldstart = .TRUE.	init_mode=1,5,6
ltile_coldstart	L	.FALSE.		If true, tiled surface fields are initialized with tile-averaged fields from a previous run with tiles. A neighbor search is applied to subgrid-scale ocean points for SST and sea-ice fraction.	init_mode=1,5,6
lvert_remap_fg	L	.FALSE.		If true, vertical remapping is applied to the atmospheric first-guess fields, whereas the analysis increments remain unchanged. The number of model levels must be the same for input and output fields, and the z_ifc (alias HHL) field pertaining to the input fields must be appended to the first-guess file.	init_mode=5,6

Parameter	Type	Default	Unit	Description	Scope
ifs2icon_filename	C			Filename of IFS2ICON input file, default ”`<path>ifs2icon_R<nroot>B<jlev>_DOM <idom>.nc`”. May contain the keywords `<path>` which will be substituted by `model_base_dir`, as well as `nroot`, `jlev`, and `idom` defining the current patch.	init_mode=2
dwdfg_filename	C			Filename of DWD first-guess input file, default ”`<path>dwdFG_R<nroot>B<jlev>_DOM <idom>.nc`”. May contain the keywords `<path>` which will be substituted by `model_base_dir`, as well as `nroot`, `jlev`, and `idom` defining the current patch.	init_mode=1,3,5,6
dwdana_filename	C			Filename of DWD analysis input file, default ”`<path>dwdana_R<nroot>B<jlev>_DOM <idom>.nc`”. May contain the keywords `<path>` which will be substituted by `model_base_dir`, as well as `nroot`, `jlev`, and `idom` defining the current patch.	init_mode=1,3,5,6
filetype	I	-1 (undef.)		One of CDI's FILETYPE_XXX constants. Possible values: 2 (=FILETYPE_GRB2), 4 (=FILETYPE_NC2). If this parameter has not been set, we try to determine the file type by its extension "*.grb*" or ".nc".	
ana_varlist	C(:)			List of mandatory analysis fields for the **global domain** that must be present in the analysis file. If these fields are not found, the model aborts. For all other analysis fields, the FG-fields will serve as fallback position.	init_mode=1,5,6
ana_varlist_n2	C(:)			List of mandatory analysis fields for **domain 2** that must be present in the analysis file. If these fields are not found, the model aborts. For all other analysis fields, the FG-fields will serve as fallback position.	init_mode=5,6

Parameter	Type	Default	Unit	Description	Scope
ana_varnames_map_file	C			Dictionary file which maps internal variable names onto GRIB2 shortnames or NetCDF var names. This is a text file with two columns separated by whitespace, where left column: ICON variable name, right column: GRIB2 short name.	
latbc_varnames_map_file	C			Dictionary file which maps internal variable names onto GRIB2 shortnames or NetCDF var names. This is a text file with two columns separated by whitespace, where left column: ICON variable name, right column: GRIB2 short name. This list contains variables that are to be read asynchronously for boundary data nudging in a HDCP2 simulation. All new boundary variables that in the future, would be read asynchronously. Need to be added to text file dict.latbc in run folder.	num_prefetch_proc=1

Defined and used in: `src/namelists/mo_initicon_nml.f90`

3.13 interpol_nml

Parameter	Type	Default	Unit	Description	Scope
l_intp_c2l	L	.TRUE.		If .TRUE. directly interpolate scalar variables from cell centers to lon-lat points, otherwise do gradient interpolation and reconstruction.	
l_mono_c2l	L	.TRUE.		Monotonicity can be enforced by demanding that the interpolated value is not higher or lower than the stencil point values.	
llsq_high_consv	L	.TRUE.		conservative (T) or non-conservative (F) least-squares reconstruction for high order transport	
lsq_high_ord	I	3		polynomial order for high order reconstruction 1: linear 2: quadratic	ihadv_tracer=4

Parameter	Type	Default	Unit	Description	Scope
				30: cubic (no 3^{rd} order cross deriv.) 3: cubic	
llsq_lin_consv	L	.FALSE.		conservative (T) or non-conservative (F) least-squares reconstruction for 2nd order (linear) transport	
nudge_efold_width	R	2.0		e-folding width (in units of cell rows) for lateral boundary nudging coefficient	
nudge_max_coeff	R	0.02		Maximum relaxation coefficient for lateral boundary nudging	
nudge_zone_width	I	8		Total width (in units of cell rows) for lateral boundary nudging zone. If < 0 the patch boundary_depth_index is used.	
rbf_dim_c2l	I	10		stencil size for direct lon-lat interpolation: 4 = nearest neighbor, 13 = vertex stencil, 10 = edge stencil.	
rbf_scale_mode_ll	I	2		Specifies, how the RBF shape parameter is determined for lon-lat interpolation. 1 : lookup table based on grid level 2 : determine automatically. So far, this routine only estimates the smallest value for the shape parameter for which the Cholesky is likely to succeed in floating point arithmetic. 3 : explicitly set shape parameter in each output namelist	
rbf_vec_kern_c	I	1		Kernel type for reconstruction at cell centres: 1: Gaussian 3: inverse multiquadric	
rbf_vec_kern_e	I	3		Kernel type for reconstruction at edges: 1: Gaussian 3: inverse multiquadric	
rbf_vec_kern_ll	I	1		Kernel type for reconstruction at lon-lat-points: 1: Gaussian 3: inverse multiquadric	
rbf_vec_kern_v	I	1		Kernel type for reconstruction at vertices:	

Parameter	Type	Default	Unit	Description	Scope
				1: Gaussian 3: inverse multiquadric	
rbf_vec_scale_c	R(n_dom)	resolution-dependent		Scale factor for RBF reconstruction at cell centres	
rbf_vec_scale_e	R(n_dom)	resolution-dependent		Scale factor for RBF reconstruction at edges	
rbf_vec_scale_v	R(n_dom)	resolution-dependent		Scale factor for RBF reconstruction at vertices	
support_baryctr_intp	L	.FALSE.		Flag. If .FALSE. barycentric interpolation is replaced by a fallback interpolation.	

Defined and used in: `src/namelists/mo_interpol_nml.f90`

3.14 io_nml

Parameter	Type	Default	Unit	Description	Scope
lkeep_in_sync	L	.FALSE.		Sync output stream with file on disk after each timestep	
dt_diag	R	86400.	s	diagnostic integral output interval	`run_nml:output = "totint"`
dt_checkpoint	R	2592000	s	Time interval for writing restart files. Note that if the value of dt_checkpoint resulting from model default or user's specification is longer than time_nml:dt_restart, it will be reset (by the model) to dt_restart so that at least one restart file is generated during the restart cycle.	`output /= "none"` (`run_nml`)
inextra_2d	I	0		Number of extra 2D Fields for diagnostic/debugging output.	dynamics_nml:iequations = 3 (to be done for 1, 2)
inextra_3d	I	0		Number of extra 3D Fields for diagnostic/debugging output.	dynamics_nml:iequations = 3 (to be done for 1, 2)

Parameter	Type	Default	Unit	Description	Scope
lflux_avg	L	.TRUE.		if .FALSE. the output fluxes are accumulated from the beginning of the run if .TRUE. the output fluxes are average values from the beginning of the run, except of TOT_PREC that would be accumulated	iequations=3 iforcing=3
itype_pres_msl	I	1		Specifies method for computation of mean sea level pressure (and geopotential at pressure levels below the surface). 1: GME-type extrapolation, 2: stepwise analytical integration, 3: current IFS method, 4: IFS method with consistency correction	
itype_rh	I	1		Specifies method for computation of relative humidity 1: WMO-type: water only (e_s=e_s_water), 2: IFS-type: mixed phase (water and ice), 3: IFS-type with clipping (rh $\leq$ 100)	
output_nml_dict	C	' '		File containing the mapping of variable names to the internal ICON names. May contain the keyword `<path>` which will be substituted by `model_base_dir`. The format of this file: One mapping per line, first the name as given in the `ml_varlist`, `hl_varlist`, `pl_varlist` or `il_varlist` of the `output_nml` namelists, then the internal ICON name, separated by an arbitrary number of blanks. The line may also start and end with an arbitrary number of blanks. Empty lines or lines starting with # are treated as comments. Names not covered by the mapping are used as they are.	`output_nml` namelists

Parameter	Type	Default	Unit	Description	Scope
netcdf_dict	C	' '		File containing the mapping from internal names to names written to NetCDF. May contain the keyword `<path>` which will be substituted by `model_base_dir`. The format of this file: One mapping per line, first the name written to NetCDF, then the internal name, separated by an arbitrary number of blanks (*inverse to the definition of* output_nml_dict). The line may also start and end with an arbitrary number of blanks. Empty lines or lines starting with # are treated as comments. Names not covered by the mapping are output as they are. Note that the specification of output variables, e. g. in `ml_varlist`, is independent from this renaming, see the namelist parameter `output_nml_dict` for this.	`output_nml` namelists, NetCDF output
restart_file_type	I	4		Type of restart file. One of CDI's FILETYPE_XXX. So far, only 4 (=FILETYPE_NC2) is allowed	
use_set_event_to_simstep	L			Currently inactive	

Defined and used in: `src/namelists/mo_io_nml.f90`

3.15 les_nml (parameters for LES turbulence scheme; valid for inwp_turb=5)

Parameter	Type	Default	Unit	Description	Scope
sst	R	300	K	sea surface temperature for idealized LES simulations	isrfc_type=5,4
shflx	R	0.1	Km/s	Kinematic sensible heat flux at surface	isrfc_type = 2
lhflx	R	0	m/s	Kinematic latent heat flux at surface	isrfc_type = 2

Parameter	Type	Default	Unit	Description	Scope
isrfc_type	I	1		surface type 0 = No fluxes and zero shear stress 1 = TERRA land physics 2 = fixed surface fluxes 3 = fixed buoyancy fluxes 4 = RICO test case 5 = fixed SST	
ufric	R	-999	m/s	friction velocity for idealized LES simulations; if $<$ 0 then it is automatically diagnosed	
psfc	R	-999	Pa	surface pressure for idealized LES simulations; if $<$ 0 then it uses the surface pressure from dynamics	
min_sfc_wind	R	1.0	m/s	Minimum surface wind for surface layer useful in the limit of free convection	
is_dry_cbl	L	.FALSE.		switch for dry convective boundary layer simulations	
smag_constant	R	0.23		Smagorinsky constant	
km_min	R	0.0		Minimum turbulent viscosity	
max_turb_scale	R	300.0		Asymtotic maximum turblence length scale (useful for coarse grid LES and when grid is vertically stretched)	
turb_prandtl	R	0.333333		turbulent Prandtl number	
bflux	R	0.0007	m^2/s^3	buoyancy flux for idealized LES simulations (Stevens 2007)	isrfc_type=3
tran_coeff	R	0.02	m/s	transfer coefficient near surface for idealized LES simulation (Stevens 2007)	isrfc_type=3
vert_scheme_type	I	2		type of time integration scheme in vertical diffusion 1 = explicit 2 = fully implicit	
sampl_freq_sec	R	60	s	sampling frequency in seconds for statistical (1D and 0D) output	
avg_interval_sec	R	900	s	(time) averaging interval in seconds for 1D statistical output	
expname	C	ICOLES		expname to name the statistical output file	

Parameter	Type	Default	Unit	Description	Scope
ldiag_les_out	L	.FALSE.		Control for the statistical output in LES mode	
les_metric	L	.FALSE.		Switch to turn on Smagorinsky diffusion with 3D metric terms to account for topography	

Defined and used in: `src/namelists/mo_les_nml.f90`

3.16 limarea_nml (Scope: l_limited_area=1 in grid_nml)

Parameter	Type	Default	Unit	Description	Scope
itype_latbc	I	0		Type of lateral boundary nudging. Nudge from 0: the initial data, 1: IFS data analysis/forecast (if `initicon_nml:init_mode`=4, we take COSMO-DE data), 2: ICON output data (with the identical 3d grid)	
dtime_latbc	R	10800.0	s	Time difference between two consecutive boundary data.	itype_latbc ≥ 1
dt_latbc	C	PT03H		Time difference between two consecutive boundary data in mtime format.	itype_latbc ≥ 1
nlev_latbc	I	0	s	Number of vertical levels in boundary data.	itype_latbc ≥ 1
latbc_filename	C			Filename of boundary data input file, default: "`prepiconR<nroot>B<jlev>_<y><m><d><h>.nc`". `<y>`, `<m>`, `<d>`, and `<h>` will be automatically replaced during the run-time. In case the time span between two consecutive boundary data is less than 1 hour, one can use `<min>` and `<sec>`. These files must be located in the `latbc_path` directory.	itype_latbc ≥ 1
latbc_path	C			Absolute path to boundary data.	itype_latbc ≥ 1

Defined and used in: `src/namelists/mo_limarea_nml.f90`

3.17 lnd_nml

Parameter	Type	Default	Unit	Description	Scope
nlev_snow	I	2		number of snow layers	lmulti_snow=.true.
ntiles	I	1		number of tiles	
lsnowtile	L	.FALSE.		.TRUE.: consider snow-covered and snow-free tiles separately	ntiles>1
frlnd_thrhld	R	0.05		fraction threshold for creating a land grid point	ntiles>1
frlake_thrhld	R	0.05		fraction threshold for creating a lake grid point	ntiles>1
frsea_thrhld	R	0.05		fraction threshold for creating a sea grid point	ntiles>1
frlndtile_thrhld	R	0.05		fraction threshold for retaining the respective tile for a grid point	ntiles>1
lmelt	L	.TRUE.		.TRUE. soil model with melting process	
lmelt_var	L	.TRUE.		.TRUE. freezing temperature dependent on water content	
lana_rho_snow	L	.TRUE.		.TRUE. take rho_snow-values from analysis file	init_mode=1
lmulti_snow	L	.TRUE.		.TRUE. for use of multi-layer snow model	
max_toplaydepth	R	0.25	m	maximum depth of uppermost snow layer	lmulti_snow=.TRUE.
idiag_snowfrac	I	1		Type of snow-fraction diagnosis: 1 = based on SWE only 2–4 = more advanced experimental methods 20, 30, 40 = same as 2, 3, 4, respectively, but with artificial reduction of snow fraction in case of melting snow	
itype_lndtbl	I	1		Table values used for associating surface parameters to land-cover classes: 1 = defaults from extpar (GLC2000 and GLOBCOVER2009) 2 = Tuned version based on IFS values for globcover classes (GLOBCOVER2009 only) 3 = even more tuned version (EXPERIMENTAL!!, GLOBCOVER2009 only)	

