Large-scale cloud properties as observed by ISCCP and MODIS

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Why a comparison?

Satellites alone provide a global view

Crucial as evaluation data sets for global models

ISCCP has long history, traction with modeling community

MODIS has more spectral information available, has consistent calibration

What differences do we expect between the data sets, and how do we understand them?

What we'll compare

ISCCP products

cloud fraction c_f, cloud top pressure p_c, cloud optical thickness τ

Comparison is ISCCP D2 to Aqua MODIS collection 5 Level 3

July 2002 - May 2004 available for this meeting

Full data stream (Terra to Feb 2000) by about year's end

Note: beginning with collection 5, MODIS L3 data contain "ISCCP-like" joint histograms of τ-p_c

MODIS and ISCCP: algorithmic differences

Sampling rate:

ISCCP samples 8x/day; reports a monthly average diurnal cycle

MODIS samples 2-4x/day; reports 1 average per platform

Cloud detection:

ISCCP uses a few channels; MODIS a great many

Cloud top pressure:

ISCCP uses emissivity; MODIS uses CO_2 slicing

Optical thickness:

ISCCP uses fixed particle size for ice/liquid;

MODIS retrieves size simultaneously

MODIS and ISCCP: philosophical differences

ISCCP gridded data products are adjusted to have fewer rough edges

- Stress continuity in time and space

MODIS L3 processing is very literal

Example: night-time cloud fraction

- ISCCP makes IR-only retrievals during the day; compares to VIS-IR retrievals; adjusts night-time retrievals
- MODIS reports a simple daily mean; ISCCP uses adjusted values

