IFS MEMORANDUM

From: *Mats Hamrud et al.* Date: *Oct 16, 2006*

To: RD Scientific Staff and Consultants. File: R48.3/MH/0683

Copy: HR, HO, HMD, HMAS, HMOS, J.Hodkinson
Jean Pailleux, François Bouttier, Claude Fischer.

Subject: Cycle CY31R1

Cycle 31r1 was created in July 2006. It went into operations on the 12th of September. Cycle 31r1 is not a common cycle with Meteo France.

Perforce release: CY31R1

Modified libraries: ifs ifsaux trans obstat scripts prepdata odb wam

Contributors: T.Auligne, P.Bauer, P.Bechtold, A.Beljaars, A.Benedetti, N.Bormann, A.Dethof, M.Dragosavac, R.Engelen, J.Flemming, A.Geer, G.van der Grijn, M.Hamrud, J.Hague, J.Haseler, S.Healy, L.Isaksen, M.Janiskova, G.Kelly, M.Koehler, M.Leutbecher, P.Lopez, J.-J.Morcrette, G.Mozdzynski, A.Orr, D.Tan, A. Tompkins, D.Salmond, S.Saarinen, S.Serrar, T.Stockdale, N.Wedi.

Peter Bechtold and Philippe Lopez

- Implicit treatment of convective transport of dry static energy and humidity in a similar way to the implicit treatment of momentum and tracers (the latter being already available in Cy30R2).
- Assure positive humidity in model physics. Most modifications concern convection (downdraught tops, implicit). For the remaining negative values introduced also by other processes (diffusion, and SL physics=sltend.F90) the qnegat.F90 routine is now called at the end of callpar.F90. Also the minimum value of humidity is increased from 1.E-12 to 1.E-8. - bugfix in new CAPE computation introduced in Cy30r2
- Together with N. Wedi assure closed budgets (take into account contribution from sltend.F90 (saturation adjustment), and correctly take into account contribution from qnegat.F90
- Together with P. Lopez provide a first full but preliminar package of TL/AD for tracer transport in physics to be evaluated in later cycles.

Modified routines:

```
phys_ec/callpar.F90 callparad.F90 callpartl.F90 cuancape2.F90 cuascn.F90
cuascnad.F90 cuascntl.F90 cuascn2.F90 cuascn2ad.F90 cuascn2tl.F90
cucalln.F90 cucallnad.F90 cucallntl.F90 cucalln2.F90 cucalln2ad.F90
cucalln2tl.F90 cuddrafn2.F90 cuddrafn2ad.F90 cuddrafn2tl.F90 cudtdqn.F90
cudtdqnad.F90 cudtdqntl.F90 cududv.F90 cududvad.F90 cuflxn.F9 cuflxnad.F90
cuflxntl.F90 cumastrn.F90 cumastrnad.F90 cumastrntl.F90 cumastrn2.F90
cumastrn2ad.F90 cumastrn2tl.F90 sucond.F90 sucumf.F90 su0phy.F90 vdfdifc.F90
vdfdifcs.F90 vdfdifcsad.F90 vdfdifcstl.F90 vdfmains.F90 vdfmainsad.F90
vdfmainstl.F90

module/yoecumf.F90 yophnc.F90

namelist/namtrajp.h
```

David Tan

Aeolus Level-2B processor

The Aeolus Level-2B Processor is currently under development as a standalone processor. Its purpose is to generate wind component observations suitable for assimilation. Integration with IFS is envisaged during 2007/2008. In preparation for this, the source code resides in PerForce and scripts have been modified to incorporate it in cycle builds and in the compilation steps of research experiments.

Modified files(aeolus):

```
numerous, but no impact on any other code.
```

Modified files(scripts):

```
build/Makefile.root.aeolus Makefile.root.ifs

build/arch/Makefile.in.p690

def/gen.def
```

Sami Saarinen

As advertised in contributions to CY30R2, the number of updates in ODB has now been re-set back to 3 from 10 ($nmxupd in odb/ddl/cma.h). Due to changes in ODB/SQL compiler and to some SQL-files that depend on $nmxupd, it is possible just to change the value of $nmxupd in odb/ddl/cma.h, recompile ODB databases and run 4DVAR with different number of updates. However, the smallest value is 1 and the largest is 10.

The ODB/SQL compiler is now capable of coping with ENDA i.e. ENsemble Data Assimilation. This is a multidatabase experiment, where each member analysis and control are brought together afterwards into a single database for postprocessing. The small challenge was to let ODB to cope with new data columns (from member analyses) which were not part of the original control database i.e. change data layout of already existing database. As result we will now be able to run OBSTAT (observation statistics) by interrogating only a single database rather than many. Please note that it would be nearly impossible and perhaps a gross waste of resources to create a BUFR-feedback out of this extended control database.

The BUFR2ODB jobs can now create databases with more pools than the $NPES_AN would normally indicate. This makes processing of AIRS and HIRS data particular a little-bit less memory intensive. This change was possible after discovering and fixing a bug in I/O-method#4.

Furthermore, I/O in ODB has been improved through introduction of OpenMP loop over reading/writing ODB table data when using I/O-method#4. This can be activated via ODB_IO_OPENMP=1 (for all databases) or ODB_IO_OPEN_ECMA=1 for particular database (here: ECMA) only and running OpenMP-multithreaded MPI-job (like 4DVAR).

A new database layout called ODBCMP has been introduced, but resides in scripts/gen directory (ODBCMP.ddl) rather than under odb/ddl.ODBCMP. This enables a very effective compression with loss of accuracy for ECMA databases in order to be able archive them in the future. Some factor of 10 or more compression over ECMA has been experienced especially for satellite data making it a good candidate for superceding feedback BUFR, since they are often SMALLER than feedback BUFR! ECMWF interim re-analysis has been testing and using this new feature intensively.

In the IFSAUX a new module mpl_arg_mod.F90 (with mpl_getarg, mpl_iargc) has been introduced. Its purpose is to propagate command line arguments and Unix environment variables transparently from master MPI-task to slave tasks. At the same time Dr.Hook & MPL_INIT have been brought closer together so that if the main programs very first call is to DR_HOOK, then MPL_INIT and MPL_GETARG are also consulted. This modification makes it easier to run on such computer systems, where MPI-library by default does not propagate arguments nor environment variables.

In Dr.Hook more robust traceback (with line numbers!) for Linux machines has been introduced, which -- if required -- consults gdb-debugger, too. Also a Sun/Solaris port of Dr.Hook is in place. It uses Solaris pstack (and -- if required -- dbx to produce) traceback with line numbers.

