SO2 and Dust Retrieval : Status Update

Adventures in SO2 retrievals

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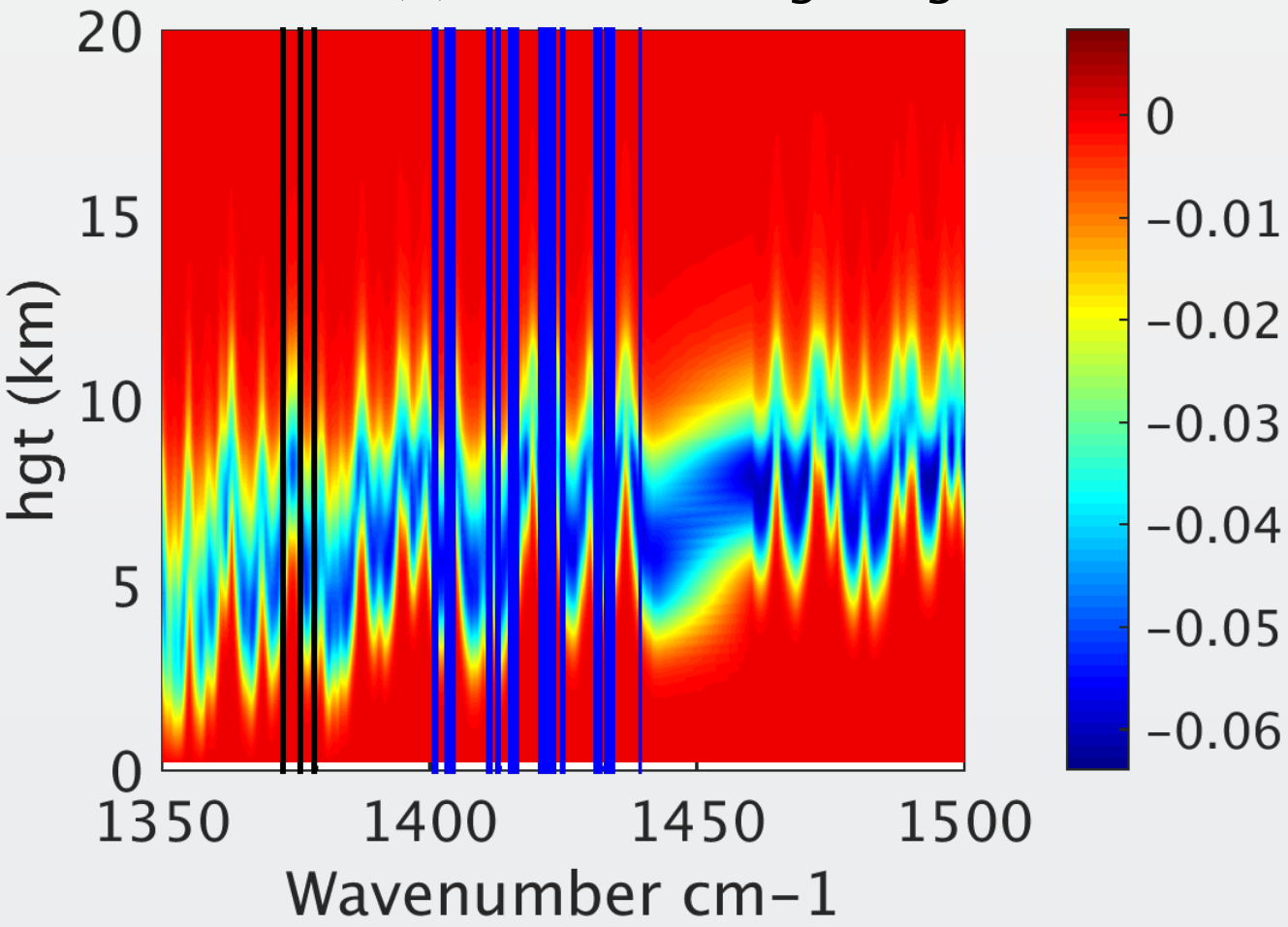
Overview

- 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 were 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)

