Workshop « Bon anniversaire InSight ! »

Activités sur les spectres et les spectrogrammes

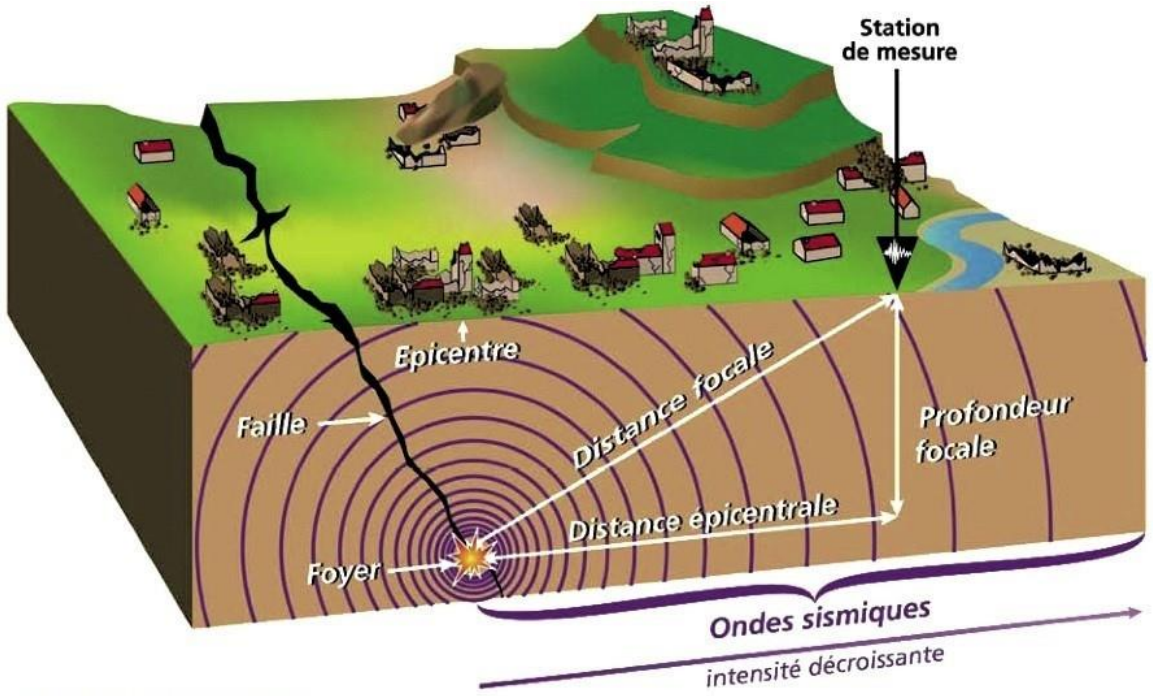
Le 1er décembre 2021

Marie BAILLET

Ingénieure d'études (CNRS-UCA)
Cellule Education
Laboratoire Géoazur

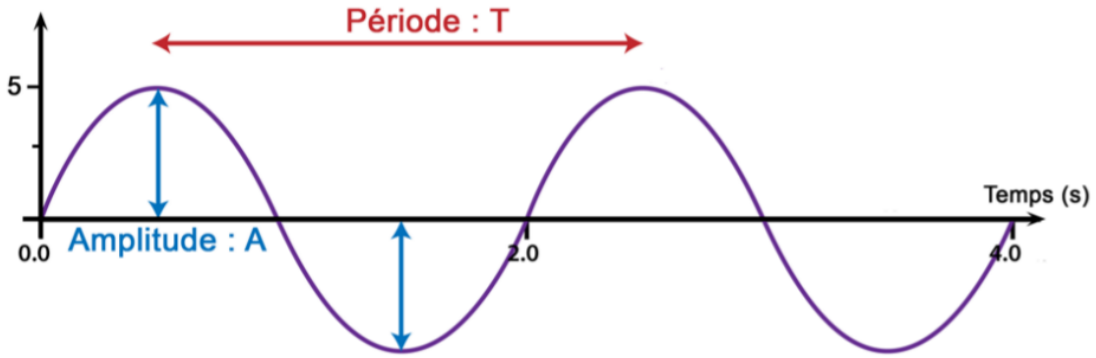
Rappels – Sismologie

❖ Séismes et ondes



Src: Préfecture des Hautes-Alpes

Signal périodique simple:



T = 2 s

f = 0.5 Hz

A = 5

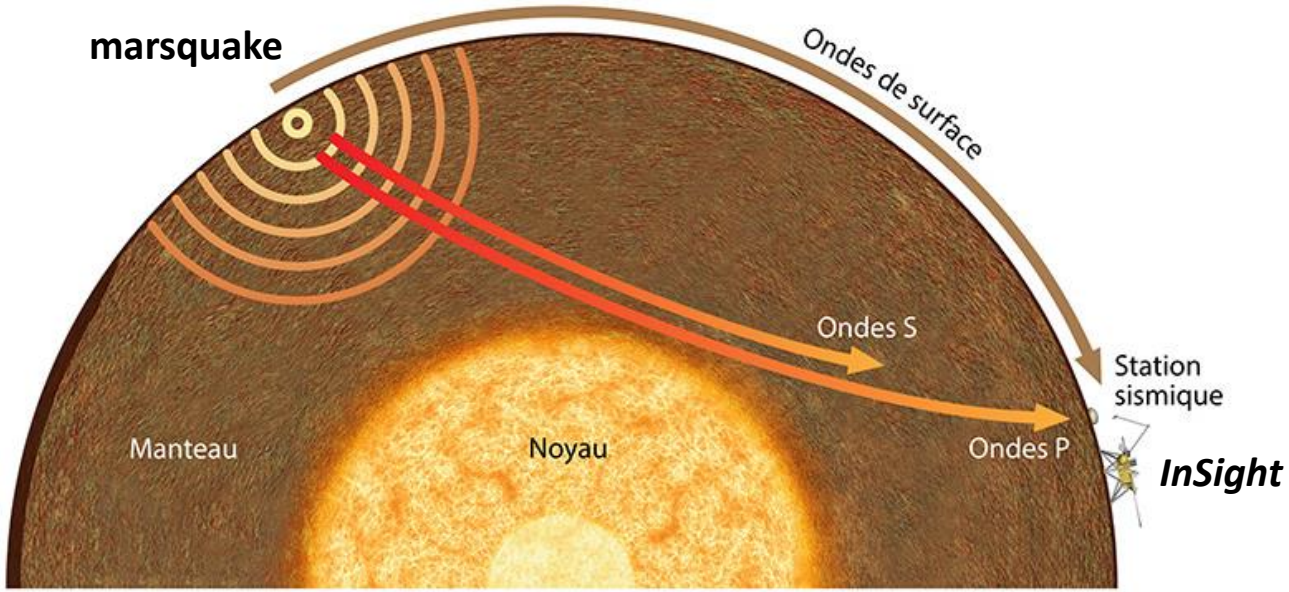
$$f = \frac{1}{T}$$

Fréquence: Hz

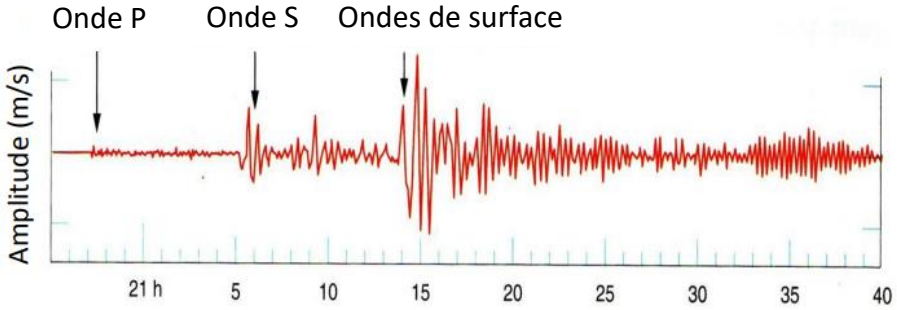
Période: s

Rappels – Sismologie

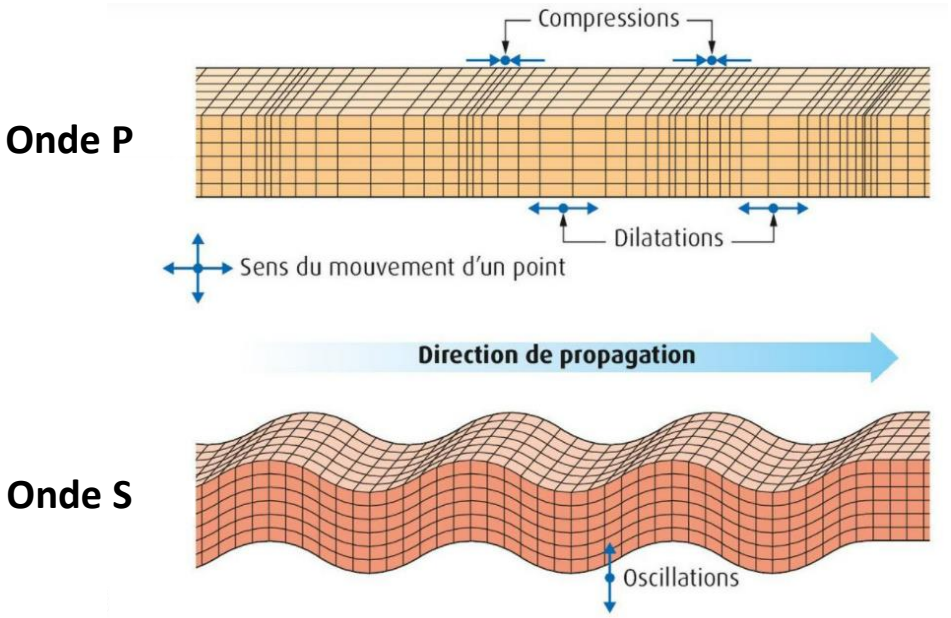
❖ Séismes et ondes



Src: © IPGP/David Ducros



Séisme de Kobe (1995, Mw 6.9)
enregistré à Hawaii (6630 km)

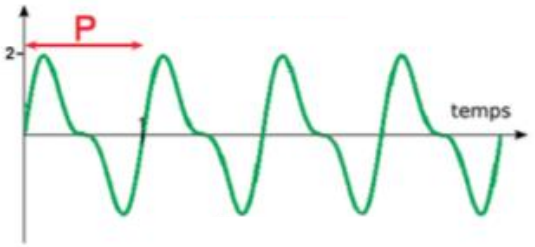


Src: Belin Education/Humensis, 2019 SVT 1er enseignement de spécialité
Coll. Archives Belin

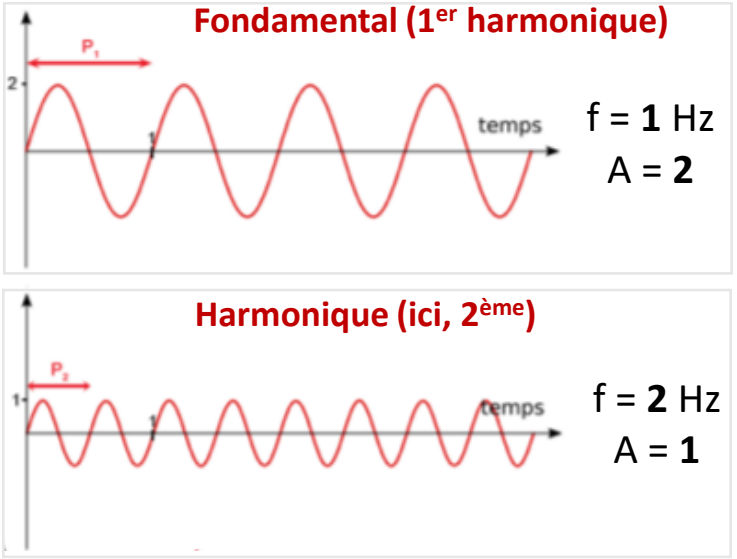
Rappels – Spectres et spectrogrammes

❖ **Changer de domaine: temporel ➡ fréquentiel**

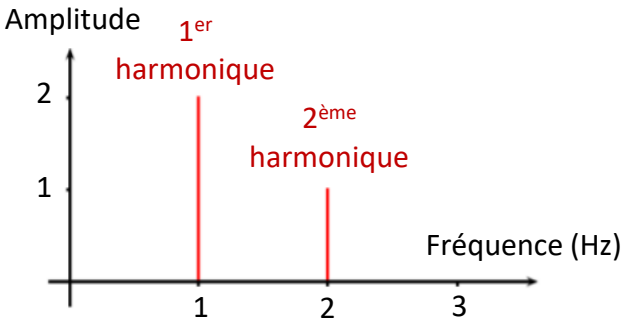
Signal périodique complexe



Décomposition en séries de Fourier



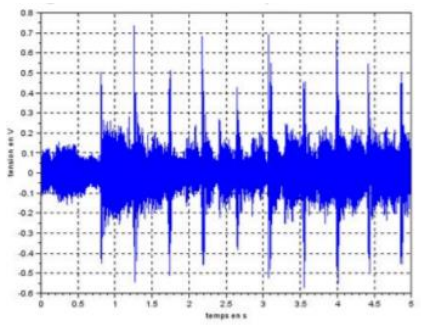
Spectre fréquentiel



Rappels – Spectres et spectrogrammes

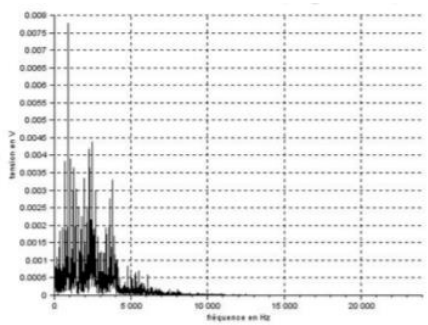
❖ Les signaux non périodiques complexes

Signal non périodique complexe



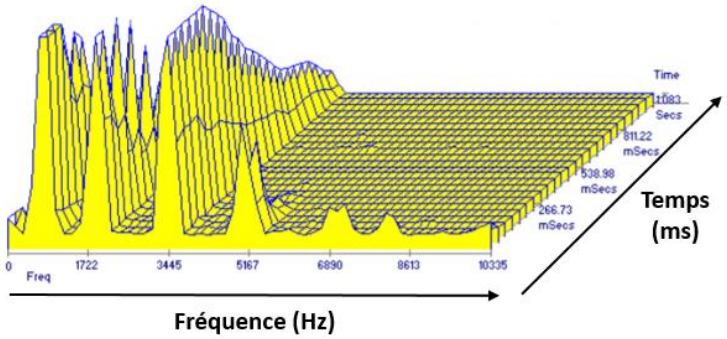
Transformation de fourier

Spectre fréquentiel



Src : cours BTS SNIR, le web pédagogique

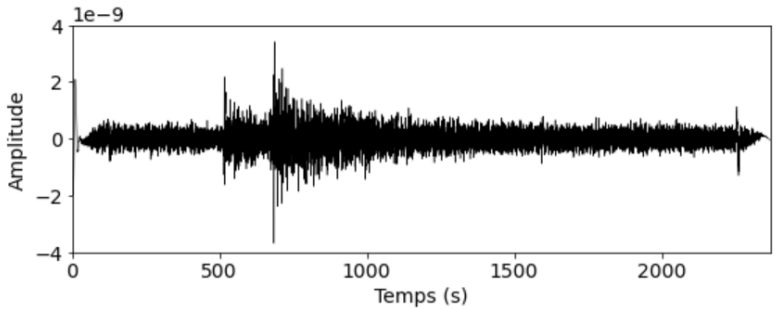
***Spectrogramme**: évolution du spectre fréquentiel au cours du temps (fft)*



