An Active-Passive Microwave Land Surface Classification from GPM

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Outline

- Introduction/Motivation
- Emissivity Retrieval
- Precipitation Screening and Cloud Clearing
- Database Construction
- Data Availability
- Land Surface Classification

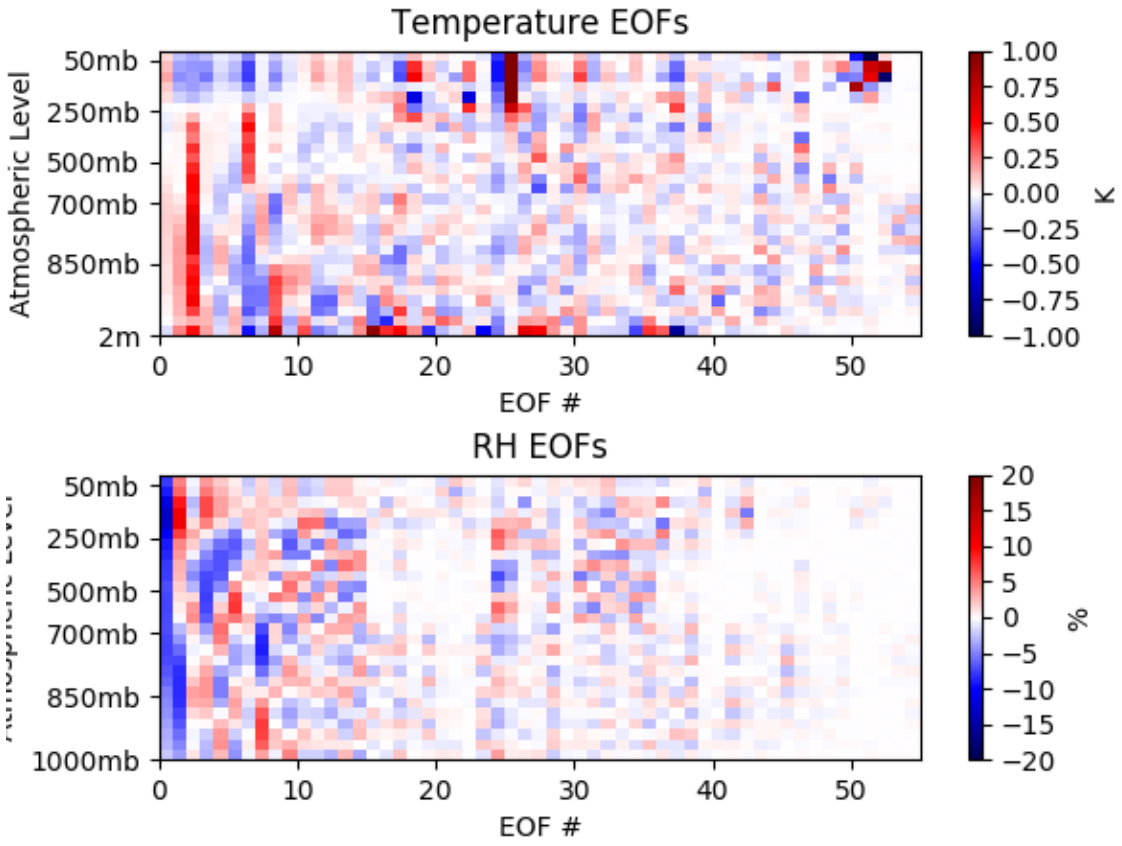
Introduction/Motivation

- Existing microwave emissivity atlases (e.g., TELSEM) are useful, but lack the full range of GMI frequencies
- Backscatter at DPR frequencies and incidence angles used in temporal reference component of SRT, but not linked to microwave emissivity
- Superior calibration, resolution, and matched active-passive data from GPM provide uniquely valuable dataset for model developers

In order to provide a dataset relevant to these application areas, we have developed a 5-year database of GPM emissivity and backscatter data

Emissivity Retrieval

- Optimal estimation at each GMI pixel
- Use MERRA2 for T_{skin} and first-guess atmosphere (temperature and water vapor profile)
- Retrieve emissivity vector and EOF representation of MERRA2 error
- No assumed covariance between emissivity at different channels (except 18V-23V-36V and 166-183) – we want to use output to discover these relationships