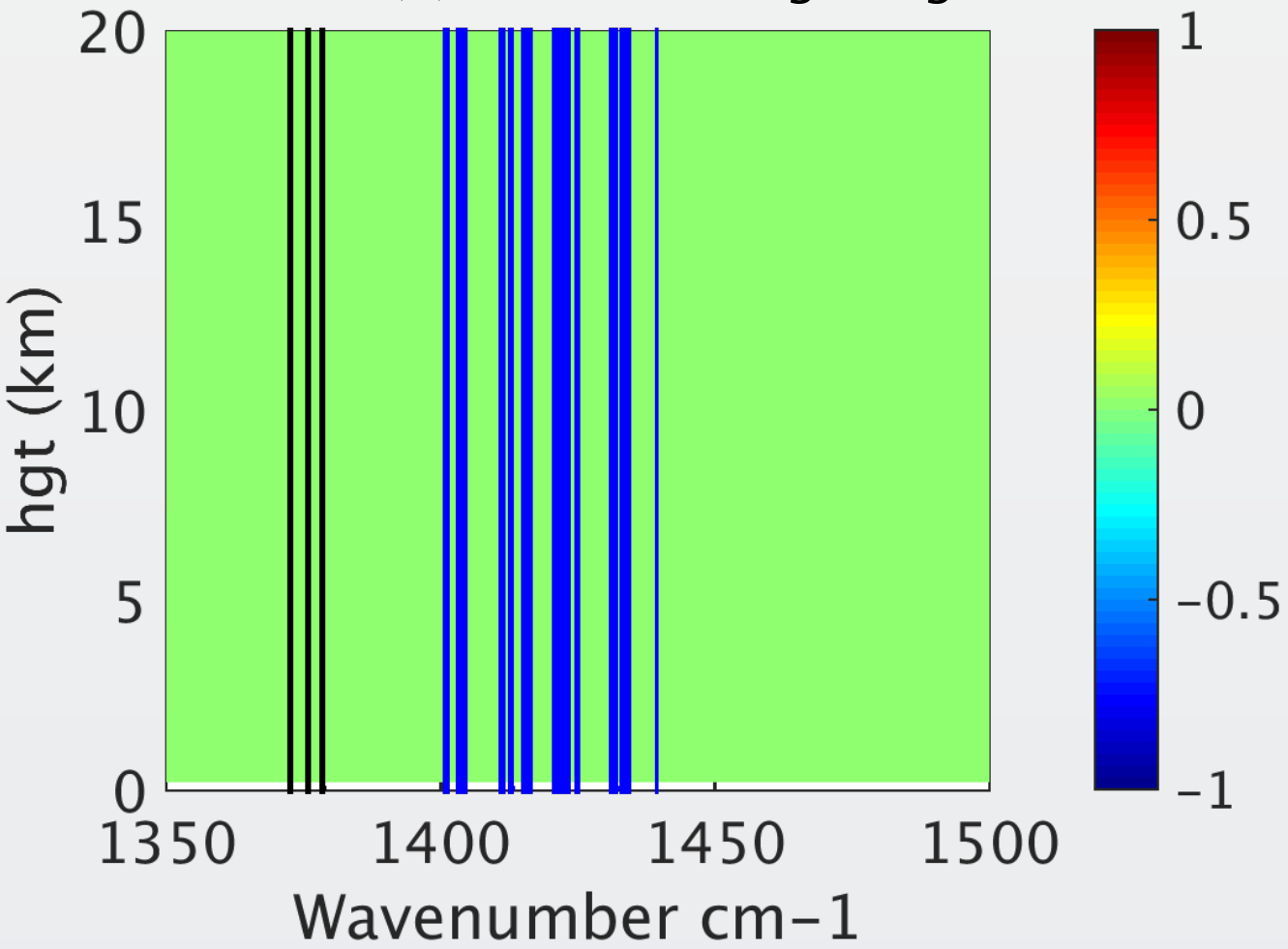
colorbar = ΔBT (K) for 10% change in gas amount in each layer



