



USAID
FROM THE AMERICAN PEOPLE



FFGS Data Ingest and Quality Control

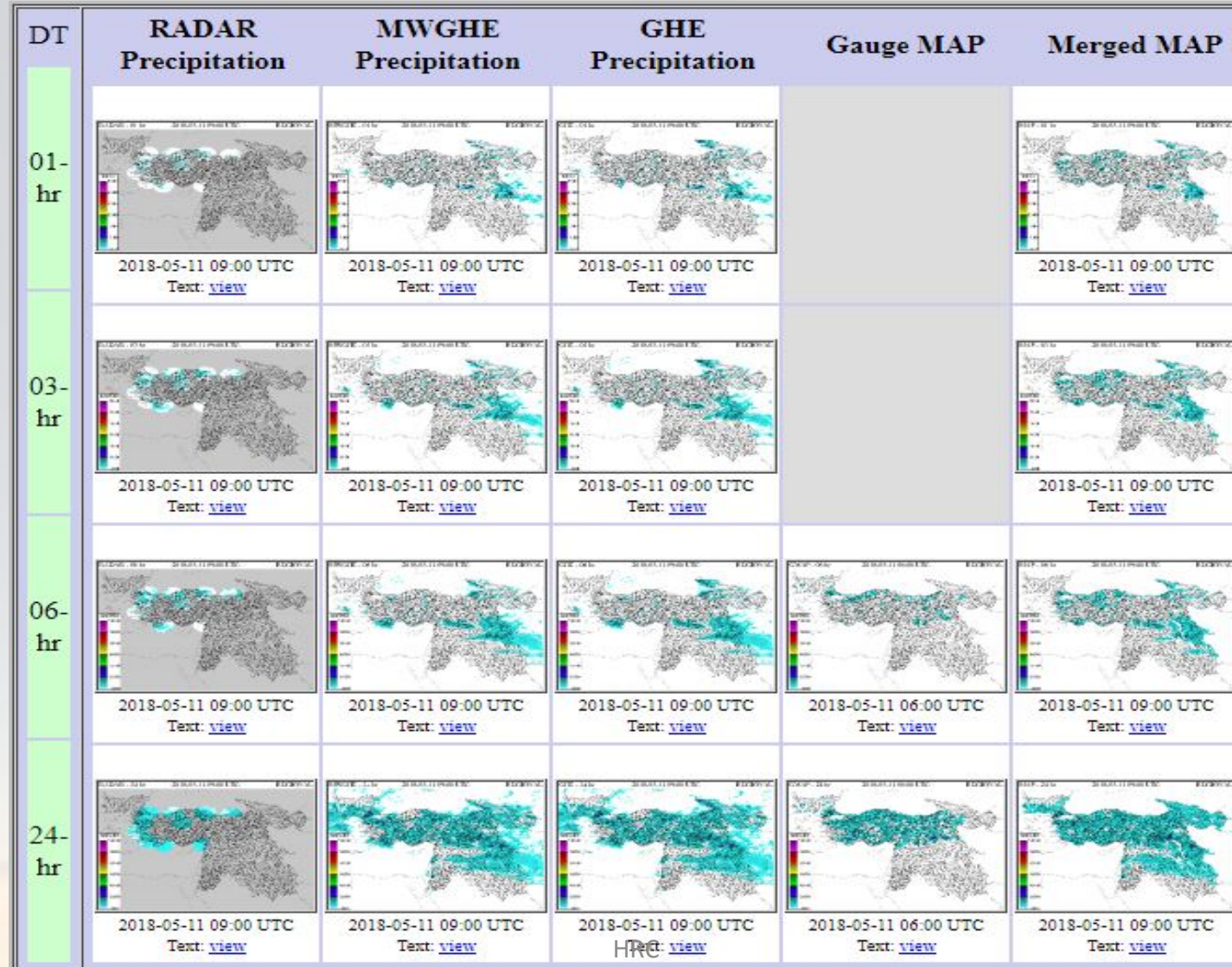
Konstantine P. Georgakakos, Sc.D.

HYDROLOGIC RESEARCH CENTER

23 May 2018

Example Data-Related User Interfaces

Observed Data and Data Quality Controlled Derivative Products



Example Data-Related User Interfaces

Observed On-Site Gauge Data

Composite Product: text , CSV , CSVt						SFTP data transfer (requires SFTP Client): EXPORTS REGIONAL/2018/05/11					
Surfmet Gauge Observations at 2018-05-11 06:00 UTC											
Station Identifier	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Snow Depth (cm)	Snow Cover (Index)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag	Enable Temperature Flag
15502	Vidin	0.00	16.20	No Report	No Report	BULGARIA	43.9942	22.8525	31	Enabled	Enabled
15525	Lovech	0.10	14.50	No Report	No Report	BULGARIA	43.1631	24.7006	220	Enabled	Enabled
15549	Razgrad	1.40	13.40	No Report	No Report	BULGARIA	43.5661	26.5078	346	Enabled	Enabled
15552	Varna	0.00	16.25	No Report	No Report	BULGARIA	43.2125	27.9522	39	Enabled	Enabled
15600	Murgash	9.00	5.25	No Report	No Report	BULGARIA	42.8333	23.6683	1687	Enabled	Enabled
15614	Sofia	0.30	13.40	No Report	No Report	BULGARIA	42.6553	23.3847	586	Enabled	Enabled

Station Identifier	17204
Station Name	Mus
Region	TURKEY
Latitude	38.7509
Longitude	41.5023
Elevation (m)	1322
Agency	TURKEY
Type	SYNOP
Precipitation Enabled Flag	Enabled
Temperature Enabled Flag	Enabled

Reported Surfmet Gauge Observations from Station '17204' within the past 30 days					
Station Identifier	Observation Date & Time	Precipitation (mm/06hr)	Temperature (C)	Snow Depth (cm)	Snow Cover (Index)
17204	2018-05-11 06:00:00-00	2.40	10.30	No Data	No Data
17204	2018-05-11 00:00:00-00	0.60	10.85	No Data	No Data
17204	2018-05-10 18:00:00-00	0.10	14.15	No Data	No Data
17204	2018-05-10 12:00:00-00	0.00	16.03	No Data	No Data
17204	2018-05-10 06:00:00-00	0.00	10.15	No Data	No Data
17204	2018-05-10 00:00:00-00	0.00	9.27	No Data	No Data
17204	2018-05-09 18:00:00-00	1.00	10.77	No Data	No Data
17204	2018-05-09 12:00:00-00	2.00	10.55	No Data	No Data
17204	2018-05-09 06:00:00-00	19.00	8.07	No Data	No Data
17204	2018-05-09 00:00:00-00	3.00	8.05	No Data	No Data
17204	2018-05-08 18:00:00-00	1.00	9.28	No Data	No Data
17204	2018-05-08 12:00:00-00	16.00	9.30	No Data	No Data
17204	2018-05-08 06:00:00-00	0.80	12.33	No Data	No Data
17204	2018-05-08 00:00:00-00	0.00	12.68	No Data	No Data
17204	2018-05-07 18:00:00-00	12.00	11.17	No Data	No Data
17204	2018-05-07 12:00:00-00	12.00	11.53	No Data	No Data
17204	2018-05-07 06:00:00-00	1.00	11.35	No Data	No Data
17204	2018-05-07 00:00:00-00	0.00	12.48	No Data	No Data
17204	2018-05-06 18:00:00-00	0.00	16.37	No Data	No Data

Example Data-Related User Interfaces

Dashboard – For Data and Server Status and Health

2018-05-11 17:22:14 EET
BSMEFFG - Real-Time Status Dashboard
2018-05-11 15:23:14 UTC

Image Products

GHE - 01 hr 2018-05-11 14:00 UTC REGIONAL

Animate 01-hr Sat Precip - 24 Images - (Pop-Up Window)

Status - 06 hr 2018-05-11 12:00 UTC REGIONAL

Blue = Reported, Red = Missing

No Animation Available for this Image

ASM - 06 hr 2018-05-11 12:00 UTC REGIONAL

Animate 06-hr ASM - 24 Images - (Pop-Up Window)

FMAP-ALADIN - 06 hr 2018-05-11 14:00 UTC REGIONAL

Animate 06-hr FMAP - 24 Images - (Pop-Up Window)

