Enhancing Multilayer Cloud Retrieval

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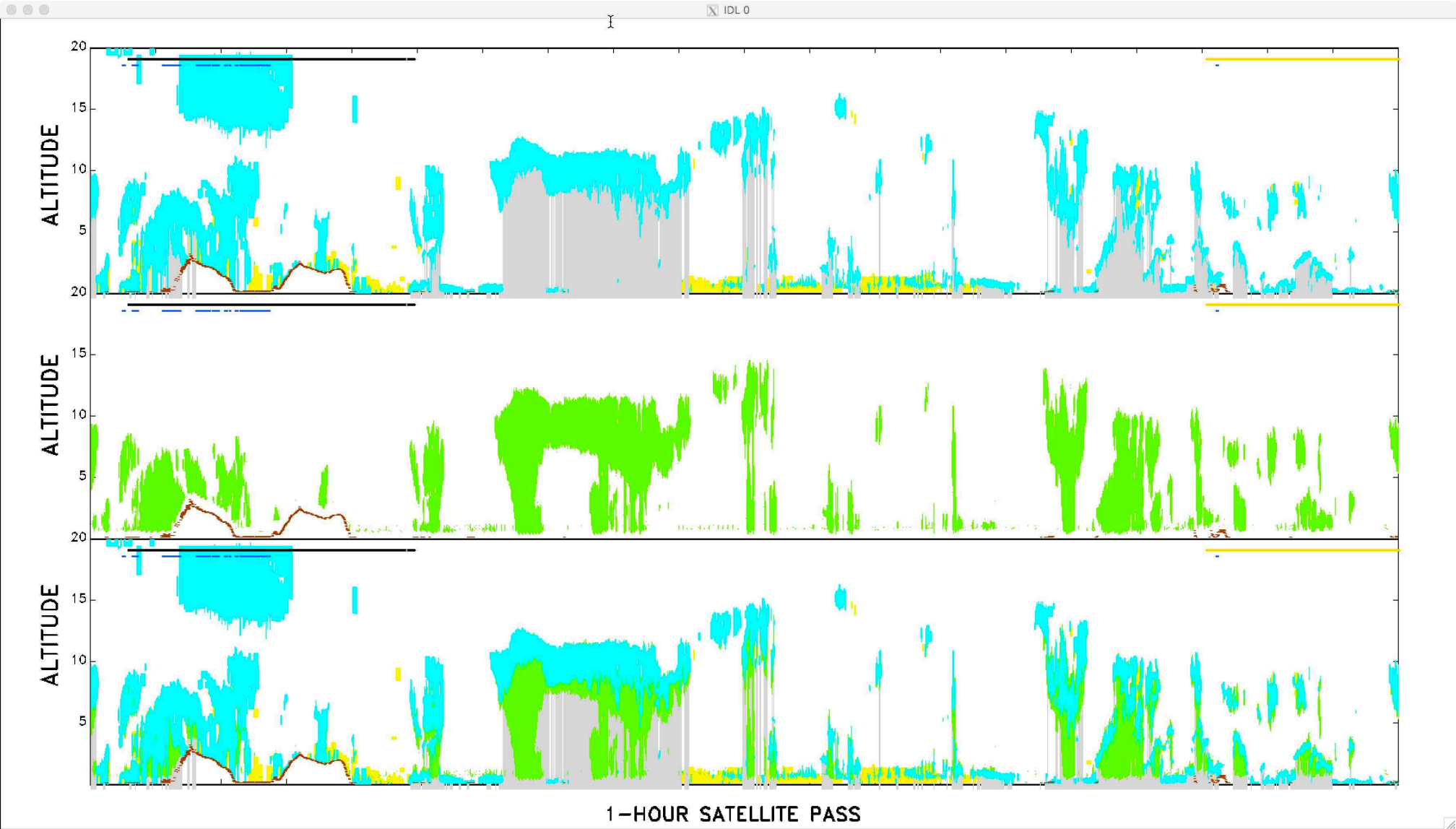
Topics of This Presentation

- 1 month (July 2008) of matched CALIOP, CloudSat and MODIS data (1-km spatial resolution) were used to evaluate our CO_2 & multilayer cloud retrievals. – Data processed by Sunny & Yan.
- How's our CO_2 cloud retrieval performed?
- How's our 2-channel vs 5-channel CO_2 cloud retrieval performed?
- How's our multilayer cloud retrieval performed?
- How to flag possible vertically-continued convection cloud?
- And more ??

