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सत्यमेव जयते

Assimilation of Cloud Clear Radiance of Megha-Tropiques SAPHIR in NCMRWF GFS (T574L64)

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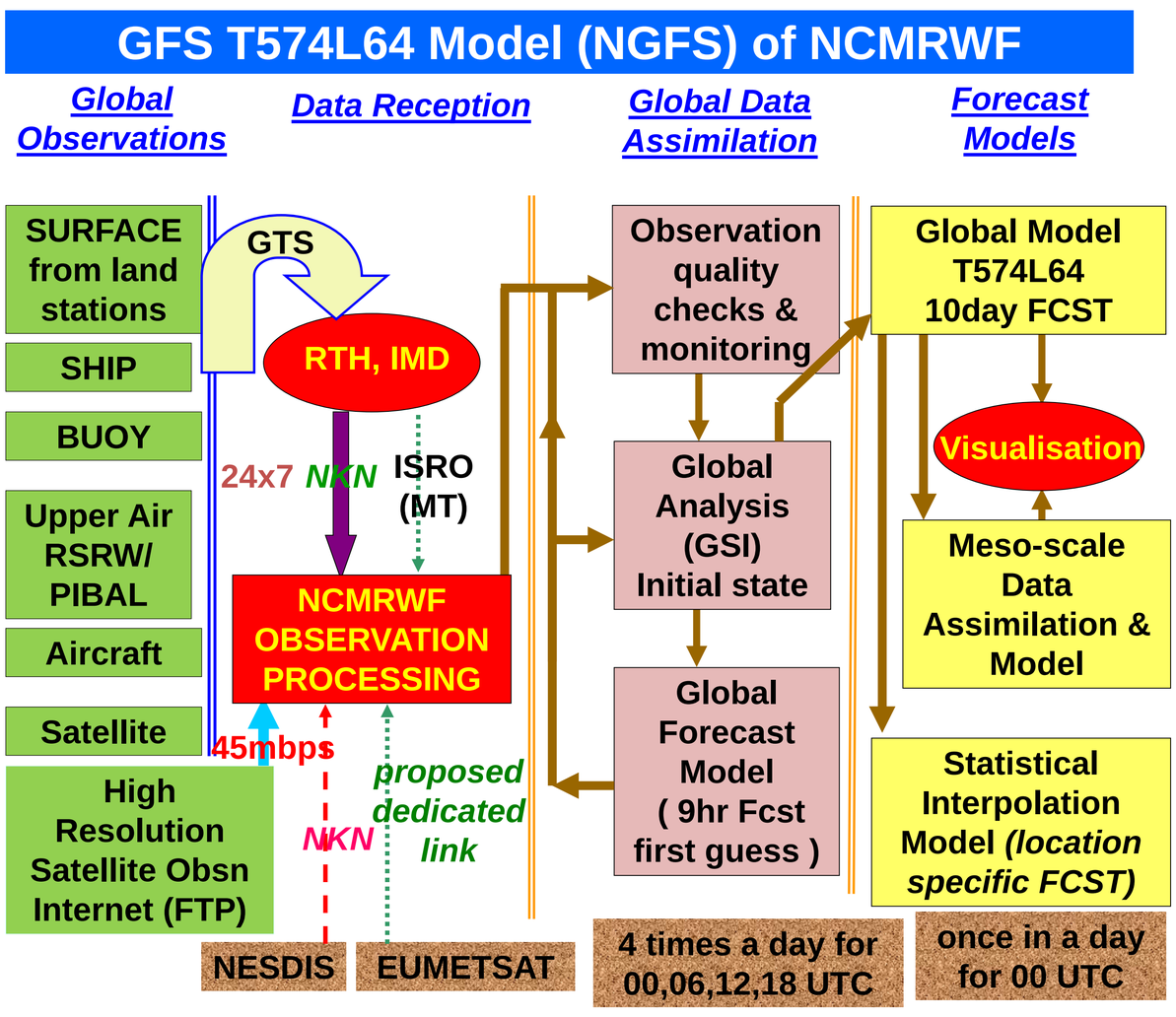
Introduction

- Data assimilation is a major component of numerical weather prediction and involves combining information coming from a forecast model together with available observations, thus providing 'analyses' of the atmosphere.
- Data assimilation is usually performed in a sequential manner, with a time series of 'assimilation cycles', including a model integration, and a correction due to observations.
- Radiance data contains cloud and precipitation signal. Clouds are considered as a source of noise that need to be removed or corrected for.

