"ANOMALOUS SNOWFALL IN SOUTH AND CENTRAL PERU DURING JANUARY 2015"

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INTRODUCTION

I am a Peruvian Weather Forecaster and I work at the National Weather Service (SENAMHI)the training was done in the South American Desk.

My interests are on

- Climatology of synoptic patterns.
- Rainfall forecasting.
- Influence of the subtropical high/ridge on the rainy season.
- Low level jets.

Once home, the desk experience will allow me to improve

- the identification of mesoscale systems.
- the quality of the short and medium range forecasts.

OBJETIVES

Understanding the conditions that generated the out-of-season snowfall in the Central and Southern mountains of Peru during January 1-12, 2015 to:

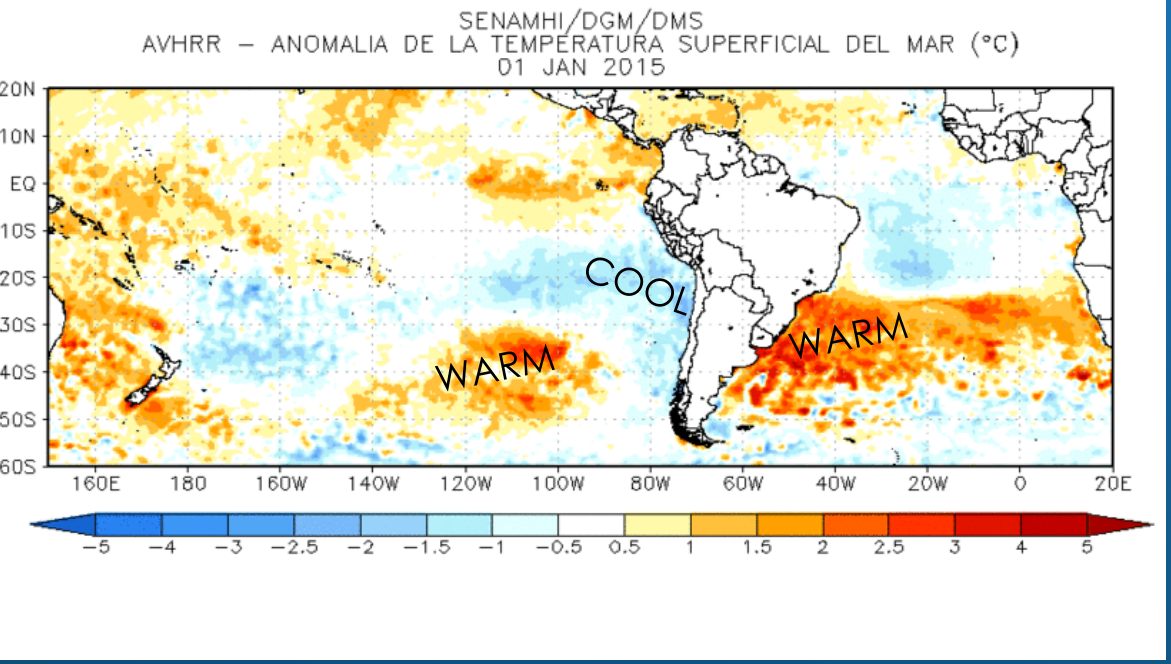
→find predictors
→improve forecasts
→mitigate risks

