Polarimeter to Unify the Corona and Heliosphere

WG 1B Overview

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PUNCH Science Meeting

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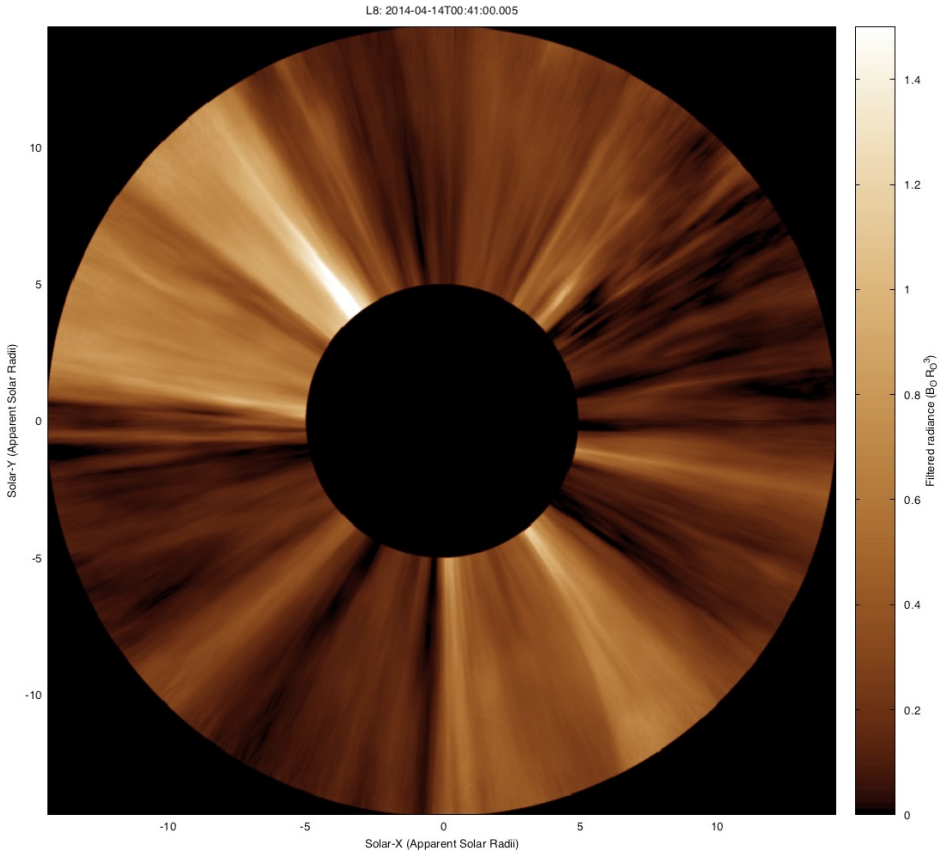
Working Group 1B

- PUNCH determines how much and what types of mesoscale structures are solar in origin, and how much and what types develops en route
- Answering these questions is important for:
  - providing critical insight into where and how kinetic energy becomes available to drive a turbulent cascade
  - understanding the solar wind variability impacting Earth's magnetosphere and other inner planets

