Mission SWARM: les premiers résultats scientifiques

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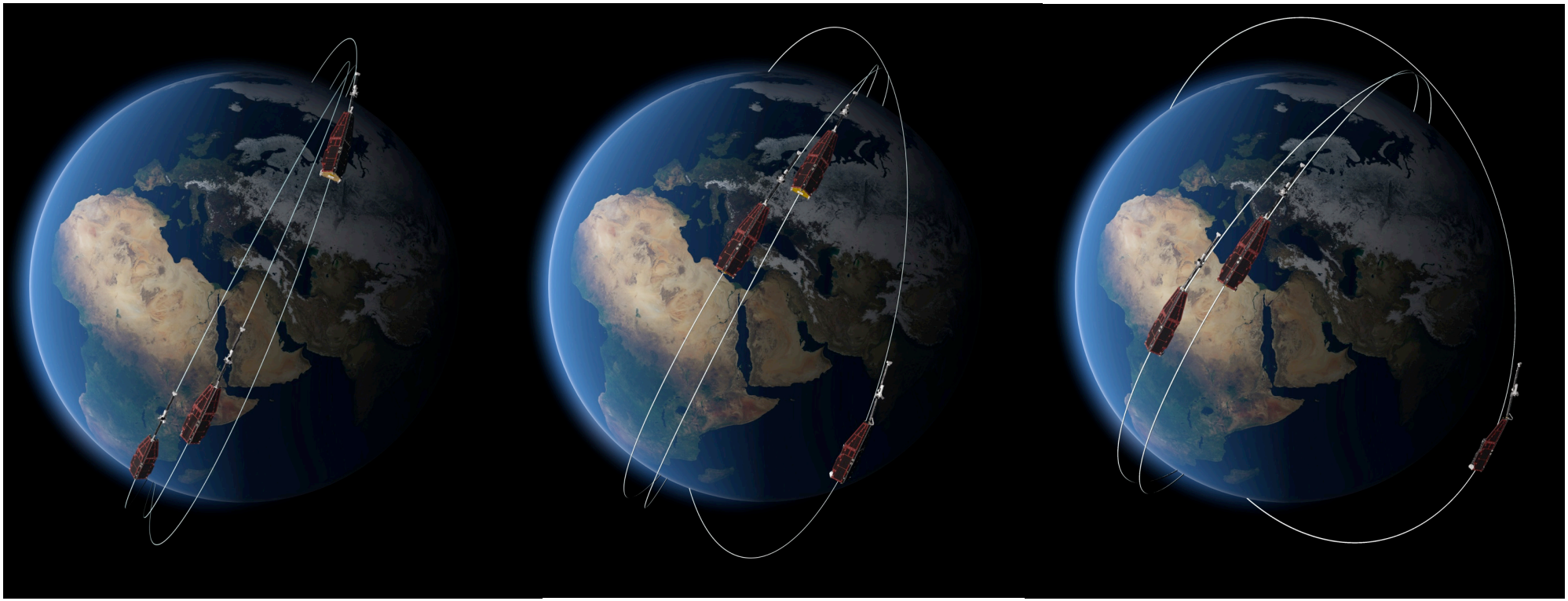
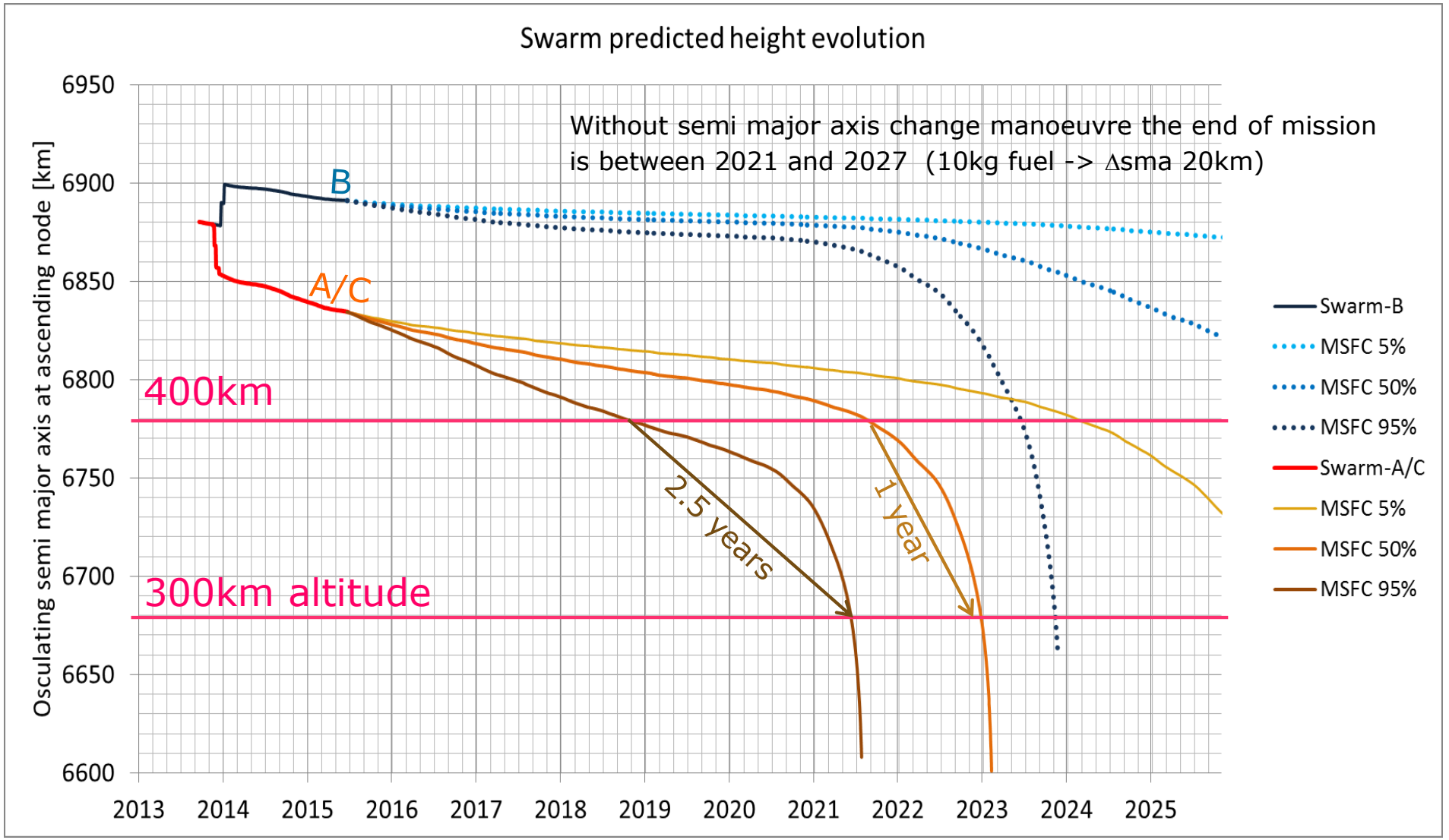
Mission Swarm

