Ocean and Land Surface Characterization in the GPM Radar-Radiometer Combined Algorithm

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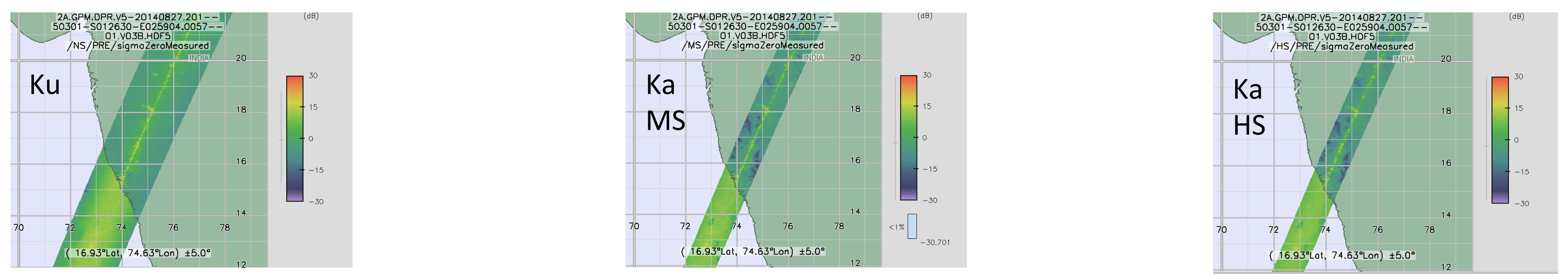
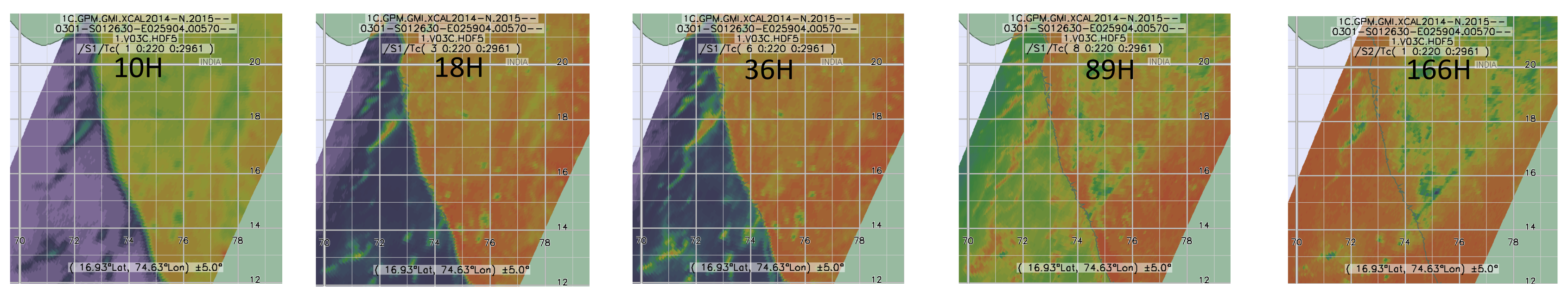
What surface properties affect the GPM and DPR measurements?

DPR measures σ_0 (surface backscatter cross-section).

