The Winter Component of T-PARC
January – March 2009

T-PARC

THORPEX – Pacific Asian Regional Campaign

Contributors:

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T-PARC: THORPEX – Pacific Asian Regional Campaign

- **Tropical Field Phase (Aug – Oct 2008)**
  West Pacific
- **Winter Field Phase (Jan – Mar 2009)**
  North Pacific

THORPEX is a long-term WMO program to accelerate improvements in the accuracy of 1-14 day weather forecasts, and the quality of information provided to users of forecast products

www.wmo.int/pages/prog/arep/thorpex/

World Meteorological Organization
Working together in weather, climate and water

MAIN THEMES OF WINTER T-PARC

To study the lifecycle of perturbations as they originate from the tropics, Asia, and/or the polar front, travel through the Pacific waveguide, and affect high-impact wintertime weather events over North America and the Arctic

To improve deterministic and probabalistic model forecasts of high-impact weather for North America and the Arctic – winter storms, floods, high winds - with a focus on medium-range prediction

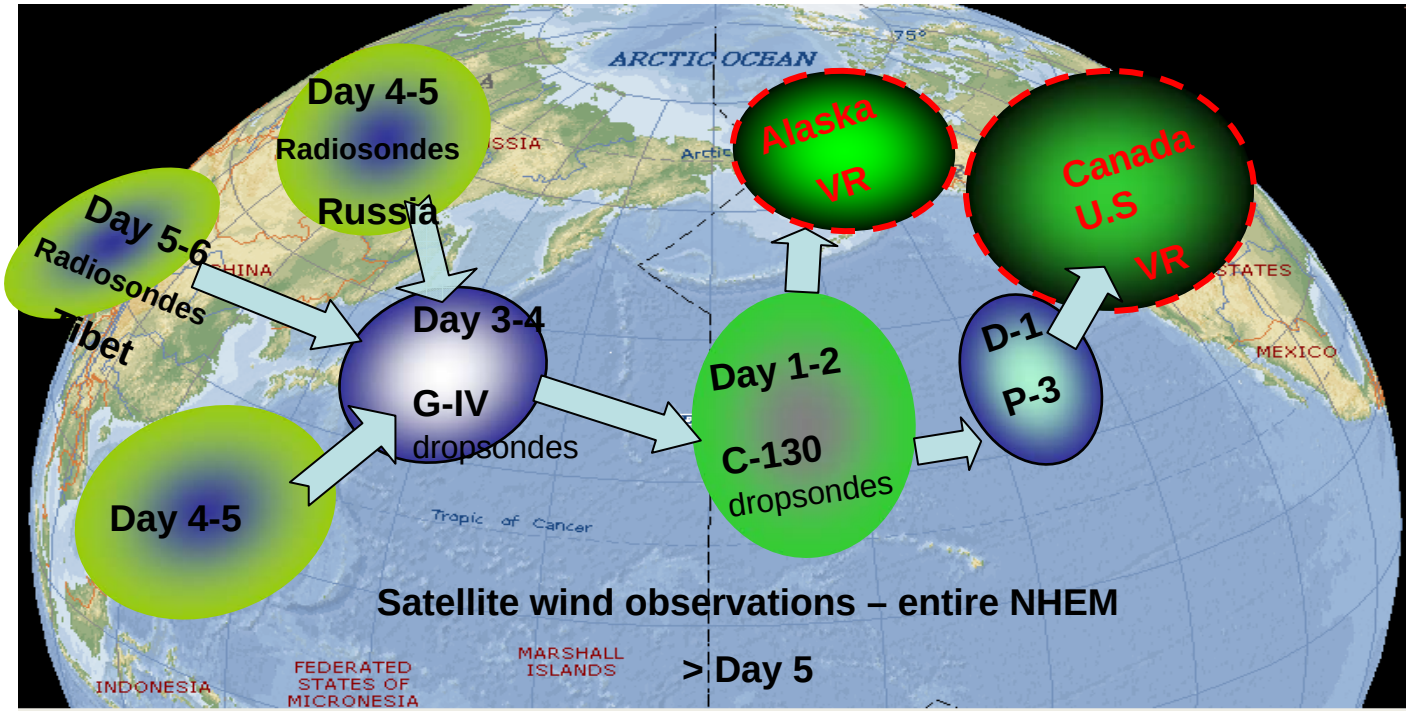
To more-effectively select and assimilate regular and targeted observations from satellite and in-situ platforms

Winter T-PARC Participants

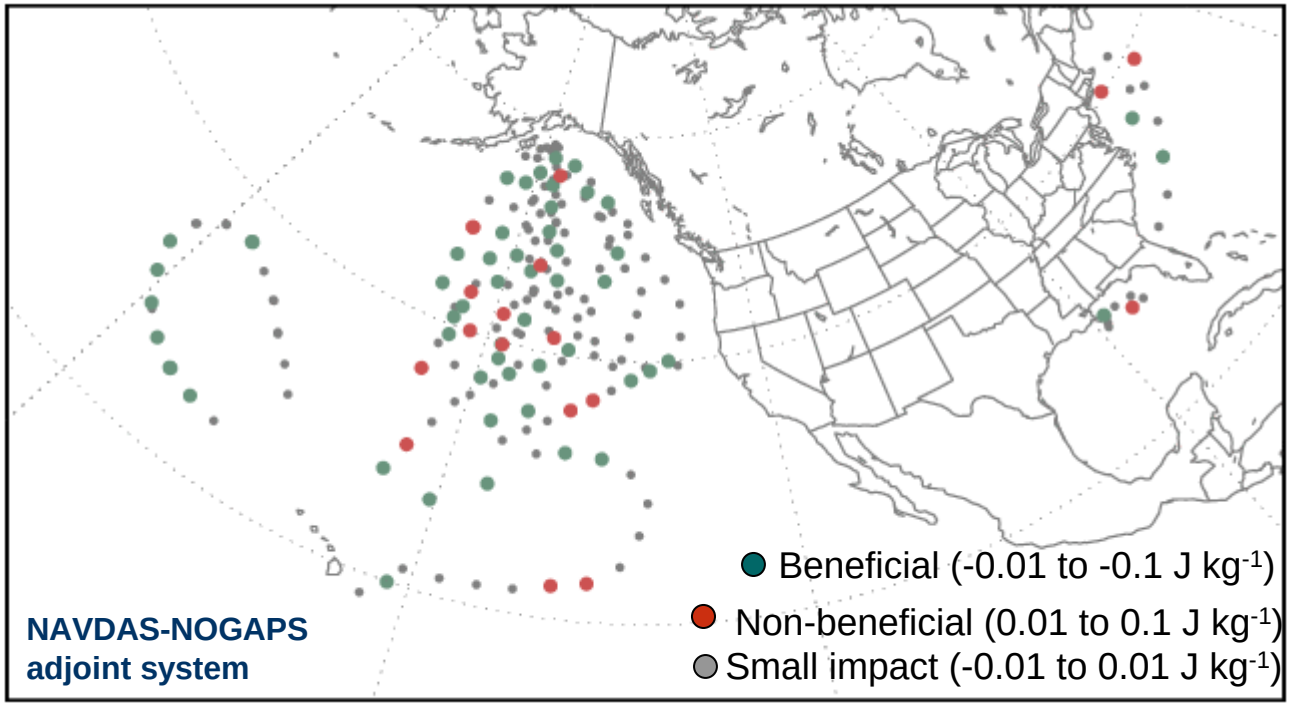
- NCEP / NOAA (G-IV, targeting, evaluation)
- USAF (C-130)
- NCAR (data archive, field operations)
- Environment Canada (targeting, evaluation)
- NRL- Monterey (targeting, evaluation)
- UKMO (targeting, evaluation)
- ECMWF (targeting, evaluation)
- CIMSS (satellite wind processing)
- Russia (raobs)
- China (raobs)
- Japan (driftsonde, raobs)
- Meteo France (driftsonde)

T-PARC: First field program to study entire north Pacific Storm Track

- Events incipient to perturbations on entrance region of westerly jet
  - Tibetan Plateau, Siberia, Western Pacific
- Follow evolution of events traveling along westerly jet with group velocity
  - Entrance region of westerly jet, Mid Pacific, Eastern Pacific



NOAA Annual Winter Storm Reconnaissance Program
Targeted dropsondes to improve 1-3 day forecasts



