

*Airborne Lidar Investigations of Ozone and Aerosols
During the Second SAGE-III Ozone Loss and
Validation Experiment (SOLVE-2)*

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Field Experiment:

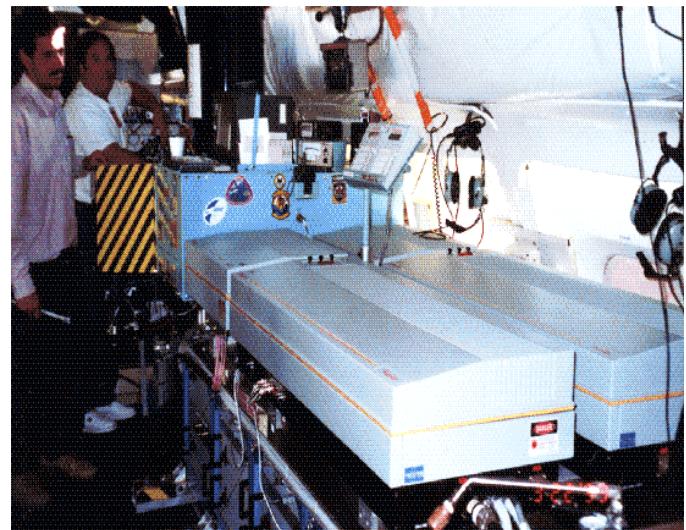
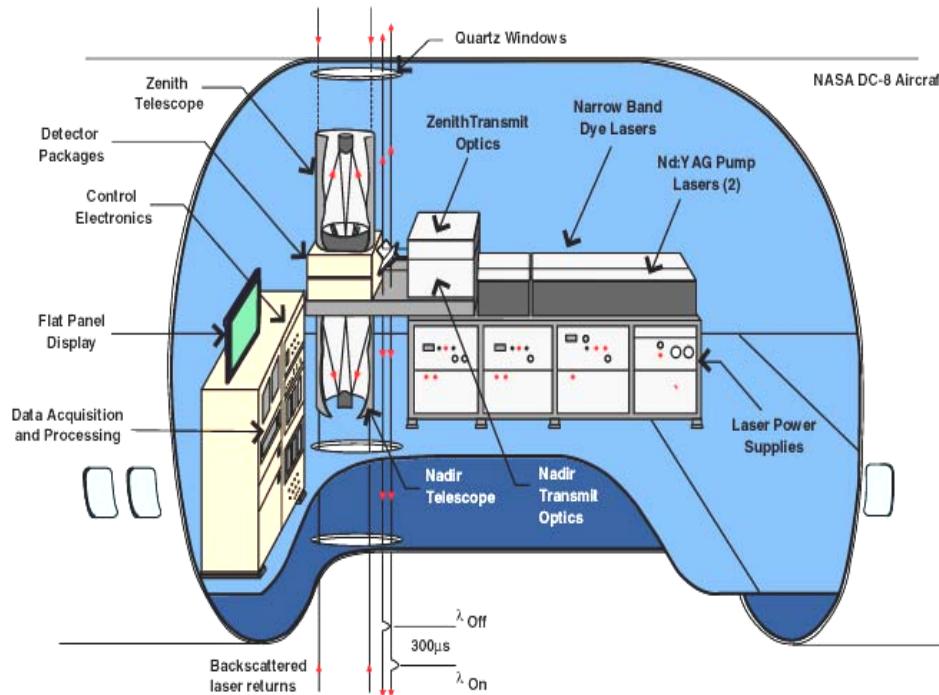
Carolyn Butler/Susan Kooi - DIAL/Data System

Tony Notari/Jerry Williams - Laser/Lidar

Post-Mission Data Reduction & Analysis:

Carolyn Butler, Vince Brackett, & Marta Fenn

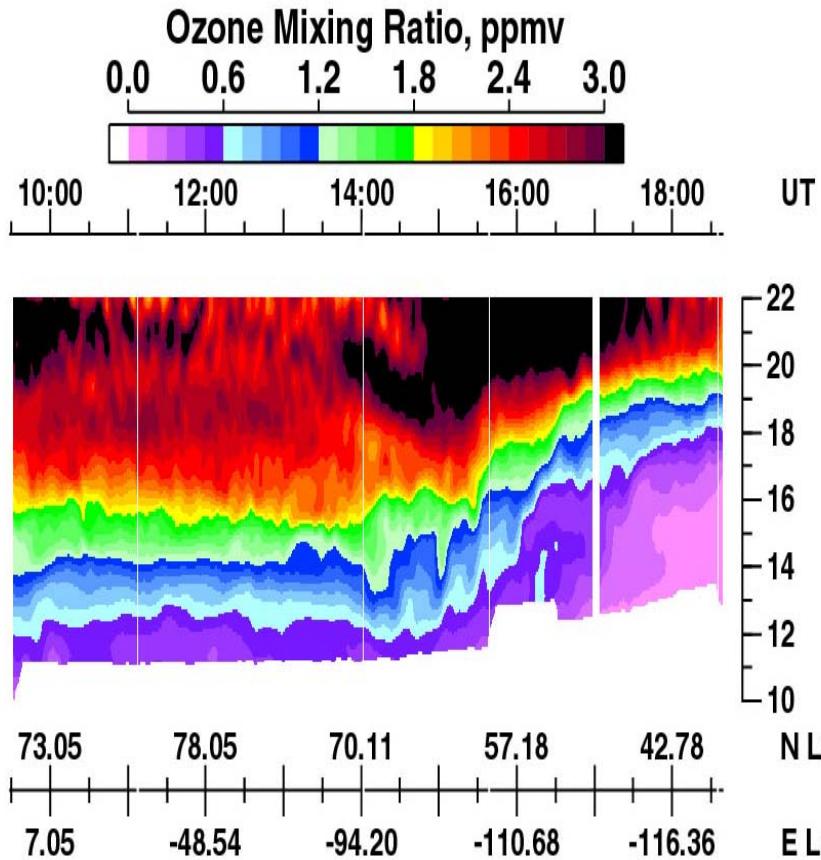
UV DIAL Ozone, Aerosol, & Cloud Measurements



