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Supplement of

Development of a MetUM (v 11.1) and NEMO (v 3.6) coupled operational forecast model for the Maritime Continent – Part 1: Evaluation of ocean forecasts

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1. NEMO compilation Keys

The preprocessing keys used for compiling the NEMO code in MCO and MCO_{ao} modeling systems are listed in Table S1.

key_mpp_mpi	Use MPI library
key_iomput	Use XIOS I/O library
key_nosignedzero	Overwrite f95 behaviour of intrinsic sign function
key_vectopt_loop	Inner loop index order
Key_netcdf4	Netcdf4 support
key_zdfgls	Use Generic Length Scale (GLS) vertical mixing
key_dynspg_ts	Use split-explicit free surface
key_ldfslp	Use Lateral Diffusion
key_bdy	Use Unstructured open boundary condition
key_zdftmx	Use tidal mixing scheme
key_tide	Use tide boundary forcing
key_vvl	Use variable volume non-linear free surface
key_diahth	Use diagnostic routines
key_oasis3mct (only for MCO_{ao})	Use coupling interface

Table S1: NEMO compilation keys used in MCO and MCO_{ao} simulations

2. NEMO Branches

NEMO branches used for creating the merged code in MCO and MCO_{ao} systems are listed in Table S2.

NEMO Branches		Modifications	Revision
1	Vn3.6 trunk	Root NEMO vn3.6 code revision	6232
2	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/CCRS_NUS_MC_STABLE	Updates to LBC	10177
3	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/2015_V36_STABLE_CO6_CO5_zenv_pomsdwl	Enables backward compatibility from CO6 to CO5	8412
4	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/r6232_hadgem3_mct	Add OASIS-MCT compatibility	7457
5	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/r6232_hadgem3_cplseq	Set the required order of coupling fields	7460
6	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/r6232_hadgem3_cplfld	Treat non-standard aspects of atmosphere coupling	9595
7	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/r6232_sst_landsea_cpl	Distinguish NEMO land SST values for coupling	7466
8	http://forge.ipsl.jussieu.fr/nemo/browser/branches/UKMO/r6232_coupling_CBIJ	Updates for using the coupled or external MSLP	11432

Table S2: NEMO branches used in the MCO and MCOao systems to the baseline trunk code at version 3.6 (revision 6232). Model codes are accessible via https://www.nemo-ocean.eu/. Registered users can directly access the copy of the code branches listed at the revision used. Branches 3-7 are similar to the UKC3 system (Lewis et al., 2019a).

3. NEMO namelists

Namelists for the NEMO ocean model employed in the MCO and MCO_{ao} simulations are listed in this section. This file should be included as the namelist_cfg file in the working directory along with the namelist_ref file.

3.1 MCO (NEMO-only model) namelists

```
&namrun
cn_exp='mc',
cn_ocerst_in='restart',
cn_ocerst_indir='./',
cn_ocerst_out='restart',
cn_ocerst_outdir='/home/bthompson/cylc-run/mss-
aa858/share/cycle/20190930T0000Z/NEMOhist',
ln_clobber=.true.,
ln_mskland=.false.,
ln_rstart=.true.,
ln_rstdate=.true.,
nn_date0=20190930,
nn_euler=1,
nn_istate=0,
nn_it000=1,
nn_itend=720,
nn_leapy=1,
nn_stock=720,
nn_write=720,
/
&namcfg
cp_cfg='nemo-mc',
jp_cfg=405,
jperio=0,
jpidta=1262,
jpiglo=1262,
jpizoom=1,
jpjdta=1082,
jpjglo=1082,
jpjzoom=1,
jpkdta=51,
/
&namzgr
ln_read_zenv=.false.,
ln_sco=.true.,
ln_zps=.false.,
/
&namzgr_sco
ln_s_sf12=.true.,
ln_s_sh94=.false.,
ln_sigcrit=.true.,
rn_alpha=4.4,
```

