Validation of SCIAMACHY BrO profiles

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Validated SCIAMACHY Products Level 1 and 2 by LPMA/DOAS

SCIAMACHY Products	Instrument	Precision	Accuracy	Validation Height Range	SCIAMACHY Height Range (ii)	IGOS target RMS error	IGOS target Bias error
T	all payloads	± 0.5 K	± 0.5 K	0 to 30/40 km	0 to 50 km	± 0.5K	n/s
P	all payloads	± 1 %	± 1 %	0 to 30/40 km	0 to50 km	n/s	n/s
O_3	DOAS	± 0.3 %	± 0.5 % 10^{10} molecule/cm^3	5 to 30/40 km	0 to 60 km	±3 %	±5 %
O_3	LPMA	± 4%	(± 4%,iv) , ± 6%	5 to 30/40 km	0 to 60 km	±3 %	±5 %
O_4	DOAS	± 4 %	± 4 %	5 to 30 km	0 to 25 km	n/s	n/s
NO_2 (i)	DOAS	± 2.0 %	<± 4.0 % ± 10^9 mole/cm^3	5 to 30/40 km	0 to 40 km	± 10 %	± 15 %
NO_2 (i)	LPMA	± 11.0 %	(± 6.0 %,iv), ± 12.5%	15 to 30/40 km	0 to 40 km	± 10 %	± 15 %
NO_3 (i)	DOAS		± 12.0 %	5 to 30/40 km	20 to 40 km	± 10 %	± 15 %
BrO (i)	DOAS	± 4.0 %	± 12.0 % plus ±5*10^{12} mole/cm^3	5 to 30/40 km	15 to 35 km	± 80 % UT ± 40 % LT	± 15 %
OClO (i)	DOAS	± 3.0 %	± 8.0 %	5 to 30/40 km	15 to 35 km	n/s	n/s
CH_4	LPMA	± 7 %	(± 5 %,iv), ± 9 %	10 to 30/40 km	0 to 40 km	± 1% UT/ ± 2% LS	± 2% UT/ ± 5% LS
CO	LPMA	± 7 %	(± 2 %,iv), ± 8 %	5 to 30/40 km	0 to 35 km	± 1% UT/ ± 5% LS	± 2% UT/ ± 10% LS
N_2O	LPMA	±10	(± 3 %,iv), ± 11 %	5 to 30/40 km	0 to 40 km	± 1% UT/ ± 2% LS	± 2% UT/ ± 4% LS
CO_2	LPMA	± 5 %	(± 2 %,iv), ± 6 %	10 to 30/40 km	0 to 60 km	±0.04 ppm UT ±0.5 ppm LT	±0.2ppm,UT ±1.0 ppm LT

4 major steps to validate SCIAMACHY BrO profiles

1. Conduct balloon flights (to date 13) for as many different geophysical condition as possible
2. Calculate matches of collocated ENVISAT/SCIAMACHY overpasses&pixels
3. Retrieve BrO SCIAMACHY Limb profiles for the corresponding overpasses&pixels
4. Calculate photochemical corrections for the balloon observation on calculated air mass trajectories

→ finally compare profiles !

Step 1 and 3: The BrO Data Sources

1. SCIAMACHY BrO Limb profile retrievals from
   - A. Rozanov, IUP-Bremen
   - C. Sioris, Harvard Smithsonian

2. Balloon-borne BrO measurements from
   - Hrechanyy&Stroh, FZK-Jülich (resonance fluorescence)
   - Goutail&Pommereau, CNRS (SAOZ)
   - Pfeilsticker et al., IUP-Heidelberg (DOAS on the LPMA/DOAS payload)

