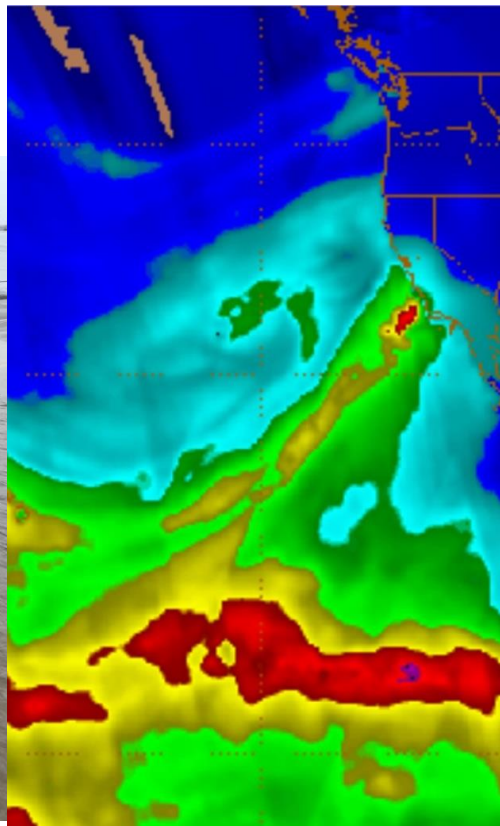




Forecasting Challenges 2017-18



Alex Tardy- NWS San Diego

Alexander.Tardy@noaa.gov



Building a Weather-Ready Nation

CW3E meetings April 2018



Atmospheric Rivers

Climate Forecast System by NOAA

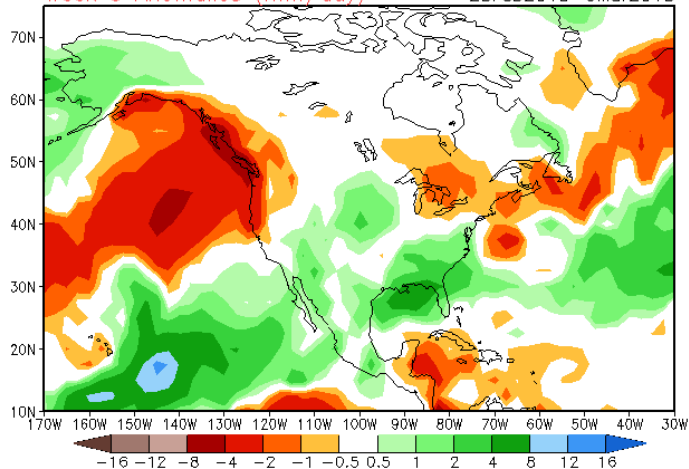


CFSv2 Weeks 3 & 4 Precipitation

16 Member Ensemble Mean Forecast from 13Feb2018

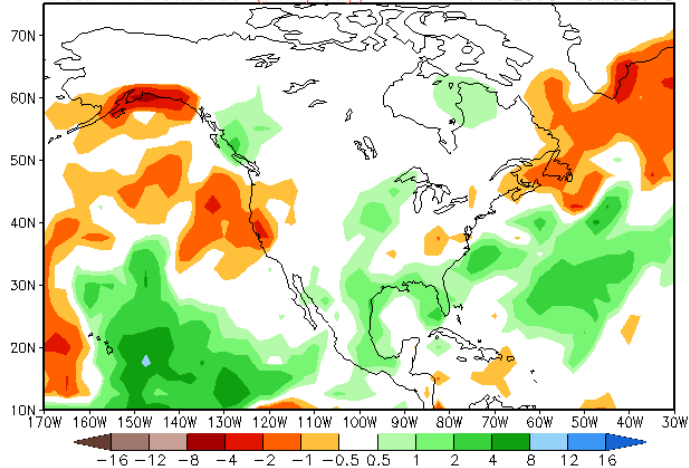
Week 3 Anomalies (mm/day)

28Feb2018–6Mar2018



Week 4 Anomalies (mm/day)

7Mar2018–13Mar2018



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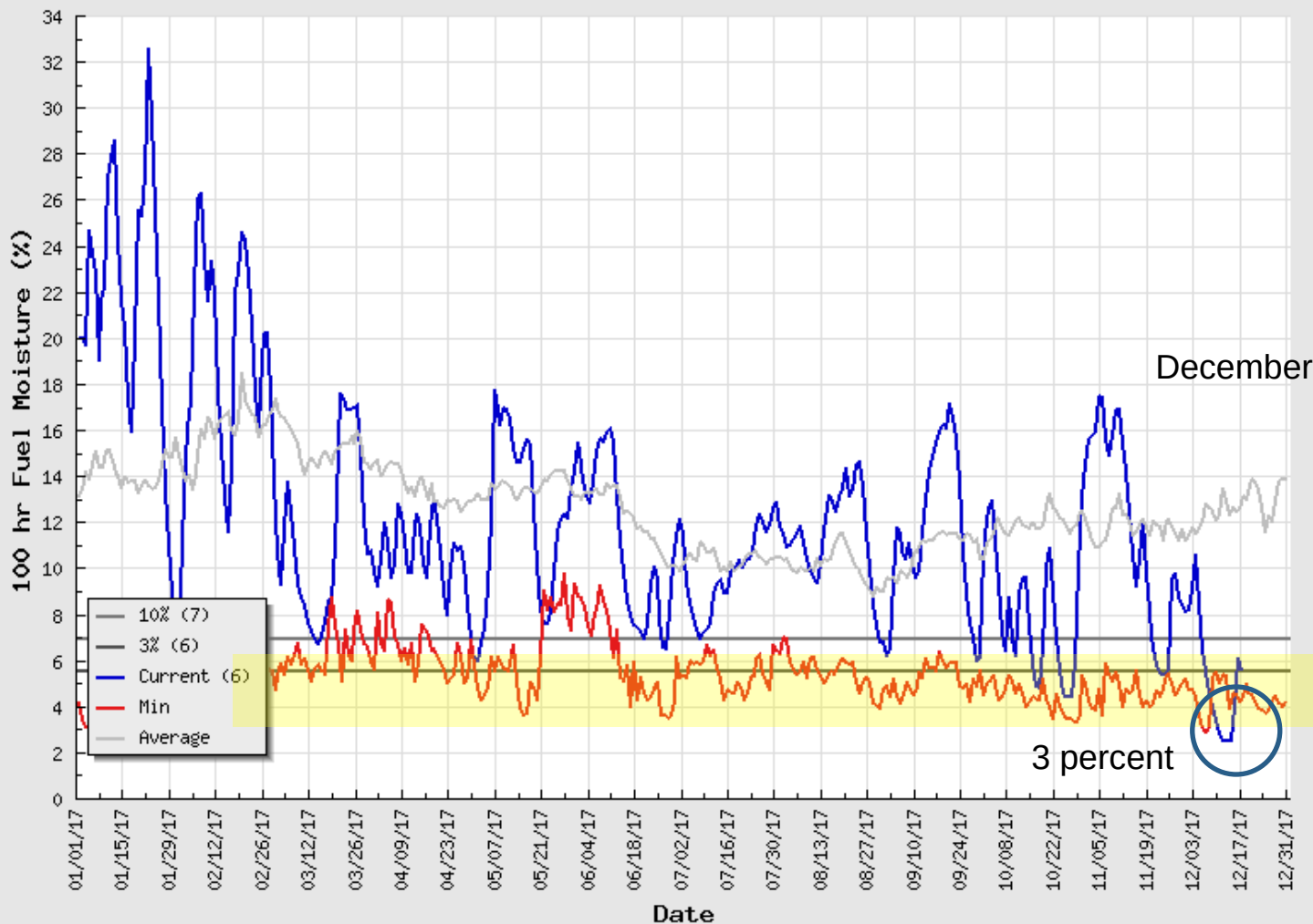


100-h fuel moisture all-time low for South Coastal CA



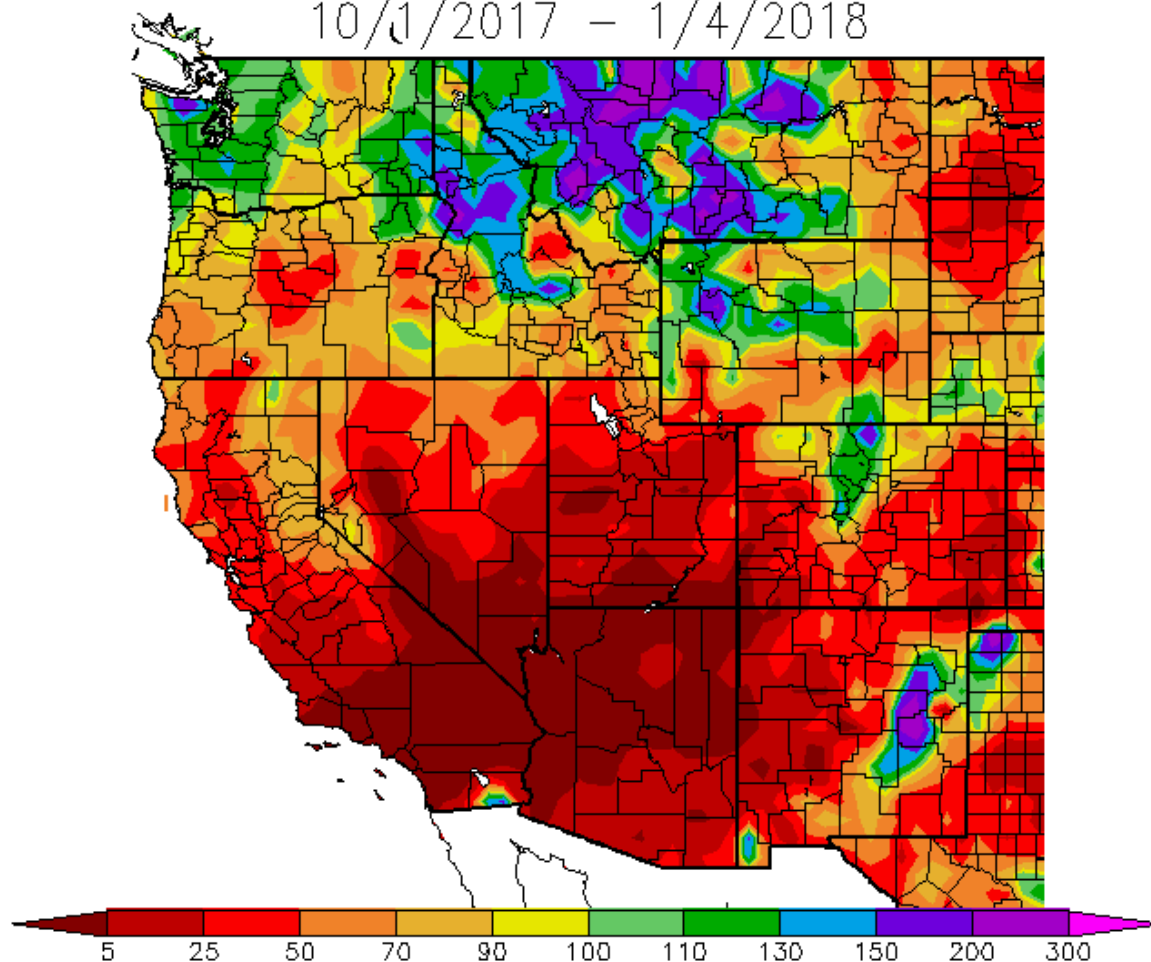
SC08 - South Coast

Valid Date: 18-Dec-2017



Driest start to the water year

Percent of Average Precipitation (%)
10/1/2017 – 1/4/2018



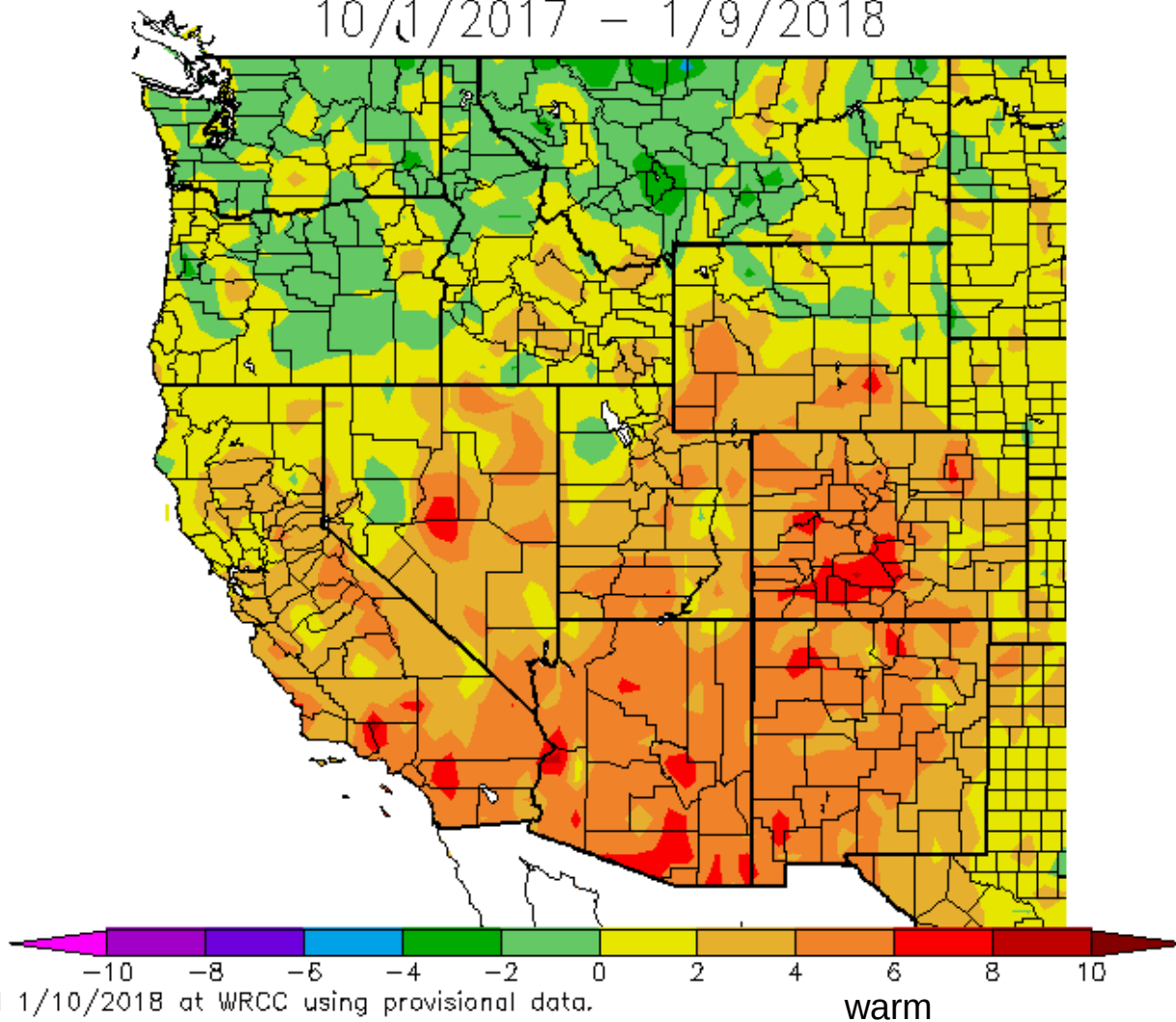
Generated 1/ 5/2018 at WRCC using provisional data.
NOAA Regional Climate Centers



Temperature departure (deg) very warm temperatures



Ave. Temperature dep from Ave (deg F)
10/1/2017 – 1/9/2018





San Diego driest starts to Water Year (WY)



minimum 97-Day Total Precipitation for San Diego Area, CA

Rank	Value	Ending Date	Missing Days
1	0.09	2018-01-05	0
2	0.24	1963-01-05	0
3	0.25	1918-01-05	0
4	0.27	1877-01-05	0
5	0.36	1981-01-05	0
6	0.39	2000-01-05	0
7	0.42	1904-01-05	0
8	0.51	1959-01-05	0
9	0.66	1882-01-05	0
10	0.71	1902-01-05	0

Period of record: 1850-10-01 to 2018-01-09

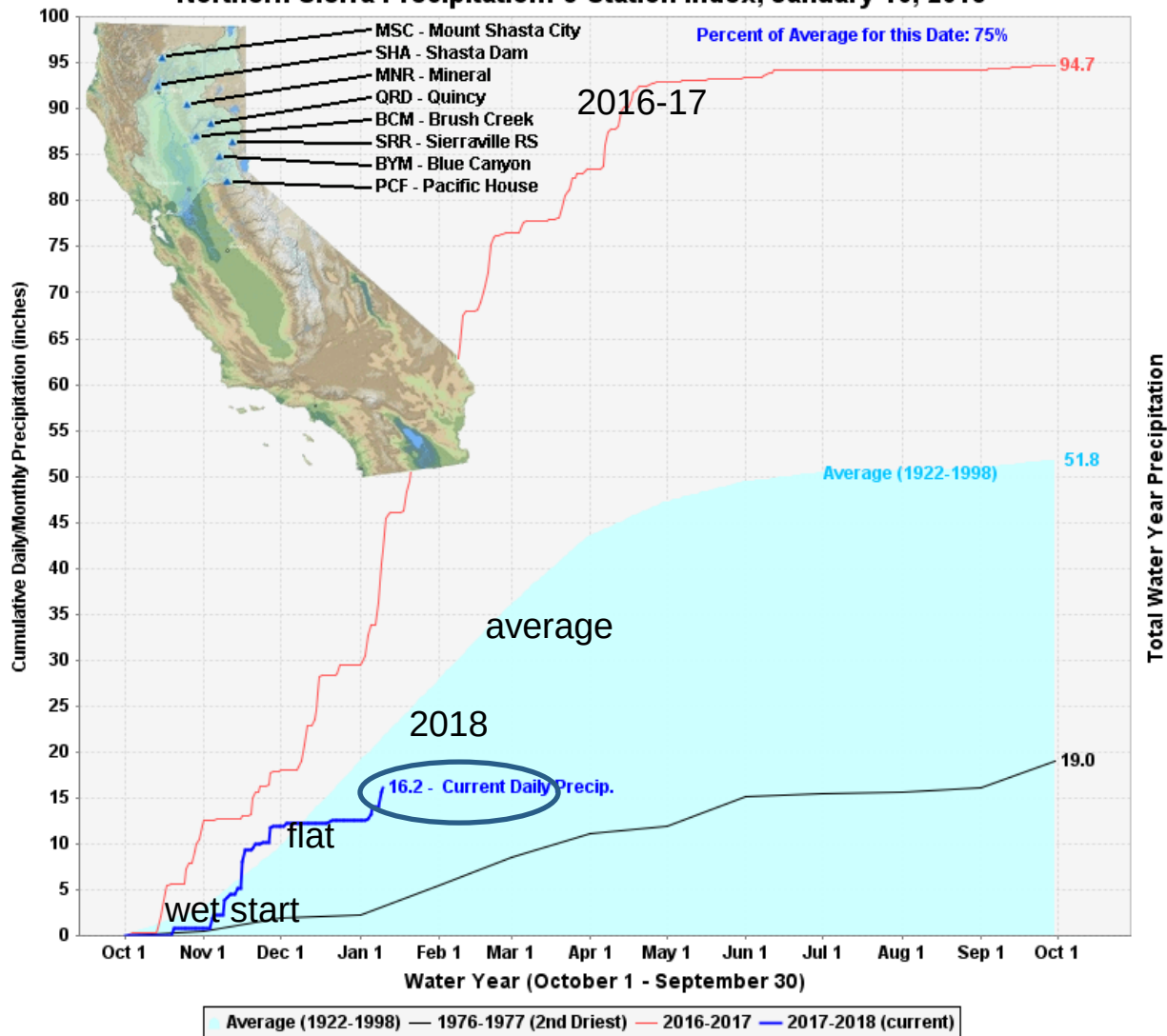




California Mountain Precipitation



Northern Sierra Precipitation: 8-Station Index, January 10, 2018





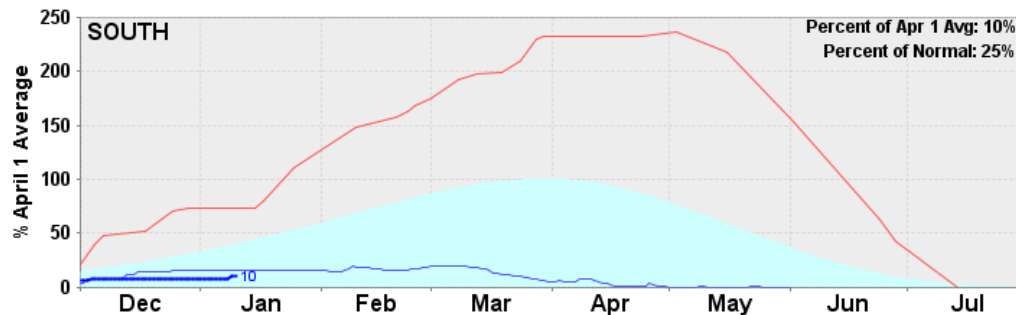
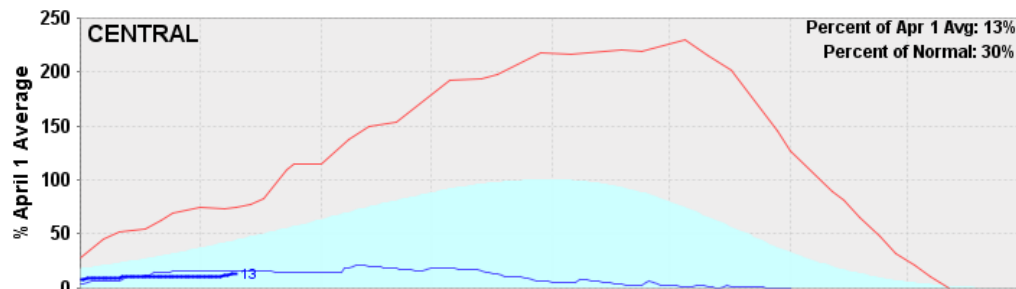
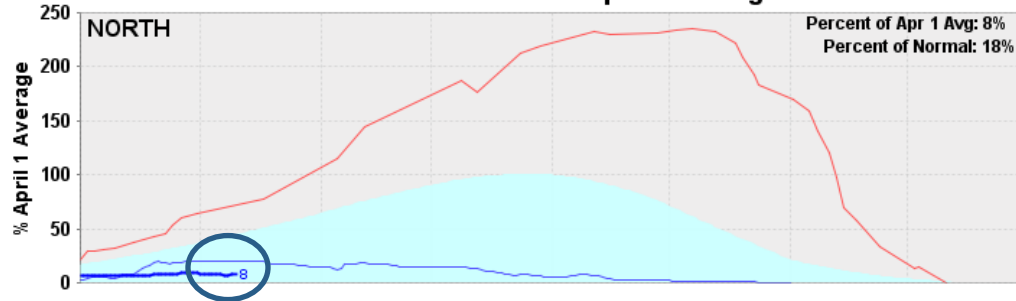
Snowpack Sierra Nevada

