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 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 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.

2.1 assimilation_nml

The main switch for the Latent heat nudging scheme is called ldass_lhn and has to be set in run_nml.

Parameter	Type	Default	Unit	Description	Scope
nlhn_start	I	-9999	s	time in seconds when LHN is applied for the first time	run_nml:ldass_lhn = .true.
nlhn_end	I	-9999	s	time in seconds when LHN is applied for the last time	run_nml:ldass_lhn = .true.
lhn_coef	R	1.0		Nudging coefficient of adding the increments	
fac_lhn_up	R	2.0		Upper limit of the scaling factor of the temperature profile.	
fac_lhn_down	R	0.5		Lower limit of the scaling factor of the temperature profile.	

Parameter	Type	Default	Unit	Description	Scope
lhn_logscale	L	.TRUE.		Apply all scaling factors as logarithmic values	fac_lhn_down, fac_lhn_up, fac_lhn_artif
thres_lhn	R	0.1/3600.	mm/s	Minimal value of precipitation rate, either of model or radar. LHN will be applied first for precipitation above it.	
start_fadeout	R	1.0		Value to determine, at which model time step a fading out of the increments might start.	
lhn_qrs	L	.TRUE.		Use a vertical average of precipitation fluxes as reference to compare with radar observed precipitation, to avoid severe overestimation due to displacement of model surface precipitation. If set .FALSE. the model surface precipitation rate is used as reference.	
rqrsgmax	R	1.0		This value determines the height of the vertical averaging, to obtain the reference precipitation rate It is the model layer where the quotion of the maximal precipitation flux occurred for the first time.	lhn_qrs = .TRUE.
lhn_hum_adj	L	.TRUE.		Apply an increment of specific humidity with respect to the estimated temperature increment to maintain the relative humidty	
lhn_no_ttend	L	.FALSE.		Only apply moisture increments. Temperature increments will only be used for calculation of moisture increments	lhn_hum_adj=.TRUE.
lhn_incloud	L	.TRUE.		Apply increments only in model layers where the underlying latent heat release of the model is positive.	lhn_artif_only=.FALSE.
lhn_limit	L	.TRUE.		Limitation of temperature increments	abs_lhn_lim
abs_lhn_lim	R	50./3600.	K/s	Lower and upper limit for temperature increments to be added.	lhn_limit = .TRUE.
lhn_filt	L	.TRUE.		Vertical smoothing of the profile of temperature increments	

Parameter	Type	Default	Unit	Description	Scope
lhn_relax	L	.FALSE.		Horizontal smoothing of radar data but also of incorporated model fields	nlhn_relax
nlhn_relax	I	2	grid points	Number of horizontal grid point, where smoothing is applied.	lhn_relax = .TRUE.
lhn_artif	L	.TRUE.		Apply an artificial temperature profile to estimate increments at model grid points without significant precipitation (determined by fac_lhn_artif).	fac_lhn_artif, tt_artif_max, zlev_artif_max, std_artif_ma
fac_lhn_artif	R	5.0		Value of the ratio of radar to model precipitation rate, from which an artificial temperature profile is applied	lhn_artif=.TRUE.
lhn_artif_only	L	.FALSE.		Scaling the artificial temperature profile instead of local model profile of latent heat release for calculation the increments at any model grid point. The scaling factor is still be determined by the ratio of observed to modelled precipitation rate.	tt_artif_max, zlev_artif_max, std_artif_max
tt_artif_max	R	0.0015	K	Maximal temperature of Gaussian shaped function used a artificial temperature profile.	lhn_artif, lhn_artif_only
zlev_artif_max	R	1000.0	m	Height of maximum of Gaussian shaped function used a artificial temperature profile.	lhn_artif, lhn_artif_only
std_artif_max	R	4.0	m	Parameter defining width of Gaussian shaped function used a artificial temperature profile.	lhn_artif, lhn_artif_only
nlhnverif_start	I	-9999	s	time in seconds when online verification within LHN is active for the first time	run_nml:ldass_lhn = .true.
nlhnverif_end	I	-9999	s	time in seconds when online verification within LHN is active for the last time	run_nml:ldass_lhn = .true.
lhn_diag	L	.FALSE.		Enable a extensive diagnostic output, writing into file lhn.log. lhn_diag is set .TRUE. automatically, when online verification is active.	
lhn_dt_obs	R	300.0	s	Frequency of the radar observations	
radar_in	C	'./'		Path where the radar data file is expected.	
radardata_file(:)	C (n_dom)			Name of the radar data file. This might be either in GRIB2 or in NetCDF (recommended).	

Parameter	Type	Default	Unit	Description	Scope
lhn_black	L	.FALSE.		Apply a blacklist information in the radar data obtained by comparison against satelite clound information	
blacklist_file(:)	C (n_dom)			Name of blacklist file, containing a mask concerning the quality of the radar data. Value 1: good quality Value 0: bad quality This might be either in GRIB2 or in NetCDF (recommended).	lhn_black=.TRUE.
lhn_bright	L	.FALSE.		Apply a model intern bright band detection to avoid strong overestimation due to uncertain radar observations.	
height_file(:)	C (n_dom)			Name of file containing the height of the lowest scan for each possible radar station within the given radar composite. This file is required, when applying bright band detection. This might be either in GRIB2 or in NetCDF (recommended).	lhn_bright=.TRUE.
nradar	I (n_dom)	200		Maximal number of radar station contained within height_file	lhn_bright=.TRUE.

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

2.2 coupling_mode_nml

Parameter	Type	Default	Unit	Description	Scope
coupled_mode	L	.FALSE.		.TRUE.: if yac coupling routines have to be called	

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

2.3 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
itype_t_diffu	I	2		Discretization of temperature diffusion: 1: $K_h \nabla^2 T$ 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.

