Challenges in convection permitting modelling

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Convection permitting models with gridlengths of order a km have been in operational use for weather forecasting for around 15 years and have also been used for downscaling regional climate models to give more information about how convection etc might change in the future. Despite these models providing benefits for the representation of convection over the previous generation of order 10km models it has been long realised that there are some serious issues. For example, convective cells being too large with too heavy rain and not enough light rain, too many along wind structures in the precipitation field and a lack of realistic convective organisation/upscaling. It is thought that many of these issues relate to convection usually being very under-resolved at km scales (certainly in the early stages of its development) which points to the solution being a scale-aware convection scheme. The current interest in 100m scale ("Urban-scale") models is helpful to aid understanding of these issues. When going to higher resolution, some aspects of convection are improved such as the heavy rain/light rain balance and more realistic storm structures when they become organised. There is, however, a tendency for small cells to become smaller as the gridlength is reduced, that shows the size is controlled by the gridlength at km scales. They also become more likely to precipitate erroneously (adding to the argument that small, under resolved cells, should be parameterised). The tendency for structures in convection to be unrealistically organised along the wind is also still evident in sub-km models. The above aspects will be briefly discussed along with current progress and challenges going forward.