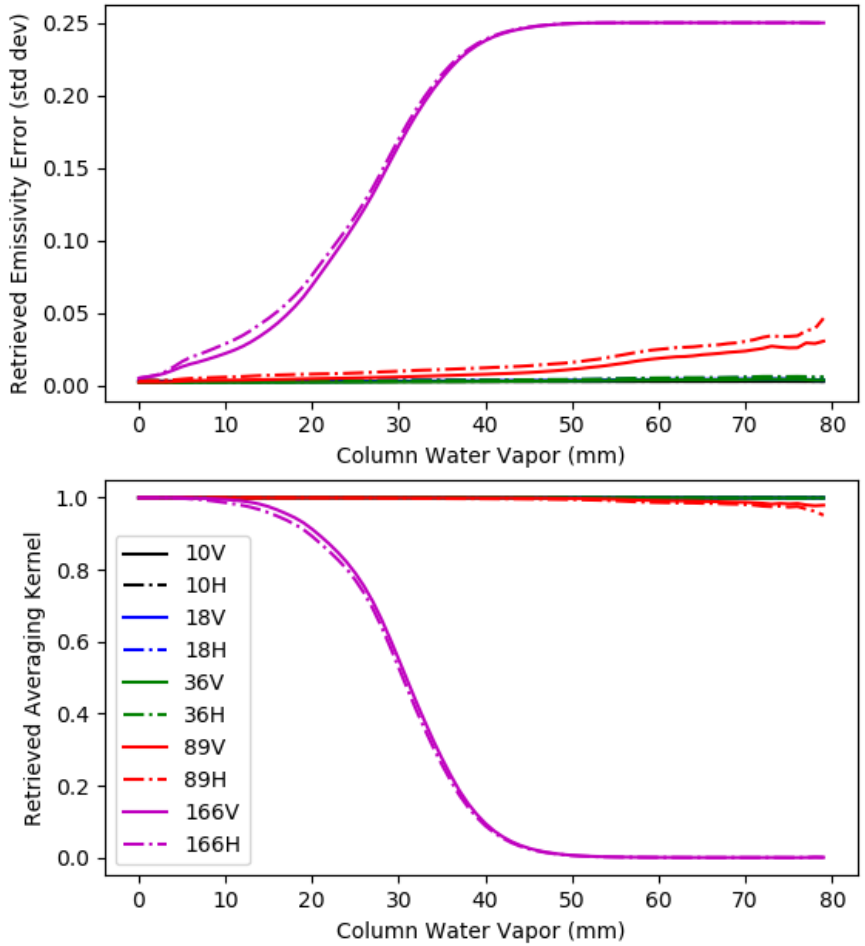


Information Content

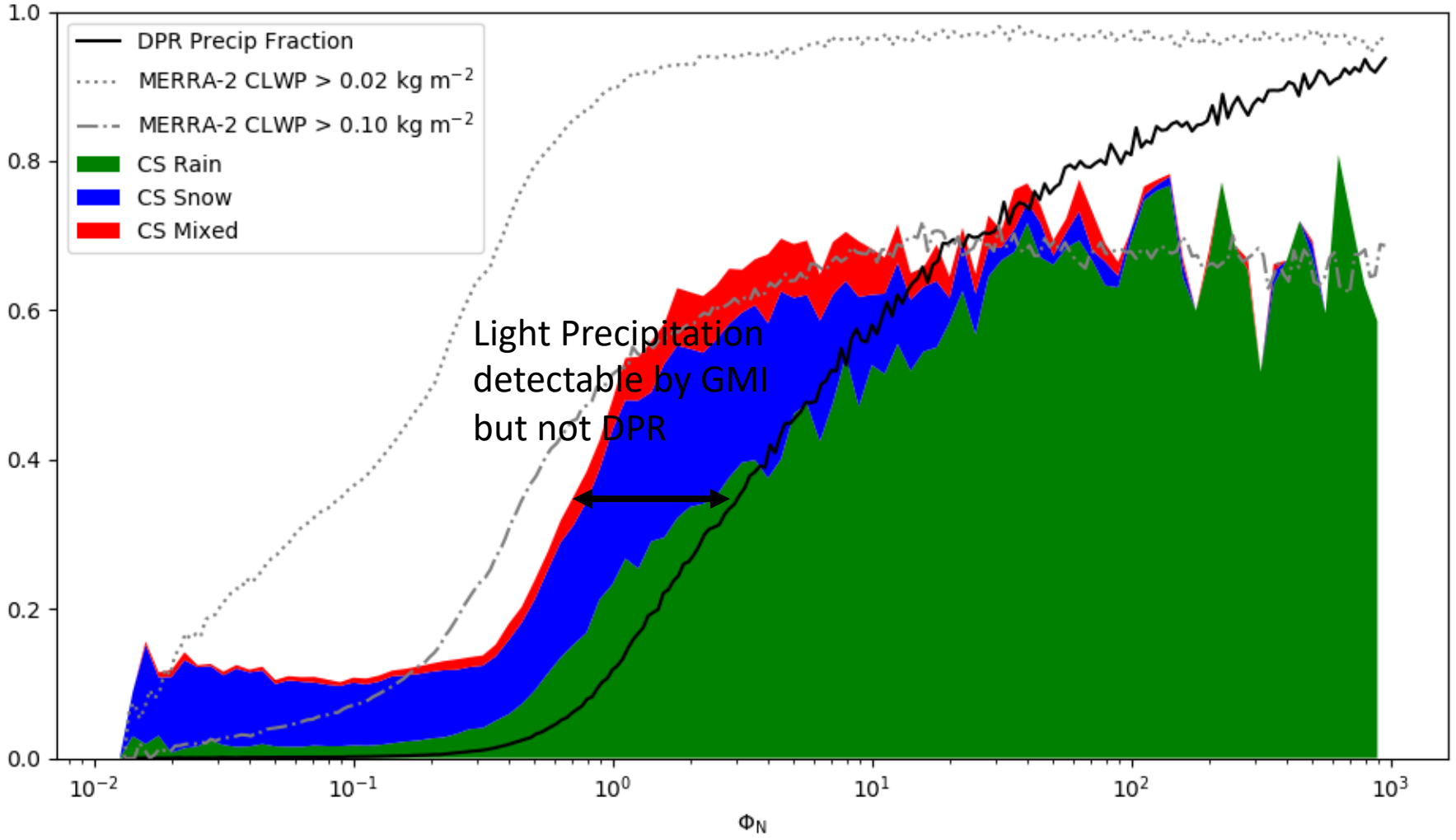
As column water vapor increases, GMI Tb becomes less sensitive to surface emissivity, therefore it becomes difficult to retrieve and can be influenced by errors in water vapor profile.

Effect is not significant below 89 GHz, and even there only for very high column water vapor (> 50 mm). At 166 GHz the impact is much larger. Retrievals not reliable above 10-20mm column water vapor.

