

SO₂ and Dust Retrieval : Status Update

Adventures in SO₂ retrievals

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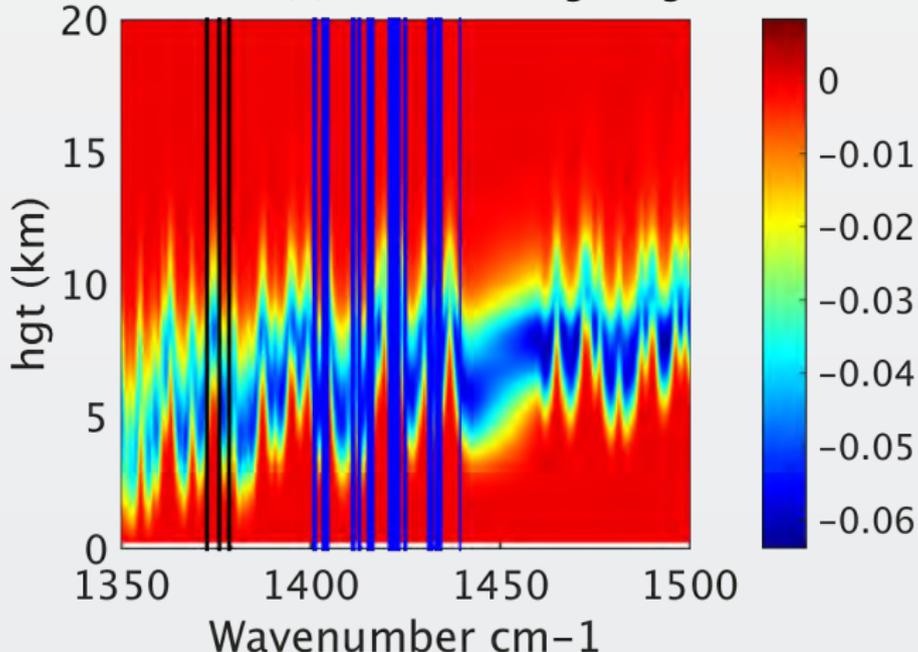
AIRS Science Team Meeting
October 2015
Greenbelt, MD

Overview

- Have delivered SARTA-scatter to JPL
- Have placed generic match-up code to run model ECM/ERA calcs with AIRS L1b data
- Have put code to match AIRS L1b data to ascending vs descending AIRS L3 climatology (very fast, less than 15 secs)
- SO2 retrievals using Scott Hannon's code and algorithm - linear interpolation
- Have also implemented OEM retrievals where col WV is adjusted (1400 cm⁻¹ channels), then SO2 retrievals done assuming WV is "corrected"
- Assumes SO2 plume is in upper troposphere, above WV (though can adjust height)
- V. Realmuto providing test cases and other retrievals to compare against

WV Jacobian (Tropical profile)

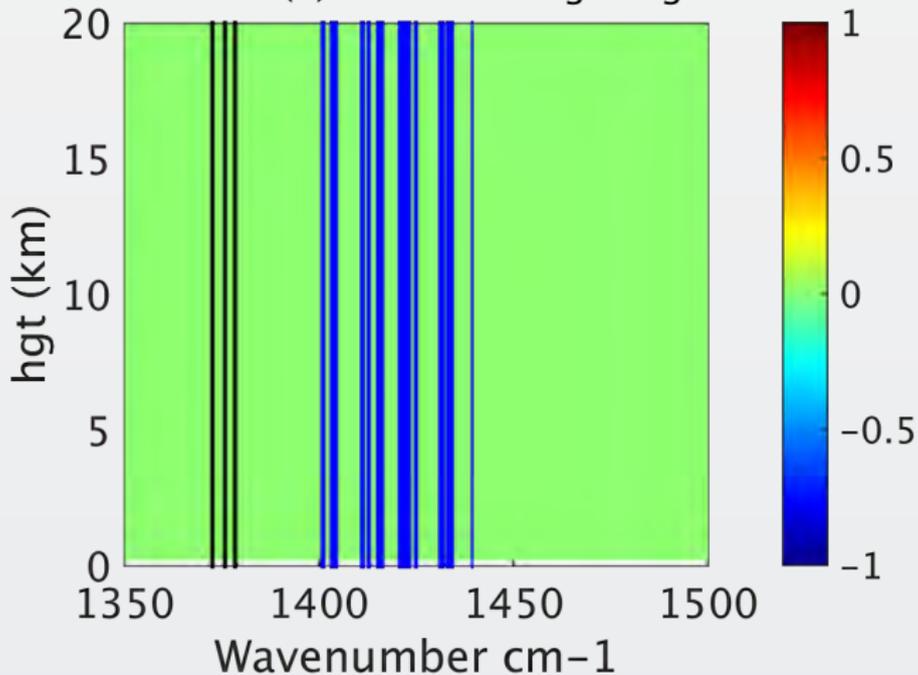
colorbar = ΔBT (K) for 10% change in gas amount in each layer



