RESEARCH DEPARTMENT MEMORANDUM

To:	RD Scientific Staff and Consultants	
Copy:	HR, HO, HMD, HMAS, HMOS, J.Hodkinson Jean Pailleux, François Bouttier, Claude Fischer	
From:	Mats Hamrud et al.	
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Subject:	**IFS Memorandum Cycle CY31R2(DRAFT 1)**	

Cycle 31r2 was created in October 2006. Cycle 31r2 is not a common cycle with Meteo France.

Modified libraries: ifs ifasux trans obstat scripts prepdata wam odb

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Mats Hamrud

Modified surface fields

The organisation of the surface fields in IFS have been changed. The division into sub-groups (SOILB,VARSF etc.) has been retained but the groups are now “GFL like” in structure. All the data structures and routines for the setup and manipulation of surface fields can be found in the new module SURFACE_FIELDS.

The old surface setup routines(SUGPPRP and SUPHYDS) have been removed and replaced with a new setup routine SU_SURF_FLDS. Most of the setup of surface fields dimensions have been removed from SUDIM1 and moved into SU_SURF_FLDS. The setup itself has been simplified in that most dependencies on NCONF has been removed (it was mainly for saving memory in obscure configurations). Only the dimensions of the extra fields can now be set by namelist variables.

As with the new structure it is no longer as easy to operate on all the surface fields, a couple of routines (GPOPER and GPPOPER) have been written to perform operations on all the surface fields or the prognostic ones only. They take the operation required as an argument and normally operate on a NPROMA block. For a full list of possible operators see e.g. GPOPER_2 in SURFACE_FIELDS.

Modified routines (IFS):

```
adiab/cpg.F90 cpg5_gp.F90 cpg_dia.F90 cpg_dyn_ad.F90 cpg_dyn_tl.F90 cpg_end.F90
cpg_gp.F90 cpg_gp_ad.F90 cpg_gp_tl.F90 cpgad.F90 cpgtl.F90 cpwts.F90 post-
phy.F90
c9xx/incli3.F90 incli6.F90
canari/caclsi.F90 caclsst.F90 cacsts.F90 caeincwdm.F90 cah2as.F90 calincwdm.F90
canali.F90 canari.F90 capotx.F90 capsax.F90 casmswi.F90 casnas.F90 castas.F90
cat2as.F90 cav1as.F90
climate/updclidm.F90 updclie.F90 updclie_CO2.F90 updcpl.F90 updnuddm.F90 up-
dsst.F90
control/cprep1.F90 gp_model_ad.F90 gp_model_tl.F90 reeresf.F90 restart_cnt3.F90
scan2mdm.F90
dia/cpphddhe.F90 inifaout.F90 ppeddhec.F90 ppfidh.F90 pregrbenc.F90 pregrb-
phy.F90 sunddh.F90 wrmlppadm.F90 wrmlppg.F90 wrmlpplg.F90
module/surface_fields.F90 traj_physics.F90 traj_surface.F90 trajectory.F90
yoe_tile_prop.F90 yomdphy.F90 yomgppb.F90 yomnud.F90 yomphyds.F90 yomradf.F90
namelist/namdphy.h namphyds.h
ocean/wrcom.F90
phys_dmn/apl_arome.F90 mf_phys.F90 mf_physad.F90 mf_phystl.F90 radaer15.F90
suphy1.F90 writeprofile.F90
phys_ec/callpar.F90 callparad.F90 callpartl.F90 ec_phys.F90 ec_phys_ad.F90
ec_phys_drv.F90 ec_phys_tl.F90 ec_physg.F90 radcfg.F90 raddrv.F90 radpar.F90
suecrad.F90 suphec.F90 wvrg2xf.F90 wvxf2gb.F90
pp_obs/fpachmt.F90 fpiniphy.F90 gridfpos.F90 hpos.F90 pos.F90 ppobsac.F90 ppob-
sacad.F90 ppobsactl.F90 pregpfpos.F90 prespfpos.F90 slint.F90 specfitadm.F90
vpos.F90
setup/su0yoma.F90 su0yomb.F90 su_surf_flds.F90 suallo.F90 sucacliadm.F90 sudim1.F90
sugfl.F90 sugrclia.F90 sugridadm.F90 sugridf.F90 sugridg.F90 sugridvadm.F90
suinif.F90 sunud.F90 suoph.F90 surfpds.F90 susc2b.F90
utility/deallo.F90 dealmod.F90 dealsc2.F90 gpnorm2.F90 gpnorm3.F90 maxgpfv.F90
```

`reset_accfie_vareps.F90 updtim.F90 wrresf.F90`
`var/cobs.F90 cobsad.F90 cobstl.F90 sushfce.F90 vec2gp.F90`

Deborah Salmond

Modification to clean pointers for Predictor-Corrector version of IFS. MP9 pointers for GFL fields to EC_PHYS are replaced by MP9_PH which is equal to MP for Predictor step and MP9 for Corrector step.

A new GFL pointer MP_SLX is introduced for passing values to CPG_PT

Routines modified(IFS):

`adiab/cpg.F90 cpqtuv.F90 gpmktend.F90 gprcp.F90 postphy.F90`

`control/gp_model.F90`

`module/gfl_subs.F90 type_gfls.F90`

`phys_ec/callpar.F90 define_pointers_mp9.F90 ec_phys.F90 ec_phys_drv.F90 radcfg.F90 raddrv.F90`

Modification to make sums in VARBC reproducible when number of MPI tasks is changed. Only under LRE-PRO4DVAR switch.

Routines Modified(IFS):

`module/yomvarbc.F90`

`pp_obs/biaspred.F90 radtrbad.F90 statpred.F90`

`var/cvarbcad.F90 cvarbcinad.F90 suvarbc.F90 taskob.F90 taskobad.F90`

Optimisations to make larcinaad and larcinbad use up to 8 OpenMP threads. Optimisations to rttov_transmit routines which increase performance from 500 Mflops to 1 Gflops on the IBM Power5 - merged with modifications from UKMet to vectorise these routines on the NEC SX.

