Committee on Earth Observation Satellites

Non-meteorological Applications for Next Generation Geostationary Satellites: A 2016 CEOS Chair Initiative

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(Adapted from Ken Holmlund, EUMETSAT)

CEOS WGCV-41 Plenary

Tokyo, Japan

7 September 2016

As Chair of CEOS for 2016, CSIRO proposed to provide leadership and coordination on two new initiatives:

1. A study of Future Data Access and Analysis Architectures (co-chaired CSIRO and USGS)

2. A study of Non-meteorological applications for next generation geostationary satellites

Studies will draw upon expertise and capacity from existing CEOS WG's and VCs, as well as member agency experts.

CEOS Study on Non-meteorological Applications for Next Generation Geostationary Satellites

Study Background and Objectives

- The next generation of advanced geostationary (GEO) meteorological capabilities provide improved capabilities for exploiting the data for “non meteorological” applications
- Observational capabilities of GEO sensors similar to medium-resolution LEO sensors; but provide additional temporal refresh
- New opportunities for GEO and LEO synergies for non-met applications
- Whilst dedicated GEO missions for e.g. for air quality (see CEOS ACC position paper) or Ocean Colour (e.g. Korean GOCI), these are mentioned but not explored in detail in this study

CEOS Non Met-Applications Task Team

Established in January 2016, activity period 1 year

Co-chaired by

CSIRO (Schroeder), ABoM (Grant),
EUMETSAT (Holmlund) and NOAA (Kalluri)

Supported by 14 other CEOS Agencies:

CNES, CSA, DLR, EC, ESA, GA, JAXA, JMA, KARI,
NASA, NSMC-CMA, UKSA, USGS, WMO

Study will result in a report that provides comprehensive and pragmatic guidance to CEOS on new opportunities arising from **next generation meteorological geostationary** satellites and GEO-LEO synergies

Study Outline and Leads

1. **Introduction & Purpose**
   - Brief outline of the opportunities offered by new GEO missions, including potential societal benefits
2. **Trends & Outlook for Geostationary EO Satellite Capabilities**
   - Catalogue of CEOS/CGMS agency missions, instruments, measurements, data volumes
3. **Potential non-meteorological applications of new generation systems**
   - Atmosphere, Ocean and Land and indicated SBA
4. **Synergistic use with LEO systems – benefits and issues**
   - Complementarities (spatial, temporal), synergies
5. **Coordinating Initiatives**
   - User engagement, GSICS, SAFs, Bilateral initiatives
6. **Summary and Recommendations**

Timeline

- Report structure developed by NMA team
- Draft report written by co-leads + few others
- 6 Sep 2016: Draft report circulated for comment
  - Full NMA team
  - CEOS WGs
  - CEOS VCs
- 12 Sep 2016: NMA side meeting at SIT workshop
- 14 Sep 2016: NMA item at SIT workshop
  - ***Discussion of recommendations***
- Report and recommendations revised
- 1-2 Nov 2016: Presentation of report and recommendations to CEOS Plenary

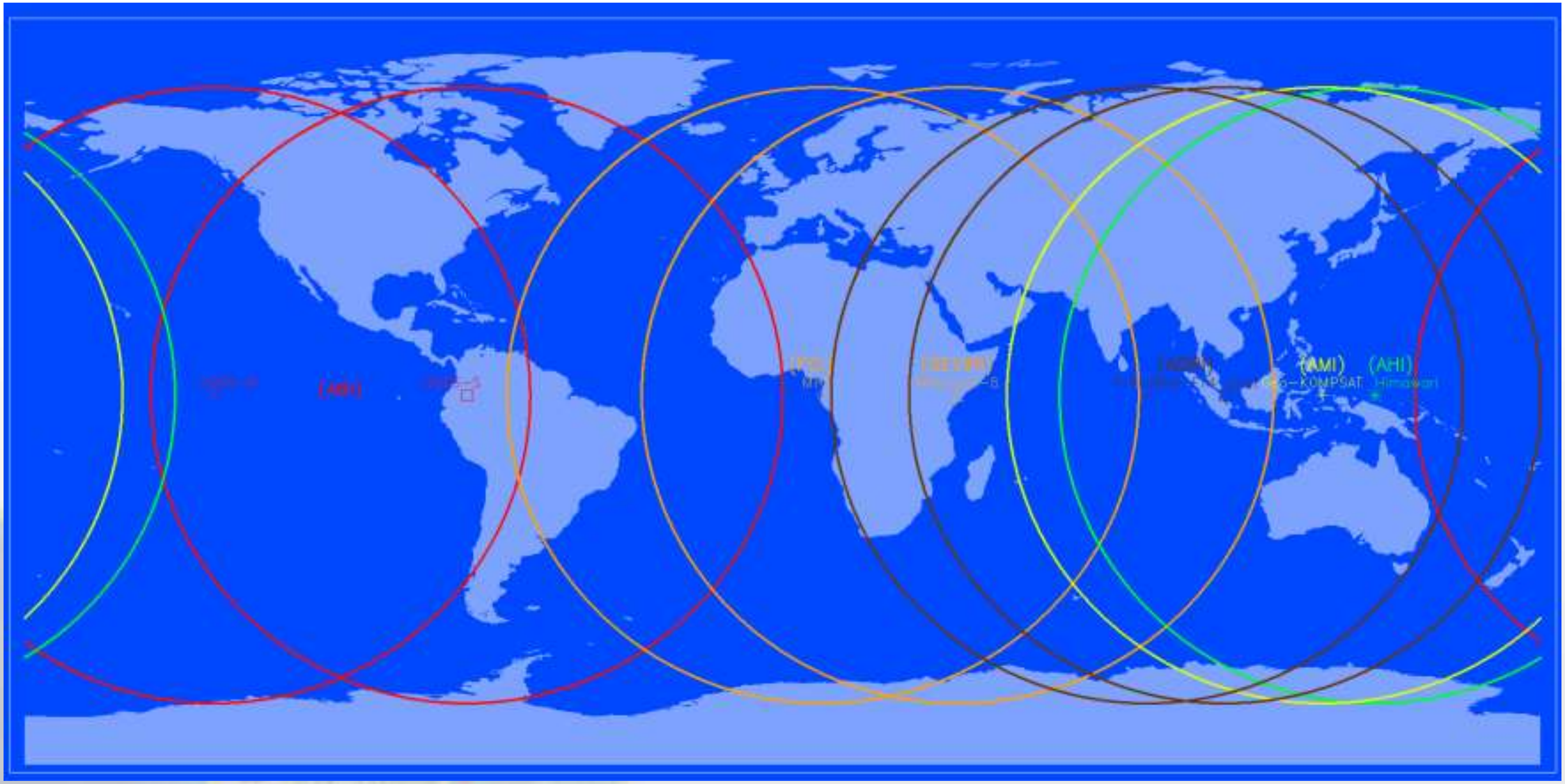
Geo-Leo Corresponding VIS-IR Imagery Bands (μm)

