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## I. Introduction

According to Webster's Dictionary an Ice Jam is "an obstruction of broken river ice in a narrow part of a channel." Many may think that an ice jam is a harmless natural occurrence; but unfortunately ice jam's can cause problems that will consume time and money to fix. These problems include flooding, and property damage. In order to study ice jams better, one would need to know where, when and how much ice is in river. Using the lower Susquehanna as a case study, answers to these questions will be estimated, with a focus on the duration ice can be found in the river.

### Example of an ice jam.



Figure 1. Susquehanna river ice jam. Source: Blogspot

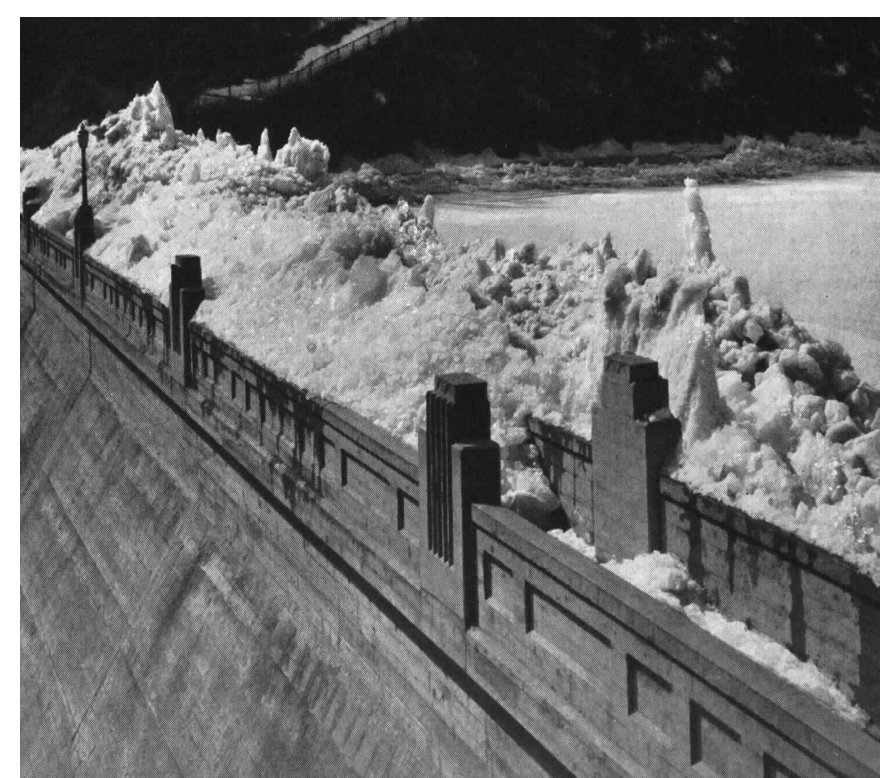


Figure 2. Ice Jam at Dam on Susquehanna River 1936. Source: CRREL, IJDB (2011)



Figure 3. Satellite image of the Yukon River, depicting the Ice Jam and it's effects—the flood. Source: NASA, May 2013.