Parameter	Type	Default	Unit	Description	Scope
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`

2.4 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., $\theta \cdot$dp	

Parameter	Type	Default	Unit	Description	Scope
				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`

2.5 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.
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.

Parameter	Type	Default	Unit	Description	Scope
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`

2.6 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	0.5		Variability range for low level wake drag constant	
range_gkdrag	R	0.04		Variability range for orographic gravity wave drag constant	
range_gfrcrit	R	0.1		Variability range for critical Froude number in SSO scheme	
range_gfluxlaun	R	0.75e-3		Variability range for non-orographic gravity wave launch momentum flux	

Parameter	Type	Default	Unit	Description	Scope
range_zvz0i	R	0.2	m/s	Variability range for terminal fall velocity of ice	inwp_gscp = 1 or 2
range_entrorg	R	0.2e-3	1/m	Variability range for entrainment parameter in convection scheme	inwp_convection = 1
range_capdcfac_et	R	0.75		Maximum fraction of CAPE diurnal cycle correction applied in the extratropics	icapdcycl = 3
range_rhebc	R	0.05		Variability range for RH threshold for the onset of evaporation below cloud base	inwp_convection = 1
range_texc	R	0.05	K	Variability range for temperature excess value in test parcel ascent	inwp_convection = 1
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	0.2		Variability range for minimum vertical diffusion for heat/moisture	inwp_turb = 1
range_tkmmin	R	0.2		Variability range for minimum vertical diffusion for momentum	inwp_turb = 1
range_tkred_sfc	R	4.0		Range for multiplicative change of reduction of minimum diffusion coefficients near the surface	inwp_turb = 1
range_rlam_heat	R	3.0		Variability range (multiplicative!) of laminar transport resistance parameter	inwp_turb = 1
range_charnock	R	1.5		Variability range (multiplicative!) of upper and lower bound of wind-speed dependent Charnock parameter	inwp_turb = 1
range_minsnowfrac	R	0.05		Variability range for minimum value to which snow cover fraction is artificially reduced in case of melting snow	idiag_snowfrac = 20/30/40
range_c_soil	R	0.25		Variability range for evaporating fraction of soil	
range_cwimax_ml	R	2.0		Variability range for capacity of interception storage (multiplicative)	
range_z0_lcc	R	0.25		Variability range (relative change) of roughness length attributed to each landuse class	
range_rootdp	R	0.2		Variability range (relative change) of root depth attributed to each landuse class	

Parameter	Type	Default	Unit	Description	Scope
range_rsmin	R	0.2		Variability range (relative change) of minimum stomata resistance attributed to each landuse class	
range_laimax	R	0.15		Variability range (relative change) of leaf area index (maximum of annual cycle) attributed to each landuse class	

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

2.7 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
tablesVersion	I	15		Main switch for Table version	filetype=2
backgroundProcess	I	0		Background process - GRIB2 code table backgroundProcess.table	filetype=2
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

Parameter	Type	Default	Unit	Description	Scope
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
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`

2.8 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		Defined as the inverse of the reduced-size earth reduction factor X. Choose `grid_rescale_factor` < `1` for a reduced-size earth. 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
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. Relative time w.r.t. experiment start date (`ini_datetime_string` / `experimentStratDate`). (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. Relative time w.r.t. experiment start date (`ini_datetime_string` / `experimentStratDate`). (namelist entry is ignored for the global domain)	n_dom>1

Parameter	Type	Default	Unit	Description	Scope
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.
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`.	

Parameter	Type	Default	Unit	Description	Scope
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`

2.9 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
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	n_dom>1

Parameter	Type	Default	Unit	Description	Scope
				2: 2nd-order method using RBF interpolation	
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
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.

Parameter	Type	Default	Unit	Description	Scope
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`

2.10 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	
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`

2.11 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
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}

2.12 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_COSMO start from prognostic set of variables as used by COSMO 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	Duration of incremental analysis update (IAU) procedure. Start time for IAU is the actual model start time (see below).	init_mode=5,6
dt_shift	R	0	s	Time by which the actual model start time is shifted ahead of the nominal date. The latter is given by either `ini_datetime_string` or `experimentStartDate`. `dt_shift` must be NEGATIVE, usually -0.5 dt_iau.	init_mode=5,6

Parameter	Type	Default	Unit	Description	Scope
iterate_iau	L	.FALSE.		If .TRUE., the IAU phase is calculated twice with halved dt_shift in first cycle (allows writing a fully initialized analysis at the nominal initialization date while using a centered IAU window for the forecast).	init_mode=5,6 and dt_shift <0
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
niter_diffu	I	10		Number of diffusion iterations applied on wind increments	init_mode=5,6
niter_divdamp	I	25		Number of divergence damping iterations applied on wind 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	
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
use_lakeiceana	L	.FALSE.		If .TRUE., analysis data for sea ice fraction are also used for freshwater lakes (for the time being restricted to the Great Lakes; extension to other lakes needs to be tested)	init_mode=5,6

Parameter	Type	Default	Unit	Description	Scope
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
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".	
check_fg(jg)%list	C(:)			In ICON a small subset of first guess input fields is declared ’optional’, meaning that they are read in if present, but they are not mandatory to start the model. By adding optional fields to this list, they become mandatory for domain jg, such that the model aborts if any of them is missing. This list may include a subset of the optional first guess fields, or even the entire set of first guess fields. On default this list is empty, such that optional fields experience a cold-start initialization if they are missing and the model does not abort.	init_mode=1,5,6

Parameter	Type	Default	Unit	Description	Scope
check_ana(jg)%list	C(:)			List of mandatory analysis fields for domain `jg` 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_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 or NetCDF var name.	

