NASA Observations and Modeling during ICE-POP

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KMA ICE-POP Meeting

27-30 November 2018

Programmatic Focus

- NASA Weather Program, Short Term Prediction and Operational Research Transition Center (SPoRT)

- NASA's Global Precipitation Measurement (GPM) Mission Ground Validation and Precipitation Measurement Mission Programs

NASA Multi-Center Team in ICE-POP

- MSFC, GSFC, WFF (+CSU)

Overarching Objective:

- Leverage international collaboration and synergistic observational (GPM- MSFC/WFF/CSU), numerical modeling (MSFC-SPoRT/GSFC), and research transition (MSFC-SPoRT) opportunity to verify, test utility, improve satellite products and numerical prediction models in heavy orographic snow regime

Provide real-time observational and NWP data in support of ICE-POP, participate in significant international science effort.

GPM Ground Validation and NASA Weather Program:

- Direct/physical validation of active/passive satellite-based snowfall retrieval algorithms over coastline and mountains; melting layer interaction with terrain

- Physics of snow, coupling to snow water equivalent rate and satellite remote sensor retrieval algorithm assumptions
    - Size distributions, types/habit, water equivalent, profiles

- NUWRF Model + Observational analyses: Movement toward "level IV products" leverage intensive and multi-faceted NWP component.

- Model precipitation processes (liquid, mixed phase and frozen); Build model testing database for further active/passive remote sensing algorithm development (e.g., satellite data simulators)

- "Integrated" validation of products in operational context
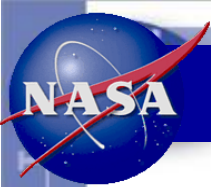
Dual Frequency Dual Polarimetric Doppler Radar (D3R)

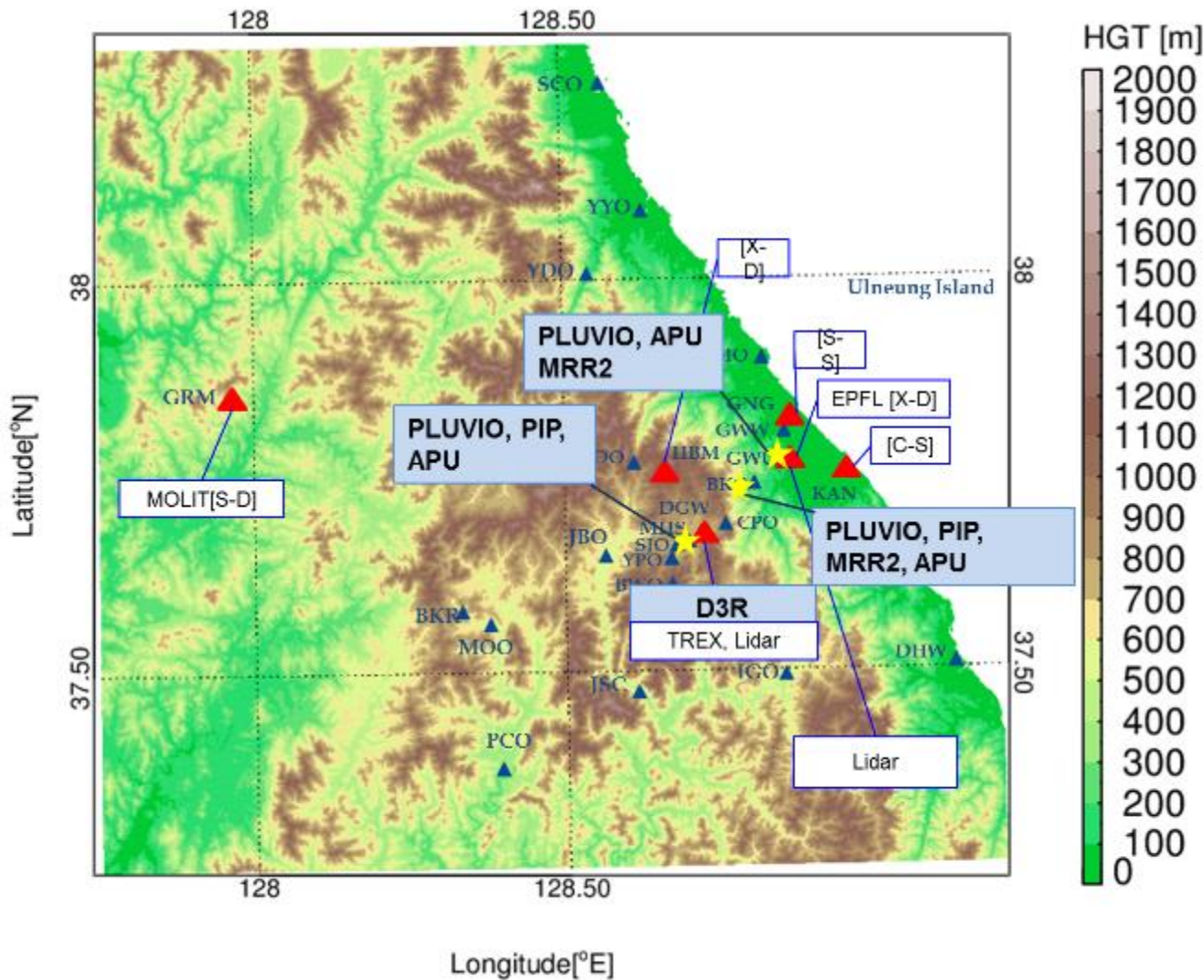**Precipitation Imaging Package (PIP) x 2 (imager/disdrometer)**
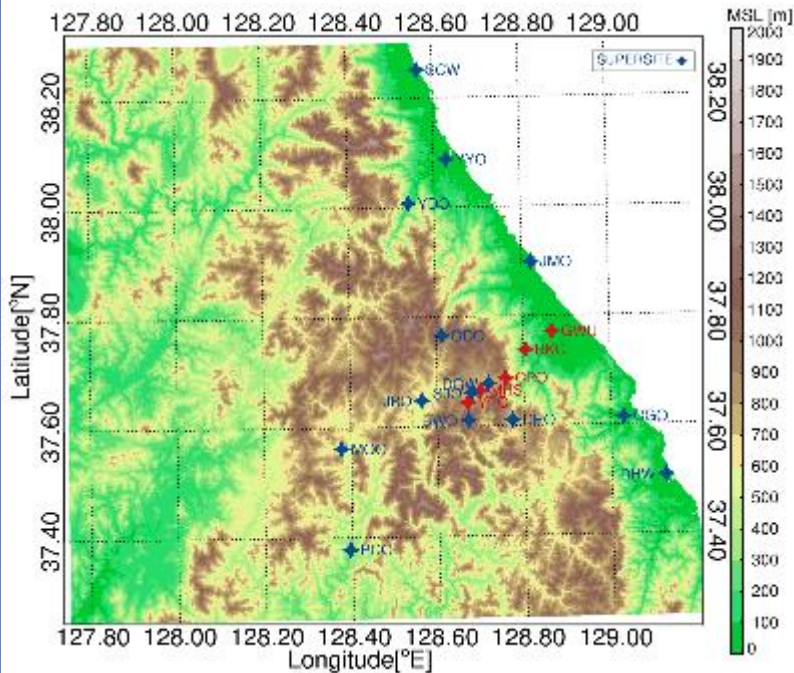
Pluvio$_2$ x 3

MRR x 2

Parsivel disdrometer (APU) x 3
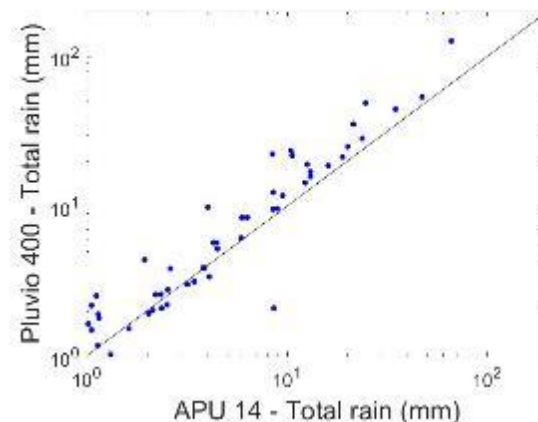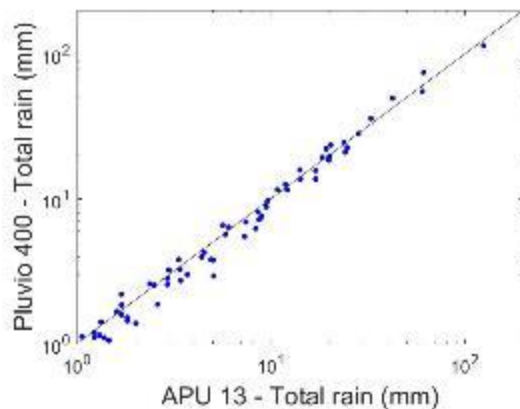
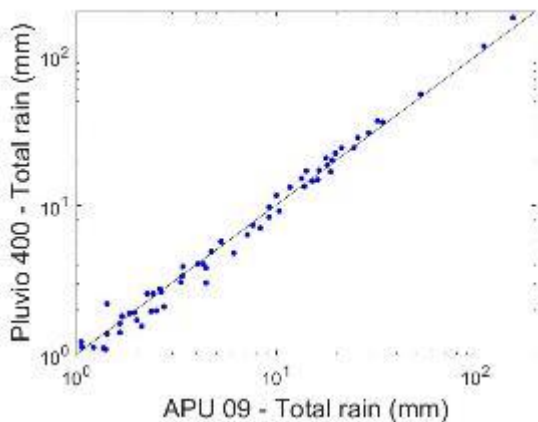- ***Processing for rain and snow, Nov 17 - April 18***

PARSIVEL Network (11/2017-04/2018)
3 NASA (GWU(APU09), BKC (APU13), MHS(APU14))
7 NIMS (JPO, DRO, CPO, YPO, ODO, BW0, SJO)
1 KNU (MHS)
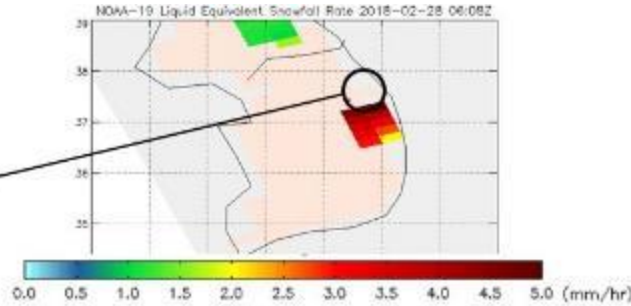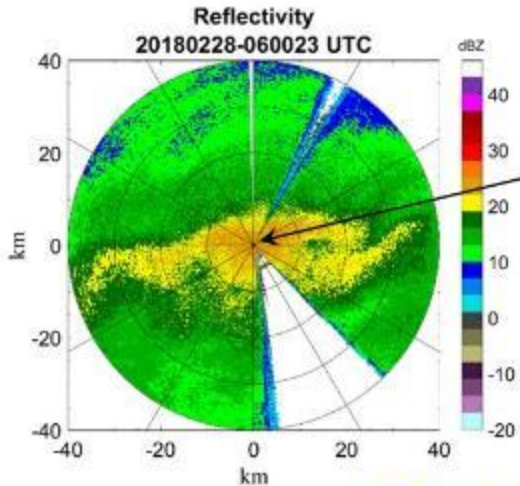1 CCU (PCO)
8 UCLM (MOO, DGW, SCW, YYO, YDO, JMO, OGO, DHW)

PLUVIO 400/200 Network (11/2017-04/2018)
3 NASA (GWU, BKC, MHS)
1 KNU (YPO)

## Event rain comparisons for EOP

Contact: Ali Tokay, ali.tokay-1@nasa.gov

Prior to 2/12/2018 (Slip ring problem)

Scan	Azimuth (degrees)	Elevation (degrees)	Scan Rate (deg/sec)	Samples	Azimuthal Resolution (degrees)	Site Name	Time taken for scan (seconds)
RHI	51.31	0 to 90	3	128	0.192	GWU-1	30
RHI	231.54	0 to 90	3	128	0.192	MHS	30
PPI	0 to 359	4	14	128	0.896		25.72
PPI	0 to 359	5	14	128	0.896		25.72
PPI	0 to 359	6	14	128	0.896		25.72
PPI	0 to 359	7	14	128	0.896		25.72
PPI	0 to 359	8	14	128	0.896		25.72
RHI	330	0 to 90	3	128	0.192	HBM*	30
Birdbath	0 to 359	90	8	128	0.512		45
							Total: 263.6

2/12/2018 to 3/12 (then down)

| Scan	Azimuth (degrees)	Elevation (degrees)	Scan Rate (deg/sec)	Samples	Azimuthal Resolution (degrees)	Site Name	Time taken for scan (seconds)
RHI	51.4	0 to 90	3	128	0.192	GWU-1	30
RHI	231.4	0 to 90	3	128	0.192	MHS	30
RHI	330.5	0 to 90	3	128	0.192	HBM*	30
PPI	0 to 359	5	14	128	0.896		25.7
							Total: 115.7**

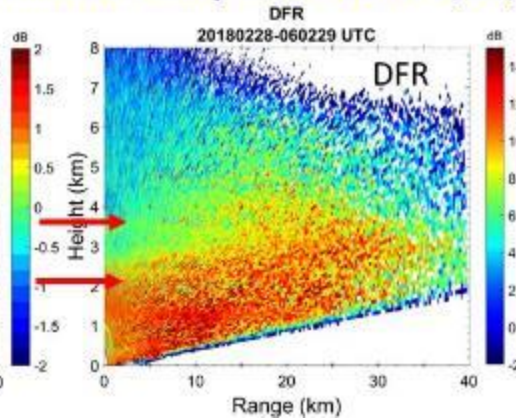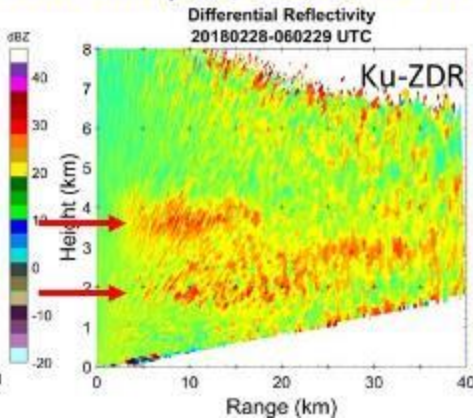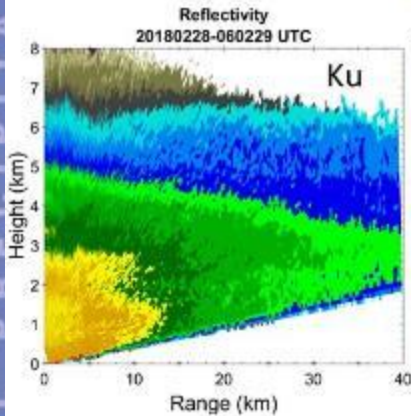# 28 February Heavy Snow Event

NESDIS SFR Algorithm (MHS; NOAA 19) Snowfall rates consistent with KMA radar and PIP (4-6 mm/hr)- but south. (GFS- issue!)
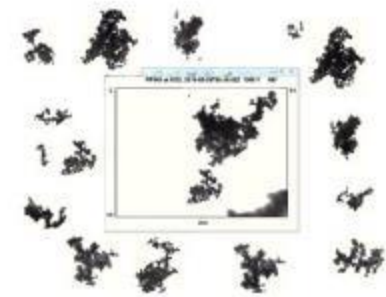
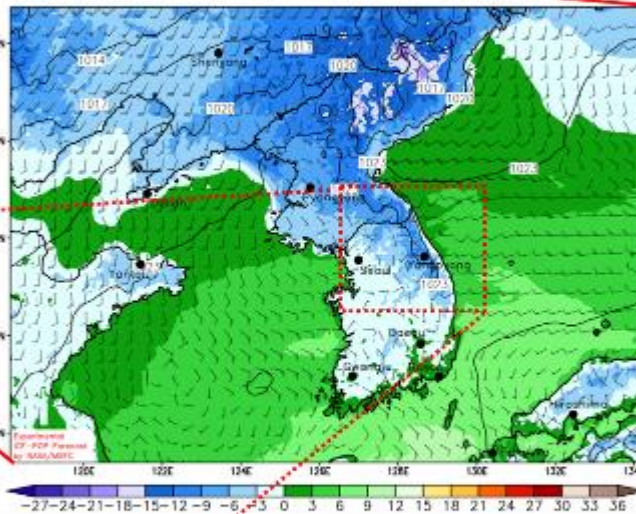PIP 0556 UTC: Large Aggregates (largest ~2.5 mm)

D3R: Complex, turbulence-enhanced heavy snow event 2/28/18
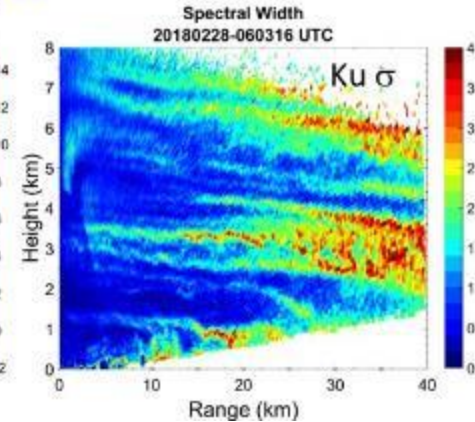
Data note: 13 dB Ka-Correction applied due to snow on radome

2m Temperature (C), MSLP (mb), 10m Wind (m/s)
24:00-h Forecast Valid: 12:00Z 08 Feb 2018

9-km outer grid

3-km Korea nest

1-km "Olympics" nest

NASA Unified-WRF (NU-WRF) Model Features:

- 4x daily 24-hour forecasts
- Initialized 00/06/12/18z
- 30 minute output
- 62 vertical levels
- PBL: MYJ; LSM: Noah
- SW/LW Radiation: NASA/GSFC schemes within NU-WRF
- Microphysics: NASA/GSFC 4-ice graupel+hail
- Cumulus: Grell-Freitas (9km only)
- ICs/BCs: NCEP/EMC GFS
- SSTs: 2-km NASA SPoRT MODIS+VIIRS product

Model grids uploaded to KMA in real-time during experiment

Example: Three Significant Snowstorms between Olympics (Feb) and Paralympics (Mar)
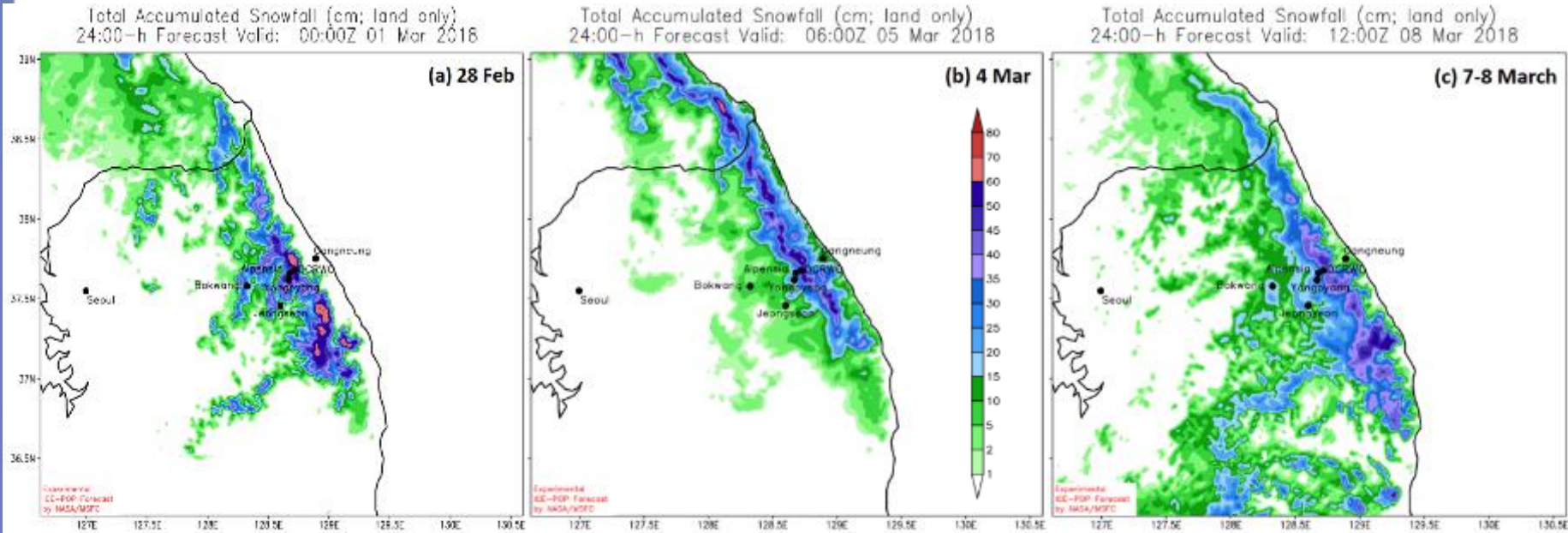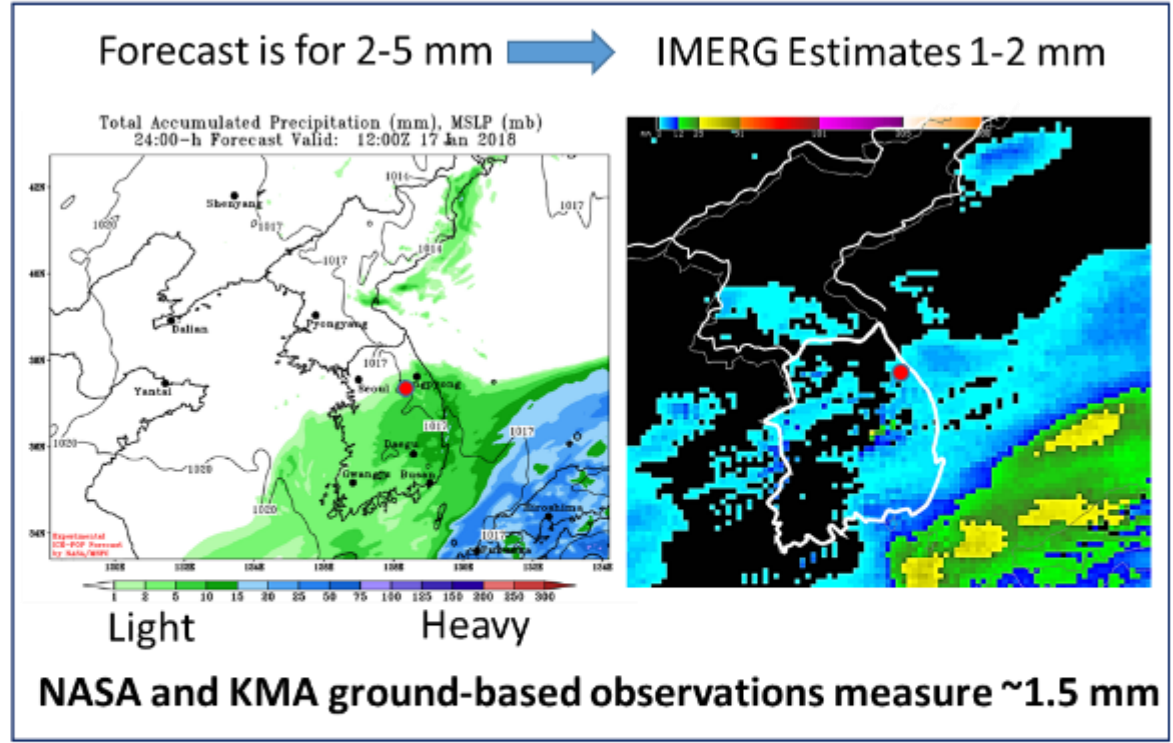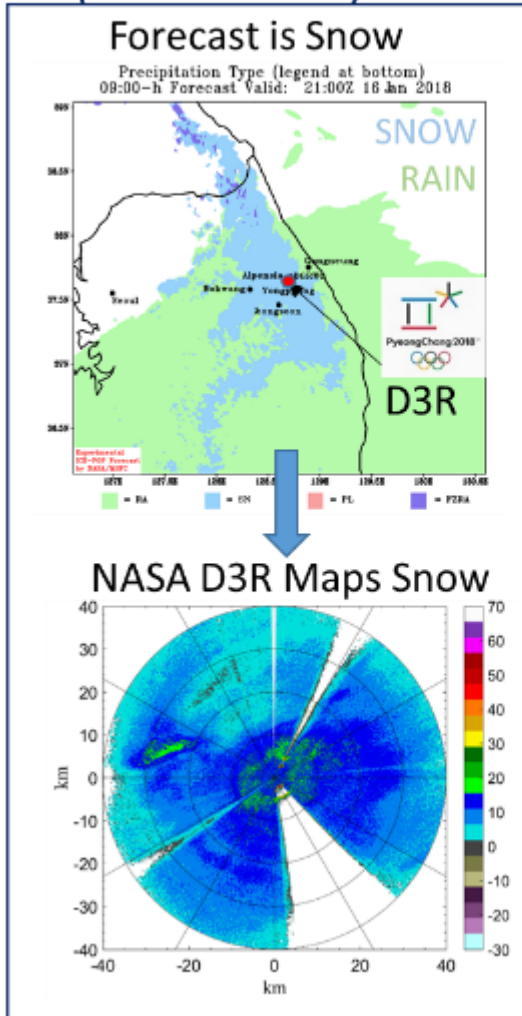

Twenty four-hour simulated snow accumulation [in cm] from the NU-WRF 1-km grid for snowstorm events on (a) 28 February, (b) 4 March, and (c) 7-8 March 2018.

