Community Satellite Processing Package (CSPP) –
Serving Savvy FY Satellite Users

Allen Huang

Space Science & Engineering Center (SSEC)

University of Wisconsin-Madison

FY 2019 FengYun Satellite User Conference
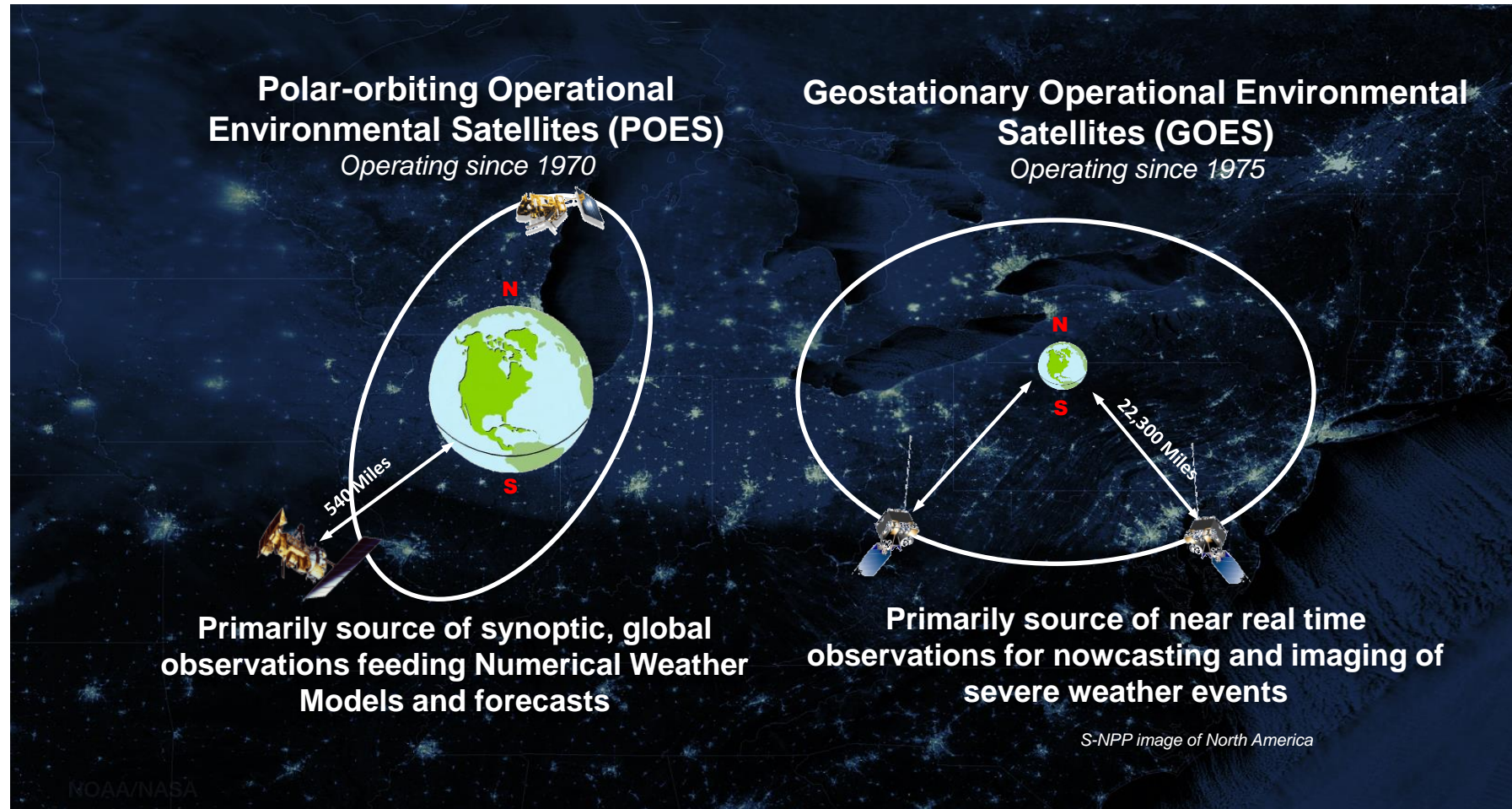
15-17 Nov., 2019

Haikou China

Met Office - UK

NOAA, CMA and EUMETSAT have the same important strategy: Operational Weather Polar and Geostationary Orbiting Satellites

Polar-orbiting Operational Environmental Satellites (POES)
Operating since 1970

540 Miles

Primarily source of synoptic, global observations feeding Numerical Weather Models and forecasts

Geostationary Operational Environmental Satellites (GOES)
Operating since 1975

22,300 Miles

Primarily source of near real time observations for nowcasting and imaging of severe weather events

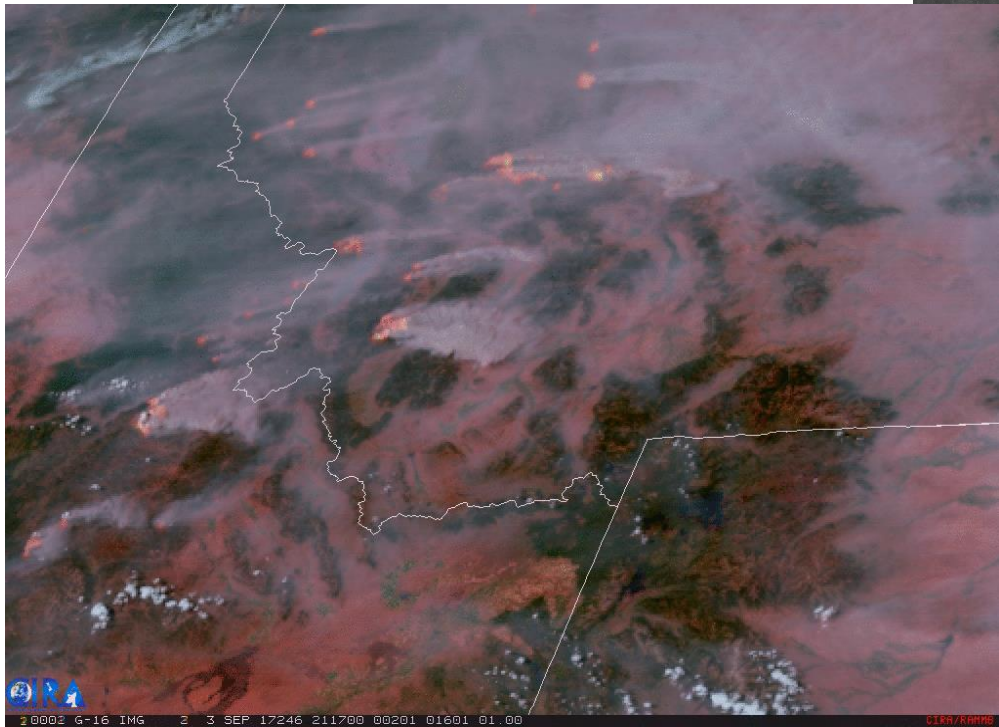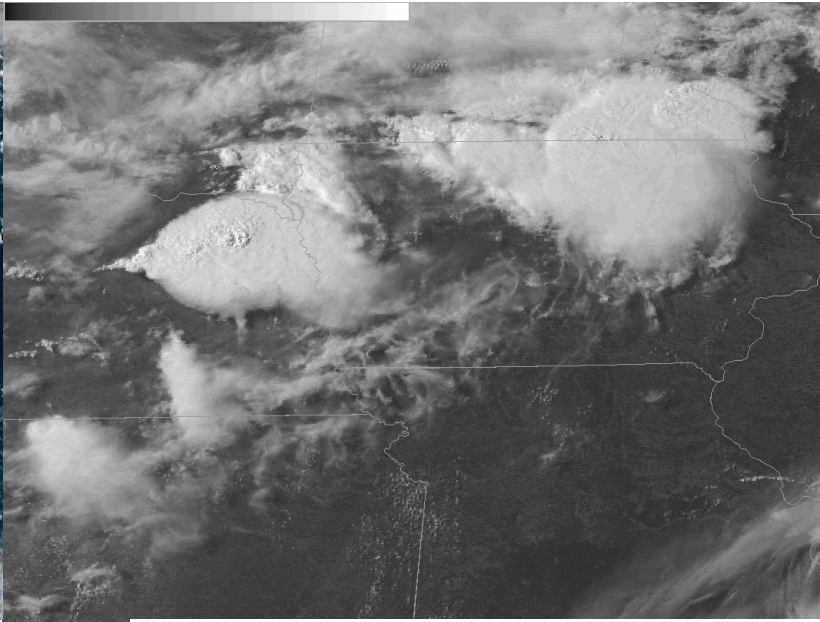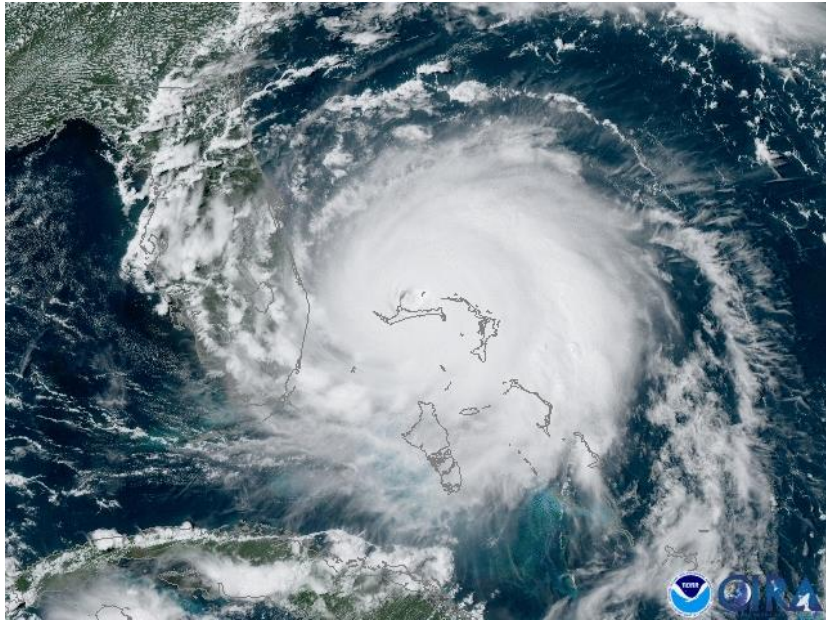*S-NPP image of North America*

We work together to support our user communities through direct access of critical satellite data and through training

NOAA Satellites Alone

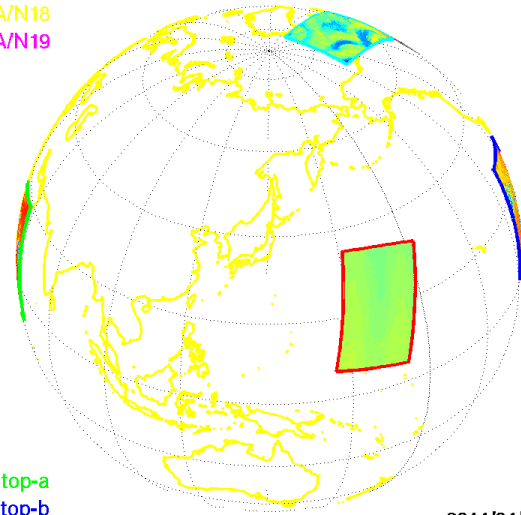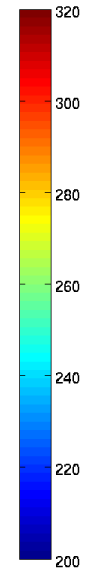## NOAA Satellites with International Partners

Tb (K) at 10.9 μm or 52.8 GHz

AMSU-A/N15
AMSU-A/N18
AMSU-A/N19

IASI/Metop-a
IASI/Metop-b
CrIS/SNPP
AIRS/Aqua

2014/04/30
18:00:00 UTC

Together the "Big Three" satellite systems measure critical variables for many applications

- Atmosphere
  - Temperature
  - Water Vapor
  - Ozone
  - Clouds
  - Lightning
  - Precipitation
  - Aerosols
  - Wind
  - CO, SO2, ...

- Land
  - Temperature
  - Soil moisture
  - Vegetation
  - Ice
  - Snow
  - Fires
  - Floods
  - Burnscars
  - Gas Flares*
  - Boats*

- Ocean
  - Temperature
  - Ocean/Coastal Water quality
  - Sediments
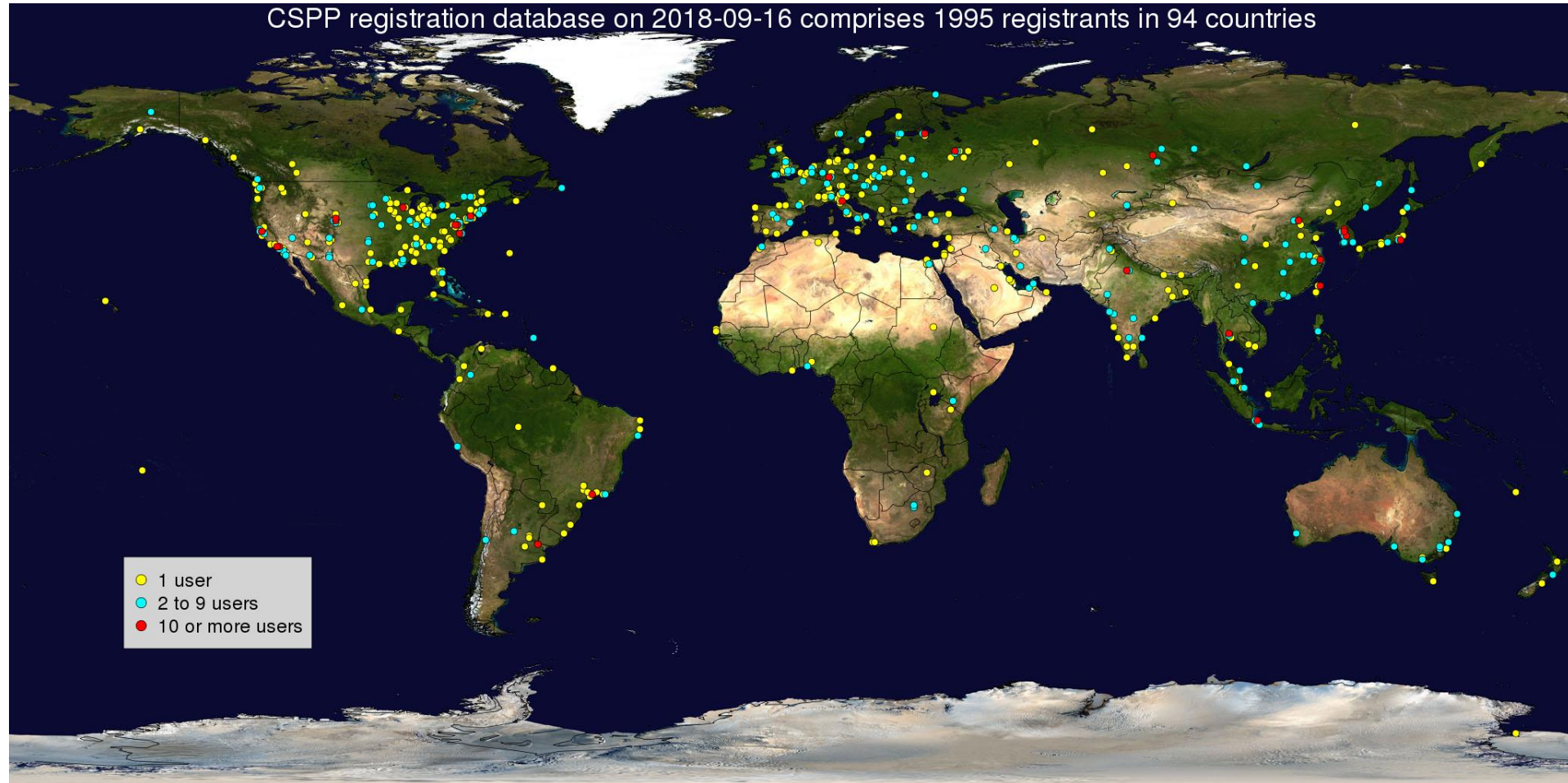 - Clouds
  - Aerosols
  - Wind

CSPP is striving to lower the users' barrier of entry to provide these complicated product software from many different sensors to the community!

What is CSPP?

• The Community Satellite Processing Package (CSPP) is a collection of freely available software for processing data from Low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO) meteorological satellites.

• CSPP LEO/GEO supports the creation of calibrated observational data, geophysical derived products, and images from visible, infrared, and microwave sensors.

• CSPP LEO is funded by NOAA JPSS Program Office & GEO is supported by NOAA NWAS

CSPP Registrants
2150 in 99 countries so far

CSPP registration database on 2018-09-16 comprises 1995 registrants in 94 countries

- ○ 1 user
- ○ 2 to 9 users
- ● 10 or more users

CSPP Users' Group Meeting

- Madison/WI, USA - May 2013
- Darmstadt, Germany – April 2015
- Madison/WI, USA - June 2017
- Chengdu, China – June 2019

2015 — EUMETSAT

2019 — Shangri-La Hotel

2017 — UW Campus

Direct Broadcast Applications Workshops
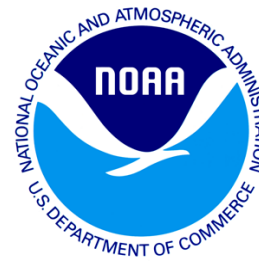
- **Promote the local use of satellite data**
  - Lectures and hands-on labs determined by student interest/needs
  - Lectures, labs, data and software freely distributed
    http://cimss.ssec.wisc.edu/dbs

- **How can the data inform decision making?**
  - Remote sensing complemented by local knowledge

- Encourages international collaborations between the global environmental science community

- Teach the principles of remote sensing to foster the next generation of scientists

- To date 19 workshops have been taught on 6 continents reaching students from more than 60 countries

CSPP LEO Software

CSPP Software	Product Description
1. SDR	S-NPP and NOAA-20 VIIRS, CrIS, and ATMS geolocated and calibrated earth observations.
2. VIIRS EDR	VIIRS imager cloud mask, active fires, surface reflectance, vegetation indices, sea surface temperature, land surface temperature, and aerosol optical depth.
3. HSRTV	Hyperspectral infrared sounder retrievals of temperature and moisture profiles, cloud properties, total ozone, and surface properties.
4. Polar2Grid	Reprojected imagery (single and multi-band) in GeoTIFF and AWIPS formats.
5. Hydra	Interactive visualization and interrogation of multispectral imagery and hyper spectral soundings.
6. MIRS	Microwave sounder retrievals of temperature and moisture profiles; surface properties; snow and ice cover; rain rate; and cloud/rain water paths.
7. CLAVR-x	Multispectral imager retrievals of cloud properties; aerosol optical depth; surface properties; ocean properties.
8. NUCAPS	Combined hyperspectral infrared sounder and microwave sounder retrievals of temperature and moisture profiles, cloud cleared radiances, and trace gases.

CSPP LEO Software Continued

CSPP Software	Product Description (continued)
9. IAPP	Combined infrared sounder and microwave sounder retrievals of temperature and moisture profiles, water vapor, total ozone, and cloud properties.
10. ACSPO	Multispectral imager retrievals of sea surface temperature.
11. Sounder Quicklook	Projected 2D maps of temperature and water vapor retrievals, and Skew-T profiles for individual atmospheric profiles.
12. VIIRS Imagery EDR	VIIRS imagery subset in Ground Track Mercator.
13. VIIRS Active Fires	S-NPP VIIRS M-Band fire and fire radiative power.
14. VIIRS Flood Detection	VIIRS 375m resolution global flood detections.

