Global 3-sec (90-m) Water Body Map [G3WBM]

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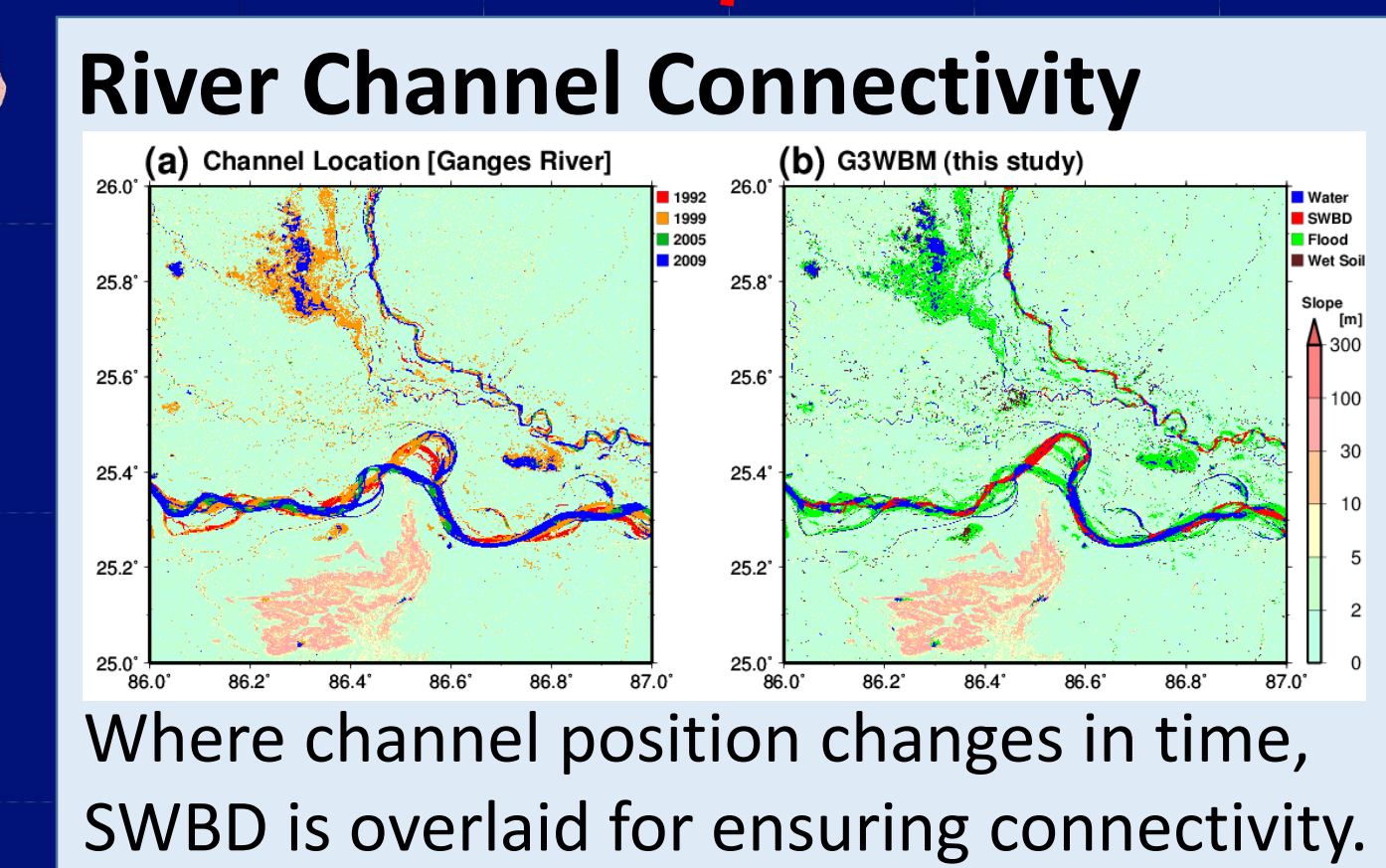