EGU21-10293

Retrieval of tropospheric BrO columns from TROPOMI and their validation using MAX-DOAS measurements in Ny-Ålesund

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1. TROPOMI tropospheric BrO retrieval

Step 1. DOAS BrO slant column retrieval

- Fit window: 334.6 - 358 nm (Seo et al., 2019)
- Cross-sections: BrO, O_3 (223K, 243K), NO_2, OClO, O_4, HCHO, Ring

Step 2. Stratospheric BrO correction

- Residual method

$$\mathrm{VCD_{tropo}} = \frac{\mathrm{SCD_{total}} - \mathrm{VCD_{strato}} \cdot \mathrm{AMF_{strato}}}{\mathrm{AMF_{tropo}}}$$

- Stratospheric BrO column (VCD_{strato})

1. 3D atmospheric chemistry model

→ C-IFS-CB05-BASCOE model product

2. Empirical multiple linear regression model

Step 3. Tropospheric AMF calculation

- Pre-calculated Box AMF LUT from the SCIATRAN
- f(λ, raa, vza, sza, surface albedo, surface altitude, z)
- Surface albedo from the geometry-dependent effective LER (0.1°x0.1°)

2. MAX-DOAS tropospheric BrO retrieval

- Differential slant column density (dSCD) is retrieved by applying the DOAS technique
- BrO profile retrieval is performed by an optimal estimation based profile retrieval (BOREAS; Bösch et al., 2018)

3. TROPOMI and MAX-DOAS tropospheric BrO vertical columns

Fig 1. (a) TROPOMI tropospheric BrO vertical columns and (b) MAX-DOAS tropospheric BrO profiles

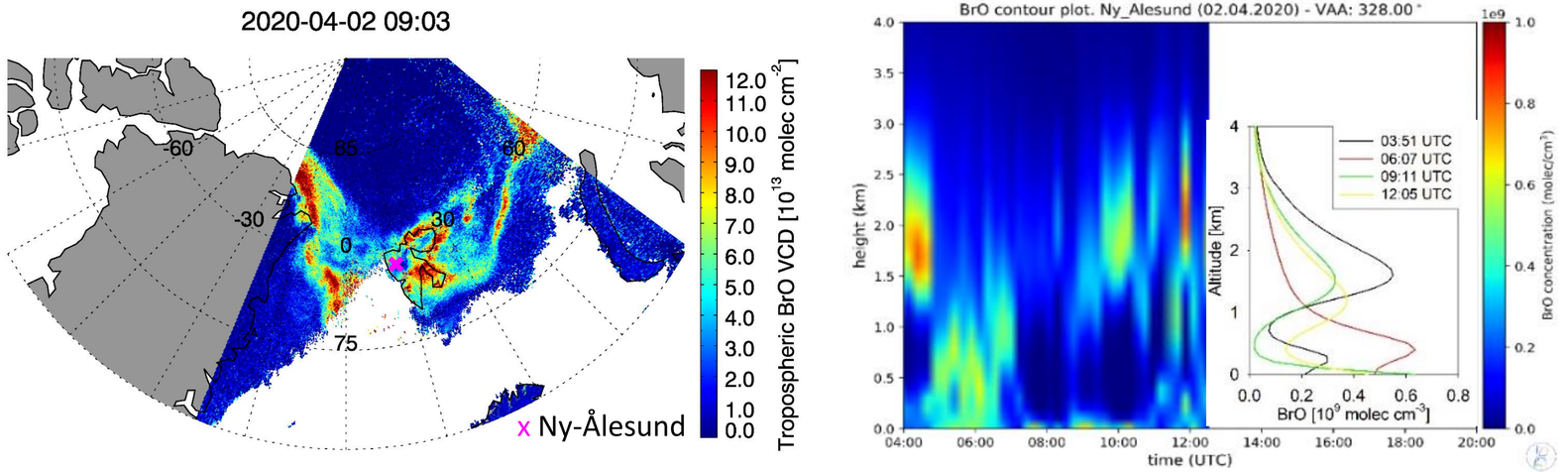
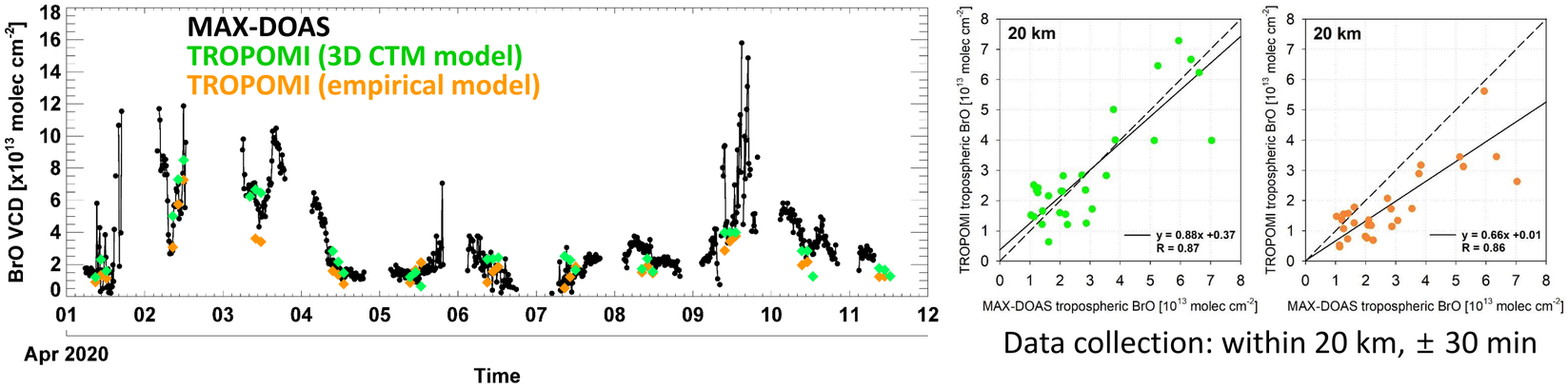


