



17 November 2012

The opportunities and possibilities for enhancing and broadening NSMC's contribution at national and international level



**Allen Huang**  
**Space Science and Engineering Center (SSEC)**  
**University of Wisconsin-Madison, USA**

Fifth Session of International Strategic Consultative Committee (ISCC-5)  
Meeting on Chinese Meteorological Satellite Programmes &  
1<sup>st</sup> FENGYUN Satellite Users' Conference  
Chengdu, China  
12 November, 2018



# Space Science & Engineering Center (SSEC)



SSEC - Home to the “Father of Satellite Meteorology”

Prof. Verner E. Suomi (1915-1995) & a close collaborator of NSMC/CMA



# Space Science & Engineering Center (SSEC)

## Satellite System Infrastructure

- ❑ One of the world largest non-profit & non-governmental Center for both GEO & LEO satellite receiving, processing, dissemination and archive.
- ❑ Has satellite sensor, algorithm, science, and application expertise
- ❑ Home to the center which provides meteorological satellite end-to-end turned key system and processing s/w packages for level 0 to level 3 (SDR to IDR)
- ❑ Has designed, built and operated UW campus largest high performance computing system for large domain and high spatial resolution weather forecast
- ❑ Has offered satellite remote sensing training and education courses/seminars to students, scientists, and professionals

The opportunities and possibilities for enhancing and broadening NSMC's contribution at national and international level

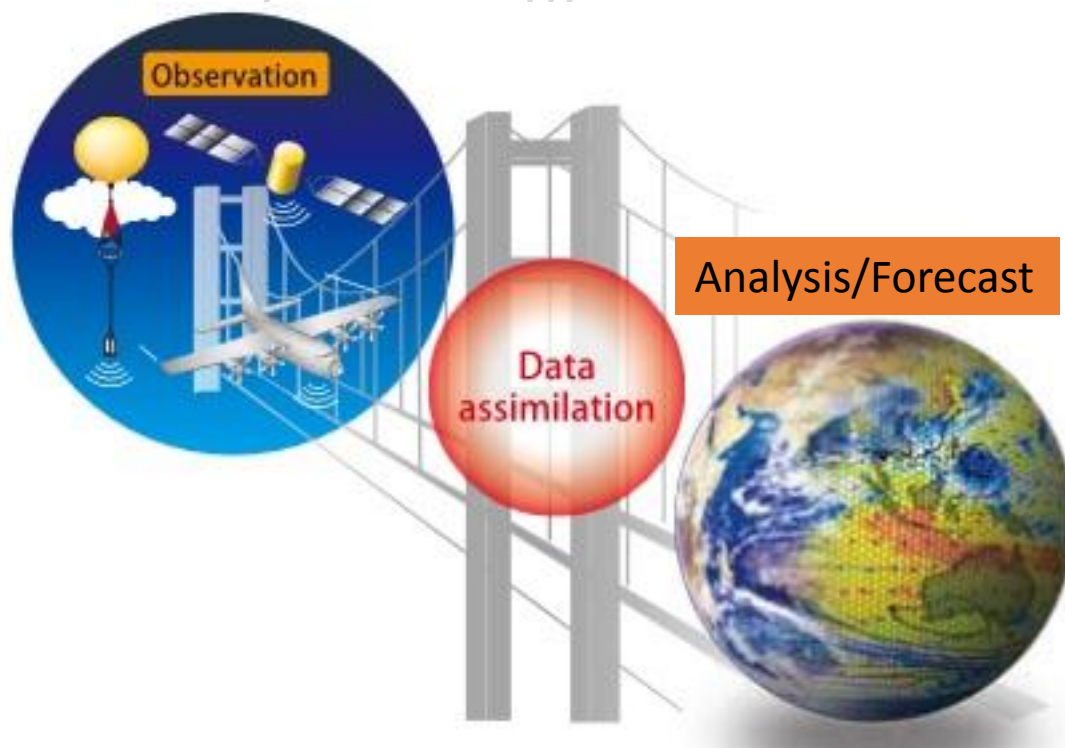
To support Belt and Road Initiative and societal & economical capacity building to

- ❑ Perfecting conventional and other community capacity
  - Satellite alone retrieval vs. data fusion/assimilation
- ❑ Innovate and adapt modern-day technology
  - Quantum Remote Sensing
  - AI and Big Data
  - Day/Night Band Imaging from GEO
- ❑ Deploy remote sensing observing beyond boarder
  - Provide sensor system and processing expertise to partner countries for unique and demanding needs

