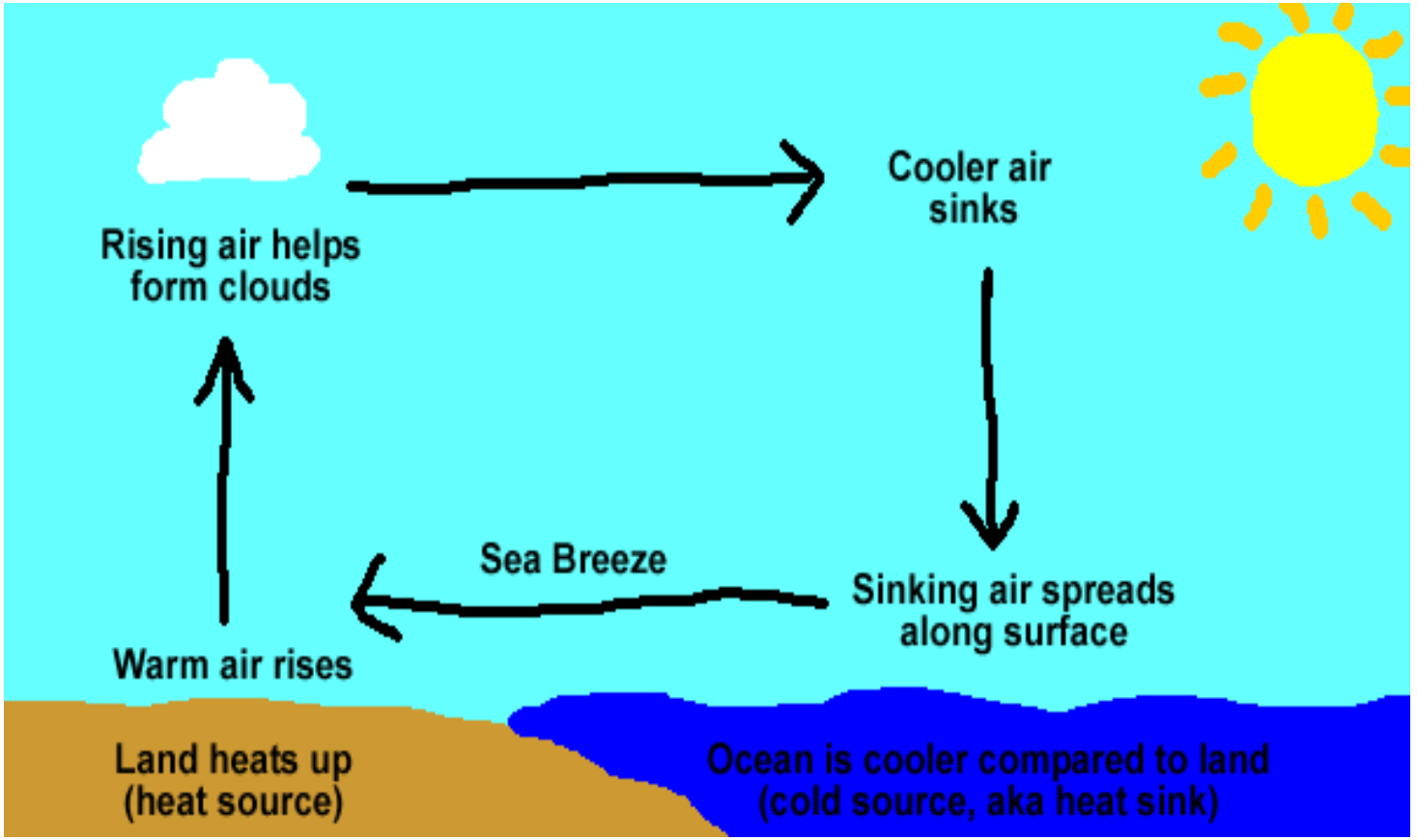

# DELTA BREEZE

## …MAKES ME FEEL FINE…

*"Between the two poles of simplicity and diversity, the searching mind of man remains caught...No matter what he does or what he invents, there is always nature to teach him a lesson in ....."*

~ H. Riehl

# Diagram of a Sea Breeze



# Wallington's (1961) factors for inland penetration of the sea breeze

- *Strength of solar radiation*
- *Direction/Strength of general wind flow*
- *Depth of marine layer*
- *Sea temperature*

As land-sea temp gradients ↑ press gradients ↑ Schmidt (1947)…

- *Sea breeze…accelerates as long as a land-sea temp gradient exists.*
- *Max sea breeze occurs well after the max temp difference between land-sea….EXCEPT… the effects of Friction……*

# The “Self-Regulating” Sea Breeze

- *The stronger the breeze…more marine air is advected inland*
- *This reduces the difference in temp/density between land/sea*
- *This contrast reduces the pressure gradient….and weakens the sea breeze*

# Onshore pressure gradient produced by…

- *Differential land/sea heating*
- *The Coriolis Effects acting on the California Current*
- *Induces upwelling of deep, cold water off the coast…80 miles wide (Williams, 1966)*
- *Surface water temps ~ 54 deg F*

# Principal Gaps in the Coastal Mtns…

- *Petaluma Gap- NW of SFO. Elev < 500 ft*
- *San Bruno Gap- S of SFO. Elev ~ 200 ft*
- *Golden Gate-SFO. @Sea Level*
- *Carquinez Strait-NE of SFO. @Sea Level*

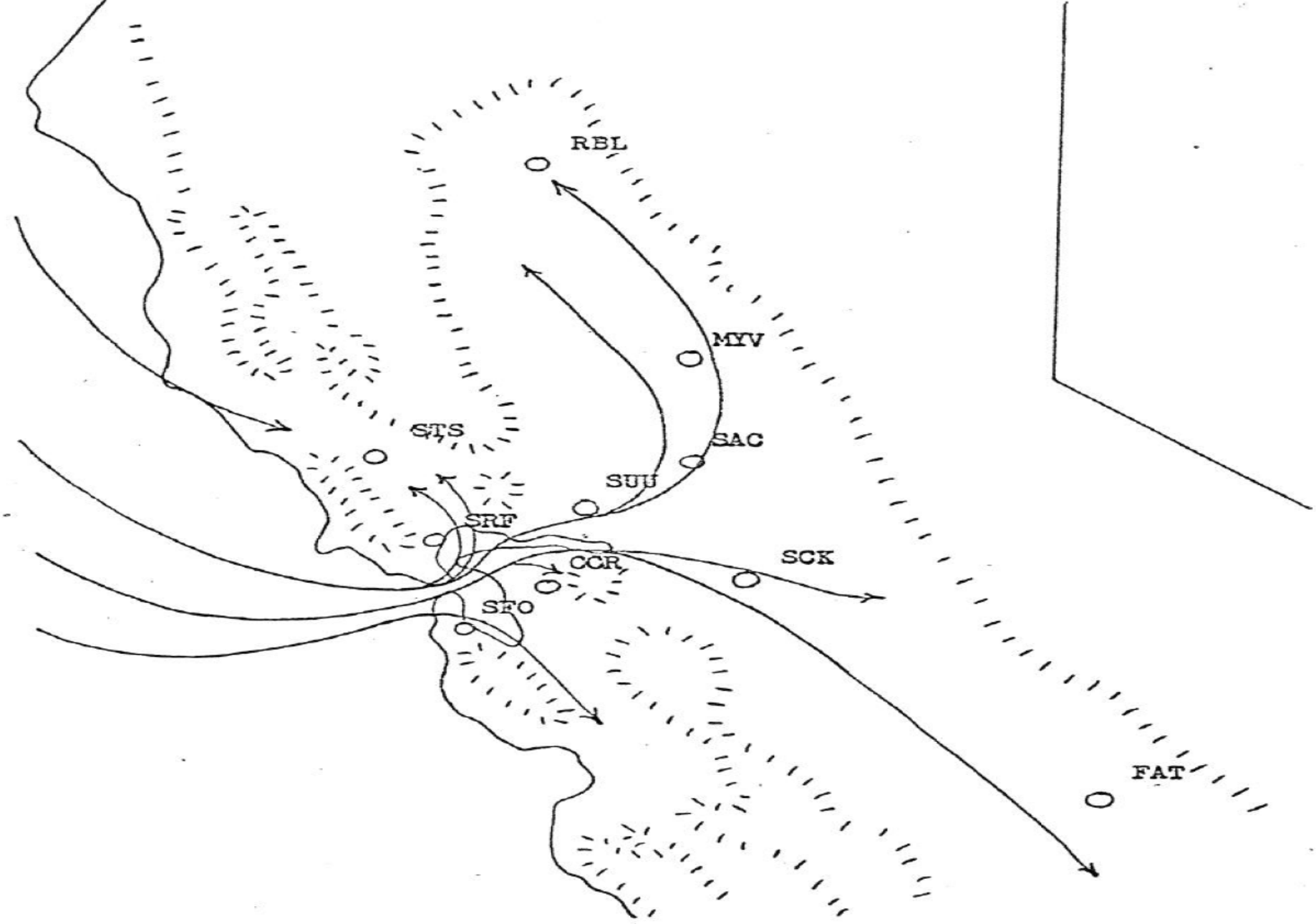



Figure 2. Normal flow patterns found in the marine layer during summer (Reed 1960).

# Factors which determine if the Sea Breeze reaches the Valley...

- *Depth & Intensity of the Marine Layer*
- *M.L. Depth ~ Controlled by height of the subsidence inversion from the Pacific High*
- *Height of S.I. ~ Position of the PH.*
- *If PH onshore ~ strong subsidence = very shallow M.L.*
- *If PH offshore ~ weaker subsidence = greater depth & inland penetration of M.L.*

# Marine Air Penetration Model

## Savage (1967)

- *Class 1 ~ Seaward displacement of PH…low pressure over OR/NV*
- *Subsidence* ↓ *and ML depth* ↑
- *Location of LP results in a Nwrd directed Pgf in the Vly*
- *Result: gusty SW winds into Sac Vly and M.P. lasting all day/night*
- *Trof aloft reinforces surface winds on initial day. Strong SW flow <10 kft*

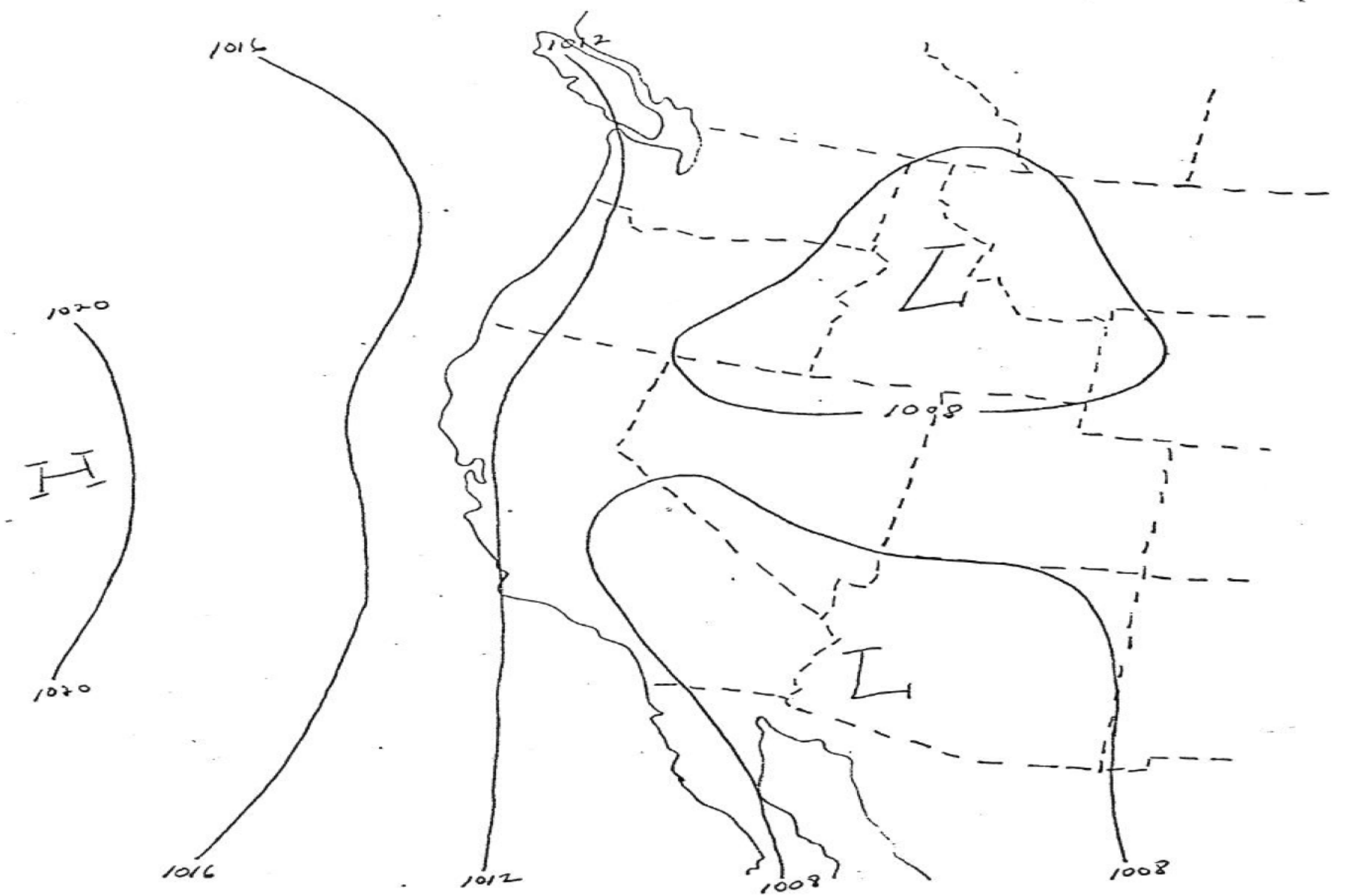



Figure 3. Pacific high pressure cell displaced seaward (composite from NMC analysis of Class I weather map).