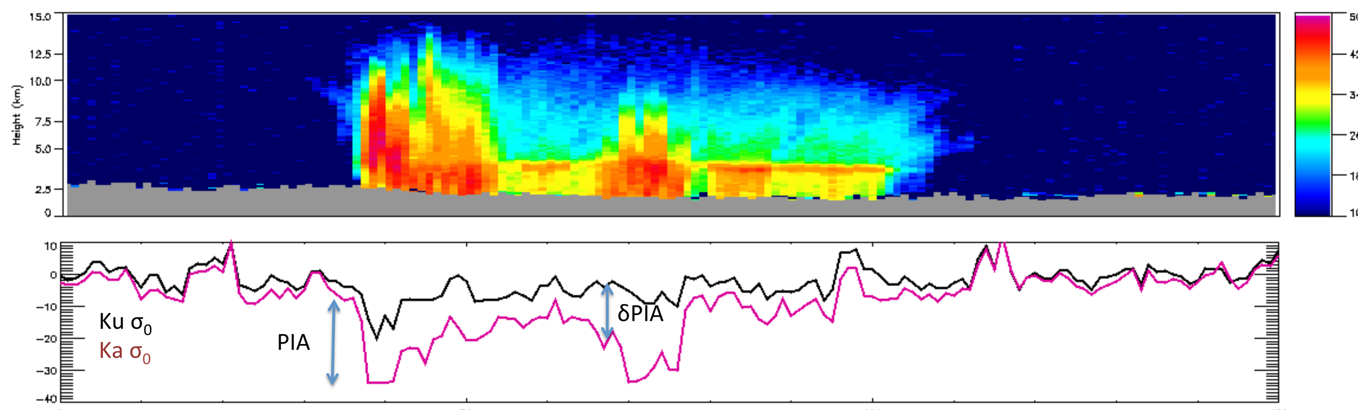


GMI Tbs are sensitive to surface emissivity, depending on atmospheric optical depth.



How are these currently treated in DPR and Combined Algorithms?

DPR and Combined use **S**urface **R**eference **T**echnique (single- and dual-frequency versions) to infer **P**ath **I**ntegrated **A**ttenuation.



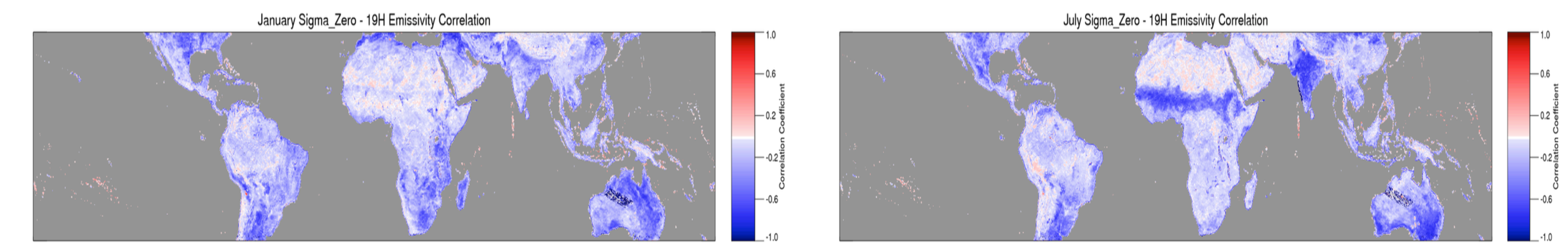
PIA is used as observational constraint by both algorithms.

Emissivity of water surfaces is calculated from a physical model as a function of frequency, incidence angle, temperature, and wind speed. Emissivity of land surfaces is taken from TELSEM atlas. No relationship between σ_0 and emissivity is assumed.

What is the new approach being developed?

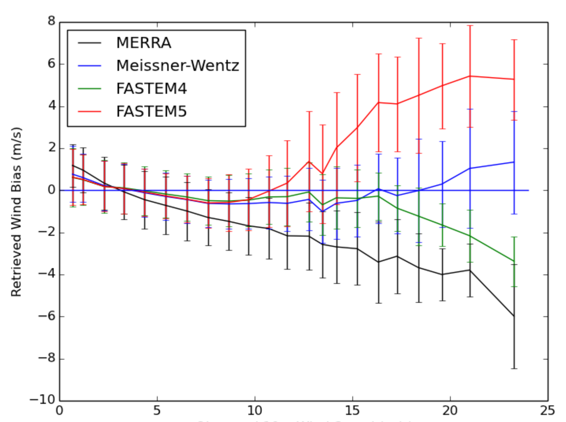
Emission and scattering are related processes, and depend on physical properties of the surface (roughness, dielectric constant, volume scattering…). Therefore σ_0 and emissivity should be related, and the combined algorithm will be better constrained by only considering realistic combinations of σ_0 and emissivity.

