Recent Developments in Data Assimilation

Florence Rabier & Jean-Noël Thépaut

November 2012

ECMWF

Introduction

- **Highlights of two major events:**
  - **Fifth WMO Workshop on the Impact of Various Observing Systems on NWP (Sedona, AZ, May 2012)**

    http://www.wmo.int/pages/prog/www/OSY/Reports/NWP-5_Sedona2012.html

  - **4th WCRP International Conference on Reanalysis (Silver Spring, May 2012)**

    http://icr4.org

- **Snapshots of recent advances and trends in DA at various NWP centres**

Why the 5th workshop on Observing Systems?

- WMO has sponsored a series of Workshops on the Impact of Various Observing System on NWP:

1. Geneva, Switzerland (1997)
2. Toulouse, France (2000)
3. Alpbach, Austria (2004)
4. Geneva, Switzerland (2008)
5. Sedona, Arizona, USA (2012)

   46 experts from 13 countries participated

- The purpose is to
  - Review latest OSE and OSSE results
  - Inform the evolution of the Global Observing System (WMO)
  - Provide guidance for satellite agencies and other providers
- Each workshop outcome is documented in a comprehensive WMO report

Observation impact in global NWP

- **The highest ranked contributors for the forecast error reductions are:**
  - **AMSU-A, AIRS/IASI, radiosonde, aircraft, AMVs**
  - **GPS-RO also has substantial impact, but the data volume is declining approaching the end of COSMIC lifetime.**

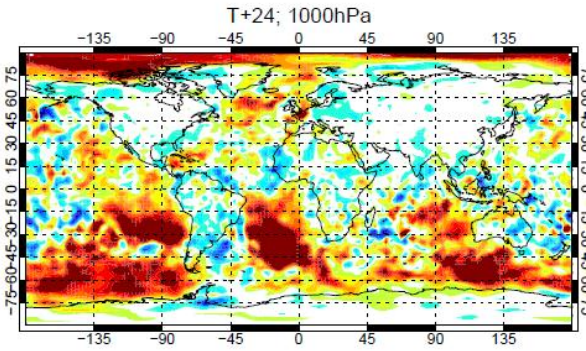
- **Several satellite sensors contribute to forecast skill. There is not a single, dominating one**
  - **More complementarity is seen, compared to previous years.**
  - **The GOS has become more resilient, but this resilience is threatened by expected decline of the operational polar orbiting satellites**
  - **When one observation type is missing or removed the contribution of other systems tend to increase without fully compensating**

Observation impact in global NWP

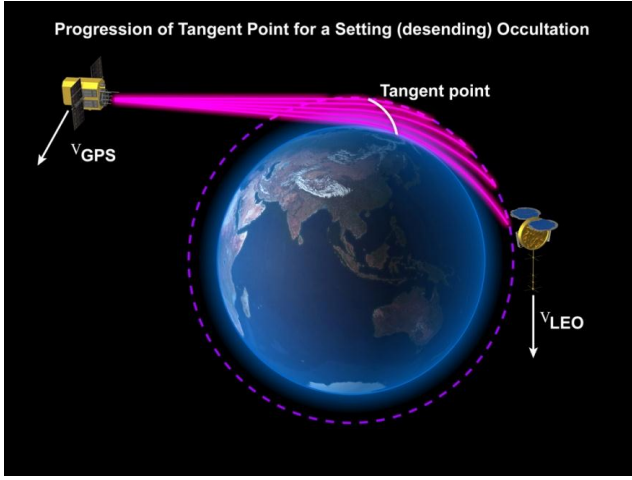
- Humidity observations - Increased evidence of beneficial impact
  - Questions about defining the appropriate metrics
- All-sky radiance assimilation leading to improved impact
- Emissivity modelling leads to improved radiance assimilation over land.
  - Good impact on humidity analysis over tropical area
- Additional radiosonde during AMMA campaign
  - Have clear humidity impact, locally
  - The radiosonde data over Western Africa can reduce the longer range forecast error over Europe (downstream) 2 to 3 days later.

FSO diagnostics

- Conventional observations and GPS-RO have the largest impact on per-observation basis.
- The impact of buoy data is particularly large.
- On radiosonde and aircraft data:
  - The impact of wind components is larger than of temperature.
  - Combined impact is larger than single component impact.
  - The main impact is found in the troposphere at 200 hPa and below.
- Concordiasi campaign over the Antarctica:
  - AIRS/IASI has large impact, but difficult to be used at lower levels.
  - GPS-RO has good impact in Polar Regions
  - Good impact of AMSU-B/MHS is demonstrated with sea-ice surface emissivity modelling



Global impact (cont.)



- **GPSRO**
  - **Has become a critical component of the GOS, through the absolute anchoring of temperature biases at upper levels.**
- **AIRS/IASI and CrIS**
  - **Can be used as reference radiance data (for calibration of other sounders). Such inter-satellite calibration is very important for GOS.**
- **Scatterometers**
  - **Their importance has been demonstrated at previous workshops**
  - **Two scatterometers on well-separated orbits are required.**

Regional NWP

- The observation with highest impact is different
  - from global NWP
  - among different regional NWP centers.
- The beneficial impact of data assimilation was shown in convective-scale NWP, by comparing with “down-scaling”
- Substantial progress on data assimilation was reported for:
  - Satellite radiances
  - Radar reflectivities
  - Doppler winds

Workshop Recommendations

- Augment the profiling network e.g. by extending coverage of ascending and descending aircraft observations to regional airports
- There is a need to invest in enhanced wind observations in the tropics and over the oceans especially.
- Study observation impact that is more closely related to high-impact weather (including TCs) and service delivery to customers and forecast users
- Encouraged studies of impact per observing system or per observation linked to their cost
- Define appropriate impact metrics for
  - humidity and
  - regional NWP including precipitation and other surface weather elements

4th International Conference on reanalyses (input M. Bosilovich)

Objectives:

1. Sharing understanding of the major challenges facing reanalyses: the changing observing system and Integrated Earth system.

1. Assessing the state of the disciplinary atmospheric, ocean and land reanalyses, including the needs of the research community for weather, ocean, hydrology and climate reanalyses.

1. Reviewing the new developments in the reanalyses, models and observations for study of the Earth System.

1. Exploring international collaboration in reanalyses including its role in regional and global climate services.

Key note: Adrian Simmons

- Ongoing business remains challenging and important
  - **recovery of observational data from past years,**
  - **improvement of assimilating models**
  - **improvement of assimilation methods, including the treatment of model error**
  - **developing longer-window data assimilation, in which reanalysis can benefit from additional observations made after the analysis time**

- And there are questions to be asked
  - **should we expect a single method to be optimal across the centuries?**
  - **how quickly and fully should coupling be introduced with the ocean circulation, with atmospheric chemistry, …?**

Data Assimilation for reanalysis

- Emerging hybrid Var/EnKf, but also other, non-Gaussian techniques such as Particle Filters being explored
- Some potential identified in ocean-atmosphere coupling
- Stratosphere/mesosphere and deep ocean: poorly observed, need some "anchoring”
- Model and obs covariances: many open questions (background, update, inflation, localization, multivariate, balance)
- Bias correction: several methods but noted both models and obs have biases
- Implementation specifics: cycling method matters, new systems have problems with older data
- Seamless nesting to work across scale with heterogeneous grids

Snapshots of recent advances/trends at various NWP Centres

Meteo-France: Towards the use of microphysical variables for the assimilation of cloud-affected IR radiances in convective scale models.

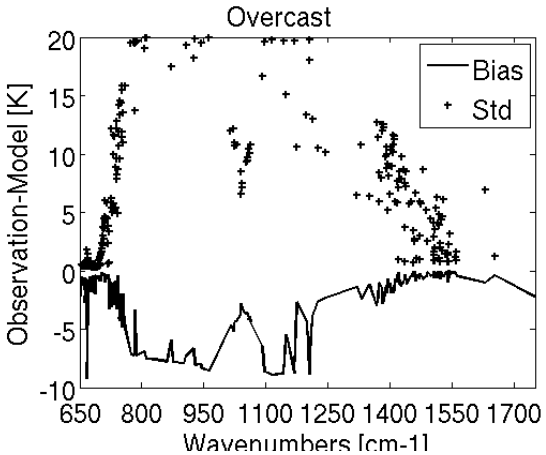
I. Context of the study

- Assimilation of cloud-affected radiances limited to opaque clouds (Ne>0.9) with a simplified modelling of clouds (single layer with constant emissivity equal to 1).

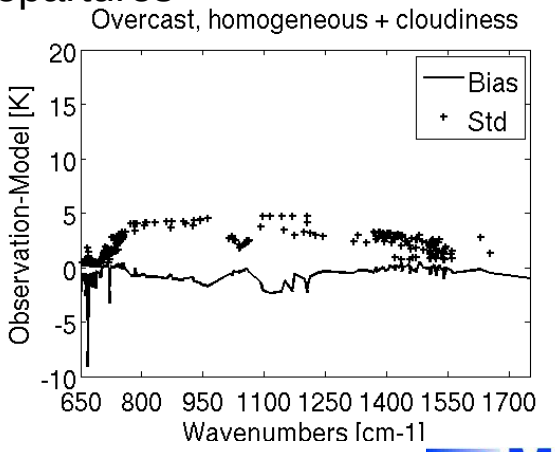
→ Take advantage of convective scale models to simulate IASI radiances directly from the **liquid water and ice water content profiles**. Modelling of multi-layer clouds and **cloud scattering** with the advanced radiative transfer model **RTTOV-CLD**.

II. Simulation of cloud-affected radiances

- Study limited to **homogeneous overcast scenes** in both the model simulation and the observation to avoid cloud mislocation.
- Use of the **AVHRR** cluster colocated to each IASI pixel to develop a screening procedure. Additional constraint on the model cloudiness
- Bias and standard deviation of the O-B first guess departures



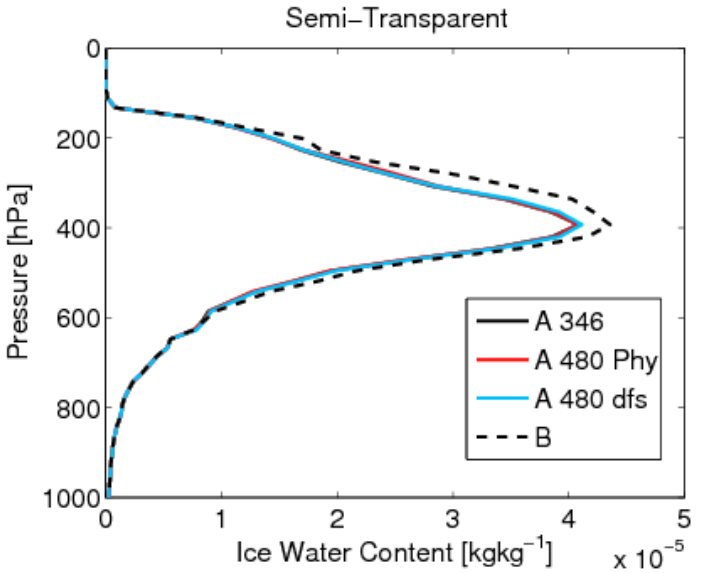
After the screening procedure

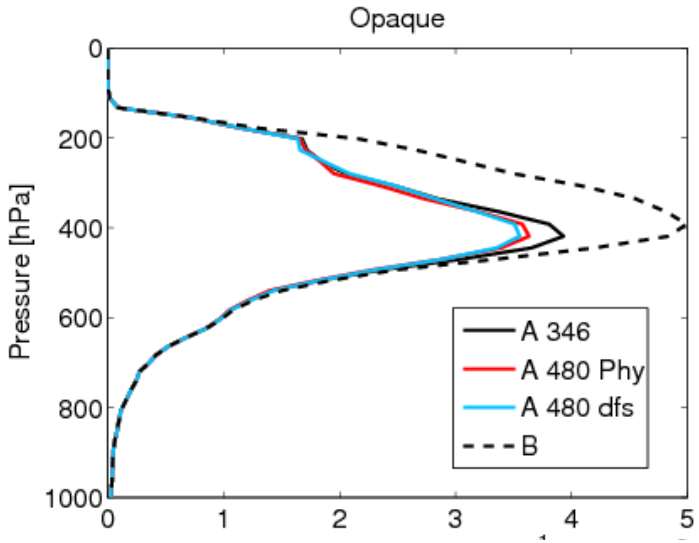


METEO FRANCE

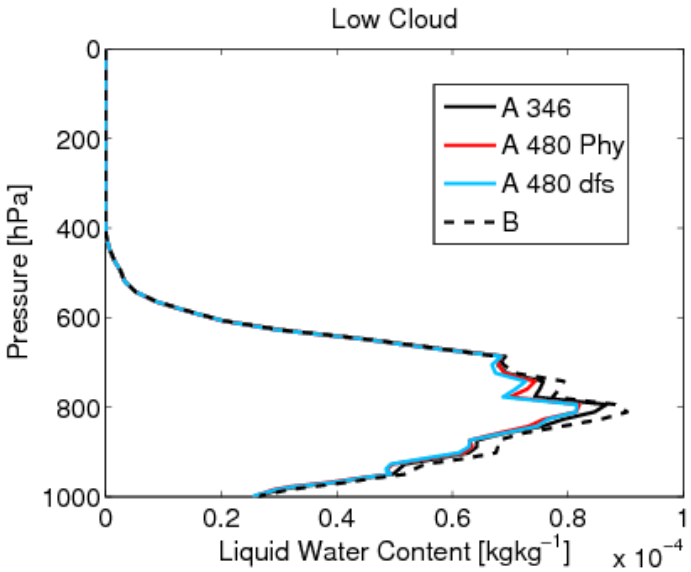
IV. Retrievals of liquid water and ice water contents in the context of OSSE.

- Validation of the new channel selections with 1D-Var retrievals of cloud variables. RMSE of the analysis agains the `true' AROME profiles.





- Improvement of the RMSE by 7% in the case of opaque clouds and 5% in the case of low clouds with the addition of cloud sensitive channels (compared to the already existing IASI channel selection).

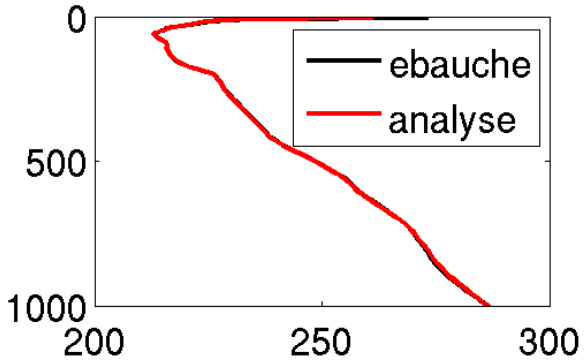


Martinet et al 2012: Evaluation of a revised IASI channel selection for cloudy retrievals with a focus on the Mediterranean basin. *QJRMS*, submitted.