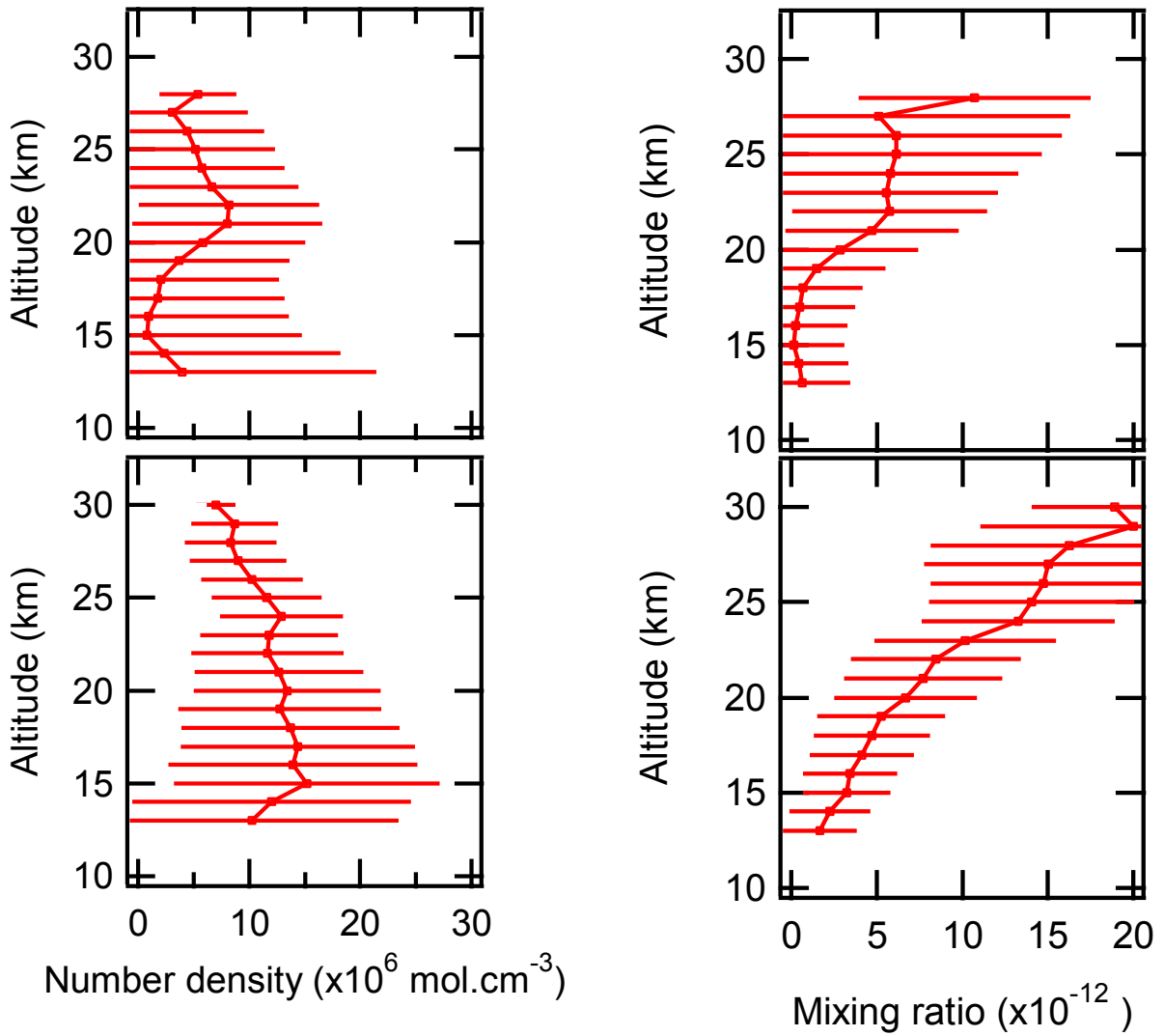
Step 1: SCIAMACHY BrO Validation Flights:

No	Date	Location	Geophys. Cond. Solar Zenith Angle	best LIMB match orbit at UT→ Step 3
1. SAOZ	Aug. 12, 02	Kiruna, 67.9°N, 21.1° E	87.3 (20 km)	#2352, 9:54, SZA= 54°
2. Triple	Sept, 24, 02	ASA, 43.7° N, 0.25°E	44 – 88°	#2968, 10:33
3. SAOZ	Oct. 1, 02	ASA, 43.7° N, 0.25°E	83.4 (20 km)	#3068, 9:43, SZA = 58°
4. SAOZ	Feb. 23, 03	Bauru, 22.35°S, 49.03°W	80.9 (20 km)	#5145, 12:07; SZA = ?
5. Triple	March 6, 03	Kiruna, 67.9°N, 21.1° E	72 – 86°	#5300, 10:03
6. SAOZ	March 16, 03	Kiruna, 67.9°N, 21.1° E	86.4 (20 km)	#5487, 09:32, inside vortex, SZA = 65°
7. LPMA/DOAS	March 23, 03	Kiruna, 67.9°N, 21.1° E	78.9 – 94.7°	#5554, 11:07; 11:10; #5588, 9:01
8. SAOZ	March 30, 03	Kiruna, 67.9°N, 21.1° E	85.8 (20 km)	#5644, 8:46; #5645, 10:20, SZA= 65°
9. Triple	June 9, 2003	Kiruna, 67.9°N, 21.1° E	40 – 70°	#6659, 8:57
10. LPMA/DOAS	Oct. 9, 2003	ASA, 43.7° N, 0.25°E	66 – 88°	#8407, 11:30; #8421, 9:17
11. SAOZ	Jan. 31, 04	Bauru, 22.35°S, 49.03°W	81.2 (at 20 km)	#10040, 11:18; #10041, 13:48, SZA=60°
12. SAOZ	Feb. 5, 04	Bauru, 22.35°S, 49.03°W	81.2 (at 20 km)	#10112, 12:49, SZA = 50°
13. LPMA/DOAS	March 24, 04	Kiruna, 67.9°N, 21.1° E	72 – 98°	#10798, 10:35
	Fall 04	Teresina, 5.1° S, 42.8° W	tropical pipe	

already conducted or scheduled within ENVISAT (SCIAMACHY, MIPAS, GOMOS,) validation