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

2.13 interpol_nml

Parameter	Type	Default	Unit	Description	Scope
l_intp_c2l	L	.TRUE.		DEPRECATED	
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 30: cubic (no 3^{rd} order cross deriv.) 3: cubic	ihadv_tracer=4
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	

Parameter	Type	Default	Unit	Description	Scope
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 (namelist parameter `output_nml::rbf_scale`, p. 56).	
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: 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	

Parameter	Type	Default	Unit	Description	Scope
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.	
lreduced_nestbdry_stencil	L	.FALSE.		Flag. If .TRUE. then the nest boundary points are taken out from the lat-lon interpolation stencil.	

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

2.14 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)
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

Parameter	Type	Default	Unit	Description	Scope
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 5: New DWD method constituting a mixture between IFS and old GME method (departure level for downward extrapolation between 10 m and 150 m AGL depending on elevation)	
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)	
gust_interval	R	3600.	s	Interval over which wind gusts are maximized	iforcing=3
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
lnetcdf_flt64_output	L	.FALSE.		If .TRUE. floating point variable output in NetCDF files is written in 64-bit instead of 32-bit accuracy. This is currently implemented for the atm. dynamical core and ECHAM physics.	
restart_file_type	I	4		Type of restart file. One of CDI's FILETYPE_XXX. So far, only 4 (=FILETYPE_NC2) is allowed	
restart_write_mode	C	" "		Restart read/write mode. Allowed settings (character strings!) are listed below.	

Parameter	Type	Default	Unit	Description	Scope
nrestart_streams	I	1		When using the restart write mode "dedicated procs multifile", it is possible to split the restart output into several files, as if `nrestart_streams * num_io_procs` restart processes were involved. This speeds up the read-in process, since all the files may then be read in parallel.	`restart_write_mode` = `"dedicated procs multifile"`
lmask_boundary	L	F		Set to `.TRUE.`, if interpolation zone should be masked in triangular output.	

2.14.1 Restart read/write mode:

Allowed settings for `restart_write_mode` are:

’’`sync`’’
: ’Old’ synchronous mode. PE # 0 reads and writes restart files. All other PEs have to wait.

’’`async`’’
: Asynchronous restart writing: Dedicated PEs (`num_restart_proc > 0`) write restart files while the simulation continues. Restart PEs can only parallelize over different patches. — Read-in: PE # 0 reads while other PEs have to wait.

’’`joint procs multifile`’’
: All worker PEs write restart files to a dedicated directory. Therefore, the directory itself is called the restart file. The information is stored in a way that it can be read back into the model independent from the processor count and the domain decomposition. — Read-in: All worker PEs read the data in parallel.

’’`dedicated procs multifile`’’
: In this case, all the restart data is first transfered to memory buffers in dedicated restart writer PEs. After that, the work processes carry on with their work immediately, while the restart writers perform the actual restart writing asynchronously. Restart PEs can parallelize over patches and horizontal indices. — Read-in: All worker PEs read the data in parallel..

’’ ’’
: Fallback mode.
If `num_restart_proc == 0` (`parallel_nml`), then this behaves like ’’`sync`’’, otherwise like ’’`async`’’.

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

2.15 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
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

Parameter	Type	Default	Unit	Description	Scope
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	
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`

2.16 limarea_nml (Scope: l_limited_area=.TRUE. in grid_nml)

Parameter	Type	Default	Unit	Description	Scope
itype_latbc	I	0		Type of lateral boundary nudging. 0: constant lateral boundary conditions derived from the initial conditions, 1: time-dependent lateral boundary conditions provided by an external source (IFS, COSMO or a coarser-resolution ICON run), 2: Test mode using time-dependent lateral boundary conditions from a nested ICON run in which the present limited-area domain was operated as a nested grid with identical(!) model level configuration.	
dtime_latbc	R	10800.0	s	Time difference between two consecutive boundary data.	itype_latbc $\geq$ 1

Parameter	Type	Default	Unit	Description	Scope
init_latbc_from_fg	L	.FALSE.		If .TRUE., take lateral boundary conditions for initial time from first guess (or analysis) field	itype_latbc ≥ 1
latbc_filename	C			Filename of boundary data input file, these files must be located in the latbc_path directory. Default: ”prepiconR<nroot>B<jlev>_<y><m><d><h>.nc”. The filename may contain keyword tokens (day, hour, etc.) which will be automatically replaced during the run-time. See the table below for a list of allowed keywords.	itype_latbc ≥ 1
latbc_path	C			Absolute path to boundary data.	itype_latbc ≥ 1
latbc_boundary_grid	C	” ”		Grid file defining the lateral boundary. Empty string means: whole domain is read for the lateral boundary. This NetCDF grid file must contain two integer index arrays: int global_cell_index(cell), int global_edge_index(edge), both with attributes nglobal which contains the global size size of the non-sparse cells and edges.	itype_latbc ≥ 1
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_limarea_nml.f90

Keyword substitution in boundary data filename (`latbc_filename`):

`<y>`	substituted by year (four digits)
`<m>`	substituted by month (two digits)
`<d>`	substituted by day (two digits)
`<h>`	substituted by hour (two digits)
`<min>`	substituted by minute (two digits)
`<sec>`	substituted by seconds (two digits)
`<ddhhmmss>`	substituted by a *relative* day-hour-minute-second string.
`<dddhh>`	substituted by a *relative* (three-digit) day-hour string.

2.17 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	.FALSE.		.TRUE. for use of multi-layer snow model (default is single-sayer scheme)	
l2lay_rho_snow	L	.FALSE.		.TRUE. predict additional snow density for upper part of the snowpack, having a maximum depth of max_toplaydepth	lmulti_snow = .FALSE.
max_toplaydepth	R	0.25	m	maximum depth of uppermost snow layer	lmulti_snow=.TRUE. or l2lay_rho_snow=.TRUE.