East China Normal University (ECNU) - Shanghai
Satellite Direct Broadcast Processing System (DBPS)

Installation: Direct Broadcast (DB) Satellite Receiving and Processing System

85m

Located at ECNU Science Bld A

EOS FES Commander Status

DB Receiving System: X & L dual bands for US, EU and China DB satellites

DBPS: real-time retrieval of atmosphere, ocean and land parameters

VCM
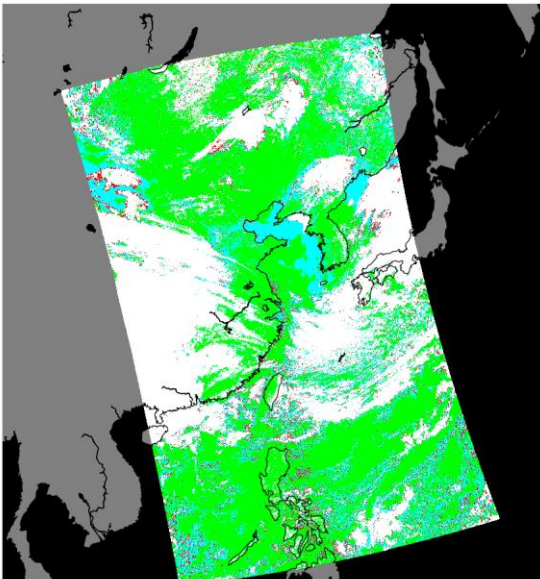
SST_EDR

confident clear probably clear probably cloudy confident cloudy
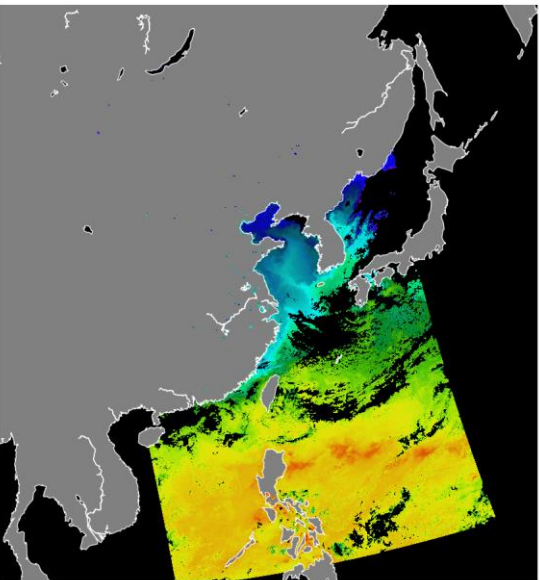
Sea Surface Temperature (K)
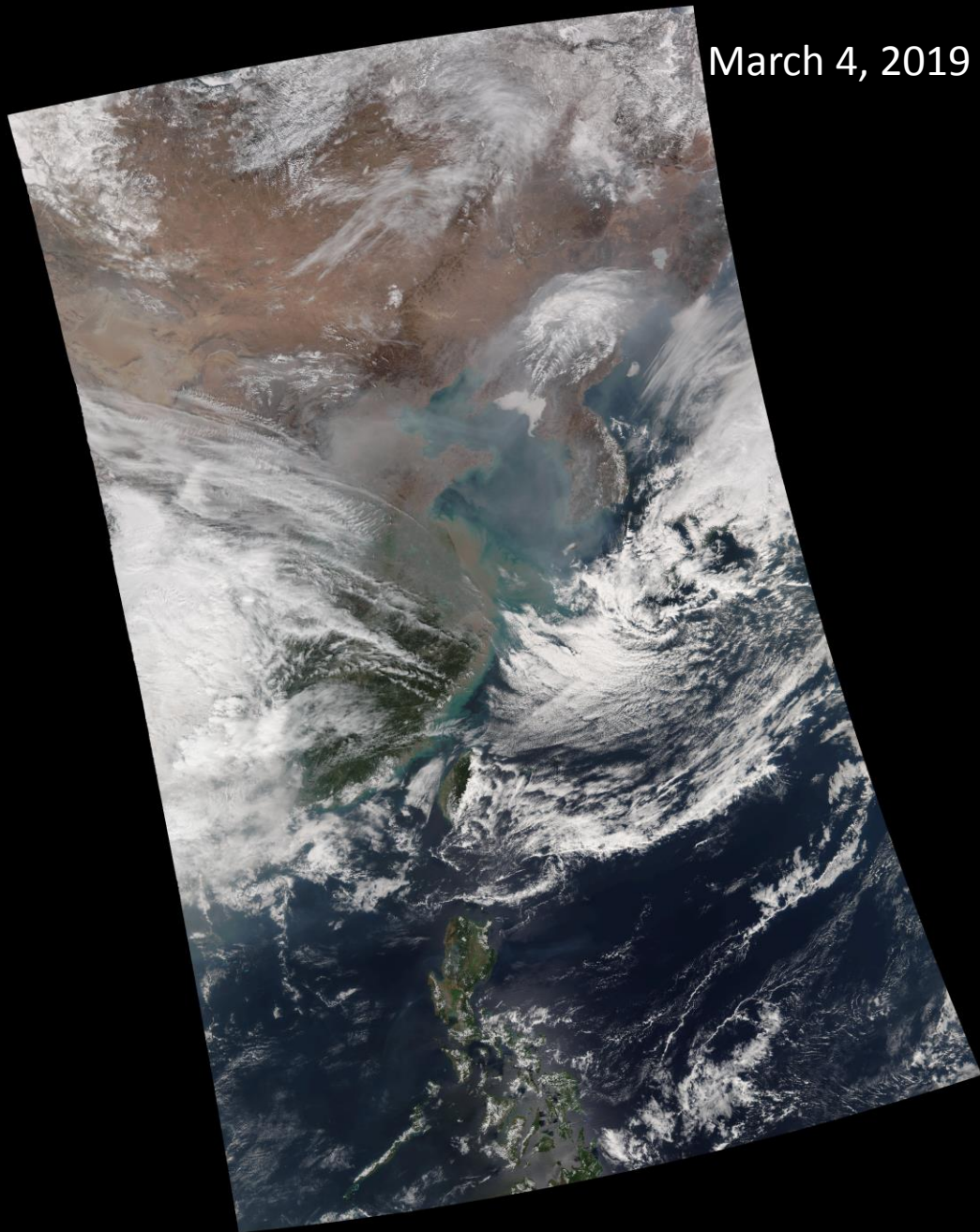
March 4, 2019

March 4, 2019
CSPP-NUCAPS
Retrieval
Temperature
@1014 mb

Temperature (K) at 1014 hPa
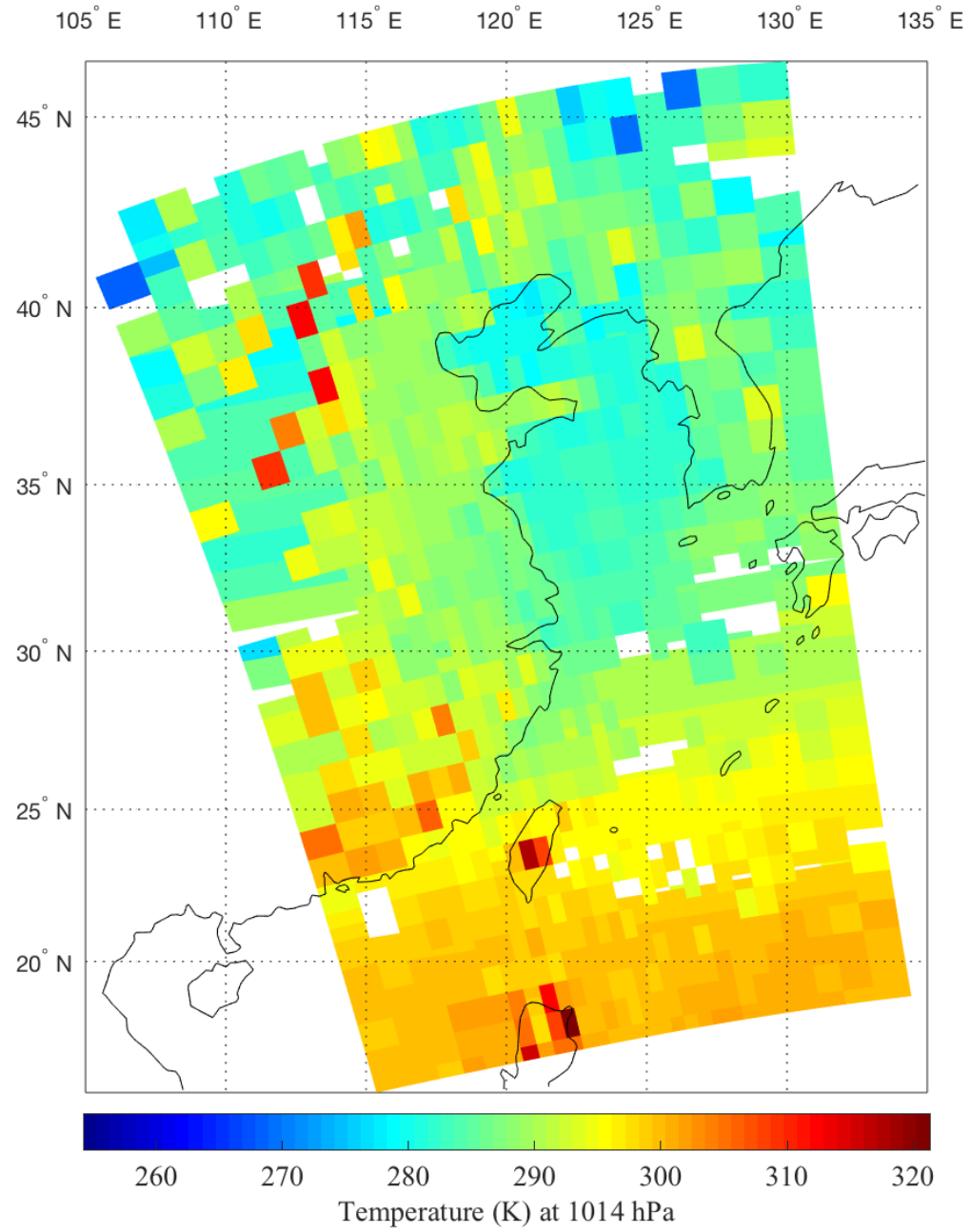
March 4, 2019
CSPP-NUCAPS
Retrieval
Water Vapor
@1014 mb

Water Vapor Mixing Ratio (g/g) at 1014 hPa ×10⁻³
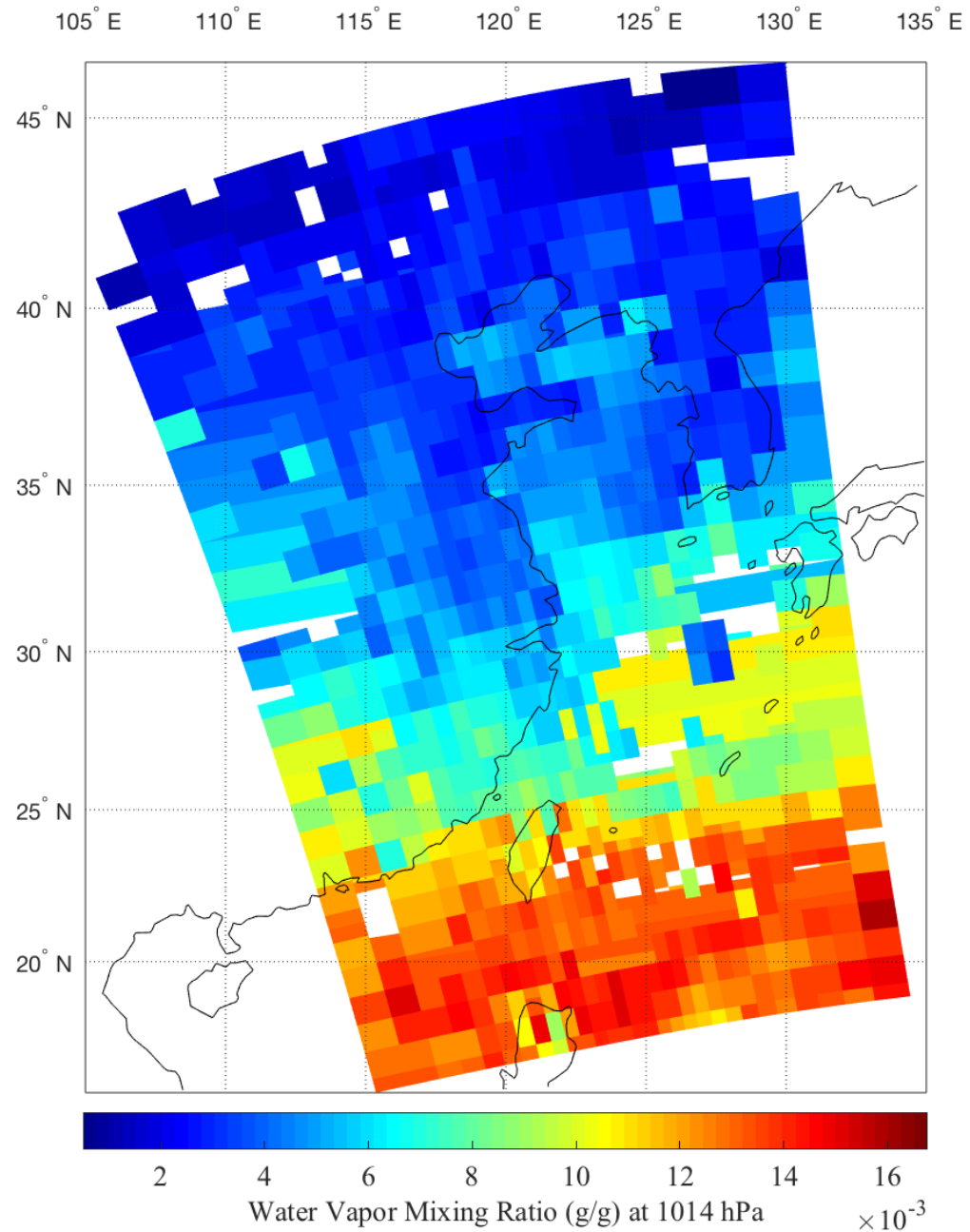
March 4, 2019
CSPP-NUCAPS
Retrieval
Ozone
@1014 mb

Ozone Mixing Ratio (ppb) at 1014 hPa
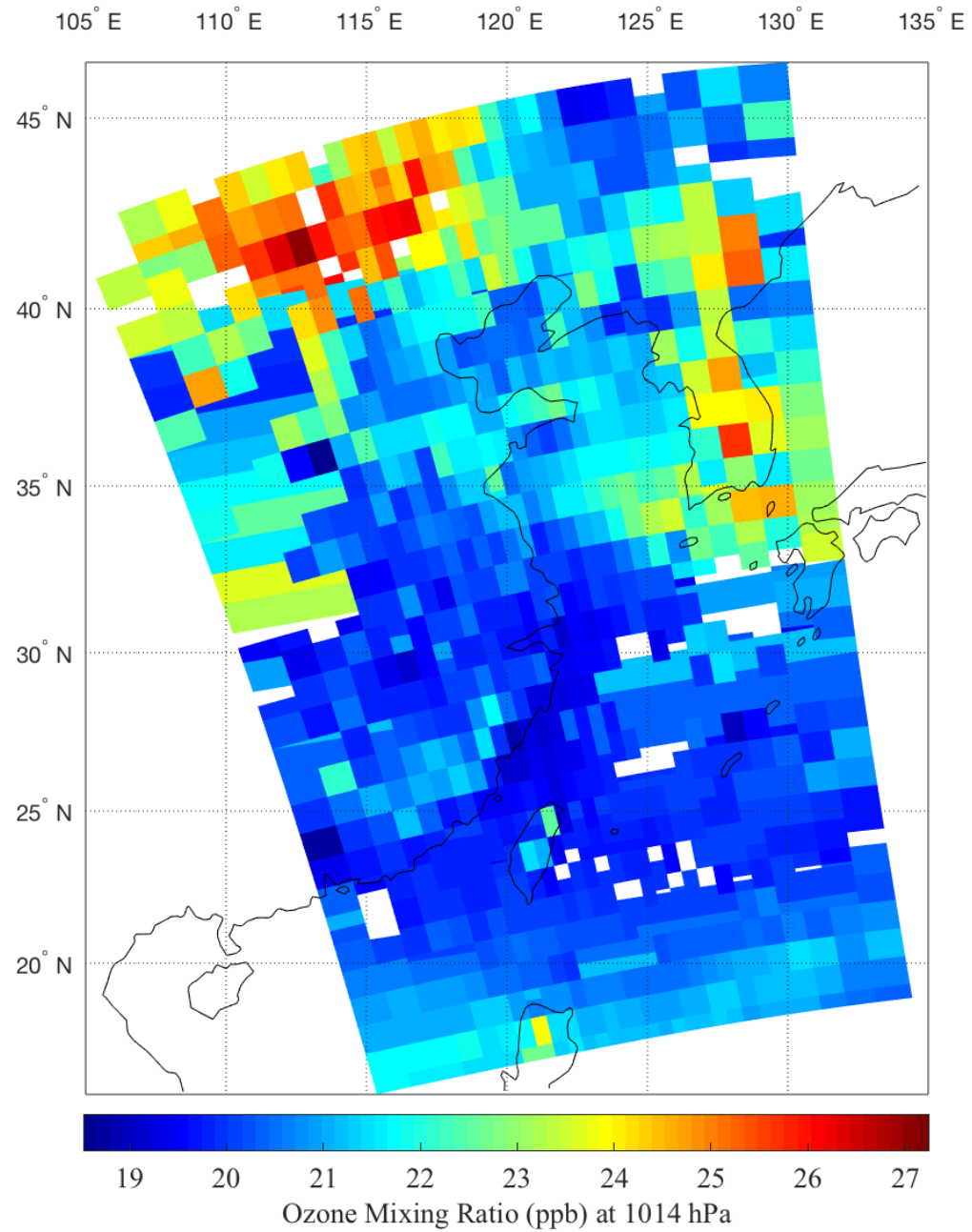
March 4, 2019
CSPP-NUCAPS
Retrieval
CO
@1014 mb

CO Mixing Ratio (ppb) at 1014 hPa
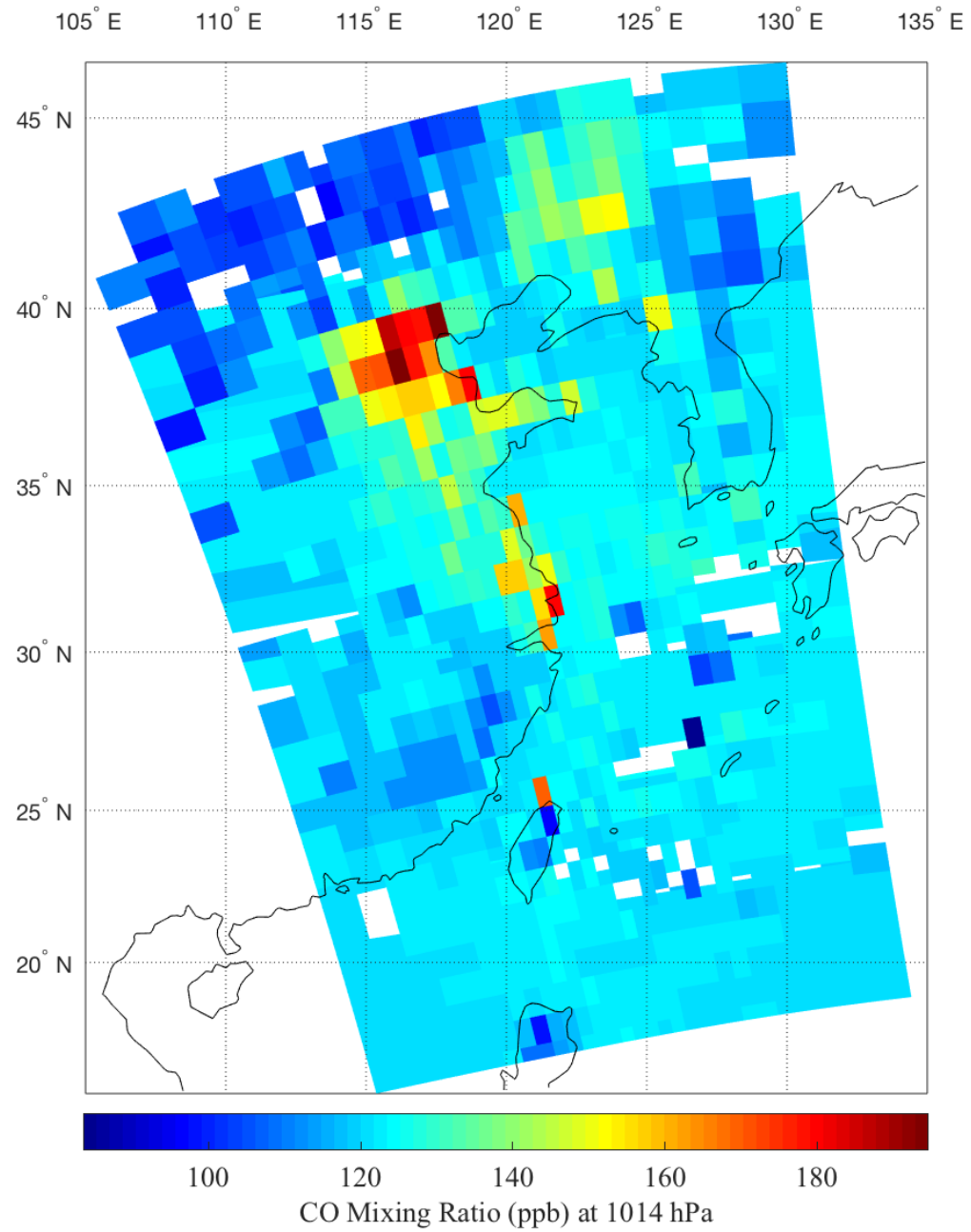
March 4, 2019
CSPP-NUCAPS
Retrieval
CH_4
@1014 mb

