Satellite retrievals relevant to cloud glaciation and electrification

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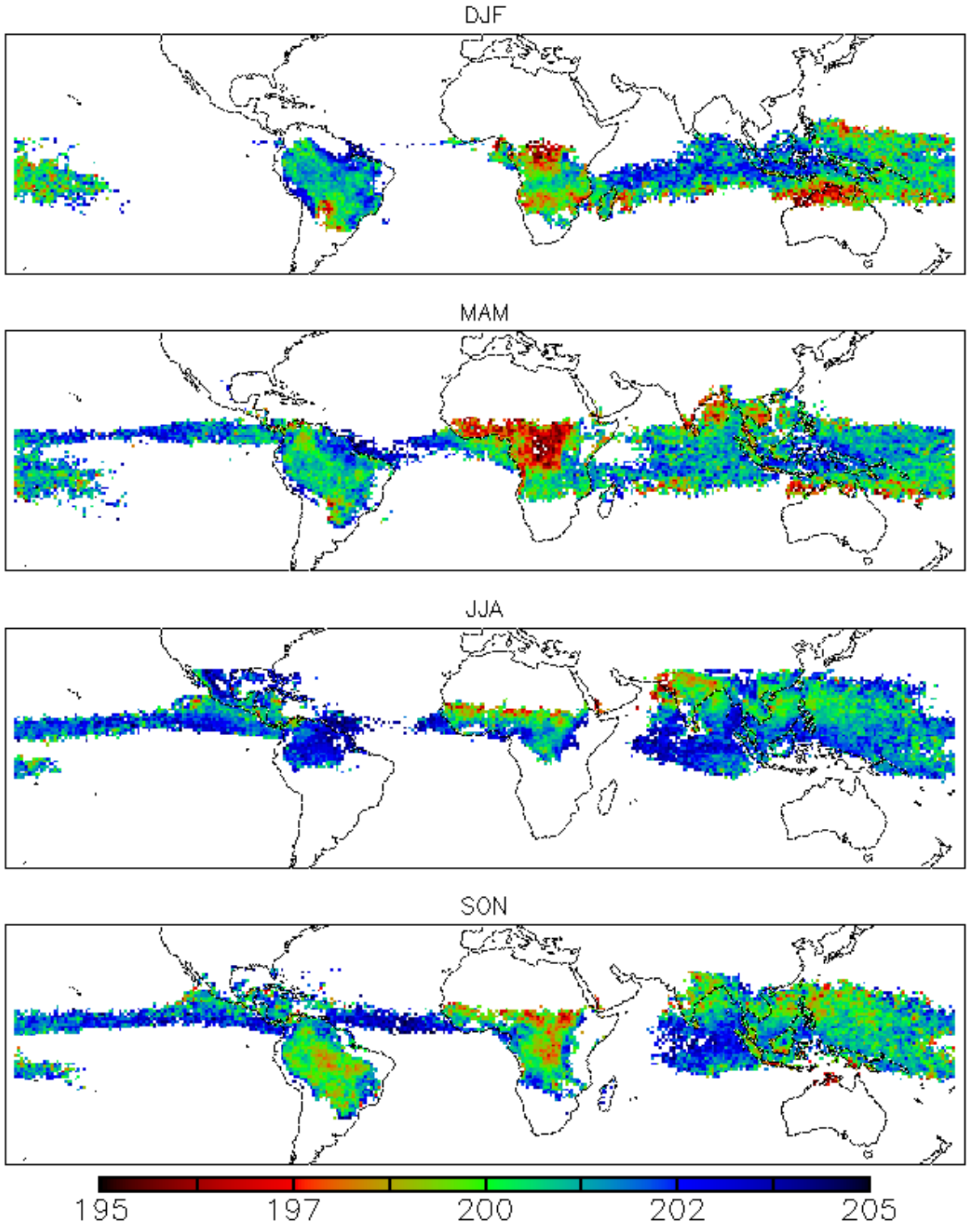
Outline

I will discuss only convective clouds. Questions:

- What can be estimated radiometrically?
  - Cloud height (window IR emission, e.g. 11 μm)
  - Total water content (visible albedo)
  - Particle size near top (NIR reflectance, e.g. 3.7 μm)
  - Phase (multispectral variation, e.g. 8.5/11/12 or 1.6/2.1 μm)
  - Crystal shape information (angular NIR reflectance var.)
  - Mass concentration near top (split window emission)
- Where is the "action" in cloud microphysical effects?
  - All over
- What have we learned about the processes?
  - Not simple.