January 17, 2018

Precipitation *Type* (Rain or Snow)

Forecast is Snow

Precipitation Type (legend at bottom)
09:00-h Forecast Valid: 21:00Z 16 Jan 2018

SNOW
RAIN

D3R

NASA D3R Maps Snow

Precipitation *Amount* (24-hr estimate)

Forecast is for 2-5 mm ➡ IMERG Estimates 1-2 mm

Total Accumulated Precipitation (mm), MSLP (mb)
24:00-h Forecast Valid: 12:00Z 17 Jan 2018

Light   Heavy

NASA and KMA ground-based observations measure ~1.5 mm
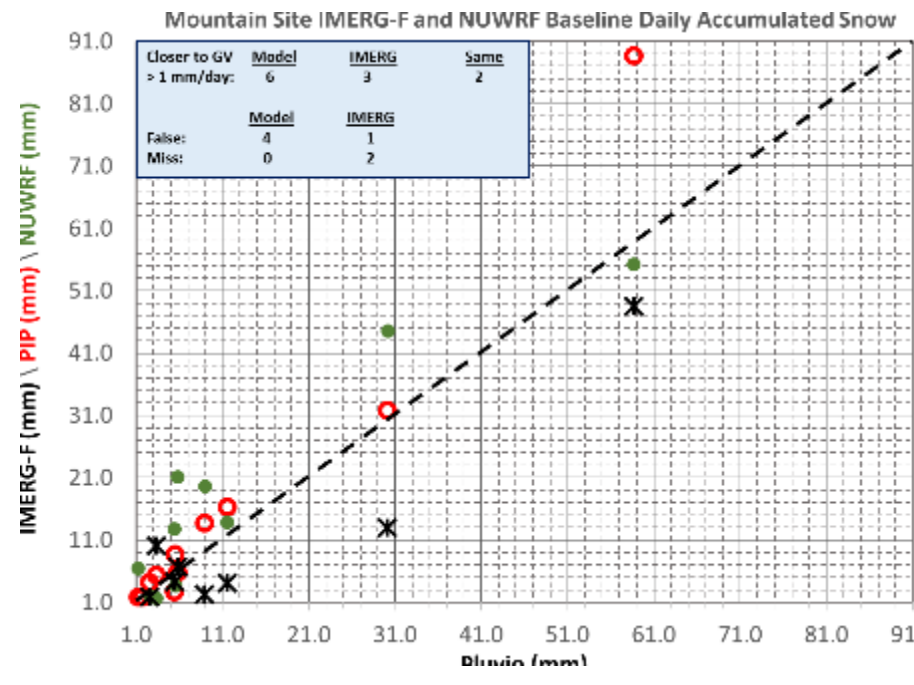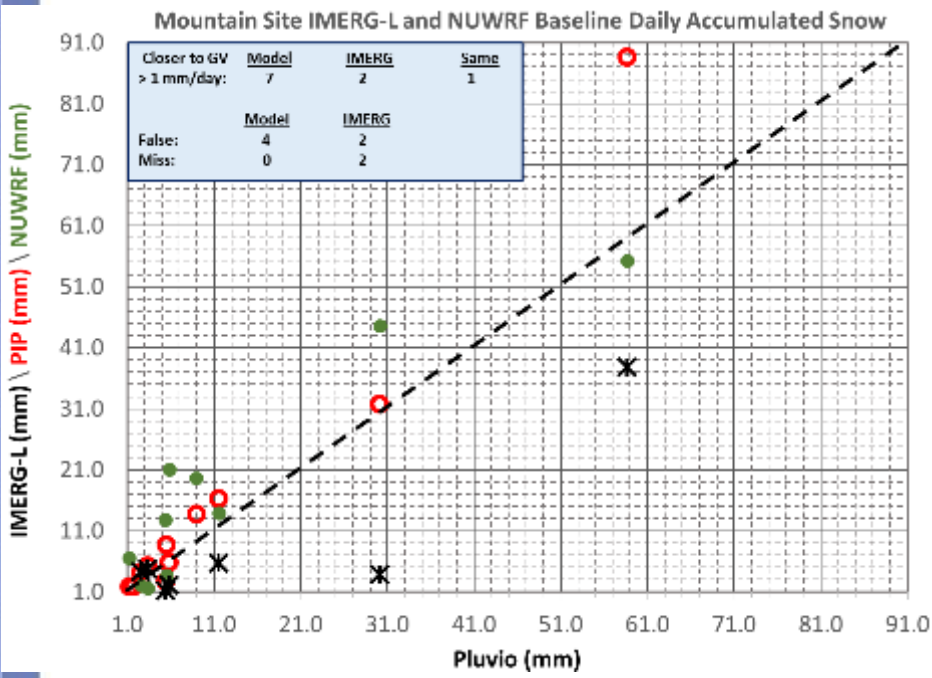
Forecast, GPM IMERG, and ICE-POP observations agree on precipitation type and amount for an early ICE-POP snow event near PyeongChang.