CH4 Mixing Ratio (ppb) at 1014 hPa
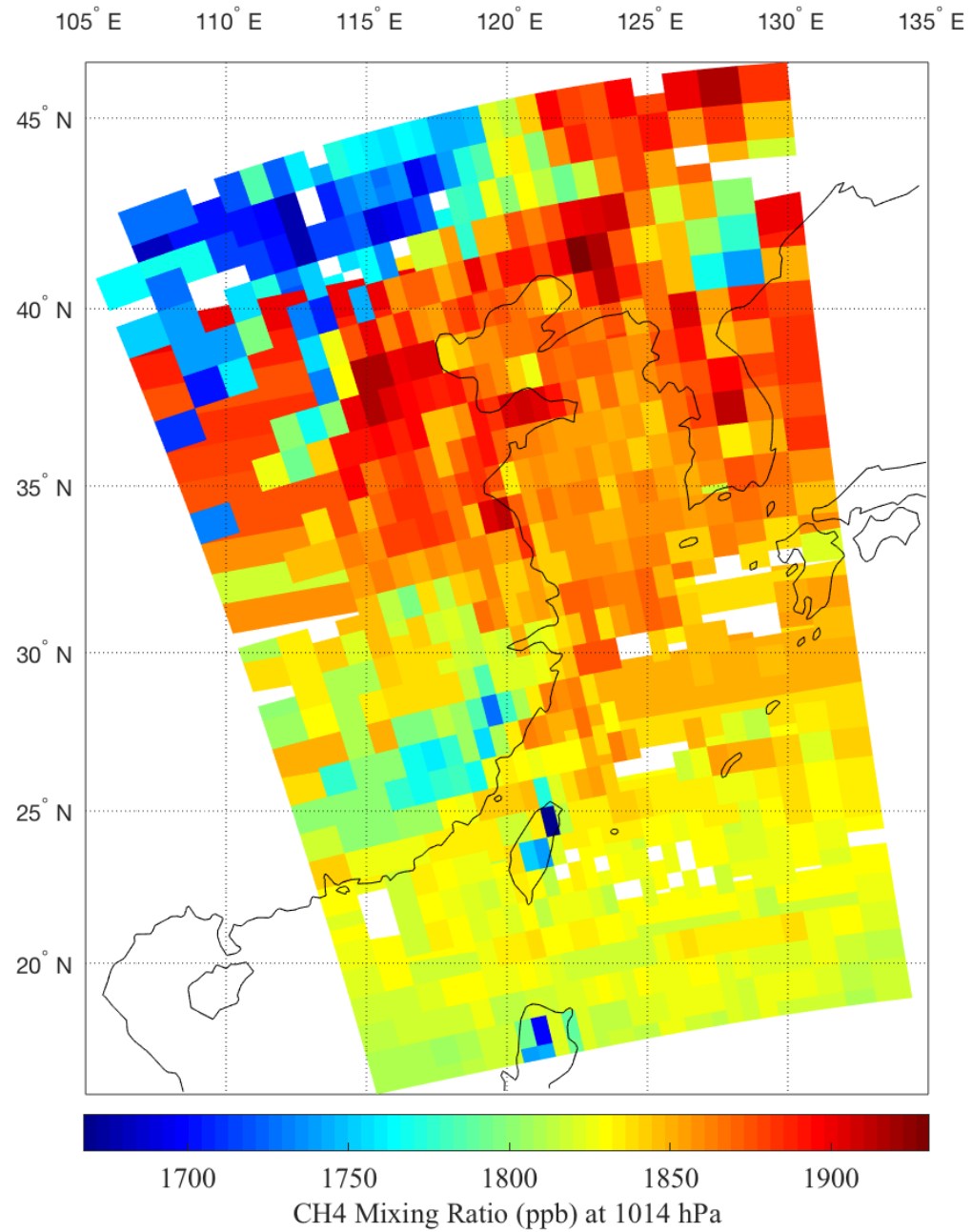
March 4, 2019
CSPP-NUCAPS
Retrieval
HNO$_3$
@1014 mb

HNO3 Mixing Ratio (ppb) at 1014 hPa
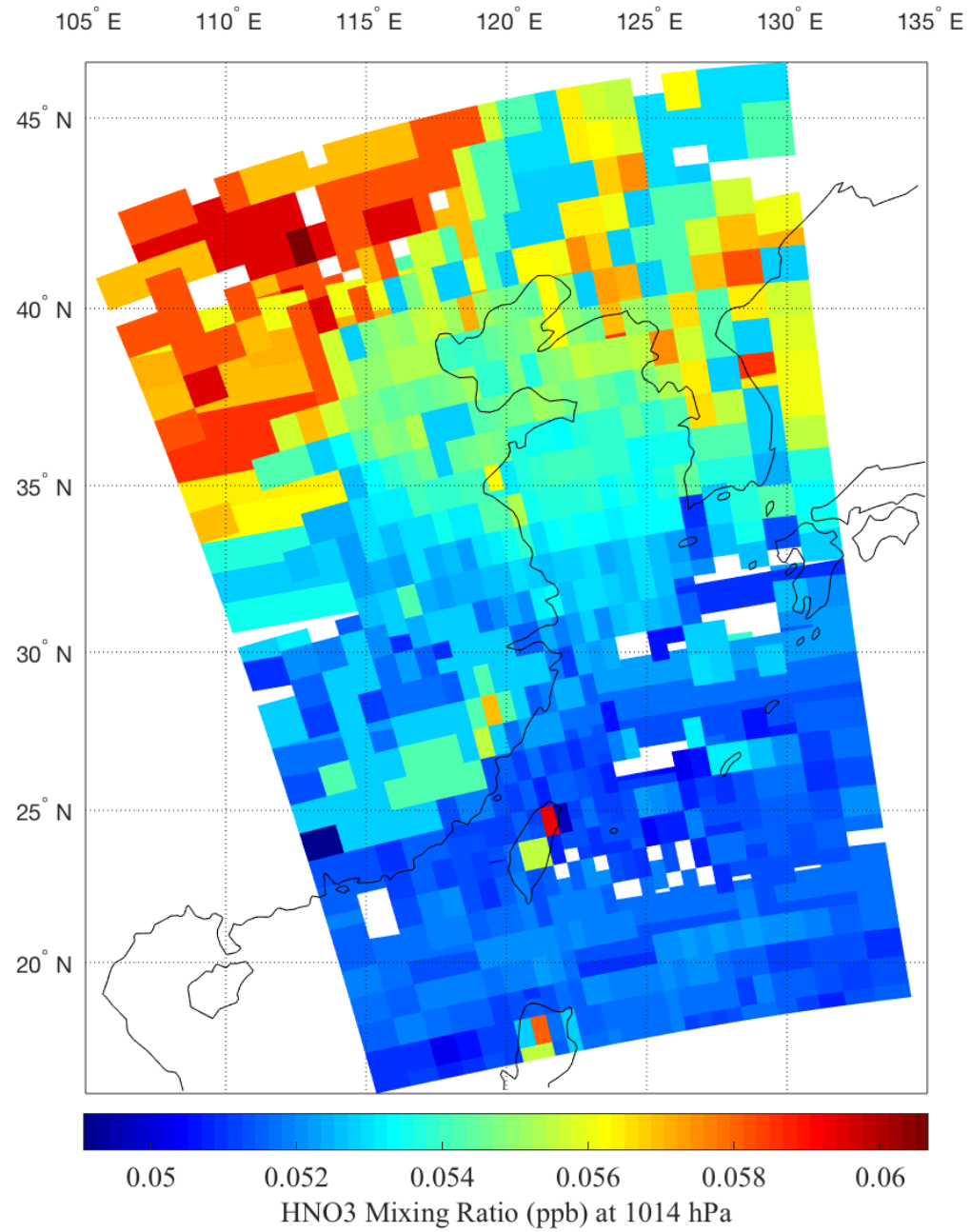
March 4, 2019
CSPP-NUCAPS
Retrieval
N_2O
@1014 mb

N2O Mixing Ratio (ppb) at 1014 hPa
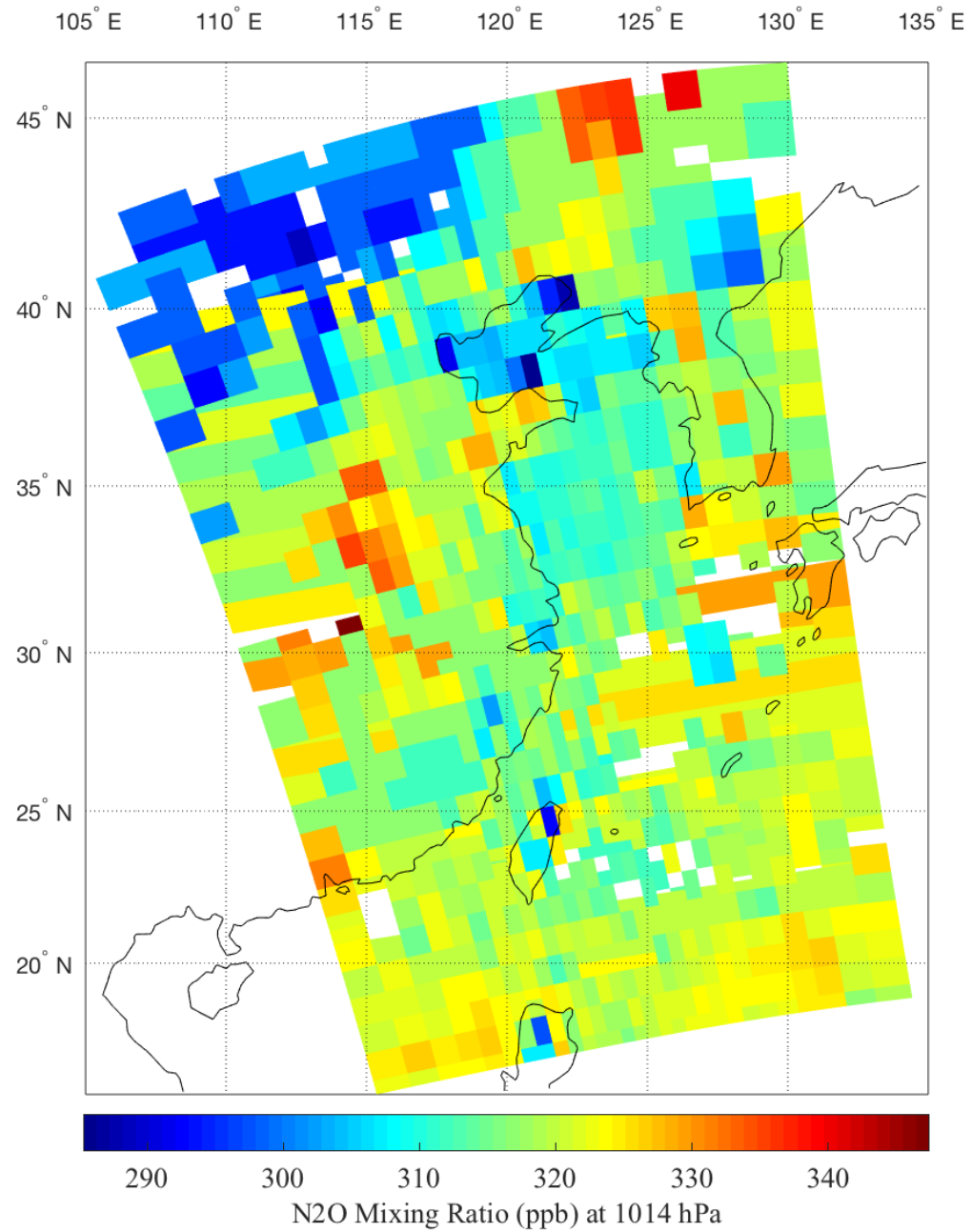
March 4, 2019
CSPP-NUCAPS
Retrieval
SO_2
@1014 mb
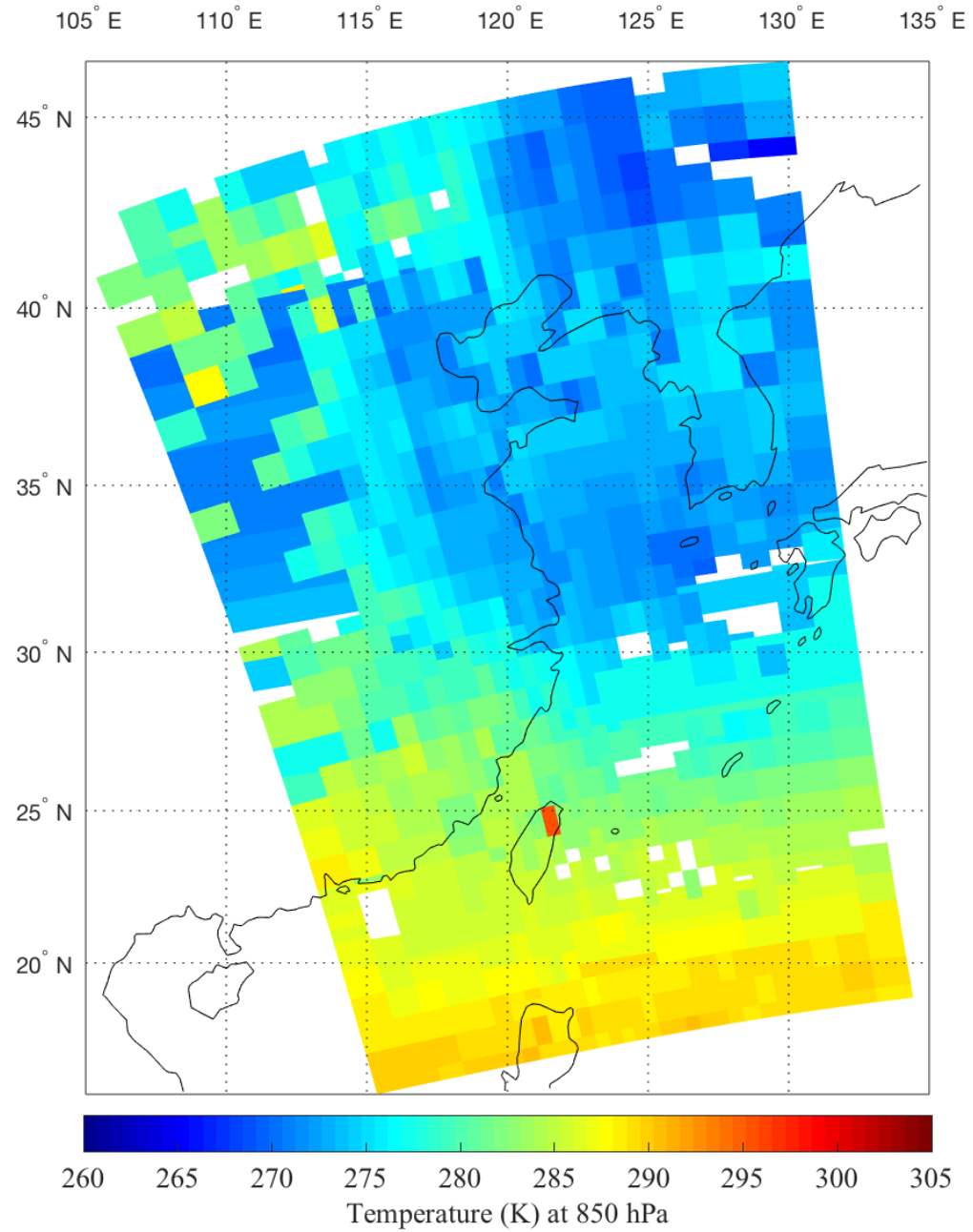
SO2 Mixing Ratio (ppb) at 1014 hPa

