COFFIES – Developing a Reliable Physical Model of the Solar Activity Cycle

Server Error in '/' Application.

The resource cannot be found.

Description: HTTP 404. The resource you are looking for (or one of its dependencies) could have been removed, had its name changed, or is temporarily unavailable. Please review the following URL and make sure that it is spelled correctly.

Requested URL: /Default.aspx

J. Todd Hoeksema, Nic Brummell, Rock Bush, Shea Hess Weber, Rudi Komm, Alexander Kosovichev, Bryan Mendez, Philip Scherrer, Lisa Upton, Alan Wray, Dan Zevin, and the COFFIES Team

Stanford University, UC Santa Cruz, National Solar Observatory, New Jersey Institute of Technology, UC Berkeley, Space Systems Research Corp, NASA Ames

Join us for COFFEE with COFFIES December 7, 2020 at 4:00 PM PT

Sign up at bit.ly/coffies or use the QR code and we'll be in touch!

PRESENTED AT:

AGU FALL MEETING

Online Everywhere | 1–17 December 2020

ABSTRACT

The solar activity cycle is the Consequence Of Fields and Flows in the Interior and Exterior of the Sun (COFFIES). The COFFIES Drive Science Center ultimately aims to develop a data driven model of solar activity. The challenging goals are 1) to understand the generation of the quasi-periodic stellar magnetic cycles, 2) further develop 3D physical models of interior dynamics and convection, 3) establish the physical links between solar flow fields and near-surface observations, and 4) develop more robust helioseismic techniques to resolve solar interior flows. To reach these goals the COFFIES team is focusing on what is needed to answer five primary science questions: 1) What drives varying large-scale motions in the Sun? 2) How do flows interact with the magnetic field to cause varying activity cycles? 3) Why do active regions emerge when and where they do? 4) What do the manifestations of activity and convection reveal about the internal processes? And 5) How does our understanding of the Sun as a star inform us more generally about activity dynamics and structure? The virtual COFFIES center is bringing together a broad spectrum of observers, analysts, theorists, computational scientists, and educators who collaborate through interacting teams focused on helioseismology, dynamos, solar convection, surface links, numerical modeling, center effectiveness, outreach, education, diversity and inclusion.

ABSTRACT & SUMMARY

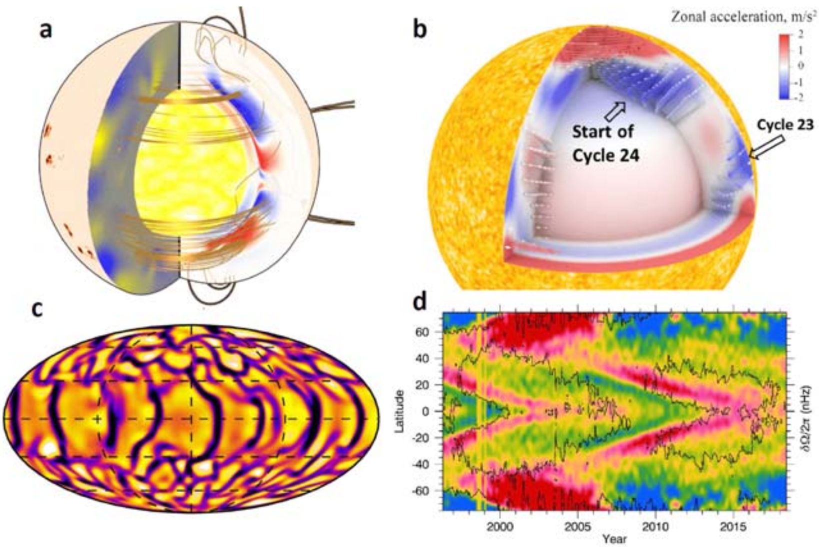
The solar activity cycle is the **Consequence Of Fields and Flows in the Interior and Exterior of the Sun (COFFIES)**. The COFFIES Drive Science Center ultimately aims to develop a data driven model of solar activity. Our challenging goals are to

- understand the generation of the quasi-periodic stellar magnetic cycles,
- further develop 3D physical models of interior dynamics and convection,
- establish the physical links between solar flow fields and near-surface observations, and
- develop more robust helioseismic techniques to resolve solar interior flows.

To reach these goals the COFFIES team is focusing on what is needed to answer five primary science questions:

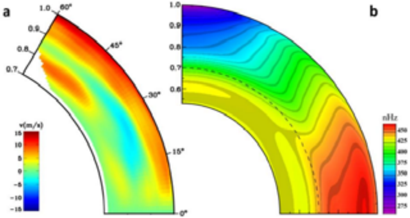
1. What drives varying large-scale motions in the Sun?
2. How do flows interact with the magnetic field to cause varying activity cycles?
3. Why do active regions emerge when and where they do?
4. What do the manifestations of activity and convection reveal about the internal processes?
5. How does our understanding of the Sun as a star inform us more generally about activity dynamics and structure?