At the same time abor1 was stream-lined and moved from IFS to IFSAUX. As result all control

of handling abnormal exits is taken care by Ryad El-Khatib's generic module sdl_module.F90 before Dr.Hook traceback is called.

ODB/SQL compiler will now also add Dr.Hook calls into generated C-code (disable by using odb98.x with -H option). This gives us much finer picture of how expensive/cheap ODB transactions are, with a minimal overhead.

ODB:

Please note that bufr2odb/odb2bufr has also other contributors e.g. Milan Dragosavac. Also, some files are mentioned twice despite they are in fact symbolic links.

Modified & new files:

```
odb/aux/bits.c cardinality.c cma_attach.c cma_close.c cma_flpcheck.c
cma_open.c cma_rewind.c cma_wrapup.c codb_netcdf.c dca.c ds.c fileutil.c
ioassign_read.c ioconcat.c iogetattr.c ioknowncmd.c iosetbuf.c iostrdup.c
magicwords.c memory.c newio.c odbi_client.c odbi_direct.c odbi_server.c
pcma.c pcma_1.c pcma_11to19.c pcma_2.c pcma_21to29.c pcma_255.c pcma_3.c
pcma_4.c pcma_5.c pcma_9.c swapbytes.c upcma.c vpack_bits.c
```

```
odb/bufr2odb/bufr2odb_aircraft.F90 bufr2odb_airs.F90 bufr2odb_atovs.F90
bufr2odb_grad.F90 bufr2odb_metar.F90 bufr2odb_msg.F90 bufr2odb_paob.F90
bufr2odb_qscat.F90 bufr2odb_reo3.F90 bufr2odb_satem.F90 bufr2odb_satob.F90
bufr2odb_scat.F90 bufr2odb_ssmi.F90 bufr2odb_synop.F90 bufr2odb_temp.F90
bufr2odb_windprofiler.F90 get_odb2bufr_varindex.F90 get_templateidx.F90
get_varindex.F90 odb2bufr_dep_001.F90 odb2bufr_dep_021.F90
odb2bufr_dep_054.F90 odb2bufr_dep_057.F90 odb2bufr_dep_065.F90
odb2bufr_dep_082.F90 odb2bufr_dep_089.F90 odb2bufr_dep_091.F90
odb2bufr_dep_101.F90 odb2bufr_dep_122.F90 odb2bufr_dep_127.F90
odb2bufr_dep_137.F90 odb2bufr_dep_142.F90 odb2bufr_dep_164.F90
odb2bufr_dep_189.F90 odb2bufr_dep_206.F90 odb2bufr_fos_001.F90
odb2bufr_fos_021.F90 odb2bufr_fos_065.F90 odb2bufr_fos_091.F90
odb2bufr_fos_101.F90 odb2bufr_fos_142.F90 odb2bufr_fos_164.F90
odb2bufr_qc_001.F90 odb2bufr_qc_021.F90 odb2bufr_qc_065.F90
odb2bufr_qc_142.F90 odb2bufr_qc_164.F90 odb2bufr_summary.F90
```

```
odb/cma2odb/buf2cmat_new.F90 ctxgetdb.F90 ctxinitdb.F90 get_rs_t_bias.F90
initmdb.F90 odbddr1.F90 odbddr2.F90 ref_time.F90 setup_obsort.F90
shuffle.F90 shuffle_odb.F90 shuffledb.F90 subuoctp.F90 update_obsdb.F90
xchangedatadb.F90
```

```
odb/compiler/cma_close.c cma_open.c cmaio.h copyfile.c defs.h fileutil.c
genc.c ioassign_read.c ioconcat.c iogetattr.c ioknowncmd.c iosetbuf.c
iostrdup.c iostuff.h lex.l list.c magicwords.c magicwords.h memory.c odb98.c
pcma_extern.h privpub.h regex.c swapbytes.c swapbytes.h tree.c yacc.y
```

odb/ddl/black_robhdr_8.sql cma.h discard_dep_2.sql fb_getupdate_1.sql
fb_getupdate_10.sql fb_getupdate_2.sql fb_getupdate_3.sql fb_getupdate_4.sql
fb_getupdate_5.sql fb_getupdate_6.sql fb_getupdate_7.sql fb_getupdate_8.sql
fb_getupdate_9.sql magicwords.h matchup_update_1.sql matchup_update_10.sql
matchup_update_2.sql matchup_update_3.sql matchup_update_4.sql
matchup_update_5.sql matchup_update_6.sql matchup_update_7.sql
matchup_update_8.sql matchup_update_9.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
obsortca_update_2.sql obsortca_update_3.sql obstat.sql obstat_reo3.sql
obstat_tovs.sql odb.h privpub.h robhdr.sql sensor.h swapbytes.h varno.h
vertco_type.h

odb/extras/ec/datecmd.h julian.h

odb/extras/emos/PBGroutines.c bupks.F buunp.F buunps.F fort2c.c
gbyte_alpha.h pbio.c

odb/extras/mpi_serial/mpi_abort.F

odb/include/bits.h cma_read.h cma_seek.h cma_write.h cmaio.h codb.h defs.h
fodb.h fodbutil.h idx.h iostuff.h magicwords.h nammatchup.h namsort.h odb.h
odbcs.h odbi.h pcma.h pcma_extern.h privpub.h setodbcs.h static.h swapbytes.h

odb/interface/ref_time.h update_obsdb.h

odb/lib/Bexit.F90 Dummies.c Magics_dummy.F90 ae_dump.c codb.c
codb_truename.c cread_iomap.c create_iomap.F90 ctx.c errtrap.c forfunc.c
fwrite_iomap.F90 infile.c msgpass_obsdata.F90 orlist.c prt.c rsort32_odb.c
savelist.c tracing.c twindow.c vecloops.c version.c wildcard.c

odb/module/bufr_module.F90 getval_module.F90 init_module.F90 odb.F90
odb2bufr_varindex_module.F90 odb_module.F90 odbaccess_module.F90
odbiomap.F90 odbmp.F90 odbnetcdf.F90 odbprint.F90 odbshared.F90 odbutil.F90
varindex_module.F90 yomboctp.F90

