Ed3 Beta2 Modified Algorithms for Multilayer Cloud Property Retrievals

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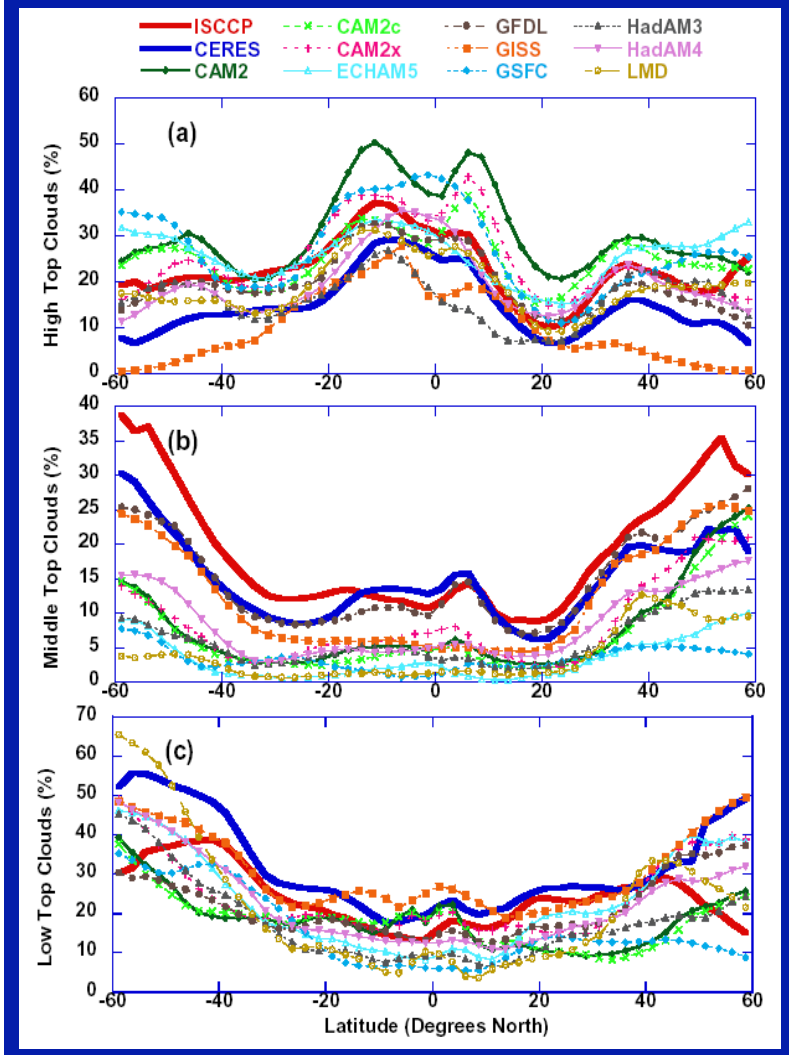
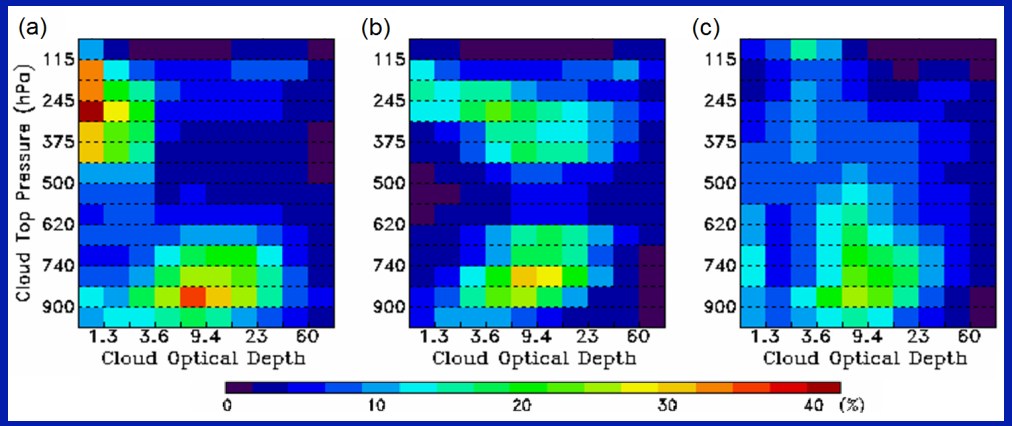
Outline

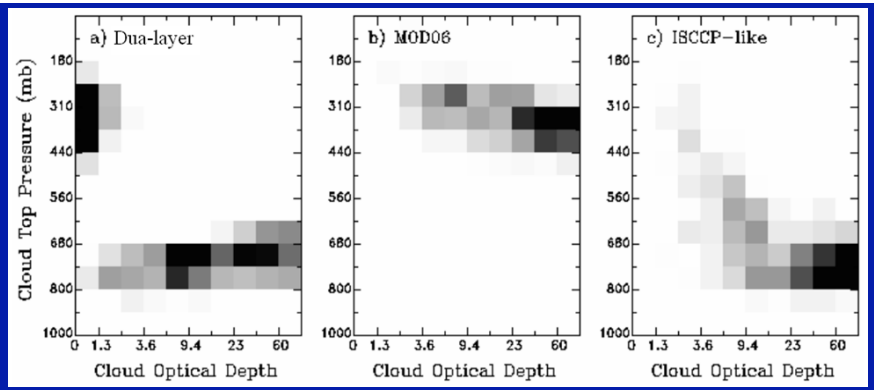
- The scientific perspective.
- New modified CO_2-absorption technique (MCO2AT) for retrieving the upper-tropospheric cloud top height (*Chang, F.-L, P. Minnis, B. Lin, M. Khaiyer, R. Palikonda, D. Spangenberg, 2009, A modified method for inferring upper cloud top height using the GOES-12 imager 10.7- and 13.3-μm data, JGR submitted*).
- Modified multilayer cloud retrieval technique for retrieving overlapping upper and lower cloud layer properties.