Parameter	Type	Default	Unit	Description	Scope
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	3		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 operational version (GLOBCOVER2009 only) 4 = tuned version for new bare soil evaporation scheme (itype_evsl=4)	
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 Planton (1989) 4 = Resistance-based scheme by Jan-Peter Schulz	
itype_trvg	I	2		type of plant transpiration parameterization 2 = BATS scheme, Dickinson (1984) 3 = Extended BATS scheme with additional prognostic variable for integrated plant transpiration since sunrise; should be used only with an appropriate first guess for this variable coming from the assimilation cycle	

Parameter	Type	Default	Unit	Description	Scope
itype_heatcond	I	2		type of soil heat conductivity 1 = constant soil heat conductivity 2 = moisture dependent soil heat conductivity 3 = variant of option 2 with reduced near-surface heat conductivity in the presence of plant cover	
itype_interception	I	1		type of plant interception 1 = standard scheme, effectively switched off by tiny value cwimax_ml 2 = Rain and snow interception (under development)	
cwimax_ml	R	1.e-6	m	scaling parameter for maximum interception storage (almost switched off); use 5.e-4 to activate interception storage	itype_interception = 1
c_soil	R	1.		surface area density of the (evaporative) soil surface allowed range: 0 – 2	
c_soil_urb	R	1.		surface area density of the (evaporative) soil surface, urban areas allowed range: 0 – 2	
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	
lprog_albsi	L	.FALSE.		If .TRUE., sea-ice albedo is computed prognostically	lseaice=.TRUE.
llake	L	.TRUE.		.TRUE. for use of lake model	

Parameter	Type	Default	Unit	Description	Scope
sstice_mode	I	1		1: SST and sea ice fraction are read from the analysis. The SST is kept constant whereas the sea ice fraction can be modified by the seaice model. 2: SST and sea ice fraction are read from the analysis. The SST is updated by climatological increments on a daily basis. The sea ice fraction can be modified by the seaice model. 3: SST and sea ice fraction are updated daily, based on climatological monthly means 4: SST and sea ice fraction are updated daily, based on actual monthly means 5: SST and sea ice fraction are updated daily, based on actual daily means (not yet implemented)	iequations=3 iforcing=3
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=3,4,5
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=3,4,5

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

2.18 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.

Parameter	Type	Default	Unit	Description	Scope
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`

2.19 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.	

2.20 master_nml

Parameter	Type	Default	Unit	Description	Scope
lrestart	L	.FALSE.		If .TRUE.: Current experiment is started from a restart.	

Parameter	Type	Default	Unit	Description	Scope
lrestart_write_last	L	.FALSE.		If .TRUE.: model run should create restart at experiment end. This is independent from the settings of the restart interval.	
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.	

2.21 meteogram_output_nml

Nearest neighbour 'interpolation' is used for all variables.

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.	
loutput_tiles	L	.FALSE.		Write tile-specific output for some selected surface/soil fields	
n0_mtgrm	I(n_dom)	0		initial time step for meteogram output.	
ninc_mtgrm	I(n_dom)	1		output interval (in time steps)	
stationlist_tot		53.633, 9.983, 'Ham-burg'		list of meteogram stations (triples with lat, lon, name string)	
silent_flush	L(n_dom)	1		do not warn about flushing to disk if .TRUE.	
max_time_stamps	I(n_dom)	1		number of output time steps to record in memory before flushing to disk	
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`

2.22 mpi_phy_nml

The MPI physics is configured by a data structure *mpi_phy_config(jg=1:ndom)%<param>*, which is a 1-dimensional array extending over all domains. The structure contains several parameters providing time control for atmospheric forcings and additional logical switches for controlling how the atmospheric boundary conditions for the MPI physics are determined. Time control parameters are available for the following atmospheric processes:

prc	*parameterized process*
rad	LW and SW radiation
vdf	vertical diffusion
cnv	cumulus convection
cld	cloud microphysics
gwd	atmospheric gravity wave drag
sso	sub grid scale orographic effects
mox	methane oxidation and water vapor photolysis
car	Cariolle's linearized ozone chemistry
art	ART chemistry

The time control for an atmospheric forcing by a process *prc* consists of three components, the time interval *dt_prc* for re-computing the forcing, and the start and end dates and times defining the interval *[sd_prc,ed_prc[*, in which the forcing is either computed, if the date/time coincides with the interval *dt_prc*, or recycled. Recycling means that the forcing stored from the last computation is used again. Outside of the interval the forcing is set to zero.
If *dt_prc* is not specified, or an empty string or a string of blanks or an interval of length 0s, e.g. *"PT0S"* is given, then the forcing is switched off for the entire experiment and the start and end dates and times are irrelevant.
If *sd_prc* or *ed_prc* are not specified, or an empty string or a string of blanks are given, then the experiment start date and the experiment stop date are used, respectively.

Parameter	Type	Default	Unit	Description	Scope
mpi_phy_config(jg)% dt_prc	C	""		This is the time interval in ISO 8601-2004 format at which the forcing by the process *prc* is computed.	run_nml/iforcing = 2

Parameter	Type	Default	Unit	Description	Scope
mpi_phy_config(jg)% sd_prc	C	""		Defines the start date/time in ISO 8601-2004 format of the interval *[sd_prc,ed_prc[*, in which the forcing by the process *prc* is computed in intervals *dt_prc*.	run_nml/iforcing = 2 and *dt_prc* > 0.000s
mpi_phy_config(jg)% ed_prc	C	""		Defines the end date/time in ISO 8601-2004 format of the interval *[sd_prc,ed_prc[*, in which the forcing by the process *prc* is computed in intervals *dt_prc*.	run_nml/iforcing = 2 and *dt_prc* > 0.000s
mpi_phy_config(jg)% lice	L	.FALSE.		.TRUE. for sea-ice temperature calculation	run_nml/iforcing = 2
mpi_phy_config(jg)% lmlo	L	.FALSE.		.TRUE. for mixed layer ocean	run_nml/iforcing = 2
mpi_phy_config(jg)% ljsb	L	.FALSE.		.TRUE. for using the JSBACH land surface model	run_nml/iforcing = 2
mpi_phy_config(jg)% lamip	L	.FALSE.		.TRUE. for AMIP boundary conditions	run_nml/iforcing = 2

