Optimizing Channel Selection for Passive Microwave Precipitation Measurement: A GPM Study

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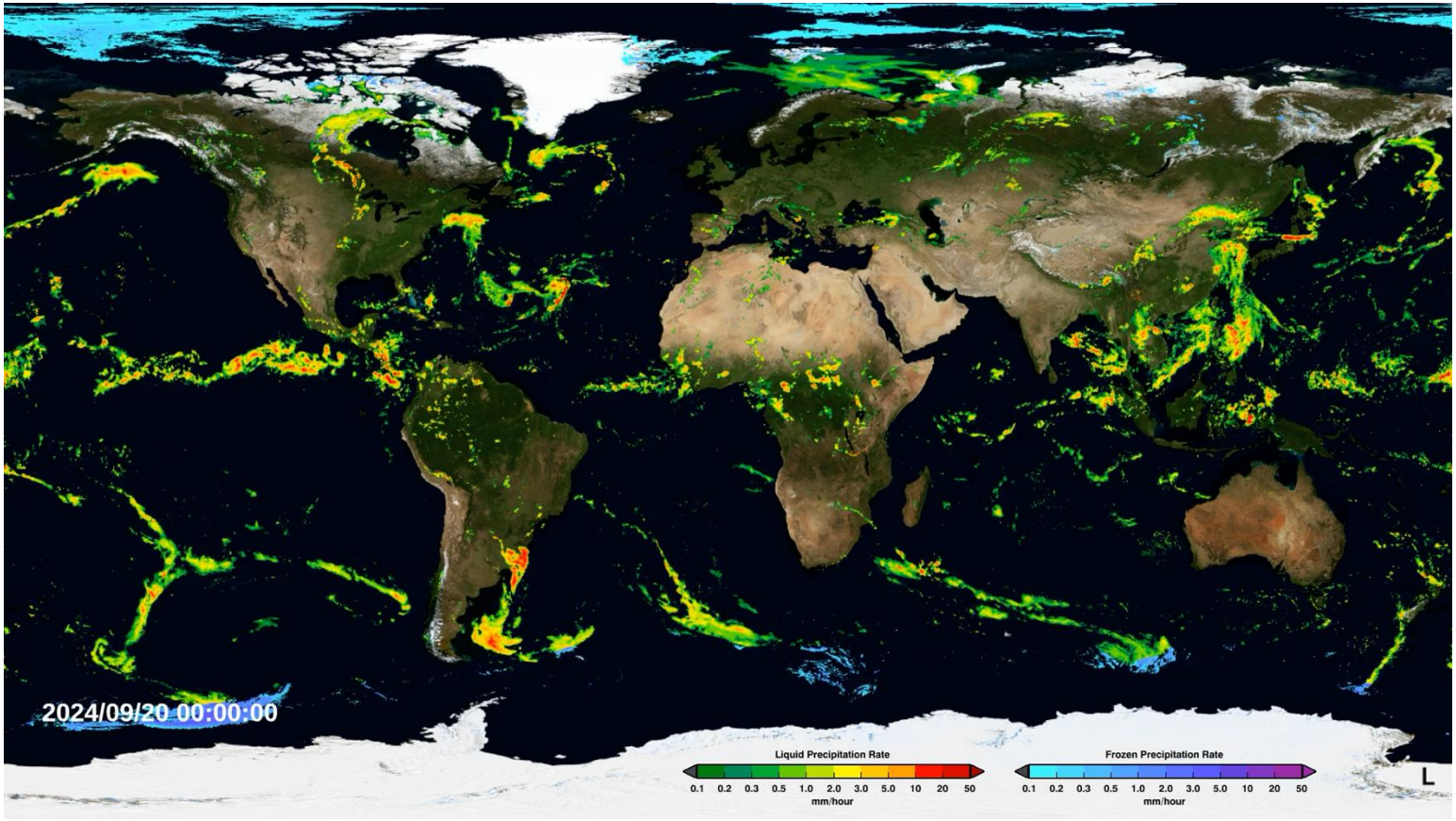
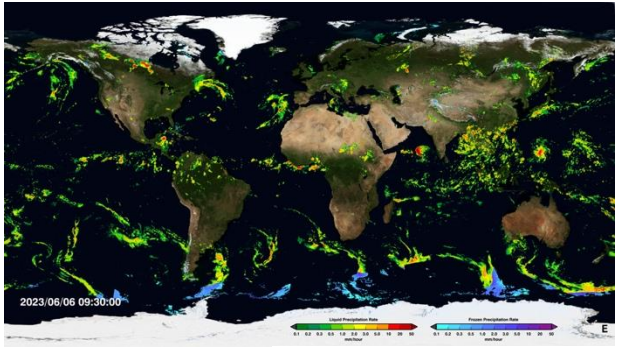
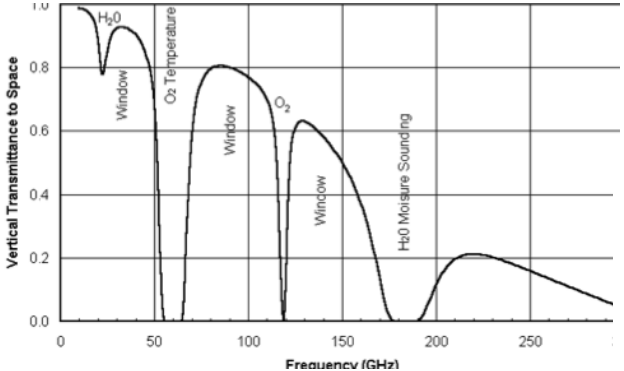
Global Precipitation