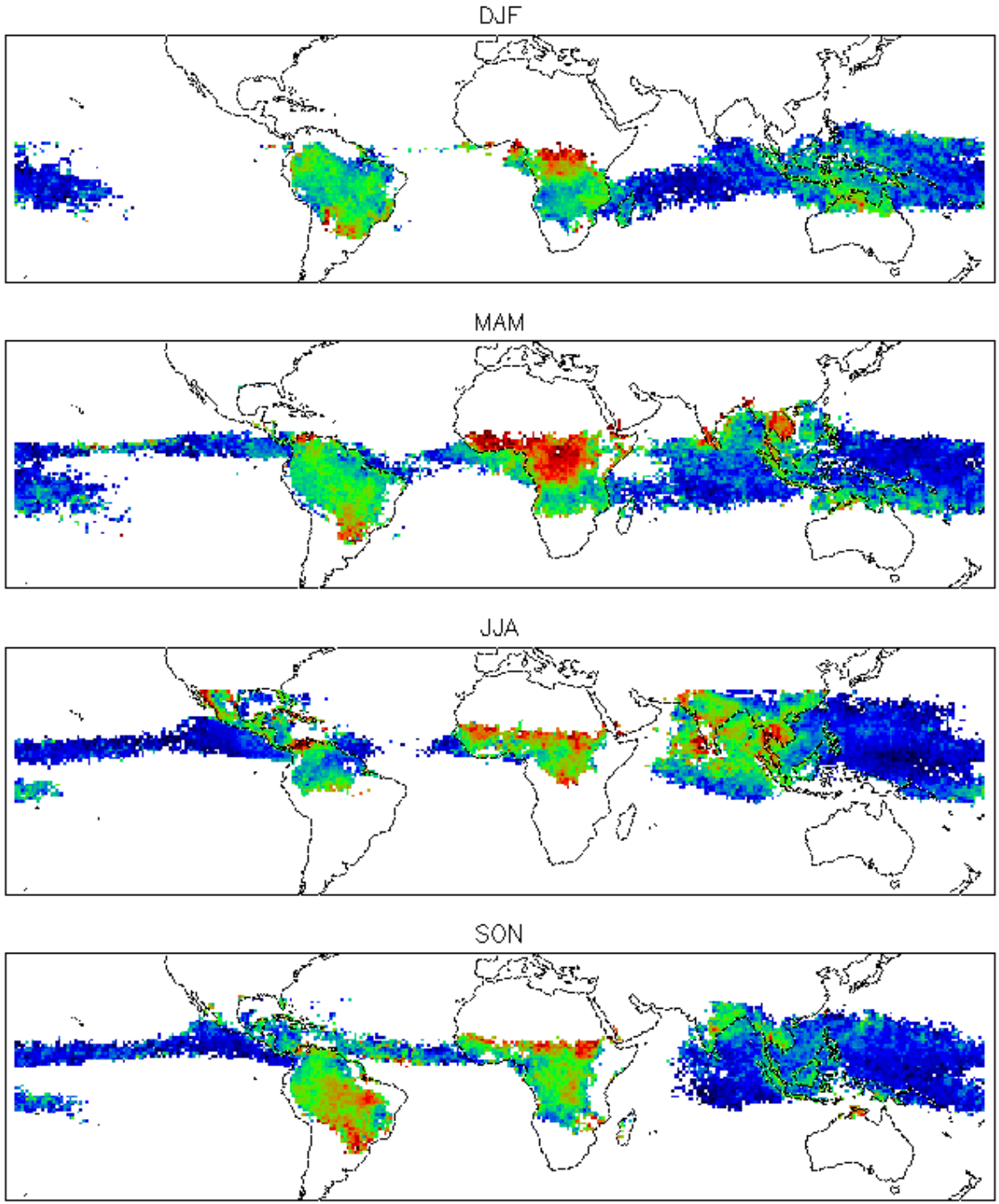
Cb height



taller

shorter

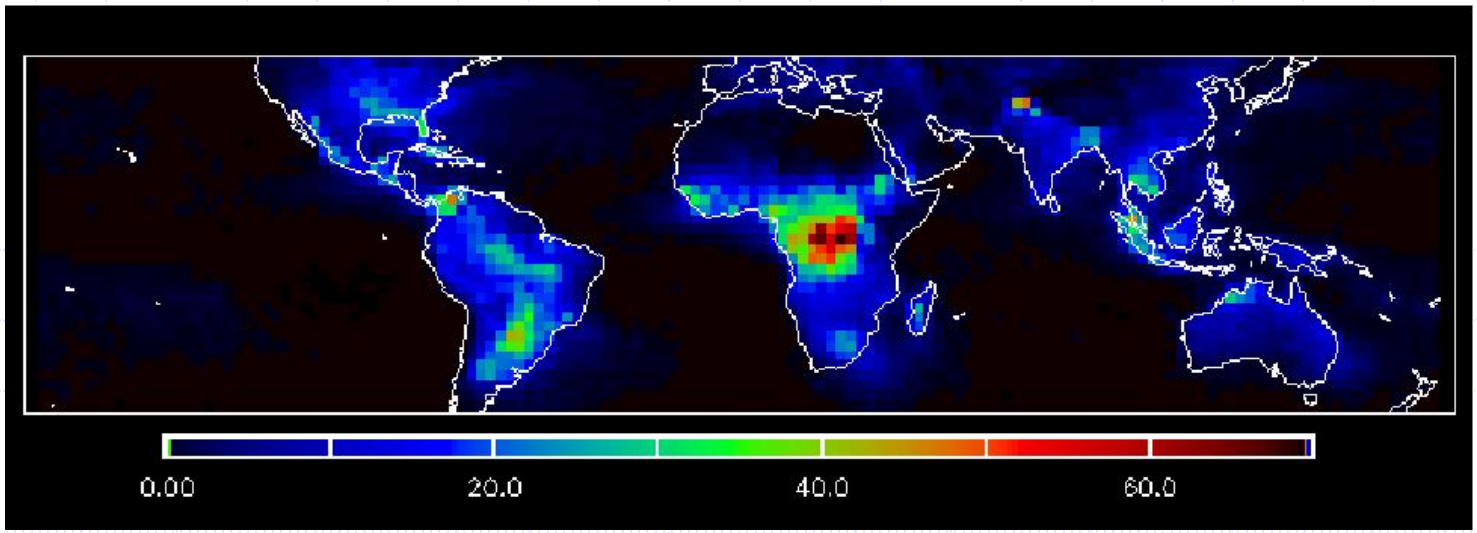
Cb ice size

