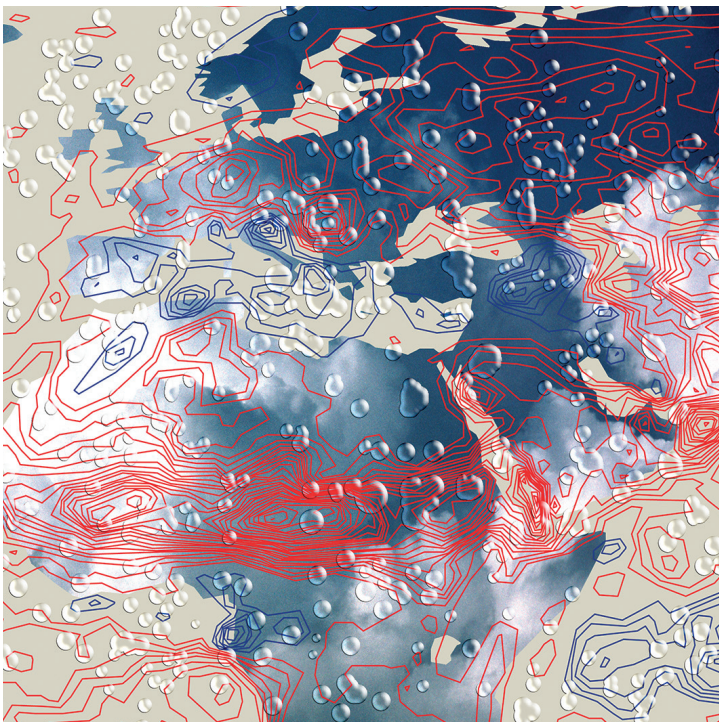


**METEOROLOGY**

Hurricane Jim over New Caledonia:  
a remarkable numerical prediction  
of its genesis and track



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## Hurricane Jim over New Caledonia: a remarkable numerical prediction of its genesis and track

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When communicating with members of the public, journalists and even scientifically educated users, we still encounter the popular belief that tropical cyclones are “capricious and unpredictable beings”. And yet using a set of global deterministic forecasts from various centres and an ensemble of forecasts from a single centre now often give very valuable information, not only in the short range, but also into the medium range. Furthermore, during the last few years, global models have been able to generate increasingly realistic tropical cyclones. Consequently National Meteorological Services are now able to issue useful medium-range public forecasts for the tropics as well as mid-latitudes (*Van der Grijn et al.*, 2004).

In January 2006, the information provided by the numerical models was clear enough to enable Météo-France’s New Caledonian forecasters to mention in their outlook the high risk of tropical cyclogenesis in the Coral Sea (northeast of Australia). And it happened! This is the story of Hurricane Jim – a highly predictable tropical cyclone.

### Medium-range bulletins in the tropics

Medium-range forecasts are no longer restricted to extra-tropical climates. Météo-France’s New Caledonia Office has been producing a 5-8 day outlook twice a week since May 2005. This bulletin describes the expected weather pattern: southeasterly trades, easterly flow, westerlies, or shift of the InterTropical/South Pacific Convergence Zone (Lefort, 2004). It is mostly based on products from the ECMWF Ensemble Prediction System (EPS) – ensemble means, probability thresholds, EPSgrams, spaghetti charts etc. Also the French Polynesia Office of Météo-France issues a 5 day text bulletin which can be found at: [www.meteo.pf/previsions.php?carte=me](http://www.meteo.pf/previsions.php?carte=me)

Another source of tropical medium-range forecasts is the Hydrometeorological Prediction Center at Camp Springs (US National Weather Service, NWS) which issues a daily extended outlook for Hawaii valid until day 8 – see the example in Box A and the information at: [www.hpc.ncep.noaa.gov/discussions/fxpa.html](http://www.hpc.ncep.noaa.gov/discussions/fxpa.html)

In addition NWS’s Samoa Office, Pago-Pago, issues a 6-day narrative synoptic discussion for US Samoa and the independent state of Samoa, as well as a 6-day marine forecast. These can be obtained from: [www.prh.noaa.gov/samoa/](http://www.prh.noaa.gov/samoa/).

