RESEARCH DEPARTMENT MEMORANDUM

To:	RD Scientific Staff and Consultants	
Copy:	HR, HO, HMD, HMAS, HMOS, J.Hodkinson Jean Pailleux, François Bouttier, Claude Fischer	
From:	Deborah Salmond et al.	
Date:	January 8, 2009	File: R48.3/DS/08119
Subject:	**IFS Memorandum Cycle CY35R2**	

Cycle 35r2 was created in October-December 2008.

Modified libraries: aeolus algor ifs ifsaux obstat odb satrad scat scripts surf ssa trans wam

Contributors: M.Fisher, A.Fouilloux, S.Saarinen, M.Janiskova, D.Dee, A.Geer, S.Healy, G.Balsamo, Y.Takaya, A.Collard, N.Bormann, C.Peuby, M.Matricardi, B,Krzeminski, G.Radnoti, G.Mozdzynski, D.Salmond, A.Orr, P.Bechtold, A.Tompkins, R.ElKhatib, S.Serrar, C.Cardinali, R.Engelen, H.Hersbach, M.Hamrud, D.Tan, C.Tavolato, L.Isaksen, Y.Tremolet, K Mogensen, J.Bidlot, S.Abdalla, A.Untch, D.Vasiljevic, E.Holm, M.Dahoui, J.Haseler

Mike Fisher

Bugfixes and improved parallelisation of the wavelet Jb statistics calculation.

Two bugfixes have been applied to the wavelet Jb code. The first only affects analyses in the case that the statistics file contains data for variables that are not being assimilated. It was encountered in the context of the GEMS assimilation system. The second bug affects the calculation of Jb statistics for spectral resolutions above T319.

In addition, some minor improvements have been made to the parallelisation of the wavelet Jb statistics calculation. Non-blocking message passing is used when gathering spectral fields, and some OpenMP optimisations have been included.

Files modified(IFS):

```
parallel/gatherspa.F90
var/sujbwavelet.F90 sujbwavelet0.F90 sujbwavgen.F90 sujbwavvc.F90
```

Sami Saarinen and Anne Fouilloux

Technical improvements to ODB

The branch contains substantial technical modifications, which enable faster sorting, more load balanced observation processing and robust interactive access to ODB-databases when post-processing.

Also implementation of country/region based observation search as well as sub-queries and data indices have been implemented for interactive access.

Files created(IFS):

```
common/activedb.h
```

Files created(IFSAUX):

```
include/ecsort_shared.h
utilities/countingsort.c get_num_threads.F90 gnomesort.c
```

Files created(ODB):

```
aux/codb2netcdf.F90 odbcs_conf.c odbdump.c
ddl.CCMA/matchupsink.sql
ddl.ECMA/matchupsink.sql obscount_1.sql obscount_2.sql
ddl/matchupsink.sql obscount_1.sql obscount_2.sql
include/codb_netcdf.h odbcsdefs.h odbdump.h regcache.h symtab.h
interface/bsslzr_odb.h gauaw_odb.h
lib/bsslzr_odb.F90 gauaw_odb.F90 rgg_regions.c
pandor/include/oulan_pardimo.h include/oulan_yombitu.h include/oulan_yomcsts.h
include/oulan_yomctpm.h include/oulan_yomdate.h include/oulan_yomdirs.h
include/oulan_yomfthermo.h include/oulan_yomnbob.h include/oulan_yompin.h
include/oulan_yomtomv.h namelist/nabiais.h namelist/naextr.h
namelist/oulan_nadirs.h namelist/oulan_nanbob.h
scripts/create_schema flexfix make.ibm_power6 make.linux_O0_newer_flex make.osx
odbcs.conf odbdump.ksh odbi_proxy odbi_show_server odbsqlmp.pl rtablel_2031
rtablel_2047 rtablel_2063 rtablel_2095 rtablel_21023 rtablel_21151 rtablel_2127
rtablel_21279 rtablel_2159 rtablel_22047 rtablel_2215 rtablel_2255 rtablel_2319
```

rtablel_2399 rtablel_2511 rtablel_2639 rtablel_2799

tools/Controdb.F90 Create_schema.F90 mysort.c odb2rgg.c odbdump_main.c odbfiletime.c odbi_host.c odbnccat.c

Files created(SCRIPTS):

build/arch/Makefile.in.c1a arch/Makefile.in.c1b arch/Makefile.in.ibm_power6

gen/addsql create_schema matchupsink odbsql

sms_an/addsql.sms odbcmp_prepare.sms

Files modified(IFS):

common/yomdb_defs.h yomdb_vars.h

module/iostream_mix.F90 pardimo.F90 yomdb.F90 yomdimo.F90 yomvnmb.F90

namelist/namdimo.h

obs_preproc/decis.F90 mkglobstab.F90 screen.F90 sudimo.F90 thiair.F90

onedvar/onedvar_find_satsens.F90

phys_ec/cuancape2.F90

setup/suvnmb.F90

utility/gstats_label_ifs.F90

var/ecset.F90 gp_nearest.F90 gp_ssmi.F90 suamv.F90 taskob.F90 taskobad.F90 taskobtl.F90 writeoba.F90

Files modified(IFSAUX):

include/drhook.h

module/ecsort_mix.F90 ifcore.F90 mpi4to8_m.F90 mpi4to8_s.F90 mpl_allreduce_mod.F90 mpl_buffer_method_mod.F90 mpl_init_mod.F90 oml_mod.F90 sdl_mod.F90

parallel/coml_binding.F90

support/cargs.c dr_hook_util.F90 drhook.c env.c

utilities/ecqsort.c gentrbk.F90 get_max_threads.F90 get_thread_id.F90 getcurheap.c linuxtrbk.c rsort32.c rsort64.c

Files modified(OBSTAT):

src/odbread.F90

Files modified(ODB):

aux/cma_open.c codb_netcdf.c dca.c dtnum.c generic.c idx.c info.c iostrdup.c newio.c odbcalc.c odbcs_signal.c odbcs_wrappers.c odbi_client.c odbi_direct.c odbi_server.c odbi_shared.c odbsql.c pcma.c pcma_9.c result.c upcma.c

bufr2odb/bufr2odb_aeolus.F90 bufr2odb_aircraft.F90 bufr2odb_airs.F90 bufr2odb_atovs.F90 bufr2odb_iasi.F90 bufr2odb_meris.F90 bufr2odb_qscat.F90 bufr2odb_satob.F90 bufr2odb_synop.F90 bufr2odb_temp.F90 get_varindex.F90 odb2bufr_dep_139.F90 odb2bufr_fos_139.F90 odb2bufr_qc_139.F90

cma2odb/addviewdb.F90 buf2cmat_new.F90 closedb.F90 ctxgetdb.F90 ctxinitdb.F90 ctxputdb.F90 dotransf.F90 gather4poolmask.F90 getactivedb.F90 getatdb.F90 getdb.F90 initmdb.F90 isopendb.F90 matchupdb.F90 obsproc_init.F90 opendb.F90 putatdb.F90 putdb.F90 reprod_seqno.F90 revmatchupdb.F90 setactivedb.F90 setbufr.F90 shuffle.F90 shuffledb.F90 subuoctp.F90 update_obsdb.F90 xchangedatadb.F90

compiler/copyfile.c genc.c lex.l odb98.c regex.c tree.c yacc.y

ddl/cma.h odb98.flags varno.h

extras/emos/bubox.F emos/pbio.c

include/cdrhook.h cmaio.h defs.h evaluate.h fodb.h fodbutil.h funcs.h info.h netcdf.h odb.h odb_macros.h odbcs.h odbcstags.h odbi.h odbi_struct.h pcma_extern.h privpub.h result.h setodbcs.h

interface/addviewdb.h append_num.h ckeysort.h ctxgetdb.h ctxputdb.h getactivedb.h matchupdb.h reprod_seqno.h setactivedb.h

lib/Dummies.c aggr.c append_num.F90 ckeysort.F90 cmdbkeys.c codb.c eq_regions.c evaluate.c funcs.c fwrite_iomap.F90 inside.c msgpass_obsdata.F90 poolmasking.c symtab.c tracing.c twindow.c vecloops.c version.c

module/getval_module.F90 odb.F90 odb2bufr_varindex_module.F90 odb_module.F90 odbgetput.F90 odbnetcdf.F90 varindex_module.F90

scripts/README askodb bufr2odb configure create_ioassign dcagen dcaquick drhook_ex.ksh get_cycle make.altix_mpi make.amd64 make.amd64_mpich make.amd64_shlib make.cray_amd make.cray_xt4 make.cygwin make.i86pc make.i86pc_gcc make.ia32 make.ia64 make.ia64_icc make.ia64_no_motif make.ia64_plain make.ia64_plain_no_openmp make.ibm_power4 make.ifort32 make.ifort_hms make.linux make.linux32 make.linux_O0 make.linux_O0_no_magics make.linux_O1 make.linux_O1_no_magics make.linux_O2 make.linux_O2_new_magics make.linux_O2_no_magics make.linux_O2_pg make.linux_gprof make.linux_mpich make.linux_nag make.linux_no_openmp make.linux_prof make.linux_shlib make.linuxg95 make.linuxg95_O2 make.linuxg95_O3 make.necsx make.necsx5 make.necsx8r make.necsx8r_memtrace make.necsx8r_mpi make.necsx_8bi make.nectx_g95 make.rs6000 make.rs6000_no_motif make.sun_linux make.sun_linux_gcc make.sun_linux_gcc_O0 make_depend make_fclibs make_lib make_tarball make_tarball_drhook makefile mpirun.linux odb1to4 odb2netcdf odb4to1 odbcc odbcomp odbdup odbf90 odbi_start_server odbi_stop_server odbls odbshuffle odbsql odbviewer odbxyplot run_fe test_arch use_odb use_odb.jacket use_odb.jacket.sh use_odb.sh

tools/Bufr2odb.F90 Fbnew2old.F90 Fodbsql.F90 Fscheduler.F90 Odb2netcdf.F90 Plotobs.F90 Rs_t_rh_bias_statistics.F90 Viewer.F90 b4.c dd2ddl.c numproducts.c odbi_direct_main.c odbi_server_main.c