	Oct 2014			2020	2018	2016	2016						
#	Himawari -8/ AHI	MTSAT-2/ IMAGER	MSG/ SEVIRI	MTG/ FCI	KOMPSAT -2A/AMI	FY-4/ AGRI	GOES-R/ABI	GOES -15	GOES -11	SNPP,JPSS/ VIIRS	Terra, Aqua/ MODIS	GCOM-C/SGLI	NOAA/ AVHRR
1	0.47			0.444	0.455	0.47	0.47			0.488 (M03)	0.488	0.490 (VN4)	
2	0.51			0.510	0.511					0.555 (M04)	0.531	0.530 (VN5)	
3	0.64	0.68	0.635	0.640	0.642	0.65	0.64	0.65	0.65	0.672 (M05) 0.64 (I01)	0.667	0.6735 (VN7,VN8,P1)	0.630
4	0.86		0.81	0.865	0.860	0.825	0.86			0.865 (M07) 0.865 (I02)	0.870	0.8685 (VN10, VN11, P2)	0.862
				0.914							0.905		
				1.380	1.38	1.375	1.38			1.378 (M09)	1.375	1.380 (SW2)	
5	1.6		1.64	1.610	1.61	1.61	1.61			1.610 (M10) 1.61 (I03)	1.640	1.630 (SW3)	1.61
6	2.3			2.250		2.25	2.26			2.250 (M11)	2.130	2.210 (SW4)	
7	3.9	3.7	3.92	3.80	3.85	3.75	3.90	3.90	3.90	3.70 (M12) 3.74 (I04)	3.750		3.74
8	6.2	6.8	6.25	6.30	6.24	6.25	6.15	6.55	6.75		6.715		
9	6.9				6.95	7.1	7.00						
10	7.3		7.35	7.35	7.34		7.40				7.325		
11	8.6		8.70	8.70	8.60	8.5	8.50			8.55 (M14)	8.550		
12	9.6		9.66	9.66	9.63		9.70				9.730		
13	10.4	10.8	10.8	10.50	10.43	10.7	10.3	10.70	10.70	10.763 (M15)		10.8 (T1)	10.80
14	11.2				11.20	11.0	11.2			11.45 (I05)	11.030		
15	12.4	12.0	12.0	12.30	12.30		12.3		11.95	12.013 (M16)	12.020	12.0 (T2)	12.00
16	13.3		13.4	13.30	13.30	13.5	13.3	13.35			13.335		

GEO LEO

(Credits: T. Kurino, JMA)

Global wall to wall coverage with new sensors every 10-30 minutes



Non met-applications from meteorological geostationary satellites

Atmosphere

Aerosol optical depth, type

Dust

Volcanic ash

Atmospheric Composition

Oceans

SST

Ice

Ocean Colour

Land

Hot spots (wild fire)