CALIOP and CloudSat Data

- 2008/07/01 Time: 00-01 Z

Black Line: Polar South Cyan: CALIOP Green: CloudSat Yellow Line: Polar North

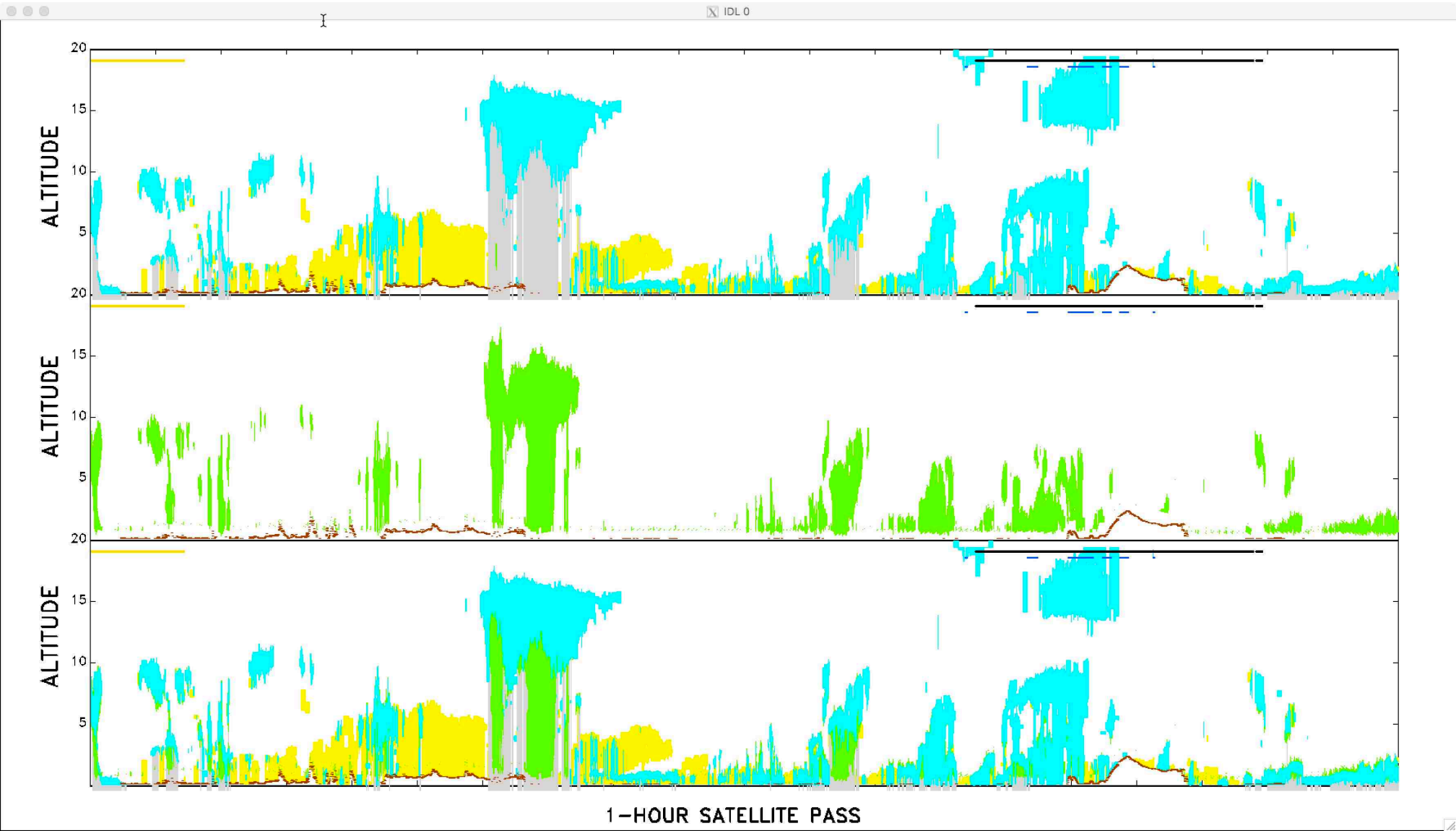


CALIOP and CloudSat Data

- 2008/07/01 Time: 01-02 Z

Yellow Line: Polar North

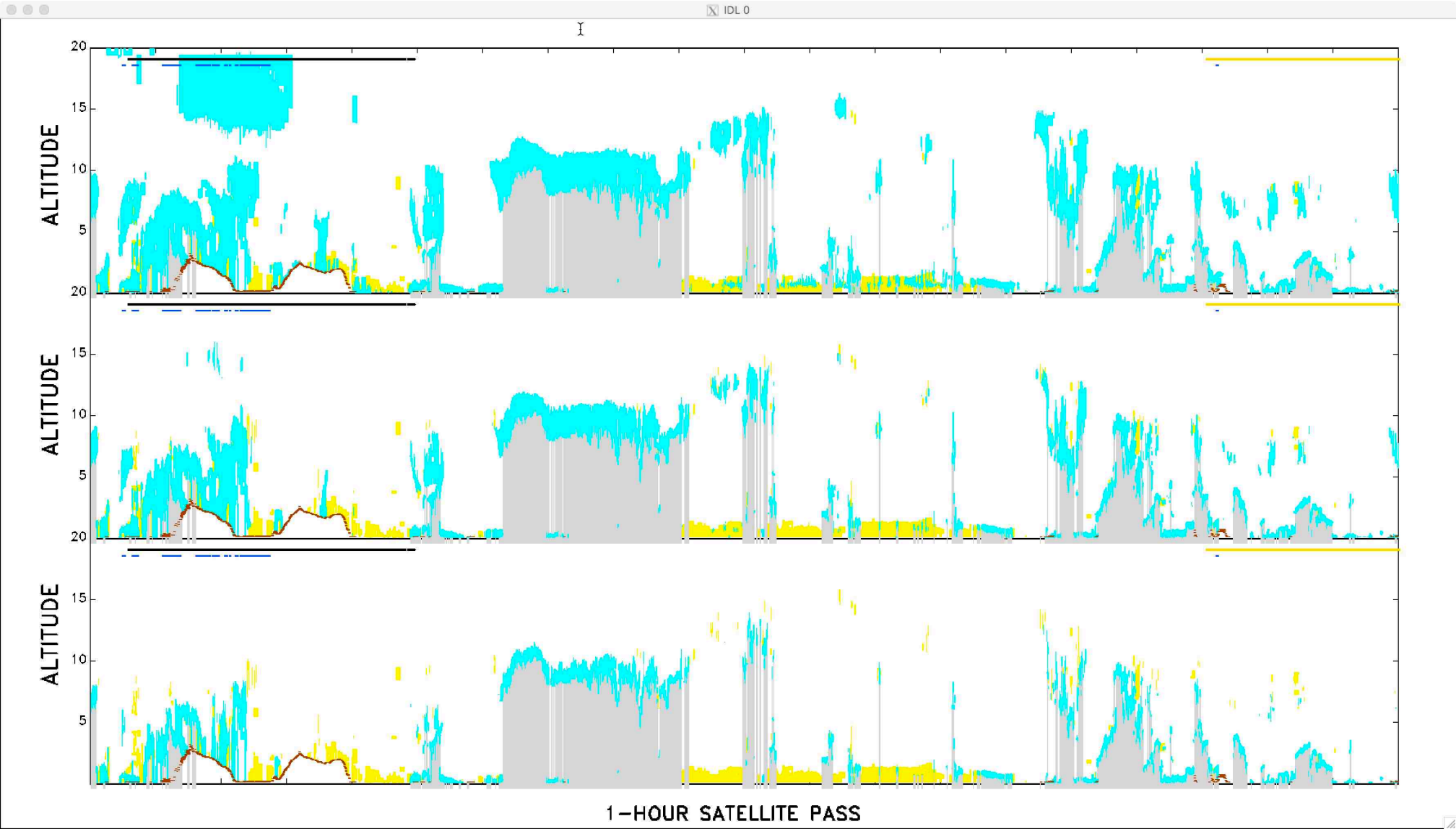
Black Line: Polar South



Example of the CALIOP Data QC

- 2008/07/01 Time: 00-01 Z

Top panel: Tau > 0. Mid panel: Tau > 0.3. Bottom Panel: Tau > 1.