Normal January

January 2015

Location

Highlands subject to snow events



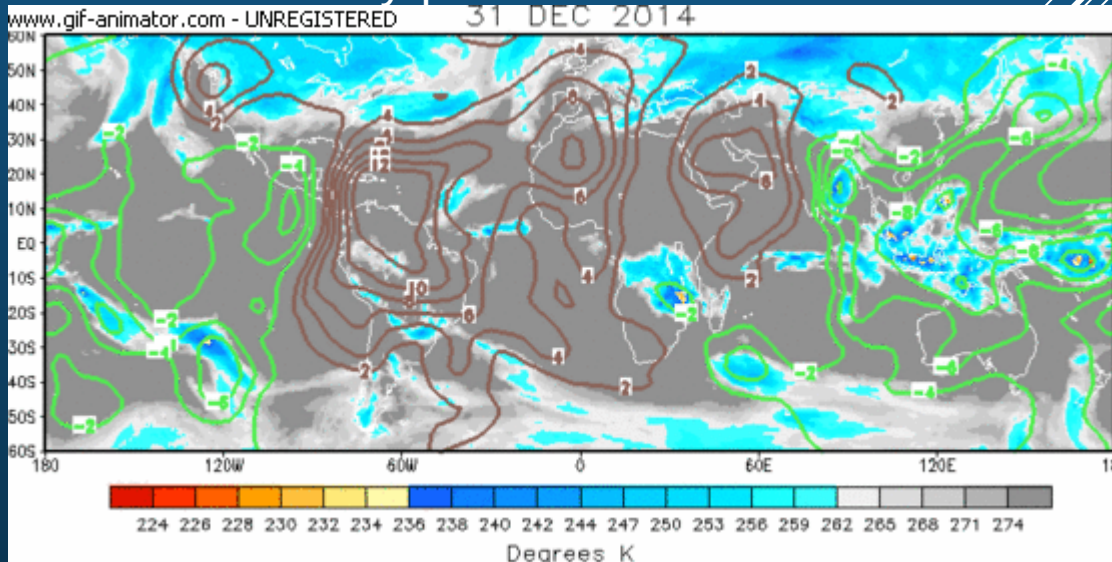
ANOMALY SST

Warm anomalies over the South Atlantic, cold over the South Pacific.

MJO

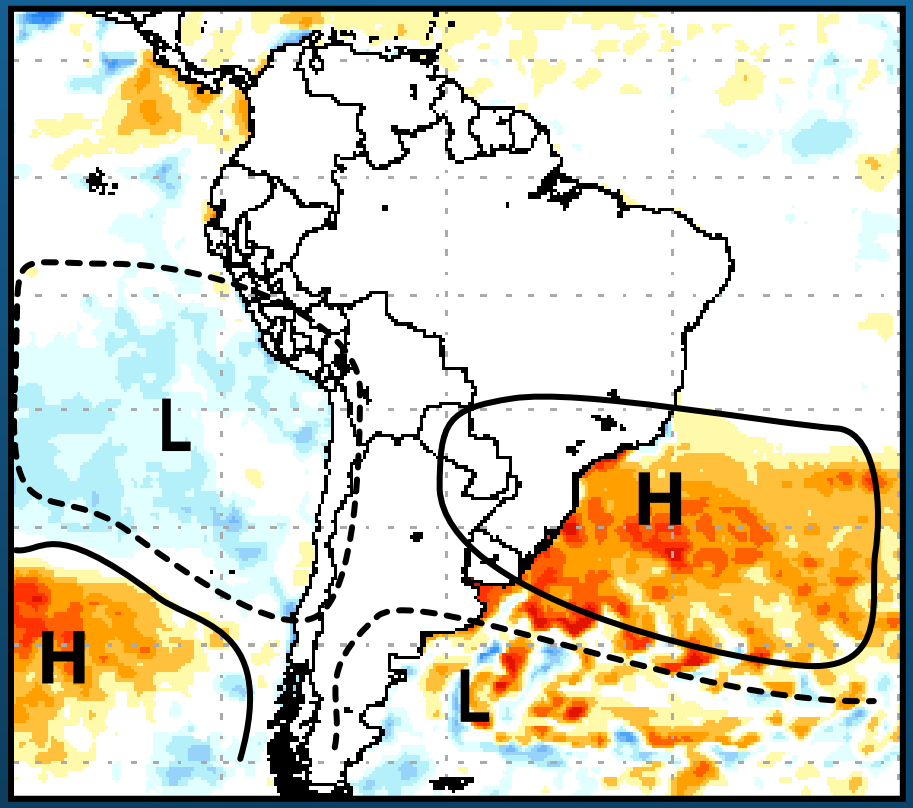
The convergent phase of MJO was present over South America, so enhanced divergence associated with it <u>was not a factor</u> that supported snowfall