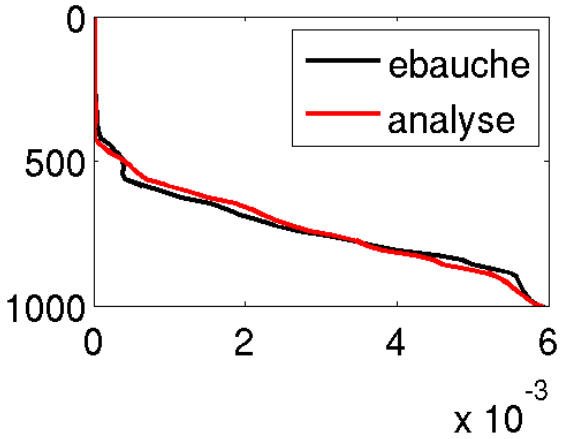
Martinet et al 2012: Towards the use of microphysical variables for the assimilation of cloud-affected infrared radiance, *QJRMS* in press.

Low-level liquid cloud

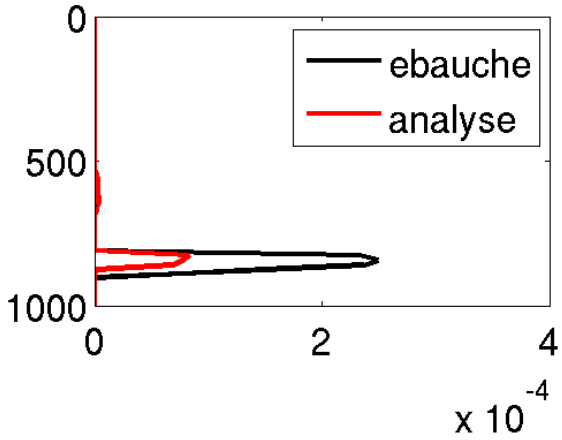
Temperature



Humidity



Liquid water content

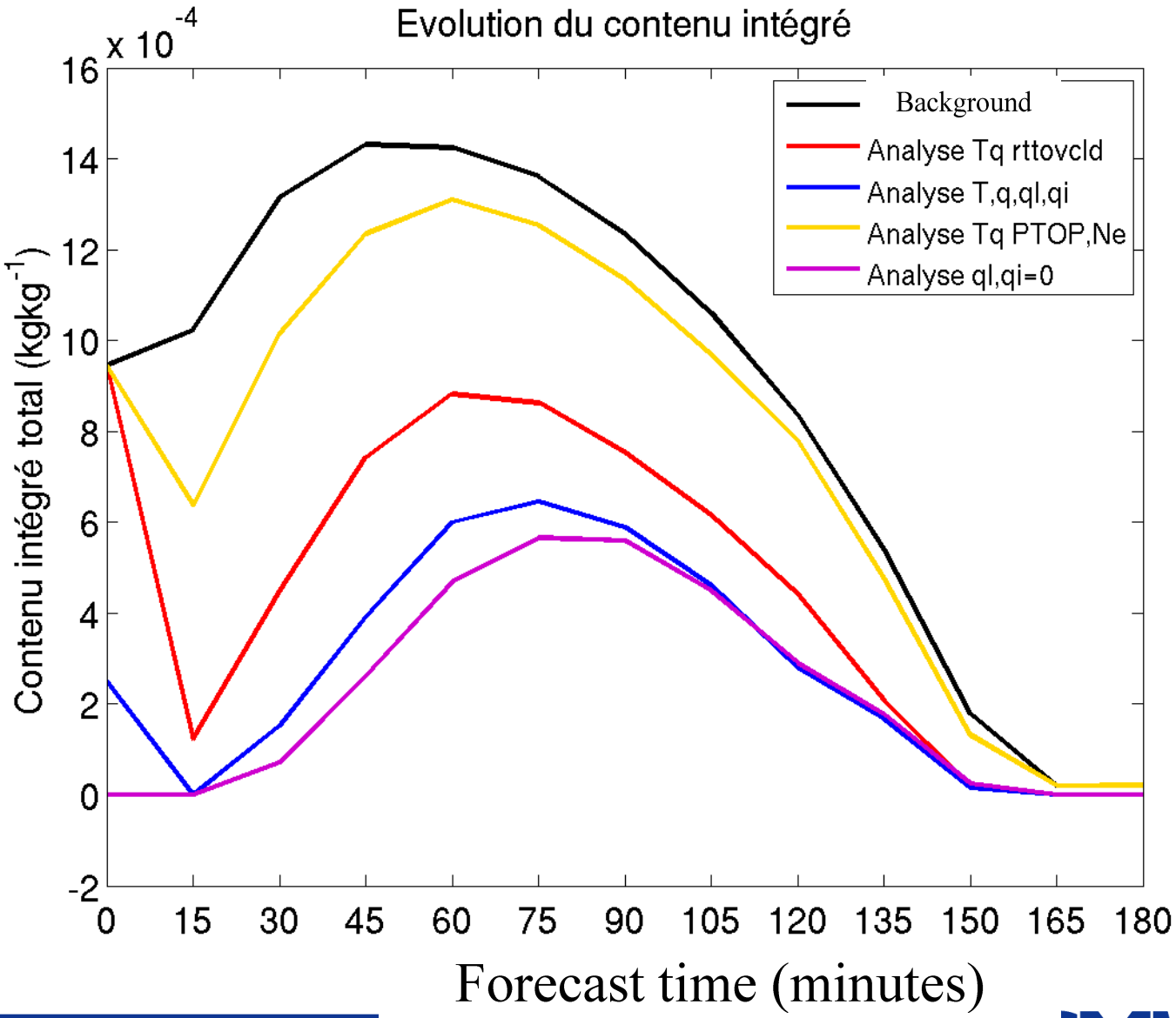


Analysis with IASI data:
Drying around 800hPa

Background

Analysis

Evolution of the Total column liquid water content



ql, qi not used

The full analysis

Simplified analysi

Resetting ql, qi

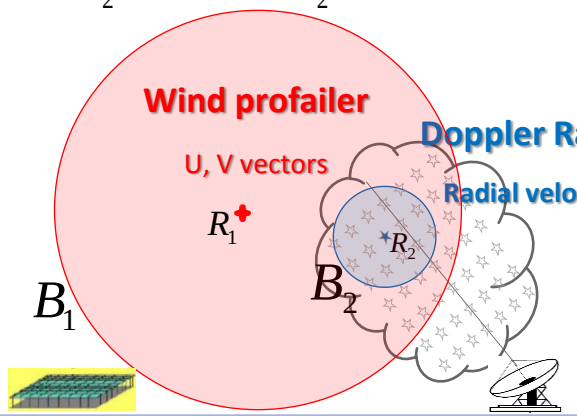
JMA: Variational assimilation method adapted to the high-frequency and high-density observation for mesoscale

Super observations (GPVs) of analysis variables which are prepared in advance with high-resolution 3D-Var are assimilated in 4D-Var.

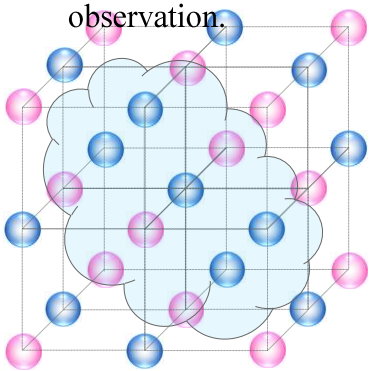
The assimilated observations are the 10-minute interval's observations of Doppler radar, wind profiler, ground based GPS and Synop.

Super observation

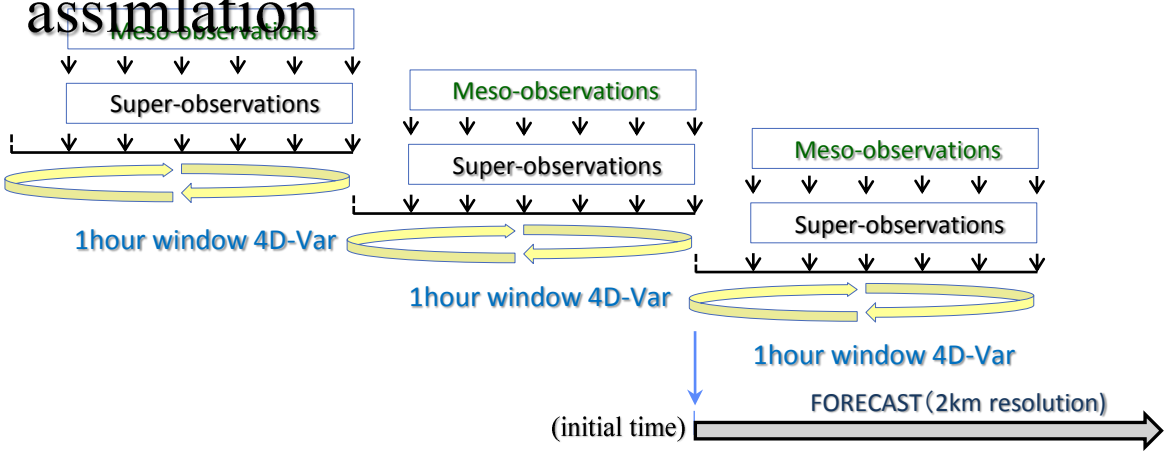
$$J(x)=\frac{1}{2}(x-x_B)B_i^{-1}(x-x_B)+\frac{1}{2}(y-H(x))^T R_i^{-1}(y-H(x))$$



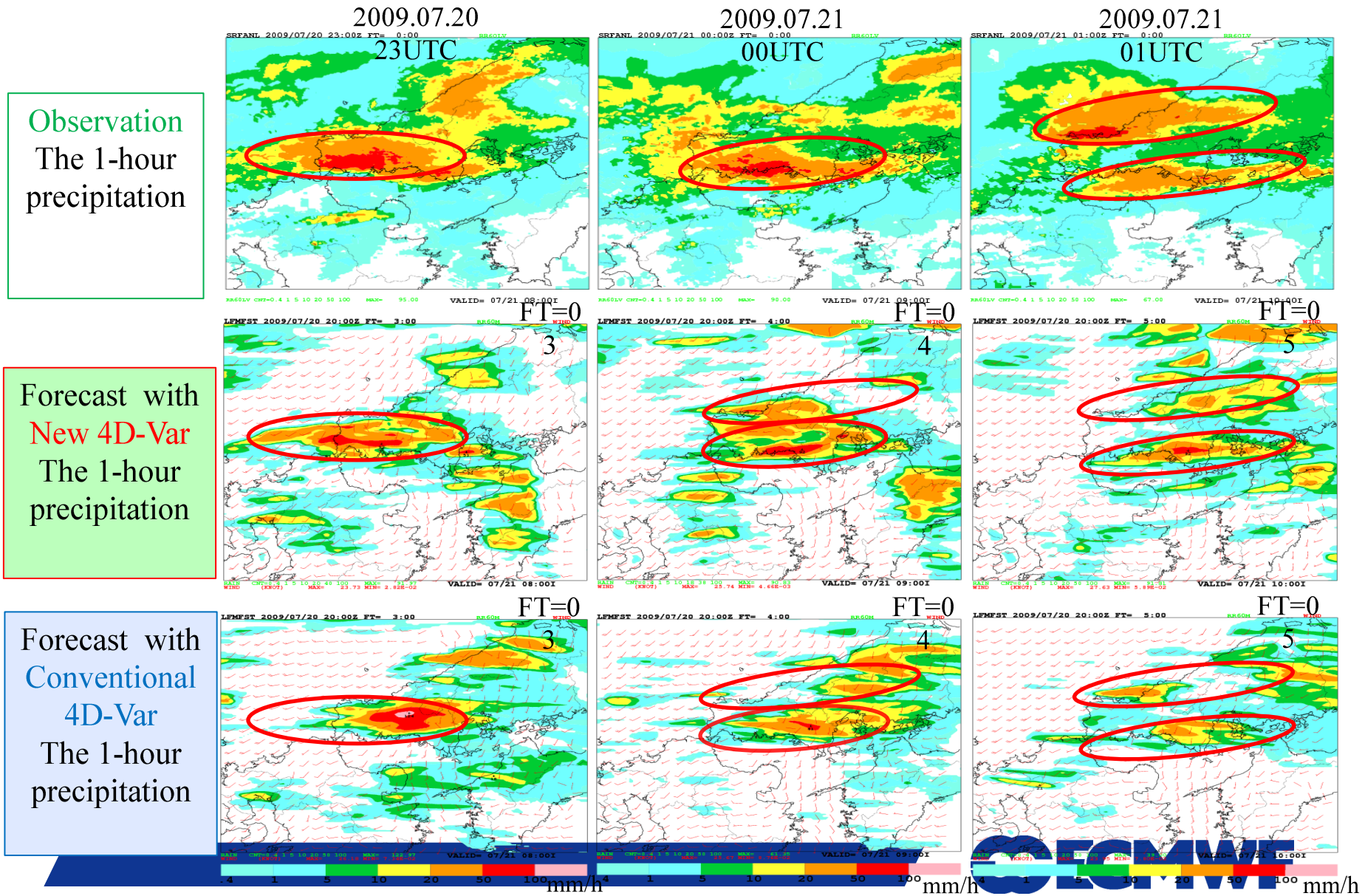
They convert into spatially smooth and homogeneous information that catches three dimensional structure of the observation.



Data assimlation



JMA (2): Variational assimilation method adapted to the high-frequency and high-density observation for mesoscale



DWD: DA algorithms

- *"Old system":* Global 3dVar and regional "nudging" scheme
- 3dVar is good, but *not fully competitive with 4dVar*
  - but we do not have the ressources for 4dVar, is it the future?
- Nudging takes place in the state space, remote sensing data need to be retrieved, strong constraints, but still not dead, it has interesting features!
- Currently (2010-15): Moving to Ensemble Data Assimilation on all scales.
- Flexible, scalable, modern, interesting new system. Strong research component!
- Takes years of development, range of research projects, **intensive collaborations with universities and research institutes**.

Kilometer Scale Ensemble Data Assimilation - KENDA@COSMO

Development of an Ensemble Kalman Filter for the convection resolving scale.

