A uniform space-time grid for the inter-comparison of global cloud top pressure retrievals

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Why grid data?

Observation **(non-uniform)** → Space-time **(uniform)**

Data reduction and accessibility
Multi-instrument data comparisons
Time series analysis

We propose a space-time gridding algorithm

Gridding on the fly
Dynamic output grid size
Time statistics made up of daily statistics
Instrument independent

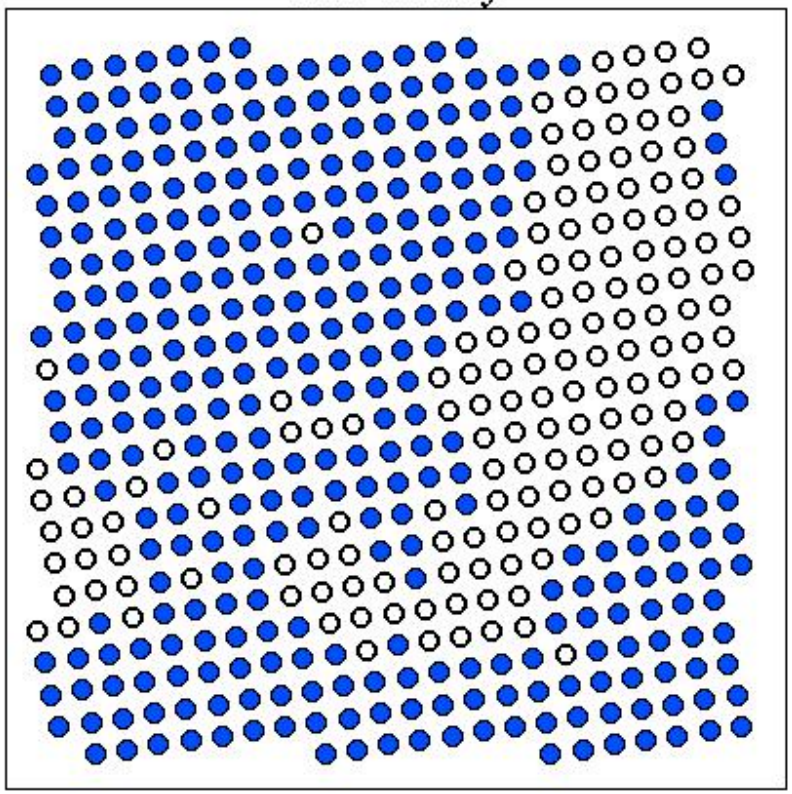
STEP 1: SPACE Gridding

1 x 1 degree grid cell

MODIS measurements = 487

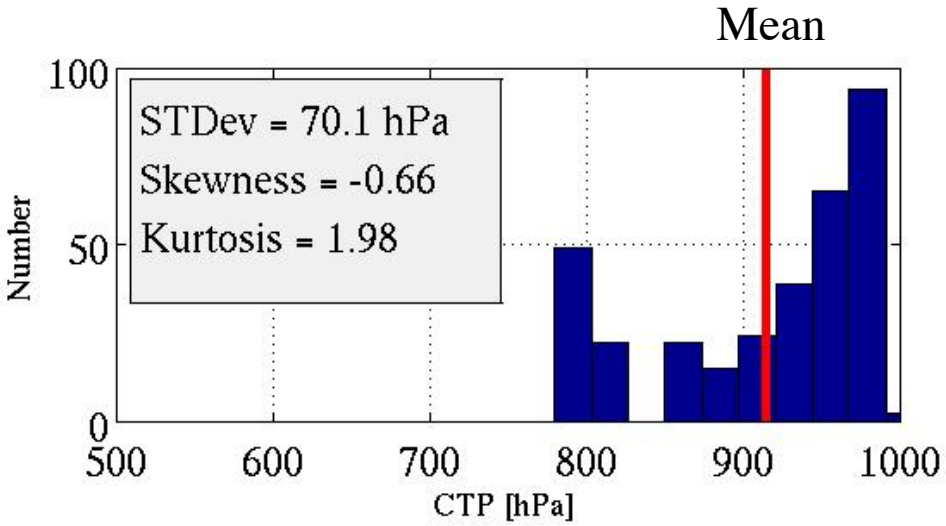
CTP retrievals = 332

68% cloudy



Physical data reduction

- day/night, nadir/off-nadir, lat/lon
- Store only parameter value and index for total observations



STEP 2: TIME Gridding

Statistical data reduction

Weighted time average

$$\mathrm{CTP}_m = \frac{\sum_{days}(\% \times \mathrm{CTP}_d)}{\sum_{days}(\%)} = \frac{\sum_{days}\left(\frac{\mathrm{obs}_C}{\mathrm{obs}_\mathrm{T}} \times \mathrm{CTP}_d\right)}{\sum_{days}\left(\frac{\mathrm{obs}_C}{\mathrm{obs}_\mathrm{T}}\right)}$$

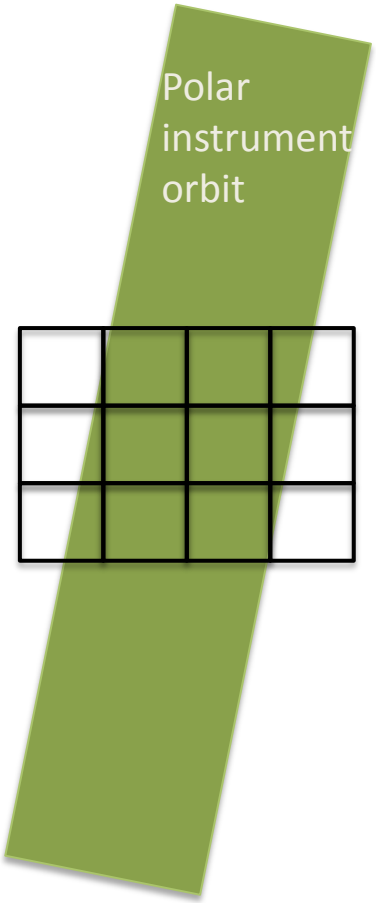
CTP_m = monthly average of cloud top pressure (CTP)

CTP_d = daily weighted average of CTP

obs_T = total clear and cloudy observations per grid cell per day

obs_C = total cloud observations per grid cell per day

Key questions that follow



- How can statistical bias be reduced?
- How to prevent misrepresentation of cloud statistics?
- When is a day of observations not worth averaging?