Animation of daily IR and 200-hPa velocity potential anomalies

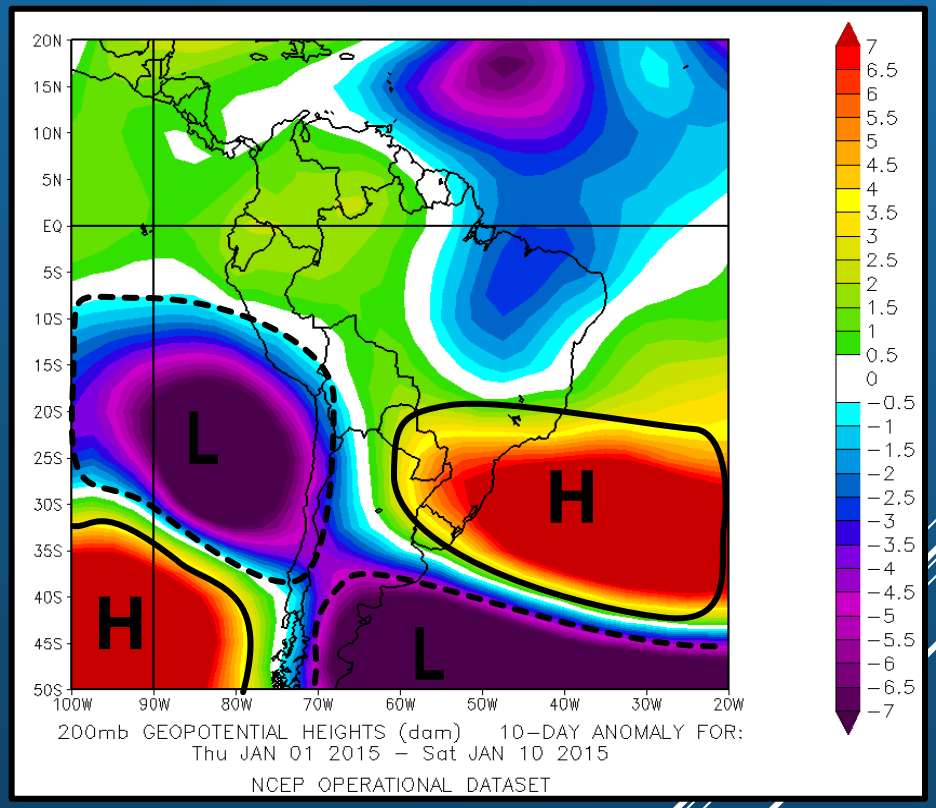


SSTs and Upper Circulations/heights

ANOMALY SST JAN 09, 2015

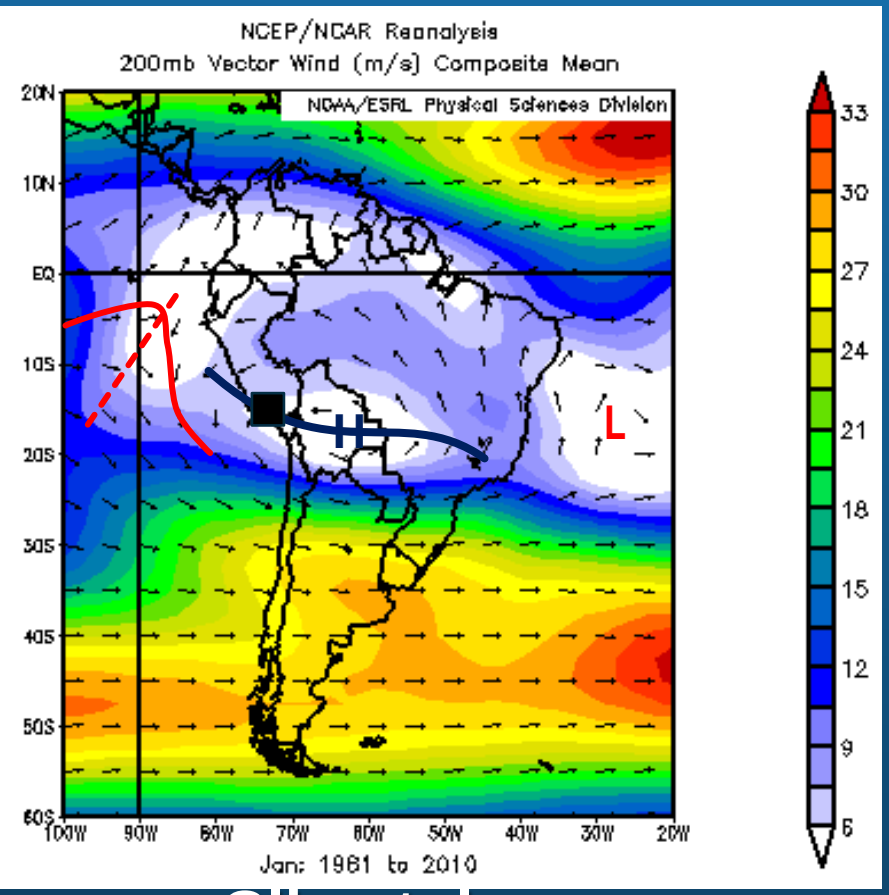


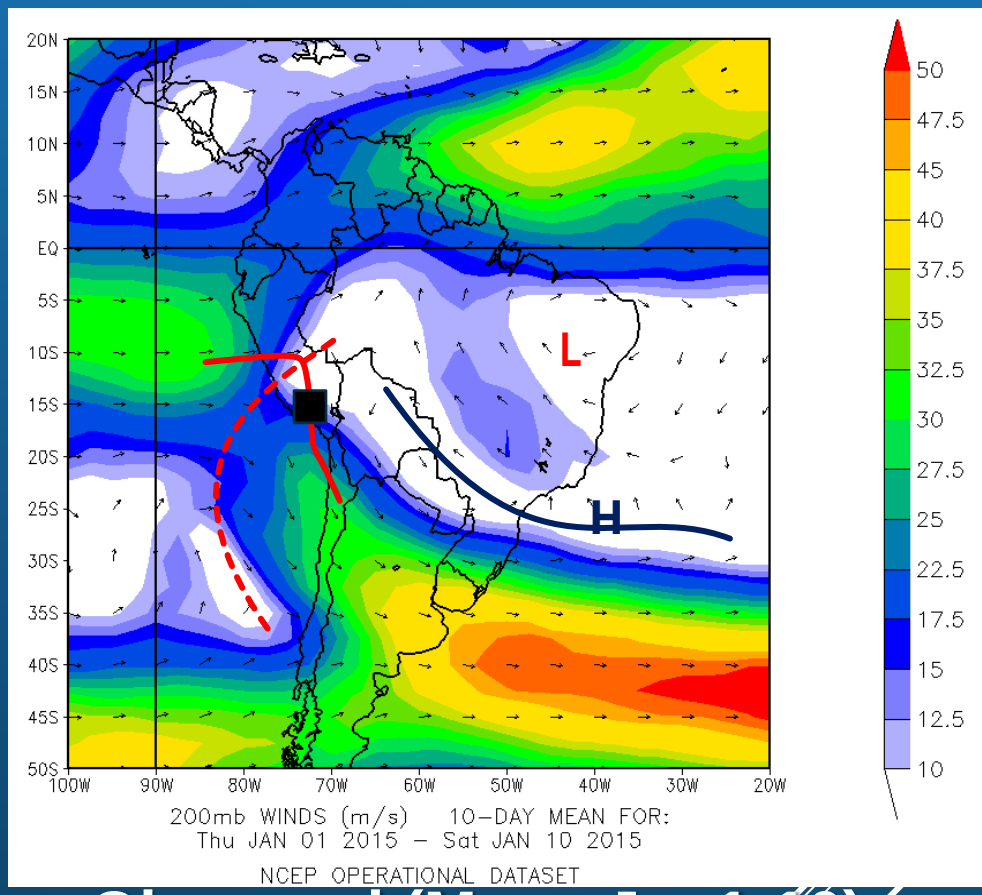
GEOPOTENTIAL ANOMALY 200 HPA



SST anomalies regulate what happens at upper levels.

Upper Flow





Climatology

Observed (Mean Jan1-10)

Climatology of wind flows as well as the location of the subtropical high differ significantly during the period