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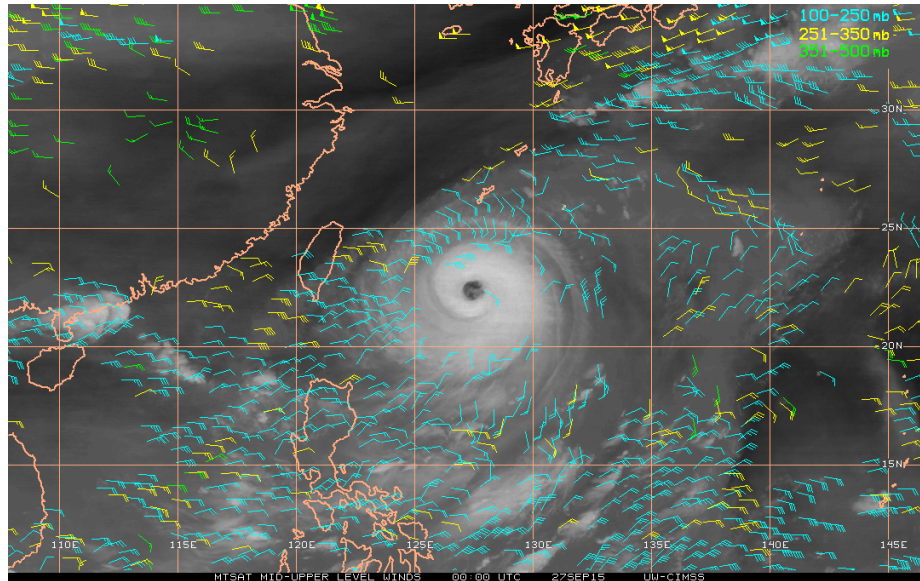
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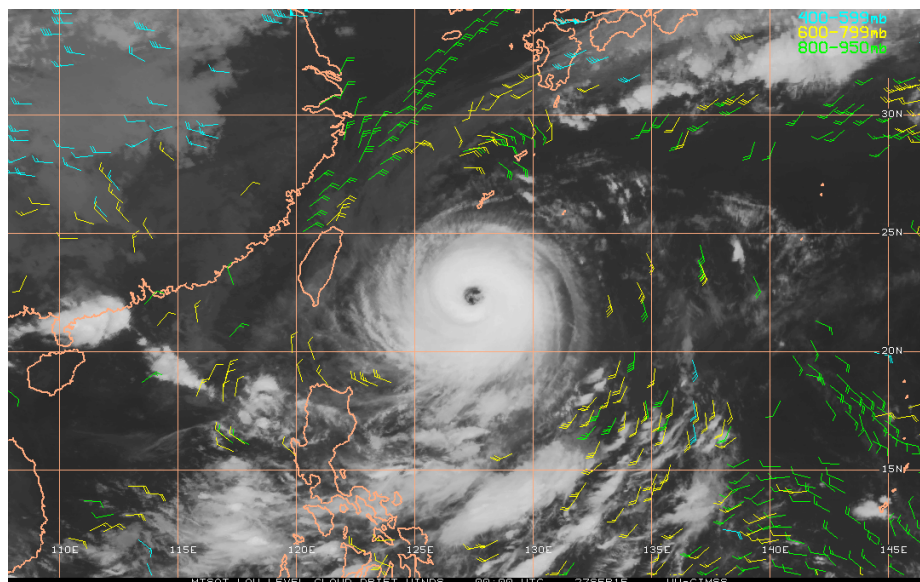


# Satellite alone vs. DA Wind for Typhoon Dujan

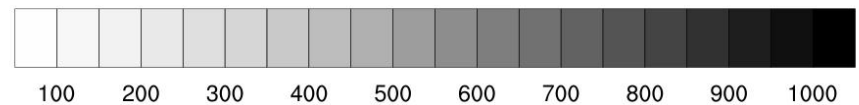
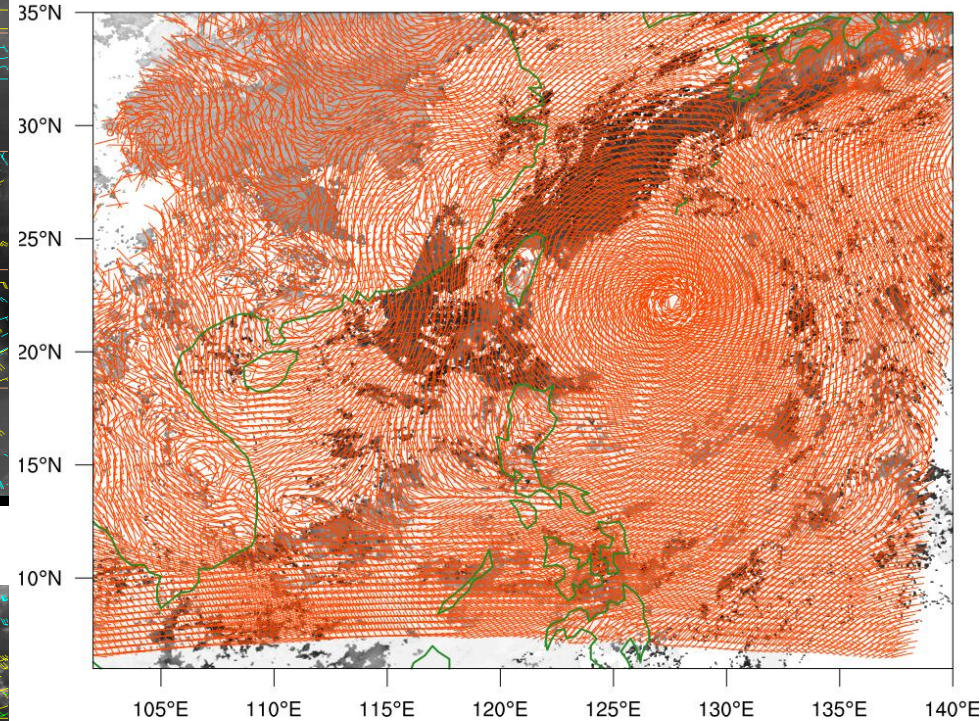
## Conventional Target Tracking Vs. Modern-Day 4D VAR AMV/Wind