Routines Modified(IFS):

`adiab/call_sl_ad.F90 larcinaad.F90 larcinbad.F90`

Routines Modified(SATRAD):

`rttov/rttov_intex.F90 rttov_transmit.F90 rttov_transmit_ad.F90 rttov_transmit_tl.F90`

Cleaning for ODB output from 1D-Var rain assimilation

Routines Modified(IFS):

`var/gp_ssmi_inv.F90`

Fix for SL Physics running with LEO3CH=.false.

Routines Modified(IFS):

`adiab/gpaddslphy.F90`

George Mozdzynski

A new partitioning scheme for IFS based on the EQ_REGIONS algorithm.

For the past 10+ years IFS has used a 2 dimensional partitioning scheme for grid space. This has served well, but has some recognised deficiencies, namely, - additional SL communication overhead for partitions at the poles due 'cake slice' shaped partitions used in these regions - partitions being relatively elongated due to the limited 2D factors that are available for any given task count (T) used, where T=NSxEW e.g. 128=16x8, 228=19x12, 256=16x16 result in differently shaped partitions with correspondingly different SL halo volumes

The EQ_REGIONS scheme avoids these problems by using an increasing number of partitions in bands from the poles to the equator. The number of bands and the number of partitions in each particular band are derived so as to provide partitions of equal area and small 'diameter'.

The partitioning of Fourier and Spectral space remains unchanged by this branch.

Use of the EQ_REGIONS partitioning scheme is controlled by a new namelist variable,

nampar1/LEQ_REGIONS=true (default), use LEQ_REGIONS partitioning =false use old 2D partitioning

More information on the EQ_REGIONS algorithm can be found at http://eqsp.sourceforge.net/#read , and in particular, http://www.maths.unsw.edu.au/applied/files/2005/amr05_18.pdf

Modified routines (TRANS):

```
module/ eq_regions_mod.F90 **new** sumplatbeq_mod.F90 **new** tpm_distr.F90
sump_trans_mod.F90 sumplat_mod.F90 sumplatb_mod.F90 sumplatf_mod.F90 sustaonl_-
mod.F90 pe2set_mod.F90 set2pe_mod.F90 inigptr_mod.F90 dist_grid_ctl_mod.F90
gath_grid_ctl_mod.F90

external/ setup_trans0.F90

interface/ setup_trans0.h
```

Modified routines (IFSAUX):

```
module/ control_vectors_data.F90 control_vectors_oper.F90
```

Modified routines (IFS):

```
adiab/ gavge.F90 gpinozstdm.F90

canari/cabane.F90 caissedm.F90

climate/ updclidm.F90

control/ cnt1.F90 reresf.F90

dia/ echkevo.F90 sumddh.F90 wrtcfou.F90

module/ iostream.F90 yomct0.F90 yommp.F90 yomprad.F90

namelist/ nampar1.h

obs_preproc/ mkglobstab.F90 suobsort.F90

parallel/ disfou.F90 disgrid.F90 disgrid_c.F90 disgrid_surf_ext.F90 diwrfou.F90
diwrgrid.F90 diwrgrid_surf_ext.F90 gathergpf.F90 gathergpf_wavelet.F90 gath-
```

ergpfphys.F90 gl2ll.F90 gpnorm1.F90 ircvgpf.F90 ircvgpffp.F90 isndgpf.F90 isndgpffp.F90 orcvgpf.F90 orcvgpffp.F90 pe2set.F90 phcset.F90 phrset.F90 rdcset.F90 rdrset.F90 set2pe.F90 slcset.F90 slrset.F90 slextpol.F90 slextpol1.F90 slextpol1a.F90 slextpol2.F90 slextpolad.F90

phys_dmn/ raddiag15.F90 radint15.F90 suecradi15.F90

phys_ec/ idisgpf.F90 radcbdy.F90 raddiag.F90 radint.F90 suecrad.F90 suecradi.F90 suecradl.F90 wvwg2rg.F90 wvxf2gb.F90

pp_obs/fpmodprec.F90

setup/ suallo.F90 sualmp0.F90 sualmp1.F90 suephypo.F90 sufpwide.F90 sugem1b.F90 sugem2.F90 sugridadm.F90 sump.F90 sump0.F90 sumpout.F90 suprocgp.F90 surcof.F90 susc2b.F90 susimpr.F90 suspectcfou.F90 sutrans.F90

utility/ deallo.F90 maxgpfv.F90 random_ctlvec.F90

var/ cossmq.F90 gp_nearest.F90 sualctv.F90 sujbwavtrans.F90 suscal.F90 taskob.F90 taskobad.F90 sujb.F90 sujbwavelet.F90

Use of reduced grids for JB wavelet scales in 4D-Var minimisation steps (instead of full grids). This has been implemented to permit the new EQ_REGIONS partitioning approach (separate branch) to scale to large numbers of tasks even with the low truncations used by the JB wavelet scheme. A further benefit is an improvement in 4D-Var minimisation performance (1.8% @ T799 194 tasks x 4 threads) and a reduction in memory use (from task max 1490 Mbytes to 1387 Mbytes for min1 and same configuration). Currently, the reduced grids used for the JB wavelet scales are not all linear grids. This will be resolved at a future cycle when the .cv files are reset (by Mike Fisher). When this happens there will be a further improvement in performance and reduction in memory use.

Modified routines (IFS):

var/sujbwavtrans.F90

Fix trmtos and trstom to stop needless aborts with the message 'NCOMBFLEN too small' when using LIMP_NOOLAP (the default); as in this case send/receive arrays are sized exactly as required and not a function of NCOMBFLEN.

Modified routines (IFS):

parallel/trmtos.F90 trstom.F90

Fix memory overwrite in getspec.F and further use MPI Isends instead of Bsends in the routine to avoid the need to increase MBX_SIZE for large numbers of tasks. *Modified routines (WAM):*

Wam_oper/getspec.F

Fix overwrite in spnorm for KINDPP=1 calls and make norms for SPA3JB/SPA2JB arrays both correct and reproducible. Note this problem had no effect on meteorological results.