Parameter	Type	Default	Unit	Description	Scope
itype_root	I	2		root density distribution: 1 = constant 2 = exponential	
itype_evsl	I	2		type of bare soil evaporation parameterization 2 = Dickinson (1984) 3 = Noilhan and Platon (1989)	
itype_heatcond	I	2		type of soil heat conductivity 1 = constant soil heat conductivity 2 = moisture dependent soil heat conductivity	
itype_interception	I	1		type of plant interception 1 = effectively switched off (secirity minimum of $1E-6$ m for surface area index) 2 = Rain and snow interception (under development)	
itype_hydbound	I	1		type of hydraulic lower boundary condition 1 = none 3 = ground water as lower boundary of soil column	
lstomata	L	.TRUE.		If .TRUE., use map of minimum stomatal resistance If .FALSE., use constant value of 150 s/m.	
l2tls	L	.TRUE.		If .TRUE., forecast with 2-Time-Level integration scheme	
lseaice	L	.TRUE.		.TRUE. for use of sea-ice model	
llake	L	.TRUE.		.TRUE. for use of lake model	
sstice_mode	I	1		1: SST and sea ice fraction are read from the analysis and kept constant. The sea ice fraction can be modified by the seaice model. 2: SST and sea ice fraction are updated daily, based on climatological monthly means 3: SST and sea ice fraction are updated daily, based on actual monthly means 4: SST and sea ice fraction are updated daily, based on actual daily means, not yet implemented	iequations=3 iforcing=3

Parameter	Type	Default	Unit	Description	Scope
sst_td_filename	C			Filename of SST input files for time dependent SST. Default is "<path>SST_<year>_<month>_<gridfile>". May contain the keyword <path> which will be substituted by model_base_dir	sstice_mode=2,3
ci_td_filename	C			Filename of sea ice fraction input files for time dependent sea ice fraction. Default is "<path>CI_<year>_<month>_<gridfile>". May contain the keyword <path> which will be substituted by model_base_dir	sstice_mode=2,3

Defined and used in: `src/namelists/mo_lnd_nwp_nml.f90`

3.18 ls_forcing_nml (parameters for large-scale forcing; valid for torus geometry)

Parameter	Type	Default	Unit	Description	Scope
is_subsidence_moment	L	.FALSE.		switch for enabling LS vertical advection due to subsidence for momentum equations	is_plane_torus=.TRUE.
is_subsidence_heat	L	.FALSE.		switch for enabling LS vertical advection due to subsidence for thermal equations	is_plane_torus=.TRUE.
is_advection	L	.FALSE.		switch for enabling LS horizontal advection (currently only for thermal equations)	is_plane_torus=.TRUE.
is_geowind	L	.FALSE.		switch for enabling geostrophic wind	is_plane_torus=.TRUE.
is_rad_forcing	L	.FALSE.		switch for enabling radiative forcing	is_plane_torus=.TRUE. inwp_rad=.FALSE.
is_theta	L	.FALSE.		switch to indicate that the prescribed radiative forcing is for potential temperature	is_plane_torus=.TRUE. is_rad_forcing=.TRUE.

Defined and used in: `src/namelists/mo_ls_forcing_nml.f90`

3.19 master_model_nml (repeated for each model)

Parameter	Type	Default	Unit	Description	Scope
model_name	C			Character string for naming this component.	
model_namelist_ filename	C			File name containing the model namelists.	
model_type	I	-1		Identifies which component to run. 1=atmosphere 2=ocean 3=radiation 99=dummy_model	
model_min_rank	I	0		Start MPI rank for this model.	
model_max_rank	I	-1		End MPI rank for this model.	
model_inc_rank	I	1		Stride of MPI ranks.	

3.20 master_nml

Parameter	Type	Default	Unit	Description	Scope
lrestart	L	.FALSE.		If .TRUE.: Current experiment is started from a restart.	
model_base_dir	C	' '		General path which may be used in file names of other name lists: If a file name contains the keyword "<path>", then this `model_base_dir` will be substituted.	

3.21 meteogram_output_nml

Parameter	Type	Default	Unit	Description	Scope
lmeteogram_enabled	L(n_dom)	.FALSE.		Flag. True, if meteogram of output variables is desired.	
zprefix	C(n_dom)	"METEO GRAM_"		string with file name prefix for output file	
ldistributed	L(n_dom)	.TRUE.		Flag. Separate files for each PE.	
n0_mtgrm	I(n_dom)	0		initial time step for meteogram output.	
ninc_mtgrm	I(n_dom)	1		output interval (in time steps)	

Parameter	Type	Default	Unit	Description	Scope
stationlist_tot		53.633, 9.983, 'Hamburg'		list of meteogram stations (triples with lat, lon, name string)	
var_list	C(:)	" "		Positive-list of variables (optional). Only variables contained in this list are included in the meteogram. If the default list is not changed by user input, then all available variables are added to the meteogram	

Defined and used in: `src/namelists/mo_mtgrm_nml.f90`

3.22 nonhydrostatic_nml (relevant if run_nml:iequations=3)

Parameter	Type	Default	Unit	Description	Scope
itime_scheme	I	4		Options for predictor-corrector time-stepping scheme: 4: Contravariant vertical velocity is computed in the predictor step only, velocity tendencies are computed in the corrector step only (most efficient option) 5: Contravariant vertical velocity is computed in both substeps (beneficial for numerical stability in very-high resolution setups with extremely steep slops, otherwise no significant impact) 6: As 5, but velocity tendencies are also computed in both substeps (no apparent benefit, but more expensive)	iequations=3
rayleigh_type	I	2		Type of Rayleigh damping 1: CLASSICAL (requires velocity reference state!) 2: Klemp (2008) type	
rayleigh_coeff	R(n_dom)	0.05 for i=1		Rayleigh damping coefficient $1/\tau_0$ (Klemp, Dudhia, Hassiotis: MWR136, pp.3987-4004); higher values are recommended for R2B6 or finer resolution	

Parameter	Type	Default	Unit	Description	Scope
damp_height	R(n_dom)	45000 for i=1	m	Height at which Rayleigh damping of vertical wind starts (needs to be adjusted to model top height; the damping layer should have a depth of at least 20 km when the model top is above the stratopause)	
htop_moist_proc	R	22500.0	m	Height above which moist physics and advection of cloud and precipitation variables are turned off	
hbot_qvsubstep	R	22500.0	m	Height above which QV is advected with substepping scheme (must be at least as large as htop_moist_proc)	ihadv_tracer=22, 32, 42 or 52
vwind_offctr	R	0.15		Off-centering in vertical wind solver. Higher values may be needed for R2B5 or coarser grids when the model top is above 50 km.	
rhotheta_offctr	R	-0.1		Off-centering of density and potential temperature at interface level (may be set to 0.0 for R2B6 or finer grids)	
veladv_offctr	R	0.25		Off-centering of velocity advection in corrector step	
ivctype	I	2		Type of vertical coordinate: 1: Gal-Chen hybrid 2: SLEVE (uses sleve_nml)	
ndyn_substeps	I	5		number of dynamics substeps per fast-physics / transport step	
lhdiff_rcf	L	.TRUE.		.TRUE.: Compute diffusion only at advection time steps (in this case, divergence damping is applied in the dynamical core)	
lextra_diffu	L	.TRUE.		.TRUE.: Apply additional momentum diffusion at grid points close to the stability limit for vertical advection (becomes effective extremely rarely in practice; this is mostly an emergency fix for pathological cases with very large orographic gravity waves)	
divdamp_fac	R	0.0025		Scaling factor for divergence damping	lhdiff_rcf = .TRUE.

Parameter	Type	Default	Unit	Description	Scope
divdamp_order	I	4		Order of divergence damping: 2 = second-order divergence damping 4 = fourth-order divergence damping 24 = combined second-order and fourth-order divergence damping and enhanced vertical wind off-centering during the initial spinup phase (does not allow checkpointing/restarting earlier than 2.5 hours of integration)	lhdiff_rcf = .TRUE.
divdamp_type	I	3		Type of divergence damping: 2 = divergence damping acting on 2D divergence 3 = divergence damping acting on 3D divergence 32 = combination of 3D div. damping in the troposphere with transition to 2D div. damping in the stratosphere	lhdiff_rcf = .TRUE.
divdamp_trans_start	R	12500.		Lower bound of transition zone between 2D and 3D divergence damping	divdamp_type = 32
divdamp_trans_end	R	17500.		Upper bound of transition zone between 2D and 3D divergence damping	divdamp_type = 32
nest_substeps	I	2		Number of dynamics substeps for the child patches. DO NOT CHANGE!!! The code will not work correctly with other values	
l_masscorr_nest	L	.FALSE.		.TRUE.: Apply mass conservation correction also in nested domain	
iadv_rhotheta	I	2		Advection method for rho and rhotheta: 1: simple second-order upwind-biased scheme 2: 2nd order Miura horizontal 3: 3rd order Miura horizontal (not recommended)	

Parameter	Type	Default	Unit	Description	Scope
igradp_method	I	3		Discretization of horizontal pressure gradient: 1: conventional discretization with metric correction term 2: Taylor-expansion-based reconstruction of pressure (advantageous at very high resolution) 3: Similar discretization as option 2, but uses hydrostatic approximation for downward extrapolation over steep slopes 4: Cubic/quadratic polynomial interpolation for pressure reconstruction 5: Same as 4, but hydrostatic approximation for downward extrapolation over steep slopes	
l_zdiffu_t	L	.TRUE.		.TRUE.: Compute Smagorinsky temperature diffusion truly horizontally over steep slopes	hdiff_order=3/5 .AND. lhdiff_temp = .true.
thslp_zdiffu	R	0.025		Slope threshold above which truly horizontal temperature diffusion is activated	hdiff_order=3/5 .AND. lhdiff_temp=.true. .AND. l_zdiffu_t=.true.
thhgtd_zdiffu	R	200	m	Threshold of height difference between neighboring grid points above which truly horizontal temperature diffusion is activated (alternative criterion to thslp_zdiffu)	hdiff_order=3/5 .AND. lhdiff_temp=.true. .AND. l_zdiffu_t=.true.
exner_expol	R	1./3.		Temporal extrapolation (fraction of dt) of Exner function for computation of horizontal pressure gradient. This damps horizontally propagating sound waves. For R2B5 or coarser grids, values between 1/2 and 2/3 are recommended.	
l_open_ubc	L	.FALSE.		.TRUE.: Use open upper boundary condition (rather than w=0) to allow vertical motions related to diabatic heating to extend beyond the model top	

Defined and used in: `src/namelists/mo_nonhydrostatic_nml.f90`

3.23 nwp_phy_nml

The switches for the physics schemes and the time steps can be set for each model domain individually. If only one value is specified, it is copied to all child domains, implying that the same set of parameterizations and time steps is used in all domains. If the number of values given in the namelist is larger than 1 but less than the number of model domains, then the settings from the highest domain ID are used for the remaining model domains. If the time steps are not an integer multiple of the advective time step (dtime), then the time step of the respective physics parameterization is automatically rounded to the next higher integer multiple of the advective time step.