Files modified(SCRIPTS):

def/an.def

gen/archive_obs blcomp bufr2odb create_ioassign create_static_stubb dcagen fetchobs getini getino3 ifsmin ifstraj ifstsave ifsvar ma_init matchup mkabs_aeolus mkabs_an mkabs_b2otools mkabs_fc mkabs_matools mkabs_mctools mkabs_obsproc mkabs_obstat mkabs_odbsql mkabs_odbtools mkabs_prepdata mkabs_reanal mkabs_satmon mkabs_satrad mkabs_scat mkabs_ssa mkabs_wam mkgenlinks mkidta mkidta_eps mkidta_ocean mkidta_sens model modeleps odb_compress odbcomp odbf90 odbprune odbshuffle p4_mklib pregeos revmatchup run_parallel satimsim simulobs.pl simulobs2odb smon_def soilana ssaana sstana

sms_an/4dvar.sms b2o_meris.sms black.sms hovmoeller_reo3.sms o2b_iasi.sms obstat_iasi.sms obstat_meris.sms odb_compress.sms odbcmp_iasi.sms odbcmp_meris.sms odbsql.sms

wav/prep_wave wave_getrst

Files deleted(ODB):

scripts/start_server

Marta Janiskova

TL and AD of the full longwave radiation code

The new tangent-linear (TL) and adjoint (AD) versions of the full longwave radiation code used few years ago in operation (Morcrette 1989) have been developed. This scheme is meant to replace the current approach for the linearized longwave radiation based on neural network and Jacobians. In addition to the greater flexibility associated to its independence from recurring updates to the model (including changes of resolution), the new approach will also permit the inclusion of sensitivity with respect to such parameters as aerosols or gases, which is desirable for their future inclusion in the assimilation processes.

A substantial amount of work has been devoted to the optimization of the code to make it acceptable for operational implementation.

The new TL/AD scheme can be activated by setting LERADLW2=true in the namelist NAMTRAJP. To use a time/memory optimized version of the code, additional set-up (LOPTLWPR=true and NLOOPLW=3) should also be included in NAMTRAJP.

For further optimization, cloud effects on the longwave radiation are only computed to the certain level determined from the cloud top height. This should be activated by LWLCLHR=true in NAMTRAJP. Using this optimization, computational cost is decreased, but TL and AD results are not bit reproducible. If reproducibility is required in 4D-Var (LREPRO4DVAR=true) the switch is automatically set to false. The same can be achieved by using default value for LWLCLHR, which is false. The computational cost is then increased.

Cleaning and optimization of existing TL/AD shortwave radiation

The existing TL and AD versions of the shortwave radiation have been cleaned and optimized in order to reduce a computational cost. For further reduction, the modifications in the adjoint code have been done in order to achieve that the nonlinear version of any shortwave radiation routine will never be called more than once during the adjoint computations.

Bugfix for TL/AD vertical diffusion

A small bug correction has been done in TL/AD versions of the vertical diffusion routine which computes the exchange coefficients between the upper model levels.

Files created(IFS):

```
module/yoelwconst.F90 yoelwrad.F90
phys_radi/lwad.F90 lwbad.F90 lwbtl.F90 lwbvad.F90 lwbvtl.F90 lwcad.F90 lwctl.F90 lwtl.F90
lwttad.F90 lwttmad.F90 lwttmtl.F90 lwtttl.F90 lwuad.F90 lwutl.F90 lwvad.F90 lwvbad.F90
lwvbr.F90 lwvbrad.F90 lwvbrtl.F90 lwvbtl.F90 lwvdad.F90 lwvdr.F90 lwvdrad.F90 lwvdrtl.F90
lwvdtl.F90 lwvnad.F90 lwvnr.F90 lwvnrad.F90 lwvnrtl.F90 lwvntl.F90 lwvtl.F90
```

Files modified(IFS):

```
module/yophnc.F90
namelist/namtrajp.h
phys_ec/callparad.F90 callpartl.F90 radinaad.F90 radinatl.F90 radlsw.F90
radlswad.F90 radlswtl.F90 suphli.F90 vdfexcusad.F90 vdfexcustl.F90
phys_radi/lw.F90 lwb.F90 lwbv.F90 lwc.F90 lwtt.F90 lwttm.F90 lwu.F90 lwv.F90
lwvb.F90 lwvd.F90 suecrad.F90 sw1s.F90 sw1sad.F90 sw1stl.F90 swad.F90 swclr.F90
swclrad.F90 swclrtl.F90 swde.F90 swdead.F90 swdetl.F90 swni.F90 swniad.F90
swnitl.F90 swr.F90 swrad.F90 swrtl.F90 swtl.F90 swtt.F90 swtt1ad.F90 swtt1tl.F90
swttad.F90 swtttl.F90 swu.F90 swuad.F90 swutl.F90
```

setup/su0phy.F90 susc2b.F90 sutrajp.F90

utility/dealsc2.F90

Files modified(SCRIPTS):

gen/ifsmin pregeos

Dick Dee

Generalisation of VarBC

VarBC was redesigned to allow the development of variational bias correction schemes for non-radiance data. Most of the code is now located in ifs/module, and many of the old varbc routines have been deleted. There are now three generic modules:

- varbc_setup: for setup and various other generic functions - varbc_pred: for implementing bias predictors - varbc_eval: to evaluate bias corrections, including TL and AD

In addition there are datatype-specific modules, currently:

- varbc_rad: for radiance data - varbc_to3: for ozone data - varbc_rad_allsky: for all-sky radiance data

Each datatype-specific module has its own namelist which can be used in ifstraj to switch varbc on or off for that datatype. By default only varbc_rad is switched on.

The format for the VARBC.cycle file (used to pass information between the different steps of 4D-Var, and also between analysis cycles) has been changed. It is now easier to read by a (qualified) human. The system is backward compatible - i.e. the code will understand older versions of the file for a warm start.

The output written to the log files in the trajectory and minimisation steps is now more extensive, providing descriptions of each of the bias groups, information about various varbc settings, and information about convergence for each bias parameter.

Files created(IFS):

module/varbc_eval.F90 varbc_pred.F90 varbc_rad.F90 varbc_rad_allsky.F90 varbc_setup.F90
varbc_to3.F90

Files created(ODB):

ddl.CCMA/varbc_rad_allsky_robhdr.sql varbc_rad_allsky_robody.sql
varbc_rad_robhdr.sql varbc_rad_robody.sql varbc_setup_robhdr.sql
varbc_setup_robody.sql varbc_to3_robhdr.sql varbc_to3_robody.sql

ddl.ECMA/varbc_rad_allsky_robhdr.sql varbc_rad_allsky_robody.sql
varbc_rad_robhdr.sql varbc_rad_robody.sql varbc_setup_robhdr.sql
varbc_setup_robody.sql varbc_to3_robhdr.sql varbc_to3_robody.sql

ddl/varbc_rad_allsky_robhdr.sql varbc_rad_allsky_robody.sql varbc_rad_robhdr.sql
varbc_rad_robody.sql varbc_setup_robhdr.sql varbc_setup_robody.sql
varbc_to3_robhdr.sql varbc_to3_robody.sql

pandor/include/oulan_pardimo.h include/oulan_yombitu.h include/oulan_yomcsts.h include/oulan_
yomctpm.h include/oulan_yomdate.h include/oulan_yomdirs.h include/oulan_yomfthermo.h
include/oulan_yomnbob.h include/oulan_yompin.h include/oulan_yomtomv.h

Files created(SCRIPTS):

sms_an/geomaps_mhs.sms hovmoeller_mhs.sms scatter_mhs.sms

Files modified(IFS):

```
common/yomdb_defs.h yomdb_vars.h
control/cdsta.F90 cnt1.F90 sim4d.F90
op_obs/hdepart.F90 hop.F90 hopad.F90 hoptl.F90 hretr.F90 rad1cobe.F90
var/cain.F90 cainad.F90 cainin.F90 caininad.F90 congrad.F90 cvar2.F90 cvar2ad.F90
cvar2in.F90 cvar2inad.F90 cvarbc.F90 cvarbcad.F90 cvarbcin.F90 cvarbcinad.F90 evcost.F90
fjvarbc.F90 sujb.F90 surad.F90 suscal.F90 svvarbc.F90 taskob.F90 taskobad.F90
```

Files modified(ODB):

```
cma2odb/ctxinitdb.F90 initmdb.F90
ddl/cma.h robody.sql robody_screen.sql robody_traj.sql
```

Files modified(SCRIPTS):

```
def/an.def
gen/ODBCMP.ddl ifsmin ifstraj obstat obstat_init
sms_an/update_psbias.sms
sms_era/obtime.sms
```

Files deleted(IFS):

```
module/yomvarbc.F90
namelist/namvarbc.h
obs_preproc/statpred.F90
op_obs/biaspred.F90 radtrb.F90 radtrbad.F90 radtrbtl.F90
var/csvarbc.F90 prvarbc.F90 rdvarbc.F90 suvarbc.F90 wrvarbc.F90
```

Alan Geer

All-sky 4D-Var assimilation of microwave imager observations

This package allows all-sky 4D-Var of microwave imagers to be switched on operationally. If this is done, a necessary side effect is that model physics (radiation, cloud, etc.) will become active in 1st minimisation. Computational cost is roughly an extra 5scores are neutral to positive compared to control, with the main improvement being in lower tropospheric moisture. In summary, the content of this update is:

- performance enhancements, bug fixes and fine-tuning of all-sky 4D-Var
- much better cloudy/rainy radiative transfer calculations in RTTOV-SCATT, along with performance enhancements of about 30
- SSMI and AMSR-E will be assimilated through the all-sky route. TMI and SSMIS will only be passively monitored, and only in clear skies.
- superobbing capability added to grid-based pre-thinning tool (bufr_grib_screen)
- model land-sea mask is now written to ODB header (applies to all observations).