10-12 percent of normal – snow drought



Draw chart (chart legend appears at bottom)

California Snow Water Content - Percent of April 1 Average For: 10-Jan-2018



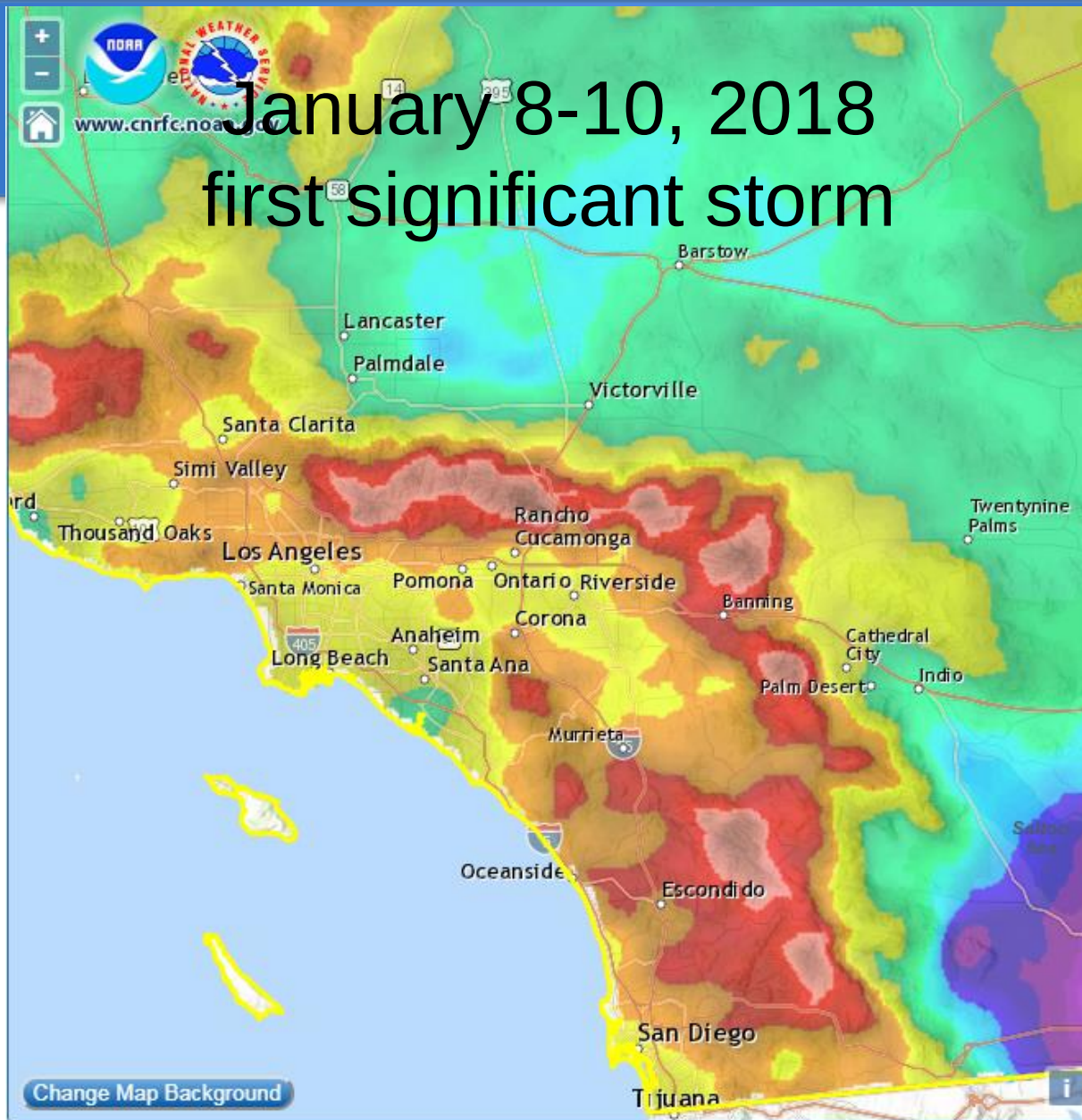
Average — 1982-1983 (max) — 2014-2015 (min) — 2017-2018 (current)



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January 8-10, 2018 first significant storm



Bu

Precipitation (inches)





Round 1
heavy rainfall
(Monday
night) impacts



Lytle Creek

ABC7 Eyewitness News @ABC7 · 15m

Heavy rain triggers road closures, rescues in Inland Empire abc7.la/2EshWvH



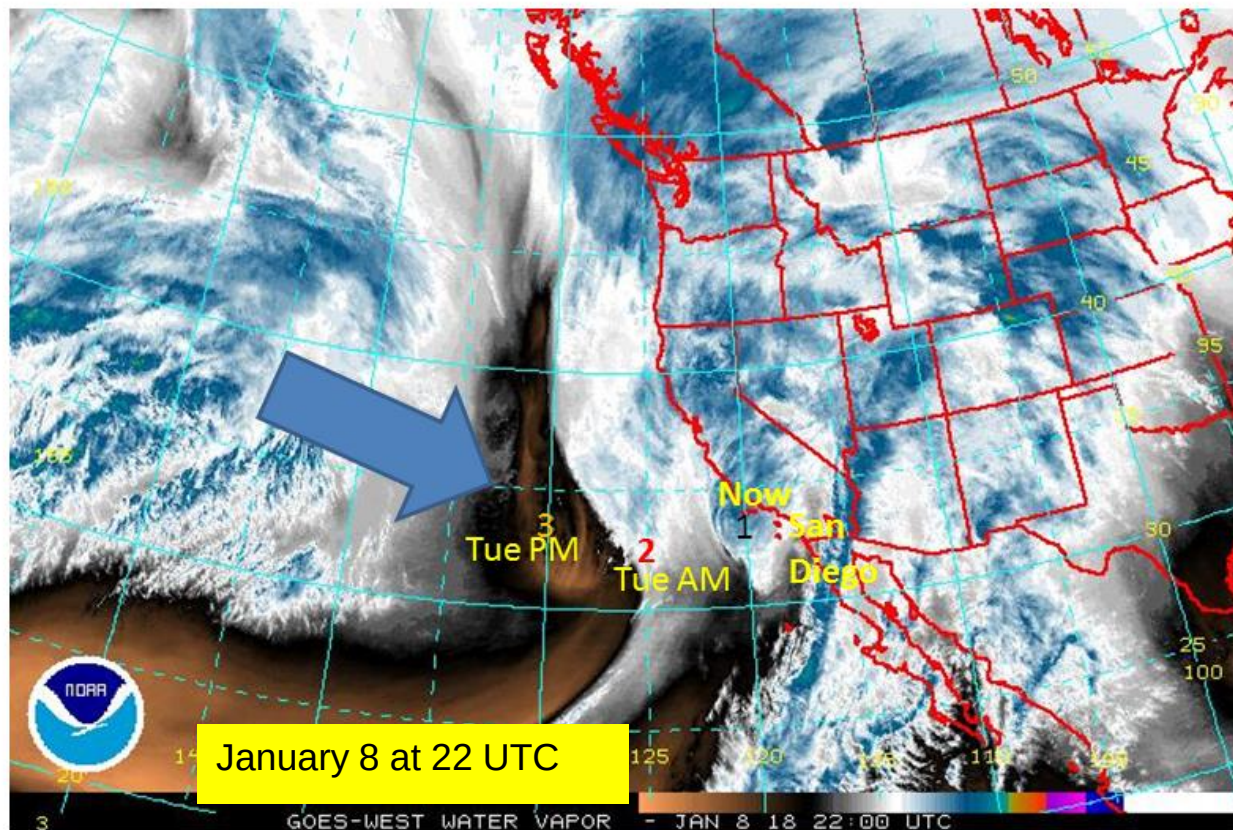
Morning of Jan 9 – Sandia Road and Santa Margarita River



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Storm Approaching

NOAA GOES West Satellite view

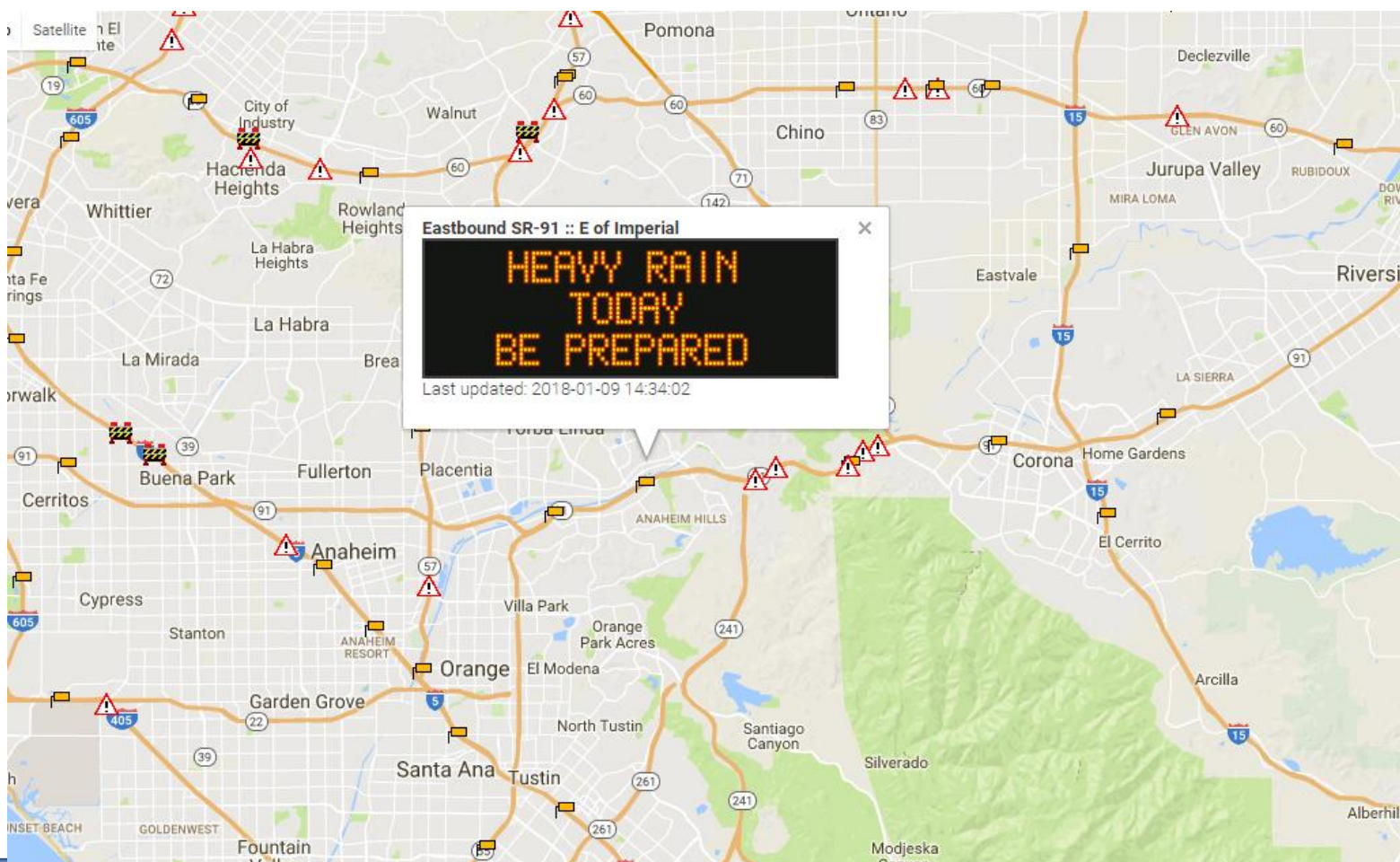


Follow Us:   

@NWSSanDiego



Caltrans placed CMS (messaging)
starting 2 pm Tuesday and continued into Wednesday afternoon



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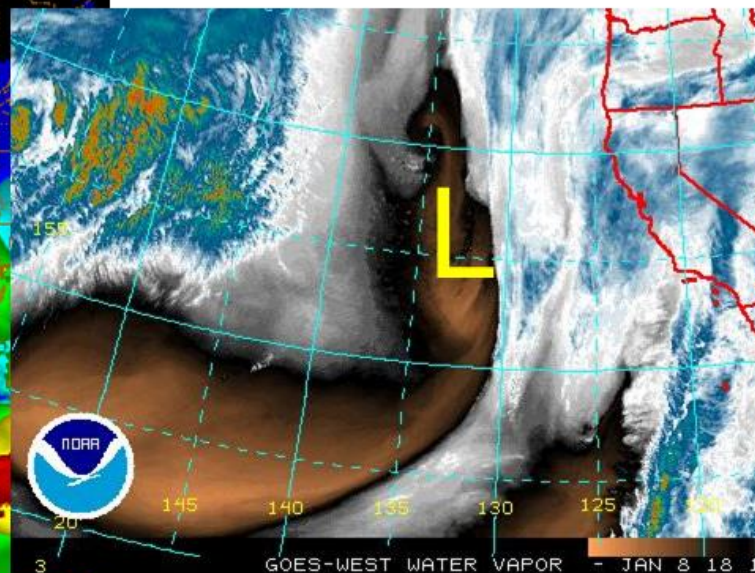
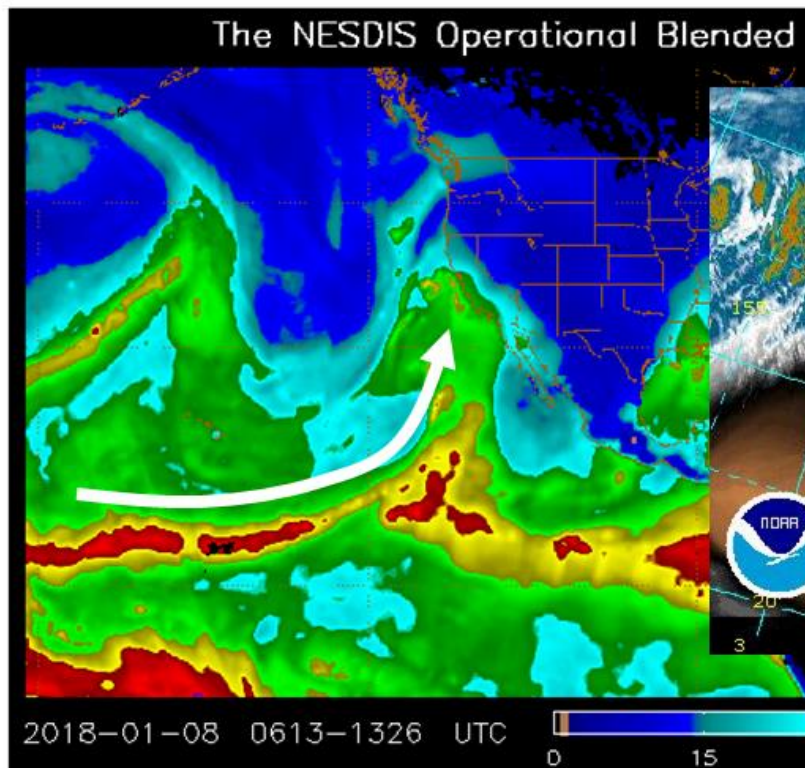
Observed on satellite January 8th 2018



Satellite view this morning



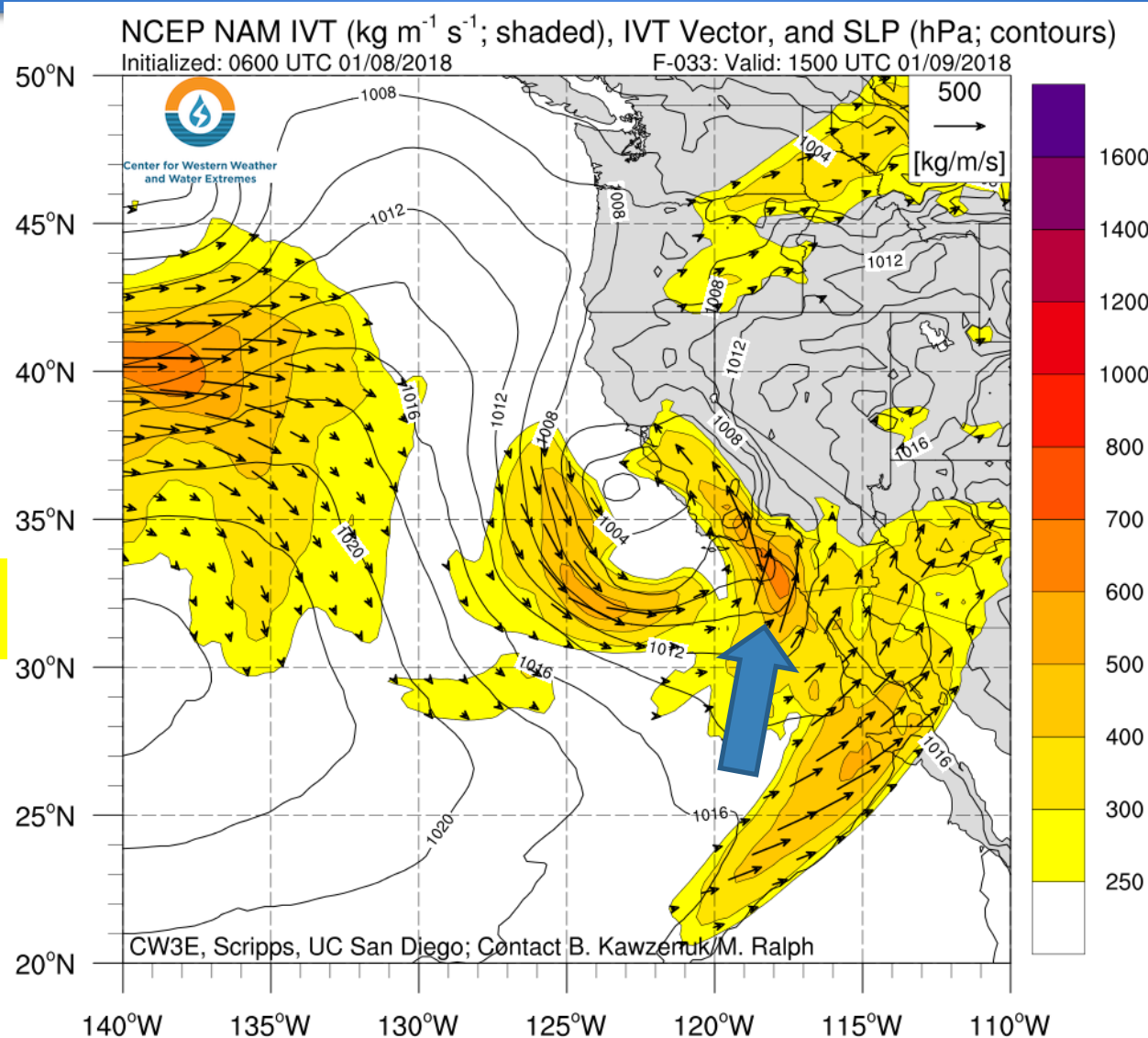
The NESDIS Operational Blended TPW Products