rn_bb=0.8,
rn_efold=0.0,
rn_hc=50.0,
rn_rmax=0.1,
rn_sbot_max=9400.0,
rn_sbot_min=10.0,
rn_theta=6.0,
rn_thetb=1.0,
rn_zb_a=0.024,
rn_zb_b=-0.2,
rn_zs=1.0,
/
&namdom
ldbletanh=.false.,
nn_bathy=1,
nn_msh=0,
ppa0=999999.0,
ppa1=999999.0,
ppa2=999999.0,
ppacr=9.0,
ppacr2=999999.0,
ppdzmin=6.0,
ppe1_deg=999999.0,
ppe1_m=999999.0,
ppe2_deg=999999.0,
ppe2_m=999999.0,
ppglam0=999999.0,
ppgphi0=999999.0,
pphmax=9400,
ppkth=23.563,
ppkth2=999999.0,
ppsur=999999.0,
rn_rdt=120.0,
/
&namsplit
ln_bt_nn_auto=.true.,
nn_baro=30,
/
&namcrs
/
&namsbc
ln_ana=.false.,
ln_apr_dyn=.true.,
ln_blk_core=.true.,
ln_dm2dc=.false.,
ln_flx=.false.,
ln_rnf=.true.,
ln_ssr=.false.,
ln_wave=.false.,
nn_drag=0,

```
nn_fsbc=1,
nn_fwb=0,
nn_ice=0,
nn_lsm=20,
/
&namsbc_core
cn_dir='/home/bthompson/cylc-run/mss-aa858/share/cycle/20190930T0000Z/EC_ANA/',
ln_taudif=.false.,
rn_pfac=1.0,
rn_vfac=0,
rn_zqt=10,
rn_zu=10,
sn_humi='ec_ana_TQ',6,'q_hum',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_ana_L
SM.nc',
sn_prec='ec_fcst_PSWLW',6,'rain',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_ana_
LSM.nc',
sn_qlw='ec_fcst_PSWLW',6,'lw_dwn',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_a
na_LSM.nc',
sn_qsr='ec_fcst_PSWLW',6,'sw_dwn',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_a
na_LSM.nc',
sn_snow='ec_fcst_PSWLW',6,'snow',.false.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_a
na_LSM.nc',
sn_tair='ec_ana_TQ',6,'tair',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_ana_LSM.n
c',
sn_wndi='ec_ana_UVMSLP',6,'u',.true.,.false.,'daily','ECAN_weights_bilinear.nc','U10','ec_a
na_LSM.nc',
sn_wndj='ec_ana_UVMSLP',6,'v',.true.,.false.,'daily','ECAN_weights_bilinear.nc','V10','ec_a
na_LSM.nc',
/
&namtra_qsr
cn_dir='/scratch/singadm/UMDIR/coupled_proj//mc2//Forcing/',
ln_qsr_2bd=.false.,
ln_qsr_bio=.false.,
ln_qsr_rgb=.true.,
ln_traqsr=.true.,
nn_chldta=1,
rn_abs=0.56,
rn_si0=0.35,
sn_chl='chlorophyll_mod',-1,'CHLA',.true.,.true.,'yearly','weights_bilinear_chl.nc','',
/
&namsbc_rnf
cn_dir='/scratch/singadm/UMDIR/coupled_proj//mc2//Forcing/',
ln_rnf_depth=.false.,
ln_rnf_mouth=.false.,
ln_rnf_sal=.false.,
ln_rnf_tem=.false.,
rn_avt_rnf=0.001,
rn_hrnf=100,
rn_rfact=1.0,
```

```
sn_cnf='runoff_1m_ORCA1_fill0.nc',0,'scoeff',.false.,.true.,'yearly','weights_runofft_bilinear.
nc','',
sn_rnf='runoff_1m_ORCA1_fill0.nc',-
1,'srunoff',.true.,.true.,'yearly','weights_runofft_bilinear.nc','',
/
&namsbc_apr
cn_dir='/home/bthompson/cylc-run/mss-aa858/share/cycle/20190930T0000Z/EC_ANA/',
ln_apr_obc=.true.,
ln_ref_apr=.false.,
rn_pref=101000.0,
sn_apr='ec_ana_UVMSLP',6,'slp',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_ana_
LSM.nc',
/
&namsbc_ssr
nn_sssr=0,
nn_sstr=0,
/
&namsbc_alb
/
&namberg
/
&namlbc
rn_shlat=1,
/
&namcla
nn_cla=0,
/
&namagrif
ln_spc_dyn=.true.,
nn_cln_update=3,
rn_sponge_dyn=2880.0,
rn_sponge_tra=2880.0,
/
&nam_tide
clname(1)='Q1',
clname(10)='M2',
clname(11)='L2',
clname(12)='T2',
clname(13)='S2',
clname(14)='K2',
clname(15)='M4',
clname(2)='O1',
