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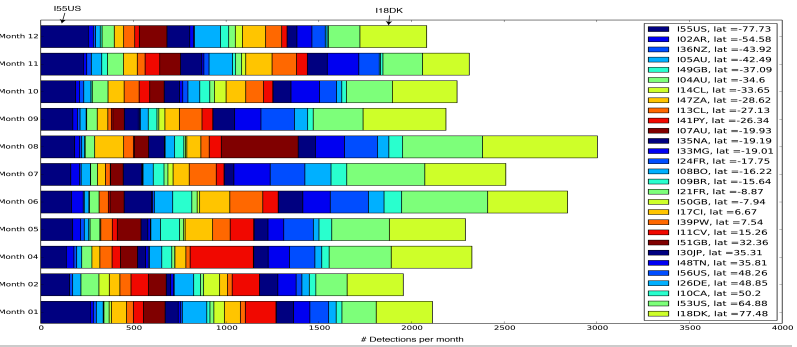

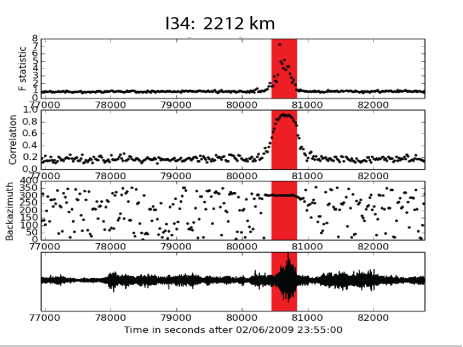

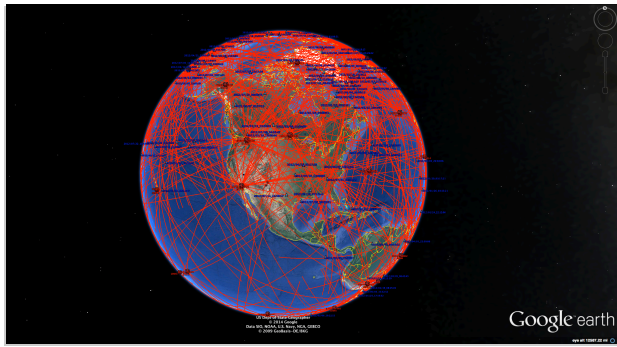

Preliminary Results from InfraPy: a Python-based Infrasound Detection, Association, and Location Suite for IMS Infrasound Array Processing

ITW October 2014

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U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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GLINDA

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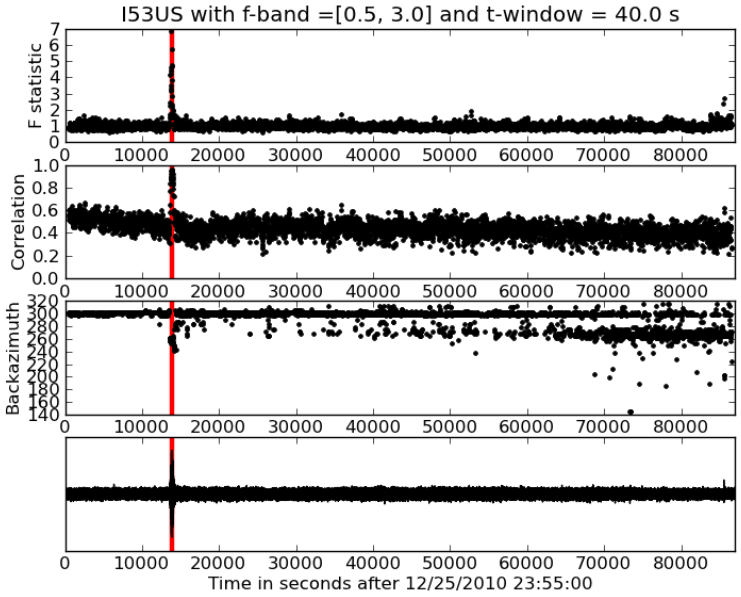
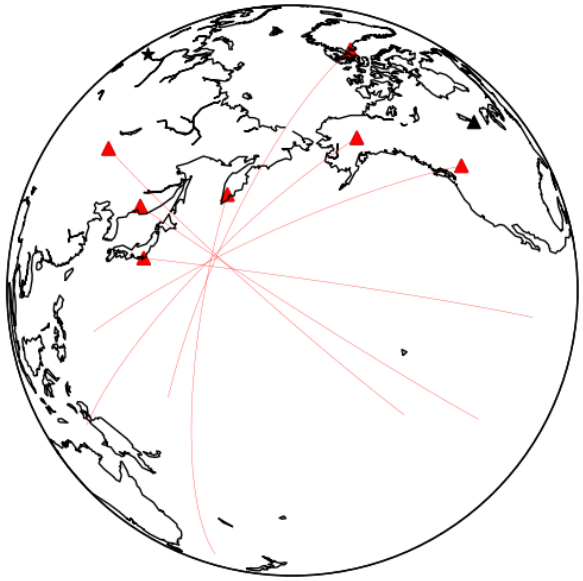
- GLobal Infrasound Network Detection and Association
  - Formerly known as SUSSAN
- Sponsored by U.S. Dept. of State Contribution in Kind through DOE
- Joint project between Sandia National Labs and Los Alamos National Lab
- Utilizes the python-based InfraPy infrasound software package developed by Stephen Arrowsmith and others at LANL

