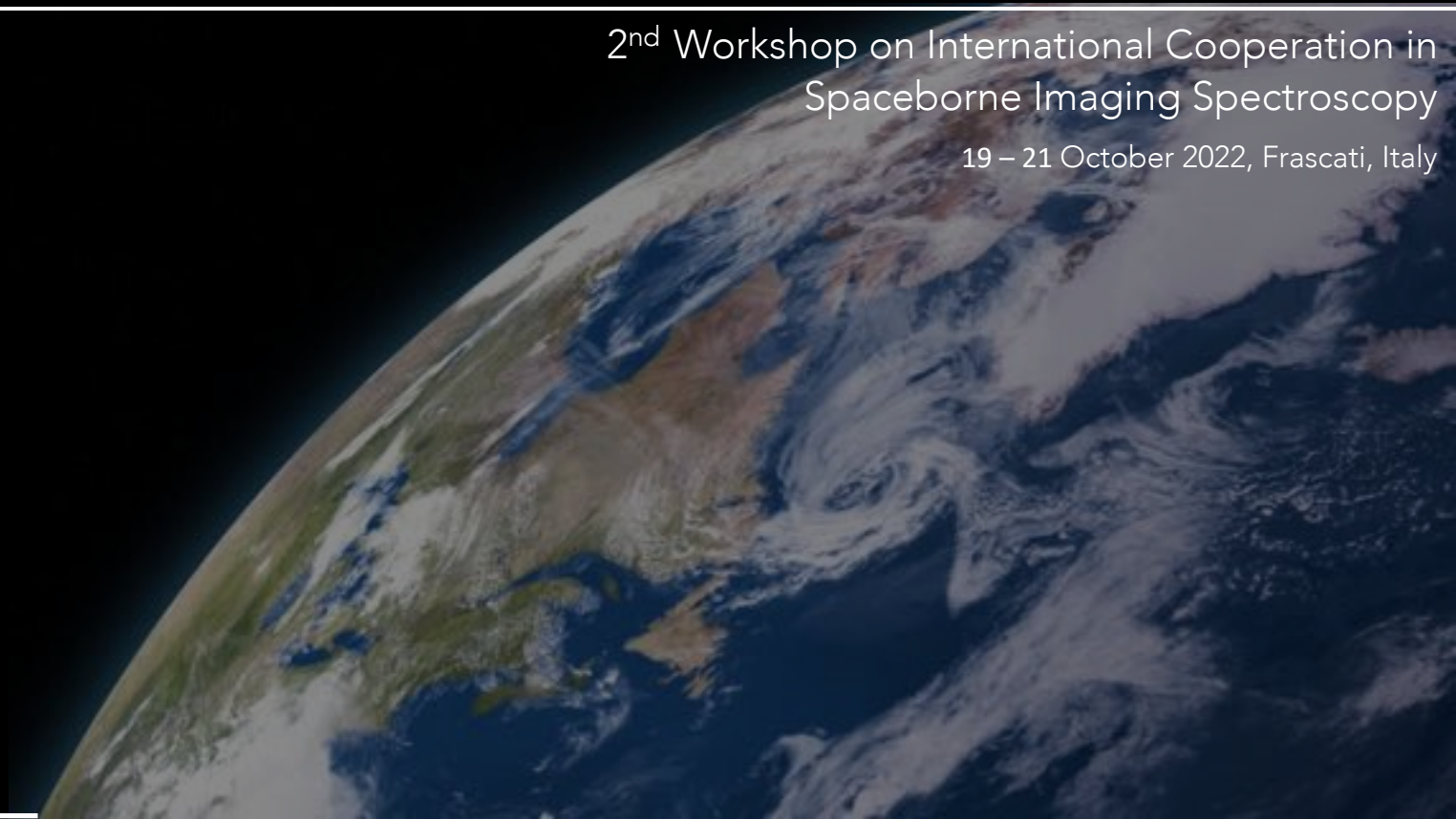
ACIX-III Land Atmospheric Correction Inter-comparison eXercise

2nd Workshop on International Cooperation in Spaceborne Imaging Spectroscopy

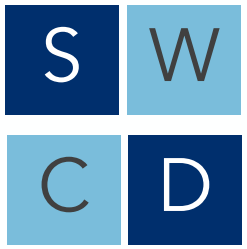
19 – 21 October 2022, Frascati, Italy



Georgia Doxani I Serco for ESA-ESRIN
Ferran Gascon I ESA-ESRIN
Philip Townsend I JPL, University of Wisconsin
David Thompson I JPL, California Institute of Technology
Philip Brodrick I JPL, California Institute of Technology
Adam Chlus I JPL, California Institute of Technology

WHY?

Free and open access policy to Earth Observation imagery has stimulated the development and operational use of AC processors for generating Bottom-of-Atmosphere (BOA) products



The objective is to point out:

- Strengths & Weaknesses
- Commonalities & Differences

How?

Definition of the inter-comparison protocol

Coordinators & Participants
discussed all the major points and defined the inter-comparison procedure.

Application of the AC processors

Participants
applied their AC schemes on a set of test sites keeping the processing parameters constant. The results were submitted for analysis to ACIX coordinators.

Analysis of the results

Coordinators
processed the AC results and assessed the inter-comparison metrics. The results presented and discussed with the participants.

When?

2016 - 2018

ACIX
11 processors
19 AERONET sites
Publication link
Website link

CMIX
10 processors
5 validation datasets
Publication link
Website link

2018 - 2022

ACIX-II Land
12 processors
120 AERONET sites
Publication (soon)
Website link

ACIX-II Aqua
8 processors
20 AERONET OC sites
Publication link
Website link

2022 - TBD

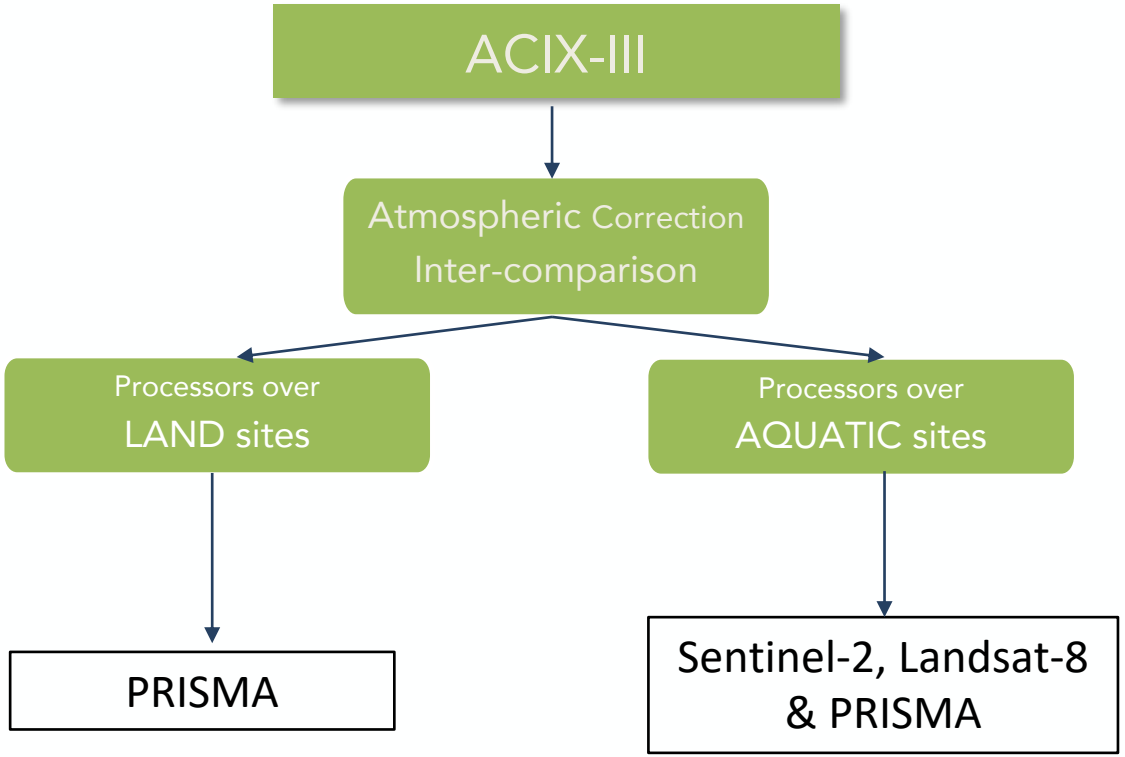
CMIX-II
13 processors

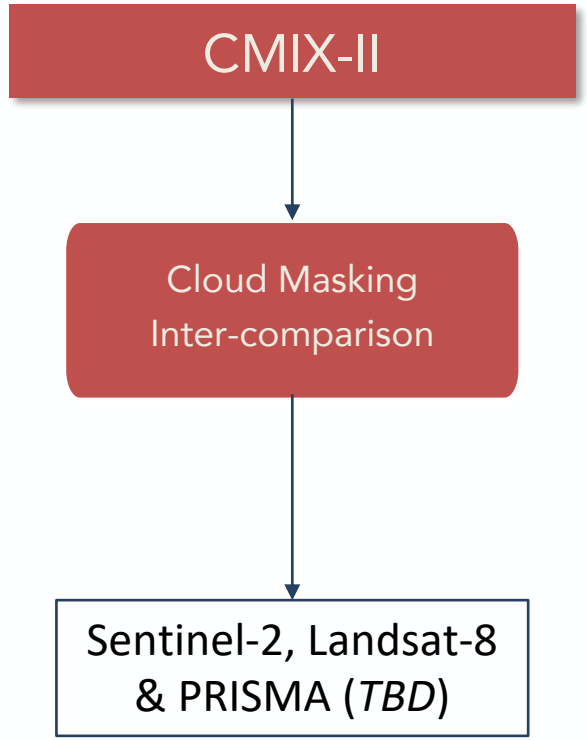
ACIX-III Land
13 processors

ACIX-III Aqua
14 processors

With the support of:

How?





With the support of: Agenzia Spaziale Italiana

How?

ACIX-III

Atmospheric Correction Inter-comparison

Processors over LAND sites

esa


Ferran Gascon


Georgia Doxani

NASA Jet Propulsion Laboratory
California Institute of Technology


Phil Townsend


David Thompson


Philip Brodrick

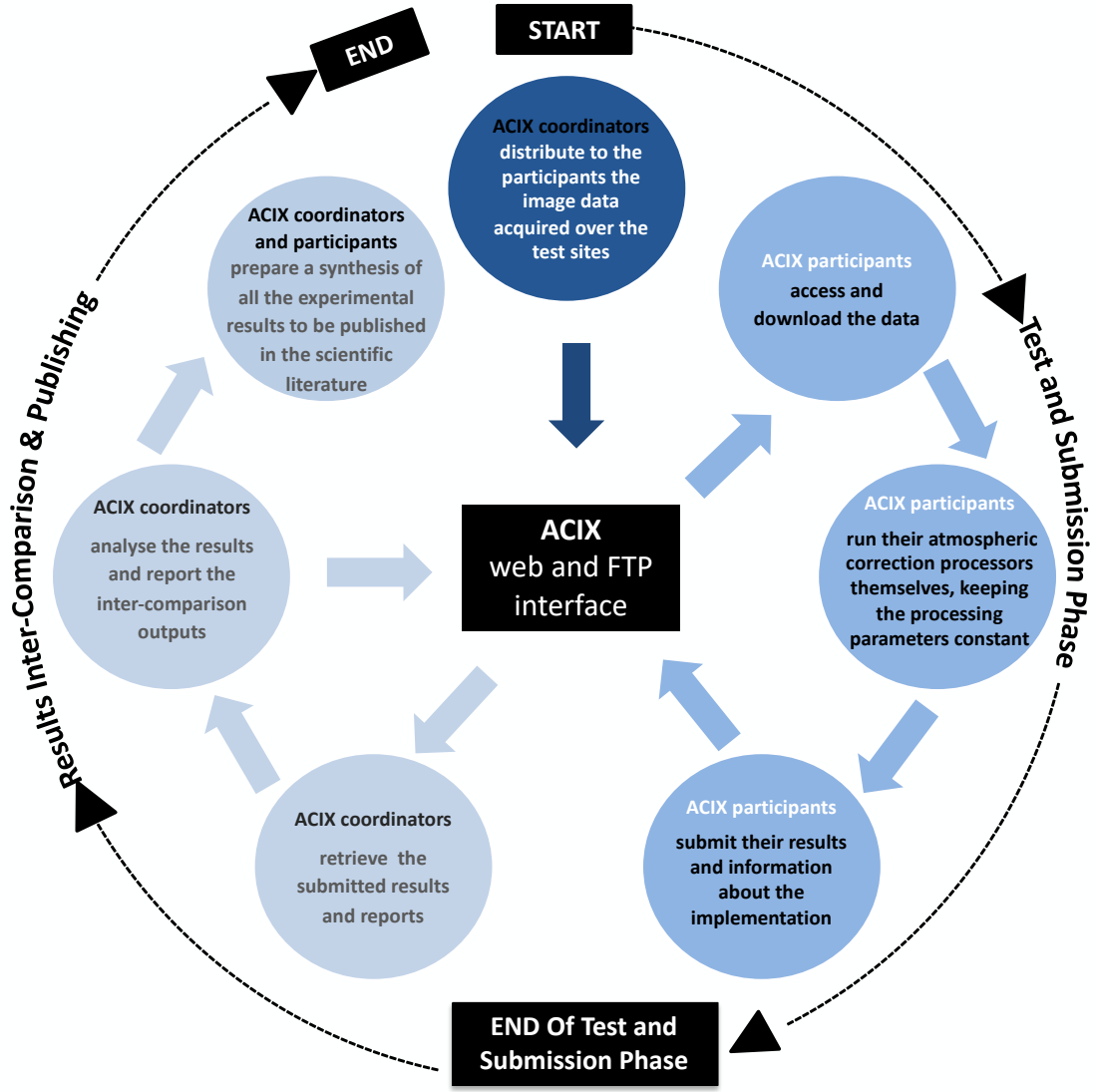

Adam Chlus

WHO?

#	Name	Affiliation	Processor's Name
1	Raquel de los Reyes	DLR	PACO
2	Feng Yin	University College London	SIAC
3	Stefan Adriaensen	VITO	iCOR
4	Béatrice Berthelot	MAGELLIUM	MAGAC
5	Tim Perkins	Spectral Sciences, Inc.	QUAC
6			FLAASH
7	Ian Brosnan	NASA Ames Research Center	HECC
8	Philip Brodrick	JPL	isofit
9	Weile Wang	NASA Ames Research Center	GeoNEX-AC
10	Laurent Poutier	ONERA	COCHISE
11	Yaokai Liu	CAS.CHINA	Hikerliu
12	Quinten Vanhellemont	RBINS	ACOLITE/DSF
13	Angelo Palombo	CNR Institute of Methodologies for Environmental Analysis (IMAA)	ImaACor
	Federico Santini		

How?

With the support of:



Input Data [ASI]

With the support of: Agenzia Spaziale Italiana

PRISMA

All PRISMA Products are in **HDF5-EOS format** and include HYP data cube + PAN image + metadata

PRISMA L1 data: **Top-of-Atmosphere Radiance** radiometrically corrected and calibrated in physical units (incl. Cloud mask; Sun-glint Mask; Classification Mask; Calibration and characterization data)

- **Absolute HYP radiometric accuracy < 5%** (TOA or BOA)
- SNR 160:1 in VNIR and 100:1 in SWIR (240:1 in PAN)
- MTF (@Nyquist) 0.3 for HYP and 0.2 for PAN
- **Geometric localization errors (CE90) < 200m** (15m with GCPs, available starting in Q1/2023)
- **Smile effect is well below 0.1 pix (1 nm)** for current products, following the product requirements. The results are **better** for **SWIR than** the **VNIR** cube.

Input Data [Users' feedback: Geometry]

With the support of:

PRISMA

Users' feedback report **geometric errors > 200m** depending on the viewing on the scene topography and viewing angles.

⬇

Action in ACIX

JPL team will implement their imaging matching code to improve the coordinate accuracies using Landsat scenes as a reference.

Input Data [Users' feedback: Smile distortion]

With the support of:

PRISMA

Users indicated that there is an important **smile effect** and **calibration error** of up to **3 nm** in the VNIR

⬇

Action in ACIX

A smile correction approach is being investigated and discussed together with the participants

Input Data [Users' feedback: Metadata]

With the support of:

PRISMA

Ancillary information, i.e., View Zenith Angle, Solar Zenith Angle, etc., is missing from PRISMA L1 data

⬇

Action in ACIX

L1 and L2C products will be downloaded and provided to participants

Quality Layers

With the support of: Agenzia Spaziale Italiana

Input

Quality flags provided as part of the products defining clearly the appropriate flags to be included in the inter-comparison process.

Ideally, **a simple mask** to be provided defining **only valid and invalid** pixels for the AC inter-comparison.

Analysis

The analysis will be made initially for the pixels that are considered of **good quality by all AC processors** (**masks' union**).

(?) Additional inter-comparison investigation may be performed using the corresponding individual quality mask per processor.

Quality Layers

With the support of:

- The quality flags can be different for AOD, WV and BOA.
  Different layers can be provided and they will be combined correspondingly.

- Each participant should indicate the flags to be involved in the analysis, eg. no clouds, no cloud shadows, no snow, no water for WV, no high aerosol for BOA, etc.

- The coordinators will not question the flags, not any quality flags validation

How?

Aerosol Optical Depth

Water Vapour

AERONET

Estimated AOD (/WV) & compared to Level 1.5 (cloud screened) AERONET data

1. Interpolate AERONET values @ **λ**=550 nm using Angstrom Exponent
2. Average AERONET values over time period within ±15 min from AOD retrieved values (PRISMA overpass)
3. Average estimated AOD values over an image subset of 9 km x 9 km centred on the AERONET Sunphotometer station

Statistics

No. of samples

R^2 (Coefficient of determination)

RMSE

bias

APU analysis

$$\textit{Accuracy (A): } A = \frac{1}{n}\left(\sum_{i=1}^{n} \Delta_{AOD}\right)$$

$$\textit{Precision (P): } P = \sqrt{\frac{1}{(n-1)}\sum_{i=1}^{n}(\Delta_{AOD} - A)^2}$$

$$\textit{Uncertainty (U): } U = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\Delta_{AOD})^2}$$

AERONET sites with PRISMA acquisitions

129 AERONET sites are covered by PRISMA

Sites mainly in Europe and North America

AERONET sites with valid measurements to be investigated

How?

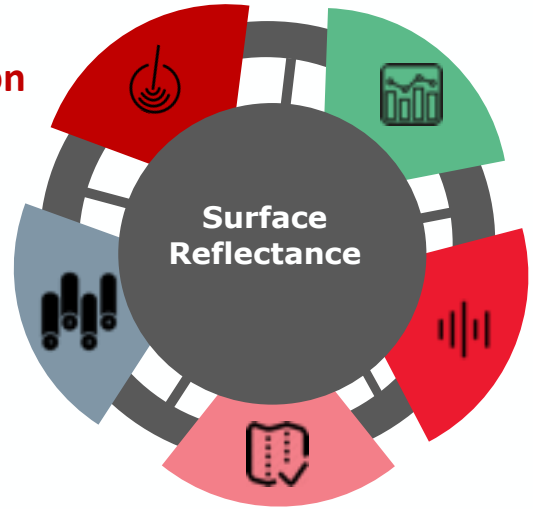
How?

01. Ground based validation

RadCalNet [La Crau] (France), Gobabeb (Namibia)], SR will be provided by CNES in the same angular conditions as PRISMA

05. SR inter-comparison

Plotting the SR time series per date, band and AC approach.



02. Campaign Data

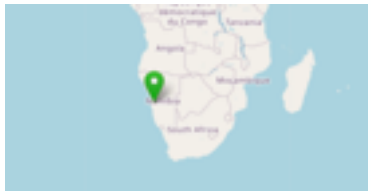
Reference BOA retrieved by AVIRIS NG for ESA CHIME & SBG 2021 campaign and NEON Airborne Observation Platform (AOP)

03. AERONET corrected data (*TBD*)

AC data generated by 6SV radiative transfer model using AERONET data. AOT, aerosol model and column water vapour will be derived from AERONET sunphotometer measurements and will be used in the radiative transfer model in order to perform the AC of TOA reflectance.

01. Ground based validation | RadCalNet

Gobabeb [Namibia]: 37 PRISMA scenes [CC<10%]



La Crau [France]: 12 PRISMA scenes [CC<10%]

The measurements will be processed to PRISMA observation geometry and reflectance spectrum by CNES

The **area of interest** will be proposed by the site PIs (CNES) regarding the homogeneity of the sites for the study period to be selected

The **study period** is proposed to be the full PRISMA archive over these sites

AVIRIS NG for ESA CHIME & SBG 2021

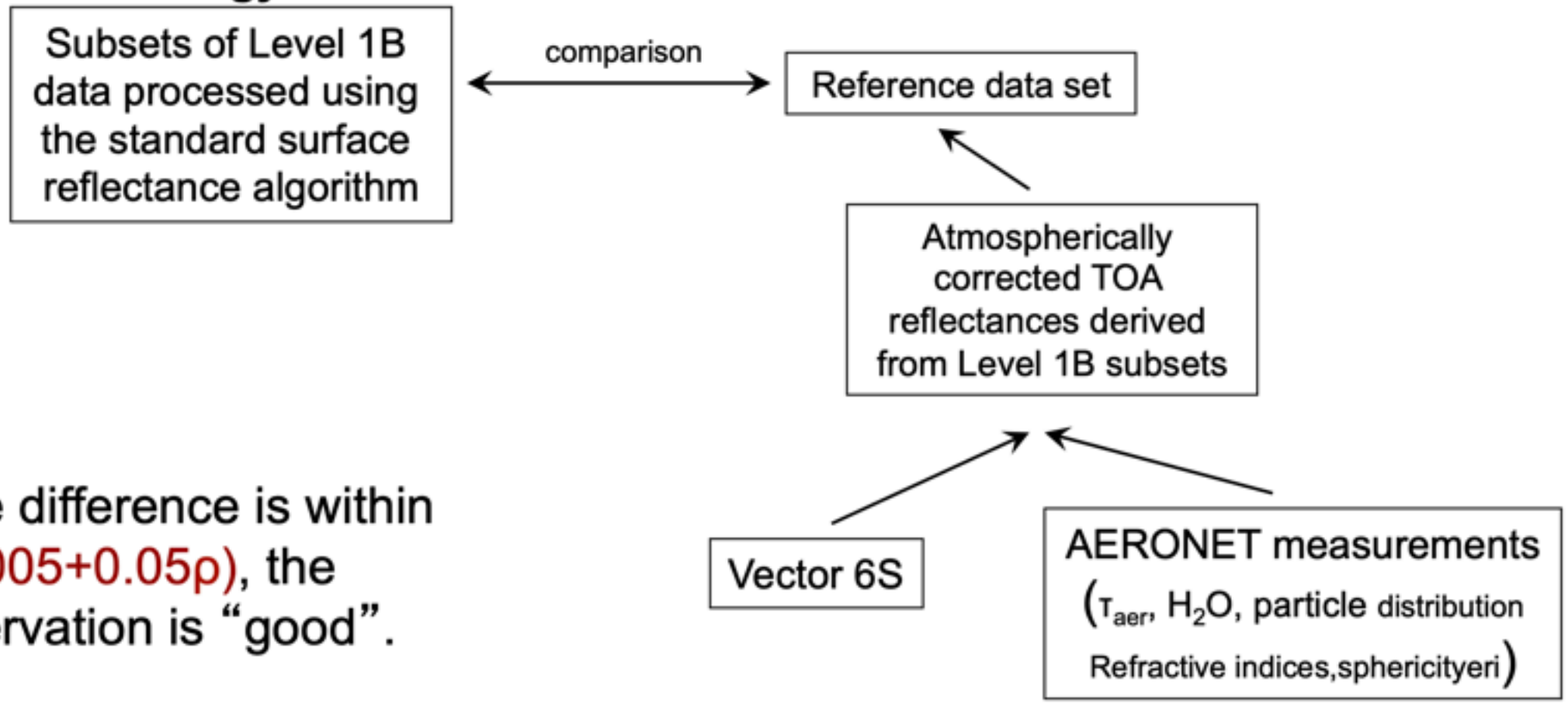
Country	Site	Latitude	Longitude	PRISMA date	AVIRIS-NG date(s)	PRISMA scene
Germany	Demmin	53.7723	13.089	20210518	20210530	20210518102102_20210518102107_0001
Spain	Camarena	39.9703	-4.1459	20210630	20210630	20210630110522_20210630110526_0001
Italy	Braccagni	42.8374	11.0709	20210604	20210604	20210604101721_20210604101725_0001
	Rio Tinto	37.7791	-6.5747	20210625	20210625	20210625111917_20210625111921_0001
	Jolanda	44.8905	11.957	20210621	20210625	20210621101020_20210621101024_0001
Great Britain	FlowCountry	58.3652	-3.9573	20210603	20210615	20210603113329_20210603113333_0001

NEON Airborne Observation Platform (AOP)

Site	Latitude	Longitude	PRISMA date	NEON AOP date(s)	PRISMA scene
MOAB	38.248283	-109.38827	20200702	20200705	20200702181741_20200702181745_0001
WREF	45.82049	-121.95191	20210729	20210718	20210729190927_20210729190932_0001
SRER	31.91068	-110.83549	20210829	20210823-20210902	20210829180958_20210829181002_0001
NIWO	40.05425	-105.58237	20200822	20200801 - 20200807	20200822175652_20200822175657_0001

03. AERONET corrected data (*TBD*)

Methodology:



If the difference is within ±(0.005+0.05ρ), the observation is "good".

Eric Vermote, 2016. MODIS/VIIRS Surface Reflectance

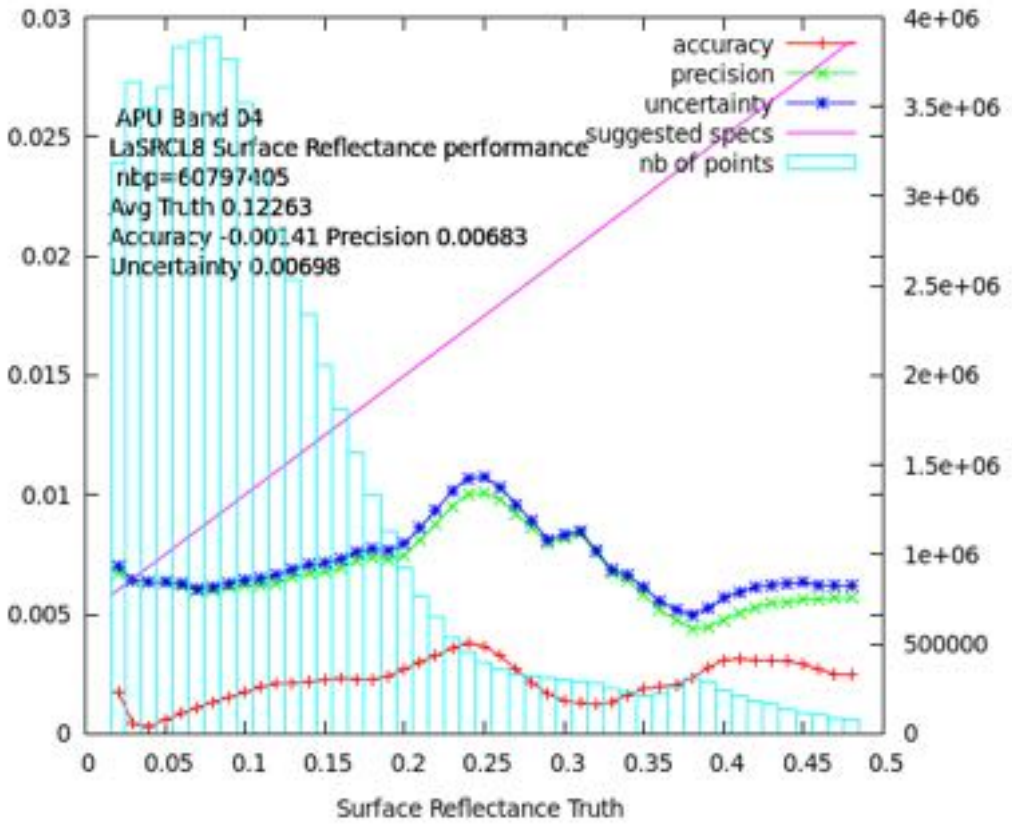
03. AERONET corrected data (*TBD*)

$$\textit{Accuracy (A)}: A = \frac{1}{n_\lambda}\left(\sum_{i=1}^{n_\lambda} \Delta\rho_{\iota,\lambda}^{SR}\right)$$

