Facilitating the use of MODIS data by modelers: A MODIS simulator and matching dataset for the evaluation of clouds in climate models

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A prototype effort (circa 2004)

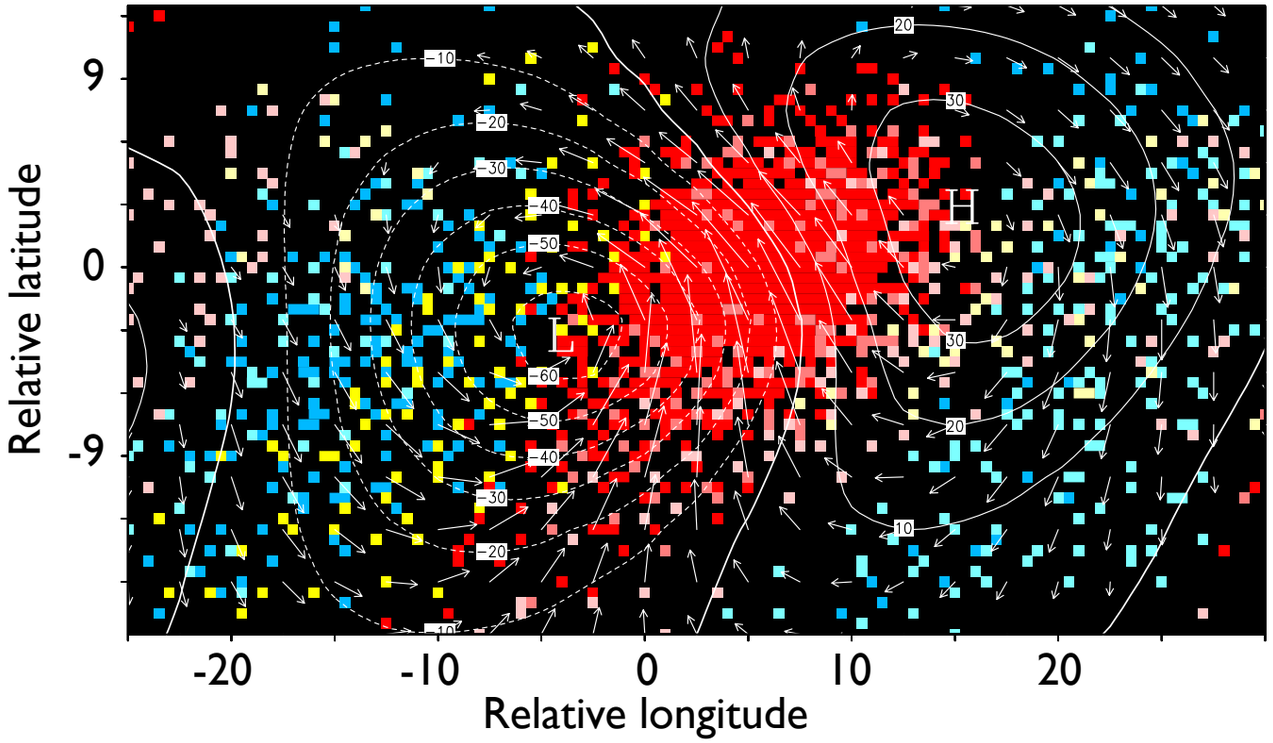
Q: Why doesn't ECMWF use MODIS data for evaluation?

A: "It's in HDF format" (cloud guy)
"I don't know which of the many datasets to use" (aerosol guy)

Result: we made a year's worth of monthly netCDF files containing a few MODIS variables. These are used in "climate mode."
(Forecasting centers have other possible uses for MODIS data, including assimilation and forecast evaluation on daily timescales)

Foreshadowing email: "Other quantities (cloud top pressure, particle size) will be useful if we can provide simple recipes that let the modelers make useful comparisons."

