

Precipitation

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Introduction

- I'm going to talk about observing and forecasting precipitation, not about the fundamental science of precipitation processes.
- I will present today's capability in observing precipitation from space
- Finally, I will discuss the future of precipitation observations



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Current Capabilities

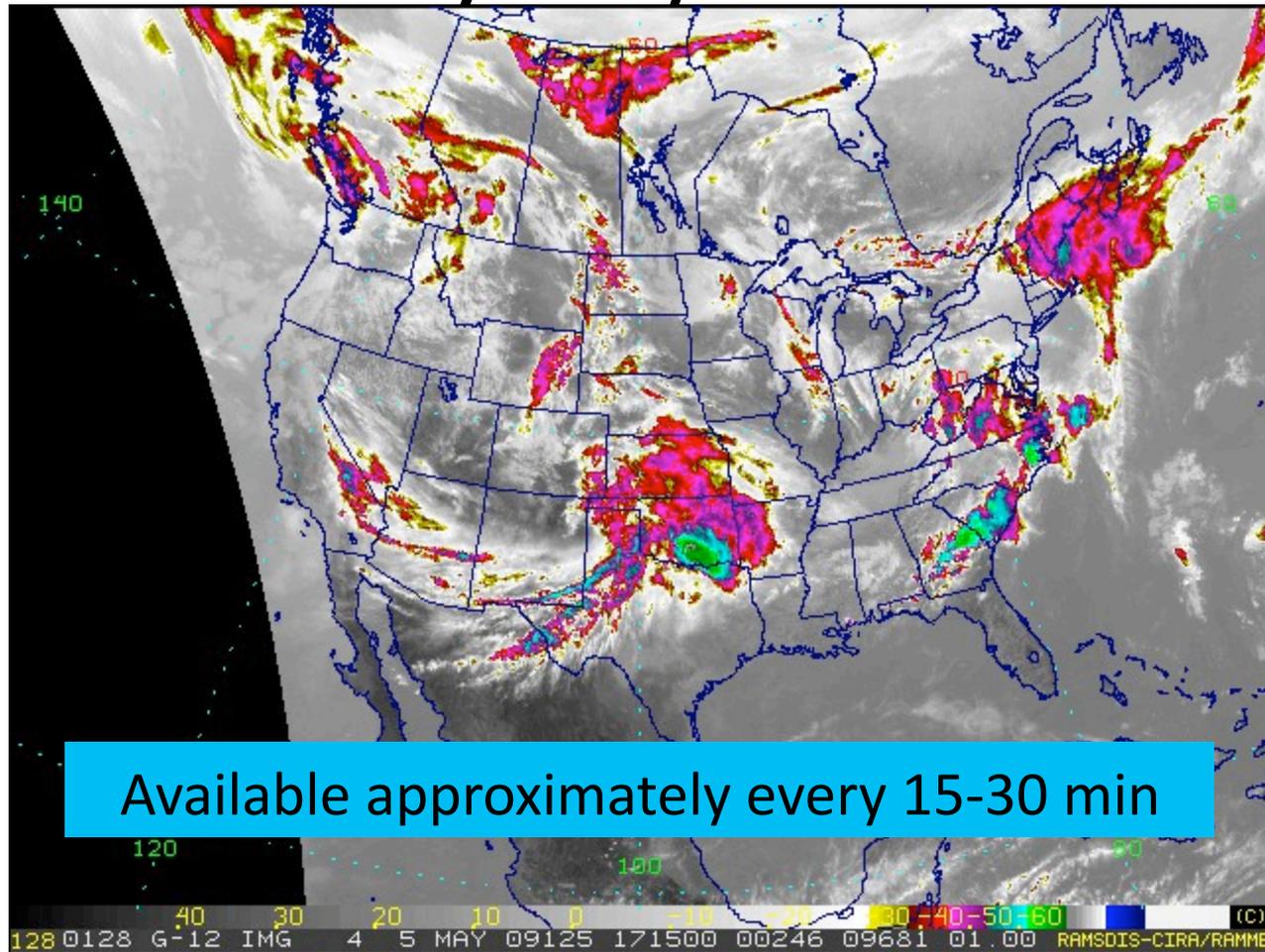
- Visible and infrared observations from LEO and GEO satellites
- Microwave observations from LEO satellites
- Ground-based radar
- Ground-based rain gauges



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Geostationary VIS/IR Observations