March 4, 2019
CSPP-NUCAPS
Retrieval
TEMPERATURE
@850 mb

Temperature (K) at 850 hPa

March 4, 2019
CSPP-NUCAPS
Retrieval
Water Vapor
@850 mb
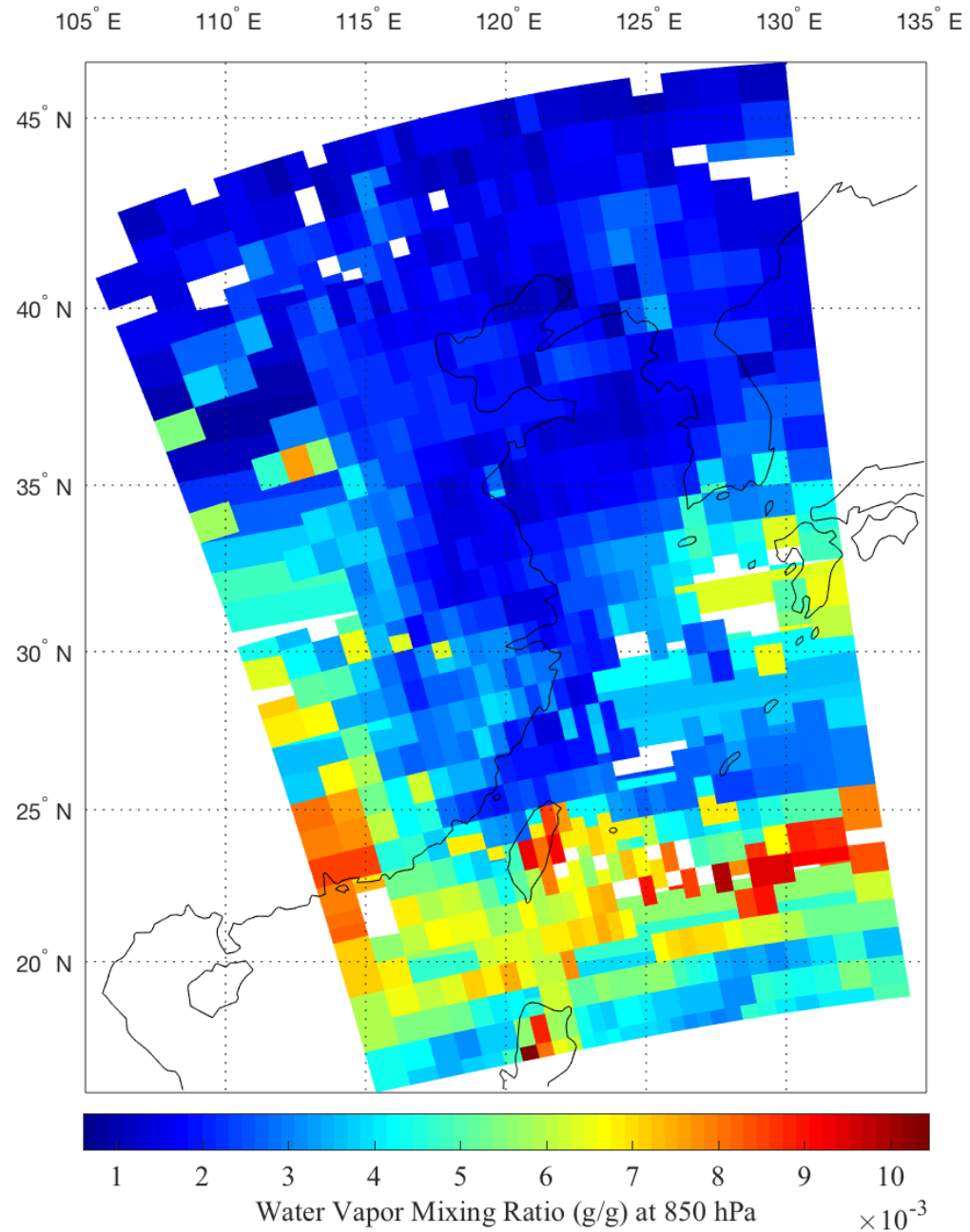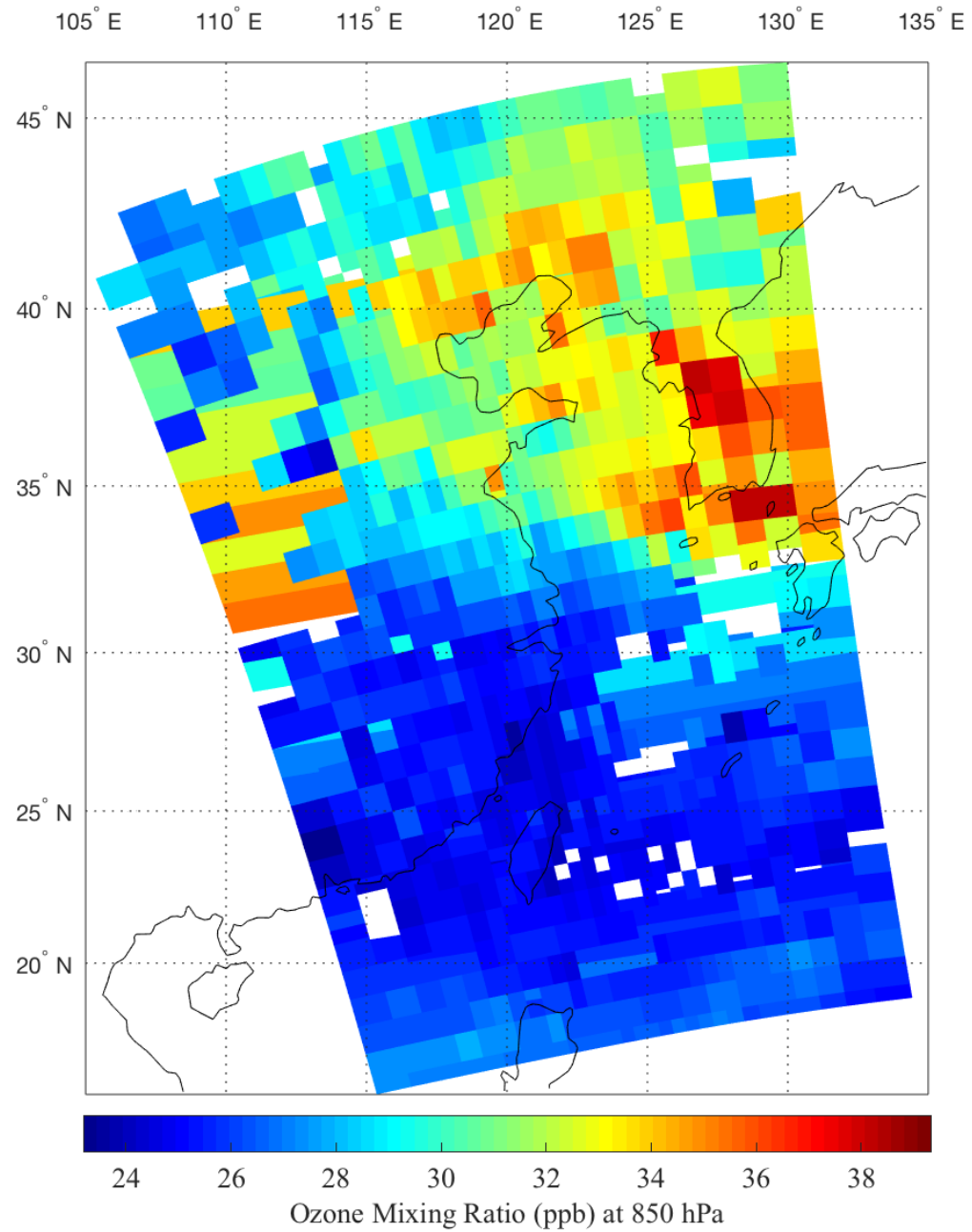
Water Vapor Mixing Ratio (g/g) at 850 hPa

March 4, 2019
CSPP-NUCAPS
Retrieval
OZONE
@850 mb

Ozone Mixing Ratio (ppb) at 850 hPa

March 4, 2019
CSPP-NUCAPS
Retrieval
CO
@850 mb

CO Mixing Ratio (ppb) at 850 hPa

March 4, 2019
CSPP-NUCAPS
Retrieval
CH_4
@850 mb

CH4 Mixing Ratio (ppb) at 850 hPa
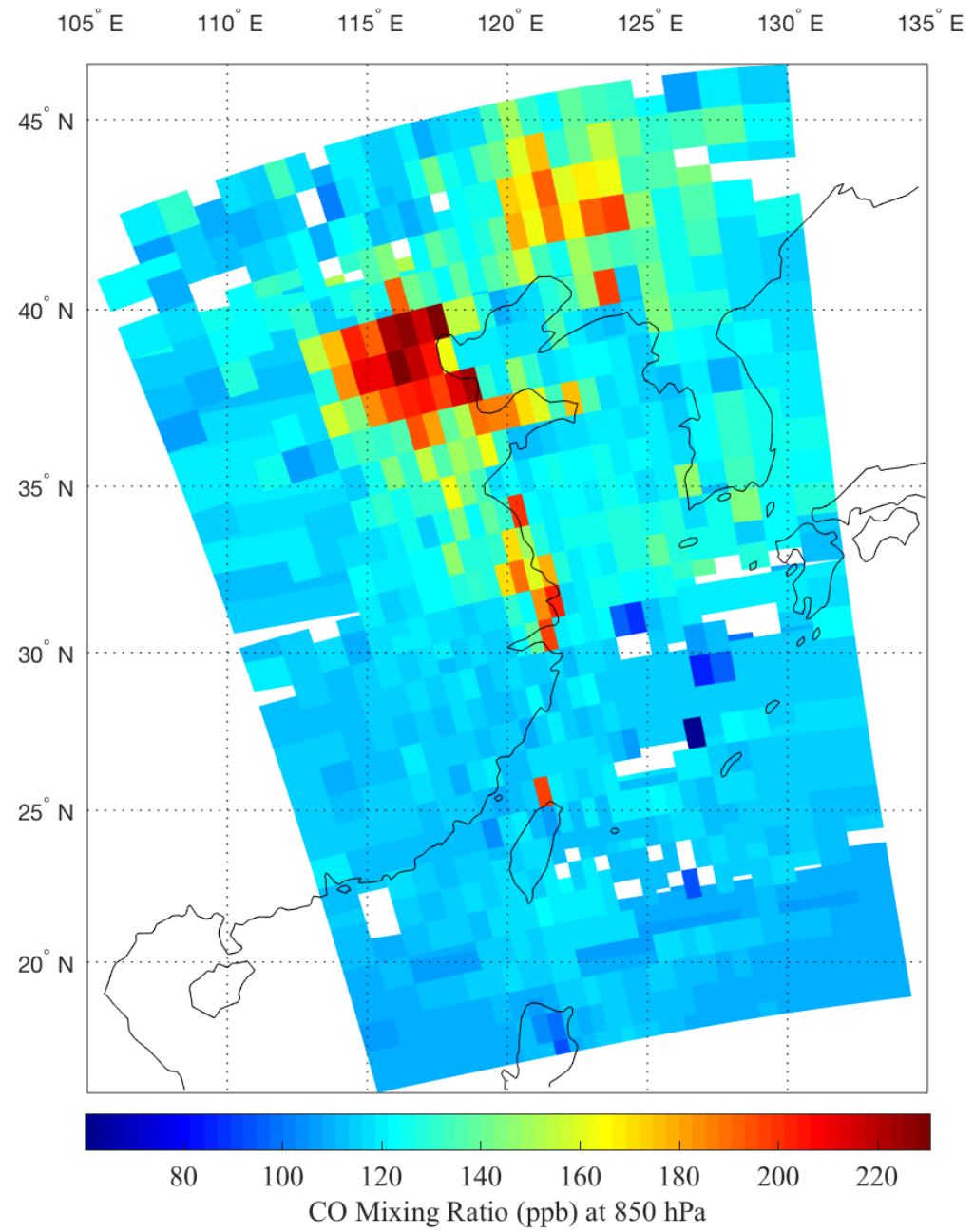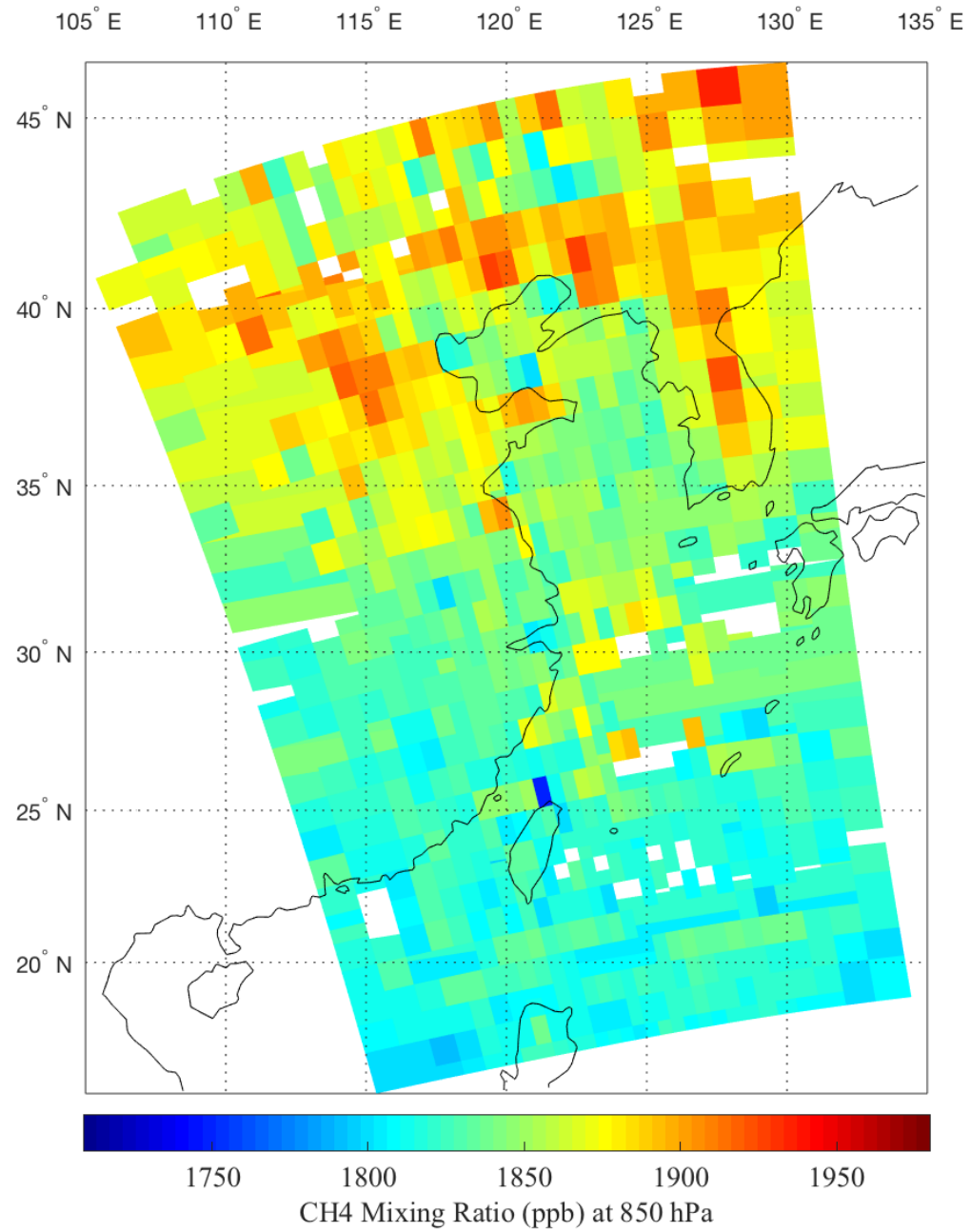
March 4, 2019
CSPP-NUCAPS
Retrieval
HNO_3
@850 mb

HNO3 Mixing Ratio (ppb) at 850 hPa
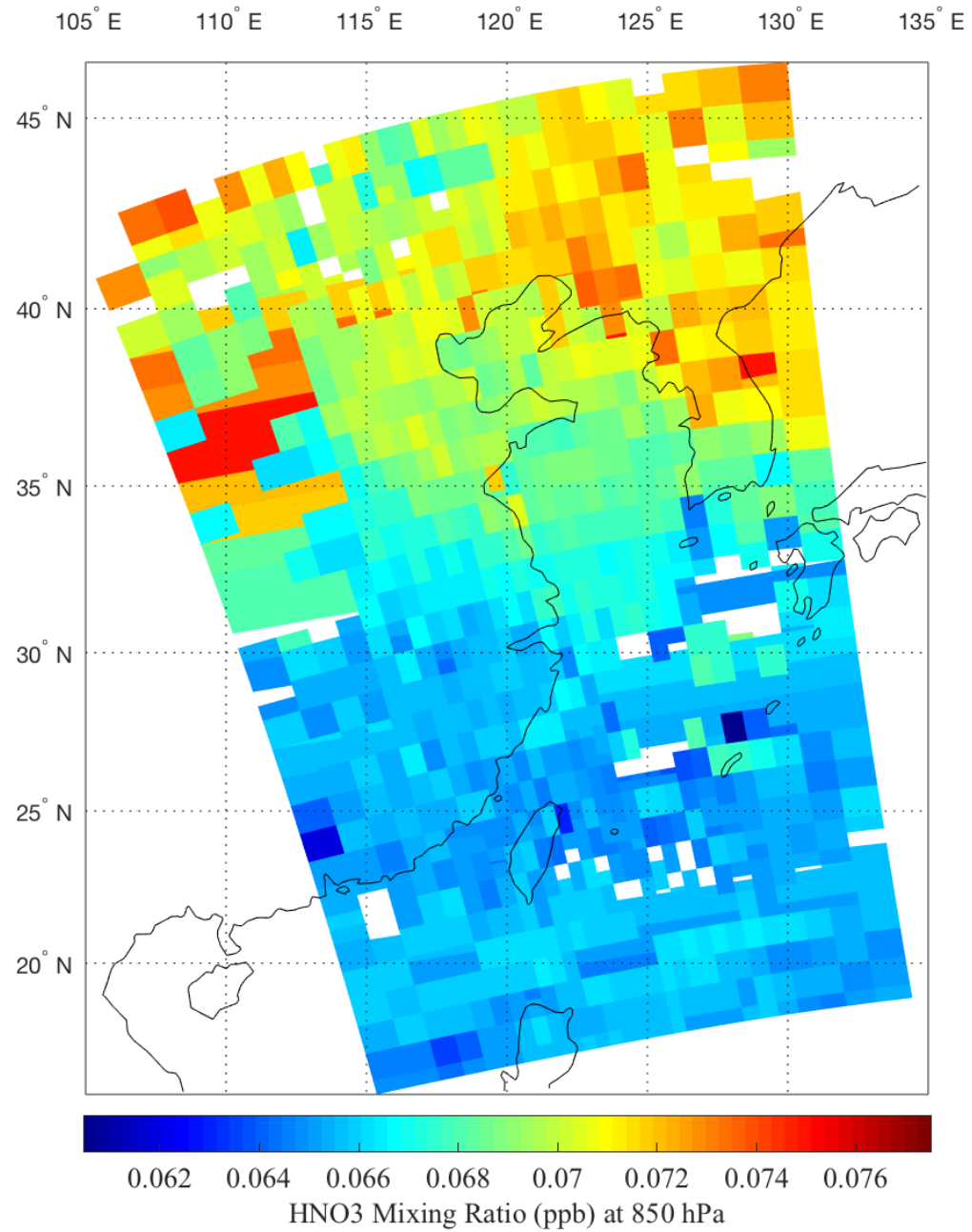
March 4, 2019
CSPP-NUCAPS
Retrieval
N_2O
@850 mb

