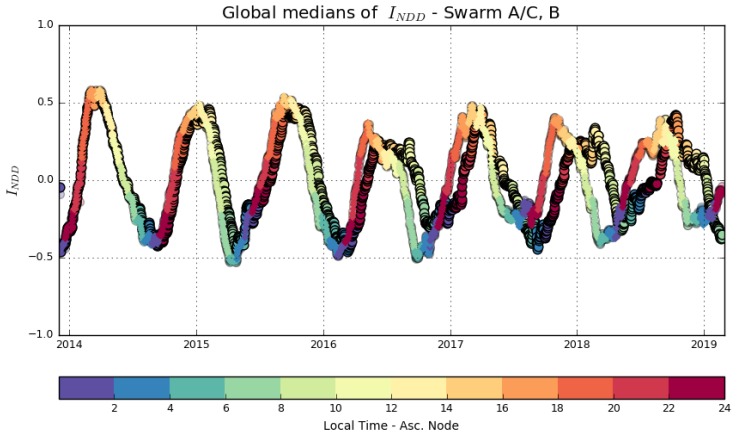
Sensitivity of the index to various solar and magnetic conditions

PM3

June 25, 2019

Climatology of I_{NDD} - Challenges

- For specific LTs it serves as good indicator of the reversed diurnal cycle.
- Pending question: Can we use I_{NDD} as a proxy for ionospheric climatology?



How to make the index a useful/versatile parameter for ionospheric observations?

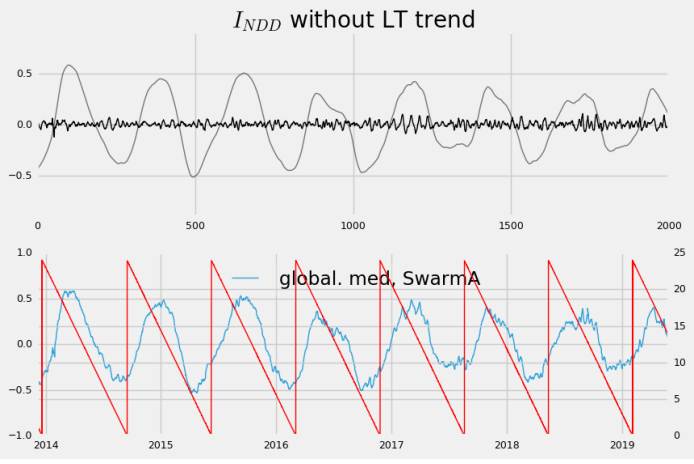
Ionospheric trends - climatological indicator

In literature:

- "long-term trends" - "over several decades"
- trend - according to definition: as a (nearly) linear change,
- for ionospheric purposes: Typical trends in hmF2 - increase/decreases of a few km/decade (or for critical freq. f0F2 MHz/decade)
- data X_{obs} may be fitted to a theoretical data set $X_{th} = A + B \cdot S + C \cdot Kp$, S is a solar activity proxy (e.g. sunspot number or F10.7 solar flux), Kp index (or another geomagnetic activity indicator), and A, B, and C fitted coefficient.
- Absolute or relative difference $\Delta X(X_{obs} - X_{th})$ is used to obtain a linear trend according to: $\Delta X = a + b \cdot year$,
- Through sine and cosine func. annual and semiannual influences can be filter out

Ionospheric trends - climatological indicator

Before we can built trends, we need to know what dominant cycles can be picked in available series of I_{NDD}?



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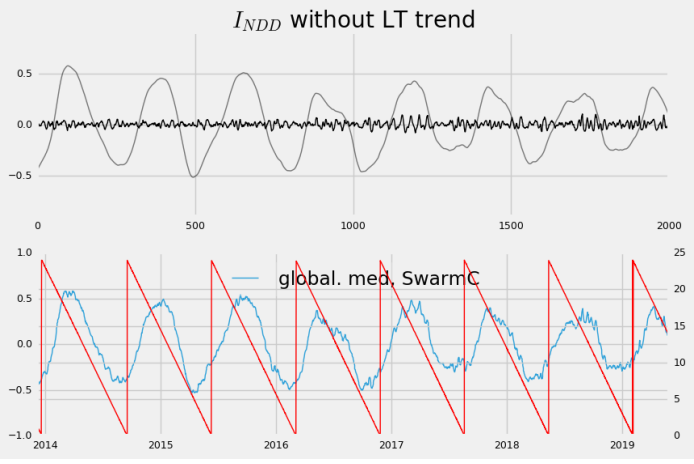