Black lines = STRONG SO₂ channels; Blue lines = Weak channels

SO2 Jacobian (Tropical profile)

colorbar = ΔBT (K) for 10% change in gas amount in each layer

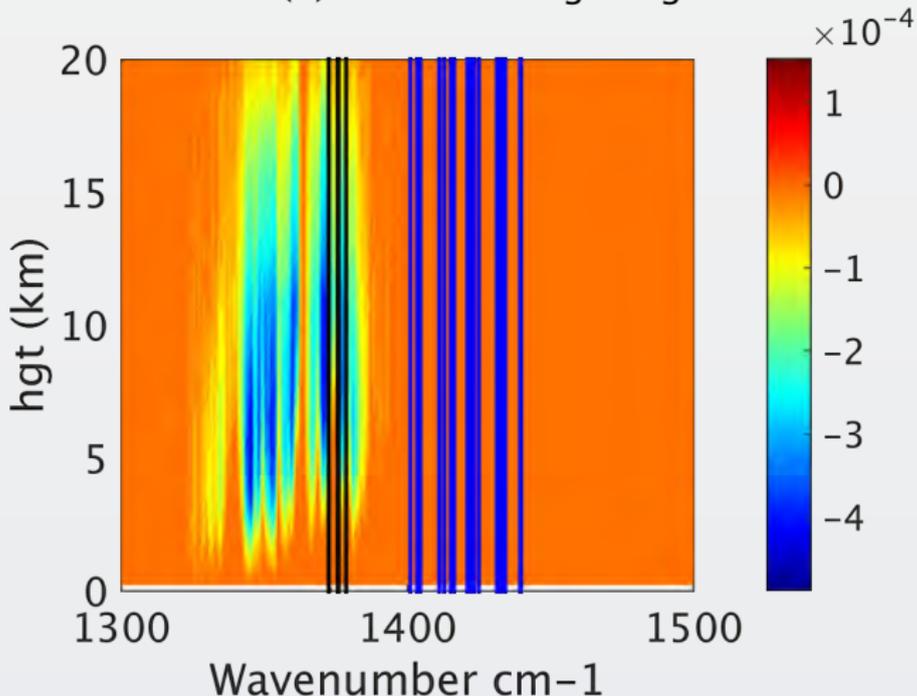


Black = STRONG SO2 channels; Blue = Weak channels

"nominal" SO2 (0.11 du) buried under water, don't see anything!!!