Modified routines (IFS):

dia/spnorm.F90

Sami Saarinen

IFS and ODB/IFS interface has introduced new auxiliary array MBODYJOBS. Its purpose is to enhance vectorization in routines like hop, hoptl, hopad, hretr, hjo and hdepart. For example, a double loop, where inner loop vectorizes (with vector len circa 512):

```
BODY_LOOP: DO JBODY=1,IMXBDY
!OCL NOVREC
  CMA_LOOP: DO JOBS = 1,ILEN
    IF(JBODY > ICMBDY(JOBS)) CYCLE CMA_LOOP
    IBODY = MLNKH2B(JOBS)+(JBODY-1)
    IVNMRQ(JOBS,JBODY) = ROBODY(IBODY,MDBVNM)
    ...
    ROBODY(IBODY,MDBIOM0(NUPTRA+1)) = RMDI
  ENDDO CMA_LOOP
ENDDO BODY_LOOP
```

This can be replaced by a single, VECTORIZABLE loop, with the vector length potentially tens or hundreds of thousands for new satellites like IASI:

```
!OCL NOVREC
NEW_BODY_LOOP: DO IBODY=1,MLNKH2B(ILEN+1)-1
  JOBS = MBODYJOBS(IBODY)
  JBODY = IBODY + 1 - MLNKH2B(JOBS)
  IVNMRQ(JOBS,JBODY) = ROBODY(IBODY,MDBVNM)
  ...
  ROBODY(IBODY,MDBIOM0(NUPTRA+1)) = RMDI
ENDDO NEW_BODY_LOOP
```

MBODYJOBS is available and created only if requested: see the logical variable create_mbodyjobs in odb/cma2odb/ctxgetdb.F9
odb/cma2odb/ctxinitdb.F90 and odb/module/context.F90.

In this release the ODB/SQL-compiler understands expressions in SELECT-statement and is capable of calculating with aggregate functions such as average, stdev, etc. and even get linear (two parameter) correlation coefficients. For example, the following is now possible:

```
SELECT obstype,codetype,stdev(fg_depar),count(*) FROM hdr,body;
SELECT stalt + 10 as stalt@hdr, degrees(lat), degrees(lon) FROM hdr;
```

The only limitation right now is that ODB/SQL doesn't allow any operations over aggregate functions. So for example the following will fail to compile at the moment:

```
SELECT obstype,codetype,int(stdev(fg_depar)/10) FROM hdr,body;
```

Furthermore, an enhancement is the expansion of missing tables to FROM statement due to table hierarchy. For example, only an experienced user could know that when she/he asks for lat@hdr,lon@hdr and scanline@atovs also the intermediate tables between "hdr" and "atovs" must be mentioned. So before this release one had to give:

```
SELECT lat,lon,scanline FROM hdr,sat,atovs;
```

but now it can also be given as:

```
SELECT lat,lon,scanline FROM hdr,atovs;
```

and ODB/SQL compiler will figure it out from table hierarchy that also ”sat”-table is needed and will add it for the user. If this feature is not wanted, add NOINSERT; statement before SELECT (or CREATE VIEW) statement.

This version also contains many modifications to enable substantially cheaper scan over large (e.g. time-series) databases and to apply aggregate functions to such data even on a single processor.

The IFSAUX modification contains some minor bug-fixes to Dr.Hook (for example crash may have occurred when finishing profiling of multithreaded application). It also contains MFlop/s counters for ECMWF’s new IBM Power5+ processor (thanks to John Hague, IBM/UK).

Furthermore, the IFSAUX contains modifications which enable it to run on 8-byte machines (i.e. where all integer and real variables are promoted to 8-byte). Such migration was done thanks to Bureau of Meteorology, Australia, which ported standalone ODB (with subset of IFSAUX) to their NEC SX-6 machine. This version may also be used by UK MetOffice in the future through their shared Data Assimilation codebase.

Finally, the newish ecqsort (ECMWF quick sort in IFSAUX) has been activated as the default sorting method on scalar machines. We may have to revisit its algorithm, since the worst case timings can be bad, whereas the normal cases should be superior over radix sort.

Modified and some new files(ODB):

```
aux/bits.c cma_flpcheck.c cma_open.c dca.c ioprealloc.c newio.c odbi_client.c
pcma.c pcma_31to39.c pcma_4.c prealloc.c upcma.c util.c

bufr2odb/bufr2odb_grad.F90

cma2odb/addviewdb.F90 ctxgetdb.F90 ctxinitdb.F90 ctxputdb.F90 get_rs_t_bias.F90
getdb.F90 initmdb.F90 opendb.F90 putatdb.F90 xchangedatadb.F90

compiler/dca.h genc.c idx.h lex.l odb.h odb98.c odb98.h odb_macros.h regex.c
tree.c yacc.y

ddl/cma.h matchup_sensorlist.sql obsort_atovs.sql obsort_atovs_pred.sql obsort_-
body.sql obsort_errstat.sql obsort_hdr.sql obsort_hdr2reo3_body.sql obsort_-
index.sql obsort_limb.sql obsort_radar.sql obsort_radar_body.sql obsort_radar_-
station.sql obsort_reo3.sql obsort_reo3_body.sql obsort_sat.sql obsort_satob.sql
obsort_scatt.sql obsort_scatt_body.sql obsort_ssmi.sql obsort_ssmi_body.sql
obsort_update.sql obsort_update_1.sql obsort_update_10.sql obsort_update_-
2.sql obsort_update_3.sql obsort_update_4.sql obsort_update_5.sql obsort_-
update_6.sql obsort_update_7.sql obsort_update_8.sql obsort_update_9.sql pcma_-
extern.h

extras/mpi_serial/tracecalls.c

include/alloc.h cma_read.h cma_seek.h cma_write.h cmaio.h codb.h dca.h defs.h
fodb.h fodbmp.h fodbmp1.h fodbmp2.h fodbutil.h odb.h odb_macros.h pcma.h pcma_-
extern.h privpub.h
```

interface/addviewdb.h fodb_checkviewreg.h

lib/aggr.c cmdbkeys.c codb.c create_iomap.F90 ctx.c dynlink.c fodb_checkviewreg.F90 forfunc.c fwrite_iomap.F90 msgpass_obsdata.F90 orlist.c peinfo.c poolmasking.c poolreg.c prt.c tracing.c var.c version.c write_ddl.c

module/bufr_module.F90 context.F90 odb.F90 odb_module8.F90 odbgetput.F90 odbmp.F90 odbprint.F90 odbshared.F90 odbstat.F90 odbutil.F90

