Increasing Exploration Success by Effective use of Remote Sensing

Michael Hall / Airbus DS Intelligence
02/03/2016
michael.hall1@airbus.com

AIRBUS
DEFENCE & SPACE

Remote Sensing in Relation to Current Exploration Challenges

Current Challenges

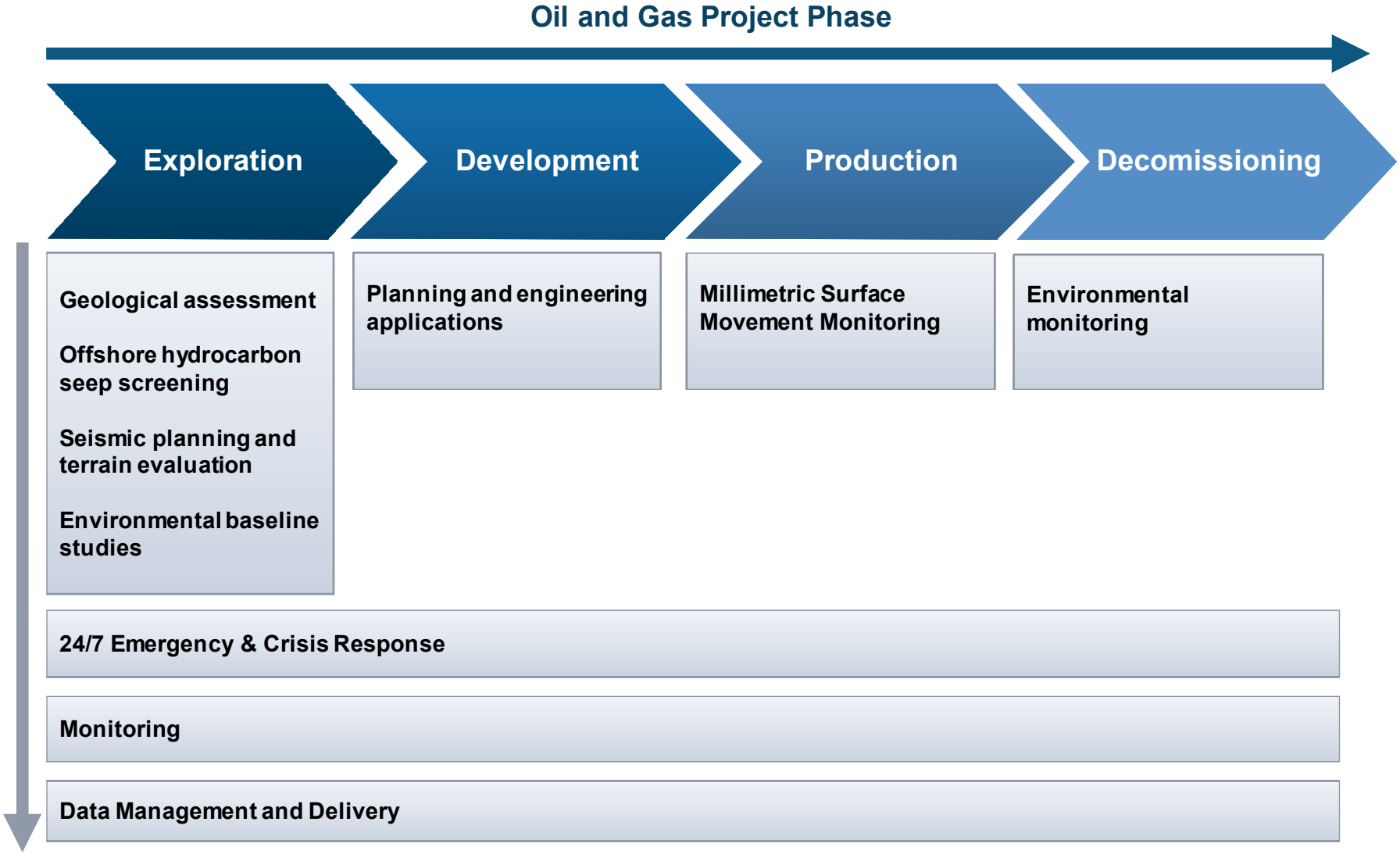
- Operational Efficiency
- Risk Reduction

Satellite remote sensing can contribute to addressing these challenges

- Remote assessment
- Up-to-date analysis
- Compliments and supports collection / analysis of other exploration datasets

AIRBUS DEFENCE & SPACE

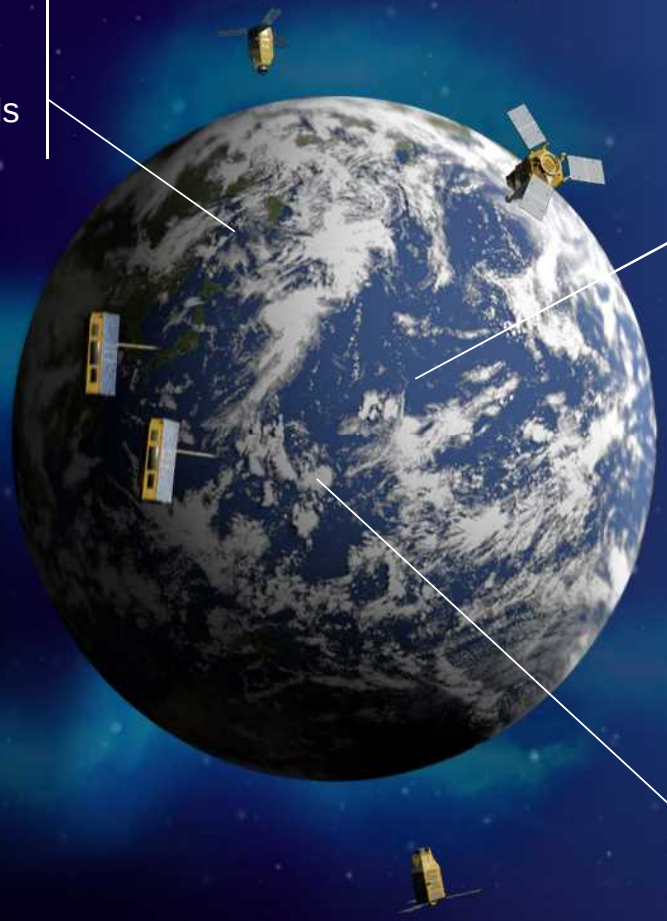
Oil and Gas Project and Remote Sensing Contribution



AIRBUS DEFENCE & SPACE

Remote Sensing Technology

Technological advances
Modern capabilities and trends



Onshore Applications for Oil and Gas Exploration

Operational techniques:

Geological interpretation
Seismic planning

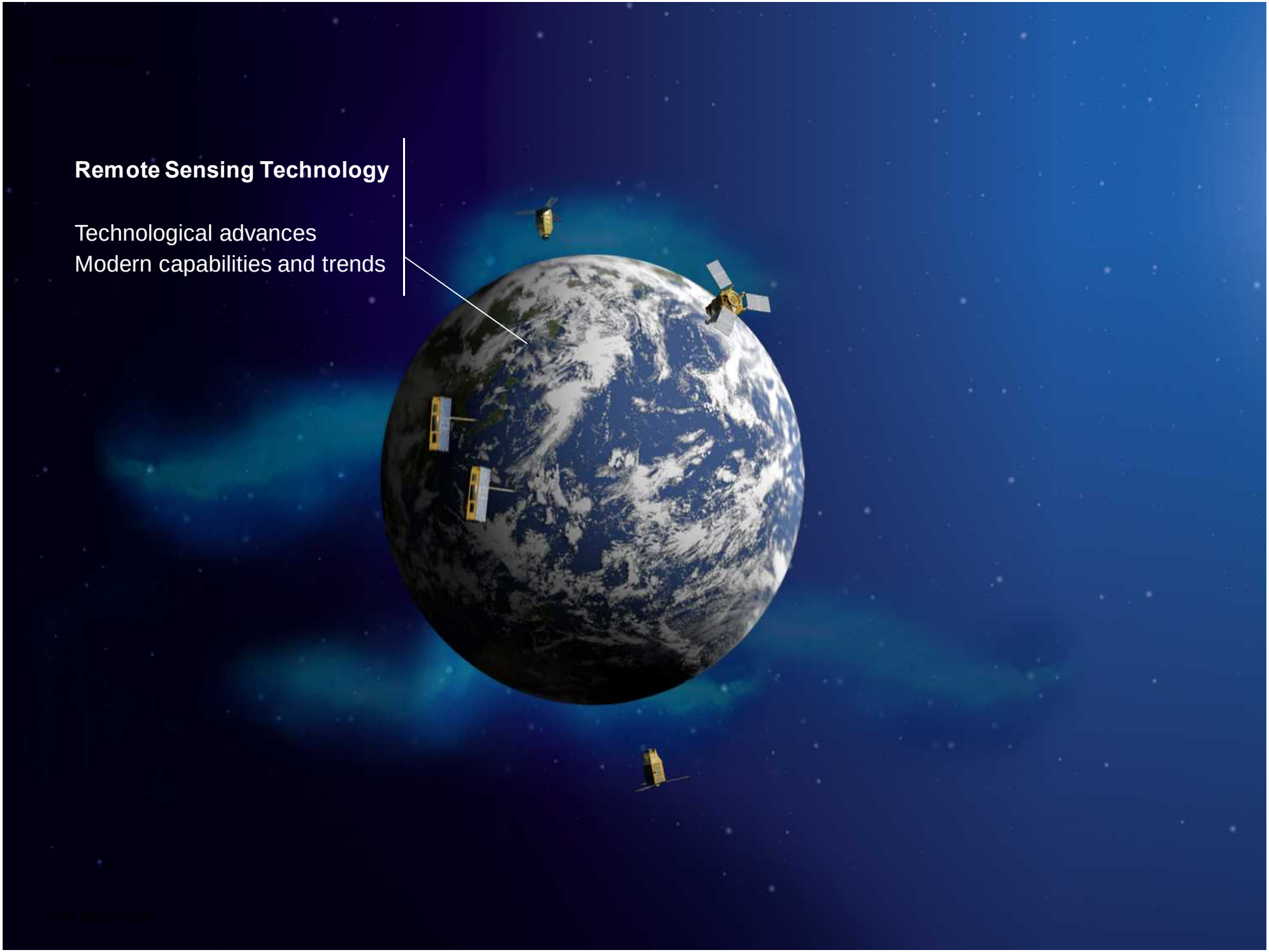
Offshore Applications for Oil and Gas Exploration

Operational techniques:

Oil seep screening

Remote Sensing Technology

Technological advances
Modern capabilities and trends



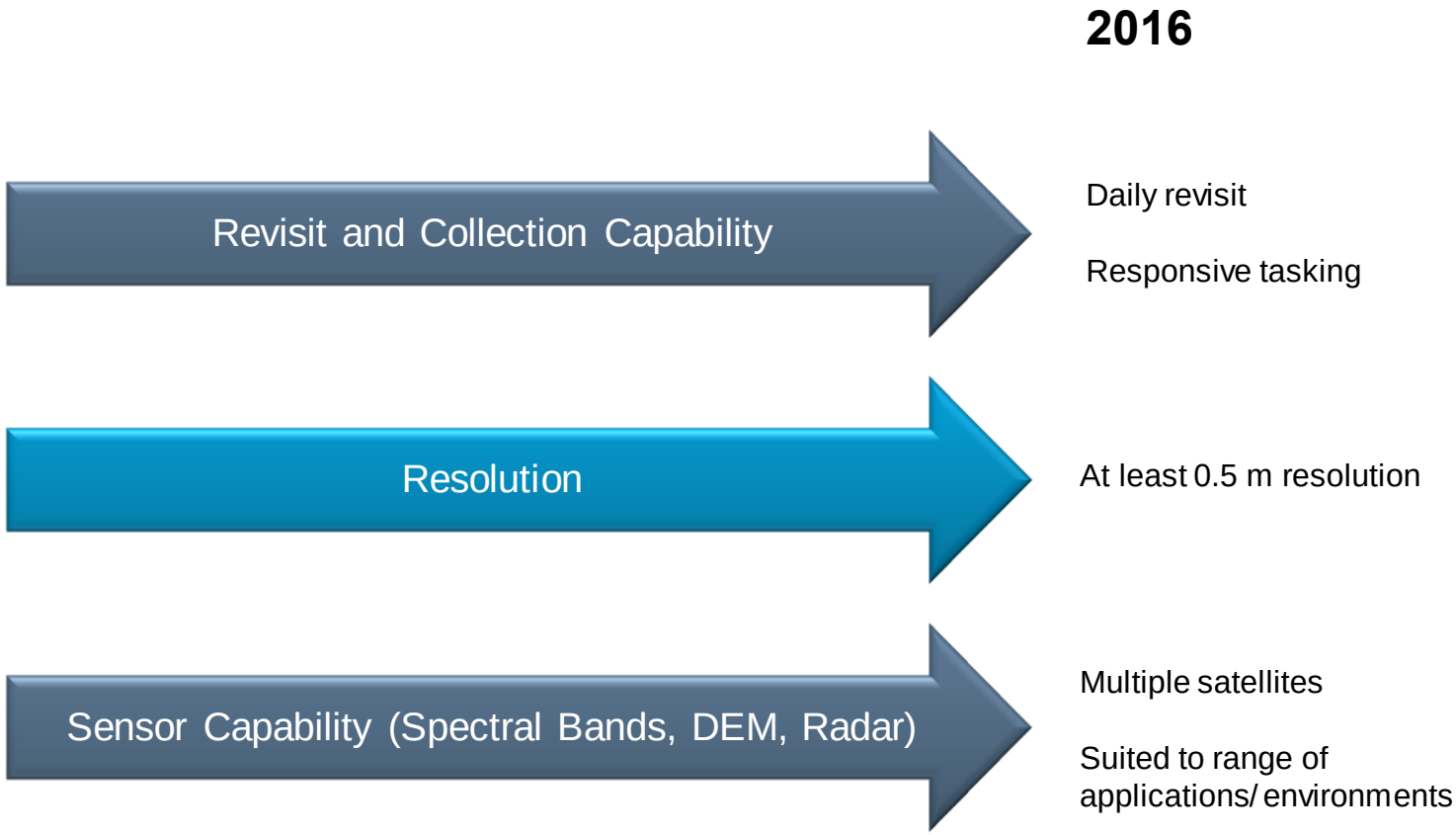
Technological Advances in Sensor Capabilities - Trends

1972 Landsat 1

2016

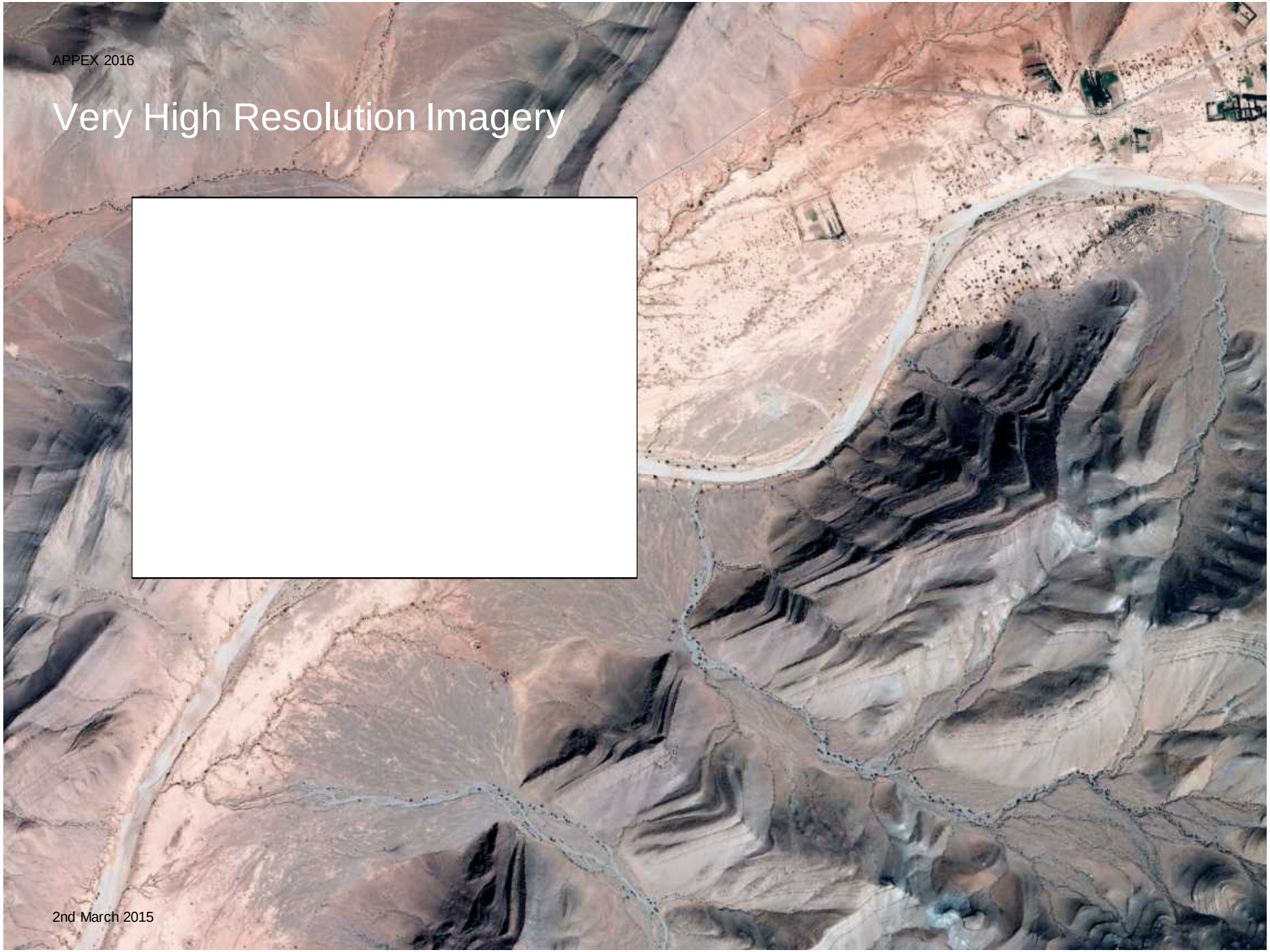
AIRBUS DEFENCE & SPACE

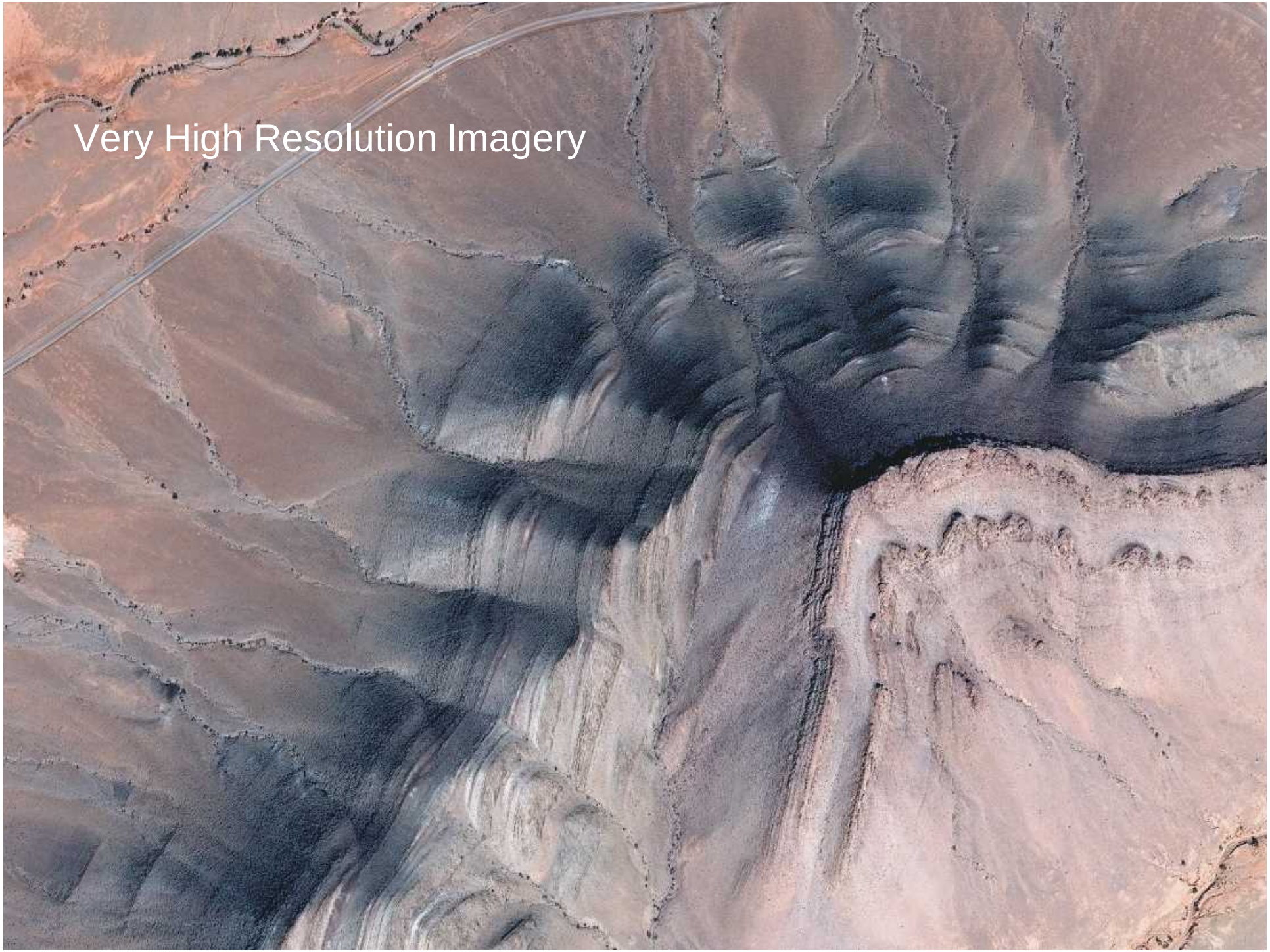
Technological Advances in Sensor Capabilities - Trends