## II. Case study: Susquehanna River at Middletown

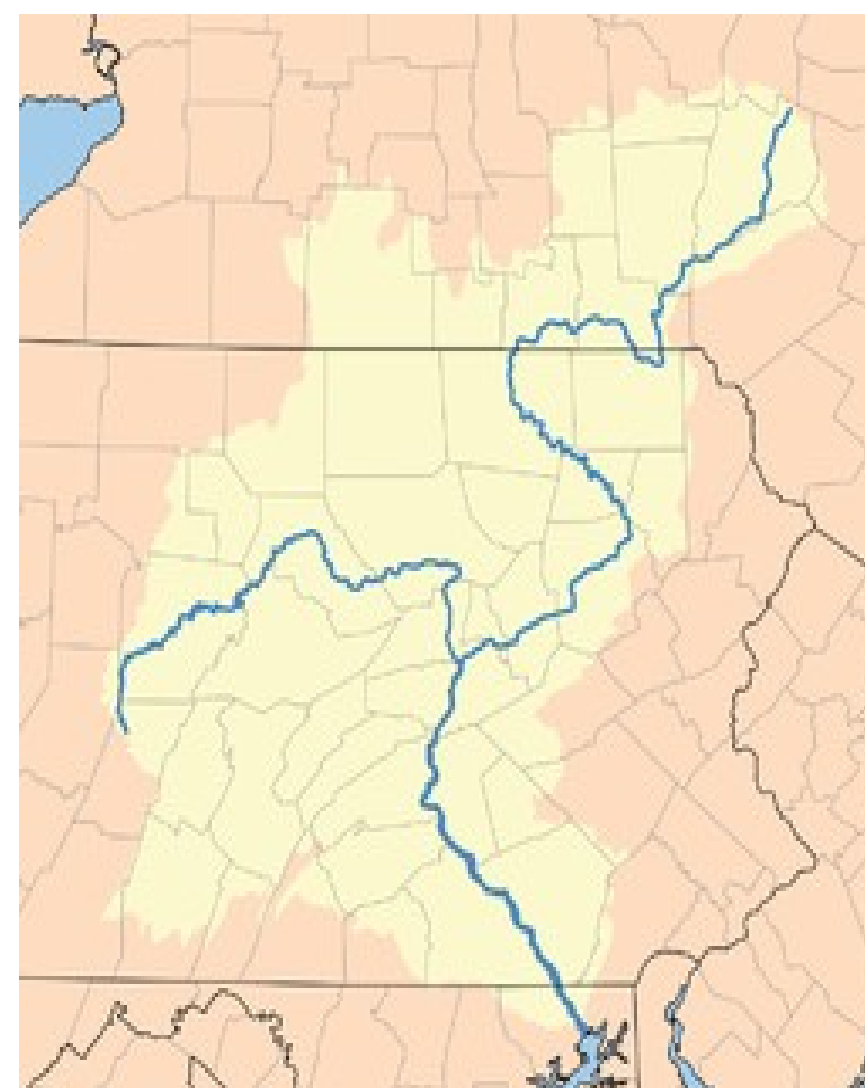


Figure 5. Physical view of the Susquehanna River. Source: Wikipedia



Figure 6. Susquehanna at its best Source: Wikipedia

## III. Results

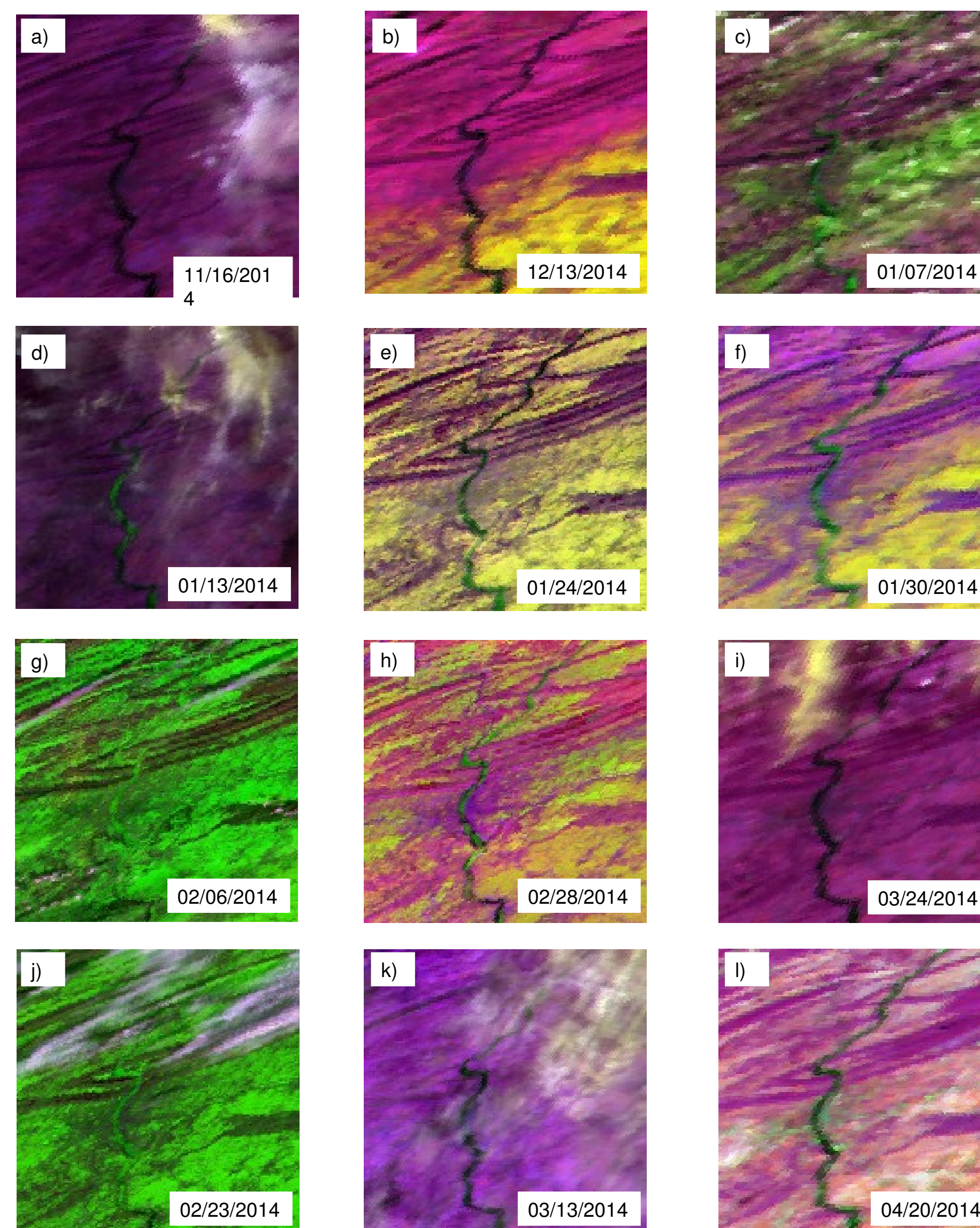


Figure 7. MODIS (aqua, 500 m) false color & scaled (5,4,7) images showing ice cover throughout the 2013-2014 winter season, on the lower Susquehanna, near Harrisburg, PA.

### Band Selection.

Using the 5,4,7 bands one is able to located the region of interest therefore allowing ice to be detected in the river. With the 5,4,7 bands the ice would be green, thus if the color green is in the river than one will know that there is ice in the river.

