SCOPE-CM #10: status report and plan of 2015

Atmospheric Motion Vectors (AMV) and Clear/All Sky Radiances (CSR/ASR) from historical meteorological satellites in geostationary and polar orbit

Arata Okuyama

Meteorological Satellite Center (MSC)

Japan Meteorological Agency (JMA)

23 Mar. 2015 SCOPE-CM 10th Executive panel meeting (SEP-10)

SCOPE • CM

Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Objective

- The major objective of this project is to provide Atmospheric Motion Vectors (AMV), Clear Sky Radiances (CSR) and All Sky Radiances (ASR) for the use in global and potentially regional Numerical Weather Prediction (NWP) model-based reanalysis.

- Furthermore, AMV data provided on regular grids may also be utilised in the analysis of dynamical systems in relation to water vapour transport or monsoon studies.

Partners

- ECMWF
- EUMETSAT (CF)
- JMA (MSC, CPD)
- NOAA (NCDC, NESDIS)
- University of Wisconsin/CIMSS

Toward goal of SCM-10: AMV/CSR

The major points to work on to reach the goal of this project are:

- Analysis of differences in AMV, CSR and ASR product definition, algorithms and processing chains for instruments in geostationary and polar orbit;
- Development of a plan for a more coherent product suite for all instruments;
- Enhancement of AMV algorithms with a quantitative uncertainty estimate;
- Establishment of a validation framework for AMVs by agreeing on a metric, certain quality analysed non-satellite observations and by utilising means from reanalysis centres;
- Enhancement of the documentation towards a coherent description of the products

Related projects

- SCM-06 (IOGEO)
  - SCM-10 would seek close interaction with SCM-06: Inter-calibration of imager observations from time-series of geostationary satellites (IOGEO) through the experience from Global Space-based Inter-calibration System (GSICS) for reprocessing AMVs and CSRs/ASRs long term records.
- GSICS
  - GSICS provides bias corrections through the inter-calibration of satellite sensors with respect to selected references that can be applied to generate reprocessed CSR and ASR products as Fundamental Climate Data Records (FCDRs) and related Thematic Climate Data Records (TCDRs).
- IWWG
  - The project would seek close interaction with the CGMS International Winds Working Group (IWWG) to benefit from ongoing comparison activities that might need to be enhanced to cover the temporal dimension of the AMVs long term records.
- Reanalysis communities
  - The project would exchange information with reanalysis communities on their calculation plans and the quality. The best forum identified for discussion of data issues is the WCRP Data Advisory Council that has representation from reanalysis centres.

Status report in 2014 (1)

Review on the use of AMV and CSR in past reanalysis

- Historical overview and the use of AMV/CSR in related reanalysis activities such as ERA-CLIM and JRA-55 was reported in IWWG-12 by Toshiyuki KURINO (presented by Kazuki Shimoji).

Analyze the differences in AMV product definition, algorithms and processing chains and develop a plan for a globally coherent product

- In 2013, a workshop including EUMETSAT and CIMSS was held at ECMWF. The differences between the EUMETSAT and CIMSS algorithms were analyzed.
- Summary of reprocessing efforts for GOES, METEOSAT, and AVHRR, mostly AMVs was reported. Appendix slides show the report from the AMV workshop with the addition of JMA's status for Himawari.
- The list is as of Sep, 2013. It needs to be updated.

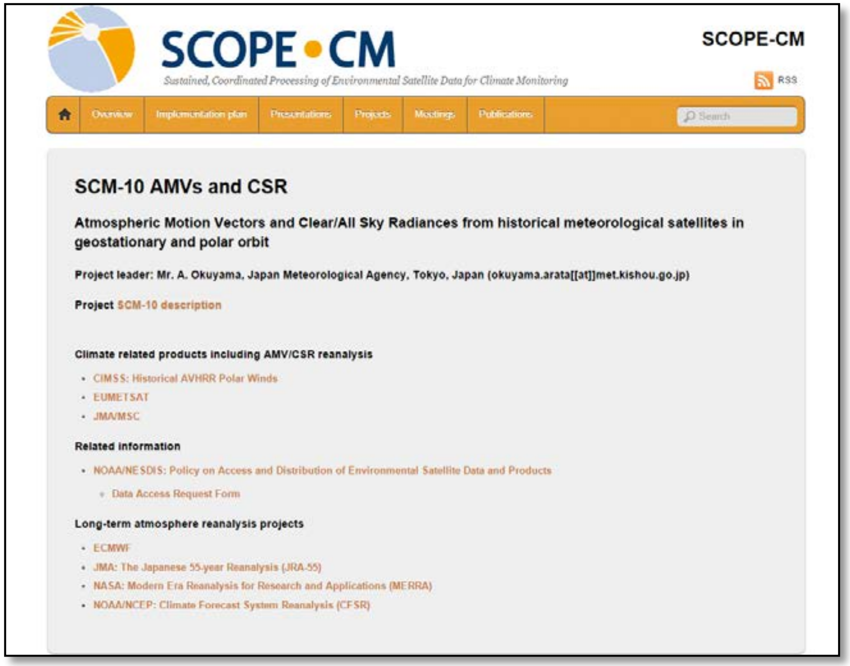
Status report in 2014 (2)