clname(3)='P1',
clname(4)='S1',
clname(5)='K1',
clname(6)='2N2',
clname(7)='MU2',
clname(8)='N2',
clname(9)='NU2',
ln_tide_pot=.true.,
```

```
/
&nambdy
cn_coords_file='coordinates.bdy_rm1.nc',
cn_dyn2d='flather',
cn_dyn3d='frs',
cn_tra='frs',
ln_coords_file=.true.,
ln_dyn3d_dmp=.false.,
ln_mask_file=.false.,
ln_sponge=.true.,
ln_tra_dmp=.false.,
ln_vol=.false.,
nb_bdy=1,
nn_dyn2d_dta=3,
nn_dyn3d_dta=1,
nn_rimwidth=1,
nn_tra_dta=1,
nn_volctl=0,
rn_sponge=5,
/
&nambdy_ssh
ln_ssh_bdy=.true.,
/
&nambdy_dta
bn_sal='MC_bdyT_tra',24,'sn',.true.,.false.,'daily','','','',
bn_ssh='MC_bdyT_ssh',24,'sshn',.true.,.false.,'daily','','','',
bn_tem='MC_bdyT_tra',24,'tn',.true.,.false.,'daily','','','',
bn_u2d='MC_bdyU_dyn2d',24,'ubar',.true.,.false.,'daily','','','',
bn_u3d='MC_bdyU_dyn3d',24,'un',.true.,.false.,'daily','','','',
bn_v2d='MC_bdyV_dyn2d',24,'vbar',.true.,.false.,'daily','','','',
bn_v3d='MC_bdyV_dyn3d',24,'vn',.true.,.false.,'daily','','','',
cn_dir='/home/bthompson/cylc-run/mss-aa858/share/cycle/20190930T0000Z/NEMO_LBC/',
ln_full_vel=.false.,
/
&nambdy_tide
filtide='/scratch/singadm/UMDIR/coupled_proj//mc2//LBC/bdydta/MC_bdytide_fes',
ln_bdytide_2ddta=.true.,
ln_bdytide_conj=.false.,
/
&nambfr
ln_bfr2d=.false.,
ln_bfrimp=.true.,
ln_loglayer=.true.,
nn_bfr=2,
rn_bfeb2=0.0,
rn_bfri1=4.0e-4,
rn_bfri2=1.0e-4,
rn_bfri2_max=1.5e-1,
rn_bfrz0=0.003,
/
```

```
&nambbc
ln_trabbc=.false.,
/
&nambbl
nn_bbl_adv=0,
nn_bbl_ldf=0,
/
&nameos
ln_usect=.false.,
nn_eos=0,
/
&namtra_adv
ln_traadv_cen2=.false.,
ln_traadv_muscl=.false.,
ln_traadv_muscl2=.false.,
ln_traadv_qck=.false.,
ln_traadv_tvd=.true.,
ln_traadv_ubs=.false.,
/
&namtra_adv_mle
/
&namtra_ldf
ln_botmix_grif=.false.,
ln_traldf_bilap=.false.,
ln_traldf_gdia=.false.,
ln_traldf_grif=.false.,
ln_traldf_hor=.true.,
ln_traldf_iso=.false.,
ln_traldf_lap=.true.,
ln_traldf_level=.false.,
ln_triad_iso=.false.,
rn_aeiv_0=0.0,
rn_aht_0=20.0,
rn_ahtb_0=0.0,
/
&namtra_ldfeiv
ln_ldfeiv=.false.,
ln_ldfeiv_dia=.false.,
nn_aei_ijk_t=21,
rn_aeiv_0=0.0,
/
&namtra_dmp
ln_tradmp=.false.,
/
&namdyn_adv
ln_dynadv_cen2=.false.,
ln_dynadv_ubs=.false.,
ln_dynadv_vec=.true.,
/
&namdyn_vor
```

```
ln_dynvor_een=.true.,
ln_dynvor_ene=.false.,
ln_dynvor_ens=.false.,
ln_dynvor_mix=.false.,
/
&namdyn_hpg
ln_dynhpg_imp=.false.,
ln_hpg_djc=.false.,
ln_hpg_prj=.true.,
ln_hpg_sco=.false.,
ln_hpg_zco=.false.,
ln_hpg_zps=.false.,
/
&namdyn_ldf
ln_dynldf_bilap=.true.,
ln_dynldf_hor=.false.,
ln_dynldf_iso=.false.,
ln_dynldf_lap=.false.,
ln_dynldf_level=.true.,
rn_ahm_0_blp=-6.0e7,
rn_ahm_m_blp=-6.0e7,
rn_ahm_m_lap=10.0,
rn_cmsh=1,
rn_cmsmag_1=3.0,
rn_cmsmag_2=3,
/
&namzdf
ln_zdfevd=.true.,
nn_evdm=1,
rn_avevd=60.,
rn_avm0=1.2e-6,
rn_avt0=1.2e-6,
/
&namzdf_mldzint
nn_mld_diag=0,
sn_mld1=1,3.0,0.8,0.1,
sn_mld2=1,10.0,0.2,0.1,
sn_mld3=1,10.0,-0.2,0.0,
/
&namzdf_gls
ln_length_lim=.true.,
ln_sigpsi=.true.,
nn_bc_bot=1,
nn_bc_surf=1,
nn_clos=1,
nn_stab_func=2,
nn_z0_met=1,
rn_charn=100000.0,
rn_clim_galp=0.267,
rn_crban_default=100.0,
```

