THORPEX

Report from THORPEX Data Assimilation and Observing Systems Working Group

Tom Hamill and Roger Saunders
DAOS co-chairs

with input from working group members

WMO
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DAOS-5 WG meeting Madison, 19-20 Sep 2012

http://www.ssec.wisc.edu/meetings/daos/agenda.html

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

- Update on targeting
- Updates on THORPEX field campaigns
- Review observing systems
- Review developments in data assimilation
- WG matters

Current membership

Tom Hamill(D), Co-chair NOAA, USA	Roger Saunders(O), Co-chair Met Office, UK	Stefan Klink(O) DWD, Germany
Carla Cardinali(D) ECMWF	Chris Velden(O) Univ Wisconsin-CIMSS, USA	Ron Gelaro(D) NOAA, USA
Tom Keenan(O) CAWCR, Australia	Rolf Langland(D) NRL, USA	Bertrand Calpini (O) MeteoSwiss, Switzerland
Andrew Lorenc(D) MetOffice, UK	Florence Rabier(D/O) Météo-France	Prof. Bin Wang(D), Chinese Academy of Sciences, China
Michael Tsyroulnikov(D) HydroMet Centre, Russia	Mark Buehner (D) Environment Canada	Sharan Majumdar (D) RSMAS, Univ Miami, USA
Daryl Kleist(D), NCEP, USA		

O=Observations D=Data Assimilation

WORLD METEOROLOGICAL ORGANIZATION

WORLD WEATHER RESEARCH PROGRAMME

COMMISSION FOR ATMOSPHERIC SCIENCES

TARGETED OBSERVATIONS FOR

IMPROVING NUMERICAL WEATHER PREDICTION:

AN OVERVIEW

Prepared by

Sharanya J. Majumdar and Co-authors

Targeted Observations

THORPEX overview report available, and soon a BAMS article to be submitted.

Impact of Targeted Dropsonde Data on Mid-latitude Numerical Weather Forecasts during the 2011 Winter Storms Reconnaissance Program

Presented by Tom Hamill

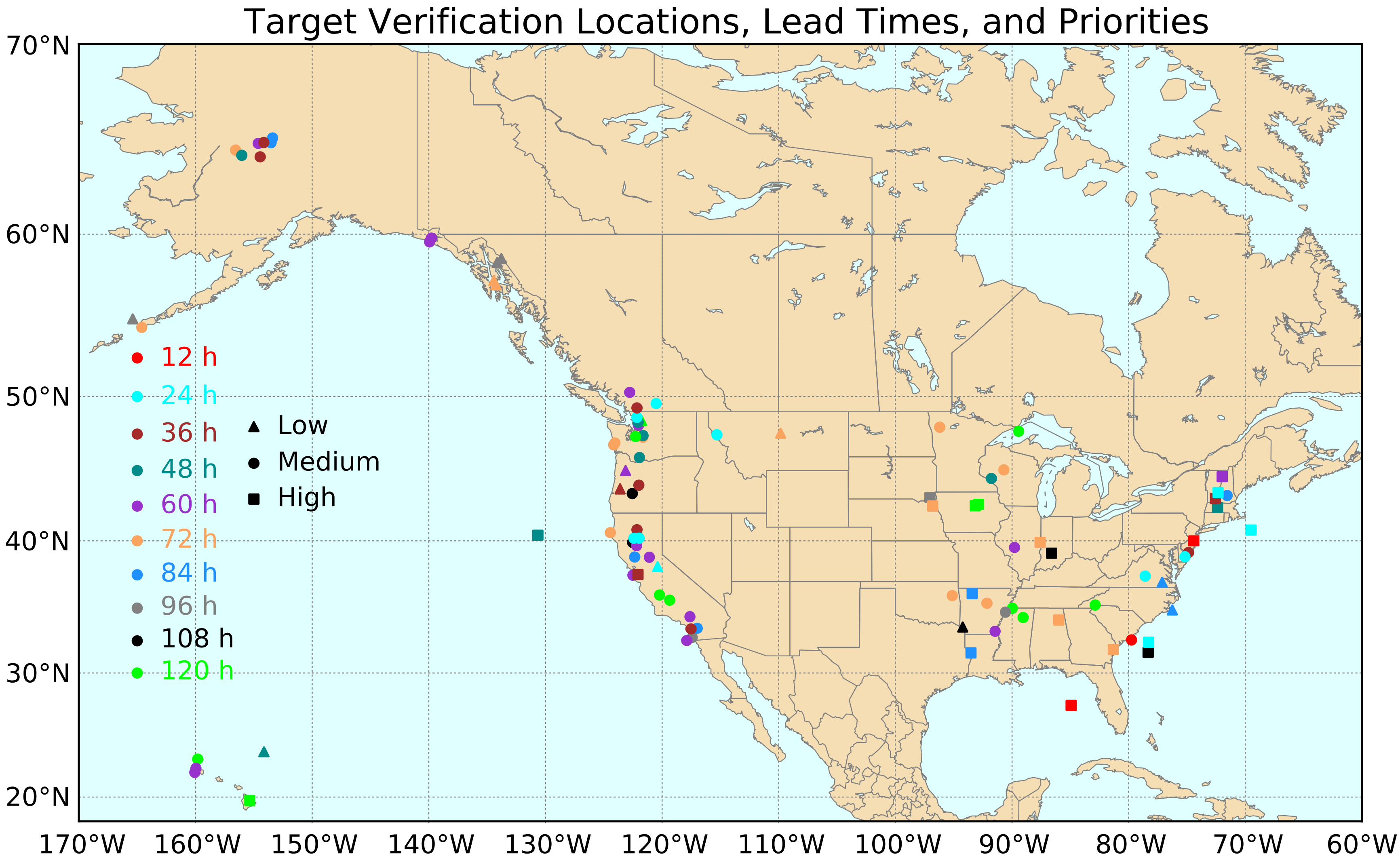
Forecasts and assimilations : Carla Cardinali, ECMWF

