

Mutual Interference between C-Band SAR

Prediction of occurrences for identification of sources

Authors: G.Hajduch, D. Le Levier

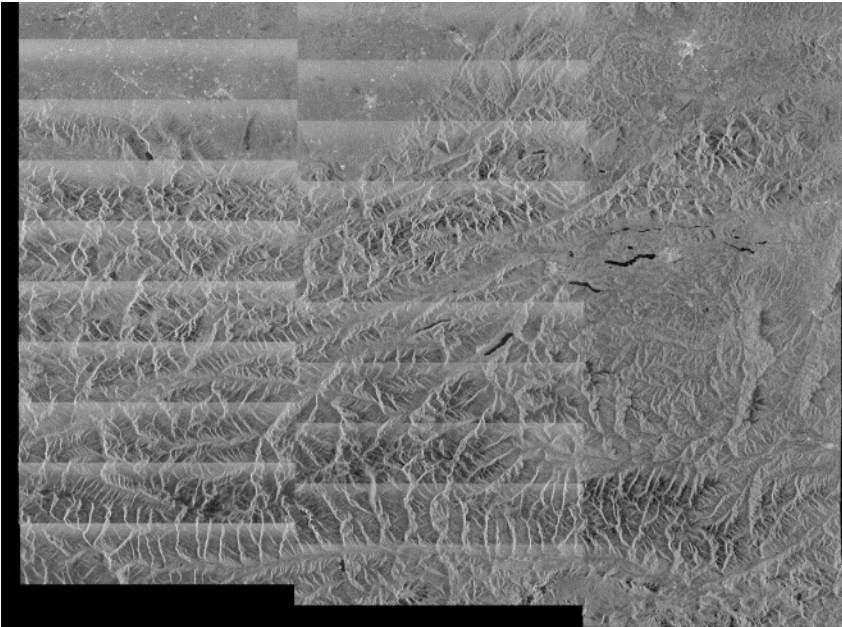
Date: 2019/11/18

Event: VH-RODA workshop

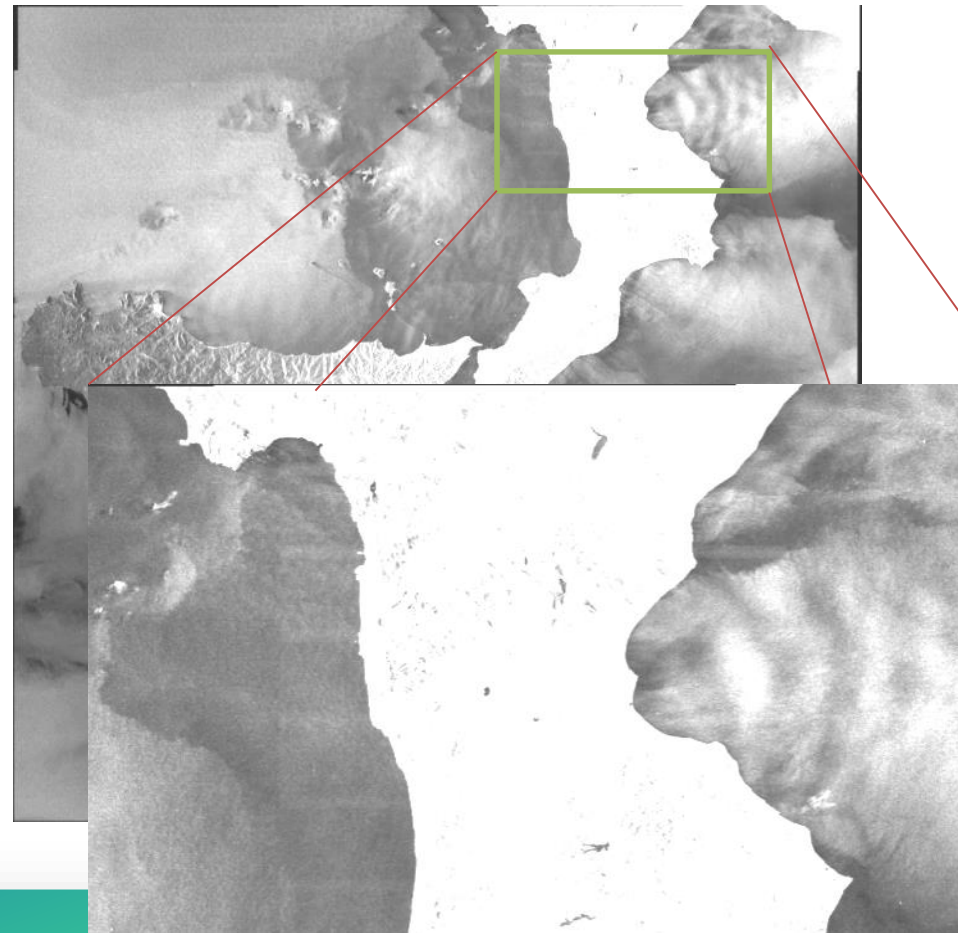
Example

~ 3mn along track

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



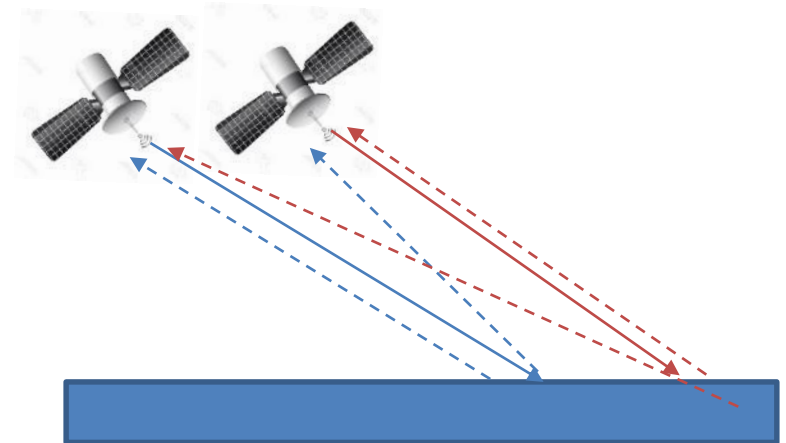
RS2_SWB_1FSCLS20150816_165532.
png



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 N2-5	RosHydroMet	≥2022	≥2027	TC & Ranging	E-S	5747.124 MHz	8M19G2D	10010 kHz	LHCP	0.1/1.0 kbps	D	Telemetry, command & ranging

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

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

Methodology

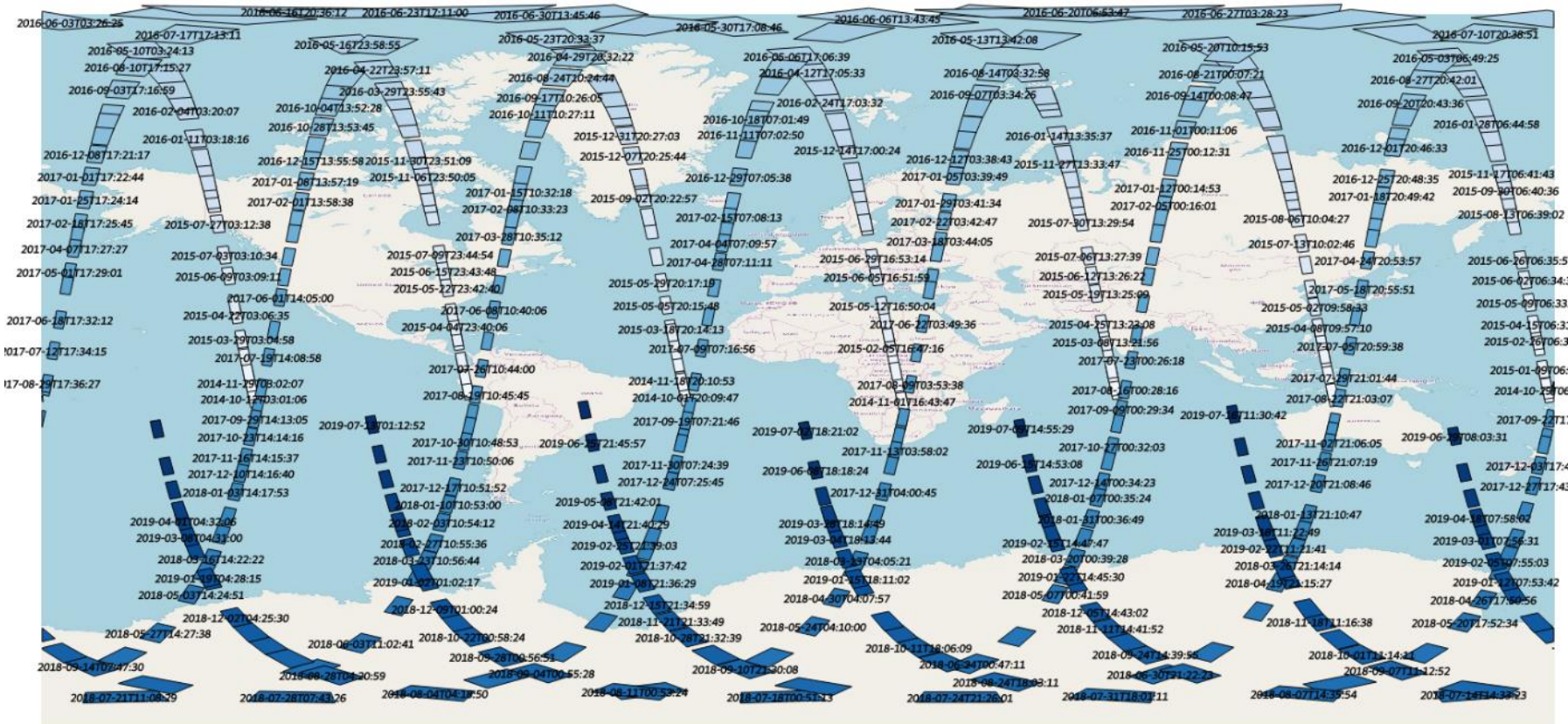
- Select a couple of spacecraft (S-1 A/B vs another)
- Screen distance between the two spacecrafts and detect times of nearest distance
- Check if S-1 data was acquired
- Check if RFI is observable
- If possible: Check if the other spacecraft was transmitting at the same time

