Arctic Weather Satellite Spillover Simulations with ARTS

UNIVERSITÄT BERN

AAC OMNISYS

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The Arctic Weather Satellite Mission

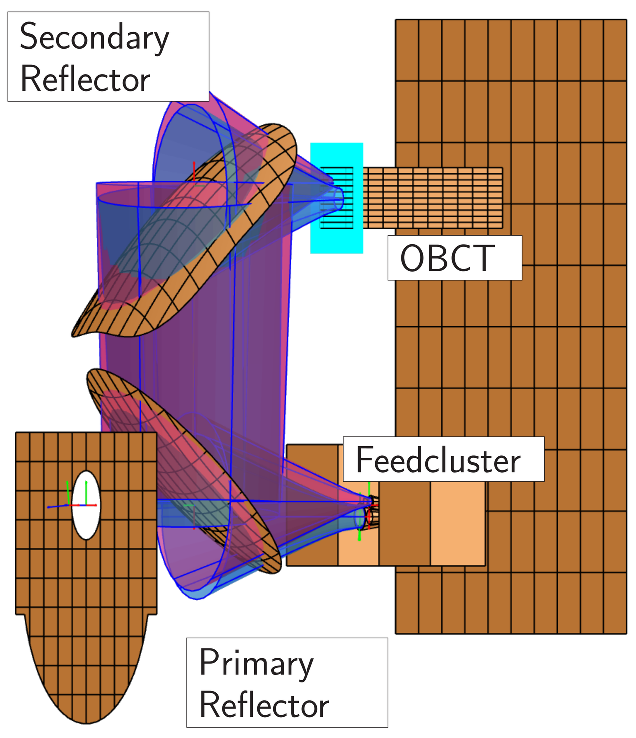
- ESA mission built by OHB Sweden and AAC Omnisys
- Prototype for a European meteorological constellation (EPS-Sterna)
- Comparable capabilities to Microwave Sounder on MetOp-SG and Advanced Technology Microwave Sounder on JPSS
- Constellation will improve global numerical weather prediction and provide nowcasting in high latitudes
- Launch in June 2024

Credit: AAC Omnisys

The AWS radiometer

53GHz 89GHz 183GHz 325GHz

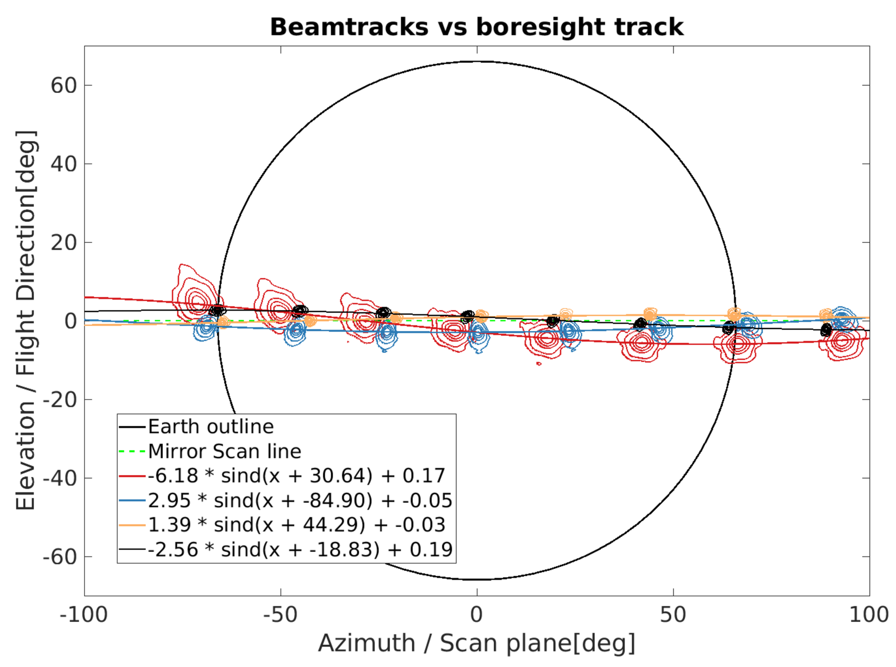
- Crosstrack scanning radiometer
- 325 GHz is a novel addition compared to other operational microwave sounders
- Four feedhorns arranged in splitblock feedcluster directly illuminating scanning reflector
- Simulations performed using both Physical Optics (PO) and Method of Moments (MoM) in Ticra Tools