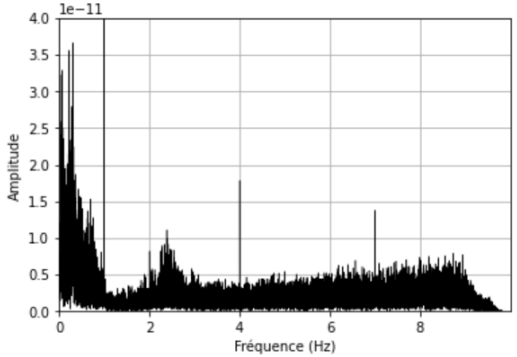
Src : INRP

❖ Exemple marsquake Sol 235

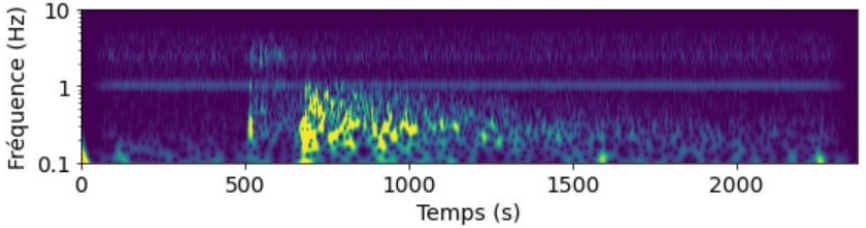
Signal non périodique complexe



Spectre fréquentiel



Spectrogramme



Nettoyer un signal grâce au spectre fréquentiel

Activité sur Audacity

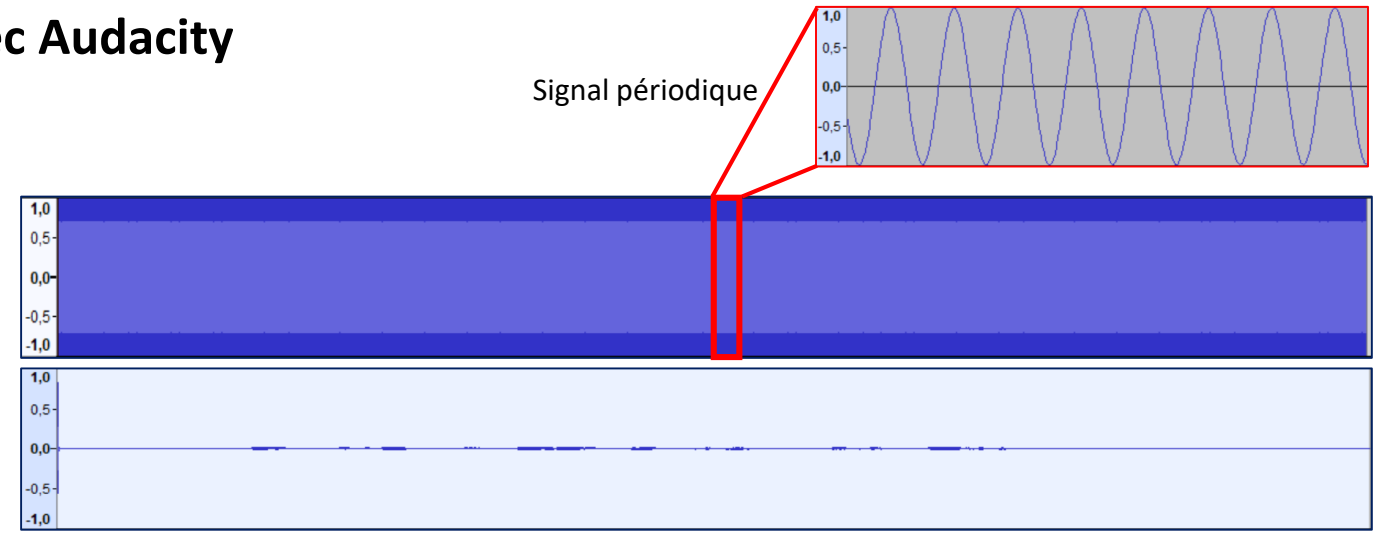
Le 1er décembre 2021

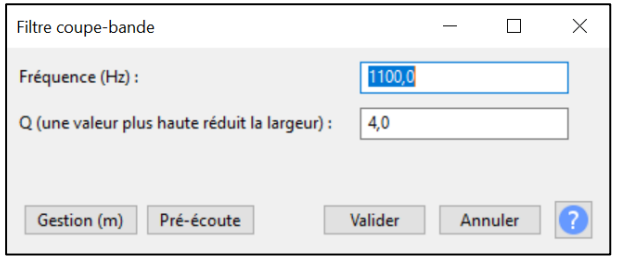
Les spectres avec Audacity

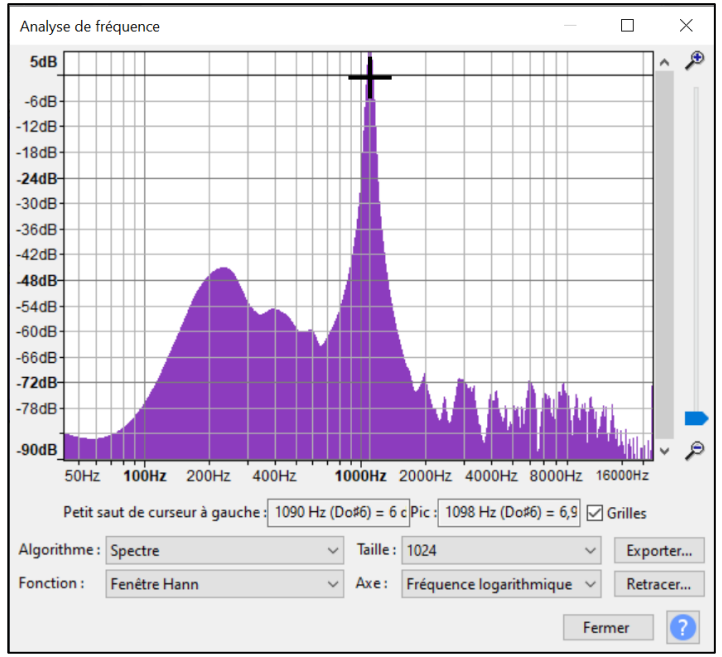
❖ Nettoyer les fréquences parasites d'un signal avec Audacity

- Ouvrir l'enregistrement .wav
  Fichier > Importer > Audio…
- Ecouter l'enregistrement audio

- Analyser le contenu fréquentiel
  Analyse > Tracer le spectre…
- Utiliser un filtre coupe-bande
  Effets > Filtre coupe-bande…
- Réécouter l'enregistrement avec un volume plus élevé







