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Low Cost Upper Atmosphere Sounder (LOCUS)

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The Mesosphere - Lower Thermosphere region (MLT) is often quoted as being the least well known region of the atmosphere, meaning that measurements of this altitude range are sparser than for the neighbouring layers. The reason for this apparent lack of observations can be traced back to a combination of two facts - A) the MLT is ill suited for in-situ sampling on a global scale because the residual air drag is prohibitive for suborbital vehicles (rockets are traditionally used to sample the MLT region, but they only provide snapshot measurements both geographically, as well as temporally), and B) Some of the most important trace gases in the MLT have spectral emission lines in the THz range, a frequency band which has only just become accessible to conventional remote sensing technologies (i.e. passive heterodyne detection) thanks to ongoing technology development, but which still poses massive - often prohibitive - demands on the complexity, weight and power consumption of satellite borne remote sensing detectors.

To mitigate the substantial power requirements of a Local Oscillator (LO) able to pump a heterodyne receiver at THZ frequencies, we are suggesting the use of Quantum Cascade Laser diodes (QCL). Combining a QCL LO with a sub-harmonic Schottky mixer in an integrated receiver system would allow us to build a THz passive heterodyne detector for atmospheric remote sensing that is both very compact and power efficient, and could therefore be built and launched much more cheaply than competitive systems.

Many of the technologies required for such an instrument already exist at technology readiness levels (TRL) of 3-5. A consortium of RAL Space, University College London (UCL), University of Leeds, Surrey Satellite Technology Ltd (SSTL) and STAR-Dundee have been awarded a grant through the ESA In Orbit Demonstration Programme (IOD) to start developing an integrated, sub-harmonic heterodyne receiver with a QCL LO up to a TRL that would allow IOD hopefully in the near future. We describe the current instrument configuration of LOCUS, and give a first preview of the expected science return such a mission would yield.

The LOCUS instrument concept calls for four spectral bands, a first band at 4.7 THz to target atomic oxygen (O), a second band at 3.5 THz to target hydroxyl (OH), a third band at 1.1 THz to cover several diatomic species (NO, CO, O_3, H_2O) and finally a fourth band at 0.8 THz to retrieve pointing information from molecular oxygen (O_2). LOCUS would be the first satellite instrument to measure atomic oxygen on a global scale with a precision that will allow the retrieval of the global O distribution. It would also be the first time that annual and diurnal changes in O are measured. This will be a significant step forward in understanding the chemistry and dynamics of the MLT. Current indications (derived from CRISTA measurement) lead us to believe that current models only give a poor representation of upper atmospheric O.

The secondary target species can help us to address additional scientific questions related to both Climate (distribution of climate relevant gases, highly geared cooling of the MLT in response to Climate change, increased occurrence of Polar Mesospheric Clouds (PMC), etc) and Space Weather (precipitation of electrically charged particles and impact on NO_x chemistry, fluctuations of solar Lyman-alpha flux through shown in the the distribution of photochemically active species, etc).