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NAM IVT 15 UTC January 9

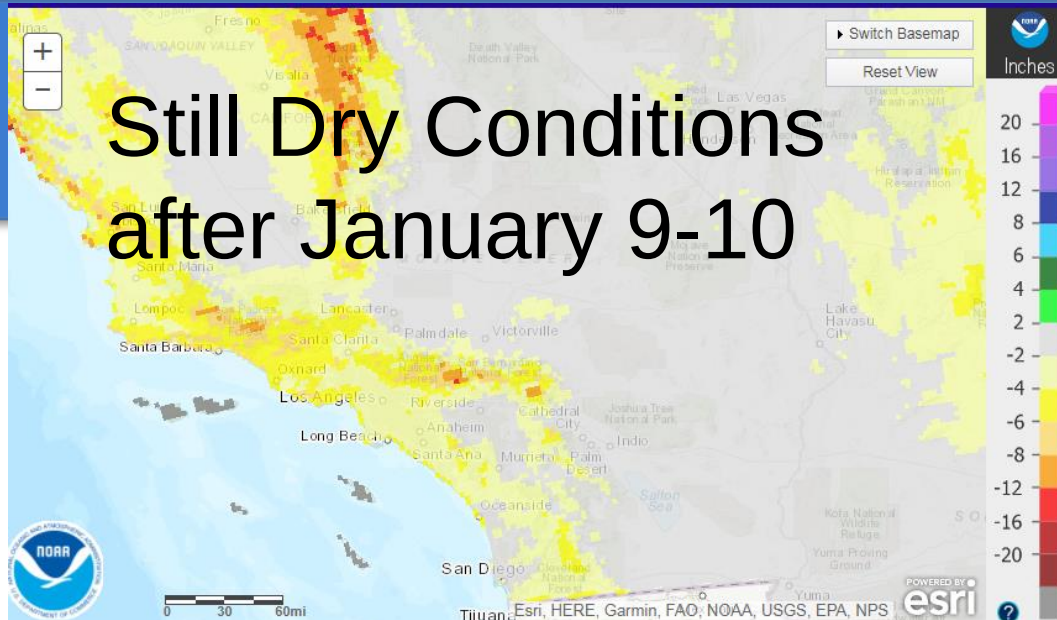
narrow strong AR



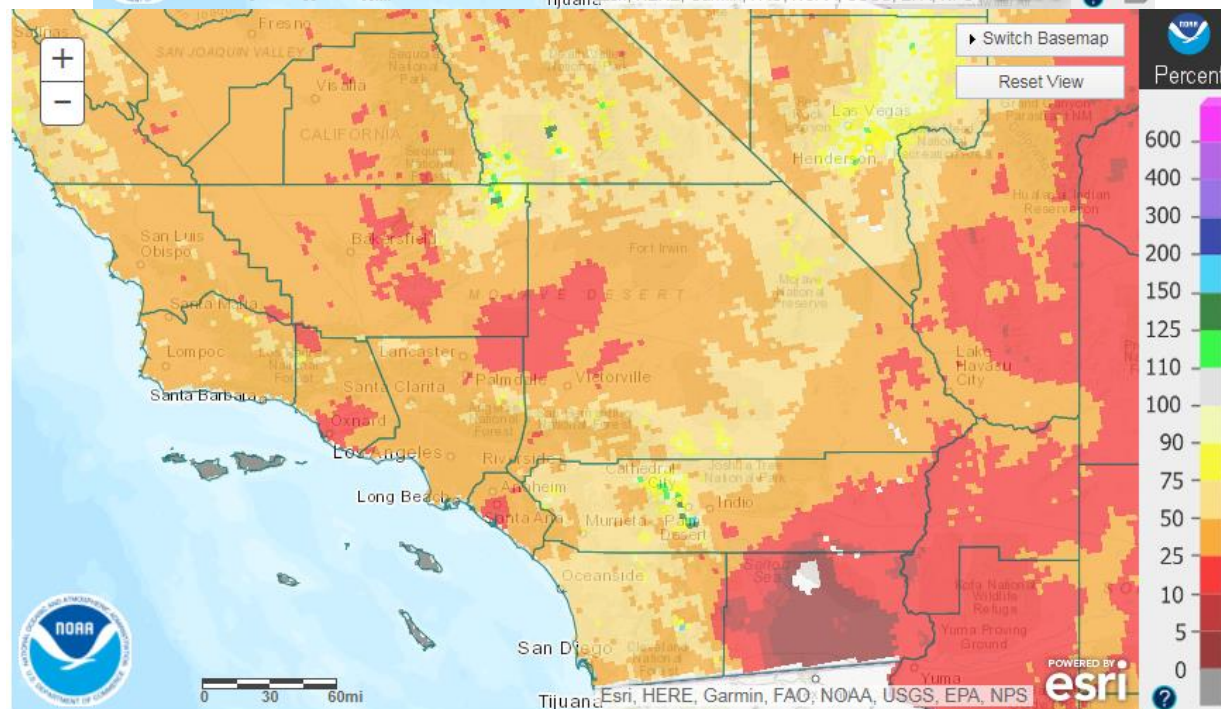
This was the end of the strong WAA



Still Dry Conditions after January 9-10



Inches
missing



Percent
normal



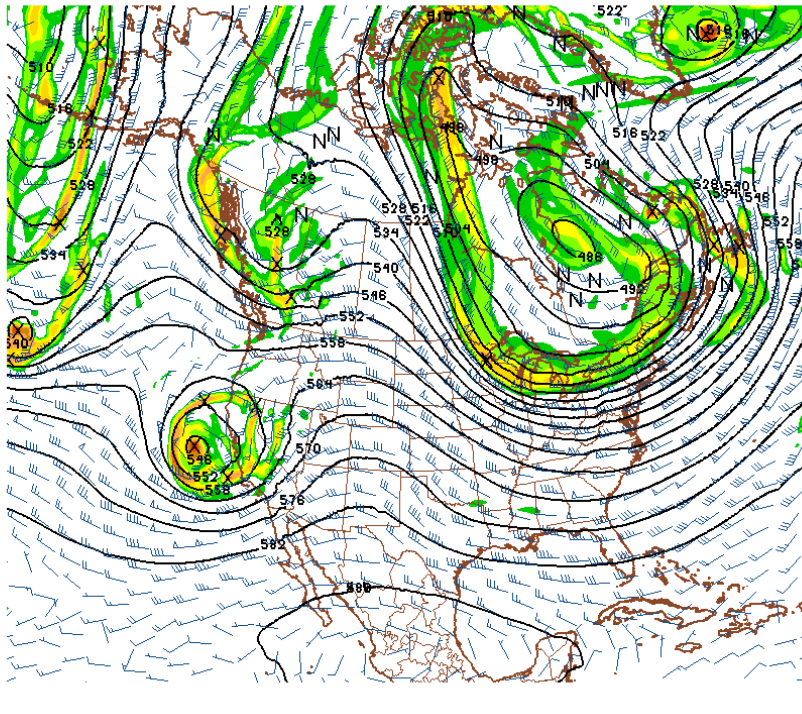
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168-h down to 84-h hour GFS forecast

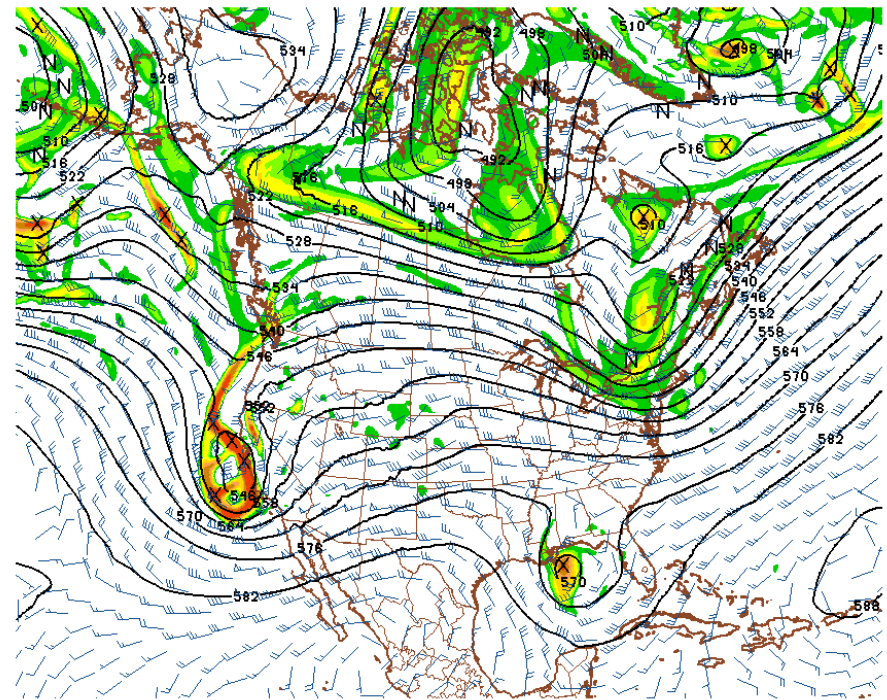


01/03/18 12UTC 168HR FCST VALID WED 01/10/18 12UTC NOAA/NWS/NCEP



180110/1200V168 BFS 500MB HGT, ABS VALUE OF ABS VOR, AND WIND

01/08/18 00UTC 084HR FCST VALID TUE 01/09/18 12UTC NOAA/NWS/NCEP



180109/1200V084 BFS 500MB HGT, ABS VALUE OF ABS VOR, AND WIND



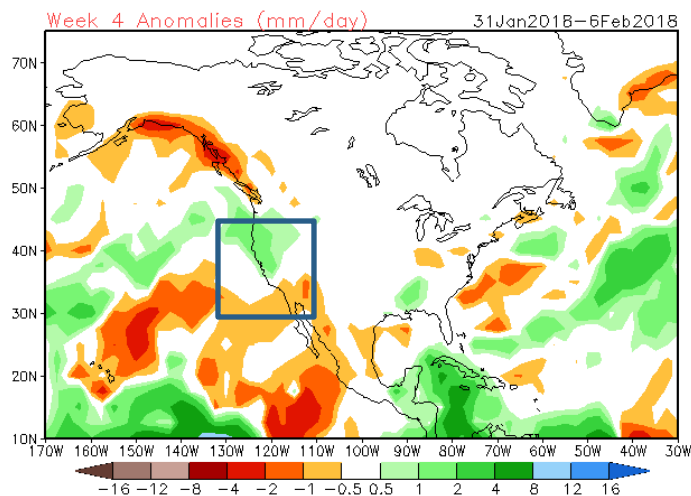
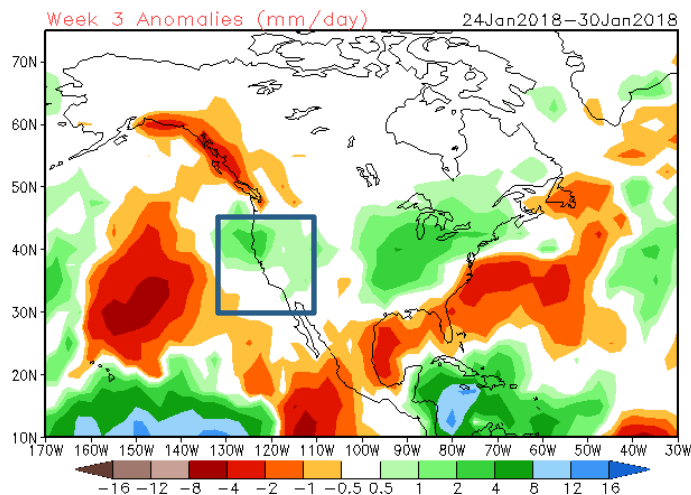
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Late January and Early February 2018 would the wet pattern continue?



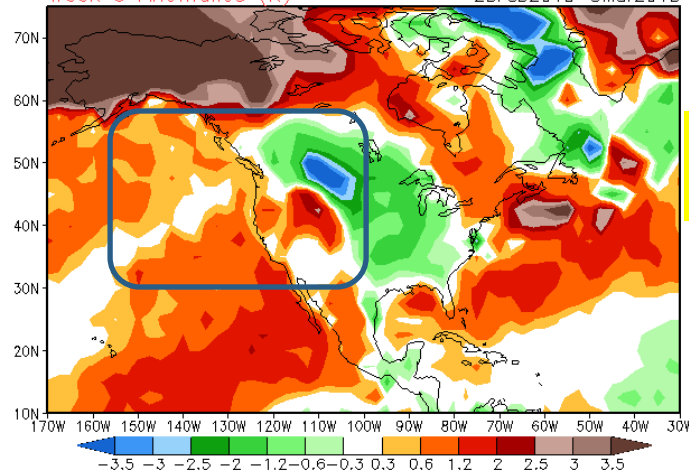
CFSv2 Weeks 3 & 4 Precipitation
16 Member Ensemble Mean Forecast from 09Jan2018



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Cold Air Outbreaks

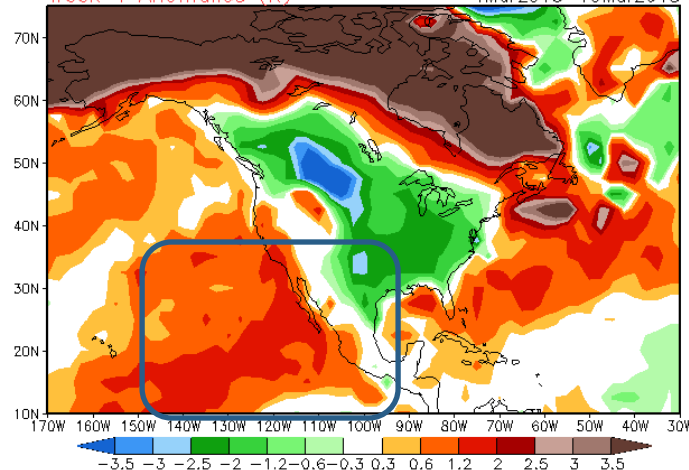
CFSv2 Extended Range Temperature
16 Member Ensemble Mean Forecast from 10Feb2018
Week 3 Anomalies (K) 25Feb2018–3Mar2018



CFSv2 February 10 run

CFSv2 depicts warmth continuing weeks 3-4

Week 4 Anomalies (K) 4Mar2018–10Mar2018

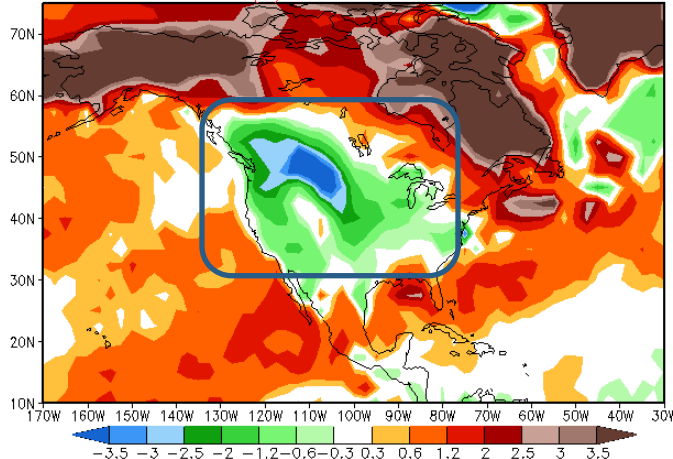




Cold Air Outbreaks – pattern change

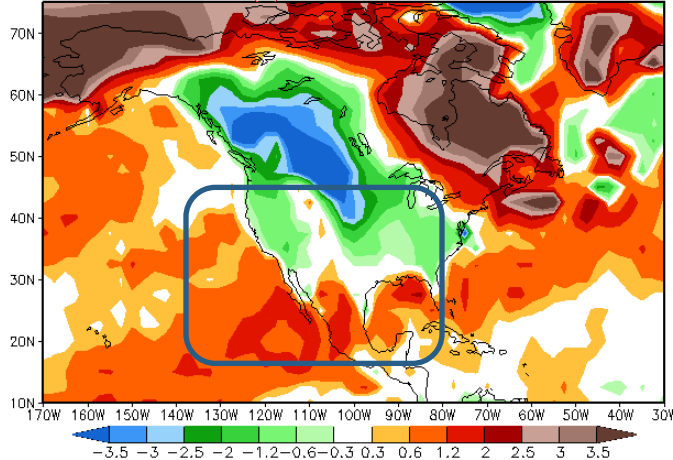


CFSv2 Extended Range Temperature
16 Member Ensemble Mean Forecast from 11Feb2018
Week 3 Anomalies (K) 26Feb2018–4Mar2018



CFSv2 began
February 11 run

Week 4 Anomalies (K) 5Mar2018–11Mar2018



weeks 3-4
Valid February 26-March 11





Next significant precipitation was surprise Atmospheric River March 10-11, 2018

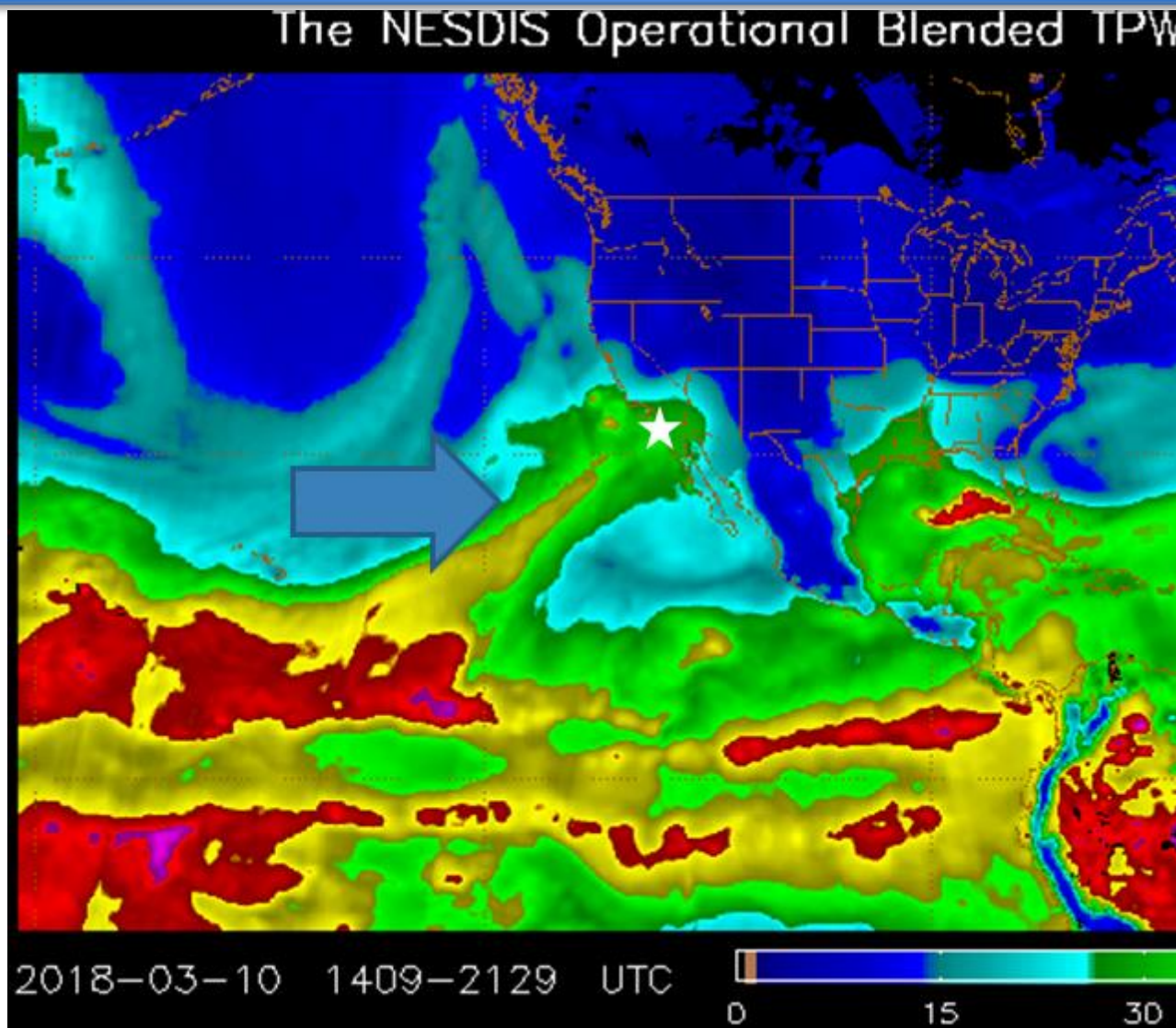


- The main trough was forecast to be weak (flat) and progressive
- The atmospheric river was well captured in the IVT (integrated water vapor transport over 500 into Orange and San Diego counties)
- The WPC, CNRFC and WFO forecasts were significant underforecast QPF prior to March 10
- March 10 WPC QPF and WFO QPF totals were doubled
- The rain was mostly 24 hours or less 4 pm Saturday to 1 am Sunday was the heaviest
- Drizzle and light rain (few hundredths) was widespread Saturday morning and afternoon (March 10) on coast and inland valleys with upslope enhancement
- **Orographic coastal slopes received 1.5 to 3.5 inches** (Palomar Mtn highest)
- Spill over into High Deserts (0.25 to 0.50) and Coachella Valley (0.10 or less)
- Orange and Inland Empire received 0.50 to 0.90 inches, and only small shadow area near Perris





