IMDAA: Indian Monsoon Assimilation and Analysis

Richard Renshaw

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Sana Mahmood ,Jemma Davie, Peter Jermey, Amy Doherty, Dale Barker

Indian Monsoon Data Assimilation and Analysis

2014 – 2017 NCMRWF, IMD, Met Office

PI: Dale Barker (MetO)

Co-PI: Richard Renshaw (MetO)

Purpose:

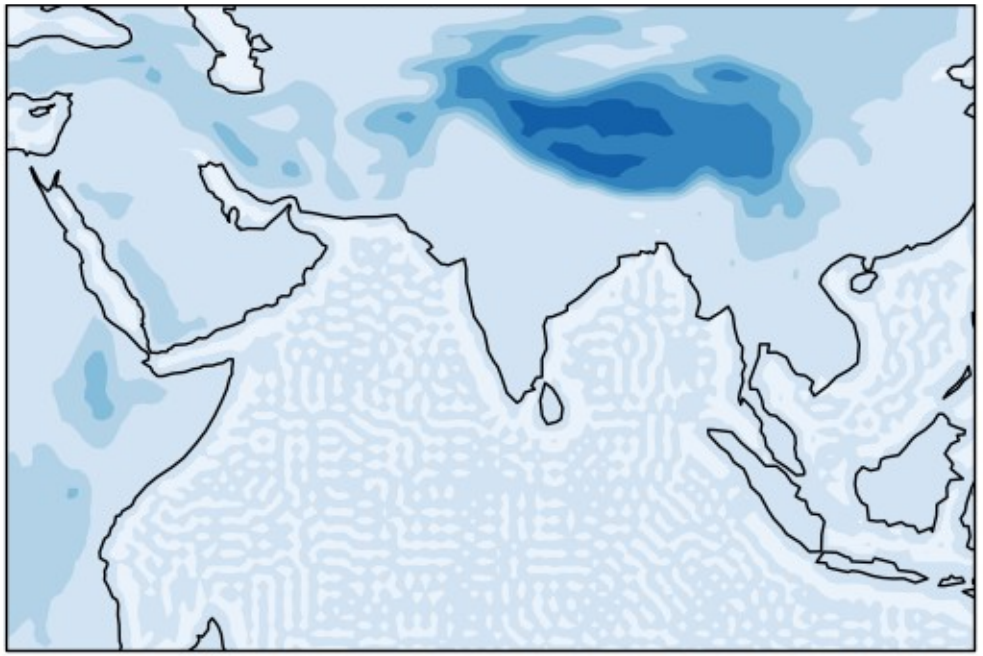
To provide a high-resolution (12km) UM-based 4DVar reanalysis of the Indian region, 1979-now

To develop an operational regional NWP system at NCMRWF

model orography

ERA-Interim

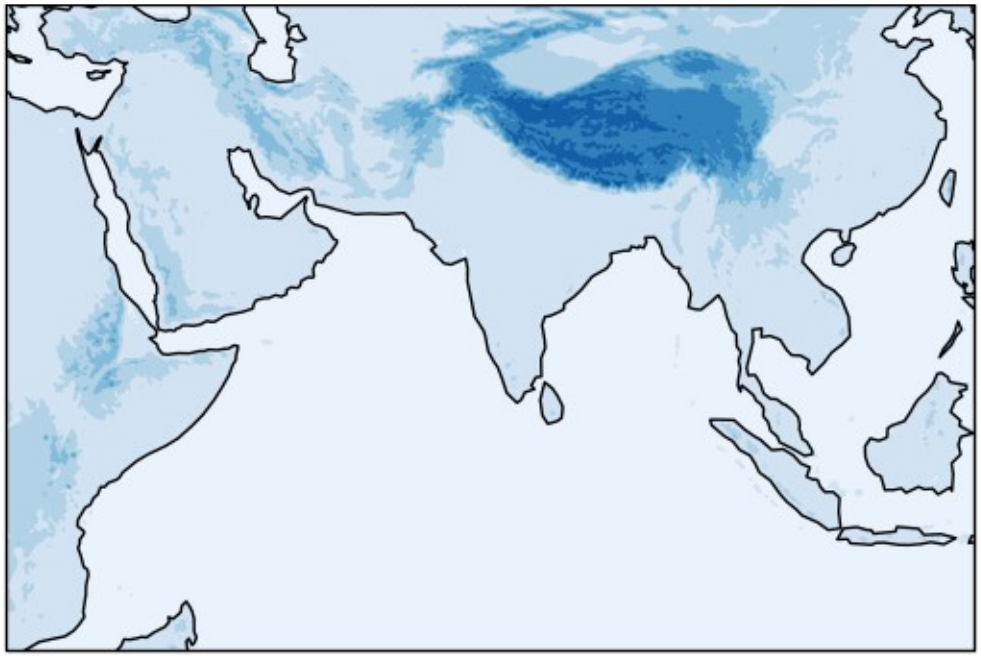
*T255 (**80km**)*



*IMDAA **12km***

30E – 120E

15S - 45N



Screen temp

14/07/2014

ERA-Interim

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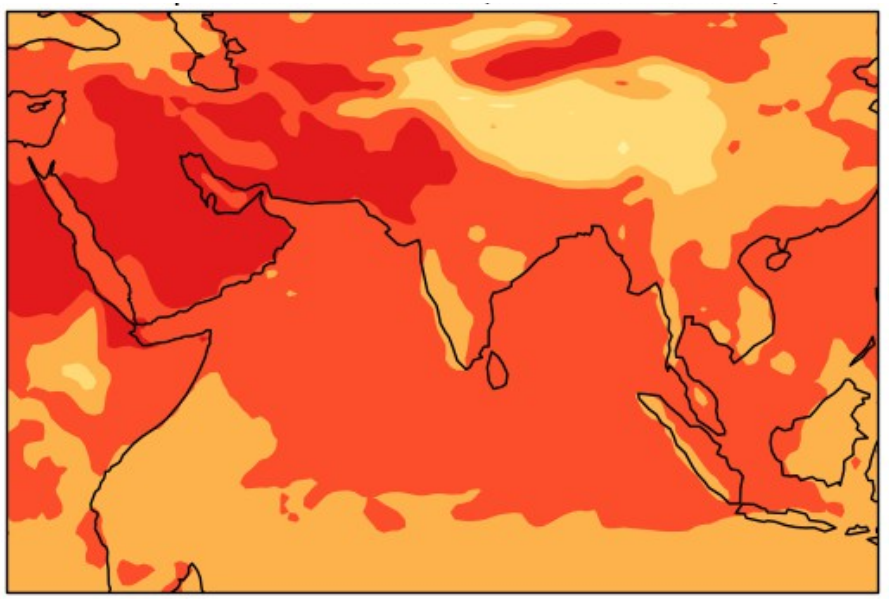
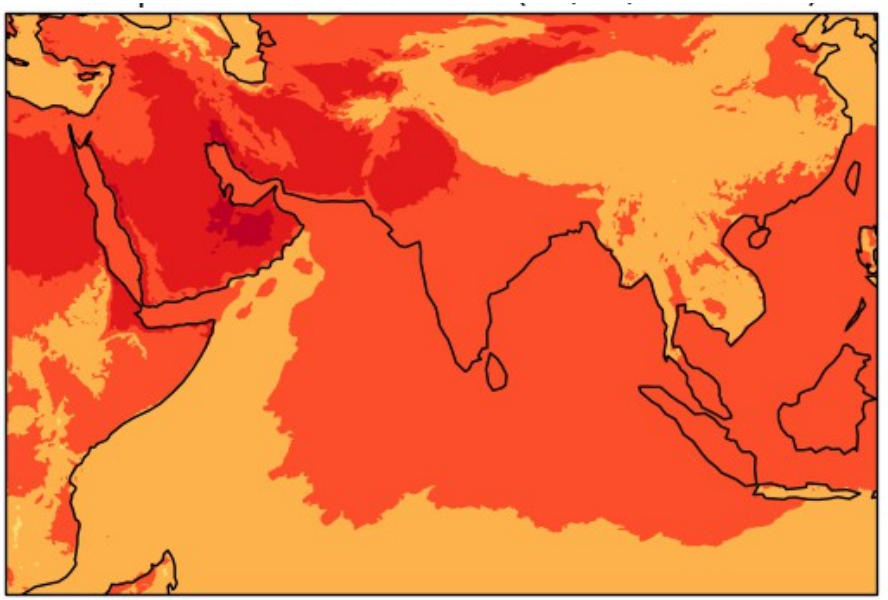
*IMDAA **12km***