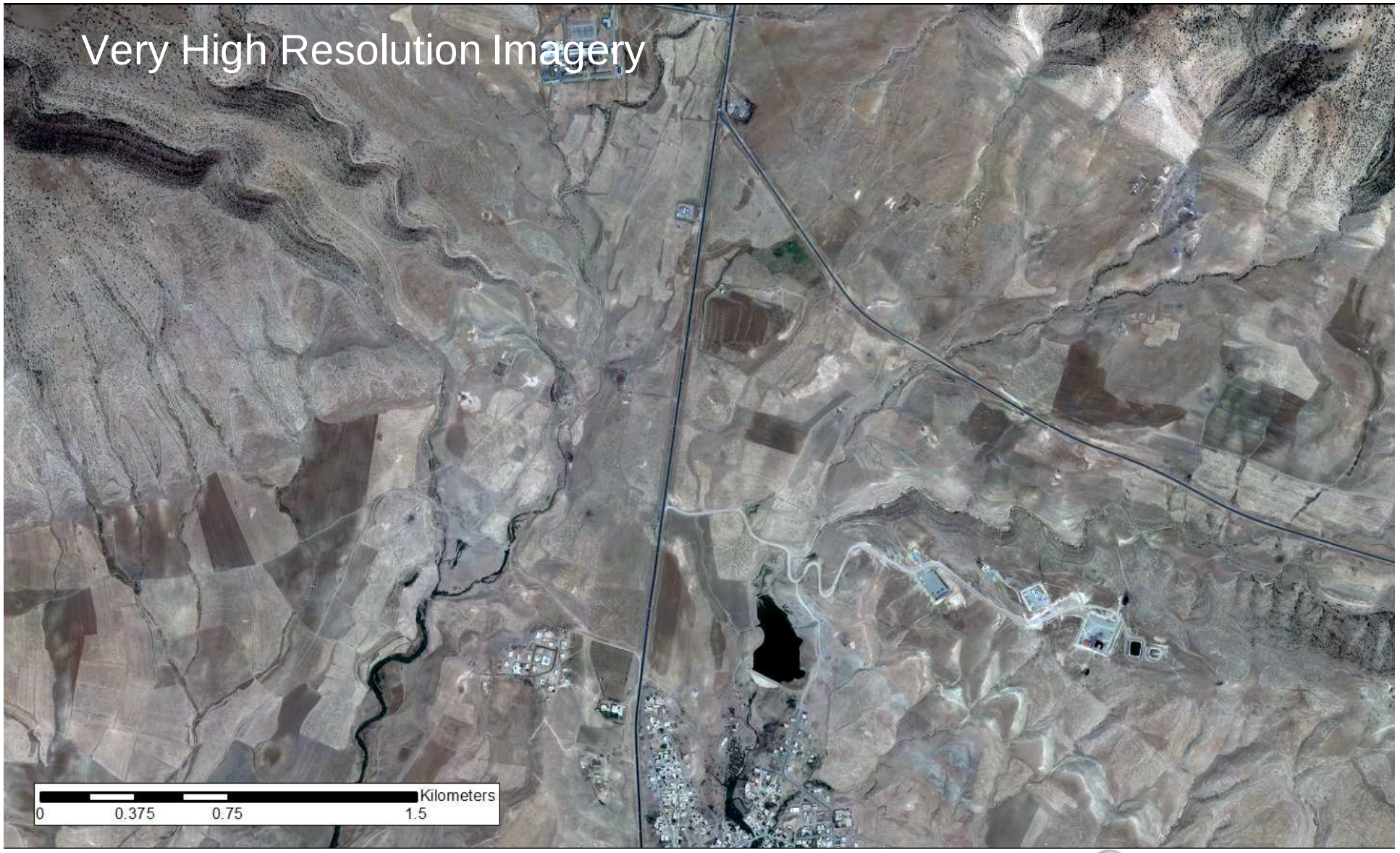
AIRBUS DEFENCE & SPACE

Very High Resolution Imagery



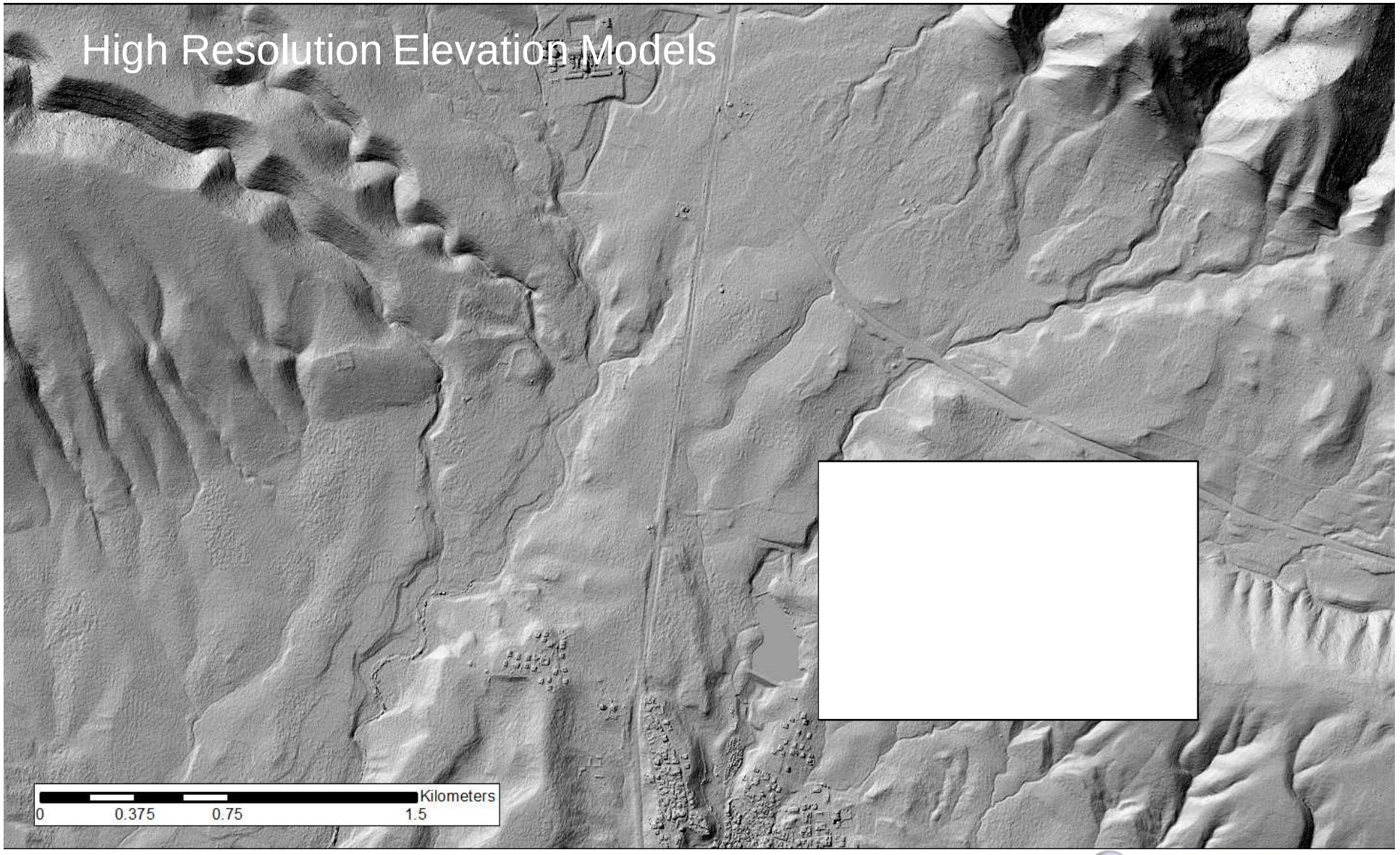

Very High Resolution Imagery

Very High Resolution Imagery



AIRBUS DEFENCE & SPACE

High Resolution Elevation Models

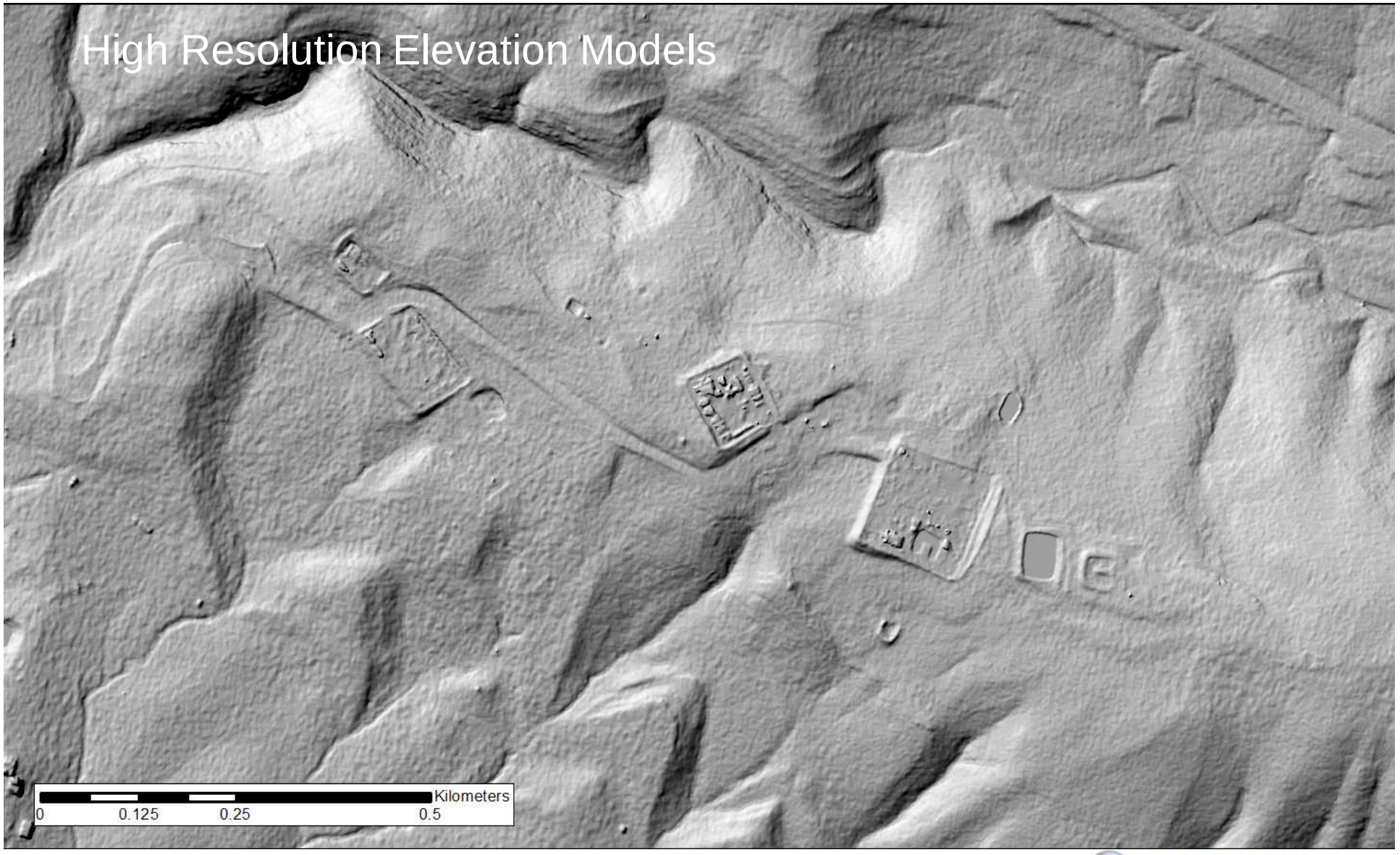


AIRBUS DEFENCE & SPACE

Very High Resolution Imagery

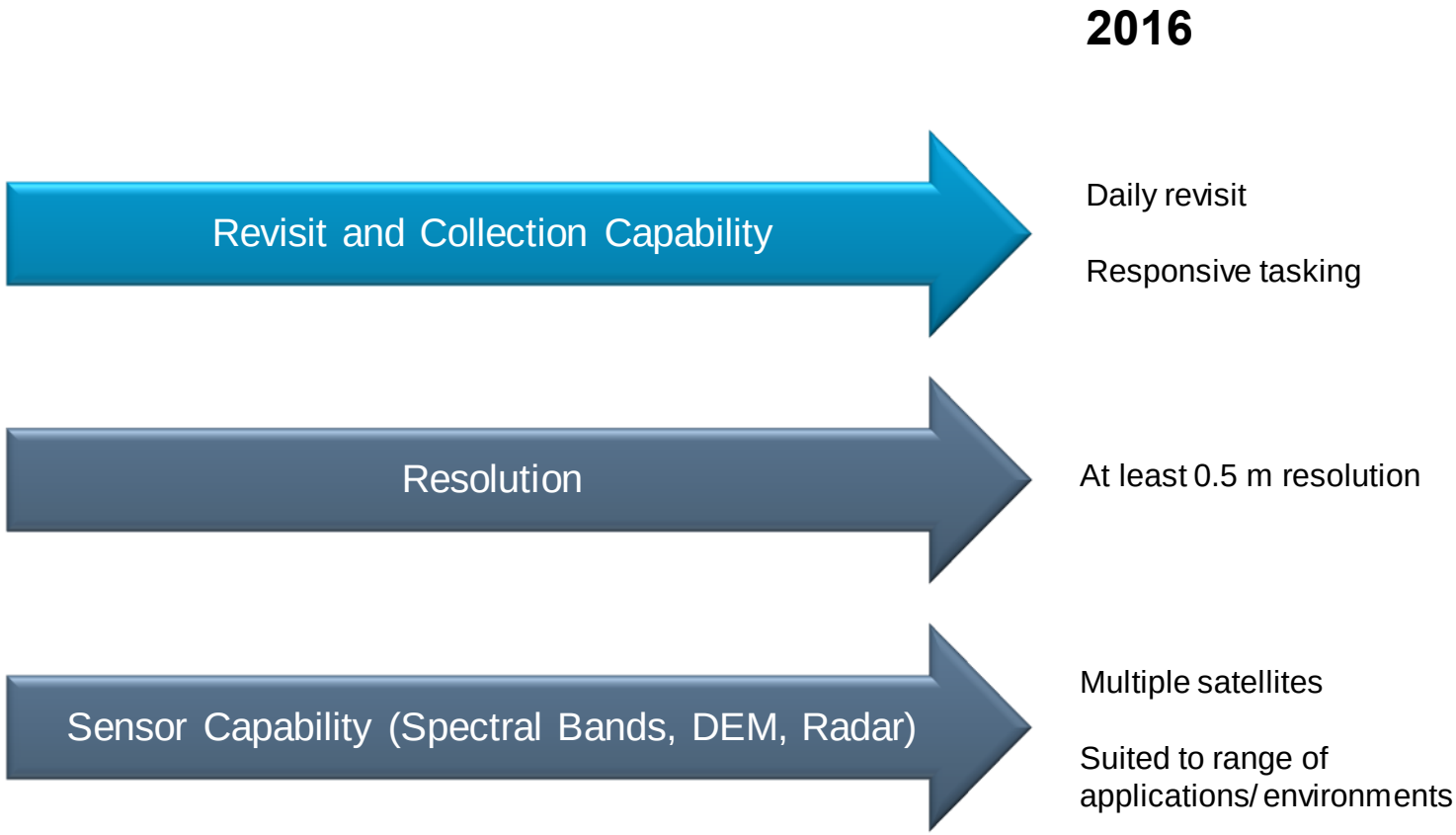
AIRBUS
DEFENCE & SPACE

High Resolution Elevation Models



AIRBUS DEFENCE & SPACE

Technological Advances in Sensor Capabilities - Trends



AIRBUS DEFENCE & SPACE


APPEX 2016
2nd March 2015

Rapid Tasking and Delivery

July 29th **July 30th**

11:48 PM
Order placed

10:44 AM
The satellite passes over the target

12:19 PM
Product ready for download

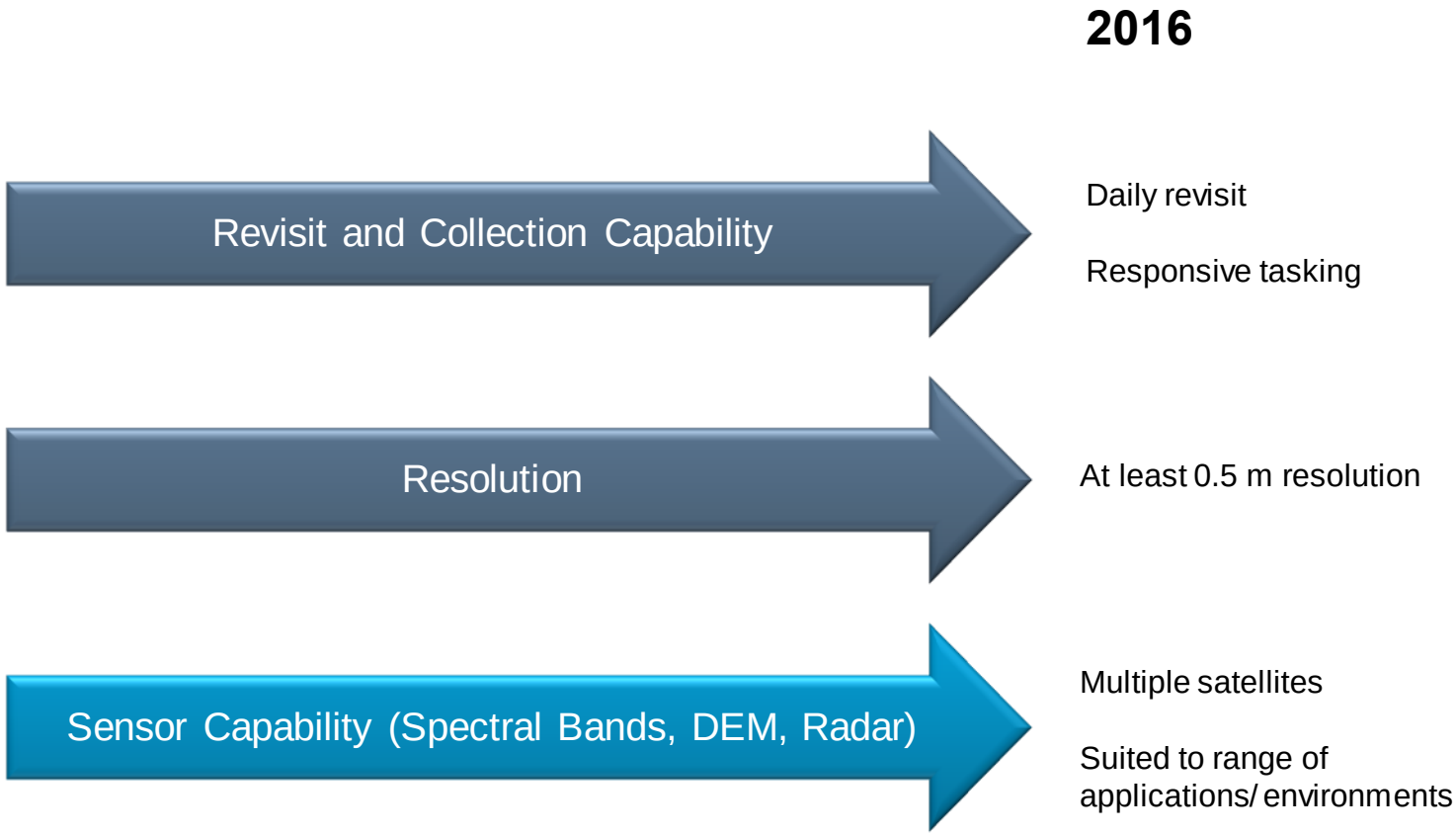
1h35
From Acquisition to Delivery

12h31
From Request to Delivery

AIRBUS DEFENCE & SPACE

2nd March 2015

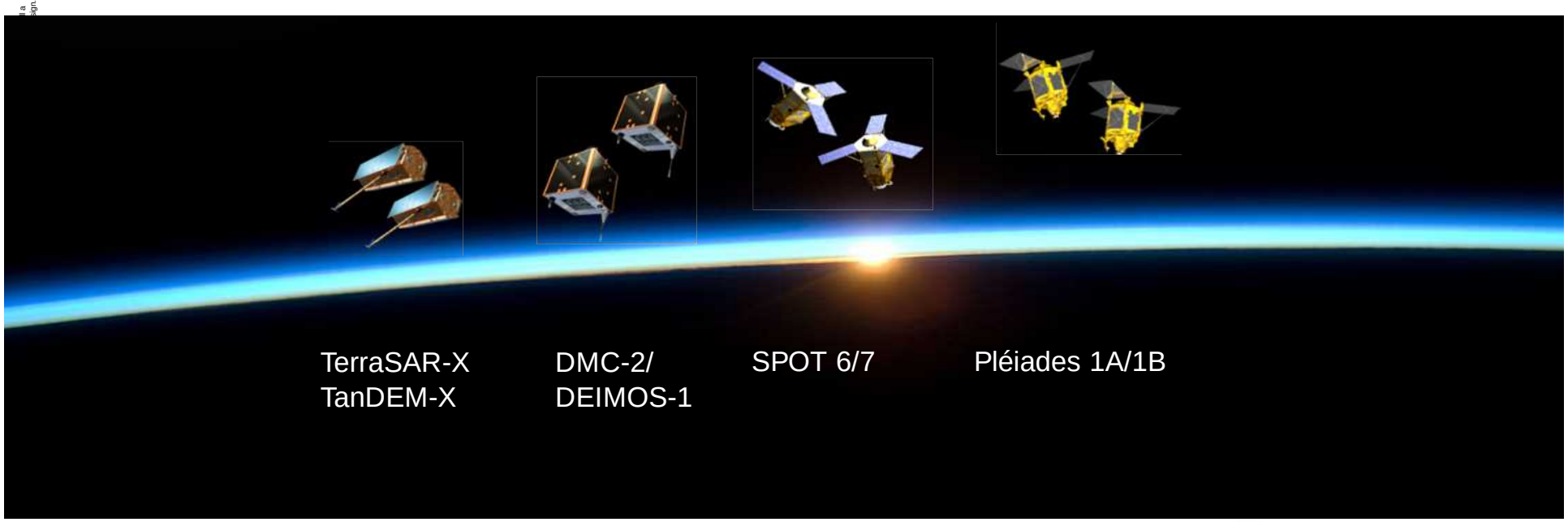
Technological Advances in Sensor Capabilities - Trends



