NATIONAL RADIO RESEARCH AGENCY

AOSWA-3

The Automatic Solar Synoptic Analyzer & High Speed Solar Wind Prediction

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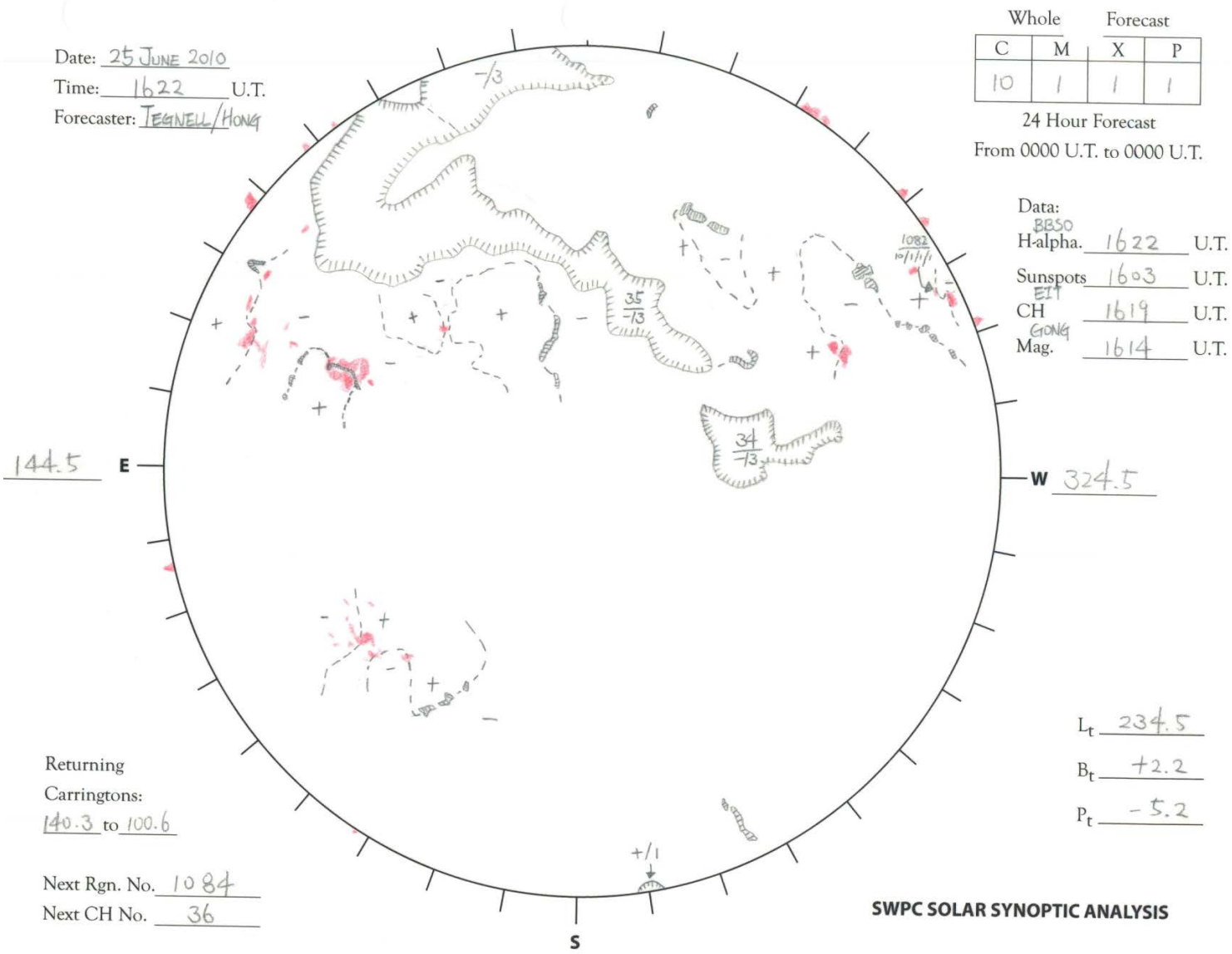
Solar Synoptic Map



Automatic Solar Synoptic Analyzer

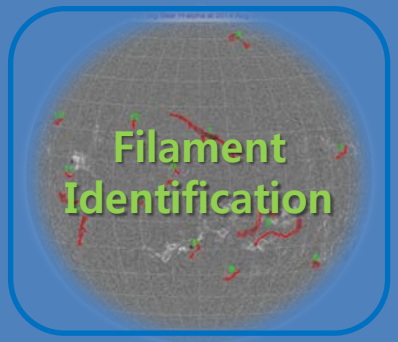
ASSA & Its Merits

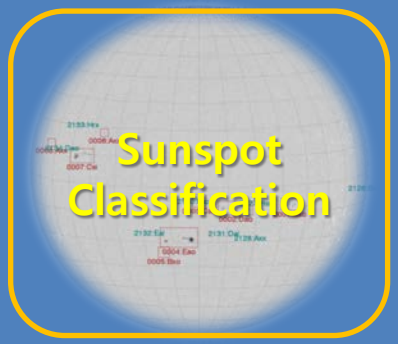
- A fruit of collaborations between RRA/KSWC and NOAA/SWPC
- Automatically identifies sunspots, CHs and filament channels
- Sunspot classification (McIntosh & Mt. Wilson) & flare probabilities

1. [Analog to Digital] Information of all the morphological parameters
   - ✓ Size, ratio, magnitude, skewness, polarity, etc.
2. [Consistency] The same criteria in every analysis
   - ✓ Sunspot Catalog with SOHO MDI data (1997~2011)
   - ✓ Sunspot Catalog with SDO HMI data (2011- 2013)
3. [High Cadence] Runs every an hour
   - ✓ NOAA SRS is issued once a day
   - ✓ Some sunspot evolves very fast, ASSA can track the changes

※ http://www.spaceweather.go.kr/assa

ASSA + Prediction Models





Prediction of Solar Wind & its Geo-effect

ASSA CH Archive(1997~2013)

CH Location, Area, Polarity

↓

(9-Day Forecast) Solar Wind Velocity, Kp, GEO Electron Flux

Calculation of Flare Prob.

C-Flare : 93 (%)
M-Flare : 29 (%)
X-Flare : 1 (%)

ASSA Sunspot Archive(1996~2013)

Flare rate depending on McIntosh Class.
Morphological Parameters Changes

↓

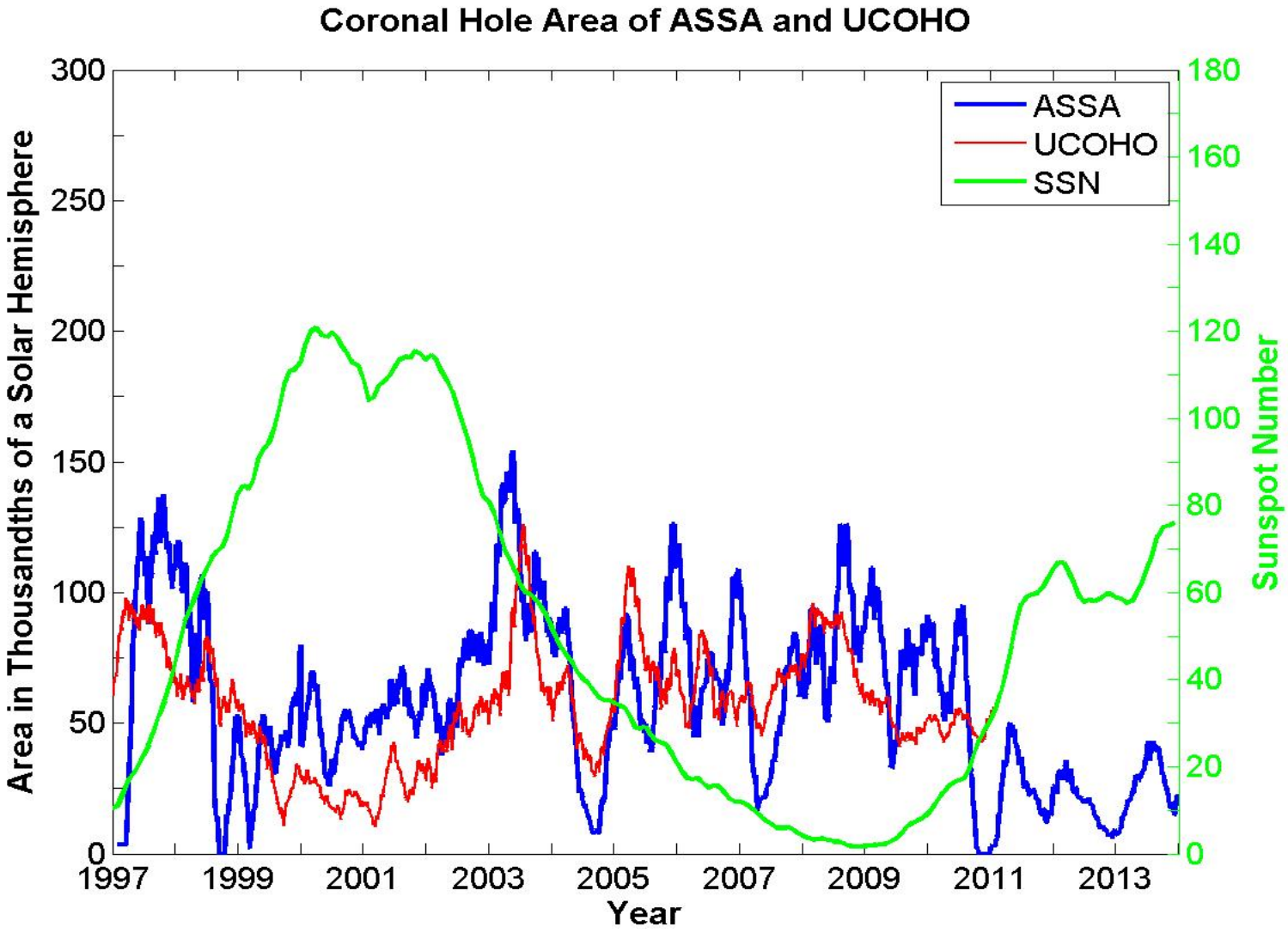
(3-Day Forecast) Flare Probability

ASSA CH Archive

- ✓ Applying ASSA algorithm to past solar images of SOHO EIT, MDI & SDO AIA, HMI magnetogram (Feb 1997 ~ Dec 2013)
- ✓ About 33,000 solar coronal holes data of area, polarity, polarity skewness, and 20 vertexes (boundary points coordinates)