Other tropical island states in the South West Pacific Ocean issue 5 to 7 day city or island forecasts.

Public outlooks for tropical cyclone usually cover a three-day period. Nevertheless, in some more technical documents, such as the example from Hawaii, there is an indication of favourable conditions for the potential development of tropical disturbances beyond that period.

When the rainy season comes, there are now times when global models, often supported by ensembles and statistical prediction methods, generate and/or move a tropical cyclone in an area covered by a tropical cyclone watch in the medium-range. Such a case happened in January 2006 in the South West Pacific Ocean: Hurricane Jim was predicted even before it existed.

### Example of a tropical medium-range forecast issued by the NOAA-NWS-Hydrometeorological Prediction Center

A

Hawaii extended forecast discussion NWS Hydrometeorological Prediction Center Camp Springs MD 732 am EDT Tue Jul 04 2006 valid 00Z Wed Jul 05 2006 - 00Z Wed Jul 12 2006 models again cont to show a weak mid level trof E of the islands that extends well NWD to a large closed mid level low off B.C. retrograding to over the islands this week contg to give a break or cull in the east to west ridging S of 30N. This weakness fills by late week. At the SFC fairly brisk trades will prevail well into next week. High pressure strengthens to the N and NE of the islands. Weak tropical disturbances will track well SWD of the islands under unfavorable conditions for development. Models are showing more favorable conds in the EPAC for potential development next week. *Rosenstein*

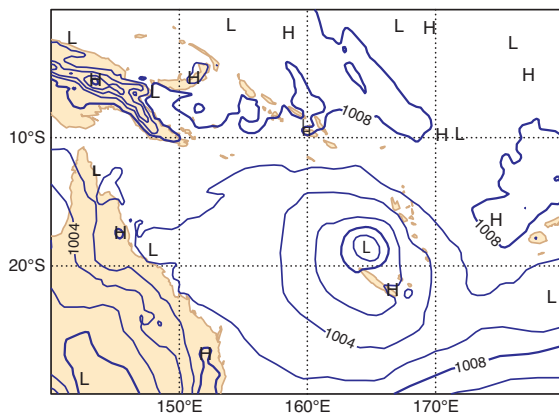
### Tropical Cyclone Jim in New Caledonia

In New Caledonia, a tropical cyclone (TC) watch is established as soon as a TC reaches tropical storm force (47 knots) in our area of national responsibility. Then, a warning at Level 1 is issued for the region which might be affected by the TC within 24 hours. A Level 2 warning means that the effect of a TC will be apparent within 6 hours.

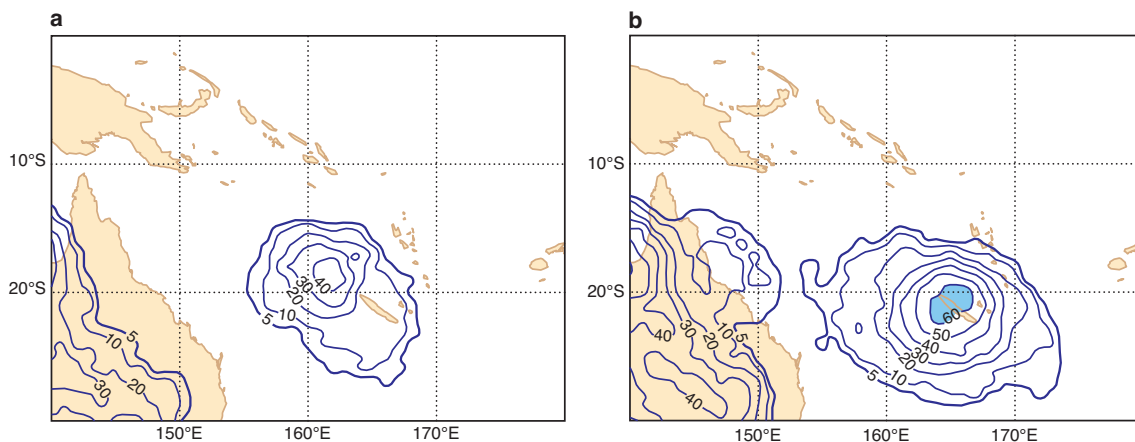
When a TC has entered our national responsibility area, the major challenge for Météo-France's forecasters in New Caledonia is to deliver to the authorities the most accurate forecast track valid for 48/72 hours ahead.

