**Assessing the Ability of IR Sounders in Detecting Extreme Weather Events and Predicting Extreme Floods**

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**Abstract**

The IPCC 4th Assessment found that changes in the frequency of extreme events, such as droughts, heat waves, and floods, are expected to increase. Extreme PWV events are predicted to increase by a factor of 5-50 between 2000-2025 and 2075-2100, depending on the season and region. This paper investigates the ability of IR sounders to retrieve PWV during extreme weather events. Additionally, a cumulative sum method will be used to examine the predictability of PWV for extreme flooding cases. Results are presented that highlight the extreme moisture during extreme flooding events through case studies, and quantify the differences and agreement between satellite retrievals and ground-based observations. In addition, the probability of extreme rain given extreme moisture will be examined.

**Boulder, CO USA Flood: September 2013**

- **CrIMSS PWV Derivative Cumulative Sum (mm/day)**
- All observations were able to capture the moisture suggesting the use of this method to monitor change detection, by adding the anomalies together consecutively. This value shows an overall change in precipitation over a period of time.
- We would like to acknowledge and thank Thomas August and Tim Hultberg at EUMETSTAT for supplying the IASI A and IASI B PWLR data for this study.
- **Atmospheric Rivers (ARs) have previously been determined as the cause of flooding in the United Kingdom.**
- Prior to the extreme flooding event in Boulder, CO, all observations successfully showed the extreme rate of moisture entering and accumulating in the region, implying a potential to incorporate these observations into now-casting or prediction of floods.
- **A new method for monitoring the rate of moisture transport, called the derivative of the cumulative sum; was utilized for the Boulder, CO flooding event of September 2013.**
- Transport of large amounts of water vapor, like moisture from the Gulf of Mexico across the Atlantic Ocean to Europe brought the enhanced moisture needed for the heavy precipitation to Boulder, CO USA.
- **Table of Daily Precipitation (inches) and Derivative of Cumulative Sum (mm/day) for Boulder, CO**
- The high values for the derivative of the cumulative sum days before the flooding event (shown in the table) suggest that extreme moisture transport was occurring and moisture was continuously accumulating in the region, suggesting the usage of this variable for predictability.
- Blue shading represents derivative values that have exceeded the 99th percentile based on the ERA-Interim (~5.5 mm/day).
- Red shading represents precipitation values above the climatological mean for September (~1.9 inches).

**United Kingdom Floods: January 2014**

- **CrIMSS PWV Derivative Cumulative Sum (mm/day)**
- These figures show PWV (mm) for January 1st 2014 based on the ERA-Interim Climatology.
- The figures above clearly show an anomalously high transport of moisture from the Gulf of Mexico across the Atlantic Ocean to Europe.
- Throughout January (figures not shown) a similar AR was seen every couple of days suggesting this might be the mechanism that has brought the enhanced moisture needed for the heavy precipitation to Europe.
- All observations were able to capture the moisture suggesting the use of these instruments in monitoring PWV for flooding purposes.
- **CrIMSS PWV Derivative Cumulative Sum (mm/day)**
- These figures show PWV Anomaly (mm) for January 1st 2014 based on the ERA-Interim Climatology.
- The high values for the derivative of the cumulative sum days before the flooding event (shown in the table) suggest that extreme moisture transport was occurring and moisture was continuously accumulating in the region, suggesting the usage of this variable for predictability.
- Blue shading represents derivative values that have exceeded the 99th percentile based on the ERA-Interim (~5.5 mm/day).
- Red shading represents precipitation values above the climatological mean for September (~1.9 inches).

**Conclusions**

- A new method for monitoring the rate of moisture transport, called the derivative of the cumulative sum; was utilized for the Boulder, CO flooding event of September 2013.
- Prior to the extreme flooding event in Boulder, CO, all observations successfully showed the extreme rate of moisture entering and accumulating in the region, implying a potential to incorporate these observations into now-casting or prediction of floods.
- Atmospheric Rivers (ARs) have previously been determined as the cause of flooding in the United Kingdom.
- This study has shown the high probability that the ARs are the reason behind the extreme moisture in the region that has led to the precipitation and flooding during 2014.
- All observations were able to capture the AR suggesting the need to incorporate these instruments into monitoring techniques for floods.

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