In more detail:

== IFS updates

1) AMSR-E is now treated with 10 to 1 superobbing before assimilation, to correctly match the observation and model resolution, which is necessary due to the small scale features in cloudy and rainy areas.

2) Satmon updates to work with the new data will be provided later by Mohamed Dahoui.

3) A new obstat option file is available to use with the new data.

4) Instrument and channel selection and observation errors have been revised. We will now only assimilate 19v/h, 22v/h, 37v and 85v channels. Only SSMI and AMSR-E will be actively assimilated.

5) Additional diagnostics are written to ECMA file: cloud fraction used by RTTOV-SCATT; cloud and rain contingency tables; model land-sea mask (the last applies to all observation types, not just all-sky)

6) Performance enhancements

- Observation to grid point code has been revised and is now much faster (mwave_nearest.F90)

- TL and AD of radiative transfer operator are only run if observation error is less than 50K. This results in significant savings, as calculations are no longer done for unused, or barely-used channels.

7) Bugs fixed:

- Bit reproducibility problem fixed in mwave_nearest.F90

- Adjoint sensitivity to convective rain was previously set to zero in the simplified operator.

- 4D-Var adjoint test (ADTEST) now works correctly with all-sky 4D-Var

- Observation errors are now scaled correctly between clear and cloudy sky in TL and AD. Previously observation errors were always set to the (generally larger) cloudy values.

- Model orography values passed to RTTOV in radtr*.F90 were wrong (this bug fix is just being bundled with all-sky 4D-Var).

8) General tidying of the new code: centralised intialisation of some arrays, variables renamed for clarity, etc.

== RTTOV and RTTOV-SCATT updates

1) Bug fixes to RTTOV core routines:

- Prevent possible segmentation violation (coefaccessed when not allocated, which is possible if addsolar is false). This bug was likely introduced with the June 2008 version of RTTOV
- Adjoint/K bug in FASTEM, which occurs when 10m v-wind $<$ 1E-4 and u-wind $>$ 1E-4. This bug has probably been in FASTEM for a long time.

2) Bug fixes in RTTOV-SCATT routines:

- Adjoint bug in rttov_mieproc.F90, occurring typically in heavy snow profiles, specifically when the extinction is greater than 20. This has been in RTTOV-SCATT for a long time.
- Other, very rare adjoint bugs and underflow possibilities have been fixed in rttov_mieproc*.F90, in the code added at version 9 of RTTOV-SCATT. These bugs were associated with the extrapolation of Mie Table parameters to very small water contents.

3) Performance enhancements

- Loops have been optimised in most of the RTTOV-SCATT code so as to access memory in correct order.
- Minimum cloud fraction (ccthres = 0.05) and single scattering albedo (min_ssa = 1E-8) thresholds were already in the code but have now been applied more generally and systematically. Below these thresholds, many of the more expensive scattering calculations are now avoided. There are small effects on simulated brightness temperatures in cloudy areas, which are of order 0.01K at channel 19v of SSM/I, rising to order 0.1K for channel 85h.

(In our tests, the results are performance enhancements of order 30%, mainly coming from the loop optimisation.)

4) New functionality

- rttov_scatt_setupindex.F90 now can now be used to generate indices for only a subset of channels, if needed. This is implemented with the optional parameter LCHANNEL_SUBSET.
- A revised cloud partitioning method has been made available. It is not used by default, but can be activated by setting LNEWCLD = .true. in the rttov_scatt/tl/ad interface. This gives a major improvement to the quality of calculations in cloud and rain regions. The evidence comes both from comparisons to radiances generated using a more accurate 10 independent column approach, and from substantial reductions in ECMWF FG departure biases compared to SSM/I.

5) Code tidying

- A number of areas have been modified simply for reasons of line length; making, where possible, TL, AD and direct versions exactly consistent; or for making the IN, INOUT, and OUT specifications more sensible.

Files created(IFS):

`mwave/mwave_postproc.F90`

Files created(ODB):

`ddl.ECMA/smon_mwimg_allsky.sql`

Files modified(IFS):

`common/yomdb_defs.h yomdb_vars.h`
`control/cnt1.F90 gp_model.F90 gp_model_ad.F90 gp_model_tl.F90`
`module/mwimager_mix.F90 parmwave.F90 yomdb.F90 yommwave.F90`
`mwave/mwave_get.F90 mwave_get_ad.F90 mwave_get_tl.F90 mwave_nearest.F90`
`mwave_obsop.F90 mwave_obsop_ad.F90 mwave_obsop_test.F90 mwave_obsop_tl.F90`
`mwave_put.F90 mwave_put_tl.F90 mwave_read_sat_error.F90 mwave_screen.F90`
`mwave_setup.F90`
`namelist/nammwave.h`
`obs_preproc/prech.F90`
`op_obs/biaspred.F90 hop.F90 hopad.F90 hoptl.F90 hretr.F90 mwimager_cloud.F90`
`mwimager_lwp.F90 radtr.F90 radtr_ml.F90 radtr_ml_ad.F90 radtr_ml_tl.F90`
`radtrad.F90 radtrb.F90 radtrbad.F90 radtrbtl.F90 radtrk.F90 radtrtl.F90`
`phys_ec/callpar.F90 callparad.F90 callpartl.F90 cloudst.F90 cloudstad.F90`
`cloudsttl.F90 cuascn2.F90 cubasen2.F90 cubasen2ad.F90 cucalln2.F90`

cucalln2ad.F90 cucalln2tl.F90 cuddrafn2.F90 cudtdqn2.F90 cudtdqn2ad.F90
cudtdqn2tl.F90 cuflx2.F90 cuflx2ad.F90 cuinin2.F90 cumastrn2.F90 cumastrn2ad.F90
cumastrn2tl.F90 cupdra.F90 ec_phys.F90 ec_phys_ad.F90 ec_phys_drv.F90
ec_phys_tl.F90 ec_physg.F90 phys_ad.F90 phys_nl.F90 phys_tl.F90

var/adtest.F90 svvarbc.F90

Files modified(ODB):

cma2odb/initmdb.F90

ddl/cma.h decis_robhdr_1.sql decis_robhdr_2.sql robhdr.sql

Files modified(SATRAD):

interface/rttov_iniscatt.h rttov_iniscatt_ad.h rttov_iniscatt_tl.h rttov_scatt.h
rttov_scatt_ad.h rttov_scatt_setupindex.h rttov_scatt_tl.h

module/bufr_grid_screen_keep.F90 gaussgrid.F90 mod_grid_screen.F90
mwave_const.F90 rttov_const.F90 rttov_types.F90

mwave/mwave_obsop_rttov.F90 mwave_obsop_rttov_ad.F90
mwave_obsop_rttov_adtest.F90 mwave_obsop_rttov_tl.F90

programs/bufr_grid_screen.F90

rttov/rttov_ad.F90 rttov_boundaryconditions.F90 rttov_boundaryconditions_ad.F90
rttov_boundaryconditions_tl.F90 rttov_calcemis_mw.F90 rttov_calcemis_mw_ad.F90
rttov_calcemis_mw_k.F90 rttov_calcemis_mw_tl.F90 rttov_direct.F90
rttov_eddington.F90 rttov_eddington_ad.F90 rttov_eddington_tl.F90
rttov_iniedd.F90 rttov_iniedd_ad.F90 rttov_iniedd_tl.F90
rttov_iniscatt.F90 rttov_iniscatt_ad.F90 rttov_iniscatt_tl.F90
rttov_integratesource.F90 rttov_integratesource_ad.F90
rttov_integratesource_tl.F90
rttov_k.F90 rttov_mieproc.F90 rttov_mieproc_ad.F90 rttov_mieproc_tl.F90
rttov_scatt.F90 rttov_scatt_ad.F90 rttov_scatt_setupindex.F90 rttov_scatt_tl.F90
rttov_tl.F90
rttovscatt_test_one.F90

Files modified(SCRIPTS):

gen/ifsmin ifstraj mklinks obstat_init premwimg

Sean Healy

Modification of GPS radio occultation observation errors

The GPS radio occultation bending angle errors above 26 km have been reduced by a factor of 2. Also changes to GPS radio occulatation 2D operator code.