Land surface temperature

Snow

Flood/Standing Water mapping

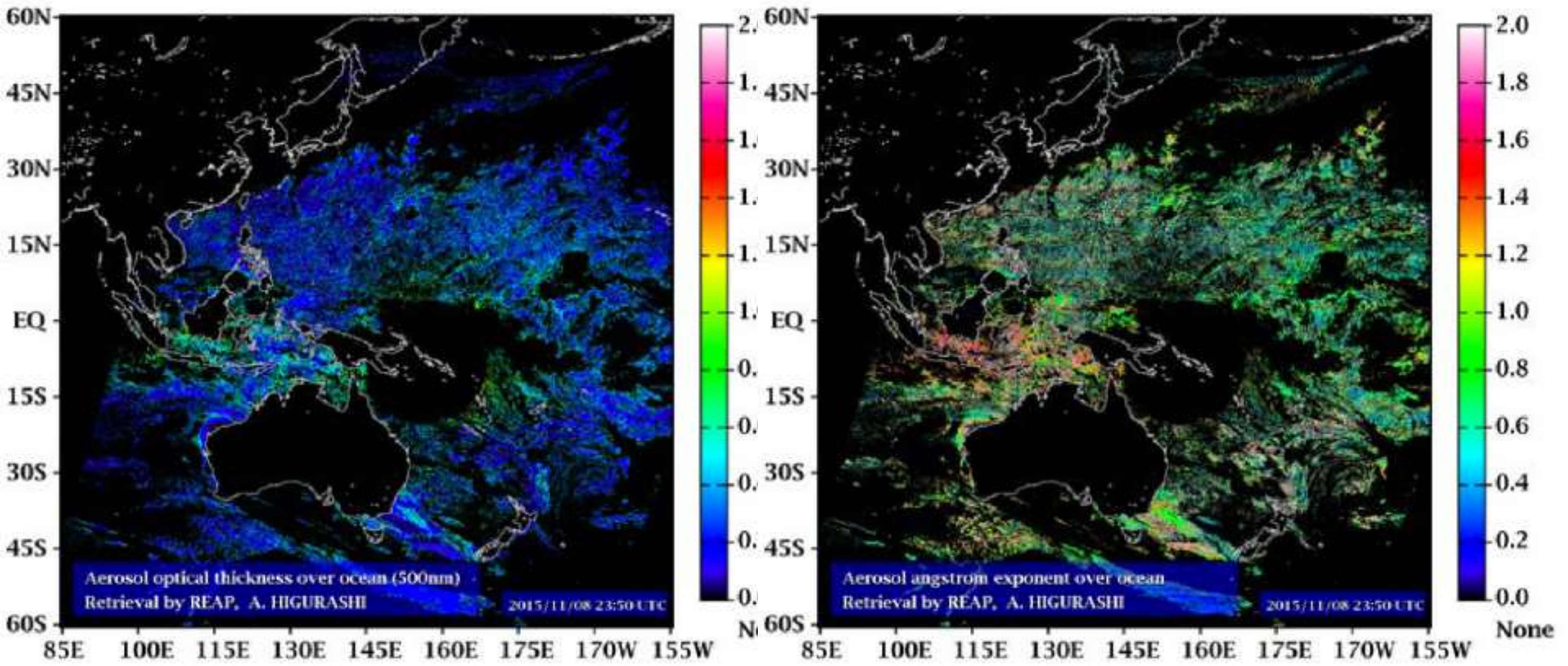
Vegetation/Drought/Evapotranspiration

Albedo

Incident Solar Radiation

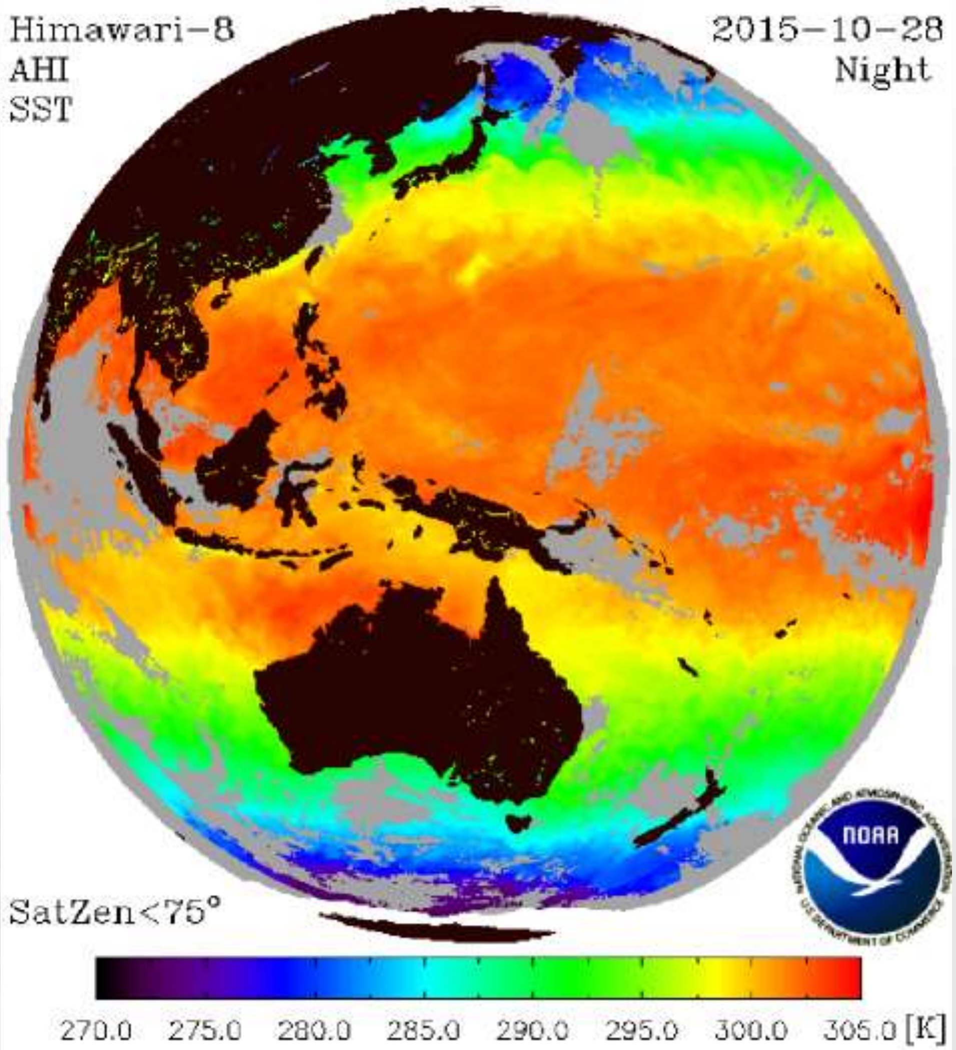
Aerosols

- **AOT at 500 nm (left) and Angstroem coefficient (right) using Himawari-8 data over ocean (Romano et al, 2013)**



