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A presentation
by
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Scientific problem

“To understand the role of the wave pouch in the vorticity upscale cascade (H1 in the marsupial paradigm) and in preventing the dry air intrusion (H2 in the marsupial paradigm)”

Dunkerton et al., 2009

- Marsupial paradigm (H1-H3)
  - H1- Roll up of vorticity/ wave breaking
  - H2- Pouch region
  - H3- Meso-scale vortices

Objectives:

- To compare the genesis sequence of a NIO (moist tropical) cyclone and AO (dry dusty) cyclone.
Data and methodology

- IMD and NHC best track dataset
- MODIS AOD – 550nm
- AI data (1°x1.25°)
- GOES satellite imagery
- MSG Satellite images
- ERA interim (0.125°x0.125°)
- NCEP ADP upper air and surface observations
- Satellite Radiances

### Satellite Sensors

<table>
<thead>
<tr>
<th>Satellite Sensors</th>
<th>Satellite Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMSU A</td>
<td>NOAA 15,16,18, EOS Aqua and METOP-2</td>
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<td>AMSU B</td>
<td>NOAA-15, 16, 17</td>
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<tr>
<td>AIRS</td>
<td>NOAA-18, and METOP -2</td>
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<tr>
<td>MHS</td>
<td>EOS Aqua</td>
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High resolution analysis is created using 3Dvar assimilation

28 July 2016

WSN - 16
### Experimental design

#### Weather Research and Forecasting - WRF (Version 3.6.1) & WRFDA

<table>
<thead>
<tr>
<th>Details</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamical core</td>
<td>ARW, compressible, Non-hydrostatic</td>
</tr>
<tr>
<td>Horizontal grid distance</td>
<td>18km(Domain 1), 6km (Domain 2)</td>
</tr>
<tr>
<td>Vertical levels</td>
<td>64</td>
</tr>
<tr>
<td>Model top</td>
<td>100 hPa</td>
</tr>
<tr>
<td>Initial and boundary conditions</td>
<td>GFS analysis (0.5 x 0.5), 6 hourly</td>
</tr>
<tr>
<td>Time step</td>
<td>30 s</td>
</tr>
<tr>
<td>Microphysics</td>
<td>Thompson</td>
</tr>
<tr>
<td>Long wave radiation</td>
<td>RRTM</td>
</tr>
<tr>
<td>Short wave radiation</td>
<td>Dudhia scheme</td>
</tr>
<tr>
<td>Surface layer</td>
<td>Monin Obukhov similarity theory</td>
</tr>
<tr>
<td>Land surface</td>
<td>Noah Land surface</td>
</tr>
<tr>
<td>PBL</td>
<td>Mellor Yemada Janjic</td>
</tr>
<tr>
<td>Cumulus</td>
<td>Kain-Fritsch scheme</td>
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28 July 2016

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Simulation verification

**Track**

- **Madi**
  - Formed on 6 December 2013
  - Category 1 on 8 December 2013

- **Florence**
  - Formed on 3 September 2006
  - Category 1 on 10 September 2006

Best track in green and 3Dvar analysis in red

- Formed on 6 December 2013
- Category 1 on 8 December 2013

3Dvar analysis shows matching track for both the cyclones

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Dry air and moist tropical

Yellow red shadings indicate likely SAL regions with increasing amounts of dust content.

Heavy dust areas are indicated by AOD > 0.5 and AI > 3.
The SAL region is associated with the air temperature (850hPa) more than 290K and RH < 70%
Both these cyclones are originated from the westward moving parent disturbance
Parent disturbance tracking

Wind speed and streamlines (850 hPa)

CAPE and CIN

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Florence vortex grew into unusually large size than Madi vortex.
Dry air intrusion – RH cross section

Dry air intrusion into the core of the vortex of Florence cyclone
Pouch acted as a protective region (H2) from the series of dust outbreaks

Vorticity upsacle cascade (H1) in the marsupial paradigm
Intensification within the pouch

Vortex of Florence cyclone is weak
Madi cyclone is associated with strong warm core
A modelling study has been carried out to understand the similarities and differences in the genesis sequence of a NIO tropical cyclone Madi (6-13 December, 2013) and Atlantic Ocean cyclone Florence (3-12 September, 2006).

The presence of dust over AO and NIO region was confirmed using microwave imageries of SAL from Wisconsin University, MODIS AOD and OMI AI products.

Both the cyclones are found to be formed in the vicinity of the ITCZ and the parent disturbance of these cyclones is traced backward in time using TPW.

Large values of CAPE is accompanied by small values of CIN prior to the genesis of Madi cyclone which is favourable for the formation of deep convection. In the case of Florence cyclone, denser contours of CIN near to the African coast (CIN ~ 500 J Kg\(^{-1}\)) indicate the presence of convective inhibition area.

Analysis of the deep layer shear indicates comparatively less values of shear in the genesis environment of Madi cyclone but the value of deep layer shear is high to the north of cyclone Florence.

The transformation of tropical storm to tropical cyclone was quick in case of Madi but tropical storm Florence encountered an area of large wind shear and delayed its intensification till 10 September 2006.
It has been noted that the failure to organize the system made Florence to grow to an unusually large size compared to that of Madi cyclone.

The developed 3DVAR analysis using WRF model and WRFDA-3DVAR provides the compelling evidence for the intrusion of dry air into the core of the vortex of Florence cyclone that delayed the organization of the vortex into hurricane strength.

As the warm and dry air intruded into the core of Florence, it began to weaken and failed to develop as quickly as that of Madi cyclone.

It is seen that the wave pouch plays a more important role in the vorticity upscale cascade (H1 in the marsupial paradigm) in the case of tropical cyclone Madi than in preventing dry air intrusion (H2 in the marsupial paradigm), whereas in the case of hurricane Florence, the pouch acted as a protective region (H2) from the series of dust outbreaks than the vorticity upscale cascade (H1 in the marsupial paradigm).
Thank you...