Offline set-up for radiative forcing calculations, and AeroCom diagnostics

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radiation.F90, schematic SW call structure:

```
#ifdef AEROFFL    ! for calculation of DRF and IndRF


! Call SW radiation code with NorESM optics but std. CCSM4 cloud droplet scheme
        call radcswmx(lchnk, &
          ... cliqwp,      rel,   ... fsnt_drf,      &
          ... per_tau,     per_tau_w,  per_tau_w_g, per_tau_w_f              )

! Call of SW radiation code with NorESM cloud droplet scheme (1.AIE & 2.AIE) but
! std. CCSM4 aerosol optics
        call radcswmx(lchnk, &
          ... cliqwx,      relca, ... fsnt_aie,      &
          ... aer_tau,     aer_tau_w,  aer_tau_w_g, aer_tau_w_f          )

!   Last call of SW radiation code with std. CCSM4 aerosol optics and cloud
!   droplet properies
        call radcswmx(lchnk, &
          ... cliqwp,      rel, ... fsnt,       &
          ... aer_tau,     aer_tau_w,  aer_tau_w_g, aer_tau_w_f              )
```

$DRF = (fsnt\_drf - fsnt)_{PD} - (fsnt\_drf - fsnt)_{PI}$

$IndRF = (fsnt\_aie - fsnt)_{PD} - (fsnt\_aie - fsnt)_{PI}$

Same meteorology!

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```
#else   ! ONLINE simulations, no separate aerosol radiative forcing calculations

! Call SW radiation code with NorESM optics and cloud droplet scheme
        call radcswmx(lchnk, &
        ... cliqwp,       relca, ... fsnt,      &
        ... per_tau,     per_tau_w,  per_tau_w_g, per_tau_w_f              )

#endif
```

… and similar for the LW calls, but only for IndRF (one extra call), using

NorESM vs. CCSM4 cloud emissivity (emisx vs. emis) as input.

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Code changes to activate AEROFFL:

There are no existing "compsets" for this offline mode. Just replace all

#undef AEROFFL

!#define AEROFFL

#define AEROFFL

Why run offline?

Online simulations (different meteorology) need to be much longer to get statistically significant results for changes in radiative fluxes, especially regionally and for small forcings. These will also include feedbacks…

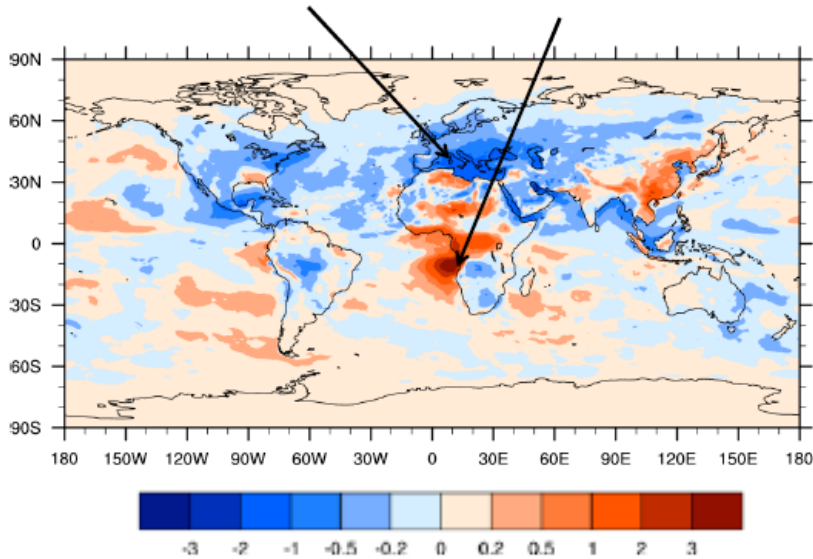Offline is also good for quick assessment of changes due to bug fixes and new parameterizations!

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Example: CAM5.1 (online, but nudged)   vs.   CAM4-Oslo (offline)

Cooling: Sulfate aerosol accumulate over dark surface (Ex: Mediterranean)
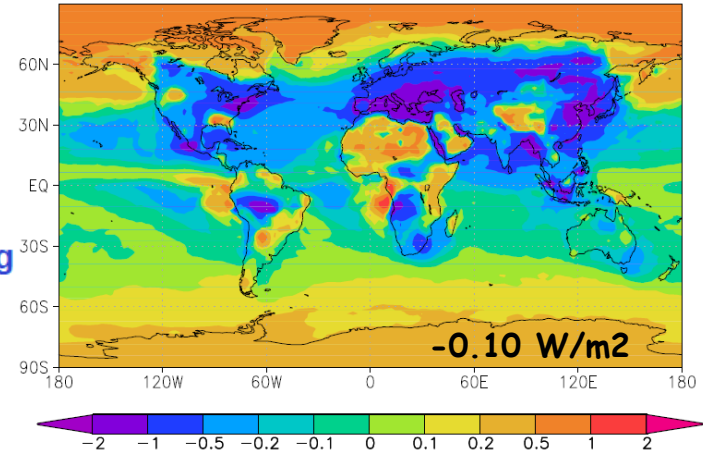
Warming: black carbon accumulate over bright surface (Ex: Biomass burning in Africa)

DRF (W m^{-2})

Direct forcing: 0.01 W/m^2

Small forcing because enhanced black carbon warming

-0.10 W/m2

(From talk by C. Hannay at the 16'th CESM workshop, 2012.)

Code changes to activate AEROCOM, for extra aerosol optics and size diagnostics:

There are no existing "compsets" for the AeroCom mode. Just replace all

!#define AEROCOM → #define AEROCOM

The AEROCOM diagnostics requires numerous additional subroutine calls and is expensive to run, CPU and memory-wise. The model simulation may end with the message "the model did not complete" and not sending output-files to archive (they remain in the run directory), but may still be restarted.

Advice: do manual restart often, every year or few years.

The model may be run with any combination:
with AEROFFL only,
with AEROCOM only,
or with AEROFFL and AEROCOM activated (or not) at the same time.

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