GLINDA

- InfraPy
  - Introduced at ITW 2013
  - Will be discussed in detail during Stephen's talk
- Fully automated IMS database processing mode
- Currently processing all IMS infrasound data from 2014 and earlier





GLINDA

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- Goals
  - A complete and independent comparison of the REB using InfraPy
  - Compare InfraPy association tables with REB events
    - Similar events (confidence)
    - Missed events (why?)
    - Extra events (why?)
  - Implement real-time IMS array processing

Results

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- Results are preliminary at this point
  - We were fully operational at the end of August
    - Processing is currently underway
  - Processing on multiple standard computers and a supercomputer
    - To process all IMS arrays for 24 hours:
      - On standard computer: 5 hours using 4 threads
      - On high-end mac server: 1.3 hours using 36 threads
    - Half of 2013
    - Half of 2012
    - All of 2010
    - Other select events

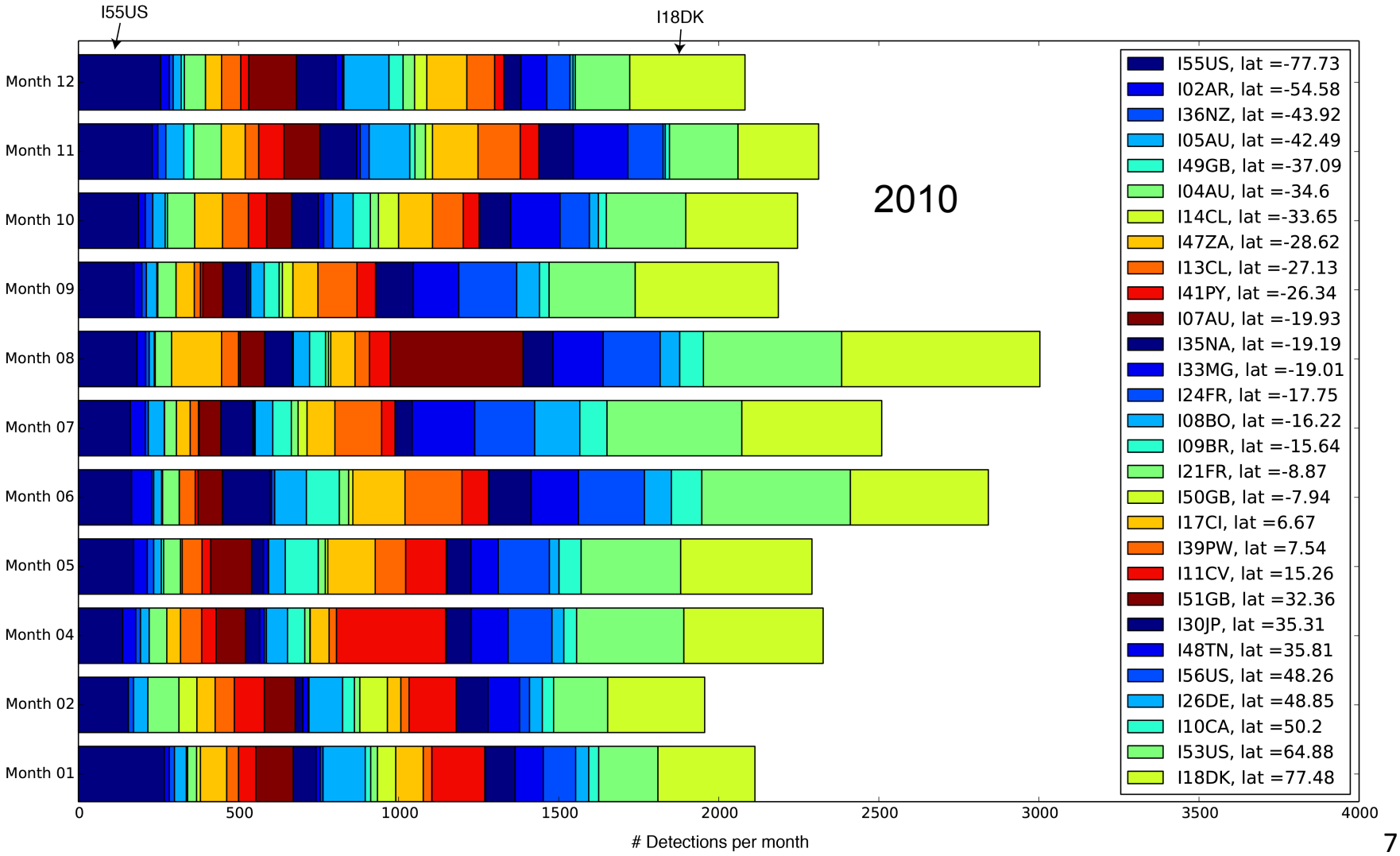
Results

- Processing

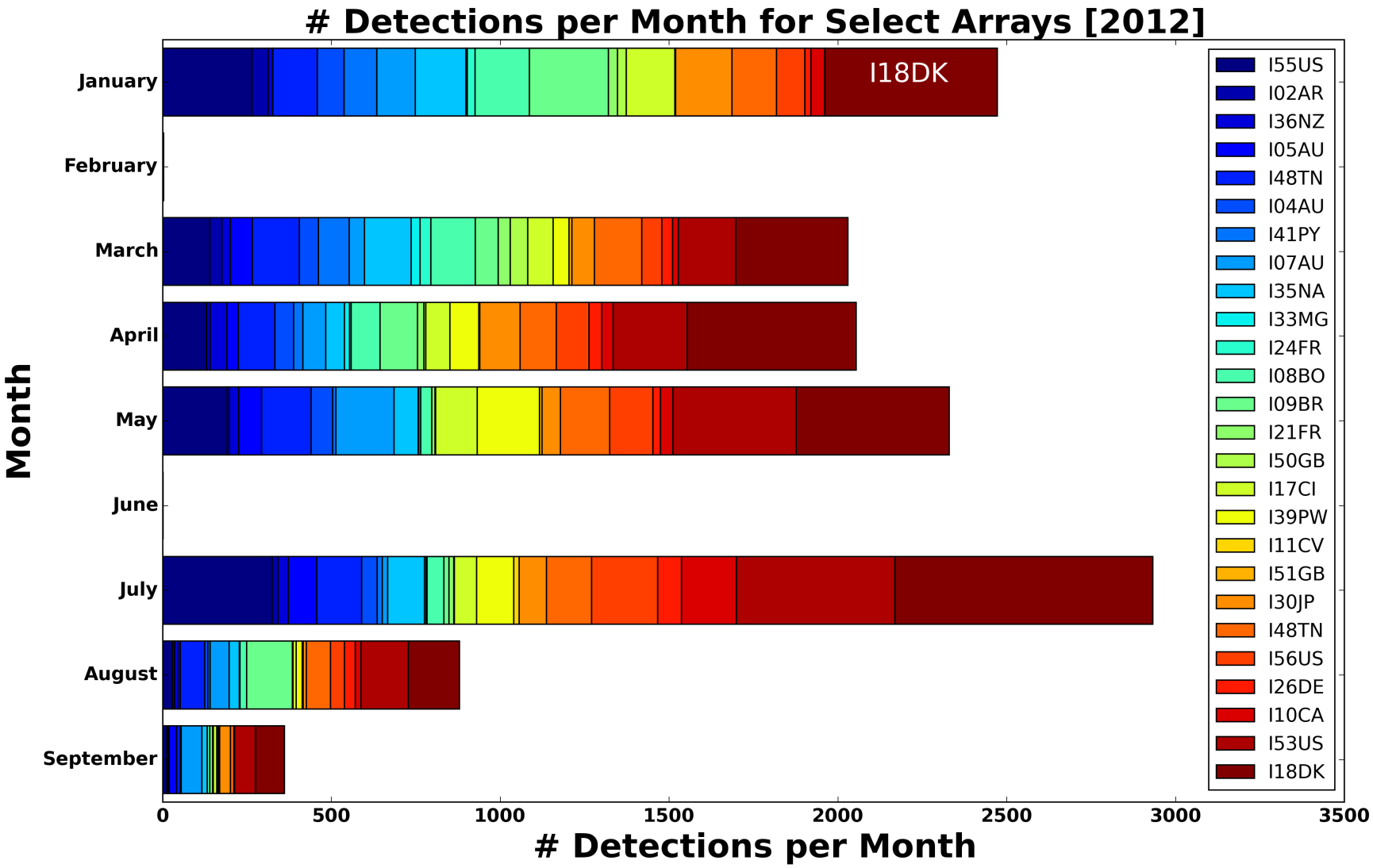
Frequency	Time Window (s)	Adaptive Time Window (s)	Overlap
0.01 – 0.5 Hz	60	900	50%
0.5 – 3 Hz	40	1800	50%