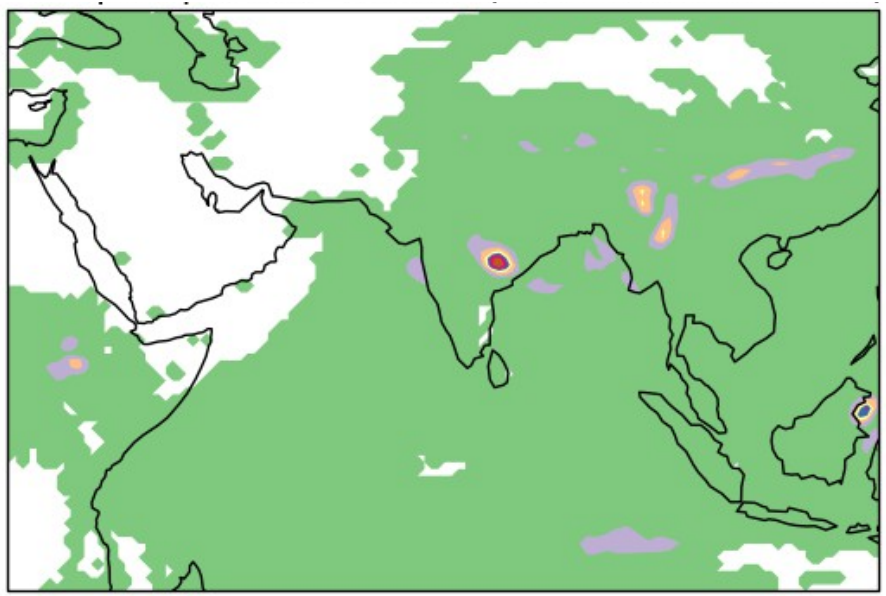
24hr precip

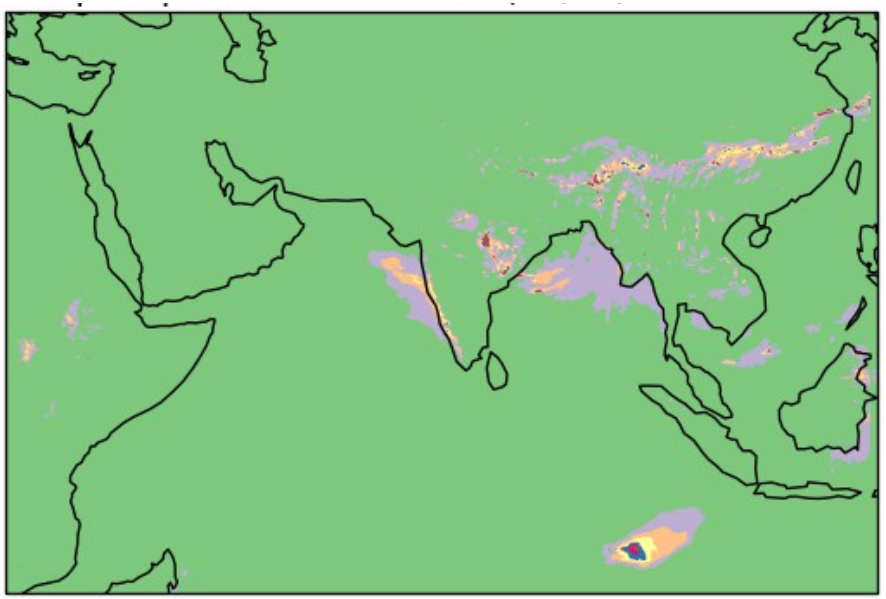
14/07/2014

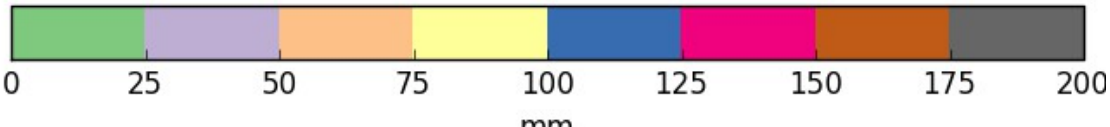
ERA-Interim

*T255 (**80km**)*

*IMDAA **12km***







Surface boundary conditions

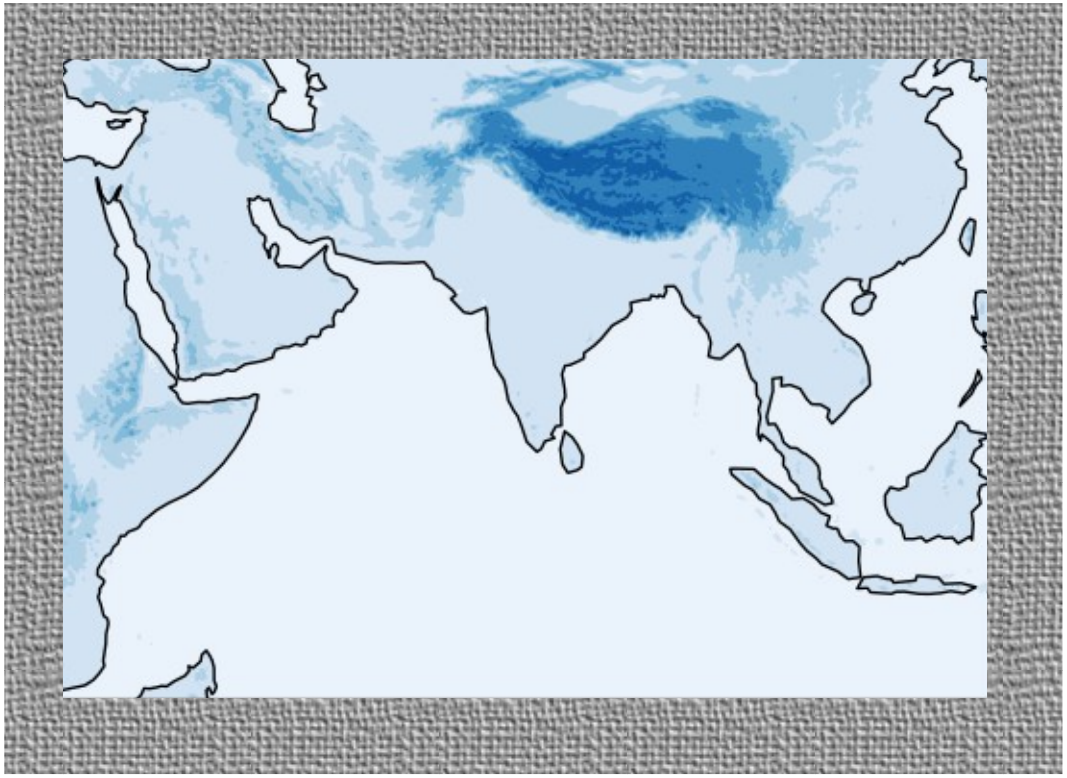
- HadISST2 (0.25^{o} lat/lon) before 1985
- OSTIA (5km) after 1985

•NESDIS IMS bulletins

•Land surface data assimilation (EKF),

•screen-level obs and ASCAT BUFR

Lateral boundary conditions



Reanalysis: ERA-Interim, 6 hourly

Operational: Global UM (NCMRWF)

Observations

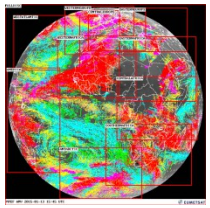
Met Office

ECMWF

Land Synop

Sondes

Ships & buoys

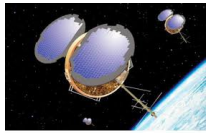


AMVs

Aircraft

(A)TOVS/AIRS/IASI

Scatwinds



GPSRO

(ERS2, SeaWinds)

Observations

Met Office

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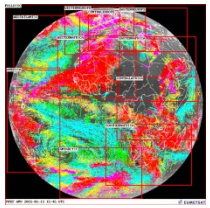
Land Synop

Sondes

Ships & buoys



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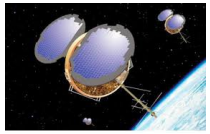


GPSRO

+ extra surface data

IMD/NCMRWF

Observation Recovery

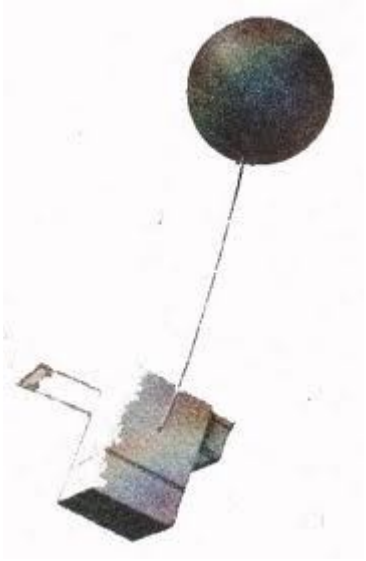
IMD and NCMRWF

Indian surface and sonde data

1995 – ongoing

extends obs available from ECMWF archive

Laskar (IMD), Srinivas (NCMRWF)