rn_emin=1.0e-6,
rn_epsmin=1.0e-12,
rn_frac_hs=1.3,
rn_hsro=0.003,
/
&namzdf_ddm
rn_avts=1.0e-4,
rn_hsbfr=1.6,
/
&namzdf_tmx
ln_tmx_itf=.false.,
rn_htmx=500.,
rn_me=0.2,
rn_n2min=1.0e-8,
rn_tfe=0.333,
rn_tfe_itf=1.0,
/
&namsol
nn_nmax=800,
nn_nmin=900,
nn_nmod=10,
nn_sol_arp=0,
nn_solv=1,
rn_eps=1.0e-6,
rn_resmax=1.0e-10,
rn_sor=1.92,
/
&nammpp
cn_mpi_send='I',
jpni=24,
jpnij=576,
jpnj=24,
ln_nnogather=.false.,
nn_buffer=0,
/
&namctl
ln_ctl=.false.,
nn_bench=0,
nn_ictle=0,
nn_ictls=0,
nn_isplt=1,
nn_jctle=0,
nn_jctls=0,
nn_jsplt=1,
nn_print=0,
nn_timing=1,
/
&namnc4
ln_nc4zip=.true.,
nn_nchunks_i=4,

```
nn_nchunks_j=4,
nn_nchunks_k=51,
/
&namtrd
ln_dyn_trd=.false.,
ln_tra_trd=.false.,
/
&namflo
jpnfl=1,
jpnnewflo=0,
ln_argo=.false.,
ln_ariane=.true.,
ln_flo_ascii=.true.,
ln_flork4=.false.,
ln_rstflo=.false.,
nn_stockfl=360,
nn_writefl=360,
/
&namptr
ln_diaptr=.false.,
/
&namhsb
ln_diahsb=.false.,
/
&nam_diaharm
nit000_han=19,
nitend_han=864,
nstep_han=18,
tname(1)='M2',
tname(2)='K1',
/
&namdct
nn_dct=15,
nn_dctwri=15,
nn_secdebug=112,
/
&namdyn_nept
ln_neptramp=.true.,
ln_neptsimp=.false.,
ln_smooth_neptvel=.false.,
rn_htrmax=200.0,
rn_htrmin=100.0,
rn_tslse=1.2e4,
rn_tslsp=3.0e3,
/
&nam_vvl
ln_vvl_layer=.false.,
ln_vvl_zstar=.true.,
/
&nam_diatmb
```

```
ln_diatmb=.true.,
/
&nam_dia25h
ln_dia25h=.true.,
/
&namtra_dwl
ln_tradwl=.false.,
ln_vary_lambda=.false.,
/
```