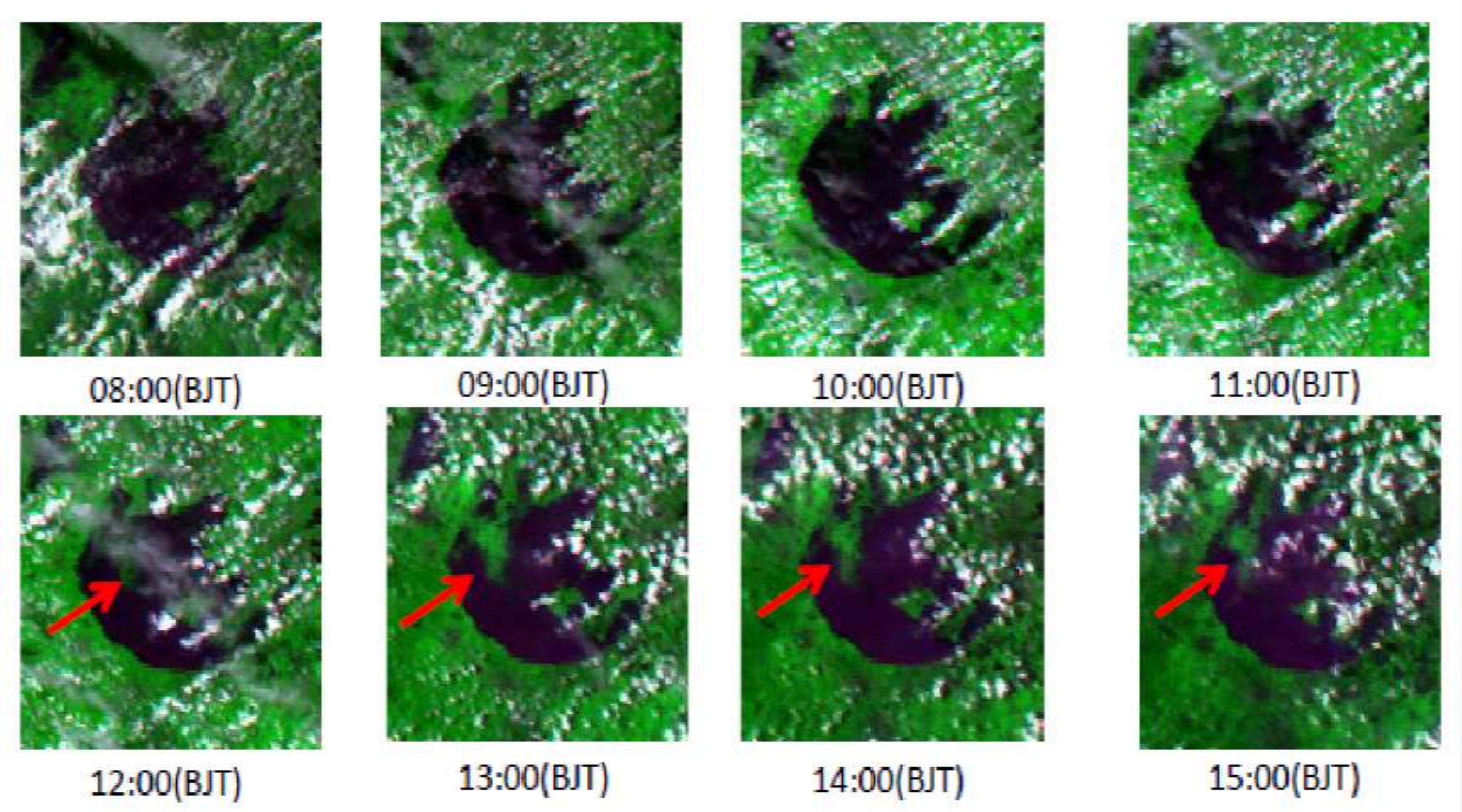
Sea Surface Temperature

- **SST from Himawari-8 using GOES-R algorithm (A. Ignatov, 2016)**