POTENTIAL PREDICTORS

The following variables were useful to capture the potential for snowfall when using GFS model data:

- Temperature at 500-550hpa.
- Relative humidity at 500-550hpa.
- Omegas at 400-450 hPa.
- Moisture flux divergence at 500-500 hPa.

- These levels/variables capture the variability over the high Andes of Southern and Central Peru (4500-5000msnm or 14000-17000 ft).

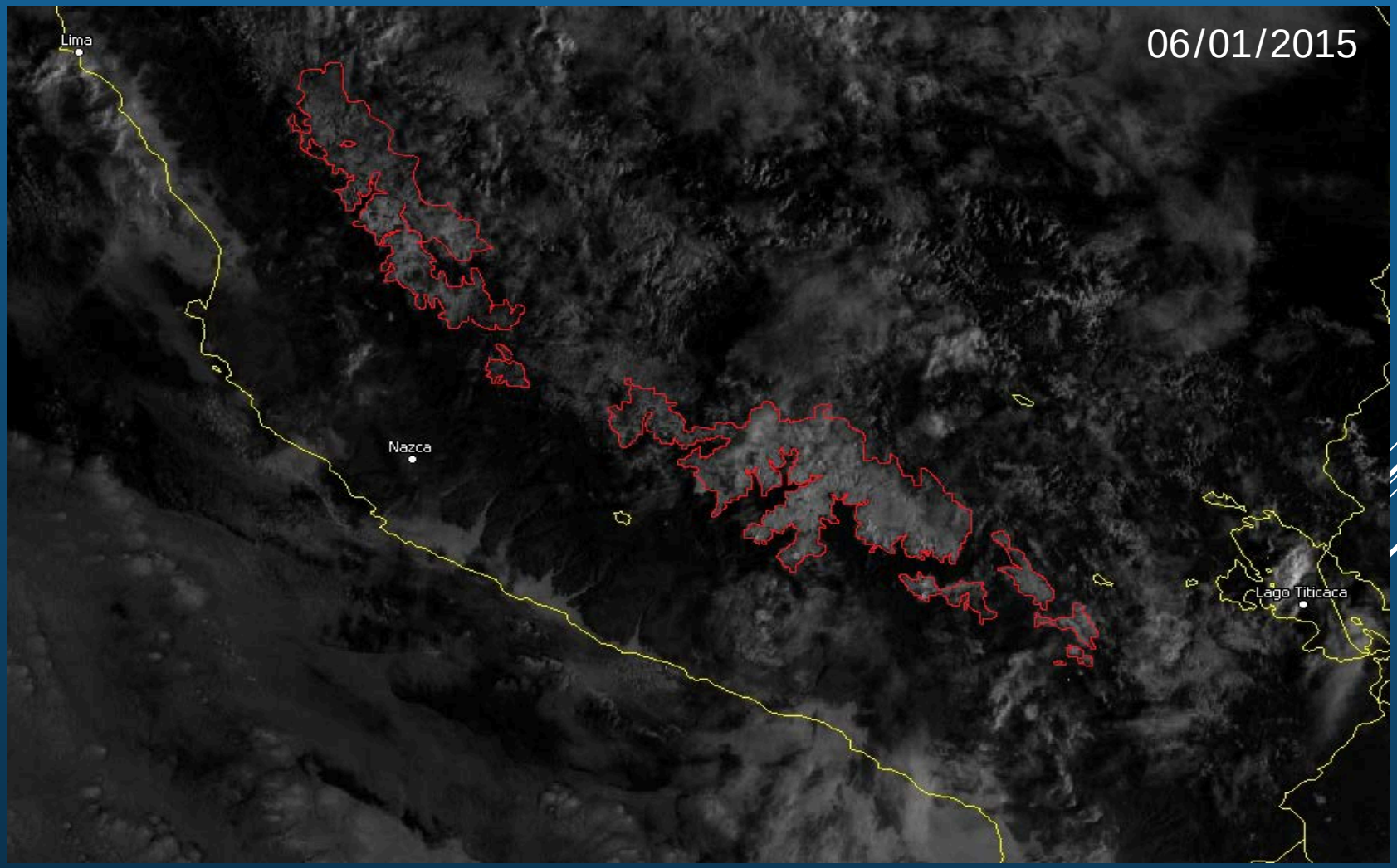
Predictor values during each evening where snow occurred