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

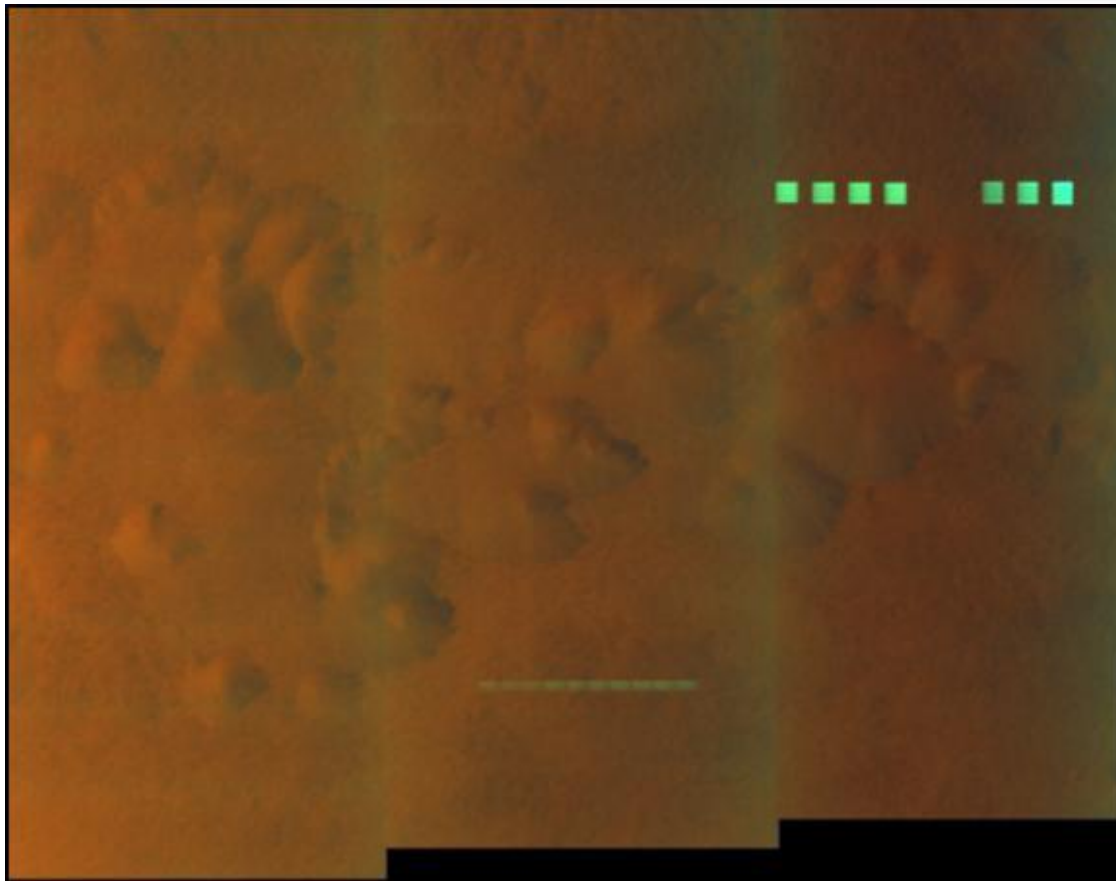
S-1A vs RS-2: Available scenes at nearest distance