The Science Part

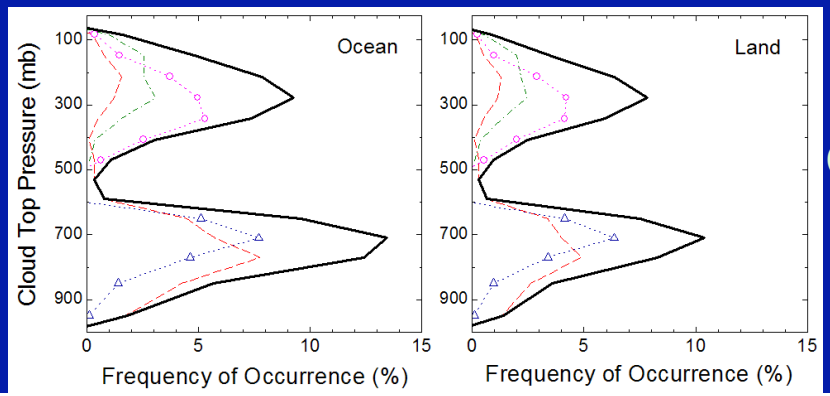


Zhang et al. 2005 JGR



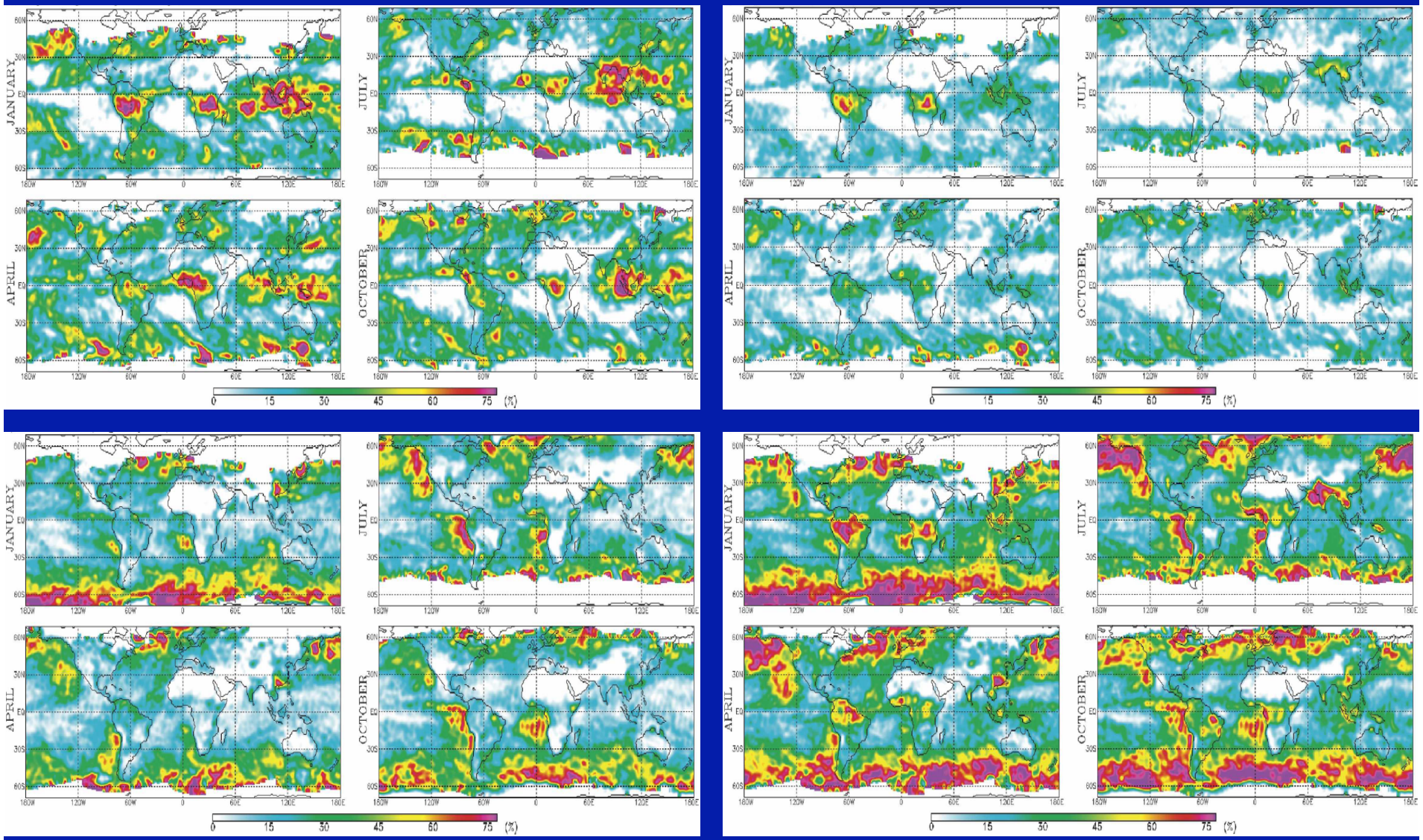


Chang 2009, Book Chapter



Chang & Li, 2005, J. Climate

Cloud Overlapping



Chang and Li, 2005a, b, JCLI, JAS

Among Past CO_2-Cloud Top Height Studies

- Cloud occupies a single layer in the FOV.
- The single-layer cloud occupies infinitesimal or zero thickness.
- The cloud emissivities are the same.
- The cloud-free surface emissivity is unity.

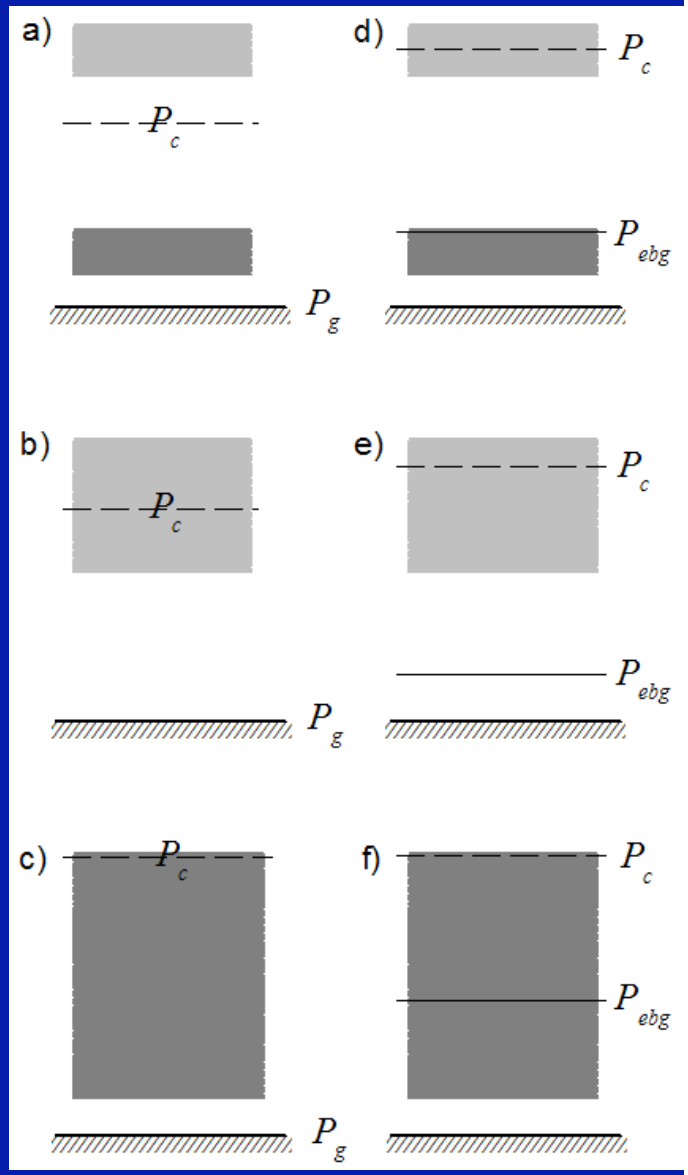
- Wylie and Menzel, 1989
- Frey et al. 1999
- Schreiner et al. 2001
- Hawkinson et al. 2005
- Holz et al. 2006
- Bedka et al. 2007
- Smith et al. 2008

$$\frac{R_{pix}^{\mathrm{Ch6}} - R_{clr}^{\mathrm{Ch6}}}{R_{pix}^{\mathrm{Ch4}} - R_{clr}^{\mathrm{Ch4}}} = \frac{\varepsilon_c^{\mathrm{Ch6}}(R_{ovc}^{\mathrm{Ch6}} - R_{clr}^{\mathrm{Ch6}})}{\varepsilon_c^{\mathrm{Ch4}}(R_{ovc}^{\mathrm{Ch4}} - R_{clr}^{\mathrm{Ch4}})}$$