Traditional Target Tracking AMV



27 Sept 2015 00z Winds at 850 hPa



### 4D DA Wind:

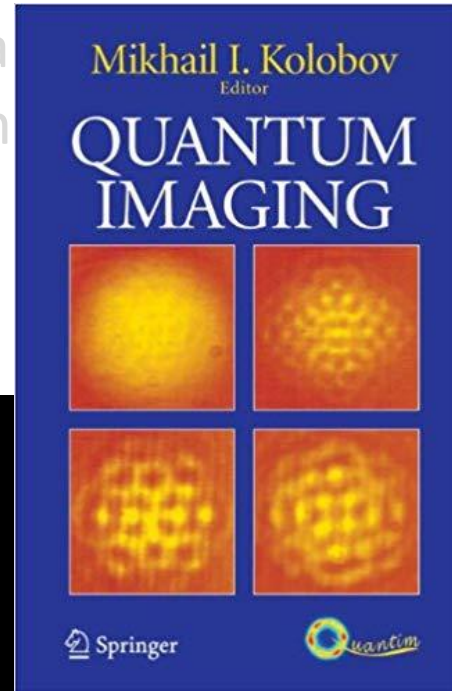
- Much higher yields (both H & V)
- No gaps in cloudy areas
- Enhanced performance

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Quantum imaging, is a **new sub-field of quantum optics** that exploits quantum correlations such as quantum entanglement of the electromagnetic field in order to image objects with a resolution or other imaging criteria that **is beyond what is possible in classical optics.**



Search Open Calls:  **GO**

Conference OP428

## Quantum Remote Sensing

This conference has an open call for papers:

**SUBMIT AN ABSTRACT**  
(SIGN IN REQUIRED)

[Submission guidelines for Authors and Presenters](#)

## Important Dates

Abstract Due:  
30 January 2019

Author Notification:  
8 April 2019

Manuscript Due Date:  
17 July 2019

## Conference Chairs

[Siwen Bi](#), Institute of Remote Sensing and Digital Earth  
(China)

[Henri-Jean Drouhin](#), Ecole Polytechnique (France)

## Call for Papers

High signal to noise ratio and high spatial resolution remote sensing technologies are urgently needed to enhance resource exploration, weather information gathering, environmental monitoring, land utilization, global change detection, and many other fields. To meet the demand for high-resolution imaging requires increases in both sensor size and optical system sensitivity. A consequence is a dramatic increase in the volume, mass, cost, and complexity of the sensor to the point that it becomes cost-prohibitive for practical deployment.

It is well known that the classical electromagnetic wave is influenced by the diffraction limit and quantum noise limit and that increasing the resolution has been close to the limit of traditional remote sensing techniques. One of the main research areas in recent years has been an attempt to identify a set of directions and ways in which quantum properties could be used to increase the performance of a wide variety of classic remote sensing devices. Although quantum sensing technology is not as mature as quantum computing, the creation of a full-scale quantum computer is a much more difficult task than that of designing quantum sensors.

Recent demonstrations and prototypes using quantum optics and quantum theory have guided our belief that quantum sensing is a promising technology that could have a significant impact on improving the overall sensing performance for both societal benefit and commercial activity.

For this conference on quantum remote sensing and quantum spectral imaging, we are calling for papers about underlying principles, modeling, devices, technology, instrument research, and innovative applications. There is also a focus on the best and most extensive applications of quantum remote sensing data to show how this technology can deliver capabilities beyond the bounds of currently exploited technologies.

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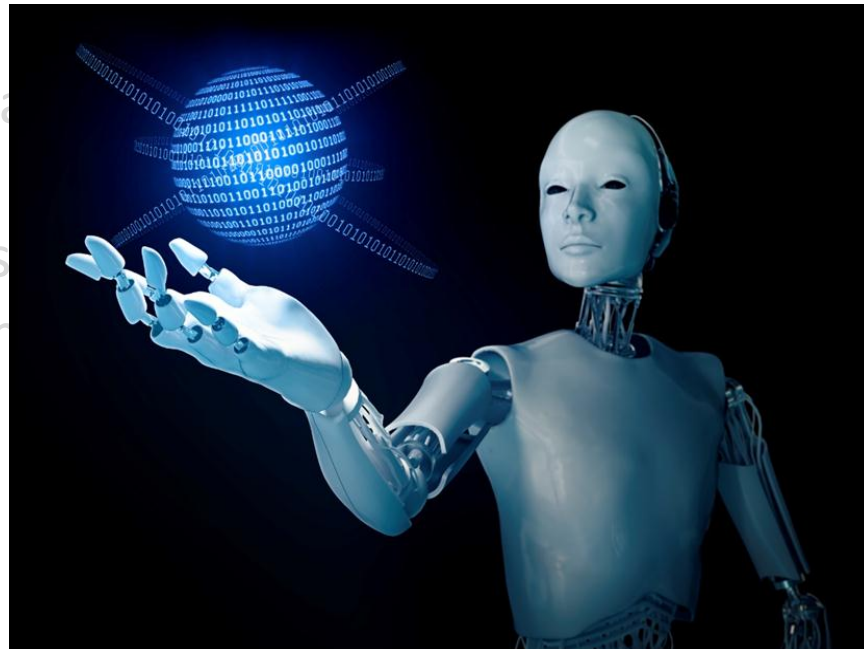
<https://spie.org/OPO/conferencedetails/quantum-remote-sensing?SSO=1>