3.2 Changed namelist parameters for MCO_{ao} (coupled NEMO model)

The following namelist parameter changes are applied to the coupled ocean model.

```
&namsbc
ln_apr_dyn=.true.,
ln_blk_core=.false.,
ln_cpl=.true.,
ln_dm2dc=.false.,
ln_rnf=.true.,
ln_ssr=.false.,
ln_wave=.false.,
nn_fsbc=1,
nn_fwb=0,
nn_ice=0,
nn_lsm=20,
/
&namsbc_cpl
sn_rcv_cal='none','no',",",",",
sn_rcv_co2='none','no',",",",",
sn_rcv_dqnsdt='none','no',",",",",
sn_rcv_emp='conservative','no',",",",",
sn_rcv_hsig='none','no',",",",",
sn_rcv_iceflx='none','no',",",",",
sn_rcv_mslp='coupled','no',",",",",
sn_rcv_phioc='none','no',",",",",
sn_rcv_qns='oce only','no',",",",",
sn_rcv_qsr='oce only','no',",",",",
sn_rcv_rnf='none','no',",",",",
sn_rcv_sdrft='none','no',",",",",
sn_rcv_tau='oce only','no','spherical',",'U,V,F',
sn_rcv_taumod='none','no',",",",",
sn_rcv_tauoc='none','no',",",",",
sn_rcv_w10m='none','no',",",",",
sn_rcv_wdrag='none','no',",",",",
sn_rcv_wfreq='none','no',",",",",
sn_rcv_wnum='none','no',",",",",
sn_rcv_wper='none','no',",",",",
sn_snd_alb='none','no',",",",",
sn_snd_co2='none','no',",",",",
```

sn_snd_crt='oce only','no','spherical','','U,V',
sn_snd_crtw='none','no','','U,V',
sn_snd_ifrac='none','no','','',
sn_snd_temp='oce only','no','','',
sn_snd_thick='none','no','','',
sn_snd_wlev='none','no','','',
/
&namsbc_apr
cn_dir='/home/bthompson/cylc-run/mss-aa858/share/cycle/20191001T0000Z/EC_MSLP/',
cpl_mslp=.false.,
ln_apr_obc=.true.,
ln_ref_apr=.false.,
rn_pref=101000.0,
sn_apr='ec_fcst_slp',3,'slp',.true.,.false.,'daily','ECAN_weights_bilinear.nc','','ec_ana_LSM.nc'
,
/