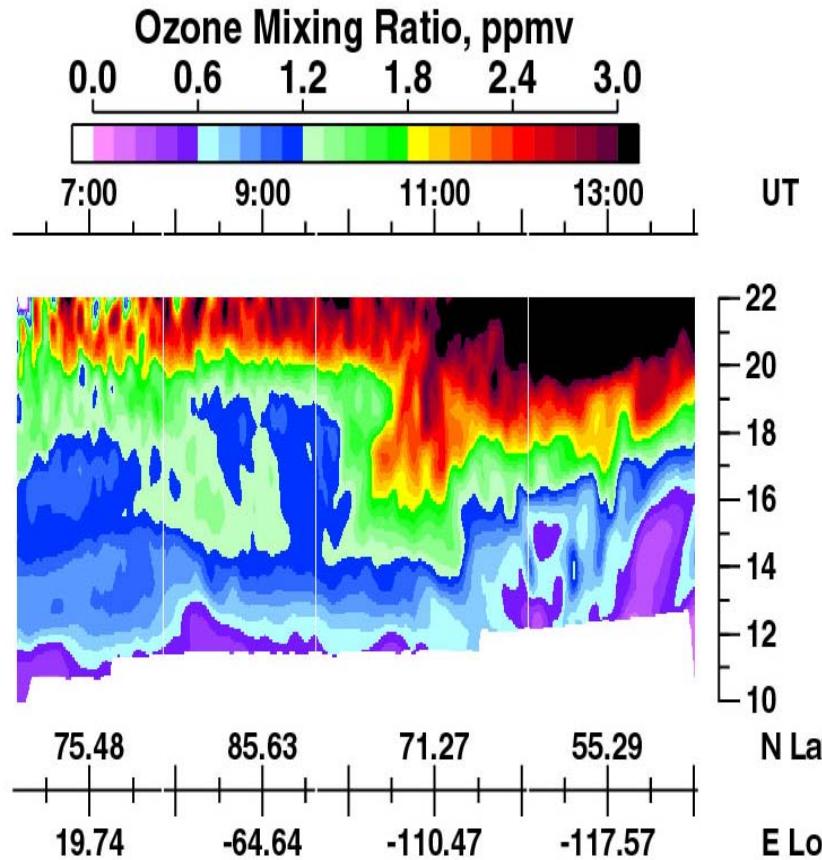
- Ozone Differential Absorption Lidar (DIAL) Profiles ($\lambda_{\text{on}}=301.5 \text{ nm}$ & $\lambda_{\text{off}}=310.8 \text{ nm}$)
- Simultaneous Nadir & Zenith Ozone DIAL Profiling (surface to ~28 km)
- Simultaneous Nadir & Zenith Aerosol & Cloud Scattering Ratio Profiling at 600 & 1064 nm
- Simultaneous Nadir & Zenith Aerosol Depolarization Profiles (600 nm)