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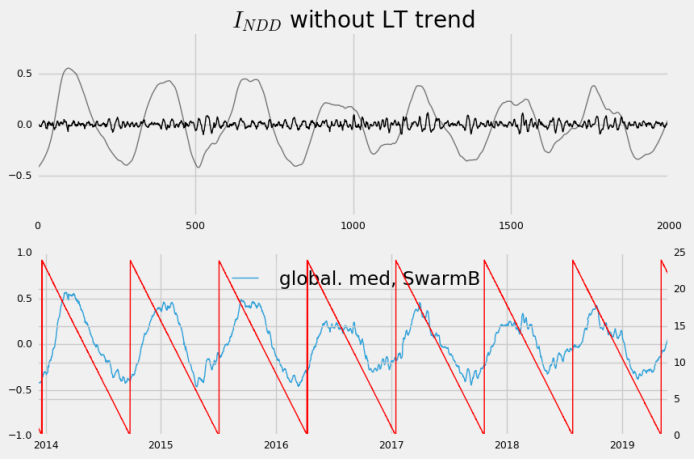
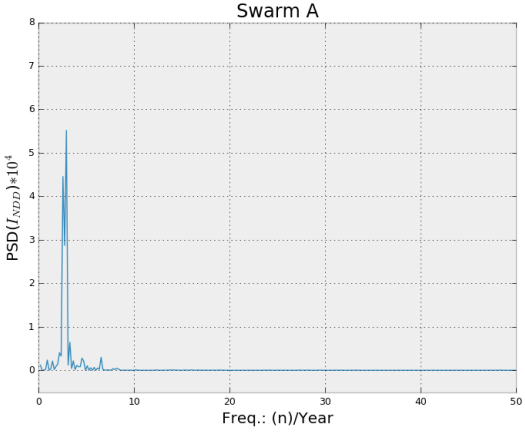
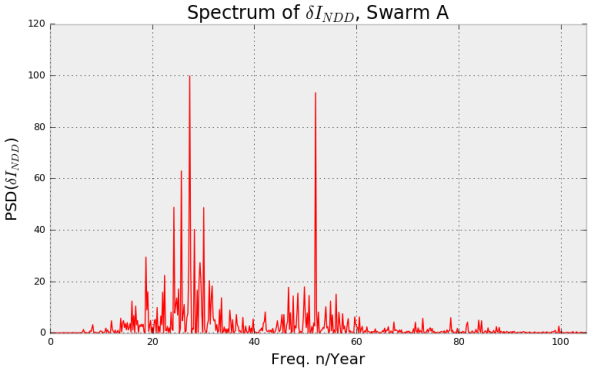


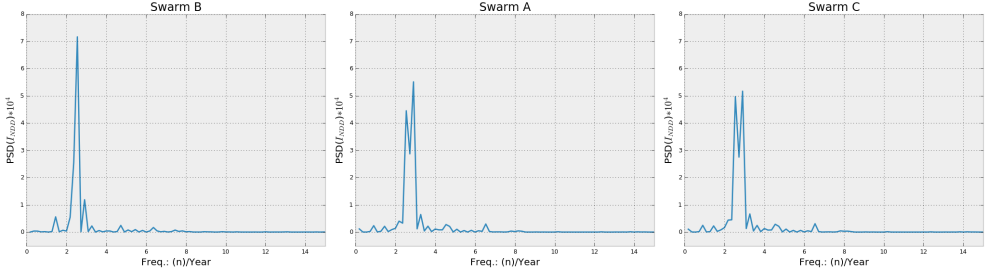
Cycles in I_{NDD} and δI_{NDD}





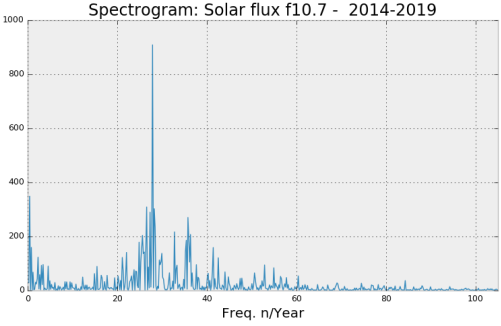
- if I_{NDD} had yearly variation, f=1 should a fundamental freq. - it is not.

