SEVIRI Radiance Data Impact to Regional Forecast using NAMRR

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OUTLINE:

• 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
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.
## Channel Selection:

<table>
<thead>
<tr>
<th>SEVIRI chn #</th>
<th>Wave length (μm)</th>
<th>Main observation application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VIS0.6</td>
<td>Surface, clouds, wind fields</td>
</tr>
<tr>
<td>2</td>
<td>VIS0.8</td>
<td>Surface, clouds, wind fields</td>
</tr>
<tr>
<td>3</td>
<td>NIR1.6</td>
<td>Surface, cloud phase</td>
</tr>
<tr>
<td>4</td>
<td>IR3.9</td>
<td>Surface, clouds, wind fields</td>
</tr>
<tr>
<td>5</td>
<td>WV6.2</td>
<td>Water vapor, high level clouds, atmospheric instability</td>
</tr>
<tr>
<td>6</td>
<td>WV7.4</td>
<td>Water vapor, atmospheric instability</td>
</tr>
<tr>
<td>7</td>
<td>IR8.5</td>
<td>Surface, clouds, atmospheric instability</td>
</tr>
<tr>
<td>8</td>
<td>IR9.7</td>
<td>Ozone</td>
</tr>
<tr>
<td>9</td>
<td>IR11.2</td>
<td>Surface, clouds, wind fields, atmospheric instability</td>
</tr>
<tr>
<td>10</td>
<td>IR12.3</td>
<td>Surface, clouds, atmospheric instability</td>
</tr>
<tr>
<td>11</td>
<td>IR13.3</td>
<td>Cirrus cloud height, atmospheric instability</td>
</tr>
</tbody>
</table>

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: 954x835x60
- 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

Brightness Temperature (K)

Before Assimilating: Thinning -> Bias Correction -> QC
Time Series of G-O valid at 00Z 01 – 00Z 31 MAR 2012

Platform: seviri_m09
G: GFS 6hs forecast
O: SEVIRI radiance observation

Without Bias Correction

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
04/03/2012 0000 UTC NAMRR 6-h FCST 700hPa RH (%)

NAMRR w/o SEVIRI
04/03/2012 0000 UTC NAMRR 6-h FCST 700hPa RH (%)

GFS
04/03/2012 0000 UTC GFS 6-h FCST 700hPa RH (%)

Difference
04/03/2012 0000 UTC NAMRR DIFF 6-h FCST 700hPa RH (%)
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.

Evolution of the storm on 4 March 2012. 10.8 μm infrared images taken by Meteosat *(from: J.M. Chamberlain et. al., 2013)*
Wind Forecast

04/03/2012 0000 UTC

04/03/2012 0300 UTC

04/03/2012 0600 UTC

10m Wind

850hPa Wind
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\textsuperscript{rd} 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:

- 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:

- 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.