# Effects of Class 1

- *Marine air fills the valley.*
- *Marine influence brief/last for days*
- *Succeeding days...less wind but still below normal temps due to CAA from the trof aloft*
- *"Lee-Side Effect" ~ warm air lee of the mtns...marine air enters SAC from the "SE"*

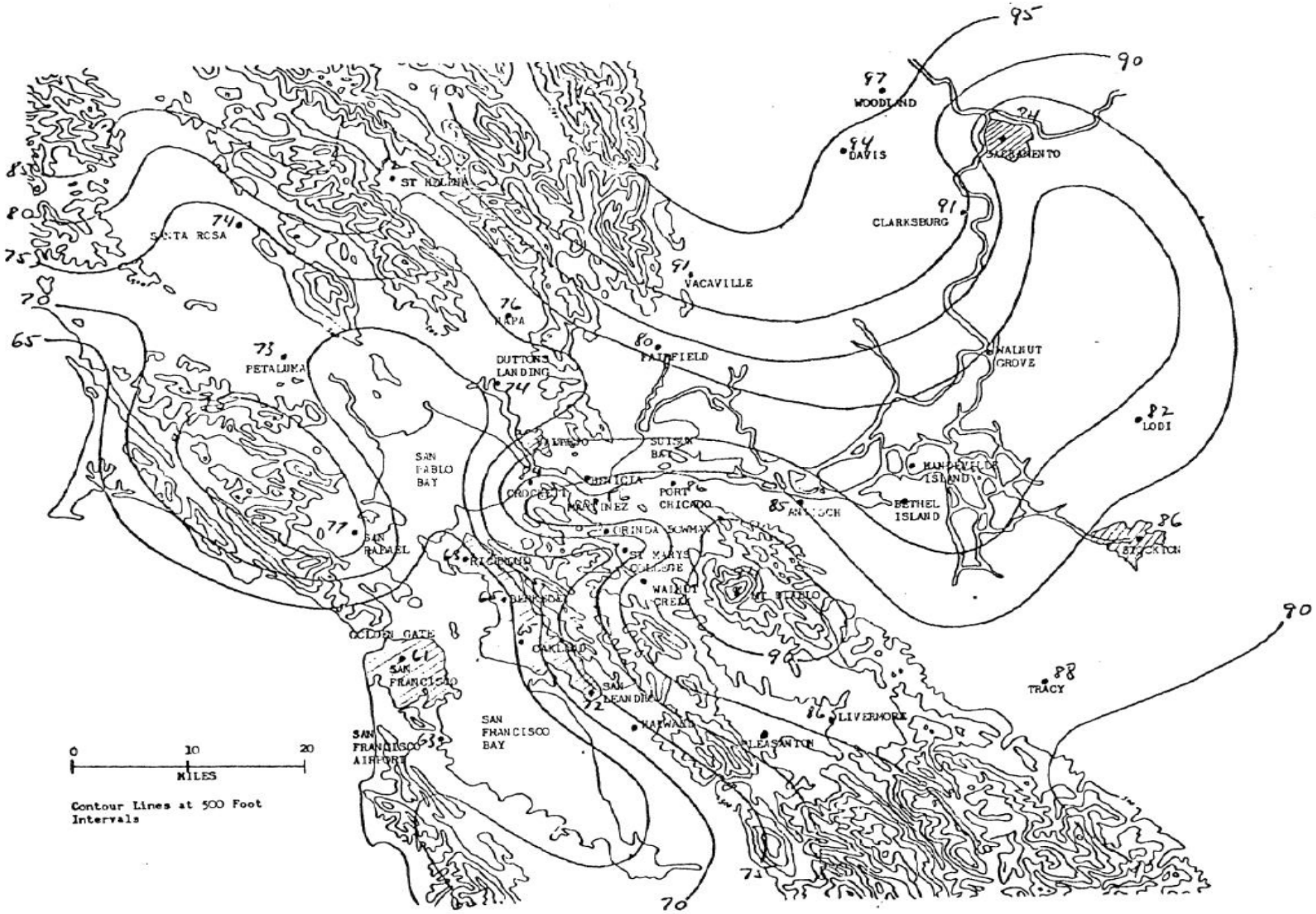



Figure 4. Maximum temperature isotherms for Class I day of July 6, 1966.

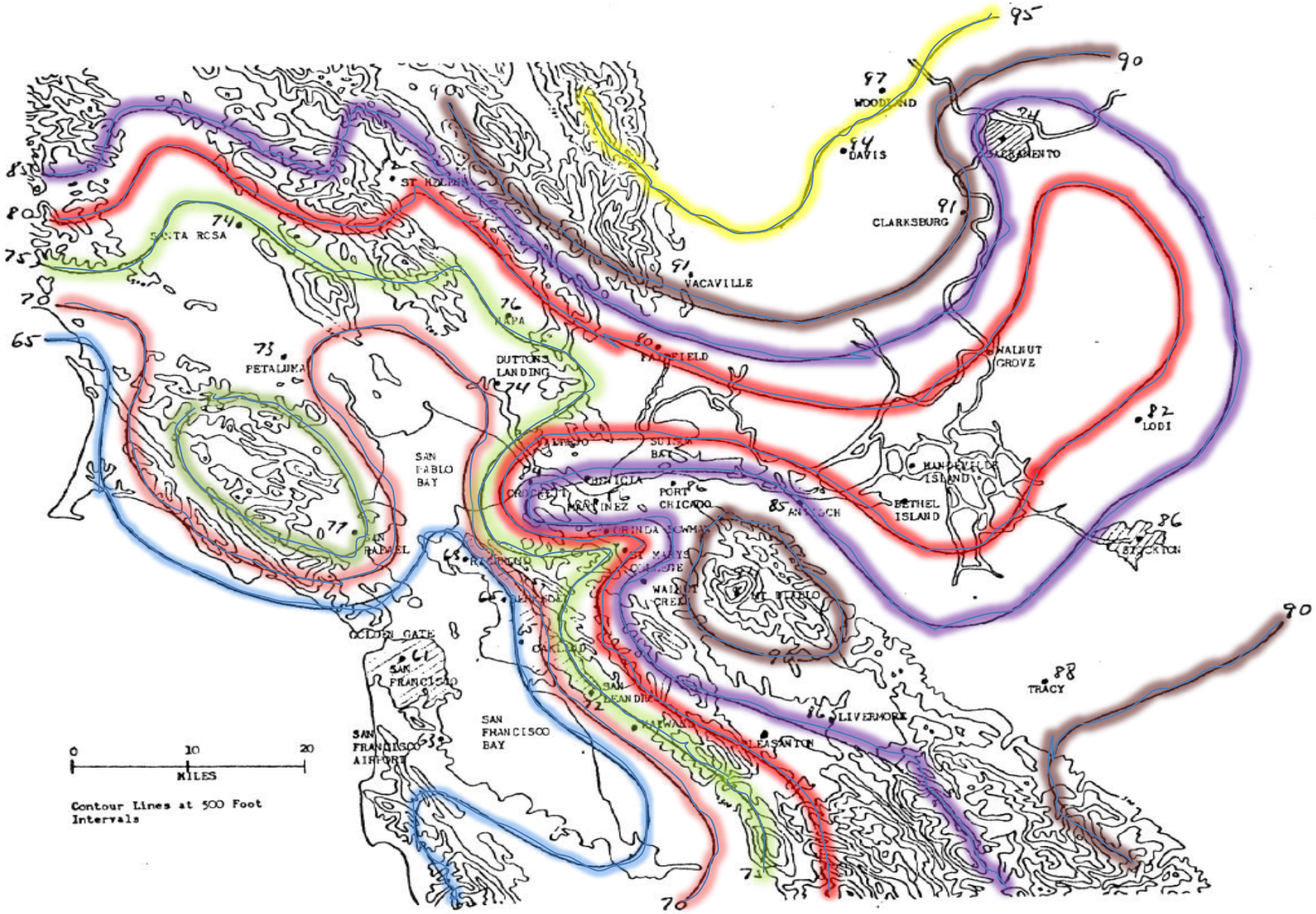



Figure 4. Maximum temperature isotherms for Class I day of July 6, 1966.

# Class II- True Sea Breeze

- *3 groups– All have shoreward displacement of PH ~ increase/lowering of subsidence inversion & decrease in ML*
- *Less extensive ML reaches SAC late PM*
- *Weak ridge over WA…thermal trof in the Vly*
- *Pressure higher to the N and E than in Class I*
- *Intense heating/onshore Pgf causes MA to move into vly*

# Class IIa- The true Sea Breeze

- *Responds to intense valley heating.*
- *Air moves thru the Strait...then nwrd*
- *Sudden increase/Gusty SW winds 2PM -4PM*
- *Temps cool rapidly...winds decrease around sunset.*
- *Barely affects max temps*

# Class IIb- Modified Sea Breeze

- *Most frequent*
- *Shallow ML, weaker onshore Pgf, higher pressures N and E.*
- *Less wind…no gusts*
- *Starts Later than CIIa, 1-2 hrs duration*
- *Barely affects max temps, if at all*

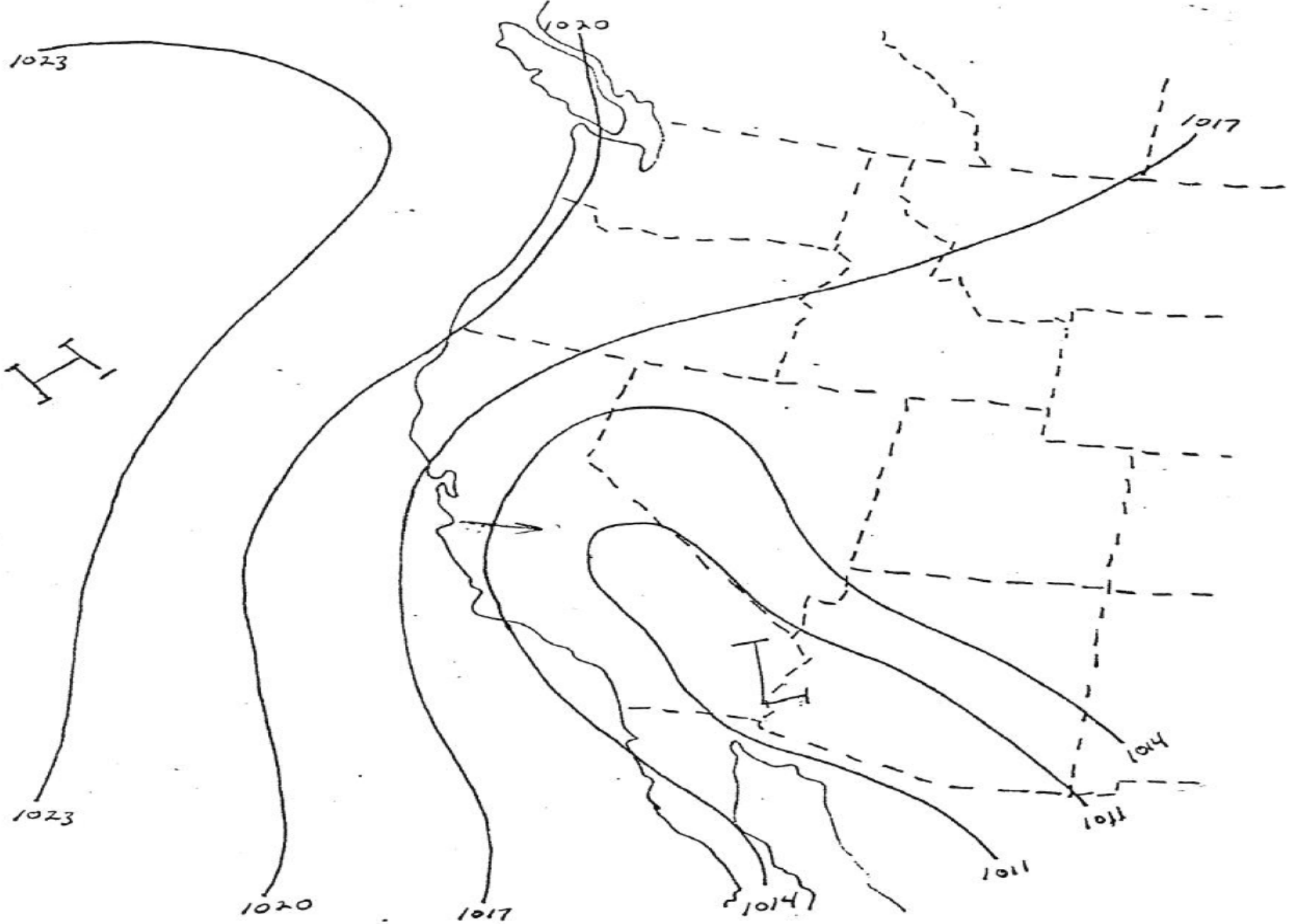



**Figure 1** Summertime pressure patterns of the west coast (Williams 1966).

# Class 11c

- *Develops into full MP (Class I) by early morning*
- *Like IIa, xcp wind >10 kts all night*
- *Results from: Vly heating + weakening of sfc High, AND retreat of High with developing LP to the north and east*
- *LP continues the n'ward directed gradient after sunset...which continues marine flow into vly.*
- *Look for DEEPENING trof ~ Class I*

# Class III- No/Little Marine Air

- *2 groups– Shoreward displacement of PH ~ increase/lowering of subsidence inversion & decrease/elimination of ML*
- *Class IIIa- Ridge from PH extends inland over ORE/NORCAL*
- *Higher pressures N and E balance onshore gradients*
- *Little/No Pgf*
- *Weak SW winds…above normal temps*

# Class III- No/Little Marine Air

- *Class IIIb- High pressure cell over NV reverses gradients creating Nly winds*
- *Adiabatic warming/drying causes hot, dry wx.*
- *"Reverse-Gap" Flow*

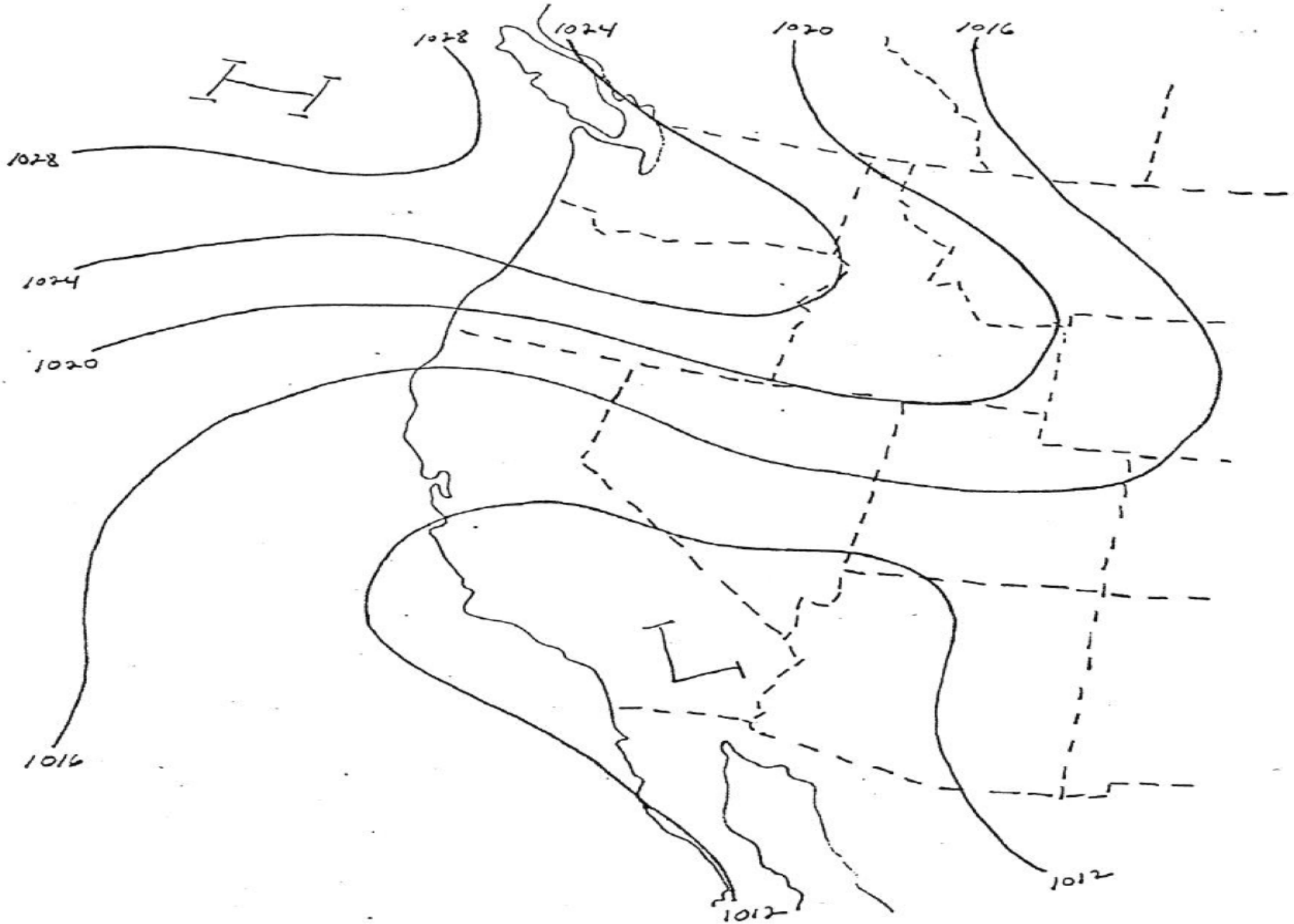



Figure 5. Pacific high pressure cell displaced inland (composite from NMC analysis of Class III weather map).