- Le 22 Novembre 2013
- 3 satellites identiques (**A**-Alpha, **B**-Bravo, **C**-Charlie)
- 2 en tandem (~460 km, **A+C**) + 1 (~520 km, **B**); 87-88°
- Champ magnétique + environnement ionosphérique

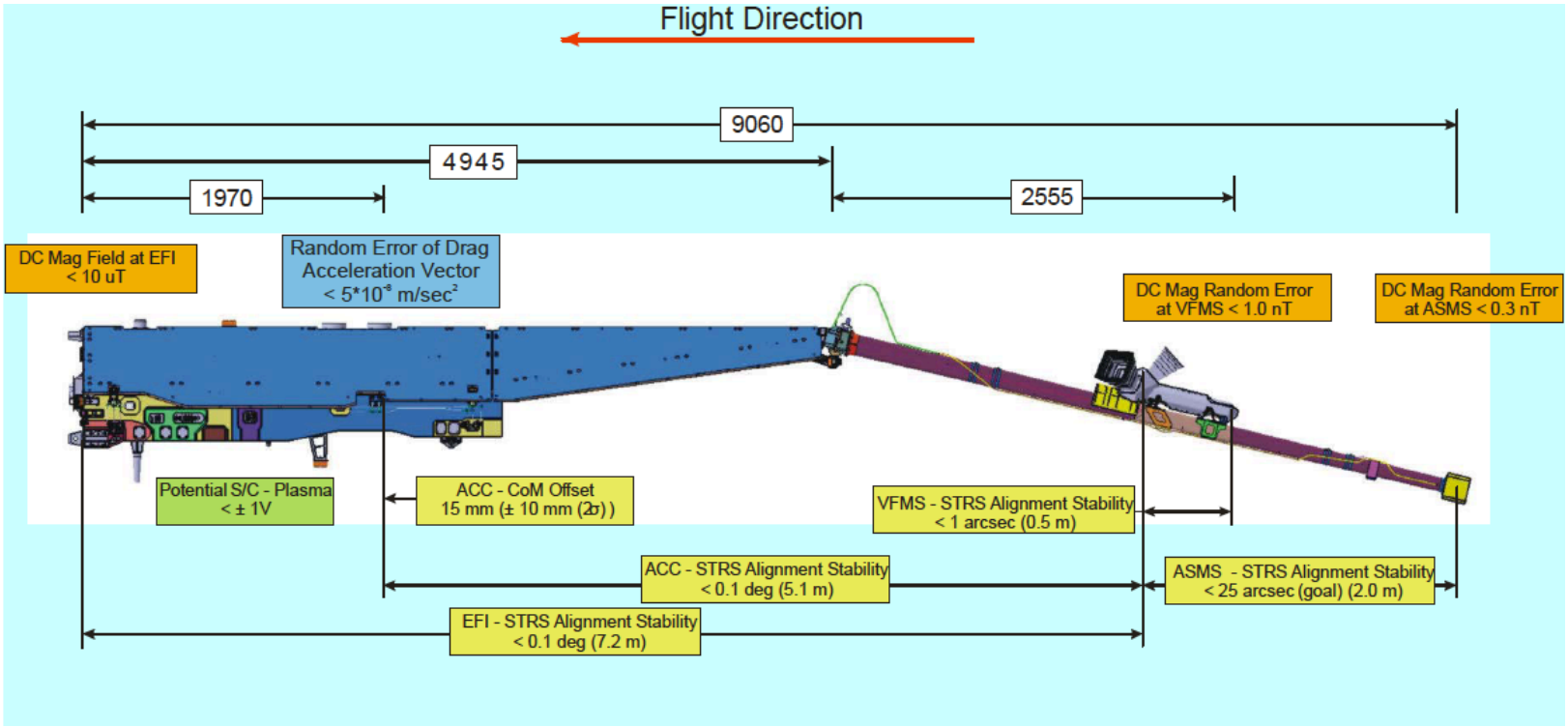


End of April 2014 | 3 hrs: April 2016 | 6 hrs: April 2018

Swarm - Durée de vie prévue



Current payload on board Swarm satellites



Absolute Scalar Magnetometer (CEA/LETI, CNES), 1Hz + 1Hz experimental vector data

