MODIS Observed Droplet Effective Radius in Developing Cumulus Clouds over North Dakota in Summer 2012

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Motivation

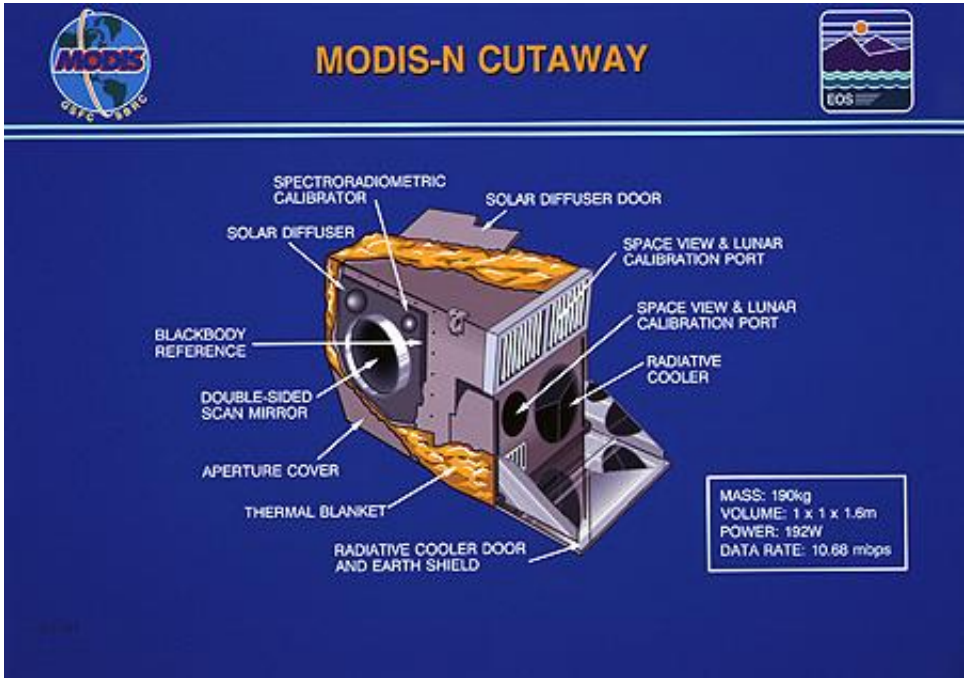
- The relationship between aerosols and cloud microphysical properties is critical to Climate and Forecast models.
- The effect of aerosols on cloud properties changes with region.

Objective

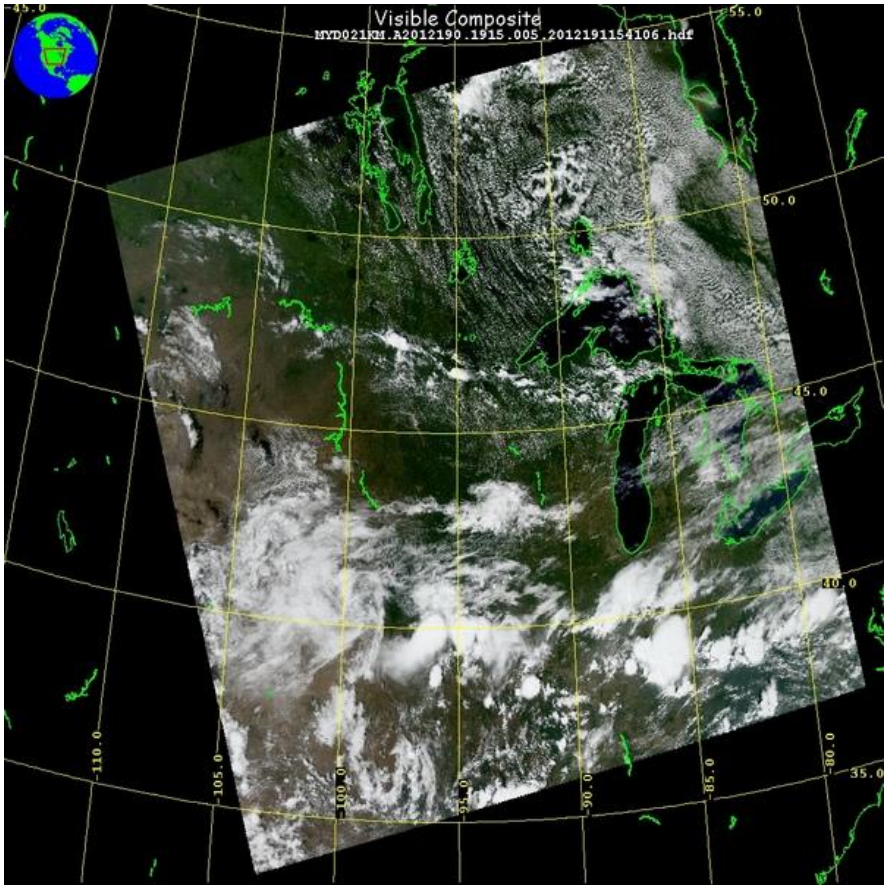
- Retrieve and subset cloud Effective Radius from the MODIS satellite.
- Determine the relationship between Cloud Effective Radius and cloud condensation nuclei measured at cloud base and at the surface.

