

SEASONAL CLIMATE PREDICTIONS IN PERU

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SENAMHI PERU

Asia Pacific Climate Symposium APEC/APCC

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Lima-Peru

OUTLINE

I. Global Numerical Modelling in SENAMHI

1.1 Statistical Downscaling: CCM3-MOS

1.2 Dynamical Downscaling:

CCM3-RAMS

CAM – CMM5

II. Statistical Modelling

III. Integrated Seasonal Climate Forecast System

IV. Verification of Seasonal Climate Forecast

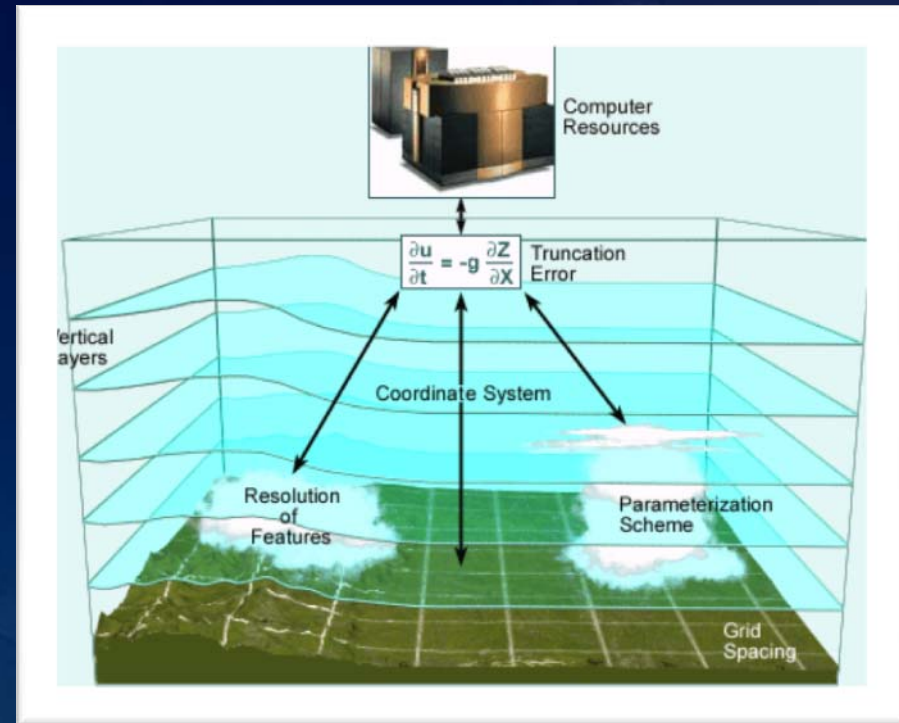
V. Products

VI. Future Challenges

VI. Remarks

I. CLIMATE MODELLING IN SENAMHI

- Global Atmospheric Model - NCAR
- Resolution T42 $\approx 2,8^\circ$
- Convective Parameterization (Zhang y McFarlane, 1995)
- Land Surface Model (LSM) (Bonan, 1996) for the behavior of the surface processes.
- 18 vertical levels and a rigid top at the 2.917mb level.
- Hybrid Vertical Coordinates (Simmons y Strüfing, 1981).



PRE – PROCESSING CCM3

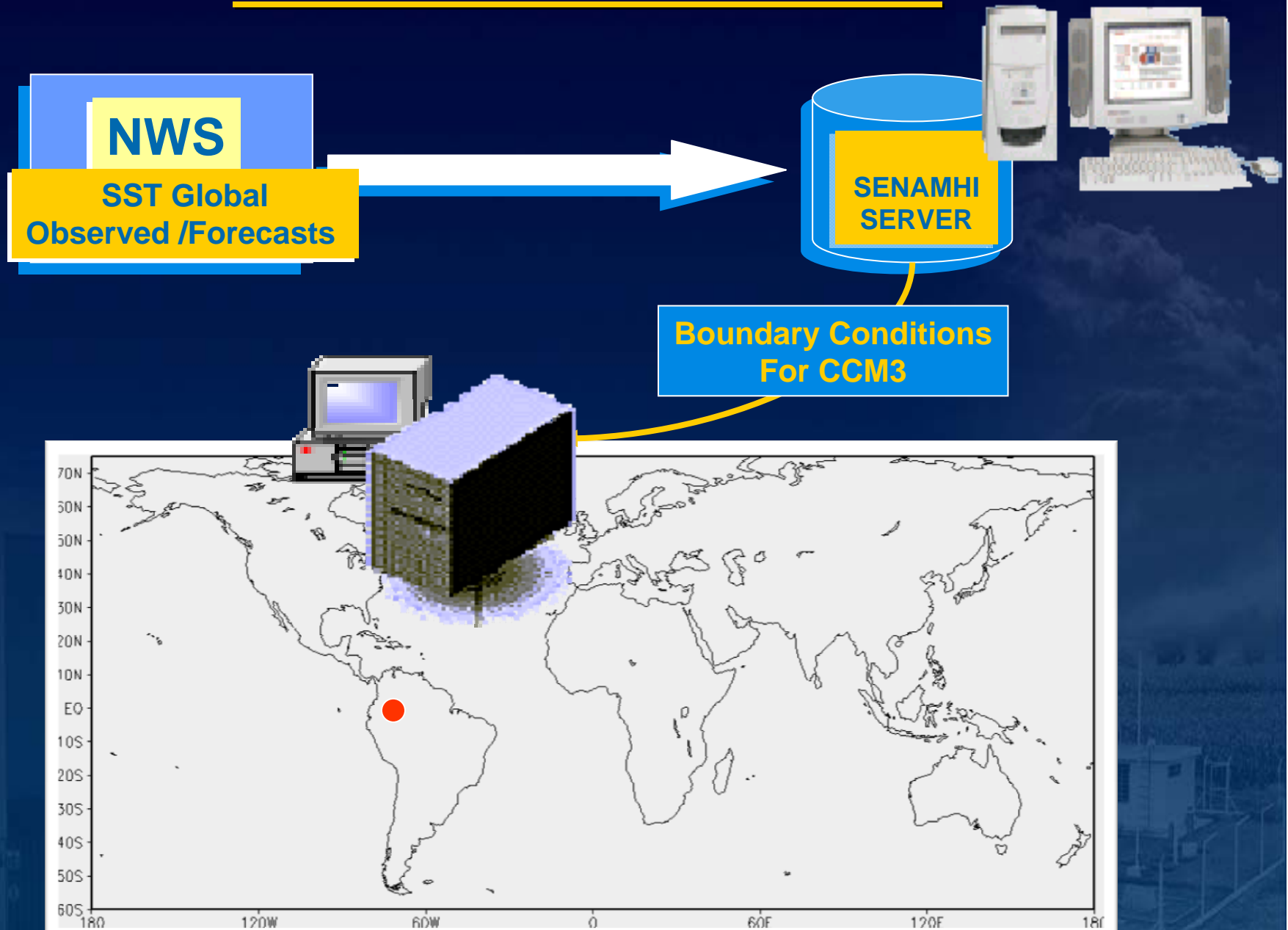
Initial Conditions :

- Specific Humidity at 18 levels
- Temperature at 18 levels
- Zonal Wind (U) at 18 levels
- Meridional Wind (V) at 18 levels
- Surface Pressure (Ps)

Boundary Conditions

- Sea Surface Temperature (SST) analyzed/forecasted
- Ozone Mixing Ratio
- LSM: Surface type, soil color, percentage of lime, clay and sand, and lakes and rivers.