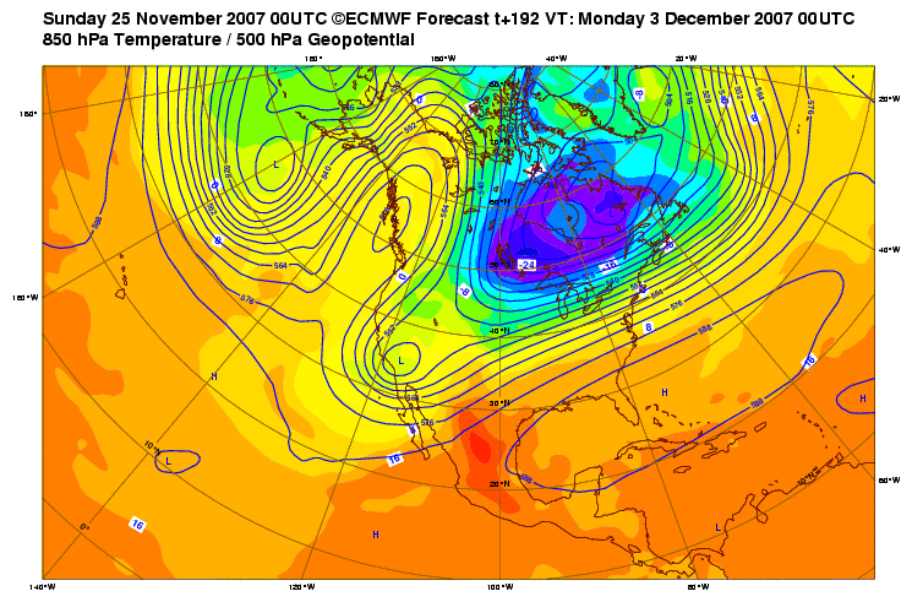
Each dot represents one complete dropsonde profile of temperature, wind, and humidity observations

Shown above: Jan-Feb 2006 dropsonde impact on 24h error

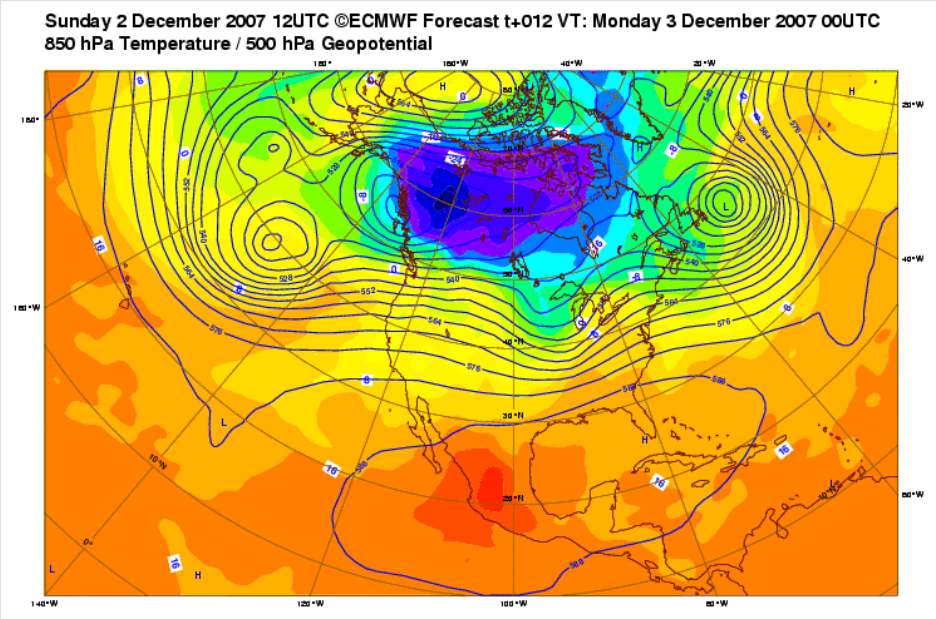
Average dropsonde profile impact on forecast skill is beneficial and ~2-3x greater than average radiosonde profile impact

ECMWF T799 T850 and Z500 forecast for **00UTC 3 Dec 2007**

192 h forecast



12 h forecast

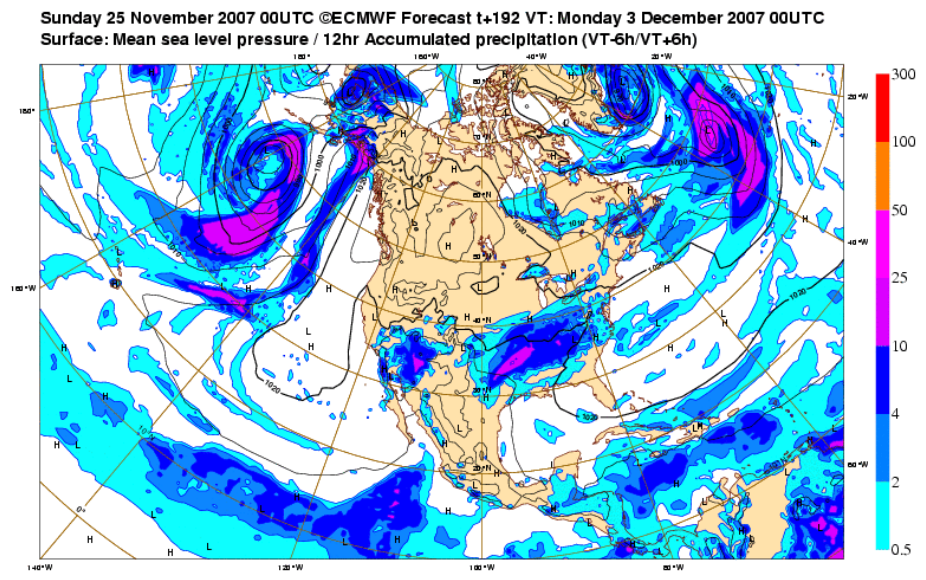


Why did this 8-day forecast fail to predict the observed event ?

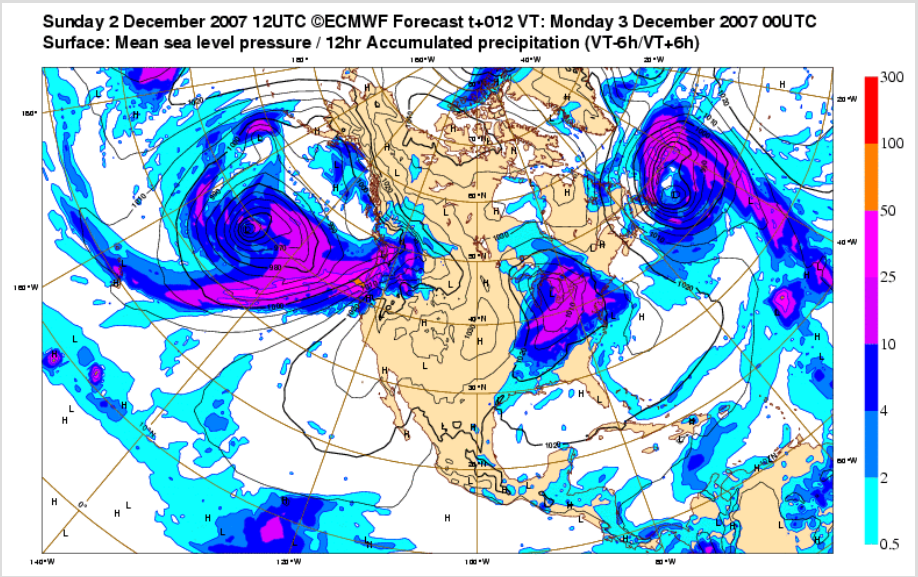
1) **Lack of enough/quality observations ?**
2) **Inability to properly assimilate observations ?**
3) **Model not able to simulate events ?**