Files modified(IFS):

op_obs/gpsro_oberror.F90 gpsro_2dop.F90 gpsro_2dtl.F90 gpsro_2dad.F90
gpscalc_refrac2d.F90 gpscalc_refrac2dad.F90 gpscalc_refrac2dtl.F90
gpscalc_nr2d.F90 gpscalc_nr2dtl.F90 gpscalc_nr2dad.F90

Files added(IFS):

op_obs/gpspderivs.F90 gpspderivstl.F90 gpspderivsad.F90 gpscalc_alpharkm2.F90
gpscalc_alpharkm2tl.F90 gpscalc_alpharkm2ad.F90

Gianpaolo Balsamo and Yuhei Takaya

Passive new surface models

- Passive introduction of a multi-layer ocean mixed layer model (KPP). Parallelization of offline surface model and extension to ocean points.
- Passive introduction of a lake tile (HTESSEL from 8 to 9 tiles) and passive introduction of lake model physics (FLAKE).

Files created(SURF):

`module/flake_driver_mod.F90 flakeene_mod.F90 flakerad_mod.F90 kpp_abk80.F90 kpp_bldepth.F90 kpp_blmix.F90 kpp_cpsw.F90 kpp_interior_mix.F90 kpp_kppmix.F90 kpp_ocnint.F90 kpp_sig80.F90 kpp_swfrac.F90 kpp_tridcof.F90 kpp_tridmat.F90 kpp_tridrhs.F90 kpp_wscale.F90 ocean_ml_driver_mod.F90 susflake_mod.F90 susocean_ml_mod.F90 yos_flake.F90 yos_ocean_ml.F90`

`offline/driver/rdocean_ml.F90 sucdfres_ocean_ml.F90 suflake.F90 wrtdcdf_ocean_ml.F90 wrtres_ocean_ml.F90 module/yomdim1s.F90`

Files modified(IFS):

`control/cnt1.F90`

`module/surface_fields_mix.F90 yoephy.F90 yomdphy.F90`

`phys_ec/callpar.F90 callparad.F90 callpartl.F90 ec_phys.F90 radpar.F90 suphec.F90 vdfdifh.F90 vdfdifhs.F90 vdfdifhsad.F90 vdfmain.F90 vdfmains.F90 vdfmainsad.F90 vdfmainstl.F90 vdfouter.F90`

`setup/su0phy.F90 sudim1.F90`

`var/svvarbc.F90`

Files modified(SURF):

`external/surfbc.F90 surfexcdriver.F90 surfrad.F90 surfseb.F90 surftstp.F90 susurf.F90`

`interface/surfbc.h surfexcdriver.h surfrad.h surfseb.h surftstp.h susurf.h`

`module/srfwexc_mod.F90 srfwexc_vg_mod.F90 srfwl_mod.F90 surfbc_ctl_mod.F90 surfexcdriver_ctl_mod.F90 surfpp_ctl_mod.F90 surfrad_ctl_mod.F90 surfseb_ctl_mod.F90 surftstp_ctl_mod.F90 surwn_mod.F90 suscst_mod.F90 susurf_ctl_mod.F90 susveg_mod.F90 vsurf_mod.F90 vupdz0_mod.F90 vupdz0s_mod.F90 vupdz0sad_mod.F90 vupdz0stl_mod.F90 yos_cst.F90`

`offline/driver/callpar1s.F90 cntend.F90 cpg1s.F90 rdclim.F90 rdclimgrb.F90 rdcoorgrb.F90 rdfvargrb.F90 rdsupr.F90 rdsuprgrb.F90 stepo1s.F90 su0phy1s.F90 su1s.F90 sucdfres.F90 sudcdf.F90 sudim1s.F90 sugc1s.F90 sugp1s.F90 sugpd1s.F90 suinif1s.F90 sulun1s.F90 supcdf.F90 suphec.F90 upddiag.F90 wrtd1s.F90 wrtdcdf.F90 wrtp1s.F90 wrtpcdf.F90 wrtres.F90 module/ptrgp1s.F90 ptrgpd1s.F90 yoephy.F90 yomdphy.F90 yomgp1s0.F90 yomgp1s1.F90 yomgp1sa.F90 yomgpd1s.F90 yomlog1s.F90 yomlun1s.F90`

`namelist/nam1s.h namdim1s.h namgp1s.h namgpd1s.h namphy1s.h phys_ec/vdfdifh1s.F90 phys_ec/vdfmain1s.F90`

Files deleted(IFS):

`phys_ec/vdfdifh5.F90`

Gianpaolo Balsamo

New snow scheme

A revised snow scheme including a diagnostic liquid water storage and a new density formulation (both active by default, with switch LESNWD=.TRUE.

Files created(SURF):

`module/srfsn_lwimp_mod.F90`

Files modified(IFS):

`module/yoephy.F90`
`namelist/naephy.h`
`phys_ec/callpar.F90 suphec.F90`
`setup/su0phy.F90`

Files modified(SSA):

`sub/cres_fill1.F90`

Files modified(SURF):

`external/surftstp.F90 susurf.F90`
`interface/surftstp.h susurf.h`
`module/sppgust_mod.F90 surftstp_ctl_mod.F90 sussoil_mod.F90 susurf_ctl_mod.F90 yos_soil.F90`
`offline/driver/callpar1s.F90 su0phy1s.F90 suphec.F90`
`offline/module/yoephy.F90`
`offline/namelist/namphy1s.h`

Andrew Collard

Active assimilation of IASI humidity channels

The active assimilation of IASI humidity channels is introduced with ten such channels used, each with an assumed observation error of 1.5K and employing the cross-band cloud detection configuration. The use of AIRS humidity information had been modified to be consistent with the IASI approach. In addition a number of ODB variables have been added so that auxiliary AVHRR data in the IASI data stream can be used for cloud detection in future cycles.

Files modified(IFS):

`common/yomdb_defs.h yomdb_vars.h obs_preproc/cloud_detect_setup.F90`

Files modified(ODB):

`bufr2odb/bufr2odb_iasi.F90 get_varindex.F90`
`cma2odb/initmdb.F90`
`ddl/cma.h sat_atovs.sql`
`module/varindex_module.F90`

Files modified(SATRAD):

`programs/bufr_screen_iasi.F90`

Files modified(SCRIPTS):

gen/mklinks

Niels Bormann, Carole Peubey, Alan Geer, Marco Matricardi

Various satellite-related modifications, including activation of RTTOV-9

Use some new features of RTTOV-9:

- Linear-in-tau parameterisation for the source function
- Variable zenith angle
- Use of internal RTTOV interpolation
- Activate new cloud parameterisation for satellite image simulation
- Relax check for surface pressure in RTTOV (to avoid problems with the T42 model)
- Minor bugfixes in RTTOV and the interface to IFS
- Update to RT coefficients

As radiance biases are significantly different due to these changes, VarBC should be cold started.

Other changes:

- Get rid of nasty hard-coding in rtsetup
- Fix incorrect bias corrections in hretr when missing channels are present
- Definition of satellite ID for NOAA-19
- Allow PACRARS data from Seoul

Files modified(IFS):

```
module/yomtvrad.F90
op_obs/bgobs.F90 hretr.F90 radtr.F90 radtr_ml.F90 radtr_ml_ad.F90
radtr_ml_tl.F90 radtrad.F90 radtrk.F90 radtrtl.F90
var/getsatid.F90 rtsetup.F90 surad.F90
```

Files modified(OBSTAT):

```
module/mod_sat_monitor.F90
```

Files modified(SATRAD):

```
interface/rttov_intavg_chan.h rttov_intavg_chan_ad.h rttov_intavg_chan_k.h
rttov_intavg_chan_tl.h
module/rttov_const.F90
programs/gensatim.F90 screen_1c.F90
rttov/rttov_ad.F90
rttov_calcemis_mw.F90 rttov_calcemis_mw_ad.F90 rttov_calcemis_mw_k.F90
rttov_calcemis_mw_tl.F90
rttov_direct.F90 rttov_distribcoeffs.F90 rttov_ec.F90
```

rttov_intavg_chan.F90 rttov_intavg_chan_ad.F90 rttov_intavg_chan_k.F90
rttov_intavg_chan_tl.F90
rttov_k.F90 rttov_readcoeffs_ascii.F90 rttov_tl.F90

Blazej Krzeminski

Revision of the HIRS cloud screening schem

Cloud detection scheme was redesigned to reduce residual cloud contamination in the HIRS radiances. Revised algorithm requires the auxiliary HIRS cloud detection tests to be removed from blacklist file.

Files modified(IFS):
obs_preproc/hirs_cld.F90
op_obs/hretr.F90

Gabor Radnoti

CVTEST and ADTEST

Bug fix for Control Variable and Adjoint Tests in 4D-Var

Files modified(IFS):
utility/jbtomodelad.F90

Gabor Radnoti

Fixes for LOBSCOR

The modifications are some fixes at accounting for horizontal observation error correlations in 4DVAR under the switch LOBSCOR. By default all this is passive and provides bit identical reproducibility.

Files modified(ALGOR):
external/lanczos/landr.F

Files modified(IFS):
obs_preproc/suobscor.F90
op_obs/hjo.F90 hoptl.F90
sinvect/nalan1.F90

George Mozdzynski

Optimisations and Fixes

- Performance optimisation to cloudvar.F90. This change produces identical results to a control model run, and an overall 0.5 percent improvement for a T399L91 model with 80 tasks x 4 threads (10 nodes).