Over water surfaces, σ_0 and emissivity can be modeled as a function of frequency, incidence angle, wind speed, and water temperature. Over land surfaces, the situation is more complex, but statistical relationships between σ_0 and emissivity have been developed to take advantage of correlations where they exist.



Water Surfaces

Step 1: Develop well-calibrated GMI wind retrieval

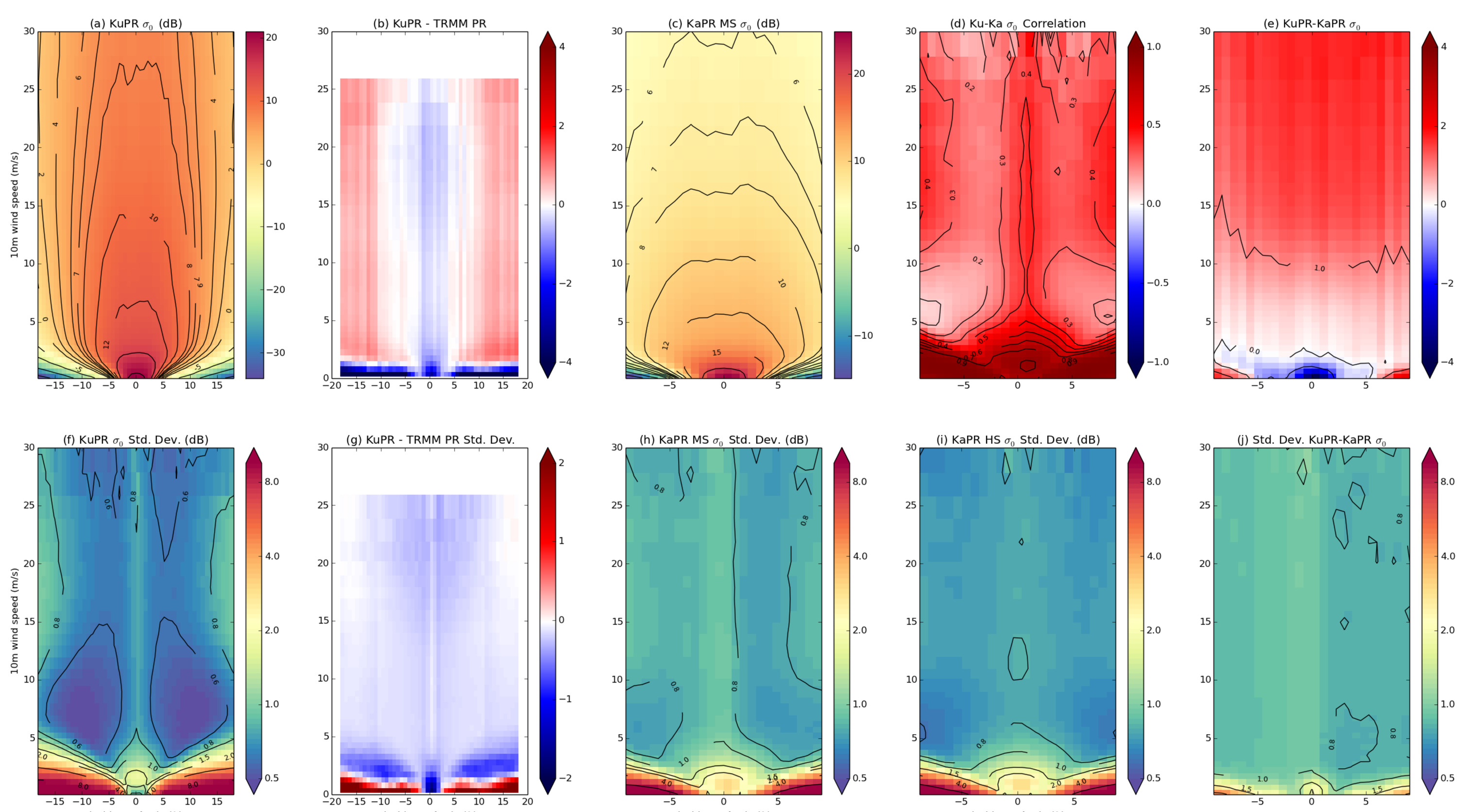


Channel	10V	10H	18V	18H	23V	36V	36H	89V	89H	166V	166H	183±3	183±7
Bias (K)	-1.0	-0.7	-0.5	0.1	-0.7	0.6	1.4	0.8	1.7	-0.2	0.3	-3.0	-1.0
RMSE (K)	0.7	0.9	1.0	1.6	1.4	1.0	1.8	1.3	2.7	1.4	2.7	3.7	1.8