Fig 2. Comparisons of retrieved tropospheric BrO VCs from TROPOMI and MAX-DOAS in Ny-Ålesund

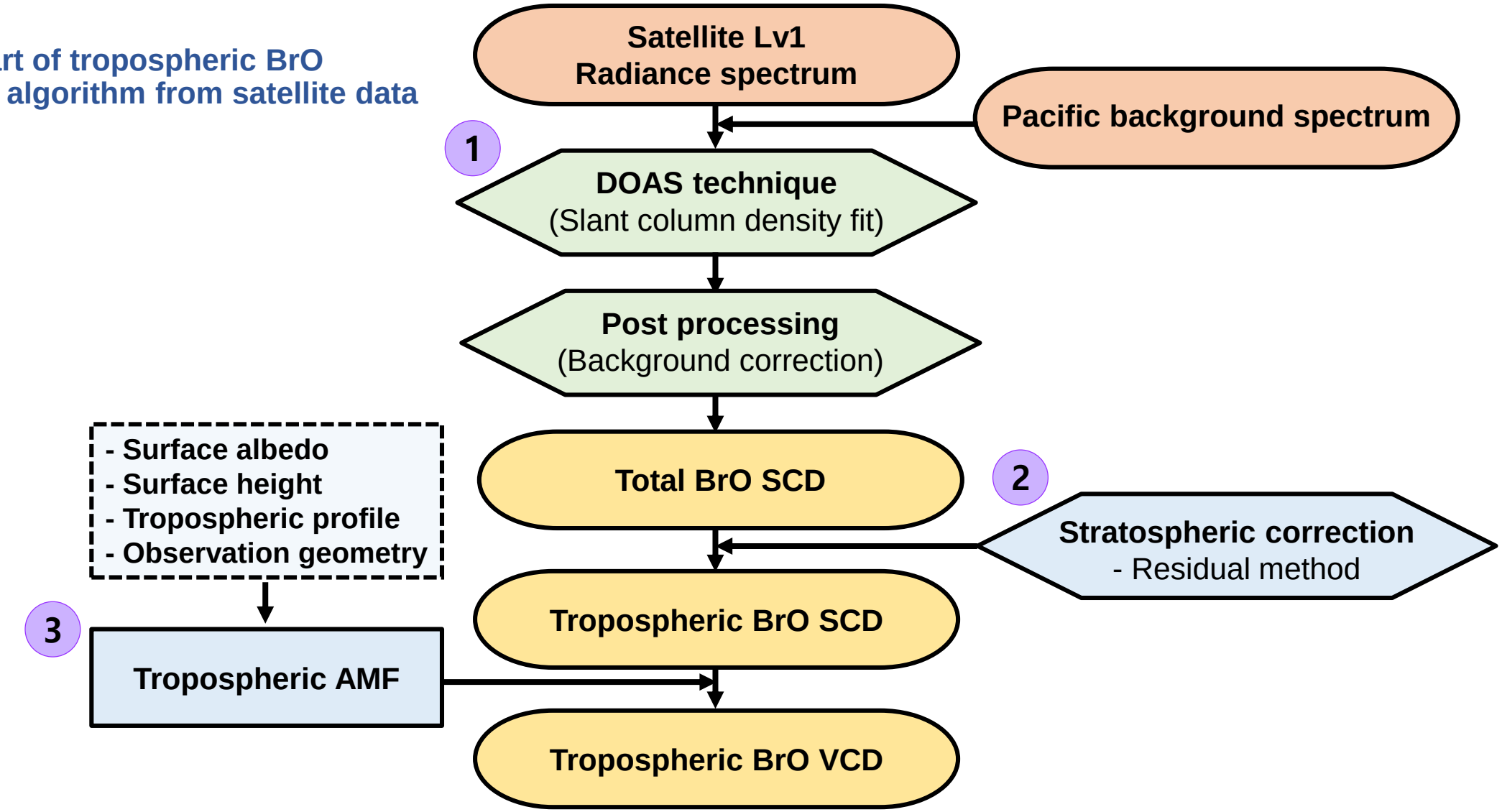


Data collection: within 20 km, ± 30 min

- We have developed an algorithm to retrieve tropospheric BrO columns from TROPOMI.
- TROPOMI tropospheric BrO vertical columns were validated with ground-based MAX-DOAS measurements. They show generally good agreement.

Satellite tropospheric BrO retrieval algorithm

Flowchart of tropospheric BrO retrieval algorithm from satellite data



Satellite tropospheric BrO retrieval algorithm

1 DOAS settings for the BrO slant column retrieval

Parameter	Description
Fitting window	334.6 - 358 nm
Absorption cross-sections	BrO (228 K), O_3 (223 and 243K), NO_2 (220 K), OClO (213 K), HCHO (298 K), O_4 (293 K), Ring
Polynomial	5 coeff.
Solar reference spectrum	Kurucz solar spectrum
Background spectrum	Daily averaged earthshine spectrum in selected Pacific region
Intensity offset correction	Linear offset [*Seo et al., 2019, 2020*]

