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EVACC, LHACC, SHACC in catchment.F90 (current develop branch)

At end of subroutine catchment()

```
EVAPX1=ETURB1(N)+DEDQA1(N)*(QA1(N)-QA1_ORIG(N))
EVAPX2=ETURB2(N)+DEDQA2(N)*(QA2(N)-QA2_ORIG(N))
EVAPX4=ETURB4(N)+DEDQA4(N)*(QA4(N)-QA4_ORIG(N))
EVAPXS=ETURBS(N)+DEDQAS(N)*DQSS(N)*(TPSN1(N)-TCS_ORIG(N))
EVACC(N)=          (1.-ASNOW0(N))*                                    &
                 ( AR1(N)*EVAPX1+                                     &
                   AR2(N)*EVAPX2+                                     &
                   AR4(N)*EVAPX4 )                                    &
               +   ASNOW0(N)*EVAPXS
EVACC(N)=EVAP(N)-EVACC(N)                    ! = SPWATR

LHACC(N)=   ALHE*(1.-ASNOW0(N))*                              &
         ( AR1(N)*EVAPX1+                                        &
           AR2(N)*EVAPX2+                                        &
           AR4(N)*EVAPX4 )                                       &
         + ALHS*ASNOW0(N)*EVAPXS
LHACC(N)=HLATN(N)-LHACC(N)

SHFLUXX1=HSTURB1(N)+DHSDTC1(N)*(TC1(N)-TC1_ORIG(N))
SHFLUXX2=HSTURB2(N)+DHSDTC2(N)*(TC2(N)-TC2_ORIG(N))
SHFLUXX4=HSTURB4(N)+DHSDTC4(N)*(TC4(N)-TC4_ORIG(N))
SHFLUXXS=HSTURBS(N)+DHSDTCS(N)*(TPSN1(N)-TCS_ORIG(N))
SHACC(N)=           (1.-ASNOW0(N))*                                  &
                  ( AR1(N)*SHFLUXX1+                                 &
                    AR2(N)*SHFLUXX2+                                 &
                    AR4(N)*SHFLUXX4 )                                &
                + ASNOW0(N)*SHFLUXXS
SHACC(N)=SHFLUX(N)-SHACC(N)                  ! = SPLAND
```

[EV,LH,SH]ACC are diagnosed as: (flux computed by Catchment) MINUS (flux expected by atmosphere/turb)

HSNACC in catchment.F90

Before call to StieglizSnow() in subroutine catchment()

```
        HSNACC(N)=0.

       CALL ENERGY[1,2,4]( .. , HSNACC[1,2,4])        ! should return HSNACC[1,2,4]=0, see fluxes()
```

After call to StieglizSnow() in subroutine catchment()

```
         HSNACC(N) = HSNACC(N) + (1.-ASNOW(N))*                                  &
              (HSNACC1(N)*AR1(N)+HSNACC2(N)*AR2(N)+HSNACC4(N)*AR4(N))            &
             + hcorr
```

! now HSNACC=hcorr from StieglitzSnow()

```
!**** 2. UPDATE SURFACE TEMPERATURE

         DTC1SN=((-(FH31W/(area(1)+1.e-20))-HFTDS1(N))*DTSTEP/CSOIL(N))/         &
                   (1.+DHFT1(N)*DTSTEP/CSOIL(N))
         DTC2SN=((-(FH31I/(area(2)+1.e-20))-HFTDS2(N))*DTSTEP/CSOIL(N))/         &
                   (1.+DHFT2(N)*DTSTEP/CSOIL(N))
         DTC4SN=((-(FH31D/(area(3)+1.e-20))-HFTDS4(N))*DTSTEP/CSOIL(N))/         &
                   (1.+DHFT4(N)*DTSTEP/CSOIL(N))

         TC1SN=TC1(N)+DTC1SN
         IF((TC1SN-TPSNB(N))*(TC1(N)-TPSNB(N)) .LT. 0.) THEN
           HSNACC(N)=HSNACC(N)+AREASC*AREA(1)*                                   &
                  (TC1SN-TPSNB(N))*CSOIL(N)/DTSTEP
           TC1SN=TPSNB(N)
           ENDIF

         TC2SN=TC2(N)+DTC2SN
         IF((TC2SN-TPSNB(N))*(TC2(N)-TPSNB(N)) .LT. 0.) THEN
           HSNACC(N)=HSNACC(N)+AREASC*AREA(2)*                                   &
                  (TC2SN-TPSNB(N))*CSOIL(N)/DTSTEP
           TC2SN=TPSNB(N)
           ENDIF

         TC4SN=TC4(N)+DTC4SN
         IF((TC4SN-TPSNB(N))*(TC4(N)-TPSNB(N)) .LT. 0.) THEN
           HSNACC(N)=HSNACC(N)+AREASC*AREA(3)*                                   &
                  (TC4SN-TPSNB(N))*CSOIL(N)/DTSTEP
           TC4SN=TPSNB(N)
           ENDIF
```