### Other considerations.

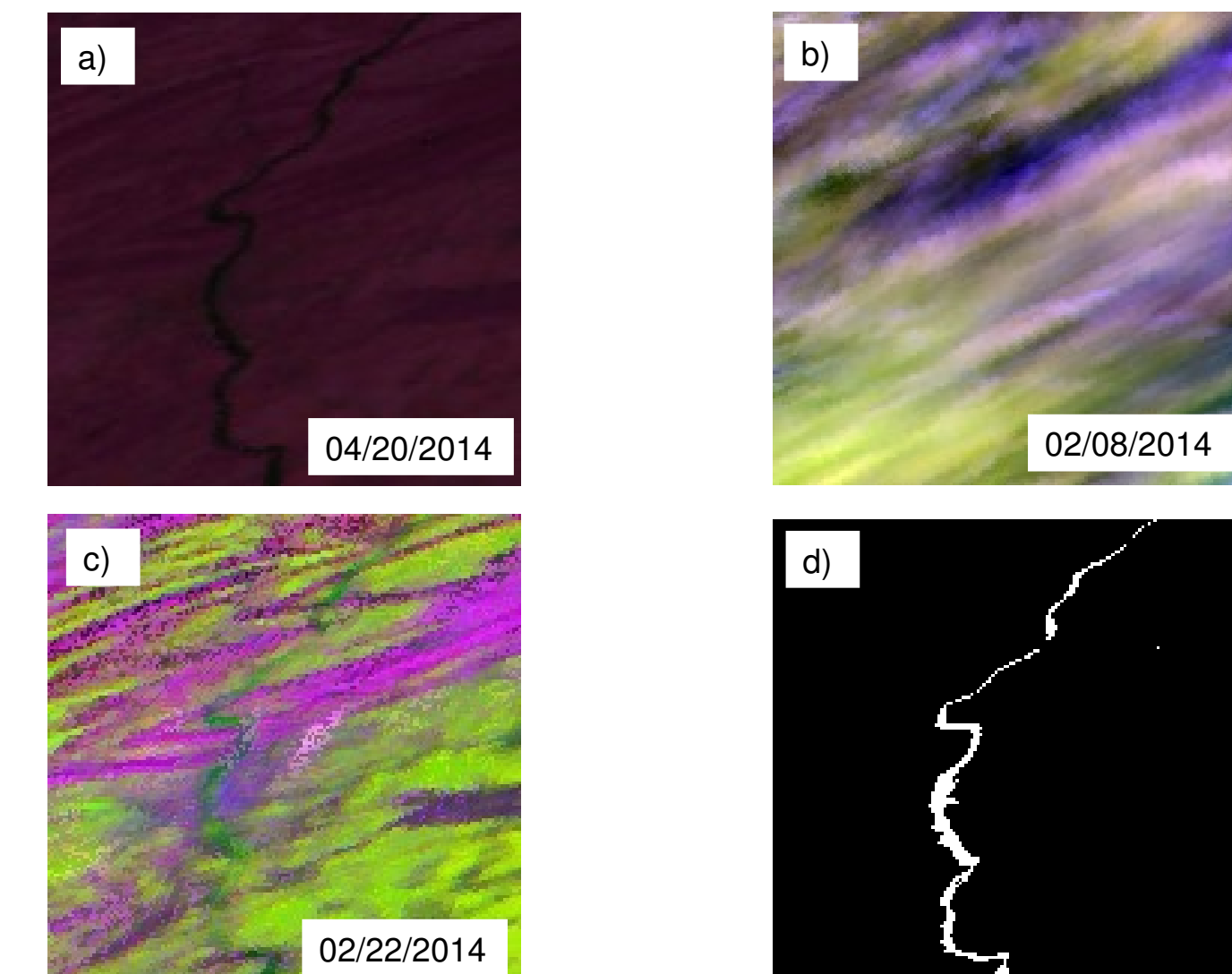


Figure 8. MODIS (aqua, 500 m) false color (5,4,7) images. (a) Example of image before scaling, (b) example of a fully cloud covered image, occurring frequently, (c) example image where river ice is visible despite cloud cover above it, (d) river mask, derived from summer 2009 images.

Images like those above are extremely cloudy which makes it extremely difficult to view the river, thus when band 5 and 7 show reflectance (which suggests cloud cover), the band 4 value (river ice) is not counted in this work.