JAMSTEC
University of BRISTOL
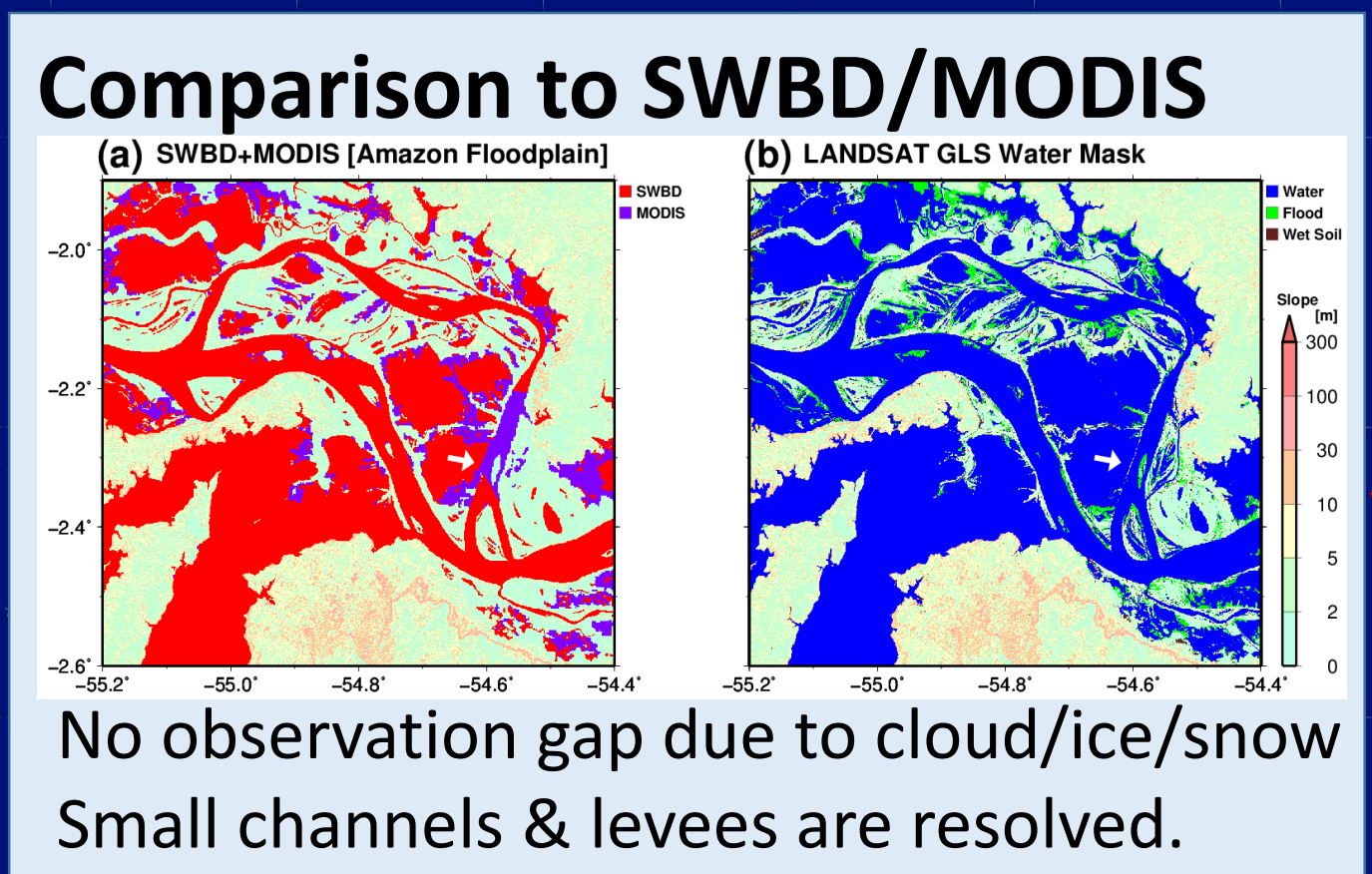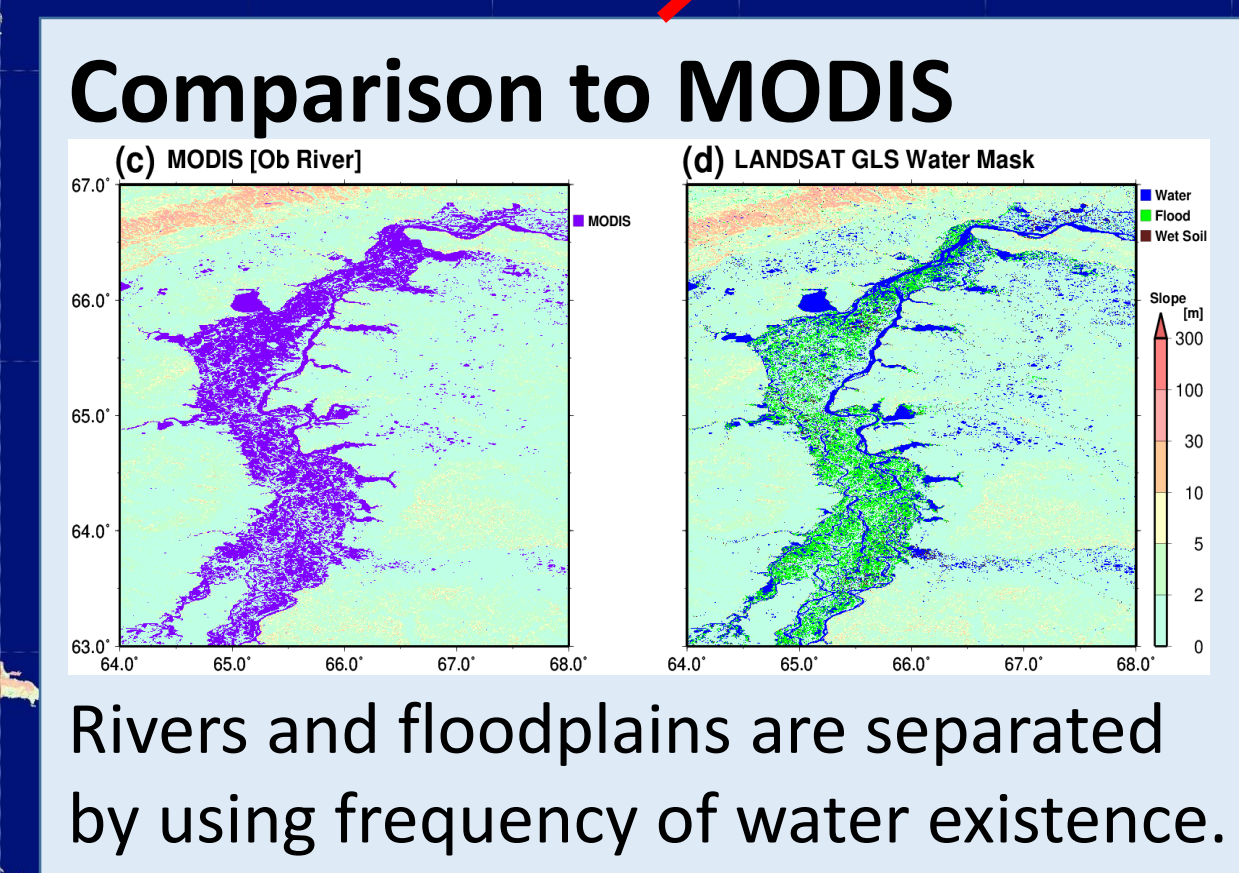