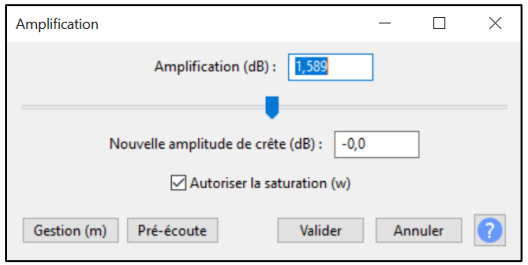
Les spectres avec Audacity

❖ Nettoyer les fréquences parasites d'un signal avec Audacity

- Augmenter l'amplitude du signal

  Effets > Amplification…

  ☒ *Autoriser la saturation*



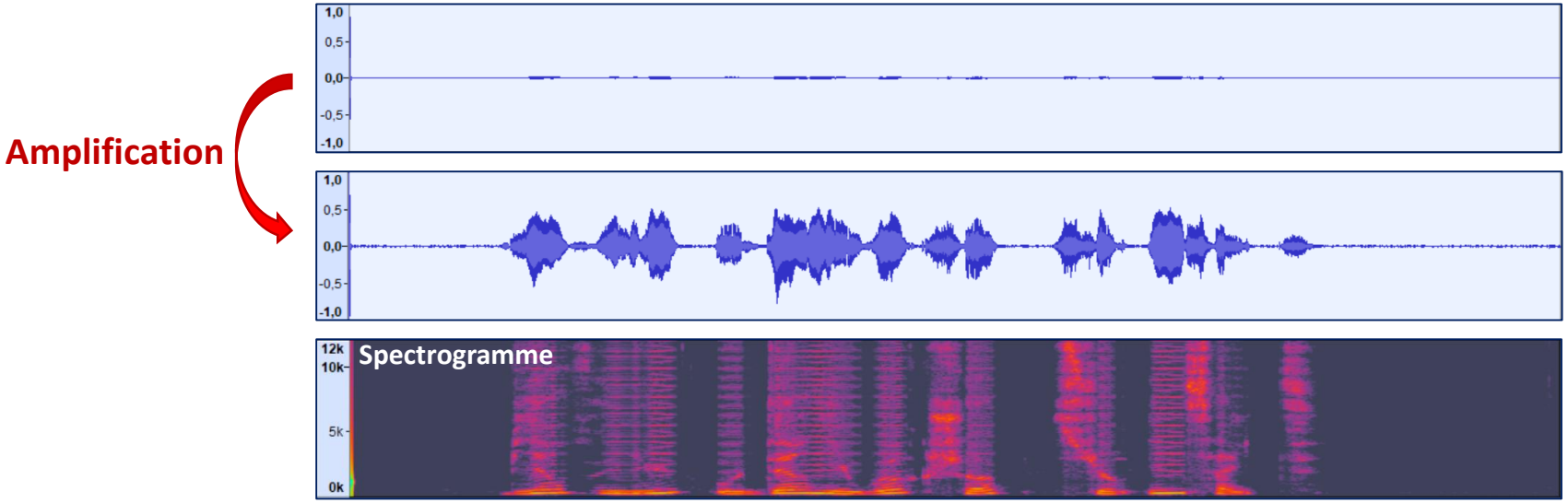
- Ecouter l'enregistrement audio

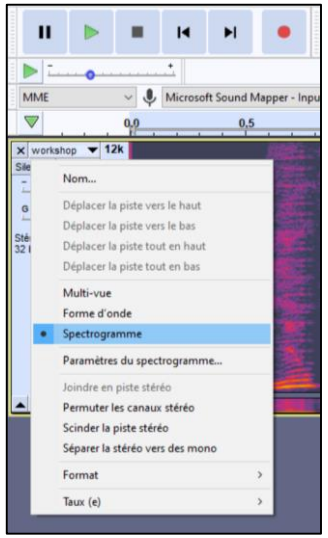
- Tracer le spectrogramme

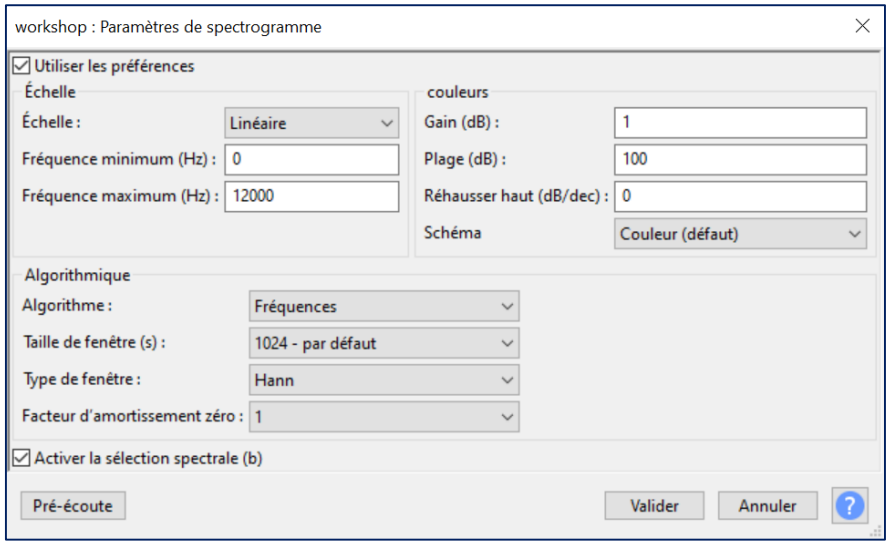
  record > Spectrogramme

- Modifier les paramètres du spectrogramme

  record > Paramètres du spectrogramme…







Mars, mise sur écoute avec InSight

Nouvelles ressources pour la classe

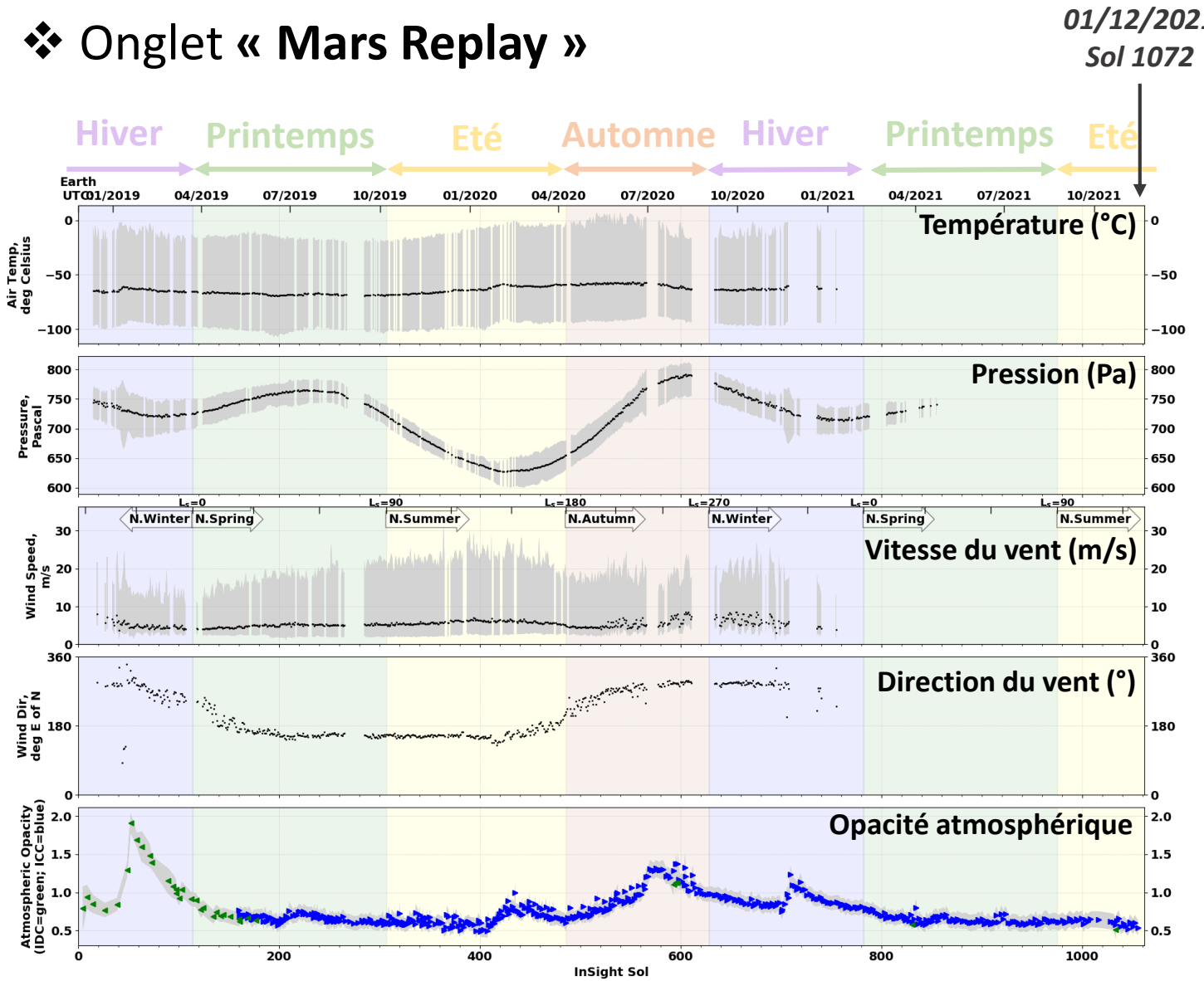
https://www.insight.oca.eu

Page Data

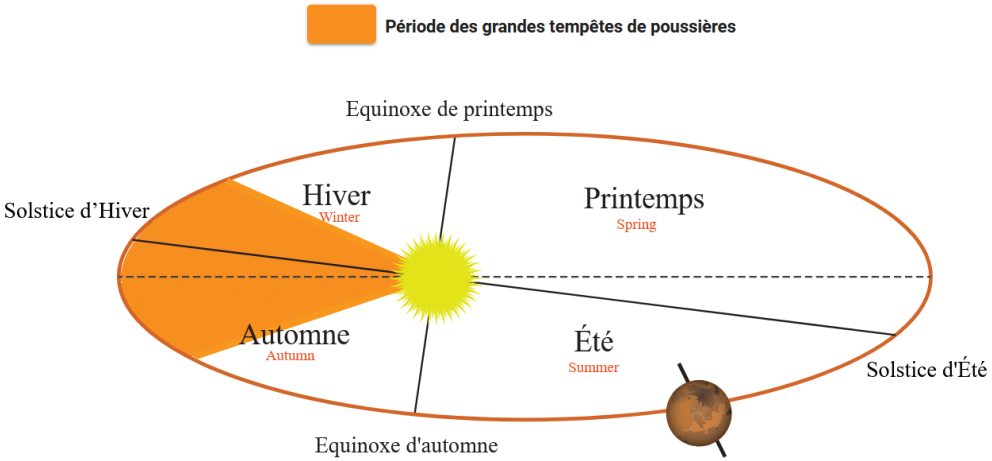
Le 1er décembre 2021

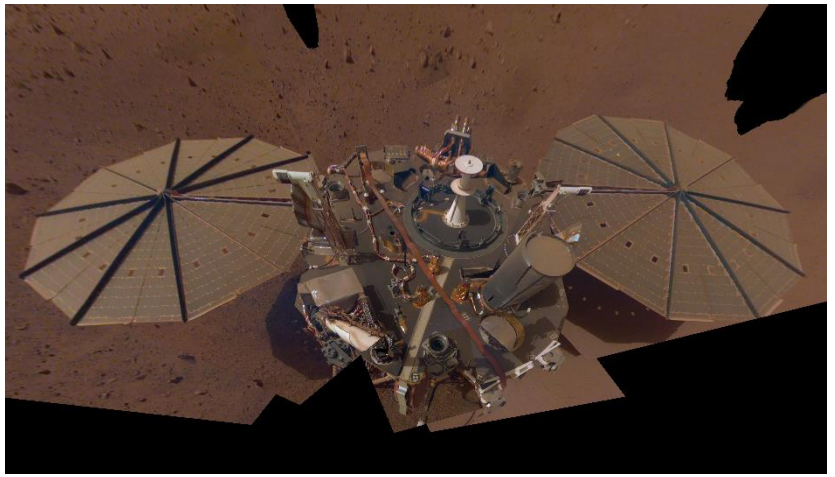
Les spectrogrammes et la météo: page DATA

❖ Onglet « **Mars Replay** »



Src: NASA/JPL-Caltech/Cornell/CAB



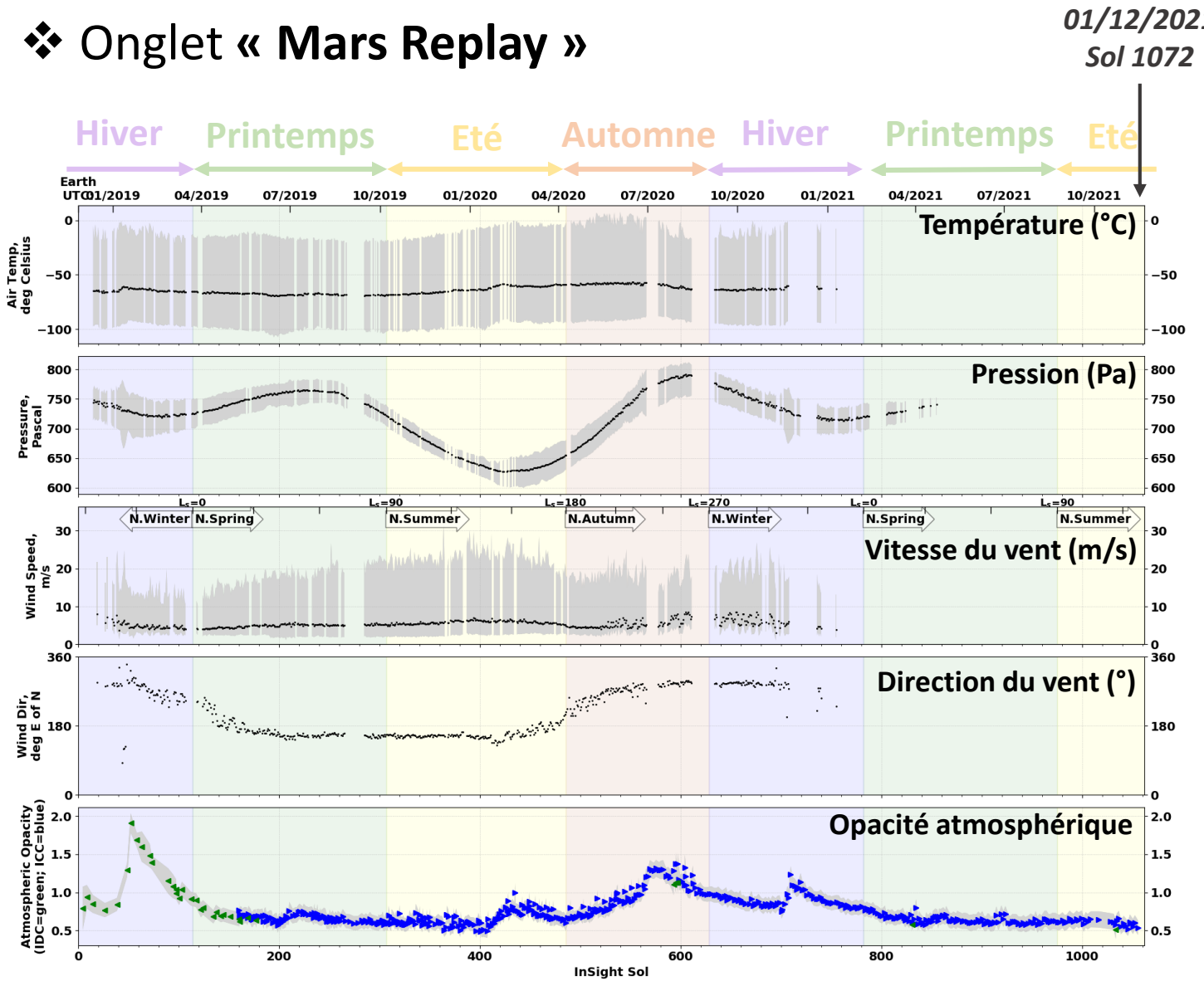


Selfie de InSight (Sols 106 à 133)

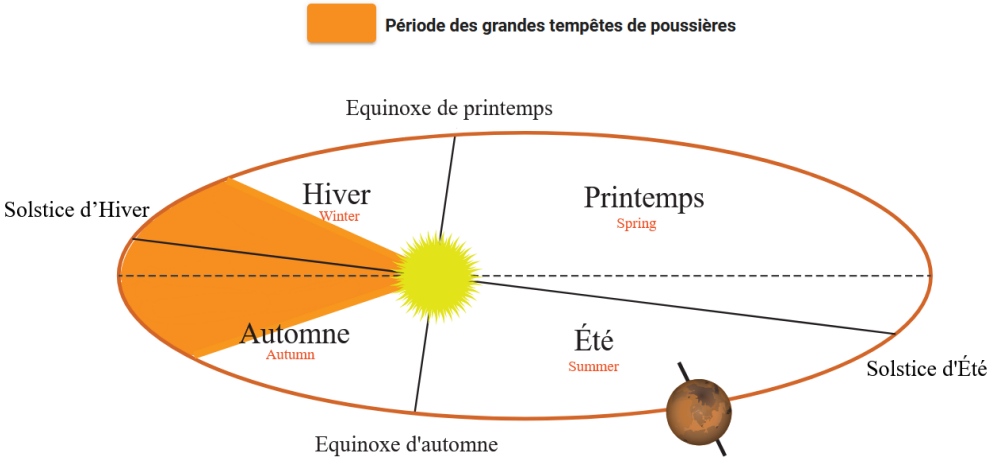
Src: NASA/JPL-Caltech

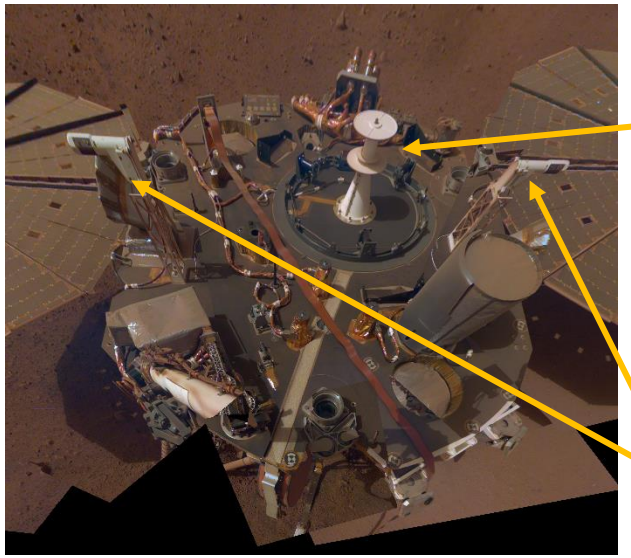
Les spectrogrammes et la météo: page DATA

❖ Onglet « **Mars Replay** »



