Ensemble-based genesis guidance

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• **Goal**: Provide objective guidance on TC genesis based on dynamical forecast models.

• **Methods**: Create probabilistic guidance based on a consensus of track forecasts from global deterministic models as well as their ensemble forecast systems.
# Models included

<table>
<thead>
<tr>
<th>Ensemble System</th>
<th># Members</th>
<th>Forecast cycle availability (UTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP</td>
<td>20</td>
<td>00, 06, 12, 18</td>
</tr>
<tr>
<td>FNMOC</td>
<td>20</td>
<td>00, 12</td>
</tr>
<tr>
<td>CMC</td>
<td>20</td>
<td>00, 12</td>
</tr>
<tr>
<td>ECMWF</td>
<td>50</td>
<td>00, 12</td>
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</tbody>
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<th>Deterministic models</th>
<th>Forecast cycle availability (UTC)</th>
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<tr>
<td>NCEP / GFS</td>
<td>00, 06, 12, 18</td>
</tr>
<tr>
<td>FNMOC / NOGAPS</td>
<td>00, 12</td>
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<td>00, 12</td>
</tr>
</tbody>
</table>
Procedure

1. Run tracker for each ensemble member

2. Post-process tracker results to filter and categorize storms.

3. Compute genesis probabilities based on track results from all members
Detect & track new storms

1. Initial scan identifies candidate lows, based only on mslp.

2. Second scan is performed to refine the location of lows, using additional parameters:
   - zeta (700 mb, 850 mb, 10-m)
   - gp height (700 mb, 850 mb)
   - minimum in wind speed (700 mb, 850 mb, 10-m)
   - mslp

3. For both scans, checks are performed to ensure each found center resembles a cyclone.
Filter & categorize storms

1. Model forecast storms that do not live for at least 24h are filtered out.

2. Checks are performed at each lead time for a closed mslp contour (1 mb interval) as well as for strength of 850 mb circulation, but results do not need to be 100% continuous.

3. Storms are categorized using two of Hart’s cyclone phase space parameters:
   – Parameter B (cyclone tilt / asymmetry): < 10 for TC
   – Lower-level (600-900 mb) warm core: > 0 for TC

4. An additional, simple check of 300-500 mb warm core is shown on track plots, but is not used for genesis probabilities.
Compute genesis probabilities

Calculate fraction of members indicating genesis within a 350 km radius of each grid point:

1. For each ensemble
2. For a consensus of the 4 global ensembles (equally weighted)
3. For a consensus of the 4 global deterministic models
Example: 2012092500 NCEP Ensemble

Three different areas in the ITCZ south of Hawaii as well as an area off the coast of Central America lead to probabilities >10%.
Example: 2012092500 ECMWF Ensemble
Genesis probabilities for 00-48h from all four global ensembles: 2012092500
Consensus-based genesis probabilities for 00-48h using all four global ensembles: 2012092500
Forecast storm tracks from all four deterministic global models: 2012092500
Consensus-based genesis probabilities for 00-48h using all four global deterministic models: 2012092500

Consensus-based Probability (%) of TC genesis using deterministic models: GFS, NOGAPS, CMC, ECMWF
For forecasts during the 00–48h period from initial time = 2012092500
Ensemble-based and Consensus-based genesis probabilities for 2012092500: 00-48h

Ensemble-based Probability (%) of TC genesis using these global ensembles: NCEP FNMOC CMC ECMWF
For forecasts during the 00–48h period from initial time = 2012092500

Consensus-based Probability (%) of TC genesis using deterministic models: GFS, NOGAPS, CMC, ECMWF
For forecasts during the 00–48h period from initial time = 2012092500

Graphical Tropical Weather Outlook
National Hurricane Center Miami, Florida

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours:
- Low <30%
- Medium 30-50%
- High >50%

Forecast hour shown at beginning of each track. PFDL is first lead time the storm was detected in model.
Genesis probabilities based on consensus of ensemble forecast systems.

Genesis probabilities based on consensus of deterministic forecasts.

Genesis probabilities based on each ensemble forecast system.
Paula McCaslin built a very nice interface for looping through images based on model or lead time.
Summary

1. Consensus-based approach to provide genesis probability guidance using global deterministic and ensemble forecast systems.

2. Cyclones are detected with the tracker and categorized using parameters from cyclone phase space.
   – May need to adjust use of cyclone phase space depending on results

3. Bug fix necessary in order to include genesis probabilities for Invest systems.