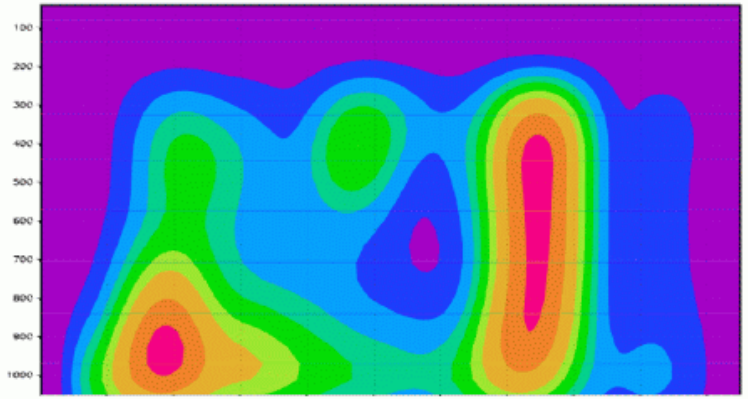
Under development by Christoph Schraff, Andreas Rhodin, Hendrik Reich, Africa Perianez, Klaus Stephan, Annika Schomburg, Gerhard Paul, Roland Potthast, etc. ...

- EnKF implemented for COSMO system (KENDA)
- EnKF Standalone Version running at DWD, LMU Munich (HErZ), MeteoSwiss, Italy, ...
- EnKF implemented in NUMEX at DWD
- Many research projects running to implement and test particular **observation operators** for the EnKF/KENDA, e.g. volume radar operator, GPS slant delay operator, cloud analysis operator etc.

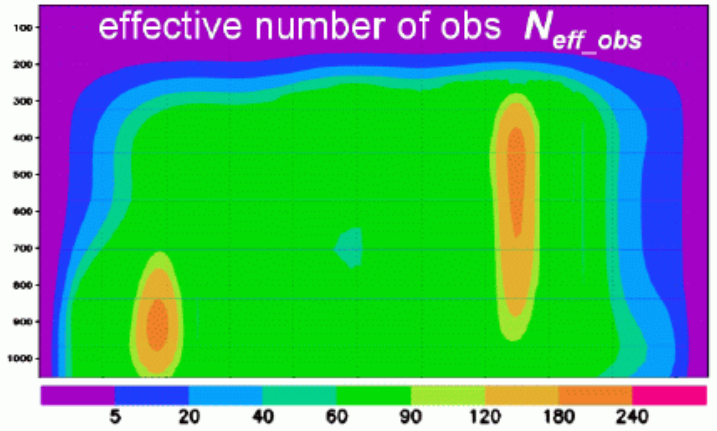
Adaptive Localization

Hendrik Reich, Africa Perianez, Roland Potthast, Christoph Schraff, ...

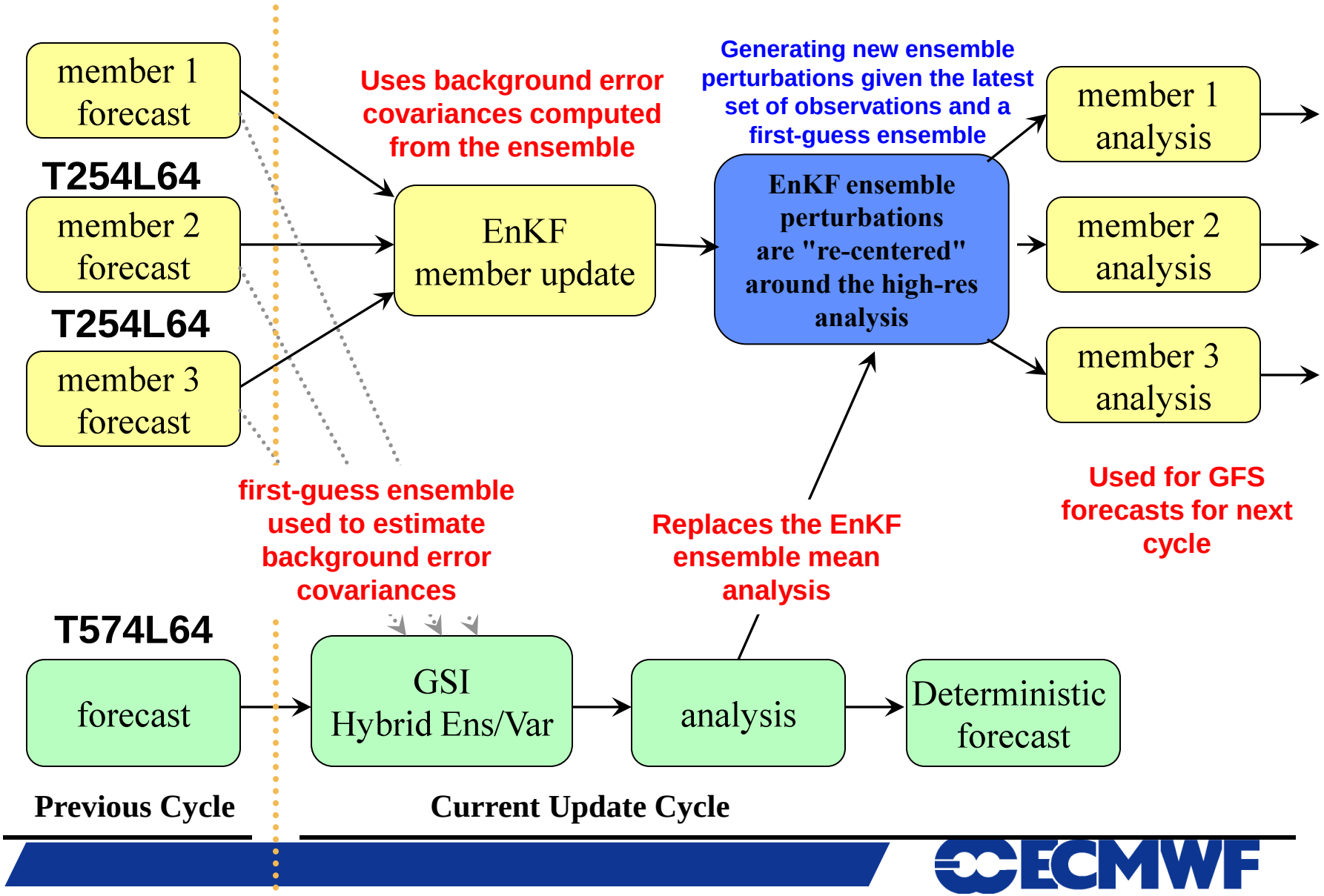
- The EnKF has only 40 (39) degrees of freedom locally!
- We need to adapt the localization radius to the number of observations, the error size and keep meteorological constraints active!
- mathematical analysis, approximation theory, regularization, meteorological/operational research, ...



→ adaptive scale s :
adapt s such that $N_{eff\_obs} \cong 70$
and $30\ km \leq s \leq 80\ km$



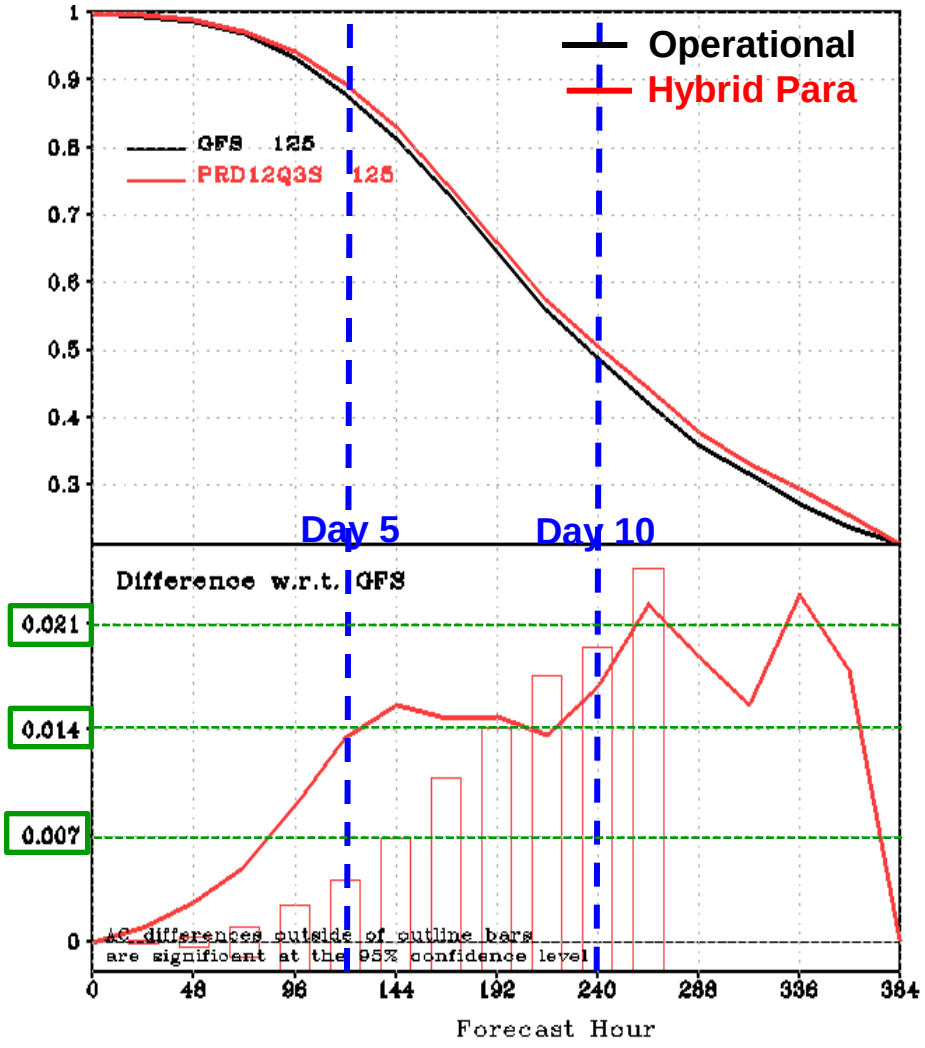
NCEP: Dual-Resolution Coupled Hybrid 3D-VAR/EnKF



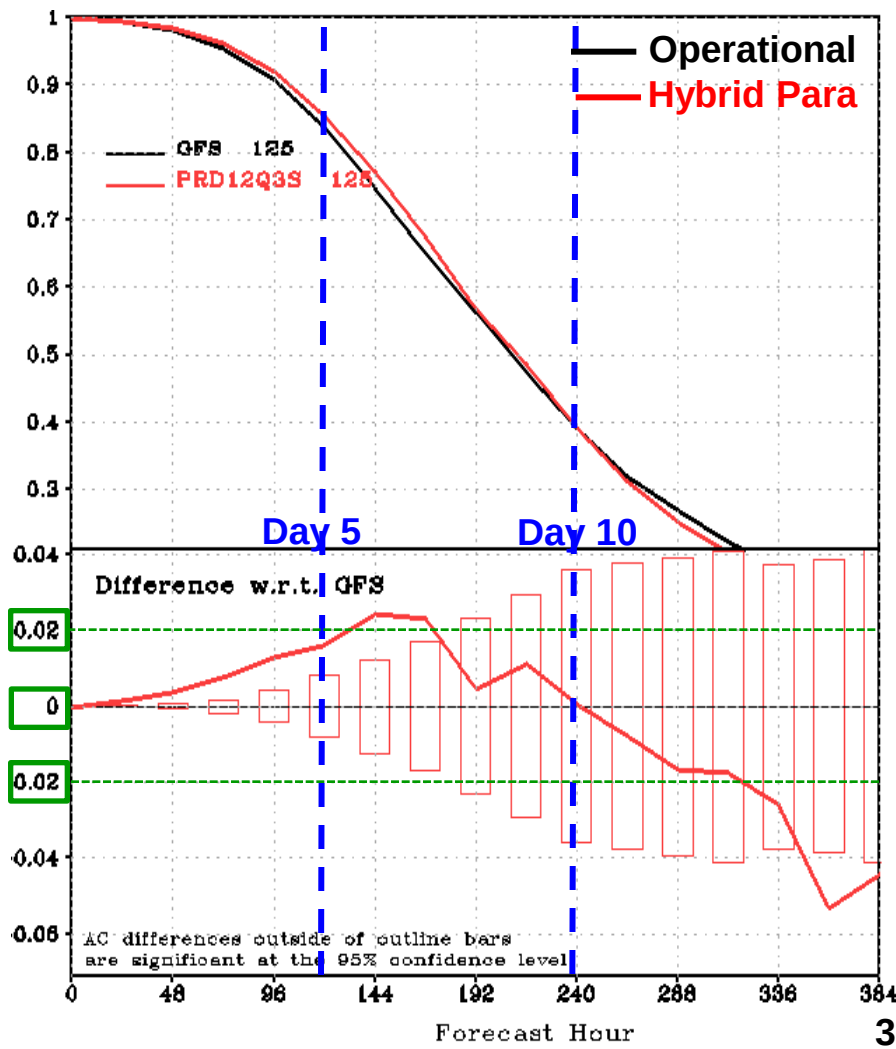
NCEP (2): 500 hPa Anomaly Correlation for Hybrid GDAS Parallel

8 Jan to 15 May 2012 (00Z cycles only)

Northern Hemisphere



Southern Hemisphere



NCEP (3): Highest Priority Data Assimilation R&D (1/2)

- **Use of cloud impacted radiances including integration of cloud clearing for IR, Microwave and visible data**
- **Development of 4-d hybrid**
- **More accurate forward models for observations**
  - **Better instrument characterization**
  - **Better physics**
  - **Less massaging of data before use**
- **Use of additional observations**
  - **More channels on current instruments**
  - **METOP-B, CrIS, SSM/IS, VIIRS, AVHRR, Chinese and Russian satellites**
- **Improve quality control and bias correction for all data (especially radiances)**

NCEP (4):Highest Priority Data Assimilation R&D (2/2)

- **Improved forecast models**
  - **Higher resolution**
  - **Improved parameterizations**
  - **Inclusion of Near Surface Ocean Temperature, Land Surface, Ice, Lakes, etc.**
- **Improvements in ensembles used in hybrid assimilation**
  - **Situation dependent error amplification and localization**
  - **Higher resolution**
- **Inclusion of aerosol model and effects (requires enhanced computing)**
- **Improved specification of observation and representativeness error**

Environment Canada: Ensemble variational data assimilation

- **Tests with 25km version of GEM show:**
  - **En-Var produces similar quality forecasts as 4D-Var below ~20hPa in extra-tropics, significantly improved in tropics**
  - **above ~20hPa, scores similar to 3D-Var, worse than 4D-Var; potential benefit from raising EnKF model top to 0.1hPa**

