



# SEVIRI Radiance Data Impact to Regional Forecast using NAMRR

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3. IMSG, College Park, MD

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# OUTLINE:

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- Introduction of NAMRR (NAM Rapid Refresh) System
- SEVIRI Data and Selected Channels
- Experiment Setup
- Experimental Demonstration
- Summary and Future Work

# Hourly-Updated NAM Forecast System

**NAM** – North American Mesoscale forecast system

Runs 4x daily at 00, 06, 12, 18Z

Short-range mesoscale NWP system for the U.S.  
which provides guidance to day 3.5

**NAMRR** – NAM Rapid Refresh

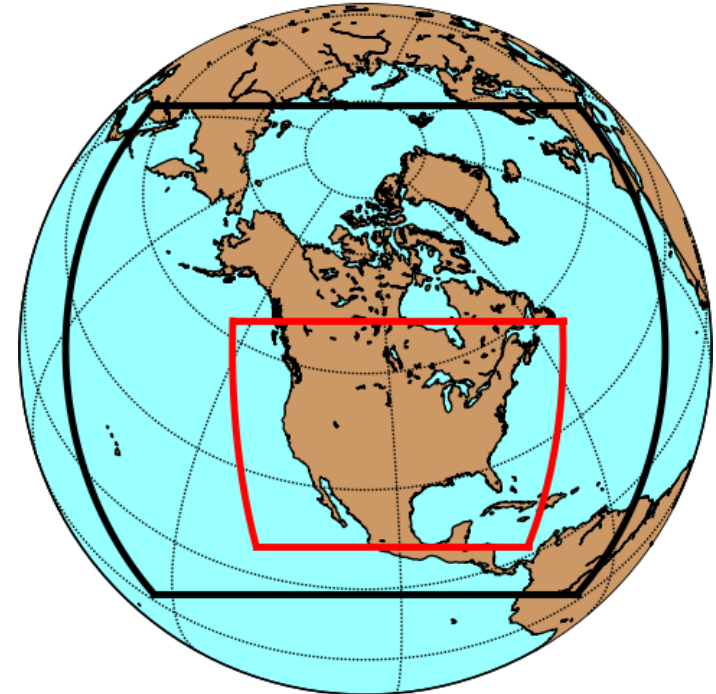
Hourly updates

Future North American Rapid Refresh Ensemble  
system (NARRE)

NAMRR + RAP/HRRR Foundation

Hourly NAM Cycling 12 km NAM and 4 (3) km CONUS  
nest with Hybrid ensemble-3DVar via Global Data  
Assimilation System's EnKF members

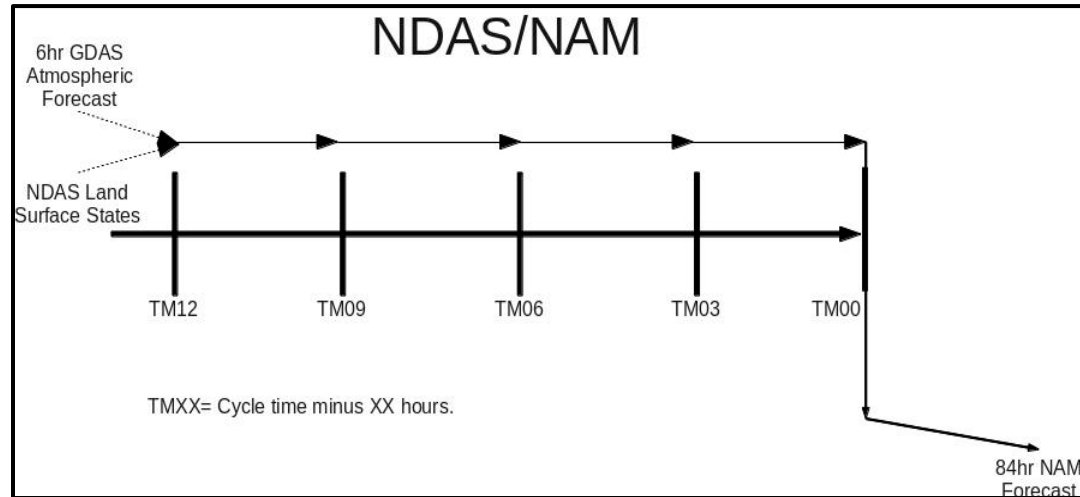
NMMB Domain Configuration



Parent dimensions: Nx = 954 Ny = 835 dx = 0.1260 dy = 0.1080  
center lat = 54.00 center lon = -106.00

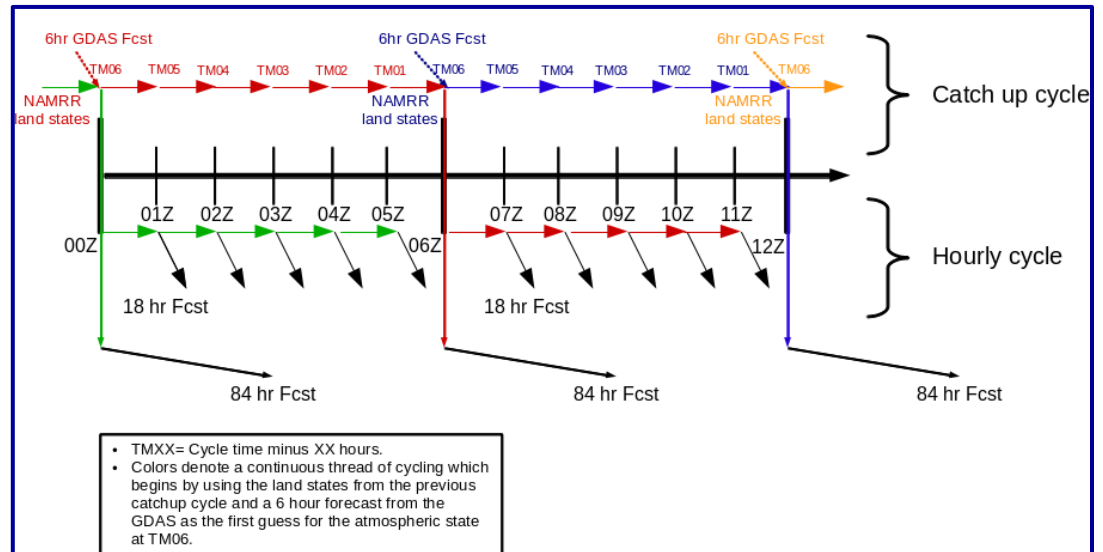
# NAMRR Overview

Current, example, NAM Data Assimilation System (NDAS) configuration for a single, arbitrary cycle:

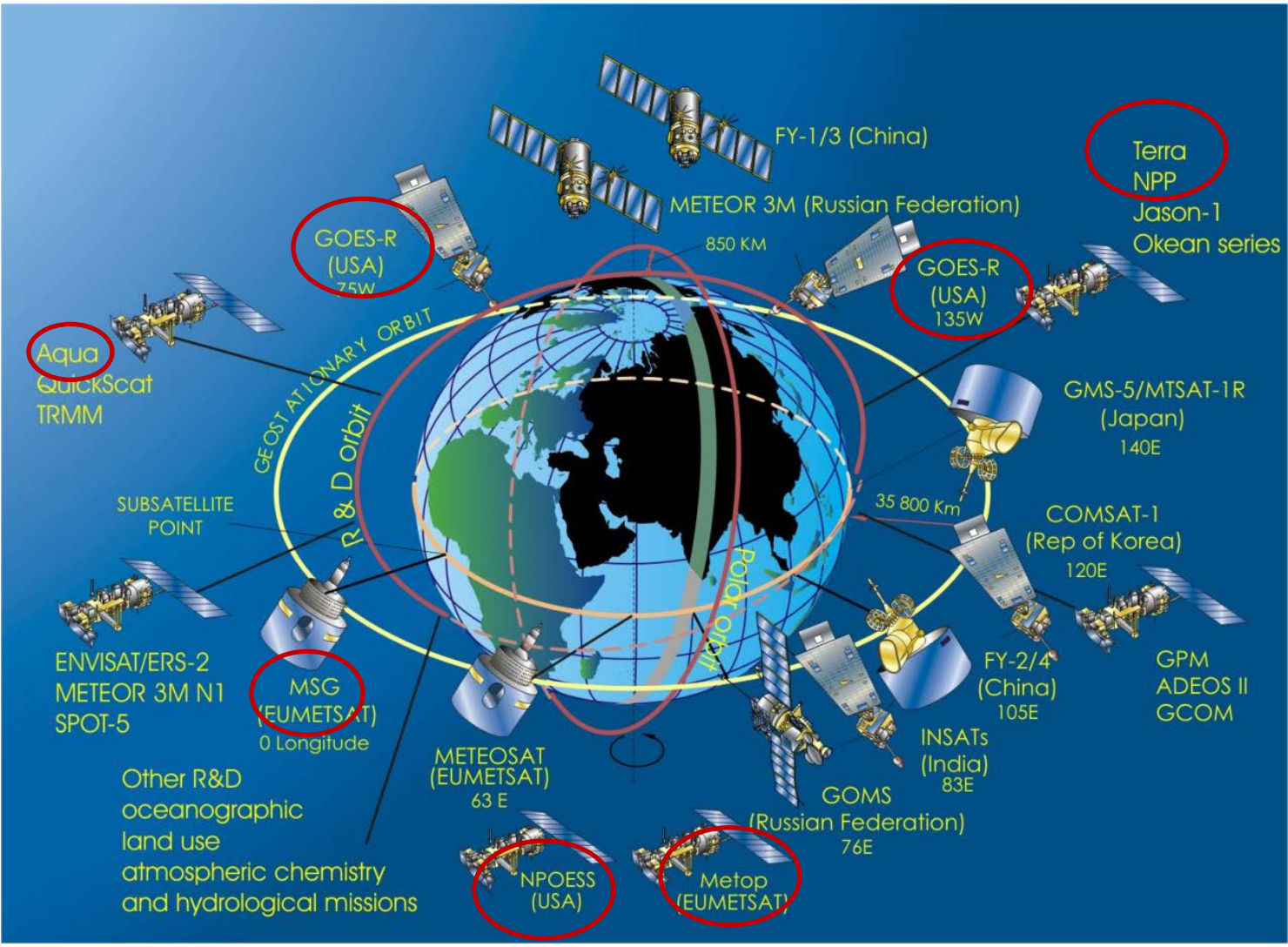


Example NAMRR configuration for 12, hourly cycles:

Both systems assimilate a wide range of conventional (e.g. surface, profiler, mesonets, Doppler radar radial velocities, etc.) and satellite observations (e.g. radiances)

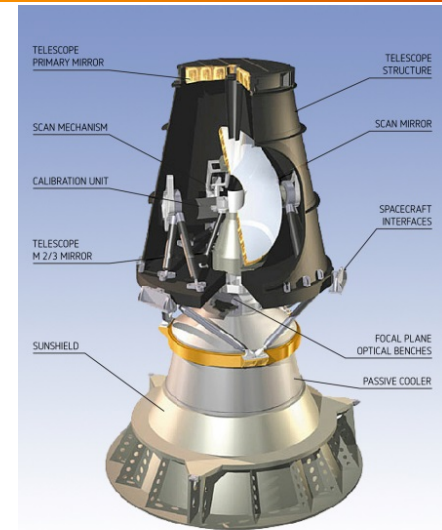


# Currently Assimilated Satellite Radiance in NCEP Operational

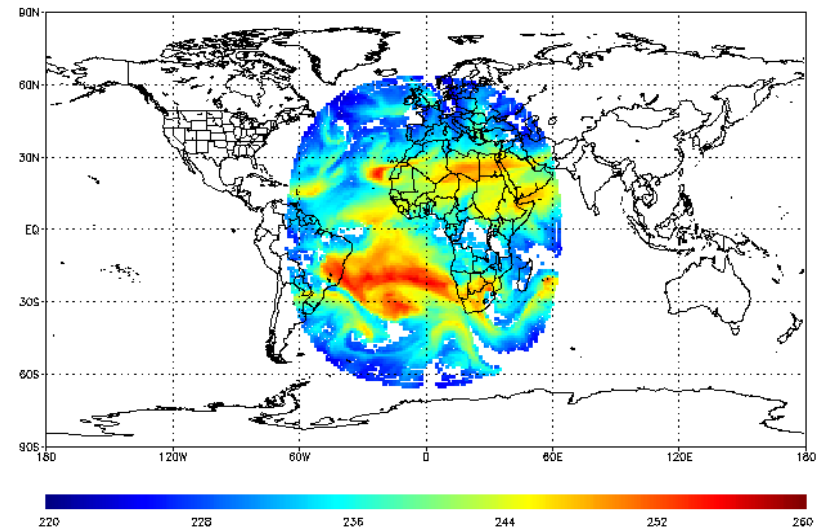


# About SEVIRI:

- ❖ **Spinning Enhanced Visible and Infrared Imager (SEVIRI)** launched on Meteosat satellite.
- ❖ **Meteosat** series are [geostationary meteorological satellites](#) operated by [EUMETSAT](#).
- ❖ Meteosat-10 (launched from the Guiana Space Centre in Kourou in 2012) is the prime operational geostationary satellite, positioned at 0 degrees and providing full disc imagery every 15 minutes.



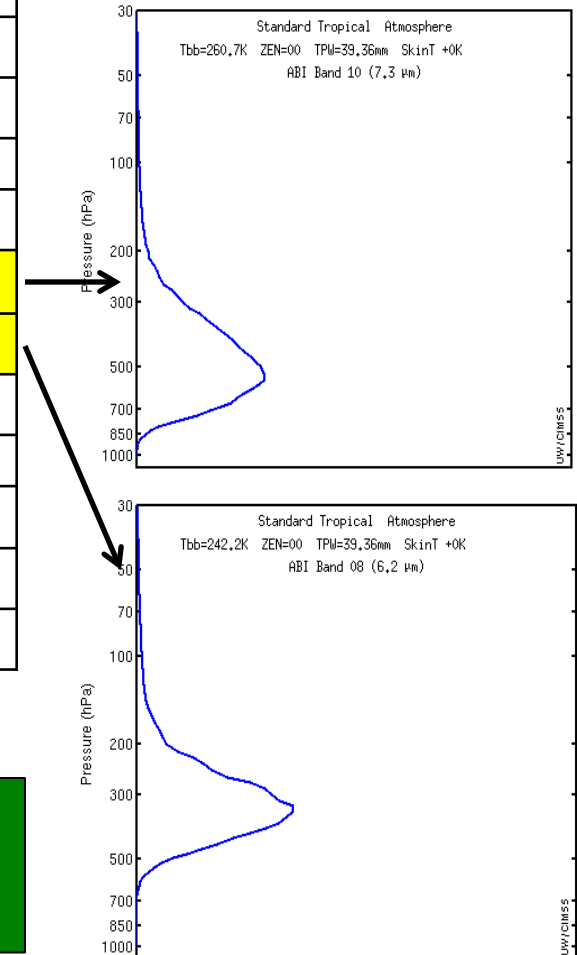
MSG/SEVIRI TB Ch5(6.2um) 2012-03-04-00



# Channel Selection:

SEVIRI chn #	Wave length ( $\mu\text{m}$ )	Main observation application
1	VIS0.6	Surface, clouds, wind fields
2	VIS0.8	Surface, clouds, wind fields
3	NIR1.6	Surface, cloud phase
4	IR3.9	Surface, clouds, wind fields
5	WV6.2	Water vapor, high level clouds, atmospheric instability
6	WV7.4	Water vapor, atmospheric instability
7	IR8.5	Surface, clouds, atmospheric instability
8	IR9.7	Ozone
9	IR11.2	Surface, clouds, wind fields, atmospheric instability
10	IR12.3	Surface, clouds, atmospheric instability
11	IR13.3	Cirrus cloud height, atmospheric instability

## Weighting Function



Two water vapor channels are assimilated in NCEP GDAS (global data assimilation system). Other IR channels (4,7-11) only being monitored.