The namelist mpi_phy_nml is defined and read in: `src/namelists/mo_mpi_phy_nml.f90`

2.23 mpi_sso_nml

The parameterization of subgrid scale orographic (SSO) effects for the MPI physics is configured by a data structure *mpi_sso_config(jg=1:ndom)%<param>*, which is a 1-dimensional array extending over all domains. The structure contains parameters providing control over the parametrized effects:

Parameter	Type	Default	Unit	Description	Scope
mpi_sso_config(jg)% gpicmea	R	40.	m	Minimum height difference of peak height and mean height to activate the SSO parameterization.	mpi_phy_config(jg)% dt_sso > 0.000s
mpi_sso_config(jg)% gstd	R	10.	m	Minimum standard deviation of the SSO height to activate the SSO parameterization.	mpi_phy_config(jg)% dt_sso > 0.000s
mpi_sso_config(jg)% gkdrag	R	0.05		Coefficient for orographic gravity wave drag.	mpi_phy_config(jg)% dt_sso > 0.000s
mpi_sso_config(jg)% gkwake	R	0.		Coefficient for low level blocking.	mpi_phy_config(jg)% dt_sso > 0.000s

Parameter	Type	Default	Unit	Description	Scope
mpi_sso_config(jg)% gklift	R	0.		Coefficient for low level lift.	mpi_phy_config(jg)% dt_sso > 0.000s

The namelist mpi_sso_nml is defined and read in: `src/namelists/mo_mpi_sso_nml.f90`

2.24 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		Rayleigh damping coefficient $1/\tau_0$ (Klemp, Dudhia, Hassiotis: MWR136, pp.3987-4004); higher values are recommended for R2B6 or finer resolution	
damp_height	R(n_dom)	45000	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	

Parameter	Type	Default	Unit	Description	Scope
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.
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.

Parameter	Type	Default	Unit	Description	Scope
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)	
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.

Parameter	Type	Default	Unit	Description	Scope
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`

2.25 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. If the radiation time step is not an integer multiple of the cloud-cover time step it is automatically rounded to the next higher integer multiple of the cloud cover 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
rain_n0_factor	R	1.0		tuning factor for intercept parameter of raindrop size distribution	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
lshallowconv_only	L (max_ dom)	.FALSE.		.TRUE.: use shallow convection only	inwp_convection = 1
ldetrain_conv_prec	L (max_ dom)	.FALSE.		.TRUE.: Activate detrainment of convective rain and snow	inwp_convection = 1

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	
iprog_aero	I	0		0: off 1: simple prognostic aerosol scheme, based on 2D aerosol optical depth fields of Tegen 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 3: PSRAD radiation	run_nml:iforcing = inwp

Parameter	Type	Default	Unit	Description	Scope
inwp_satad	I	1		saturation adjustment 0: none 1: saturation adjustment at constant density	run_nml:iforcing = inwp
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 (does not account for tiles) 2 = land-cover-related roughness based on tile-specific landuse class 3 = land-cover-related roughness based on tile-specific landuse class including contribution from sub-scale orography	inwp_turb > 0

Parameter	Type	Default	Unit	Description	Scope
dt_conv	R (max_dom)	600.	s	time interval of convection and cloud-cover call. If convection is switched off, dt_conv controlls the time intervall of cloud-cover, only. 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
lrtm_filename	C(:)	"rrtmg_lw.nc"		NetCDF file containing longwave absorption coefficients and other data for RRTMG_LW k-distribution model.	
cldopt_filename	C(:)	"ECHAM6_CldOptProps.nc"		NetCDF file with RRTM Cloud Optical Properties for ECHAM6.	

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

2.26 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 (max_dom)	1.5		low level wake drag constant	run_nml:iforcing = inwp
tune_gkdrag	R (max_dom)	0.075		gravity wave drag constant	run_nml:iforcing = inwp
tune_gfrcrit	R (max_dom)	0.4		critical Froude number (controls depth of blocking layer)	run_nml:iforcing = inwp
tune_grcrit	R (max_dom)	0.25		critical Richardson number (controls onset of wave breaking)	run_nml:iforcing = inwp

Parameter	Type	Default	Unit	Description	Scope
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	0.01		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	1.85e-3	1/m	Entrainment parameter valid for dx=20 km (depends on model resolution)	run_nml:iforcing = inwp
tune_capdcfac_et	R	0.125		Fraction of CAPE diurnal cycle correction applied in the extratropics	icapdcycl = 3
tune_rhebc_land	R	0.75		RH threshold for onset of evaporation below cloud base over land	run_nml:iforcing = inwp
tune_rhebc_land_trop	R	0.75		RH threshold for onset of evaporation below cloud base over land in the tropics	run_nml:iforcing = inwp
tune_rhebc_ocean	R	0.85		RH threshold for onset of evaporation below cloud base over sea	run_nml:iforcing = inwp
tune_rhebc_ocean_trop	R	0.80		RH threshold for onset of evaporation below cloud base over sea in the tropics	run_nml:iforcing = inwp
tune_rcucov	R	0.05		Convective area fraction used for computing evaporation below cloud base	run_nml:iforcing = inwp
tune_rcucov_trop	R	0.05		Convective area fraction used for computing evaporation below cloud base in the tropics	run_nml:iforcing = inwp
tune_texc	R	0.125	K	Excess value for temperature used in test parcel ascent	run_nml:iforcing = inwp
tune_qexc	R	0.0125		Excess fraction of grid-scale QV used in test parcel ascent	run_nml:iforcing = inwp
tune_box_liq	R	0.05		Box width for liquid cloud diagnostic in cloud cover scheme	run_nml:iforcing = inwp; inwp_cldcover = 1
tune_box_liq_asy	R	2.5		Asymmetry factor for liquid cloud cover diagnostic	run_nml:iforcing = inwp; inwp_cldcover = 1