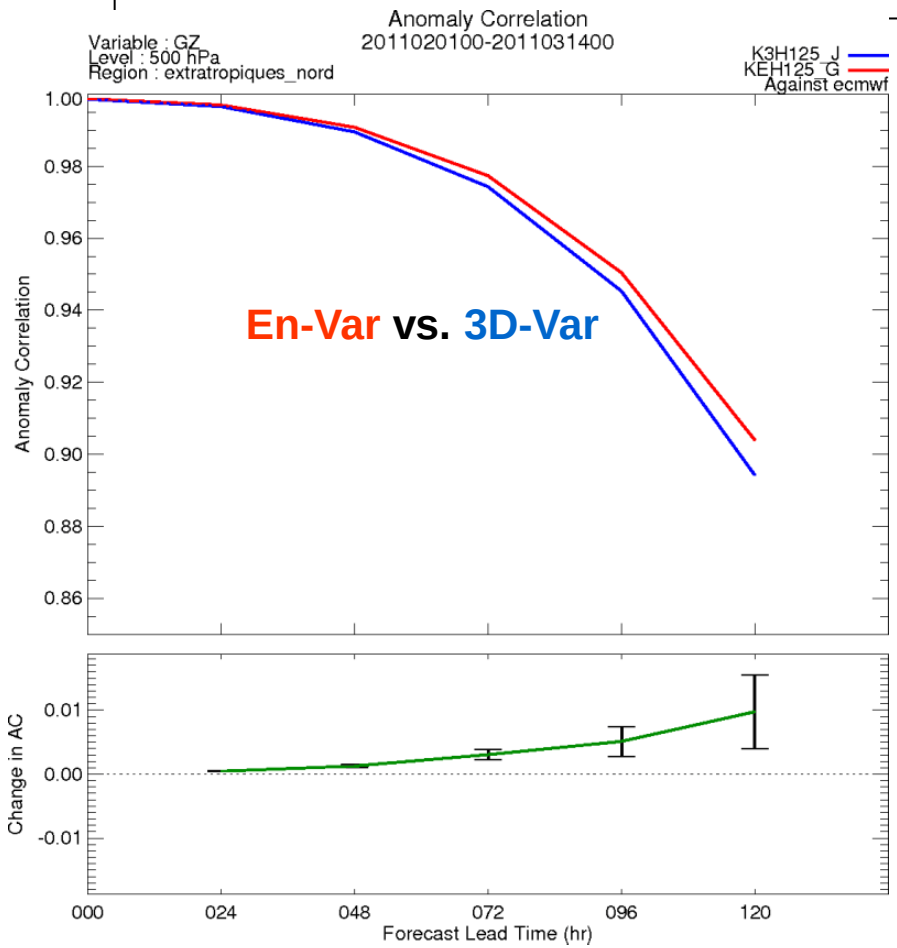
- **En-Var is attractive alternative to 4D-Var:**
  - **like EnKF, uses full nonlinear model dynamics/physics to evolve covariances; no need to maintain TL/AD version of model**
  - **make use of already available 4D ensembles**
  - **more computationally efficient and easier to parallelize than 4D-Var for high spatial resolution and large data volumes**
  - **computational saving allows increase in analysis resolution and volume of assimilated observations; more resources for EnKF and forecasts**

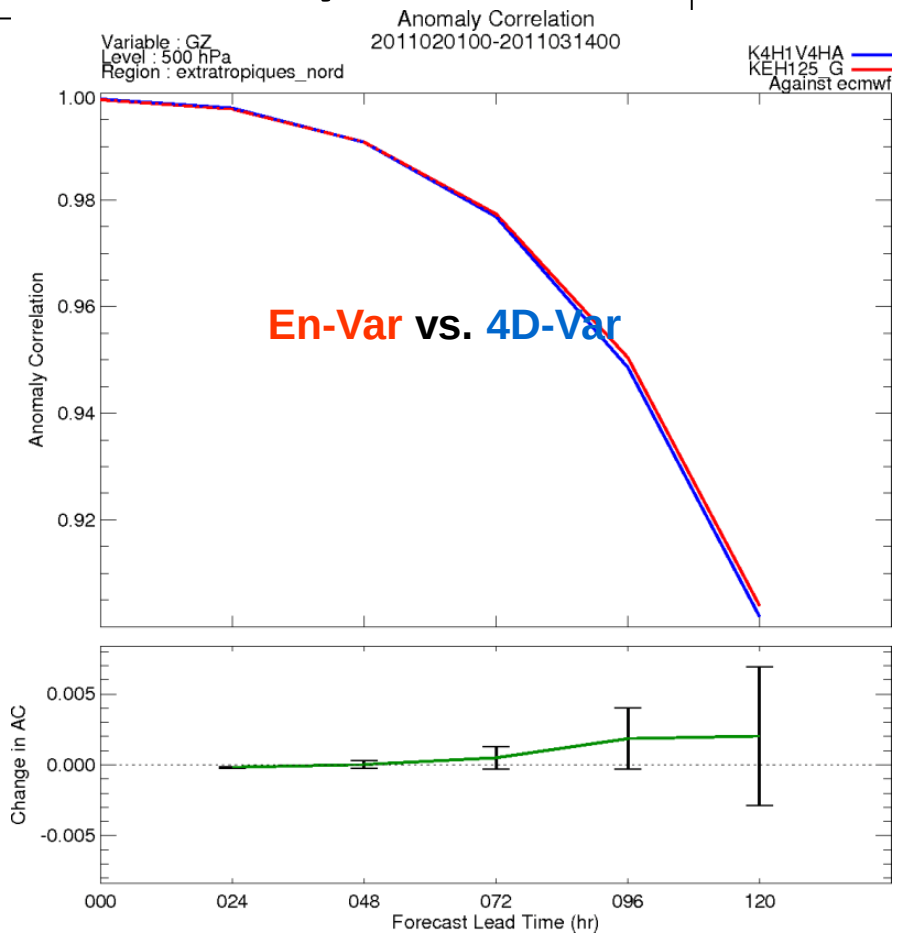
Forecast Results: En-Var vs. 3D-Var and 4D-Var

Verification against ERA-Interim analyses – 6 weeks, Feb/Mar 2011

North extra-tropics

500hPa GZ correlation anomaly





Environment Canada (2)

- **Continue testing En-Var with goal of replacing 4D-Var in GDPS during 2013 in combination with other changes:**
  - **15km version of GEM on Yin-Yang grid**
  - **CALDAS: new surface analysis system**
  - **modified satellite radiance bias correction scheme that gives conventional observations more influence on correction**
  - **improved use of radiosonde and aircraft data**
  - **additional AIRS/IASI channels and modified observation errors for all radiances**
  - **explore possibility of raising EnKF model top to 0.1hPa???**
- **Continue to modularize/unify the code for Variational and EnKF data assimilation systems**

CMA: Milestone of GRAPES variational data assimilation system

2001

Serial regional P3DVAR using pressure coordinate

2005

Serial global P3DVAR

2008

Parallel global P3DVAR

2005

Serial regional M3DVAR using height-based terrain following coordinate

2005

Serial regional 4DVAR

2010

Serial global M3DVAR

2010

Parallel regional 4DVAR

2010

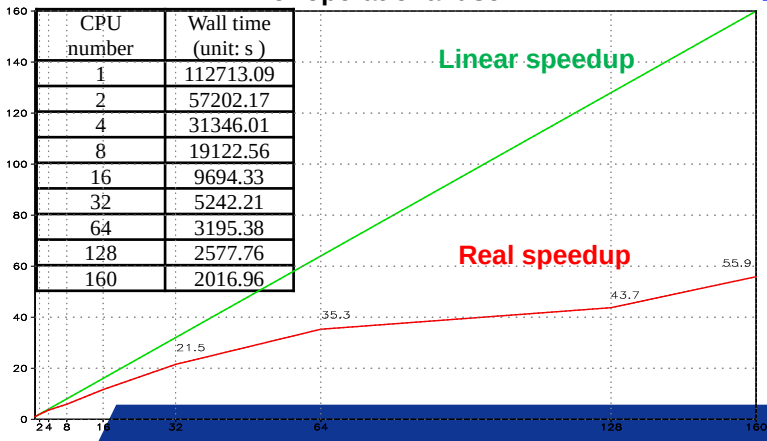
Serial global 4DVAR

2013

Parallel global 4DVAR

Wall time of regional 4DVAR experiment for operational use

CPU number	Wall time (unit: s)
1	112713.09
2	57202.17
4	31346.01
8	19122.56
16	9694.33
32	5242.21
64	3195.38
128	2577.76
160	2016.96



Black: developed

Blue: in progress

Red: in the future

CMA (2): Advance of GRAPES Global Data Assimilation

Observations assimilated

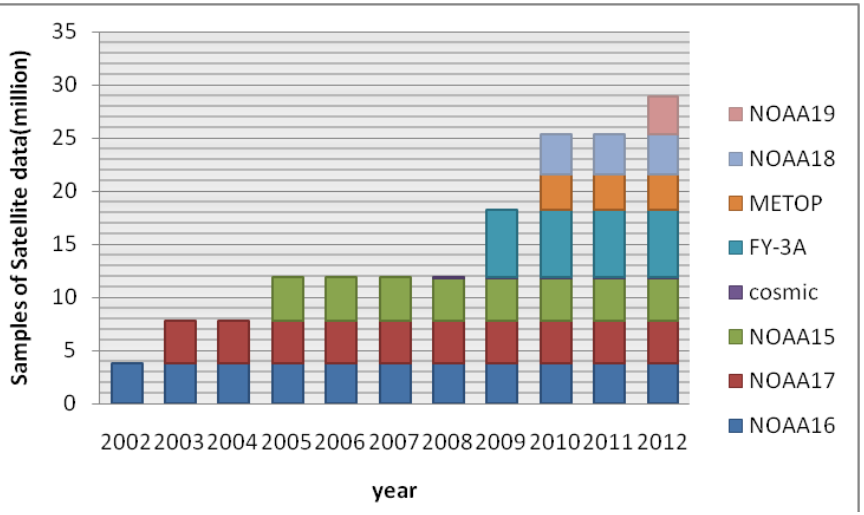
- **Conventional obs.**
- **TEMP, SYNOP, SHIPS, AIRCRAFT**
- **AMV**

- **Unconventional obs.**
- **TOVS(NOAA15/16/17/18/19/METOP)**
- **GPS/RO(COSMIC)**
- **RADAR(wind and refractivity)**
- **GPS/PW**
- **FY-3A/FY-2E**
- **AIRS**
- **TC Bogus**

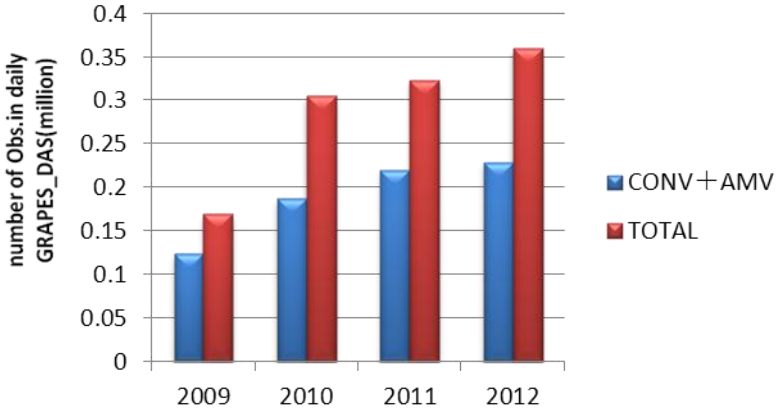
To be assimilated:

- **IASI**
- **ASCAT**

Daily sat. Obs. Received in CMA



Daily Obs. Used in GRAPES_DAS



RHMC: Developments in data assimilation

3D-Var

A unified 3D-Var technology being developed at the HydroMetCentre of Russia is now extended to the regional domain (using stretched geometry). The regional version is intended to be used for the limited-area data assimilation for Sochi-2014 Olympic Games, among other applications. First results show slight improvement in near-surface temperature forecast bias.

Estimation of model error statistics

A study on objective estimation of model (tendency) error statistics is completed. It is shown that the accuracy and resolution of current in-situ observational networks are far not enough for realistic model errors to be reliably objectively estimated.

Pattern generator development

A 1st version of a 4-D pseudo-random field generator based on a stochastic partial differential equation is developed for use in LAM model-error simulations (both in additive and multiplicative model-error formulations). The generator is highly tunable: variance, spatial and temporal length scales, and the degree of spatial smoothness of generated fields are user defined.

Satellite data assimilation

Based on the results of the recent study on AMSU-A observation-error covariances (Gorin and Tsyrulnikov MWR 2011), research is underway to optimally use multivariate observation-error correlations in data assimilation (in collaboration with Environment Canada, P.Houtekamer).

Authors: M Tsyrulnikov, P Svirenko, V Gorin, M Gorbunov, A Ordin, I Mamay

RHMC (2): Experimental ensemble assimilation scheme for SL-AV global atmospheric model

- **Data assimilation scheme: LETKF [Hunt et al, 2007]**
- **Assimilation for the global SL-AV model (0.9x0.72 resolution, 28 sigma-levels)**
- **Observations assimilated: synops, radiosondes, satobs.**
- **Soil analysis [Giard, Bazile, 2000] included in the assimilation cycle, separate analysis for T2m and RH2m increments**
- **Account for filter divergence: multiplicative and additive inflation, experiments on perturbed parameters of the deep convection parametrization**
- **Experiments on the assimilation in full cycle for several months: scheme is stable but needs tuning**

- **Future plans: adding new observations (aireps, amv's); considering physical methods to account for filter divergence (perturbed parameters and others)**

Data Assimilation @ CAWCR / BoM

- **Main focus on convective scale NWP**
  - 1.5km, 3dVAR, latent heat nudging, Doppler winds
  - Centred on Sydney (central east coast)
    - population, obs coverage, high impact weather (t/storms, E.Coast Lows, fires etc.)
- **9 months trial, 3hourly 3dVAR**
  - Hourly rainfall: 1.5km+3dVAR(3hour) no better than
    12km+4dVAR(6hour) interpolated to 4km… if start at same time
  - BIG advantage from more frequent update (compare “latest run”)
  - Model rainfall bias major source of error
  - Skilful length scales still ~150km or more
  - Latent Heat Nudging: small positive gain for a few hours
- **Clear air winds**
  - Model comparisons show small bias

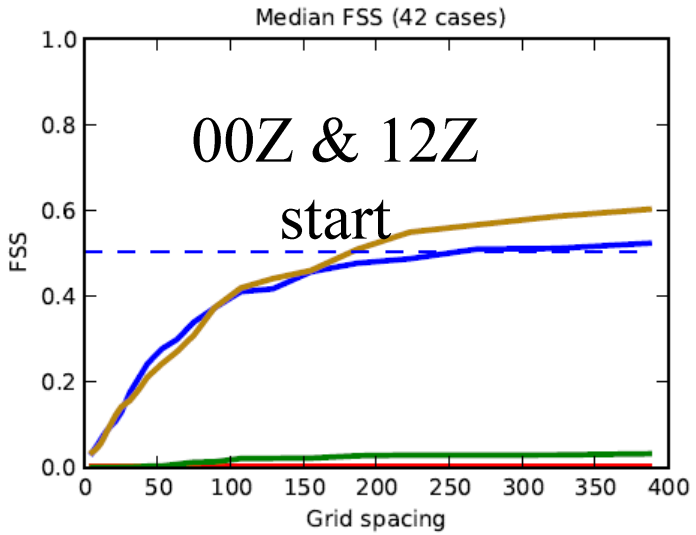
Where to?