# Experiment Design

## Two Experiments:

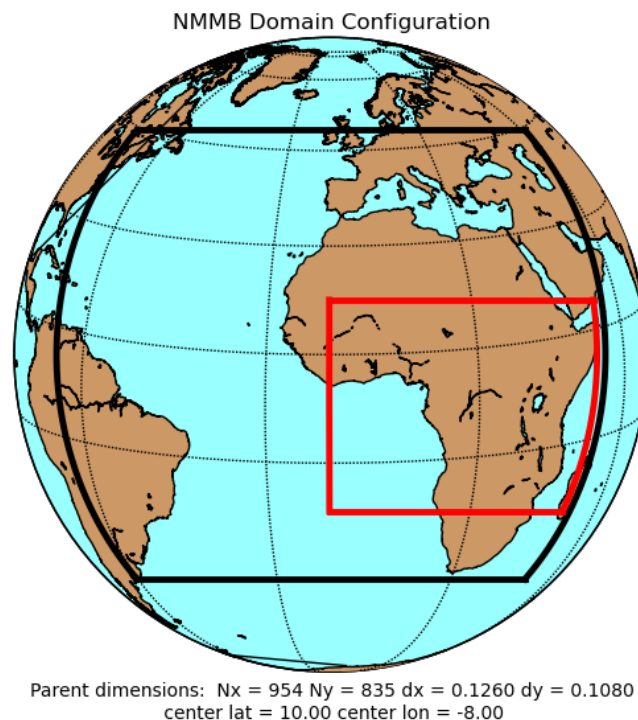
**CTRL:** Conventional data and radiance observations as operational NDAS

**Baseline:** + SEVIRI clear-sky radiance

- Hourly update with NAMRR
- GSI 3D-Var & NMMB Model
- Model resolution is 12km, no nested domain
- Grid size: 954x835x 60
- Region: Europe and Africa
- Period: March 1-31 2012

## Satellite Radiance include:

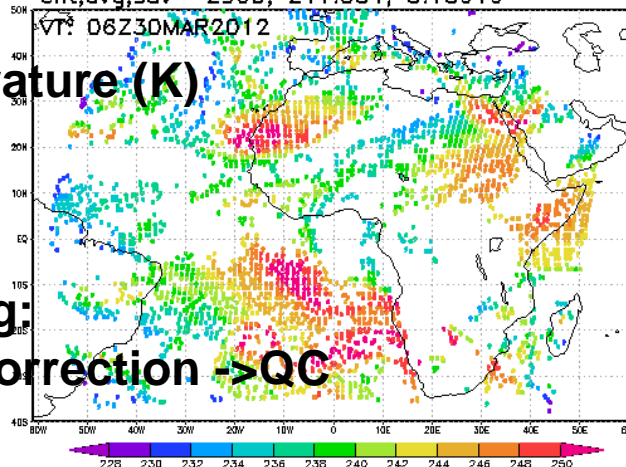
- AMSUA (METOP-a; NOAA-15;NOAA-18;NOAA-19)
- AMSUB (NOAA-17)
- HIRS4 (METOP-a,NOAA-19)
- IASI (METOP-a); AIRS (AQUA)
- MHS (METOP-a; NOAA-19)
- Clear-sky SEVIRI (MSG-9)





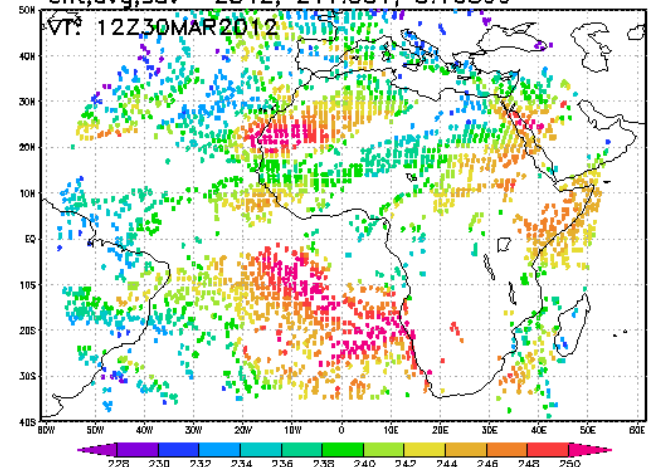
# Assimilated SEVIRI Radiance Observations

platform: seviri m09  
variable: channel 2 observation (K)  
cnt,avg,sdv= 2905, 241.034, 5.15919  
VT: 06Z30MAR2012



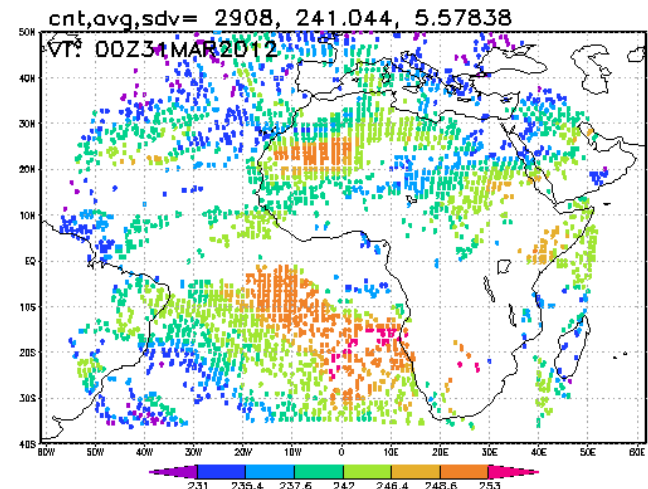
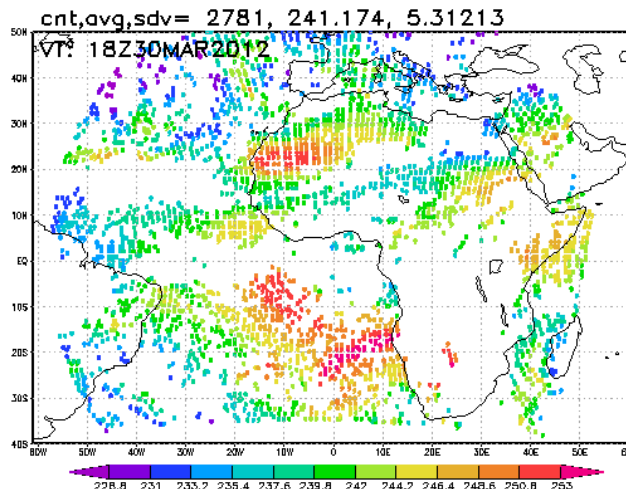
frequency: 47887.96 GHz  
wavelength: 6.26  $\mu\text{m}$