N2O Mixing Ratio (ppb) at 850 hPa

March 4, 2019
CSPP-NUCAPS
Retrieval
SO$_2$
@850 mb

SO2 Mixing Ratio (ppb) at 850 hPa
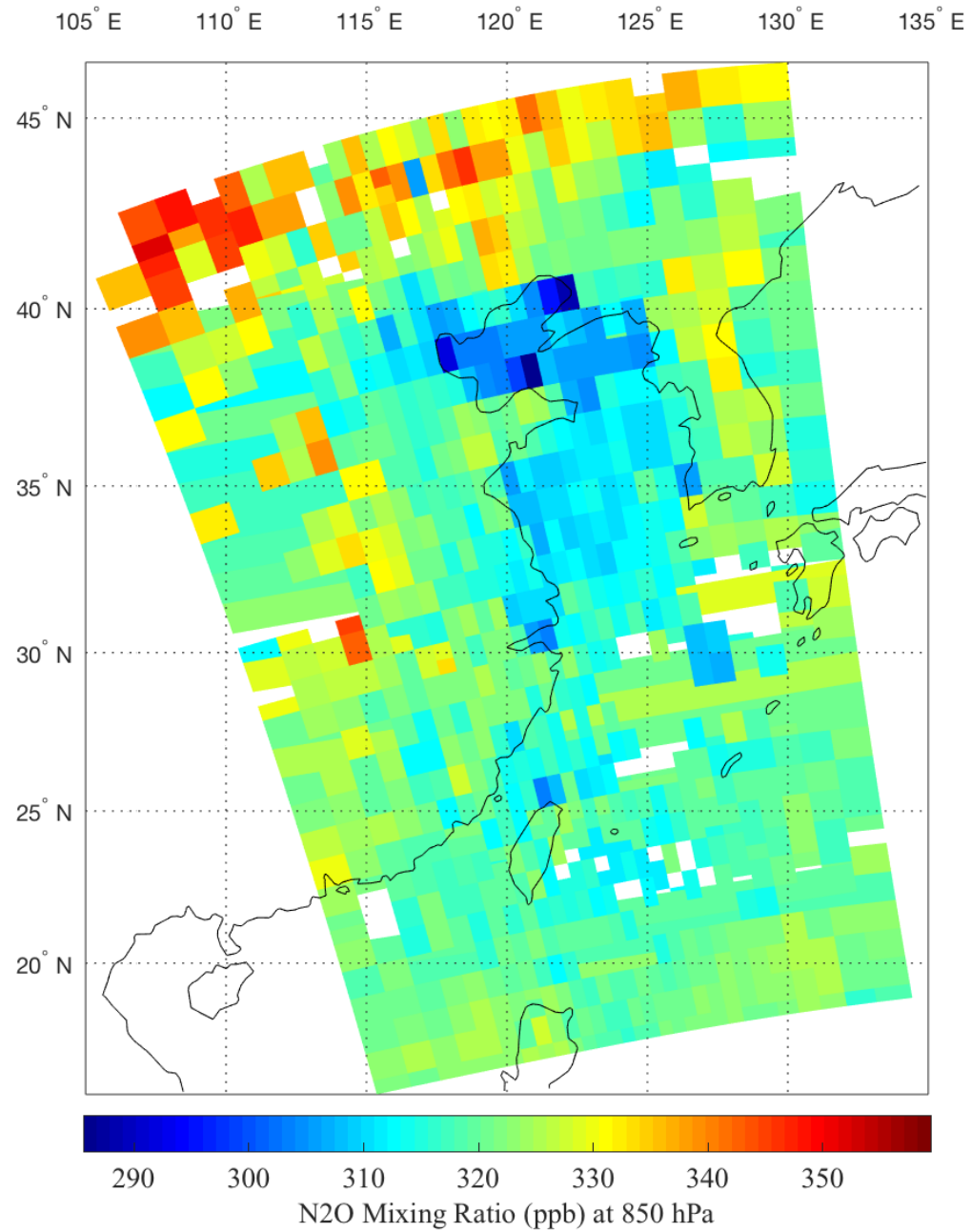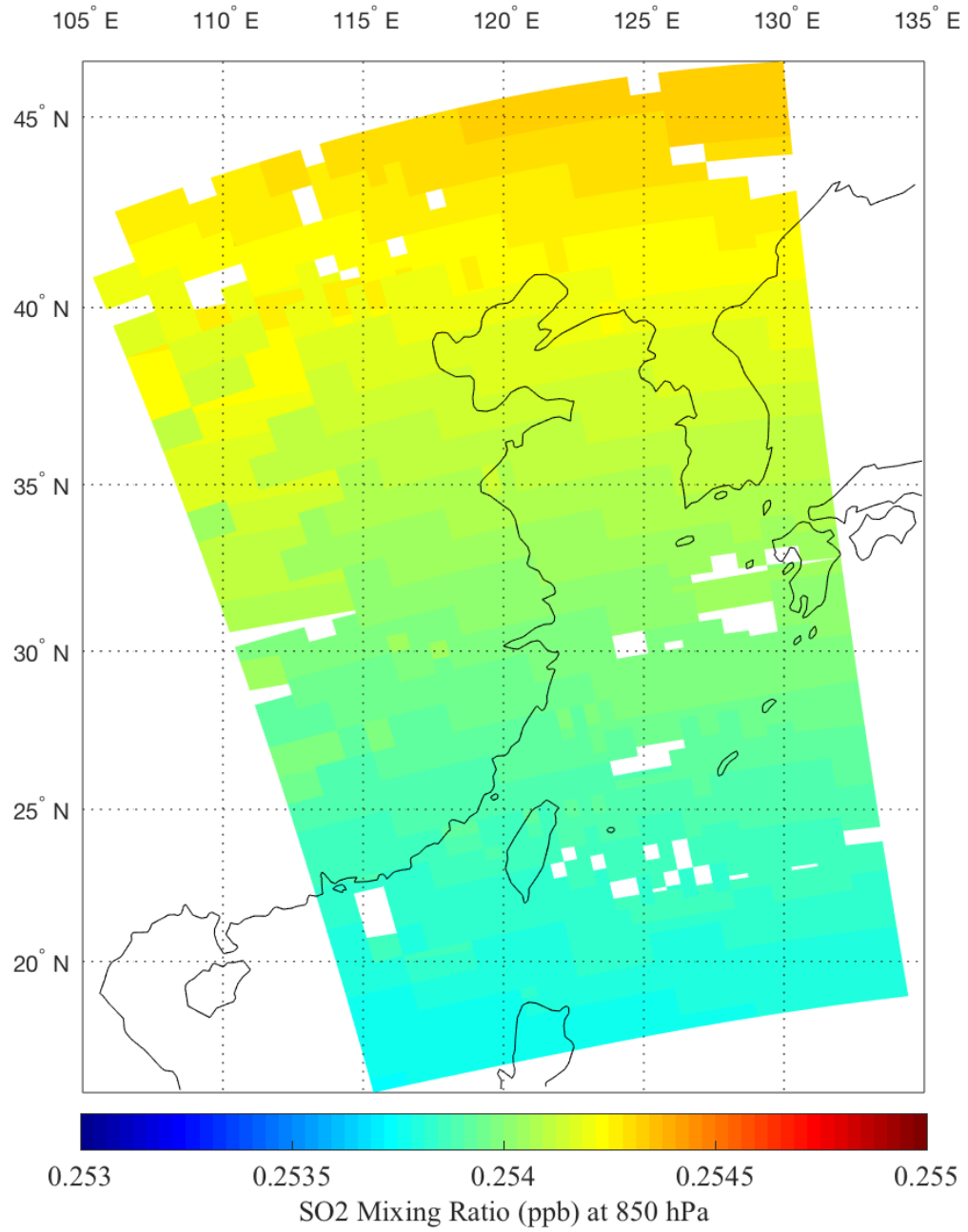
CSPP Geo CLAVR-x Cloud Products on AHI (1)

False Color Image (0.65, 0.86, 11μm)
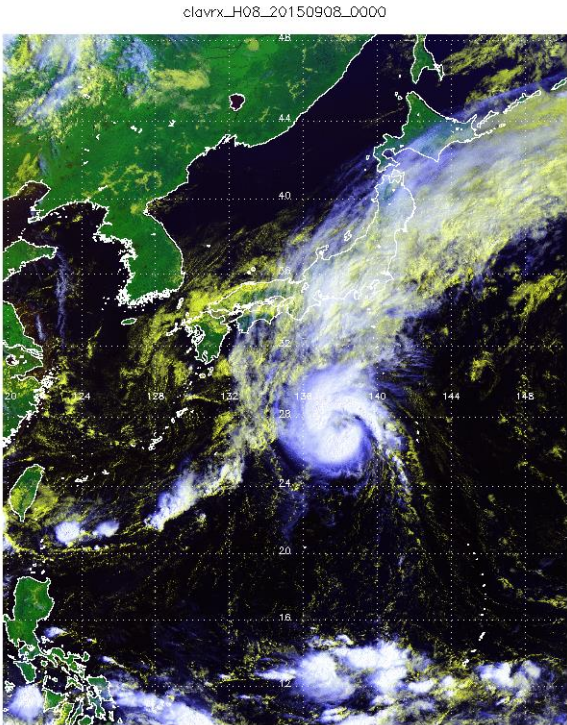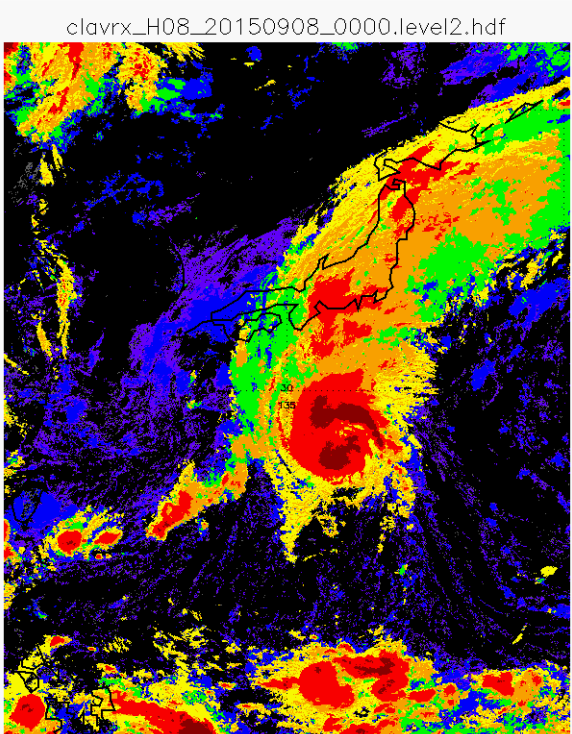
Cloud Type
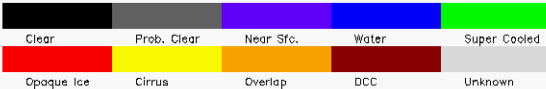
Cloud Optical Depth
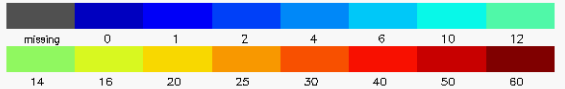
Himawari 8 - AHI, TS Etau, September 8, 2015

CSPP Geo CLAVR-x Cloud Products on AHI (2)

False Color Image (0.65, 0.86, 11μm)
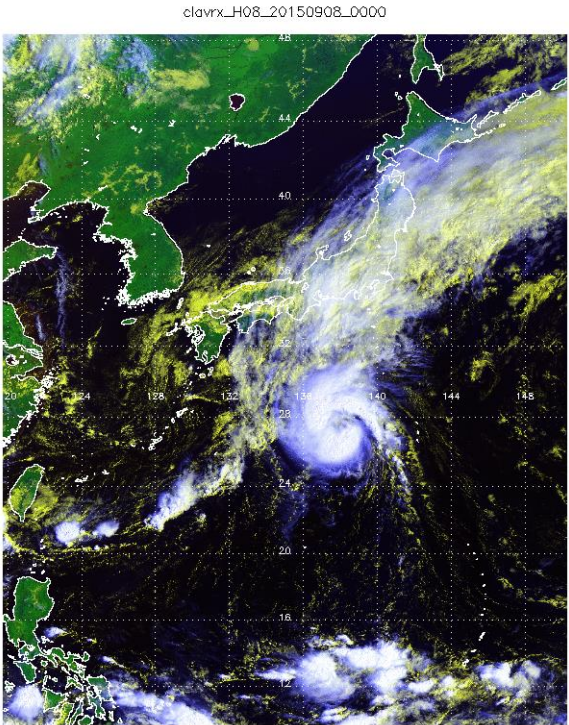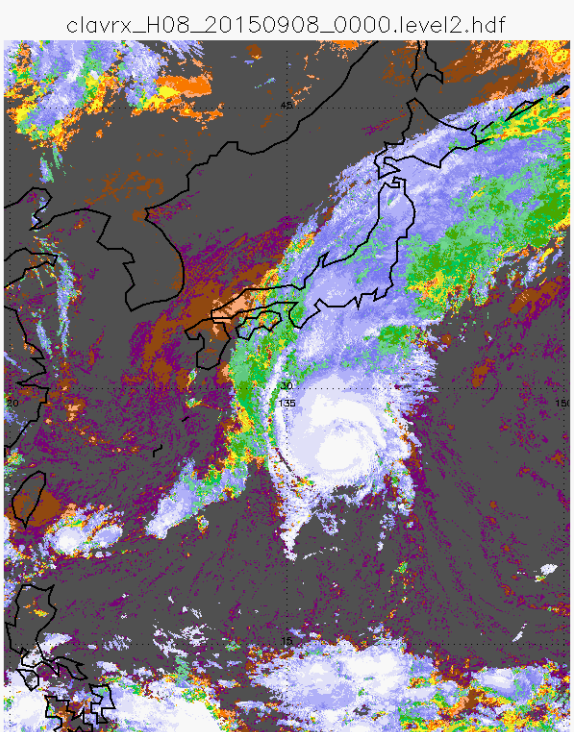
Cloud Top Temperature
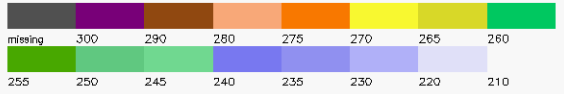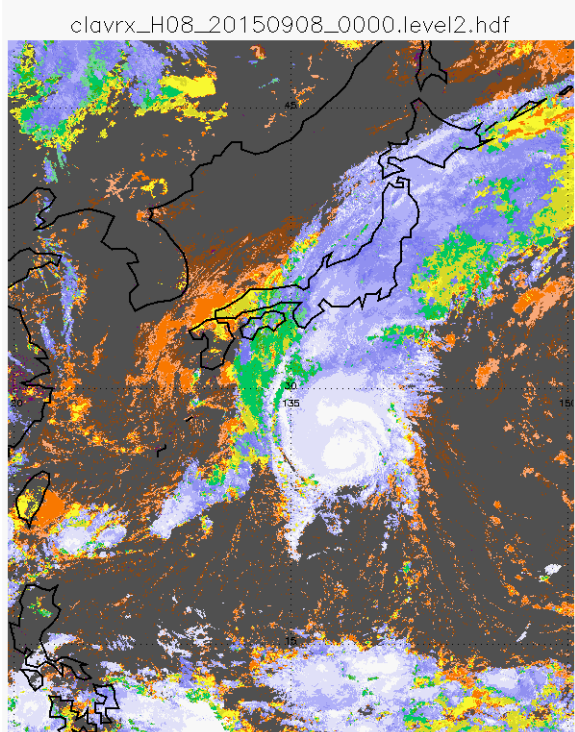
Cloud Top Pressure

Himawari 8 - AHI, TS Etau, September 8, 2015
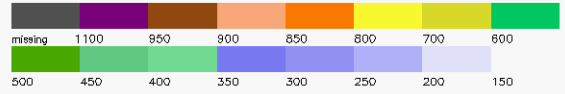
VIIRS image

Liquid Water Path (RWP+CLW), mm
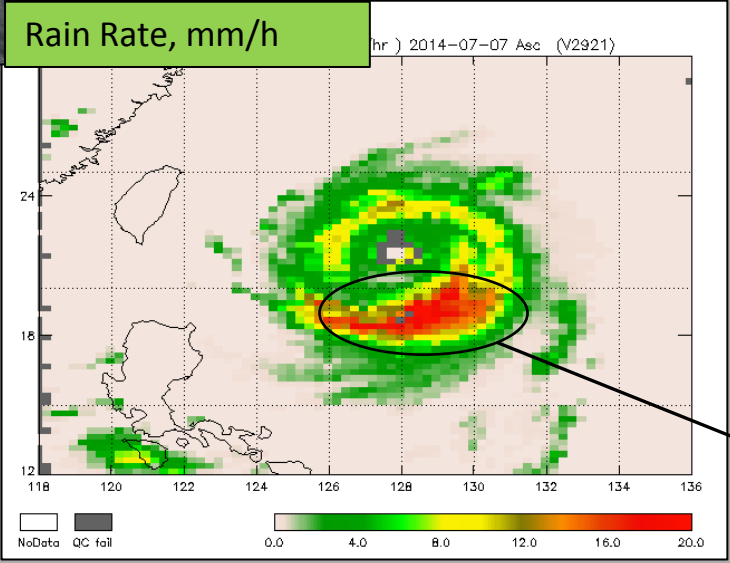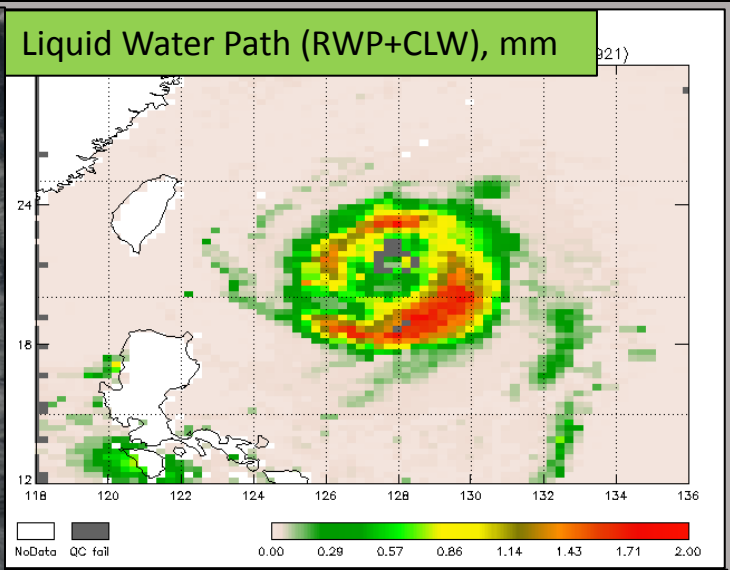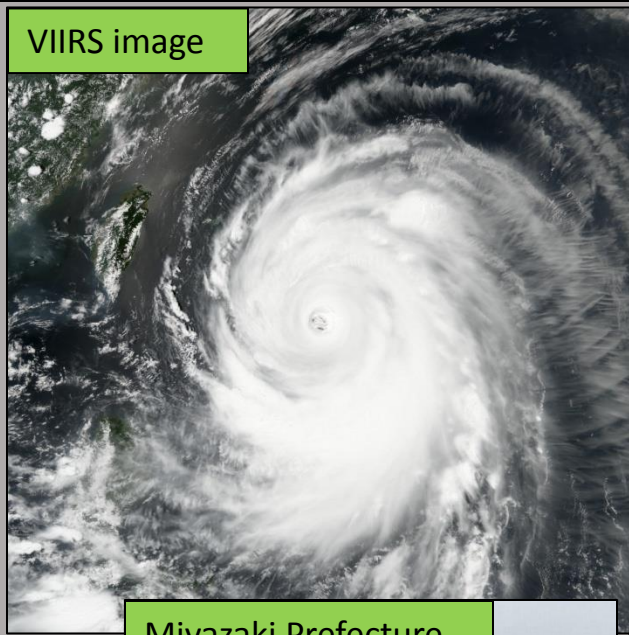
- SNPP/ATMS data

- Cyclone impacted Okinawa on 8 July

Miyazaki Prefecture

Rain Rate, mm/h

RR > 20 mm/h consistent with reports post-landfall (e.g. 340 mm in 24 h)