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

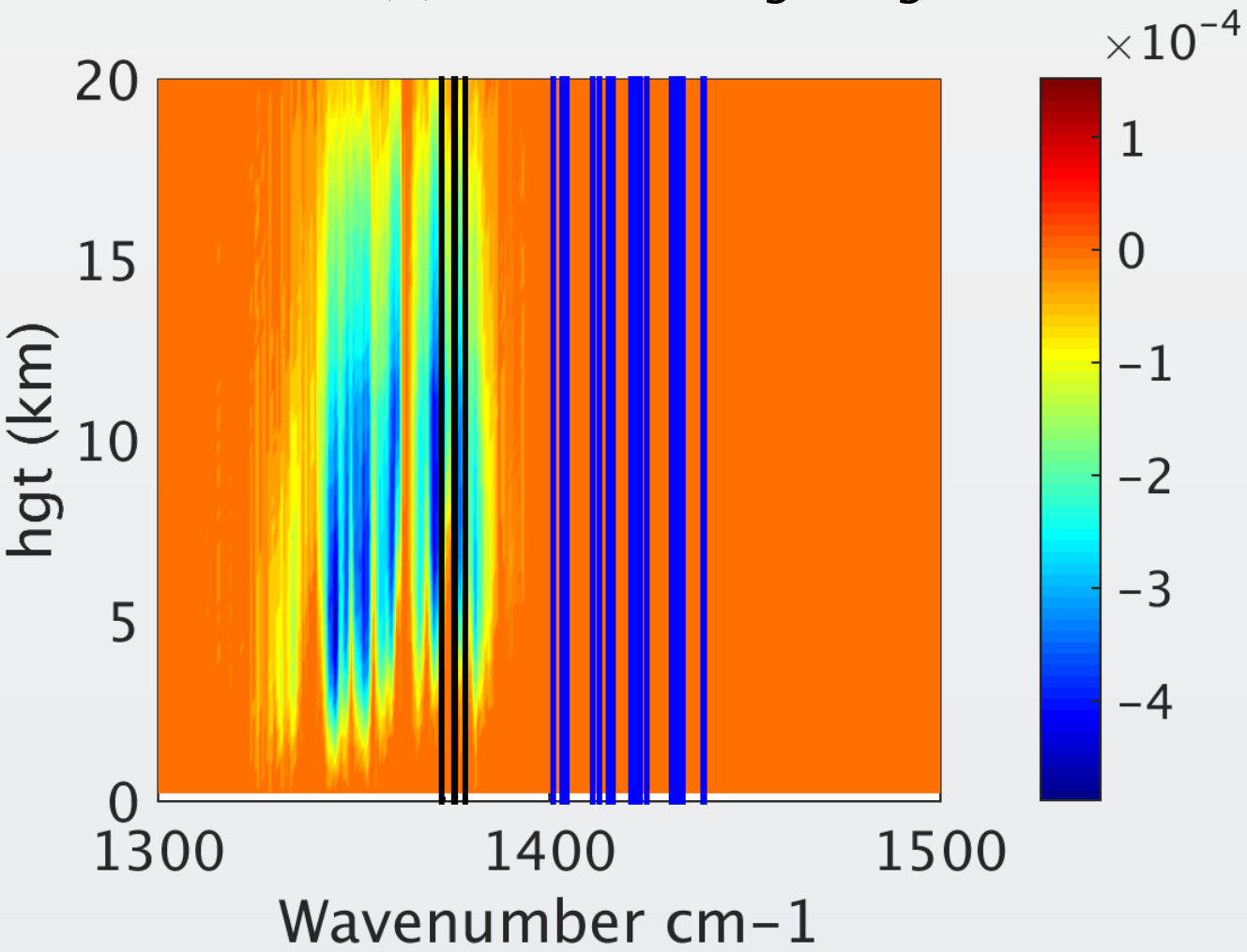


Black = STRONG SO2 channels; Blue = Weak channels

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

SO2 Jacobian x10 (Tropical profile)

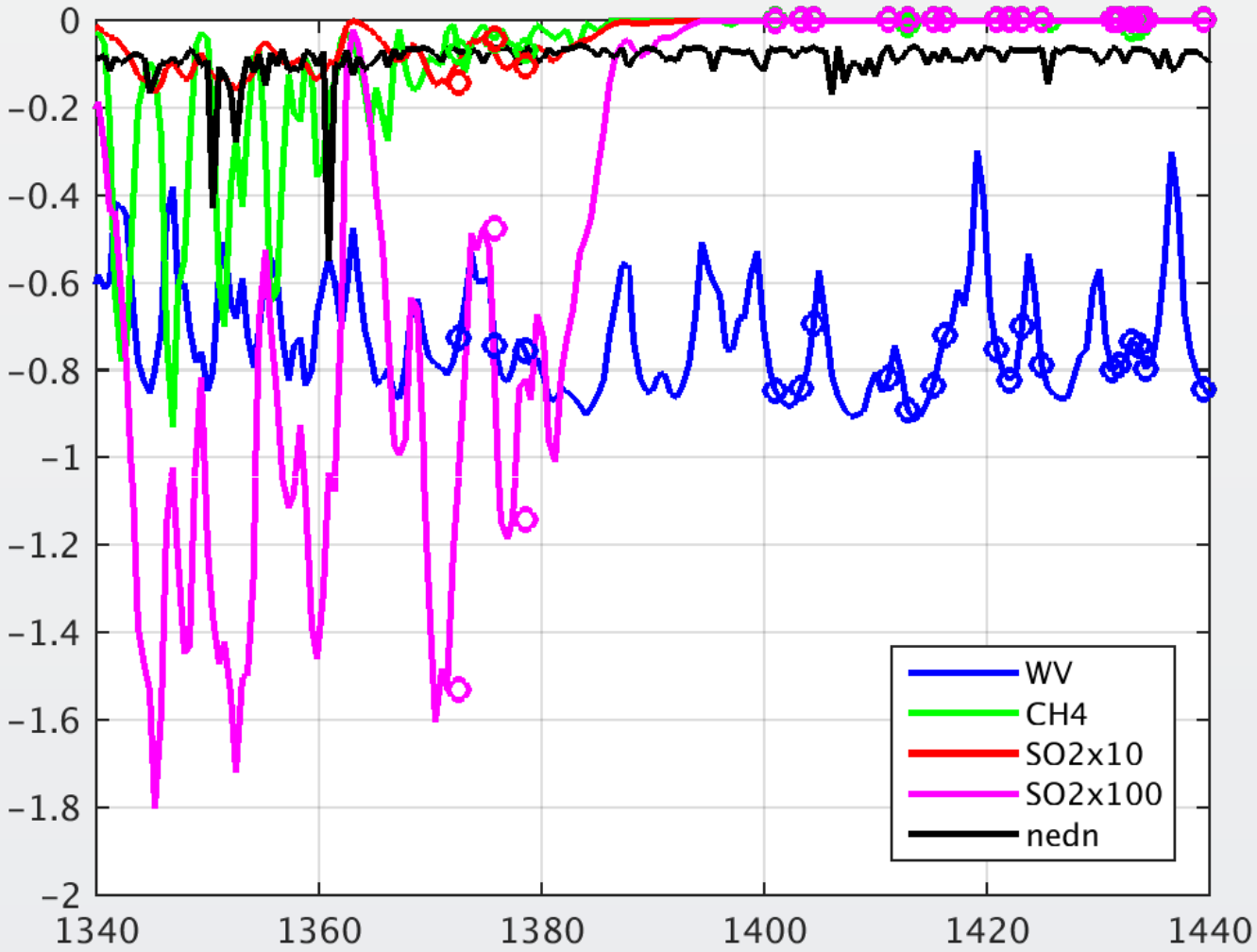
colorbar = ΔBT (K) for 10% change in gas amount in each layer