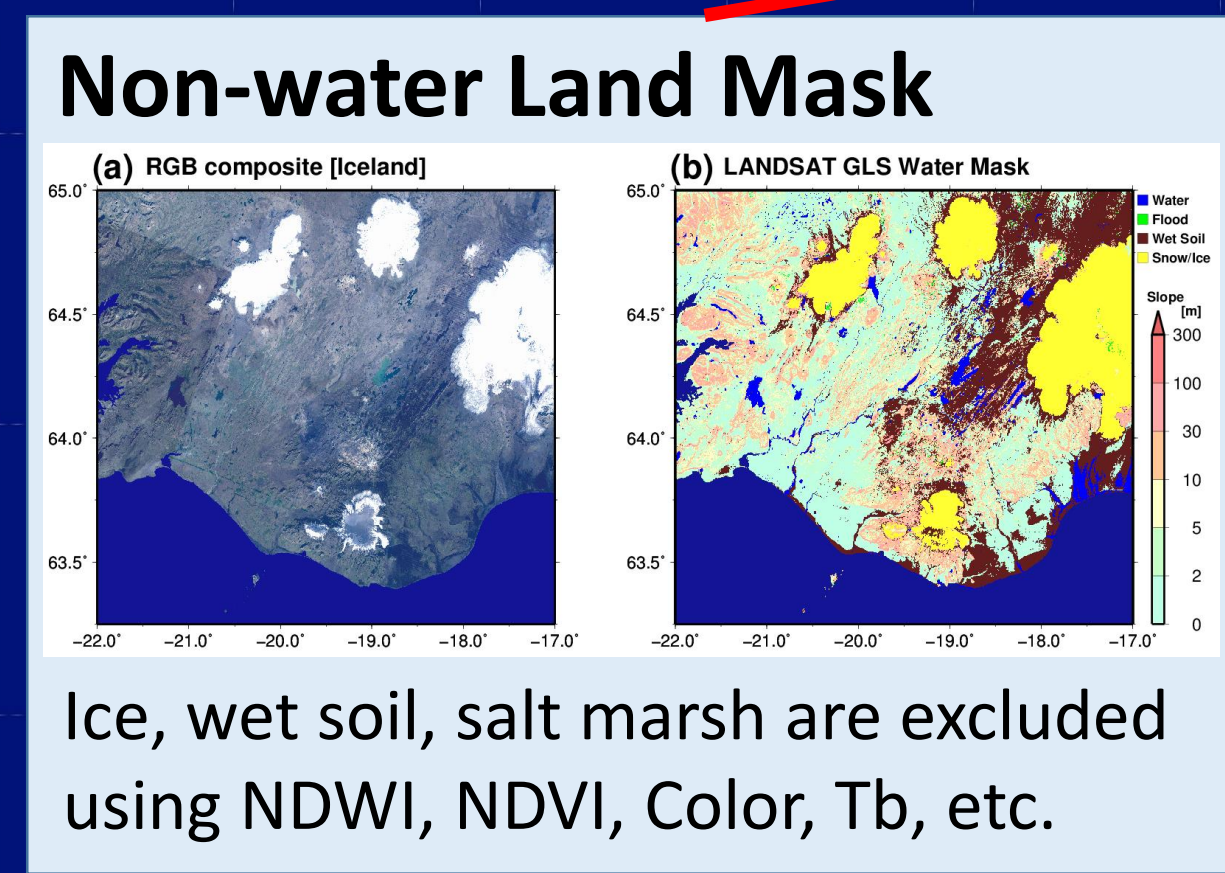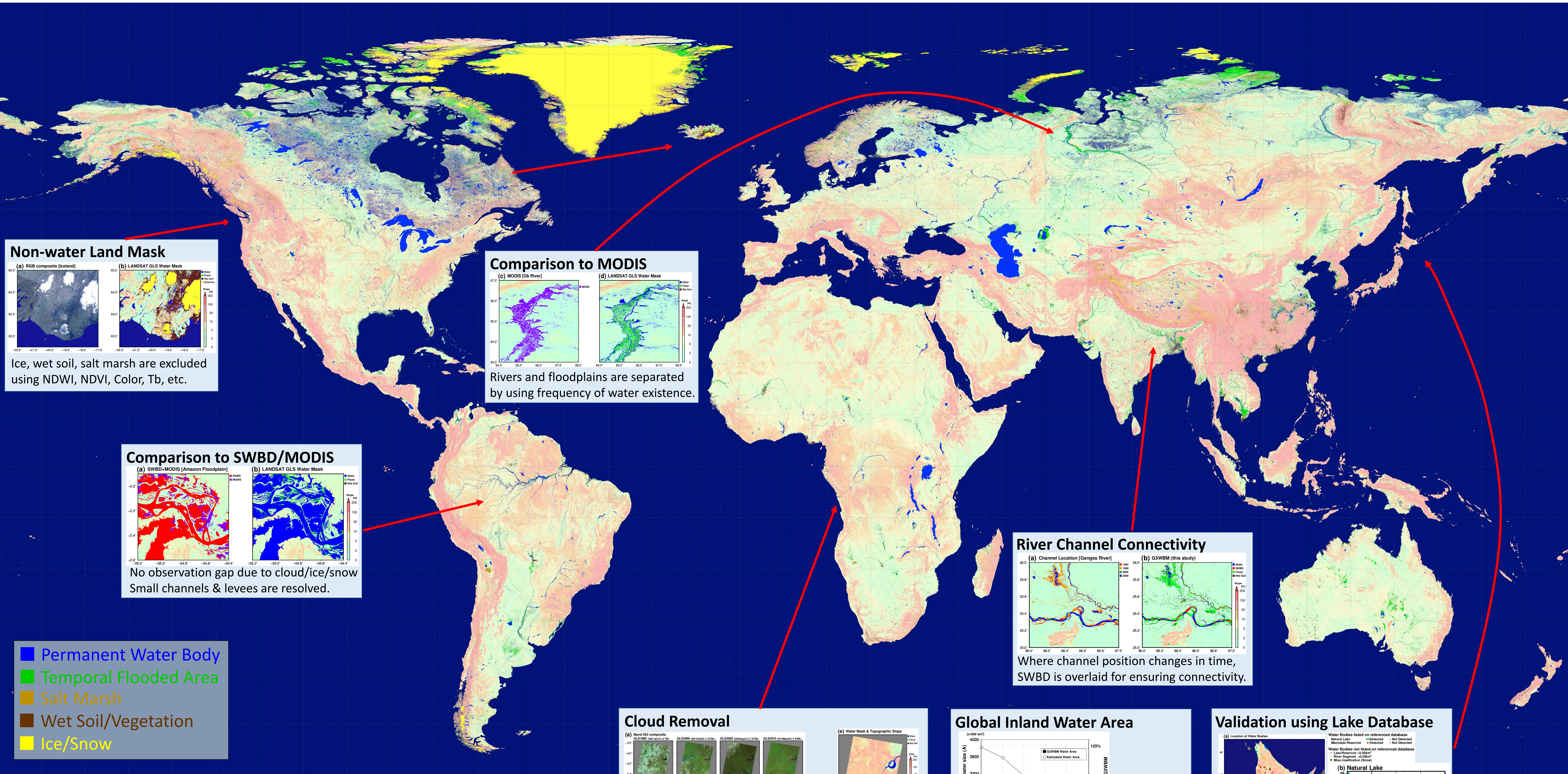Correspondence : d-yamazaki@jamstec.go.jp

