GPM
and
Weather Forecasting

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European Centre for Medium-range Weather Forecasts

Reading, UK
**ECMWF**

- An independent intergovernmental organisation; established in 1975
- 20 Member States, 14 Co-operating States, 45 M£ annual budget (staff:HPC)
- 270 staff (110 RD, 55 CD, 65 FD, 40 AD)

<table>
<thead>
<tr>
<th></th>
<th>Forecast/Analysis</th>
<th>Number of members</th>
<th>Horizontal resolution</th>
<th>Vertical levels and pressure at model top (hPa)</th>
<th>Perturbation models</th>
<th>IFS cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRES</td>
<td>Forecast 0–10 days</td>
<td>1</td>
<td>T1279/16 km</td>
<td>L137/0.01</td>
<td>No</td>
<td>Latest</td>
</tr>
<tr>
<td>ENS</td>
<td>Forecast 0–10 days</td>
<td>51</td>
<td>T639/32 km</td>
<td>L91/0.01 (in analysis and model physics)</td>
<td>Yes</td>
<td>Latest</td>
</tr>
<tr>
<td></td>
<td>Forecast 10–32 days</td>
<td></td>
<td>T319/64 km</td>
<td>L91/0.01 (in analysis and model physics)</td>
<td>Yes</td>
<td>Latest</td>
</tr>
<tr>
<td>4DVAR</td>
<td>Analysis</td>
<td>1</td>
<td>T1279/16 km (T255 inner loops)</td>
<td>L137/0.01</td>
<td>No</td>
<td>Latest</td>
</tr>
<tr>
<td>EDA</td>
<td>Analysis</td>
<td>11</td>
<td>T399/50 km (T159 inner loops)</td>
<td>L137/0.01</td>
<td>Yes (in observations and model physics)</td>
<td>Latest</td>
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<tr>
<td>SEAS</td>
<td>Forecast 0–13 months</td>
<td>51</td>
<td>T255/80 km</td>
<td>L91/0.01 (in analysis and model physics)</td>
<td>Yes</td>
<td>2011 version</td>
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<tr>
<td>ERA</td>
<td>Analysis</td>
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<td>T255/80 km</td>
<td>L60/0.1</td>
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<td>BC</td>
<td>Forecast 0–90 hours, hourly output</td>
<td>1</td>
<td>T1279/16 km</td>
<td>L137/0.01</td>
<td>No</td>
<td>Latest</td>
</tr>
</tbody>
</table>

- No regional systems
- No warnings issued
- Only limited value adding applied to forecast model output
Assimilated satellite data

2013: 50+ instruments assimilated, \(\sim 10^7\) observations per day

... and GPM
Data assimilation system

Analysis = initial state

Forecast

4D-Var trajectories

First guesses

Observation

Surface pressure

Assimilation window

Time

09Z  12Z  15Z  18Z  21Z

Forecast
95% of all data is assimilated as radiances (i.e. level-1)
100% of cloud/precipitation satellite data is assimilated as radiances (i.e. level-1*)
Cloud/precipitation assimilation:
  • 8 years of development time x 2-3 FTE

(* with SSM/I, TMI, SSMIS, ASMR-E, AMSR2)
Verification of model forecasts with TRMM

- **a** Phase (LST) TRMM radiometer
- **b** Phase (LST) CTL (Old model)
- **c** Phase (LST) NEW (New model)
Verification of model forecasts with TRMM
AMSU-A currently most important single observing system (5 satellites) = fct. (data volume, single observation impact, synergy with others)

Microwave imagers most important instrument for lower tropospheric moisture!
Data impact on forecasts: Case North Atlantic storm

All observations from which Forecast Error Reduction < -20 kJ/kg
Data impact on forecasts: Case North Atlantic storm

FEC-contribution by type for analysis 6 November 00 UTC in 30°x30° box

- All other observations
- AUTOMATIC SHIP
- NOAA 18 AMSUA RADIANCES
- DMSP 17 SSMIS RADIANCES ALL-SKY
- AIREP
- DRIBU

Forecast sensitivity [-1 * kJkg⁻¹]

MSLP

GPM Applications WS Weather Forecasting PB 11/2013 © ECMWF
British meteorologists predicted Sandy’s course

When scientists at the European Weather Centre in England saw a cold front from the north joining with a hurricane to send it into the northeast, they’d rarely seen anything like it. Without their forecasts over a week ahead of time, the human outcome could have been worse. NBC’s Keir Simmons reports.

http://intra.ecmwf.int/publications/cms/get/weekly_news/2012-11-02
Data impact on forecasts: Sandy

- No MW imagers
- Full EOS forecast
- Verifying analysis
- No LEO satellites
- No GEO satellites
- No drop sondes
- No MW/IR sounders
- No GPS-RO
- No AMV
Model impact on forecasts: Sandy

20121030 12 UTC
**Future**

**NWP systems:**
- Improved hybrid data assimilation to produce optimal analysis (initial state) + uncertainties
- Resolutions of 10 km in 2015, 5 km in 2020, 2.5 km in 2025
- Coupling with ocean/sea-ice/atmospheric composition (model and assimilation)
- Better characterisation of observation + model errors
- Computer codes that scale on massively parallel HPC
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Satellite data:
• Bulk of data as level-1 product (radiance, reflectivity, backscatter x-section)
• Increased usage of:
  • Cloud/precipitation/water vapour
  • Aerosol/composition
  • Land surface
  • Snow/ice
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Requirements:
• Continuity of core observation types (sounders, imagers) with sufficient global coverage
• Enhanced modelling capabilities for process representation
• Enhanced observational capabilities for process studies and verification
• Enhanced data assimilation capabilities for optimal data exploitation

→ Only combination of the above will produce return on investment!