preodb/preodb_xcheck.F90

scripts/configure configure_drhook create_odbglue create_static_stubb dcagen drhook_ex.ksh gen_static make.all make.decalpha make.i86pc make.i86pc_gcc make.ibm_power4 make.ifort_hms make.linux_O0 make.linux_O0_no_magics make.linux_O1_no_magics make.linux_O2_pg make.necsx make.necsx5 make.necsx_8bi make.rootdir make.sun_linux make.sun_linux_gcc make.sun_linux_gcc_O0 make_depend make_fclibs make_install make_lib make_tarball make_tarball_drhook makefile mpif.h.necsx.E mpif.h.necsx5.CSCS newodb notimestamp.x odb1to4 odb4to1 odb_compress odb_compress.pl.obsolete odbc odbcc odbcomp odbdup odbf90 odbless odbshuffle odbviewer parse_log.pl run_fe runfe test_arch timestamp.c use_odb use_odb.sh

tools/Fscheduler.F90 Odbdiff.F90 Odbless.F90 Viewer.F90 bufr_split.F dcagen.c xldummy.c

Modified routines (IFS):

common/yomdb_defs.h yomdb_vars.h

module/parcma.F90 yomdb.F90

pp_obs/hdepart.F90 hjo.F90 hop.F90 hopad.F90 hoptl.F90 hretr.F90

var/gp_ssmi_inv.F90

Modified routines (IFSAUX):

include/drhook.h

module/mpi4to8.F90 mpi4to8_m.F90 mpi4to8_s.F90 mpl_allgatherv_mod.F90 mpl_allreduce_mod.F90 mpl_alltoallv_mod.F90 mpl_arg_mod.F90 mpl_barrier_mod.F90 mpl_broadcast_mod.F90 mpl_buffer_method_mod.F90 mpl_close_mod.F90 mpl_end_mod.F90 mpl_gatherv_mod.F90 mpl_groups.F90 mpl_init_mod.F90 mpl_ioinit_mod.F90 mpl_locomm_create_mod.F90 mpl_message_mod.F90 mpl_mygatherv_mod.F90 mpl_myrank_mod.F90 mpl_nproc_mod.F90 mpl_open_mod.F90 mpl_probe_mod.F90 mpl_read_mod.F90 mpl_recv_mod.F90 mpl_scatterv_mod.F90 mpl_send_mod.F90 mpl_setdflt_comm_mod.F90 mpl_wait_mod.F90 mpl_write_mod.F90 sdl_module.F90 yomoml.F90

support/coml_binding.F90 dr_hook_util.F90 drhook.c

utilities/ecqsort.c linuxtrbk.c

Modified script:

build/Makefile Makefile.root.odbsqlcompiler odb_create_static_stubb.ksh odb_filter.ksh

build/perl/depend.pl

gen/ODBCMP.ddl bias_calc bufr2odb grpsize inter_fp ma_init mergeodb mknam mknam_-fp odb_compress odbcomp p4_mklib run_fp satmon_getdat simulobs2odb

sms_an/bufr2odb.sms simulobs2odb.sms

Martin Koehler

Single-Column Model version of IFS

This upgrade fixes various conflicts with various 31r1 components (e.g. aerosols and tracers). Also an option was added to externally specify surface roughness lengths in SCM runs.

Modified routines (IFS):

phys_ec/callpar.F90 vdfouter.F90 vdfdifh.F90 vdfmain.F90 suphec.F90

module/susveg_mod.F90 yomct0.F90

Modified routines (SMEC):

source/sudim1c.F90 suvert1c.F90 wrtd1c_nc.F90 surip1c.F90 su1c.F90 suphec1c.F90

module/pardim1c.F90

Modified routines (SURF):

external/susurf.F90

module/susurf_ctl_mod.F90 suvexc_mod.F90 vupdz0_mod.F90 yos_exc.F90

interface/susurf.h

Judith Berner

Stochastic Physics

Introduction of two new stochastic physics options, the cellular automaton stochastic backscatter scheme (CASBS) and the spectral backscatter scheme (SPBS). These options are currently switched off in operational mode.

Modified routines (IFS):

adiab/spchor.F90

control/cnt4.F90 reresf.F90

module/random_streams.F90 yomstoph.F90

namelist/namstoph.h

phys_ec/callpar.F90 callparad.F90 cumastrn.F90 ec_phys.F90 ec_phys_drv.F90 ec_physg.F90 vdfincr.F90 vdfmain.F90 vdfouter.F90

setup/ca.F90 surand1.F90 surand2.F90

Philippe Lopez

A separate routine (SUCUMF2) and module (YOECUMF2) have been created for the initialization of parameters and switches that are used in the new linearized convection scheme.

New routine and module (IFS):

`phys_ec/sucumf2.F90`

`module/yoecumf2.F90`

Modified routines and module (IFS):

`phys_ec/sucumf.F90 cumastrn2tl.F90 cumastrn2ad.F90 cumastrn2.F90 cupdratl.F90 cupdraad.F90 cupdra.F90 cuinin2ad.F90 cuinin2tl.F90 cuinin2.F90 cuflx2tl.F90 cuflx2ad.F90 cuflx2.F90 cubasen2tl.F90 cubasen2ad.F90 cubasen2.F90 cuddrafn2tl.F90 cuddrafn2ad.F90 cuddrafn2.F90 cucalln2tl.F90 cucalln2ad.F90 cucalln2.F90 cuascn2tl.F9 cuascn2ad.F90 cuascn2.F90`

`module/yoecumf.F90`

Deep convection is no longer allowed to be initiated from lowest model level in the new linearized convection scheme (CUBASEN2) to ensure more consistency with the full nonlinear scheme.