Step 1: BrO profiles by SAOZ c.f., Bauru, Brazil

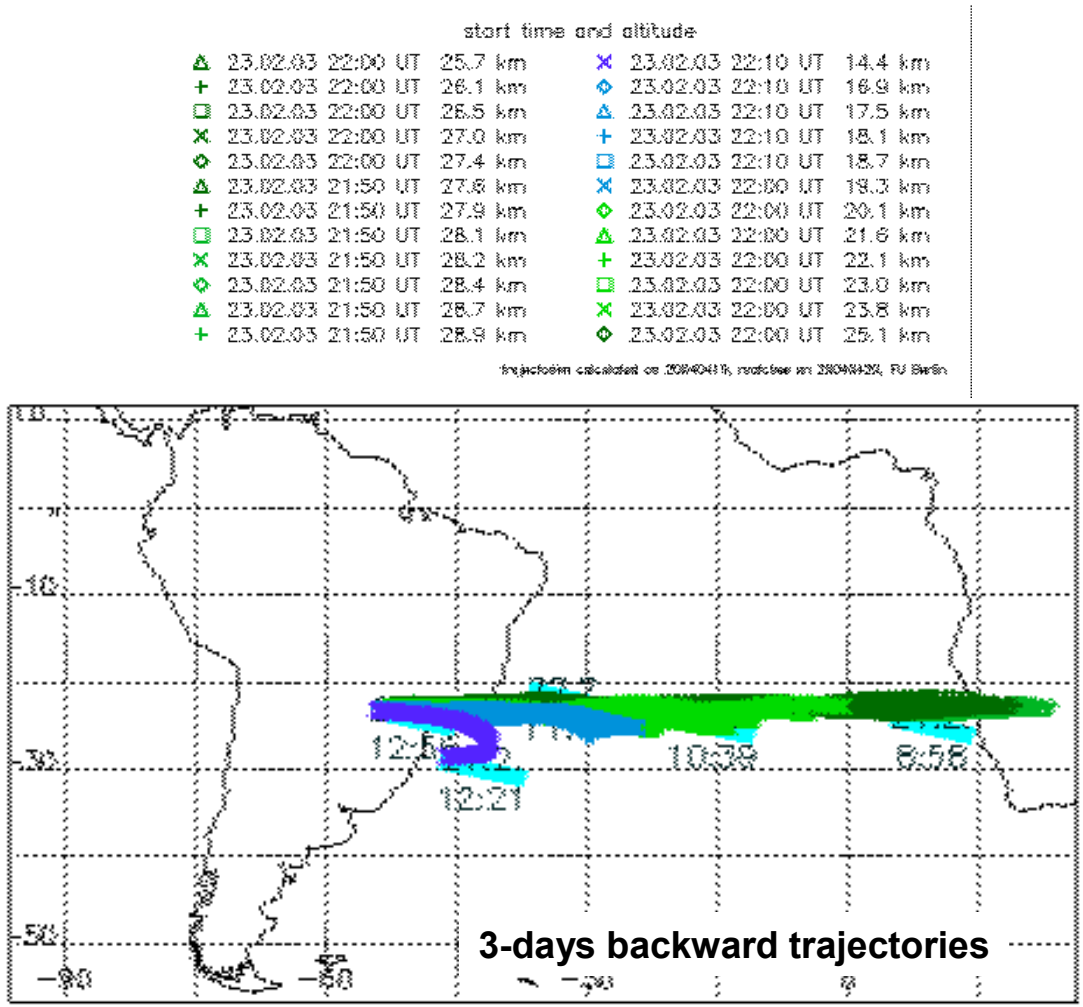
on Feb. 23, 03 (upper two panels) and Jan. 31, 04 (lower two panels)



Step 2: Meteorological forecasting/analysis by FU-Berlin

SAOZ balloon ascent at Bauru on Feb. 23, 03

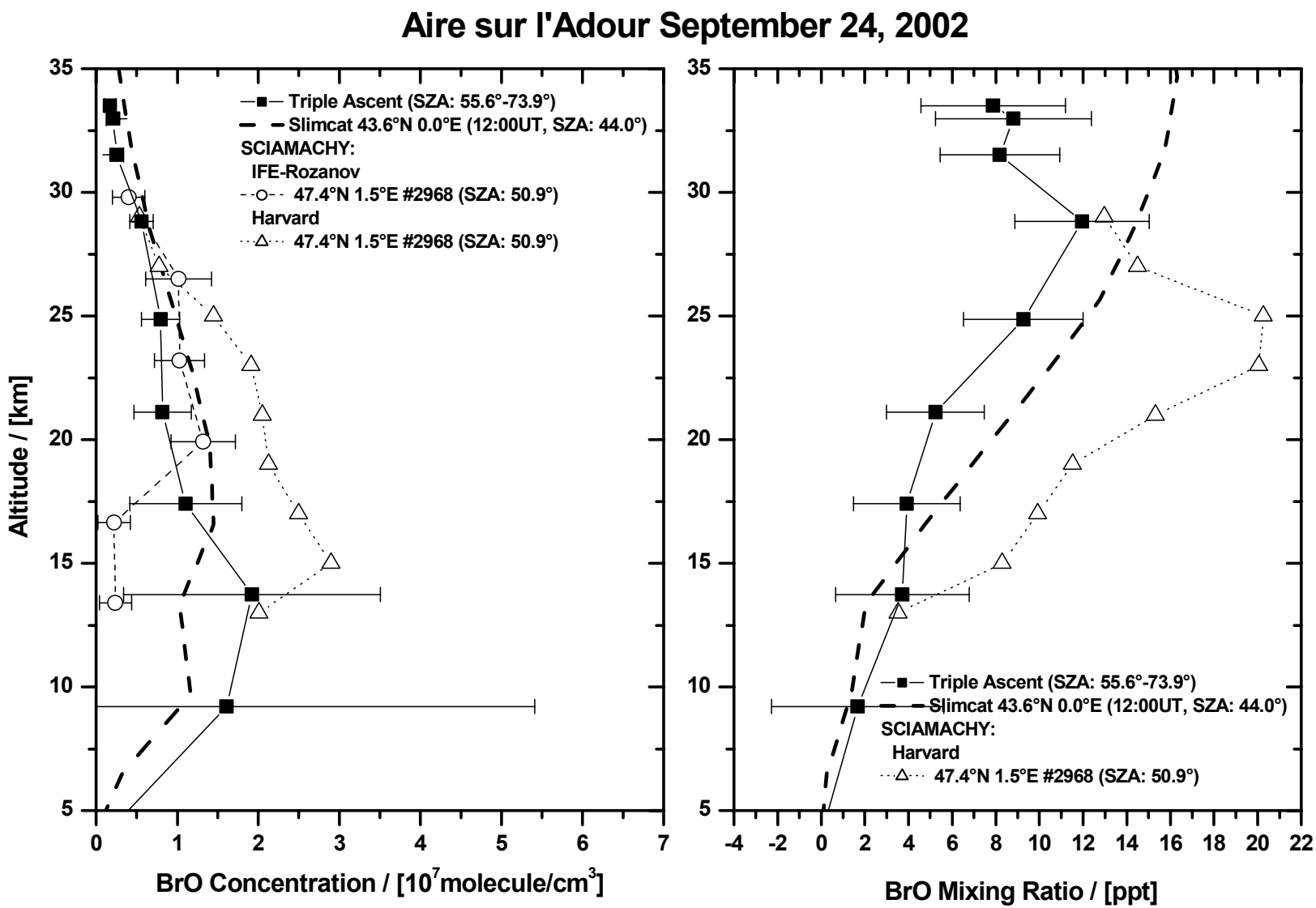
Trajectories started at the predicted balloon measurement points and colocated SCIA LIMB scans