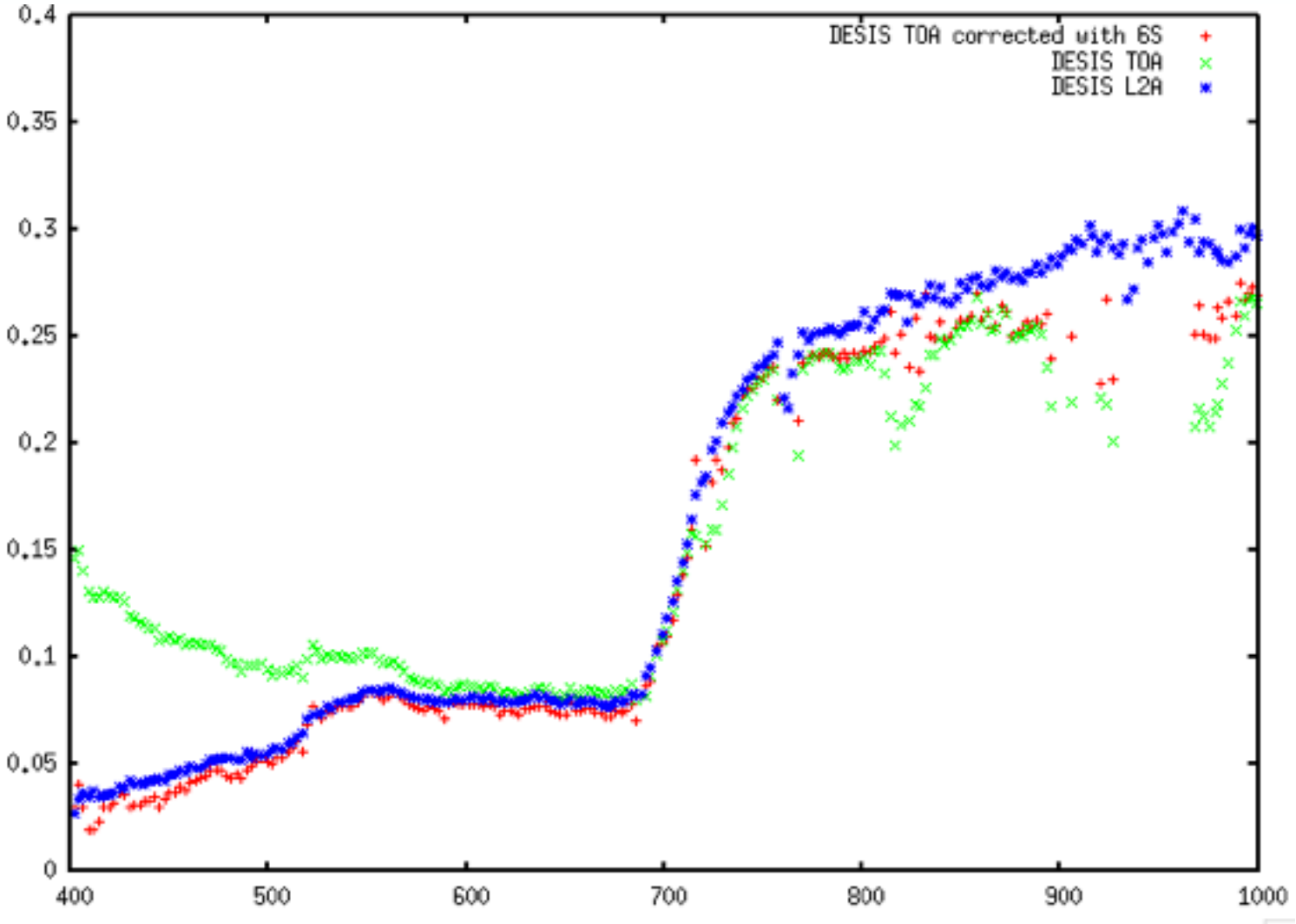
$$\textit{Precision (P)}: P = \sqrt{\frac{1}{(n_\lambda - 1)}\sum_{i=1}^{n_\lambda}\left(\Delta\rho_{\iota,\lambda}^{SR} - A\right)^2}$$

$$\textit{Uncertainty (U)}: U = \sqrt{\frac{1}{n_\lambda}\sum_{i=1}^{n_\lambda}(\Delta\rho_{\iota,\lambda}^{SR})^2}$$

Example from ACIX-II



03. AERONET corrected data (*TBD*)



Lessons Learnt

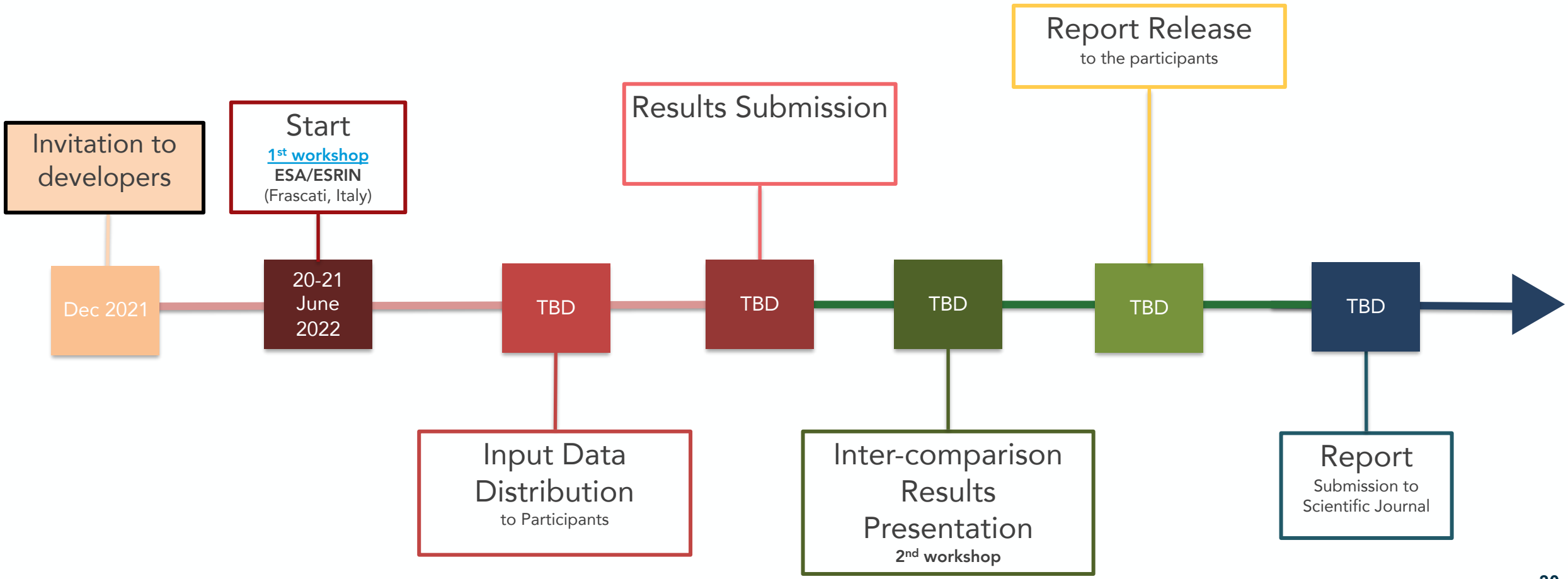
Respect the protocol and follow the filenames, file formats, etc. as agreed