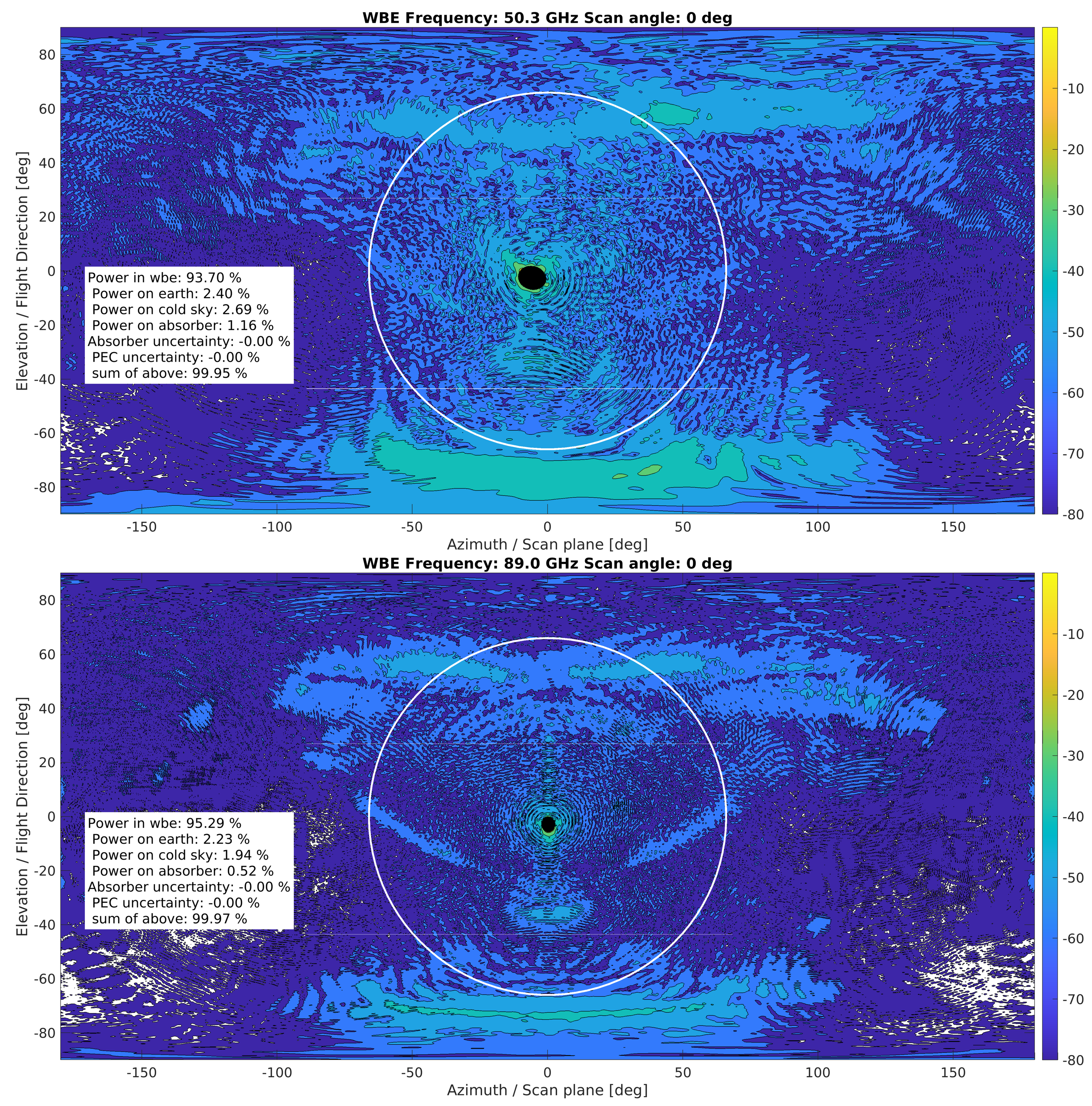
R. Albers, A. Emrich and A. Murk, "Antenna Design for the Arctic Weather Satellite Microwave Sounder," in IEEE Open Journal of Antennas and Propagation, vol. 4, pp. 686-694, 2023, doi: 10.1109/OJAP.2023.3295390.

Farfield Performance

- Beams are offset from boresight of scanning reflector
- Beams rotate around boresight as a function of scan angle
- For combined data products each measurement needs to be geolocated
- Asymmetric beam shape due to off-axis geometry
- Simulating several scan angles crucial for accurate performance assessment