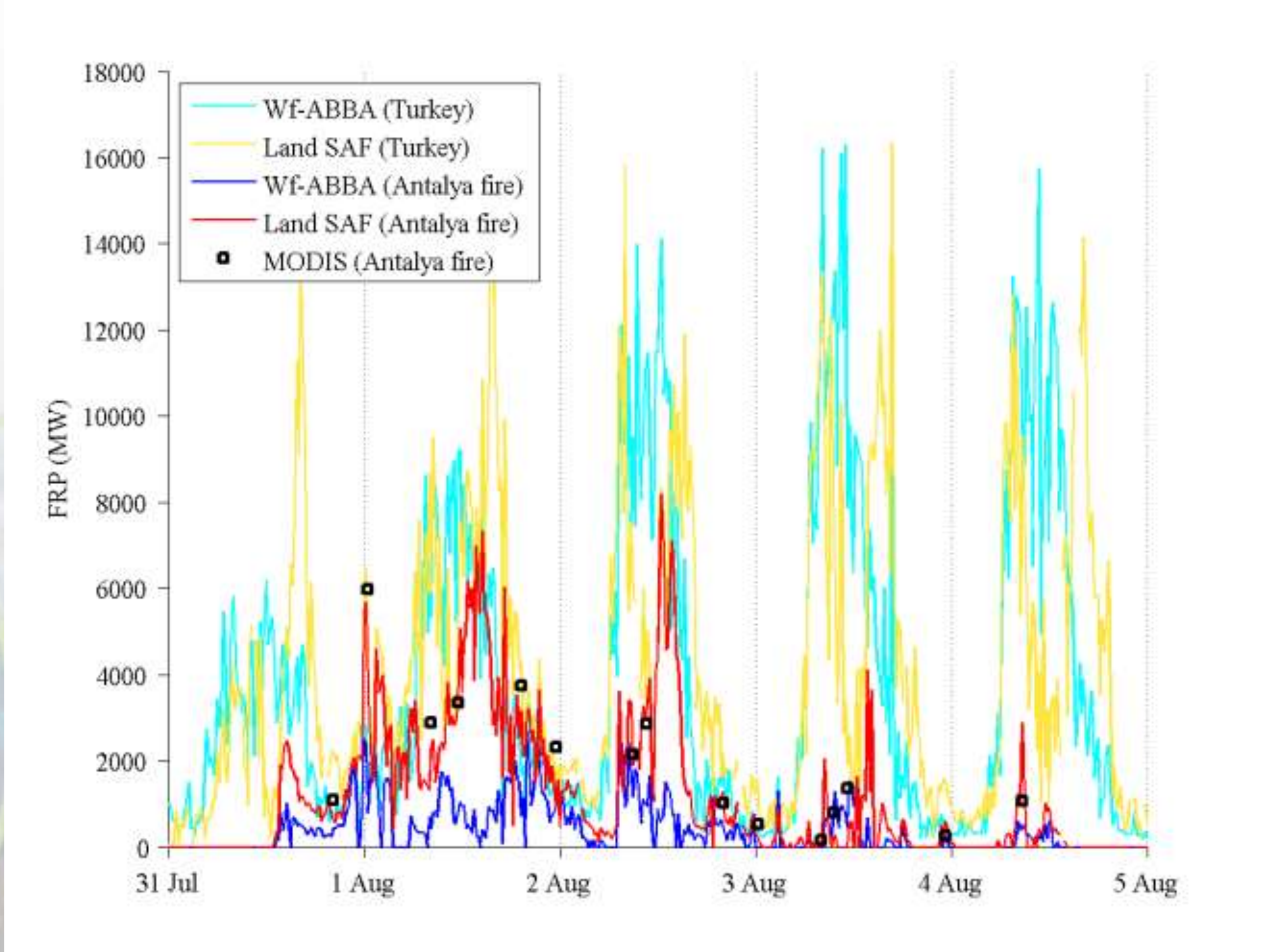
Ocean Colour

- **Blue-green algae monitoring of Taihu Lake using Himawari-8 satellite data on Sep 8 2015 (Lu, 2016)**



