

Putting an end to nuclear explosions through science

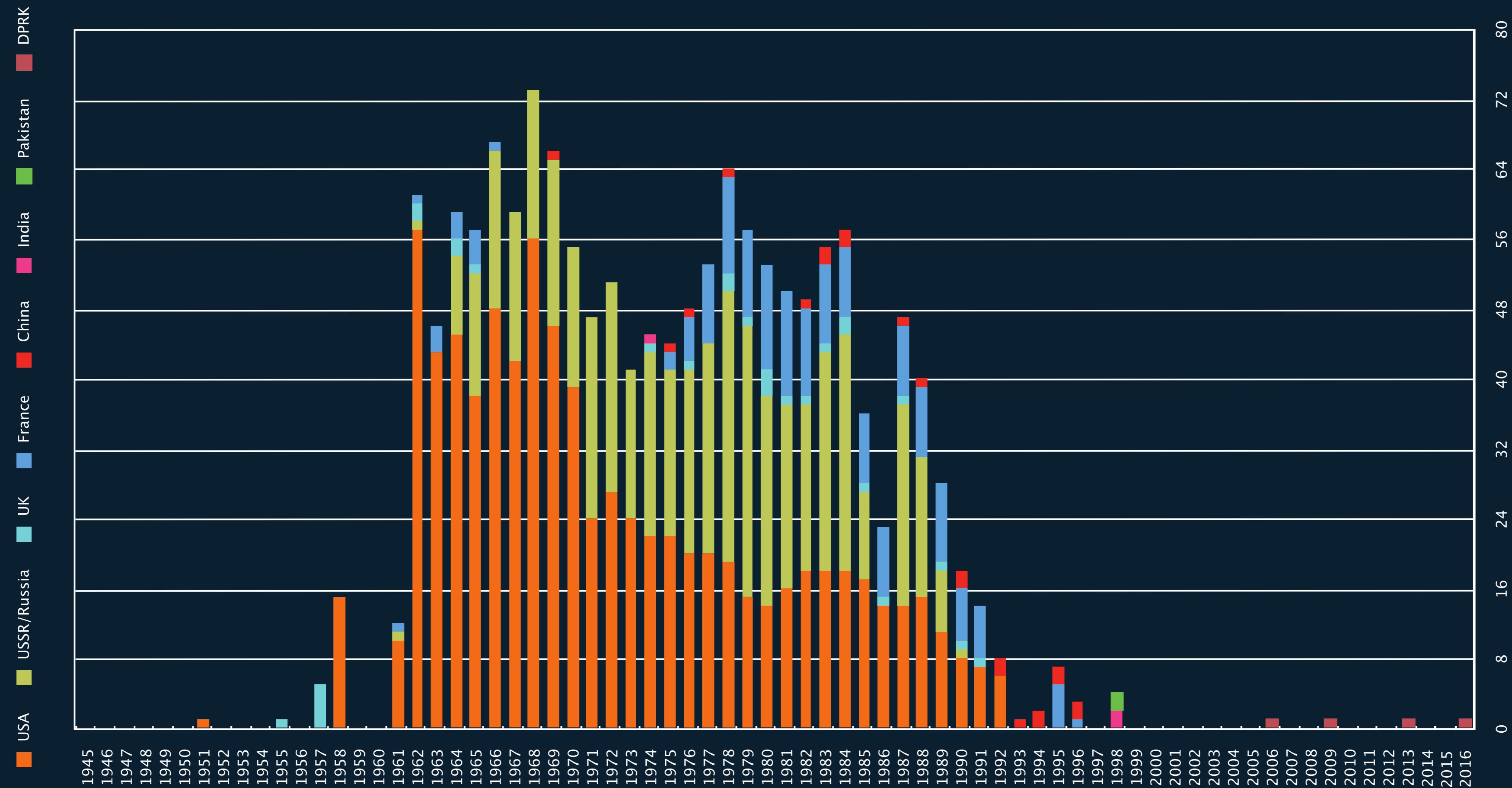
Martin Kalinowski

Head Scientific Methods Unit, IDC/SA/SM

Introduction & History



Worldwide Nuclear Testing 1945 - 2016

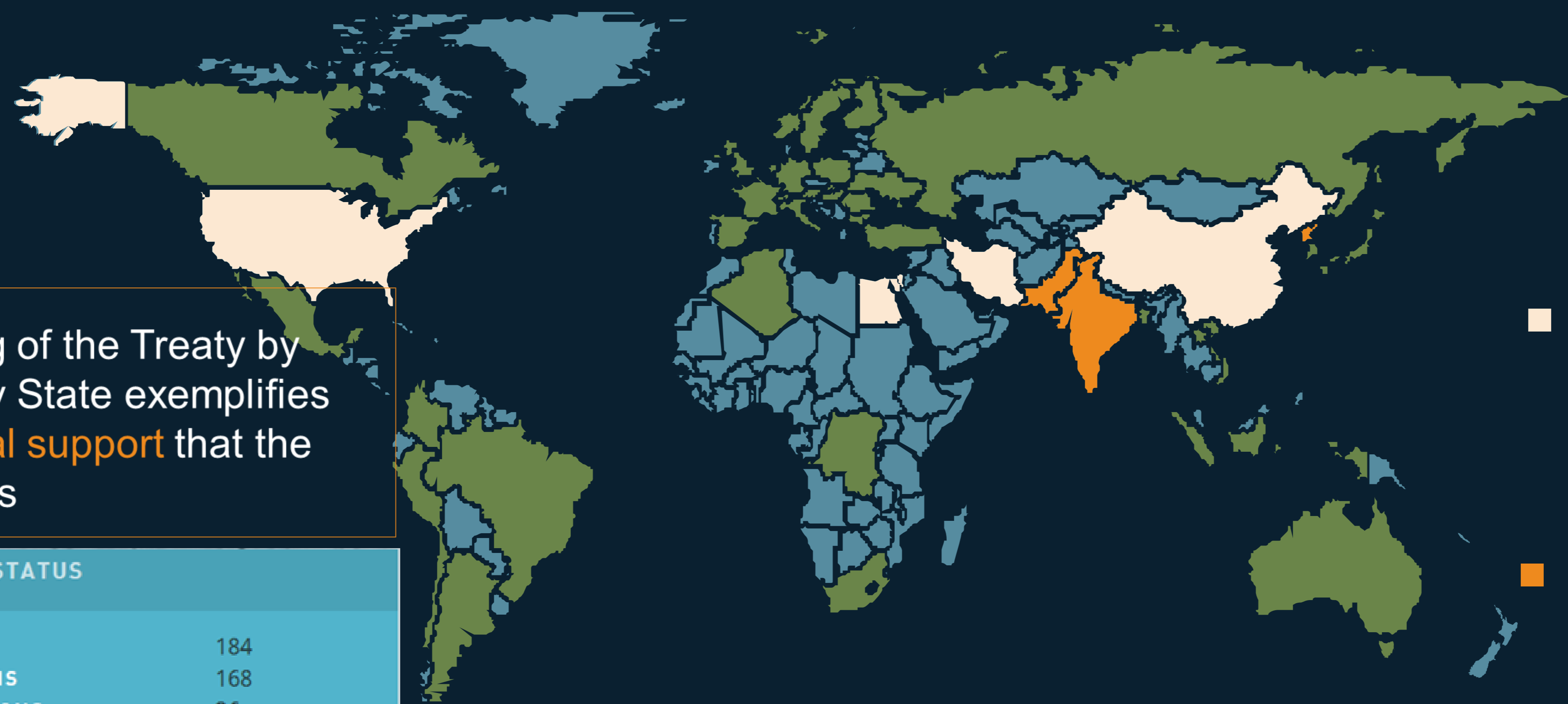


**The Comprehensive Nuclear-Test-Ban Treaty (CTBT)
bans all nuclear explosions, by anyone, anywhere, for ever.**

Entry into Force – 44 Annex 2 States need to ratify

8

remain



The backing of the Treaty by nearly every State exemplifies the **universal support** that the CTBT enjoys