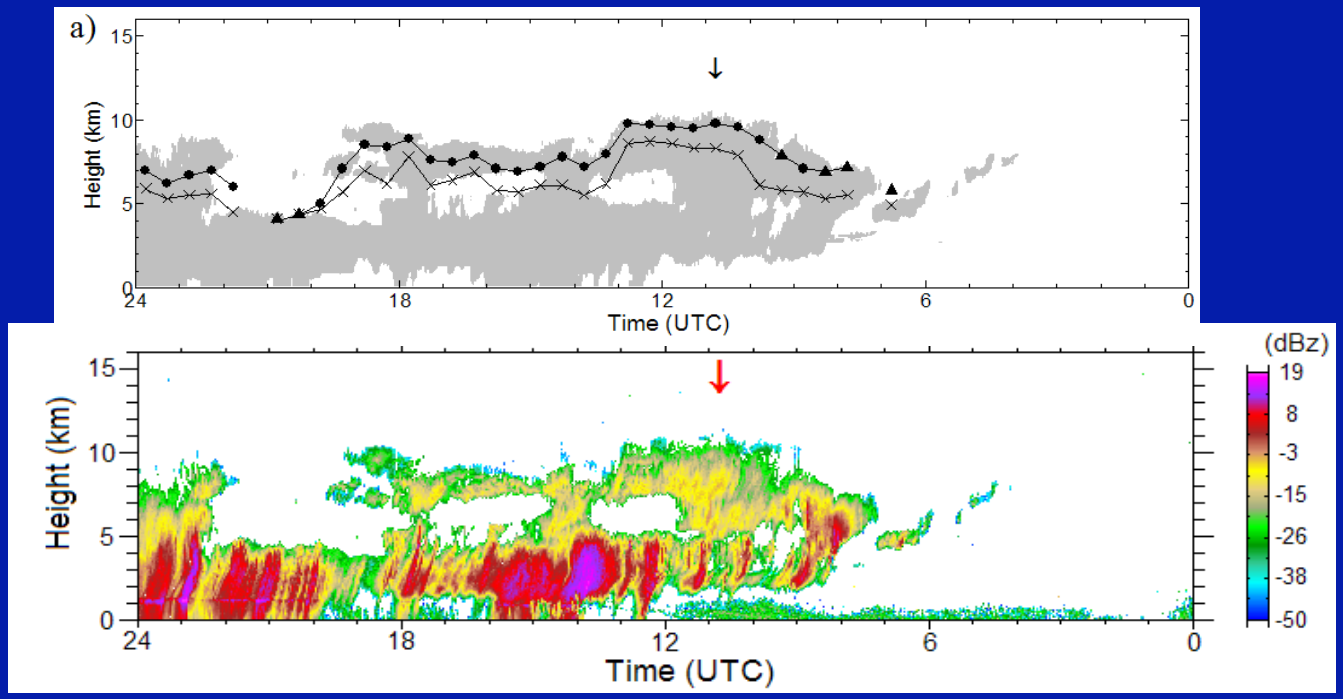
The MCO2AT (Chang et al. 2009)

- The underestimation of upper CTH due to impact of underlying lower cloud.
- The underestimation of single-layer cirrus CTH due to assumption of infinitesimal thin cloud thickness.
- The retrieval uncertainties due to the impact of errors in surface emissivities and clear-sky radiances.
- The retrieval uncertainties due to the spectral cloud emissivity changes.

$$\frac{R_{pix}^{\mathrm{Ch6}} - R_{ebg}^{\mathrm{Ch6}}}{R_{pix}^{\mathrm{Ch4}} - R_{ebg}^{\mathrm{Ch4}}} = \frac{\varepsilon_c^{\mathrm{Ch6}}(R_{ovc}^{\mathrm{Ch6}} - R_{ebg}^{\mathrm{Ch6}})}{\varepsilon_c^{\mathrm{Ch4}}(R_{ovc}^{\mathrm{Ch4}} - R_{ebg}^{\mathrm{Ch4}})}$$

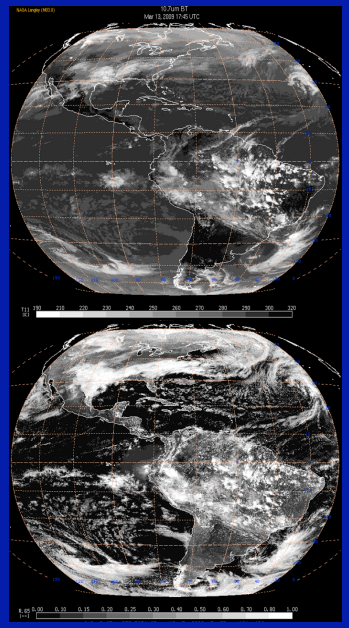


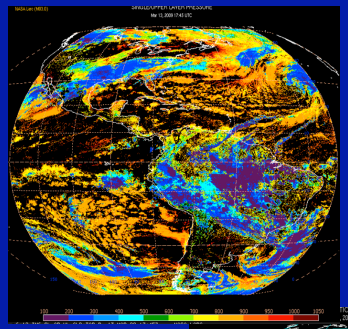
Comparison of SCO2AT and MCO2AT

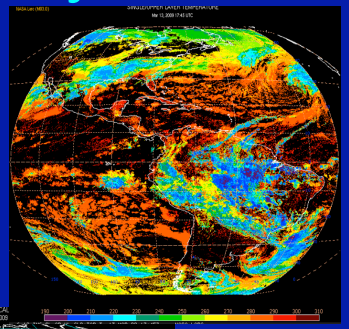


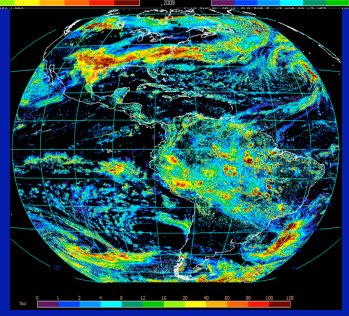
- One month of half-hourly GOES overcast upper-cloud scenes:
  MCO2AT-ARSCL: -0.3 km ± 1.5 km (31% within ±0.5 km, 69% within ±1.5 km)
  SCO2AT-ARSCL: -1.6 km ± 2.1 km (20% within ±0.5 km, 48% within ±1.5 km)
- For broken upper-cloud scenes:
  MCO2AT-ARSCL: -2.6 km ± 1.8 km (50% within ±3 km)
  SCO2AT-ARSCL: -4.7 km ± 2.3 km (20% within ±3 km)
- Overall rms biases reduced by 30%.
- > 10% thin cirrus cases missed.