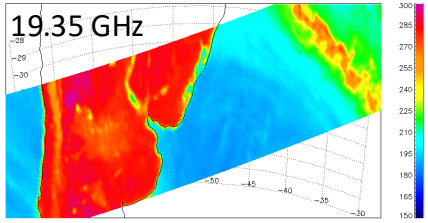


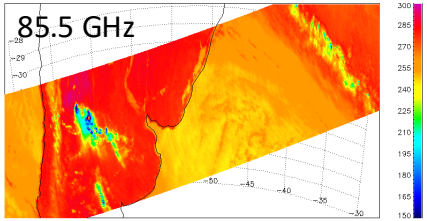
Necessary Ingredients for Multi-Satellite Product

- Sensors with appropriate information content and observation frequency
  - Frequency, resolution
- Passive microwave observations form the backbone of the global product
- Sampling/configuration of constellation members
- Calibration
  - Hardware + software
    - GPM: XCAL & L1C
    - IMERG calibrates using 2BCMB
- Processing system



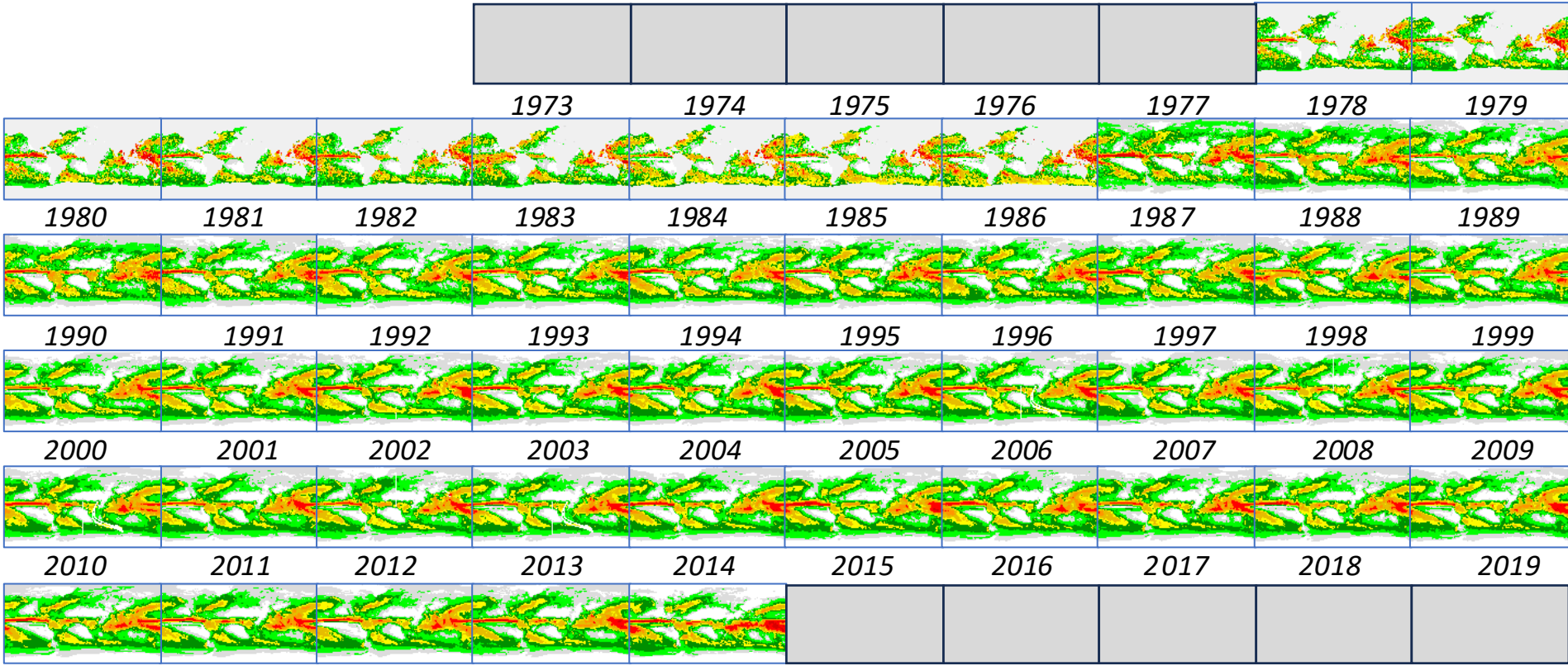




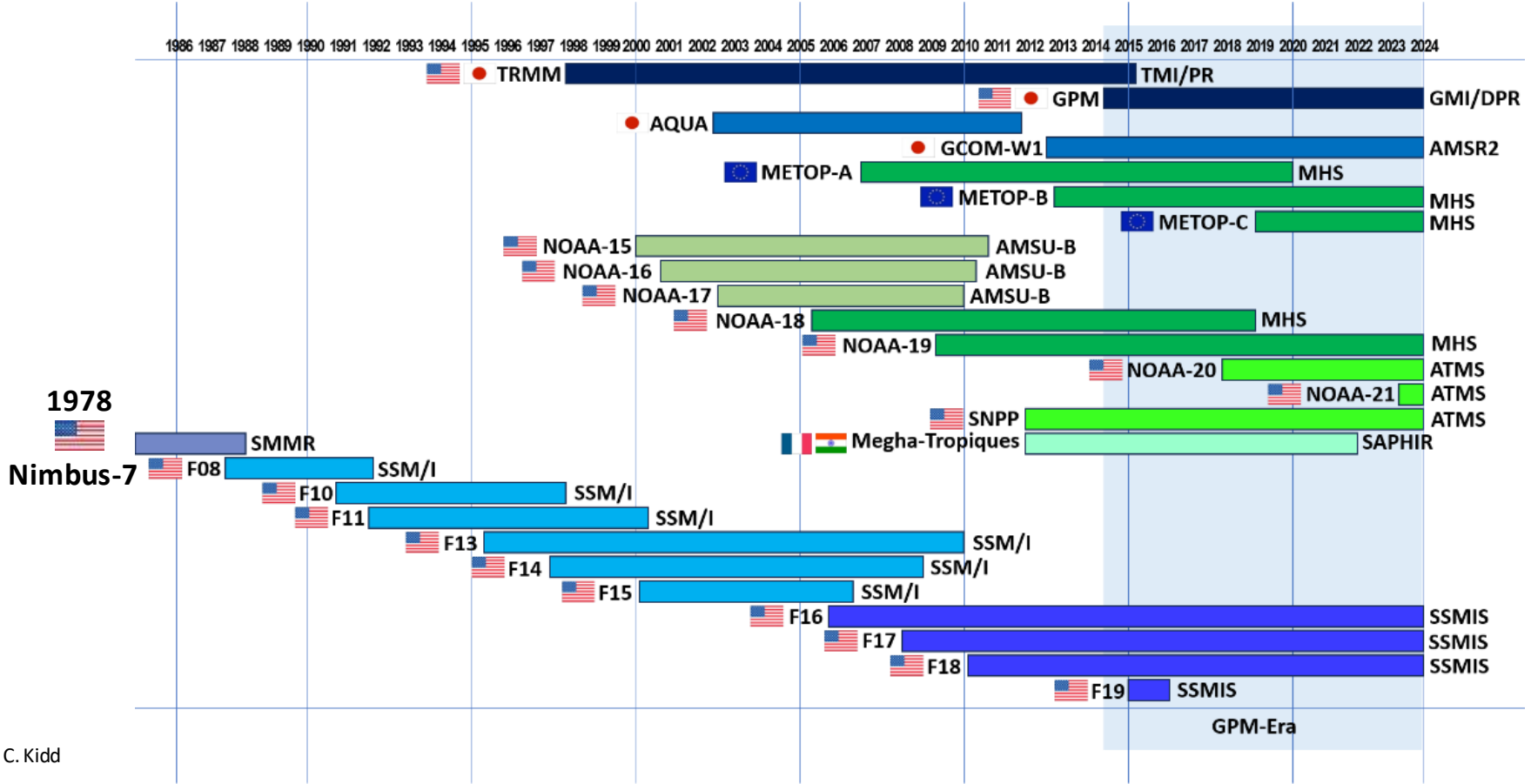


The passive microwave precipitation data record