2 Stratospheric correction (VCD_{strat})

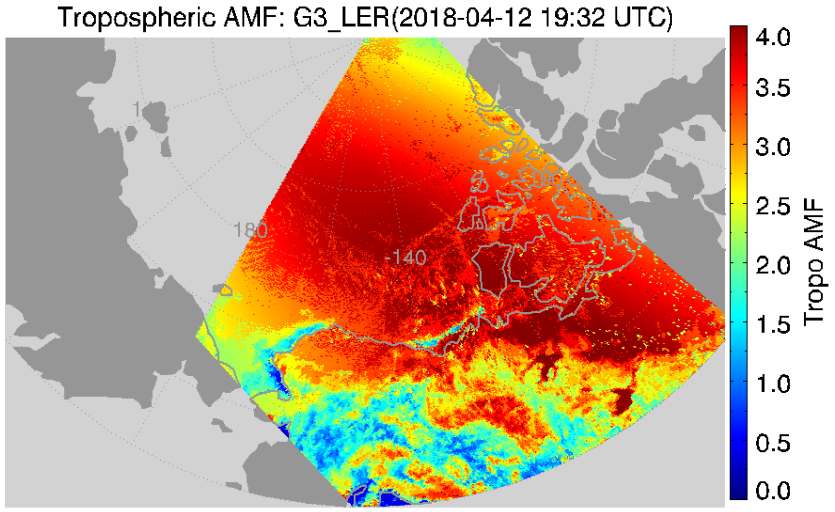
1. **3D atmospheric chemistry transport model** (CAMS C-IFS-CB05-BASCOE model product)
2. **Climatological approach (→ ongoing test)**

   stratospheric BrO VCs derived from the BASCOE model climatology LUT with satellite retrievals of O_3 (total) and NO_2 (stratospheric) as input data (Theys et al., 2009)
3. **Empirical multiple linear regression model**

$$a_0 + a_{lon} \cdot lon + a_{lat} \cdot lat + a_{sza} \cdot \cos(SZA) + a_{los} \cdot \cos(VZA) + a_{tropoH} \cdot \frac{1}{tropoH}$$

3 Tropospheric AMF calculation

- Pre-calculated Box AMF LUT from the SCIATRAN model
- f(λ, raa, vza, sza, surface albedo, surface elevation, z)
- Surface albedo from the geometry-dependent effective LER
- Surface height from Global 30 Arc-Second Elevation
- A priori BrO profile from GEOS-Chem BrO profile
- Linear interpolation for LUT parameters



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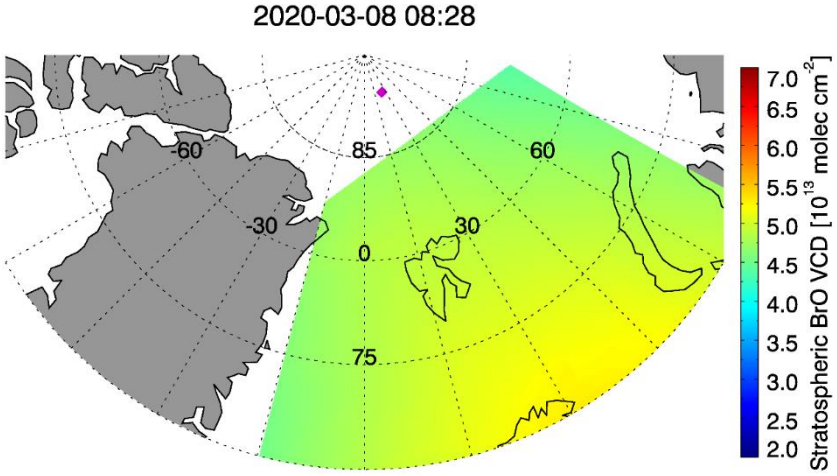
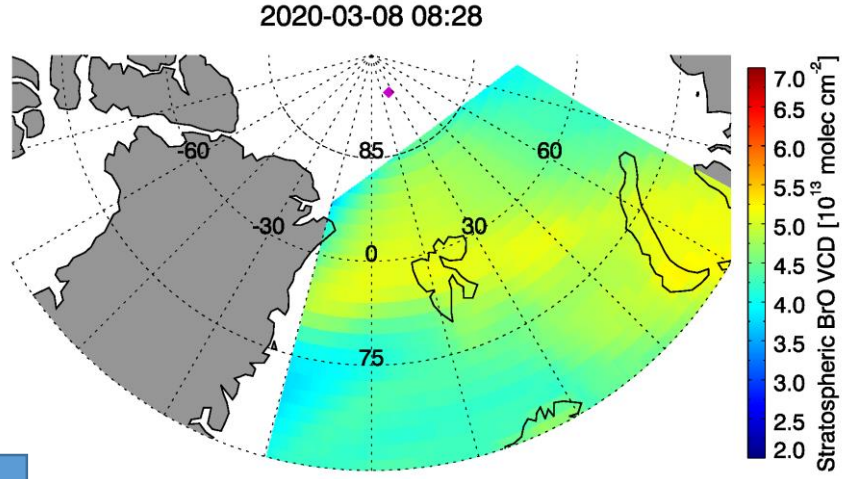
Satellite tropospheric BrO retrieval algorithm