	dia 1-2	dia 2-3	dia 3-4	dia 4-5	dia 5-6	dia 6-7	dia 7-8	dia 8-9	dia 9-10	dia 10-11	dia 11-12
RH %	69 to 74	65 to 80	75 to 80	72 to 87	75 to 87	78 to 81	78 to 84	78 to 81	81 to 84	69 to 84	-69 to 75
500-550 Temp C	-1.8 to -2.2	-2.6 to -3.0	-3.5	-2.8 to -3.3	-2.8 to -3.3	-2.6 to -3	-1.2 to -1.8	-1.2 to 1.8	-1.6 to 2.0	-2.6 to -3.4	-2.0 to -2.6
vvel bar/s	-2 to -8	-2 to -12	-4 to -10	-2 to -4	-2 to -12	-3 to -7	-2 to -5	-2 to -10	-2 to -24	-7 to -10	-3 to -6
div(mass)	-3 to -15	-12 to -15	-12 to -14	-6 to -15	-8 to -24	-6 to -15	-3 to -24	-12 to -21	-12 to -27	-6 to -15	-6 to 15

- The periods with largest/most significant snow cover were right after the Jan 4-5 & 5-6 nights. We will analyze these two cases with some detail.

Example of morning snow cover on Jan 6

- Snowline significantly lower than normal
- Snowfall in January (summer) is uncommon