Real-Time Data Download and Inventory Status

NESDIS GHE Download					GAUGE Download					IMS Download					RADAR Download					ALADIN Download					NESDIS MWGHE Download					IFS Download					WRF Download									
ENABLED					ENABLED					ENABLED					ENABLED					ENABLED					ENABLED					ENABLED														
SUCCESS					SUCCESS					SUCCESS					SUCCESS					SUCCESS					SUCCESS					SUCCESS														
May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11	May-07	May-08	May-09	May-10	May-11					
24	24	24	24	14	91%	91%	91%	91%	90%	1	1	1	1	1	239	240	240	240	154	0	0	0	0	0	24	24	24	24	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Real-Time Data Processing Status

NESDIS GHE Data Processing		GAUGE Data Processing		IMS Data Processing		RADAR Data Processing		ALADIN Data Processing		NESDIS MWGHE Data Processing		IFS Data Processing		WRF Data Processing	
ENABLED		ENABLED		ENABLED		ENABLED		ENABLED		ENABLED		ENABLED		ENABLED	
SUCCESS		SUCCESS		SUCCESS		PENDING		PENDING		SUCCESS		SUCCESS		PENDING	

Model Processing Status

SNOW Model Processing			SACSMA & FFG Model Processing		
ENABLED			ENABLED		
SUCCESS			SUCCESS		

Export Processing Status

Text/CSV Exports			Image Exports		
ENABLED			ENABLED		
SUCCESS			PENDING		

Computational Server Status

General Info				Processing Load				CPU Activity				Disk Activity			Storage			
IP Address	Hostname	Uptime	Active Logins	1-Min	5-Min	15-Min	Swap Used	User	System	IOWait	Idle	Transfers	Read	Write	Free	Used	% Used	Days to Filled
192.168.2.78	BSMEFFG-CS	465.09 days	0	22.62%	20.16%	18.66%	144817 KB	16.11%	0.88%	0.00%	83.01%	494.80 t/s	2.00 KB/s	8.723.20 KB/s	10,374,189 MB	5,301,008 MB	34%	2026 days

Dissemination Server Status

General Info				Processing Load				CPU Activity				Disk Activity			Storage			
IP Address	Hostname	Uptime	Active Logins	1-Min	5-Min	15-Min	Swap Used	System	User	IOWait	Idle	Transfers	Read	Write	Free	Used	% Used	Days to Filled
192.168.2.79	BSMEFFG-DS	472.11 days	3	29.16%	29.00%	26.00%	1481636 KB	4.22%	0.75%	6.51%	88.52%	409.00 t/s	1,631.20 KB/s	43.60 KB/s	5,232,071 MB	10,443,129 MB	67%	1022 days

Regional [Armenia](#) [Azerbaijan](#) [Bulgaria](#) [Georgia](#) [Iraq](#) [Lebanon](#) [Syria](#) [Turkey](#) [Jordan](#)

Go to Regional Product Console

23 May 2018
4

BSMEFFG Real-Time Status Dashboard v.1.0, © 2013 Hydrologic Research Center

Example Data-Related User Interfaces

Processing LOGS – Warnings, Errors and Processing Summaries

BSMEFFG - Black Sea Middle East Flash Flood Guidance System

Current Date: 2018-05-11 15:41 UTC Nav Date: 2018-05-11 15:00 UTC

Year: 2018 Month: 05 Day: 11 Hour: 15 Submit

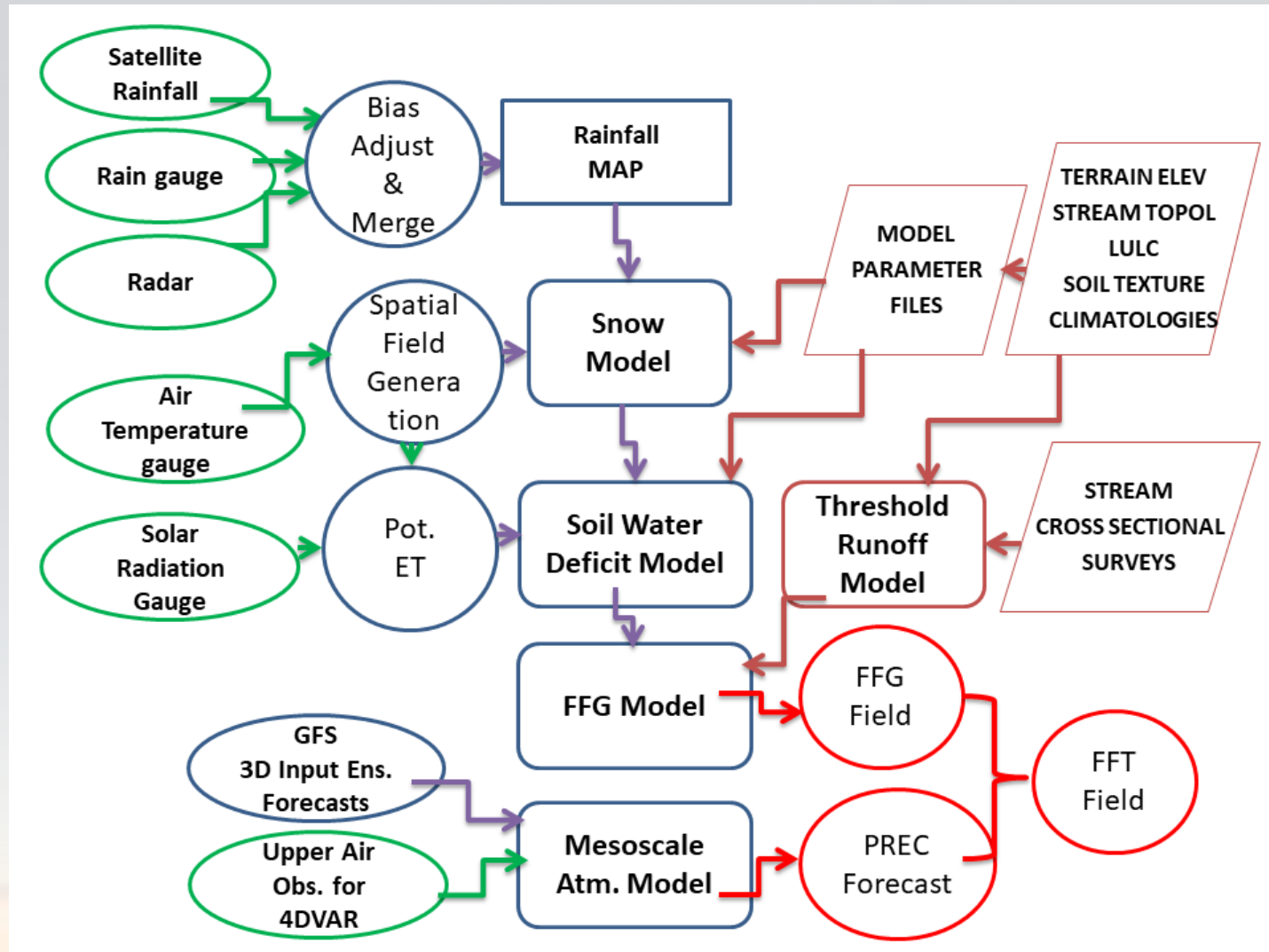
-1 Month -1 Day -6 Hours -1 Hour +1 Hour +6 Hours +1 Day +1 Month

Prev 6-hr Interval (12 UTC) Reset to Current Next 6-hr Interval (18 UTC)