Modified routines (IFS):

`phys_ec/cubasen2.F90 cubasen2tl.F90 cubasen2ad.F90`

Angela Benedetti

- changes to the aerosol optical depth observation operator
- inclusion of pathway for other MODIS aerosol-related observations (aerosol reflectance, multi-channel optical depth, ratio of fine-to-total aerosol optical depth at 0.55microns)
- inclusion of pathway for cloud optical depth observation (in collaboration with Marta and Jean-Jacques)
- observational operator for MODIS cloud optical depth (experimental, with Marta)

Modified routines (IFS):

`common/yomdb_defs.h yomdb_vars.h`

`module/pardimo.F90 trajectory.F90 yomaneb.F90 yomcosjo.F90 yomjg.F90 yommvo.F90`

`obs_preproc/defrun.F90 fgchk.F90 reo3sin.F90`

`phys_ec/aer_climg.F90`

`pp_obs/aod_ad.F90 aod_op.F90 aod_tl.F90 bgobs.F90 hop.F90 hopad.F90 hoptl.F90 hvnmtlt.F90`

`setup/cmoctmap.F90 sudyn.F90 sugfl.F90 susc2b.F90 suvnmb.F90`

`var/estsig.F90 estsiga.F90 rdfpinc.F90 sujb.F90 susepfce.F90 vec2gp.F90 writesd.F90`

Modified routines (ODB):

`cma2odb/initmdb.F90 ddl/cma.h varno.h`

Modified routines (SURF):

`external/surfrad.F90`

`interface/surfrad.h`

`module/surfexcdriver_ctl_mod.F90 surfrad_ctl_mod.F90 surwn_mod.F90 susveg_-mod.F90`

New routines (IFS):

`pp_obs/cod_op.F90 cod_optl.F90 cod_opad.F90`

`module/yoeclop550.F90`

Sean Healy and Milan Dragosavac

- Milan's odb_2bufr changes for GPSRO
- black.F90. mods for gpsro
- first.F90 so that gpsro go through fgcheck.
- hdepart.F90, to stop missing data increments being used in the 2nd trajectory.
- fetchobs scripts for picking up gpsro data
- correct symbolic link for obstat_gpsro.sms
- smon.sms: increase consumable memory.

Routines modified(IFS):

`obs_preproc/black.F90 fgchk.F90 first.F90`

`pp_obs/hdepart.F90`

Routines modified(ODB):

`bufr2odb/bufr2odb_radio.F90 odb2bufr_dep_250.F90 odb2bufr_fos_250.F90 odb2bufr_-qc_250.F90 odb2bufr_summary.F90`

`tools/Fbnew2old.F90`

Scripts modified:

`sms_an/obstat_gpsro.sms smon.sms`

Niels Bormann

Various satellite-related changes:

Updates for SSMIS, TMI, AMSRE (all passive):
- New observation errors and FG check limits for SSMIS

- New flagging of suspicious SSMIS FOVs (in SSMIS_FLAGGING, called from FIRST)
- New regressions for liquid water path for cloud/rain flagging; use of bias corrected radiances for liquid water path regressions to allow harmonised threshold used for flagging; move varbc code in hretr before call to rad1cemis to make bias corrections available in rad1cemis (where liquid water path calculations are performed)
- Disable Harris and Kelly bias for SSMIS and DMSP bias-files from DMSP-16 onwards
- Use correct SSMIS data
- Increase number of allowed satellite series to 10

varbc-related changes:

- Implement new predictor: nadir angle**4; used for SSMIS, AMSR-E, and TMI
- Put cold-start option=0 back in (got lost in 31r1)
- Avoid rejection of observations which have all body entries passive (ie blacklisted with fail(EXPERIMENTAL) for varbc calculations, but no weight in the analysis). This allows fail(EXPERIMENTAL)- blacklisting by header entry (ie satellite ID). Note that if data is flagged passive by header entry, no thinning is performed on the data. Use dummy blacklisting by channel if thinning is desired (note that this may be at the expense of data from other satellites which should be used).
- Fix feature through which the varbc conditioning statistics were added twice for data for which cloudy radiance computations are switched on

Move HIRS cloud detection from thinning to HRETR:

- Performing the HIRS cloud detection within the thinning caused undesired artefacts in connection with passive data (blacklisted with fail(EXPERIMENTAL) for varbc). The cloud detection is now performed in HRETR. The thinning for HIRS has been modified to favour HIRS FOVs with some channels used (not passive) in addition to favouring the warmest FOV. This gives results similar to the old thinning for used channels, with a slight increase in numbers of used data for channels 4 and 12.

Implement MHS:

- MHS has been included as a new sensor in preparation for METOP. For continuity, NOAA-18 MHS will continue to be treated as AMSU-B.

Various updates and fixes, including:

- Add upcoming satellite IDs in getsatid and mod_sat_monitor.F90 (DMSP-17, GOES-13-15)
- Correct numbering for METOP RT subtype in getsatid

Routines modified(IFS):

`module/yomtvrad.F90 yomvarbc.F90`

`namelist/namvarbc.h`

`obs_preproc/black.F90 blacksat.F90 defrun.F90 fgchk.F90 first.F90 gefger.F90 hirs_cld.F90 new_thinn.F90 new_thinner_no_sq.F90 ngenada.F90 post_thinner.F90 pre_thinner.F90 ssmis_flagging.F90 thinn.F90 thinner.F90 thinner_no_sq.F90`

`pp_obs/biaspred.F90 emis_mw.F90 emis_mw_n.F90 hretr.F90 hsatang.F90 rad1cemis.F90 rad1cobe.F90 statpred.F90`

`var/csvarbc.F90 getsatid.F90 rdvarbc.F90 suvarbc.F90 taskob.F90`

Routines modified(OBSTAT):

```
bias_sat/cycle_biasprep_1c.F90
data/dobstat dobstat_bufr dobstat_quick
module/mod_rad_bias_1c.F90 mod_sat_monitor.F90
satmon/get_mwimg_odb.F90
src/buxtract.F90
```

Routines modified(ODB):

```
bufr2odb/bufr2odb_atovs.F90
ddl/sathdr_screen_atovs.sql
```

Routines modified(REANAL):

```
Mon/obstat_timeseries.F90
```

Routines modified(SATRAD):

```
bias/getbias.F90 suadvar.F90
module/param_1dvar.F90
pre_screen/bufr_screen_ssmis.F90 screen_1c.F90
```

Scripts modified:

```
def/an.def
gen/ODBCMP.ddl bufr2odb cleanodb fdbksave fetchobs getbias ifsmin ifstraj mergebufr
obstat obstat_init pre1crad_screen preobs satmon_getdat smon_def
sms_an/b2o_mhs.sms feedback.sms makeodb.sms o2b_mhs.sms obstat_mhs.sms pre1crad_-
mhs.sms
sms_era/obtime.sms obtime_mhs.sms
```

Yannick Tremolet

This branch makes it possible to use the Jb balance operators in the model error term, it has a new model error setup to apply the forcing only at the begining of each sub-window (like if it was an increment) and has a few fixes for the adjoint test and inner-outer loop test, taking all GFL variables into account.