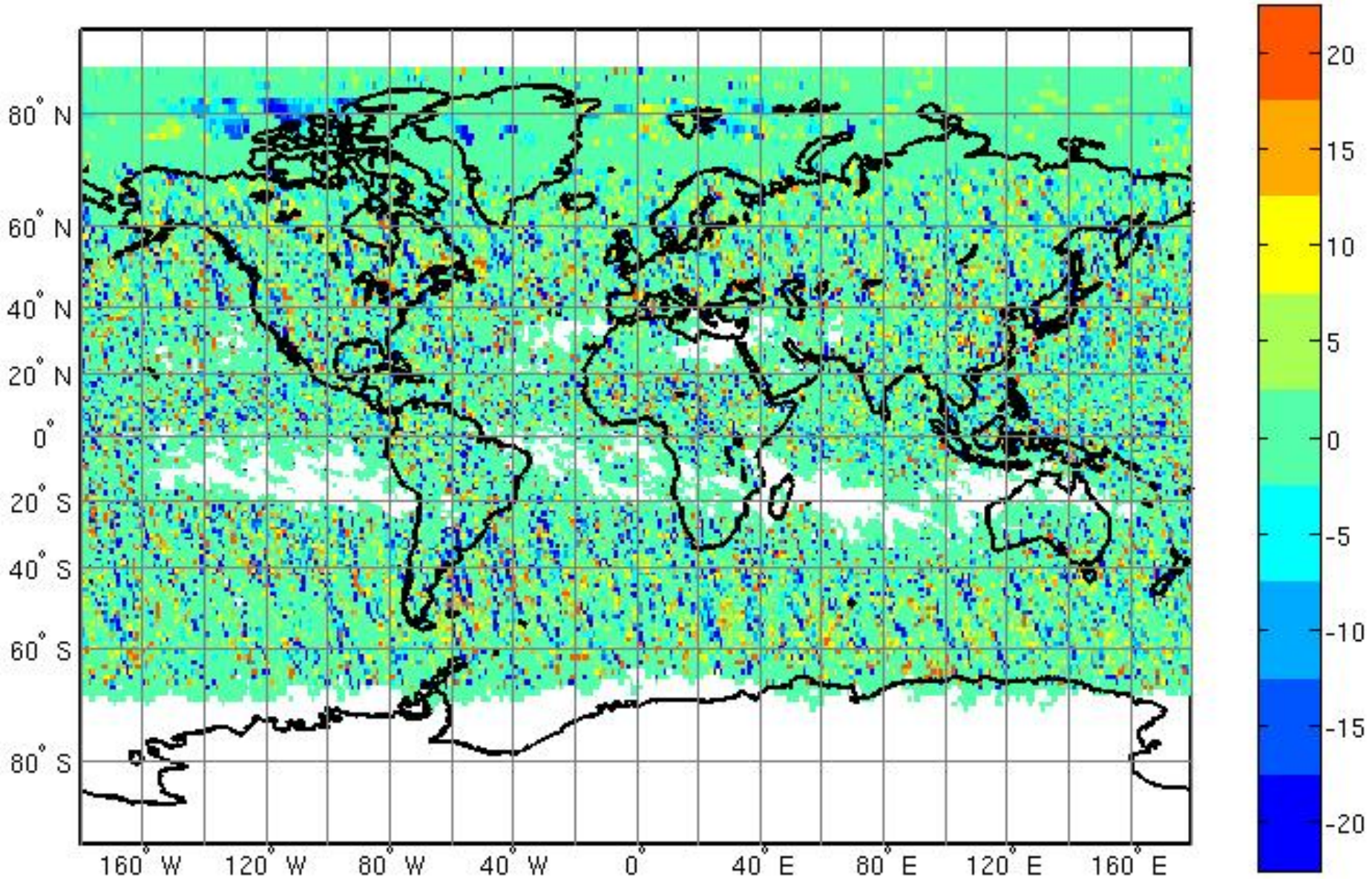
(1) $\text{obs}_T \geq 0$

(2) $\text{obs}_T \geq \bar{m} - 1.5\sigma$

(93% of the observations)

$$\bar{m} = \frac{\sum \text{obs}_T}{\sum_{days} days}$$

Monthly average difference: (All) minus (Filtered)