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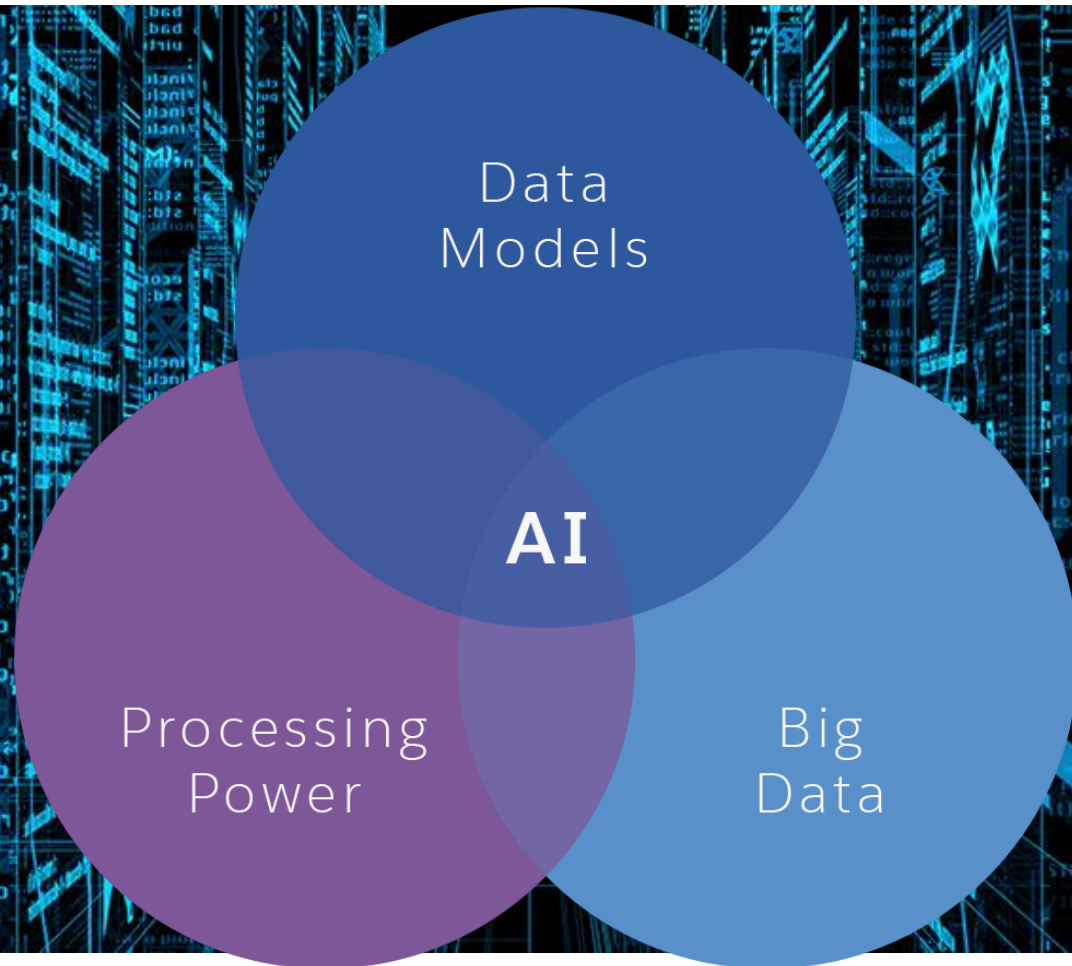
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tries