Routines modified(IFS):

```
control/cdsta.F90 cnt4.F90 cnt4ad.F90 cnt4tl.F90 cva1.F90 scan2mad.F90 scan2mdm.F90
scan2mtl.F90 sim4d.F90
dia/spnorm.F90
module/model_error.F90 yomjq.F90 yomspjb.F90
namelist/nammoderr.h
```

setup/su0yomb.F90 su1yom.F90 sudim1.F90 sudim2.F90 suinimoderr.F90

transform/grid2spec.F90 grid2specad.F90 spec2grid.F90 spec2gridad.F90

utility/addbgs.F90 addfgs.F90 dealctv.F90 dealspa.F90 jbtomodel.F90 jbtomodelad.F90 prt_ctlvec_max.F90 prt_ctlvec_norms.F90 random_ctlvec.F90 rdmoderr.F90 save_-merr_tend.F90 save_test4dinc.F90 savmoderr.F90 spec_concat.F90 spec_split.F90 sualspajb.F90 subbgs.F90 subfgs.F90 write_ctlvec_grib.F90 wrmoderr.F90

var/add_modbias.F90 add_modbias_ad.F90 add_modbias_tl.F90 add_moderr.F90 add_-moderr_ad.F90 add_moderr_tl.F90 adtest.F90 balvert.F90 balvertad.F90 balverti.F90 balvertiad.F90 bgvecs.F90 cain.F90 cainad.F90 cainin.F90 caininad.F90 chavarin.F90 chavarinad.F90 cvar2.F90 cvar2ad.F90 cvar2in.F90 cvar2inad.F90 cvar3.F90 cvar3ad.F90 cvar3in.F90 cvar3inad.F90 cvargpad.F90 cvargptl.F90 cvaru2.F90 cvaru2ad.F90 cvaru2i.F90 cvaru2iad.F90 evjq.F90 jbvcor_wavelet.F90 jbvcor_waveletin.F90 jbvcor_waveletinad.F90 jgcor.F90 jgcorad.F90 jgcori.F90 jgcoriad.F90 jghcos.F90 jghcosad.F90 jghcosi.F90 jghcosiad.F90 jgnrs.F90 jgnrsi.F90 readvec.F90 scaljgg.F90 scaljgs.F90 sqrtb.F90 sqrtbad.F90 sqrtbin.F90 sqrtbinad.F90 sualctv.F90 sualges.F90 sujb.F90 sujbtest.F90 sujbwavgen.F90 sujbwavvc_sp.F90 sujq.F90 sumoderr.F90 suscal.F90 suvazx.F90 weak_constraint.F90 weak_constraint_ad.F90 weak_constraint_-tl.F90

Scripts modified:

def/an.def

gen/anml getgrbme getini ifsmin ifstraj mklinks model var_include vardata

sms/getfcdata.sms

Thomas Auligne

VarBC changes

- rdvarbc.F90: skip reading the predictor statistics in the trajectories (where they are not used)

- csvarbc.F90 and svvarbc.F90: bugfix for the use of the coldstart from the mode of the departures (NCS_-CONFIG=2) (this option is not used in operations)

Routines modified(IFS):

control/cnt1.F90

module/yomtvrad.F90 yomvarbc.F90

namelist/namvarbc.h

pp_obs/hop.F90

var/csvarbc.F90 prvarbc.F90 suvarbc.F90 svvarbc.F90

Soumia Serrar

Include new tracers for diagnostics on atmospheric transport and new outputs for DDH. All the modifications are GEMS related and are not used operationally:

New GFL fields are defined for tracers used in atmospheric transport diagnostics (SF6 and Radon). Like for GHG, their attributes can be set in NAMGFL and their surface fluxes are controlled by a logical.

New diagnostics (DDH) have been introduced in the IFS to check tracer mass conservation. When requested, they are generated regularly during the forecast model runs.

Modified routines(IFS):

`adiab/cpedia.F90 postphy.F90`

`dia/pregbenc.F90 ppeddhec.F90 ppfidh.F90 ppsyddh.F90 sucddh.F90 sunddh.F90`

`wrmflp.F90 wrmflpl.F90`

`control /scan2mdm.F90`

`module /iostream.F90 parfpos.F90 ptrgpd.F90 yom_ygfl.F90 yomafn.F90`

`yomcosjo.F90 yomcst.F90 yomgrb.F90 yomtddh.F90`

`namelist/namgfl.h`

`parallel/dresddh.F90`

`phys_ec/callpar.F90 ec_phys.F90 ec_phys_drv.F90 sltend.F90 sltend1.F90`

`pp_obs/specfitg.F90 hpos.F90 pos.F90 vpos.F90`

`setup/suafn1.F90 suafn2.F90 suafn3.F90 sucst.F90 sudim1.F90 sudyn.F90`

`sufpc.F90 sugfl.F90 sugpprp.F90 suphyds.F90 supp.F90 sugridg.F90`

`utility/deallo.F90`

Jean-Jacques Morcrette, Martin Kohler and Soumia Serrar

Five additional variables are post-processed and introduced in the DDH code: the TOA incident solar radiation, the clear sky photosynthetically active radiation, the clear sky TOA SW radiation, the clear sky TOA thermal radiation and the vertically integrated moisture divergence

To avoid conflict between variables having the same gribcode, two corrections were necessary:

- BSR (Bare surface Roughness*g) is no longer post processable (grib code to -9999 in suafn1.F90). The variable is though still available in the IFS.