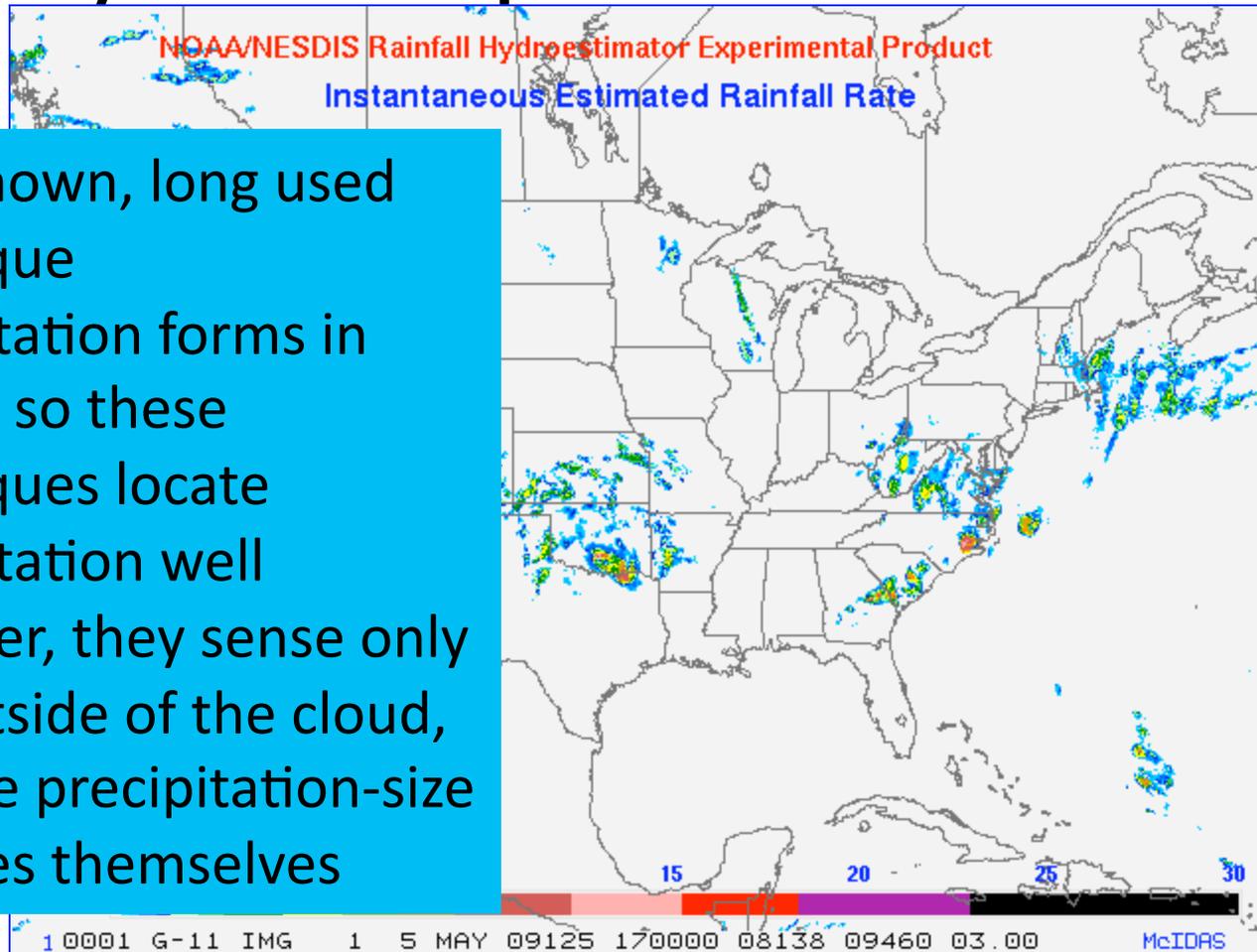


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VIS/IR Precipitation Estimates

- Well known, long used technique
- Precipitation forms in clouds, so these techniques locate precipitation well
- However, they sense only the outside of the cloud, not the precipitation-size particles themselves