cnt,avg,sdv= 2842, 241.031, 5.16899  
VT: 12Z30MAR2012



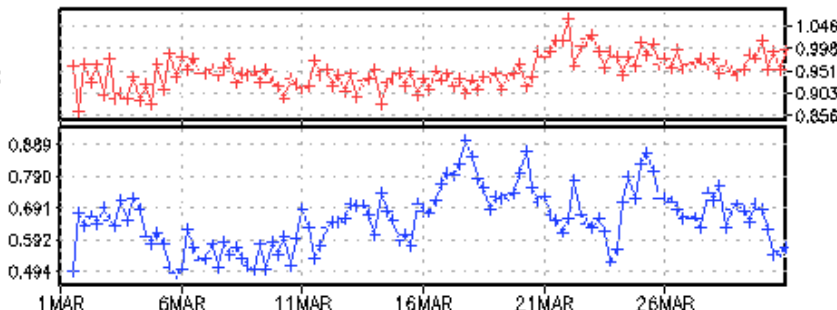
**Brightness Temperature (K)**

**Before Assimilating:  
Thinning -> Bias Correction -> QC**

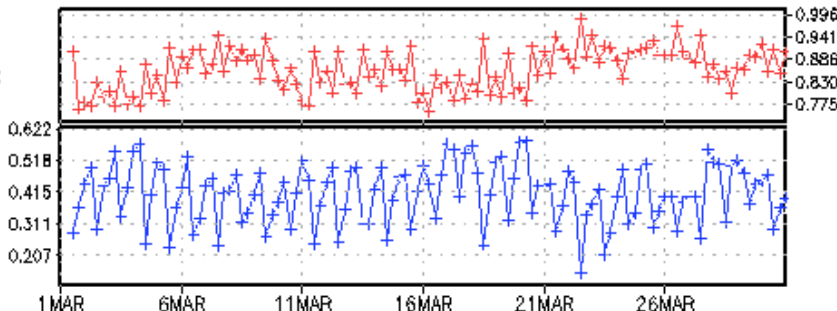


# Time Series of G-O valid at 00Z 01 – 00Z 31 MAR 2012

channel 2  
x 0.3781  
f 47887.96 GHz  
λ 6.28 μm  
avg: 0.658  
sdv: 0.950



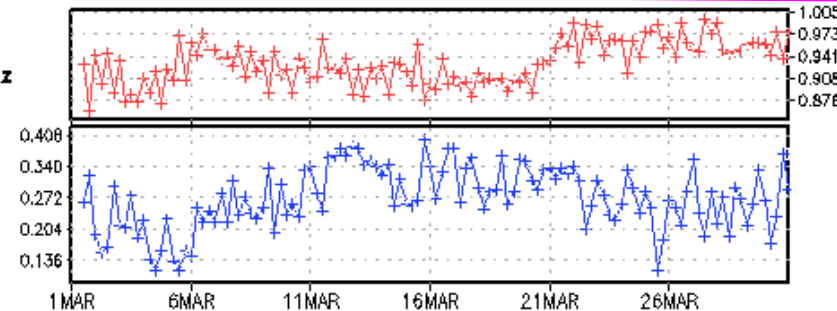
channel 3  
x 0.3680  
f 40759.03 GHz  
λ 7.36 μm  
avg: 0.407  
sdv: 0.859



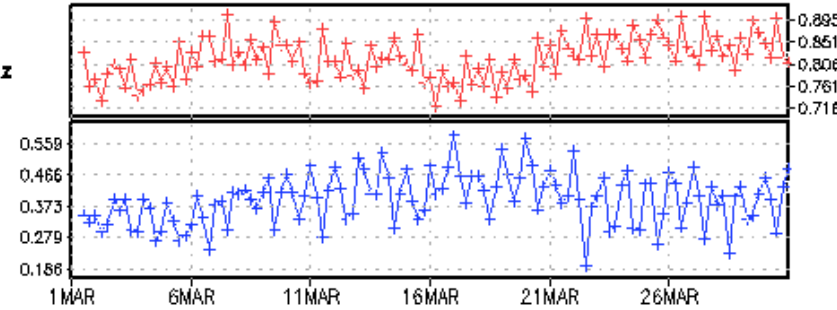
Platform: seviri\_m09  
G: GFS 6hs forecast  
O: SEVIRI radiance observation

Without Bias Correction

channel 2  
x 0.3781  
f 47887.96 GHz  
λ 6.28 μm  
avg: 0.270  
sdv: 0.931



channel 3  
x 0.3680  
f 40759.03 GHz  
λ 7.36 μm  
avg: 0.392  
sdv: 0.816

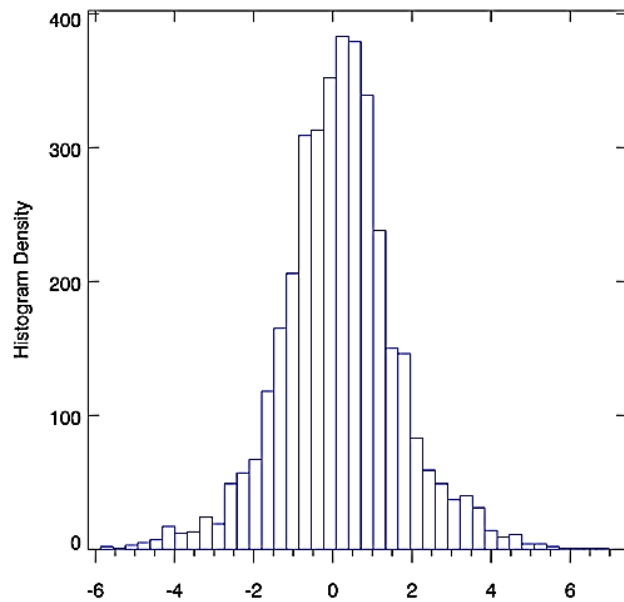


With Bias Correction

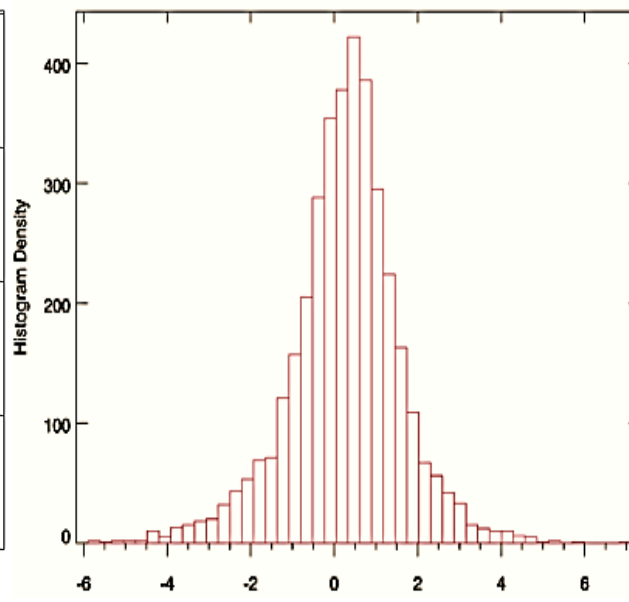
Enhanced bias correction method developed by Yanqiu Zhu. Bias starts from zero and self spun-up.

