Assessing two-stream fluxes from optimal estimation cloud properties

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● Overview
● In Situ Comparisons - Liquid
● In Situ Comparisons - Ice
● In Situ Comparisons - Fluxes
● Extended Cases - Liquid v. Ice
● Ice Cases
● Initial approach
● Tightened OD constraint
● Tightened OD constraint - i4
● Tightened OD constraint - i5
● Retrieval development (in progress or near-term)

Overview

- What's been done:
  - Evaluation of retrieved cloud properties and modeled fluxes using a BBHRP "instantaneous" approach
  - Liquid, ice cloud optimal estimation retrievals (RO, RVOD)
  - BBHPRP, BEFlux, Cloud OD, NASA VISST
- What's current:
  - Comparisons with in situ observations
  - Better understanding of ice results
  - Aerosols for ice cloud cases
  - Retrieval developments

In Situ Comparisons - Liquid

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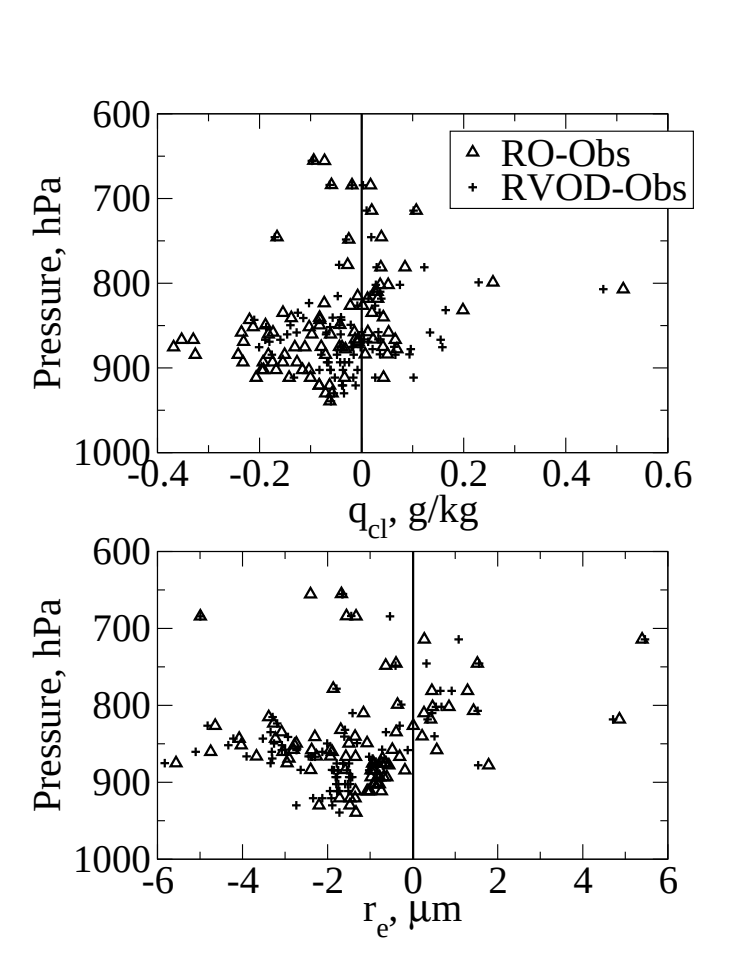
	N	Observed	RO - Obs	RVOD - Obs
Liquid Re, μm	91	6.37 (2.15)	-1.23 (2.11)	-1.58 (2.38)
q_{cl}, mg kg^{-1}(King)	91	315. (124.)	-219. (243.)	-171. (202.)
q_{cl}, mg kg^{-1}(FSSP)	91	163. (138.)	-66. (144.)	-19. (102.)