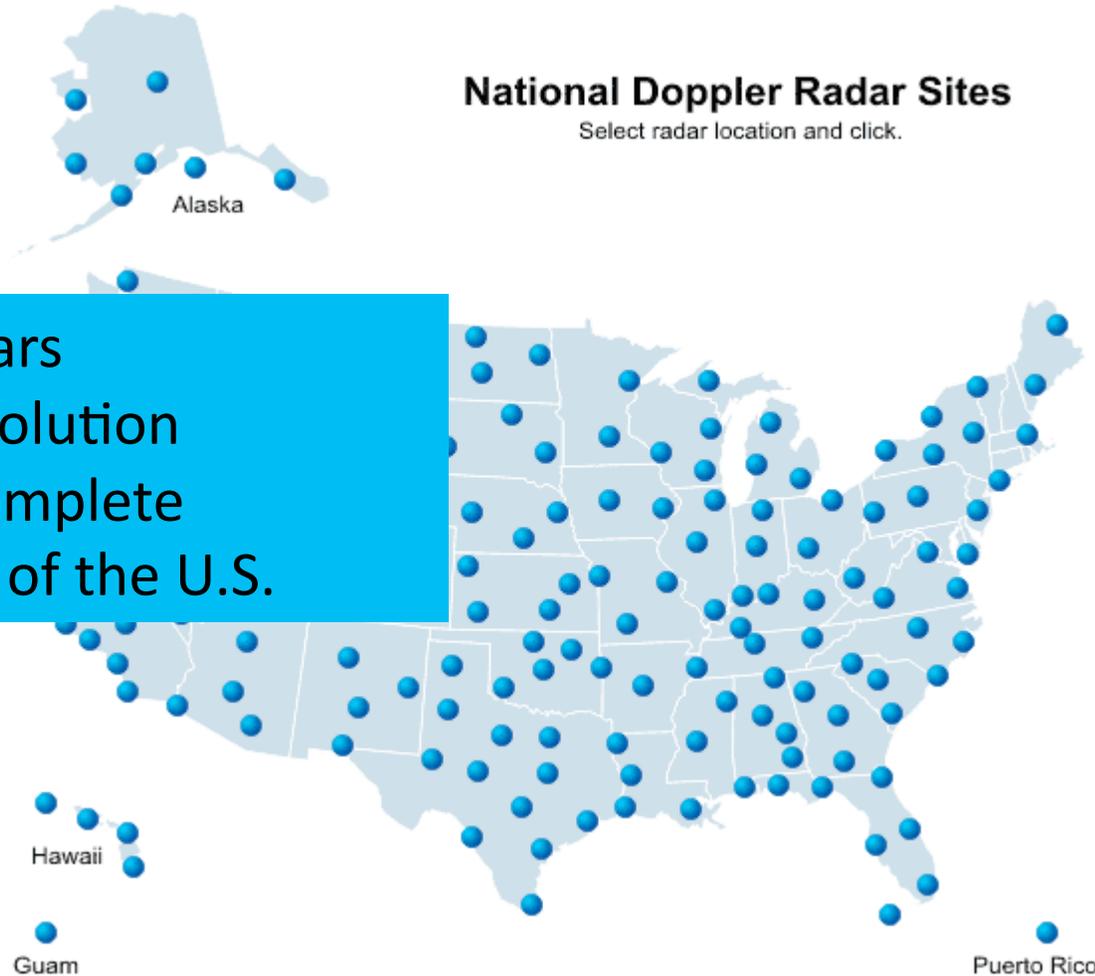


Radar Coverage

National Doppler Radar Sites

Select radar location and click.

- ~120 radars
- 5 min resolution
- Nearly complete coverage of the U.S.