Return to Main

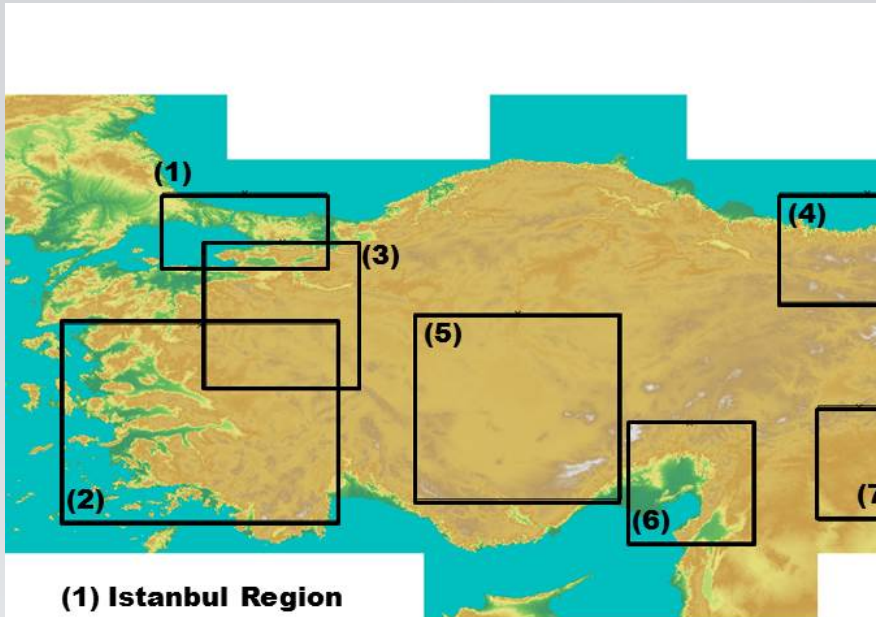
DISPLAY BSMEFFG Real-Time Product Console SYSTEM PROCESSING LOGS	
Selected Hourly Logs	Viewing Selected Log File
20180511-150999 99999 BSMEFFG-CS_warnings_summary.txt 20180511-150999 99999 BSMEFFG-CS_error_summary.txt 20180511-153246 99999 BSMEFFG-CS_process_branch_radar_precip_cron_log.txt 20180511-153214 99999 BSMEFFG-CS_process_branch_she_precip_cron_log.txt 20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt 20180511-152501 99999 BSMEFFG-CS_process_sequence_she_precip_cron_log.txt 20180511-151755 99999 BSMEFFG-CS_process_branch_gauge_surfmet_cron_log.txt 20180511-151501 99999 BSMEFFG-CS_process_sequence_radar_precip_cron_log.txt 20180511-151501 99999 BSMEFFG-CS_process_sequence_gauge_surfmet_cron_log.txt 20180511-150731 99999 BSMEFFG-CS_process_branch_forecast2_precip_cron_log.txt 20180511-150701 99999 BSMEFFG-CS_process_branch_forecast1_precip_cron_log.txt 20180511-150252 99999 BSMEFFG-CS_process_branch_forecast2_precip_cron_log.txt 20180511-150124 99999 BSMEFFG-CS_process_branch_ims_snowcover_cron_log.txt 20180511-150120 99999 BSMEFFG-CS_process_branch_gfs_master_cron_log.txt 20180511-150102 99999 BSMEFFG-CS_process_sequence_ims_snowcover_cron_log.txt 20180511-150102 99999 BSMEFFG-CS_process_sequence_gfs_master_cron_log.txt 20180511-150102 99999 BSMEFFG-CS_process_sequence_forecast2_precip_cron_log.txt 20180511-150102 99999 BSMEFFG-CS_process_sequence_forecast2_precip_cron_log.txt 20180511-150102 99999 BSMEFFG-CS_process_sequence_forecast1_precip_cron_log.txt	<p>WARNING Summary Log last updated: Fri May 11 15:39:05 UTC 2018</p> <p>This is a collection of all logged WARNING messages for the current day and for any date within the TEMP processing directories.</p> <p>***** MESSAGES WITHIN /BSMEFFG/OPERATIONAL/TEMP *****</p> <p>20180511-153214_32118_export_product_image_gridded_precip_ghe.exe_bsmeffg/20180511-153214_32118_export_product_image_gridded_precip_ghe.exe_20180511-1500.</p> <p>***** MESSAGES FROM CRON LOGS WITHIN /BSMEFFG/OPERATIONAL/LOGS/2018/05/11 *****</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named 'FFGS_MODULE_AGGREG.</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-153001 99999 BSMEFFG-CS_process_sequence_models_cron_log.txt:WARNING: aggregate_product_selection_basin_map_merged.exe, initialize_aggregate_prod</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: extract_native_gridded_precip_ghe.exe, main(0): Unable to retrieve f.</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: extract_native_gridded_precip_ghe.exe, main(0): Unable to retrieve fi</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: export_product_text_gridded_precip_ghe.exe, main(0): Processed data f.</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: export_product_image_gridded_precip_ghe.exe, main(0): Processed data</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: aggregate_areal_average_basin_map_ghe.exe, main(0): Unable to retrieve</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: aggregate_areal_average_basin_map_ghe.exe, main(0): Processed NESDIS</p> <p>20180511-152501 99999 BSMEFFG-CS_process_sequence_ghe_precip_cron_log.txt:WARNING: acquire_remote_realtime_ghe_precip.exe, retrieve_remote_data_product(1)</p> <p>20180511-151501 99999 BSMEFFG-CS_process_sequence_gauge_surfmet_cron_log.txt:WARNING: hourly_process_sequence_gauge_surfmet.sh's crontab entry is active,</p> <p>20180511-150102 99999 BSMEFFG-CS_process_sequence_ims_snowcover_cron_log.txt:WARNING: hourly_process_sequence_ims_snowcover.sh's crontab entry is active,</p> <p>20180511-150102 99999 BSMEFFG-CS_process_sequence_gfs_master_cron_log.txt:WARNING: hourly_process_sequence_gfs_master.sh's crontab entry is active, but \$!</p> <p>20180511-150102 99999 BSMEFFG-CS_process_sequence_forecast3_precip_cron_log.txt:WARNING: hourly_process_sequence_forecast3_precip.sh's crontab entry is a</p> <p>20180511-150102 99999 BSMEFFG-CS_process_sequence_forecast2_precip_cron_log.txt:WARNING: hourly_process_sequence_forecast2_precip.sh's crontab entry is a</p> <p>20180511-150102 99999 BSMEFFG-CS_process_sequence_forecast1_precip_cron_log.txt:WARNING: hourly_process_sequence_forecast1_precip.sh's crontab entry is a</p> <p>20180511-144601 99999 BSMEFFG-CS_process_sequence_mwghc_precip_cron_log.txt:WARNING: extract_native_gridded_precip_mwghc.exe, main(0): Unable to retriev</p> <p>20180511-144601 99999 BSMEFFG-CS_process_sequence_mwghc_precip_cron_log.txt:WARNING: extract_native_gridded_precip_mwghc.exe, main(0): Unable to retriev</p> <p>20180511-144601 99999 BSMEFFG-CS_process_sequence_mwghc_precip_cron_log.txt:WARNING: export_product_text_gridded_precip_mwghc.exe, main(0): Processed da</p> <p>20180511-144601 99999 BSMEFFG-CS_process_sequence_mwghc_precip_cron_log.txt:WARNING: export_product_image_gridded_precip_mwghc.exe, main(0): Processed da</p>

Data and Model Flow Diagram

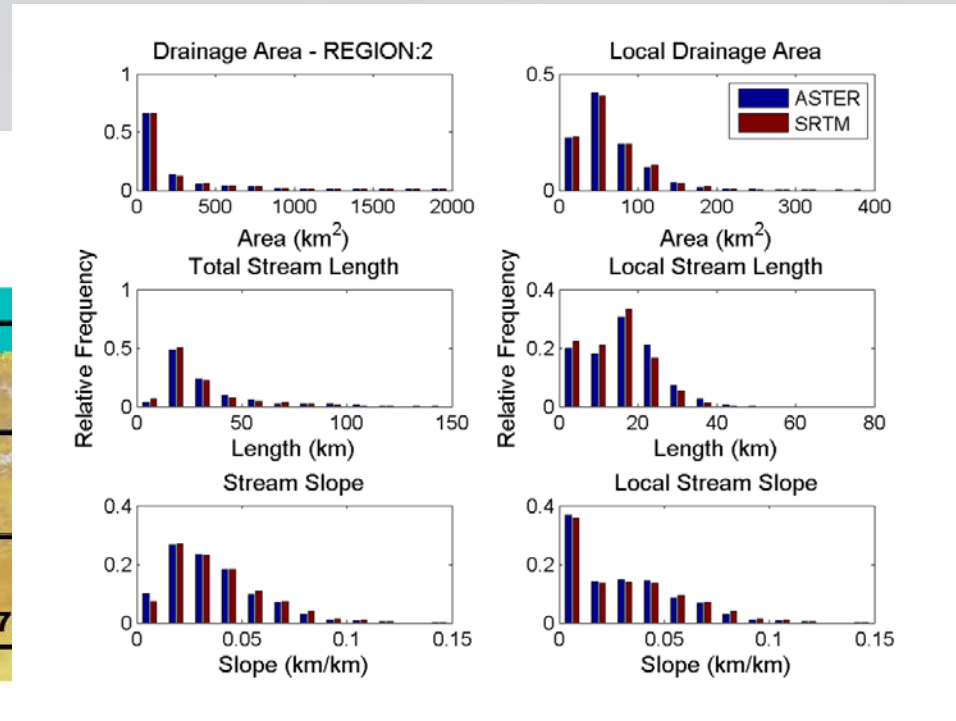


Delineations Worldwide

SRTM 90m versus ASTER 30m

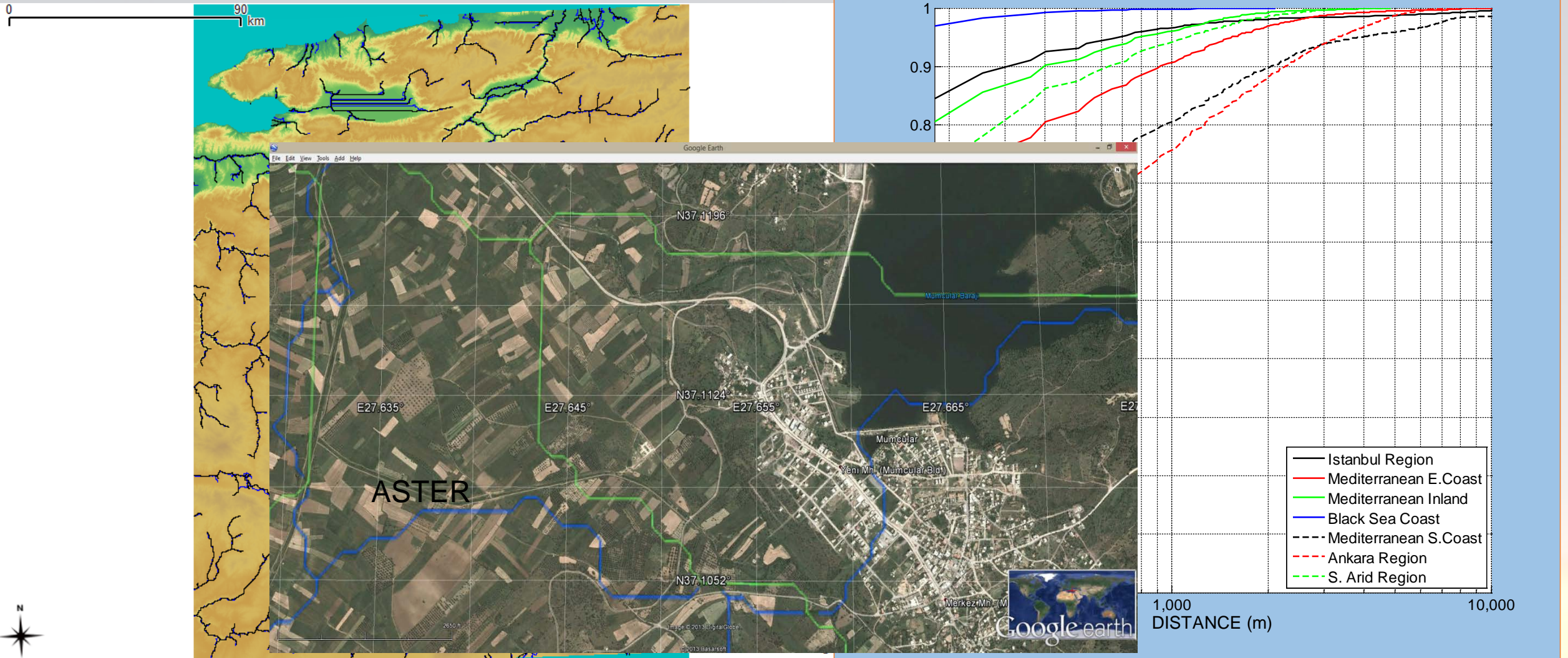


- (1) Istanbul Region**
- (2) Mediterranean Coast**
- (3) Mediterranean Inland**
- (4) Black Sea Coast**
- (5) Region South of Ankara**
- (6) South Mediterranean Coast**
- (7) Southern Arid Region**

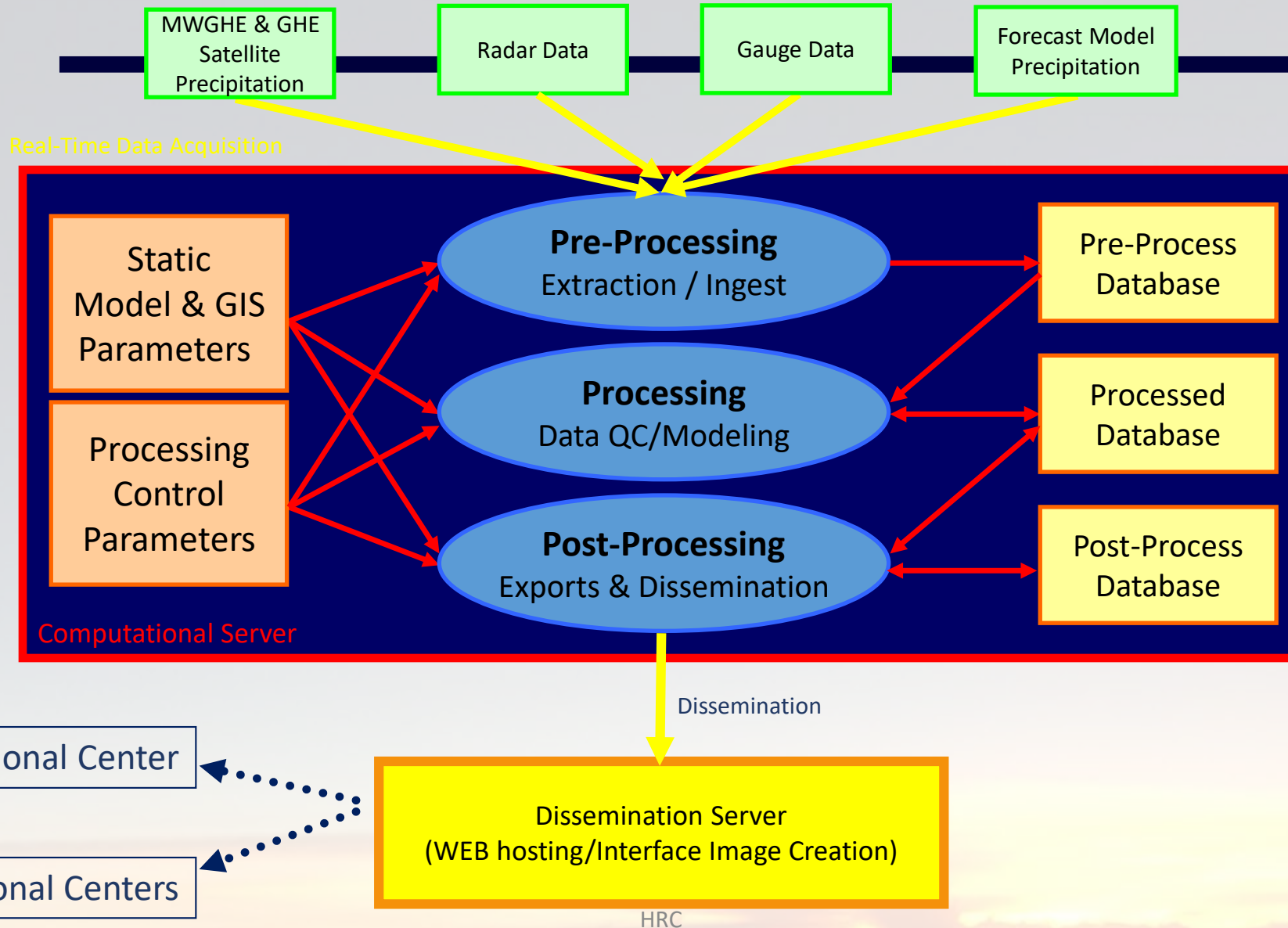


Delineations Worldwide

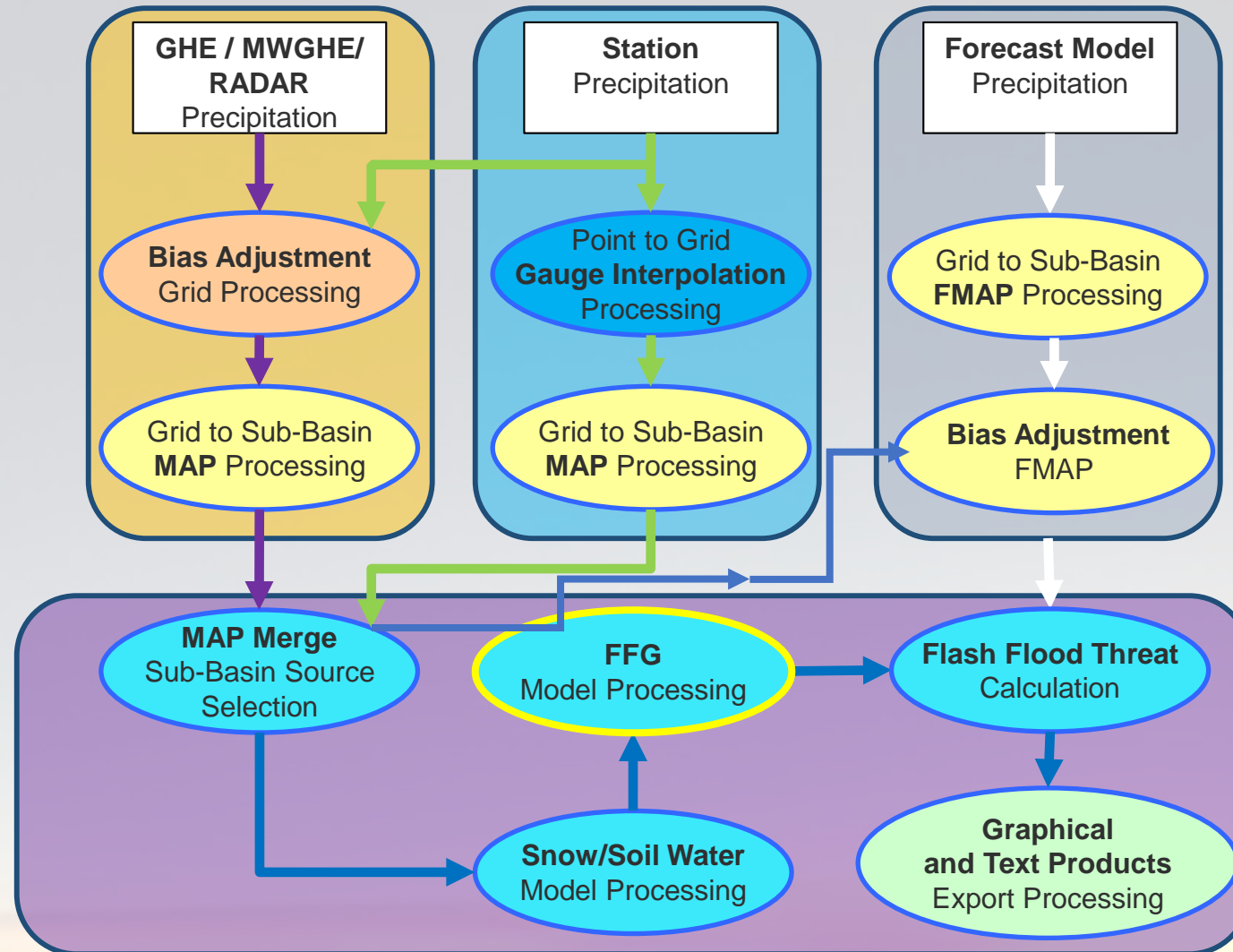
Before Finalizing Shapefiles Reviewed by Countries and Appropriate Adjustments are Made at HRC



FFGS General Data Flow Processing Design



FFGS Precipitation Processing



Current Multi-Sensor Strategy

Global Data

NESDIS GLOBAL HYDROESTIMATOR (IR, MODEL, OROGRAPHY) – Short Latency
CMORPH (MW-BASED) – Longer latency

Regional and Local Data

OPERATIONAL RADAR CAPPI (IF IN DIGITAL FORM) – Short latency
OPERATIONAL PRECIPITATION GAUGES – Short Latency

Initial Quality Control – Requires historical data – Requires NMHS Agency Collaboration

Snow Mask for CMORPH (IMS)

Radar CAPPI Analysis to develop Radar Mask of Invalid Data for Application

Raingauge data analysis for persistent errors and unrealistic values

Bias Adjustments – Requires historical data - Requires NMHS Agency Collaboration

CMORPH + GHE → MWGHE (gridded)

MWGHE, Radar Data, Raingauge Data → MWGHE, Radar, Raingauge MAP

MWGHE MAP + Raingauge MAP → Bias Adj MWGHE MAP

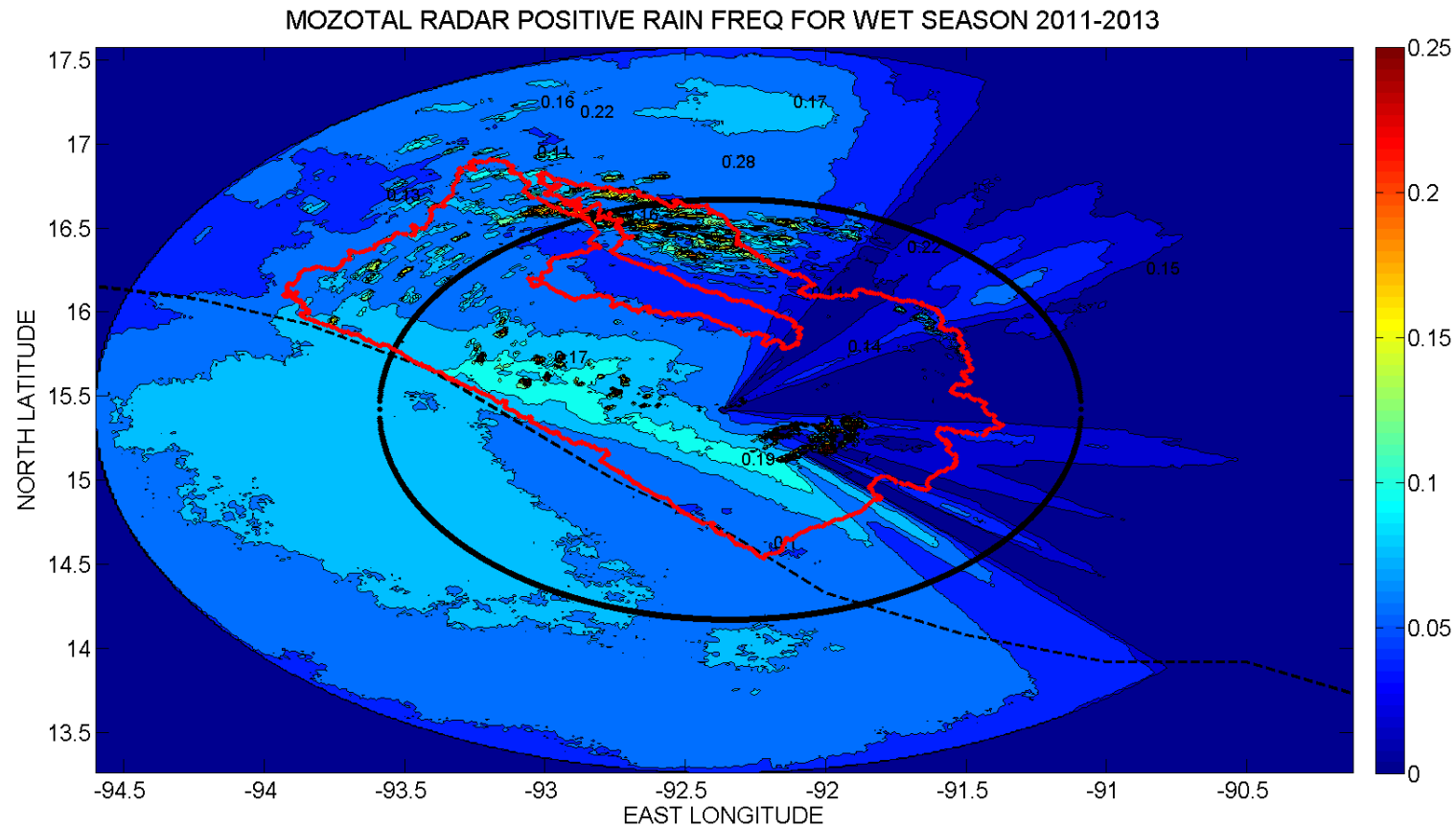
RADAR MAP + Raingauge MAP → Bias Adj RADAR MAP