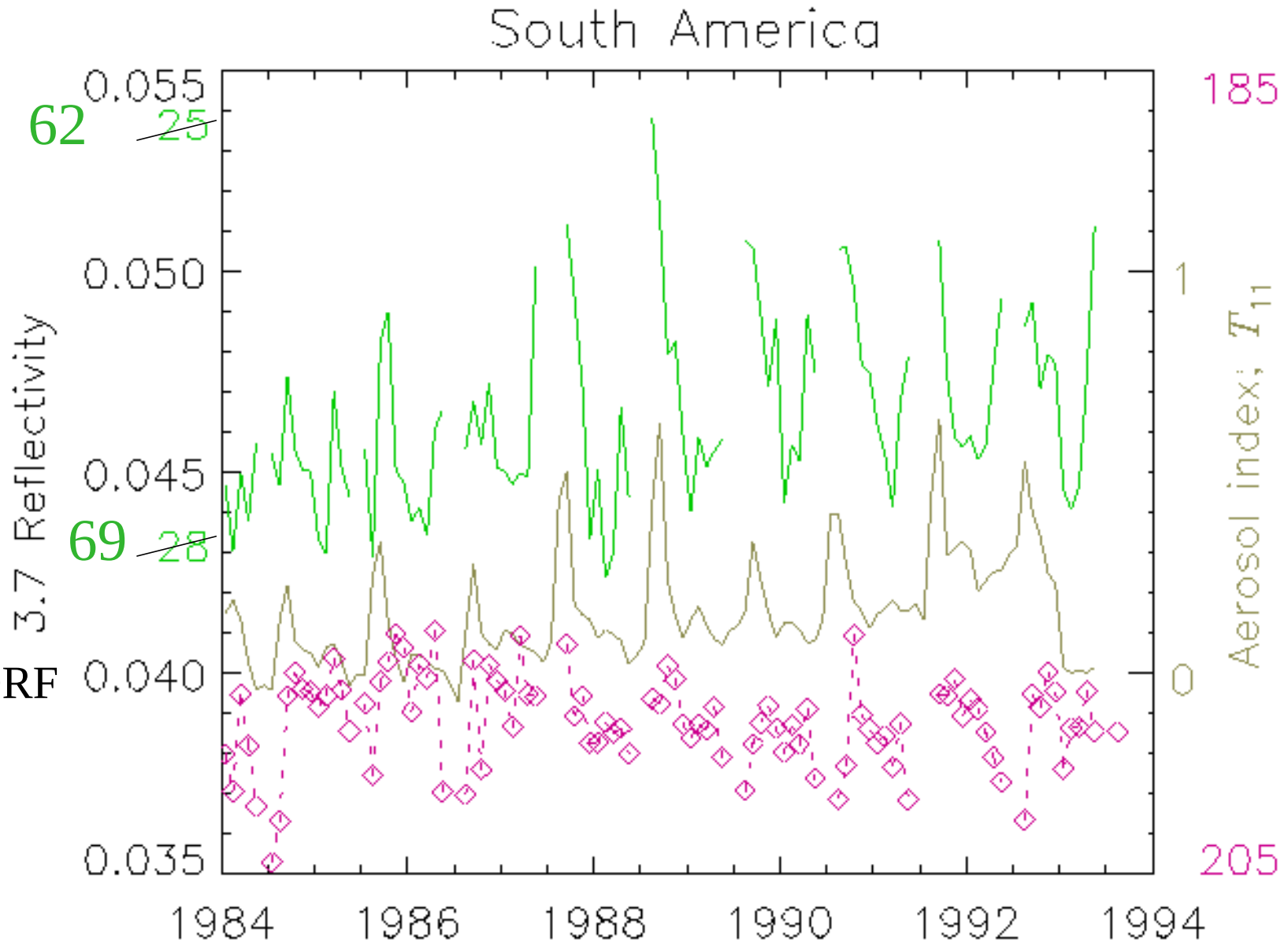


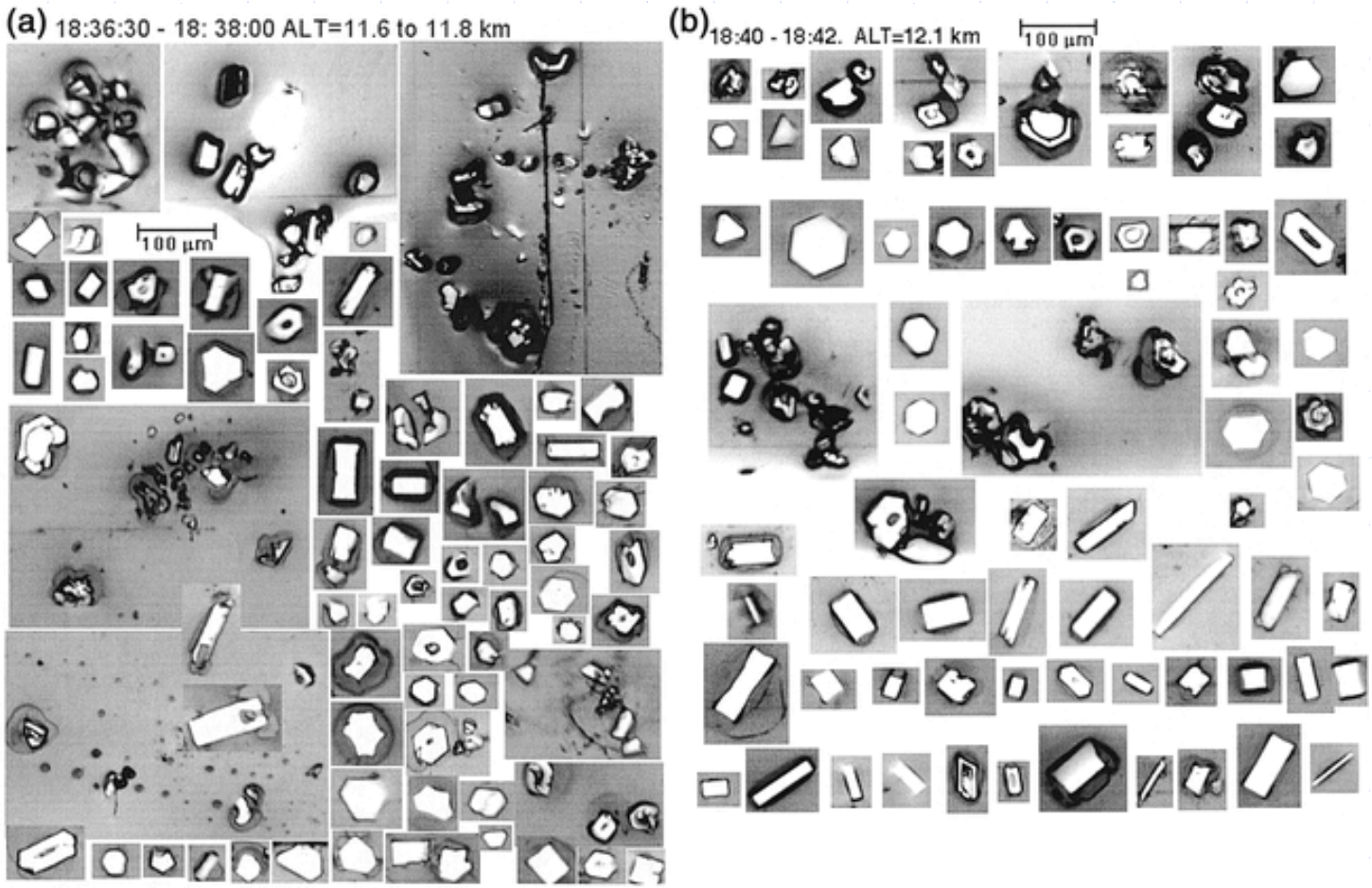
BDRF x 2

large D_e < › small D_e

Lightning strike rate (LIS)