Src: NASA/JPL-Caltech/Cornell/CAB



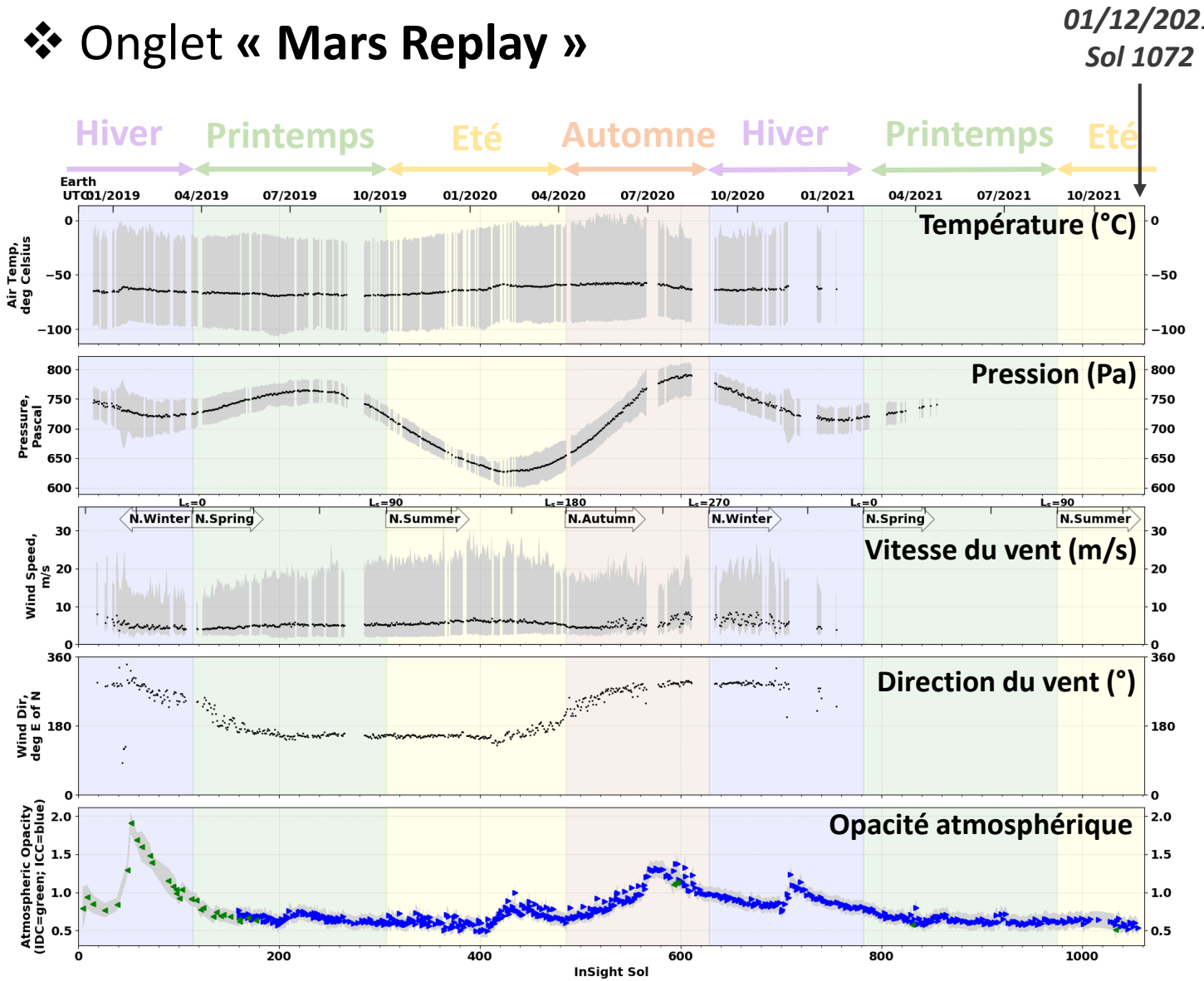


Selfie de InSight (Sols 106 à 133)

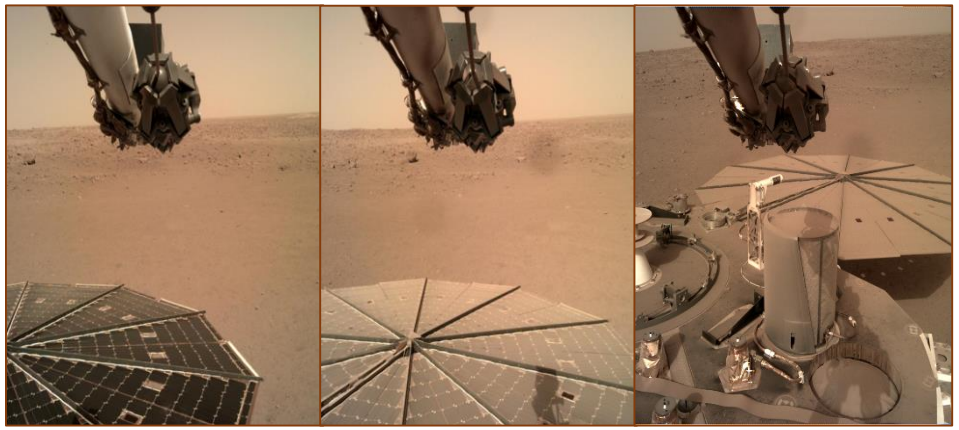
Src: NASA/JPL-Caltech

Les spectrogrammes et la météo: page DATA

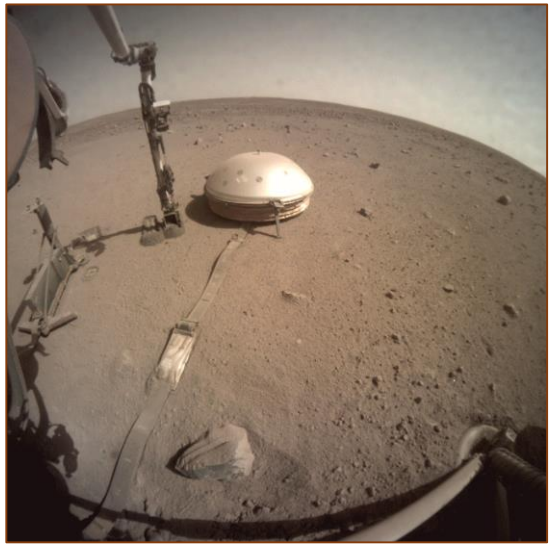
❖ Onglet « **Mars Replay** »



Src: NASA/JPL-Caltech/Cornell/CAB



Sol 14 Sol 100 Sol 578



Sol 816

Src: NASA/JPL-Caltech

Les spectrogrammes et la météo: page DATA

❖ Onglet « **Tuned into Mars** »

Le bruit sismique

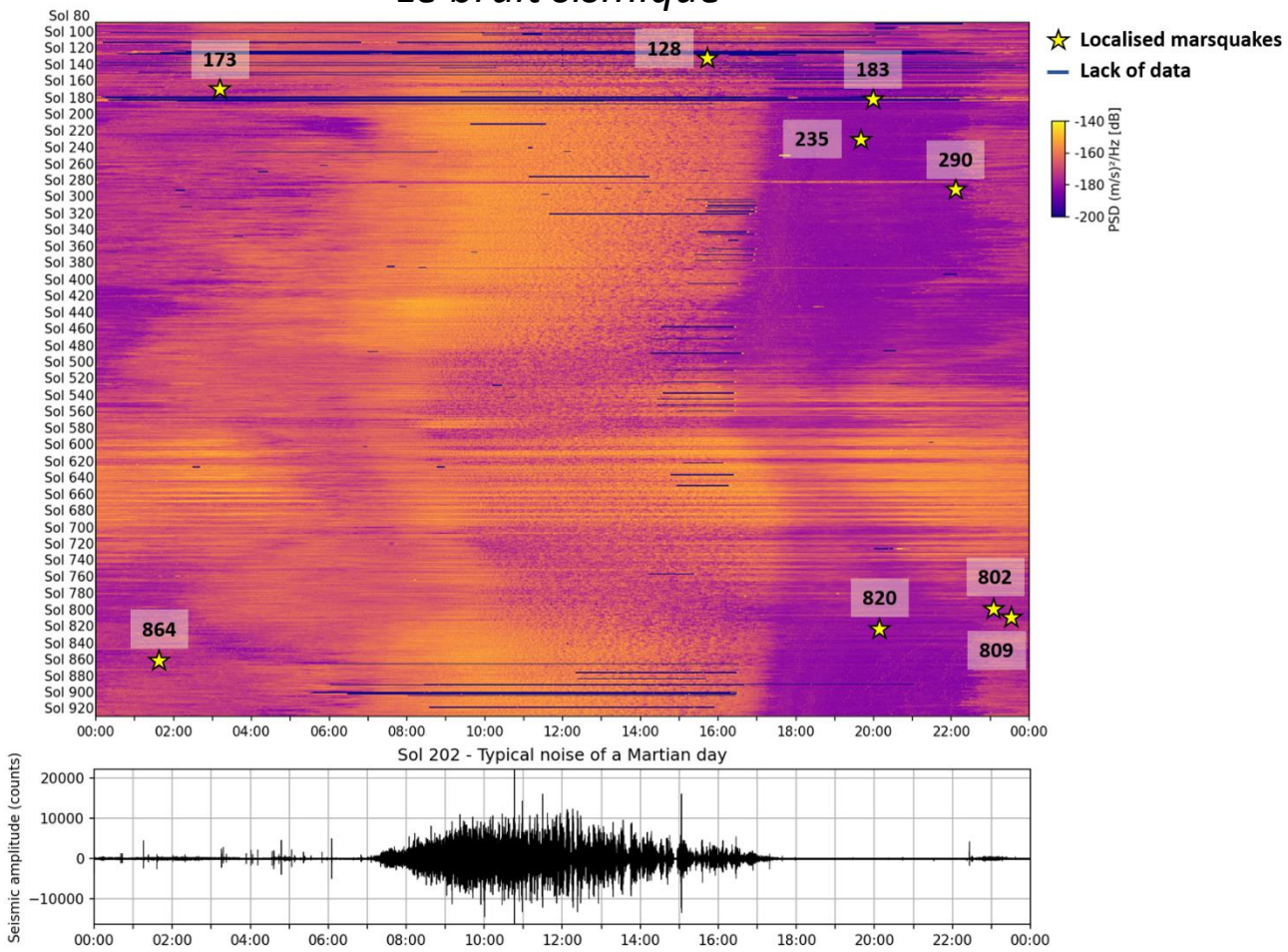
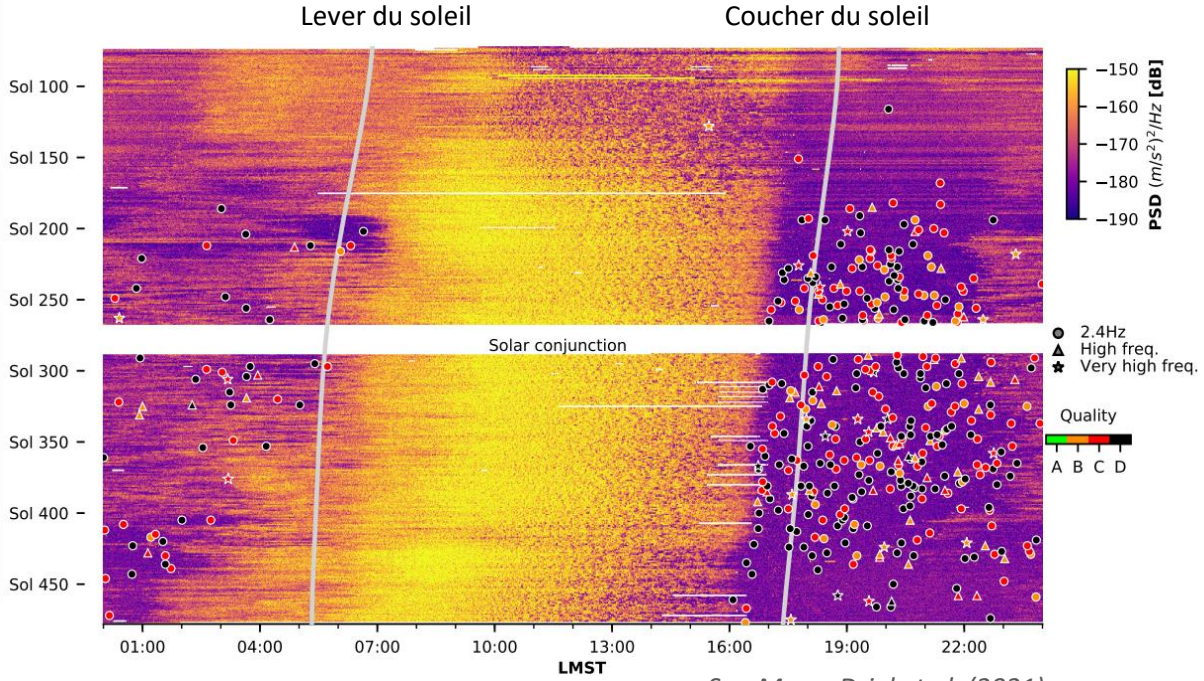


Figure inspirée de S. Ceylan, et al (2020)

Jour solaire Terrien:
24h 0min 0s

Jour solaire Martien:
24h 39min 35s = 1 Sol

LMST:
temps solaire moyen local sur 24h
(local mean solar time)



Src: M van Driel et al. (2021)

Les spectrogrammes et la météo: page DATA

❖ Le bruit au fil des Sols

Onglet « **Tuned into Mars** »