- **Hourly DA**
  - High resolution AMV's
  - Remove large scale from bkg. error covariance estimation
  - MTSAT cloud top info
  - Explore possibility of using some satellite radiances
    - ~1/3 domain is ocean
  - Doppler winds (rain & clear)

- **<u>May</u> also explore**
  - 3dVAR(6hr+FGAT) vs 4dVAR(6hr) in large regional model
    - NIWA found 3dVAR beats 4dVAR ???
  - Nudging of larger scales (c/o GSD)

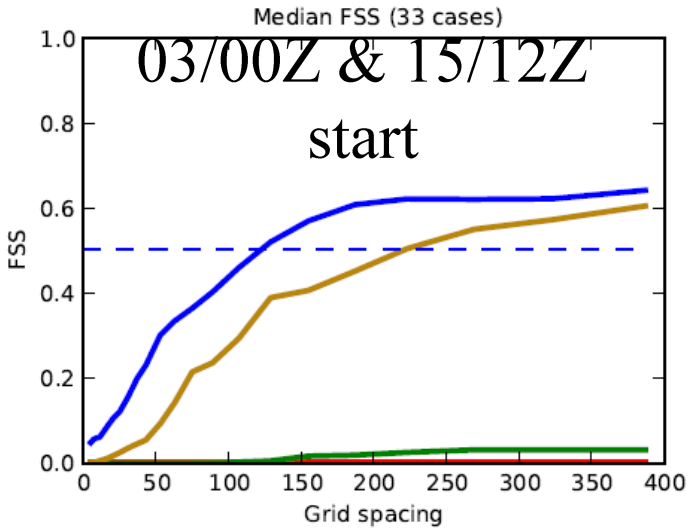
- **Effect of meso DA fades by ~12hours (LBC's, predictability etc.)**

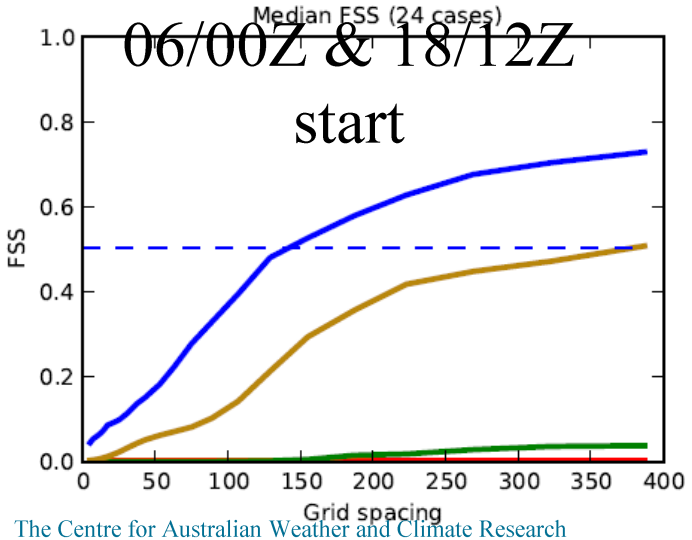
FSS for 8mm/h threshold



1.5km+3dVAR+LHN
ACCESS-A 12km

ACCESS-SY 0.05º (APS0)
ACCESS-SY 4km (APS1)

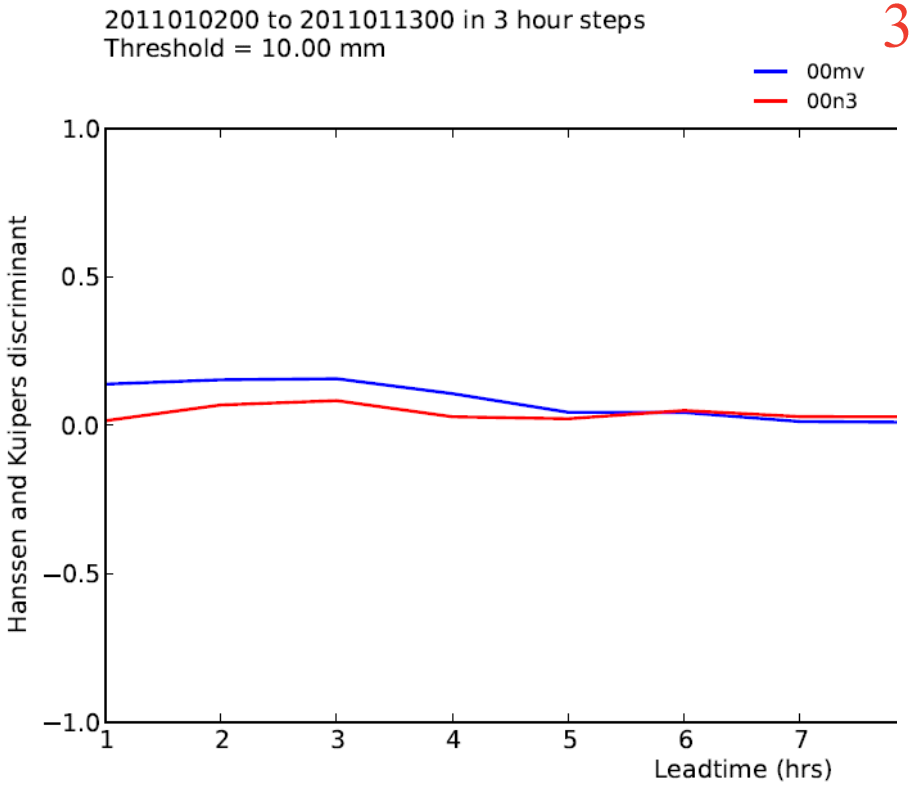


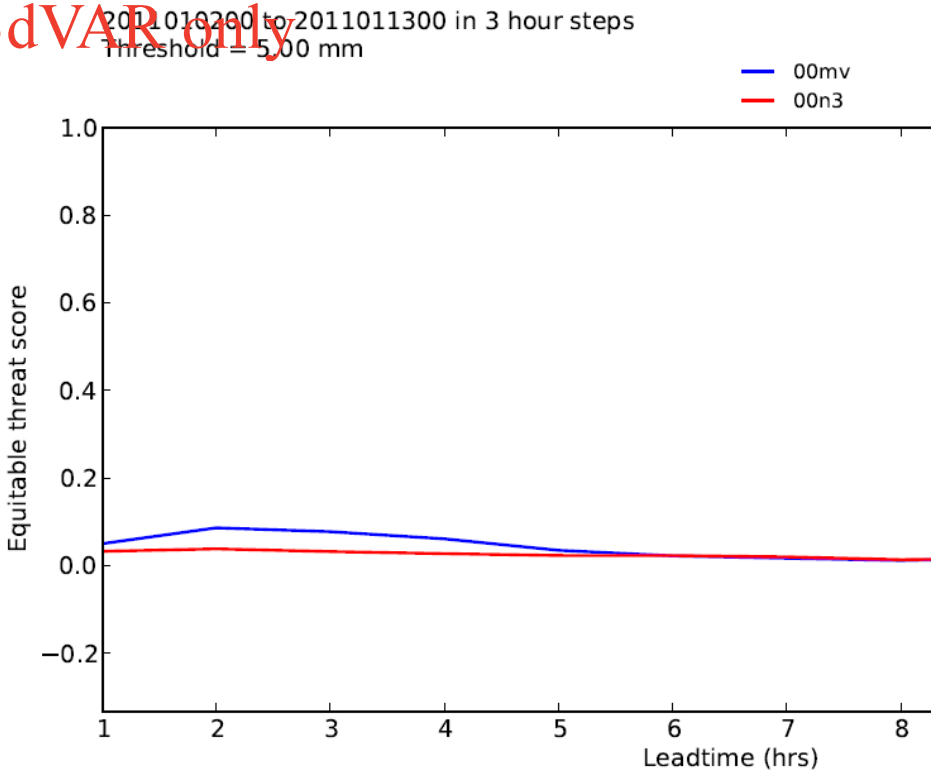


Value-added by Latent Heat Nudging over 3dVAR

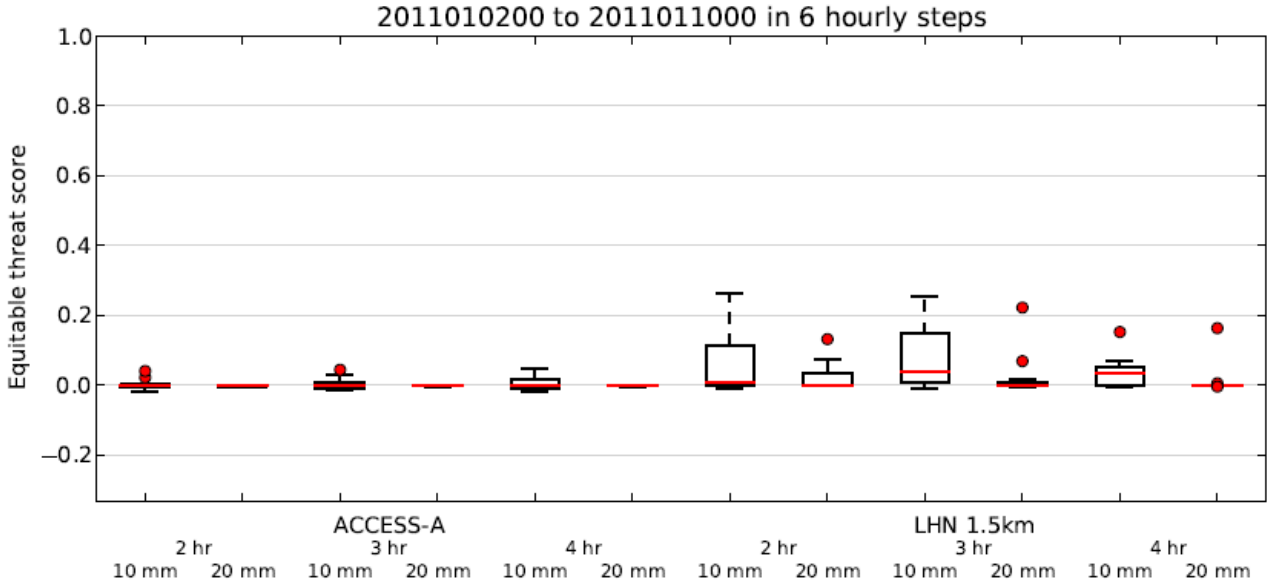
Latent Heat Nudging +
3dVAR

3dVAR only

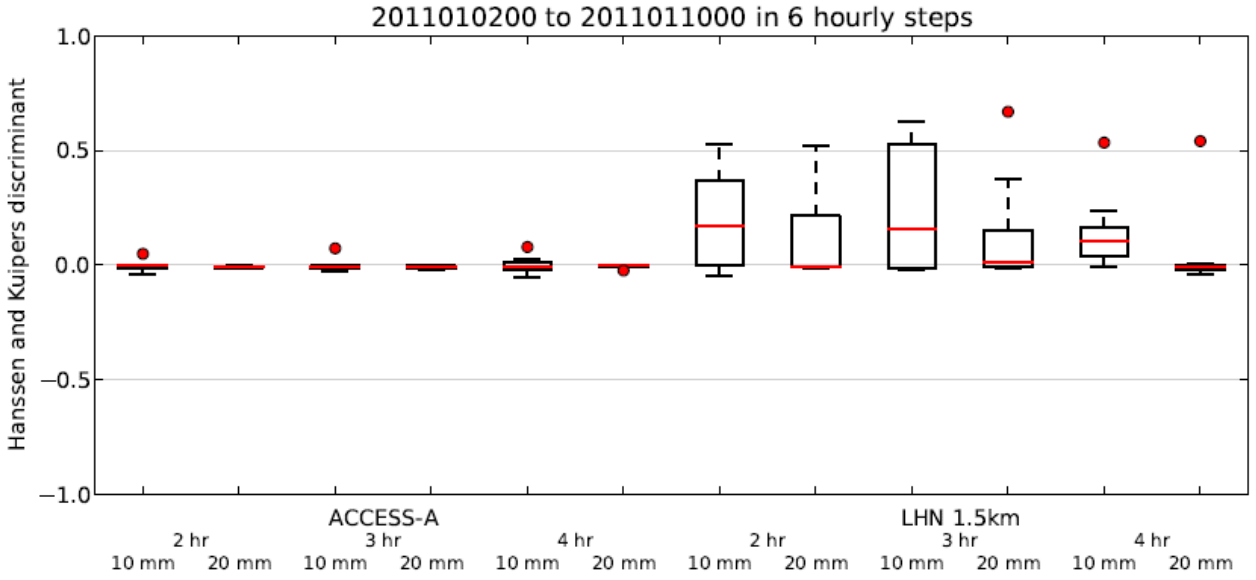




APS0 & SREP
Scores vs 10mm & 20mm thresholds



Hourly Precip
&
Model native
grid



Current DA Status at CPTEC/INPE

CPTEC is replacing its former DA system (PSAS) by the Gridpoint Statistical Interpolation (GSI), currently at NCEP and NASA, starting in the GCM (T299L64) by the end of 2011. During 2013, the same system is going to be implemented in the regional BRAMS model.
LETKF research continues with the mid/long term goal of a hybrid DA system

DA System	Operational?	Model/Config	Obs Type	Number of Obs	Remarks
Global PSAS	Since 2002	TQ213L42	Conventional, satellite retrievals	~10^5	Decommissioning on Mar/2013
Regional PSAS	Since 2000	Eta 40Km, 38 levs	Conventional, satellite retrievals	~10^5	Decommissioned on Mar/2012
Global GSI	In pre-ops since Jul/2012	T299L64	Conventional, Radiances, GPS	~10^6	To operational on Dec/2012
Global LETKF	Research Mode	T299L64	Conventional, satellite retrievals	~10^5	Towards inclusion radiances and GPS
Regional GSI	No	BRAMS, 5 km	Conventional, Radiances, GPS	~10^6	Begin of work on Jan/2013

GSI implementation at CPTEC/INPE

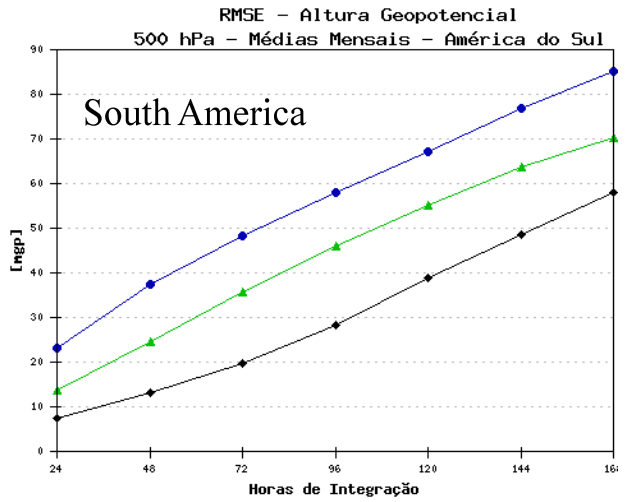
- Preliminary results comparing the newly implemented Global GSI system (G3DVar) against the current Global PSAS (GPSAS) operational DA are presented.