Detections

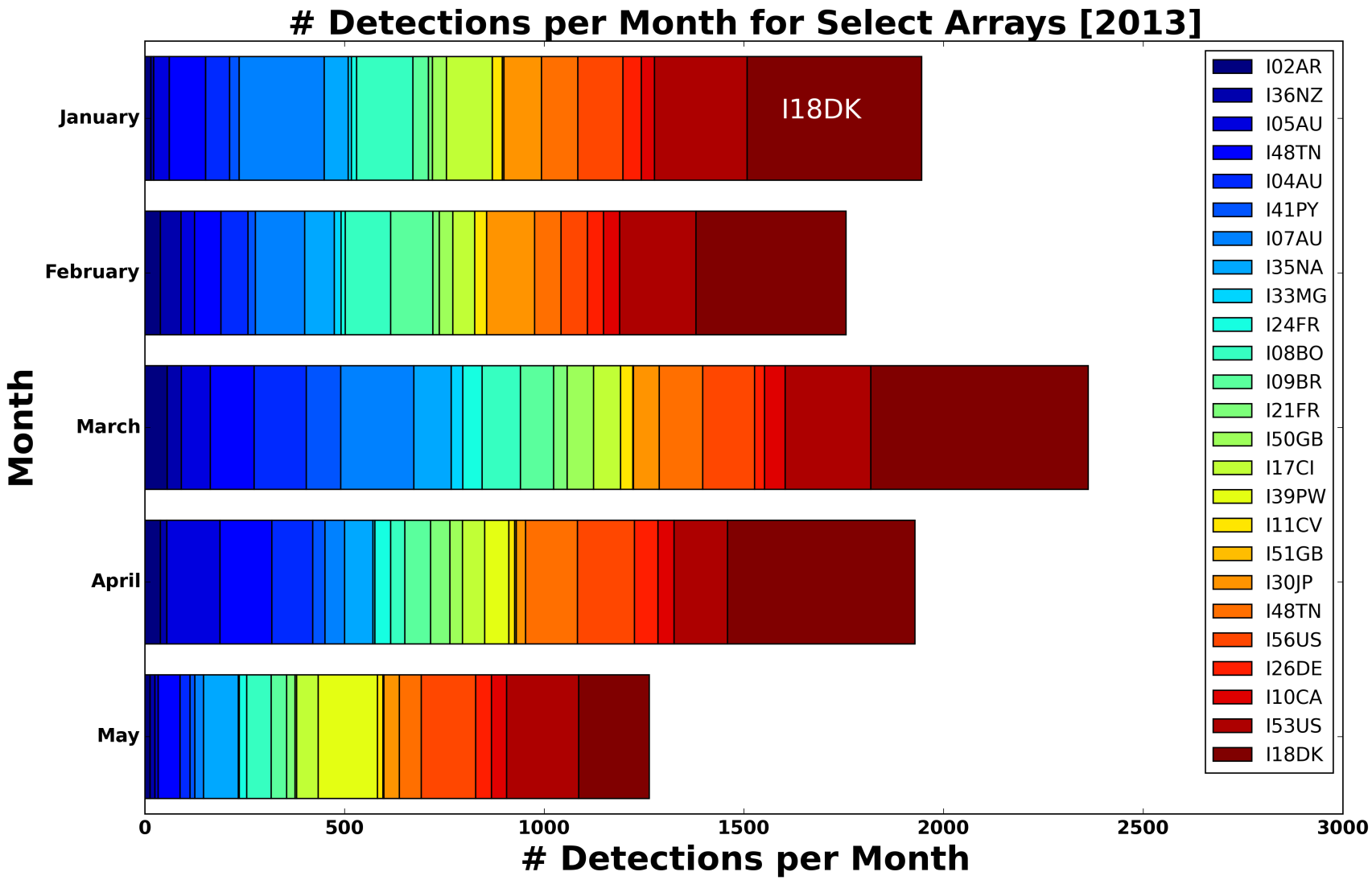
- Number of detections vary by array



Detections


Detections per Month for Select Arrays [2012]
January
February
March
April
May
June
July
August
September
Month
I18DK
I55US
I02AR
I36NZ
I05AU
I48TN
I04AU
I41PY
I07AU
I35NA
I33MG
