Mutual Interference between C-Band SAR

Prediction of occurrences for identification of sources

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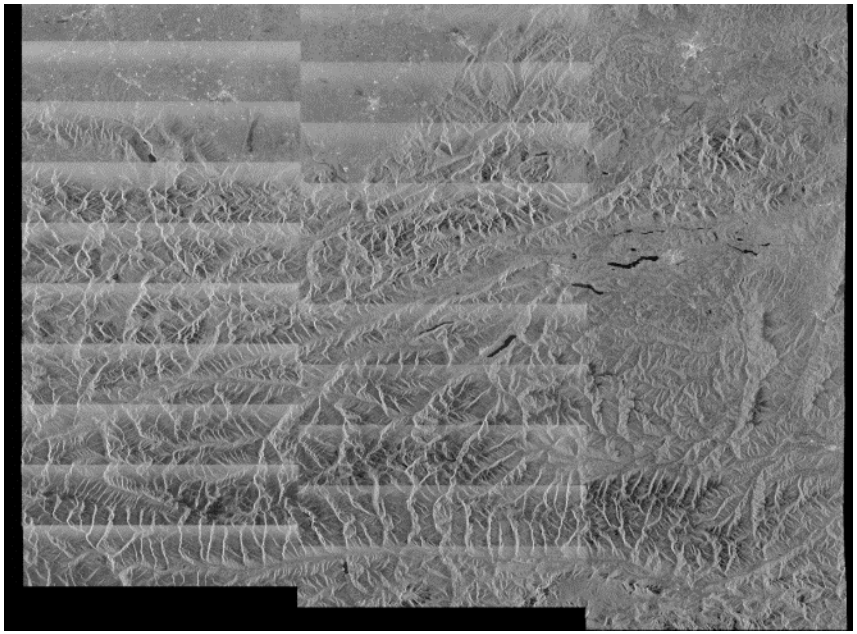
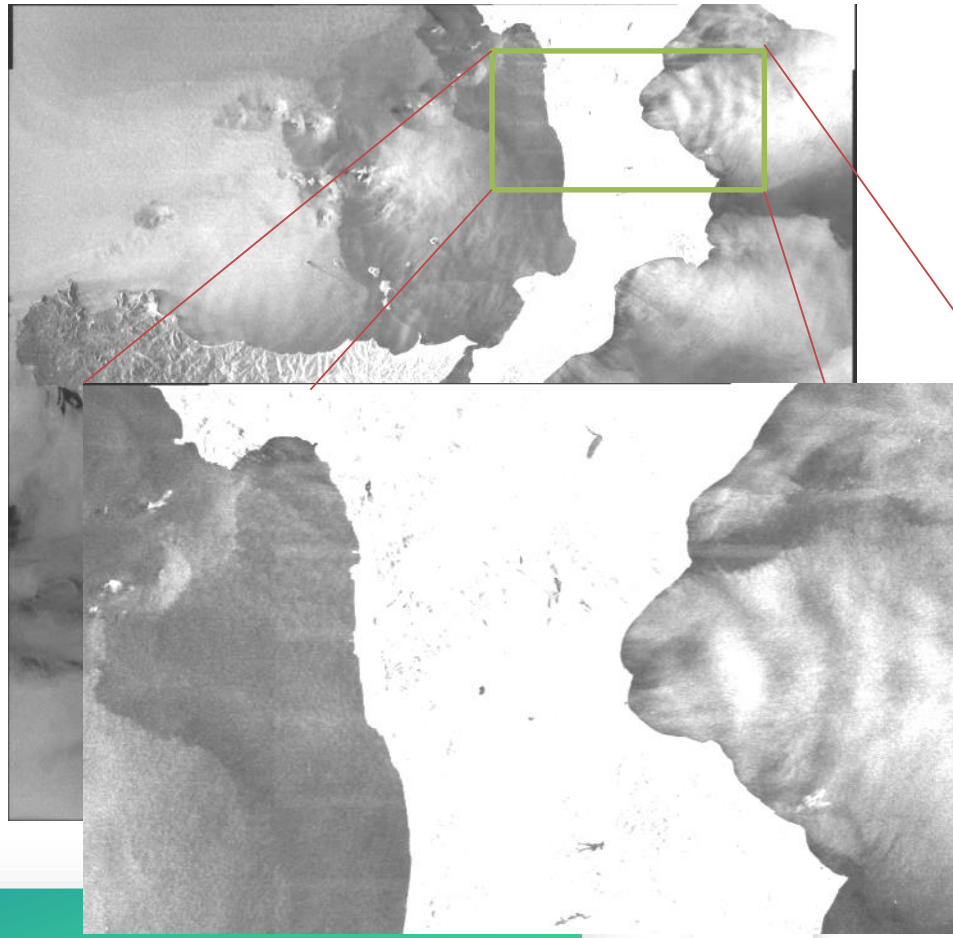
Example

~ 3mn along track

S1A-GRDH-IW-20150816_165825-007291-G0-VH-r10.rsl-id2b.png



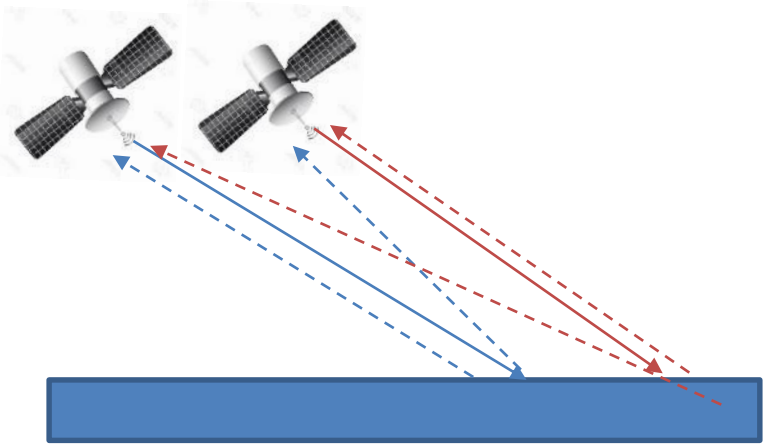
RS2_SWB_1FSCLS20150816_165532.png



Context

- C-Band transmissions from other spacecraft can interfere with the signal received by Sentinel-1A or Sentinel-1B (and inversely)
- This induces degradation of the image quality through “stripes” in the images.
- Duration of the interferences is variable, depending on mutual operations of the sensors and their proximity

- Example of spacecraft configuration (proximity)



- Prediction of RFI from know sources
- Identification of yet unknown sources

Known C-Band emitters

- From https://www.wmo-sat.info/oscar/spacecapabilities

ID	Satellite	Main Agency	Launch	EOL	Service	Direction or sensing mode	Frequency	Emission designator	Bandwidth	Polarisation	Data rate or Baseband	D/A	Comments
2509	JASON-CS-A	NASA	≥2020	≥2027	Altimeter	active	5300 MHz		N/R kHz	TBD		D	SRAL C-band
2511	JASON-CS-B	NASA	≥2025	≥2032	Altimeter	active	5300 MHz		N/R kHz	TBD		D	SRAL C-band
3112	Envisat	ESA	2002-03-01	2012-04-08	IMAGER	active	5331 MHz		N/R kHz	TBD		D	ASAR
2441	RadarSat-2	CSA	2007-12-14	≥2019	IMAGER	active	5405 MHz		100000 kHz	H&V		D	C-band SAR
2442	RCM-1	CSA	2019-06-12	≥2026	IMAGER	active	5405 MHz		100000 kHz	H&V		D	C-band SAR
2443	RCM-2	CSA	2019-06-12	≥2026	IMAGER	active	5405 MHz		100000 kHz	H&V		D	C-band SAR
2444	RCM-3	CSA	2019-06-12	≥2026	IMAGER	active	5405 MHz		100000 kHz	H&V		D	C-band SAR
2519	Sentinel-1A	ESA	2014-04-03	≥2021	IMAGER	active	5405 MHz		N/R kHz	TBD		D	SAR-C
2520	Sentinel-1B	ESA	2016-04-25	≥2023	IMAGER	active	5405 MHz		N/R kHz	TBD		D	SAR-C
3545	Sentinel-1C	ESA	≥2022	≥2029	IMAGER	active	5405 MHz		N/R kHz	TBD		D	SAR-C
3546	Sentinel-1D	ESA	≥2023	≥2030	IMAGER	active	5405 MHz		N/R kHz	TBD		D	SAR-C
1798	Electro-L N4	RosHydroMet	≥2021	≥2028	TC & Ranging	E-S	5747.124 MHz	8M19G2D	10050 kHz	LHCP	0.1/1.0 kbps	D	Telemetry, command & ranging
1548	Meteor-M N2-2	RosHydroMet	≥2019-07	≥2024	TC & Ranging	E-S	5747.124 MHz	8M19G2D	10010 kHz	LHCP	0.1/1.0 kbps	D	Telemetry, command & ranging
1813	Meteor-M N2-3	RosHydroMet	≥2020	≥2025	TC & Ranging	E-S	5747.124 MHz	8M19G2D	10010 kHz	LHCP	0.1/1.0 kbps	D	Telemetry, command & ranging
1828	Meteor-M N2-4	RosHydroMet	≥2021	≥2026	TC & Ranging	E-S	5747.124 MHz	8M19G2D	10010 kHz	LHCP	0.1/1.0 kbps	D	Telemetry, command & ranging
1843	Meteor-M	RosHydroMet	≥2022	≥2027	TC & Ranging	E-S	5747.124 MHz	8M19G2D	10010 kHz	LHCP	0.1/1.0 kbps	D	Telemetry, command &

