1. Red-Green-Blue (RGB) Composites
   - Combine information from several channels into one composite image to address a specific forecast problem
   - Aids in quick, real-time assessment of atmospheric processes
   - Products from Aqua and Terra MODIS and VIIRS on Suomi NPP are proxies for future GOES-R RGB products

2. Challenges with RGB Composites Derived from Polar Orbiters
   A) Limb Effect (Limb Cooling)
      - Interferes with qualitative interpretation of RGB composites at large scan angles
      - Occurs as satellite scans from nadir to limb, increasing the optical path length of the absorbing atmosphere
      - Causes anomalous cooling of 5-10 K on the limb in water vapor and ozone channels
      - Uncorrected RGB composites from polar orbiting instruments, such as MODIS and VIIRS, cannot be reliably interpreted close to nadir

   B) Calibration Differences (Sensor Bias)
      - RGB products from multiple satellite sensors are often used jointly to provide a more temporally continuous product and better track atmospheric features over time
      - MODIS and VIIRS do not have the exact same channels as SEVIRI or GOES-R ABI, and there are additional sensor differences between Terra and Aqua MODIS
      - Calibration differences between sensors:
        - Limit the use of proxy products
        - Make comparison of similar products from multiple sensors difficult

3. Limb Correction
   - Using a globally distributed subset of ECMWF model profiles, brightness temperatures were simulated for varying scan angles (0°-60°) for each profile.
   - The best fit slope between the change in brightness temperature from nadir to the limb and the natural log of the cosine of the satellite scan angle (θ) is defined as the limb correction coefficient (Cθ).
   - A quadratic fit was applied to the distribution of Cθ versus latitude to obtain a representative correction coefficient for each latitude, Cθ(latitude).
   - Cθ was applied to calculate the limb-corrected brightness temperature (Tcorr) from the uncorrected brightness temperature (Traw) given the scan angle:
     \[ T_{corr} = T_{raw} - C_{θ} \ln(\cos θ) \]

4. Bias Correction
   - Nadir brightness temperatures for MODIS were adjusted to match the nadir brightness temperatures of SEVIRI
   - Limb effect is not a factor at nadir, so any differences in measured brightness temperature between the sensors can be attributed to sensor bias

5. Results
   - Removal of anomalous cooling near swath edges (Air Mass)
   - Very similar appearance of MODIS RGB products between Terra and Aqua after bias correction (Dust, 24 Hour Micro.)
   - Corrections had very little impact on Night Microphysics RGB

6. Advantages of Limb/Bias Corrected RGBs
   - More accurate representation of atmosphere and surface
   - Ability to utilize the full satellite image, rather than just part of the image close to nadir
   - Seamless transition between adjacent or overlaid RGB composite images
   - Availability of high quality proxy products for GOES-R era
     - Increased confidence in interpretation of RGB features
     - Improved forecaster situational awareness
     - No longer limited to using just two overpasses per day from a single instrument, but have ability to jointly use the same RGB product from several sensors

7. Future Work
   - Extend the limb and bias correction methodology to MODIS and VIIRS infrared channels for additional RGBs
   - Investigate limb effect for geostationary satellite channels, such as Meteosat-10 SEVIRI, GOES-R ABI, and Himawari AHI.

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M15 - M14 was applied to calculate the limb
imb effect is

M16 - M15

Cθ was applied to calculate the limb-corrected brightness temperature (Tcorr) from the uncorrected brightness temperature (Traw) given the scan angle:

Tcorr = Traw - Cθ ln(cos θ)

32nd - 31st

Tcorr = Traw - Cθ ln(cos θ)

Tcorr = Traw - Cθ ln(cos θ)

Tcorr = Traw - Cθ ln(cos θ)

R era

R ABI, and Himawari AHI.

Air Mass

Dust

Night Microphysics

24 Hour Microphysics

4. 2012 October 27 Aqua (0755 UTC) and Terra (0950 UTC) MODIS Air Mass RGB composites (original and corrected) showing a developing Hurricane Sandy with a dry air intrusion.

5. 2014 March 18 Aqua (0945 UTC) and Terra (1010 UTC) MODIS Dust RGB composites (original and corrected) indicating airborne dust over the Texas panhandle.

6. 2014 October 06 Aqua (0710 UTC) and Terra (0805 UTC) MODIS Night Microphysics RGB composites (original and corrected) indicating the presence of fog and low clouds over Texas (light blue) and central North Dakota (light green). Limited to night only usage.