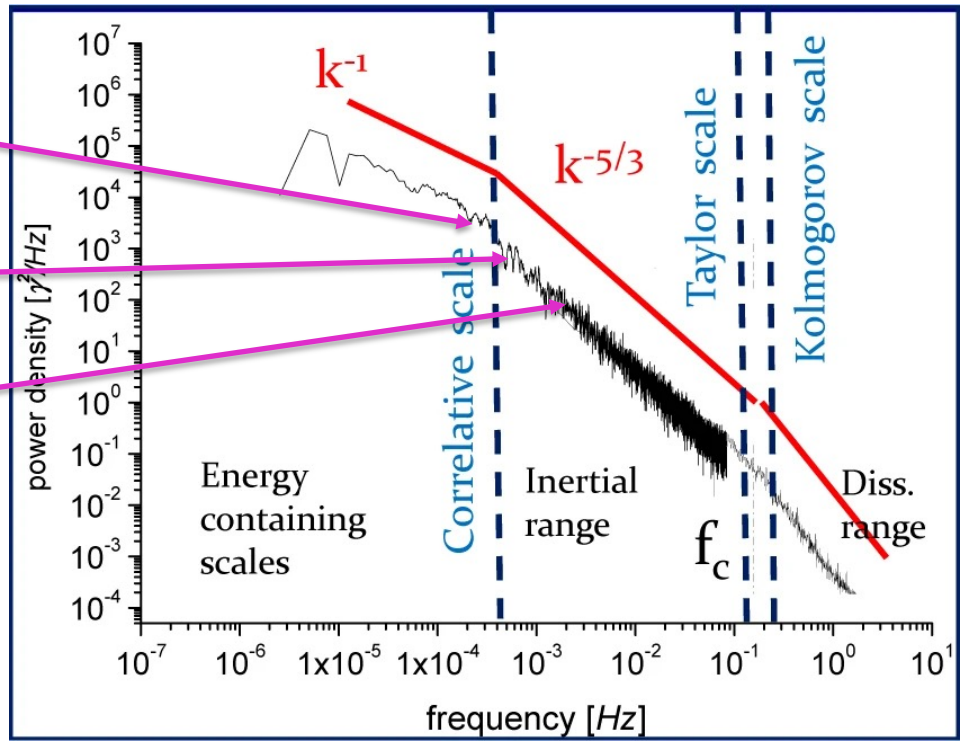


PUNCH Timescales

100 minutes

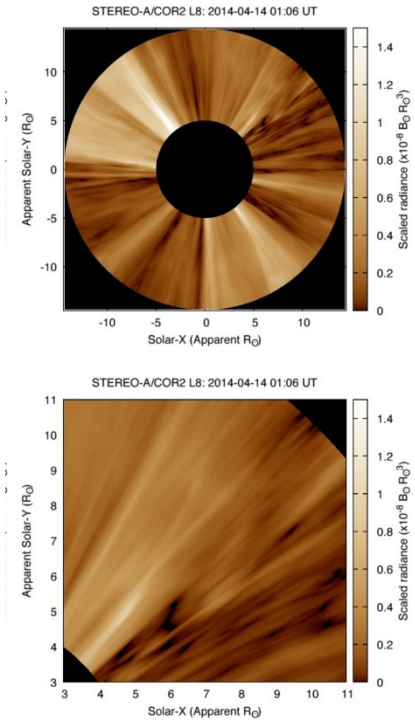
20 minutes

8 minutes

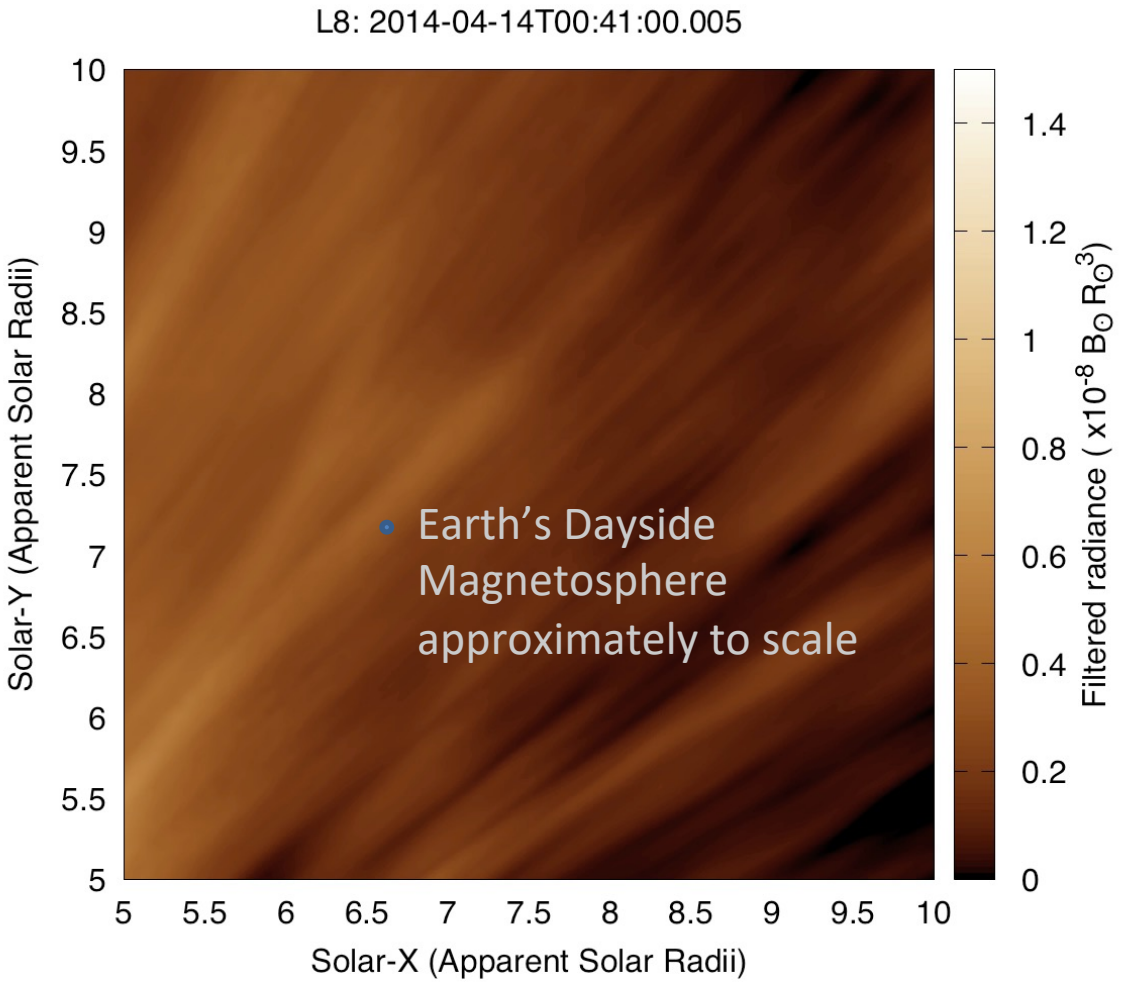