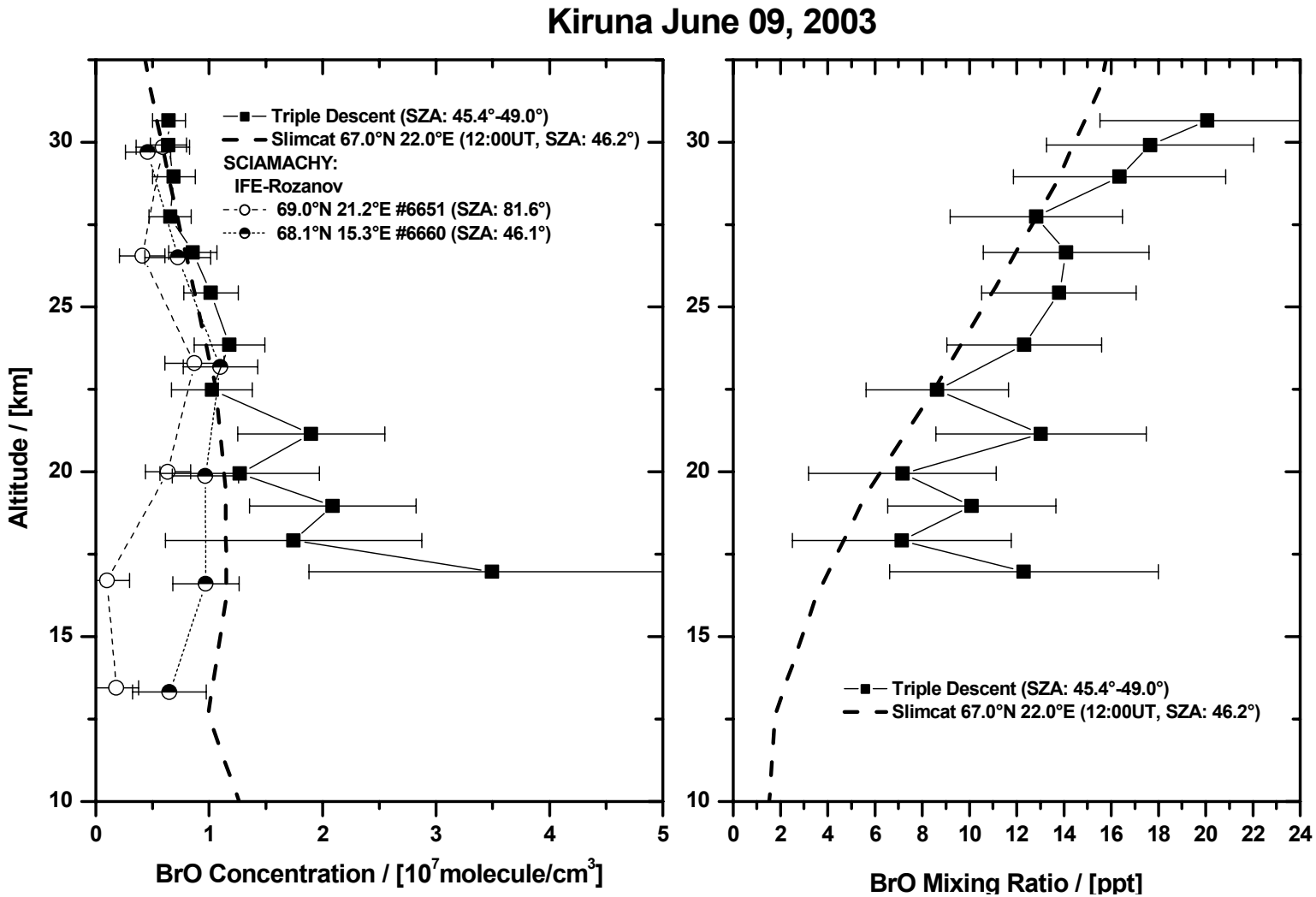
Matching orbits:

#5145, 12:07
#5130
#5116
#5115
#5114

Step 1 + 3: Jülich BrO profile measurements with SCIA-LIMB



Step 1 + 3: Jülich BrO profile measurements with SCIA-LIMB



Step 2: Meteorological forecasting/analysis by FU-Berlin

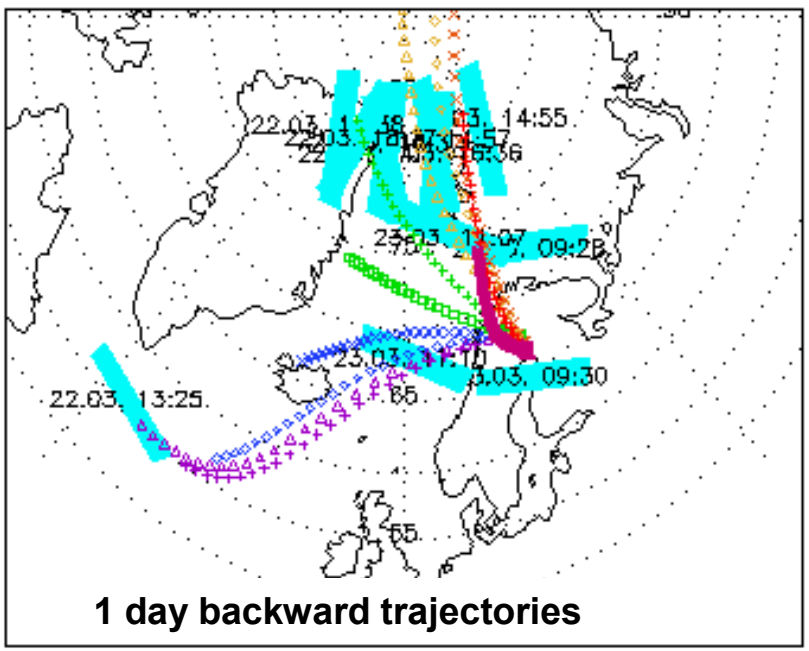
LPMA/DOAS Flight – balloon ascent in Kiruna, March 23, 03

Trajectories started at the predicted balloon measurement points and colocated SCIA LIMB scans

start time and altitude

◇	23.03.03 15:20 UT	25 km	△	23.03.03 16:30 UT	32 km
△	23.03.03 15:10 UT	22 km	+	23.03.03 16:20 UT	32 km
+	23.03.03 15:00 UT	19 km	□	23.03.03 16:10 UT	32 km
□	23.03.03 14:50 UT	17 km	×	23.03.03 16:00 UT	32 km
×	23.03.03 14:40 UT	14 km	◇	23.03.03 15:50 UT	32 km
◇	23.03.03 14:30 UT	12 km	△	23.03.03 15:50 UT	32 km
△	23.03.03 14:20 UT	10 km	+	23.03.03 15:40 UT	31 km
+	23.03.03 14:10 UT	7 km	×	23.03.03 15:30 UT	28 km

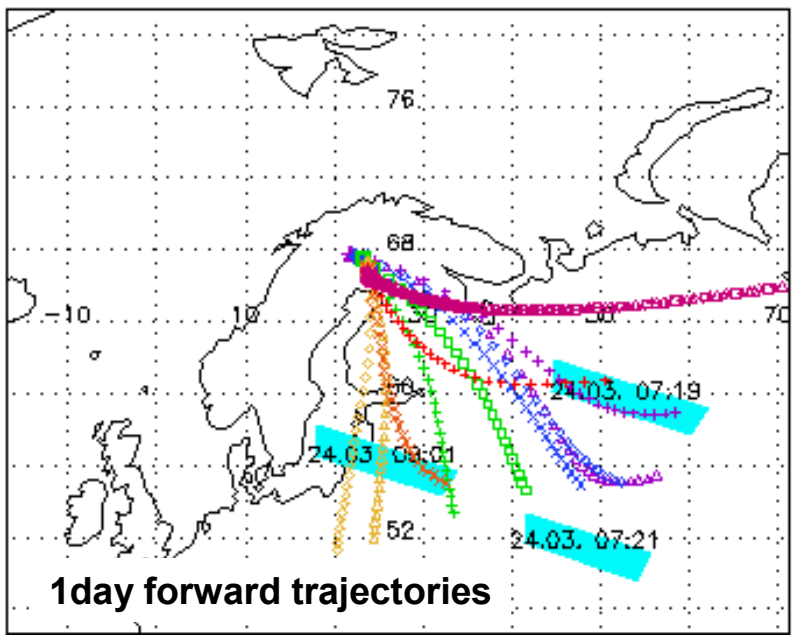
Orbit: 5532, 5533, 5534, 5535, 5544, 5545