New 90-m global water body map is developed using 33,890 LANDSAT GLS images.
Permanent water bodies and temporal flooded area are separated by flood frequency analysis. No gaps due to cloud/ice.
Data is available online. http://hydro.iis.u-tokyo.ac.jp/~yamadai/G3WBM/

Non-water Land Mask

(a) RGB composite [Iceland]   (b) LANDSAT GLS Water Mask

Ice, wet soil, salt marsh are excluded using NDWI, NDVI, Color, Tb, etc.

Comparison to MODIS

(c) MODIS [Ob River]   (d) LANDSAT GLS Water Mask

Rivers and floodplains are separated by using frequency of water existence.

Comparison to SWBD/MODIS

(a) SWBD+MODIS [Amazon Floodplain]   (b) LANDSAT GLS Water Mask

No observation gap due to cloud/ice/snow
Small channels & levees are resolved.

River Channel Connectivity

(a) Channel Location [Ganges River]   (b) G3WBM (this study)

Where channel position changes in time, SWBD is overlaid for ensuring connectivity.

Legend:
- ■ Permanent Water Body
- ■ Temporal Flooded Area
- ■ Salt Marsh
- ■ Wet Soil/Vegetation
- ■ Ice/Snow

Cloud Removal

(a) Band 542 composite
(e) Water Mask & Topographic Slope
(b) Observation Confidence
(c) Probability of Water Body Existence
(d) Frequency of Water Body Existence

Clouds are removed by compositing multiple scenes with Observation-Confidence-weighted average.

Global Inland Water Area

Global water area in G3WBM = 3.1 Mkm^2
20% water body missed (estimated using US hydrology map)
Small lakes are not negligible.

Validation using Lake Database

(a) Location of Water Bodies
(b) Natural Lake

Water classification accuracy is very high
(almost no miss classification of non-water surface)