GFS T574L64 Model (NGFS) of NCMRWF



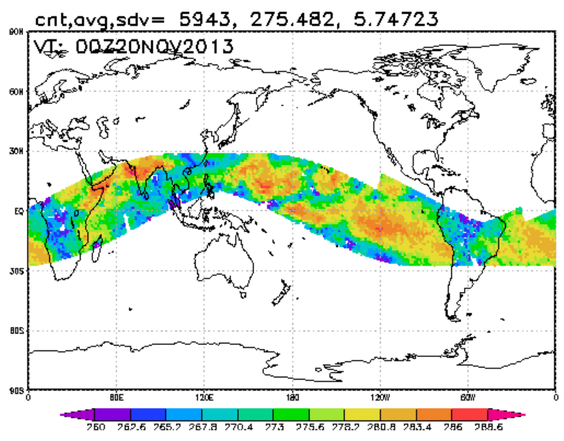
Identification of Deep Convective Cloud Pixels

The study done by Hong et al. (2005) is adapted to detect the deep convective clouds in SAPHIR radiances and then these cloud free radiances are used to improve the initial conditions and subsequent forecasts of NGFS model. In order to verify the criteria, cloudy pixels obtained from SAPHIR channels are compared with the TRMM daily accumulated rainfall.

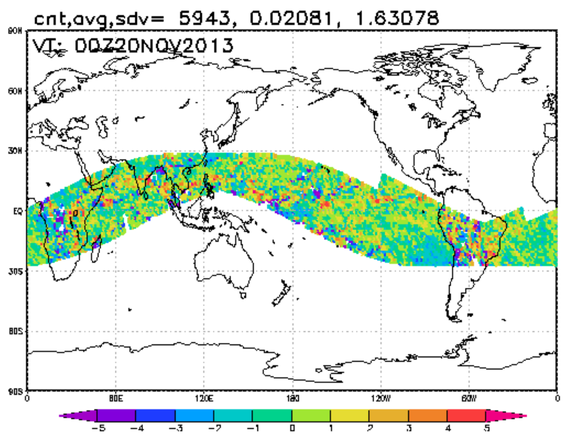
MT SAPHIR: Simulation/Assimilation

In the absence of cloud absorption and atmospheric scattering from precipitation, an accurately parameterized community radiative transfer model (CRTM) is used to simulate/assimilate the radiances from/in the NGFS models (Prasad et al., 2011) for clear atmospheric conditions.

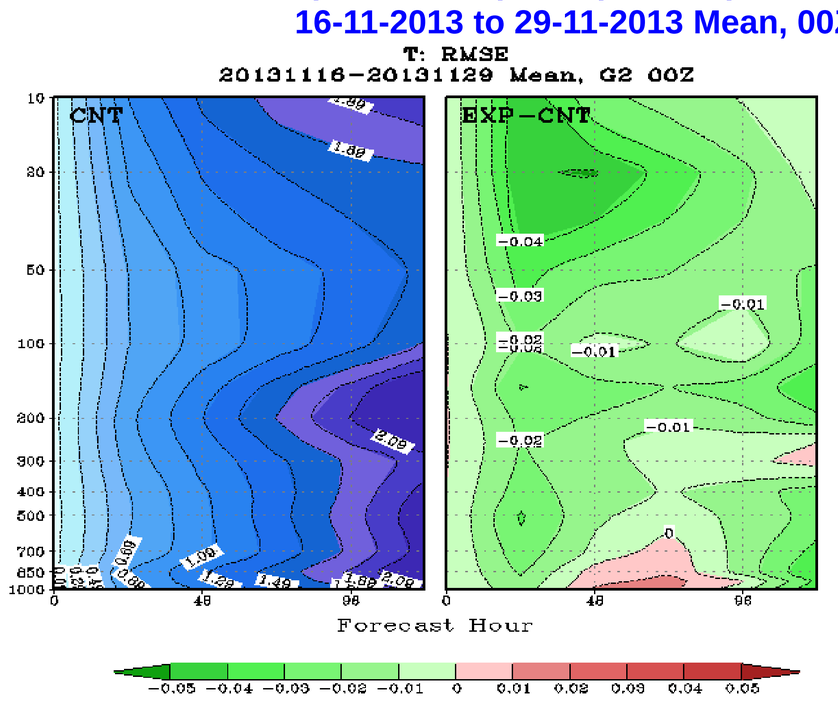
MT: SAPHIR Ch-5 on 20-11-2013 00 UTC Observation (K)



MT: SAPHIR Ch-5 on 20-11-2013 00 UTC Guess (with Bias Corr.) – Observation (K)



Root Mean Square Error (RMSE) in Temperature over Global
16-11-2013 to 29-11-2013 Mean, 00Z



SAPHIR data assimilation in NGFS shows positive impact in temperature globally.