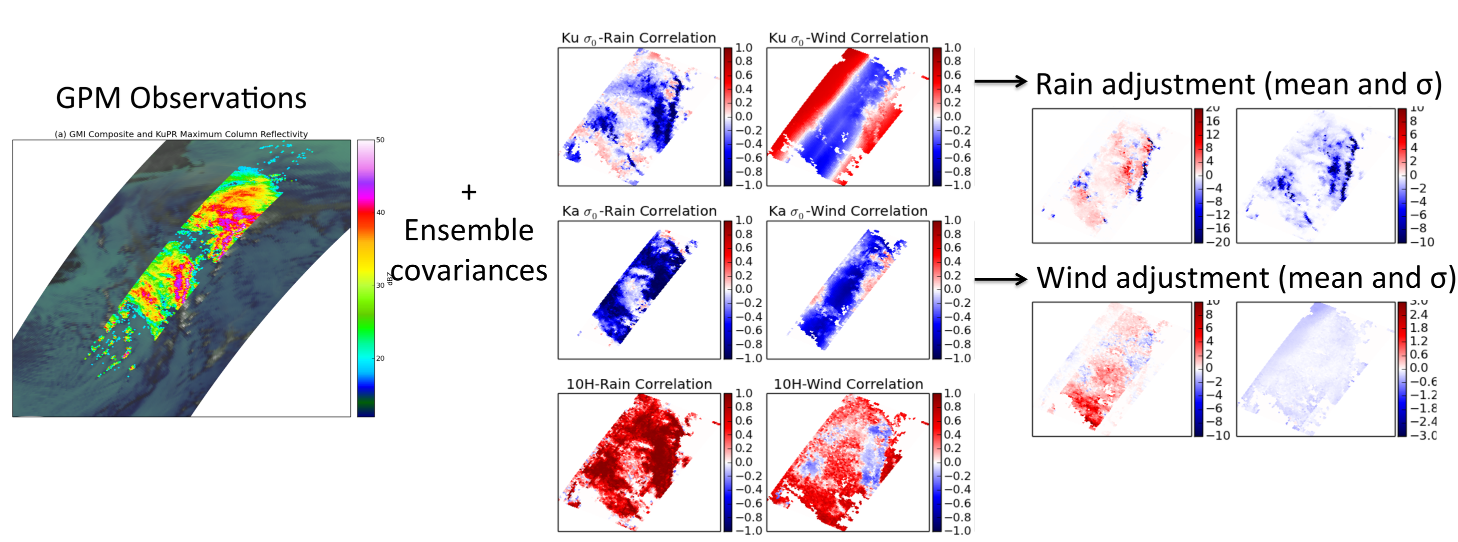
Left: GMI wind retrieval error (versus buoy measurements) for three different emissivity models
Top: GMI residual bias and root-mean-square error (after bias correction) when forced with buoy observations

Step 2: Derive Geophysical Model Function for σ_0 from co-located clear-sky GMI and DPR observations

Right: Several two-dimensional (incidence angle and GMI-derived 10m wind speed) tables have been compiled from precipitation-free and attenuation-corrected DPR σ_0 observations for use in the Combined Algorithm.