- Signed but not ratified
China
Egypt
Iran
Israel
USA
- Neither signed nor ratified
DPRK
India
Pakistan

CURRENT TREATY STATUS	
MEMBER STATES	184
TOTAL RATIFICATIONS	168
ANNEX 2 RATIFICATIONS	36
LATEST STATE SIGNATORY	Tuvalu
LATEST RATIFYING STATE	Zimbabwe

The Organization



At a glance



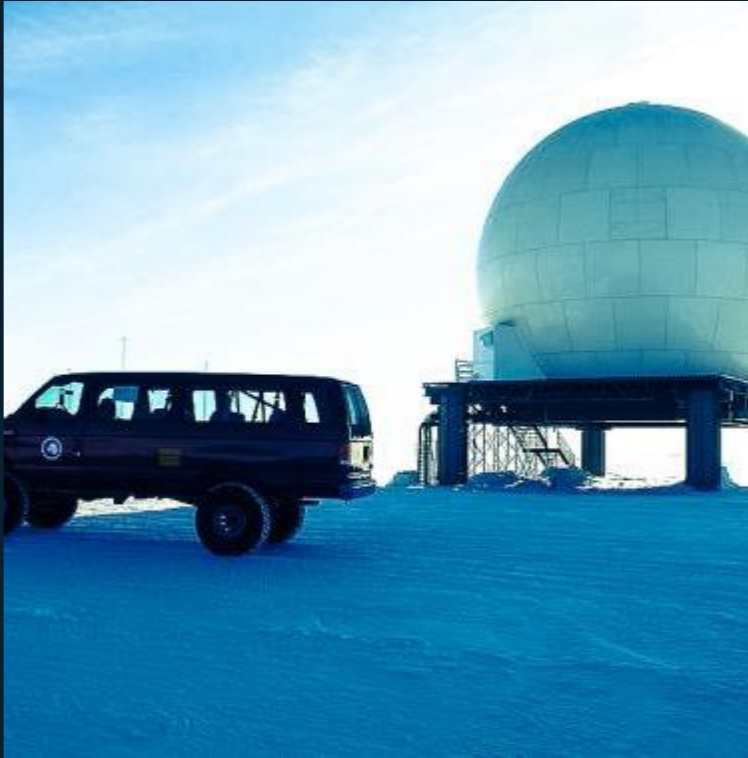
Staff

over 260



Headquarters

Vienna



5 Divisions

- Administration
- Legal and External Relations
- International Monitoring System
- International Data Centre
- On-Site Inspections