Parameter	Type	Default	Unit	Description	Scope
inwp_gscp	I (max_dom)	1		cloud microphysics and precipitation 0: none 1: hydci (COSMO-EU microphysics, 2-cat ice: cloud ice, snow) 2: hydci_gr (COSMO-DE microphysics, 3-cat ice: cloud ice, snow, graupel) 3: as 1, but with improved ice nucleation scheme by C. Koehler 4: Two-moment microphysics by A. Seifert 9: Kessler scheme	run_nml:iforcing = inwp
qi0	R	0.0	kg/kg	cloud ice threshold for autoconversion	inwp_gscp=1
qc0	R	0.0	kg/kg	cloud water threshold for autoconversion	inwp_gscp=1
mu_rain	R	0.0		shape parameter in gamma distribution for rain	inwp_gscp>0
mu_snow	R	0.0		shape parameter in gamma distribution for snow	inwp_gscp>0
icpl_aero_gscp	I	0		0: off 1: simple coupling between autoconversion and Tegen aerosol climatology; requires irad_aero=6 More advanced options are in preparation	currently only for inwp_gscp = 1
inwp_convection	I (max_dom)	1		convection 0: none 1: Tiedtke/Bechtold convection	run_nml:iforcing = inwp

Parameter	Type	Default	Unit	Description	Scope
icapdcycl	I	0		Type of CAPE correction to improve diurnal cycle for convection: 0 = none (IFS default prior to autumn 2013) 1 = intermediate testing option 2 = correctoins over land and water now operational at ECMWF 3 = correction over land as in 2 restricted to the tropics, no correction over water (this choice optimizes the NWP skill scores)	inwp_convection = 1
icpl_aero_conv	I	0		0: off 1: simple coupling between autoconversion and Tegen aerosol climatology; requires irad_aero=6	
icpl_o3_tp	I	1		0: off 1: simple coupling between the ozone mixing ratio and the thermal tropopause, restricted to the extratropics	irad_o3 = 7 or 9
inwp_cldcover	I (max_dom)	1		cloud cover scheme for radiation 0: no clouds (only QV) 1: diagnostic cloud cover (by Martin Koehler) 2: prognostic total water variance (not yet started) 3: clouds from COSMO SGS cloud scheme 4: clouds as in turbulence (turbdiff) 5: grid scale clouds	run_nml:iforcing = inwp
inwp_radiation	I (max_dom)	1		radiation 0: none 1: RRTM radiation 2: Ritter-Geleyn radiation	run_nml:iforcing = inwp
inwp_satad	I	1		saturation adjustment 0: none 1: saturation adjustment at constant density	run_nml:iforcing = inwp

Parameter	Type	Default	Unit	Description	Scope
inwp_turb	I (max_ dom)	1		vertical diffusion and transfer 0: none 1: COSMO diffusion and transfer 2: GME turbulence scheme 3: EDMF-DUALM (work in progress) 5: Classical Smagorinsky diffusion	run_nml:iforcing = inwp
inwp_sso	I (max_ dom)	1		subgrid scale orographic drag 0: none 1: Lott and Miller scheme (COSMO)	run_nml:iforcing = inwp
inwp_gwd	I (max_ dom)	1		non-orographic gravity wave drag 0: none 1: Orr-Ern-Bechtold-scheme (IFS)	run_nml:iforcing = inwp
inwp_surface	I (max_ dom)	1		surface scheme 0: none 1: TERRA	run_nml:iforcing = inwp
ustart_raylfric	R	160.0	m/s	wind speed at which extra Rayleigh friction starts	inwp_gwd > 0
efdt_min_raylfric	R	10800.	s	minimum e-folding time of Rayleigh friction (effective for u > ustart_raylfric + 90 m/s)	inwp_gwd > 0
latm_above_top	L (max_ dom)	.FALSE.		.TRUE.: take into account atmosphere above model top for radiation computation	inwp_radiation > 0
itype_z0	I	2		Type of roughness length data used for turbulence scheme: 1 = land-cover-related roughness including contribution from sub-scale orography 2 = land-cover-related roughness only	inwp_turb > 0
dt_conv	R (max_ dom)	600.	s	time interval of convection call currently each subdomain has the same value	run_nml:iforcing = inwp
dt_rad	R (max_ dom)	1800.	s	time interval of radiation call currently each subdomain has the same value	run_nml:iforcing = inwp
dt_sso	R (max_ dom)	1200.	s	time interval of sso call currently each subdomain has the same value	run_nml:iforcing = inwp
dt_gwd	R (max_ dom)	1200.	s	time interval of gwd call currently each subdomain has the same value	run_nml:iforcing = inwp

Parameter	Type	Default	Unit	Description	Scope
lrtm_filename	C(:)	"rrtmg_ lw.nc"		NetCDF file containing longwave absorption coefficients and other data for RRTMG_LW k-distribution model.	
cldopt_filename	C(:)	"ECHAM 6_CldOpt Props.nc"		NetCDF file with RRTM Cloud Optical Properties for ECHAM6.	

Defined and used in: `src/namelists/mo_nwp_phy_nml.f90`

3.24 nwp_tuning_nml

Please note: These tuning parameters are NOT domain specific.

Parameter	Type	Default	Unit	Description	Scope
SSO (Lott and Miller)					
tune_gkwake	R	1.5		low level wake drag constant	run_nml:iforcing = inwp
tune_gkdrag	R	0.075		gravity wave drag constant	run_nml:iforcing = inwp
GWD (Warner McIntyre)					
tune_gfluxlaun	R	2.50e-3		total launch momentum flux in each azimuth (rho_o x F_o)	run_nml:iforcing = inwp
Grid scale microphysics (one moment)					
tune_zceff_min	R	0.075		Minimum value for sticking efficiency	run_nml:iforcing = inwp
tune_v0snow	R	25.0		factor in the terminal velocity for snow	run_nml:iforcing = inwp
tune_zvz0i	R	1.25	m/s	Terminal fall velocity of ice	run_nml:iforcing = inwp
Convection scheme					
tune_entrorg	R	1.825e-3	1/m	Entrainment parameter valid for dx=20 km	run_nml:iforcing = inwp
Misc					
itune_albedo	I	0		MODIS albedo tuning 0: None 1: dimmed sahara	run_nml:iforcing = inwp albedo_type=2
IAU					

Parameter	Type	Default	Unit	Description	Scope
max_freshsnow_inc	R	0.025		Maximum allowed freshsnow increment per analysis cycle (positive or negative)	init_mode=5 (MODE_IAU)

Defined and used in: `src/namelists/mo_nwp_tuning_nml.f90`

3.25 output_nml (relevant if run_nml/output='nml')

Please note: There may be several instances of output_nml in the namelist file, every one defining a list of variables with separate attributes for output.

Parameter	Type	Default	Unit	Description	Scope
dom	I(:)	-1		Array of domains for which this name-list is used. If not specified (or specified as -1 as the first array member), this name-list will be used for all domains. Attention: Depending on the setting of the parameter l_output_phys_patch these are either logical or physical domain numbers!	
file_interval	C	' '		Defines the length of a file in terms of an ISO-8601 duration string. An example for this time stamp format is given below. This namelist parameter can be set instead of `steps_per_file`.	
filename_format	C	see description.		Output filename format. Includes keywords `path`, `output_filename`, `physdom`, etc. (see below). Default is <output_filename>_DOM<physdom>_<levtype>_<jfile>	
filename_extn	C	"default"		User-specified filename extension (empty string also possible). If this namelist parameter is chosen as "default", then we have ".nc" for NetCDF output files, and ".grb" for GRIB1/2.	

Parameter	Type	Default	Unit	Description	Scope
filetype	I	4		One of CDI's FILETYPE_XXX constants. Possible values: 2=FILETYPE_GRB2, 4=FILETYPE_NC2, 5=FILETYPE_NC4	
m_levels	C	None		Model level indices (optional). Allowed is a comma- (or semicolon-) separated list of integers, and of integer ranges like "10...20". One may also use the keyword "nlev" to denote the maximum integer (or, equivalently, "n" or "N"). Furthermore, arithmetic expressions like "(nlev - 2)" are possible. Basic example: `m_levels = "1,3,5...10,20...(nlev-2)"`	
h_levels	R(:)	None	m	height levels	
p_levels	R(:)	None	Pa	pressure levels	
i_levels	R(:)	None	K	isentropic levels	
ml_varlist	C(:)	None		Name of model level fields to be output.	
hl_varlist	C(:)	None		Name of height level fields to be output.	
pl_varlist	C(:)	None		Name of pressure level fields to be output.	
il_varlist	C(:)	None		Name of isentropic level fields to be output.	
include_last	L	.TRUE.		Flag whether to include the last time step	
mode	I	2		1 = forecast mode, 2 = climate mode In climate mode the time axis of the output file is set to TAXIS_ABSOLUTE. In forecast mode it is set to TAXIS_RELATIVE. Till now the forecast mode only works if the output is at multiples of 1 hour	

Parameter	Type	Default	Unit	Description	Scope
taxis_tunit	I	2		Time unit of the TAXIS_RELATIVE time axis. 1 = TUNIT_SECOND 2 = TUNIT_MINUTE 3 = TUNIT_HOUR For a complete list of possible values see cdi.inc	mode=1
output_bounds	R($k*$ 3)	None		Post-processing times: start, end, increment. We choose the advection time step matching or following the requested output time, therefore we require `output_bounds(3) > dtime`. Multiple triples are possible in order to define multiple starts/ends/intervals. See namelist parameters `output_start`, `output_end`, `output_interval` for an alternative specification of output events.	
output_time_unit	I	1		Units of output bounds specification. 1 = second 2 = minute 3 = hour 4 = day 5 = month 6 = year	
output_filename	C	None		Output filename prefix (which may include path). Domain number, level type, file number and extension will be added, according to the format given in namelist parameter "filename_format".	
output_grid	L	.FALSE.		Flag whether grid information is added to output.	
output_start	C(:)	' '		ISO8601 time stamp for begin of output. An example for this time stamp format is given below. More than one value is possible in order to define multiple start/end/interval triples. See namelist parameter `output_bounds` for an alternative specification of output events.	

Parameter	Type	Default	Unit	Description	Scope
output_end	C(:)	' '		ISO8601 time stamp for end of output. An example for this time stamp format is given below. More than one value is possible in order to define multiple start/end/interval triples. See namelist parameter `output_bounds` for an alternative specification of output events.	
output_interval	C(:)	' '		ISO8601 time stamp for repeating output intervals. We choose the advection time step matching or following the requested output time, therefore we require `output_bounds(3) > dtime`. An example for this time stamp format is given below. More than one value is possible in order to define multiple start/end/interval triples. See namelist parameter `output_bounds` for an alternative specification of output events.	
pe_placement_il	I(:)	-1		Advanced output option: Explicit assignment of output MPI ranks to the isentropic level output file. At most `stream_partitions_il` different ranks can be specified. See namelist parameter `pe_placement_ml` for further details.	
pe_placement_hl	I(:)	-1		Advanced output option: Explicit assignment of output MPI ranks to the height level output file. At most `stream_partitions_hl` different ranks can be specified. See namelist parameter `pe_placement_ml` for further details.	
pe_placement_ml	I(:)	-1		Advanced output option: Explicit assignment of output MPI ranks to the model level output file. At most `stream_partitions_ml` different ranks can be specified, out of the following list: `0` ... (`num_io_procs` - 1). If this namelist parameters is not provided, then the output ranks are chosen in a Round-Robin fashion among those ranks that are not occupied by explicitly placed output files.	

Parameter	Type	Default	Unit	Description	Scope
pe_placement_pl	I(:)	-1		Advanced output option: Explicit assignment of output MPI ranks to the pressure level output file. At most `stream_partitions_pl` different ranks can be specified. See namelist parameter `pe_placement_ml` for further details.	
ready_file	C	'default'		A *ready file* is a technique for handling dependencies between the NWP processes. The completion of the write process is signalled by creating a small file with name `ready_file`. Different `output_nml`'s may be joined together to form a single ready file event. The setting of `ready_file = "default"` does not create a ready file. The ready file name may contain string tokens `<path>`, `<datetime>`, `<ddhhmmss>` which are substituted as described for the namelist parameter `filename_format`.	
reg_def_mode	I	0		Specify if the "delta" value prescribes an interval size or the total *number* of intervals: 0: switch automatically between increment and no. of grid points, 1: `reg_lon/lat_def(2)` specifies increment, 2: `reg_lon/lat_def(2)` specifies no. of grid points.	remap=1
remap	I	0		interpolate horizontally 0: none 1: to regular lat-lon grid	
north_pole	R(2)	0,90		definition of north pole for rotated lon-lat grids.	
reg_lat_def	R(3)	None		start, increment, end latitude in degrees. Alternatively, the user may set the number of grid points instead of an increment. Details for the setting of regular grids is given below together with an example.	remap=1

Parameter	Type	Default	Unit	Description	Scope
reg_lon_def	R(3)	None		The regular grid points are specified by three values: start, increment, end given in degrees. Alternatively, the user may set the number of grid points instead of an increment. Details for the setting of regular grids is given below together with an example.	remap=1
steps_per_file	I	-1		Max number of output steps in one output file. If this number is reached, a new output file will be opened.	
steps_per_file_inclfirst	L	see descr.		Defines if first step is counted wrt. `steps_per_file` files count. The default is `.FALSE.` for GRIB2 output, and `.TRUE.` otherwise.	
stream_partitions_hl	I	1		Splits height level output of this namelist into several concurrent alternating files. See namelist parameter `stream_partitions_ml` for details.	
stream_partitions_il	I	1		Splits isentropic level output of this namelist into several concurrent alternating files. See namelist parameter `stream_partitions_ml` for details.	
stream_partitions_ml	I	1		Splits model level output of this namelist into several concurrent alternating files. The output is split into N files, where the start date of part i gets an offset of $(i-1) * $ `output_interval`. The output interval is then replaced by $N *$ `output_interval`, the `include_last` flag is set to `.FALSE.`, the `steps_per_file_inclfirst` flag is set to `.FALSE.`, and the `steps_per_file` counter is set to `1`.	
stream_partitions_pl	I	1		Splits pressure level output of this namelist into several concurrent alternating files. See namelist parameter `stream_partitions_ml` for details.	
rbf_scale	R	-1.		Explicit setting of RBF shape parameter for interpolated lon-lat output. This namelist parameter is only active in combination with interpol_nml:rbf_scale_mode_ll=3.	interpol_nml:rbf_scale_mode_ll=3

Defined and used in: `src/io/shared/mo_name_list_output_init.f90`

Interpolation onto regular grids: Horizontal interpolation onto regular grids is possible through the namelist setting `remap=1`, where the mesh is defined by the parameters

- `reg_lon_def`: mesh latitudes in degrees,
- `reg_lat_def`: mesh longitudes in degrees,
- `north_pole`: definition of north pole for rotated lon-lat grids.

The regular grid points in `reg_lon_def`, `reg_lat_def` are each specified by three values, given in degrees: *start*, *increment*, *end*. The mesh then contains all grid points $start + k * increment <= end$, where k is an integer. Instead of defining an increment it is also possible to prescribe the number of grid points.

- Setting the namelist parameter `reg_def_mode=0`: Switch automatically from increment specification to no. of grid points, when the `reg_lon/lat_def(2)` value is larger than 5.0.
- 1: `reg_lon/lat_def(2)` specifies increment
- 2: `reg_lon/lat_def(2)` specifies no. of grid points

For longitude values the last grid point is omitted if the end point matches the start point, e.g. for 0 and 360 degrees.