# AI & Big Data - The Three-Pillar

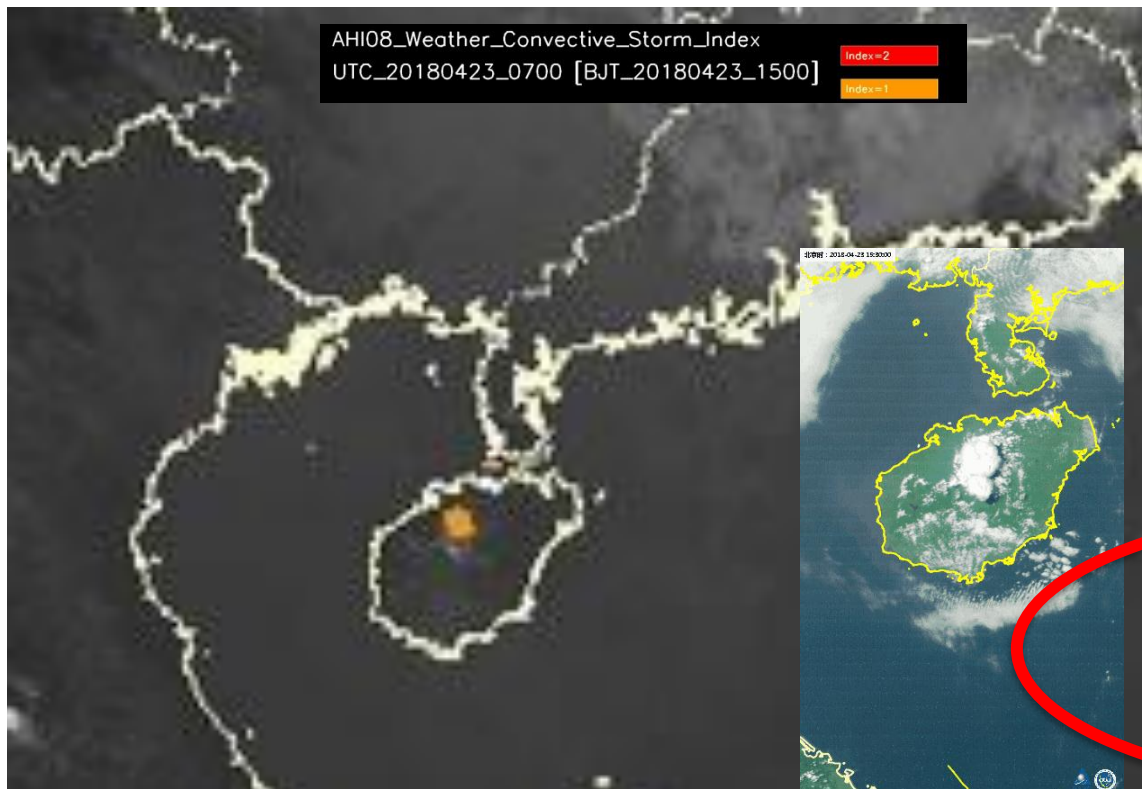


AI is new electricity

# Storm Warning In Pre-convection Environment (SWIPE)

- A new real-time product based on high resolution geostationary satellite and NWP data with AI

Jun Li ([Jun.Li@ssec.wisc.edu](mailto:Jun.Li@ssec.wisc.edu)), Zhenglong Li, CIMSS/University of Wisconsin-Madison



Random forest is applied to predict the possibility of local severe storm outbreak based on geostationary satellite (AHI) observations and short term NWP forecast output. **A 40-min lead time is achieved for the case demonstrated.**

SWIPE sees at 14:50 pm, storm initiated at 15:30 pm, 40 min ahead!

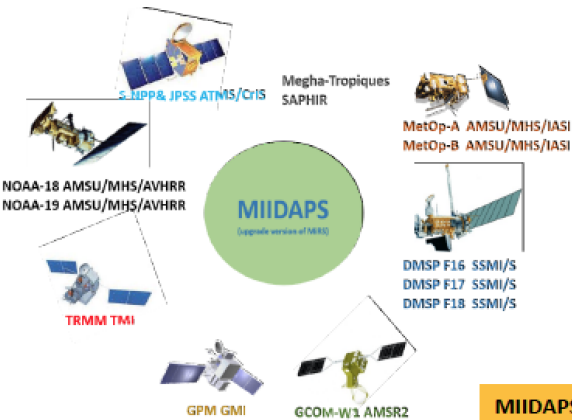


# NOAA AI & Big Data Pilot Project Example

## Pilot Project: MIIDAPS-AI:

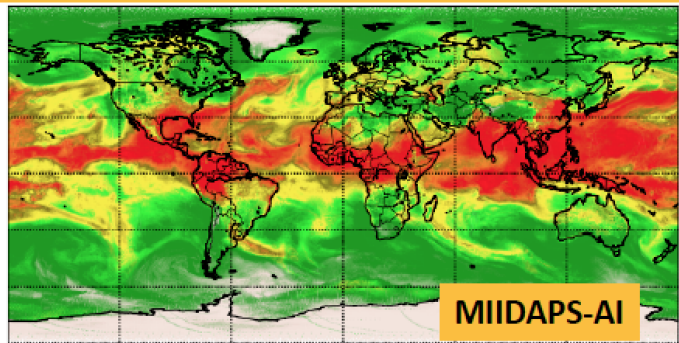
*Multi-Instrument Inversion and Data Assimilation Preprocessing System*

Exploring Artificial Intelligence for Remote Sensing/Data Assimilation/Fusion Applications

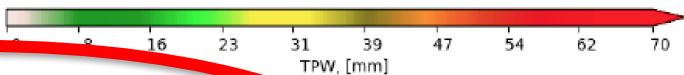
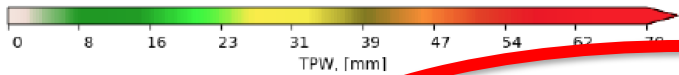
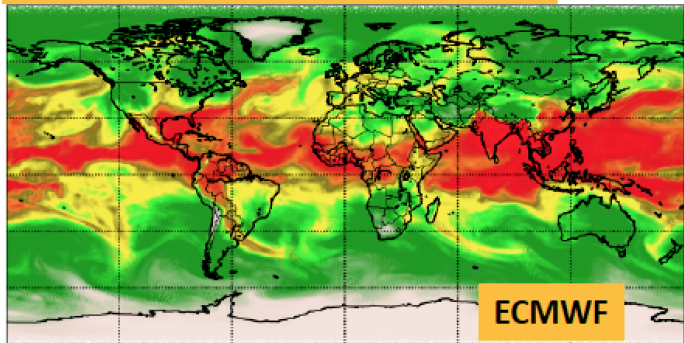