* **Stratospheric BrO** fields from different methods

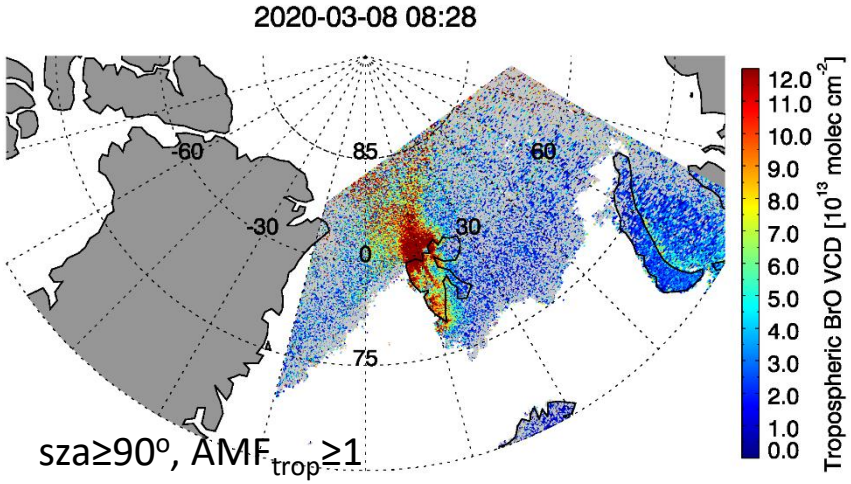
Empirical MLR model

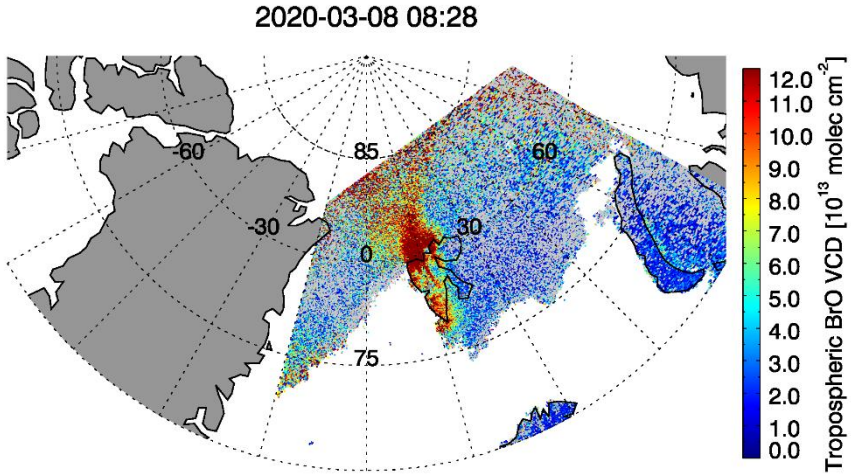


CB05-BASCOE scaled stratospheric BrO ($VCD_{scaled_strato} = VCD_{strato}$ x scale factor)



* **TROPOMI tropospheric BrO vertical columns** applying different stratospheric correction methods





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preliminary results!

Satellite tropospheric BrO retrieval algorithm

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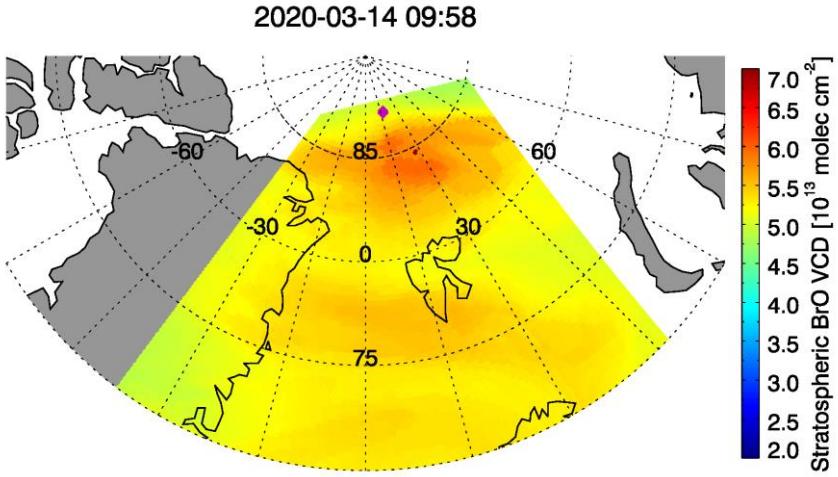
Empirical MLR model



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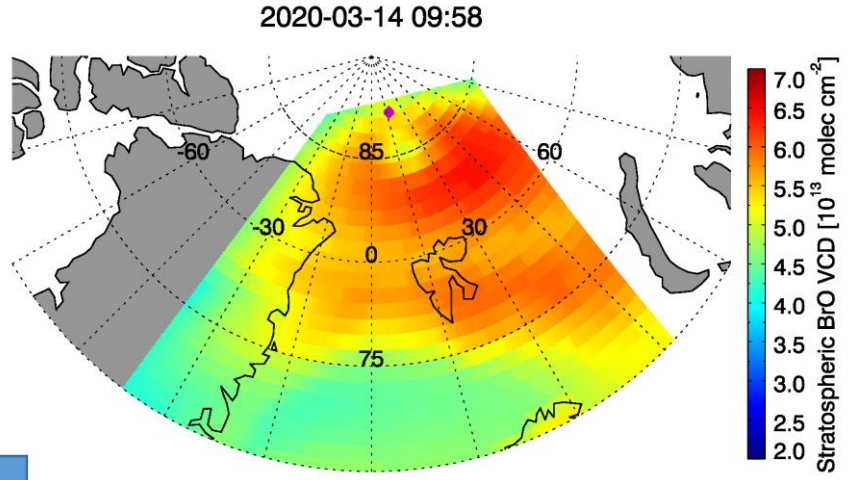

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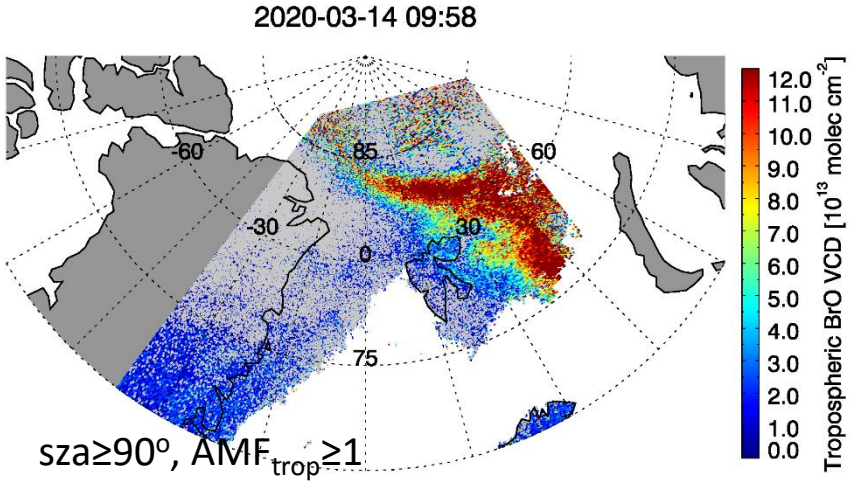