The virtual COFFIES center is bringing together a broad spectrum of observers, analysts, theorists, computational scientists, and educators who collaborate through interacting teams focused on helioseismology, dynamos, solar convection, and surface links, as well as numerical modeling, center effectiveness, outreach, and DEIA (diversity,education, inclusion & access).



Panel A is a cartoon showing the Sun's dynamo action, with twisted lines representing magnetic field, blue and red representing new and old fluxes. (Munoz-Jaramillo et al. 2009). Panel B is a cutaway view of the Sun indicating the acceleration of its internal zonal flows observed near the peak of Cycle 23; Cycle 24 appears in its early phase at high latitude (Kosovichev & Pipin, 2019). Panel C is a model approximation of the Sun's interior convection, simulated using the Anaelastic Spherical Harmonic (ASH) code (Miesch et al., 2006). Panel D represents the Sun's torsional oscillation at 0.99 Rs from helioseismology (Howe et al, 2018).

COFFIES – Consequences of Fields and Flows in the Interior and Exterior of the Sun



a) Multi-cell meridional (N-S) circulation in the Sun's convection zone with latitude and depth: red poleward; blue equatorward. b) Differential rotation frequency; blue slower.

Benefits: COFFIES will galvanize collective scientific community participation across disciplines to...

- Greatly improve confidence in interpretation of acoustic wave propagation in the solar interior, e.g. in the accuracy of variable meridional circulation and differential rotation.
- Constrain understanding of convection zone dynamics and large-scale circulation in the Sun and stars using observations of surface properties and 3D internal flows.
- Develop open, high-performance, predictive models of solar dynamics and magnetic activity that are driven in a meaningful way by observations.
- Involve STEM students and post-docs, building on programs strongly committed to advancing inclusion, diversity, equity, and access.

Vision: COFFIES will provide accurate measurements of 3D plasma flows in the Sun sufficient to drive a reliable physical model of the solar activity cycle and consequent magnetic field evolution.

COFFIES Goals:

- **Understand how the Sun and stars generate quasi-periodic magnetic activity cycles.**
- **Advance fully 3D physical models of solar and stellar interior dynamics and convection.**
- **Establish the physical links between flow fields and evolving near-surface observations.**
- **Develop robust helioseismic techniques to confidently resolve solar interior flows.**

COFFIES Team: J. T. Hoeksema, **PI** & **Surface Links** Team Lead; R. Bush, **PM.** Other Team Leads: **Helioseismology**: J. Zhao & C. Baldner; **Dynamo**: A. Kosovichev; **Convection**: N. Brummell; **Effectiveness**: L. Upton; **Education & Outreach**: D. Zevin; **Diversity & Inclusion**: B. Mendez.

Participating U.S. institutions include: Stanford, NJIT, UC Berkeley, UC Santa Cruz, NASA Ames, SAO, SSRC, NSO, HAO, SWRI, and LMSAL. Foreign CoIs come from UFMS, Brazil; MPS, Germany; and ISTP, Irkutsk.

Phase I sponsors only critical pathfinding research efforts and leverages other projects. COFFIES will ultimately involve a much larger community through workshops, visitor programs, and 'summer' schools.

COFFIES' VISION, GOALS, AND SCIENCE QUESTIONS

COFFIES Vision

Develop a data-driven model of solar activity such that accurate measurements of 3D plasma flows in the Sun are sufficient to drive a reliable physical model of the solar activity cycle and consequent magnetic field evolution.

COFFIES Goals

Goal 1: Understand how the Sun and stars generate quasi-periodic magnetic activity cycles

Goal 2: Advance fully 3D physical models of solar and stellar interior dynamics and convection

Goal 3: Establish the physical links between flow fields and evolving near-surface observations

Goal 4: Develop robust helioseismic techniques to confidently resolve solar interior flows

COFFIES Science Questions

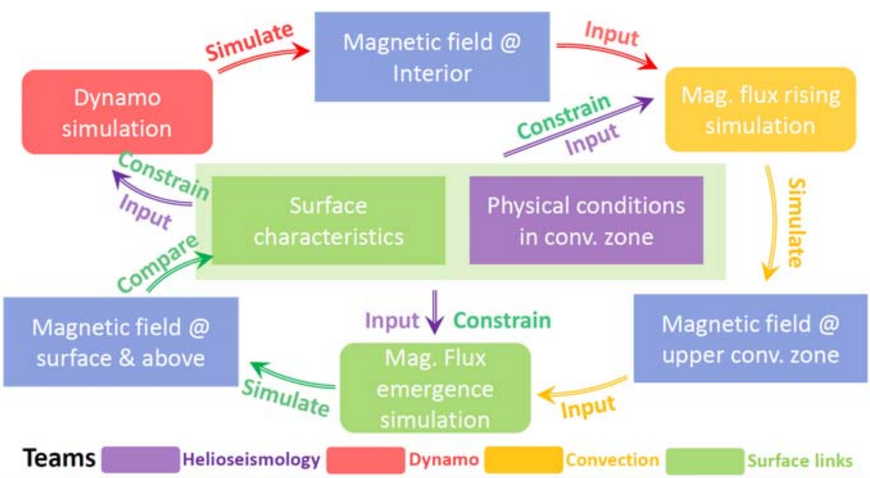
SQ 1: What drives varying large-scale solar motions such as meridional flow and differential rotation?