	Time	Num	Area	Polarity	Skewness	CarrLon	B_angle	VLON01VLON02VLON03VLON04VLON05VLON06VLON07VLON08VLON09VLON10VLON11VLON12VLON13VLON14VLON15VLON16VLC
2	199701301904	1	039	-5.91	-2.09	2.21	-5.95	+001.7-006.2-017.3-029.9-042.7-050.6-068.4-090.0-090.0-063.6-090.0+060.5+031.6+006.2-017.6-025.7-02
3	199703250800	1	056	-29.53	-0.71	36.28	-6.85	-090.0-066.2-071.2-071.3-052.2-042.7-030.8-023.0-016.3-008.6+000.5+008.1+017.6+031.1+052.6+070.4+05
4	199703252355	1	006	5.91	-1.13	-7.10	-6.83	-043.9-064.4-090.0-056.3-013.7-014.4-023.1-028.3-039.2-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
5	199703260800	1	055	-29.53	-0.85	26.88	-6.81	-062.5-038.7-061.0-066.6-042.9-033.5-025.9-019.1-009.6-009.0-003.6+004.4+012.2+024.5+035.9+054.5+06
6	199703260800	2	006	5.91	-3.95	-12.32	-6.81	-026.0-036.8-050.4-090.0-090.0-011.3-013.2-020.4-999.9-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
7	199703262355	1	006	5.91	-1.24	-13.25	-6.78	-013.2-020.9-033.2-059.1-090.0-075.1-011.4+000.3-007.4-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
8	199703271559	1	010	17.72	1.15	3.41	-6.75	-000.3-005.1-005.3-009.7-015.7-015.9-018.1-012.2-012.1-009.2-007.8-003.4-001.6-999.9-999.9-999.9-99
9	199703271559	2	005	-5.91	-1.81	-11.02	-6.75	+000.3-010.3-018.3-031.3-090.0-061.8+016.7+007.5-999.9-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
10	199703280800	1	065	-29.53	-0.82	1.33	-6.72	-031.5-058.7-065.7-057.1-037.5-025.9-025.1-024.6-018.0-012.7-005.8+006.1+012.4+018.3+019.5+036.9+06
11	199703280800	2	012	5.91	2.26	9.57	-6.72	-001.3-006.3-007.2-005.8+001.7+005.1+009.5+013.8+020.2+018.7+014.2+015.4+009.4+010.4+005.1-002.2+00
12	199703280800	3	008	17.72	-3.99	-8.95	-6.72	-007.2-014.9-012.7-015.3-051.1-090.0+047.9+015.8+005.2-005.3-009.9-999.9-999.9-999.9-999.9-999.9-99
13	199703300800	1	070	-17.72	-0.67	337.10	-6.62	-043.1-065.4-067.4-027.5-026.6-023.4-019.1-010.7-010.0-006.5-000.4+008.1+004.6+014.1+026.4+038.6+04
14	199703300800	2	009	17.72	-2.76	346.88	-6.62	-005.0-011.5-010.3-029.8-090.0+090.0+082.6+041.5+026.1+019.6+002.2+001.0-999.9-999.9-999.9-999.9-99
15	199703300800	3	007	5.91	1.30	368.42	-6.62	+028.2+023.9+026.0+022.5+029.5+039.8+038.9+042.5+036.0+028.0+028.2-999.9-999.9-999.9-999.9-999.9-99
16	199703310800	1	065	-29.53	-0.79	334.32	-6.57	-039.0-068.7-064.5-030.8-016.0-011.2-006.0+001.6+006.1+011.5+020.4+020.8+028.0+039.9+054.4+064.1+06
17	199703310800	2	006	-5.91	-4.14	361.48	-6.57	+007.7+008.8+006.6+090.0+057.9+078.3+056.0+030.7+041.9+040.6+018.7+012.9-999.9-999.9-999.9-999.9-99
18	199703311559	1	066	-17.72	-0.73	331.09	-6.55	-044.8-066.4-058.5-024.8-011.2-006.9-002.9-002.0+006.3+011.6+016.6+022.7+023.4+032.7+046.8+058.7+06
19	199703311559	2	006	-5.91	-2.23	356.15	-6.55	+013.3+015.4+016.1+013.3+035.3+087.9+090.0+038.1+019.6-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
20	199704010803	1	061	-29.53	-0.68	325.13	-6.52	-041.4-056.1-047.1-021.6-006.3+002.6+004.0+008.8+004.1+011.6+015.4+025.2+035.0+029.3+045.4+057.8+07
21	199704010803	2	005	-5.91	-1.37	288.85	-6.52	-023.1-026.5-028.6-025.3-022.0-018.1-015.0-018.1-020.7-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
22	199704020804	1	056	-17.72	-0.62	313.93	-6.46	-035.1-072.8-037.5-020.1-003.1+007.3+012.2+018.6+017.0+013.3+015.8+020.7+029.1+040.5+048.5+069.7+07
23	199704080455	1	022	-29.53	-1.12	208.23	-6.10	+018.7-013.9-048.5-067.1-081.6-089.2-062.7-040.4-028.1-017.5-018.0-012.1+000.8+008.1+020.5+042.7+06
24	199704081256	1	021	-29.53	-1.32	204.55	-6.08	-009.0-044.6-049.9-080.6-090.0-061.8-039.2-026.2-014.9-012.9-005.3+008.1+015.8+024.6+043.5+061.6+05
25	199704100759	1	023	-29.53	-1.76	173.78	-5.95	-009.0-034.2-054.5-074.5-090.0-090.0-058.0-047.0-043.0-033.4-024.5-013.9-001.7+007.6+020.3+029.7+04
26	199704100759	2	005	17.72	-3.15	165.42	-5.95	-013.0-025.4-038.0-061.3-090.0-061.7+090.0-013.5-999.9-999.9-999.9-999.9-999.9-999.9-999.9-99
27	199704101600	1	024	-29.53	-1.13	169.55	-5.93	-035.3-058.7-068.7-075.5-086.9-065.6-050.1-040.3-032.5-025.3-014.1-004.7+004.1+016.4+035.5+055.0+05
28	199704101600	2	007	17.72	-3.26	171.74	-5.93	+003.6-003.2-012.3-025.2-037.4-090.0-090.0+090.0-006.0-005.9+001.6-999.9-999.9-999.9-999.9-999.9-99
29	199704102355	1	025	-29.53	-0.60	163.54	-5.90	-010.5-028.4-066.3-062.7-082.5-090.0-058.1-042.2-031.1-024.9-024.4-017.2-007.0+004.6+015.6+030.2+05
30	199704102355	2	010	17.72	-1.54	177.29	-5.90	+015.8+011.1+004.9-004.5-015.9-029.5-044.0-090.0+019.2+004.5+010.9+019.5+020.3-999.9-999.9-999.9-99
31	199704112055	1	037	-29.53	-2.29	156.84	-5.84	-010.6-041.1-071.3-090.0-090.0-050.2-034.0-022.1-010.5-003.8+003.7+004.1-004.1-012.3-008.6+003.2+01