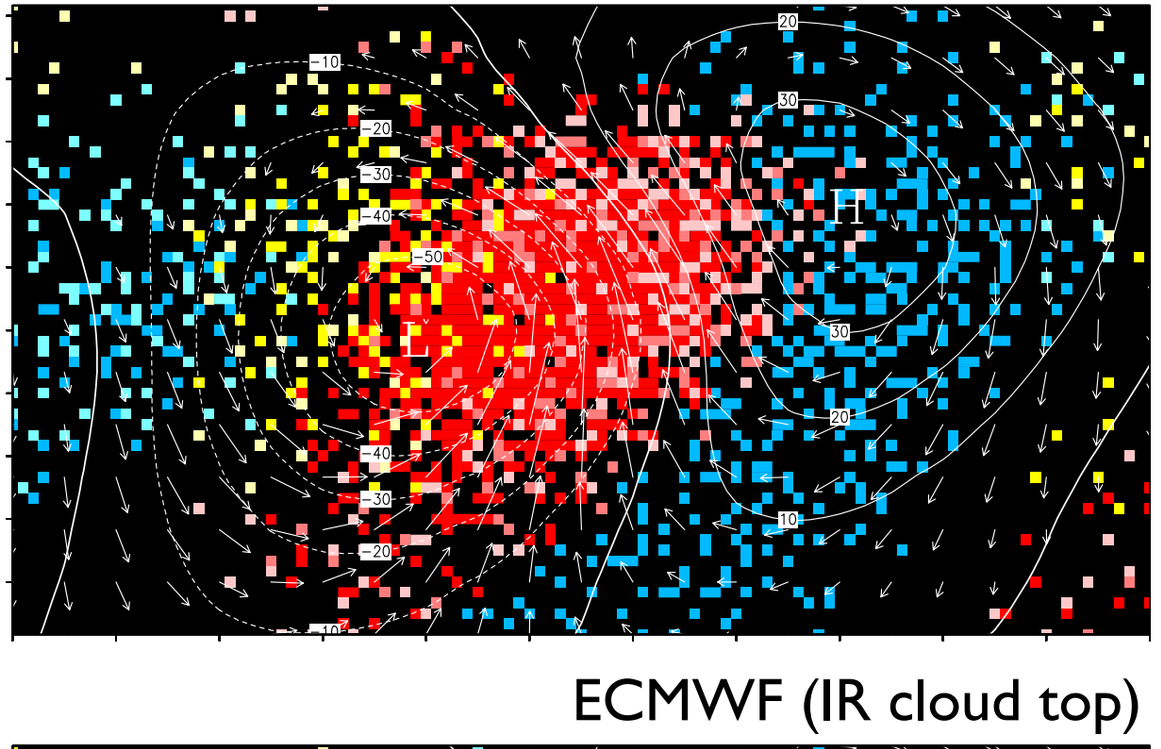
ISCCP



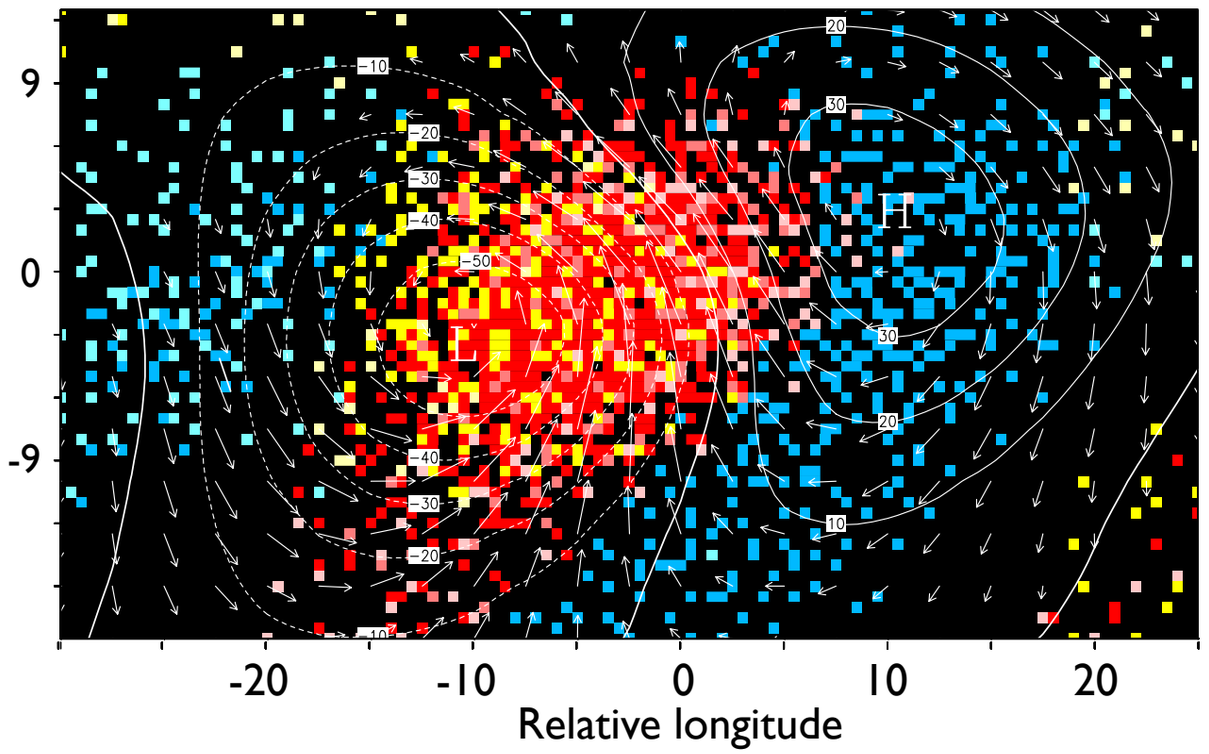
low top mid high

After Klein and Jakob, MWR, 1999

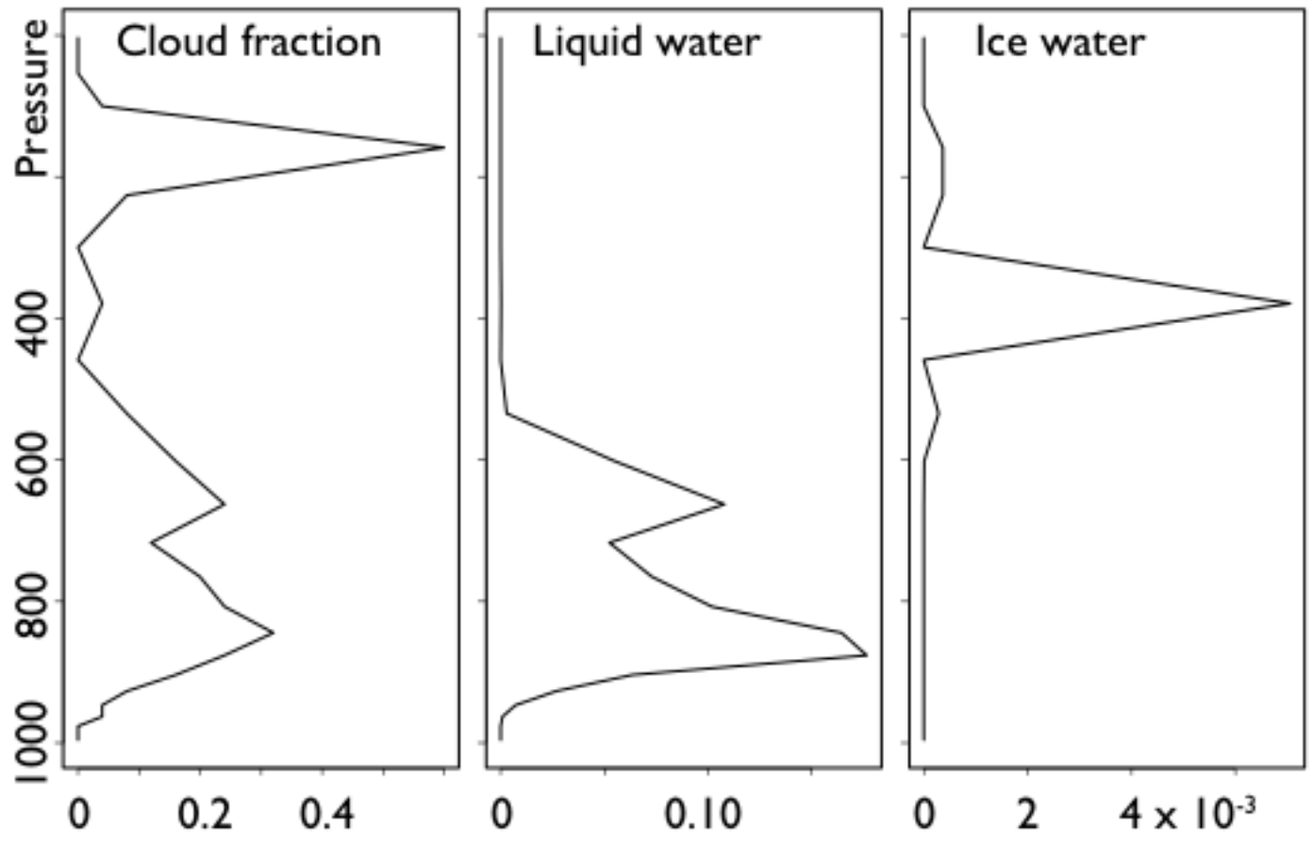
ECMWF



ECMWF (IR cloud top)



Sampling model state to treat fractional cloudiness/masking



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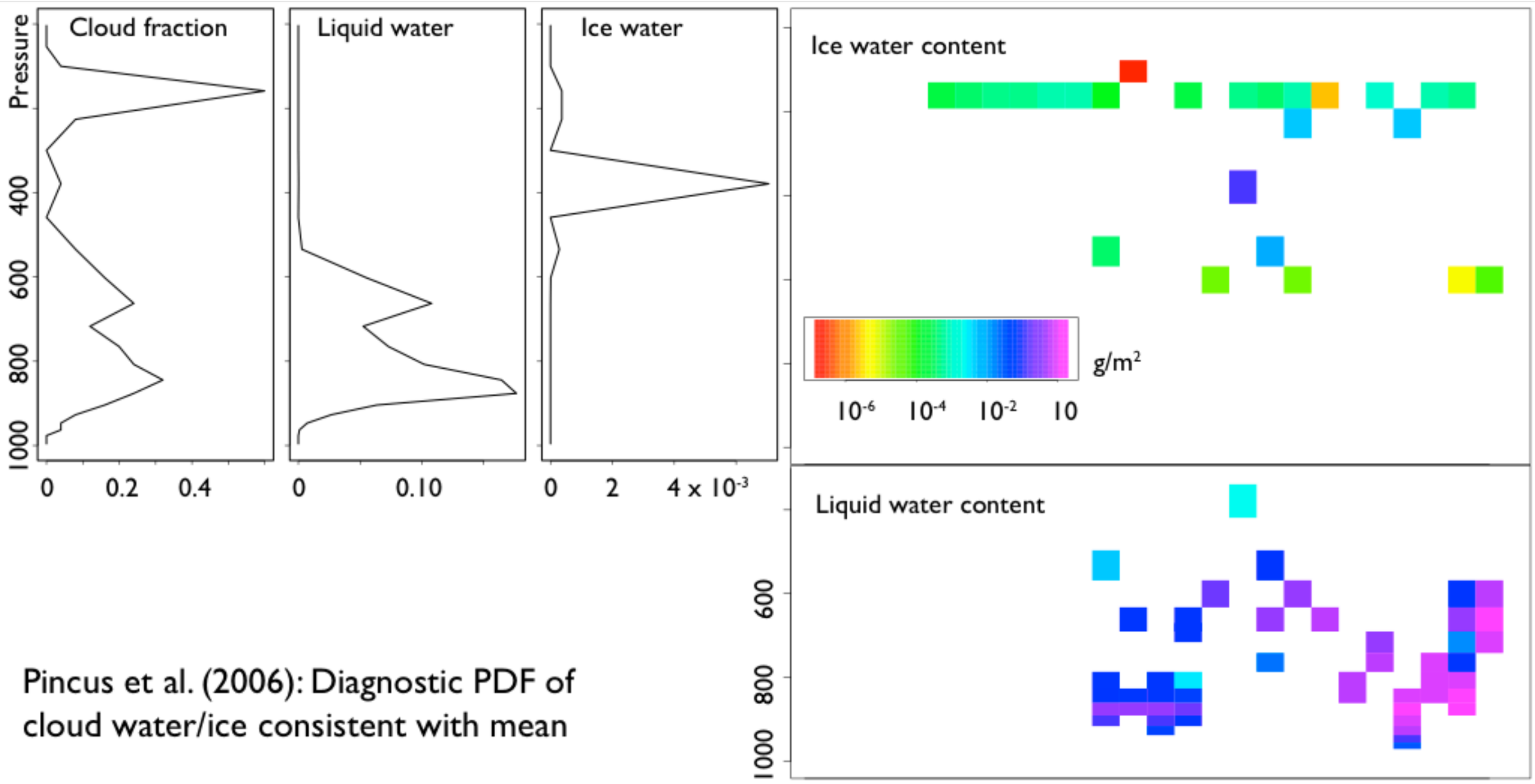


Pincus et al. (2006): Diagnostic PDF of cloud water/ice consistent with mean

MODIS complements ISCCP (i)

The record is much shorter and the sampling is poorer, but...

... different information is available

- Cloud properties are separated by phase
- Cloud particle size
- Many observations come with uncertainty estimates

... biases are different

- Cloud top pressure is determined using CO_2 slicing above ~700 mb
- MODIS is more conservative than ISCCP when determining cloud properties (esp. in Collection 5)

MODIS complements ISCCP (ii)

... averaging is different

ISCCP provides albedo-weighted optical thickness

A custom observational data set for climate model evaluation

We are providing daytime-only estimates of

$\tau, \log 10(\tau), r_e$, liquid/ice water path, sorted by phase, with uncertainties

cloud fraction: total, low, mid, high (mask),
total, liquid, ice, high, mid, low (retrieval)

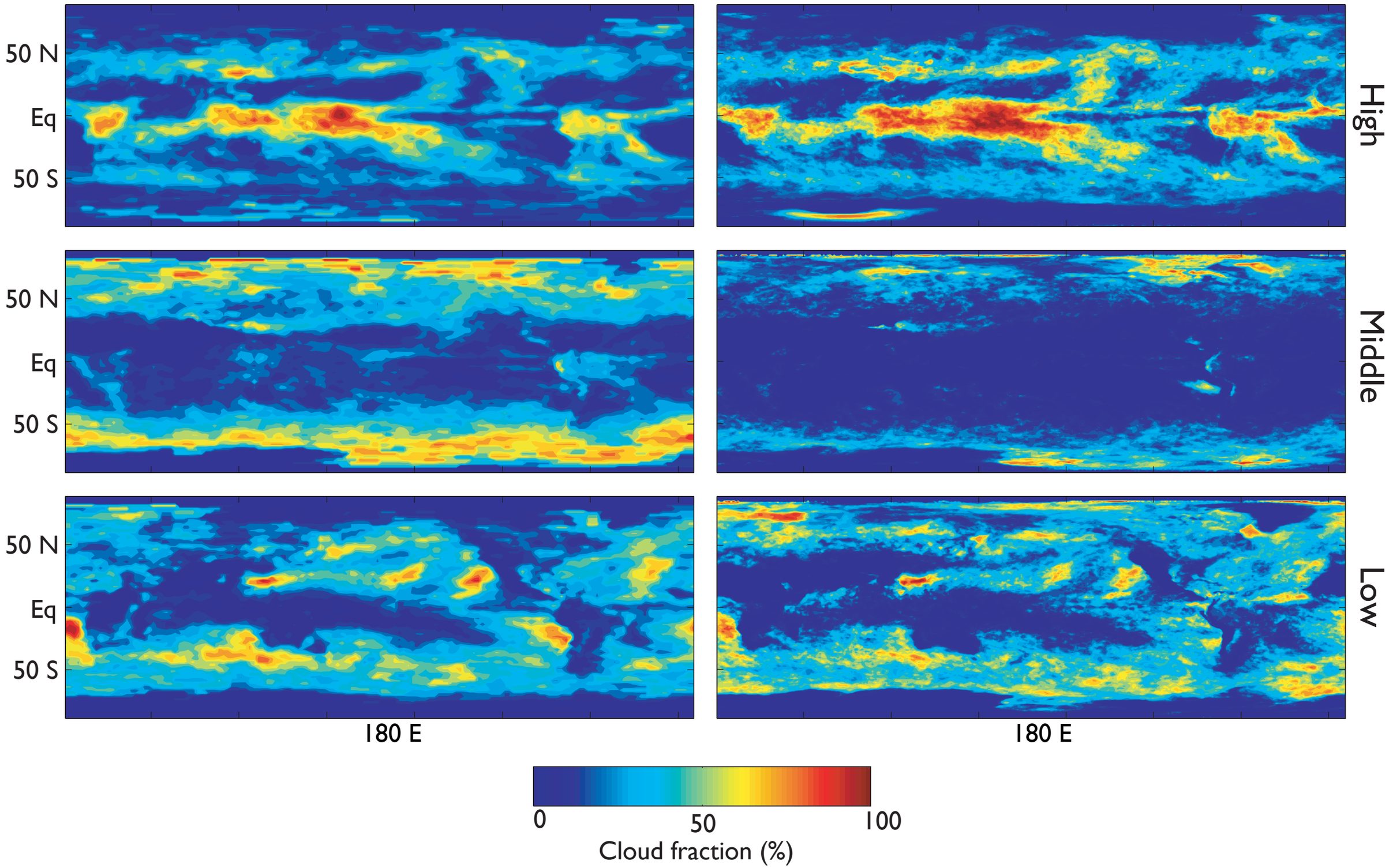
cloud top pressure

joint optical thickness/cloud top pressure histogram

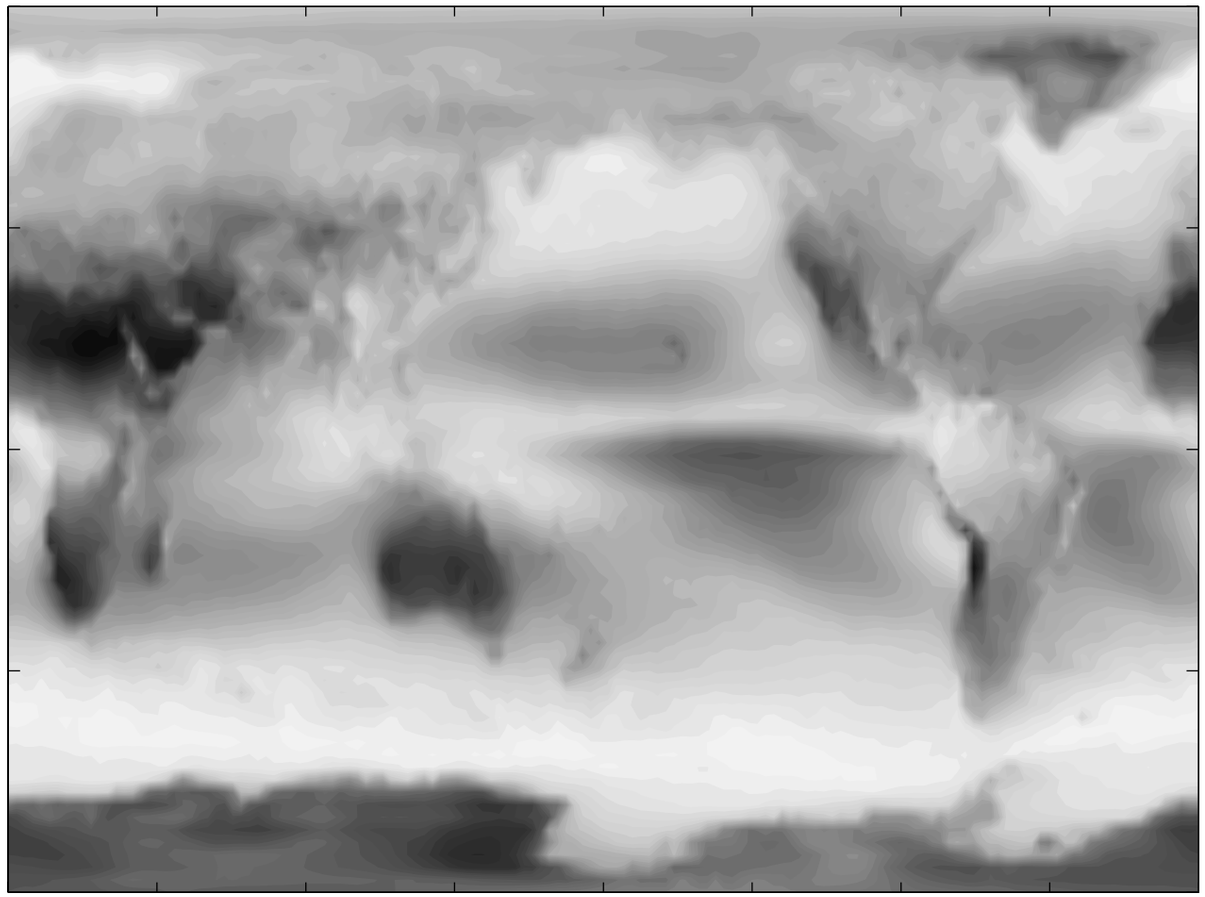
as monthly means on 1° grid.

These are standard MODIS products converted to CF-compliant netCDF files.