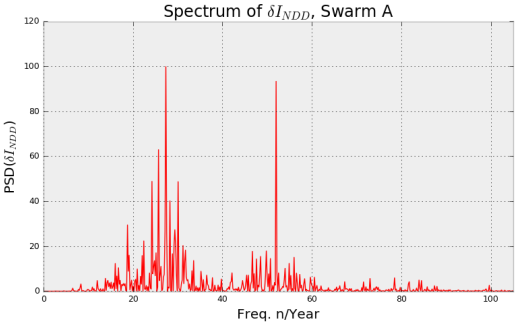
Cycles in I_{NDD}



- Bravo:**n=1.45 - 251 days (LT)**, n=2.57 (142 days), 3.2 (114 days), 4.7, 6.3, 7.5
- Alpha/Charlie - slightly differ in amplitudes, but corresponding *n* (A:) 0.9 (405 days), **n=1.48 - 246.6 days**, 2.54, 2.87, 3.29, 2.68, 4.56, 6.5,8.1,

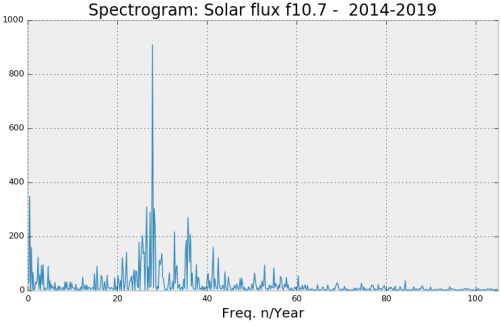
Trends from global I_{NDD}

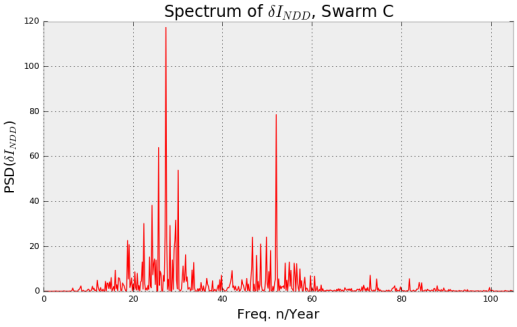




- Bravo:δI_{NDD} = 12.9, 13.5, 18.8, 22.3, 25, 30.1, 52, 54)
- Alpha/Charlie: δI_{NDD}, n=8.4, 12.2, 16, 18.4, 27.2, 51.7
- **Fluctuations of the index should exhibit correspondence with solar/magnetic activity**

Trends from global I_{NDD}





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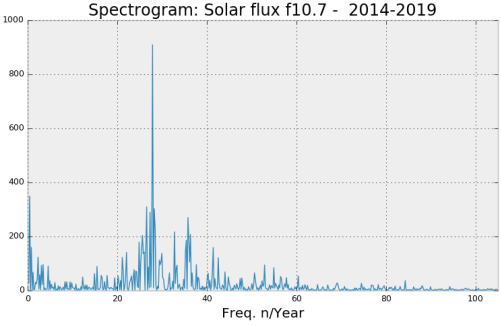

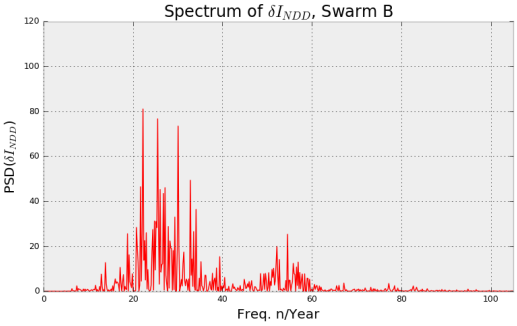

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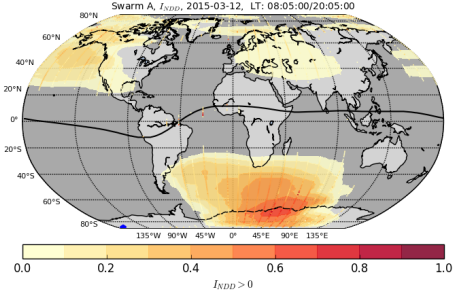
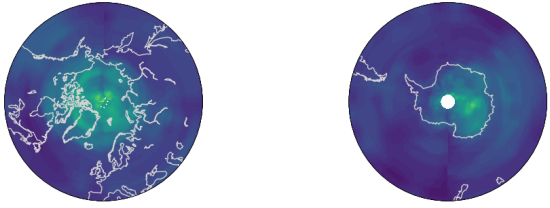
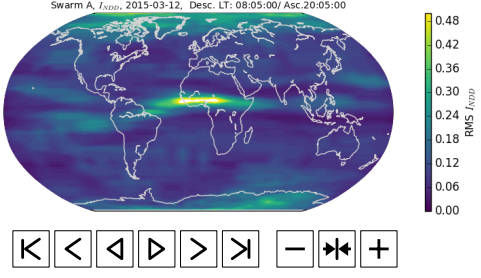
St. Patrick storm of 2015

