A MICROWAVE RADIANCE ASSIMILATION STUDY FOR A TUNDRA SNOWPACK

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1. INTRODUCTION

Recent studies have begun exploring the assimilation of microwave radiances for the modeling and retrieval of snow properties [1—6]. At a point scale, and for short durations (1 week), radiance assimilation (RA) results are encouraging [5, 6]. However, in order to determine how practical RA might be for snow retrievals when applied over longer durations, larger spatial scales, and/or different snow types, we must expand the scope of the tests. In this paper we use coincident microwave radiance measurements and station data from a tundra site on the North Slope of Alaska. The field data are from the 3rd Radiobrightness Energy Balance Experiment (REBEX-3) carried out in 1994-95 by the University of Michigan [7, 8]. This dataset will provide a test of RA over months instead of one week, and for a very different type of snow than previous snow RA studies. We will address the following questions: How well can a snowpack physical model (SM), forced with local weather, match measured conditions for a tundra snowpack?; How well can a microwave emission model, driven by the snowpack model, match measured microwave brightnesses for a tundra snowpack?; How well does RA increase or decrease the fidelity of estimates of snow depth and temperatures for a tundra snowpack?

2. METHODS AND MATERIALS

2.1. REBEX-3 dataset

Three types of automatically-recorded observations from REBEX-3 will be used in this study.

2.1.1. Microwave radiance observations

For this study, we will use radiance observations from dual-polarized microwave radiometers at 19 and 37 GHz deployed on a 10-m tower at the REBEX-3 site (Fig. 1). Specifically, we will use radiances from two study periods: mid-September to late-October, 1994 (accumulation) and mid-January to late-April, 1995 (depletion).

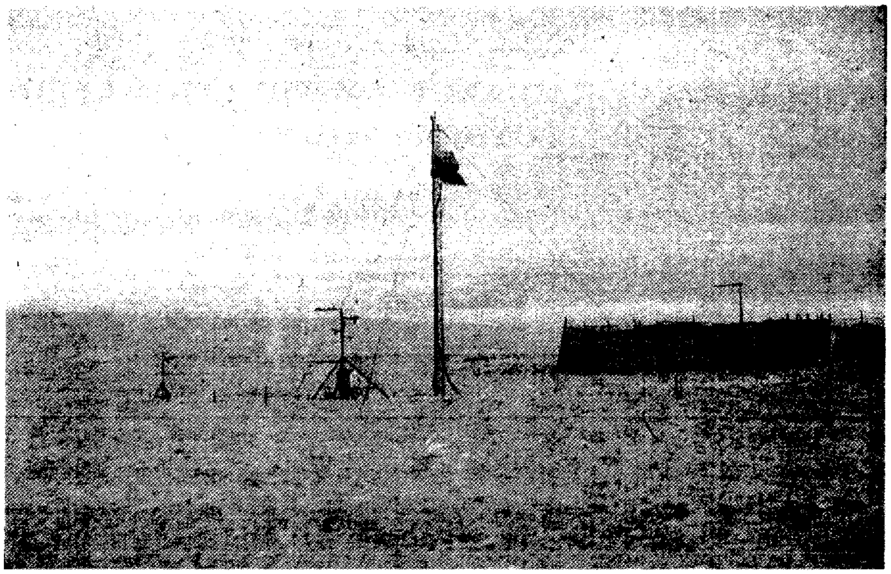

Figure 1. REBEX-3 tundra site photo in January. Microwave radiometers are at the top of the tall 10-meter tower. Meteorological instruments are to the left of the 10-m tower.

2.1.2. Meteorological forcing observations

Standard surface variables such as air temperature, relative humidity, wind speed, and downwelling shortwave radiation were recorded throughout REBEX-3. For certain periods, more comprehensive variables are also available, including soil temperature profile, soil heat flux, net radiation, and thermal IR skin temperature.

2.1.3. Snow ground truth measurements

Snow temperature profile and depth are available for the two study periods. Measurements from a single snowpit are also available at the end of March, 1995.

2.2. Snowpack model

A multilayer snow model will be selected based on ability to reproduce known unique features of tundra snow, including dense wind slab overlying well-developed depth hoar with very large grains (1cm is common). These characteristics reflect the extreme weather conditions in such areas: low total snow depth and cold air temperatures leading to strong metamorphism, sustained high winds promoting significant ablation, and .low solar insolation.

2.3. Microwave emission model

The (MEMLS) will be driven with the output of the snowpack model to generate predicted radiances at 19 and 37 GHz [9].

2.4. Assimilation scheme

An ensemble Kalman filter assimilation scheme will be employed as in [5, 6].

3. EXPECTED RESULTS

The study will test snow modeling for a tundra snowpack—a very different type of snowpack—as well as forward emission modeling for this type of snowpack, over periods of weeks to months during both accumulation and depletion periods. In addition, the performance of RA will be quantified for this different tundra snow, and over much longer time periods than some of the existing snow RA studies. When combined with those existing studies, the result will be an assessment of snow RA strengths and weaknesses under a wider range of conditions, leading to a more realistic understanding of how it might eventually perform in connection with year-round regional or global assimilation systems.

11. REFERENCES

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