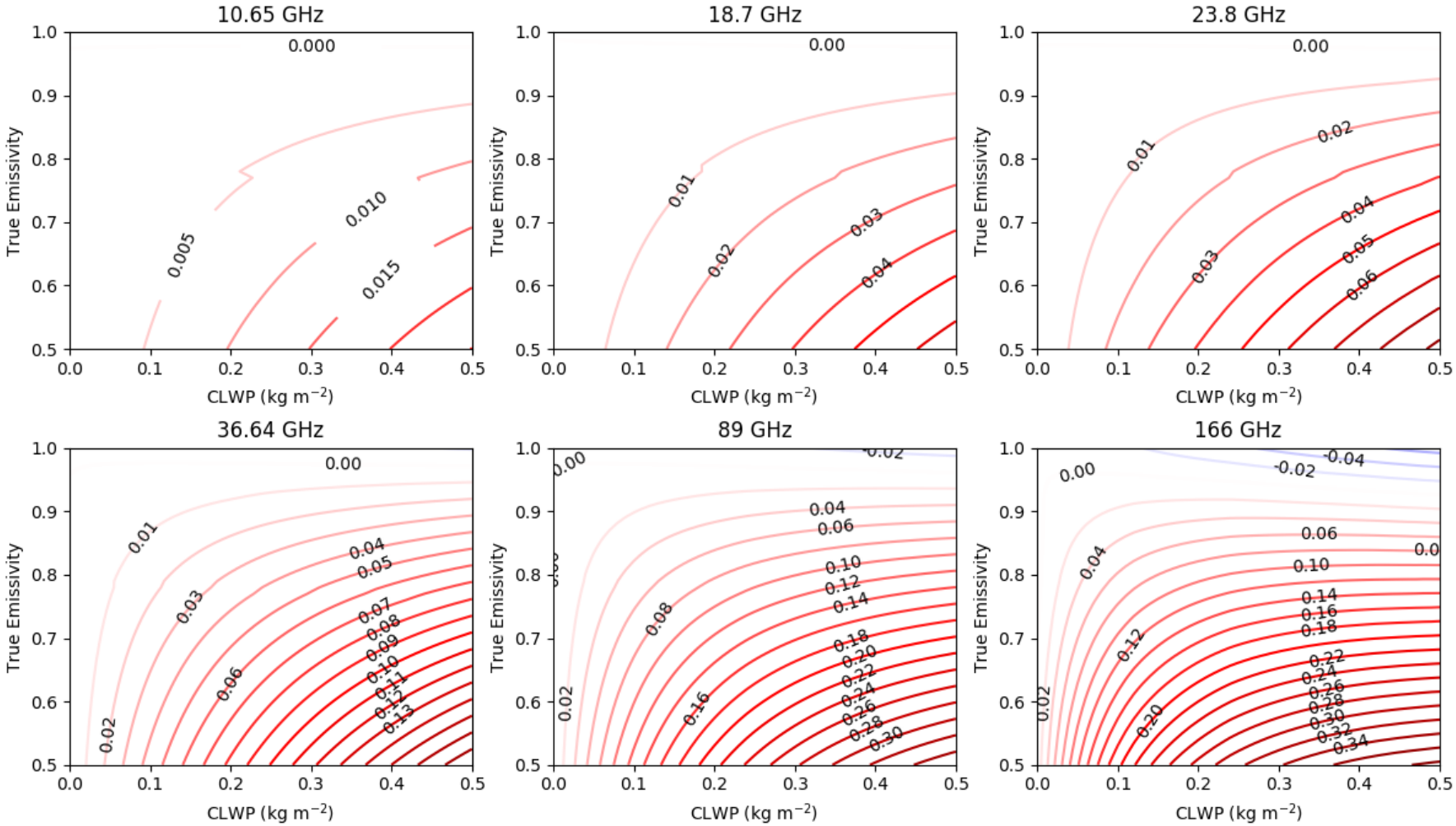
Clouds and precipitation also impact retrievals significantly and must be screened, as these are not accounted for in the forward model.



Precipitation Screening by Normalized Cost Function



Influence of Liquid Clouds on Retrieved Emissivity



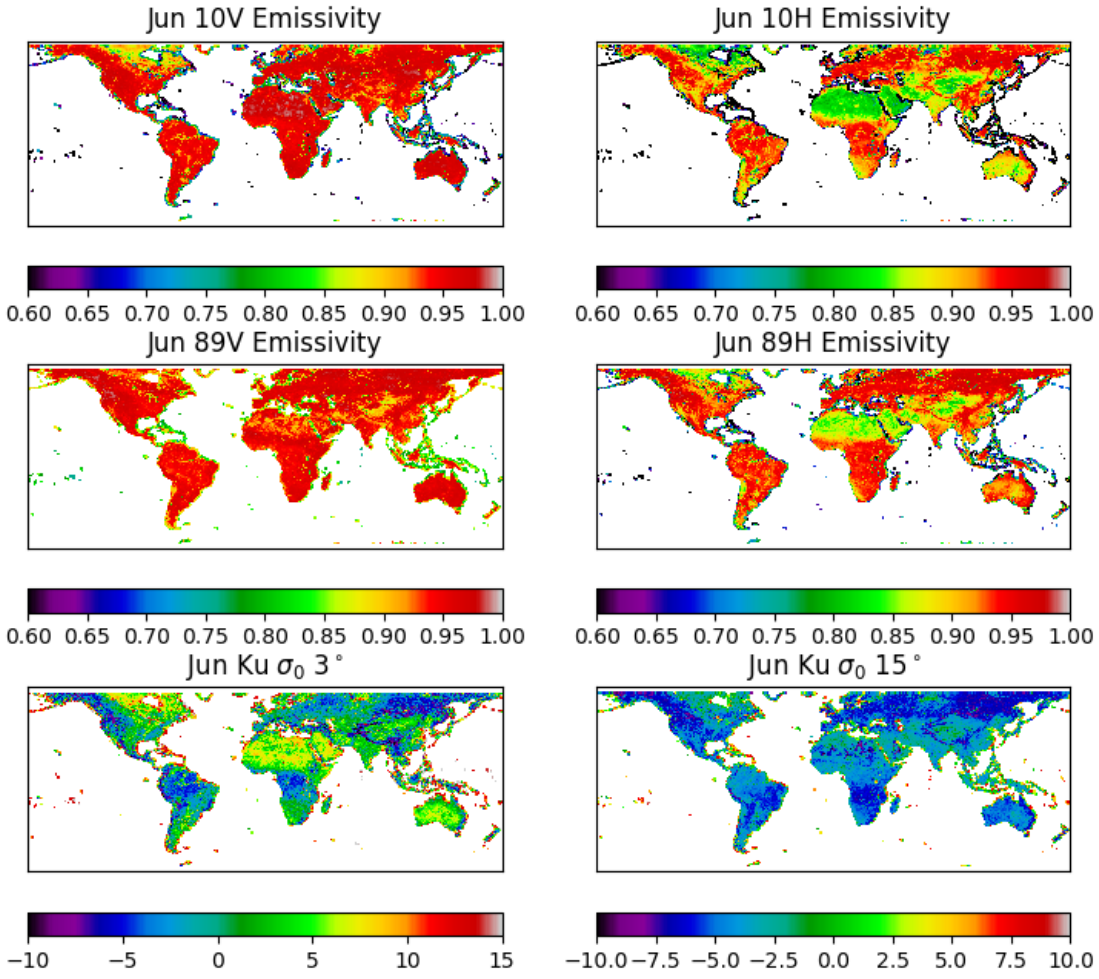
Contours are retrieved emissivity error (retrieved minus true). Error can be significant, yet difficult to retrieve cloud unless emissivity is already strongly constrained. Solution: Use ancillary data (MERRA2) to screen clouds.