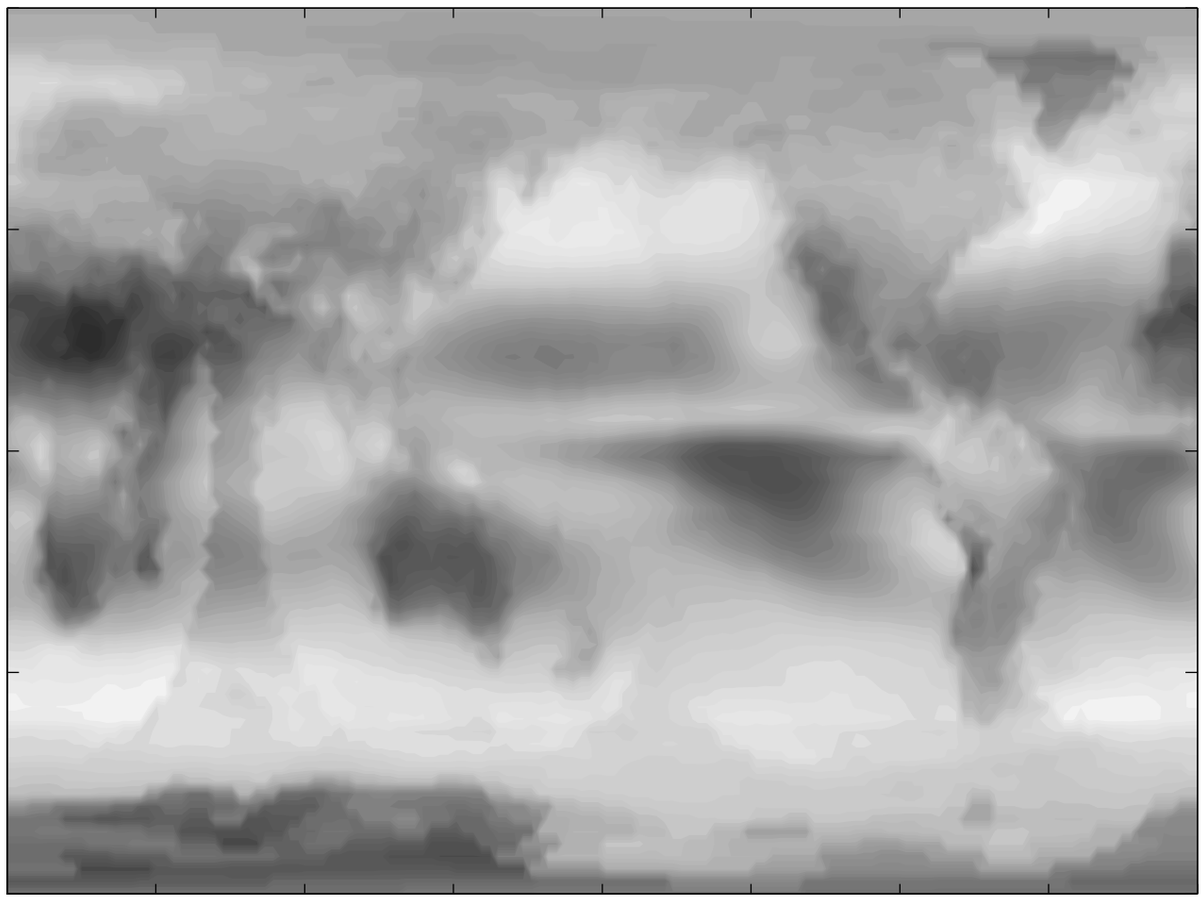
Differences with ISCCP are real, complicated