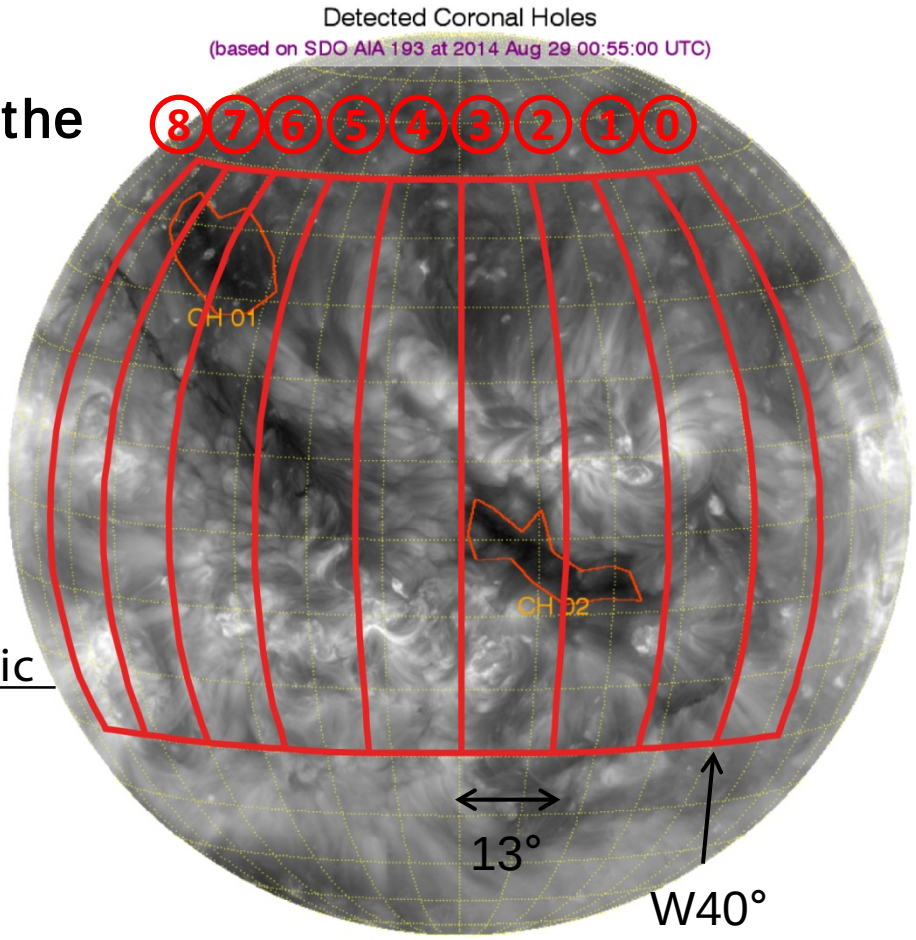
Solar Cycle & CH Area Changes



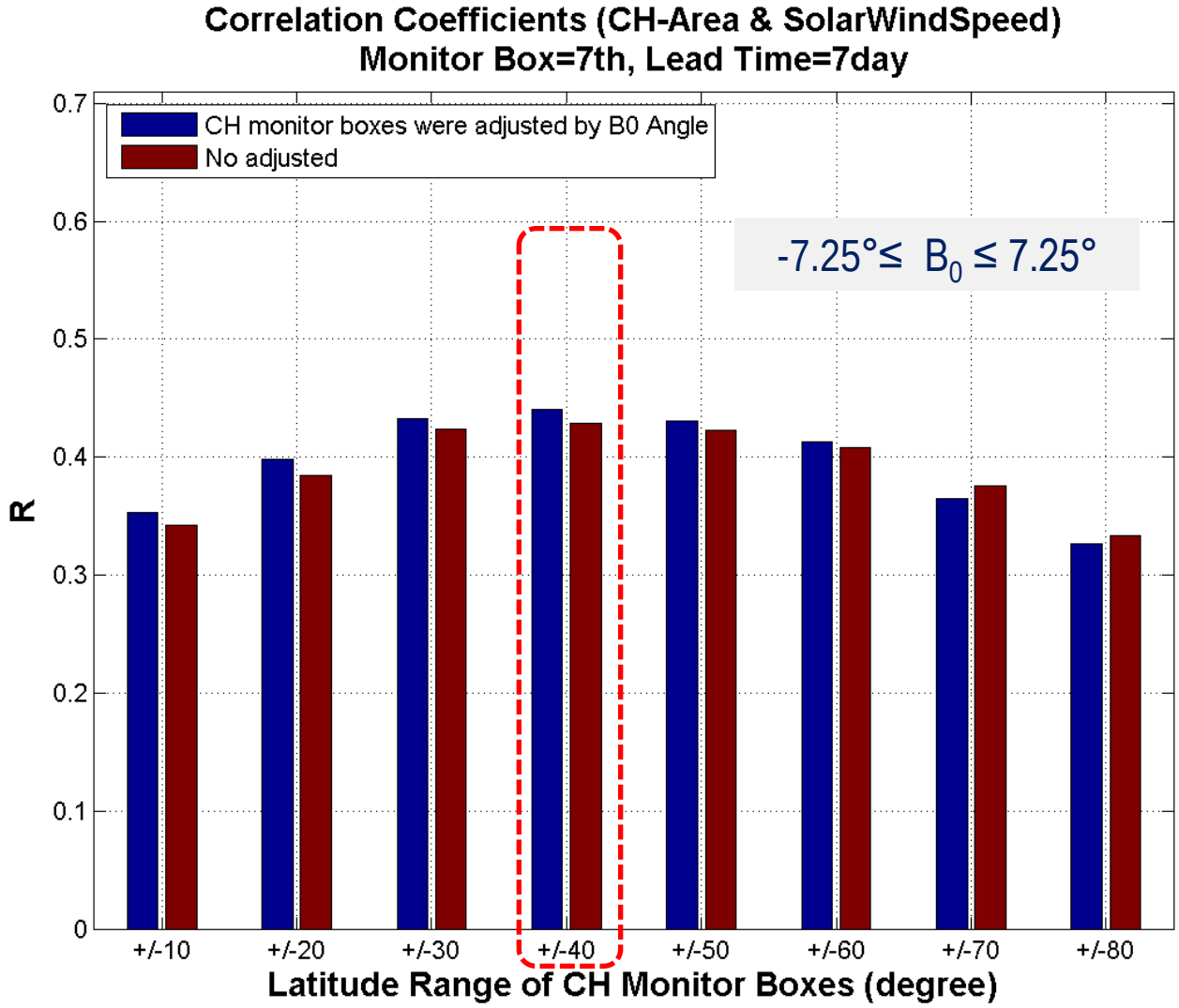
CH Monitoring Sectors

A Traditional Method of forecasting the CH- driven Geomagnetic Activities.

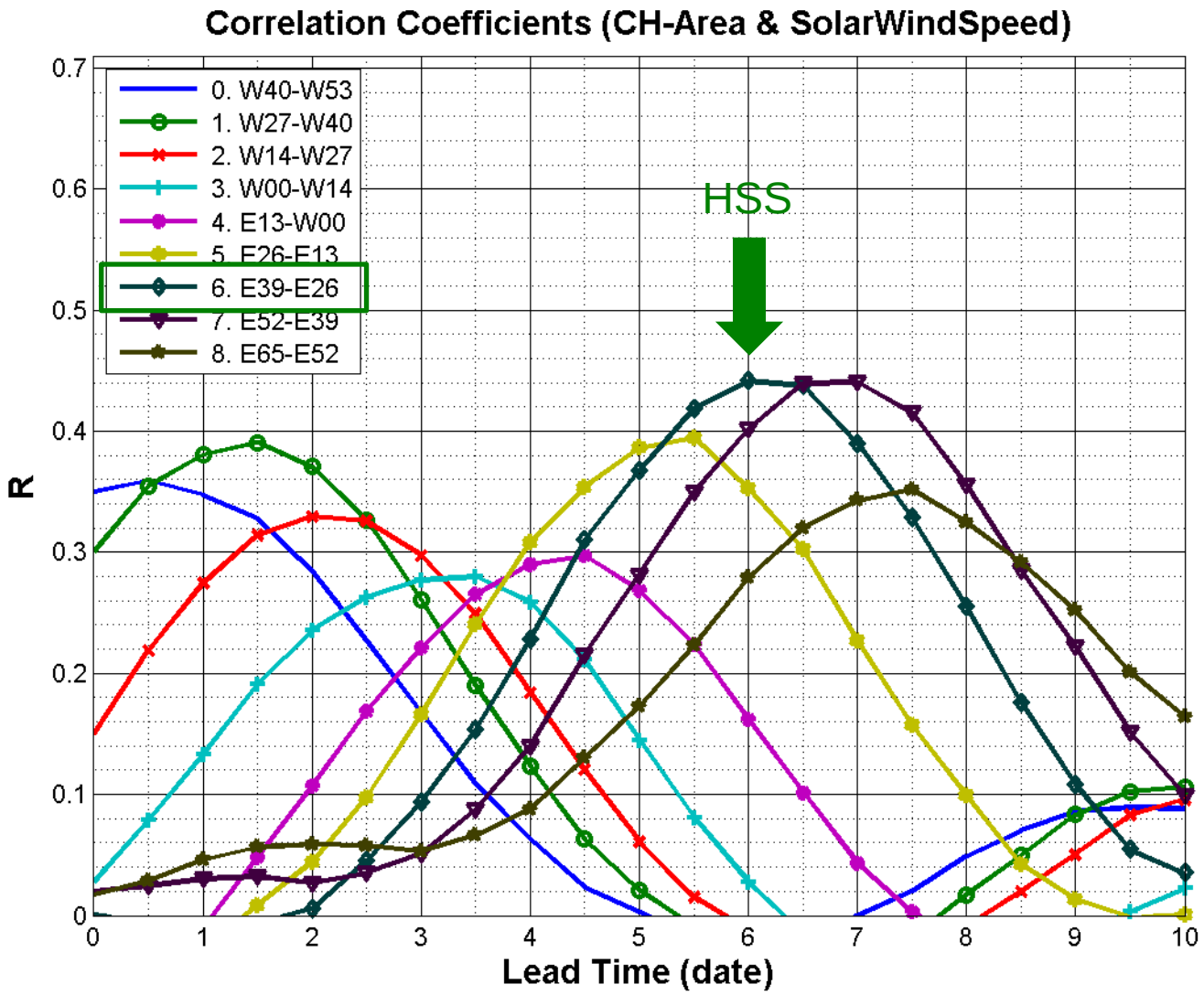
1. Geomagnetic activity starts when CH leading edge is at W40°.
2. Geomagnetic active period can be estimated with CH width and solar daily rotation angle (13°).
3. Bigger CH area, bigger geomagnetic activity
4. Kp follows 27day recurrent rule