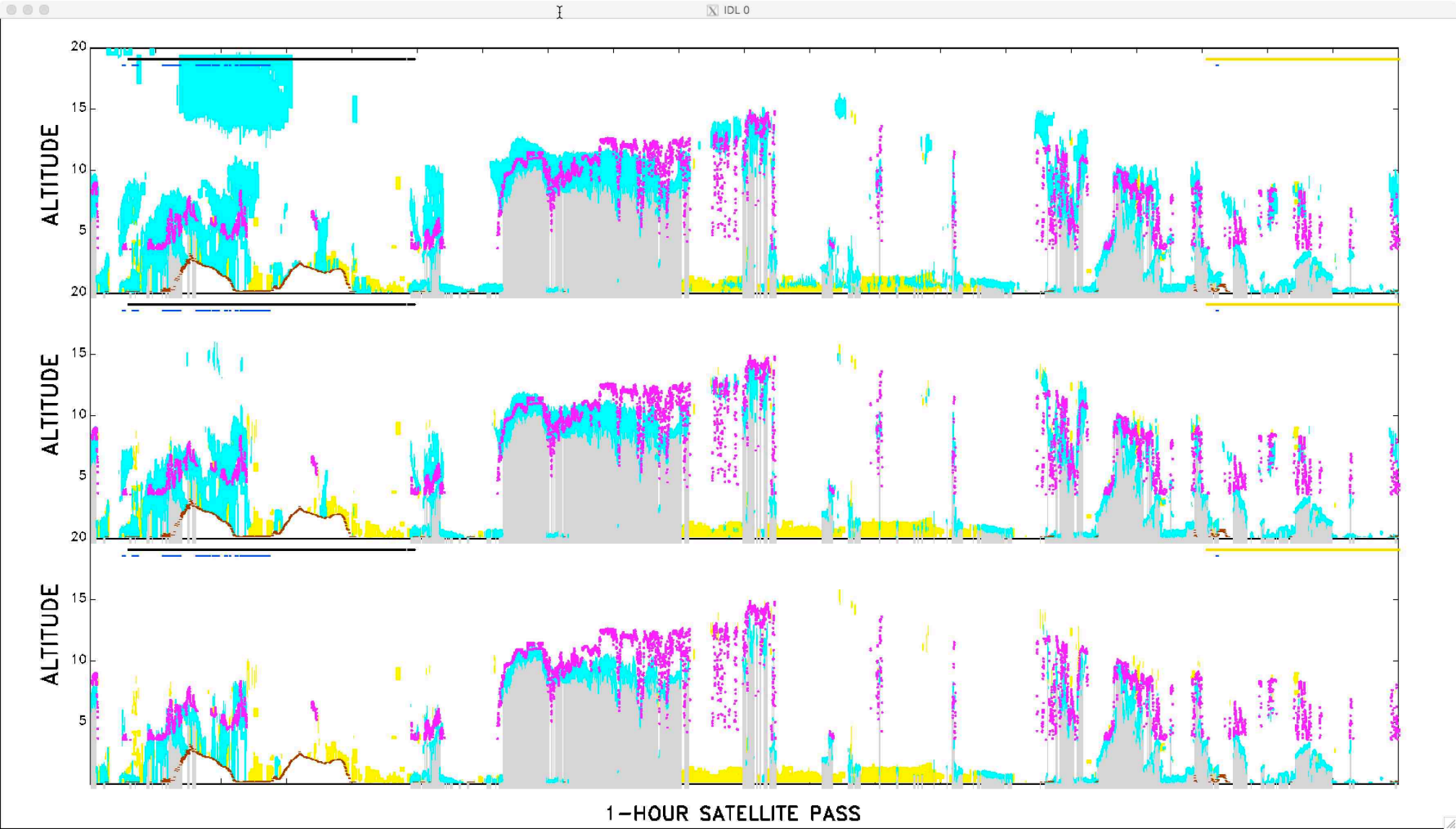


Topic: How's our 2-channel CO_2 Cloud Retrieval

- 2008/07/01 Time: 00-01 Z ~ 24,500 1-km data

Pink: CO_2

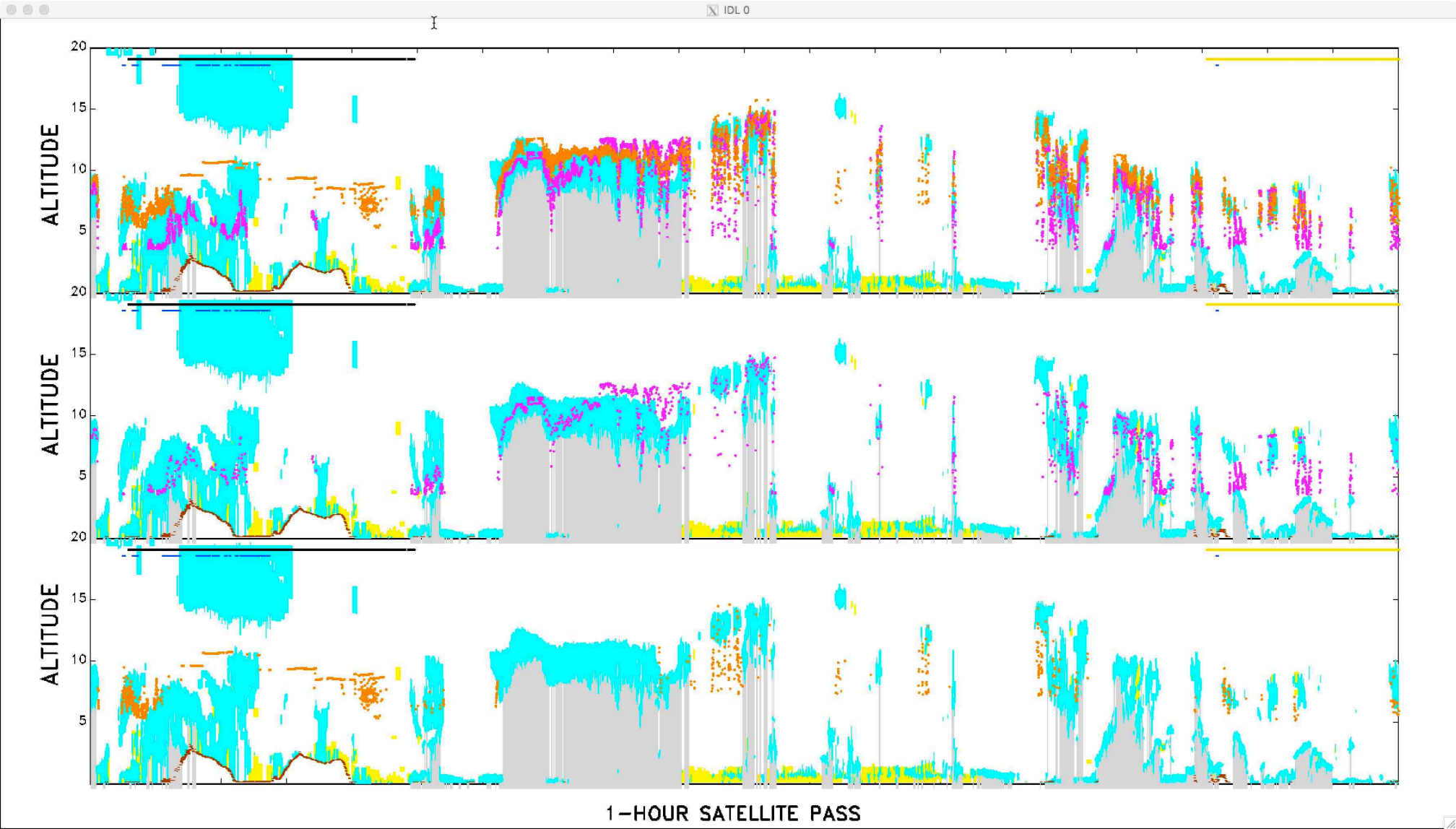
Top: Tau > 0. Mid: Tau > 0.3. Bottom panel: Tau > 1.



How's our 2-ch. vs 5-ch. CO_2 Cloud Retrieval (1)

- 2008/07/01 Time: 00-01 Z ~ 24,500 1-km data

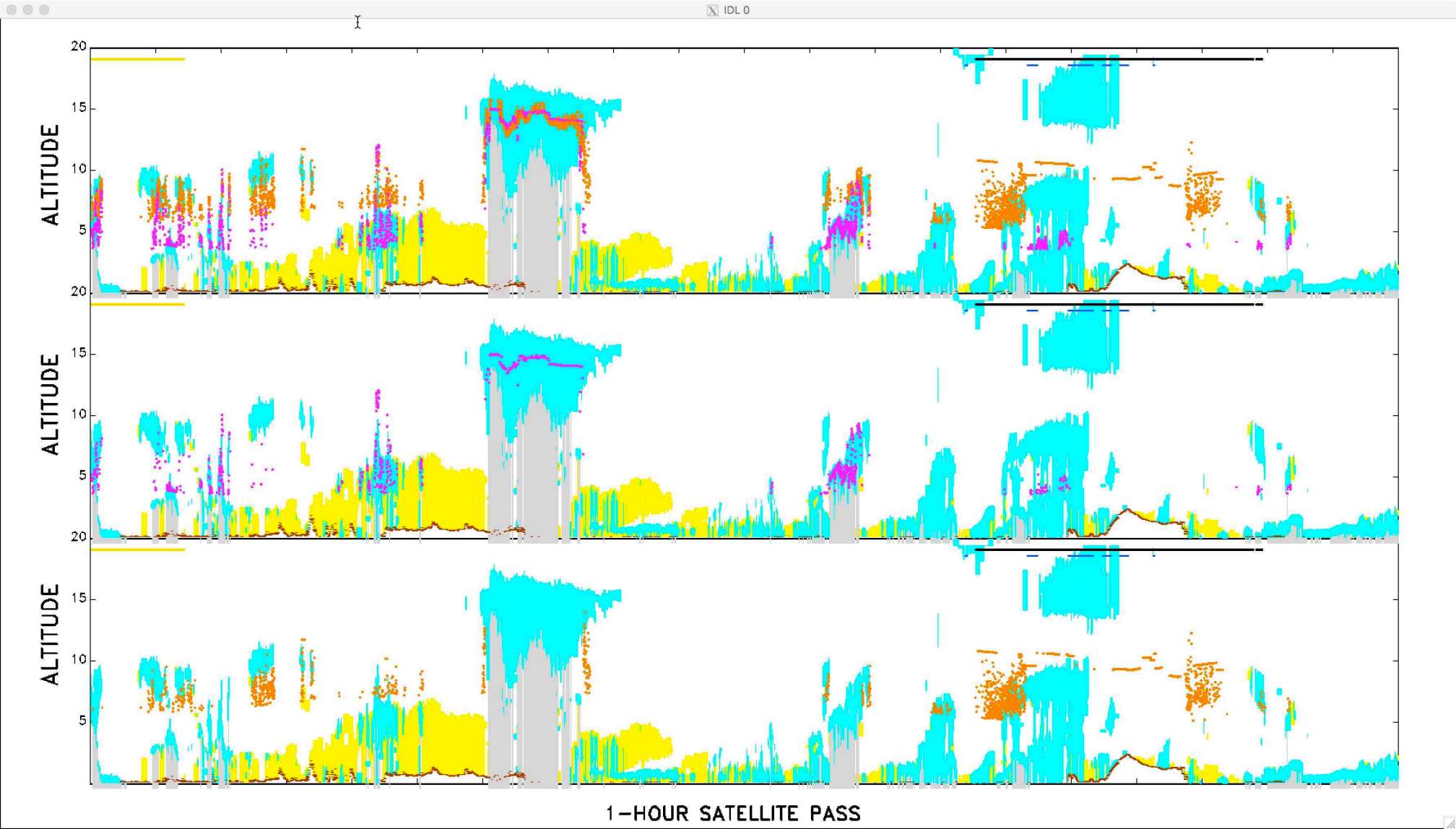
2-ch. CO_2 | Top: 2-ch. & 5-ch. Mid: 2-ch./no 5-ch. Bottom: 5-ch./no 2-ch. | 5-ch. CO_2