I24FR
I08BO
I09BR
I21FR
I50GB
I17CI
I39PW
I11CV
I51GB
I30JP
I48TN
I56US
I26DE
I10CA
I53US
I18DK
0
500
1000
1500
2000
2500
3000
3500
Detections per Month

Detections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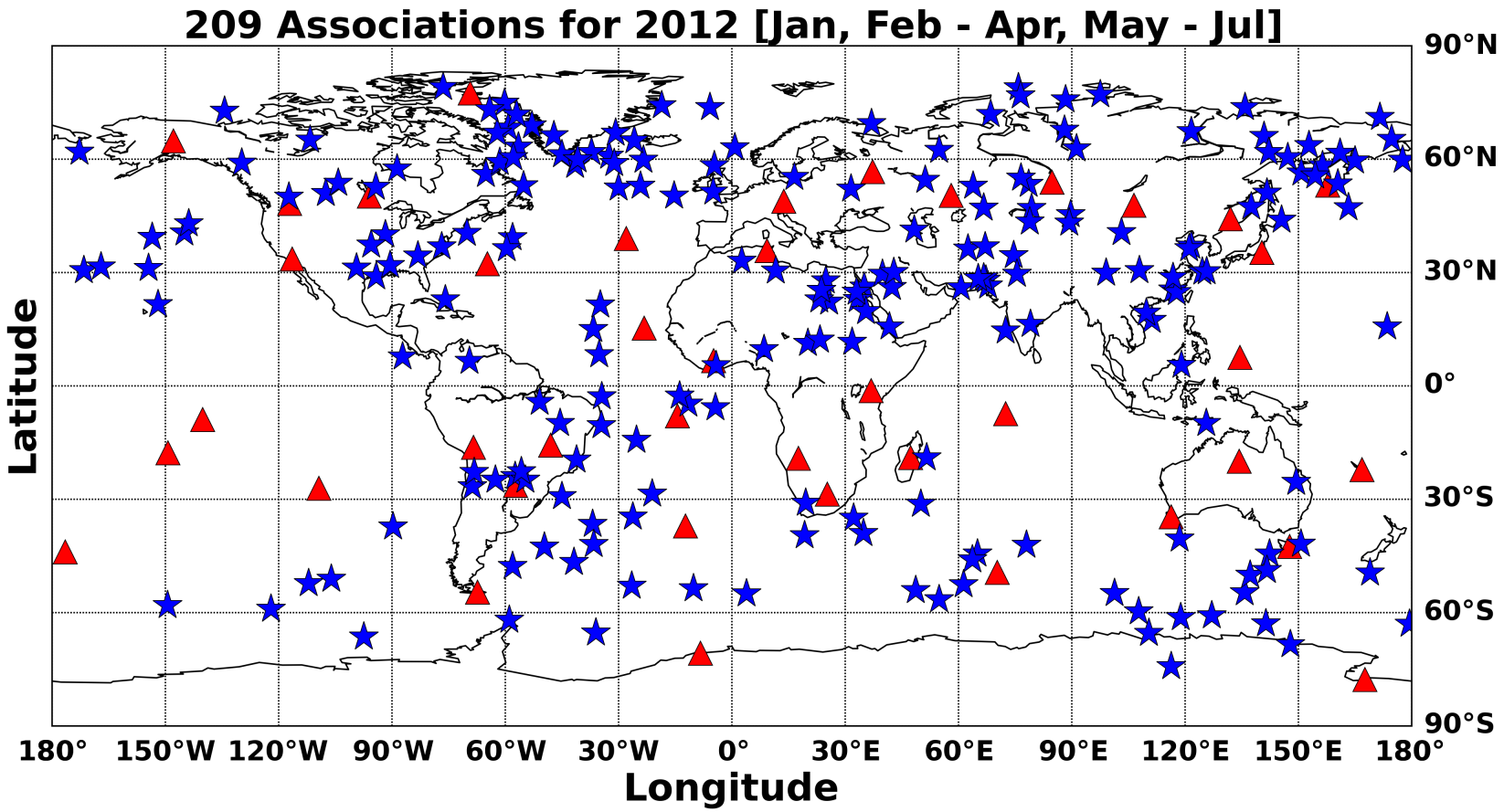
Detections per Month