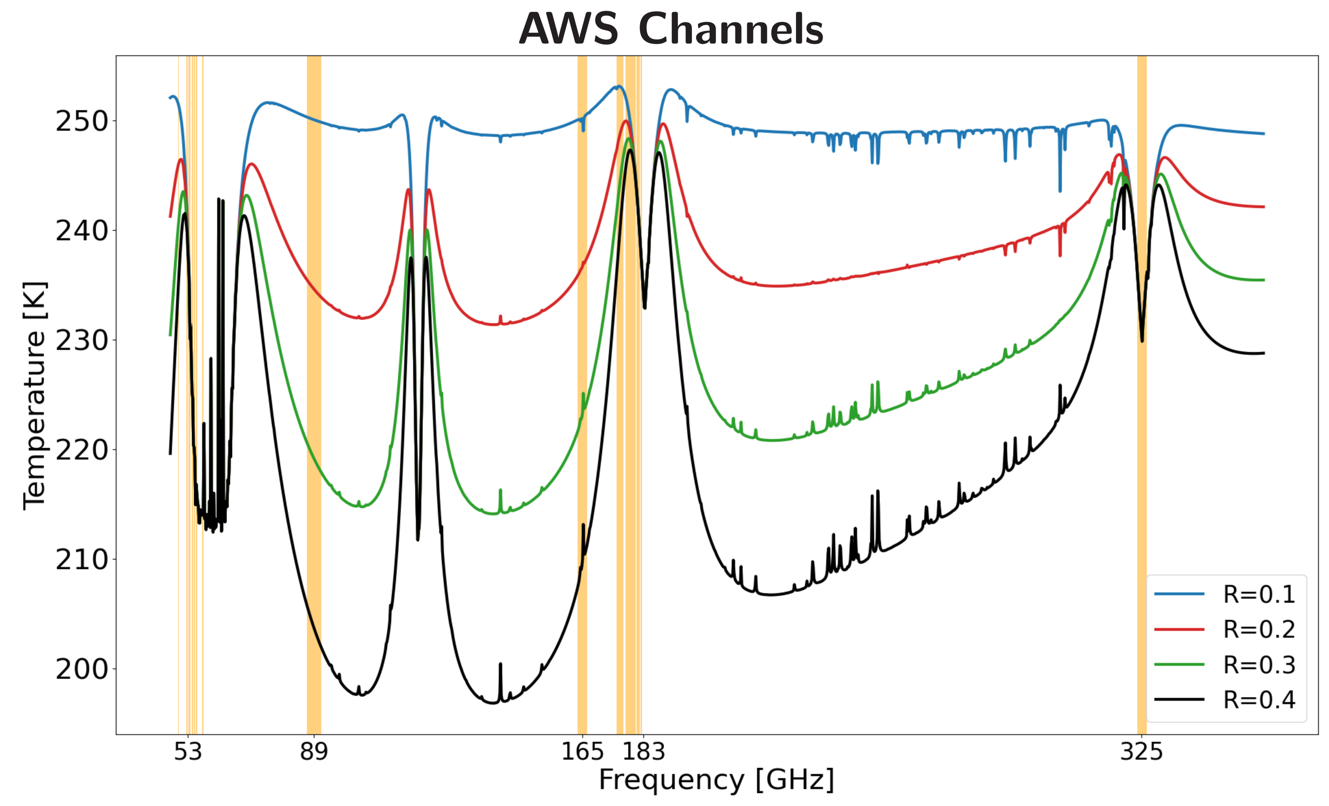


Spillover Changes with Scan Angle for each Frequency



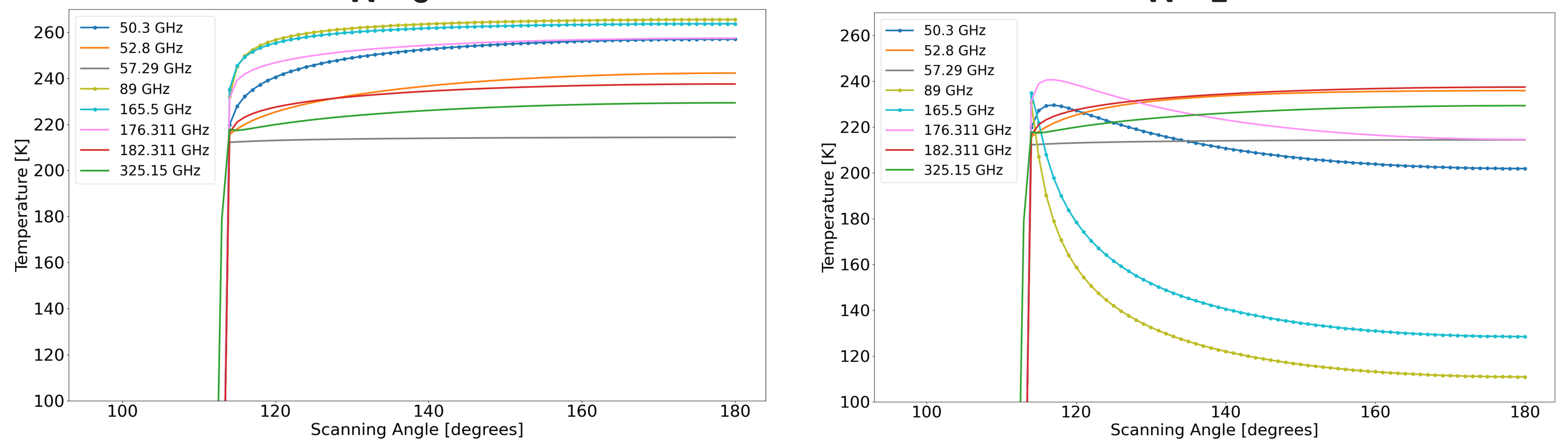
ARTS Simulations

- Motivation: Determine the bias in measured temperature caused by the spillover and far sidelobes of the radiometer