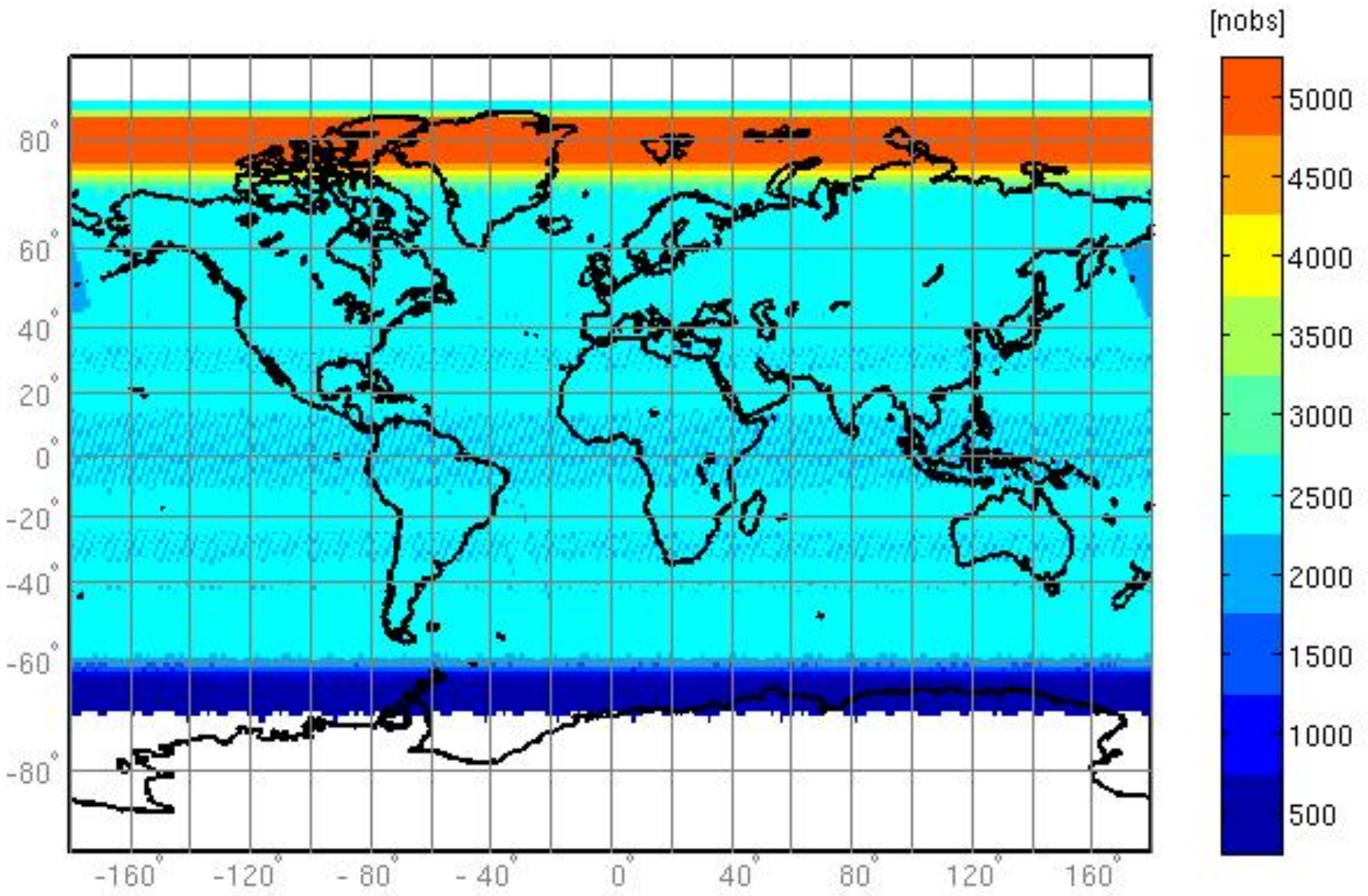


TIME

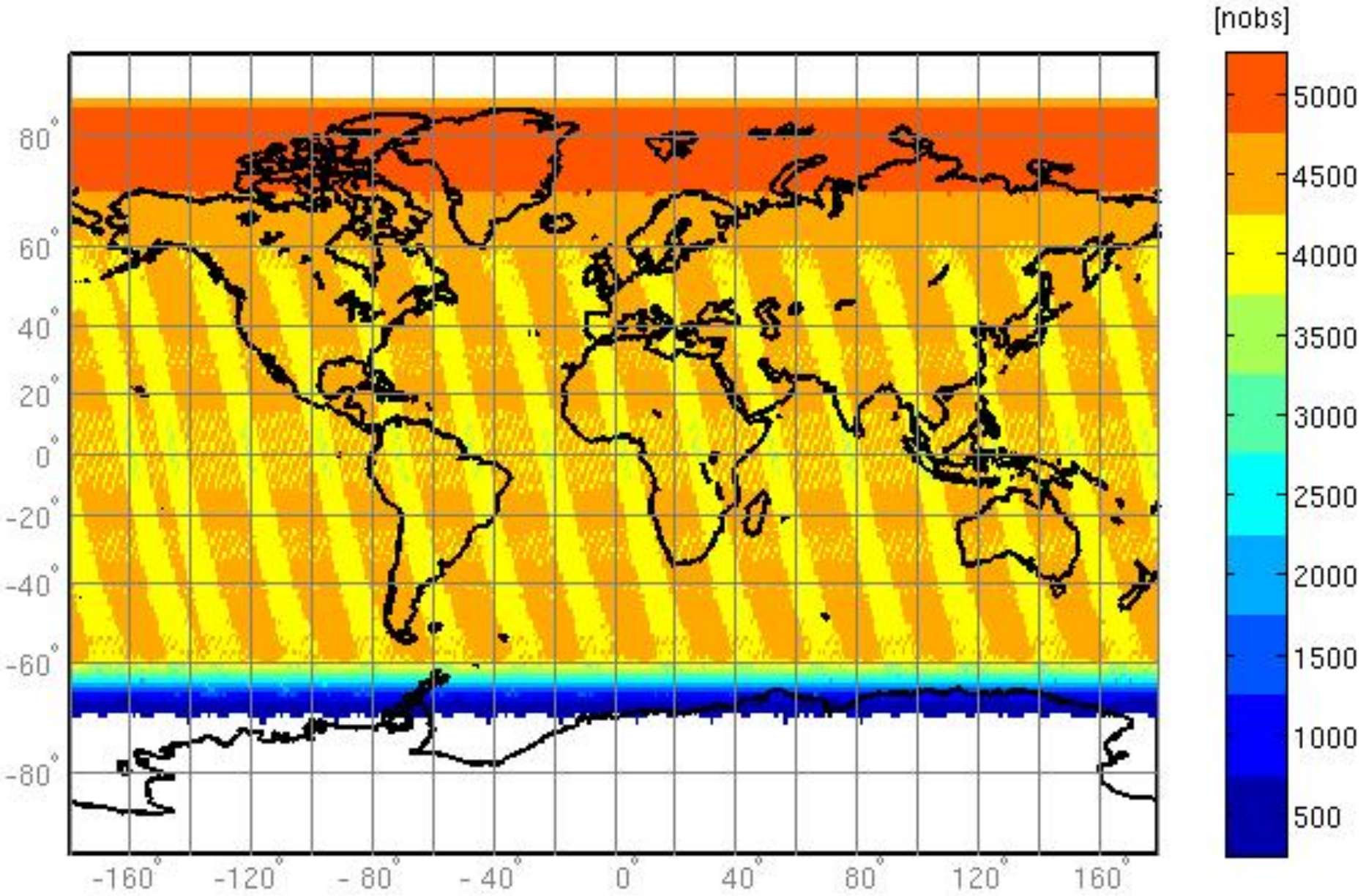
Aqua/MODIS CTP operational product (MYD06, coll. 5)

- High clouds only (CTP < 440 hPa)
- August 2009
- Daytime (sun zenith < 84˚)
- near-nadir (satellite zenith < 32˚)
- 1˚ × 1˚ grid size
- OBS_T filter