Data analysis : Fanglin Yang, NCEP

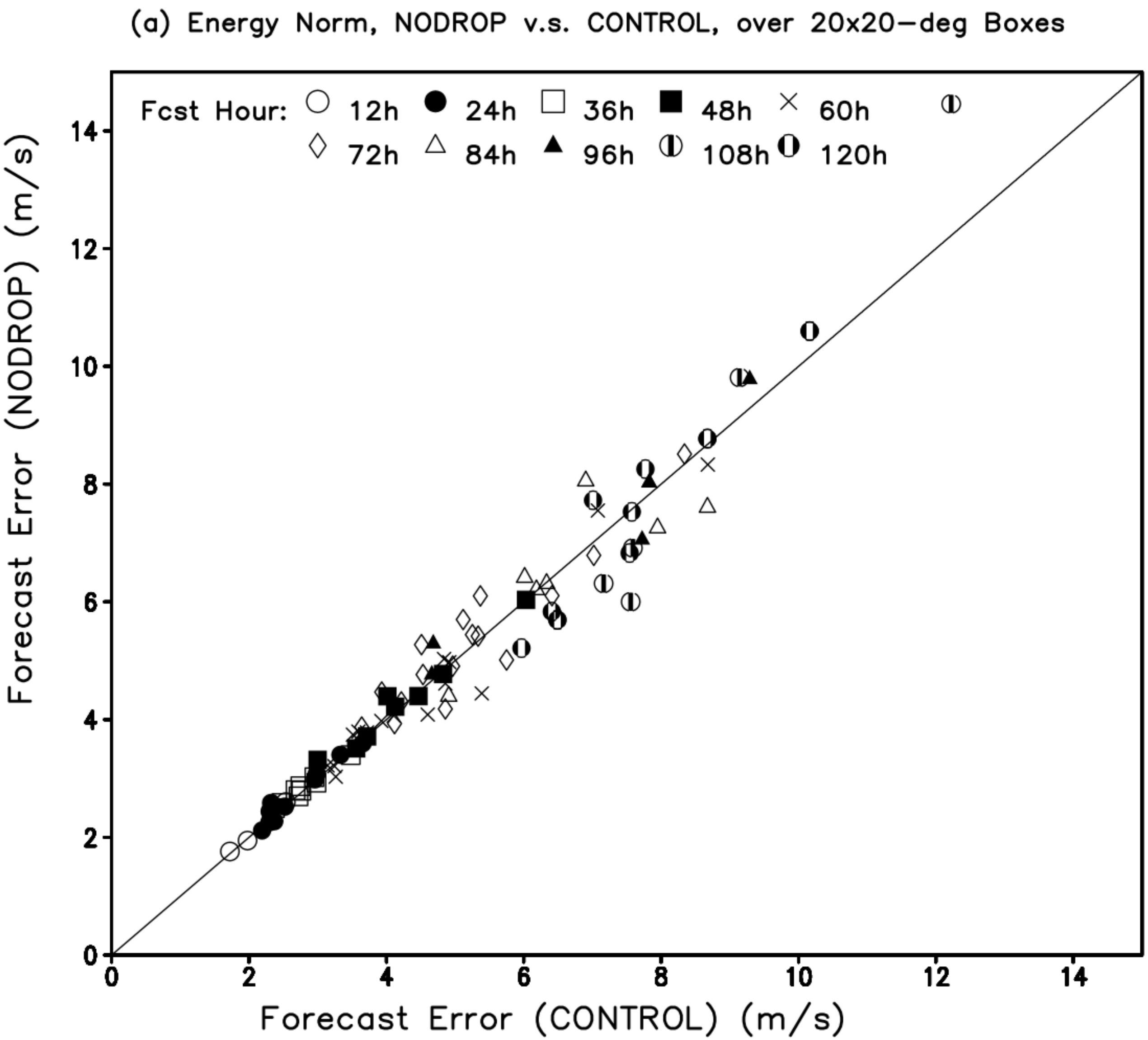
also: Sharanya Majumdar, RSMAS, U. Miami

Question: will assimilation of mid-latitude dropsonde data have as large an impact as previously shown, given denser observation network, better assimilation systems and models?

2010/11 WSR campaign



Scatterplot of impacts



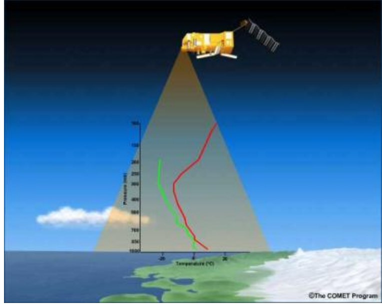
For each case where dropsondes were launched, a downstream target location and verification time are identified. Data are plotted here only for these times/target locations.

Verification area here is a +/- 10 degree box centered on target. Verification norm is an approximation to the total-energy norm.

Cases above line indicate benefit from targeted data.

No obvious beneficial impact.

Concordiasi = CONCORDIA-IASI



A French-US initiative for climate / meteorology over Antarctica

Improve the use of space-borne atmospheric sounders over polar regions, in particular IASI on board MetOp

Benefit from the continental French-Italian station

Concordia

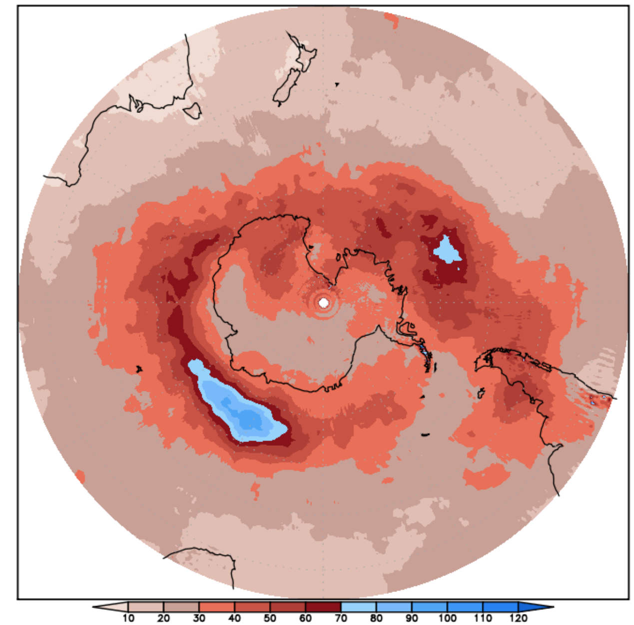
ConcordIASI : Analysis Uncertainty, 45° S to 70° S

To the north: Geostationary satellite winds, ship surface obs, commercial aircraft routes

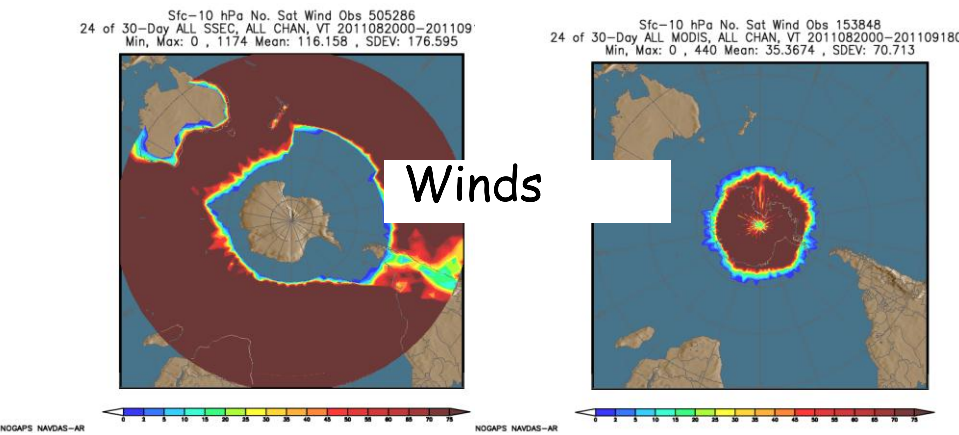
To the south: Antarctic raobs and land surface data, MODIS and AVHRR winds