Fire Radiative Power

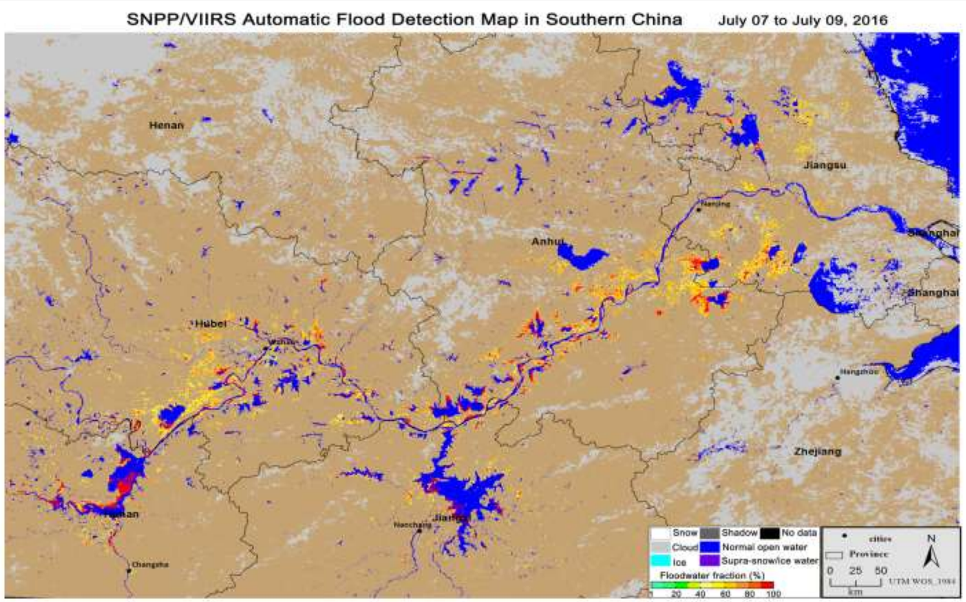
- **LSA SAF SEVIRI FRP-PIXEL Product captures peaks better than MODIS (Baldassarre et al., 2015).**



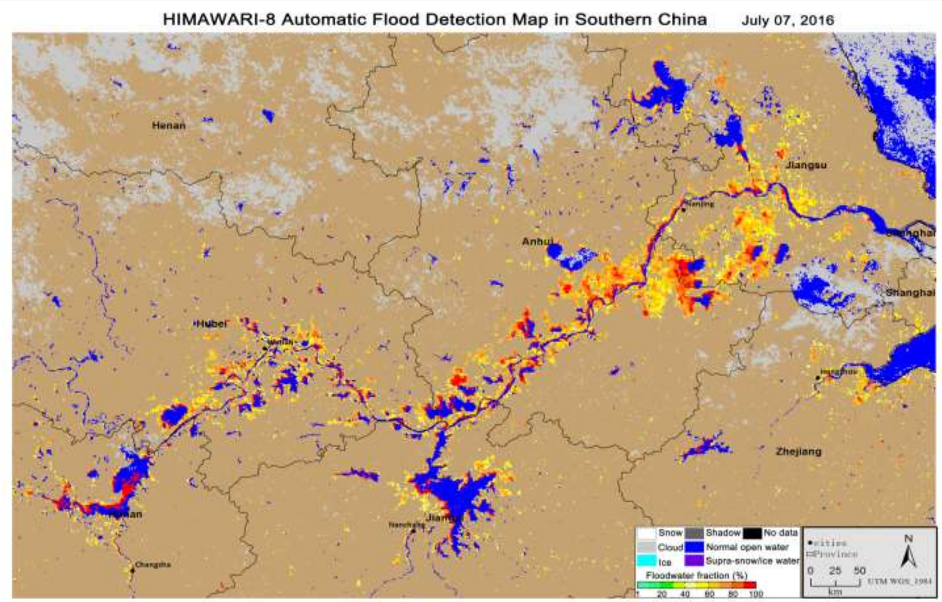
Flood Monitoring

Flood mapping over China (Goldberg, 2016)

SNPP/VIIRS 3-day composite
7-9 July 2016



Himawari-8 1-day composite
7 July 2016



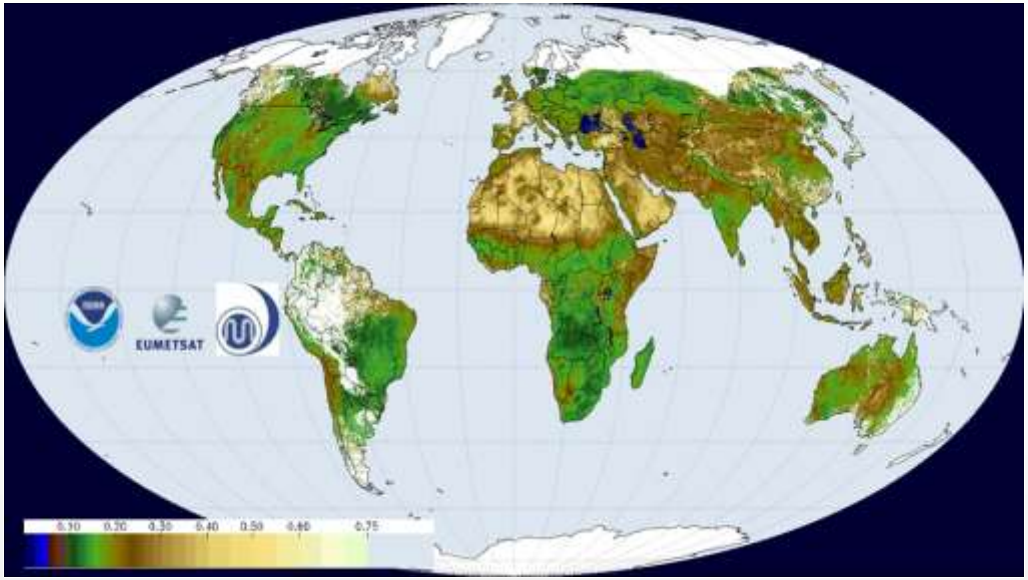
SCOPE-CM Albedo GEO vs LEO

(Schüller, 2016)