Ozone Loss During SOLVE

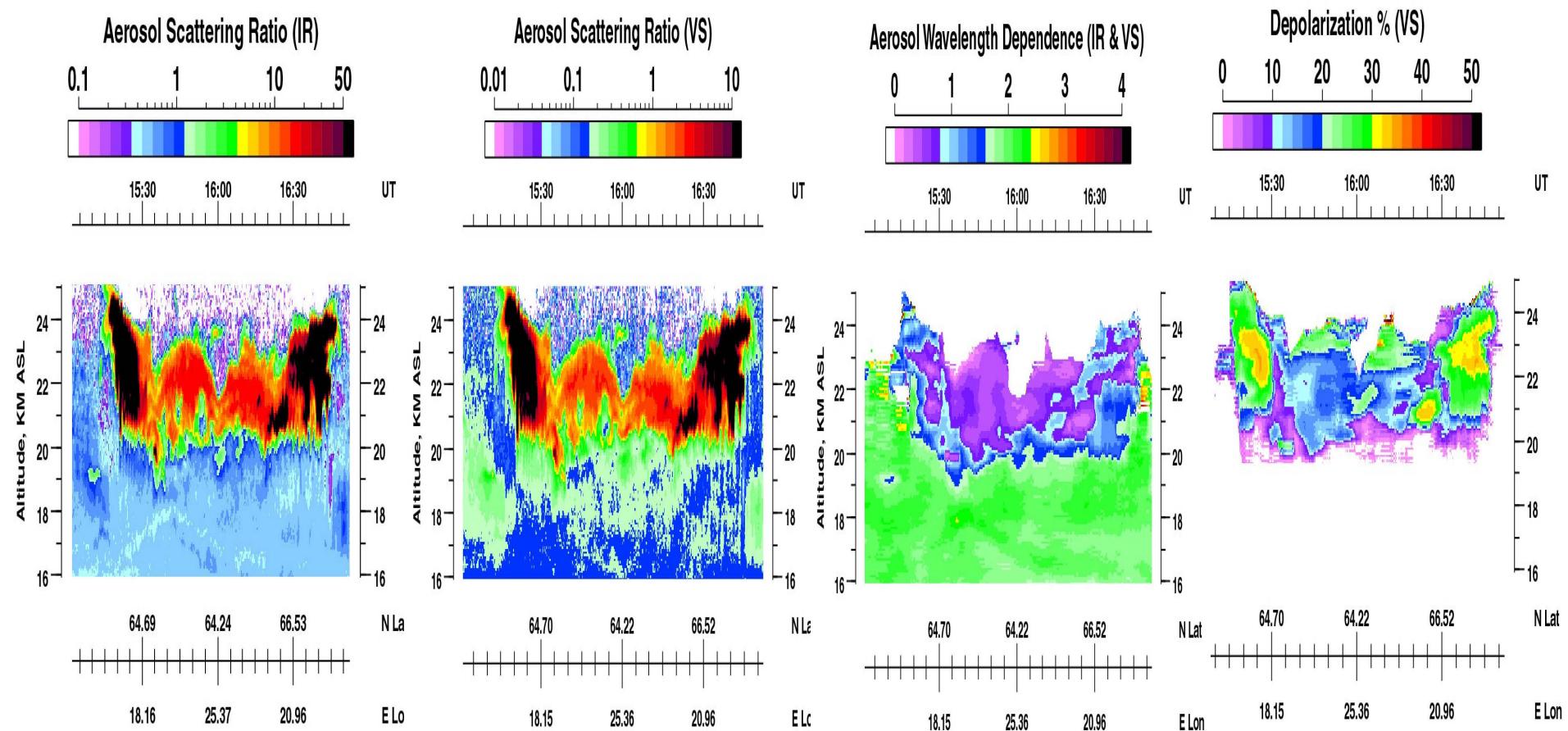
16 December 1999



15 March 2000

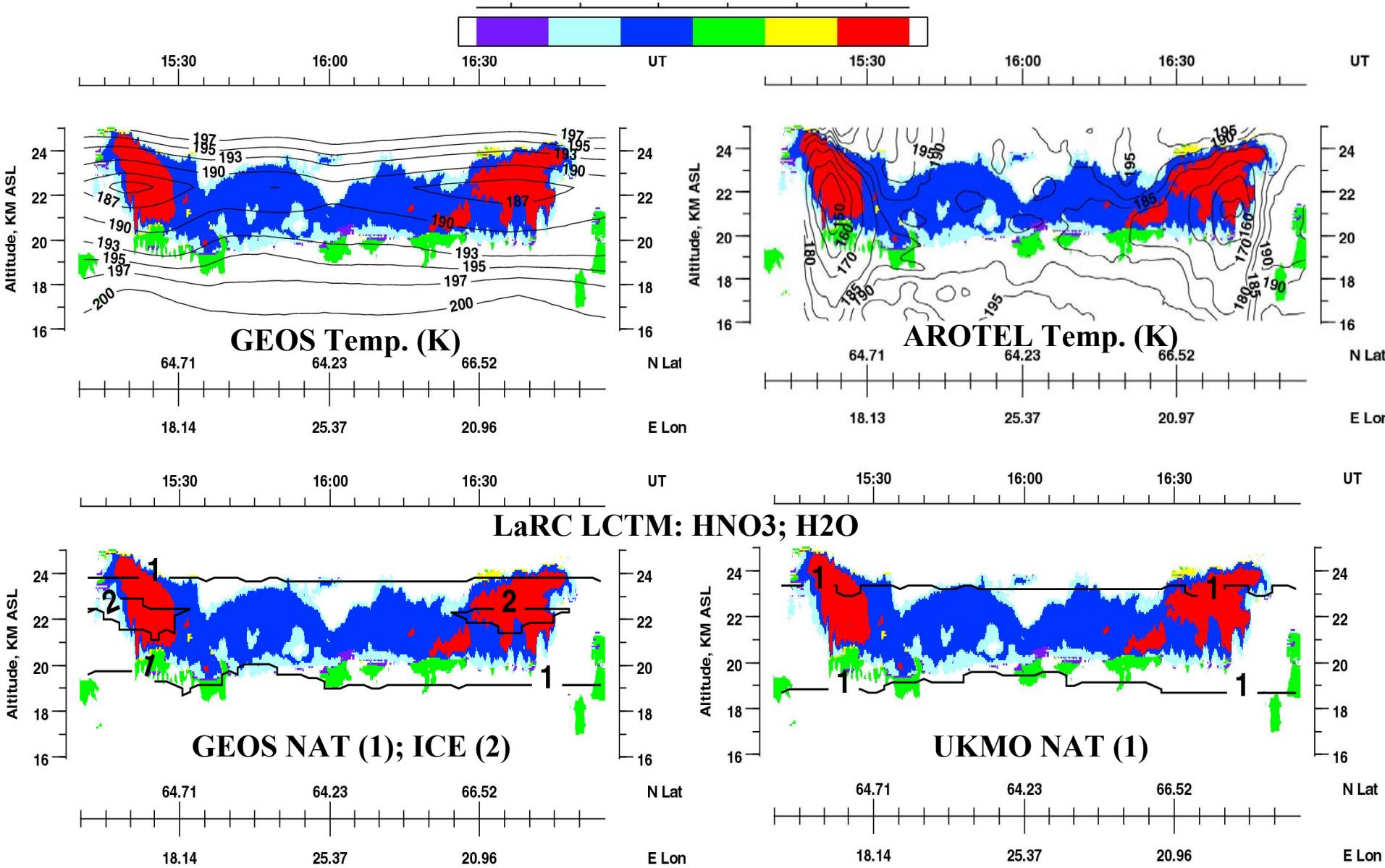


IR & VIS Aerosol Scattering Ratios, Wavelength Dependence, and Depolarizations on 25 Jan. 2000 (Flt. 19)