- Reduction to the computational cost of cldpp by only computing the cloud cover diagnostic arrays when they are needed. For our current operational model configuration (384Tx4t, 48 nodes) this branch results in a 1.0 percent performance improvement. For 4D-Var there is a smaller improvement.
- Resolve problem 'User pack or receive buffer is too small (0)'
- Make NPHYINT=1 (coarse grid physics) configuration work again
- Computation of grid-point norms using a more efficient and scalable approach. For a T799L91 model using 384 tasks x 4 threads, this has improved overall performance by 0.6 percent (seen in reduced communications time). And for a T799L91 model using 768 tasks x 4 threads, overall performance has improved by 2.7 percent.
- Add a number of gstats_barrier calls that are only active with LBARRIER_STATS=T (default is F). These are added to provide a clearer understanding of load imbalances in model physics and also TL and AD physics.

Files modified(IFS):
`phys_ec/cloudvar.F90 raddrv.F90 wvxf2gb.F90 callpar.F90 callparad.F90 cldpp.F90 radpar.F90 ec_physg.F90`
`parallel/commspnorm1.F90 gpnorm1.F90 ec_phys_drv.F90`
`setup/sucoaphy.F90`
`climate/cormassdry.F90`
`control/gp_model.F90 gp_model_ad.F90 gp_model_tl.F90`
`dia/gridpoint_norm.F90`
`utility/gpnorm2.F90 gpnorm3.F90 gstats_label_ifs.F90`

Files modified(IFSAUX):
`module/mpl_gatherv_mod.F90`
`support/getstats.F90`

Files modified(TRANS):
`external/gpnorm_trans.F90`
`interface/gpnorm_trans.h`

Deborah Salmond

Bug Fixes

Various fixes to enable IFS to run with Array-bounds checking and initialisation to NANS.

Files modified(IFS):
`op_obs/hoptl.F90 hretr.F90`
`setup/suecphypo.F90`
`var/surad.F90`

Files modified(IFSAUX):
`support/gstats_print.F90`

Jean-Jacques Morcrette and S.Bekki (UPMC-SA)

Preparatory work for a prognostic stratospheric aerosol model No impact on IFS

Files created(IFS):

`module/yoeaerst1.F90`

`phys_ec/aer_straact.F90 aer_straero.F90 aer_strclog.F90 aer_strcomp.F90 aer_strdens.F90 aer_strfind.F90 aer_strfree.F90 aer_strrlog.F90 aer_strvelo.F90`

Andrew Orr, Peter Bechtold, Jean-Jacques Morcrette

Representation of non-orographic gravity waves and various bug-fixes

- Introduction of a Warner-McIntyre-Scinocca non-orographic gravity wave (GWWMS) scheme in the operational library.
- Cleaning and full coupling of GWWMS scheme with convection within callpar and small bugfix in LBUD23
- dissipation budget.
- Set lower limit of adjustment time to 720., instead as time step PTSPHY (this will only have effect for the next T1279 resolution when PTSPHY=450 s).
- Bug-fix in the (unused) 2D MOBIDIC-derived ozone climatology.

N.B.: GWWMS and new trace gases climatologies are not active in operational configuration.

Files created(IFS):

`module/yoegwwms.F90`

`phys_ec/gwdrag_wms.F90 sugwwms.F90`

Files modified(IFS):

`module/yoephy.F90`

`namelist/naephy.h`

`phys_ec/callpar.F90 cuflxnad.F90 cuflxntl.F90 cumastrn.F90 cumastrnad.F90 cumastrntl.F90 radintg.F90 suphec.F90`

`phys_radi/radghg.F90`

`setup/su0phy.F90`

Jean-Jacques Morcrette and Adrian Tompkins

Upgrade to GEMS-AER forward model

- Revision of the sulphur-related aerosols
- Revision of sources for dust aerosols
- Possibility of using 10-m wind including gustiness effects as predictor for sea salt and dust emission.

- Direct and indirect aerosol effects

Files created(IFS):

`namelist/namcldp.h`

`phys_ec/aer_clcld.F90 aer_cld.F90 aer_rad.F90 aer_so2so4.F90 aer_wind.F90 cloudaer.F90`

Files modified(IFS):

`module/yoeaeratm.F90 yoeaermap.F90 yoeaersnk.F90 yoeaersrc.F90 yoecldp.F90 yoerdu.F90`

`namelist/naeaer.h`

`phys_ec/aer_bdgtmss.F90 aer_drydep.F90 aer_phy1.F90 aer_phy2.F90 aer_phy3.F90 aer_scavbc.F90 aer_scavin.F90 aer_sedimnt.F90 aer_src.F90 aer_ssalt_ms.F90 callpar.F90 cloudsc.F90 radcfg.F90 raddrv.F90 radint.F90 radintg.F90 radlswr.F90 radpar.F90 su_aerp.F90 su_aerw.F90 sucldp.F90 suphec.F90`

`phys_radi/suecrad.F90 uvradi.F90`

Klaus Scipal

Modifications to sekf

Files created(ODB):

`ddl.ECMA/ascatsm_robhdr_1.sql ascatsm_robody_1.sql`

`ddl/ascatsm_robhdr_1.sql ascatsm_robody_1.sql`

Files modified(IFS):

`control/csekf2.F90`

`module/yomsekf.F90`

`namelist/namsekf.h`

`obs_preproc/sekf_prep_ascat.F90`

`sekf/pertsekf_v2.F90 sekf_gain.F90 sekf_write.F90 sm_ekf_main.F90 susekf.F90`

Files modified(ODB):

`cma2odb/ctxinitdb.F90`

Soumia Serrar

Fix to the post-processing of physics tendencies

The routine failed in case part of the tendencies only were requested for the post-processing. No error occurred in case all or none of the tendencies were post-processed. The problem is now fixed. A change has been done at scripts level to take into account the new variable D3GGFIELDSSTEND in prep_IFS (PP controls)

Files modified(IFS):

`pp_obs/pos.F90`

Files modified(SCRIPTS):

`sms/ml.sms`

Anne Fouilloux

Improvement to processor binding for IBM Power5 and Power6 New option for EC_BIND=default introduced

This option only works when using full node and

- if the number of threads per MPI tasks is odd then it defines EC_BIND="0 16 1 17 2 18 3 19..." on hpce (Power5) and EC_BIND="0 32 1 33 2 34..." on c1a (Power6)
- otherwise it sets EC_BIND using the number of threads per tasks and SIBLING_CPU_OFFSET (16 or 32) For instance for 4 OpenMP threads: on hpce: OpenMP threads MPI-0: 0 1 17 16 MPI-1: 2 3 19 18 MPI-2: 4 5 21 20 ... on c1a: OpenMP threads MPI-0: 0 1 33 32 MPI-1: 2 3 35 34 MPI-2: 4 5 37 36 ...

Files modified(IFSAUX):
`eclite/bindproc.c`

Ryad El Khatib

Improvement to n_precision

Files modified(IFSAUX):
`eclite/n_precision.c`

Martin Leutbecher

Clipping of humidity and cloud variables at first time step

In order to use perturbations of the moist part of the state vector in the EPS, code has been introduced to bound humidity, cloud water, cloud ice and cloud fraction to physically reasonable ranges. The code is activitated with switches LECLIPQT0 and LECLIPCLDT0 in namelist NAEPHY for specific humidity and cloud variables, respectively. By default these switches are set to false; it is intended to set them to true in the perturbed forecast of the EPS only.

Files created(IFS):
`phys_ec/qsupersatclip.F90`

Files modified(IFS):
`module/yoephy.F90`
`namelist/naephy.h`
`phys_ec/callpar.F90`
`setup/su0phy.F90`

Carla Cardinali

Forecast sensitivity to observation (FSO)

Compute the observation impact in the forecast. FSO calculation is plugged in the IFS and experiment are performed by choosing type=fsobs in PrepIFS.

Files created(SCRIPTS):

```
def/fsobs.def
```

Files modified(IFS):

```
common/yomdb_defs.h yomdb_vars.h
control/cva1.F90
module/yomvar.F90
namelist/namvar.h
var/readvec.F90 suvar.F90
```

Files modified(ODB):

```
cma2odb/initmdb.F90 ddl/cma.h robody.sql
```

Files modified(SCRIPTS):

```
def/gen.def
gen/anml anpl ansfc anwave getgrbe getini ifsmin ifstraj ifsvar varconsts
vardata
sms/logfiles.sms
```

Nils Wedi

Semi-Lagrangian dynamics diagnostics

The new routine dia/cpdysldia.F90 computes the Lipschitz number of the flow and the Jacobian. The Jacobian diagnostic can be used to diagnose the loss of mass as it measures how well the continuity equation is satisfied. The Lipschitz number measures the accuracy of the semi-Lagrangian trajectory, where Lipschitz numbers greater one indicate trajectory intersections and implications on accuracy and stability. The branch also fixes the use of dynamic extra fields which was broken. The diagnostics can be invoked using LSLDIA=TRUE (NAMDYNA). Optionally, if NVEXTRA .GE. NVEXTRADYN .GE. 2 the diagnostics are postprocessed as a 3D field. The thresholds for printing (if .GE. value) may be specified via RJACSLDIA, RLIPSLDIA (NAMDYNCORE).