ECMWF T799 MSLP and Precip forecast for **00UTC 3 Dec 2007**

192 h forecast



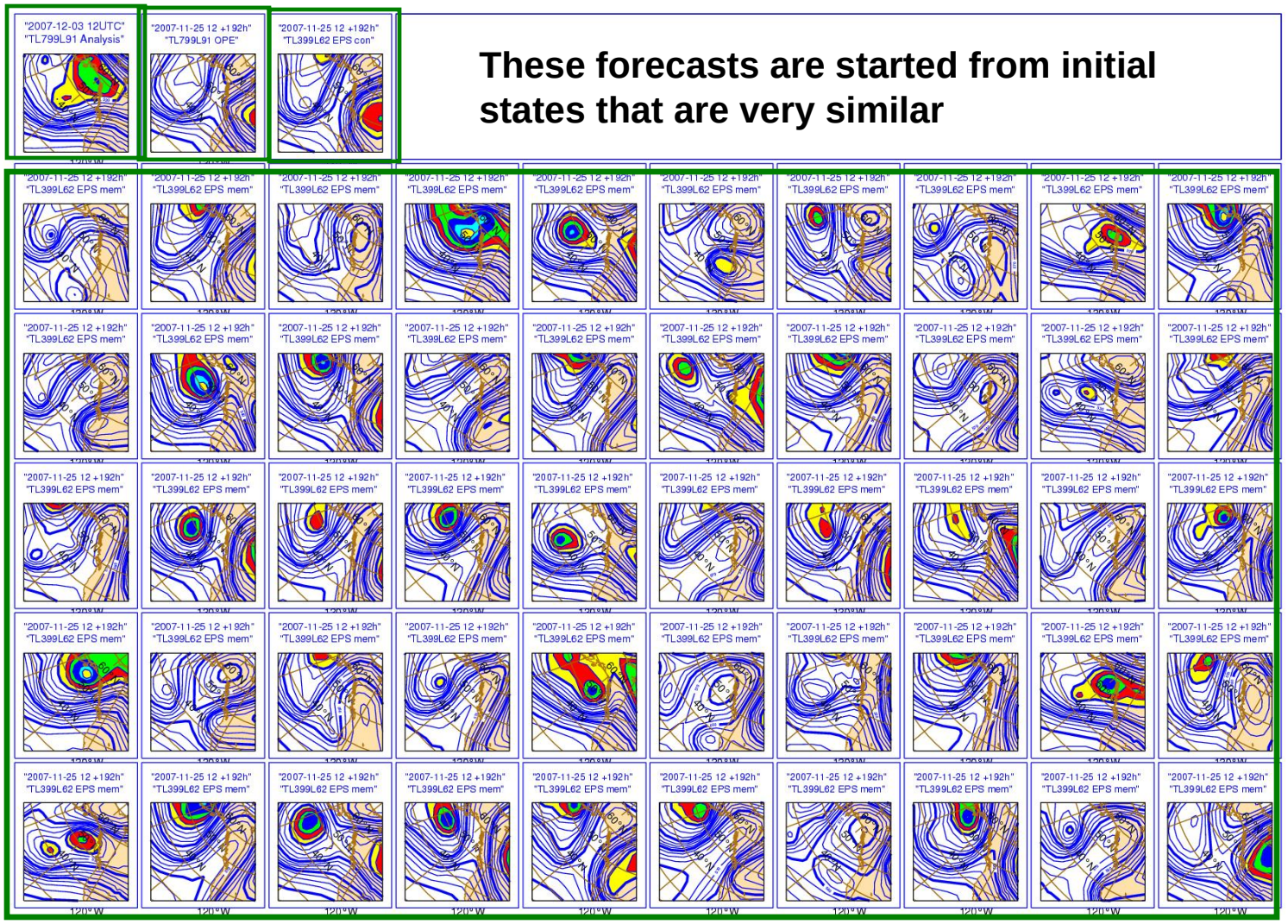
12 h forecast



T799 and EPS +192h Z500 forecast for 12UTC 3 Dec 2007

Top row: T799 analysis, T799 fcst and T399 EPS-con fcst

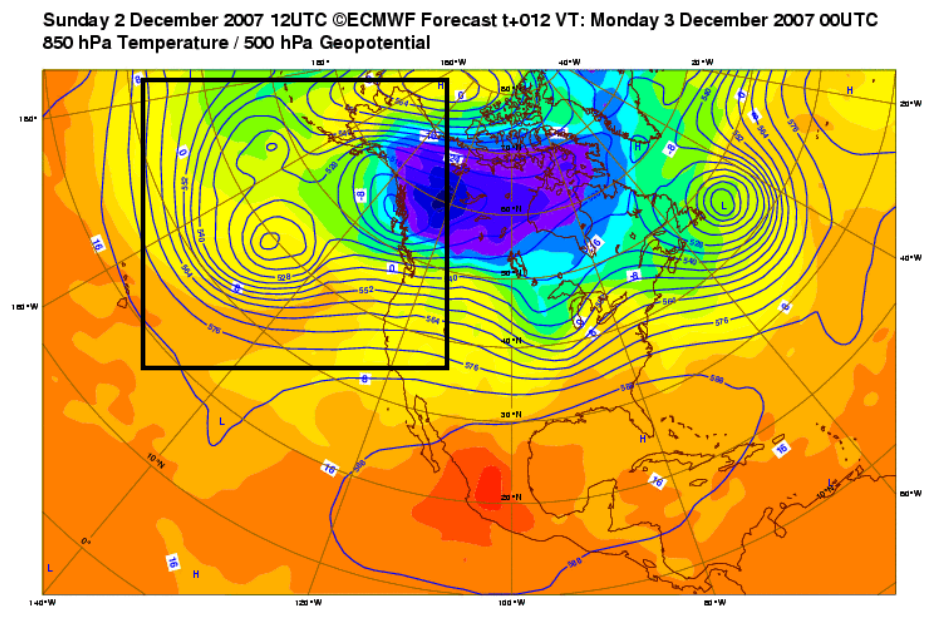
Other rows: T399 EPS-fcsts (50)



Courtesy of Roberto Buizza, ECMWF

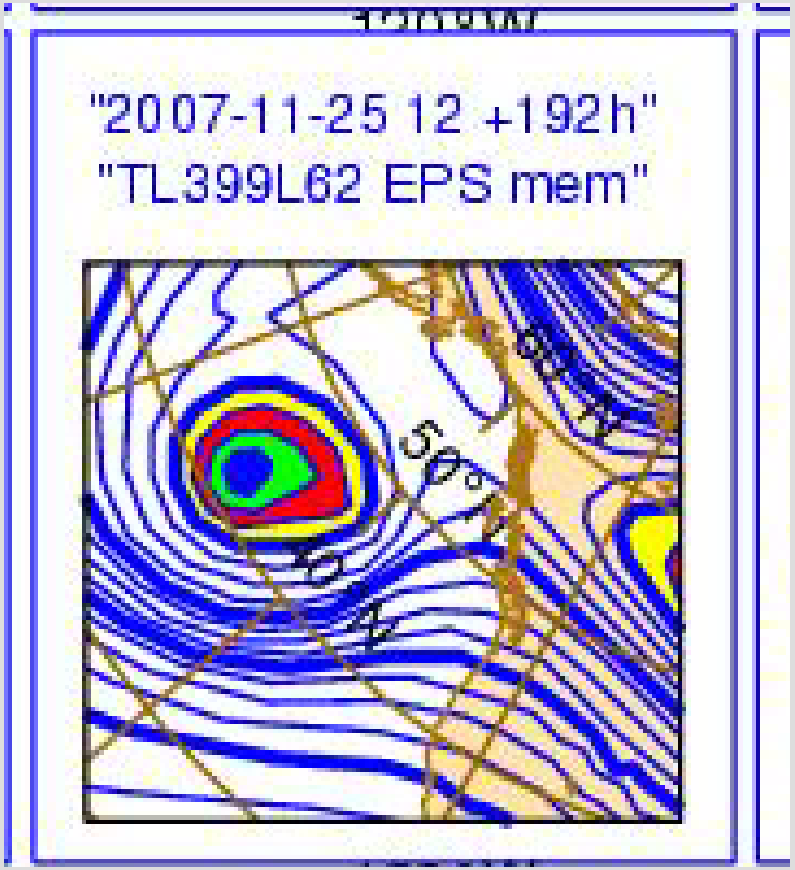
One ECMWF ensemble member made a fairly good 192h forecast !