Merging: Bias Adj RADAR MAP – Bias Adj MWGHE MAP -

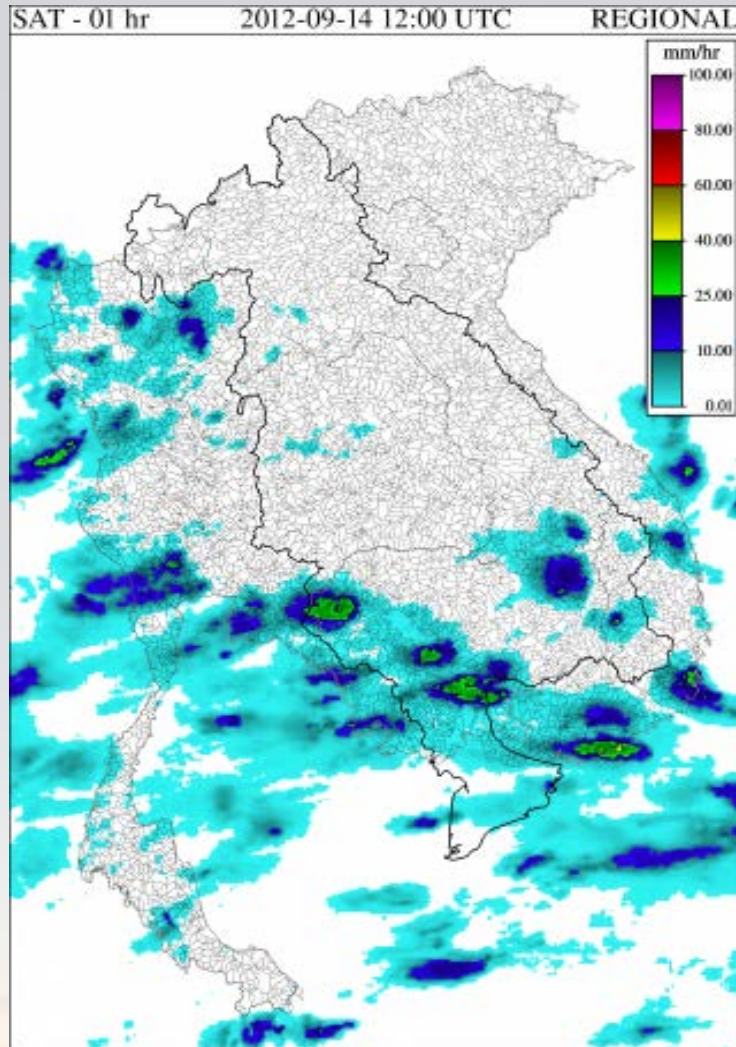
Example Positive Rainfall Frequency

C-band (1 degree beam width) Radar at ~3 km altitude ; 4km CAPPI

Gauges with < 20% of time missing data used for reference



Satellite Precipitation – NESDIS Global Hydroestimator (GHE)



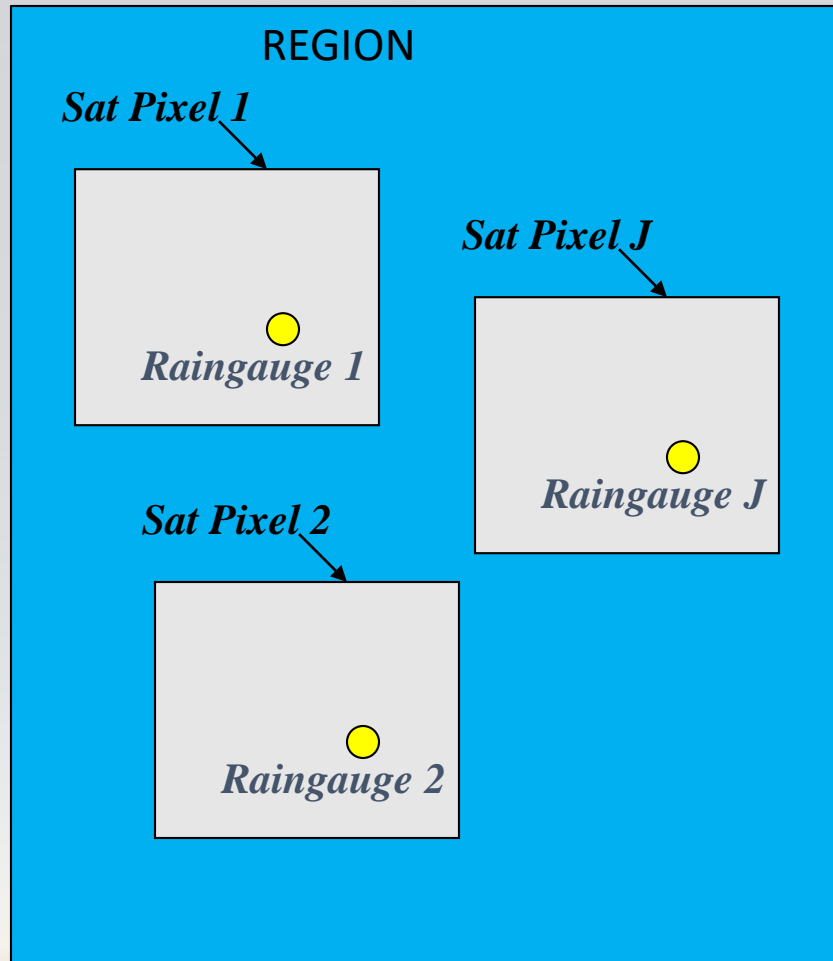
- IR based (10.7 μm)
- Short latency

Rain Rate =
Function of brightness temperature

Enhanced for:

1. Atmospheric moisture effects
2. Orography (upslope/downslope)
3. Convective Equilibrium Level (warm-top convection)
4. Local pixel T difference with surroundings
5. Convective core/no-core region

Bias and Log-Bias Factors



Log-Bias

$$\beta_t = \ln \left[\frac{\sum_{j=1}^{N_g} R_g(t, j)}{\sum_{j=1}^{N_g} R_s(t, j)} \right]$$

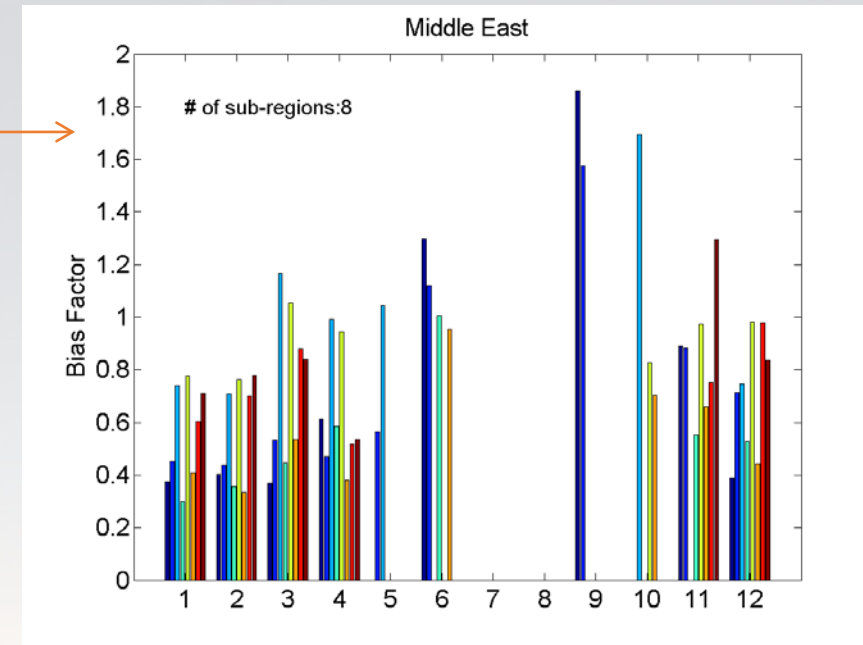
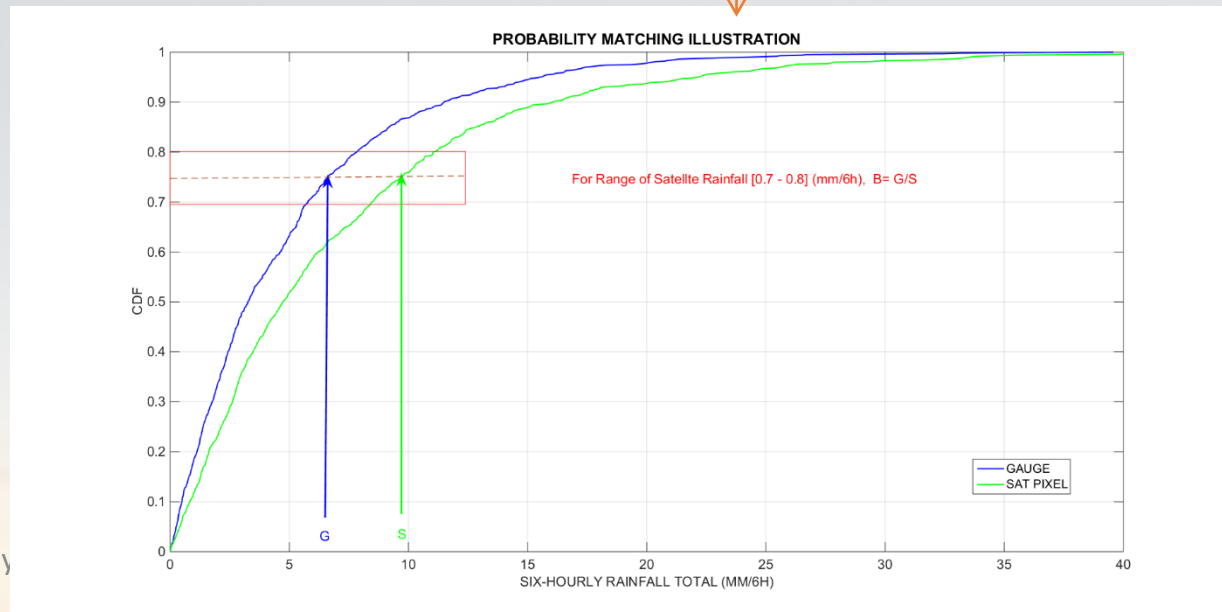
Bias (B)

