

```

subroutine vaf(mobs,npar,iy,im,id,ih,exper,
2      idim,jdim,gscale,rmax,sdevfg,sdevob,
3      lunobs,lunfgs,lunana,lunref,
4      latm,lonm,dlat,dlon,clat,
5      lfgs,lref,maxiter,alpha,igcut,jgcut,lwin)
c
c +-----+
c + A simple analysis program for VAN +
c + 1. variable declaration +
c + 1.1 dimension +
c + 1.2 namelist +
c + 1.3 grid parameters +
c + 1.4 observational data fields +
c + 1.5 observations selected for analysis +
c + 1.6 information about rejected data +
c + 1.7 covariance matrix fields +
c + 1.8 administrative parameters +
c + 2. derived parameters +
c + 3. write input parameters (namelist) +
c + 4. open input and output files +
c + 4.1 observation file +
c + 4.2 references file +
c + 4.3 firstguess file +
c + 4.4 result file +
c + 5. read and (gross) check observations +
c + 6. analysis loop over all parameters +
c + 6.1 read firstguess +
c + 6.2 read references +
c + 6.3 VAN +
c + 6.3.1 select influencing observations +
c + 6.3.2 construct (only) covariance matrix +
c + 6.3.3 use fgs as ana before at iter=0 +
c + 6.3.4 background innovation vector +
c + 6.3.5 initialize Z +
c + 6.3.6 transform Z to observation locations +
c + 6.3.7 calculation innovation vector +
c + 6.3.8 cost function gradient for observation grad(Jo) +
c + 6.3.9 cost function gradient for background grad(Jb) +
c + 6.3.10 cost function gradient grad=grad(Jo)+grad(Jb) +
c + 6.3.11 minimization step +
c + 6.3.12 transform from Z to X +
c + 7. derived variables +
c + 8. statistics +
c + 9. store analyses and observations +
c + 10. close obs, ana and chk files +
c + end of the analysis +
c + A1. write format +
c +-----+
c 1 +-----+ variable declaration =
implicit none
c 1.1 +-----+ dimension -
integer mobs,npar,idim,jdim,nhor
c 1.2 +-----+ namelist -
integer iy,im,id,ih
integer maxiter(npar),igcut,jgcut
real latm,lonm,dlat,dlon,rmax,alpha(npar)
real gscale(npar),sdevfg(npar),sdevob(npar)
character exper*3
logical lfgs,lref,lwin
c 1.3 +-----+ grid -
integer iana,jana
real lats,lonw,dlatfgs,dlonfgs,dlatref,dlonref
real refrms
real ana(idim,jdim),fgs(idim,jdim),ref(idim,jdim)
real p_ana(idim,jdim),t_ana(idim,jdim),u_ana(idim,jdim)
real v_ana(idim,jdim),d_ana(idim,jdim)
real zana(idim,jdim)
real grad_o(idim,jdim),grad_b(idim,jdim),grad(idim,jdim)
real zgrad_o(idim,jdim)
c 1.4 +-----+ observational data fields -
integer nobs,iiiobs(mobs),nrobs(mobs),flgobs(mobs,npar)
real oriobs(mobs,npar),latobs(mobs),lonobs(mobs)
character filmn*12
c 1.5 +-----+ observations selected for analysis -
integer nana,iiival(mobs),nrval(mobs)
real latval(mobs),lonval(mobs),valobs(mobs),valmean
real valfgs(mobs),valinn(mobs),valana(mobs)
real valinb(mobs)
c 1.6 +-----+ information about rejected data -
integer nskip,lskip(mobs),flag(mobs),dev(mobs)
logical skip(mobs)
c 1.7 +-----+ filter coefficients -
real g(-igcut:igcut,-jgcut:jgcut)
c 1.8 +-----+ administrative parameters -
real lat,lon,cos,jo,jb
integer i,j,k,il,i2,iter
integer ipar,ios
integer lunobs,lunfgs,lunana,lunref
real clat ! cos(lat)=111111.1111