Jan 4-5: 0 Isotherm sinks, snow at lower elevations

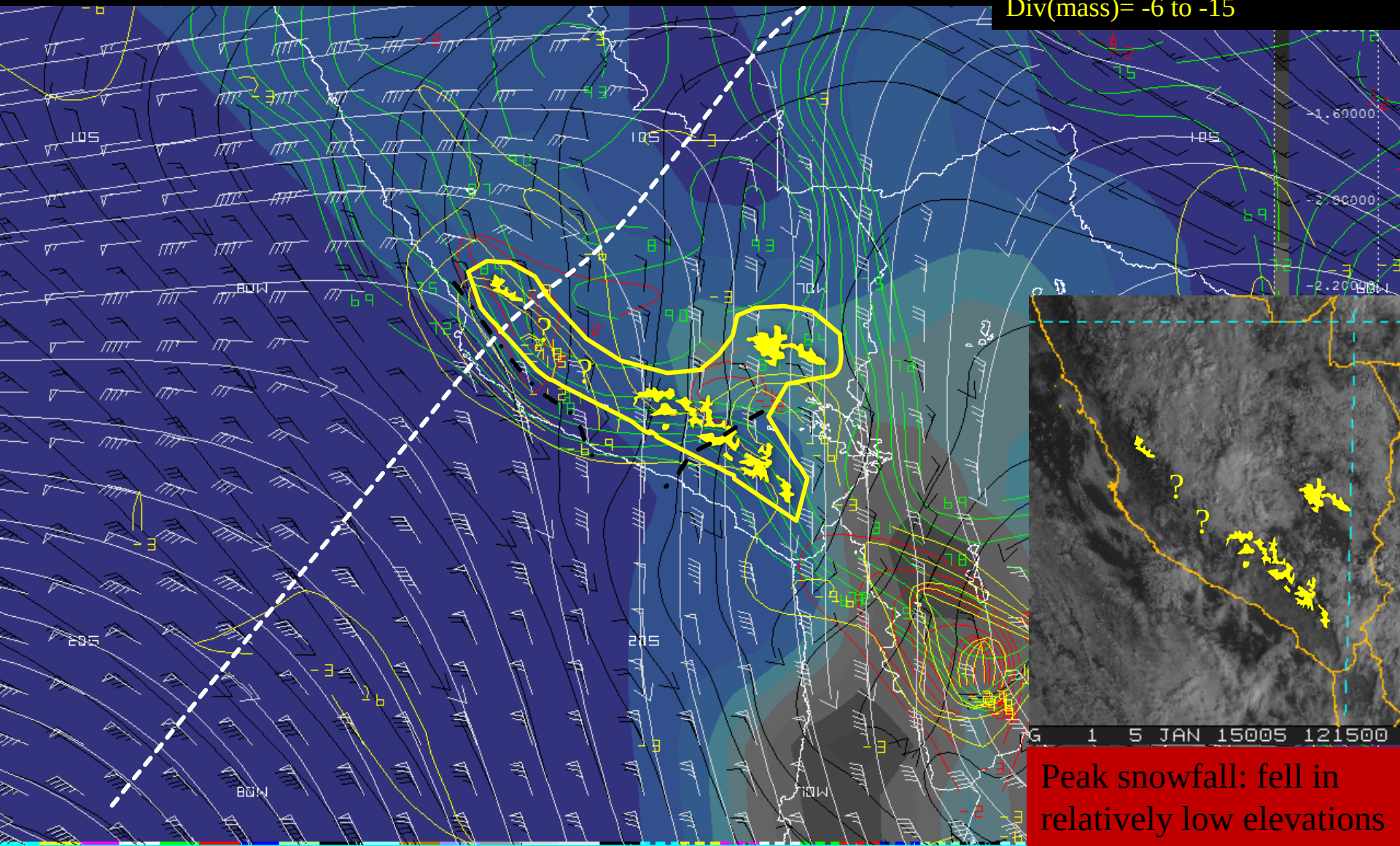
Se acentúa mas la nieve incrementando el area por la nuvosidad alta no se observa con precicion en algunos lugares, asi como el descenzo de la temperatura es mas para este dia.

$RH_{400-450}$= 72-87%

$T_{500-550}$ = -2.8 to -3.3C

$OMEG_{400-450}$= -2 to -4 microbar/s

Div(mass)= -6 to -15



Peak snowfall: fell in relatively low elevations

Jan 5-6: Cools more. Cloud cover limits snowfall analysis.

Areas similares al dia anterior por la nuvosidad no podemos observar hacia la zona central .