AIRBUS DEFENCE & SPACE

Satellite Imagery - The Airbus DS Constellation Underpinning Exploration Services

- Multi source, multi resolution constellation with suite of derived elevation products

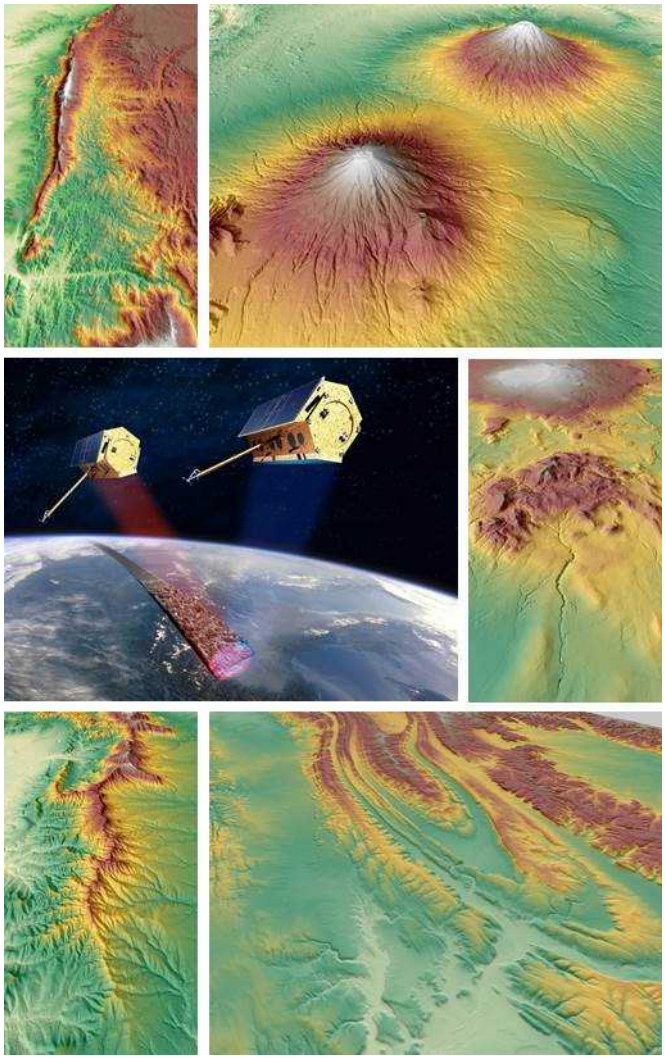


AIRBUS DEFENCE & SPACE

WorldDEM and TanDEM-X Mission

- First worldwide, consistent and seamless elevation model
  - ï Covering the entire Earthôs land mass (pole-to-pole)
  - ï Data collected by twin satellites: TerraSAR-X & TanDEM-X flying in a very close and precise formation

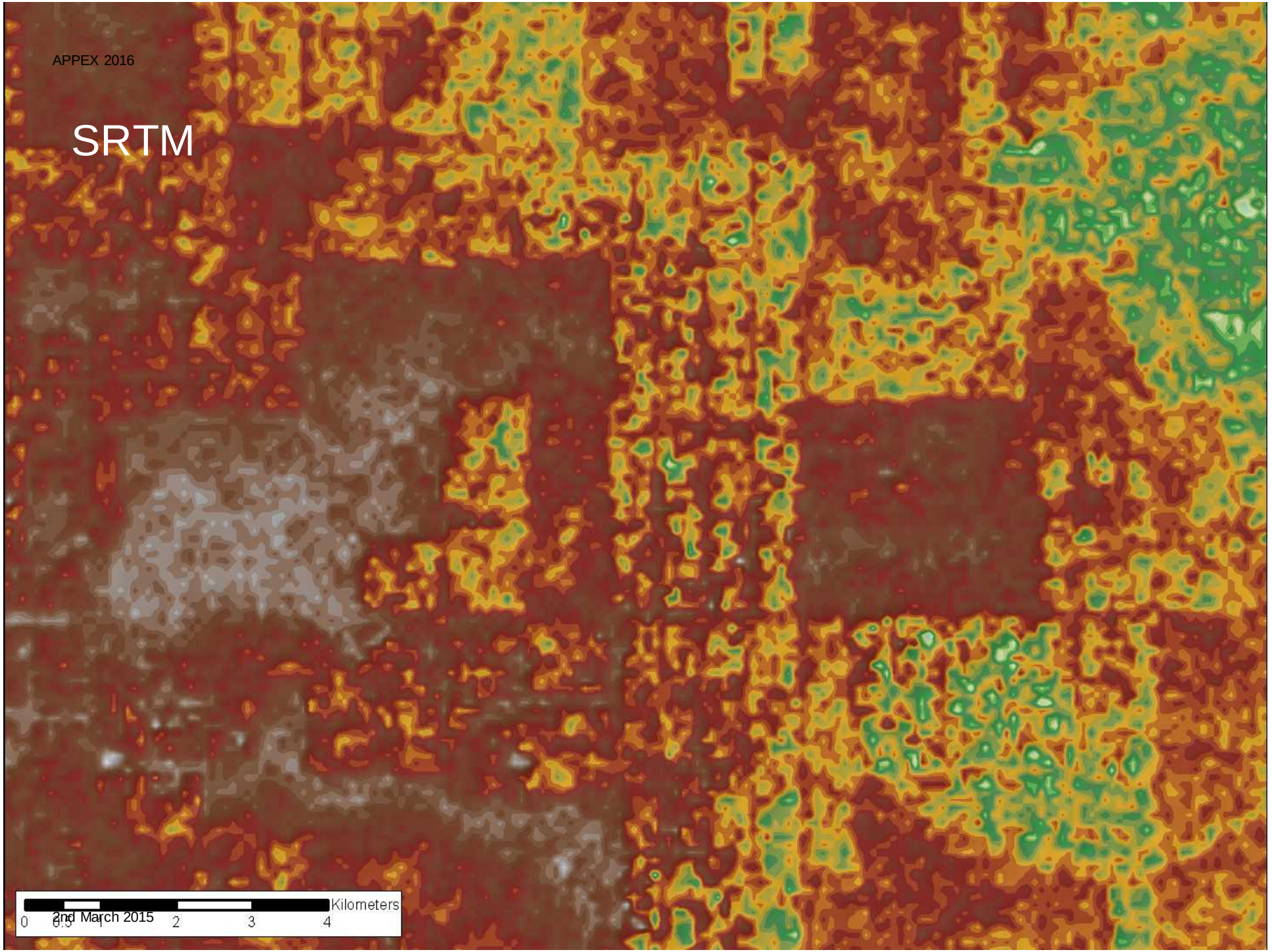
Å Specification
- ï 12m resolution Digital Surface Model
- ï Accuracies 2m (relative)
- ï 4m (absolute)



AIRBUS DEFENCE & SPACE

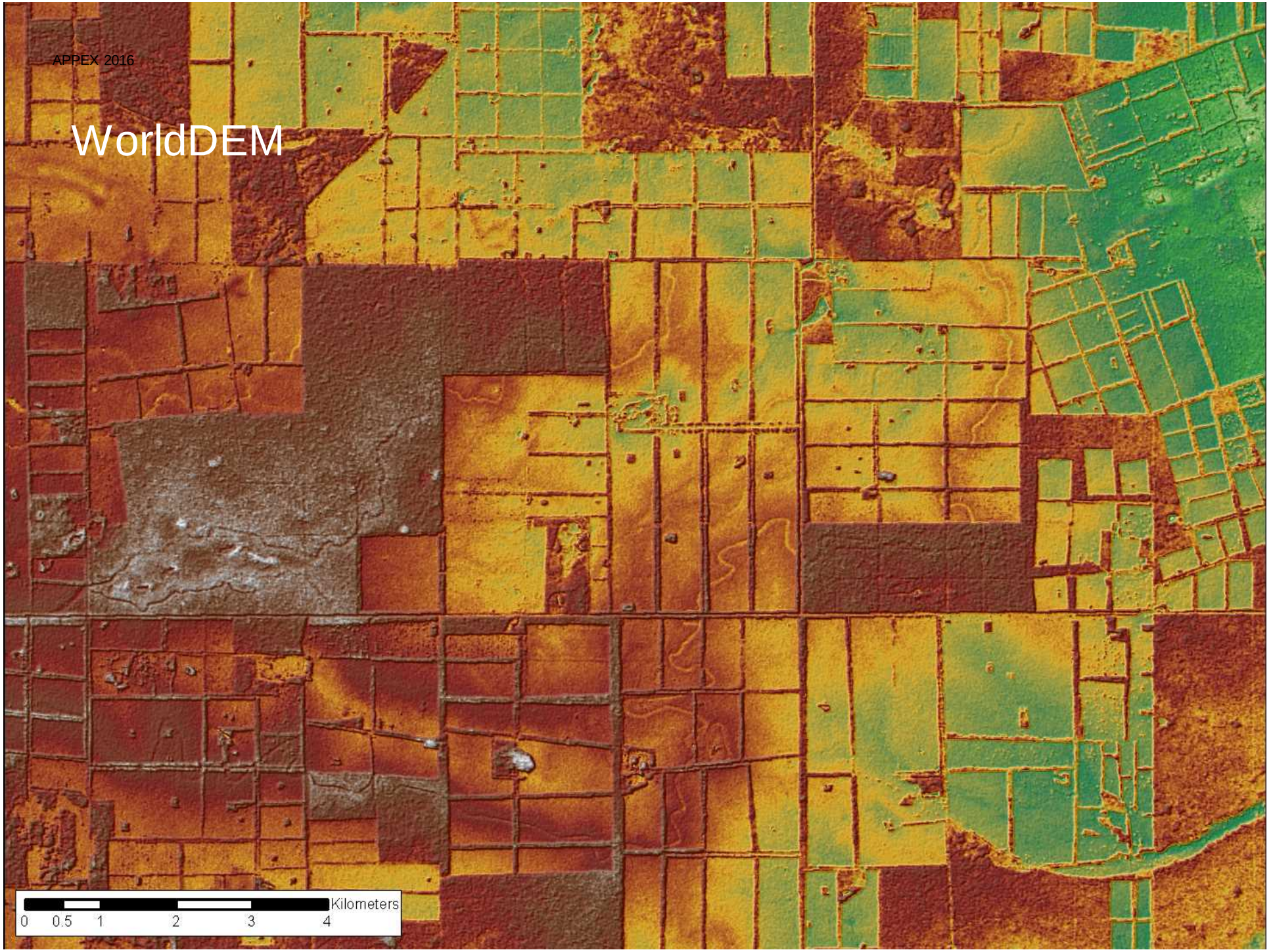
APPEX 2016

SRTM



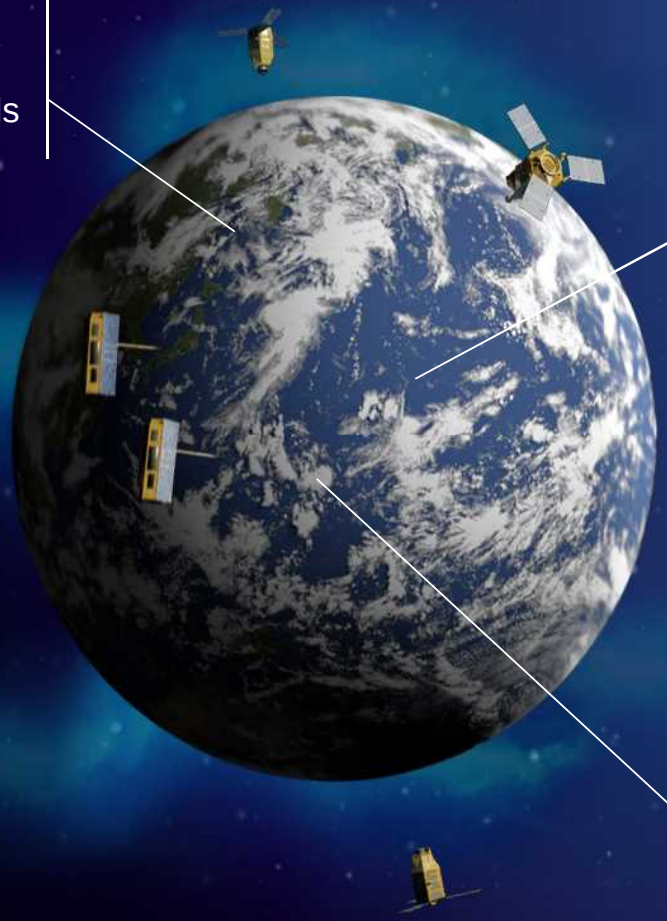
APPEX 2016

WorldDEM



Remote Sensing Technology

Technological advances
Modern capabilities and trends



Onshore Applications for Oil and Gas Exploration

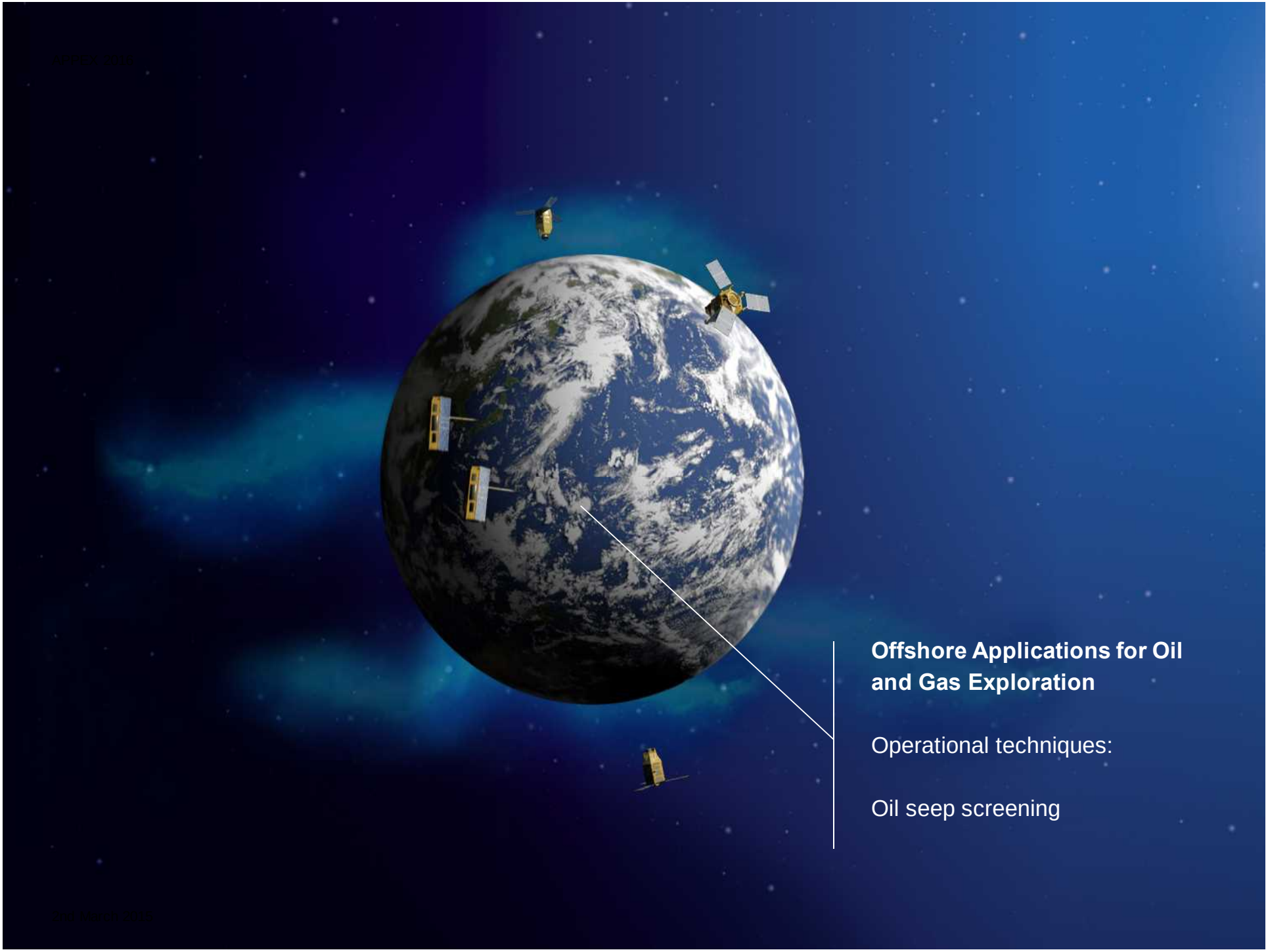
Operational techniques:

Geological interpretation
Seismic planning

Offshore Applications for Oil and Gas Exploration

Operational techniques:

Oil seep screening



Offshore Applications for Oil and Gas Exploration

Operational techniques:

Oil seep screening

Global Seeps

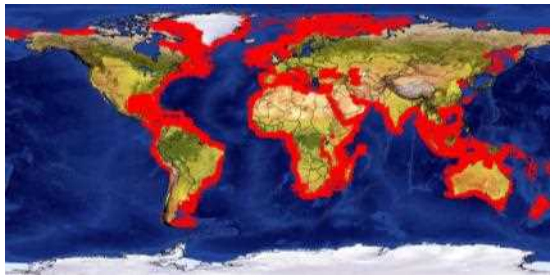
Å Natural seeps occur in many offshore basins and provide a direct indication of a working hydrocarbon system

DESCRIPTION

- ✓ Non-exclusive database of offshore oil slicks, developed over 20 years
- ✓ Risk ranking tool prior to new exploration