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

SO2 (1.1 du) but still very tiny jacobian (0.0001K)!!!

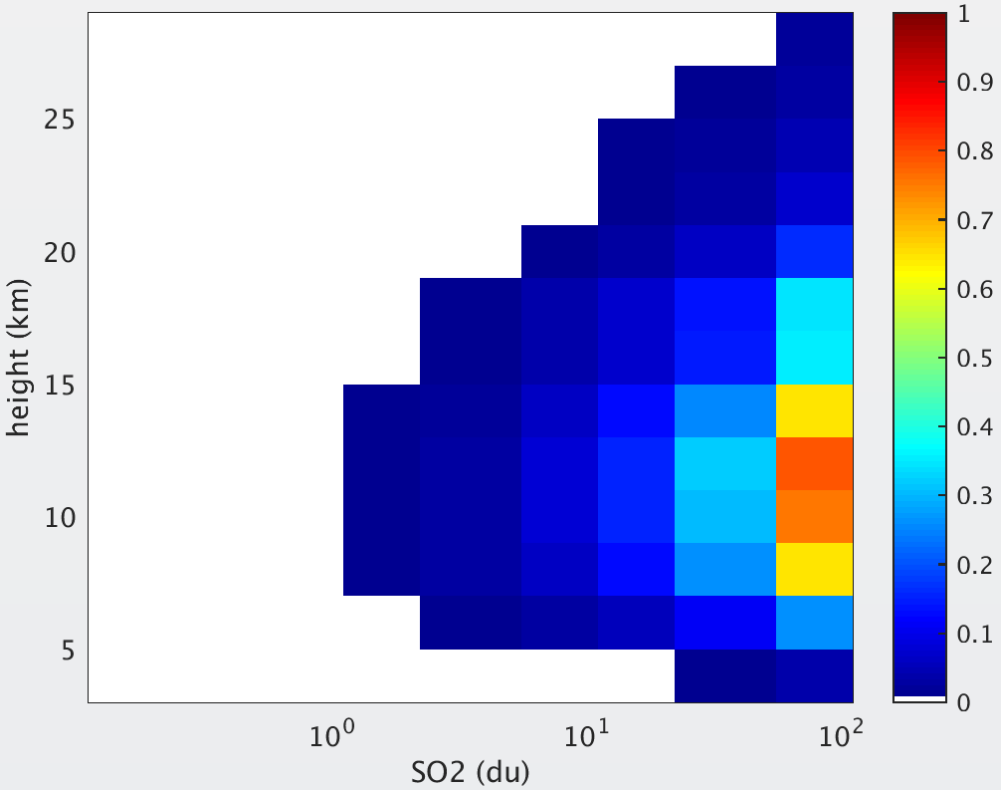
Column Jacobians (with SO2 x 10,100) (Tropical profile)