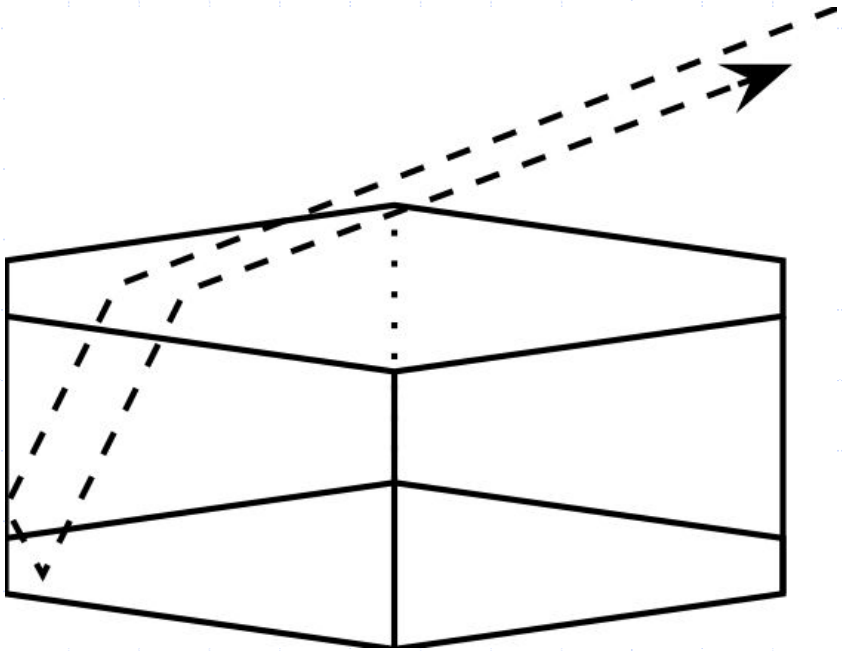


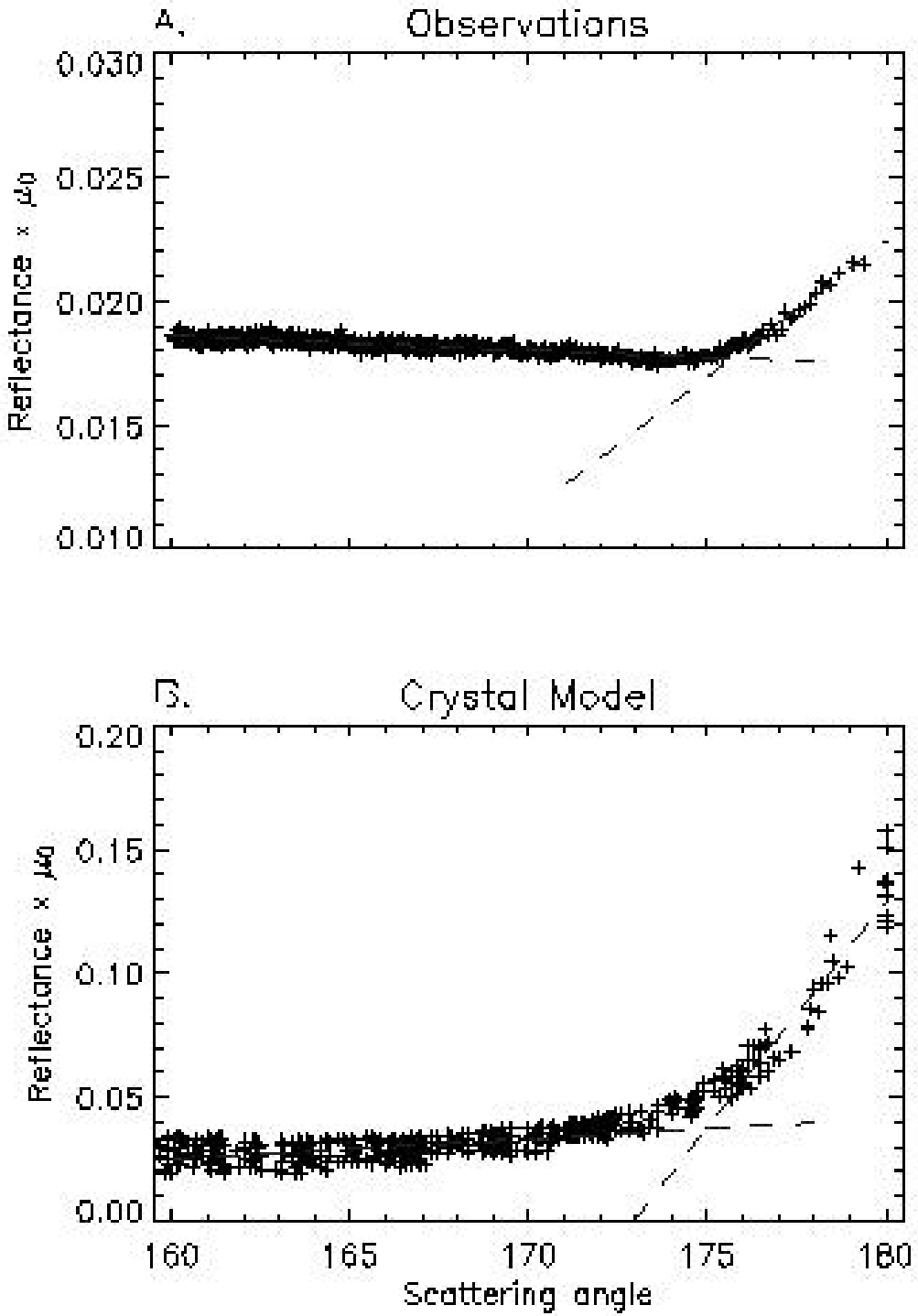

South America
0.055
0.050
0.045
0.040
0.035
3.7 Reflectivity
62
25
69
28
2xBDRF
185
1
0
205
Aerosol index; T_{11}
1984
1986
1988
1990
1992
1994