Showing 1 to 59 of 59 entries - filtered from 2,537 records

However, not exhaustive as for instance does not mention GAOFEN-3

Methodology

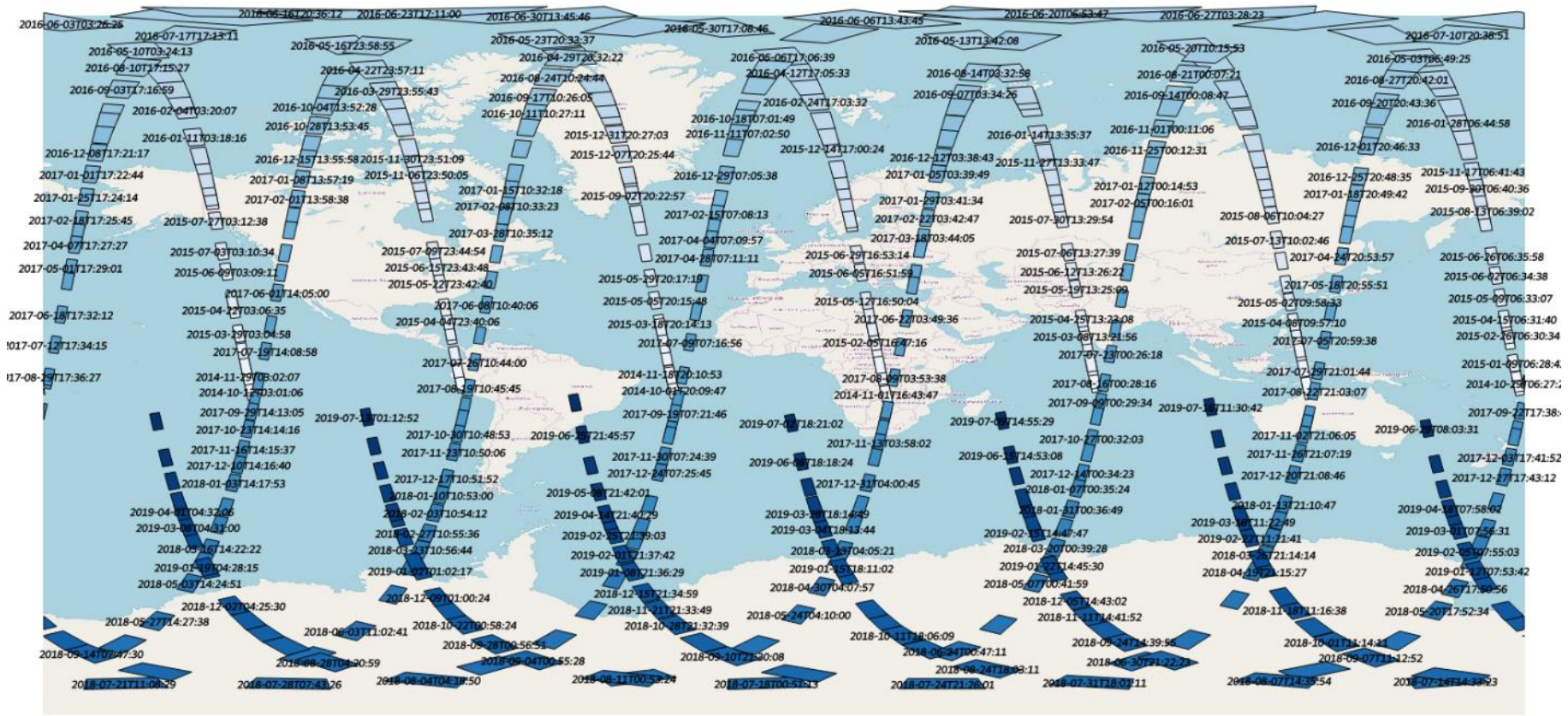
- Select a couple of spacecraft (S-1 A/B vs another)
- Screen distance between the two spacecrafts and detect times of nearest distance
- Check if S-1 data was acquired
- Check if RFI is observable
- If possible: Check if the other spacecraft was transmitting at the same time

SENTINEL-1A VS RADARSAT-2

S1-A vs RS-2: **Potential** scene coverage at nearest distance

From 2014-sept to 2019-sept

Color code: increasing acquisition date is darker



Orbit cycle is 24 days for RS-2 (vs 12 days for S-1A). 7 proximity configuration per cycle.

Crossing slowly moving along orbit from one cycle to another

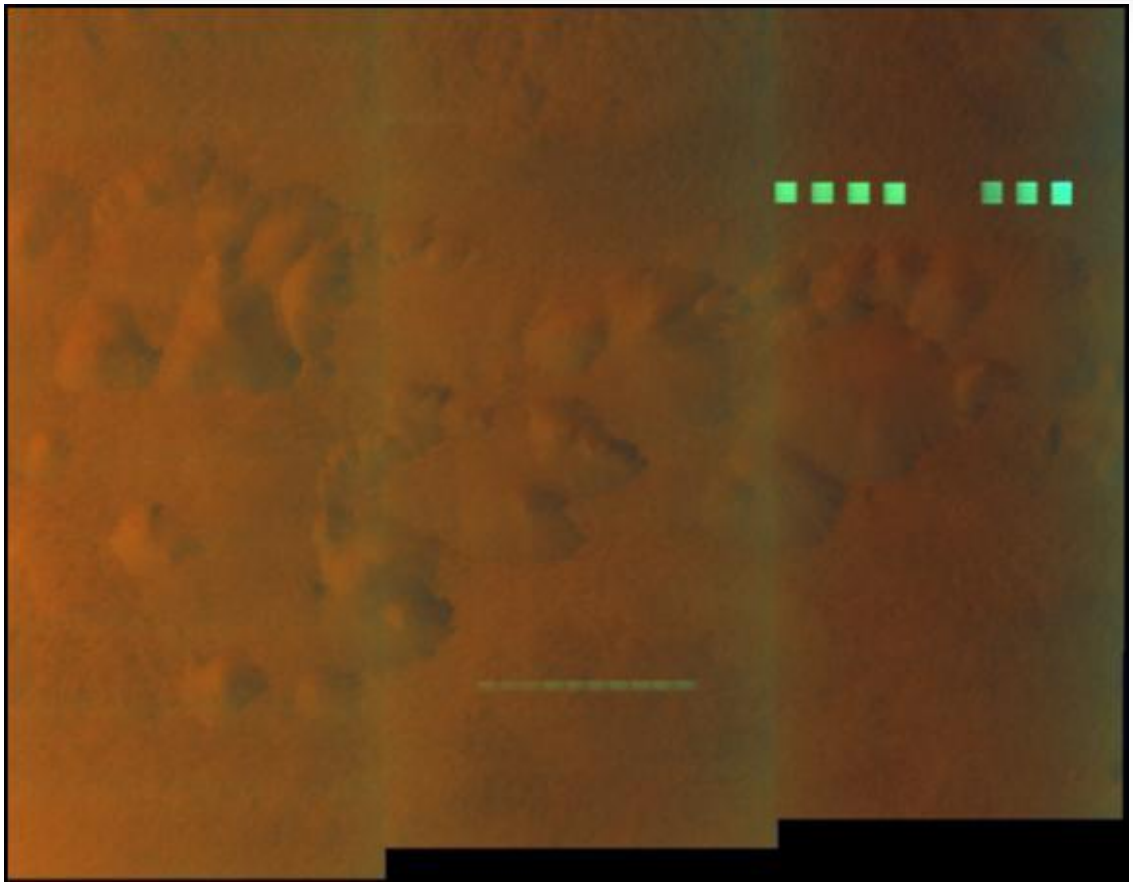
Shortest distance between S/C at crossing: 95 to 105 km

S-1A vs RS-2: **Available** scenes at nearest disttance

From 2014-sept to 2019-sept
Color code: nb of S-1A scenes within +/- 5mn around each crossings

107 times of proximity identified
38 of them with S-1A acquisitions

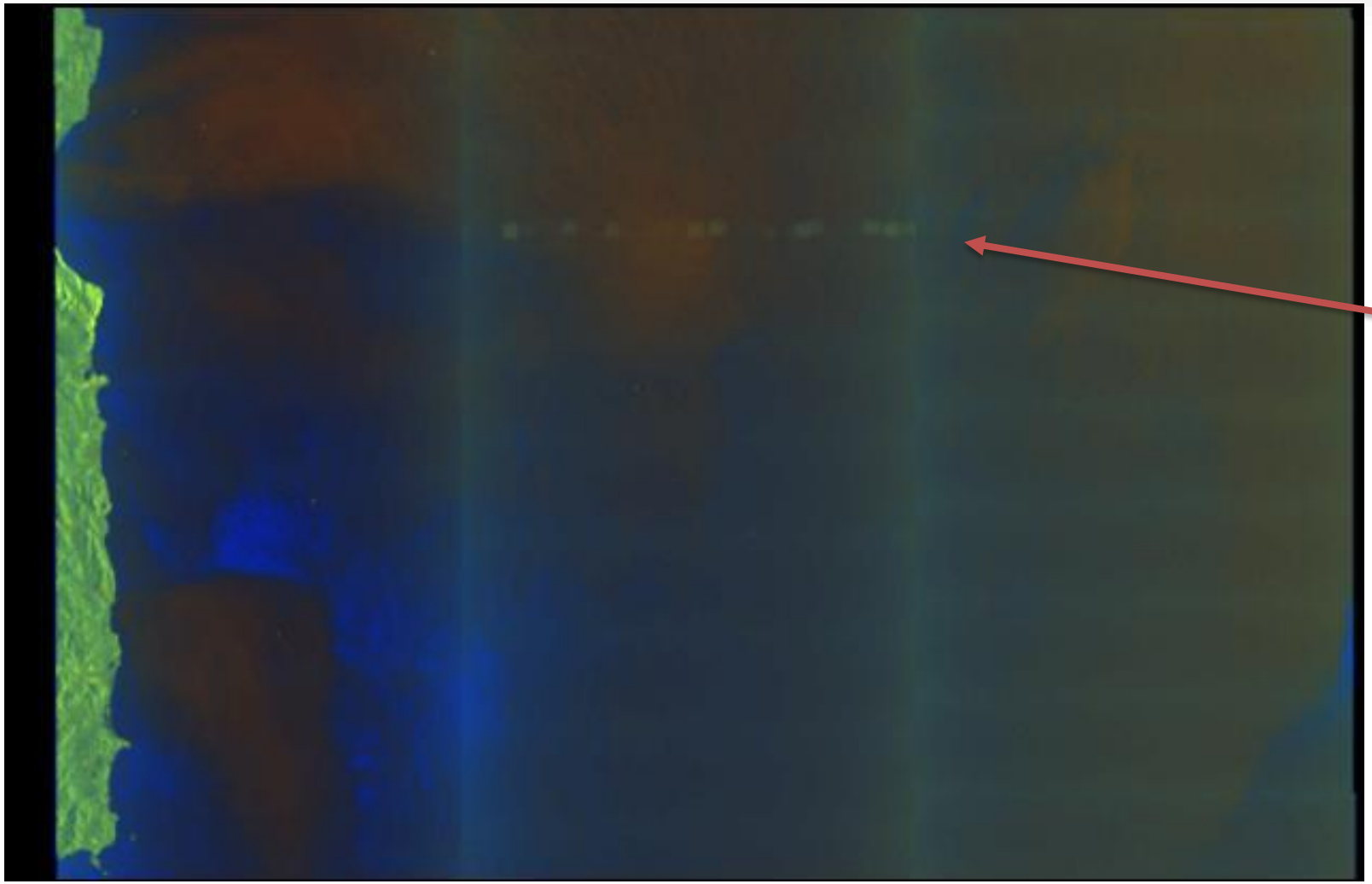
S1A_IW_GRDH_1SDV_20180402T184050_20180402T184119_021292_024A1F_14A5