odb/scripts/Fortran90_stuff.pm askodb bufr2odb configure configure_drhook
create_ioassign create_odbglue create_static_stubb dcafix dcagen
drhook_ex.ksh drhook_ex2.F90 insert_drhook make.altix_mpi make.amd64
make.amd64_shlib make.decalpha make.hppa make.ia32 make.ia64 make.ia64_icc
make.ia64_no_motif make.ia64_plain make.ibm_power4 make.ifort32 make.linux
make.linux32 make.linux_gprof make.linux_mpich make.linux_nag
make.linux_no_openmp make.linux_shlib make.linuxg95 make.rs6000 make.sgimips
make.sgimips_openmp make.vpp5000 make_depend make_fclibs make_install
make_lib make_shlib make_tarball make_tarball_drhook mpif.h mpif.h.mpich-
1.2.5.2 mpirun.ibm mpirun.linux newodb obstat_odb odb2grads odb2mysql
odb2mysql_api odb2netcdf odb_compress odbcc odbclean odbcomp odbdiff odbdup
odbf90 odbf90mp odbshuffle odbviewer odbxyplot simulobs2odb start_server
use_odb use_odb.sh xvi

odb/tools/Bufr2odb.F90 Fbnew2old.F90 Mpi_scheduler.F90 Mrfscopy.F90
Odb2bufr.F90 Odb2grads.F90 Odb2mysql.F90 Odb2mysql_api.F90 Odb2netcdf.F90
Odb_compress.F90 Odbdiff.F90 Odbtools.F90 Plotobs.F90 Ps_bias_correction.F90
Simulobs2odb.F90 Viewer.F90 b4.c bufr_check.F bufr_split.F conv_le2be.c
dcagen.c dd2ddl.c dtfilt.c hcat.c ioassign.c mr2d_create.c mr2d_split.c
numproducts.c odbcksum.c odbi_direct_main.c odbi_server_main.c pcma_main.c
scheduler.c typebits.c xldummy.c

IFSAUX:

Modified & new files:

```
ifsaux/grib_io/splitgrib.F

ifsaux/include/drhook.h

ifsaux/module/distio.F90 mpl_buffer_method_mod.F90 mpl_data_module.F90
mpl_end_mod.F90 mpl_init_mod.F90 mpl_module.F90 sdl_module.F90 yomoml.F90

ifsaux/support/cdrhookinit.F90 cmpl_binding.F90 cptime.F crc.c
dr_hook_util.F90 drhook.c endian.c get_opt.F timef.F

ifsaux/utilities/ecqsort.c gentrbk.F90 getcurheap.c rsort32.c rsort64.c
```

SCRIPTS:

Modified files:

```
scripts/build/perl/depend.pl

scripts/def/an.def

scripts/gen/archive_obs bufr2odb dcagen fdbksave ifstraj matchup mergeodb
mkabs_odbtools mkabs_satrad odb2bufr odbcomp odbshuffle prescat revmatchup
run_parallel

scripts/sms_an/4dvar.sms create_ccma ifsmin.sms ifstraj.sms matchup.sms
mergeodb.sms recreate_ccma.sms revmatchup.sms
```

New files:

```
scripts/gen/grpsize

gen/libsgen
```

Andrew Orr

Orography changes for CY31R1.

1) Use of an 'effective' mountain height to calculate gravity wave drag due to sub-grid scale orography (SSO).

2) Introduction of a turbulent orographic form drag (TOFD) scheme (Beljaars et al. 2004) and a revised vegetative roughness length table. This replaces the effective roughness length scheme (EFRL), whereby the vegetative roughness length was enhanced to represent the additional contribution from unresolved orography. The TOFD scheme directly parameterises turbulent orographic drag (i.e. drag from obstacles with sub-grid scales less than 5000 m) and distributes it vertically, allowing the vegetative roughness to be treated independently. The TOFD scheme uses the input surface field SDFOR (standard deviation of filtered orography) which is essentially the standard deviation of small-scale orography (i.e. horizontal scales less than 2 km and greater than 20 km have been removed).

Beljaars, A. C. M., A. R. Brown, and N. Wood, 'A new parameterization of turbulent

orographic form drag', Quart. J. Roy. Met. Soc., 130, pp 1327-1347, 2004.

3) Momentum tendencies computed by the TOFD scheme and the SSO gravity-wave drag scheme are computed in a joint implicit calculation. This introduces some degree of dependency as these processes are coupled, leading to a reduction in time step sensitivity of surface stress and gravity wave stress over orography.

Routines changed(IFS):

```
dia/wrmlfp.F90 wrmlfpl.F90

module/parfpos.F90 ptrgpd.F90 traj_const.F90 yomafn.F90 yomgrb.F90

namelist/namafn.h

phys_ec/callpar.F90 callparad.F90 callpartl.F90 ec_phys.F90 ec_phys_ad.F90
ec_phys_tl.F90 gwdrag.F90 gwdragad.F90 gwdragtl.F90 gwprofil.F90 gwsetup.F90
sugwd.F90 vdfdifm.F90 vdfincr.F90 vdfmain.F90 vdfmains.F90 vdfmainsad.F90
vdfmainstl.F90 vdfouter.F90 gwdrags.F90 vdftofdc.F90

pp_obs/hpos.F90 specfitg.F90

setup/suafn1.F90 suafn2.F90 suafn3.F90 sudim1.F90 sugpprp.F90 sugridg.F90
suphyds.F90
```

Scripts modified:

```
build/find_mk.ksh /build/perl/recursive_bins.pl

def/an.def eps_varfc.def fast_sgint getgrb getini inter_fp

gen/mknam_fp obstat satmon_getdat sstana

sms_an/sst.sms
```

Routines modified(SURF):

```
external/surfdeallo.F90 surfexcdriver.F90 surfexcdrivers.F90
surfexcdriversad.F90 surfexcdriverstl.F90

interface/surfexcdriver.h surfexcdrivers.h surfexcdriversad.h
surfexcdriverstl.h

module/surfexcdriver_ctl_mod.F90 surfexcdrivers_ctl_mod.F90
surfexcdriversad_ctl_mod.F90 surfexcdriverstl_ctl_mod.F90 susveg_mod.F90
vupdz0_mod.F90 yos_veg.F90
```

Anton Beljaars

1. Revision of the computation of wind gusts.

The wind gusts turned out to be unrealistic over orography and in the EPS with stochastic physics. The latter was due to a fundamental incompatibility between the gust computation and stochastic physics (also resulting in a strong time step dependence). The problem has been alleviated by using the friction velocity as computed in the vertical diffusion code for the gusts rather than recomputing the friction velocity from the wind profile. The new procedure turns out to be more resilient to stochastic physics. For details see "Gusts and stochastic physics" by