From 2014-sept to 2019-sept

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

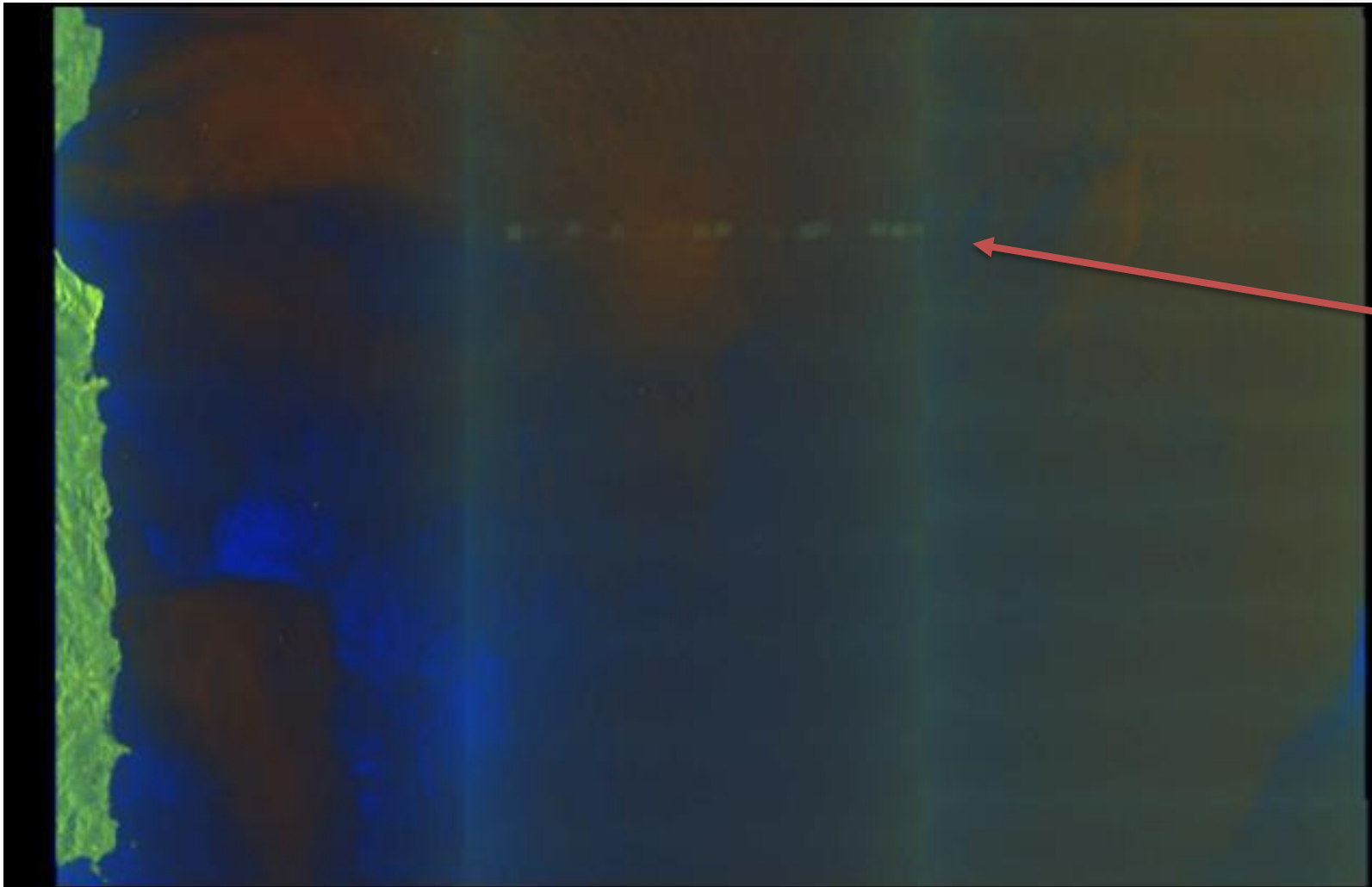


107 times of proximity identified
38 of them with S-1A acquisitions

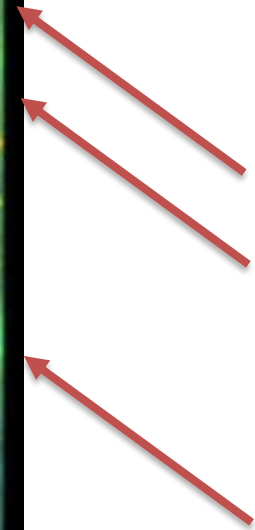
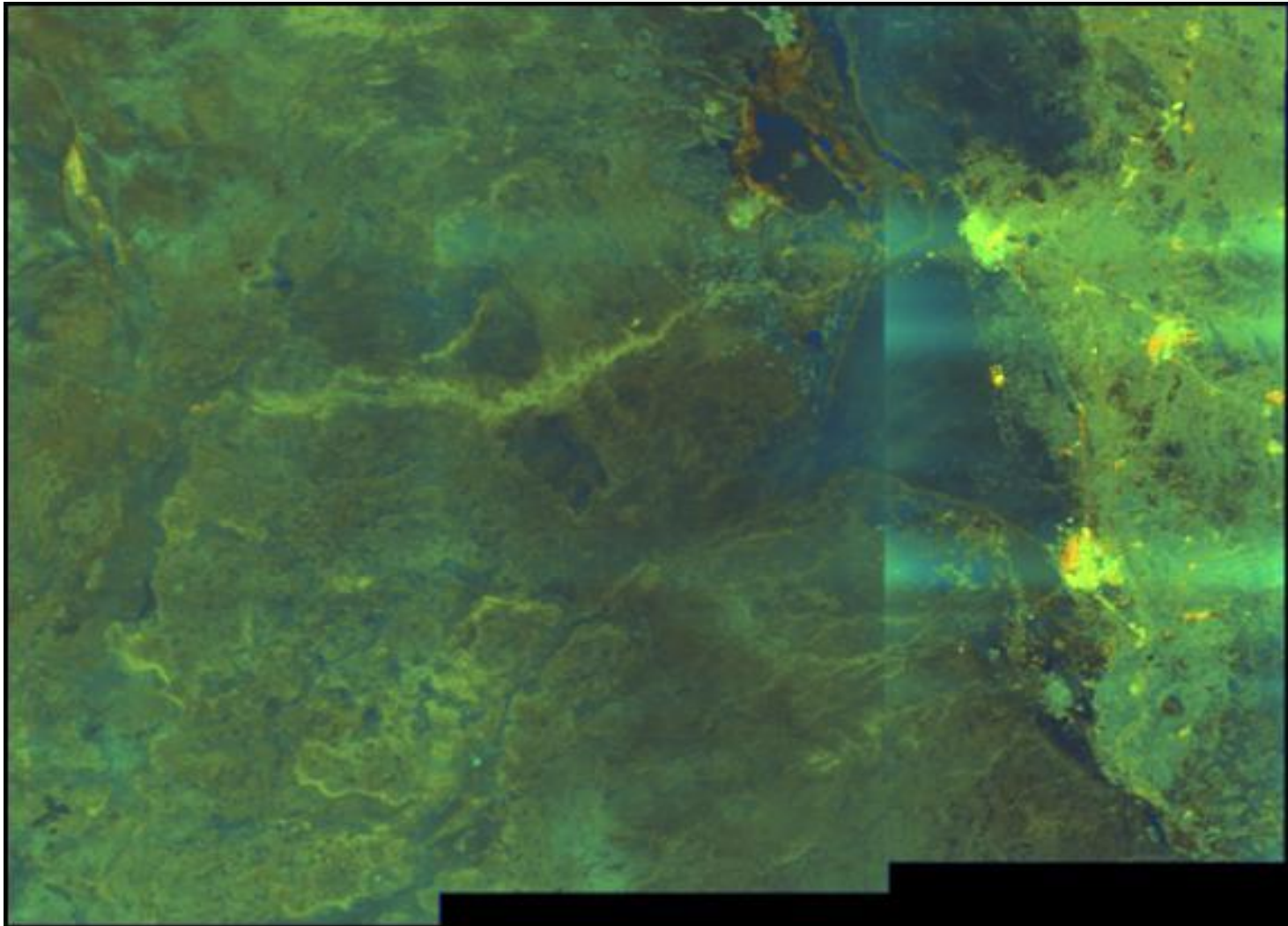


- Not a « massive » signature of RFI
- However, Radarsat-2 was in operation around that time

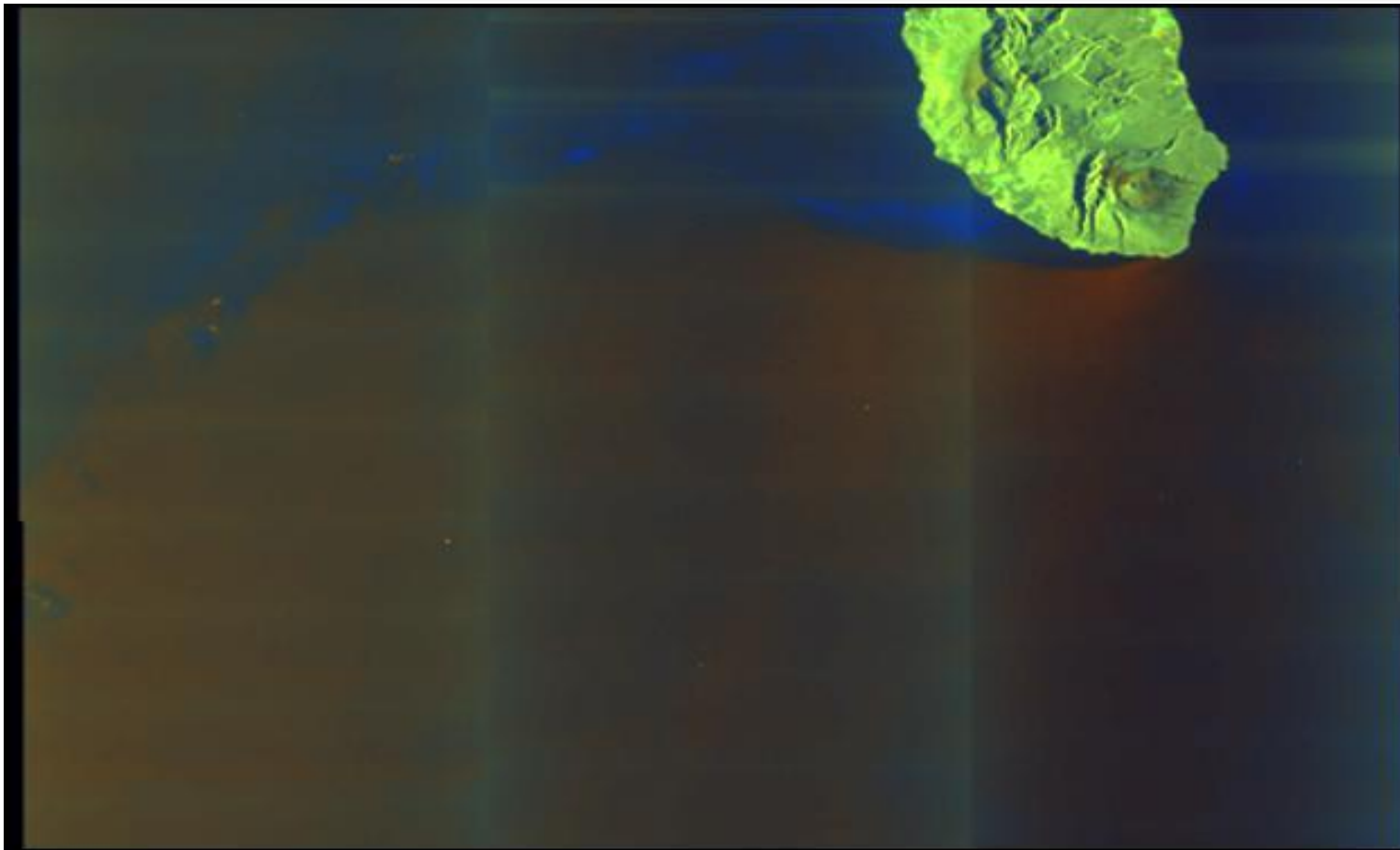
startQuery	endQuery	nbS1Products	RFI Observable	RFI Location	RFI Date	RS-2 acquisition	RS-2 Details
02/04/2018 18:39	02/04/2018 18:44		7 Yes		18:40:50	Yes	18:43: WideF (F0W1)



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)



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, XFOW3 between 15:04 and 15:09, WideU U26, WideU U14, WideU (U1W2)