Associations

- Associations are made using 3 or more arrays



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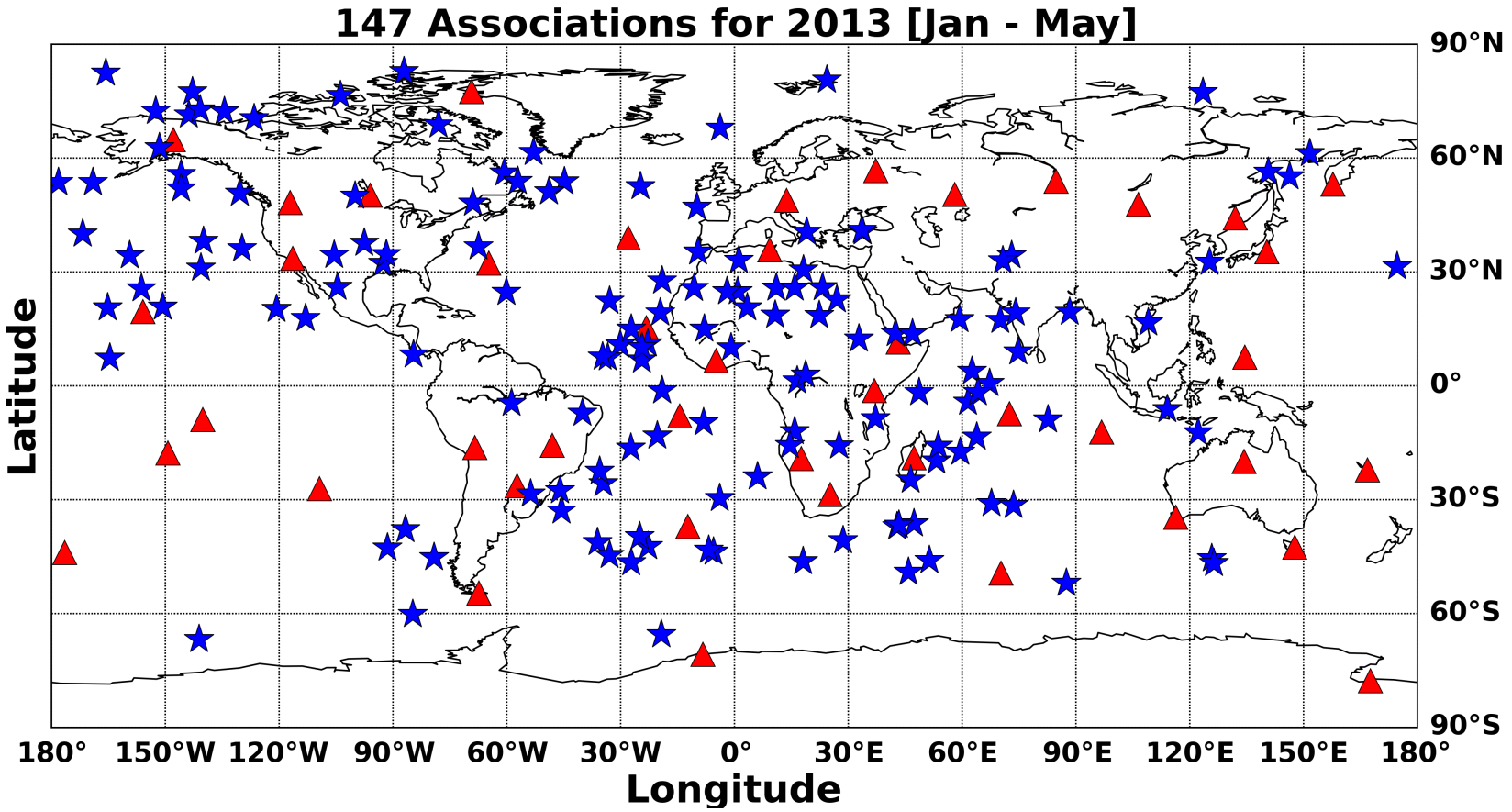