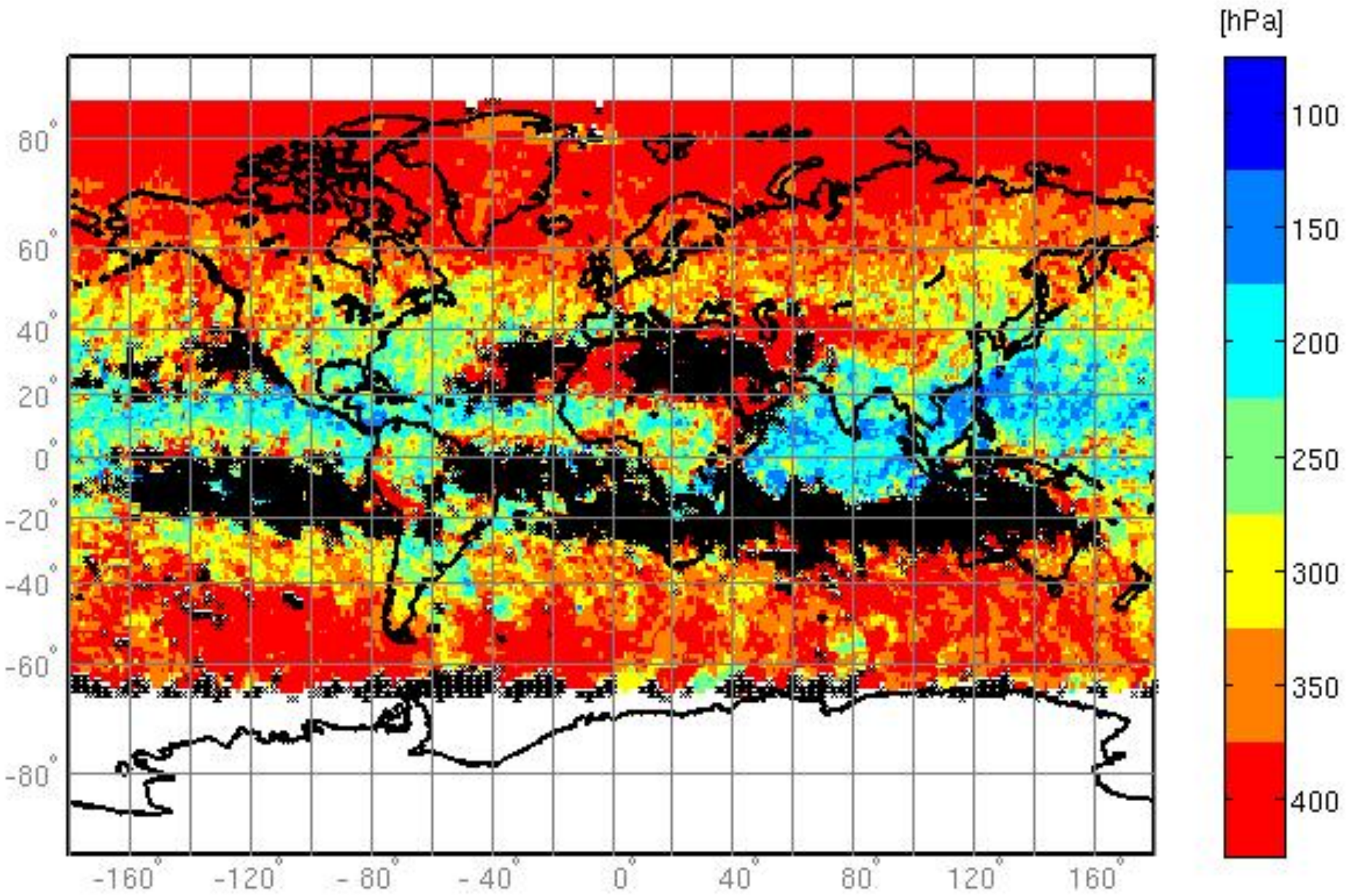
Total observations 1-16 Aug



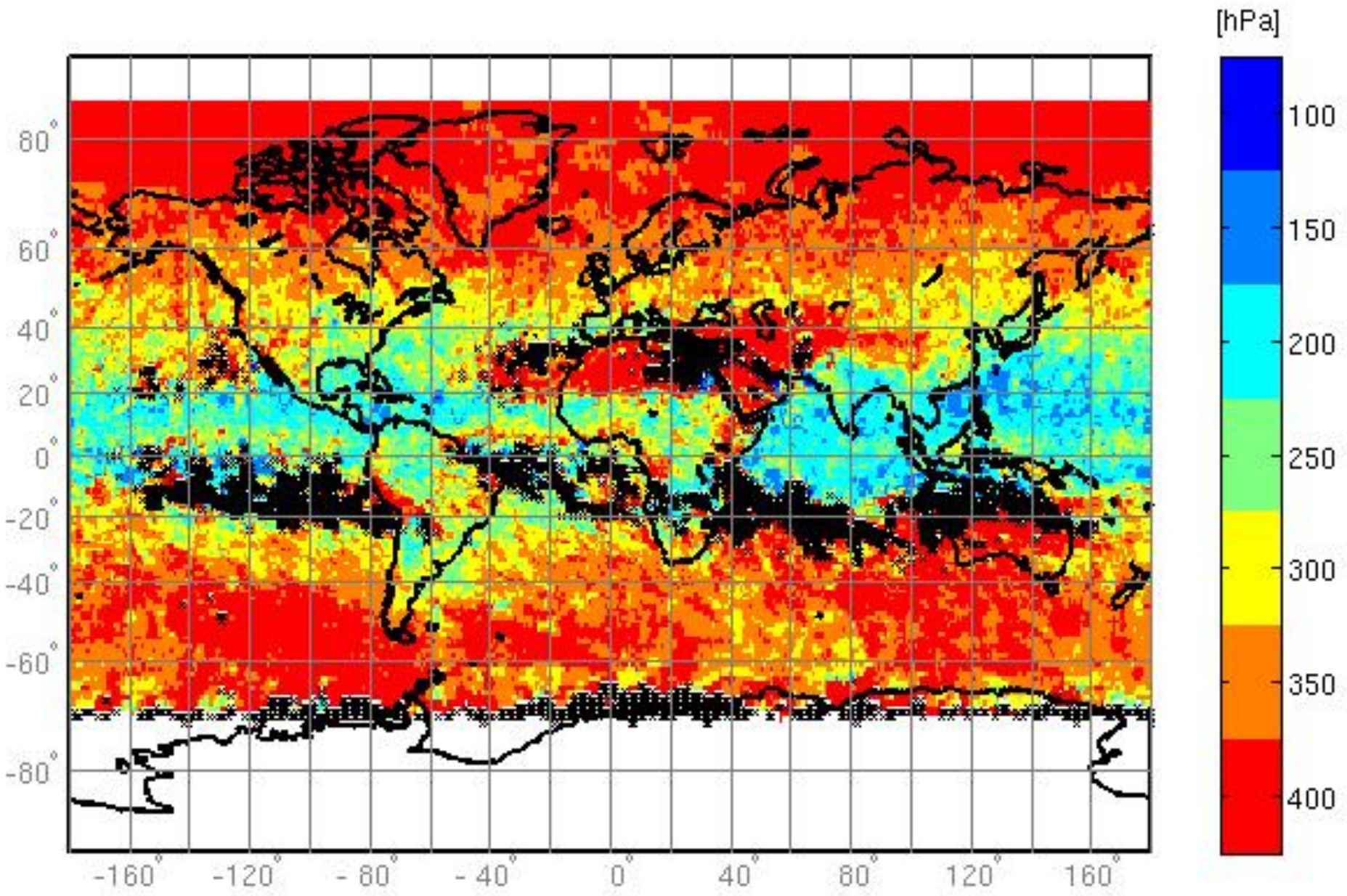
Total observations 1-31 Aug



Average of 16 days



Average of 31 days

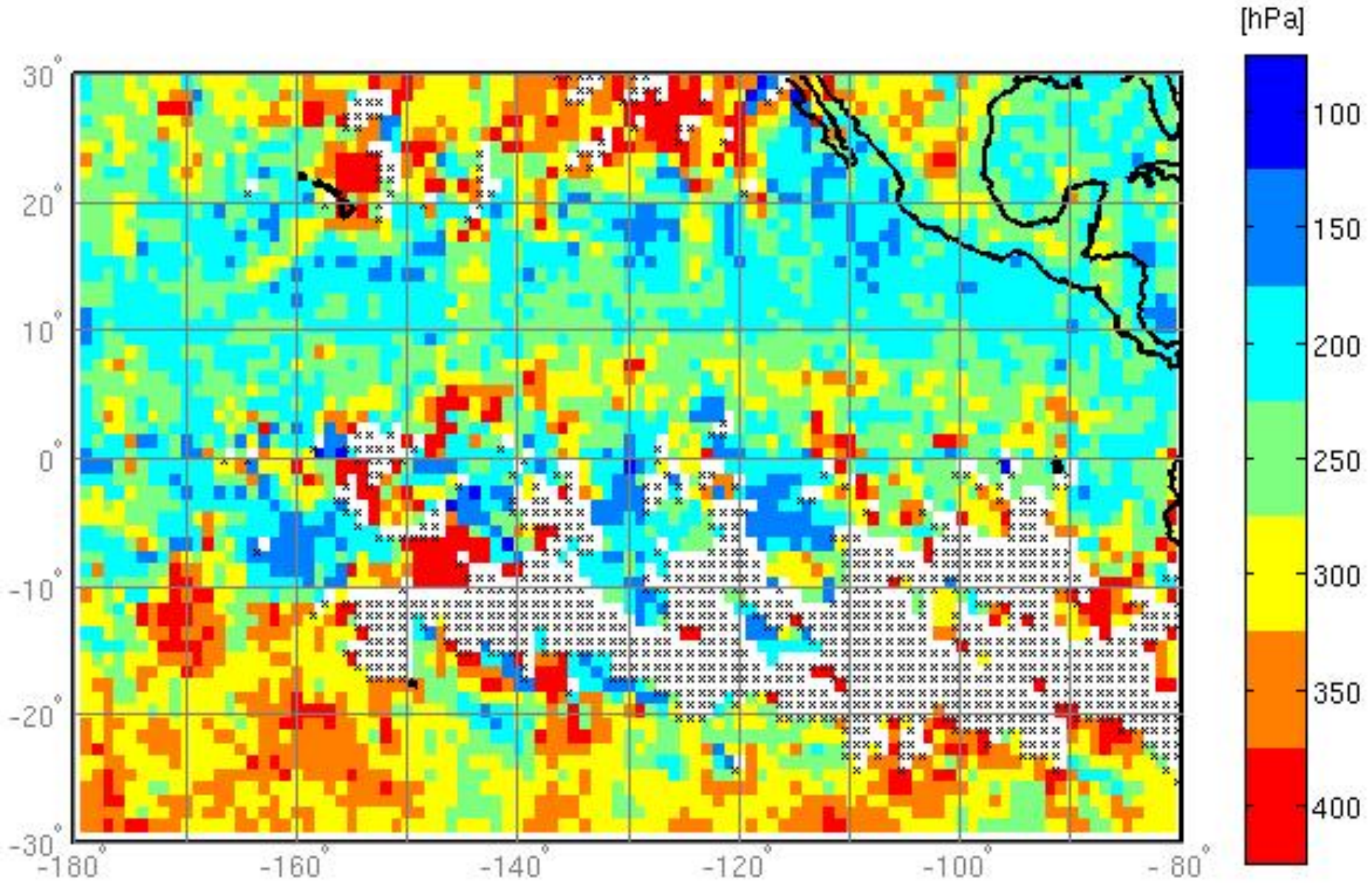