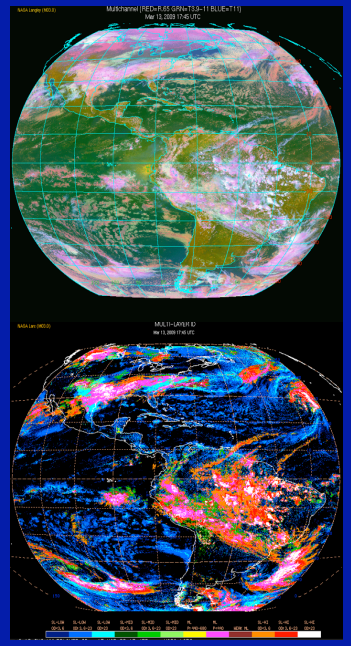
An Evolutionary Overview

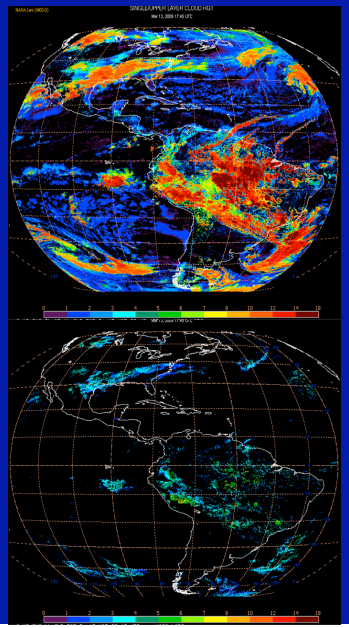


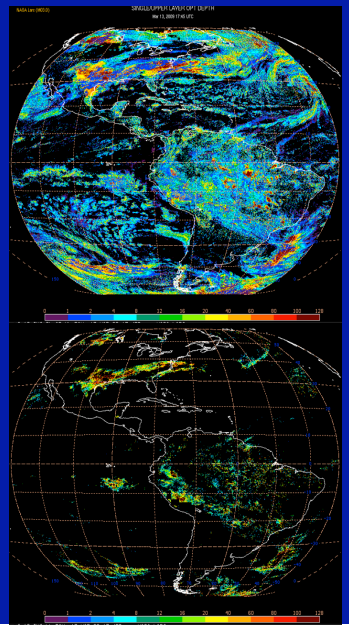


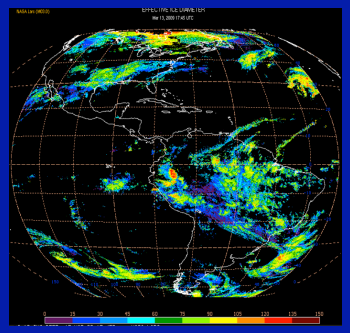


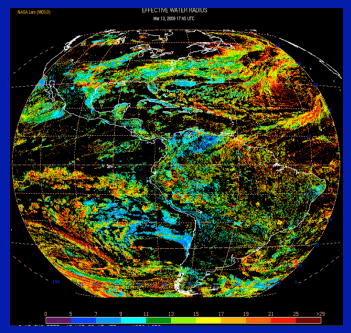


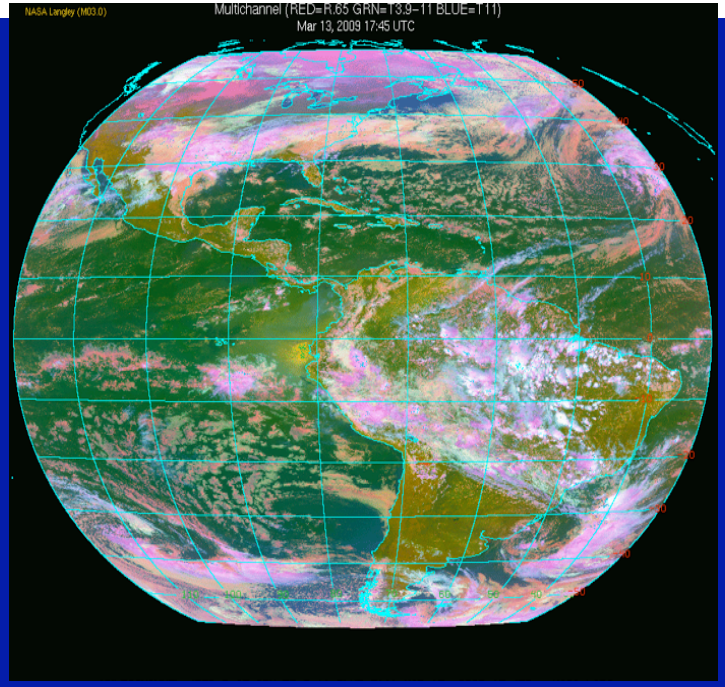