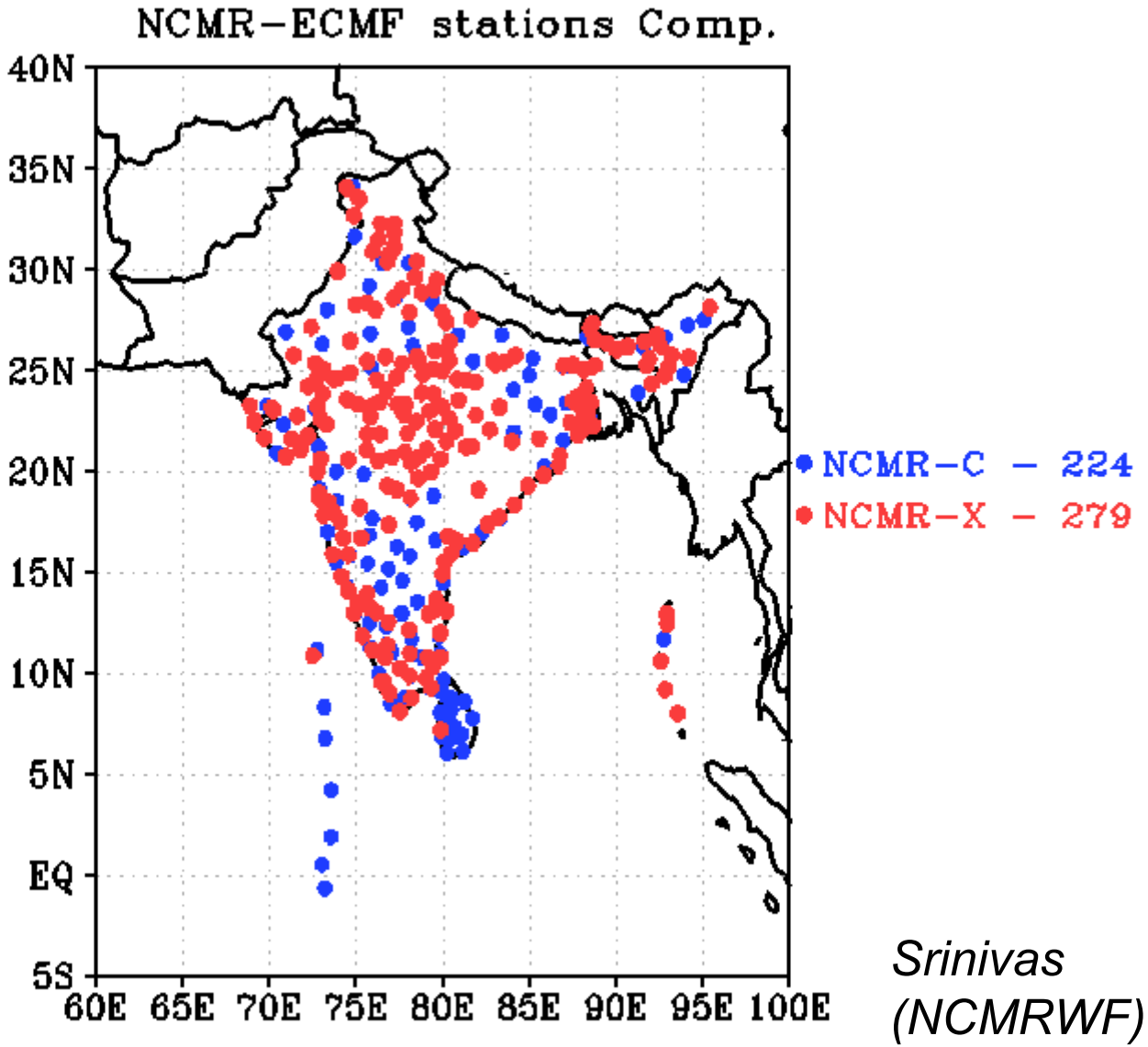


Observation Recovery

SYNOPs

06Z

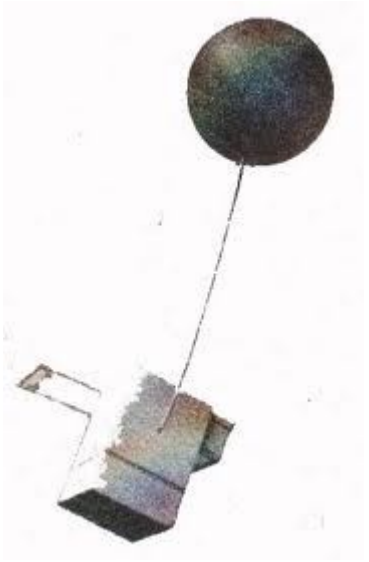
14/04/2014



Srinivas (NCMRWF)

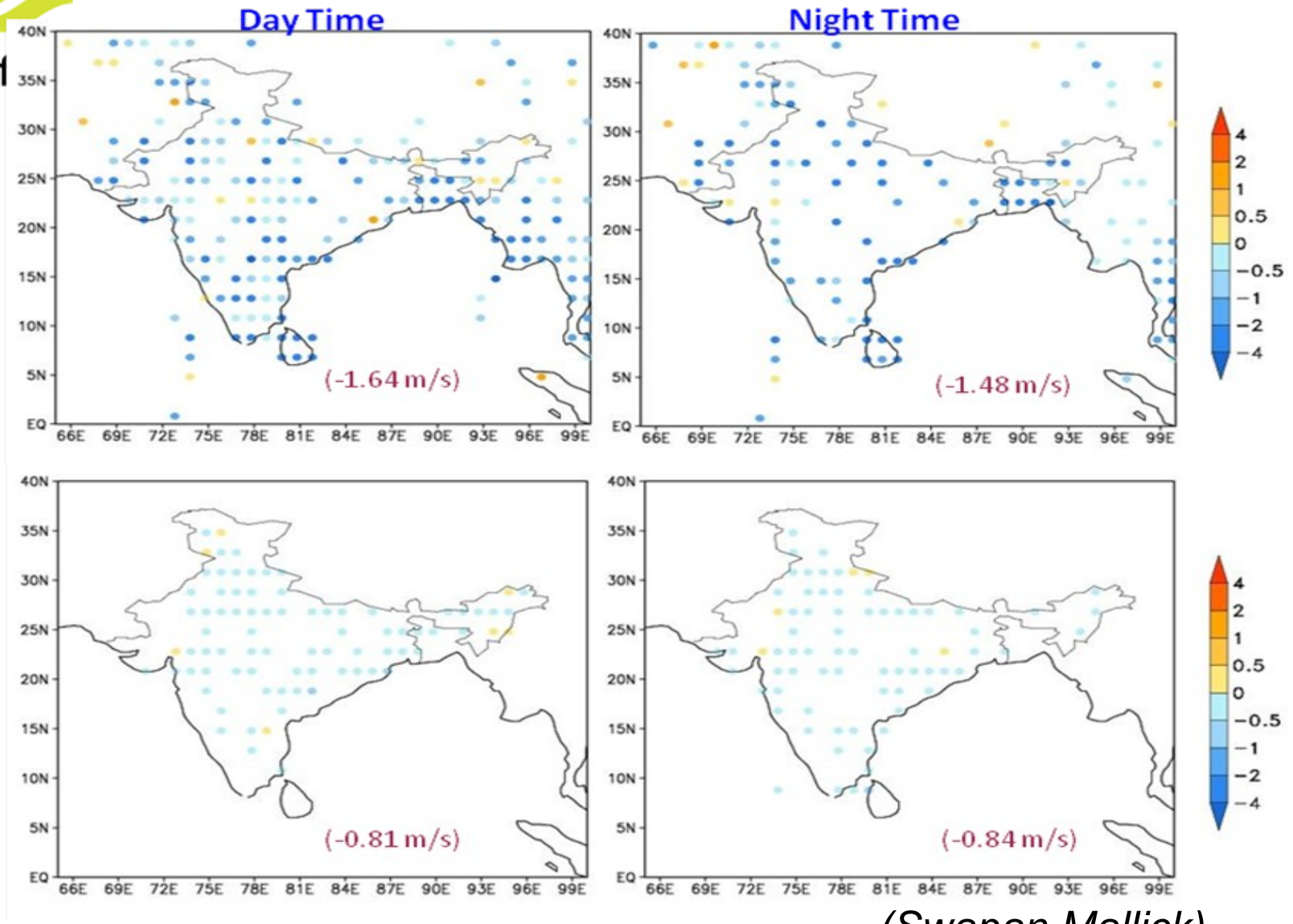
Observation rejection lists

- Based on monthly monitoring of O-B
- UKMO operational system is old, inflexible, not portable
- New system being written:
  - in python
  - based on ODBs
  - flexible, portable, and easy to modify
  - already working for surface data
    - extend for upper air + aircraft