In Situ Comparisons - Ice

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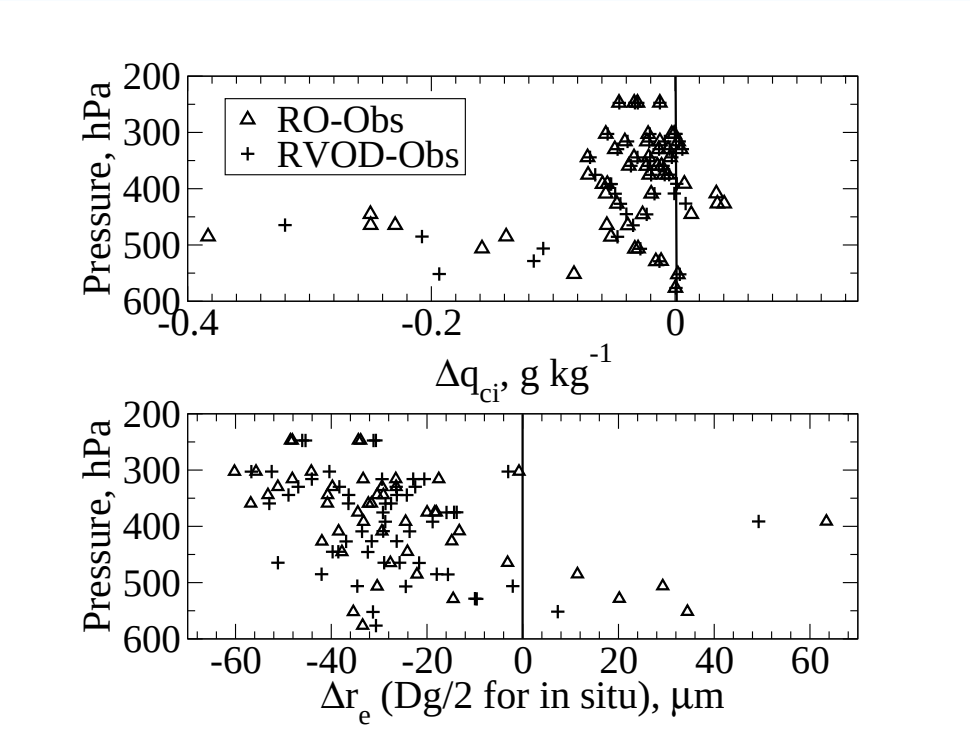
	N	Observed	RO - Obs	RVOD - Obs
q_{ci}, mg kg^{-1}	50	66. (88.)	-30. (53.)	-40. (72.)



In Situ Comparisons - Fluxes

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	N	Observed	RO - Obs	RVOD - Obs
Liquid, shortwave	14	143.8	67.1 (120.2)	-10.2 (20.1)
Liquid, longwave	14	342.6	-2.6 (5.1)	-2.3 (4.6)
Ice, shortwave	14	469.1	142.2 (166.2)	128.1 (144.7)
Ice, longwave	14	301.0	-2.4 (5.3)	-0.8 (3.6)

Extended Cases - Liquid v. Ice

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- Liquid

	TOA		
		MC	
	Observed	RO - Obs	RVOD - Obs
Shortwave	0.573	0.082 (0.102)	0.092 (0.107)
Longwave	243.6	4.55 (9.5)	4.03 (9.2)
	Surface		
		MC	
	Observed	RO - Obs	RVOD - Obs
Shortwave	133.4	8.2 (25.3)	-8.3 (19.0)
Longwave	373.1	-1.66 (6.9)	-1.63 (6.6)

- Ice

	TOA		
		MC	
	Observed	RO - Obs	RVOD - Obs
Shortwave	0.309	-0.030 (0.082)	-0.017 (0.084)
Longwave	207.8	5.46 (46.5)	-0.47(47.3)
	Surface		
		MC	
	Observed	RO - Obs	RVOD - Obs
Shortwave	500.4	103.3 (128.0)	90.4 (114.1)
Longwave	340.7	2.2 (8.9)	3.8 (10.1)

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Ice Cases

- Smaller optical depth
  - Fluxes more sensitive to errors in optical depth
  - Aerosol plays a role
- Sampling
  - Thin cloud optical depth from direct beam
  - Ice clouds higher

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- Loosely constrain the optical depth: ~5% -> 20%

Case	Observed	RO	RVOD	RVOD_scaled	RVOD_02p
i1	1.49 (0.79)	1.01	1.20	1.49	–
i2	1.08 (0.53)	0.18	0.21	1.10	–
i3	0.72 (0.30)	0.03	0.03	0.72	0.18
i4	3.11 (0.62)	0.72	0.91	3.11	2.81
i5	7.30 (2.32)	2.77	3.36	7.30	6.69
i6	2.87 (1.84)	0.16	0.18	2.85	–
i7	2.21 (0.46)	0.91	1.18	2.29	–
i8	0.66 (0.03)	0.02	0.02	0.65	–
i9	4.31 (0.81)	1.16	1.46	4.33	–