c 2 +-----+ default values =
nhor=idim*jdim
c 3 +-----+ write some input parameters =
c
c added by Mingjing
c +-----+ initialize observation data
do j=1,npar
do i=1,mobs
flgobs(i,j)=0
enddo
enddo
c +-----+

```

```

write(6,1001)
write(6,'(2a)') exp : ',exper
write(6,'(a,4(1x,i2.2))') date:',iy-1900,im,id,ih
write(6,1001)
write(6,*) parameter pressure temperature
write(6,1002)
write(6,*) sdev of fg ',sdevfg
write(6,*) sdev of obs ',sdevob
write(6,*) Gaussian parameters ',gscale
write(6,1001)
c 4 +-----+ open input and output files =
c 4.1 +-----+ observation file -
write(filnm(1:12),'(4i2.2,a4)') mod(iy,100),im,id,ih,'.obs'
open(lunobs,file=filnm,iostat=ios,status='old')
c 4.2 +-----+ firstguess file -
if(lref) then
write(filnm(1:12),'(4i2.2,a4)') mod(iy,100),im,id,ih,'.ref'
open(lunref,file=filnm,iostat=ios,status='old')
read(lunref,*) iana,jana,lats,lonw,dlatref,dlonref
if(dlatref.ne.dlat.or.dlonref.ne.dlon) then
write(6,*) 'from ref, dlon and dlat = ',dlonref,dlatref
write(6,*) 'namelist, dlon and dlat = ',dlon,dlat
stop
endif
endif
c 4.3 +-----+ firstguess file -
if(lfgs) then
write(filnm(1:12),'(4i2.2,a4)') mod(iy,100),im,id,ih,'.fgs'
open(lunfgs,file=filnm,iostat=ios,status='old')
read(lunfgs,*) iana,jana,lats,lonw,dlatfgs,dlonfgs
if(dlatfgs.ne.dlat.or.dlonfgs.ne.dlon) then
write(6,*) 'from fgs, dlon and dlat = ',dlonfgs,dlatfgs
write(6,*) 'namelist, dlon and dlat = ',dlon,dlat
stop
endif
endif
c 4.4 +-----+ result file -
write(filnm(1:12),'(4i2.2,a3)') mod(iy,100),im,id,ih,'.',exper
open(lunana,file=filnm,iostat=ios,status='unknown')
c 5 +-----+ read and (gross) check observations =
call getobs(lunobs,npar,mobs,nobs,
+ iiiobs,nrobs,latobs,lonobs,oriobs,flgobs)
c 6 +-----+ analysis loop over all parameters =
do ipar=1,2
c 6.1 +-----+ read firstguess -
if(lfgs) call getfld(idim,jdim,fgs,lunfgs)
c 6.2 +-----+ read firstguess -
if(lref) call getfld(idim,jdim,ref,lunref)
c 6.3 +-----+ VAF analysis -
write(6,*) 'VAF: Variational Analysis using a Filter'
c 6.3.1 +-----+ select influencing observations .
call choose_box(1,idim,jdim,0,0,
+ iiiobs,latobs,lonobs,oriobs(1,ipar),
+ nrobs,nobs,latm,lonm,dlat,dlon,rmax,mobs,1,
+ iiival,nrval,latval,lonval,valobs,nana)
write(6,*) 'selected obs : ',nana
c 6.3.2 +-----+ construct (only) covariance matrix .
call gfini(igcut,jgcut,g,
+ latm,dlat,dlon,clat,sdevfg(ipar),gscale(ipar),lwin)
c 6.3.3 +-----+ use fgs as ana before at iter=0 .
write(6,*) 'ana=fgs'
if(.not.lfgs)
1 call avefgs(idim*jdim,fgs,mobs,npar,oriobs,nrobs,ipar)
call hcpa2b(idim*jdim,fgs,ana)
if( lref ) then
call hrms(idim*jdim,ana,ref,refrms)
iter=0
chans write(6,*)'iter = ',iter,' rms = ',refrms
write(6,*)iter,refrms
endif
c 6.3.4 +-----+ background innovation vector .
call H(idim,jdim,nana,latval,lonval,
+ latm,lonm,dlat,dlon,ana,valana)
do i=1,nana
valinb(i) = valana(i)-valobs(i)
enddo
c 6.3.5 +-----+ initialize Z .
call hseta2c(idim*jdim,zana,0.)
c +-----+ loop for minimization iterations .
do iter = 1,maxiter(ipar)
c 6.3.6 +-----+ transform zana to observation locations (Hx) .