Examples

local grid with 0.5 degree increment:	`reg_lon_def = -30.,0.5,30.` `reg_lat_def = 90.,-0.5, -90.`
global grid with 720x361 grid points:	`reg_lon_def = 0.,720,360.` `reg_lat_def = -90.,360,90.`

Time stamp format: The namelist parameters `output_start`, `output_end`, `output_interval` allow the specification of time stamps according to ISO 8601. The general format for time stamps is `YYYY-MM-DDThh:mm:ss` where `Y`: year, `M`: month, `D`: day for dates, and `hh`: hour, `mm`: minute, `ss`: second for time strings. The general format for durations is `PnYnMnDTnHnMnS`. See, for example, `http://en.wikipedia.org/wiki/ISO_8601` for details and further specifications.

NOTE: as the mtime library underlaying the output driver currently has some restrictions concerning the specification of durations:

1. Any number `n` in `PnYnMnDTnHnMnS` must have two digits. For instance use `"PT06H"` instead of `"PT6H"`

2. In a duration string `PnyearYnmonMndayDTnhrHnminMnsecS` the numbers `nxyz` must not pass the carry over number to the next larger time unit: 0<=nmon<=12, 0<=nhr<=23, 0<=nmin<=59, 0<=nsec<=59.999. For instance use `"P01D"` instead of `"PT24H"`, or `"PT01M"` instead of `"PT60S"`.

Soon the formatting problem will be resolved and the valid number ranges will be enlarged. (2013-12-16).

Examples

date and time representation (`output_start`, `output_end`)	`2013-10-27T13:41:00Z`
duration (`output_interval`)	`P00DT06H00M00S`

Variable Groups

Keyword `"group:"`: Using the `"group:"` keyword for the namelist parameters `ml_varlist`, `hl_varlist`, `pl_varlist`, sets of common variables can be added to the output:

`group:all`	output of all variables (caution: do not combine with <u>mixed</u> vertical interpolation)
`group:atmo_ml_vars`	basic atmospheric variables on model levels
`group:atmo_pl_vars`	same set as atmo_ml_vars, but except pres
`group:atmo_zl_vars`	same set as atmo_ml_vars, but expect height
`group:nh_prog_vars`	additional prognostic variables of the nonhydrostatic model
`group:atmo_derived_vars`	derived atmospheric variables
`group:rad_vars`	
`group:precip_vars`	
`group:cloud_diag`	
`group:pbl_vars`	
`group:phys_tendencies`	
`group:land_vars`	
`group:snow_vars`	snow variables
`group:multisnow_vars`	multi-layer snow variables
`group:additional_precip_vars`	
`group:dwd_fg_atm_vars`	DWD first guess fields (atmosphere)
`group:dwd_fg_sfc_vars`	DWD first guess fields (surface/soil)
`group:ART_AERO_VOLC`	ART volcanic ash fields
`group:ART_AERO_RADIO`	ART radioactive tracer fields
`group:ART_AERO_DUST`	ART mineral dust aerosol fields

`group:ART_AERO_SEAS`	ART sea salt aerosol fields
`group:prog_timemean`	time mean output: temp, u, v, rho
`group:tracer_timemean`	time mean output: qv, qc, qi
`group:echam_timemean`	time mean output: most echam surface variables
`group:atmo_timemean`	time mean variables from `prog_timemean`,`tracer_timemean`, `echam_timemean`

Keyword `"tiles:"`: The `"tiles:"` keyword allows to add all tiles of a specific variable to the output, without the need to specify all tile fields separately. E.g. `"tiles:t_g"` (read: "tiles of `t_g`") automatically adds all `t_g_t_X` fields to the output. Here, `X` is a placeholder for the tile number. Make sure to specify the name of the aggregated variable rather than the name of the corresponding tile container (i.e. in the given example it must be `t_g`, and not `t_g_t`!).

Note:

There exists a special syntax which allows to remove variables from the output list, e. g. if these undesired variables were contained in a previously selected group.
Typing "-<varname>" (for example `"-temp"`) removes the variable from the union set of group variables and other selected variables. Note that typos are not detected but that the corresponding variable is simply not removed!

Keyword substitution in output filename (`filename_format`):

`path`	substituted by `model_base_dir`
`output_filename`	substituted by `output_filename`
`physdom`	substituted by physical patch ID
`levtype`	substituted by level type "ML", "PL", "HL", "IL"
`levtype_l`	like `levtype`, but in lower case
`jfile`	substituted by output file counter
`datetime`	substituted by ISO-8601 date-time stamp in format `YYYY-MM-DDThh:mm:ss.sssZ`
`datetime2`	substituted by ISO-8601 date-time stamp in format `YYYYMMDDThhmmssZ`
`datetime3`	substituted by ISO-8601 date-time stamp in format `YYYYMMDDThhmmss.sssZ`
`ddhhmmss`	substituted by *relative* day-hour-minute-second string
`hhhmmss`	substituted by *relative* hour-minute-second string
`npartitions`	If namelist is split into concurrent files: number of stream partitions.
`ifile_partition`	If namelist is split into concurrent files: stream partition index of this file.
`total_index`	If namelist is split into concurrent files: substituted by the file counter

(like in `jfile`), which an "unsplit" namelist would have produced

3.26 parallel_nml

Parameter	Type	Default	Unit	Description	Scope
nproma	I	1		chunk length	
n_ghost_rows	I	1		number of halo cell rows	
division_method	I	1		method of domain decomposition 0: read in from file 1: use built-in geometric subdivision	
division_file_name	C			Name of division file	division_method = 0
ldiv_phys_dom	L	.TRUE.		.TRUE.: split into physical domains before computing domain decomposition (in case of merged domains) (This reduces load imbalance; turning off this option is not recommended except for very small processor numbers)	division_method = 1
p_test_run	L	.FALSE.		.TRUE. means verification run for MPI parallelization (PE 0 processes full domain)	
l_test_openmp	L	.FALSE.		if .TRUE. is combined with p_test_run=.TRUE. and OpenMP parallelization, the test PE gets only 1 thread in order to verify the OpenMP parallelization	p_test_run = .TRUE.
l_log_checks	L	.FALSE.		if .TRUE. messages are generated during each synchonization step (use for debugging only)	
l_fast_sum	L	.FALSE.		if .TRUE., use fast (not processor-configuration-invariant) global summation	
use_dycore_barrier	L	.FALSE.		if .TRUE., set an MPI barrier at the beginning of the nonhydrostatic solver (do not use for production runs!)	
itype_exch_barrier	I	0		1: set an MPI barrier at the beginning of each MPI exchange call 2: set an MPI barrier after each MPI WAIT call 3: 1+2 (do not use for production runs!)	

Parameter	Type	Default	Unit	Description	Scope
iorder_sendrecv	I	1		Sequence of send/receive calls: 1 = irecv/send 2 = isend/recv 3 = isend/irecv	
itype_comm	I	1		1: use local memory for exchange buffers 3: asynchronous halo communication for dynamical core (currently deactivated)	
num_io_procs	I	0		Number of I/O processors (running exclusively for doing I/O)	
num_restart_procs	I	0		Number of restart processors (running exclusively for doing restart)	
num_prefetch_proc	I	0		Number of processors for prefetching of boundary data asynchronously for a limited area run (running exclusively for reading Input boundary data. Maximum no of processors used for it is limited to 1).	itype_latbc ≥ 1
pio_type	I	1		Type of parallel I/O. Only used if number of I/O processors greater than number of domains. Experimental!	
use_icon_comm	L	.FALSE.		Enable the use of MPI bulk communication through the icon_comm_lib	
icon_comm_debug	L	.FALSE.		Enable debug mode for the icon_comm_lib	
max_send_recv-_buffer_size	I	131072		Size of the send/receive buffers for the icon_comm_lib.	
use_dp_mpi2io	L	.FALSE.		Enable this flag if output fields shall be gathered by the output processes in DOUBLE PRECISION.	
restart_chunk_size	I	1		*(Advanced namelist parameter:)* Number of levels to be buffered by the asynchronous restart process. The (asynchronous) restart is capable of writing and communicating more than one 2D slice at once.	

Defined and used in: `src/namelists/mo_parallel_nml.f90`

3.27 psrad_nml

Parameter	Type	Default	Unit	Description	Scope
lradforcing	L(2)	.FALSE.		switch for diagnostics of aerosol forcing in the solar spectral range (lradforcing(1)) and the thermal spectral range (lradforcing(2)).	
lw_gpts_ts	I	1		number of g–points in Monte–Carlo spectral integration for thermal radiation, see lw_spec_samp	
lw_spec_samp	I	1		sampling of spectral bands in radiation calculation for thermal radiation lw_spec_samp = 1: standard broad band sampling lw_spec_samp = 2: Monte–Carlo spec- tral integration (MSCI); lw_gpts_ts randomly chosen g–points per column and radiation call lw_spec_samp = 3: choose g–points not completely randomly in order to reduce errors in the surface radiative fluxes	
rad_perm	I	0		integer number that influences the perturba- tion of the random seed from column to column	
sw_gpts_ts	I	1		number of g–points in Monte–Carlo spectral integration for solar radiation, see sw_spec_samp	
sw_spec_samp	I	1		sampling of spectral bands in radiation calculation for solar radiation sw_spec_samp = 1: standard broad band sampling sw_spec_samp = 2: Monte–Carlo spectral integration (MSCI); lw_gpts_ts randomly chosen g–points per column and radiation call sw_spec_samp = 3: choose g–points not completely randomly in order to reduce errors in the surface radiative fluxes	

Defined and used in: `src/echam_phy_psrad/mo_psrad_radiation.f90`

3.28 radiation_nml

Parameter	Type	Default	Unit	Description	Scope
ldiur	L	.TRUE.		switch for solar irradiation: .TRUE.:diurnal cycle, .FALSE.:zonally averaged irradiation	
nmonth	I	0		0: Earth circles on orbit 1-12: Earth orbit position fixed for specified month	
lyr_perp	L	.FALSE.		.FALSE.: transient Earth orbit following VSOP87 .TRUE.: Earth orbit of year yr_perp of the VSOP87 orbit is perpertuated	
yr_perp	L	-99999		year used for lyr_perp = .TRUE.	
isolrad	I	0		Insolation scheme 0: Use original SRTM insolation. 1: Use insolation from external file containing the spectrally resolved insolation (monthly means) 2: Use preindustrial insolation as in CMIP5 (average from 1844–1856) 3: Use insolation for AMIP–type CMIP5 simulation (average from 1979–1988)	
izenith	I	4		Choice of zenith angle formula for the radiative transfer computation. 0: Sun in zenith everywhere 1: Zenith angle depends only on latitude 2: Zenith angle depends only on latitude. Local time of day fixed at 07:14:15 for radiative transfer computation (sin(time of day) = 1/pi 3: Zenith angle changing with latitude and time of day 4: Zenith angle and irradiance changing with season, latitude, and time of day (iforcing=inwp only)	

Parameter	Type	Default	Unit	Description	Scope
albedo_type	I	1		Type of surface albedo 1: based on soil type specific tabulated values (dry soil) 2: MODIS albedo	iforcing=inwp
direct_albedo	I	4		Direct beam surface albedo. Options mainly differ in terms of their solar zenith angle (SZA) dependency 1: SZA dependency following Ritter-Geleyn; applied to unconditionally all grid points 2: SZA dependency following Zaengl (pers. comm.). Same as 1 for water, but for 'rough surfaces' over land the direct albedo is not allowed to exceed the corresponding broadband diffuse albedo. 3: SZA dependency following Yang (2008) for snow-free land points. Same as 1 for water/ice and 2 for snow. 4: SZA dependency following Briegleb (1992) for snow-free land points. Same as 1 for water/ice and 2 for snow.	iforcing=inwp albedo_type=2
irad_h2o irad_co2 irad_ch4 irad_n2o irad_o3 irad_o2 irad_cfc11 irad_cfc12	I	1 2 3 3 0 2 2 2		Switches for the concentration of radiative agents 0: 0. 1: prognostic variable 2: global constant 3: externally specified irad_o3 = 2: ozone climatology from MPI irad_o3 = 4: ozone clim for Aqua Planet Exp irad_o3 = 6: ozone climatology with T5 geographical distribution and Fourier series for seasonal cycle for run_nml/iforcing = 3 (NWP) irad_o3 = 7: GEMS ozone climatology (from IFS) for run_nml/iforcing = 3 (NWP) irad_o3 = 8: ozone climatology for AMIP irad_o3 = 9: MACC ozone climatology (from IFS) for run_nml/iforcing = 3 (NWP)	Note: until further notice, please use irad_h2o = 1 irad_co2 = 2 and 0 for all the other agents for run_nml/iforcing = 2 (ECHAM).

Parameter	Type	Default	Unit	Description	Scope
vmr_co2 vmr_ch4 vmr_n2o vmr_o2 vmr_cfc11 vmr_cfc12	R	348.0e-6 1650.0e-9 306.0e-9 0.20946 214.5e-12 371.1e-12		Volume mixing ratio of the radiative agents	
irad_aero	I	2		Aerosols 1: prognostic variable 2: global constant 3: externally specified 5: Tanre aerosol climatology for run_nml/iforcing = 3 (NWP) 6: Tegen aerosol climatology for run_nml/iforcing = 3 (NWP) .AND. itopo =1	
lrad_aero_diag	L	.FALSE.		writes actual aerosol optical properties to output	
ighg	I	0		Select dynamic greenhouse gases scenario (read from file) 0 : select default gas volume mixing ratios - 1990 values (CMIP5) 1 : transient CMIP5 scenario from file	run_nml/iforcing=2 (ECHAM)

Defined and used in: `src/namelists/mo_radiation_nml.f90`

3.29 run_nml

Parameter	Type	Default	Unit	Description	Scope
nsteps	I	-999		Number of time steps of this run. Allowed range is ≥ 0; setting a value of 0 allows writing initial output (including internal remapping) without calculating time steps.	