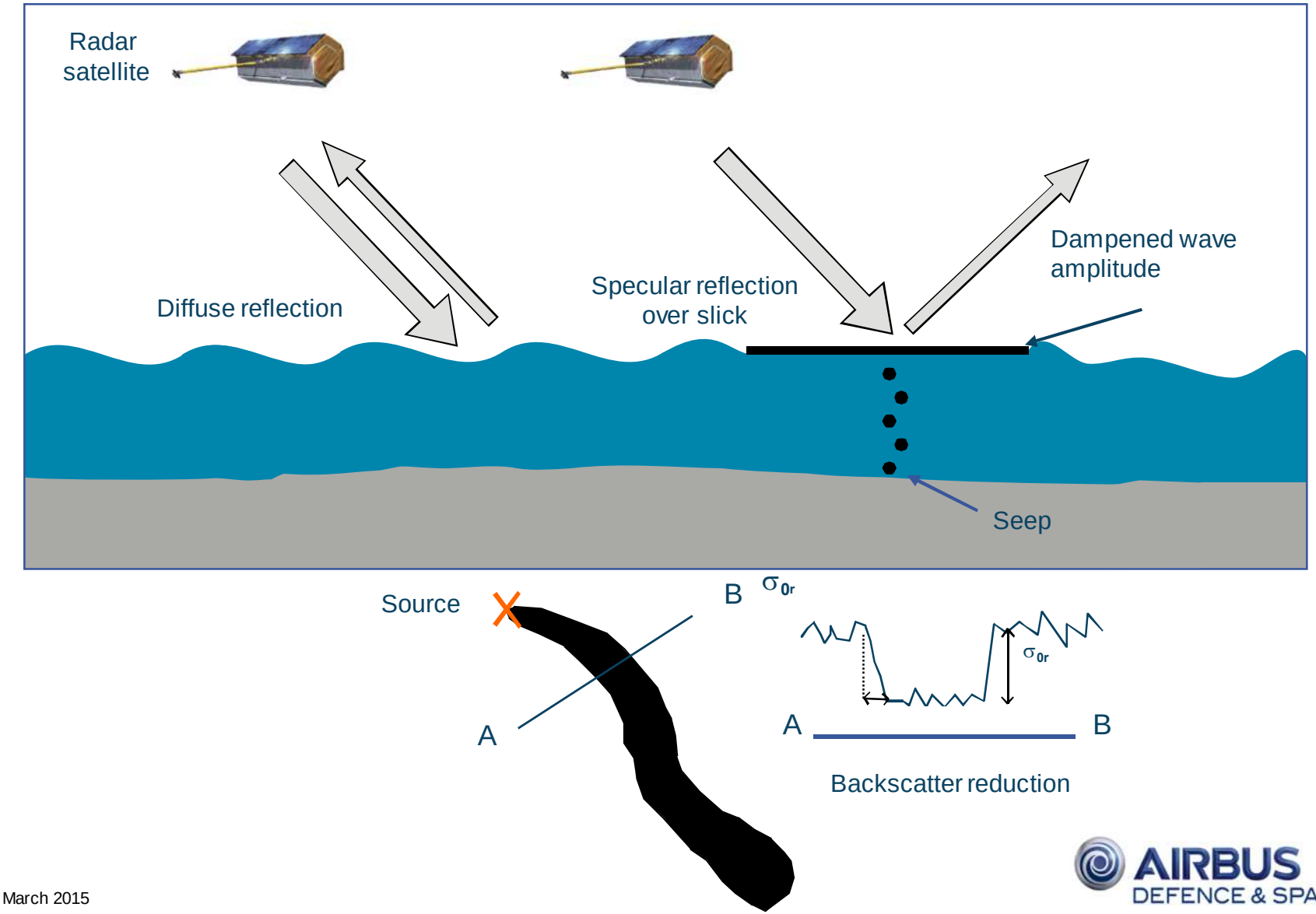
CHARACTERISTICS

- ✓ Systematically screening the worlds offshore basins (archive and newly programmed satellite data)
- ✓ Mixture of datasets from TerraSAR-X, Radarsat, Sentinel, ERS, ENVISAT, JERS, ALOS Palsar, Landsat and ASTER
- ✓ Continuous updates with new satellite data



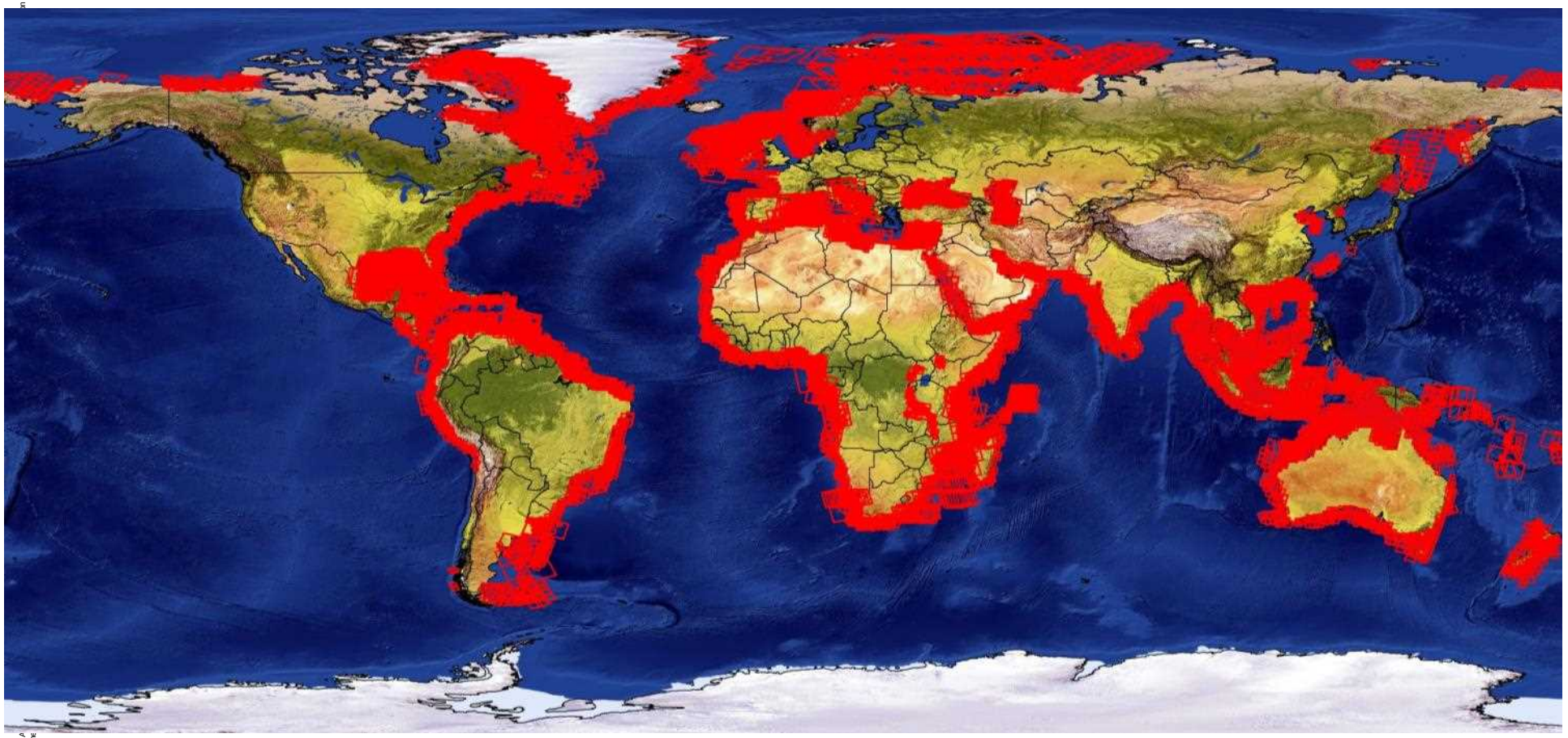
AIRBUS DEFENCE & SPACE

Global Seeps - Offshore Radar Slick Detection



AIRBUS DEFENCE & SPACE

Global Seeps ï 60 Million KM^2

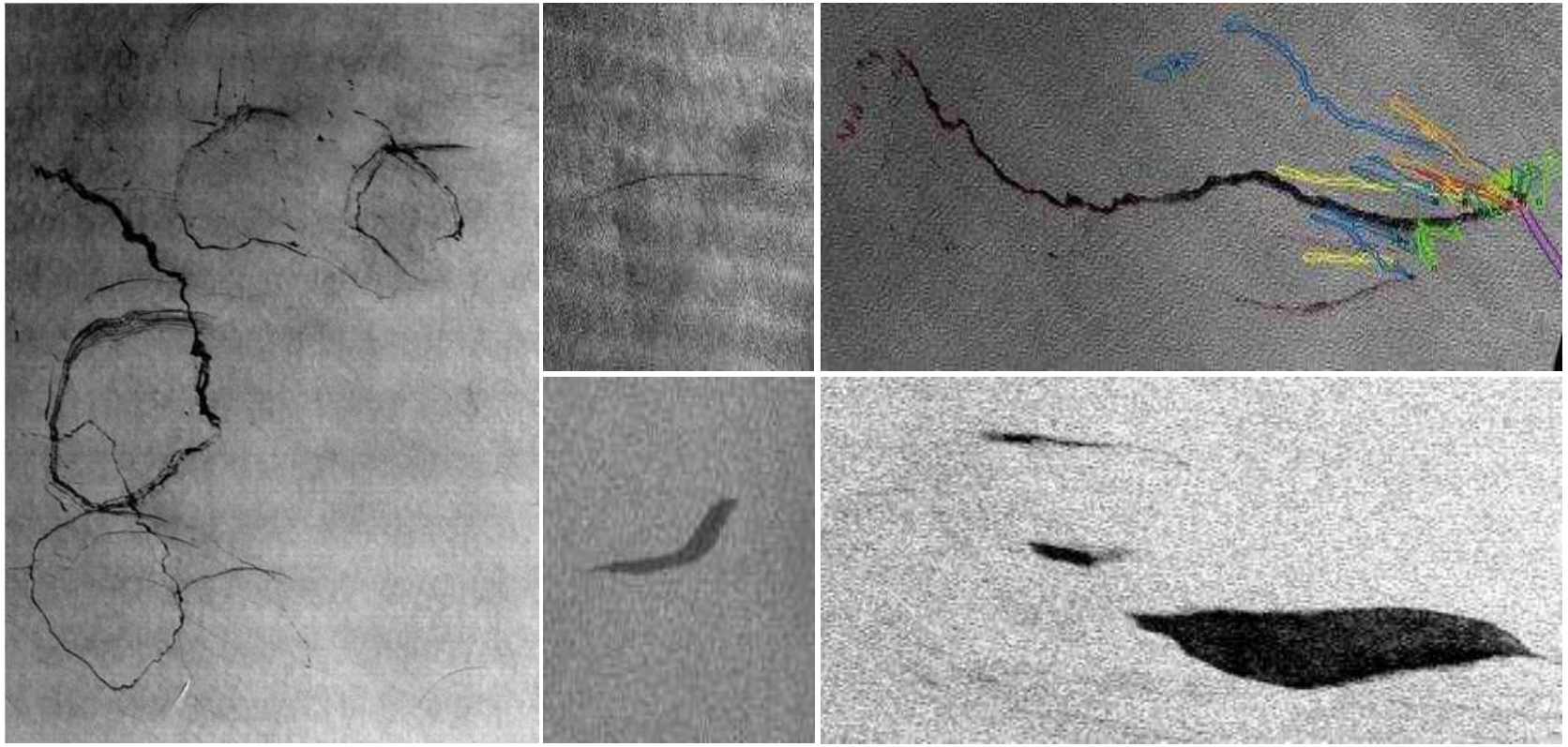


20,000+ **Scenes from multiple sensors**

2nd March 2015

AIRBUS DEFENCE & SPACE

Global Seeps Database



25,000+ **Potential Seepage Slicks Identified**

2nd March 2015

AIRBUS DEFENCE & SPACE

Interpretation Methodology

Aquisition of Suitable Imagery

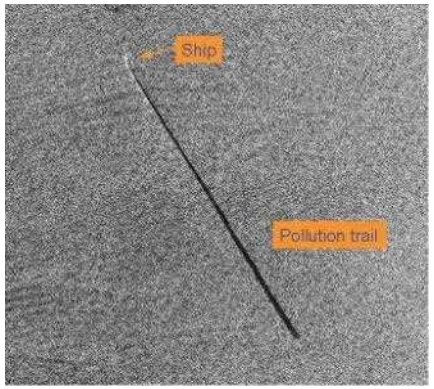
- ✓ Minimum dual coverage
- ✓ Greater repeat coverage increases likelihood of detection

Slick Identification

- ✓ Optimal weather conditions only
- ✓ Manual screening approach

Classification

- ✓ Assessment of slick characteristics



AIRBUS DEFENCE & SPACE

Offshore Seep Mapping - Key Applications

- Screening frontier basins & new exploration licensing rounds
- Seismic planning
- Seismic integration
- Oil spill detection and pollution monitoring
- Planning geochemical sampling programmes
- Environmental baseline

AIRBUS DEFENCE & SPACE

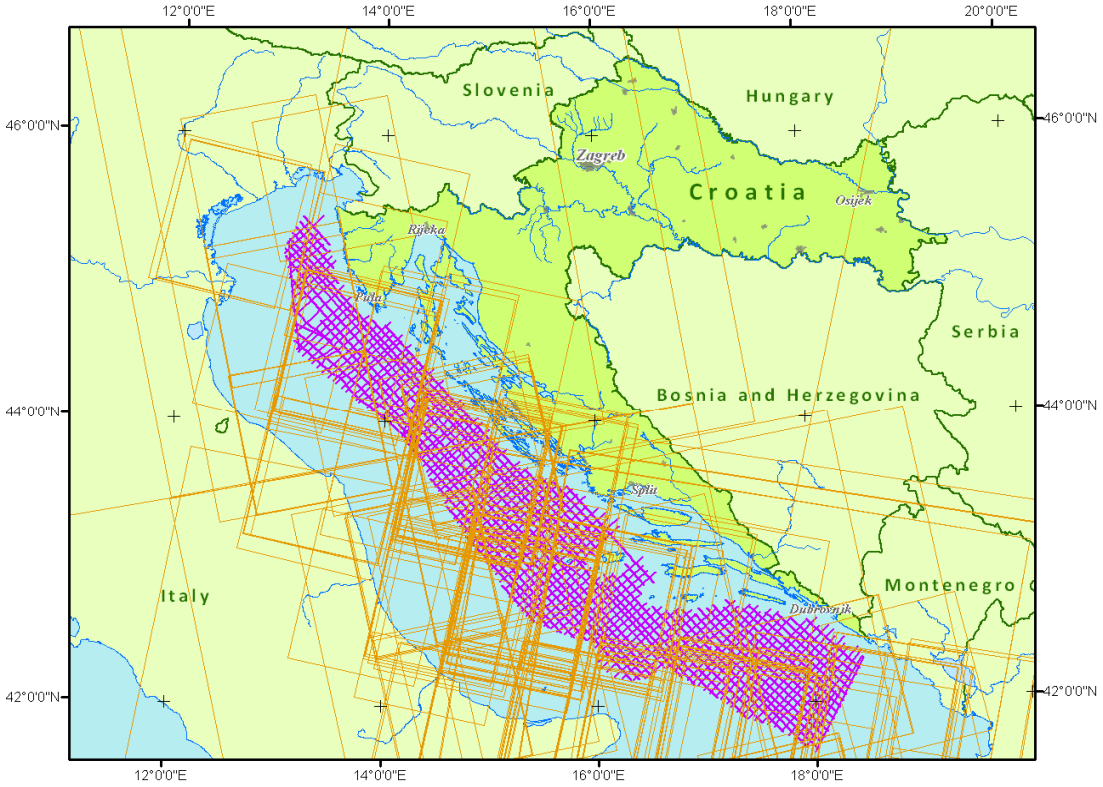
Offshore Seep Mapping - Key Applications

- Screening frontier basins & new exploration licensing rounds
- Seismic planning
- Seismic integration
- Oil spill detection and pollution monitoring
- Planning geochemical sampling programmes
- Environmental baseline

AIRBUS DEFENCE & SPACE

Seep-Seismic Correlation Study

- Joint project with Spectrum to screen 250 new satellite images for slicks and assess against seismic data acquired by Spectrum in 2013
- Timed with the launch of Croatia's first licensing round.



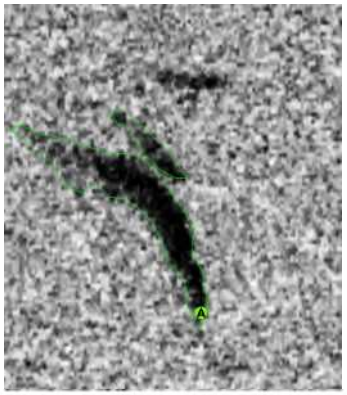
Historical Exploration

Adriatic exploration:

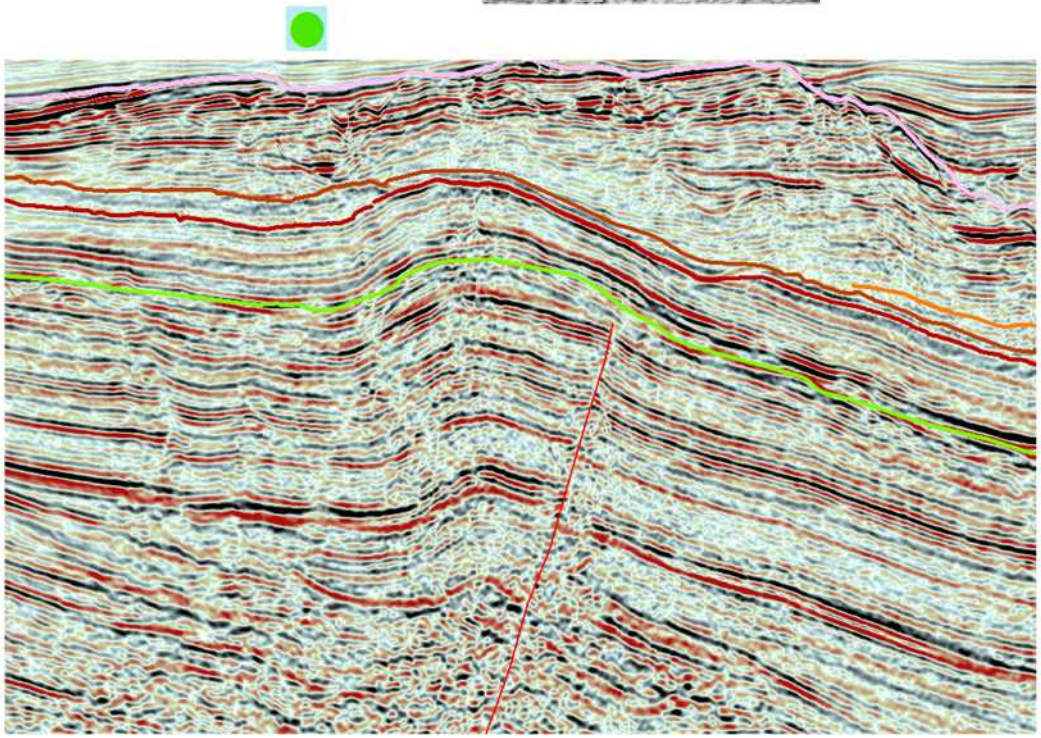
- Significant success in Croatia with shallow dry gas discoveries in the North
- Oil shows in deeper wells in the central and South areas.
- Question:-
  Does Offshore Croatia have
  1. ?Issue with Source / Charge
  2. ?Issue with Reservoir
  3. ?Issue with Structures/Traps

Identification of hydrocarbon seeps helps de-risk the source element;
A key concept for evaluating Adriatic licenses.

Seep-Seismic Correlation Study



- Strong correlation between higher confidence slicks and structural features interpreted on the seismic



- SW Central Basin
- Located directly above major thrust and associated anticline.
- Thrusting provides potential migration pathway from Triassic to upper Sequences.

