Development of a chemical model and comparison with ILAS data in the winter and early spring of 1997

Akiko Kagawa and Sachiko Hayashida
(Faculty of Science, Nara Women’s University, Nara, Japan)

1. Background and Purpose
   - The Arctic, extremely low ozone values were observed frequently. Rex et al. [e.g., 1997] estimated the Arctic chemical ozone loss by using “Match” technique. Match technique derives chemical ozone loss from a pair of balloon sounding based on trajectory calculations. Match-derived ozone loss was compared with a box model calculations by Becker et al. [1998, 2000] in the Arctic winters of 1991/92 and 1994/95. Box model calculations allow a quantitative comparison with Match result.

   - ILAS measured ozone and ozone-related species. Observations of ozone-related species enable to investigate ozone loss mechanisms. Chemical ozone loss by using ILAS data by Sasano et al. [2000] in the 1996/97 winter using a similar technique to Rex et al. [1997]. They demonstrated that satellite data can be used to the Match analysis.

   - The purpose: To investigate the chemical mechanisms of ozone destruction observed with ILAS in the winter of 1997 over the Arctic

2. Model calculations on trajectories
   - Air mass factor exceeding 90 degrees are calculated for twilight condition.

3. Chemical box model
   - The model includes 59 stratospheric chemical species. 101 gas phase reactions, 47 photodissociations and 7 heterogeneous reactions.
   - Photodissociation calculations are closely investigated for the study of Polar Regions.

   - Air mass factor exceeding 90 degrees are calculated for twilight condition.

   - ILAS ozone profile of trajectory starting point is used to calculate ozone column above a target altitude.

   - PSC growing along trajectory: Super-cooled Ternary Solution (STS) [Carslaw et al., 1995].

   - Nitric Acid Trihydrate (NAT) [Hanson and Maurerberger, 1988]

4. Model calculations on trajectories

   - Initial values
     - Model: STS
     - ILAS (v4.2) Diabatic
   - Output of 1-D model by S. Solomon (courtesy of S. Solomon)

   - Potential Temperature [K]
     - CL = 3.0 ppbv, BR = 20.0 pptv [WMO, 1998]

5. Summary
   - We presented box model calculations in the Arctic winter and early spring of 1997 that correspond to the ILAS-Match analysis.
   - Simulated ozone decrease significantly in February and March about 425K and enhanced over 475K in March.
   - ILAS-derived ozone also decreased significantly. However, altitude of maximum loss was not agree with both ILAS and Match.
   - Further investigation is needed for selecting ILAS-Match pair.

   - Simulated HNO3 strongly decreases at high altitude region in March. ILAS-derived HNO3 also decreases from mid-February. However, ILAS loss is smaller than simulated loss. Calculated HOx and NOx increase at high altitude in March. Behaviors of HOx and NOx suggest photo-dissociation loss of HNO3.

6. Future plans
   - Re-analysis of ILAS-Match pair.
   - To include PSC scheme in more sophisticated way.