# 6 Forecasting Parameters

- *PDX-SFO & RNO-SAC Pgfs: + values = no marine penetration. Indicate presence/lack of a ridge over ORE/NV*
- *Depth of the ML (Oak raob) and SUU wind speed (rate of flow)*
- *RBL-SAC Pgf & 24hr 1000-700 mb thickness change: Valley Pgf and potential for CAA (trof aloft)*
- *Calculated # correlates to type of marine intrusion, if any.*

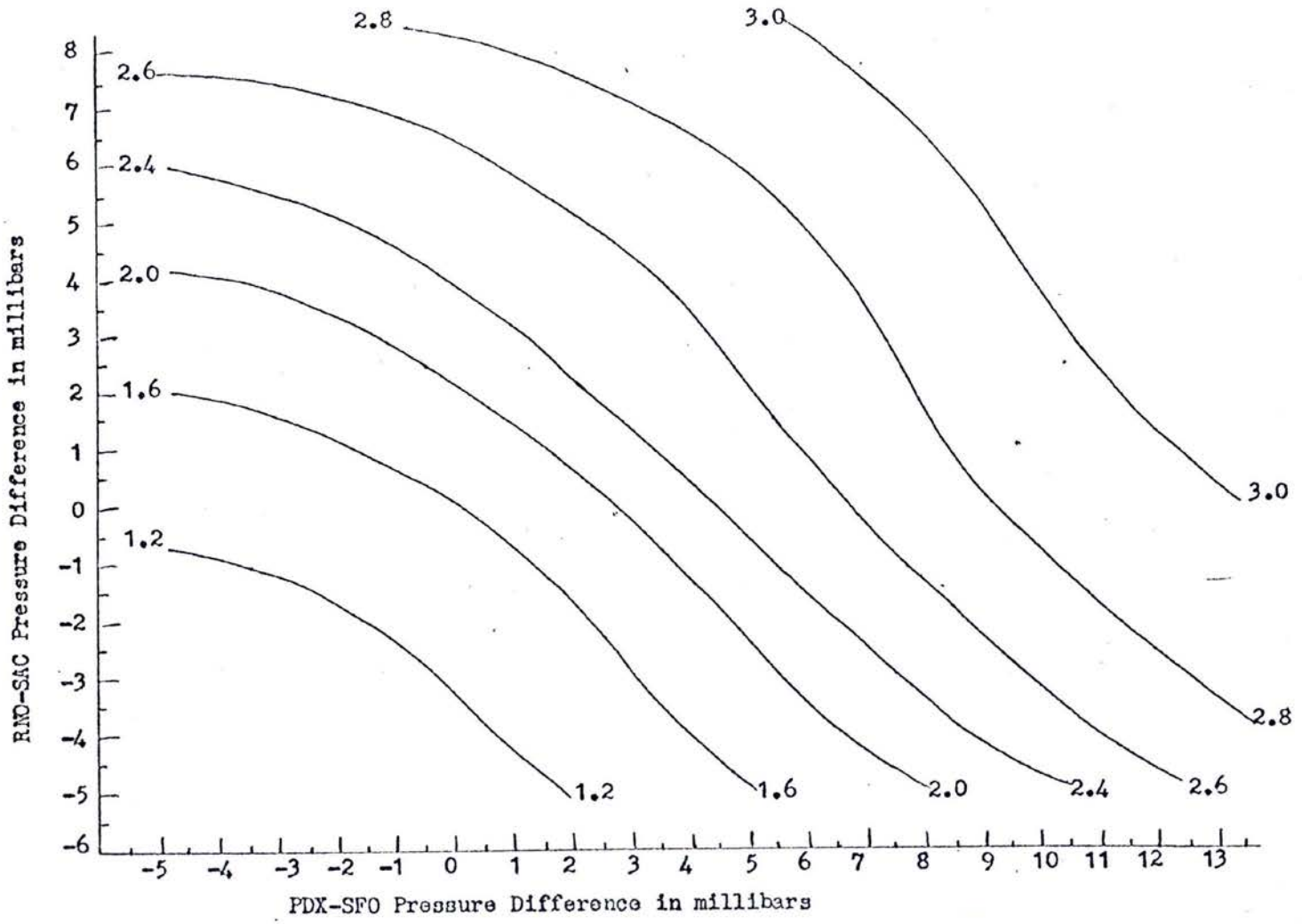



Figure 6 Marine penetration forecast graph.