Vector Field Magnetometer and Star Tracker (DTU Space), 50Hz, 1Hz

Accelerometer (VZLU, CZ), 1Hz

Electric Field Inst. (Charge particle imager, UC; Langmuir Probe, Uppsala), 2Hz

GPSR (Ruag), 1 Hz

Swarm (Level-2) Products

Science Objective	Name	Format	Description
(needed for Level-1b processing)	MSW_EUL_2_	ASCII	Time series of Euler angles describing transformation from STR-CRF to VFM frame for all three *Swarm* satellites (3 × 3 Euler angles)
Core field	MCO_SHA_2_	ASCII	Spherical harmonic model of the core field and its temporal variation
Lithospheric field	MLI_SHA_2_	ASCII	Spherical harmonic model of the lithospheric field
Electrical conductivity of the mantle	MIN_1DM_2_	ASCII	1D model of mantle conductivity
	MIN_3DM_2_	ASCII	3D model of mantle conductivity
	MCR_1DM_2_	ASCII	1D C-responses
	MCR_3DM_2_	ASCII	3D C-response maps
External current systems	MMA_SHA_2_	CDF	Spherical harmonic model of the large-scale magnetospheric field and its Earth-induced counterpart
	MIO_SHA_2_	ASCII	Spherical harmonic model of the daily geomagnetic variation at middle latitudes (Sq) and low latitudes (EEJ)
Precise Orbit Determination (POD)	SP3xCOM_2_	SP3	Time series of position and velocity of the center of mass for satellite x (x = A, B or C)
	ACCxCAL_2_	CDF	Accelerometer calibration parameters for satellite x
	ACCxPOD_2_	CDF	Time series of non-gravitational accelerations estimated for satellite x
Magnetic Forcing of the Upper Atmosphere	ACCx_AE_2_	CDF	Time series of calibrated and pre-processed accelerometer observations and of aerodynamic accelerations for satellite x
	DNSxWND_2_	CDF	Time series of neutral thermospheric density and wind speed for satellite x
Earth environment and Space-Weather (Cat-2 products)	IBIxTMS_2F	CDF	Ionospheric bubble index for satellite x
	TECxTMS_2F	CDF	Time series of the ionospheric total electron content for satellite x
	FAC_TMS_2F	CDF	Time series of field-aligned currents determined from combination of *Swarm* A and *Swarm* B
	FACxTMS_2F	CDF	Time series of field-aligned currents (single-satellite solution) for satellite x
	EEFxTMS_2F	CDF	Equatorial Electric Field for satellite x

Olsen et al., EPS, 2013

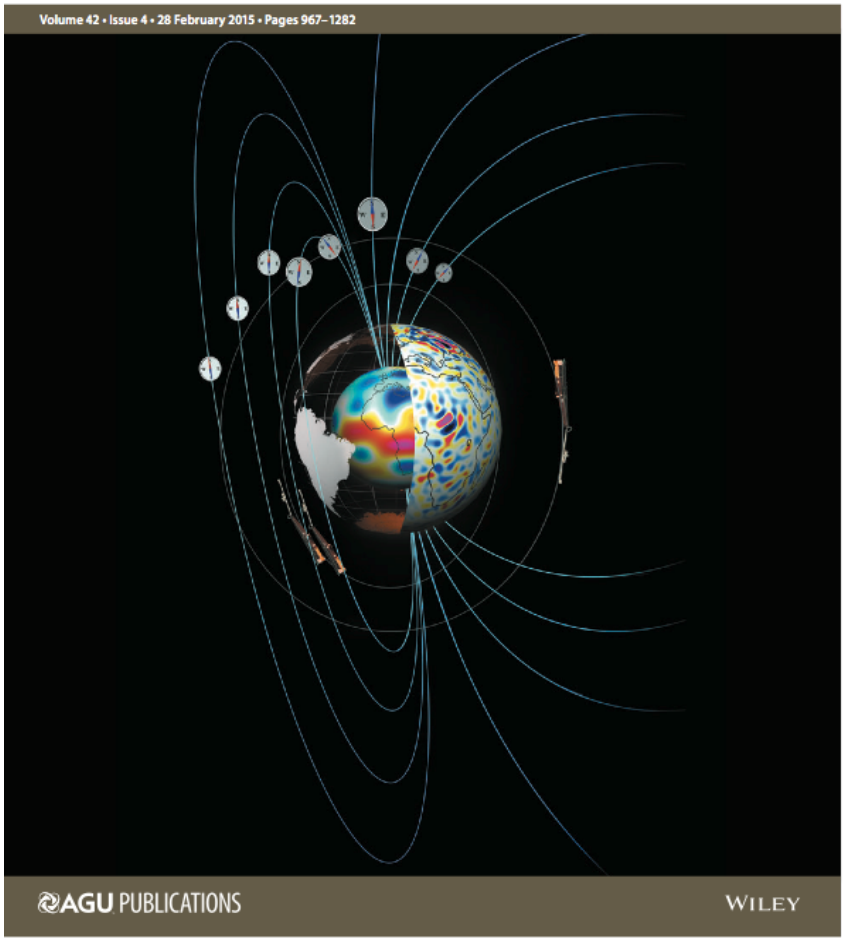
Swarm – First scientific results

- Geophysical Research Letters - 2014
- Earth Planets Space – 2016

-Swarm Initial Field Model (SIFM)- a new model of the Earth's magnetic field & time variations (***Olsen et al., GRL, 2015***)