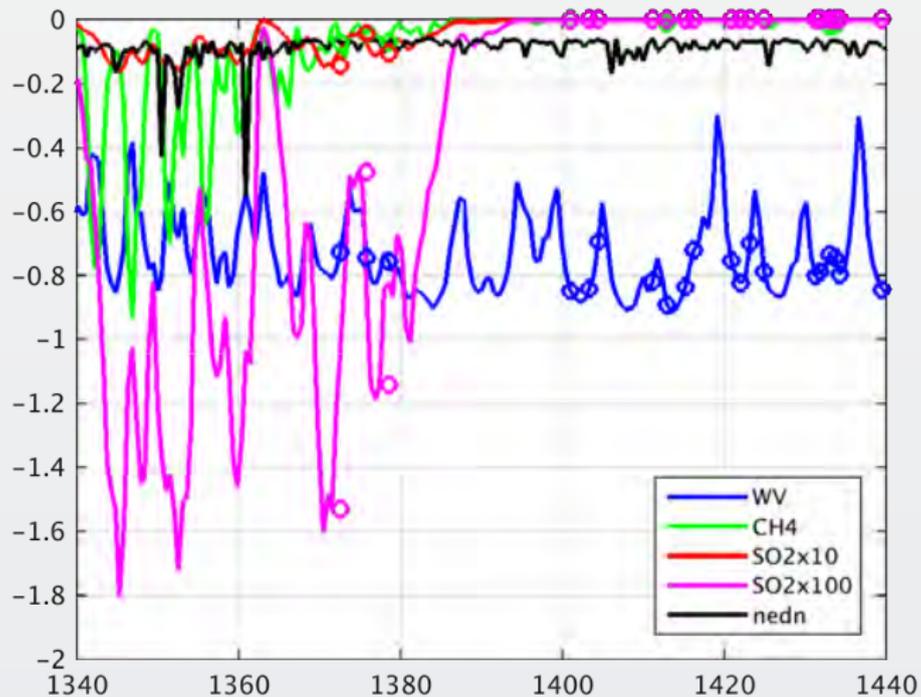
SO2 Jacobian $\times 10$ (Tropical profile)

colorbar = ΔBT (K) for 10% change in gas amount in each layer



Black lines = STRONG SO2 channels; Blue lines = Weak channels
SO2 (1.1 du) but still very tiny jacobian (0.0001K)!!!

Column Jacobians (with SO₂ x 10,100) (Tropical profile)

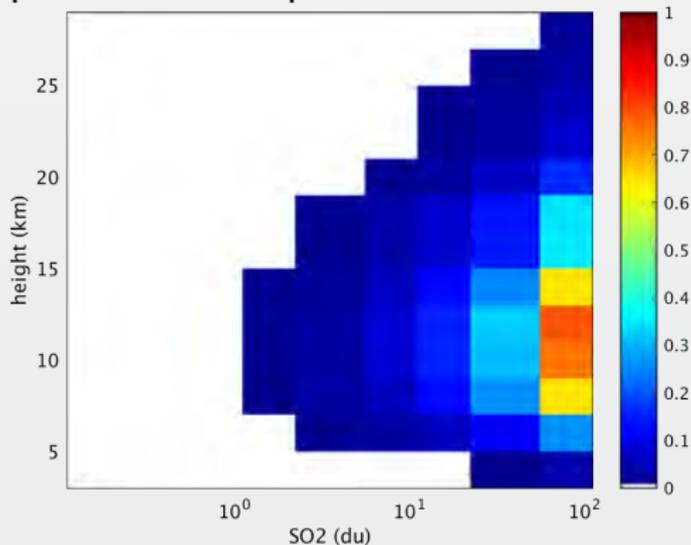


Begin to see the signal pop out beyond noise at x10 (1 du) levels

△ BT(SO₂ mult, height) (Tropical profile)

AIRS NeDN in strong SO₂ channels ~ 0.07 K

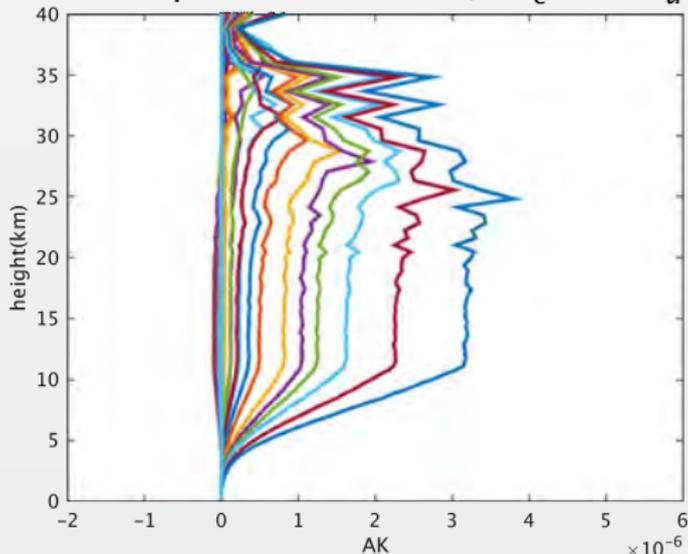
See how AIRS observed BT in strong SO₂ channel(s) change as we put in slab SO₂ perturbation in 2 km thick layer