Offshore Seep Mapping - Key Applications

Screening frontier basins & new exploration licensing rounds

Seismic planning

Seismic integration

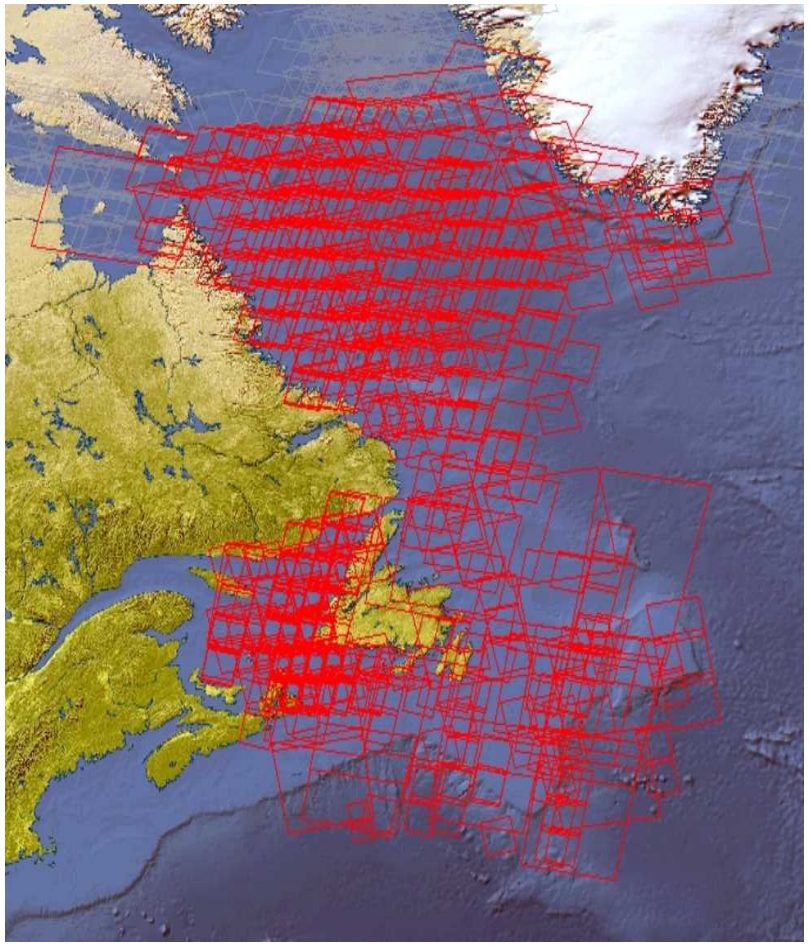
Oil spill detection and pollution monitoring

Planning geochemical sampling programmes

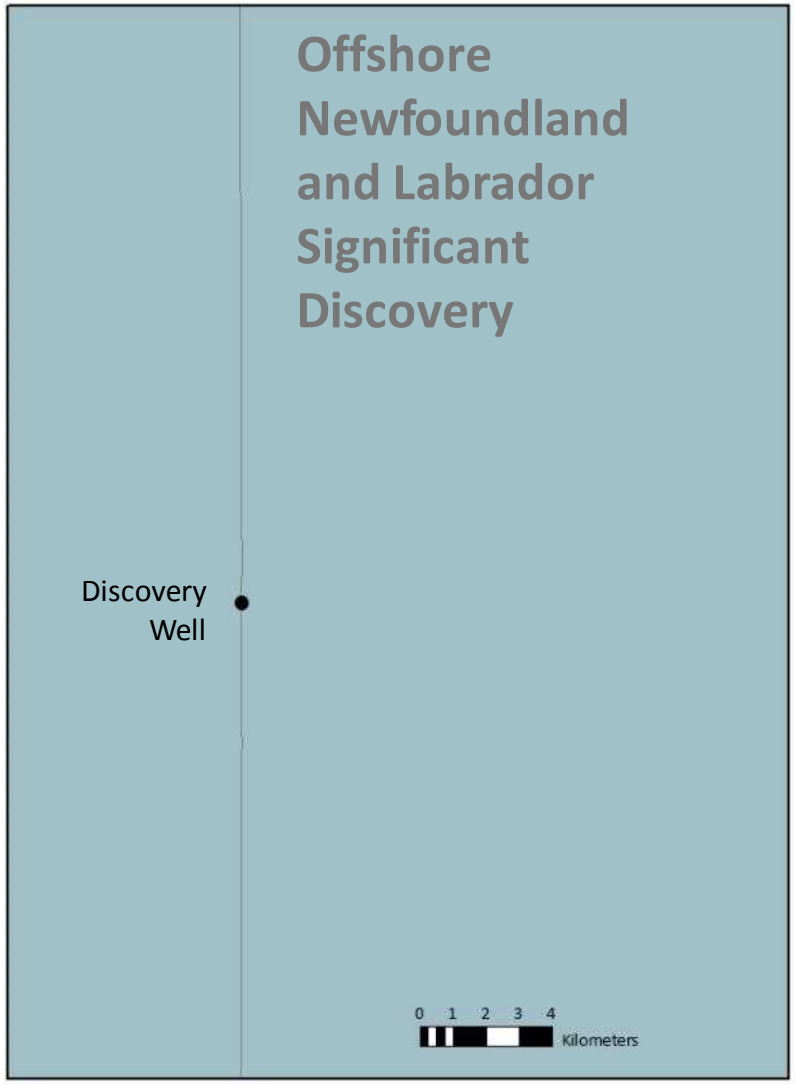
Environmental baseline

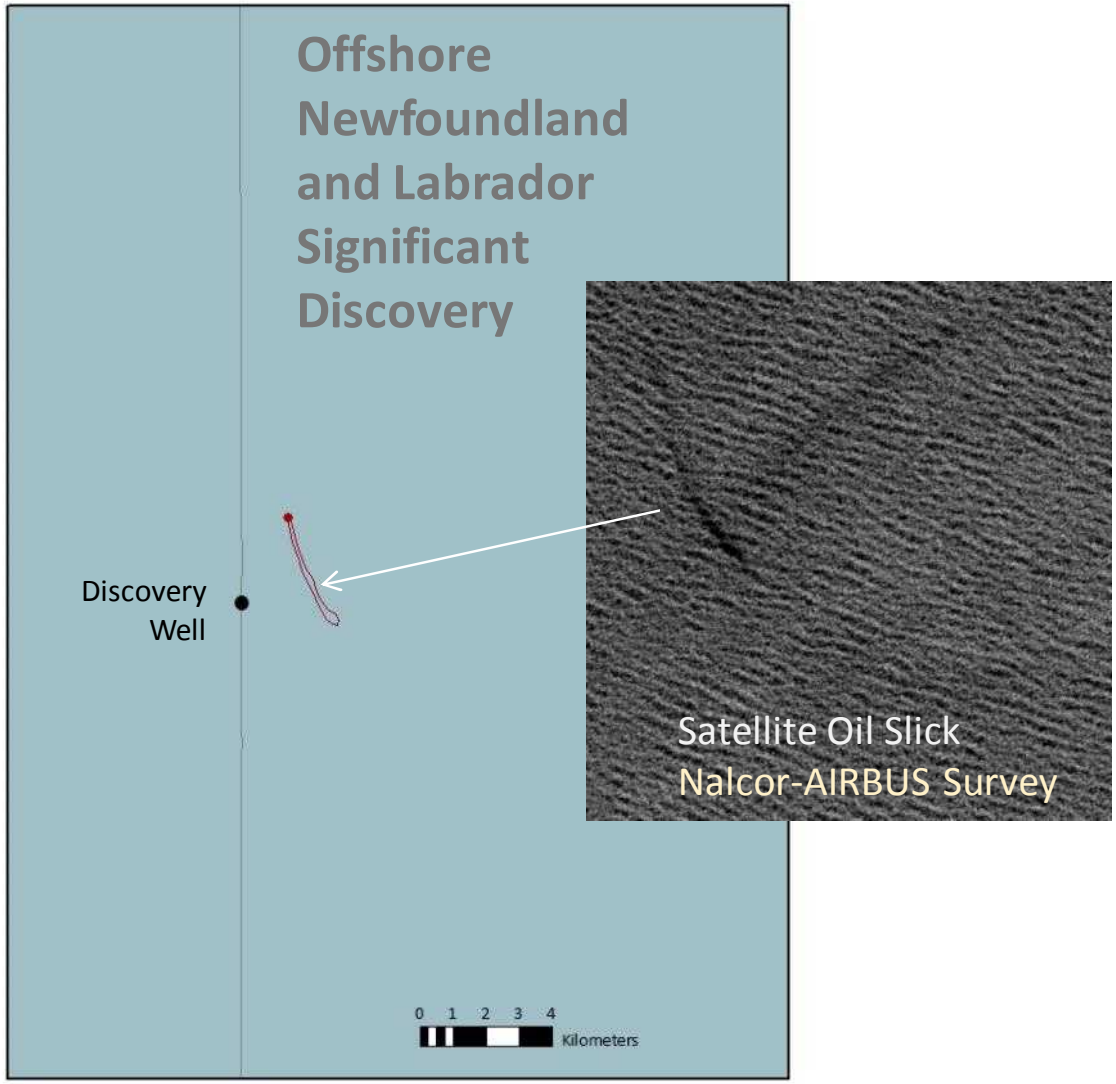
AIRBUS DEFENCE & SPACE

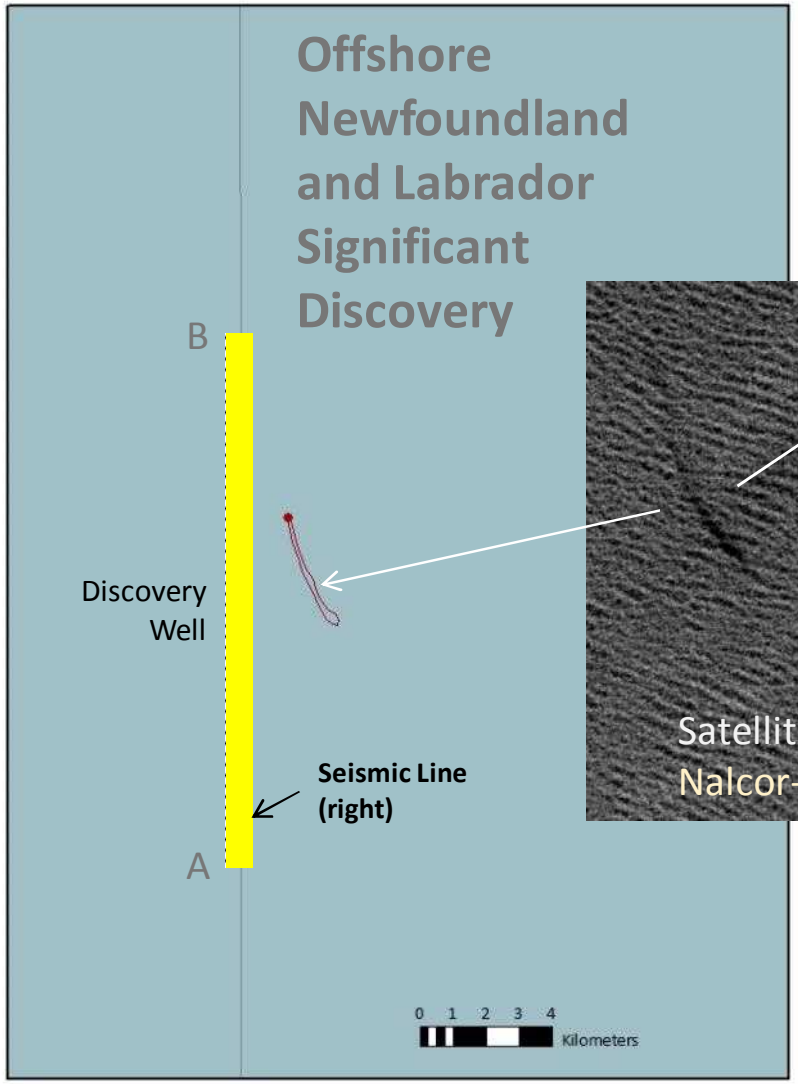
Nalcor ï Airbus Satellite Seeps Project

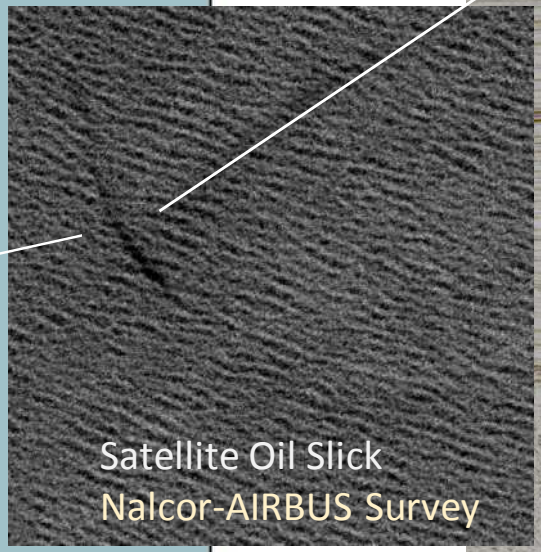


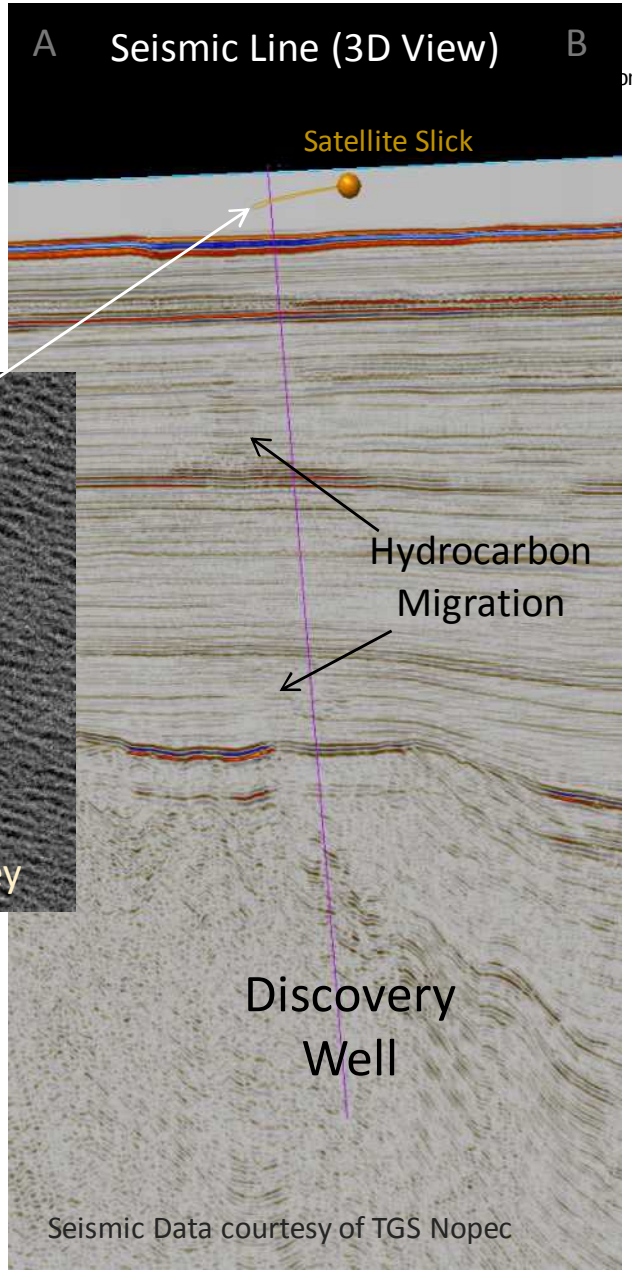
- In preparation for targeting a large scale regional 2D seismic program Newfoundland and Labrador
- Nalcor partnered with Airbus to conduct a satellite oil slick mapping project




Offshore
Newfoundland
and Labrador
Significant
Discovery
Discovery
Well
Satellite Oil Slick
Nalcor-AIRBUS Survey
0 1 2 3 4
Kilometers





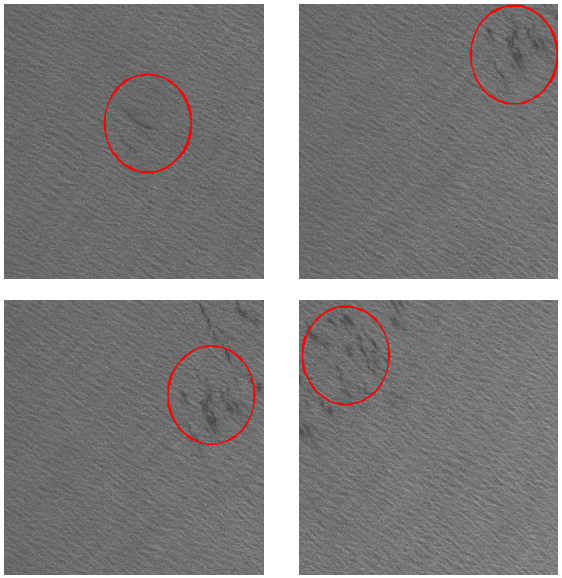


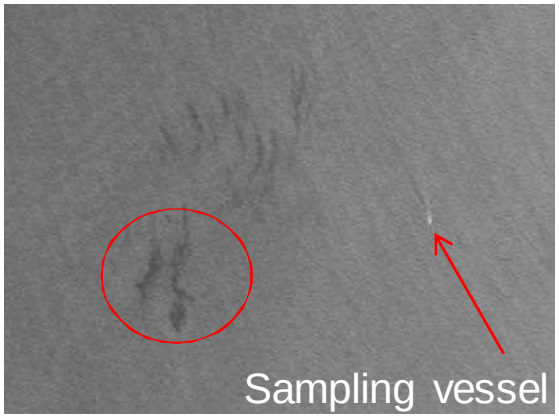
Offshore Seep Mapping - Key Applications

- Screening frontier basins & new exploration licensing rounds
- Seismic planning
- Seismic integration
- Oil spill detection and pollution monitoring
- Planning geochemical sampling programmes
- Environmental baseline

AIRBUS DEFENCE & SPACE

Near Real-Time Slick Mapping and Sampling

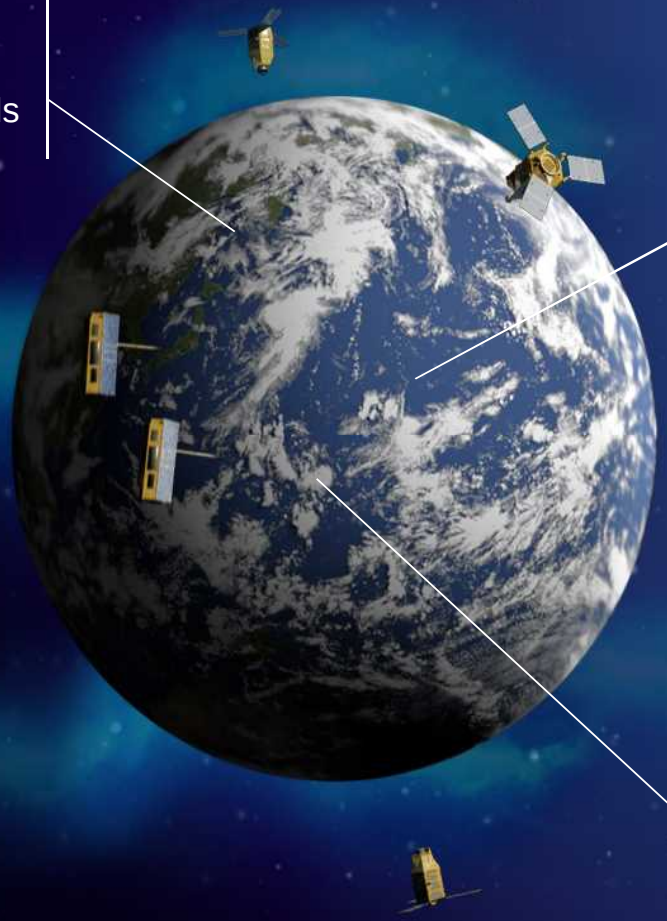




AIRBUS DEFENCE & SPACE

Remote Sensing Technology

Technological advances
Modern capabilities and trends



Onshore Applications for Oil and Gas Exploration

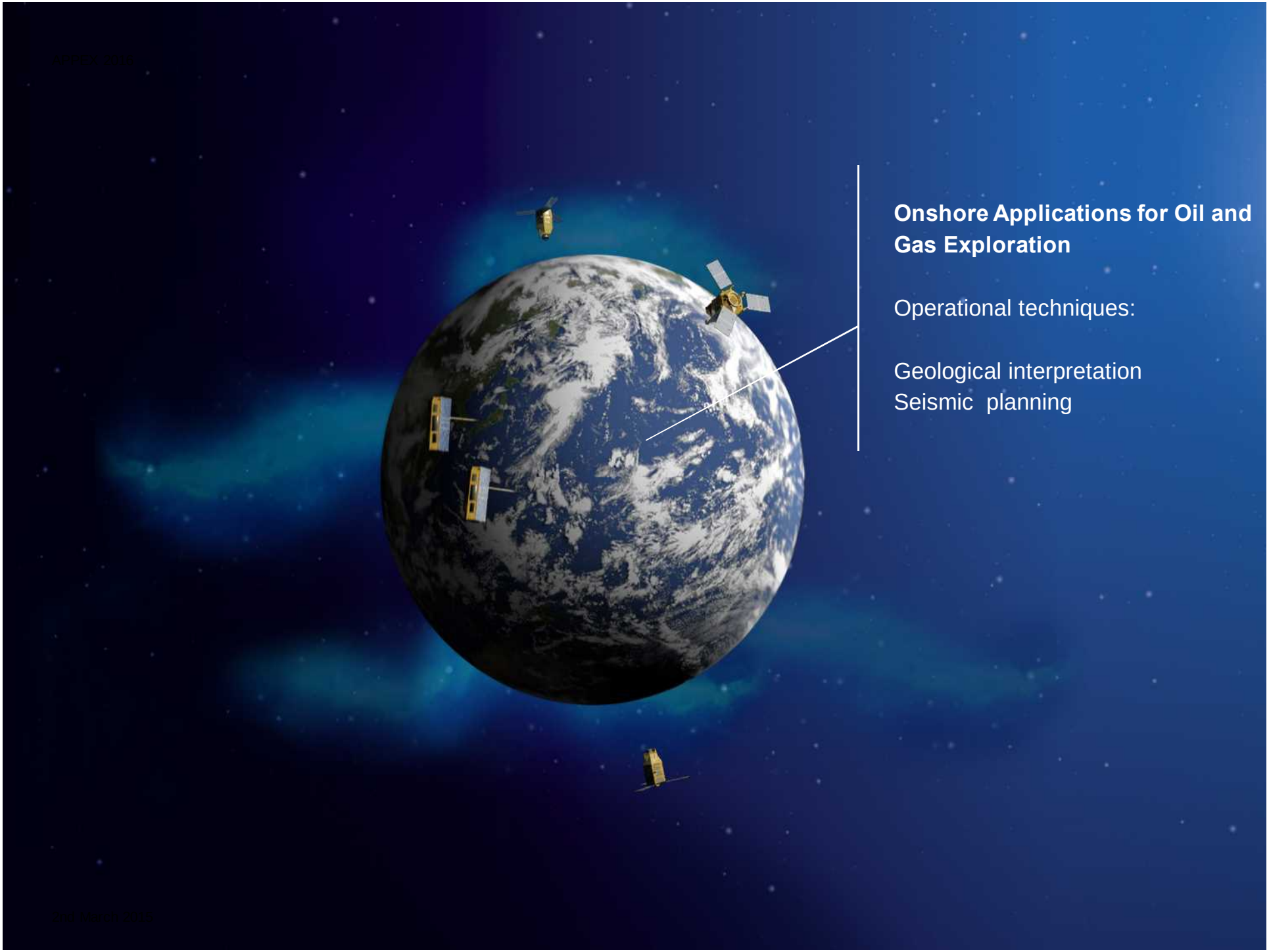
Operational techniques:

Geological interpretation
Seismic planning

Offshore Applications for Oil and Gas Exploration

Operational techniques:

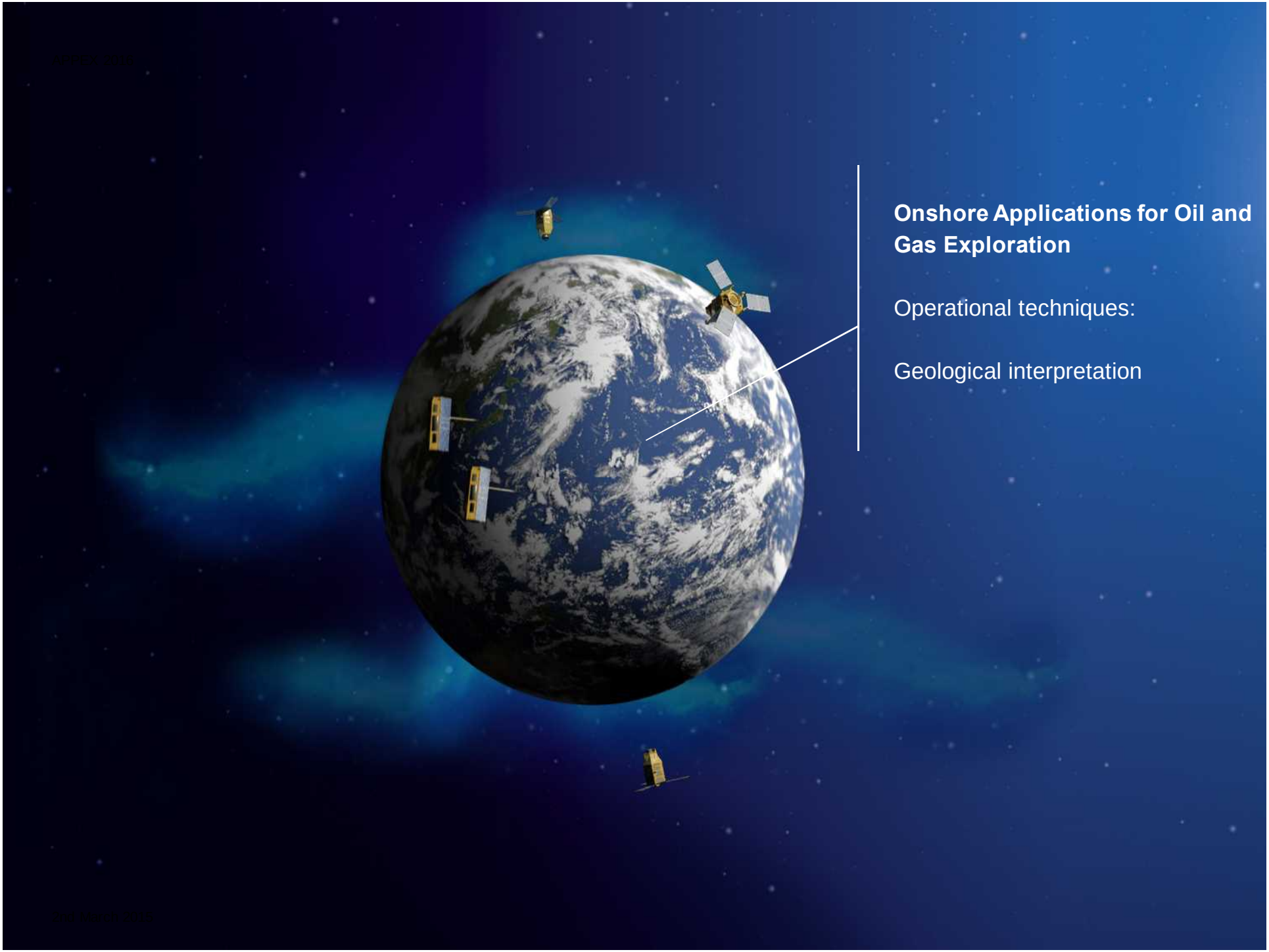
Oil seep screening



Onshore Applications for Oil and Gas Exploration

Operational techniques:

Geological interpretation
Seismic planning



Onshore Applications for Oil and Gas Exploration

Operational techniques:

Geological interpretation

Geological Assessment

Requirement

- Many frontier areas of exploration have a lack of existing surface geological mapping at a suitable scale or accuracy
- Locations may be challenging to access for logistical or security reasons

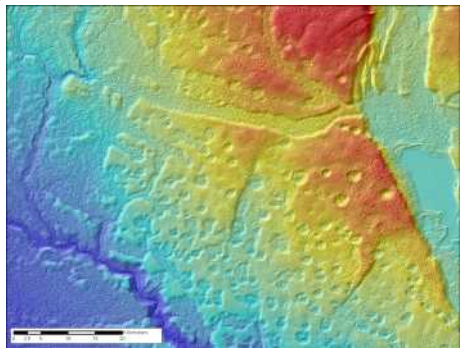
Remote Sensing Contribution

- Rapid regional assessment and appraisal of surface geological structure and stratigraphy
- Detailed studies at the license block scale or regional assessment

AIRBUS DEFENCE & SPACE

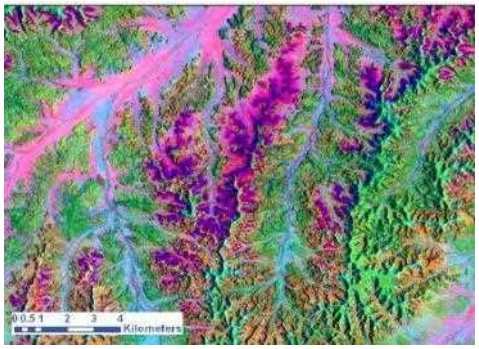
Geological Assessment - Methodology

Earth Observation Data



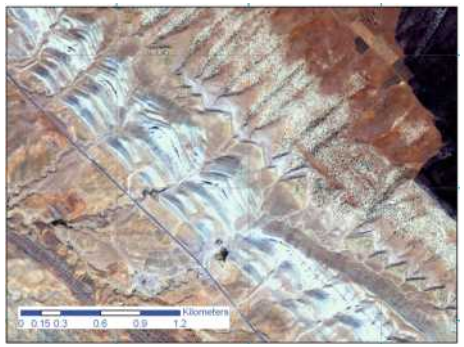
Geomorphology/ drainage patterns

DEM



Spectral response

Multispectral Imagery

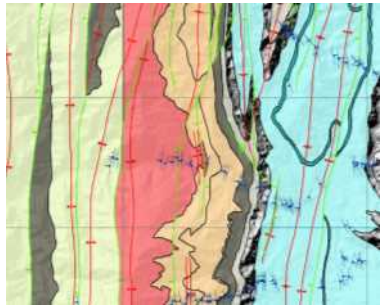


Texture and Detail

VHR Imagery

Supporting Information

Field data



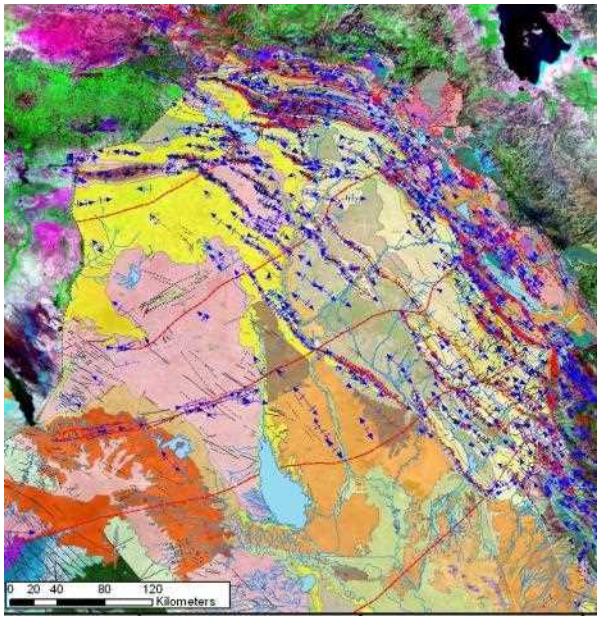
Existing Mapping

GIS integration, analysis and interpretation

AIRBUS DEFENCE & SPACE

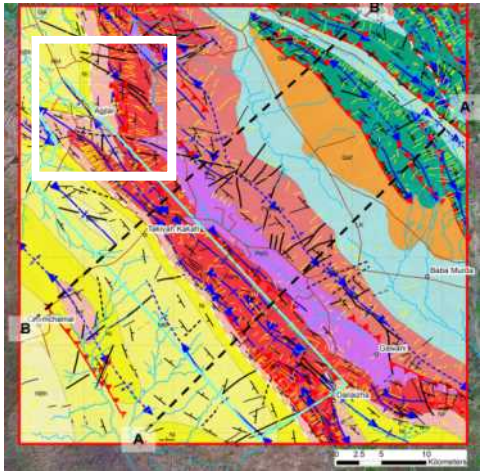
Geological Assessment

Regional → Sub-Regional → Licence Block



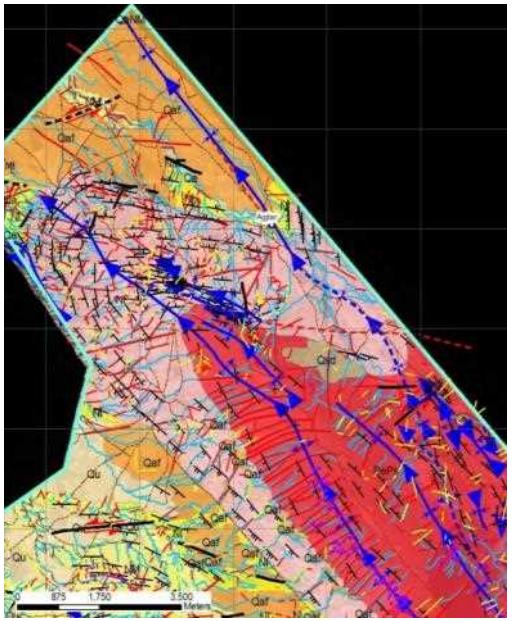
1:50,000 ï 1:100,000

Landsat 15m/SRTM 90m



1:25,000

SPOT 2.5m/Elevation 30



1:10,000

Pleiades 0.5m/ DEM 1m

AIRBUS DEFENCE & SPACE

Remote Sensing Geological Appraisal

Regional

Licence Block

AIRBUS DEFENCE & SPACE

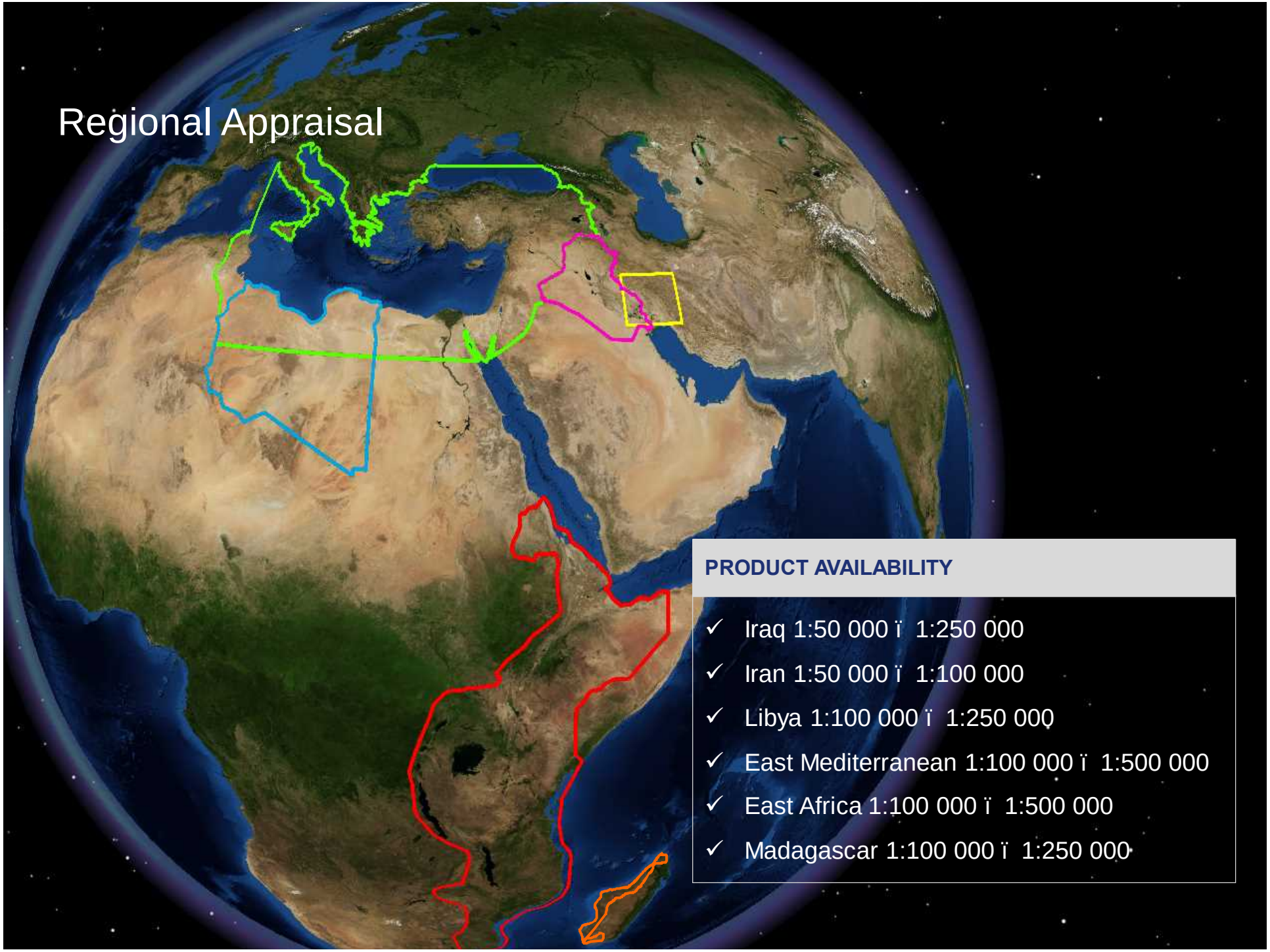
Remote Sensing Geological Appraisal

Regional

Licence Block

AIRBUS DEFENCE & SPACE

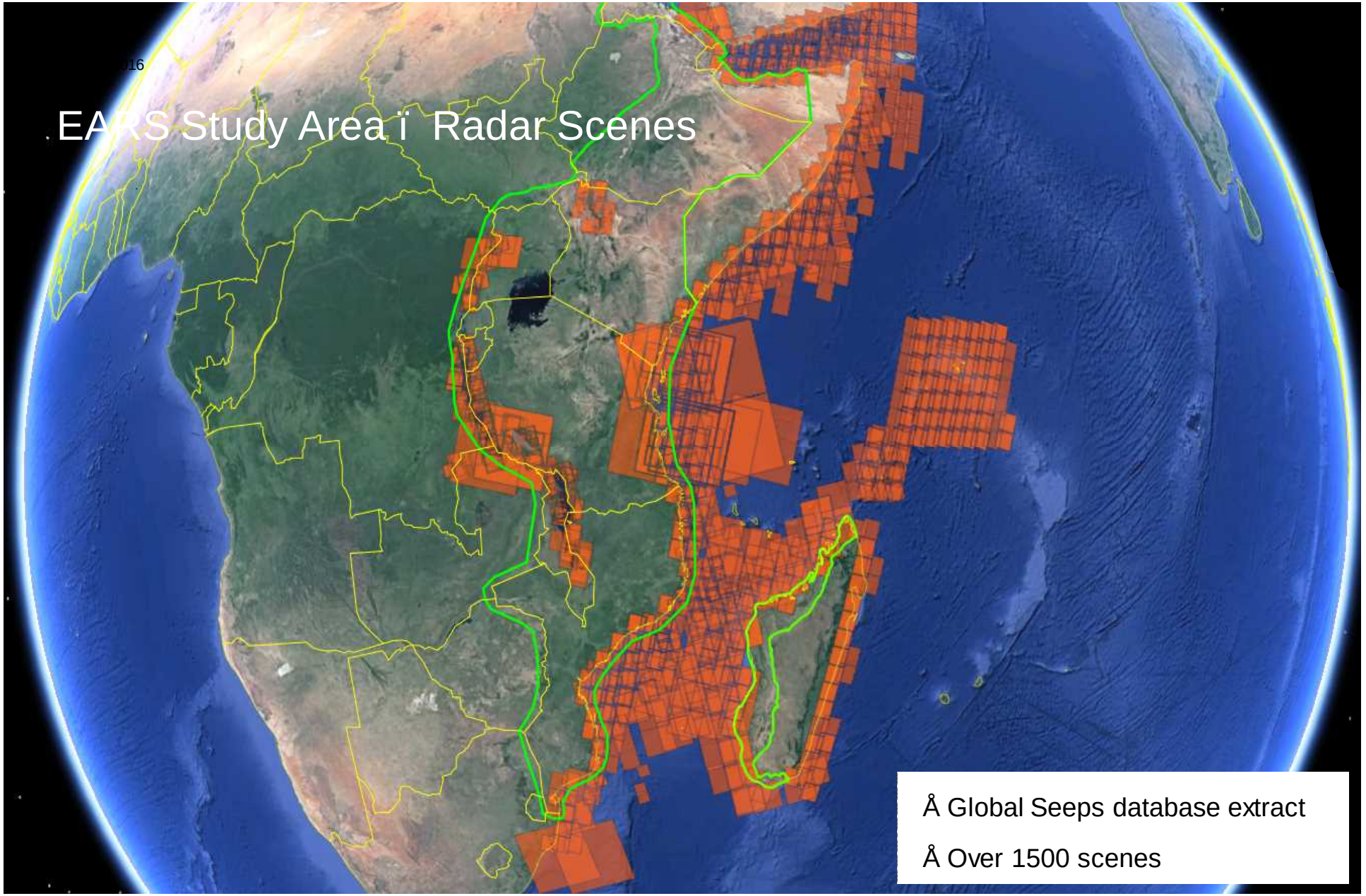
Regional Appraisal



PRODUCT AVAILABILITY

- ✓ Iraq 1:50 000 ï 1:250 000
- ✓ Iran 1:50 000 ï 1:100 000
- ✓ Libya 1:100 000 ï 1:250 000
- ✓ East Mediterranean 1:100 000 ï 1:500 000
- ✓ East Africa 1:100 000 ï 1:500 000
- ✓ Madagascar 1:100 000 ï 1:250 000