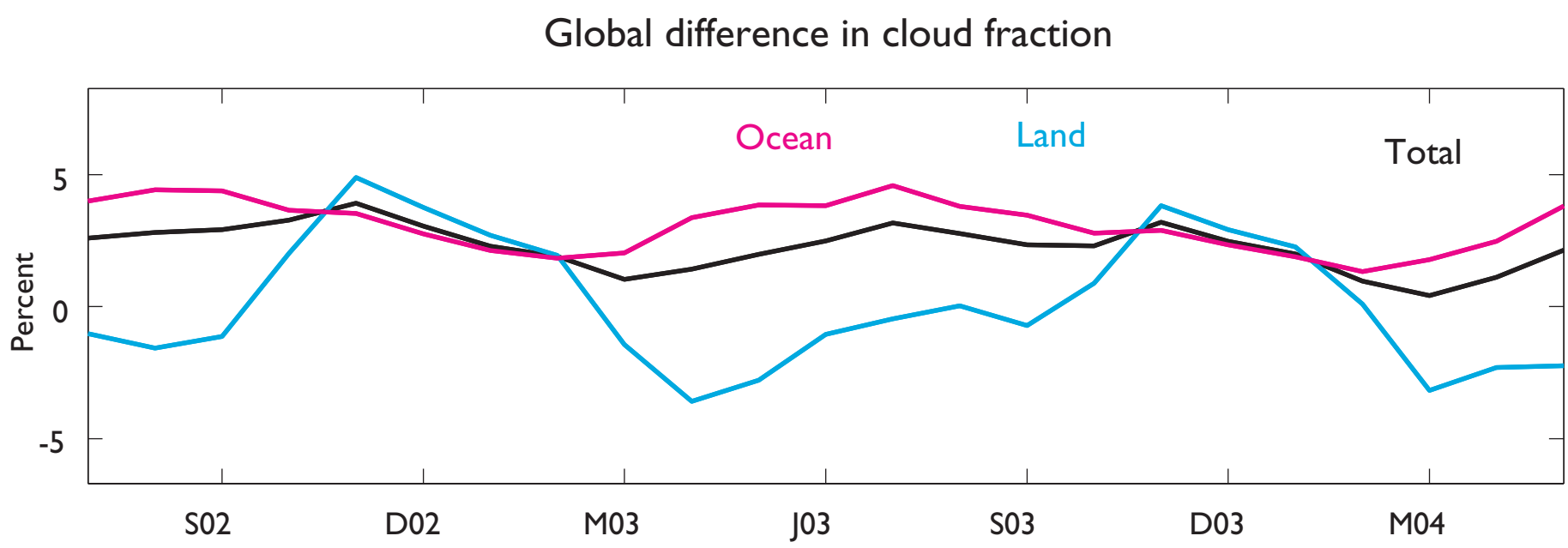
On comparing apples with apples

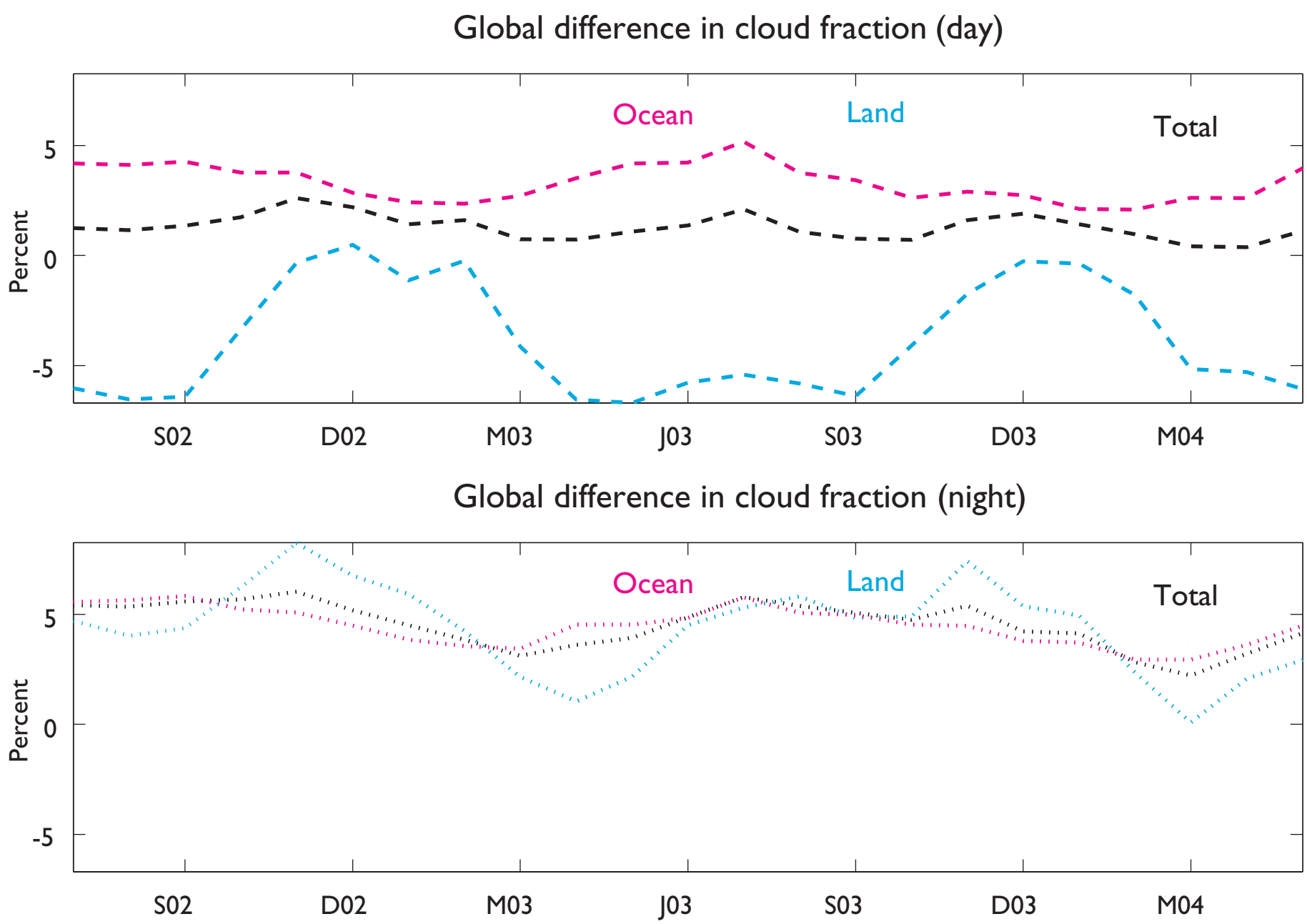
ISCCP averages optical thickness in two ways:

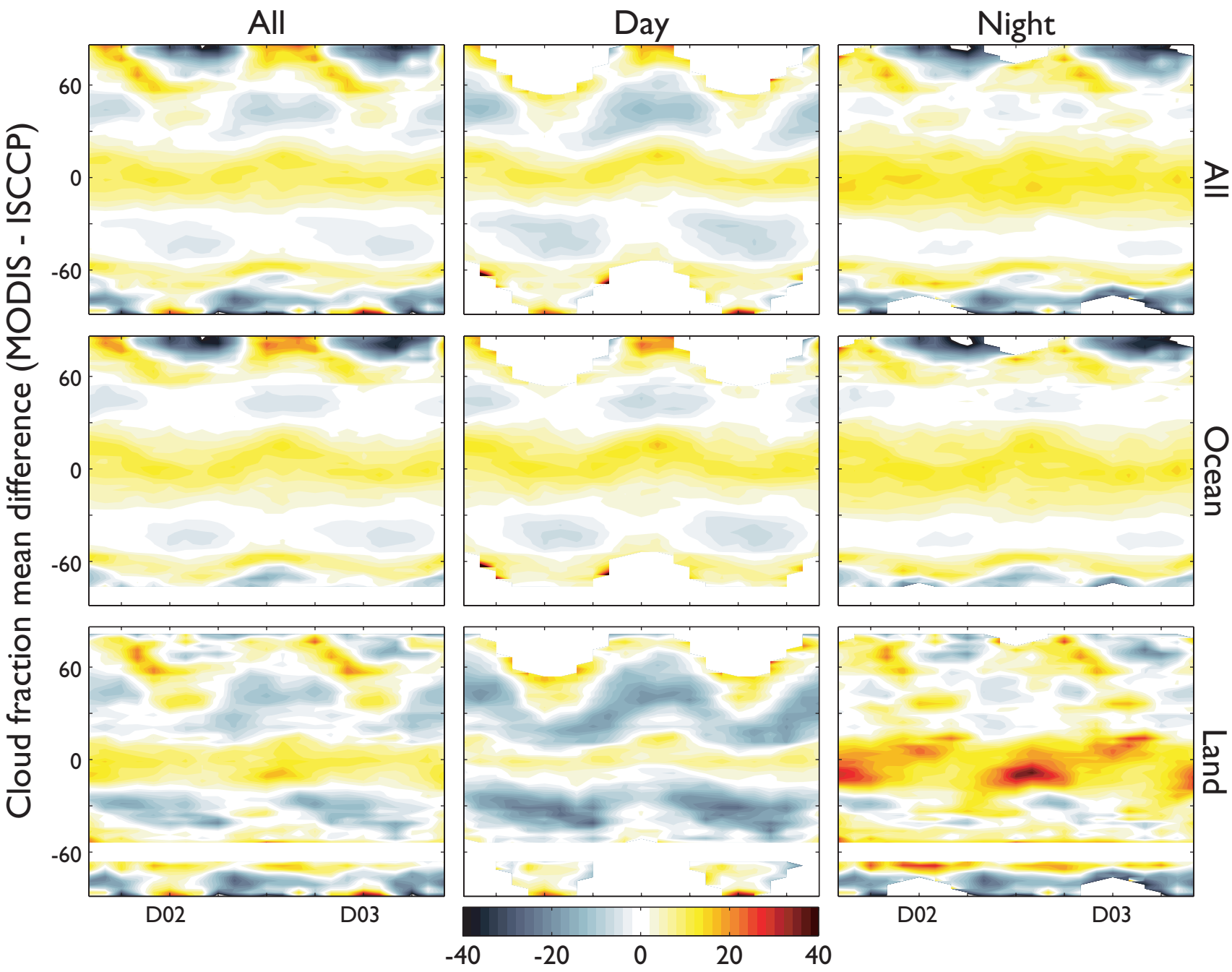
- linear in albedo - reported as “optical depth”
- linear in water - reported as “water path”; comparable to MODIS