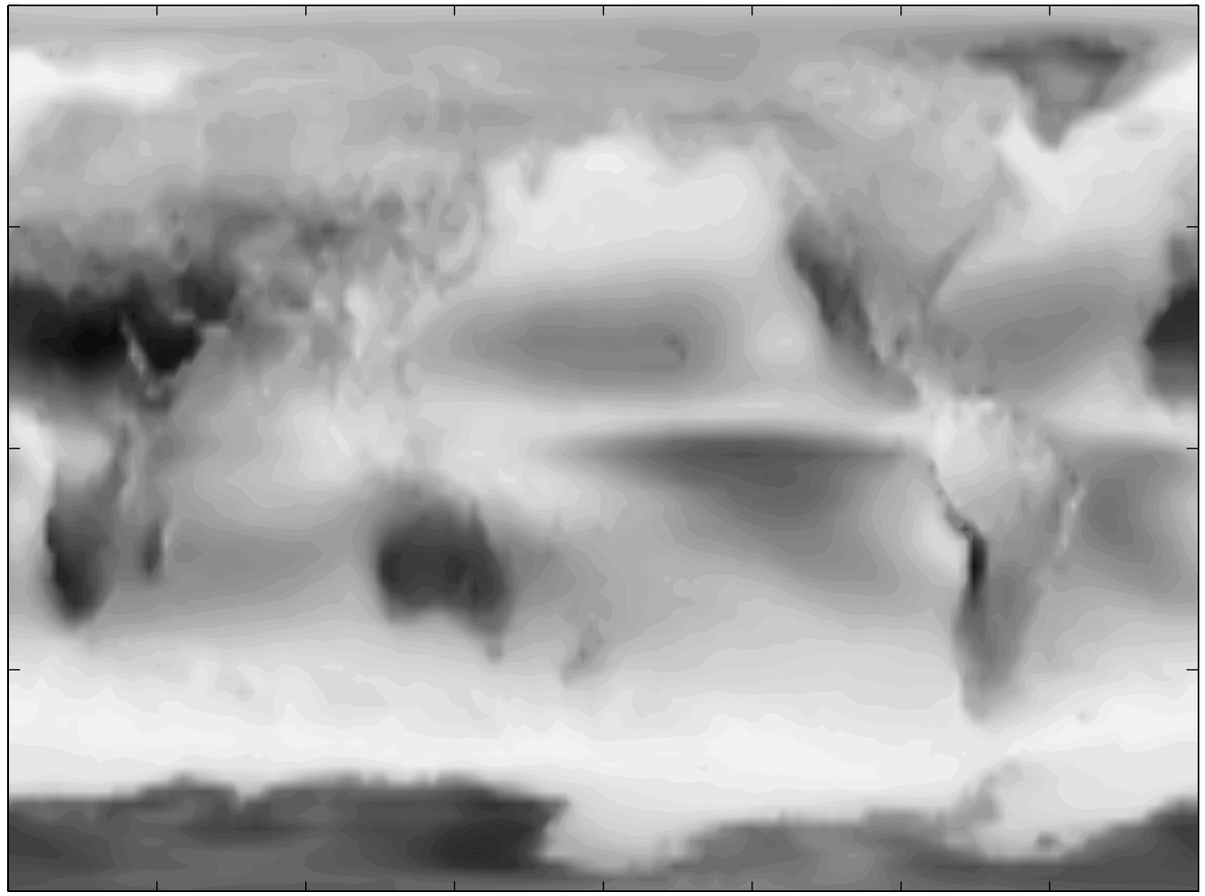
MODIS mask



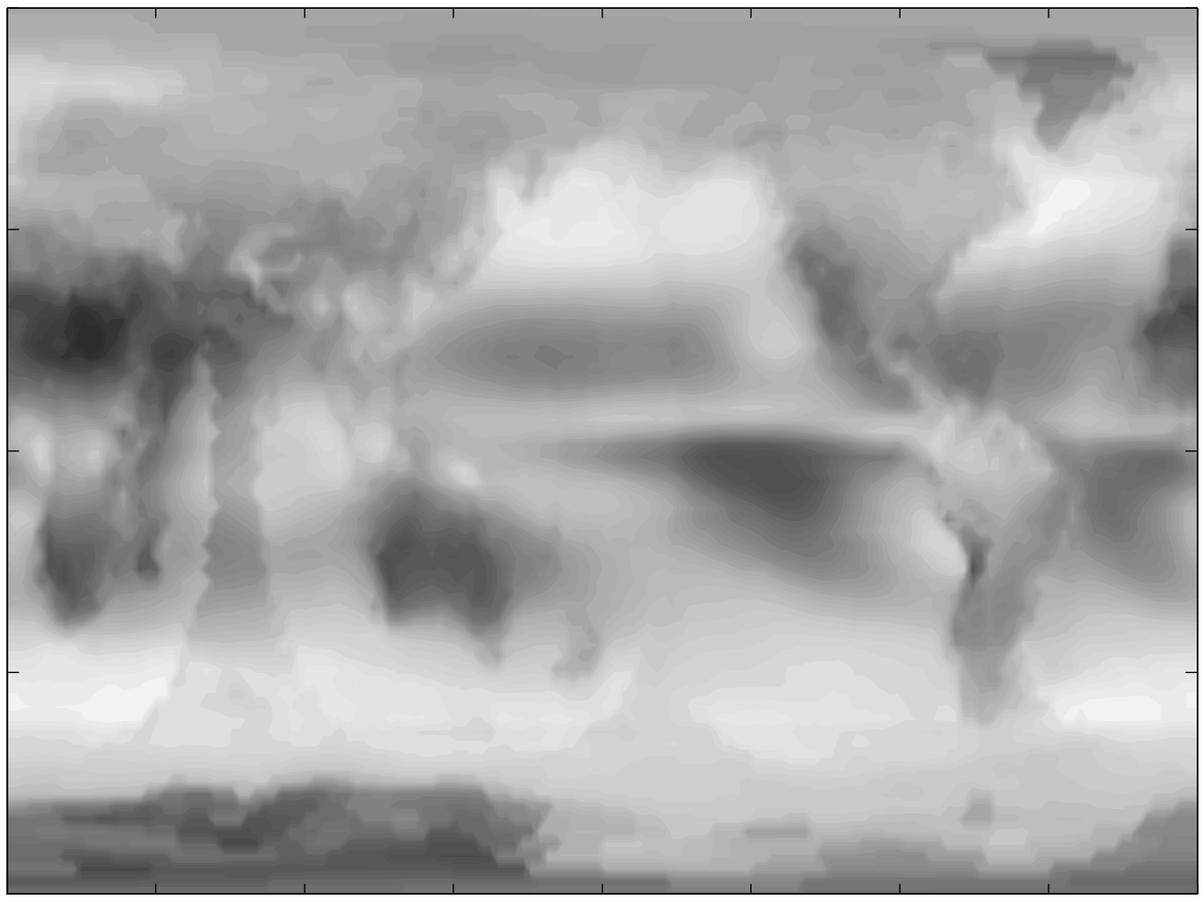
ISCCP cloud fraction

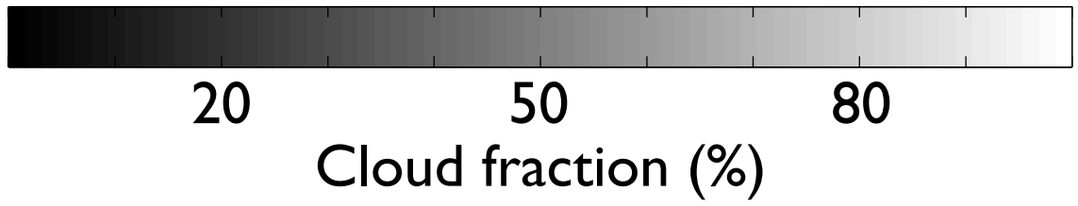


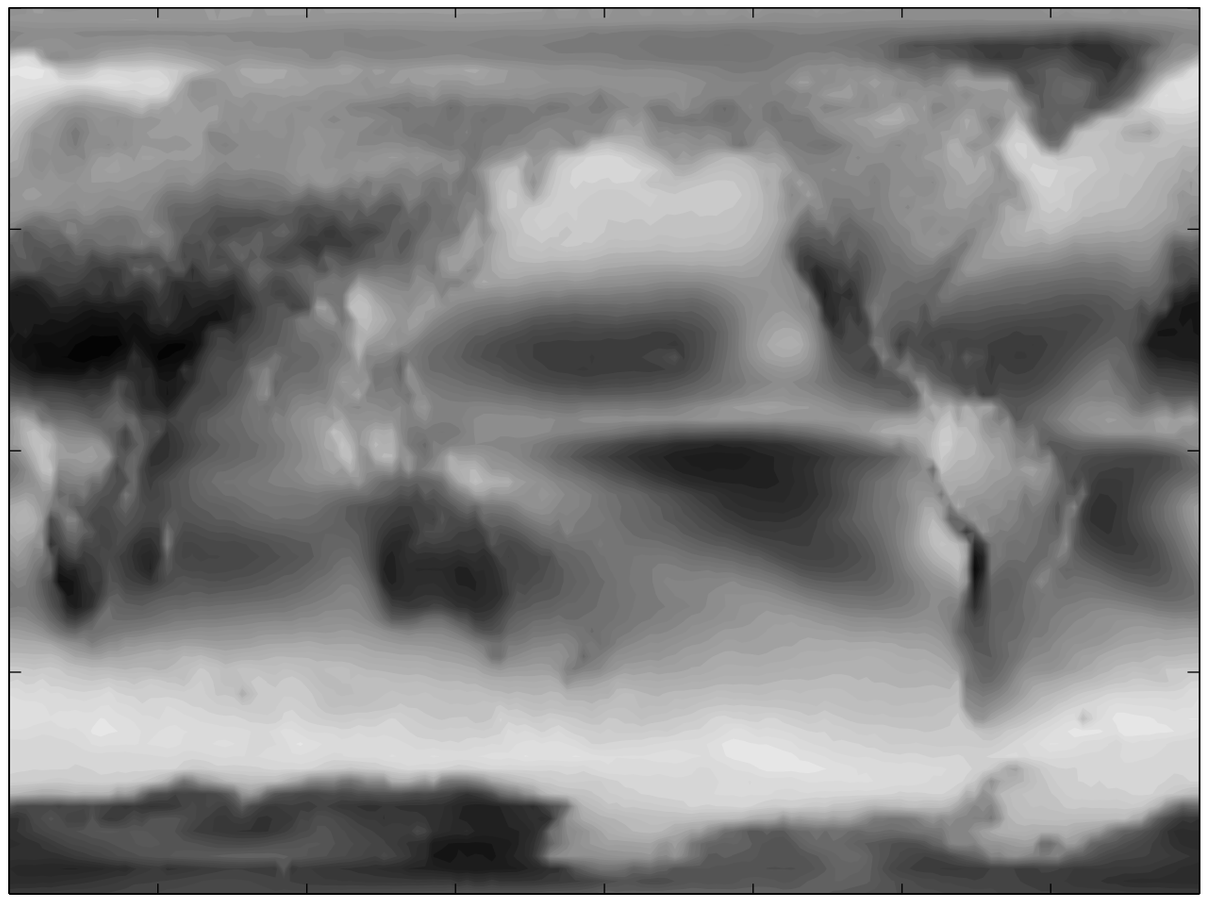
MODIS mask



ISCCP cloud fraction