! now HSNACC = (hcorr from StieglitzSnow()) + (contribution from surf temp update)

SP[*] and [*]ACC in GEOS_CatchGridComp.F90 (current develop branch)

after call to catchment()

Offline only:

```
EVACC = 0.0
SHACC = 0.0
```

AGCM only:

```
HLATN = HLATN - LHACC
SUMEV = EVPICE+EVPSOI+EVPVEG+EVPINT
where(SUMEV>0.)
   EVPICE = EVPICE - EVACC*EVPICE/SUMEV
   EVPSOI = EVPSOI - EVACC*EVPSOI/SUMEV
   EVPINT = EVPINT - EVACC*EVPINT/SUMEV
   EVPVEG = EVPVEG - EVACC*EVPVEG/SUMEV
endwhere
```

```
EVLAND = EVAPOUT-EVACC
LHLAND = HLATN
SHLAND = SHOUT  -SHACC

SPLAND = SHACC
SPWATR = EVACC

SPSNOW = HSNACC
```

In other words:

AGCM: **[EV,LH,SH]LAND = flux expected by atmosphere/turb**
SP[LAND,WATR] = flux computed by Catchment MINUS flux expected by atmosphere/turb
Based on plots: EVACC~0 where SUMEV>0
➔ SUMEVP ~ LHLAND + LHACC = flux computed by Catchment
(only approximately true)

Offline: **[EV,LH,SH]LAND = flux computed by Catchment**
SP[LAND,WATR] = 0
SUMEVP = LHLAND = flux computed by Catchment (by construction)
LHACC = n/a

Proposed changes

1) For clarity, rename/add export variables as follows:

```
Existing short & long names                    → Proposed short & long names
-------------------------------------------------------------------------------------------------------
SPLAND  ! rate of spurious energy source land  → SPSHLAND  ! spurious sensible heat flux land  [W m-2]
SPWATR  ! rate of spurious water source land   → SPEVLAND  ! spurious evaporation flux land    [kg m-2 s-1]
LHACC   ! [n/a]                                → SPLHLAND  ! spurious latent heat flux land    [W m-2]
SPSNOW  ! rate_of_spurious_snow_energy         → SPSNLAND  ! spurious_snow_energy_flux_land    [W m-2]
```

2) Change GEOS_CatchGridComp.F90 as follows (changes in yellow highlighting):

after call to catchment()

Offline only:

```
EVACC = 0.0
SHACC = 0.0
LHACC = 0.0
```

AGCM and offline (for simplicity, but may result in roundoff diffs for offline LHLAND & EVP[*] output; restore "if AGCM" statements if needed):

```
SUMEV = EVPICE+EVPSOI+EVPVEG+EVPINT
where(SUMEV/=0.)                                  ! add residual for evap and dewfall
    EVPICE = EVPICE - EVACC*EVPICE/SUMEV
    EVPSOI = EVPSOI - EVACC*EVPSOI/SUMEV
    EVPINT = EVPINT - EVACC*EVPINT/SUMEV
    EVPVEG = EVPVEG - EVACC*EVPVEG/SUMEV
elsewhere                                         ! also add residual when SUMEV=0.
    EVPICE = EVPICE - EVACC*ASNOW
    EVPSOI = EVPSOI - EVACC*(1.-ASNOW)            ! add residual to soil evap only
endwhere
```

[alternatively, could just apply the "elsewhere" block to all tiles]

```
EVLAND = EVAPOUT-EVACC
LHLAND = HLATN  -LHACC
SHLAND = SHOUT  -SHACC

SPLAND = SHACC
SPWATR = EVACC
SPLH   = LHACC                                    ! new output, see above

SPSNOW = HSNACC
```

Does this ensure SUMEVP=LHLAND in AGCM and offline??

If yes, does adding SPLHLAND to the land energy balance in the AGCM yield closure??