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Temperature and Pressure Dependence of the Rain-Snow Phase Transition over Land and Ocean

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The phase of precipitation is important for land hydrology and remote sensing. To quantify the temperature and pressure dependence of snow (including freezing rain) frequency (F, in %) when precipitation occurs, we have analyzed 3-hourly weather reports of surface air temperature (*Ts*, ^{o}C) and pressure (*Ps*), and snow and rain occurrences from over 15,000 stations and many ship observations from 1977-2007. The *F-Ts* relationship is found to be represented well by a hyperbolic tangent: *F(Ts)* = a[tanh (b(*Ts* – *c*))$-$ $-$ d], with the slope parameter b close to 0.75 over land and 0.45 over ocean. The pressure-dependence is only secondary and reflected in the parameters. The results show that snow occurs often (F >50%) for *Ts*≤1.3^{o}C over land and *Ts*≤2.3^{o}C over ocean, and are non-negligible (F >5%) for *Ts*≤3.75^{o}C over land and *Ts*≤5.75^{o}C over ocean. This warm "bias" results from the falling of snowflakes into warmer surface layers, which is especially true over ocean during cold season. Since snow flakes fall faster in thinner air, the warm bias is higher when air pressure is below ∼700mb. The results can be modified for use in numerical modeling and remote sensing.