



Australian Government

Geoscience Australia



# CEOS Analysis Ready Data

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# Background

*CEOS Future Data Architectures (FDA) Report*: examined the changing landscape and context for CEOS agency EO programs and how they service user communities

Common concern raised by many CEOS agencies was the need for simplification of data handling and uptake by users

*One solution*: Pursuit of CEOS standards for Analysis Ready Data (ARD), as part of a broader CEOS ARD strategy

**ARD products are intended to be accessible and suitable for a wide range of users for a wide variety of applications ... but may not be suitable for all purposes, and are not intended as a 'replacement' for other types of satellite products**

# CEOS ARD strategy components

Activities foreseen in a successful strategy on ARD for CEOS:

- Thematic product families (CARD4L is the first)
- ARD stocktake and outlook (user investment confidence)
- Technical specification development and maintenance
- Pilots and feedback
- Promotion

# CEOS ARD for Land – CARD4L

LSI-VC served as the forum for developing the CEOS Analysis-Ready Data definition (now known as CARD4L – CEOS Analysis-Ready Data for Land)

The CARD4L definition and the overall framework were endorsed at the CEOS Plenary in 2016

CARD4L underpins future data architectures work being progressed within CEOS, enabling many users to more rapidly use data and help space agencies to maximise the potential of their data.

Work on ARD standards across CEOS has kicked-off with the development of the Product Family Specification for 3 initial products under CARD4L:

- Surface Reflectance (optical);
- Surface Temperature (thermal);
- Backscatter (Synthetic Aperture Radar)
- Future SAR: Interferometric, Polarimetric & others..

# CARD4L framework components

Three components: Definition, Product Family Specifications, and Product Alignment Assessment

‘Threshold’ and ‘Target’ requirements for candidate products in the Product family include:

- General metadata
- Per-pixel metadata
- Radiometric and atmospheric correction
- Geometric correction

CARD4L specifications for three initial products have been reviewed by expert community groups, and endorsed at LSI-VC7 (Feb 2019)

 Committee on Earth Observation Satellites	<b>Analysis Ready Data For Land</b>	Product Family Specification Optical Surface Reflectance (CARD4L-OSR)
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## Document Status

### Product Family Specification, Surface Reflectance

This Specification should next be reviewed on: December 2019

Proposed revisions may be provided to: [lsi@lists.ceos.org](mailto:lsi@lists.ceos.org)

## Document History

Version	Date	Description of Change	Author
0.0.2	01-03-2017	Zero Draft translating previous materials to this format. With many thanks to all CEOS contributors.	Ross
1.0.0	16-04-2017	Included document history; added numbering and pagination to improve navigability and internal referencing of sections; Added Guidance Section: <ul style="list-style-type: none"><li>- various minor edits</li><li>- revised 1.4 'target'</li><li>- 1.7, 1.8, 1.9 may need revisiting</li><li>- Added 3.1, measurement</li><li>- Added 3.2, uncertainty</li><li>- Added 2.10, terrain occlusion</li></ul>	Lewis
2.0.0	30-08-2017	Feedback incorporated, circulated to LSI-VC	Lewis
2.1.0	06-09-2017	Feedback from ESA incorporated and comments noted on 1.11, 1.12, 1.8; 1.15; 1.17; 3.6-3.8; 4.1. Tracked changes rolled in.	Lewis
2.1.1	06-09-2017	Edits.	Lewis
2.1.2	11-11-2017	Edits.	Lewis
3.0	22.01.2018	Feedback from the teleconference (06/12/2018) and post teleconference (emails) included.	Siqueira
3.1	31.01.2019	Proposed final SR PFS draft shared with USGS, ESA, and GA self-assessment leads seeking further comments. The draft addressed the feedback provided by the agencies' ARD data self-assessment process.	Siqueira
3.1.1	06.02.2019	Final draft shared with LSI-VC list and LSI-VC-7 meeting participants seeking support for document endorsement at the LSI-VC-7.	Siqueira
3.1.1	22.02.2019	Comments and suggestions from LSI-VC-7 meeting (minutes) and feedback from USGS incorporated.	Siqueira
3.1.2	28.02.2019	Formatting and verbiage updated for consistency.	Mertzger
4.0	02.03.2019	Version endorsed at LSI-VC7 meeting (14Feb 2019)	LSI-VC

# CEOS ARD for Land (CARD4L)

## Product Family Specifications

### Surface Reflectance

Data collected with multispectral sensors operating in the VIS/NIR/SWIR wavelengths. These typically operate with ground sample distance and resolution in the order 10-100m however the Specification is not inherently limited to this resolution.

[Read Product Family Specification >>](#)

### Surface Temperature

Data collected with multispectral sensors operating in the thermal infra-red (TIR) wavelengths. These typically operate with ground sample distance and resolution in the order 10-100m.

[Read Product Family Specification >>](#)

### Radar Backscatter

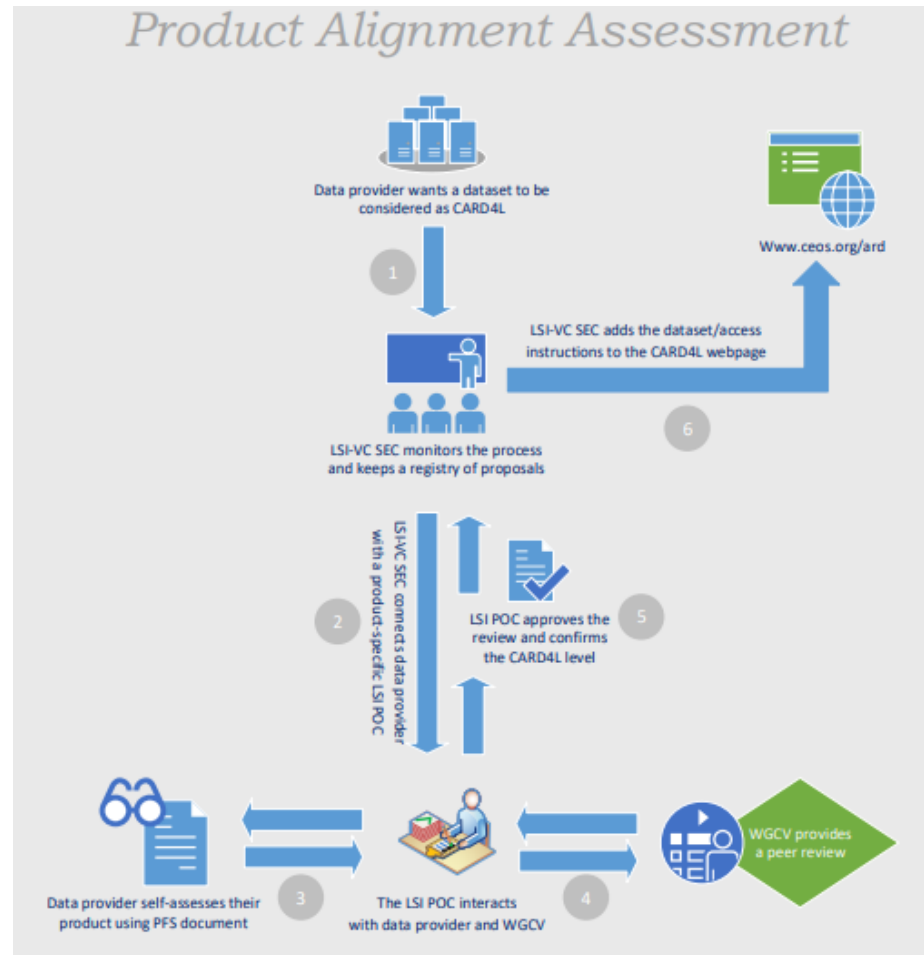
Data collected by Synthetic Aperture Radar (SAR) sensors.

[Read Product Family Specification >>](#)

[ceos.org/ard](https://ceos.org/ard)

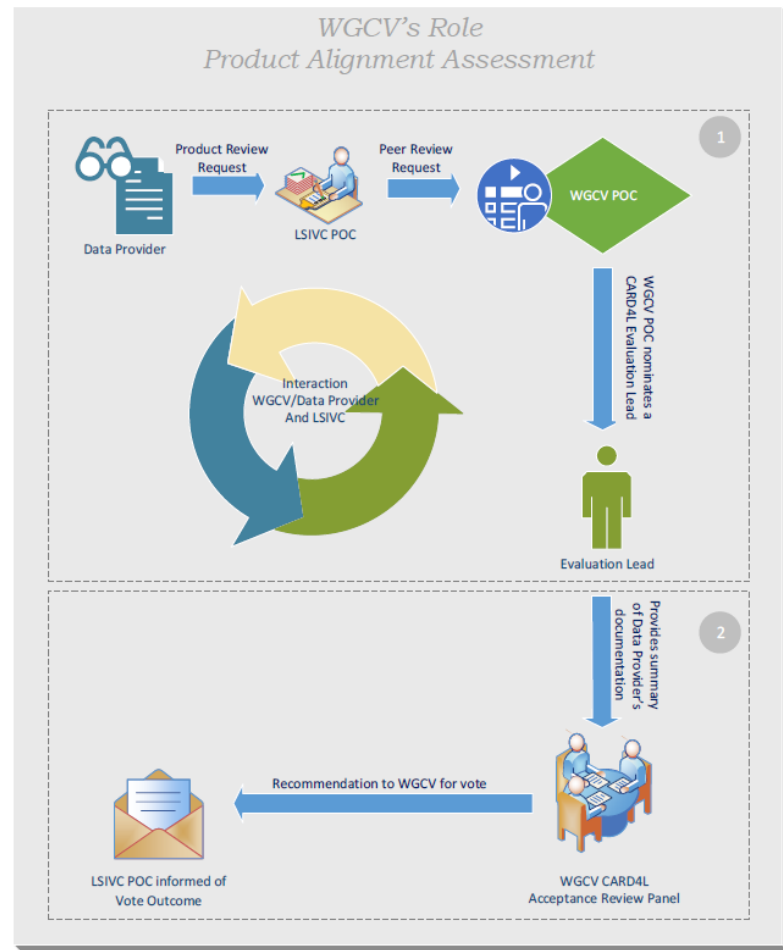
# CARD4L product alignment assessment

- A process to assess products that are CARD4L compliant has been defined
- Data providers proposing products for CARD4L assessment would do a self-assessment of products against the CARD4L specs as the first step
- Data providers would then approach LSI-VC for endorsement of a product as CARD4L compliant
- LSI-VC would work with WGCV to assess the product against CARD4L specifications



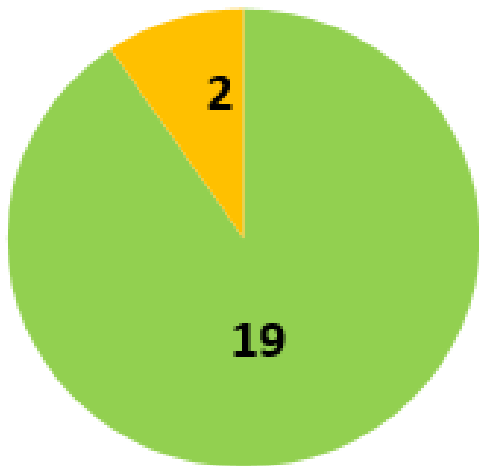
# CARD4L product assessment: WGCV role and current status

- To assist with CARD4L product reviews, WGCV has proposed a process workflow
- Self assessment of surface reflectance and radar backscatter products derived from Landsat, Sentinel-2 and ALOS were completed by: USGS, ESA, JAXA, GA and outcomes reported at LSI-VC7 (February 2019)
- Feedback provided to LSI-VC about experience with the process, description of the metadata parameters and need for clarity in some cases.
- Feedback about CARD4L specifications for Surface Reflectance was sought from the WGCV membership - written feedback from N Fox on potential improvements.





# GA Landsat SR: THRESHOLD specifications - summary



■ COMPLIANT

■ NOT COMPLIANT



• "General Metadata": 8/10



• "Per-pixel metadata": 7/7

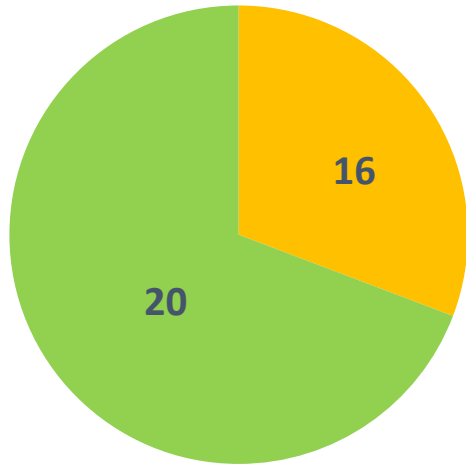


• "Radiometric and atmospheric corrections": 3/3



• "Geometric corrections": 1/1

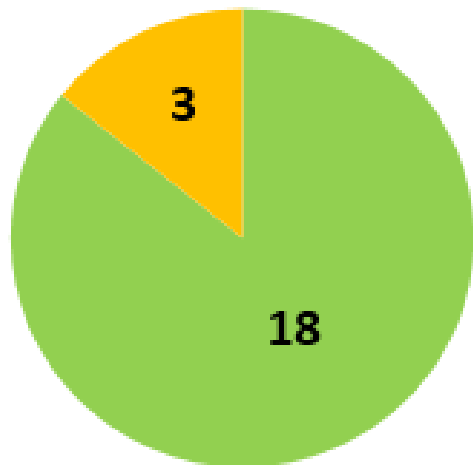
# GA Landsat SR: TARGET specifications - summary



■ Not Compliant ■ Compliant

- ✘ • **"General Metadata":** 9/17
- ✘ • **"Per-pixel metadata":** 6/12
- ✘ • **"Radiometric and atmospheric corrections":** 4/6
- ✔ • **"Geometric corrections":** 1/1

# GA Sentinel-2 SR: THRESHOLD specifications - summary

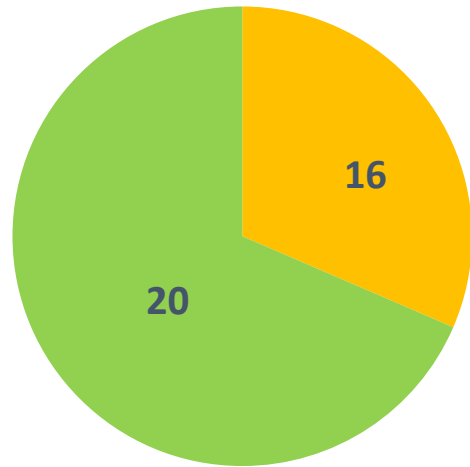


■ COMPLIANT

■ NOT COMPLIANT

- ✘ • "General Metadata": 8/10
- ✘ • "Per-pixel metadata": 6/7
- ✔ • "Radiometric and atmospheric corrections": 3/3
- ✔ • "Geometric corrections": 1/1

# GA Sentinel-2 SR: TARGET specifications - summary



■ Not Compliant ■ Compliant

- ✘ • "General Metadata": 9/17
- ✘ • "Per-pixel metadata": 6/12
- ✘ • "Radiometric and atmospheric corrections": 4/6
- ✔ • "Geometric corrections": 1/1



# Digital Earth Africa ... is next



Digital Earth  
AUSTRALIA

## Structured time-series



Observations

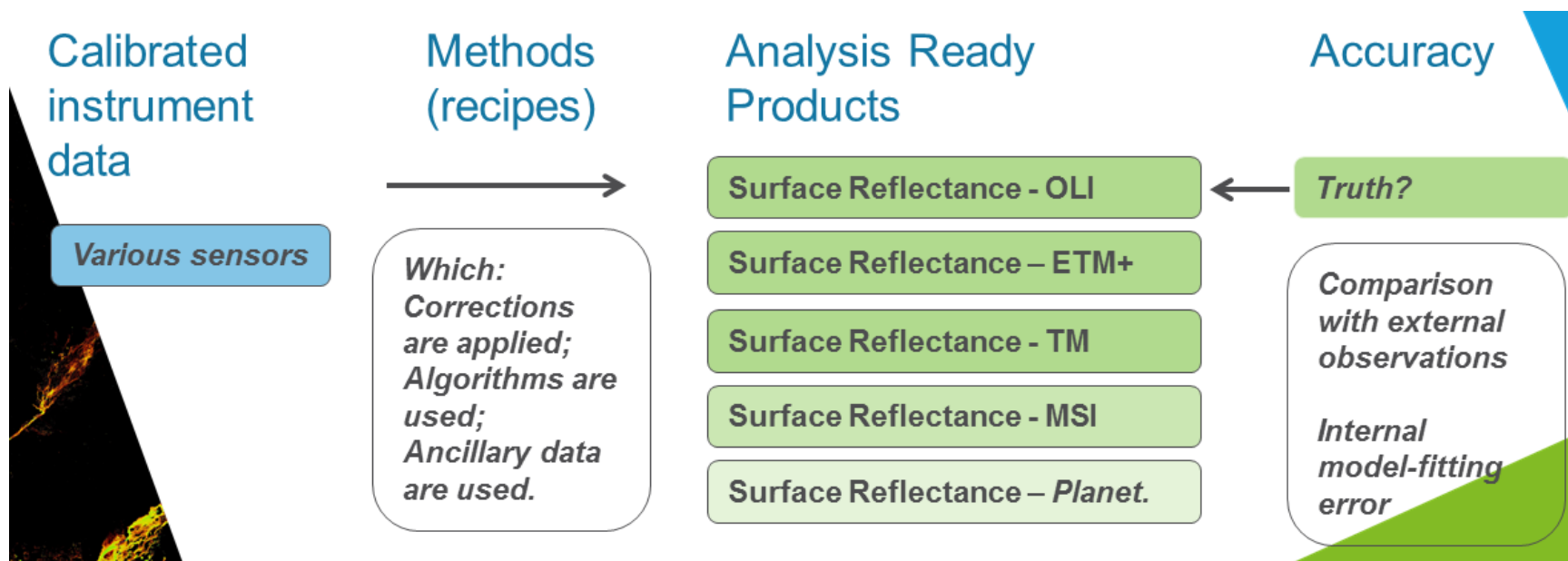
Analysis  
Ready Data

Products

Information  
for decisions

*A fundamental requirement is: EO data that have been processed to a minimum set of requirements and organised into a form that allows immediate analysis with a minimum of additional user effort, and, interoperability both through time and with other datasets ...**Analysis Ready Data***

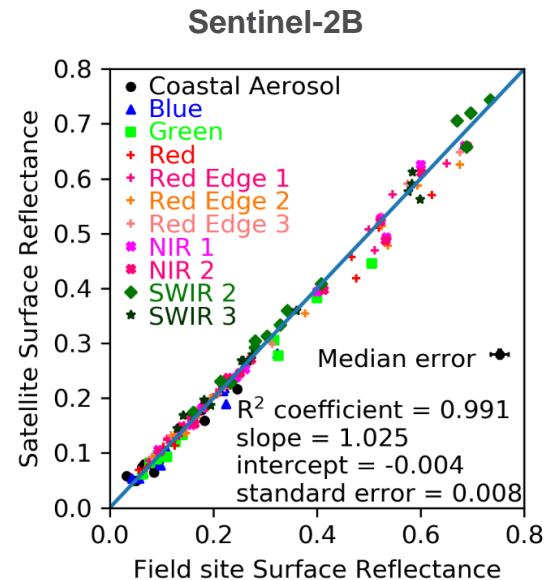
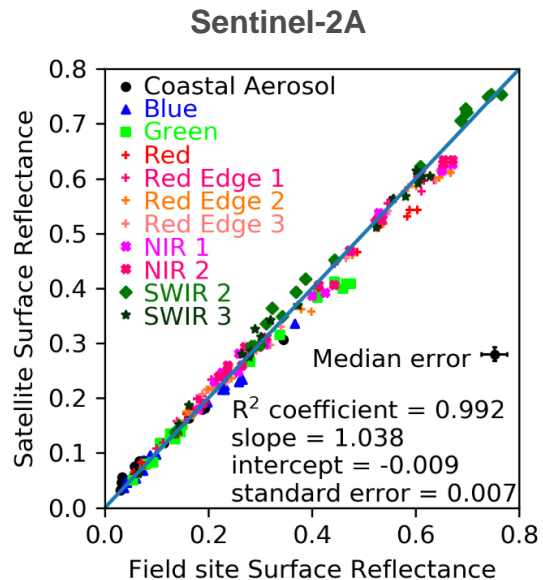
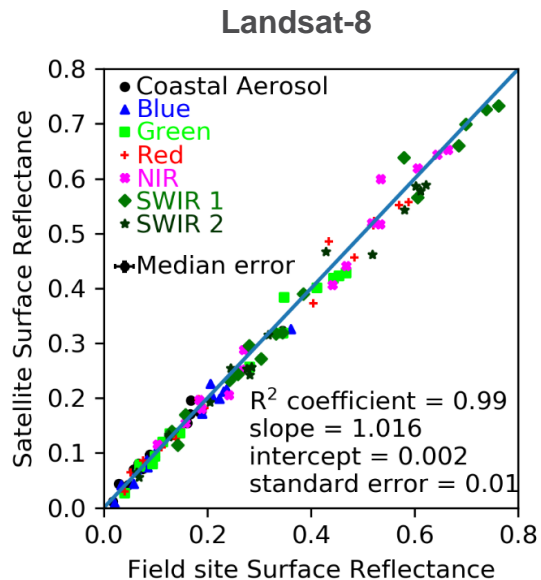
# ARD products and validation



## PFS Process - CARD4L

Focus of validation is not *how* the corrections are made, but *how effective* the corrections are

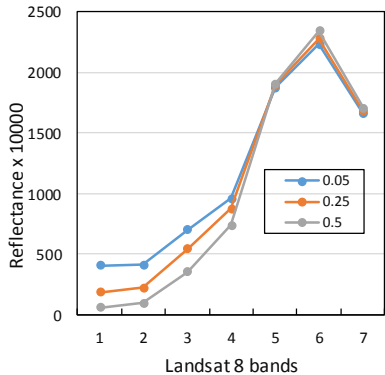
# Summary results from field validation of SR



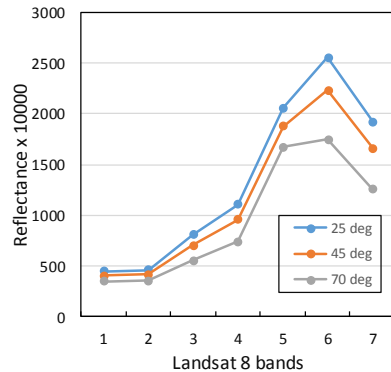
# Sensitivity analyses for ARD parameters

Parameters	Low	Medium	High
Aerosol optical depth	0.05	0.25	0.50
Water vapor (g/cm <sup>2</sup> )	0.5	1.5	3.5
Solar angle	25	45	70
BRDF	low	medium	high

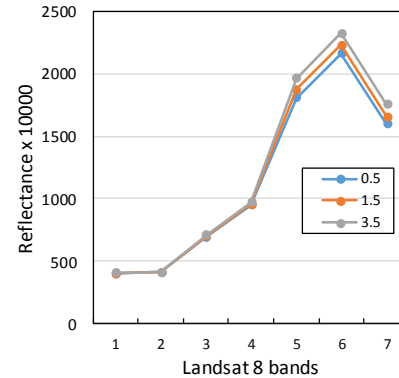
Mean surface reflectance at different aerosol values



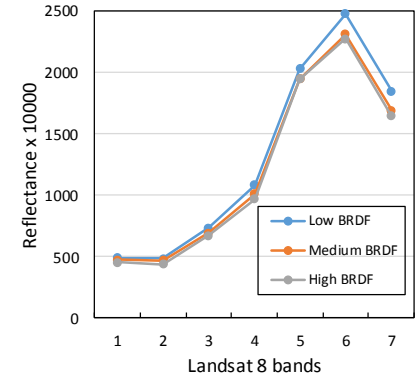
Mean surface reflectance at different values of solar angle normalisation



Mean surface reflectance at different water vapour values



Mean surface reflectance at different BRDF levels





# ESA Living Planet Symposium May 2019 Milan



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## 2019 Living Planet Symposium 13-17 May 2019, MiCo - Milano Congressi Milan, Italy

We are pleased to invite you to participate in the European Space Agency's 2019 Living Planet Symposium. The event, which is held every three years, will take place on 13-17 May 2019 in Milan, Italy. The Symposium is organised with the support of the Italian Space Agency.

This symposium focuses on how Earth Observation contributes to science and society, and how disruptive technologies and actors are changing the traditional Earth Observation landscape, which is also creating new opportunities for public and private sector interactions.

We look forward to meeting you in Milan.

## LPS 2019: Two sessions on Analysis Ready Data

The ARD session will consolidate the current state of knowledge, uptake and benefits of global efforts towards producing Analysis Ready Data (ARD) for Earth observations across the optical, thermal and microwave domains.

**Friday 17 May 2019**



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# Thank you

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