Database construction and availability

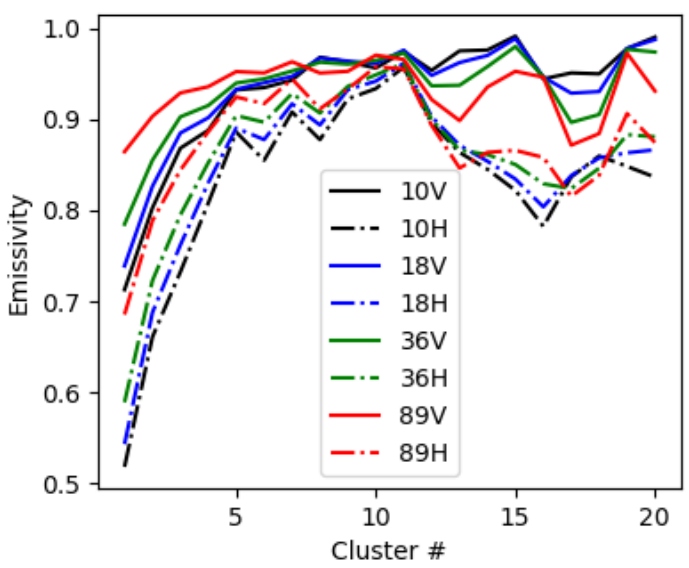
- Retrieval run for full GMI swath at GMI resolution (GMI.*.HDF5 files)
  - Contains retrieved emissivities, column water vapor, GMI observed and simulated Tbs, retrieval cost function, MERRA2 fields (Tskin, cloud LWP, column water vapor)
- Match to DPR resolution (nearest neighbor) (GPM.*.HDF5 files)
  - All the data in the GMI files, plus several fields copied from DPR files (incl. GANAL Tskin, precip flags, snow flags, sigma_zero, PIA from gas attenuation)
- Files for March 2014 – February 2019 available at ftp://meso-a.gsfc.nasa.gov/pub/munchak/gpm/emis/
  - Switching to ftps in near future
  - Anticipated to be part of GPM combined algorithm V7