From Sassen et al. 2003

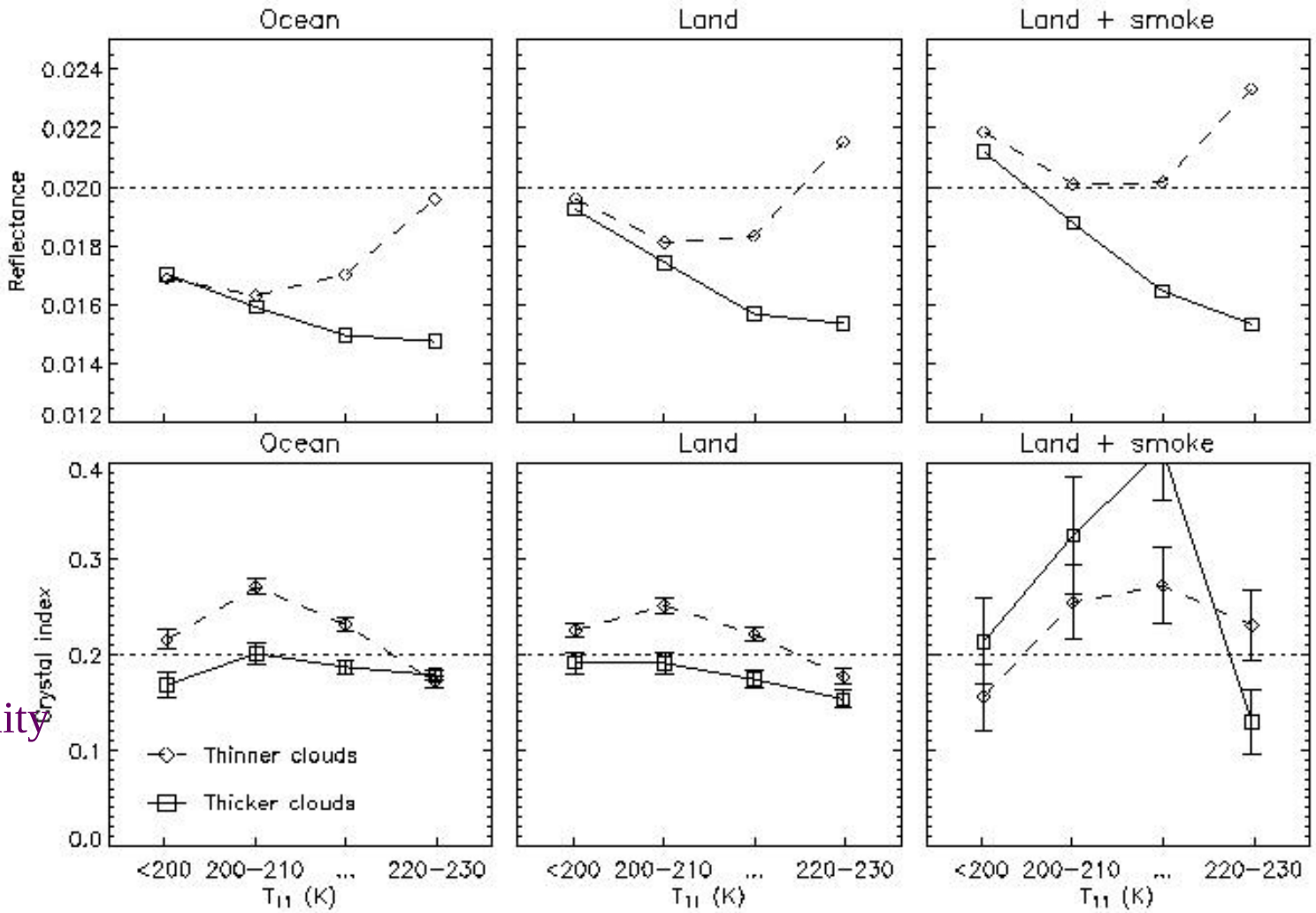
An antisolar peak from regular crystals





Mean value is ~15% regular crystals by area.

