COLD: a mid-infrared quantum cascade laser spectrometer for in-situ airborne measurement of stratospheric trace gases

Francesco D'Amato (1), Silvia Viciani (1), Alessio Montori (1), Antonio Chiarugi (2), Federico Fierli (3), Francesco Cairo (3), Silvia Bucci (4), Bernard Legras (4), Fabrizio Ravegnani (5), and Alexey Ulanovsky (6)

(1) CNR-INO, Firenze, Italy (francesco.damato@ino.it), (2) INGV, Pisa, Italy, (3) CNR-ISAC, Roma, Italy, (4) Laboratoire de Météorologie Dynamique, ENS, Paris, France, (5) CNR-ISAC, Bologna, Italy, (6) CAO, Dolgoprudny, Moskow Region, Russia

The instrument COLD (Carbon Oxide Laser Detector) is a mid-infrared Quantum Cascade Laser spectrometer developed for in-situ measurements of carbon monoxide (CO) in the upper troposphere and lower stratosphere (UTLS). The analyzer is designed, and fully qualified, for operation on board of the stratospheric aircraft Miyashichev M55 Geophysica, able to reach an altitude up to 21-22 km. The instrument is based on direct absorption in combination with multipass cell and it provides absolute mixing ratio values without any kind of calibration. The analyzer features small size, light weight and low power consumption, without being pressurized.

COLD was installed in the dome of the M55 aircraft and it was successfully employed in the frame of the StratoClim campaign (Stratospheric and upper tropospheric processes for better climate predictions) during 8 scientific flights over Nepal, India and Bangladesh in July-August 2017, during the Asian summer monsoon season. COLD provided CO mixing ratios and for some flights also nitrous oxide (N_2O) mixing ratios, achieving an in-flight sensitivity of 1-2 ppb for CO and 10 ppb for N_2O, with a time resolution of 1 s.

The results collected during the campaign will be shown to demonstrate the COLD in-flight performances. In particular CO vertical profiles will be presented with emphasis on enhanced CO layers, that are often observed in UT, with respect to a CO mean vertical profile. The CO positive anomalies are analyzed jointly with aerosol / cloud observations (from MAS, Multiwavelength Aerosol Scatterometer) and convective tracers from lagrangian models to identify convective influence and source region of potential pollutants in the UT. Moreover we perform a comparison with CO from Microwave Limb Sounder (MLS) for the whole campaign and a correlation with other species (i.e. Ozone from FOZAN, Fast OZone ANalyser).