Files created(IFS):

```
dia/cpdysldia.F90
```

Files modified(IFS):

```
adiab/call_sl.F90 cpg.F90 lapinea.F90 lapineb.F90 larmes.F90
control/gp_model.F90 scan2m.F90
module/yom_ygfl.F90 yomdyna.F90 yomdyncore.F90
namelist/namdyna.h namdyncore.h namgfl.h
phys_ec/callpar.F90 ec_phys_drv.F90
setup/sudefo_gflattr.F90 sudim1.F90 sudyn_setgflattr.F90 sudyna.F90 sudyncore.F90
sugfl.F90
```

Richard Engelen and GEMS team

GEMS updates

- Introduction of variable CO2 for the version 7 coefficients of RTTOV9
- Moving most of the GEMS related code in calpar/tl/ad to separate routines
- script changes to run GEMS configurations more smoothly

Files created(IFS):

`phys_ec/gems_dealloc.F90 gems_dealloc_ad.F90 gems_dealloc_tl.F90 gems_init.F90 gems_init_ad.F90 gems_init_tl.F90 gems_tend.F90 gems_tend_ad.F90 gems_tend_tl.F90`

Files created(SCRIPTS):

`def/ifs_ctm.def`

`gen/ctm_ctm_smioc.xml getinigems ifs_ifs_smioc.xml prep_couplo4`

`sms/libmozart.sms`

`sms_an/b2o_reo3ak.sms`

Files modified(IFS):

`adiab/call_sl_ad.F90`

`control/gp_model.F90`

`module/couplo4_mix.F90 pardimo.F90`

`obs_preproc/new_thinn.F90 new_thinner.F90 new_thinner_no_sq.F90 post_thinner.F90 pre_thinner.F90 reo3sin.F90`

`op_obs/hopad.F90 hretr.F90 hvnmtlt.F90 radtr.F90 radtr_ml.F90 radtrad.F90`

`phys_ec/callpar.F90 callparad.F90 callpartl.F90 ec_phys_ad.F90 ec_phys_tl.F90 grg_tendctm.F90 radintg.F90 rndecay.F90`

`pp_obs/ppobsa.F90 ppobsaad.F90 ppobsatl.F90`

`prism/couplo4_definitions.F90 couplo4_endmpi.F90 couplo4_exchange.F90 couplo4_grg_input.F90 couplo4_grg_stats.F90 couplo4_inimpi.F90`

`setup/sugfl.F90 suvnmb.F90`

`var/sujbwavelet.F90`

Files modified(SATRAD):

`rttov/rttov_initcoeffs.F90 rttov_setpredictors_7.F90 rttov_setpredictors_7_ad.F90 rttov_setpredictors_7_tl.F90`

Files modified(SCRIPTS):

`era/monthlyMean obstat2timeplot.pl`

`gen/ODBCMP.ddl anil anml anpl bufr2odb fast_sgint fdbksave fetcherr gems_ifsnam.pl gems_setup getgrb getgrbe getini getmars getpersSST ifsmin ifstraj inter_fp mergebufr mkidta mklinks mknam_fp model obstat_init pregeos prereo3 varconsts`

`sms/getini.sms getpersSST.sms ml.sms pl.sms sfc.sms`

`sms_an/anil.sms fetchobs.sms lowres.sms obstat_iasi.sms obstat_meris.sms pobstat.sms prereo3.sms`

`sms_era/obtime.sms`

Files deleted(IFS):

`module/yom_grgctm.F90`

Hans Hersbach

Preparation for the usage of ocean currents in the analysis system, and assimilation of scatterometer data as (equivalent) neutral wind.

Although the default setting is bit-reproducible to 35R1, this branch allows (by setting appropriate switches) for:

- The usage of ocean currents in the model forecast from an external source, other than from the OASIS coupler. - Tested examples are ocean currents from the ECMWF system 3 ocean analysis, and from MERCATOR. - A possible application could, e.g., be the usage of such external info in the first leg of EPS rather than none, and from OASIS in the second leg. - External fields are interpolated on the model grid at the place of the SST analysis, and archived as type=an,levtype=sfc,param=131.151/132.151.
- Usage of any ocean currents (external or from OASIS) in the 4D-Var trajectory, and the inclusion of the effect of ocean currents on observation operators in 4D-Var that act on ocean-surface parameters (buoys, scatterometer data, ..)
- Archiving of any ocean current fields (external or from OASIS) as used in the forecast (trajectory), as type=fc (4v),levtype=sfc,param=131.151/132.151.
- The assimilation of scatterometer data as equivalent neutral wind, by adaptation of the scatterometer observation operator on one hand and modification of the wind-inversion scheme of scatterometer data on the other hand.

Some technical details:

The script-part of this branch involves three new switches: LECURR, LECURRCOLD : related to the usage of ocean currents LSCATT_NEUTRAL : related to the assimilation of neutral winds

They are to be preset in the file setup.h with the following values: LECURR=false LECURRCOLD=false LSCATT_NEUTRAL=false This setting is bit-reproducible to 35R1

For the time being they should NOT appear as buttons in PrepIFS, but in a later cycle they should be placed under: LECURR, LECURRCOLD –> ”Surface analysis” LSCATT_NEUTRAL –> ”Satellites”, below ”LSCAT scatterometer data”

Effect of script variable LECURR:

1)Sets the existing namelist variable LECURR in: gen/ifstraj, gen/ifsmin, gen/model. When .TRUE., this activates the usage of ocean-currents in the model boundary-layer formalism. By default, namelist variable LECURR is set to .FALSE. in setup/su0phy.F90. Script variable LECURR does NOT affect the usage of namelist variable LECURR=OCCURR in oce/model_oceatm.

2)Script variable LECURR also sets a new namelist variable LWCUR that, when true, will pass pass on ocean-current information to the wave model. In the current branch, however, this information is not picked up in the wave model. This is to be done in a separate branch: wab_CY35R1_CURRENTS_NEUTRAL. By default, namelist variable LWCUR is set to .FALSE. in setup/su0phy.F90

Effect of script variable LECURRCOLD:

This script variable allows the resetting of namelist variable LECURR to false in the make family, in case no archived ocean-current fields are available for INIEXPVER.

Effect of script variable LSCATT_NEUTRAL:

This variable sets a new equally-named namelist variable, which, when .TRUE. assimilates scatterometer data as neutral winds. By default, namelist variable LSCATT_NEUTRAL is set to .FALSE. in ifs/obs_preproc/defrun.F90

Files created(IFS):

`op_obs/z0sea.F90 z0seaad.F90 z0seatl.F90`

Files created(PREPDATA):

`module/gribdim.F90 griddef.F90`

`programs/bsslzr.F90 cint.F90 cinterpol.F90 gauaw.F90`

Files created(SCAT):

`gmf/cmod5.F`

`programs/comp_cmodtabs.F`

Files modified(IFS):

`climate/updclie.F90`

`dia/pregrbenc.F90`

`fullpos/hpos.F90 specfitg.F90 sufpc.F90`

`module/goms_mix.F90 iostream_mix.F90 surface_fields_mix.F90 traj_surface_mod.F90 yoewcou.F90 yomafn.F90 yomgrb.F90 yomobs.F90`

`namelist/naephy.h namafn.h namobs.h`

`obs_preproc/defrun.F90`

`op_obs/bgobs.F90 cobs.F90 cobslag.F90 cobstl.F90 hop.F90 hopad.F90 hoptl.F90 hretr.F90 mpobseq.F90 mpobseq_pack.F90 obshor.F90 preints.F90 preintsad.F90 preintstl.F90 slint.F90`

`phys_ec/ec_phys.F90`

`pp_obs/ppobsas.F90 ppobsasad.F90 ppobsastl.F90 ppuv10m.F90 ppuv10mad.F90 ppuv10mtl.F90`

`setup/modgrin.F90 su0phy.F90 su_surf_flds.F90 suafn1.F90 suafn2.F90 suafn3.F90 supp.F90 susc2b.F90`

Files modified(SCAT):

`programs/qscat25to50km.F`

Files modified(SCRIPTS):

`def/an.def`

`gen/ansfc fetchmars fetchobs getgrb grib_def.h ifsmin ifstraj lowres_fp mkabs_prepdata mkabs_scat mklinks mknam_fp model prescat sstana varconsts`

Hans Hersbach

ASCAT

Enable the processing of ASCAT EARS, ASCAT Soil Moisture, and ASCAT L2 winds (change from L1B).

Files modified(SCAT): `programs/ascat_bufr_filter.F`

Mats Hamrud

Optimisation of gather_spec and updtim

Bit of improved scaling in in gath_spec_control_mod.F90 + proper gstats calls in these routines. Also removal of repeat work in updtim.

Files modified(IFS):
`utility/gstats_label_ifs.F90 updtim.F90`

Files modified(TRANS): `module/dist_grid_ctl_mod.F90 dist_spec_control_mod.F90 gath_grid_ctl_mod.F90 gath_spec_control_mod.F90`

Mats Hamrud and George Mozdzynski

Speedup of writing and reading restart files

Should gain 5 minutes for operational deterministic forecast run.