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

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

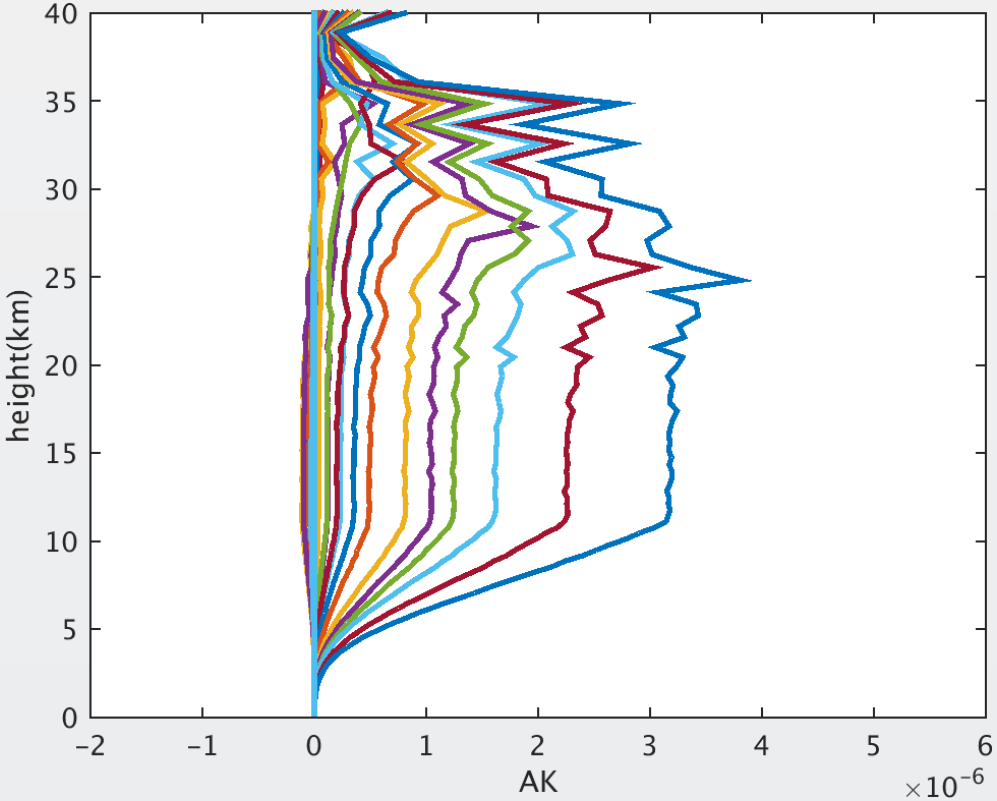
AIRS NeDN in strong SO2 channels ~ 0.07 K
See how AIRS observed BT in strong SO2 channel(s) change as we put in slab SO2 perturbation in 2 km thick layer



Optimal SO2 height detection is in UT or higher

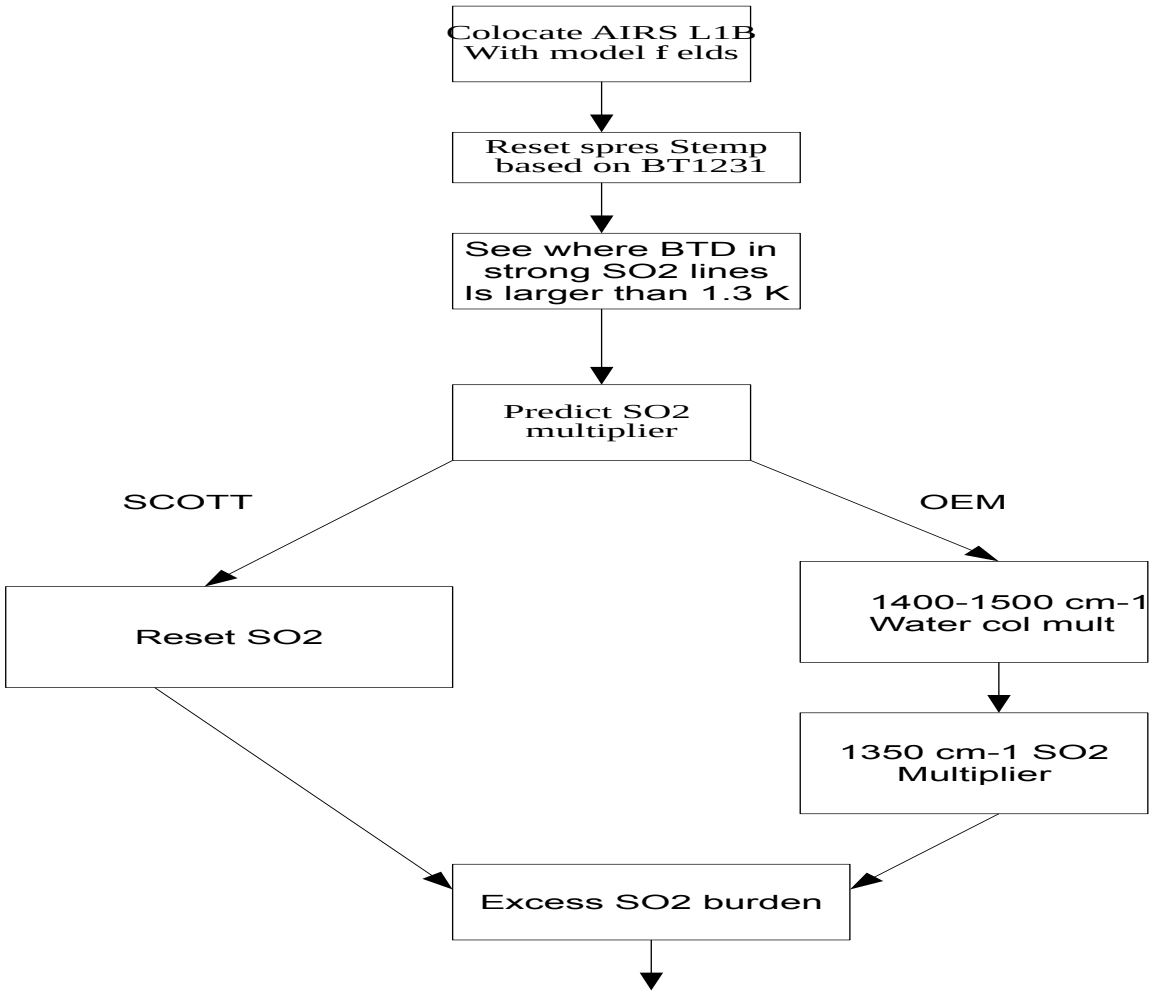
Averaging Kernel (Tropical profile)