T799 T850 and Z500 12h forecast for 00UTC 3 Dec 2007



Courtesy of Roberto Buizza ECMWF

EPS +192h Z500 forecast for 12UTC 3 Dec 2007



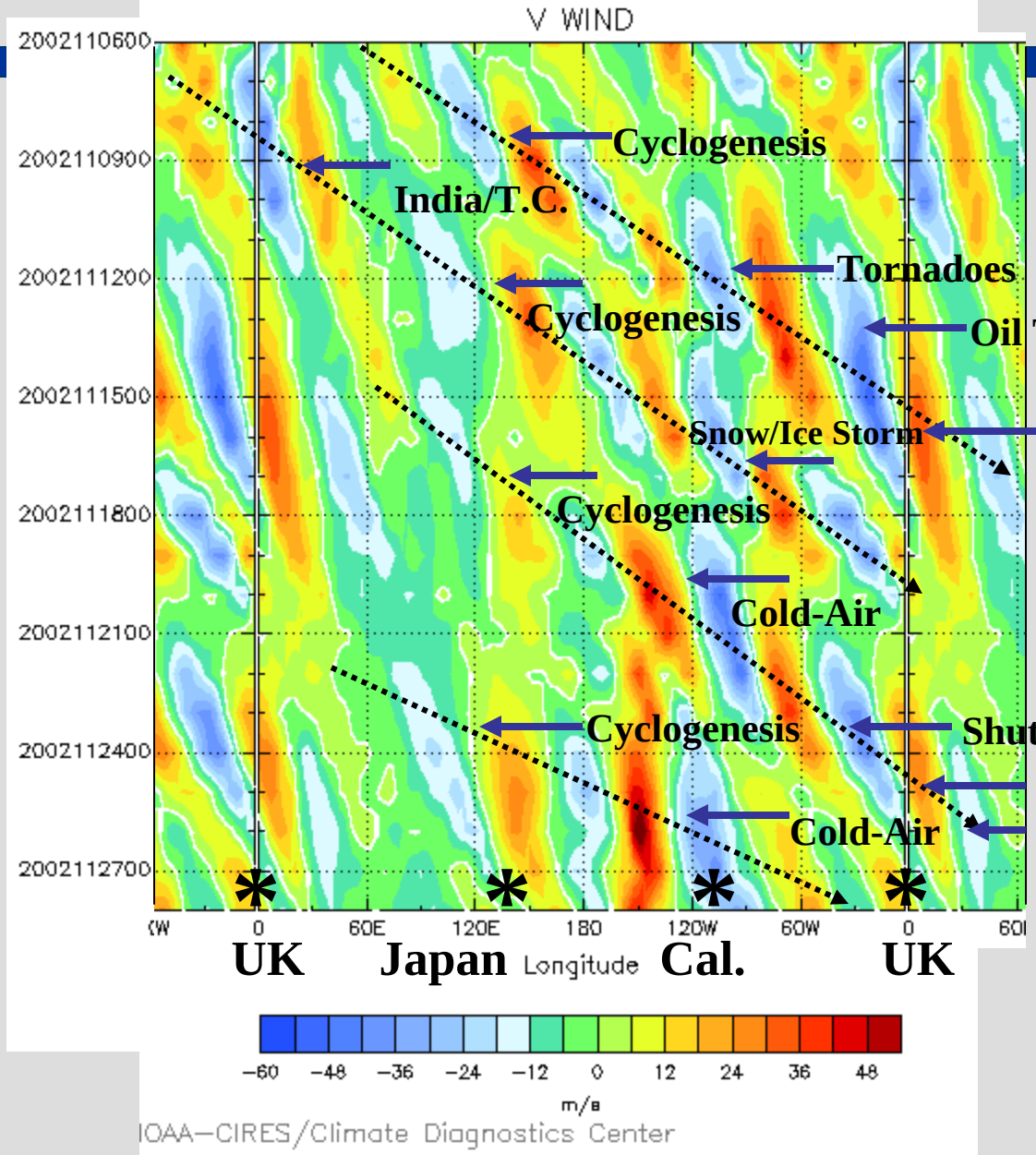
T-PARC HYPOTHESES

- Rossby-wave propagation plays a major role in the development of high impact weather events over North America and the Arctic on the medium-range forecast time scale (esp. leading edge of Rossby wave trains) →

- New DA, modeling and ensemble methods can better capture and predict the initiation and propagation of Rossby-waves leading to high impact events

- Forecast products, including those developed as part of the TPARC research, will have significant social and/or economic value

Time/Longitude Diagram: 250-mb Meridional Wind (m s^{-1})
Latitude Belt (35-60 N) 6-28 November 2002



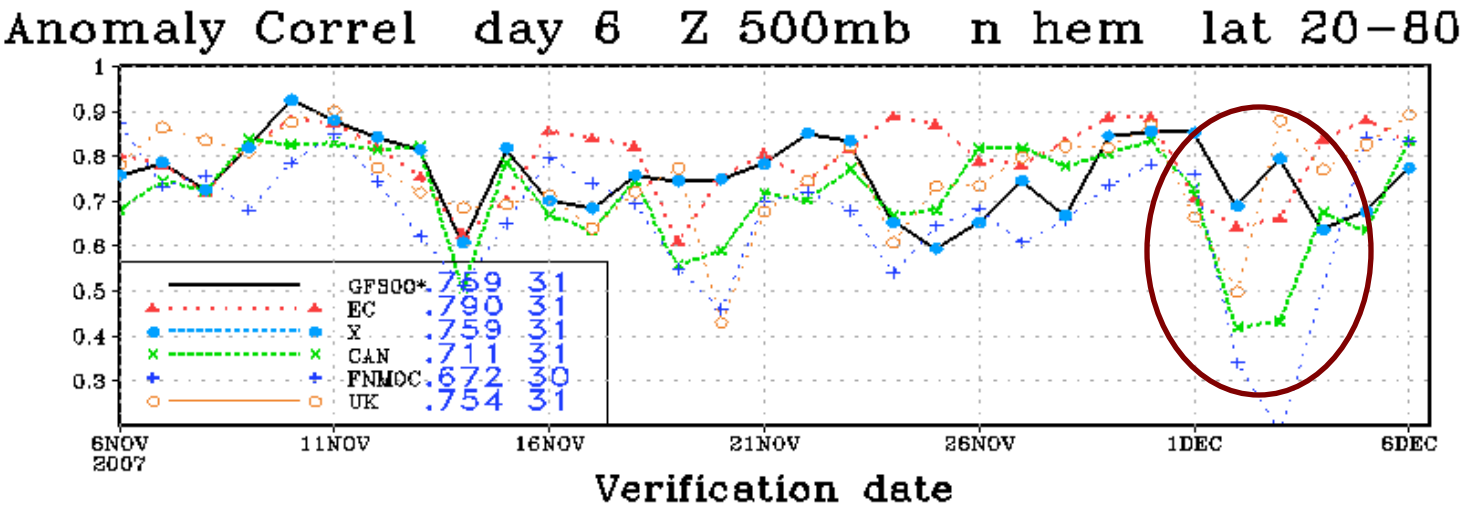
Courtesy of Mel Shapiro

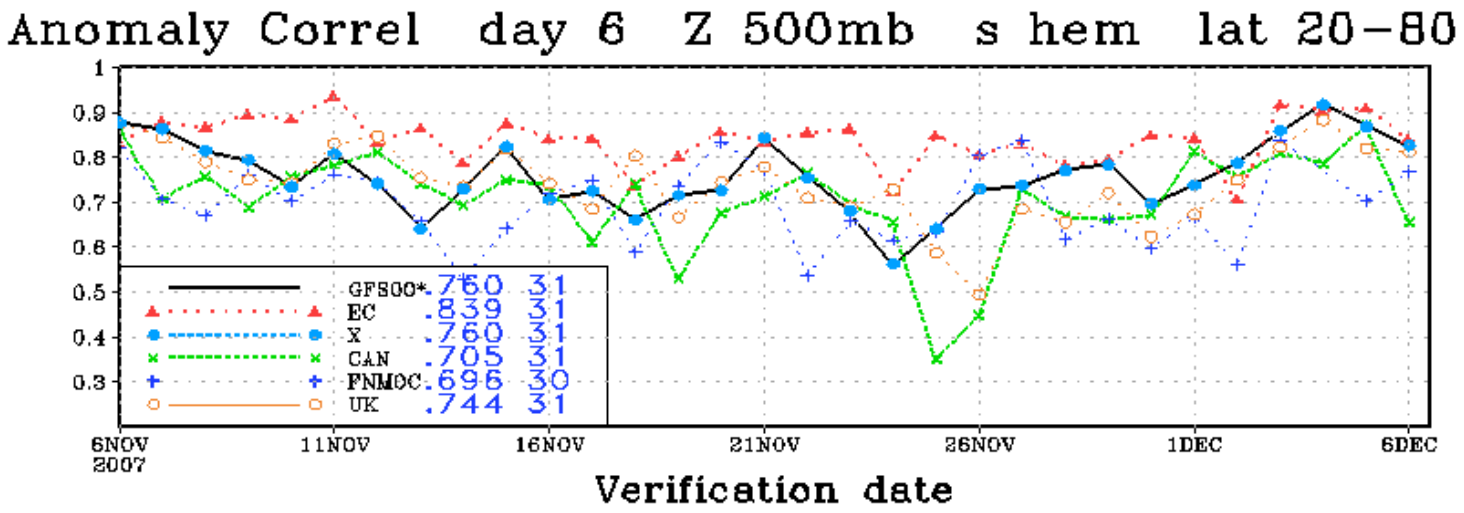
T-PARC HYPOTHESES

- Additional remotely-sensed and in-situ data can complement the standard observational network in capturing critical multi-scale processes in Rossby-wave initiation (tropical convection?) and propagation

- Adaptive configuration of the observing network and data selection can significantly improve the quality of data assimilation and forecast products
  - Regime dependent planning/targeting
  - Case dependent targeting