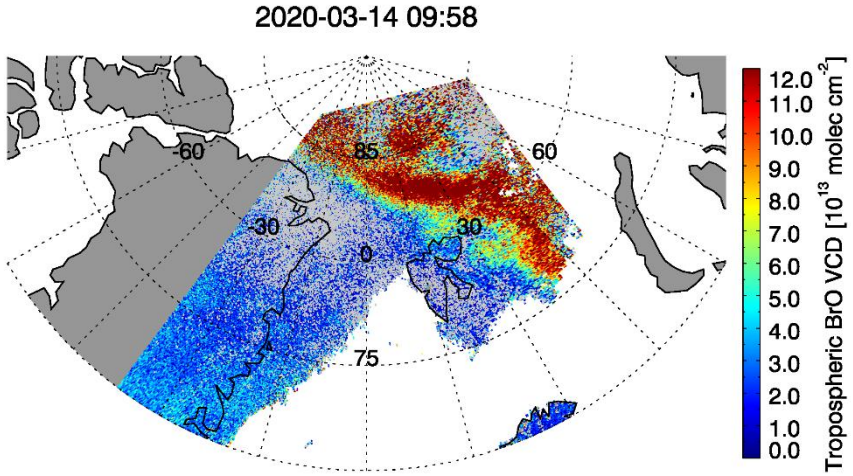

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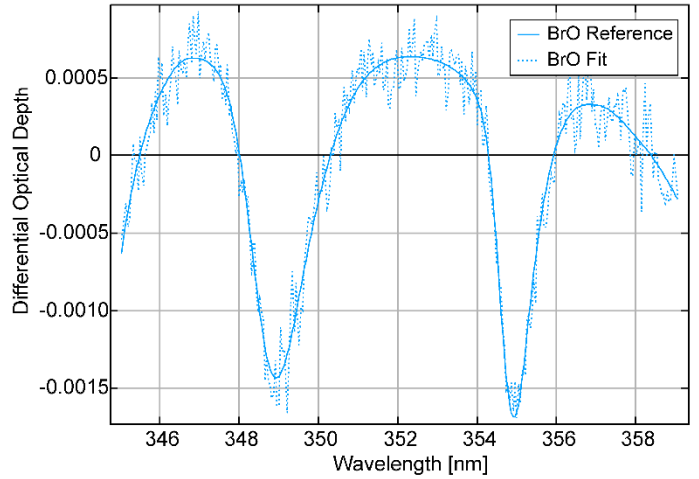
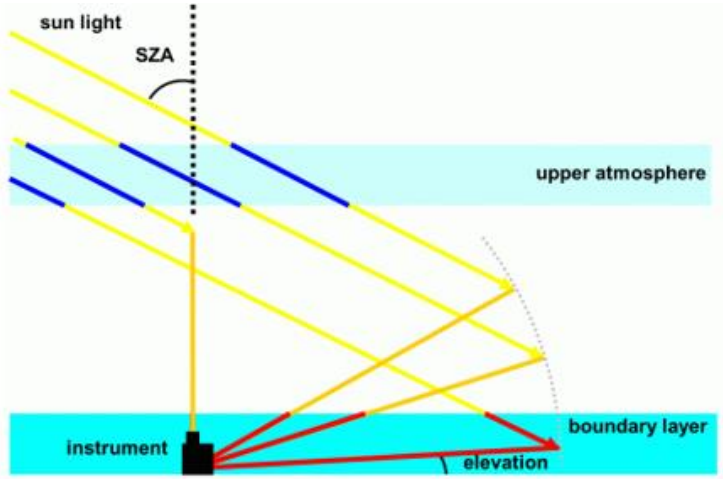
MAX-DOAS tropospheric BrO retrieval



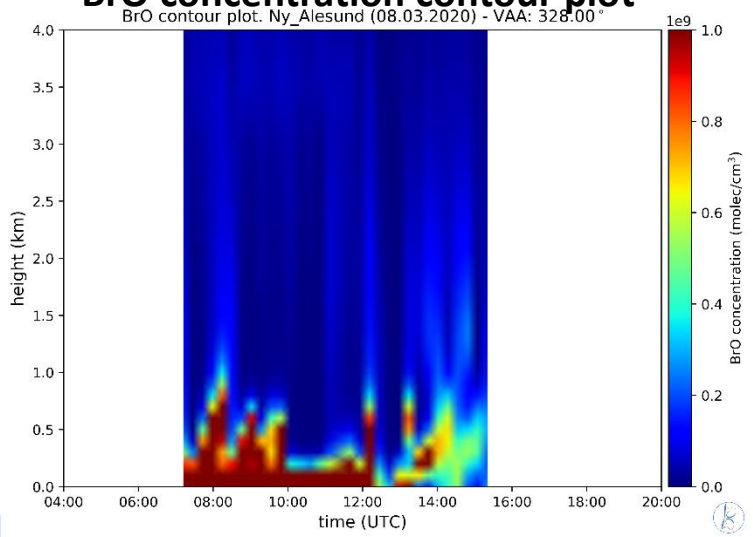
- MAX-DOAS measurements at the NDACC station in Ny-Ålesund, Svalbard (78˚6’ N, 11˚6’ E)
- DOAS BrO fit setting used for MAX-DOAS measurements