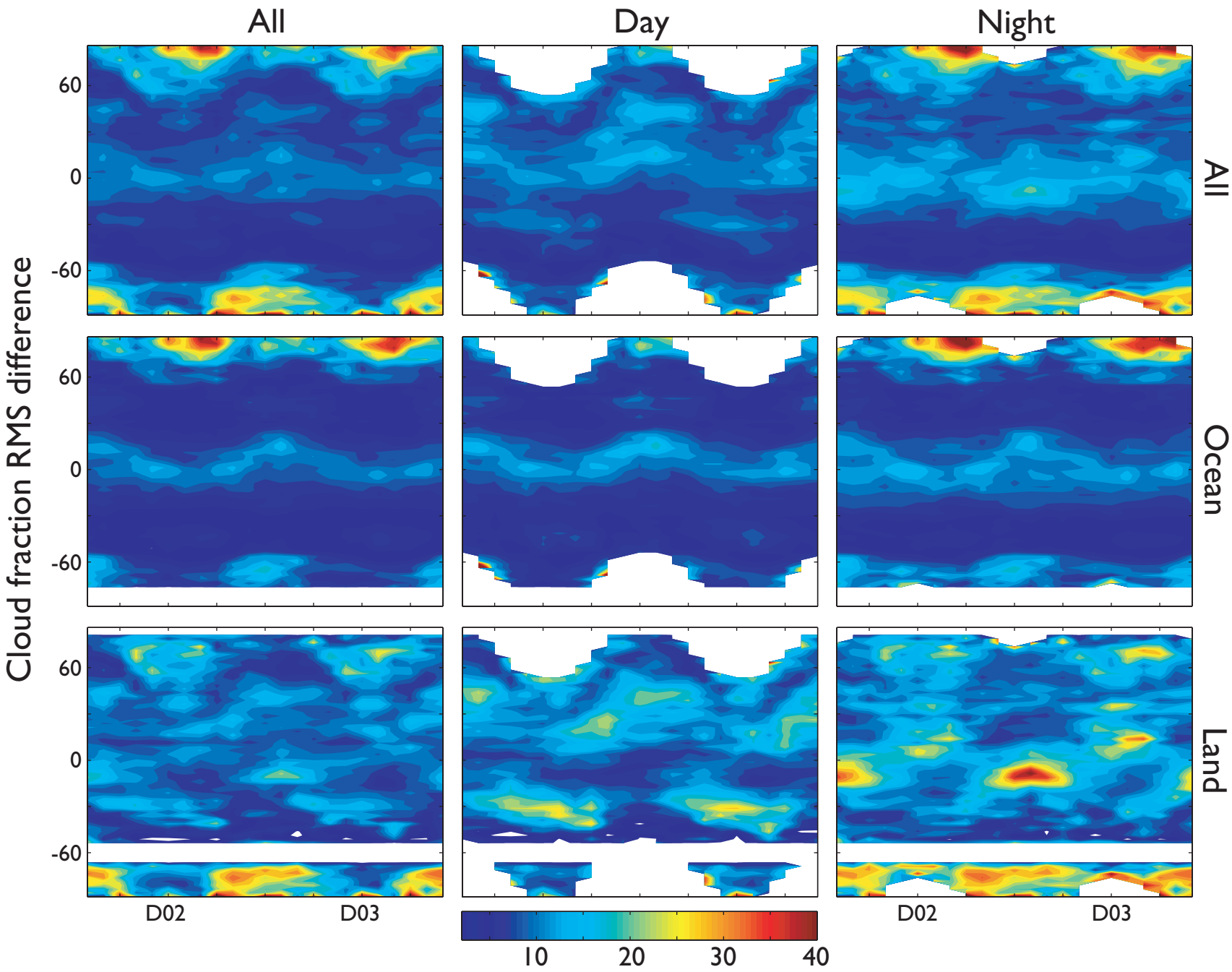
Comparisons are with MODIS collection 5

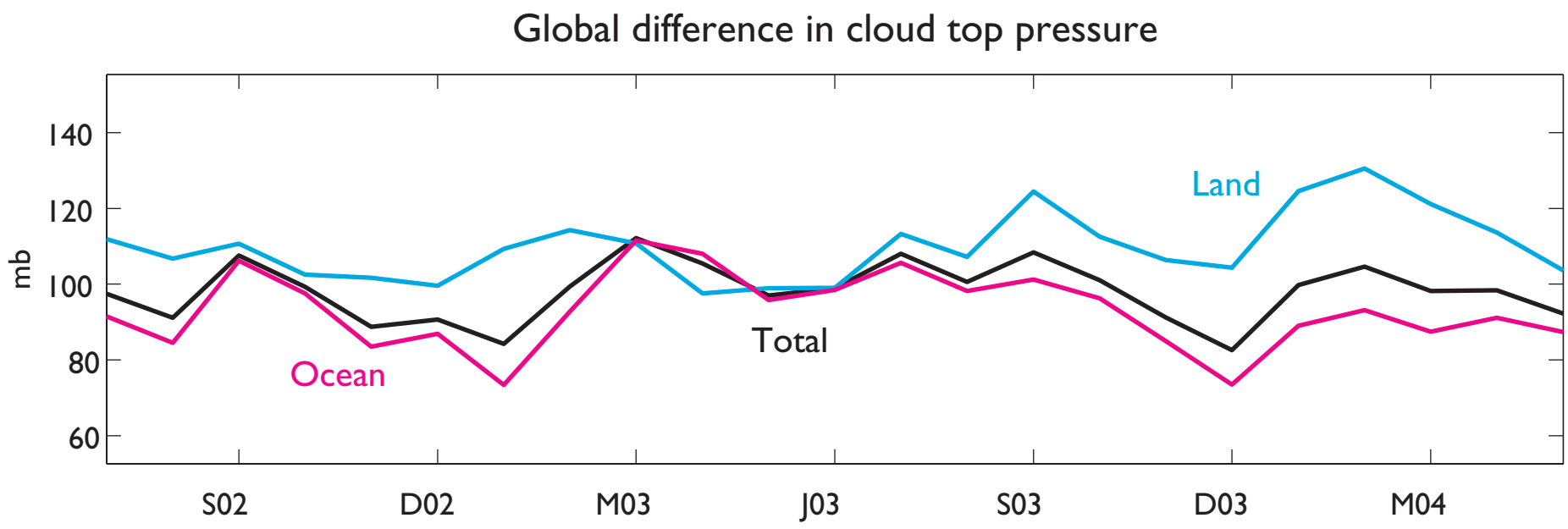
- Collection 4 has been available since 2004
- Largest differences are for clouds at night over the ocean

