1. Introduction

Airborne Remote Sensing of Arctic Clouds and Sea Ice
• high impact of clouds and sea ice on Arctic energy budget
• high contrast between sea ice and open water
• interaction of clouds and sea ice in radiative transfer

HDRF calculated with reflected radiance directional reflectivity may help to improve retrievals

SOPRICO (Study on Solar Radiation and Phase Discrimination of Arctic Clouds)
  • airborne remote sensing and in situ measurements with Polar 5 (AWI) in May 2010[1]
  • operations from Spitsbergen with measurement area above Greenland sea
  • remote sensing: SMART-Albedometer, AISA-Eagle, Canon camera, AMAI, AMSPI[1]
  • CMOS sensor with 28.1×18.7 mm sensor area
  • angle of view of 30°
  • exposure time 1/2656 s
  • raw data with 16 bit dynamic range
  • geometric correction of raw data and spectral calibration
  • angular resolution of each pixel is about 0.025°

Radiative transfer model: DISORT 2 using libRadtran

Clouds
• Clouds at 530 nm wavelength
• variation of cloud droplet effective radius Reff between 4 μm and 10 μm: Reff = 9 μm measured by in situ instruments
• results: cloud bow more pronounced for large droplets, (a) and (b): for Reff = 10 μm, (c) and (d): Simulated HDRF are shown in panel (a) and (b) for Reff = 1 μm, (c) and (d): Color-coded differences between measured and simulated HDRF

2. CANON EOS-1D Mark III

Camera Specifications
• digital single-lens reflex camera
• CMOS sensor with 28.1×18.7 mm sensor area
• angle of view of 30°
• exposure time 1/2656 s
• raw data with 16 bit dynamic range
• geometric correction of raw data and spectral calibration
• angular resolution of each pixel is about 0.025°

Variation of surface wind speed
• variation of surface wind speed
• 11 images of 14 May, 10:22 UTC
• high contrast between sea ice and open water
• high impact of clouds and sea ice on Arctic energy budget
• interaction of clouds and sea ice in radiative transfer

3. Hemispherical-Directional Reflectance Factor HDRF

• HDRF calculated with reflected radiance λ from the camera and Fλ
• sequence of images were averaged
• depending on the heterogeneity of the surface less than 20 images are required

Open Water
• 46 images of 14 May, 8:25 UTC
• high contrast between sea ice and open water
• interaction of clouds and sea ice in radiative transfer

6. Outlook

Improvements
• systematic retrieval of particle size
• circular flight patterns or spiral patterns to extend field of view
• polarization camera for linear and circular polarization

VERO (Study on the Vertical Distribution of Ice in Arctic Clouds)
• April/May 2012, Inukshuk, Canada
• 13 flights above Beaufort sea (similar instrumentation to SOPRICO)
• improved flight pattern, use of AISA-Eagle cameras

References: