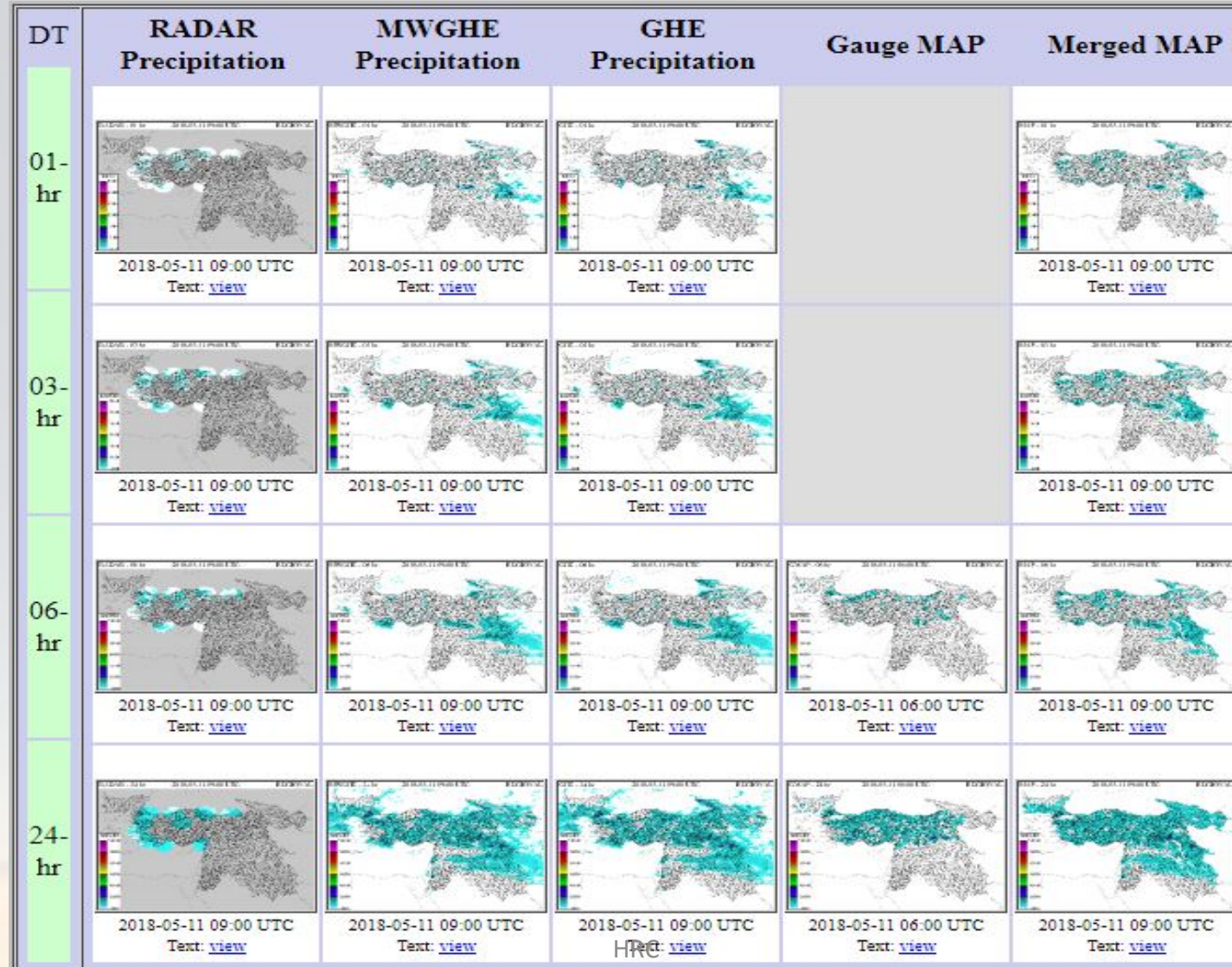# FFGS Data Ingest and Quality Control

Konstantine P. Georgakakos, Sc.D.

HYDROLOGIC RESEARCH CENTER

23 May 2018

Example Data-Related User Interfaces
Observed Data and Data Quality Controlled Derivative Products

HRC

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

Example Data-Related User Interfaces
Processing LOGS – Warnings, Errors and Processing Summaries

Data and Model Flow Diagram
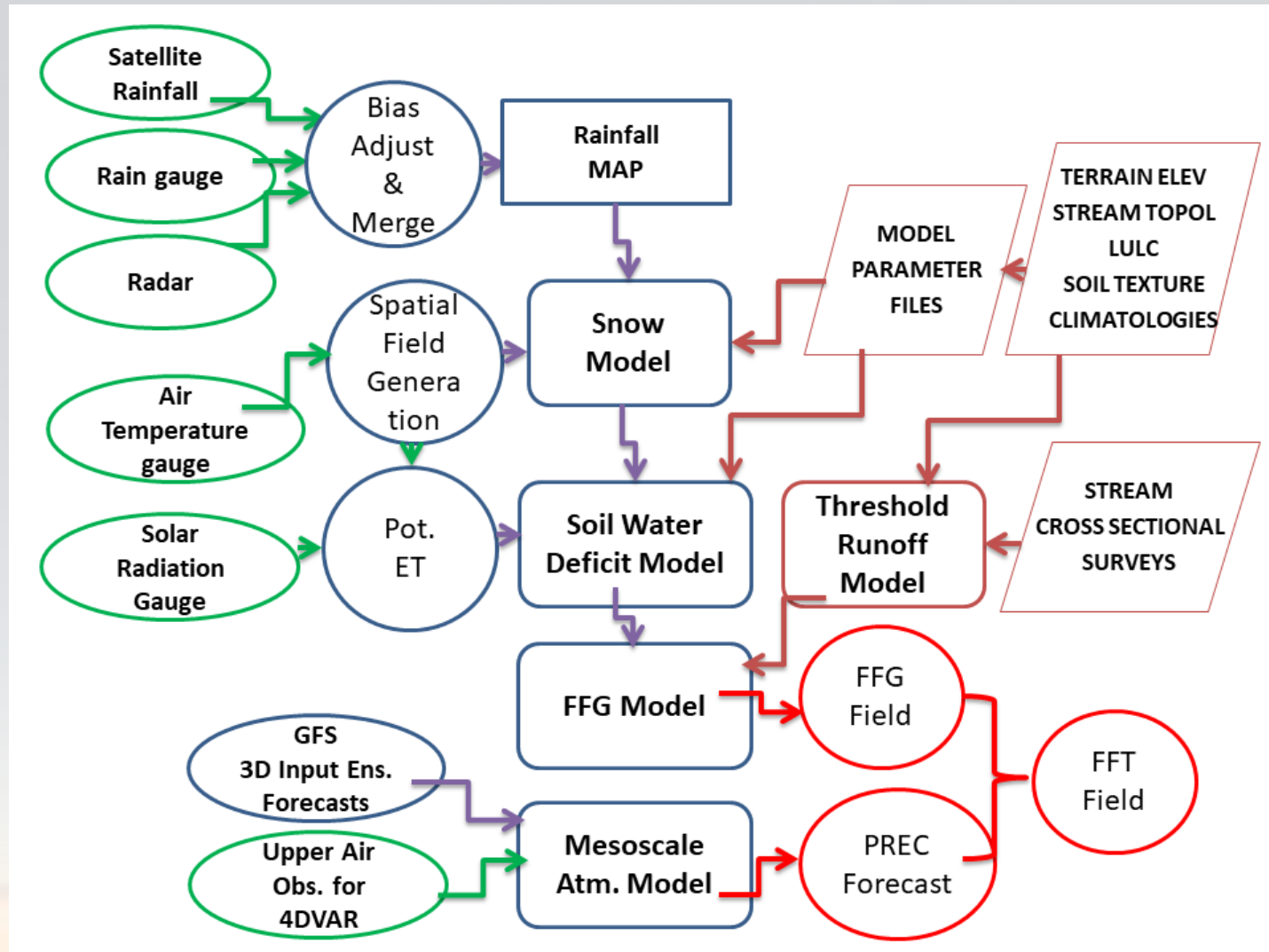
Delineations Worldwide

SRTM 90m versus ASTER 30m
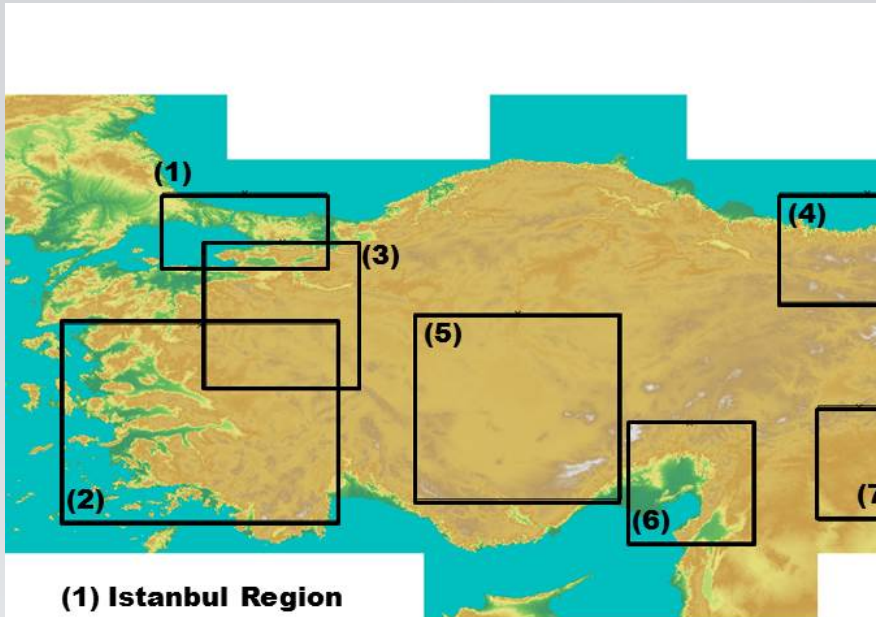
(1) Istanbul Region
(2) Mediterranean Coast
(3) Mediterranean Inland
(4) Black Sea Coast
(5) Region South of Ankara
(6) South Mediterranean Coast
(7) Southern Arid Region
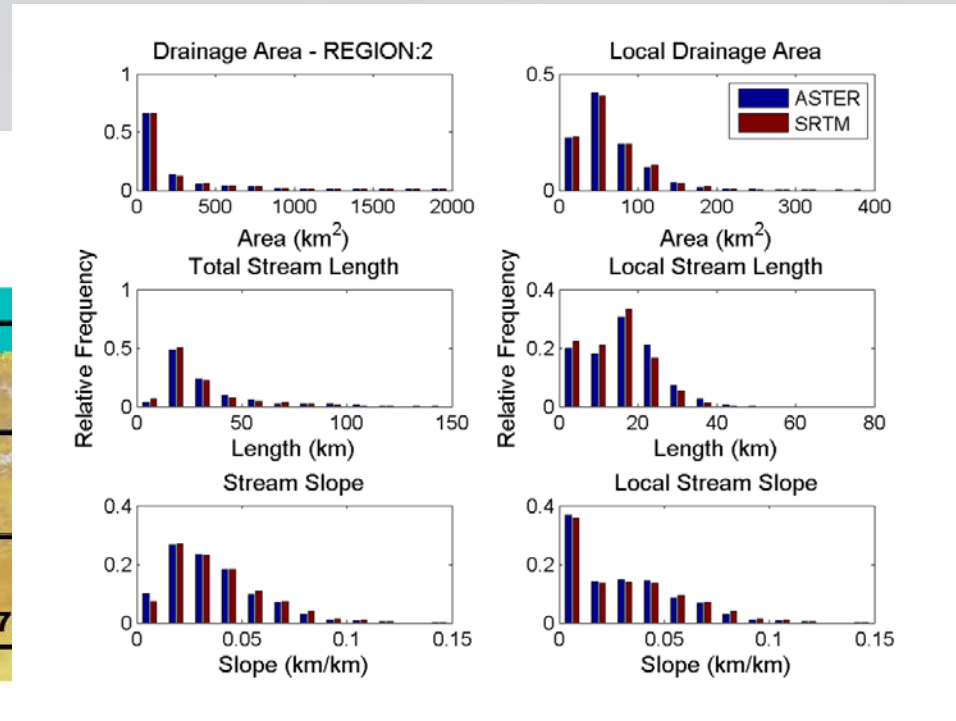
Delineations Worldwide

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

Distance Between ASTER and SRTM

ASTER

- Istanbul Region
- Mediterranean E.Coast
- Mediterranean Inland
- Black Sea Coast
- Mediterranean S.Coast
- Ankara Region
- S. Arid Region

DISTANCE (m)
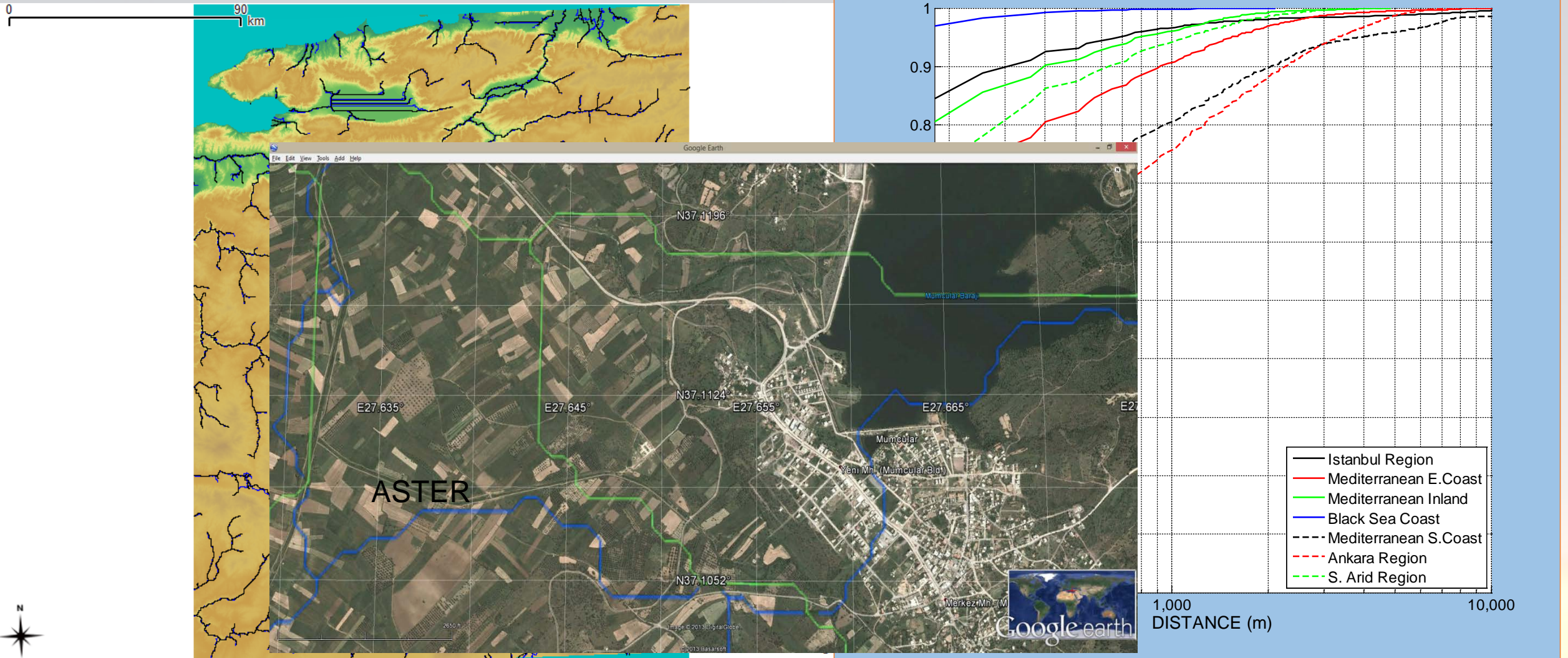
FFGS General Data Flow Processing Design
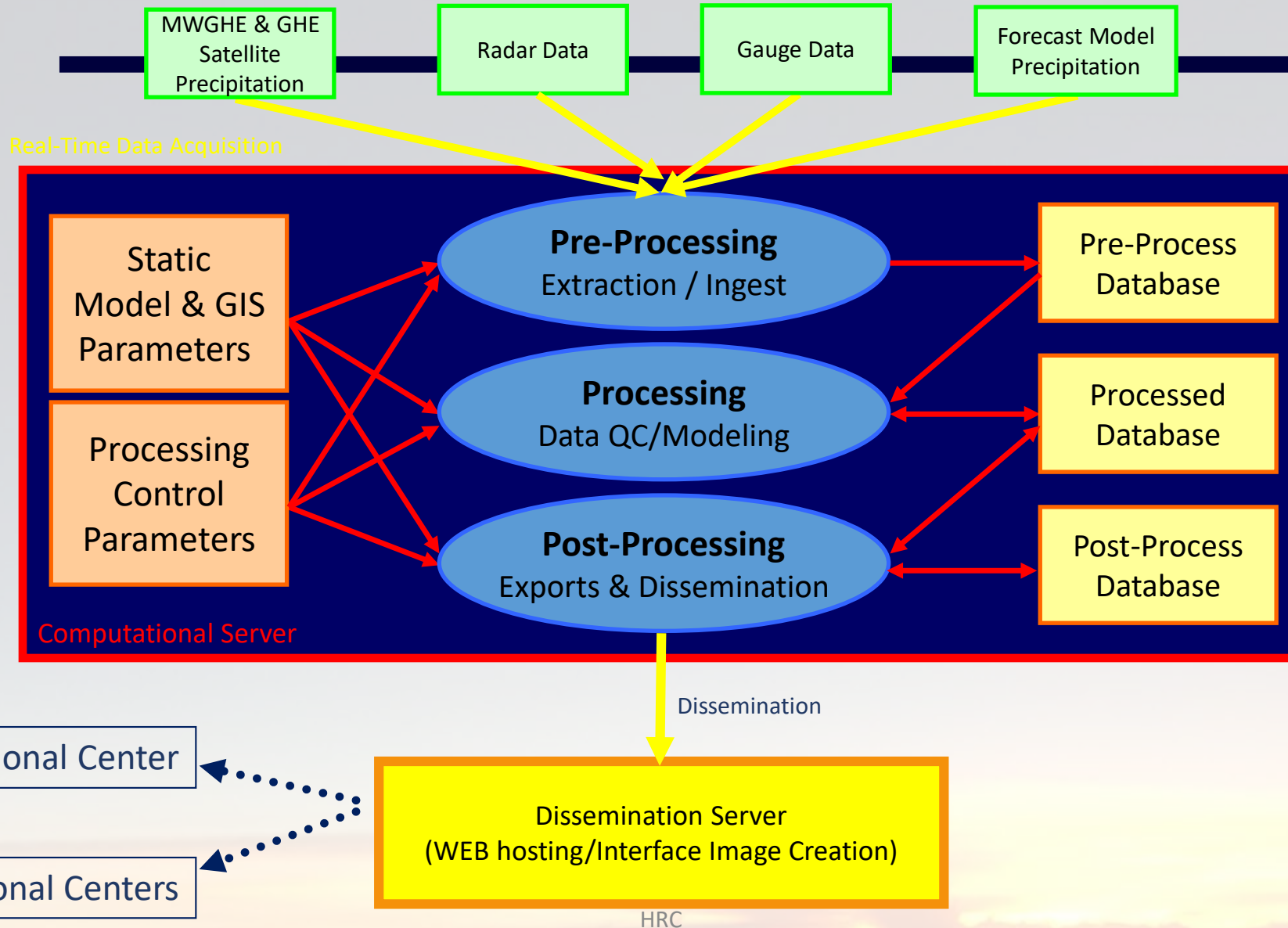
FFGS Precipitation Processing
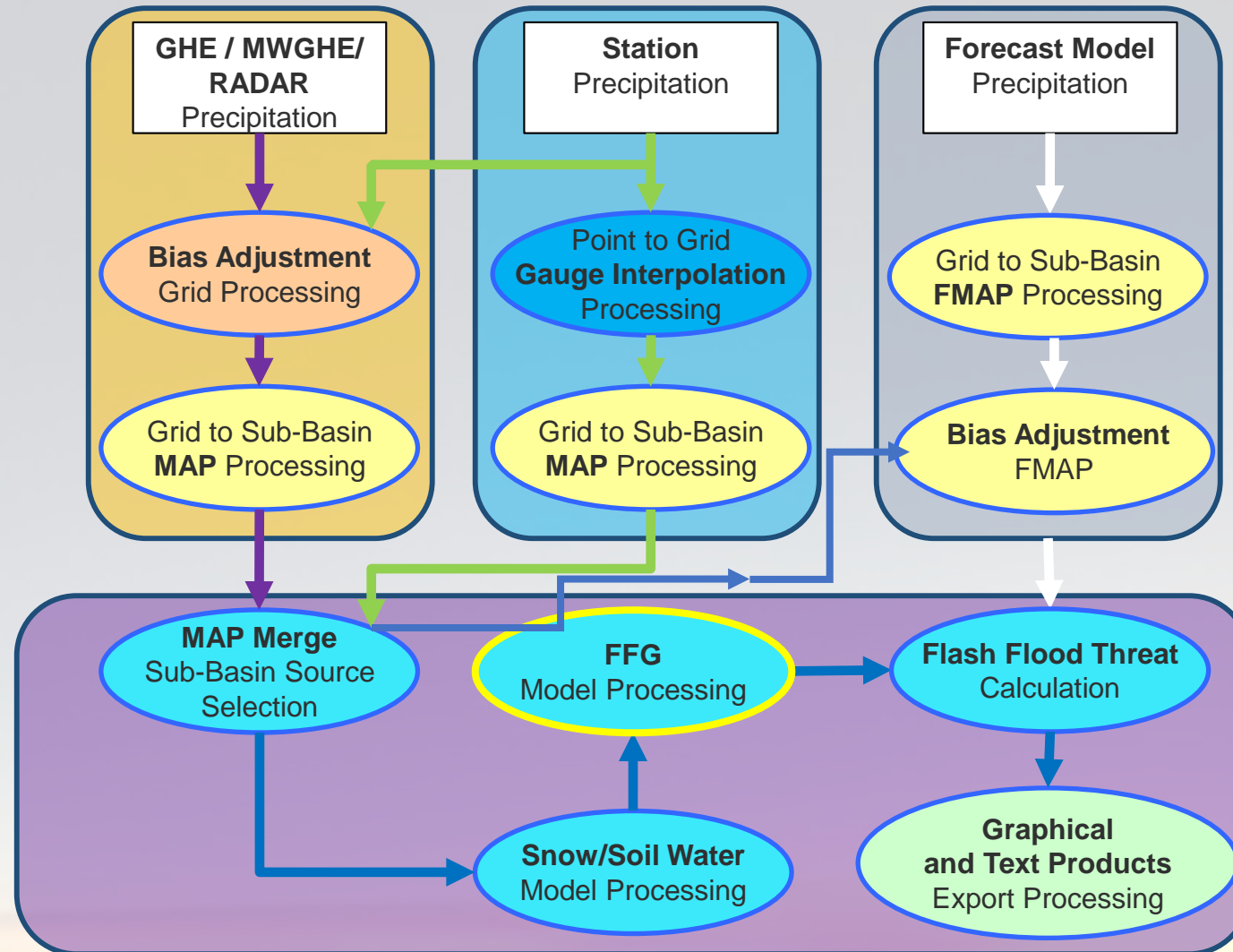
Current Multi-Sensor Strategy

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

MOZOTAL RADAR POSITIVE RAIN FREQ FOR WET SEASON 2011-2013
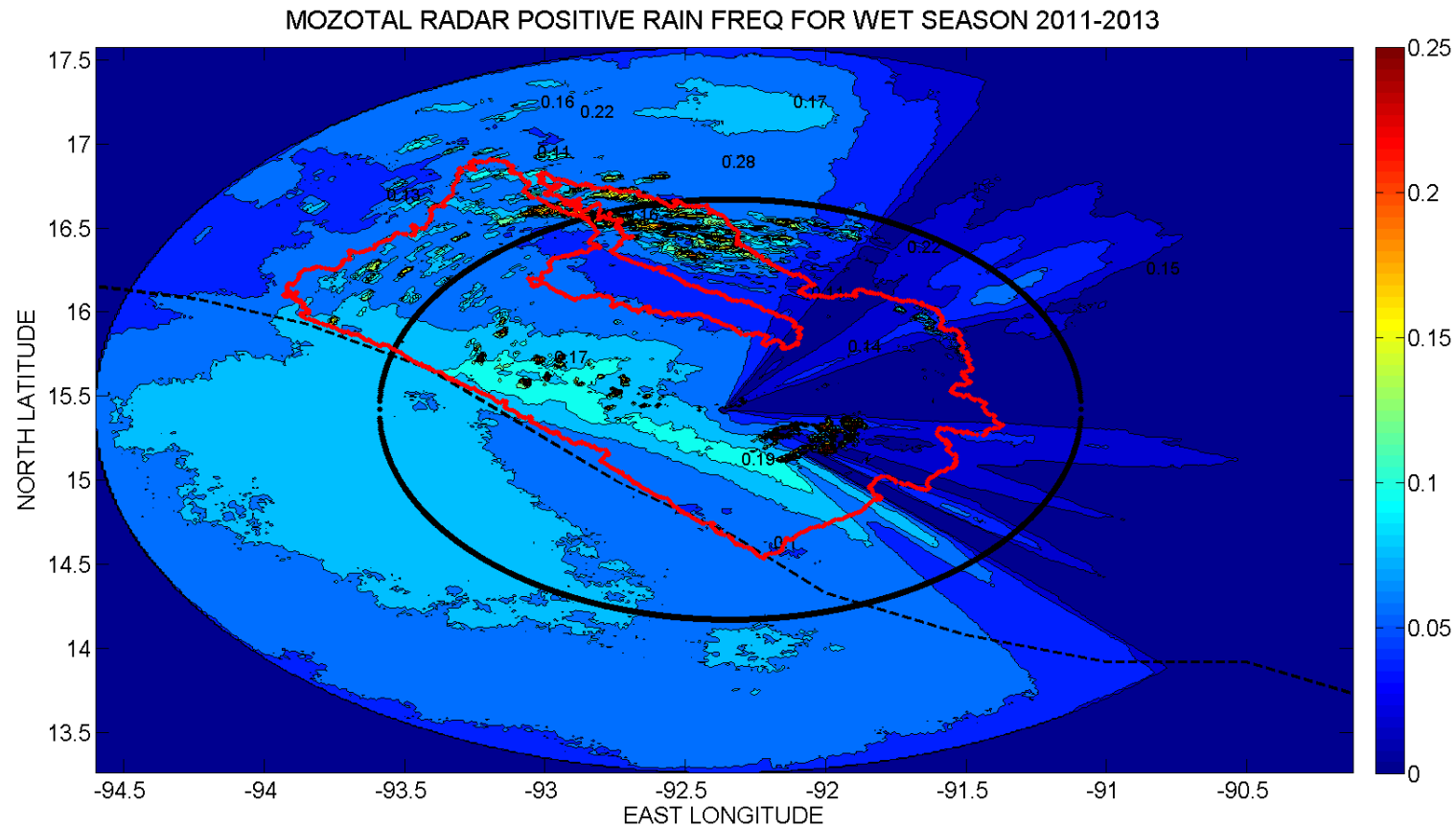
Satellite Precipitation – NESDIS Global Hydroestimator (GHE)
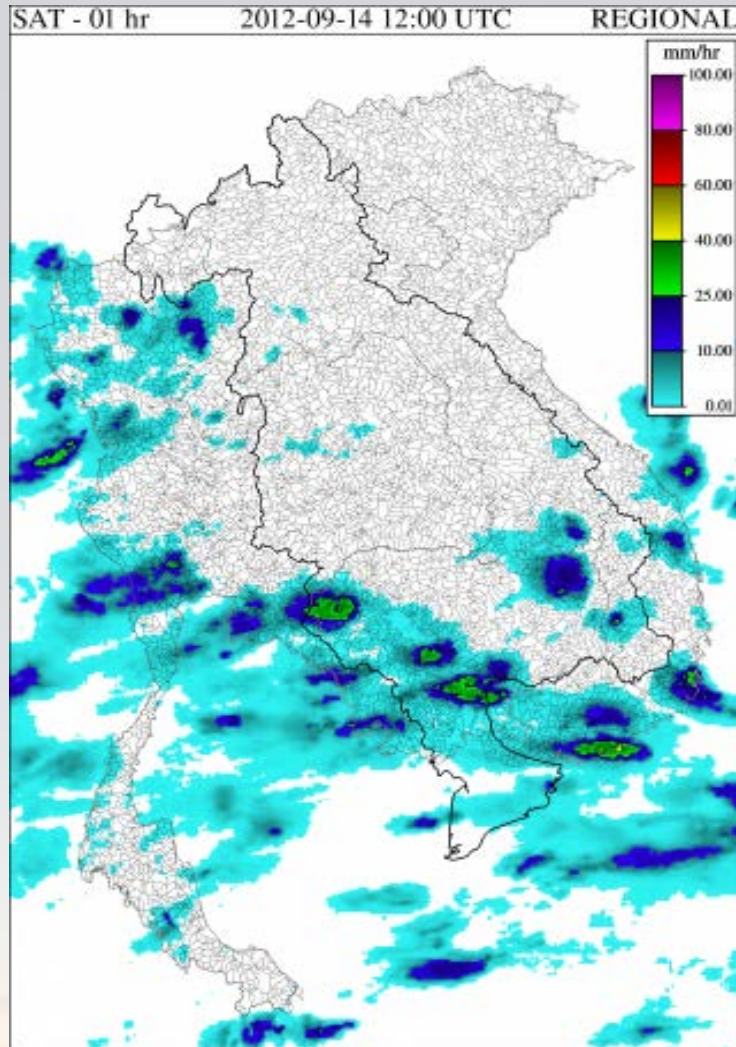
- **IR based (10.7 μm)**
- **Short latency**

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

REGION

Sat Pixel 1

Sat Pixel J

Raingauge 1

Raingauge J

Sat Pixel 2

Raingauge 2
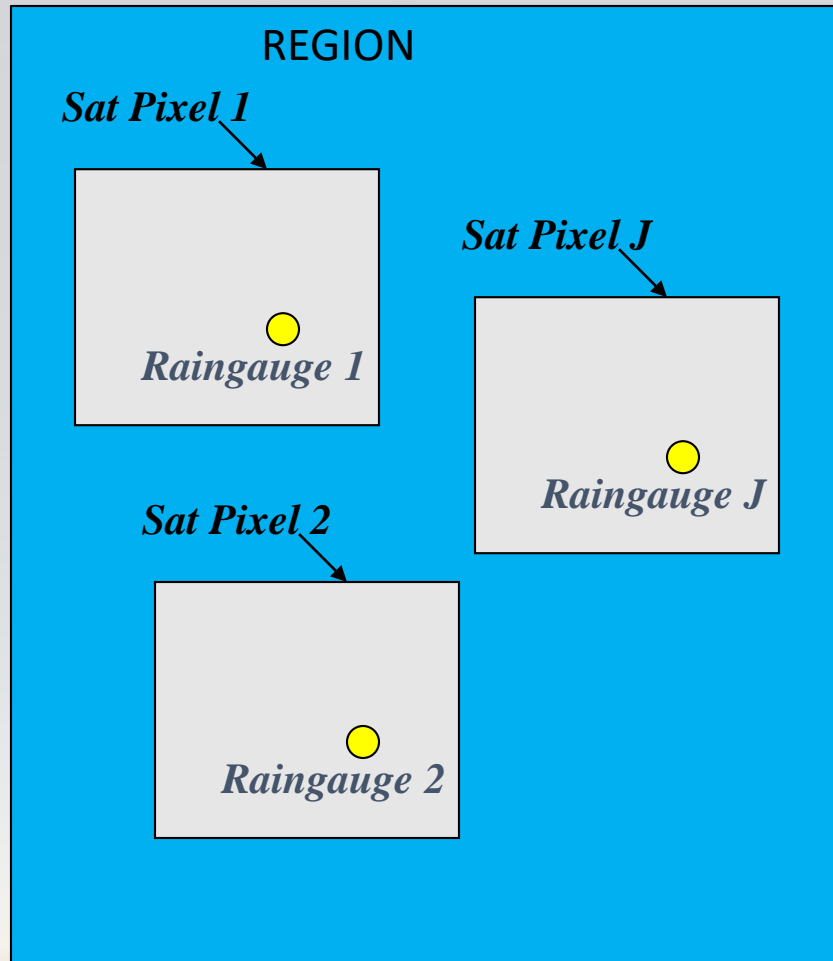
$$\beta_t = \ln \left[\frac{\sum\limits_{j=1}^{N_g} R_g(t,j)}{\sum\limits_{j=1}^{N_g} R_s(t,j)} \right]$$

Log-Bias

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

PROBABILITY MATCHING ILLUSTRATION

For Range of Satelite Rainfall [0.7 - 0.8] (mm/6h), B= G/S

Middle East

# of sub-regions:8

23 May

15
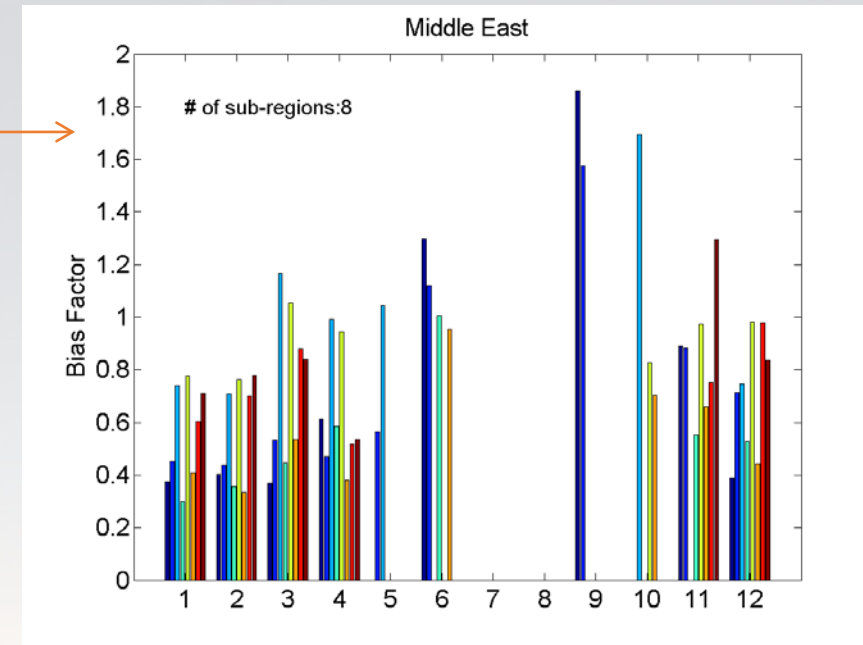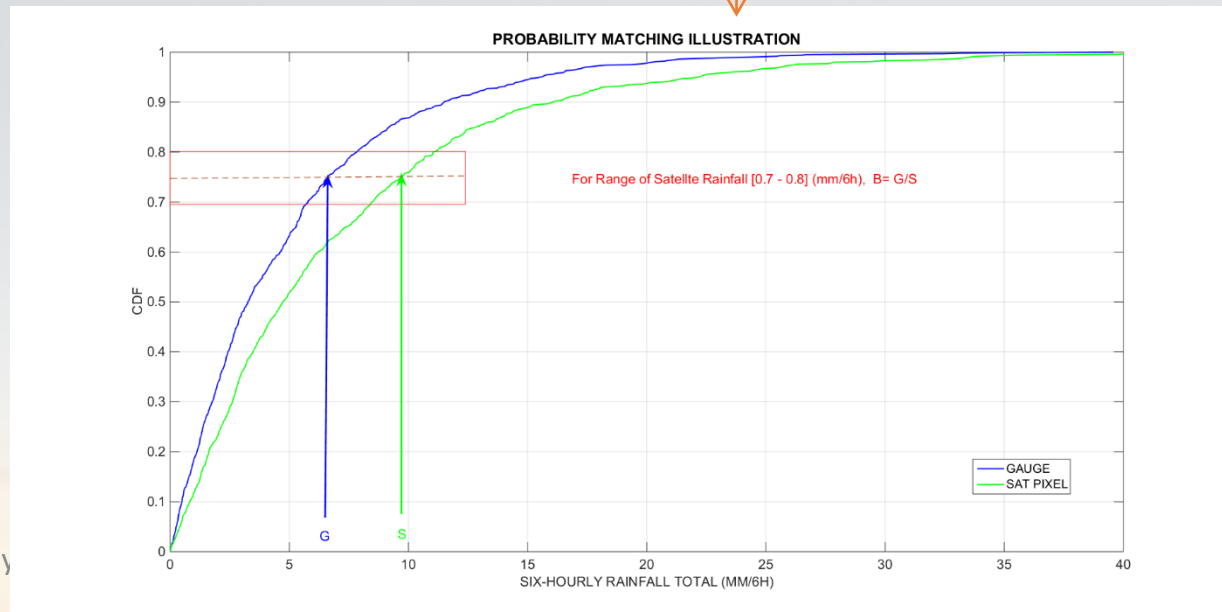
Dynamic Bias Adjustment Basics

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

$$\beta_{t+1} = \beta_t + w_{t+1}$$

$$z_{t+1} = \beta_{t+1} + v_{t+1}$$

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
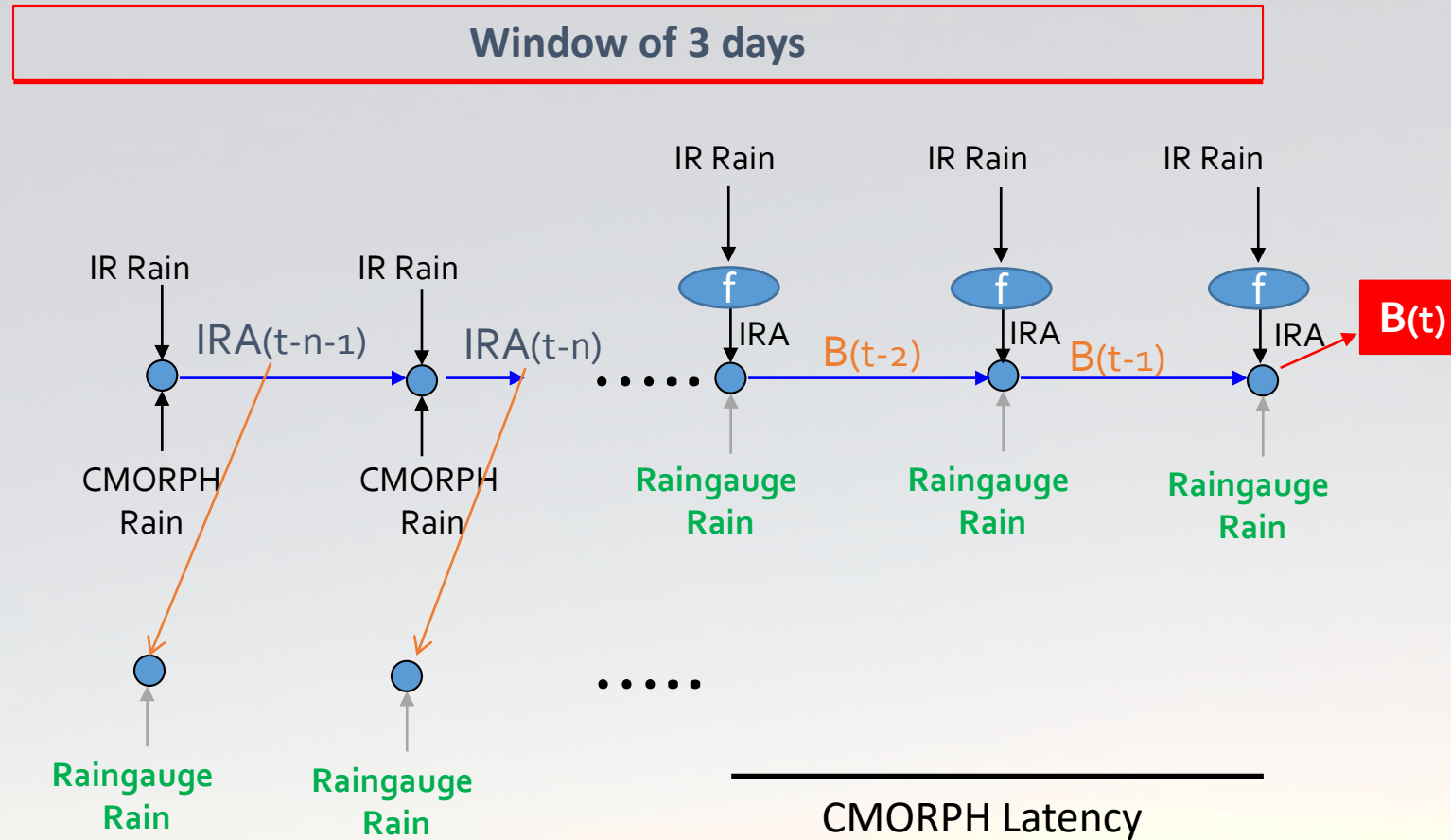
Examples from BSMEFFG

Original GHE

Adjusted GHE

Evaluation from SARFFG

LOCATION OF GAUGES AND ANALYSIS REGIONS IN SOUTH AFRICA
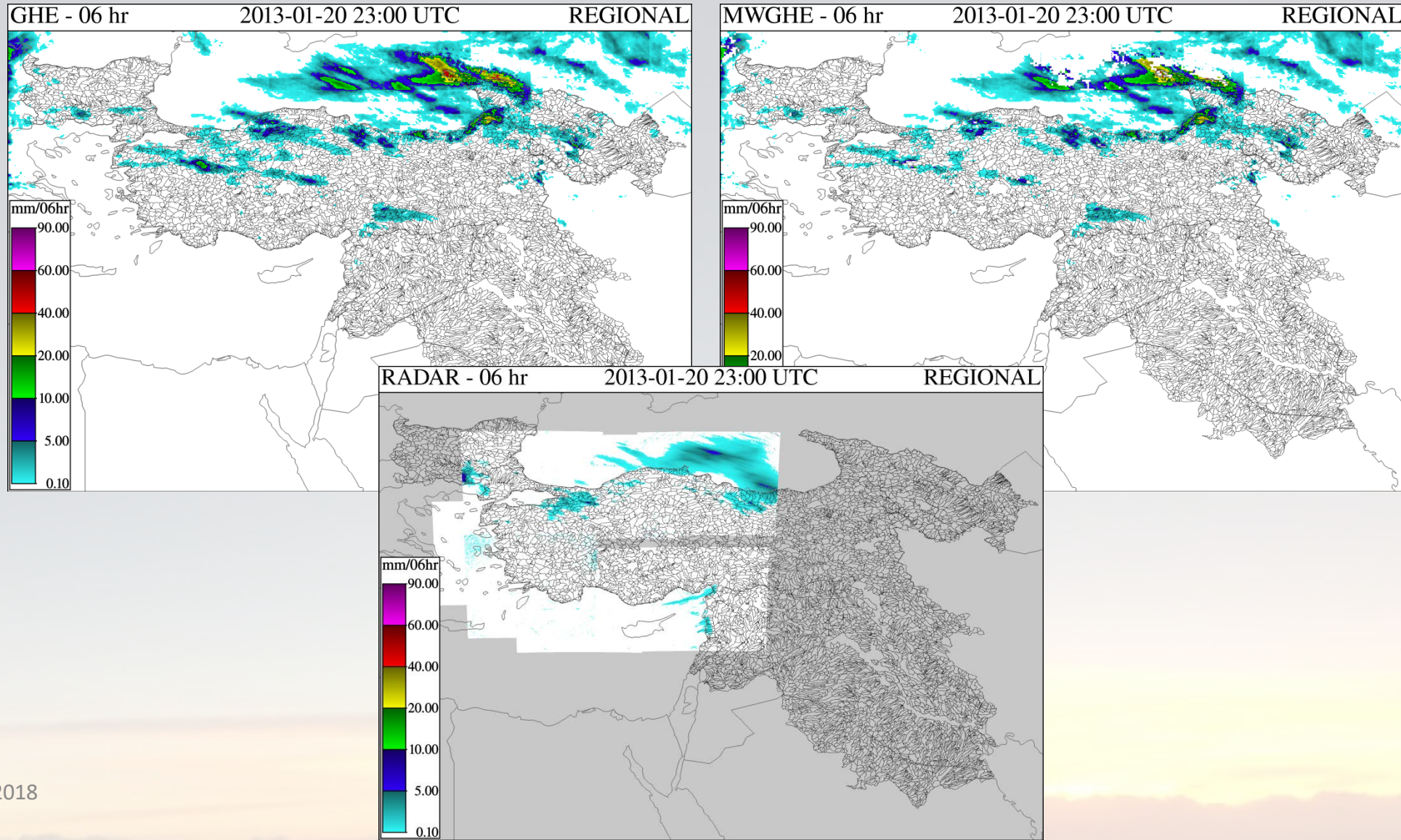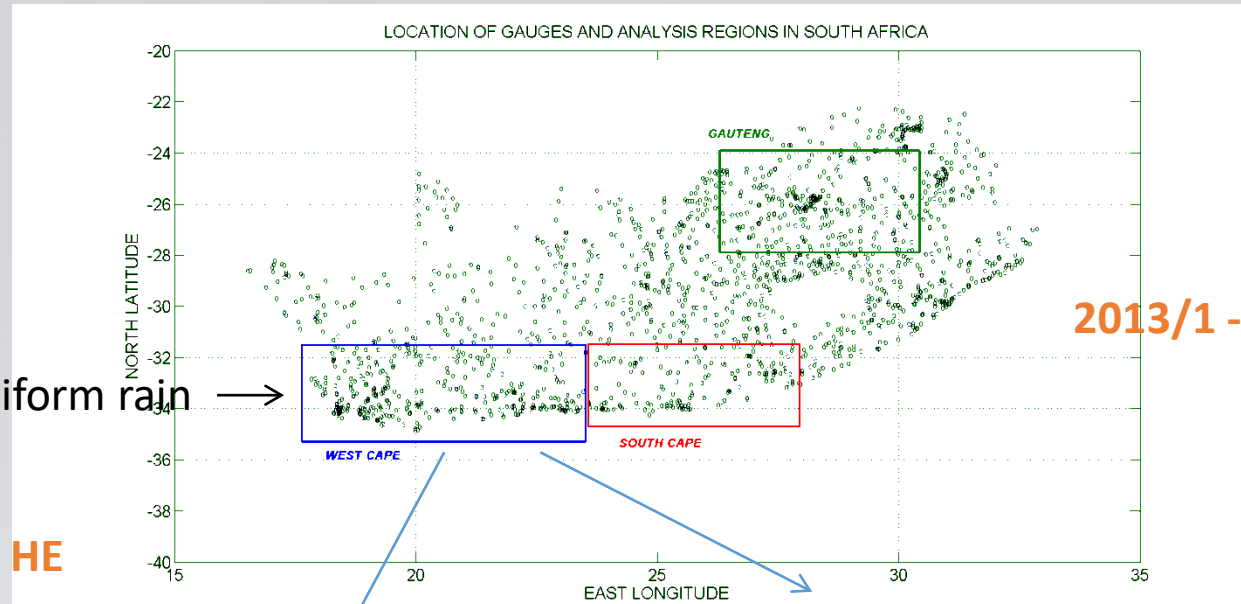
2013/1 - 2014/3

Low Level stratiform rain →

UM Adjusted HE

MWGHE

W CAPE TRANSFORMED REGIONAL AVERAGES OF HOURLY PRECIPITATION

CSI(>0)=0.12

$\nu p = 0.1975 * \nu p_S + (0.8756)$

$R^2 = 0.19$

W CAPE TRANSFORMED REGIONAL AVERAGES OF HOURLY PRECIPITATION

CSI(>0)=0.18

$\nu p = 0.4061 * \nu p_S + (0.879)$

$R^2 = 0.103$
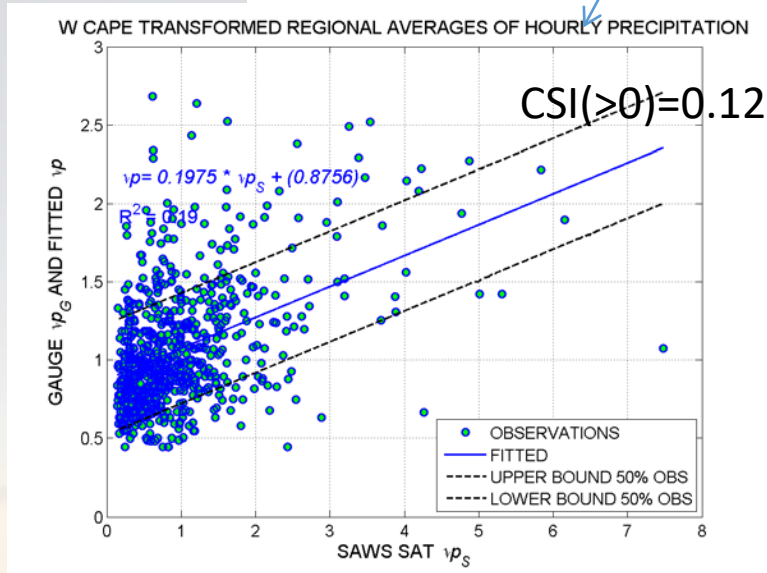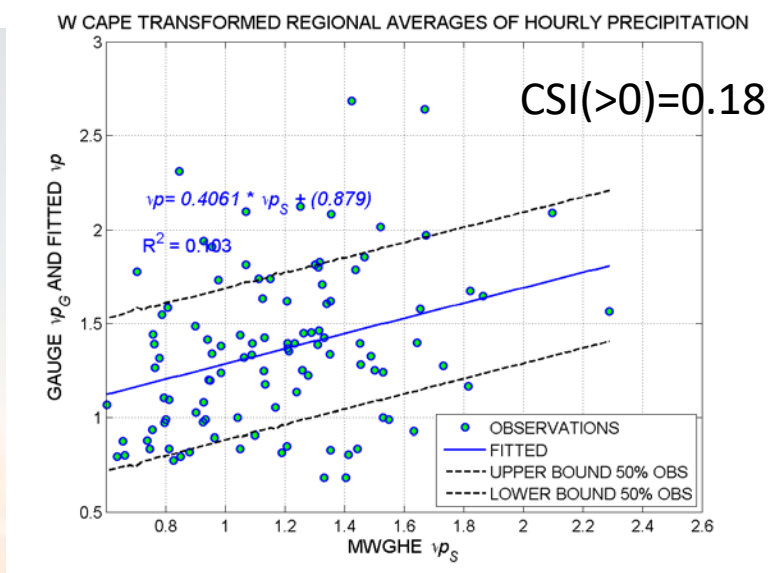
Challenges FFGS Had to Overcome
Data and Information Focus

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.