Time Series of Young Sea Ice Signatures for Forward and Inverse Models

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Abstract

Ti me series of young sea ice signatures is a series of microwave signatures, S11("1) as backscatter or emissivity, me asured at successive stages of" the early sea ice growth phase or during the course of a physical p rocess in youn g ice. These measurements together with the corresponding da ta for sea ice physical chara cteri zations establish a consist ent dat a set for sea ice forward and inverse mo del de velopment and verification. 11) such a data set, the microwave signatures and the physical pa ameters are interrelated. Fur thermore, the observations at each of the successive stages are not independent but the tr ends of the obser vables over these stages are governed by the undergoing sea ice physical process. The interrelations a m ong the mea sured paran eters at a given stage and the physical transitions from one stage 1(I another stage in the time series allow for a more definitive investigation of the dominant scattering mechani sm and provide physical insights to electromagnetic wa ve interactions in the ice sheet. For forward scatterin g, the scaice 1110(1 ('1 111)(1('1' consideration has to predict the observed signatures 111) (1('1' constraint Of the measured physical parameters not only at a given stage but also at all stages of the time series. For inverse scattering, the interrelations restrict the solut ion space and force t h e inversgoi it hm to converge to the physical solutio). The idea behind this approach is {() create an overdetermining dataset by making 11101'(" measurements without introducing 11101'(" unknows at the different stages. This is achieved by utilizing the physical interrela tionship among sea ice parameters in the physical process. We have carried out various active and passive t ime-series measurements in the laboratory and in the Arctic field environments for young ice. The observations include simple conditions such as quiescent constant saline ice growth to mu ch 11101'(" complicated cases of thermal cycling, frost flowers, snow cover, pancake ice, and large brine channel formation. These cases are 11 sed to identify corresponding dominant scattering mechanism s for forward modeling and to develop physi cally convergent algorith ms for sea ice parameter inversion with time-series dat a. Even with sparse temporal resol - tions, tin ie-series data are ill so obtainable from satellite sensors with ancillary synoptic environmental paran eters, which help to test the 11)() (1('1S for practical applications.