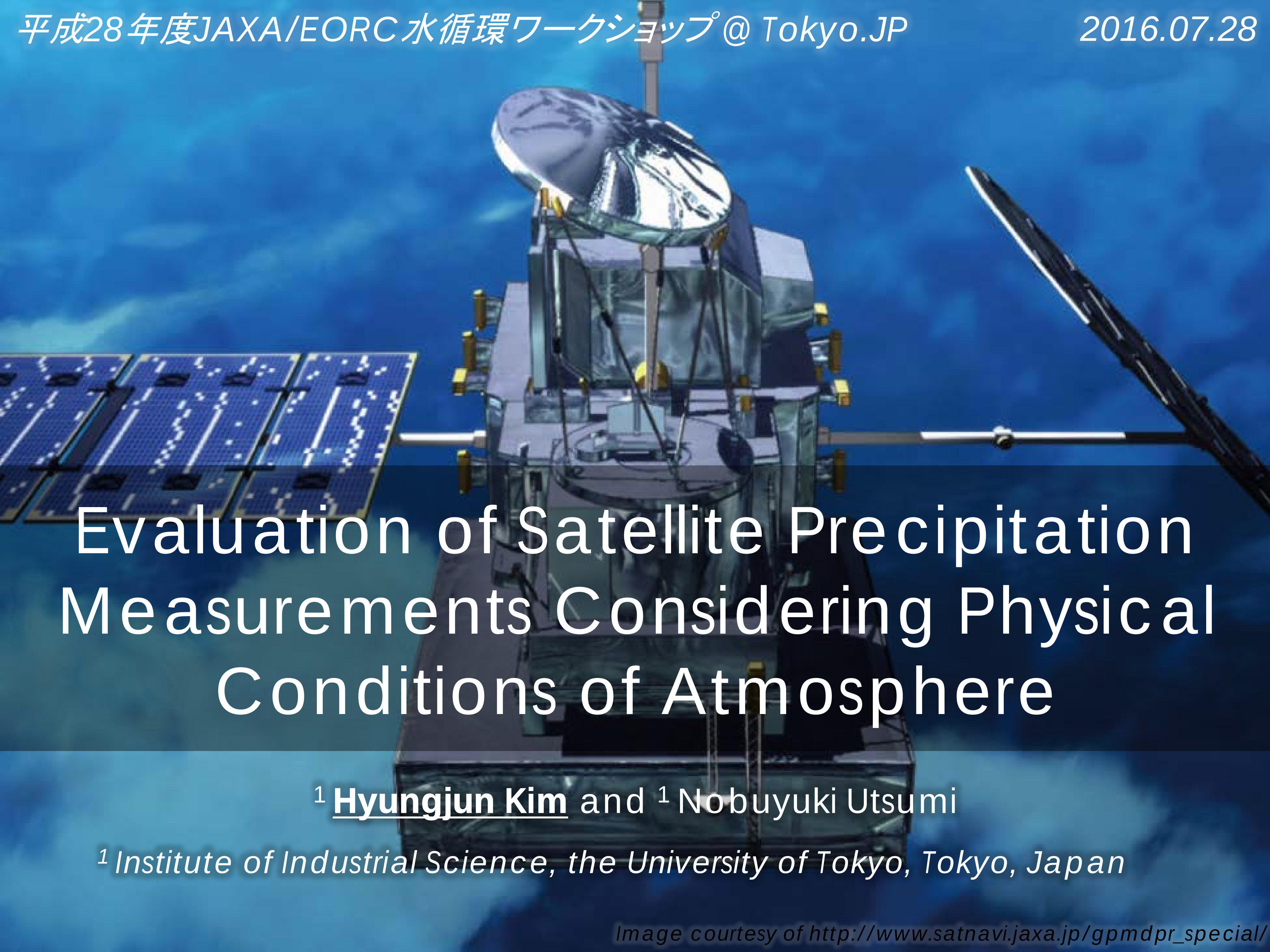


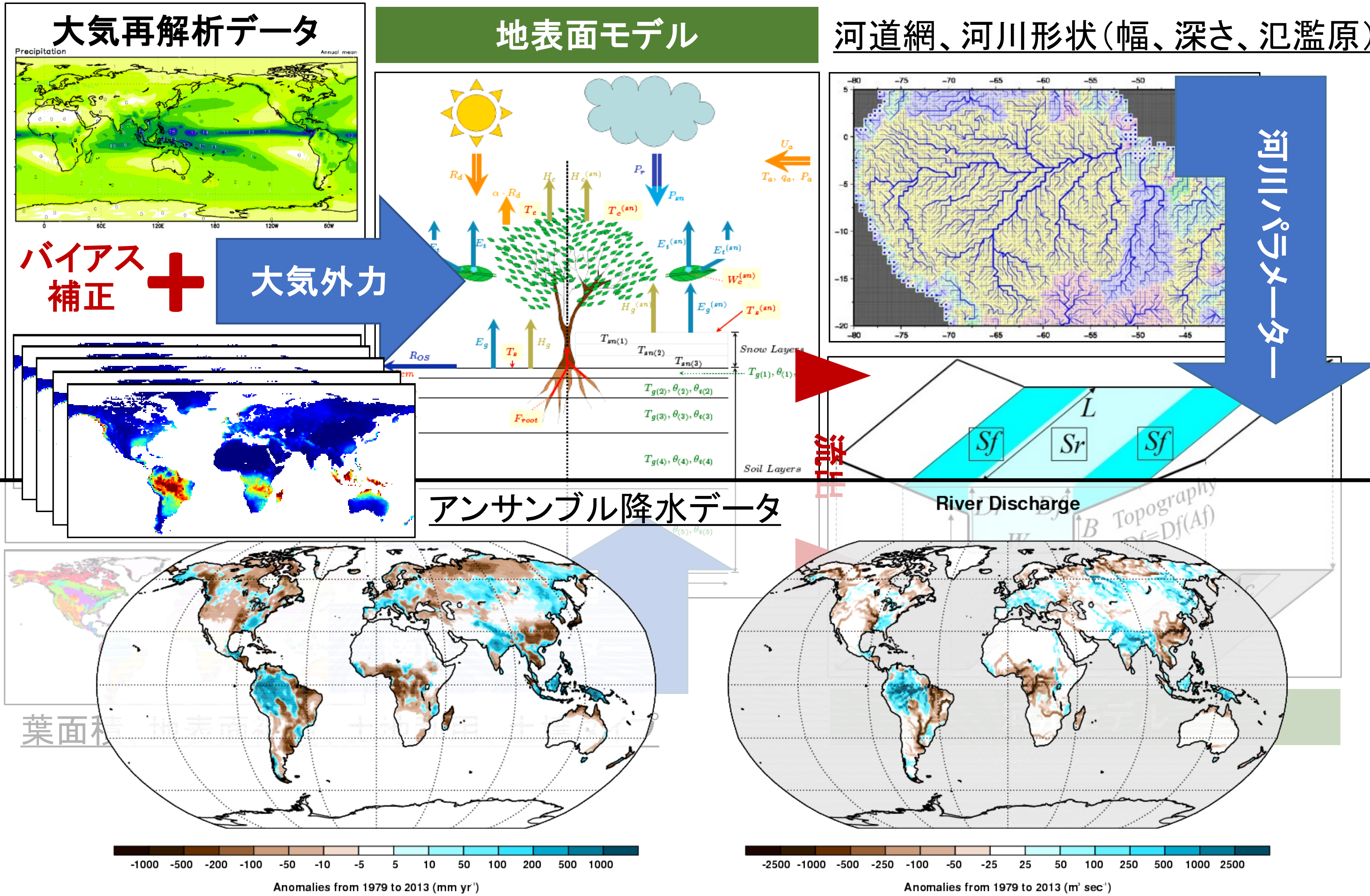
Evaluation of Satellite Precipitation Measurements Considering Physical Conditions of Atmosphere