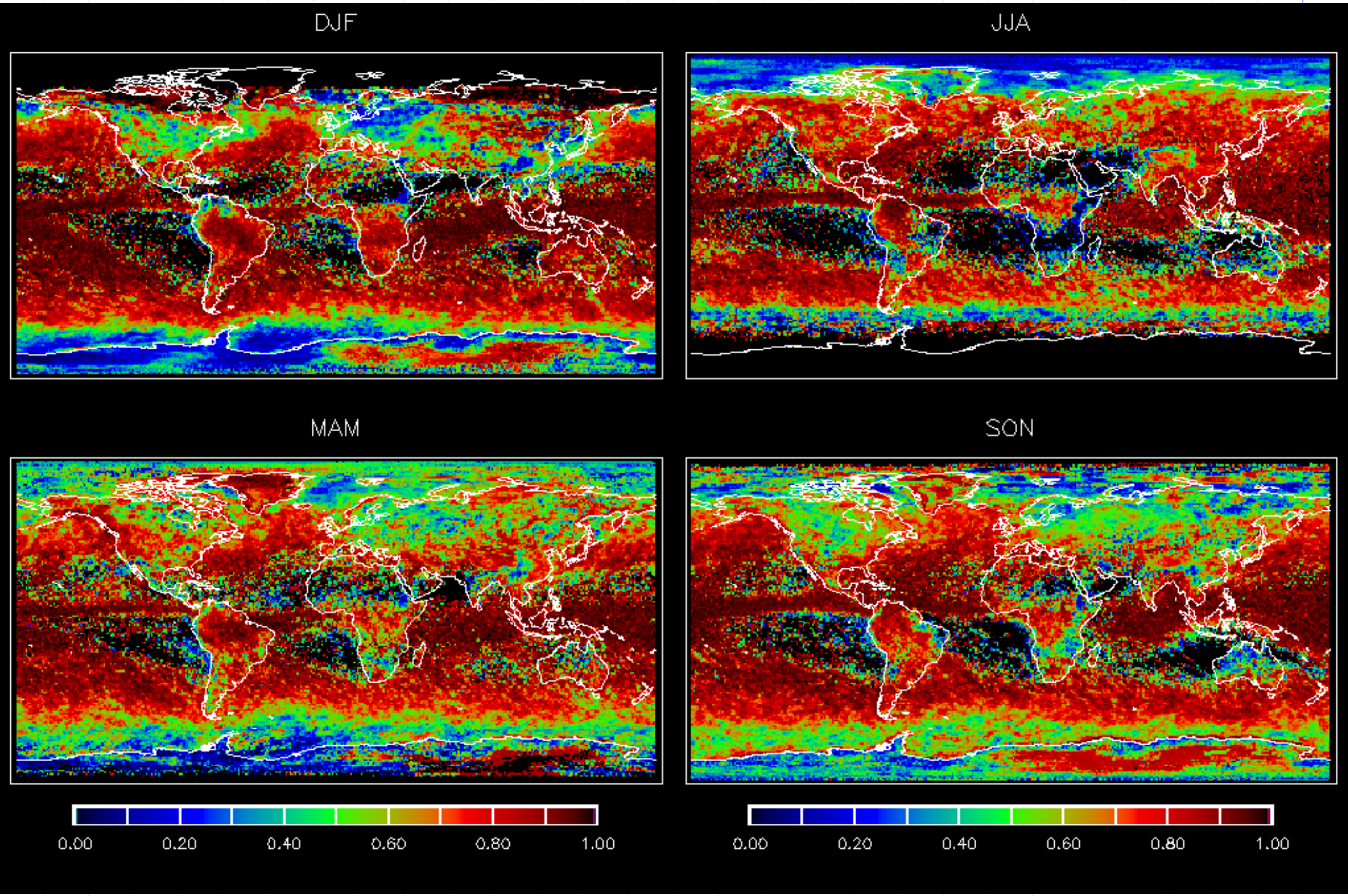
D_e



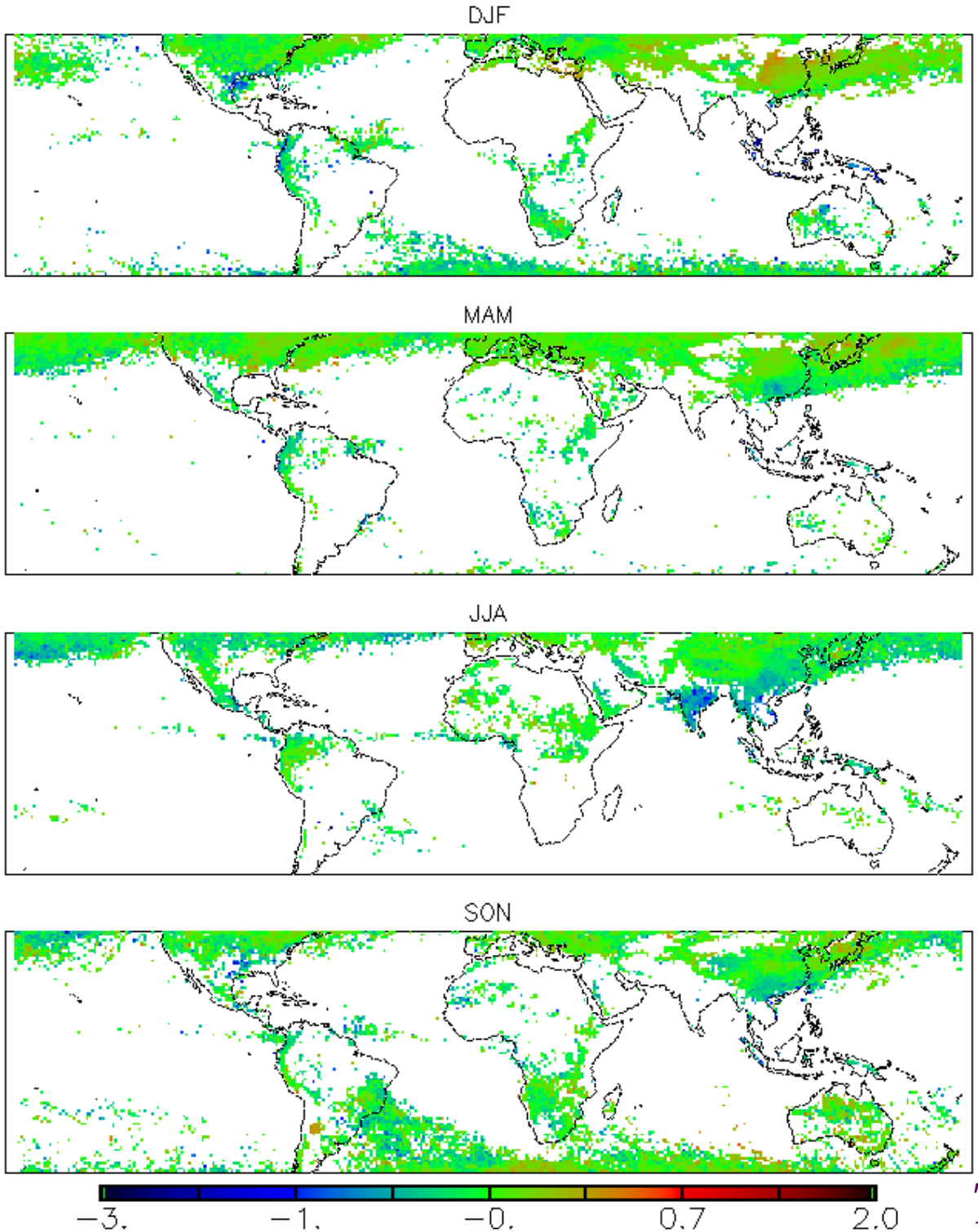
crystallinity

← height

MODIS-A ice fraction, -40C<T<0C, τ>20, 7/02-6/03

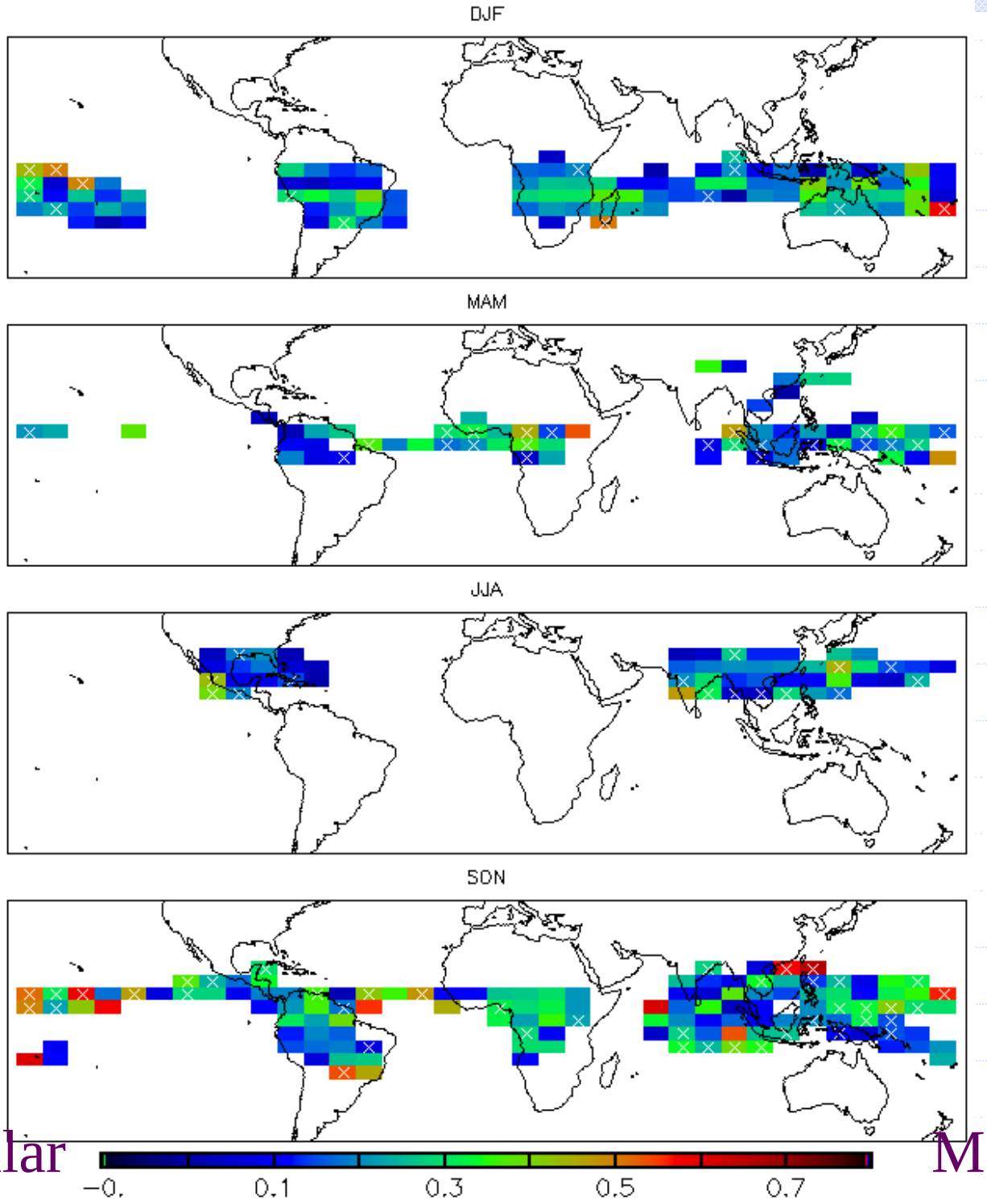


Split-window Optical Density, mid-level Cu/St, 255K<T_{11}<265K, albedo>0.4



Summary

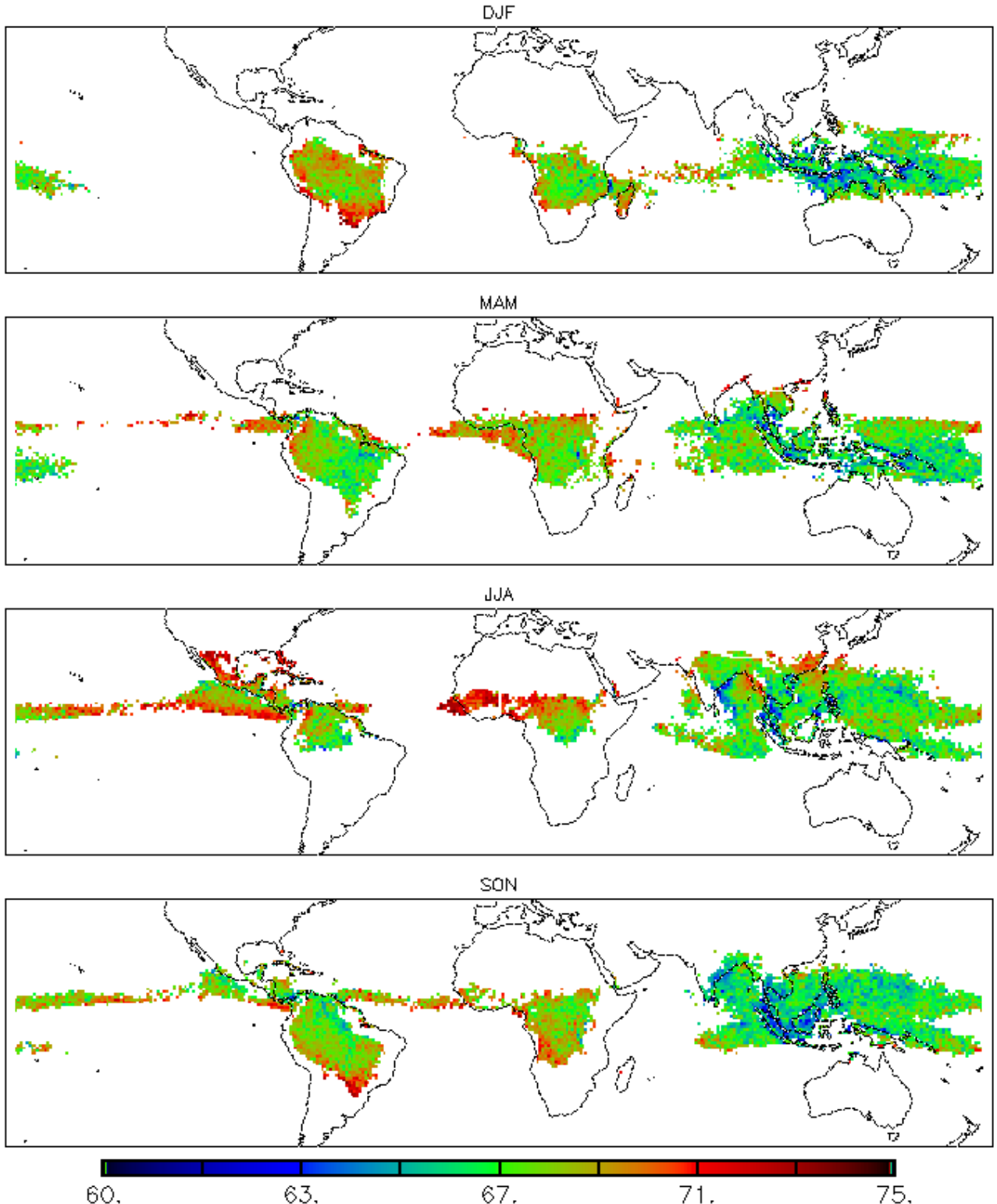
- "Cb" D_e, lightning well correlated, height too but less so; D_e variations greatest for extreme Cb.
  - $\rightarrow$ Hypothesis: secondary droplet nucleation key to low D_e
- Glaciation controlled by subcloud moisture?
  - $\rightarrow$ Hypothesis: droplet growth, size effect on nucleation
- Crystallinity confusing, not related to others, seems larger in burning areas, ITCZ.
- Cloud tops over India and southern China unusually tenuous during JJA