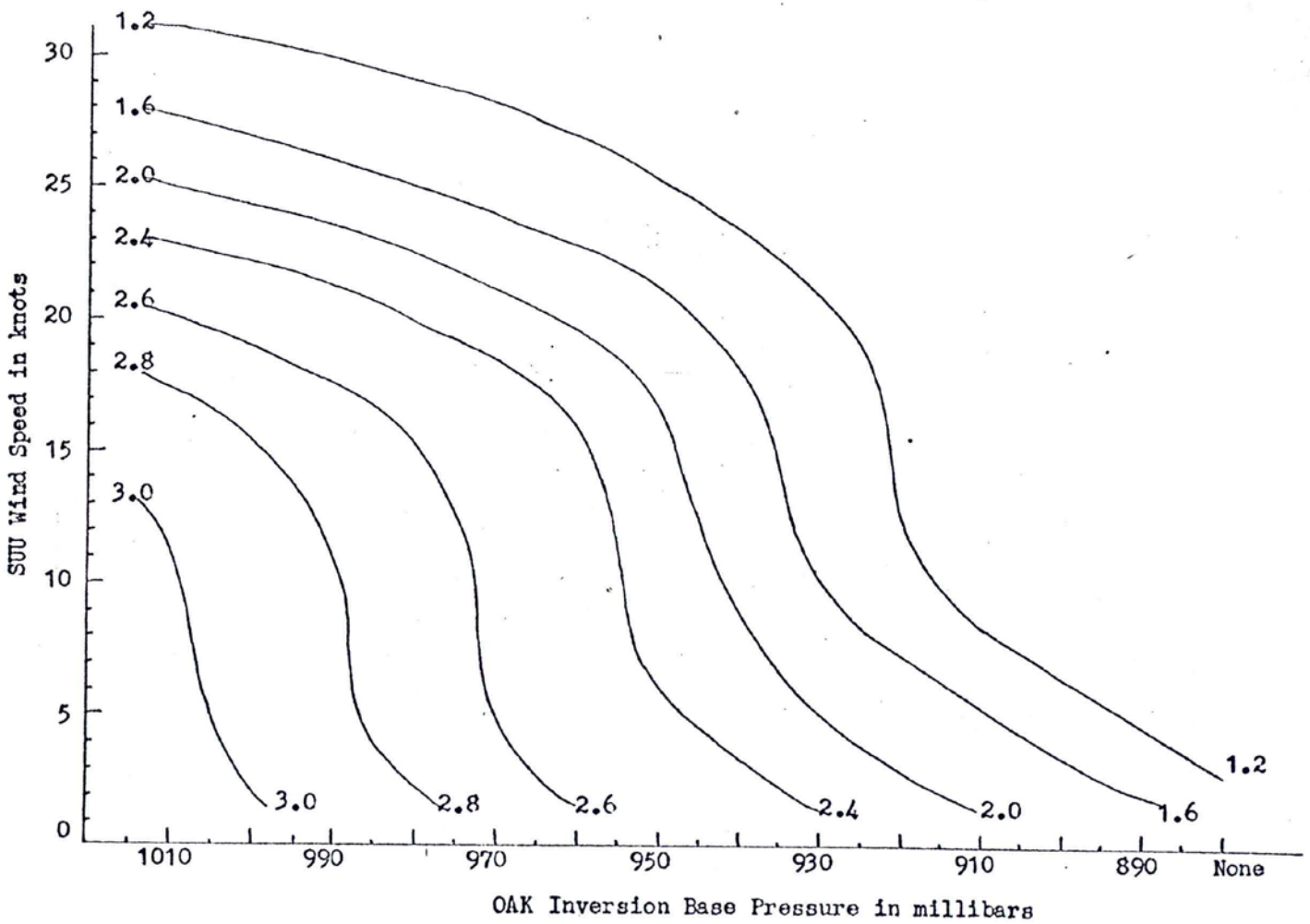



Figure 7 Marine penetration forecast graph. 42

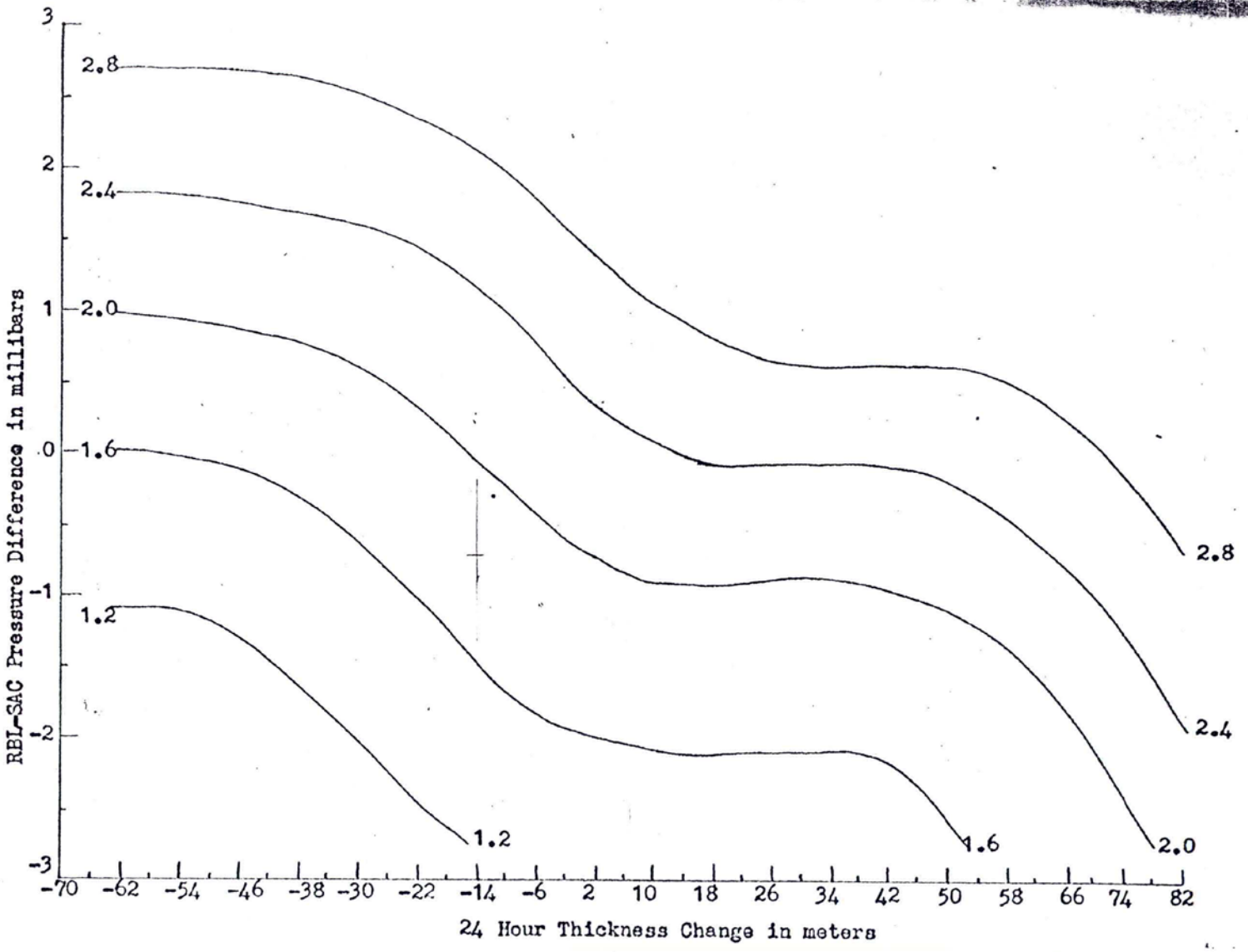



Figure 8 Marine penetration forecast graph. 43

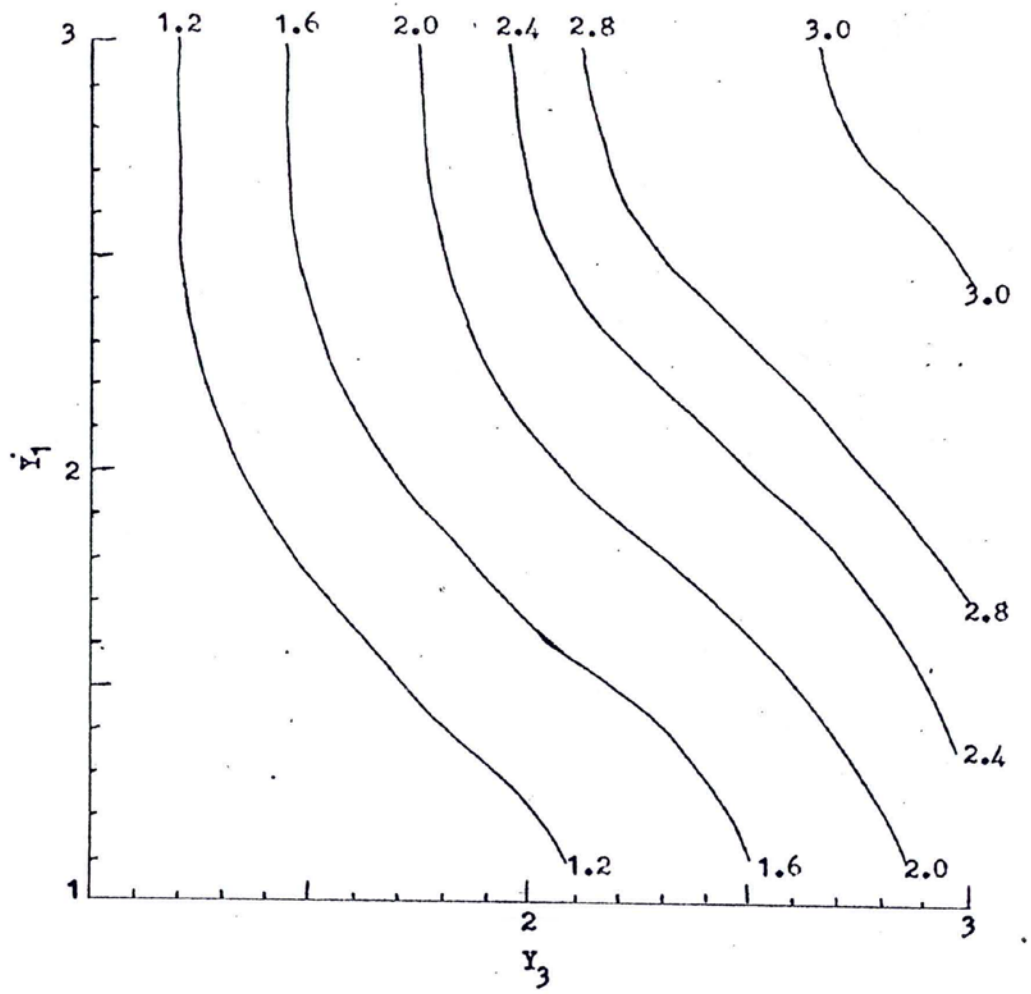



Figure 9 Marine penetration forecast graph. 44

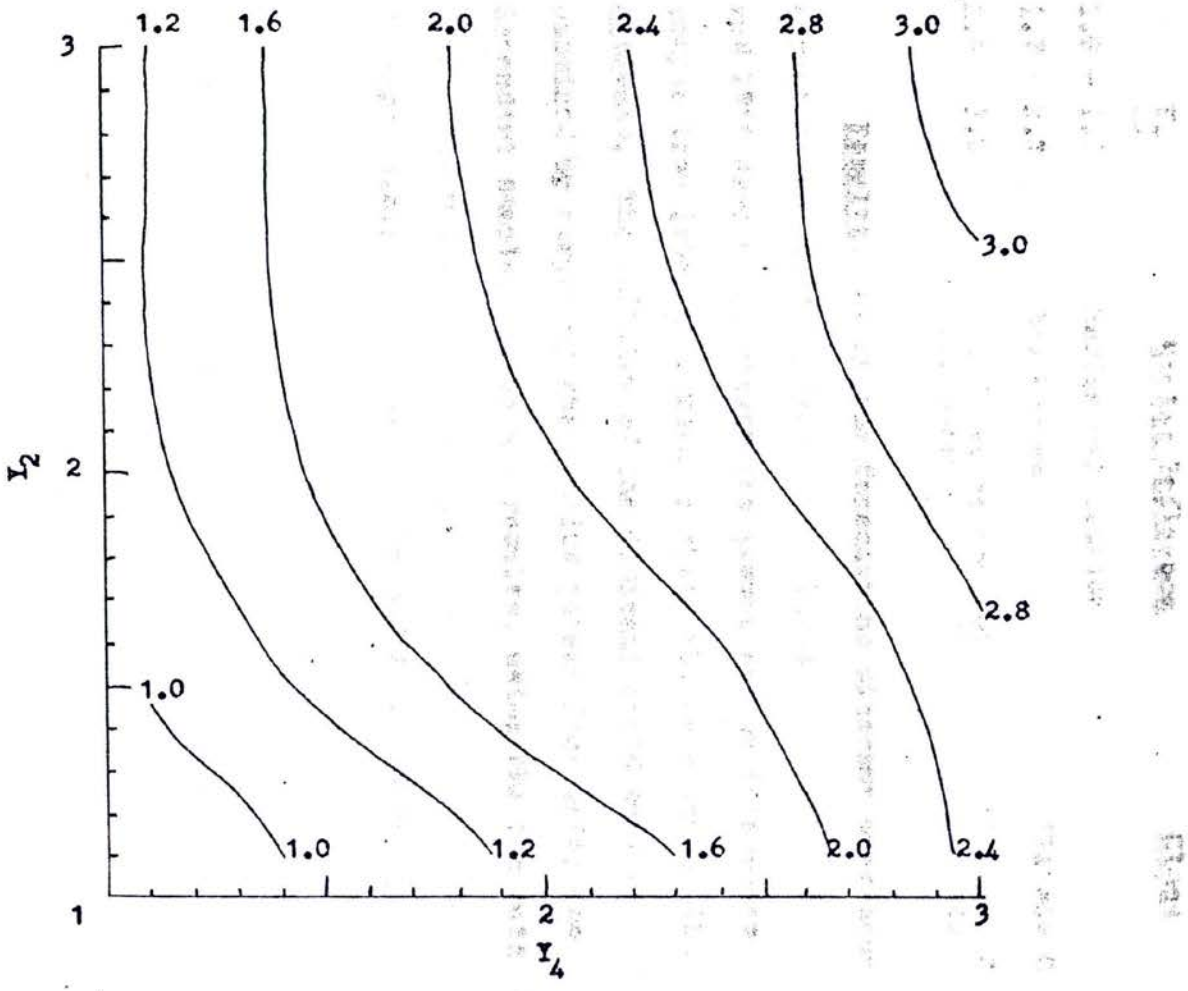



Figure 10. Marine penetration forecast graph. 45

# Type of Marine Intrusion

- *Values <1.6 ~ Class I*
- *Values >2.4 ~ Class III, IIb*
- *Intermediate Values ~ Class IIa, IIc*

## Some (Forecast) Rules of

- *"Delta Breeze" begins with >= 1.8 mbs SFO-SAC gradient.*
- *ML depth must be >= 2000 ft to make inland penetration into the valley.*
- *For inland penetration of ML ~ Upper level trof must be "inside" 130W.*
- *Use NAM 925 mbs wind prog, BUFKIT forecast soundings, KDAX VWP to approximate gust potential.*
- *OTHERS??????*

*“Between the two poles of simplicity and diversity, the searching mind of man remains caught…No matter what he does or what he invents, there is always nature to teach him a lesson in ……..*