[1] **Hyungjun Kim** and [1] Nobuyuki Utsumi

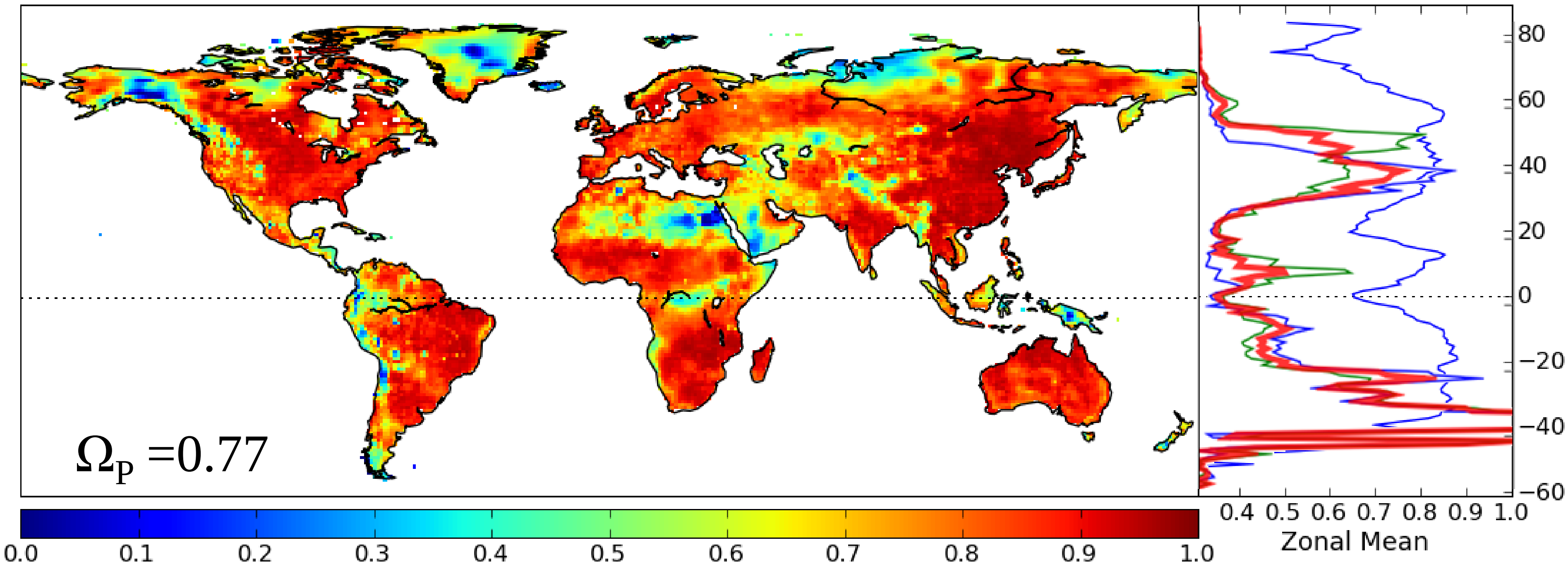
[1] *Institute of Industrial Science, the University of Tokyo, Tokyo, Japan*

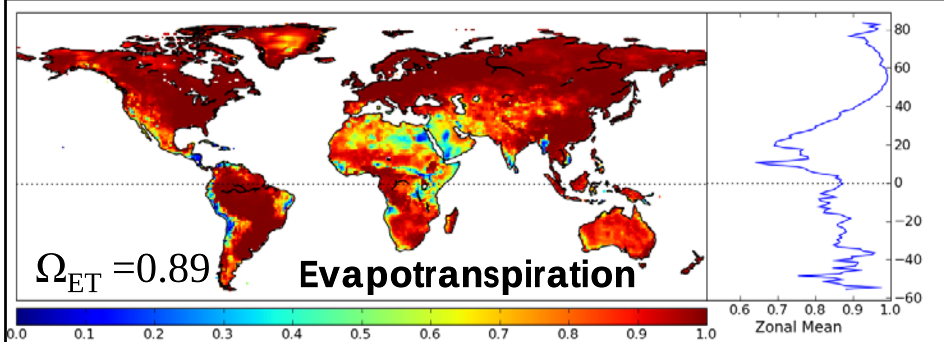
Image courtesy of http://www.satnavi.jaxa.jp/gpmdpr_special/

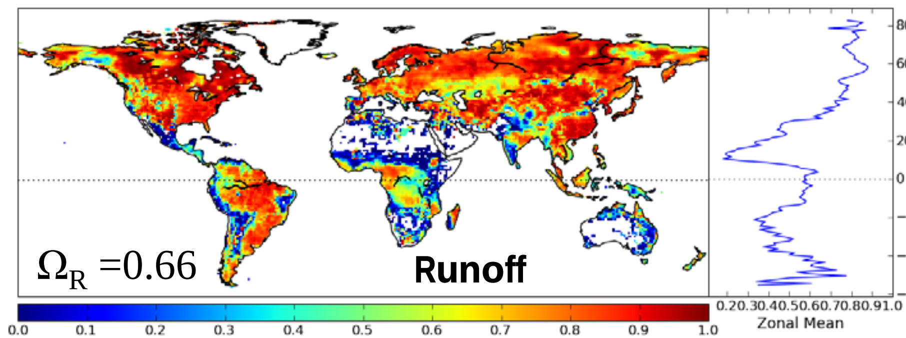
全球水文シミュレーションと申請者の既往研究



Uncertainty in Observational Precipitation







+ Uncertainty in precipitation has heterogeneous global distribution
+ Non-linear impacts in land surface simulations

** Kim 2010*

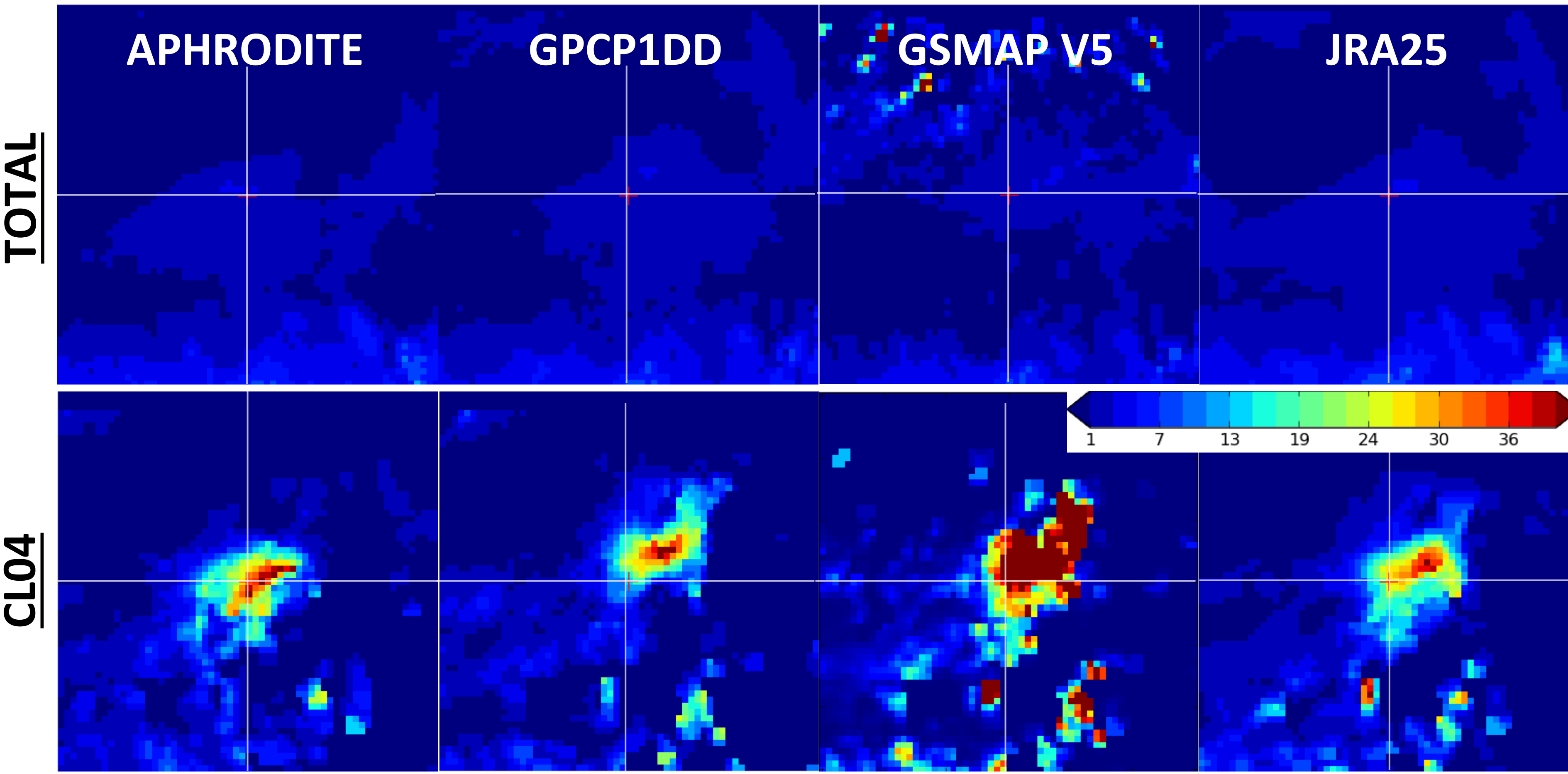
Domain: 30°N – 38°N; 60°E – 149°E

Precipitation Composite for @ 2001 – 2004 (DJF)

Intercomparison for Extratropical Cyclone

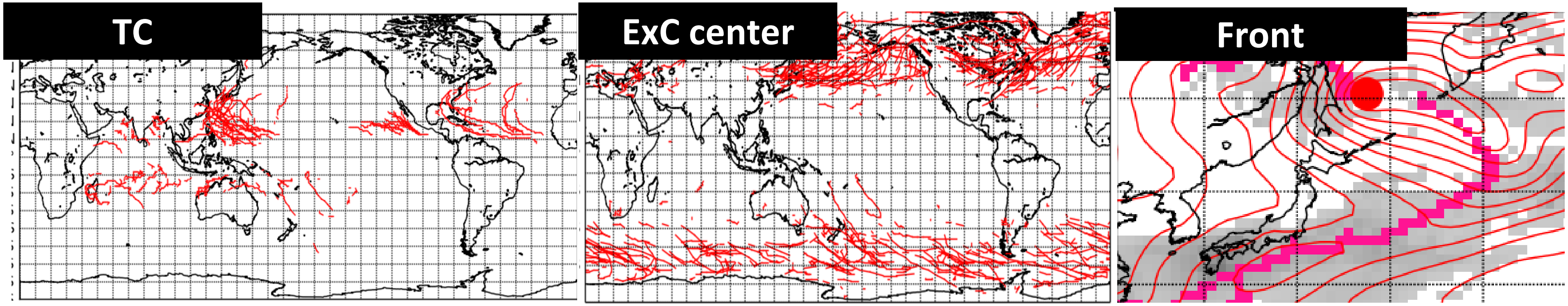
Class	Central Pressure Gradient
CL01	0.3 – 5.0 [hPa/1000km]
CL02	5.0 – 10.0
CL03	10.0 – 15.0
CL04	15.0 –

Product	Type	S. Res.	T. Res.	Period
[1]APHRODITE	Gauge	0.25°	Daily	1951 – 2007
[2]GPCP 1DD	Hybrid	1.0 °	Daily	1996 – 2009
[3]GSMaP V5.222.1	Satellite	0.1°	Hourly	2000 – 2010
[4]JRA25	Reanalysis	T106°	Monthly	1979 –



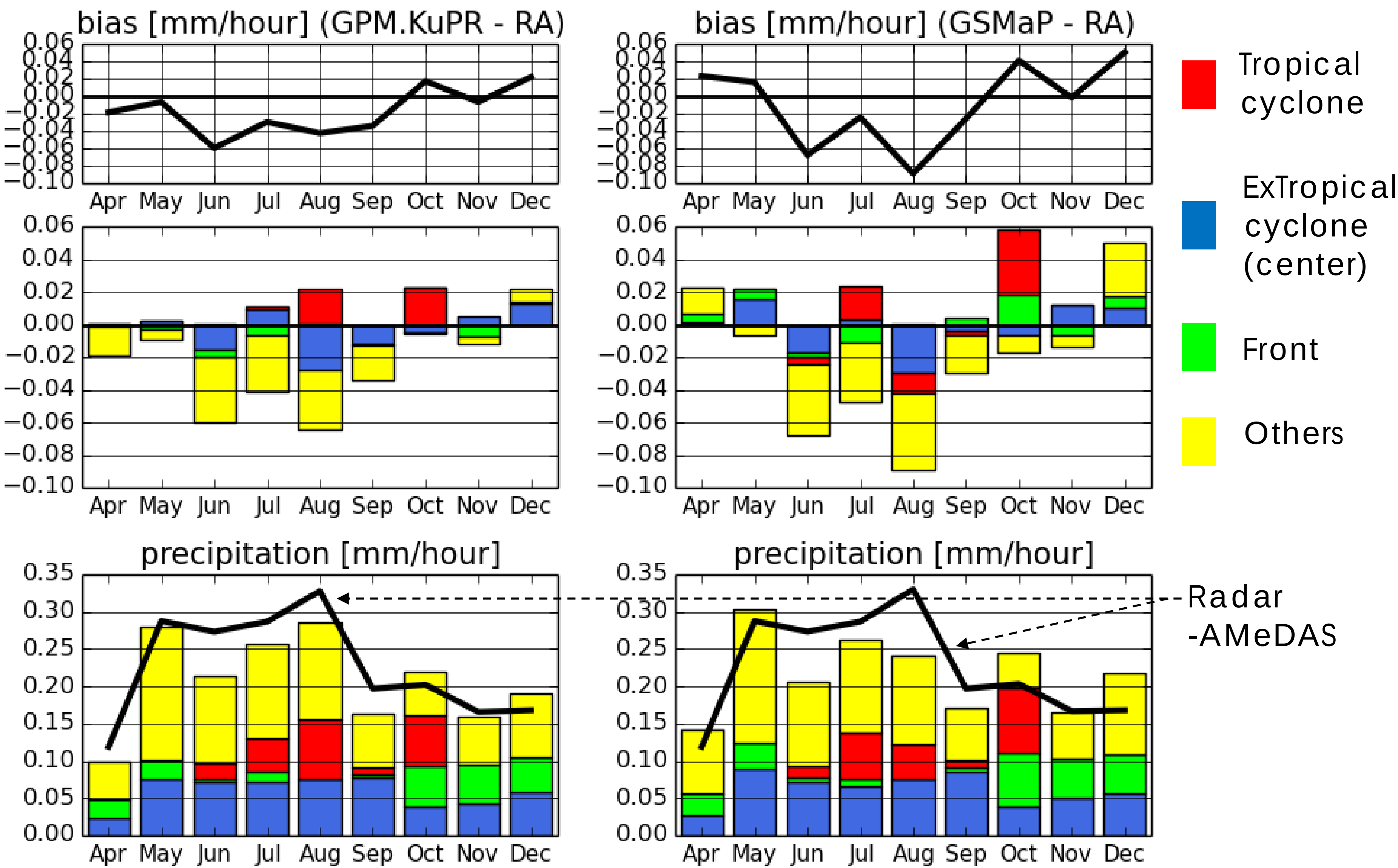
Weather System Mask

Weather Systems	- Tropical cyclone - Extratropical cyclone center - Front (temperature) - “Others”
Spatiotemporal Resolution	1.25 degree, 6-hourly *(can be downscaled)*
Timespan	1990-2014 (possible extension to 1958)
Input dataset	- JRA-55 (SLP, U, V, T, Q) - IBTrACS (TC best track)
Data format	Binary file
Supplementary Tool	** Python module for handling (in Beta)*



** Utsumi et al., under review*

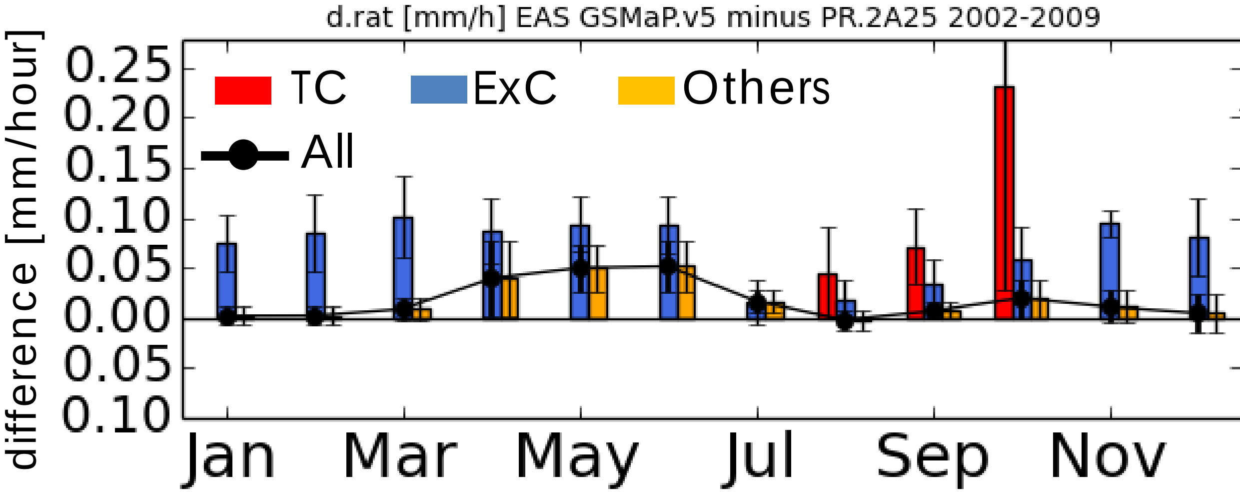
Error Estimation by Weather Systems: Sensitivity

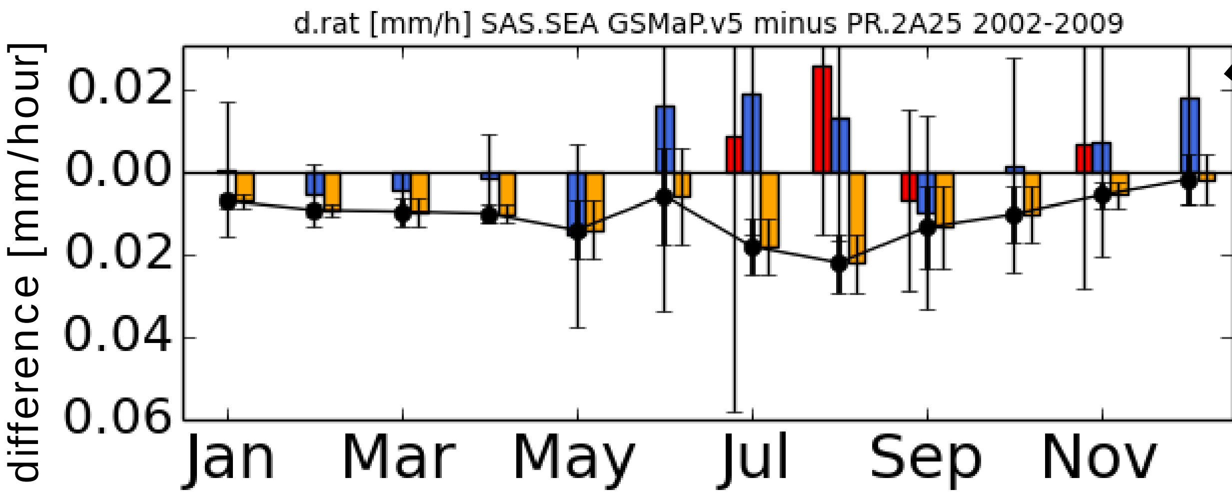


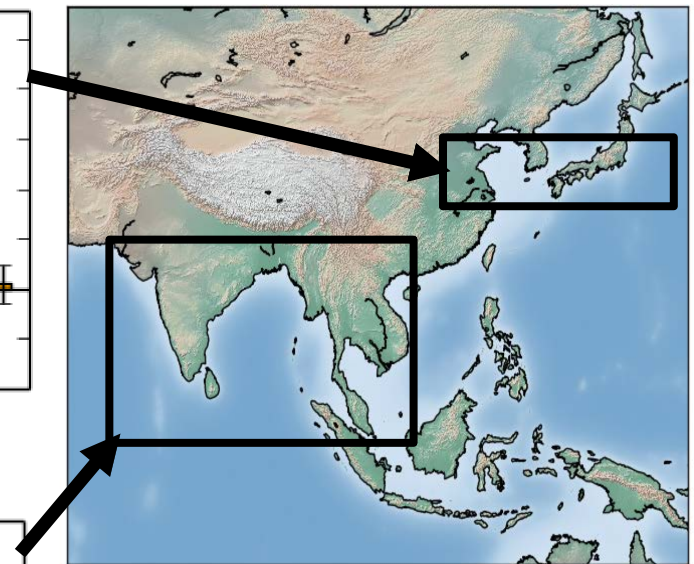
+ Different algorithms show biases of different amounts and directions.

Error Estimation by Weather Systems: Sensitivity

(GSMaPv5 – TRMM/PR 2A25v7; 2002-2009)







Different biases for …

- ✓ Different weather systems
- ✓ Different seasons
- ✓ Different regions

** Utsumi et al., in preparation; Azariah et al., in preparation*

Decomposition of River Discharge by Precipitation Induced by Different Weather Systems