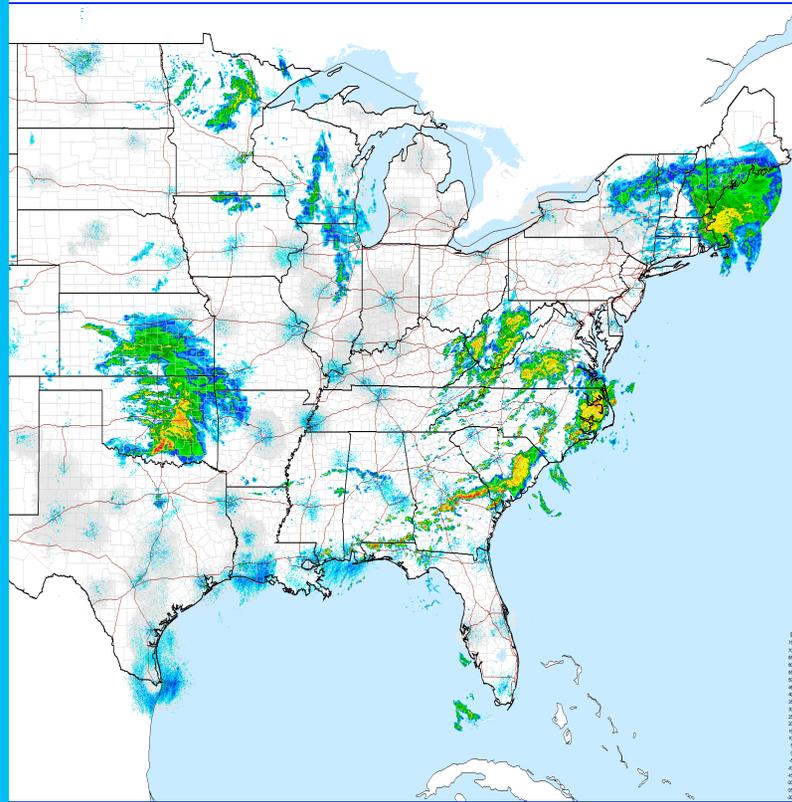


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Radar Composite

- With 5-min resolution, this is what forecasters turn to when the weather gets bad
- Thunderstorms have a lifetime of perhaps 30-60 min
- These are radar reflectivities, not rain rates
- The next generation of GEOs (GOES-R) will have 5-min resolution (30-sec for small areas).



LEO Microwave

- Several LEOs make passive microwave observations of precipitation
- Microwaves penetrate the clouds and sense the precipitation-size particles inside
- From these measurements, rain rate can be retrieved
- Although they cannot make synoptic observations, the measurements from several satellites can be combined to produce nearly global precipitation estimates



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QMORPH

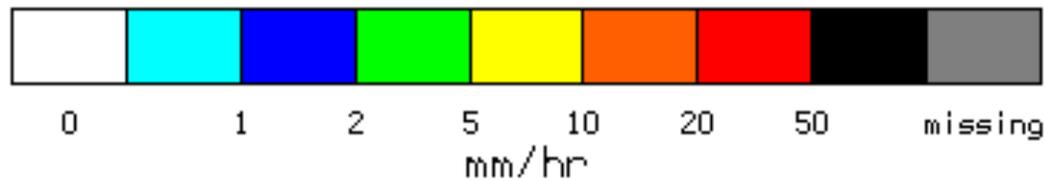
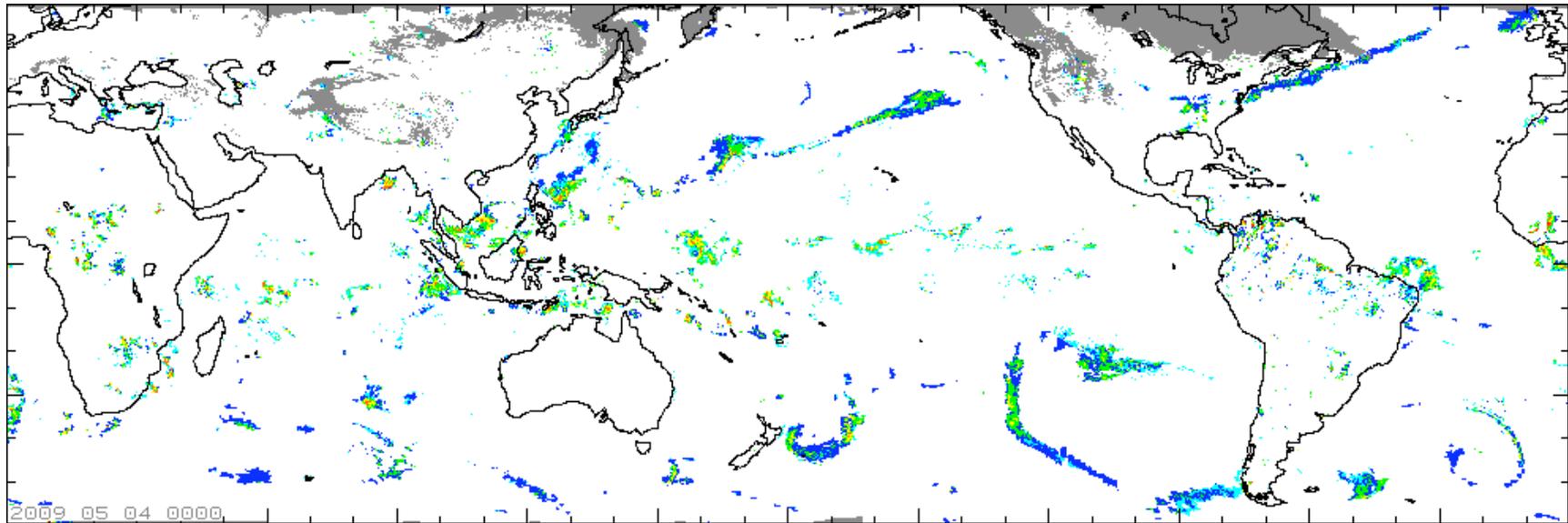
- QMORPH is produced by NOAA's Climate Prediction Center (CPC) from (currently) 4 NOAA satellites, 1 DMSP satellite, and NASA's TRMM Microwave Imager (TMI).
- The observations are moved forward in time using cloud motion vectors from IR observations. This lessens the problems caused by infrequent observations.