Google TensorFlow Tool used for MIIDAPS-AI

MIIDAPS-AI outputs (TPW) Using SNPP/ATMS Real Data



Reference source of TPW: ECMWF Analysis



- How to assess that AI-based output (Satellite Analysis) is valid?**
- (1) Assessing quality by comparing against independent analyses
  - (2) Assessing Radiometric Fitting of Analysis
  - (3) Assessing analysis spatial coherence
  - (4) Assessing inter-parameters correlations

	MIIDAPS-AI	MIIDAPS
Processing Time for a full day data. A single sensor (ATMS). Excluding I/O	~5 seconds	~ 2 hours

S. Boukabara, NOAA

# AI and Big data for Remote Sensing Research and Applications

## A New SPIE Remote Sensing Track Conference

- Optics and Photonics
- 2018 Event Highlights
- Nanoscience + Engineering
- Organic Photonics + Electronics
- Optical Engineering + Applications
- Courses
- Exhibition
- Sponsors
- Travel to San Diego
- For Authors and Presenters
- For Chairs and Committees
- For Exhibitors



San Diego Convention Center  
San Diego, California, United States

**11 - 15 August 2019**

Search Open Calls:  **GO**

Conference OP427



### AI and Big Data for Remote Sensing Research and Applications

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and commercial enterprises.

# AI and Big Data In Weather & Climate Science

## A New IUGG Joint Session



The banner features a green and white color scheme. On the left is a circular logo divided into four quadrants: top-left (black paw print), top-right (aurora borealis), bottom-left (orange maple leaf), and bottom-right (green evergreen tree). In the center, the text reads '27<sup>th</sup> IUGG General Assembly' and 'Assemblée Générale de l'UGGI'. Below this is the full name of the organization in English and French. To the right is a photograph of the Montreal skyline at night. On the far right is another circular logo, a stylized four-leaf clover in green and blue. At the top, it says 'JULY 8-18 JUILLET 2019 | MONTRÉAL, CANADA'. At the bottom, it says 'IUGG Centennial | 1919-2019 | Centenaire de l'UGGI'. A navigation bar at the bottom contains links: HOME, COMMITTEES, PROGRAM (highlighted with a dropdown arrow), EVENTS, WORKSHOPS/FIELDTrips, SPONSORSHIP/EXHIBITS (dropdown arrow), REGISTRATION (dropdown arrow), ACCOMMODATION, and MONTREAL & QUEBEC.

JULY 8-18 JUILLET 2019 | MONTRÉAL, CANADA

**27<sup>th</sup>** IUGG General Assembly  
Assemblée Générale de l'UGGI

International Union of Geodesy and Geophysics | Union Géodésique et Géophysique Internationale

IUGG Centennial | 1919-2019 | Centenaire de l'UGGI

HOME COMMITTEES **PROGRAM ▼** EVENTS WORKSHOPS/FIELDTrips SPONSORSHIP/EXHIBITS ▼ REGISTRATION ▼ ACCOMMODATION MONTREAL & QUEBEC

### JM07 - ARTIFICIAL INTELLIGENCE AND BIG DATA IN WEATHER AND CLIMATE SCIENCE (IAMAS, IAHS)

**Convener:** Philippe Roy (Canada, IAMAS)

**Co-Conveners:** Alexis Hannart (Canada, IAMAS), David Hall (USA, IAMAS), Allen Huang (USA, IAMAS), Scott Hosking (UK, IAMAS), Ashish Sharma (Australia, IAHS)

#### Description

Rapid advances in artificial intelligence, combined with the availability of enormous amount of data (termed Big Data) is opening new avenues for climate analysis and climate scenarios. The long awaited promises of AI is now common in many disciplines. Applying AI methods, combined with physical knowledge, can improve climate analysis and provide better climate simulations and climate products, notably for high-impact events, such as floods, wildfires and winds.



NOAA is planning the 1st Workshop on

Using AI to Exploit Big Data in Satellite Earth  
Observation & Numerical Weather Prediction (NWP)

Theme Description:

Using Artificial Intelligence (AI) and Deep/Machine Learning Techniques for the Exploitation of Big Environmental Data, Including Satellite Data and Internet-Of-Things (IoT), in Earth Observation Remote Sensing, NWP Data Assimilation, Forecasting and Situational Awareness Applications

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## Critical Environmental Intelligence - Power Outages

Only available from GEO for around the clock information gathering

17/20

This map is available at night with the VIIRS Day Night Band

**VIIRS – Day Night Band**  
24 July 2017, 2:00 am AST

Using multiband observations, VIIRS (Visible Infrared Imaging Radiometer Suite) made at night, we are able to see social and economical behaviors that cannot be seen by remote sensing in daytime.

This map employs annual data of Nighttime Lights from 2015, VIIRS Boat Detections from 2017, and VIIRS Nightfire from 2017.