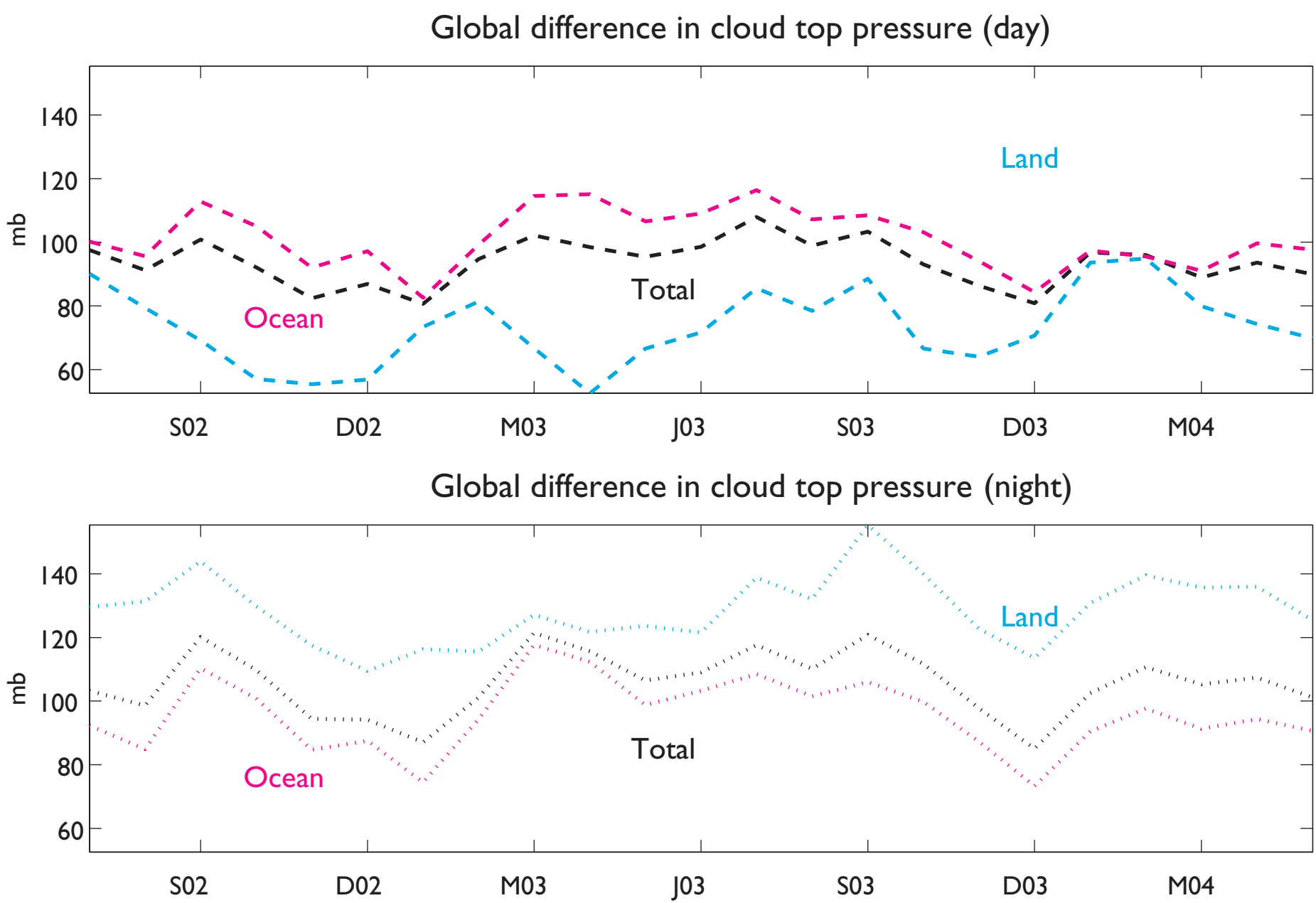

Global difference in cloud fraction
Ocean
Land
Total
Percent
5
0
-5
S02
D02
M03
J03
S03
D03
M04

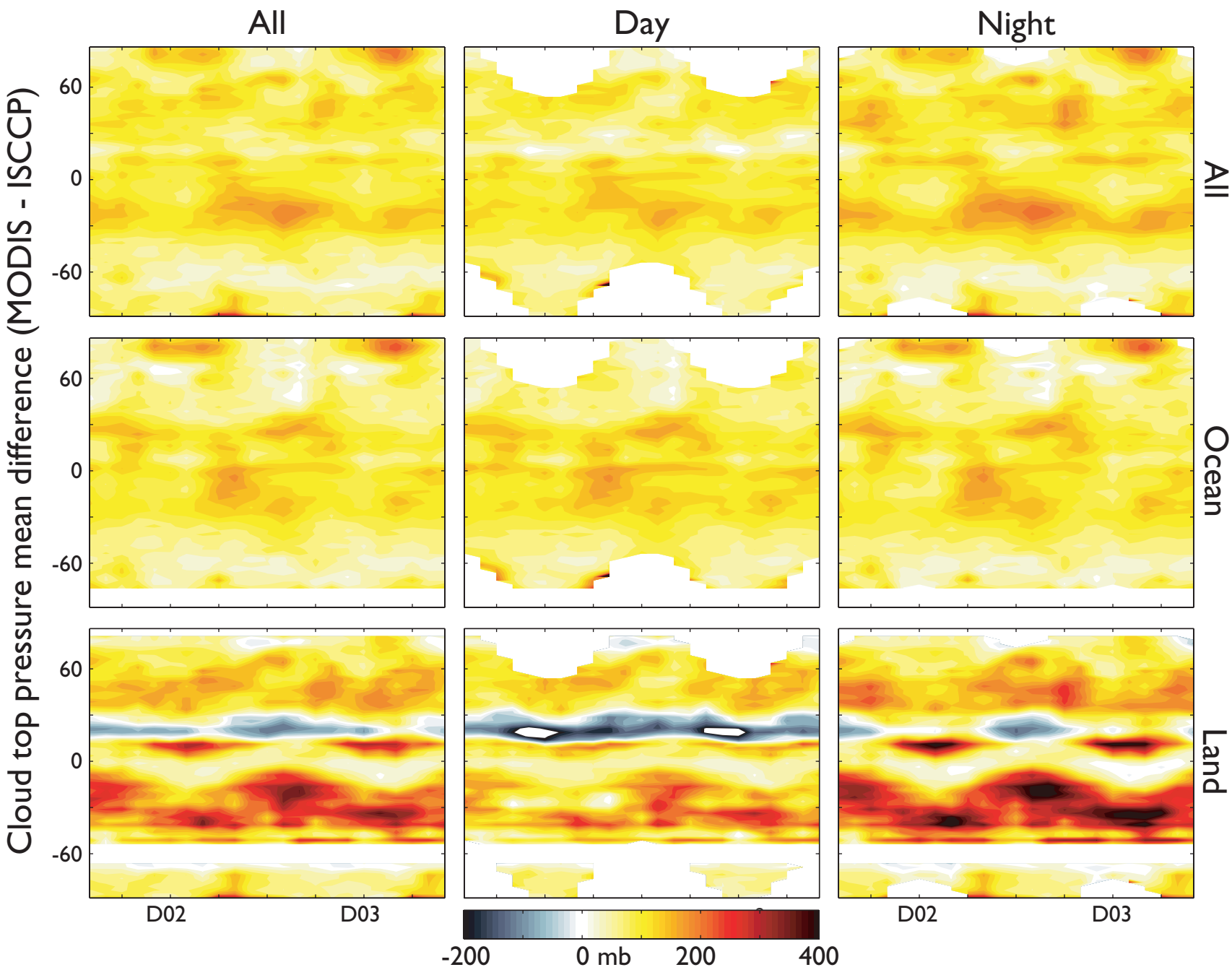

Global difference in cloud fraction (day)
Ocean
Land
Total
Percent
5
0
-5
S02
D02
M03
J03
S03
D03
M04
Global difference in cloud fraction (night)
Ocean
Land
Total
Percent
5
0
-5
S02
D02
M03
J03
S03
D03
M04