SQ 2: How do flows interact with magnetic fields to create varying activity cycles?

SQ 3: What causes active regions to emerge when and where they do during the solar cycle?

SQ 4: How do observed manifestations of activity and convection reflect and constrain internal processes?

SQ 5: How does considering the Sun as a star inform us more generally about activity, dynamics, and structure?



Answering the COFFIES sciences questions is only possible through interactions of the four principal science teams. The flow chart illustrates the interconnections among the COFFIES Science Teams (color coded). The **Surface Links** and **Helioseismology** teams act as the observational core, providing the measurements that constrain all of the models and simulations. The **Dynamo**, **Convection**, and **Surface Links** teams perform an array of simulations that take advantage of the observations and synergistically interact with each other to model the evolution of the solar global and small-scale magnetic field. The regimes being studied are shown in blue. Together they provide a complete picture of the dynamo.

PRINCIPAL SCIENCE TEAMS -- CONVECTION & DYNAMO

CONVECTION TEAM

Team Core Paradigm: Direct Numerical Simulation (DNS) models of mixing / transport / instability processes in the deeper interior. Team topics are not confined to convection, although processes in, around and associated with convection zone are key. The Convection Team is organized into three working groups.

WG-C1: Tachocline Dynamics

- Testing theories for the formation of the tachocline
- FAST tachocline: Confinement of radiative zone dipolar fields by convective overshoot
- Effect of small-scale dynamo

Cross-over Topics

- DYNAMO TEAM: Incorporation of realistic tachocline dynamics into global dynamo codes
- Can ILES (Implicit Large-Eddy Simulation) models capture SLOW theories?
- Can global models capture FAST dynamics?

WG-C2: Creation and rise of magnetic structures

- Testing theories for the formation of sunspots and active regions
- New theory for the origin of the Solar Hemispherical Helicity Rules (SHHR)

Cross-over Topics

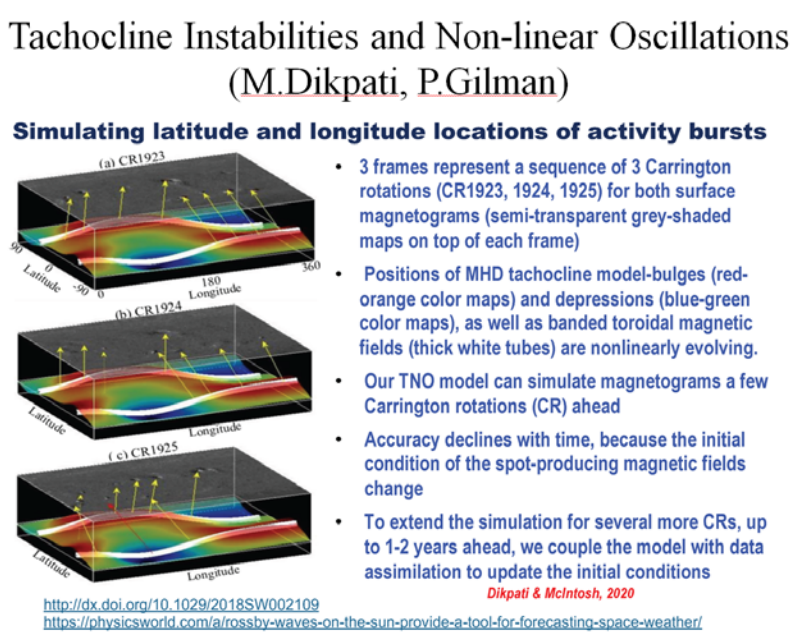
- Surface Links/ Modeling Teams: Holistic interior-to-surface modeling of rise and emergence of magnetic structures
- Helioseismology Team: Test predictions of new SHHR theory

WG-C3: Alternative dynamo theories

- Essentially nonlinear dynamos
- Non-kinematic, non-alpha-omega
- Dynamos that are robust at high Re
- “Strong field” branches

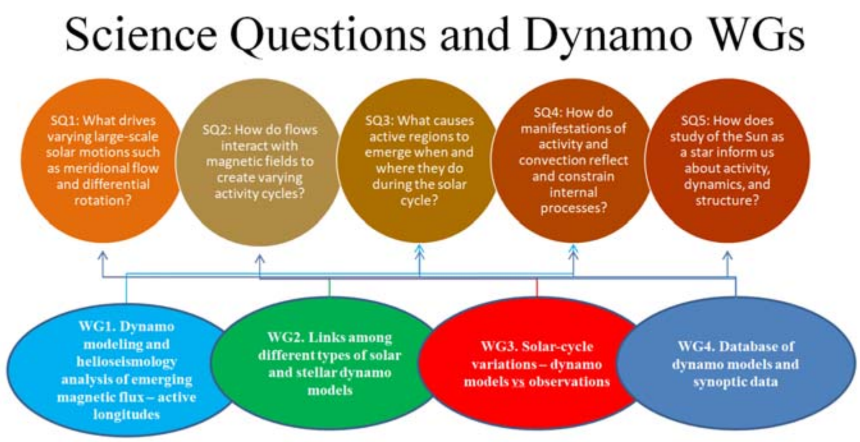
Cross-over Topics

- DYNAMO TEAM: relationship between ILES dynamos and DNS dynamos – are ILES dynamos mean-field dynamos?



DYNAMO TEAM

The Dynamo team develops techniques to perform numerical simulations of solar and stellar dynamo processes, characterize dynamo models, and connect them to observations of the solar interior structure and dynamics.



WG-D1: Dynamo modeling nad helioseismology analysis of emerging magnetic flux - active longitudes (M. Dikpati)

- Analysis of non-axisymmetric instabilities and non-linear oscillations) of the toroidal magnetic field in the tachocline – modeling active longitudes (together with Convection Team)
- Investigation of magnetic buoyancy effects leading to flux emergence (together with Convection Team)
- Modeling of emerging flux and coronal eruptions
- Formation of sunspots and starspots
- Modeling of Rossby in 3D dynamo simulations (together with WG-D2)

WG-D2: Links among different types of solar and stellar dynamo models (G.Guerrero)

1. Global dynamos:

- Dynamo benchmark
- Rossby waves in global models
- Comparison of local/global modeling of F stars

2. Connection between solar interior and the solar corona

- Local magnetoconvection simulations as boundary conditions (BC) for global dynamo models
- Simplified corona as BC for the magnetic field in global models
- Correlation between X-ray luminosity and the magnetic field

3. Dynamos in radiative zones

- Evolution of a toroidal field in stable layer in the presence of rotation and shear
- Essentially nonlinear dynamos (non- alpha-omega dynamos from shear in radiative zones = subcritical instabilities

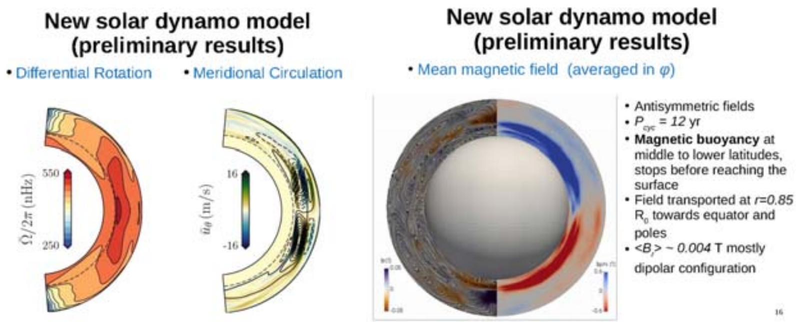
4. Tachocline confinement -- slow or fast tachocline?

- What happens with a poloidal field when a T-Tauri star develops a tachocline?
- Confinement of a poloidal field for different Rayleigh numbers in anelastic/compressible global models (compared to previous Boussinesq)
- Relation with helioseismology team

5. Mean field dynamo modeling

- Data assimilation and Machine Learning for obtaining dynamo coefficients from observations
- Mean-field dynamo models with coefficients from global simulations
- Evolution of migrating field bands, cross collaboration with WG-D1.

New 3D dynamo models G.Guerrero, R. Barbosa)



WG-D3: Solar-cycle variations of tachocline - dynamo models vs gloval heliosesimology

- Variations of the solar differential rotation in the solar atmosphere (with Links Team)
- Explanation of the extended solar cycle and torsional oscillations
- Potential for helioseismic predictions of the solar activity
- Development of the uniform (MDI-HMI-GONG) global helioseismology dataset (with HS Team)
- Development of 3D acoustic code for forward modeling and testing global and local helioseismology techniques (with HS Team)
- Helioseismic detection of emerging magnetic flux
- Investigation of solar rotation in the subsurface shear layer

WG4: Data base of dynamo models and synoptic data - extension of Helioportal

- ML synoptic database of coronal holes
- Development of ML synoptic database of coronal holes – investigation of open flux
- Preparation of the synoptic database (with Links and Helioseismology Teams)
- Development of the model database – publicly available on the NASA Data Portal (with other WGs)

PRINCIPAL SCIENCE TEAMS -- SURFACE LINKS & HELIOSEISMOLOGY

HELIOSEISMOLOGY TEAM

The accumulation of helioseismic observations over two full solar cycles now allows us to investigate the Sun's interior dynamics, long-term evolution, and cycle-to-cycle differences.