From Bruno & Carbone 2005, Living Reviews in Solar Physics

PUNCH Spatial Scales



DeForest et al. 2018

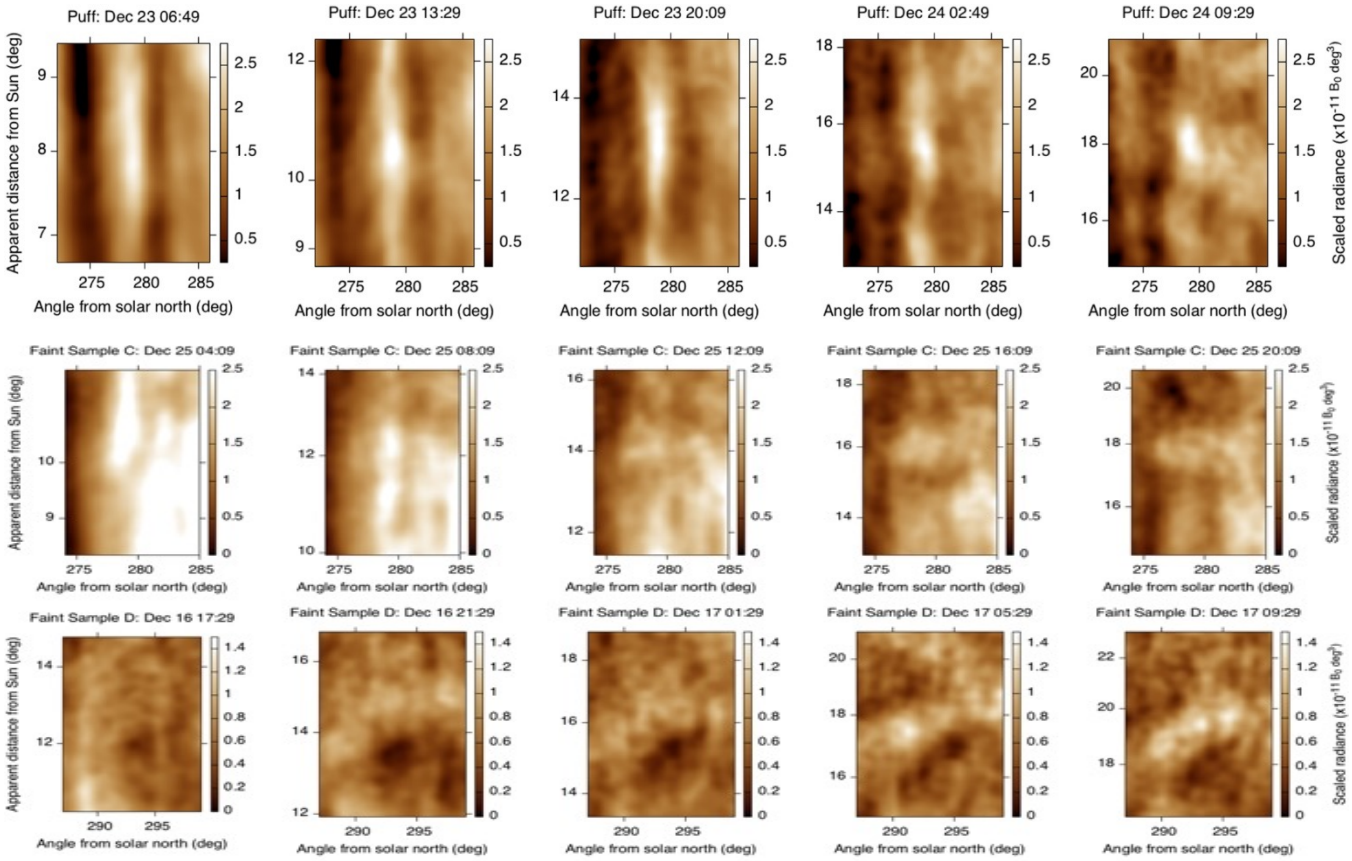


1 Solar Radii = 0.25 degrees