SPACE

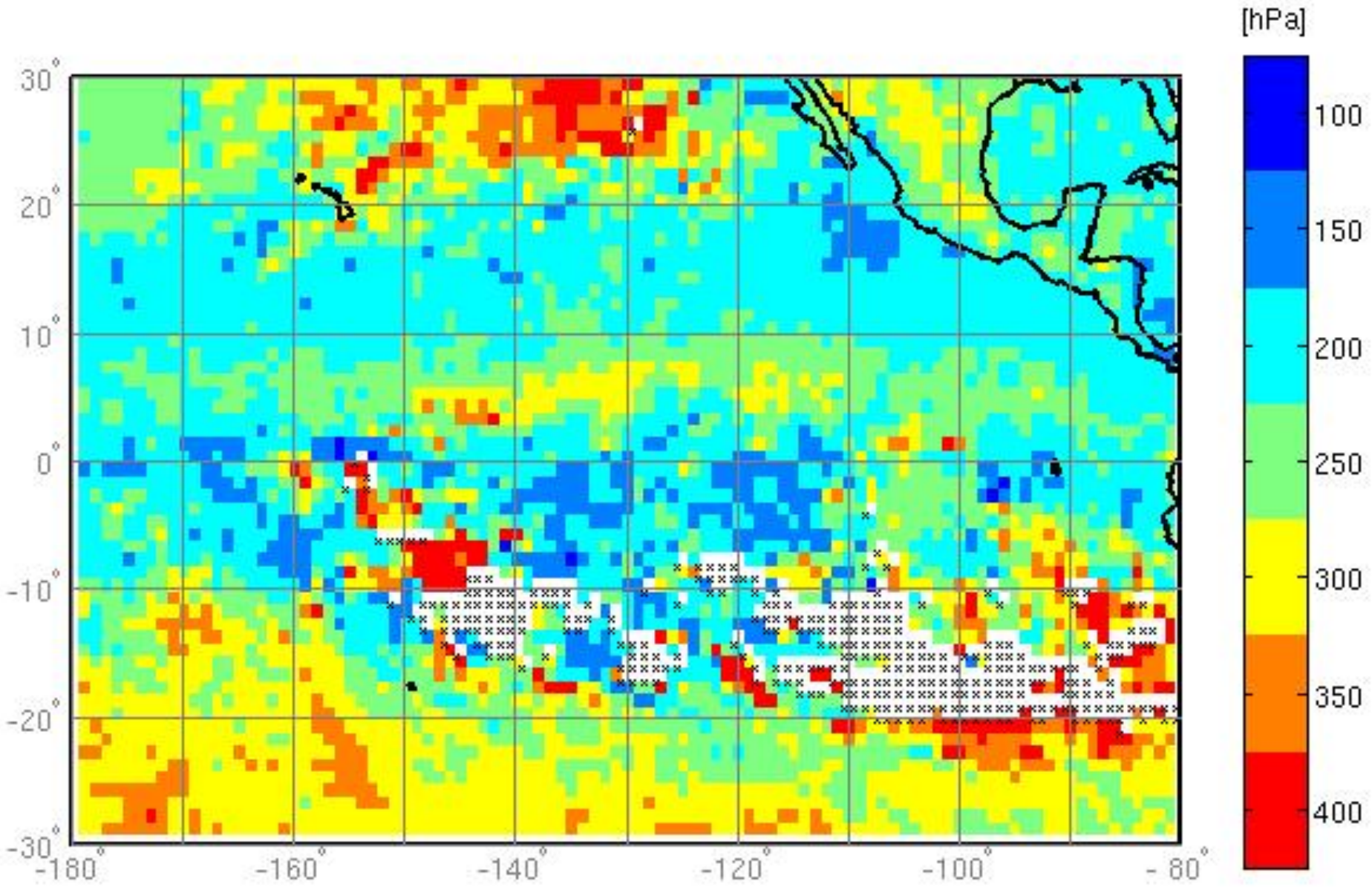
Aqua/MODIS CTP operational product (MYD06, coll. 5)

- High clouds only (CTP < 440 hPa)
- 1 – 31 August 2009
- Daytime (sun zenith < 84˚)
- OBS_T filter