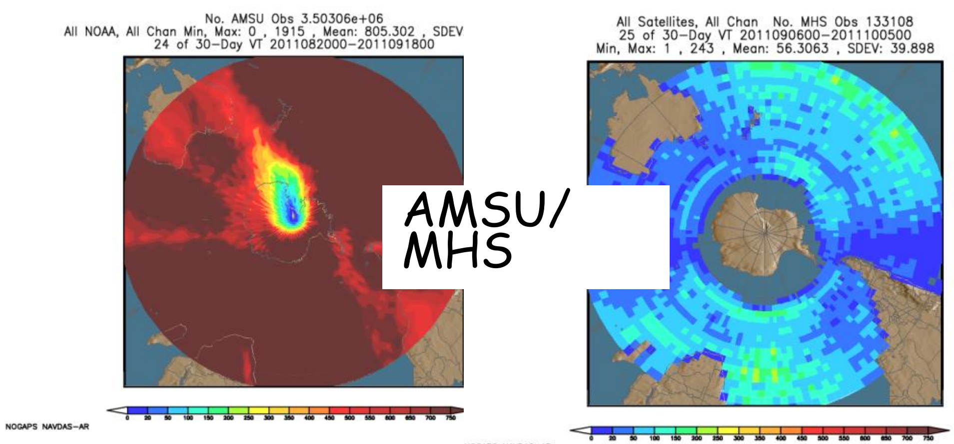
Analysis differences: observational gap leads to large differences off Antarctica

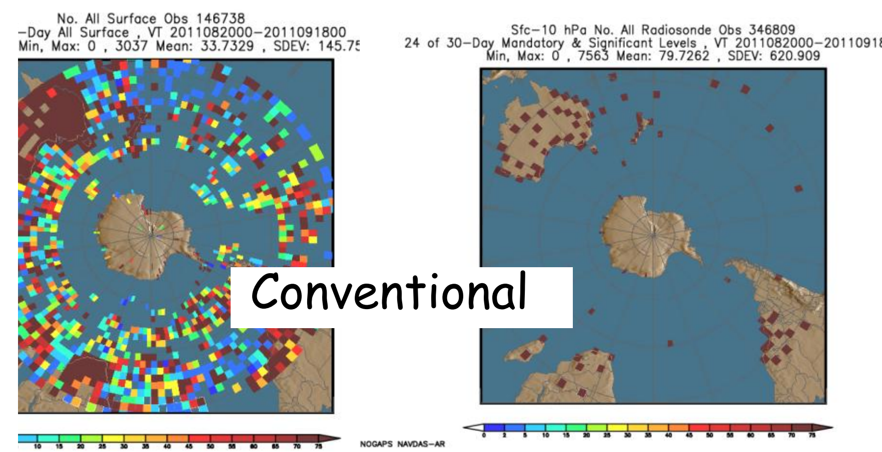
Mean Z500 variance ECMWF NOGAPS METFRANCE GEOS5



00UTC27Sept – 12UTC16Nov 2010 100 analyses

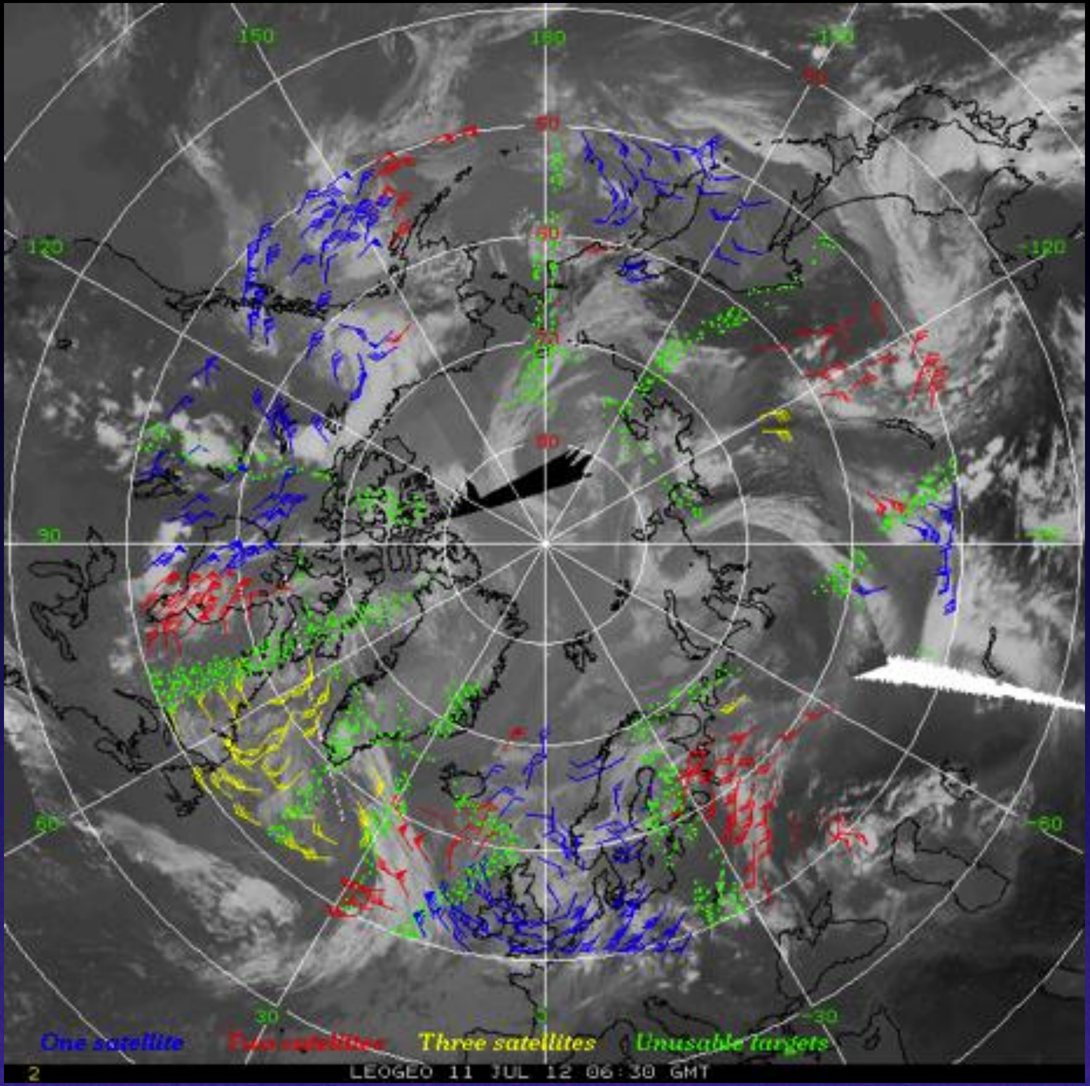






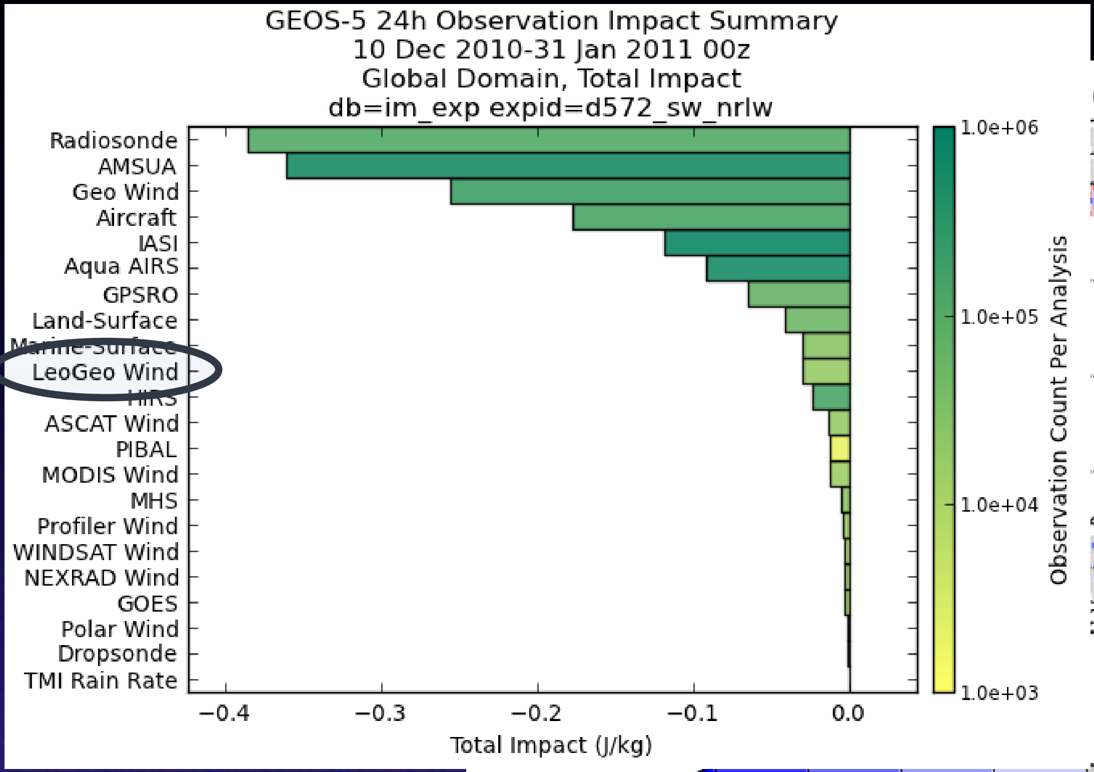
3. New and future AMVs/products: Closing the gap with Leo/Geo winds

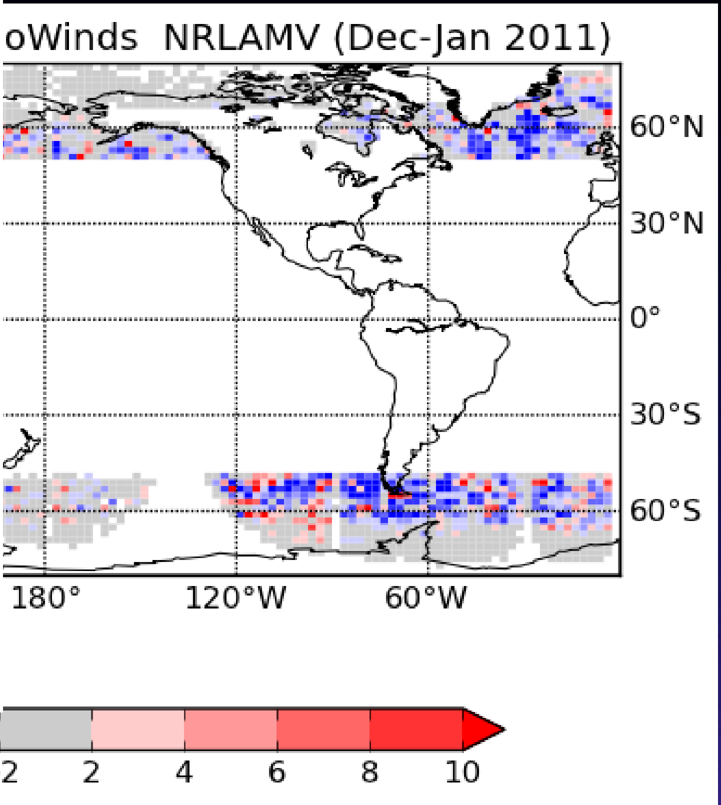
- Composites of GOES, Meteosat, FY-2, MTSAT, AVHRR, MODIS
  - AVHRR: Metop A, NOAA-15, 16, 18, 19
  - MODIS: Terra and Aqua
- Tracking clouds in infrared window channel, accounting for:
  - Variable pixel time
  - Parallax



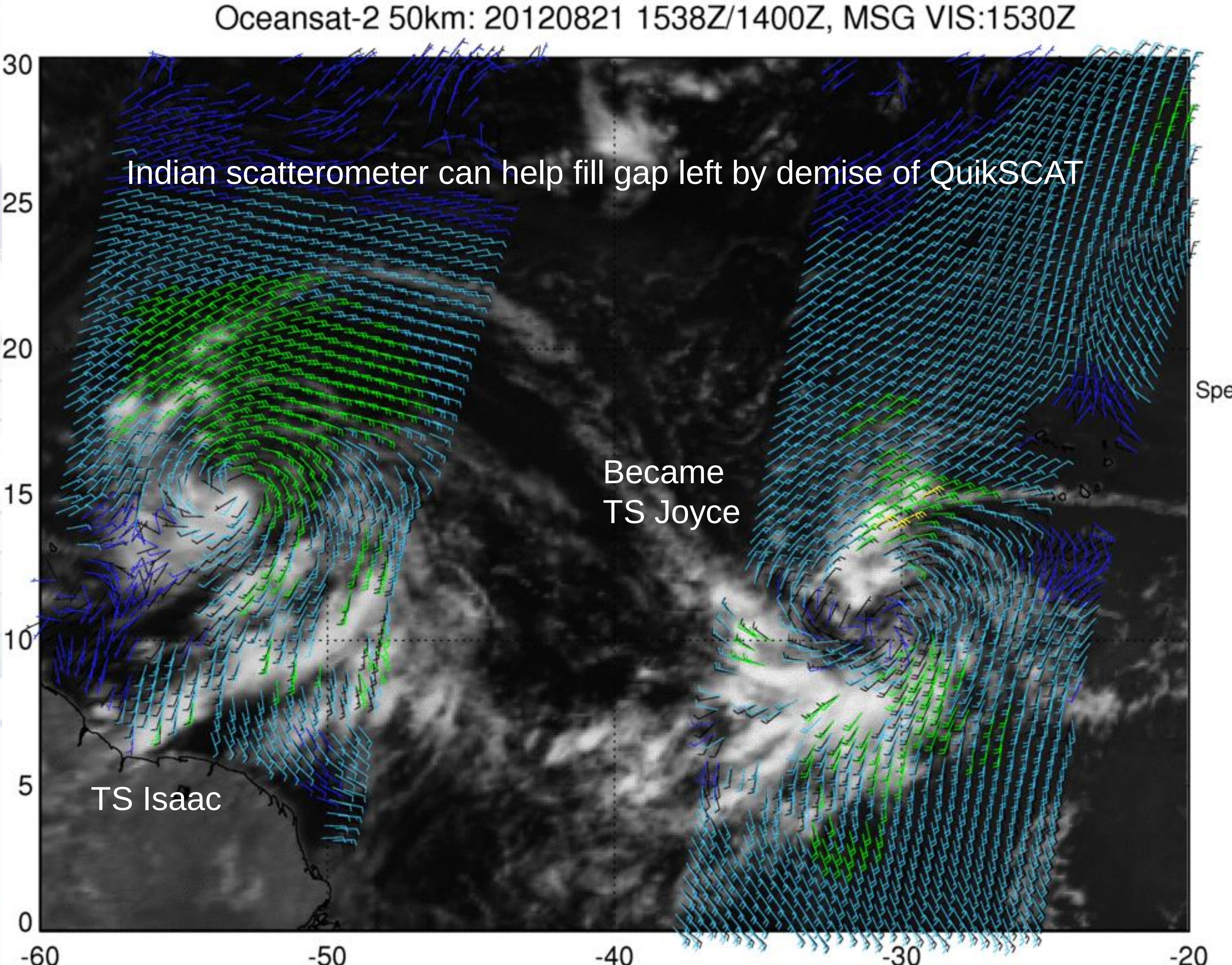
3. New and future AMVs/products: Closing the gap with Leo/Geo winds

Impact of Leo/Geo winds: NRL superobbed winds in NASA GMAO GEOS-5





Courtesy of Dagmar Merkova and Ron Gelaro



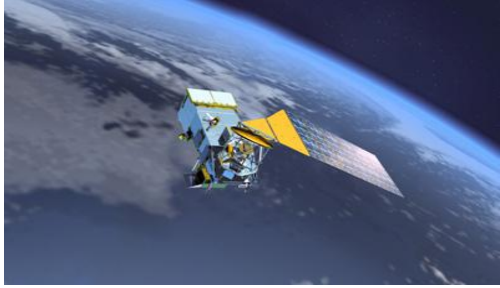
Oceansat-2 50km: 20120821 1538Z/1400Z, MSG VIS:1530Z
Indian scatterometer can help fill gap left by demise of QuikSCAT
Became
TS Joyce
TS Isaac
30
25
20
15
10
5
0
-60
-50
-40
-30
-20

Private industry to supply hyperspectral data? GeoMetWatch, a US Company

GeoMetWatch™
ADVANCED, AFFORDABLE WEATHER.

- Privately owned commercial data provider offers **“STORM”** ***leveraging GIFTS technology development***
- Oct 2010: Licensed by US Dept. of Commerce for hyper-spectral data collection at ***6 sites around the world*** (under the US Remote Sensing Act of 2003)
- Promises to restore critical data for severe weather forecasting cancelled from GOES-R and much more ***at a fraction of the cost, in record time!***
- Potential Customers: US, top sovereign governments world-wide, and & commercial enterprises

Conclusions on satellite observation platforms



• Research satellites/instruments can be valuable as operational data providers, but can fail suddenly without backups (e.g. ENVISAT, AMSR-E are recent examples)

• Satellite data contributions to the GOS by nations increasing (e.g. FY-3, Oceansat-2), to hopefully help fill future gaps

•New privately funded initiatives to provide satellite data

• Impact of satellite data in medium range NWP is dominant in many advanced DA systems

•Research underway to extend/improve use of advanced IR sounders (cloudy rads, use PCs, more data over land etc.)

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Distribution of gobal ASAP soundings 2010

[input from ASAP report at SOT-VI meeting 2011, author: Rudolf Krockauer, chairperson ASAP Task Team]

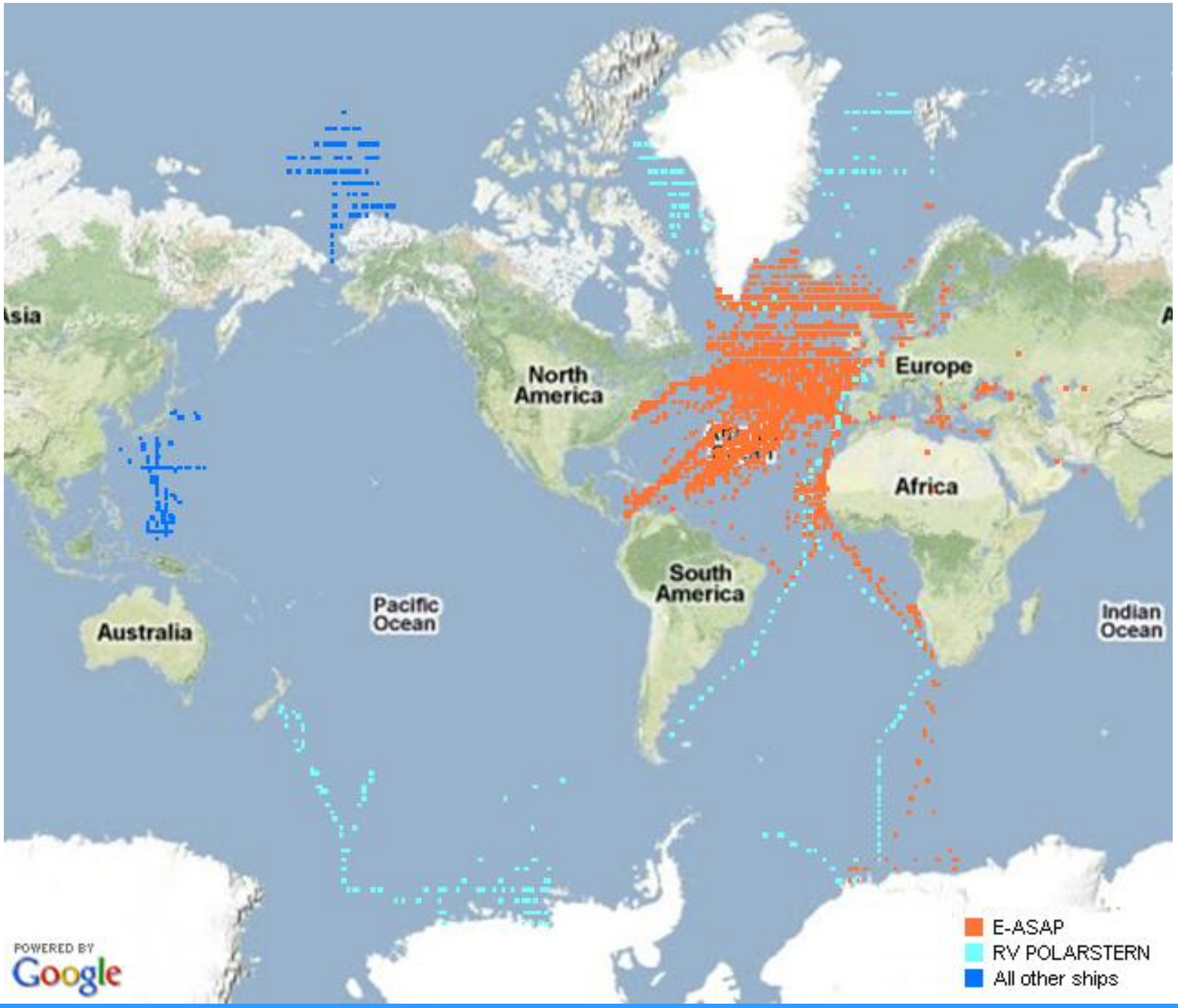
<u>6011 Snd. on the GTS</u>

82% E-ASAP fleet

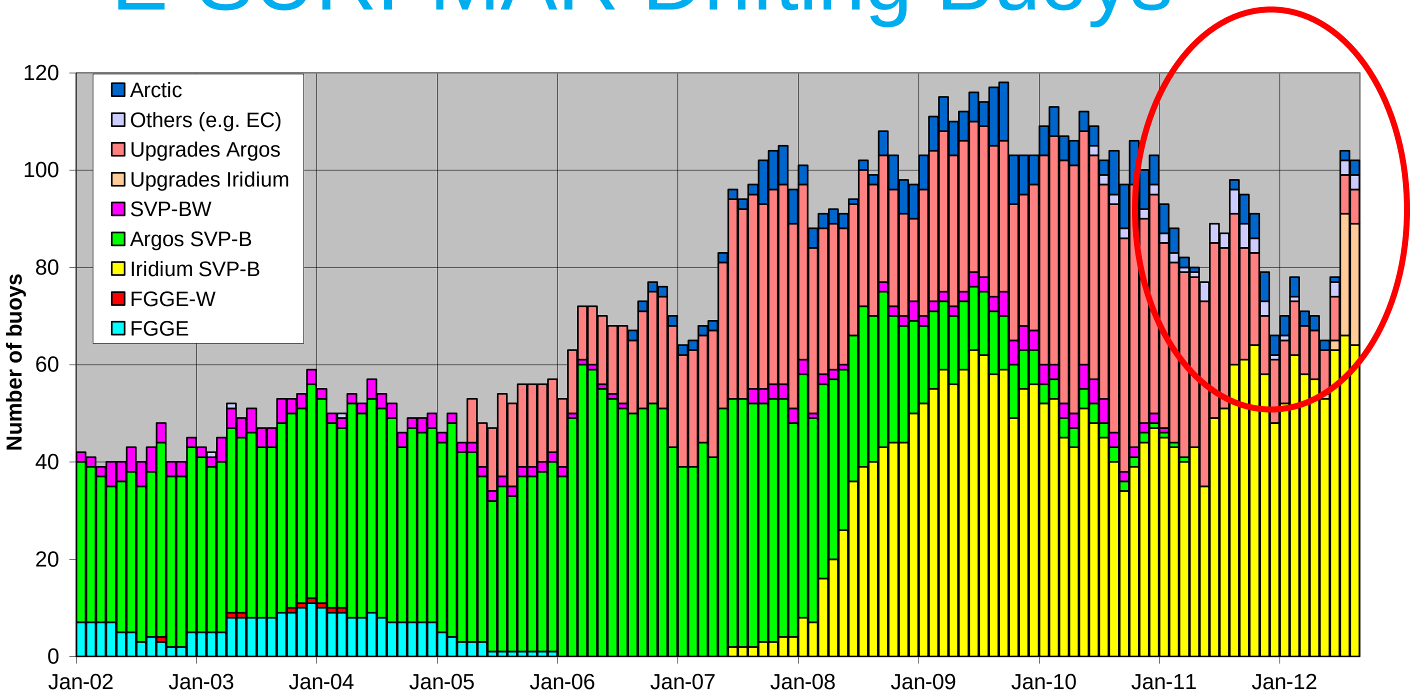
7% RV Polarstern

11% All other (mainly 2 Japanese ships)

Note: Soundings over East Europe are due to longitude errors



E-SURFMAR Drifting Buoys



The number of operating buoys significantly dropped in 2011. This was mainly due to a decrease in lifetime of Iridium buoys deployed in 2010-2011.

Since June 2012 the number of operating buoys has been increasing again.

Problems with short buoy lifetimes seem having been fixed.

The E-SURFMAR design study (2004) recommended 175 drifting buoys.

Data assimilation methods

Ensemble-variational with Integrated Lanczos (EVIL)

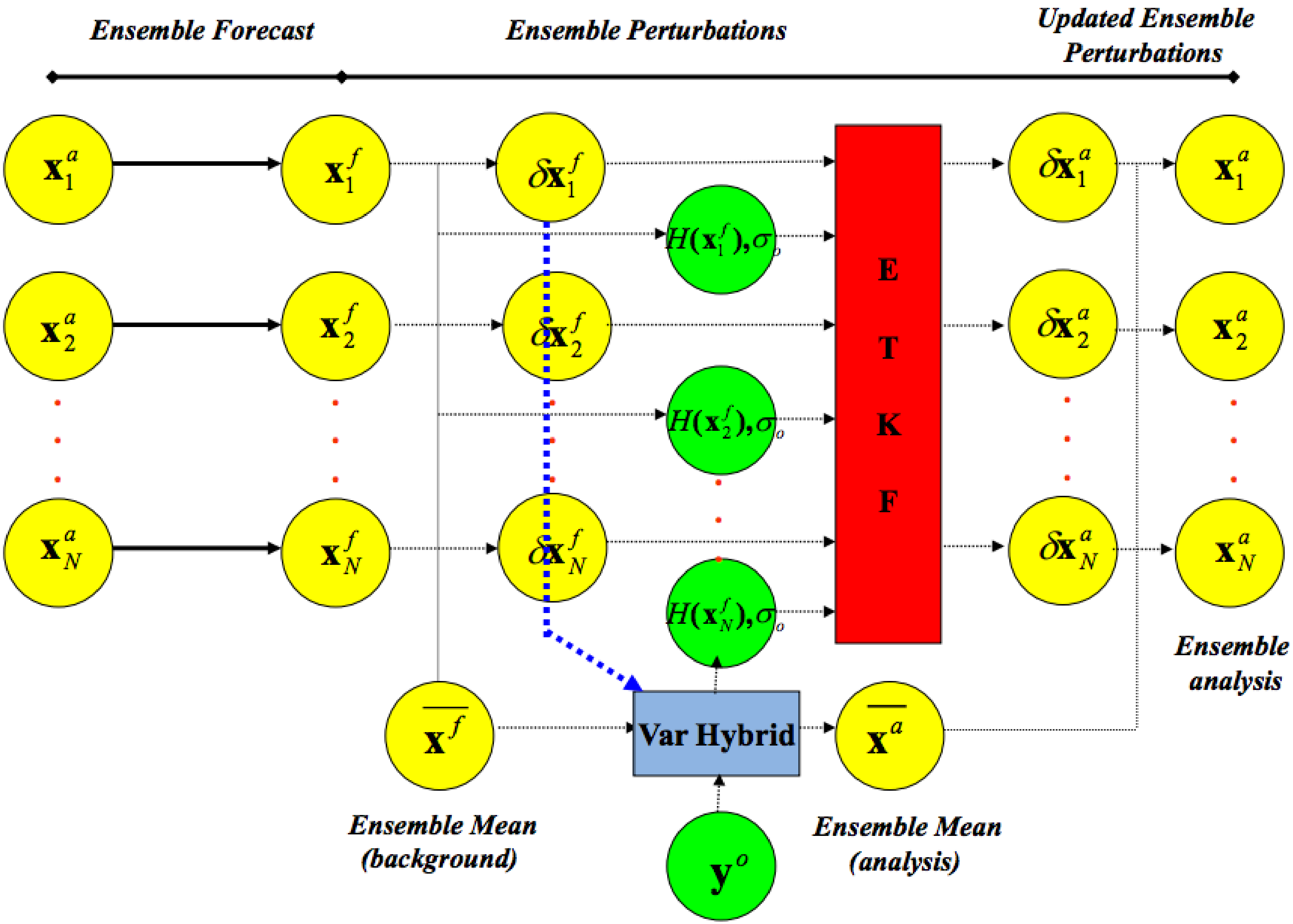
Tom Auligne, NCAR

Ensembles as used in data assimilation typically require a separate cycling of an ensemble methods such as an EnKF. To blend with variational, effectively two different assimilation methods must be run?

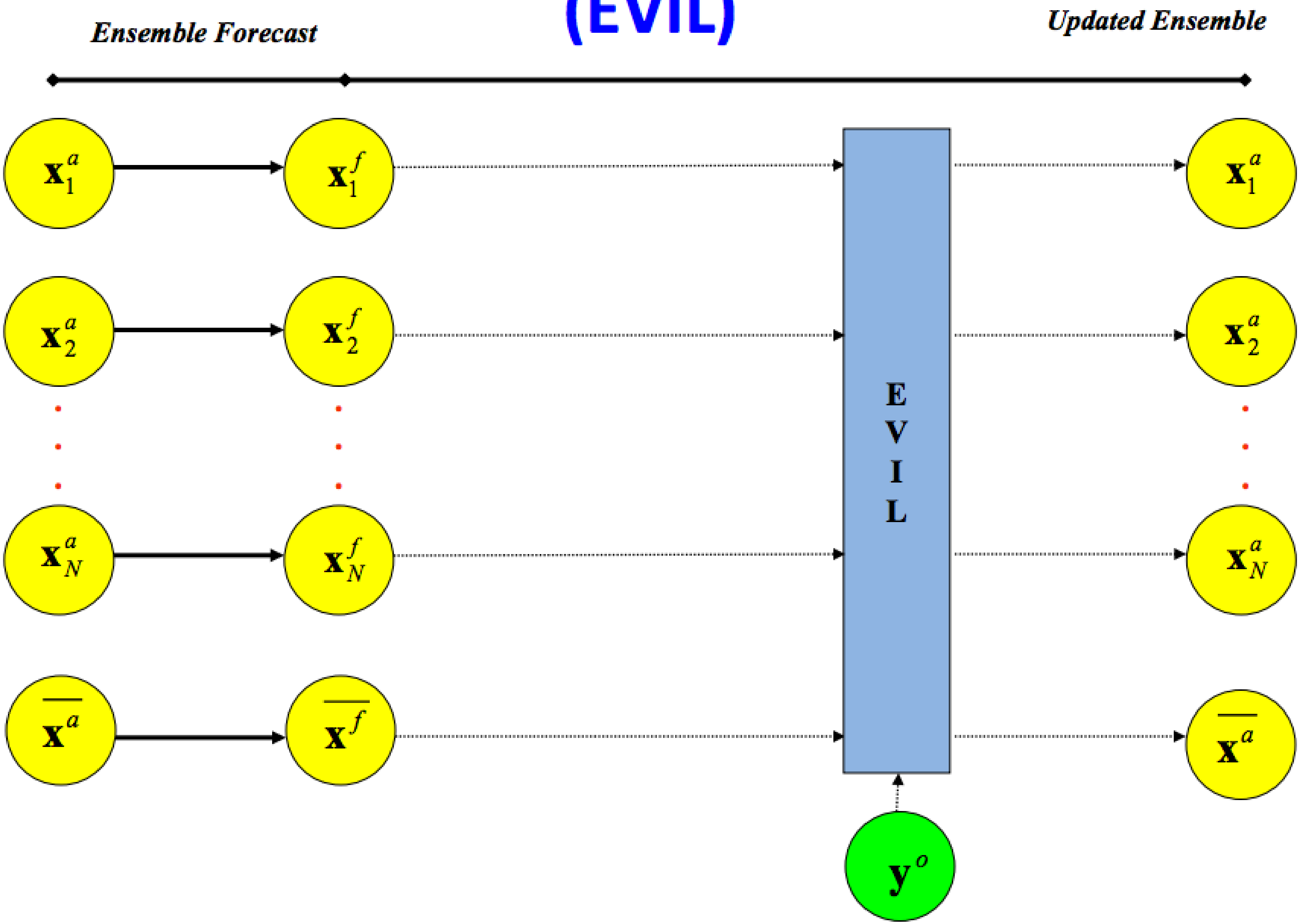
Can the ensemble cycling be performed within the variational system itself?