A. Beljaars (RD memo 9 March 2006, R/48.3/AB/0617, http://w3ec2.ecmwf.int/publications/library/do/references/list/8).

Modified routines:

```
ifs/phys_ec/callpar.F90 vdfmain.F90 vdfouter.F90
surf/external/surfpp.F90
surf/interface/surfpp.h
surf/module/sppgust_mod.F90 surfpp_ctl_mod.F90
```

2. Revised air/sea interaction.

Three new aspects of air/sea interaction have been introduced each of which can be activated by a namelist logical in NAEPHY: - Relative humidity at the ocean surface is reduced from 100% to 98% to account for salinity effects (LOOCSA, default: TRUE). - Cold skin layer parametrization (LOOCCO, default: FALSE). - Warm layer parametrization (LOOCWA, default: FALSE). The 98% relative humidity results in a slight reduction of the ocean latent heat flux. The cold skin and warm ocean layer schemes are not activated yet. The cold skin scheme is described in Beljaars (1997: "Air-sea interaction in the ECMWF model, ECMWF seminar proceedings on: Atmosphere-surface interaction, 8-12 September, 33-52). The warm layer parametrization provides a diurnal cycle of the skin temperature at low wind speeds and is described by Zeng and Beljaars (2005, A prognostic scheme of sea surface skin temperature for modeling and data assimilation, JGR, 32, L14605)

Modified routines:

```
ifs/climate/updclie.F90
ifs/module/yoephy.F90 ifs/namelist/naephy.h
ifs/phys_ec/suphec.F90
ifs/phys_ec/vdfdifh.F90 vdfmain.F9
ifs/setup/modgrin.F90 su0phy.F90
surf/external/surfpp.F90 susurf.F90
surf/interface/surfpp.h susurf.h
surf/module/surfexcdriver_ctl_mod.F90 surfpp_ctl_mod.F90 susurf_ctl_mod.F90
suvexc_mod.F90 vsurf_mod.F9 yos_exc.F90 voskin_mod.F90
```

Martin Köhler

Single-Column Model - now integrated within IFS

The single column model (SCM) version of the ECMWF-IFS was originally developed by Martin Miller and Alan Betts in the 1980ties. In this century it has evolved to become an easy to use tool (10min learning curve) to test all parameterized physics. This substantial upgrade further simplifies development by integrating the SCM within the perforce code base of the IFS. This enables researchers to test identical code (using compile.p in perforce) in the SCM and 3D IFS environments.

Technically, a new project SCMEC was created that includes all SCM unique code. The coupling code within the IFS was included within an if structure using the new logical LSCMEC (false for 3D IFS). The SCMEC code is excluded from standard compilations in perforce. Instead the SCM user links with a precompiled SCM library containing project SCMEC. A detailed documentation of the SCM is available on request by Martin Koehler.

Modified and added routines (IFS):

```
module/yomct0.F90 yomphyds.F90 yomdyn.F90

namelist/namct0.h namphyds.h namdyn.h phys_ec/callpar.F90 ec_phys.F90
vdfmain.F90

setup/suct0.F90 sulun.F90 sumpini.F90 suphyds.F90

utility/updtim.F90
```

Modified scripts (IFS):

```
sms/p4setup.F90
```

Added routines and scripts (SCMEC):

```
source/accum1c.F90 cnt1c.F90 cnt41c.F90 cntend.F90 cpdyn1c.F90 cpg1c.F90
gpcty1c.F90 gptf11c.F90 gptf21c.F90 gptfs1c.F90 handle_err_nc.F90
lacdyn1c.F90 lainor1c.F90 laitli1c.F90 laitqm1c.F90 laitri1c.F90
lapine1c.F90 larcin1c.F90 larmes1c.F90 lascaw1c.F90 master1c.F90
read_obs.F90 read_sst.F90 stepo1c.F90 su0yom1c.F90 su1c.F90 suallo1c.F90
suarg1c.F90 sud1c_nc.F90 sudim1c.F90 sudyn1c.F90 suecrad1c.F90
sugem1c_nc.F90 sugfl1c.F90 suinif1c_nc.F90 suinif21c_nc.F90 sup1c_nc.F90
suphec1c.F90 suphyds1c.F90 surip1c.F90 suvert1c.F90 varsetup1c_nc.F90
varwrite1c_nc.F90 wrtd1c.F90 wrtd1c_nc.F90 wrtp1c.F90 wrtp1c_nc.F90

dummy/abor1.F90 abort_surf_mod.F90 flush.F90 gstats.F90 sumpout.F90
updclidm.F90 updclie.F90 updclie_CO2.F90 updcpl.F90 updnuddm.F90 vdiv.F90
vexp.F90 vlog.F90 vrec.F90 yomhook.F90

include/nam1c.h

module/mpl_broadcast_mod.F90 mpl_module.F90 pardim.F90 pardim1c.F90
parrrtm.F90 parsrtm.F90 yomgc1c.F90 yomgf1c.F90 yomgp1c0.F90 yomgp1c1.F90
yomgp1c9.F90 yomgpd1c.F90 yomgt1c0.F90 yomgt1c1.F90 yomgt1c9.F90
yomlog1c.F90

scripts/check_inc_intfb.pl compile.i compile.p make_intfbl.1.pl gen/p4_mklib
build/Makefile.root.scmall build/perl/depend.pl
```

Tim Stockdale.

Bugfix to allow the coupler to work properly.

Routine modified(IFS):

```
setup/sumcc.F90
```

Thomas Auligne

New variables in prepIFS

SHELL variable NCS_CONFIG (default is set to 1 in ifstraj)
SMS variable NCS_CONFIG (default needs to be set to 1 in prepIFS).

New blacklist

Extra quality control tests for the window channels in the blacklist. ec:/stt/blacklists/black_ds2006011700_window_channels_qc

VarBC technical changes

* Bugfixes for the adaptive mode option (not active) in VarBC.

* Bugfixes for VarBC coldstart option from the mode of the departures.

* Namelist flag to force coldstart for individual channels in VarBC.

* Removed unecessary lines in taskobl/ad.

* Scan correction for SSMI.

* Fixes in the reading of the flag EXPERIMENTAL from the blacklist.