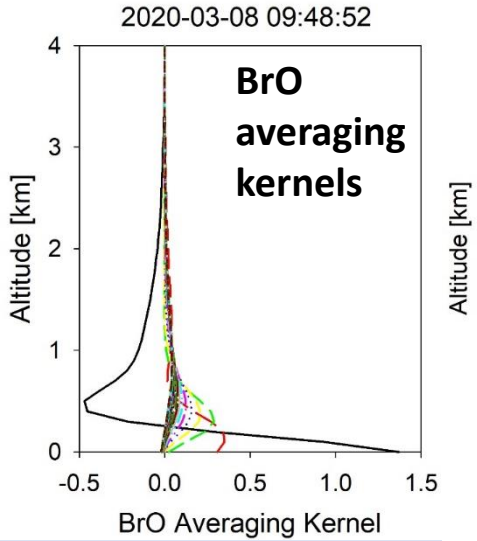
Parameter	Description
Fitting window	337 – 367 nm
Absorption cross sections	BrO (228 K), O_3 (223 K, 243 K), NO_2 (220 K), O_4 (293 K), Ring spectrum
Background spectrum	Zenith sky spectrum
Polynomial	5th order

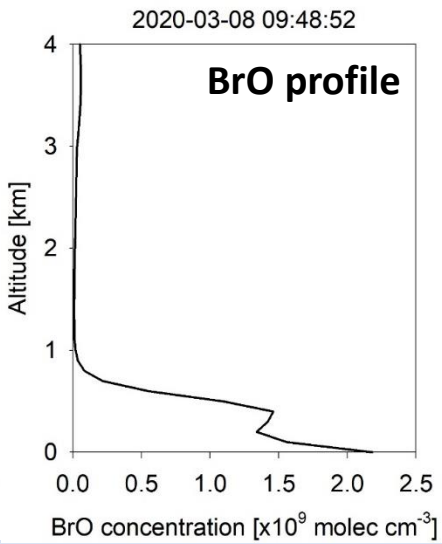




BrO concentration contour plot







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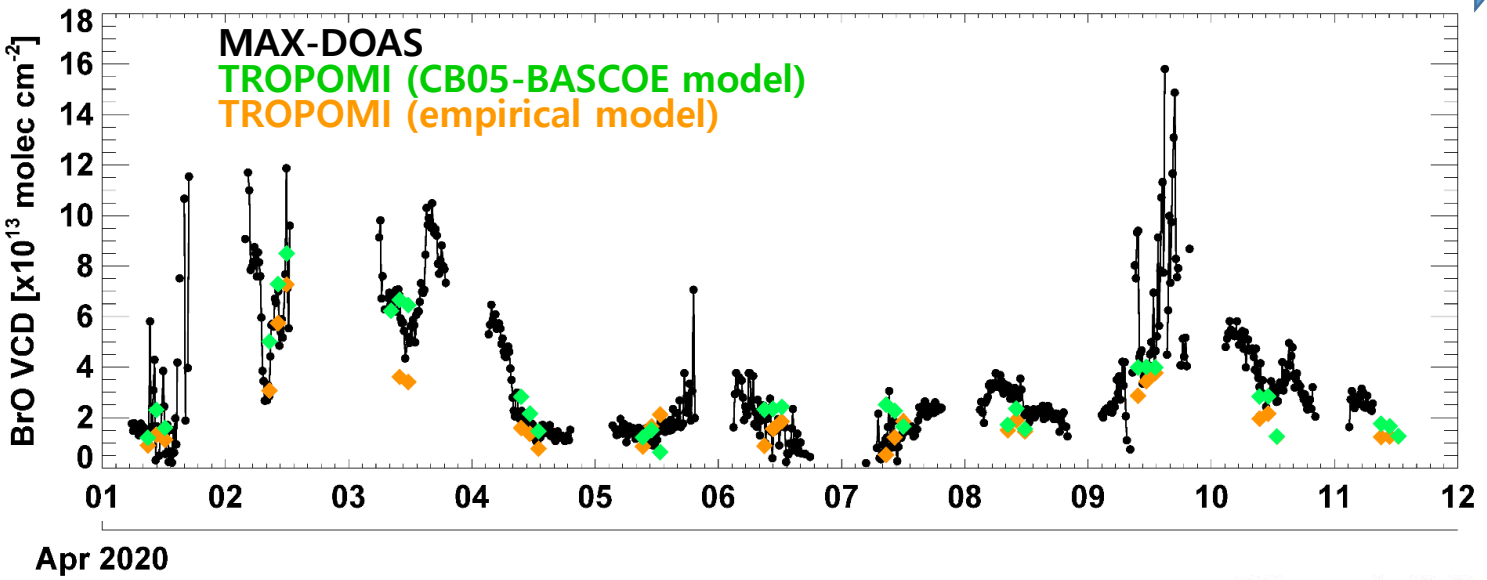
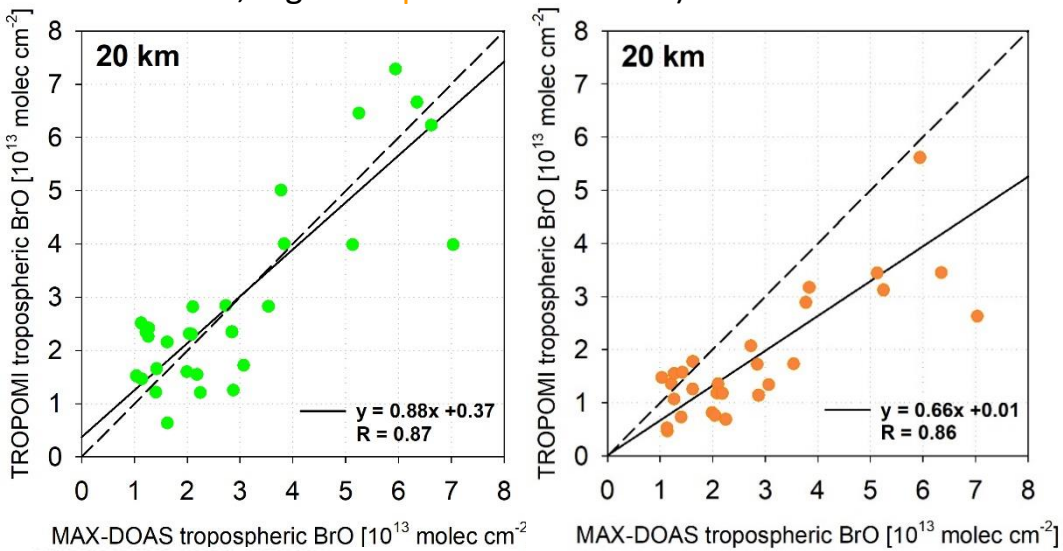
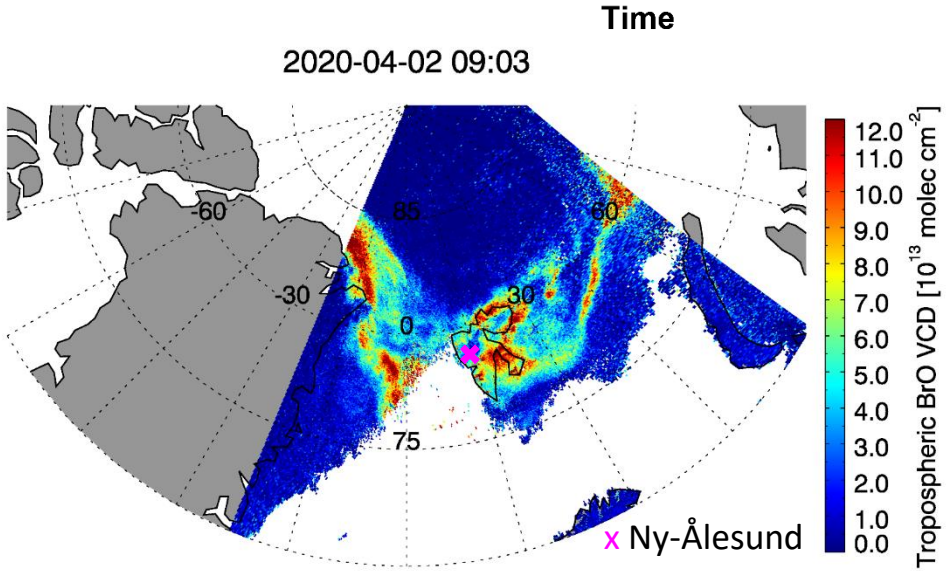
Validation of TROPOMI tropospheric BrO with MAX-DOAS