1 day backward trajectories

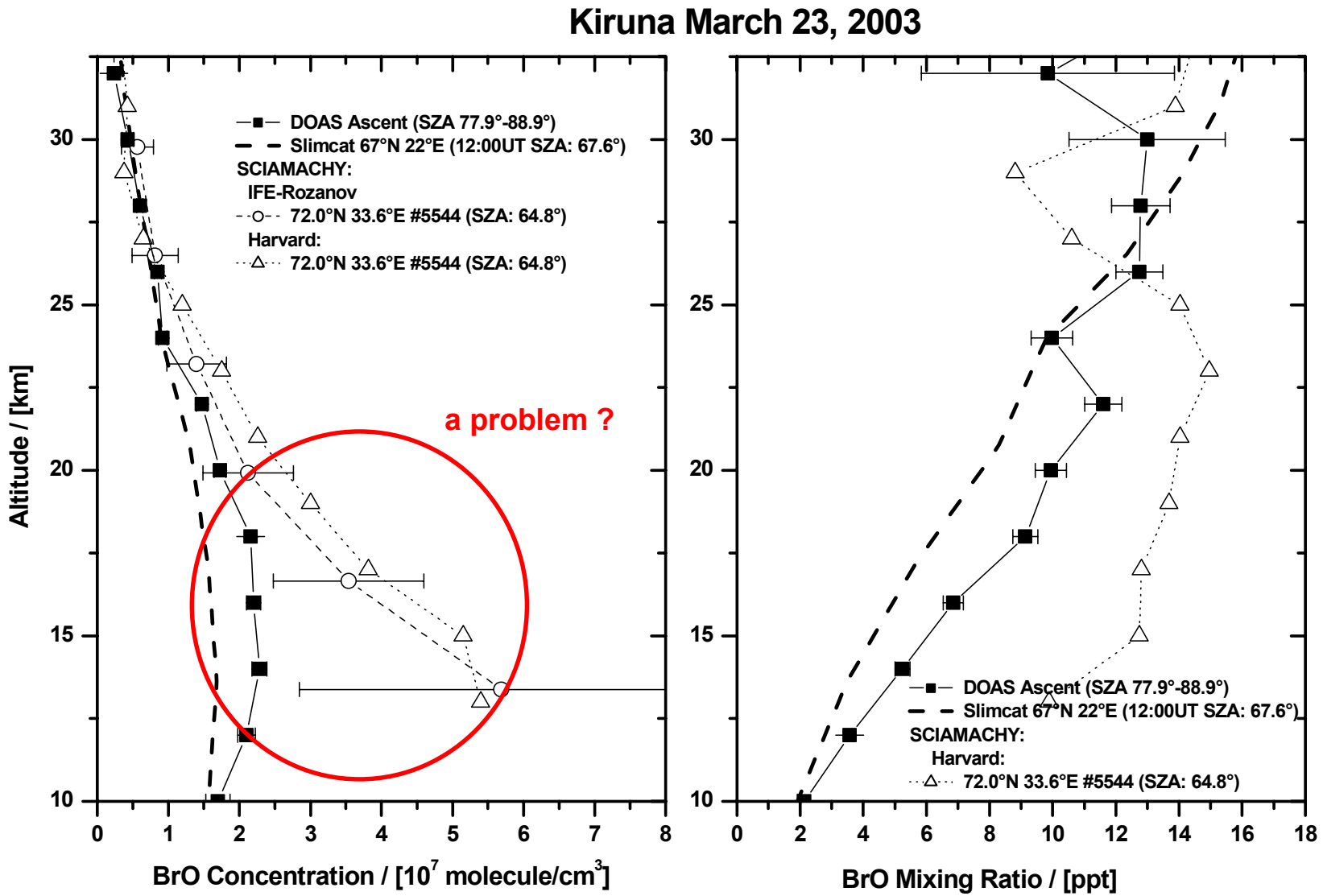
Limb scan

Orbit: 5557, 5558



1day forward trajectories

Step 1 + 3: BrO profiles from solar occultation (DOAS) and LIMB-SCIA



Step 2: Meteorological forecasting by FU Berlin

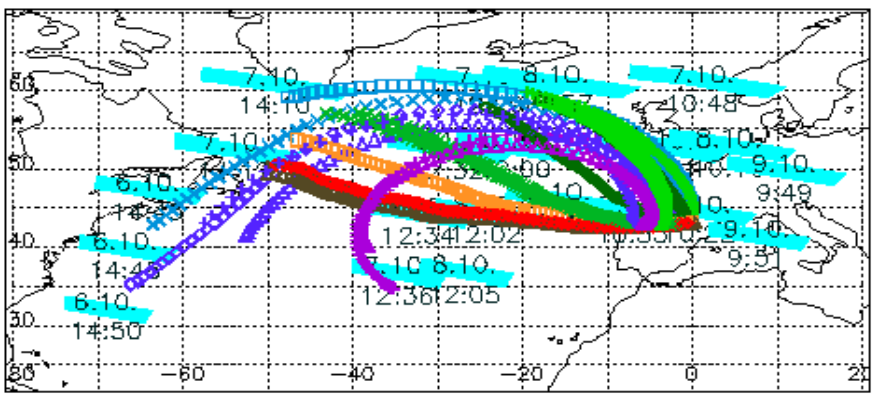
LPMA/DOAS Flight – balloon ascent in Aire sur l'Adour, October 23, 03