Perform feasibility analysis of GOES AMV processing with respect to satellite observation schedule and forward analysis result to reanalysis centers

- It was reported in IWWG-12. Hourly AMV datasets have been re-processed for GOES East/West from 1995 to 2013.

Open a project portal site

- A simple site is open on the SCM-10 Web page in Oct. 2014.



SCOPE • CM
Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Plan for 2015 -

−	Review on the use of AMV and CSR in past reanalysis; Analyze requirement for future reanalysis; Analyze the differences in AMV product definition, algorithms and processing chains and develop a plan for a globally coherent product; Perform feasibility analysis of GOES AMV processing with respect to satellite observation schedule and forward analysis result to reanalysis centres Encourage other space agencies operating geostationary /polar orbital instruments to join the project; Open a project portal site	2014	All All JMA, EUM, NOAA, NOAA JMA, EUM JMA
−	Build common validation framework following agreed metric such as polar orbiting satellites and radiosonde observations;	2015	EUM, JMA, NOAA
−	Perform processing of polar orbit data; Perform processing of geostationary products; Validate products from geostationary satellites; Analyze feedback on early phase products from reanalysis centers	2016	EUM EUM, JMA, NOAA All
−	Update the documentation of all products in coherent style; Validate products from polar orbiting satellites;	2017	EUM , JMA, NOAA
−	Analyze feedback on products from reanalysis centres and other applications and develop a plan for SCOPE-CM phase 3	2018	All

SCOPE • CM

Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Thank you for your attention

Appendix

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs (report from AMV workshop at ECMWF with the addition of JMA's status for Himawari)

as of Sep, 2013
(need to be updated)

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (1/10)

(1) Programmatic

	CIMSS	EUMETSAT	JMA/MSC
Current data holdings	GOES, SMS-1, -2, MODIS, KALPANA, POES AVHRR, COMS, GMS, METEOSAT-3 onwards, MTSAT, FY-2C/D/E	METEOSAT, METOP and POES AVHRR (starting with NOAA-18)	GMS, (GOES-9), MTSAT
Already reprocessed	AMV from POES AVHRR (NOAA-7 to –18)	1) AMV and CSR from METEOSAT-2 to -7 up to end of 2000 2) AMV from AVHRR METOP-A up to end of 2012 (using two algorithms, EUMETSAT operational and CIMSS)	AMVs from GMS-1 to MTSAT, CSRs from GMS-5 to MTSAT
Current production	GOES GVAR -8 to -15 (1995-present): AMV. Expected to be available by 2014. Includes processing of 30-minute images, 15-minute images, and 7-minute rapid scan images (producing possibly 1 wind product every 7 minutes, though limited to extreme weather situations)	AMV, CSR, ASR, THU, CTH, NDVI, CLM, Cloud type, cloud top pressure, cloud top temperature, from METEOSAT-8 and -9. Expected to be available by 2014	AMVs and CSRs

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (2/10)

	CIMSS	EUMETSAT	JMA/MSC
Funding for current production	SSEC grant	EU FP7 ERA-CLIM and EUMETSAT own resources	JMA/MSC own resources
Committed reprocessing		1) AMV, CSR, ASR from Meteosat-7 for years 2001-2004 for zero degree, and for years from 2001 and up to real time for Indian Ocean Data Coverage. Expected to be available by 2014. 2) AMV from AVHRR POES and AVHRR METOP-A and -B reprocessed by 2015. 3) AMV, CSR, ASR from METEOSAT-2 to -9 based on inter-satellite calibrated IR radiances and updated algorithm. Expected to be available by 2016.	
Funding for committed reprocessing		EU FP7 ERA-CLIM2 and EUMETSAT own resources	