# Histogram of O-G (Ch.2)

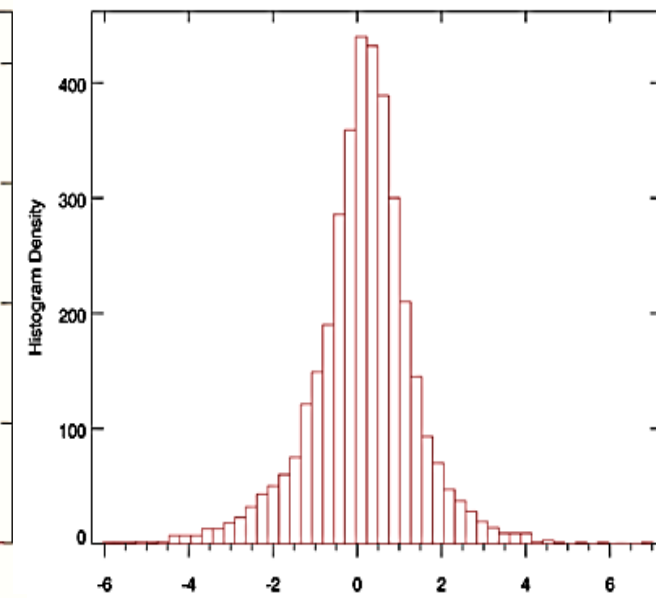
O-G w/o BC



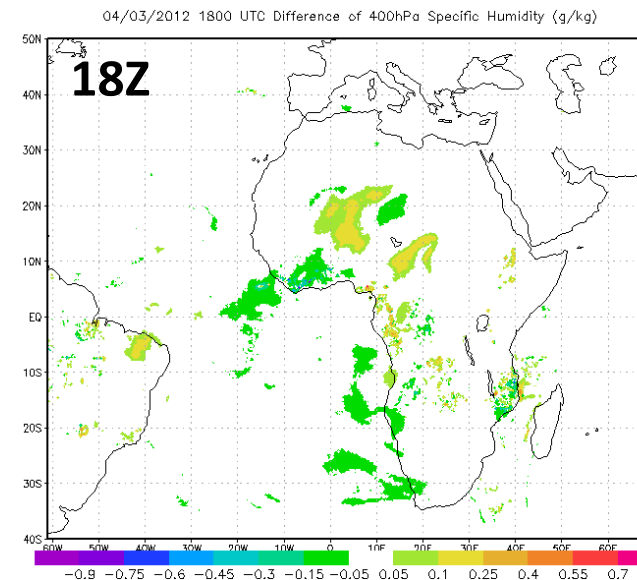
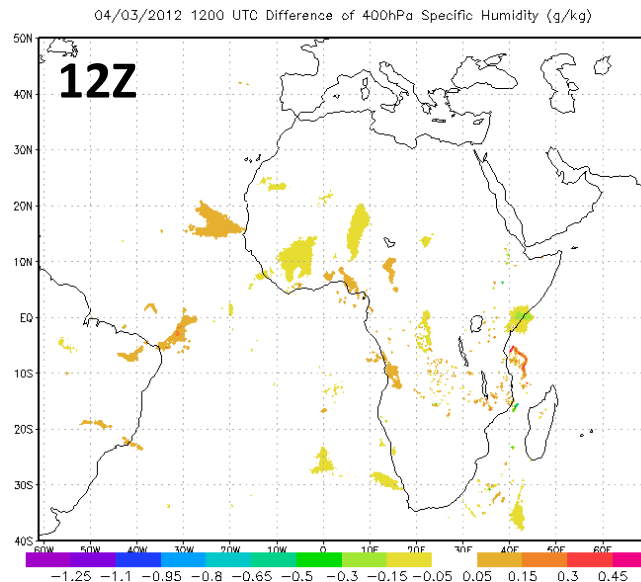
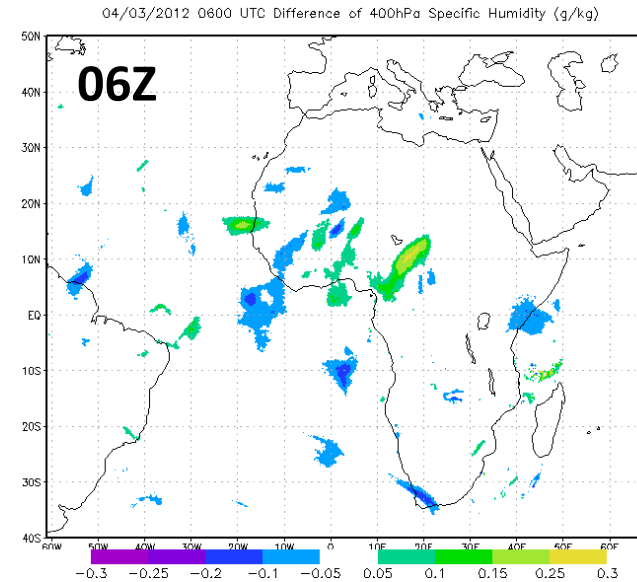
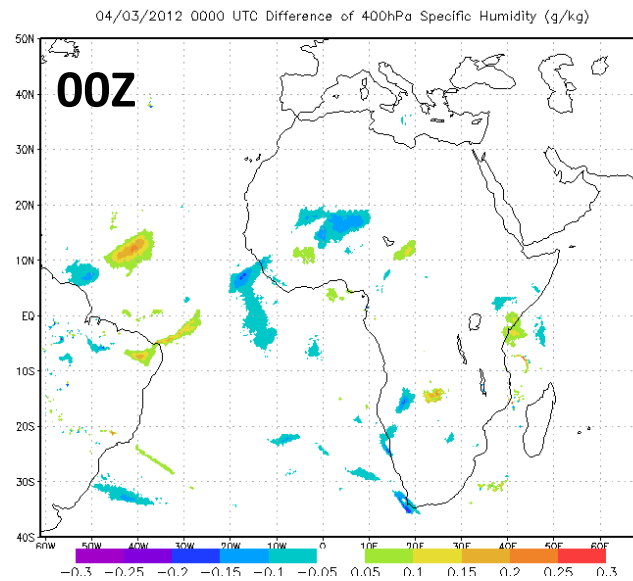
O-G with BC