- gribcodes are set in coherence with the updated MARS-table in yomgrb.F90: NGRB212 and NGRB213 suppressed, surface emissivity has now been attributed a new gribcode (124)

Modified routines(IFS):

`adiab/cpedia.F90 postphy.F90`

control/reresf.F90

module/ptrgpd.F90 yomafn.F90 yomgrb.F90 yomradf.F90 yoephy.F90

yoerad.F90

namelist/naephy.h naerad.h

phys_dmn/recmwf.F90

phys_ec/callpar.F90 ec_phys.F90 ec_physg.F90, ec_phys_drv.F90,

radcbdy.F90 radclb.F90 raddrv.F90 radheatn.F90 radina.F90

radint.F90 radintg.F90 radlsw.F90 radlswr.F90 sw.F90

vdfmainsad.F90

pp_obs/hpos.F90

setup/su0phy.F90 sudim1.F90 suafn1.F90 suafn2.F90 suafn3.F90

sugpprp.F90 suphyds.F90

dia/sundd.F90 sucddh.f90

utility/deallo.F90 wrresf.F90

Vanda Bechtold and Rossana Dragani

Changes to add MSG-8 total ozone in the IFS

Routines modified(SATRAD):

pre_screen/reo3_prescreen.F90

Scripts modified:

gen/fetchobs prereo3

Rossana Dragani

Minor bugfix.

Routines modified(OBSTAT):

module/mod_sat_monitor.F90

Peter Bechtold

- mods for future entrainment formulation (under a switch), and

- bug corrections for TL/AD for tracer transport in physics (Philippe, Richard and me could never test it before).

Routines modified(IFS):

`module/yoecumf.F90`

`phys_ec/callparad.F90 cubasen.F90 cubasenad.F90 cubasentl.F90 cuctracertl.F90 cumastrn.F90 cumastrnad.F90 cumastrntl.F90 sucumf.F90`

- clean up of tracers (reduce code lines by 60%) and consistent use of tracers in VDIF, (not updated value by tendencies)
- remove all tracer related code in sltend*.F90, as not used anyway because of lack of positive definitness
- remove commented out diagnostic lines for radiation

Routines modified(IFS):

`phys_ec/callpar.F90 sltend.F90 sltend1.F90 sltend2.F90`

Nils Wedi

VarEPS technical mods.

Routines modified(IFS):

`setup/sugrib.F90 suoph.F90`

Scripts modified:

`gen/modeleps`

Routines modified(WAM):

`Wam_oper/fld2fdb.F`

Mike Fisher

1) Add a new ”information-based” convergence criterion for the minimization. This stops the minimization when the relative change per iteration of the norm of the control vector drops below a given threshold. I’ve also added a namelist variable NITER_MIN, which allows the user to specify a minimum number of iterations that should be performed.

2) Corrections to an.def, getini and vardata for the long-window case. These have no impact for standard configurations.

Routines modified(IFS):

`control/cva2.F90 forecast_error.F90`

`module/yomvar.F90`

`namelist/namvar.h`

`sinvect/nalan1.F90`

`var/congrad.F90 predict_runtime.F90 suvar.F90`

Routines modified(SCRIPTS):

`def/an.def`

```
gen/getini ifsmin vardata
```

Order-independent summation

Subroutines have been added for summing one-dimensional arrays, and for calculating scalar products of pairs of arrays. The routines produce results that are independent of the ordering of elements within the arrays, and are of guaranteed accuracy. Parallel versions are included, and these produce results that are also independent of the distribution of array elements over processors and threads.

The interface is as follows:

```
USE ORDER_INDEPENDENT_SUMMATION
result1 = ORDER_INDEPENDENT_GLOBAL_SUM  (P1)       ! Sum on one processor
result2 = ORDER_INDEPENDENT_LOCAL_SUM   (P1)       ! Sum over all processors
result3 = ORDER_INDEPENDENT_DOT_PRODUCT (P1,P2)    ! Euclidean dot product
result3 = ORDER_INDEPENDENT_DOT_PRODUCT (P1,P2,PW) ! Weighted dot product
```

The algorithm is based on the method of compensated summation, and routines for performing compensated summation are exposed as:

```
USE COMPENSATED_SUMMATION
CALL COMPENSATED_SUM     (P,KN,PCORR,PERR) ! non-parallel version
CALL COMPENSATED_SUM_OMP (P,KN,PCORR,PERR) ! OpenMP version
```

A draft memo describing the algorithm in detail, and documenting the interface, is available on request.

New routines (IFSAUX):

```
module/compensated_summation.F90 order_independent_summation.F90
```

Mariano Hortal

Correct Eularian finite-element.

Routines modified(IFS):

```
adiab/cpeuldyn.F90
```

```
setup/suct0.F90
```

Lars Isaksen

OBSTAT enhancements.

Routines modified(OBSTAT):

```
module/globvar.F90 obsdata.F90 statsoft.F90
```

src/buread.F90 iniglob.F90 iniodb.F90 inisoft.F90 inisoftdef.F90 inisoftstat.F90 mergesoft.F90 odbread.F90 odbscaling.F90 plothis.F90 plotime.F90 plotrms.F90 plotrmsbias.F90 plotsoft.F90 plotusage.F90 prtobs.F90 satobfreq_obstat.F90 updhard.F90 updsoft.F90 writesoft.F90 wrsoftdef.F90

Routines modified(ODB):

ddl/obstat_gpsro.sql

Routines modified(REANAL):

Mon/obstat_timeseries.F90 plot_curves.F90

Scripts modified:

def/an.def

era/obstat2timeplot.pl obtime_vmr.pl varbc_merge.pl

gen/obstat obstat_init

sms_an/perltools.sms

sms_era/obtime.sms

John Hague

Increased the maximum number of entries (JPMAXSTATS in yomgstats.F90) from 2000 to 2500. The number of individual processor outputs can be set by the variable NPRNT_STATS in the namelist NAMPAR0.

Entries in gstats_label_ifs.F90 now have codes to control their summation and drhook calls:

```
MPL:  Communication
OMP:  Parallel Region
SER:  No OpenMP
IO-:  IO
TRS:  Translation Package
MP_:  High order (gstats 250 to 300)
```

Routines modified(IFS):

namelist/nampar0.h

parallel/brptob.F90 commfce2.F90 commjbbal.F90 commjbdat.F90 commspnorm.F90 dot_product_ctlvec.F90 gatherbdy.F90 gathercost1.F90 gathercost2.F90 gathergom.F90 gathergpf.F90 gathergpfphys.F90 gathertc.F90 slcomm.F90 slcomm1.F90 slcomm2.F90 slcomm2a.F90 trmtos.F90 trstom.F90

pp_obs/mpobseq.F90 mpobseqad.F90

setup/sumpini.F90

utility/gstats_label_ifs.F90

Routines modified(IFSAUX):

`module/yomgstats.F90`

`support/gstats.F90 gstats_barrier.F90 gstats_label.F90 gstats_print.F90 gstats_-setup.F90`

Routines modified(TRANS):

`module/trgtol_mod.F90 trltog_mod.F90 trltom_mod.F90 trmtol_mod.F90`

More OpenMP. Saves 1-2% and since serial time has been converted to parallel, 4D-Var will be a slightly more scalable.