How's our 2-ch. vs 5-ch. CO_2 Cloud Retrieval (2)

- 2008/07/01 Time: 01-02 Z ~ 24,500 1-km data

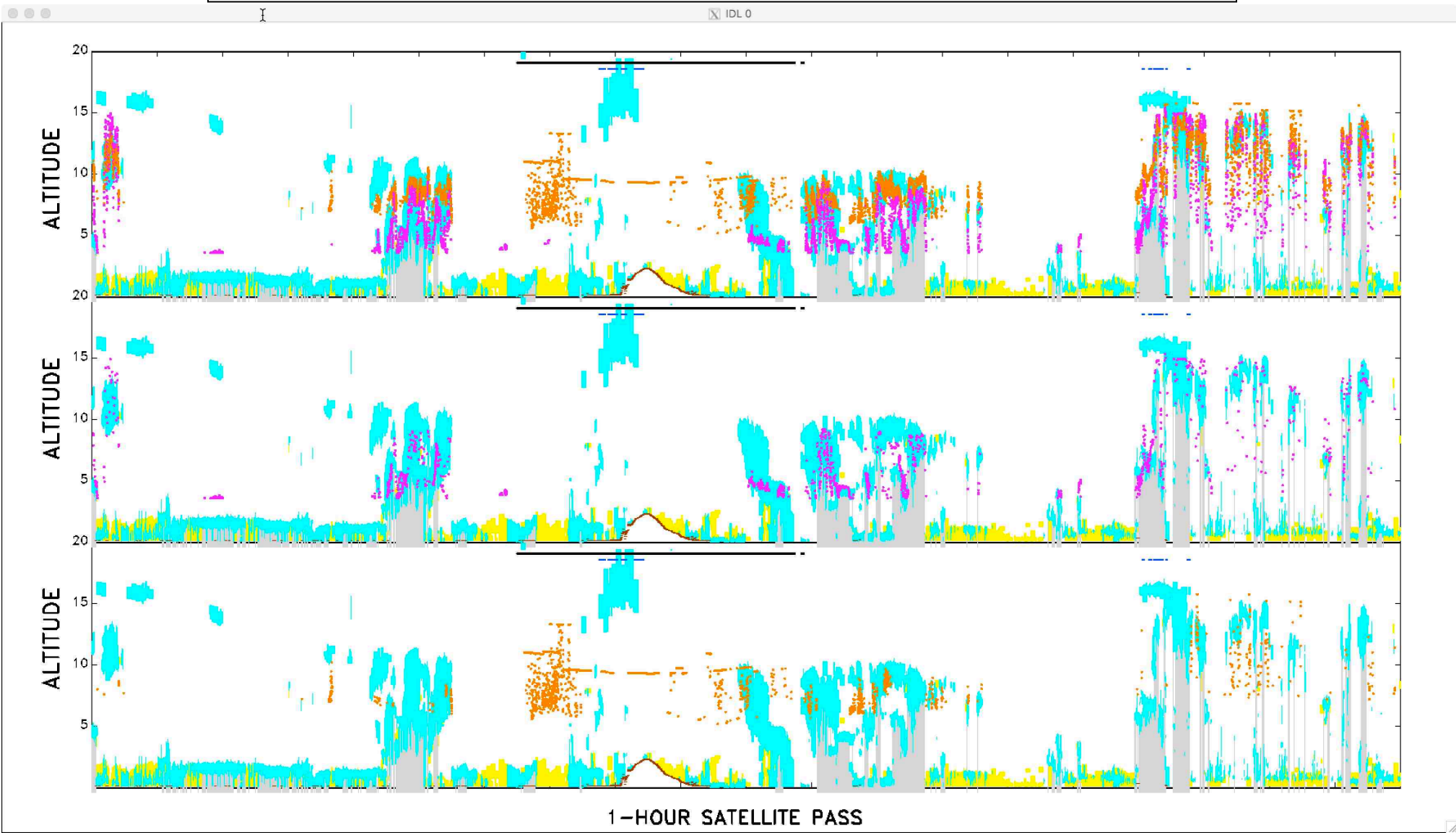
2-ch. CO_2 | Top: 2-ch. & 5-ch. Mid: 2-ch./no 5-ch. Bottom: 5-ch./no 2-ch. | 5-ch. CO_2



How's our 2-ch. vs 5-ch. CO_2 Cloud Retrieval (3)

- 2008/07/01 Time: 03-04 Z ~ 24,500 1-km data

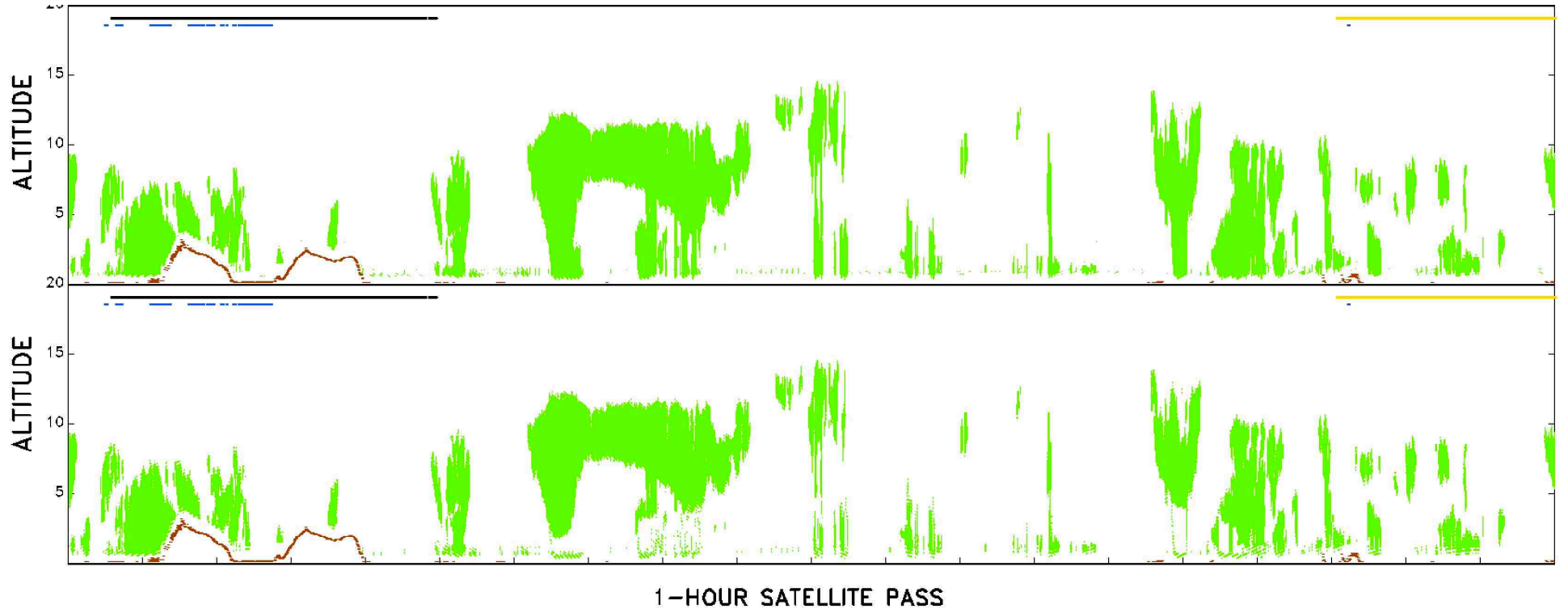
2-ch. CO_2 | Top: 2-ch. & 5-ch. Mid: 2-ch./no 5-ch. Bottom: 5-ch./no 2-ch. | 5-ch. CO_2