REB Comparisons

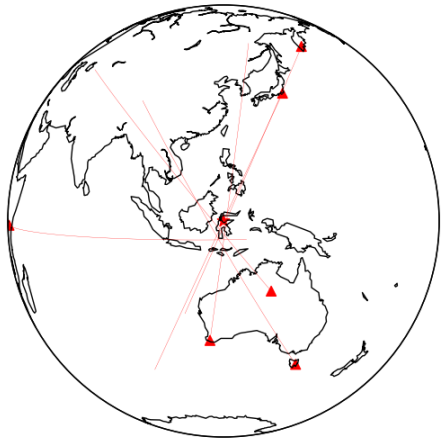
- Large infrasound events from the REB
- > 5 arrivals
- Automated processing
- Same two frequency bands
- All but 3 events were associated using InfraPy
- Lower number of associated detections with InfraPy

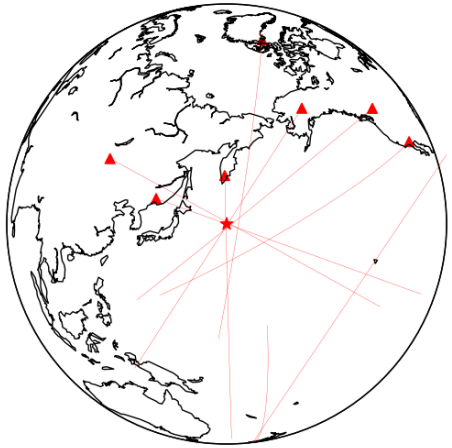
Event #	Date	Latitude	Longitude	Description	# Associated detections in REB	# Associated detections in this study
1	02/07/2009	56.0779	76.7068	Russian mining explosion?	6	Not associated
2	10/08/2009	-4.2261	121.1155	Large bolide near Sulawesi	14	6
3	12/26/2010	40.0244	156.9966	Large bolide over North Pacific	11	8
4	04/18/2011	0.831	-126.5921	Large bolide over Central Pacific?	8	6
5	05/21/2011	64.688	-17.368	Eruption of Grimsvotn, Iceland	6	Not associated
6	05/05/2012	76.7401	-10.5816	Bolide east of Greenland?	8	4
7	10/22/2012	51.7055	117.1126	Russian mining explosion?	6	Not associated
8	02/15/2013	54.0563	61.8062	Large bolide over Chelyabinsk, Russia	17	5
9	10/18/2013	56.1074	160.9198	Eruption of Klyuchevsky, Kamchatka	6	7
10*	12/13/2014	-8.5353	109.7683	Eruption of Kelud, Indonesia	13	13

Arrowsmith et. al 2014 (in review)