- Not a « massive » signature of RFI
- However, Radarsat-2 was in operation around that time

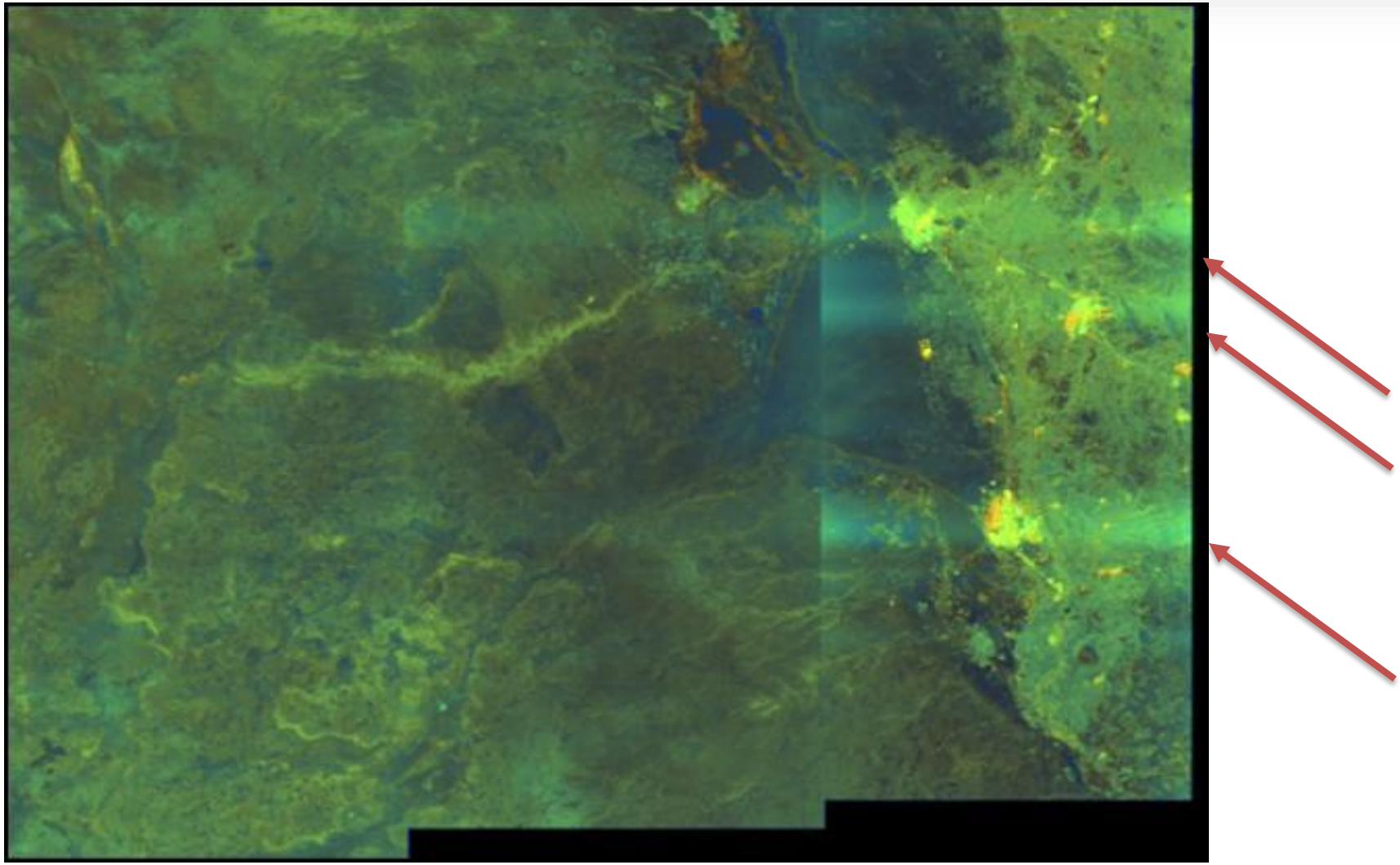
startQuery	endQuery	nbS1Products	RFI Observable	RFI Location	RFI Date	RS-2 acquisition	RS-2 Details
02/04/2018 18:39	02/04/2018 18:44	7	Yes		18:40:50	Yes	18:43: WideF (F0W1)

S1A_IW_GRDH_1SDV_20190119T052035_20190119T052100_025542_02D546_824C



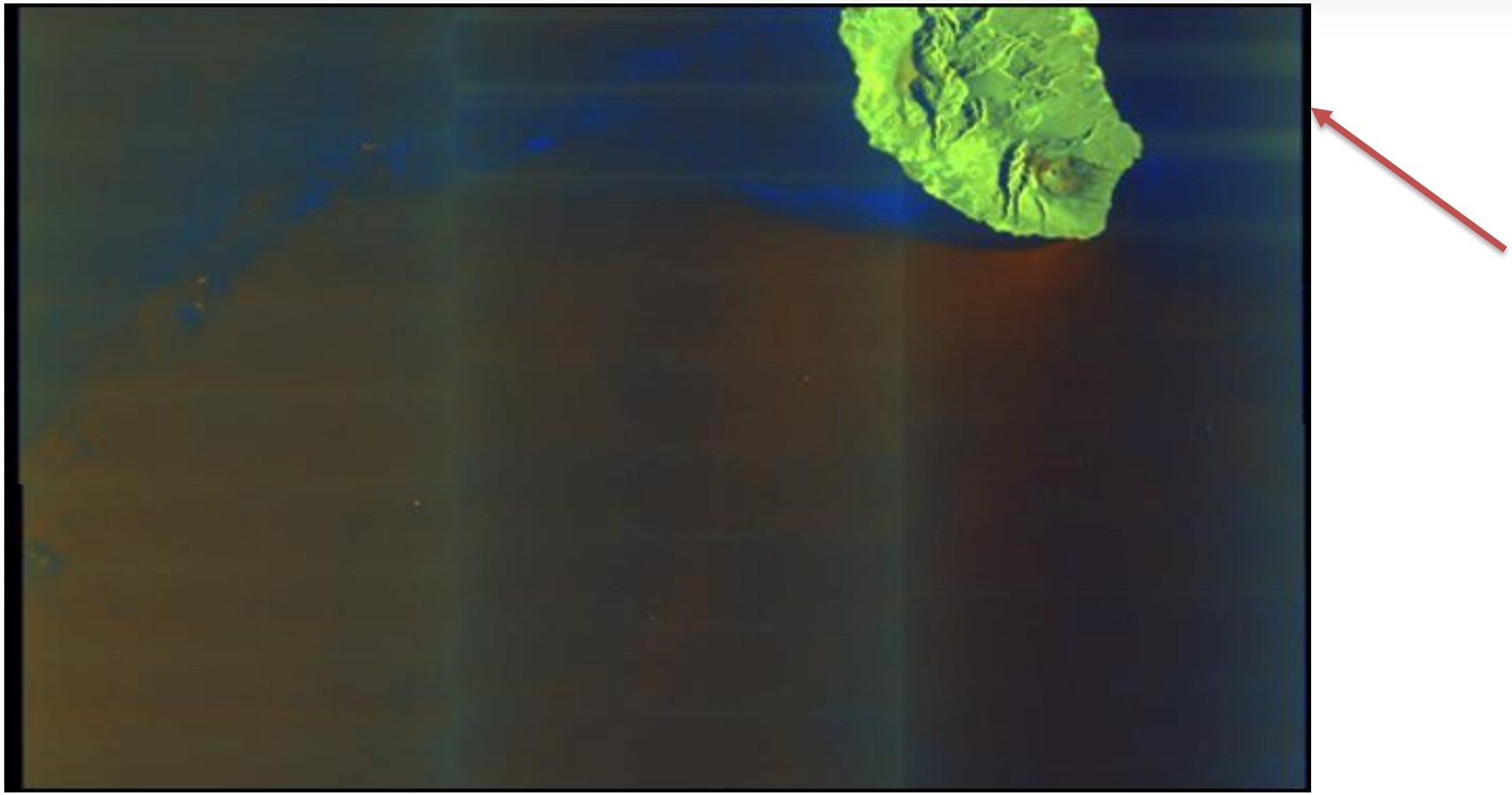
startQuery	endQuery	nbS1Products	RFI Observable	RFI Location	RFI Date	RS-2 Acquisition	RS-2 Details
19/01/2019 05:14	19/01/2019 05:25	23	Yes	Sardaigna	05:20:35	Yes	05:12 to 05:20 SCWA, MF(MF21F), U (U6), SCW1, U4, S3 (at 05:20:08)

S1A_IW_GRDH_1SDV_20190215T150741_20190215T150810_025942_02E3B5_2656



startQuery	endQuery	nbS1Products	RFI Observable	RFI Location	RFI Date	RS-2 Acquisition	RS-2 Details
15/02/2019 15:03	15/02/2019 15:14	10	Yes	Irak	15:07:41	Yes	15:02 to 15:14 WideU, XF0W3 between 15:04 and 15:09, WideU U26, WideU U14, WideU (U1W2)

S1A_IW_GRDH_1SDV_20190522T145251_20190522T145316_027341_031575_8415



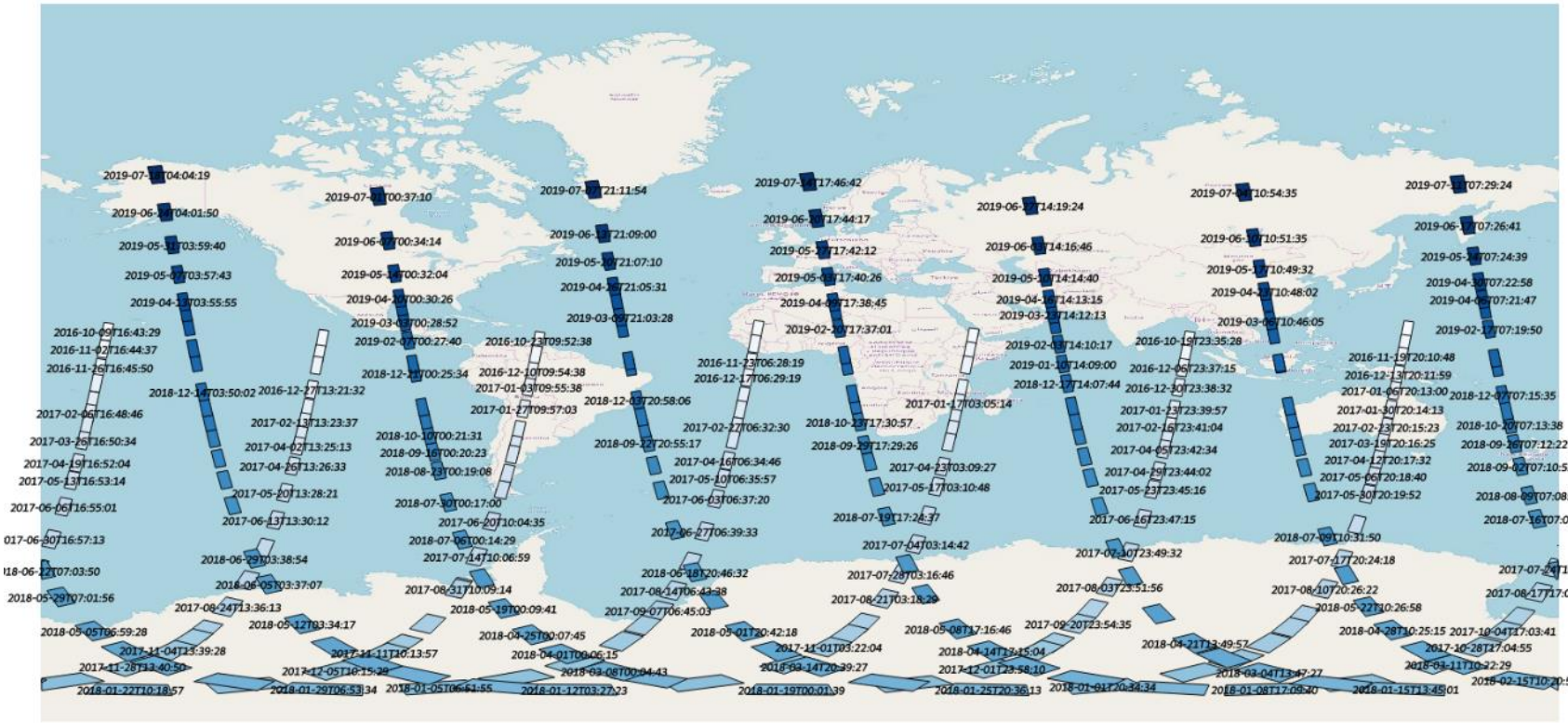
Weak interference
Does not look like usual mutual interferences as identified up to now (sharper and shorter)

startQuery	endQuery	nbS1Products	RFI Observable	RFI Location	RFI Date	RS-2 Acquisition	RS-2 Details
22/05/2019 14:46	22/05/2019 14:57	10	Yes	Réunion	14:52:51	Yes	14:52 SCWA

SENTINEL-1B VS RS-2

S1-B vs RS-2: **Potential** scene coverage at nearest distance

From 2016-sept to 2019-sept
Color code: increasing acquisition date is darker



Orbit cycle is 24 days for RS-2 (vs 12 days for S-1A). 7 crossings per cycle.
Crossing slowly moving along orbit from one cycle to another
Shortest distance between S/C at crossing: 95 to 105 km

S-1B vs RS-2: **Available** scenes at nearest distance

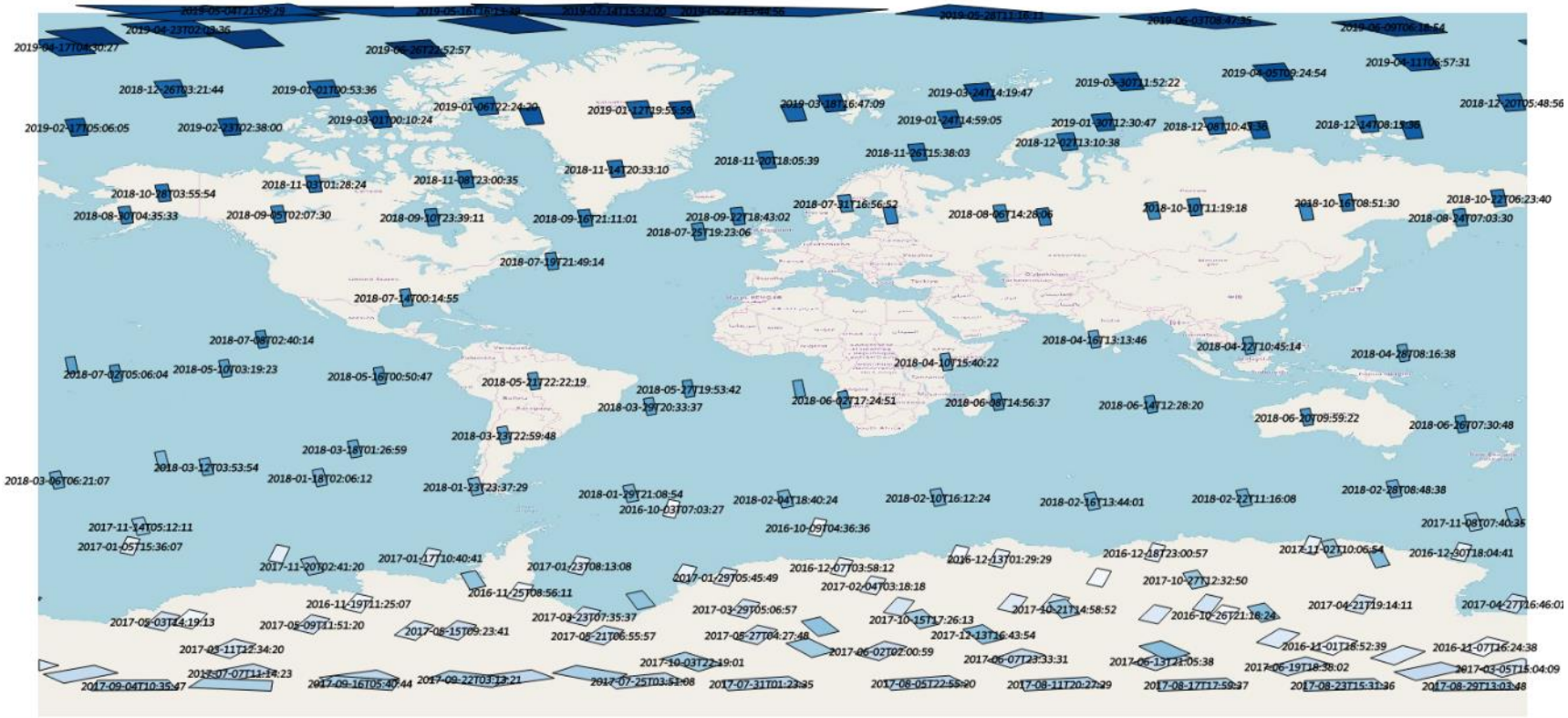
Color code: nb of S-1A scenes within +/- 5mn around each crossings