Pretend entire SO2 profile is x10, compute jacobians at each layer, then compute $AK = GK = (K' S_\epsilon^{-1} K + S_a^{-1})^{-1} K' S_\epsilon^{-1} K$

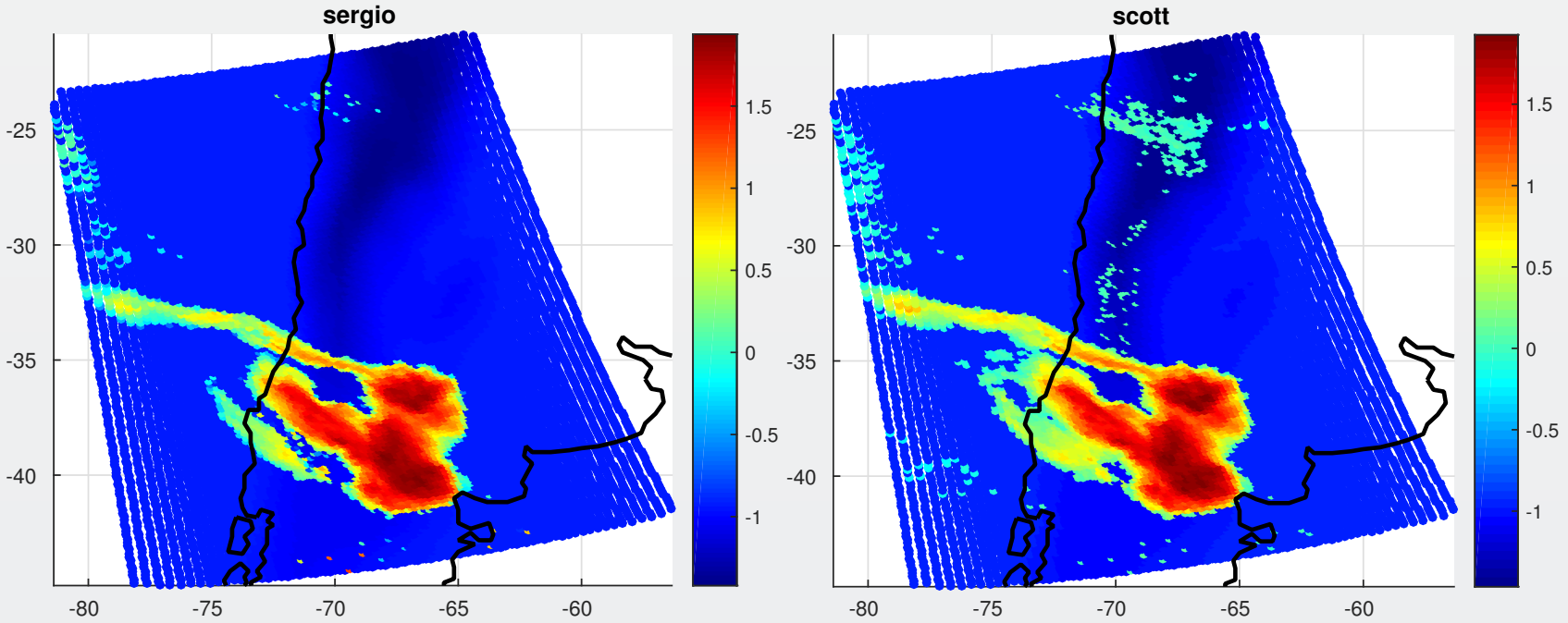


Assumed 10% uncertainty in SO2 profile

Retrieval Outline



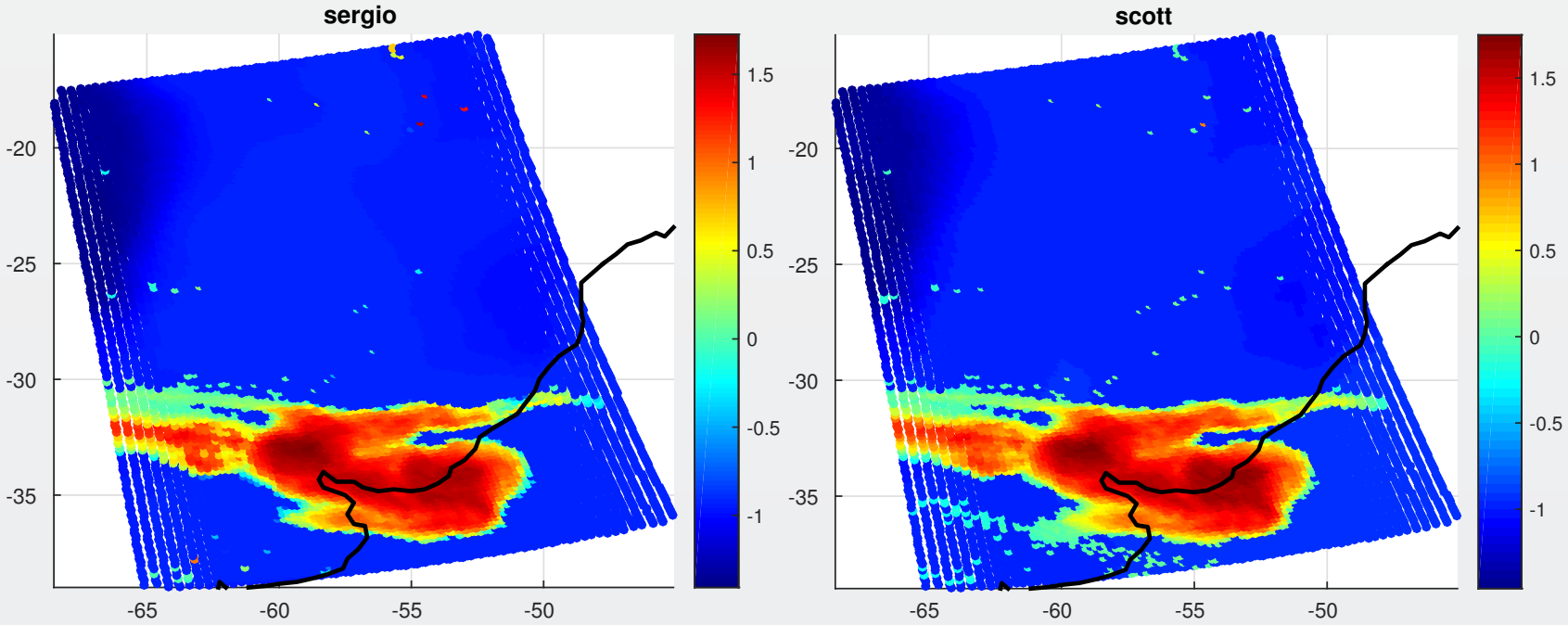
Calbuco (S. Chile) 23 Apr 2015



Left : OEM
colorbar is log10(du)
