Use of satellite data in NWP and Reanalysis/Development of NWP

CGMS-40 Panel Discussion
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Nobuo SATO
former Director-General
of the Meteorological Research Institute, JMA
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• Scope of Satellite Data Utilization
Nobuo Sato
Head of Satellite Program Office (1997-2000)

GMS (Geostationary Meteorological Satellite)
- GMS (Himawari): Jul 1977
- GMS-3 (Himawari-3): Aug 1984
- GMS-4 (Himawari-4): Sep 1989

MTSAT (Multi-functional Transport Satellite)
- MTSAT-1R (Himawari-6): Feb 2005
- MTSAT-2 (Himawari-7): Feb 2006

Back-up operation of GMS-5 with GOES-9 by NOAA/NESDIS

May 2003

Launch failure Nov 1999

Himawari
- Himawari-8: 2014

Nobuo Sato
Head of Satellite Program Office (1997-2000)
History of JMA’s Geostationary Meteorological Satellites “Himawari” and Global Numerical Prediction Models

*GMS (Geostationary Meteorological Satellite)*
- GMS-1 (Himawari-1): Jul 1977
- GMS-3 (Himawari-3): Aug 1984
- GMS-4 (Himawari-4): Sep 1989
- GMS-5 (Himawari-5) (GOES-9): May 2003

*MTSAT (Multi-functional Transport Satellite)*
- MTSAT-1R (Himawari-6): Feb 2005
- MTSAT-2 (Himawari-7): Feb 2006
- MTSAT-2 (Himawari-7): 2014
- MTSAT-2 (Himawari-7): 2016

*Global Spectral Model*
- Horizontal resolution: 381 km L4
- Vertical layer: 280 km L12
- 110 km L21
- 60 km L30
- 60 km L40

*Launch failure*
- Nov 1999

*Back-up operation of GMS-5 with GOES-9 by NOAA/NESDIS*

*Nobuo Sato*
- Director of NWP Division (2000-2002)

*Nobuo Sato*
- Head of Satellite Program Office (1997-2000)

*Japan Meteorological Agency*
Improvement of Global NWP

RMSE of 500 hPa geopotential height in Northern Hemisphere (20-90N)
(JMA Global Model. Bar: annual mean)

The accuracy of 72hr forecast in 2010 exceeded that of 24hr forecast in 1980’s.
History of Assimilated Data Amount and Forecast Error Trend

- MWS(T)
- SCAT
- MWS(W)
- AMV
- GEO
- CSR

Upper Air sounding
Surface Observation

- MWS retrieval
- MWS(T)
- AMV
- Upper Air sounding
- Surface Observation
Improvement of Tropical Cyclone Forecast

Annual means of position errors
(Official Forecast of RSMC Tokyo – Typhoon Center)

Smaller error
Example of Tropical Cyclone Forecasts Improved by Satellite Data

Typhoon Track Forecast
12 UTC, Sep. 4, 2005

This example demonstrates assimilation of AMV (Atmospheric Motion Vectors) gives significant improvement on typhoon track forecast.
Trend of JMA MSM Precipitation Forecast Accuracy

Verification Grid: 20km Square
Verified Element: 5mm/3hr, FT00-15 mean

- Threat Score
- Threat Score (12 month mean)

Improvement of Mesoscale NWP

- GPS-PW Direct Assimilation of satellite radiance
- SSMI, TMI
- QuikSCAT
- AMSR-E
- 4DVar
- HourlyAMV
- 10km to 5km
- WDR
- Major revision of physical processes
- Improvement of convective scheme
- Radar reflectivity
- Nonhydro model
- Nonhydro 4DVar
- 4DVar

Japan Meteorological Agency
Contribution to Reanalysis Studies

Reanalyses have become an integral part of Earth system science research across many disciplines.

Proposed in 1988 by Bengtsson & Shukla and Trenberth & Olson
- for climate studies, following ECMWF and GFDL “FGGE” reanalyses for 1979

Three responses in the mid 1990s
- ERA-15 (1979 - 93), NASA/DAO (1980 - 93) and NCEP/NCAR (1948 - …)

Second round followed

Now towards end of third generation of comprehensive global reanalysis

Presentation by Adrian Simmons, ECMWF, at 4th WCRP International Conference on Reanalysis (2012)
Reprocessed AMVs and CSRs are provided to the Japanese 55-year Reanalysis (JRA-55).

Results of OSEs using the JRA-55 data assimilation system (TL319L60):
Reprocessed GMS AMVs significantly improve model forecasts.

*Z500 forecast scores for the extra tropical southern hemisphere for Jun. 1990*

Presentation by Shinya Kobayashi, JMA
at 4th WCRP International Conference on Reanalysis (2012)
The Road So Far

• Over the last 40 years, the utilization of satellite data, together with development of data assimilation, brought tremendous improvement in numerical weather prediction.

• Reprocessing of the past satellite data contributes to improvement of reliability of Reanalysis products.

Expectations

• Frequent satellite data would improve nowcasting, and thus, disaster prevention

• Long-term satellite data would contribute to climate monitoring from space

• Possible satellite data users would be found in wider areas: ex. environment, natural energy, agriculture, ...
I have a dream!

Continuous assimilation of Rapid Scan imagery, i.e. "Super Rapid Update Cycle," would enable nowcasting of convective weather!