Let us go back to Monday 23 January 2006: it is the rainy season in the South Pacific Ocean. Some rather cool air has just spread over New Caledonia after a heavy rain event in the Coral Sea. The monsoon trough is located around 15°S: to the north there are light to moderate north-westerlies with light to moderate easterly trade winds to the south. A small-scale convective cluster can be seen along the Queensland coast on the trough, but nothing impressive. In New Caledonia, the weather is expected to be very pleasant during the coming week.

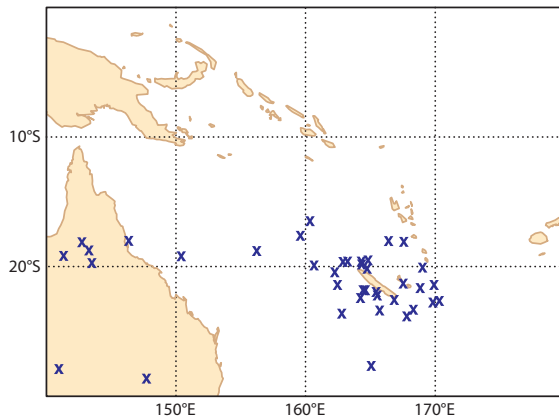
For several runs now, most global models were consistently generating a TC in the Coral Sea, off Cairns. The development was supported by the ECMWF EPS. Even more exciting, the models predicted that once the TC formed it would then move quickly towards New Caledonia as it intensified. Figure 1 shows the T+168 h deterministic forecast from the ECMWF T511 model. There is an indication of a modest TC with a centre of 996 hPa located north of New Caledonia. The probability fields of sea level pressure from later runs (Figures 2) show that the EPS supports this scenario: 35 out of the 50 runs show a sign of TC over or near New Caledonia (Figure 3). It really does seem that New Caledonia is the target of future TC Jim!



**Figure 1** T+168 h forecast of the mslp from the ECMWF T511 model, based on 12 UTC run on 23 January 2006.



**Figure 2** T+156 h forecasts of the probability of mslp less than 1000 hPa from the ECMWF EPS, based on runs from (a) 00 UTC on 24 January and (b) 00 UTC on 25 January 2006.



**Figure 3** T+156 h forecast of locations of mslp minima less than 995 hPa from the ECMWF EPS, based on the run from 00 UTC on 25 January 2006.

These developments were associated with an active phase of a Madden-Julian-Oscillation (MJO) approaching from the west. The MJO has been proved to strongly influence TC genesis in the South Pacific Ocean. Mostly based on the sea surface temperature and MJO, weekly statistical predictions of TC genesis and occurrence are made for a large domain roughly from the coast of Queensland to Fiji (Leroy, 2004). The results show a peak of probability of about 60% compared with a value of about 40% from climatology (Figure 4a), and a chance of the presence of a TC of up to 80% with the climatological value being about 60% (Figure 4b). Also note that this peak – although not as sharp – was present in the week 3 forecast (blue lines in Figures 4a and 4b.)

With such a consistent signal in the NWP products, the duty forecasters could expect a high risk of a TC watch being required for next Sunday or Monday, and a significant risk of a Level 1 or Level 2 warning for the Monday or Tuesday.