Parameter	Type	Default	Unit	Description	Scope
dtime	R	600.0	s	time step. For real case runs the maximum allowable time step can be estimated as $1.8 \cdot \text{ndyn\_substeps} \cdot \overline{\Delta x}\,\mathrm{s\,km^{-1}}$, where $\overline{\Delta x}$ is the average resolution in km and ndyn_substeps is the number of dynamics substeps set in nonhydrostatic_nml. ndyn_substeps should not be increased beyond the default value 5.	
ltestcase	L	.TRUE.		Idealized testcase runs	
ldynamics	L	.TRUE.		Compute adiabatic dynamic tendencies	
iforcing	I	0		Forcing of dynamics and transport by parameterized processes. Use positive indices for the atmosphere and negative indices for the ocean. 0: no forcing 1: Held-Suarez forcing 2: ECHAM forcing 3: NWP forcing 4: local diabatic forcing without physics 5: local diabatic forcing with physics -1: MPIOM forcing (to be done)	
ltransport	L	.FALSE.		Compute large-scale tracer transport	
ntracer	I	0		Number of advected tracers handled by the large-scale transport scheme	
lvert_nest	L	.FALSE.		If set to .true. vertical nesting is switched on (i.e. variable number of vertical levels)	
num_lev	I(max_dom)	31		Number of full levels (atm.) for each domain	lvert_nest=.TRUE.
nshift	I(max_dom)	0		vertical half level of parent domain which coincides with upper boundary of the current domain required for vertical refinement, which is not yet implemented	lvert_nest=.TRUE.
ltimer	L	.TRUE.		TRUE: Timer for monitoring the runtime of specific routines is on (FALSE = off)	
timers_level	I	1			

Parameter	Type	Default	Unit	Description	Scope
activate_sync_timers	L	F		TRUE: Timer for monitoring runtime of communication routines (FALSE = off)	
msg_level	I	10		controls how much printout is written during runtime. For values less than 5, only the time step is written.	
msg_timestamp	L	.FALSE.		If .TRUE., precede output messages by time stamp.	
test_mode	I	0		Setting a value larger than 0 activates a dummy mode in which time stepping is changed into just doing iterations, and MPI communication is replaced by copying some value from the send buffer into the receive buffer (does not work with nesting and reduced radiation grid because the send buffer may then be empty on some PEs)	iequations = 3
debug_check_level	I	0		Setting a value larger than 0 activates debug checks.	
output	C(:)	“nml”, ”totint”		Main switch for enabling/disabling components of the model output. One or more choices can be set (as an array of string constants). Possible choices are: • “none”: switch off all output; • “nml”: new output mode (cf. `output_nml`); • “totint”: computation of total integrals. If the `output` namelist parameter is not set explicitly, the default setting “nml”,”totint” is assumed.	
restart_filename	C			File name for restart/checkpoint files (containing keyword substitution patterns `<gridfile>`, `<idom>`, `<rsttime>`, `<mtype>`). default: ”`<gridfile>_restart_<mtype>_<rsttime>.nc`”.	

Parameter	Type	Default	Unit	Description	Scope
profiling_output	I	1		controls how profiling printout is written: TIMER_MODE_AGGREGATED=1, TIMER_MODE_DETAILED=2, TIMER_MODE_WRITE_FILES=3.	
lart	L	.FALSE.		Main switch which enables the treatment of atmospheric aerosol and trace gases (The ART package of KIT is needed for this purpose)	
check_uuid_gracefully	L	.FALSE.		If this flag is set to `.TRUE.` we give only warnings for non-matching UUIDs.	

Defined and used in: `src/namelists/mo_run_nml.f90`

3.30 sleve_nml (relevant if nonhydrostatic_nml:ivctype=2)

Parameter	Type	Default	Unit	Description	Scope
min_lay_thckn	R	50	m	Layer thickness of lowermost layer; specifying zero or a negative value leads to constant layer thicknesses determined by top_height and nlev	
max_lay_thckn	R	25000	m	Maximum layer thickness below the height given by htop_thcknlimit (NWP recommendation: 400 m) *Use with caution! Too ambitious settings may result in numerically unstable layer configurations.*	
htop_thcknlimit	R	15000	m	Height below which the layer thickness does not exceed max_lay_thckn	
top_height	R	23500.0	m	Height of model top	
stretch_fac	R	1.0		Stretching factor to vary distribution of model levels; values <1 increase the layer thickness near the model top	
decay_scale_1	R	4000	m	Decay scale of large-scale topography component	
decay_scale_2	R	2500	m	Decay scale of small-scale topography component	
decay_exp	R	1.2		Exponent of decay function	
flat_height	R	16000	m	Height above which the coordinate surfaces are flat	

Parameter	Type	Default	Unit	Description	Scope
lread_smt	L	.FALSE.		read smoothed topography from file (TRUE) or compute internally (FALSE)	

Defined and used in: `src/namelists/mo_sleve_nml.f90`

3.31 synsat_nml[1]

This namelist enables the RTTOV library incorporated into ICON for simulating satellite radiance and brightness temperatures. RTTOV is a radiative transfer model for nadir-viewing passive visible, infrared and microwave satellite radiometers, spectrometers and interferometers, see

`https://nwpsaf.eu/deliverables/rtm`

for detailed information.

Parameter	Type	Default	Unit	Description	Scope
lsynsat	L (max_dom)	.FALSE.		Main switch: Enables/disables computation of synthetic satellite imagery for each model domain.	
nlev_rttov	I	51		Number of RTTOV levels.	

Enabling the synsat module makes the following 32 two-dimensional output fields available:

SYNMSG_RAD_CL_IR3.9	SYNMSG_BT_CL_IR3.9	SYNMSG_RAD_CL_WV6.2	SYNMSG_BT_CL_WV6.2
SYNMSG_RAD_CL_WV7.3	SYNMSG_BT_CL_WV7.3	SYNMSG_RAD_CL_IR8.7	SYNMSG_BT_CL_IR8.7
SYNMSG_RAD_CL_IR9.7	SYNMSG_BT_CL_IR9.7	SYNMSG_RAD_CL_IR10.8	SYNMSG_BT_CL_IR10.8
SYNMSG_RAD_CL_IR12.1	SYNMSG_BT_CL_IR12.1	SYNMSG_RAD_CL_IR13.4	SYNMSG_BT_CL_IR13.4
SYNMSG_RAD_CS_IR3.9	SYNMSG_BT_CS_IR3.9	SYNMSG_RAD_CS_WV6.2	SYNMSG_BT_CS_WV6.2
SYNMSG_RAD_CS_WV7.3	SYNMSG_BT_CS_WV7.3	SYNMSG_RAD_CS_IR8.7	SYNMSG_BT_CS_IR8.7
SYNMSG_RAD_CS_IR9.7	SYNMSG_BT_CS_IR9.7	SYNMSG_RAD_CS_IR10.8	SYNMSG_BT_CS_IR10.8
SYNMSG_RAD_CS_IR12.1	SYNMSG_BT_CS_IR12.1	SYNMSG_RAD_CS_IR13.4	SYNMSG_BT_CS_IR13.4

Here, `RAD` denotes radiance, `BT` brightness temperature, `CL` cloudy, and `CS` clear sky, supplemented by the channel name.

[1] Important note: This feature is currently active for configuration `dwd+cray` only.

Defined and used in: `src/namelists/mo_synsat_nml.f90`

3.32 time_nml

Parameter	Type	Default	Unit	Description	Scope
calendar	I	1		Calendar type: 0=Julian/Gregorian 1=proleptic Gregorian 2=30day/month, 360day/year	
dt_restart	R	86400.*30.	s	Length of restart cycle in seconds. This namelist parameter specifies how long the model runs until it saves its state to a file and stops. Later, the model run can be resumed, s. t. a simulation over a long period of time can be split into a chain of restarted model runs. Note that the frequency of writing restart files is controlled by `io_nml:dt_checkpoint`. Only if the value of `dt_checkpoint` resulting from model default or user's specification is longer than `dt_restart`, it will be reset (by the model) to `dt_restart` so that at least one restart file is generated during the restart cycle. If `dt_restart` is larger than but not a multiple of `dt_checkpoint`, restart file will *not* be generated at the end of the restart cycle.	
ini_datetime_string	C	'2008-09-01T 00:00:00Z'		Initial date and time of the simulation	
end_datetime_string	C	'2008-09-01T 01:40:00Z'		End date and time of the simulation	
is_relative_time	L	.FALSE.		.TRUE., if time loop shall start with step 0 regardless whether we are in a standard run or in a restarted run (which means re-initialized run).	

Length of the run If "nsteps" in run_nml is positive, then nsteps*dtime is used to compute the end date and time of the run. Else the initial date and time, the end date and time, dt_restart, as well as the time step are used to compute "nsteps".

3.33 transport_nml (used if run_nml/ltransport=.TRUE.)

Parameter	Type	Default	Unit	Description	Scope
lvadv_tracer	L	.TRUE.		TRUE : compute vertical tracer advection FALSE: do not compute vertical tracer advection	
ihadv_tracer	I(ntracer)	2		Tracer specific method to compute horizontal advection: 0: no horiz. transport (note that the specific tracer quantity q is kept constant and not tracer mass ρq) 1: upwind (1st order) 2: Miura (2nd order, linear reconstr.) 3: Miura3 (quadr. or cubic reconstr.) 4: FFSL (quadr. or cubic reconstr.) 5: hybrid Miura3/FFSL (quadr. or cubic reconstr.) 20: miura (2nd order, lin. reconstr.) with subcycling 22: combination of miura and miura with subcycling 32: combination of miura3 and miura with subcycling 42: combination of FFSL and miura with subcycling 52: combination of hybrid FFSL/Miura3 with subcycling Subcycling means that the integration from time step n to n+1 is splitted into substeps to meet the stability requirements. For NWP runs, substepping is generally applied above $z = 22\,\mathrm{km}$ (see nonhydrostatic_nml/hbot_qvsubstep).	 lsq_high_ord $\in$ [2,3] lsq_high_ord $\in$ [2,3] lsq_high_ord $\in$ [2,3]
ivadv_tracer	I(ntracer)	3		Tracer specific method to compute vertical advection:	lvadv_tracer=TRUE

Parameter	Type	Default	Unit	Description	Scope
				0: no vert. transport (note that tracer mass ρq instead of the specific tracer quantity q is kept constant. This differs from the behaviour in horizontal direction!) 1: upwind (1st order) 3: ppm_cfl (3^{rd} order, handles CFL > 1) 30: ppm (3rd order, CFL<=1)	
iadv_tke	I	0		Type of TKE advection 0: no TKE advection 1: vertical advection only 2: vertical and horizontal advection	inwp_turb=1
lstrang	L	.FALSE.		Time splitting method TRUE: second order Strang splitting FALSE: first order Godunov splitting	
ctracer_list	C	”		list of tracer names	ltestcase=.TRUE.
npassive_tracer	I	0		number of additional passive tracers which have no sources and are transparent to any physical process (no effect). Passive tracers are named Qpassive_ID, where ID is a number between `ntracer` and `ntracer`+`npassive_tracer`. **NOTE:** By default, limiters are switched of for passive tracers and the scheme 52 is selected for horizontal advection.	
init_formula	C	’ ’		Comma-separated list of initialization formulas for additional passive tracers.	npassive_tracer > 0
itype_hlimit	I(ntracer)	4		Type of limiter for horizontal transport: 0: no limiter 3: monotonous flux limiter 4: positive definite flux limiter	
itype_vlimit	I(ntracer)	1		Type of limiter for vertical transport: 0: no limiter 1: semi-monotone slope limiter 2: monotonous slope limiter	

Parameter	Type	Default	Unit	Description	Scope
				4: positive definite flux limiter	
niter_fct	I	1		number of iterations of monotone flux correction procedure (experimental!)	itype_hlimit = 3
beta_fct	R	1.005		factor of allowed over-/undershooting in monotonous limiter	itype_hlimit = 3
iord_backtraj	I	1		order of backward trajectory calculation: 1: first order 2: second order (iterative; currently 1 iteration hardcoded; experimental!)	ihadv_tracer='miura'
igrad_c_miura	I	1		Method for gradient reconstruction at cell center for 2nd order miura scheme 1: Least-squares (linear, non-consv) 2: Green-Gauss	ihadv_tracer=2
ivcfl_max	I	5		determines stability range of vertical PPM-scheme in terms of the maximum allowable CFL-number	ivadv_tracer=3
llsq_svd	L	.TRUE.		use QR decomposition (FALSE) or SV decomposition (TRUE) for least squares design matrix A	
lclip_tracer	L	.FALSE.		Clipping of negative values	

Defined and used in: `src/namelists/mo_advection_nml.f90`

3.34 turbdiff_nml

Parameter	Type	Default	Unit	Description	Scope
imode_turb	I	1		Mode of solving the TKE equation for atmosph. layers: 0: diagnostic equation 1: prognostic equation (current version) 2: prognostic equation (intrinsically positive definite)	
imode_tran	I	0		Same as *imode_turb* but only for the transfer layer	