PUNCH resolution requirement inner is 3' ~ 140 Mm

140 Mm advecting at 400 km/s = 350s (6 minutes)-> well matched to temporal resolution

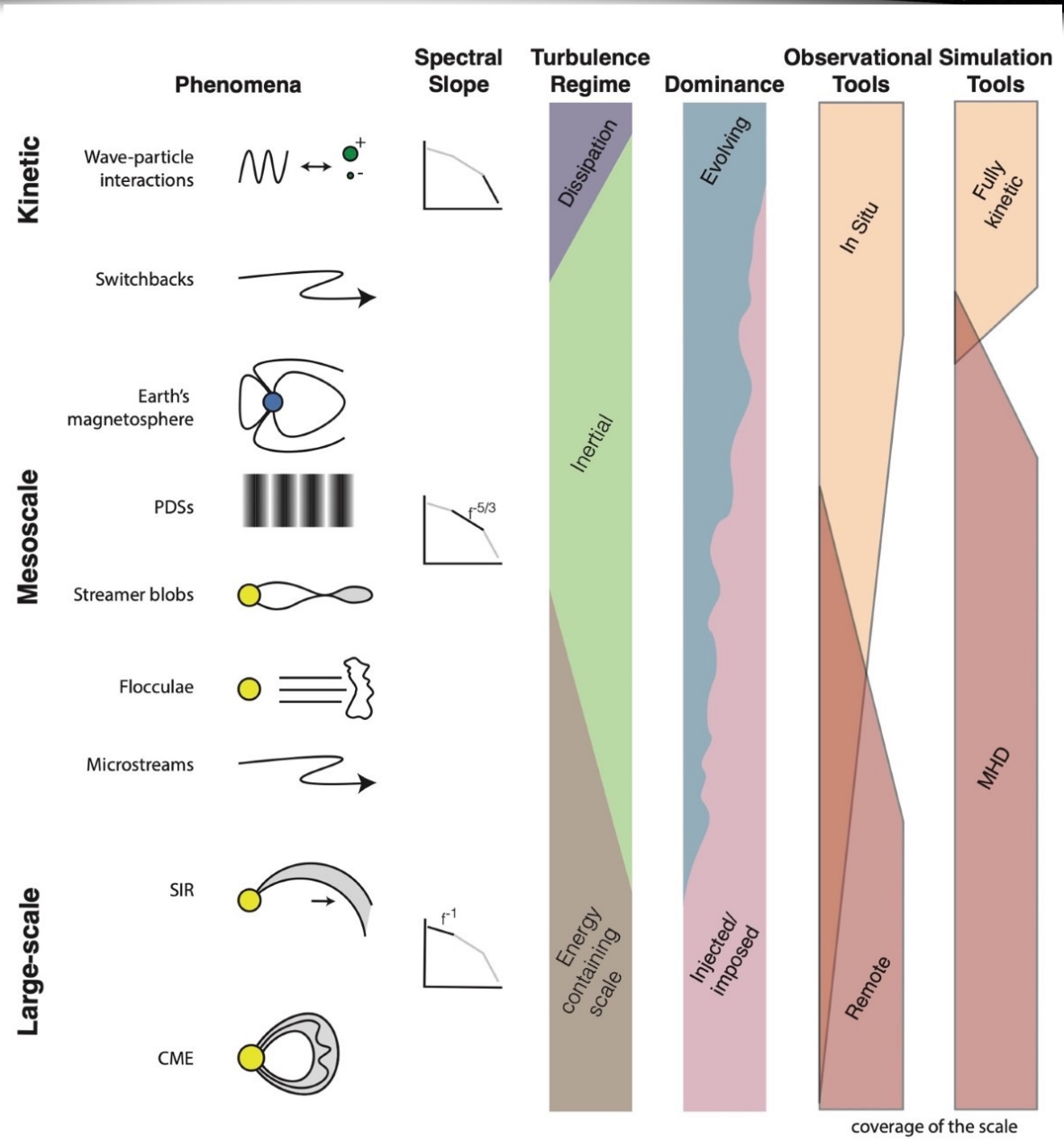
STEREO has Observed Ample Evidence of Structures from the Corona and Structures formed en Route



- How much of each type?
- Under what conditions?
- How do they interact with each other?