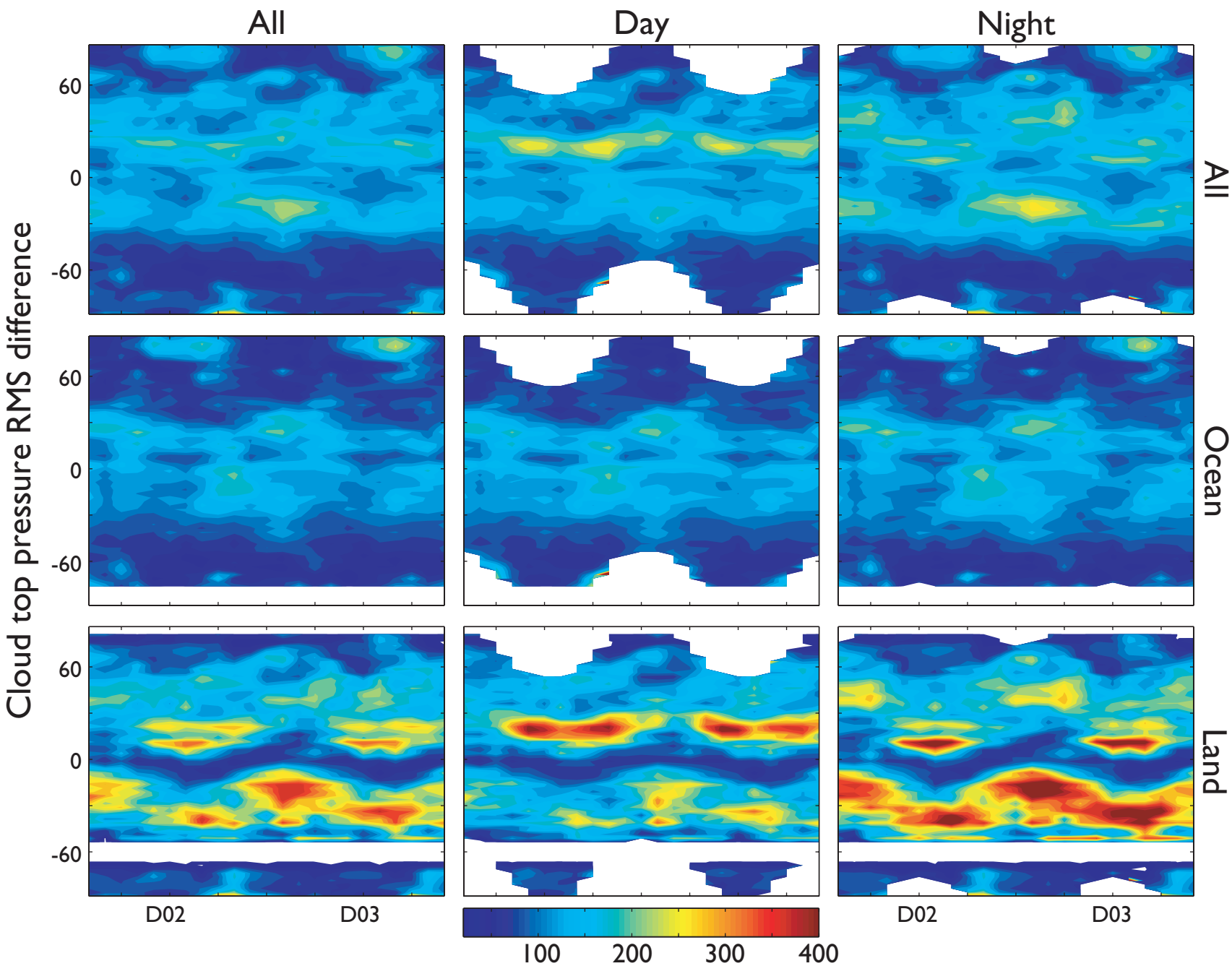

All
Day
Night
All
Ocean
Land
Cloud fraction mean difference (MODIS - ISCCP)
60
0
-60
D02
D03
-40
-20
0
20
40