QC of the CloudSat Data, Mask or Tau?

- 2008/07/01 Time: 00-01 Z

Top panel: Gaze-bin Tau > 0. Bottom: Gaze-bin Tau > 0.01



Matched CALIOP and/or CloudSat Data, Difference?

- 2008/07

		CL + CS			
	(N)	Sum	H	M	L
75N-90N	1096430	78.5	35.3	16.1	27.1
55N-75N	1843886	78.2	39.4	15.7	23.2
35N-55N	1768428	71.0	38.7	9.5	22.8
15N-35N	1748319	66.6	40.9	4.8	20.9
Tropics	2613269	77.3	51.1	5.5	20.7
15S-35S	1751525	62.0	18.1	6.2	37.7
35S-55S	1770265	87.0	38.8	10.1	38.2
55S-75S	1837787	90.8	57.1	9.8	23.8
75S-90S	1092694	89.9	79.9	5.6	4.4

CL only			
Sum	H	M	L
28.0	5.7	3.0	19.2
29.5	8.6	5.9	15.0
27.8	8.8	5.5	13.5
32.2	16.2	3.1	12.9
38.4	23.2	3.4	11.8
23.7	5.2	2.7	15.8
22.9	9.1	1.9	11.9
42.1	31.2	2.0	8.9
71.1	66.1	2.3	2.7

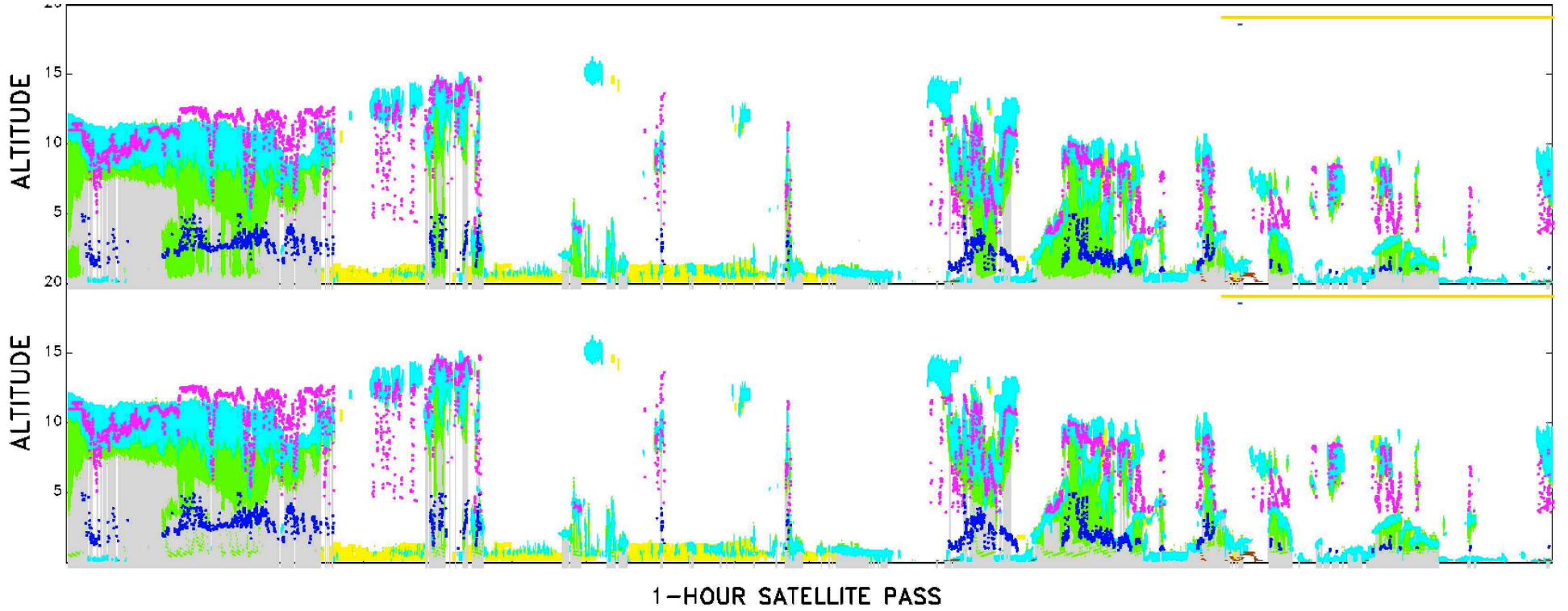
CS only			
Sum	H	M	L
5.2	2.8	1.0	1.4
3.1	1.5	0.6	1.0
3.2	0.9	0.5	1.9
2.6	0.5	0.4	1.7
2.3	0.3	0.3	1.6
3.8	0.2	0.6	2.9
3.5	0.4	0.8	2.4
1.5	0.1	0.4	1.0
0.4	0.0	0.1	0.3