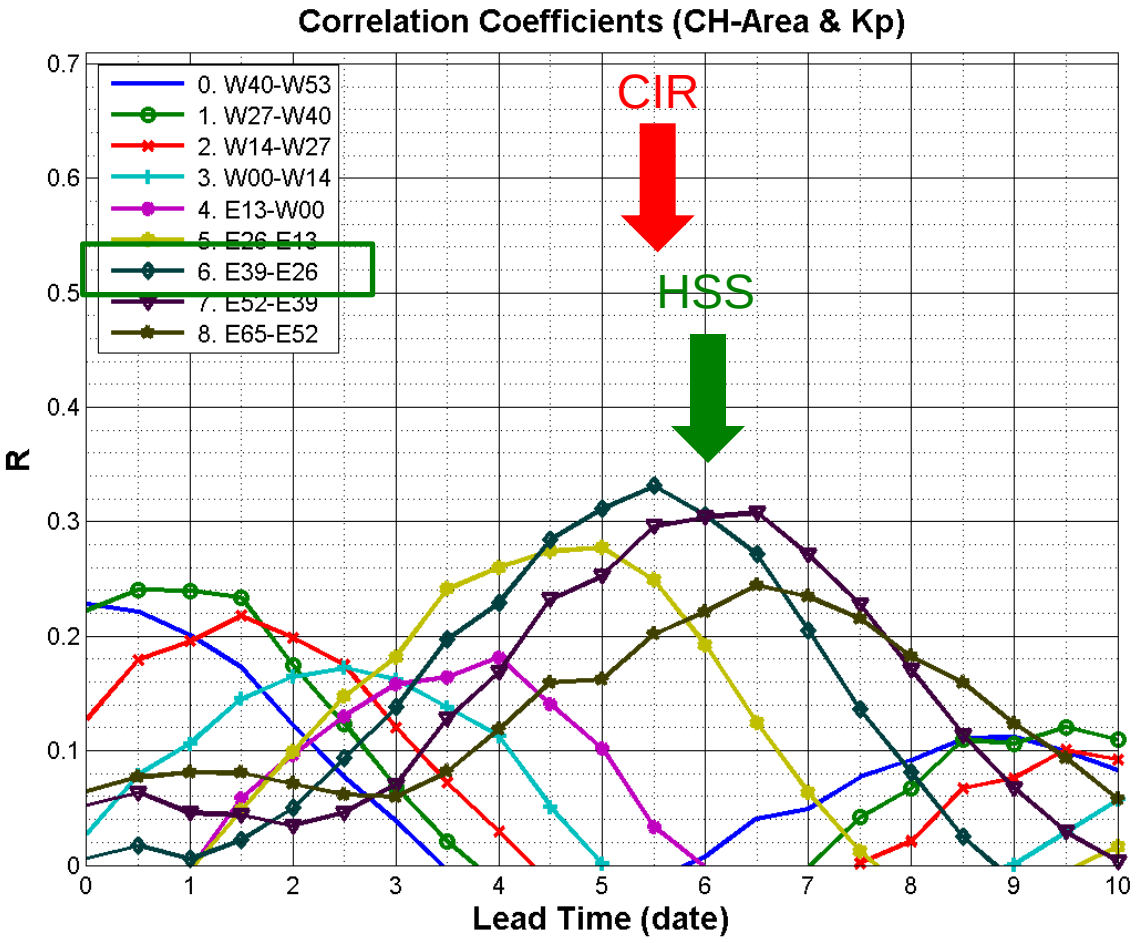
Sector Height & B_0 Angle Adjustment

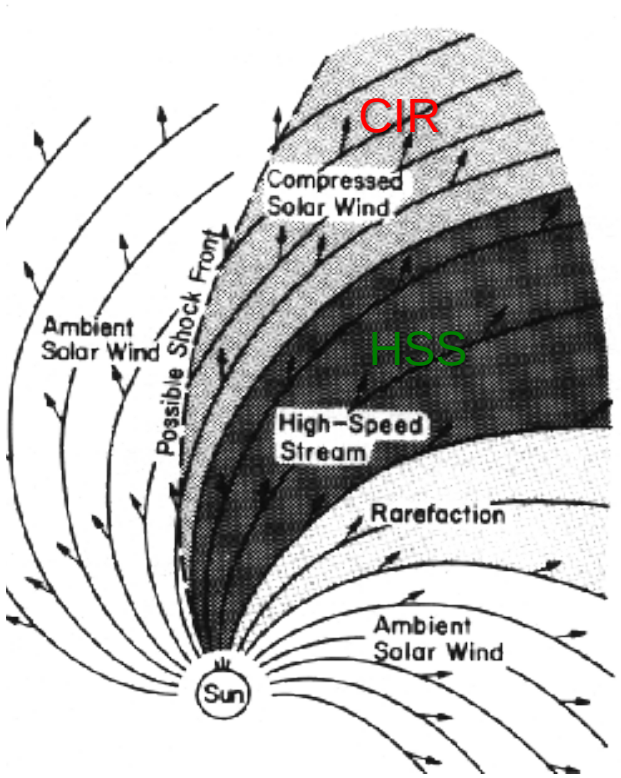


Sector- based CH Area & Vx

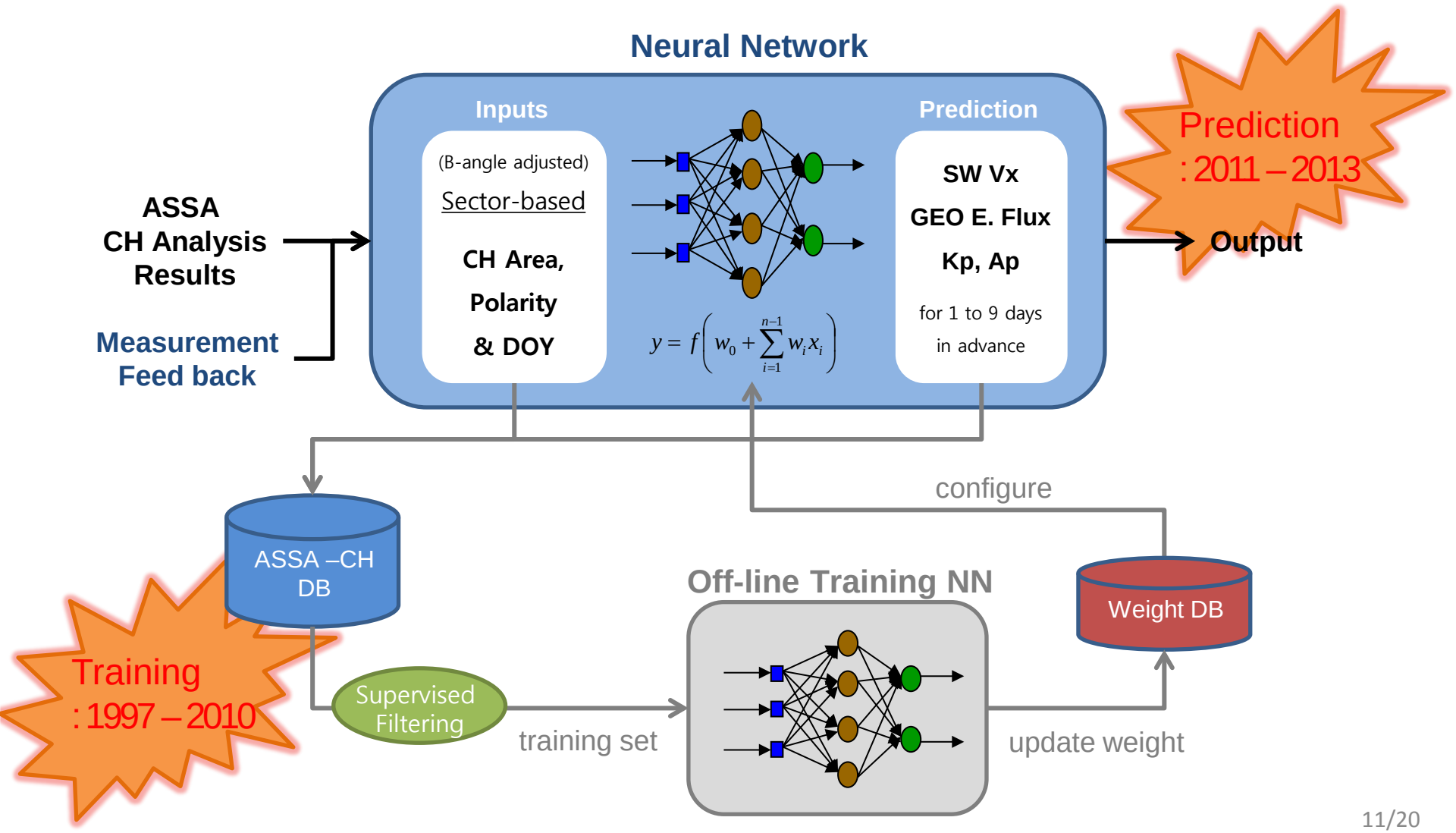


Sector- based CH Area & Kp



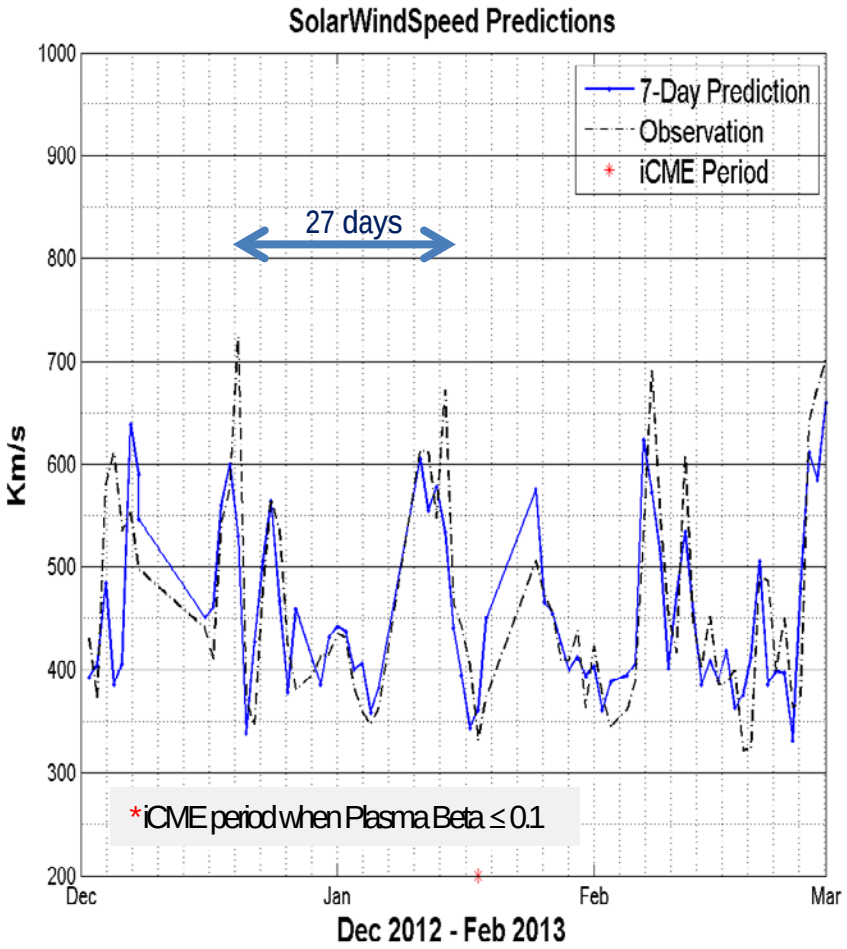


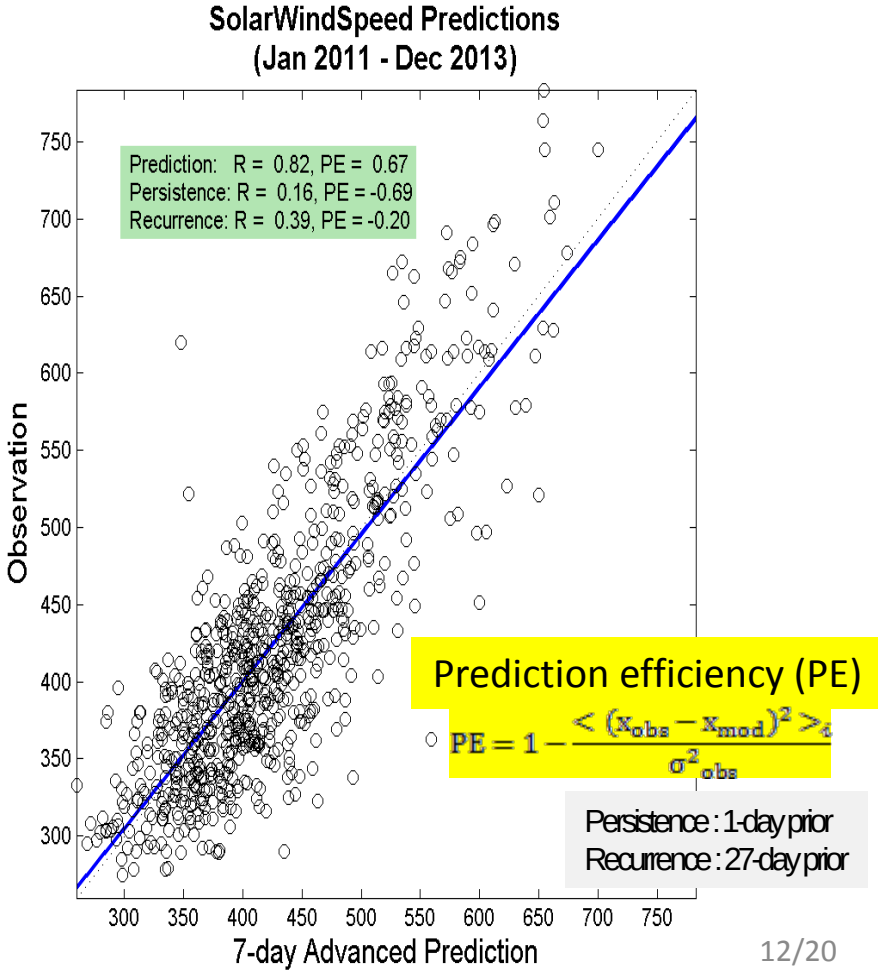
CH Effects Prediction Model