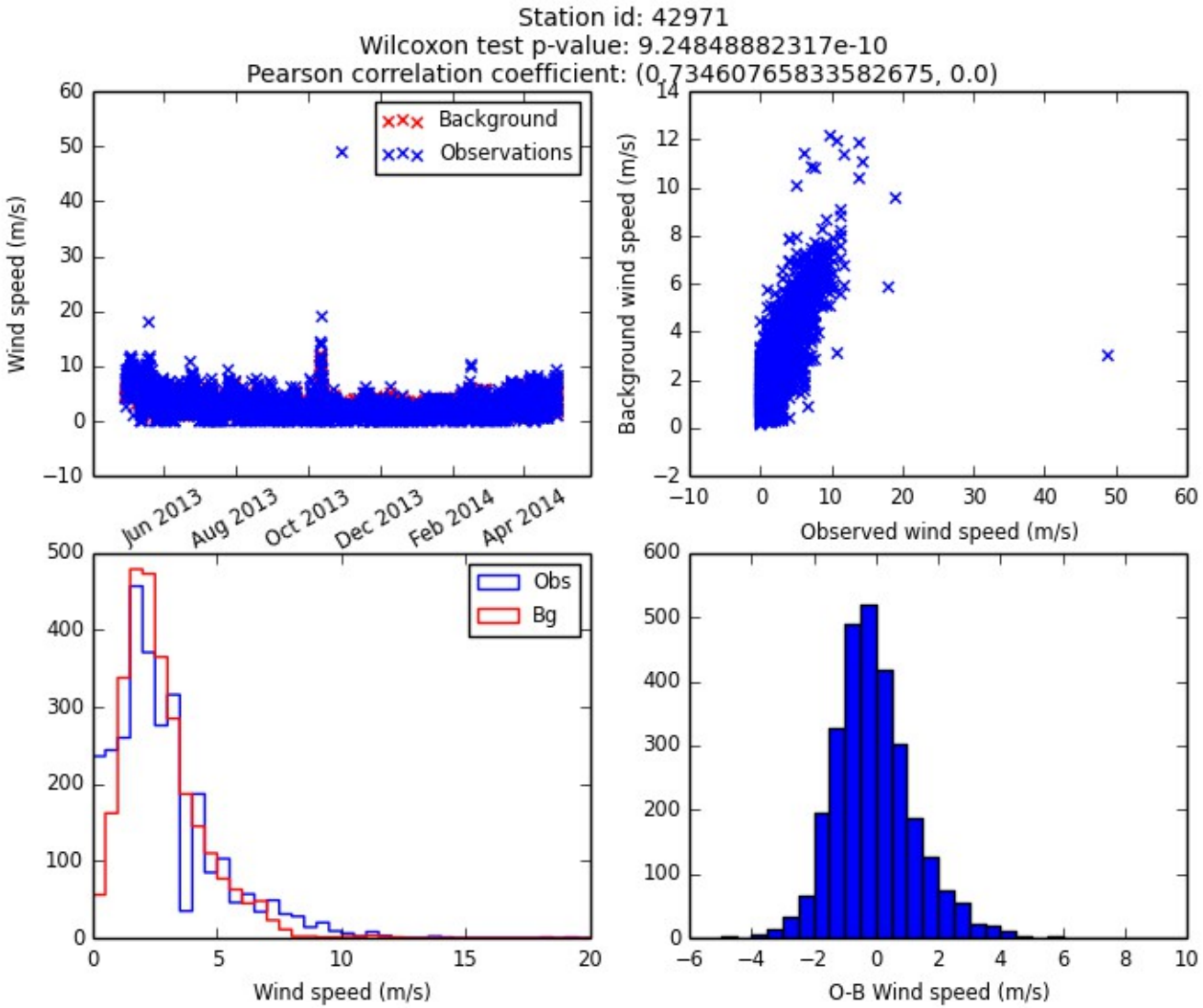
(Jemma Davie)

Surface wind speed bias



(Swapan Mallick)

Surface wind speed bias



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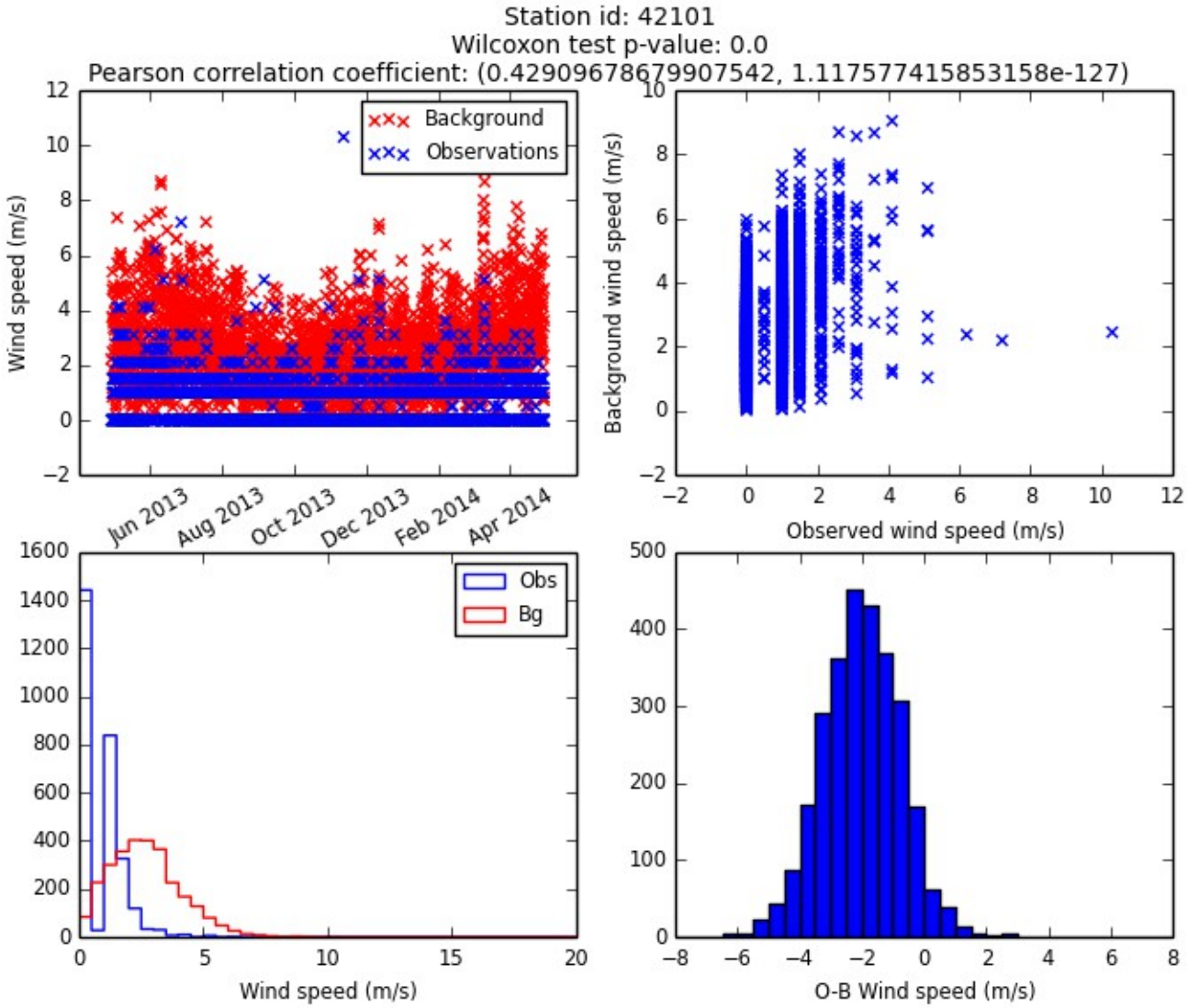
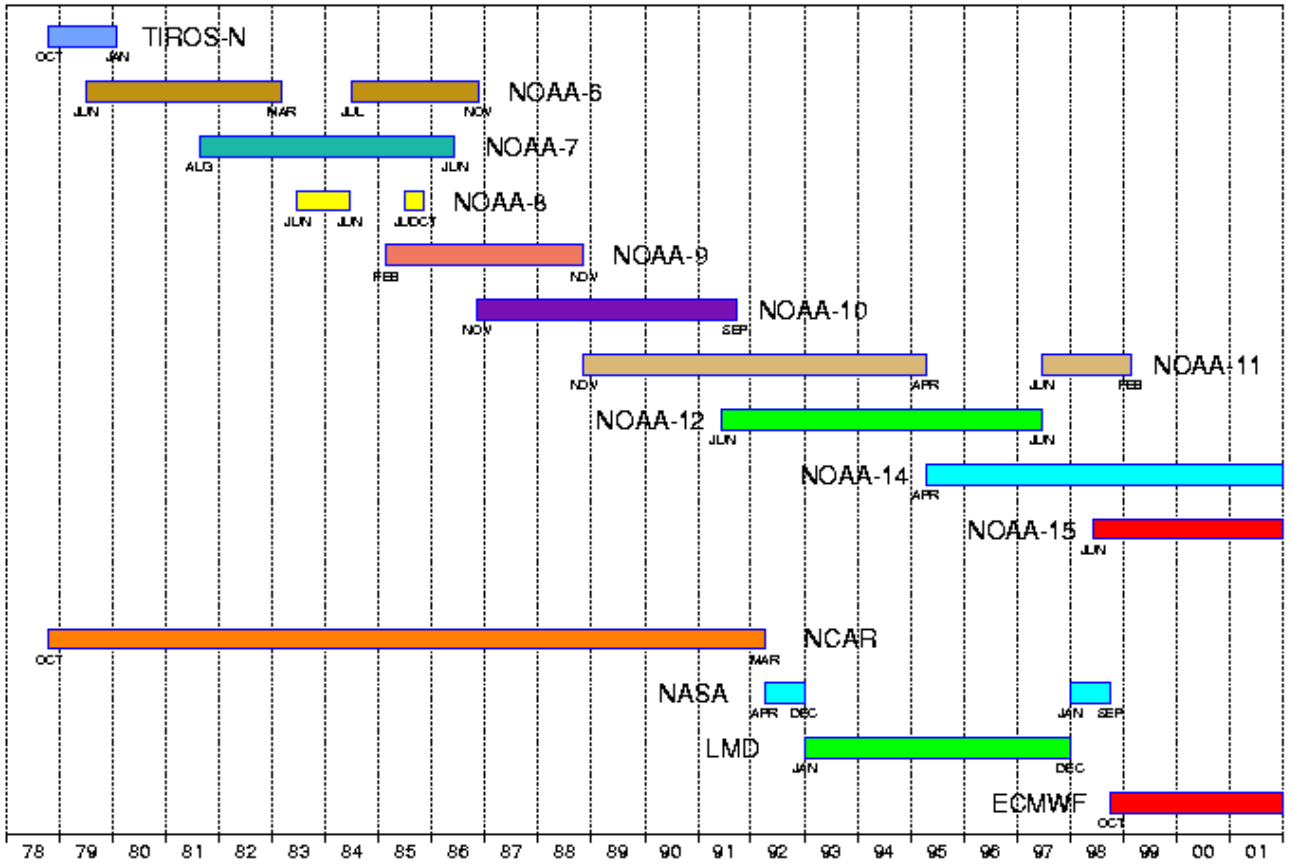