Topic: How's our current Multilayer Cloud Retrieval

- 2008/07/01 Time: 00-01 Z : Daytime only, SZA > 75 deg

Pink: 2-ch. CO_2

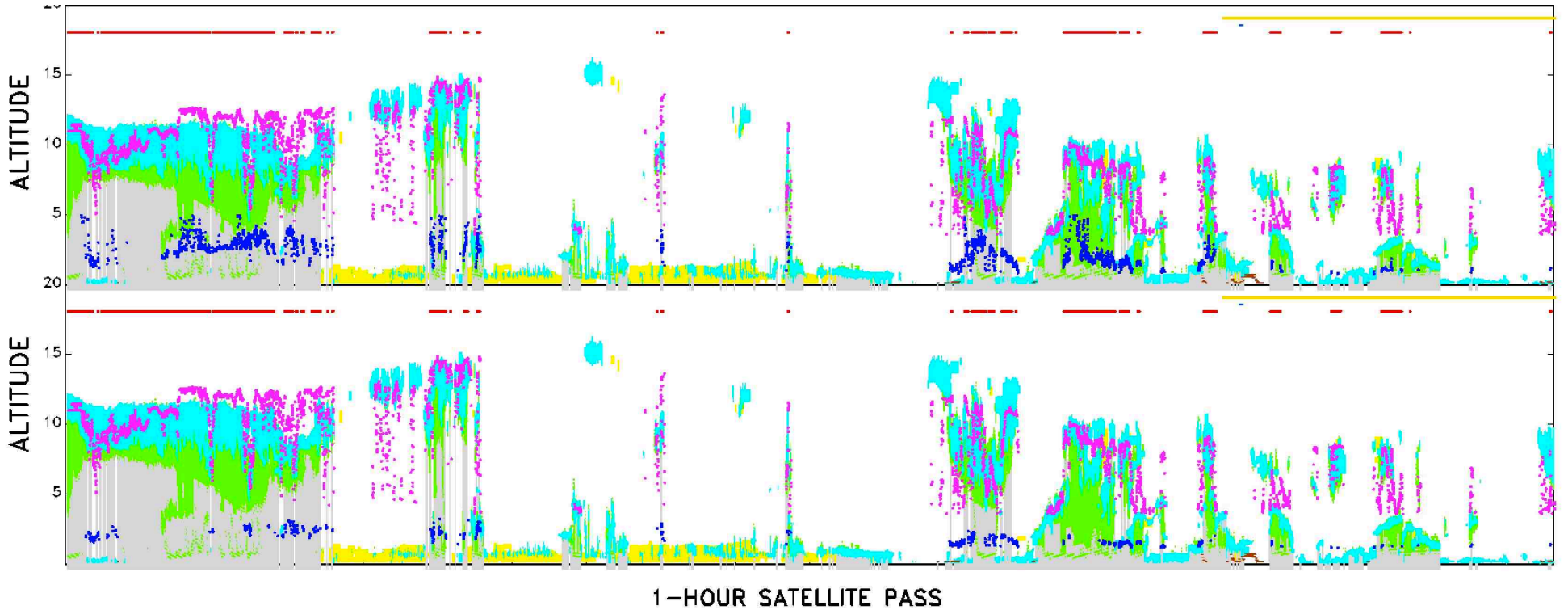
Blue: Lower Cloud Height



How to Flag Multilayer Cloud Retrieval

- 2008/07/01 Time: 00-01 Z : Daytime only, SZA > 75 deg

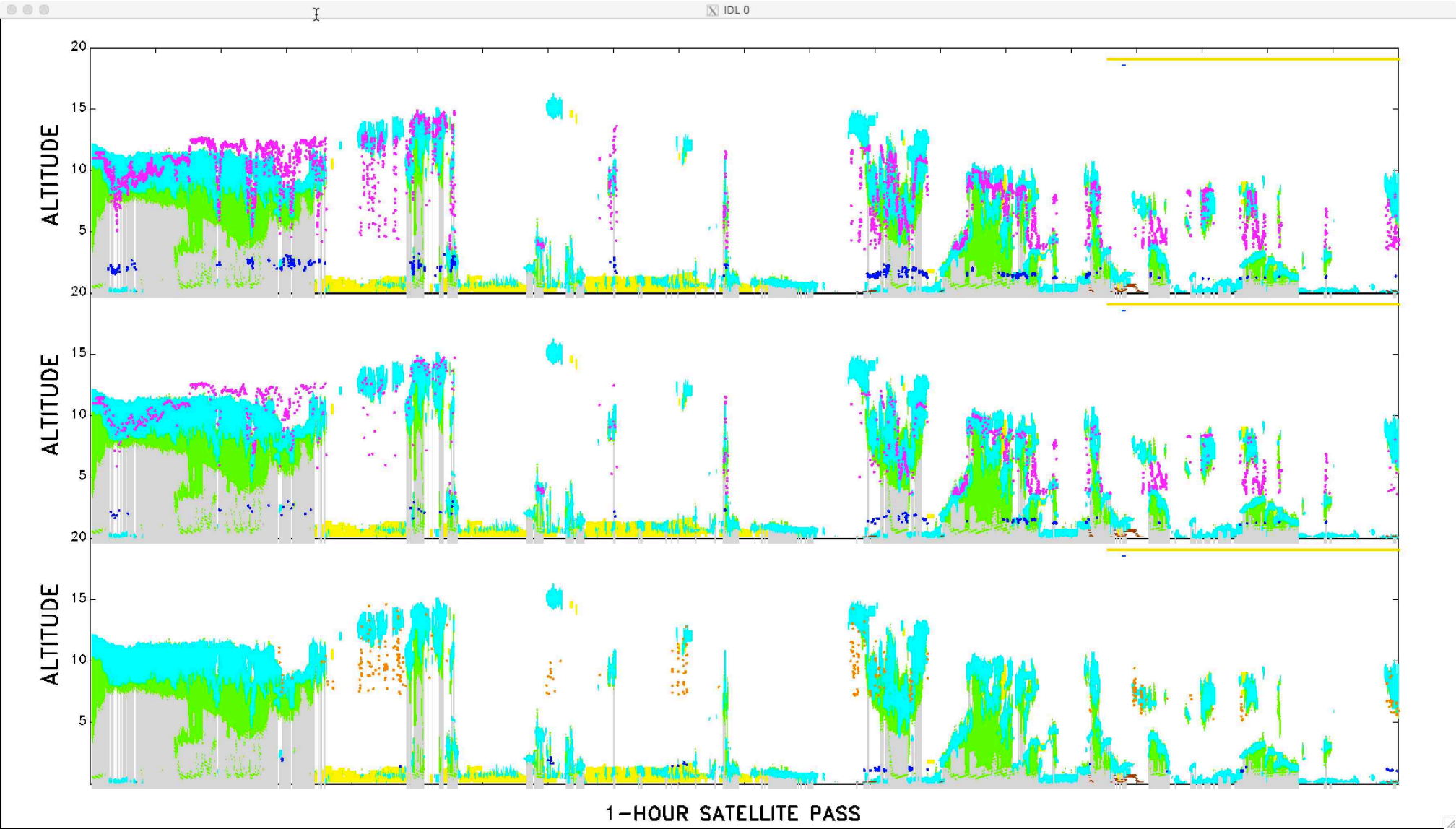
Pink: 2-ch. CO_2 Red Flag: Removed Possible Convection Lower Cloud (bottom panel)