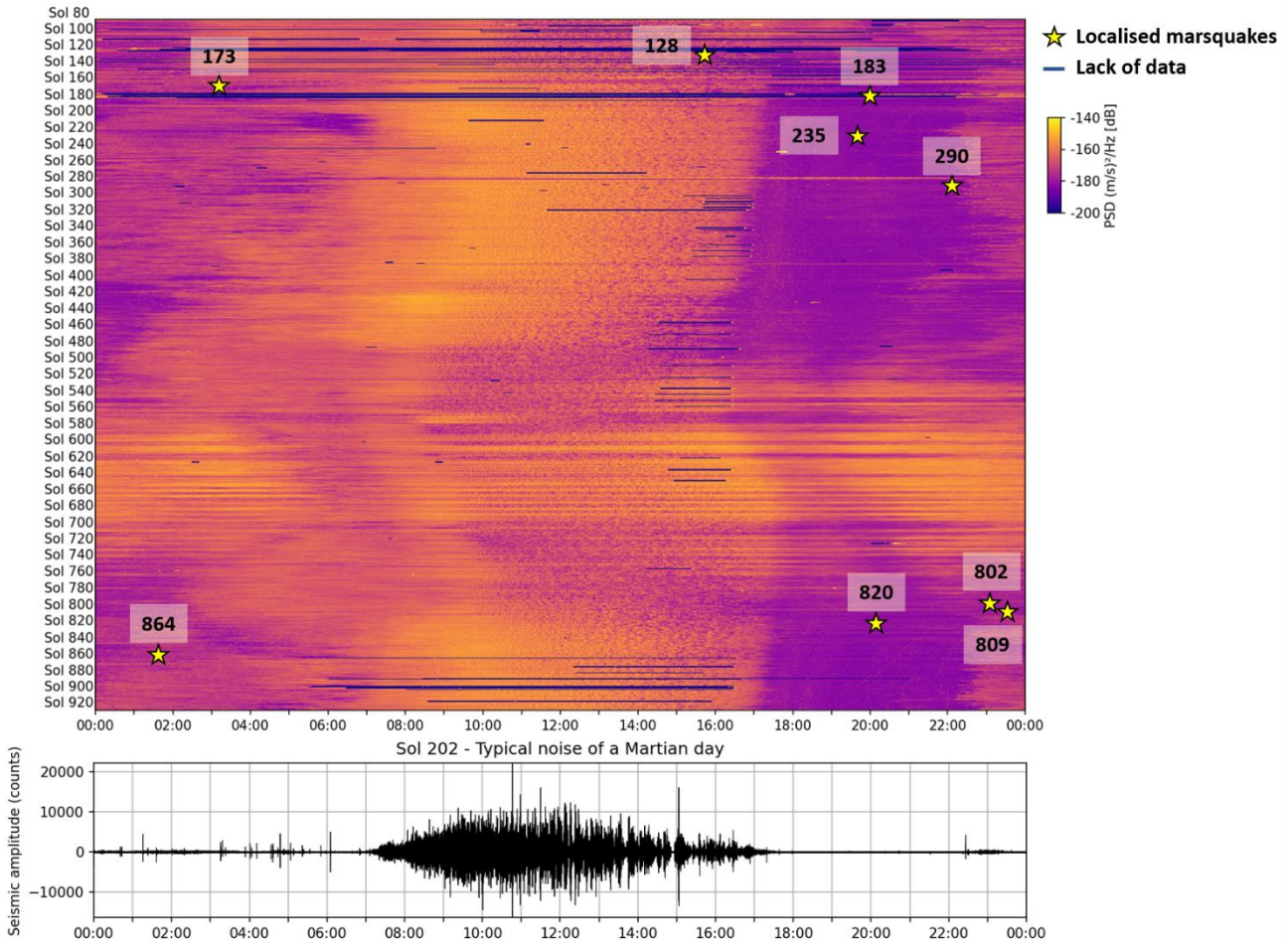


Figure inspirée de S. Ceylan, et al (2020)

Onglet « **Marsquake view** »

Id	Origin Time (UTC*)	Origin Time (LMST*)	Latitude	Longitude	Depth	Status	Data
S0864a	2021-05-02T00:57:46	Sol 864 01:40:38	0.71	163.25	-	Marsquake	sac
S0820a	2021-03-18T14:51:38	Sol 820 20:05:58	4.90	165.01	-	Marsquake	sac
S0809a	2021-03-07T11:09:33	Sol 809 23:33:38	5.39	164.65	-	Marsquake	sac
S0802a	2021-02-28T06:07:26	Sol 802 23:09:18	17.23	162.35	-	Marsquake	sac
S0290b	2019-09-21T03:15:42	Sol 290 22:08:00	14.49	163.38	-	Marsquake	sac
S0235b	2019-07-26T12:16:15	Sol 235 19:30:12	10.99	160.95	-	Marsquake	sac
S0183a	2019-06-03T02:21:55	Sol 183 19:53:46	15.29	-179.06	-	Marsquake	sac
S0173a	2019-05-23T02:19:33	Sol 173 02:55:15	3.45	164.68	-	Marsquake	sac
S0128a	2019-04-07T09:31:52	Sol 128 15:28:18	-	-	-	Marsquake	sac

*__UTC__: Coordinated Universal Time (Earth time)

*__LMST__: Local Mean Solar Time (Mars time)

Les spectrogrammes et la météo: page DATA

❖ Onglet « **Tuned into Mars** »

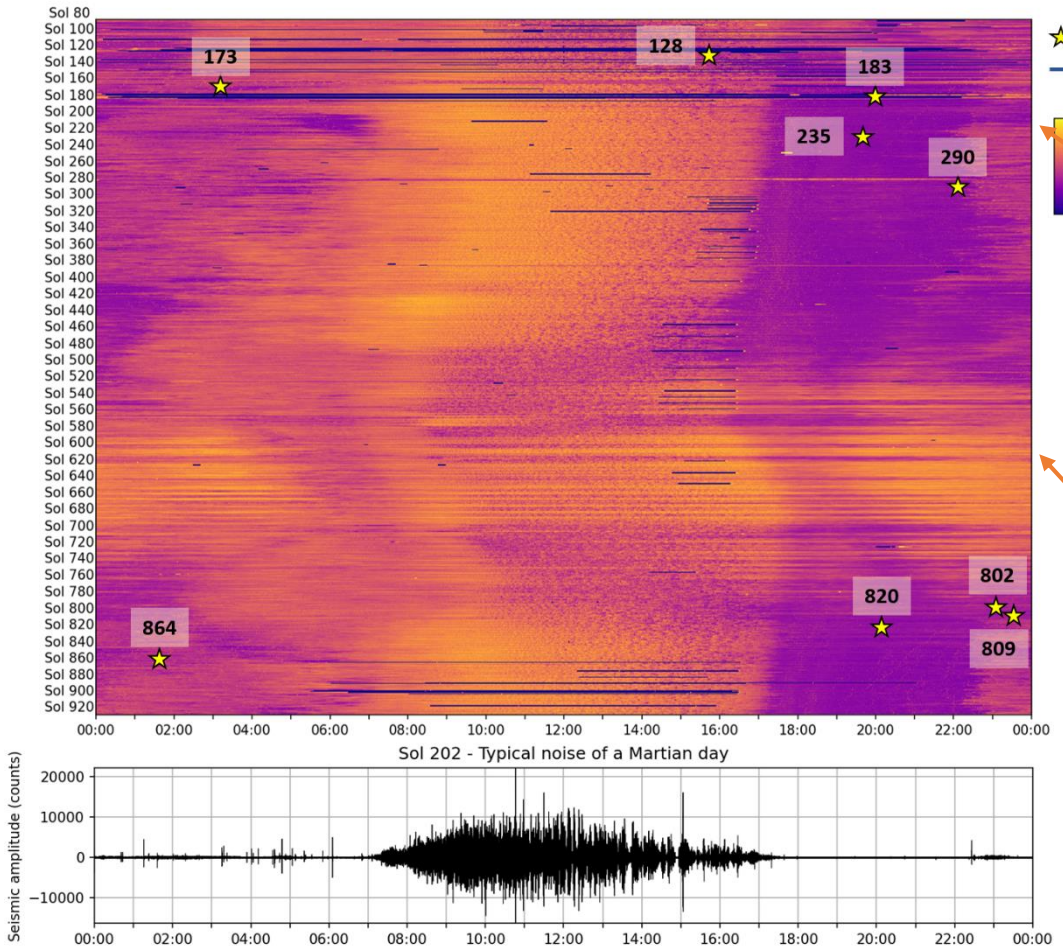
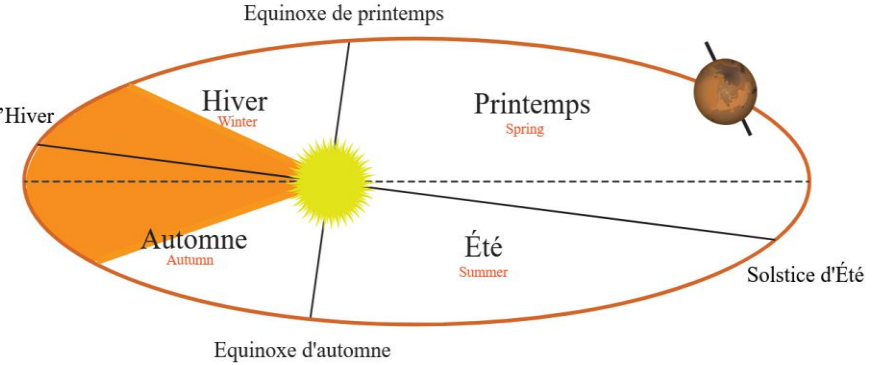


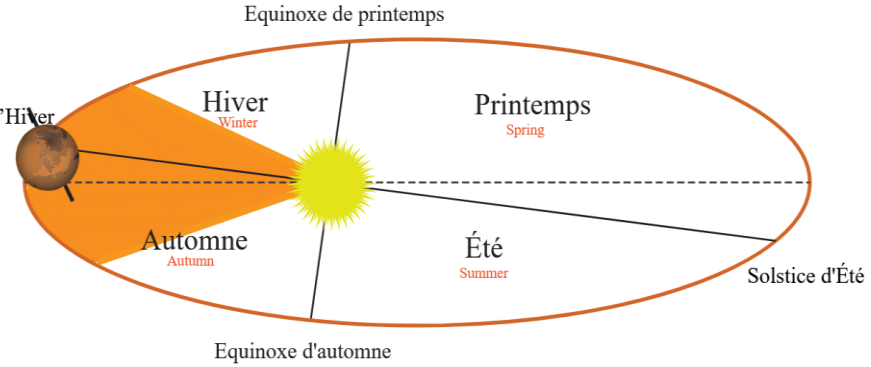
Figure inspirée de S. Ceylan, et al (2020)

Période des grandes tempêtes de poussières

Date: 2019-06-22
Insight Sol: 202
Ls: 42.87°

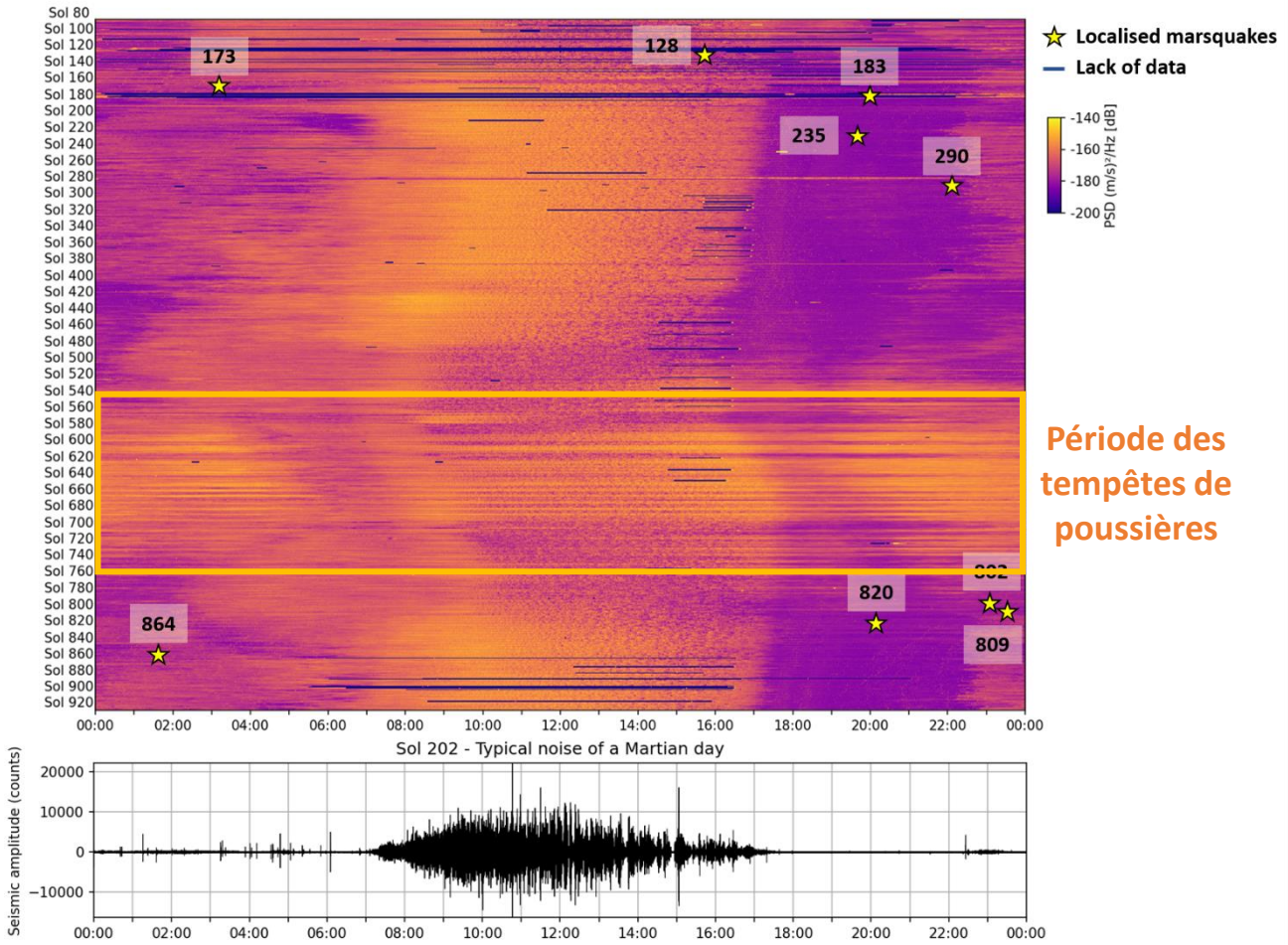


Date: 2020-08-24
Insight Sol: 620
Ls: 264.62°



Les spectrogrammes et la météo: page DATA

❖ Onglet « **Tuned into Mars** »