Optimal SO₂ height detection is in UT or higher

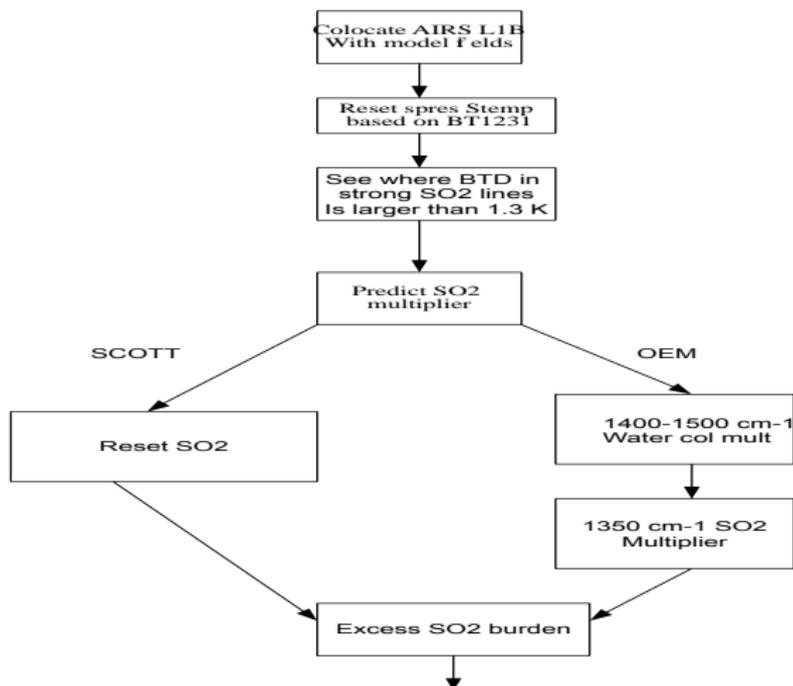
Averaging Kernel (Tropical profile)

Pretend entire SO₂ profile is $\times 10$, compute jacobians at each layer, then compute $AK = GK = (K' S_{\epsilon}^{-1} K + S_a^{-1})^{-1} K' S_{\epsilon}^{-1} K$