How's our 2-ch. vs 5-ch. Multilayer Cloud Retrieval

- 2008/07/01 Time: 00-01 Z : Daytime SZA > 75 deg

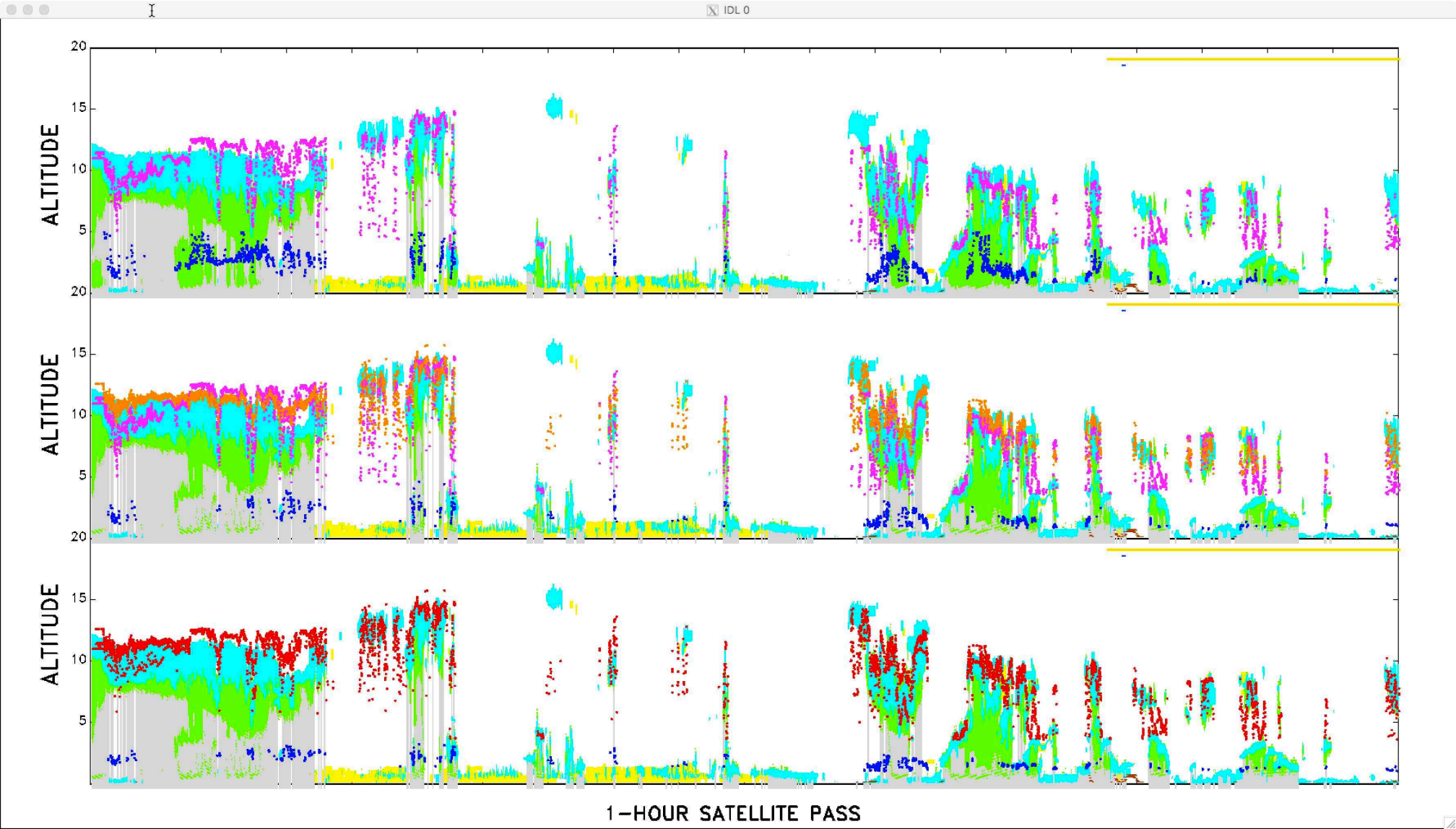
(2-ch. CO_2) | Top: 2-ch. only Mid: 2-ch./no 5-ch. Bottom: 5-ch./no 2-ch. | (5-ch. CO_2)



How's the Before & After Multilayer Cloud Retrieval

- 2008/07/01 Time: 00-01 Z : Daytime SZA > 75 deg

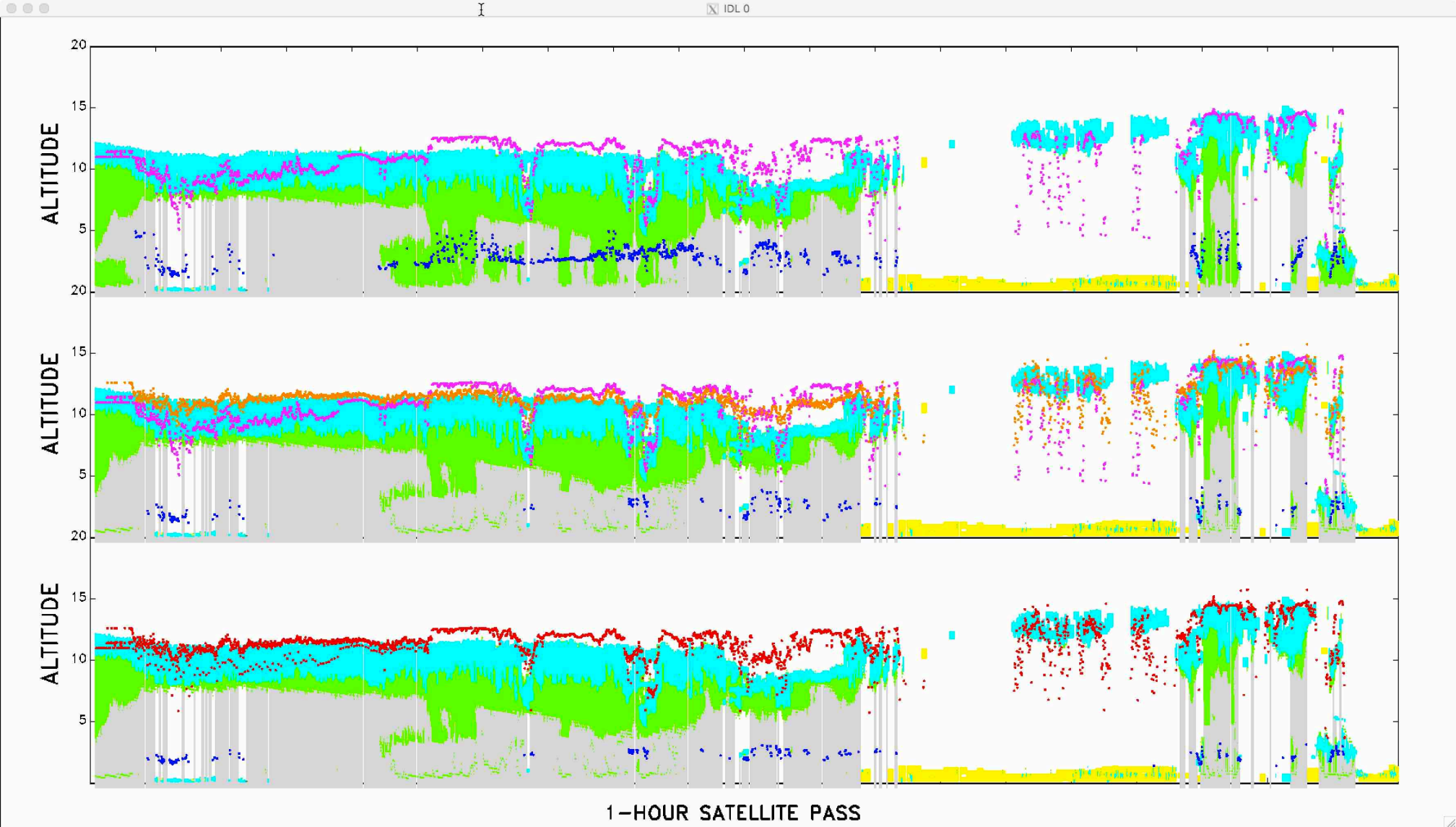
(2-ch. CO_2) | Top: Before | Mid: 2-ch. & 5.ch. | Bottom: After | (5-ch. CO_2)



