ICON model parameters suitable for model tuning

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The table summarizes the most important tuning variables for the ICON model, and is largely based on Reinert et al. (2020), chapter 12.2. Those parameters that have been identified as sensitive parameters in Avgoustoglou et al. (2020) are highlighted in green. Parameters that are mostly relevant for simulations covering the tropics are highlighted in blue.

Yet, the document and the list of variables should be handled with care. Purely varying some of the listed parameters blindly will most likely not give satisfactory results. A physical understanding of the identified model shortcomings/biases should be built up first, followed by a choice of the associated model parameters and a systematic variation and evaluation of simulations. The parameters of interest may strongly vary for the region of interest, the model resolution and the specific purpose.

Please also keep in mind that the list is neither exhaustive, nor complete. There may well be further model parameters that are more suitable for individual applications.

Parameter	Description	Meaningful Range	Comment
Tuning of the SSO and GWD parameters is dependent on the employed external paramters			
	SSO tuning		
gkwake	low level wake drag constant C_d for blocking	1.5 ± 0.5	Very strong dependency on raw data resolution: for ICON-D2 with ASTER data, we use 0.25
gkdrag	gravity wave drag constant G, a function of mountain sharpness	0.075 ± 0.04	Should be zero (turned off) at convection-permitting resolutions
gfrcrit	critical Froude number determining depth of blocked layer $H_{n_{crit}}$	0.4 ± 0.1	
grcrit	critical Richardson number	0.25	
tune_minsso	minimal value of SSO-STDH (m) where SSO-effects are being considered	default 10	must also be adapted in extpar!
tune_blockred	multiples of the SSO-STDH, above which the SSO-blocking tendency is being reduced proportionally to STDH/z_AGL	1.5	default 100 = deactivated
	GWD tuning		
gfluxlaun	variability range for non-orographic gravity wave launch momentum flux	$2.50 \cdot 10^{-3} \pm 0.75 \cdot 10^{-3}$ [Pa]	relevant for global applications only

Parameter	Description	Meaningful Range	Comment
	grid scale microphysics		
zvz0i	terminal fall velocity of ice	0.85 ± 0.25 [m/s]	allows temperature bias tuning in the upper tropical troposphere as well as TOA long-wave fluxes
zceff_min	minimum value for sticking efficiency	0.01 - 0.075	tropics
v0snow	factor in the terminal velocity for snow	10.0 - 30.0	recommended value 25.0
icesedi_exp	exponent for density correction of cloud ice sedimentation	0.3 - 0.33	no perturbation recommended
rain_n0fac	multiplicative change of intercept parameter of raindrop size distribution	0.25 - 4.	multiplicative perturbation
	cloud cover		
box_liq	Box width for liquid cloud diagnostic in cloud cover scheme	0.05 ± 0.02	
box_liq_asy	Asymmetry factor for liquid cloud cover diagnostic	2.0 - 4.0 (def. 3.25)	sensitive to TOA solar fluxes and to a lesser degree long-wave fluxes
thicklayfac	factor for increasing the box width for layer thicknesses exceeding 150 m	0.005 ± 0.005 [1/m]	accounting for vertical sub-grid overlap
sgsclifac	Scaling factor for turbulence-induced subgrid-scale contribution to diagnosed cloud ice	0.0 - 1.0	0.0 turns this contribution off
allow_overcast	Tuning factor for steeper dependence CLC (RH)	≤ 1.0	setting allow_overcast<1 together with reduction of tune_box_liq_asy causes steeper CLC(RH) dependence. recommendation: allow_overcast<1 should not be used in combination with lsgs_cond=.TRUE.