Much less acquisitions in configuration of proximity compared to S-1A

SENTINEL-1A VS GAOFEN-3

S1-A vs GF-3: **Potential** scene coverage at nearest distance

From 2016-oct to 2019-Sept
Color code: increasing acquisition date is darker

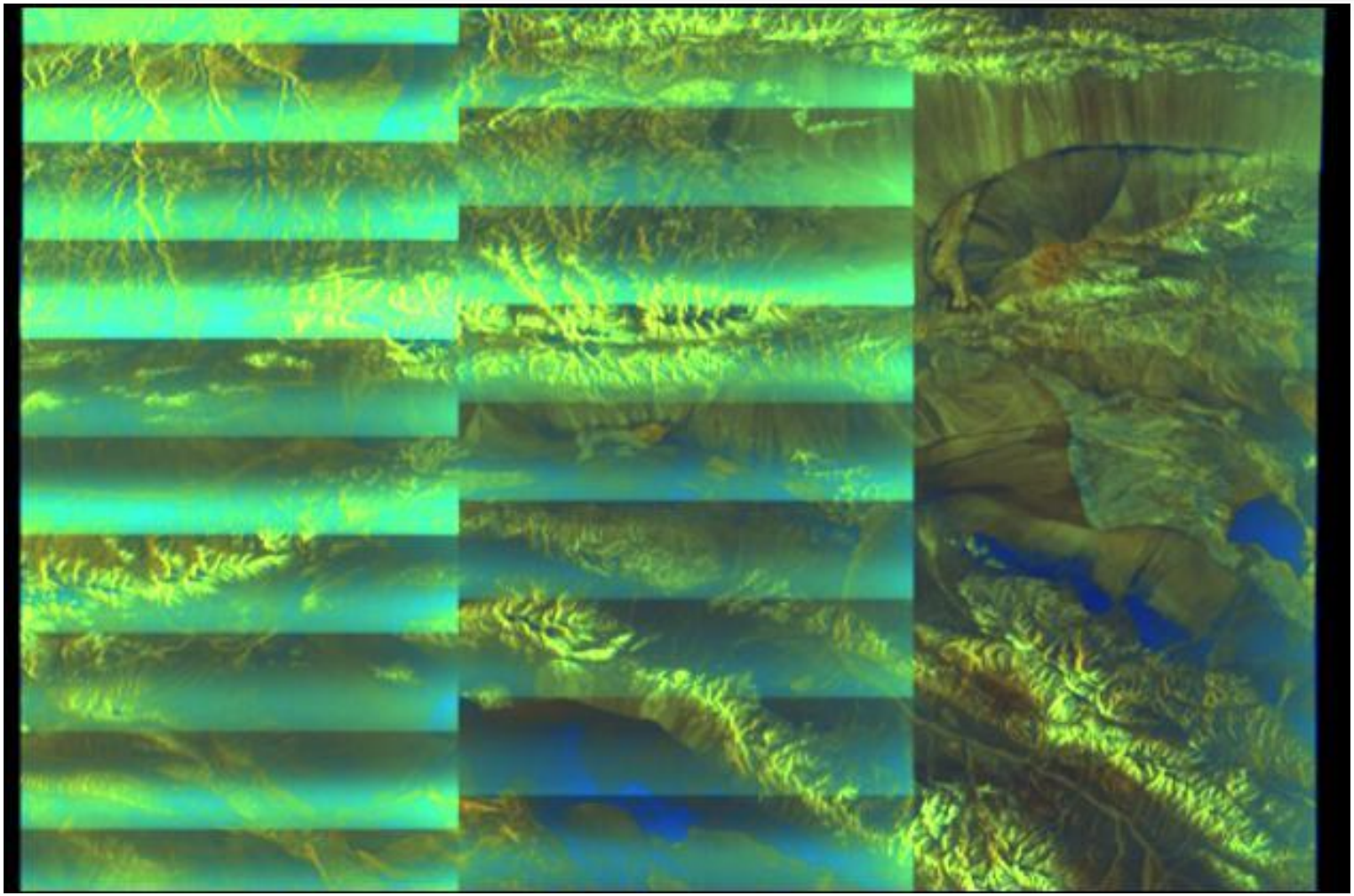


Orbit cycle is 29 days for GF-3 (vs 12 days for S-1A).
Shortest distance between S/C : 55 to 70 km

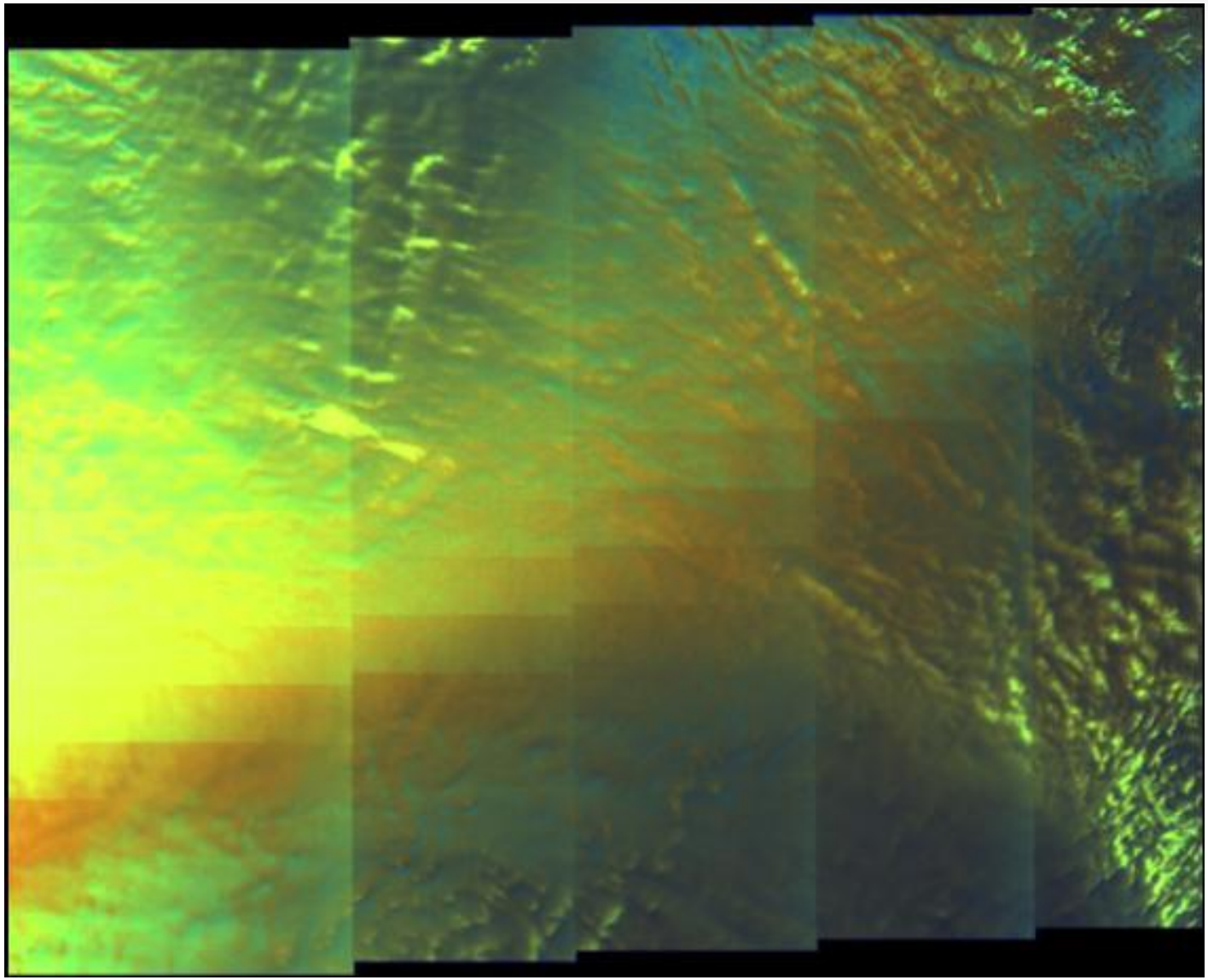
S-1A vs GF-3: **Available** scenes at nearest distance

From 2016-oct to 2019-Sept
Color code: nb of S-1A scenes within +/- 5mn around each crossings

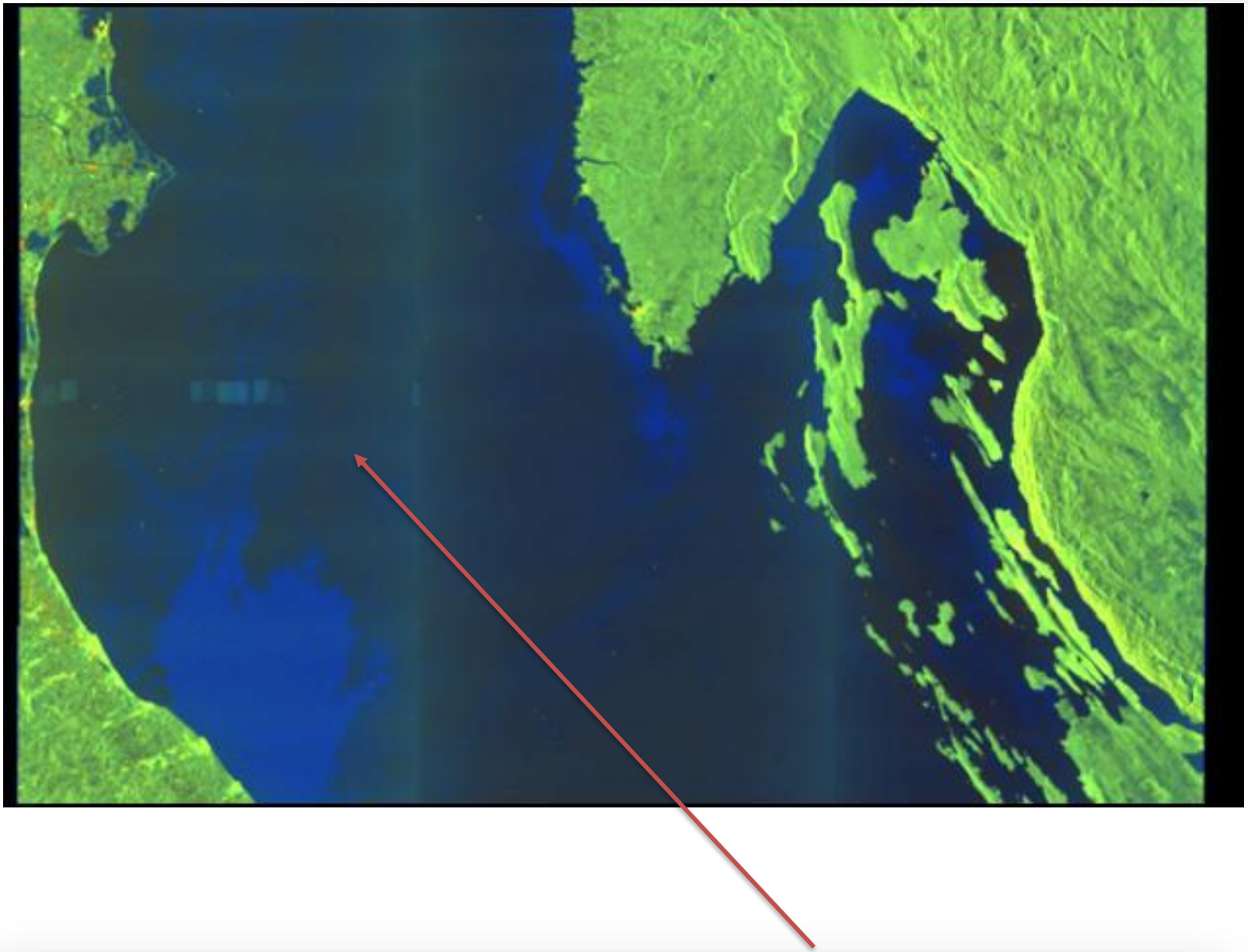
S1A_IW_GRDH_1SDV_20180812T120009_20180812T120034_023213_0285CA_1E6B