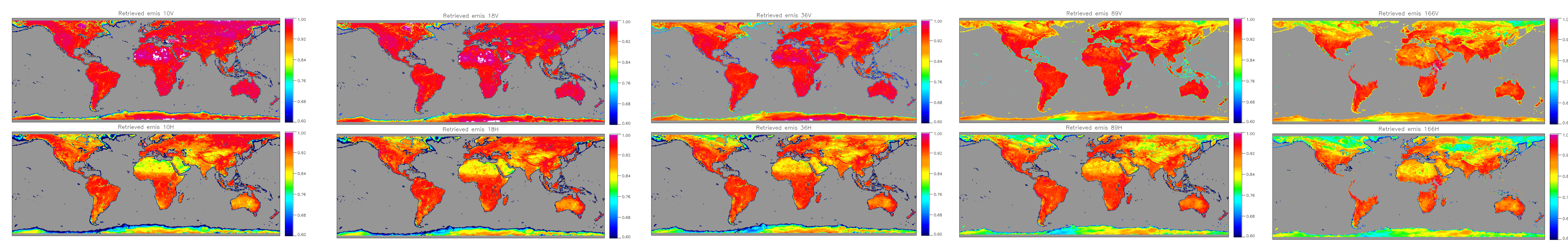
Step 3: Modify combined algorithm by adding wind speed as a retrieved variable and replace PIA with σ_0 in observation vector



Land Surfaces

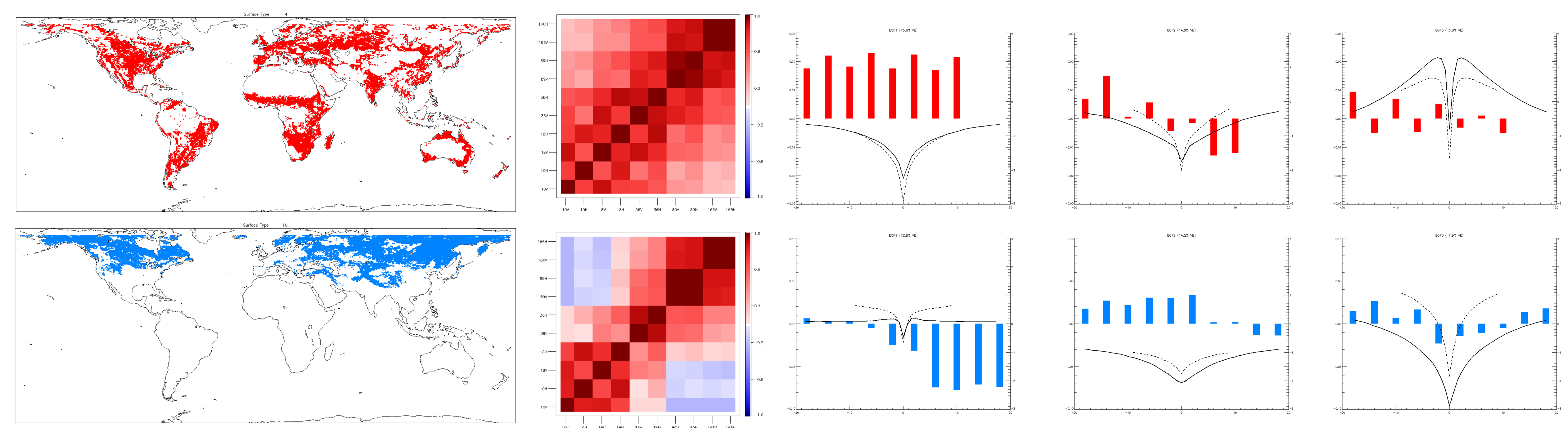
Step 1: Develop GMI land emissivity retrieval

Right: GMI-derived mean emissivities from May 2014-April 2015.



Step 2: Derive covariance matrices and EOFs of emissivity and σ_0 within previously-defined surface classes

Maps, emissivity correlation matrices, and first three EOFs (and regression of Ku and Ka σ_0) for surface types classes representing moderate vegetation (top) and moderate snow (bottom).



Step 3: Modify combined algorithm by generating ensemble of surface emissivities and σ_0 via randomly perturbed EOFs prior to filtering with observed Tbs and σ_0