O-A

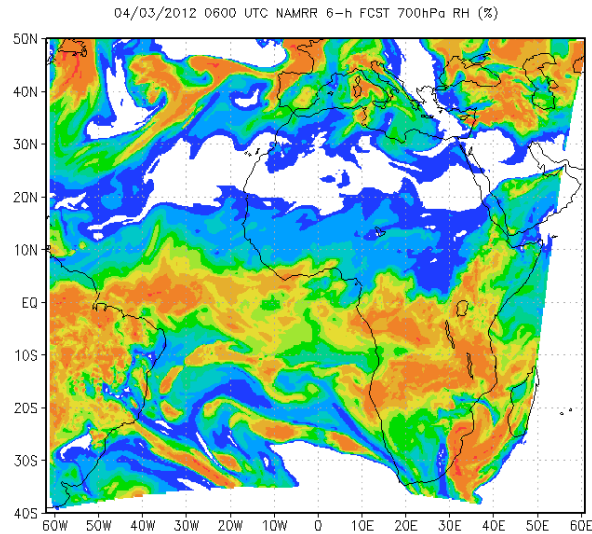


# 400hPa Specific Humidity Analysis Difference (w/n) SEVIRI

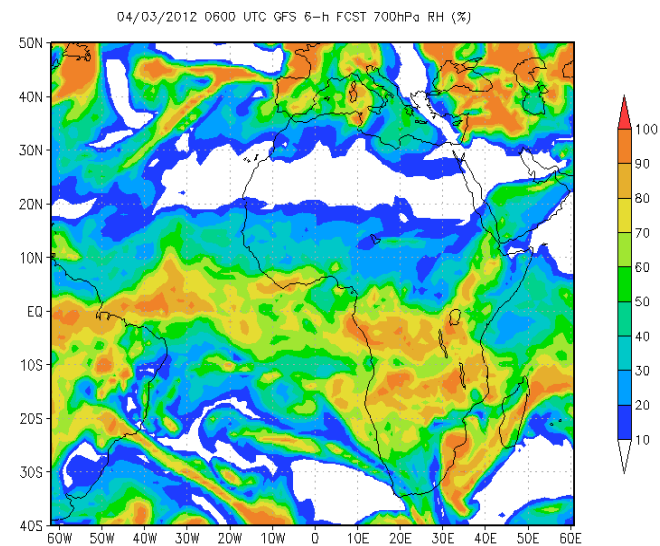


# 6-hour Forecast for 700 hPa Relative Humidity

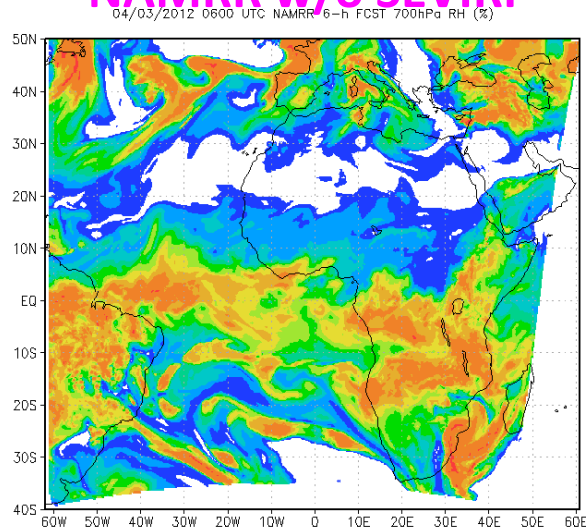
## NAMRR with SEVIRI



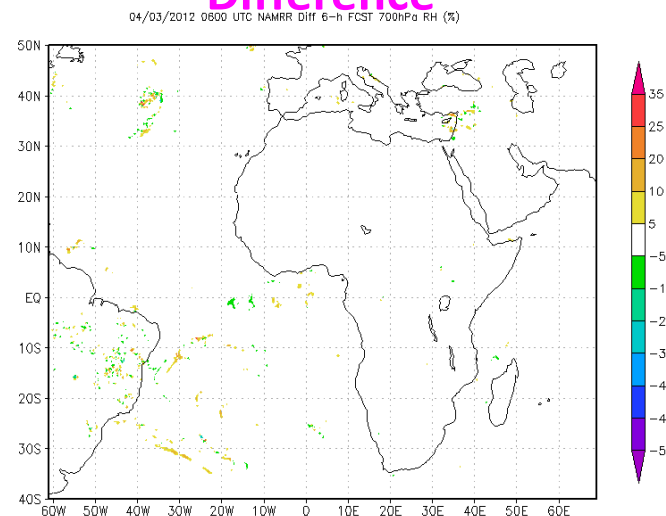
## GFS



## NAMRR w/o SEVIRI



## Difference

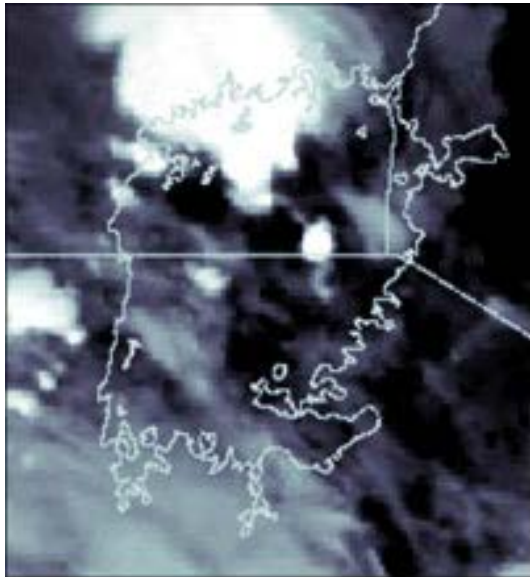




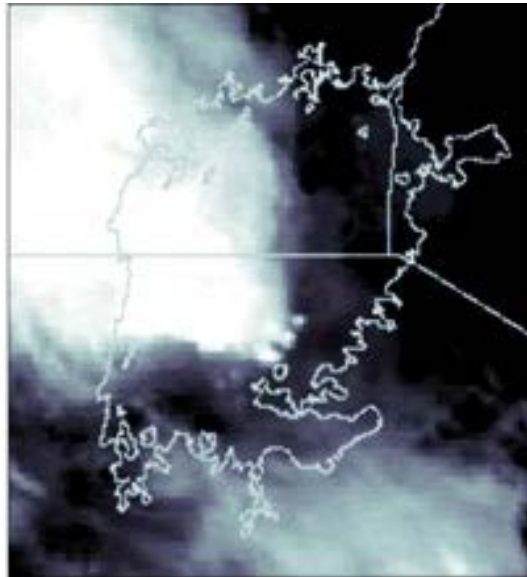
# Storm Case

The storm case of 0600 UTC, 4 March 2012 made a fishing boat was lost in the Bukoba region of Tanzania in the western part of the lake, resulting two fishermen's death. The storm grew over Kampala from approximately **0000** UTC (0300LT) and moved southwards towards the Bukoba region by **0300** UTC (0600LT). It is assumed the boat experienced dangerous weather conditions around this time

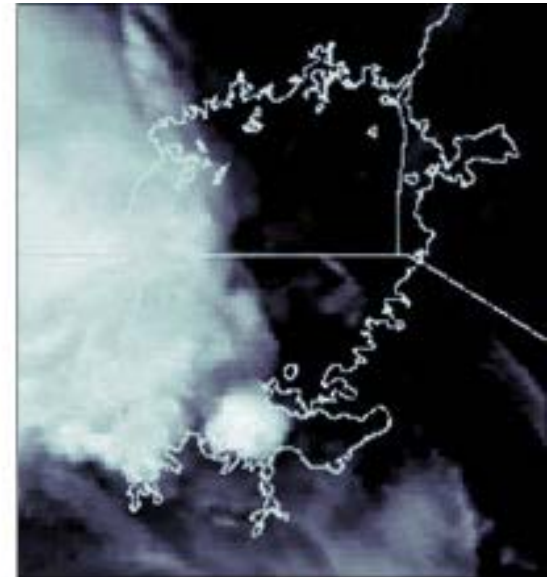
IR 04/03/2012 0000 UTC



IR 04/03/2012 0300 UTC



IR 04/03/2012 0600 UTC

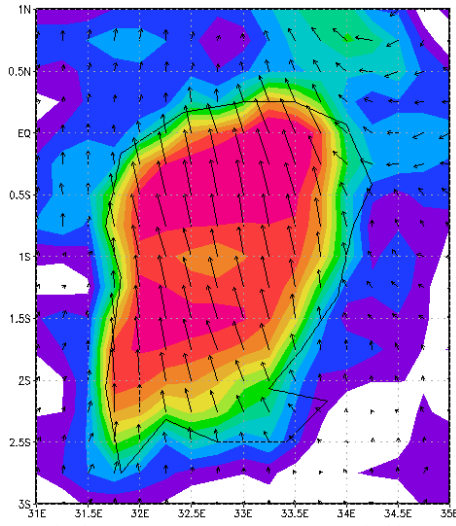


Evolution of the storm on 4 March 2012. 10.8  $\mu\text{m}$  infrared images taken by Meteosat ([from: J.M. Chamberlain et. al. , 2013](#))

# Wind Forecast

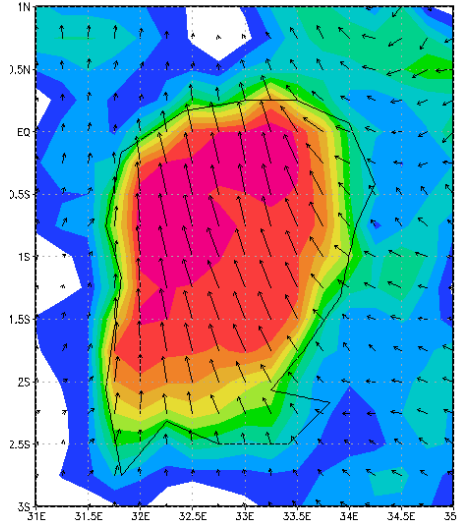
**04/03/2012 0000 UTC**

04/03/2012 0000 UTC Baseline 10m Wind (m/s)



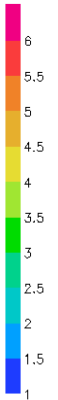
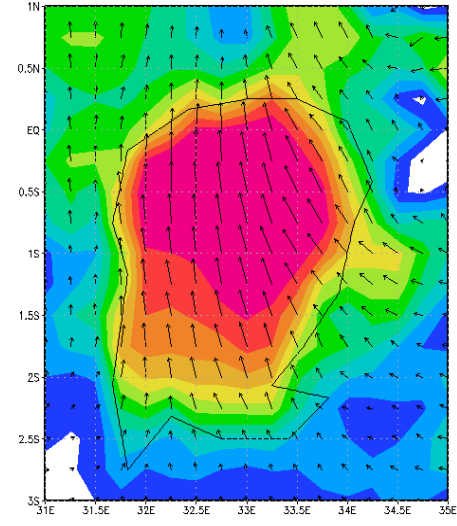
**04/03/2012 0300 UTC**

04/03/2012 0300 UTC Baseline 10m Wind (m/s)

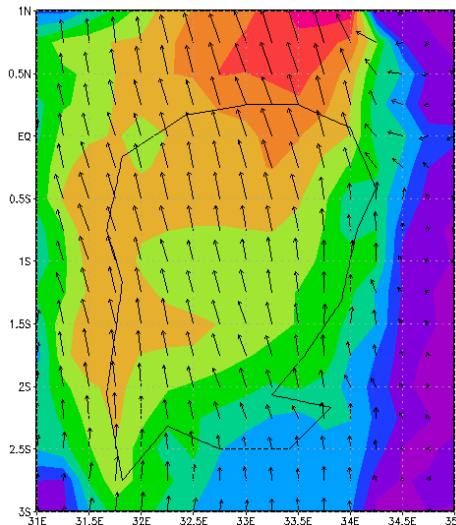


**04/03/2012 0600 UTC**

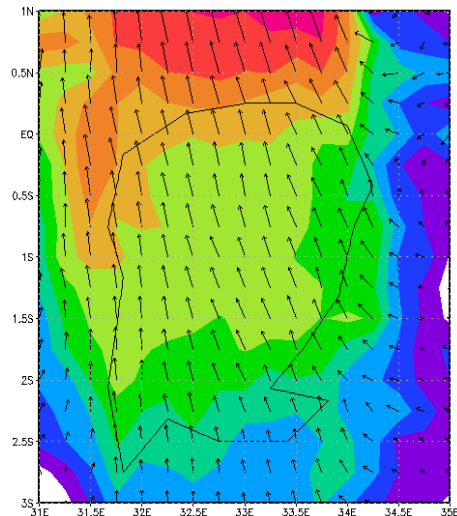
04/03/2012 0600 UTC Baseline 10m Wind (m/s)