Skill of 5-day Forecasts: Z500, 6Nov-6Dec 2007

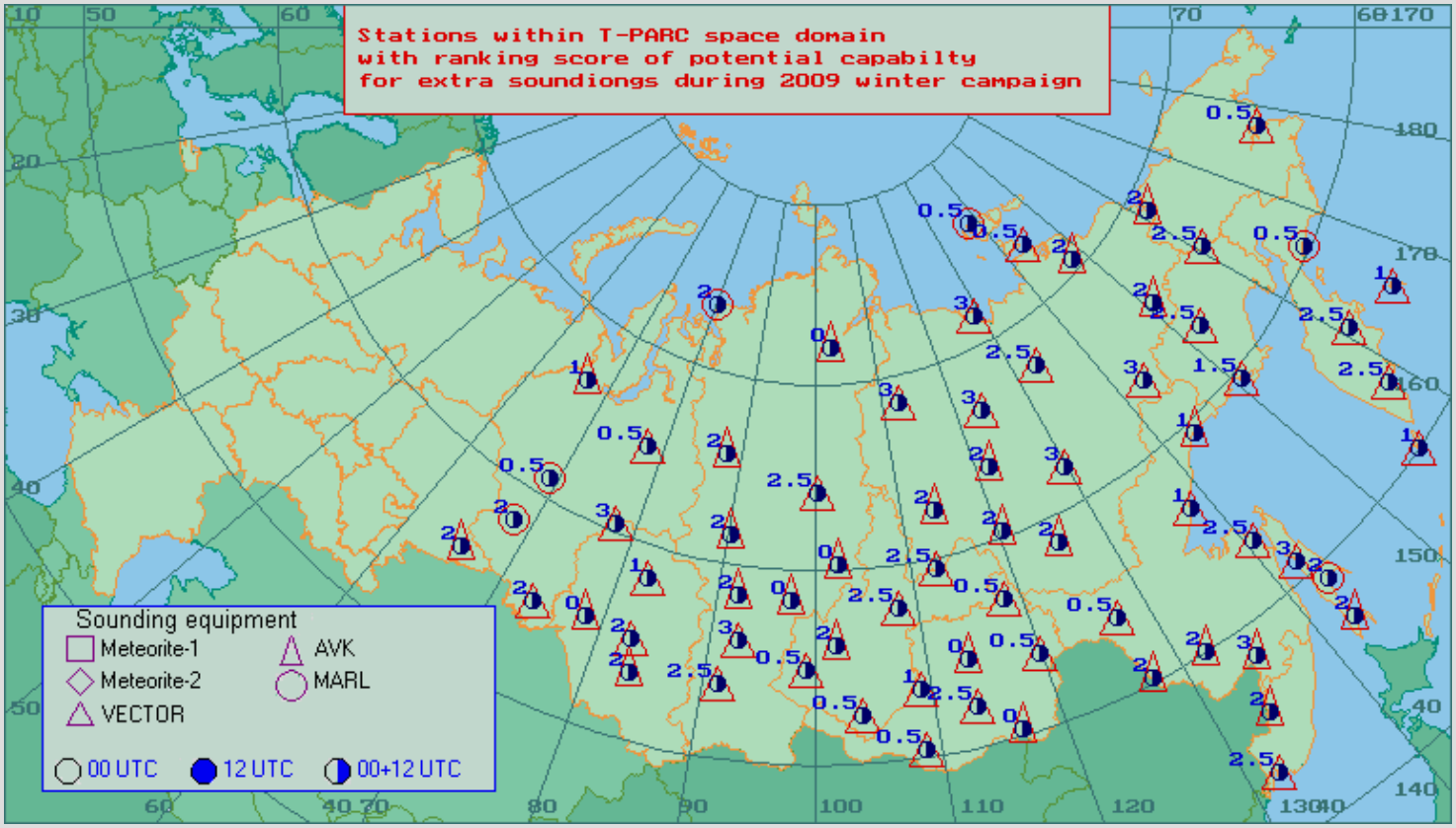




PROPOSED T-PARC OBSERVING PLATFORMS

- **NOAA and NASA satellites**
- **G-IV out of Japan, ~120 hrs in Jan-Feb period**
  - G-IV 45,000 ft flight level, centering around 00z
- **C-130 – covering the mid Pacific over the same time period (USAF)**
  - C-130 30,000 ft flight level, centering around 00z
- **P3 (or other asset)**
  - East Pacific or western US (planned contribution by HMT/NOAA)
- **Enhanced Siberian network**
  - Potential Roshydromet / NOAA and/or NRL contribution
- **Tibetan Plateau**
  - Asian THORPEX community contribution
- **Other possible platforms** (see T-PARC plan)
  - Global Hawk from Dryden (NOAA UAV program)
  - Rapid scan satellite data (JMA)
  - Airborne Doppler wind lidar (P-3)

Locations where additional (off-time) radiosonde observations may be obtained during winter T-PARC



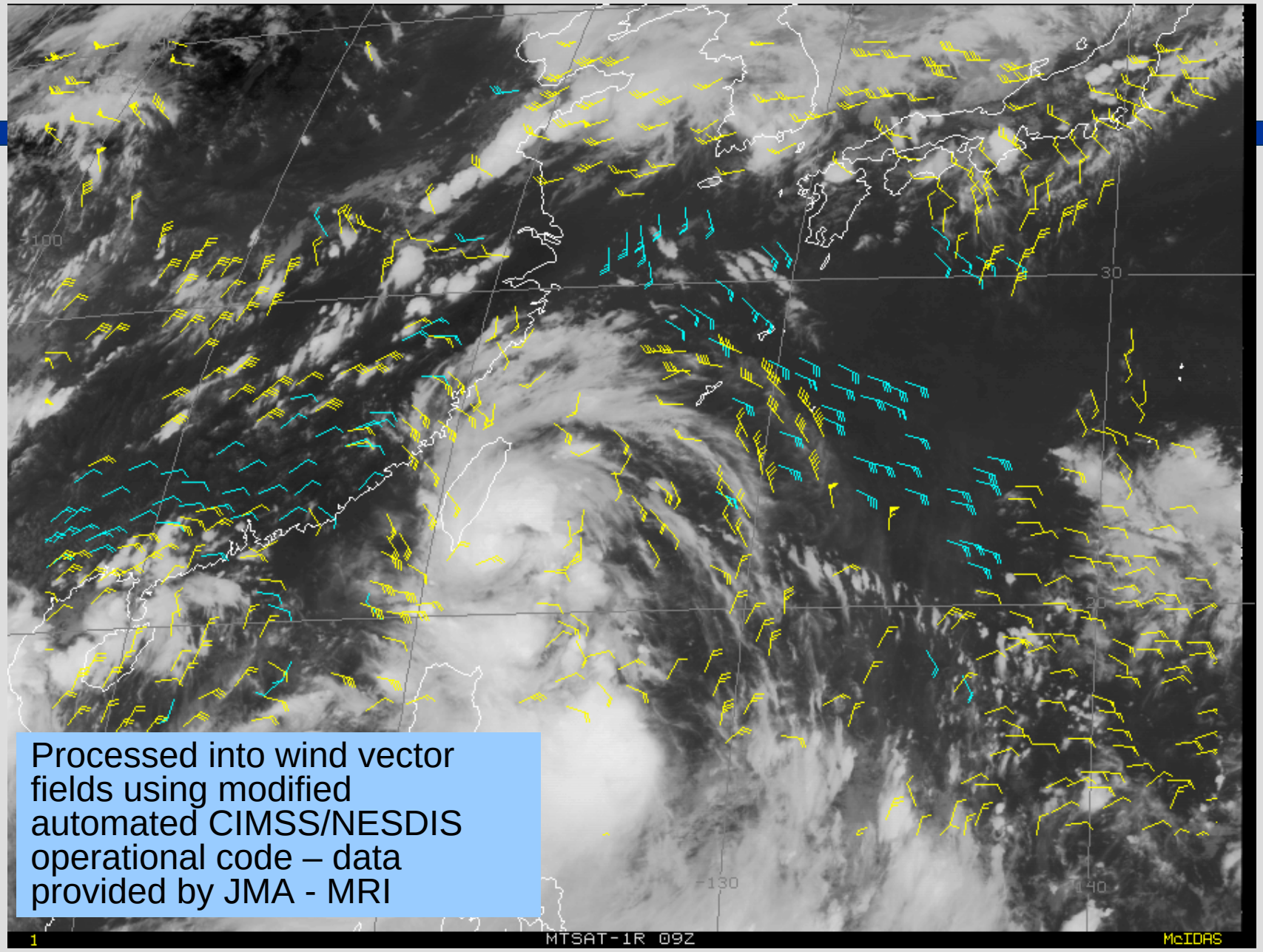
Targeting with Satellite Observations

New satellite instruments can provide continuous data stream, but targeting is essential for:

- selective dynamically-based utilization of the huge data flows from satellites and
- determining locations for higher scan rates, and channel selection procedures

There are regions where the new satellite instruments will have poor resolution such as in cloud layers and below cloud-base