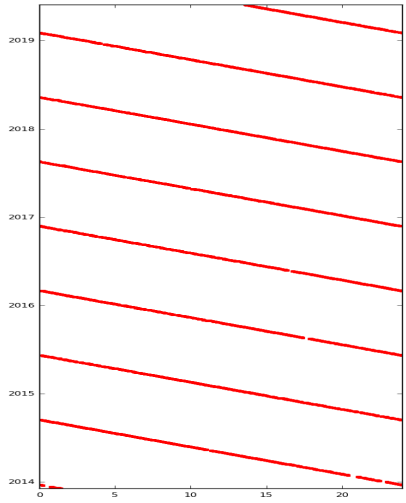
		Ap	00-03h	03-06h	06-09h	09-12h	12-15h	15-18h	18-21h	21-00h	Kp max
1	2015/03/17	108	2	5-	6-	5+	8-	8-	7+	8-	8-

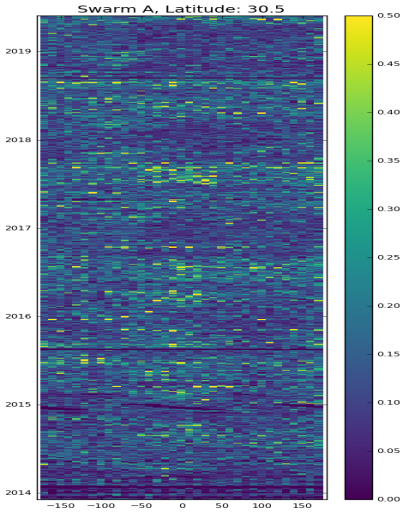






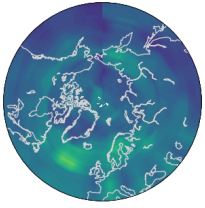
Fluctuations of the index - Longitudinal transect

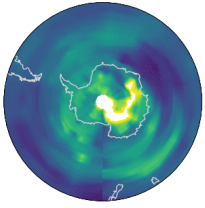


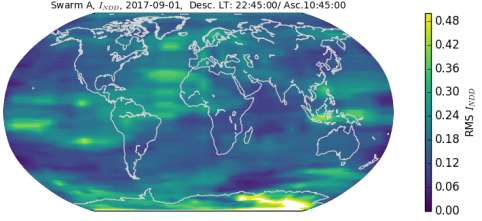


Fluctuations of the index during magnetic storm δI_{NDD} - Swarm A

		Ap	00-03h	03-06h	06-09h	09-12h	12-15h	15-18h	18-21h	21-00h
1	2017/09/08	106	8	5-	4+	5	8+	7+	6+	5+
2	2017/09/28	51	5+	6+	7-	5-	4-	4	4-	5+

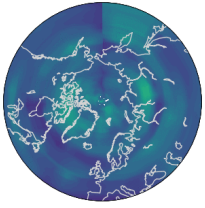


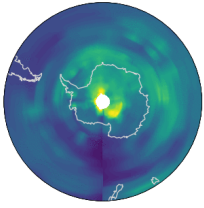




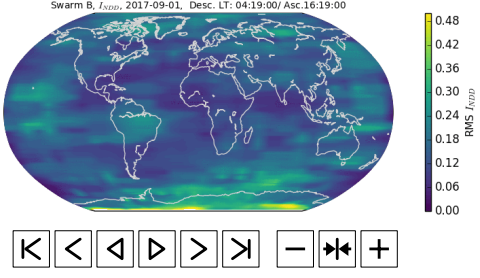
Fluctuations of the index during magnetic storm δI_{NDD} - Swarm B

		Ap	00-03h	03-06h	06-09h	09-12h	12-15h	15-18h	18-21h
1	2017/09/08	106	8	5-	4+	5	8+	7+	6+
2	2017/09/28	51	5+	6+	7-	5-	4-	4	4-





Despite different local times between Swarm A and B, fluctuations in δI_{NDD} as a response to magnetic storm reveal similar behaviour



Summary

- The concept of I_{NDD} assumes that we eliminate quickly varying, small scale fluctuations of electron density.
- I_{NDD} suitable for analysis of large scale ionospheric features, allows for cross-comparison with various missions, models
- But, fluctuations of the index (δI_{NDD}) are suitable for space weather applications
- δI_{NDD} exhibits analogy with the ROTI index, but has much lower time resolution - daily representation of ionospheric state.