Radiometric Calibration Techniques for Signal-of-Opportunity Reflectometers

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ABSTRACT
Bi-static reflection measurements utilizing global navigation satellite service (GNSS) or other signals of opportunity (SoOp) can be used to sense ocean and terrestrial surface properties. End-to-end calibration of GNSS-It has been performed using well-characterized reflection surface (e.g., water), direct path antenna, and receiver gain characterization [1]. Here, we propose an augmented approach using onboard receiver electronics for radiometric calibration.

Using similar techniques long-term (days to weeks) calibration stability of the L-band scatterometer and radiometer on Aquarius/SAC-D has been achieved better than 0.1% [9]. Similar long-term stability would likely be needed for a spaceborne reflectometer mission to measure terrestrial properties such as soil moisture.

MOTIVATION
- Internal Calibration
  - Stabilizes receiver gains and offsets
  - Measures correlation efficiency
  - Defeats fluctuations with rapid and periodic updates
- Electronic Calibration Sources
  - Reference switch
  - Common noise source
  - Applicable to general SoOp reflectometers, e.g., [2]
- Similar to Conventional Microwave Instruments
  - L-band radiometer and scatterometer (e.g., [3-4])
  - Reference switches, noise diodes and loop-back circuits

METHODOLOGY
- Reference switching
  - Overcomes thermal and 1/f fluctuations
  - Allows removal of receiver noise offset
  - Useful for low SNR direct antenna configurations
- Noise source timing
  - Allows measurement of receiver gains and correlation efficiency
  - Cross-power appears at zero delay
  - Simultaneously observe reflected cross-power when delay difference is much larger than coherence time of signal

REFERENCES

Simulation & Calibration
- Simulation parameters (static ground system)
  - Instrument parameter set (input power, transmitter, receiver)
  - Bragg scatter reflectivity, antenna gain, antenna temperature
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Simulation Results
- Estimated reflectivity

Sea Ice
Soil Moisture
Ocean Winds

(Doppler-shift notation removed for simplicity - ground-based case)