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (3/10)

	CIMSS	EUMETSAT	JMA/MSC
Considered reprocessing	POES AVHRR using updated code and input and more metadata in output MODIS from EOS-Aqua and Terra Repeat current GVAR reprocessing but with latest algorithm (NESDIS GOES-R tracking), and extend reprocessing to older GOES satellites, pre-GVAR.	After ERA-CLIM2 updated codes may arrive from SCOPE-CM and can be used for increasing the consistency of geostationary AMV products. Also planned Meteosat First Generation image reprocessing and inter-satellite calibration lead to new reprocessing of the same data	
Of value, but unfunded	- KALPANA - GOES-1 to -7 (1978-1995) - SMS-1 and SMS-2 (1979-1981) - ATS (1974)	- Routine METEOSAT-8 and -9 rapid scan images (since May 2008) at 5-minute intervals, producing possibly 1 wind product every 20 minutes, limited to 15N-70N - METEOSAT-8 and -9 high resolution visible channel images	

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (4/10)

	CIMSS	EUMETSAT	JMA/MSC
Problems preventing reprocessing of earlier data	- GOES-1 to -7 cannot be reprocessed until navigation and calibration have been corrected - Upcoming (GOES-R) winds algorithm cannot be applied to reprocessing prior to GOES-8; requires development to cloud analysis	- Current CCC algorithm cannot be applied to METEOSAT-2 to -7 on the current EUMETSAT reprocessing system; requires development to cloud analysis product - For Meteosat First Generation a reprocessing of the Image data including improvements in navigation and image resampling as well as anomaly detection is planned but the resources are tight and time of realisation is uncertain.	VIS AMV of GMS-1 not processed due to stripe noise
Input data preservation	All original tapes transferred to digital (online) at SSEC Data Centre	Funded and committed archive preservation (EUMETSAT Data Centre)	Some original digital data was lost in early date for GMS period; IR image before March 1981, VIS image before March 1987 excepting 1979

SCOPE • CM
Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (5/10)

	CIMSS	EUMETSAT	JMA/MSC
Input data backup (disaster recovery)	- NOAA NCDC holds the official GOES archive - SSEC has additionally processed the original GOES archive and has rescued more data and produced data of higher quality than current NCDC holdings.	- EUMETSAT Data Centre - Third copy back-up off-site	- JMA/MSC Data Archives - Third copy back-up in distributed universities and research institutes (no systematic preservation)

(2) Reprocessing methods, including input and output interfaces

	CIMSS	EUMETSAT	JMA/MSC
Input sensor data	GVAR level 1b AVHRR POES level 1b and regridded	METEOSAT level 1.5 MVIRI and SEVIRI AVHRR METOP level 1b (and IASI METOP level 1c)	VISSR, SVISSR for GMS HIRID and HRIT for MTSAT

SCOPE • CM
Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (6/10)

	CIMSS	EUMETSAT	JMA/MSC
Input channels	- AVHRR: IR 10.8 micron - GOES: WV 6.7 micron, IR 10.7 micron, SWIR 3.9 micron, and VIS 0.63 micron	- AVHRR: IR 10.8 micron - METEOSAT-8 and -9: IR 10.8 micron, WV 6.2 and 7.3 micron, VIS 0.8 micron Note: VIS 0.6 micron not used for AMV METEOSAT-2 to -7: IR [10.5-12.5 micron], WV [5.7-7.1 micron], VIS [0.5-0.9 micron]	GMS-5,GOES-9 and MTSAT (IR,WV,VIS) GMS-(1-5) (IR, VIS)
Input background	- GOES: ERA-Interim reanalysis analyses Pressure levels 1x1 degree2 grid 6-hourly - AVHRR: NCEP/NCAR reanalysis analyses Pressure levels 1x1 degree2 grid 6-hourly	ERA-Interim 6-hourly forecasts (+6h and +12h steps) 60 model levels for AVHRR, 31 model levels for METEOSAT-8 and -9, 16 model levels for METEOSAT-2 to - 7 0.5x0.5 degree2 grid for AVHRR, 1x1 degree2 grid for METEOSAT-8 and -9, 1.5x1.5 degree2 grid for METEOSAT-2 to -7 6-hourly	JRA-25 reanalysis data (Grid:1.25 degree 23 Layers)
Background time interpolation	Linear in time	Linear in time	Linear in time