g 186

Right : RESET

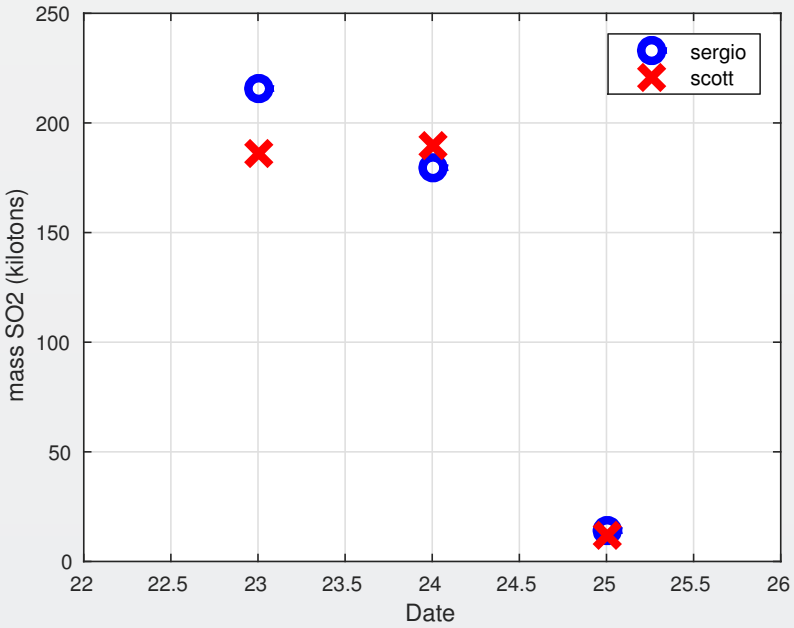
Calbuco (S. Chile) 24 Apr 2015



Left : OEM
colorbar is log10(du)
g 177

Right : RESET

Calbuco (S. Chile) 23-25 Apr 2015

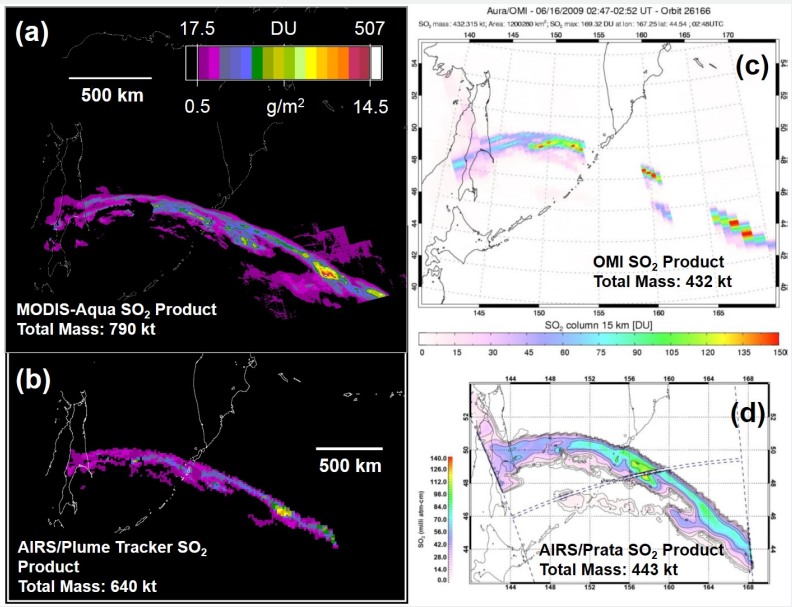


Added together couple or so granules per day, most of SO2 burden in one of them

Emission (kilotons)