S1A_EW_GRDM_1SDH_20171213T164154_20171213T164245_019686_021748_A2B2



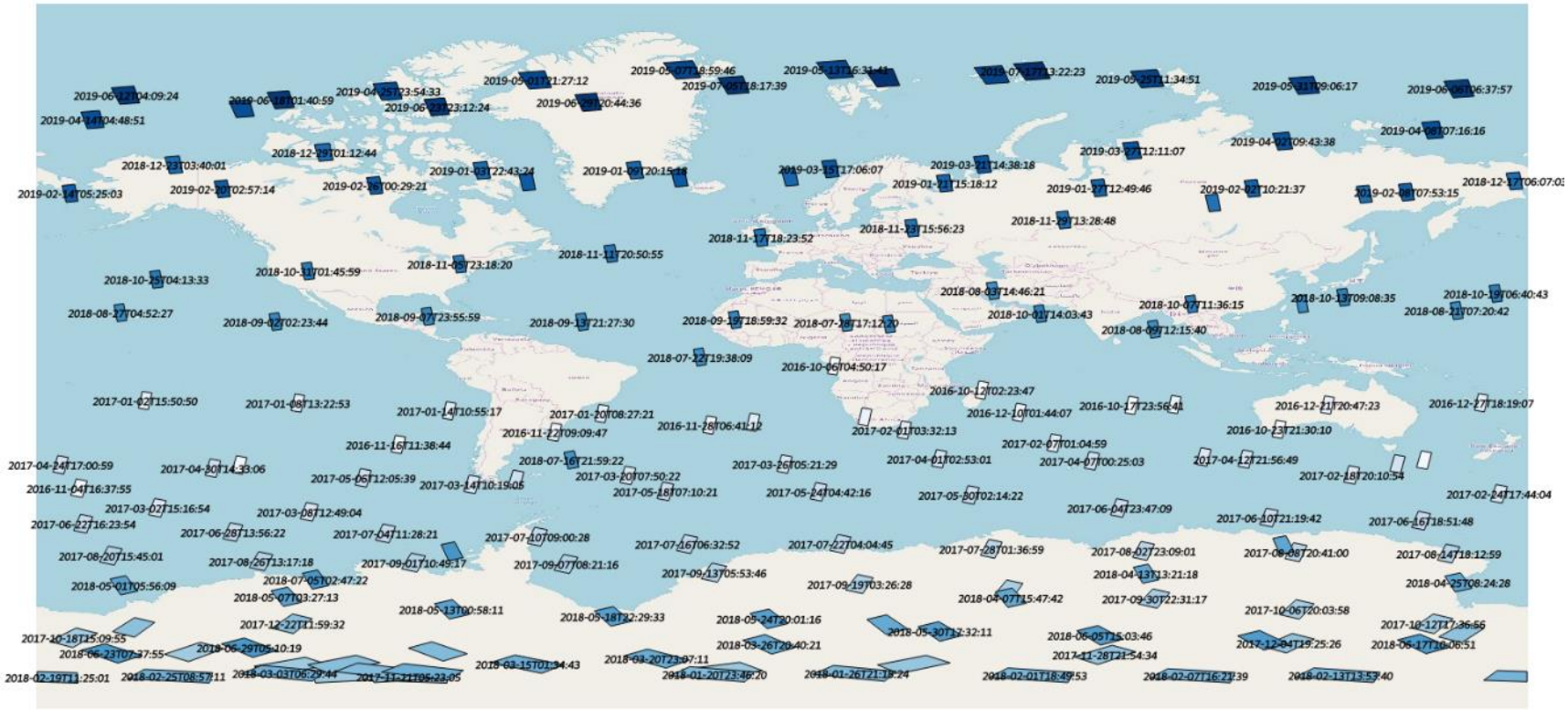
S1A_IW_GRDH_1SDV_20180731T165812_20180731T165837_023041_02804F_2C63