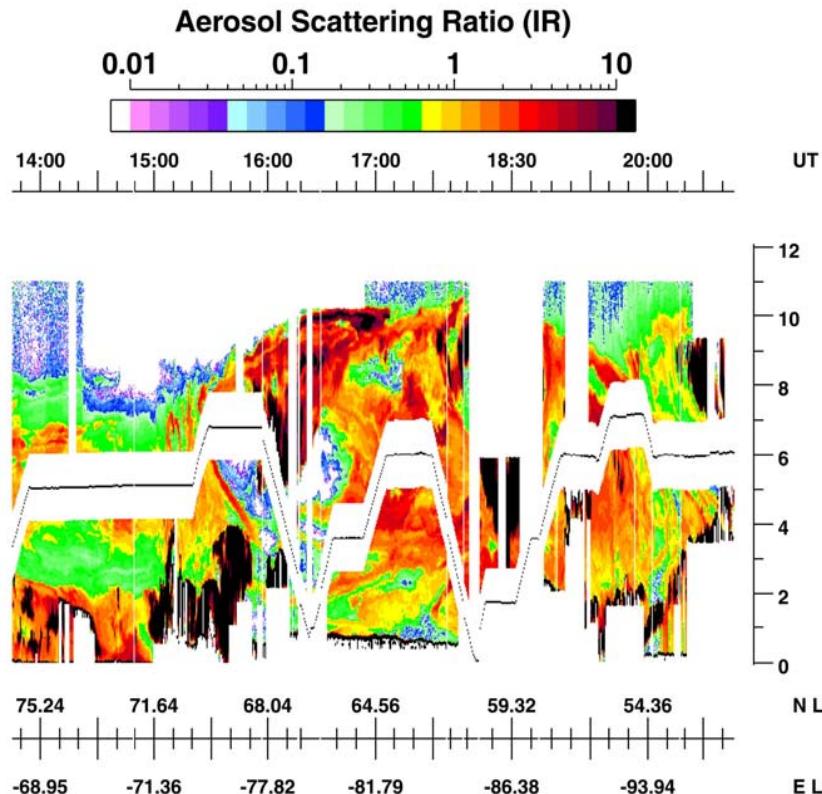
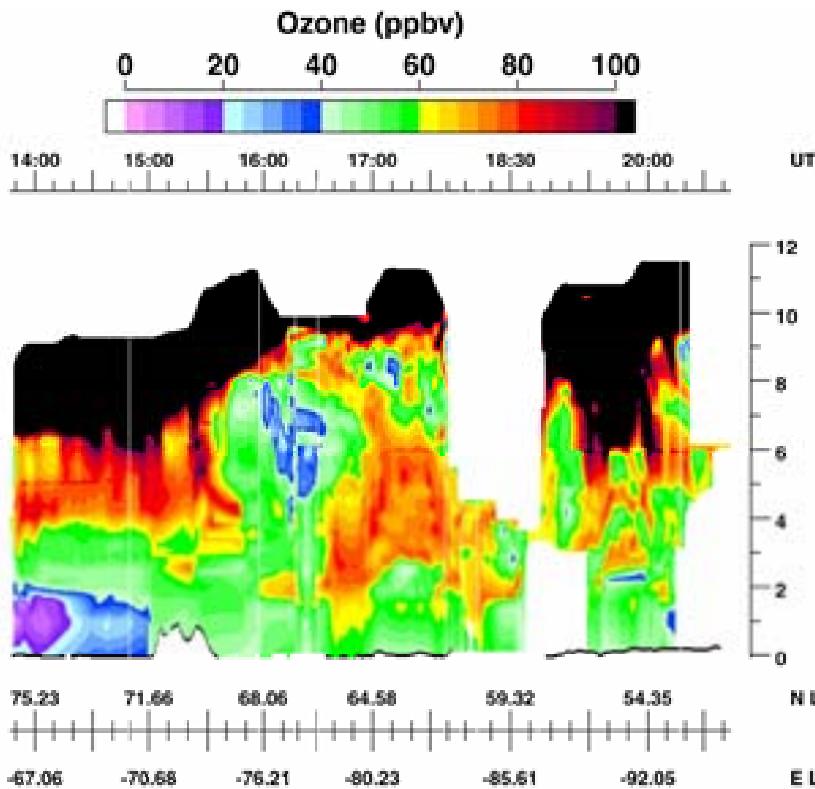
PSC Types on 25 January 2000 (Flt. 19)

. Mix Ia Ia-e Ib Ic II .