PRE – PROCESSING CCM3



PROCESSING : DETERMINISTIC RUNS

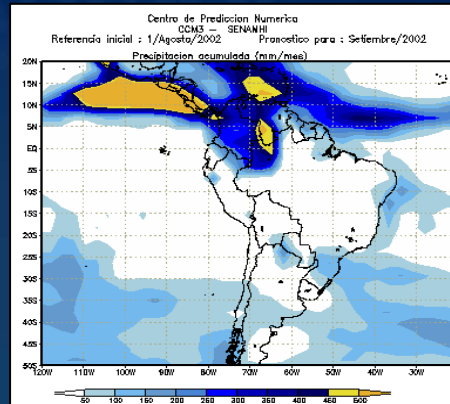
Initial Conditions

Pre-processing of
analyzed/forecasted
data

CCM3
Process

Post-process:
Forecast of
atmospheric variables

Boundary
Conditions



Output:
1 Forecast or
Climate Scenario

High uncertainty!!!

PROCESSING : ENSEMBLES

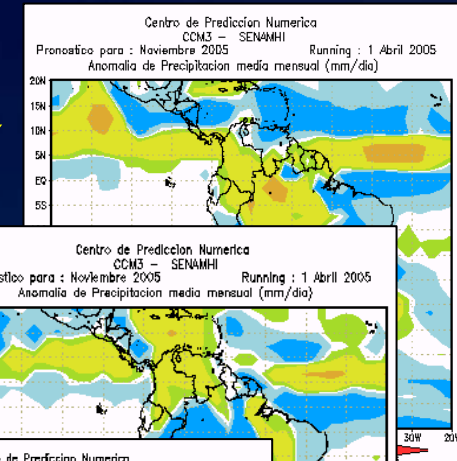
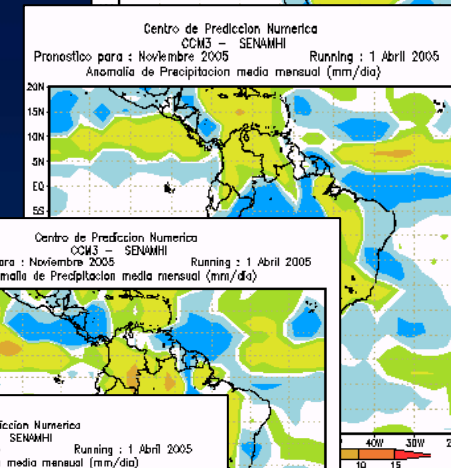
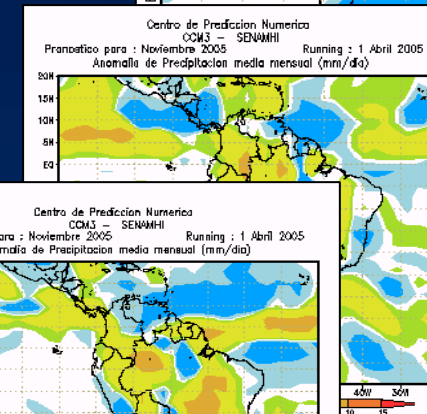
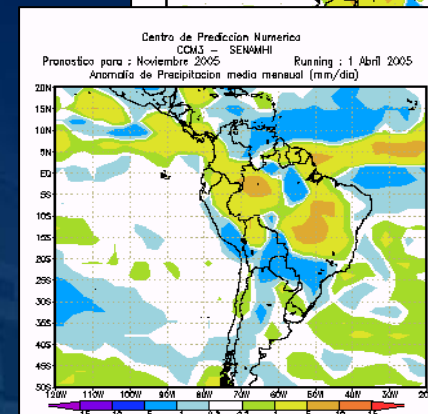
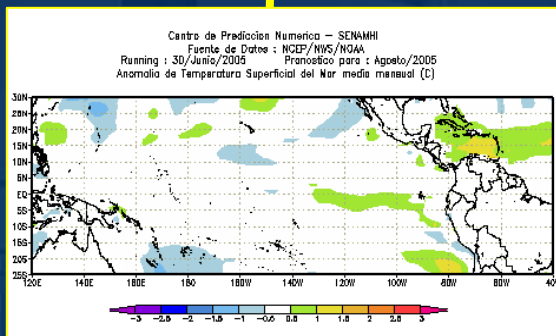
Initial Conditions