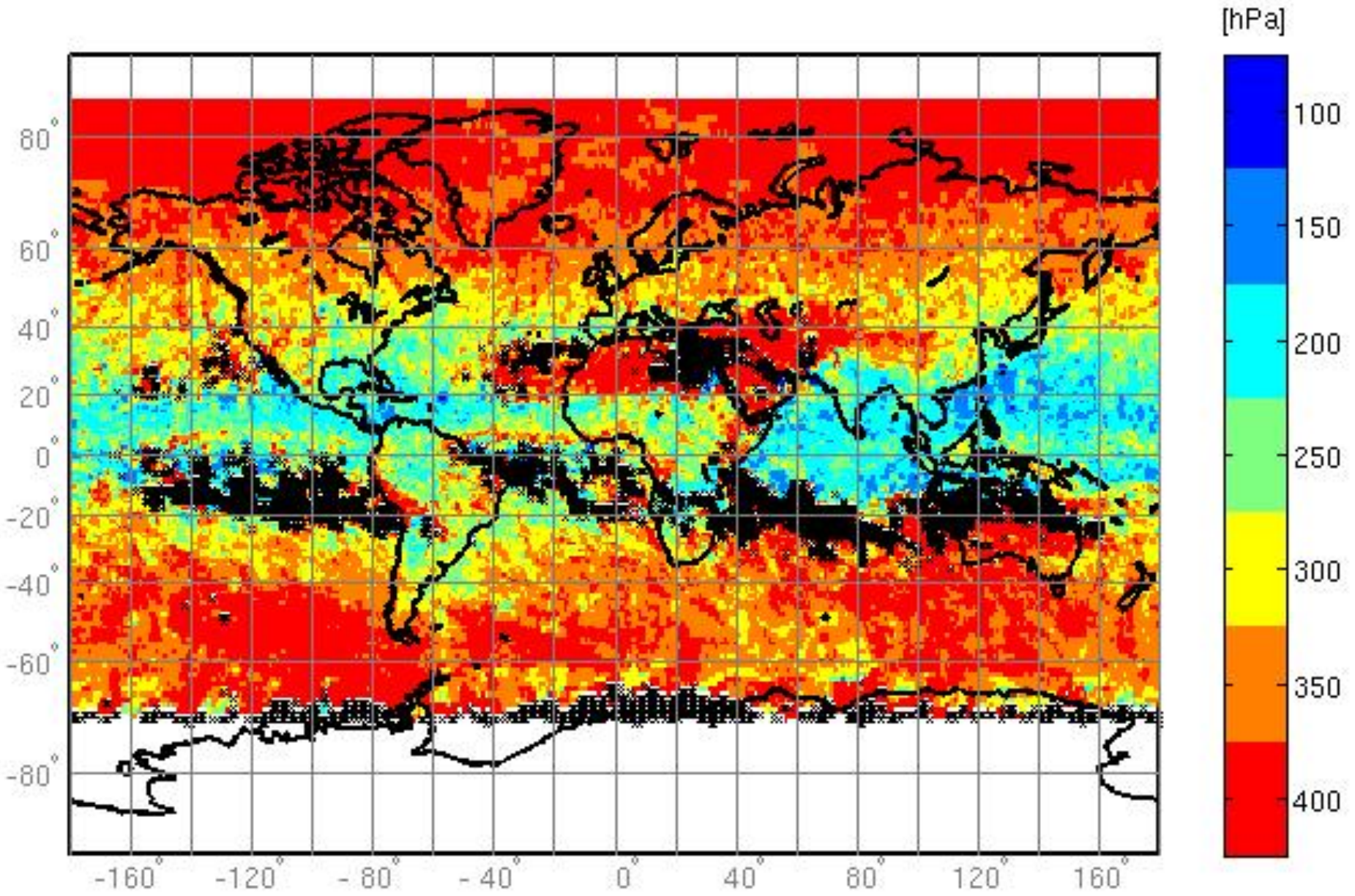
MODIS CTP average: viewing angle ≤ 32˚



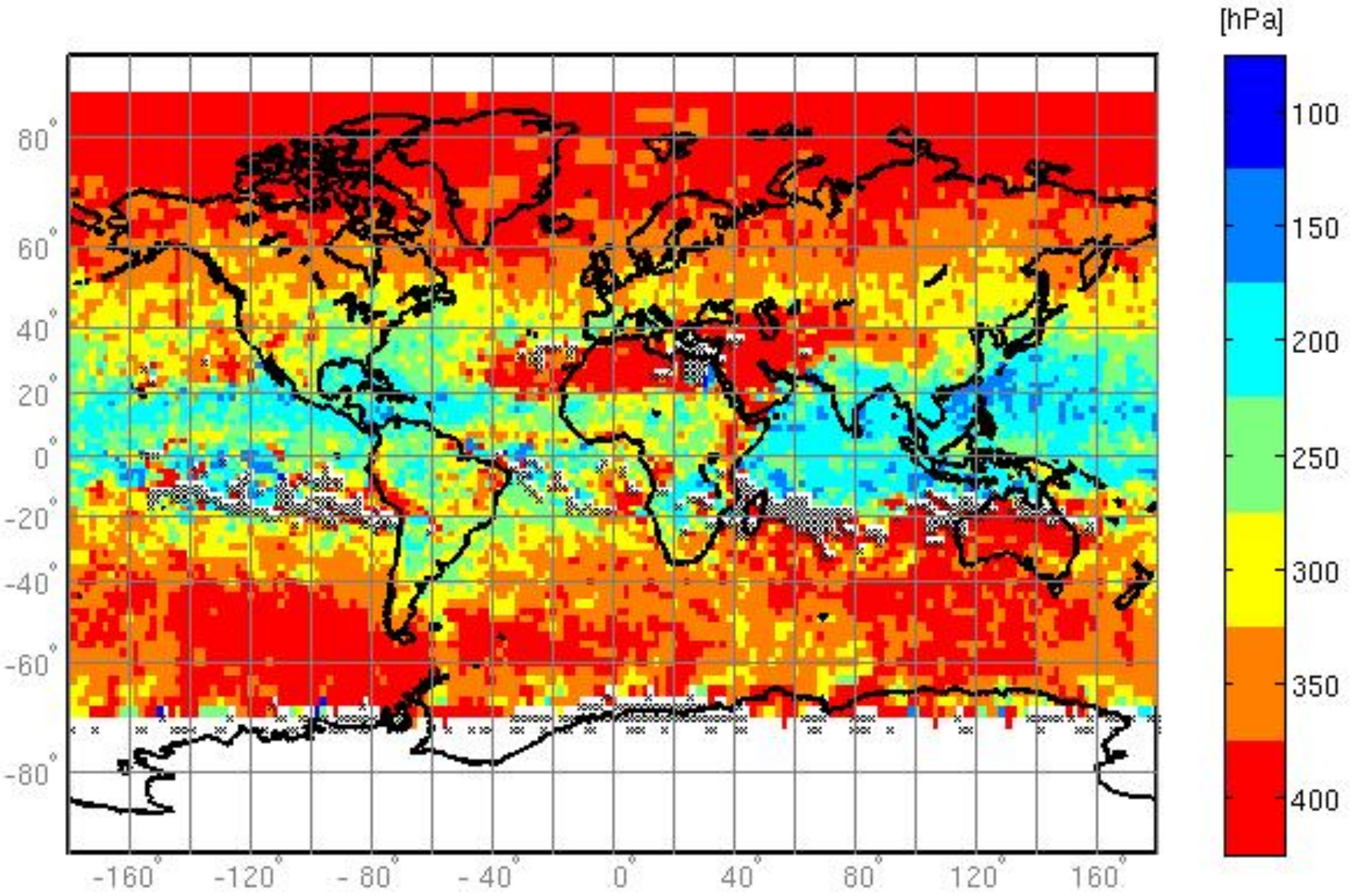
MODIS CTP average: ALL viewing angles



MODIS CTP average: grid size = 1.0˚