DeForest, Matthaeus, Viall & Cranmer 2016

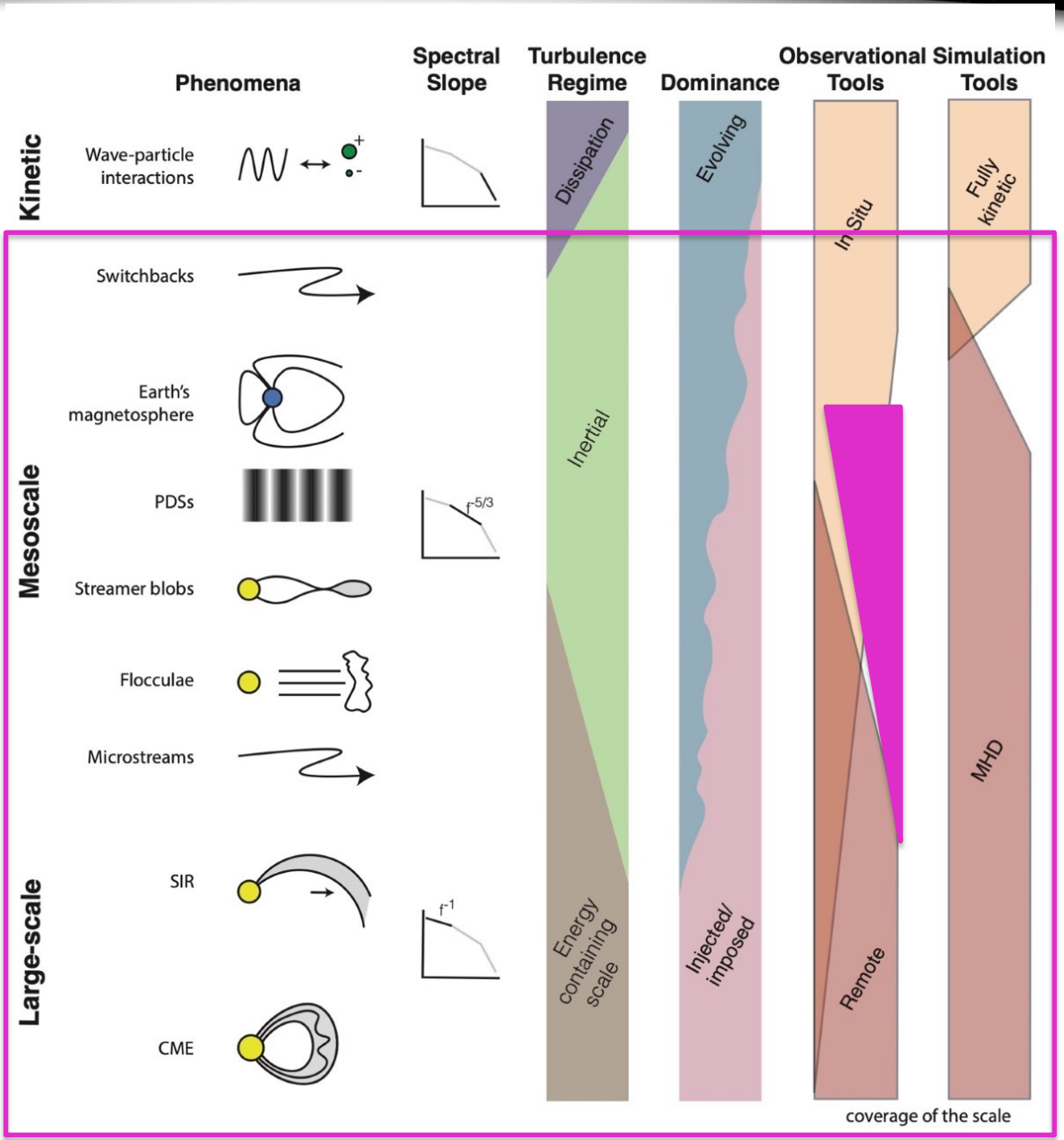
Mesoscale structures in the solar wind are injected/imposed from the Sun, and generated en route through turbulence/dynamics



Viall, DeForest & Kepko, Mesoscale Structures in the Solar Wind, Frontiers

Mesoscale structures in the solar wind are injected/imposed from the Sun, and generated enroute through turbulence/dynamics