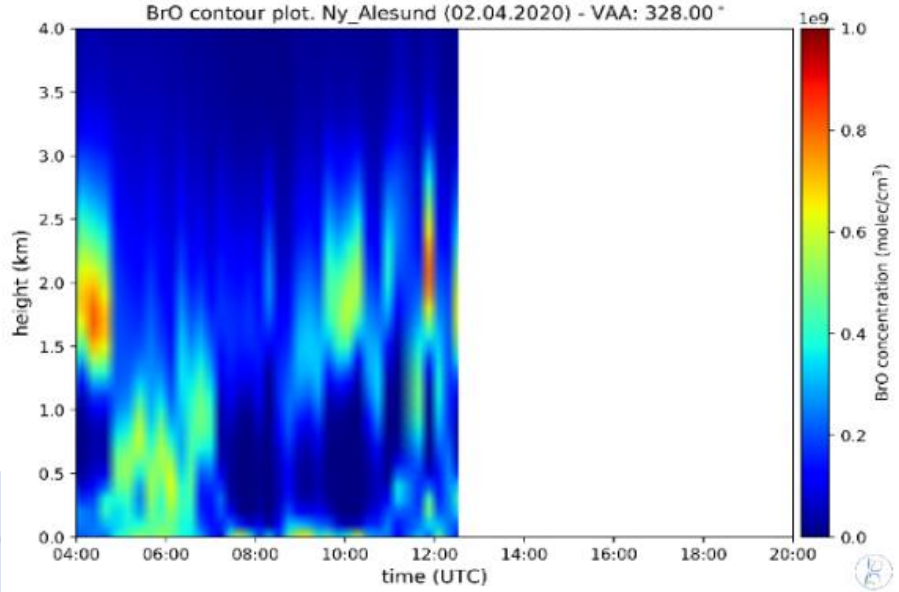
- Time-series of retrieved tropospheric BrOVCDs from TROPOMI and ground-based MAX-DOAS measurements in Ny-Alesund

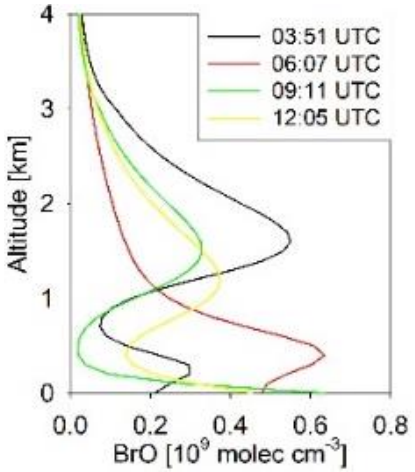


- 1 to 1 comparison (collection: ±30 min, 20 km)
  - ✓ Different stratospheric correction (left: CB05-BASCOE model, right: empirical MLR model)