Atmospheric River and weak upper trough yielded orographic heavy rain

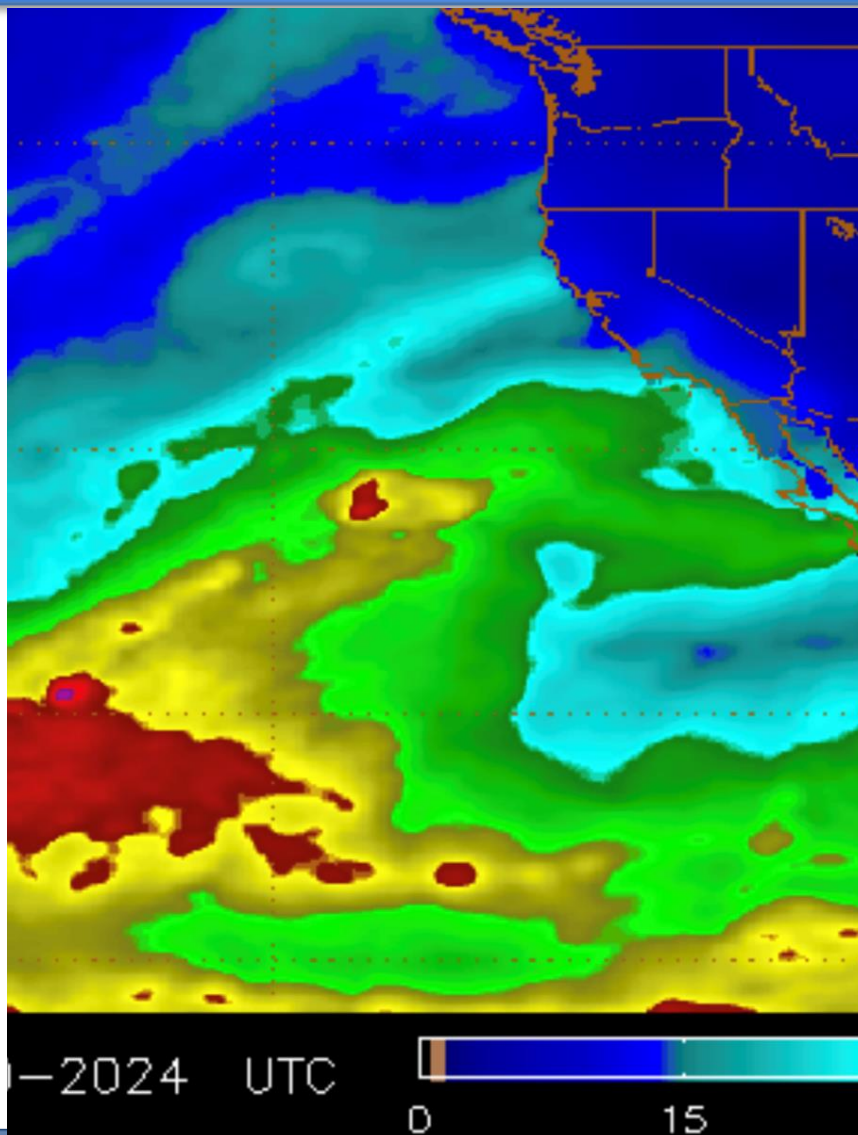




Start of the AR approaching Socal Surprise AR challenges

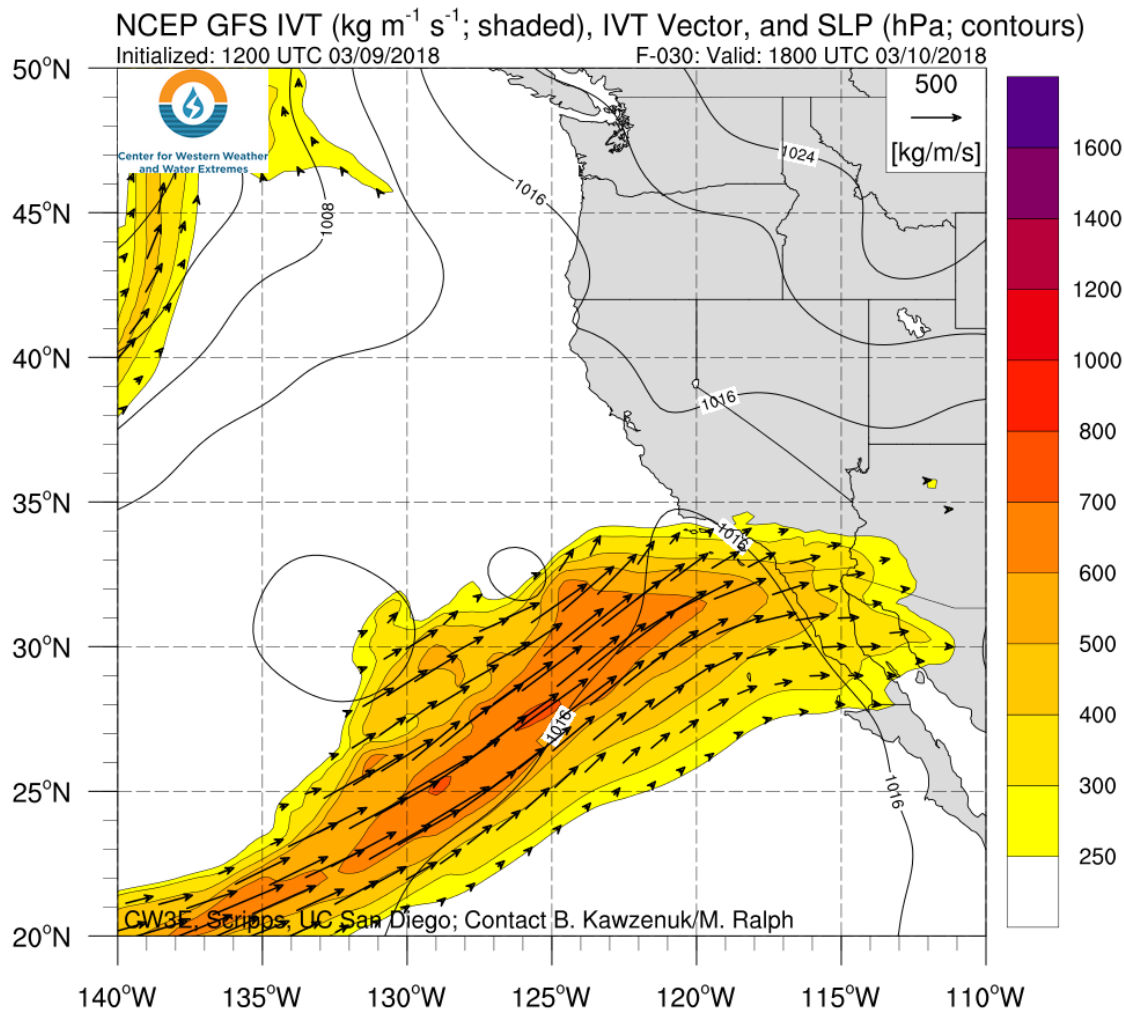


Friday
March 9



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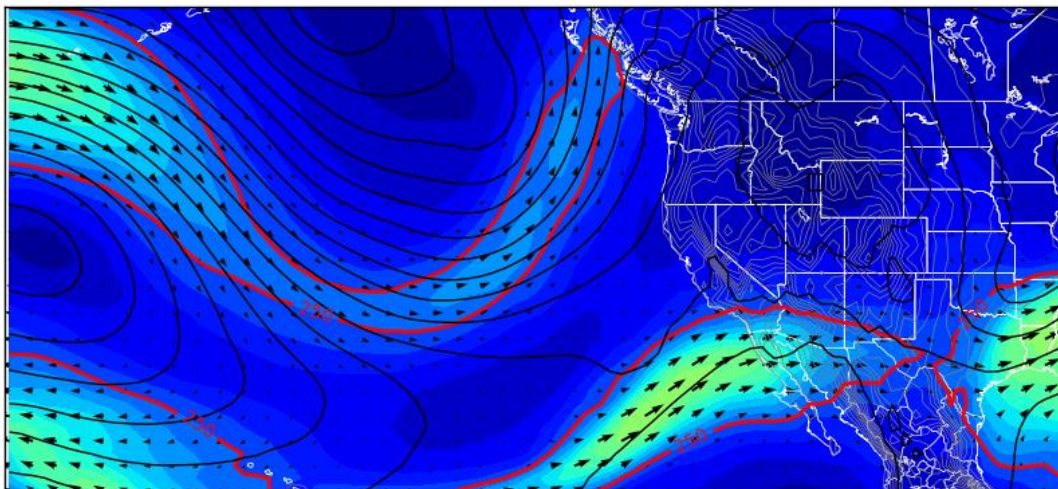
12 UTC 9 March GFS 30-h forecast of AR potential



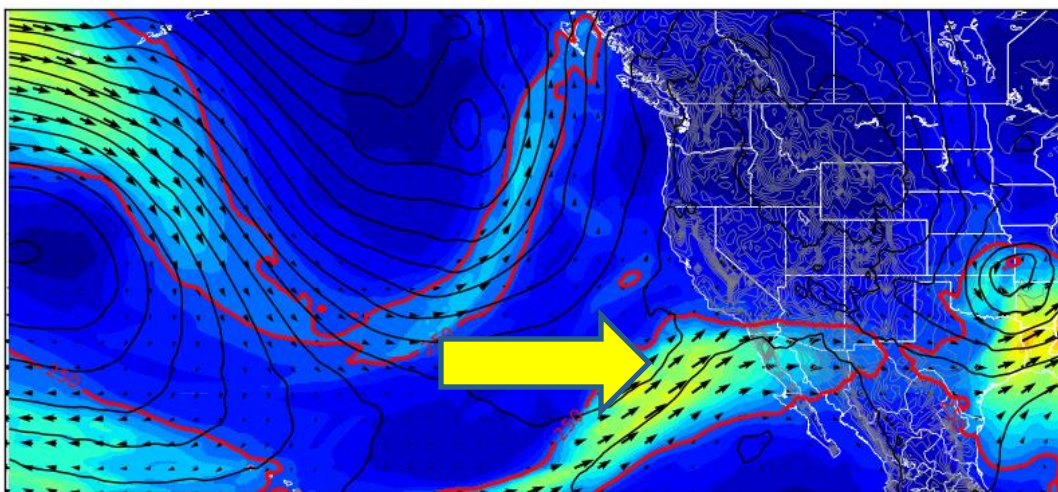
120 hour GFS Finding an AR

Integrated Water Vapor Transport ($\text{kg m}^{-1} \text{s}^{-1}$)
120-h forecast valid 00:00 UTC Sun 11 Mar 2018

GEFS
Ensemble
Mean



GFS

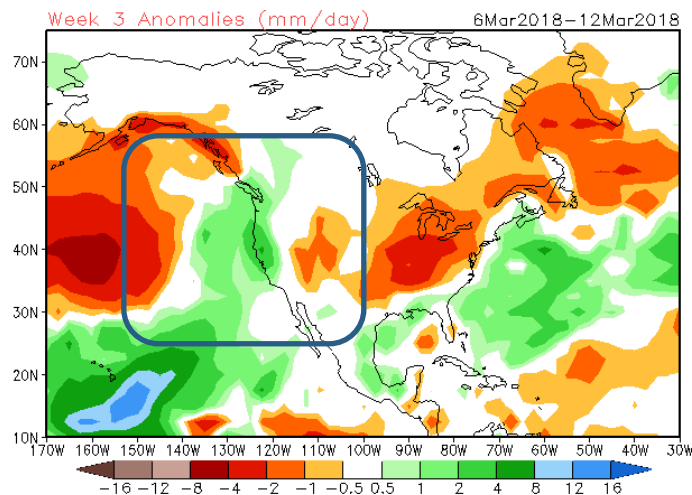




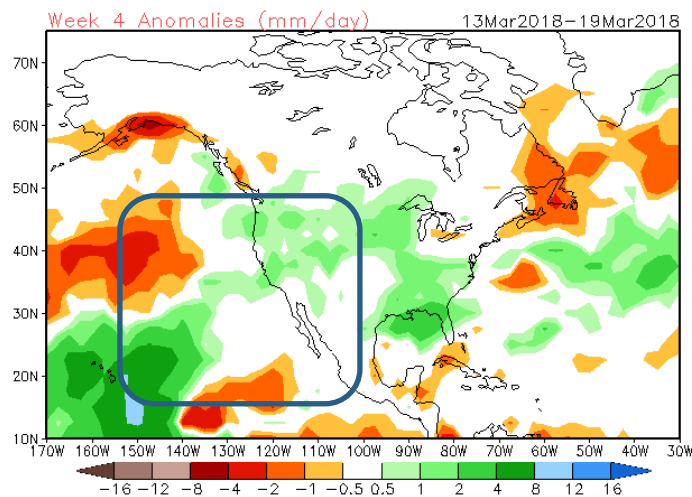
CFSv2 week 3 and 4 - Precipitation issued February 19



CFSv2 Weeks 3 & 4 Precipitation
16 Member Ensemble Mean Forecast from 19Feb2018



Valid March 6-12



Valid March 13-19



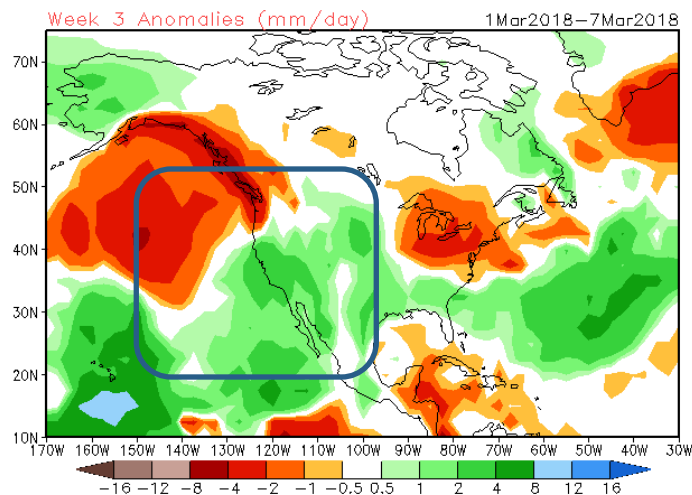
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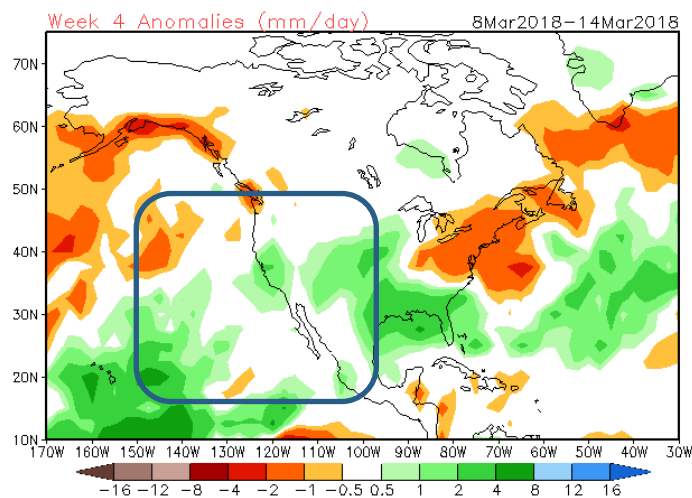
CFSv2 week 3 and 4 - Precipitation issued February 14



CFSv2 Weeks 3 & 4 Precipitation
16 Member Ensemble Mean Forecast from 14Feb2018



Valid March 1-7



Valid March 8-14



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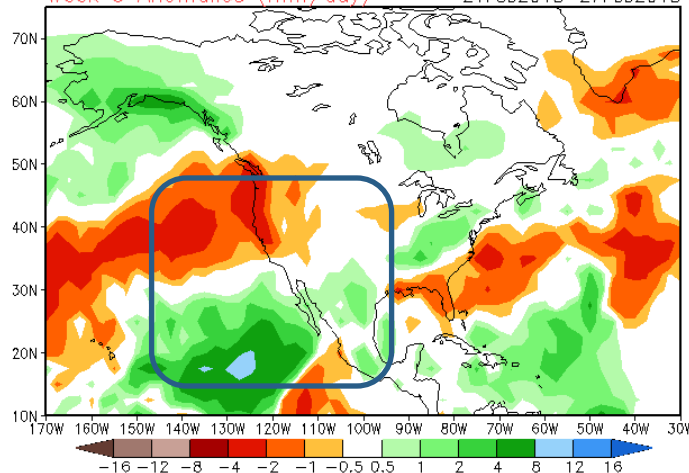


CFSv2 week 3 and 4 - Precipitation issued February 6



CFSv2 Weeks 3 & 4 Precipitation
16 Member Ensemble Mean Forecast from 06Feb2018

Week 3 Anomalies (mm/day) 21Feb2018–27Feb2018

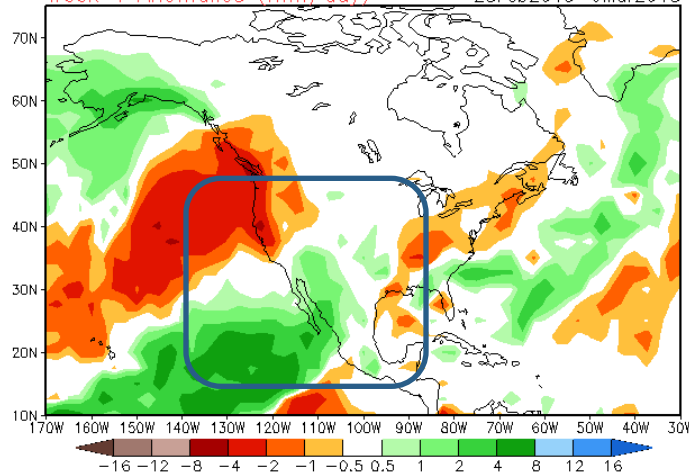


Valid Feb 21-27

Other than January 10-11,
2018 event, 2017-2018 was
off to the driest start to the
water year through January 5

4-week lead

Week 4 Anomalies (mm/day) 28Feb2018–6Mar2018



Valid February 28-March 6

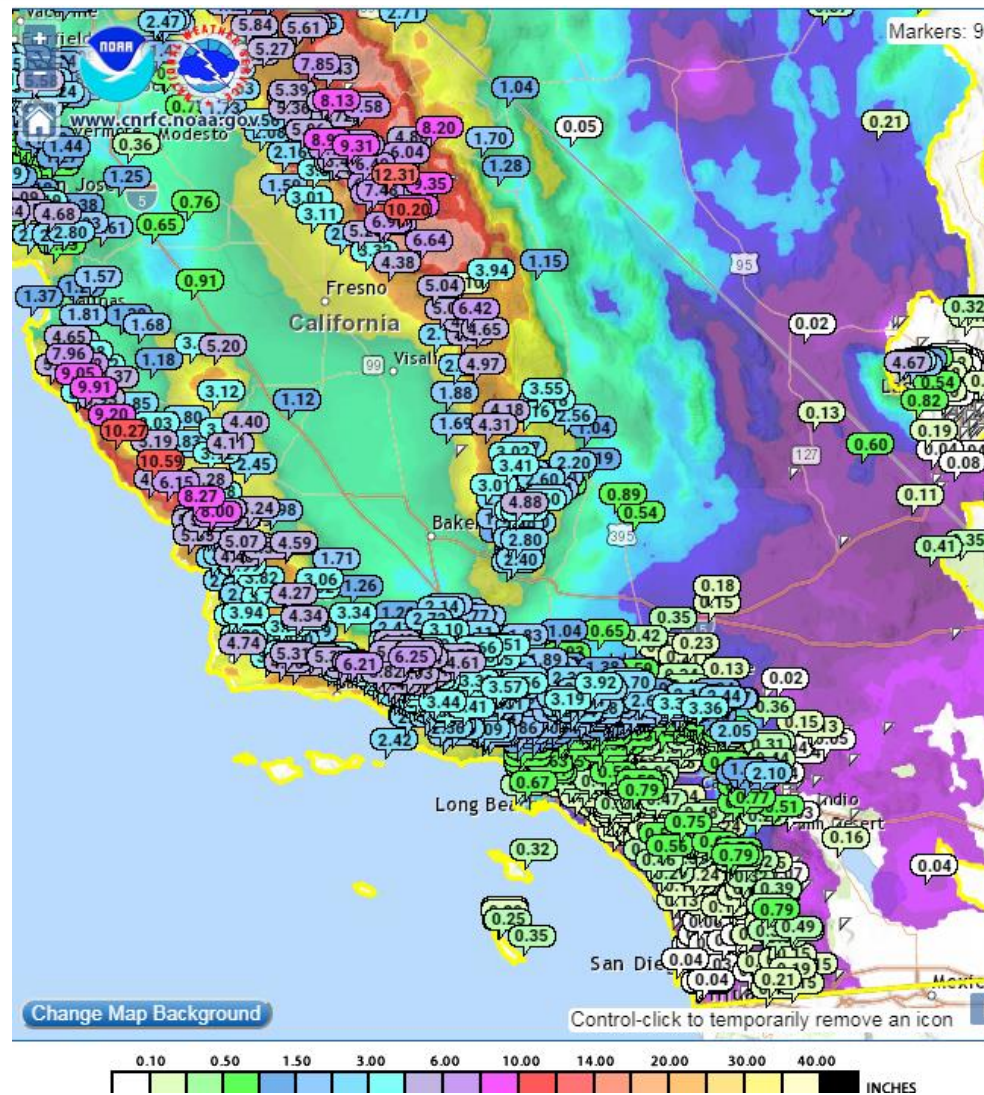


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Precipitation March 19-24, 2018