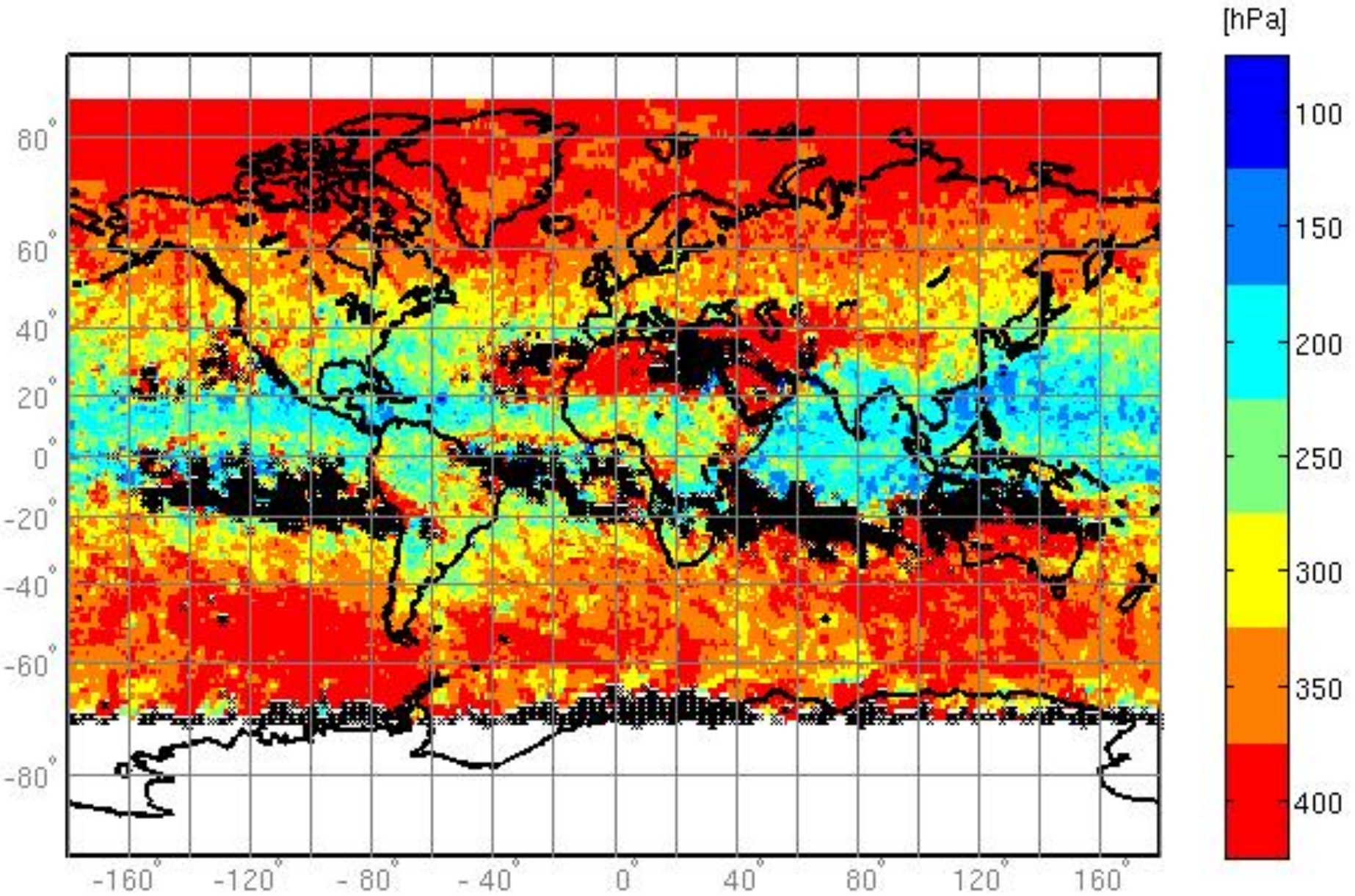
MODIS CTP average: grid size = 2.0˚



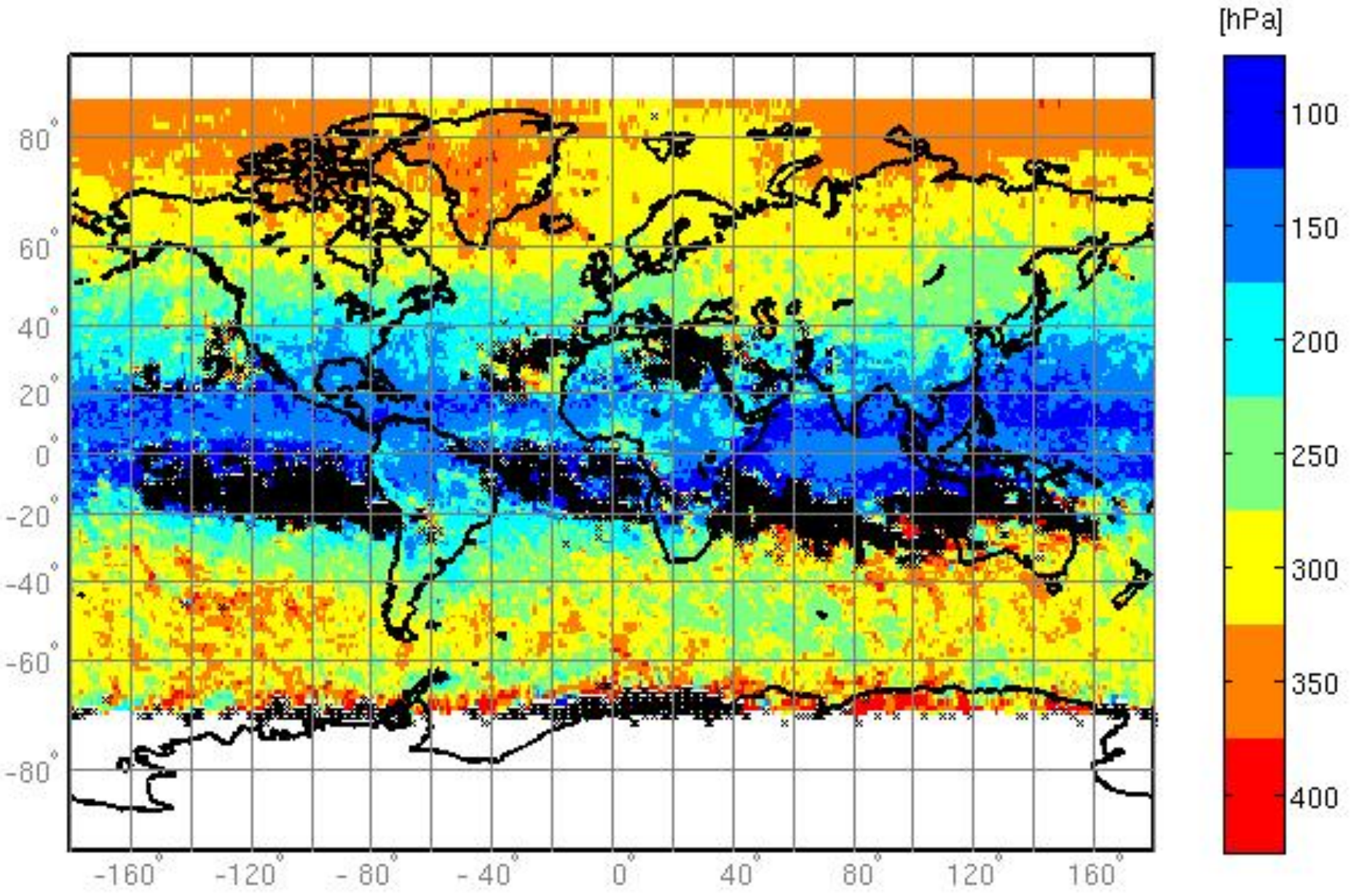
Multiple instrument comparison of
daytime (sun zenith < 84º)
monthly average (1-31 Aug 2009)
high CTP (< 440 hPa)