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QMORPH Rain Rate



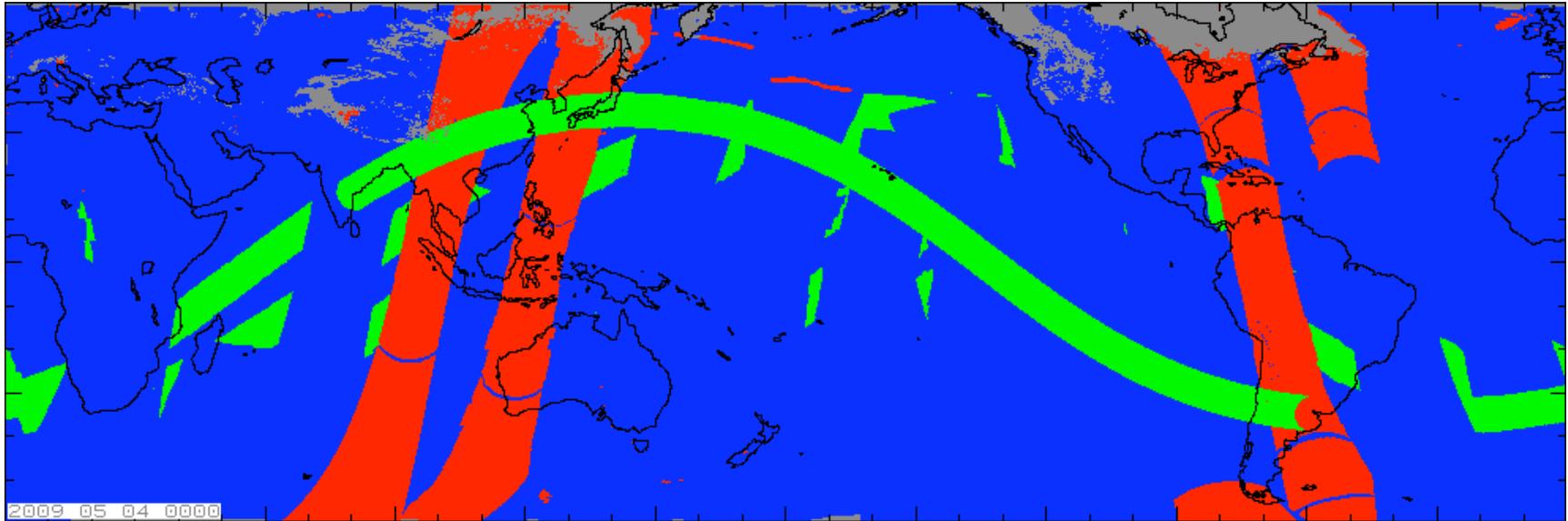
QMORPH rain rates look good, with some problems.