Overforecasting AR in Socal



Building a Weather-Ready Nation



AR event summary

March 20-23, 2018

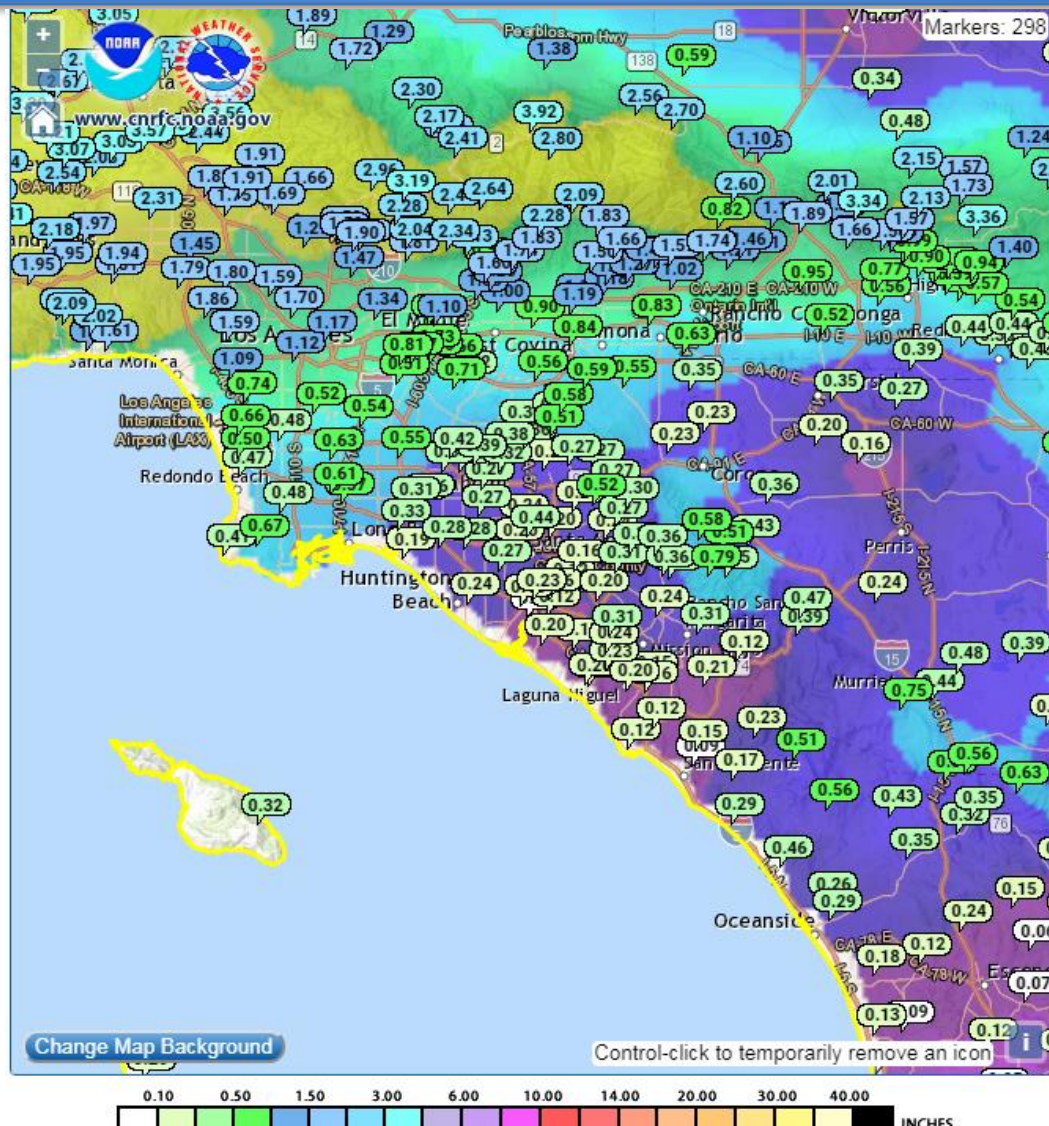


- ✓ Long range guidance (GFS) had a strong AR (IVT over 800) as far as 180 hours in forecast
- ✓ The AR was targeted over LA and San Diego, but <120 hour forecasts trended northward starting March 15-16
- ✓ Partners were given long range outlooks March 14-16 about the potential for an AR event
- ✓ Higher resolution NWP within 84-h was focused on Point Conception and a very sharp gradient over Orange, Riverside and San Diego County
- ✓ Weekend of March 17-18 guidance and WPC had over 6 inches for Santa Barbara terrain areas
- ✓ There was little forcing though Warm Conveyor Belt (warm air advection) and moisture advection for March 20-21
- ✓ NWP guidance (global) trended lower over SGX CWA weekend March 17-18
- ✓ NWP high resolution trended low over San Diego County on March 20-21
- ✓ There was a large **break in precipitation March 21 evening** and overnight and **noteable shift northward of the PW plume** towards SFO and central California (see maps)
- ✓ Precipitation in the core of the IVT (600-800 on NAM and GFS over California bight) developed over SGX on March 22 – see the IVT forecasts
- ✓ Precipitation rates were only 0.10 to 0.15 per hour in high dBZ composite reflectivity (weak forcing and some subcloud dry layer) in 1 to 1.30 inch PWAT plume on March 22





LA and Orange Counties



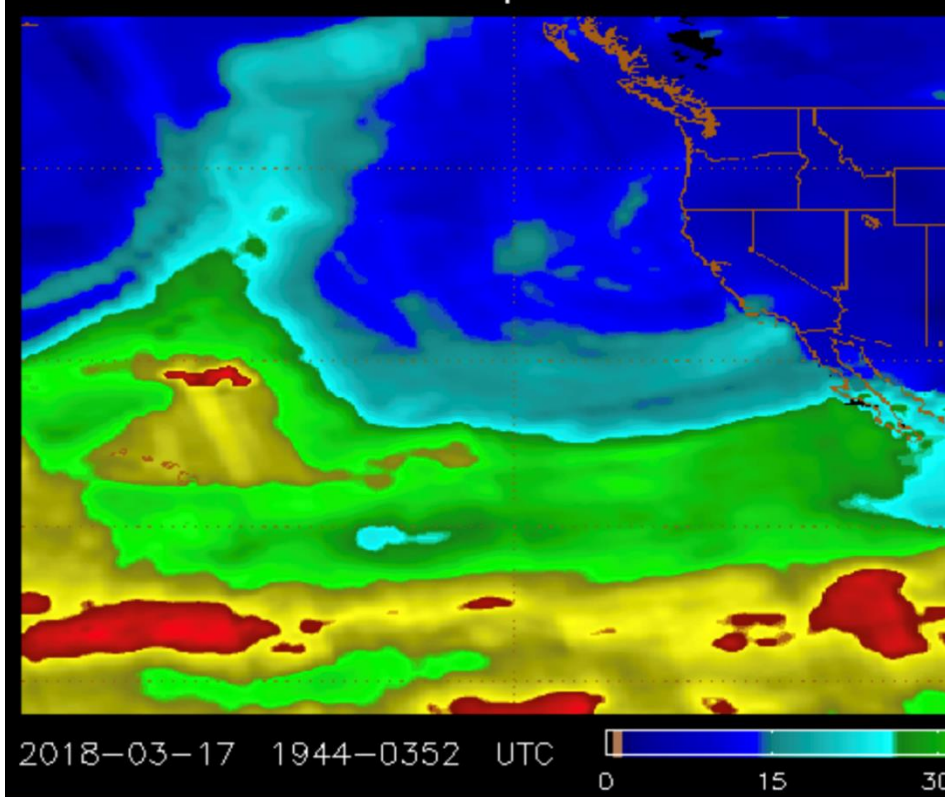
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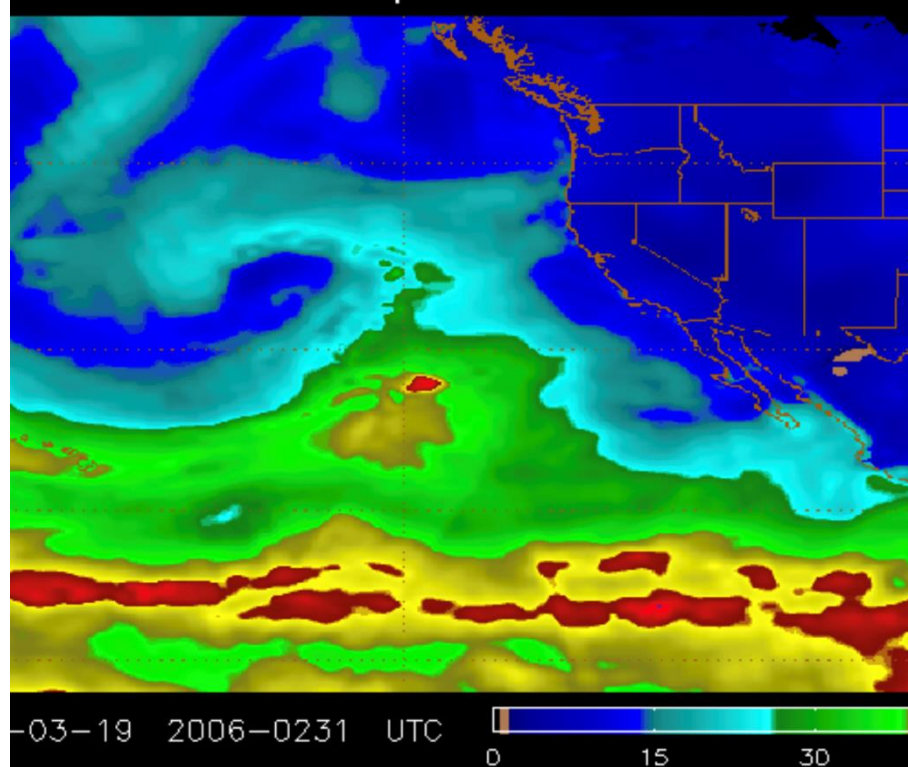
Start of AR on March 16-18, 2018



The NESDIS Operational Blended TPW



The NESDIS Operational Blended TPW over



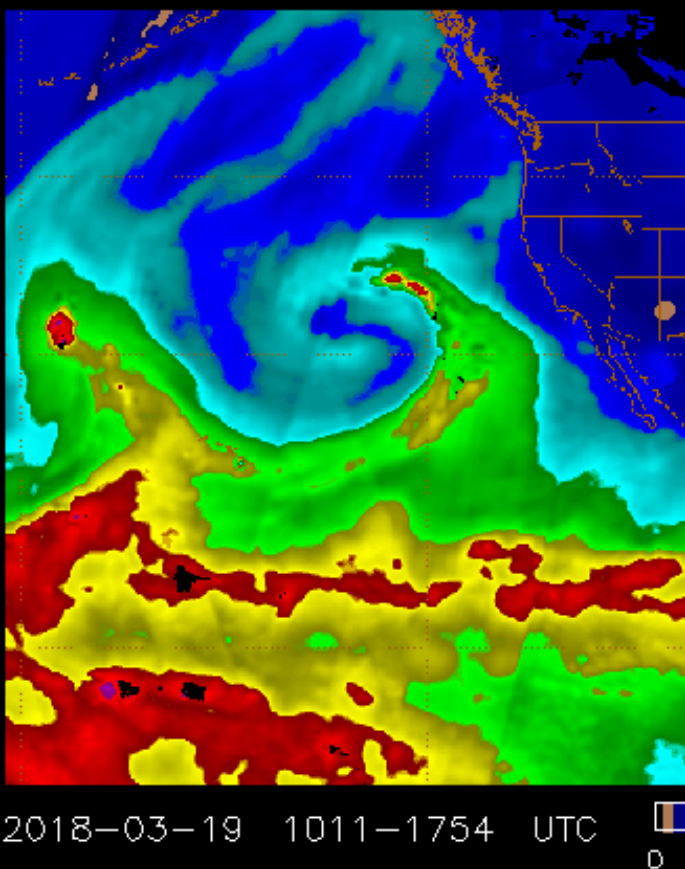
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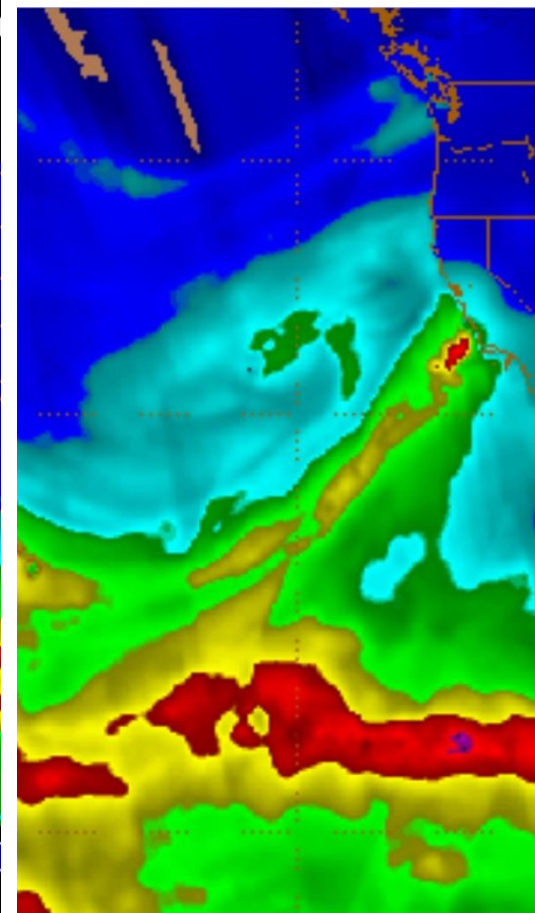
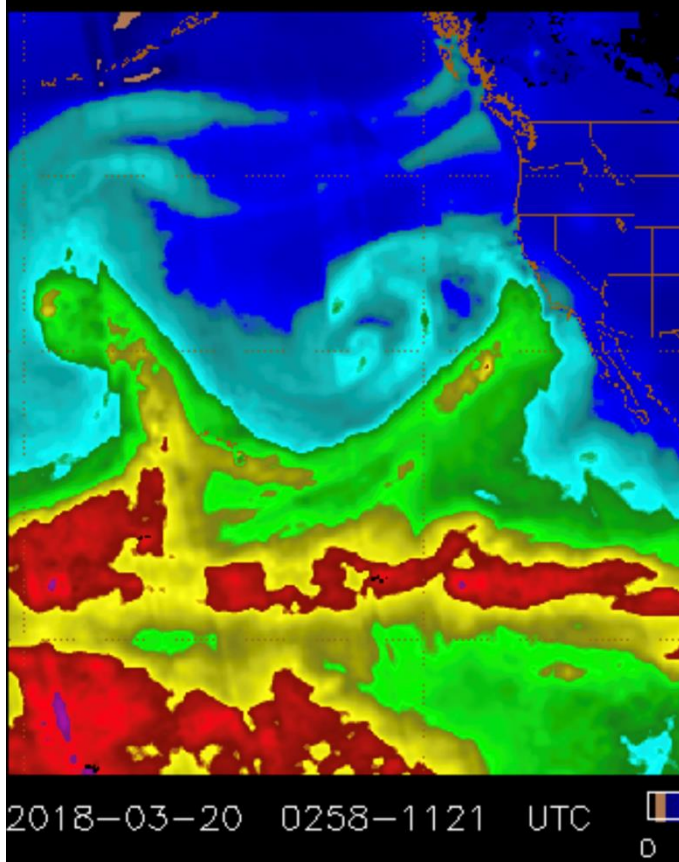
The beginning and landfall of AR March 19-20



The NESDIS Operation



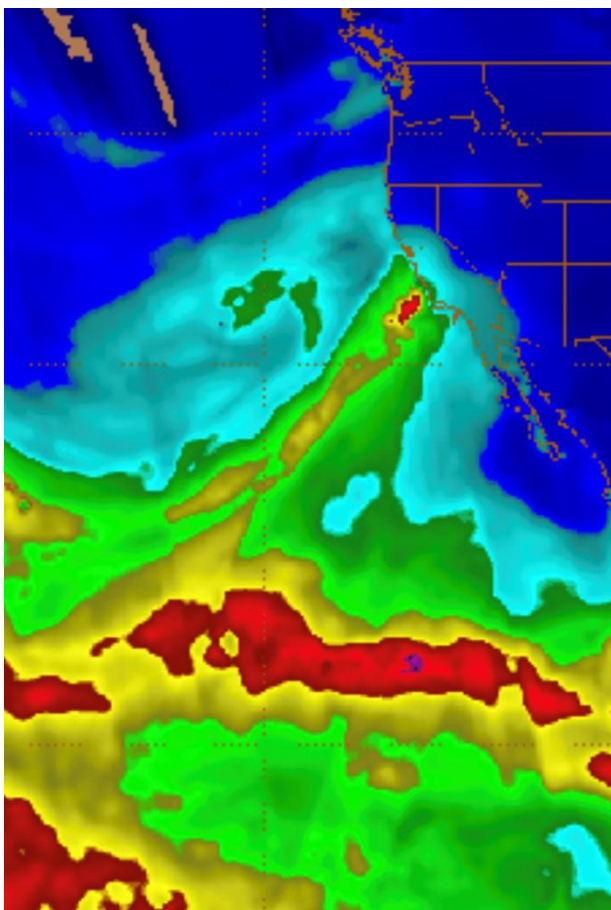
The NESDIS Operation



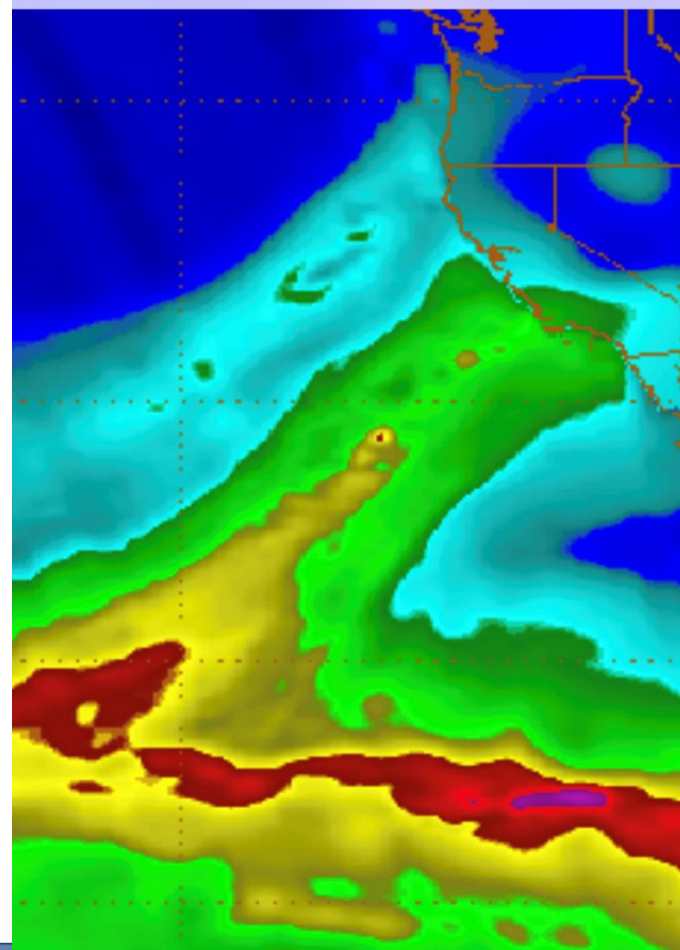
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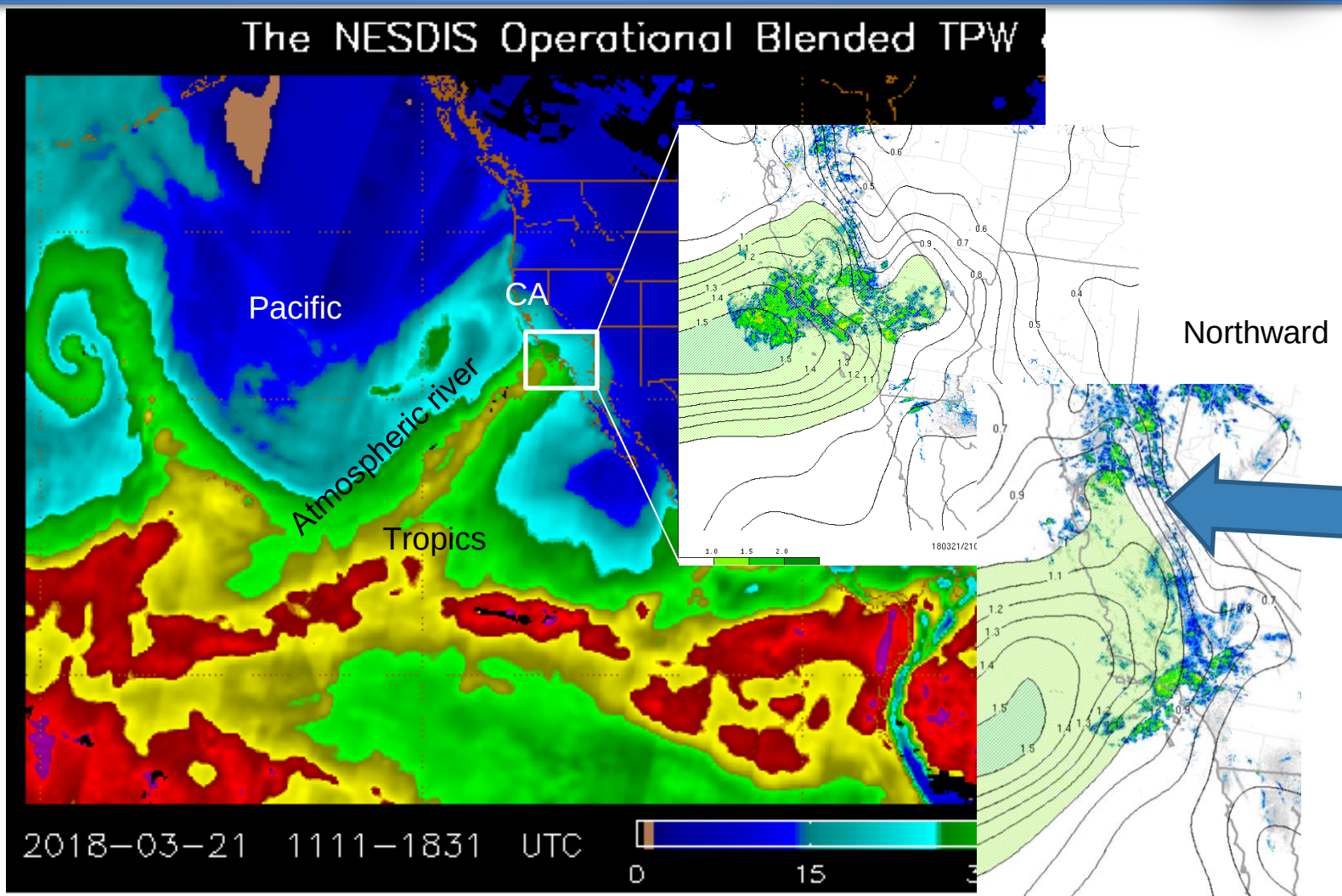
AR plume on March 21