47 years of PMW precipitation products on the NASA GES-DISC (C. Kidd)

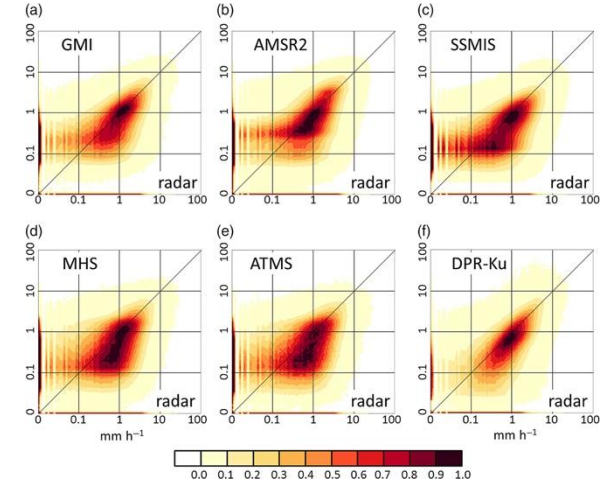


Timeline of passive microwave precipitation observations

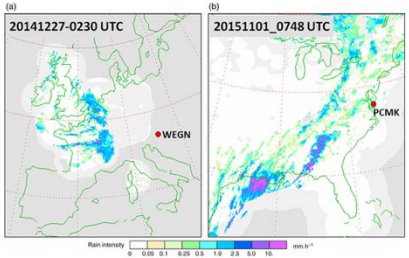


Courtesy C. Kidd

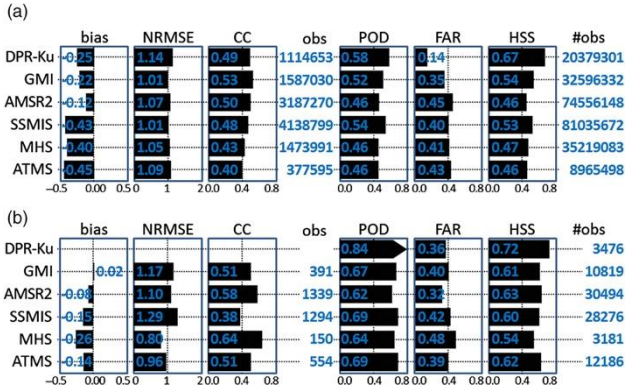
Comparisons to Surface Radar: Kidd et al. 2017