SENTINEL-1B VS GAOFEN-3

S1-B vs GF-3: **Potential** scene coverage at nearest distance

2016-Sept to 2019-Sept
Color code: increasing acquisition date is darker

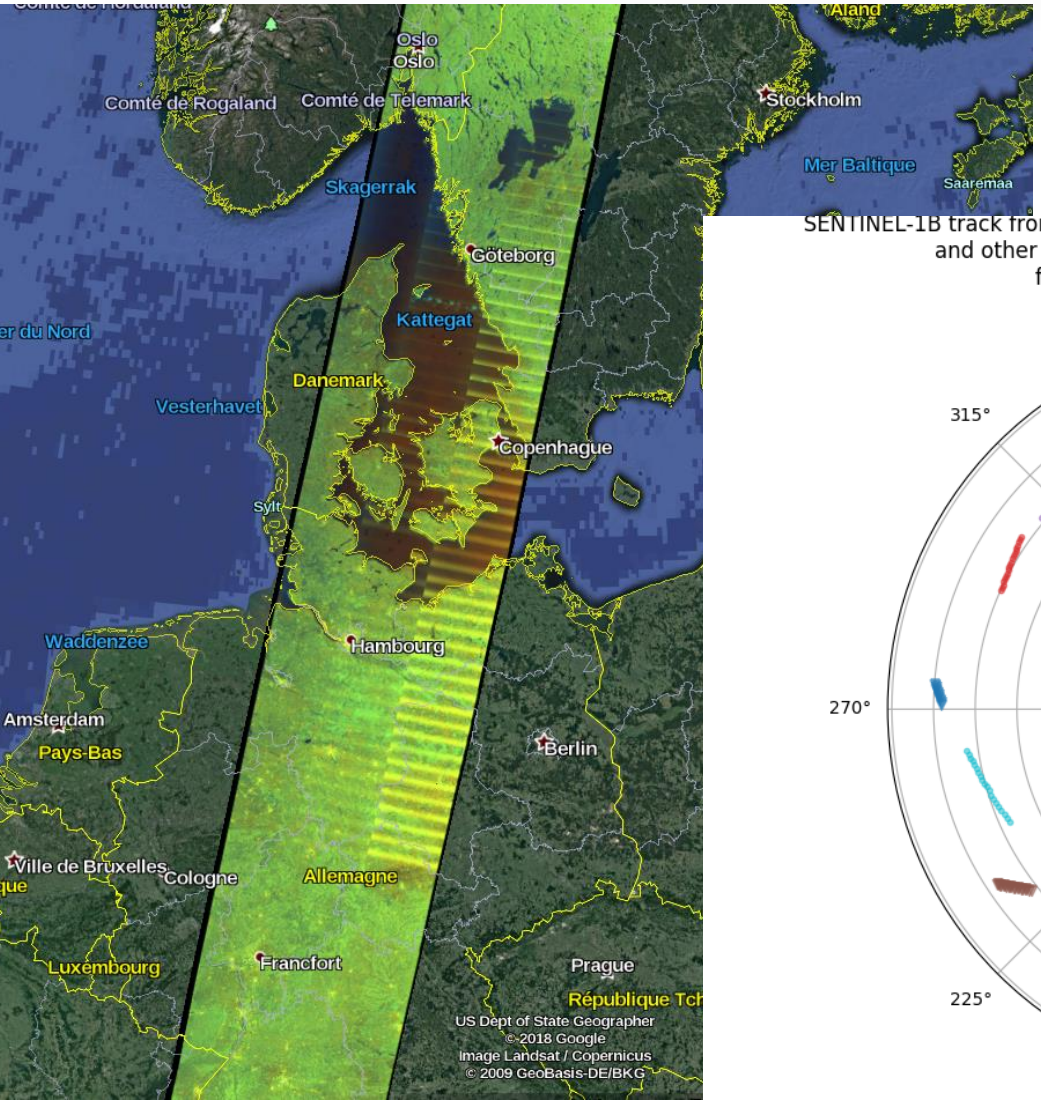


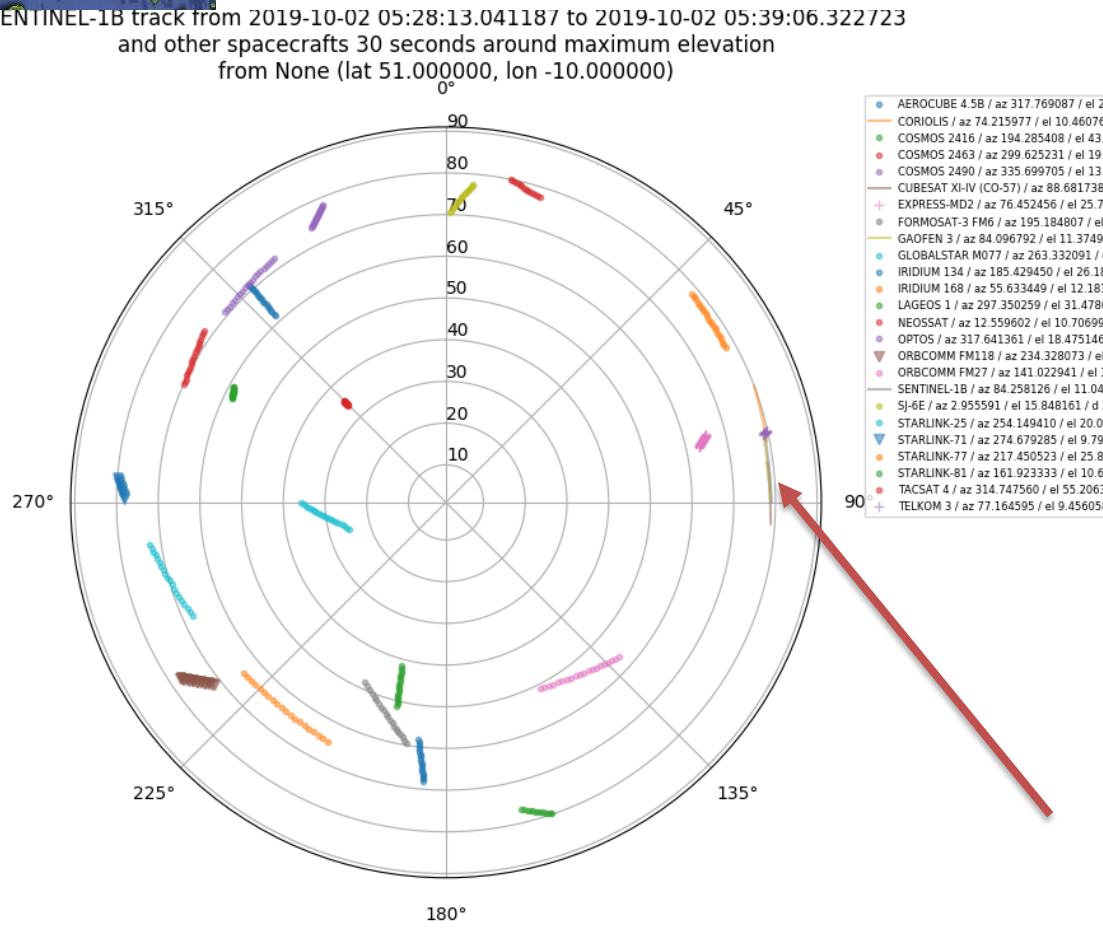
Orbit cycle is 29 days for GF-3 (vs 12 days for S-1A).
Shortest distance between S/C : 55 to 84 km

S-1B vs GF-3: **Available** scenes at nearest distance

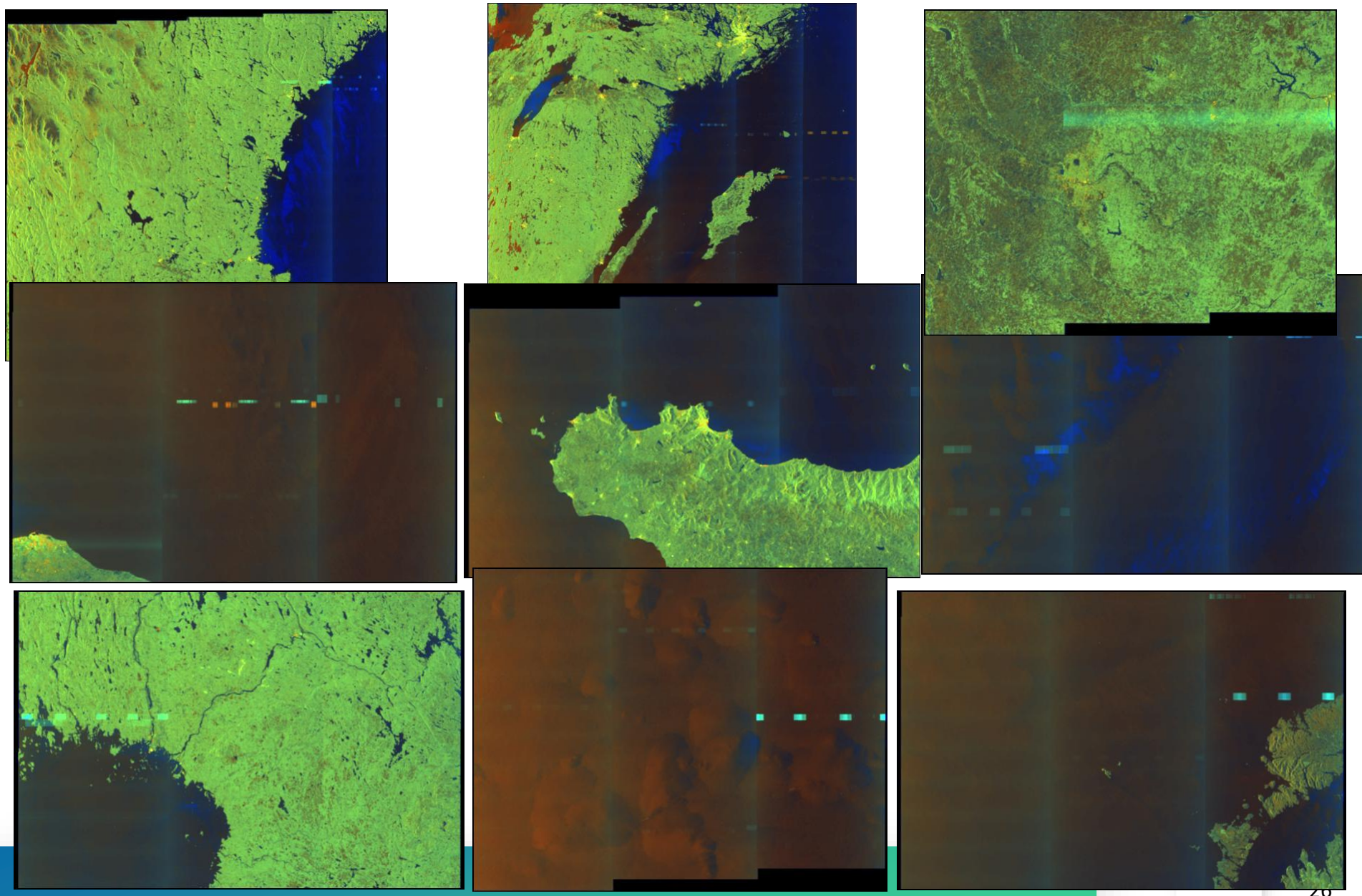
2016-Sept to 2019-Sept
Color code: nb of S-1A scenes within +/- 5mn around each crossings