Weak interference

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

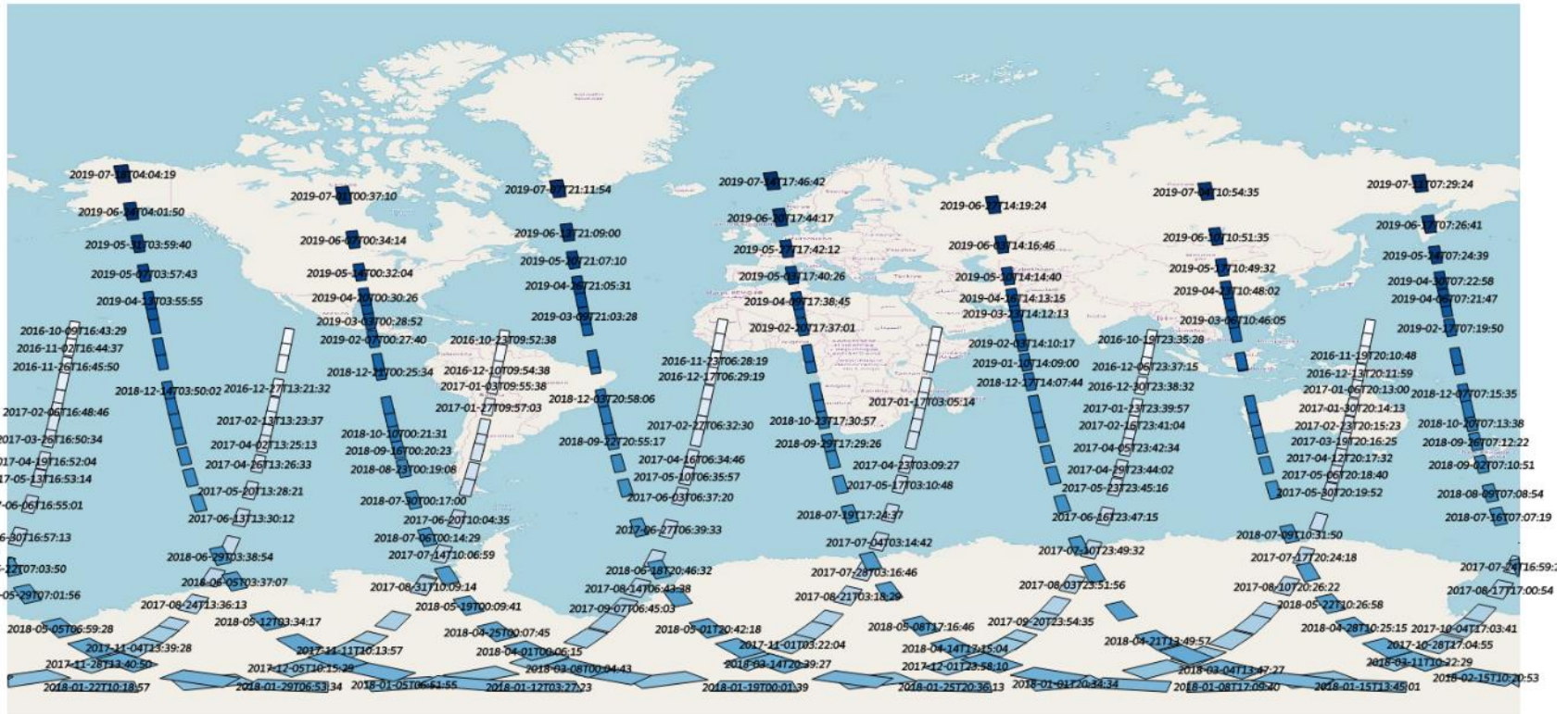
startQuery	endQuery	nbS1Products	RFI Observable	RFI Location	RFI Date	RS-2 Acquisition	RS-2 Details
22/05/2019 14:46	22/05/2019 14:57	10	Yes	Réunion	14:52:51	Yes	14:52 SCWA

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



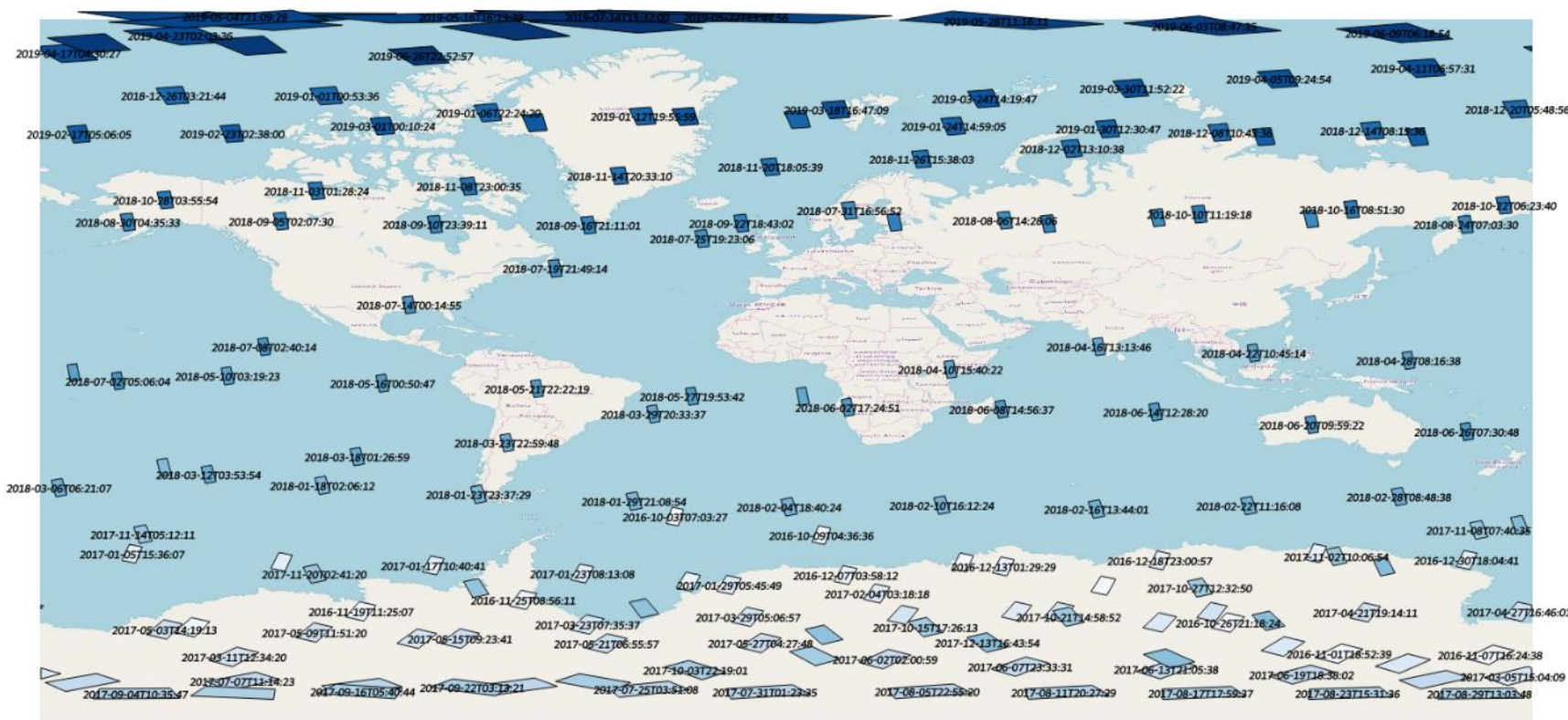
Much less acquisitions in configuration of proximity compared to S-1A

