A robust observation operator and associated background covariances to assimilate rain microwave radiance into cloud-permitting models

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- Express radiances ($T_b(1), \ldots, T_b(9)$) over each pixel as a function $OO(x_1, \ldots, x_{504})$ of the underlying geophysical variables in that pixel, using forward simulations + clever ways to condense the info (and $OO$ is infinitely differentiable, and independent of microphysics)

- Test: start with a blank-slate background + 9 radiances per pixel (11GHz-V, 11GHz-H, 19V, 19H, 23V, 37V, 37H, 85V, 85H), forward-calculated from a simulation, of a hurricane; Then 1Dvar-assimilate these radiances into the “background” using $OO$. Result:

**Hurricane Earl, 1 September 2010 – vertically integrated variables**

![Temperature (C)](image1)

![Vertical Wind (m/s)](image2)

![Relative Humidity (%)](image3)

![Ice (g/Kg)](image4)

![Rain (g/Kg)](image5)