These comparisons will continue as ICE-POP progresses

How do IMERG and NUWRF Perform Relative to Surface Obs (GV) for Estimating/Predicting Daily Snow Water Accumulation?


Mountain Site IMERG-L and NUWRF Baseline Daily Accumulated Snow

Closer to GV > 1 mm/day:	Model 7	IMERG 2	Same 1
False:	Model 4	IMERG 2	
Miss:	0	2	

Mountain Site IMERG-F and NUWRF Baseline Daily Accumulated Snow

| Closer to GV > 1 mm/day:	Model 6	IMERG 3	Same 2
False:	Model 4	IMERG 1	
Miss:	0	2	

● NUWRF (baseline) ○ PIP (mm/day) ✳ IMERG (mm/day)

- Baseline NUWRF 24-hour forecast accumulation does as well or better than IMERG*.
- *Caveat*- Model had more false alarms; IMERG more misses

Objectives:

Leverage GPM microwave imagers to generate real-time ocean turbulent heat flux dataset (T/Q/Wind); subsequent global archive.

Data Assimilation testing for ICE-POP NWP
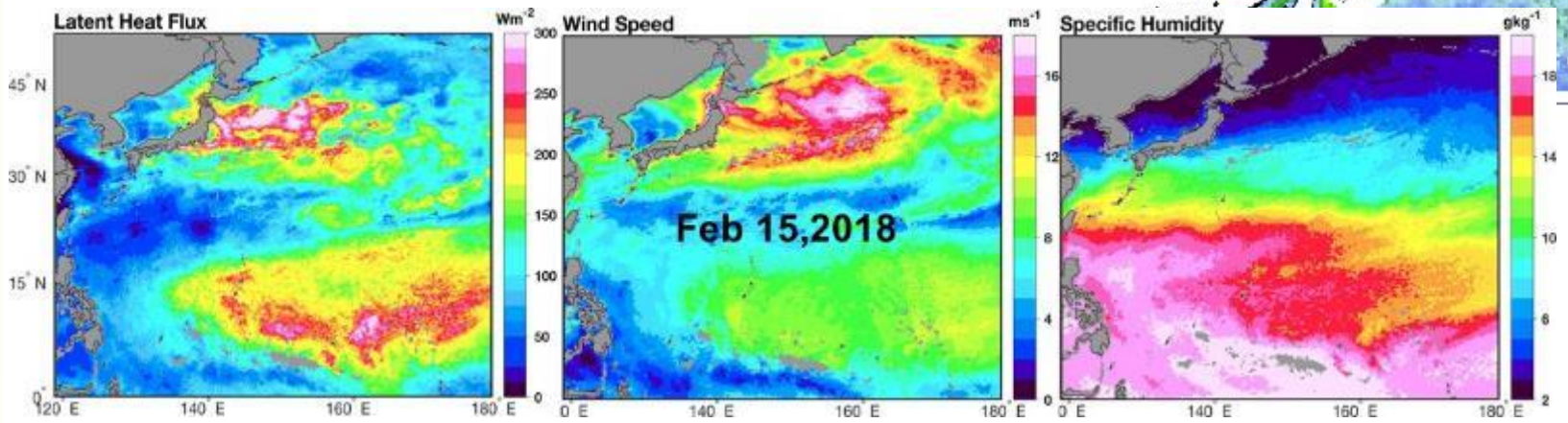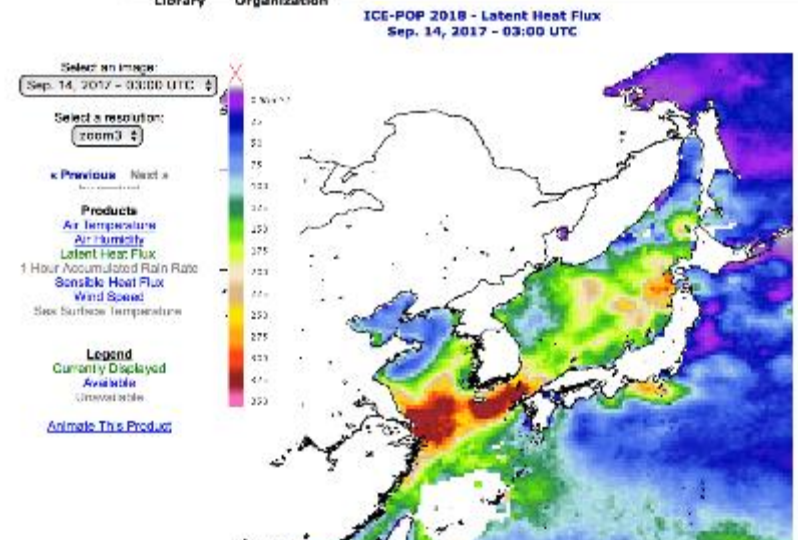
- *Global , 25km archive generated for the GPM-Era (Feb. 2014 - Mar. 2018)*
    - *Swath level (L2) surface meteorology*
        - *GMI, AMSR-2, SSMIS (F16, F17, F18, F19)*
    - Hourly, gridded (L3) meteorology and turbulent heat fluxes
- Data are/were made available through web server and visualizations in real-time

Objectives: Assimilate surface temperature, moisture, and wind speed products retrieved from GPM L1C data; Assess impacts on snow storm events observed during ICE-POP.