AR plume on March 22



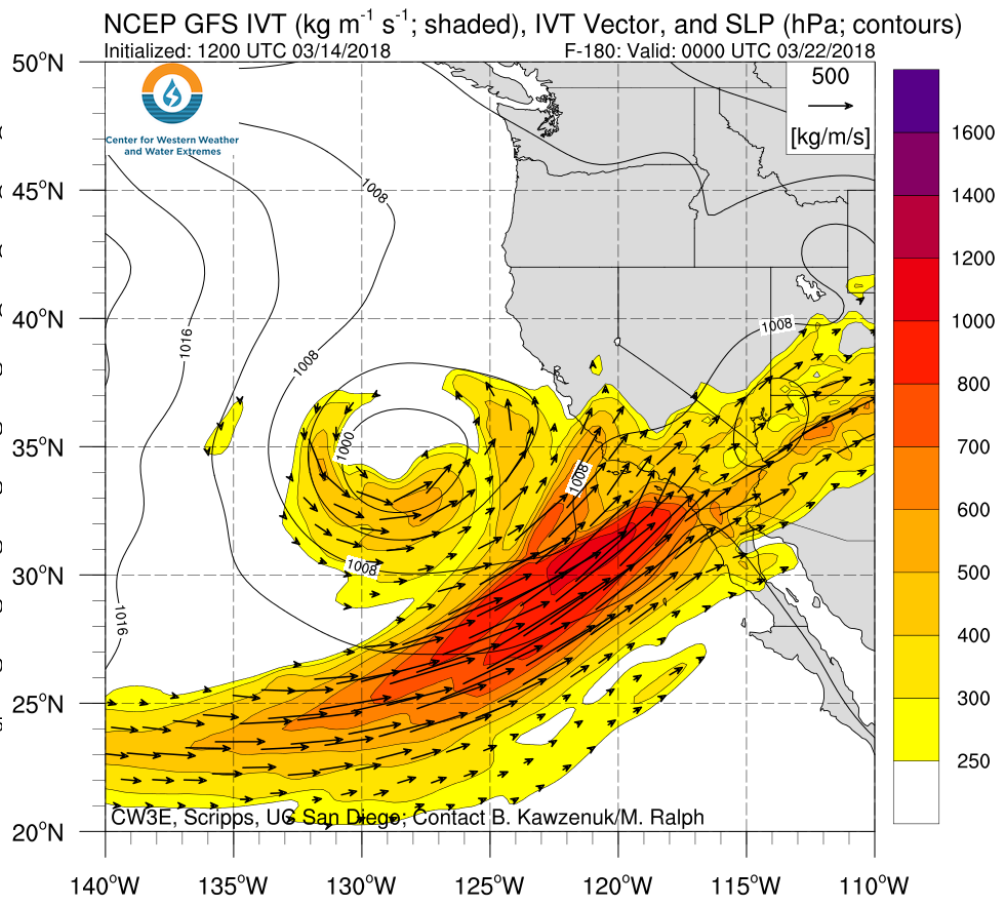
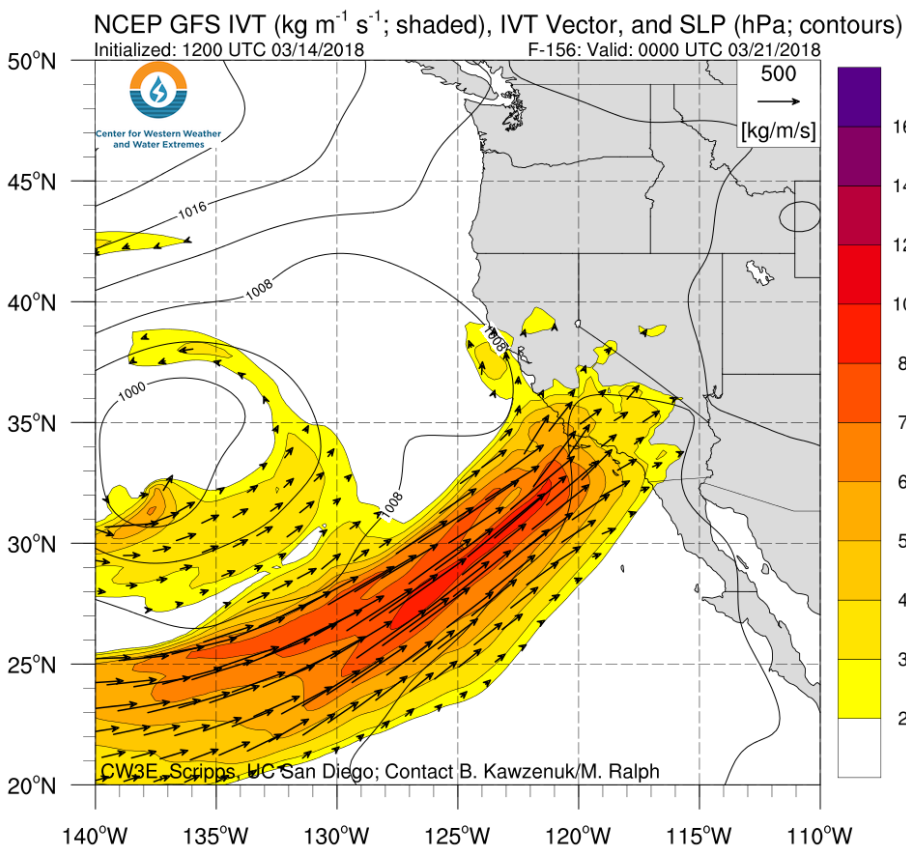
Atmospheric River view on Satellite image



2 pm Wednesday March 21, 2018



Long lead time IVT 180 hours out!

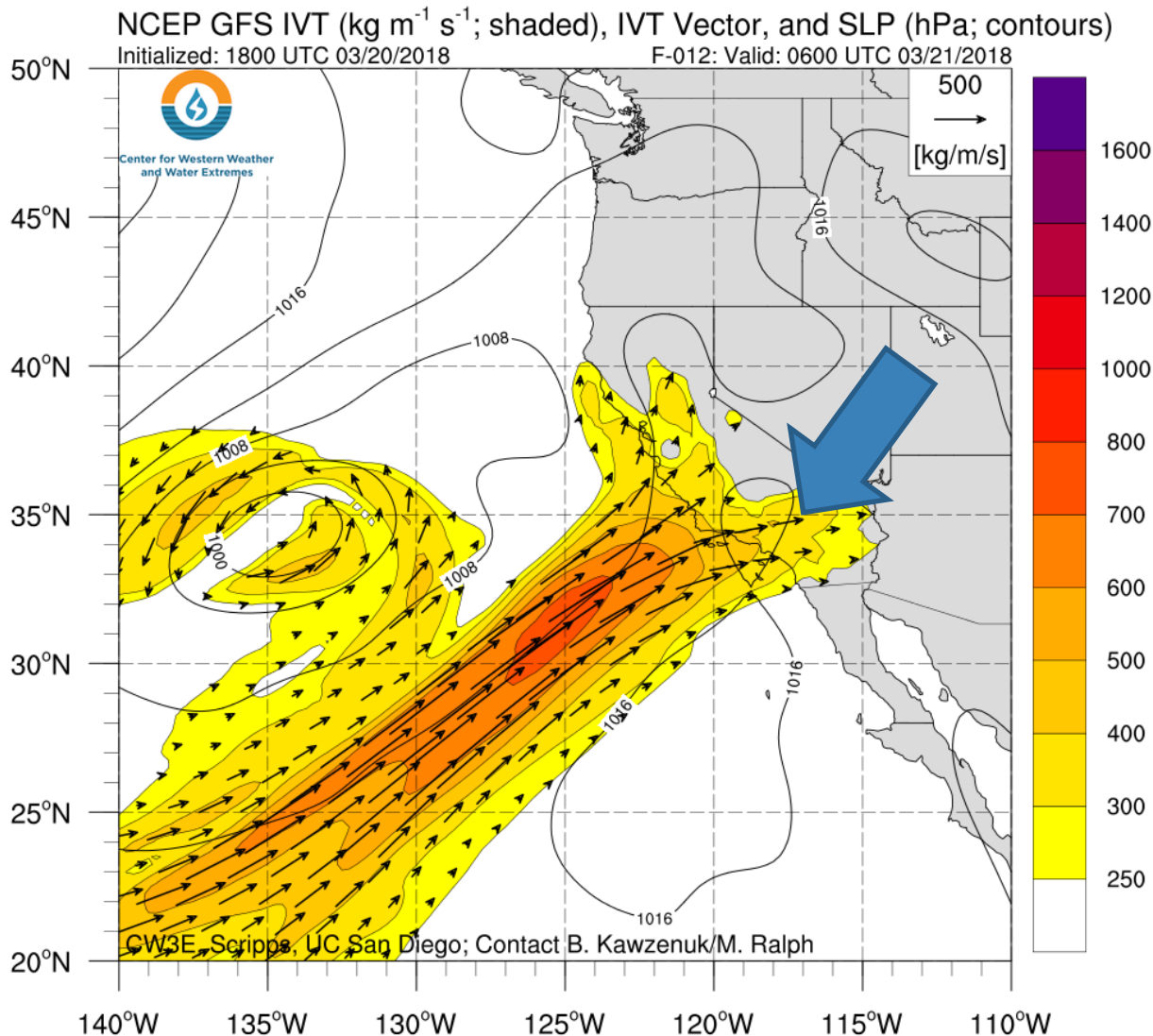


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AR IVT forecasts

Forecast hours 12 valid at 06 UTC 21 March



The initial surge brought a sharp gradient of zero to 0.50 inches on March 21

Wednesday high had little rainfall as AR lifted northward



Weather Radar
Image at 940 am Wednesday March 21



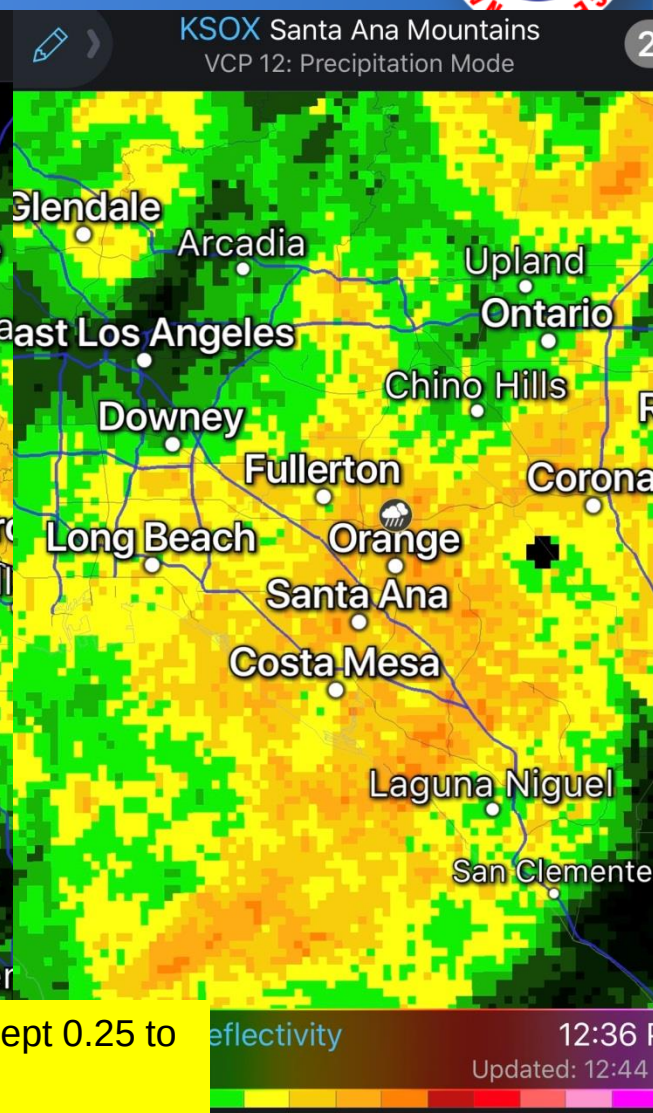
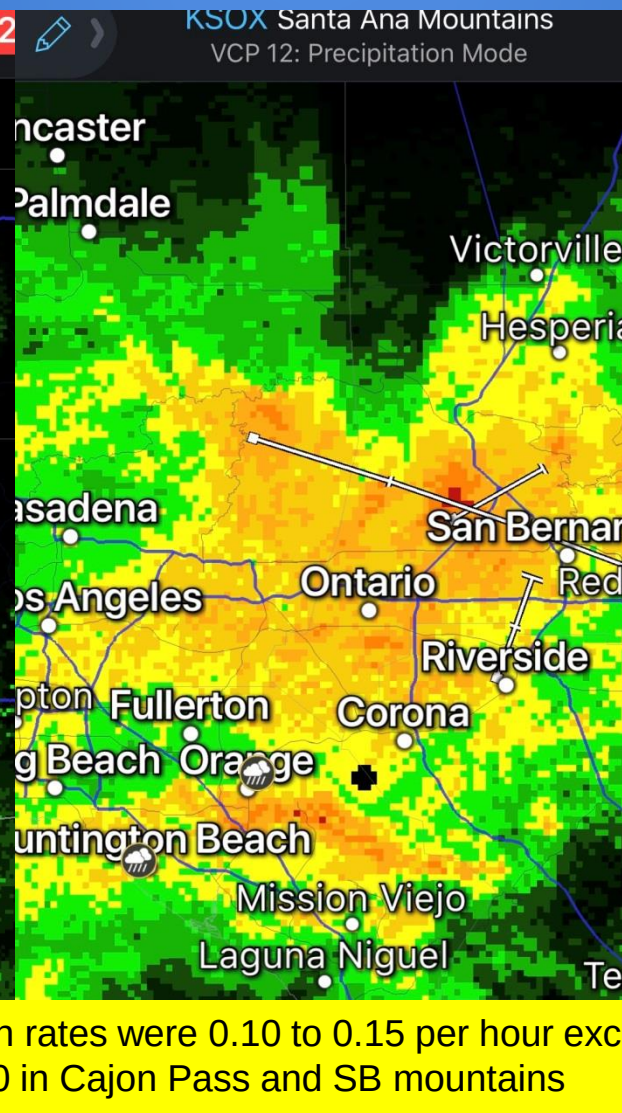
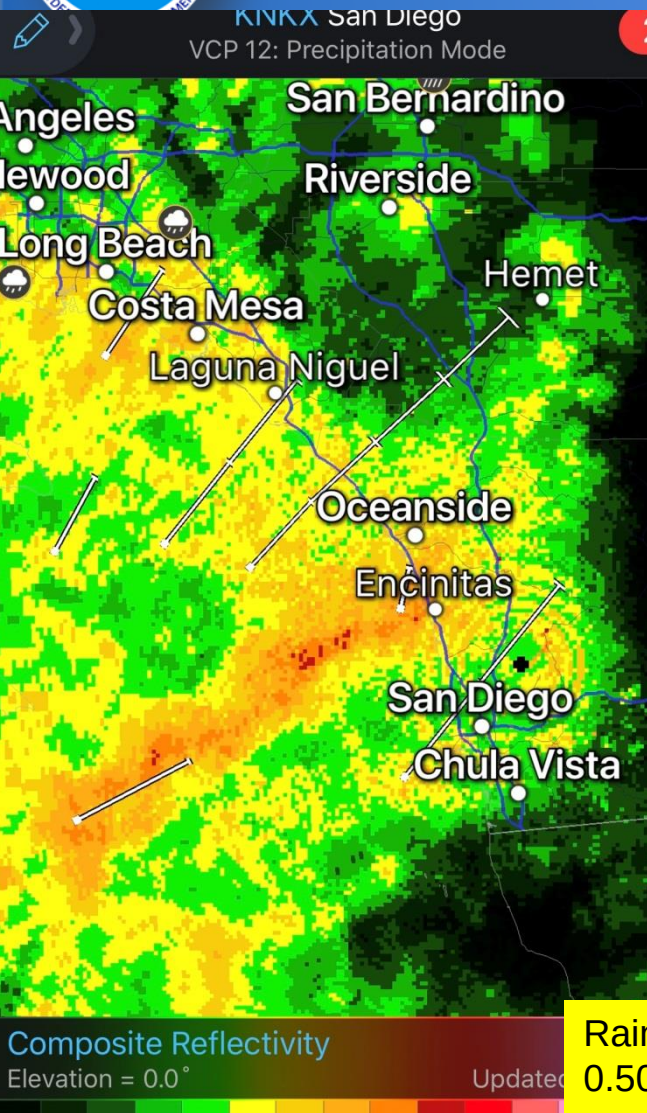
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Follow us on:





Core of AR arrival



Rain rates were 0.10 to 0.15 per hour except 0.25 to 0.50 in Cajon Pass and SB mountains

