

NSRC February 20, 2010



Studying the Mesosphere by Adapting Sounding Rocket Instruments to Suborbital Spacecraft

S. Knappmiller¹, J. Gumbel², M. Horányi¹, S. Robertson¹, and Z. Sternovsky¹

¹Laboratory for Atmospheric and Space Physics (LASP) University of Colorado, Boulder ²Institute of Meteorology, Stockholm University, Sweden

Outline

- Motivation: Why Study the Mesosphere?
- What don't we understand?
- Using existing rocket instruments on Suborbital spacecraft to further our understanding.
- Summary



NLC & PMSE



NLC = Noctilucent Clouds "Night Shining Clouds"



Polar Mesospheric Clouds NLC = PMC



Polar Mesospheric Summer Echoes (PMSE)



Why Study?

- Basic science: how/why do they form?
- How often NLC forms possible related to global climate change.



NLC & PMSE Formation







A Few Scientific Questions:



- 1. What are the condensation nuclei if any for NLC formation?
 - Suggested answers: meteoric dust, water cluster ions, sulfate aerosols, and homogeneous nucleation.
- 2. How do NLC particles and meteoric dust charge?
 - Most in-situ instruments detect the charge on these aerosols, do we know what we are detecting?
- 3. How is NLC formation effected by atmospheric gravity waves/ turbulence? What causes spatial variation in NLC?



Condensation Nuclei: Meteoric Dust



Model Predictions:







Measuring Seasonal Variation in Condensation Nuclei

Instruments:

Mesospheric Aerosol Sampling Spectrometer



Measures number density of charged aerosols in four different size ranges (<0.5, 0.5-1, 1-2, and >3 nm) for both polarities

Magic Instrument



Collects and stores aerosol particles to determine their mass composition, which is done in the laboratory.

Requirements:

Pointing in ram direction with velocity near 1 km/s between 80-90 km.

 Suborbital spacecrafts allow for multiple flights throughout the year and at different locations.



Particle Charging





Need to measure:

- Electron density (1)
- Ion density (2)
- UV radiation (3)
- Aerosol charge number density (4)

Make measurement:

• At multiple solar zenith angles, varying the amount of UV.

Langmuir Probe (1)



Positive Ion Probe (2)

UV Spectrometer (3) Mesospheric Aerosol Sampling Spectrometer (4)



8





Spatial Variation in NLC

NLC with wave structures caused by gravity waves / turbulence



NLC have large spatial variation.

Rockets only sample two locations.

Suborbital Spacecraft can fly horizontally through an NLC covering a large area.

Need to measure:

- Neutral air density
- Temperature



COmbined Instrument for Neutrals and Electrons (CONE). Similar to an ionization gauge.



Conclusions



- Studying NLCs helps our understanding of the Sun-Earth connection and possibly Global Climate Change.
- Modifying existing rocket instruments for suborbital spacecraft can help answer many scientific questions regarding NLCs including:
 - Possible NLC condensation nuclei.
 - Charging properties of NLC particles and meteoric dust particles.
 - Spatial variation of NLC.