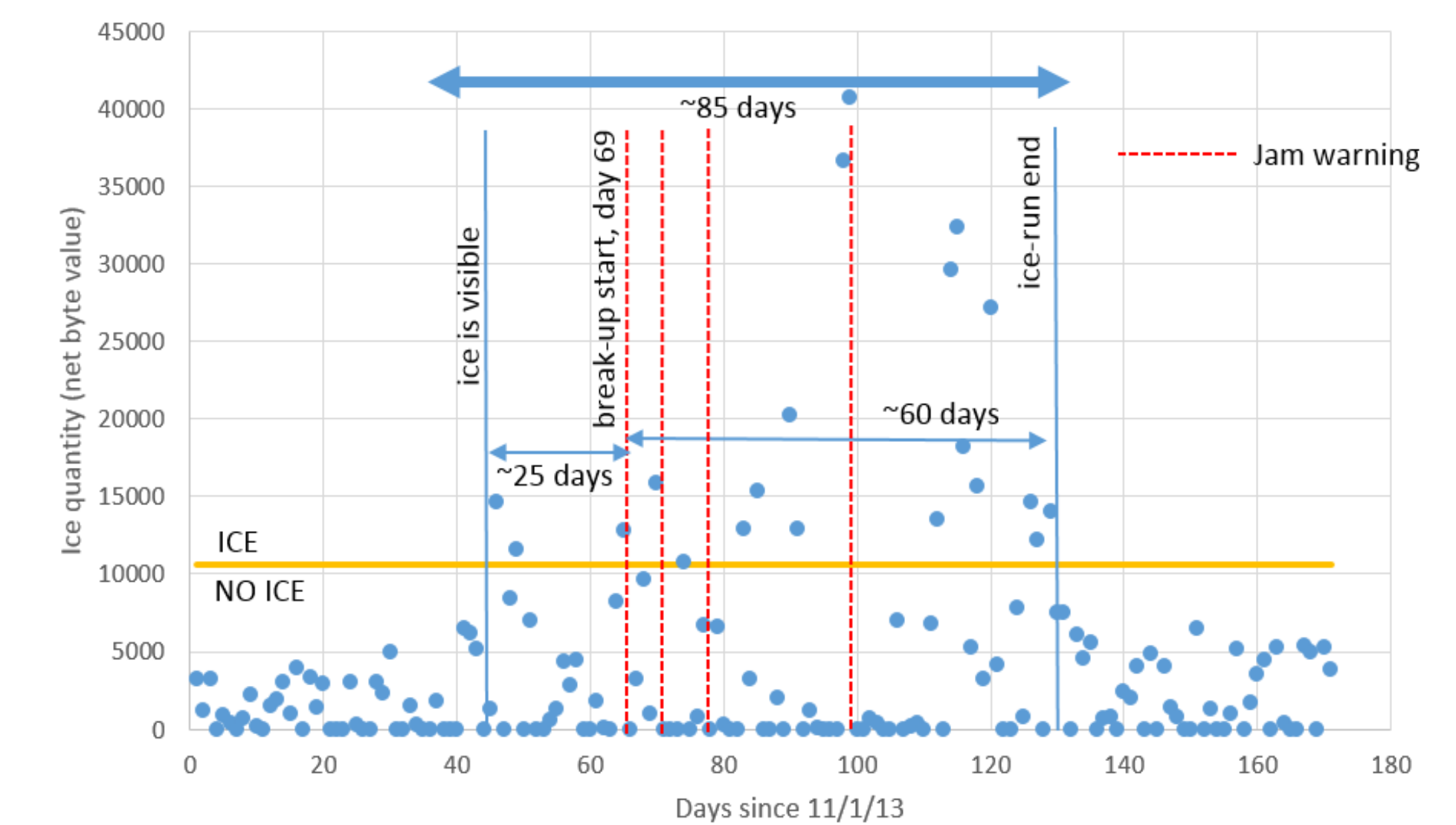


Figure 5. Time Series of the estimated ice run in the winter 2013-2014 of the lower Susquehanna River. The ice/no ice line was found by adding 1 standard deviation to the mean. Source (jam warning): CRREL, 2014

## IV. Discussion

According to the time series above, ice runs usually begins in the middle of the winter. It took about 25 days since the first ice was visible, for it to break up near Harrisburg. Ice in the river is not clear for another 60 days. Using this information one would be able to warn others when to steer clear of the Susquehanna River in order to stay safe.

## V. Concluding remarks

Despite the fact that this research is only focused on a very small part of the large Susquehanna River, we were still able to collect results in order to estimate the duration of ice run. Using the satellite images of the Susquehanna River, we were able to estimate the duration of an ice run. According to the data, in the 2013-2014 winter, river ice was observable for a duration of 85, barring gaps in observations due to clouds.