- Legend**
- Nighttime Lights
  - VIIRS Nightfire (VNF)
  - VIIRS Boat Detection (VBD)



Data analysis and images created by  
Christopher A. Trepte, Patrick S. Smith  
Michael S. Timlin, Feng Q. Wu  
Toshiyuki Shimizu  
Background  
NASA Earth System Data Visualization Center



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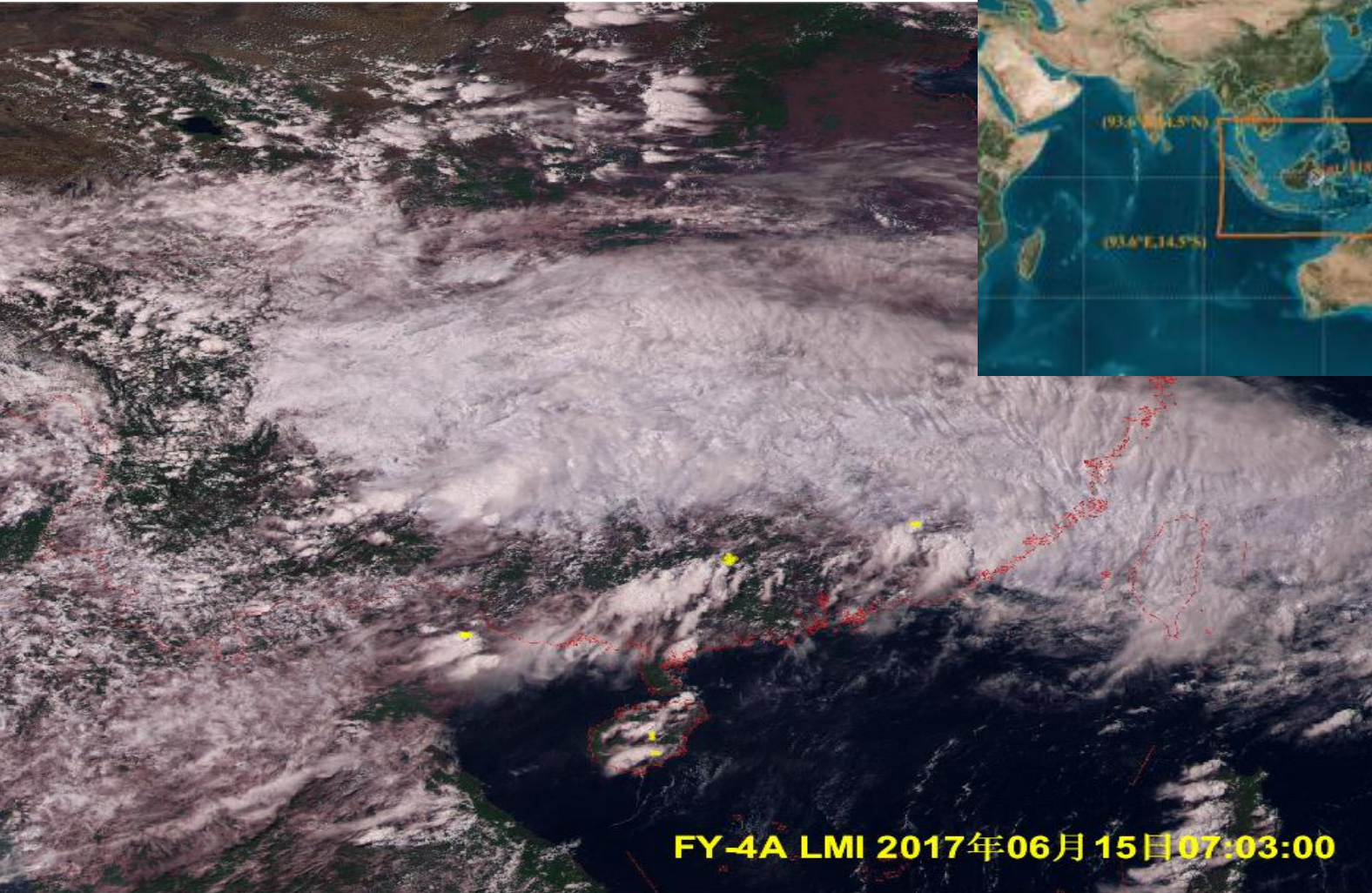
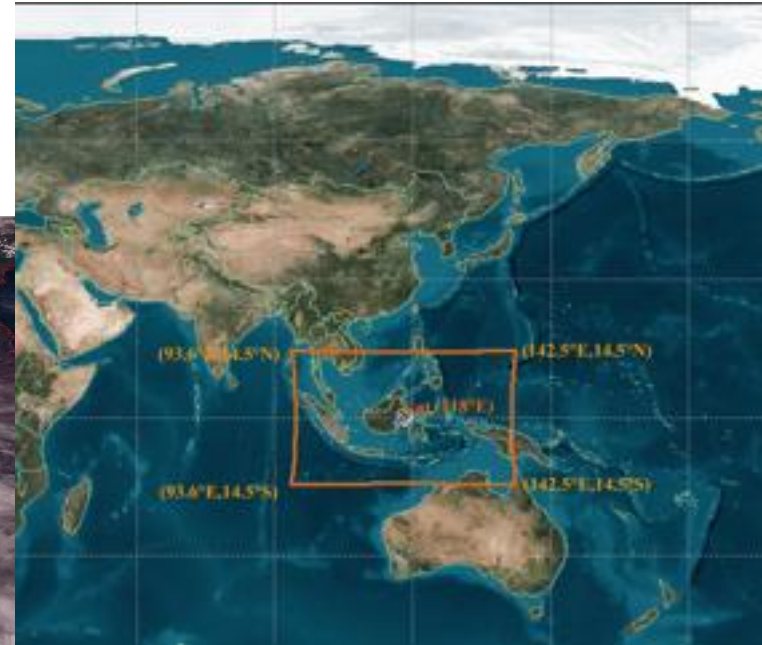
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# A Dedicated LMI Observation Demonstration for Indonesia is under discussions