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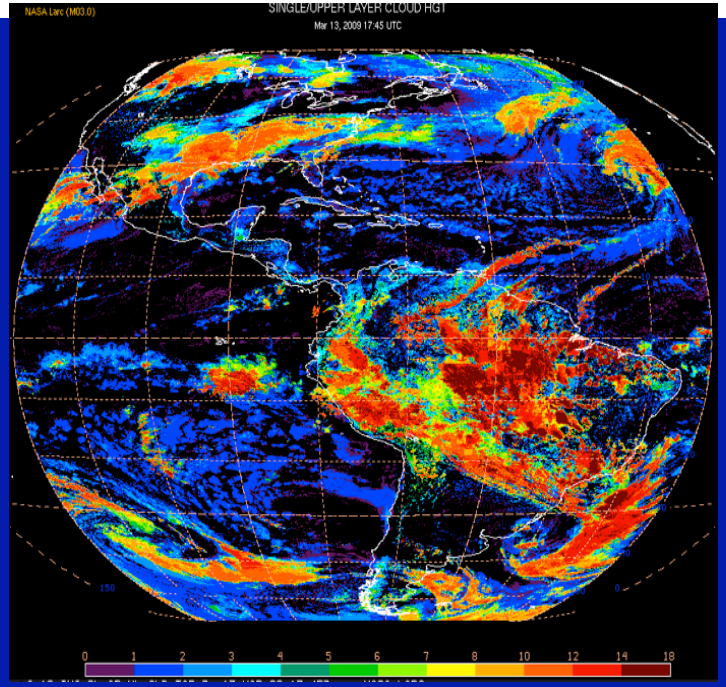
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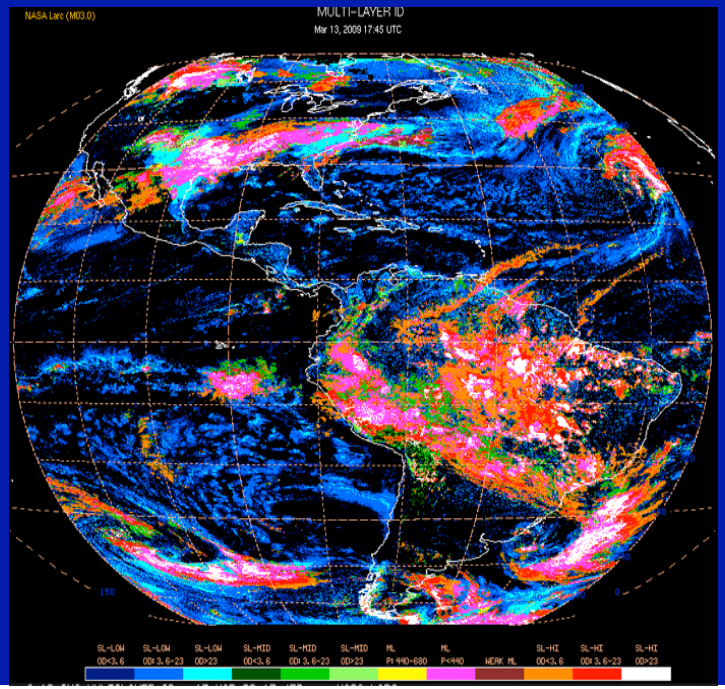
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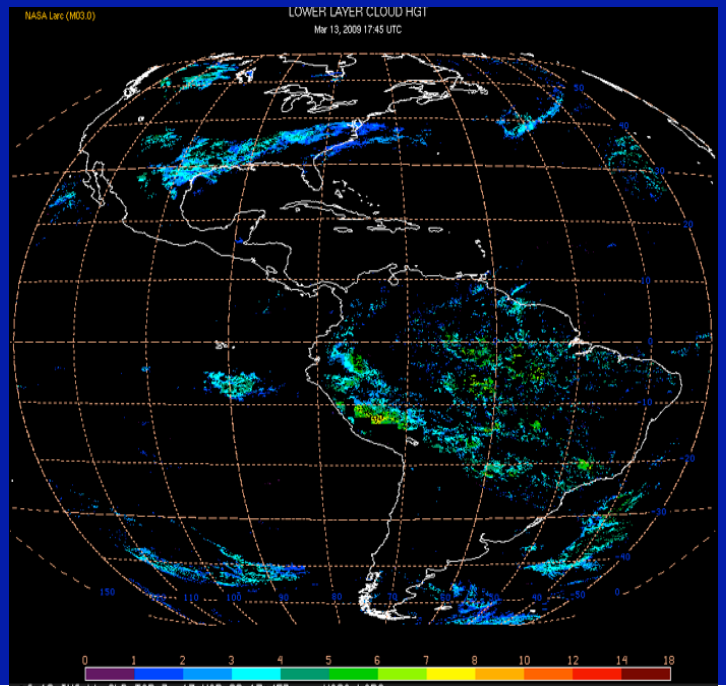