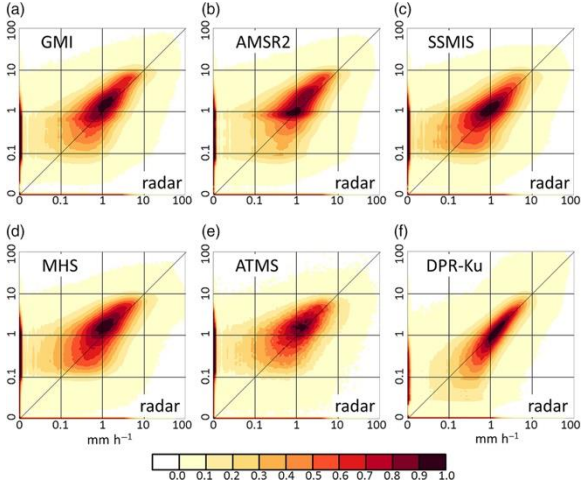


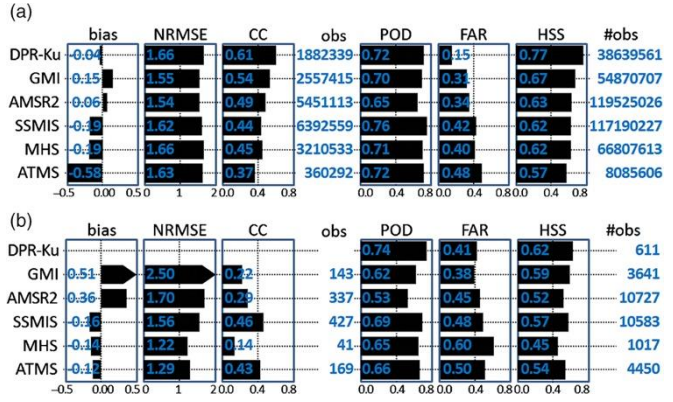
Compare GPM constellation retrievals with surface radar networks in US and Western Europe



High frequency sounders generally show lower skill compared to imagers, especially at lower rain rates

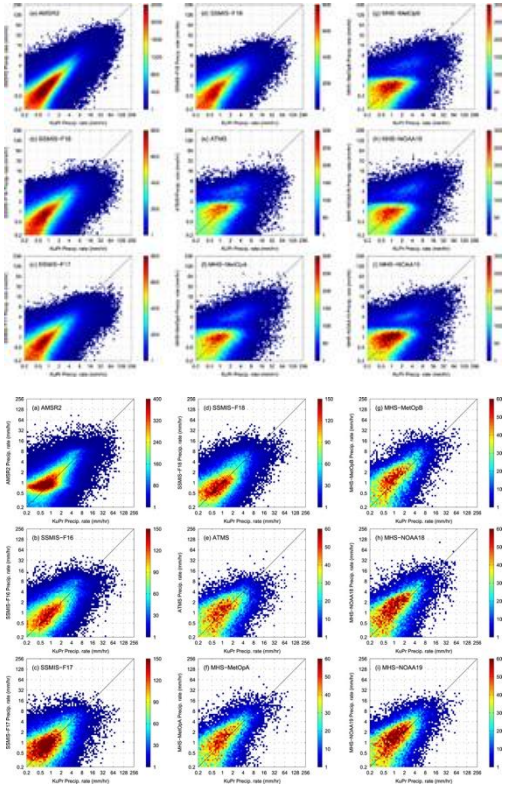






GODDARD EARTH SCIENCES Comparison to GPM Ku: You et al. 2020

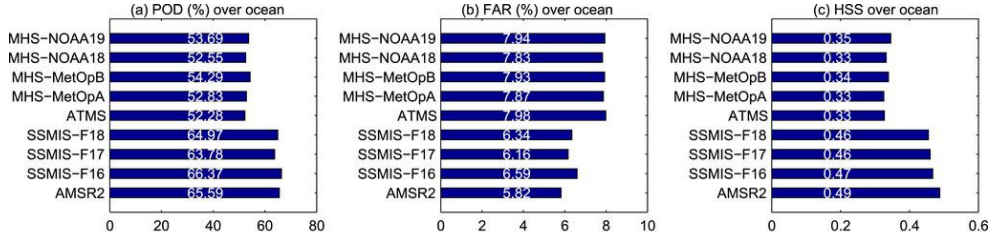
Compare constellation radiometer estimates to spaceborne radar 65N-65S