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QMORPH Observing Satellite



Blue = NOAA satellites

Red = DMSP satellites

Green = NASA satellites

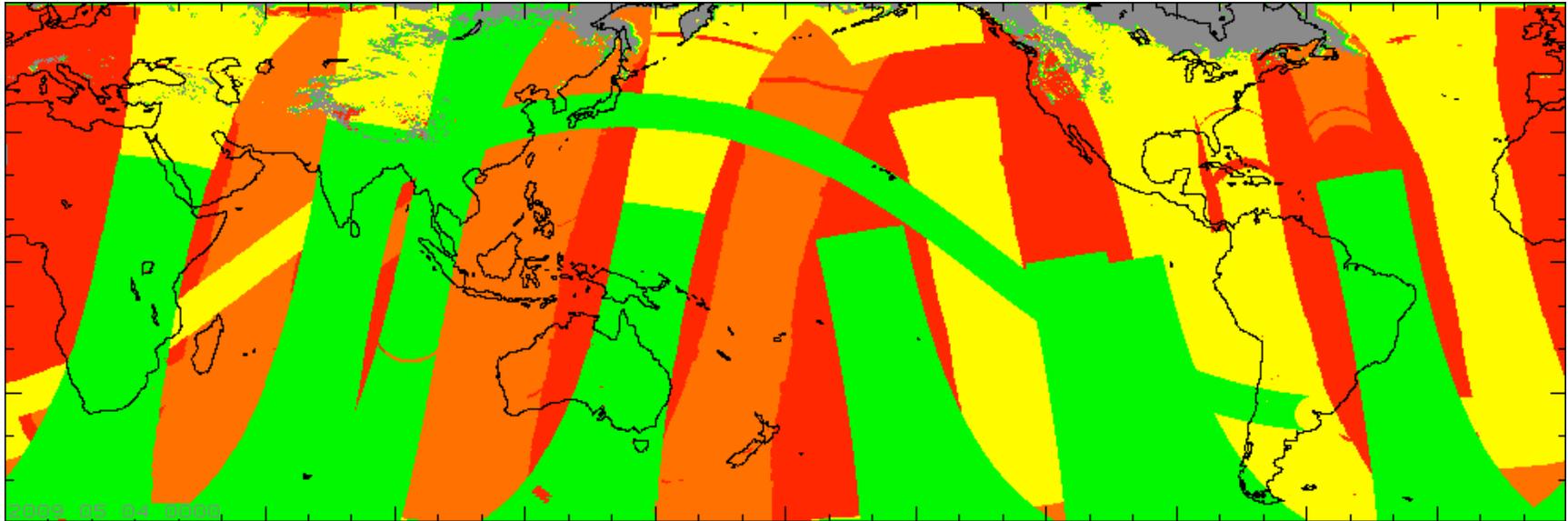
Gray = missing (snow & ice)



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QMORPH Age of Observation



Green = 3 – 4 hours

Yellow = 4 – 5 hours

Orange = 5 – 6 hours

Red = > 6 hours

QMORPH rain rates are the best that exist, but they are too old for most forecasters to use.

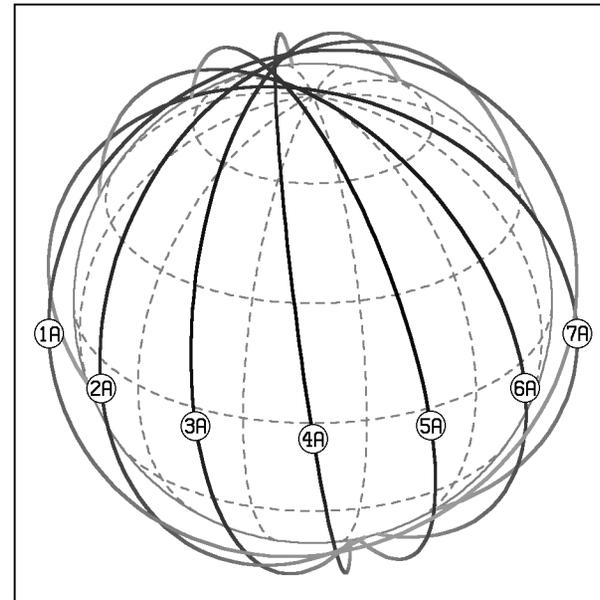


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What's Next?

- A constellation of LEOs with passive microwave instruments would help
- If two satellites were placed in each of seven orbital planes, we could achieve 50-min resolution everywhere on earth
- But that's a lot of satellites



GEO Microwave

- To achieve 15-30-min resolution, we will have to go to GEO microwave.
- This has been discussed for at least 30 years
- New technology appears to be making GEO microwave possible—finally!



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Conclusions

- Today precipitation estimation is limited by too few observations
- We have progressed about as far as we can go with today's technology
- To improve observation and forecasting of precipitation, we need more frequent microwave observations, on the order of 15-30 min, or half of the lifetime of a thunderstorm
- This probably means that we need microwave observations from geostationary satellites



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