TOVS sounding instrument



1978 ⟶ *2001*

(Amy Doherty)

TOVS progress

Retrieve data from ECMWF MARS

Convert to level 1d with AAPP:

- convert counts to radiances
- map MSU to HIRS fields-of-view

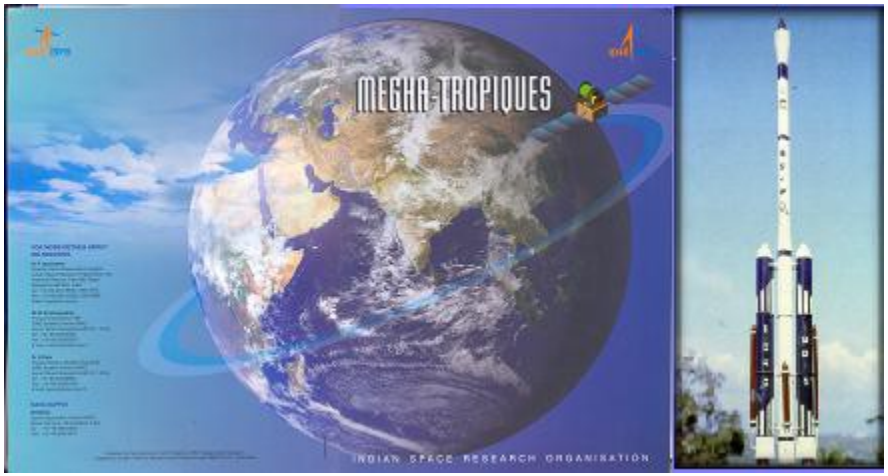
Process in 1DVar

- quality control
- monitoring
- retrieve skin temperature

Code to assimilate radiances in 4DVar

(Amy Doherty)

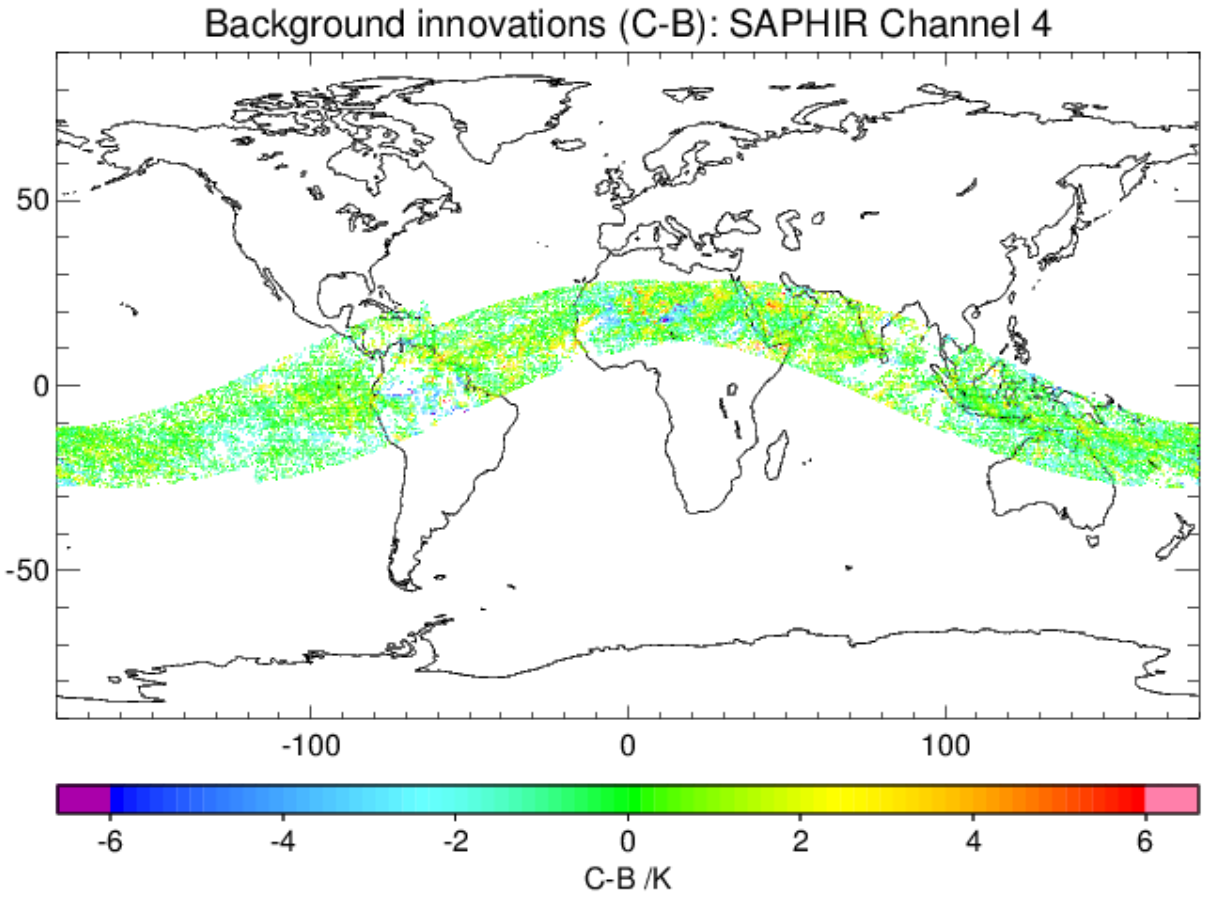
Saphir - Megha-Tropiques



- Launched 2011
- Inclined orbit 20º
- 6-channel microwave radiometer
- 183 GHz water vapour line

Indira Rani S. - NCMRWF

Saphir - Megha-Tropiques



Indira Rani S. - NCMRWF

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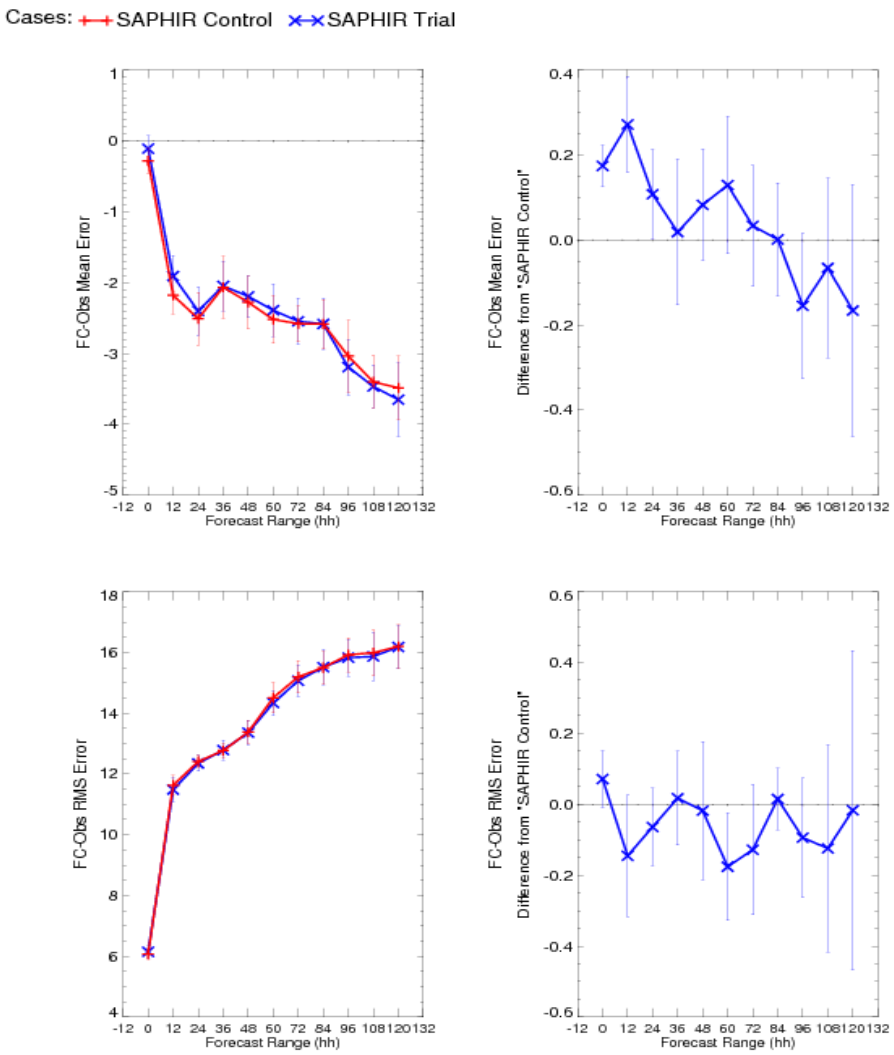