GEO 10-day

GMS-5, MET-5, MET-7, GOES-8, GOES-10

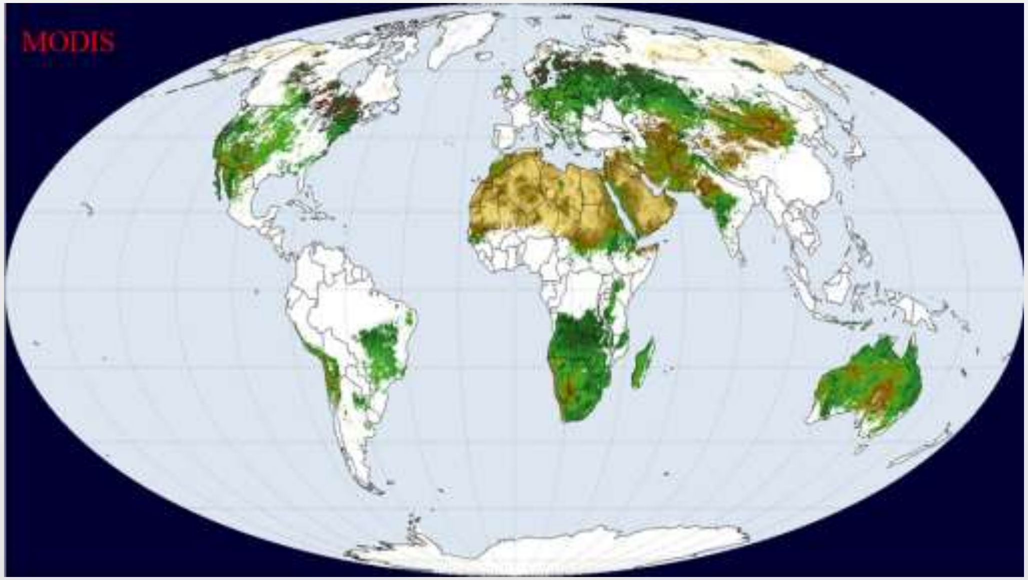
1-10 May 2001



LEO 16-day

Terra/MODIS, Aqua/MODIS

1-16 May 2001



Synergistic use with LEO systems – Comparison of Capabilities

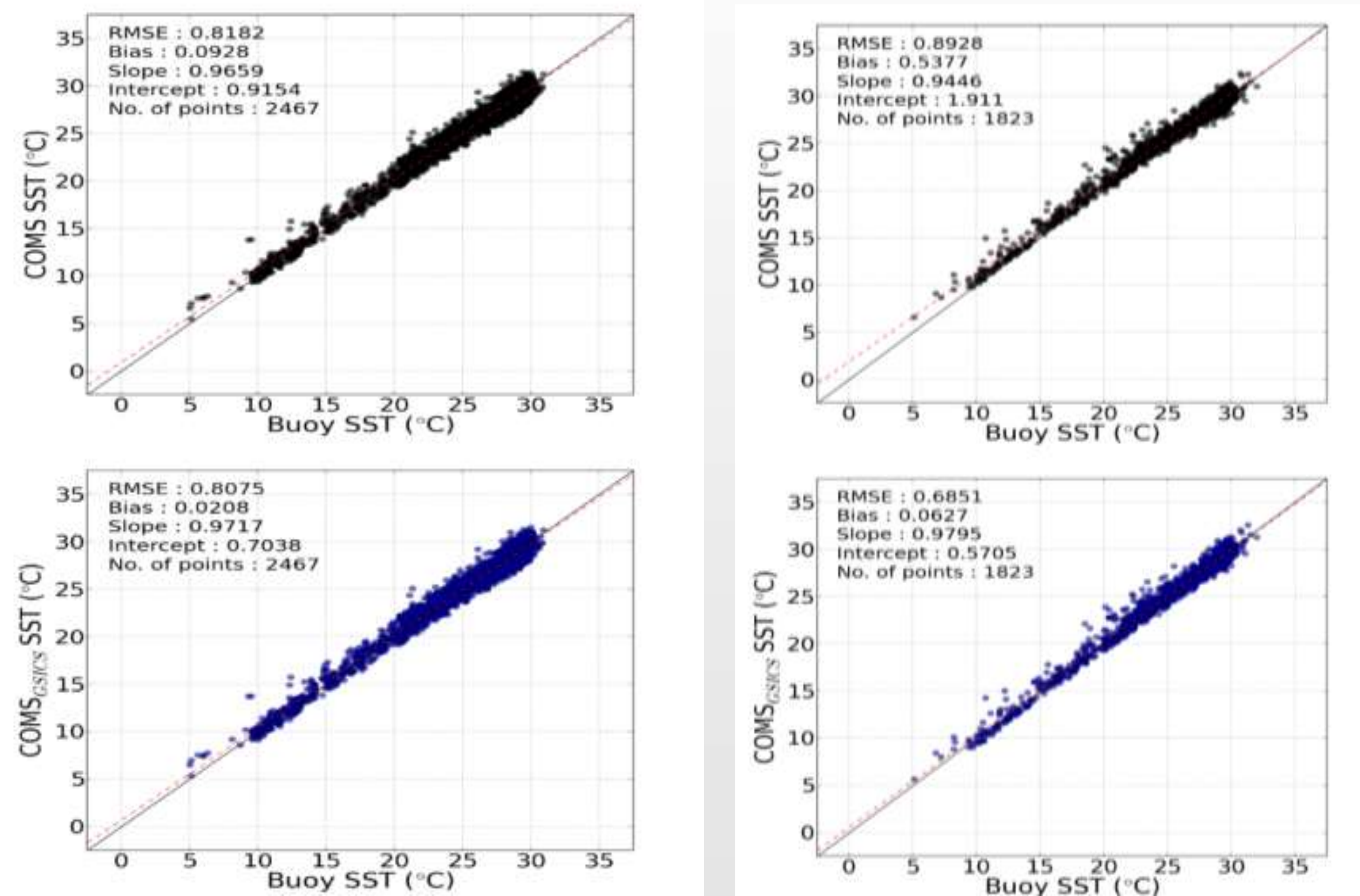
	GEO	LEO
Spatial resolution	Coarse	Fine
Temporal resolution	Fine	Coarse
Spectral coverage	Similar	Similar
View geometry	Fixed	Varying
Illumination geometry	Varying (full diurnal cycle)	~Fixed
Coverage	Regional (~60S-60N)	Global