EARS Study Area ï Radar Scenes

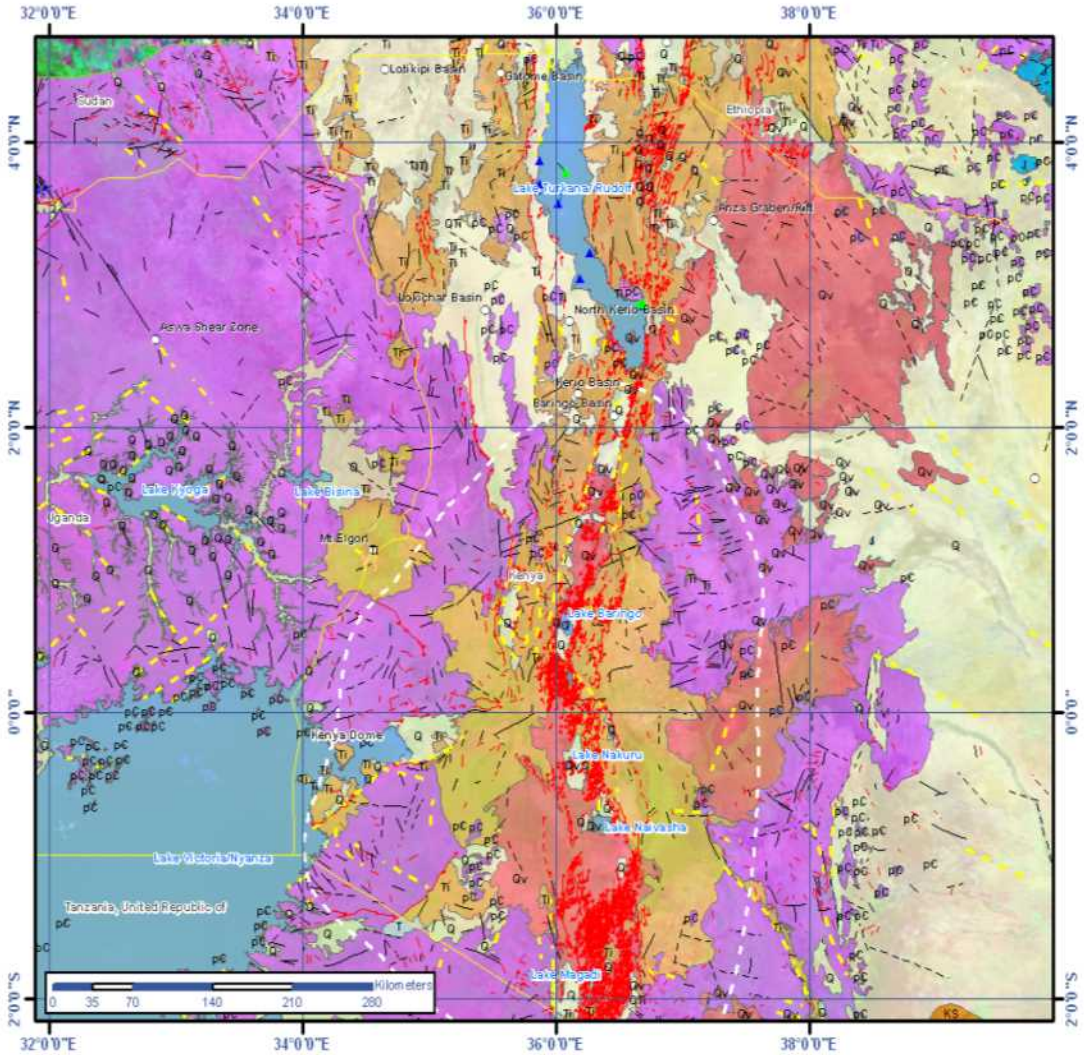


Å Global Seeps database extract

Å Over 1500 scenes

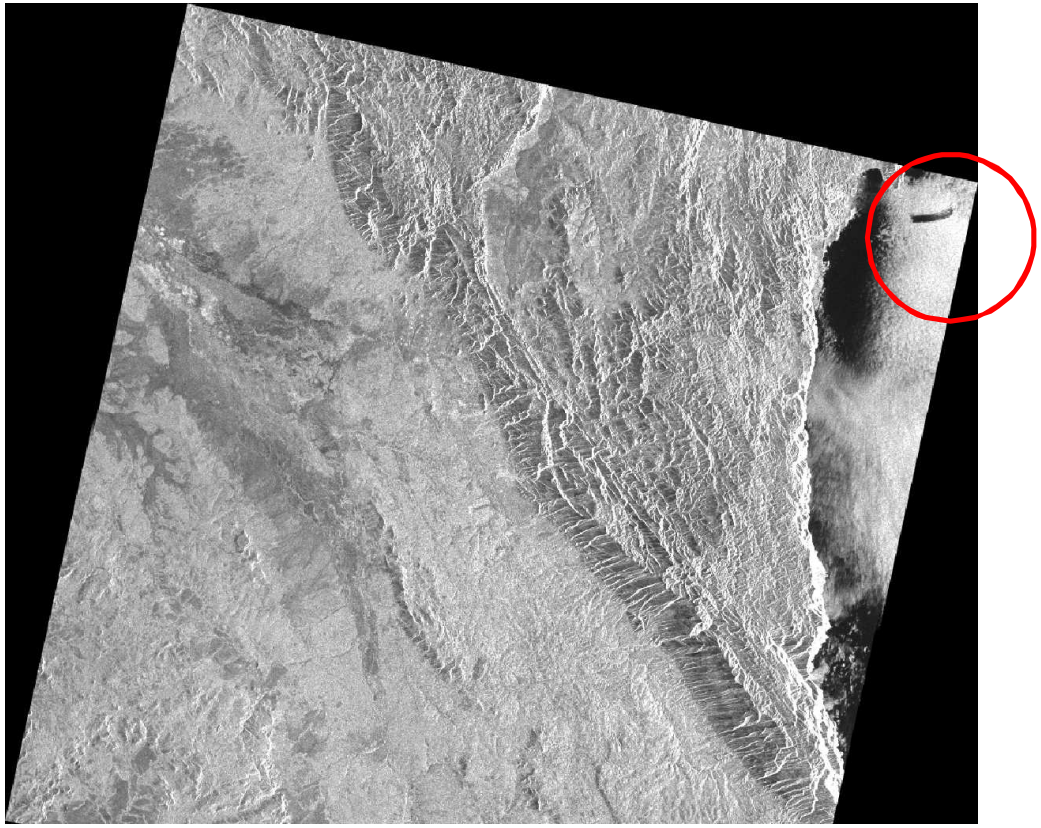
AIRBUS DEFENCE & SPACE

Lake Turkana ï Interpretation Example



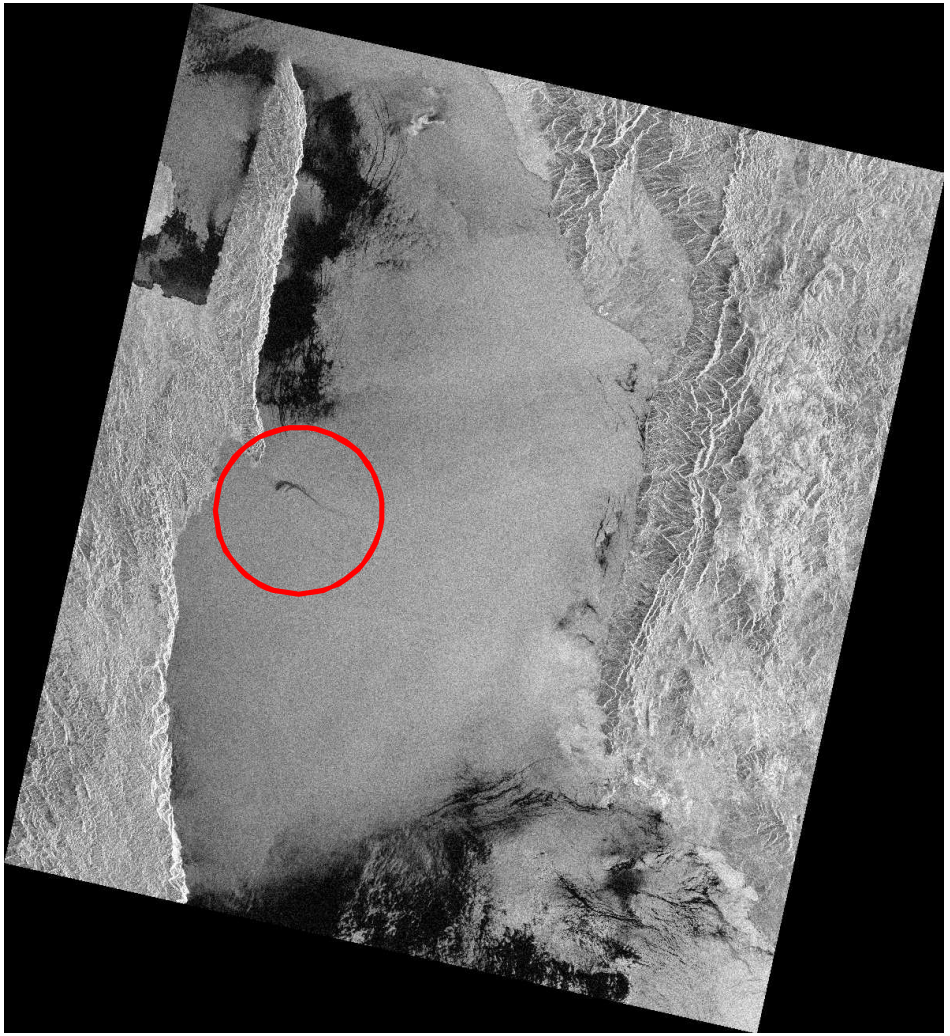
AIRBUS DEFENCE & SPACE

Lake Tanganyika Repeating High Confidence Seep



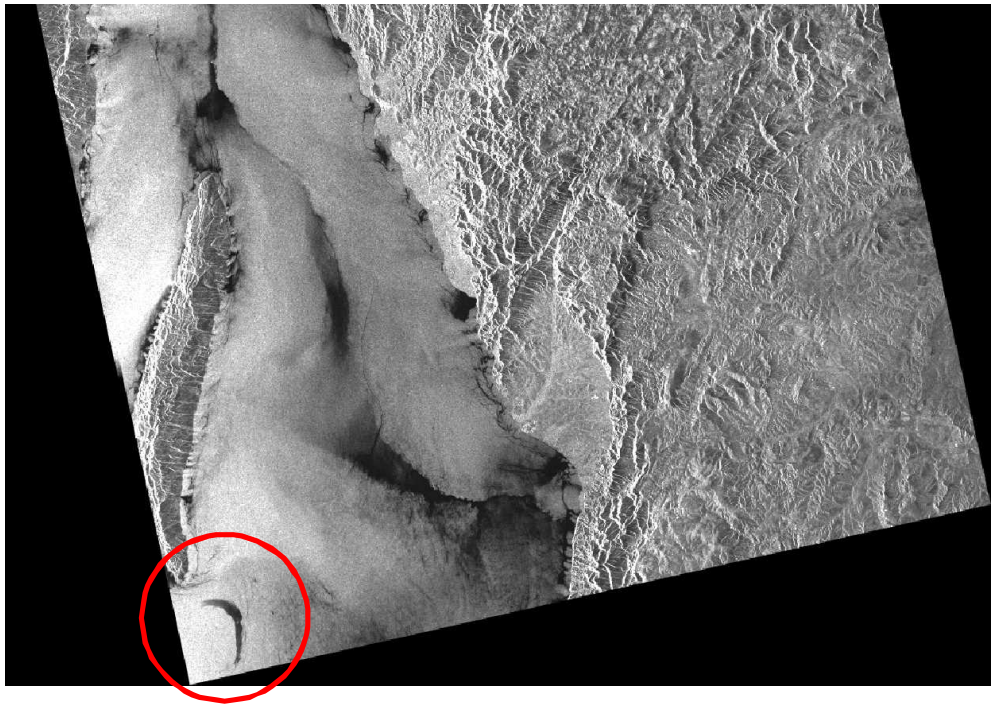
AIRBUS DEFENCE & SPACE

Lake Tanganyika Repeating High Confidence Seep



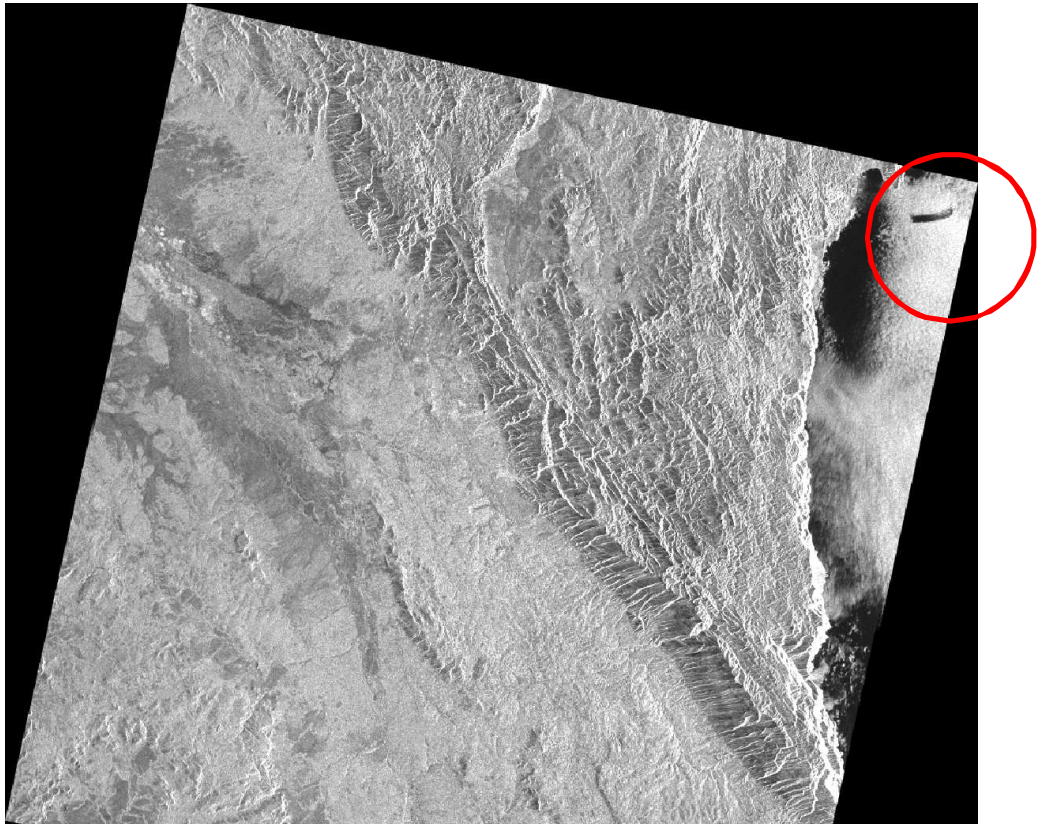
AIRBUS DEFENCE & SPACE

Lake Tanganyika Repeating High Confidence Seep



AIRBUS DEFENCE & SPACE

Lake Tanganyika Repeating High Confidence Seep



AIRBUS DEFENCE & SPACE

Remote Sensing Geological Appraisal

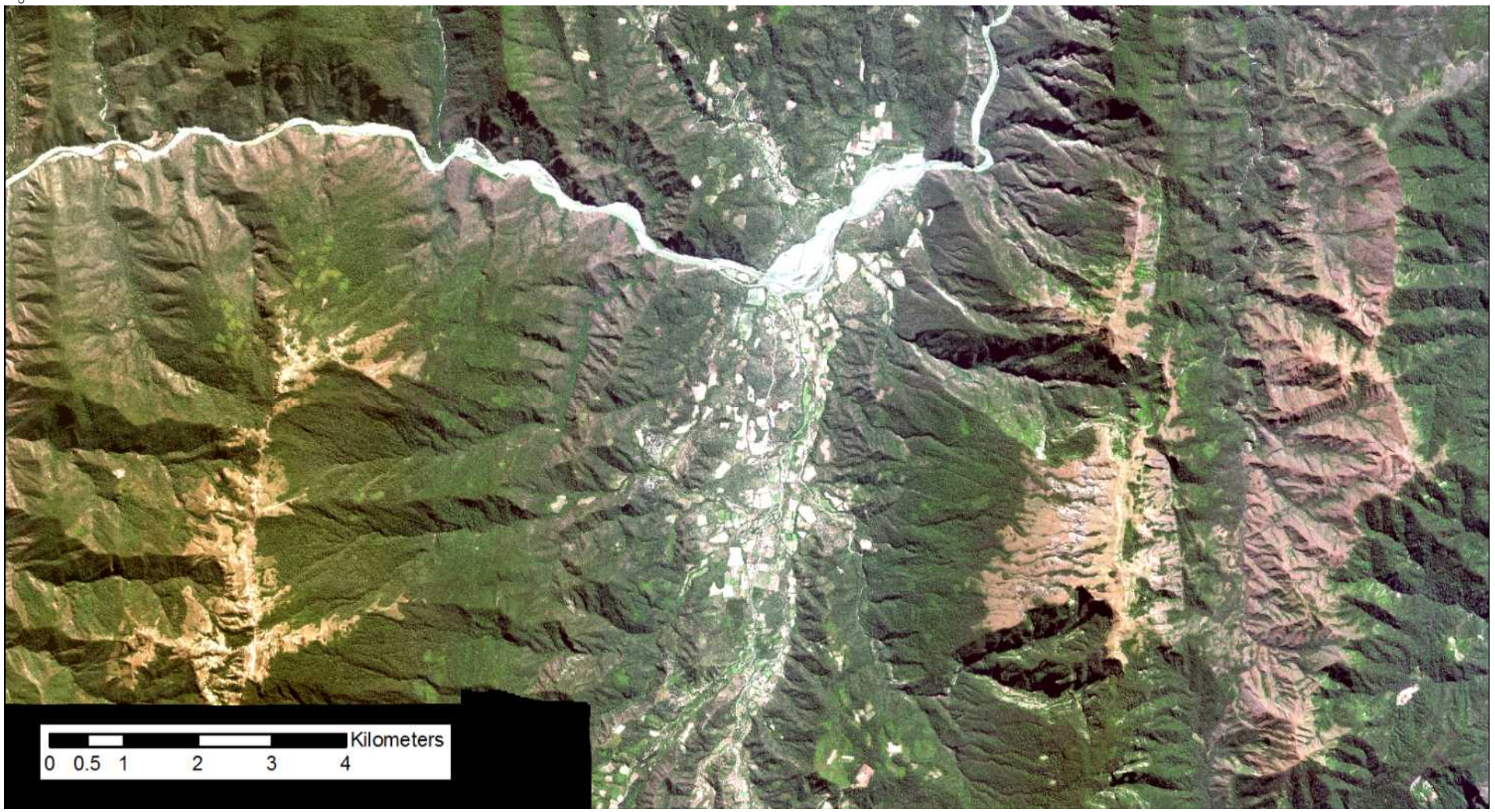
Regional

Licence Block

AIRBUS DEFENCE & SPACE

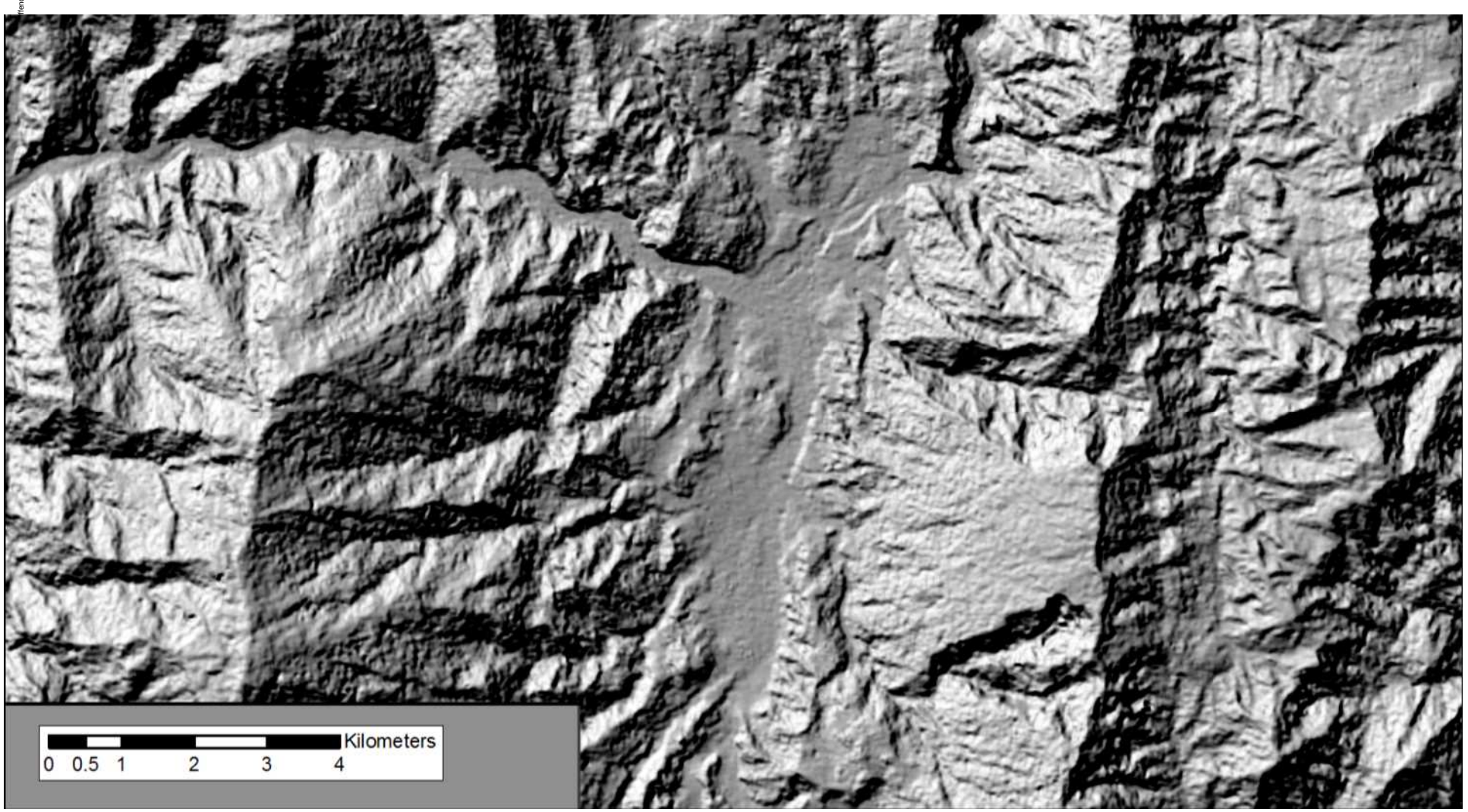
High Resolution Imagery

Offenders



AIRBUS DEFENCE & SPACE

Remote Sensing Derived Elevation Data



AIRBUS DEFENCE & SPACE

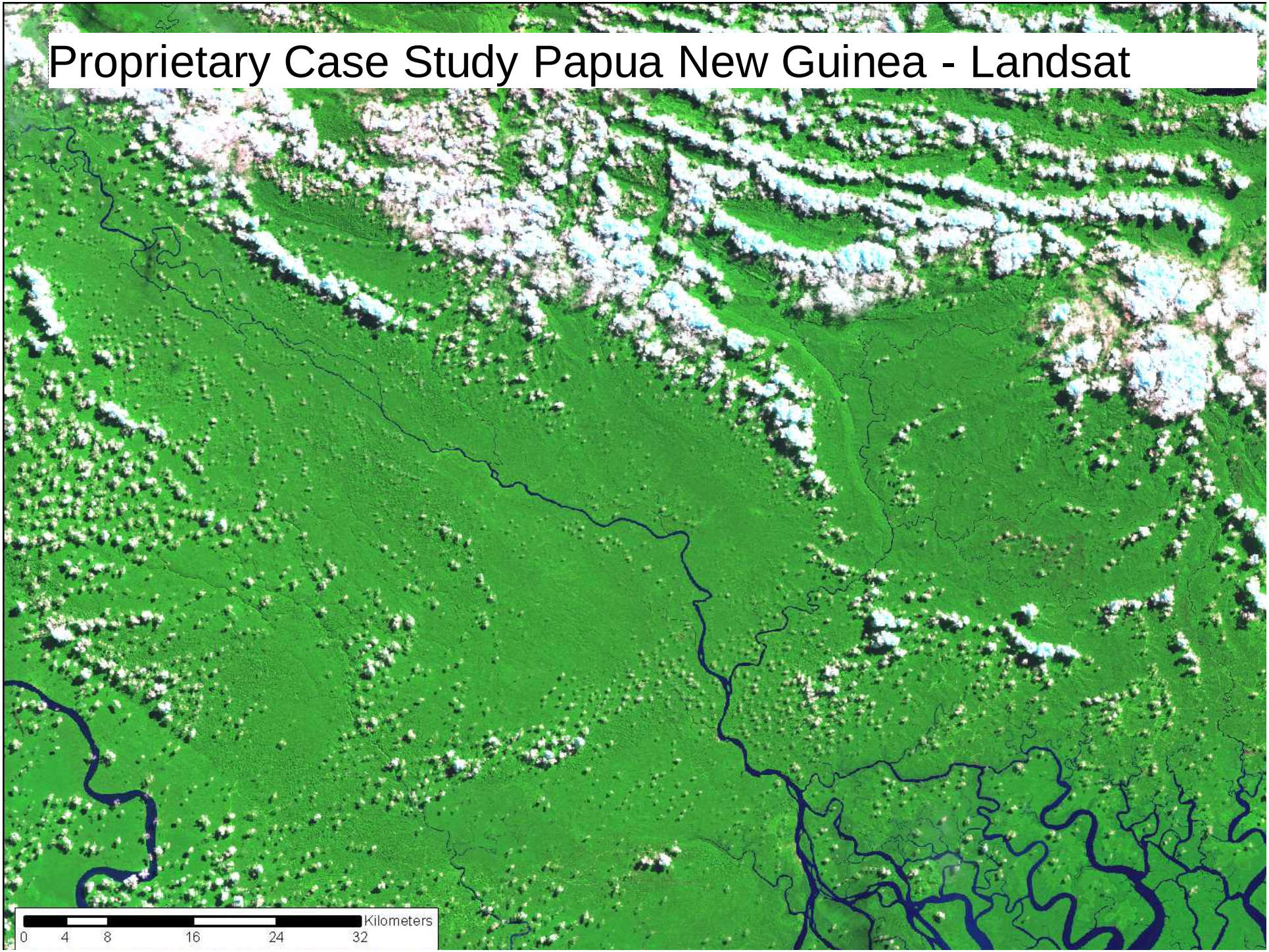
Remote Sensing Geological Appraisal

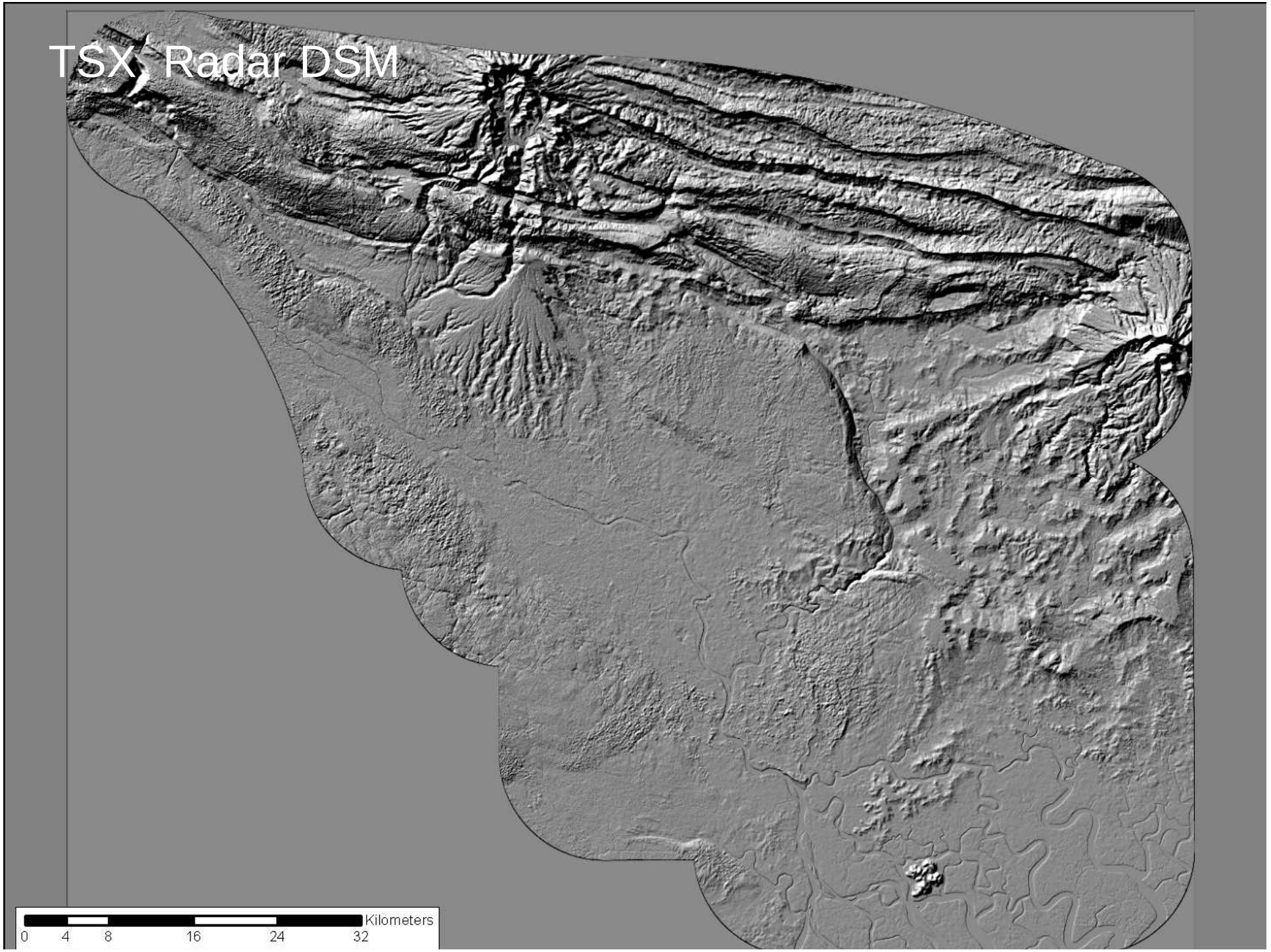
Regional

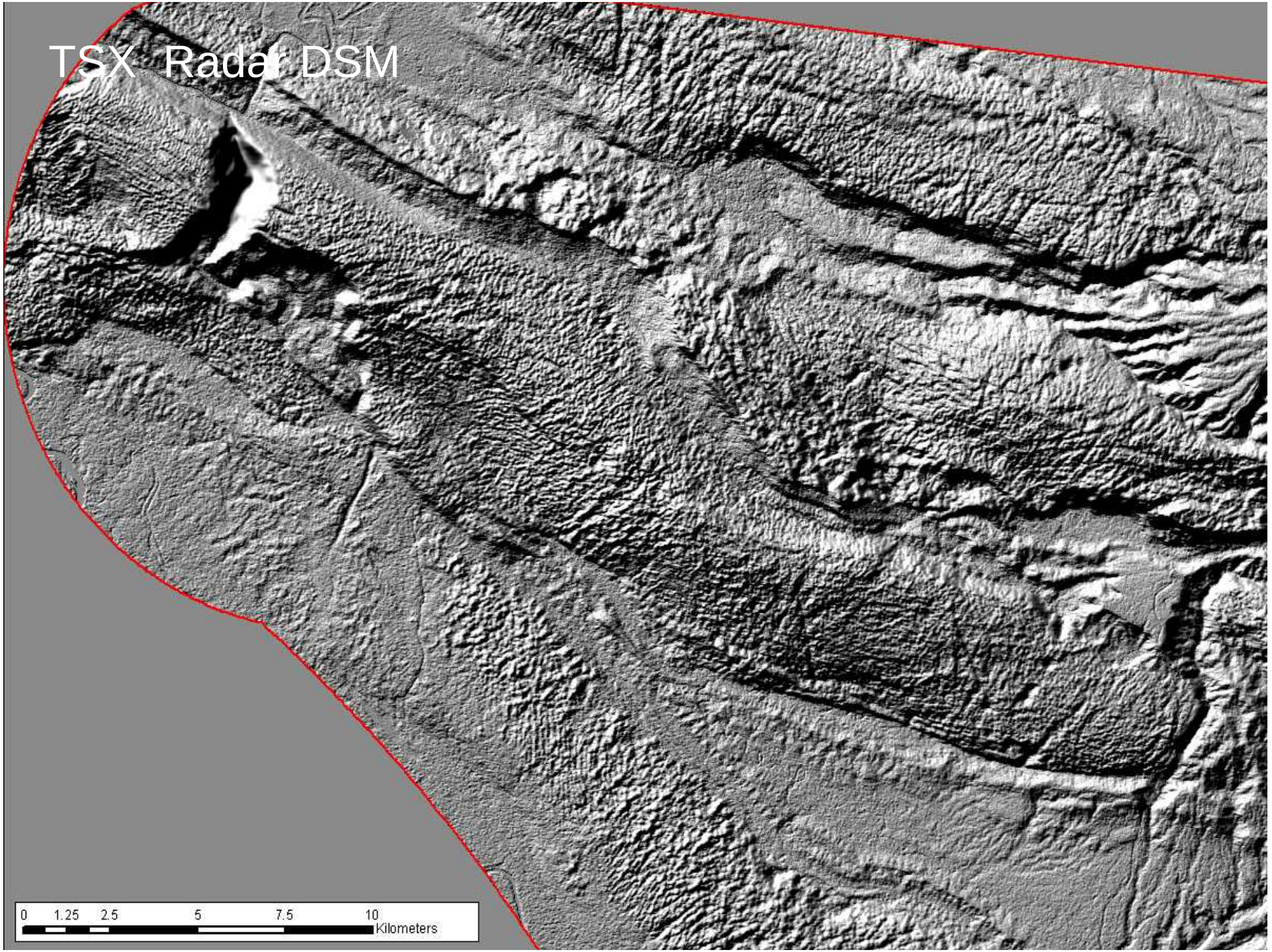
Licence Block

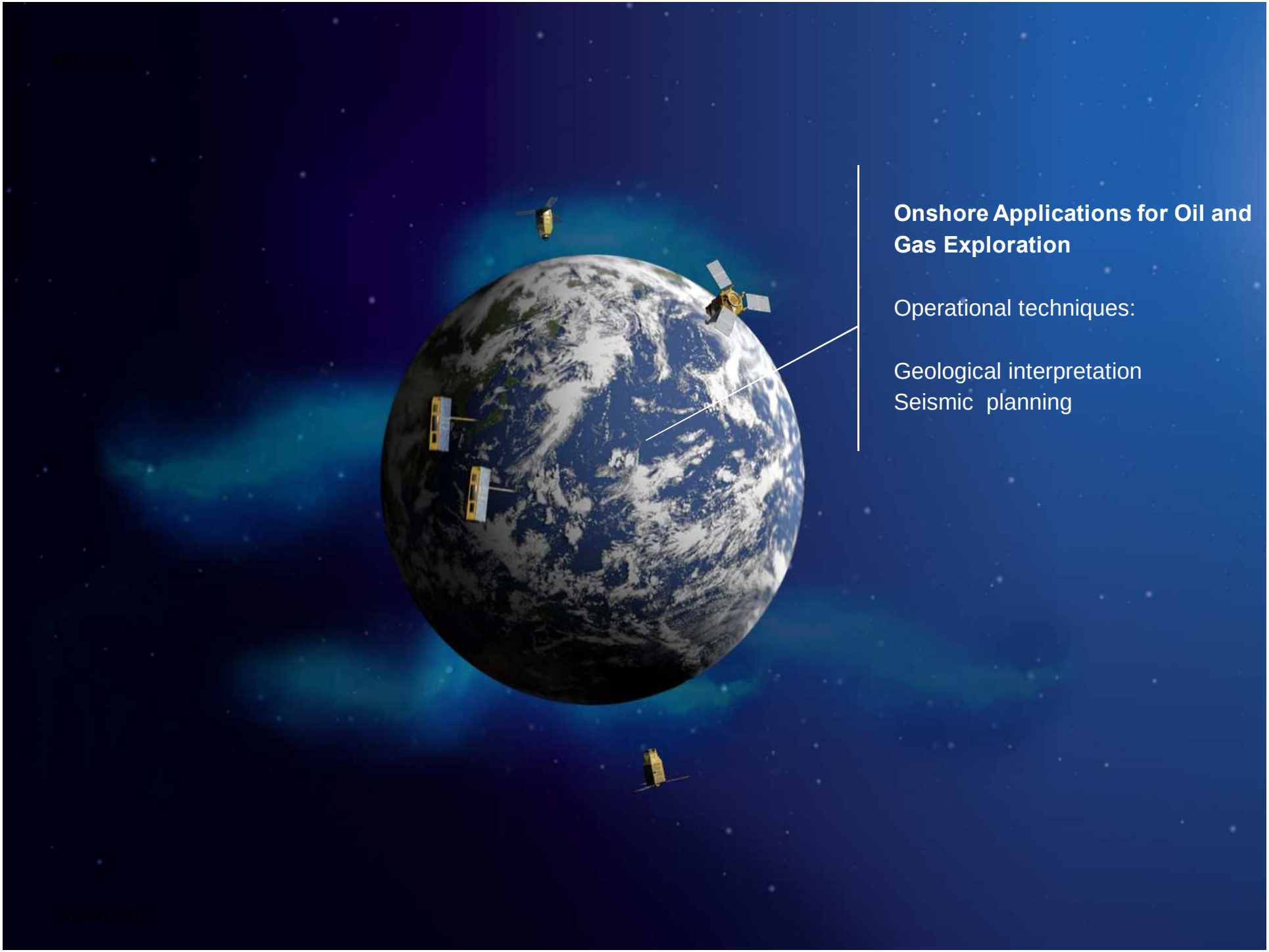
AIRBUS DEFENCE & SPACE

Proprietary Case Study Papua New Guinea - Landsat




