The PHOCUS project – particle interactions in the polar summer mesosphere

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PHOCUS – Particles, Hydrogen and Oxygen Chemistry in the Upper Summer mesosphere.
With PHOCUS we intend to study mesospheric particles (ice and smoke) and their interaction with their neutral and charged environment.

A Comprehensive sounding rocket campaign from Esrange in July 2011.
The rocket payload will contain 17 instruments from 7 scientific groups in Sweden, Norway, Germany, Austria and the USA

Smoke ↔ O_x/HO_x
Heterogeneous chemistry? Recombination of H_2 and O on smoke particles has been suggested to explain observations of mesospheric HO_x chemistry and unexpectedly high water concentrations [Summers and Siskind, 1999]. The odd hydrogen/odd oxygen chemistry in the middle atmosphere is not well understood and might not be explainable with conventional gas-phase chemistry alone, the “HO_x dilemma” [Conway et al., 2000].

Post-flight analysis
Lab (MISU, Leeds)

Model (MISU, IAP, LASP)

TEM (SU, NRL)

Ground-based monitoring

NLC (Lidar)

PMSE (Esrad, EISCAT)

T, ρ, ions and e
A comprehensive characterisation of particle processes in the mesosphere is not possible without a simultaneous analysis of the state of the background atmosphere.

Chemistry (fluorescence, airglow)

Smoke (MAGIC)

Water (183 & 557 GHz)

Ice (Photometry)

T, ρ, ions and e

Smoke particles in cm^{-3}

Water vapour
A sufficient supply of water vapour is a basic pre-condition for the formation of ice particles. Also, being the main source of HO_x species, water vapour together with atomic oxygen controls the chemical environment in the mesopause region. Large effects of NLC on the (re-) distribution of water vapour have been reported [Summers et al, 2001] and modelled [e.g. von Zahn and Berger 2002]. For the very first time, water vapour will be measured in situ during daytime conditions.

Ice ↔ O_x/HO_x
Bite-outs? Altered HO_x chemistry? NLC particles are thought to influence atomic oxygen indirectly by affecting the distribution of water vapour and, thus, gas-phase HO_x chemistry [Murray and Plane, 2005]. Measurements will be performed during midday to avoid a strong gradient in the Lyman-α radiation at NLC altitudes.

References
- Summers et al, 2001
- von Zahn and Berger 2002
- Murray and Plane, 2005

Smoke ↔ Ice
The direct connection between Noctilucent clouds (NLC) and their potential condensation nuclei has never been investigated experimentally. Meteori smoke particles have been suggested as dominant condensation nuclei for ice particles [e.g. Rapp and Thomas, 2006]. How does ions and charged particles influence ice nucleation? What are the typical number densities and particle sizes of various aerosol types in the summer mesosphere? What is the shape of the ice particles?