Global NWP trial

2 weeks so far

Verification vs sonde:

850hPa Rel Hum

Indira Rani S. - NCMRWF

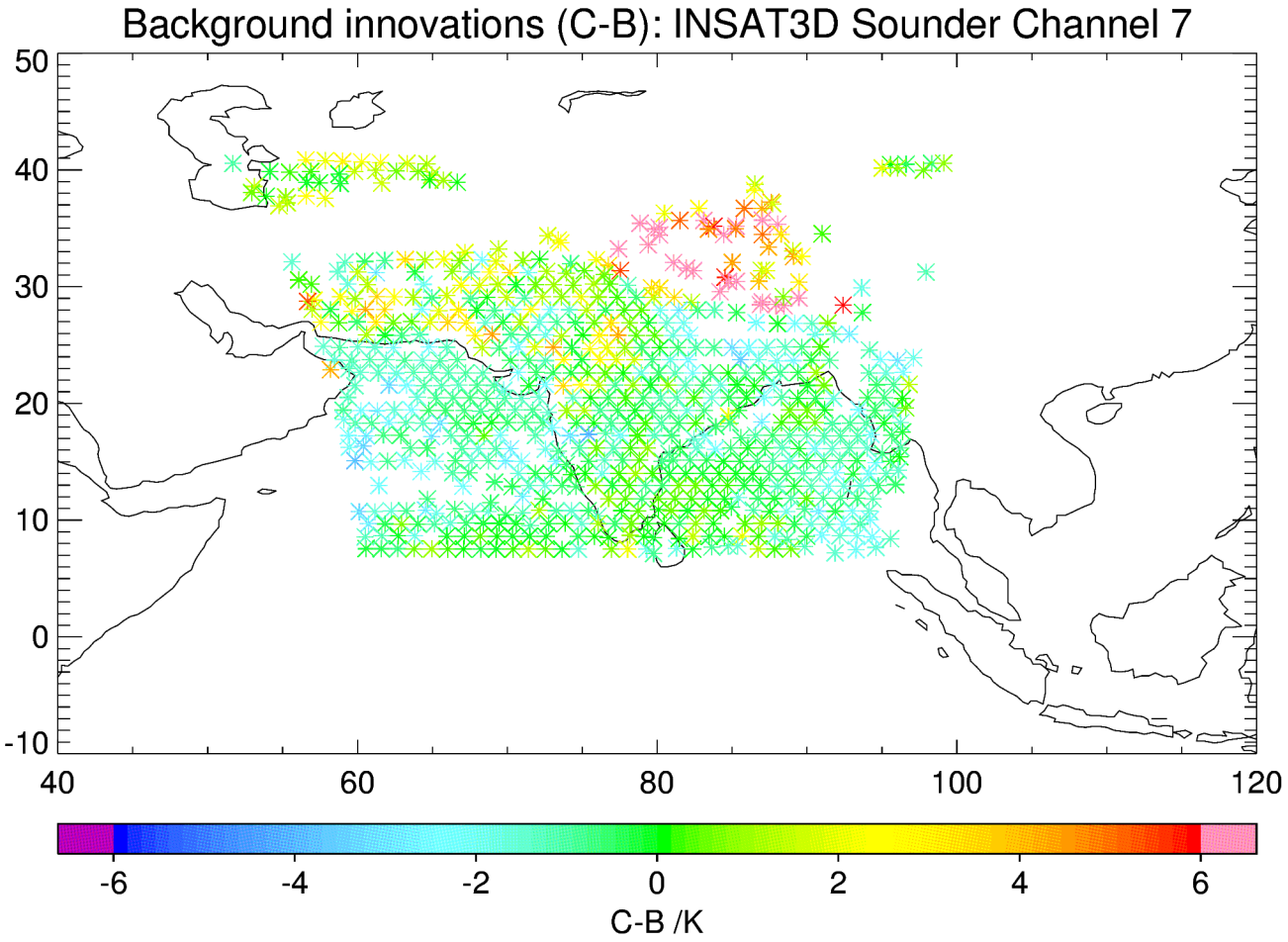
6-channel imager

19-channel sounder

- Launched 2011
- Geostationary, 82º E

Indira Rani S. - NCMRWF

INSAT-3D



Indira Rani S. - NCMRWF

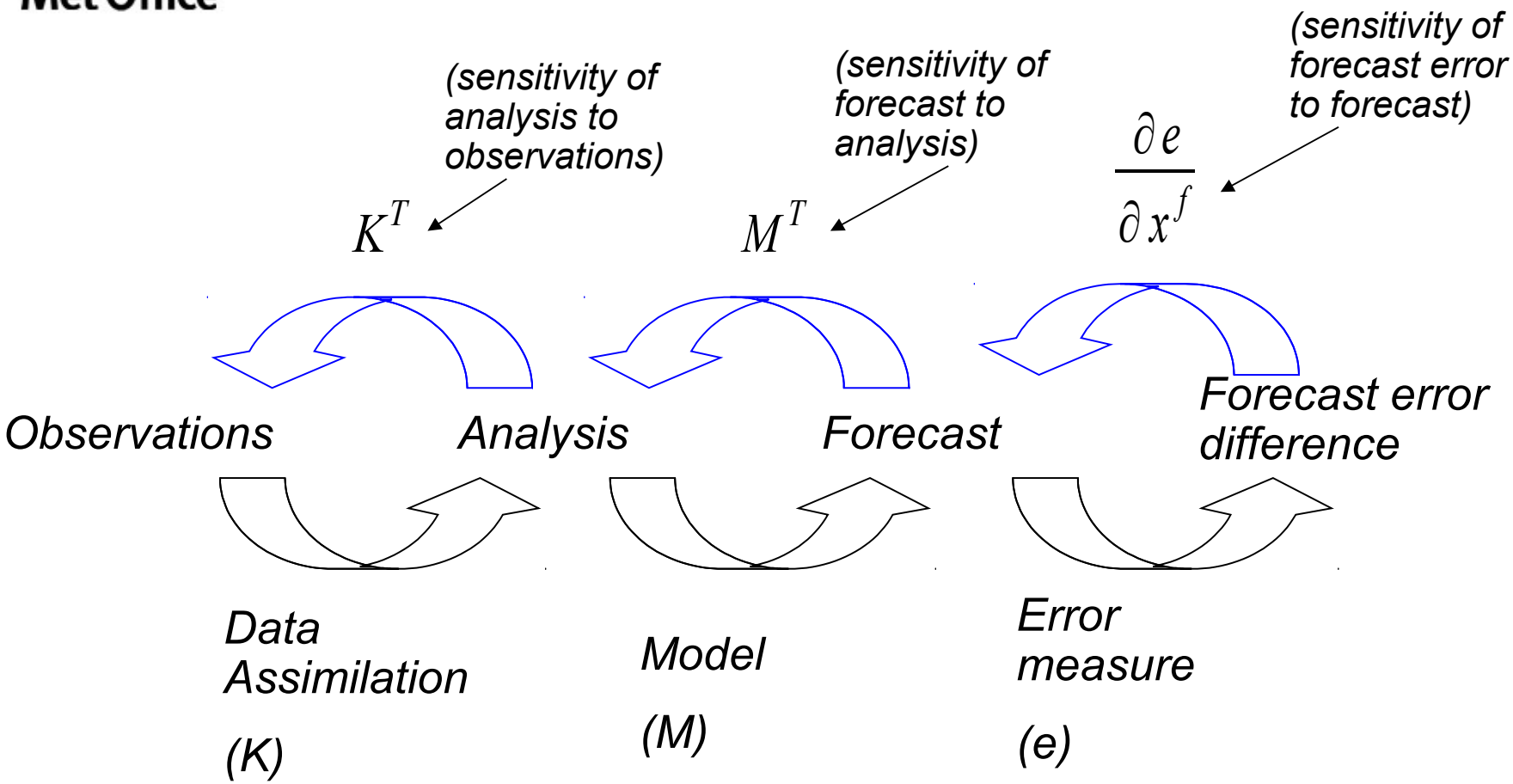
Technical Progress

NCMRWF

- FCM code management in place
- FCM repositories mirrored on server
- Rose/cylc in place
- Compiled and run UM9.1
- Land surface DA: Nudging system works.