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



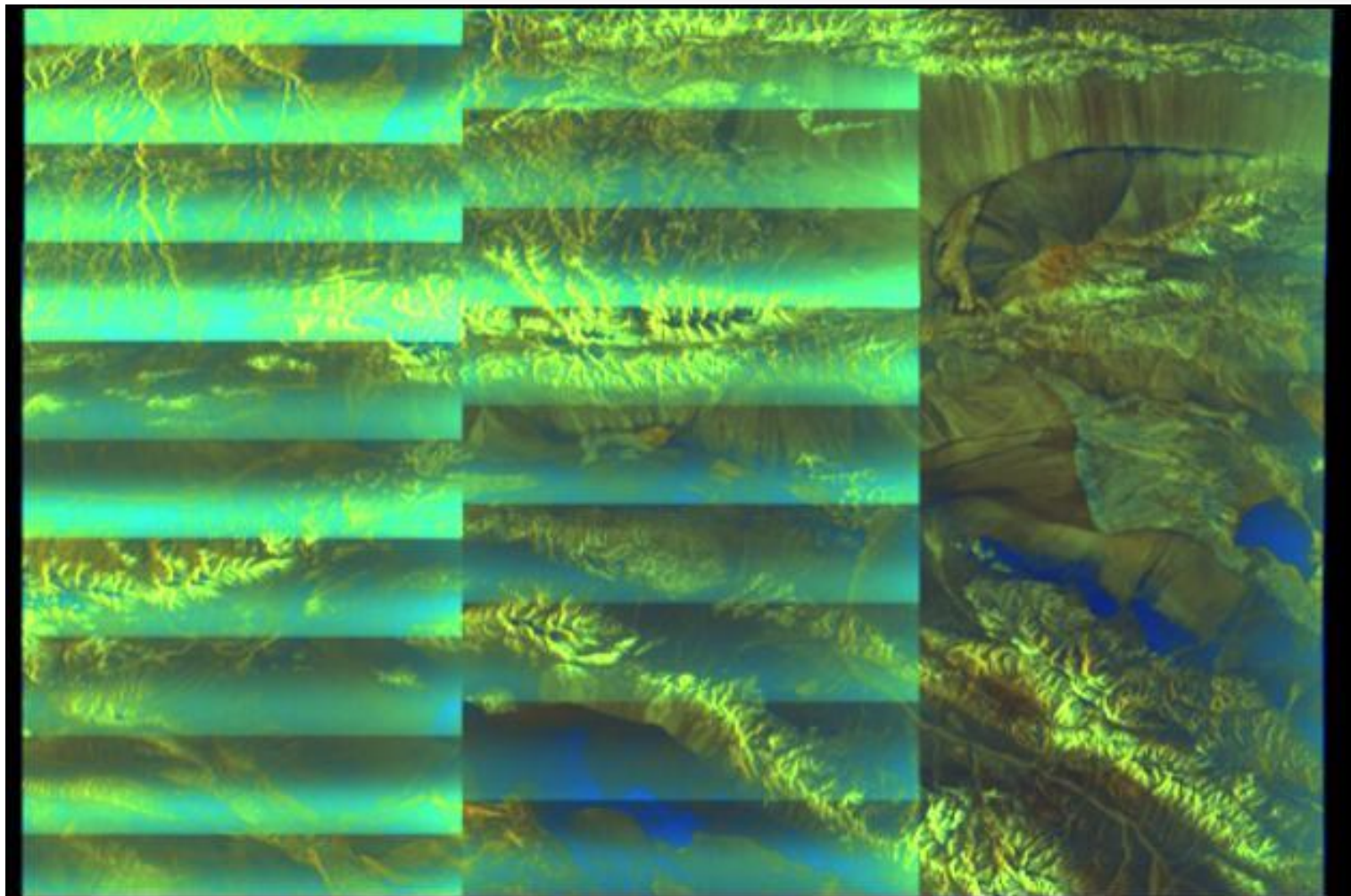
Orbit cycle is 29 days for GF-3 (vs 12 days for S1-A).
Shortest distance between S/C : 55 to 70 km

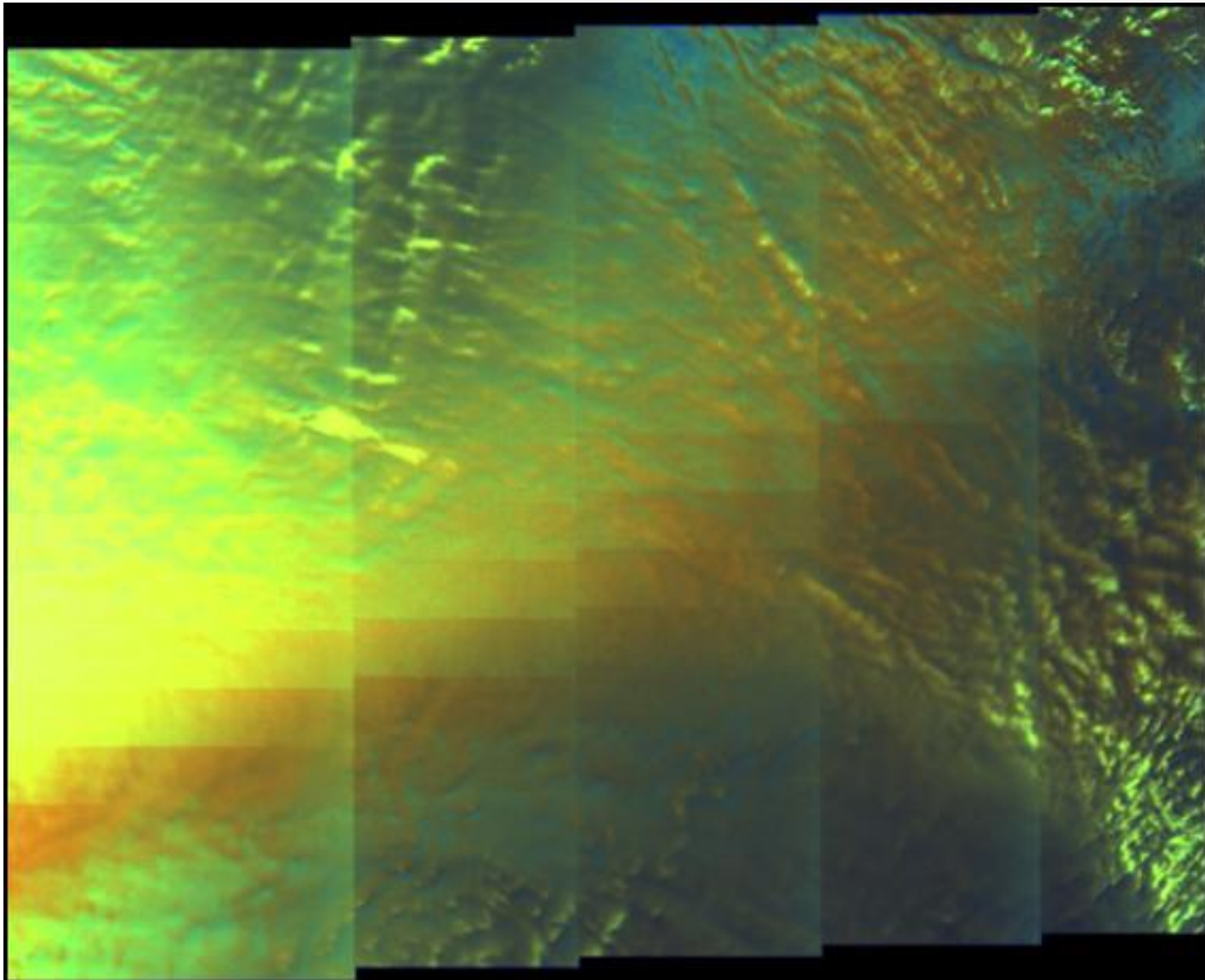
S-1A vs GF-3: Available scenes at nearest distance