Pre-processing of
analyzed/forecasted
data

Boundary
Conditions
with modified SST

CCM3
Process

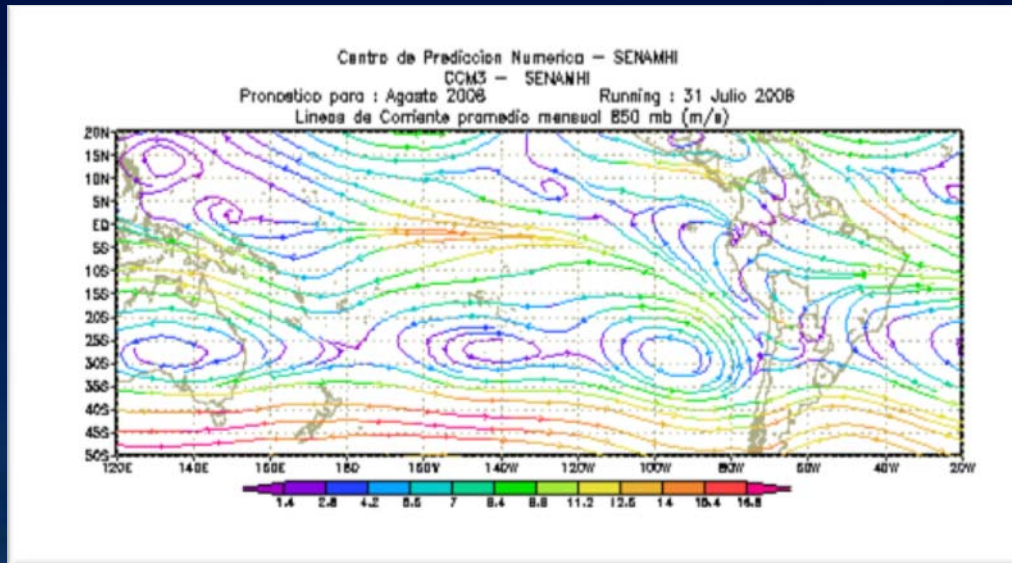
Post-process: Forecast



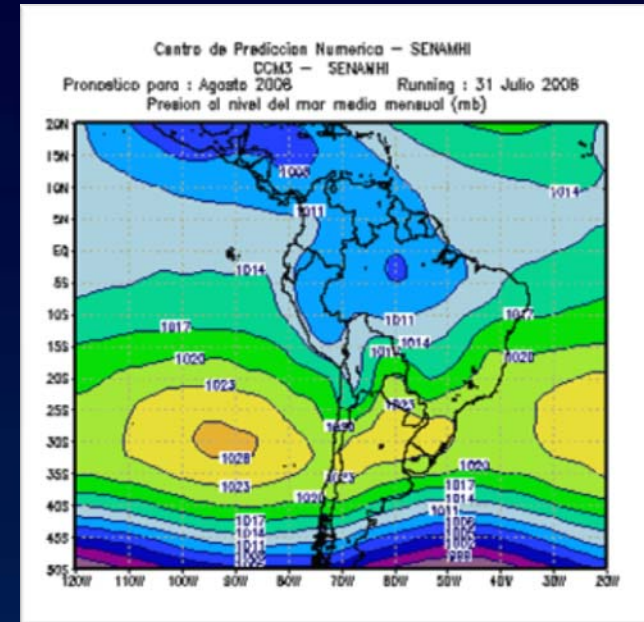
12 ensemble
outcomes

CCM3 MODEL OUTPUTS

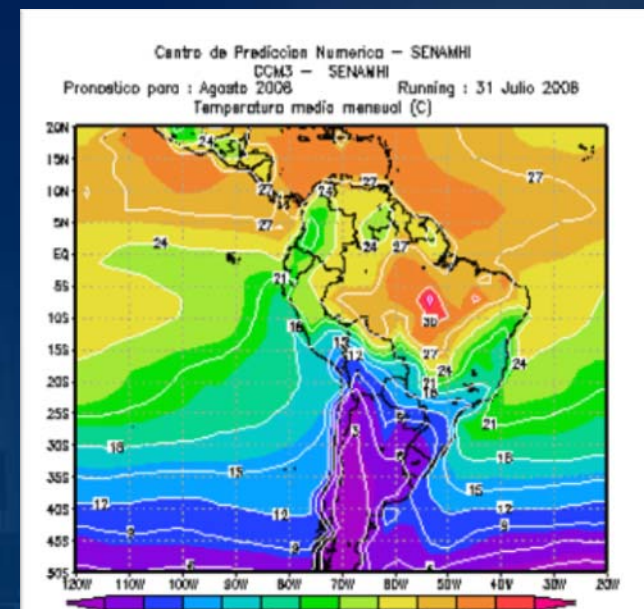
Wind streamlines of the Tropical Pacific at 850mb



Sea surface pressure



Monthly Mean Temperature



1.1 STATISTIC DOWNSCALING

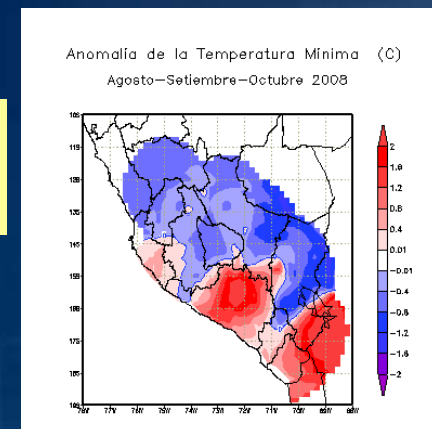
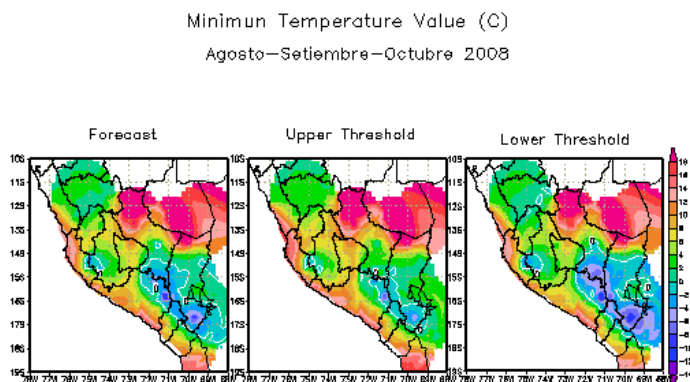
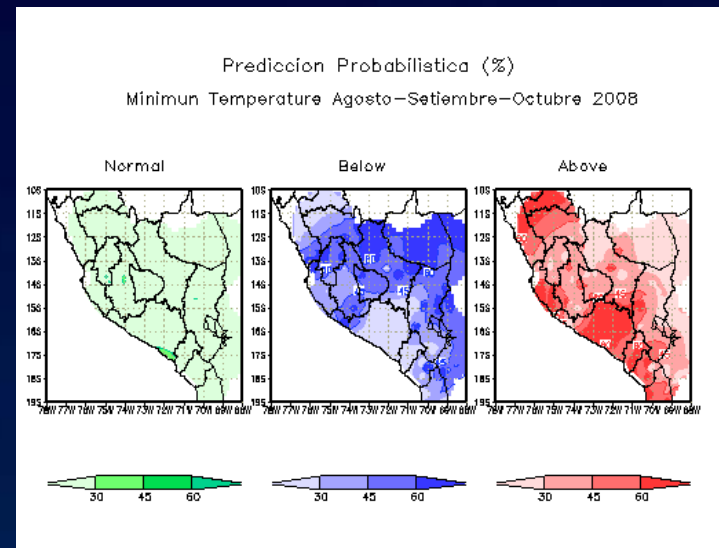
**Predictant:
Historical data**

**Predictor:
Output of CCM3**

**MOS:
Canonical
Correlation
Analysis**

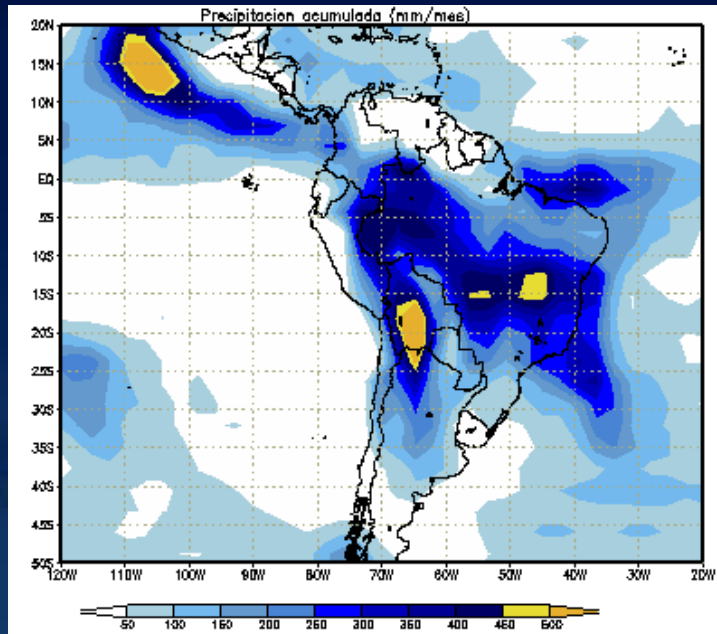
**Output:
Higher Resolution of CCM3**

**Result:
Forecast**



1.2 DYNAMIC DOWNSCALING

Downscaling CCM3-RAMS (Regional Atmospheric Modeling System)



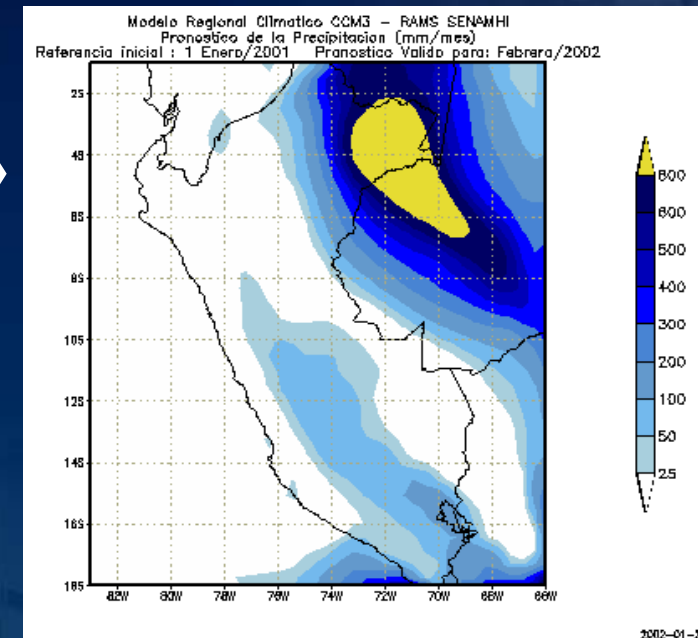
CCM3

Horizontal Resolution : 280 Km.

**Downscaling
RAMS**

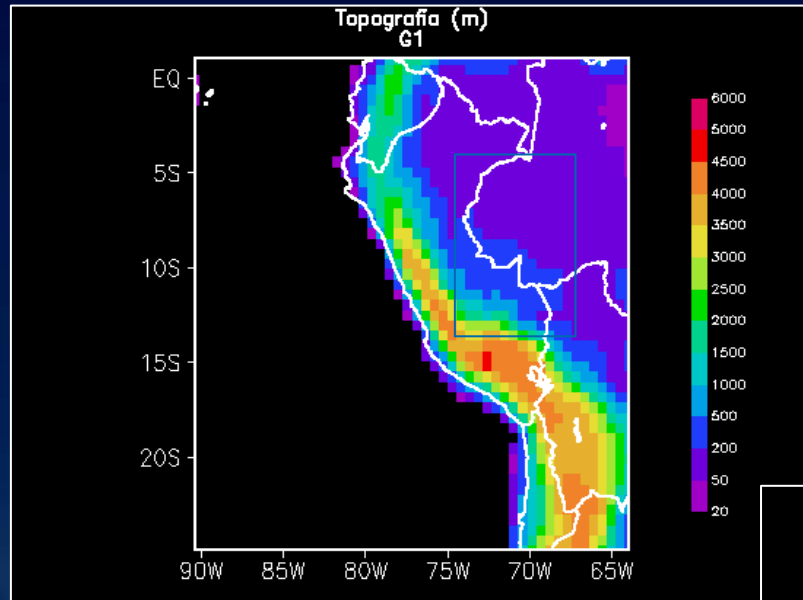
RAMS

Horizontal Resolution: 60 Km

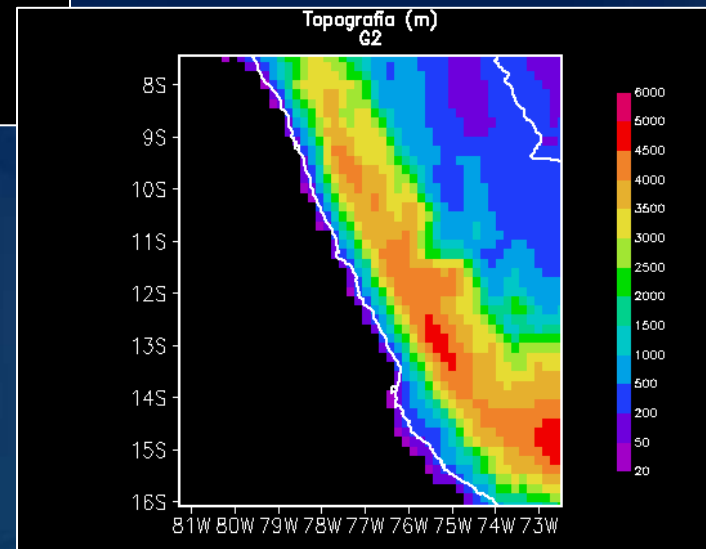


2002-01-3

DYNAMICAL DOWNSCALING: NESTING

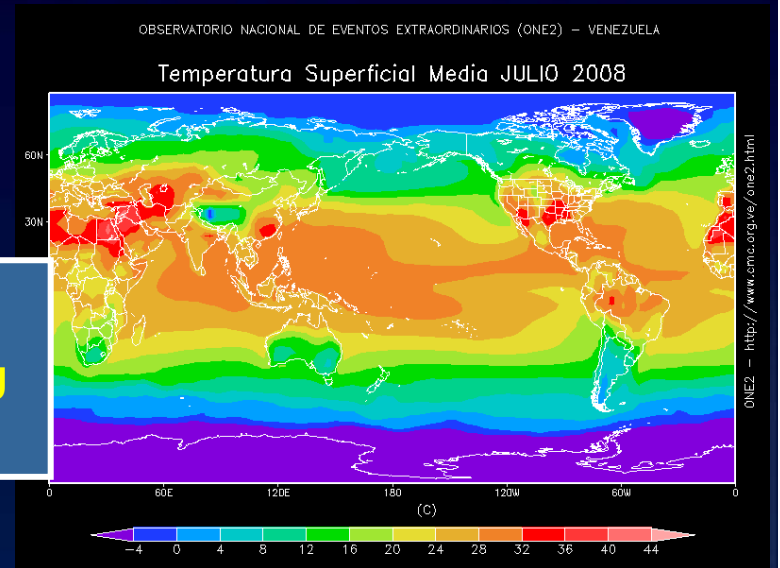


60 Km



20 Km

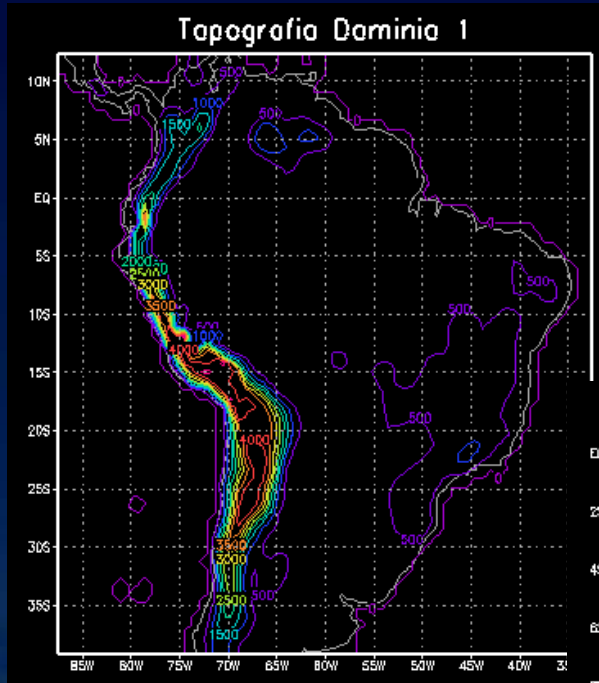
Dynamical Downscaling CAM-CMM5



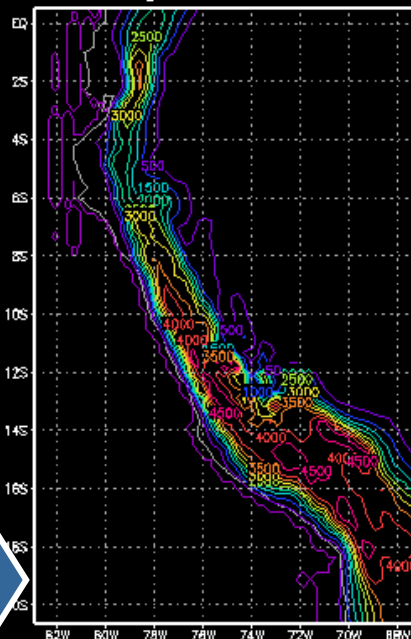
Downscaling

90 km

280 km



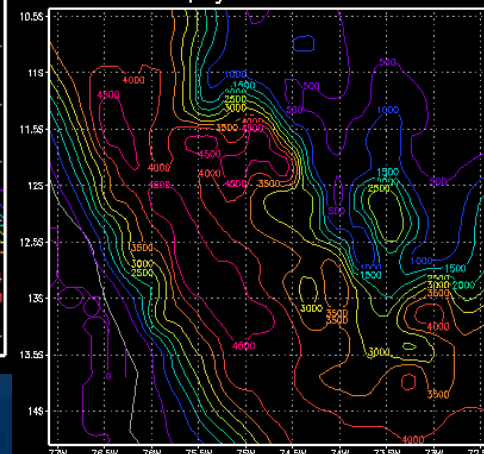
Topografía Dominio 2



30 km

Nesting
CMM5

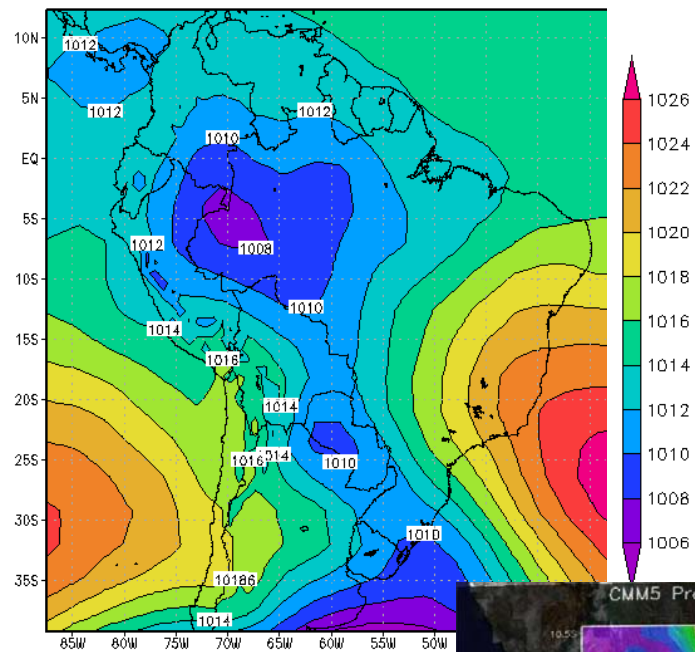
Topografía Dominio 3



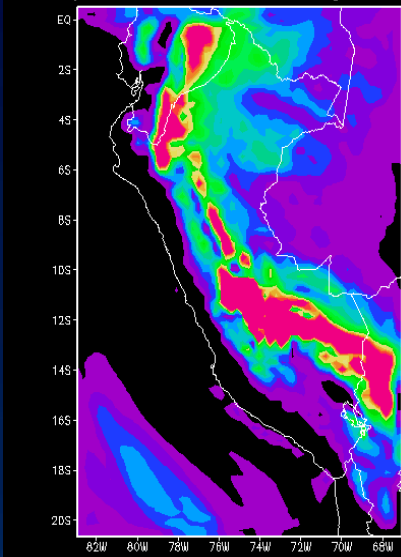
10 km

CAM – CMM5 OUTPUTS

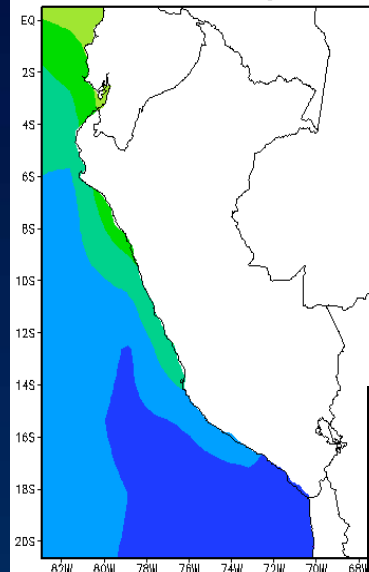