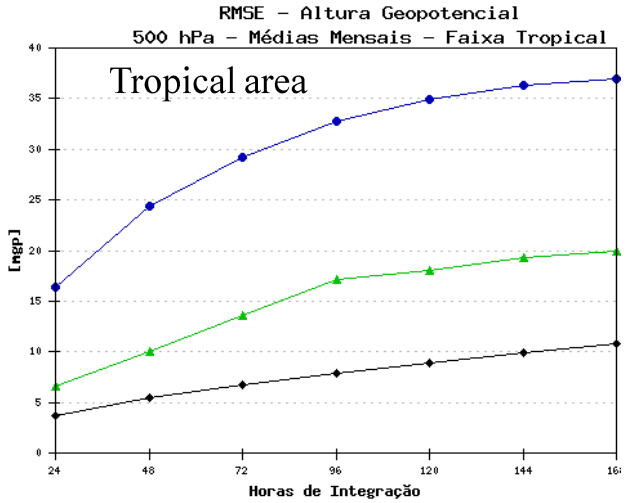
- RMSE and Biases averaged over Jun, Jul, Aug/2012 were computed for different regions: Northern (HN) and South (SH) Hemispheres, Tropical region and South America.

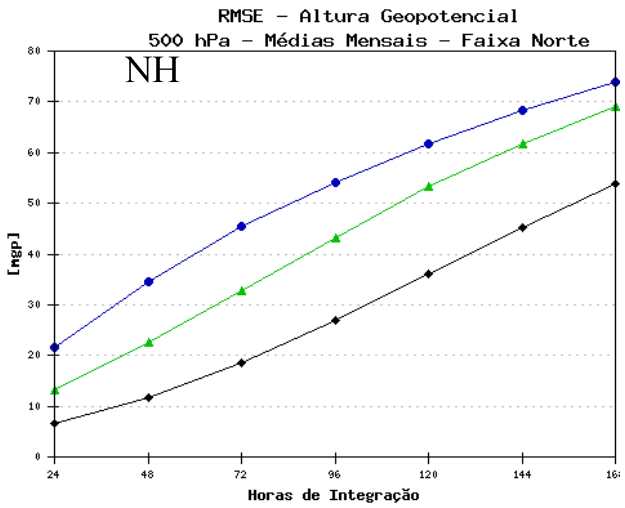
- In the panels that follow, GPSAS is shown in blue, G3DVar in green and GFS (for reference purposes only) in black.

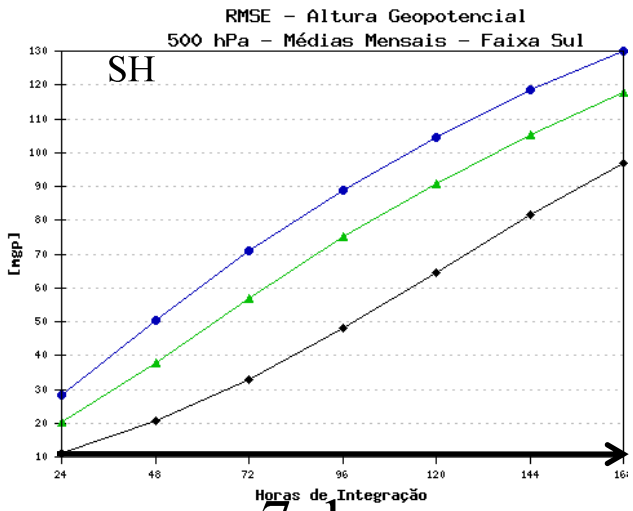
Geopotential Height at 500 hPa – RMSE

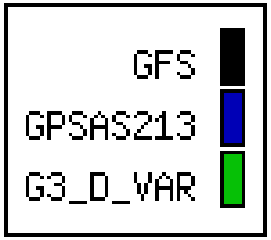
RMSE averaged over Jun, Jul, Aug/2012 for different regions: Northern (HN) and South (SH) Hemispheres, Tropical region and South America.







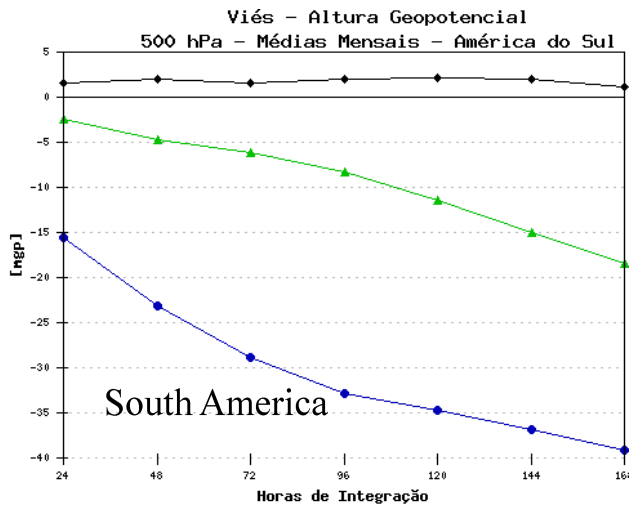


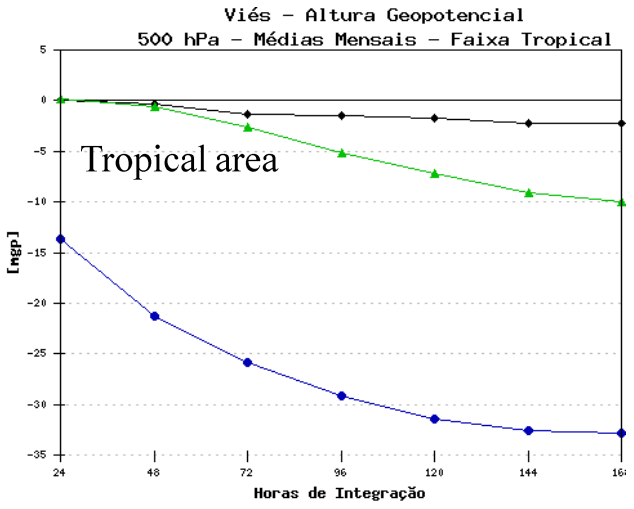


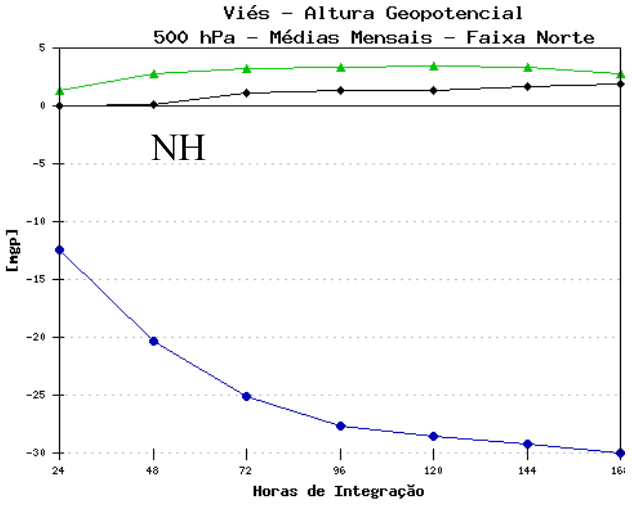
7 days

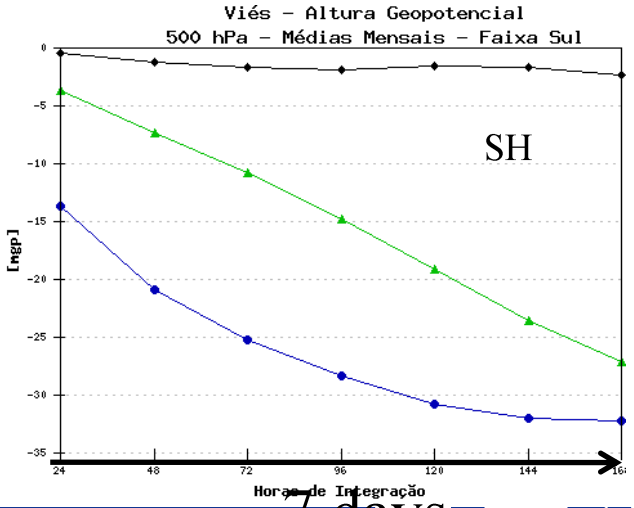
Geopotential Height at 500 hPa – Bias

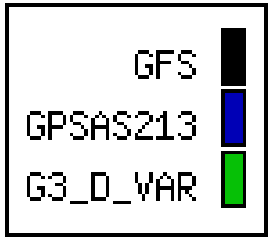
Bias averaged over Jun, Jul, Aug/2012 for different regions:
Northern (HN) and South (SH) Hemispheres, Tropical region and South America







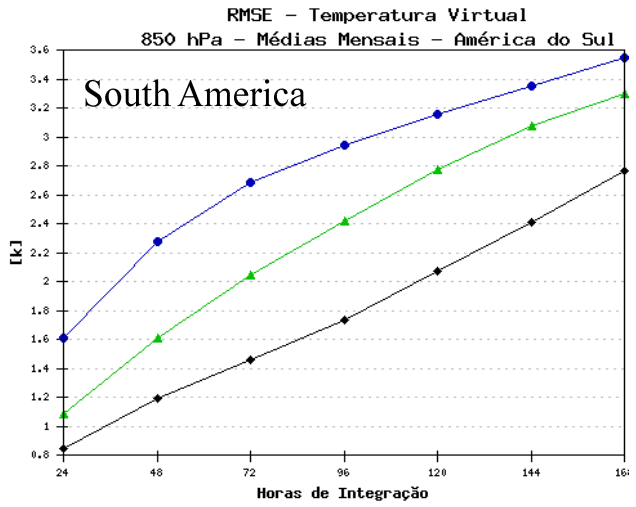


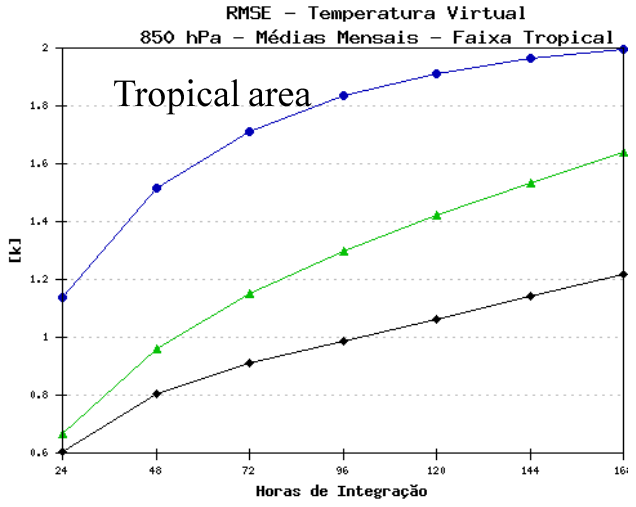


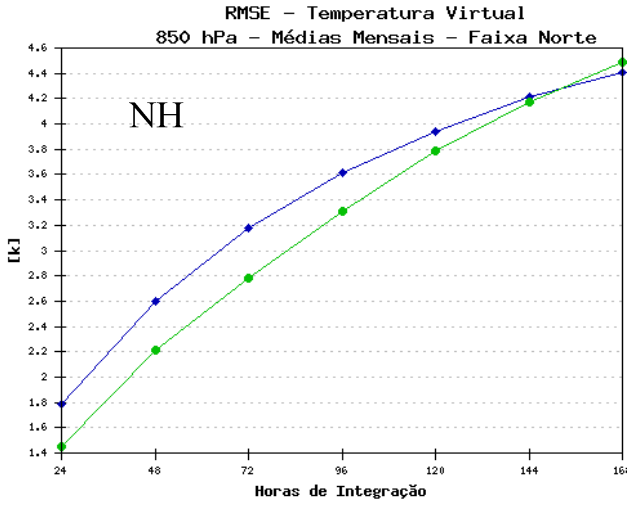
7 days

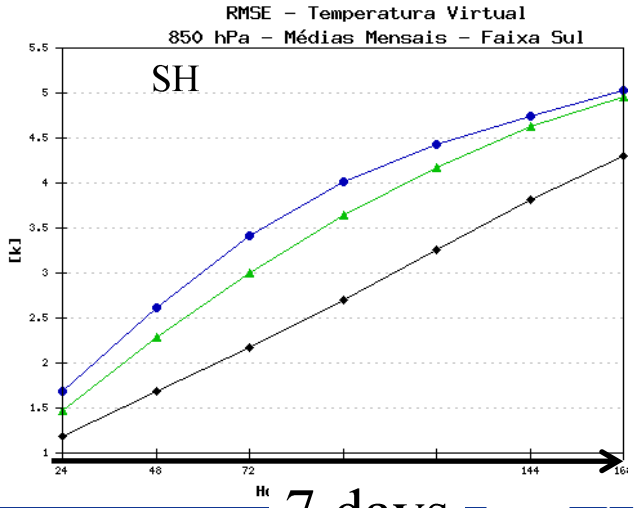
Virtual Temperature at 850 hPa – RMSE

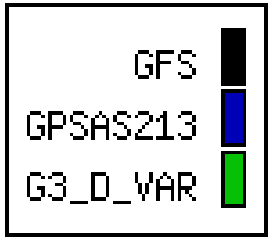
RMSE averaged over Jun, Jul, Aug/2012 were computed for different regions: Northern (HN) and South (SH) Hemispheres, Tropical region and South America. , GPSAS is shown in blue, G3DVar in green and GFS (for reference purposes only) in black.