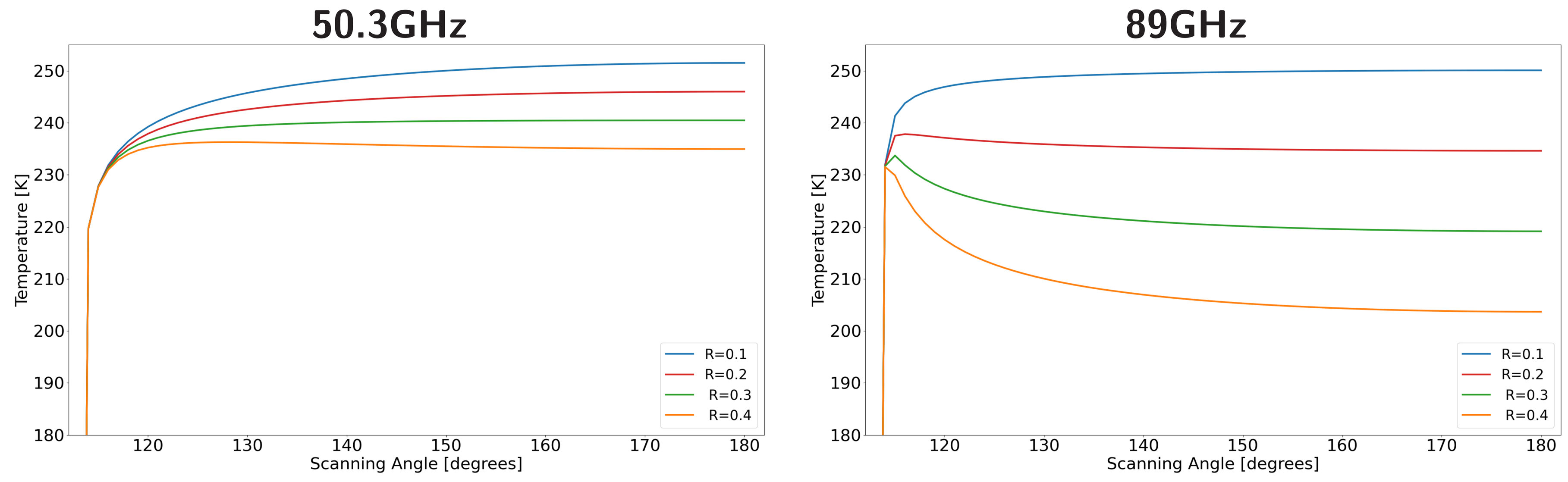


- 1D Atmosphere
- Three atmosphere models considered: Tropical, Midlatitude-Winter, Subarctic-Winter
- Four surface reflectivities considered
- Ideal 1D antenna sensor

Brightness Temperature for Different Frequency Channels



Brightness temperature for Different Surface Reflectivities



Predicted Brightness Temperature Considering Spillover Distribution at Nadir

50.3GHz	Power[%]	Temperature[K]
Main Beam	93.7	251.499
Earth	2.4	234.946
Cold Sky	2.69	2.7
Absorber	1.16	273.15
Tb uncalibrated		244.53
Tb difference		6.96(0.4*)

*Contribution from spillover over earth

89GHz	Power[%]	Temperature[K]
Main Beam	95.29	250.079
Earth	2.23	203.677
Cold Sky	1.94	2.7
Absorber	0.52	273.15
Tb uncalibrated		244.315
Tb difference		5.76(1.034*)

*Contribution from spillover over earth

- Main Beam looking to a surface with R=0.1
- Earth Spillover looking to a surface with R=0.4
- Tb predicted calculated from the power distribution in each surface
- Tb difference between main beam and predicted temperatures

Conclusions

- Spillover power distribution changes for each frequency and scan angle
- Brightness temperature measured by the instrument will vary for each frequency and scan angle depending on the surface properties
- The most affected bands are the window channels

Future Work

- Model improvement
- Simulating different scan angles with their correspondent spillover distribution for an assessment of the instrument calibration

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