Remotely Located Radiometers

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This presentation presents topics germane to radiometers that are physically located on platforms that are separated by many hundreds of meters to several kilometers apart.

Topics for Consideration for Spatially-Separated Radiometers

- Bandwidth-separation trade-off (ambiguity resolution)
- Synchronization (correlation)
- Doppler compensation (moving platforms)
- Calibration

At the 10th meeting of the WG, we glimpsed at the relationship between separation of radiometers and bandwidth required to resolve ambiguities.

Other considerations for spatially-separated radiometers are synchronization of sampling processes, Doppler compensation for moving platforms, and calibration.

Synchronization

- Synchronization of sampling rates on separated platforms
  - Lack of frequency and phase sync results in loss of cross-correlation enhancement between platforms
- Synchronization of time for proper registration of images of the scene
  - Time mismatch results in lack of registration of image

To achieve perfect cross-correlation enhancement of the scene, the sampling clocks on different platforms must have identical sampling periods and zero time offset between clocks. Our WG needs to address how this may be accomplished.

To geolocate the image, the measurement of each pixel must be linked to a common time. Any offset between times will attribute different positions to elements in the scene and result in smearing of the pixels.

Doppler Compensation

- Motions produce platform-dependent Doppler shifts depending on both motion and viewing aspect of line-of-sight to each emitter in the scene. Doppler shifts degrade cross-correlation enhancement even if sampling rates are perfectly synchronized.
  - Different platforms may travel at different velocities
  - Some platforms may experience approaching Doppler (noise fluctuations appear contracted in time relative to stationary platform) whereas other platforms may experience receding Doppler (noise fluctuations appear elongated in time relative to stationary platform). These effects cause loss of cross-correlation enhancement. (See study-group tutorial material).

Even if sampling rates are perfectly synchronized, moving platforms require Doppler compensation for their motions. Compensation is a computationally-intensive undertaking because for a given platform, every emitter in the scene is at a different viewing aspect to that platform's radiometer. Also, a given emitter in the scene presents different Doppler to radiometers on different platforms because the viewing angles to each platform are different and the motions of the platforms themselves may be different. For example, that given emitter's radiation may be shifted higher in frequency for an approaching platform and shifted lower in frequency for a receding platform. If not compensated, the cross-correlation between these platforms will be degraded.

Calibration

- From our discussion of sampling-clock and time synchronization and Doppler compensation, it is evident that calibration of the array of spatially-separated radiometers requires special consideration with respect to:
  - Reference signals (type, location, availability)
  - Post calibration residual errors (Are these time dependent?)
  - Perishability (How often does the array need recalibration?)

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Clearly, calibration of an array of spatially-separated radiometers requires special consideration.

One consideration is the type of reference source used. Is the source monochromatic? Polychromatic? Noise-like? Another consideration is the location of the source. Is there a common source on the ground that illuminates all radiometers? Must there be a set of spatially dispersed sources that illuminate all the radiometers in the array? Or must reference sources exist at each radiometer location? Should we have a combination of ground-based and platform-based calibrators?

What is the magnitude of post-calibration residual errors? Do these errors grow with time? If so, at what time intervals does the array need recalibration because the current calibration is not acceptable?