FY-4 LMI



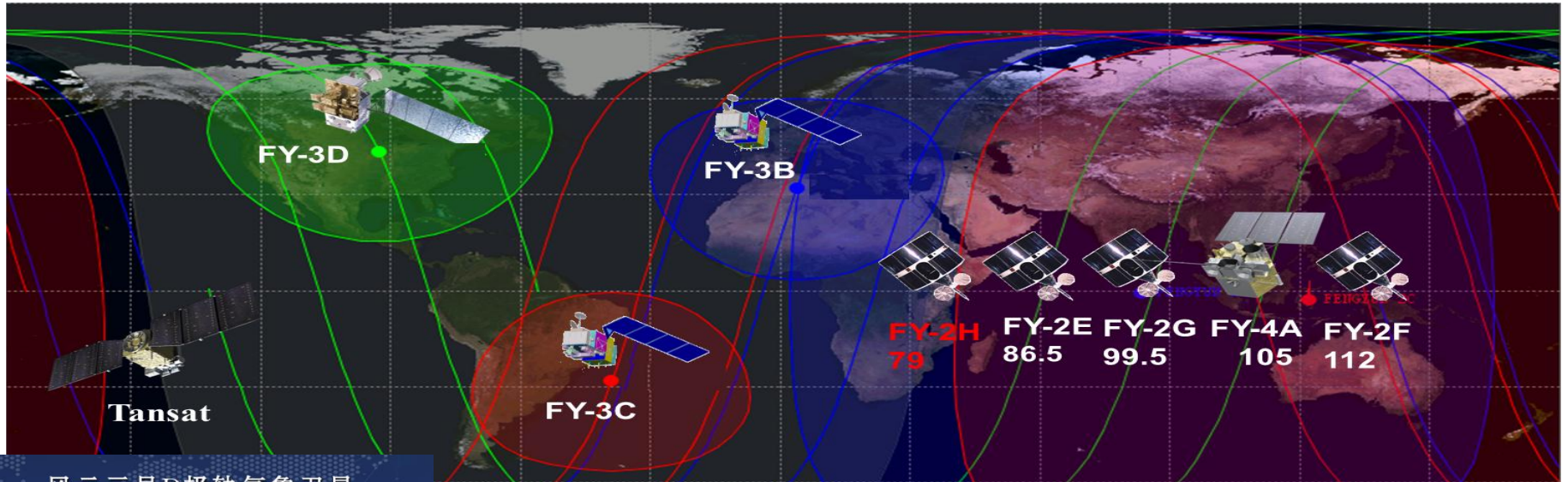
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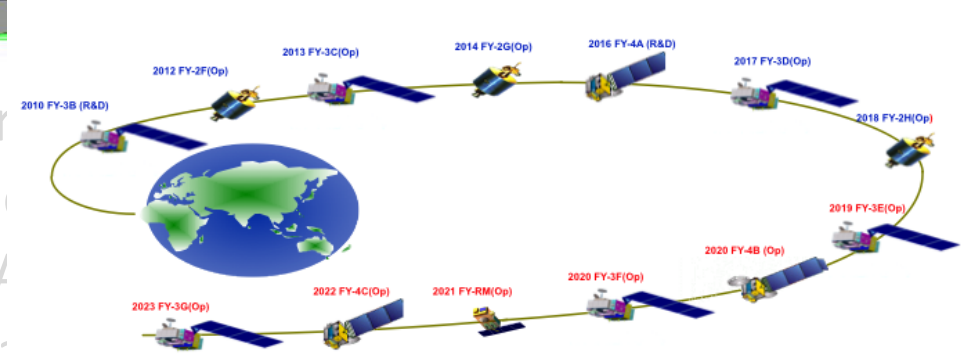
## Summary

In my humble opinion, CMA/NSMC has great opportunities, desire and capability to support the Belt and Road Initiative to



**风云三号D极轨气象卫星**  
FY-3D Polar-orbiting Meteorological Satellite

National Program for Fengyun Meteorological Satellite from 2011-2020



6 satellites will be launched within this decade



The opportunities and possibilities for enhancing and broadening NSMC's contribution at national and international level - **Summary**

In my humble opinion, CMA/NSMC has great opportunities, desire and capability to support Belt and Road Initiative to

- ❑ Strengthen FY Satellite products and applications performance by adapting NWP community matured data assimilation technique to develop an unique **satellite-focused assimilation retrieval technique**

- ❑ Innovate and adapt modern-day sensing technology and information extraction in areas of

  - **Quantum Remote Sensing Imaging of earth system**

  - **Big Data and AI to supplement and advance time-critical operations with low costs**

  - **Be the 1<sup>st</sup> to demonstrate Day/Night Band imaging in GEO**

- ❑ Deploy remote sensing observing beyond boarder

  - Assist partnering countries in achieving their demanding needs, such as **assisting Australia/Indonesia to meet their needs for unique observations** (i.e. lightning imaging data)



17 November 2012

Thank you for your attentions  
Any Question is welcomed!



[allenh@ssec.wisc.edu](mailto:allenh@ssec.wisc.edu)