From 2016-oct to 2019-Sept

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







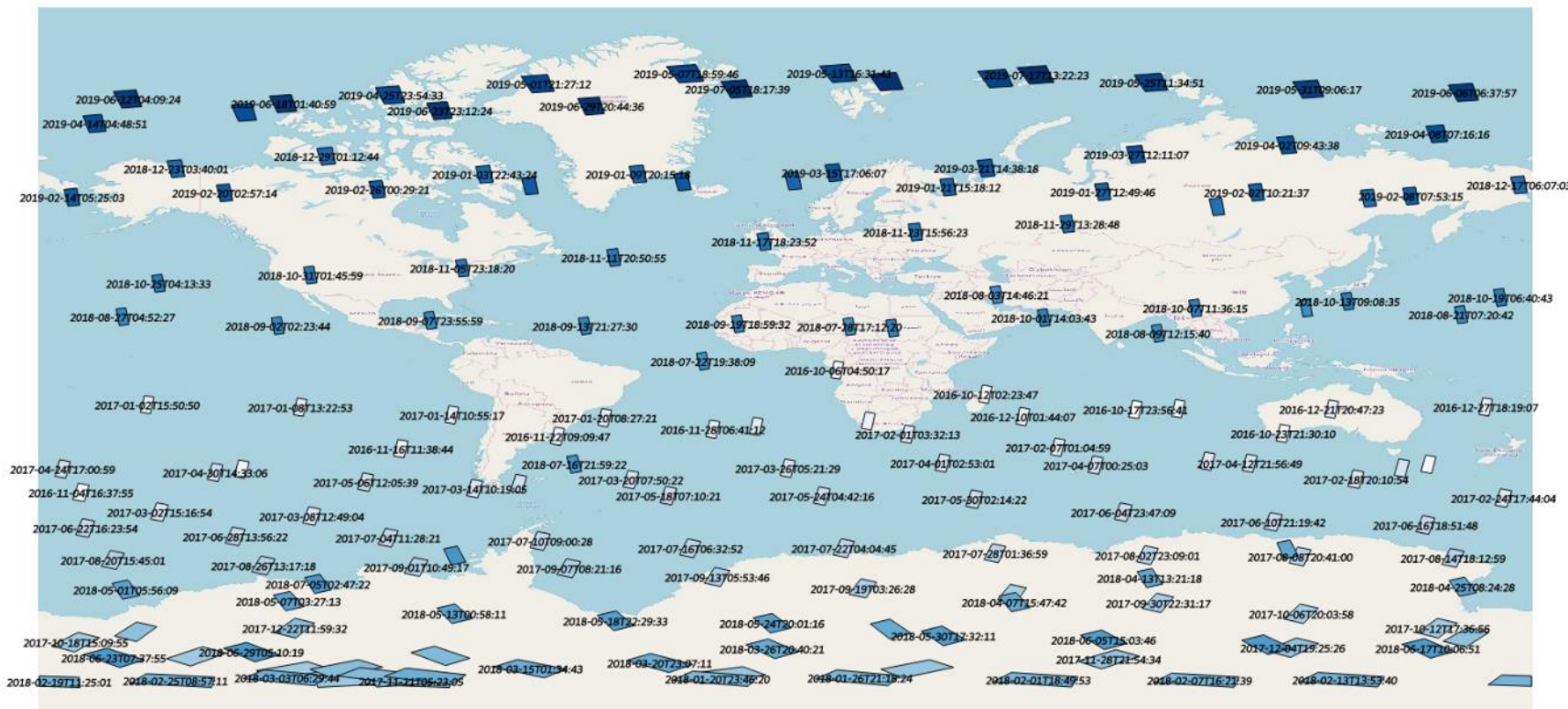


SENTINEL-1B VS GAOFEN-3

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

2016-Sept to 2019-Sept

Color code: increasing acquisition date is darker

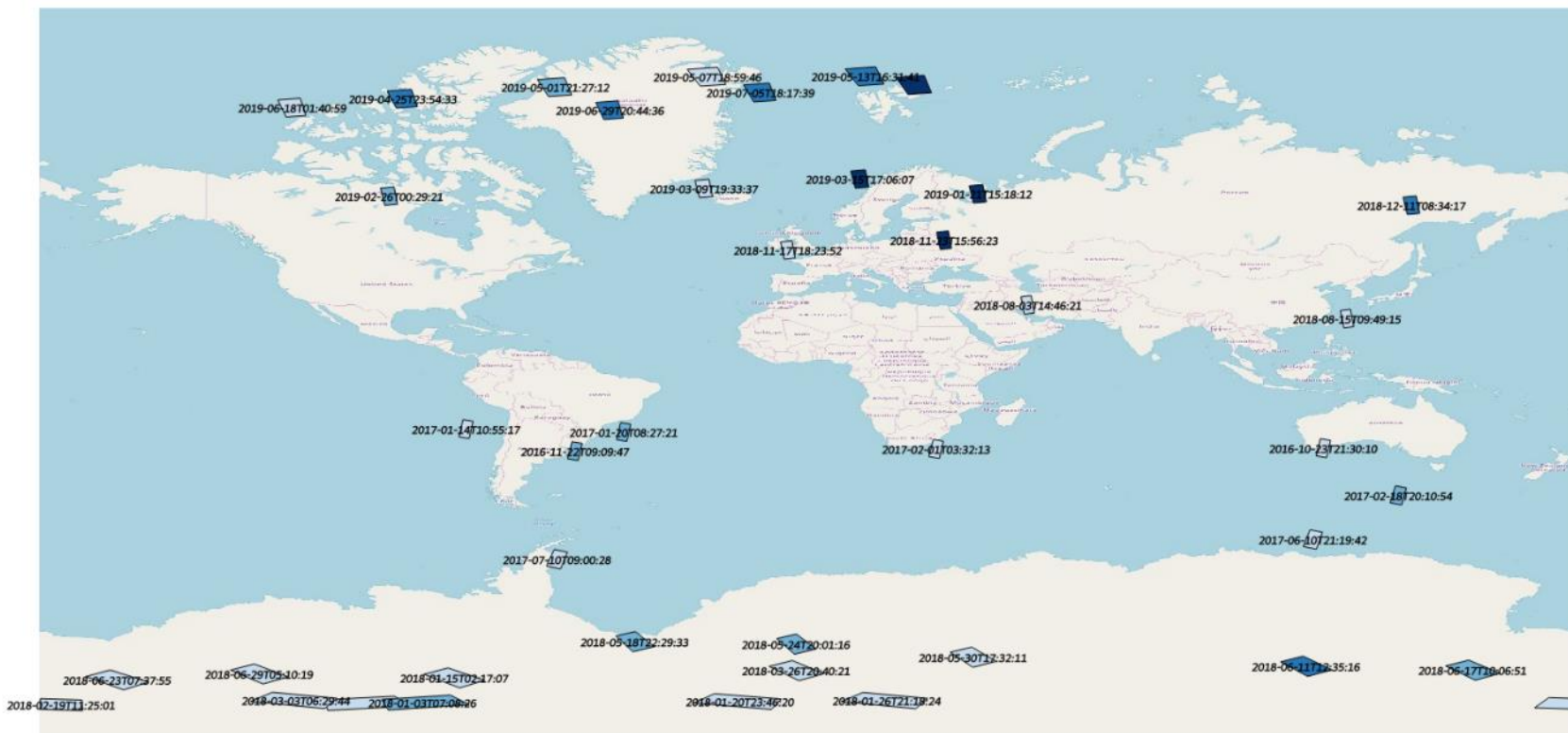


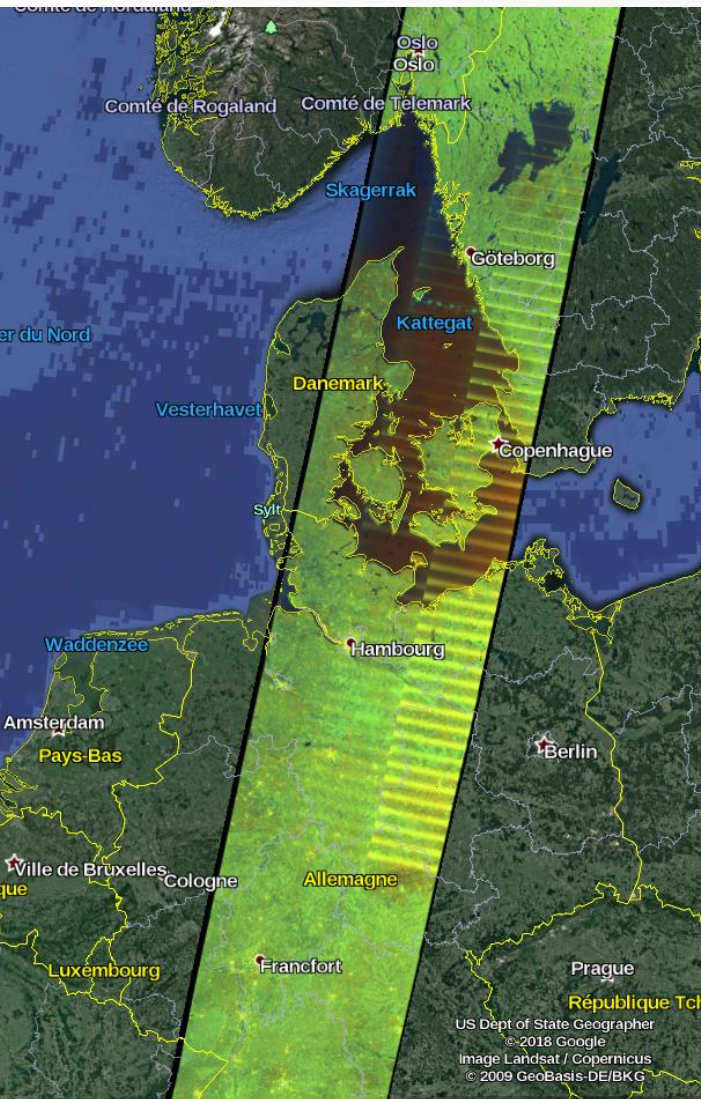
Orbit cycle is 29 days for GF-3 (vs 12 days for S-1A).
Shortest distance between S/C : 55 to 84 km

