Simple “MODIS-Simulator”

A light alternative for some applications

Johannes Quaas, MPI for Meteorology, Hamburg

What should a simulator do?
- emulate retrievals in GCM (not really forward operator)

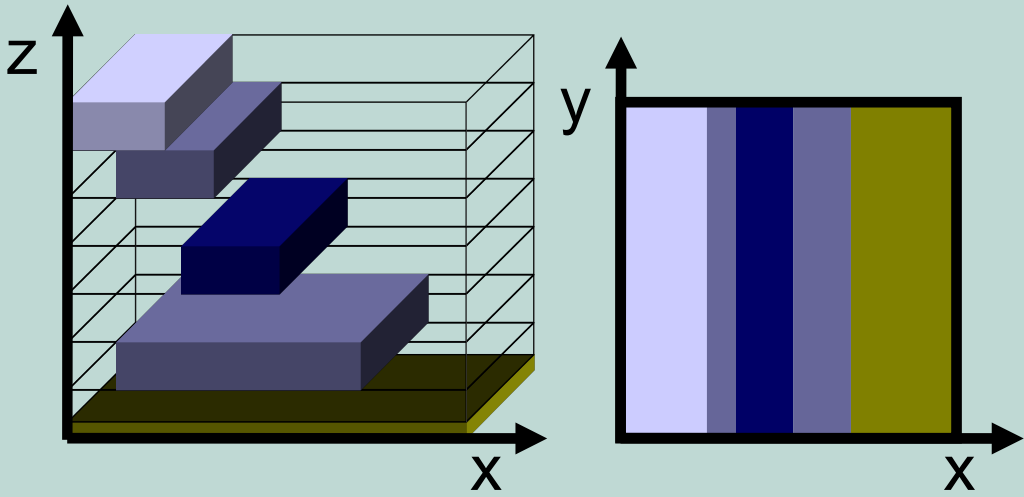
1a) subgrid-scale sampling
1b) (passive instrument) 2D view of cloud fields
2) provide consistent sampling
3) account for retrieval sensitivity

Deliverable D1.12, month 3 (May 2010)
http://wiki.esipfed.org/index.php/Indirect_forcing

Simple “MODIS Simulator”

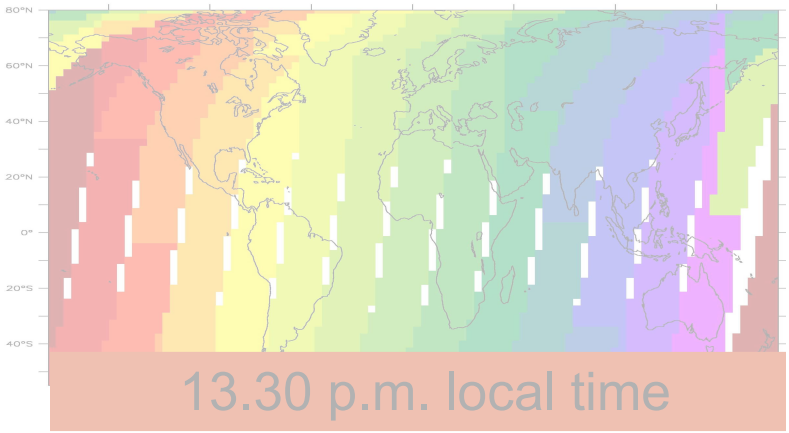
- 2D cloud top quantities from 3D cloud field using overlap assumption

  (instead of SCOPS)



- Sampling of daily fields at satellite overpass time

  (here: just choosing latitude according to local solar time ± ½ Δt)



- Visible clouds only ($\tau_c > 0.3$)

  (to account for instrument sensitivity)