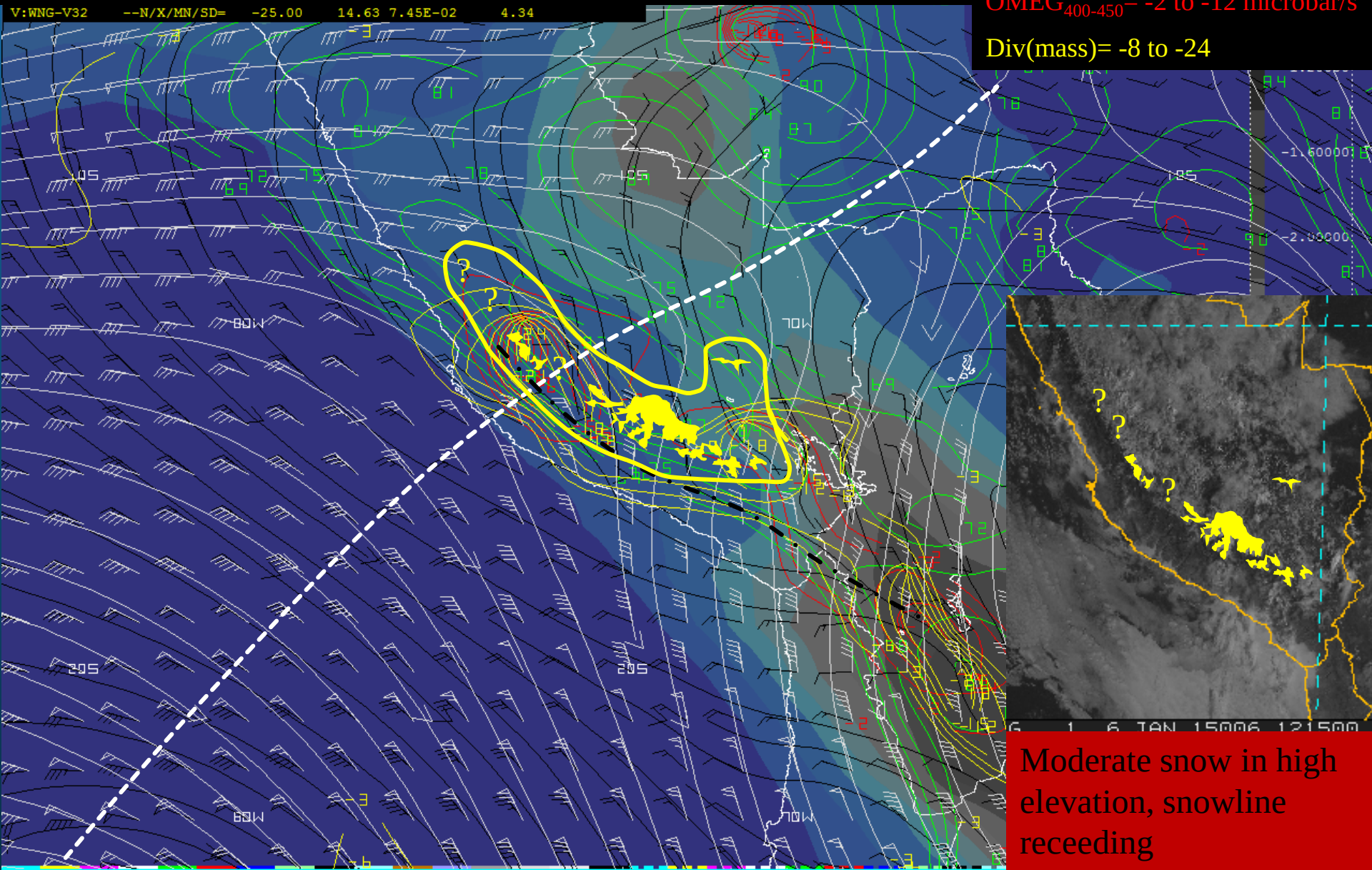
Peak day, freezing line sinks

$RH_{400-450}$= 75-87%

$T_{500-550}$ = -2.8 to -3.3C

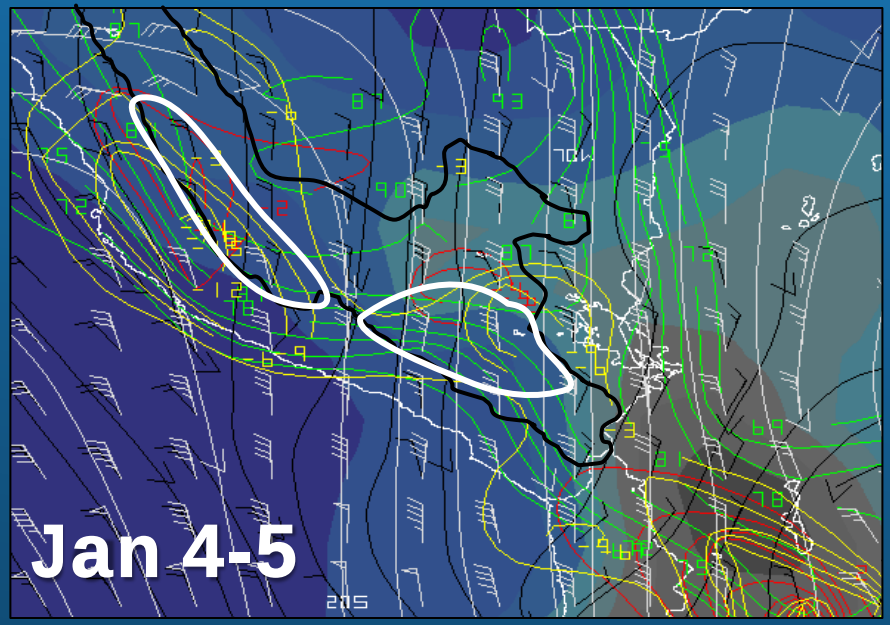
$OMEG_{400-450}$= -2 to -12 microbar/s

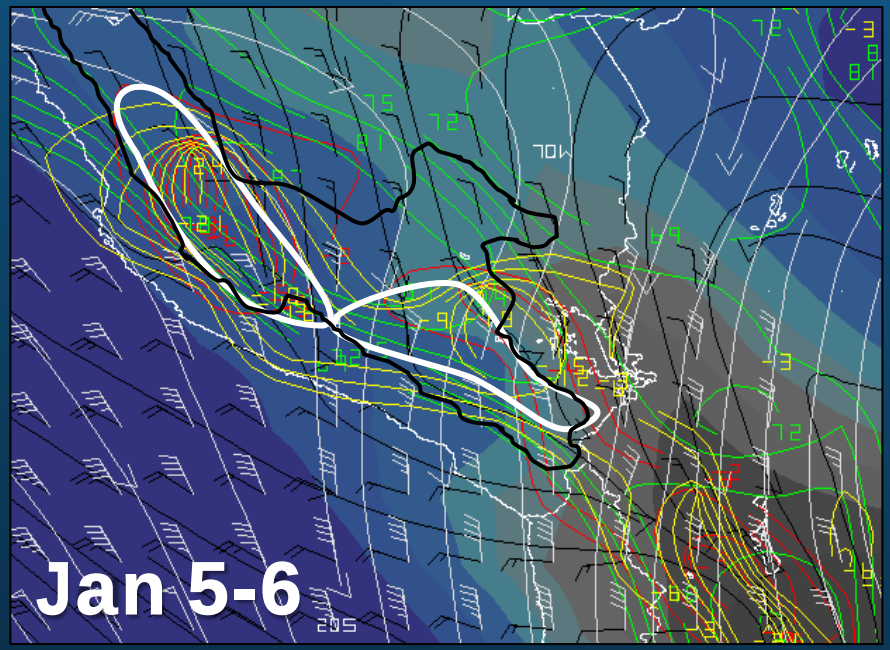
Div(mass)= -8 to -24



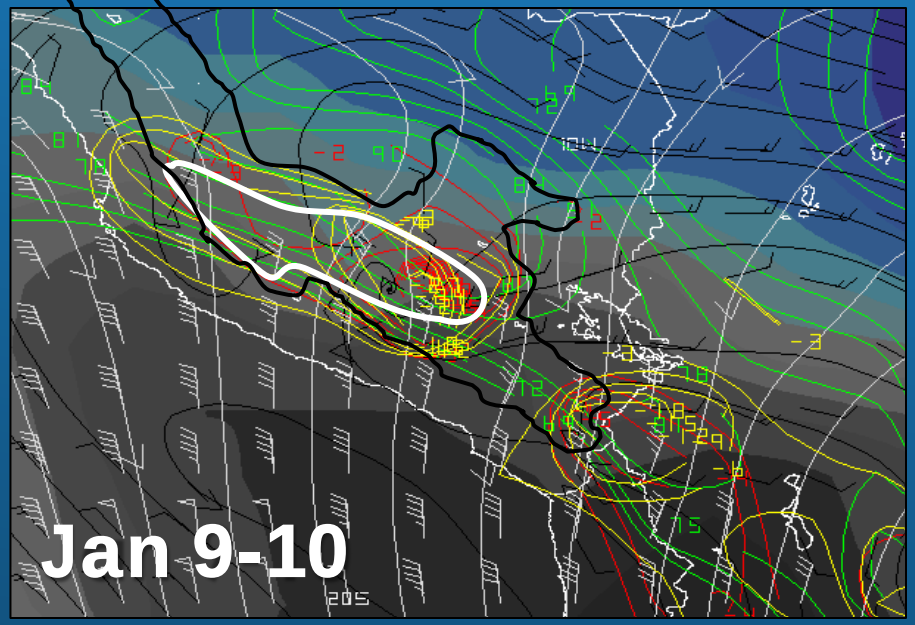
Moderate snow in high elevation, snowline receeding

SNOWIEST DAYS





SNOW FREE DAY



- Temperature was the dominant factor
- Usually mid-level temps do not change much in January, and they are often warmer than -2C

CONCLUSIONS

Four predictors were identified in order of importance

(1) Temperature$_{\text{500-550hPa layer}}$	**≤ -2.8 C [27F]**
(2) Moisture flux divergence$_{\text{500-500 hPa}}$	≤ -6x$10^{8} m^{-2}.s^{-2}$
(3) Relative humidity$_{\text{500-550hPa layer}}$	≥ 75%, gradient helps
(4) Omegas at 400-450 hPa.	≤ -2 $bar.s^{-1}$

Upper synoptic features:

- Upper trough over central Peru / Subtropical high to the south east.

Mid-level features:

- Enhanced confluence and moisture flux convergence along and/or to the southwest of the western cordillera.
- RH gradient along western cordillera (often, not always).
- Adiabatic ascent and cooling within dry tier of RH gradient helps, not compulsory (SW winds preferable)
- Moist air mass to the east off the western cordillera.