STRAPOLETE : Studying the summer polar stratosphere

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Abstract

The polar stratosphere in the summertime remains largely unexplored. Dynamical conditions are characterized by large scale transport and mixing between air masses of higher and lower latitude origins. Understanding these exchanges is crucial since they have a large impact on the distribution of trace gases and aerosols at polar latitudes, and thus on the stratospheric ozone budget. Ozone change affects the radiative balance, the coupling between troposphere and stratosphere, and therefore the climate. In the framework of the International Polar Year, the STRAPOLETE project starts on January 2009. It is associated with a successful balloon borne campaign which took place close to Kiruna (Sweden) from 2 August 2009 to 10 September 2009 with eight balloon flights. During this campaign the main characteristics of the summertime arctic stratosphere have been captured. The data set obtained using UV-visible and infrared instruments, remote and in situ sensing embarked spectrometers provided detailed information on vertical distributions of more than fifteen chemical tracers and reactive species from the upper troposphere to the middle stratosphere. A number of in situ optical aerosol counters, a UV-visible remote spectrometer for the aerosol extinction and a photopolarimeter provided information on the nature and size distribution of the stratospheric aerosols. These balloon measurements with high precision and high vertical resolution are relevant to qualify the dynamical processes occurring in this region during summertime, the aerosols variability, the bromine abundance and establish a reference state of the polar summer stratosphere. The data set is completed by satellite data offering large spatial coverage of the region of interest. Data analysis is made using relevant dynamical (trajectory calculations, contour advection model) and chemistry-transport models (CTM) to highlight major mechanisms that control the distribution of tracers, aerosols and bromine.

An overview of the project, its scientific issues, the measurement campaign and some balloon measurements obtained is presented, as well as preliminary comparisons between measurements and models outputs.

PROJECT Description

(January 2009-December 2011)

Main Coordinator : N. Huret

- **WP I : Campaign,** Coordinator: V. Catoire, G. Berthet

Consistent coordination of the ensemble of balloon flights and satellite observations with respect to their advantages and their observation technique for the campaign. Instrumental developments for bromine and aerosol detections.

- **WP II: Dynamics,** Coordinators: N. Huret and F. Lefèvre

Characterization of the dynamical state of the summer polar stratosphere tracer-tracer correlations with particular emphasis on specific phenomena:"Frozen-In anticyclone", "polar vortex remnants", "W structure evolution", boreal forest fire plumes, using tracer measurements (N_2O, CH_4, CO, O_3, HCl).

1. Assessment of the Chemistry-Transport Models REPROBUS and MIMOSA-CHIM by comparing the simulated and observed vertical profiles of N_2O, CH_4, CO, O_3, HCl long-lived species.
2. Diagnostic and improvement of transport representation by tests on the horizontal resolution and on the diabatic descent scheme and use of different assimilated wind fields to constrain model calculations.

- **WP III: Summer stratospheric aerosol content**, Coordinators: J.-B. Renard, C. Brogniez

Determination of partitioning between liquid (sulphate droplets) and solid (soot and interplanetary dusts) particles.

1. Determination of surface area density of liquid sulphate droplets. Improvement of CTM calculations by using the new and realistic surface area densities as input data and quantification of the impact on the simulations of the nitrogen species concentrations.
2. Determination of the contribution of soots to the total aerosol content with respect to altitude. The latitudinal origin of soot and the possible role of boreal forest fires to the stratospheric soot content will be investigated.

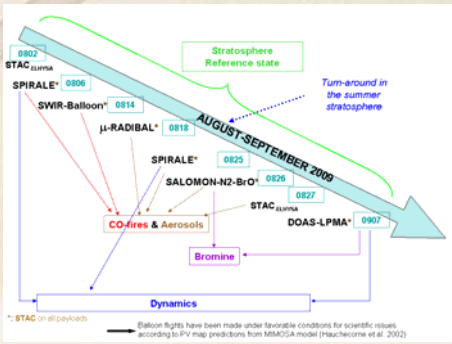
- **WP IV: Budget of inorganic bromine and trend,** coordinator: G. Berthet

Measurements of the BrO radical amounts in the stratosphere from two different instruments to determine of the stratospheric bromine trend taking into account age of air issues (WMO, 2006; Dorf et al., 2006).