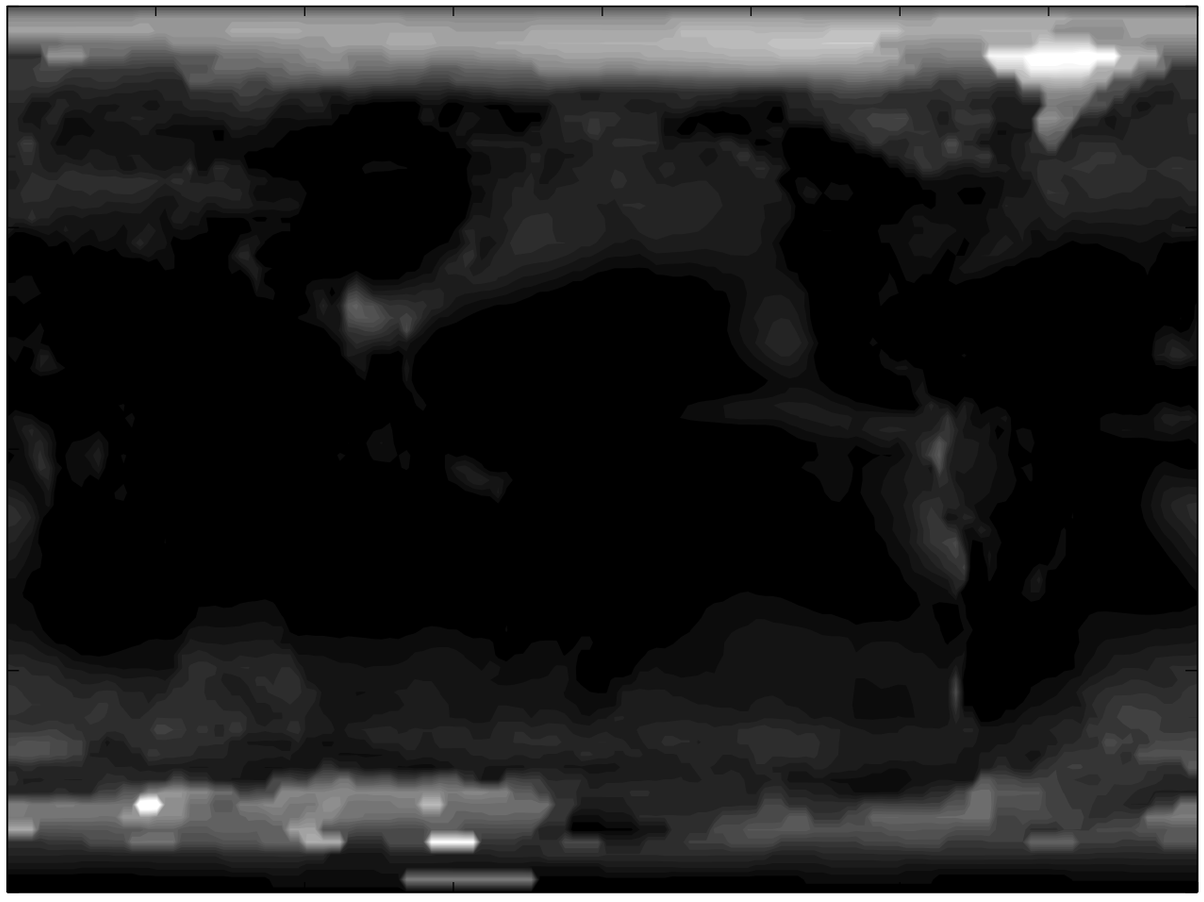


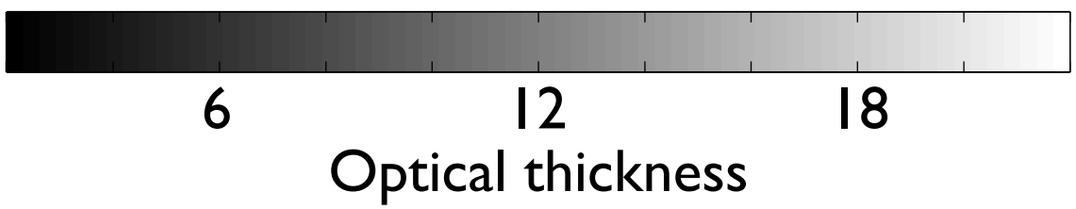




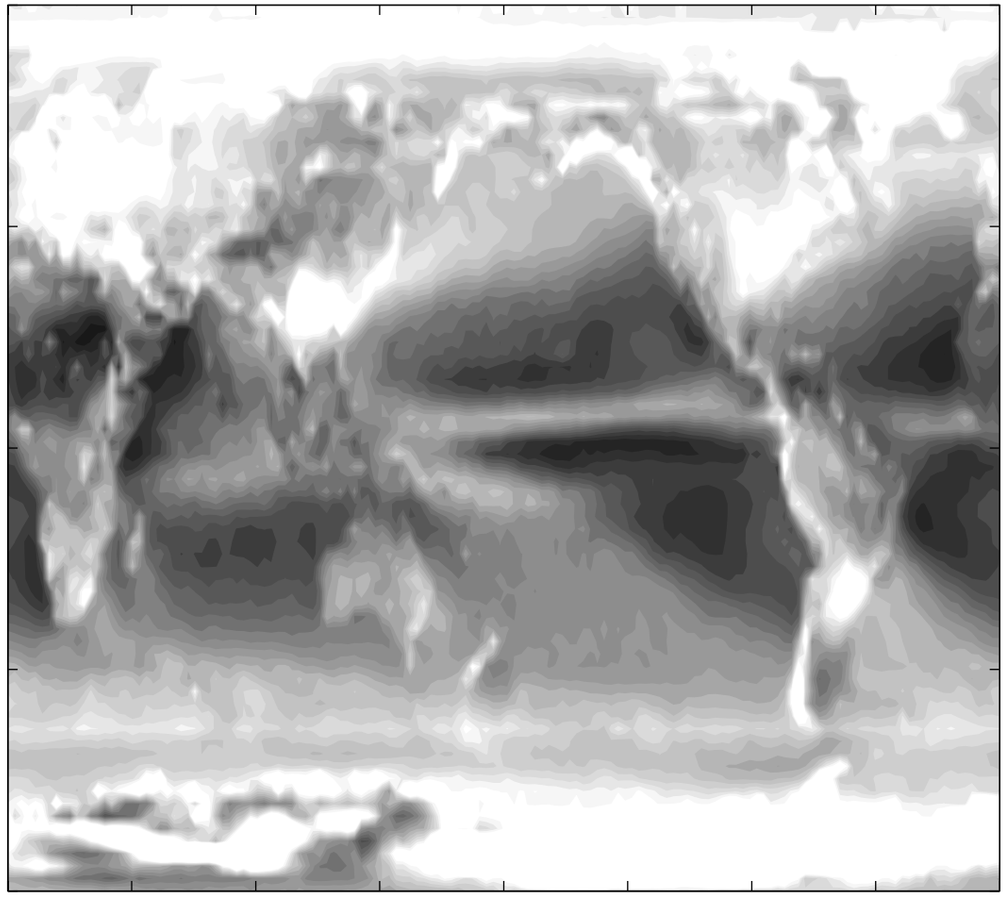
MODIS retrieval

ISCCP mean τ

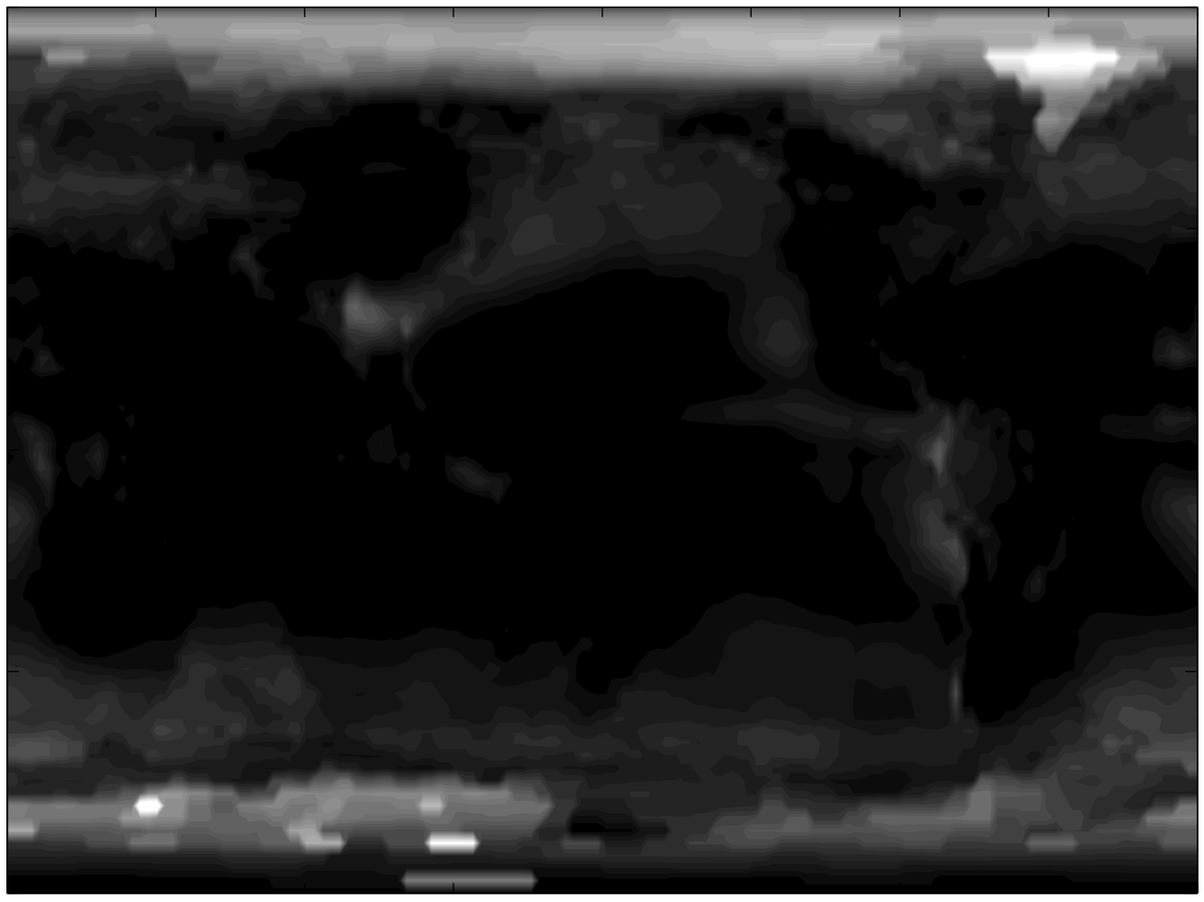




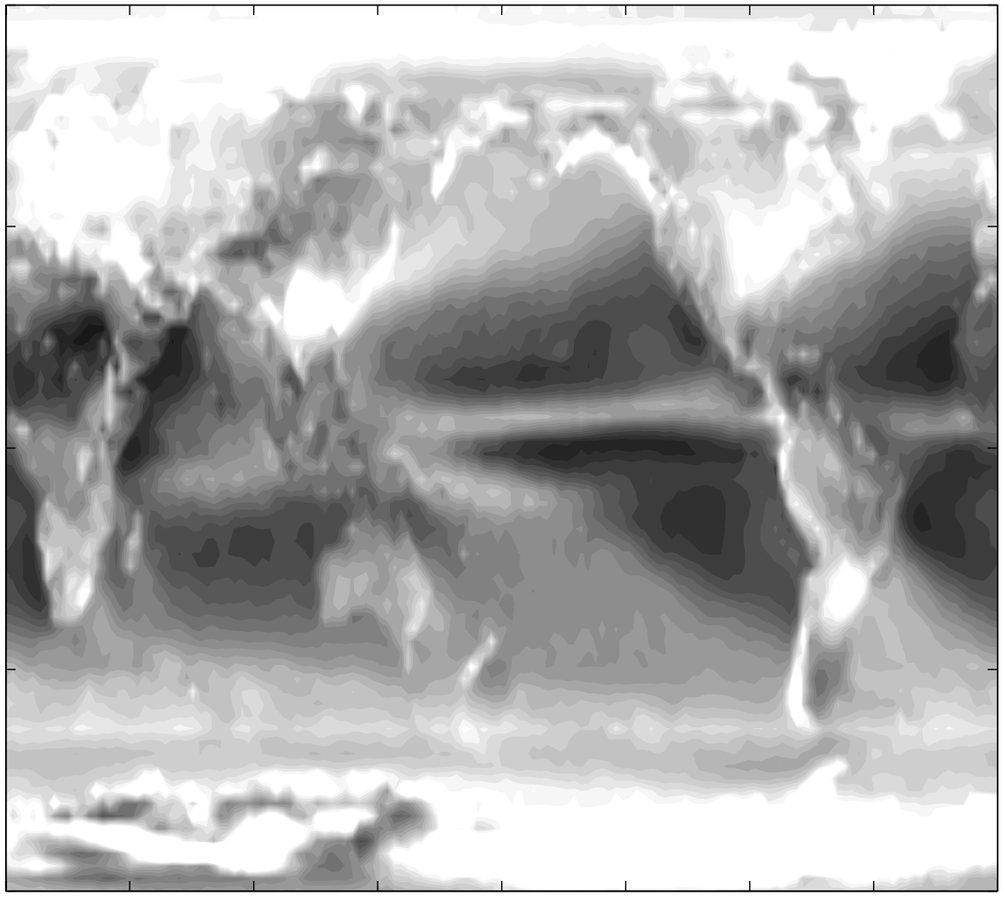
MODIS (linear mean)