On Monday 23<sup>rd</sup>, in the 5–8 day outlook bulletin, the favourable situation for the formation of a TC in the Coral Sea was mentioned. Subsequently a vigorous westerly monsoon surge took place over the Arafura Sea on Tuesday 24<sup>th</sup>. This was captured by the models.

On Wednesday 25<sup>th</sup>, even though there is no operational medium-range warning system in place, the Head of Forecasting Division in New Caledonia informed the authorities by phone that they should be aware of the likelihood of a TC threatening the Territory by the end of the week.

The westerlies reached the Coral Sea on Thursday 26<sup>th</sup>. It is likely that this inflow contributed to bringing low-level vorticity into the old low east off the Queensland coast. The convection developed suddenly, and at 00 UTC on Saturday 28<sup>th</sup> the disturbance was designated as Tropical Cyclone Jim by Brisbane RMSC. This was quite an emotional moment for the forecasters: the TC had formed where predicted by the NWP models five to six days ahead. At that time, the track appeared to be much more likely to be to the east of the main island (Figure 5), and the forecast tracks from different Meteorological Services were in good agreement.

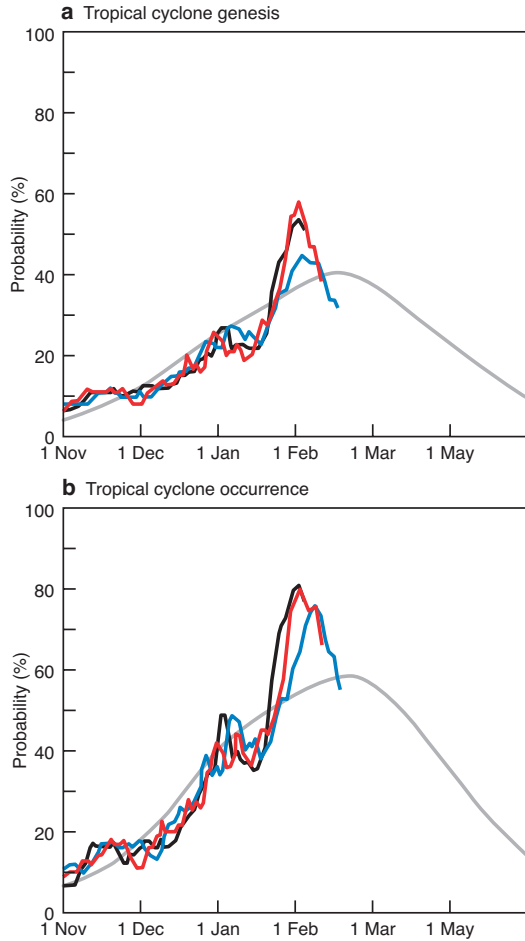
At 06 UTC on Monday 30<sup>th</sup>, Jim was already a hurricane, with wind speeds estimated to have reached 80 kn and with a central pressure of 955 hPa. In the morning the TC watch was established. As a result there were requests for more information from radio and TV stations and newspapers. In the evening, a Level 1 warning was issued for the north of the main island and the Loyalty islands, and it was planned to upgrade the warning to Level 2 on Tuesday 31<sup>st</sup> at 0600 local time. The forecaster who watched Hurricane Jim on the satellite picture still had in mind the model charts he had seen more than 7 days earlier: “models were incredibly right!”. While everybody could enjoy the calm, pleasant, and rather cool weather at a time when there was no hint of TC threat of any kind on the satellite pictures and short-range forecasts, the forecasters had the medium-range NWP products that predicted the formation of a TC which would threaten New Caledonia seven days later.

Eventually, Jim weakened on Tuesday 31<sup>st</sup> and it passed, as predicted, 50 km to the east of the Loyalty islands (Figures 6 and 7). There was only very little damage on most exposed areas of New Caledonia and the islands nearby.

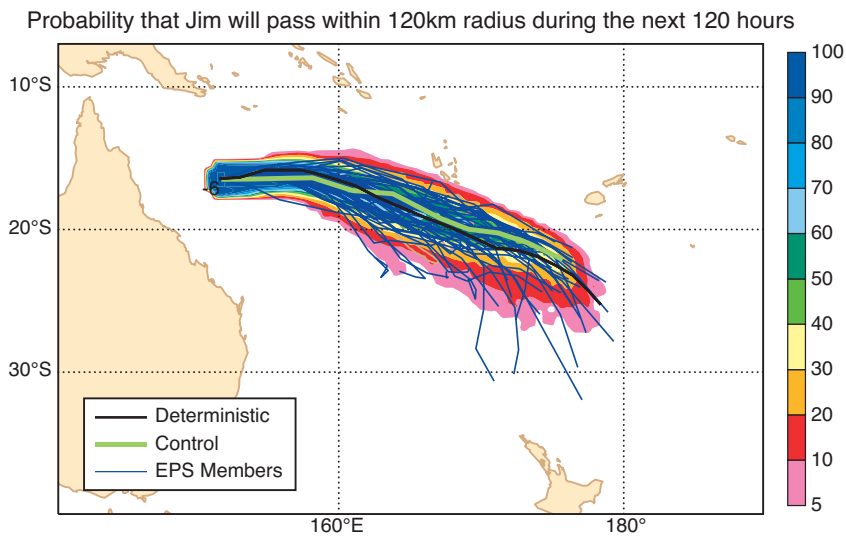
It is not only important to predict the track – predicting the intensity is also important. However, for Hurricane Jim it was difficult to predict the intensity, even at 24 hour lead time. Even intensity analyses from different centres differed significantly. Clearly the consistency in intensity forecasts is rather poor.

It seems that the situation was highly predictable, probably because of the well-analysed vigorous westerly flow that spread over the Coral Sea.

The accurate forecast of the formation and track of Hurricane Jim was an important event in the development of tropical numerical prediction: advanced warning of the formation of a TC was given seven days ahead.



**Figure 4** Predicted probability of (a) TC genesis and (b) TC occurrence in the South West Pacific Ocean based on forecasts made each Monday (black: week 1; red: week 2; blue: week 3). The last point of each line shows the prediction made on 23 January 2006. The smooth curve is the probability according to climatology.



**Figure 5** Probability that Jim will pass within 120 km radius during the next 120 hours plus the individual tracks based on the ECMWF EPS run from 12 UTC on 28 January 2006.

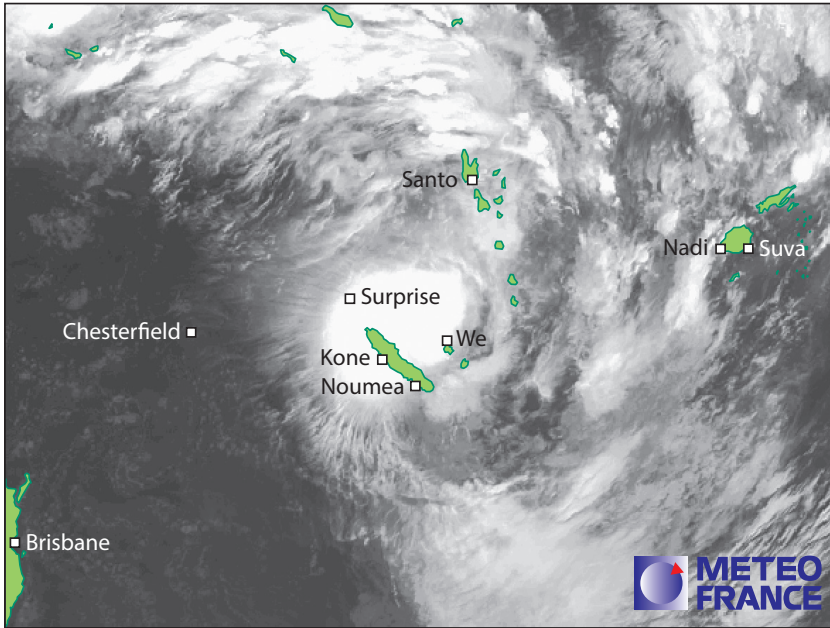


Figure 6 MTSAT IR picture of Jim at 21 UTC on 30 January 2006 (source Météo-France).