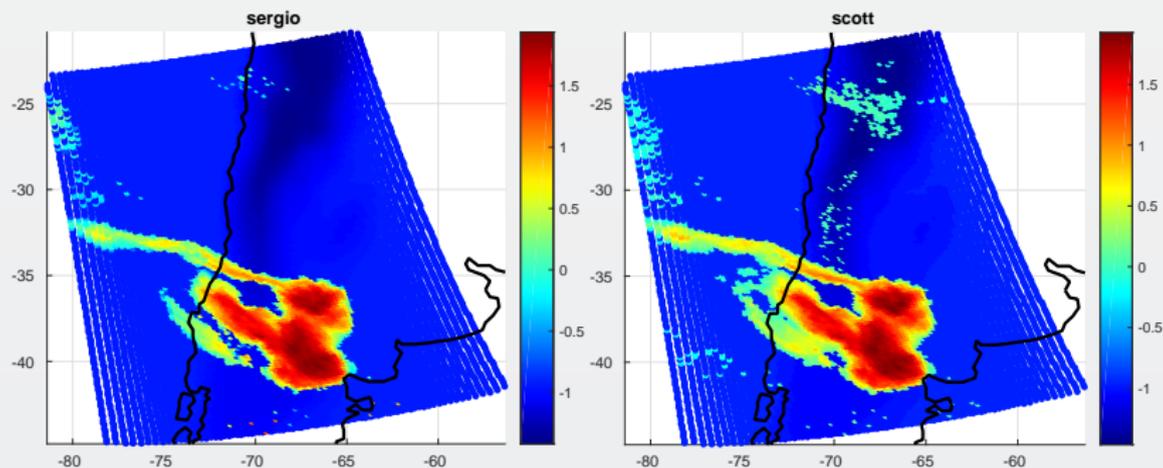


Assumed 10% uncertainty in SO₂ profile

Retrieval Outline



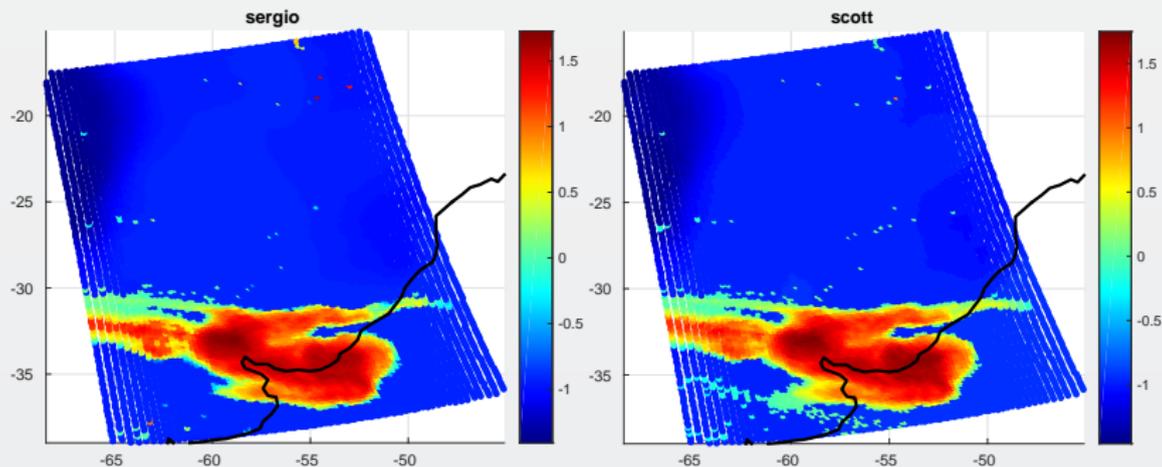
Calbuco (S. Chile) 23 Apr 2015



Left : OEM
colorbar is $\log_{10}(\text{du})$
g 186

Right : RESET

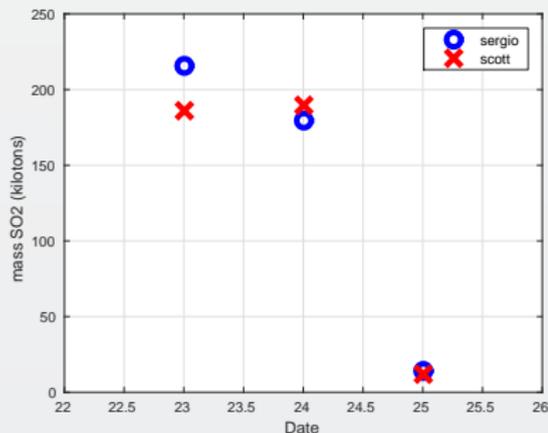
Calbuco (S. Chile) 24 Apr 2015



Left : OEM
colorbar is $\log_{10}(du)$
g 177

Right : RESET

Calbuco (S. Chile) 23-25 Apr 2015

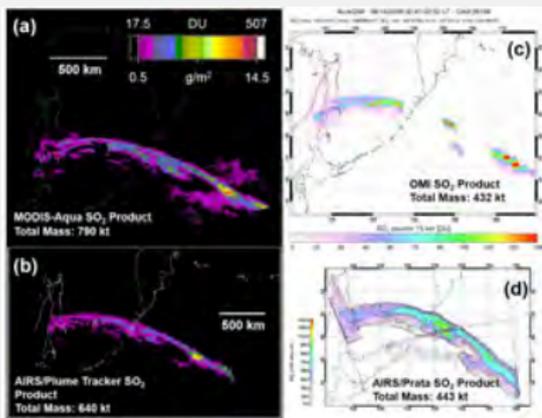


Added together couple or so granules per day, most of SO₂ burden in one of them

Emission (kilotons)