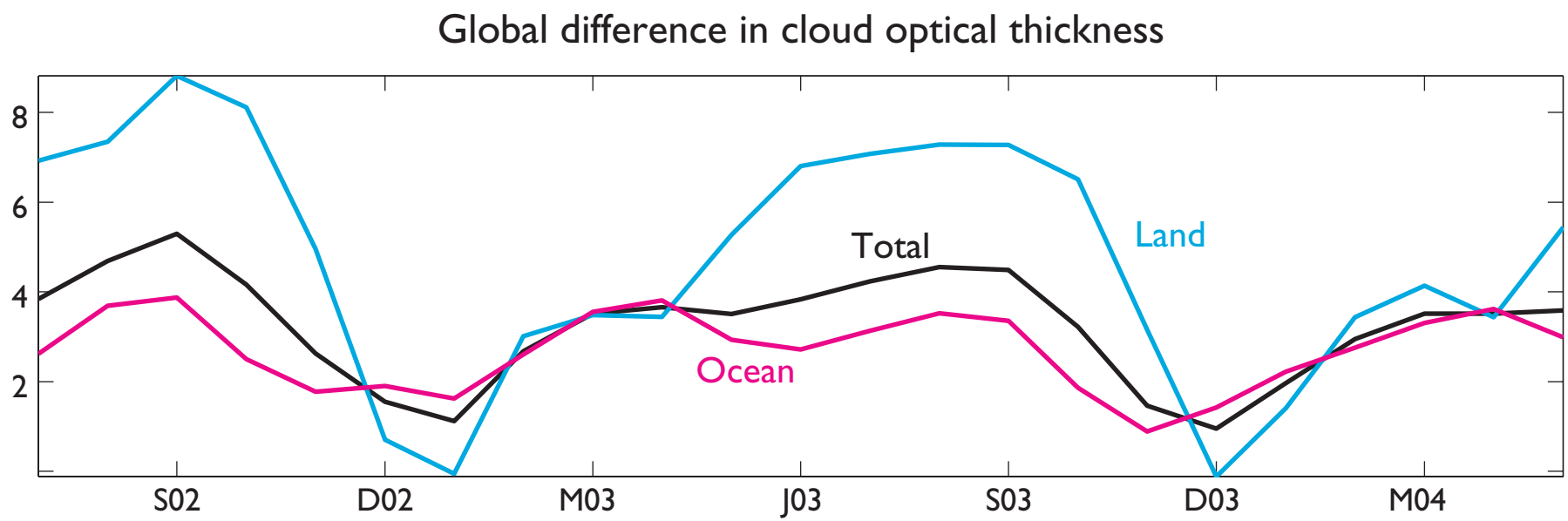

All
Day
Night
All
Ocean
Land
Cloud fraction RMS difference
60
0
-60
D02
D03
10
20
30
40


Global difference in cloud top pressure
mb
140
120
100
80
60
Land
Total
Ocean
S02
D02
M03
J03
S03
D03
M04


Global difference in cloud top pressure (day)
mb
140
120
100
80
60
Land
Total
Ocean
S02
D02
M03
J03
S03
D03
M04
Global difference in cloud top pressure (night)
mb
140
120
100
80
60
Land
Total
Ocean
S02
D02
M03
J03
S03
D03
M04


All
Day
Night
All
Ocean
Land
Cloud top pressure mean difference (MODIS - ISCCP)
60
0
-60
D02
D03
-200
0 mb
200
400


All
Day
Night
All
Ocean
Land
Cloud top pressure RMS difference
60
0
-60
D02
D03
100
200
300
400


Global difference in cloud optical thickness
8
6
4
2
Land
Total
Ocean
S02
D02
M03
J03
S03
D03
M04

Cloud optical thickness mean difference (MODIS - ISCCP)
All
Ocean
Land
60
0
-60
D02
D03
-10
0
10

Our story so far

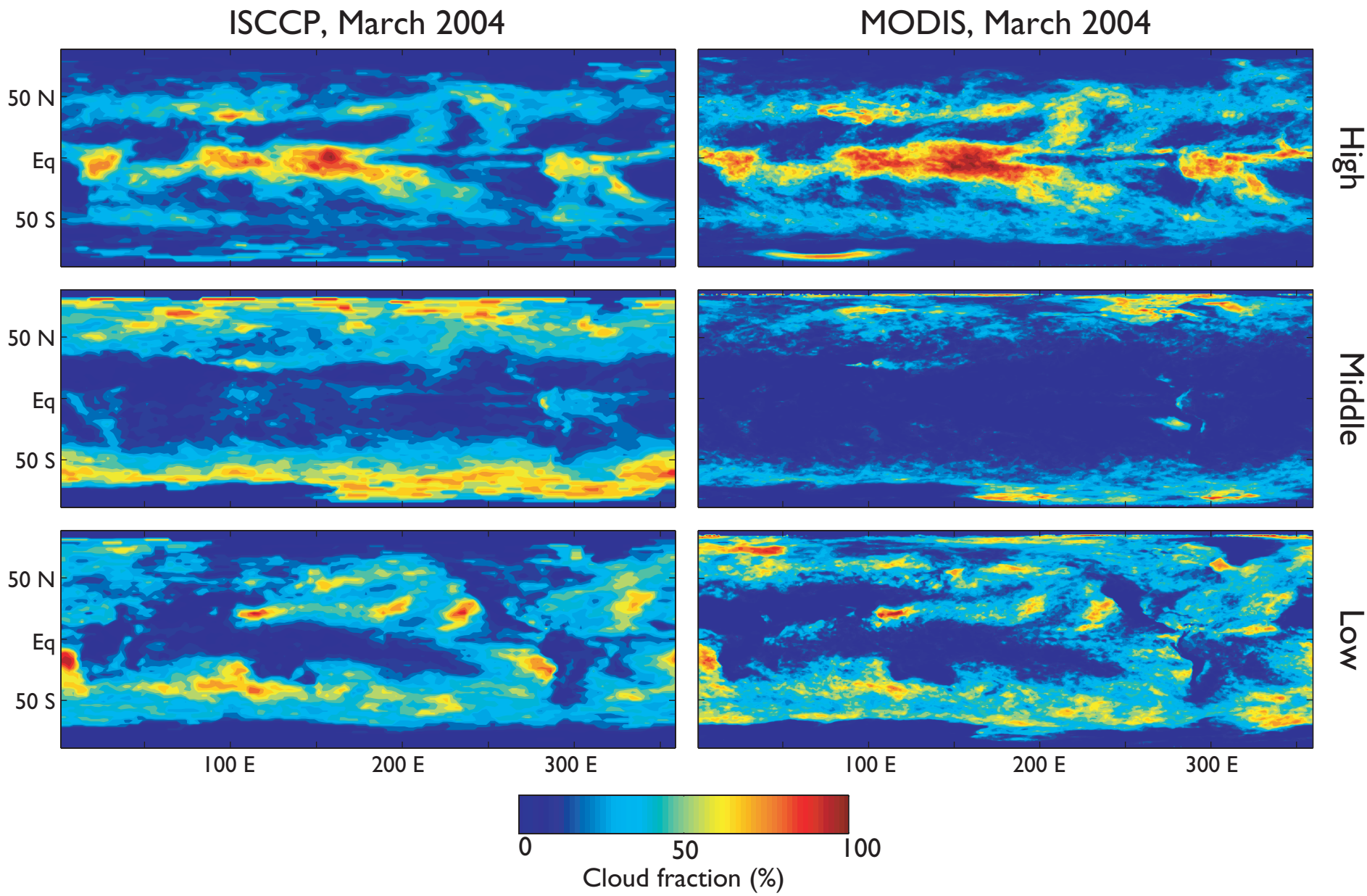
Relative to ISCCP, clouds observed by MODIS tend to be