Climatological Adjustment Using Gauges and Corresponding Satellite Pixel Data

- Historical Data for regions of uniform hydroclimatology, terrain and gauge density
- Usually done for an given month or season
- Result is bias factor for each region and month/season

Bias Factor computed from:

- (1) Mean values
- (2) Probability matching considerations



Dynamic Bias Adjustment Basics

$$\beta_t = \ln \left[\frac{\sum_{j=1}^{N_g} R_g(t, j)}{\sum_{j=1}^{N_g} R_s(t, j)} \right]$$
$$\beta_{t+1} = \beta_t + w_{t+1}$$
$$z_{t+1} = \beta_{t+1} + v_{t+1}$$

Kalman Filter Stochastic Approximations

- N pairs of consecutive values
- At least 20% raingauges with rain
- Conditional Mean > Threshold (mm/h)
(satellite/radar and gauge)

Bias (B)

Important issue:
Gauge data quality control

Multi-Spectral Satellite Rainfall

HE

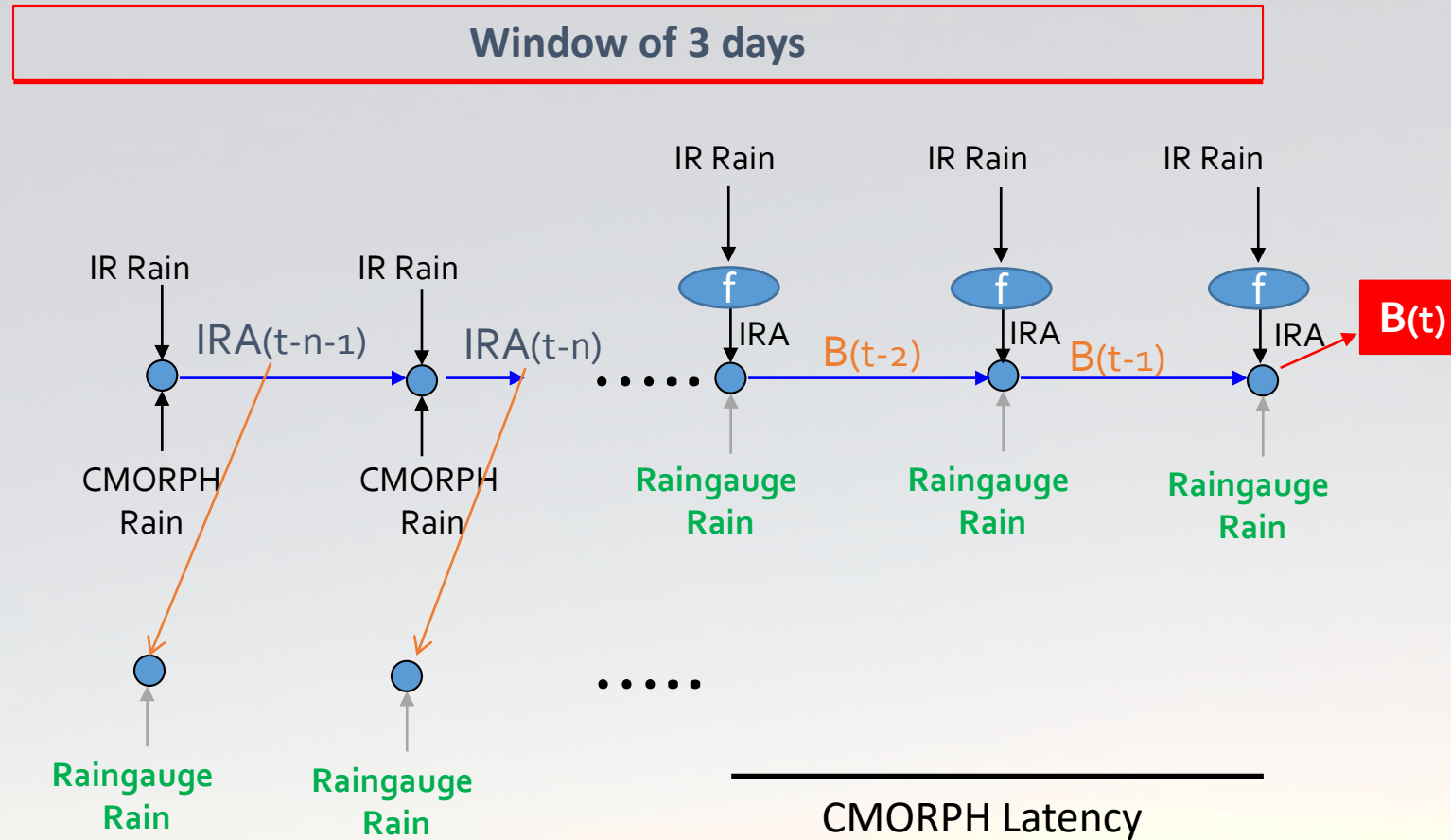
IR – Based
30-min latency in operations
Based on measurements of top
cloud brightness temperature

CMORPH

MW – Based
18-26 hour latency in operations
Based on measurements of
microwave scattering from raindrops

New global FFGS product combines IR-based HE rainfall with MW-based CMORPH rainfall