Performance Analysis 1-1

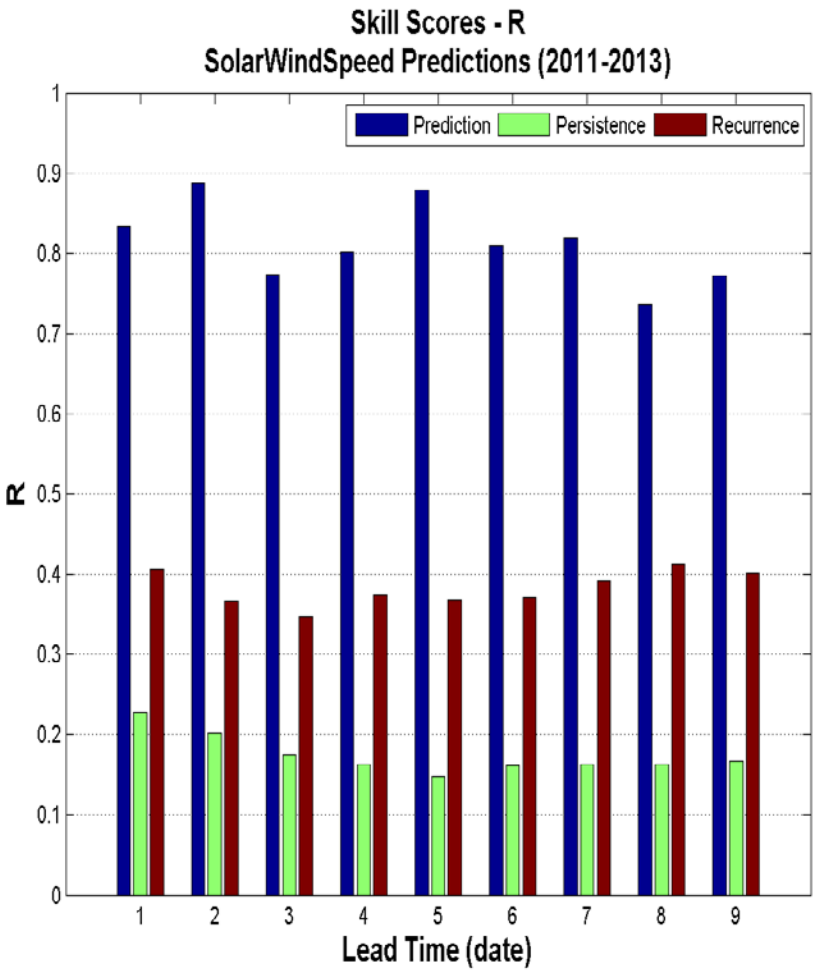
L1 Solar Wind Speed

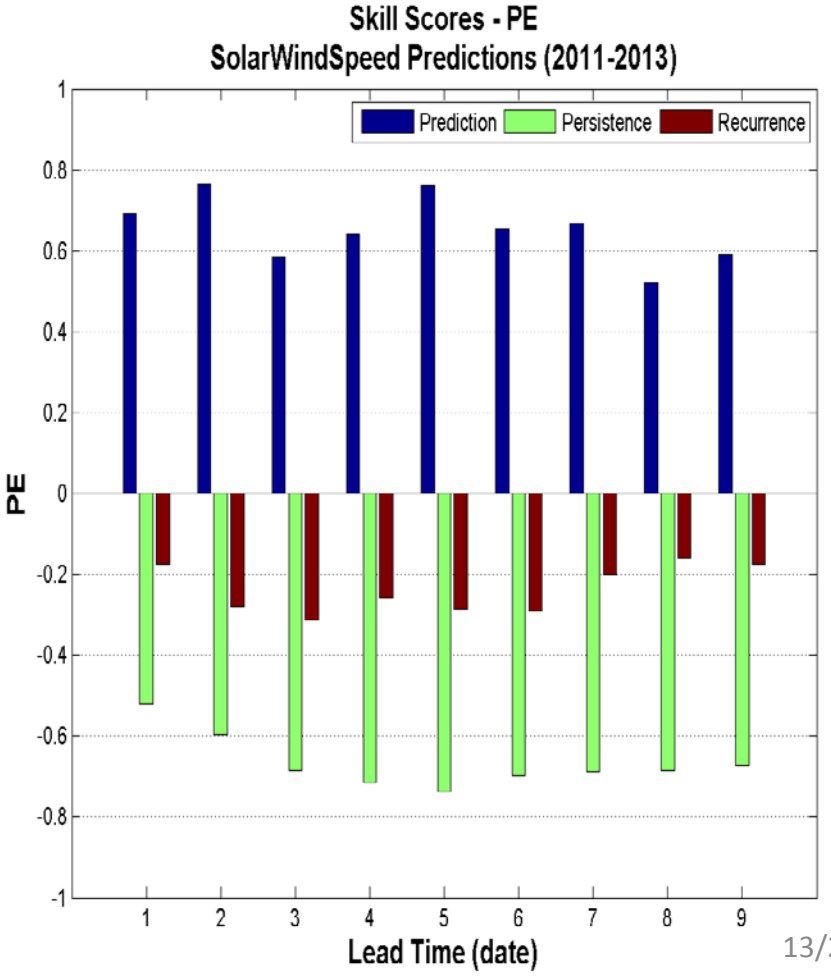




Performance Analysis 1-2

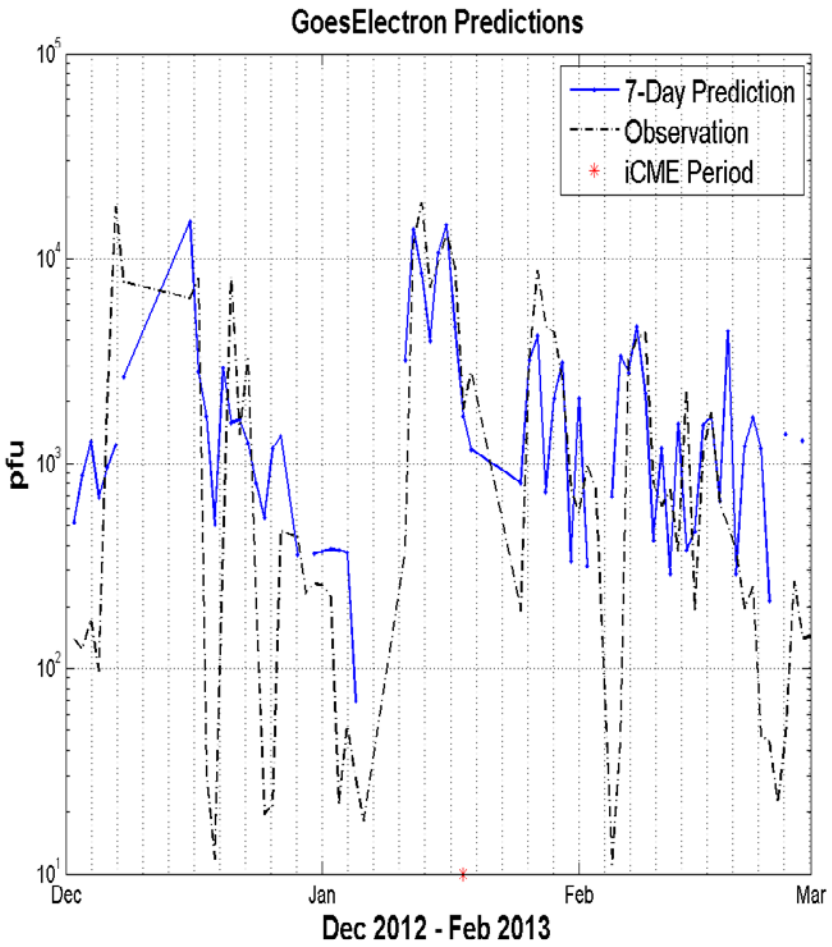
L1 Solar Wind Speed

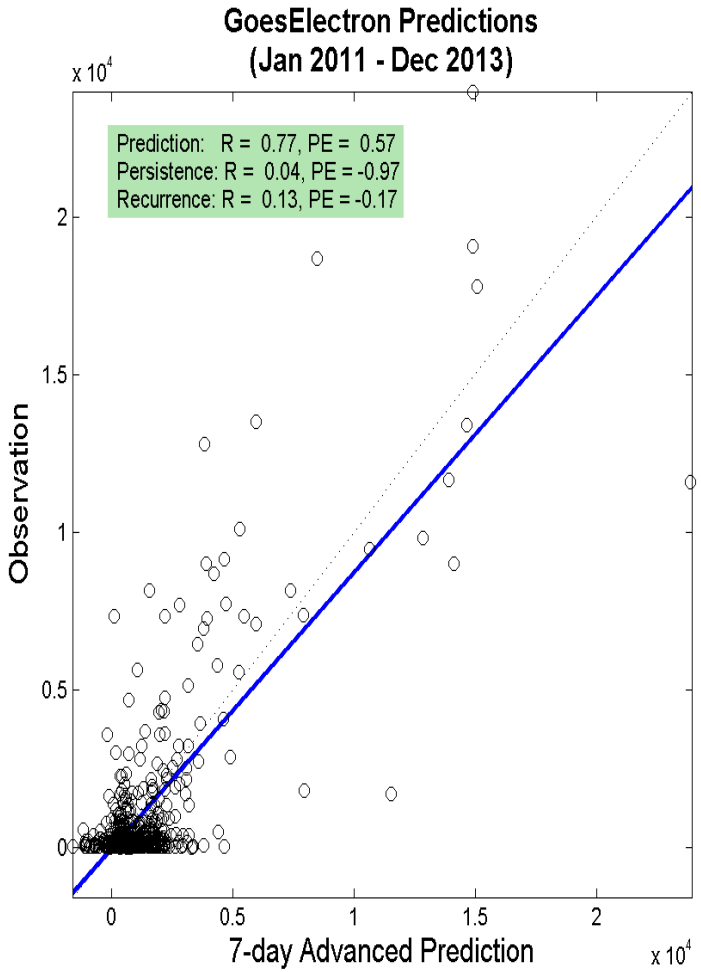




Performance Analysis 2-1

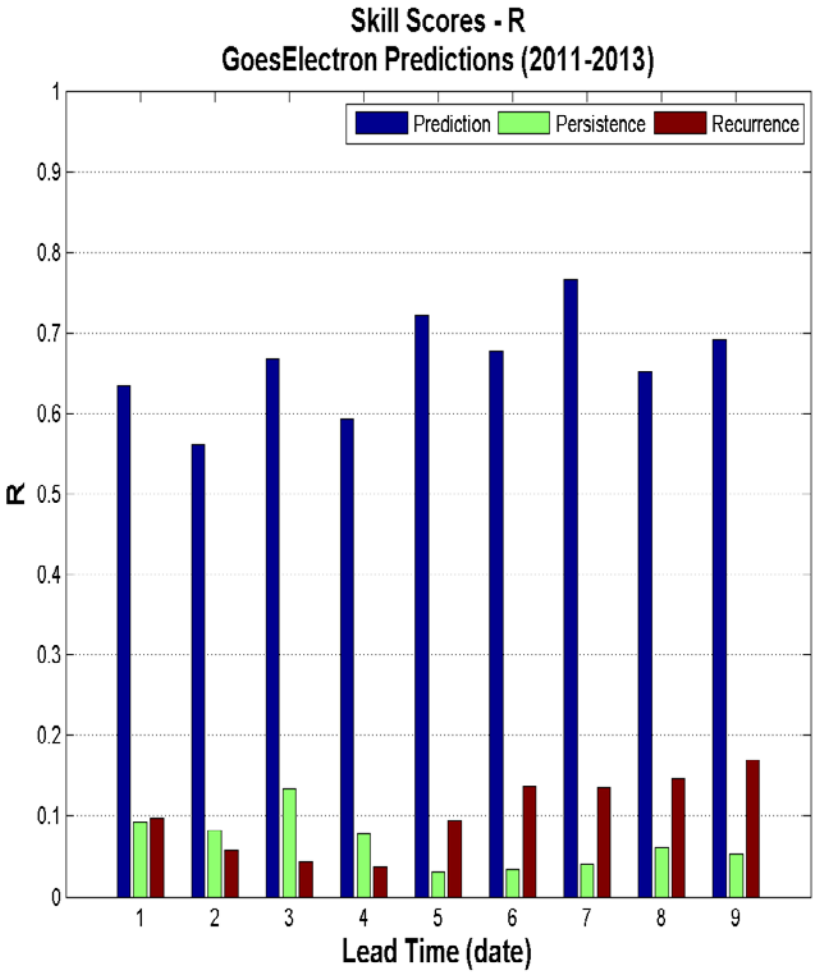
Electron Flux (GOES >2Mev)