Parameter	Type	Default	Unit	Description	Scope
lcalib_clcov	L	.TRUE.		Apply calibration of layer-wise cloud cover diagnostics	run_nml:iforcing = inwp
Misc					
itune_albedo	I	0		MODIS albedo tuning 0: None 1: dimmed sahara	run_nml:iforcing = inwp albedo_type=2
tune_minsnowfrac	R	0.125		Minimum value to which the snow cover fraction is artificially reduced in case of melting show	lnd_nml:idiag_snowfrac = 20/30/40
IAU					
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`

2.27 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`.	

Parameter	Type	Default	Unit	Description	Scope
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.	
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.	

Parameter	Type	Default	Unit	Description	Scope
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	
taxis_tunit	I	2		Time unit of the TAXIS_RELATIVE time axis. 1 = TUNIT_SECOND 2 = TUNIT_MINUTE 5 = TUNIT_HOUR 9 = TUNIT_DAY For a complete list of possible values see cdilib.c	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.	

Parameter	Type	Default	Unit	Description	Scope
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.	
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.	
operation	C	None		Choose `"mean"` for generating time averaged output for the given list of variables or groups. The corresponding interval is the `output_interval`. Supported are 2D and 3D fields on model levels of the atmosphere and land model. Any other value than `mean` will be ignored.	
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.	

Parameter	Type	Default	Unit	Description	Scope
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.	
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>`, `<dddhhmmss>` 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

Parameter	Type	Default	Unit	Description	Scope
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 (`[longitude, latitude]`.	
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
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.	

Parameter	Type	Default	Unit	Description	Scope
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 mixed 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
`dddhhmmss`	substituted by *relative* three-digit 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

2.28 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	1		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`

2.29 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`

2.30 psrad_orbit_nml

Parameter	Type	Default	Unit	Description	Scope
cecc	R	0.016715		eccentricity of earth's orbit	
cobld	R	23.44100		obliquity of earth in degrees	
l_orbvsop87	L	.TRUE.		switch on (.TRUE.) the (real) observed orbit of the earth (not idealized) or switch it off (.FALSE.). In the latter case, a Kepler orbit is used.	
l_sph_symm_irr	L	.FALSE.		switch on (.TRUE.) a spherically symmetric irradiation from all sides or use an irradiation by a point source like the sun (.FALSE.).	

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

2.31 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.	

Parameter	Type	Default	Unit	Description	Scope
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) 4: Use insolation for RCE–type simulation with cos(zenith angle) = pi/4 (with PSRAD: use “4” if the diurnal cycle is switched on) 5: Use insolation for RCE–type simulation with PSRAD if the diurnal cycle is switched off.	
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)	
islope_rad	I	0		Slope correction for surface radiation: 0: None 1: Slope correction for direct solar radiation without shading effects	
albedo_type	I	1		Type of surface albedo 1: based on soil type specific tabulated values (dry soil) 2: MODIS albedo	iforcing=inwp

Parameter	Type	Default	Unit	Description	Scope
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
icld_overlap	I	2		Method for cloud overlap calculation in shortwave part of RRTM 1: maximum-random overlap 2: generalized overlap (Hogan, Illingworth, 2000) 3: maximum overlap 4: random overlap	iforcing=inwp inwp_radiation=1

Parameter	Type	Default	Unit	Description	Scope
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 irad_xyz = 0: set to zero irad_h2o = 1: vapor, cloud water and cloud ice from tracer variables irad_co2 = 1: CO_2 from tracer variable irad_co2/ch4/n2o/o2/cfc11/cfc12 = 2: concentration given by vmr_co2/ch4/n2o/o2/cfc11/cfc12 irad_ch4/n2o = 3: tanh-profile with surface concentration given by vmr_ch4/n2o irad_co2/cfc11/cfc12 = 4: time dependent concentration from greenhouse gas file irad_ch4/n2o = 4: time dependent tanh-profile with surface concentration from greenhouse gas file 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) irad_o3 = 79: Blending between GEMS and MACC ozone climatologies (from IFS) for run_nml/iforcing = 3 (NWP); MACC is used over Antarctica irad_o3 = 97: As 79, but MACC is also used above 1 hPa with transition zone between 5 hPa and 1 hPa irad_o3 = 10: Linearized ozone chemistry (ART extension necessary) for run_nml/iforcing = 3 (NWP)	

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	
fh2o fco2 fch4 fn2o fo3 fo2 fcfc	R	1. 1. 1. 1. 1. 1. 1.		Scaling factors for concentrations used in radiation	run_nml/iforcing=2 (ECHAM)
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 9: ART online aerosol radiation interaction, uses Tegen for aerosols not chosen to be represented in ART for run_nml/iforcing = 3 (NWP) .AND. itopo =1 .AND. lart=TRUE .AND. iart_ari=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`

2.32 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.	
dtime	R	600.0	s	time step. For real case runs the maximum allowable time step can be estimated as $1.8 \cdot \text{ndyn\_substeps} \cdot \overline{\Delta x}\,\text{s}\,\text{km}^{-1}$, 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)	

Parameter	Type	Default	Unit	Description	Scope
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			
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.	

