Continuum Model of Faceted Ice Crystal Growth in Cirrus Clouds in 1 Dimension

Ella Slattery

Follow this and additional works at: https://soundideas.pugetsound.edu/summer_research

Part of the Dynamic Systems Commons, Non-linear Dynamics Commons, and the Partial Differential Equations Commons

Recommended Citation
https://soundideas.pugetsound.edu/summer_research/464

This Article is brought to you for free and open access by Sound Ideas. It has been accepted for inclusion in Summer Research by an authorized administrator of Sound Ideas. For more information, please contact soundideas@pugetsound.edu.
Equations (1) and (2) suggest that one variable models of this system can be developed if we consider the relationship between the quasi-liquid water layer and total thicknesses:

\[ N_{\text{qll}}(N_{\text{tot}}) = \tilde{N} - N^* \sin(2\pi N_{\text{tot}}) \]

One variable models were developed and are described by Equations (3) and (4).

Equation (4) cannot accurately simulate any stable growth until the location of sign changes in the square root term are determined.

Figure 2. The number of steps achieved over time for the two variable model (left), Equations (1) and (2), and the one variable model (right), Equation (3).

Figure 3. The quasi-liquid and ice layers of each model in Figure 2 respectively at the final timestep: the total thickness of the layers (blue) and the thickness of the quasi-liquid water layer (black).

Results

The two variable system tends towards stable limit cycles over the one variable system.

The two and one variable models still exhibit numerical instabilities.

Future Directions

Develop a theoretical explanation for why the models are not identical.

Establish a condition to determine the location of sign changes in Equation (4). Investigate the periodicity of related functions.

Continue work on the transform in order to stabilize the model and run longer simulations. Determine whether a Fourier transform is appropriate for higher dimensional models.

Apply the model to 2 dimensions and begin to describe roughening of the ice crystals along the prismatic facet.

Acknowledgements

I would like to thank the Clare Boothe Luce grant for funding my research.