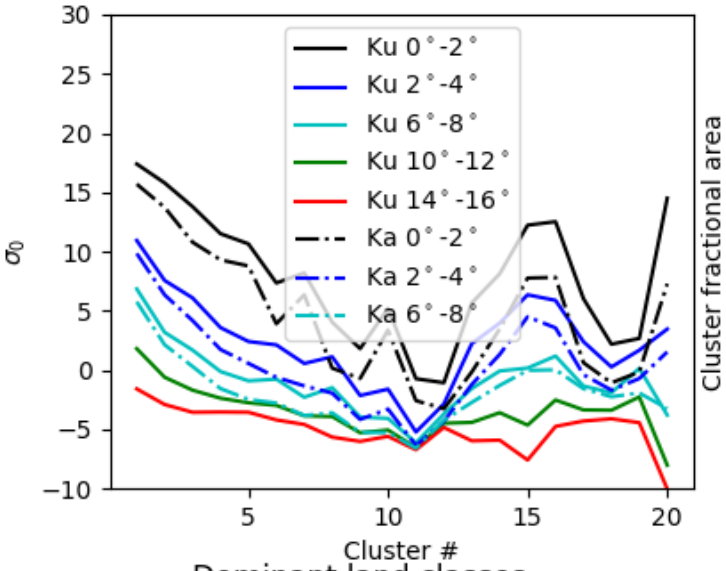
Gridded Database Construction

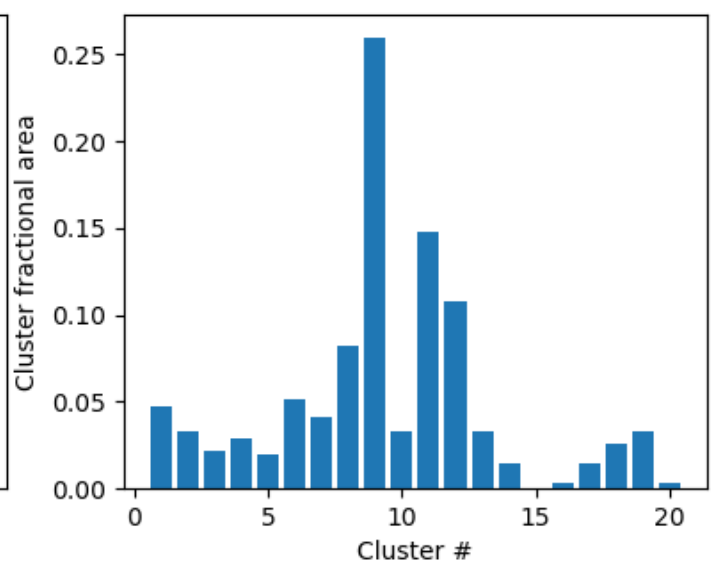
- 0.25°-resolution grids of the following statistics compiled:
  - Mean emissivity (n=11)
  - Mean sigma_zero (n=25+13)
  - Emissivity covariance matrix (n=66)
  - Sigma_zero covariances (n=51)
  - Emissivity-sigma_zero covariances (n=418)
- Separate grids for each month
- Separate grids for snow/sea ice

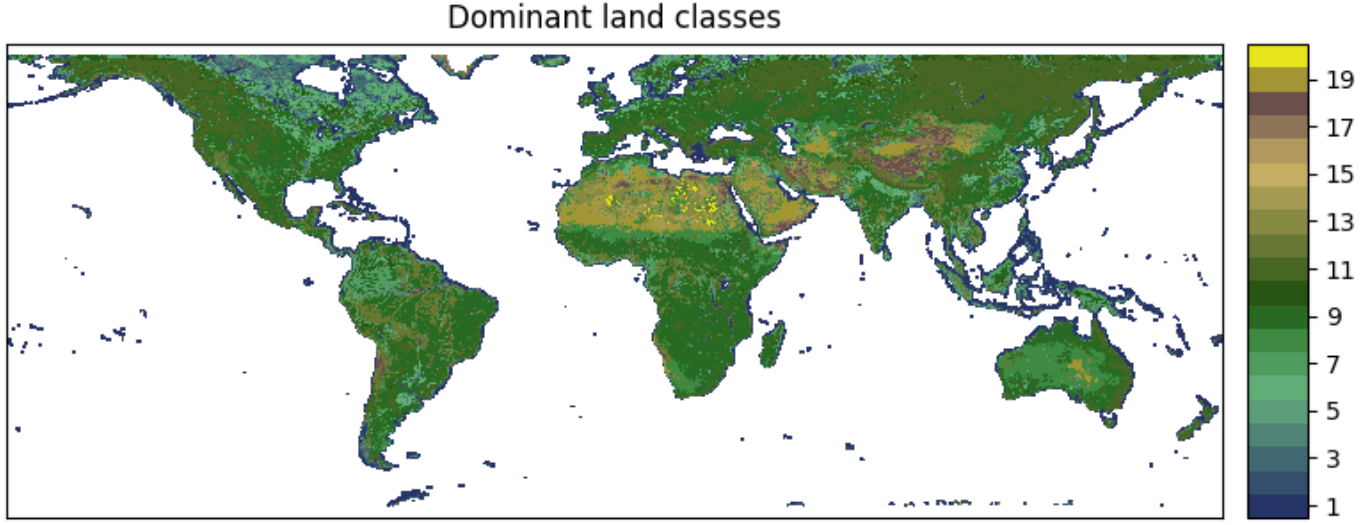


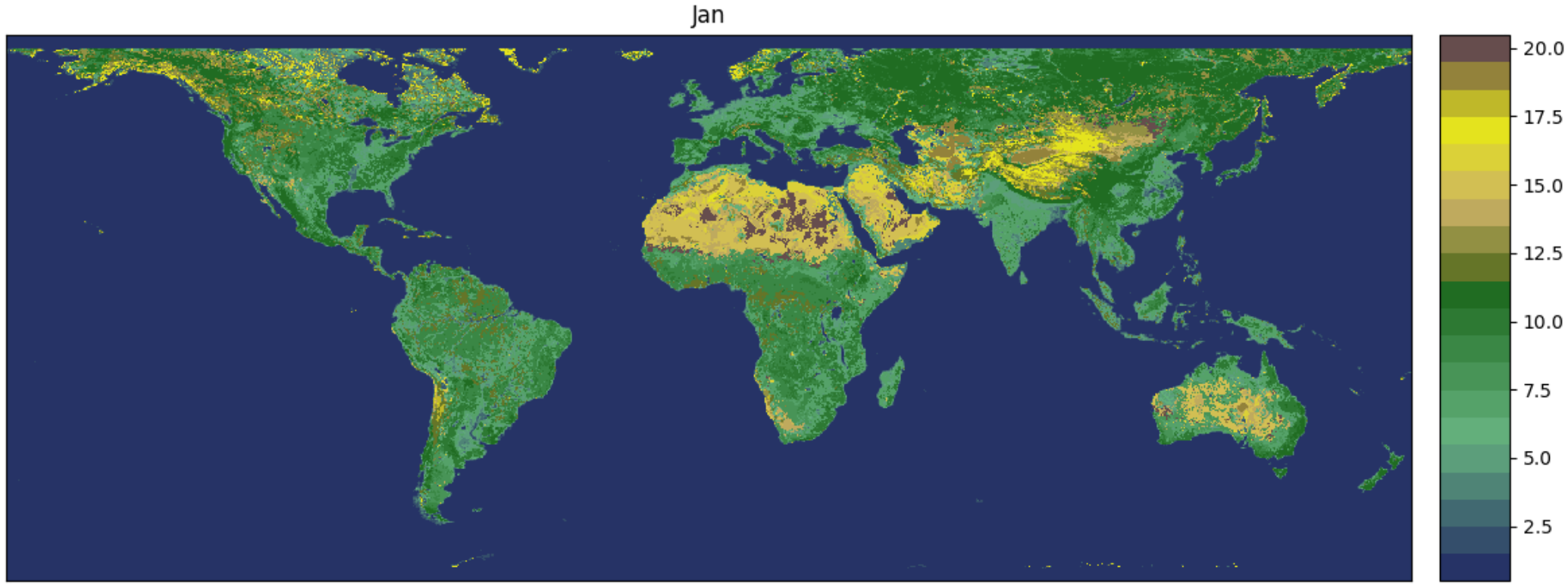
Kohonen Self-Organizing Map Clustering Method: Snow-free land