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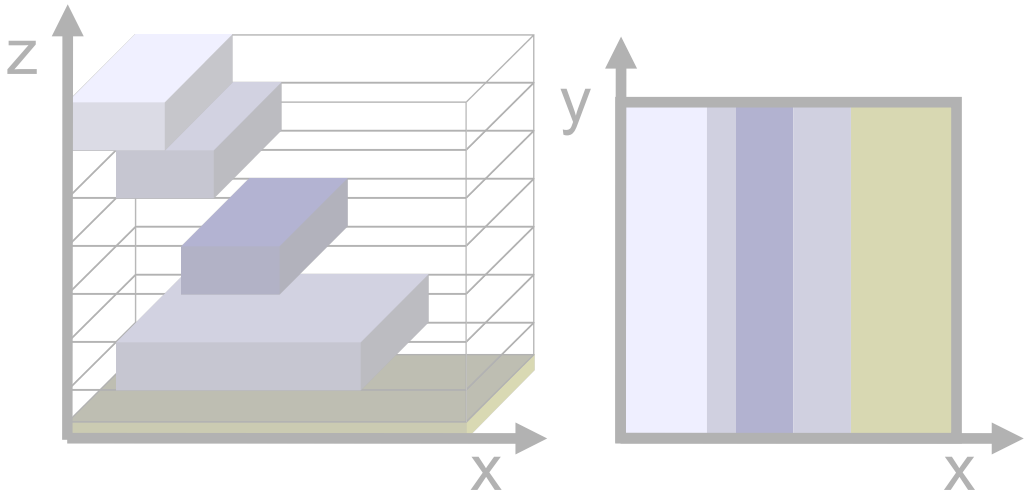

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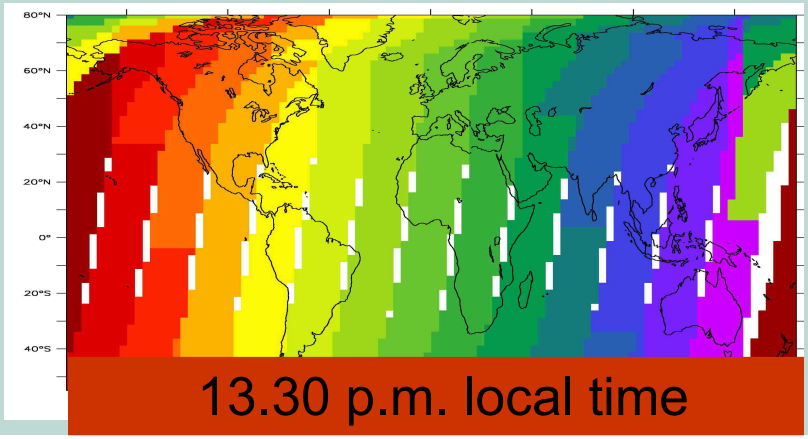

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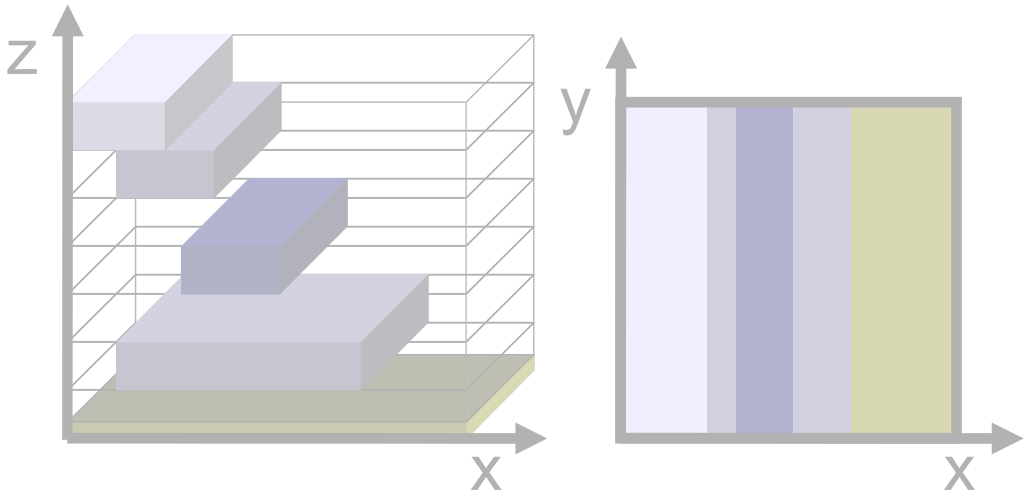