Trajectories started at the predicted balloon measurement points and colocated LIMB scans of SCIAMACHY

start time and altitude

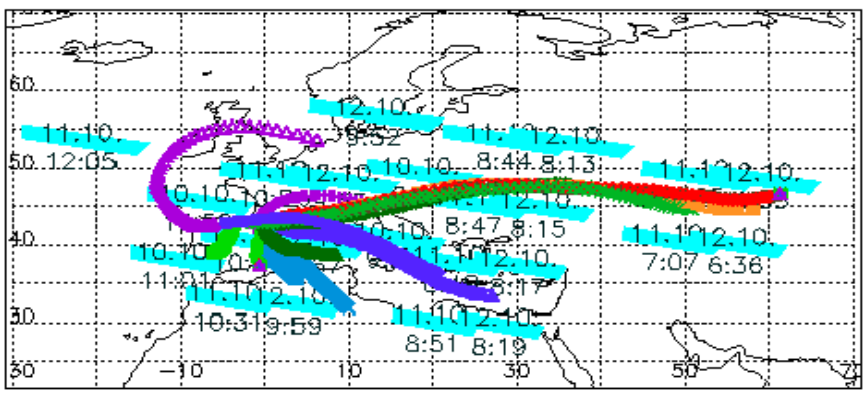
×	09.10.03 16:30 UT	29.3 km	△	09.10.03 17:50 UT	7.8 km
◇	09.10.03 16:20 UT	27.0 km	+	09.10.03 17:40 UT	13.4 km
△	09.10.03 16:10 UT	24.2 km	□	09.10.03 17:40 UT	22.3 km
+	09.10.03 16:00 UT	21.4 km	×	09.10.03 17:30 UT	29.5 km
□	09.10.03 15:50 UT	18.9 km	◇	09.10.03 17:20 UT	32.8 km
×	09.10.03 15:40 UT	16.6 km	△	09.10.03 17:10 UT	33.6 km
◇	09.10.03 15:30 UT	14.1 km	+	09.10.03 16:50 UT	33.1 km
△	09.10.03 15:20 UT	10.8 km	□	09.10.03 16:40 UT	31.3 km
+	09.10.03 15:10 UT	7.6 km			