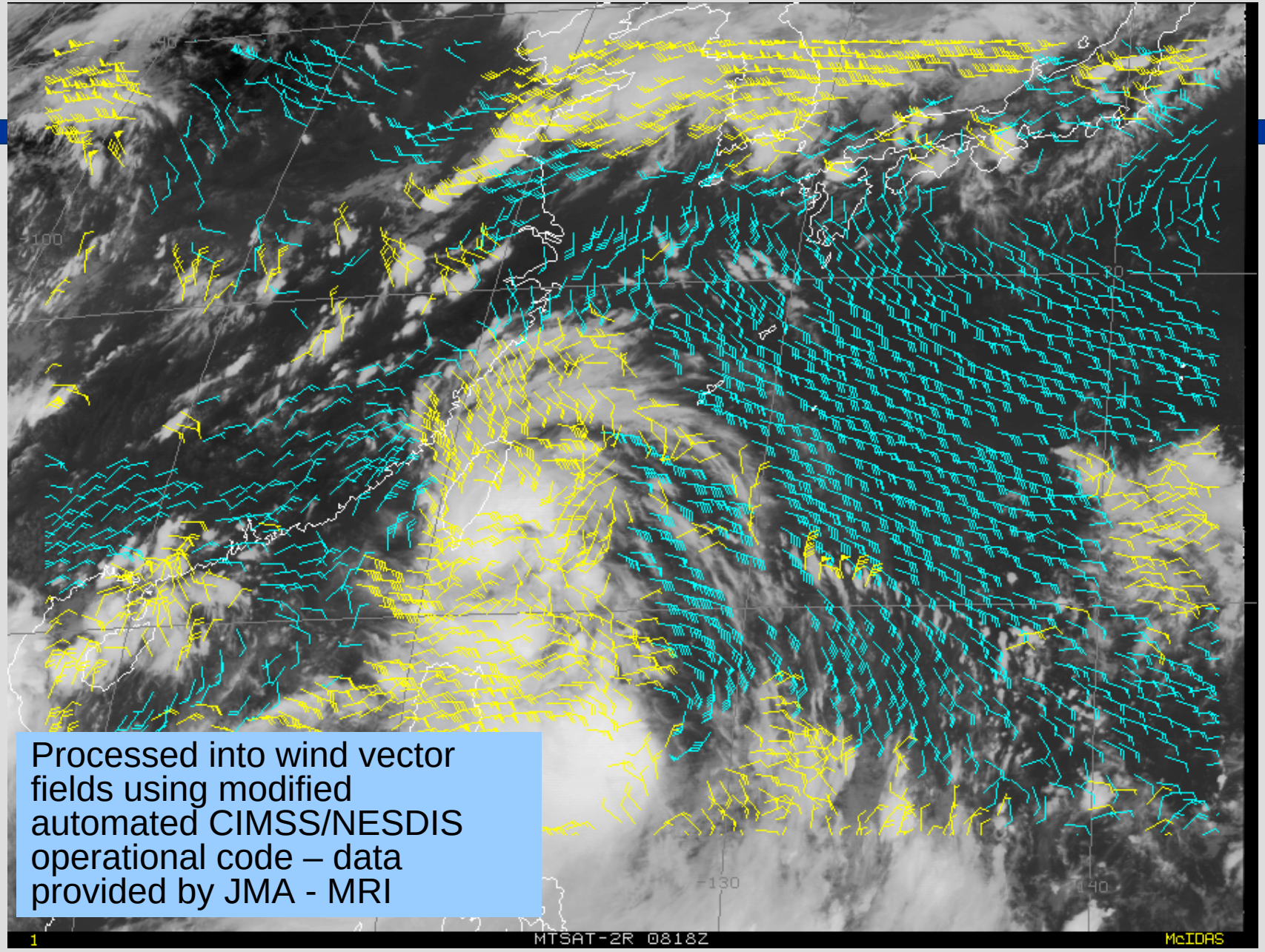
Example case from 08GMT, 7th August 2007, during TCs Wutip and Pabuk



Processed into wind vector fields using modified automated CIMSS/NESDIS operational code – data provided by JMA - MRI

Routine Processing (using 30-min imagery)

Example case from 08GMT, 7th August 2007, during TCs Wutip and Pabuk



Special Processing (using 3-min rapid-scan imagery)

CONCEPT OF T-PARC OPERATIONS

- **Identify potential high impact weather events over NA and Arctic**
  - At 5-7 day lead time, to improve shorter lead time forecasts
  - Use NAEFS ensemble forecast products
  - Weather Service forecaster involvement from US, Canada, Mexico
- **Determine sensitive areas affecting verification events at different times**
  - Use ETKF and adjoint techniques
  - Inter-compare results from NCEP, NRL, NASA/GSFC, ECMWF
  - Consensus decision
- **Observe conditions in sensitive areas**
  - Use various observing platforms as sensitive areas move through their respective domains during the event

CONCEPT OF T-PARC OPERATIONS - continued

- **Assimilate all standard and adaptive observations**
  - Use operational DA and forecast systems
  - New NAEFS forecast products (sea-ice, freezing spray, river flow, etc)
- **Near real-time evaluation (during field phase)**
  - NCEP parallel model runs with and w/o special observations
  - NRL adjoint-based observation impact evaluation
  - Solicit feedback from user community (forecasters,winter Olympics, etc.)
- **Post field-phase evaluation**
  - Use either operational or experimental DA/Modeling/ensemble systems
  - Data denial studies, adjoint-based observation impact
  - Guidance for design of GEOSS

T-PARC Science Challenges

- What critical features need to be observed, analyzed, and simulated (link data assimilation to process studies)
- Model parameterizations – convection
- Ensemble forecasting – multi-model ensembles, TIGGE
- Comparison of data assimilation methods – 4D-Var and ensemble

Tropical - Extratropical Interactions

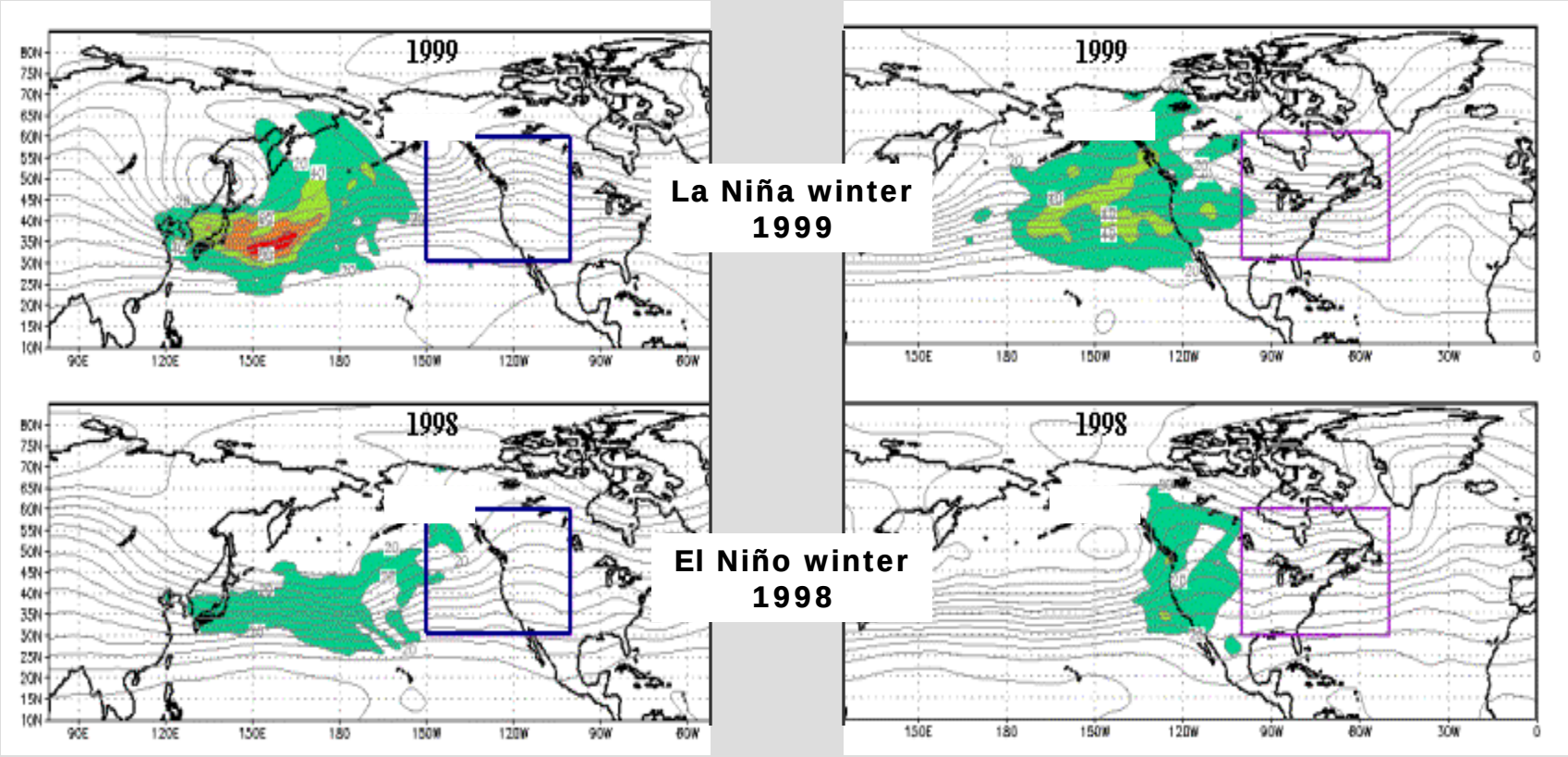
Energy from tropical convection can propagate into the extratropics to influence predictive skill

- El Nino and La Nina regimes have significantly different extratropical sensitive regions
- Rossby wave initiation and propagation
- Effects of Madden-Julian oscillation

Sensitivity of Large 72-hr Forecast Errors to Initial Conditions in Two Winters

Verification Region: Western N. America

Verification Region: Eastern N. America



Shading is the sensitivity calculated using the NOGAPS forecast and adjoint models. Contours are mean 500 mb ht. For January & February

T-PARC Science Challenges

- Adaptive use of satellite data – channel selection, thinning and super-obbing procedures – “continuous targeting” of high-impact events
- Targeting methods for 3-5 day forecasts (beyond linear regime)
- Satellite data bias correction, cloudy radiances, calibration and validation with in-situ observations, covariance, error correlation
- Contribute to design of GEOSS (Global Earth Observation System of Systems)

T-PARC Research Collaborations

Research community interaction with operational forecast centers

Visiting Scientist and post-doc research opportunities at NRL-Monterey

- **Data Assimilation**
- **Global and Mesoscale Modeling**
- **Predictability and Process Studies**
- **Applications of Satellite Data**

T-PARC research funding provided by: NOAA-THORPEX, ONR, NSF, JCSDA

ADDITIONAL T-PARC INFORMATION

An international T-PARC planning meeting was held in Princeville, Hawaii, Dec 4-6, 2007.