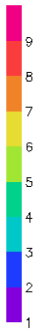
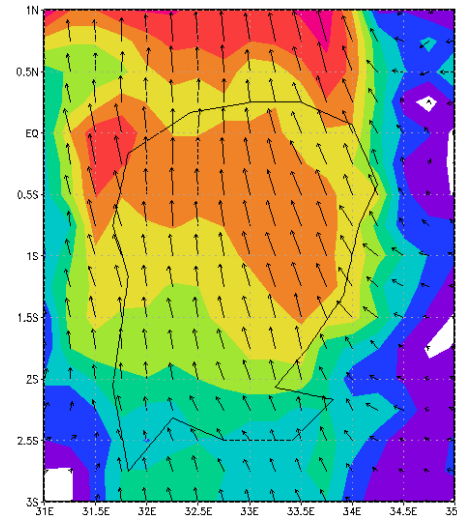
04/03/2012 0000 UTC Baseline 850hPa Wind (m/s)



04/03/2012 0300 UTC Baseline 850hPa Wind (m/s)



04/03/2012 0600 UTC Baseline 850hPa Wind (m/s)





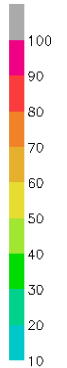
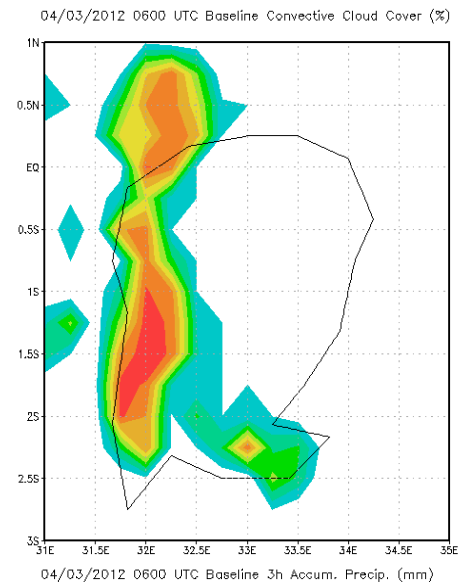
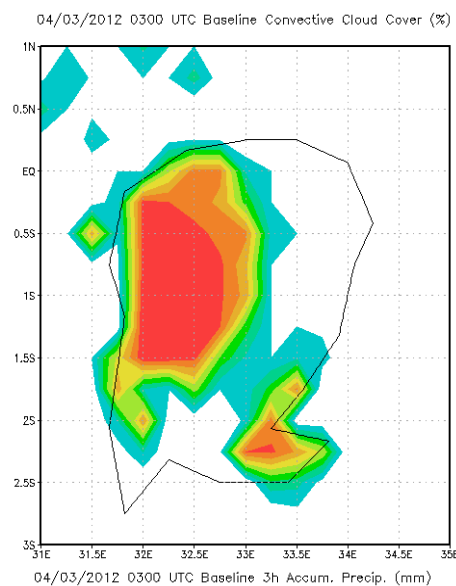
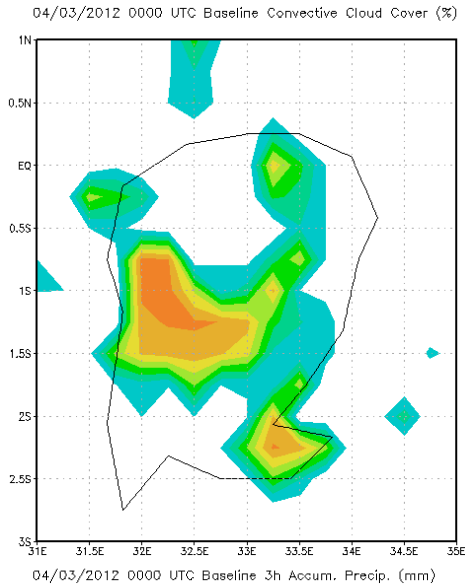
# Cloud Cover & Accumulate Precip.

04/03/2012 0000 UTC

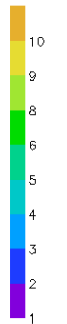
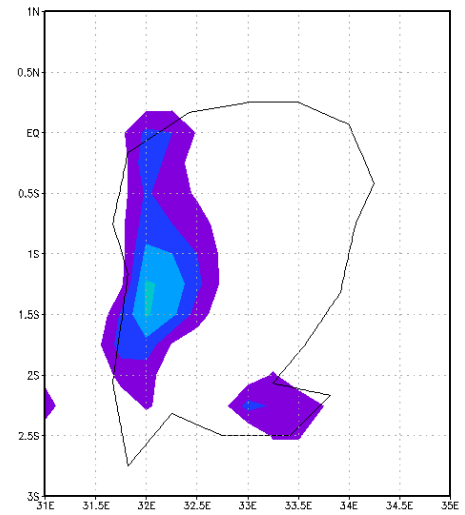
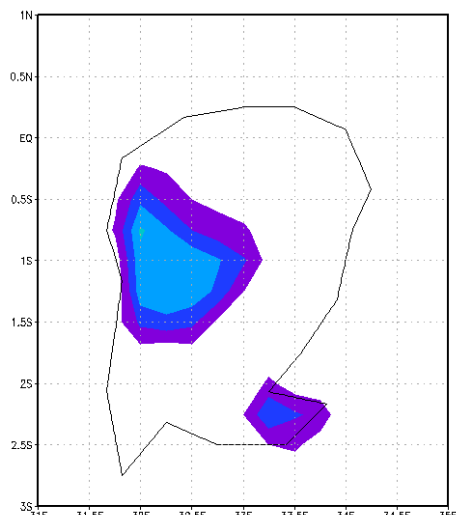
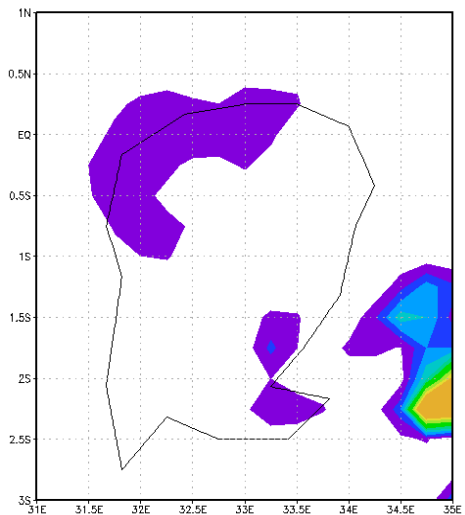
04/03/2012 0300 UTC