Orbit: 8367, 8379, 8380, 8381, 8393, 8394, 8407, 8408



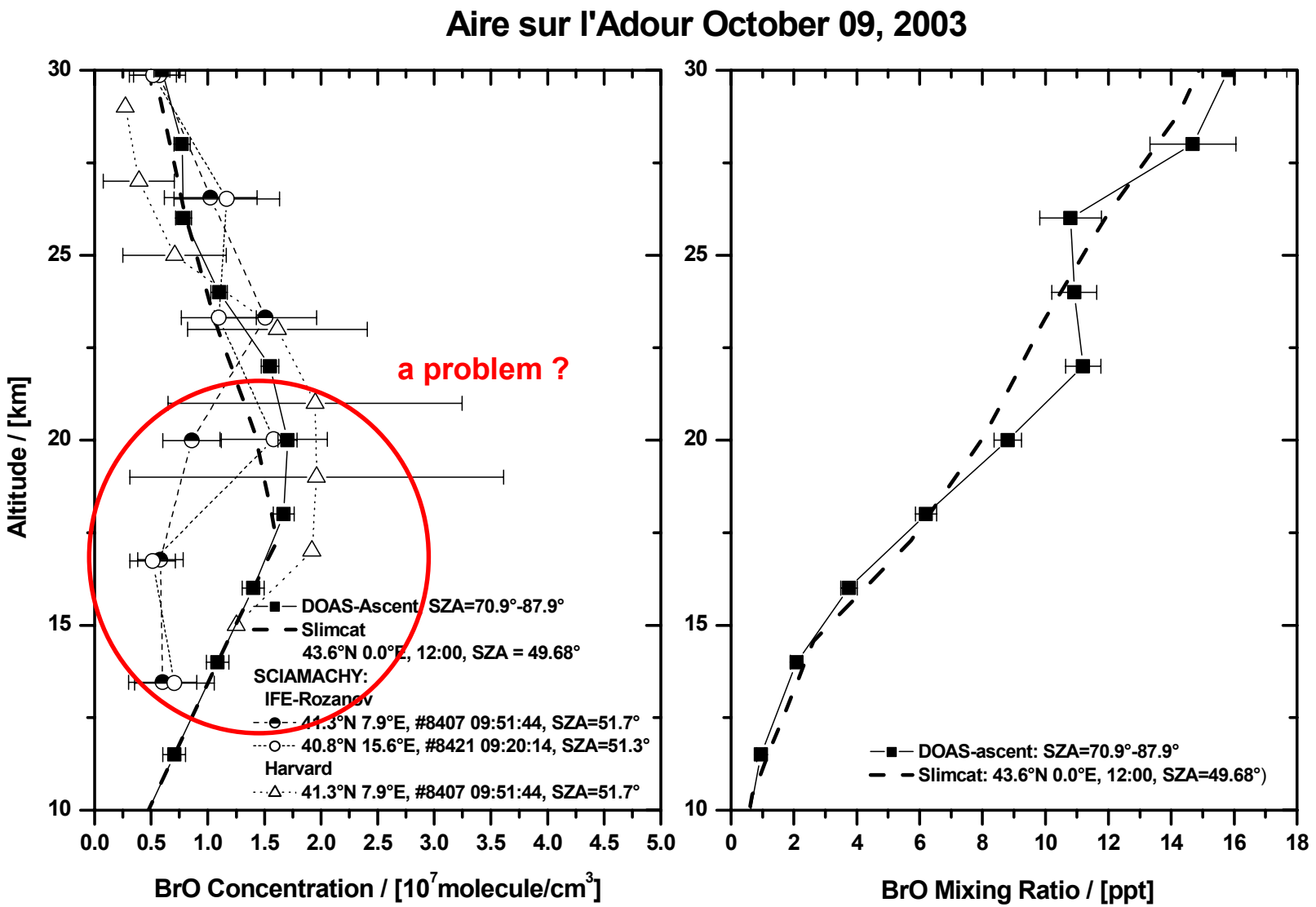
3 day backward trajectories

Orbit: 8421, 8422, 8434, 8435, 8436, 8437, 8448, 8449, 8450,



3 day forward trajectories

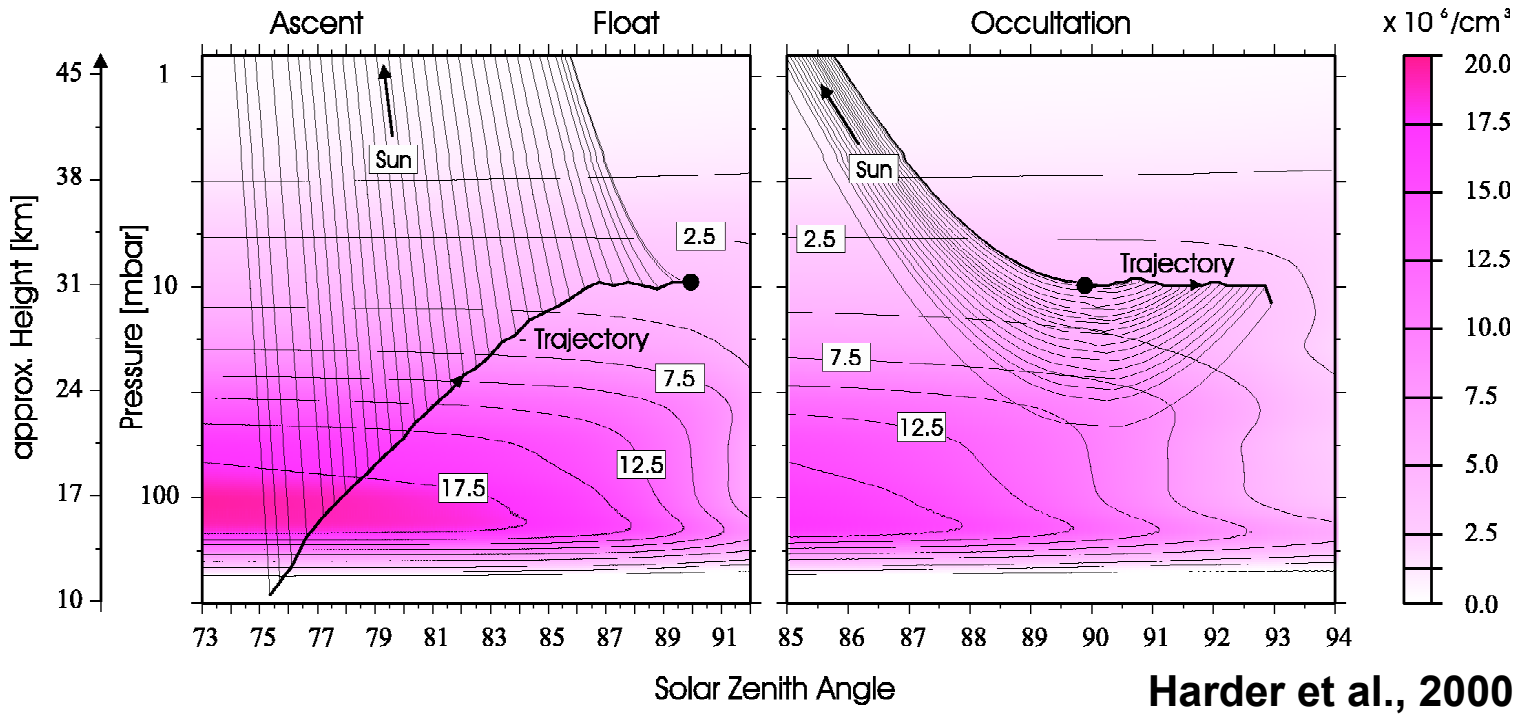
Step 1 + 3: BrO profiles from solar occultation (DOAS) and LIMB-SCIA



Step 4: Photochemical Correction

is necessary !!!!!!!!!!!! since

1.) stratospheric BrO concentration is a function of SZA, geophysical condition, ...
2.) SCIAMACHY LIMB measurements are in general conducted at different times and SZA's than the validation balloon flights



Harder et al., 2000

Summary&Conclusion&Status

Report on the 4 major steps to validate SCIAMACHY-Limb BrO profiles

1. Conduct balloon flights (to date 13) for as many different geophysical conditions as possible (done)
2. Calculate matches of collocated ENVISAT/SCIAMACHY overpasses&pixels (mostly done)
3. Retrieve BrO SCIAMACHY Limb profiles for the corresponding overpasses&pixels (mostly done, but not yet available for the standard processor), and validate LIMB retrieval (mini-DOAS) (under way)
4. Calculate photochemical corrections for the balloon observations on calculated air mass trajectories (to be done)

Status of SCIAMACHY BrO profile validation:

→ The direct comparison of photochemical uncorrected BrO profiles from balloon-borne sondes with SCIA-LIMB BrO is already very promising, but

→ problems remain for altitudes below 20 km !