* CSPP_MIRS is V9.2

GOES-13
2345 UTC 27APR

Vilonia, AR ~00 UTC

MiRS MetopB RR (mm/h) ~0300 UTC

Produced with McIDAS-V
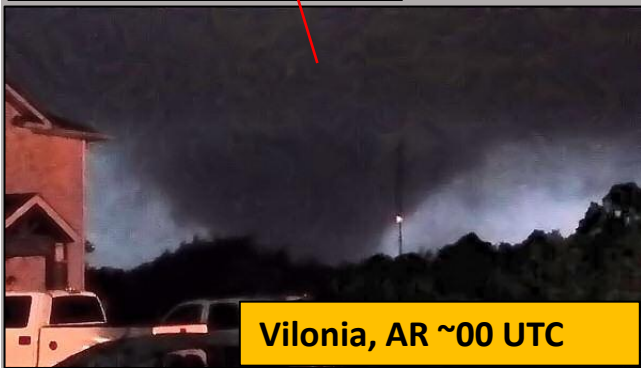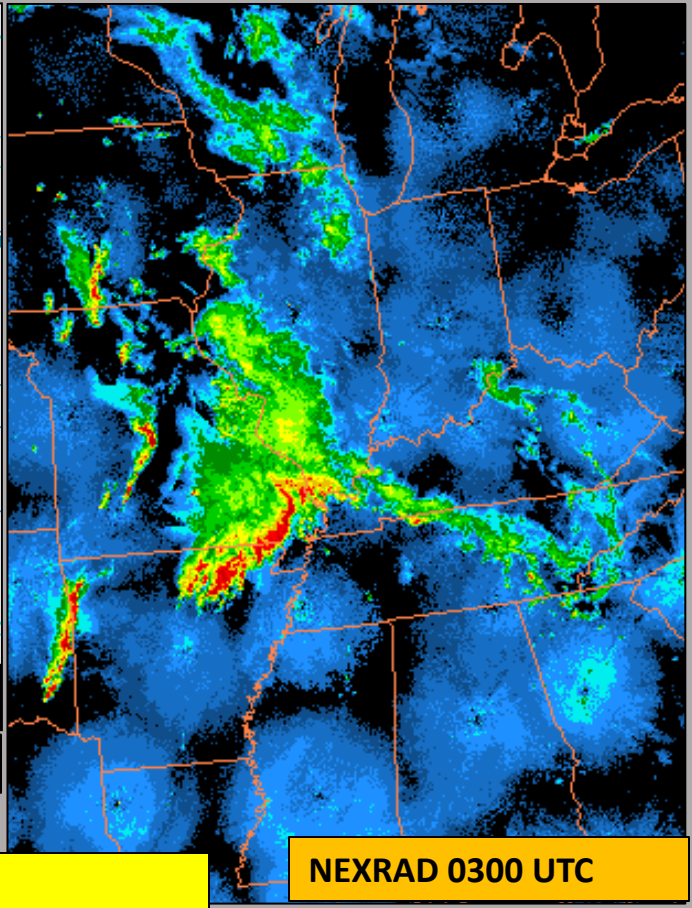
NEXRAD 0300 UTC
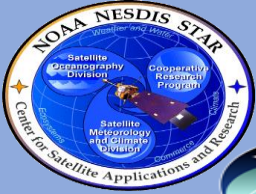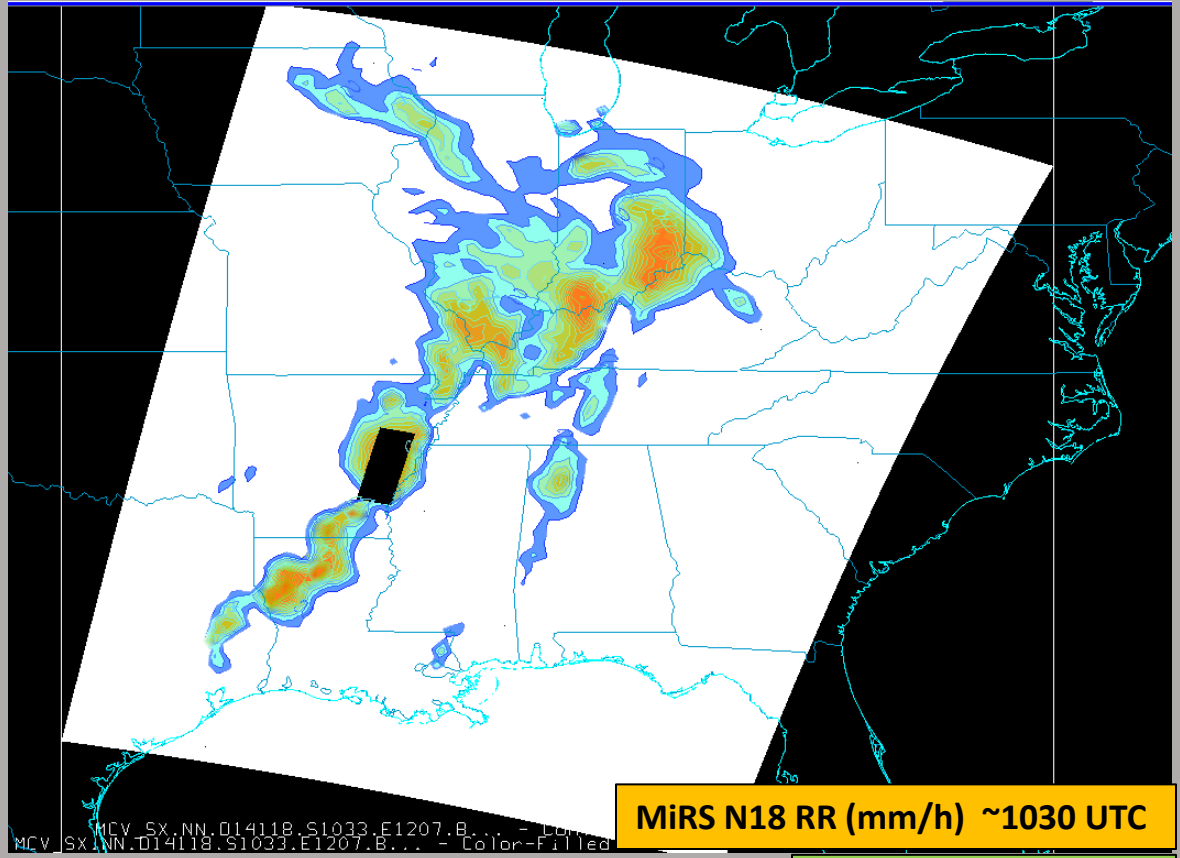
27-30 Apr 2014 Severe Weather
- 84 tornadoes, 35 fatalities
- Vilonia EF4 tornado 28 Apr 2014 ~0000 UTC
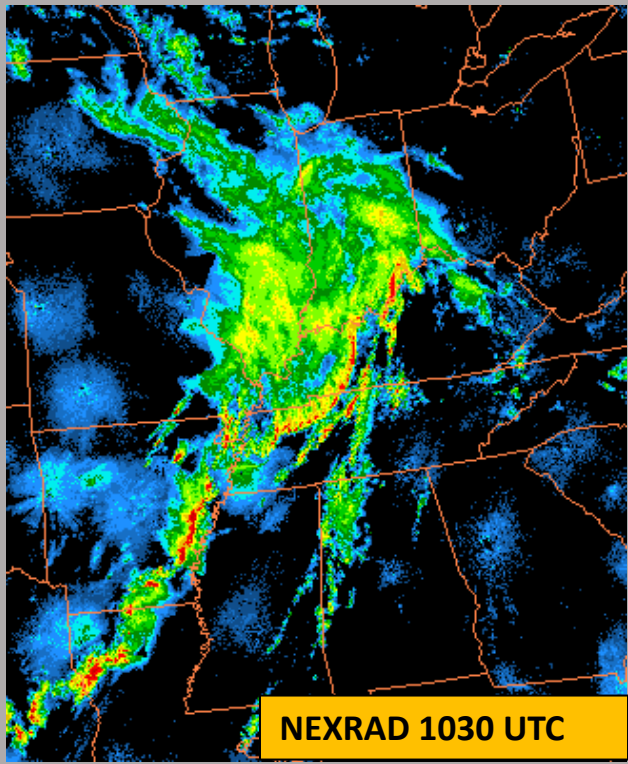- MetopB valid ~0300 UTC
- N18 vaild ~1030 UTC

MiRS N18 RR (mm/h) ~1030 UTC
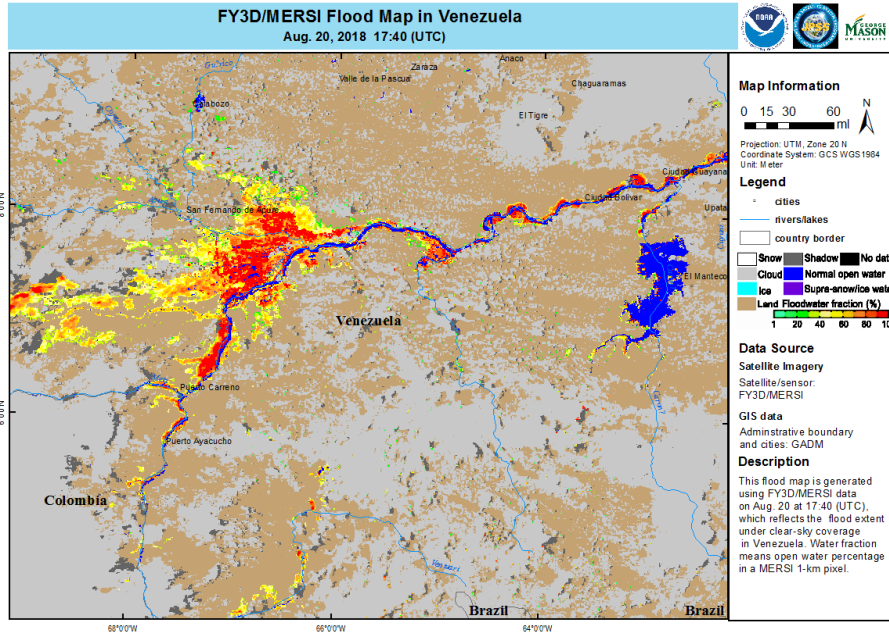
Produced with McIDAS-V
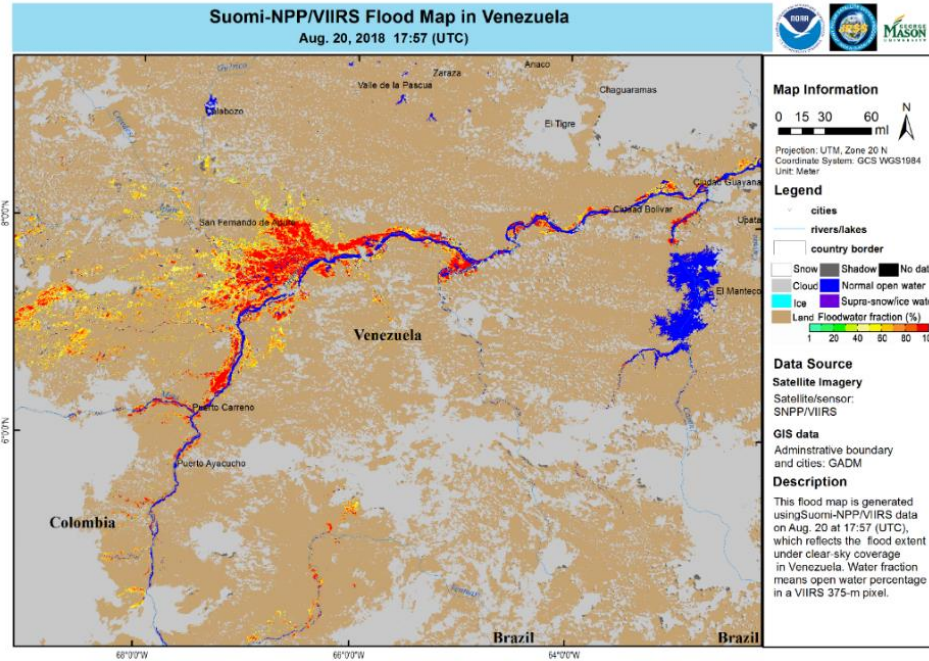
NEXRAD 1030 UTC

28 Apr 2014 Severe Weather
- **Vilonia tornado ~0000 UTC**
- **MetopB valid ~0300 UTC**
- **N18 vaild ~1030 UTC**

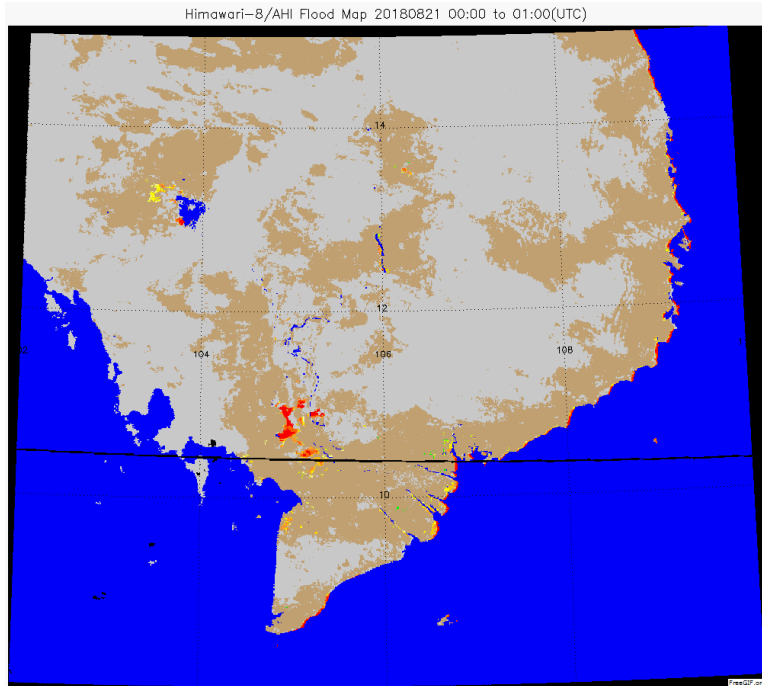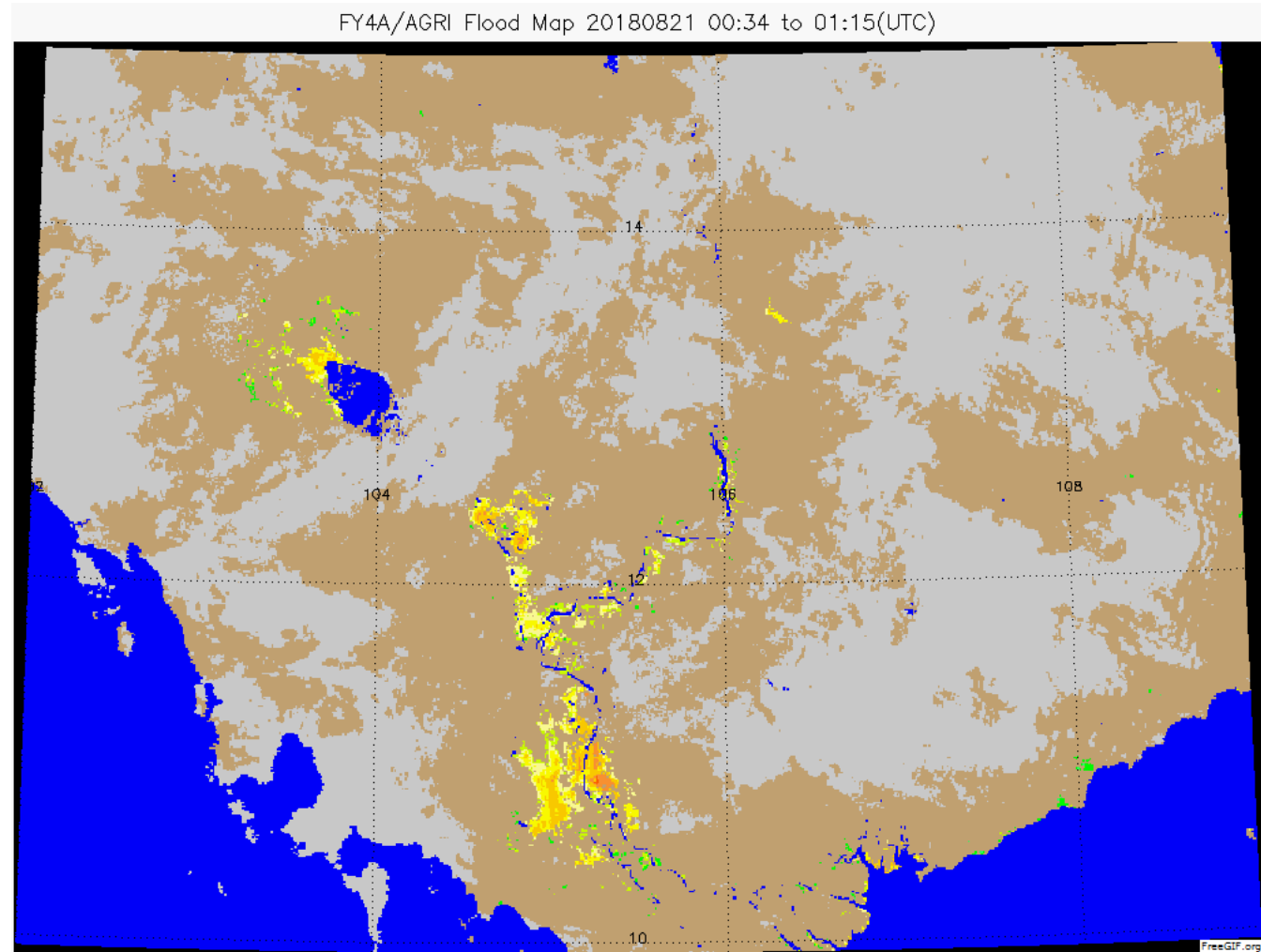# Flood Mapping from CMA FY3D vs JPSS (S-NPP) Observations

FY3D/MERSI

Using same algorithm (available from CSPP) for both FY3D & S-NPP producing consistent flood product

S-NPP/VIIRS

Slide curtosey of Sanmei Li & Donglian Sun
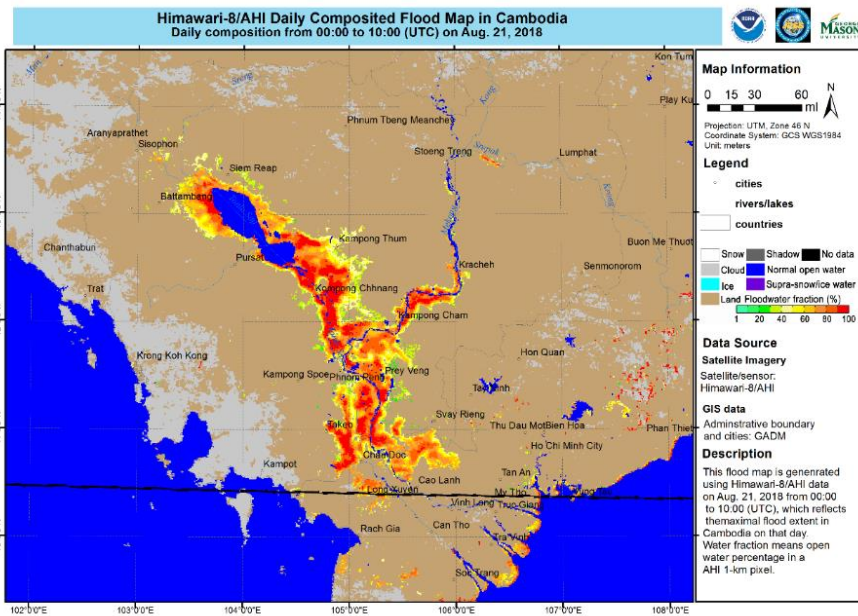
Flood Mapping from First FY4A (AGRI- GEO) results

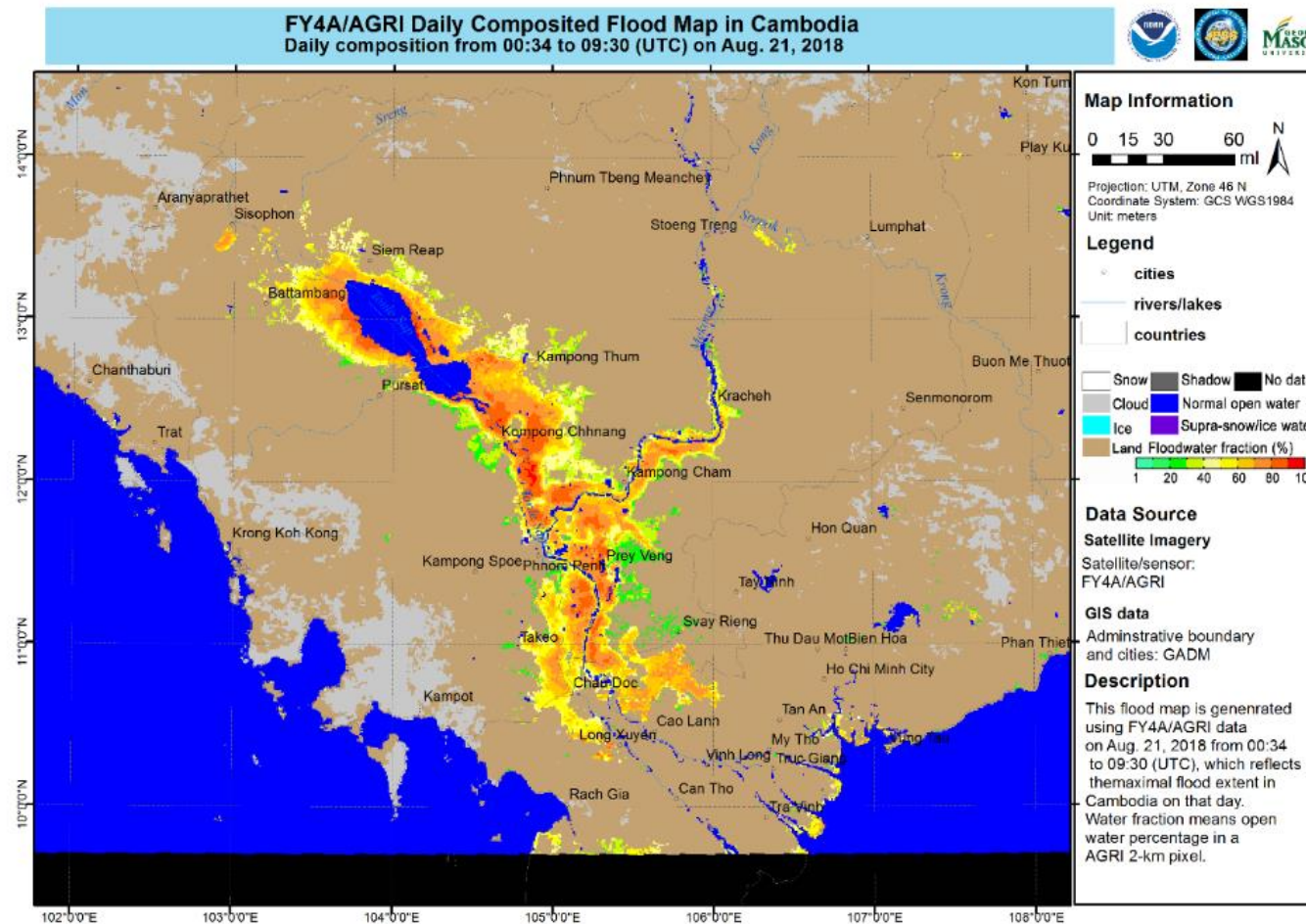
Himawari/AHI

FY4A/AGRI

Slide curtosey of Sanmei Li & Donglian Sun

Flood Mapping from First FY4A (AGRI- GEO) results

~ 10 hour composite

Himawari/AHI

FY4A/AGRI

Slide curtosey of Sanmei Li & Donglian Sun

2018-04-22 21:00UTC
17.31S 54.14W

2018-04-22 21:00UTC
48.48N 107.84W

	Snow		Shadow		No data
	Cloud		Normal open water		
	Ice		Supra-snow/ice water		
	Land	Floodwater fraction (%)			