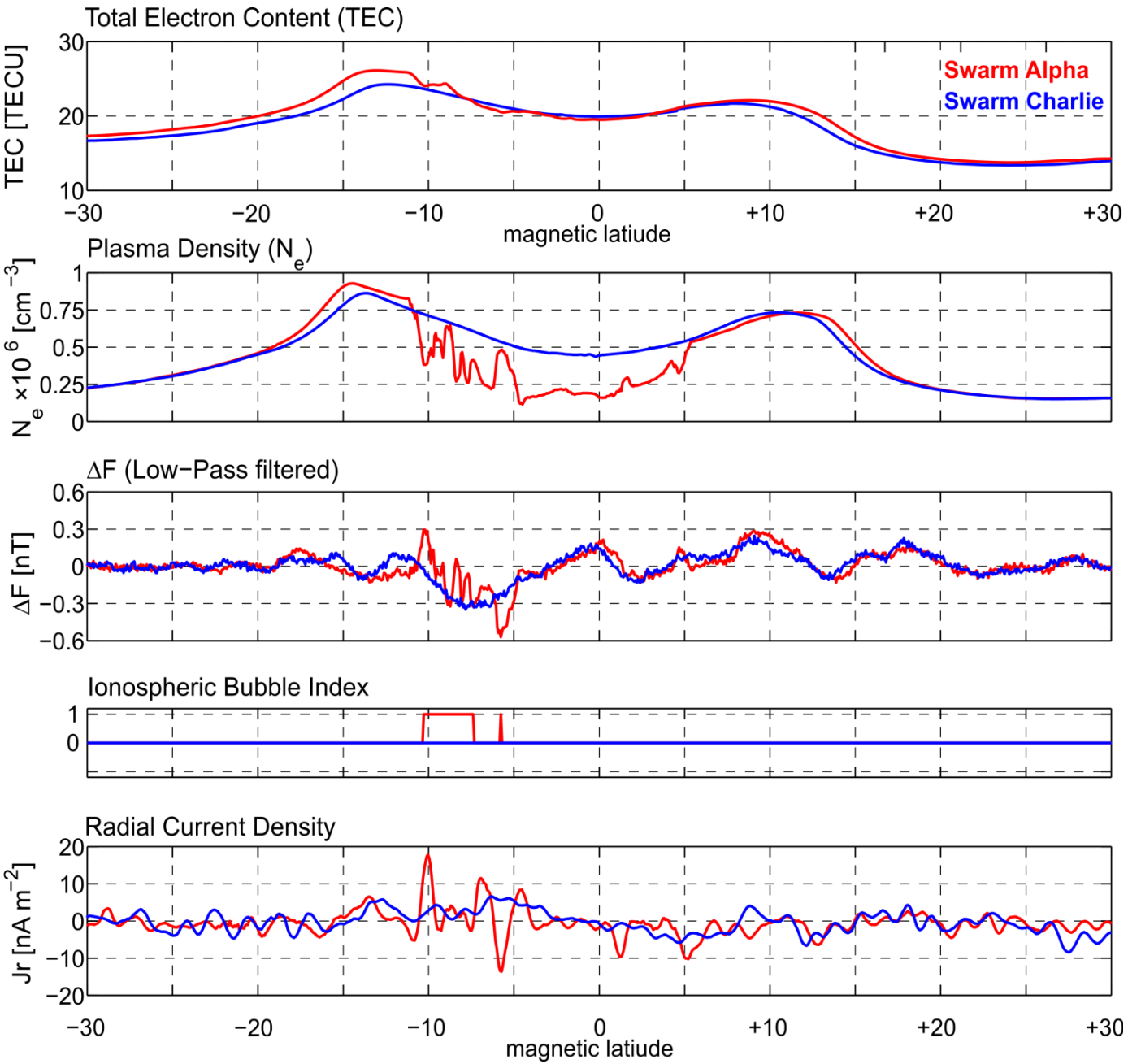
- Study of Field-aligned currents (FACs) – -Variations and scales (***Lühr et al., GRL, 2015***)

-FACs from Swarm & Cluster missions- (***Dunlop et al., GRL, 2015***)



Plasma Bubbles by Swarm (different parameters)

11 October 2014, 16:06 UT, 22 LT



Swarm Data

TECxTMS_2F

EFIx_PL_1B

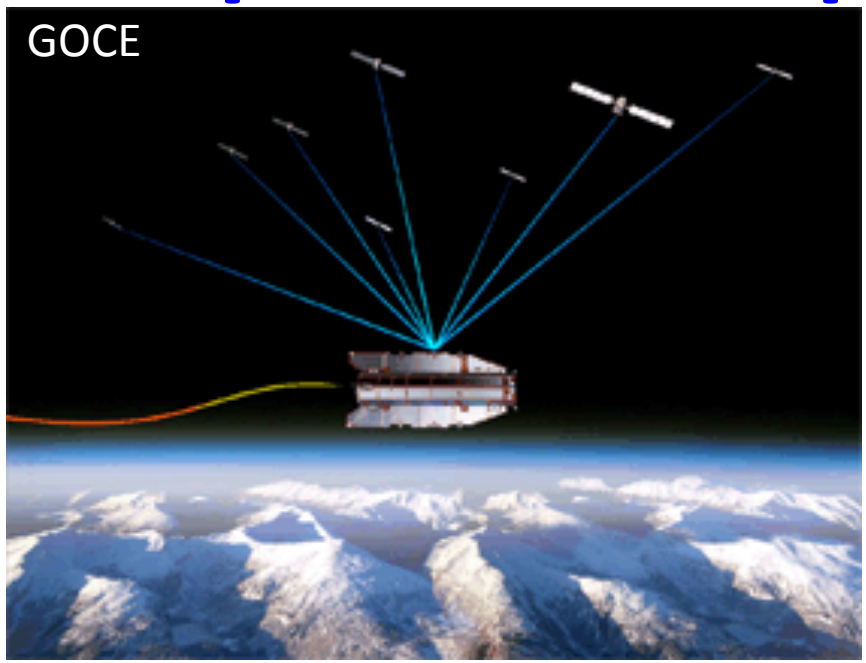
MAGx_LR_1B

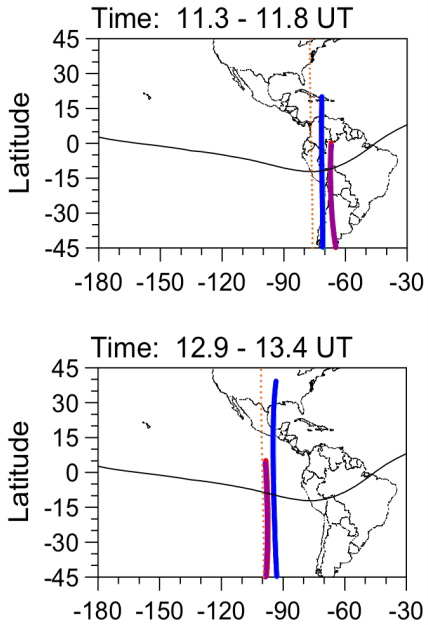
IBIxTMS_2F

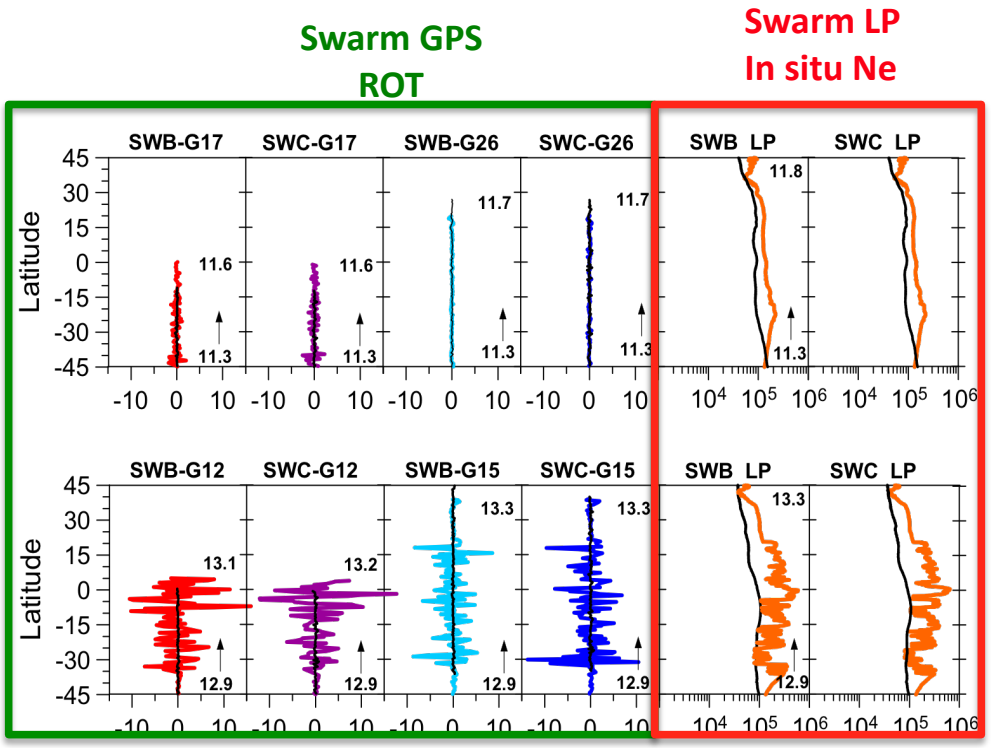
FACxTMS_2F

Courtesy: C. Stolle / GFZ

Topside ionospheric irregularities







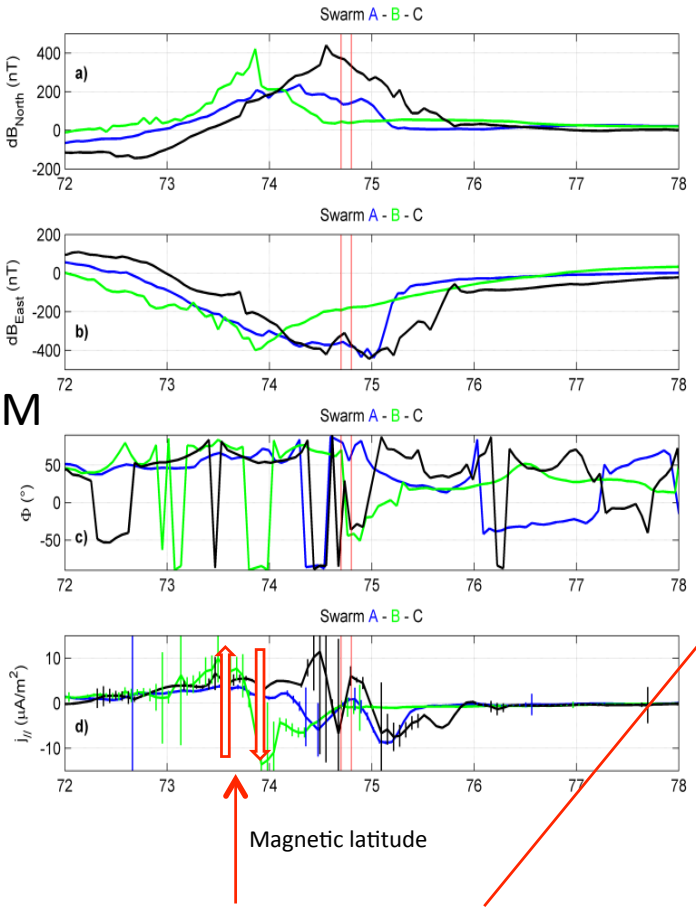
–> Poster 7.24 - PNST

(Zakharenkova et al., JGR, 2015)

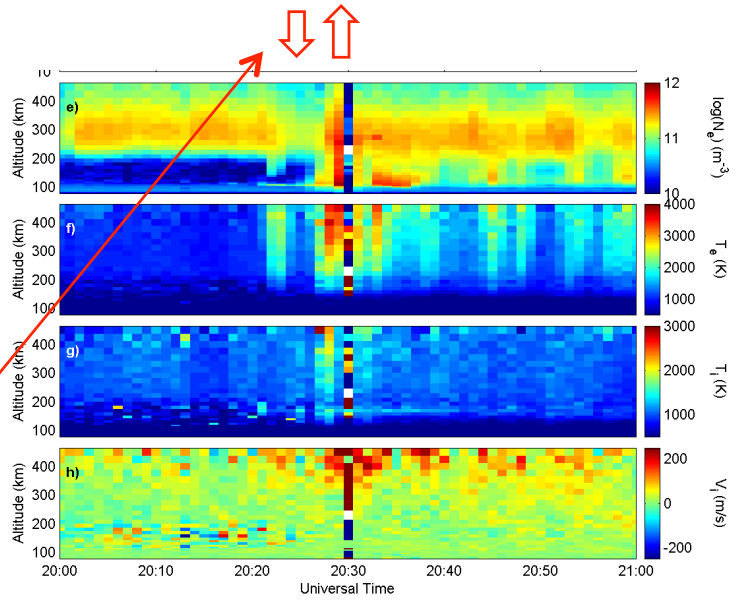
Courants alignés (FACs) : réponse de l'ionosphère avec EISCAT