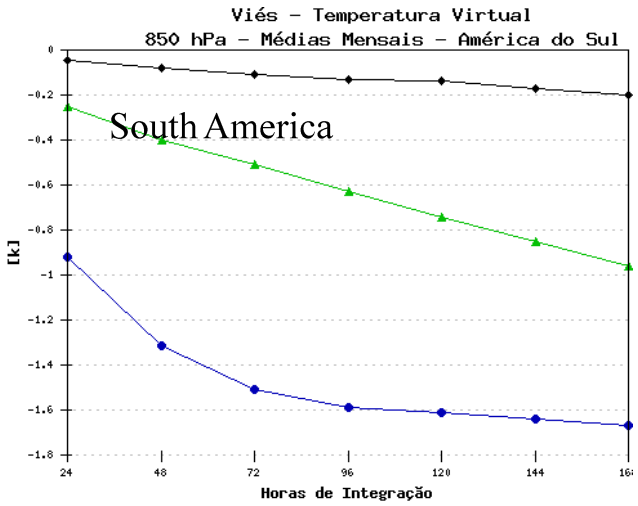


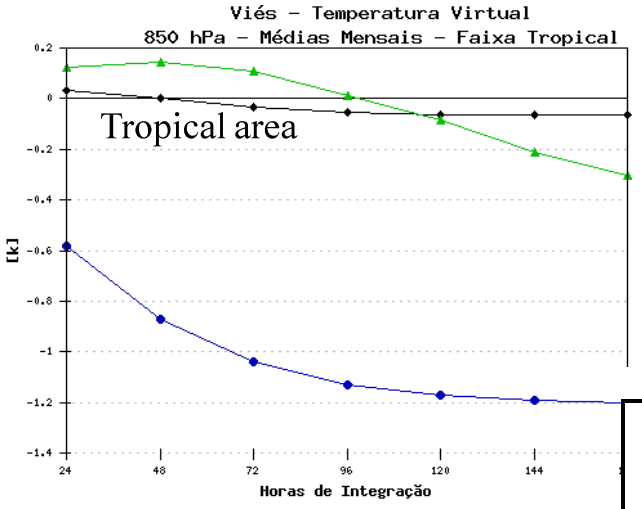


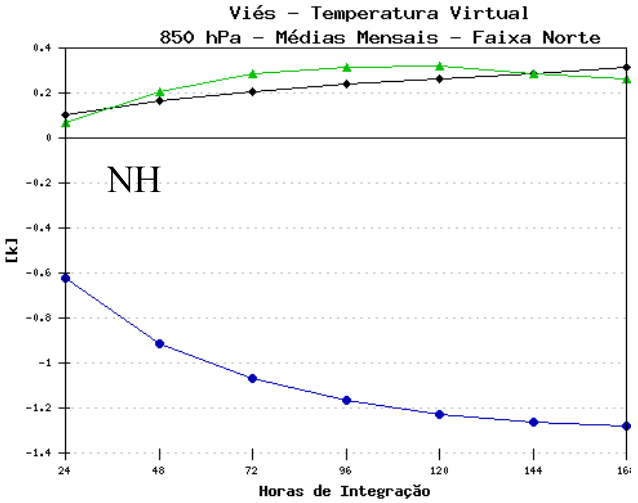
Virtual Temperature at 850 hPa – Bias

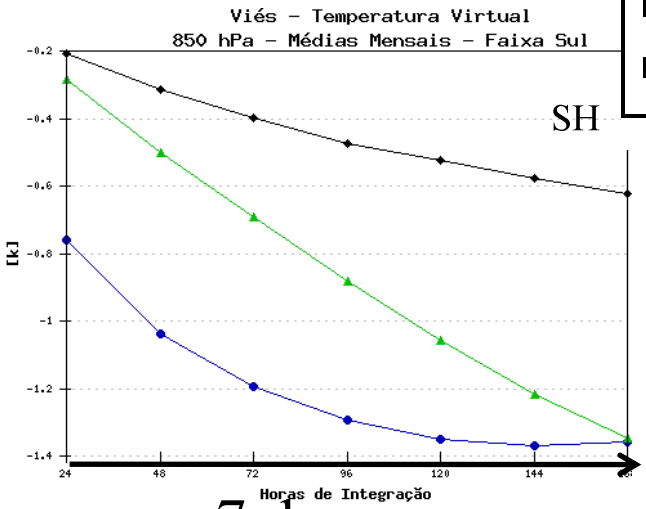
Bias averaged over Jun, Jul, Aug/2012 for different regions:

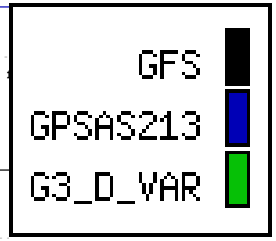
Northern (HN) and South (SH) Hemispheres, Tropical region and South America.









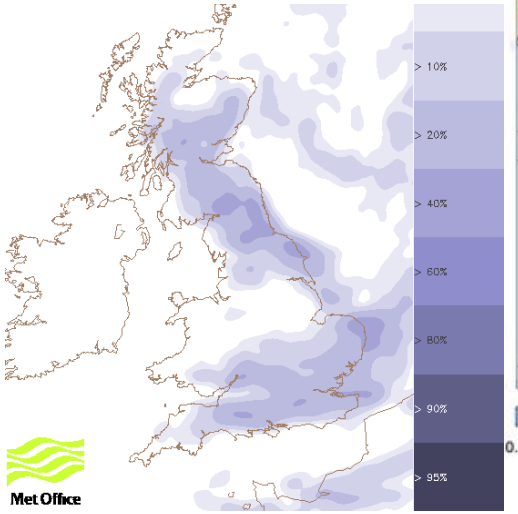


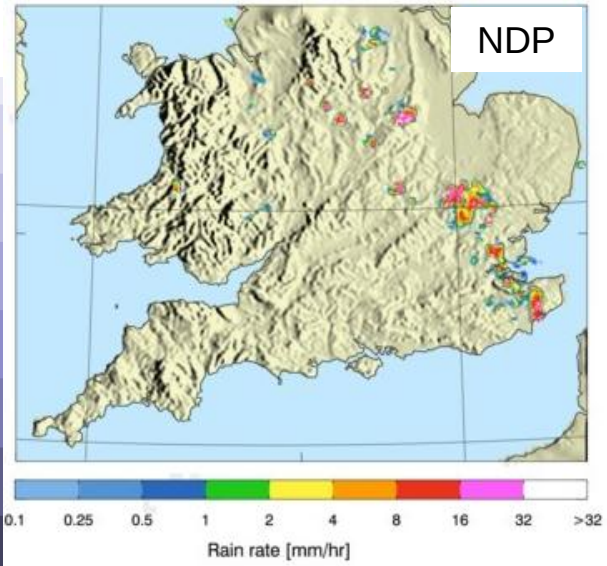
7 days

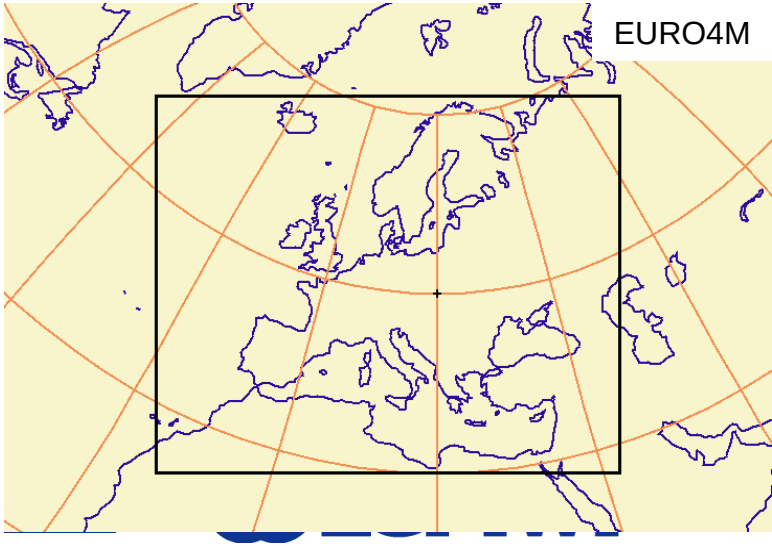
UKMO: FY12-16 DAE Theme R&D Highlights

- Olympics Demonstrators:
  - Nowcasting Demonstration Project (NDP – see Ballard talk)
  - 2.2km MOGREPS-UK ensemble (see Golding talk)
- 4D-Ens-Var development ongoing – target tests vs 4D-Var in 2014.
- Extended Kalman Filter Land Surface DA system being tested.
- Coupled MOGREPS-15/GloSea project initiated in 2012.
- Pilot 4D-Var European regional reanalysis due Feb 2013 (EURO4M).

MOGREPS-UK: Probability Of Precipitation (6/8/2012)

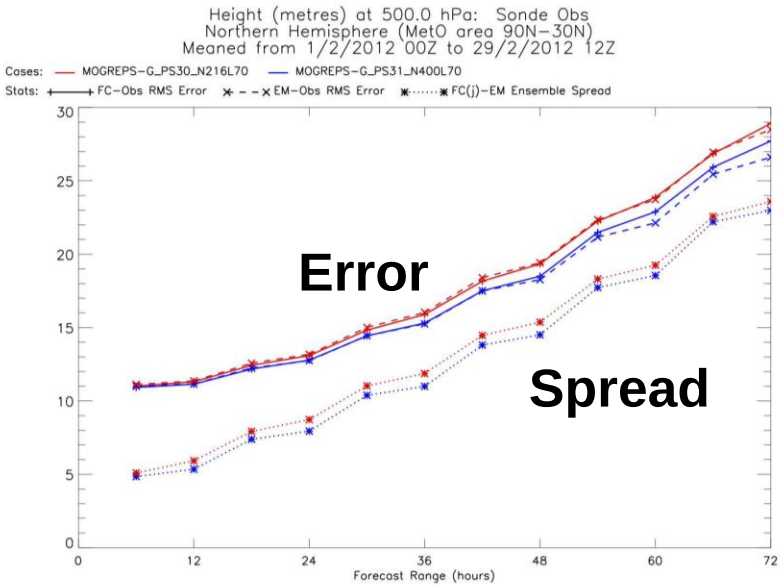


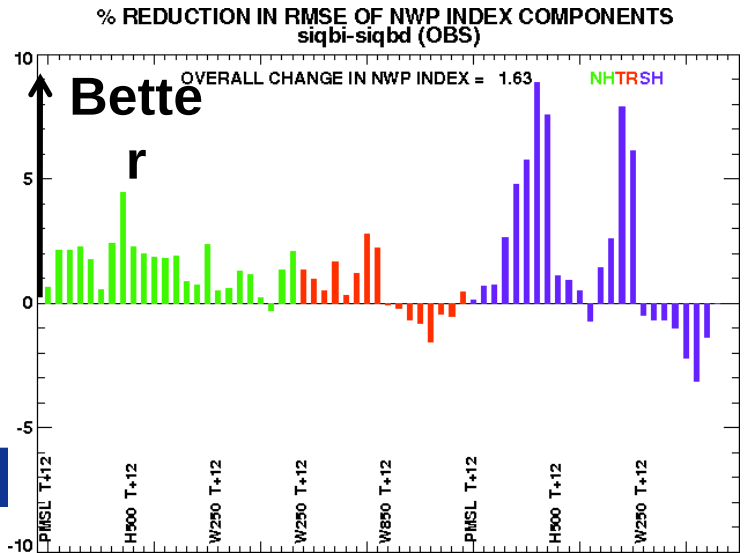




UKMO: DAE Contributions to Autumn 2012 Operational Global Upgrade (PS31):

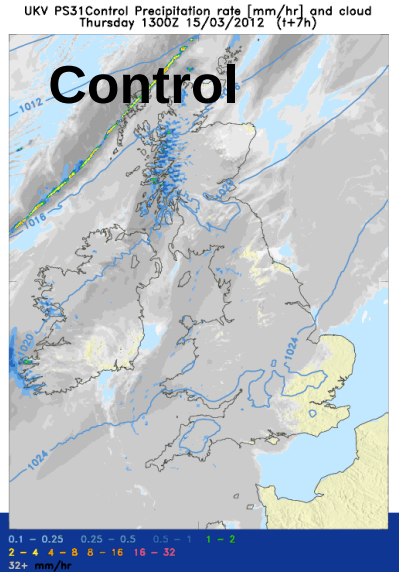
- Short-range global ensemble (MOGREPS-G) resolution increased from N216 (~60km) to N400 (about 33km). **PWS Cat A Key Deliverable**
- MOGREPS-G ensemble size for hybrid 4D-Var/ETKF data assimilation increased from 22 to 44 members. **PWS Cat A KD**
- Mix of climatological/ensemble covariances in hybrid tuned.
- Large impact of DAE and SA upgrades in PS31 from two seasons' trials: **~1.5pts** on the global (deterministic) NWP index.