***HUMILITY”***

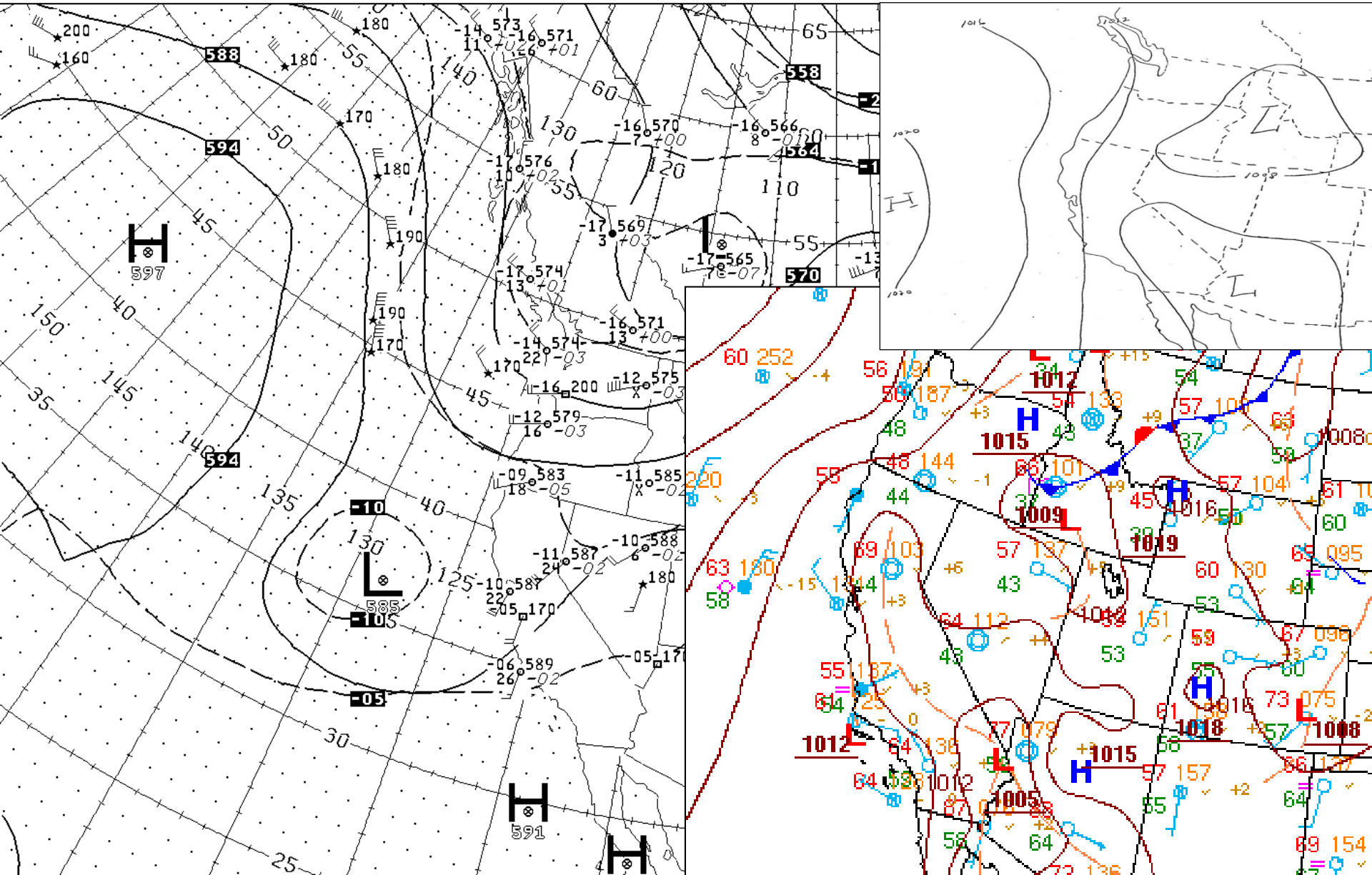
~ H. Riehl

# DELTA BREEZE STRATUS INTRUSION

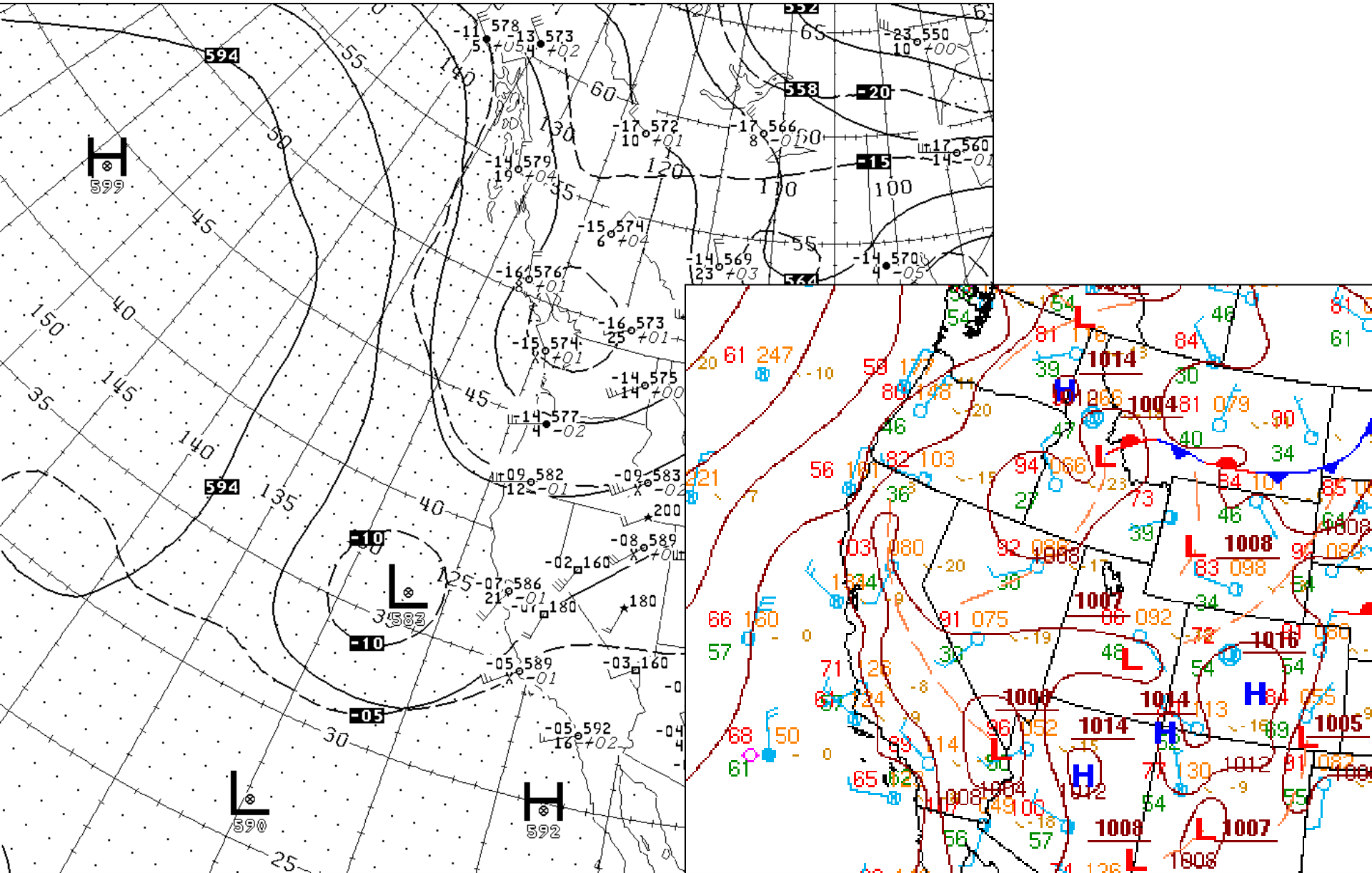

## CASE STUDY

## 4-6 AUG 2007

# 4 AUG 2007 12Z

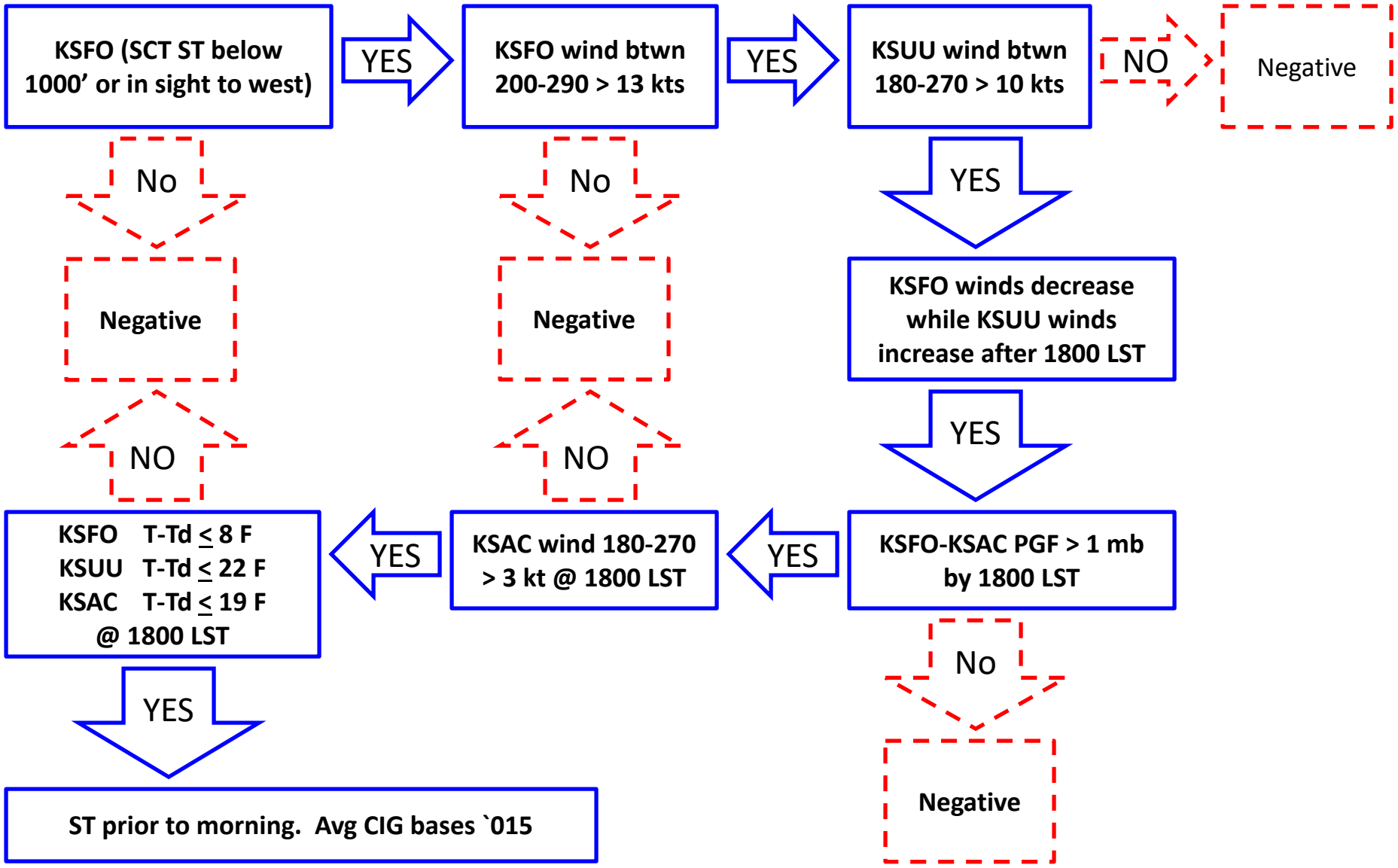


# 5 AUG 2007 00Z



# FORECASTING STRATUS FORMATION AT KSAC

Using 1700 LST obs:



# OBS – 4 AUG EVENING

## TIMES - LOCAL STANDARD TIME

**KSFO**

1456 31020KT FEW007 10 65/52
1556 31017KT FEW005 10 63/52
1656 31016KT FEW005 10 61/52
1756 32016KT FEW005 10 58/52
1856 31016KT FEW004 10 57/52
1956 31011KT FEW004 10 56/52
2056 29011KT FEW007 10 57/51

**KSUU**

1655 WSW17KT SKC 95/40
1755 WSW13KT SKC 92/37
1855 SW14KT SKC 86/43
1955 SW17KT SKC 76/46
2055 SW20KT SKC 71/45
2155 SW18KT SKC 66/49
2255 WSW16KT SKC 63/49
2355 WSW19G27KT SKC 62/51
0055 WSW19G28KT SKC 60/52
0155 WSW12KT SKC 59/52
0255 WSW21G27KT SKC 57/52
0355 SW20G28KT SKC 57/52
0455 WSW29G36KT SKC 57/52

**KSAC**

1653 23012KT CLR 10 98/40
1753 23011KT CLR 10 94/38
1853 21008KT CLR 10 86/39
1953 22010KT CLR 10 78/41
2053 23010KT CLR 10 74/41
2153 20005KT CLR 10 70/43
2253 17005KT CLR 10 66/45
2353 18006KT CLR 10 64/47
0053 17004KT CLR 10 63/48
0153 19006KT CLR 10 62/49
0253 19007KT CLR 10 59/49
0353 21007KT CLR 10 58/50

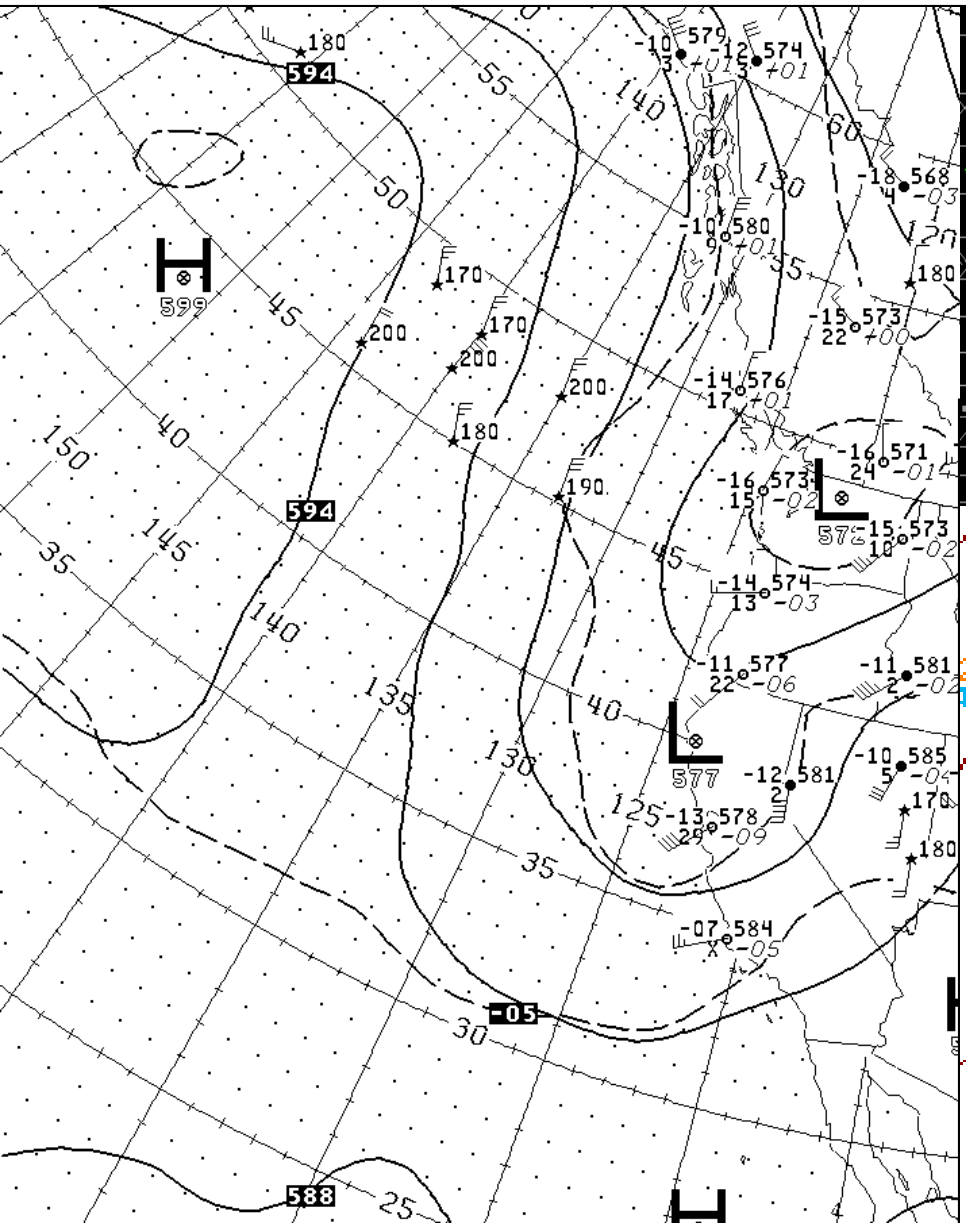
***WINDS DID INCREASE AT KSUU***

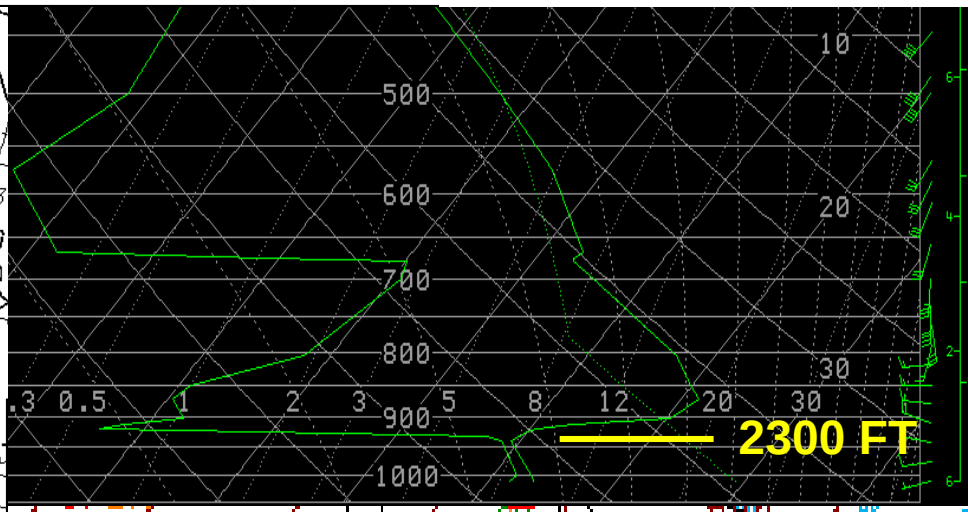
***NO STRATUS COMIN' AT US***

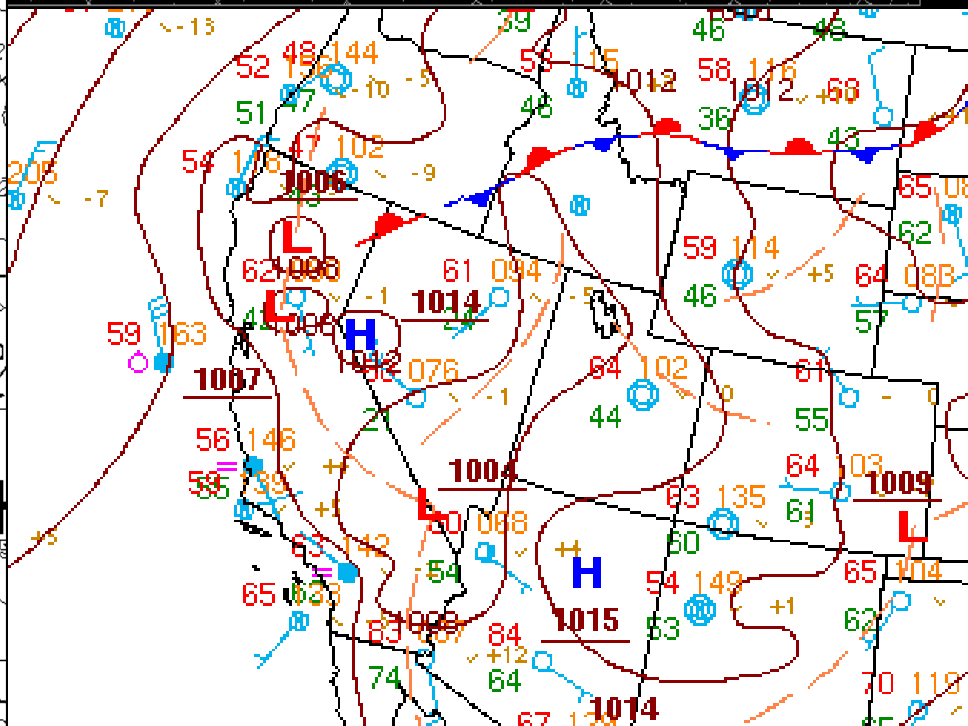
# RESULTS - 4-5 AUG

- Thermal low in valley on 4th
  - Max T Downtown Sacramento: 104F
  - Max T KSAC: 101F
- Winds did increase at KSUU
- KSFO-KSAC 3.5 to 4 MB, but…
- Subsidence inv still too strong for ST
- Max T Downtown Sacramento minus 28F on 5th to 76F