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LOWER LAYER CLOUD HGT
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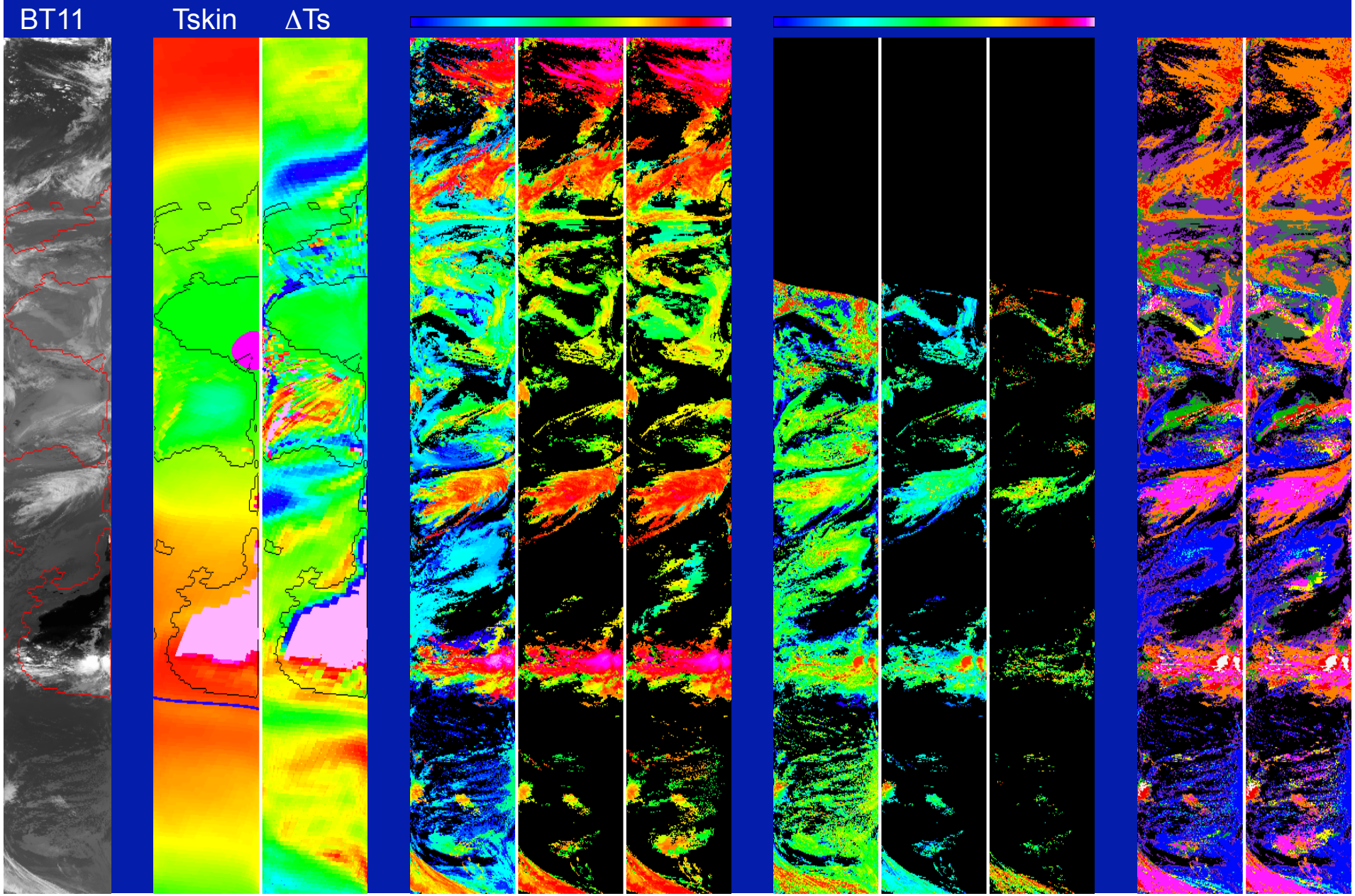
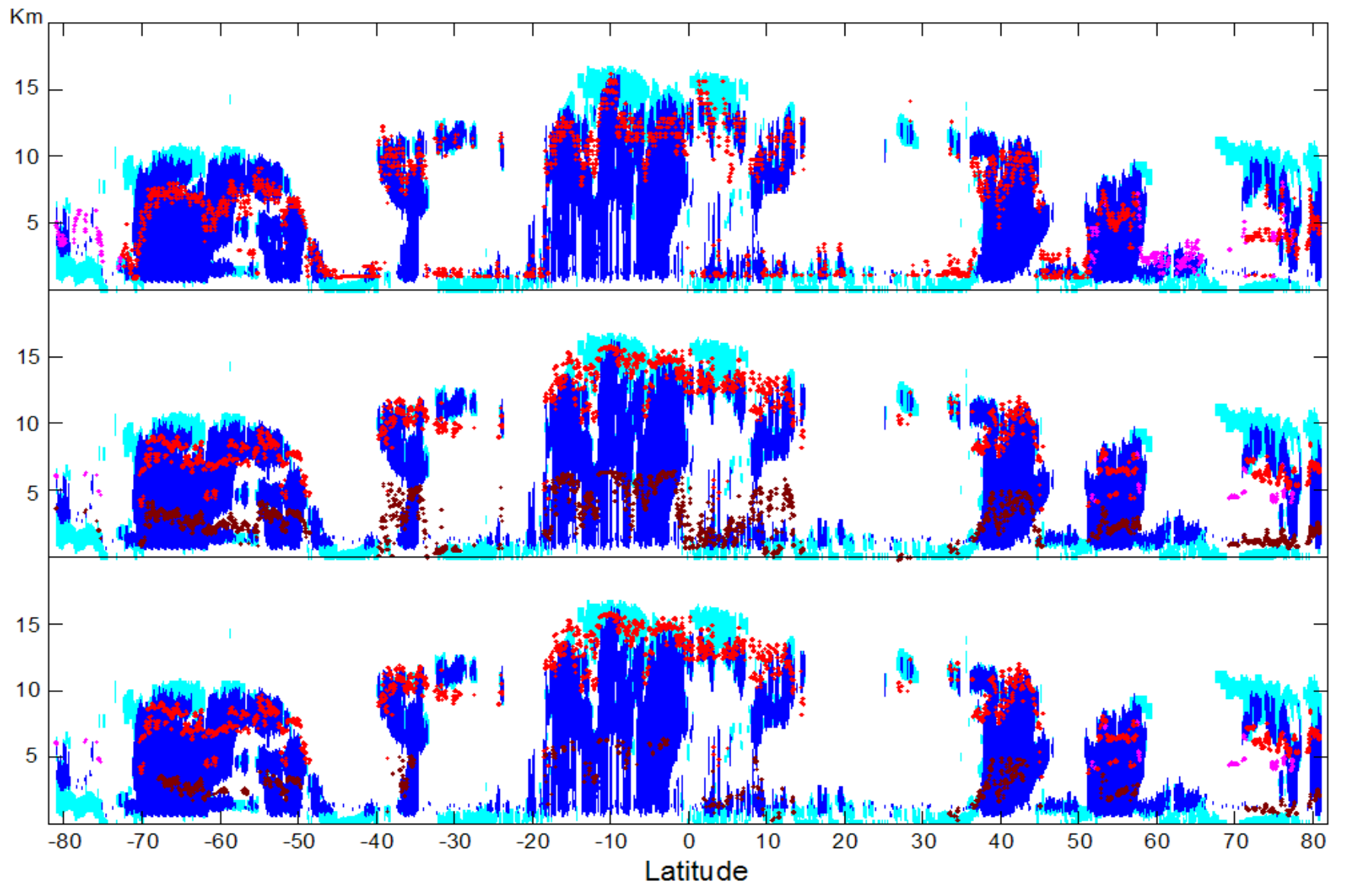
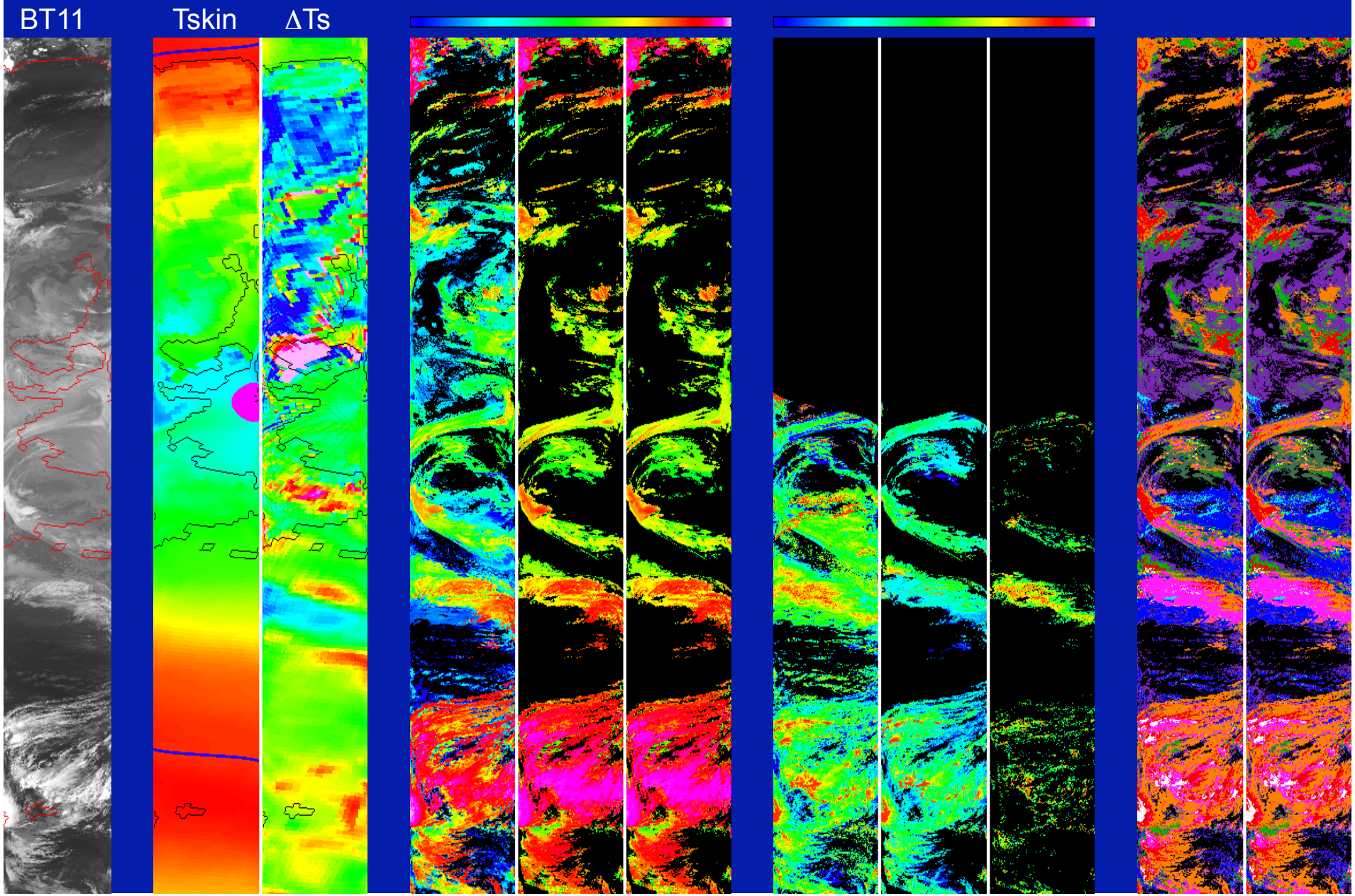
Algorithm Sensitivity Test