Lake area tends to be underestimated
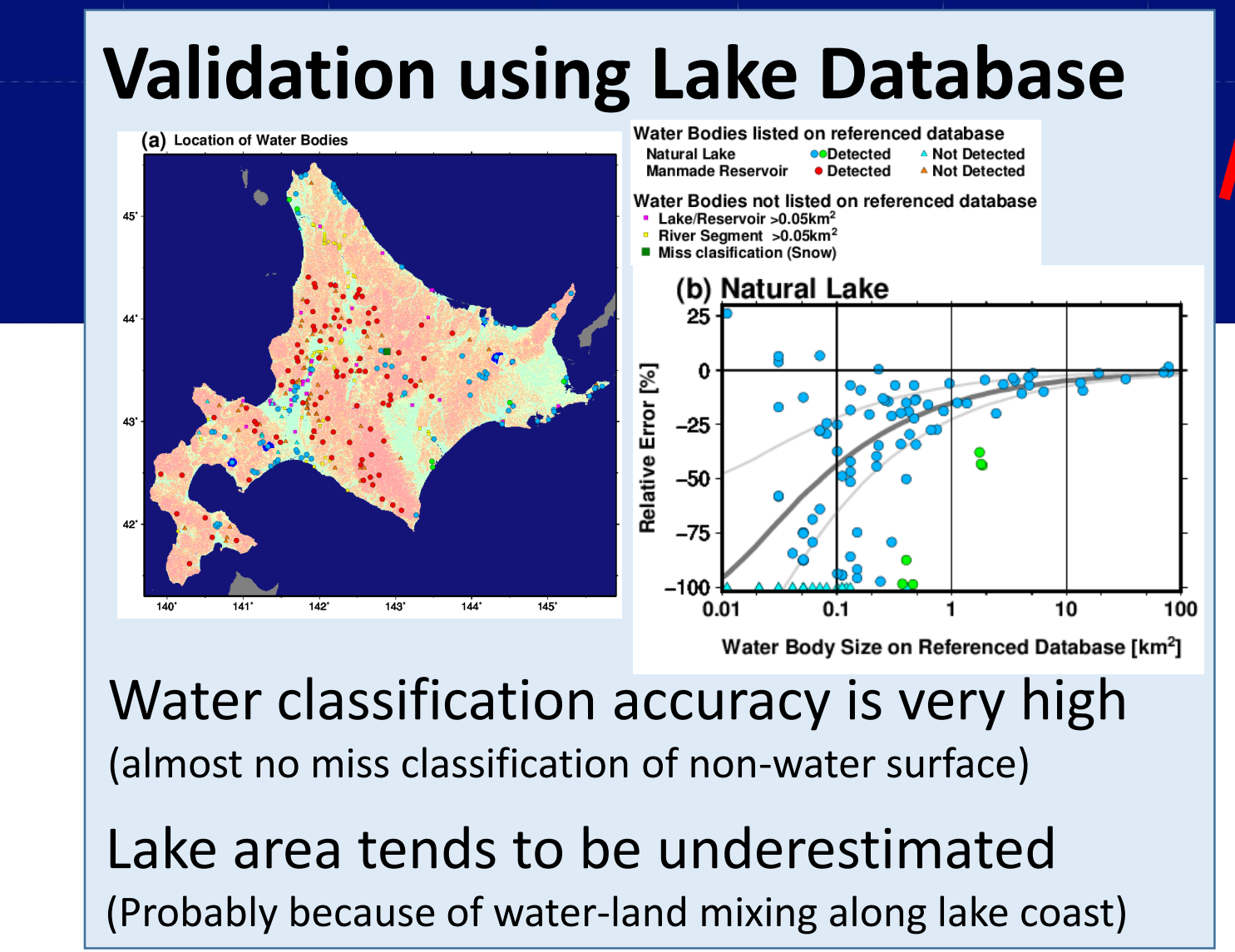