- Resulting fluxes, using scaled IWC

	RVOD - Obs	RVOD_scaled - Obs
albedo	-0.017 (0.084)	0.087 (0.119)
SW dn	90.4 (114.1)	-28.1 (66.8)
LW up	-0.47 (47.3)	-53.0 (62.2)
LW dn	3.8 (10.1)	15.6 (17.6)

Tightened OD constraint

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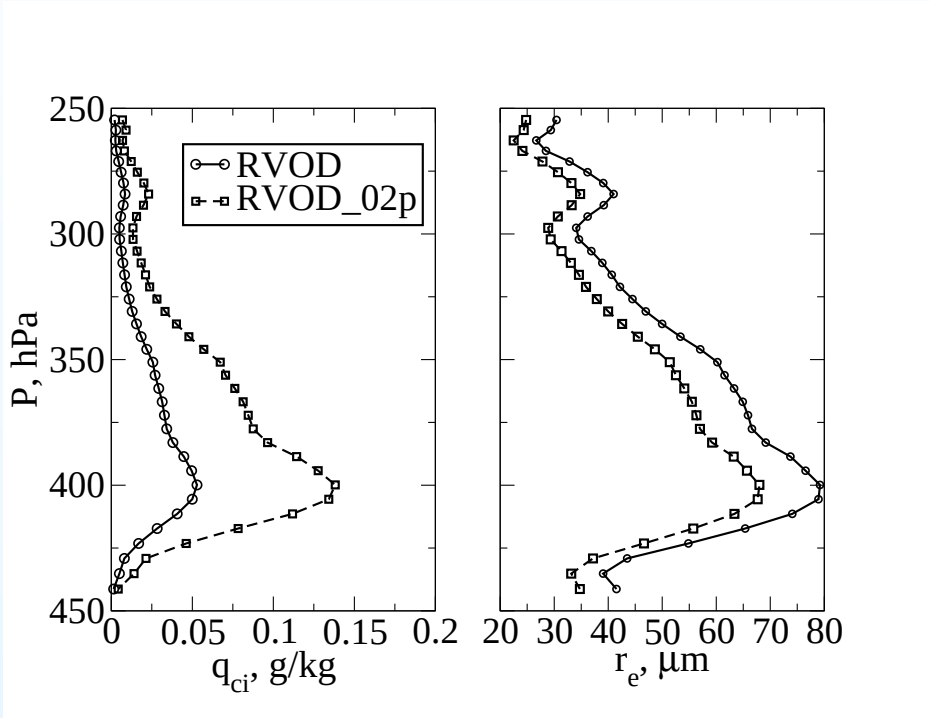
- Constrain optical depth with 2% uncertainty



		SW dn	LW dn	albedo	LW up
i4	Observed	530.46	305.59	0.278	173.79
i4	RVOD	678.64	309.92	0.281	173.56
i4	RVOD_02p	525.88	321.03	0.401	133.31
i5	Observed	347.07	331.59	0.368	169.47
i5	RVOD	435.23	337.22	0.437	143.81
i5	RVOD_02p	309.83	339.40	0.544	133.49

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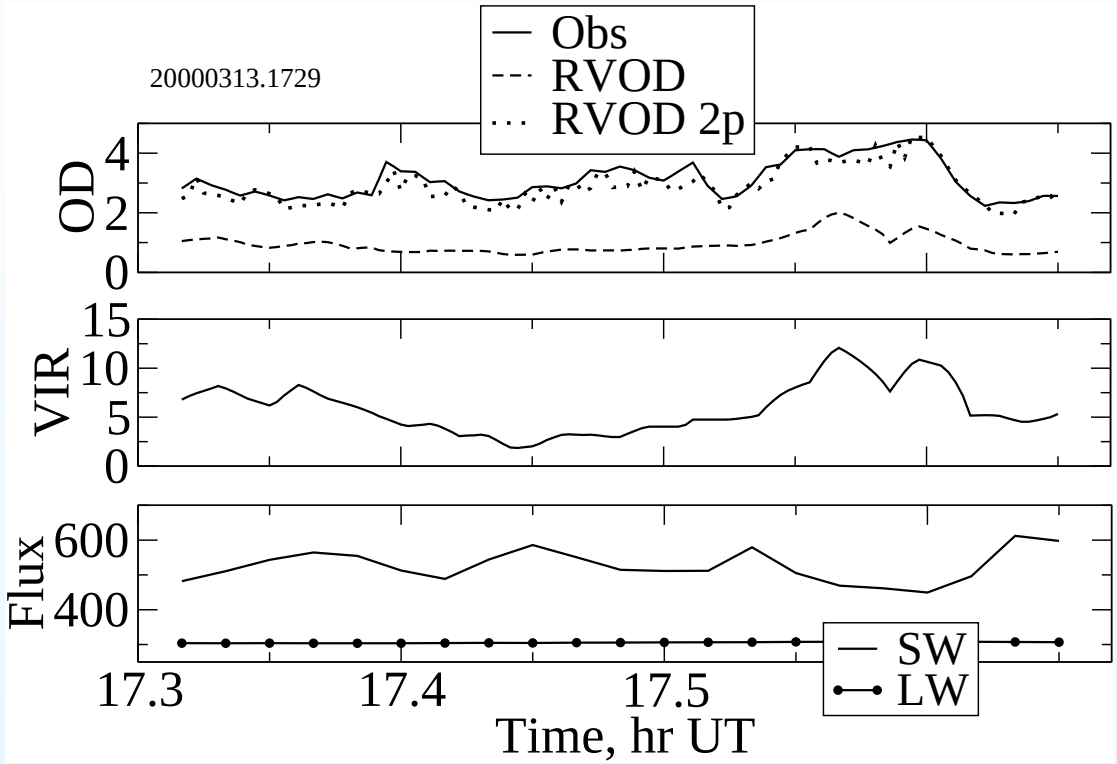