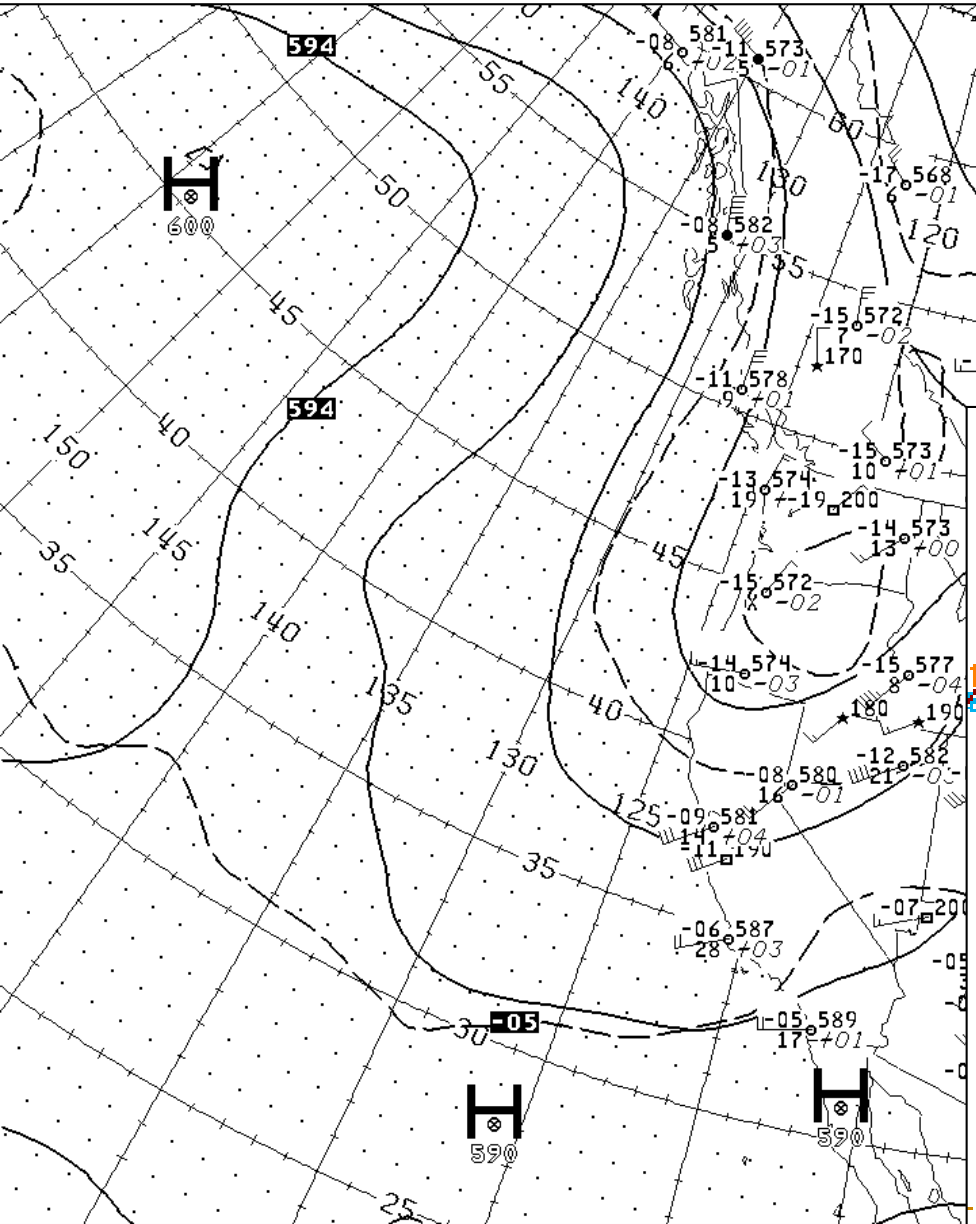
# 500 MB 5 AUG 2007 12Z

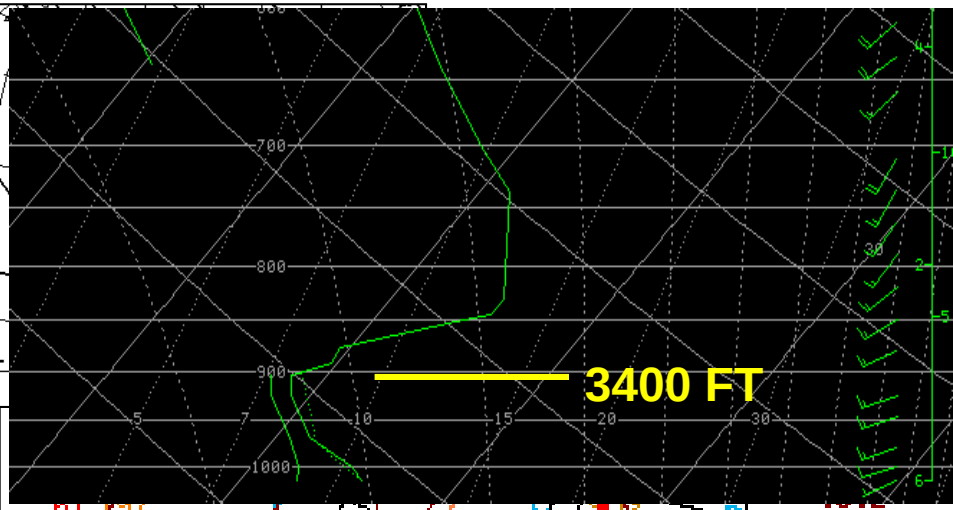


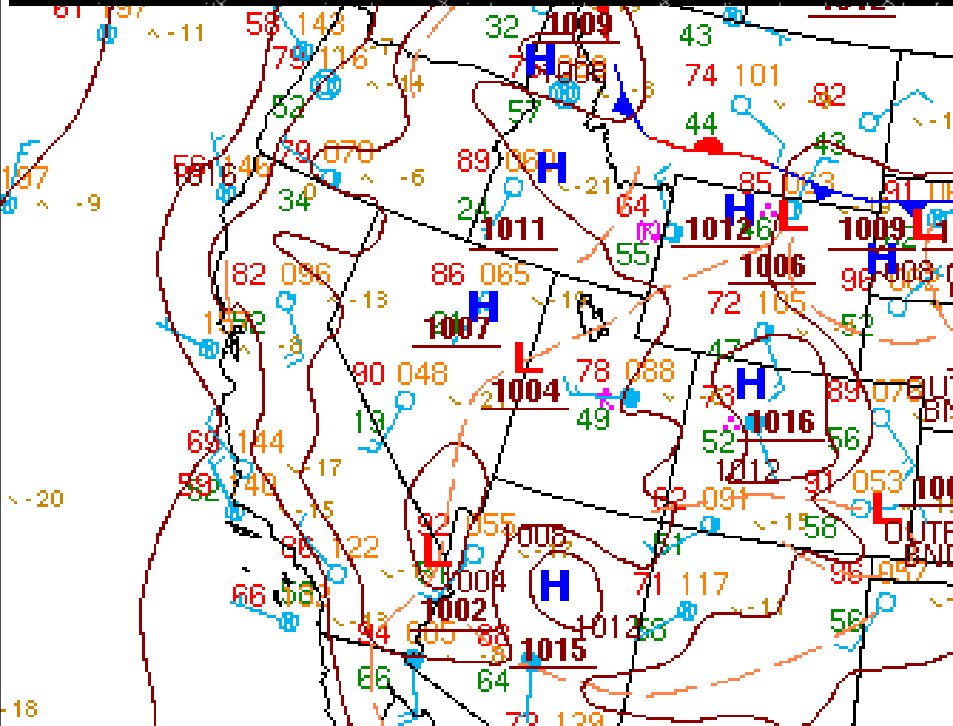



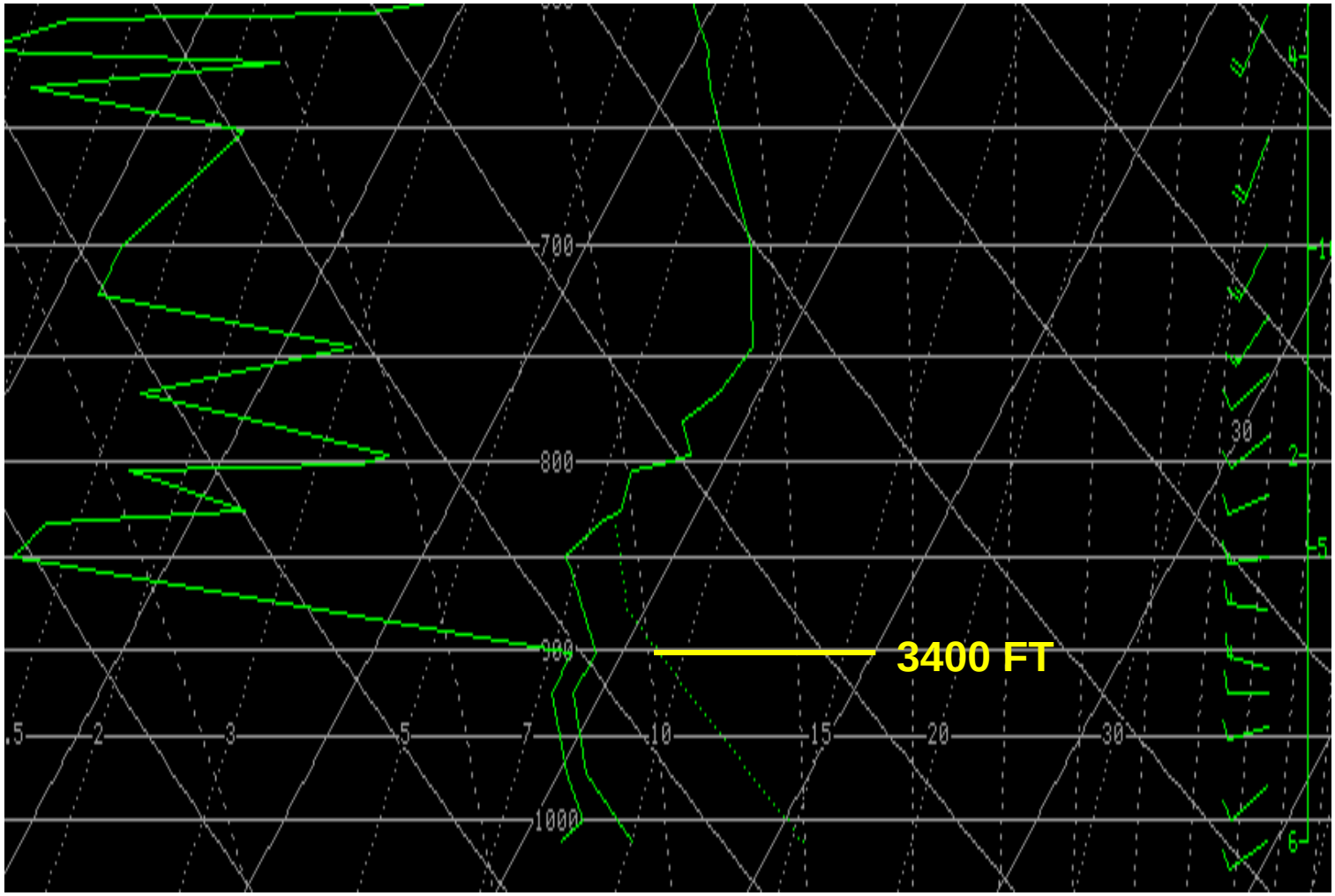
# 500 MB 6 AUG 2007 00Z



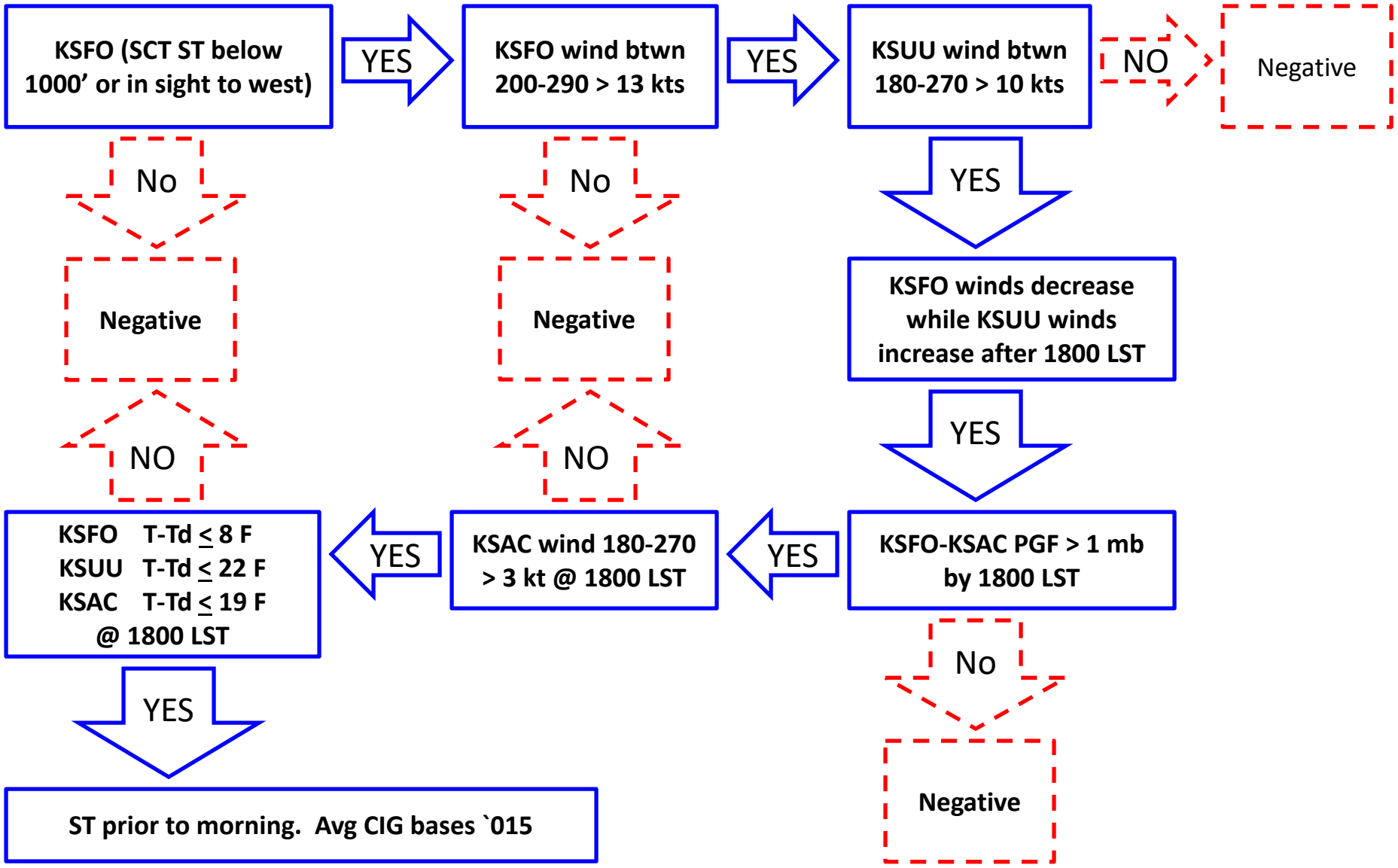
# UPPER AIR SOUNDINGS




OAK 6 AUG 12Z

# FORECASTING STRATUS FORMATION AT KSAC

Using 1700 LST obs:



# OBS – 5 AUG EVENING

## TIMES - LOCAL STANDARD TIME

**KSFO**

1656 26011KT FEW006 BKN013 BKN018 60/52
1756 25011G21KT FEW006 BKN013 OVC018 59/52
1856 25012G18KT FEW009 BKN013 OVC018 59/52
1956 25011KT FEW009 BKN013 OVC018 59/52
2056 26009KT FEW010 BKN013 OVC018 59/52
2156 26012KT FEW010 BKN013 OVC018 59/52
2256 28009G18KT OVC013 59/51
2356 26012KT OVC013 59/52