### Acknowledgements

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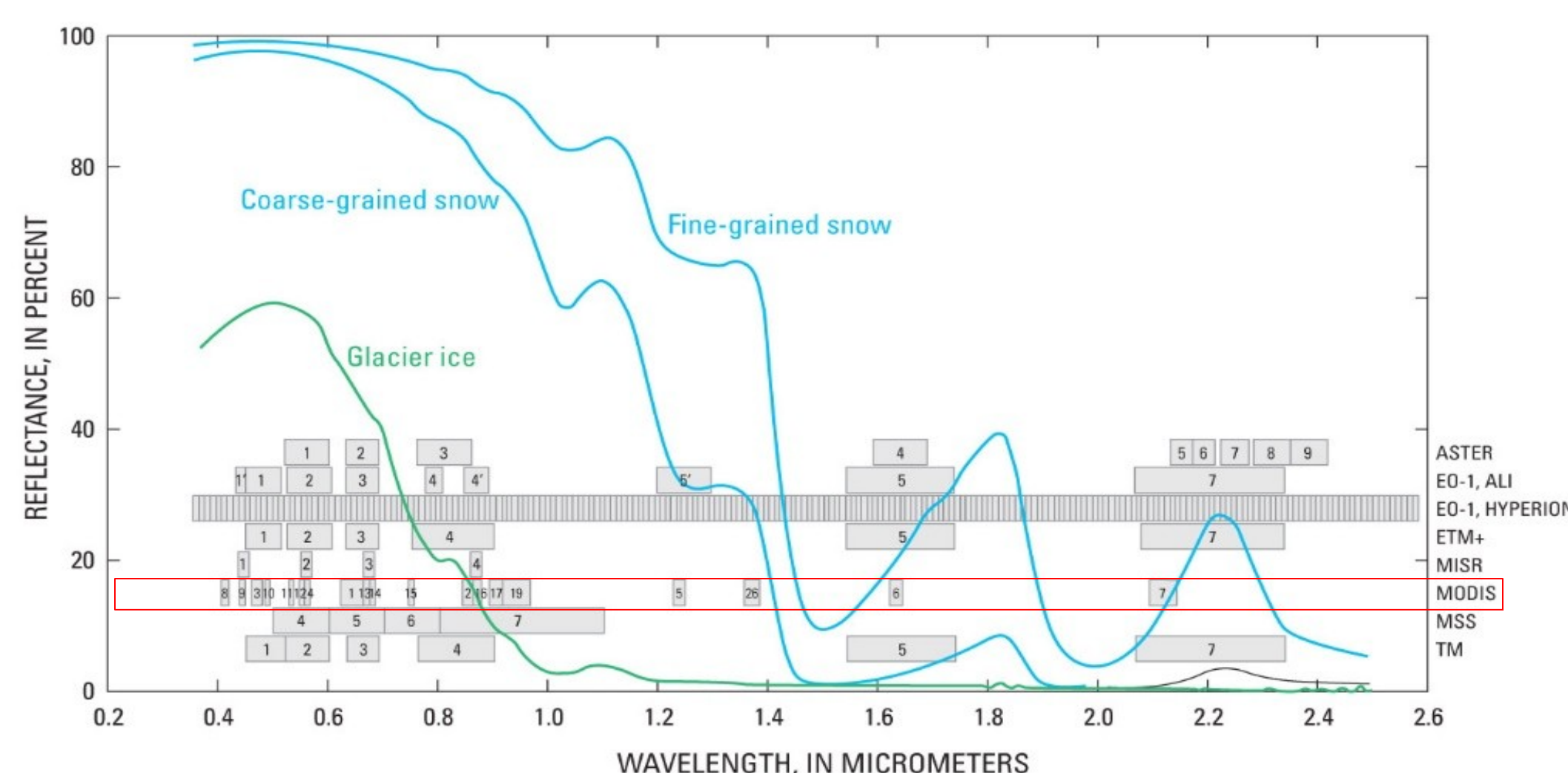


Figure 4. Reflectance of ice and snow in the solar channels. Indicated are which bands are probed for different instruments. Source: USGS, p1386a.

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