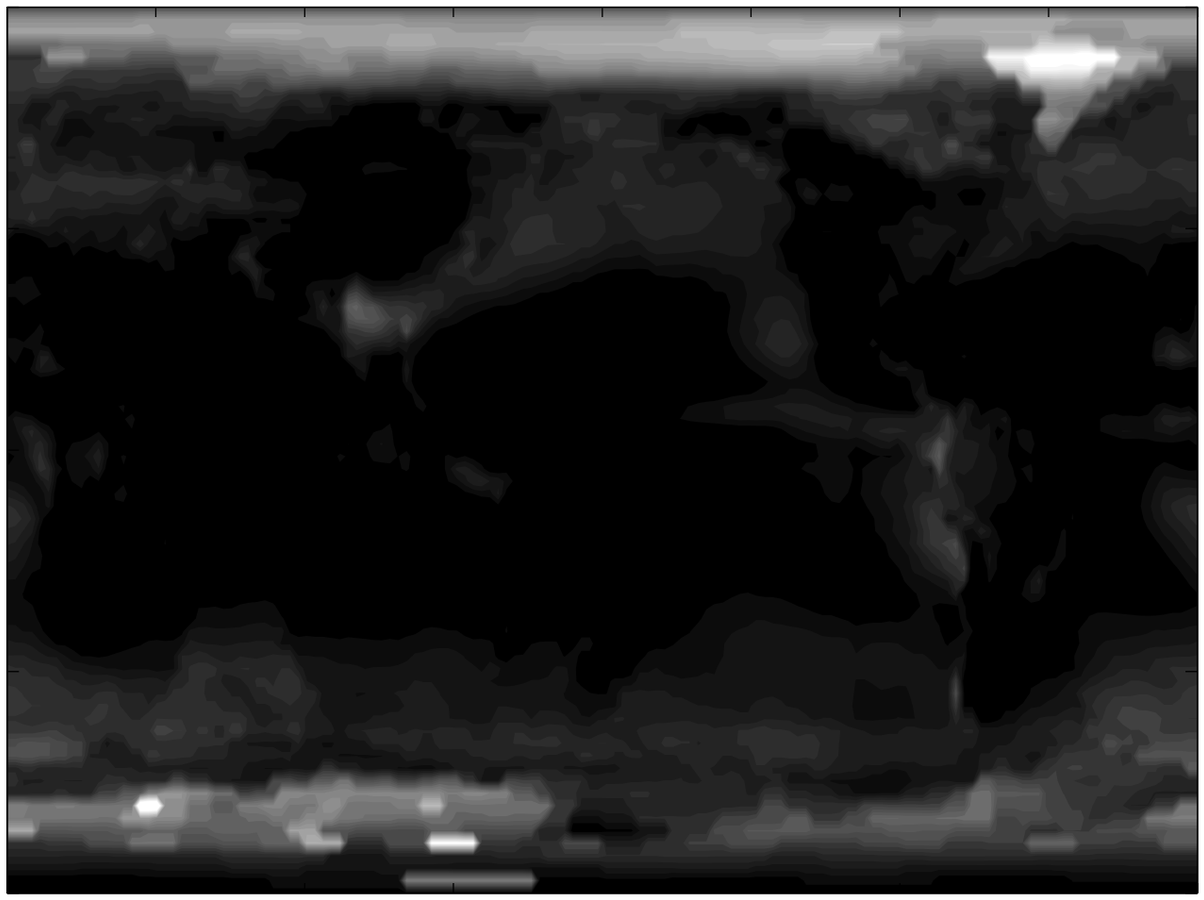
ISCCP mean τ

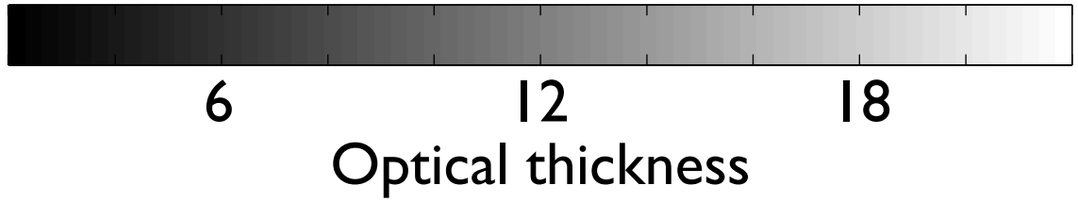


MODIS (linear mean)

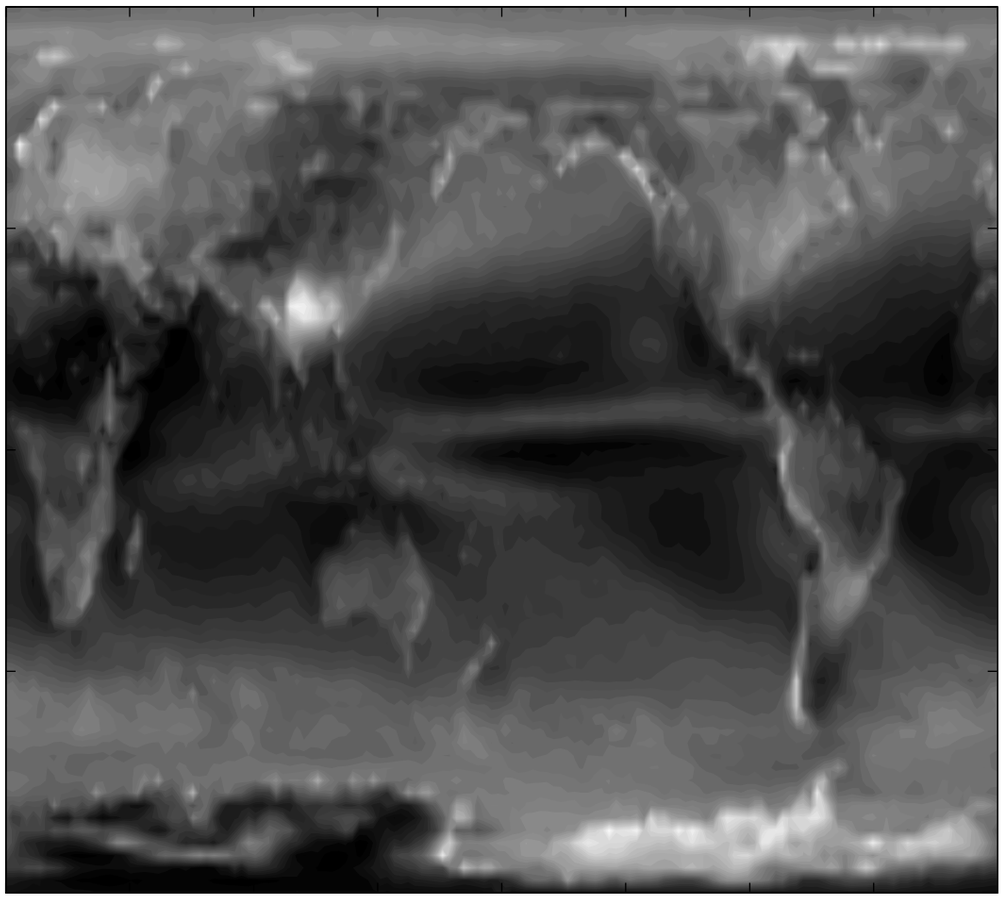


ISCCP mean τ





MODIS (logarithmic mean)



A MODIS simulator for climate models (i)

Accepts sub-column inputs of $r_{e(l,i)}(z), \tau_{(l,i)}(z)$ or $q_{(l,i)}(z)$

Provides subcolumn estimates of

$$\tau = \int_{\mathrm{TOA}}^{\mathrm{sfc}} \sigma_c(z) dz$$ (no errors, as ISCCP simulator)

$$p_c = 1/2 \int_{\mathrm{TOA}}^{\tau=2} p(z)\sigma_c(z) dz$$ (when > 700 mb, use ISCCP IR)

$$P = \int_{\mathrm{TOA}}^{\tau=1} P(z)\sigma_c(z) dz$$ (can be "undetermined")

$$r_e = F^{-1}(F(r_e(z)))$$ (pseudo-retrieval based on near-IR fluxes)