**KSUU**

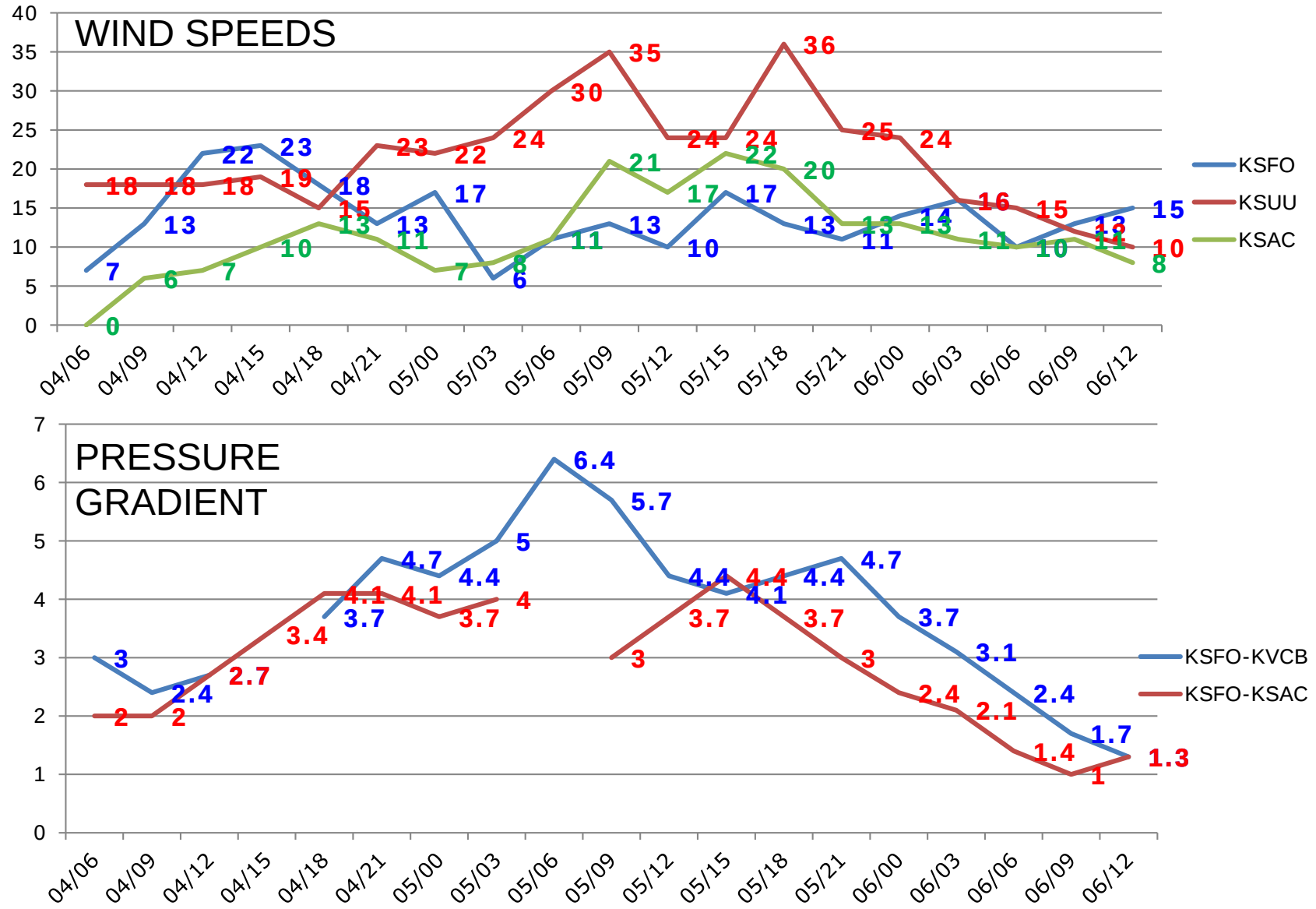
1655 66/54 WSW25G32KT FEW019
1755 64/53 SW31G39KT BKN019
1855 61/53 SW33G41KT BKN015
1955 59/52 SW30G36KT BKN015
2029 59/52 SW22G33KT BKN014
2059 59/52 SW22G32KT BKN014
2155 58/52 SW22G27KT OVC014
2255 58/52 WSW20G28KT BKN013
2355 59/52 WSW21G29KT OVC013

**KSAC**

1653 20014G21KT CLR 67/53
1753 19017G23KT CLR 64/53
1853 20012G16KT CLR 61/52
1953 20015G19KT CLR 59/52
2019 18015G19KT BKN016 59/52
2053 19013G19KT BKN016 59/52
2153 19008G16KT OVC016 59/52
2253 19011KT OVC016 60/52
2353 21011KT OVC016 59/52

# WIND-SFC GRADIENT

## TIMES - LOCAL STANDARD TIME

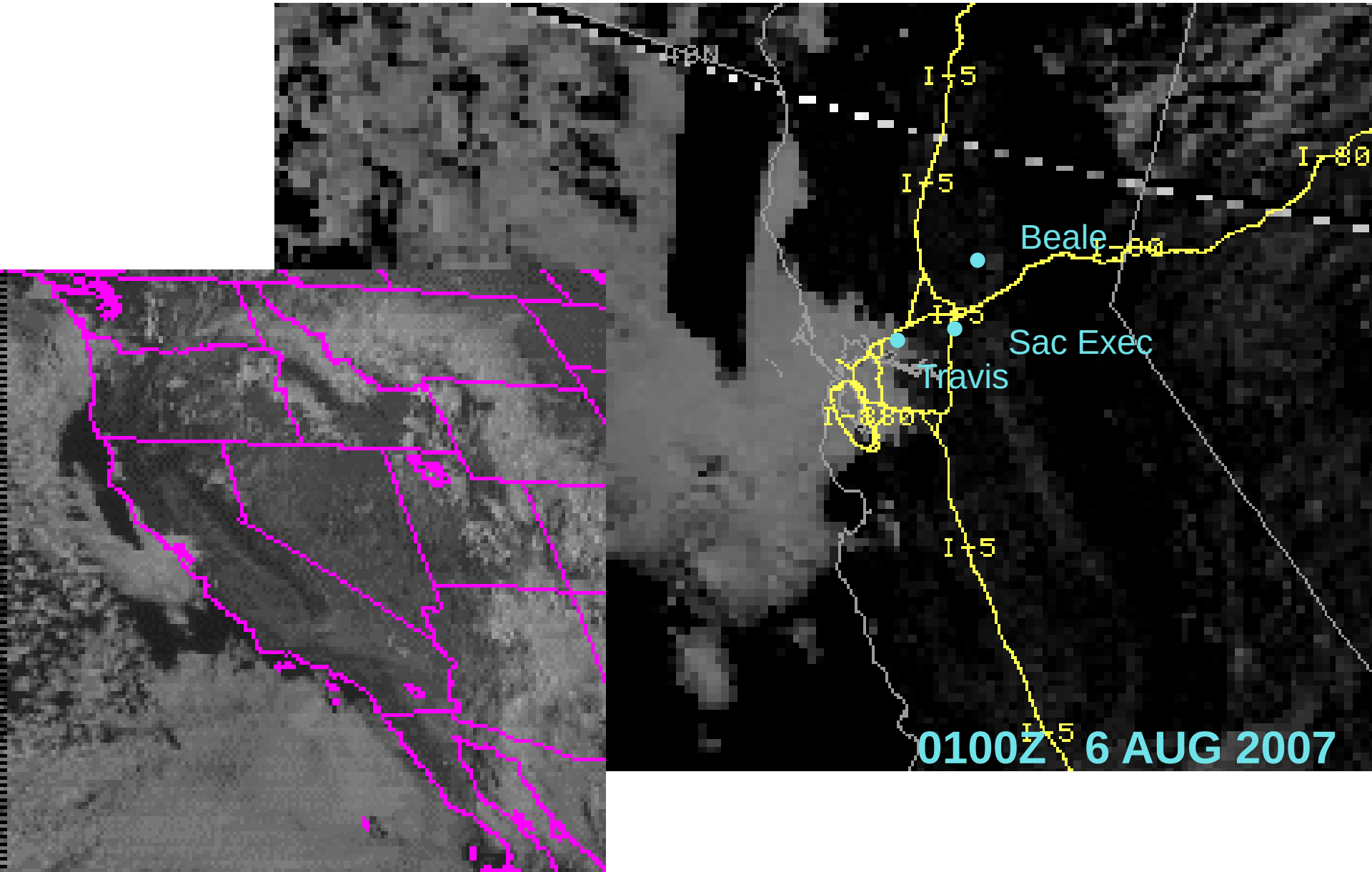


# MARINE STRATUS

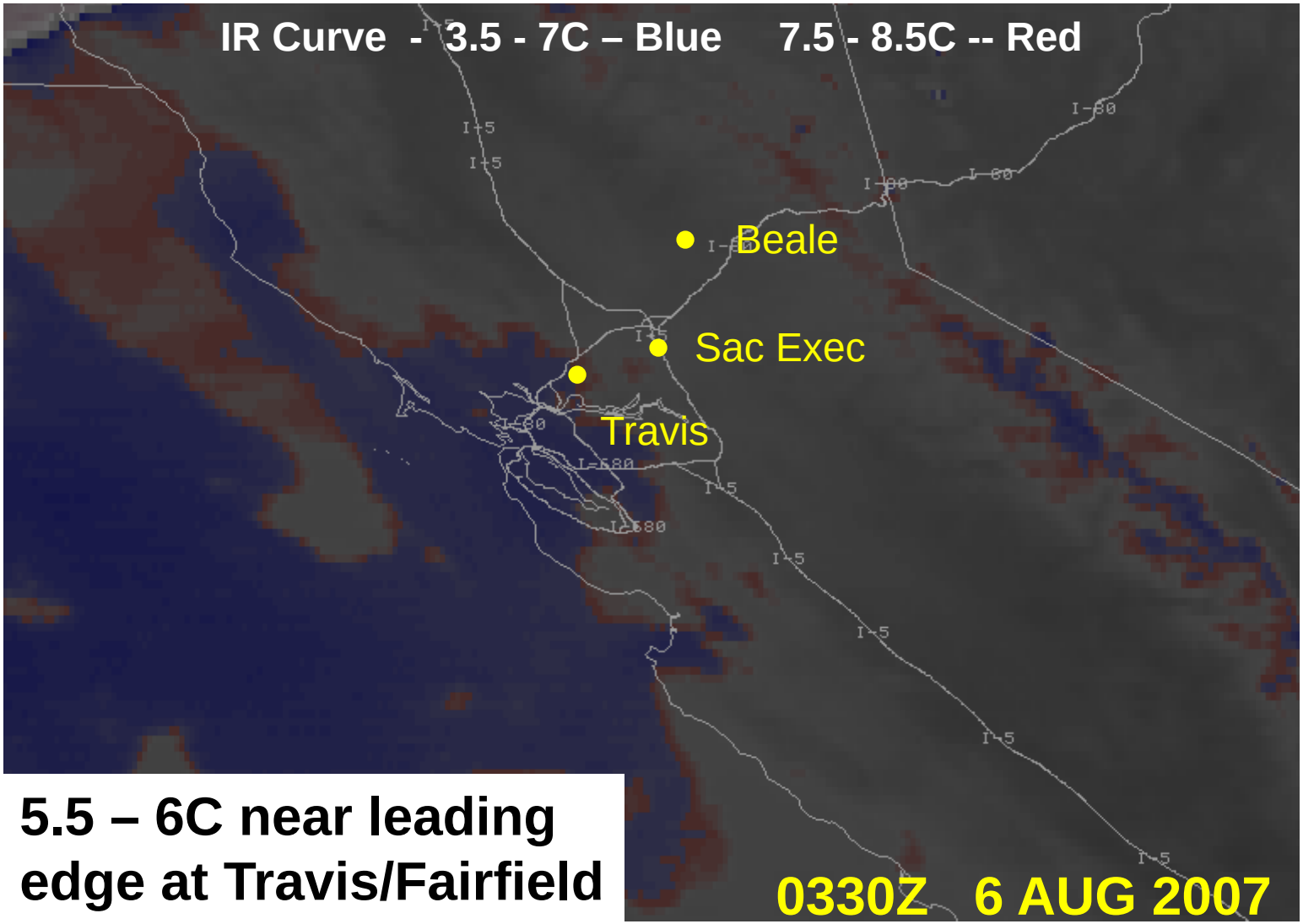
## TIME OF FORMATION

- Take Avg wind speed (SFC-2000') from KSFO 1800 LST METAR/0000 GMT OAK Skew-T, and double it.
- Divide this doubled average wind speed into 100
- Add answer (which is expressed in hrs) to 1800 LST
  - Thus 2.5 would mean 2.5 hrs after 1800 LST, which would be 2030 LST.
  - Depends on wind speeds (stronger winds = sooner ST onset)