Presion a Nivel del Mar Agosto 2008
CAM-CMM5



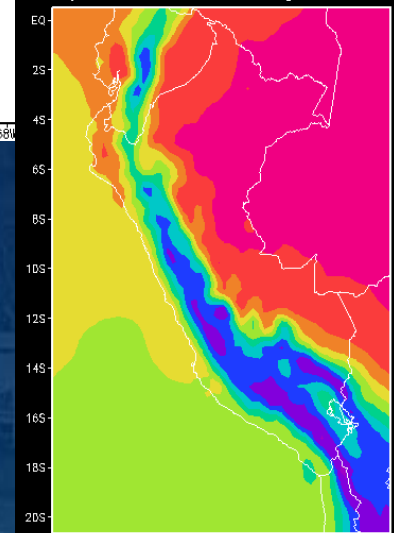
Precipitacion Acumulada Agosto 2



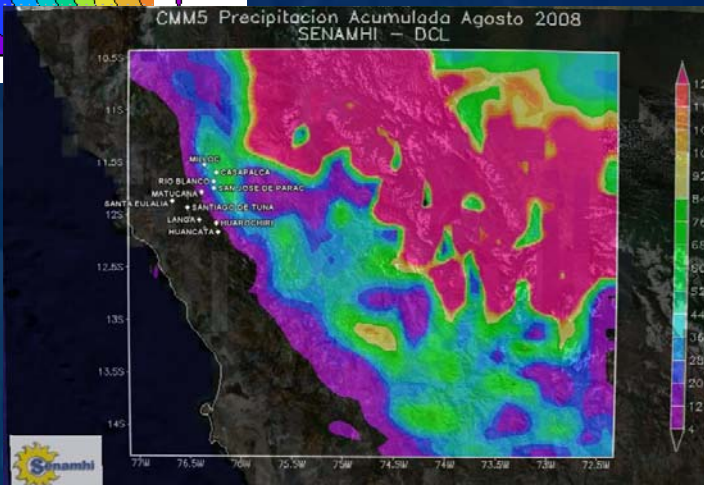
TSM Pronosticada Agosto 2008



Temperatura Media Agosto 20



CMM5 Precipitacion Acumulada Agosto 2008
SENAMHI – DCL



II. STATISTICAL MODELLING

CLIMATE PREDICTABILITY TOOL - IRI

- Climate Predictability Tool (CPT) provides:
 - Climate Seasonal Forecasting
 - Model Validation
 - Uses data input files from IRI Library
- Options:
 - Principal Components Regression (PCR)
 - Canonical Correlation Analysis (CCA)
 - Multiple Linear Regression (MLR)

STATISTICAL FORECASTING PROCEDURES

➤ **PREDICTOR (INDEPENDENT VARIABLES):**

- **SST**
- **TEMPERATURE (850, 500, ..)**
- **WIND (U, V)**
- **OLR**
- **PRESSURE**
- **VERTICAL VELOCITY**
- **GEOPOTENTIAL HEIGHT**

➤ **PREDICTANT (DEPENDENT VARIABLES):**

- **TEMPERATURE**
- **PRECIPITATION**

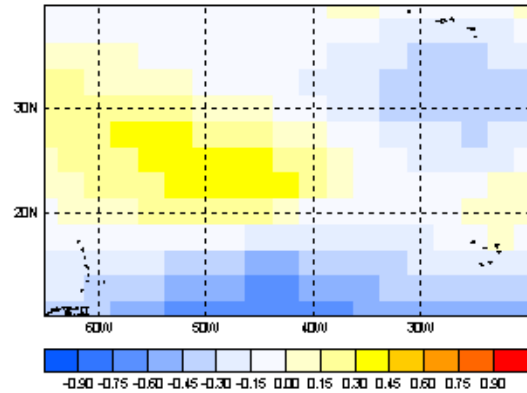
➤ **INPUT AND OUTPUT:**

- **MONTHLY MEAN**
- **BI-MONTHLY MEAN**
- **TRI-MONTHLY MEAN**

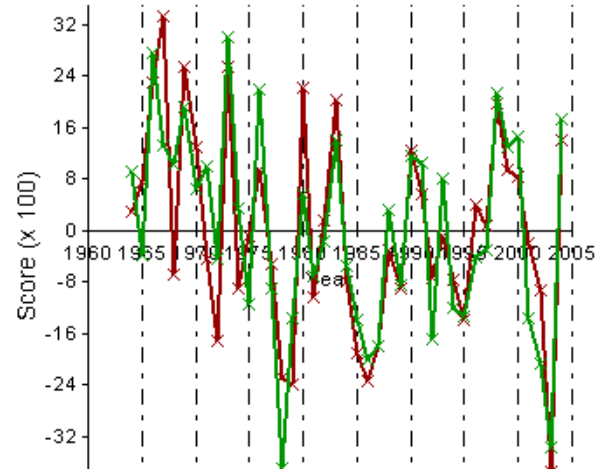
CCA mode: Canonical correlation: 0.8412

WIND 250 MB

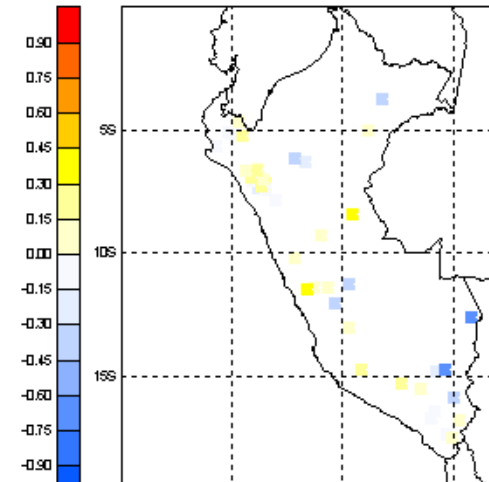
X Spatial Loadings (EOF1)



Temporal Scores (Model)



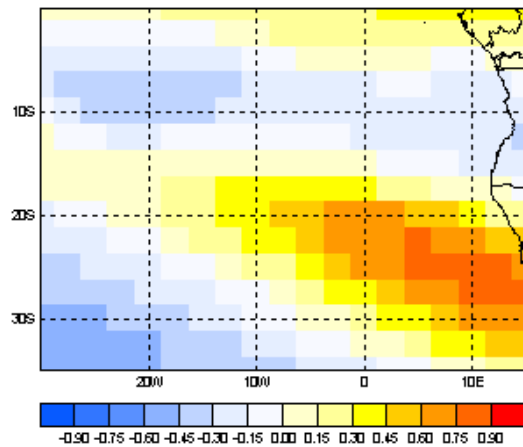
Y Spatial Loadings (EOF1)



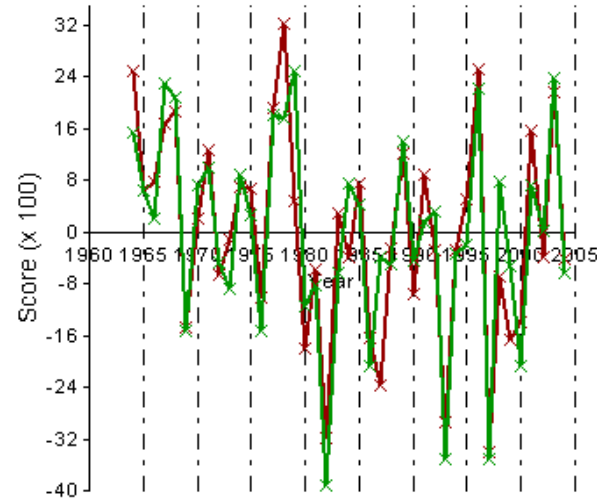
CCA mode: Canonical correlation: 0.8806

WIND 500 MB

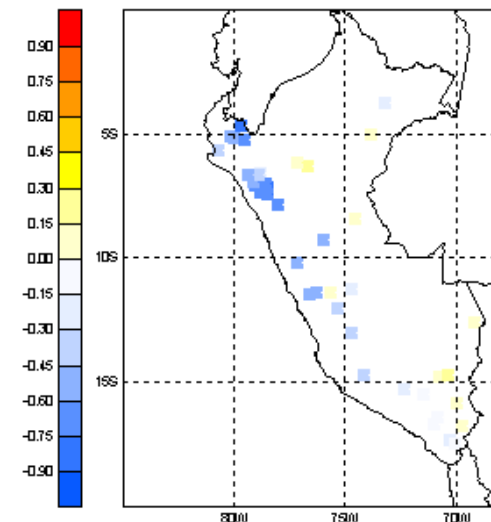
X Spatial Loadings (EOF1)