REB Comparisons

2	10/08/2009	-4.2261	121.1155	Large bolide near Sulawesi	14	6





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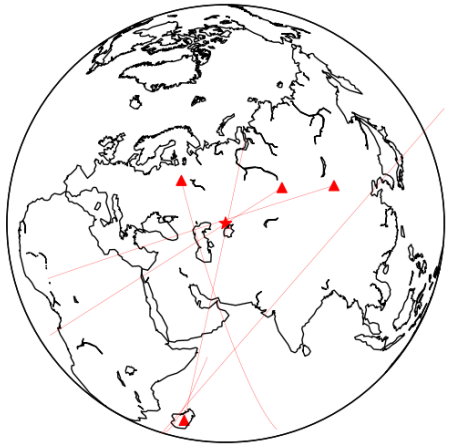
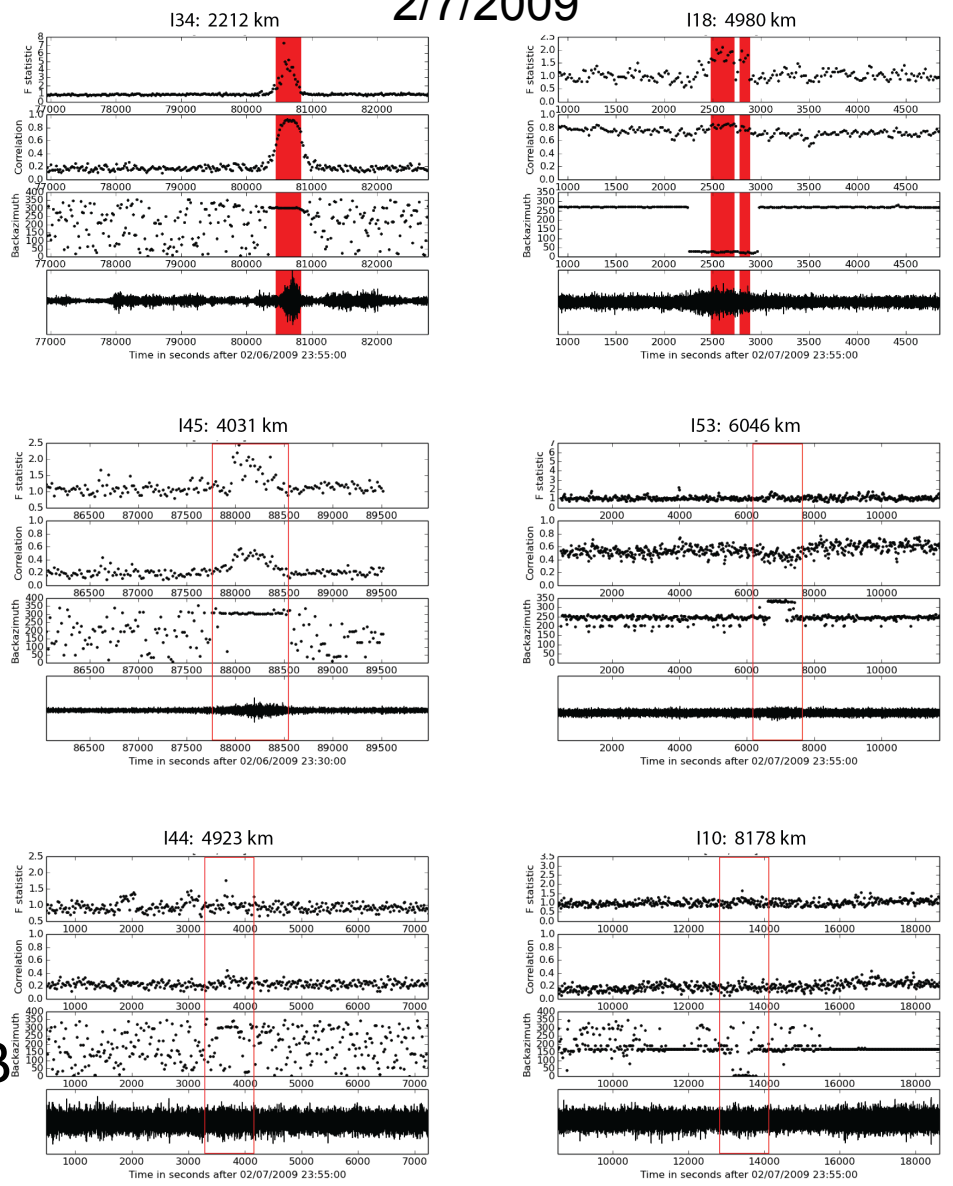


Arrowsmith et. al 2014 (in review)

REB Comparisons

- InfraPy detection processing results for a REB event missed by InfraPy
- Detailed analysis revealed that only two arrays (top) met the threshold requirements
- The event can be seen at the other four arrays
- Back azimuths from all arrays are consistent with reported REB event



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Future Work

- Continue to process IMS infrasound data with InfraPy
- Begin comparing associated events with REB results
- Tune the detector and associator as needed for
  - Maximum associations with minimal false alarms

Arrowsmith et. al 2014 (in review)

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Questions?