Files modified(IFS):
`control/reresf.F90`
`module/iostream_mix.F90 yomios.F90 yomres.F90`
`namelist/namios.h namrcf.h namres.h`
`parallel/ddhrcv.F90 ddhsnd.F90`
`setup/suios.F90 sures.F90`
`utility/gstats_label_ifs.F90 wrresf.F90`

Files modified(SCRIPTS):
`gen/model save_out`
`oce/checkrestarts model_oceatm save_cprestart saverestarts`
`sms_oc/occleanallrestarts.sms`

Mats Hamrud

GSTATS

- Improved gstats timing.
- Replace use of broadcint etc. with calls to mpl_broadcast in IFS.
- introduce barriers after communications controled by LBARRIER_STATS2

Files created(IFSAUX):
`support/getstats.F90 gstats_barrier2.F90`

Files created(TRANS):

external/gpnorm_trans.F90
interface/gpnorm_trans.h

Files modified(IFS):
climate/cormassdry.F90
control/cnt0.F90 cnt1.F90 gp_model.F90 gp_model_ad.F90 gp_model_tl.F90
dia/gridpoint_norm.F90
fullpos/sufpsc2_dep.F90
module/control_vectors_comm_mod.F90 iostream_mix.F90 traj_main_mod.F90
namelist/nampar0.h
obs_preproc/mkglobstab.F90 statpred.F90 suobs.F90
op_obs/mpobseq.F90 mpobseqad.F90
parallel/brptob.F90 commfce2.F90 commjbbal.F90 commjbdat.F90 commspnorm.F90
dot_product_ctlvec.F90 gatherbdy.F90 gathercost1.F90 gathercost2.F90
gathercosto.F90 gathergom.F90 gathergpf.F90 gpnorm1.F90 read_spec.F90 slcomm.F90
slcomm1.F90 slcomm2.F90 slcomm2a.F90 trmtos.F90 trstom.F90 write_spec.F90
phys_ec/ec_phys_drv.F90 wvxf2gb.F90
setup/su0yoma.F90 su0yomb.F90 suarg.F90 sumpini.F90 susc2b.F90 suspsp.F90
utility/gpnorm2.F90 gpnorm3.F90 grid_biconserv.F90 grid_bilinear.F90
gstats_label_ifs.F90 interp_gp.F90
var/cvarbcad.F90 cvarbcinad.F90 ecset.F90 evcost.F90 getmini.F90 rdvarbc.F90 savmini.F90
suhifce.F90 sujbbal.F90 sujbdat.F90 sujbwavallo.F90 sujbwavalls.F90 sujbwavelet.F90
sujbwavelet0.F90 suvarbc.F90 suvazx.F90 taskob.F90 taskobad.F90 taskobtl.F90 wrvarbc.F90

Files modified(IFSAUX):
module/yomgstats.F90
parallel/broadcchar.F90 broadcint.F90 broadcreal.F90
support/gstats.F90 gstats_print.F90 gstats_setup.F90

Files modified(TRANS):
external/setup_trans.F90
module/dist_grid_ctl_mod.F90 dist_spec_control_mod.F90 gath_grid_ctl_mod.F90 gath_-
spec_control_mod.F90 sustaonl_mod.F90 trgtol_mod.F90 trltog_mod.F90 trltom_mod.F90
trmtol_mod.F90

David Tan

Doppler wind lidar assimilation.

Infrastructure (no meteorological impact) for generation of ADM-Aeolus Level-2B retrievals within the IFS screening task.

IFS: detailed interfacing to aeolus project – setup, Level-2B retrievals, and "unsetup" (i.e. deleting of various data structures); repair hoptl (restore code inexplicably deleted by Meteo-France in CY34/35).

ODB: bugfixes and minor upgrades to bufr2odb_aeolus and aeolus sqls.

SCRIPTS: new tasks to process Aeolus metadata (predicted orbit locations), treatment of aeolus in other families. Associated changes in aeolus project ("Release 1.33") to permit calling from IFS (minimal pending further

development).

Files created(AEOLUS):

`external/aeolus_l2bp_odb_transfers.F90 aeolus_l2bp_primary_ec.h aeolus_l2bp_setup_ec.F90 aeolus_l2bp_unsetup_ec.F90`

Files created(IFS):

`var/suaeolus.F90`

Files created(SCRIPTS):

`gen/create_s2o_aeolus_md`

`sms_an/create_s2o_aeolus_md.sms s2o_aeolus_md_nadir.sms s2o_aeolus_md_offnadir.sms`

Files modified(AEOLUS):

`Application_Client_Example/application_client_example.F90`

`DataStructures/amd_datastructure.F90 l1b_datastructure.F90 l1b_pcd_ads.F90 virtual_das.F90`

`external/aeolus_l2bp_primary_ec.F90`

`main/L2B_processor.F90 l2bp_module.F90`

`support/datetimemod.F90`

Files modified(IFS):

`common/yomdb_defs.h yomdb_vars.h`

`module/aeolus_getamd_mod.F90 aeolus_l2bp_wrapper_mod.F90`

`obs_preproc/suobs.F90`

`op_obs/hoptl.F90 hretr.F90`

`var/taskob.F90`

Files modified(ODB):

`bufr2odb/bufr2odb_aeolus.F90 get_varindex.F90`

`cma2odb/ctxinitdb.F90 getdb.F90 initmdb.F90`

`ddl/cma.h robhdr_screen.sql sathdr_screen_aeolus_1b.sql sathdr_screen_aeolus_hdr.sql`

Files modified(SCRIPTS):

`def/an.def`

`gen/create_ioassign fdbksave ifstraj simulobs.pl simulobs2odb`

`sms_an/simulobs2odb.sms`

`sms_era/obtime.sms`

Christina Tavolato and Lars Isaksen

Huber Norm Update and Surface Bias correction limits

This is an update on code for Huber norm variational quality control and retuning of observations errors as implemented in CY33R2.

The Update involved retuning of some control variables in defrun.F90 and hjo.F90 as well as some observation errors have been readjusted according to observation error estimates within suobserr.F90.

Further a relaxation of the Ps bias limits was done in Ps_bias_correction.F90. This will be needed once the Huber norm VarQC gets switched on. This change will bias correct more surface pressure observations. This will potentially lead to more used surface pressure observations in the analysis. (Bias corrections will only be changed after at least 3 assimilation cycles. Until then this code is reproducible.)

The Huber code is not active in this cycle and gives bit-identical results when switches off. It is controlled by the main switches LHUBERMINQCG=.false., and LHUBERBGQCG=.false..

Files modified(IFS):
`obs_error/suobserr.F90`
`obs_preproc/defrun.F90`
`pp_obs/hjo.F90`

Files modified(ODB):
`tools/Ps_bias_correction.F90`

Yannick Tremolet

Technical preparation for split outer loops and long window 4D-Var

The branch contains modifications to the ODB and related scripts which will make it possible to develop and test the possibility to run the outer loops of 4D-Var in parallel over independent sub-windows. The departures computed in the outer loops can then be merged together for the minimisation which (in this first implementation) will be run as a single job over the entire assimilation window.

Files: *Files created(ODB):*
`ddl.CCMA/adjust_seqnos.sql`
`ddl/adjust_seqnos.sql`
`tools/Adjust_seqnos.F90`

Files modified(IFS):
`common/yomdb_defs.h yomdb_vars.h`
`module/yommodel_error.F90`
`var/suvar.F90`

Files modified(ODB):
`cma2odb/initmdb.F90`
`ddl/cma.h robody.sql`

Files modified(SCRIPTS):
`gen/bufr2odb cleanodb create_ioassign ifssvtraj ifsvar mergeodb mkabs_odbtools restartodb simulobs2odb vardata`
`sms_an/mergeodb.sms`

Kristian Mogensen

Fix for restart in seasonal forecasts

Files modified(IFS):
`control/cnt4.F90`

Jean Bidlot and Saleh Abdalla

Technical changes were needed for the pre-processing of Jason-2 altimeter data and the assimilation of these data

Jason-2 will replace Jason-1, until Jason-1 is moved to cover different tracks.

If the irregular grid option is selected, then the wave model domain can be extended to the poles. This is useful for aqua planet simulation as well as for extending the model domain to the north pole. By default all model configurations, except the regular 1.5 and 3.0 degree regular grid, have a northern boundary at the north pole. This was achieved by removing the singularity (1/cos(phi)) at the poles. No extra treatement of the wave propagation at the poles is done beside the averaging over the 2 grid points at the poles in output fields.

A new routine (wvwaminit.F) was introduced to read in the wave model configuration such that the IFS no longer use values for the wave model north and south boundaries as well as the grid size that were supplied in namelist NAEPHY.

Global communications between the different tasks used when fields are returned from WAM to IFS were replaced by more local ones in a manner very similar to what had been done some time ago for the exchange of fields from IFS to WAM. The interpolation weights to interpolate from WAM grid to IFS grid are calculated once and kept for later use.

An array bound violation in create_wam_bathymetry was removed.

A bug was found in the calculation of the sub-grid parametrisation for the limited area configuration medite10 (10km resolution). It was connected to the wrong use of the value of the first frequency because wave_create_-bathymetry and preproc did not share a common set of files containing all parameters used to defined the model configuration. It is now done by using a single script function (wave_set_config) that centralise all the information. Following that change, all constant files are specific for the resolution in space but also for a given number of frequencies and directions.

In order to remove the use of hardcoded fortran unit, the input files to the wave model were renamed. Similarly, input file names are generic and no longer contain a date as part of their names.