Modified routines(IFS):

```
control/cnt1.F90
module/yomvarbc.F90
namelist/namvarbc.h
obs_preproc/black.F90 fgchk.F90 upecma.F90
pp_obs/hop.F90 hopad.F90 hoptl.F90 hsatang.F90 radtrb.F90 radtrbad.F90
radtrbtl.F90 statpred.F90
var/csvarbc.F90 prvarbc.F90 suvarbc.F90 taskobad.F90 taskobtl.F90
```

Modified scripts:

```
def/an.def
gen/ifstraj
Description:
```

Niels Bormann, Peter Bauer, Milan Dragosavac, Sean Healy, Lars Isaksen, Graeme Kelly

Introduction of SSMIS, TMI, and AMSRE; preparation for Metop ATOVS; GPSRO through BUFR; bugfix in rttov/tl/ad

The modifications introduce SSMIS, TMI, AMSRE, and Metop ATOVS to the IFS, including the necessary bufr2odb, odb2bufr, and satmon changes. Quality control and blacklisting for these data still need to be fine-tuned for assimilation experiments. Correction of radiance biases for the three new instruments is through varbc - for TMI and AMSRE this is the only option. As part of the implementation, the routine getsatid has been rewritten to make it easier to introduce new satellites.

Also new are the bufr-route for GPSRO data and modifications how RO are passed through the system.

The above changes are entirely passive - the new data are switched off in 31r1.

A bug in our RTTOV implementation has also been fixed. The setup of the channel and polarisation indexing was inconsistent. This affects microwave instruments which require RTTOV to calculate a different number of polarisation states for different channels. Luckily, this has not been the case for any of the microwave instruments so far present in the system, but SSMIS data are affected.

Modified routines (IFS):

```
common/yomdb_defs.h yomdb_vars.h

module/yomlimb.F90 yomtvrad.F90 yomvarbc.F90

namelist/namsats.h namvarbc.h

obs_preproc/black.F90 defrun.F90 new_thinn.F90 ngenada.F90 upecma.F90

pp_obs/emis_ir.F90 emis_mw.F90 emis_mw_n.F90 gpscalc_alpha.F90
gpscalc_alphaad.F90 gpscalc_alphatl.F90 gpserf.F90 gpsro_ad.F90
gpsro_oberror.F90 gpsro_op.F90 gpsro_tl.F90 hretr.F90 hsatang.F90
rad1cemis.F90 rad1cobe.F90 radtr.F90 radtrad.F90 radtrtl.F90

var/csvarbc.F90 getsatid.F90 rtsetup.F90 sulimb.F90 surad.F90 suvarbc.F90
```

Modified routines (OBSTAT):

```
data/bufrcodes.cfg bufrodbcodes.cfg

module/globvar.F90 mod_sat_create_netcdf.F90 mod_sat_monitor.F90 obsdata.F90
statsoft.F90

satmon/get_mwimg_odb.F90 sat_geo_plot.F90 sat_hist_plot.F90 sat_hov_plot.F90
sat_monitor.F90

src/abor1.F90 bucoord.F90 buxtract.F90 iniglob.F90 inisoft.F90
inisoftarea.F90 inisoftdef.F90 inisoftstat.F90 mergesoft.F90 odbread.F90
odbscaling.F90 plothis.F90 plotrms.F90 plotrmsbias.F90 plotsoft.F90
prthard.F90 updsoft.F90 writesoft.F90
```

Modified files (ODB):

```
bufr2odb/bufr2odb_aircraft.F90  bufr2odb_airs.F90 bufr2odb_amsre.F90
bufr2odb_atovs.F90 bufr2odb_grad.F90 bufr2odb_iasi.F90 bufr2odb_metar.F90
bufr2odb_msg.F90 bufr2odb_paob.F90 bufr2odb_qscat.F90 bufr2odb_radio.F90
bufr2odb_reo3.F90 bufr2odb_satem.F90 bufr2odb_satob.F90 bufr2odb_scat.F90
bufr2odb_ssmi.F90 bufr2odb_ssmis.F90 bufr2odb_synop.F90 bufr2odb_temp.F90
bufr2odb_tmi.F90 bufr2odb_windprofiler.F90 get_odb2bufr_varindex.F90
get_templateidx.F90 get_varindex.F90 odb2bufr_dep_001.F90
odb2bufr_dep_021.F90 odb2bufr_dep_049.F90 odb2bufr_dep_054.F90
odb2bufr_dep_057.F90 odb2bufr_dep_059.F90 odb2bufr_dep_065.F90
odb2bufr_dep_082.F90 odb2bufr_dep_089.F90 odb2bufr_dep_091.F90
odb2bufr_dep_101.F90 odb2bufr_dep_110.F90 odb2bufr_dep_122.F90
odb2bufr_dep_127.F90 odb2bufr_dep_129.F90 odb2bufr_dep_137.F90
odb2bufr_dep_142.F90 odb2bufr_dep_164.F90 odb2bufr_dep_189.F90
odb2bufr_dep_206.F90 odb2bufr_dep_250.F90 odb2bufr_fos_001.F90
odb2bufr_fos_021.F90 odb2bufr_fos_049.F90 odb2bufr_fos_059.F90
odb2bufr_fos_065.F90 odb2bufr_fos_091.F90 odb2bufr_fos_101.F90
odb2bufr_fos_110.F90 odb2bufr_fos_129.F90 odb2bufr_fos_142.F90
odb2bufr_fos_164.F90 odb2bufr_fos_250.F90 odb2bufr_qc_001.F90
odb2bufr_qc_021.F90 odb2bufr_qc_049.F90 odb2bufr_qc_059.F90
odb2bufr_qc_065.F90 odb2bufr_qc_110.F90 odb2bufr_qc_129.F90
odb2bufr_qc_142.F90 odb2bufr_qc_164.F90 odb2bufr_qc_250.F90
odb2bufr_summary.F90

cma2odb/buf2cmat_new.F90 initmdb.F90 subuoctp.F90 update_obsdb.F90

ddl.CCMA/obstat_gpsro.sql obstat_gpsro.sql

ddl.ECMA/smon_mwimg.sql

ddl/black_robhdr_8.sql cma.h obstat_gpsro.sql obstat_tovs.sql robhdr.sql
sensor.h smon_mwimg.sql varno.h vertco_type.h

module/bufr_module.F90 getval_module.F90 init_module.F90
odb2bufr_varindex_module.F90 odbaccess_module.F90 varindex_module.F90
yomboctp.F90

tools/Bufr2odb.F90 Fbnew2old.F90 Odb2bufr.F90 bufr_split.F
```