Comparison with CALIPSO (cyan) and CloudSat (blue)



Algorithm Sensitivity Test (Tskin)



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1315440.	37.7	38.9	23.8	26.3
1315440.	37.6	35.3	16.4	20.1
1315440.	28.6	27.1	11.3	14.3
1315440.	18.0	18.7	7.1	7.7
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1315440.	27.8	26.5	10.7	14.5
1315440.	24.0	26.4	10.7	14.4
1315440.	31.7	30.9	15.2	17.9
1315440.	34.8	33.2	17.4	20.7
1315440.	34.6	37.0	21.3	24.3
1315440.	24.7	22.7	8.9	10.7
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1315440.	16.5	16.2	1.1	2.1
1315440.	17.8	19.1	2.9	6.5

1315440.	25.6	27.3	10.8	12.7
1315440.	29.7	33.6	15.4	20.3
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1315440.	23.4	27.8	9.3	12.9
1315440.	20.6	21.6	6.6	7.9
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1315440.	24.6	25.0	12.0	13.1
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1315440.	19.0	22.6	7.3	9.4
1315440.	18.5	20.5	4.6	5.0
1315440.	22.8	25.7	7.9	11.4
1315440.	24.3	26.4	9.4	14.0
1315440.	30.2	28.7	12.2	16.0
1315440.	29.7	29.4	12.4	15.6
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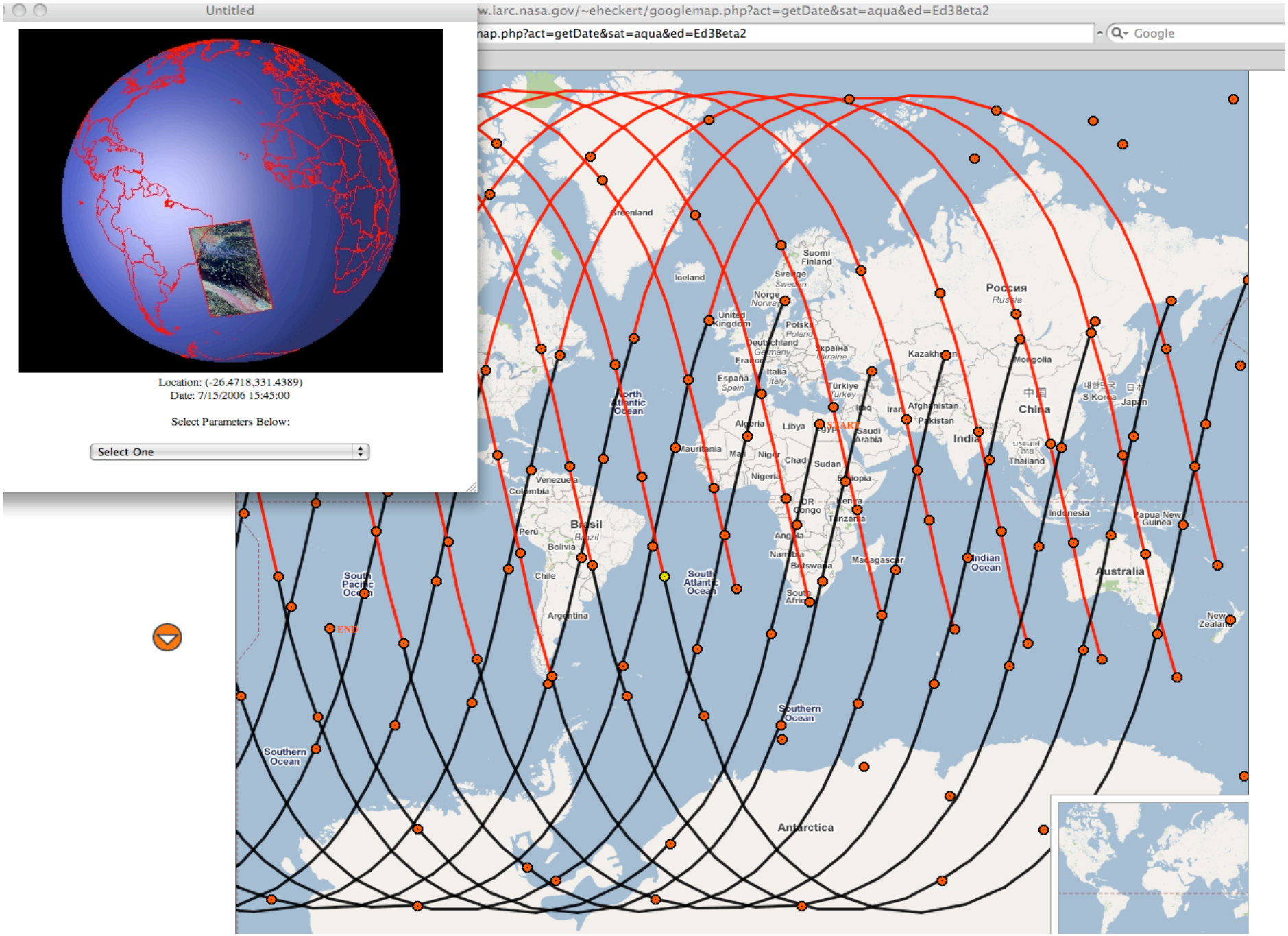
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Australia
New Zealand
Brasil
Venezuela
Colombia
Perú
Bolivia
Chile
Argentina