1 20 40 60 80 100
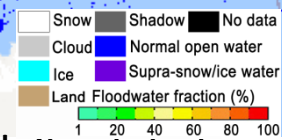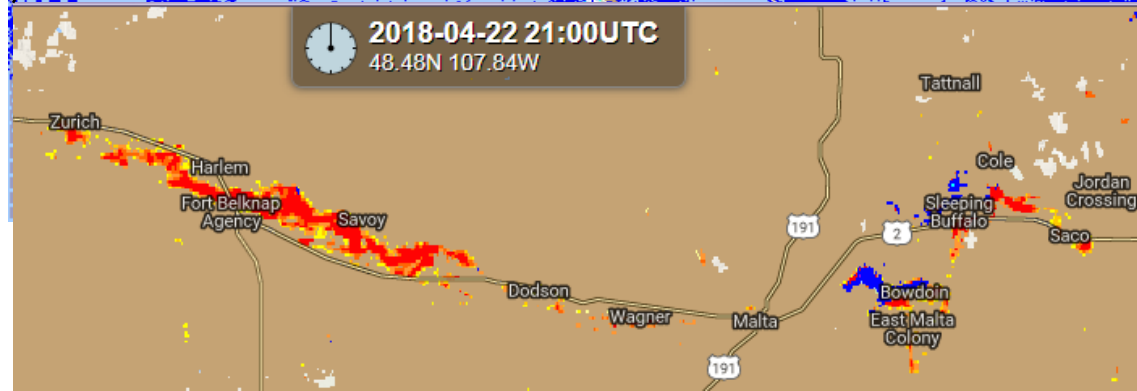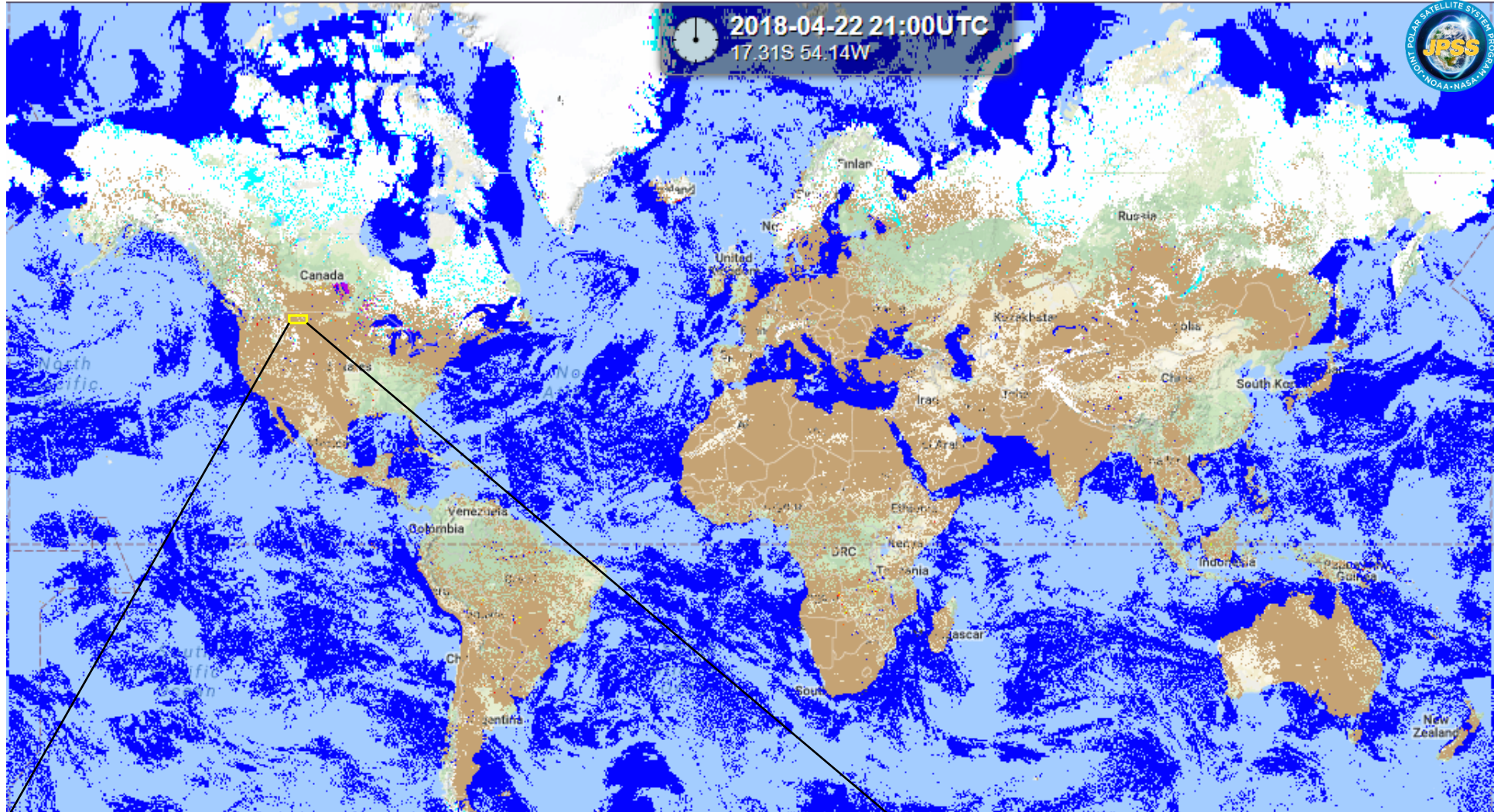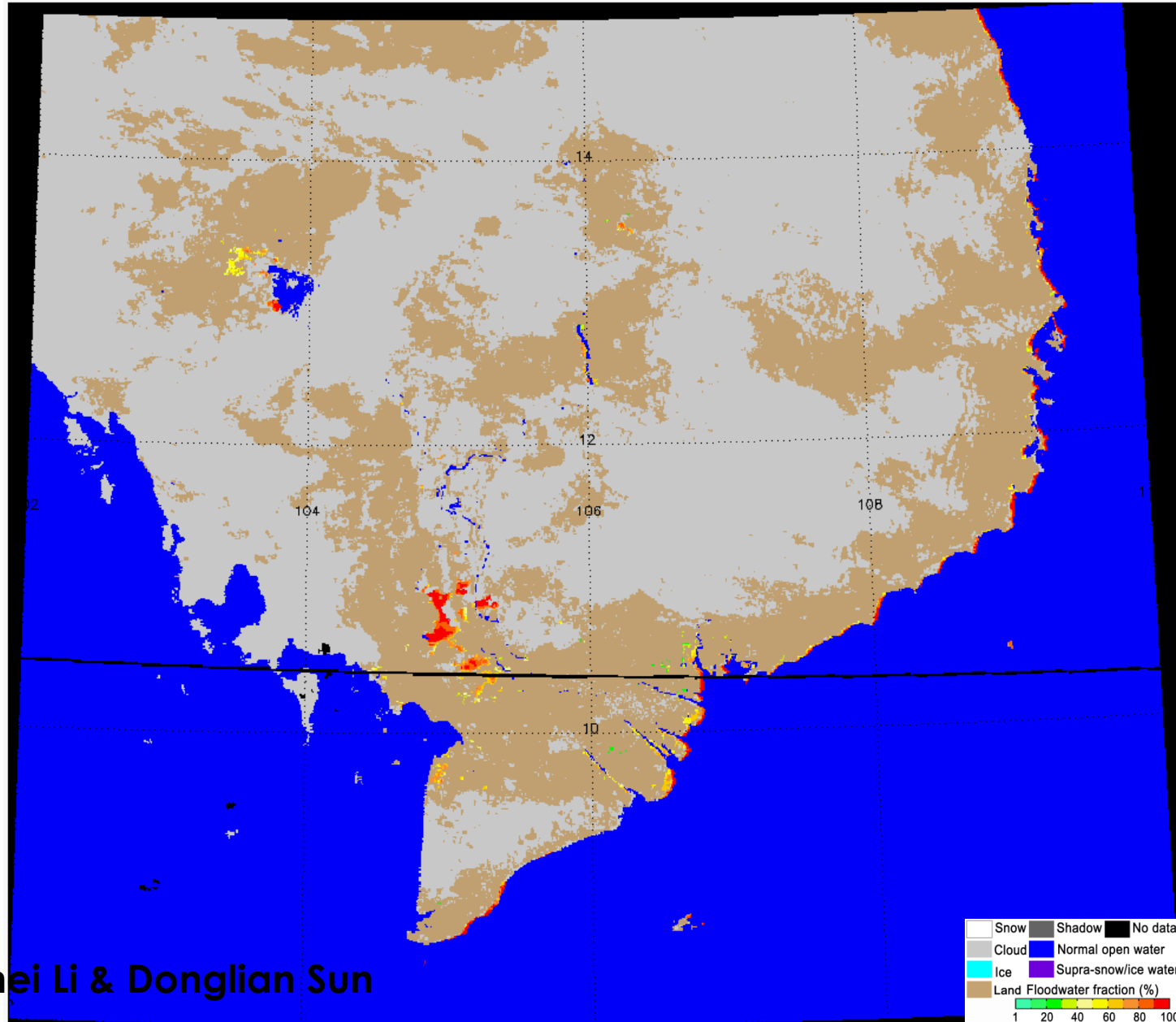
CSPP is now processing daily global VIIRS flood maps and distributes the maps through Real Earth.

Himawari-8/AHI Flood Mapping

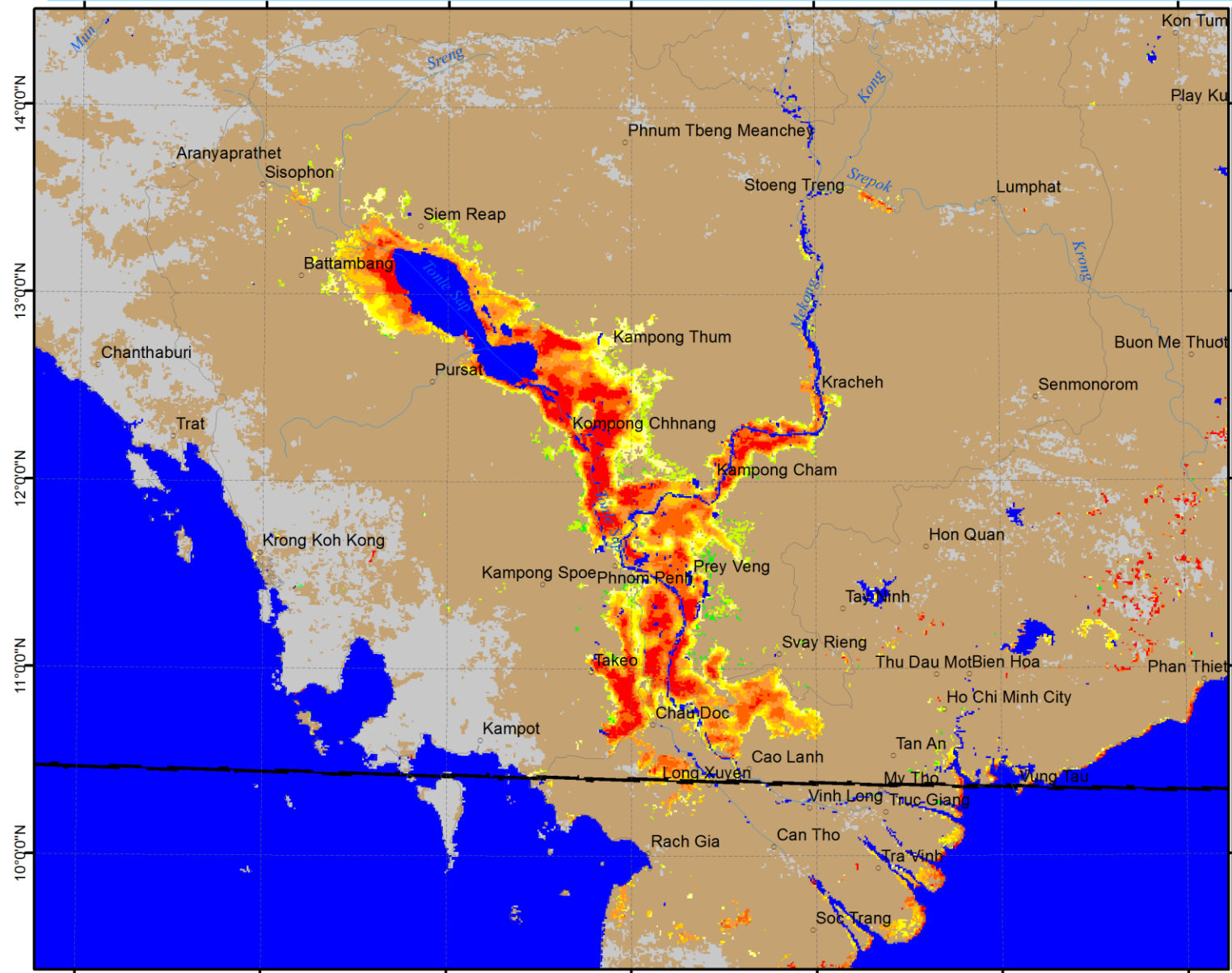Himawari-8/AHI Flood Map 20180821 00:00 to 01:00(UTC)

Himawari-8/AHI flood animation in Cambodia on Aug. 21, 2018

Slide curtosey of Sanmei Li & Donglian Sun

Snow	Shadow	No data
Cloud	Normal open water	
Ice	Supra-snow/ice water	
Land	Floodwater fraction (%)	

1 20 40 60 80 100

Himawari-8/AHI Daily Composited Flood Map in Cambodia
Daily composition from 00:00 to 10:00 (UTC) on Aug. 21, 2018

Slide curtosey of Sanmei Li & Donglian Sun

Suomi-NPP & NOAA-20/VIIRS Composited Flood Map in Cambodia
Maximal flood extent composition on Aug. 21, 2018

Slide curtosey of Sanmei Li & Donglian Sun
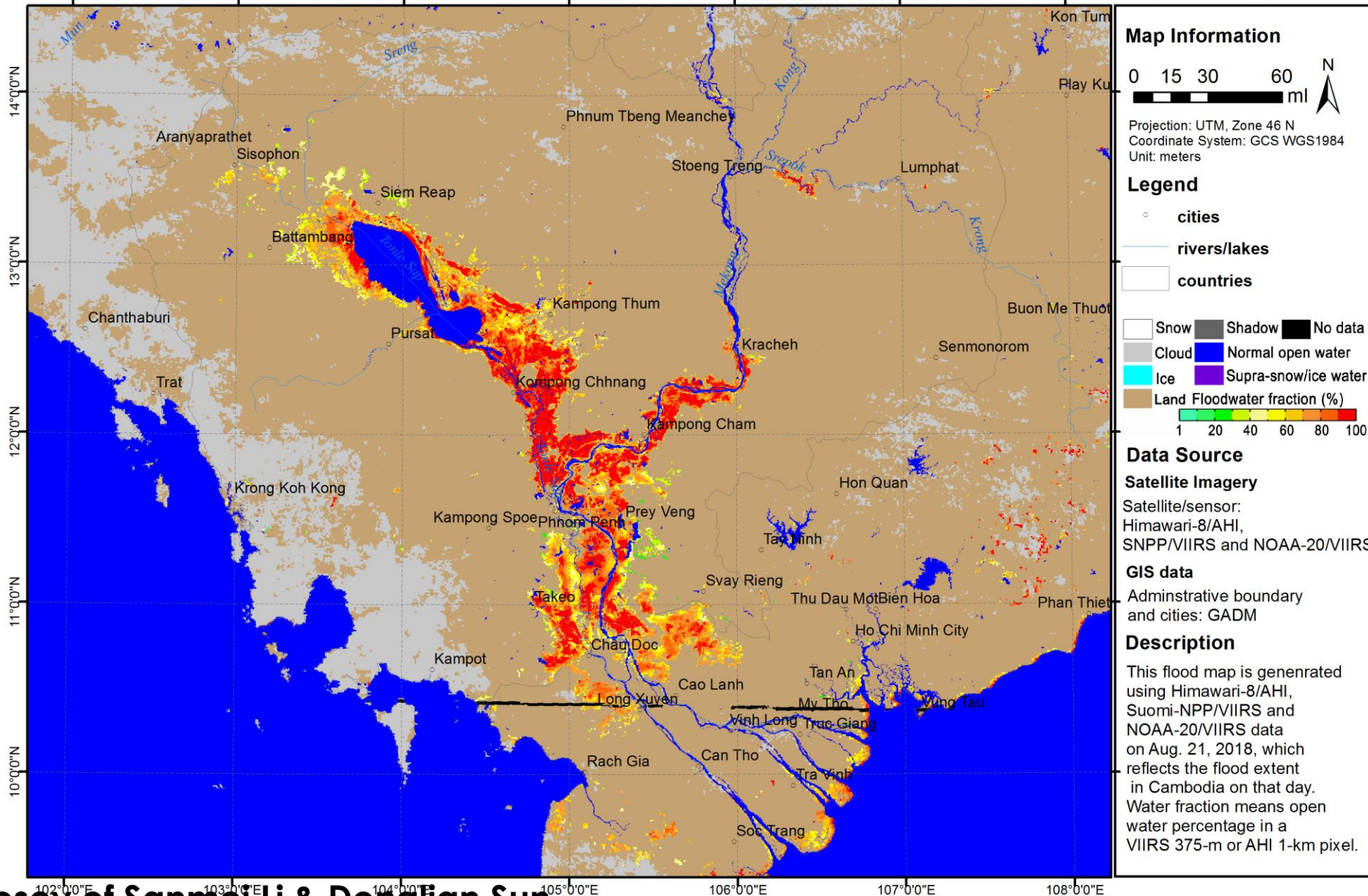
Slide curtosey of Sanmei Li & Donglian Sun