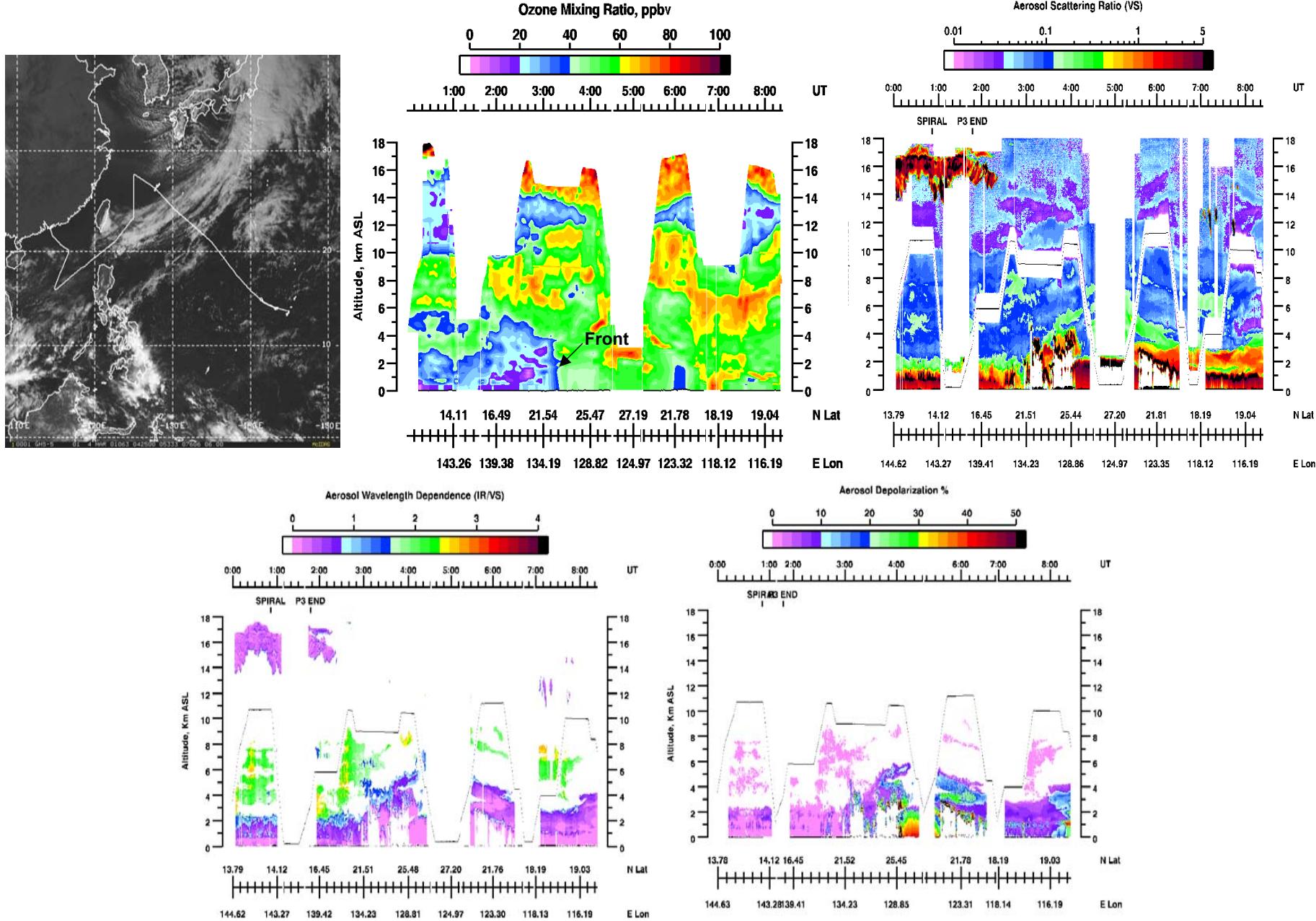


Aerosol & Ozone Measurements

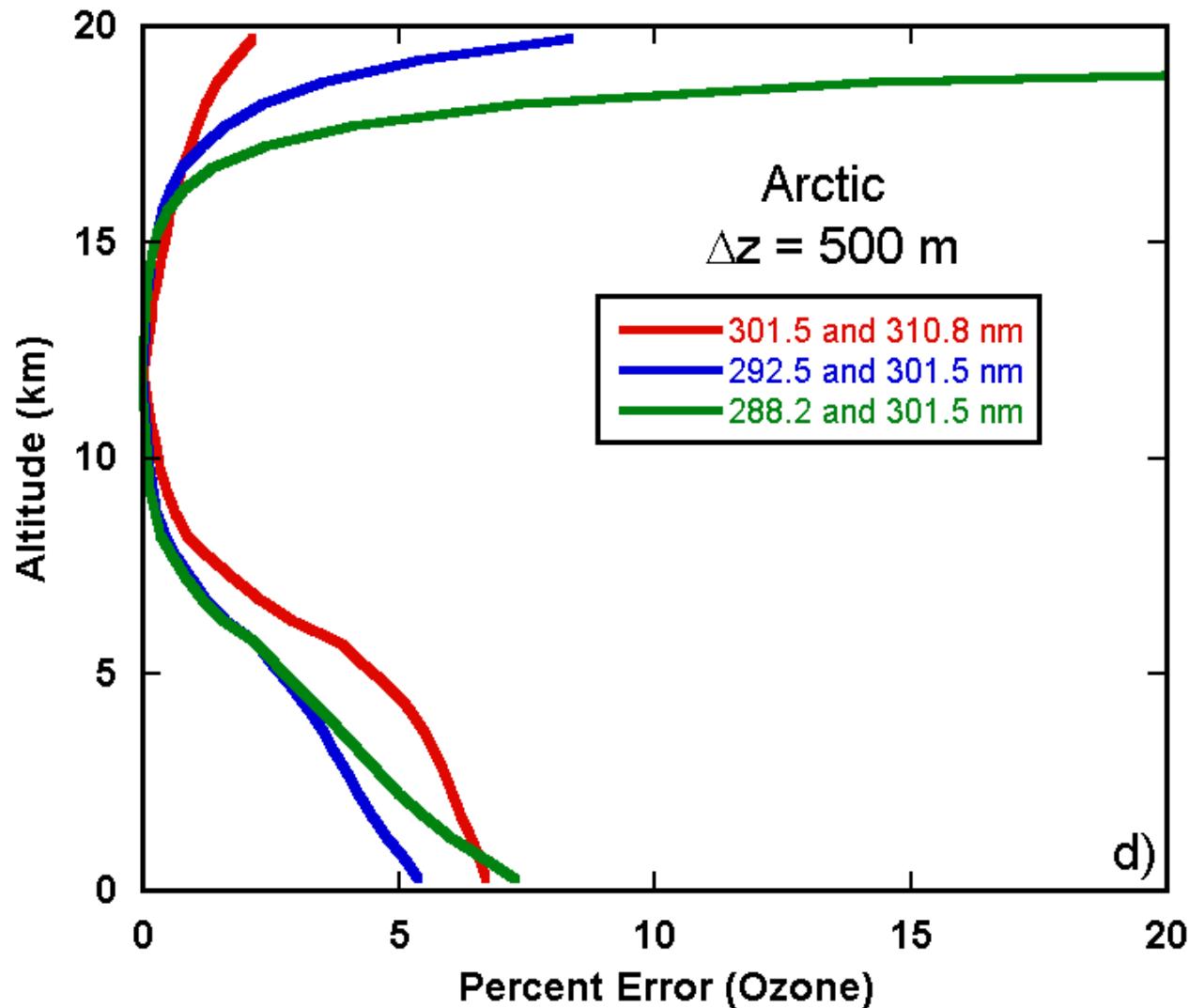
Flight 41 - May 22, 2000
Thule to Winnipeg



TRACE-P Flt. 6 Guam to Hong Kong 3-4 March 2001



*Simulations of Tropospheric & Lower Stratospheric
Ozone Measurements with Different DIAL Wavelength Pairs*



PSC Types Observed During SOLVE

Flight	Date	Vertical Area (km ²)	PSC Types (Percentage of Area)						
			Ia	Ia-enh.	Ib	Mix	Ic	IIa	II
8	12/5/99	483	98.2	0	0	1.8	0	0	0
9	12/7/99	1597	90	1.2	0	1.1	0	7.7	0
10	12/10/99	574	100	0	0	0	0	0	0
Deployment #1		2654	93.6	0.7	0	1.0	0	4.7	0
15	1/14/00	2003	30.6	1.7	51.5	14.4	0.8	0	1
16	1/16/00	651	81.9	0	1.1	16	1.0	0	0
17	1/20/00	6973	51.7	8.6	10.6	29	0.2	0	0
18	1/23/00	19667	34.6	39.4	10.4	5.7	7.1	0.1	2.6
19	1/25/00	16123	31.8	29.2	20.8	5.7	3.1	0.2	9.2
20	1/27/00	2289	29.4	9.5	49.7	6.8	4.5	0.1	0
21	1/29/00	2490	98.9	0	0.5	0.6	0	0	0
Deployment #2		50196	39.5	26.5	16.6	9.2	4.1	0.1	4
25	3/5/00	6037	31.5	0.2	48.4	18.5	1.4	0	0
26	3/8/00	2456	62.9	0.2	23.6	7.7	5.6	0	0
Deployment #3		8493	40.6	0.2	41.2	15.4	2.6	0	0
SOLVE		61343	42	21.7	19.3	9.7	3.7	0.3	3.3