Method	model	Date	Date	Date
		23	24	25
UMBC OEM	L3	187	176	14
UMBC OEM	ECM	179	173	9
UMBC RESET	ECM	179	182	11

Sarychev 2009/09/16 (g26,27)

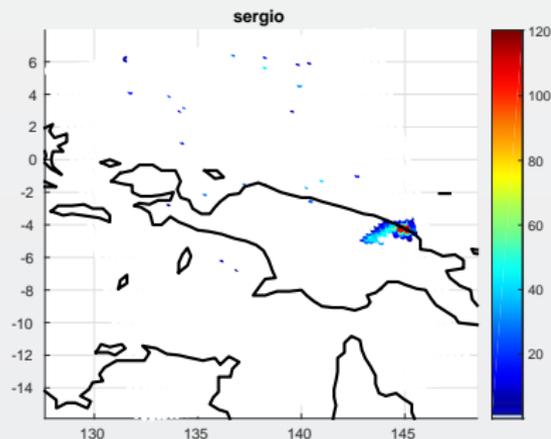


Emission (kilotons) using ECM

UMBC OEM	AIRS	220.8
UMBC RESET	AIRS	212.9

Plume Tracker	MODIS	790
Plume Tracker	AIRS	640
Prata-Bernando	AIRS	440
Yang	OMI	430

Manam PNG 31 July 2015 g044



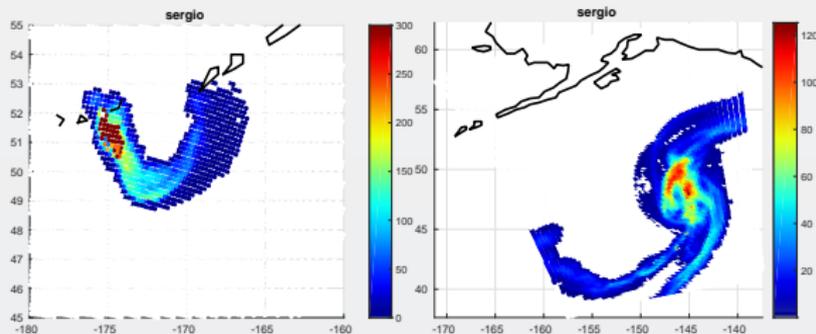
	Emission (kilotons)	
	ECM	AIRS L3
OEM	9.1	12.5
RESET	1.7	1.6

Plume Tracker	MODIS	100-400
Prata-Bernardo	AIRS	52
Yang	OMI	2.67
Yang	OMPS	1.5
Krotkov	OMI/OMPS	3.12

Kasatochi 2008/08

Left : Aug 08, g137 (du)

Right Aug 10, g230 (du)



DAY	Granule	OEM (kt) 15km	Linear (kt) 15 km	OEM 10 km	Linear 10 km	OMI
8	137	352.99	129.85	15000	602	850
8	232	89.28	62.44	18000	684	
9	9	56.03	45.31	6600	365	870
9	127	291.4	159.54	7436	471	
9	128	211.2	184.44	40000	2279	
10	229	4.72	4.06	150	23	1340
10	230	353.3	314.4	41000	3011	

Conclusions

- implemented Scott Hannon's "reset" (based on linear interp)
- also implemented OEM retrieval (with column water vapor burden retrieval done prior to SO₂ column)
- compared against results for various eruptions; agree to within order of magnitude (all results have large differences amongst each other)
 - My OEM does a column WV adjustment before doing the OEM SO₂ column retrieval, while Scott only did a linearized SO₂ column retrieval (so water could be incorrect)
 - there are discrepancies between using easily available AIRS L3 climatology for model fields versus eg ECMWF or ERA, for which I have to wait for the model fields to come in
 - retrievals between different methods and instruments show much variability, as they differ in their sensitivities to surface and atmospheric properties, compositions of plumes, clouds/ash in the way
 - AIRS retrievals available day and night, window channels could be used to report on presence of ash and/or clouds

Thanks to Scott Hannon and Larrabee Strow!