Parameter	Type	Default	Unit	Description	Scope
icldm_turb	I	2		Mode of water cloud representation in turbulence for atmosph. layers: -1: ignoring cloud water completely (pure dry scheme) 0: no clouds considered (all cloud water is evaporated) 1: only grid scale condensation possible 2: also sub grid (turbulent) condensation considered	
icldm_tran	I	2		Same as *icldm_turb* but only for the transfer layer	
itype_wcld	I	2		type of water cloud diagnosis within the turbulence scheme: 1: employing a scheme based on relative humitidy 2: employing a statistical saturation adjustment	icldm_turb=2 or icldm_tran=2
itype_sher	I	0		Type of shear forcing used in turbulence: 0: only vertical shear of horizontal wind 1: previous plus horizontal shear correction 2: previous plus shear from vertical velocity 3: same as option 1, but (when combined with ltkeshs=.TRUE.) scaling of coarse-grid horizontal shear production term with $\frac{1}{\sqrt{Ri}}$	
ltkeshs	L	.FALSE.		Include correction term for coarse grids in horizontal shear production term (needed at non-convection-resolving model resolutions in order to get a non-negligible impact)	itype_sher ≥ 1
ltkesso	L	.FALSE.		Consider TKE-production by sub grid SSO wakes	inwp_sso = 1
ltkecon	L	.FALSE.		Consider TKE-production by sub grid convective plumes (inactive)	inwp_conv = 1
ltkeshs	L	.FALSE.		Consider TKE-production by separated horizontal shear eddies (inactive)	
ltmpcor	L	.FALSE.		Consider thermal TKE sources in enthalpy equation	
lsflcnd	L	.TRUE.		Use lower flux condition for vertical diffusion calculation (TRUE) instead of a lower concentration condition (FALSE)	

Parameter	Type	Default	Unit	Description	Scope
lexpcor	L	.FALSE.		Explicit corrections of implicitly calculated vertical diffusion of non-conservative scalars that are involved in sub grid condensation processes	
tur_len	R	500.0	m	Asymptotic maximal turbulent distance ($\kappa * tur\_len$ is the integral turbulent master length scale)	
pat_len	R	100.0	m	Effective length scale of thermal surface patterns controlling TKE-production by sub grid kata/ana-batic circulations. In case of $pat\_len = 0$, this production is switched off.	
c_diff	R	0.2	1	Length scale factor for vertical diffusion of TKE. In case of $c\_diff = 0$, TKE is not diffused vertically.	
a_stab	R	0.0	1	Factor for stability correction of turbulent length scale. In case of $a\_stab = 0$, the turbulent length scale is not reduced for stable stratification.	
a_hshr	R	0.20	1	Length scale factor for the separated horizontal shear mode. In case of $a\_hshr = 0$, this shear mode has no effect.	ltkeshs=.TRUE.
alpha0	R	0.0123	1	Lower bound of velocity-dependent Charnock parameter	
alpha0_max	R	0.0335	1	Upper bound of velocity-dependent Charnock parameter. Setting this parameter to 0.0335 or higher values implies unconstrained velocity dependence	
tkhmin	R	0.75	m^2/s	Scaling factor for minimum vertical diffusion coefficient (proportional to $1/\sqrt{Ri}$) for heat and moisture	
tkmmin	R	0.75	m^2/s	Scaling factor for minimum vertical diffusion coefficient (proportional to $1/\sqrt{Ri}$) for momentum	
tkmmin_strat	R	5	m^2/s	Enhanced scaling factor for minimum vertical diffusion coefficient (proportional to $1/\sqrt{Ri}$) for momentum, valid in the stratosphere above 30 km	

Parameter	Type	Default	Unit	Description	Scope
tkhmin_strat	R	5	m^2/s	Enhanced scaling factor for minimum vertical diffusion coefficient (proportional to $1/\sqrt{Ri}$) for heat and moisture, valid in the stratosphere above 30 km	
itype_synd	I	2		Type of diagnostics of synoptic near surface variables: 1: Considering the mean surface roughness of a grid box 2: Considering a fictive surface roughness of a SYNOP lawn	
rlam_heat	R	1.0	1	Scaling factor of the laminar boundary layer for heat (scalars). The larger rlam_heat, the larger is the laminar resistance.	
rat_sea	R	10.0	1	Ratio of laminar scaling factors for scalars over sea and land. The larger rat_sea, the larger is the laminar resistance for a sea surface compared to a land surface.	
tkesmot	R	0.15	1	Time smoothing factor within $[0, 1]$ for TKE. In case of $tkesmot = 0$, no smoothing is active.	
frcsmot	R	0.0	1	Vertical smoothing factor within $[0, 1]$ for TKE forcing terms. In case of $frcmot = 0$, no smoothing is active.	
imode_frcsmot	I	1		1 = apply vertical smoothing (if frcsmot>0) uniformly over the globe 2 = restrict vertical smoothing to the tropics (reduces the moist bias in the tropics while avoiding adverse effects on NWP skill scores in the extratropics)	
impl_s	R	1.20	1	Implicit weight near the surface (maximal value)	
impl_t	R	0.75	1	Implicit weight near top of the atmosphere (minimal value)	
lconst_z0	L	.FALSE.		TRUE: horizontally homogeneous roughness length z0	

Parameter	Type	Default	Unit	Description	Scope
const_z0	R	0.001	m	value for horizontally homogeneous roughness length z0	lconst_z0=.TRUE.
ldiff_qi	L	.FALSE.		Turbulent diffusion of cloud ice, if .TRUE.	
itype_tran	I	2		type of surface-atmosphere transfer	
lprfcor	L	.FALSE.		using the profile values of the lowest main level instead of the mean value of the lowest layer for surface flux calculations	
lnonloc	L	.FALSE.		nonlocal calculation of vertical gradients used for turbul. diff.	
lfreeslip	L	.FALSE.		.TRUE.: use a free-slip lower boundary condition, i.e. neither momentum nor heat/moisture fluxes (use for idealized runs only!)	
lcpfluc	L	.FALSE.		consideration of fluctuations of the heat capacity of air	

Defined and used in: `src/namelists/mo_turbdiff_nml.f90`

3.35 vdiff_nml

Parameter	Type	Default	Unit	Description	Scope
lsfc_mon_flux	L	.TRUE.		Switch on surface momentum flux.	lvdiff = .TRUE.
lsfc_heat_flux	L	.TRUE.		Switch on surface sensible and latent heat flux.	lvdiff = .TRUE.

Defined and used in: `src/namelists/mo_vdiff_nml.f90`

4 Ocean-specific namelist parameters

4.1 ocean_physics_nml

Parameter	Type	Default	Unit	Description	Scope
i_sea_ice	I	1		0: No sea ice, 1: Include sea ice	

Parameter	Type	Default	Unit	Description	Scope
				.FALSE.: compute drag only	
richardson_factor_tracer	I	0.5e-5	m/s		
richardson_factor_veloc	I	0.5e-5	m/s		
l_constant_mixing	L	.FALSE.			

4.2 sea_ice_nml (relevant if run_nml/iforcing=2 (ECHAM))

Parameter	Type	Default	Unit	Description	Scope
i_ice_therm	I	2		Switch for thermodynamic model: 1: Zero-layer model 2: Two layer Winton (2000) model 3: Zero-layer model with analytical forcing (for diagnostics) 4: Zero-layer model for atmosphere-only runs (for diagnostics)	In an ocean run i_sea_ice must be >=1. In an atmospheric run the ice surface type must be defined.
i_ice_dyn	I	0		Switch for sea-ice dynamics: 0: No dynamics 1: FEM dynamics (from AWI)	
i_ice_albedo	I	1		Switch for albedo model. Only one is implemented so far.	
i_Qio_type	I	2		Switch for ice-ocean heat-flux calculation method: 1: Proportional to ocean cell thickness (like MPI-OM) 2: Proportional to speed difference between ice and ocean	Defaults to 1 when i_ice_dyn=0 and 2 otherwise.
kice	I	1		Number of ice classes (must be one for now)	
hnull	R	0.5	m	Hibler's h_0 parameter for new-ice growth.	
hmin	R	0.05	m	Minimum sea-ice thickness allowed.	
ramp_wind	R	10	days	Number of days it takes the wind to reach correct strength. Only used at the start of an OMIP/NCEP simulation (not after restart).	

5 Namelist parameters for testcases (NAMELIST_ICON)

The ICON model code includes several experiments, so-called test cases, for the shallow water model as well as the 3-dimensional atmosphere. Depending on the specified experiment, initial conditions and boundary conditions are computed internally.

5.1 ha_testcase_nml (Scope: ltestcase=.TRUE. and iequations=[0,1,2] in run_nml)

Parameter	Type	Default	Unit	Description	Scope
ctest_name	C	'JWw'		Name of test case: 'SW_GW': gravity wave 'USBR': unsteady solid body rotation 'Will_2': Williamson test 2 'Will_3': Williamson test 3 'Will_5': Williamson test 5 'Will_6': Williamson test 6 'GW': gravity wave (nlev=20 only!) 'LDF': local diabatic forcing test without physics 'LDF-Moist': local diabatic forcing test with physics initalised with zonal wind field 'HS': Held-Suarez test 'JWs': Jablonowski-Will. steady state 'JWw': Jablonowski-Will. wave test 'JWw-Moist': Jablonowski-Will. wave test including moisture 'APE': aqua planet experiment 'MRW': mountain induced Rossby wave 'MRW2': modified mountain induced Rossby wave 'PA': pure advection 'SV': stationary vortex 'DF1': deformational flow test 1 'DF2': deformational flow test 2 'DF3': deformational flow test 3	 lshallow_water=.TRUE. lshallow_water=.TRUE. lshallow_water=.TRUE. lshallow_water=.TRUE. lshallow_water=.TRUE. lshallow_water=.TRUE. lshallow_water=.FALSE. lshallow_water=.FALSE. and iforcing=4 lshallow_water=.FALSE., and iforcing=5 lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE. lshallow_water=.FALSE., ntracer = 2

Parameter	Type	Default	Unit	Description	Scope
				'DF4': deformational flow test 4 'RH': Rossby-Haurwitz wave test	lshallow_water=.FALSE.
rotate_axis_deg	R	0.0	deg	Earth's rotation axis pitch angle	ctest_name= 'Will_2', 'Will_3', 'JWs', 'JWw', 'PA', 'DF1234'
gw_brunt_vais	R	0.01	1/s	Brunt Vaisala frequency	ctest_name= 'GW'
gw_u0	R	0.0	m/s	zonal wind parameter	ctest_name= 'GW'
gw_lon_deg	R	180.0	deg	longitude of initial perturbation	ctest_name= 'GW'
gw_lat_deg	R	0.0	deg	latitude of initial perturbation	ctest_name= 'GW'
jw_uptb	R	1.0	m/s (?)	amplitude of the wave pertubation	ctest_name= 'JWw'
mountctr_lon_deg	R	90.0	deg	longitude of mountain peak	ctest_name= 'MRW(2)'
mountctr_lat_deg	R	30.0	deg	latitude of mountain peak	ctest_name= 'MRW(2)'
mountctr_height	R	2000.0	m	mountain height	ctest_name= 'MRW(2)'
mountctr_half_width	R	1500000.0	m	mountain half width	ctest_name= 'MRW(2)'
mount_u0	R	20.0	m/s	wind speed for MRW cases	ctest_name= 'MRW(2)'
rh_wavenum	I	4		wave number	ctest_name= 'RH'
rh_init_shift_deg	R	0.0	deg	pattern shift	ctest_name= 'RH'
ihs_init_type	I	1		Choice of initial condition for the Held-Suarez test. 1: the zonal state defined in the JWs test case; other integers: isothermal state (T=300 K, ps=1000 hPa, u=v=0.)	ctest_name= 'HS'
lhs_vn_ptb	L	.TRUE.		Add random noise to the initial wind field in the Held-Suarez test.	ctest_name= 'HS'
hs_vn_ptb_scale	R	1.	m/s	Magnitude of the random noise added to the initial wind field in the Held-Suarez test.	ctest_name= 'HS'
lrh_linear_pres	L	.FALSE.		Initialize the relative humidity using a linear function of pressure.	ctest_name= 'JWw-Moist','APE', 'LDF-Moist'
rh_at_1000hpa	R	0.75		relative humidity $0,1$ at 1000 hPa	ctest_name= 'JWw-Moist','APE', 'LDF-Moist'
linit_tracer_fv	L	.TRUE.		Finite volume initialization for tracer fields	ctest_name='PA'

Parameter	Type	Default	Unit	Description	Scope
ape_sst_case	C	'sst1'		SST distribution selection 'sst1': Control experiment 'sst2': Peaked experiment 'sst3': Flat experiment 'sst4': Control-5N experiment 'sst_qobs': Qobs SST distribution exp 'sst_ice': Control SST distribution with -1.8 C above 64 N/S.	ctest_name='APE'
ildf_init_type	I	0		Choice of initial condition for the Local diabatic forcing test. 1: the zonal state defined in the JWs test case; other: isothermal state (T=300 K, ps=1000 hPa, u=v=0.)	ctest_name= 'LDF'
ldf_symm	L	.TRUE.		Shape of local diabatic forcing: .TRUE.: local diabatic forcing symmetric about the equator (at 0 N) .FALSE.: local diabatic forcing asym. about the equator (at 30 N)	ctest_name= 'LDF','LDF-Moist'

Defined and used in: `src/testcases/mo_ha_testcases.f90`

5.2 nh_testcase_nml (Scope: ltestcase=.TRUE. and iequations=3 in run_nml)

Parameter	Type	Default	Unit	Description	Scope
nh_test_name	C	'jabw'		testcase selection '**zero**': no orography '**bell**': bell shaped mountain at 0E,0N '**schaer**': hilly mountain at 0E,0N '**jabw**': Initializes the full Jablonowski Williamson test case. '**jabw_s**': Initializes the Jablonowski Williamson steady state test case.	