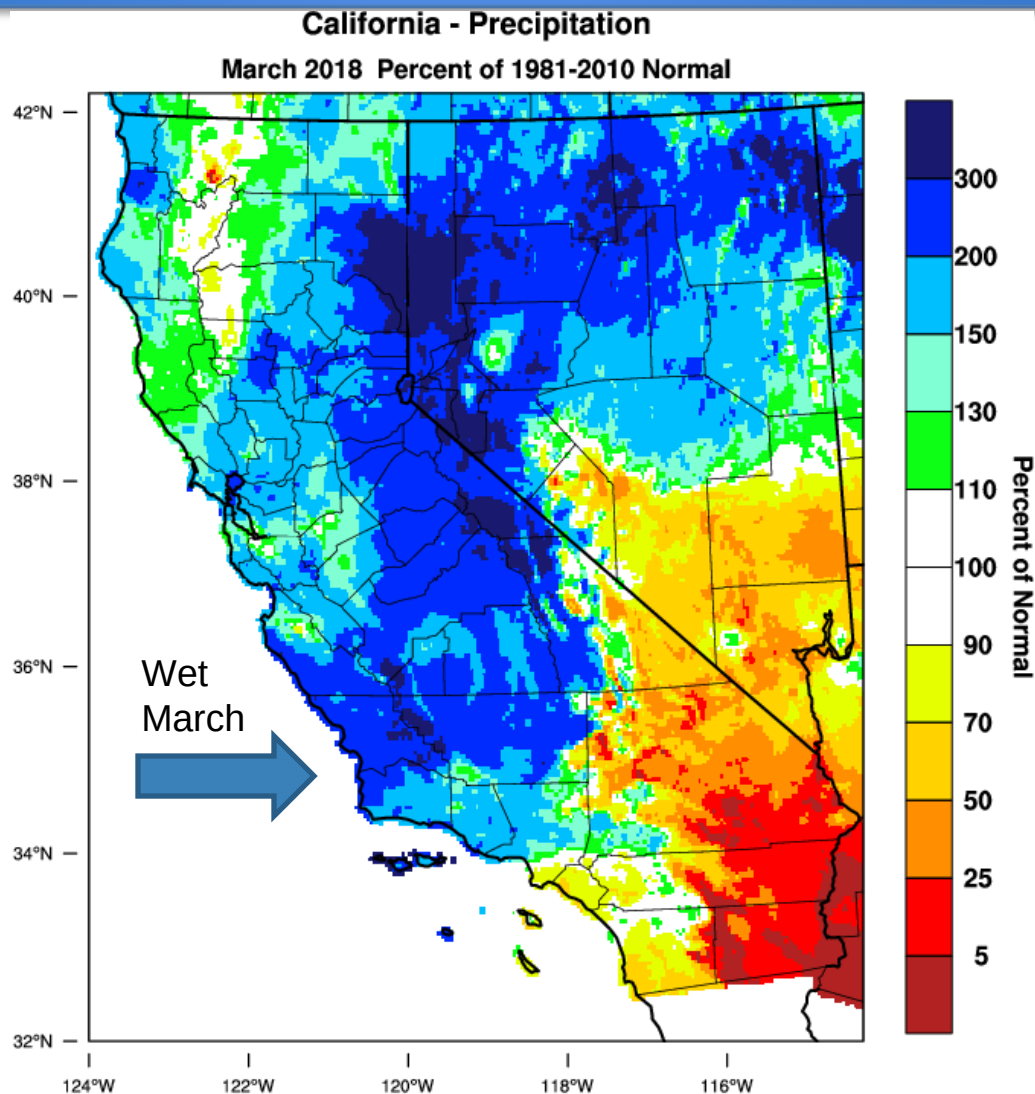


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Miracle March? – not quite

Percent of normal March 2018



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 APR 2018



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CFS monthly forecasts for March 2018

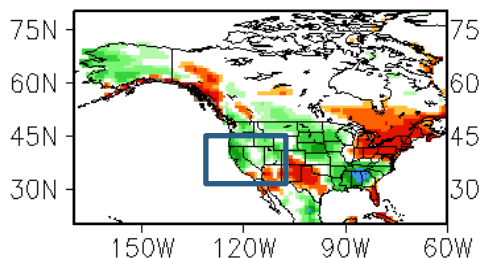


NWS/NCEP/CPC

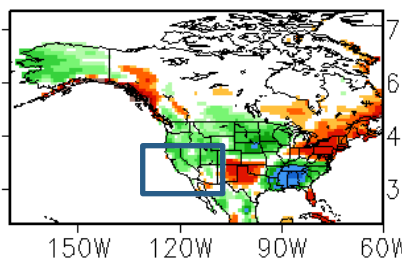
Last update: Wed Feb 28 2018

CFSv2 monthly Prec(mm/month) forecast for Mar2018

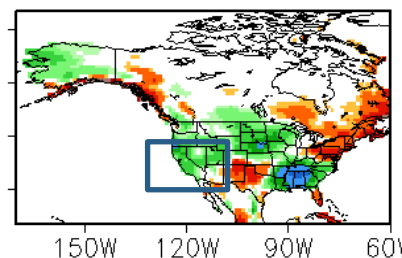
IC: 20Feb2018



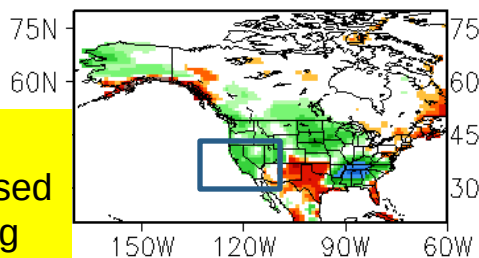
IC: 21Feb2018



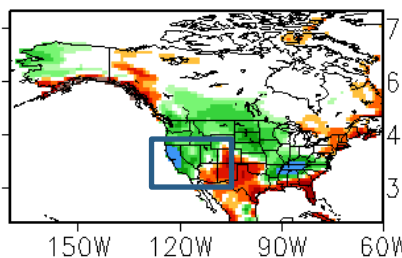
IC: 22Feb2018



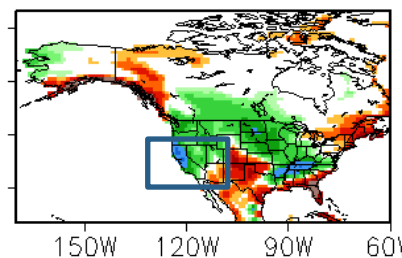
IC: 23Feb2018



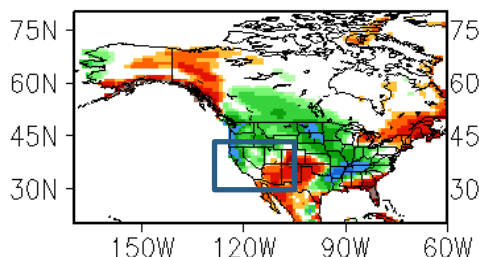
IC: 24Feb2018



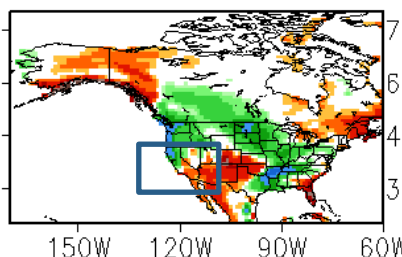
IC: 25Feb2018



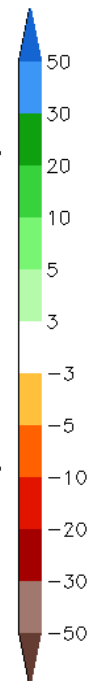
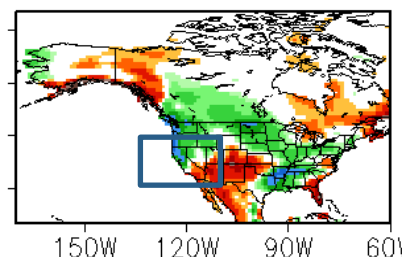
IC: 26Feb2018



IC: 27Feb2018



IC: 28Feb2018



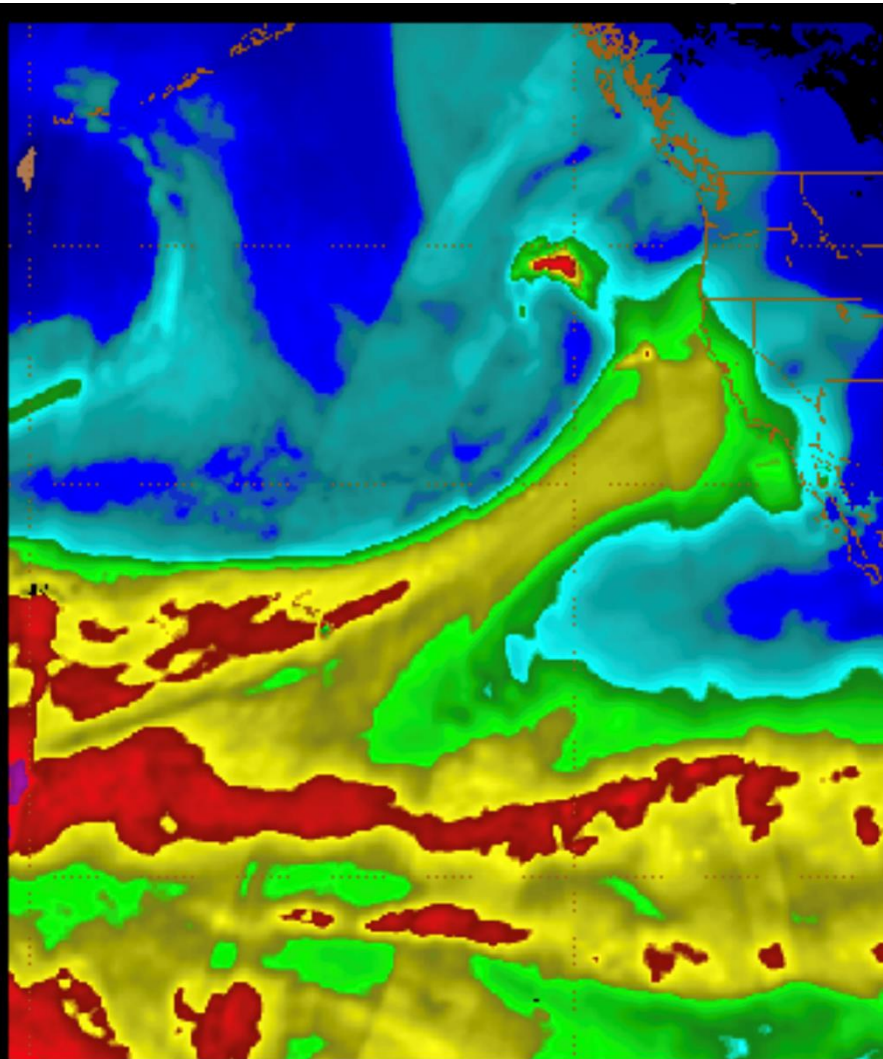
Wet and dry
anomaly increased
creating strong
gradient



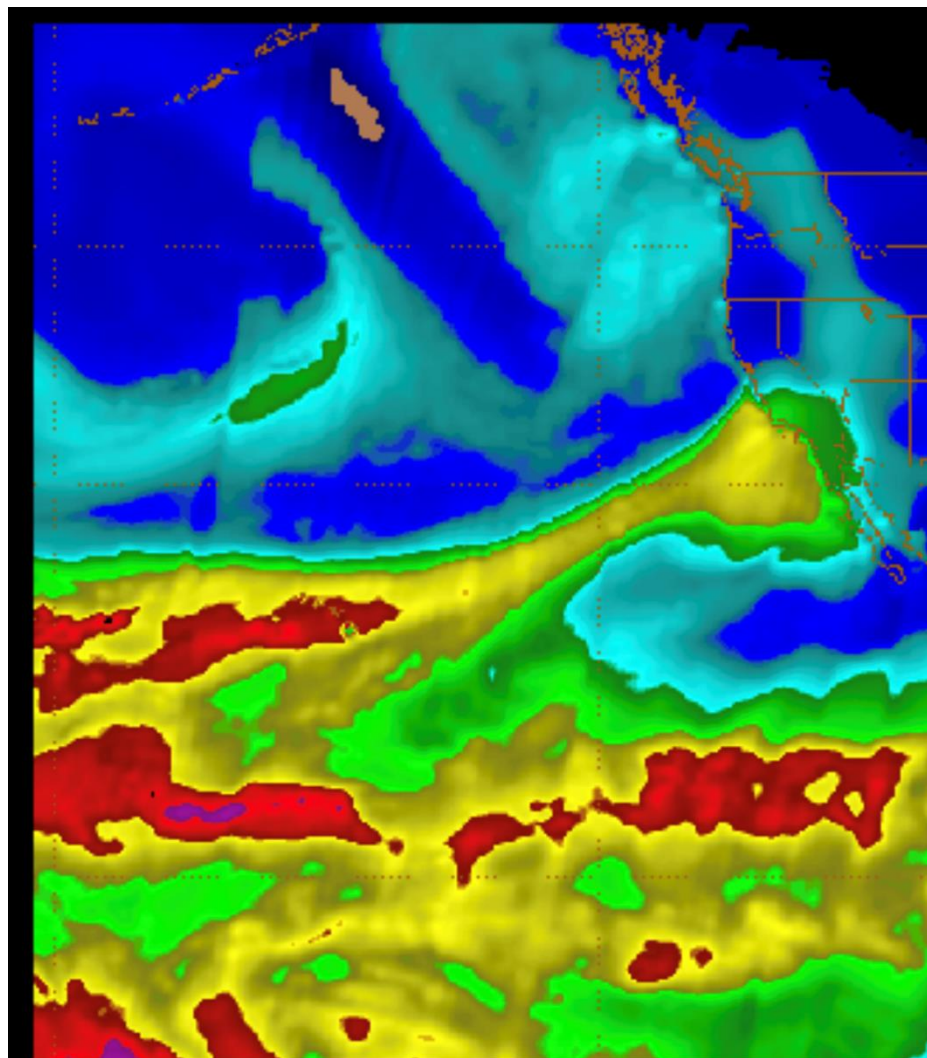
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Final Atmospheric River landfall – save us? record moisture but no rain April 6, 2018

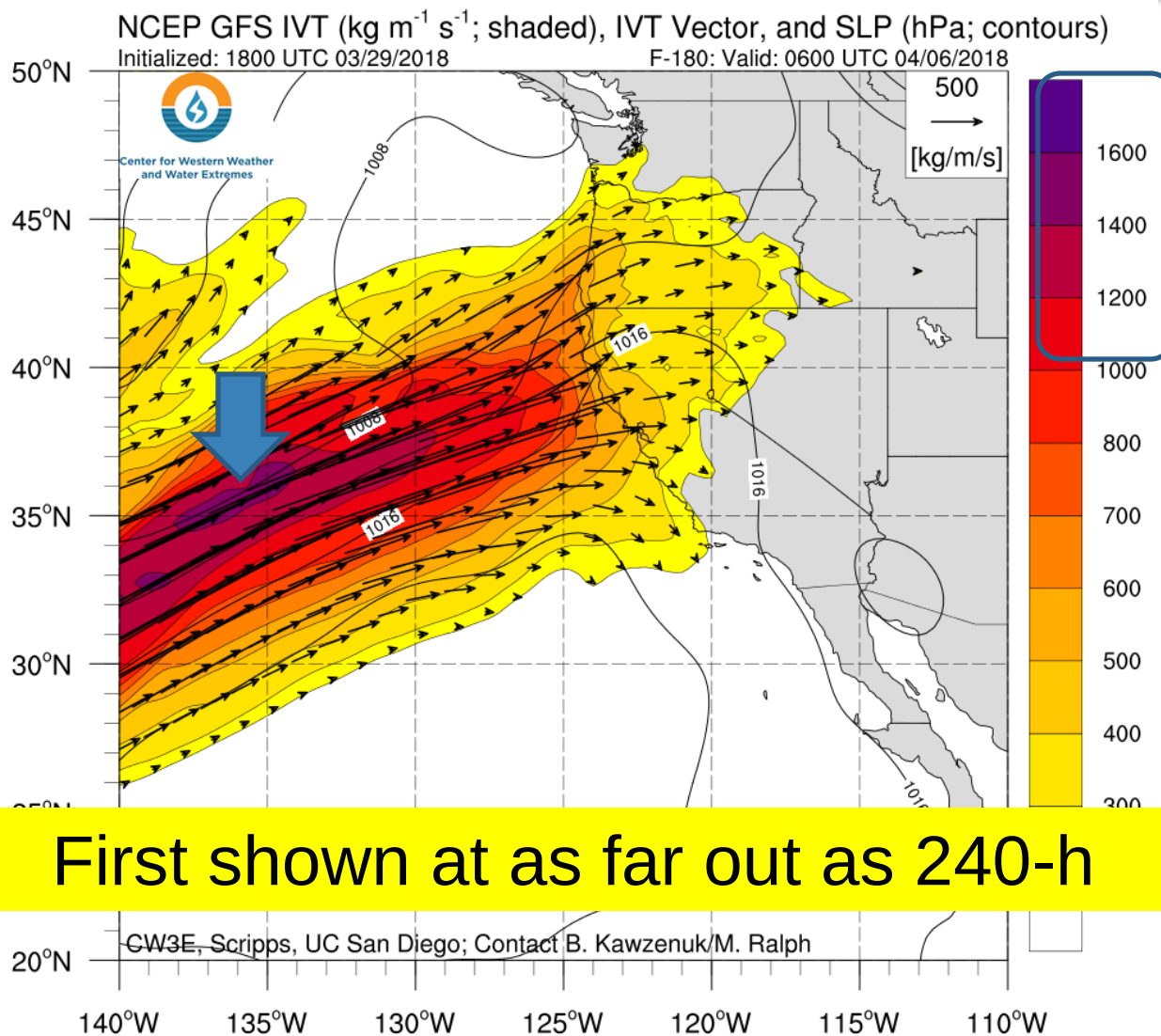


2018-04-06 1434-2242 UTC



2018-04-07 0838-1636 UTC

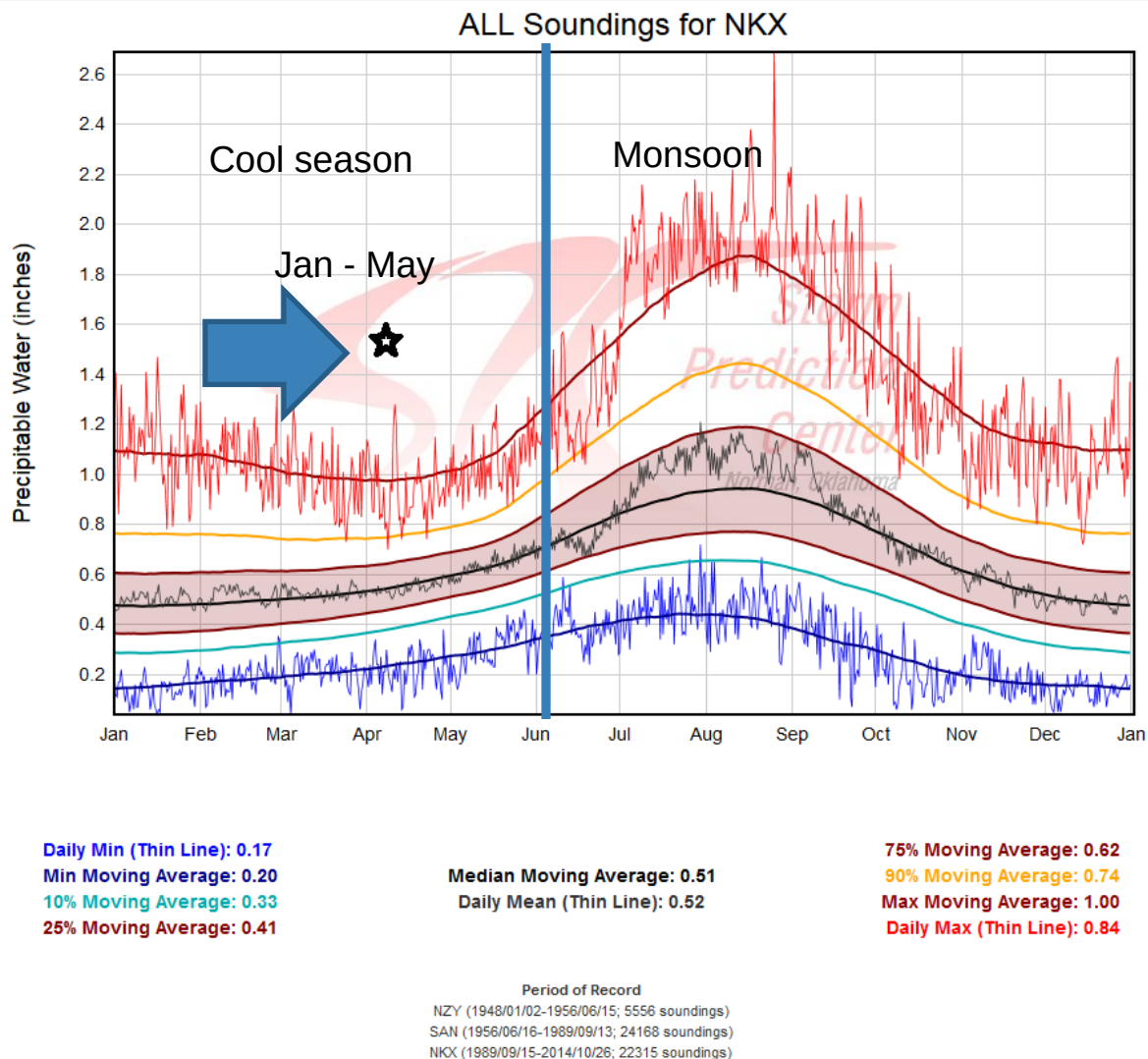
180-h IVT plume from GFS



First shown at as far out as 240-h



Record Precipitable water at San Diego (NKX)