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (7/10)

	CIMSS	EUMETSAT	JMA/MSC
Background used for	- Height assignment for AVHRR and GOES - First-guess to tracking solution for AVHRR and GOES - Quality control for GOES and AVHRR in recursive filter editing system	- Height assignment for AVHRR and METEOSAT (no best fit applied, EBBT only) - First-guess to tracking solution for AVHRR	Cloud height assignment for AMV, Sea Surface Temperature for CSR
Tracking	Compute 2 vectors from 3 consecutive images, spaced by 30 minutes for GOES and 100 minutes for AVHRR, using first-guess tracking solution from background, and then average the two individual vectors to produce final solution Lp norm for GOES Cross-correlation for AVHRR	METEOSAT: Compute 3 vectors from 4 consecutive images, spaced by 30 minutes for METEOSAT-2 to -7, and 15 minutes for METEOSAT-8 and -9 AVHRR: Compute 1 vector from 2 consecutive images spaced by 100 minutes, using first-guess tracking solution from background	Cross Correlation method, Compute 2 vectors from 3 consecutive imagery
Height assignment	GOES: EBBT for VIS, IR, and WV H2O-intercept for IR and cloudy WV, only upper levels CO2-slicing for IR and cloudy WV, only upper levels Cloud base for VIS and IR, only low levels Height assignment based on the above (decision tree) POES AVHRR: Same as above, but no H2O-intercept and CO2-slicing	METEOSAT: EBBT for VIS, IR, and WV and H2O-intercept for IR and WV from METEOSAT-2 to -7, Cloud analysis product's output for METEOSAT-8 and -9 (CCC method) Final assignment for METEOSAT based on 3 intermediate products (average) METOP AVHRR: EBBT (and IASI)	EBBT : from GMS-1 to GMS-4 EBBT and IR-WV intercept : GMS-5, GOES-9, MTSAT

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (8/10)

	CIMSS	EUMETSAT	JMA/MSC
Height assignment future method	1DVAR for GOES and AVHRR	Optimal estimation using the OCA output for METEOSAT-8 and -9	
Quality indicator	EUMETSAT quality indicators (QIs), with and without background (forecast) check RFF quality indicator using height reassignment and potential speed bias adjustment	EUMETSAT quality indicators (QIs), with and without background (forecast) check	EUMETSAT QI
Quality control (yes/no)	QI has to exceed **60** Visual inspection of time-series of validation metrics w.r.t RAOB	QI has to exceed **30**	QI has to exceed **60**
Native output format	McIDAS MD format (binary)	METEOSAT-native EPS format for AVHRR	"JMA Vector File"
Delivery format	Text (space-separated)	BUFR	BUFR

SCOPE • CM
Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Summary of reprocessing efforts for GOES, METEOSAT, Himawari, and AVHRR, mostly AMVs as of Sep, 2013 (9/10)

	CIMSS	EUMETSAT	JMA/MSC
Processing system: input data acquisition	Satellite data online	Satellite data retrieved from EUMETSAT Data Centre	Satellite data retrieved from JMA/MSC Data Centre
Processing system: hardware	Linux cluster, can run ~50 simultaneous streams	Legacy RMPEF (32-bit SUN environment) for METEOSAT R-EPS (IBM AIX Power6) for AVHRR Can run 3 simultaneous streams for METEOSAT, and 24 for AVHRR	Linux
Hardware resource	In-kind contribution from SSEC	Funded by EUMETSAT	Funded by JMA/MSC
Processing system: main software	For GOES, NOAA/NESDIS operational For AVHRR, CIMSS code	EUMETSAT operational ground segment software, adapted for reprocessing purposes	JMA AMV derivation software
Reprocessing speed	3900 days/day for AVHRR (using regridded input) Estimated 440 days/day for GOES	50 days/day for AVHRR (including radiance mapping) 9 days/day for METEOSAT	MTSAT : 10days/1day OTHERS : 45days/1day

SCOPE • CM
Sustained, Coordinated Processing of Environmental Satellite Data for Climate Monitoring