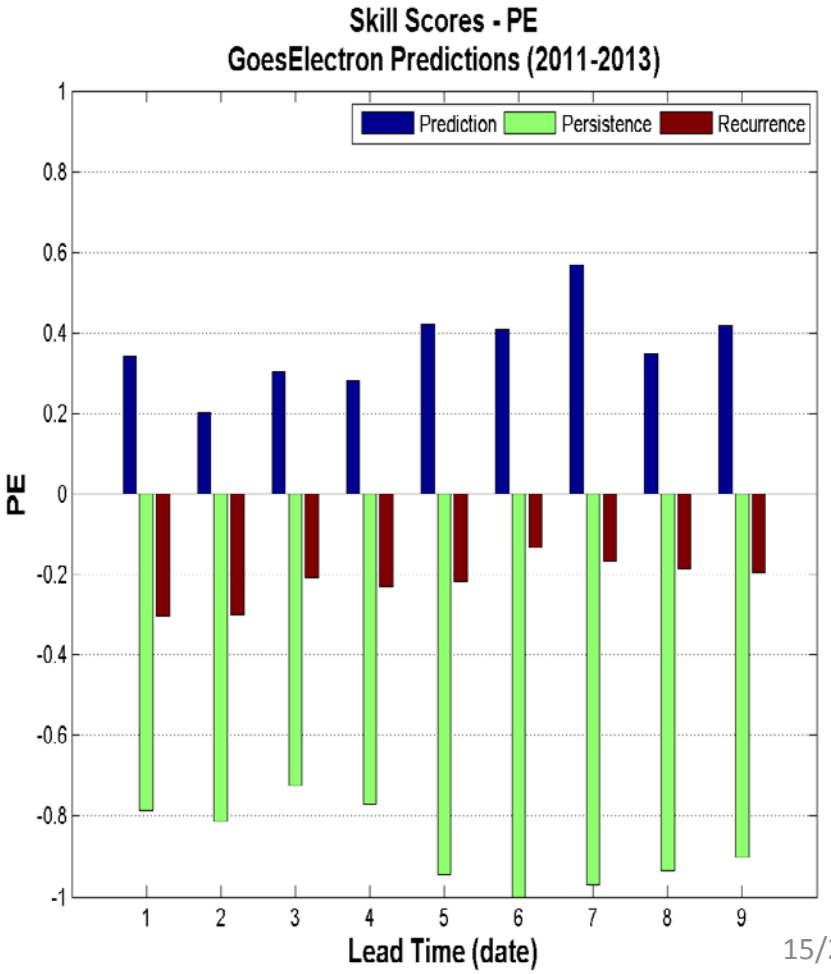




Performance Analysis 2-2

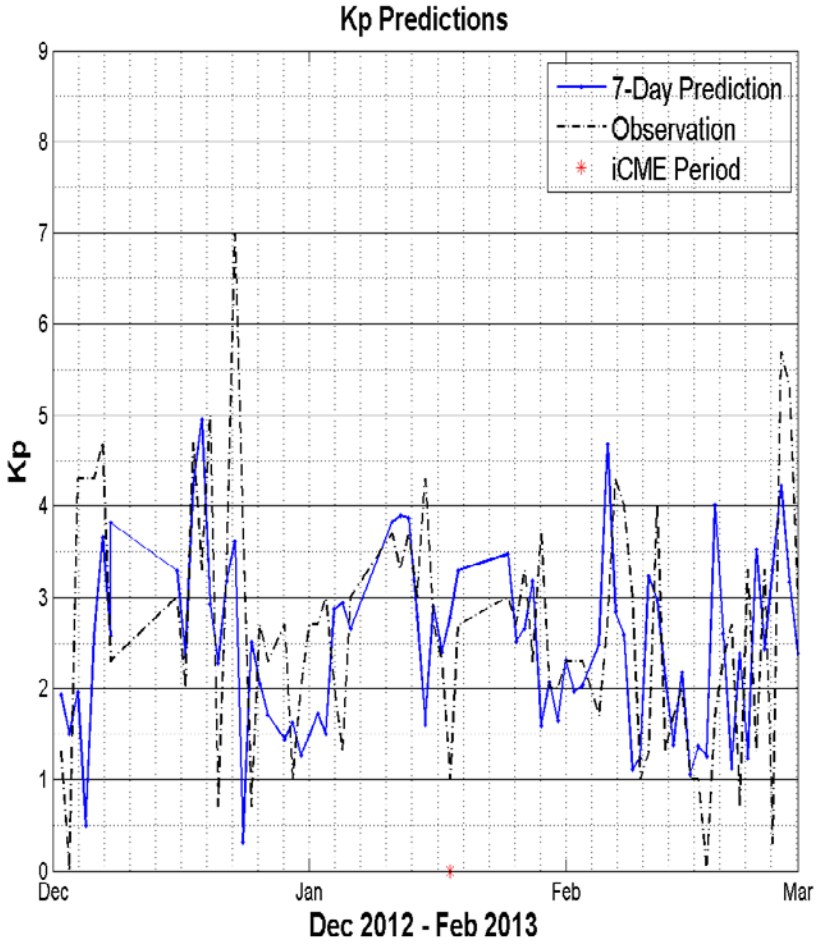
Electron Flux (GOES >2Mev)