Parameter	Type	Default	Unit	Description	Scope
				'jabw_m': Initializes the Jablonowski Williamson test case with a mountain instead of the wind perturbation (specify mount_height). **'mrw_nh'**: Initializes the full Mountain-induced Rossby wave test case. **'mrw2_nh'**: Initializes the modified mountain-induced Rossby wave test case. **'mwbr_const'**: Initializes the mountain wave with two layers test case. The lower layer is isothermal and the upper layer has constant brunt vaisala frequency. The interface has constant pressure. **'PA'**: Initializes the pure advection test case. **'HS_nh'**: Initializes the Held-Suarez test case. At the moment with an isothermal atmosphere at rest (T=300K, ps=1000hPa, u=v=0, topography=0.0). **'HS_jw'**: Initializes the Held-Suarez test case with Jablonowski Williamson initial conditions and zero topography. **'APE_nh'**: Initializes the APE experiments. With the jabw test case, including moisture.	
				'wk82': Initializes the Weisman Klemp test case	l_limited_area =.TRUE.
				'g_lim_area': Initializes a series of general limited area test cases: itype_atmos_ana determines the atmospheric profile, itype_anaprof_uv determines the wind profile and itype_topo_ana determines the topography **'dcmip_pa_12'**: Initializes Hadley-like meridional circulation pure advection test case.	
				'dcmip_rest_200': atmosphere at rest test (Schaer-type mountain)	lcoriolis = .FALSE.
				'dcmip_mw_2x': nonhydrostatic mountain waves triggered by Schaer-type mountain	lcoriolis = .FALSE.
				'dcmip_gw_31': nonhydrostatic gravity waves triggered by a localized perturbation (nonlinear)	

Parameter	Type	Default	Unit	Description	Scope
				'**dcmip_gw_32**': nonhydrostatic gravity waves triggered by a localized perturbation (linear)	l_limited_area =.TRUE. and lcoriolis = .FALSE.
				'**dcmip_tc_51**': tropical cyclone test case with 'simple physics' parameterizations (**not yet implemented**)	lcoriolis = .TRUE.
				'**dcmip_tc_52**': tropical cyclone test case with with full physics in Aqua-planet mode	lcoriolis = .TRUE.
				'**CBL**': convective boundary layer simulations for LES package on torus (doubly periodic) grid	is_plane_torus= .TRUE.
jw_up	R	1.0	m/s	amplitude of the u-perturbation in jabw test case	nh_test_name='jabw'
u0_mrw	R	20.0	m/s	wind speed for mrw(2) and mwbr_const cases	nh_test_name= 'mrw(2)_nh' and 'mwbr_const'
mount_height_mrw	R	2000.0	m	maximum mount height in mrw(2) and mwbr_const	nh_test_name= 'mrw(2)_nh' and 'mwbr_const'
mount_half_width	R	1500000.0	m	half width of mountain in mrw(2), mwbr_const and bell	nh_test_name= 'mrw(2)_nh', 'mwbr_const' and 'bell'
mount_lonctr_mrw_deg	R	90.	deg	lon of mountain center in mrw(2) and mwbr_const	nh_test_name= 'mrw(2)_nh' and 'mwbr_const'
mount_latctr_mrw_deg	R	30.	deg	lat of mountain center in mrw(2) and mwbr_const	nh_test_name= 'mrw(2)_nh' and 'mwbr_const'
temp_i_mwbr_const	R	288.0	K	temp at isothermal lower layer for mwbr_const case	nh_test_name= 'mwbr_const'
p_int_mwbr_const	R	70000.	Pa	pres at the interface of the two layers for mwbr_const case	nh_test_name= 'mwbr_const'
bruntvais_u_mwbr_const	R	0.025	1/s	constant brunt vaissala frequency at upper layer for mwbr_const case	nh_test_name= 'mwbr_const'
mount_height	R	100.0	m	peak height of mountain	nh_test_name= 'bell'

Parameter	Type	Default	Unit	Description	Scope
layer_thickness	R	-999.0	m	thickness of vertical layers	If layer_thickness < 0, the vertical level distribution is read in from externally given HYB_PARAMS_XX.
n_flat_level	I	2		level number for which the layer is still flat and not terrain-following	layer_thickness > 0
nh_u0	R	0.0	m/s	initial constant zonal wind speed	nh_test_name = 'bell'
nh_t0	R	300.0	K	initial temperature at lowest level	nh_test_name = 'bell'
nh_brunt_vais	R	0.01	1/s	initial Brunt-Vaisala frequency	nh_test_name = 'bell'
torus_domain_length	R	100000.0	m	length of slice domain	nh_test_name = 'bell', lplane=.TRUE.
rotate_axis_deg	R	0.0	deg	Earth's rotation axis pitch angle	nh_test_name= 'PA'
lhs_nh_vn_ptb	L	.TRUE.		Add random noise to the initial wind field in the Held-Suarez test.	nh_test_name= 'HS_nh'
lhs_fric_heat	L	.FALSE.		add frictional heating from Rayleigh friction in the Held-Suarez test.	nh_test_name= 'HS_nh'
hs_nh_vn_ptb_scale	R	1.	m/s	Magnitude of the random noise added to the initial wind field in the Held-Suarez test.	nh_test_name= 'HS_nh'
rh_at_1000hpa	R	0.7	1	relative humidity at 1000 hPa	nh_test_name= 'jabw', nh_test_name= 'mrw'
qv_max	R	20.e-3	kg/kg	specific humidity in the tropics	nh_test_name= 'jabw', nh_test_name= 'mrw'
ape_sst_case	C	'sst1'		SST distribution selection 'sst1': Control experiment 'sst2': Peaked experiment 'sst3': Flat experiment 'sst4': Control-5N experiment 'sst_qobs': Qobs SST distribution exp.	nh_test_name='APE_nh'
linit_tracer_fv	L	.TRUE.		Finite volume initialization for tracer fields	pure advection tests, only
lcoupled_rho	L	.FALSE.		Integrate density equation 'offline'	pure advection tests, only
qv_max_wk	R	0.014	Kg/kg	maximum specific humidity near the surface, range 0.012 - 0.016 used to vary the buoyancy	nh_test_name='wk82'

Parameter	Type	Default	Unit	Description	Scope
u_infty_wk	R	20.	m/s	zonal wind at infinity height range 0. - 45. used to vary the wind shear	nh_test_name='wk82'
bub_amp	R	2.	K	maximum amplitud of the thermal perturbation	nh_test_name='wk82'
bubctr_lat	R	0.	deg	latitude of the center of the thermal perturbation	nh_test_name='wk82'
bubctr_lon	R	90.	deg	longitude of the center of the thermal perturbation	nh_test_name='wk82'
bubctr_z	R	1400.	m	height of the center of the thermal perturbation	nh_test_name='wk82'
bub_hor_width	R	10000.	m	horizontal radius of the thermal perturbation	nh_test_name='wk82'
bub_ver_width	R	1400.	m	vertical radius of the thermal perturbation	nh_test_name='wk82'
itype_atmo_ana	I	1		kind of atmospheric profile: 1 piecewise N constant layers 2 piecewise polytropic layers	nh_test_name= 'g_lim_area'
itype_anaprof_uv	I	1		kind of wind profile: 1 piecewise linear wind layers 2 constant zonal wind 3 constant meridional wind	nh_test_name= 'g_lim_area'
itype_topo_ana	I	1		kind of orography: 1 schaer test case mountain 2 gaussian_2d mountain 3 gaussian_3d mountain any other no orography	nh_test_name= 'g_lim_area'
nlayers_nconst	I	1		Number of the desired layers with a constant Brunt-Vaisala-frequency	nh_test_name= 'g_lim_area' and itype_atmo_ana=1
p_base_nconst	R	100000.	Pa	pressure at the base of the first N constant layer	nh_test_name= 'g_lim_area' and itype_atmo_ana=1
theta0_base_nconst	R	288.	K	potential temperature at the base of the first N constant layer	nh_test_name= 'g_lim_area' and itype_atmo_ana=1
h_nconst	R(nlayers _nconst)	0., 1500., 12000.	m	height of the base of each of the N constant layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=1

Parameter	Type	Default	Unit	Description	Scope
N_nconst	R(nlayers _nconst)	0.01	1/s	Brunt-Vaisala-frequency at each of the N constant layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=1
rh_nconst	R(nlayers _nconst)	0.5	%	relative humidity at the base of each N constant layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=1
rhgr_nconst	R(nlayers _nconst)	0.	%	relative humidity gradient at each of the N constant layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=1
nlayers_poly	I	2		Number of the desired layers with constant gradient temperature	nh_test_name= 'g_lim_area' and itype_atmo_ana=2
p_base_poly	R	100000.	Pa	pressure at the base of the first polytropic layer	nh_test_name= 'g_lim_area' and itype_atmo_ana=2
h_poly	R(nlayers _poly)	0., 12000.	m	height of the base of each of the polytropic layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=2
t_poly	R(nlayers _poly)	288., 213.	K	temperature at the base of each of the polytropic layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=2
rh_poly	R(nlayers _poly)	0.8, 0.2	%	relative humidity at the base of each of the polytropic layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=2
rhgr_poly	R(nlayers _poly)	5.e-5, 0.	%	relative humidity gradient at each of the polytropic layers	nh_test_name= 'g_lim_area' and itype_atmo_ana=2
nlayers_linwind	I	2		Number of the desired layers with constant U gradient	nh_test_name= 'g_lim_area' and itype_anaprof_uv=1
h_linwind	R(nlayers _lin-wind)	0., 2500.	m	height of the base of each of the linear wind layers	nh_test_name= 'g_lim_area' and itype_anaprof_uv=1

Parameter	Type	Default	Unit	Description	Scope
u_linwind	R(nlayers _lin- wind)	5, 10.	m/s	zonal wind at the base of each of the linear wind layers	nh_test_name= 'g_lim_area' and itype_anaprof_uv=1
ugr_linwind	R(nlayers _lin- wind)	0., 0.	1/s	zonal wind gradient at each of the linear wind layers	nh_test_name= 'g_lim_area' and itype_anaprof_uv=1
vel_const	R	20.	m/s	constant zonal/meridional wind (itype_anaprof_uv=2,3)	nh_test_name= 'g_lim_area' and itype_anaprof_uv=2,3
mount_lonc_deg	R	90.	deg	longitud of the center of the mountain	nh_test_name= 'g_lim_area'
mount_latc_deg	R	0.	deg	latitud of the center of the mountain	nh_test_name= 'g_lim_area'
schaer_h0	R	250.	m	h0 parameter for the schaer mountain	nh_test_name= 'g_lim_area' and itype_topo_ana=1
schaer_a	R	5000.	m	-a- parameter for the schaer mountain, also half width in the north and south side of the finite ridge to round the sharp edges	nh_test_name= 'g_lim_area' and itype_topo_ana=1,2
schaer_lambda	R	4000.	m	lambda parameter for the schaer mountain	nh_test_name= 'g_lim_area' and itype_topo_ana=1
lshear_dcmip	L	FALSE		run dcmip_mw_2x with/without vertical wind shear FALSE: dcmip_mw_21: non-sheared TRUE : dcmip_mw_22: sheared	nh_test_name= 'dcmip_mw_2x'
halfwidth_2d	R	10000.	m	half lenght of the finite ridge in the north-south direction	nh_test_name= 'g_lim_area' and itype_topo_ana=1,2
m_height	R	1000.	m	height of the mountain	nh_test_name= 'g_lim_area' and itype_topo_ana=2,3

Parameter	Type	Default	Unit	Description	Scope
m_width_x	R	5000.	m	half width of the gaussian mountain in the east-west direction half width in the north-south direction in the rounding of the finite ridge (gaussian_2d)	nh_test_name= 'g_lim_area' and itype_topo_ana=2,3
m_width_y	R	5000.	m	half width of the gaussian mountain in the north-south direction	nh_test_name= 'g_lim_area' and itype_topo_ana=2,3
gw_u0	R	0.	m/s	maximum amplitude of the zonal wind	nh_test_name= 'dcmip_gw_3X'
gw_clat	R	90.	deg	Lat of perturbation center	nh_test_name= 'dcmip_gw_3X'
gw_delta_temp	R	0.01	K	maximum temperature perturbation	nh_test_name= 'dcmip_gw_32'
u_cbl(2)	R	0:0	m/s and 1/s	to prescribe initial zonal velocity profile for convective boundary layer simulations where u_cbl(1) sets the constant and u_cbl(2) sets the vertical gradient	nh_test_name=CBL
v_cbl(2)	R	0:0	m/s and 1/s	to prescribe initial meridional velocity profile for convective boundary layer simulations where v_cbl(1) sets the constant and v_cbl(2) sets the vertical gradient	nh_test_name=CBL
th_cbl(2)	R	290:0.006	K and K/m	to prescribe initial potential temperature profile for convective boundary layer simulations where th_cbl(1) sets the constant and th_cbl(2) sets the gradient	nh_test_name=CBL

Defined and used in: `src/testcases/mo_nh_testcases.f90`

6 External data

6.1 extpar_nml (Scope: itopo=1 in run_nml)

Parameter	Type	Default	Unit	Description	Scope
itopo	I	0		0: analytical topography/ext. data 1: topography/ext. data read from file	
n_iter_smooth_topo	I(n_dom)	0		iterations of topography smoother	itopo = 1
fac_smooth_topo	R	0.015625		pre-factor of topography smoother	n_iter_smooth_topo > 0
hgtdiff_max_smooth_topo	R	0.	m	RMS height difference to neighbor grid points at which the smoothing pre-factor fac_smooth_topo reaches its maximum value (linear proportionality for weaker slopes)	n_iter_smooth_topo > 0
heightdiff_threshold	R(n_dom)	3000.	m	height difference between neighboring grid points above which additional local nabla2 diffusion is applied	
l_emiss	L	.TRUE.		read and use external surface emissivity map	itopo = 1
extpar_filename	C			Filename of external parameter input file, default: "`<path>extpar_<gridfile>`". May contain the keyword `<path>` which will be substituted by `model_base_dir`.	
extpar_varnames_map_file	C	' '		Filename of external parameter dictionary, This is a text file with two columns separated by whitespace, where left column: NetCDF name, right column: GRIB2 short name. It is required, if external parameter are read from a file in GRIB2 format.	

