A unified model of failure initiation for whumpfs and slab avalanches

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We base upon recent experimental results that have shown that primary fracture in snow is not necessarily in pure shear as assumed in earlier theories of avalanche initiation, nor necessarily dilatant. We present a new model of weak layer failure which for the first time takes into account both slope-parallel shear and slope-normal displacements (in the form of settling or collapse of the weak layer) during fracture nucleation. This model generalizes existing theories. However it predicts substantially decreased energy barrier and critical crack length for fracture nucleation. Unlike previous theories, the model is consistent with a critical crack length that may increase with increasing slope angle, as recently observed by Gauthier and Jamieson. We also address related issues such as crack formation under local loading (e.g. skier loading) and apply the present model to a recently introduced type of field tests.