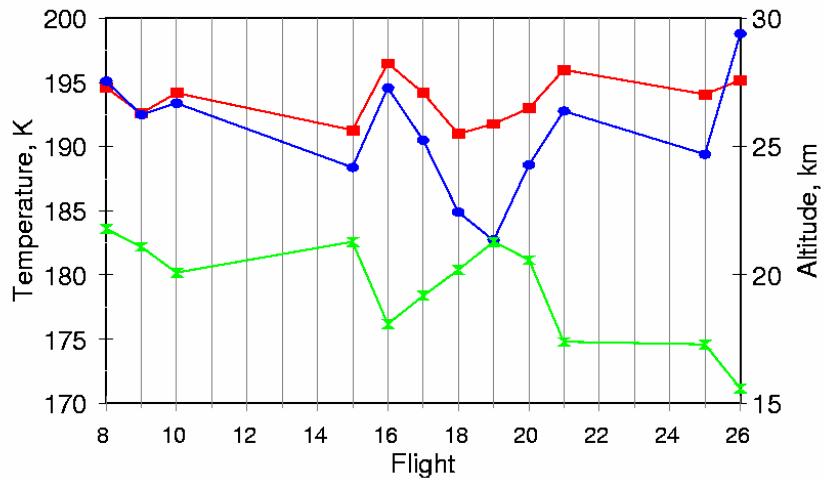
Optical Characteristics of PSC Types

		PSC Types						
		Ia	Ia-e	Ib	Mix	Ic	IIa	II
S_{IR}	Deploy. #1	1.8	4.9	---	1.0	---	6.6	---
	Deploy. #2	2.0	11.9	4.8	2.6	7.0	7.7	184.9
	Deploy. #3	1.4	4.6	2.1	1.7	1.6	---	---
	SO LVE	1.9	11.9	4.0	2.4	6.4	6.9	184.9
S_{VIS}	Deploy. #1	0.3	0.6	---	0.2	---	0.6	---
	Deploy. #2	0.3	1.7	1.1	0.6	1.3	0.7	35.5
	Deploy. #3	0.3	1.2	0.5	0.4	0.4	---	---
	SO LVE	0.3	1.7	0.9	0.6	1.2	0.7	35.5
S_{UV}	Deploy. #1	0.04	0.05	---	0.03	---	0.06	---
	Deploy. #2	0.05	0.22	0.19	0.10	0.24	0.07	3.36
	Deploy. #3	0.04	0.17	0.08	0.06	0.05	---	---
	SO LVE	0.05	0.22	0.16	0.09	0.22	0.06	3.36
D_{IR} (%)	Deploy. #1	33.0	38.4	---	28.2	---	33.9	---
	Deploy. #2	21.3	17.9	0.7	8.4	0.8	34.3	26.5
	Deploy. #3	9.8	6.4	0.9	4.2	1.5	---	---
	SO LVE	20.6	17.9	0.8	7.5	0.8	34.0	26.5
D_{VIS} (%)	Deploy. #1	16.3	27.2	---	1	---	28.2	---
	Deploy. #2	16.8	20.9	0.7	0.8	8.5	25.9	24.9
	Deploy. #3	6.0	3.6	0.8	1.4	3.4	---	---
	SO LVE	15.3	20.9	0.7	1.0	7.9	27.5	24.9
α_{IR-VS}	Deploy. #1	0.54	0.16	---	0.96	---	-0.08	---
	Deploy. #2	1.15	0.61	1.49	1.44	1.30	-0.06	0.98
	Deploy. #3	1.33	1.55	1.66	1.50	1.74	---	---
	SO LVE	1.13	0.61	1.54	1.45	1.35	-0.08	0.98
α_{VS-UV}	Deploy. #1	1.69	0.75	---	1.91	---	0.51	---
	Deploy. #2	1.24	0.70	1.41	1.36	1.36	0.35	0.62
	Deploy. #3	0.95	0.87	1.14	1.07	0.97	---	---
	SO LVE	1.23	0.70	1.33	1.30	1.31	0.46	0.62

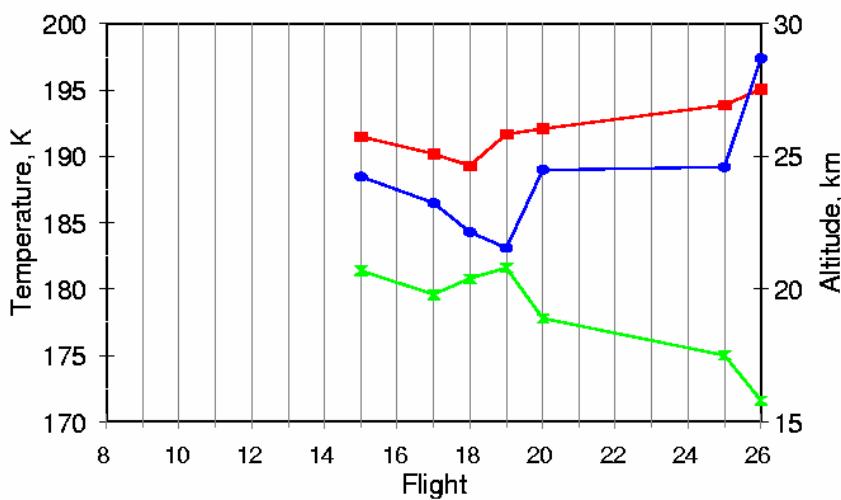
Average Temperature & Height of PSC Types