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

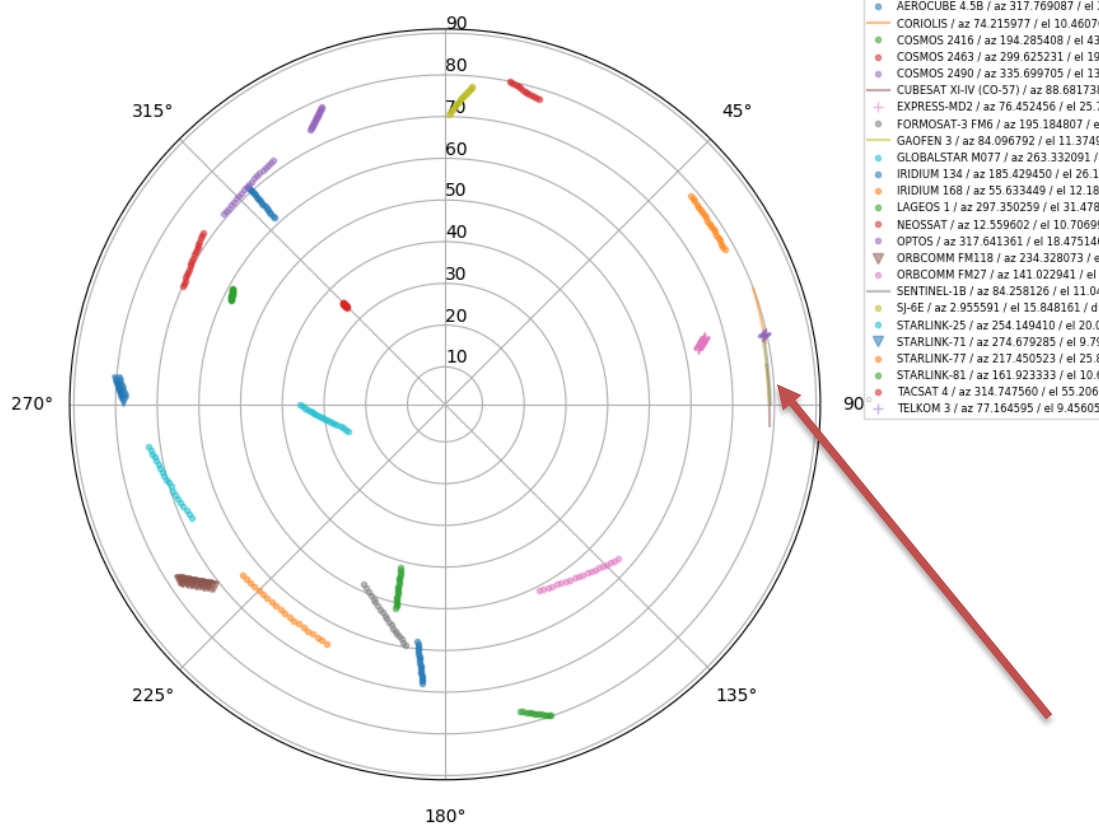
2016-Sept to 2019-Sept

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

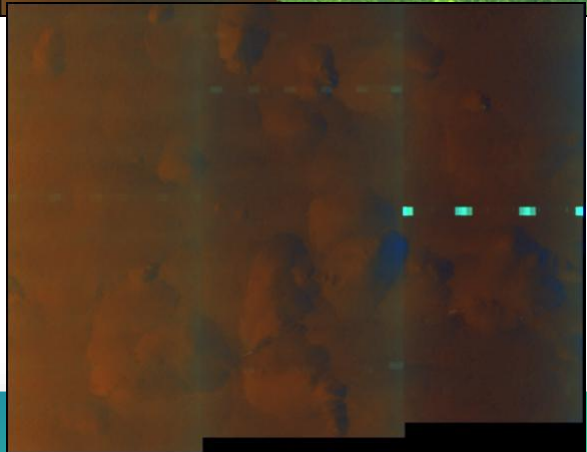
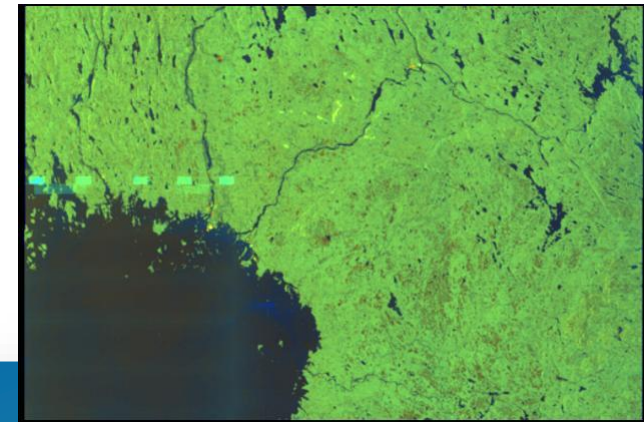
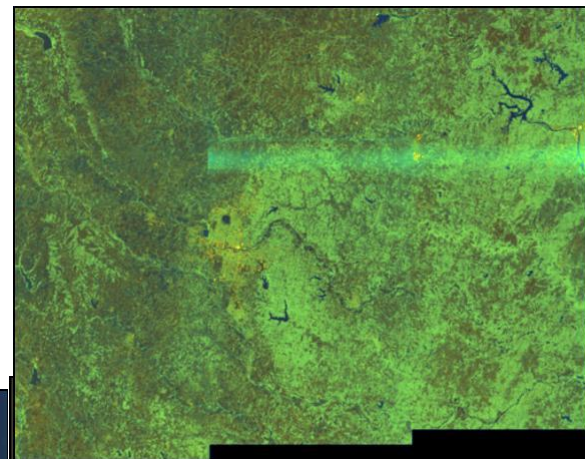
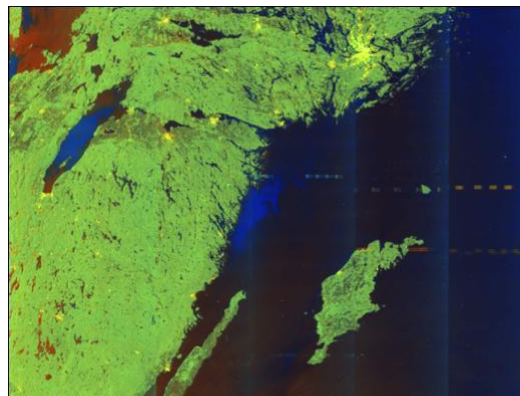
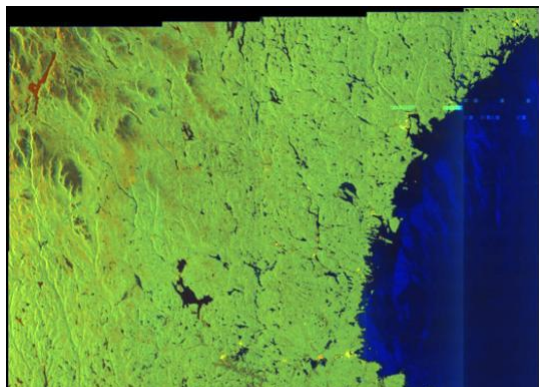




SENTINEL-1B track from 2019-10-02 05:28:13.041187 to 2019-10-02 05:39:06.322723 and other spacecraft 30 seconds around maximum elevation from None (lat 51.000000, lon -10.000000)



