Advances in Filtering for Boundary Layers

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Abstract. Utilizing filtering to extract extra information from data allows for interaction between disparate scales while minimising error and decreasing noise in data. While the ability to move data from fine resolutions to coarser resolutions is straight forward, moving data from a coarse resolution to a finer resolution while reducing errors is more challenging. This relies on utilizing ideas from multi-resolution analysis combined with symmetric convolutional filters [Ryan, CAMC 2022; Picklo & Ryan, SISC 2022]. This approach has the further advantage of requiring fewer computations to gain insight into calculations such as for Bohm speed [Picklo et al., arXiv:2308.12807, 2023]. Advances in non-symmetric filtering, especially for boundary layers, have become increasingly necessary in order to understand the detailed physics in applications such as hypersonics. In this talk, we review the necessary properties for effective filters and the difficulties in constructing useful non-symmetric filters, especially for boundary layers. As basis for discussion, we utilize the Smoothness-Increasing Accuracy-Conserving (SIAC) filtering framework, which inherently takes advantage of the underlying physics and allows for the full resolution of the approximation and its derivatives in both the physical domain and Fourier signal space. We discuss recent advances in non-symmetric filtering and reliance of the approach on the underlying numerical method that generated the data.