- **WP V: Reference state of the Summer stratosphere,** Coordinator: S. Payan

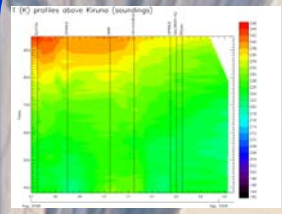
1. Comparison and compilation of vertical profiles from balloons, satellites and operational models of N_2O, CH_4, O_3, CO, NO_2, HNO_3, HCl, BrO, and aerosols at the end of summer in the Arctic stratosphere.
2. Production of new accurate reference vertical profile of N_2O, CH_4, O_3, CO, NO_2, HNO_3, HCl, BrO, and aerosols at the end of summer in the Arctic stratosphere to document the Arctic stratospheric state before the onset of winter stratospheric conditions.

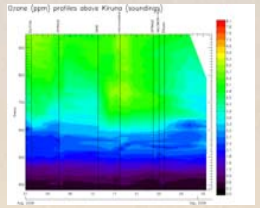
Balloon Campaign, Esrange (67° 53' N, 21° 05' E), 2rd August 2008- 7th September 2008



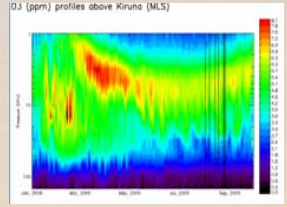
Instrument	Measurement technique	Measurements used	Retrieval altitudes provided & Vertical resolution
SPIRALE (*LPC2E*)	*In situ* Direct Infra-red absorption	O_3, CH_4, N_2O, HCl, CO, HNO_3, NO_2, OCS	10km-35km 5m
SWIR-Balloon (*LPMAA*)	*Remote sensing* Infra-red, nadir	CO, CH_4, CO_2, OCS	Partial columns
LPMA (*LPMAA*)	*Remote sensing* Infra-red solar Occultation	O_3, HNO_3, NO, NO_2, CH_4, N_2O, HCl	15km-35 km 1km
DOAS (*Univ Heildelberg*)	*Remote sensing* UV/Vis Solar occultation	BrO, NO_2, O_3	15km-35km 1km
SALOMON-N2 (*LPC$_2$E*)	*Remote sensing* UV-visible solar pointing	O_3, NO_2, BrO, aerosol extinction	7km-35km 1 km
STAC (*LPC$_2$E*)	*In situ* aerosol counter	Size distribution of aerosols	10km-35 km 10m
MicroRADIBAL (*LOA*)	*Remote sensing* Scattering and polarization by photopolarimetry	Nature (liquid, solid), size distribution of aerosols	15km-35 km 1km

Temperature and ozone VMR from radiosoundings above Esrange during the campaign

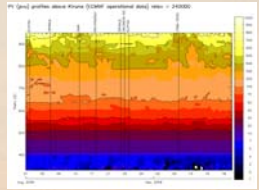




Ozone VMR from MLS satellite instrument above Esrange from January 2009



Time evolution of potential vorticity above Kiruna



MODELS involved

MODEL	Type	Scale	Characteristics	Outputs
FLEXPART	Trajectories calculations	Global & synoptic	ECMWF fields	Air mass origin
REPROBUS Lefèvre et al., 1998	Tridimensional chemical transport	Global	Comprehensive chemistry	Chemical species maps and vertical profiles
MIMOSA Hauchecorne et al., 2002	Tridimensional dynamics	Global & synoptic	High resolution PV advection	Potential vorticity maps
MIMOSA_CHIM Tripathi et al., 2006	Tridimensional chemical transport	Global & synoptic	Advection on isentropic surfaces + Comprehensive Chemistry	Tracers (N_2O, CH_4) maps and vertical profiles

Satellite Measurements to be used

Instrument	Measurements used	Retrieval altitudes provided & Vertical resolution
MLS (Aura satellite)	N_2O, H_2O, HCl,CO, O_3,	18km-40km 2-3km
MIPAS (ENVISAT satellite)	O_3, N_2O, CH_4,CO , NO_2, HNO_3, N_2O_5	18km-40km 3km
IASI (MetOp satellite)	O_3, CO, CH_4, N_2O, O_3	Column and partial column

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Related posters :

Thieblement *et al.* : EGU2010-10435 (XY132)

Catoire *et al.* EGU2010-13509 (XY109)

ANR 2008 : BLAN08-1_316271
IPEV : 2008
IPY : Expression of Intent #1252 du Project Cluster Oracle-O3 (#99)
CNES :2009-20012
ETHER Database