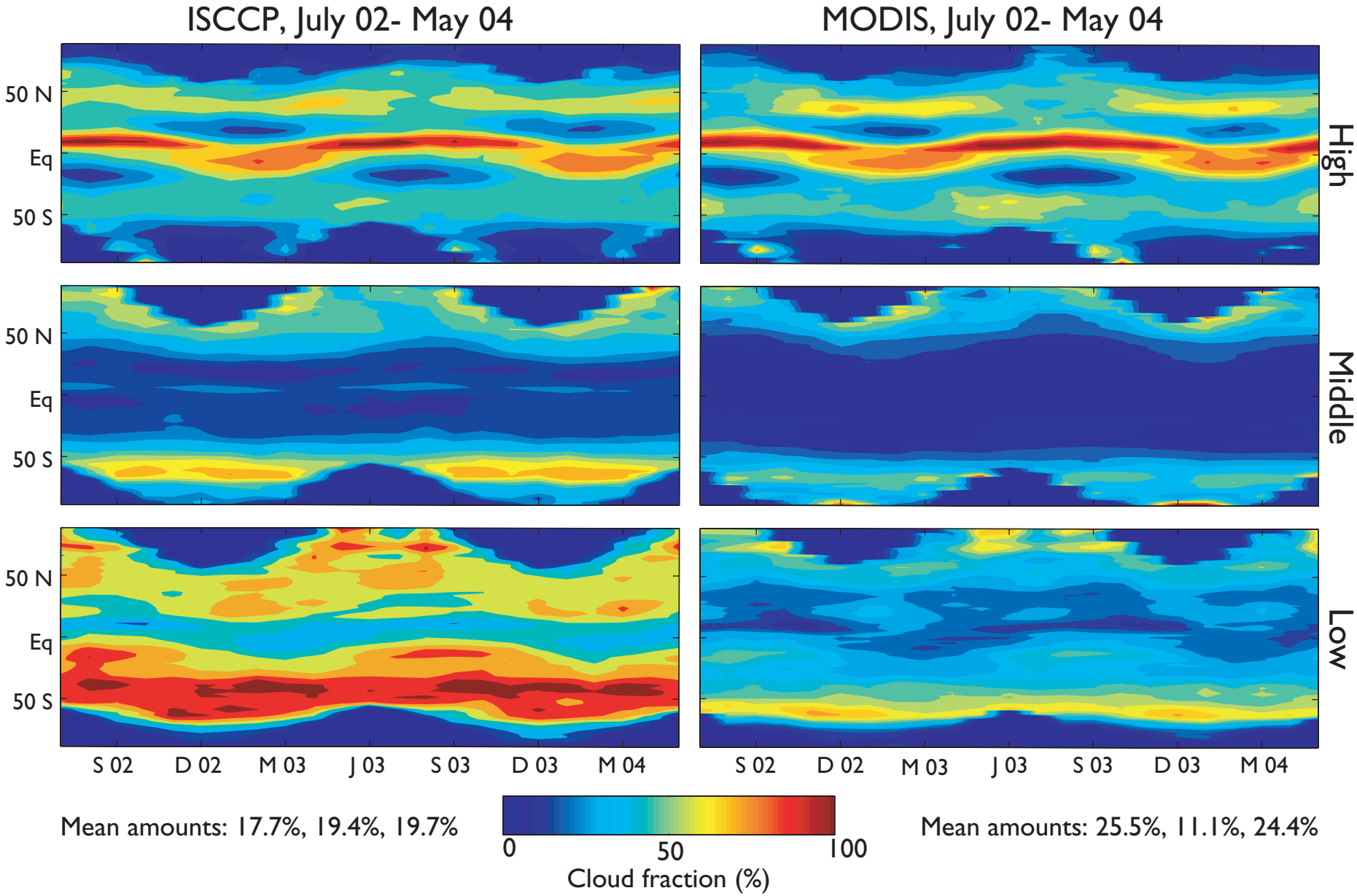
slightly more frequent, lower in the atmosphere (and warmer), and optically thicker

Differences are most pronounced over land during the day

Re-sampling ISCCP to match MODIS observation time doesn't improve agreement substantially (not shown)

MODIS is more likely to put clouds at high or low levels than ISCCP




ISCCP, July 02- May 04
MODIS, July 02- May 04
50 N
Eq
50 S
High
Middle
Low
S 02
D 02
M 03
J 03
S 03
D 03
M 04
Mean amounts: 17.7%, 19.4%, 19.7%
Mean amounts: 25.5%, 11.1%, 24.4%
0
50
100
Cloud fraction (%)

Guidance on using MODIS and ISCCP cloud data sets

The devil is in the details

e.g. averaging methods, adjustments, …

MODIS and ISCCP seem about the same clouds, on average

MODIS puts less cloud in the middle of the atmosphere

Diurnal sampling errors for (single-platform) MODIS data are moderate