Parameter	Type	Default	Unit	Description	Scope
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. • "maxwinds": write max. winds to separate ASCII file "maxwinds.log". 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`".	
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)	
ldass_lhn	L	.FALSE.		Main switch which enables the assimilation of radar derived precipitation rate via Latent Heat Nudging	
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`

2.33 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	
itype_laydistr	I	1		Type of analytical function used to specify the distribution of the vertical coordinate surfaces 1: transformed cosine, 2: third-order polynomial	
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	
lread_smt	L	.FALSE.		read smoothed topography from file (TRUE) or compute internally (FALSE)	

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

2.34 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

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

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

2.35 time_nml

Parameter	Type	Default	Unit	Description	Scope
calendar	I	1		Calendar type: 0=Julian/Gregorian 1=proleptic Gregorian 2=30day/month, 360day/year	

Parameter	Type	Default	Unit	Description	Scope
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	'2008-09-01T00:00:00Z'		Initial date and time of the simulation	
end_datetime_string	C	'2008-09-01T01:40:00Z'		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".

2.36 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.)	lsq_high_ord $\in$ [2,3]
				4: FFSL (quadr. or cubic reconstr.)	lsq_high_ord $\in$ [2,3]
				5: hybrid Miura3/FFSL (quadr. or cubic reconstr.)	lsq_high_ord $\in$ [2,3]
				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).	
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	
tracer_names	C(:)	'Int2Str(i)'		Tracer-specific name suffixes. When running idealized cases or the hydrostatic ICON, this variable is used to specify tracer names. If nothing is specified, the tracer name is given as `PREFIX+Int2String(i)`, where `i` is the tracer index. Note that this namelist variable has no effect for nonhydrostatic real-case runs, if the NWP- or ECHAM physics packages are switched on.	iforcing≠ inwp, iecham'
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:	

Parameter	Type	Default	Unit	Description	Scope
				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 4: positive definite flux limiter	
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`

2.37 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	
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	
q_crit	R	1.6		critical value for normalized super-saturation	
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	.TRUE.		Consider TKE-production by sub grid SSO wakes	inwp_sso = 1

Parameter	Type	Default	Unit	Description	Scope
imode_tkesso	I	1		mode of calculat. the SSO source term for TKE production: 1: original implementation 2: Ri-dependent reduction factor for Ri>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)	
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	

Parameter	Type	Default	Unit	Description	Scope
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 $Ri^{-2/3}$) for heat and moisture	
tkmmin	R	0.75	m^2/s	Scaling factor for minimum vertical diffusion coefficient (proportional to $Ri^{-2/3}$) for momentum	
tkmmin_strat	R	4	m^2/s	Scaling factor for stratospheric minimum vertical diffusion coefficient (proportional to $Ri^{-1/3}$) for momentum, valid above 17.5 km (tropics above 22.5 km)	
tkhmin_strat	R	0.75	m^2/s	Scaling factor for stratospheric minimum vertical diffusion coefficient (proportional to $Ri^{-1/3}$) for heat and moisture, valid above 17.5 km (tropics above 22.5 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.	

Parameter	Type	Default	Unit	Description	Scope
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	
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`

2.38 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`

3 Ocean-specific namelist parameters

3.1 ocean_physics_nml

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

3.2 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.	

Parameter	Type	Default	Unit	Description	Scope
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).	

4 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.

4.1 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	 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

Parameter	Type	Default	Unit	Description	Scope
				'HS': Held-Suarez test	lshallow_water=.FALSE.
				'JWs': Jablonowski-Will. steady state	lshallow_water=.FALSE.
				'JWw': Jablonowski-Will. wave test	lshallow_water=.FALSE.
				'JWw-Moist': Jablonowski-Will. wave test including moisture	lshallow_water=.FALSE.
				'APE': aqua planet experiment	lshallow_water=.FALSE.
				'MRW': mountain induced Rossby wave	lshallow_water=.FALSE.
				'MRW2': modified mountain induced Rossby wave	lshallow_water=.FALSE.
				'PA': pure advection	lshallow_water=.FALSE.
				'SV': stationary vortex	lshallow_water=.FALSE., ntracer = 2
				'DF1': deformational flow test 1	
				'DF2': deformational flow test 2	
				'DF3': deformational flow test 3	
				'DF4': deformational flow test 4	
				'RH': Rossby-Haurwitz wave test	lshallow_water=.FALSE.
tracer_inidist_list	I(:)	1		For a subset of testcases pre-defined initial tracer distributions are available. This namelist parameter specifies the initial distribution for each tracer. In the following the testcases and the pre-defined numbers are given: 'PA': 4,5,6,7,8 'JABW':1,2,3,4 'DF': 5,6,7,8,9 For more details on the initial distributions, please have a look into the code.	ha_testcase_nml='PA', 'JABW','DF'
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'

Parameter	Type	Default	Unit	Description	Scope
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'
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'

Parameter	Type	Default	Unit	Description	Scope
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`

4.2 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. '**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.	

Parameter	Type	Default	Unit	Description	Scope
				'**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_nwp, APE_echam, APE_nh, APEc_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_bw_11**': Initializes (moist) baroclinic instability/wave (**DCMIP2016**) '**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)	
				'**dcmip_gw_32**': nonhydrostatic gravity waves triggered by a localized perturbation (linear)	l_limited_area =.TRUE. and lcoriolis = .FALSE.

