Four years measurements of the mesospheric nitric oxide (NO) and ozone with a ground-based millimeter-wave spectral radiometer at Syowa station, Antarctica

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1. Composition changes in polar mesosphere caused by energetic particle precipitation (EPP)

- Precipitation of SEPs (Solar Energetic Particles) into the middle atmosphere induces chemical composition changes;
  - N2 and O3 are dissociated and/or ionized, resulting production of N+2, N, O, O3+...;
  - leading to production of HOX and NOX.
- Can induce O3 depletion.

2. Millimeter-wave measurements of ozone and nitric oxide (NO) at Syowa station, Antarctica

Syowa station (69.00°S, 39.85°E, Mlat=66°S)

- Hardware specification:
  - Antenna: 12 cm parabolic mirror
  - Receiver: 4 K-cooled SS mixer (Tsys ~ 300 K@250 GHz)
  - SPECTROMETER: Agilent Digital FFT (B=1 GHz, ΔB=70 kHz)

- Measurements:
  - Period: January 2012 ~Jan 2015
  - Number of measurements: 807 days (2012-2015)
  - Targets: NO: 250.796 GHz, τO3: 239.039 GHz (8 times/day)
  - Data Acquisition: every 10 min.
  - Integrated every 3 hrs for NO, integrated every 0.5 hrs for O3

- Estimation of the NO column amount in the upper mesosphere approximately from 75 to 105 km (NNO):
  \[ N_{NO}(cm^{-2}) \sim \text{Integrated Intensity (K MHz)} \times 3.9 \times 10^{14} \]

3. Temporal variations of the column amount of NO in the upper mesosphere

- NNO clearly shows seasonal variations except for 2014. 
  - NNO = 2.0 x 1015 cm^-2 in winter ~ 0.6 x 1015 cm^-2 in others
- Photochemical processes are dominant in the mesospheric NO chemistry.
- In 2014 winter, there is no significant enhancement of NNO.

4. Summary and next steps

- The observed NNO shows a seasonal variation with a winter maxima except for 2014. 
  - In case of 2014, NNO with an energy of >30 keV is by 1/5 less than those in 2012 and 2013, suggesting it is a key parameter of the seasonal variation of NNO.
- Short-term NNO enhancements are derived from the 2014-2015 dataset, however, no significant correlation with Dm is found, implying the quantity of precipitating particles is important to the NNO enhancement rather than geomagnetic environmental indices.
- Extension of the millimeter-wave measurement sites to the Arctic region
- Does NNO enhancement appear in Arctic and Antarctic regions at an EPP event?
- Do the seasonal and long-term variations of NNO show a similar pattern?
- A new spectral radiometer is installed in Tromso, Norway, and will start simultaneous measurements in both the polar regions.

References