04/03/2012 0600 UTC

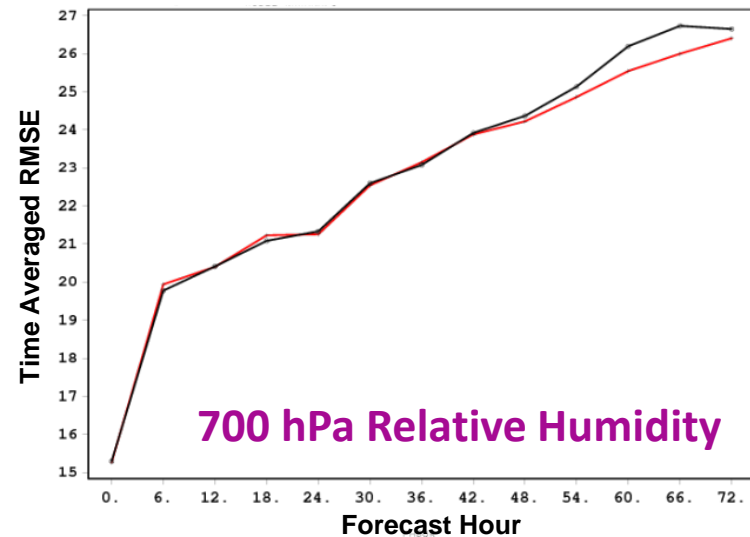
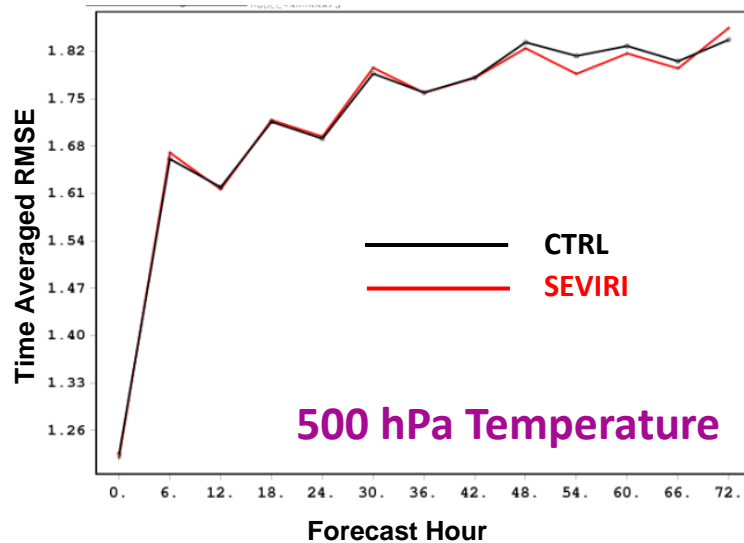
Cloud Cover



3hs Precip.

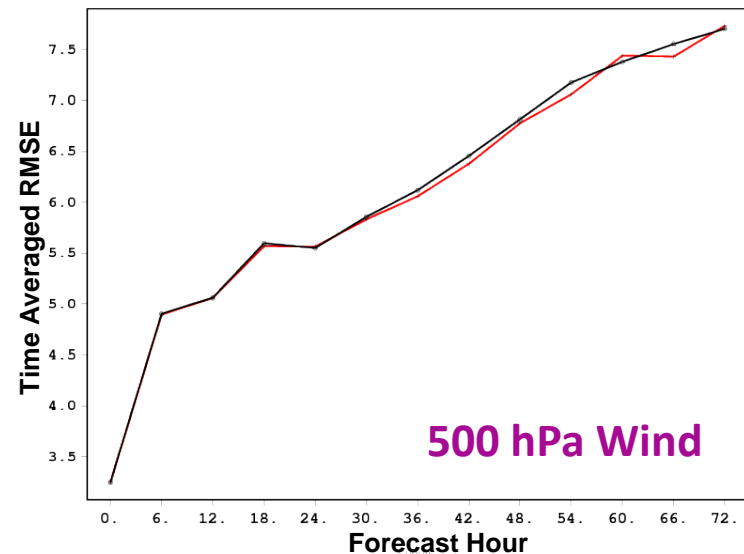


# SEVIRI Impact on Forecast (March 1-30 2012)



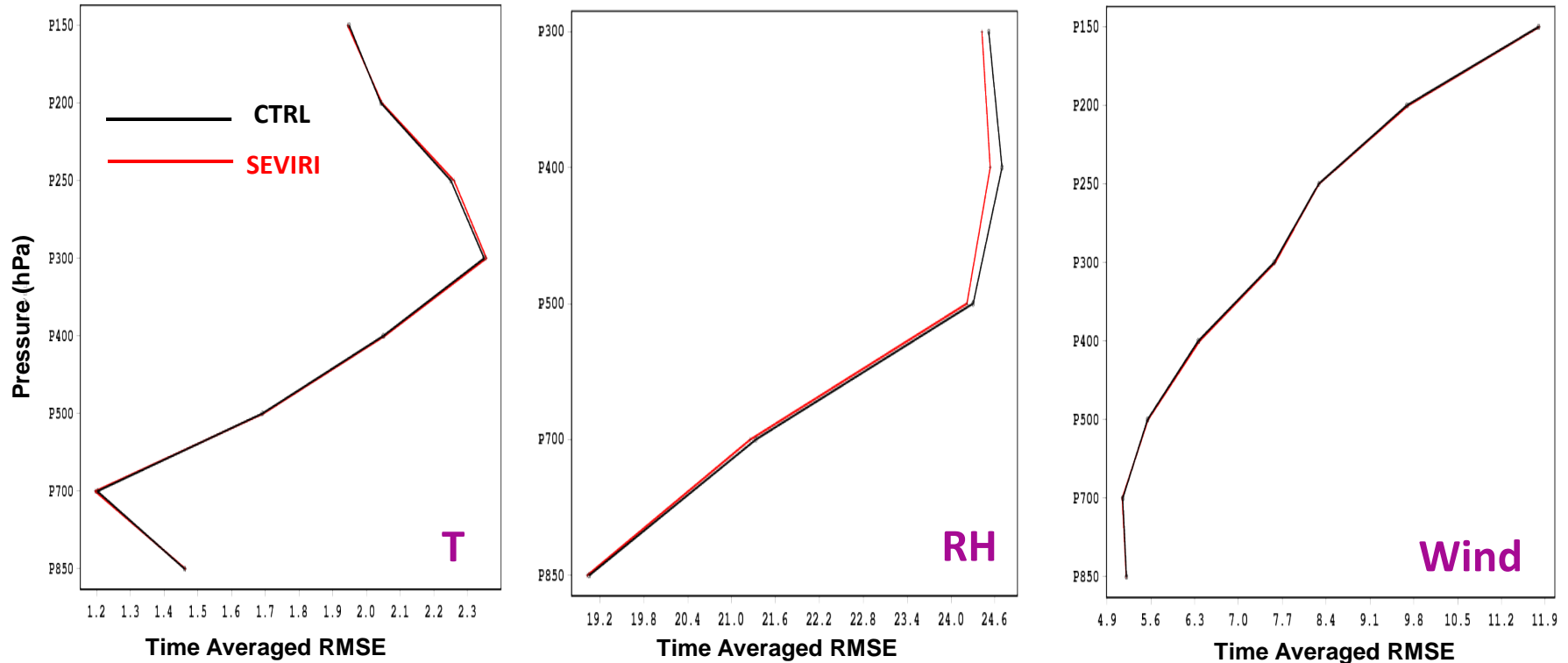
SEVIRI clear-sky radiance does improve the forecast at the 3<sup>rd</sup> day.

Verification against conventional observation: raob, profiler, meta....



# SEVIRI Impact on Forecast (March 1-30 2012)

## Profiles of 24h forecast RMSE



SEVIRI improved the RH 24-hour forecast above 500 hPa

# Summary:

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- ❖ Clear-sky SEVIRI radiance has slightly positive impact on 3-day forecasts, especially the relative humidity field;
- ❖ Assimilation of two water vapor channels has the positive impact on upper level (500-300hPa) 24-h moisture forecast;
- ❖ NMMB with 12-km horizontal resolution captured the storm over Lake Victoria, but not strong enough. High resolution nested domain 4 (3) –km is needed for storm scaled weather forecast;
- ❖ NAMRR system works properly for Europe-Africa region, it could be the Lake Victoria field program pre-research system.

# Future Work:

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- Improve the storm forecast with higher resolution nested domain (4 or 3km);
- Assimilate SEVIRI cloudy radiance in GSI with EUMESAT all-sky SEVIRI product;
- Include some characterization of clouds in the GSI control variable: cloud top & cloud fraction;
- Single-layer cloud-top height and fraction of opaque cloud;
- DO NOT touch the sophisticated treatment of multi-layer clouds via input profile of liquid and ice water at this moment.