MODIS

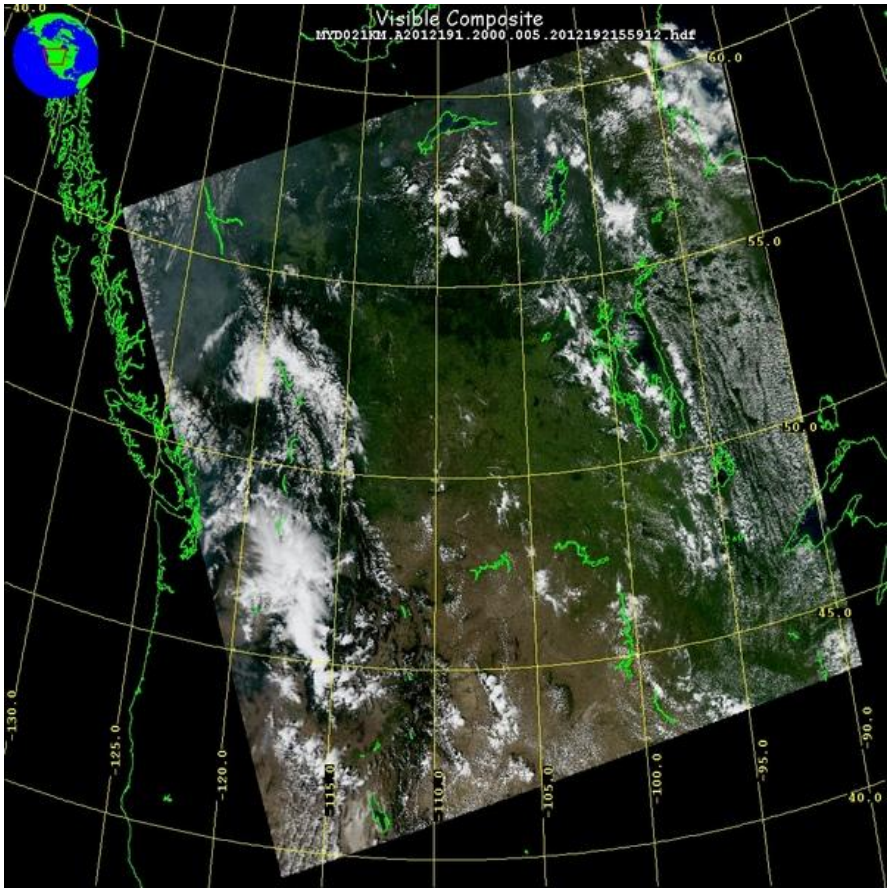
- MODIS is an instrument onboard both the Aqua and Terra polar orbiting satellites.
- Effective radius values are available at 1 km resolution.