Parameter	Description	Meaningful Range	Comment
	turbulence		
q_crit	critical value for normalised super-saturation	1.6-4.0	
rlam_heat	scaling factor of the laminar boundary layer for heat (scalars), the change in rlam_heat is accompanied by an inverse change of rat_sea in order to keep the evaporation over water (controlled by rlam_heat · rat_sea) the same. recommendation: the product of rlam_heat and rat_sea should not be significantly larger than 10. Otherwise, there will be too little evaporation over the oceans.	10.0±8.0	additive perturbation
rat_sea	controls latent and sensible heat fluxes over water	0.8 - 10.0	lower values increase latent and sensible fluxes over water; different values in data_turbulence.f90 and turb_data.f90 ?
a_hshr	Length scale factor for the separated horizontal shear mode	1.0 ± 1.0	
a_stab	factor for stability correction of turbulent length scale	0.0	turned off by default because it degrades global skill scores
c_diff	length scale factor for vertical diffusion of TKE	0.1-0.4	
alpha0	lower bound of velocity-dependent Charnock parameter	0.0123-0.0335	additive ensemble perturbation of Charnock-parameter
alpha1	parameter scaling the molecular roughness of water waves	0.1-1.0	lower values increase latent and sensible fluxes over water, particularly at low wind speeds. alpha1=1.0 in data_turbulence.f90 and alpha1=0.75 in turb_data.f90, recommended value of 0.125
tur_len	asymptotic maximal turbulent distance	500. alpha± 150. [m]	
tkhmin	scaling factor for minimum vertical diffusion coefficient for heat and moisture	0.6 ± 0.2	0.75 default in code
tkmmin	scaling factor for minimum vertical diffusion coefficient for momentum	0.75 ± 0.2	
tkred_sfc	multiplicative change of reduction of minimum diffusion coefficients near the surface	0.25 - 4.0	multiplicative perturbation

Parameter	Description	Meaningful Range	Comment
	TERRA		
c_soil	evaporating fraction of soil	1.0 ± 0.25	
cwimax_ml	scaling parameter for maximum interception storage	$5.\cdot 10^{-7} - 5. \cdot 10^{-4}$	low values ($< 10^{-6}$) turn off interception layer
	snow cover diagnosis		
minsnowfrac	Lower limit of snow cover fraction to which melting snow is artificially reduced in the context of the snow-tile approach	0.2 ± 0.1	
	radiation		
dust_abs	Tuning factor for enhanced LW absorption of mineral dust in the Saharan region	0.0	Reduces bias over Sahara for the RRTM scheme but not necessary and implemented with ecRad and itype_lwemiss=2

Parameter	Description	Meaningful Range	Comment
	convection		
entrorg	Entrainment parameter in convection scheme valid for dx=20km	$1.95 \cdot 10^{-3} \pm 0.2 \cdot 10^{-3}$	corresponds to entr_sc in the shallow convection part of COSMO Tiedtke scheme
rdepths	maximum allowed shallow convection depth	$2.0 \cdot 10^{4} \pm 5.0 \cdot 10^{3}$ Pa	
rprcon	coefficient for conversion of cloud water into precipitation	$1.4 \cdot 10^{-3} \pm 0.25 \cdot 10^{-3}$	
capdcfac_et	fraction of CAPE diurnal cycle correction applied in the extratropics	0.5 ± 0.75	
capdcfac_tr	fraction of CAPE diurnal cycle correction applied in the tropics	0.5 ± 0.75	
lowcapefac	Tuning parameter for diurnal-cycle correction in convection scheme: reduction factor for low-cape situations	1.0 ± 0.5	
negpblcape	Tuning parameter for diurnal-cycle correction in convection scheme: maximum negative PBL CAPE allowed in the modified CAPE closure	-500.- 0.	
rhebc_land	RH threshold for onset of evaporation below cloud base over land	0.825 ± 0.05	0.75 as default in code
rhebc_ocean	RH threshold for onset of evaporation below cloud base over sea	0.85 ± 0.05	
rhebc_land_trop	RH threshold ... over tropical land	0.70 ± 0.05	tropics
rhebc_ocean_trop	RH threshold ... over tropical sea	0.76 ± 0.05	tropics
rcucov	Convective area fraction used for computing evaporation below cloud base	0.075	0.05 coded as default
rcucov_trop	Convective area fraction used for computing evaporation below cloud base, tropics	0.03	tropics
texc	Excess value for temperature used in test parcel ascent	0.125 ± 0.05 [K]	
qexc	Excess fraction of grid-scale QV used in test parcel ascent	0.0125 $\pm$ 0.005 [kg/kg]	

References

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