Requires harmonisation of GEOs and LEOs, particularly

- Relative calibrations
- Spectral Response Function mismatch
- Coregistration

Coordinating Initiatives include CEOS WGCV and GSICS

- **Support to satellite checkout**
- **Improved calibration**
- **Consistent calibration across platforms**
- **Improved products**



Draft Conclusions

- Meteorological geostationary satellites provide for many applications a distinct advantage over medium-resolution Low Earth Orbit (LEO) satellites particularly wrt to temporal sampling that enables:
  - Early detection of rapidly changing phenomenon
  - Better description of diurnal cycles
  - Increase opportunities of cloud free observations over limited time-period (e.g. one day)
- LEO satellites provide basically complete global coverage with higher resolution and better calibration
- Many opportunities for improved products though synergetic (LEO+GEO) use of data exists

Draft Conclusions

- Significant development activities are already taking place within the satellite agencies to derive NMA products from meteorological geostationary satellites.
- Key GEO non-met radiometric applications (land surface reflectance, ocean-leaving radiance) will enable the development of higher level non-met products for various terrestrial and oceanic applications.
- The geostationary NMA have a potential to have a positive impact on all associated SBAs

Draft Conclusions

- Agencies can get a better return on their existing substantial investment in GEO and LEO infrastructure and applications, by applying their infrastructure and expertise to non-meteorological GEO applications.
- This will strengthen the science and environmental monitoring and the associated impact on the various SBA

Draft Recommendations

To achieve better integration and uptake of non-met GEO observations across the full range of Earth observation applications recommendations are:

- Meteorological satellite operators should explore collaborative efforts for algorithm development and intercomparison activities (consistent GEO-ring)
- Meteorological satellite operators should engage broadly with the "non-met user community" and LEO science teams to foster the collaborative development of advanced algorithms and to identify and to reach consensus on suitable algorithms types and non-met applications for coordinated GEO-ring implementation.

Draft Recommendations

- Meteorological satellite operators should promote non-met GEO products widely and include these applications into the training requirements for the user community such as SATURN, EUMETRAIN and WMO-CGMS-VLab.
- To the extent possible, in order to ease data use, products from different agencies should be distributed in similar formats, with similar content (including quality and meta data information)
- Meteorological Satellite Operators and Space Agencies should take advantage of modern data approaches such as the CEOS AHT on Future Data Architectures to address the data volume issue. Cost-efficient solutions for data distribution like GEONETCast should be exploited.

Draft Recommendations

- Meteorological satellite operators should progressively work towards the operational delivery of geophysical products to achieve quasi-global consistent coverage, particularly radiometric products that underpin downstream products.
- The potential of GEOs to contribute to ECVs/CDRs should be studied in detail

Draft Recommendations (cal/val related)

- In order to achieve consistent products a strong inter-agency coordination and engagement in various calibration initiatives, with various calibration approaches, like GSICS and CEOS WGCV is required
- In-situ validation data and simulated test data sets should be shared openly to allow algorithm development and validation. Coordinate collection of validation data.
- Space agencies should directly support where possible cal/val infrastructure for validation of radiometric products such as the RadCalNet or AERONET(-OC) network including system vicarious calibration sites and foster interactions with the user community to support validation and accuracy assessments.

Calibration/harmonisation needs

- GEO-GEO (for GEO-ring consistency – transfer via LEO?)
- GEO-LEO (for synergistic products)