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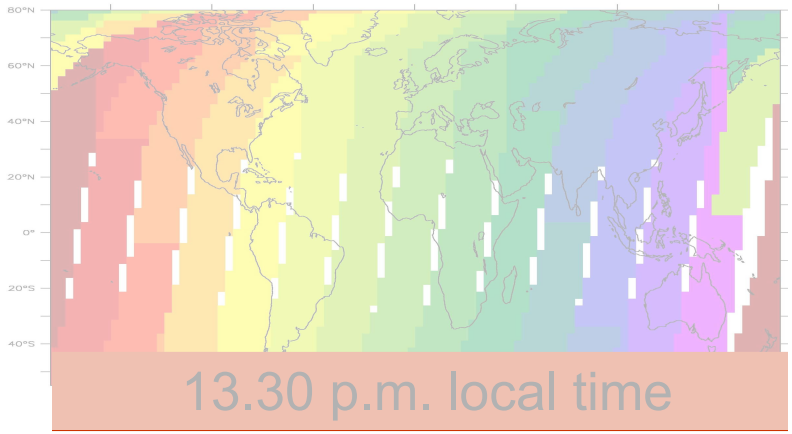

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- useful to sample 2D cloud-top properties
  (cloud-top droplet effective radius, cloud-top temperature,
  cloud-top phase etc.)

- cheap & easy to implement
- accurate enough for comparability given coarse GCM clouds

- has been applied in aerosol indirect effect model
  intercomparison (AEROCOM; Quaas et al. ACP 2009)

- implemented in several of our models
  HadGEM2 Nicolas Bellouin / Olivier Boucher
  LMDZ Yves Balkanski / Michael Schulz
  ECHAM5 Ulrike Lohmann / Johannes Quaas

  plus CAM-NCAR, CAM-Oslo, CAM-PNNL, CAM-Umich, GFDL, GISS, SPRINTARS

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```
thres_cld = 0.001
thres_cod = 0.3
IF ( iovl = random OR iovl = maximum-random ) THEN
  tcc(i) = 1.
ELSE
  tcc(:) = 0
ENDIF
icc(:) = 0
lcc(:) = 0
ttop(:) = 0
cdr(:) = 0
icr(:) = 0
cdnc(:) = 0


DO i=1,nx
        DO k=2,nz ! assumption: uppermost layer is cloud-free (k=1)
                IF ( cod3d(i,k) > thres_cod and f3d(i,k) > thres_cld ) THEN ! visible, not-too-small cloud
                        ! flag_max is needed since the vertical integration for maximum overlap is different from the two others: for maximum, tcc is the a
                        ! ftmp is total cloud cover seen from above down to the current level
                        ! tcc is ftmp from the level just above
                        ! ftmp - tcc is thus the additional cloud fraction seen from above in this level

                        IF ( iovl = maximum ) THEN
                                flag_max = -1.
                                ftmp(i) = MAX( tcc(i), f3d(i,k))  ! maximum overlap
                        ELSEIF ( iovl = random ) THEN
                                flag_max = 1.
                                ftmp(i) = tcc(i) * ( 1 - f3d(i,k) ) ! random overlap
                        ELSEIF ( iovl = maximum-random ) THEN
                                flag_max = 1.
                                ftmp(i) = tcc(i) * ( 1 - MAX( f3d(i,k), f3d(i,k-1) ) ) / &
                    ( 1 - MIN( f3d(i,k-1), 1 - thres_cld ) )  ! maximum-random overlap
                        ENDIF
                        ttop(i) = ttop(i) + t3d(i,k) * ( tcc(i) - ftmp(i) )*flag_max

                        ! ice clouds
                        icr(i) = icr(i) + icr3d(i,k) * ( 1 - phase3d(i,k) ) * ( tcc(i) - ftmp(i) )*flag_max
                        icc(i) = icc(i) + ( 1 - phase3d(i,k) ) * ( tcc(i) - ftmp(i) )*flag_max

                        ! liquid water clouds
                        cdr(i) = cdr(i) + cdr3d(i,j) * phase3d(i,k) * ( tcc(i) - ftmp(i) )*flag_max
                        cdnc(i) = cdnc(i) + cdnc3d(i,j) * phase3d(i,k) * ( tcc(i) - ftmp(i) )*flag_max
                        lcc(i) = lcc(i) + phase3d(i,k) * ( tcc(i) - ftmp(i) )*flag_max

                        tcc(i) = ftmp(i)
                ENDIF ! is there a visible, not-too-small cloud?
        ENDDO ! loop over k

        IF ( iovl = random OR iovl = maximum-random ) THEN
                tcc(i) = 1. - tcc(i)
        ENDIF
ENDDO ! loop over I
```

MODIS Simulator

- More elaborate MODIS simulator available in COSP (R. Pincus et al.)

- uses COSP subcolumn sampler
- better account for instrument sensitivities
- creates joint histograms
- recommended for future use