TSX Radar DSM
Kilometers
0 4 8 16 24 32

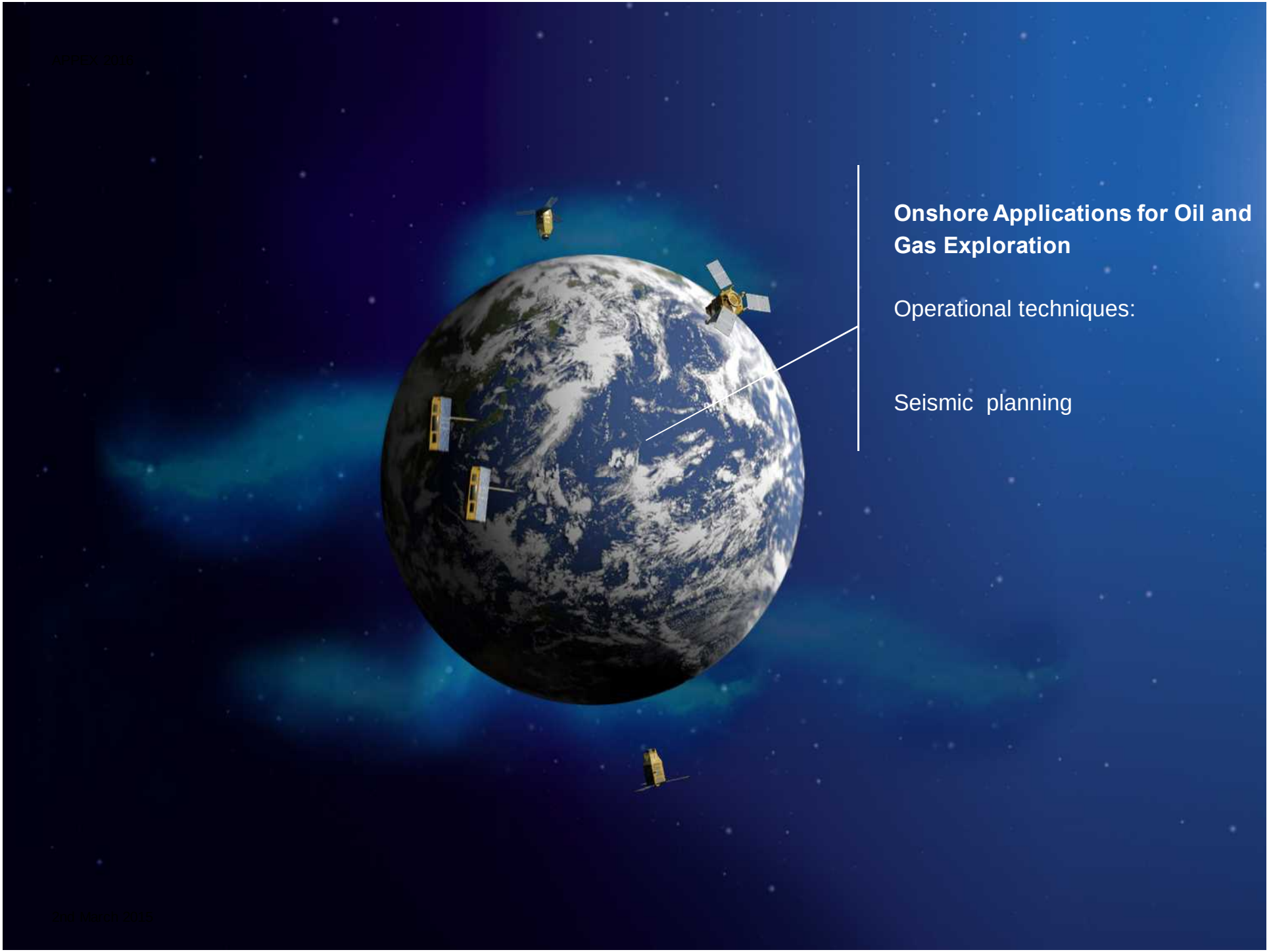

TSX Radar DSM
0 1.25 2.5 5 7.5 10
Kilometers



Onshore Applications for Oil and Gas Exploration

Operational techniques:

Geological interpretation
Seismic planning



Onshore Applications for Oil and Gas Exploration

Operational techniques:

Seismic planning

Seismic Planning / Well location Planning

Requirement

- Seismic acquisition planning is influenced by:
  - Ground conditions
  - Slope
  - Natural hazards
  - Landcover
  - Geology
- Often a lack of suitable information to make informed decisions

EO Approach

- DEM
- Satellite imagery for classification
- GIS analysis to model between derived layers

Benefits

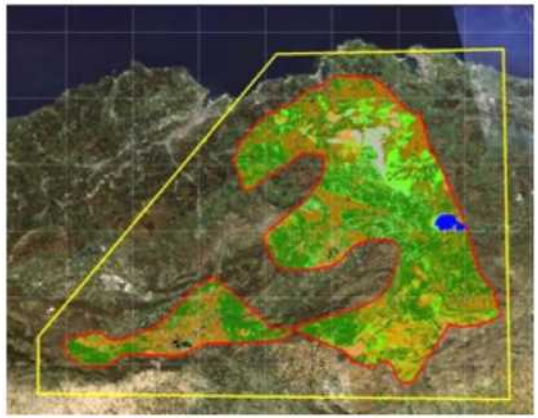
- Efficient planning
- Minimise local community impact
- Reduction in risk to personnel/equipment

AIRBUS DEFENCE & SPACE

Regional Terrain Evaluation ï Seismic Planning

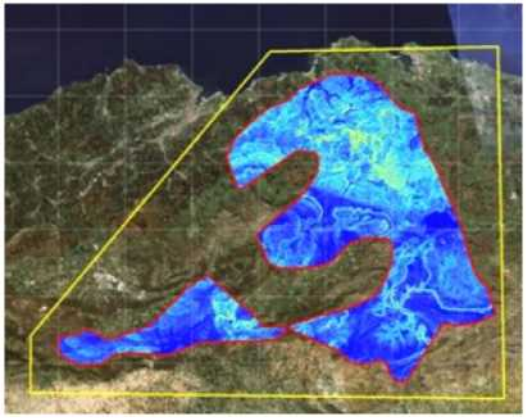
Å Regional terrain evaluation for seismic planning / well location feasibility

Landcover class



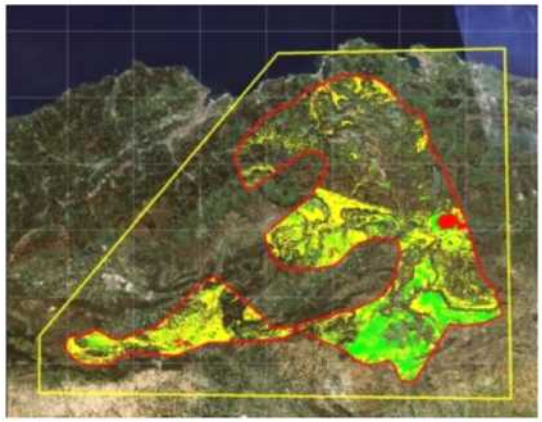
Agriculture
Bare Ground
Forest
Grass
Scrub
Settlement
Water

Slope thresholds



Slope

Accessible areas



Go
No Go Secondary
No Go Primary

AIRBUS DEFENCE & SPACE

Thank You