Approach: WRF model with 9 km + 3 km resolution and 62 vertical levels; Community GSI v3.6.

Cases: TEST 15-17 February 2018 Japan (currently completed 2 DA cycles, working on 6 more DA cycles available at later times); 27-28 February 2018, 4-5 March 2018 .

Impact: Preliminary result indicates an increment of ~2° C in low level temperature and 1-2 g/kg in moisture field. Impact on precipitation forecast is also found.

0600 UTC 2018-02-15

12-h Surface Precipitation Forecast Valid at 1800 UTC 2018-02-15

X. Li and J. Roberts
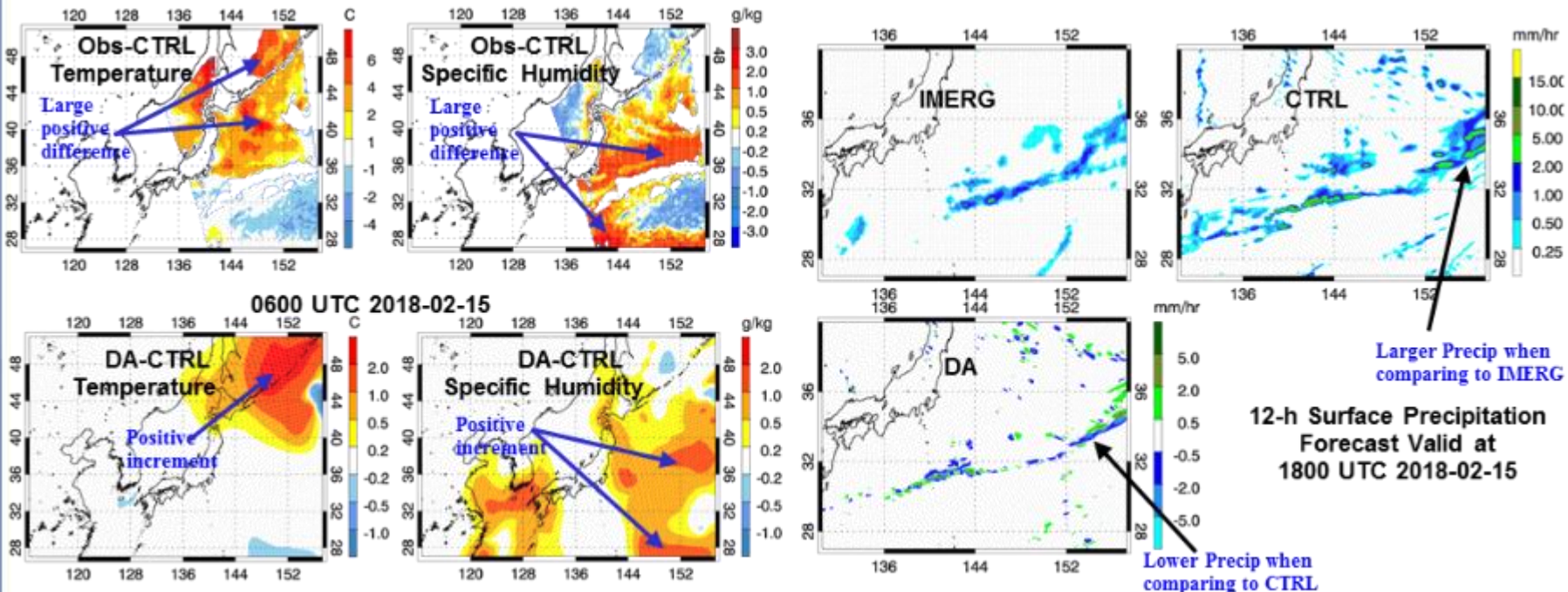
Data

- Dataset(s) successfully collected and generally are quite robust (D3R mechanical issue, occasional Pluvio capping/hysteresis etc.)

- Many GPM overpasses of domain during IOP (primarily passive microwave, limited DPR)

- Observational inventory (QC) uploaded, satellite products (available via NASA DAAC-can make subsets for ICE-POP), surface parameters (LH/SH fluxes), high resolution SST, NUWRF FDP model products also uploaded.

  - Some issues with instrumentation noted (D3R, Pluvios)

  - Action: need to ensure data repository is complete, inventoried/documented properly, final QC versions.

Science:

- Direct/physical validation of satellite-based snowfall retrievals over complex terrain underway

- Preliminary looks at snow physics, cloud model ice processes

- Preliminary data assimilation testing underway

- Limited presentations at AMS Wea. Fcstg., ERAD, PMM Science Team etc.