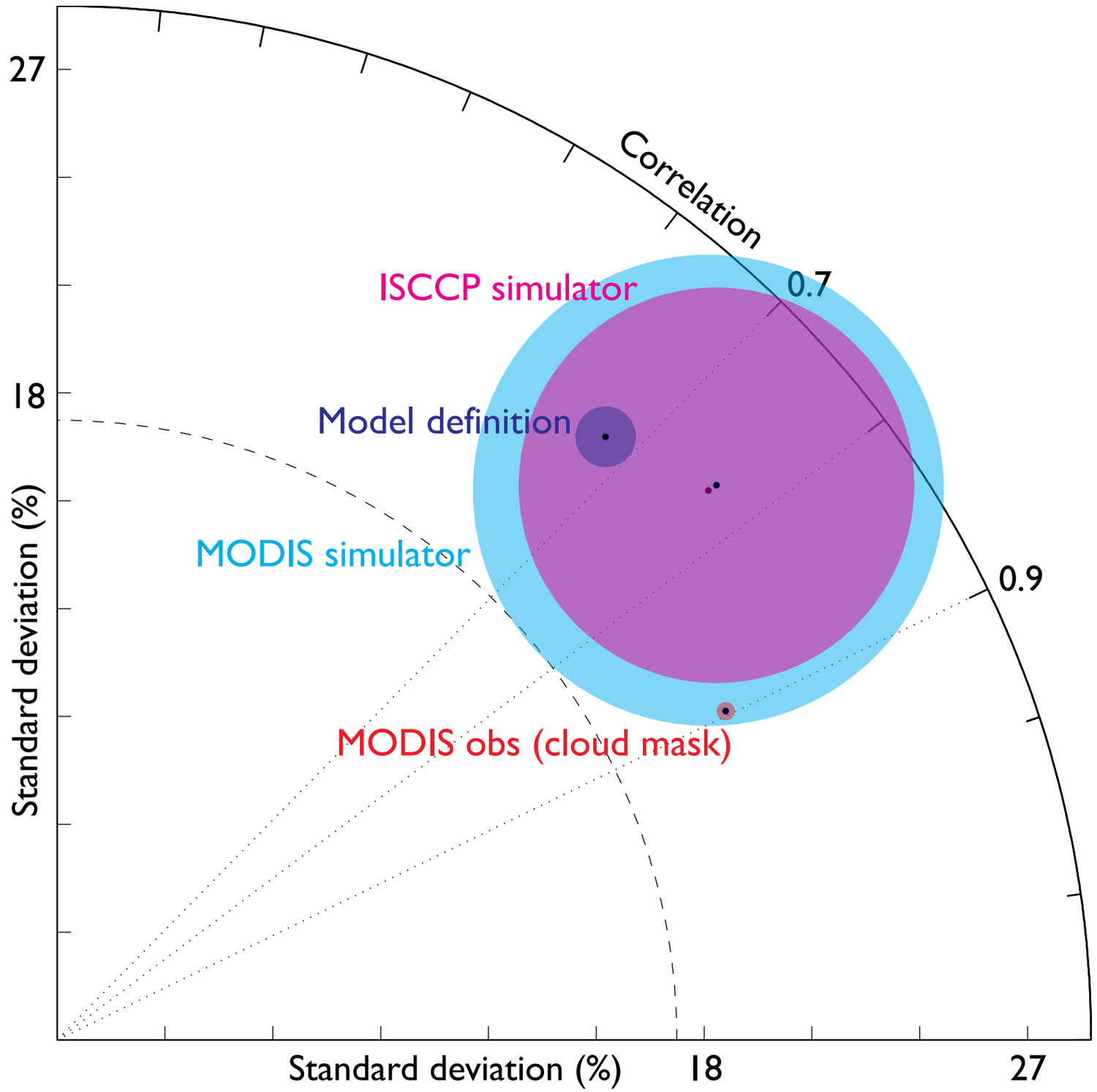
A MODIS simulator for climate models (ii)

Estimate liquid, ice water path from optical thickness, particle size

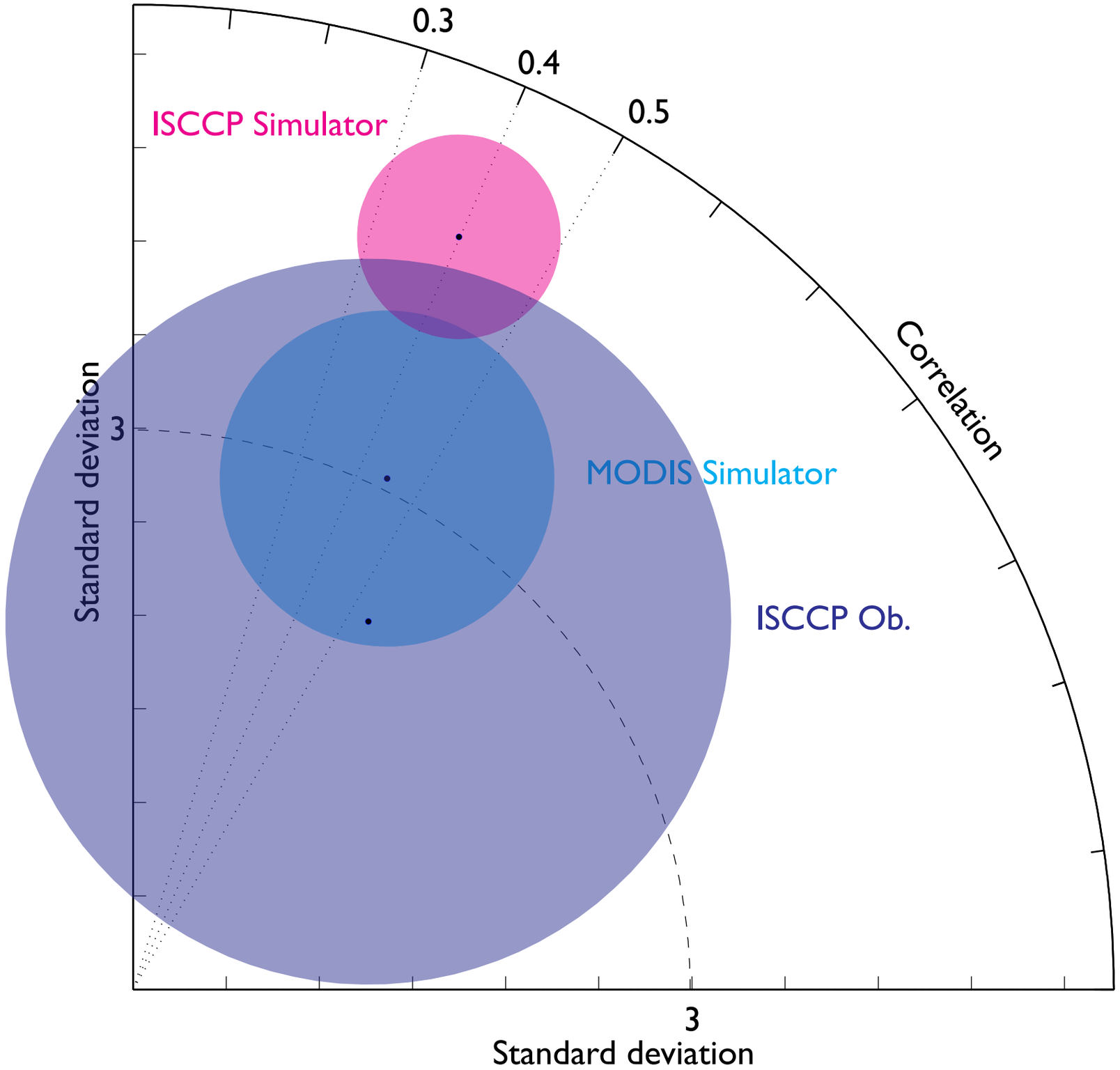
Aggregate sub-columns

cloud fractions (total, liquid, ice, high, middle, low)
in-cloud linear means of all quantities
in-cloud logarithmic mean for optical thickness
optical thickness/cloud top pressure joint histogram

Results from GFDL's new climate model: cloud fraction...



... and optical thickness



Getting the word out

The observational datasets will be available from

LAADSWEB (http://laadsweb.nascom.nasa.gov/) and

CF-OBS (http://climserv.ipsl.polytechnique.fr/cfmip-obs.html)

The MODIS simulator is available as part of COSP 1.2

(http://www.cfmip.net/)

We are writing a paper for BAMS describing

the data, the simulator, guidance in interpretation

We designed Level-3 products to be monolithic - something for everybody.

Should we consider targeting specific end-user communities? Which ones?