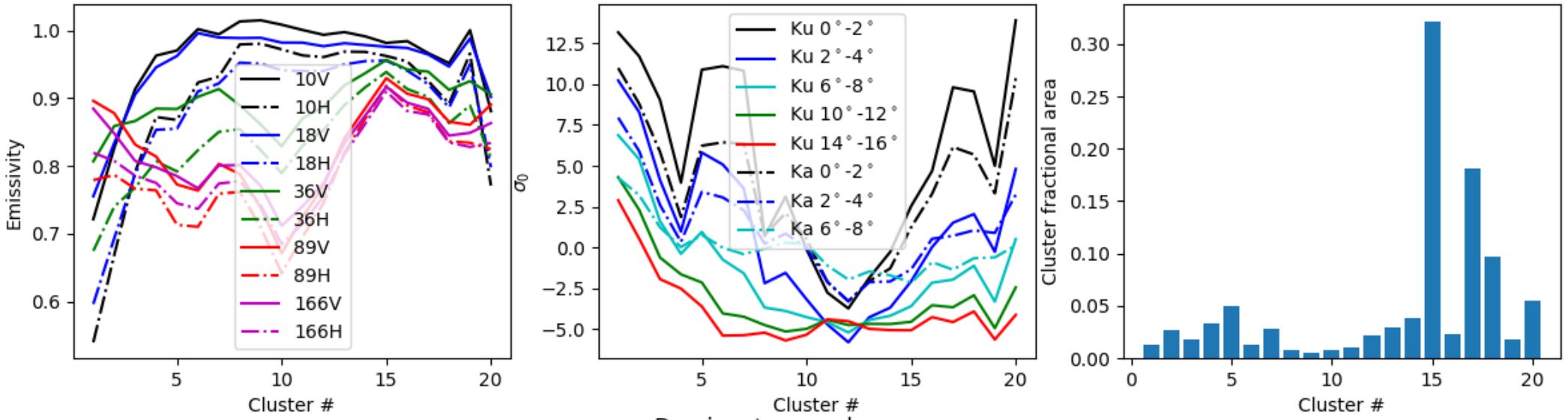




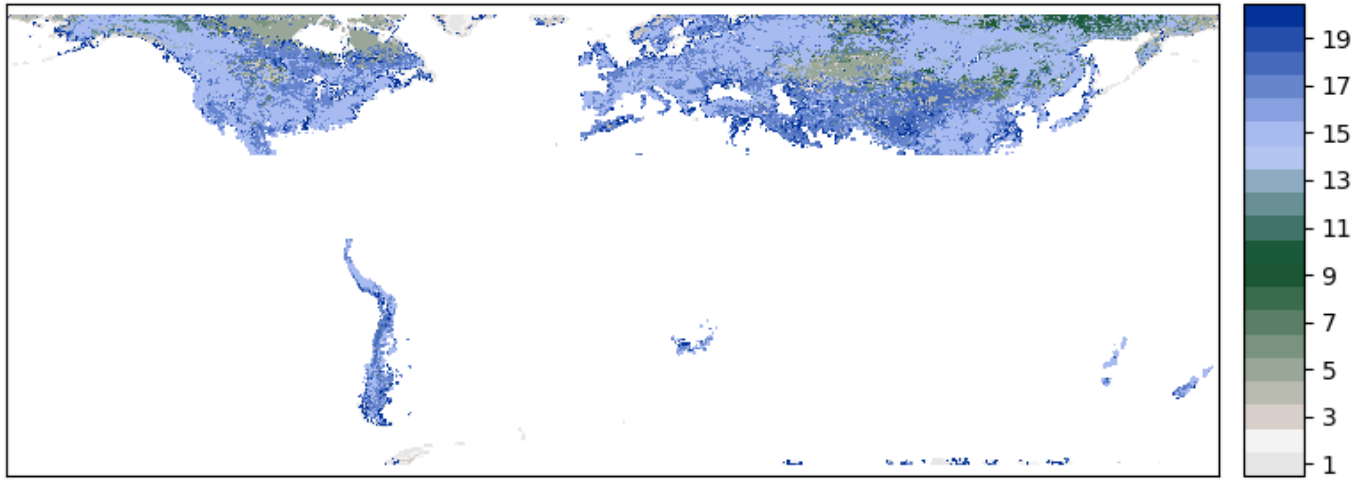


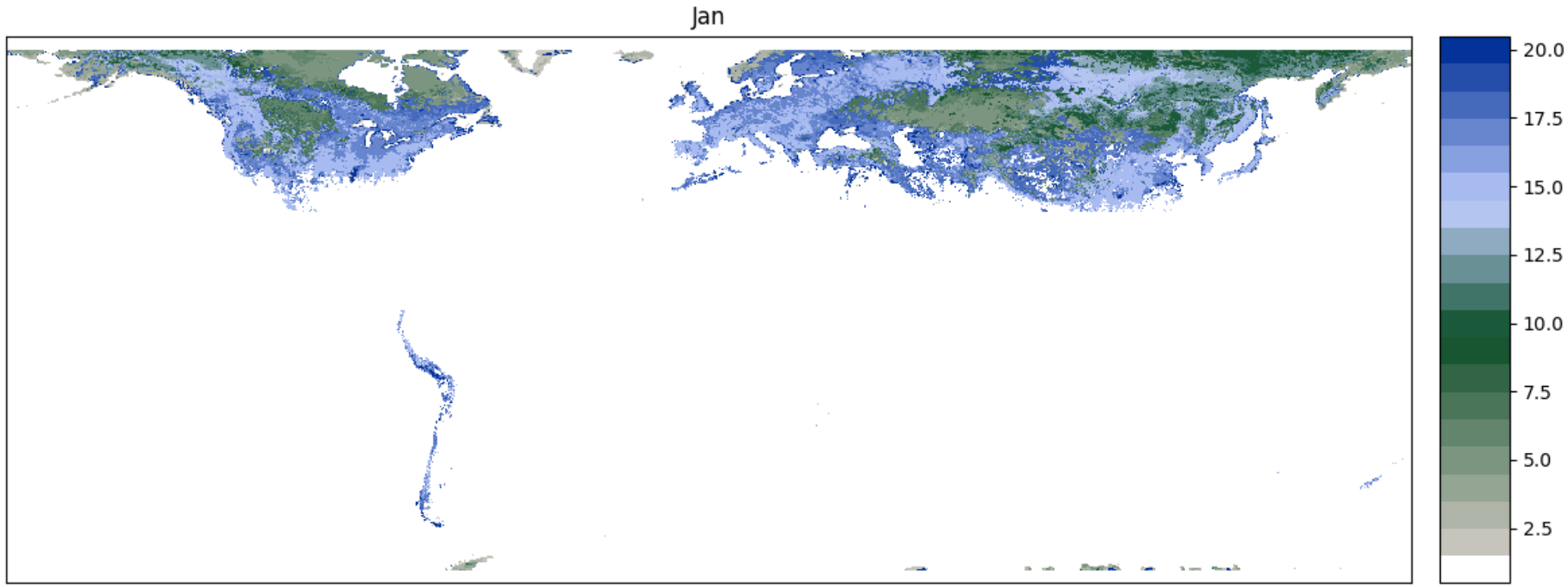

Jan
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5

Kohonen Self-Organizing Map Clustering Method: Snow-covered land