S-1B vs GF-3

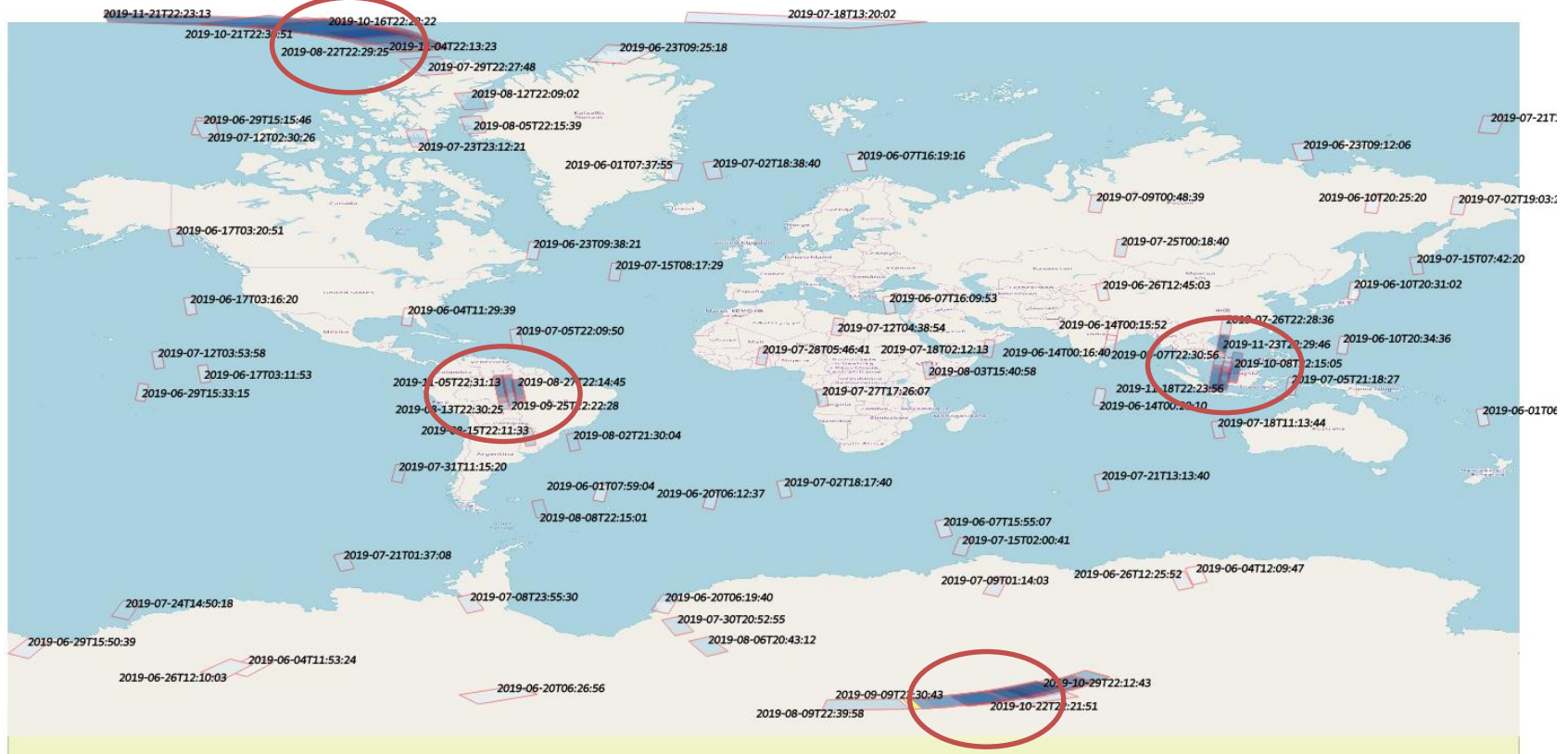


SENTINEL-1A VS RCM-1/2/3

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

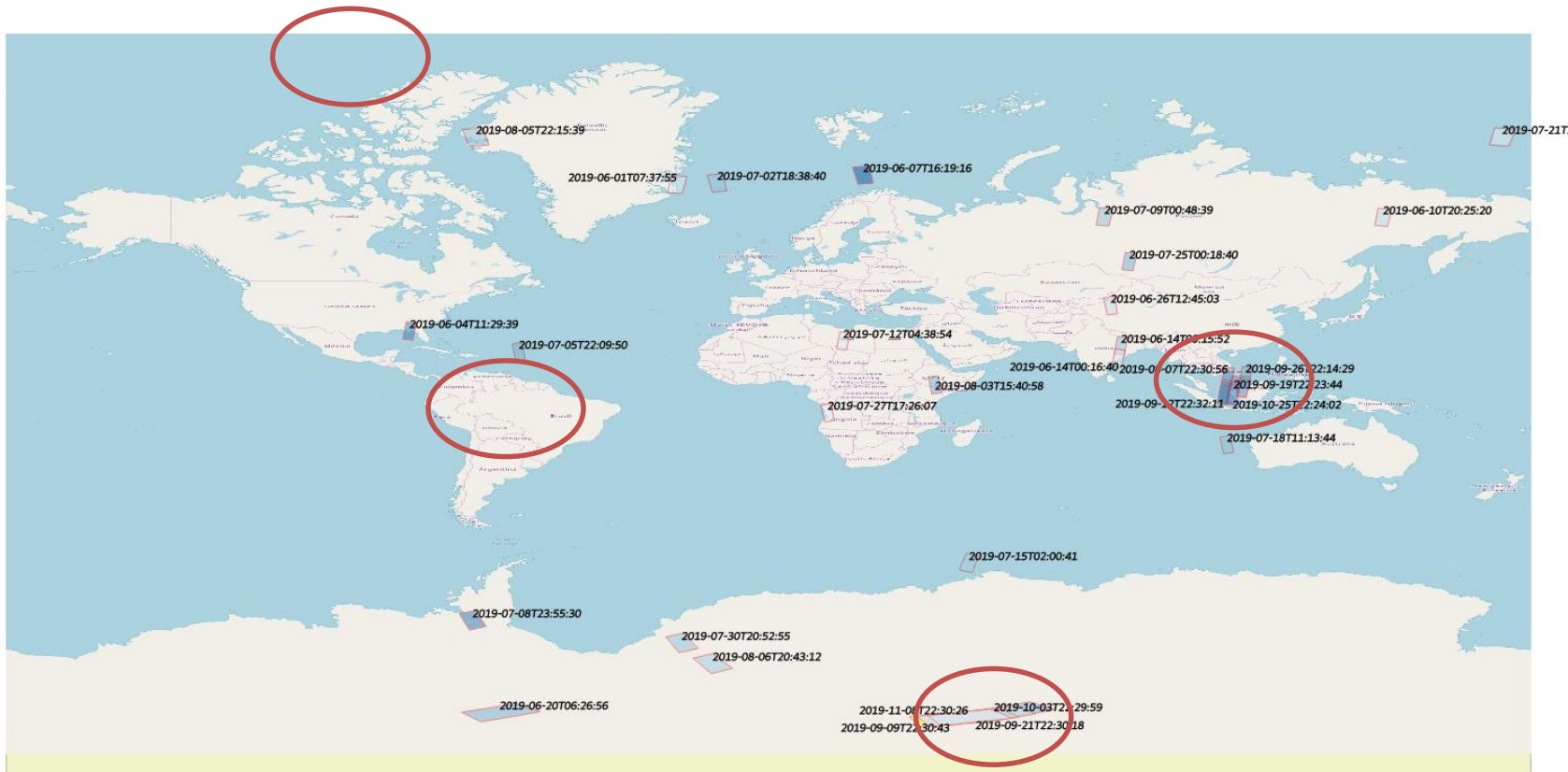
Orbit cycle is 12 days for each RCM unit (vs 12 days for S-1A)

Proximity over 4 areas

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

From 2019-Jun to 2019-Nov

Color code: increasing acquisition date is darker



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

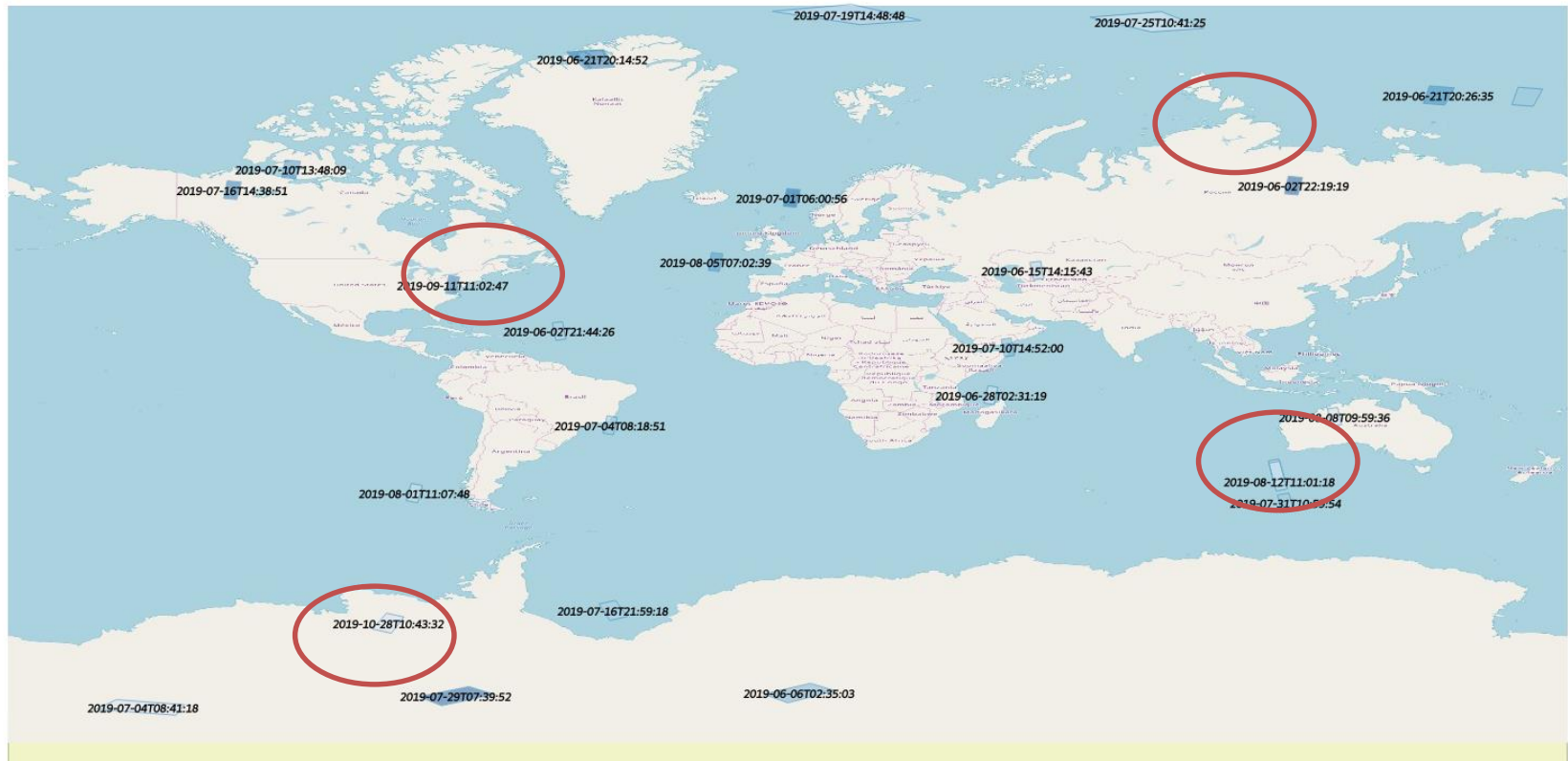
Orbit cycle is 12 days for each RCM unit (vs 12 days for S-1A)

Proximity over 4 areas

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

From 2019-Jun to 2019-Nov

Color code: increasing acquisition date is darker



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 emitter