call GF(idim,jdim,zana,ana,igcut,jgcut,g)
call H(idim,jdim,nana,latval,lonval,
+ latm,lonm,dlat,dlon,ana,valana)
c 6.3.7 +-----+ calculate inc innovation vector .
do i=1,nana
valinn(i) = valana(i)+valinb(i)
enddo
c 6.3.8 +-----+ cost function gradient for observation grad(Jo) .
call hab2c(1,nana,1,valinn,valinn,jo)
jo = jo / (2.*sdevob(ipar)*sdevob(ipar))
do i=1,nana
valinn(i) = valinn(i) / (sdevob(ipar)*sdevob(ipar))
enddo
call hseta2c(idim*jdim,zgrad_o,0.)
call H_ad(idim,jdim,nana,latval,lonval,
+ latm,lonm,dlat,dlon,zgrad_o,valinn)
call GF(idim,jdim,zgrad_o,grad_o,igcut,jgcut,g)

```

```

c 6.3.9 ..... cost function gradient for background grad(Jb) .
  call GF(idim,jdim,zana,grad_b,igcut,jgcut,g)
  call hab2c(1,nhor,1,zana,grad_b,jb)
  jb = jb/2.
c 6.3.10 ..... cost function gradient grad=grad(Jo)+grad(Jb) .
  do i=1,idim
  do j=1,jdim
    grad(i,j)=grad_b(i,j) + grad_o(i,j)
  enddo
  enddo
c 6.3.11 ..... minimization step .
  call stemin(nhor,zana,grad,alpha(ipar))
  if( .not.lref )
  1   write(6,'(a,i5,a,3e12.5)')
  2   'iter = ',iter, '   jb,jo,j= ',jb,jo,jb+jo
c 6.3.12 ..... transform from zana to ana.
  if( lref .or. iter.eq.maxiter(ipar) ) then
    call GF(idim,jdim,zana,ana,igcut,jgcut,g)
    do i=1,idim
    do j=1,jdim
      ana(i,j)=fgs(i,j)+ana(i,j)
    enddo
    enddo
    if(ipar.eq.1) then
      call hcpa2b(idim*jdim,ana,p_ana)
    else
      call hcpa2b(idim*jdim,ana,t_ana)
    endif
    if( lref ) then
      call hrms(idim*jdim,ana,ref,refrms)
chans write(6,*)'iter = ',iter,' rms = ',refrms
    endif
  endif
  enddo ! end of iteration loop
  enddo ! end of parameter loop
c 7  ===== derived variables =
  call derivf(t_ana,p_ana,
+    u_ana,v_ana,d_ana,idim,jdim,latm,clat,dlat)
c 8  ===== statistics =
  write(6,*)' statistics : '
  call stasis(' p min/max = ',idim,jdim,p_ana)
  call stasis(' t min/max = ',idim,jdim,t_ana)
  call stasis(' u min/max = ',idim,jdim,u_ana)
  call stasis(' v min/max = ',idim,jdim,v_ana)
  call stasis(' dyn min/max = ',idim,jdim,d_ana)
  write(6,1001)
c 9  ===== store the analyses and observations =
  write(lunana,'(2i4,4f10.4)')idim,jdim,
+    latm-jdim/2*dlat,lonm-idim/2*dlon,dlat,dlon
  call putfld('p',lunana,idim,jdim,p_ana,idim,jdim)
  call putfld('t',lunana,idim,jdim,t_ana,idim,jdim)
cc  call putfld('u',lunana,idim,jdim,u_ana,idim,jdim)
cc  call putfld('v',lunana,idim,jdim,v_ana,idim,jdim)
  call putobs('obs',mobs,npar,nobs,lunana,
x    iiiobs,latobs,lonobs,oriobs,flgobs)
c 10 ===== close obs, ana and chk files =
  close(lunobs)
  close(lunfgs)
  close(lunana)
  close(lunref)
c  ===== end of the analysis =
  write(6,*)'analysis finished without any error!'
  write(6,1001)
  return
c A1 ===== formats =
1001 format("=====")
1002 format("-----")
6211 format(1x,a,20(/,2x,10i7))
6212 format(1x,a,20(/,2x,10f7.1))
  end

```