http://www.ssec.wisc.edu/meetings/daos/DAOS5_Day2/Auligne_6_2.pdf

Variational/Ensemble Hybrid DA

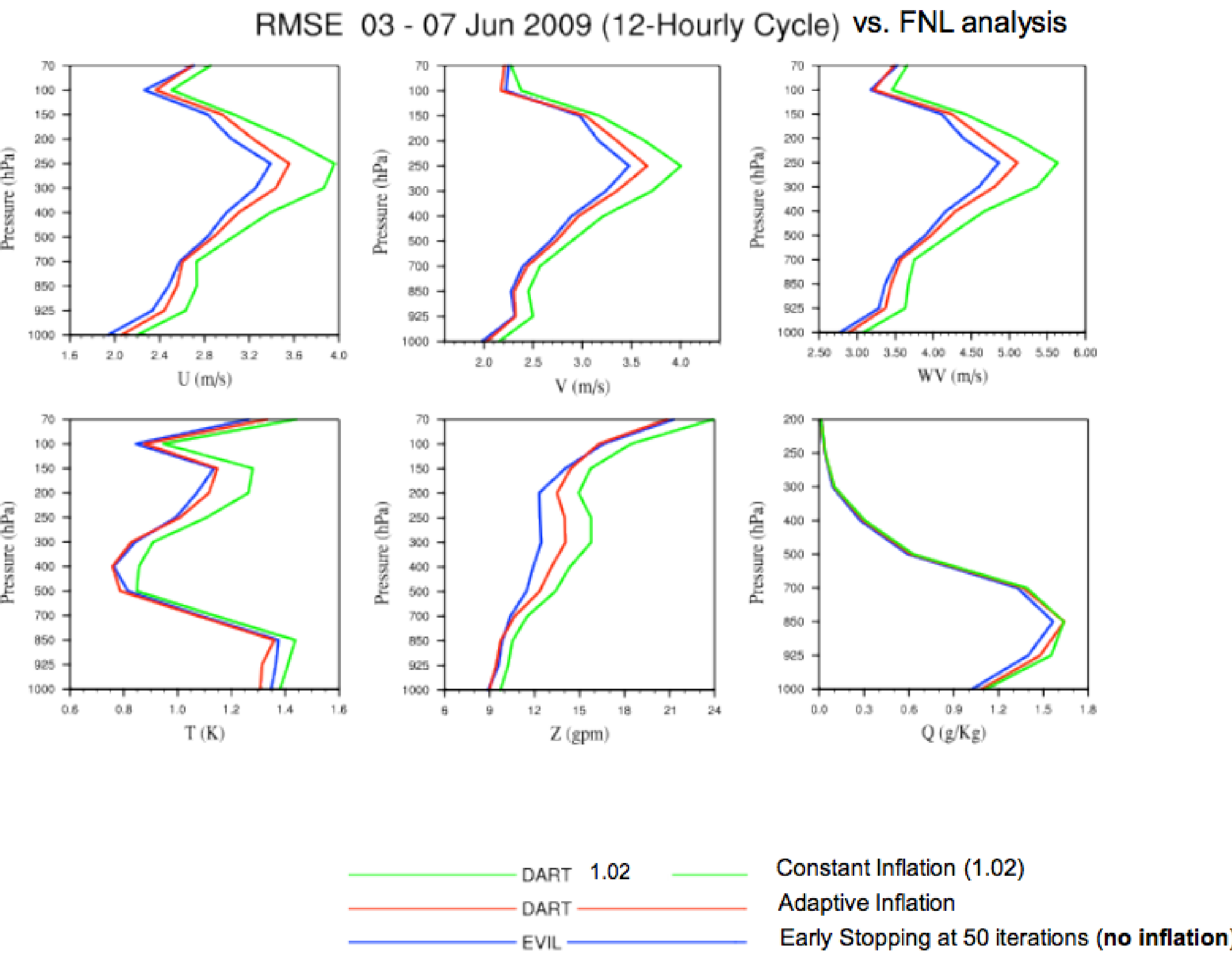


Ensemble Variational Integrated Lanczos (EVIL)



Comparison with NCAR “DART” EnKF using WRF regional model

EVIL can outperform EnKF method. The stopping criteria when applying the iterated Lanczos algorithm controls how much spread reduction is applied (i.e., prevents possible overfitting to noisy data).



Data Assimilation Terminology
Suggestions based on usual current usage.

"hybrid" applies to covariance, not method. E.g. "hybrid 4D-Var" → blend of stationary, ensemble-estimated covariances used in 4D-Var

EnKF, ETKF, etc. acronyms indicate method of updating ensembles

3D-Var, 4D-Var, EnVar, etc. generate a single best estimate, unless specified e.g. "An ensemble of 4D-Vars"

4D-Var **always** uses a forecast model and adjoint to generate time−covariances

4D-EnVar, 4DEnKF, etc. use the ensemble to generate time−covariances. (The 4D may be omitted)

— in 4D-Var, 3D-Var was standardised by Ide et al 1997 (and QJ), but not elsewhere. It may be omitted in new names.

Actions from DAOS-5

Carried forward from DAOS 4

Action 4-3: All DAOS members to provide recommendations on links to data monitoring sites and to other field campaign sites of interest.

Action 4-4: Consider organising future DAOS “back to back” with the MWFR meeting as a workshop (Co-Chairs/D. Barker).

Action 4-8: The DAOS WG should consider taking a leading role in organising the next WMO DA symposium

DAOS 5 New Actions

Action 5-1: DAOS-WG members to assess if they have any observations or model outputs to contribute to the four high-impact precipitation African RC case studies:
E. Africa October Oct 17-28 1997; S. Africa Nov 11-12 2008; N. Africa Nov 29-30 2010; W. Africa Sept 1 2009

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Actions from DAOS-5

Action 5-2: Submit peer review paper on 2010/11 ECMWF WSR impact study (T. Hamill, S. Majumdar & C. Cardinali)

Action 5-3: Submit BAMS paper on targeting (S. Majumdar)

Action 5-4: Look at observation sensitivities and possibly run a short OSE for Jan 2012 period where dropsondes had a sustained high impact in the GMAO system (R. Gelaro and C. Cardinali)

Action 5-5. The terminology for adjoint sensitivity impacts should be discussed and agreed (Ron Gelaro and Carla Cardinali)

Action 5-6: The USA and Europe are encouraged to liaise concerning the issue of wider exchange of GPS data (R. Saunders with Z. Toth)

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Actions from DAOS-5

Action 5-7: The working group ***recommends*** to NOAA that GEO-LEO AMVs are made available to NWP centres in BUFR.

Action 5-8: GMAO to continue to investigate why the NRL GOES AMVs give more impact than the operational AMVs and report at the next meeting. (R. Gelaro)

Action 5-9: A DAOS representative to attend CBS workshop on radar data exchange in Exeter in Nov 12 (R. Saunders)

Action 5-10: The working group ***recommends*** to NOAA that the successor to CrIS provides the contiguous infrared spectrum to users to maximise the information content for assimilation in NWP and climate. A reduction in the field of view should also be considered for maximising clear sky scenes.

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Actions from DAOS-5

Action 5-11: Circulate a proposal for a common terminology for hybrid ensemble variational methods and circulate it to DAOS and WGNE for comment. (A. Lorenc)

Action 5-12: The co-chairs to request approval of the changes to DAOS-WG membership as outlined in the report to ICSC-10. (Co-Chairs) **.**

Actions from ICSC-9

Action 8: The USA and Europe are encouraged to liaise concerning the issue of wider exchange of GPS total zenith delay data (with Zoltan Toth)

Action 9: Maintain close links with EGOS on evolution of the GOS and definition of optimum network

Action 10: The ICSC encouraged DAOS to consider DA for convective scale models.

Action 15: All THORPEX WGs to examine how they can further develop activities to assist the African RC

DAOS-WG Future Meetings

- Propose to hold next dedicated DAOS-WG meeting in 2014
- Location TBD (probably Europe)
- Allow more time for discussions (fewer/shorter presentations)
- Co-ordinate next WMO Data Assimilation Symposium in Late 2013

DAOS-WG Future (1)

- Recognised as leading group for DA in WMO
- Acknowledged by WGNE which has less focus on DA.
- Strong links with ET-EGOS, MWFR, ….
- DAOS remains a global focus not mesoscale 1 day to seasonal timescales
- Joint meeting with MFWR under discussion
- Continue mix of Observations and DA

DAOS-WG Future (2)

- Membership to evolve but size of group remains about the same
- Proposal is for DAOS-WG to become a sub-group in WWRP
- Strong links would be retained with any *THORPEX-Follow-On* project
- ICSC invited to comment