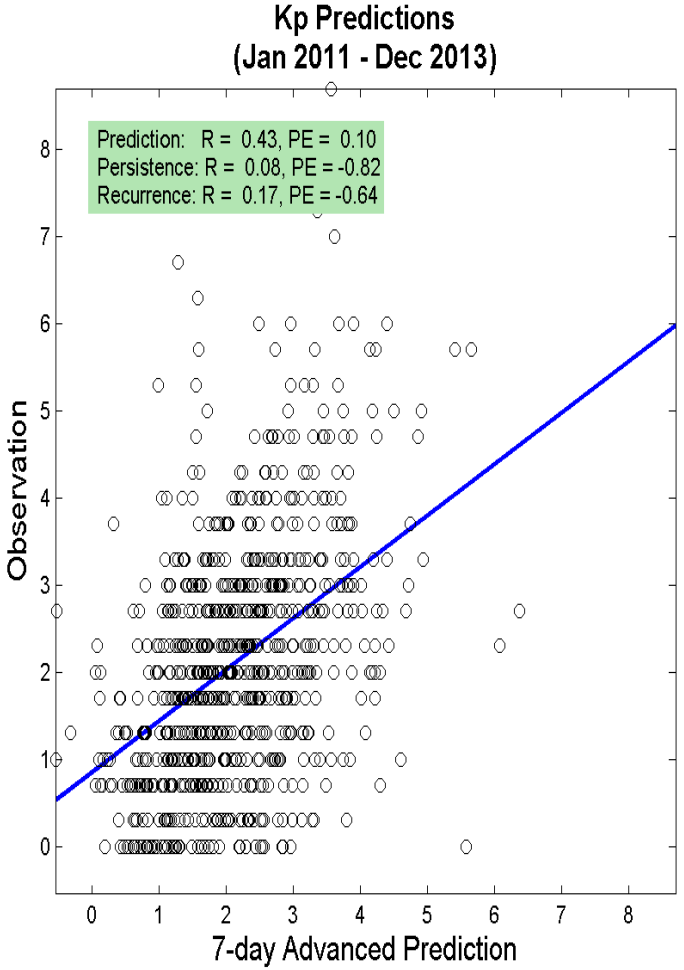




Performance Analysis 3-1

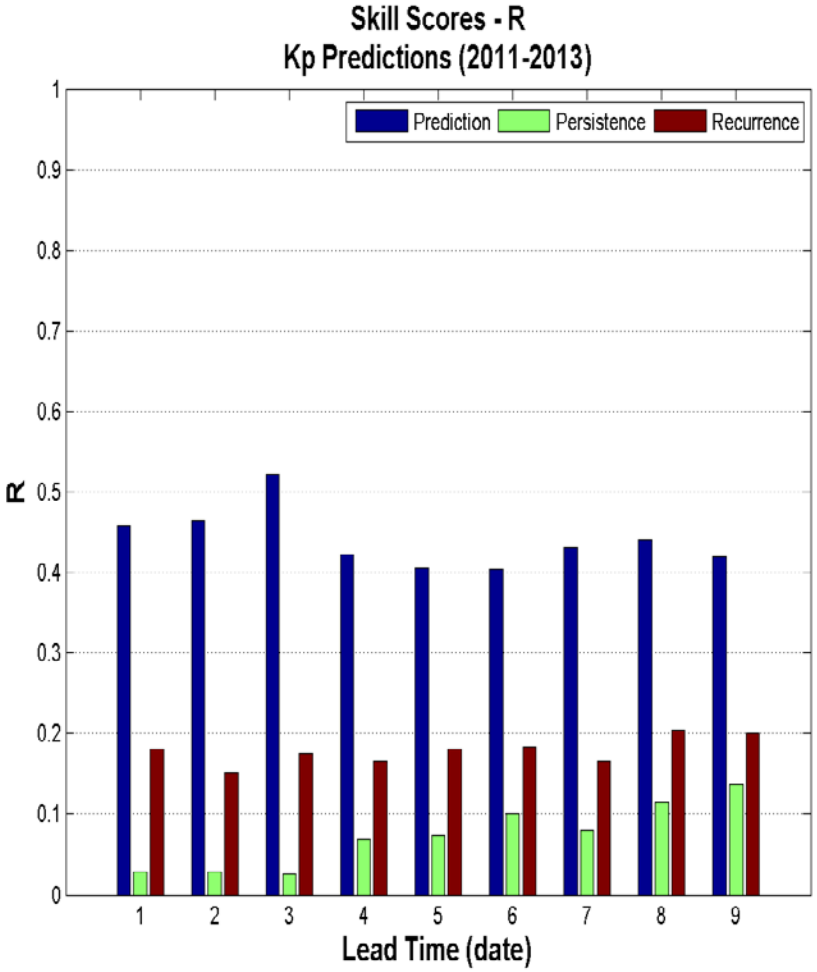
Kp Index

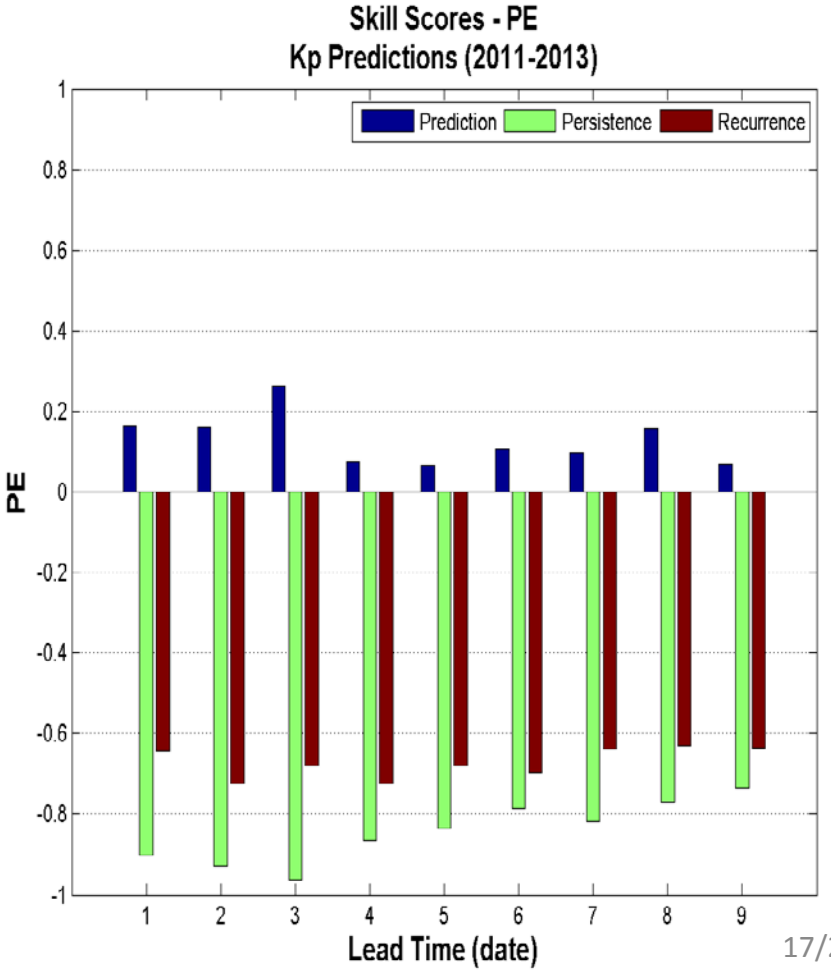




Performance Analysis 3-2

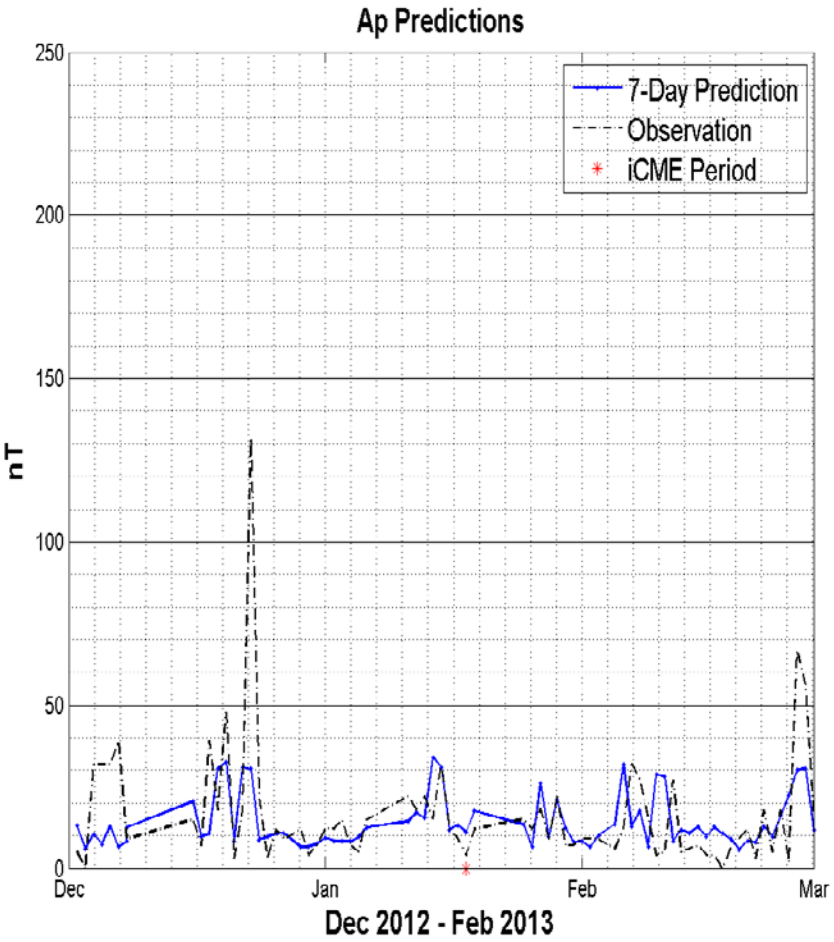
Kp Index

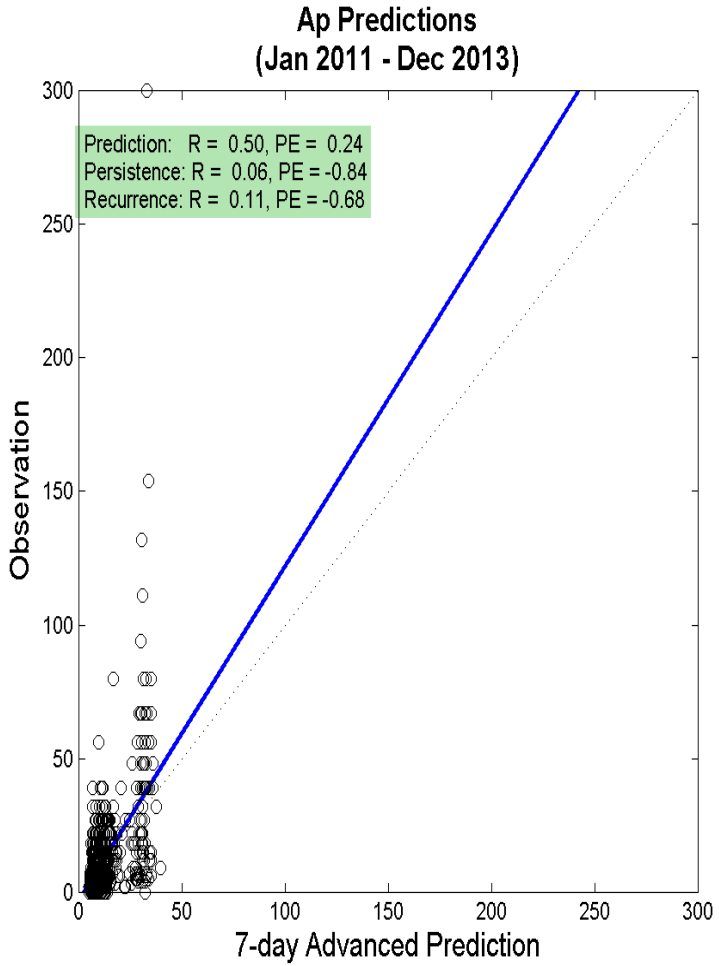




Performance Analysis 4-1

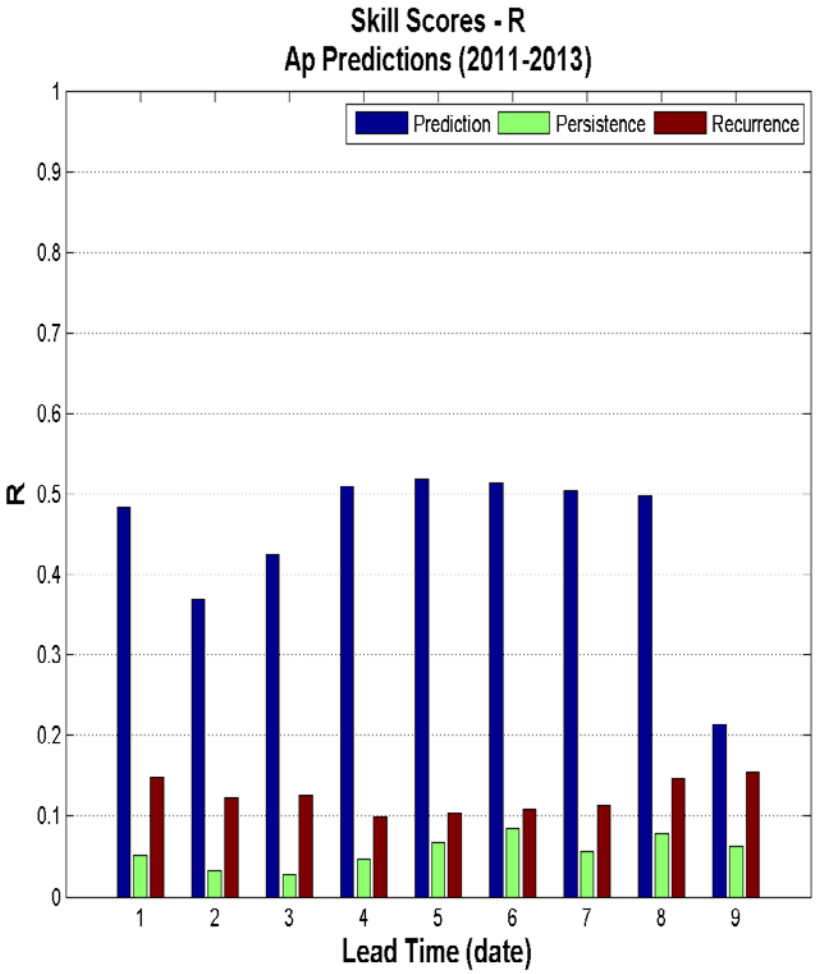
Ap Index

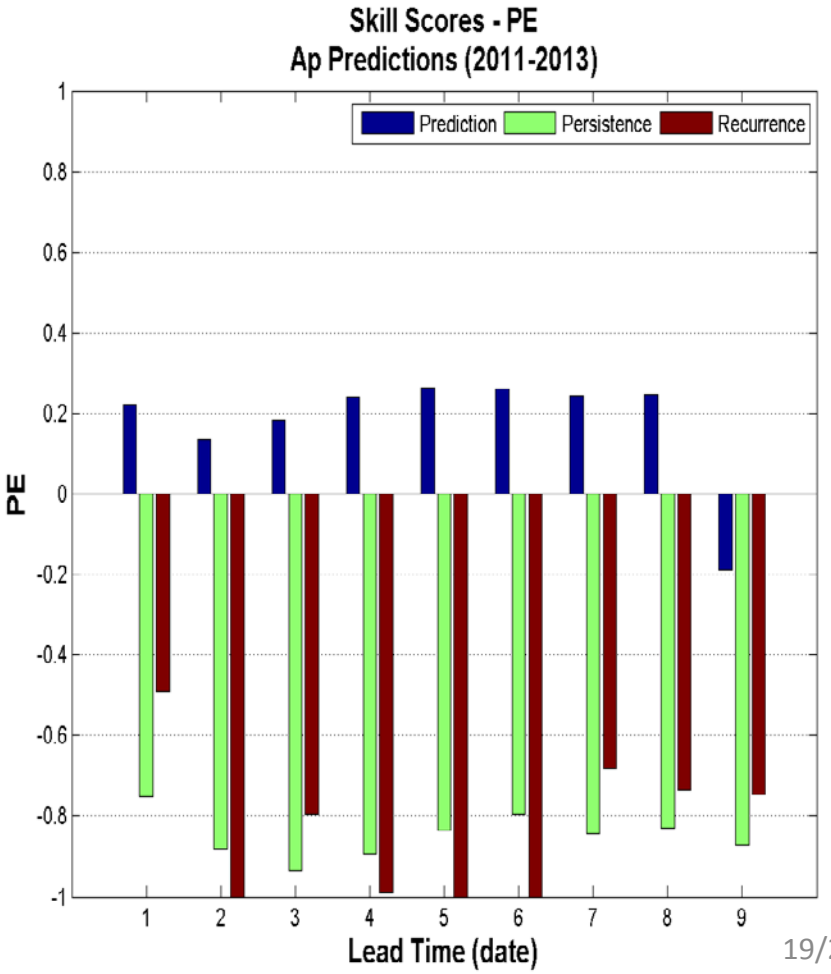




Performance Analysis 4-2

Ap Index





Summary

- ASSA-CH Archive
  - Feb 1997 ~ Dec 2013
  - about 33,000 CH data (time, area, polarity, and 20 vertexes)
- Correlation Study
  - Sector-based CH Area & Vx → sector # ≒ lead time (days)
  - Sector-based CH Area & Kp → sector # ≒ lead time - 0.5 (days)
- CH-driven HSS Prediction Model
  - L1 Solar Wind Speed → Very good performance (R=0.82, PE=0.67)
  - GEO Electron Flux → Good (R=0.77, PE=0.57)
  - Kp & AP → Not too bad (R=0.50, PE=0.24)

  → better performance comparing with persistence & recurrence methods