FY4A/AGRI flood animation in India on Aug. 21, 2018
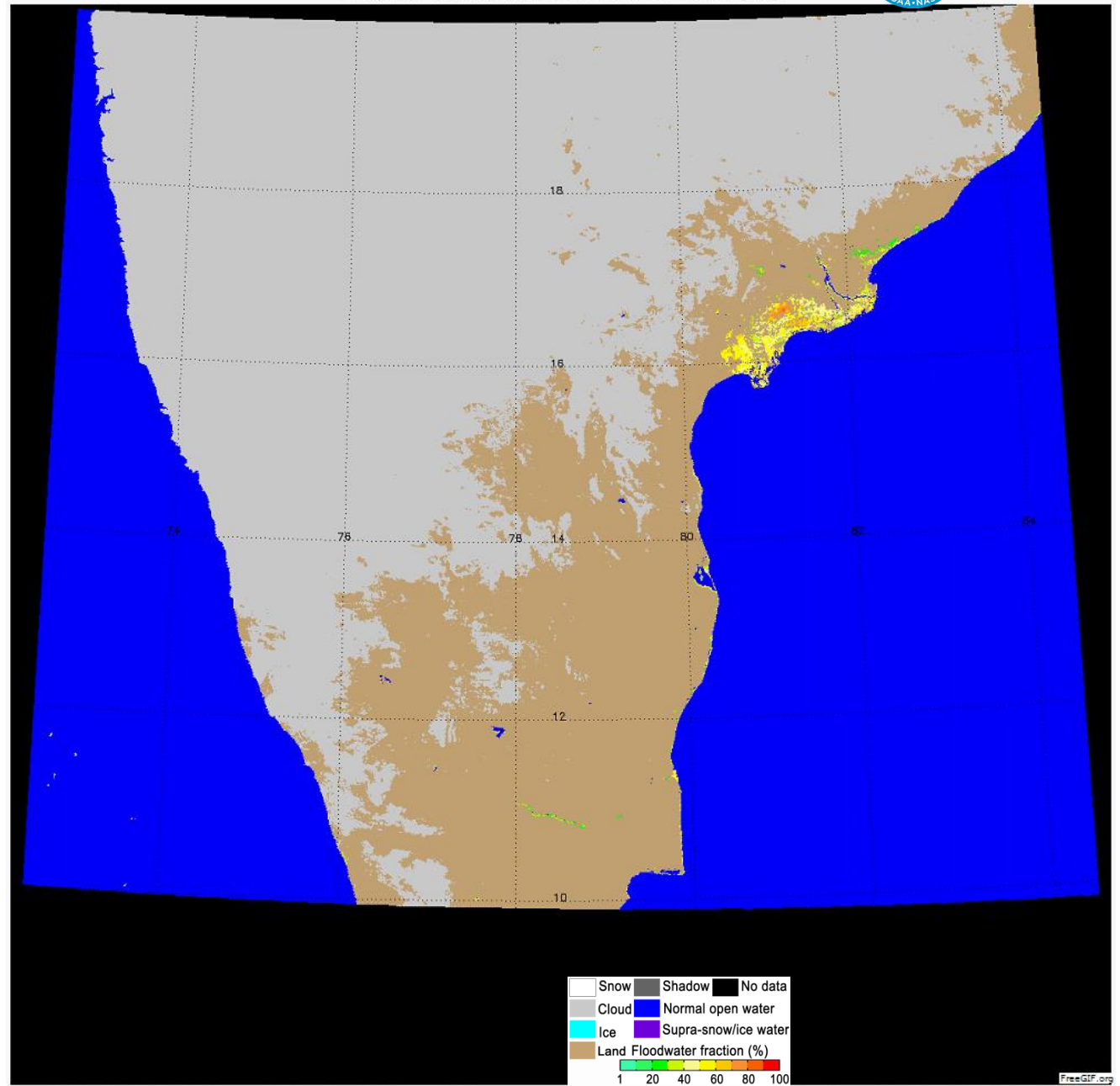
Slide curtosey of Sanmei Li & Donglian Sun
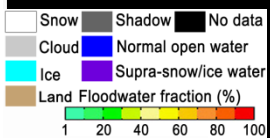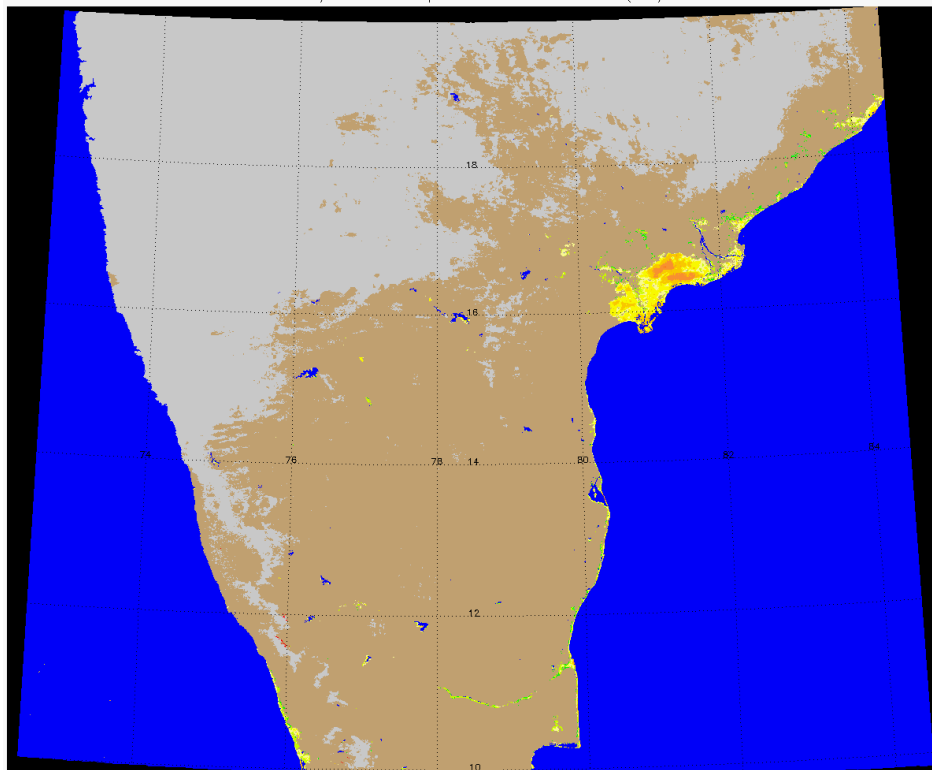
AGRI

AGRI (centering around 104.7 ℉) has better spatial resolution and geolocation accuracy around India.
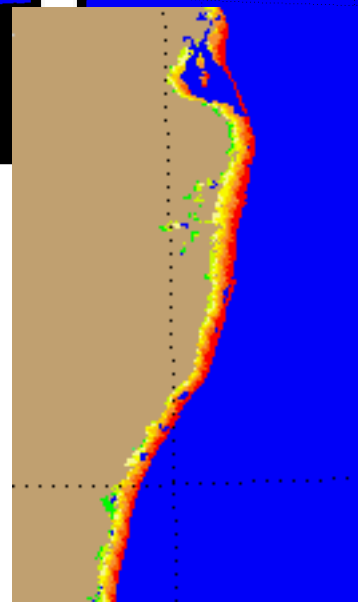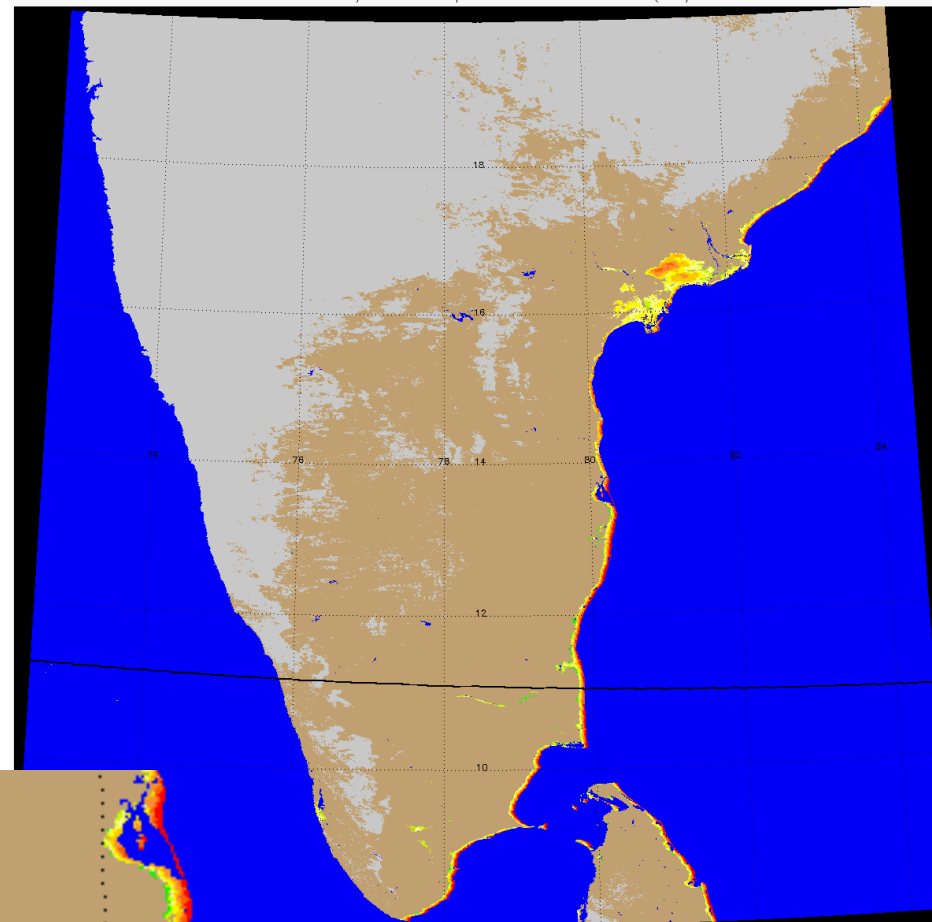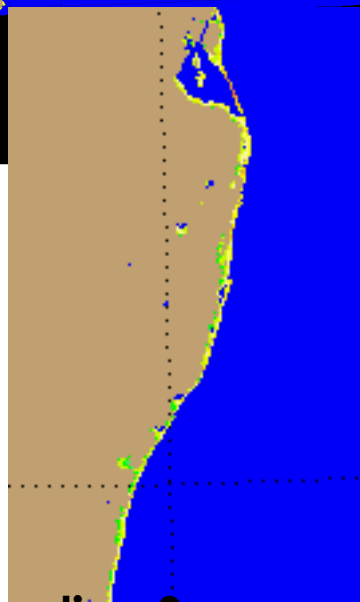
AHI   The spatial resolution of AHI around India decreases to 3-km in longitude direction, which brings issues to the flood detection and geolocation.

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FY3D/MERSI Flood Mapping
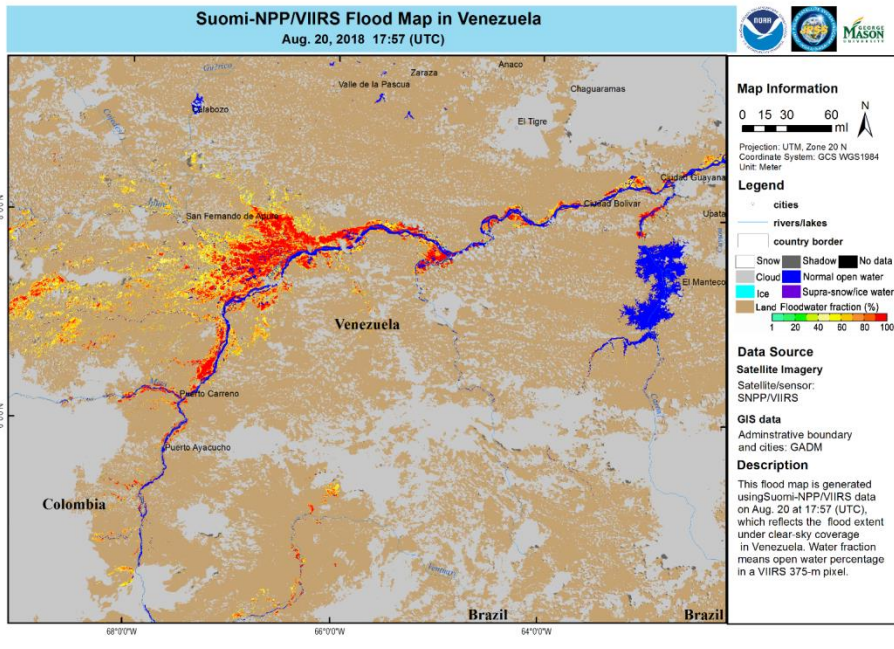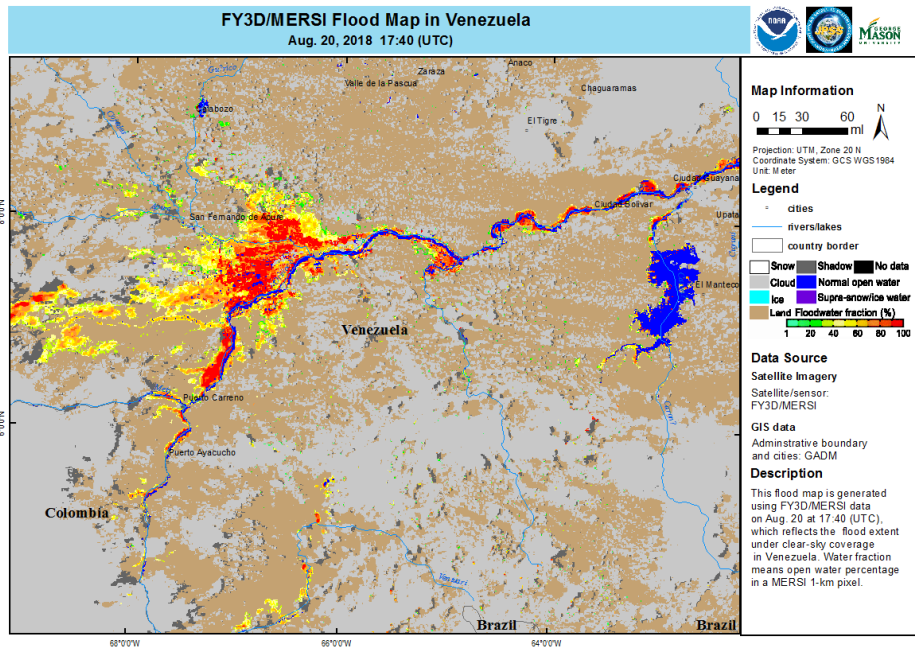
FY-3D/MERSI flood map in Venezuela shows consistent flood detection results to Suomi-NPP/VIIRS.

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VIIRS

ABI

Joint ABI/VIIRS flood maps integrating GEO/LEO
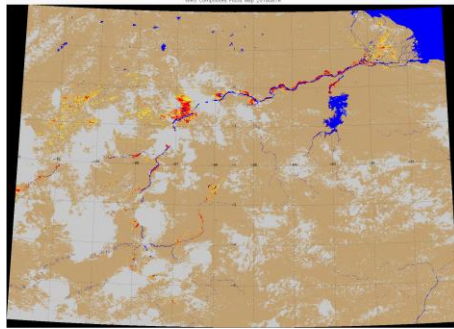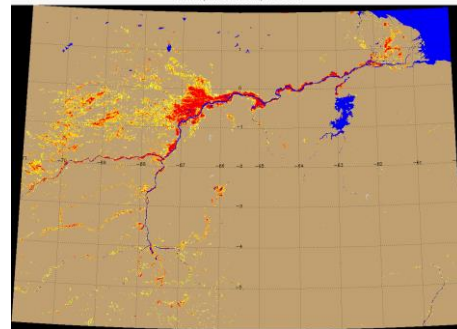
Blended

Blended Flood Map from VIIRS and ABI 20180816
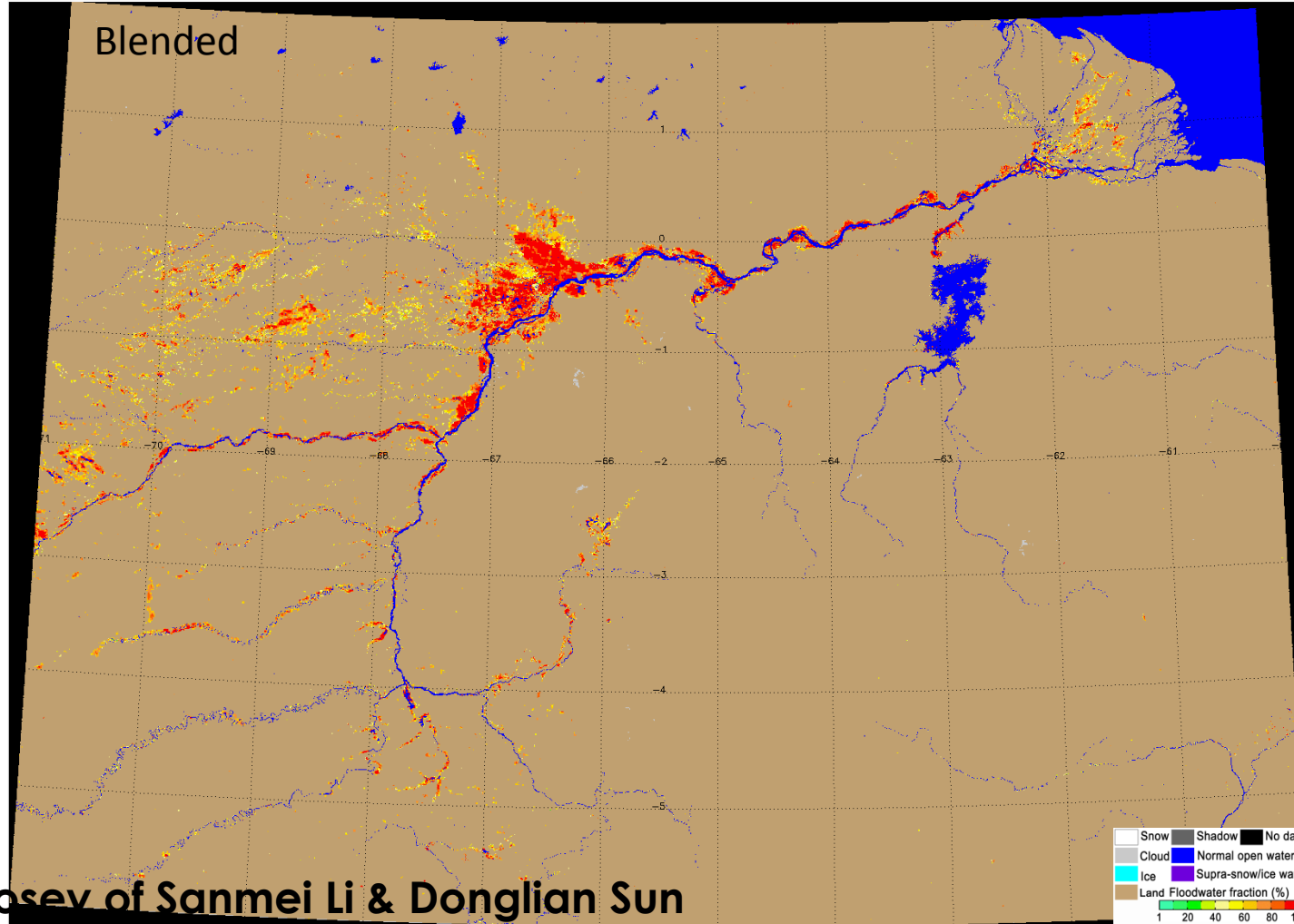
◆ The joint ABI/VIIRS flood maps inherit both the maximal clear-sky coverage from the ABI results and the good inundation detail from the VIIRS results.

Snow
Cloud
Ice
Land Floodwater fraction (%)
Shadow
Normal open water
Supra-snow/ice water
No data

1 20 40 60 80 100

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Community Satellite Processing Package (CSPP) – Serving Savvy FY Satellite Users
SUMMARY

CSPP is to empower you with tools for intelligent use of FY and international meteorological satellite data

- Continue to upkeep and support you with the most advanced algorithms to produce the products/applications that you need
- Continue to innovate and improve your capability to harness the global and regional weather satellite data/products provided by the "Big Three" (NOAA, CMA, & EUMETSAT)
- Continue to provide timely support and training

CSPP

SATELLITES:
- S-NPP
- NOAA-20
- TERRA/AQUA
- METOP-A/-B
- FY-3C/3D
- GOES-15/16/17
- HIMAWARI

CSPP S/W Product Packages:
- Clouds - CLAVR$_X$
- Profiles & Trace Gases: NUCAPS
- Profiles: HSRTV
- Profiles & Clouds: MIRS
- SST: ACSPO
- Flood Detection: Flood
- Active Fire: Fire
- ATOVS: IAPP
- Clouds & Profile: GeoAIT/GRB/GVAR
- Imagery clouds, aerosol & LST - AITF
- Clouds, Fog - GEOCAT

SDR/LEV 1 Preprocessing:
Calibration/NAVIGATION

EDR/LEV 2
Atmospheric/Land/Oceanic PRODUCTS

IDR/LEV 3
Applications

CSPP S/W Tool Packages:
- Map Projection --Polar2Grid & Geo2Grid
- Visualization – HYDRA & RealEarth

SENSORS:
- AVHRR
- VIIRS
- MODIS
- AIRS/AMSU
- ATMS
- CrIS
- IASI
- MERSI
- ABI & GLM
- AHI

PRODUCTS:
- RGB images
- Clouds
- Profiles
- Trace gases
- LST/SST
- Aerosol/Dust
- Fire
- Flood
- Others

Applications:
- Weather forecast
- Fire & Flood
- Air Quality
- Aviation Safety
- Severe Storm

https://cimss.ssec.wisc.edu/cspp/ & https://cimss.ssec.wisc.edu/csppgeo

Community Satellite Processing Package (CSPP) –
Serving Savvy FY Satellite Users

CSPP Leo: http://cimss.ssec.wisc.edu/cspp/

CSPP Geo: http://cimss.ssec.wisc.edu/csppgeo/

ISEE/RealEarth: http://isee.ssec.wisc.edu/

Direct Broadcast Workshop:
http://cimss.ssec.wisc.edu/dbs/