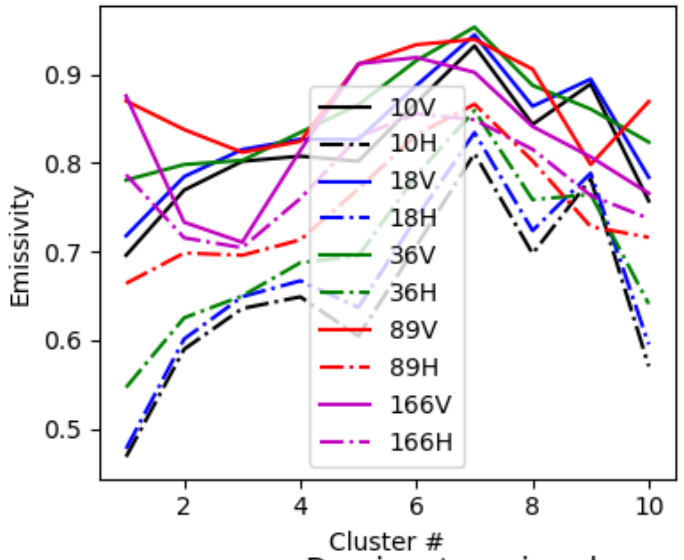


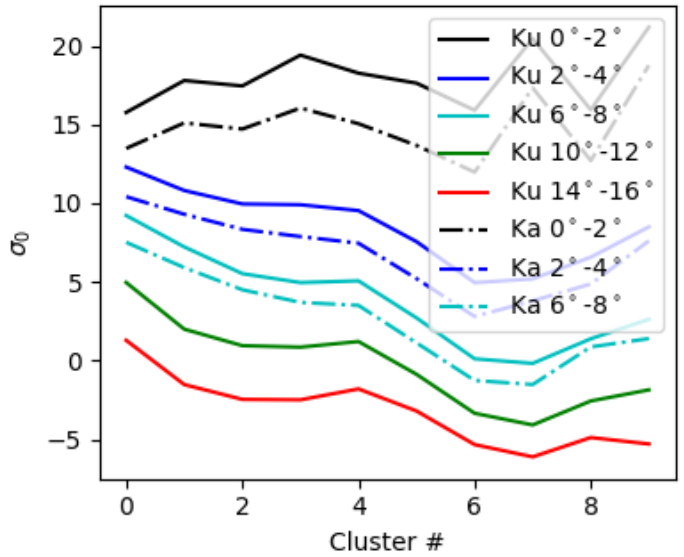
Dominant snow classes

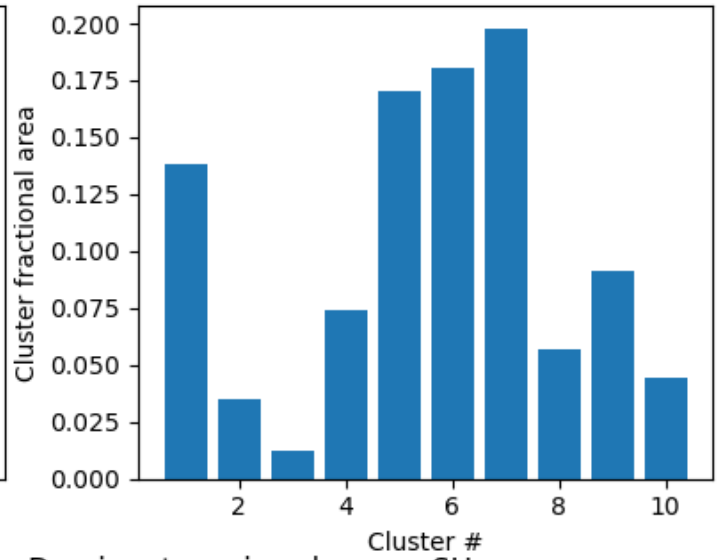


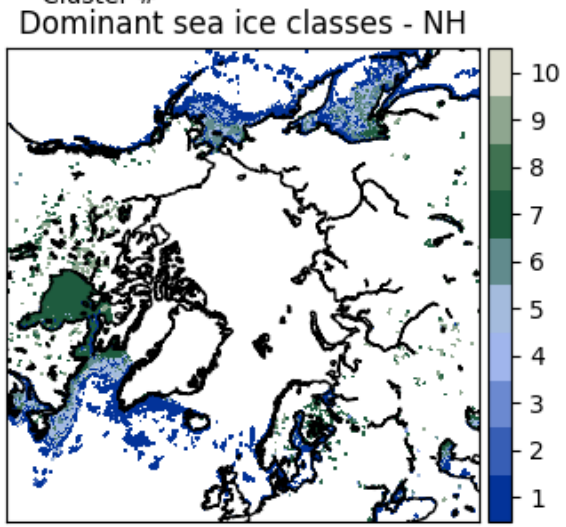

Jan
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5