Période des tempêtes de poussières

Figure inspirée de S. Ceylan, et al (2020)

Sismomètre SEIS (sol 145)

Rover Curiosity pendant une tempête de poussière

Src: NASA/JPL-Caltech

Les spectrogrammes et la météo: page DATA

❖ Onglet « **Tuned into Mars** »

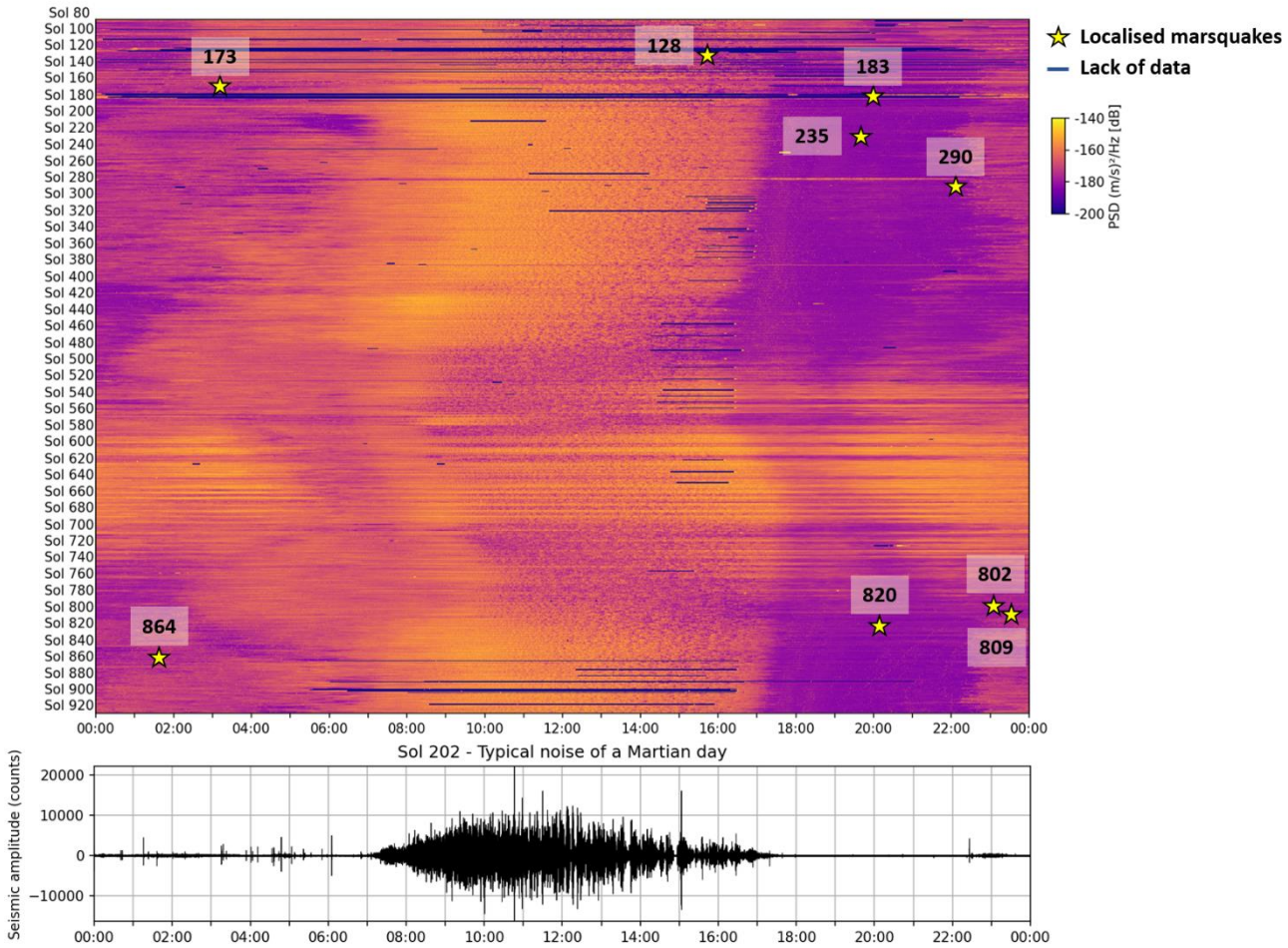
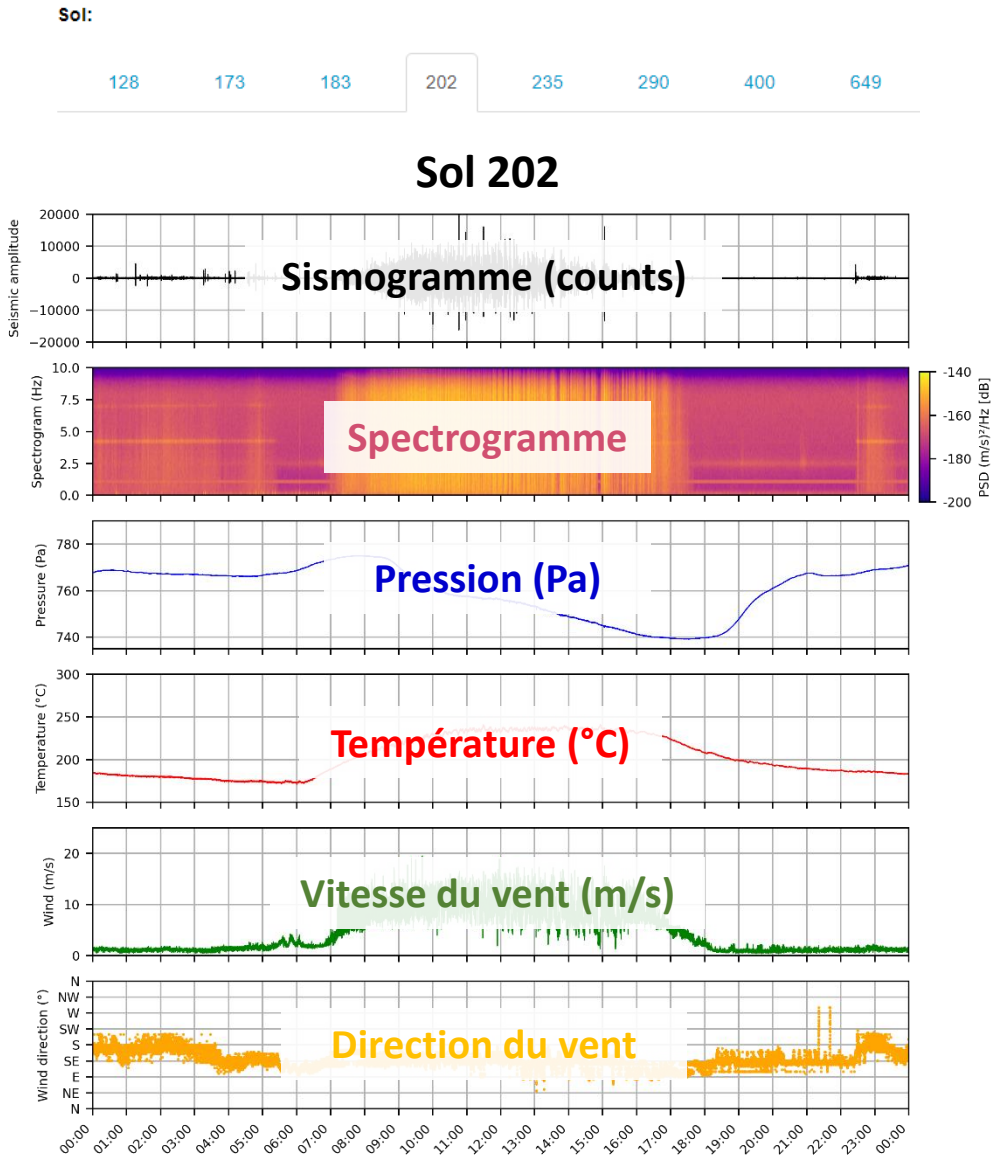


Figure inspirée de S. Ceylan, et al (2020)



Les spectrogrammes et la météo: page DATA

❖ Onglet « **Tuned into Mars** »

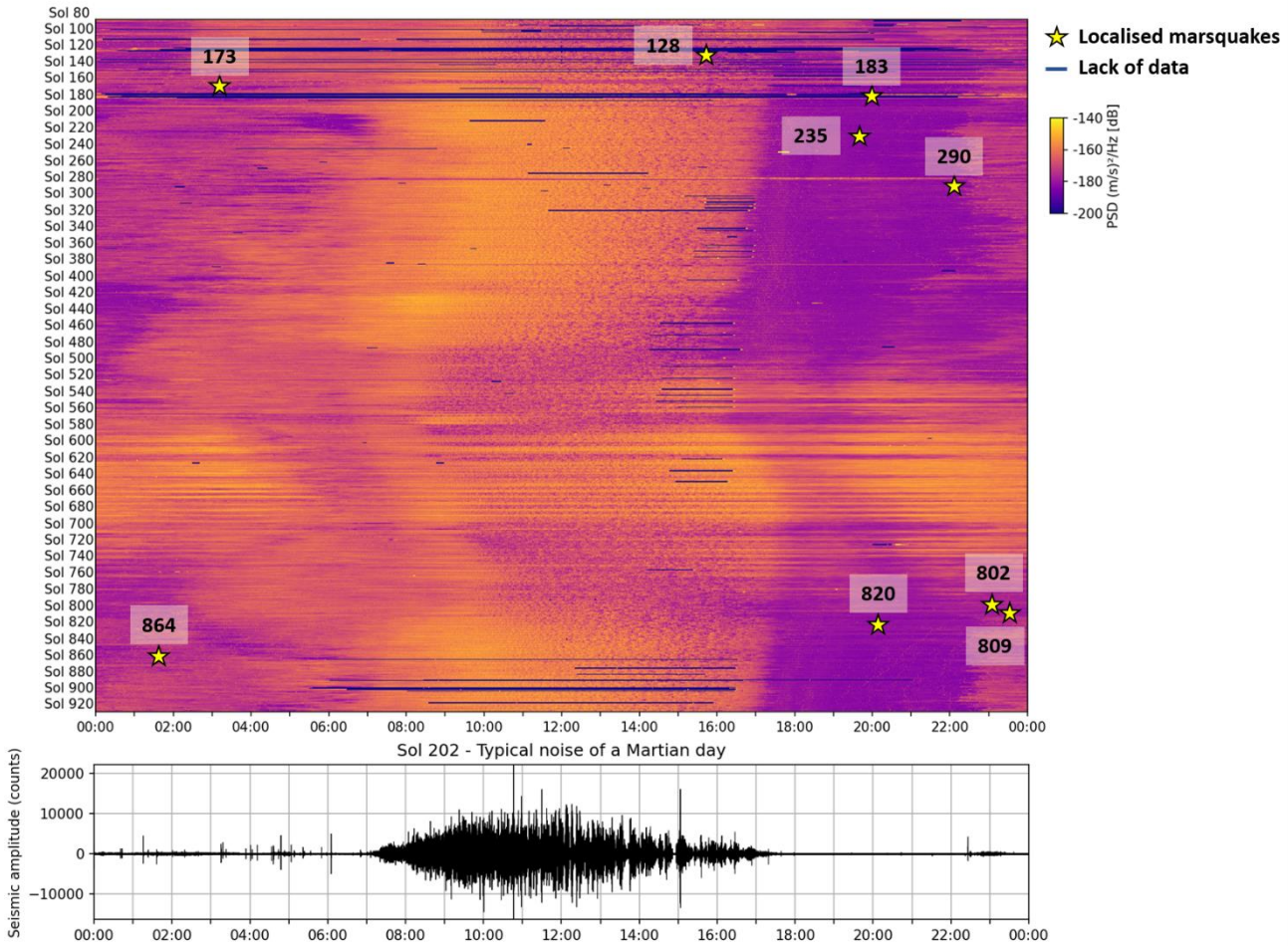
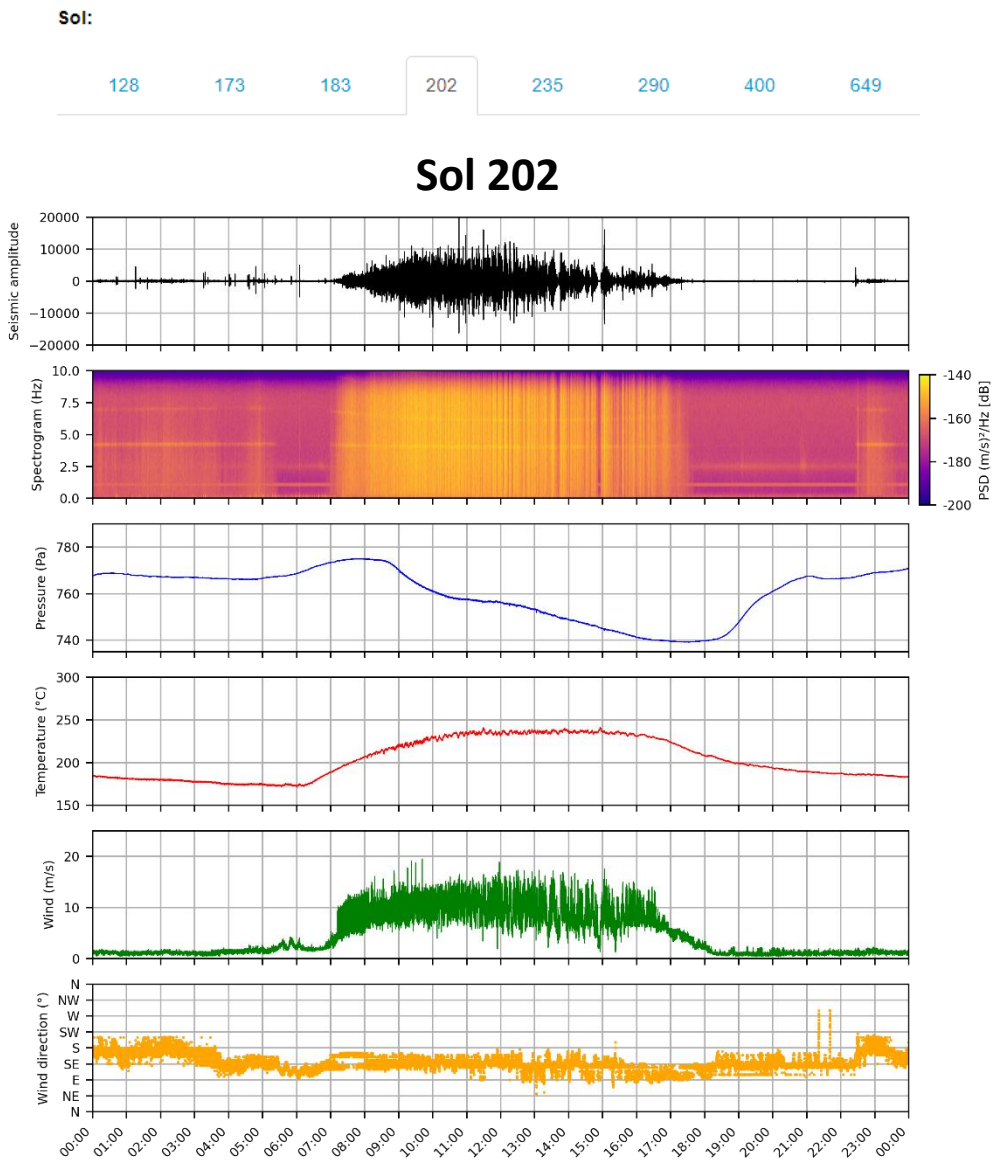