Parameter	Type	Default	Unit	Description	Scope
				'**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.
is_toy_chem	L	.FALSE.		Terminator toy chemistry activated when .TRUE.	
tracer_inidist_list	I(:)	1		For a subset of testcases pre-defined initial tracer distributions are available. This namelist parameter specifies the initial distribution for each tracer. In the following the testcases and the pre-defined numbers are given: 'PA': 4,5,6,7,8 'JABW':1,2,3,4 'DF': 5,6,7,8,9 For more details on the initial distributions, please have a look into the code.	nh_test_name='PA', 'JABW','DF'
dcmip_bw%				DCMIP2016 baroclinic wave test	'dcmip_bw_11'
deep	I	0		deep atmosphere (1 = yes or 0 = no)	
moist	I	0		include moisture, i.e. $qv \neq 0$ (1 = yes or 0 = no)	
pertt	I	0		type of initial perturbation (0 = exponential, 1 = stream function)	
toy_chem%				terminator toy chemistry	is_toy_chem=.TRUE.
dt_chem	R	300	s	chemistry tendency update interval	
dt_cpl	R	300	s	chemistry-transport coupling interval	
id_cl	I	1		Tracer container slice index for species CL	
id_cl2	I	2		Tracer container slice index for species CL2	
jw_up	R	1.0	m/s	amplitude of the u-perturbation in jabw test case	nh_test_name='jabw'

Parameter	Type	Default	Unit	Description	Scope
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'
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.

Parameter	Type	Default	Unit	Description	Scope
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. 'sst_const': constant SST	nh_test_name='APE_nwp', 'APE_echam'
ape_sst_val	R	29.0	degC	aqua planet SST for ape_sst_case='sst_const'	nh_test_name= 'APE_nwp', 'APE_echam'
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'
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'

Parameter	Type	Default	Unit	Description	Scope
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
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

Parameter	Type	Default	Unit	Description	Scope
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
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

Parameter	Type	Default	Unit	Description	Scope
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
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'

Parameter	Type	Default	Unit	Description	Scope
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`

5 External data

5.1 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	
itype_vegetation_cycle	I	1		1: annual cycle of LAI solely based on NDVI climatology 2: additional use of monthly T2M climatology to get more realistic values in extratropics (requires external parameter data contining this field)	
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

Parameter	Type	Default	Unit	Description	Scope
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	
lrevert_sea_height	L	.FALSE.		If .TRUE., sea point heights will be reverted to original (raw data) heights after topography smoothing was applied.	n_iter_smooth_topo > 0
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`

6 External packages

7 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.

8 Compile flag for mixed precision

To speed up code parts strongly limited by memory bandwidth (primarily the dynamical core and the tracer advection), an option exists to use single precision for variables that are presumed to be insensitive to computational accuracy. This affects most local arrays in the dynamical core routines (solve_nonhydro and velocity_advection), some local arrays in the tracer transport routines, the metrics coefficients, arrays used for storing tendencies or differenced fields (gradients, divergence etc.), reference atmosphere fields, and interpolation coefficients. Prognostic variables and intermediate variables affecting the accuracy of mass conservation are still treated in double precision. To activate the mixed-precision option, the cpp flags '-D__MIXED_PRECISION' and '-D__MIXED_PRECISION_2' need to be specified in the configuration settings used for generating the Makefile. The latter flag is used for physics tendencies. Note that interpolation to a latitude-longitude grid is not supported for single-precision variables; if you desire to output physics tendency fields on a regular grid for diagnostic purposes, do not set '-D__MIXED_PRECISION_2'.

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(:,:)".

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**

[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).

- 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. `lzaxis_reference` finally removed in `r24606`.

Change: **limarea_nml**
Date of Change: **2016-02-08**
Revision: **26390**

- Namelist parameter `dt_latbc` has been removed. Its value is now identical to the namelist parameter `dtime_latbc`.

Change: **interpol_nml**
Date of Change: **2016-02-11**
Revision: **26423**

- Namelist parameter `l_intp_c2l` is deprecated and has no effect anymore.

Change: **lnd_nml**
Date of Change: **2016-07-21**
Revision: **28536**

- The numbering of the various options for `sstice_mode` has changed. Former option 2 became 3, former option 3 became 4, and former option 4 became 5. This was necessary, because a new option was introduced (option 2).

Change: **initicon_nml**
Date of Change: **2016-07-22**
Revision: **28556**

- Namelist parameter `latbc_varnames_map_file` has been moved to the namelist `limarea_nml`.

Change: **transport_nml**
Date of Change: **2016-09-22**
Revision: **29339**

- Namelist parameter `niter_fct` has been removed, since the functionality of iterative flux correction is no longer available.

Change: **initicon_nml**
Date of Change: **2016-10-07**
Revision: **29484**

- Namelist parameter `l_sst_in` has been removed. In case of init_mode=2 (IFSINIT), sea points are now initialized with SST, if provided in the input file. Otherwise sea points are initialized with the skin temperature. The possibility to use the skin temperature despite having the SST available has been dropped.

Change: **initicon_nml**
Date of Change: **2016-12-14**
Revision: **62288ed77b2975182204a2ec6fa210a3fb1ad8a7**

- Namelist parameters `ana_varlist, ana_varlist_n2` have been renamed to `check_ana(jg)%list`, with jg indicating the patch ID.

Change: **initicon_nml**
Date of Change: **2017-01-27**
Revision: **ae1be66f**

- The default value of the namelist parameter `num_prefetch_proc` has been changed to 1, i.e. asynchronous read-in of lateral boundary data is now enabled.

Change: **interpol_nml**
Date of Change: **2017-01-31**
Revision: **e1c56104**

- With the introduction of the namelist parameter `lreduced_nestbdry_stencil` in the namelist `interpol_nml` the nest boundary points are no longer removed from lat-lon interpolation stencil by default.

Change: **limarea_nml**
Date of Change: **2017-03-14**
Revision: **631b731627**

- The namelist parameter `nlev_latbc` is now deprecated. Information about the vertical level number is taken directly from the input file.

Change: **echam_phy_nml / mpi_phy_nml**
Date of Change: **2017-04-19**
Revision: **icon-aes:icon-aes-mag 9ecee54f69108716308029d8d7aa0296c343a3c2**

- The namelist echam_phy_nml is replaced by the namelist mpi_phy_nml, which extends the control to multiple domains and introduces time control in terms of start and end date/time [sd_prc,ed_prc[and time interval dt_prc for individual atmospheric processes *prc*.