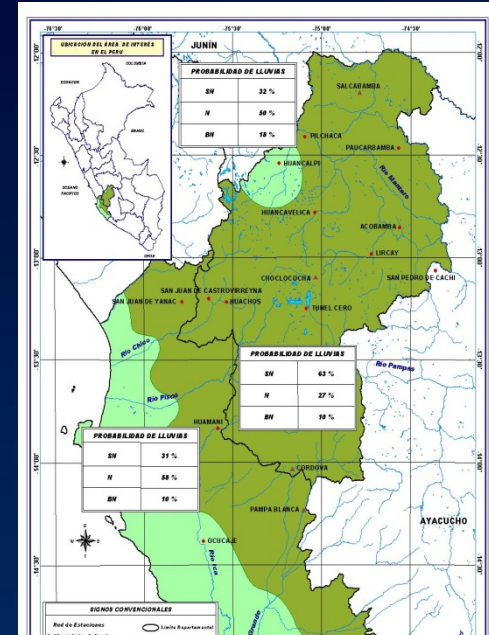
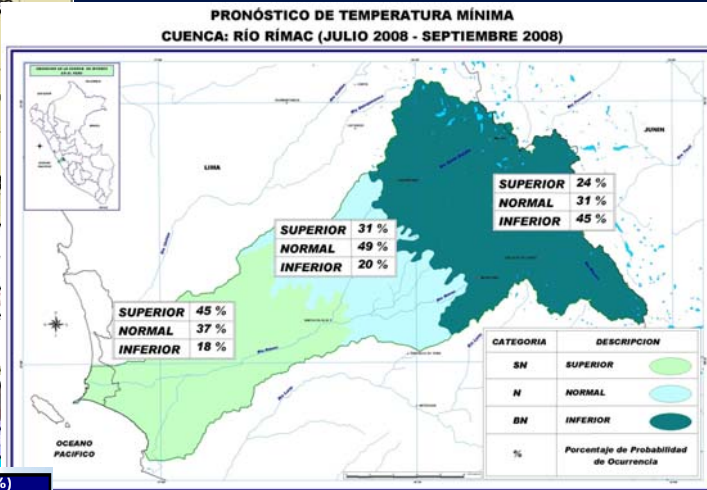
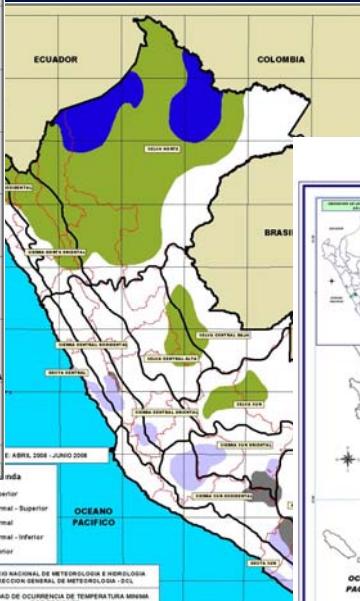
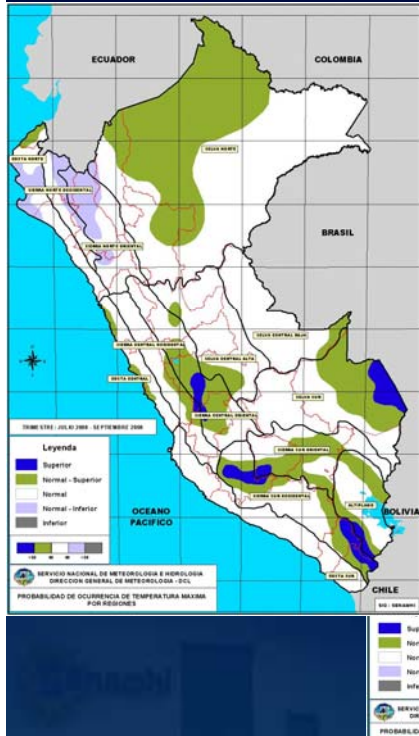
Temporal Scores (Model)



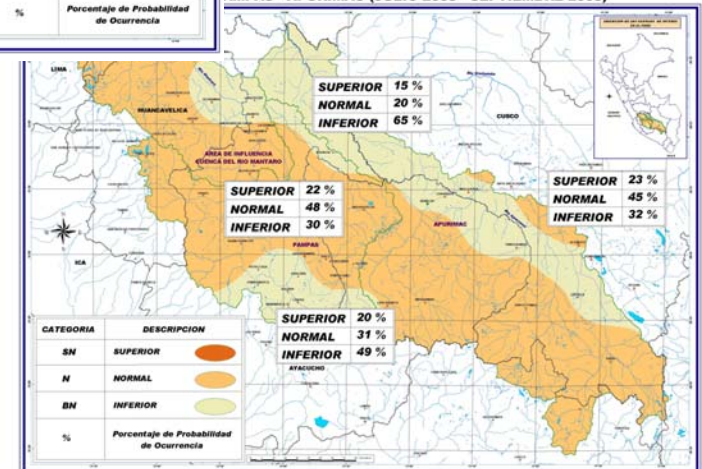
Y Spatial Loadings (EOF1)