The following files should be provided:

input namelist, wam_namelist

model configuration:

wam_grid : model grid and tables.

wam_subgrid : information for model advection, including sub-grid parametrisation.

initial data and forcing:

sfcwindin : initial value of U10, V10, sea ice fraction (in stand alone it also contains the same fields as forcing for the length of the run).

cdwavein : initial value of drag coeffcient.

uwavein : initial value of wind speed.

specwavein : initial wave spectra.

currents: surface currents for stand alone runs.

In all scripts pointing to wave input data, ADIR was replaced to WDIR.

readwind can now cope with reading in sea ice informaion even when it is not used.

Initial spectra can be reset to noise level by setting LNSESTART to true in the input namelist. Wave induced stress will also be reset to zero then.

Bug fix in grb2wgrd to deal with negative starting longitude.

A few more OpemMP directives were used.

Files new(SCRIPTS):

```
wav/input_to_wam_bathymetry wam_bathy_correction_standrewbay wam_preproc_input
wave_set_config
```

Files modified(SCRIPTS):

```
eps/ifsnam.eps_fc.h
gen/fetchobs ifstraj mknam_fp model modeleps preobs varconsts
oce/model_oceatm
sms_an/clean_an.sms
sms_oc/iniatmos.sms
wav/prep_wave wam_input wam_reference_levels_global wave_const wave_cpini wave_create_-
bathymetry wave_data_dates wave_getalt wave_getobs wave_getrst wave_getsar wave_-
getwave wave_getwind wave_run wave_runcold wave_save wave_setup wave_setup_3v wave_-
setup_4v wave_setup_an
```

Files removed(SCRIPTS):

```
wav/input_to_wam_bathymetry_global100 input_to_wam_bathymetry_global150 input_to_-
wam_bathymetry_global25 input_to_wam_bathymetry_global300 input_to_wam_bathymetry_-
global36 input_to_wam_bathymetry_global50 input_to_wam_bathymetry_global511 input_-
to_wam_bathymetry_medite10 input_to_wam_bathymetry_medite15 input_to_wam_bathymetry_-
medite25 preproc_input_global100 preproc_input_global150 preproc_input_global25 preproc_-
input_global300 preproc_input_global36 preproc_input_global50 preproc_input_global511
preproc_input_gm20 preproc_input_medite10 preproc_input_medite15 preproc_input_medite25
preproc_input_onegrdpt preproc_input_standrewbay preproc_input_swamp
```

Files modified(IFS):

```
module/yoewcou.F90
namelist/naephy.h
phys_ec/suwcou.F90 wvcouple.F90 wvwg2rg.F90
setup/su0phy.F90
utility/gstats_label_ifs.F90
```

Files new(WAM):

```
Alt/plot_rfl_file.F
Wam_oper/mpfldtoifs.F wvwaminit.F
```

Files modified(WAM):

```
Alt/Include/parameters.h alt_hist_prep.F coltro.F colura.F decplp.F expnl.F
i_get_unit.F make_progs.mk plotdat.F pltetr.F pltura.F trocol.F urabu5.F
uracol.F uraetr.F urapfs.F uraplt2.F uraqcm.F uraqes.F uraqmh.F uraqms.F
uraqrd.F uraqwf.F urasor.F
```

Buoy/make_progs.mk
Wam_oper/buildstress.F chief.F create_wam_bathymetry.F ctuw.F getinptb.F getspec.F getstress.F grb2wgrd.F gribpac.F initialint.F initmdl.F intwaminput.F mpdecomp.F mpuserin.F mubuf.F outbeta.F preproc.F preset.F readwind.F rfl4wam.F savspec.F uiprep.F userin.F wamassi.F wamodel.F wavemdl.F write_currents.F write_mpdecomp.F wvalloc.F
Wam_setup/extract_WAM_code
module/yowaltas.F yowcoup.F yowmap.F yowstat.F

Agathe Untch

New ozone chemistry (version 2.9)

Ozone chemistry code adapted for the new chemistry version 2.9 from D. Cariolle (Meteo-France). The old version can be switched back on by setting LO3CH_OLDVER= .TRUE. (in NAEPHY or in setup/su0phy.F90). Default LO3CH_OLDVER=.FALSE.

Files modified(IFS):
climate/updo3ch.F90
module/yoephy.F90
namelist/naephy.h
phys_ec/o3chem.F90
setup/su0phy.F90

Lars Isaksen and Drasko Vasiljevic

Fix for problems with American profilers

Files modified(IFS):
obs_preproc/ewprfin.F90

Elias Holm and Mats Hamrud

Optimization of conserving interpolation

The conserving interpolation has been recoded so that its cost is now negligible in comparison with other calculations in the trajectory. The optimized interpolation gives practically identical results, with differences only at the level of roundoff errors.

Files modified(IFS):
utility/grid_biconserv.F90

Peter Bechtold

Convection mods

Limit adjustment time scale to 720 s, instead of 450 s. This mod will be automatically become effective with the next resolution T1279.

Files modified(IFS):

`phys_ec/cumastrn.F90 cumastrnad.F90 cumastrntl.F90`

Peter Bechtold, Andrew Orr, Agathe Untch, Soumia Serrar

Full working package of an optimised version of the Warner-McIntyre Scinoccia non-orographic gravity wave scheme

Package can be activated by just setting LEGWWMS=.true.. It also works in assimilation mode.

If the GWD scheme is used switch off Rayleigh friction apart from Tropics, where a special formulation is retained to dampen waves reflected from model top

For computational reasons the scheme is called only every hour for resolutions >255 and every 2 hours for all lower resolutions. This required keeping tendencies in memory through a new family of GFL fields

Files created(IFS):

`module/yoegwwms.F90`

`phys_ec/gwdrag_wms.F90 sugwwms.F90`

Files modified(IFS):

`adiab/fspglh.F90 lattex.F90 lattex5.F90 lattexad.F90 lattextl.F90`
`module/parfpos.F90 yoephy.F90 yom_ygfl.F90 yomafn.F90`
`namelist/naephy.h namgfl.h`
`phys_ec/callpar.F90 cumastrn.F90 cumastrnad.F90 cumastrntl.F90 suphec.F90`
`pp_obs/pos.F90`
`setup/su0phy.F90 suafn1.F90 suafn2.F90 sudefo_gflattr.F90 sudim1.F90 sudyn_setgflattr.F90 sugfl.F90`

Mohamed Dahoui

Upgrades to SATMON

I have upgraded SATMON to allow :

1) Data selection according to new flags (”Obs passed FG check”, ”VarBC passive data” and ”scan dependent statistics for ATOVS obs”),

2) DMSP mode can now read data from ODB and BUFR feedback files,

3) The monitoring of ”All sky” microwave observations. It’s backward compatible. So to monitor ”Clear Sky” mwimg we need just to use L_ALLSKY key inside the option file.

4) Some modifications in the declarations and use of some variables

Files modified(OBSTAT):

`module/mod_sat_monitor.F90 mod_sat_common.F90 mod_sat_create_netcdf.F90, satmon/get_-mwimg_odb.F90 sat_create_netcdf.F90 sat_hist_plot.F90 sat_monitor.F90,`

Files new(ODB):

`ddl/smon_mwimg_allsky.sql`

Jan Haseler

GRIB_API tools

Convert GRIB manipulation from modify_grib to GRIB_API tools

Files modified(SCRIPTS):

`gen/coldstart_tiles getgrb_vareps getini getmars getpersSST lowres_fp ma_init mk abs_prepdata mkidta mkidta_eps mkidta_ocean sample_svs soilana ssaana sstana var data`

`oce/extrafields_create extrafields_veps_create ninoatmos`

`sms/pertinic.sms`

`sms_oc/extendrecodegrib.sms wmanom.sms`

`wav/prep_wave wave_getrst`

Migration to c1a

Mods for running on ibm_power6 architecture

Files created(SCRIPTS):

`build/arch/Makefile.in.c1a arch/Makefile.in.c1b arch/Makefile.in.ibm_power6`

Files modified(SCRIPTS):

`gen/blcomp getini getino3 ifsmin ifstraj ifstsave ma_init mkabs_aeolus mkabs_an mkabs_b2otools mkabs_fc mkabs_matools mkabs_mctools mkabs_obsproc mkabs_obstat mkabs_odbtools mkabs_prepdata mkabs_reanal mkabs_satmon mkabs_satrad mkabs_scat mkabs_ssa mkabs_wam mkgenlinks mkidta mkidta_eps mkidta_ocean mkidta_sens model modeleps odb_compress odbcomp odbf90 run_parallel satimsim smon_def soilana ssaana sstana`

`sms_an/black.sms`

`wav/prep_wave wave_getrst`

T1279 data assimilation

Files modified(SCRIPTS):

`def/an.def`

`sms/libs.sms`

`sms_an/ssaana.sms sst.sms`

Back-fixes to CY35R1 operational suite

Correct error in cold-start of VARBC. Fixes for OSTIA SST analysis. Don't delete binary versions of large rttov coefficient files. Date-dependent AIRS cloud-detection files

Files modified(IFS):

`control/cnt1.F90`

`var/svvarbc.F90`

Files modified(SCRIPTS):

`def/an.def`

```
gen/satimsim sstana varconsts
```

Files modified(SSA):

```
module/yomarrays.F90 yomsst.F90
namelist/namssa.h
sub/control_ssa.F90 ice_analysis.F90 inisst.F90 reg2gg_ci.F90 reg_to_gg.F90
util/alloc_mem.F90 field2array.F90
```