Tightened OD constraint - i5

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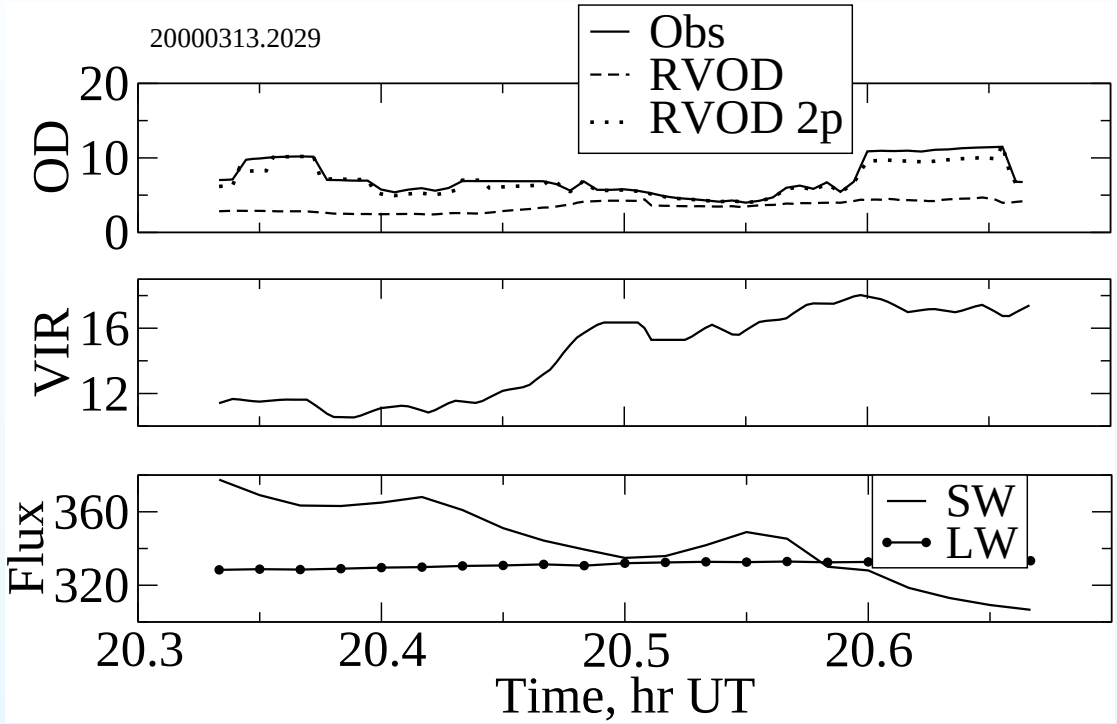

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Retrieval development (in progress or near-term)

- Examine sensitivities to parameters that are poorly constraint by obs.
- Reduce constraints on some parameters (e.g, number concentration)
- Temperature-based a priori data for IWC retrieval
- Combine IWC & LWC retrievals for columns with both

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Ongoing work

- Evaluate influence of sampling mismatch
- Yearlong SGP cloud evaluation for water (RO & RVOD) and ice (RO only?)
- Extensions to other sites (RO at TWP or NSA)