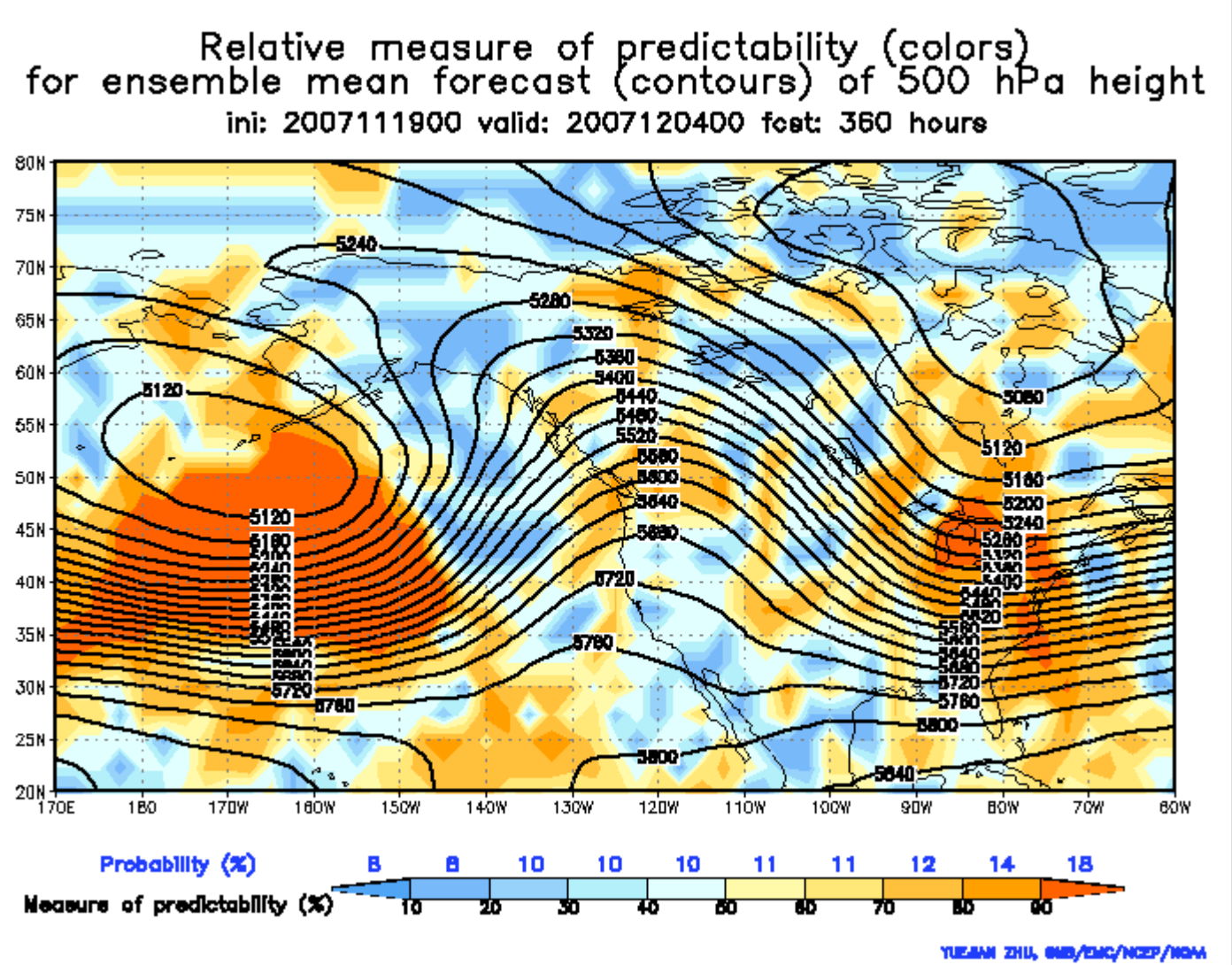
Copies of presentations from the Hawaii meeting are on-line (including both Tropical and Winter T-PARC):

Google search for: "T-PARC Hawaii NCAR"

Also, search for "Winter T-PARC" for Science Plan by Yucheng Song and Zoltan Toth

Go to "North American THORPEX" web site for information about previous and planned meetings