Modified routine (REANAL):

```
Mon/obstat_timeseries.F90
```

Modified routines(SATRAD):

```
bias/getbias.F90 suadvar.F90

module/data_files.F90 mod_cparam.F90 param_1dvar.F90

pre_screen/bufr_screen_amsre.F90 bufr_screen_ssmi.F90 bufr_screen_ssmis.F90
bufr_screen_tmi.F90 screen_1c.F90

rtlimb/rtlimb_calc_pathcg_2d_ad.F90

rttov/rttov_calcemis_mw.F90 rttov_checkinput.F90 rttov_ec.F90
rttov_integrate.F90 rttov_parm_ec.F90 rttov_setupchan_ec.F90
rttov_setupindex_ec.F90 rttovad.F90 rttovtl.F90 rttvi.F90
```

Modified scripts:

```
def/an.def fc.def

gen/archive_obs  bufr2odb cleanodb cmaobs fdbksave fetchobs getbias getsmon
ifsmin ifstraj mergebufr mkabs_b2otools mkabs_satmon mkabs_satrad mklinks
obstat obstat_init p4_mklib preobs satmon_getdat satmon_monitor save_out smon
smon_clean smon_def smon_funcs varconsts

sms_an/b2o_amsre.sms b2o_gpsro.sms b2o_ssmis.sms b2o_tmi.sms o2b_amsre.sms
o2b_gpsro.sms o2b_ssmis.sms o2b_tmi.sms obstat_amsre.sms obstat_gpsro.sms
obstat_ssmis.sms obstat_tmi.sms

sms_era/get_obtime.sms obtime.sms obtime_amsre.sms obtime_gpsro.sms
obtime_ssmis.sms obtime_tmi.sms
```

Nils Wedi

Cleaning up the NH and callpar and sltend in preparation of the next update for NH with physics. Also contains a change in the NH initial data.

Modified routines(IFS):

```
adiab/gpmktend.F90

phys_ec/callpar.F90 cloudsc.F90 ec_phys.F90 ec_phys_drv.F90 ec_phys_tl.F90
sltend.F90 sltend1.F90 sltend2.F90

setup/suspecg.F90

utility/sualspa.F90
```

Marta Janiskova

Completion of splitting the surface and vertical diffusion parametrization schemes used by TL/ AD physics from those used in the full nonlinear model

- Obsolete TL/AD surface routines not corresponding anymore to any nonlinear routines were deleted.
- New TL and AD of surface routines can be activated using the logical switch LENOPERT=.false.The default for the moment is LENOPERT=.true., i.e. TL/AD routines are not called and perturbations of surface variables are put to zero.
- When using the default switch, results should only be affected marginally due to some optimization in the nonlinear code profitable for the TL and AD computations (e.g. removal of divisions).

Modified routines(IFS):

```
phys_ec/ vdfmainstl.F90 vdfmainsad.F90 suphli.F90

setup/ su0phy.F90

namelist/ namtrajp.h
```

Modified routines(SURF):

```
interface/ surfexcdriverstl.h surfexcdriversad.h
extrenal/ surfexcdriverstl.F90 surfexcdriverstl.F90
module/ surfexcdrivers_ctl_mod.F90 surfexcdriverstl_ctl_mod.F90
surfexcdriversad_ctl_mod.F90 vexcss_mod.F90
```

New routines(SURF):

```
module/ vexcsstl_mod.F90 vexcssad_mod.F90 vsurfs_mod.F90 vsurfstl_mod.F90
vsurfsad_mod.F90 vupdz0s_mod.F90 vupdz0stl_mod.F90 vupdz0sad_mod.F90
vevaps_mod.F90 vevapstl_mod.F90 vevapsad_mod.F90
```

Deleted routines(SURF):

```
module/ vexcstl_mod.F90 vexcsad_mod.F90 vsurftl_mod.F90 vsurfad_mod.F90
vupdz0tl_mod.F90 vupdz0ad_mod.F90 vevaptl_mod.F90 vevapad_mod.F90
```

Martin Leutbecher

This contribution makes sure that ensemble forecasts are bit-reproducible if the order of fields in singular vector files changes.

Deleted files:

```
ifs/dia/fitspec.F90
```

New files:

```
ifsaux/module/yomfitspec.F90
```

Modified files:

```
ifs/dia/pregrbenc.F90
prepdata/mc_tools/aev_norm.F90 te_norm.F90
prepdata/module/svgg.F90 svtools.F90
scripts/gen/mkabs_mctools
```

George Mozdzynski

Improve performance of gath_grid for large number of tasks.

Routines modified(TRANS):

```
module/gath_grid_ctl_mod.F90
```

Fix a bug in slcomm2 and slcomm2a, where array IPTA was allocated many times larger than was needed.

For T799 4D-Var (traj0) running on 256 tasks this over allocation was about 400 Mbytes for some tasks, where only 1 Mbyte was actually used.

Routines modified (IFS):

```
parallel/ slcomm.F90 slcomm1.F90 slcomm2.F90 slcomm2a.F90
```

Fix FPE in addbgs encountered while running T511 4D-Var with 256 tasks x 1 thread. Problem was due to use uninitialised NGPBLKS remnant.

Routine modifed (IFS):

```
var/suecges.F90
```

John Hague, Deborah Salmond, J.-J. Morcrette

Improved performance and bug-fix in srtm_vrtqdr

Modified routines:

```
ec_phys/srtm_spcvrt.F90 srtm_reftra.F90 srtm_vrtqdr.F90
```

Mats Hamrud

Extenended use of the high level IO in IFS (IOSTREAM)

The use of the IOSTREAM package in the IFS has been extended, particularely for the trajectory handling and in the computations of singular vectors. The timing statistics produced has been enhanced. The routine SUWAVEDI has been removed from the IFS and replaced by a new routine in the trans library, INI_SPEC_DIST.

Routines modified(IFS):

```
control/cnt0.F90
dia/pregrbenc.F90 wrmlfp.F90
module/iostream.F90 traj_main.F90 yomlcz.F90
parallel/read_spec.F90 write_spec.F90
setup/suarg.F90 sump.F90
sinvect/balanced_reduction.F90 cun2.F90 cun3.F90 nalan1.F90 nalan2.F90
rdtllcz.F90 su_subspace.F90 wrtllcz.F90
transform/trageo.F90 trageoad.F90
utility/mod_ini.F90 read_grid_traj.F90 write_grid_traj.F90
var/readvec.F90 suscal.F90
```

Routine deleted(IFS):

```
setup/suwavedi.F90
```

Routine modified(IFSAUX):

```
module/spectral_fields.F90
```

Routines modified(TRANS):

```
external/dist_spec.F90 gath_spec.F90 ini_spec_dist.F90

interface/dist_spec.h gath_spec.h ini_spec_dist.h

module/dist_grid_ctl_mod.F90 dist_spec_control_mod.F90
gath_spec_control_mod.F90 sump_trans_mod.F90 sump_trans_preleg_mod.F90
suwavedi_mod.F90

Scripts modified:

build/Makefile.root.ifs Makefile.root.ifsaux

build/arch/Makefile.in.hpce

gen/run_parallel
```

Security against observation locations north of the North Pole or south of the South Pole.