The Helioseismology Team seeks to more accurately and precisely measure flows throughout the solar convection zone: Differential rotation (DR), meridional circulation (MC), radial flows, and their spatial and temporal variations. This requires improvement of helioseismology techniques and cross-validation of results from different helioseismology methods. The team will compare their results with near surface measurements and develop meaningful constraints for interior simulations. For this purpose, the team formed working groups that address four specific topics listed in the Phase I proposal.

WG-H1. Reconcile flow results from different helioseismic techniques

Two helioseismic techniques, ring-diagram analysis and time-distance analysis, already have near-real-time data-processing pipelines using the SDO/HMI Doppler data (Bogart et al., 2011; Zhao et al., 2012b). CoIs Zhao and Komm will compare results from these two methods, identify the discrepancies between them, and find ways of reconciling the results., Milestone: Discrepancies will be identified and understood.

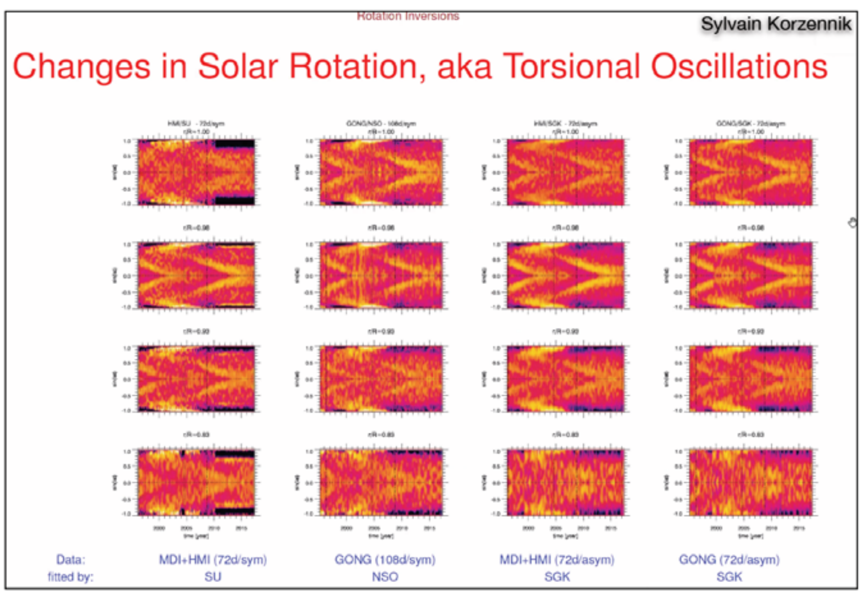
Lead: R Komm; Members: R Bogart, S Hess Webber, J. Zhao

WG-H2. Improve inversions of differential rotation

Work on inversion of global helioseismic rotational splittings will be focused on improving inferences of the so-called torsional oscillations. A concerted effort will be carried out to derive a robust measure of the changes of the DR with time, and hence activity, with an emphasis on its extent with depth. This effort will be led by CoI Korzennik. Milestone: Improved inversion codes are tested and validated.

Lead: S. Korzennik; Members: C. Baldner, S. Basu, K. Jain, T. Larson

Differential Rotation



WG-H3. Characterize the thermal structure at and near the tachocline.

Measurements of the thermal structure near the convection zone base and tachocline can be made by analyzing global helioseismic mode parameters; this has been done in the past to precisely measure the depth of the CZ (Basu & Antia, 1997). CoI Baldner will focus on characterizing small-scale changes that may be related to the phase of the solar cycle and on relating these to changes in flow structure. Milestone: Analysis codes will be improved and applied to long-term data.