Figure inspirée de S. Ceylan, et al (2020)



Les spectrogrammes et la météo: page DATA

❖ Onglet « **Tuned into Mars** »

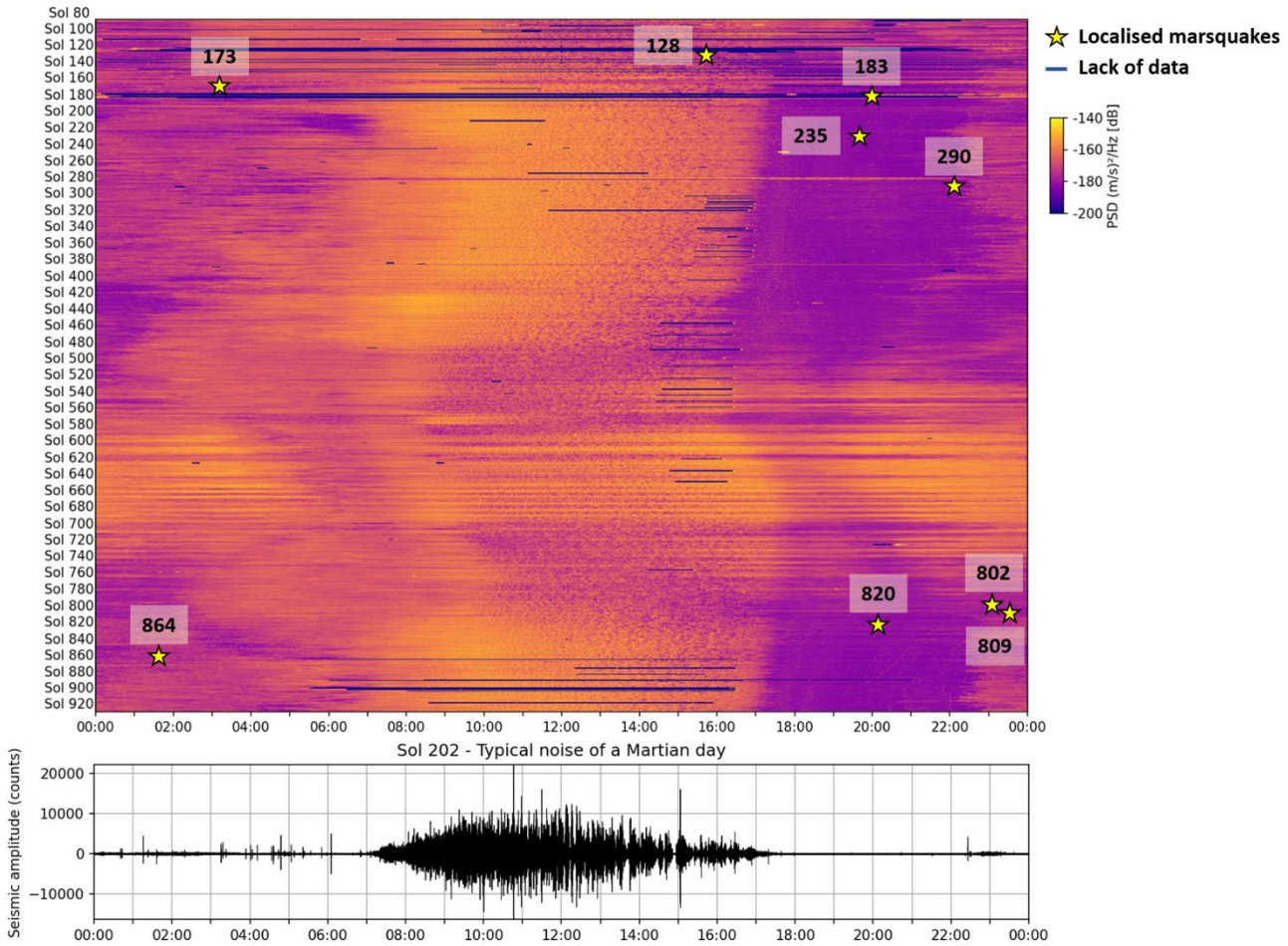
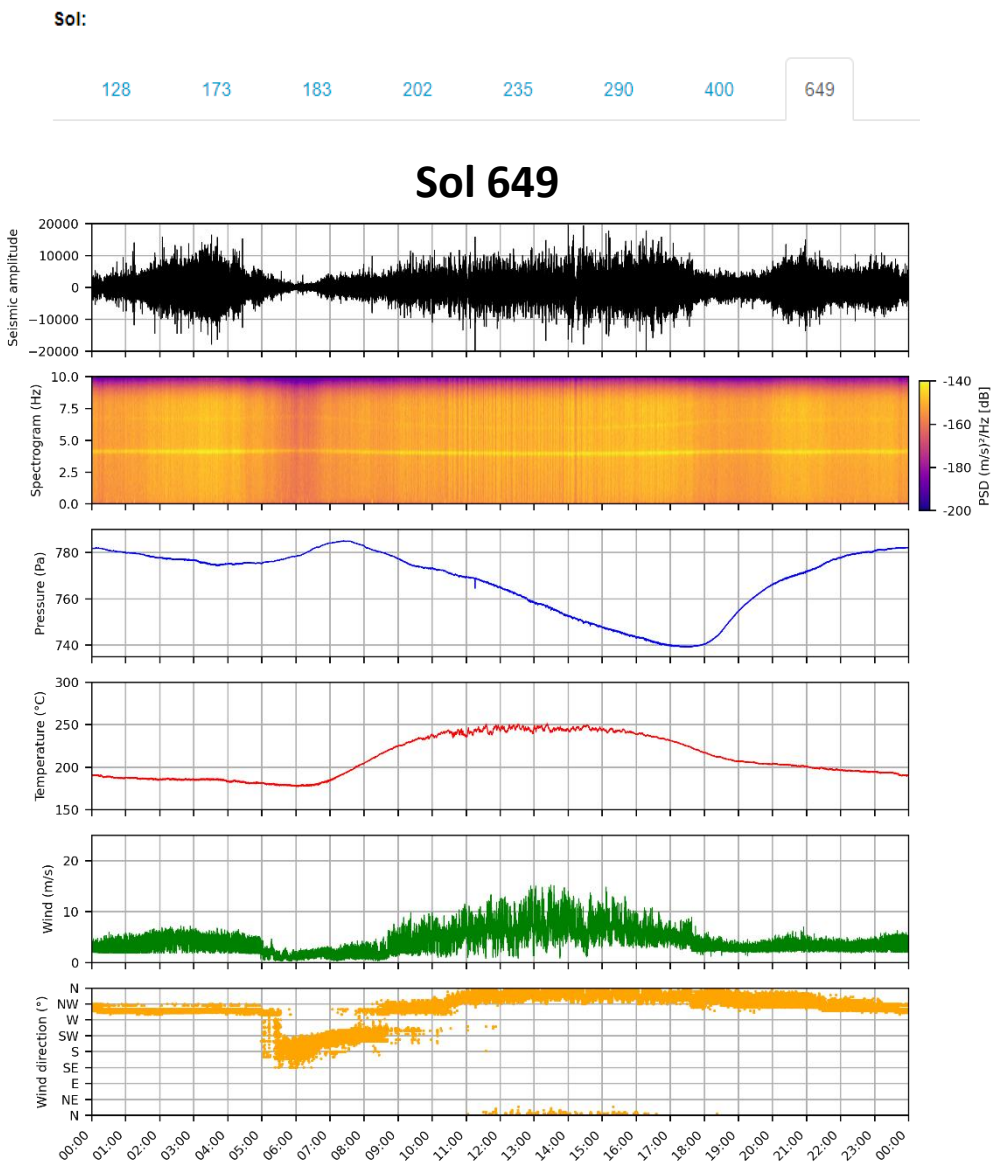


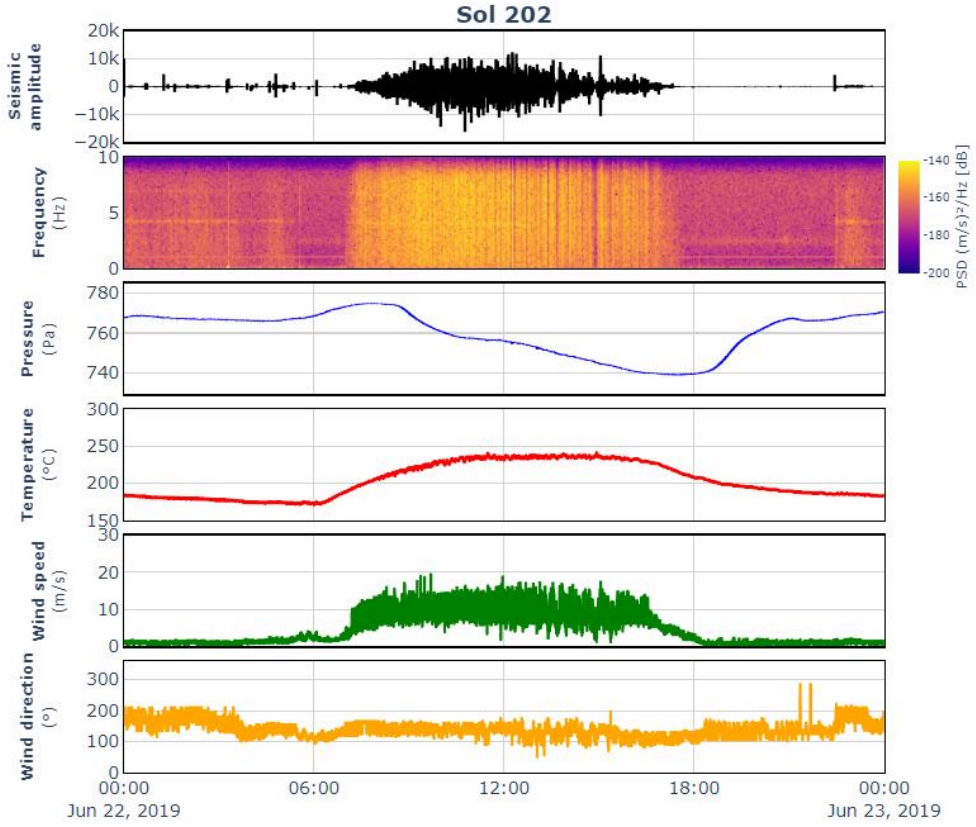
Figure inspirée de S. Ceylan, et al (2020)



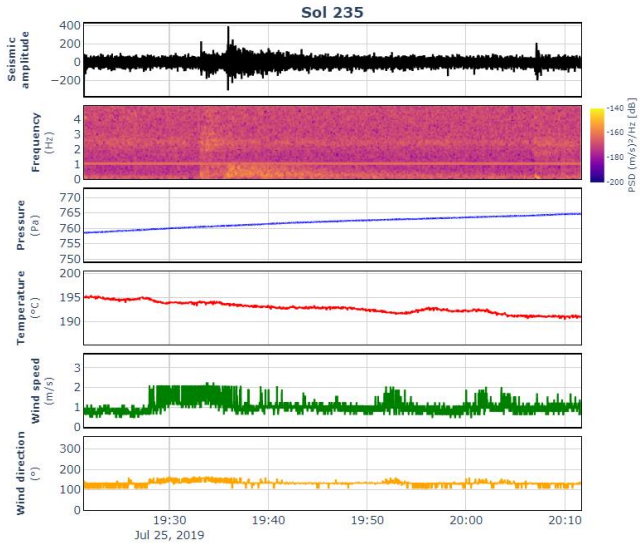
Les spectrogrammes et la météo: page DATA