Routine modified:

```
obs_preproc/mkglobstab.F90
```

Increase some limits in FullPos

Routine modified:

```
module/parfpos.F90
```

Adrian Tompkins, Martin Koehler, Nils Wedi

Enhancement of the climate package, with upgrades for:

- parallel execution on the linux cluster
- offline execution with a new prepIFS "climplot" job
- comparisons against observational climatologies for e-suite validation
- validation of coupled model and EPS runs
- additional plot enhancements including polar projections

Script modified:

```
metview/climate_obs.met
```

Gerald Van der Grijn

Monitoring capability of GPS Radio Occultation data in SATMON.

Peter Bauer and Alan Geer

Rain assimilation changes

:- inclusion of 10m wind speed in 1D-Var control vector
- improved calculation of eigenvectors for 1D-Var preconditioning
- revised screening identifiers
- better screening of frozen precipitation
- SSM/I sensor dependent bias correction (the old one is mot very good because the same bias correction is applied to all sensors)

Modified routines(IFS)

```
common/yomdb_vars.h

module/paronedvar.F90 yom_ptr_ssmi.F90 yom_ssmi.F90 yomonedvar.F90

namelist/namonedvar.h

onedvar/onedvar_get_bias.F90 onedvar_obsop.F90 onedvar_obsop_grad.F90
onedvar_raintb.F90 onedvar_raintb_hlp.F90 onedvar_raintb_rcv.F90
onedvar_raintb_set.F90 onedvar_raintb_snd.F90 onedvar_screen.F90
onedvar_setup.F90 onedvar_simul.F90

phys_ec/ec_phys.F90

var/gp_ptr_ssmi.F90 gp_ssmi.F90 gp_ssmi_igp2obs.F90 gp_ssmi_iobs2gp.F90
gp_ssmi_inv.F90
```

Modified routines(IFSAUX)

```
minim/m1qn3_1dv.F m1qn3a_1dv.F mlis0_1dv.F
```

Modified routines(ODB)

```
cma2odb/initmdb.F90

ddl/cma.h robhdr_gp_get_ssmi.sql robhdr_gp_put_ssmi.sql tcwv.sql
```

Modified routines(SATRAD)

```
interface/rttov_setupindex.h

onedvar/onedvar_obsop_grad_rttov.F90 onedvar_obsop_rttov.F90
```

Modified scripts

```
gen/ifstraj mklinks p4_mklib varconsts
```

Jan Haseler

Script modifications.

New satellites:

```
def/an.def
```

```
gen/archive_obs, bufr2odb, cleanodb, fdbksave, fetchobs, getbias, getsmon,
ifsmin, ifstraj, mergebufr, mkabs_satmon, mkabs_satrad, mklinks, obstat,
obstat_init, preobs, satmon_getdat, satmon_monitor, smon, smon_clean,
smon_def, smon_funcs, varconsts
```

```
sms_an/b2o_amsre.sms, b2o_gpsro.sms, b2o_ssmis.sms, b2o_tmi.sms,
o2b_amsre.sms, o2b_gpsro.sms, o2b_ssmis.sms, o2b_tmi.sms, obstat_amsre.sms,
obstat_gpsro.sms, obstat_ssmis.sms, obstat_tmi.sms, sms_era/get_obtime.sms,
obtime.sms, obtime_amsre.sms, obtime_gpsro.sms, obtime_ssmis.sms,
obtime_tmi.sms
```

Satellite name structure:

```
gen/ifsmin, ifstraj
```

Rain assimilation:

```
gen/mklinks, varconsts
```

Variational bias correction:

```
gen/getini, ifstraj
```

Subgridscale orography:

```
gen/ansfc, fast_sgint, getgrb, getini, ifstraj, inter_fp, mknam_fp
```

Ozone:

```
gen/fetchobs
```

Mods for hpce:

```
build/arch/Makefile.in.hpce def/an.def gen/model, run_parallel sms/ifs.sms
sms_an/b2otools.sms
```

Build ancillary binaries at run-time:

```
def/an.def, eps_fc.def, eps_sv.def, eps_varfc.def, fc.def, sens.def, wam.def
gen/mkabs_prepdata sms/prepdata.sms
```

Limit number of simultaneous jobs on linux_cluster:

```
def/an.def
```

Reorganise libraries:

```
build/Makefile.root.ifs, Makefile.root.ifsaux
```

ODB:

```
build/Makefile.root.odbdummy, perl/depend.pl
```

```
def/an.def, fc.def
```

```
gen/ODBCMP.ddl, archive_obs, create_odbglue, cma2odb, dcagen, fdbksave,
grpsize, ifstraj, matchup, mergeodb, mkabs_odbtools, mkabs_satrad,
mkabs_scat, odb2bufr, odb_compress, odbclean, odbcomp, odbgunzip, odbgzip,
odbshuffle, p4_mklib, prescat, revmatchup, run_parallel, save_out
```

```
sms_an/4dvar.sms, create_ccma.sms, matchup.sms, mergeodb.sms,
odb_compress.sms, odbcmp_airs.sms, odbcmp_amsre.sms, odbcmp_amsua.sms,
odbcmp_amsub.sms, odbcmp_conv.sms, odbcmp_geos.sms, odbcmp_gpsro.sms,
odbcmp_hirs.sms, odbcmp_msu.sms, odbcmp_reo3.sms, odbcmp_satob.sms,
odbcmp_scatt.sms, odbcmp_ssmi.sms, odbcmp_ssmis.sms, odbcmp_ssu.sms,
odbcmp_tmi.sms, odbcmp_vtpr1.sms, odbcmp_vtpr2.sms, revmatchup.sms
```

Wave model:

```
gen/fdbksave, fetchobs, preobs sms_an/clean_an.sms wav/wam_input,
wave_getalt, wave_getsar, wave_getsda, wave_run, wave_save, wave_setup_3v,
wave_setup_4v
```