Le 9 janvier 2014

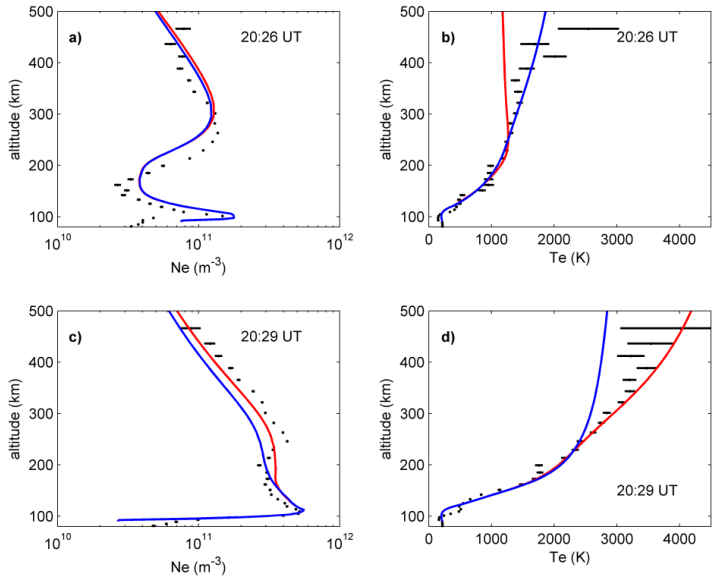
SWARM



EISCAT



TRANSCAR (Modèle)

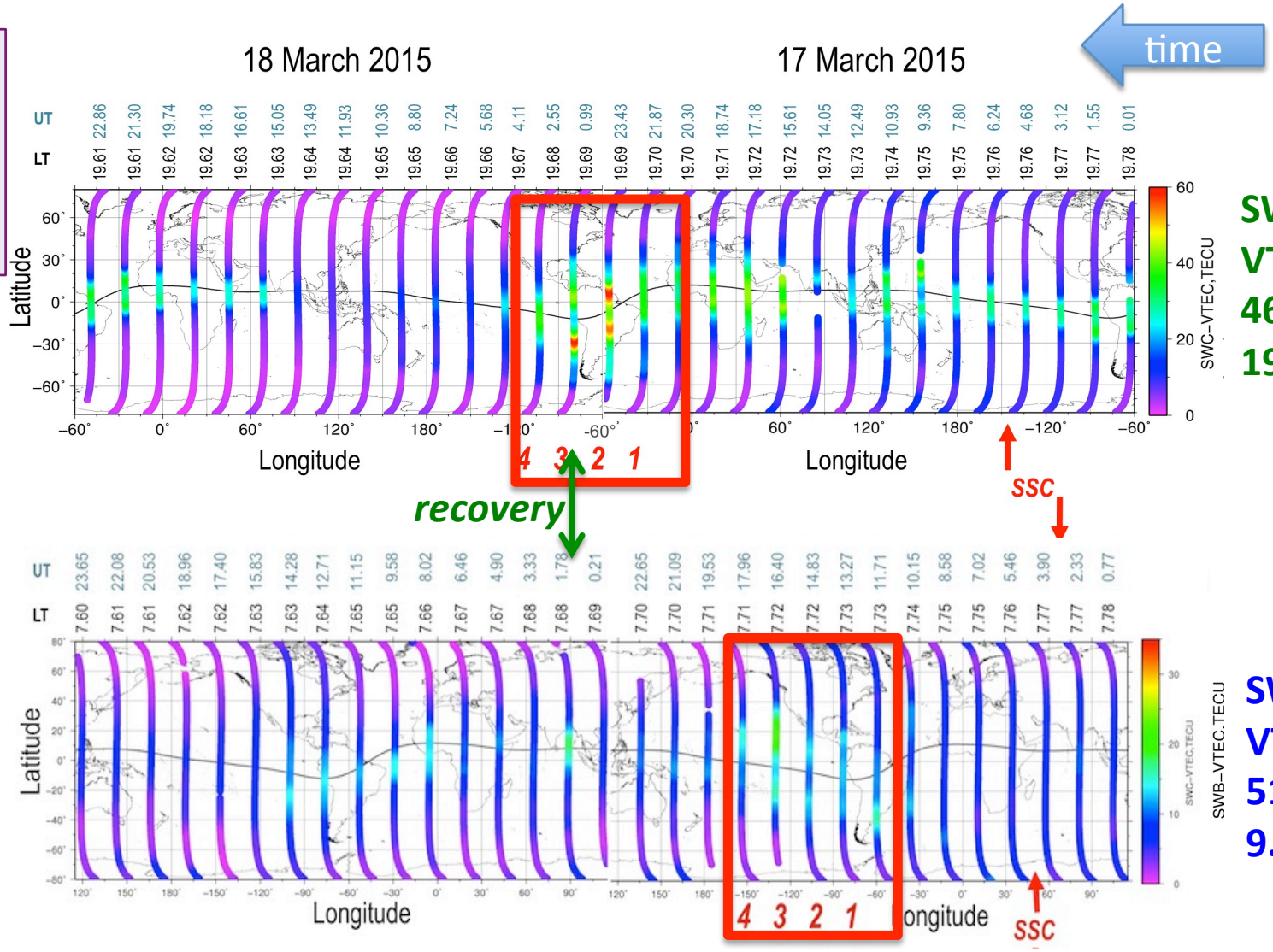


Une structure de courants montant-descendant est mesurée par SWARM au-dessus d'EISCAT. Son effet sur l'ionosphère est mesuré par le radar et quantifié avec le modèle TRANSCAR.

(Pitout et al., GRL, 2015)

St. Patrick's Day Geomagnetic Storm

Swarm: A+C, B
Ne
VTEC
EEJ/EEF (A + B)
ρ (C only)

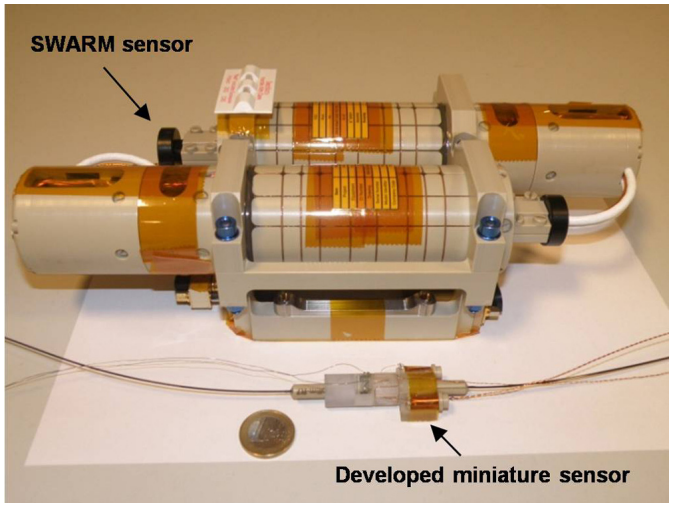


–> Poster 7.2 - PNST

(Astafyeva et al., JGR, 2015)