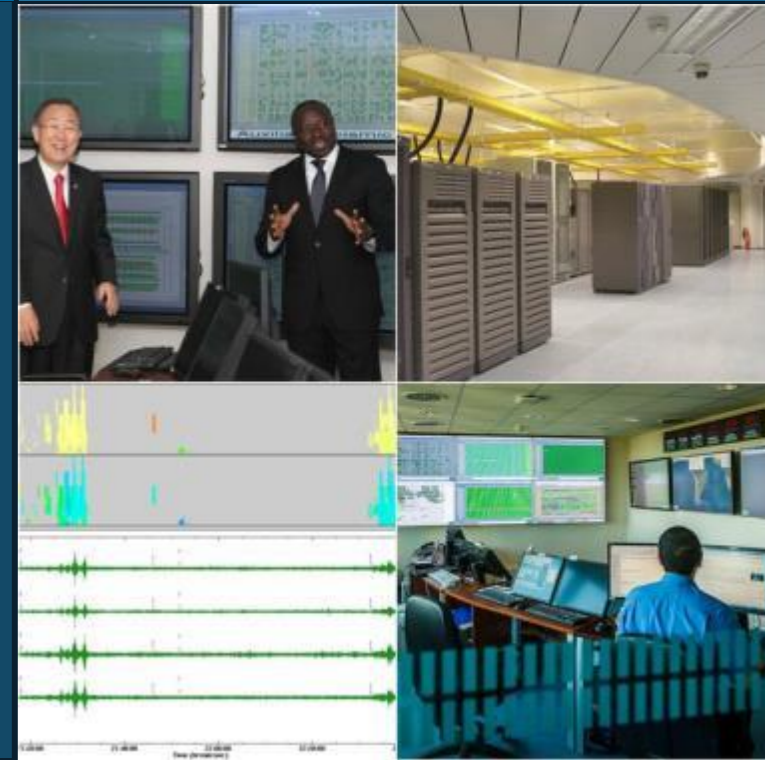
Executive Secretary
Dr Lassina Zerbo



International
Staff from 70 countries



Budget
120.000.000 Euro





Our Verification System

International Monitoring System: 337 Facilities



4 Monitoring Technologies



Seismic: 170

Listening underground



Hydroacoustic: 11

Listening under water



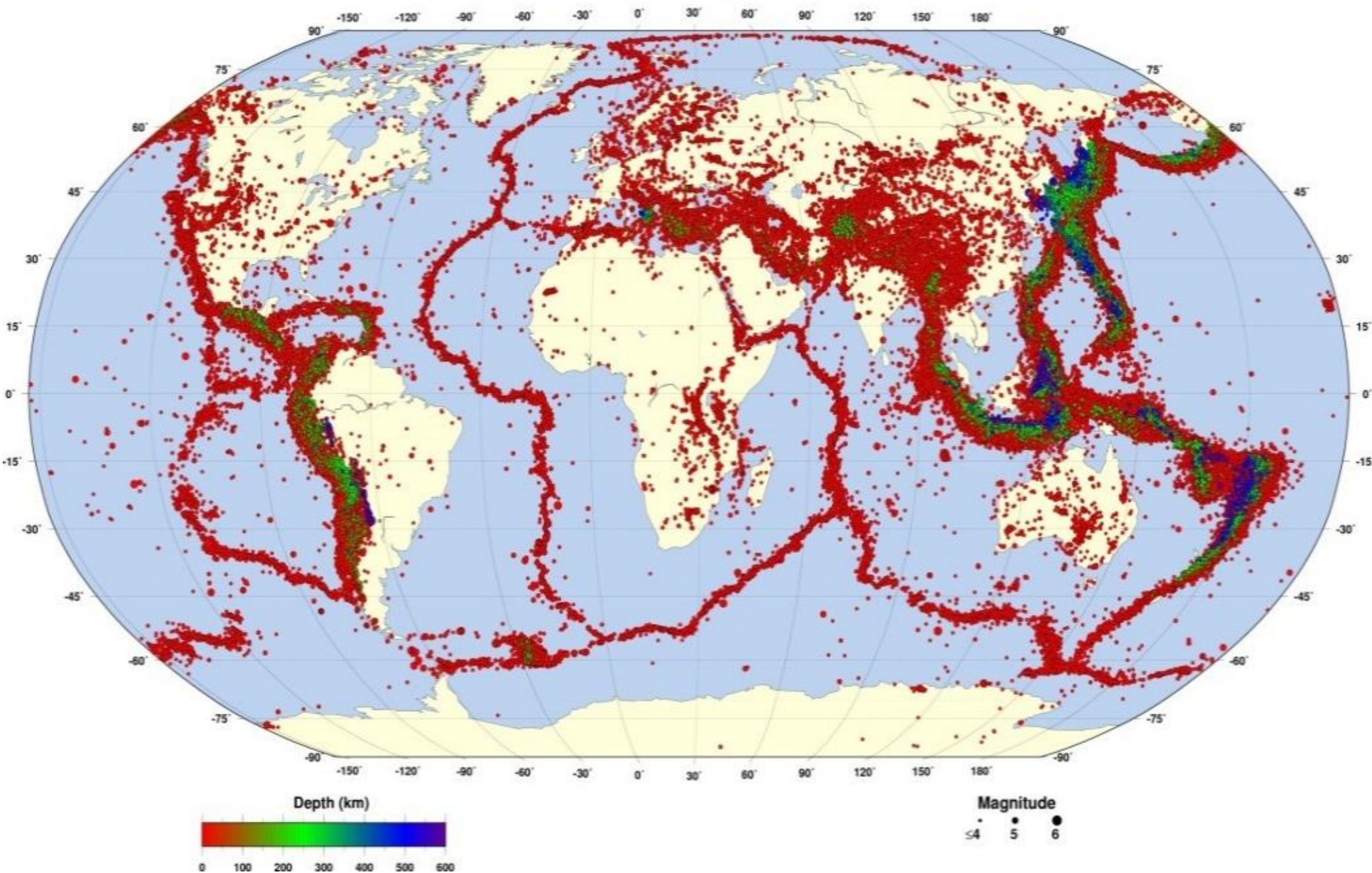
Infrasound: 60

Listening above ground



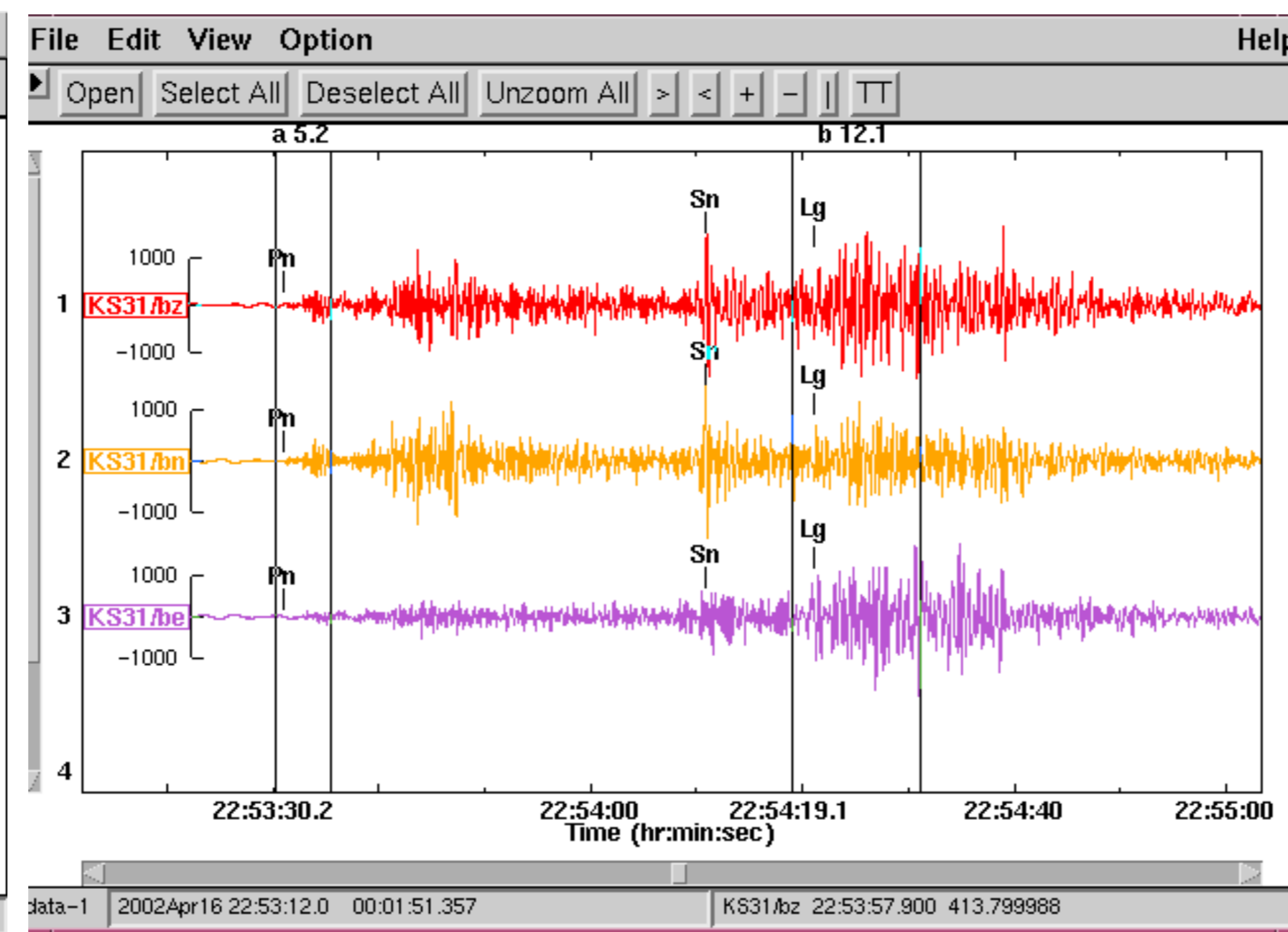
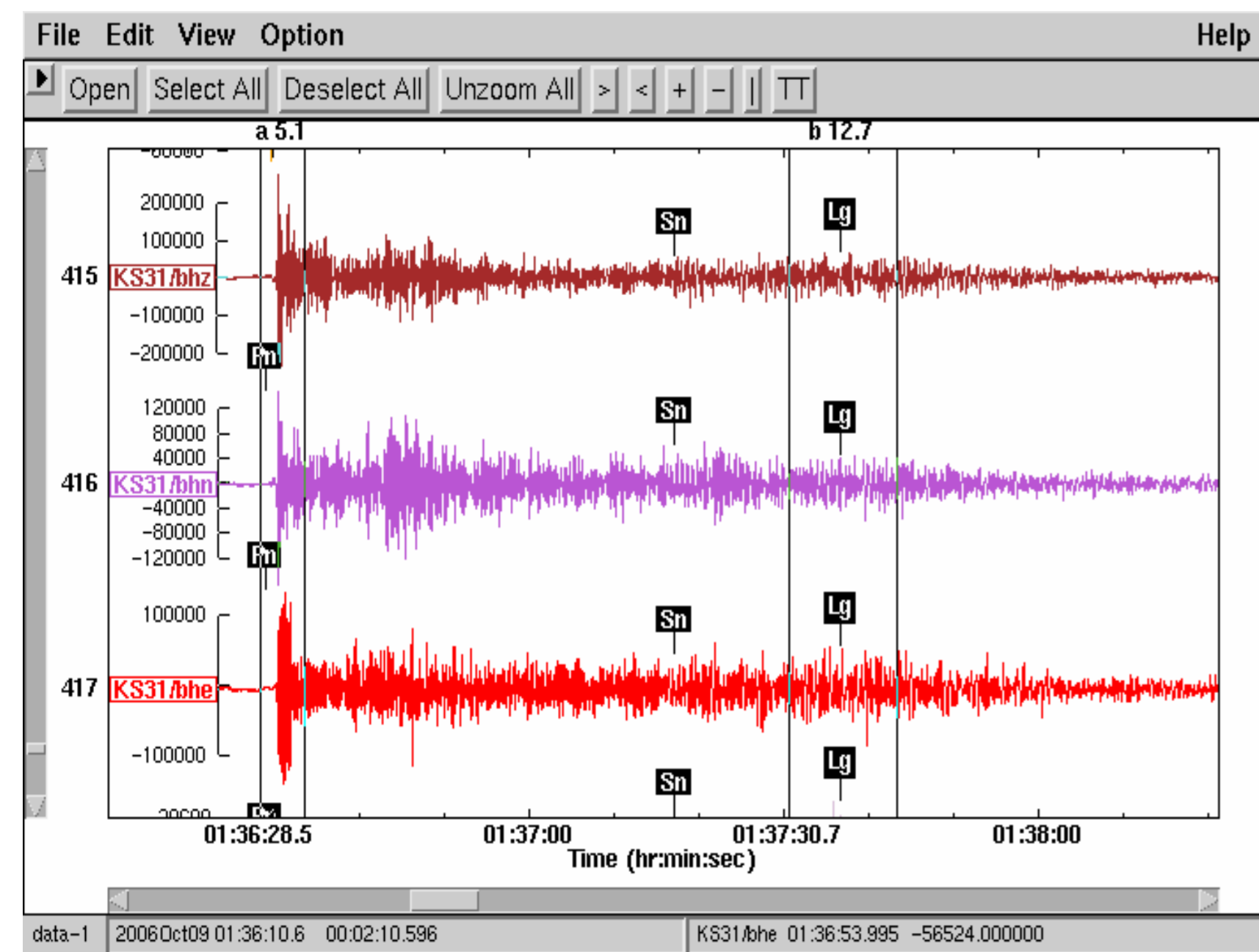
Radionuclide: 80

Sniffing for radiation



Over 625,000

Seismic – Hydroacoustic - Infrasound events
located by the **International Data Centre**
from February 2000 to November 2019



Recording of
DPRK event (2006)

6th announced nuclear test by Democratic People's Republic of Korea (DPRK) on 3 September 2017

2017 event information (REB)

Date: 3 September 2017

Origin Time: 03:30:01.08 UTC \pm 0.18 seconds

Latitude: 41.3205 degrees North

Longitude: 129.0349 degrees East

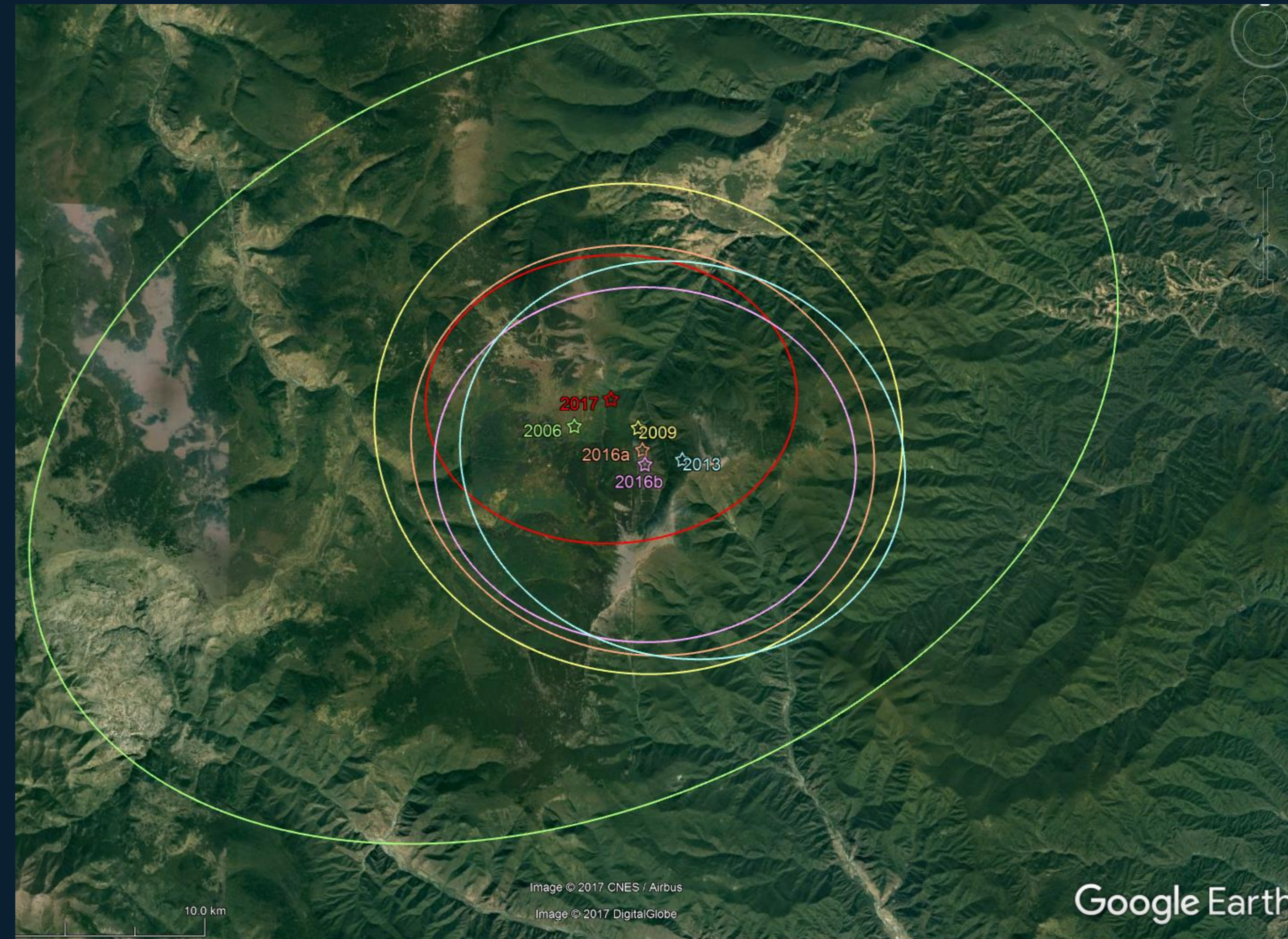
Approximate Location Accuracy: \pm 6.7 km (109 km²)

Depth: 0.0 km (fixed)

Body Wave Magnitude mb (IDC): 6.07

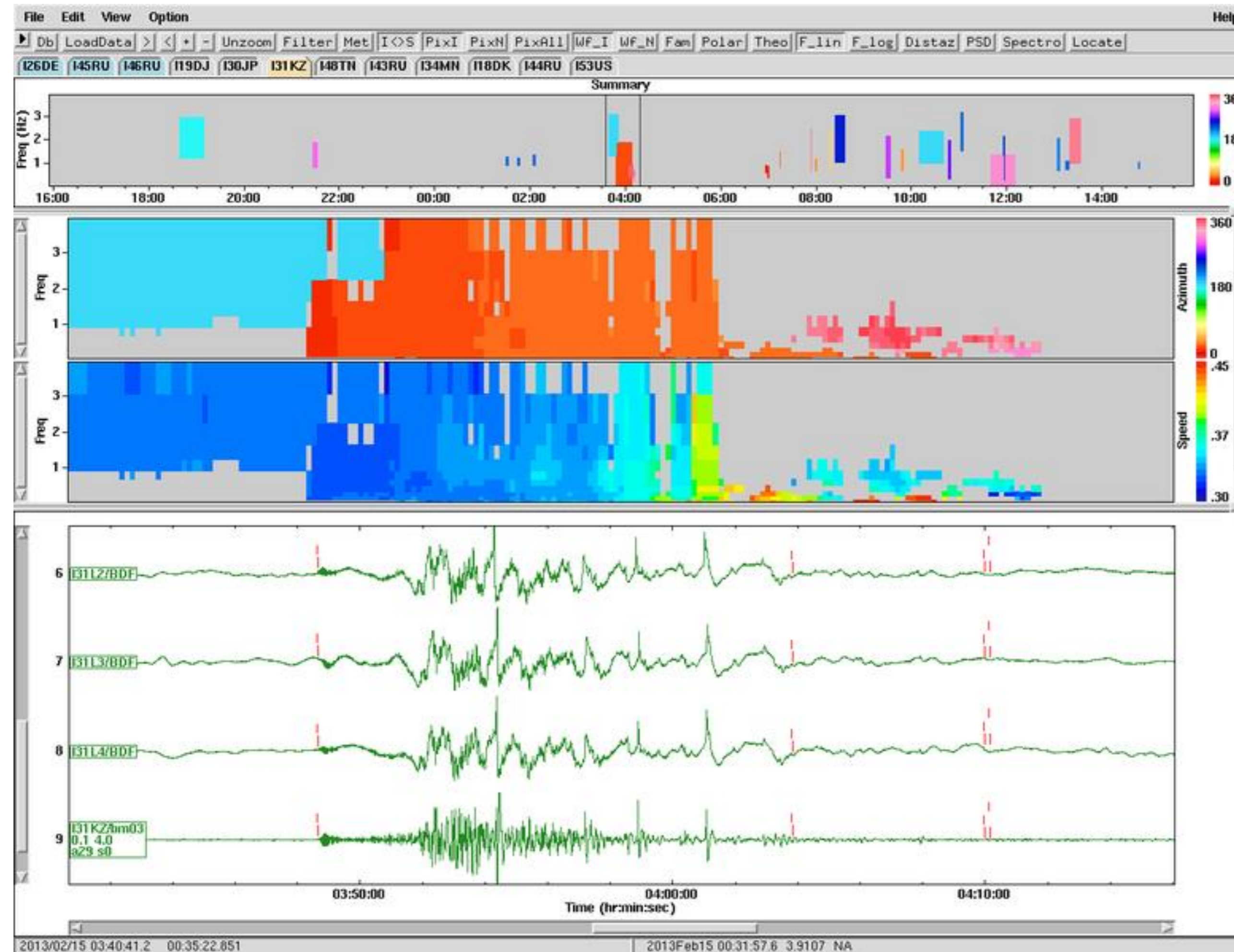
Number of Seismic Stations Used: 125

Issued: 5 September 2017 17:40:22 UTC (within EIF timeline)





Civil and Scientific Applications



The Chelyabinsk meteor

- detected by **20** IMS infrasound stations
- infrasound data provided a publicly available **accurate size estimate**
- statistically, such meteor hits the Earth **once every 50-100 years**



2013 Russian fireball **largest event** recorded by IMS infrasound stations

- Signals produced observed at extreme ranges by 20 IMS stations
- Most energetic ever detected by IMS network (occurrence 50-100 years)