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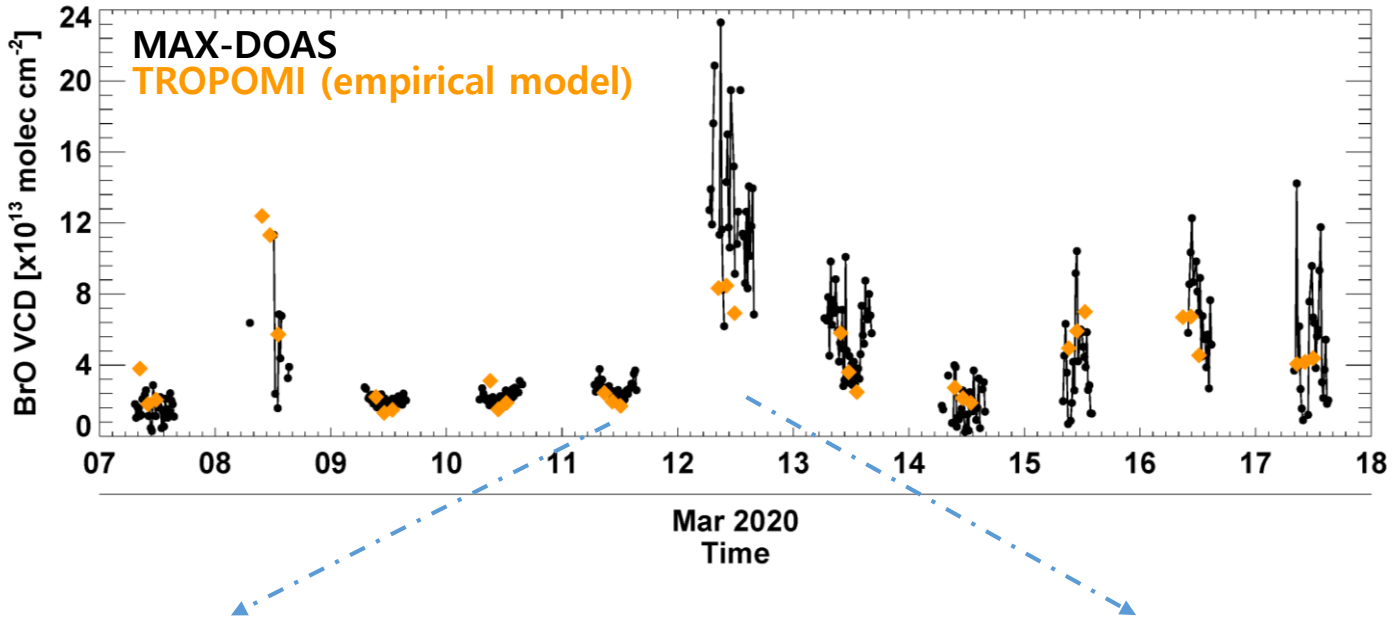
Validation of TROPOMI tropospheric BrO with MAX-DOAS



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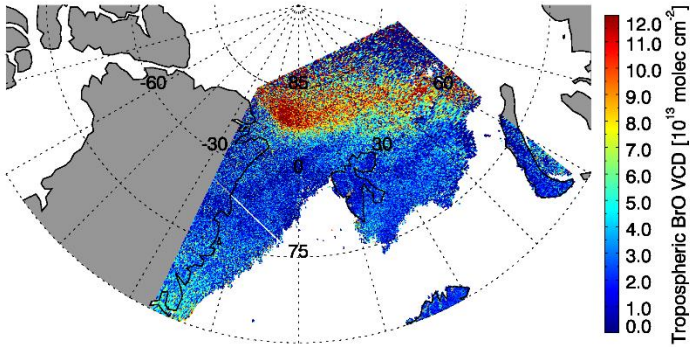

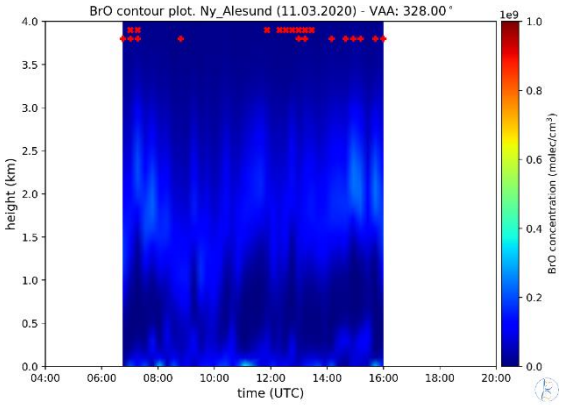

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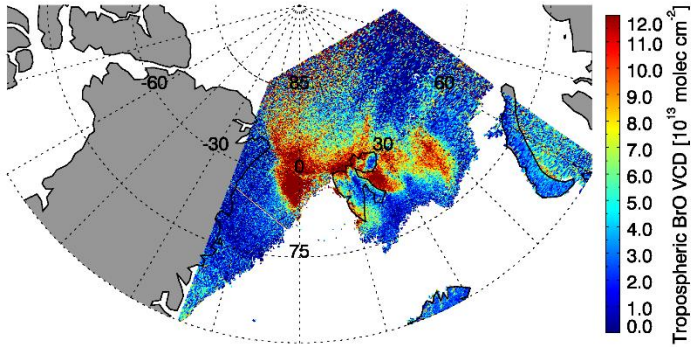

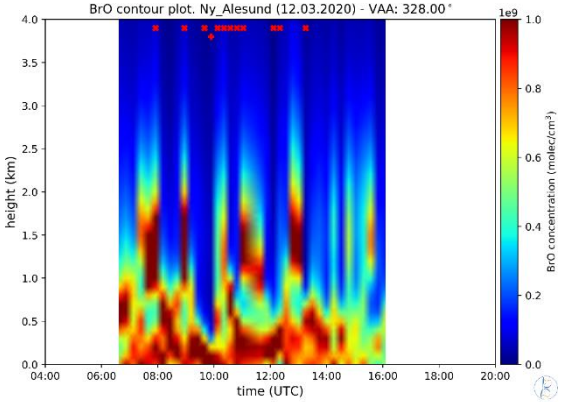

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