# SATELLITE (VIS)

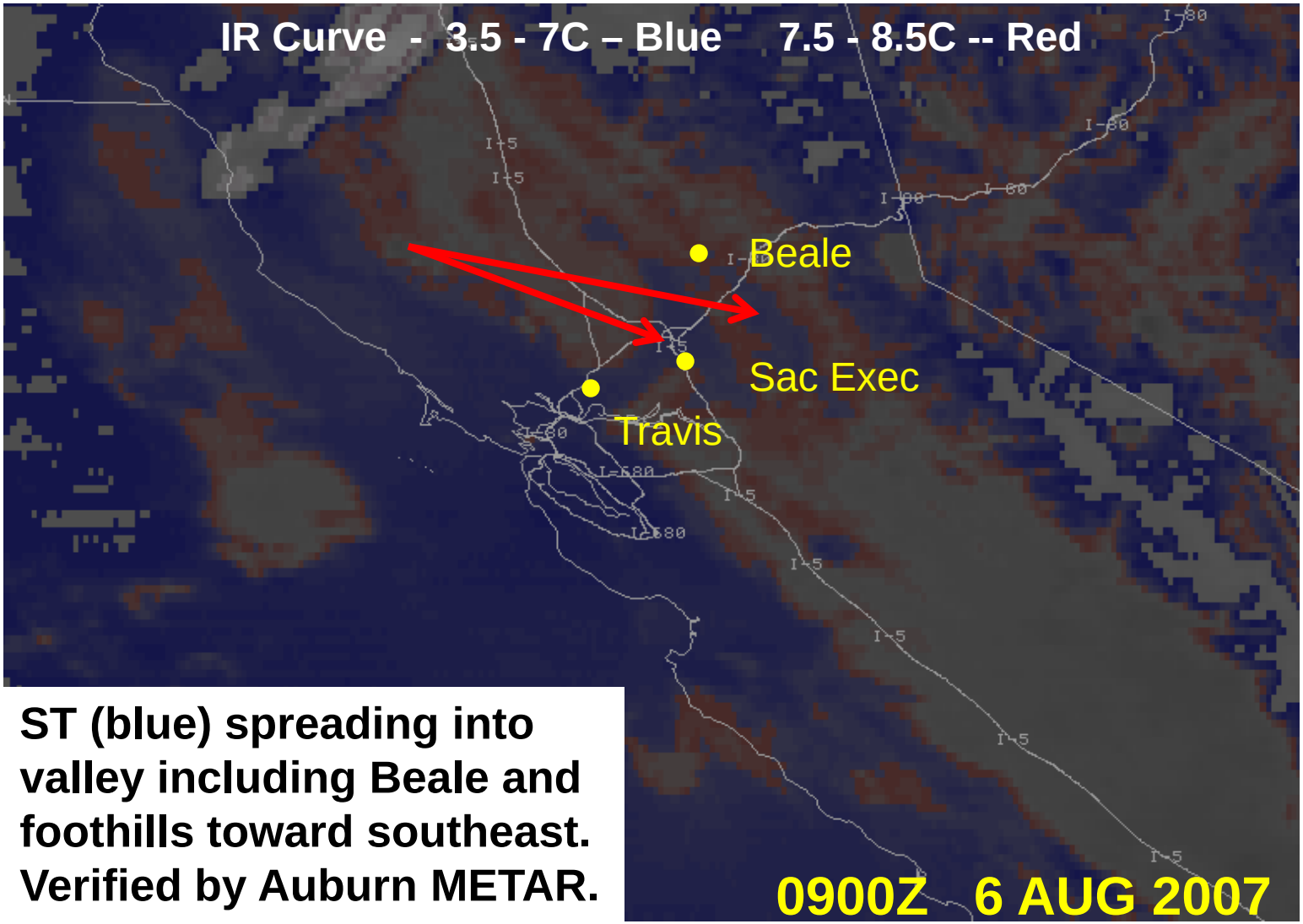


# SATELLITE (IR)



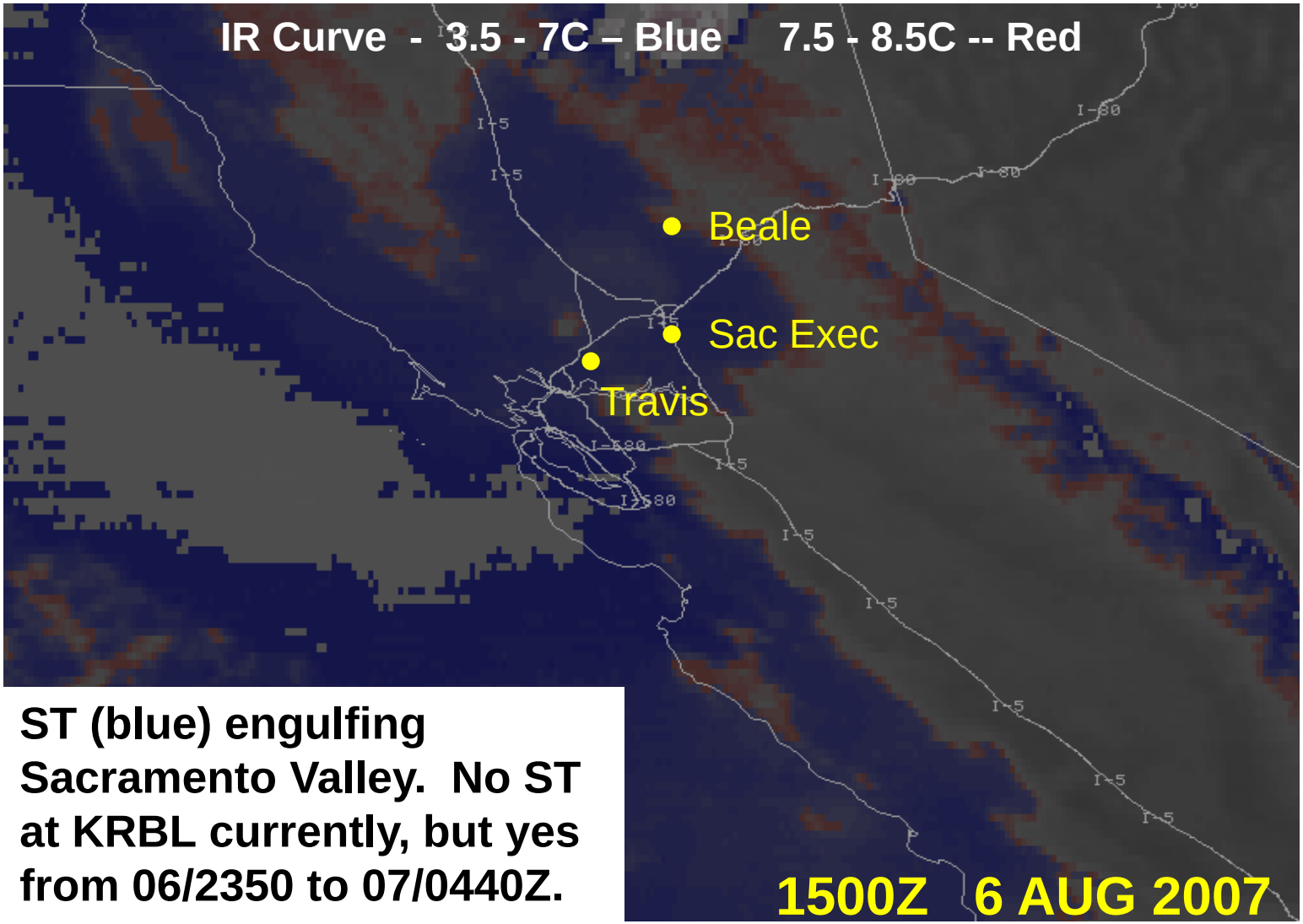

**5.5 – 6C near leading edge at Travis/Fairfield**

# SATELLITE (IR)



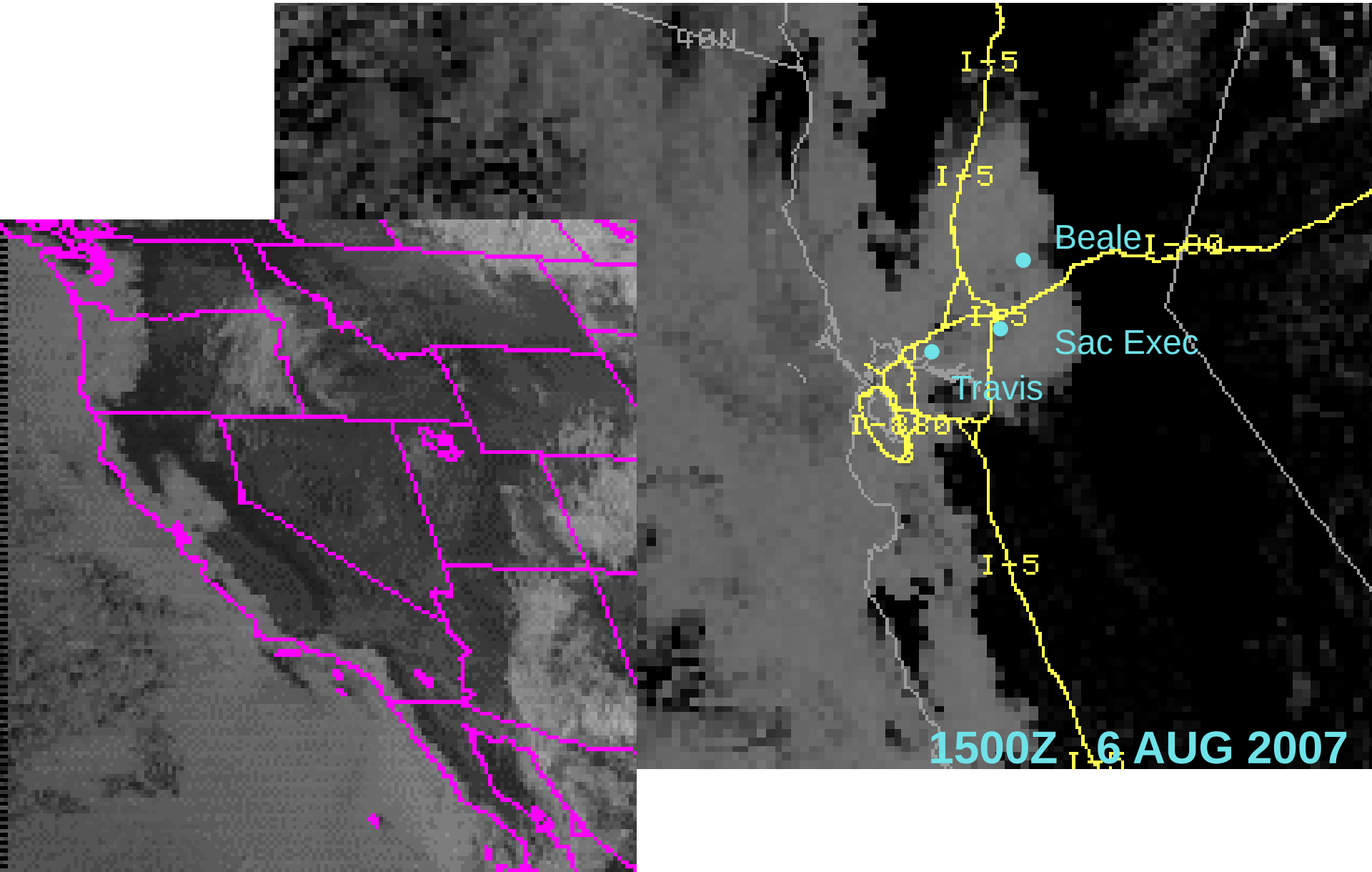

**ST (blue) spreading into valley including Beale and foothills toward southeast. Verified by Auburn METAR.**

# SATELLITE (IR)




**ST (blue) engulfing Sacramento Valley. No ST at KRBL currently, but yes from 06/2350 to 07/0440Z.**

# SATELLITE (VIS)



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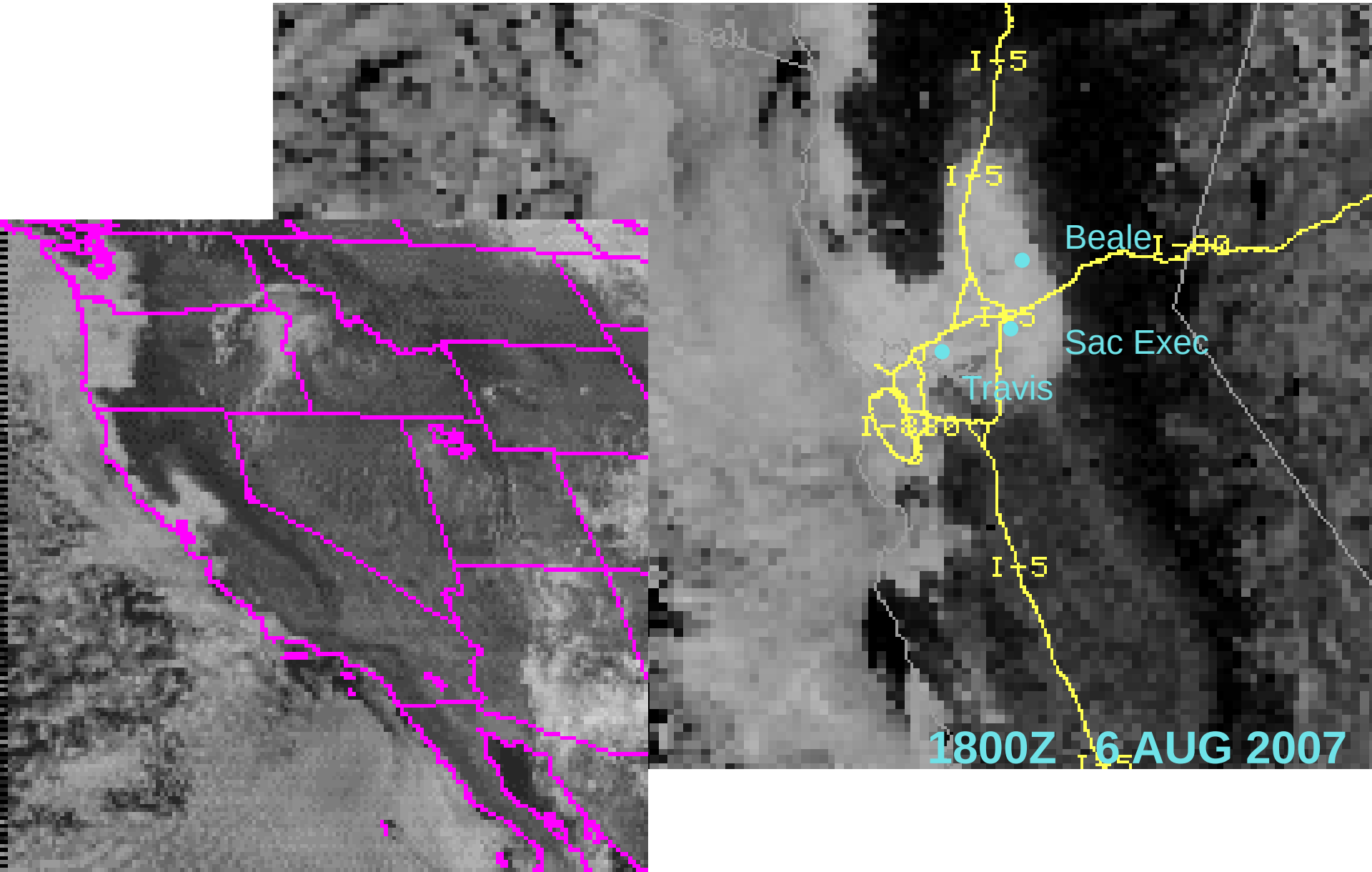

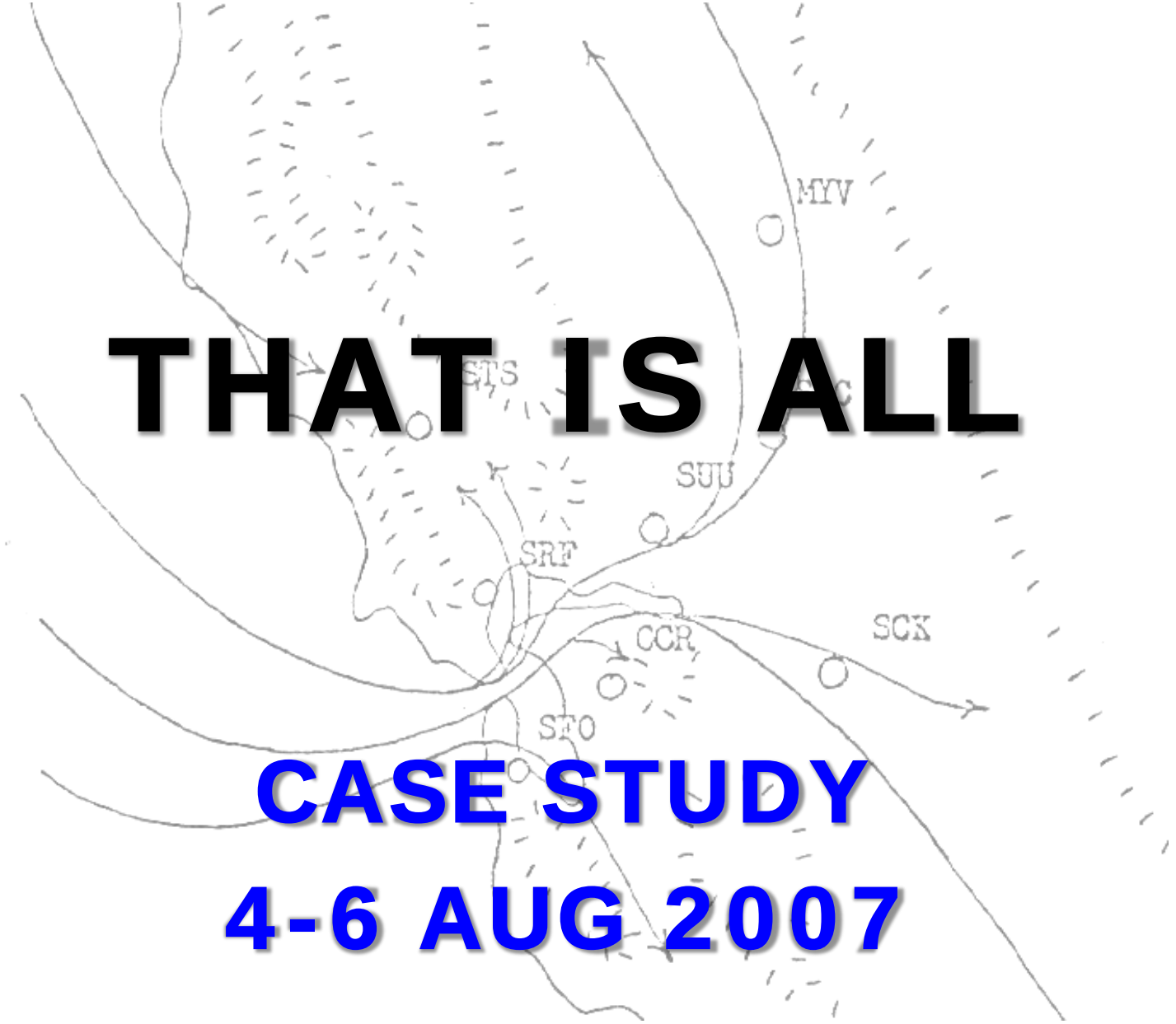


# THAT IS ALL

## CASE STUDY

## 4-6 AUG 2007