S-1B 2019-10-02T05:28





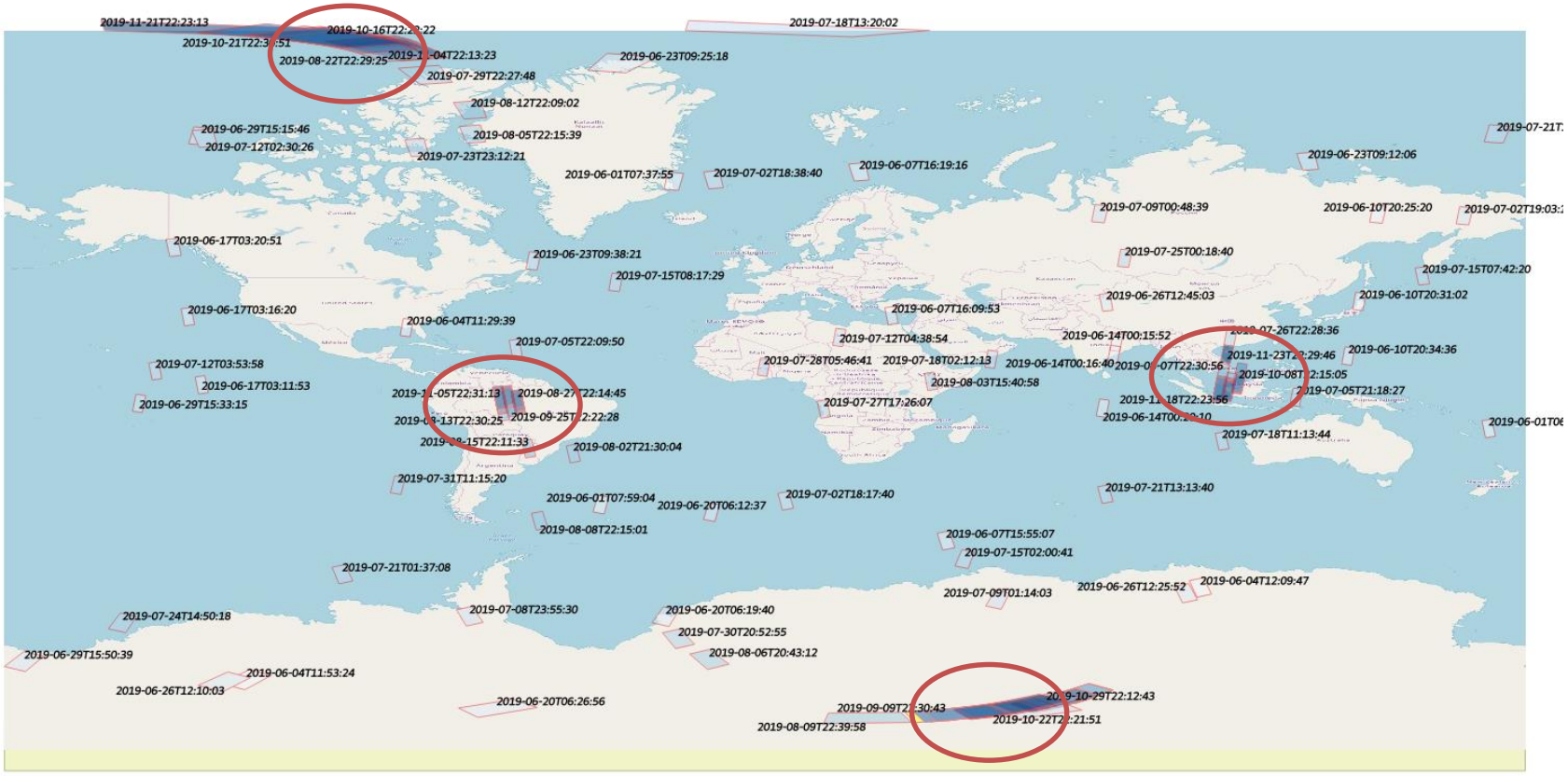
S-1B vs GF-3



SENTINEL-1A VS RCM-1/2/3

S1-A vs RCM-1/2/3: **Potential** scene coverage at nearest distance

From 2019-Jun to 2019-Nov
Color code: increasing acquisition date is darker



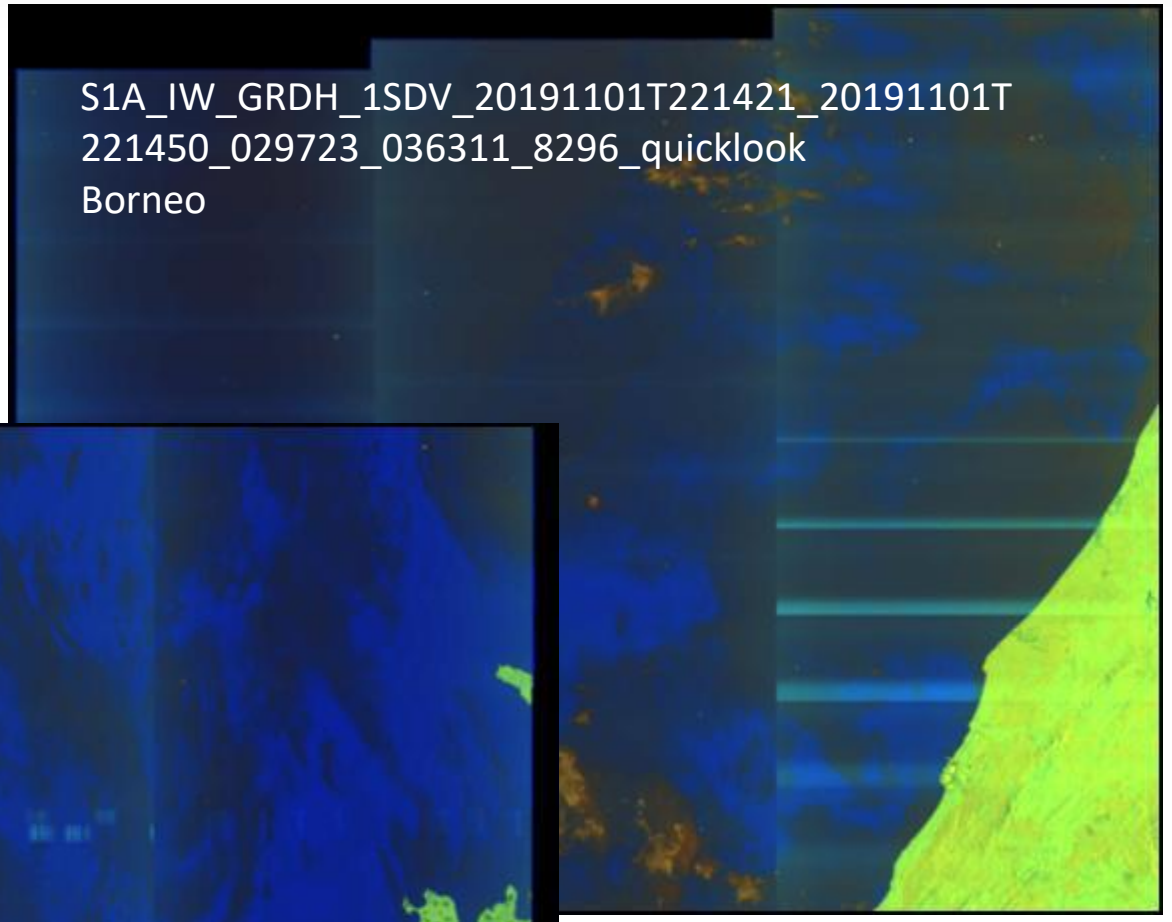
RCM 1/2/3 progressively reaching their nominal orbit
Orbit cycle is 12 days for each RCM unit (vs 12 days for S-1A)
Poximity over 4 areas

S1-A vs RCM-1/2/3: **Available** scene coverage at nearest distance

From 2019-Jun to 2019-Nov
Color code: nb of S-1A scenes within +/- 5mn around each crossings

Two sites without S-1A acquisitions
Cooperation between ESA & CSA ?

S-1A vs RCM


S1A_IW_GRDH_1SDV_20191101T221421_20191101T
221450_029723_036311_8296_quicklook
Borneo


S1A_IW_GRDH_1SDV_20190607T162056_20190607T
162121_027576_031CA9_239B_quicklook
Baltic Sea

SENTINEL-1B VS RCM-1/2/3

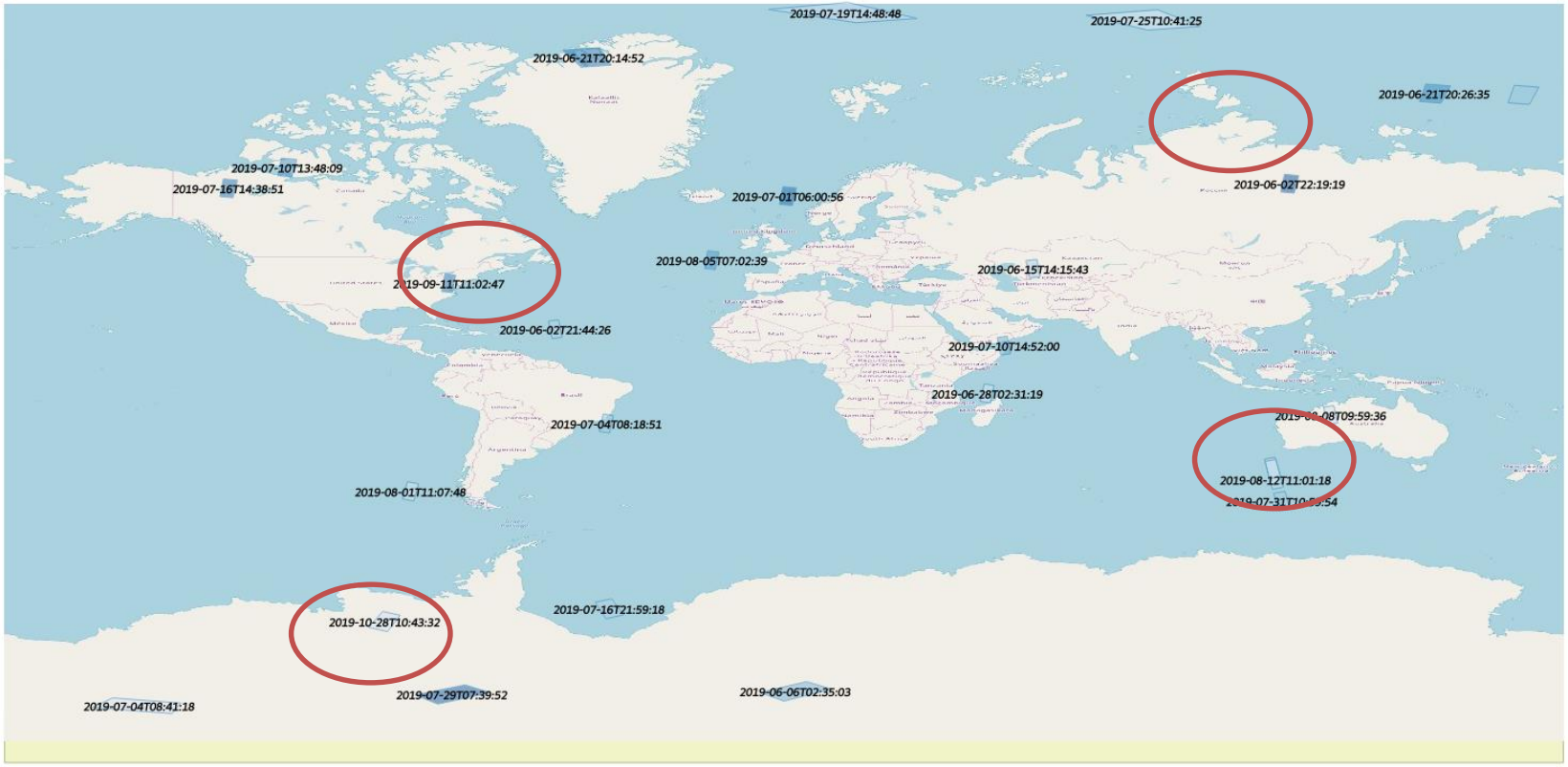
S1-B vs RCM-1/2/3: **Potential** scene coverage at nearest distance

From 2019-Jun to 2019-Nov
Color code: increasing acquisition date is darker

RCM 1/2/3 progressively reaching their nominal orbit
Orbit cycle is 12 days for each RCM unit (vs 12 days for S-1A)
Proximity over 4 areas

S1-B vs RCM-1/2/3: **Available** scene coverage at nearest distance

From 2019-Jun to 2019-Nov
Color code: nb of S-1A scenes within +/- 5mn around each crossings



4 sites without S-1B acquisitions
Cooperation between ESA & CSA ?

Conclusion

- Number of configuration of mutual RFI increases with new missions
- Prediction of proximity other spacecrafts allows a better monitoring of RFI
  - Location of RFI are either concentrated or shifting or spread over the globe
- Not always very long RFI signatures
  - Depends on mode and acquisition duration of the second instrument
- Acquisition plan of S-1 seems to consider RCM as a potential source of RFI
- Gaofen-3 is a source of very large interferences

- But some sources of interferences still to be identified…

Sentinel-1B 2019-04-11 vs unknown emiter