The American Meteorological Society
Committee on Radio Frequency Allocations

Jordan Gerth, AMS Committee Chair
With contributions from the committee
NAS CORF Meeting, Washington, DC, 8 May 2020
AMS Committee on RF Allocations

- Organizes members to review and coordinate on all matters of radio frequency spectrum management pertinent to the enterprise

- Contains academic, government, and private sector professionals with expertise in remote sensing, radar meteorology, satellite meteorology, systems engineering, telecommunications, and policy

- Reviews and revises the policy statement on radio frequency allocations for the Society
Committee Goals

• Increase membership awareness of spectrum management matters and their potential impacts on the weather, water, and climate enterprise,

• Develop coalitions with other entities to inform the public and policymakers on radio frequency interference and its consequences, and

• Provide subject-matter expertise on how changes in spectrum policy and allocations could affect the collection or delivery of meteorological, hydrological, and oceanographical data
Committee Activities

Encouraging ex parte briefings at FCC

Filings in FCC dockets

Informational meetings with legislative staff

Op-eds and media interviews

Outreach to interested groups

ametsoc.org/radio
AMS and member organizations have participated in relevant FCC proceedings on spectrum sharing.
Committee Priorities

• 1675-1680 MHz (L band) and related Ligado proceedings
  – GOES-R data relay and image rebroadcast (Delivery)

• 23.8/24 GHz (K band) and greater frequencies
  – Passive microwave water vapor sensing (Collection)

• Whatever comes next
GOES-R data relay and image rebroadcast (Delivery)

1675-1680 MHZ
HRIT/EMWIN
1694.1 MHz

GRB (31 Mbps)
1686.6 MHz

DCP Report Relay
1679.9 MHz and 1680.2 MHz
Remote Automatic Weather Stations (RAWS)

Photo Source: Rob Swofford (BLM)
18 AUGUST 2019 2135 UTC
GOES-16 LOST DATA EXAMPLE
GOES REBROADCAST (GRB) USES

- Primary data feed for many National Weather Service (NWS) “National” centers
- Important source of full-resolution imagery outside of the contiguous United States
- Routinely used in television broadcasts
- Supports aviation, energy, ground transportation, and other weather-sensitive industry sectors
- Most timely and reliable source of satellite cloud/moisture imagery and lightning products
The delivery of satellite weather data must always be timely, consistent, and reliable.
Our coalition, made up of industries dependent upon and dedicated to protecting Global Positioning Systems (GPS) and satellite communications, strongly opposes the recent FCC Order that approved the Ligado Networks L-Band application.
14 of 68 organizations were part of the weather and water enterprise, including:

American Geophysical Union

American Meteorological Society

American Weather and Climate Industry Association

Space Science and Engineering Center at University of Wisconsin-Madison
SUMMARY OF CONCERN

• There will be interference if Ligado’s proposal moves forward.
• This is a unique method for delivering weather satellite data.
• Non-federal users need to be protected from interference.
• A cloud-based content delivery network is not viable since it relies on terrestrial connectivity, which can be compromised during/after storms.
• There are costly solutions to shift to a different satellite downlink prior to the next-generation of weather satellites.
Passive microwave water vapor sensing (Collection) 23.8/24 GHz
Contributors for Reducing NWP Forecast Errors

Advanced Microwave Sounders and Hyperspectral Infrared Sounders:
Top Two Contributors for Reducing NWP Forecast Errors

- AMSU-A: Adv MW Sounding Unit A on Aqua and NOAA POES (T)
- IASI: IR Atmos Interferometer on Metop (T, H)
- AIRS: Atmos IR Sounder on Aqua (T, H)
- AIREP: Aircraft, T, H, and winds
- GPSRO: RO bending angles from COSMIC, Metop
- TEMP: Radiosonde, T, H, and winds
- QuikSCAT: sfc winds over oceans
- SYNOP: Sfc P over land and oceans, H, and winds over oceans
- AMSU-B: Adv MW Sounding Unit B on NOAA POES
- GOES winds
- Meteosat winds
- Ocean buoys (Sfc P, H and winds)
- PILOT: Pilot balloons and wind profilers (winds)
- HIRS: High-Res IR Sounder on NOAA POES (T, H)
- MSG: Meteosat 2nd Generation IR rad (T, H)
- MHS: MW humidity sounder on NOAA POES and Metop (H)
- *AMSR-E: MW imager radiances (clouds and precip)
- SSM/I: Special Sensor MW Imager/Sounder (H and sfc winds)
- GMS: Japanese GEO satellite winds
- MODIS: EOS Aqua and Terra (winds)
- GOES IR rad (T, H)
- MTSAT/M: Japanese GEO satellite vis and IR imagery
- METEOSAT IR rad (T, H)
- O3: Ozone from satellites