Predictability Index: NCEP Forecasts valid 00UTC 4Dec 2007

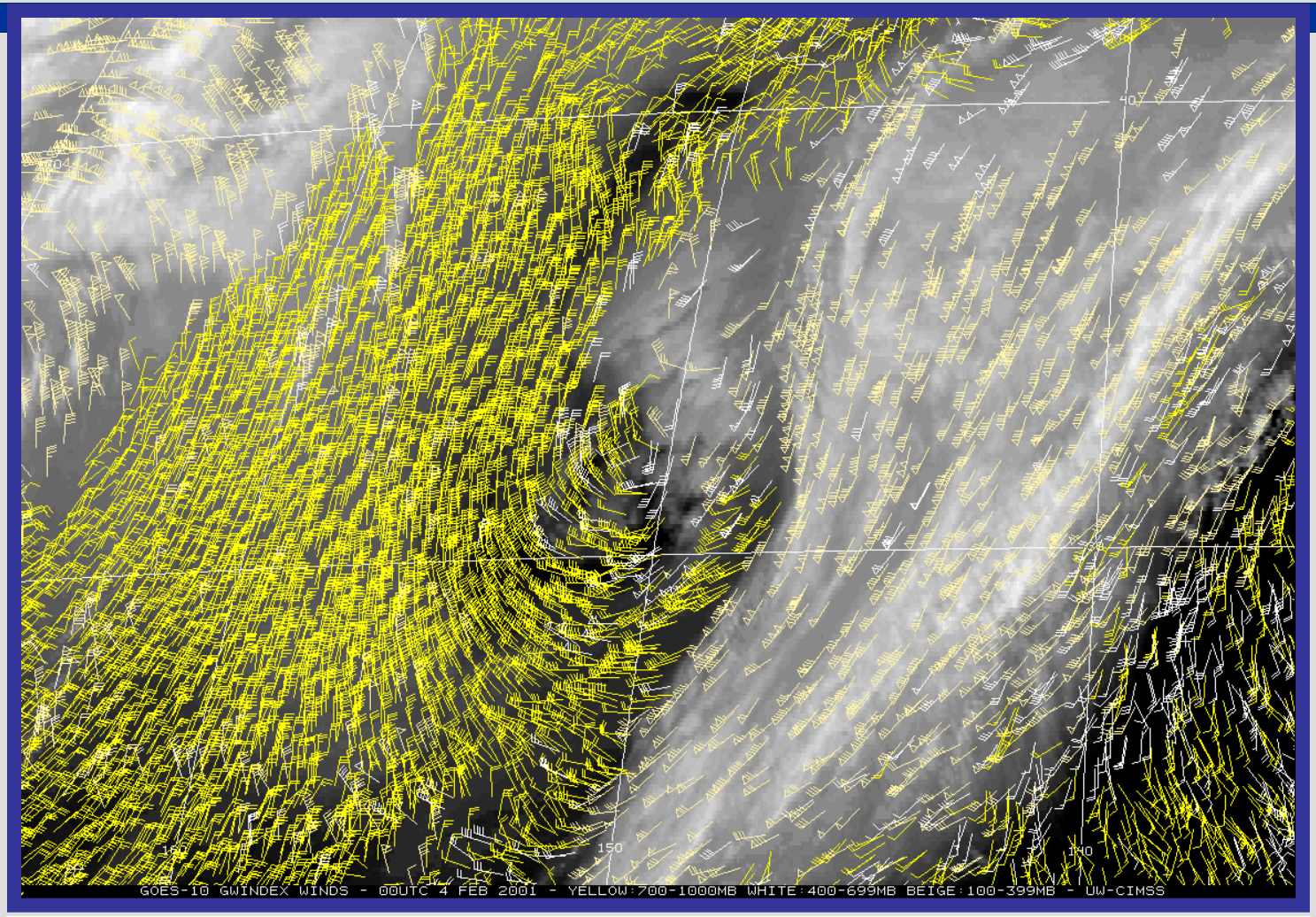


Note: NCEP forecasts generally more skillful than ECMWF in this case

Courtesy of Zoltan Toth NCEP

GOES Satellite Winds

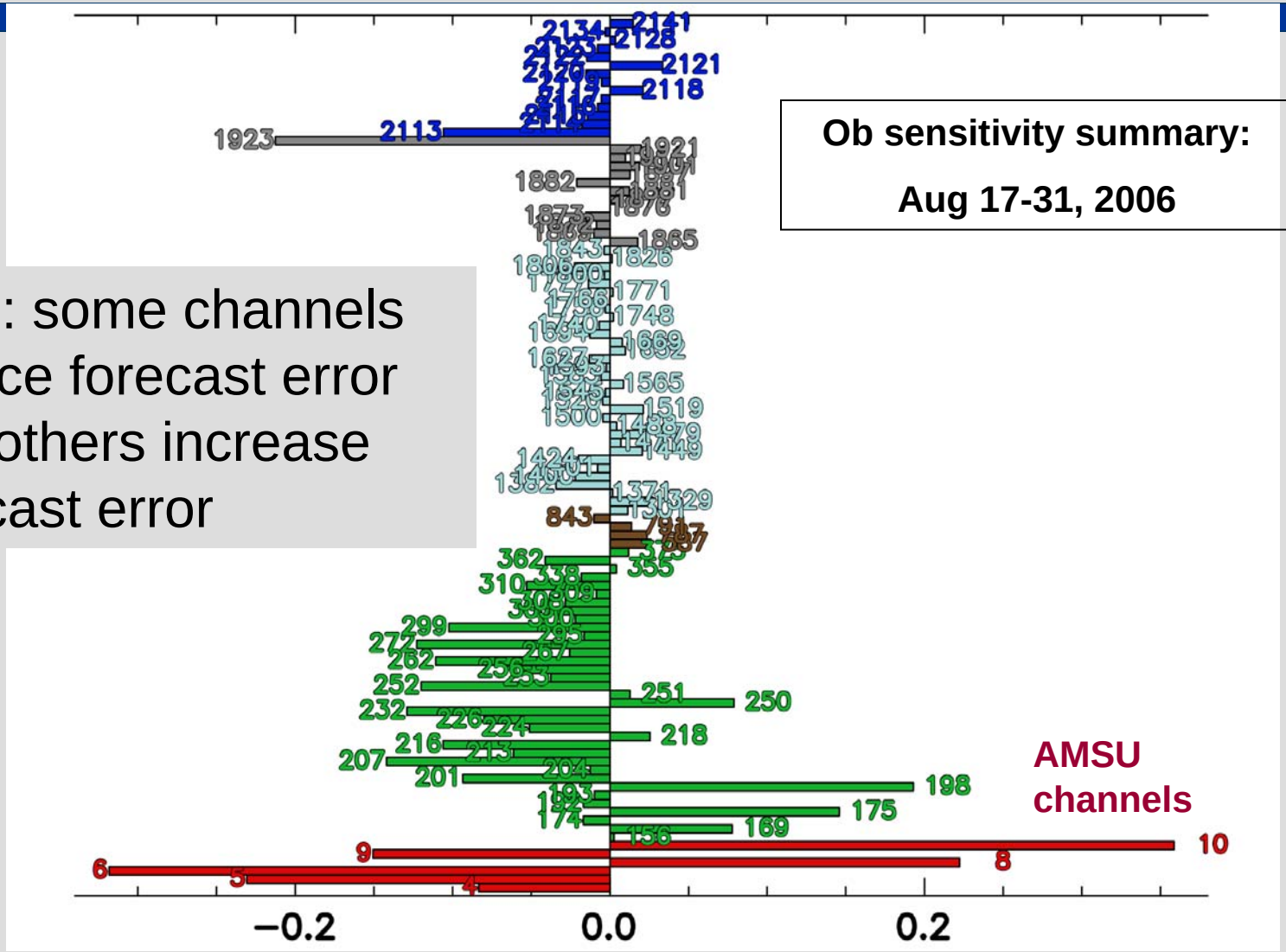
University of Wisconsin/CIMMS



Low-level (bright yellow); Mid-level (white); Upper-level (light yellow)

Observation Impact – AIRS Test

using NAVDAS-NOGAPS adjoint system

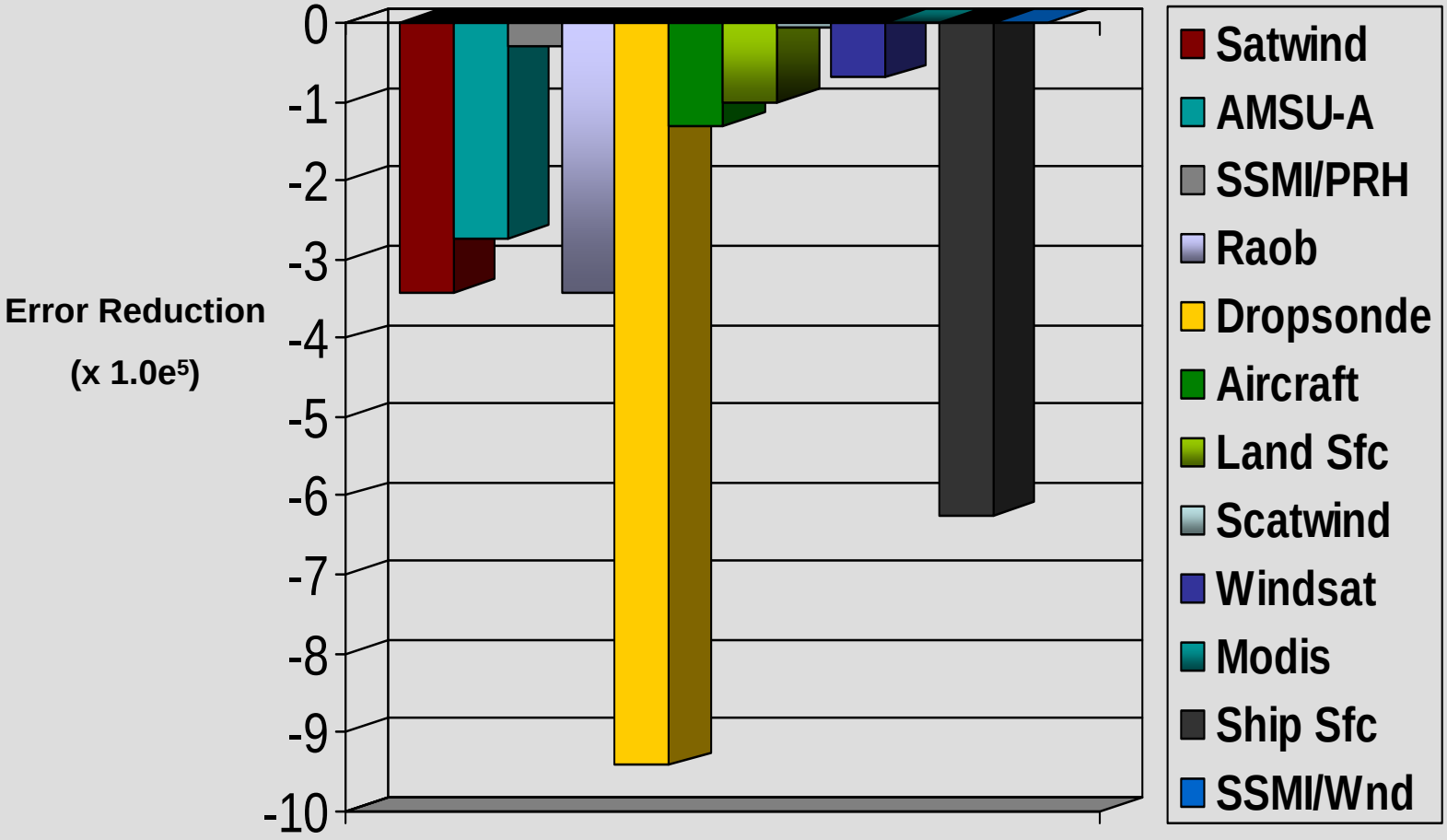


Note: some channels reduce forecast error and others increase forecast error

North Pacific forecast error reduction per-observation

Change in 24h moist total energy error norm (J kg^{-1})

1-31 Jan 2007 (00UTC analyses)



Platforms planned

- **G-IV Stationed in Japan**

(Japan contacts: Yoshio Asuma and Tetsuo Nakazawa)

- Can reach 45,000 feet high, centered on 00Z UTC
- Maximum range:3800 nmi
- Maximum duration: 8 hrs 45 mins
- Contribution from NWS WSR program
- Backbone of the whole program
- Requested 120 flight hours 360 dropsondes

- **ISSUES:**
- **Air traffic control**
- **Yokota or Misawa AFB, Japan?**

(AOC contacts: Jack Parrish and Michele Finn)

Enhanced Siberian network

-Additional 06 and 18 UTC observations from the subset of about 40 designated operational stations about 6 weeks

- Space and time distribution (and may be amount of additional observations on each station) will be uneven depending from the weather conditions.

- They will be carried out during ten – fifteen 24-h intensive observing periods (IOPs) with 6-hrs soundings in some sensitive areas to be determined during the campaign depending from the weather conditions

- Depending on geographical location of sensitive area, during each IOP about 20 of the available 40 stations will be requested (in 18-24 hrs prior to the IOP beginning) to produce two additional 06 and 18 UTC soundings.

Continued

- Expected maximum total amount of additional soundings during the campaign is 15 (IOP) x 20 (sites) x 2 (extra soundings) ~ 600 soundings.

- Taking into account possible uneven distribution of sounding it is necessary to have on each stations consumables for some 25 additional soundings to avoid running out of consumables at any of the stations before the end of the campaign.

- This gives us maximum amount of additional consumables to be distributed for as many as 25 (soundings) x 40 (sites) ~ 1000 soundings. Remaining consumables will be used for the regular soundings after the end of the campaign.

Network for Tibetan Plateau observations