Allow for studying in detail **infrasound propagation around the globe** and for **calibrating the performance of the IMS network**

- Provide **benchmark** for studies on exploding fireballs → help to **advance** the **development of monitoring procedures** to identify potentially dangerous exploding near-Earth objects

Infrasound – Civil & Scientific Applications

Chelyabinsk Fireball – 2013/02/15



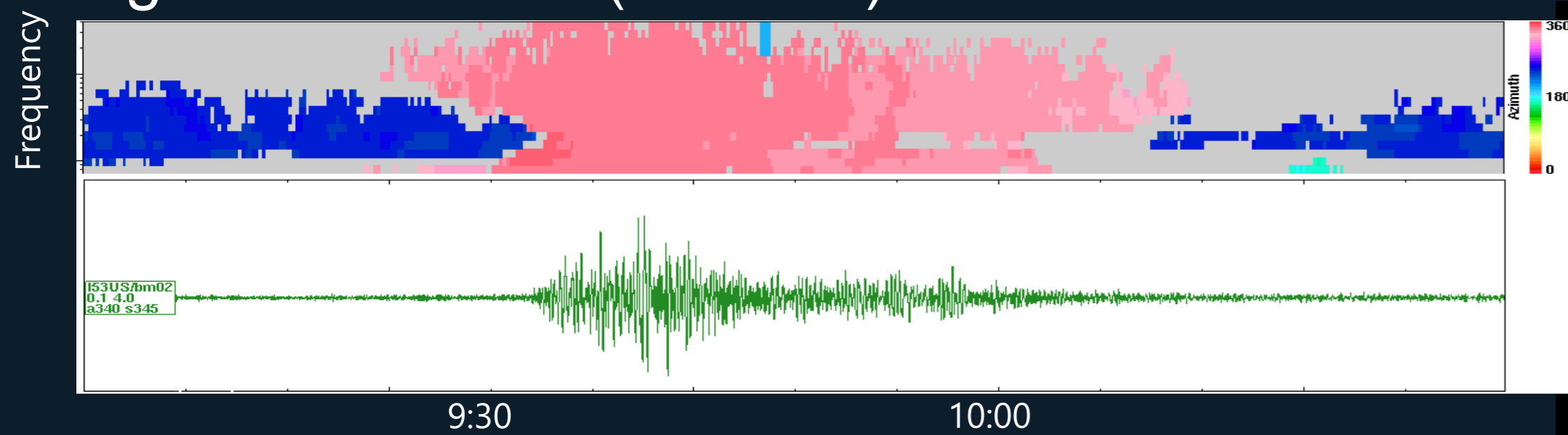
Fireball detected by 20 (red stars) out of 42 operational stations at the time of the event



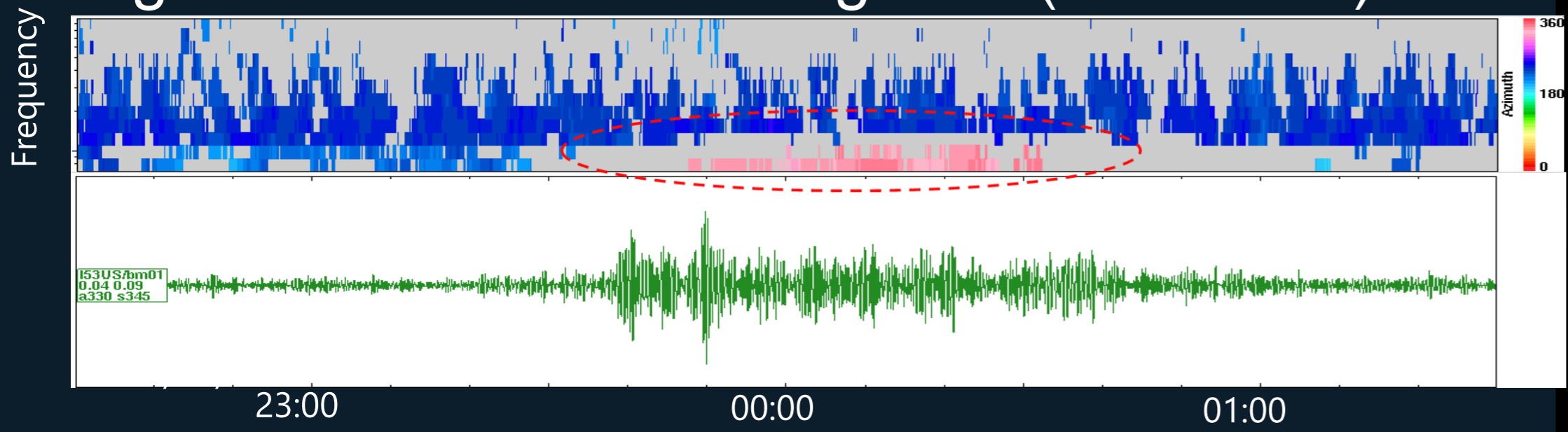
Infrasound – Civil & Scientific Applications

Chelyabinsk Fireball – 2013/02/15

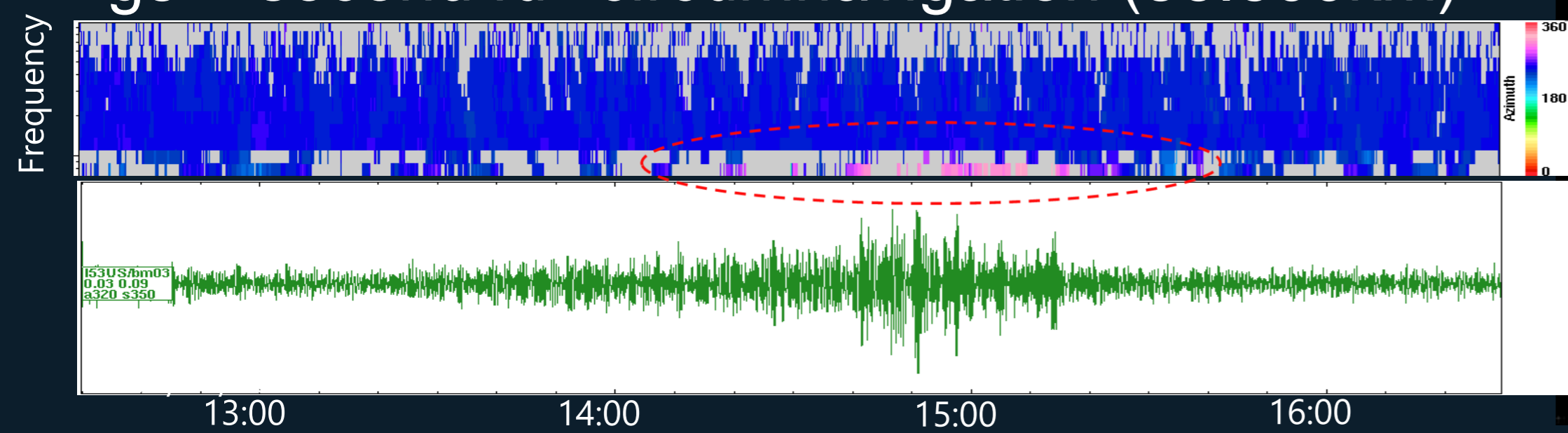
Ig1 – first arrival (6500km)