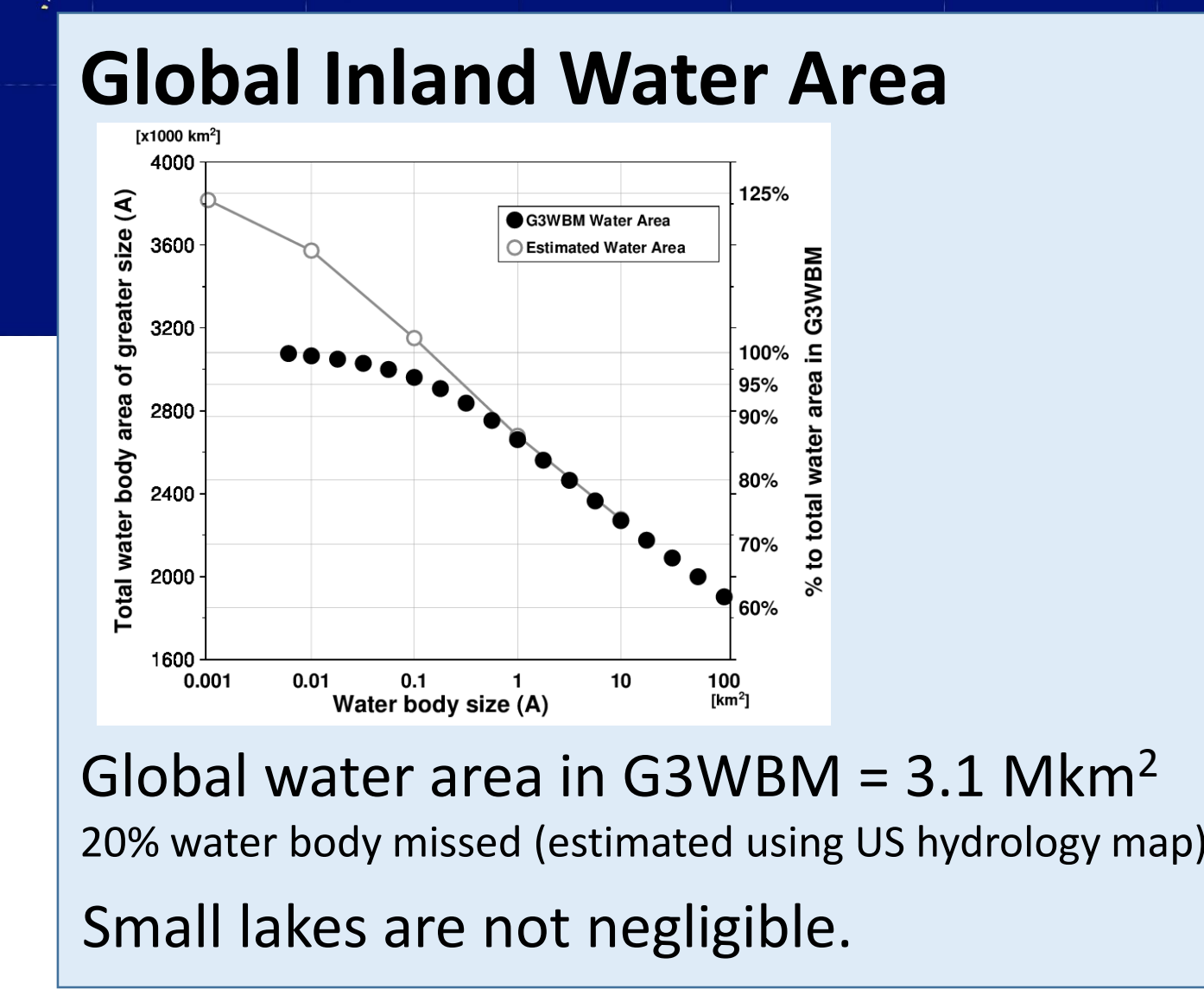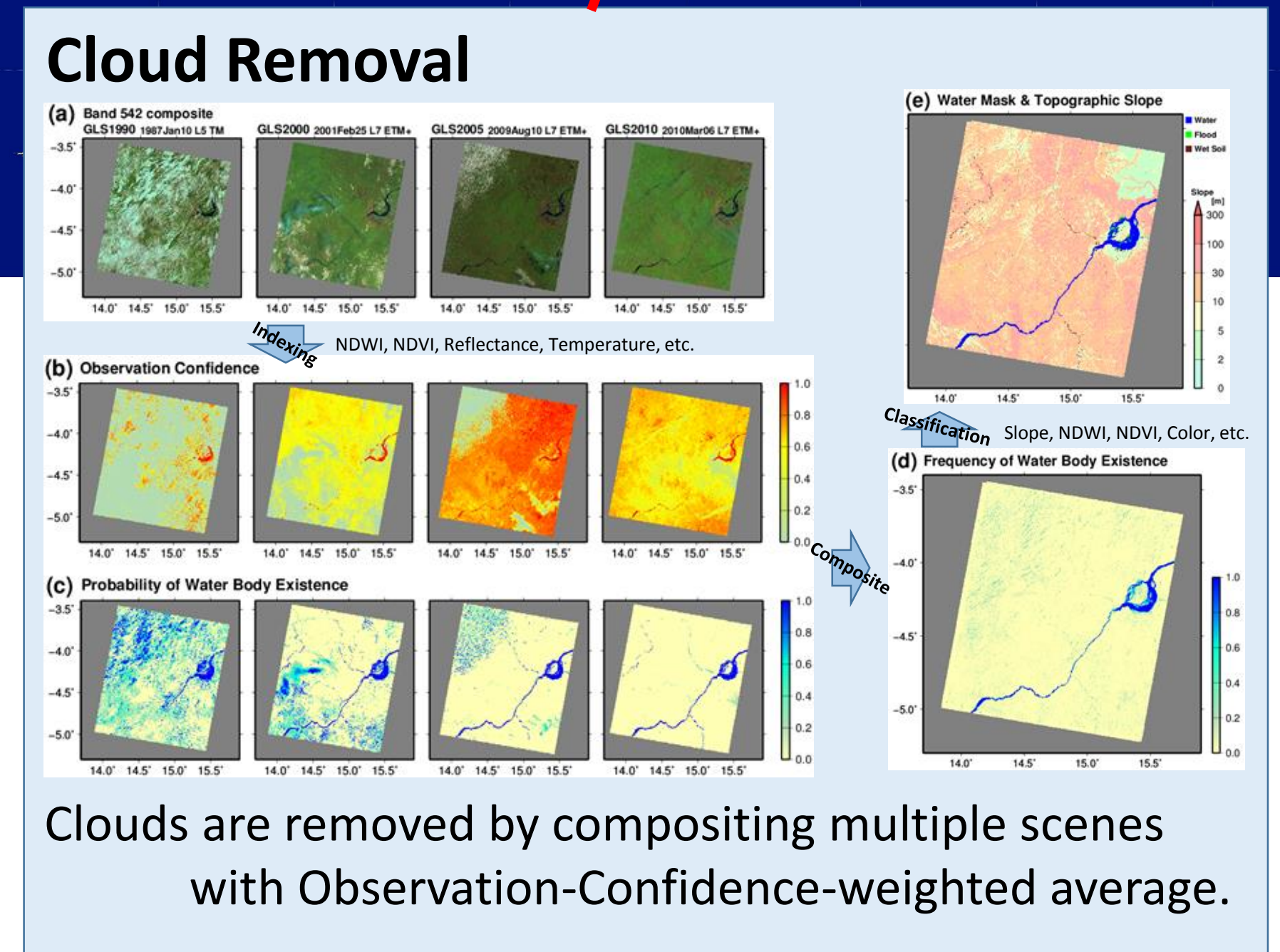