Defined and used in: `src/namelists/mo_extpar_nml.f90`

7 External packages

8 Information on vertical level distribution

If no vertical sleve coodinate is chosen (ivctype / =2), the hydrostatic and nonhydrostatic models need hybrid vertical level information to generate the terrain following coordinates. The hybrid level specification is stored in <icon home>/hyb_params/HYB_PARAMS_<nlev>. The **hydrostatic** model assumes to get **pressure based** coordinates, the **nonhydrostatic** model expects **height based** coordinates. For further information see <icon home>/hyb_params/README.

A Arithmetic expression evaluation

The `mo_expression` module evaluates basic arithmetic expressions specified by character-strings. It is possible to include mathematical functions, operators, and constants. An application of this module is the evaluation of arithmetic expressions povided as namelist parameters.

Besides, Fortran variables can be linked to the expression and used in the evaluation. The implementation supports scalar input variables as well as 2D and 3D fields.

From a users' point of view, the basic usage of this module is described in Section A.1 below. Technically, infix expressions are processed based on a Finite State Machine (FSM) and Dijkstra's shunting yard algorithm. A more detailed described of the Fortran interface is given in Section A.3.

A.1 Examples for arithmetic expressions

Basic examples:

- `"sqrt(2.0)"`
- `"sin(45*pi/180.) * 10 + 5"`
- `"if(1. > 2, 99, -1.*pi)"`
- `"min(1,2)"`

Variables are used with a bracket notation:

- `"sqrt([u]^2 + [v]^2)"`

Note that the use of variables requires that these are enabled ("linked") by the Fortran routine that calls the `mo_expression` module.

A.2 Expression syntax

A.2.1 List of functions

name	#args	description
`log()`, `exp()`	1	natural logarithm and its inverse function.
`sin()`, `cos()`	1	trigonometric functions
`sqrt()`	1	square root
`min()`, `max()`	2	minimum and maximum of two values
`if(`*value*`,`*then*`,`*else*`)`	3	conditional expression (*value* `> 0.`)

A.2.2 List of operators

name	evaluates to
`a + b`, `a - b`, `a * b`, `a / b`	$(a+b)$, $(a-b)$, $(a*b)$, (a/b)
`a ^ b`	a^b
`a > b`	$\begin{cases} 1, & \text{if } a > b, \\ 0, & \text{otherwise.} \end{cases}$
`a < b`	$\begin{cases} 1, & \text{if } a < b, \\ 0, & \text{otherwise.} \end{cases}$

A.2.3 List of available constants

name of constant	assigned value	description
`pi`	4 atan(1)	mathematical constant equal to a circle's circumference divided by its diameter
`r`	$6.371229 \cdot 10^6$	Earth's radius[1]

A.3 Usage with Fortran

The minimal Fortran interface is as follows:

1. The `TYPE expression` which is initialized with the character-string that specifies the arithmetic expression.
2. The type-bound procedure `evaluate()`, which returns the result (scalar or array-shaped) as a `POINTER`.
3. The type-bound procedure `link()` connecting a variable to a name in the character-string expression.

A.3.1 Fortran examples

The following examples illustrate the arithmetic expression parser. The calls to `DEALLOCATE` the data structures have been ommitted for the sake of brevity:

1. Scalar arithmetic expression:

```
formula = expression("sin(45*pi/180.) * 10 + 5")
CALL formula%evaluate(val)
  ... use "val" for some purpose ...
```

2. Masking of a 2D array as an example for the `link` procedure:

```
formula = expression("if([z_sfc] > 2., [z_sfc], 0. )")
CALL formula%link("z_sfc", z_sfc)
CALL formula%evaluate(val_2D)
  ... use "val_2D(:,:)" for some purpose ...
```

A.3.2 Error handling

Invalid arithmetic expressions yield "empty" expression objects. When these are evaluated, a `NULL()` pointer is returned.

A successful expression evaluation can be tested with the `err_no` variable:

```
IF (formula%err_no == ERR_NONE) THEN
  ...
END IF
```

In case of error, the `err_no` variable also provides the reason for the aborted evaluation process.

A.4 Remarks

- Variable names are treated case-sensitive!
- For 3D array input it is implicitly assumed that 2D fields are embedded in 3D fields as "3D(:,level,:) = 2D(:,:)".

[1]This number seems to be based on Hayford's 1910 estimate of the Earth. It is used in ICON as well as MPAS and was almost certainly taken from the Jablonowski and Williamson test case (QJRMS, 2006).

B Changes incompatible with former versions of the model code

Change: **var_names_map_file, out_varnames_map_file**
Date of Change: **2013-04-25**
Revision: **12016**

- Renamed **var_names_map_file** → **output_nml_dict**.
- Renamed **out_varnames_map_file** → **netcdf_dict**.
- The dictionary in *netcdf_dict* is now reversed, s.t. the same map file as in output_nml_dict can be used to translate variable names to the ICON internal names and back.

Change: **output_nml: namespace**
Date of Change: **2013-04-26**
Revision: **12051**

- Removed obsolete namelist variable **namespace** from **output_nml**.

Change: **gribout_nml: generatingCenter, generatingSubcenter**
Date of Change: **2013-04-26**
Revision: **12051**

- Introduced new namelist variables **generatingCenter** and **generatingSubcenter**.
- If not set explicitly, center and subcenter information is copied from the input grid file

Change: **radiation_nml: albedo_type**
Date of Change: **2013-05-03**
Revision: **12118**

- Introduced new namelist variable **albedo_type**

- If set to 2, the surface albedo will be based on the MODIS data set.

Change:	**initicon_nml: dwdinc_filename**
Date of Change:	**2013-05-24**
Revision:	**12266**

- Renamed dwdinc_filename to dwdana_filename

Change:	**initicon_nml: l_ana_sfc**
Date of Change:	**2013-06-25**
Revision:	**12582**

- Introduced new namelist flag **l_ana_sfc**
- If true, soil/surface analysis fields are read from the analysis fiel dwdfg_filename. If false, surface analyis fields are not read. Soil and surface are initialized with the first guess instead.

Change:	**new_nwp_phy_tend_list: output names consistent with variable names**
Date of Change:	**2013-06-25**
Revision:	**12590**

- temp_tend_radlw → ddt_temp_radlw
- temp_tend_turb → ddt_temp_turb
- temp_tend_drag → ddt_temp_drag

Change:	**prepicon_nml, remap_nml, input_field_nml**
Date of Change:	**2013-06-25**
Revision:	**12597**

- Removed the sources for the "prepicon" binary!
- The "prepicon" functionality (and most of its code) has become part of the ICON tools.

Change:	**initicon_nml**
Date of Change:	**2013-08-19**
Revision:	**13311**

- The number of vertical input levels is now read from file. The namelist parameter **nlev_in** has become obsolete in r12700 and has been removed.

Change:	**parallel_nml**
Date of Change:	**2013-10-14**
Revision:	**14160**

- The namelist parameter exch_msgsize has been removed together with the option iorder_sendrecv=4.

Change:	**parallel_nml**
Date of Change:	**2013-08-14**
Revision:	**14164**

- The namelist parameter **use_sp_output** has been replaced by an equivalent switch **use_dp_mpi2io** (with an inverse meaning, i.e. we have **use_dp_mpi2io** = **.NOT. use_sp_output**).

Change:	**parallel_nml**
Date of Change:	**2013-08-15**
Revision:	**14175**

- The above-mentioned namelist parameter **use_dp_mpi2io** got the default .FALSE. By this, the output data are sent now in single precision to the output processes.

Change: **initicon_nml: l_ana_sfc**
Date of Change: **2013-10-21**
Revision: **14280**

- The above-mentioned namelist parameter **l_ana_sfc** has been replaced by **lread_ana**. The default is set to .TRUE., meaning that analysis fields are required and read on default. With lread_ana=.FALSE. ICON is able to start from first guess fields only.

Change: **output_nml: lwrite_ready, ready_directory**
Date of Change: **2013-10-25**
Revision: **14391**

- The namelist parameters **lwrite_ready** and **ready_directory** have been replaced by a single namelist parameter **ready_file**, where `ready_file /= 'default'` enables writing ready files.
- Different `output_nml`'s may be joined together to form a single ready file event – they share the same `ready_file`.

Change: **output_nml: output_bounds**
Date of Change: **2013-10-25**
Revision: **14391**

- The namelist parameter **output_bounds** specifies a start, end, and increment of output invervals. It does no longer allow multiple triples.

Change: **output_nml: steps_per_file**
Date of Change: **2013-10-30**
Revision: **14422**

- The default value of the namelist parameter **steps_per_file** has been changed to `-1`.

Change: **run_nml**
Date of Change: **2013-11-13**
Revision: **14759**

- The dump/restore functionality for domain decompositions and interpolation coefficients has been removed from the model code. This means, that the parameters
  - `ldump_states`,
  - `lrestore_states`,
  - `ldump_dd`,
  - `lread_dd`,
  - `nproc_dd`,
  - `dd_filename`,
  - `dump_filename`,
  - `l_one_file_per_patch`

  have been removed together with the corresponding functionality from the ICON model code.

Change: **output_nml: filename_format**
Date of Change: **2013-12-02**
Revision: **15068**

- The string token `<ddhhmmss>` is now substituted by the *relative* day-hour-minute-second string, whereas the absolute date-time stamp can be inserted using `<datetime>`.

Change: **output_nml: ready_file**
Date of Change: **2013-12-03**
Revision: **15081**

- The ready file name has been changed and may now contain string tokens `<path>`, `<datetime>`, `<ddhhmmss>` which are substituted as described for the namelist parameter `filename_format`.

Change:	**interpl_nml: rbf_vec_scale_ll**
Date of Change:	**2013-12-06**
Revision:	**15156**

- The real-valued namelist parameter `rbf_vec_scale_ll` has been removed.
- Now, there exists a new integer-valued namelist parameter, `rbf_scale_mode_ll` which specifies the mode, how the RBF shape parameter is determined for lon-lat interpolation.

Change:	**io_nml**
Date of Change:	**2013-12-06**
Revision:	**15161**

- Removed remaining vlist-related namelist parameter. This means that the parameters
  - out_filetype
  - out_expname
  - dt_data
  - dt_file
  - lwrite_dblprec, lwrite_decomposition, lwrite_vorticity, lwrite_divergence, lwrite_pres, lwrite_z3, lwrite_tracer, lwrite_tend_phy, lwrite_radiation, lwrite_precip, lwrite_cloud, lwrite_tke, lwrite_surface, lwrite_omega, lwrite_initial, lwrite_oce_timestepping

  are no longer available.

Change:	**gridref_nml**
Date of Change:	**2014-01-07**
Revision:	**15436**

- Changed namelist defaults for nesting: `grf_intmethod_e`, `l_mass_consvcorr`, `l_density_nudging`.

Change: **interpol_nml**
Date of Change: **2014-02-10**
Revision: **16047**

- Changed namelist default for `rbf_scale_mode_ll`: The RBF scale factor for lat-lon interpolation is now determined automatically by default.

Change: **echam_phy_nml**
Date of Change: **2014-02-27**
Revision: **16313**

- Replace the logical switch `lcover` by the integer switch `icover` that is used in ECHAM-6.2. Values are transferred as follows: .FALSE. = 1 (=default), .TRUE. = 2.

Change: **turbdiff_nml**
Date of Change: **2014-03-12**
Revision: **16527**

- Change constant minimum vertical diffusion coefficients to variable ones proportional to $1/\sqrt{Ri}$ for inwp_turb = 10; at the same time the defaults for tkhmin and tkmmin are increased from $0.2\,\mathrm{m}^2/\mathrm{s}$ to $0.75\,\mathrm{m}^2/\mathrm{s}$.

Change: **nwp_phy_nml**
Date of Change: **2014-03-13**
Revision: **16560**

- Removed namelist parameter `dt_ccov`, since practically it had no effect. For the quasi-operational NWP-setup, the calling frequency of the cloud cover scheme is the same as that of the convection scheme. I.e. both are synchronized.

Change: **nwp_phy_nml**
Date of Change: **2014-03-24**
Revision: **16668**

- Changed namelist default for **itype_z0**: use land cover related roughness only (itype_z0=2).

Change: **nonhydrostatic_nml**
Date of Change: **2014-05-16**
Revision: **17293**

- Removed switch for vertical TKE advection in the dynamical core (**lvadv_tke**). TKE advection has been moved into the transport scheme and can be activated with **iadv_tke=1** in the **transport_nml**.

Change: **nonhydrostatic_nml**
Date of Change: **2014-05-27**
Revision: **17492**

- Removed namelist parameter `model_restart_info_filename` in namelist `master_model_nml`.

Change: **transport_nml**
Date of Change: **2014-06-05**
Revision: **17654**

- Changed namelist default for `itype_hlimit` from monotonous limiter (3) to positive definite limiter (4).

Change: **nh_pzlev_nml**
Date of Change: **2014-08-28**
Revision: **18795**

- Removed namelist nh_pzlev_nml. Instead, each output namelist specifies its separate list of p_levels, h_levels, and i_levels.

Change:	**nonhydrostatic_nml**
Date of Change:	**2014-10-27**
Revision:	**19670**

- Removed namelist parameter l_nest_rcf in namelist nonhydrostatic_nml.

Change:	**nonhydrostatic_nml**
Date of Change:	**2014-11-24**
Revision:	**20073**

- Removed namelist parameter iadv_rcf in namelist nonhydrostatic_nml. The number of dynamics substeps per advective step are now specified via ndyn_substeps. The meaning of run_nml:dtime has changed and denotes the advective time step.

Change:	**io_nml**
Date of Change:	**2015-03-25**
Revision:	**21501**

- Namelist parameter lzaxis_reference is deprecated and has no effect anymore. However, users are not forced to modify their scripts instantaneously: lzaxis_reference=.FALSE. is still a valid namelist setting, but it has no effect and a warning will be issued.