Routines modified(IFS):

`parallel/dot_product_ctlvec.F90`

`utility/gstats_label_ifs.F90`

`var/preppcm.F90 congrad.F90`

Improve the performance of laitqm.F90, and laitqmh.F90

The modification uses a statement function to change the MAX and MIN functions to an FSEL intrinsic function. This produces an fsel assembler instruction (which is produced automatically with -O4, but not with -O3 -qstrict).

The modification is controlled by ”#ifdef RS6K”.

Routines modified(IFS):

`adiab/laitqm.F90 laitqmh.F90`

John Hague, Lars Isaksen and Jan Haseler

The total time spent in the ifstraj and ifsmin steps of T799 4D-Var is reduced by between 200 and 300 sec.

This is out of a total elapsed time in ifstraj and ifsmin) of about 4800 sec (and 2600 sec for early delivery) on 24 P5+ nodes. So the saving is between 4% and 11%. Furthermore, this is serial time (inside a parallel job), so 4D-Var will be more scalable.

The savings are in two areas:

1) In each uptraj_* step (except the first), ifstraj creates traj4v_* files for next ifstraj step. This creation has been moved to a serial process (ifstsave) which runs concurrently with the ifsmin step.

2) At the beginning of each ifsmin step (except the first), an ICMSH¡exp¿IMIN file was created. This file is no longer needed if LTRAJHR is true. Its creation is now bypassed if LTRAJHR=T.

Routines modified(IFS):

`control/cva1.F90 scan2mdm.F90`

`setup/su1yom.F90 suspecg.F90`

Scripts modified:

`def/an.def`

gen/ ifsmin ifstsave ifsvar

sms_an/ifstsave.sms

Jean-Jacques Morcrette

Modifications to the IFS code (ifs/ ... and surf/ ...) to get

- RRTM_SW and LW working in a McICA configuration
- use of MODIS surface albedo
- some modifications to the prognostic aerosols

All this is protected by either logicals (LSRTM, LE4ALB, LEPAERO) or a configuration index (NMcICA) and does not have any impact on the current cy31R1 model.

New routines(IFS):

phys_ec/ mcica_cld_gen.F90 mcica_cld_generator.F90 rrtm_ecrt_140gp_mcica.F90 rrtm_rrtm_140gp_mcica.F90 rrtm_rtrn1a_140gp_mcica.F90 srtm_spcvrt_mcica.F90 srtm_srtm_224gp_mcica.F90 su_mcica.F90

Modified routines(IFS):

climate/ updclie.F90

dia/ wrmlfp.F90 wrmlfpl.F90

module/ ptrgpd.F90 yoeaersrc.F90 yoephy.F90 yomafn.F90 yomgrb.F90

namelist/ naephy.h naerad.h

phys_ec/ aer_bdgtmss.F90 aer_phy2.F90 aer_sdust.F90 aer_src.F90 aer_ssalt.F90 callpar.F90 callparad.F90 callpartl.F90 ec_phys.F90 radcfg.F90 radclb.F90 radint.F90 radintg.F90 radlswr.F90 radpar.F90 su_aerop.F90 suecrad.F90 suphec.F90

pp_obs/ aod_op.F90 aod_ad.F90. aod_tl.F90 hpos.F90 specfitg.F90

setup/ su0phy.F90 suafn1.F980 suafn2.F90 suafn3.F90 sugpprp.F90 suphyds.F90 sugridg.F90 summc.F90

Routines modified(SURF):

external/ surfrad.F90

interface/ surfrad.h

module/ surfrad_ctl_mod.F90

Gabor Radnoti

Some fixes and modifications that have effect on the correlated perturbations generated for analysis ensemble.

Correction for analysis sensitivity on observations calculations under the switch LANOBS.

Modified routines(IFS):

`obs_preproc/gen_corr_pert.F90 pertobs.F90`

`pp_obs/hoptl.F90`

Frederic Vitart

Change to code properly the grib header when doing coupled VAREPS integrations. Remove some unecessary writouts.

Modified routines(IFS):

`setup/sugrib.F90`

Ulf Andrae, Leo Haimberger and Dick Dee

Radiosonde temperature bias correction for ERA.

Modified routines(IFS):

`obs_preproc/hatbiasc.F90 biascor_era40.F90`

Modified routines(REANAL):

`biascor/fdb2sta.F90`

Matthias Drusch and Dick Dee

Sea-ice interpolation for ERA.

Modified routines(SSA):

`sub/reg_to_gg.F90 control_ssa.F90`

`namelist/namssa.h`

`module/yomsst.F90`

Clive Temperton

Mods to enable the IFS to be run in shallow-water mode (NCONF=201)

Routines modified(IFS):

`adiab/lacdynshw.F90`

`setup/su0yoma.F90 su0yomb.F90 suspecb.F90`

Antje Dethof

Changes and fixes for GEMS.

Routines modified(IFS):

`pp_obs/hop.F90`

`setup/sudim1.F90 sudyn.F90 sugfl.F90 sugpprp.F90 suvnmb.F90`

`var/rdfpinc.F90`

Scripts modified:

`gen/inter_fp`

Adrian Tompkins

Allow ice supersaturation in forecasts when semi-Lagrangian advection is switched off (e.g. column model integrations) and redundant second clipping in SLTEND removed. No meteorological impact for operational configuration.

Routines modified(IFS):

`module/yoecldp.F90`

`phys_ec/cloudsc.F90 sltend.F90`

Major upgrade to the climplot package, including updated datasets and the ability to plot model monthly means against observation climatologies.

Scripts modified:

`def/climplot.def fc.def`

`metview/climate_obs.met climplot_batch monmeans_clim.met monmeans_clim_batch`

`sms/climplot.sms mmeans.sms mmeans_ml.sms mmeans_pl.sms mmeans_sfc.sms`