MODIS Visible Images



July 8, 2012



July 9, 2012

Photo courtesy of NASA

Effective Radius

- The effective radius is a weighted mean radius of all the droplets in a cloud region.

$$r_e = \frac{\int_0^\infty r^3 n(r)\,dr}{\int_0^\infty r^2 n(r)\,dr}$$

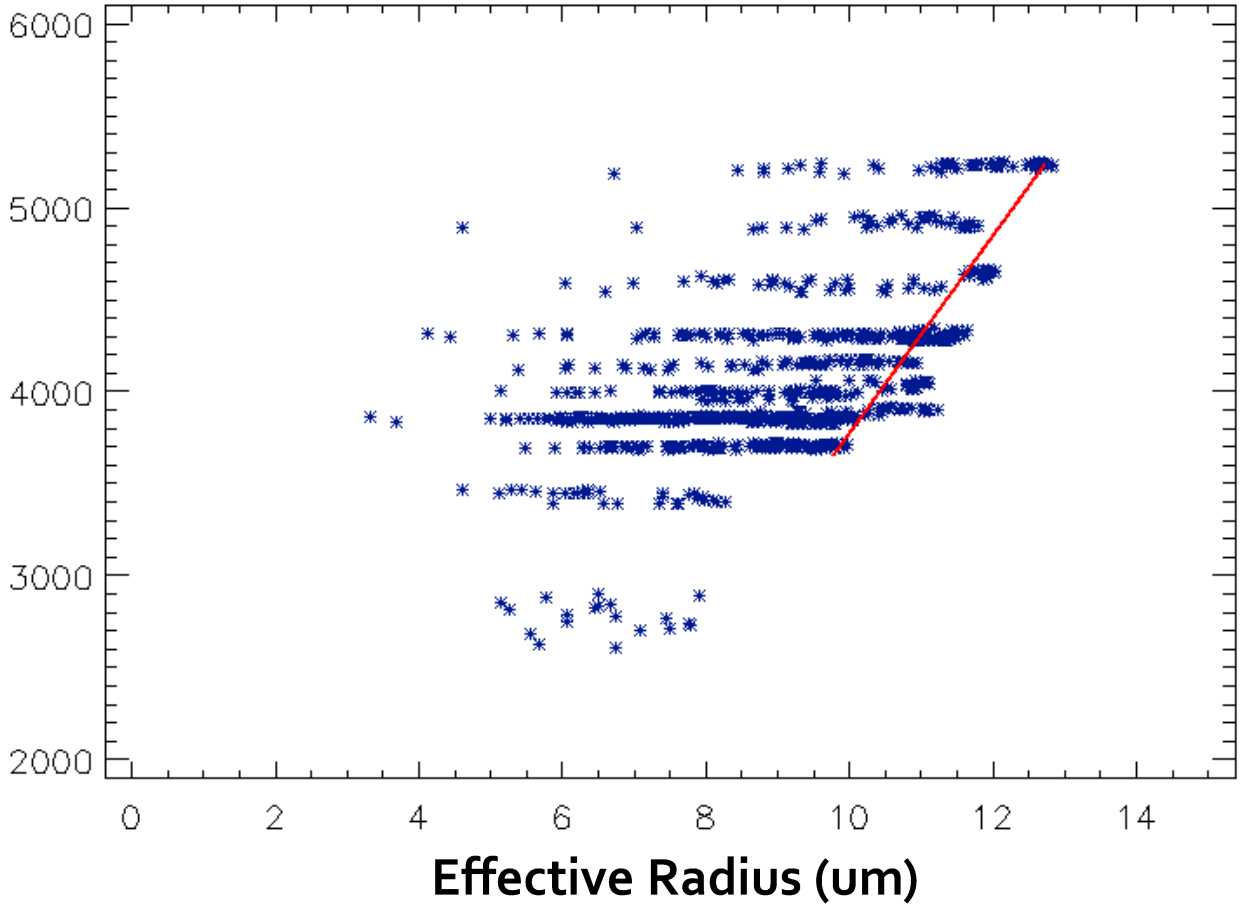
- n(r) is the number concentration and r is droplet radius.
- Effective radius is heavily dependent upon number concentration.

Methodology

- Satellite retrievals are from the MODIS instrument, onboard the Aqua polar orbiting satellite.
- Observations are cropped to the North Dakota region.
- Cloud top temperature is used to subset the image so only developing cumulus clouds of similar heights are retained.
- Subsetting and statistics are done using the IDL programming language.