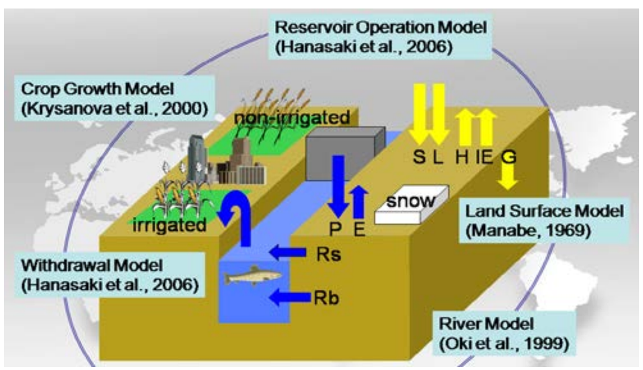
Tagged precipitation Products

TC	ExTrop Cyclone	Front	Others

Weather system Classification Method

+ Forcing data

Land surface model with tracer module



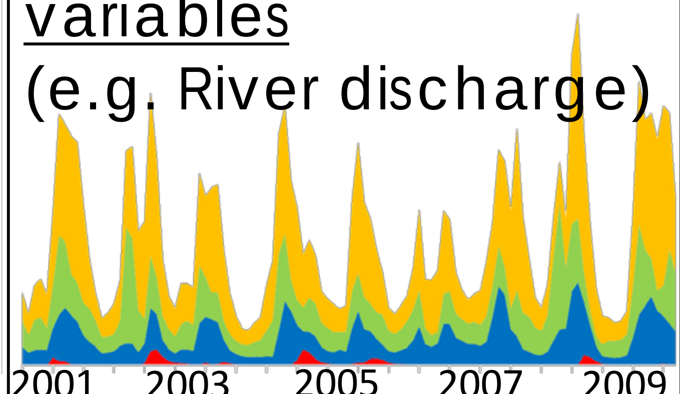
Hanasaki et al.,2008

Tracer module

Utsumi et al., 2016

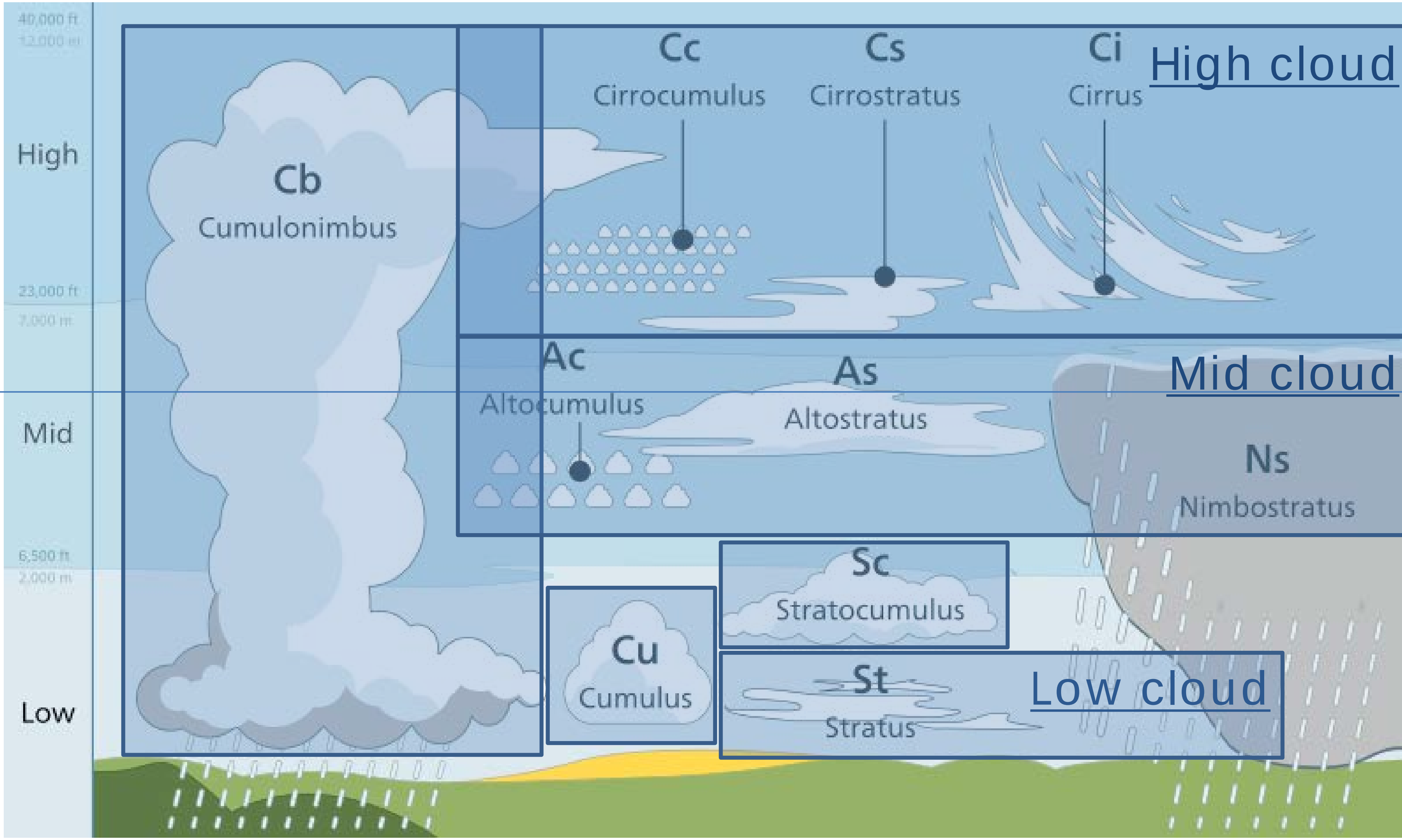
Tagged hydrological variables

(e.g. River discharge)



+ Multi-scale analysis for the propagation of extreme signal from climate to local scale
+ Climate regime shift and long-term water security problem