Megha -Tropiques (MT) SAPHIR Overview

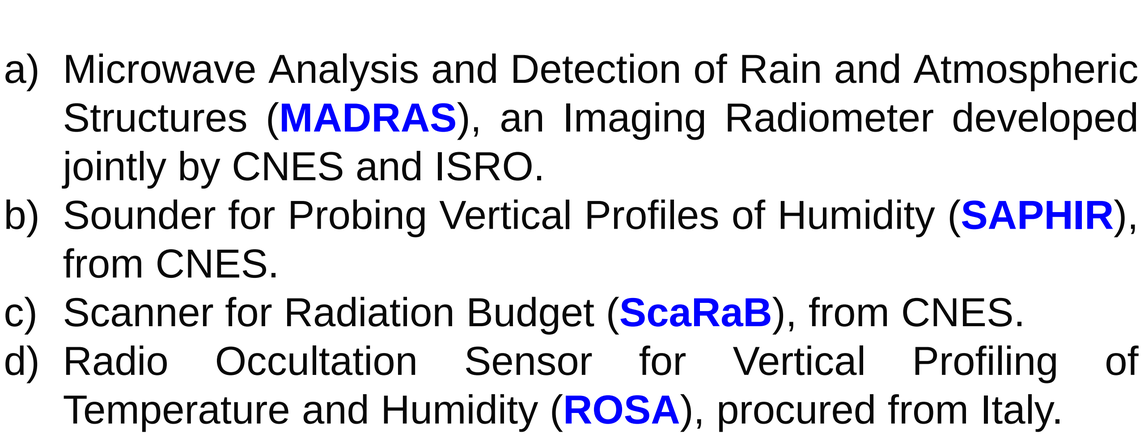
- The Megha-Tropiques (MT), a joint Indo-French satellite, was launched by the Indian Satellite launch vehicle on 12 October 2011 from Satish Dhawan Space Centre. The satellite is positioned in a highly inclined equatorial plane of 20° at a height of 867 km above the Earth so as to orbit the tropical region (30°S to 30°N) nearly 14-15 times per day.

- MT carries the following four payloads:

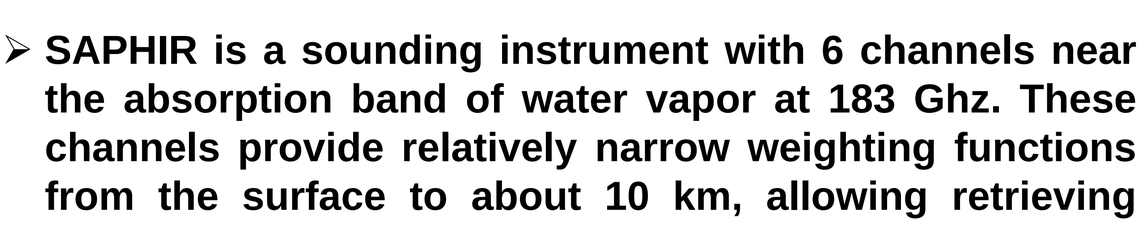
a) Microwave Analysis and Detection of Rain and Atmospheric Structures (**MADRAS**), an Imaging Radiometer developed jointly by CNES and ISRO.
b) Sounder for Probing Vertical Profiles of Humidity (**SAPHIR**), from CNES.
c) Scanner for Radiation Budget (**ScaRaB**), from CNES.
d) Radio Occultation Sensor for Vertical Profiling of Temperature and Humidity (**ROSA**), procured from Italy.

- SAPHIR is a sounding instrument with 6 channels near the absorption band of water vapor at 183 Ghz. These channels provide relatively narrow weighting functions from the surface to about 10 km, allowing retrieving water vapor profiles in the cloud free troposphere. The scanning is cross-track, up to an incidence angle of 50°.

Identification of Deep Convective Cloud Pixels on 2013_11_24
From Megha-Tropiques Saphir Channels



Daily TRMM 3B42(V7) 24Nov2013
Accumulated Rainfall [cm]



Mean RMSE in relative humidity (Global)
16-11-2013 to 29-11-2013 (00Z)

Level	FCST hour	CNT	EXP	% improvement
850 hPa	day1	11.0	10.6	4.3
	day2	15.5	15.3	1.2
	day3	18.5	18.3	0.9
	day4	20.8	20.7	0.1
	day5	22.7	22.7	0
700 hPa	day1	13.4	12.8	4.5
	day2	18.6	18.3	1.5
	day3	22.3	22.1	1.0
	day4	25.3	25.2	0.6
	day5	27.6	27.6	0
500 hPa	day1	16.2	15.6	3.6
	day2	21.9	21.8	0.2
	day3	25.9	25.9	0.0
	day4	29.0	29.1	-0.4
	day5	31.3	31.6	-0.8

SAPHIR data assimilation showed improvement in relative humidity which varies from 0.1 to 4.5 % in day1 to day4 at 700 and 850 hPa. However, in day5 no improvement has been seen. At 500 hPa, improvement can be seen up to day-2.

References

Prasad V.S., Saji Mohandas, Munmun Das Gupta, E.N. Rajagopal and Surya Kanti Dutta, 2011: Implementation of Upgraded Global Forecasting Systems (T382L64 and T574L64) at NCMRWF , NCMRWF Technical Report, pp. 1-72.

Hong, Gang and Georg Heygster, 2005: 'Detection of Tropical Deep Convective Clouds from AMSU-B Water Vapor Channels Measurements, Journal of Geophysical Research, VOL. 110, D05205, doi:10.1029/2004JD004949, 2005.

The 19th International TOVS study Conference (ITSC-19), Jeju Island, South Korea
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