  Setting up EKF.
- Preparing FSO capability

Forecast Sensitivity to Observations



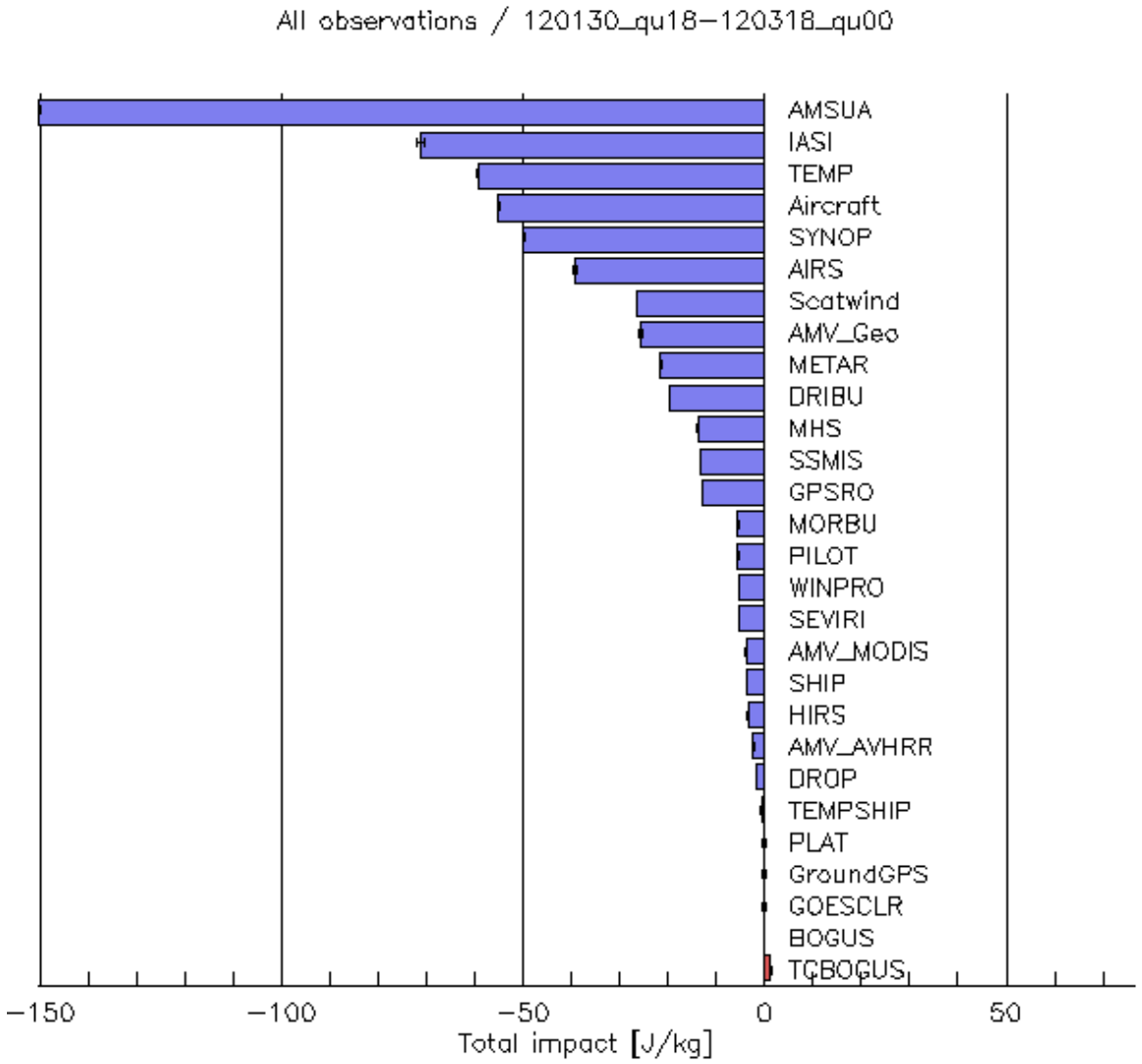
FSO impacts

***Total** impact of observations by type*

(January – March 2012)

Beneficial impacts are indicated by negative values – they reduce forecast error (shown in blue)

Detrimental impacts are indicated by positive values – they increase forecast error (shown in red)



Precipitation Assimilation

Use gridded daily accumulations

Disaggregate to 6-hour windows

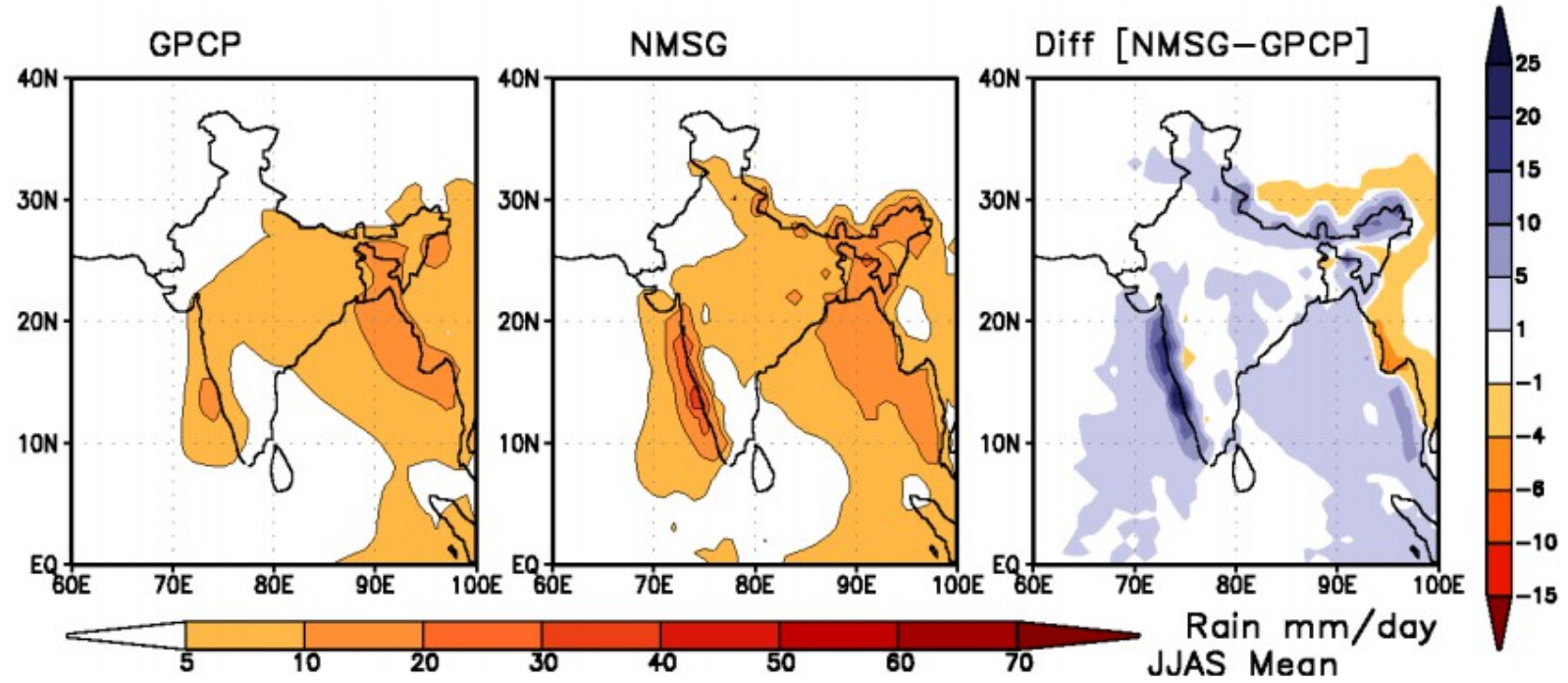
Assimilate accumulations in 4DVAR
- 4DVar linearised forecast model includes convection and cloud scheme

Aim is for reanalysis to match observations
Results not guaranteed!