Enlarged (1) Before & After Multilayer Cloud Retrieval

- 2008/07/01 Time: 00-01 Z : Daytime SZA > 75 deg

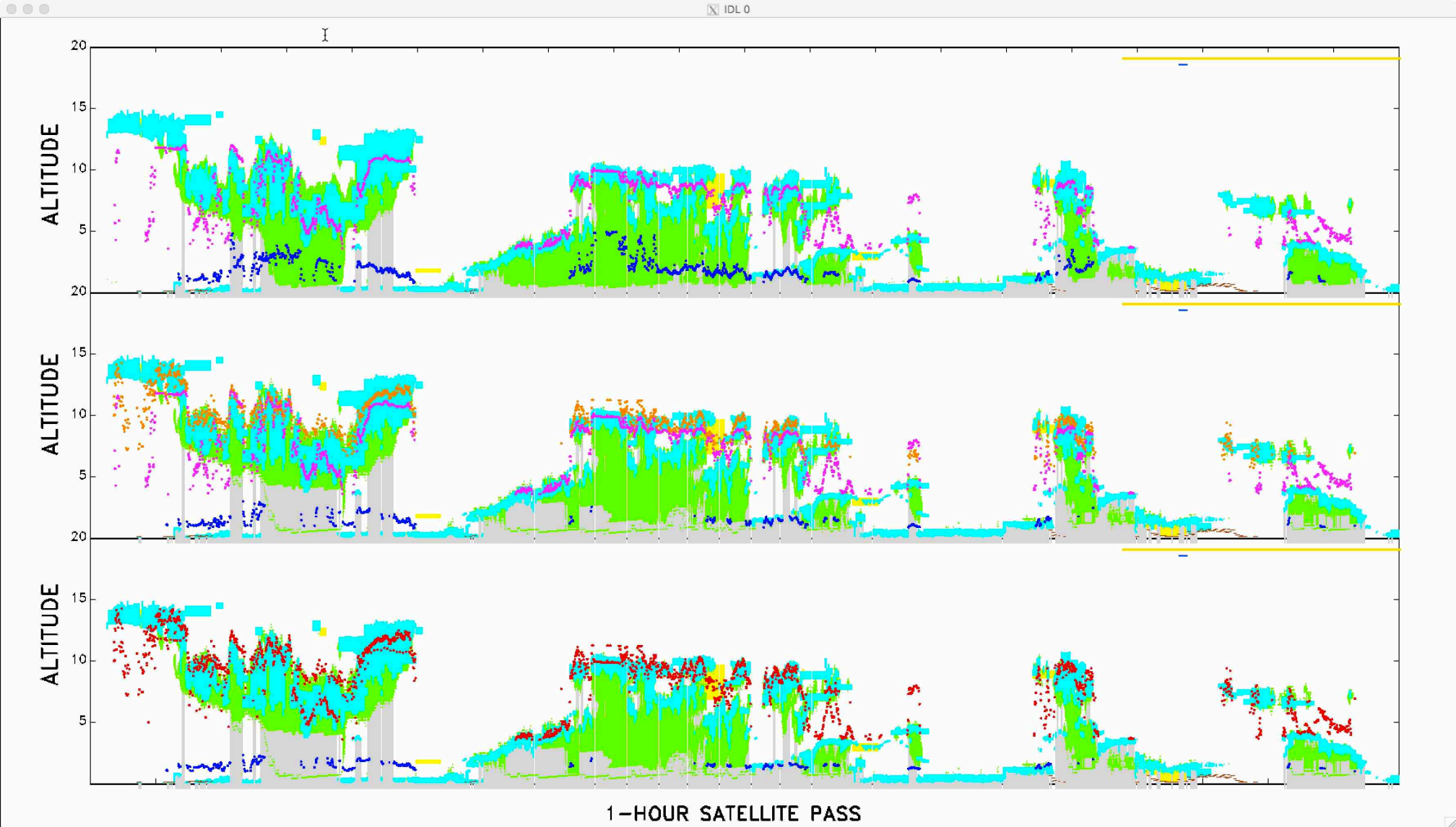
(2-ch. CO_2) | Top: Before Mid: 2-ch. & 5.ch. Bottom: After | (5-ch. CO_2)



Enlarged (2) Before & After Multilayer Cloud Retrieval

- 2008/07/01 Time: 00-01 Z : Daytime SZA > 75 deg

(2-ch. CO_2) | Top: Before Mid: 2-ch. & 5.ch. Bottom: After | (5-ch. CO_2)



CL+CS Data and our 2-ch./5-ch. CO_2 Cloud Retrieval

- 2008/07

		CL + CS			
	(N)	Sum	H	M	L
75N-90N	1096430	78.5	35.3	16.1	27.1
55N-75N	1843886	78.2	39.4	15.7	23.2
35N-55N	1768428	71.0	38.7	9.5	22.8
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35S-55S	1770265	87.0	38.8	10.1	38.2
55S-75S	1837787	90.8	57.1	9.8	23.8
75S-90S	1092694	89.9	79.9	5.6	4.4

	CL+CS: H					CL+CS: M					CL+CS: L					CL+CS: None				
	H	2+5	2&5	2o	5o	M	2+5	2&5	2o	5o	L	2+5	2&5	2o	5o		2+5	2&5	2o	5o
75N-90N	35.3	19.7	12.9	6.9	2.6	16.1	8.9	2.6	6.3	0.4	27.1	1.6	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0
55N-75N	39.4	25.2	17.9	7.4	2.9	15.7	7.5	1.7	5.7	0.3	23.2	0.7	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
35N-55N	38.7	26.1	18.9	7.2	2.8	9.5	3.5	0.5	3.0	0.2	22.8	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
15N-35N	40.9	25.9	20.4	5.5	3.4	4.8	1.4	0.5	1.0	0.2	20.9	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
tropics	51.1	32.2	26.3	5.9	4.0	5.5	2.0	0.4	1.5	0.1	20.7	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
15S-35S	18.1	12.5	8.9	3.6	1.1	6.2	2.5	0.3	2.1	0.1	37.7	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
35S-55S	38.8	26.2	18.4	7.7	3.2	10.1	3.8	0.7	3.1	0.2	38.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55S-75S	57.1	20.8	14.4	6.4	16.2	9.8	2.0	0.4	1.6	1.8	23.8	0.1	0.0	0.1	1.9	0.0	0.1	0.0	0.0	2.1
75S-90S	79.9	12.3	10.8	1.5	39.2	5.6	0.2	0.2	0.0	2.5	4.4	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	5.3

CALIOP+/-CloudSat Multilayer Cloud Mask or Tau, Difference?

- 2008/07

	(N)	H	(	H/L	H/M	)	M	(	M/L	M/M	)	L
55N-75N	934217	38.9	(	12.4	6.4	20.1)	15.9	(	5.2	1.1	9.6)	25.2
35N-55N	882615	37.8	(	11.2	5.5	21.1)	10.1	(	2.9	0.9	6.4)	24.5
15N-35N	869372	37.4	(	8.3	4.9	24.3)	5.1	(	1.5	0.6	3.0)	20.9
tropics	1298027	45.8	(	13.0	5.1	27.6)	5.8	(	1.7	0.4	3.6)	22.4
15S-35S	870094	17.5	(	6.1	1.7	9.7)	6.0	(	1.5	0.3	4.2)	36.7
35S-55S	554008	38.4	(	15.3	4.1	19.0)	9.1	(	2.9	0.4	5.8)	36.8
55S-75S	0	0.0	(	0.0	0.0	0.0)	0.0	(	0.0	0.0	0.0)	0.0

	(N)	H	(	H/L	H/M	)	M	(	M/L	M/M	)	L
55N-75N	934217	38.9	(	23.4	6.9	8.5)	15.9	(	10.1	2.3	3.4)	24.5
35N-55N	882615	37.8	(	18.8	8.0	11.0)	10.1	(	4.6	1.5	4.0)	23.0
15N-35N	869372	37.4	(	14.5	6.3	16.6)	5.1	(	2.1	0.8	2.2)	19.6
tropics	1298027	45.8	(	20.0	5.1	20.6)	5.7	(	3.0	0.7	2.1)	21.1
15S-35S	870094	17.5	(	9.3	2.2	5.9)	5.9	(	3.6	0.6	1.7)	34.7
35S-55S	554008	38.4	(	27.0	4.2	7.2)	9.1	(	7.5	0.9	0.7)	35.6
55S-75S	0	0.0	(	0.0	0.0	0.0)	0.0	(	0.0	0.0	0.0)	0.0

Multilayer Cloud Retrieval Questions to be Answered

- How's its performance on thin cirrus over thin low cloud ?
- How's its performance on vertically-thin but continued convection cloud?
- How's its performance on the other cloud types?
- How's its performance on the upper-layer cloud property retrieval?
- How's its performance on the lower-layer cloud property retrieval?
- Future work ??