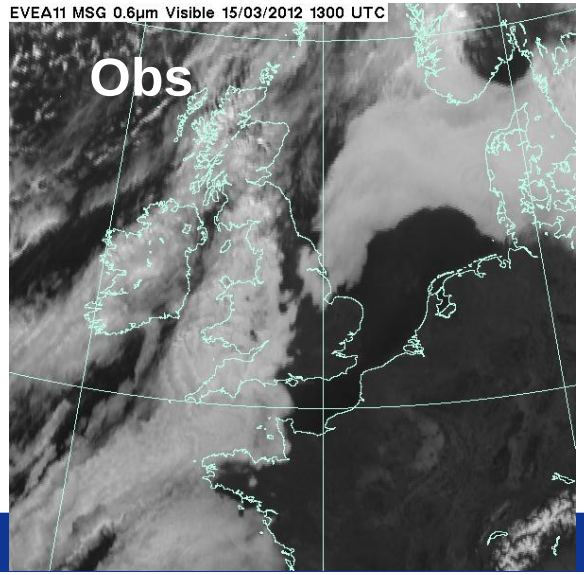


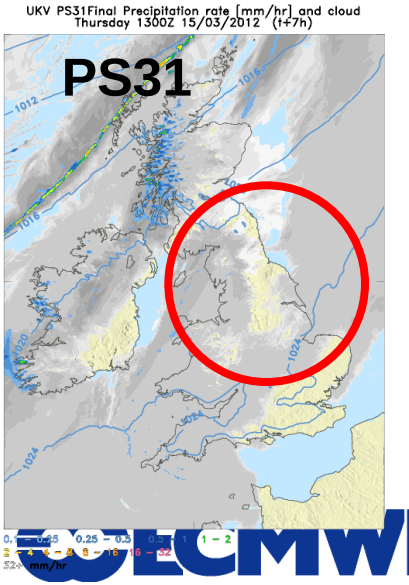


UKMO: DAE Contributions to Autumn 2012 Operational UKV DA Upgrade (PS31):

- **New covariances derived from 'CVT' software + new training data.**
- **Much shorter horizontal length scales for humidity, unbalanced pressure and log (aerosol).**
- **Add SEVIRI ch 5 over low cloud and AMSU-B (+0.75% in UK4 trial)**
- **Change from MOPS cloud profiles to GeoCLOUD (cloud top only)**
- **Minor corrections**







ECMWF Data Assimilation progress

EDA based flow-dependent background error variance with improved filtering

New background error statistics

Bias correction of aircraft temperature

Super saturation humidity analysis

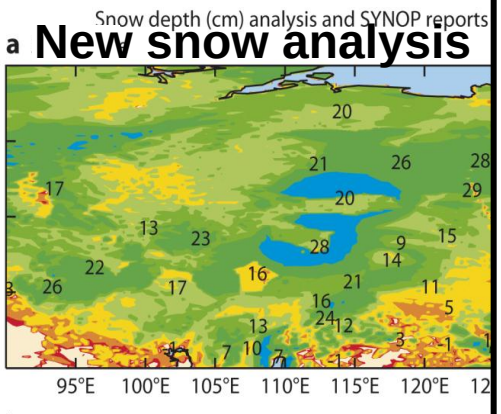
Cycling weak-constraint model error

Assimilation of all-sky radiances

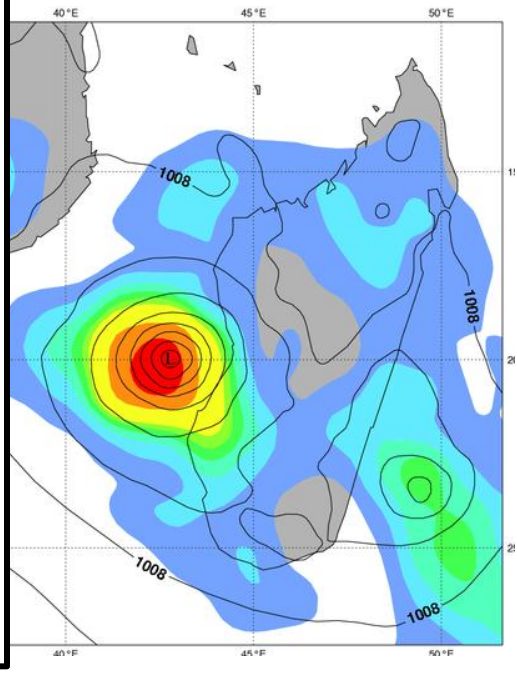
Extended Kalman Filter soil moisture an.

New snow analysis and more snow data

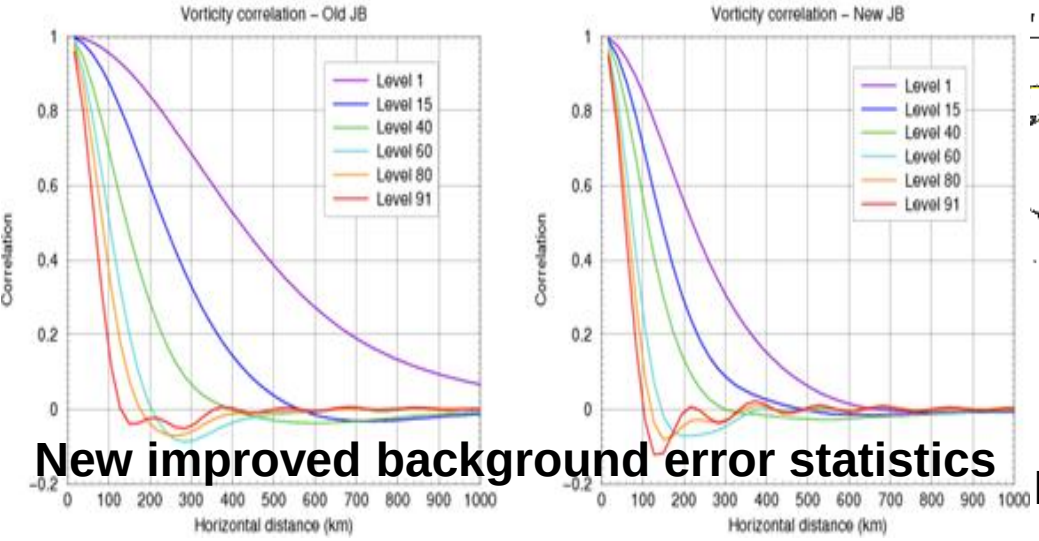
New snow analysis



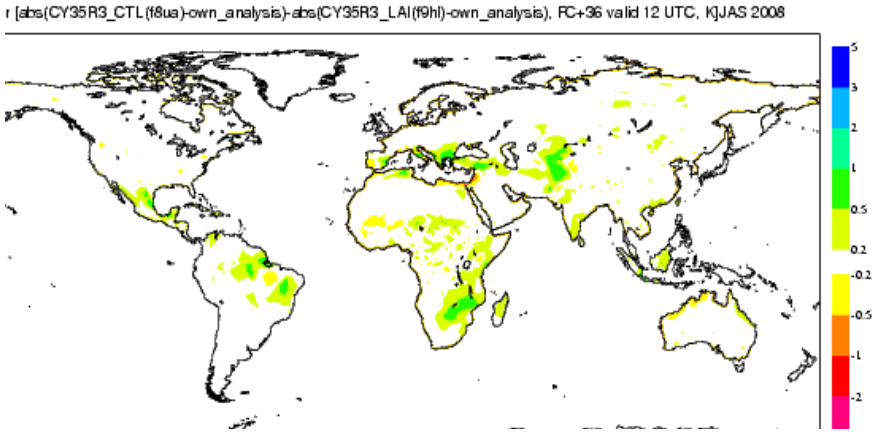
Flow dependent bg error variance



New improved background error statistics



EKF soil moisture ana. improve T2m fc



ECMWF

ECMWF (2): DA plans

Vertical resolution increase to137 levels

ASCAT data in EKF soil moisture analysis

Retune observation errors for all data

EDA based flow-dependent covariance

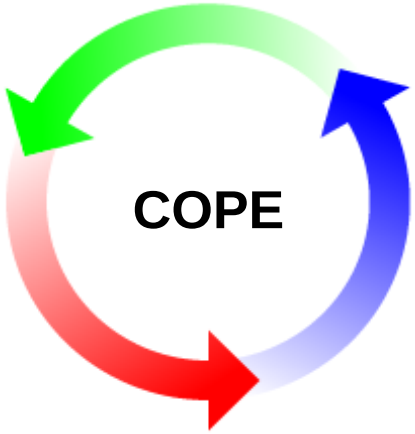
Cloud condensate as analysis variable

Improve scalability of 4D-Var

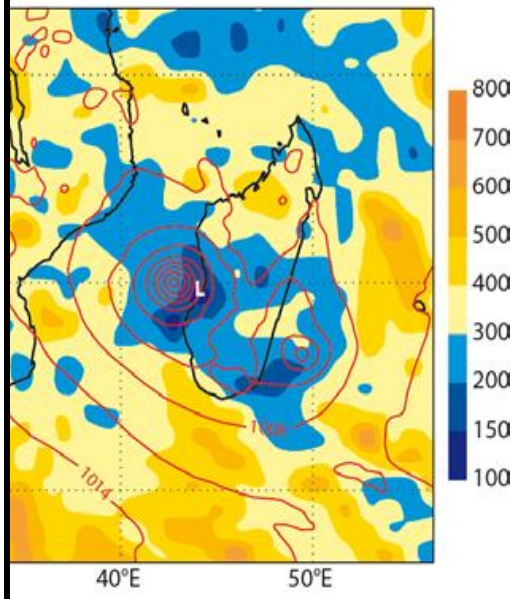
Object **O**riented **P**rogramming **S**ystem

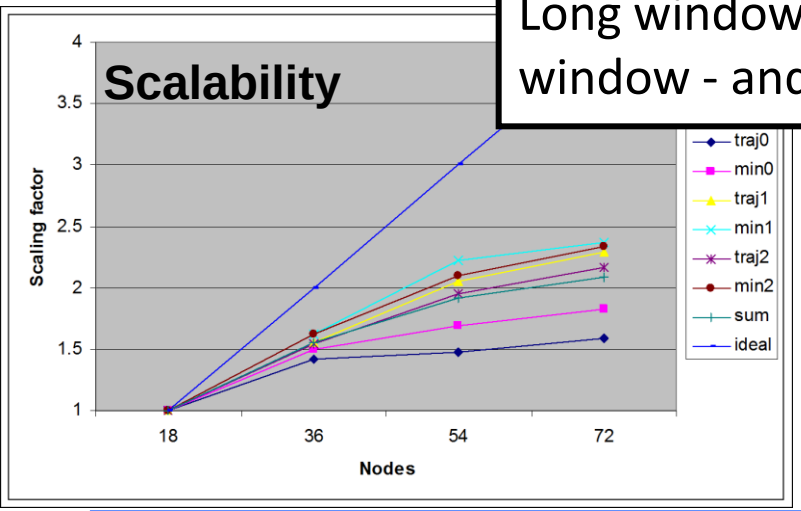
Continuous Observation Processing Environment - **COPE**

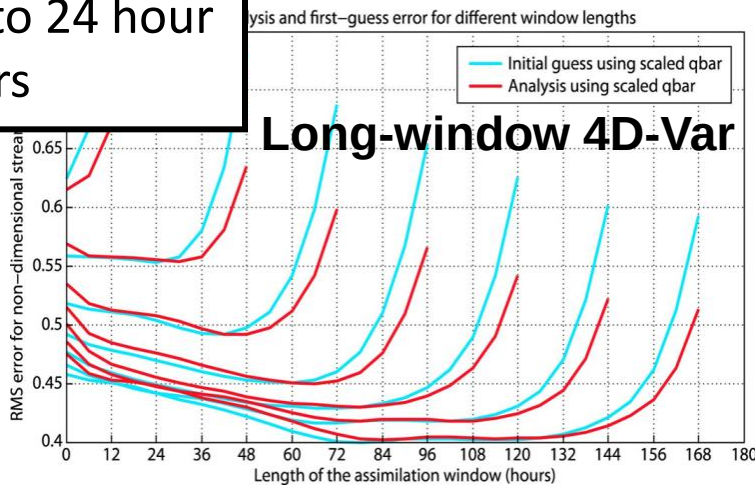
Long window 4D-Var: extend to 24 hour window - and later 48-72 hours



Flow dependent length scales



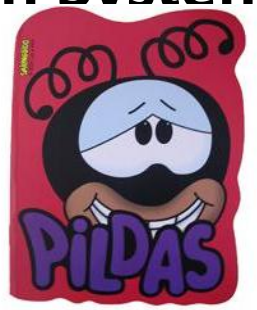




ECMWF

Land Data Assimilation Activities

Project for the Intercomparison of Land Data Assimilation Systems (PILDAS)



Rolf Reichle* (NASA/GSFC)

Jean-François Mahfouf (Météo-France), Qing Liu (NASA/GSFC), and Sujay Kumar (NASA/GSFC)

*Email: Rolf.Reichle@nasa.gov

Phone: +1-301-614-5693

ECMWF

PILDAS Objectives and Overview

OBJECTIVE:

Comparison of land data assimilation systems (LDAS) to provide **guidance and priorities** for land assimilation research and applications and, ultimately, produce **enhanced global data sets** of land surface fields.

The **first experiment (PILDAS-1)** will focus on

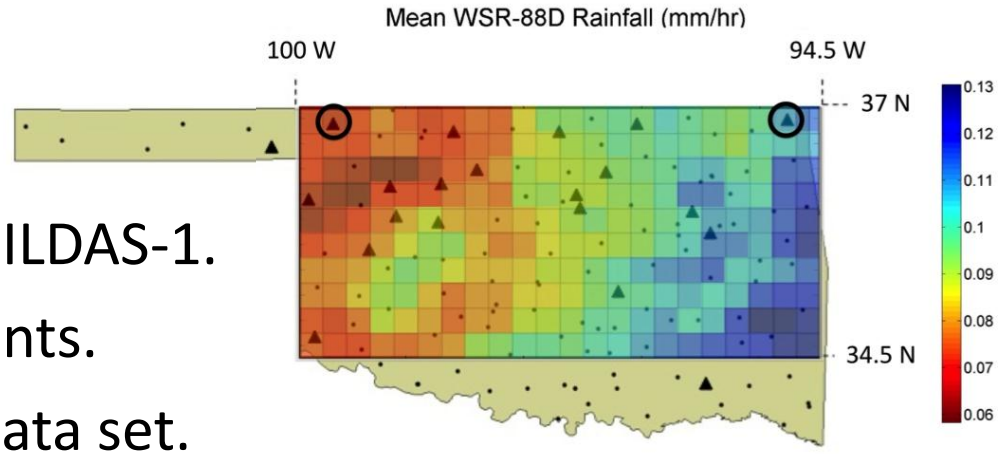
- systems targeted for weather and seasonal forecasting at operational centers and research institutions,
- soil moisture retrieval assimilation, and
- development of a framework for LDAS comparison.

PILDAS-1 will use

- various assimilation approaches (EnKF, EKF, …),
- multiple “off-line” land models (not coupled to atmosphere), &
- synthetic observations.

Future experiments will assimilate satellite observations (e.g., SMOS, SMAP) and use coupled land-atmosphere modeling and assimilation systems.

PILDAS-1 Status and Concerns



Status

- Drafted experiment plan for PILDAS-1.
- Identified interested participants.
- Assembled tentative forcing data set.
- Started dry-run with two systems (NASA/GEOS-5 and NASA/LIS/H-Tessel).

Concerns

- Anyone missing from the list of target participants?
- Are **systems ready** [ECMWF?] and **resources available** (staff, computing) [everyone…]?
- **Core group infrastructure** (web server, postdoc) and **funding**?

THE END