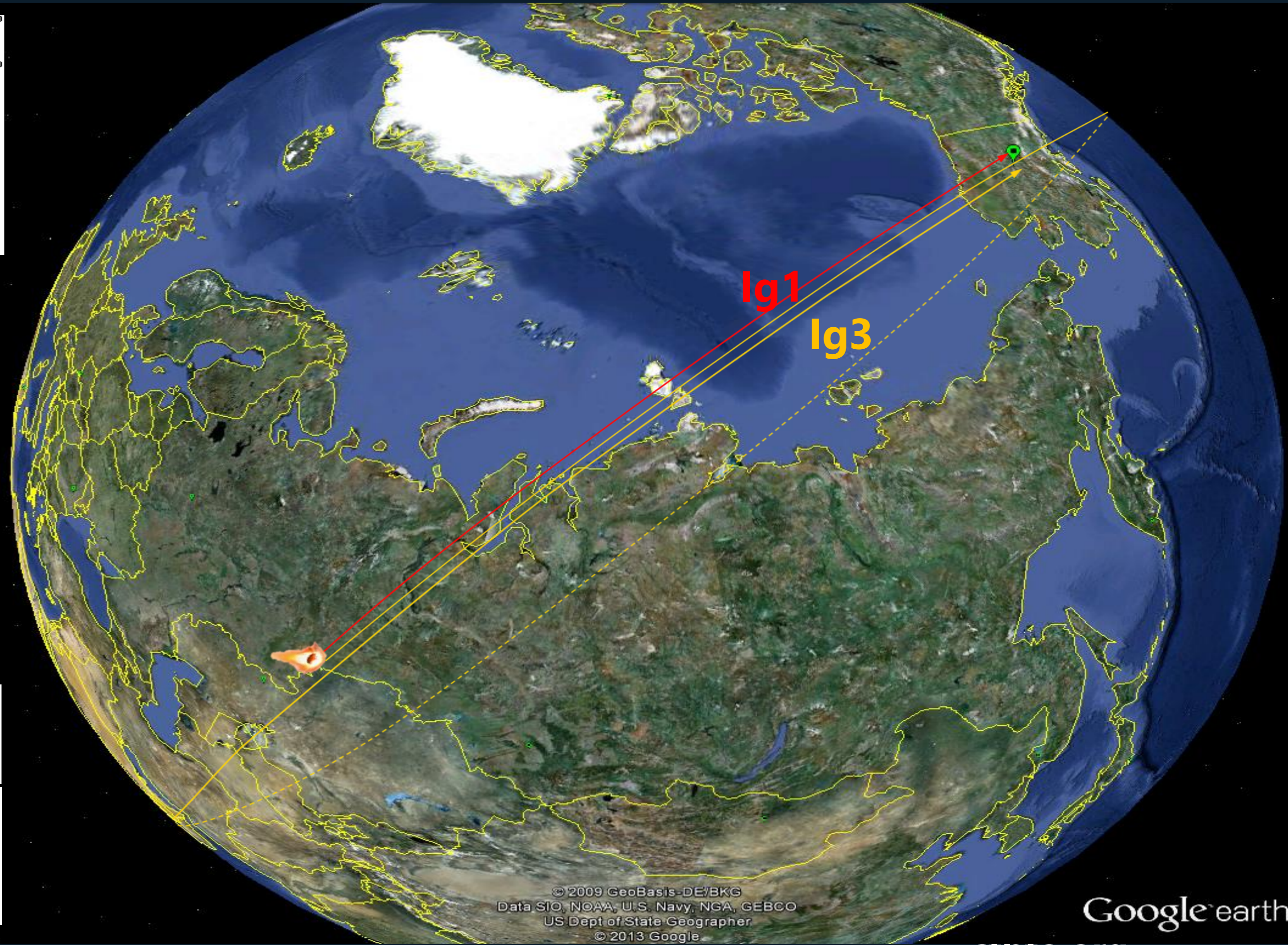
Ig3 – first full circumnavigation (46.600km)



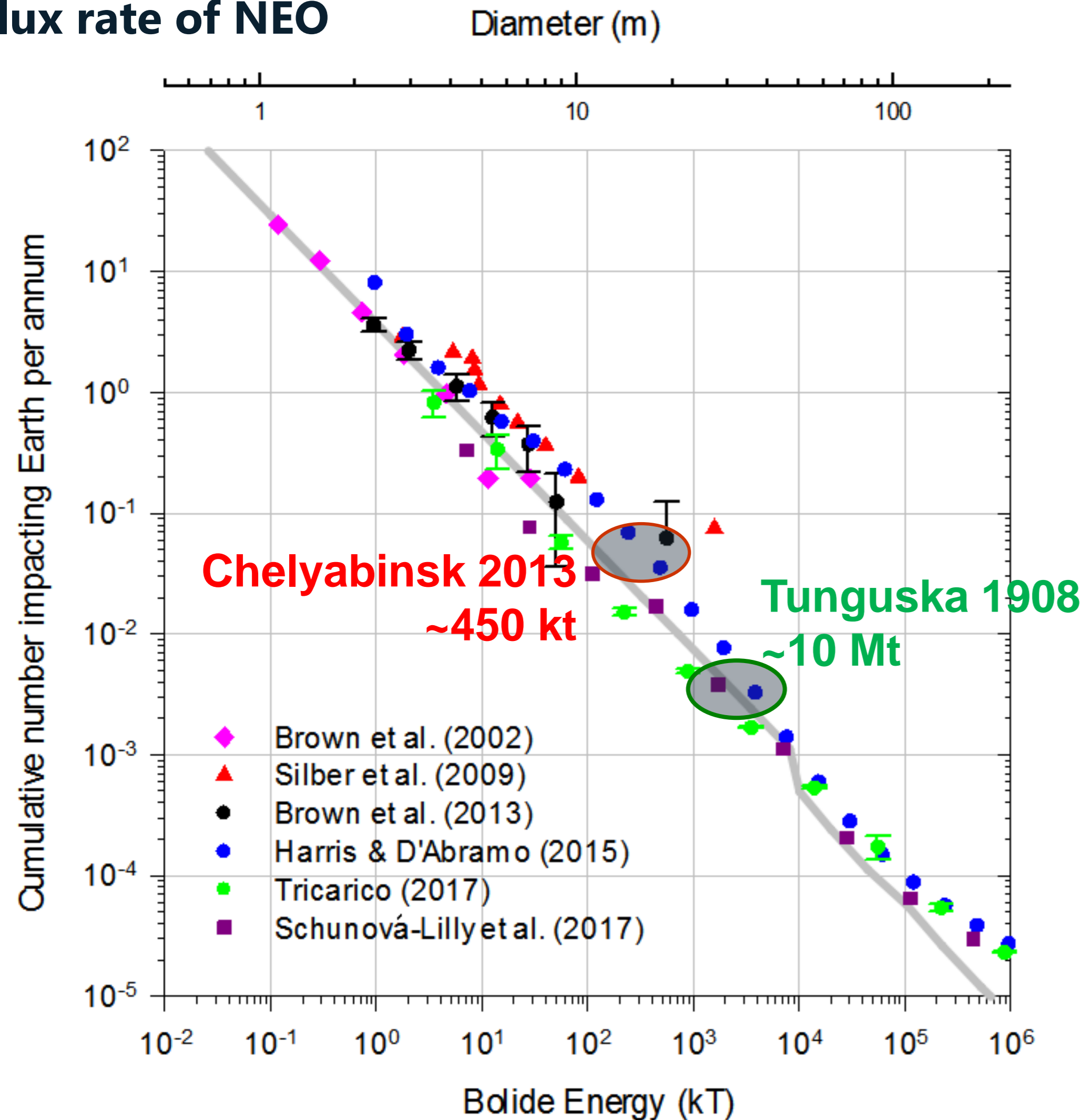
Ig5 – second full circumnavigation (86.600km)