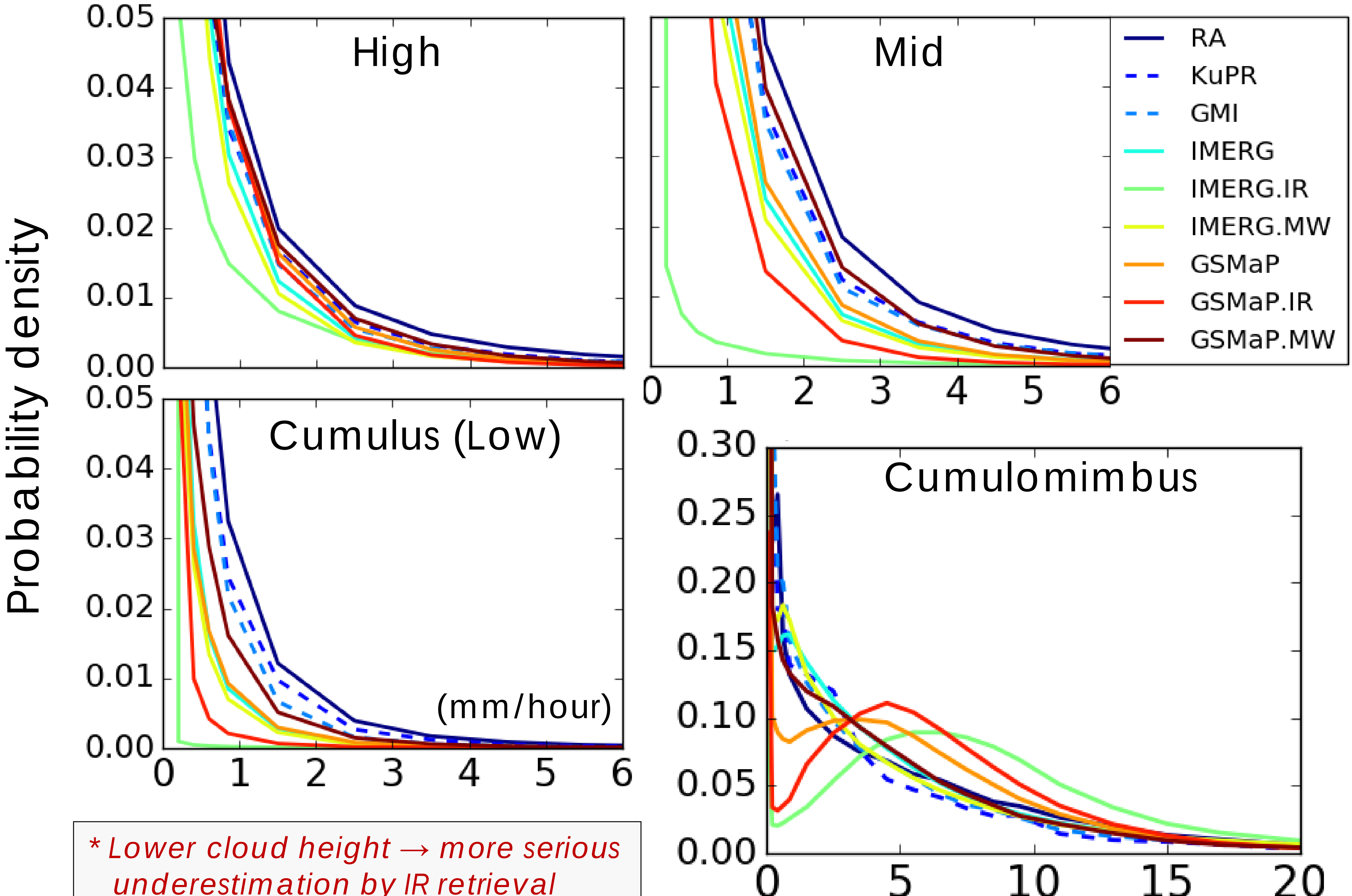
Cloud Type Mask



** Satellite Cloud Grid Information over Western North Pacific by JMA*

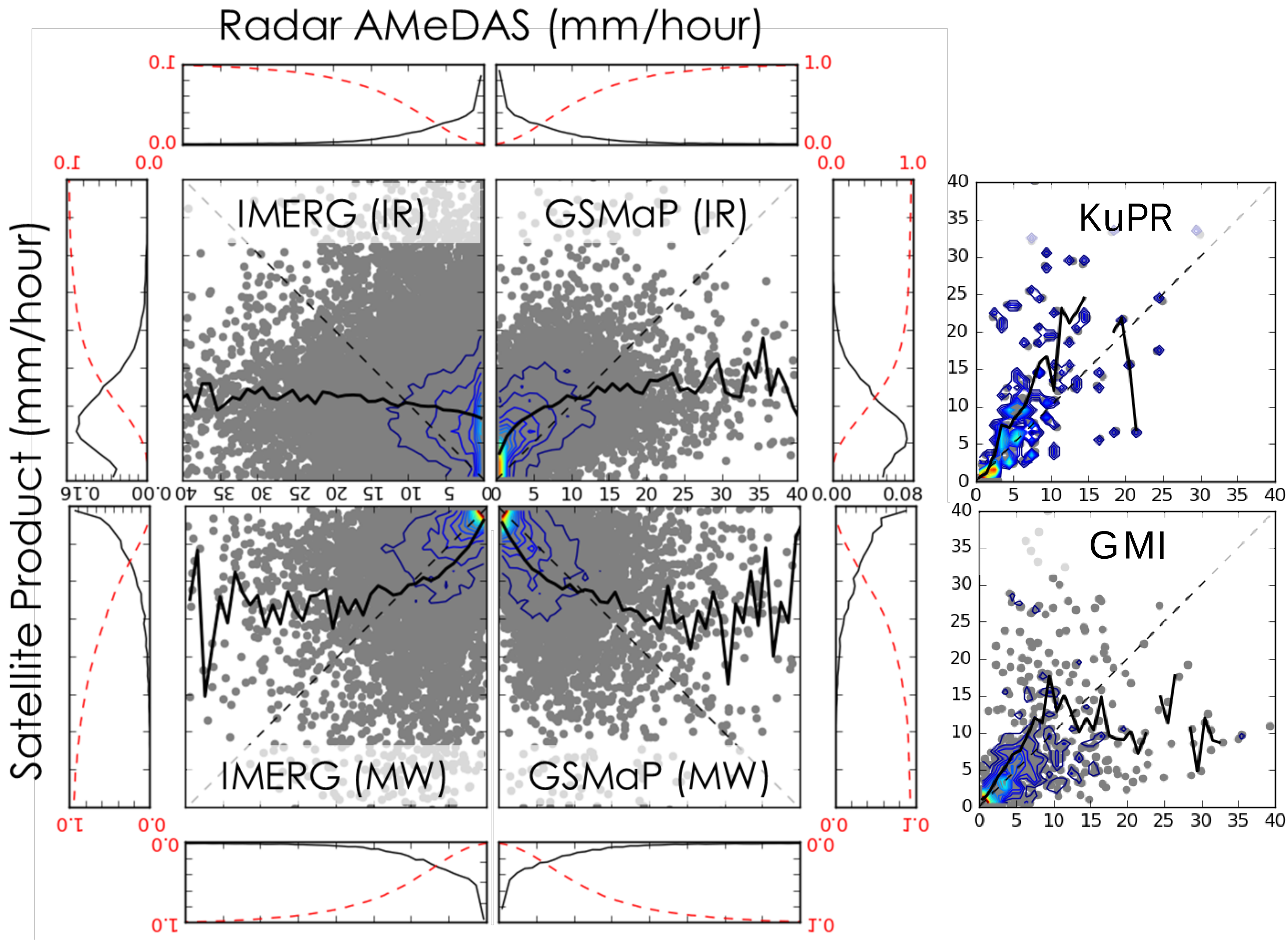
** Visible and Infrared (IR) from Himarwari-6 (0.2 x 0.25 deg., hourly)*