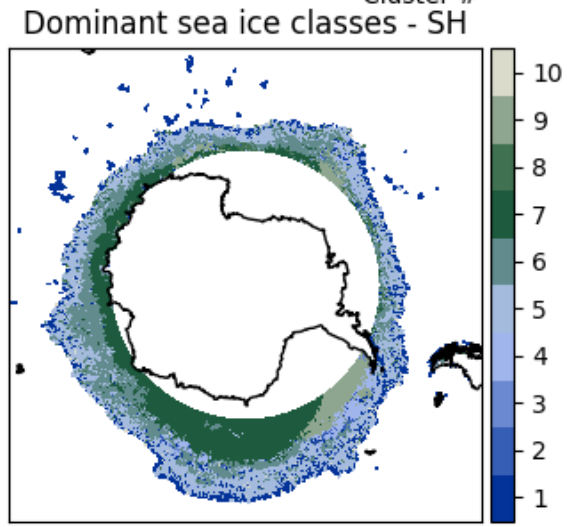
Kohonen Self-Organizing Map Clustering Method: Sea ice

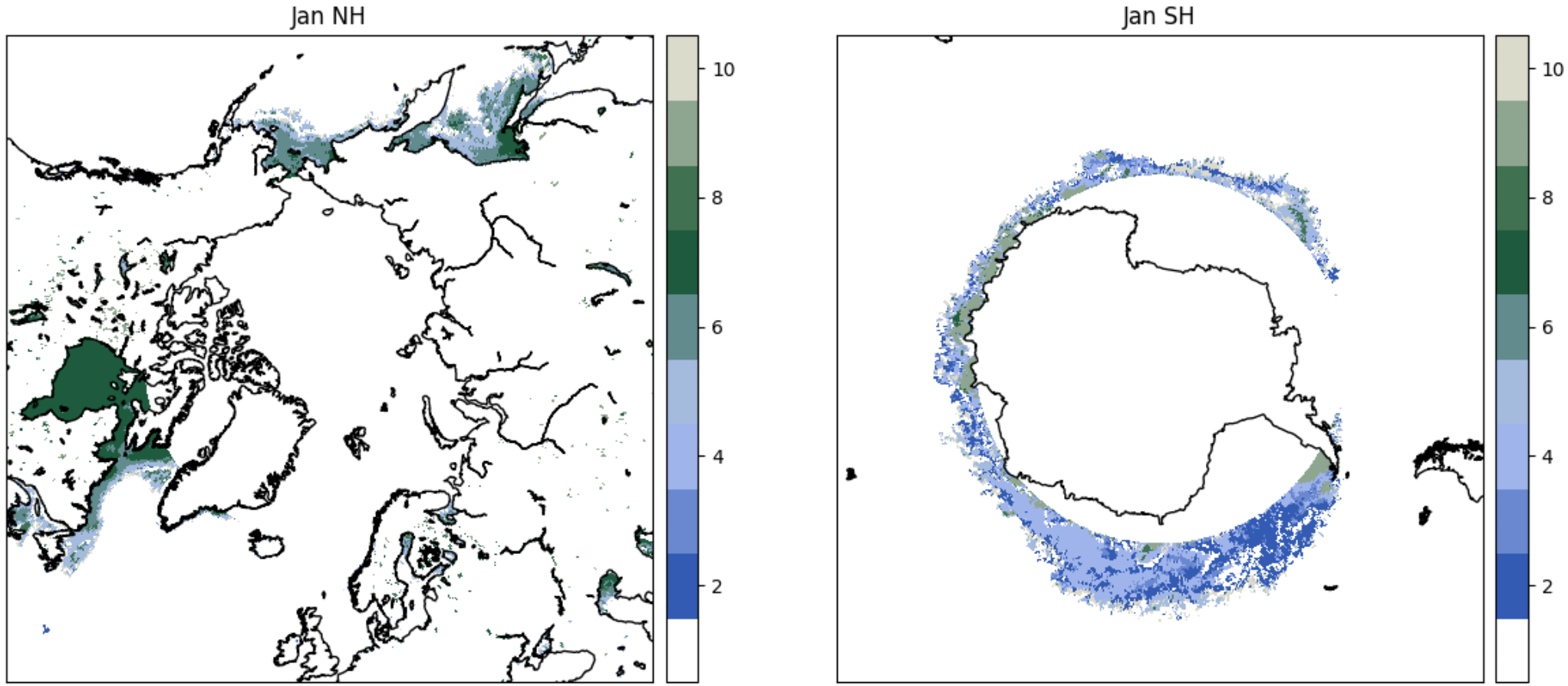











Jan NH
Jan SH
10
8
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