IMD/NCMRWF daily precipitation

Mitra et al 2014

1x1 deg daily data for Indian Monsoon 1998 to May 2012
June 2012 onwards 0.5 x 0.5 grid data daily
Useful for MISO Obs and Model Verification Studies



Plans for 2015

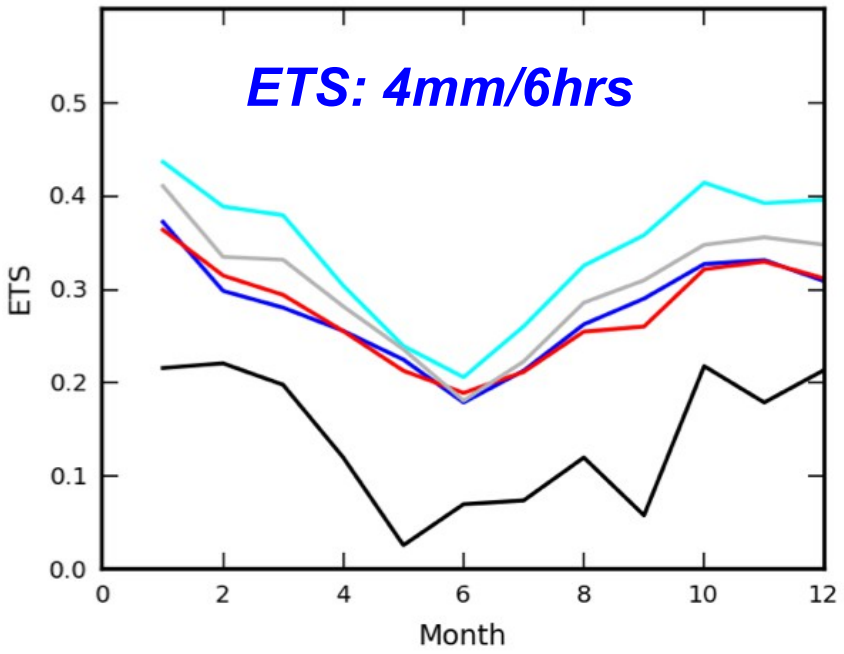
- *Upgraded UM systems, incl Rose suite framework*
- *Automated obs monitoring for surface, upper air, aircraft using ECMWF ODB tools*
- *VarBC tested, spinning up new instruments*
- *Trials including TOVS data*
- *Surface fields generated/analysed for regional model*
- *Trial and assess precipitation assimilation*
- *Continuing data recovery work*
- *...initial IMDAA pilot reanalysis, 2-year period*

Thank You

Impact of Model/DA on Precip Skill

(no direct reanalysis precipitation assimilation as yet)

2008 ETS for Europe area



UM 4DVar Regional Reanalysis

UM Downscaler (ECMWF BCs)

HIRLAM 3DVar Regional Reanalysis

ERA-INTERIM Global Reanalysis

UM Climate Run (No analysis)

Impact of Model/DA on Precip Skill

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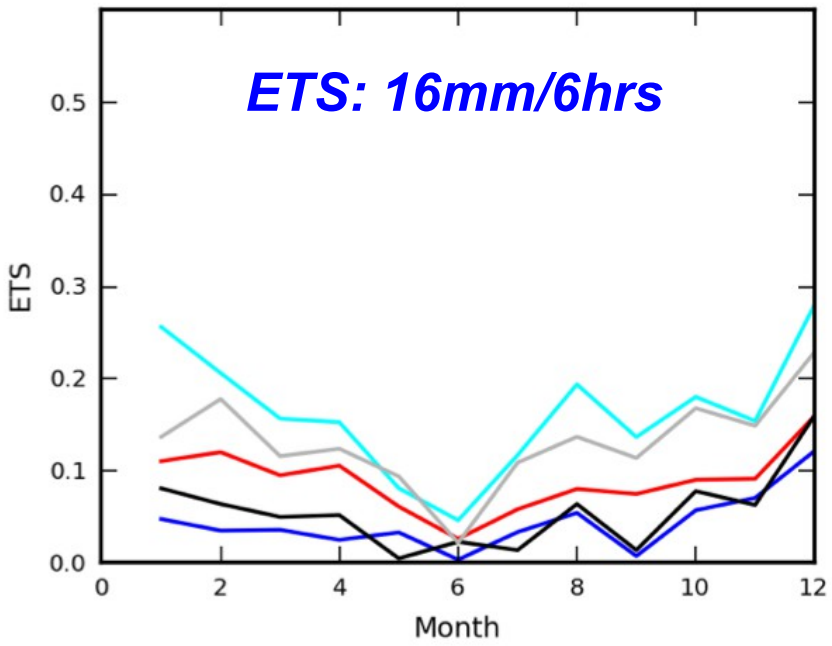

UM 4DVar Regional Reanalysis

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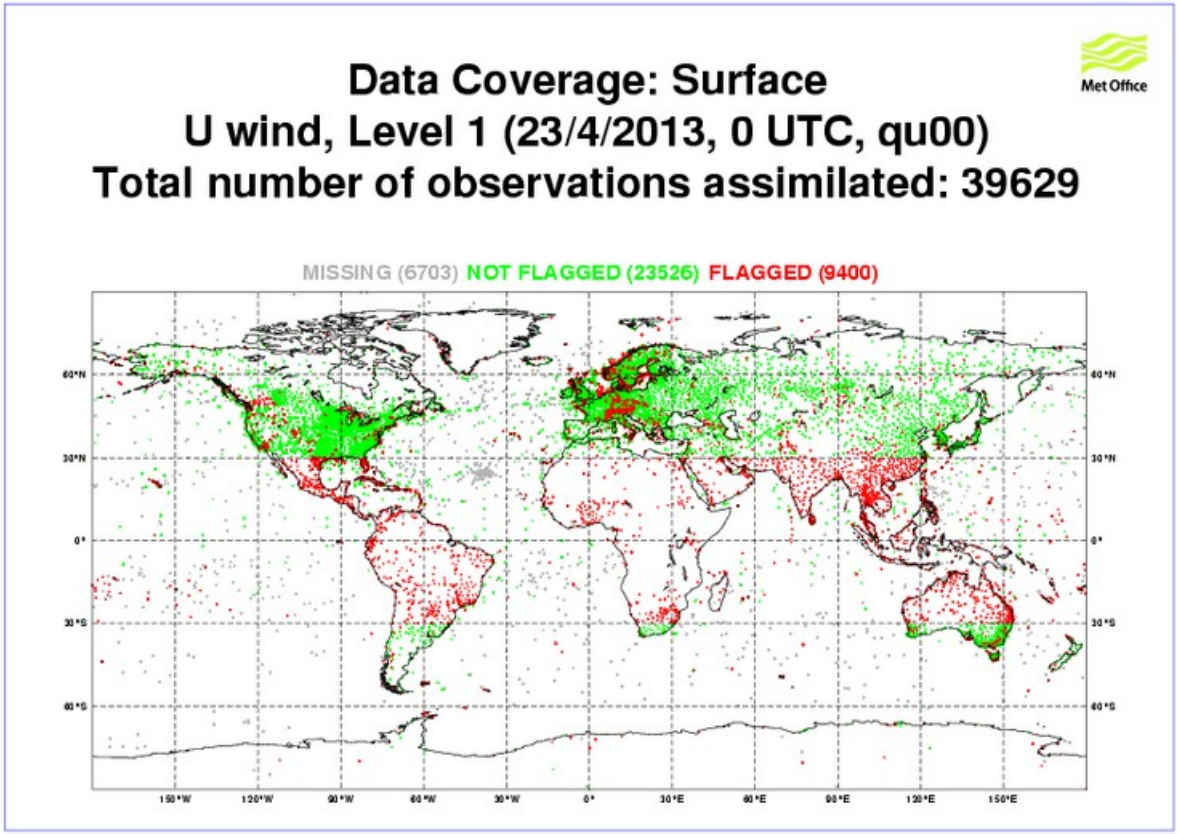
ERA-INTERIM Global Reanalysis

UM Climate Run (No analysis)

***Regional* Improvement Over *Global* Reanalysis**	*1mm*	*4mm*	*8mm*	*16mm*
Regional Model	*1%*	*9%*	*50%*	*300%*
Regional Assimilation	*8%*	*13%*	*14%*	*30%*

Observation error examples:

SYNOPs



- *Anemometers insensitive to weak surface winds in the tropics.*
- *Obs permanently rejected. (“If in doubt, chuck it out.”)*

FSO – Forecast Sensitivity to Observations

Station list for surface reports

Inputs for each variable and observation type:

- *O-B values from previous month (or months if few obs)*
- *Previous station list*

Process for each variable and station ID:

- *Calculate % of O-B values > thresholds*
- *If many obs fail on bias, std dev or % gross errors → reject*
- *If station/variable was previously rejected → use stricter limits*

Pressure is processed differently:

- *Put O-B values into 1hPa bins and find peak (mode)*
- *If peak far from 0 → reject*
- *Calculate bias and std dev O-B near peak*
- *Compare bias and std dev to thresholds and whether previously rejected or corrected to decide whether to reject, correct or neither*

Outputs: Station list

- *Stations/variables to reject*
- *Pressure bias correction*

(Jemma Davie)

Station lists: Plans

Extend surface scheme to upper air and aircraft including bias correction for temperatures

Ground-based GPS: monthly monitoring

Satellite radiances, AMVs and GPSRO:
choose which instruments to use for what periods based on ERA-Interim

Satellite BC

- VarBC

$$bias = c^{scan} + \sum_{i=1}^{n} ci^{air} f(x_b)$$

Airmass-dependent bias correction of satellite radiances (based on Harris and Kelly, 2001)

VarBC will give smooth and automatic updating (DingMin Li, Andrew Lorenc , Dale Barker)

•Thanks to Richard Renshaw

Variational Bias Correction

Progress:

- *Basic scheme coded and tested in 4DVar*

Plans:

- *Separate VarBC minimisation for channels not assimilated (passive channels, new instruments)*
- *Tune adjustment timescales*

  e.g. varying with ERA-Interim bias volatility