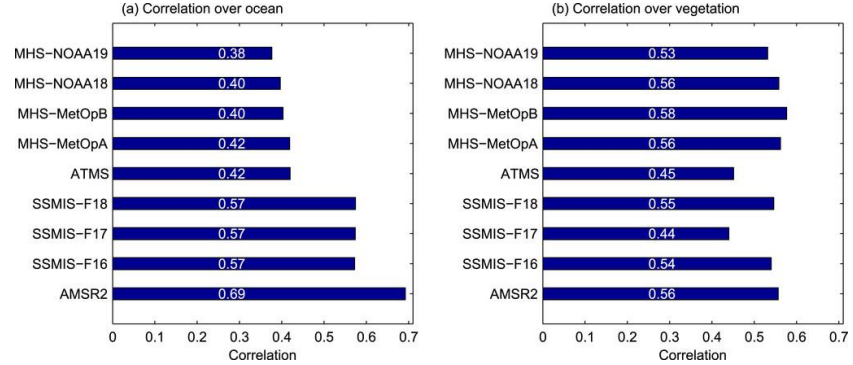


Over ocean, detection performance (top) and intensity correlation (bottom) significantly higher for imagers

Over land, skill is degraded and differences smaller

Authors note differences in frequency, footprint size, conical vs. cross-track, etc.





Experiment Design

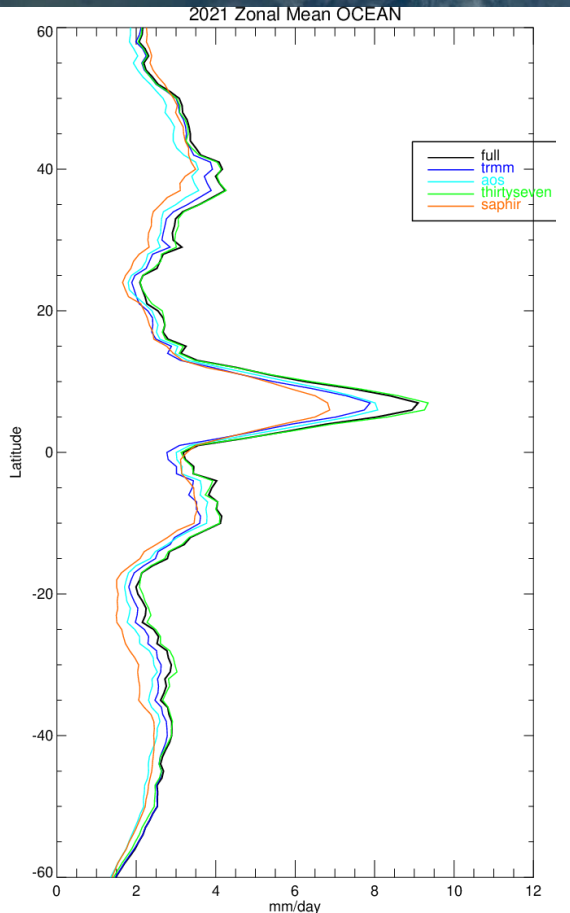
- One year of Bayesian precipitation retrievals 65N-65S using GMI
- Channel subsets used for retrieval, all else constant
- Compare retrieved surface rain rates with Ku and with retrievals using full set of channels

Freq (GHz)	10.65 V/H	18.7 V/H	23 V	37 V/H	89 V/H	166 V/H	183 +/-3 V	183 +/-7 V
Full	x	x	x	x	x	x	x	x
Trmm	x	x	x	x	x			
AOS					x		x	x
37				x	x	x	x	x
Saphir							x	x