Effective Radius vs. Cloud Height

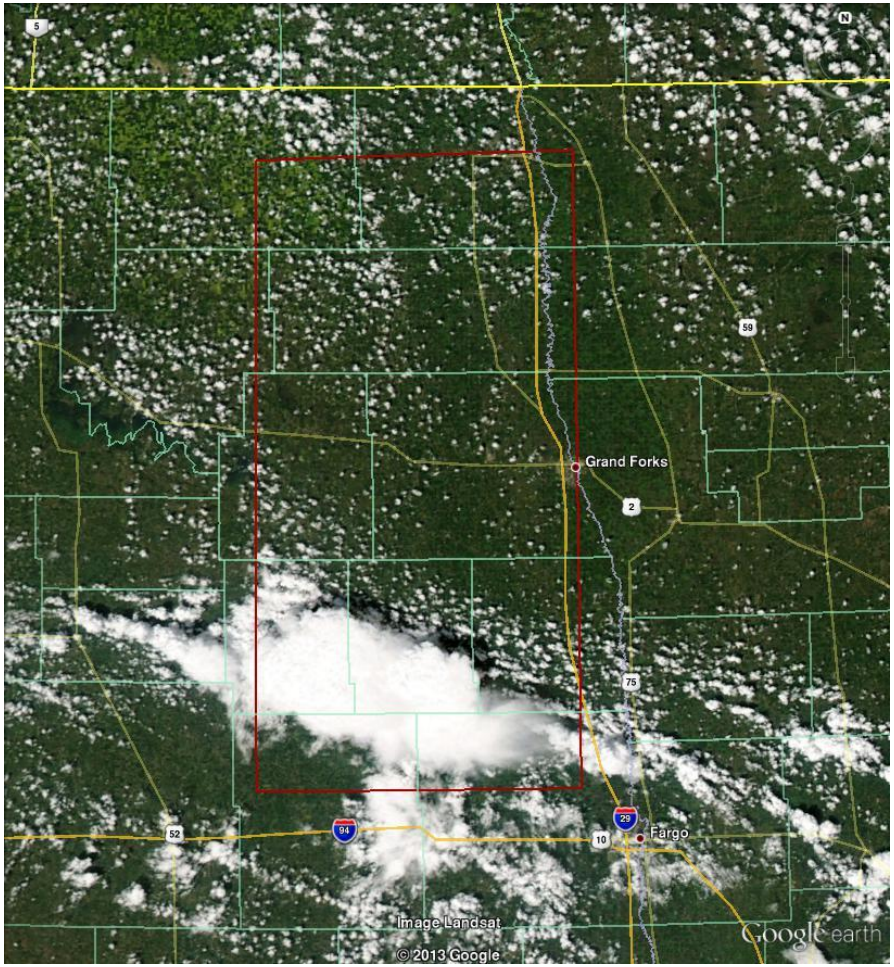
Aircraft Observations in North Dakota on July 13, 2010



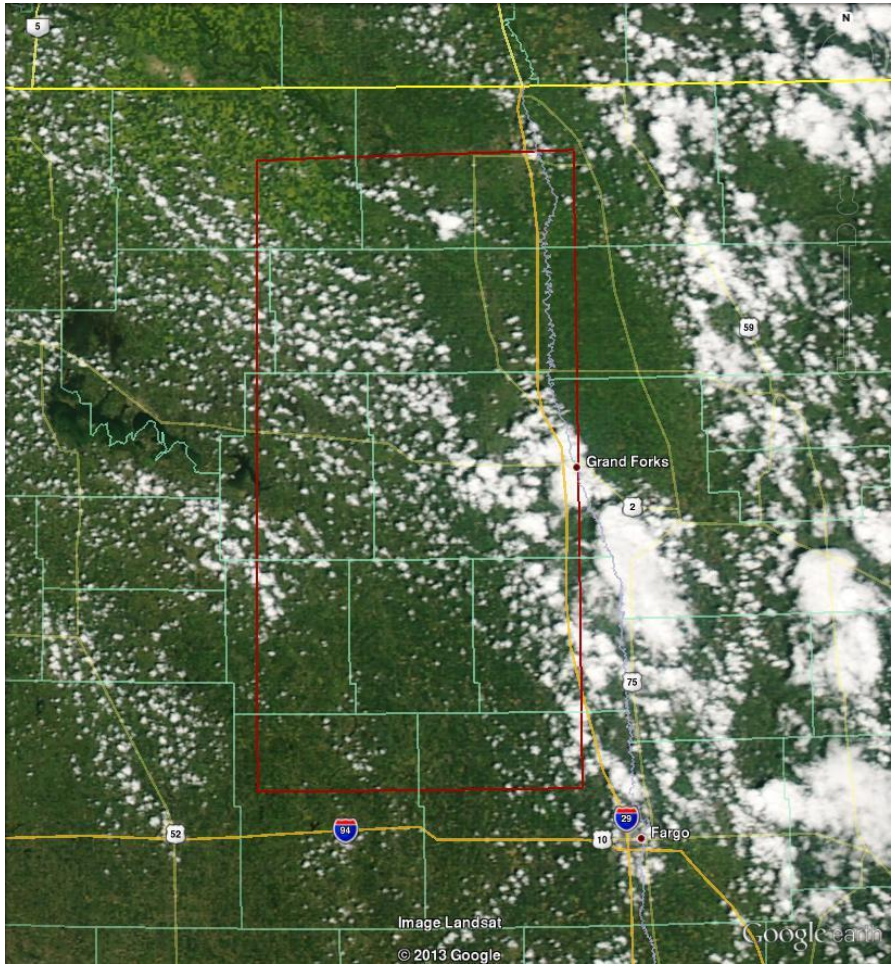
Measurements from the cloud droplet probe at a frequency of 1 Hz.