Method	model	Date 23	Date 24	Date 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)

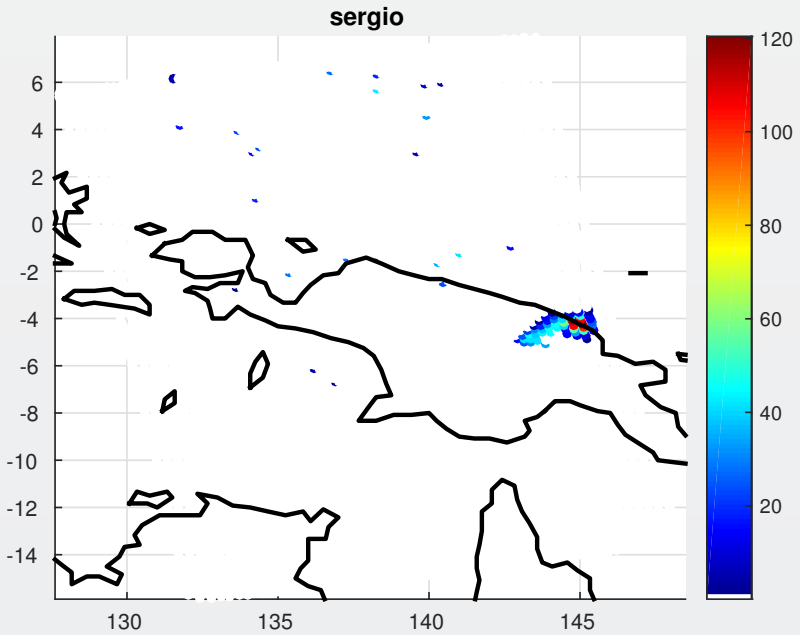


Emission (kilotons) using ECM

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)

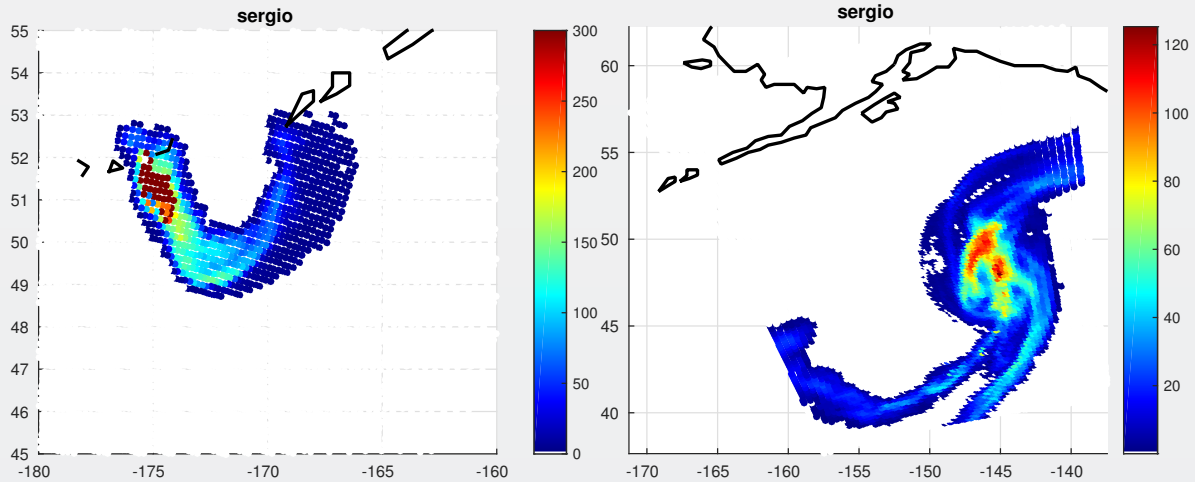
	ECM	AIRS L3
OEM	9.1	12.5
RESET	1.7	1.6

Plume Tracker	MODIS	100-400
Prata-Bernando	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!