Source: Dave Lubar
ECMWF Hurricane Sandy Predictions
Location of landfall with and without satellite microwave observations

Without microwave obs (red), Sandy predicted for landfall in Maine 24 hours later, instead of New Jersey (black)

Source: McNally, et. al., ECMWF
"Monthly Weather Review" Vol 142
ATMS

Advanced Technology Microwave Sounder
Joint Polar Satellite System (JPSS)
## ATMS Channel Characteristics and Applications

<table>
<thead>
<tr>
<th>Central Frequency (GHz)</th>
<th>Application</th>
<th>Footprint Size: Nadir View (km)</th>
<th>Footprint Size: Edge of Scan (km, Δy by Δx)</th>
</tr>
</thead>
</table>
| 23.8  31.4              | - Total precipitable water vapor  
- Precipitation  
- Integrated cloud liquid water | 75 x 75                        | 142 x 323                               |
| 50.3  51.76  52.8  88.2 | - Integrated cloud ice water  
- Snow and ice cover characteristics (ice concentration, snow water equivalent)  
- Land surface temperature | 32 x 32                        | 60 x 137                                |
| 53.6 – 57.29 (10 channels) | - Atmospheric temperature sounding | 32 x 32                        | 60 x 137                                |
| 165.5  183.31 +/- 1 to 183.31 +/- 7 (5 channels) | - Atmospheric moisture sounding | 16 x 16                        | 30 x 68                                 |

Δy: Satellite’s orbiting direction  
Δx: Perpendicular to satellite’s orbiting direction

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NASA GMAO GEOS 24h Observation Impact Per Channel, 6 February through 6 May 2020 00 UTC

0.9%

1.1%
NASA GMAO GEOS 24h Observation Impact Per Channel, 6 February through 6 May 2020 00 UTC
In numerical forecast model data assimilation, some of the observations are largely complementary (many individual platforms have small impacts).

Removing one observation platform (one satellite) may not notably affect the skill of the model solution in any given run, but it may lower the skill floor over time.

The most likely consequence of microwave interference on numerical weather predictions is a general/gradual lowering of the skill floor.

There are various methods to assess the model forecast sensitivity to certain observations over time.

One type of observation has decreased 80% since February... Let’s investigate what observations compensated for that.
ECMWF FORECAST SENSITIVITY TO ALL OBSERVATIONS (JULY/AUG 2016)


- Southern hemisphere middle latitudes
- Central contiguous United States
- Equatorial Africa
- Eastern Asia and the Tropical Western North Pacific Ocean
ECMWF FORECAST SENSITIVITY OBSERVATION IMPACT (FSOI)

2006
Microwave water vapor observations for the entire world
6%

2016
Microwave water vapor observations for the entire world
20%

<table>
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<tr>
<th>Year</th>
<th>Description</th>
<th>Impact</th>
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<tbody>
<tr>
<td>2016</td>
<td>Microwave water vapor observations for the entire world</td>
<td>20%</td>
</tr>
<tr>
<td>2016</td>
<td>Microwave water vapor observations over Canada, Siberia, South America, and Africa</td>
<td>25%+</td>
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<tr>
<td></td>
<td>Over oceans</td>
<td>25 to 45%</td>
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IMPACTS SUMMARY

• Value of microwave water vapor observations is not easily achievable through other means
  • Unique observations based on physical properties of water vapor and oxygen
  • Maintains high data rate and assures high reliability over vast area of globe

• Continuing important observing capabilities maintains the value of our satellite constellations and quality of local and global weather forecasts.
The weather enterprise must better capture and communicate the relative value of disparate observation sets to meteorologists for prediction and warning purposes.
COMMUNITY CHALLENGES

• Explaining that weather forecasts improve annually, largely due to satellite observations
• Explaining that the atmosphere is emitting microwaves that are useful to sense
• Finding compelling examples of microwave passive remote sensing interference in imagery
• The speed of science and peer review is slower than current spectrum auctions
• Building consensus and coalitions
Questions?

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