Results: Ocean

Statistics wrt Ku radar estimates

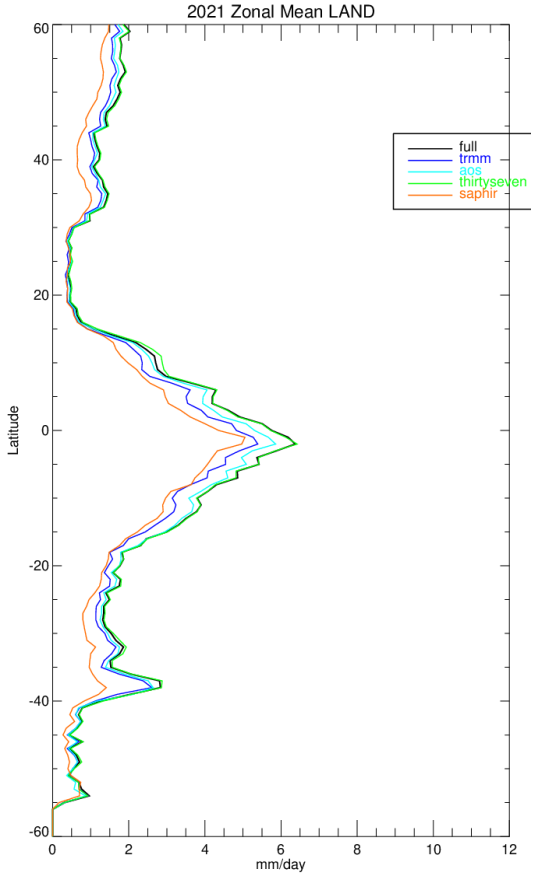
Freq Set	Corr	RMSE	POFA	POD	HSS
Full	0.78	0.61	0.38	0.77	0.65
TRMM	0.84	0.45	0.38	0.76	0.65
AOS	0.53	0.75	0.54	0.72	0.51
37	0.63	0.71	0.39	0.75	0.64
Saphir	0.28	0.80	0.74	0.59	0.28



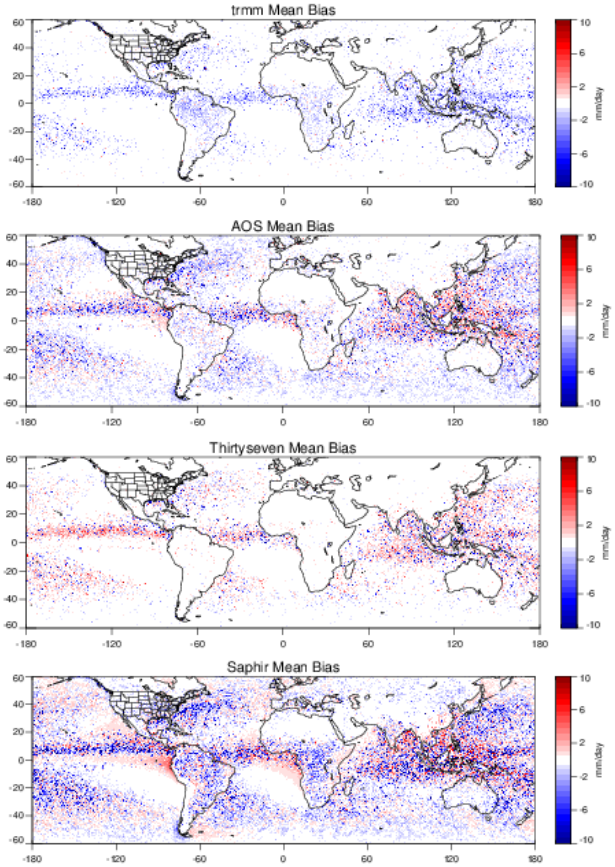
Results: Land

Statistics wrt Ku radar estimates

Freq Set	Corr	RMSE	POFA	POD	HSS
Full	0.57	0.71	0.37	0.73	0.66
TRMM	0.62	0.67	0.36	0.74	0.67
AOS	0.52	0.73	0.39	0.74	0.65
37	0.56	0.71	0.38	0.74	0.65
Saphir	0.19	0.84	0.80	0.63	0.25



Results: Global



(Subset – full channel set retrieval)
Blue – underestimate
Red- overestimate

Biases are not uniform

Convective-stratiform differences

Generally less retrieved precipitation over ocean without 10, 19, 37 GHz

Summary

- Using GMI as a testbed can help quantify rain rate differences based upon channel selection
- Lower GMI frequencies significantly impact estimates over ocean, less over land
- 37 GHz adds significant information impacting skill score over ocean
- Differences are not uniform biases – related to scattering and emission
- Dynamic constellation **will** affect character and continuity of multi-satellite precipitation products