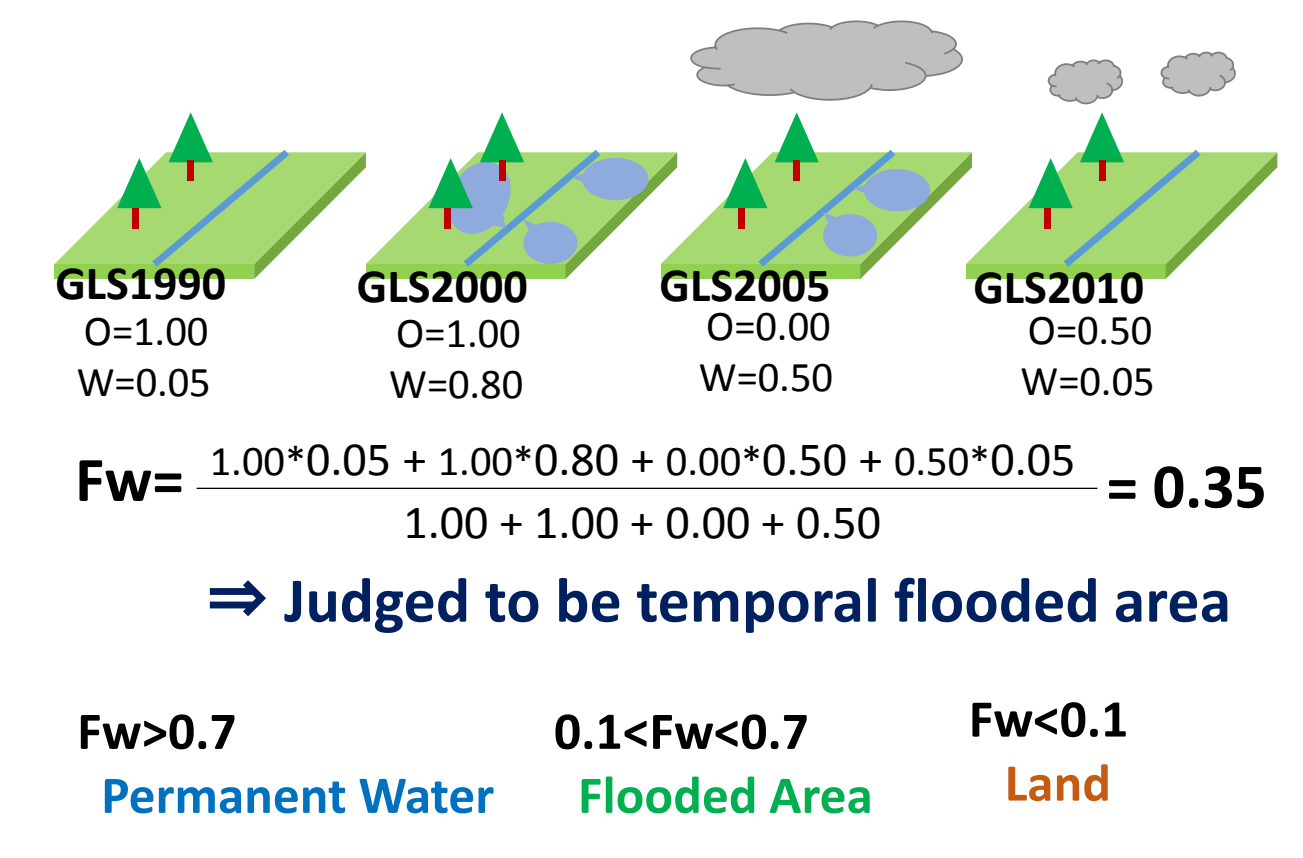(Probably because of water-land mixing along lake coast)