Aqua/MODIS (MYD06, coll. 5)
AIRS (Level 2 product)
CALIOP (Level 2 product)

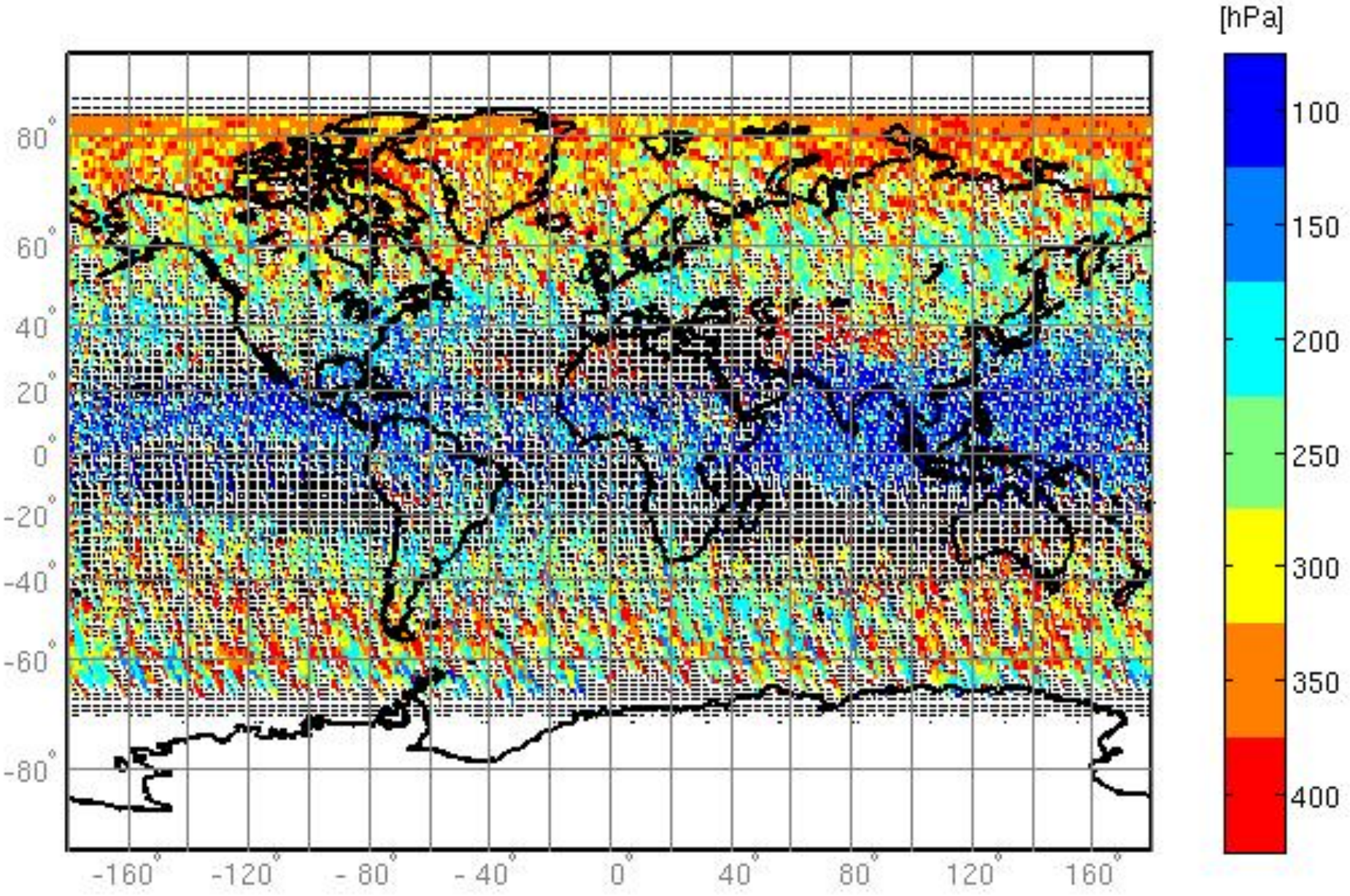
MODIS


[hPa]
100
150
200
250
300
350
400
80°
60°
40°
20°
0°
-20°
-40°
-60°
-80°
-160°
-120°
- 80°
- 40°
0°
40°
80°
120°
160°

AIRS


[hPa]
100
150
200
250
300
350
400
80°
60°
40°
20°
0°
-20°
-40°
-60°
-80°
-160°
-120°
- 80°
- 40°
0°
40°
80°
120°
160°

CALIOP


[hPa]
100
150
200
250
300
350
400
80°
60°
40°
20°
0°
-20°
-40°
-60°
-80°
-160°
-120°
- 80°
- 40°
0°
40°
80°
120°
160°

This gridding tool allows us to address new types of science questions…

What are the strengths and weakness of different instruments and retrieval algorithms?

Can we blend/map different cloud retrieval products together for improved pattern and process analysis?

What is the behavior of different cloud properties over time and how are they correlated with each other?

How can we represent uncertainty over space and time?

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