Swarm «Delta»

- Core instrument payload:
  - ASM (vector and Burst mode) + VFM
  - STR
  - GPS dual frequency
  - Langmuir probe



- Phase 0 CNES – project “NanoMagSat”

Les données de la mission Swarm :

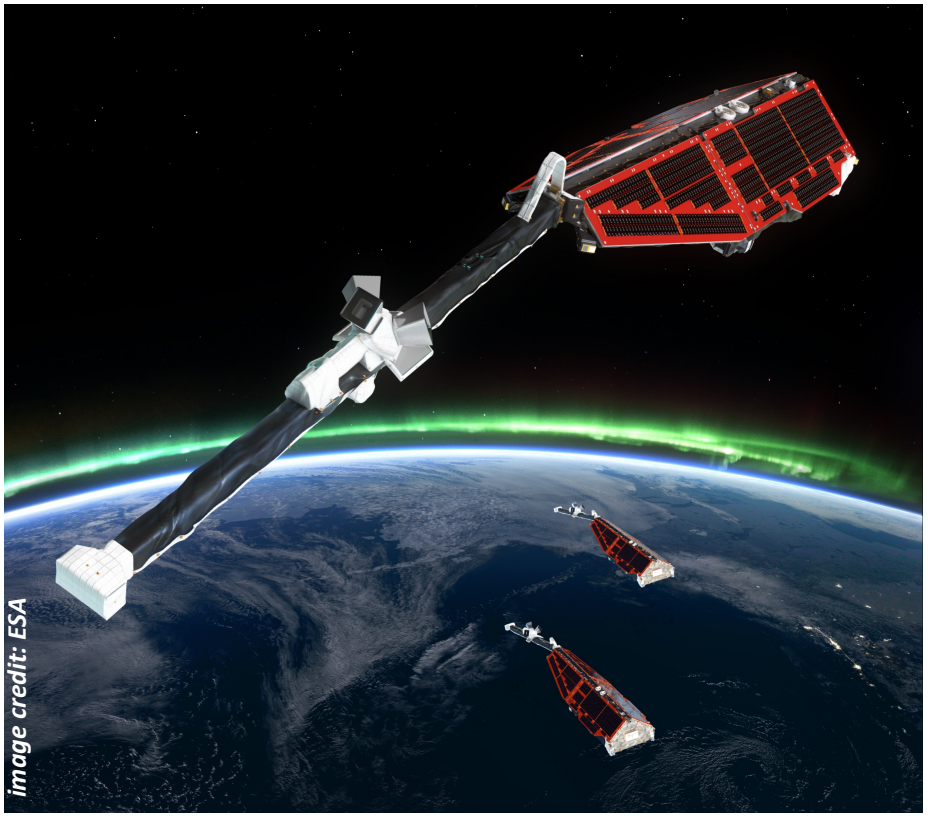
sur ESA EarthNet services

http://earth.esa.int/swarm

IPGP
INSTITUT DE PHYSIQUE
DU GLOBE DE PARIS

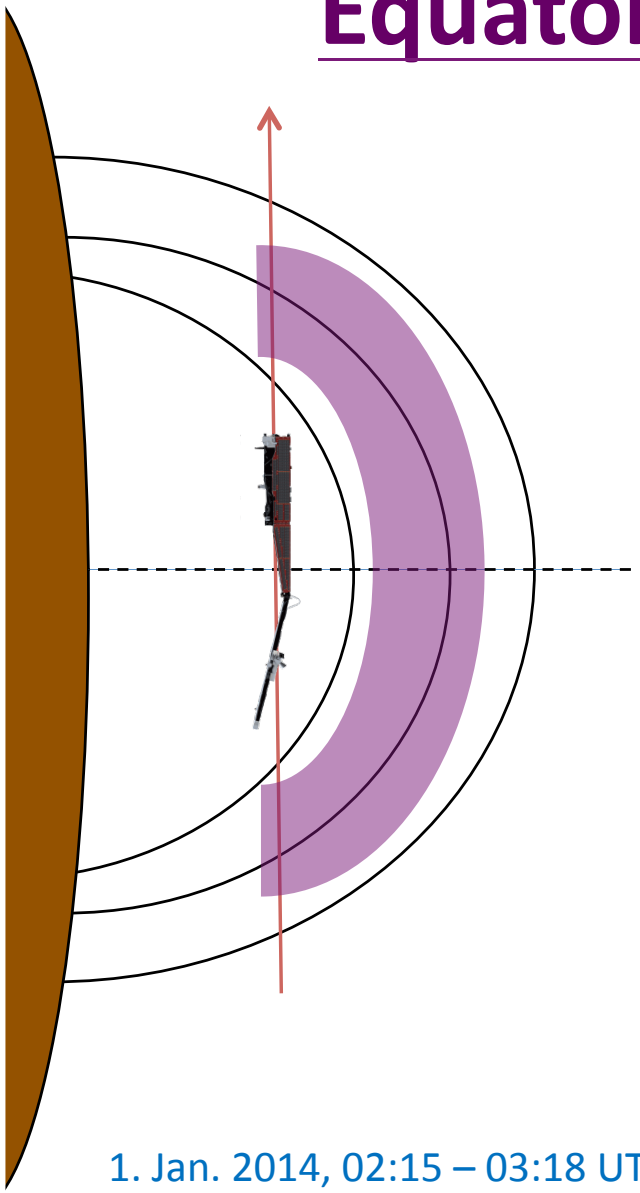
esa
European Space Agency

Merci!