❖ Les figures météo interactives

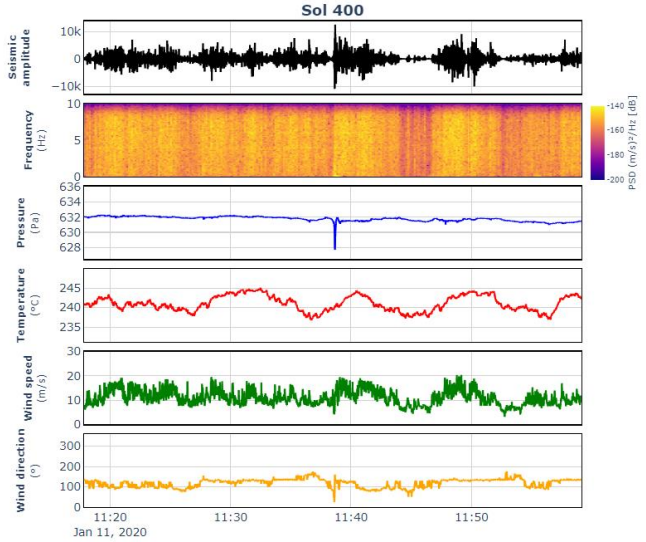
Enregistrer la figure
Zoomer / Dézoomer
Zoomer avec le curseur
Recentrer la figure
Se déplacer dans la figure



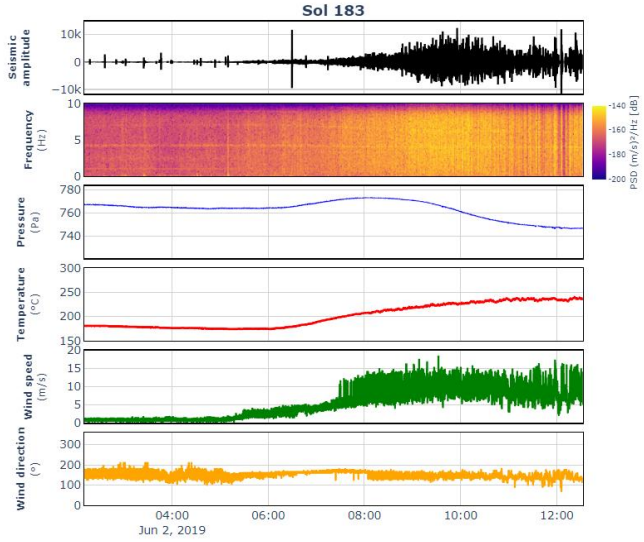
Marsquake du Sol 235



Chute de pression Sol 400



Début de journée Sol 183

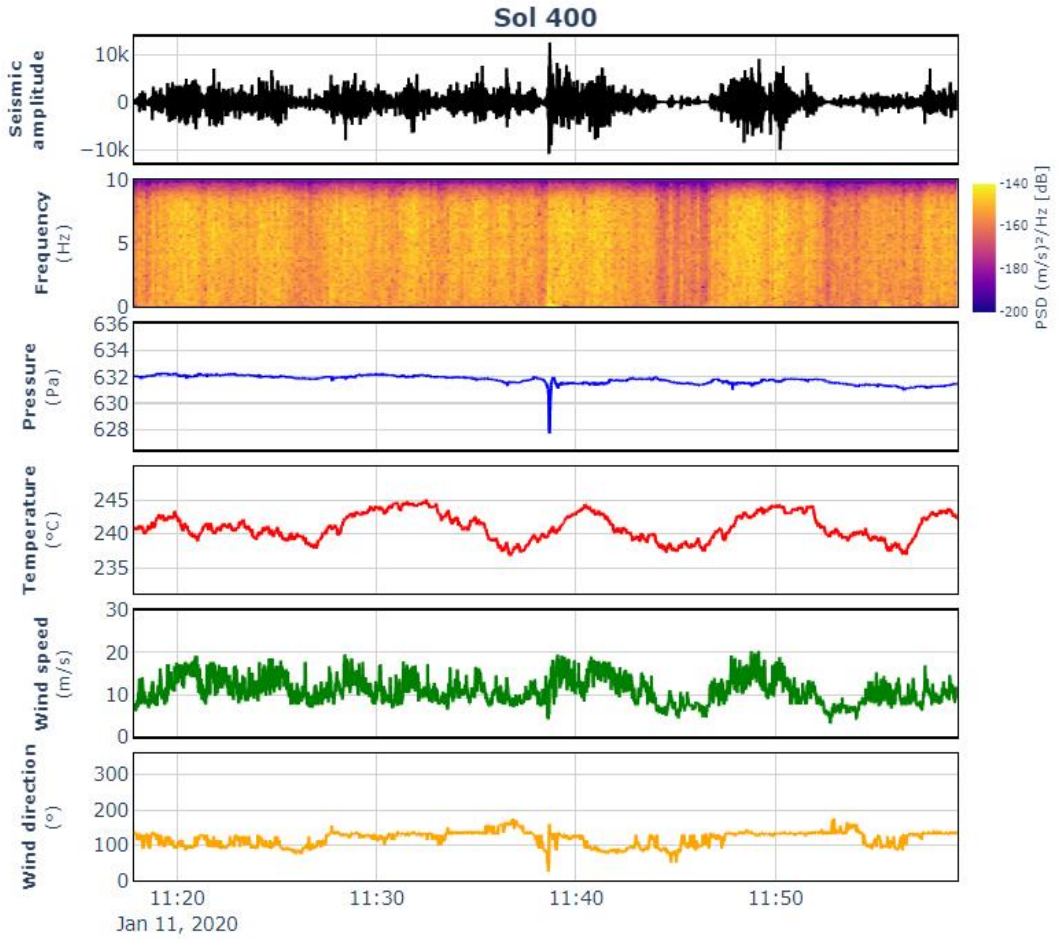


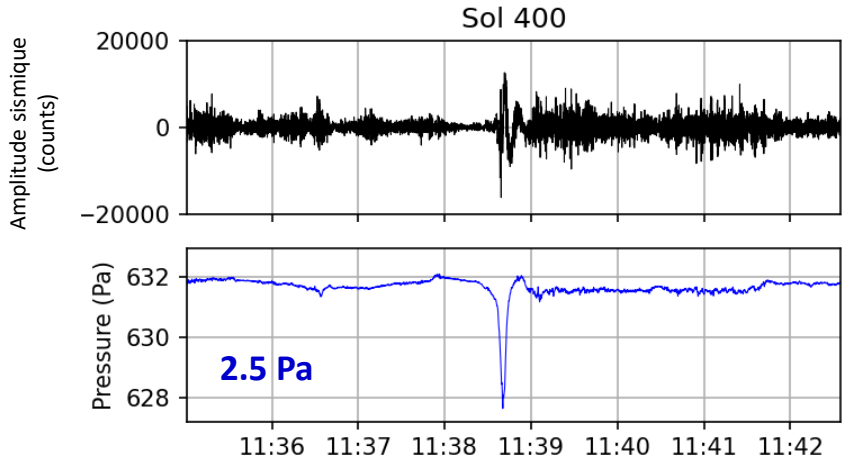
Merci de votre attention

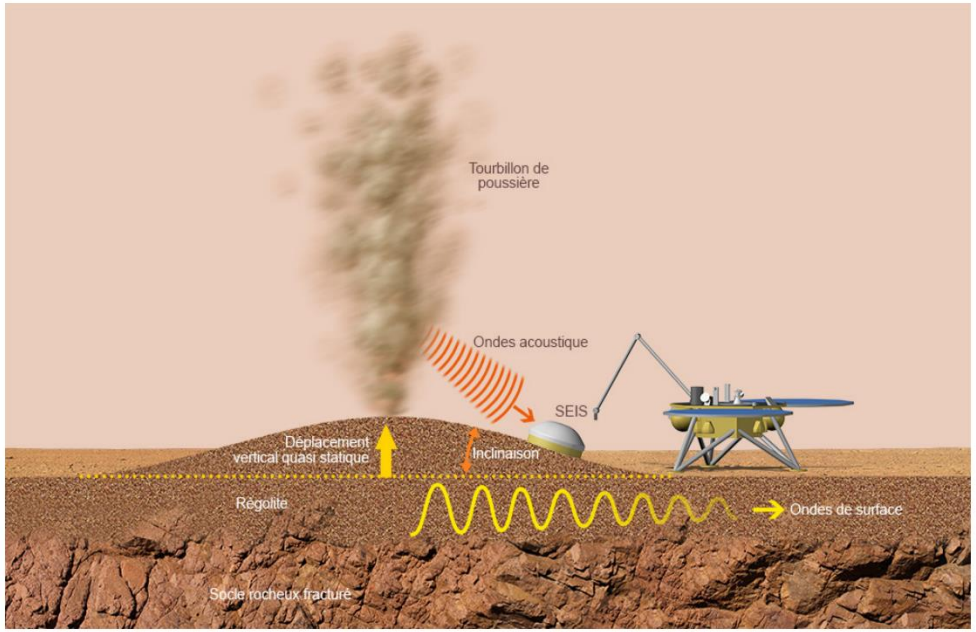
Les spectrogrammes et la météo: page DATA

❖ Les figures météo interactives

Les chutes de pression





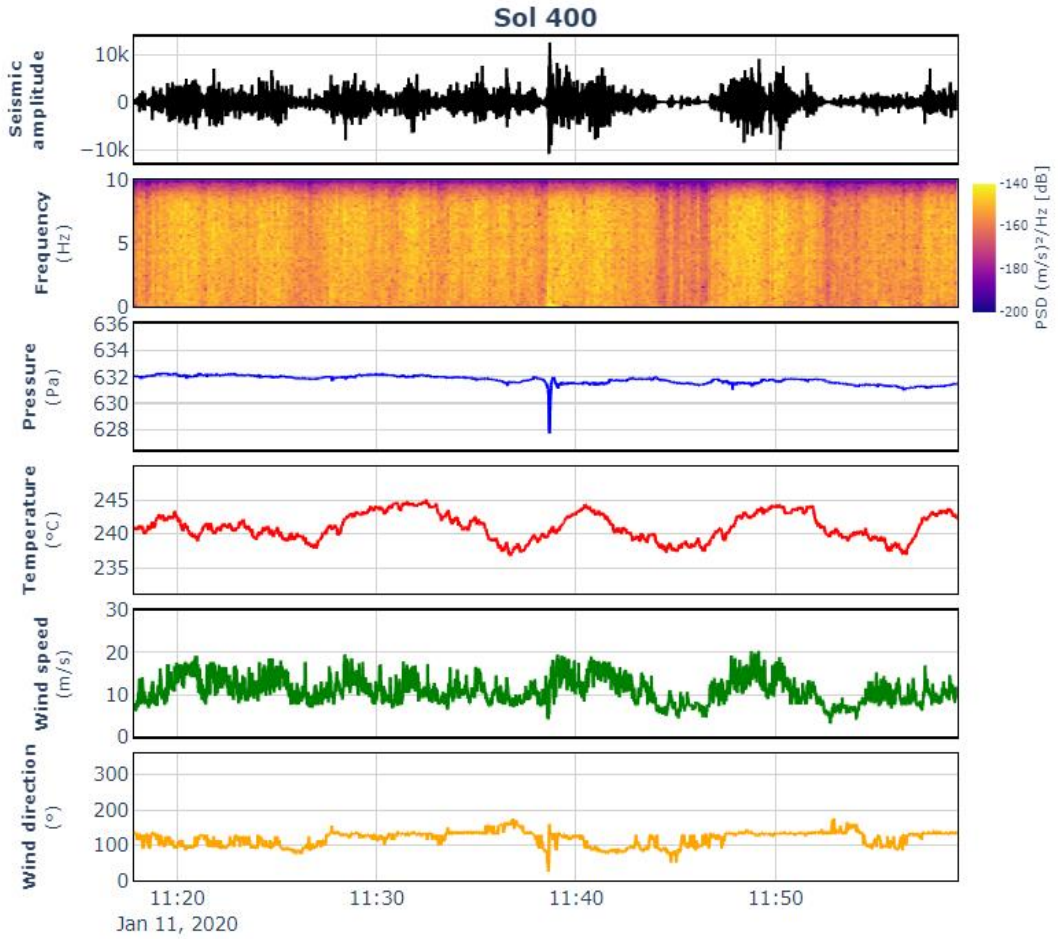


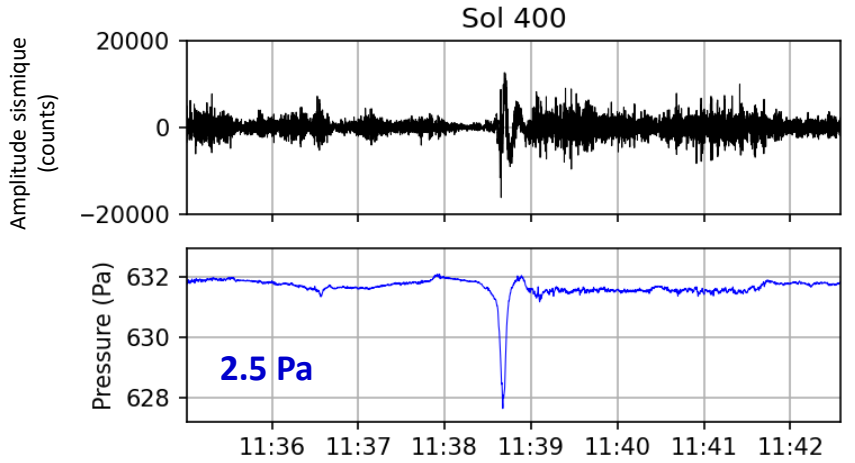
Src: © IPGP/David Ducros

Les spectrogrammes et la météo: page DATA

❖ Les figures météo interactives

Les chutes de pression





Src: NASA/JPL/University of Arizona