Detection by IS53 (Fairbanks, Alaska)



Flux rate of NEO



Signals produced observed at global ranges by 20 IMS stations

Explosive yield: ~450 kt of TNT

The most energetic event since the Tunguska meteor (1908)

Expected to occur once every 100 years

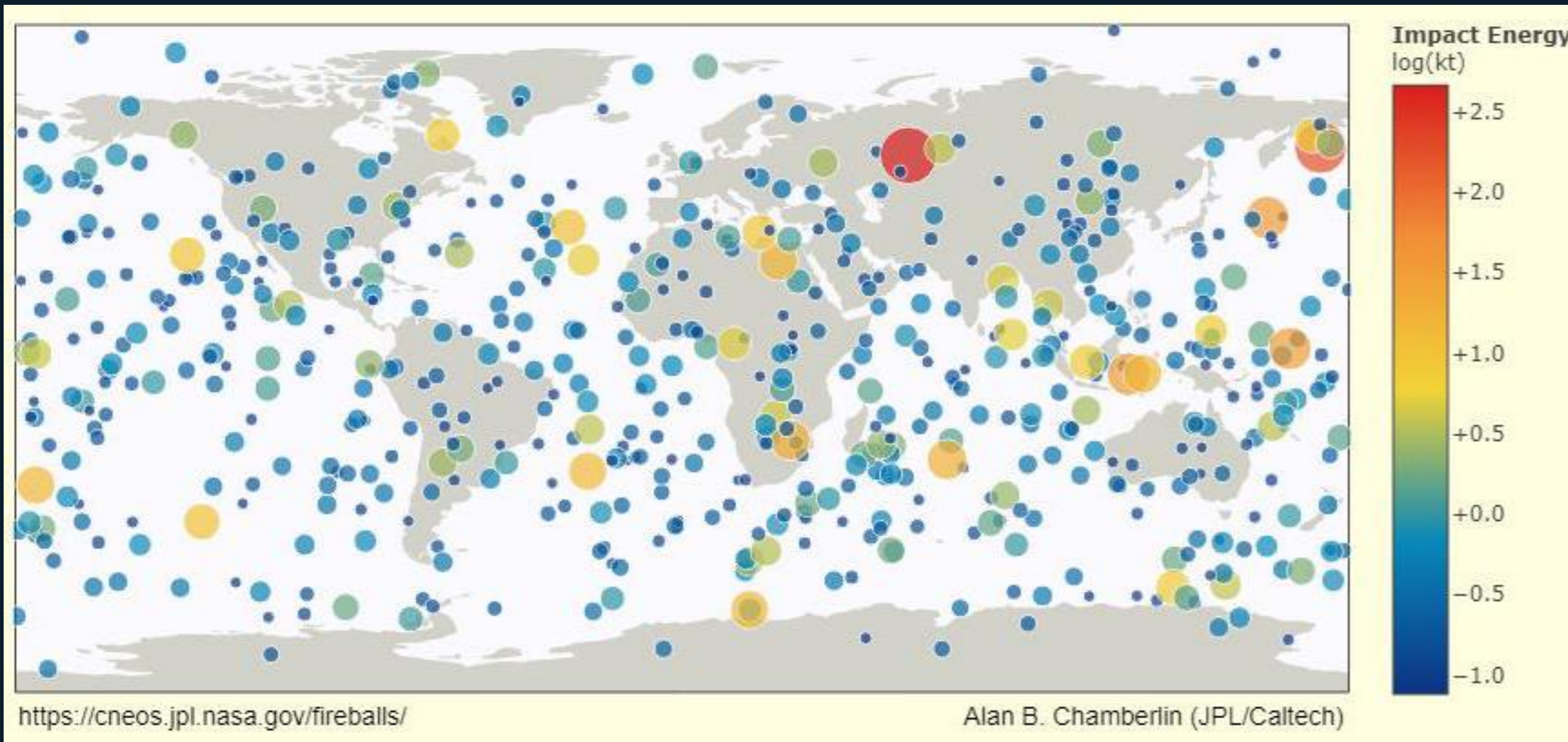
Brown et al., Nature, 2002

CTBTO Civil and Scientific Applications – Infrasound Technology

- Exploration of potential civil and scientific use of IMS data and IDC products is encouraged
- Univ. of Oldenburg has a research project on near real-time monitoring system for atmospheric impacts from small NEOs
- IMS data access for scientific studies possible through a zero-cost contract

NASA US Govt. Satellite Data

From CNEOS (Center for NEO Studies) at JPL (Jet Propulsion Laboratory)



April 1988 to November 2019

Presentation by T. Ott (Uni. Oldenburg) at SnT2019



Daytime fireball over Russia 21 June 2018 - 01:15 UT (04:15 LT)

Infrasound

- 10 Infrasound stations
- a source energy of **2.4 kt TNT.**
 - a size of about **4 m**

- CNEOS/JPL found
- a source energy of **2.8 kt TNT.**



Thank you