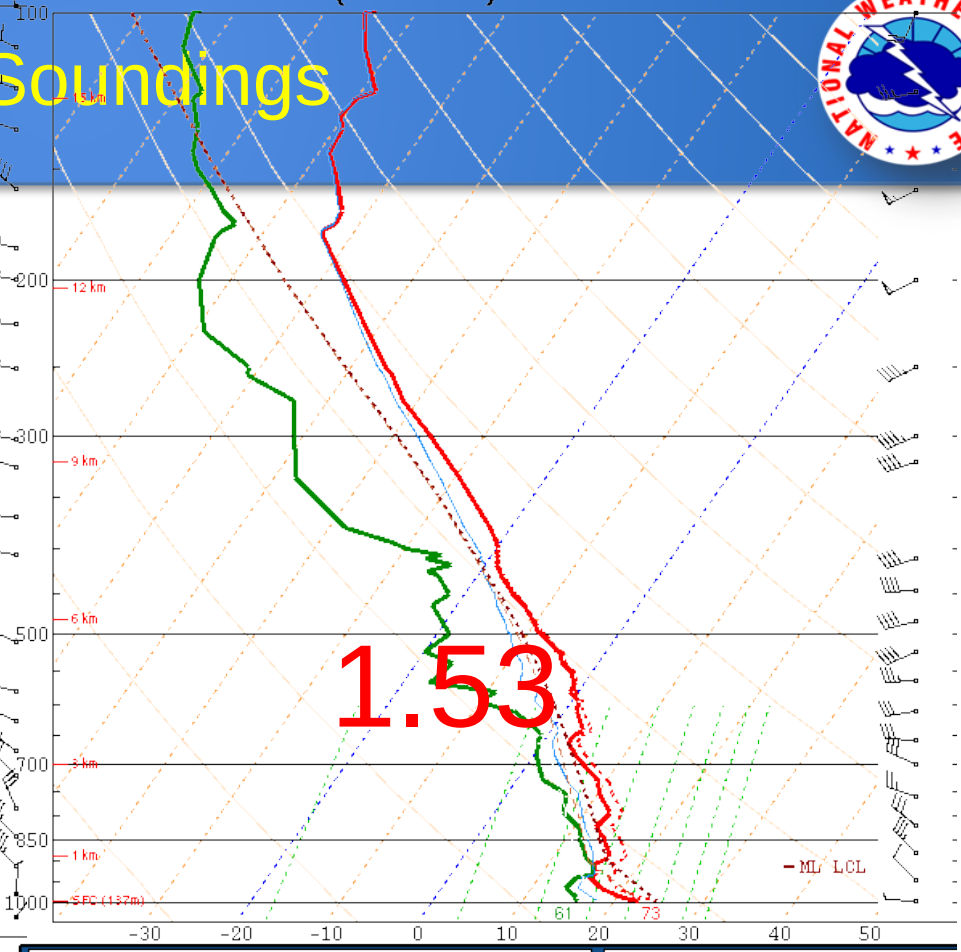
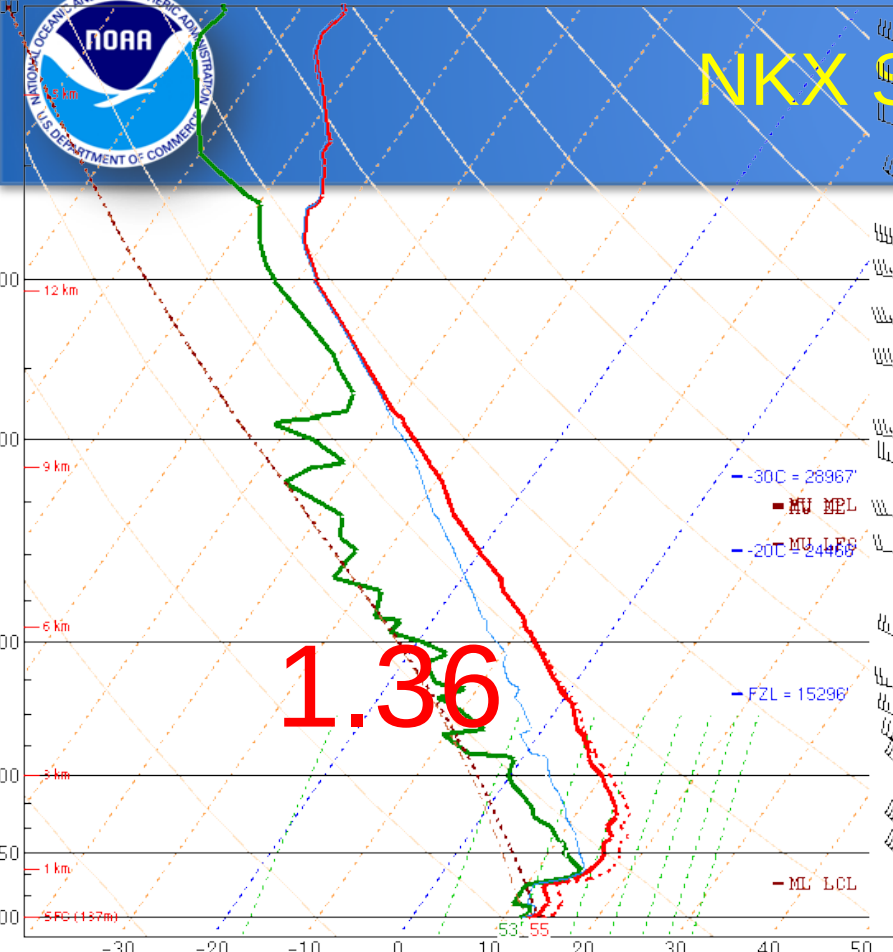


NKX 180407/1200 (Observed)

NKX 180408/0000 (Observed)



NKX Soundings



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	0	0	114m	15	M	374'
MIXED LAYER	0	0	865m	10	M	2183'
FCST SURFACE	0	0	1681m	5	M	5514'
MU (889 mb)	2	-403	1058m	1	M	27045'

PW = 1.36 in	3CAPE = 0 J/kg	WBZ = 11762'	WNDG = 0.0
K = 25	DCAPE = 480 J/kg	FZL = 15296'	ESP = 0.0
MidRH = 56%	DownT = 65 F	ConvT = M	MMP = 0.16
LowRH = 87%	MeanW = 9.2 g/kg	MaxT = 79F	NCAPE = 0.00
SigSevere = 0 m3/s3			

Sfc-3km Agl Lapse Rate = 1.1 C/km	Supercell = 0.0
3-6km Agl Lapse Rate = 6.7 C/km	Left Supercell = 0.0
850-500mb Lapse Rate = 5.7 C/km	STP (eff layer) = 0.0
700-500mb Lapse Rate = 6.6 C/km	STP (fix layer) = 0.0
	Sig Hail = 0.0

SRH(m2/s2)	Shear(kt)
SFC - 1 km	75
SFC - 3 km	61
SFC - 6 km	27
SFC - 8 km	29

BRN Shear = 46 m/s²
4-6km SR Wind = 211/21 kt

.....Storm Motion Vectors.....
Bunkers Right = 337/30 kt
Bunkers Left = 268/20 kt
Corfidi Downshear = 290/36 kt
Corfidi Upshear = 274/12 kt

PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	0	0	889m	2	M	2917'
MIXED LAYER	0	0	760m	3	M	2491'
FCST SURFACE	27	-145	1324m	0	M	24033'
MU (889 mb)	0	0	1338m	1	M	4388'

PW = 1.53 in	3CAPE = 0 J/kg	WBZ = 12704'	WNDG = 0.0
K = 30	DCAPE = 618 J/kg	FZL = 14545'	ESP = 0.0
MidRH = 76%	DownT = 63 F	ConvT = 88F	MMP = 0.19
LowRH = 86%	MeanW = 11.6 g/kg	MaxT = 80F	NCAPE = 0.00
SigSevere = 0 m3/s3			

Sfc-3km Agl Lapse Rate = 5.9 C/km	Supercell = 0.0
3-6km Agl Lapse Rate = 5.9 C/km	Left Supercell = 0.0
850-500mb Lapse Rate = 5.6 C/km	STP (eff layer) = 0.0
700-500mb Lapse Rate = 5.7 C/km	STP (fix layer) = -0.0
	Sig Hail = 0.0

SRH(m2/s2)	Shear(kt)	MnW
SFC - 1 km	-78	308'
SFC - 3 km	-64	26
SFC - 6 km		33
SFC - 8 km		37

BRN Shear = 36 m/s²
4-6km SR Wind = 188/29 kt

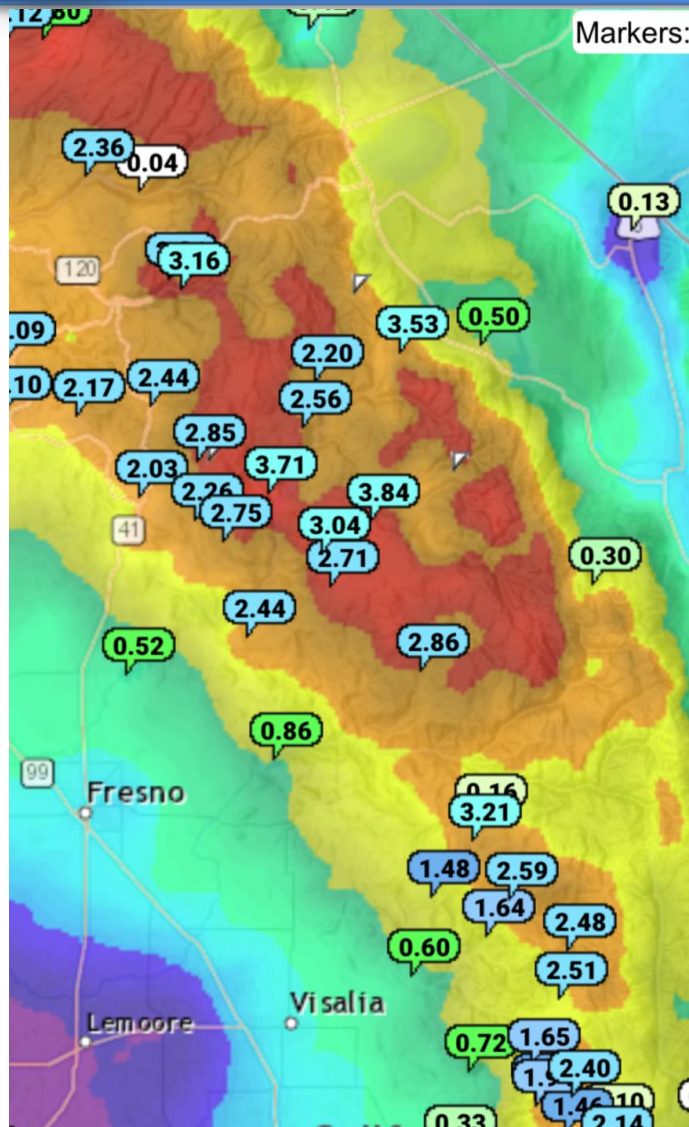
.....Storm Motion Vectors.....
Bunkers Right = 305/36 kt
Bunkers Left = 250/21 kt
Corfidi Downshear = 251/53 kt
Corfidi Upshear = 227/23 kt



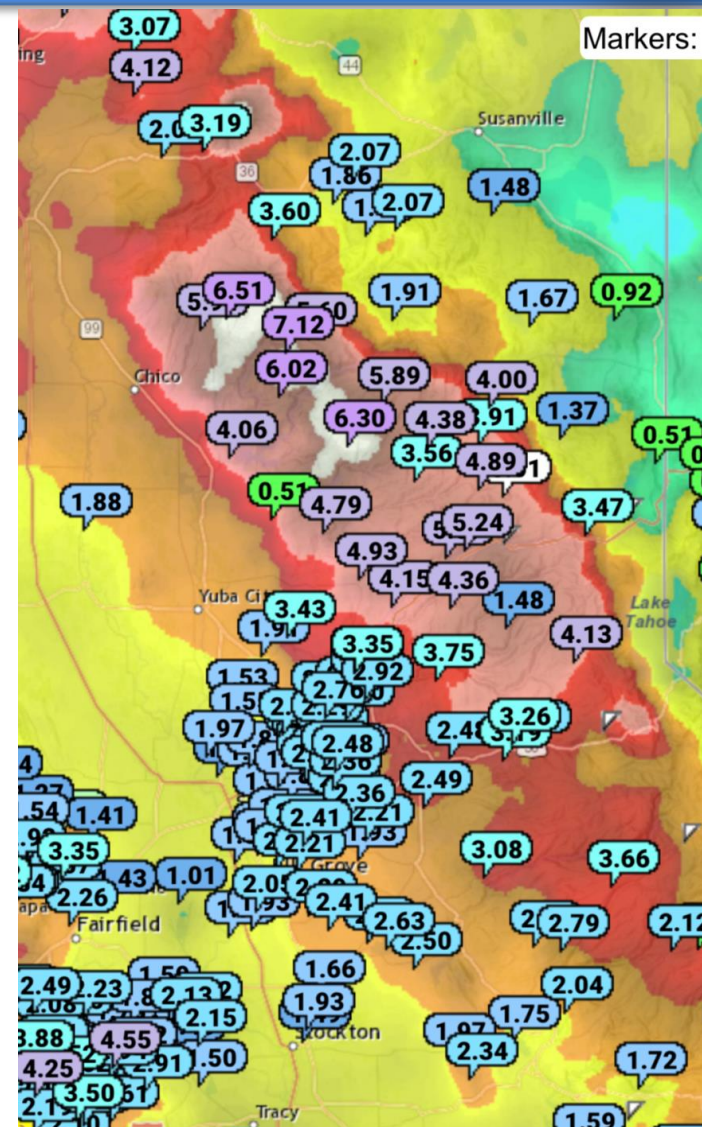
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April 5-6, 2018 precipitation



Sierra Nevada



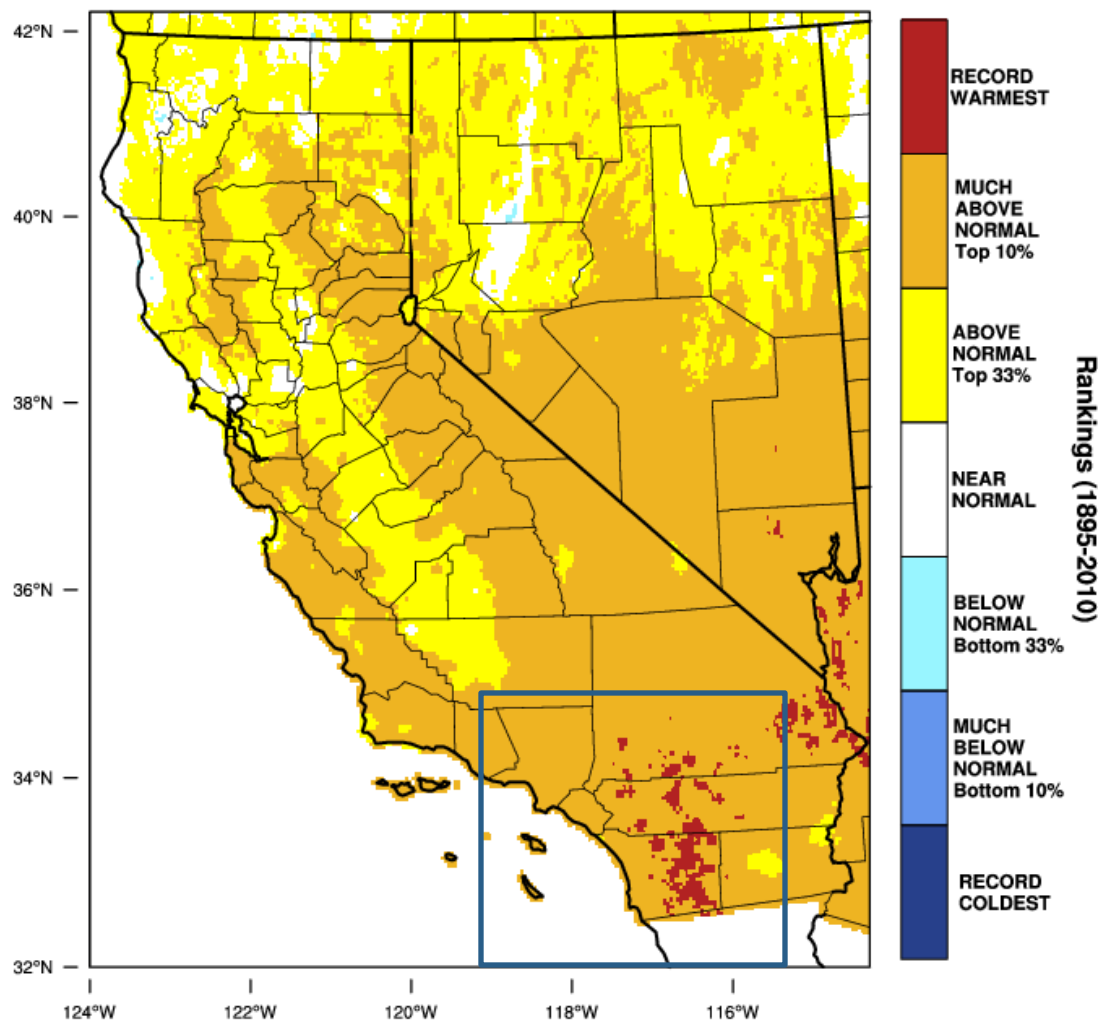


Temperature for 2017-18 (departure from normal)



California - Mean Temperature

October-April 2018 Percentile



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 11 MAY 2018



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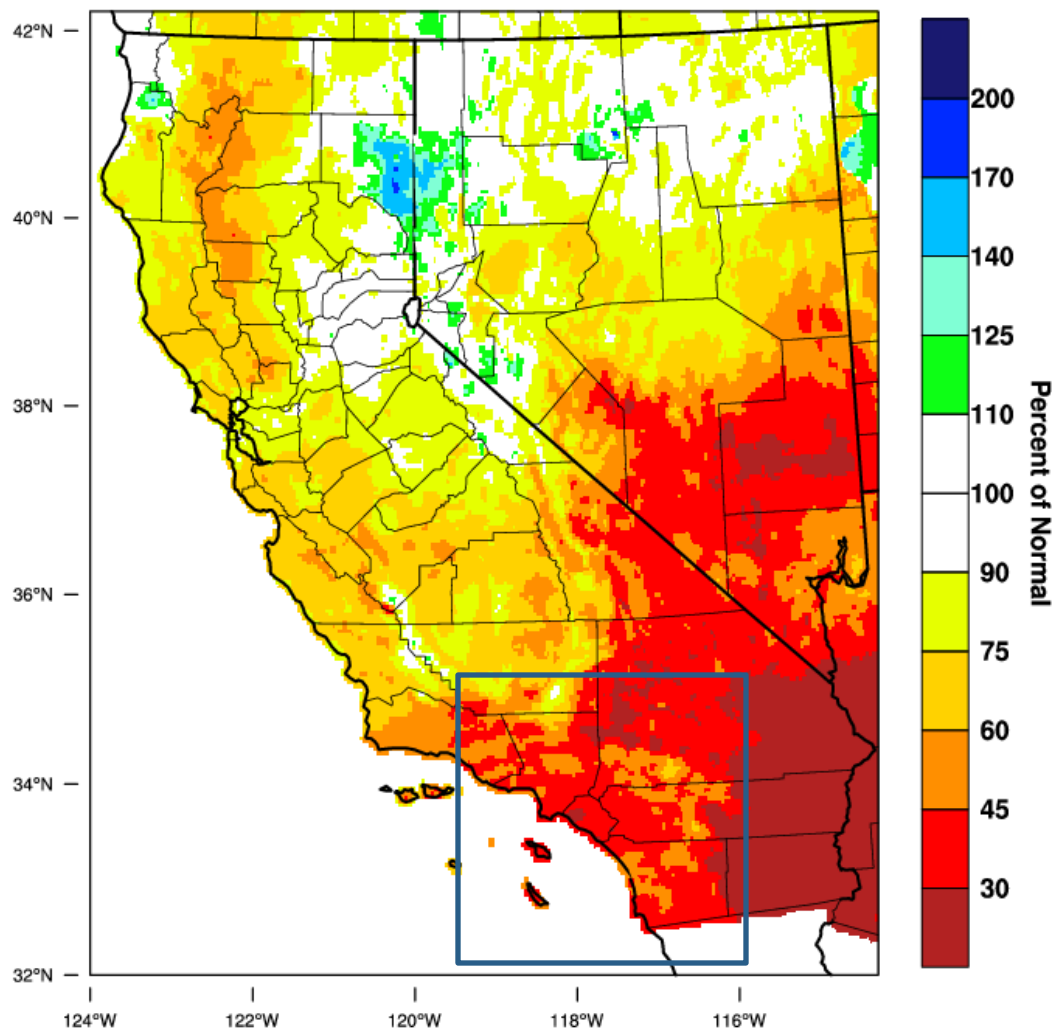


Precipitation for 2017-18 (percent of normal)



California - Precipitation

October-April 2018 Percent of 1981-2010 Normal



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 11 MAY 2018



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Summary



- Record dry start (and warm) to 2017-18 water year
- Significant Pacific trough and heavy precipitation January 9-10, 2018 (impacts)
- Surprise wet Pacific system March 10-11, 2018 (AR)
- Major atmospheric river March 20-22 (focused on Point Conception), more to north and less to the Mexico border
- Record breaking moisture (precipitable water) atmospheric river April 6-8 but no precipitation in far Socal
- 2017-18 was near record driest (Top 3) in far Socal and near record warmest (Top 10 coast, Top 5 inland)
- GFS and CFSv2 provided long lead time in AR events (up to 4 weeks), however the March 10-11 was short
- CFSv2 indicated pattern changes to wetter first half of winter in weeks 3-4
- CFSv2 only gave 10 day lead time to February pattern change to much cooler in the West
- CFS week 2 to 4 during the historical strongest (2.6C) El Nino 2015-16 generally carried too much bet bias