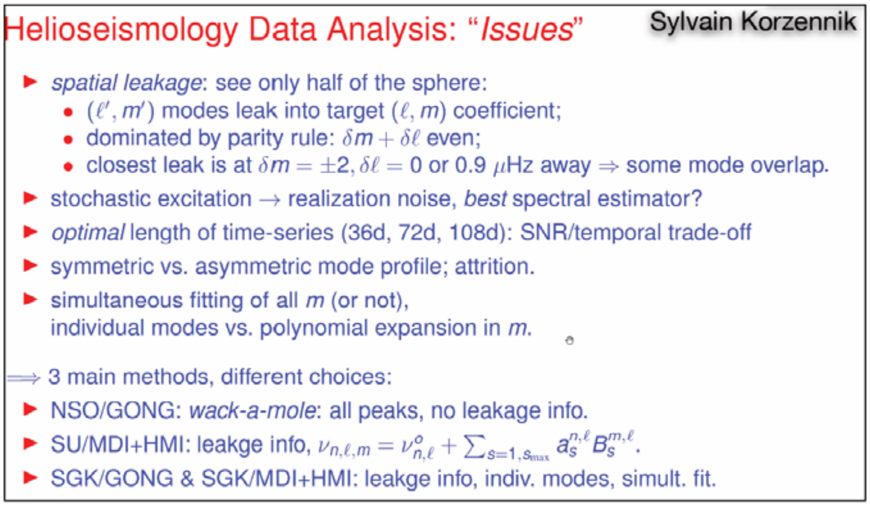
Lead: C. Baldner, Members: S. Basu

WG-H4. Understand and remove the center-to-limb)CtoL) effect that complicates meridional circulation measurements.

We will carry out simulations to understand the physical cause of the systematic CtoL effect in helioseismic methods and design ways to remove the effects from measurements. This task is primarily sponsored by a separate research grant led by CoIs Zhao and Chen. Kitiashvili provides simulations. Milestone: The CtoL effect will be better understood, and new ways of removing the effect from measurements will be designed and tested.

Since the work of this group directly impacts the measurement of meridional flows, that topic is also included in WG-H4.

Lead: R. Chen; Members: C. Baldner, D. Braun, T. Duvall, I. Kitiashvili, R. Komm, J. Zhao



HS Cross-Team Collaborations

The Helioseimology Team primarily collaborates with the Dynamo and Surface Links Teams.

- Center-to-Limb effects & meridional flow
- Rotation rate results (frequency splittings) and ring-diagram flow maps
- Help assemble a flow data base, including subsurface flows
- Kinetic helicity values of subsurface flows of specific active regions to compare the sign and values of current and kinetic helicity.

SURFACE LINKS TEAM

The Surface Links team develops techniques to connect observations of exterior solar features to the interior in order to provide inputs and constraints to the deep interior models. The team seeks to

- Explain how flux emerges through the outer convection zone of a star like the Sun to form a typical Active Region (AR)
- Characterize the properties and patterns of flux emergence related to internal processes
- Understand surface flux transport and the relationship of interior and exterior flows
- Work with other teams to determine how photospheric flux interacts with the interior and relates to the next solar cycle

WG-L1: Characterize properties of active regions and patterns of flux emergence - Aimee Norton

- Identify useful parameters not in current catalogs – for COFFIES & others
- Regularize observations between solar cycles and various instruments
- Begin assembly of catalogs
- Analyze Cycle 24 for similarities/differences with Cycles 23 and before

WG-L2: Measure variable photospheric flow patterns and connect them to other measures - Lisa Upton

- Develop a database/catalog of all the relevant measurements
- Gather data from each technique, understand uncertainties, reconcile comparable measurements
- Connect surface observations to shallow helioseismology (~16Mm-30Mm)
- Characterize flows at high latitudes

WG-L3: Relate the polar field to active region emergence, large-scale flows, and cross-equatorial flux transport - Marc DeRosa

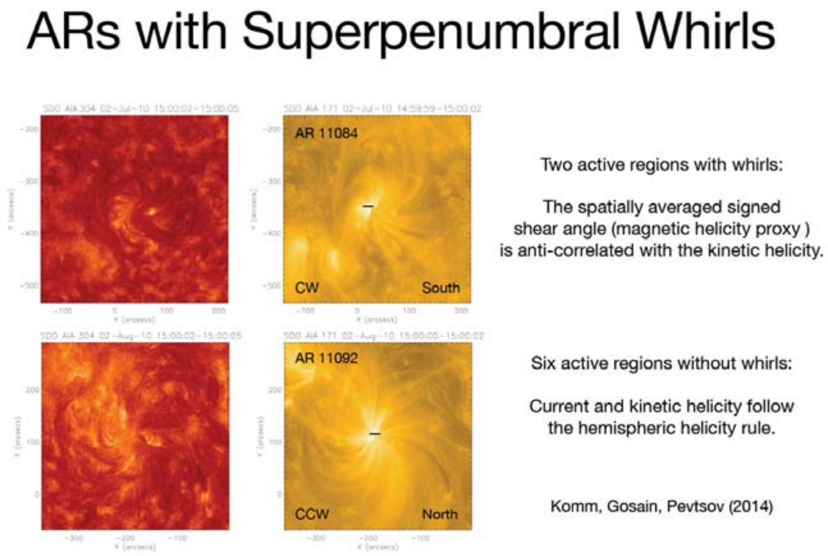
- Update and improve Surface Flux Transport code
- Allow specification of specific AR/flux inputs and other parameters to the SFT Model
- Make SFT code available to the community

WG-L4: Develop a coupled model of flux emergence through the outer convection zone - Bill Abbett

- Update and improve existing flux emergence code
- Explore interactions with other COFFIES models of the interior