Method (in short)

Calculate frequency of water body existence from multiple images
for removing observation gaps due to cloud/ice and
for separating permanent water from temporally flooded area.

$$F_w = \frac{\sum_{j=1}^{N} (O_{i,j} W_{i,j})}{\sum_{j=1}^{N} O_{i,j}}$$

Observation-Confidence-weighted average of Water Probability

$W_{i,j}$: Water Probability at pixel i in LANDSAT scene j
$O_{i,j}$: Observation Confidence at pixel i in LANDSAT scene j
$O_{i,j}$ becomes smaller when land is covered by cloud/ice.

GLS1990   GLS2000   GLS2005   GLS2010
O=1.00   O=1.00   O=0.00   O=0.50
W=0.05   W=0.80   W=0.50   W=0.05

$$Fw = \frac{1.00*0.05 + 1.00*0.80 + 0.00*0.50 + 0.50*0.05}{1.00 + 1.00 + 0.00 + 0.50} = 0.35$$

⇒ Judged to be temporal flooded area

Fw>0.7   0.1<Fw<0.7   Fw<0.1
Permanent Water   Flooded Area   Land

Reference

Yamazaki & Trigg (in prep.)
Development of global 90-m water body map based on multi-decadal LANDSAT GLS database

Data Used

GLCF LANDSAT GLS (baseline data)
http://glcf.umd.edu/data/gls/
Viewfinder Panorama DEM (for shadow classification)
http://www.viewfinderpanoramas.org/dem3.html
NASA/NGA SWBD water mask (connectivity / comparison)
https://dds.cr.usgs.gov/srtm/version2_1/SWBD/
GLCF MODIS water mask (comparison)
http://glcf.umd.edu/data/watermask/
HRO GIS data (validation)
http://envgis.ies.hro.or.jp/