PUNCH fills in the missing coverage and resolution of mesoscales



Viall, DeForest & Kepko, Mesoscale Structures in the Solar Wind, Frontiers

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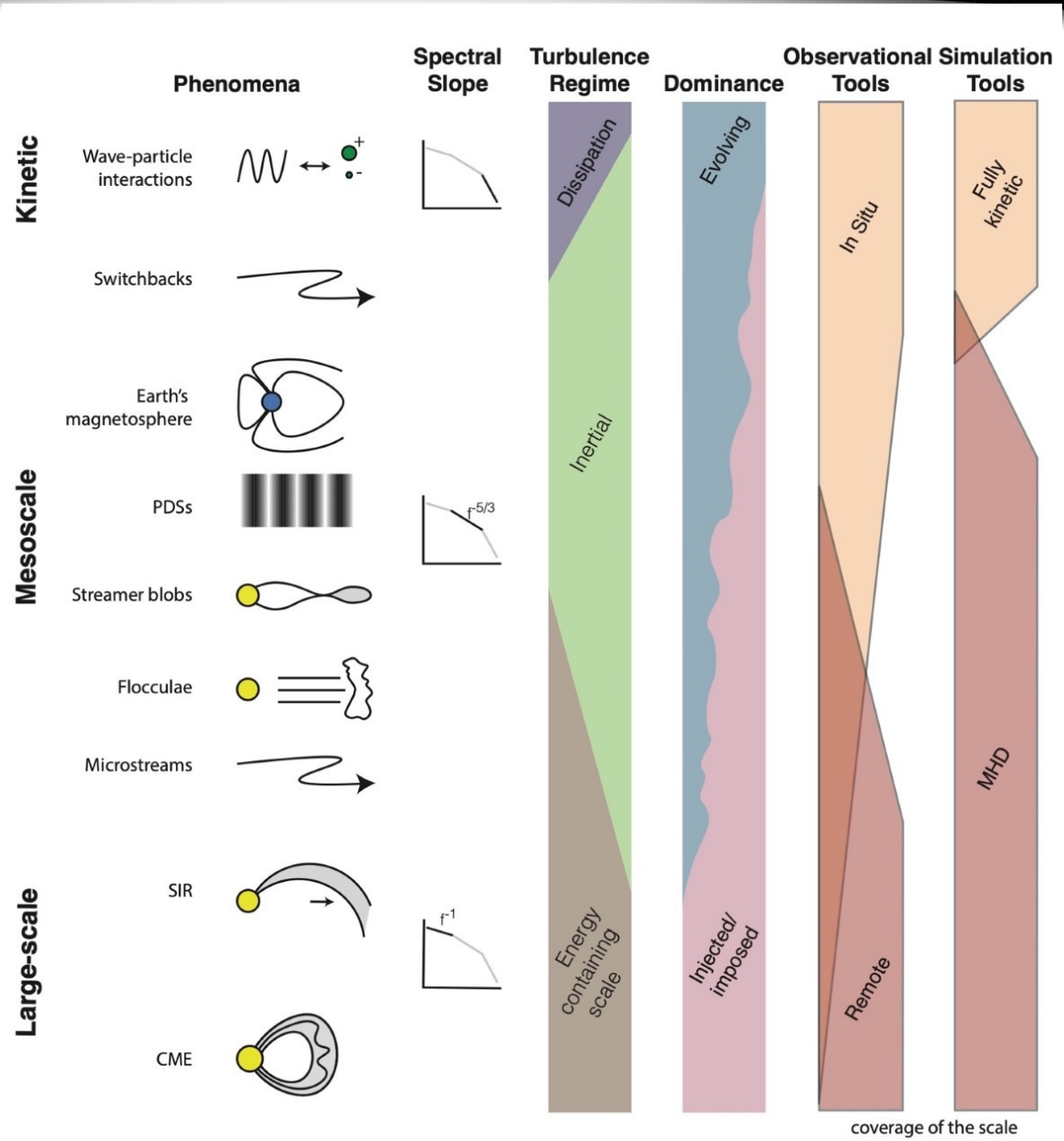
PUNCH can embrace this opportunity to finally enable an understanding of the complex, 3D, time-dynamic solar wind



Viall, DeForest & Kepko, Mesoscale Structures in the Solar Wind, Frontiers

Analysis: Tools and Measurements

Properties to Measure:

Velocity – bulk, flow shears, and compression and rarefaction fronts

Density – relative changes, and absolute mass

Scale sizes – distribution, characteristic, anisotropies, 3D

Location – 3D

Tools:

Fourier spectra

Structure Functions

Auto-correlation

Image deblurring

Photometric mass

Polarization (3D)

Flow mapping

By eye – i.e. the brute force approach (event studies only)

Tools can be applied to measure these properties for in-depth event studies as well as statistical studies investigating how the properties evolve with distance from the Sun (solar wind advection) and from one solar rotation to next

WG1B Intra-PUNCH Synergies

- WG1A: How is the development of the turbulent cascade, growth and evolution of structures from the corona, and interaction between structures tied to the velocity field?
- WG1C: How do the characteristics of turbulence relate to the Alfven surface?
- WG2: How often/under what conditions/on what size scales are the upstream solar wind structures swept up and amplified by compression regions from CIRs, SIRs and CMEs?
- WG2: How often/under what conditions/on what size scales do compression regions from CIRs, SIRs, and CMEs generate new waves and structures?

Synergies with Other Missions/Data/Models

- PUNCH-WL overlapping image plane comparisons including polarimetry to test 3D aspects of mesoscale structures
- PUNCH-in situ collocated comparisons for understanding the relationship between mesoscale structures and variability in N, V, T and B
- PUNCH-in situ L1/Earth for quantifying geo-effectiveness of mesoscale structures
- PUNCH-remote (WL/EUV) below 5 Rsun to determine solar sources
- Models, models, models