WG-L5: Track the evolution of helicity through Cycle 24 - Yang Liu

- Identify and analyze a meaningful cross section of SC 24 acitve regions
- Cross-check results of various methods used to determine helicity evolution
- Identify links between helicity measurements at the surface and helicity effects of COFFIES models of the solar interior



CROSS-TEAM LEADERSHIP AND SUPPORT - BARISTAS, CENTER EFFECTIVENESS, MODELING, EDUCATION, AND DEIA

BARISTAS

COFFIES is organized into eight teams to accomplish the goals of the Center. COFFIES Team leaders make up the Executive Team, called the ***Baristas***. There are teams for the four principal science disciplines: **Convection**, **Dynamo**, **Helioseismology**, and **Surface Links**. These are augmented by teams for **Center Effectiveness**, **Modeling**, **Education**, and **DEIA**. The Baristas work with the PI and Program Manager to provide direction to the Center.

Center Effectivenss Team (CET)

Baristas: Lisa Upton & Shea Hess Webber

The CET works to Identify and overcome unique obstacles Science Centers face and to find and explore novel ways to align and direct the Science Teams with the goal of enabling breakthrough science.

See below for more info about the CET

ModelingTEAM

Baristas: Alan Wray and Irina Kitiashvili

The Modeling team addresses issues related to computing and modeling that are relevant to multiple science teams. It assists with computing and code-coupling issues and seeks to help COFFIES teams develop and enhance simulations and models.

See below for more about the Modeling Team

Education Team

Barista: Dan Zevin

COFFIES education activities focus on two primary initiatives: Research Experiences for Undergraduates (REU) and Public Outreach and Informal Science Education (POISE). A primary emphasis is to reach, motivate, and support education and career paths for individuals from underrepresented populations in Science, Technology, Engineering, and Mathematics (STEM).

See below for more about the Education Team.

Diversity, Equity, Inclusion & Access Team (DEIA)

Barista: Bryan Mendez

The COFFIES DEIA Team has as its primary objectives to (1) help provide multiple and equitable pathways for diverse individuals to pursue STEM futures and (2) infuse COFFIES with new, diverse, and talented individuals by attracting and retaining researchers at all levels.

MORE ABOUT The Center Effectivenss Team (CET)

The CET works to Identify and overcome unique obstacles faced by Science Centers.

The CET will:

- Report directly to and advise the COFFIES Executive Leadership (the Baristas).
- Focus on finding and exploring novel ways to align and direct the Science Teams with the goal of enabling breakthrough science.
- Provide structural support (such as maintaining ongoing transparent communications between all COFFIES members) to reduce ambiguity and provide stability.
- Work with team leads to facilitate COFFIES-wide collaboration, knowledge integration, goal alignment, and task interdependence.
- Organize activities to promote engagement with the broader scientific community
- Facilitate growth of the COFFIES Center and onboard new members.
- Work with the Diversity & Inclusion Team to help implement diversity & inclusion training and tools for all COFFIES

members.

- Work with the Education & Outreach Team to help organize COFFIES' academic opportunities, professional development activities, and public engagement events.

There are 7 fundamental challenges to large research Centers such as ours, which have been outlined in a report by the National Research Council, *Enhancing the Effectiveness of Team Science* (NRC 2015):

1. High diversity of membership
2. Deep knowledge integration
3. Large size
4. Goal misalignment between teams
5. Permeable boundaries
6. Geographic dispersion
7. High task interdependence

The CET has been addressing these seven challenges for COFFIES by:

- Arranging community networking and engagement events (join us for Coffee with COFFIES - see upper right logo)
- Organizing various team-building activities
- Publishing a quarterly newsletter
- Rolling out and evaluating the effectiveness of various communication and collaboration software tools
- Helping to facilitate regular virtual Science Team and Working Group meetings
- Organizing quarterly virtual all-hands meetings

And much more!!

MORE ABOUT THE Modeling Team

The Modeling team addresses issues related to computing and modeling that are relevant to multiple science teams. It assists with computing and code-coupling issues and seeks to help COFFIES teams develop and enhance simulations and models to

1. Discover and verify connections between solar interior processes and their external manifestations; (Primarily: Surface Links, Convection)

2. Improve the analysis of observational data to refine its contribution to our knowledge of solar physics; (Primarily: Helioseismology, Surface Links)

3. Create predictive procedures for understanding the solar cycle and space weather production generally; (Primarily: Convection, Dynamo, Surface Links)

4. Advance toward a complete model of the solar dynamo and the internal flows of mass and energy that drive it. (Primarily: Dynamo, Convection)

MORE ABOUT THE EDUCATION TEAM

COFFIES' education activities focus on two primary initiatives: Research Experiences for Undergraduates (REU) and Public Outreach and Informal Science Education (POISE).