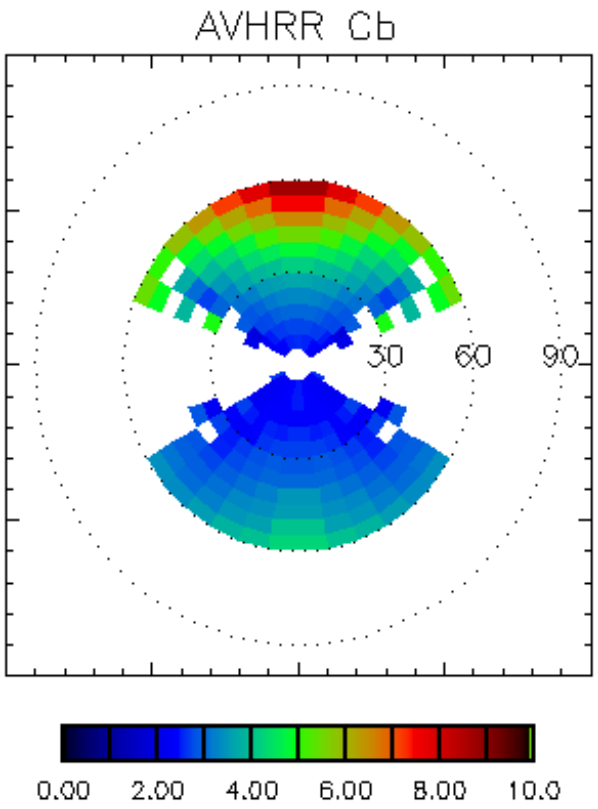
Less regular

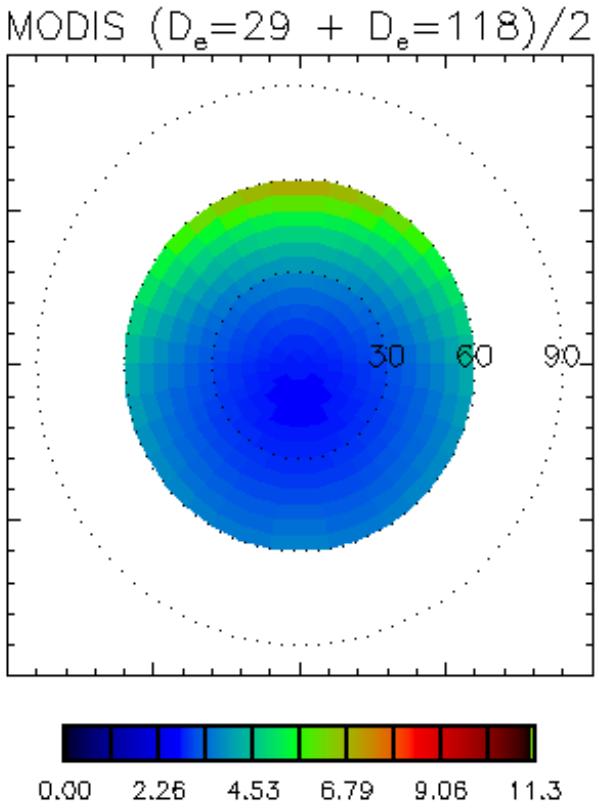
More regular

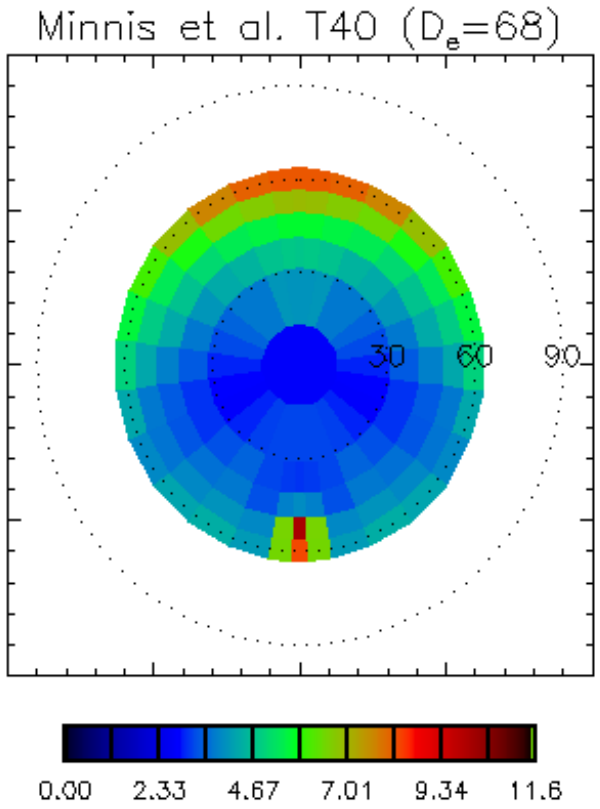
Cb albedo



comparison at SZA=53º (μ_0=.6)







BDRF (%)

Herman et al. 1997 biomass burning