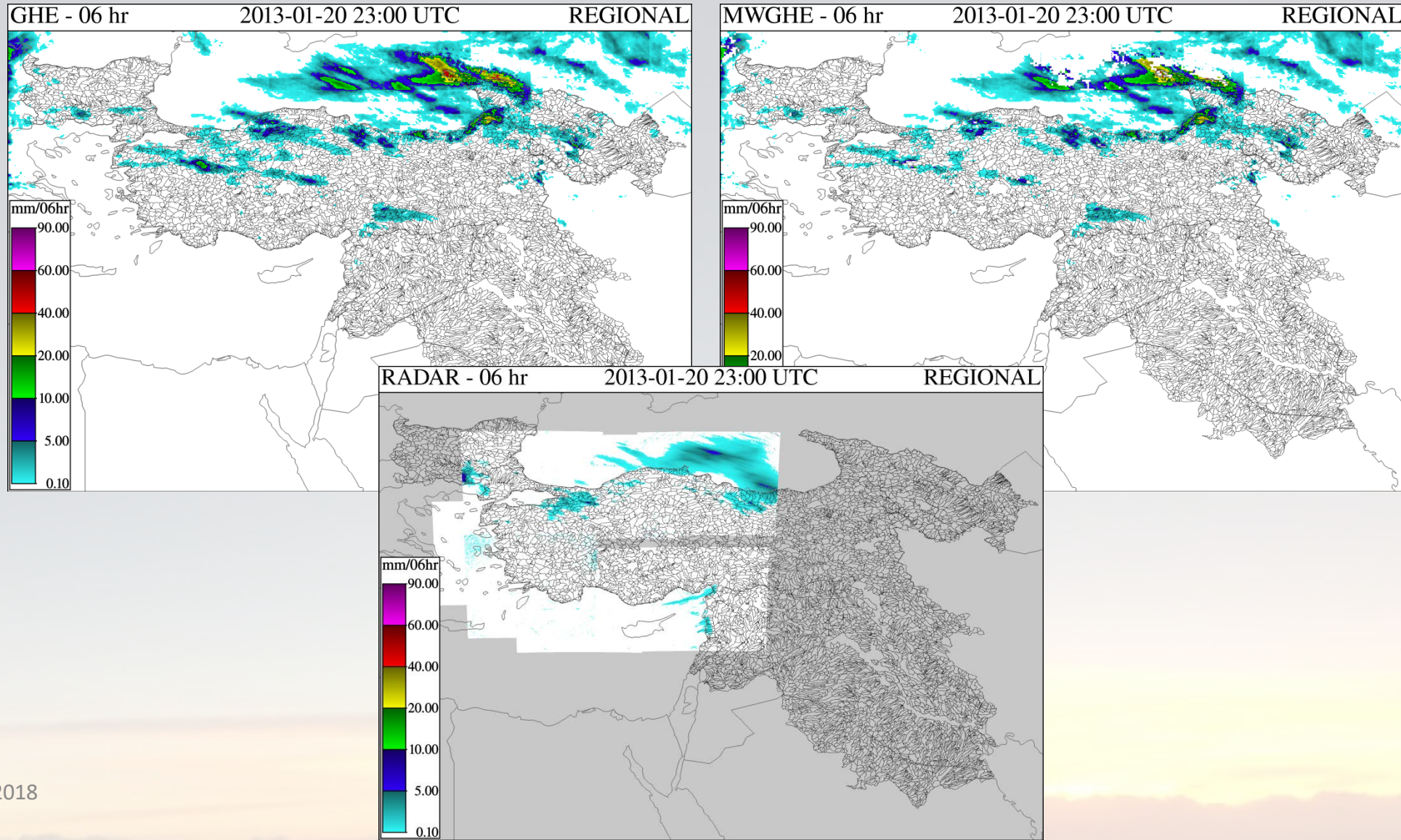
Multi-Spectral Satellite Rainfall for FFG Systems



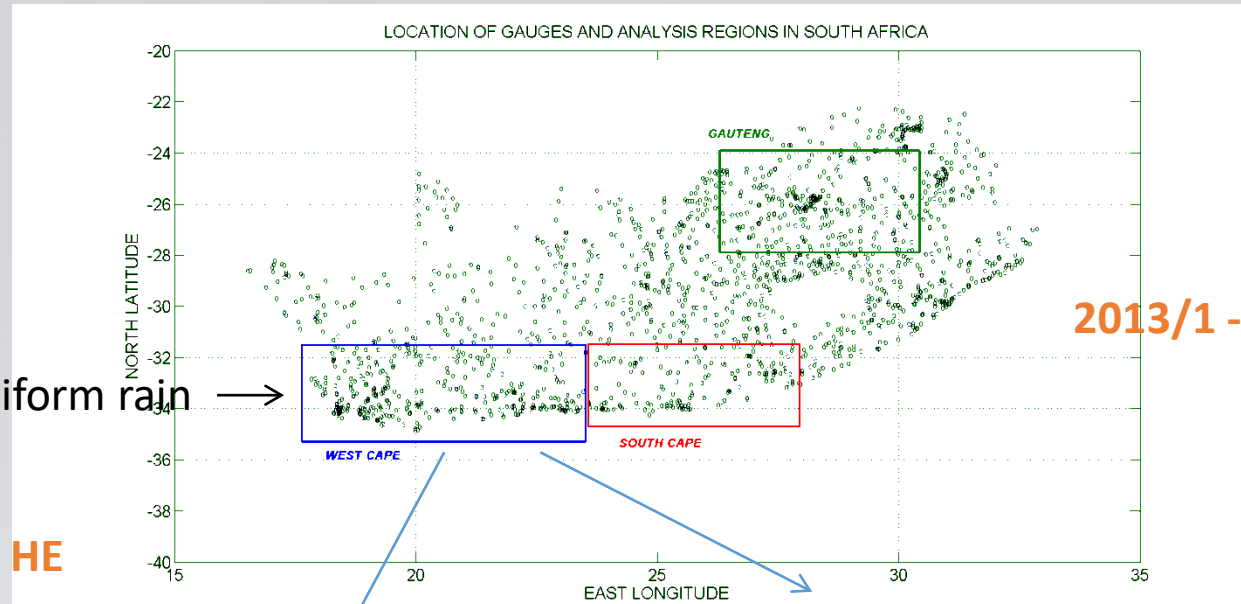
Examples from BSMEFFG

Original GHE

Adjusted GHE



Evaluation from SARFFG

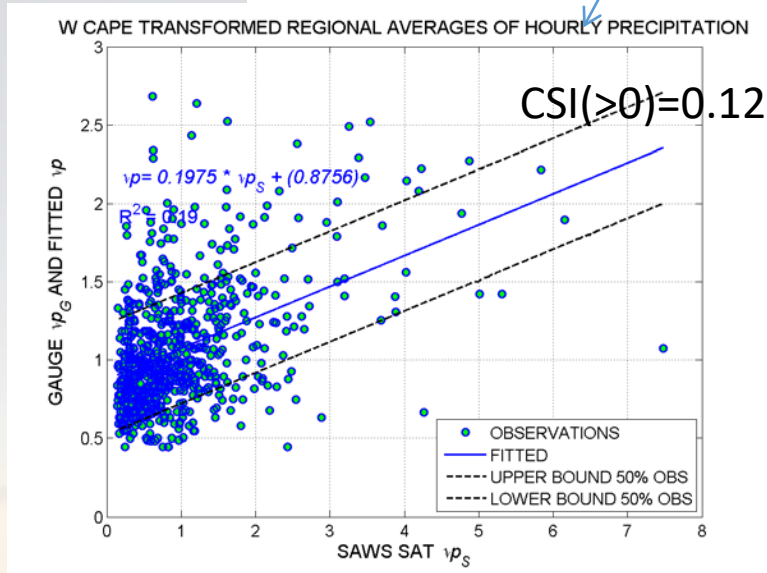


2013/1 - 2014/3

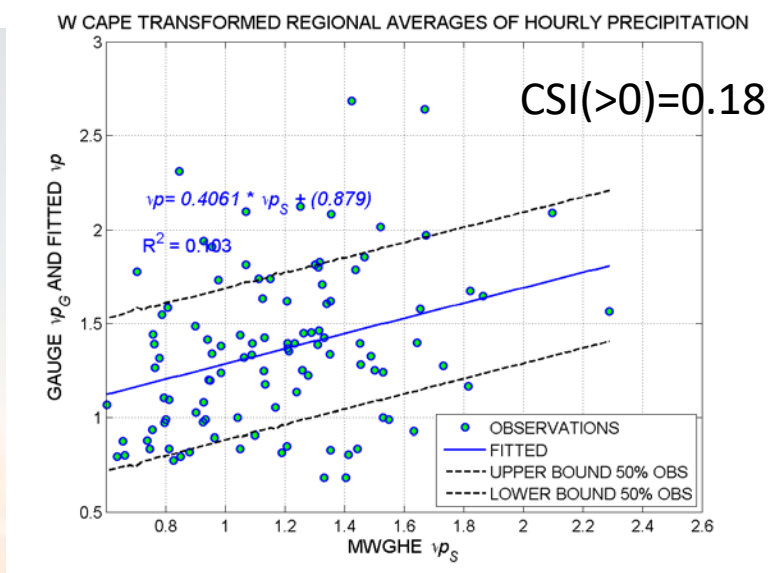
Low Level stratiform rain →

UM Adjusted HE

MWGHE



HRC



Challenges FFGS Had to Overcome

Data and Information Focus

1. **Data Ingest** (format type variety, public versus private, asynchronous, variable space-time resolution)
2. **Measurement /Forecast Uncertainty** (climatological vs time varying, short records for reliability fine-tuning)
3. **Timely Product/Warning Generation** (computer and comm. requirements and constraints, timely forecaster adjustment and response)
4. **Products Easily Accessible and Searchable by NMHSs** (interface and database requirements, local versus regional data storage, requirement to use free and open source software for developing countries)
5. **Education and Training in Product Interpretation and Communication with DMAs** (diverse backgrounds, inter- and multi-disciplinary focus, cultural diversity in the perceived value of and the response to warnings)

Thank you

The strong support of the country National Meteorological, Hydrological and Disaster Management Services has been essential for the useful operational utilization of the regional FFG systems.