More time to read data and investigate the mismatching with the protocol than the validation analysis itself

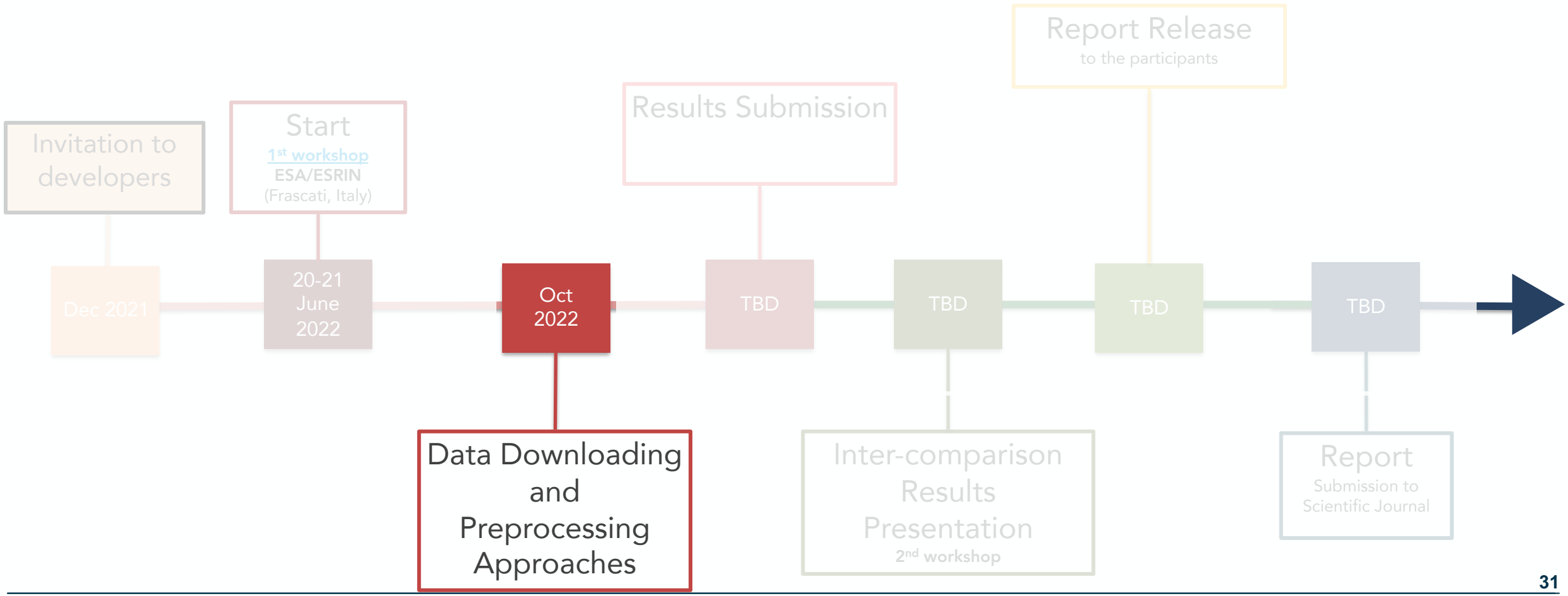
Respect the deadlines

Requests for including results after the result submission deadline is not fair and respectful to the rest of the group

Timeline


Invitation to developers
Dec 2021
Start
1st workshop
ESA/ESRIN
(Frascati, Italy)
20-21 June 2022
TBD
Input Data Distribution
to Participants
Results Submission
TBD
TBD
Inter-comparison Results Presentation
2nd workshop
Report Release
to the participants
TBD
TBD
Report
Submission to Scientific Journal

Timeline


Invitation to developers
Dec 2021
Start
1st workshop
ESA/ESRIN
(Frascati, Italy)
20-21 June 2022
Oct 2022
Data Downloading and Preprocessing Approaches
Results Submission
TBD
Inter-comparison Results Presentation
2nd workshop
TBD
Report Release
to the participants
TBD
Report
Submission to Scientific Journal
TBD

Thank you for your attention!

1st WS of ACIX-III Land, -Aqua and CMIX-II:
https://earth.esa.int/eogateway/events/1st-workshop-of-acix-iii-land-aqua-and-cmix-ii/agenda