MODIS Images

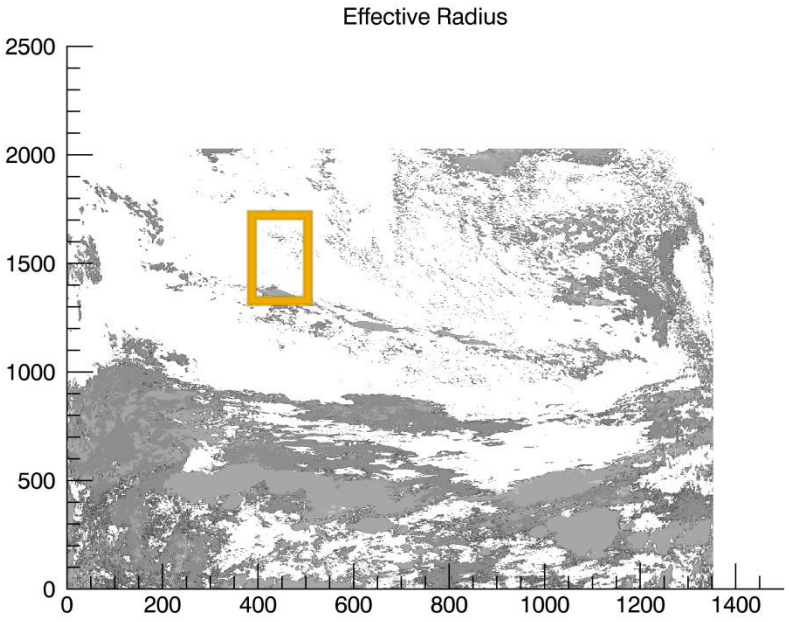
MODIS image on the 8th of July 2012



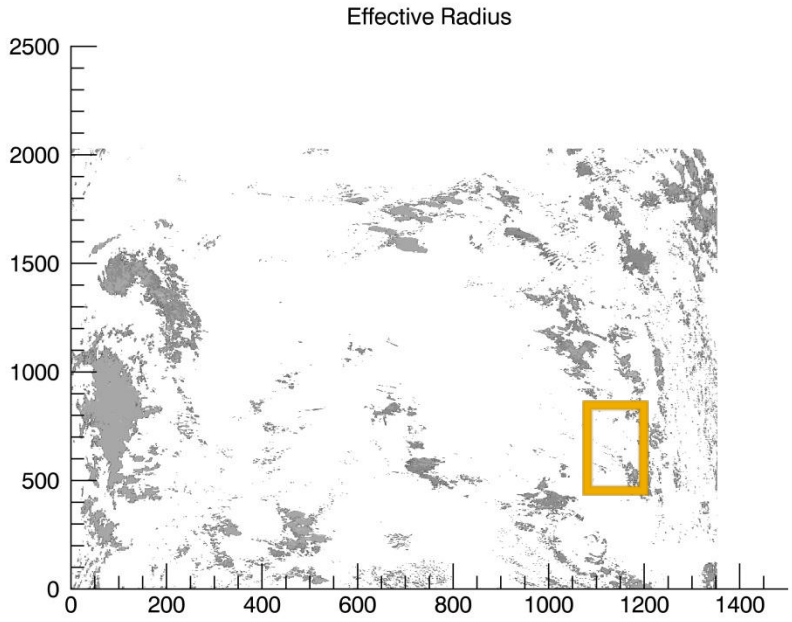
MODIS image on the 9th of July 2012



Results

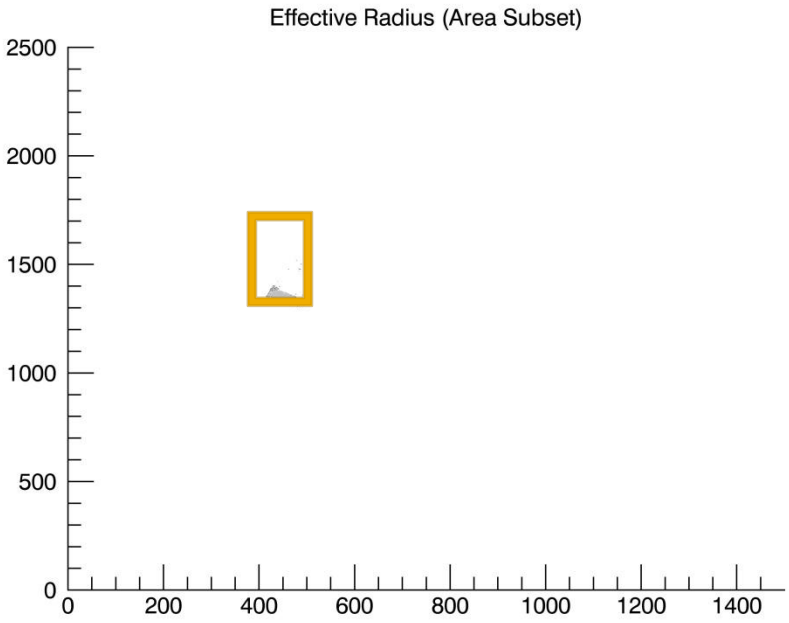


July 8th 2012

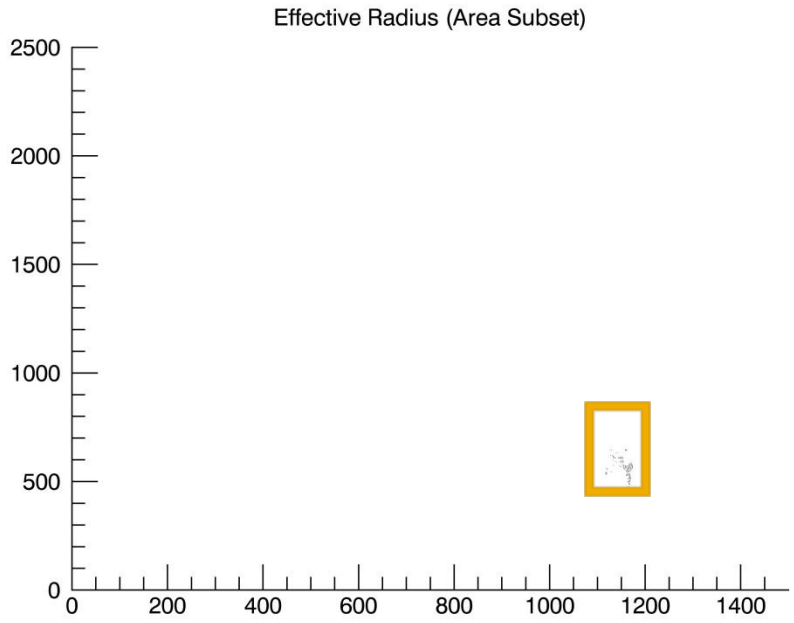


July 9th 2012

Results



July 8th
Mean: 21.1 (um)
Mean Dev. : 3.3 (um)
Std. Dev. : 5.1 (um)
Skewness: .35



July 9th
Mean: 16.9 (um)
Mean Dev. : 4.0 (um)
Std. Dev. : 5.0 (um)
Skewness: .60

Conclusion

- Lots more work. All data from POLCAST4 and data this summer from POLCAST5
- Revise program to subset by cloud top temperature.

Acknowledgements

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