Probability Density of Precipitation by Cloud Types



** Lower cloud height → more serious underestimation by IR retrieval*

Validation of Sensitivity by Sensors /* Cumulonimbus */



Concluding Remarks

+ Uncertainty in forcing data is one of important uncertainty sources of hydrologic simulations.

+ Multiple precipitation products including satellite measurement show systematic bias by different causal weather systems.

+ Weather system mask is not only useful to classify measurement error and update algorithms but also to trace reasons of water excess (flood) or deficit (drought) in different spatiotemporal scale.

+ Satellite retrieval algorithms show different sensitivities to various cloud types.

+ Algorithms using IR tend to underestimate week precipitation, but its impact is not considerable in IMERG product.

+ Overall, current satellite precipitation retrievals mostly underestimate precipitation comparing to Radar-AMeDAS.

GPyM: a Python Module to Interface TRMM/GPM Data

I/O Interface

```
In [2]: from GPyM import GPM

In [3]: prdLv   = 'L2'
        prdVer  = '03'
        #prdName = 'GPM.KuPR'
        #varName = 'NS/SLV/precipRateESurface'
        prdName = 'GPM.GMI'
        varName = 'S1/surfacePrecipitation'

In [4]: gpm = GPM( prdName, prdLv, prdVer )

In [5]: sdtime = datetime(2014,4,30,12)
        edtime = datetime(2014,5,2,12)
        domain = [[20,118],[48,150]]
        res    = 0.2

In [7]: jp = gpm( varName, sdtime, edtime, domain, res)

* [_] ground track dimension (cached): /tank/hjkim/GPM/GPM.GMI/L2/03/2014/04/GPMCOR_GMI_1404301136_1308_000962_L2S_GL2_03C.h5
* [_] ground track dimension (cached): /tank/hjkim/GPM/GPM.GMI/L2/03/2014/04/GPMCOR_GMI_1404301308_1441_000963_L2S_GL2_03C.h5
* [V] ground track dimension (cached): /tank/hjkim/GPM/GPM.GMI/L2/03/2014/04/GPMCOR_GMI_1404301441_1613_000964_L2S_GL2_03C.h5
* [V] ground track dimension (cached): /tank/hjkim/GPM/GPM.GMI/L2/03/2014/04/GPMCOR_GMI_1404301613_1746_000965_L2S_GL2_03C.h5
* [_] ground track dimension (cached): /tank/hjkim/GPM/GPM.GMI/L2/03/2014/04/GPMCOR_GMI_1404301746_1918_000966_L2S_GL2_03C.h5
* [_] ground track dimension (cached): /tank/hjkim/GPM/GPM.GMI/L2/03/2014/04/GPMCOR_GMI_1404301918_2051_000967_L2S_GL2_03C.h5
```

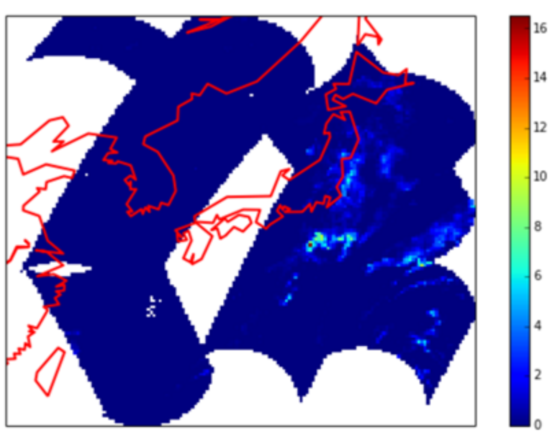
```
In [2]: gpm = GPM( 'GPM.KuPR', 'L2', '03' )

In [3]: gpmJP = gpm( 'NS/SLV/precipRateESurface',
   ...: datetime(2014, 4, 1, 12), datetime(2014, 4, 3),
   ...: [[30.0, 125.0], [45.0, 145.0]],
   ...: 0.1 )
```

```
        [READ_HDF5] /tank/hjkim/GPM/GPM.GMI/L2/03/2014/05/GPMCOR_GMI_1405012305_0037_000985_L2S_GL2_03C.h5 (2962, 221) -> (112,
 221)
        [GRANULE2MAP] Domain:[[20, 118], [48, 150]] (112, 221) -> (140, 160)
        [READ_HDF5] /tank/hjkim/GPM/GPM.GMI/L2/03/2014/05/GPMCOR_GMI_1405020037_0210_000986_L2S_GL2_03C.h5 (2962, 221) -> (96, 2
21)
        [GRANULE2MAP] Domain:[[20, 118], [48, 150]] (96, 221) -> (140, 160)
```

```
        M.imshow( ma.masked_less_equal( jp.griddata, 0).sum(0),
                  interpolation='nearest' )
        colorbar()

Out[10]: <matplotlib.colorbar.Colorbar instance at 0x4601ab8>
```



Features

+ Archive data from G-Portal (SFTP protocol)
+ Search granules by timespan and spatial domain
+ Convert and upscale granules to maps
+ Cached IO (e.g., orbits)

https://github.com/kimlab/GPyM

Image courtesy of http://www.satnavi.jaxa.jp/gpmdpr_special/