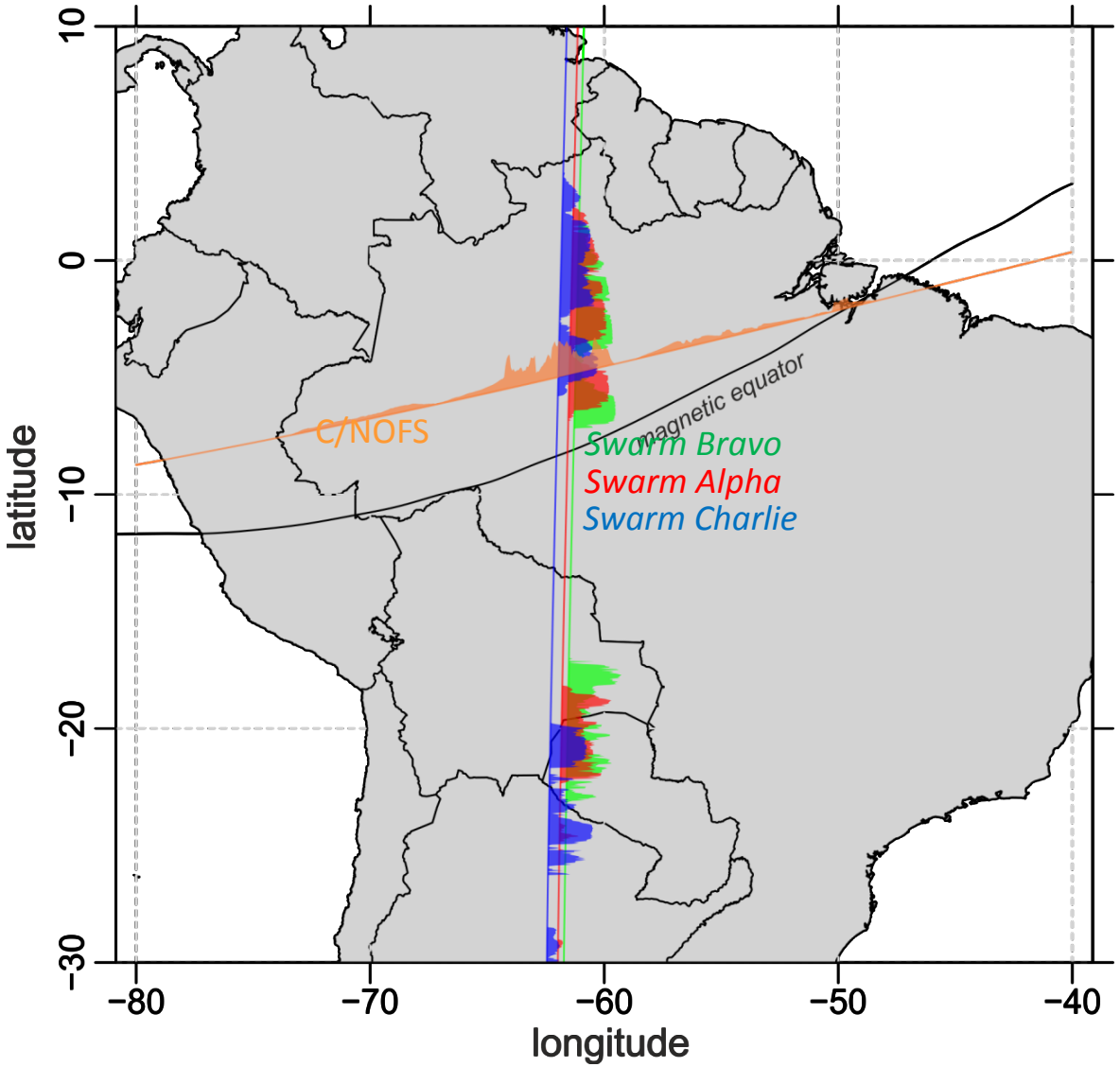
cnrs

Multi-Point observation of Equatorial plasma irregularities



1. Jan. 2014, 02:15 – 03:18 UT

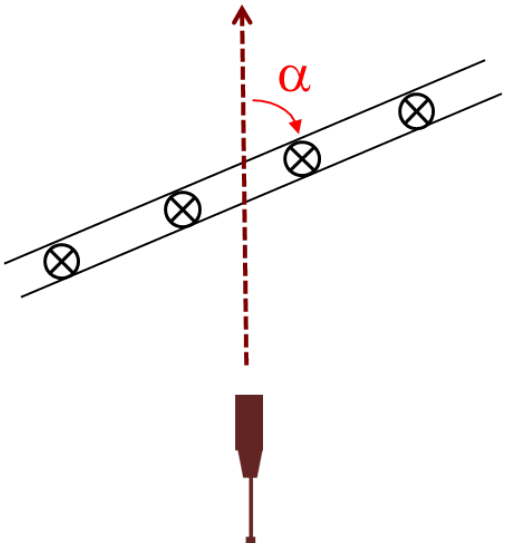
Plasma density anomaly



Courtesy: C. Stolle / GFZ

Courants alignés (2) : modèle analytique pour une nappe de courant courbe *(thèse X. Bai)*

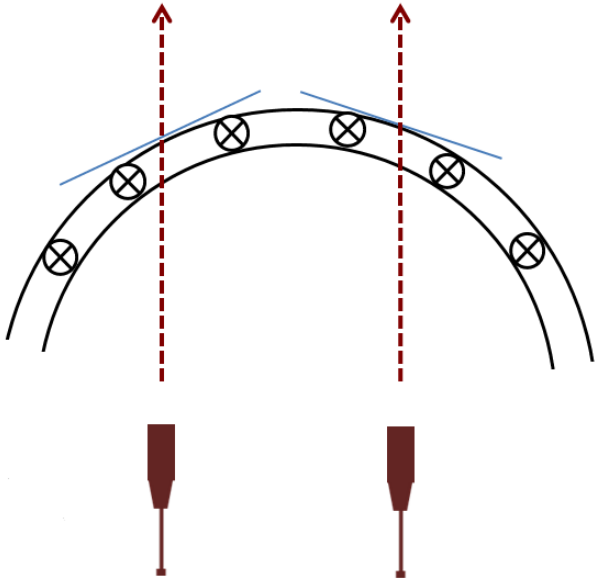
Nappe de courant infinie et plane.



Expression simple :

$$J_{//} = \frac{dB}{\mu_0 V_{sc}\, cos\alpha\, dt}$$

Nappe de courant finie et en arc de cercle.



Résultats :
- Densité de courant identique que le cas plan pour une même variation de B.
- Avec deux satellites, le rayon de courbure est accessible.