World Meteorological Organization

Working together in weather, climate and water

TIGER TEAM ON EVALUATION OF BENEFITS OF REDEPLOYING A MISSION ON AN EARLY MORNING ORBIT

Objectives and major outcomes of the Seminar

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World Meteorological Organization (WMO)

CGMS 40 Action: 40.03 vs action taken

- WMO to convene a CGMS tiger team to coordinate the technical evaluation of the global and regional impact of flying a FY-3 satellite in early morning orbit, in order to support CMA in the assessment process.

- WMO letter OBS/SAT/SS-CHINA 18 Dec 2012. Completed.
- Studies in progress by several NWP centres.
- Tiger Team seminar held from 25-26 April 2013 in Beijing hosted by CMA.
- Thanks to CMA !

Tiger Team Members:

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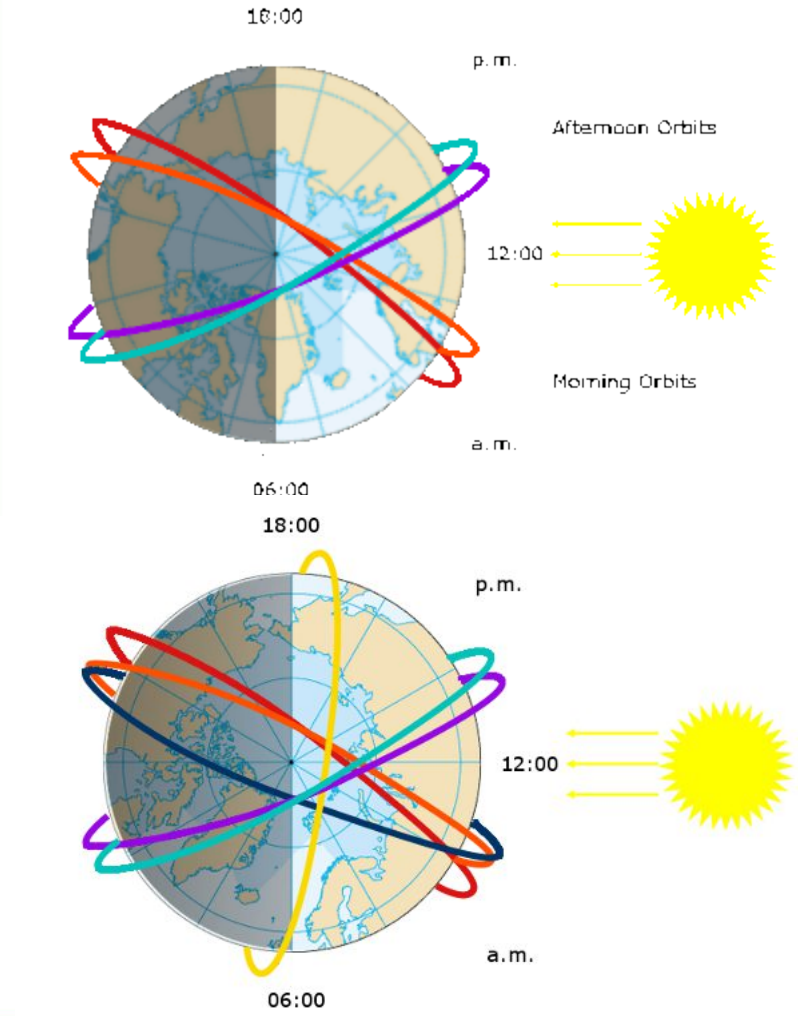
New baseline in the Vision for the Global Observing System in 2025

- The new baseline for the core LEO constellation is to be deployed over three orbital planes around 13:30, 17:30 and 21:30 Equatorial Crossing Time (ECT) in Local Solar Time (LST).
- This should ensure regular sampling of the atmosphere avoiding too large a temporal gap around dawn and dusk, in order to satisfy as far as possible the observing cycle requirements from NWP and climate monitoring as concerns atmospheric temperature and humidity profiles. In addition, in-orbit redundancy should be available around these orbital planes, to the extent possible.



NWP Studies discussed by Tiger Team

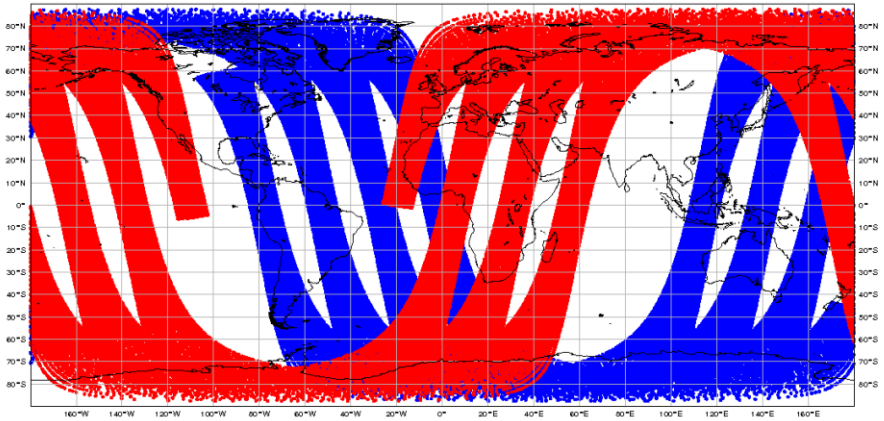
Centre	Type of study	Scenarios	Evaluation Period
ECMWF	OSE	AMSU-A/B on Metop-A, N15, N18, N19, N16, N17 http://cimss.ssec.wisc.edu/itwg/itsc/itsc18/program/files/links/4.36_DiTomaso_po.pdf	
ECMWF	OSE	NPP/ATMS, Metop-A/AMSU-A, + NOAA-15/AMSU-A (selected channels) + NOAA-18/AMSU-A (selected channels)	2012/09/26 to 2012/12/26
ECMWF	OSE	NPP/ATMS,CrIS, Metop-A/ AMSU-A,IASI + NOAA-15/AMSU-A (selected channels) + NOAA-18/AMSU-A (selected channels)	2012/09/26 to 2012/12/26
Met Office	Conceptual experiment	Impact of temporal spacing of observations on analysis errors http://www.metoffice.gov.uk/learning/library/publications/science/weather-science/forecasting-research-technical-report Report No.573.	-
DWD	OSE	NOAA-15/AMSU-A denial. (N15 assimilated over sea only)	Nov 2012
KMA	FSO	FSO experiments as a function of time Global / Regional(East Asia)	July to Sept 2012
Met Office	FSO	FSO experiments as a function of time Global / Regional(East Asia)	Feb to March 2012
JMA	OSE	Relative impact of AMSU-A radiances of N15, Metop-A, N18 when added to the set of other data (e.g. GNSS-RO, scat). Comparison of 3 satellites /2 satellites	Aug 2012
JCSDA	OSSE	OSSE for DoD with different sounder options on Early Morning orbit	Summer/ Winter
JCSDA	OSE	Comparison of 1-2-3 sats; impact of N15 added to a.m./p.m. constellation.	
CMA / NWPC	OSE	NOAA-15/AMSU-A denial. (N15 assimilated over sea only, verification over East Asia)	July 2011

Data coverage

Slide from Steve English, ECMWF

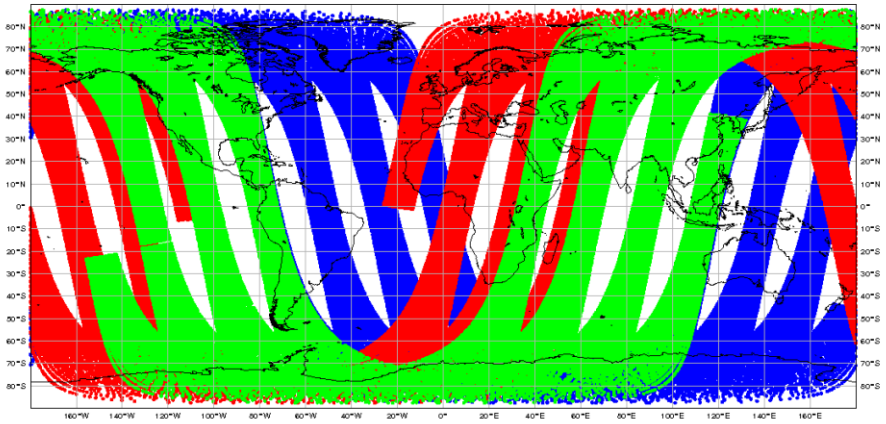
"two-satellite experiment"

* MetOp-A * NOAA-18



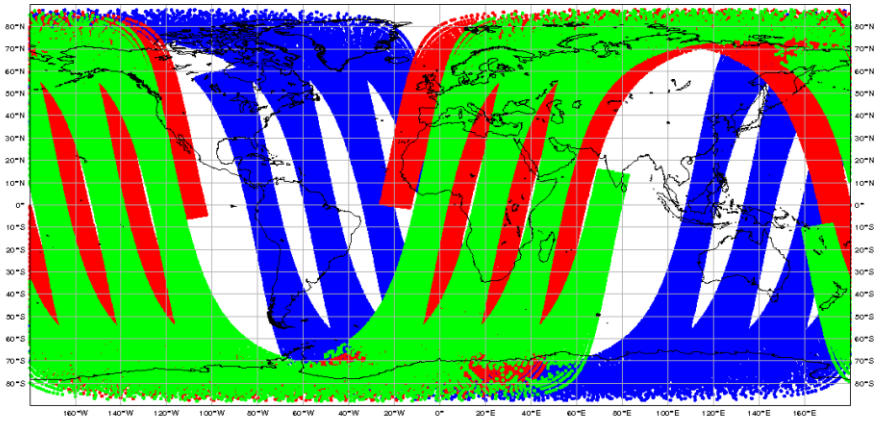
"NOAA-15 experiment"

* MetOp-A * NOAA-18 * NOAA-15



"NOAA-19 experiment"

* MetOp-A * NOAA-18 * NOAA-19

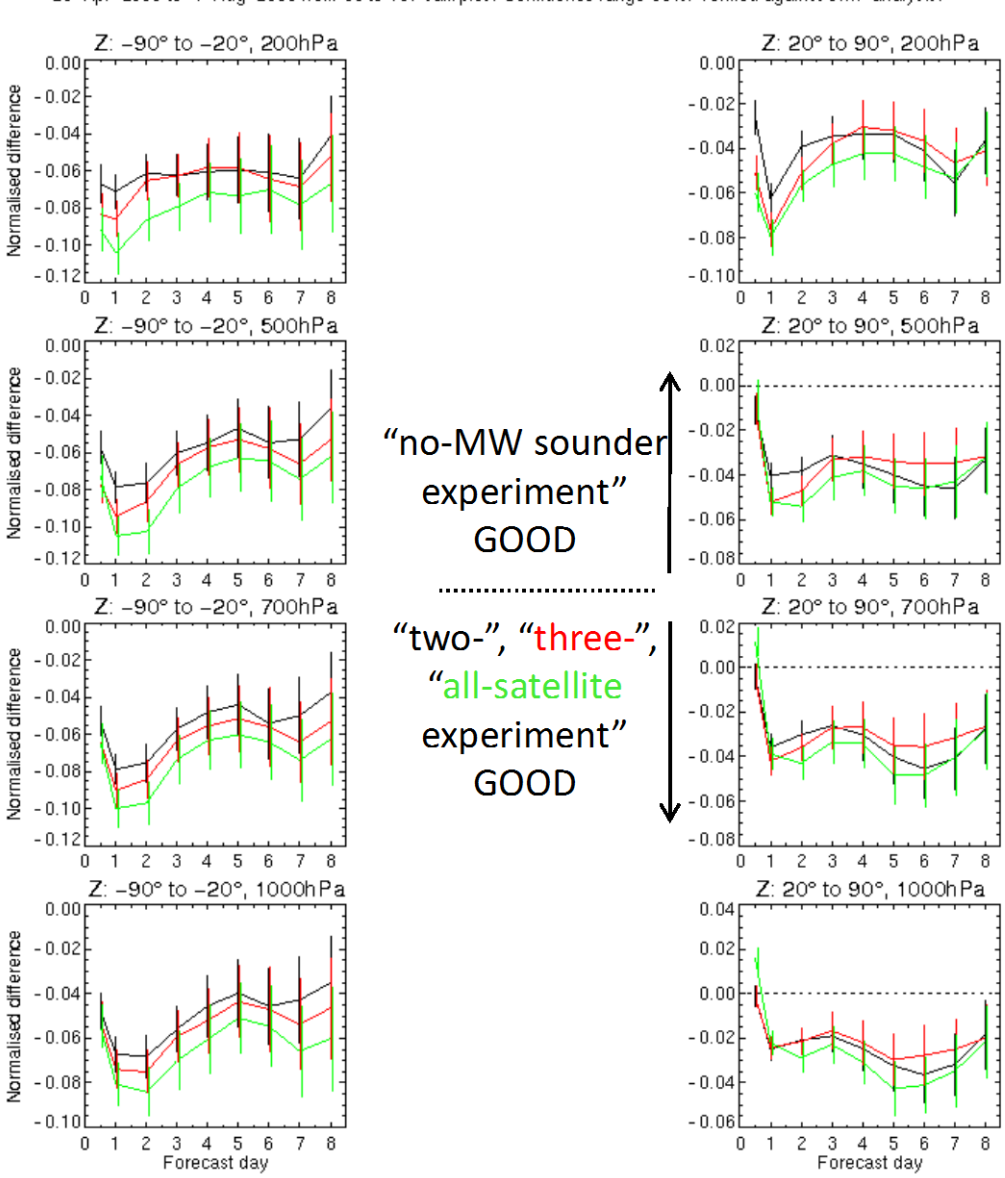


3.5 months 107 cases
CY36R1 T511

Are 3 satellites better than 2?

YES

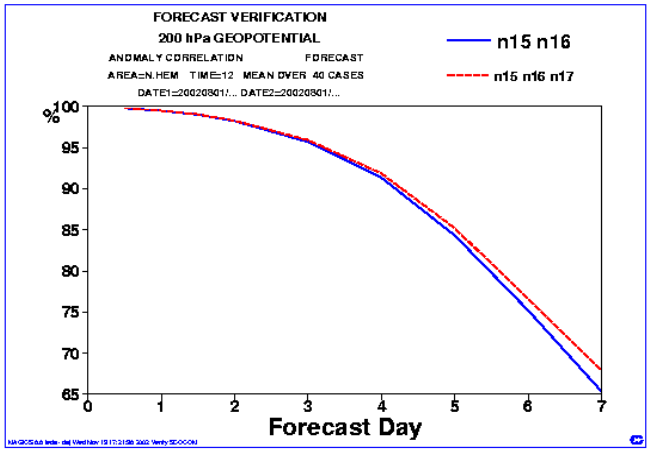
Slide from Steve English, ECMWF

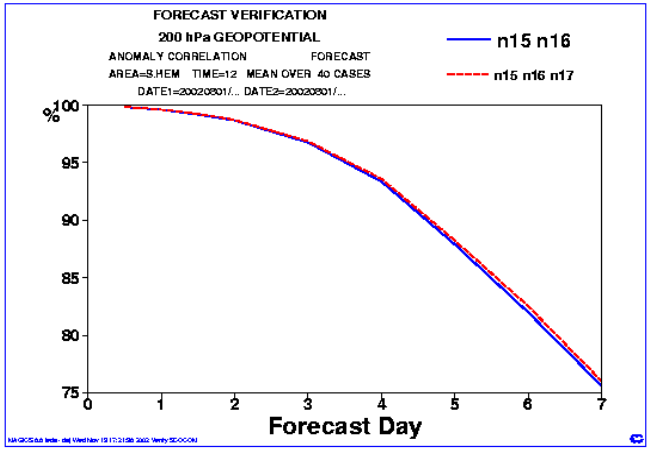


Outcome of the assimilation studies (3SAT versus 2SAT)

Z200 scores averaged over 40 cases

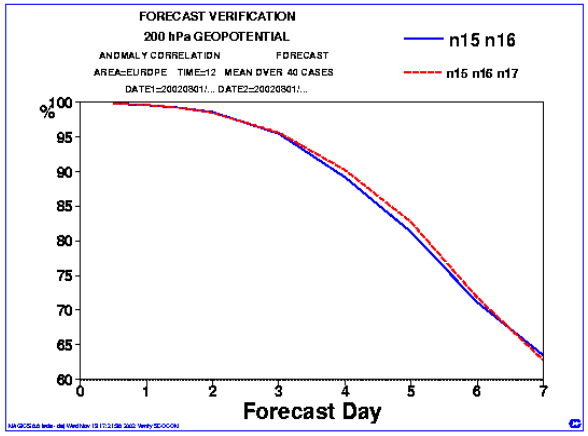
Half hemispheric

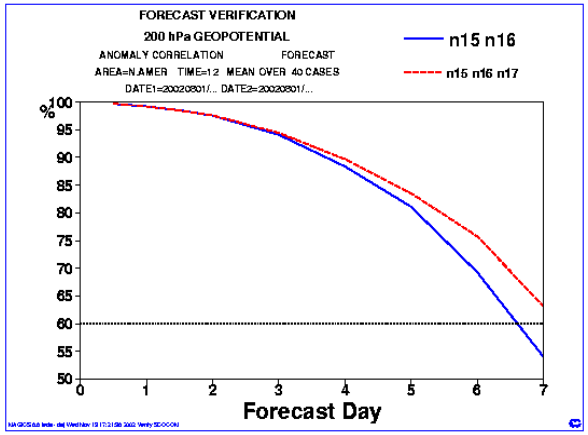




- **3SAT is better than 2SAT for hemispheric scores**
- **3SAT is neutral or better than 2SAT up over Europe**
- **3SAT is impressively better than 2SAT over North-America!**

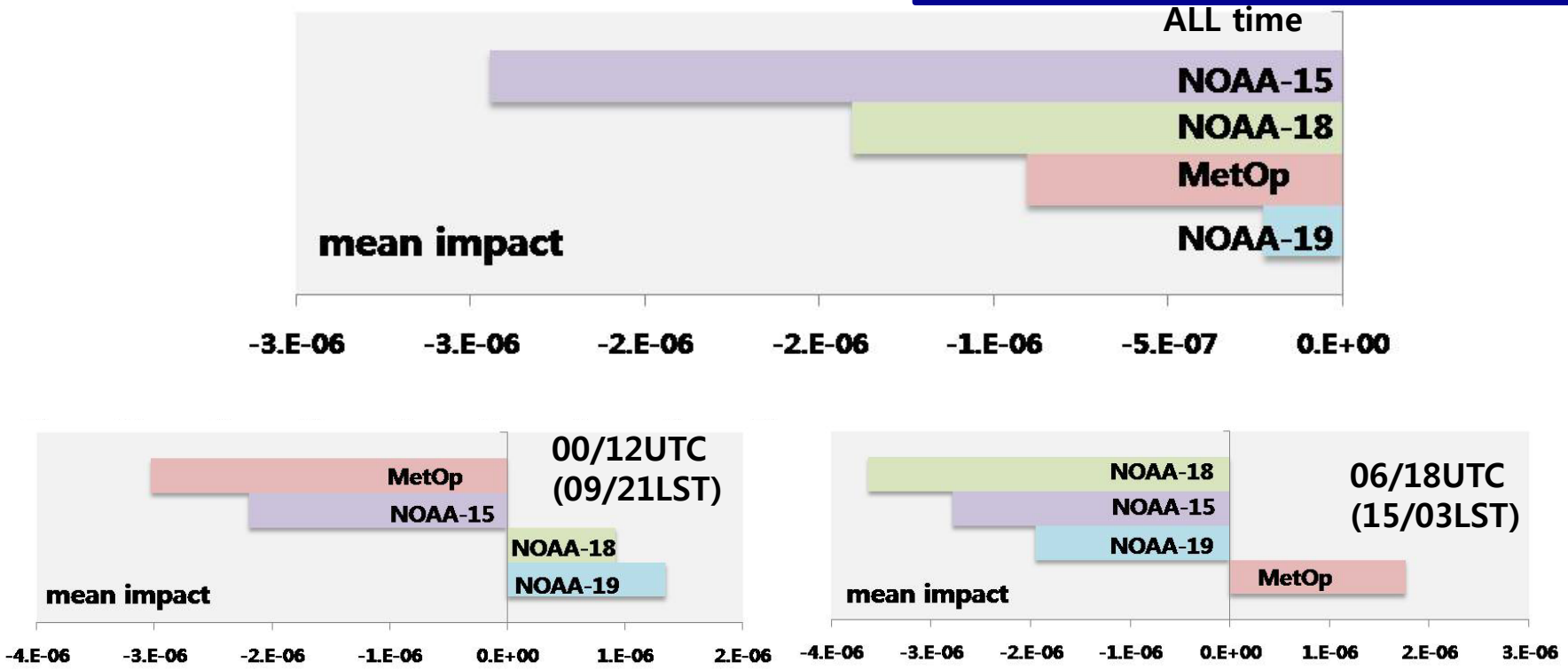
Regional





Impact of "AMSUA" at "East Asia"

Slide from Eunjung Kim, KMA

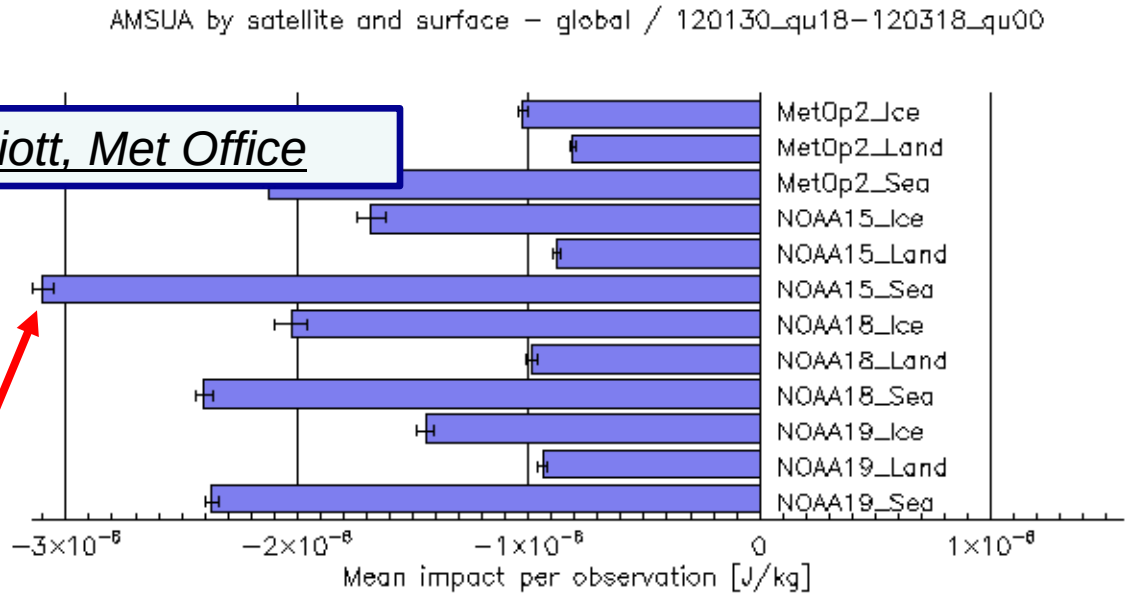


- The largest positive impact is N15, followed by N18, MetOp, and N19.
- Only early morning satellite(N15) shows positive impact at every analysis time.
- AM (PM) satellite shows positive impact at 00/12UTC (09/21LST), but AM (PM) satellite shows negative impact at 06/18UTC (15/03LST) when they pass the edge (land) of the East Asia domain except N15 (see the next page)

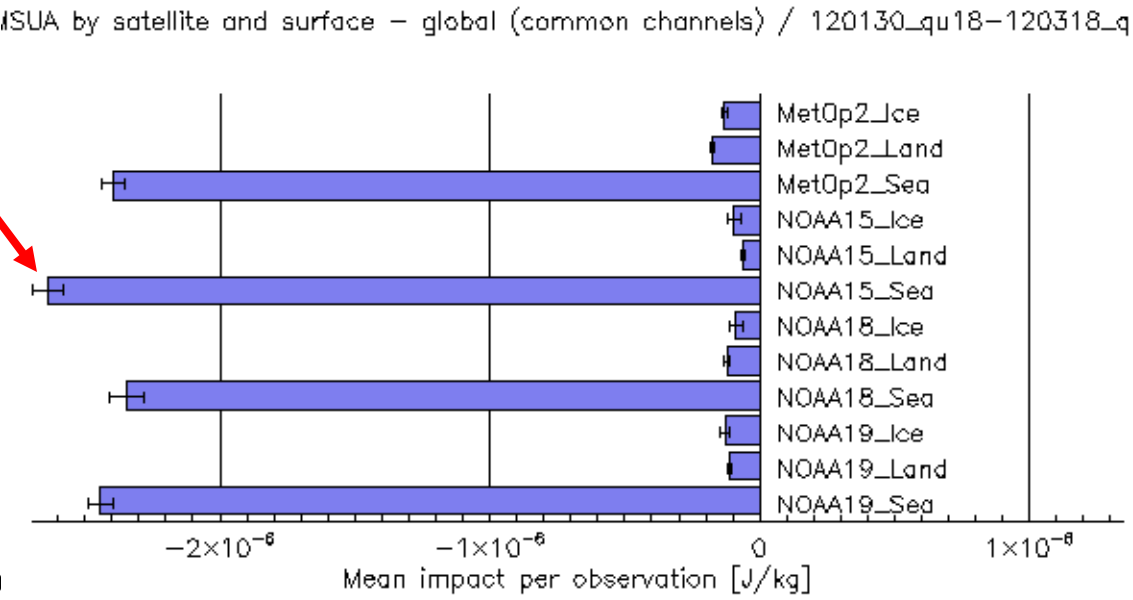
Mean AMSU-A Impacts per Observation – Global

Slide from Richard Marriott, Met Office

All channels:

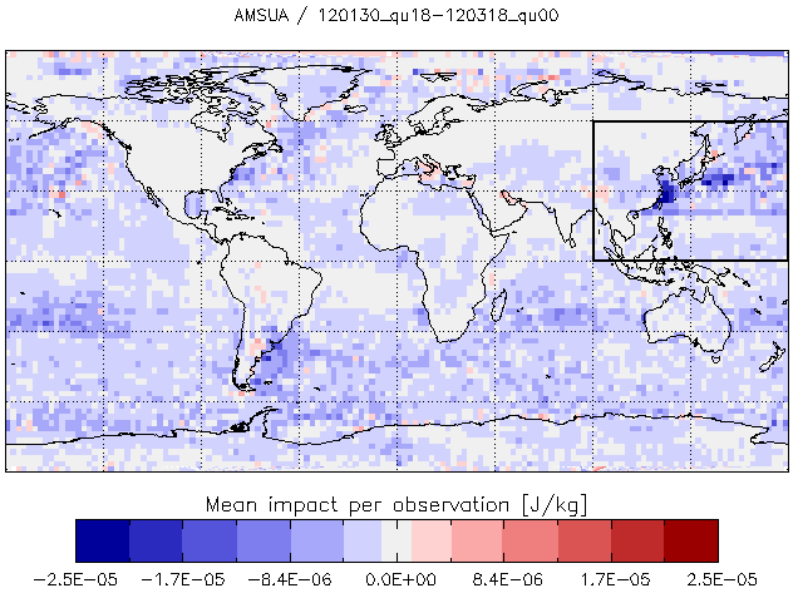


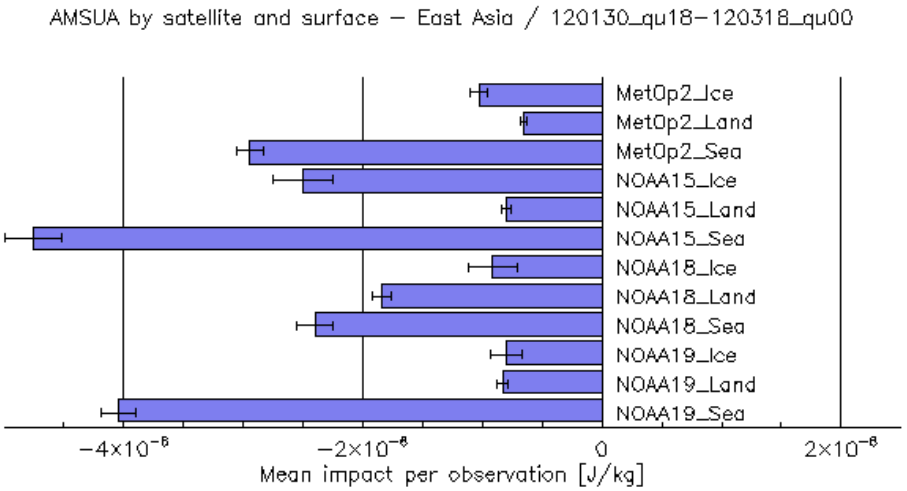
NOAA-15_sea



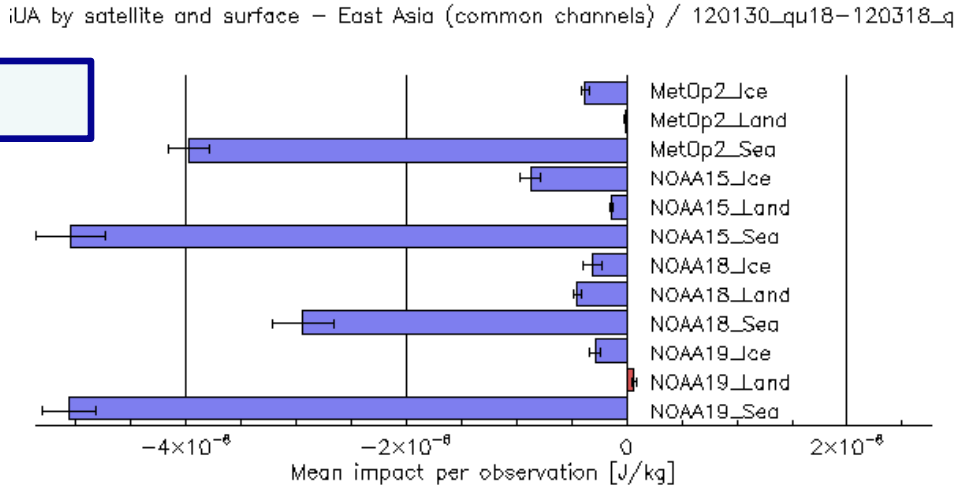
Channels common to all satellites:

Mean AMSU-A Impacts per Observation – East Asia





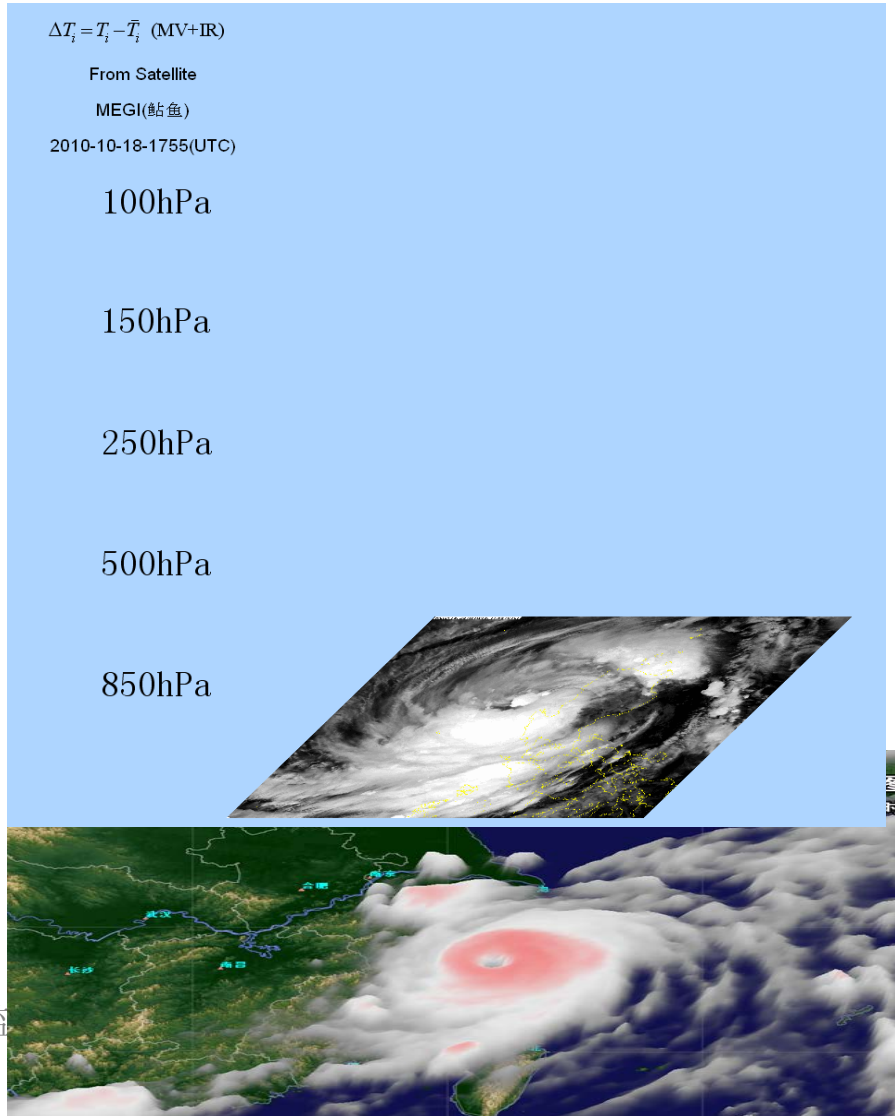
Slide from Richard Marriott, Met Office



3 orbital planes will enable more frequent/regular MW sampling Tropital Cycle (TC) structure-DRR

Biggest TC forecast challenge is rapid intensity change

- Monitoring warm core anomaly is critical to timing and placement of watchs/warnings
- New 3 orbital LEO constellation sounding could help improve TC intensity forecast models
- Better satellite wind data and temperature data have potential to improve subjective estimates of TC structure and better data for assimilation into the models
- Regular/more frequent high resolution (vs GEO) images sampling can help identify timely disaster regions (convections, floods, fires, etc)



Tiger Team Conclusions

(from Final Report, available at http://www.wmo.int/pages/prog/sat/documents/CGMS_LEO-TigerTeam-Final-Report-April-2013.pdf)

On NWP:

- *"There is a consensus among scientific experts in the international community to acknowledge the benefits that will be brought by a satellite mission in an early morning orbit, i.e. with an Equatorial Crossing Time (ECT) around 6:00 in Local Solar Time."*
-
- *"Significant benefits will arise from improved accuracy of weather forecast through assimilation of sounding radiances into Numerical Weather Prediction models, thanks to the optimum temporal distribution of observations provided by the early morning, mid-morning and afternoon satellite missions respectively."*

Conclusions (II)

On other (non-NWP) applications, the following benefits were noted:

- *"Shorter revisit time for Tropical Cyclone monitoring by infrared and microwave imagery and sounding,*
- *More efficient fog and fire detection in the early morning and late afternoon,*
- *More efficient air quality monitoring for particular species (e.g. CO and O3) in thermal infrared channels,*
- *Improved sampling of the diurnal cycle for accurate climate data records,*
- *Quasi-continuous monitoring of the Sun for Space Weather and climate applications."*

Recommendations on activities supporting a possible decision on FY-3

- *WMO and CGMS to support trade-off studies (including e.g. OSSEs) as necessary in the course of the development phase of the FY-3 early morning mission;*
- *CMA and international partners to pursue strong international collaboration on data assimilation in order, as soon as possible, to maximize the benefits of future (early morning) and current FY-3 missions;*
- *CMA with international community to further prepare to exploit the benefit of the early morning orbit polar satellite monitoring payload for space weather, climate monitoring, air quality and disaster monitoring;*
- *WMO and CGMS to promote the use of FY-3 early morning data, contributing to a robust and efficient Global Observing System, taking advantage of the Asia-Oceania Meteorological Satellite Users Conference.*

Recommendation on FY-3

- The Tiger Team acknowledged that the FY-3 programme offers a unique opportunity to China to play this important role as one of the three major components of the global constellation besides the European programme in the mid-morning orbit and the USA's programme in the afternoon orbit, while complementary missions would provide the necessary redundancy for operational robustness.
- **It is therefore strongly recommended to CMA to implement a FY-3 mission in an Early Morning orbit, with the appropriate platform and payload adaptations, and to sustain such mission in the long term.** The forthcoming CGMS-41 meeting in July 2013 would enable CMA to update CGMS Members on its plans and to exchange views and experience on any outstanding platform or payload issues.