— GSFC/DAO — AROTEL — PSC Alt

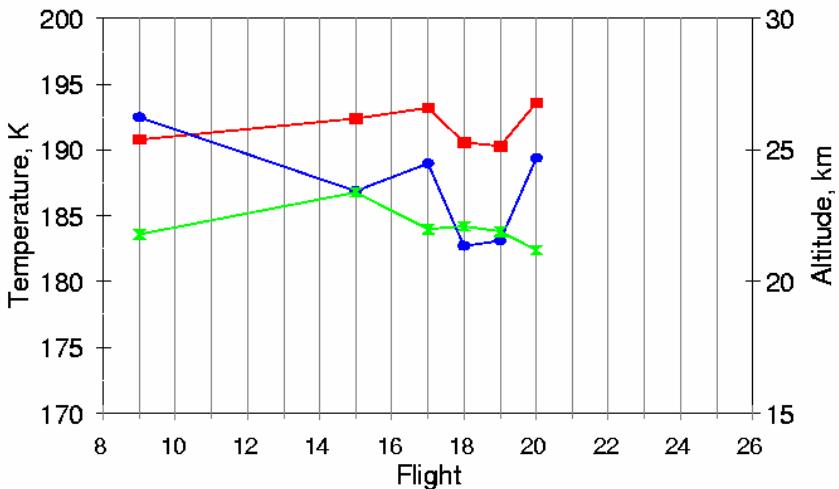
PSC TYPE Ia



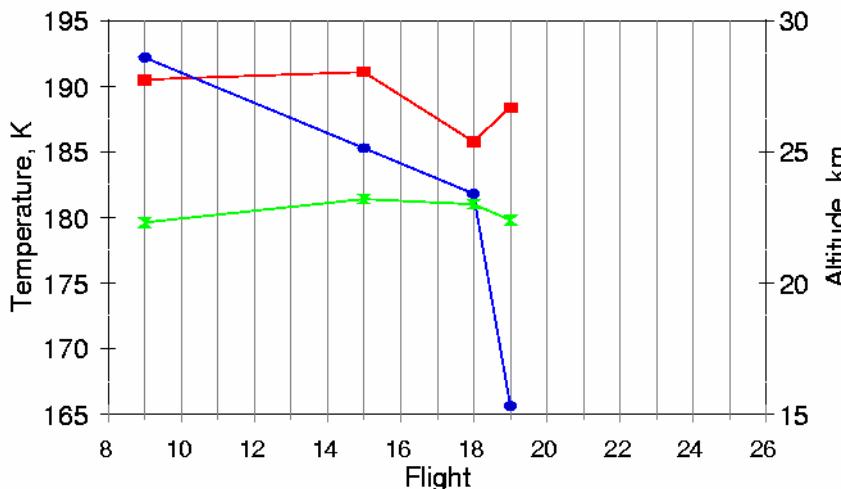
PSC TYPE Ib



PSC TYPE Ia-enhanced



PSC TYPE II



Science During SOLVE-2

- Obtain stratospheric and tropospheric O₃ and aerosol distributions in conjunction with SAGE-III measurements and participate in interpretation of results.
- Obtain stratospheric O₃ and aerosol distributions and characteristics and compare with SOLVE results using meteorological fields (PV, Θ, T) and model results (CTM's).
- Obtain first large-scale tropospheric O₃ and aerosol distributions and characteristics across wintertime Arctic and compare to TOPSE results.
- Collaborate with other remote sensing and in situ measurement teams on interpretation of their/our data sets.
- Provide unique data to modeling, SAGE-III, and other satellite teams for validation activities and to examining dynamics and chemistry in Arctic during Jan. 03.

Criteria Used for Defining PSC Types

(All PSC Types: $S_{\text{IR}} > 0.8$; $S_{\text{VIS}} > 0.18$)

Type Ia: Solid nitric acid trihydrate (NAT)

$D_{\text{IR}} \& D_{\text{VIS}} > 2.5\%$; $S_{\text{IR}} < 4.0$; $S_{\text{VIS}} < 0.5$

Type Ib: Liquid supercooled ternary solution (STS)

$D_{\text{IR}} \& D_{\text{VIS}} < 2.5\%$

Type II: Water ice

$D_{\text{IR}} \& D_{\text{VIS}} > 2.5\%$: $S_{\text{IR}} > 20$; $S_{\text{VIS}} > 5$ or
 $4.0 < S_{\text{IR}} < 20$; $0.5 < S_{\text{VIS}} < 5$; $\alpha_{\text{IR-VIS}} < 0.1$

Type Ia-enhanced: Small NAT, possibly wave-induced

$D_{\text{IR}} \& D_{\text{VIS}} > 2.5\%$; $4 < S_{\text{IR}} < 20$; $0.5 < S_{\text{VIS}} < 5$; $\alpha_{\text{IR-VIS}} > 0.1$

Type M: Mixture of Type Ia & Ib PSC's

$D_{\text{IR}} > 2.5\%$ & $D_{\text{VIS}} < 2.5\%$

Type Ic: Small non-spheres, possibly NAT

$D_{\text{IR}} < 2.5\%$ & $D_{\text{VIS}} > 2.5\%$

PSC Observations Compared to Model Predictions

Flight	Date	DIAL OBS		GEOS		UKMO		DIAL OBS / GEOS %		DIAL OBS / UKMO %	
		Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II
6	1130	0	0	85	0	680	0	0	---	0	---
7	1202	0	0	0	0	491	0	0	---	0	---
8	1205	483	0	1181	0	1323	0	41	---	37	---
9	1207	1473	124	18711	0	17048	0	8	a	9	a
10	1210	574	0	11137	0	9474	0	5	---	6	---
11	1212	0	0	18886	0	14874	0	0	---	0	---
12	1214	0	0	28	0	38	0	0	---	0	---
13	1216	0	0	19	0	227	0	0	---	0	---
Deploy. #1		2530	124	50047	0	44155	0	5	a	6	a
15	0114	1983	20	11246	0	10130	0	18	a	20	a
16	0116	651	0	3553	0	6237	0	18	---	10	---
17	0120	6973	0	28690	0	31298	321	24	---	22	0
19	0125	12682	1518	25156	1172	27500	0	50	130	46	a
20	0127	2286	3	25572	0	20129	0	9	a	11	a
21	0129	2490	0	7305	0	7655	0	34	---	33	---
Deploy. #2		27065	1541	101522	1172	102949	321	27	131	26	---
23	0227	0	0	8188	0	7102	0	0	---	0	---
24	0303	0	0	8240	0	4158	0	0	---	0	---
25	0305	6037	0	20010	0	22108	0	30	---	27	---
26	0308	2456	0	10404	0	9252	0	24	---	27	---
28	0311	0	0	614	0	5736	0	0	---	0	---
30	0315	0	0	57	0	57	0	0	---	0	---
Deploy. #3		8493	0	47513	0	48413	0	18	---	18	---
SOLVE		38088	1664	199082	1172	195517	321	19	---	19	---

a-PSC's observed but none predicted from model.