Initiative 1: Research Experiences for Undergraduates (REU)

Our REU program will provide diverse undergraduates with authentic research experiences gleaned from throughout our COFFIES Center to spark their interests in STEM, increase their understanding of modern research methodologies and practices, expand their professional networks and communication skills, and cultivate a sense of possible self that includes careers in solar research, as well as in NASA science and academia in general. Many of COFFIES' researchers already have a solid track record of engaging in significant transformative work with undergraduates, and our postdocs and graduate students will also serve as mentors and fellow educators, thus improving their leadership skills as well. Current team members include Dan Zevin (UC Berkeley), Bianca Luansing (UC Berkeley), and John Stefan (New Jersey Institute of Technology). However, new COFFIES members will be added as we get deeper into planning for Phase 2.

Initiative 2: Public Outreach and Informal Science Education (POISE)

The primary goals of the COFFIES public outreach and informal science education (POISE) activities are to advance enthusiasm and support for NASA science among the general public, make the public aware of and interested in the intricacies of the Sun and our Center-connected research, and help motivate the next generation of diverse scientists and engineers for successful admission to college and STEM majors. Through leadership from public engagement experts at UC Berkeley's Space Sciences Laboratory and Lawrence Hall of Science, an internationally renowned informal science center, we will make use of intensive visual tools and models to translate COFFIES research for general audiences and disseminate it through NASA's previous investments in public engagement nationally via partnership with a longstanding, trusted network of science centers and museums. Throughout our POISE development process, COFFIES researchers and engineers (including postdocs and graduate students) will join the POISE team to help clarify and hone public messaging before moving toward final creation and implementation of our engagement elements. Current team members include Dan Zevin (UC Berkeley) and John Erickson

TEAM MEMBERSHIP

TEAM Membership - COFFIES Teams are organized around tasks that span multiple goals and science questions. The four principal science teams - Convection, Dynamo. Surface Links, and Helioseismology follow familiar research approaches. Most members of COFFIES participate in multiple teams. Current membership for several of the teams is listed below. There are 53 Active COFFIES Team Members.

Let us know if you would like to participate in the science of COFFIES.

Current Convection Team Members

***Nic Brummell (Barista**, UCSC)*

Pascale Garaud (UCSC)

Lisa Upton (SSRC, Boulder)

Bhishek Manek (Grad)

Jacob Noone-Wade (Grad)

Lydia Korre (postdoc, CU Boulder)

Nick Featherstone (CU Boulder)

Brad Hindman (CU Boulder)

Ben Brown (CU Boulder)

Jorn Warnecke (MPS, Gottingen)

Bill Abbett (SSL, UCB)

Marc Derosa (LMSAL)

Radostin Simitev (Glasgow, UK)

Current Dynamo Team Members

Alexander Kosovichev (Barista)

Bill Abbett

Nic Brummell

Mausumi Dikpati

Lucia Duarte

Alexander Getling

Peter Gilman

Gustavo Guerrero

Egor Illarionov

Irina Kitiashvili

Maarit Käpylä

Rudi Komm

Sylvain Korzennik

Bhishek Manek

Andrés Muñoz-Jaramillo

Aimee Norton

Valery Pipin

Johann Reiter

Viacheslav Sadykov

Radostin Simitev

John Stefan

Andrey Stejko

Andrey Tlatov

Roger Ulrich

Jörn Warnecke

Alan Wray

Current Surface Links Team Members

Todd Hoeksema (Barista)

Bill Abbett

Dave Bercik

Luca Bertello

Marc DeRosa

Irina Kitiashvili

Yang Liu

Bhishek Manek

Andrés Muñoz-Jaramillo

Aimee Norton

Alexei Pevtsov

John Stefan

Roger Ulrich

Lisa Upton

Current Helioseismology Team Members

Rudi Komm (Barista)

Charles Baldner

Sarbani Basu

Rick Bogart

Doug Braun

Ruizhu Chen

Tom Duvall

Shea Hess Webber

Kiran Jain

Sylvain Korzennik

Sasha Kosovichev

John Stefan

Junwei Zhao

Current Center Effectiveness Team Members - Includes All *Baristas (italicized)*

Shea A Hess Webber (CET barista)

Lisa Upton (CET barista)

Nic Brummell

Rock Bush (Program Manager)

Ruizhu Chen

Todd Hoeksema

Irina Kitiashvili

Rudi Komm

Sasha Kosovichev

Bhishek Manek

Bryan Mendez

Andres Munoz-Jaramillo

Jacob Noone Wade

Phil Scherrer

John Stefan

Alan Wray

Dan Zevin

Current Modeling Team Members

Alan Wray (Barista)

Irina Kitiashvili (Barista)

Bill Abbett

David Bercik

Nic Brummell

Marc DeRosa

Gustavo Guerrero

Rudi Komm

Sasha Kosovichev

Viacheslav Sadykov

Phil Scherrer

Andrey Stejko

Lisa Upton

Joern Warnecke

Shea A Hess Webber