Aeolus:

build/Makefile.root.aeolus, Makefile.root.ifs, arch/Makefile.in.p690 def/gen.def gen/libsgen

Observation plotting:

```
gen/obstat
```

Satellite monitoring:

```
def/an.def gen/getsmon, mkabs_prepdata, mkabs_satmon, satmon_getdat,
satmon_monitor, smon, smon_clean, smon_def, smon_funcs sms/getae.sms sms_an/
smon.sms
```

VAREPS:

```
gen/getgrb_vareps, ifstraj, mkabs_mctools, mklinks, model, modeleps,
varconsts
```

```
sms/getiniLeg.sms, getssvs.sms, getvarepsdata.SMS, inidata.sms, intHtoL.sms
```

From MetApps:

```
gen/anil, ansfc, ifstraj, ma_get_ana, mkabs_b2otools, mkabs_satim,
mkidta_sens, model, preobs sms/pertinic.sms, targets.sms, wavesave.sms
```

```
sms_an/anml.sms, anpl.sms, obstat.sms
```

```
wav/wave_getalt, wave_setup, wave_setup_an
```

Compilation:

```
sms/p4setup.sms
```

Climate plots:

```
metview/climate_obs.met
```

Miscellaneous:

```
gen/coldstart_tiles, kproctoab
```

Remove obsolete tasks:

```
gen/cmaobs, makecma
```

Angela Benedetti, Antje Dethof, Richard Engelen, Johannes Flemming, Jean-Jacques Morcrette, Soumia Serrar

Introduction of GEMS variables into analysis and forecasting system.

Most of the code changes needed to include the various tracers for the GEMS project (greenhouse gases, reactive gases, aerosols) have been introduced in this cycle. The new variables make use of the already introduced generalisations for advective transport and interpolation to observation locations. Various other parts of the IFS code have now also been made more flexible to make it possible to include the various new tracers (e.g., model physics, observation operators, control vector and wavelet Jb). New routines have been introduced for the modelling of aerosol.

All the changes have been coded with switches that are off by default (LGHG, NGHG, LGRG, NGRG, LAERO, and NAERO).

Files modified (IFS):

```
adiab/cpedia.F90 postphy.F90

control/cdsta.F90 scan2mdm.F90 scan2mtl.F90

dia/pregrbenc.F90 wrmlfp.F90 wrmlfpl.F90

module/goms.F90 iostream.F90 pardimo.F90 parfpos.F90 ptrgpd.F90
traj_const.F90 trajectory.F90 yoephy.F90 yom_ygfl.F90 yomafn.F90 yomaneb.F90
yomcosjo.F90 yomgrb.F90 yomjg.F90 yommcc.F90 yomphyds.F90 yomtvrad.F90
yomvnmb.F90

namelist/naephy.h namafn.h namgfl.h

obs_preproc/defrun.F90 fgchk.F90 first.F90 gefger.F90 reo3sin.F90 sugoms.F90

parallel/gathergom.F90

phys_ec/callpar.F90 ec_phys.F90 sltend.F90 sucumf.F90 suecrad.F90

pp_obs/bgobs.F90 endpos.F90 endvpos.F90 hop.F90 hopad.F90 hoptl.F90 hpos.F90
hretr.F90 hvnmtlt.F90 pos.F90 ppobsa.F90 ppobsaad.F90 ppobsatl.F90
preint.F90 preintad.F90 preinttl.F90 radtr.F90 radtrad.F90 radtrcld.F90
radtrtl.F90 slintad.F90 specfitg.F90 vpos.F90

setup/cmoctmap.F90 modgrin.F90 su0phy.F90 suafn1.F90 suafn2.F90 suafn3.F90
sucmoctp.F90 sudim1.F90 sudim2.F90 sudyn.F90 sufpc.F90 sufpgrib.F90
sugfl.F90 sugpprp.F90 sugrib.F90 sugridf.F90 sugridg.F90 suphyds.F90
supp.F90 susc2b.F90 suvnmb.F90

utility/deallo.F90 jbtomodel.F90 prtgom.F90 subfgs.F90 updtim.F90
write_wavelet_initcv_grib.F90

var/estsig.F90 estsiga.F90 rdfpinc.F90 rtsetup.F90 suinfce.F90 sujb.F90
sujbwavelet.F90 surad.F90 suvarbc.F90 vec2gp.F90 writesd.F90
```

Files modified (ODB)

```
cma2odb/initddrs.F90

ddl/varno.h
```

Files modified (PREPDATA)

```
programs/timeint.F90
```

Files modified (SATRAD)

```
interface/rttvi.h

module/rtlimb_const.F90 rttov_const.F90

rttov/rttov_checkinput.F90 rttov_ec.F90 rttov_integrate_ad.F90 rttovad.F90
rttovcld.F90 rttovtl.F90 rttvi.F90
```

Files modified (SURF)

```
external/surf_inq.F90

interface/surf_inq.h

module/susveg_mod.F90
```

Files added (IFS):

```
climate/updcalsec.F90 updclie_CO2.F90

module/gems_profiles.F90 yoeaeratm.F90 yoeaermie.F90 yoeaerop.F90
yoeaersnk.F90 yoeaersrc.F90 yoedbug.F90 yomgems.F90 yommvo.F90

namelist/naeaer.h

phys_ec/aer_bdgtmss.F90 aer_bdgtmss_ad.F90 aer_bdgtmss_tl.F90 aer_clim.F90
aer_climg.F90 aer_climz.F90 aer_clist.F90 aer_dmso.F90 aer_drydep.F90
aer_drydep_ad.F90 aer_drydep_tl.F90 aer_negat.F90 aer_phy1.F90 aer_phy2.F90
aer_phy3.F90 aer_radon.F90 aer_scavbc.F90 aer_scavbc_ad.F90
aer_scavbc_tl.F90 aer_scavin.F90 aer_scavin_ad.F90 aer_scavin_tl.F90
aer_sdust.F90 aer_sdust_ad.F90 aer_sdust_tl.F90 aer_sedim.F90
aer_sedimnt.F90 aer_sedimnt_ad.F90 aer_sedimnt_tl.F90 aer_src.F90
aer_ssalt.F90 aer_ssalt_ad.F90 aer_ssalt_tl.F90 aer_tau2mixr.F90
aer_unit_conv.F90 rndecay.F90 su_aerop.F90 su_aerp.F90 su_aerw.F90

pp_obs/aerod_ad.F90 aerod_op.F90 aerod_tl.F90 aod_ad.F90 aod_op.F90
aod_tl.F90
```