South Pacific Ocean
South Atlantic Ocean
North Atlantic Ocean
Indian Ocean
Southern Ocean
Antarctica
Madagascar
Botswana
Namibia
Angola
Tanzania
Kenya
Sudan
Chad
Niger
Nigeria
Libya
Algeria
Mauritania
Saudi Arabia
Afghanistan
Pakistan
Iran
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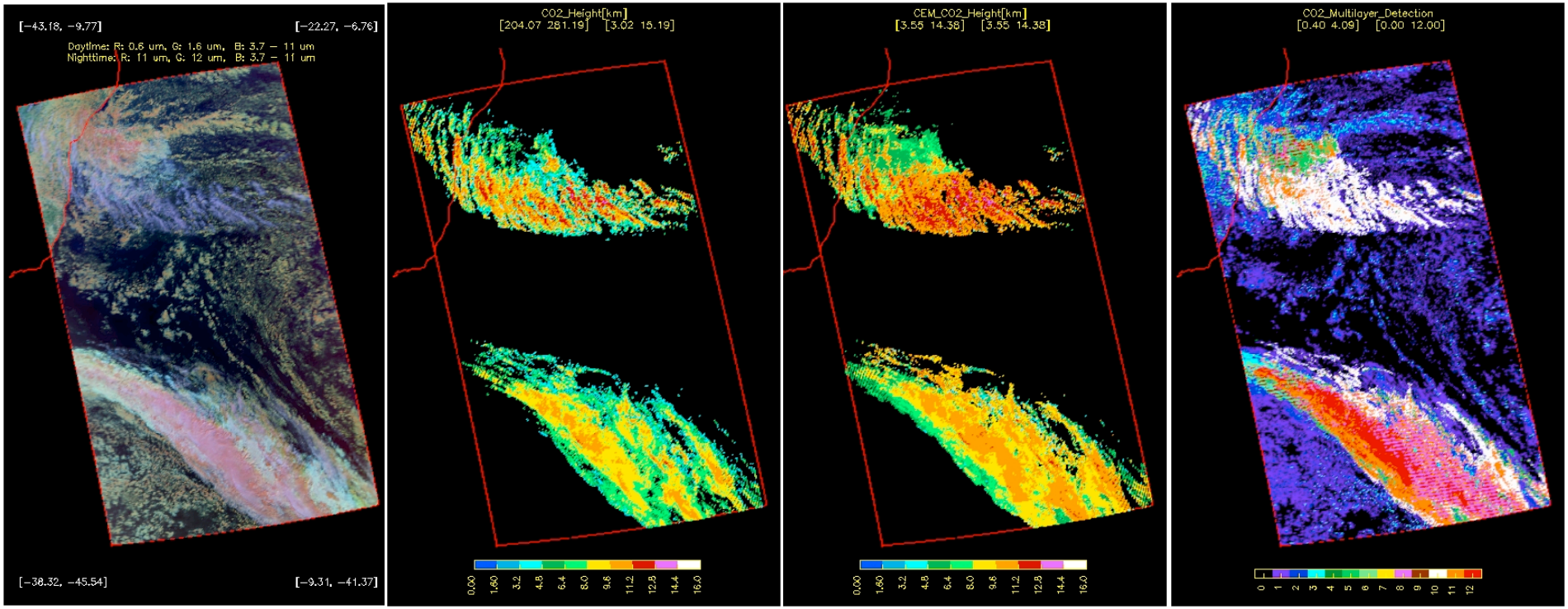
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[−22.27, −6.76]
Daytime: R: 0.6 um, G: 1.6 um, B: 3.7 − 11 um
Nighttime: R: 11 um, G: 12 um, B: 3.7 − 11 um
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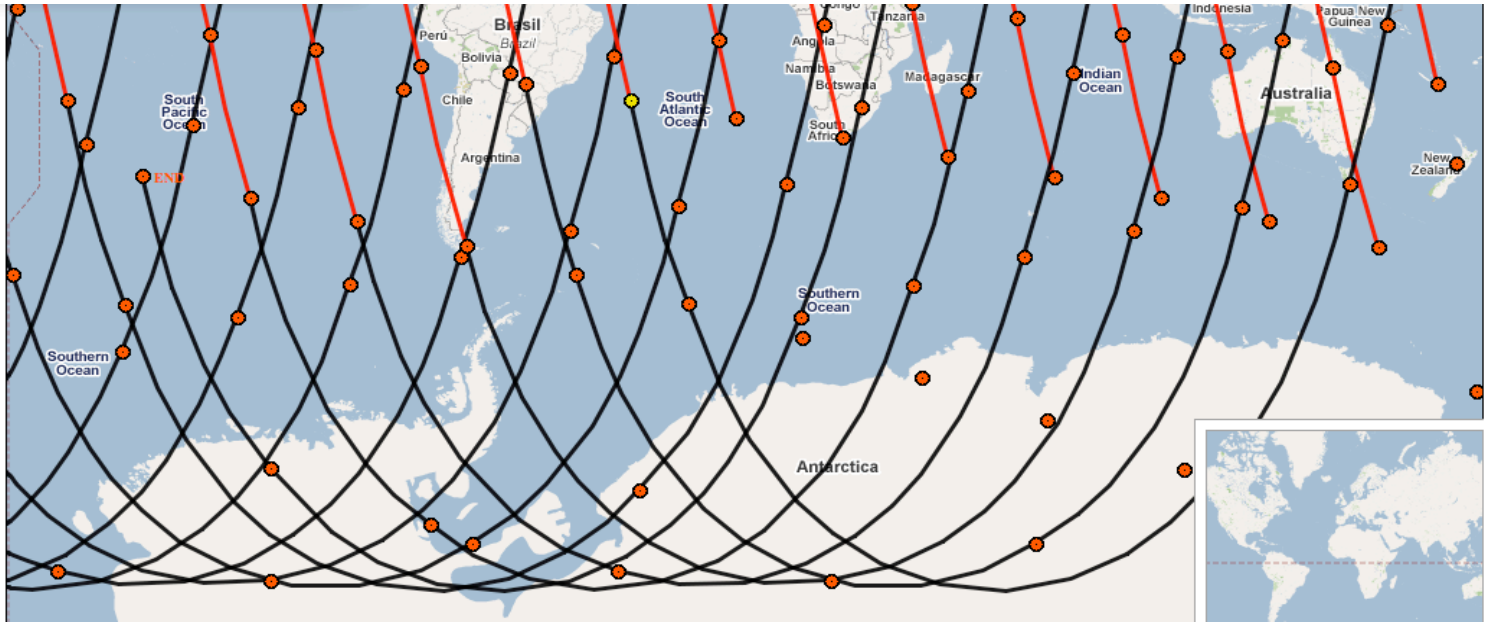
[204.07 281.19] [3.02 15.19]
CEM_CO2_Height[km]
[3.55 14.38] [3.55 14.38]
CO2_Multilayer_Detection
[0.40 4.09] [0.00 12.00]
0.00 1.60 3.2 4.8 6.4 8.0 9.6 11.2 12.8 14.4 16.0
0 1 2 3 4 5 6 7 8 9 10 11 12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Chile
Argentina
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END
South Atlantic Ocean
Angola
Namibia
Botswana
South Africa
Madagascar
Indian Ocean
Australia
Papua New Guinea
New Zealand
Southern Ocean
Southern Ocean
Antarctica

Continuous Work

- First thing first!!
- Continuous evaluation and algorithm refinement?
- Enhanced thin cirrus detection?
- Add BTD method for enhanced multilayer algorithm.
- Regularly bias corrections.
- Submit papers.