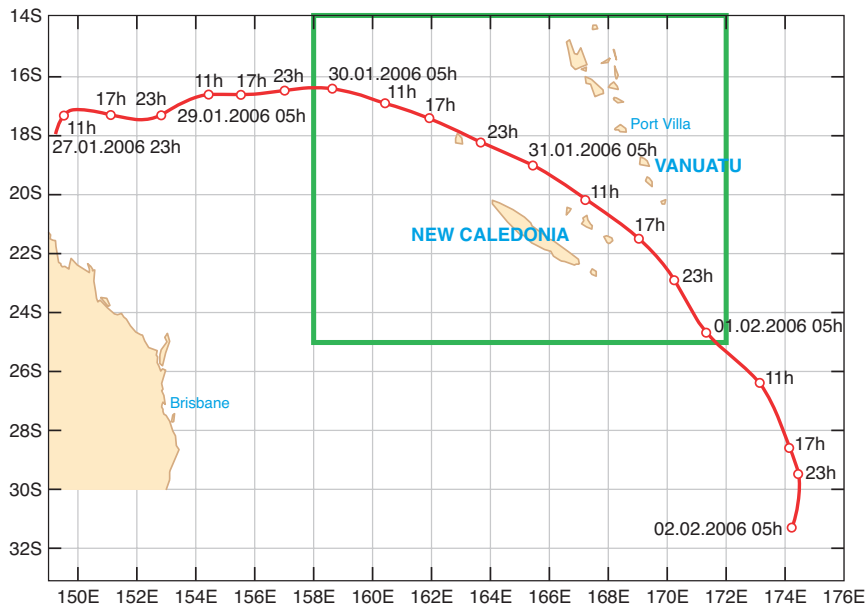


Figure 7 Analysed track of TC Jim with TC watch area indicated by the green square (source Météo-France).

## Discussion and perspectives

What is the risk of the presence of a tropical cyclone within a certain domain, or along a certain route, during the coming week, or the coming two weeks? This is a frequent question asked by sailors who need five to seven days to cross the Coral Sea from Noumea to Cairns. All kinds of vessels need this kind of information. As has been shown with Hurricane Jim, NWP models and the associated ensemble forecasts can sometimes provide valuable information which can answer questions of that kind.

The predicted formation of tropical cyclones is one of the many aspects that will benefit from the multi-ensemble approach that is being developed within the TIGGE component of WMO's THORPEX programme.

Even if the forecast is increasingly precise when shifting from medium to short range, there is still often much uncertainty about track and intensity at 24 hour lead time. However, there might be some decision-making processes or mitigation actions for which advanced warnings five to seven days ahead based on probabilistic information may be of value, especially if a high false alarm rate can be tolerated. It is clear that the provision of advanced warnings going into the medium range should be considered in order to help mitigation actions. But some questions remain:

- Should we validate the formation of tropical cyclones by the models?
- What should the forecasters do with the information about tropical cyclones available from the models?

## Further reading

**Lefort, T.**, 2004: Starting up medium-range forecasting in New Caledonia. *ECMWF Newsletter No. 102*, 1–7.

**Leroy, A.**, 2004: Statistical prediction of the weekly tropical cyclone activity in the southern hemisphere. *Rapport de stage de fin d'études*, **939**, Météo-France, Met College-ENM, Toulouse, France.

**Van der Grijn, G., J.E. Paulsen, F. Lalaurette & M. Leutbecher**, 2004: Early medium-range forecasts of tropical cyclones. *ECMWF Newsletter No. 102*, 7–14.

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