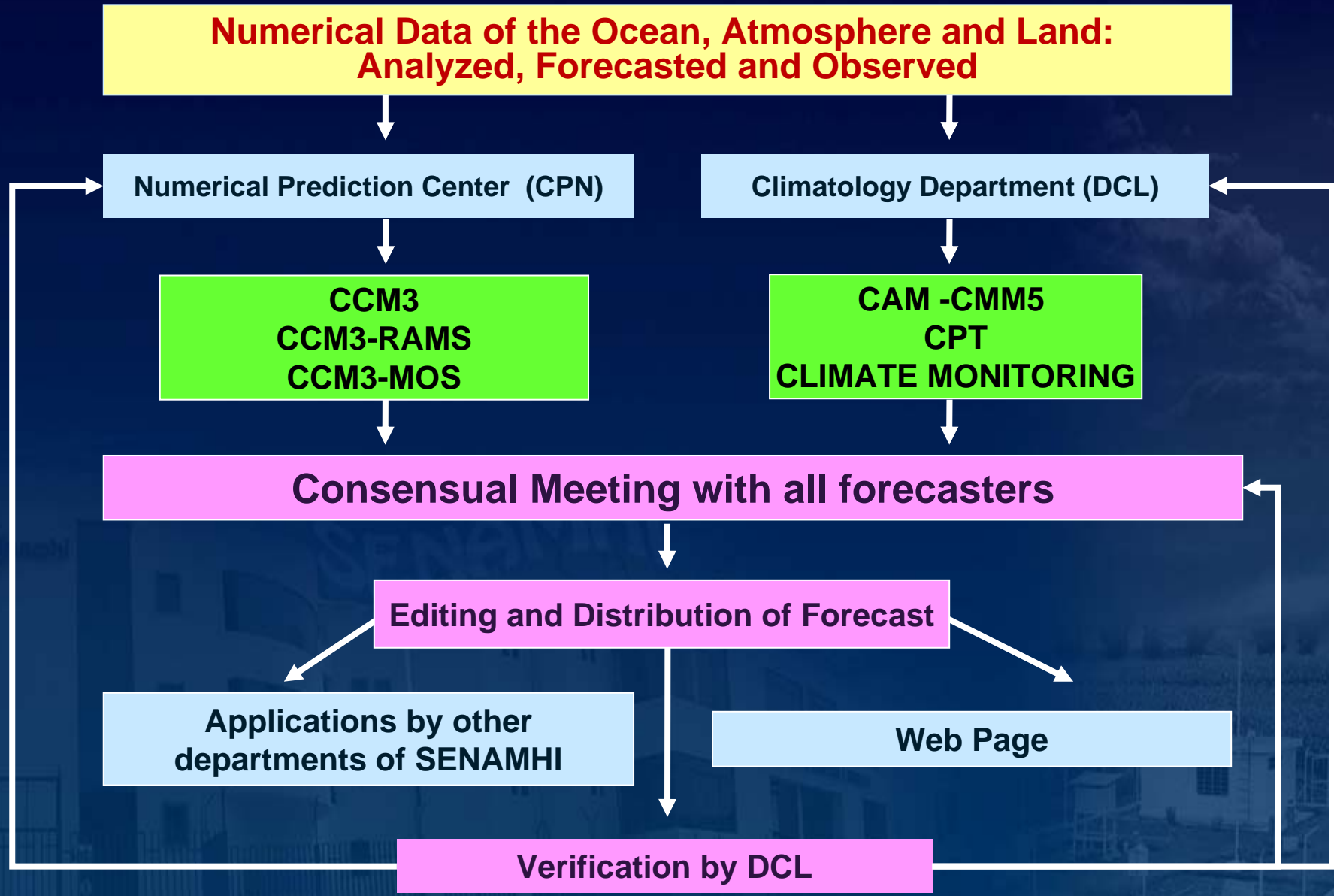
STATISTICAL MODEL OUTPUTS



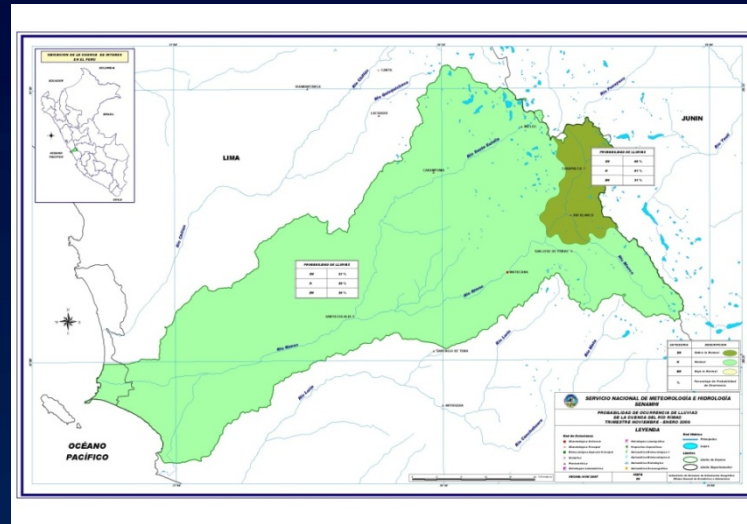
SECTOR	PROBABILIDAD DE OCURRENCIA EN PORCENTAJE (%)			CLASIFICACION
	BAJO	NORMAL	ALTO	
COSTA NORTE	15	55	30	Normal
COSTA NORTE (SUR)	20	60	20	Normal
COSTA CENTRO	20	55	25	Normal
COSTA SUR	15	60	25	Normal
SIERRA NORTE OCCIDENTE	15	65	20	Normal
SIERRA NORTE ORIENTE	10	50	40	Normal a Superior
SIERRA CENTRAL OCCIDENTAL	45	40	15	Normal a Inferior
SIERRA CENTRAL ORIENTAL	15	58	27	Normal
SIERRA SUR OCCID.	45	40	15	Normal a Inferior
SIERRA SUR ORIENTAL	45	42	13	Normal a Inferior
SELVA NORTE	10	40	50	Normal a Superior
SELVA CENTRAL BAJA	10	55	35	Normal
SELVA CENTRAL ALTA	15	40	45	Normal a Superior
SELVA SUR BAJA	35	55	10	Normal
SELVA SUR ALTA	20	60	20	Normal
HOYA TITICACA	40	40	20	Normal



III. INTEGRATED SEASONAL CLIMATE FORECAST SYSTEM



IV. VERIFICATION OF SEASONAL CLIMATE MODEL



PRECIPITACI?

Estaci?	2007 -2008				LIMITE NORMAL (mm)		DATOS PRONOSTICADOS	DATOS OBSERVADOS	
	Nov	Dic	Ene	Promedio	LIMITE INFERIOR	LIMITE SUPERIOR			
Carampoma	22.9	50.9	130.3	204.1	130.3	176.1	N	S	
Matucana	0.0	26.9	75.5	102.4	82.8	116.3	N	N	ACIERTO
San Jos? de P	19.6	69.4	133.6	222.6	207.7	261.3	N	N	ACIERTO
Canta	12.2	22.3	99.1	133.6	122.3	171.0	N	N	ACIERTO
Huaro-chiri	9.0	40.4	232.4	281.8	87.8	136.7	N	S	
Marcapomaco	64.6	105.6	190.5	360.7	359.2	445.0	N	N	ACIERTO
Milloc	59.1	77.3	192.6	329.0	324.0	413.1	N	N	ACIERTO
Rio Blanco	25.1	79.2	139.3	243.6	171.1	223.8	S	S	ACIERTO
Casapalca	46.8	65.0	162.9	274.7	215.9	281.7	S	N	
Santiago de T	11.4	18.4	62.9	92.7	75.1	136.9	N	N	ACIERTO
Antioquia	0.0	2.0	16.7	18.7	13.8	34.1	N	N	ACIERTO
Tanta	66.5	108.1	219.0	393.6	278.7	395.3	N	N	ACIERTO
Lachaqui	18.0	29.7	116.3	164.0	161.3	253.7	N	N	ACIERTO
Huamantanga	5.3	11.1	105.0	121.4	86.5	130.6	N	N	ACIERTO
Santa Eulalia	0.6	1.0	12.7	14.3	4.5	18.3	N	N	ACIERTO
Autisha	0.0	0.0	62.2	62.2	41.8	78.4	N	N	ACIERTO

PORCENTAJE DE ACIERTO 81.3%

V. PRODUCTS

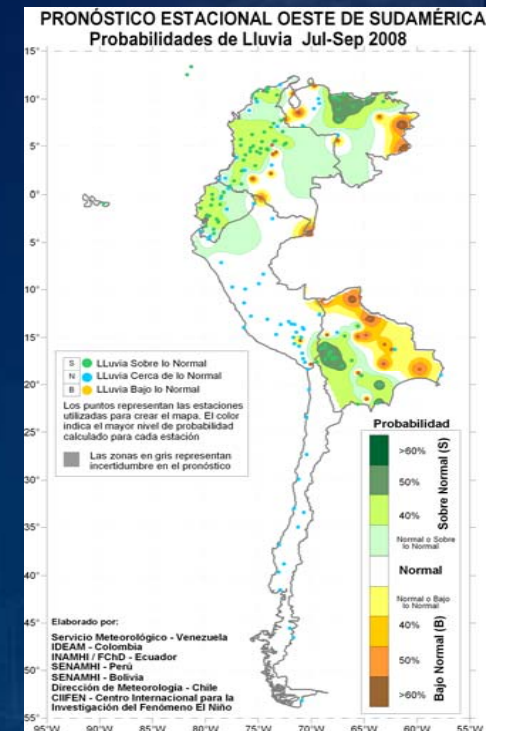
Website www.senamhi.gob.pe

- Early Warnings
- Climate Forecasts.

Bulletins :

- Meteorological & Hydrological
- Agro meteorological

Regional Climate Forecast - CIIFEN



VI. FUTURE CHALLENGES

- Increase our capacity
- Enhance our professional knowledge about methods and techniques on climate prediction.
- Run the atmosphere model CAM in a operational mode
- Incorporate WRF Model as a tool.
- Incorporate new SST forcing (from others International Prediction Centers).
- Improve verification of the statistical and dynamical models.
- Adopt suitable parameterizations for a better climate simulation.

VII. REMARKS

The continuous implementations of new dynamical and statistical tools and techniques, as well as climate monitoring and the expertise of our forecasters improves the forecast quality.

Due to the users needing of climate forecasts, the SENAMHI aims to improve the climate prediction in terms of accuracy and anticipation. Our mission is to contribute to the national socio-economic development and to protect the wellbeing of the Peruvian population.



THANK YOU !!